X-7525

1975 AND 1976 MAINTENANCE MANUAL MOTOR HOME

ZEO 6581

AND

TRANS MODES

ZEO 6083
ZEO 6583

GMC

TRUCK & COACH DIVISION
GENERAL MOTORS CORPORATION
PONTIAC, MICHIGAN 48053

Printed in U.S.A.
X-7525, 5M

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SECTION 0
GENERAL INFORMATION, PERIODIC MAINTENANCE, AND LUBRICATION

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VEHICLE IDENTIFICATION

The Vehicle Identification and Weight Rating Plate (figure 1) located behind the right front access door shows the "Vehicle Identification Number", and the "As Manufactured" Gross Vehicle Weight Rating for the vehicle to which it is attached.

In order that the vehicle may be specifically identified as to manufacturer, engine type, year of manufacture, etc., refer to Figure 2.

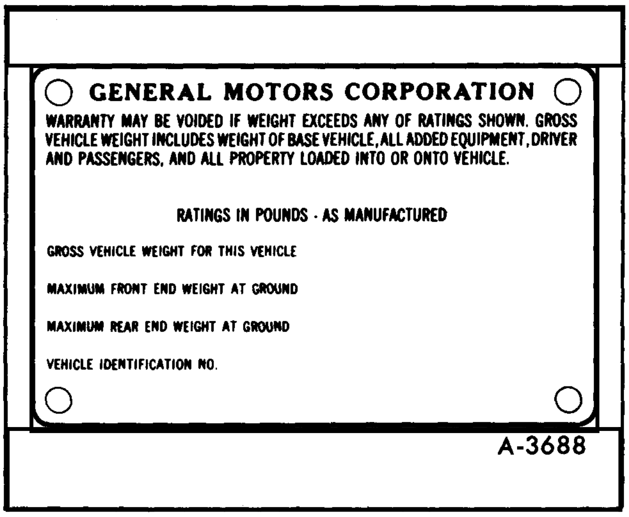

Figure 1—Vehicle Identification Plate

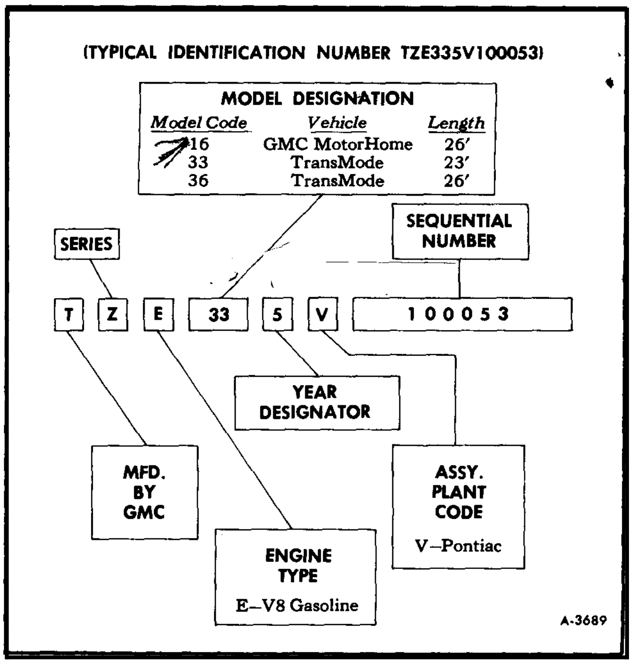

Figure 2—Vehicle Identification Number

COMPONENT IDENTIFICATION

ENGINE

The engines are identified by a code tape installed directly above the engine serial number which is stamped on the engine oil fill tube (figure 3).

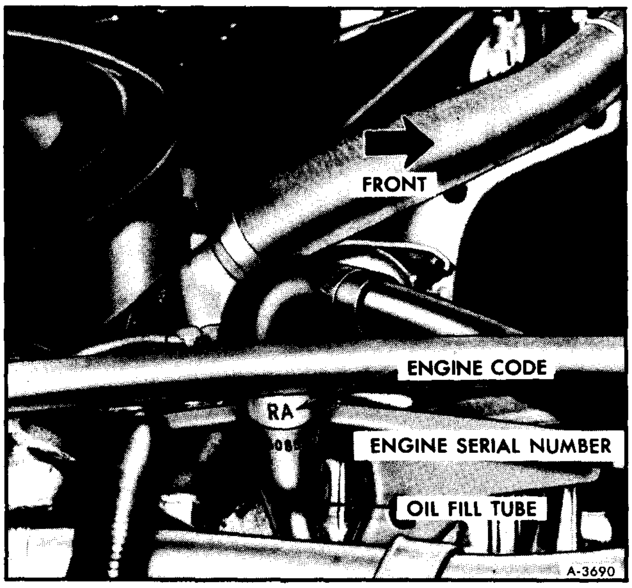

Figure 3—Engine Identification

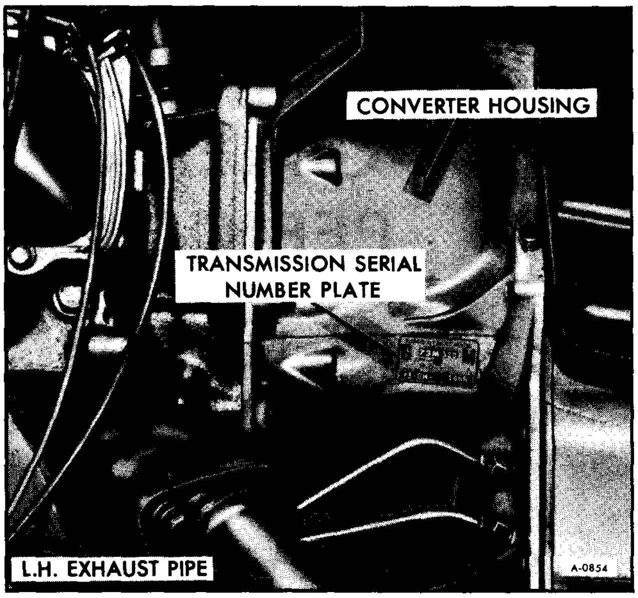

Figure 4—Transmission Serial Number Plate

TRANSMISSION

The transmission model and code numbers are stamped on the converter housing as shown in Figure 4.

FINAL DRIVE

The ratio and date codes are stamped on the flange near the right hand spreader hole as shown in Figure 5.

Date Code: The code letter is for the month and the number(s) are for actual date.

Ratio Code: "T" = 3.07:1 EXAMPLE: T A12 = 3.07:1, built January 12 (J = 9th month, I is not used).

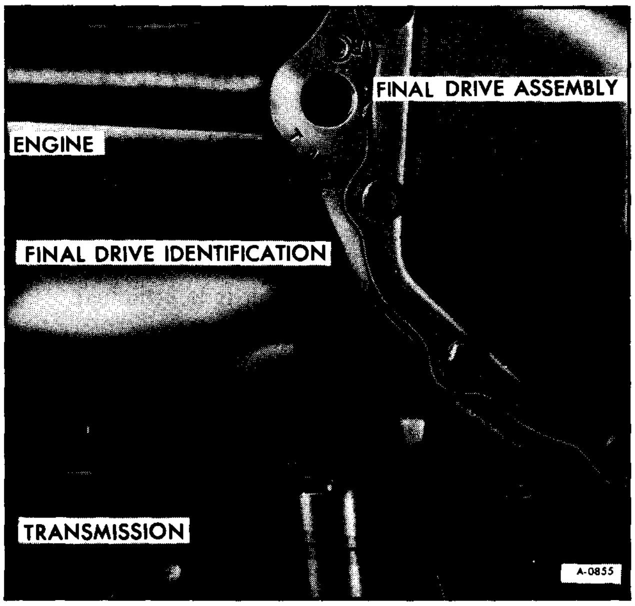

Figure 5—Final Drive Identification

HOISTING INSTRUCTIONS

A twin post hoist of sufficient capacity and with proper adapters and/or fittings must be used.

Front hoisting position is the front engine cross-member.

Rear hoisting must be done at the rear suspension brackets. If an "I" beam type adapter is used it should be approximately 82 inches in length to gain adequate support at suspension brackets. (figure 6)

If vehicle is to be placed on jack stands for maintenance or repairs, the hoisting points should be used.

CAUTION: *To help avoid serious damage to your vehicle, the vehicle should be raised only on twin post hoists of 15,000 pounds or more total rated capacity, at the suspension points noted (see diagram). Before raising, check overhead clearance to see that it is sufficient for the vehicle. Do NOT use the vehicle jack for hoisting or maintenance. It is designed for use only when changing tires.*

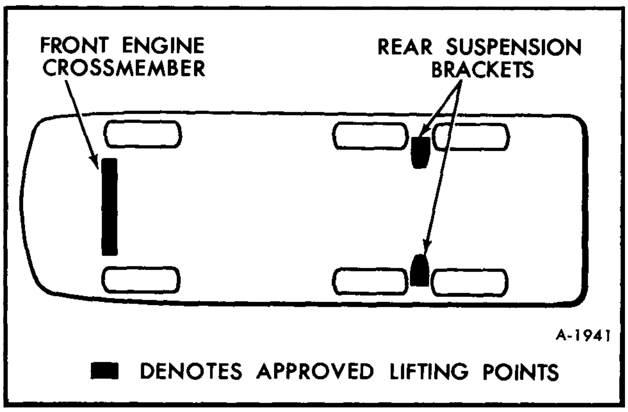

Figure 6—Vehicle Hoisting Points

JACK USAGE INSTRUCTIONS

CAUTIONS

1. Follow jacking instructions in order to reduce the possibility of serious personal injury.

2. The jack is designed for use only when changing wheels.

3. Never get beneath the vehicle when using jack.

4. Do not start or run engine while vehicle is on jack.

INSTRUCTIONS

- Park on level surface and set parking brake firmly.
- Set transmission in "PARK".
- Activate Hazard Warning Flasher.
- Jack, jack chain, handle, "jacking pad" (wooden block), and lug wrench are located under dinette seat.

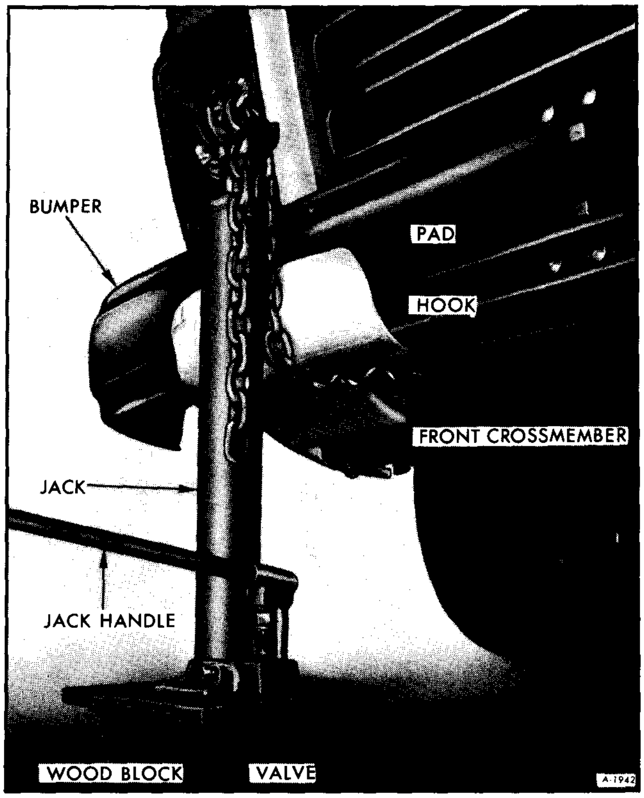

Figure 7—Jacking at Front of Vehicle

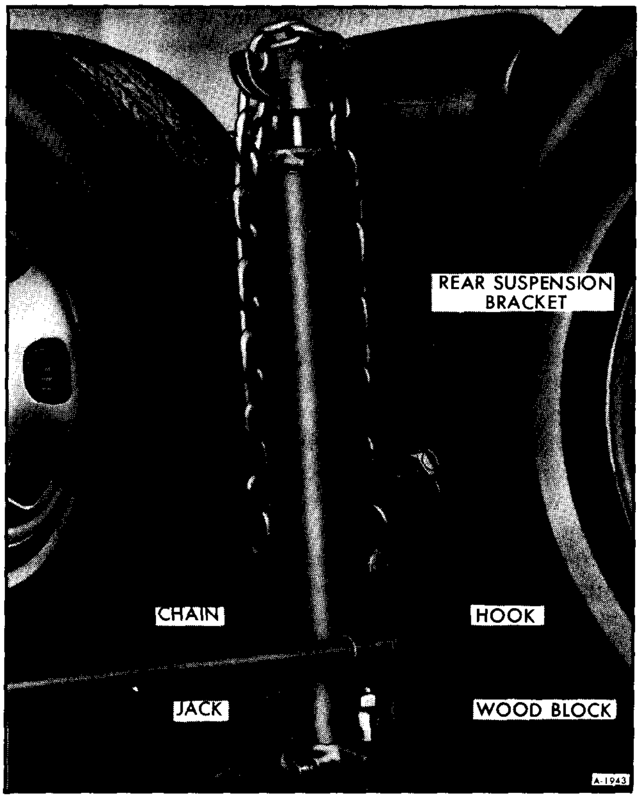

Figure 8—Jacking at Rear of Vehicle

● Block both front and rear of the wheel diagonally opposite the jack position.

● Loosen but do not remove wheel nuts.

● JACKING AT FRONT—Place hydraulic jack on wood block near energy absorbing front bumper bracket. Place hook at flange of front cross-member. Pass chain under bumper and adjust chain length to snug fit on fork on top of jack (See figure 7).

● JACKING AT REAR—Place hydraulic jack on wood block close to rear suspension bracket (See figure 8). The hook is placed in the drainage slot under bracket. Adjust chain length so link will fit in fork at top of jack.

● Close valve at base of jack and insert jack handle.

● Always operate jack with slow, smooth motion.

● Raise vehicle so tire just clears surface, replace wheel and slightly tighten wheel nuts.

● Open valve at base of jack to lower, then fully tighten wheel nuts. Proper torque is 250 foot pounds.

CAUTION: *Use lug wrench provided to tighten wheel nuts securely if torque wrench is not available. (Follow the nut tightening sequence shown in WHEELS AND TIRES, Section 10 of this manual. At the earliest opportunity have wheel nut torque checked. This is necessary to help prevent loosening or stripping of the wheel nuts.*

TOWING VEHICLE

TOWING

Proper lifting and towing equipment is necessary to prevent damage to the vehicle during any towing operation. State (Provincial in Canada) and local laws applicable to vehicles to tow must be followed. No towing operation should be attempted which would jeopardize the safety of the wrecker operator, any bystanders or other motorists. Passengers should never ride in a towed vehicle for any reason.

NOTE: Since the vehicle could exceed the lift and GVW capacity of most sling type equipment, heavier equipment such as chains and spreader bar should be used. Also, a wrecker with at least 8,000 lbs. capacity should be used.

Vehicle may be towed on all six wheels, at speeds less than 35 MPH, for distances up to 50 miles, provided the final drive, axle, transmission, and steering system are otherwise normally operable. Use only towing equipment specifically designed for this purpose following the instructions of the towing equipment manufacturer. A separate safety chain system must be used. For such towing the steering must be unlocked, transmission in neutral and the parking brake released. Attachments must be to engine front crossmember. Do not attach to bumpers or associated brackets. Remember that power brakes and power steering assists will not be available when engine is inoperative.

TOWING AT FRONT

When towing the vehicle the air bellows in the rear suspension should be inflated to maximum capacity and then place the power level controls in "HOLD" (vehicles with power level option). On vehicles without the power level option, disconnect the height control valve link (figure 9) on each side of the vehicle. Raise the arm on each height control valve to inflate the air bellows to provide maximum ground clearance for the vehicle. The leveling valve can then be released to the neutral position. Tow chains should be attached to engine front crossmember (See figure 10). Note that a six inch length of 2" x 4" wood block must be placed on top of the engine

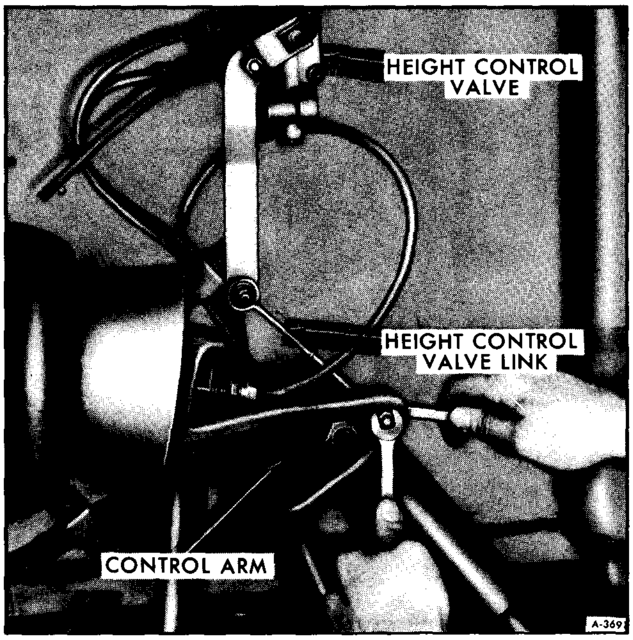

Figure 9—Disconnecting Height Control Valve Link

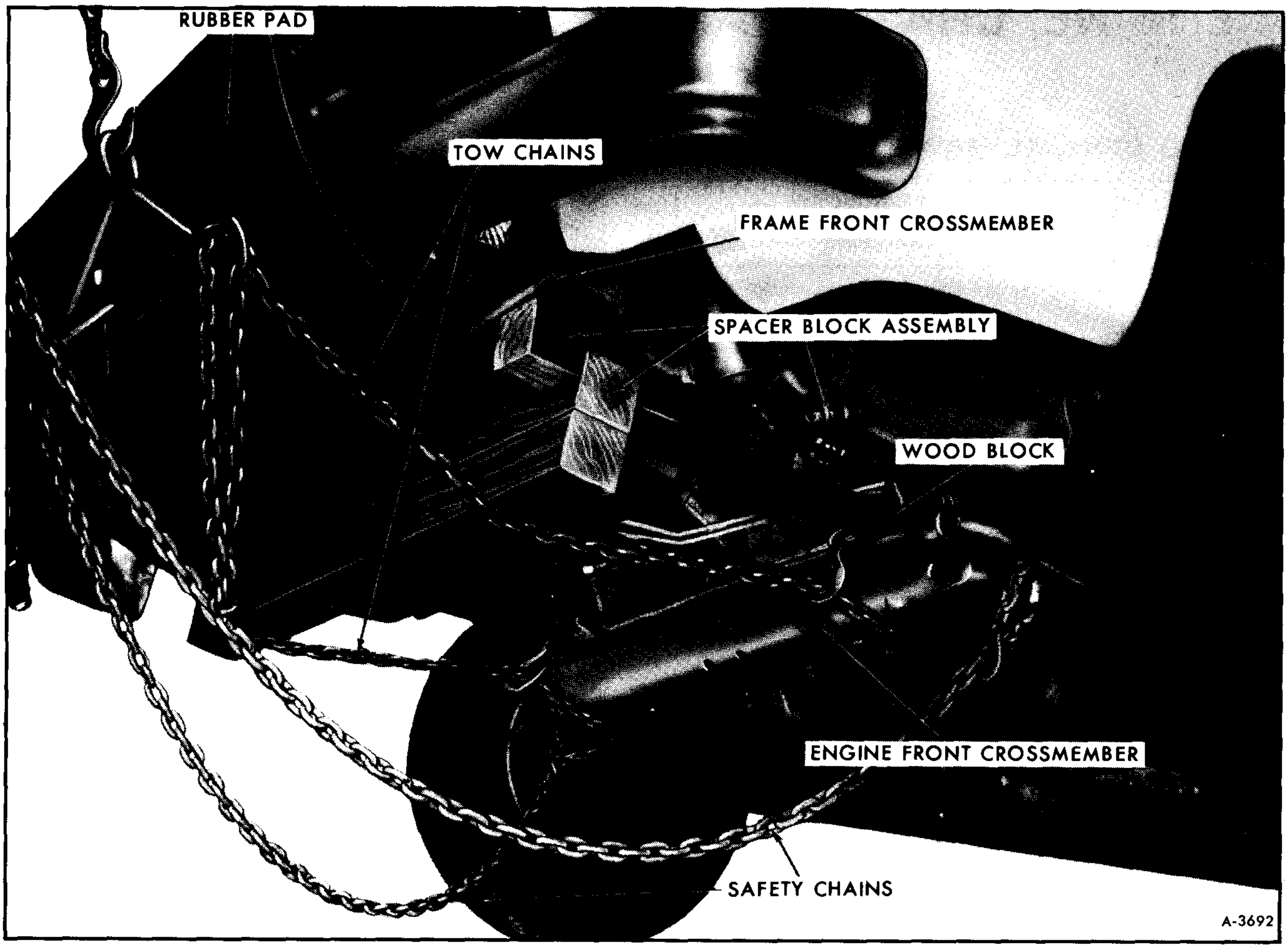

Figure 10—Towing Vehicle

front crossmember on the left side. The chain should then be attached around both the wood block and the engine front crossmember. Care should be taken so that the chain does not contact the fuel line on the engine front crossmember.

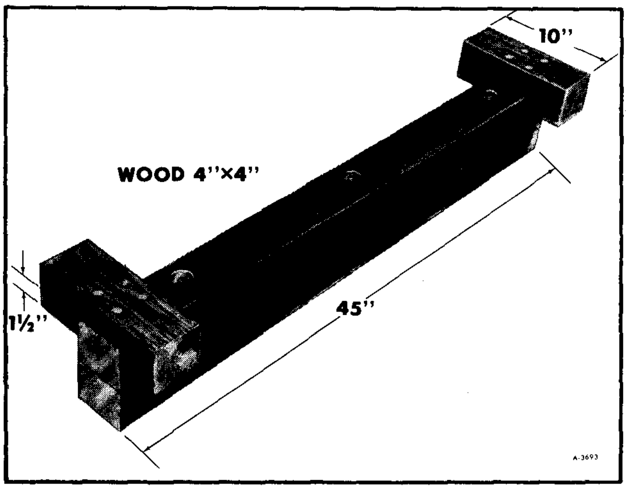

Figure 11—Spacer Block Assembly

CAUTION: *If the six inch length wood block is not installed, the towing chain could sever the fuel line on the engine front crossmember.*

A wood spacer block assembly should be placed under the front crossmember (See figure 10) to relieve some of the load from the energy absorbers and bumper. This spacer block assembly should be dimensioned, constructed of hardwood, and bolted together with three thru-bolts as shown in Figure 11.

Raising front of vehicle so front wheels are four inches off the ground will provide about five-inch ground clearance at the rear when towing. Separate safety chains should be attached to lower control arms.

TOWING AT REAR

It is not recommended that vehicle be towed with the rear raised as this could result in suspension or crossmember damage.

ENGINE, CHASSIS, AND BODY MAINTENANCE SCHEDULE

LUBE AND GENERAL MAINTENANCE

WHEN TO PERFORM SERVICES (Months or Miles, Whichever Occurs First)	Item No.	SERVICES (For Details, See Numbered Paragraphs)
Every 3 months or 3,000 miles	1	Chassis Lubrication
	2	Engine Oil – Change
Every 6 months or 6,000 miles	3	Fluid Levels – Check
	4	Air Conditioning System – Check
	5	Air Compressor Air Filter – Clean
Every 6,000 miles (Check wheel nut torque after 1st 500 miles)	6	Tire Rotation
At 1st oil change and then every 2nd	7	Engine Oil Filter – Replace
Every 12 months or 12,000 miles	8	Automatic Transmission and Final Drive Lubricant – Change
	9	Cooling System – See Explanation of Maintenance Schedule
Every 24,000 miles	10	Rear Wheel Bearings – Clean & Repack
	11	Final Drive Boots & Output Shaft Seals – Check

SAFETY MAINTENANCE

Every 6 months or 6,000 miles	12	Owner Safety Checks
	13	Tires and Wheels – Inspection
	14	Exhaust System – Check
	15	Engine Drive Belts – Check
	16	Suspension and Steering – Check
	17	Brake and Power Steering – Check
Every 12 months or 12,000 miles	18	Drum Brakes and Parking Brake – Check
	19	Throttle Linkage – Check
	20	Underbody – Flush and Check
	21	Bumper – Check

EMISSION CONTROL MAINTENANCE (1974 CERTIFIED ENGINE)*

At 1st 6 months or 6,000 miles – then at 12 months/12,000 mile intervals	22	Thermostatically Controlled Air Cleaner
	23	Carburetor Choke
	24	Timing, Dwell, Carb. Idle, Distributor & Coil
At 1st 6 months or 6,000 miles	25	Carburetor & Intake Manifold Mounting
Every 6,000 miles	26	Spark Plugs (When using leaded fuels)
Every 12 months or 12,000 miles	27	Thermal Vacuum Switch and Hoses
	28	Carburetor Fuel Filter
	29	PCV System
	30	Air Cleaner Element
	31	Spark Plugs and Ignition Coil Wires
Every 24 months or 24,000 miles	32	Engine Compression
	33	ECS System
	34	Fuel Cap. Tanks and Lines

EMISSION CONTROL MAINTENANCE (1975 AND 1976 CERTIFIED ENGINE)

At 1st 6 months or 6,000 miles – then at 12 months/12,000 mile intervals	35	Thermostatically Controlled Air Cleaner – Check
	36	Carburetor Choke – Check
	37	Engine Idle Speed and Mixture Adjustment
	38	Carburetor and Intake Manifold Mounting Torque
Every 6,000 miles	39	Spark Plug Replacement
Every 12 months or 12,000 miles	40	Carburetor Fuel Filter Replacement
	41	Thermal Vacuum Switch and Hoses – Check
	42	PCV System – Check
	43	Air Cleaner Element Replacement
	44	Spark Plug Wires – Check
	45	Engine Timing Adjustment and Distributor – Check
	46	Throttle Return Control – Check
Every 24 months or 24,000 miles	47	ECS System Check and Filter Replacement
	48	Fuel Cap, Tanks and Lines – Check

*To determine year engine was certified, refer to emission control decal on engine valve cover.

EXPLANATION OF MAINTENANCE SCHEDULE

Presented below is a brief explanation of each of the services listed in the preceding Maintenance Schedule.

Vehicle operation under conditions such as heavy dust, continuous short trips, use of other than unleaded or low lead fuels or pulling trailers, is not considered normal use and therefore more frequent maintenance will be required. Such additional maintenance requirements are included where applicable.

LUBE AND GENERAL MAINTENANCE

ITEM

NO. SERVICES

1 CHASSIS—Lubricate all grease fittings in front and rear suspension and steering linkage. Also lubricate transmission shift linkage, brake pedal spring, parking brake cable guides and linkage.

2 ENGINE OIL—Change each 3 months or 3,000 miles, whichever occurs first.

3 FLUID LEVELS—Check level of fluid in brake master cylinder, power steering pump, all batteries, engine, final drive, transmission, and windshield washer. The engine coolant should be checked for proper level and freeze protection to at least -20°F. (-29°C.) (-37°C. in Canada), or to the lowest temperature expected during the period of vehicle operation. Proper engine coolant also provides corrosion protection.

Any significant fluid loss in any of these systems or units could mean that a malfunction is developing and corrective action should be taken immediately. A low fluid level in the brake master cylinder front reservoir could also be an indicator that the disc brake pads need replacing.

4 AIR CONDITIONING—Check condition of air conditioning system hoses and refrigerant charge at sight glass. Replace hoses and/or refrigerant if need is indicated.

5 AIR COMPRESSOR—Filter should be washed with soap and water solution or replaced.

6 TIRES—To equalize wear, rotate tires as illustrated in Section 10 and adjust tire pressures as shown on tire placard on glove box door. Have wheel-nut torque checked after 1st 500 miles and 500 miles after every wheel replacement thereafter.

7 ENGINE OIL FILTER—Replace at the first oil change and every 2nd oil change thereafter.

8 AUTOMATIC TRANSMISSION FLUID AND FINAL DRIVE LUBRICANT—Change the transmission fluid and filter; change final drive lubricant.

9 COOLING SYSTEM—At 12-month or 12,000-mile intervals, wash radiator cap and filler neck with clean water, pressure test system and radiator cap for proper pressure holding capacity. (Tighten hose clamps and inspect condition of all cooling and heater hoses.) Replace hoses every 24 months or 24,000 miles or earlier if checked, swollen or otherwise deteriorated.

Also each 12 months or 12,000 miles, clean exterior of radiator core and air conditioning condenser. Every 24 months or 24,000 miles, drain, flush, and refill the cooling system with a new coolant solution.

10 REAR WHEEL BEARINGS—Clean and repack rear wheel bearings with a lubricant as specified in the "Recommended Fluids and Lubricants" chart.

CAUTION: *"Long fiber" or "viscous" type greases should not be used. Do not mix wheel bearing lubricants. Be sure to thoroughly clean bearings and hubs of all old lubricant before replacing.*

11 FINAL DRIVE AXLE BOOTS AND OUTPUT SHAFT SEALS—Check for damaged, torn or leaking boots on drive axles and for leaking output shaft seal. Replace defective parts as necessary.

SAFETY MAINTENANCE

12 OWNER SAFETY CHECKS—The maintenance schedule folder in the glove box lists several items the owner should check and have repaired if not correct.

13 TIRES AND WHEELS—To equalize wear, rotate tires as illustrated in Section 10. Adjust tire pressures as recommended on tire placard on glove box door. Check disc brake pads and condition of rotors while wheels are removed. Check tires for excessive wear or damage. Make certain wheels are not bent or cracked and wheel nuts are tight. Check tire inflation pressure at least monthly, or more often if daily visual inspection indicates the need.

14 EXHAUST SYSTEM—Check complete exhaust system and nearby body areas of vehicle engine and motor-generator system for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections or other deterioration which could permit exhaust fumes to seep into the passenger compartment. Dust or water in the passenger compartment may be an indication of a problem in one of these areas. Any defects should be corrected immediately. To help ensure continued integrity, exhaust system pipes rearward of the muffler must be replaced whenever a new muffler is installed.

15 ENGINE DRIVE BELTS—Check belts driving fan, Delcotron, power steering pump and air conditioning compressor for cracks, fraying, wear and tension. Adjust or replace as necessary.

It is recommended that belts be replaced every 24 months or 24,000 miles, whichever occurs first.

16 SUSPENSION AND STEERING—Check for damaged, loose or missing parts, or parts showing visible signs of excessive wear or lack of lubrication in front and rear suspension and steering system. Questionable parts noted should be replaced by a qualified mechanic without delay.

17 BRAKES AND POWER STEERING—Check lines and hoses for proper attachment, leaks, cracks, chafing, deterioration, etc. Any questionable parts noted should be replaced or repaired immediately. When abrasion or wear is evident on lines or hoses, the cause must be corrected.

18 DRUM BRAKES AND PARKING BRAKE—Check drum brake linings and other internal brake components at each wheel (drums, wheel cylinders, etc.). Parking brake adjustment also should be checked whenever drum brake linings are checked.

NOTE: More frequent checks should be made if driving conditions and habits result in frequent brake application.

19 THROTTLE LINKAGE—Check for damaged or missing parts, interference or binding. Any deficiencies should be corrected without delay.

20 UNDERBODY—In geographic areas using a heavy concentration of road salt or other corrosive materials for snow removal or road dust control, flush and inspect the complete under side of the vehicle at least once each year, preferably after a winter's exposure. Particular attention should be given to cleaning out underbody members where dirt and other foreign materials may have collected.

21 BUMPERS—Check the front and rear bumper systems at 12-month/12,000-mile intervals to be sure the impact protection and clearance originally designed into the system remains in a state of full readiness. They also should be checked whenever there is obvious bumper misalignment, or whenever the vehicle has been involved in a significant collision in which the bumper was struck, even when no damage to the bumper system can be seen.

EMISSION CONTROL MAINTENANCE

(1974 CERTIFIED ENGINE)

22 THERMOSTATICALLY CONTROLLED AIR CLEANER—Inspect installation to make certain that all hoses and ducts are connected and correctly installed. Also check valve for proper operation.

23 CARBURETOR CHOKE—Check choke mechanism for free operation. Any binding condition which may have developed due to petroleum gum formation on the choke shaft or from damage should be corrected.

24 TIMING, DWELL, CARBURETOR IDLE, DISTRIBUTOR AND COIL—Adjust ignition timing, dwell and carburetor idle speed accurately (following the specifications shown on the label attached to engine rocker cover) at the first 6 months or 6,000 miles of operation then at 12 month or 12,000 miles. Then at 12 month or 12,000 mile intervals. Adjustment must be made with test equipment known to be accurate.

Replace distributor points every 12 months or 12,000 miles and replace cam lubricator every 24 months or 24,000 miles. In addition, carefully inspect the interior and exterior of the distributor cap, distributor rotor and coil for cracks, carbon tracking, and terminal corrosion. Clean or replace as necessary at 24-month/24,000 mile intervals to prevent misfiring and/or deterioration.

Proper functioning of the carburetor is particularly essential to control of emissions. Correct mixtures for emission compliance and idle quality have been preset by GMC Truck. Plastic idle mixture limiters have been installed on the idle mixture screws to discourage unauthorized adjustment. These idle limiters are not to be removed unless some major carburetor repair or replacement which affects the idle screw adjustment has been necessary.

At 12 months or 12,000 mile intervals or in case of major carburetor overhaul, or when poor idle quality exists, the idle mixture should be adjusted by use of a CO meter when an accurate meter is available, or the alternate mechanical method should be used to adjust idle mixture (See SECTION 6M).

25 CARBURETOR AND INTAKE MANIFOLD MOUNTING—Torque carburetor and intake manifold attaching bolts and/or nuts at first 6 months or 6,000 miles of vehicle operation.

26 SPARK PLUGS—Replace at 6,000 mile intervals when operating with leaded fuels, or at 12,000-mile intervals when using unleaded fuels. Use of leaded fuels results in lead deposits on spark plugs and can cause misfiring at mileages less than 12,000 miles. Where misfiring occurs prior to 6,000 miles, spark plugs in good condition can often be cleaned, tested, and reinstalled in an engine with acceptable results.

27 THERMAL VACUUM SWITCH AND HOSES—Check for proper operation. A malfunctioning switch must be replaced. Check hoses for proper connection, cracking, abrasion or deterioration and replace as necessary.

28 CARBURETOR FUEL FILTER—Replace filter at 12-month/12,000-mile intervals or more frequently if clogged.

29 POSITIVE CRANKCASE VENTILATION SYSTEM (PCV)—Check system for satisfactory operation at 12-month or 12,000-mile intervals using a tester, and clean filter. Replace the PCV valve at 24-month or 24,000-mile intervals and blow out PCV valve hose with compressed air. The PCV valve should be replaced at 12-month or 12,000-mile intervals when the vehicle is used in operations involving heavy dust, extensive idling, trailer pulling, and short trip use at freezing temperatures where engine does not become thoroughly warmed-up.

30 AIR CLEANER ELEMENT—Replace the engine air cleaner element under normal operating conditions every 12,000 miles. Operation of vehicle in dusty areas will necessitate more frequent element replacement.

> **CAUTION:** *Do not operate the engine without the air cleaner unless temporary removal is necessary during repair or maintenance of the vehicle. When the air cleaner is removed backfiring can cause fire in the engine compartment.*

31 SPARK PLUG AND IGNITION COIL WIRES—Inspect spark plug and ignition coil wires for evidence of checking or cracking of exterior insulation and tight fit in the distributor cap and at the spark plugs. Exterior of wires should be cleaned, any evidence of corrosion on ends removed and wire replaced if deteriorated.

32 ENGINE COMPRESSION—Test engine cranking compression. If a problem exists, have correction made. Minimum compression recorded in any one cylinder should not be less than 70% of the highest cylinder. For example, if the highest pressure in any one cylinder is 150 lbs., the lowest allowable pressure for any other cylinder would be 105 lbs. (150 X 70% = 105).

33 EVAPORATION CONTROL SYSTEM (ECS)—Check all fuel and vapor lines and hoses for proper connections and correct routing as well as condition. Remove canister(s) and check for cracks or damage. Replace damaged or deteriorated parts as necessary. Replace filter in lower section of canister.

If vehicle is equipped with two canisters, filter is located in the lower canister only.

34 FUEL CAP, FUEL LINES AND FUEL TANKS—Inspect the fuel tank cap and lines for damage which could cause leakage. Inspect fuel cap for correct sealing ability and indications of physical damage. Replace any damaged or malfunctioning parts.

EMISSION CONTROL MAINTENANCE

(1975 - 1976 CERTIFIED ENGINE)

35 THERMOSTATICALLY CONTROLLED AIR CLEANER—Inspect installation to make certain that all hoses and ducts are connected and correctly installed. Also check valve for proper operation.

36 CARBURETOR CHOKE AND HOSES—Check choke mechanism for free operation. Any binding condition which may have developed due to petroleum gum formation on the choke shaft or from damage should be corrected. Check carburetor choke hoses for proper connection, cracking, abrasion or deterioration and correct or replace as necessary.

37 ENGINE IDLE SPEED AND MIXTURE—Adjust engine idle speed accurately (following the specifications shown on the label attached to the engine rocker cover) at the first 6 months or 6,000 miles of operation, then at 12 month or 12,000 mile intervals. Adjustment must be made with test equipment known to be accurate.

At 12 month or 12,000 mile intervals or in case of major carburetor overhaul, or when poor idle quality exists, the idle mixture should be adjusted by use of a CO meter when an accurate meter is available, or the alternate mechanical method (lean drop) should be used to adjust the idle mixture. (See Section 6M).

38 CARBURETOR AND INTAKE MANIFOLD MOUNTING—Torque carburetor and intake manifold attaching bolts and/or nuts at first 6 months or 6,000 miles —then at 12 month/12,000 mile intervals.

39 SPARK PLUGS—Replace at 6,000 mile intervals when operating with leaded fuels, or at 12,000-mile intervals when using unleaded fuels. Use of leaded fuels results in lead deposits on spark plugs and can cause misfiring at mileages less than 12,000 miles. Where misfiring occurs prior to 6,000 miles, spark plugs in good condition can often be cleaned, tested, and reinstalled in an engine with acceptable results.

40 CARBURETOR FUEL FILTER—Replace filter at 12-month 12,000-mile intervals or more frequently if clogged.

41 THERMAL VACUUM SWITCH AND HOSES—Check for proper operation. A malfunctioning switch must be replaced. Check hoses for proper connection, cracking, abrasion or deterioration and replace as necessary.

42 POSITIVE CRANKCASE VENTILATION SYSTEM (PCV)—Check the PCV system for satisfactory operation at 12,000-mile intervals, and clean filter (located in rocker cover). Replace the PCV valve at 24,000-mile intervals and blow out PCV valve hose with compressed air. Replace deteriorated hoses.

43 AIR CLEANER ELEMENT—Replace the engine air cleaner element under normal operating conditions every 12,000 miles. Operation of vehicle in dusty areas will necessitate more frequent element replacement. Your GMC MotorHome dealer can be of assistance in determining the proper replacement frequency for the conditions under which you operate your vehicle.

CAUTION: DO not operate the engine without the air cleaner unless temporary removal is necessary during repair or maintenance of the vehicle. When the air cleaner is removed back-firing can cause fire in the engine compartment.

44 SPARK PLUG WIRES—Clean exterior of wires; remove any evidence of corrosion on end terminals. Inspect spark plug wires for evidence of checking, burning, or cracking of exterior insulation and tight fit at distributor cap and spark plugs or other deterioration. If corrosion cannot be removed or other conditions above are noted, replace wire.

45 TIMING AND DISTRIBUTOR CAP—Adjust ignition timing following the specification on label attached to the engine rocker cover.

Also, carefully inspect the interior and exterior of the distributor cap and rotor for cracks, carbon tracking and terminal corrosion. Clean or replace as necessary.

46 THROTTLE RETURN CONTROL (TRC)—(California Vehicles) Check hoses for cracking, abrasion or deterioration and replace as necessary. Check system for proper operation.

47 EVAPORATION CONTROL SYSTEM (ECS)—Check all fuel and vapor lines and hoses for proper connections and correct routing as well as condition. Remove canister(s) and check for cracks or damage. Replace damaged or deteriorated parts as necessary. Replace filter in lower section of canister.

If vehicle is equipped with two canisters, filter is located in the lower canister only.

48 FUEL CAP, FUEL LINES AND FUEL TANKS—Inspect the fuel tank cap and lines for damage which could cause leakage. Inspect fuel cap for correct sealing ability and indications of physical damage. Replace any damaged or malfunctioning parts.

RECOMMENDED FLUIDS AND LUBRICANTS

USAGE	FLUID/LUBRICANT	CAPACITIES
Engine oil	High quality SE oil	5 qts. (6 w/filter)
Power steering system and pump reservoir. Includes windshield wiper motor	GM power steering fluid Part No. 1050017 – if not available use DEXRON® II automatic transmission fluid	1 1/2 Qts.
Final drive	SAE 80W or SAE 80W-90 GL-5 gear lubricant (SAE 80W GL-5 in Canada)	4 Pts.
Brake system and master cylinder	Delco Supreme 11 or, DOT-3 fluid or equivalent	
Transmission shift linkage	Engine oil	
Chassis lubrication	Chassis grease meeting requirements of GM 6031-M	
Transmission	DEXRON® II automatic transmission fluid	4 Qts. *
Parking brake cables	Chassis grease	
Front wheel bearings	High-melting point lubricant Part No. 1051344	
Rear wheel bearings	Chassis grease meeting requirements of GM 6031-M	
Body door hinge pins, hinges and latches at the front access doors, external utilities, generator/storage and LP gas doors. Gas fill door hinge	Engine oil	
Windshield washer solvent	GM Optikleen washer solvent Part No. 1050001 or equivalent	
Energizers (Batteries)	Colorless, odorless, drinking water	
Engine coolant	Mixture of water and a high quality Ethylene Clycol base type anti-freeze conforming to GM Spec. 1899-M	21 Qts.

NOTE: Fluids and lubricants identified with GM part numbers or GM specification numbers may be obtained from your GMC Motor Home Service Outlet.

*12 qts. after complete overhaul.

LUBRICATION DETAILS

ENGINE

ENGINE OIL AND FILTER RECOMMENDATIONS

- Use only SE engine oil.

- Refer to "Engine, Chassis and Body Maintenance Schedule" for oil change and filter replacement intervals.

The recommendations in the "Engine, Chassis and Body Maintenance Schedule" apply to the first change as well as subsequent oil changes. The oil change interval for the vehicle's engine is based on the use of SE oils and quality oil filters. Oil change intervals longer than those listed above will seriously reduce engine life and may affect GMC Truck Coach's obligation under the provisions of the New Vehicle Warranty.

A high quality SE oil was installed in the engine at the factory. It is not necessary to change this factory-installed oil prior to the recommended normal change period. However, check the oil level more frequently during the break-in period since higher oil consumption is normal until the piston rings become seated.

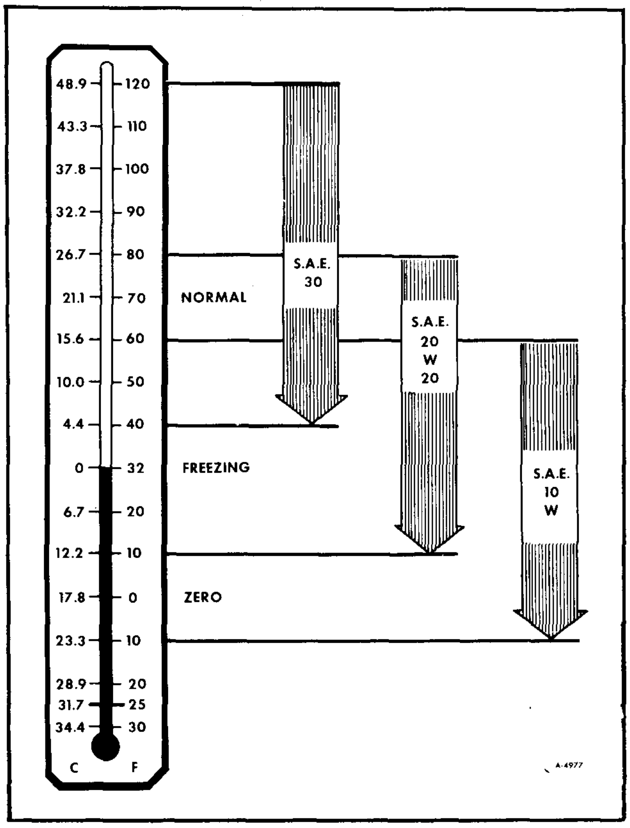

Figure 12—Engine Oil Viscosity Chart

NOTE: Non-detergent and other low quality oils are specifically not recommended. Only the use of SE engine oils and proper oil and filter change intervals assure of continued proper lubrication of the vehicle's engine.

RECOMMENDED SAE VISCOSITY (FIGURE 12)

- Single grade oils are preferred, however, multigrades such as SAE 10W-30 or 10W-40 are also acceptable.

- SAE 5W-20 oils are not recommended for sustained high speed driving.

- SAE 5W-30 oils (if available) may be used if extreme low temperatures are anticipated.

SUPPLEMENTAL ENGINE OIL ADDITIVES

The regular use of supplemental additives is specifically not recommended and will increase operating costs. However, supplemental additives are available that can effectively and economically solve certain specific problems without causing other difficulties. For example, if higher detergency is required to reduce varnish and sludge deposits resulting from some unusual operational difficulty, a thoroughly tested and approved additive—"Super Engine Oil Supplement"—is available at your GMC Motor Home service outlet.

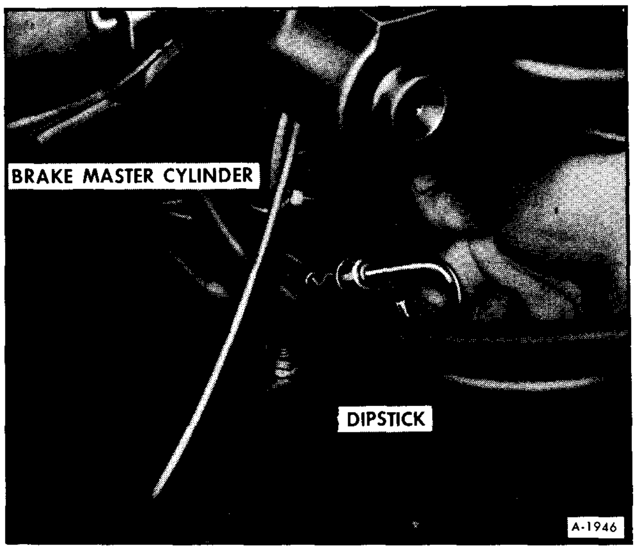

Figure 13—Removing Engine Oil Dipstick

CHECKING OIL LEVEL

The engine oil should be maintained at the proper level. The best time to check it is before operating the engine or as the last step in a fuel stop. This will allow the normal oil accumulation in the engine to drain back into the crankcase. To check the level, remove the oil level dipstick located inside the left front access door (See figure 13) wipe it clean and reinsert it fully for accurate reading. The oil level dipstick is marked "FULL" and "ADD." (figure 14) The oil level should be maintained within the margin, neither going above the "FULL" line nor below the "ADD" line. Reseat the dipstick firmly after taking the reading. One (1) quart will raise the oil level from "ADD" to "FULL."

> **NOTE:** The oil dipstick is also marked "USE SE ENGINE OIL," as a reminder to use only SE oils.

TRANSMISSION

The transmission dipstick and fill tube is located under the engine access cover on the left side of the engine. (figure 15)

Use only automatic transmission fluids identified with the mark DEXRON®II. These fluids have been specially formulated and tested for use in the automatic transmission, and are available from the GMC Motor Home service outlet or local service station.

Check the fluid level at each engine oil change period. To make an accurate fluid level check:

1. Drive vehicle several miles, making frequent starts and stops, to bring transmission up to normal operating temperature (approx. 190-200°F.) (87.8°C.-93.3°C.).

2. Park MotorHome on a level surface.

3. Apply parking brake.

4. Place selector lever in "PARK" and leave engine running.

5. Open all but the two rear windows, then remove engine cover.

6. Remove dipstick and wipe clean.

7. Reinsert dipstick until cap seats.

8. Remove dipstick and note reading. (figure 16)

If fluid level is at or below the "ADD" mark, add sufficient fluid to raise the level to the "FULL" mark. One pint raises the level from "ADD" to "FULL." Do not overfill. Refer to the Maintenance Chart for servicing schedule.

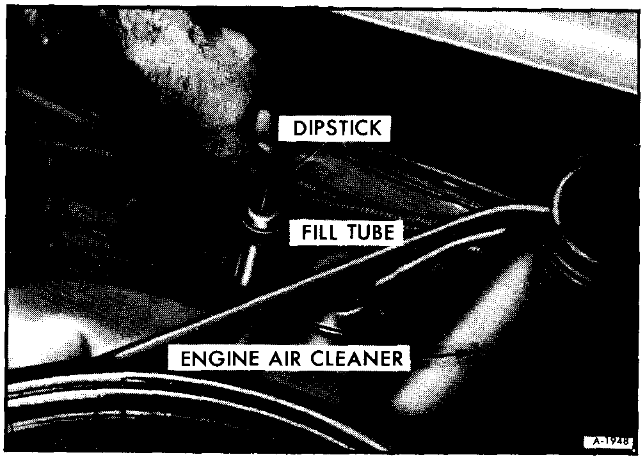

Figure 15—Removing Transmission Dipstick

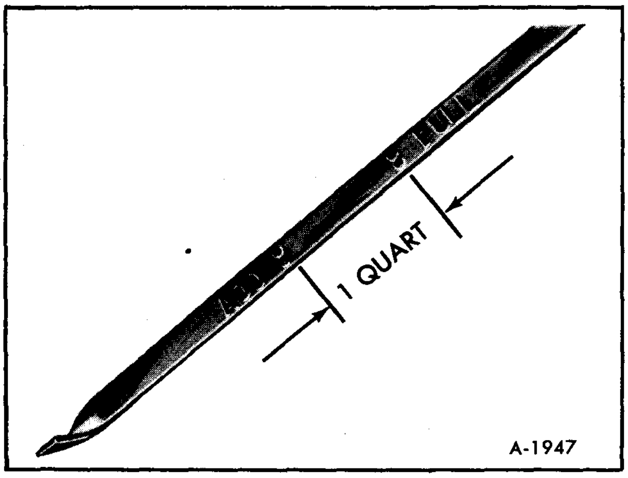

Figure 14—Engine Oil Dipstick

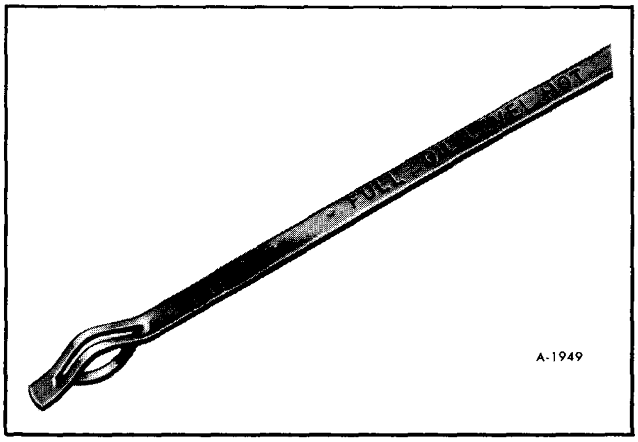

Figure 16—Transmission Dipstick

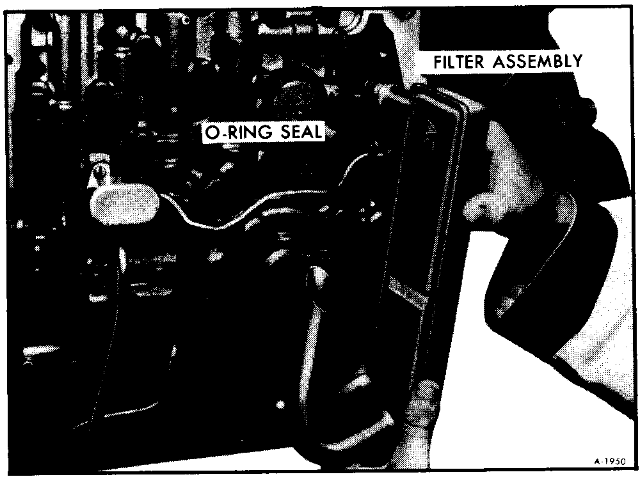

Figure 17—Replacing Transmission Oil Filter

TRANSMISSION OIL FILTER REPLACEMENT (FIGURE 17)

NOTE: Have a drain pan ready as lubricant will begin to drain as bolts are loosened.

1. Remove (13) bottom pan attaching screws.

2. Remove bottom pan and discard gasket.

3. Remove and discard oil filter assembly.

4. Install new O-ring seal on new filter and intake pipe and filter assembly and install.

5. Using a new pan gasket, install pan. Torque attaching screws to 12 foot-pounds.

6. Add four (4) quarts of DEXRON ® II automatic transmission fluid and check fluid as noted above.

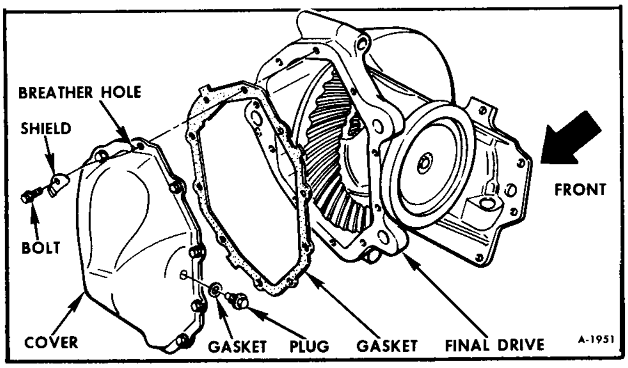

Figure 18—Final Drive Cover Removed

FINAL DRIVE (FIGURE 18)

FINAL DRIVE LUBRICANT REPLACEMENT

1. Remove (10) cover attaching bolts. Have a drain pan ready as lubricant will begin to drain as bolts are loosened.

2. Remove cover and allow lubricant to drain. Discard old gasket.

3. Using a new cover gasket, install cover. Torque attaching bolts to 24 foot-pounds. Shield to be bent over breather hole.

4. Add four pints of recommended lubricant through fill plug hole or fill until lubricant level is at the plug hole.

STEERING SYSTEM

POWER STEERING SYSTEM (FIGURE 19)

Check the fluid level in the power steering pump reservoir at each oil change period. This requires the removal of the engine access cover. The reservoir is located near the Delcotron. Add GM Power Steering Fluid (if GM Power Steering Fluid is not available, DEXRON®II Automatic Transmission Fluid may be used) as necessary to bring level into proper range on the filler cap indicator depending on fluid temperature.

If at operating temperature (approx. 150°F. *65.6°C.) hot to the touch) fluid should be between "HOT" and "COLD" marks. If at room tempera-*

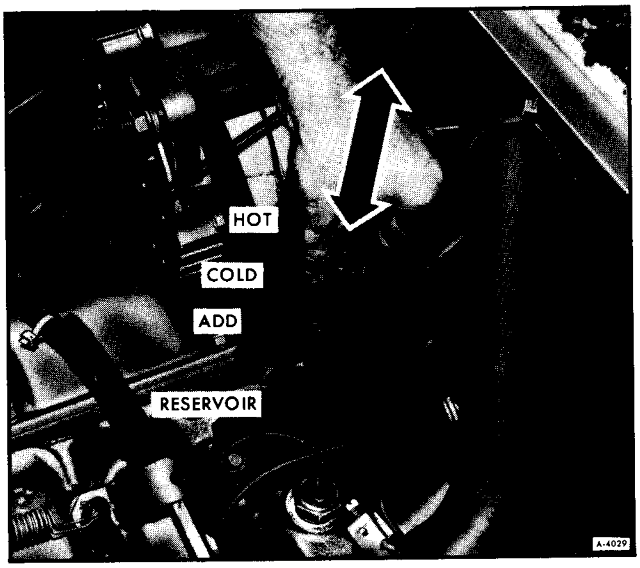

Figure 19—Checking Power Steering Fluid Level

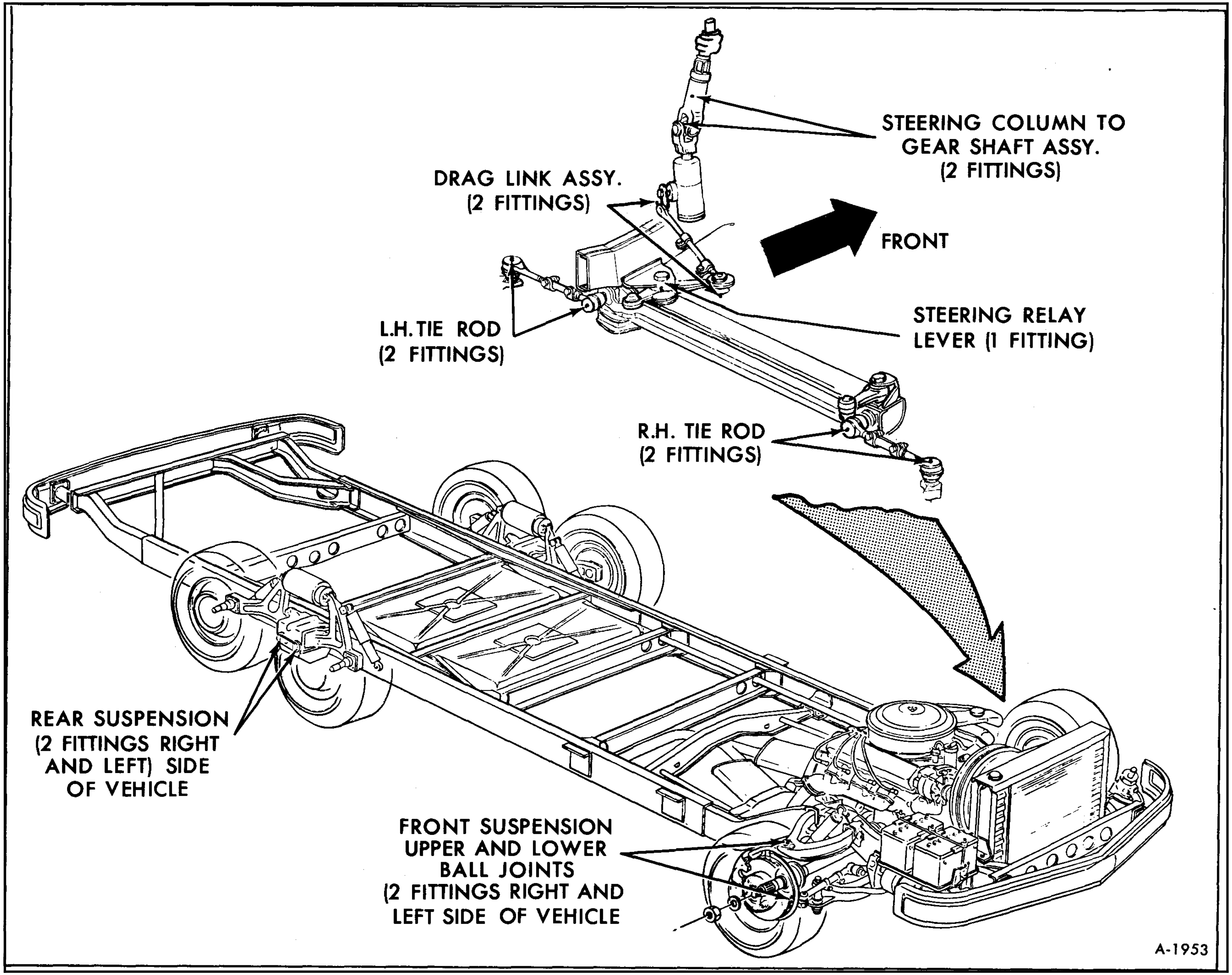

Figure 20—Location of Chassis Lubrication Fittings (Typical)

ture (approx. 70°F. (21.1°C.) fluid should be between "ADD" and "COLD" marks. The fluid does not require periodic changing.

STEERING LINKAGE (FIGURE 20)

The steering linkage (tie rods) and suspension should be lubricated, using a water resistant E.P. Chassis Lubricant that meets GM Specification 6031-M, at every oil change. Seals should be checked for damage.

BRAKE SYSTEM

BRAKE MASTER CYLINDER (FIGURE 21)

The master cylinder is located behind the left-side access door on the front of the vehicle. The fluid level in the master cylinder should be checked at each oil change. Wipe off the brake cylinder filler cap and unsnap the retainer. A low fluid level in the front brake master cylinder reservoir could be an indicator that the disc brake pads need replacing. The fluid level must be maintained at 1/4-inch below the top of each reservoir with Delco Supreme No. 11 or DOT-3 Brake Fluid or equivalent. When replacing the cap be sure to fasten the retainer securely, taking care not to let dirt enter the reservoirs.

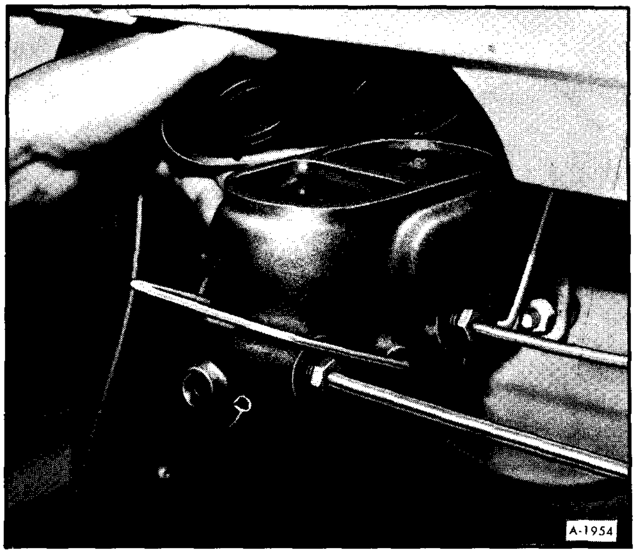

Figure 21—Checking Brake Master Cylinder

BLEEDING BRAKES

The need for bleeding brakes is generally indicated by springy, spongy pedal action. Pressure bleeding equipment must be used and a definite bleeding sequence and procedure must be followed. For proper bleeding sequence see BRAKES (SECTION 5) of this manual.

WINTERIZATION AND VEHICLE STORAGE

Winterization and vehicle storage are essential service functions which must be performed on GMC Motor Homes. Details on these items are covered in SECTION 24A "Periodic Maintenance and Lubrication"

SECTION 1
BODY, HEATING AND AIR CONDITIONING

This section includes the following:

SUBJECT	PAGE NO.
Body	1-1
Air Conditioning System (Includes Heating)	1-29
Heating System (Without Air Conditioning)	1-106

BODY

Contents of this section are listed below:

SUBJECT	PAGE NO.
Key Information	1-1
Exterior Maintenance	1-2
Interior Maintenance	1-2
Dust and Water Leaks	1-3
Painting	1-4
Glass	1-5
Windshield Wiper System	1-14
Entrance Door	1-17
Access Doors	1-19
Lap Belt Maintenance	1-20
Floor	1-20
Body	1-22
Fiberglass Repair	1-23
Sheet Metal Repair	1-25
Seats	1-25
Mirrors and Sun Visor	1-26
Radiator Grille	1-27
End Cap	1-27
Special Tools	1-28

KEY INFORMATION

Two keys are furnished with the vehicle. Each key has a different cross section so that it can be inserted only in certain locks. The key with a square head is for the ignition switch only. The key with an oval head fits the side entrance door lock, the glove box, and the external utilities compartment.

All models have ignition and glove compartment lock cylinders incorporating coded keyways and keys. The code letter is located on the key shank and the code number is stamped on the knock-out portion of the key head. These numbers identify the locks in which the keys are used and are required when ordering or making new keys.

Notch dept information will be provided, on current production keys, upon request through the manufacturer of your key cutting equipment or his locksmith association. Also he will be able to furnish a conversion package for your cutter, if required, for grinding new keys.

EXTERIOR MAINTENANCE

Entire vehicle should be regularly inspected for condition of paint and for corrosion damage, with particular attention given to chrome. Inspection should be made more frequently in freezing weather due to the corrosive effect of road deicing materials (salt, calcium chloride, etc.) on metal. If inspection discloses any evidences of corrosion, paint failure, or bare metal, corrective measures as outlined under "Painting" (later in this section) should be immediately employed.

Body painted surfaces and chrome plating should be protected by a coating of wax, applied at regular intervals. Periods between applications should be sufficiently short to assure continuous protection of the finish; 30 days after delivery, and at least once a year thereafter. Any good body wax can be used for both painted and chrome surfaces. Wax should be applied immediately after vehicle has been cleaned.

NOTE: Calcium chloride and other salts, road tar, excretion from insects, ("treesap"), chemicals from factory chimneys and other foreign matter may permanently damage paint and chrome. Frequent, regular washing and a thorough cleaning after exposure is recommended to prevent damage by these substances. Use either cold or lukewarm water. Never wash vehicle in direct rays of the sun and always wait until painted surfaces have cooled.

INTERIOR MAINTENANCE

Dust and loose dirt that accumulate on interior fabric trim should be removed frequently with a vacuum cleaner, whisk broom or soft brush. Vinyl or leather trim should be wiped clean with a damp cloth. Normal cleanable trim soilage, spots or stains can be cleaned with the proper use of trim cleaners available through General Motors Dealers or other reputable supply outlets.

IMPORTANT: Do not use commercial paint, chrome or glass cleaners on interior bright trim or painted surfaces. If cleaning is required, lukewarm water and a neutral soap may be used.

Before attempting to remove spots or stains from upholstery, determine as accurately as possible the nature and age of the spot or stain. Some spots or stains can be removed satisfactorily with water or mild soap solution (refer to "Removal of Specific Stains" later in this section). For best results, spots or stains should be removed as soon as possible.

Some types of stains or soilage such as lipsticks, some inks, certain types of grease, mustard, etc., are extremely difficult and, in some cases, impossible to completely remove. When cleaning this type of stain or soilage, care must be taken not to enlarge the soiled area. It is sometimes more desirable to have a small stain than an enlarged stain as a result of attempted cleaning.

CAUTION: *When cleaning interior do not use volatile cleaning solvents such as: acetone, lacquer thinners, enamel reducers, nail polish removers; or such cleaning materials as laundry soaps, bleaches or reducing agents (except as noted in the instructions on "Cleaning Fabrics" and "Removal of Specific Stains.") Never use carbon tetrachloride, gasoline, or naphtha for any cleaning purpose. The above materials may be toxic or flammable, or may cause damage to interior.*

INTERIOR GLASS

The interior glass surface should be cleaned on a periodic basis for continued good visibility. A commercial household glass cleaning agent containing ammonia will remove normal tobacco smoke and dust films sometimes caused by ingredients used in vinyls, plastics, or other interior trim materials.

CLEANING FABRICS

IMPORTANT: Be sure vehicle is well ventilated while using the following cleaning agents. Follow manufacturer's recommendations in using such products.

CLEANING FABRICS WITH CLEANING FLUID

This type of cleaner should be used for cleaning stains containing grease, oil, or fats. Excess stain should be gently scraped off trim with a clean dull knife or scraper. Use very little cleaner, light pressure, and clean cloths (preferably cheesecloth). Cleaning action with cloth should be from outside of stain towards center and constantly changing to a clean section of cloth. When stain is cleaned from fabric, immediately wipe area briskly with a clean absorbent towel or cheesecloth to help dry area and prevent a cleaning ring. If ring forms, immediately clean entire area or panel section of the trim assembly.

NOTE: Sometimes a difficult spot may require a second application of cleaning fluid followed immediately by a soft brush to completely remove the spot.

CLEANING FABRICS WITH DETERGENT FOAM CLEANERS

This type of cleaner is excellent for cleaning general soilage from fabrics and for cleaning a panel section where a minor cleaning ring may be left from spot cleaning. Vacuum area to remove excess loose dirt. Always clean at least a full trim panel or section of trim. Mask adjacent trim along stitch or weld lines. Mix detergent type foam cleaners in strict accordance with directions on label of container. Use foam only on a clean sponge or soft bristle brush—Do not wet fabric excessively or rub harshly with brush. Wipe clean with a slightly damp absorbent towel or cloth. Immediately after cleaning fabric, dry fabric with a dry towel or hair dryer. Rewipe fabric with dry absorbent towel or cloth to restore the luster of the trim and to eliminate any dried residue.

REMOVAL OF SPECIFIC STAINS

CANDY—Chocolate, use cloth soaked in lukewarm water; other than chocolate, use very hot water. Dry if necessary, clean lightly with fabric cleaning fluid.

CHEWING GUM—Harden gum with ice cube and scrape off with dull knife. Moisten with fabric cleaning fluid and scrape again.

FRUIT STAINS, COFFEE, LIQUOR, WINE, SOFT DRINKS, ICE CREAM AND MILK—Wipe with cloth soaked in cold water. If necessary, clean lightly with fabric cleaning fluid. Soap and water is not recommended as it might set the stain.

CATSUP—Wipe with cloth soaked in cool water. If further cleaning is necessary, use a detergent foam cleaner.

GREASE, OIL, BUTTER, MARGARINE AND CRAYON—Scrap off excess with dull knife. Use fabric cleaning fluid.

PASTE OR WAX TYPE SHOE POLISH—Light application of fabric cleaning fluid.

TAR—Remove excess with dull knife, moisten with fabric cleaning fluid, scrape again, rub lightly with additional cleaner.

BLOOD—Wipe with clean cloth moistened with cold water. Use no soap.

URINE—Sponge stain with lukewarm soap suds from mild neutral soap on clean cloth, rinse with cloth soaked in cold water; saturate cloth with one part household ammonia and five parts water, apply for one minute, rinse with clean, wet cloth.

VOMITUS—Sponge with clean cloth dipped in clean, cold water. Wash lightly with lukewarm water and mild neutral soap. If odor persists, treat area with a water-baking soda solution (one teaspoon baking soda to one cup of tepid water). Rub again with cloth and cold water. Finally, if necessary, clean lightly with fabric cleaning fluid.

BALL POINT INK—Try rubbing alcohol. If stain remains after repeated applications, no other measure should be tried.

LIPSTICK—Difficult to remove. Cleaning fluid works on some brands. If stain remains after repeated applications, do not try other measures.

MUSTARD—Damp sponge with warm water, then rub detergent on dampened stain and work into fabric. Repeat several times. Some discoloration may remain.

DUST AND WATER LEAKS

Test windshield, windows and vehicle under flooring for leaks by spraying water under pressure against vehicle while assistant inside marks points of leakage, if any exist.

If location of leak has been determined to be around windshield or rear glass, dry surface and apply rubber cement. Apply cement to outside, both between glass and weatherstrip and between weatherstrip and body.

If the leak is around any side window it will be necessary to remove the window and install a new seal.

A quick method for locating many air and water leaks at windshield, backglass, bolt holes, weather-stripping and joints is as follows:

Close all windows and vents, turn air conditioning or heater blower motor to high position and outside air and close doors. Run water over suspected leak area in a small controllable stream and observe area for pressure bubbles.

Water which shows up at a certain place inside vehicle may actually be entering at a point other than where water is found. Back-track path of water to point of entry. Apply body sealing compound over all leak points. If leakage occurs at door opening, check weatherstrip. Seal with rubber cement or replace if necessary. If door does not firmly contact weatherstrip, align door. Refer to "Door Adjustment" later in this section.

PAINTING

Aluminum corrodes just as iron and steel rusts. Under certain conditions aluminum will corrode more rapidly than steel. Inspect body surfaces regularly for corrosion and paint condition.

Only sound parts can be refinished. If corrosion is excessive, replace with new parts. Remove old parts. Refinish all exposed adjacent parts which remain on vehicle. When installing new parts use only zinc or cadmium coated bolts, washers, and nuts.

The instructions which follow cover both aluminum and fiberglass, and both new and old parts.

1. Through cleaning is essential; all corrosion, grease, and other foreign matter must be removed. Solvent cleaning, pressure steam cleaning, wire brushing, and hand sanding methods are recommended.

2. Completely remove old paint by use of organic solvents. Do not use alkaline paint remover on aluminum. If old primer is very difficult to remove and there is no evidence of metal corrosion, old primer may be left on, but all loose paint must be removed.

3. Wipe the entire area to be refinished with cloths saturated with DuPont No. T-3812 reducer (or equivalent). Wipe dry.

4. Treat any scratched or abraded areas with DuPont No. VM-5717 metal conditioner (or equivalent) reduced one (1) part by volume with four (4) parts of water.

a. Apply the above mixture with a sponge or brush and allow to stand approximately three (3) minutes.

b. Wipe area with a damp cloth. Dry thoroughly.

5. Apply a coat of pre-primer (sometimes called wash- primer), preferably by spraying to a uniform and complete coverage coat on all surfaces. This type primer uses a special accelerating agent containing phosphoric acid which produces an excellent bond to metal. AP-10 or A-158 made by M & T Chemical Co., XE-5220 made by Bakelite Corporation, and 818-012 (2 parts), plus T8539 (1 part) made by DuPont, or any equivalent material made by a reputable paint manufacturer should be acceptable. These materials must be used within a few hours after addition of accelerator, therefore, directions of manufacturer should be observed carefully. Apply by spraying. Allow parts to dry.

6. Use a zinc chromate primer such as DuPont No. 63-150 or Pontiac Varnish Company's GMT-434, or any equivalent material made by a reputable manufacturer. Apply primer, preferably by spraying, to a minimum thickness of 0.5 mils. Allow parts to dry.

7. Apply finish coats:

a. A minimum of two finish coats is required.

b. For understructure and other parts not requiring color, apply a second coat of DuPont No. 63-150, or Pontiac Coatings Division GMT-434, or equivalent.

c. To exposed understructure body parts, apply desired color coats in accordance with standard practice.

d. Effective with vehicle serial number TZE 165V100089, vehicles are painted with DuPont urethane paint trademarked "IMRON". Paint repairs on these vehicles should be made with IMRON, or an equivalent material, or a high grade automotive enamel paint. Spray touch up paint is also available for minor repairs.

NOTE: Lacquer should NOT be used to repair body finish on these vehicles.

MOTORHOME AND TRANSMODE PAINT CODES

MOTOR HOME and TRANSMODE PAINT CODES

INSTRUMENT PANEL PAINT CODES

RPO	Color	Fisher No.	DuPont Code No.	Pontiac Coatings Code No.	Refinish No.
690, 692 693, 695	Midnight Neutral	W25A-4300	864-AF738		9994LH
696	Dark Amber	W25A-4530	864-AF941		42911LH
697	Dark Saddle	W25A-4098	864-AF038		
697	Dark Saddle	GMT-544		GMT 544	
698	Dark Lime	GMT-551		GMT 551	

EXTERIOR PAINT CODES

RPO	Color	Fisher No.	DuPont Code No.	Pontiac Coatings Code No.	Refinish No.
525	Chamois	WEA-4326	5481		5481A
534	Beige*	WUEK-4527	826-Y-AF926		42807U
521	White*	WUEK-5111	826-Y-21667		817U
531	Buttercup Yellow*	WUEK-5241	826-Y-AH434		43916U
553	Frosted Mint*	WUEK-5254	826-Y-AH541		44017U
557	Aspen Gold*	WUEK-5267	826-Y-AH580		44313U
558	Cameo White*	WUEK-3967	826-Y-99642		5338U
580	Yellow*	WUEK-5269	826-Y-AH640		44365U
585	Cream White *	WUEK-5222	826-Y-AH718		44570U

*Effective with vehicle serial number TZE165V100089, vehicles are being painted with DuPont urethane paint trademarked IMRON. Paint repairs should be made with IMRON (DuPont refinish No. ends in U) or equivalent or a high grade enamel (DuPont acrylic enamel refinish No. ends with A) automotive paint.

NOTE: Lacquer should not be used to repair body finish on these vehicles.

GLASS

WINDSHIELD REPLACEMENT

Windshield glass is retained in the opening by a molded rubber weatherstrip with an insert-type rubber seal as shown in Figure 1. Two glass sections are used in this vehicle.

When replacing a cracked windshield glass, it is very important that the cause of the glass breakage be determined and the condition corrected before a new glass is installed. Otherwise, it is highly possible that a small obstruction or high spot somewhere around the windshield opening will continue to crack or break the newly installed windshield; especially when the strain on the glass caused by the obstruction is increased by such conditions as wind pressures, extremes of temperature, motion of the vehicle, etc.

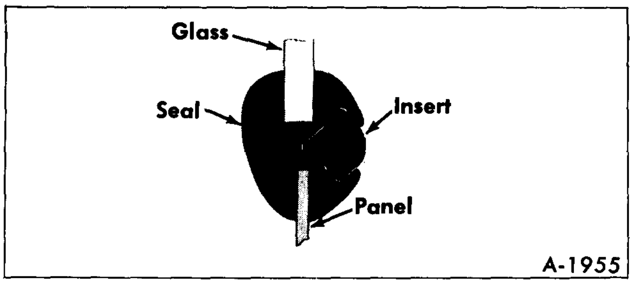

Figure 1—Windshield Weatherstrip

REMOVAL

If cracks in glass extend to outer edge of glass, mark body with chalk at these points so that weatherstrip flange opening can be examined later for possible distortion.

Protect the interior finish by placing a protective covering over steering wheel and dash panel. Mask around the windshield opening and lay a suitable cover to protect body.

WARNING: ALWAYS WEAR HEAVY GLOVES TO PREVENT POSSIBLE INJURY WHEN HANDLING GLASS.

1. Pry end of insert out of rubber seal with a pointed tool; pull insert completely out of seal.

2. With aid of an assistant to hold glass outside vehicle, push glass forward from inside vehicle.

INSPECTION

Due to the expanse and contour of the windshield, it is imperative in the event of a strain break that the windshield opening be thoroughly checked before installing a replacement windshield.

1. Check for the following conditions at the previous marked point of fracture:

a. Chipped edges on glass.

b. Irregularities in body opening.

c. Irregularities in rubber channel weatherstrip.

2. Remove all sealer from flange and body around windshield opening.

3. Check flange area for high spots. Remove all high spots.

INSTALLATION

NOTE: If desired, sealing cement can be applied between lip of seal and glass and seal lip at opening flange.

1. Assemble the rubber weatherstrip to the window opening flanges. Insert one end of the glass into its channel in the weatherstrip and seat into position

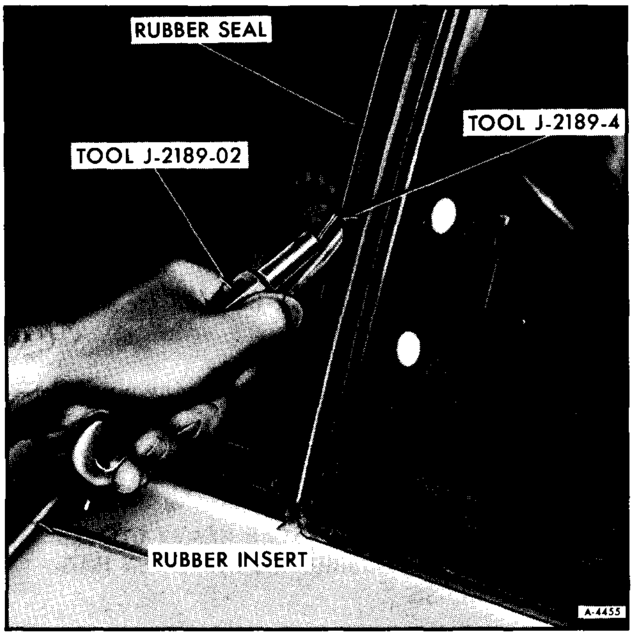

Figure 2—Installing Rubber Insert

Figure 3—Seating Rubber Insert Into Groove

using channel spreader hook of Glass Installing Tool J-2189-02.

2. Install Inserter J-2189-4 of Glass Installing Tool J-2189-02 into handle of tool. Feed the rubber insert (locking strip) and insert into the channel and draw the tool through the channel, feeding the rubber insert into position as shown in Figure 2. Use a hitching movement of tool to avoid elongating insert.

3. If new insert is being used, cut off insert allowing sufficient overlap for a tight joint. Use the small pin on the tool handle end to smooth the weatherstrip over the rubber insert (locking strip) as shown in Figure 3.

4. Install insert in center vertical seal (2-piece windshield) in same manner previously described in Step 2.

GMC SIDE WINDOWS

There are two types of windows or sash installed in the vehicle. Either a fixed or sliding window is mounted in an extruded aluminum channel. All side sash uses solid tempered glass. Both the glass and the channel is replaceable.

SASH ASSEMBLY

Removal

1. Remove trim mouldings as shown in Figure 4. "A" sash assemblies (sash assemblies in the drivers/-

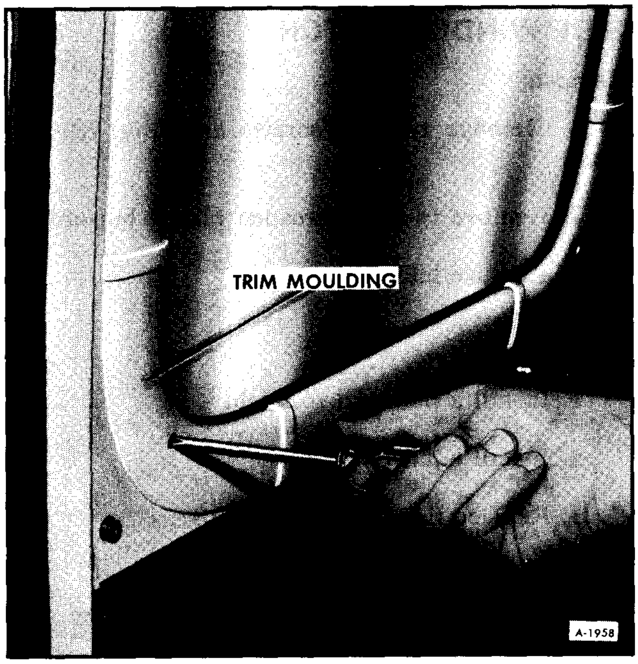

Figure 4—Removing Window Trim Moulding Screws

passenger area) will require interior trim panel removal.

2. All sash assemblies are mounted as typically shown in Figure 5. Remove retainers.

3. Tap on the inside channel using a wooden block and rubber mallet.

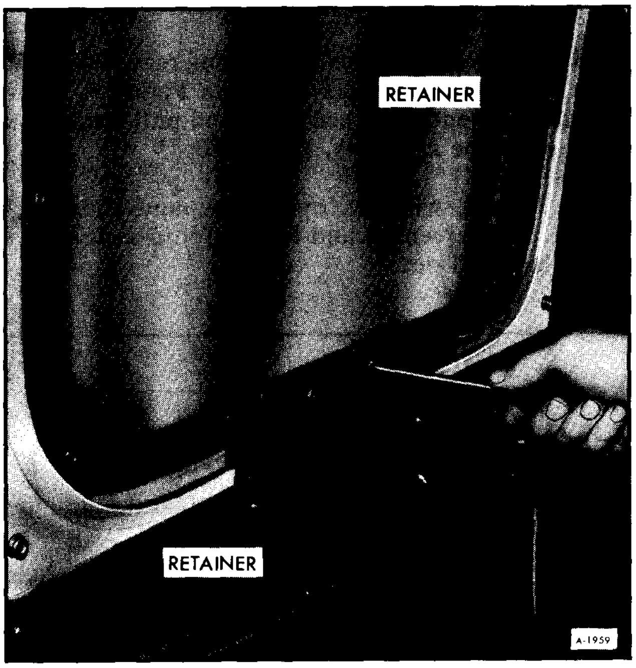

Figure 5—Removing Sash Retainers

NOTE: The sash assemblies are heavy. Have someone assist by supporting the assembly from the outside.

4. Remove sash assembly.

5. Remove filler seal from sash assembly.

Installation

1. Apply a new filler seal to the sash assembly.

2. Install sash assembly. Position spacers as shown in Figure 6.

NOTE: Late model vehicles are not equipped with spacers (figure 6). A 3/16 inch gap should be maintained between sill and sash.

3. Install retainers.

4. Install panels if removed and install trim mouldings.

GLASS

Removal

1. Remove sash assembly. Refer to "Sash Assembly - Removal" earlier in this section.

2. Remove the banding strap, if equipped, as shown in figure 7, then disassemble sash assembly as shown in Figure 8.

3. Remove glass.

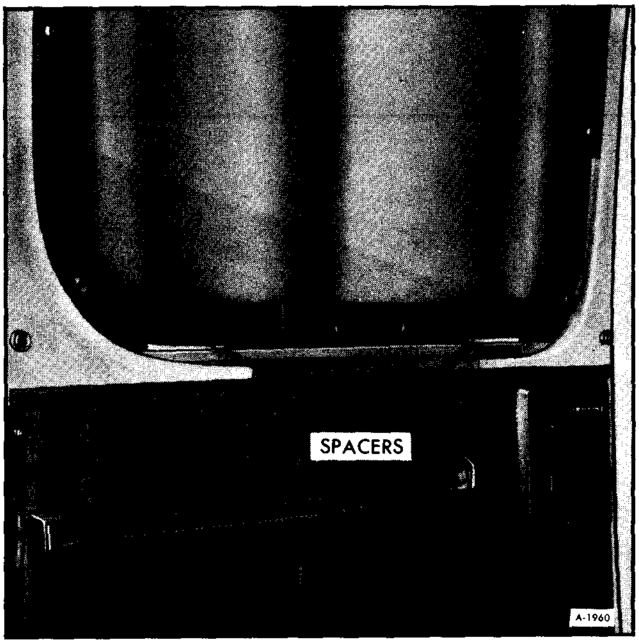

Figure 6—Sash Spacers

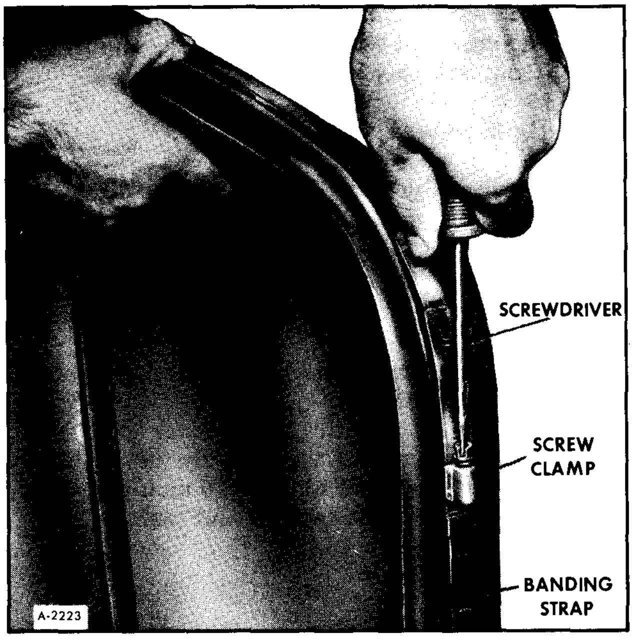

Figure 7—Removing Sash Banding Strap

4. Clean glass sash channels thoroughly.

Installation

1. Install glass into sash.

2. Referring to Figure 7 and 8, assemble sash.

3. Install sash assembly. Refer to "Sash Assembly-Installation" earlier in this section.

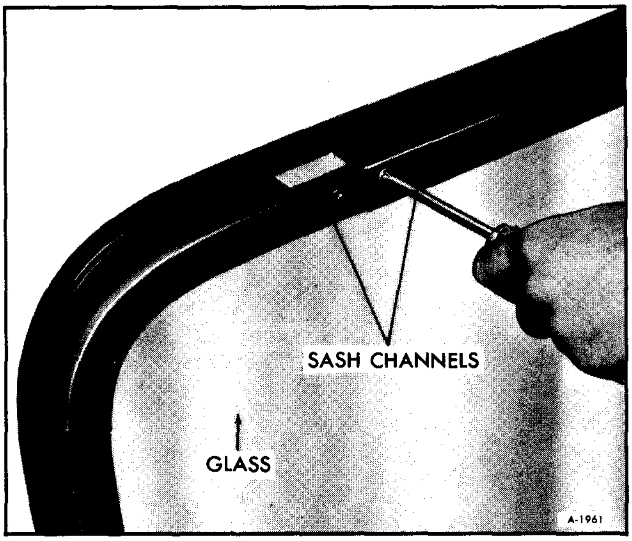

Figure 8—Disassembling Sash

SIDE WINDOW LATCH

Removal

1. Remove two (2) screws attaching latch to glass.

2. Remove two (2) threaded plastic buttons.

3. Remove latch.

Installation

1. Install a new seal to latch.

2. Install latch to glass.

3. Replace threaded plastic buttons.

"HEHR" LIVING AREA SIDE WINDOW ASSEMBLIES

A new type living area side window is now in production on 1975 GMC MotorHomes and Trans-Modes. The window assembly is identified by its one piece sash and center latch and handle. The fiber glass screen, the vent (sliding) glass, and the stationary glass are serviced with the window assembly in the vehicle as follows:

SCREEN AND VENT ASSEMBLY

Removal

1. Remove top screen track using reasonably stiff wire shaped to form tool shown in Figure 9. Insert tool at outer end of screen track and pull track from window frame assembly, Figure 10.

2. Unlock window, open vent, and slide back screen. Lift screen up and forward into sash assembly. Then pull out.

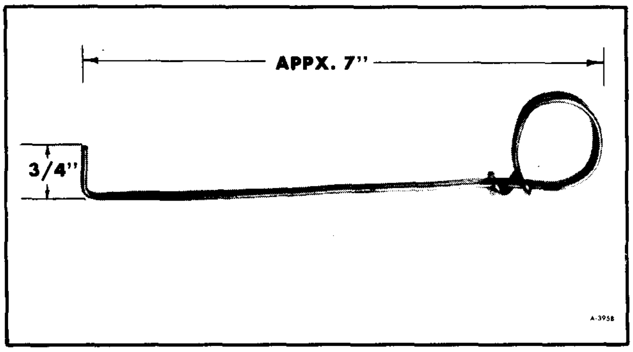

Figure 9—Fabricated Track Removal Tool

Figure 10—Removing Screen Track

3. Close vent. Remove top vent track in same manner as the screen track. Refer to Figure 10.

4. Now, open vent. Lift vent up into the window

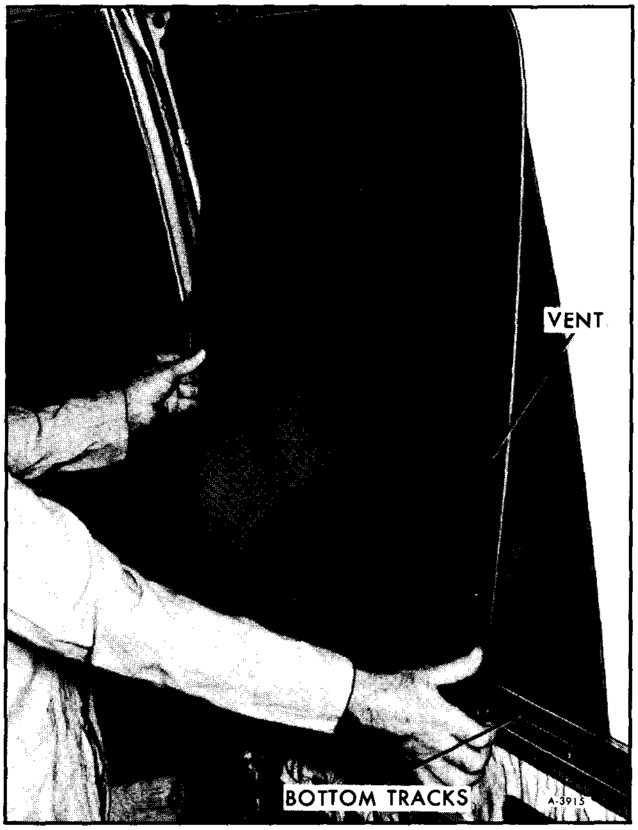

Figure 11—Removing Vent

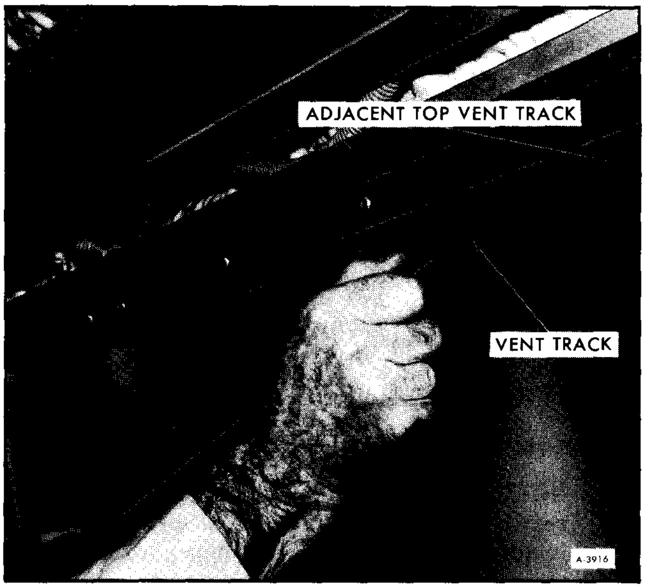

Figure 12—Installing Vent Track

frame assembly. Pull bottom of vent forward and remove vent as shown in Figure 11.

NOTE: Observe that screen track is wider than, and sits in front of vent track.

Installation

1. The screen and vent are installed by reversing removal procedure. Move vent to closed position.

2. Place vent track in groove and push against adjacent top vent track, Figure 12. Use hammer and

Figure 13—Seating Vent Track

1/8" thick plexiglass or plywood block to seat the track in place, Figure 13.

3. Install screen into widest channel of bottom screen track.

4. With vent glass and screen in closed position, seat top screen track in place in same manner as vent track. Refer to Figures 12 and 13.

CAUTION: *Do not use a screwdriver to install track. Screwdriver may fracture glass.*

STATIONARY GLASS ASSEMBLY

Removal

NOTE: Before stepping outside vehicle to remove stationary glass, release window latch. It is not necessary to remove vent glass when servicing stationary glass.

1. Use a screwdriver to unseat vent gasket as shown in Figure 14. Pull gasket back about six inches.

2. Dislodge mullion (center bar) with block and hammer, Figure 15. Pull mullion to side and lift it out of window frame.

3. Using a screwdriver, remove stationary gasket (or glazing bead) completely from assembly.

4. From inside vehicle, pry stationary glass from butyl sealer, using a scraper as shown in Figure 16. An assistant, standing outside vehicle, should support glass during removal.

Figure 14—Unseating Vent Gasket

Figure 15—Dislodging Mullion

5. Observe position of four plastic spacers, Figure 17. Lift spacers from butyl sealer.

6. Use a putty knife to remove all old butyl sealer from plastic spacers and window frame.

Installation

1. Install new butyl sealer in window frame. (A little water on fingertips will prevent butyl from sticking).

Figure 16—Prying Stationary Glass from Butyl Sealer

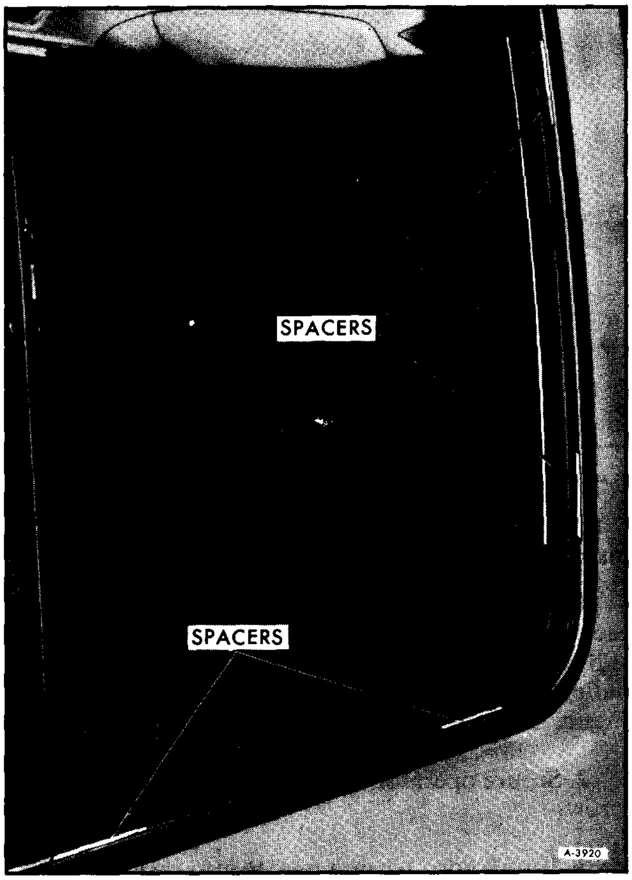

Figure 17—Location of Plastic Spacers

2. Lay plastic spacers in place as shown in Figure 17.

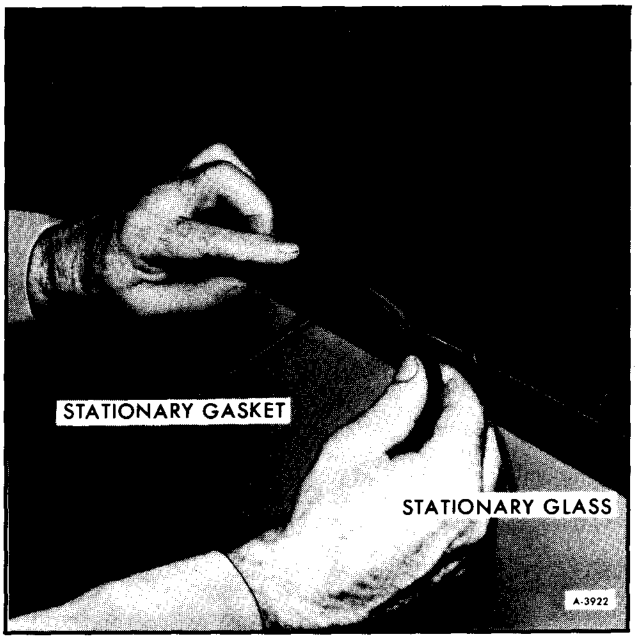

Figure 18—Installing Stationary Gasket

NOTE: Be sure when installing spacers to position them so as to contact edge of window glass.

3. Use suction cups to install glass.

Press glass firmly against butyl sealer to insure bonding.

4. Using hammer and block, install mullion.

5. Install stationary gasket by pushing it into place and locking grooves into window frame, Figure 18.

NOTE: Push stationary gasket back while installing it to avoid being left with an extra length of gasket. It may be useful to soften gasket in hot water (150°F.) (65.6°C.) before installation. Avoid leaving corner installation to last. After installation, if lumps or uneven seams appear, gasket is improperly seated. Loosen and seat gasket again.

6. Seat vent gasket back into place.

7. Using liquid butyl sealer, seal ends of stationary and vent gasket at mullion.

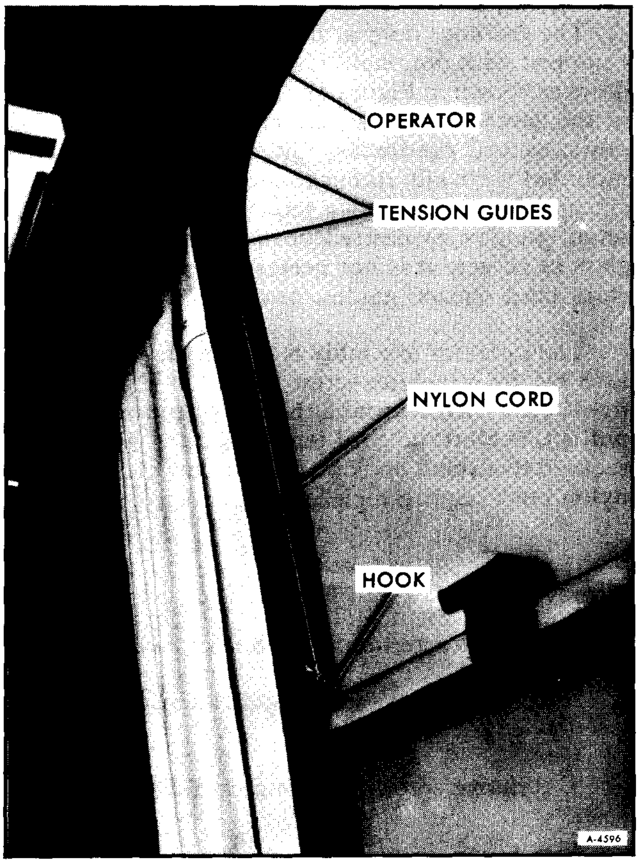

Figure 19—Vertical Sliding Window

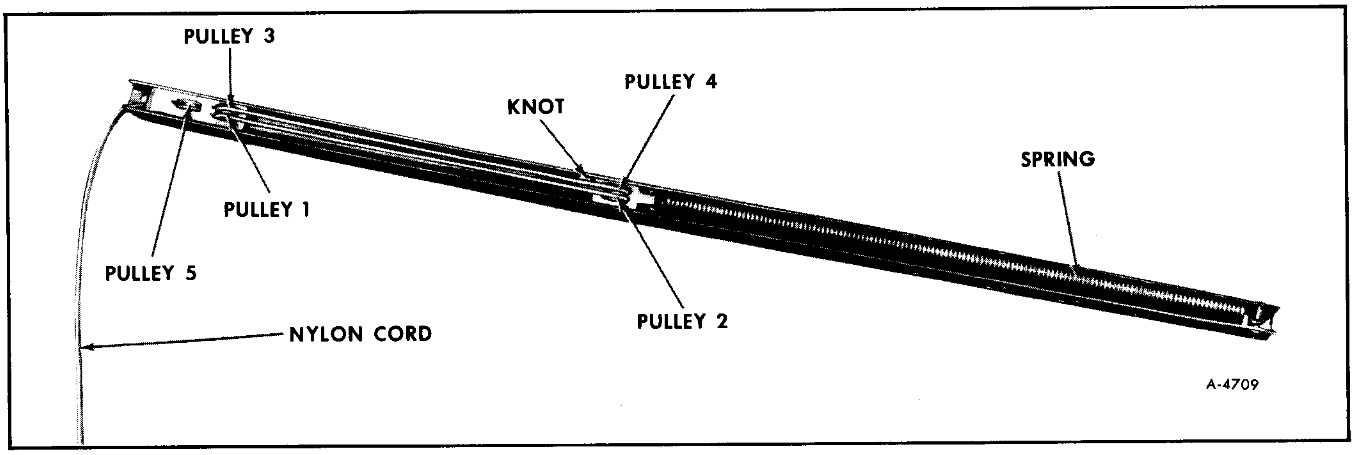

Figure 20—Operator Assembly

IMPORTANT: To avoid damaging screen track or vent track, DO NOT remove screen before removing screen track, or vent glass before removing vent track.

If screen or window does not slide easily in track, spray track grooves with Silicone Spray Lubricant, GM Part No. 150018 or equivalent.

VERICAL SLIDING WINDOW (OPTIONAL)

The entrance door at the galley windows may be equipped with optional "Hehr" vertical sliding windows as shown in Figure 19. This window is serviced in the same manner as the horizontal sliding windows, except, the tracks, vent glass, and screen are mounted vertically rather than horizontally. An operator (spring and pulley tension device) is used to retain window at desired open position. To service glass or screen, it is not necessary to remove nylon cord, cord tension guides, or operator.

The operator assembly is secured to the window sash by the attaching screw shown in Figure 20. A nylon cord travels around the five operator assembly pulleys, behind the cord tension guides, and is then secured to a small hook on the window glass. Should nylon cord require replacement, procure locally.

Removal

1. Remove screw securing hook to window glass.

2. Remove screws securing cord tension guides to window sash.

3. Remove screw attaching operator to window sash.

4. Remove nylon cord from hook and operator assembly.

Installation

1. String nylon cord from knotted hole around each consecutive pulley. Cord should travel under and over pulleys one and three, but over and under pulleys two and four, and under pulley five. Refer to Figure 20.

2. Secure operator to window sash with attaching screw.

3. Install cord tension guides into sash assembly. Be sure nylon cord is behind positioned behind the guides.

4. Secure nylon cord to hook and attach hook to glass with screw.

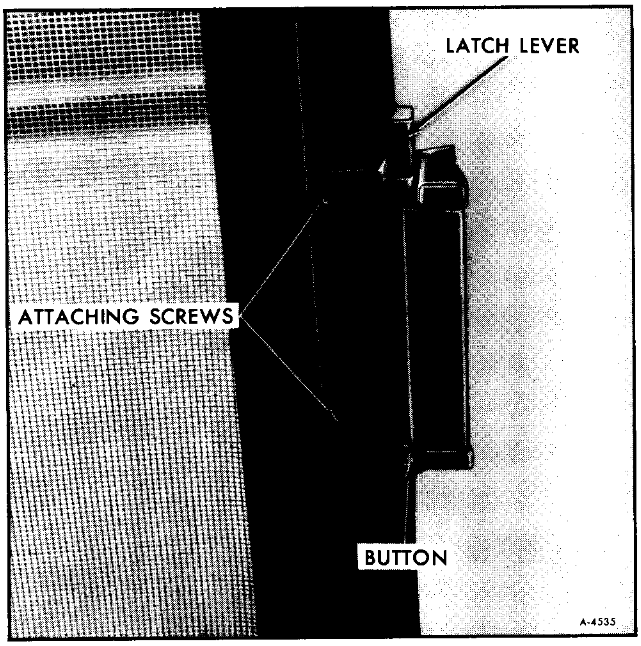

Figure 21—"Hehr" Latch in Open Position

"HEHR" WINDOW LATCH

The horizontal and optional vertical sliding "Hehr" windows are equipped with a center mounted, locking type latch. Unlock window latch by pushing upward on button until latch lever is exposed, as shown in Figure 21. To lock, push downward on latch lever until button is exposed.

Removal

1. Remove two (2) screws attaching latch to glass.

2. Remove latch and gasket.

Installation

1. Install new gasket to latch.

2. Secure latch and gasket to glass with two (2) attaching screws.

"A" WINDOWS

SASH ASSEMBLY

For removal and installation of sash, refer to discussion under Standard Side Windows. It may be necessary to remove interior furnishings (such as davo or dinette) and interior trim panels to remove sash assembly.

GLASS

Removal

1. Remove sash assembly. Refer to "Sash Assembly - Removal" earlier in this section.

2. Remove leading edge post from frame, Figure 22.

3. Slide upper glass panel and seal out of frame assembly. Stretch seal over glass to remove.

4. Remove glass run (or sash channel). Slide lower front glass panel out of frame assembly.

5. Remove screws securing rail to center bar and lower frame assembly.

6. Slide lower, rear glass panel out of frame assembly.

Installation

To install glass, reverse removal procedure.

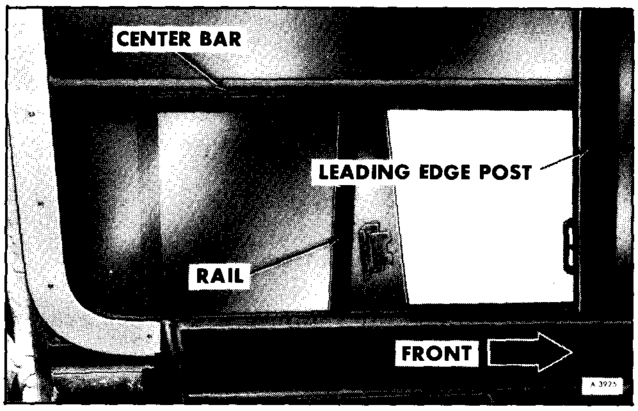

Figure 22—"A" Window

REAR WINDOW REPLACEMENT

The rear window is retained in the opening by a molded rubber weatherstrip with an insert-type rubber seal.

When replacing a cracked window, it is very important that the cause of the glass breakage be determined and the condition corrected before a new glass is installed. Otherwise it is highly possible that a small obstruction or high spot somewhere around the opening will continue to crack or break the newly installed window; especially when the strain on the glass caused by the obstruction is increased by such conditions as wind pressures, extremes of temperature, motion of vehicle, etc.

REMOVAL

If crack extends to outer edge of glass, mark body with chalk at this point so that weatherstrip flange opening can be examined later for possible distortion.

Protect interior finish by using a protective covering mask around window opening and lay a suitable cover to protect body.

WARNING: ALWAYS WEAR HEAVY GLOVES TO PREVENT POSSIBLE INJURY WHEN HANDLING GLASS.

1. From inside of vehicle pull insert out of rubber seal by pulling on ring located at top center of window; pull insert out completely.

2. With aid of an assistant to hold glass outside vehicle, push glass out from inside vehicle.

INSPECTION

Due to the expanse of rear window, it is imperative in the event of a strain break that the window opening be throughly checked before installing a replacement window.

1. Check for the following conditions at the previously marked point of fracture.

A. Chipped edges on glass.

B. Irregularities in body opening.

C. Irregularities in rubber channel weatherstrip.

2. Remove all sealer from flange and body around window opening.

3. Check flange area for high spots. All high spots should be removed.

INSTALLATION

CAUTION: *Do not strike glass against body. Chipped edges on the glass can lead to future breaks.*

If glass clearance is too small and glass is to be ground off, place a strip of tape on a line where glass is to be removed. Grind up to edge of tape.

NOTE: Add build-up to flange where necessary. Usually the building up to only one side and one-half way around one corner will provide proper glass and seal fit. Taper off ends of build-up to conform to edge of glass, otherwise glass breakage may occur, originating at a point adjacent to end of flange build-up.

NOTE: If desired, sealing cement can be applied between lip of seal and glass and seal and opening flange.

1. Assemble the rubber weatherstrip to the window opening flanges. Insert end of glass into its channel in the weatherstrip and seat into position using channel spreader hook of Glass Installing Tool J-2189-02. Move tool around glass to force outer lip of seal over edge of glass.

2. Install Inserter J-2189-4 of Glass Installing Tool J-2189-02 into handle of tool. Feed the rubber insert through the handle and inserter eye. Move inserter and tool to middle of rubber insert. Starting at top center of rubber seal push tool loop and insert into seal groove. Feed in rubber insert while proceeding around one side of window. Use a hitching movement of tool to avoid elongating insert. Position emergency exit pull ring on rubber insert at top center of window. Thread other end of rubber insert through handle and loop of inserter tool. Push tool loop and rubber insert into seal groove and position pull ring in place. Feed in rubber insert while proceeding around other side of window. If new rubber insert is being used, cut off insert allowing sufficient overlap for a tight joint; use the small pin on the tool handle end to smooth the weatherstrip over the rubber insert as shown in Figure 3.

WINDSHIELD WIPER SYSTEM

GENERAL INFORMATION

The vehicle is equipped with variable speed hydraulic wipers with washers as standard equipment. A single motor powers both blades.

The wiper motor is mounted to a bracket on the left side of the vehicle in front of the driver's toe board. A lever control on the left side of the instrument panel varies the speed of the wiper blades. The hydraulic motor is powered by power steering fluid from the discharge side of the power steering pump.

WINDSHIELD WASHER ASSEMBLY REPLACEMENT

The windshield washer reservoir and pump are one unit. The 12 volt pump in the windshield washer reservoir must be replaced with the entire washer assembly.

REMOVAL

1. Disconnect battery ground cables and then disconnect wire leads (2) to washer motor.

2. Disconnect hose at the rear of the washer reservoir.

3. Lift reservoir out of its bracket and remove it from the vehicle.

INSTALLATION

1. Position resevoir in its bracket.

2. Install two wires to terminals on motor.

3. Connect hose to back of reservoir.

4. Connect battery ground cables and check for proper operation.

WASHER NOZZLE ADJUSTMENT

The windshield washer nozzle is located on the end of the wiper arm. The nozzle is retained by the same nut and bolt which attaches the blade to the wiper arm. The nozzle should be parallel with the windshield as shown in Figure 23.

Nozzles are adjustable by loosening the attaching bolt, position nozzle as described above and tighten bolt.

TRANSMISSION PIVOT SHAFT AND LINK REPLACEMENT

REMOVAL

1. To release tension, lift wiper arm off windshield and insert pin into aligned holes at wiper arm spline shaft. Remove wiper arms from pivot shafts by removing wiper arm retaining nuts (See figure 24).

2. Remove linkage from wiper motor crank arm by sliding back clip(s) away from motor (figure 25).

3. Remove three bolts from transmission pivot shaft mounting bracket as shown in Figure 26. Remove assembly.

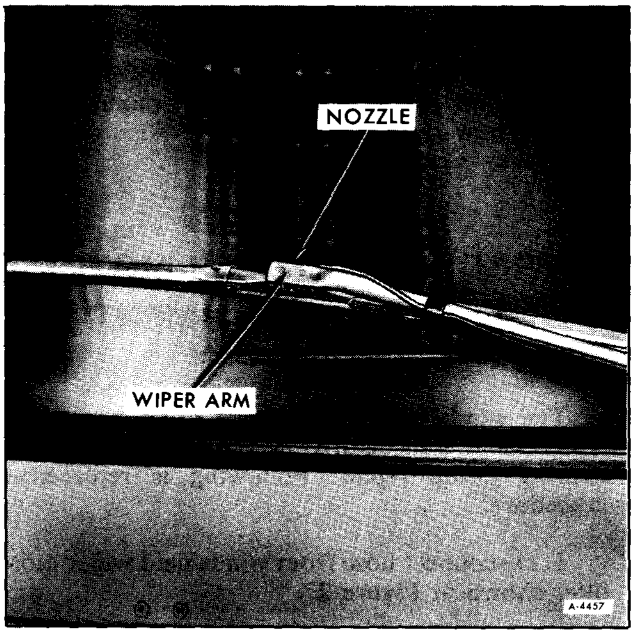

Figure 23—Windshield Wiper Nozzle Alignment

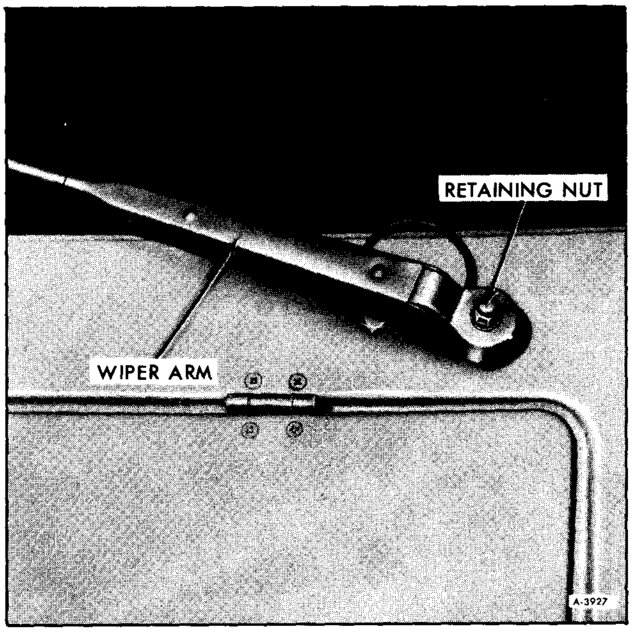

Figure 24—Wiper Arm Removal

INSTALLATION

1. Position transmission pivot shaft and secure with three bolts at its mounting bracket.

2. Install linkage to crank arm on wiper motor.

3. Install wiper arms on pivot shafts.

WIPER BLADE REPLACEMENT

The wiper blade is retained by the use of a spring type retainer clip in the end of the blade element.

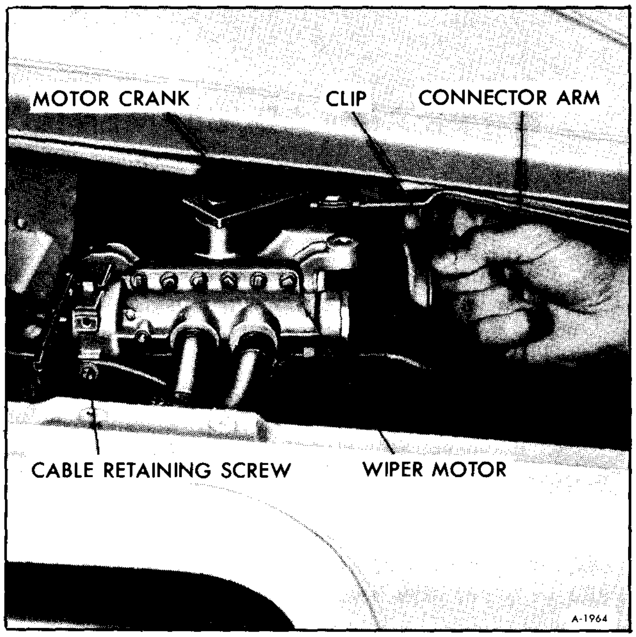

Figure 25—Removing Linkage

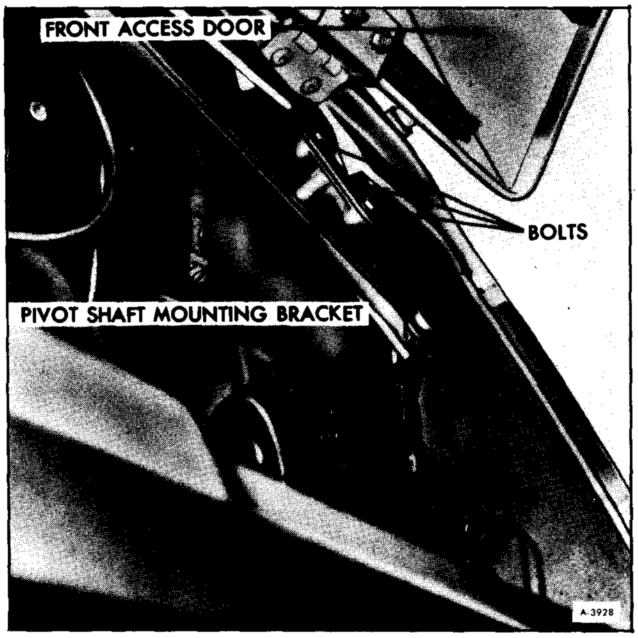

Figure 26—Pivot Shaft Mounting Bracket

When the retainer clip is squeezed together, the blade can be removed by sliding out of the blade assembly.

The blade assembly is retained to the wiper arm by a nut and bolt at the end of the arm. The removal of this nut and bolt will allow removal of the blade assembly and the windshield washer nozzle.

Wiper blades should be installed with the wiper arm in "park" position and the blade to arm bolt approximately 3.25 inches above the windshield rubber moulding.

WIPER ARM ADJUSTMENT

To adjust sweep of blades to provide maximum visibility, turn on wipers, then note sweep of arms.

CAUTION: *Do not attempt to manually force wiper arms into position as damage to linkage or motor may occur.*

If necessary, remove arms as follows;

1. Remove nut from end of wiper arm and remove arm.

2. Arm can be reinstalled in any one of several positions due to serrations on pivot shaft driver head and in wiper arm head.

NOTE: Checking blade sweep should be done with the windshield wet.

WINDSHIELD WIPER MOTOR REPLACEMENT

NOTE: The windshield wiper motor is serviced as an assembly. Do not attempt to repair the motor.

REMOVAL

1. Disconnect hoses (2) at motor and tape end to prevent loss of fluid and entrance of dirt or water into system.

2. Loosen cable retaining screw at bottom of motor and remove pin from arm on motor assembly. See Figure 24.

3. Remove connector arms by sliding back clips and disconnecting arms from the motor assembly.

4. Remove three bolts retaining motor assembly to its bracket.

INSTALLATION

1. Position wiper motor on bracket and install three retaining bolts.

2. Position connector arms on motor crank arm and secure with slide clips.

3. Insert pin at end of cable assembly and secure with retaining screw on motor assembly.

4. Connect hoses to motor assembly as shown in Figure 27.

5. Check power steering fluid level. Operate wipers on a wet windshield for several minutes. Then recheck power steering fluid level. Also check for fluid leaks. Correct as necessary.

WINDSHIELD WIPER MOTOR FILTER REPLACEMENT

The windshield wiper motor filter may require replacement particularly in the event of a power steering pump repair. Following is replacement procedure.

1. Disconnect hose from windshield wiper motor filter shown in Figure 27.

2. Remove filter from windshield wiper motor and discard.

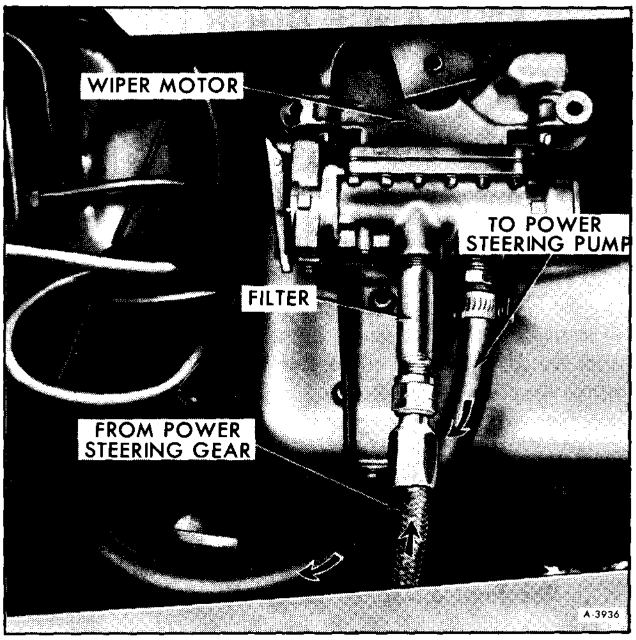

Figure 27—Windshield Wiper Motor

3. Apply pipe joint sealer to filter threads 1/8" from end of filter as shown in Figure 28.

4. Carefully screw filter into wiper motor.

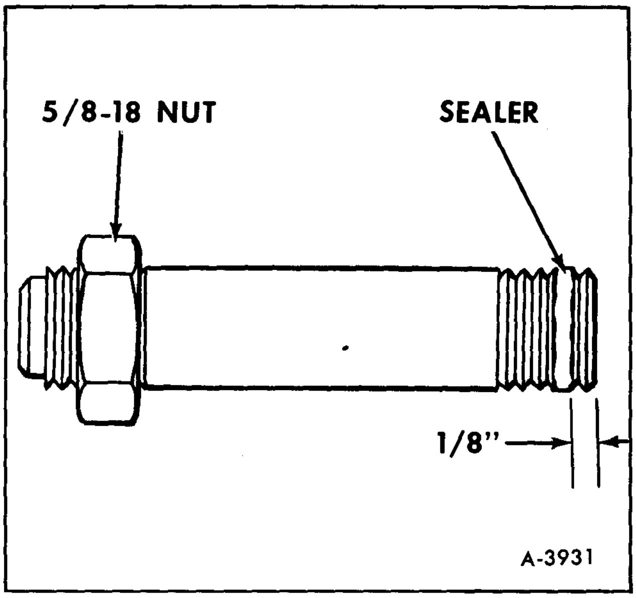

Figure 28—Windshield Wiper Motor Filter

NOTE: Do not get foreign material on motor end of filter.

5. Torque filter to 25 ft. lbs. using a 5/8-18 nut.

6. Reconnect hose to filter.

ENTRANCE DOOR

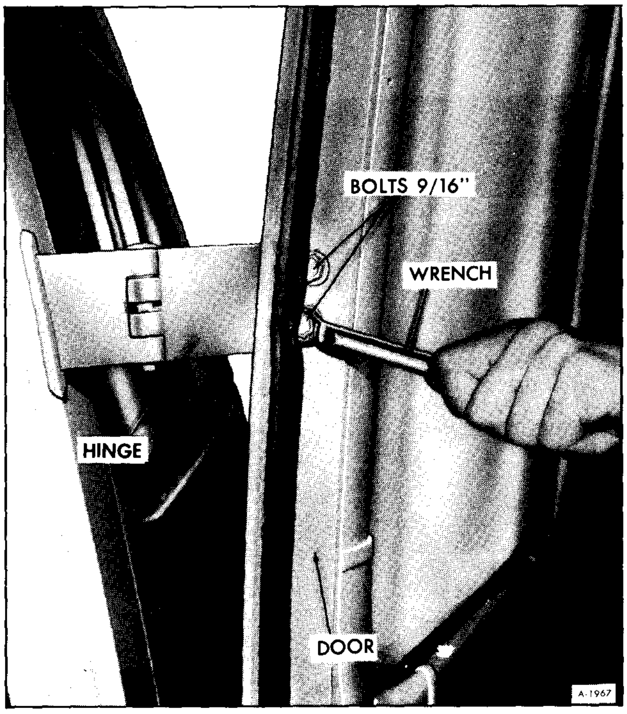

Figure 29—Entrance Door Adjustment-Vertical

ADJUSTMENT

The door may be adjusted vertically by loosening the bolts at both hinges as shown in Figure. 29.

Horizontal adjustment may be made by shimming or removing metal at the shaded area of the hinges as shown in Figure 30.

DOOR SEAL

The entrance door seal is replaceable. Clean old seal from door frame, apply adhesive to frame then install new seal.

DOOR REMOVAL

1. Remove four (4) hinge to door frame attaching bolts.

2. Remove door.

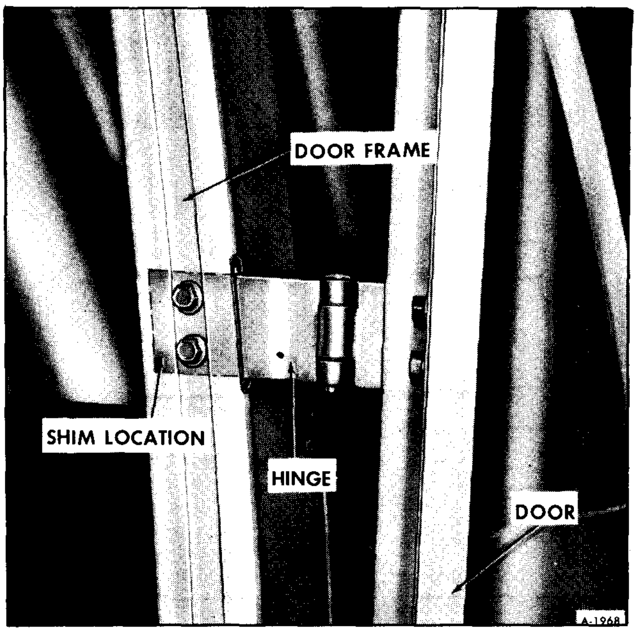

Figure 30—Entrance Door Adjustment-Horizontal

DOOR INSTALLATION

1. Install door.

2. Install four (4) bolts, torque to 25-30 ft. lbs.

3. Check for leaks and correct as necessary.

ENTRANCE DOOR LOCK

REMOVAL (FIGURE 31)

1. Remove lower door trim panel.

2. Remove lock button.

3. Remove lower window moulding.

4. Remove upper trim panel and inner handle assembly by loosening screws shown in Figure 32 and removing all other screws. Use care when removing panel to avoid damaging door handle mechanism.

5. Remove cotter pin from handle control rod. Slide rod out of lever at lock mechanism.

6. Remove actuator lever pin and lock button rod clip. See Figure 33.

7. Remove (2) screws from latch assembly at door frame. Remove this portion from the door.

8. Remove four (4) nuts and lock tumbler clip. Remove lock mechanism. See Figure 33.

INSTALLATION

1. Check sealer around lock opening in door, replace or fill in as required to insure proper seal between lock assembly and door.

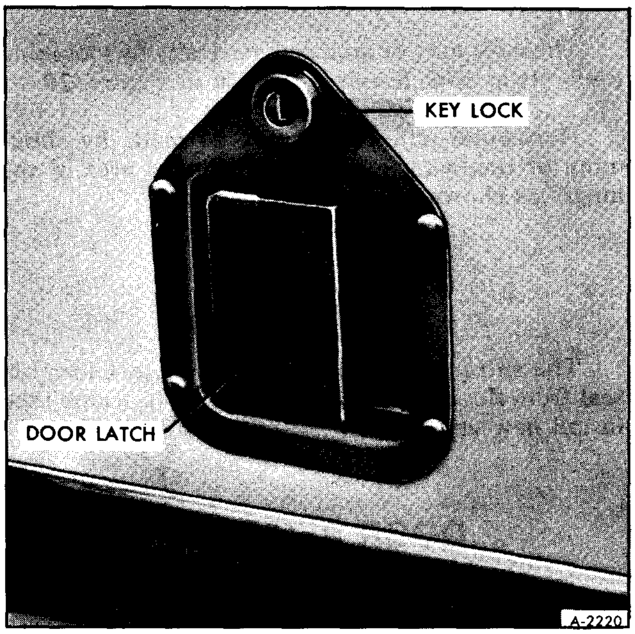

Figure 31—Door Lock

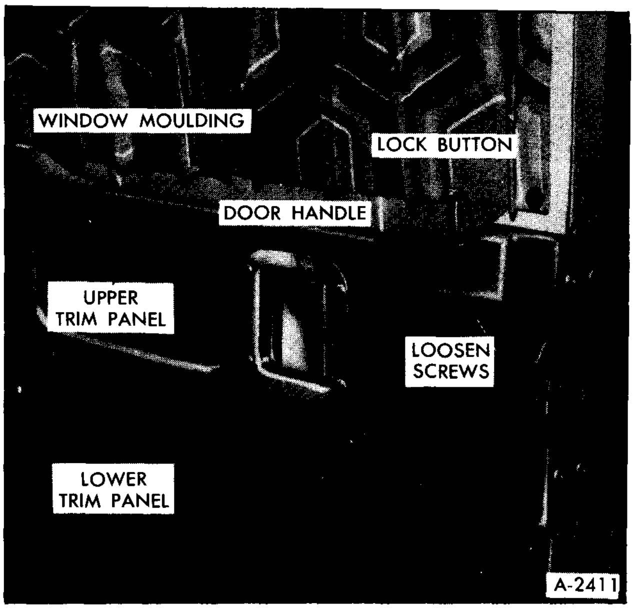

Figure 32—Removing Trim Panels

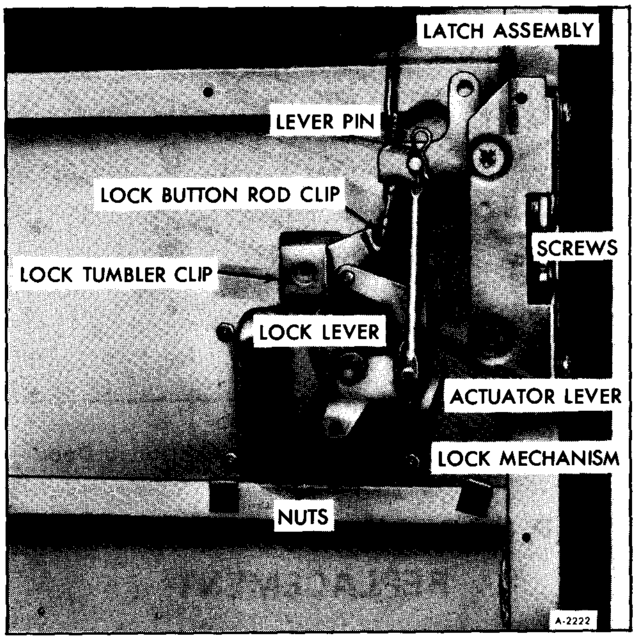

Figure 33—Lock Assembly

2. Apply a liberal amount of lubriplate to all contacting surfaces. Secure assembly with four (4) nuts.

3. Install lock tumbler and secure with clip.

4. Install latch assembly on door frame and loosely secure with two (2) screws on door frame.

5. Install lock button rod clip and actuator lever pin as shown in Figure 33.

6. Install inner panel and handle assembly. At the same time guide handle rod into lever at lock mechanism.

7. Install cotter pin to secure rod to lever.

8. Secure upper trim panel with screws.

9. Install lower door trim panel and window moulding.

DOOR HINGES

REMOVAL

1. Remove entrance door. Refer to "Door-Removal" earlier in this section.

2. Remove two (2) bolts per hinge.

3. Remove hinge.

INSTALLATION

1. Install hinge on door frame and two (2) bolts. Torque to 25-30 ft. lbs.

2. Install entrance door. Refer to "Door-Installation" earlier in this section.

ACCESS DOORS

FRONT ACCESS DOOR LATCH REPLACEMENT

REMOVAL

1. Drill out rivets (2) on each side of handle. See Figure 34.

2. Remove "T" pin. See Figure 34.

3. Slide latch mechanism out of door.

INSTALLATION

1. Position latch mechanism in access door.

2. Install pop rivets.

3. Install "T" pin.

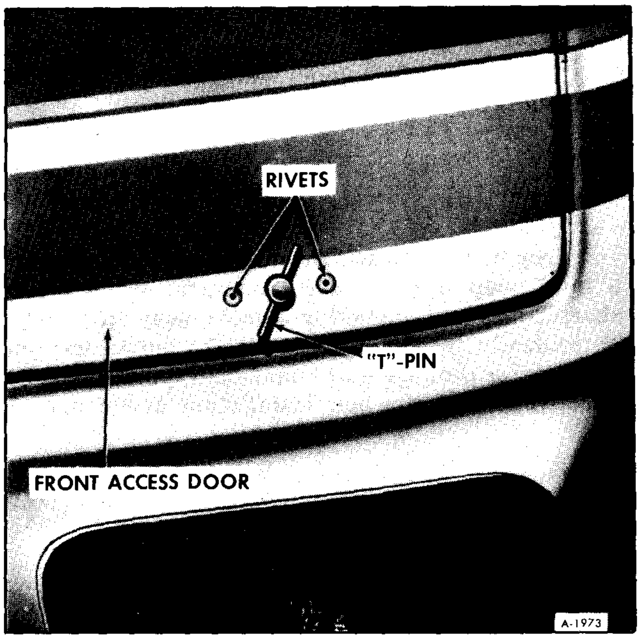

Figure 34—Front Access Door Latch

FRONT ACCESS DOOR REPLACEMENT

REMOVAL

1. On outboard side of door remove two nuts and bots retaining support to door.

2. Remove nuts and bolts retaining hinge to body.

3. Remove access door.

INSTALLATION

1. Postion access door in body opening and install hinge retaining nuts and bolts to body.

2. Position access door support to access door and secure with nut and bolt.

EXTERNAL UTILITIES COMPARTMENT DOOR REPLACEMENT

REMOVAL

1. Drill out four pop-rivets holding piano hinge to body (See figure 35).

2. Remove door. Door may be removed from hinge by drilling out four pop-rivets retaining door to hinge.

INSTALLATION

Position door and hinge assembly in its opening and pop-rivet door in place.

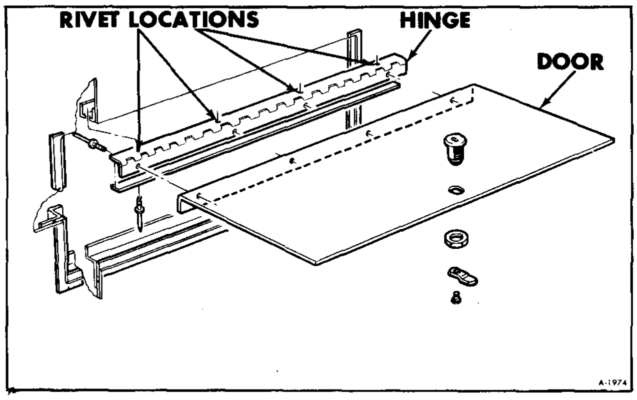

Figure 35—External Utilities Compartment Door

LP GAS, OR STORAGE DOOR REPLACEMENT

Both LP gas door and the storage (or motor generator) door are removed and installed in the same manner.

REMOVAL

1. With the access door closed drill out pop rivets that retain the hinge to the body.

2. Unfasten latches and remove door.

INSTALLATION

1. Position door in its opening.

2. Pop rivet hinge to body.

LAP BELT MAINTENANCE

Keep belts clean and dry. Clean periodically with a mild soap solution and lukewarm water. Keep sharp edges and damaging objects away from belts. Periodically inspect belts, buckles, retractors, and anchors for damage that could materially lessen the effectiveness of the belt installation and repair or replace the questionable parts. Do not bleach or dye belts as this may cause severe loss of strength.

If necessary, to replace belts or related attaching parts be sure to tighten lap belt anchor bolts to 30-45 foot-pounds torque.

FLOOR

GENERAL INFORMATION

The floor of the vehicle is made of 3/4" plywood sections. The plywood sections are bonded and pop-riveted to the floor sub-structure and the panels of heavy duty floor insulation. The floor insulation panels fit within the lateral cross members of the sub-structure, Figure 36. Both insulation panels and

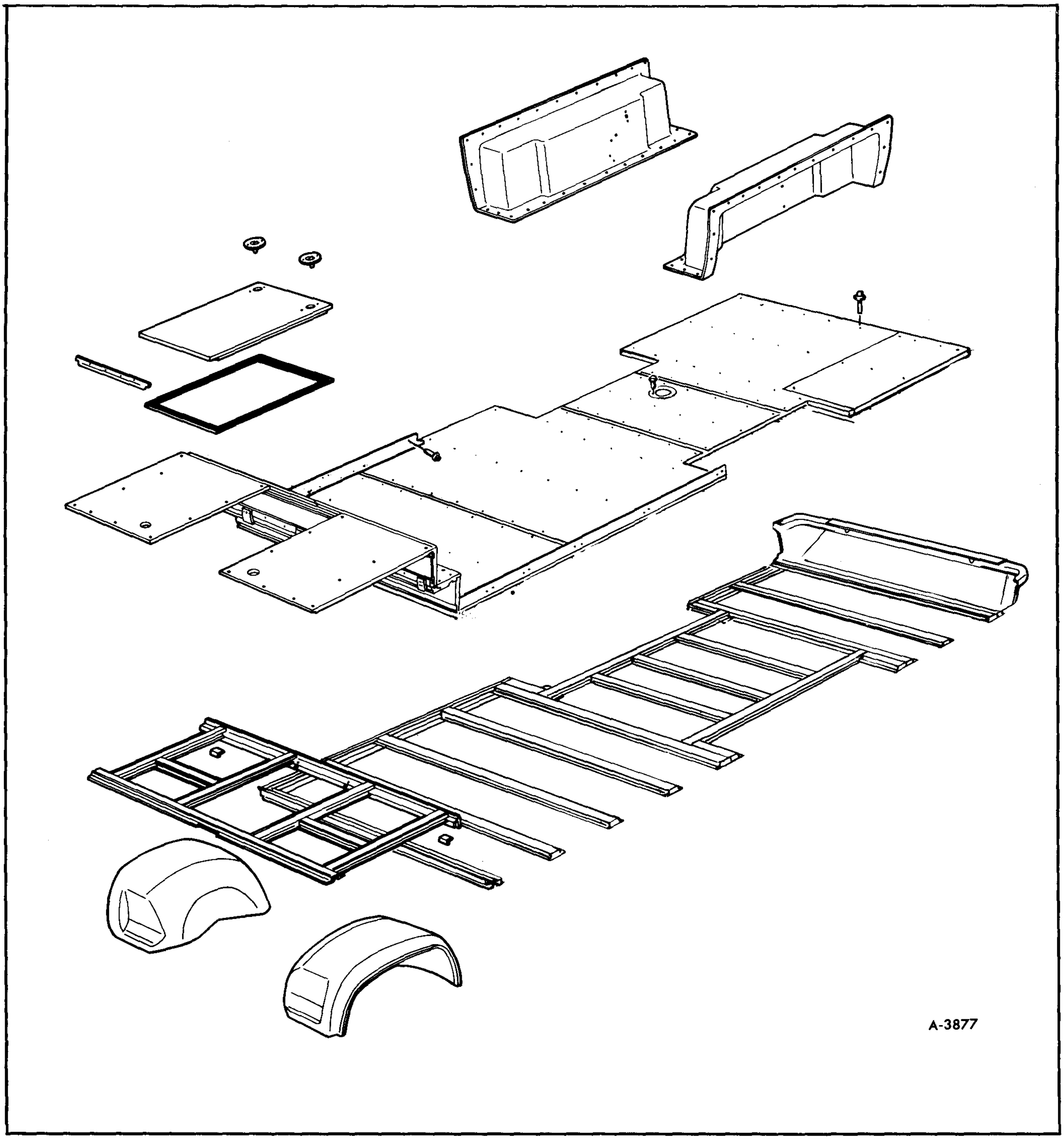

Figure 36—Wheel Housings and Floor

plywood sections can be replaced; however, repair of plywood floor is more practical and is corrected later in this section.

The engine cover, the only section designed to be removed, is located between the driver and passenger seat and is secured by a lip in the front and two screw attachments at each rear corner.

The front wheel houses are made of plastic polyethylene while the rear wheel houses are fiber glass. The front housings are repairable or replaceable if damaged. The rear housings are repairable of damaged. The entire underfloor area has been sprayed with a rust preventative and sealer undercoating.

FRONT WHEEL HOUSINGS

REMOVAL

1. Remove six (6) screws securing housing to fiberglass wheel opening.

2. Remove one (1) bolt securing housing to floor support.

3. Remove wheel housing.

INSTALLATION

1. Install and position wheel housing.

2. Install one (1) bolt securing housing to floor support.

3. Install six (6) screws to secure housing to fiberglass wheel opening.

PLYWOOD FLOOR

CAUTION: *Before drilling, sawing, chiseling etc. the plywood be sure damage will not occur to components directly under the floor.*

A thorough inspection of the damaged floor area should be made before attempting any repair. The damaged area should be replaced with 3/4 inch exterior grade plywood. It is not necessary to replace an entire section but this will depend on the location and the extent of the damage.

All sections are secured to the supports with poprivets. Any pop-rivet may be removed by drilling into the center of the rivet with a 3/16" drill bit. Drill approximately 1/8" deep and with a punch tap into this hole to drive the rivet shaft out.

CAUTION: *Care must be taken to properly seal any seams or joints resulting from floor section replacement or repair. Exhaust gases, dust, water etc. will leak past any seam or joint not caulked.*

The underside surfaces of new plywood must be coated with a wood preservative.

FLOOR INSULATION

Panels of heavy duty floor insulation fit inside the lateral cross members of the floor sub-structure (optional on TransMode vehicles). The insulation consists of rigid polyurethane foam panels bonded to an aluminum protective skin and, in turn, bonded to the sub-structure and plywood floor. Care should be used in repairing plywood floor so as not to damage the insulation package. The insulation panels are replaceable if damaged.

CAUTION: *Urethane foam is a flammable material. Welding near insulation may result in damage to insulation and/or vehicle.*

ENGINE COVER

This removable floor section is made of one inch plywood. A seal is secured to the underside of the cover with an adhesive and staples. A damaged gasket should be replaced using a suitable adhesive and staples.

The rear corners of the cover are secured by screwing the bolt into a clip nut mounted to the cover frame. Proper operation of this fastener is important to allow the cover seal to make good contact with the frame.

Fasterners are replaceable and are held in place with two wood screws. Peel back the carpeting from the corner as required to gain access to wood screws. The clip nut is a standard hardware item and is replaceable.

If the fastener is replaced apply some adhesive to the cover to hold the carpet in place at the corners.

REAR WHEEL HOUSINGS

As mentioned previously, rear wheelhouses are constructed of fiberglass and are repairable.

Any repair to the wheelhouses should be done with fiberglass patch and epoxy adhesive. Use as sufficient amount of adhesive to insure an air seal between the inside and the outside of the vehicle. Be sure to follow precautions and procedures given later in this section on repairing fiberglass components.

BODY

GENERAL INFORMATION

The body of the vehicle is constructed of aluminum and fiberglass. Extruded aluminum ribs and struts are welded together to form a cage-like framework. The exterior skin is than bonded directly to the framework (See Figure 38).

Figure 37—Cab Roof Insulation

Both front and rear end caps are fiberglass; and the lower side panels, below the belt line, are fiberglass. The side panels, above the belt line, are sheet aluminum. The main roof panel is also sheet aluminum.

The roof and side panels are bonded directly to the aluminum framing. Pop rivets are then used to secure the panels where the roof and side panels are joined. Rivets are also used at the belt line.

INSULATION

The main body area, rear end cap, side panels, and roof cap of the driver's compartment are coated with 3/4" thick rigid urethane foam, (figure 37). Areas which must remain accessible for servicing have not been coated with insulation. These areas include electrical harnesses, structure flanges, interior component mounting surfaces, and pre-insulated areas.

CAUTION: *Urethane foam is a flammable material. Welding near insulation may result in damage to insulation and/or vehicle.*

As previously discussed, polyurethane foam panels insulate the floor area. The driver toe pan mat is insulated with 1/4" of "ENSOLITE". The lower dash area is also insulated.

The insulation package applied to vehicle insures temperature control and improves performance of heating and air conditioning systems. Be careful not to damage insulation when making repairs.

REPAIR OF FIBERGLASS COMPONENTS

Before starting repair operations, look for hidden damage by applying force around the damaged area, looking for hairline cracks and other breakage. Early repair of minor damage may prevent major reapir later.

PRECAUTIONS

Creams are available to protect the skin from a condition known as occupational, or contact dermititis. Improved resin formulas have almost eliminated skin irritation. Cream is available for persons who may have a tendency toward skin irritation from the resins or dust.

The application of these creams is recommended whenever the resin materials are used. Generally the cream is not required when the plastic (epoxy) solder kit is being used.

1. Remove resin mixture from hands as soon as possible and always before mixture starts to gel. This can be observed by the action of the material being

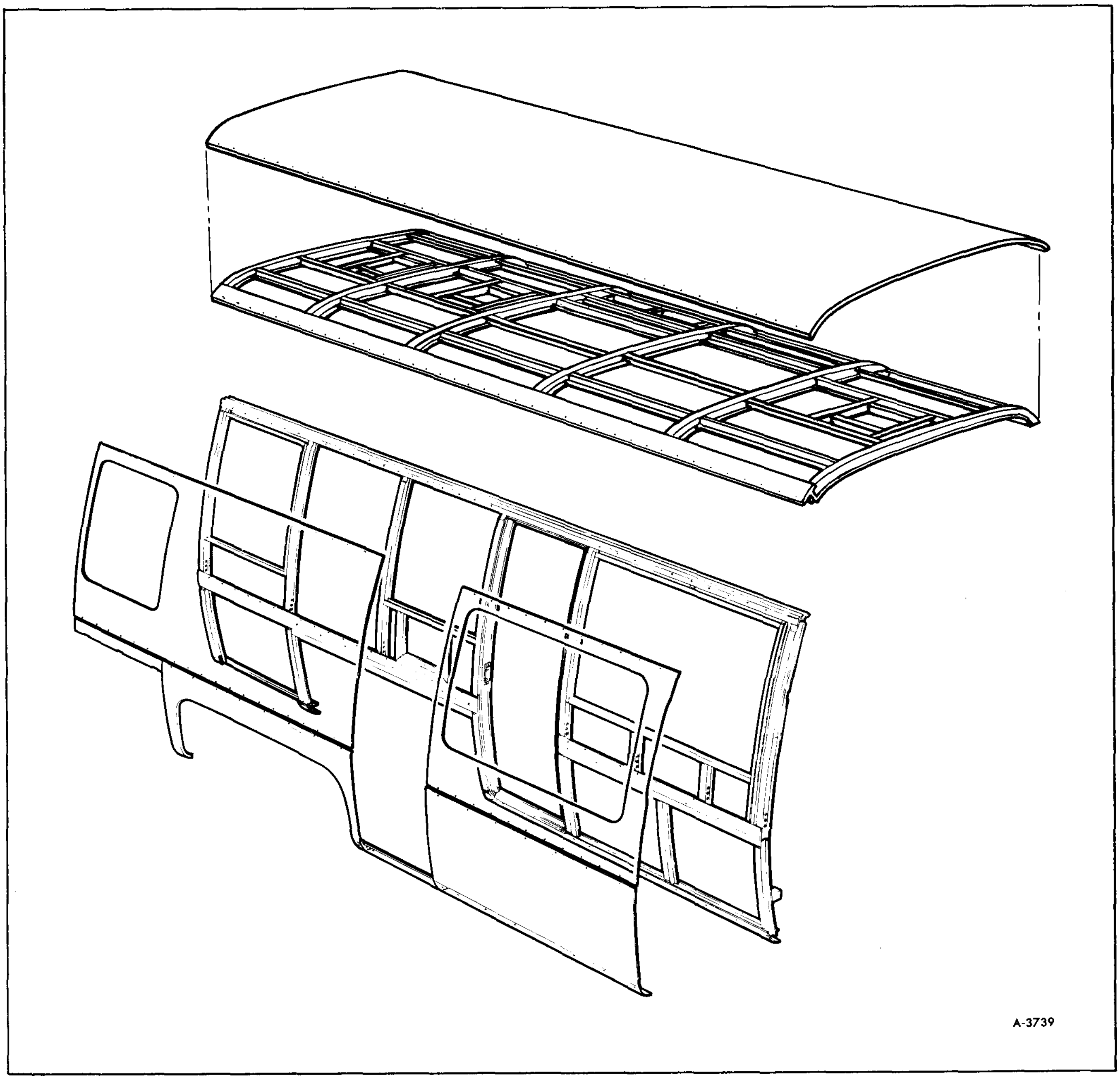

Figure 38—Side and Roof Frame

used. Resin may be removed with lacquer thinner by washing in soap and water.

2. Respirators are recommended when grinding. Also, some minor skin irritation from glass and powdered cured resin may be evident. Washing in cold water will help to minimize.

3. Use a sander with a vacuum attachment for dust control whenever possible.

4. Resin mixtures may produce toxic fumes and should be used in well vantilated areas.

5. Be careful not to get any resin material on clothing.

6. Use the proper materials for the job.

7. Keep materials, utensils and work area clean and dry. These repairs involve chemical reactions, and dirt or moisture may upset the chemical balances and produce unsatisfactory results.

8. To protect the eyes, wearing goggles is also recommended. Do not rub eyes or face when working with fiberglass.

REPAIR PROCEDURES

For repair procedures refer to General Motors Service Information Bulletin (B-4). Copies of the fiberglass repair bulletin (B-4) may be ordered from the following address:

General Motors Service Information

P. O. Box 7124

Detroit, Michigan, 48202

Materials, for repairing damaged fiberglass panels, are available in kit form through GM Dealerships, or equivalent kits can be purchased locally.

SHEET METAL REPAIR

The aluminum panels on the body may be repaired if damaged. Filler putty can be used for minor dents, scratches, scrapes etc. However, major damage to a panel will require removal of at least part of the panel. Because the panels are secured to the ribs with a polyurethane adhesive, separating and removing panels is difficult. Any rivets used on the panels are easily removed by drilling off the rivet head and, using a punch, drive out the rivet shaft.

All windows, access doors, vents, belt and roof line trim mouldings in the damaged area should be removed before removing the panel.

An air chisel will be helpful to remove the panel. Operate the air chisel along the rib to break the adhesive bond between the panel and the rib.

CAUTION: *Be careful during chiseling, sawing, drilling etc. on the aluminum panels not to damage wiring, piping, insulation, components etc. which are located immediately behind the panels.*

Any damaged rib will have to be straightened, replaced or have shim material fastened to the rib so proper support will be provided for the aluminum panel.

A replacement panel should be fitted after the ribs have been thoroughly cleaned of adhesive. A suggested method would be to grind off the adhesive with an extra coarse disc on an air driven grinding wheel.

With the ribs cleaned a new panel may be fitted into the opening. Next, with the panel in place drill holes, or use existing holes, (at each corner and along the belt line and roof line) through the panel and rib for using pop-rivets.

Remove panel and apply adhesive such as manufactured by Minnesota Mining and Manufacturing, 3539 A/B, or equivalent to the rib. This is a two part (base and accelerator) urethane adhesive designed for bonding aluminum, polyester, and steel. It is essential that the surface be thoroughly clean, dry, and grease free before application. Follow the manufacturers' mixing and curing instructions. Avoid repeated skin contact and use only in a well ventilated area.

Position panel in place and pop-rivet using predrilled holes. The adhesive will cure at room temperature in 24 hours. The rivet holes may be ground off and the holes filled with a body putty.

SEATS

DRIVER AND SINGLE PASSENGER SEAT

The seat assembly can be removed by itself or as a unit with pedestal assembly.

SEAT REMOVAL

1. Swivel chair to a 45° position.

2. This will allow access to the four retaining bolts. Remove four bolts (See figure 39).

3. Remove seat.

SEAT INSTALLATION

1. Swivel top of pedestal to allow access to seat mounting holes.

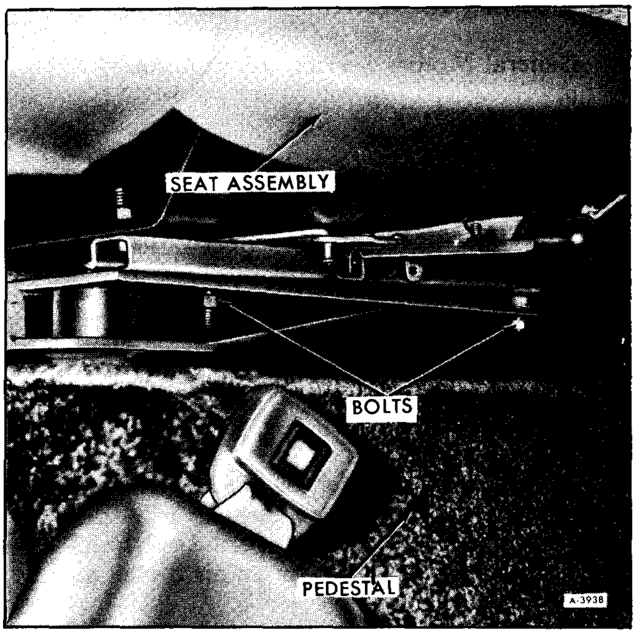

Figure 39—Seat Attaching Bolts

2. Position spacers and install retaining bolts to weld nuts in base of seat. Tighten securely.

PEDESTAL REPLACEMENT

REMOVAL

1. Remove seat as described above.

2. Remove twelve nuts and bolts from base of pedestal. (Access to nuts can be made through the engine access cover)

3. Remove pedestal.

INSTALLATION

1. Position pedestal over mounting holes.

2. Install nuts and bolts to retain pedestal.

3. Install seat as described previously in this section.

DUAL PASSENGER SEAT REPLACEMENT

The dual passenger seat is removed in the same manner as the driver and single passenger seat, refer to the preceding procedures for removal and installation.

The pedestal for the dual passenger seat is also removed by the same method as the driver and single passenger seat pedestal.

MIRRORS AND SUN VISOR

INSIDE REAR VIEW MIRROR

REMOVAL

1. Loosen set screw at base of mirror.

2. Slide mirror to the rear and remove.

INSTALLATION

1. Position mirror on sun visor and mirror mounting bracket.

2. Tighten set screw.

OUTSIDE REARVIEW MIRROR (FIGURE 40)

The entire mirror assembly can be removed by removing four retaining bolts from the mirror bracket. Install by replacing these four bolts.

Either the mirror head or support arm can be removed by removing the acorn nut as shown in Figure 40.

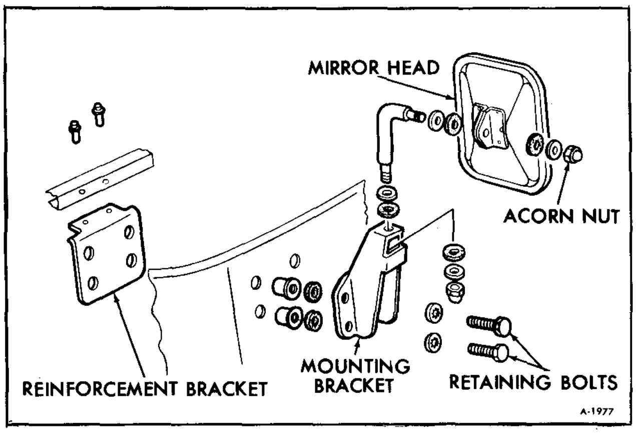

Figure 40—Exterior Mirror

A reinforcement bracket is used to back the riv-nuts which retains the mirror assembly to the body. This bracket is held in place by two rivets to the sill.

SUN VISOR

REMOVAL

Remove visor from center support bracket, and swing visor to side. Visor can now be removed by loosening hex head bolt at end of visor shaft.

INSTALLATION

Position visor and install threaded end of visor arm into its mounting bracket. Tighten hex head bolt and position visor in support clip.

RADIATOR GRILLE (FIGURE 41)

REMOVAL

1. Open front access doors.

2. Remove six nuts from inside of grille.

3. Remove grille.

INSTALLATION

1. Position grille with studs through body.

2. Install six nuts and washers to retain grille in proper position.

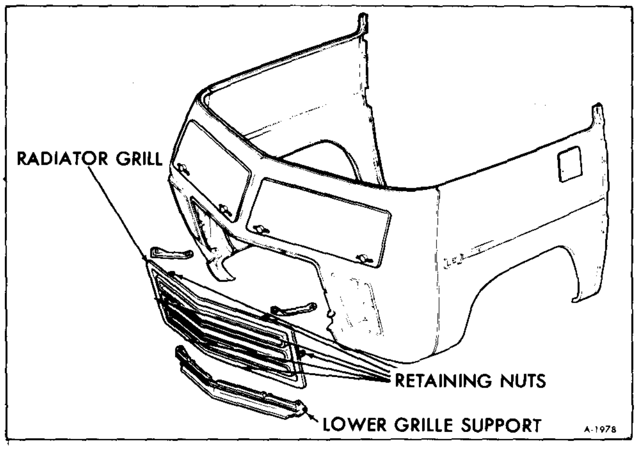

Figure 41—Radiator Grille

END CAP

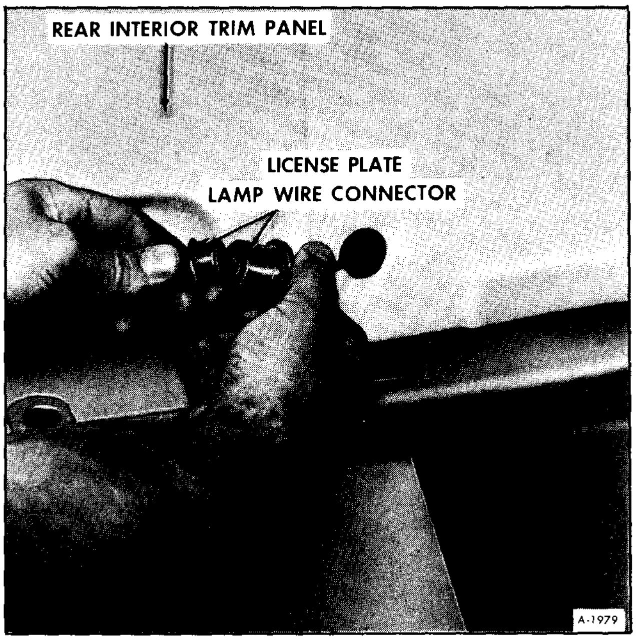

Figure 42—Disconnecting Wire to License Plate Lamp

REMOVAL

1. Disconnect wires for license plate light at lower left-hand inside corner as shown in Figure 42.

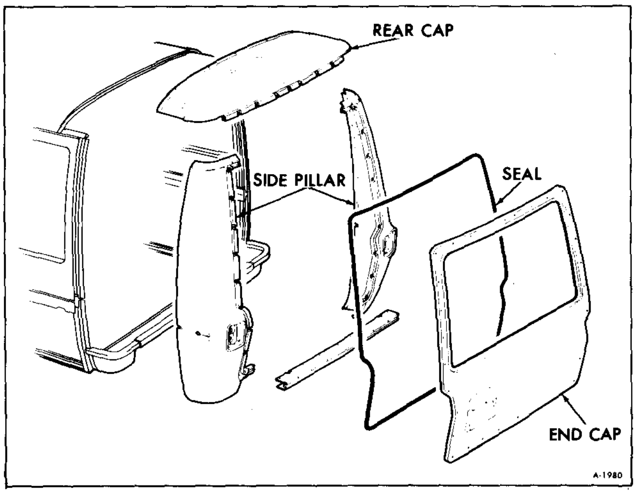

Figure 43—End Cap Components

NOTE: It may be necessary to remove interior trim at rear of Motor Home to gain access to license plate wiring connector.

2. Remove screws from interior trim to end cap.

3. Remove end cap to body retaining screws (32) from end cap (See figure 43).

4. Remove end cap from body.

INSTALLATION

1. Check seal to make sure it is still intact. Replace seal, if necessary.

2. Position end cap in place and install 32 retaining screws.

NOTE: The seven lower screws are self-tapping screws while the 25 screws on the sides and top of the end cap are hi-low screws.

3. Install screws retaining interior trim to end cap.

4. Reconnect license plate wiring.

SPECIAL TOOLS

J-2189-02	Glass Installing Tool

AIR CONDITIONING SYSTEM (INCLUDES HEATING)

Contents of this section are listed below:

SUBJECT	PAGE NO.
General Description	1-29
System Components and Their Function	1-37
General Information	1-51
Inspection and Periodic Service	1-56
Evacuting and Charging Procedures	1-57
Refrigerant Quick Check Procedure	1-61
Maintenance and Adjustments	1-62
General Repair Proceduces and Component Replacement	1-63
Compressor Minor Overhaul Procedures	1-72
Compressor Major Overhaul Procedures	1-80
Leak Testing the Compressor	1-97
Air Conditioning Diagnosis	1-98
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GENERAL DESCRIPTION

Both the heating and cooling functions are performed by this system. Air entering the vehicle must pass through the cooling unit (evaporator) and through (or around) the heating unit, in that order, and the system is thus referred to as a "reheat" system.

The evaporator provides maximum cooling of the air passing through the core when the air conditioning system is calling for cooling. A thermostatic switch, located in the blower-evaporator case, acts to control compressor operation by sensing the fin temperature of the evaporator core.

System operation is as follows: Air, either outside air or recirculated air, enters the system and is forced through the system by the blower. As the air passes through the evaporator core, it receives maximum cooling if the air conditioning controls are calling for cooling. After leaving the evaporator, the air enters the Heater and Air Conditioner Selector Duct Assembly where, by means of diverter doors, it is caused to pass through or to bypass the heater core in the proportions necessary to provide the desired outlet temperature. Conditioned air then enters the vehicle through the dash outlets. When, during cooling operations, the air is cooled by the evaporator to below comfort level, it is then warmed by the heater to the desired temperature. During "heating only" operations, the compressor will not be in operation and ambient air will be warmed to the desired level in the same manner.

The dash outlets are rectangular in design and have two-way action. The whole outlet can be swiveled and the inside louvers can be turned to direct air as desired. Also there are two floor outlets.

THEORY OF OPERATION

HEAT

We all know what air conditioning does for use but very few understand how or why it works. An air conditioner is functionally very similar to a refrigerator. A refrigerator is a simple mechanism which, surprisingly enough, works quite a bit like a teakettle boiling on a stove. That may sound far-fetched, but there is more similarity between the two than most of us would suspect. A modern refrigerator can make ice cubes and keep food cool and fresh only because a liquid called the refrigerant boils inside the freezer.

Everyone knows a boiling teakettle is "hot" and a refrigerator is "cold". We usually think of "cold" as a definite, positive condition. The only way we can define it is in a rather negative sort of way by saying "cold" is simply the lack of heat, just as darkness is the lack of light. We can't make things cold directly. All we can do is remove some of the heat they contain and they will become cold as a result. And that is the main job of any refrigerator. Both are simply devices for removing heat.

Transfer of Heat

The only thing that will attract heat is a colder object. Like water, which always flows downhill,

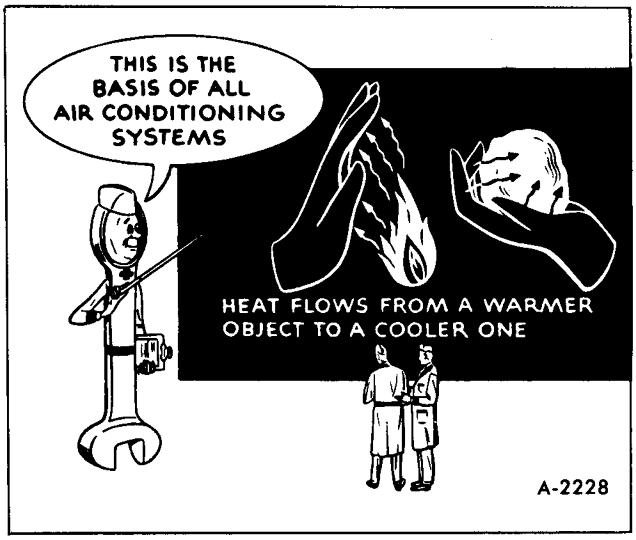


Figure 1—Heat Transfer

heat always flows down a temperature scale - from a warm level down to a colder one. When we hold our hands out toward the fireplace, heat flows from the hot fire out to our cold hands (figure 1). When we make a snowball, heat always flows from out warm hands to the colder snow.

Measurement of Heat

Everyone thinks he knows how heat is measured. Thermometers are used in every home. **(Whenever we speak of temperature from now on, we will mean Fahrenheit).** They can tell how hot a substance is, but they can't tell us everything about heat.

When we put a teakettle on a stove, we expect it to get hotter and hotter until it finally boils. All during the process, we can tell exactly how hot the water is by means of a thermometer (figure 2). Our thermometer will show us that the flame is just as hot

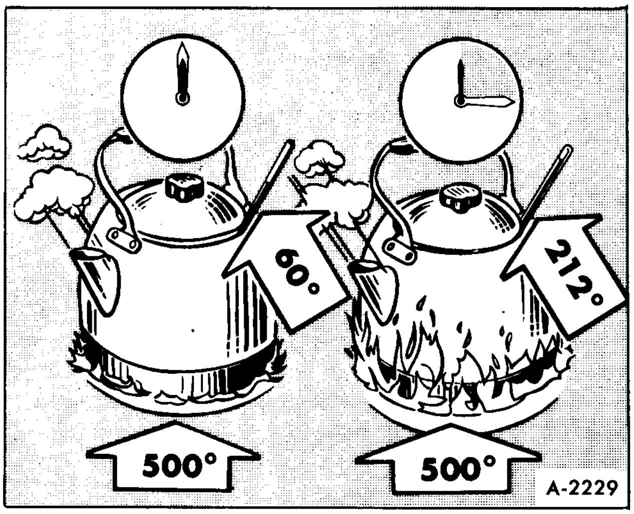


Figure 2—Measurement of Heat

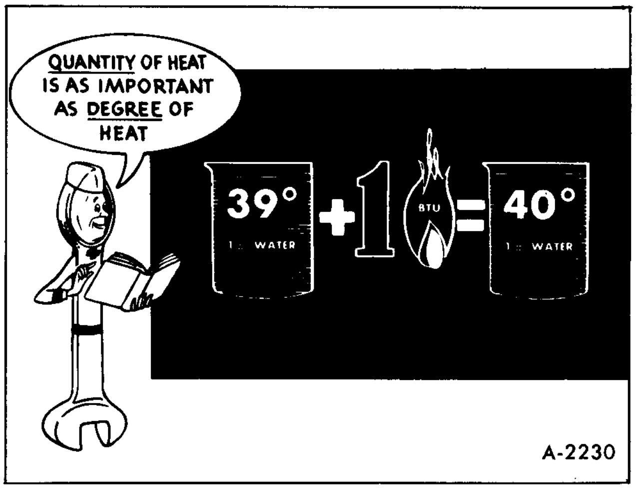


Figure 3—Quantity of Heat

when we first put the teakettle on the stove as it is when the water finally boils. Why doesn't the water boil immediately? Why does it take longer to boil a quart of water than a cupful? Obviously temperature isn't the only measurement of heat.

Even though heat is intangible, it can be measured by quantity as well as intensity. Thermometers indicate only the intensity of heat. The unit for measuring quantity of heat is specified as that amount necessary to make 1 pound of water 1 degree warmer (figure 3). We call this quantity of heat a British Thermal Unit. Oftentimes, it is abbreviated to B.T.U.

Perhaps we can get a better idea of these two characteristics of heat if we think of heat as a sort of coloring dye. If we add one drop of red dye to a glass of water, it will turn slightly pink Another drop will make the water more reddish in color. The more drops of dye we add, the redder the water will get. Each drop of dye corresponds to 1 B.T.U. and the succedingly deeper shades of red are like increases in temperature.

It may seem a little puzzling to talk about heat in a manual on air conditioning...but, when you stop to think about it, we are handling heat exclusively. Although we ordinarily think of an air conditioner as a device for making air cold, it does that indirectly. What it does is to take heat away from the air and transfer that heat outside the vehicle.

We know now that cold is nothing more than the absence of heat, and that heat always flows from a warm object to a colder one. We also have a clearer idea of how heat is measured.

From everything we've learned about heat so far, it seems to behave in a perfectly normal manner. Yet sometimes heat will disappear without leaving a single clue.

Ice vs Water For Cooling

Every once in a while in the old days, the iceman would forget to stop by to refill the icebox. Ocassionally, as the last sliver of ice melted away, somebody would come up with a bright idea. He would remember that the water in the drainpan always felt icecold when he emptied it other times. So, he would get the thermometer out and check its temperature. Sure enough, it usually was about as cold as the ice. Why not put the drainpan back in the ice compartment to keep things cold until the iceman returned the next day?

For some strange reason, the icebox never stayed cold. The drain water soon got quite warm and in a couple of hours, the butter in the icebox would begin to melt, the milk would start to sour, and the vegetables would wilt.

The drain water was only a few degrees warmer than the ice yet it didn't draw nearly as much heat out of the stored foods. The difference between the behavior of cold drain water and ice is the real secret as to how any refrigerator works, and we can easily see this by using an ordinary thermometer.

When we put a drainpan full of cold water into the ice compartment, we expect the heat to flow from the warm foods to the colder water. Remember, that heat always flows from a warm object to a colder object and when we add heat to water, it gets warmer. Each B.T.U. of heat added to a pound of water makes it one degree warmer.

If we were to put a thermometer in the cold drain water, we would see the temperature gradually creep upwards. That is to be expected because heat is flowing into the cold water making it warmer. Before long the water would be as warm as the stored foods. Then the water could no longer attract heat because heat will not flow from one warm object to another equally warm object. Since we no longer can draw heat out of the foods we no longer are cooling them.

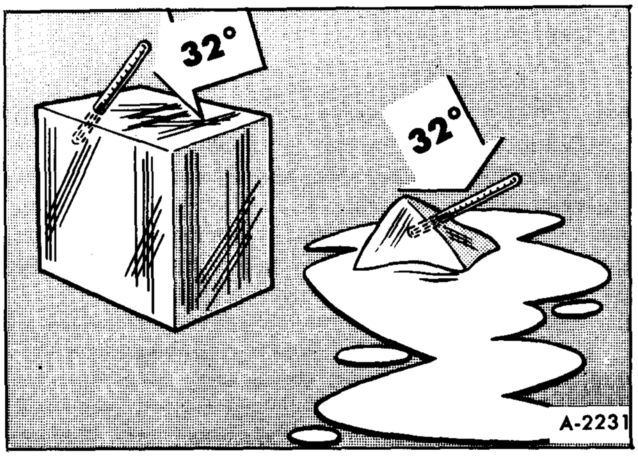


Figure 4—Melting Ice Remains at 32°F. (0°C.)

Now, let's see what happens when we put ice instead of cold water into the icebox. This time, we'll set the thermometer on top of the ice (figure 4). When we first look at the thermometer, it reads 32°F. (0°C.) A couple of hours later, the ice chunk is smaller because some of the ice has already melted away — but the thermometer still reads 32°F (0°C.).

All this time, the ice has been soaking up heat, yet it never gets any warmer no matter how much heat it draws from the stored food. On the other hand, the cold drain water got progressively warmer as it soaked up heat. The addition of heat will make water warmer yet won't raise the temperature of ice above the 32°F. (0°C.) mark.

If we fill one drinking glass with ice and another with cold water, and put both glasses in the same room where they could absorb equal amounts of heat from the room air, we will find it takes much, much longer for the ice to melt and reach room temperature than it did for the water in the other glass to reach the same temperature. Obviously, most of the heat was being used to melt the ice. But it was the heat that apparently disappeared or was transformed because it couldn't be located with a thermometer. To describe this disappearing heat scientists chose the word "latent" which means hidden.

Latent Heat

So latent heat is nothing more or less than hidden heat which can't be found with a thermometer.

At first it was thought that latent heat was in the water that melted from the ice. But that wasn't exactly the right answer because, upon checking water temperature as it melts from ice, it will be found that

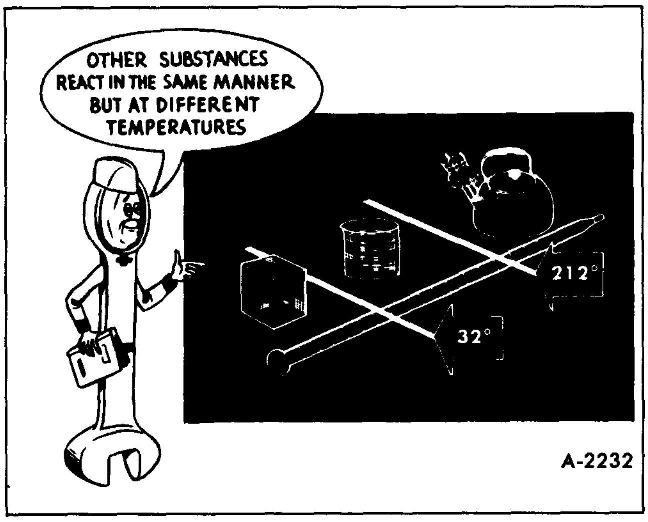


Figure 5—Temperature Determines the State of Water

it is only a shade warmer than the ice itself. It is not nearly warm enough to account for all the heat the ice had absorbed. The only possible answer is that the latent heat had been used up to change the ice from a solid into a liquid.

Many substances can be either a solid, or a liquid, or a gas. It just depends on the temperature whether water for example was a liquid, or a solid (ice), or gas (steam) (figure 5).

All solids soak up huge amounts of heat without getting any warmer when they change into liquids, and the same thing will happen when a substance changes from a liquid into a gas.

Put some water in a teakettle, set it over a fire and watch the thermometer as the water gets hotter and hotter, the mercury will keep rising until the water starts to boil. Then the mercury seems to stick at the 212°F. (100°C.) mark. Put more wood on the fire, despite all the increased heat, the mercury will not budge above the 212°F. (100°C.) mark (figure 6).

No matter how large or hot you make the flame, you can't make water any hotter than 212° at sea level. As a liquid changes into a gas, it absorbs abnormally great amounts of heat without getting any hotter.

Now we have two different kinds of latent heat, which are quite a bit alike. To keep their identities separate, the first one is called **latent heat of fusion,** which means the same as melting. The other kind is called **latent heat of vaporization** because that means the same as evaporation.

Refrigeration

It may seem as though we have discussed heat instead of refrigeration. But in doing so, we have

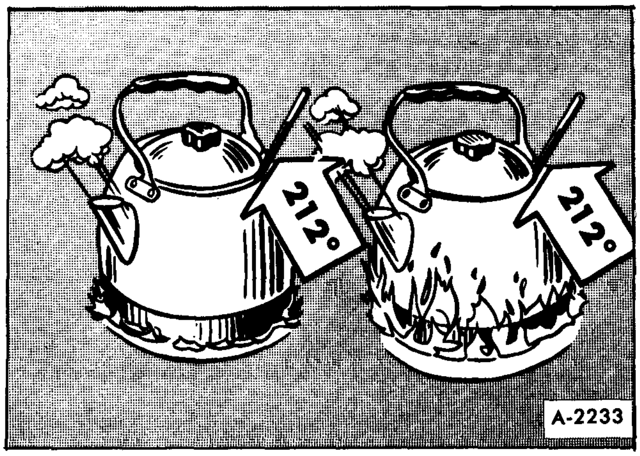


Figure 6—Boiling Water Never Exceeds 212°F. (100°C.) at Sea Level

learned how a simple icebox works. It's because the latent heat of fusion gives ice the ability to soak up quantities of heat without getting any warmer. Since it stays cold, it can continue to draw heat away from stored foods and make them cooler.

The latent heat of vaporization can be even better because it will soak up even more heat.

Whenever we think of anything boiling, we think of it being pretty hot, but that's not true in every case. Just because water boils at 212°F. (100°C.) doesn't mean that all other substances will boil at the same temperature. Some would have to be put into a blast furnace to make them bubble and give off vapor. On the other hand, others will boil violently while sitting on a cake of ice.

And so each substance has its own particular boiling point temperature. But regardless of whether it is high or low, they all absorb unusually large quantities of heat without getting any warmer when change from a liquid into a vapor.

Consequently, any liquid that will boil at a temperature below the freezing point of water, will make ice cubes and keep vegetables cool in a mechanical refrigerator.

REFRIGERANTS

The substance that carries heat out of a refrigerator cabinet is the refrigerant.

There are many refrigerants known to man. In fact, any liquid that can boil at temperatures somewhere near the freezing point of water can be used.

But a boiling point below the temperature at which ice forms is not the only thing that makes a good refrigerant. A refrigerant should also be non-poisonous and non-explosive to be safe. Besides that, we want a refrigerant that is non-corrosive and one that will mix with oil.

Chemists tried to improve existing natural refrigerants. But after exploring along that line, they still hadn't succeeded. They started from scratch and juggled molecules around to make an entirely new refrigerant. Eventually they succeeded by remodeling the molecules in carbon tetrachloride. This is the same fluid that was used in fire extinguishers and dry-cleaners' solvents.

From this fluid, the chemists removed two chlorine atoms and replaced them with two flourine atoms. This newly formed fluid carried the technical chemical name of dichlorodifluoromethane. Today, it is sold commercially by manufacturers as Refrigerant-12 or R-12. Non-tox, non-inflammable, nonexplosive, and non-poisonous, however, breathing large quantities of R-12 should be avoided.

Refrigerant-12

Refrigerant-12, which we use in Air Conditioning Systems, **boils** at 21.7°F. (-5.7°C.) below zero. Picture a flask of R-12 sitting on the North Pole boiling away just like a teakettle on a stove. No one would dare pick up the flask with his bare hands because, even though boiling, it would be so cold and it would be drawing heat away from nearby objects so fast that human flesh would freeze in a very short time.

If we were to put a flask of R-12 inside a refrigerator cabinet, it would boil and draw heat away from everything surrounding it (figure 7). So long as any refrigerant remained in the flask, it would keep on soaking up heat until the temperature got clear down to 21.7°F. (-5.7°C.) below zero.

Now we can begin to see the similarity between a boiling teakettle and a refrigerator. Ordinarily we think of the flame pushing heat into the teakettle. Yet, it is just as logical to turn our thinking around and picture the teakettle pulling heat out of the flame. Both the teakettle and the flask of refrigerant do the same thing — they both draw in heat to boil although they do so at different temperature levels.

There also is another similarity between the icebox and the mechanical refrigerator. In the icebox, water from melting ice literally carried heat out of the cabinet. In our simple refrigerator, rising vapors do the same job.

Reusing R-12

R-12, or any other refrigerant, is too expensive just to let float away into the Atmosphere. If there was some way to remove the heat from the vapor and change it back into a liquid, it could be returned to the flask and used over again (figure 8).

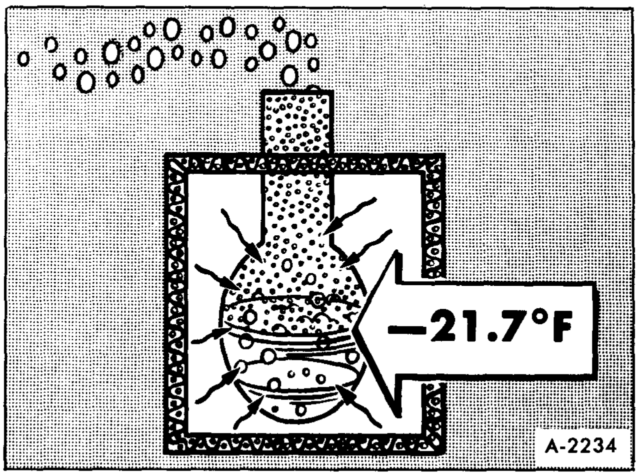


Figure 7—A Simple R-12 Refrigerator

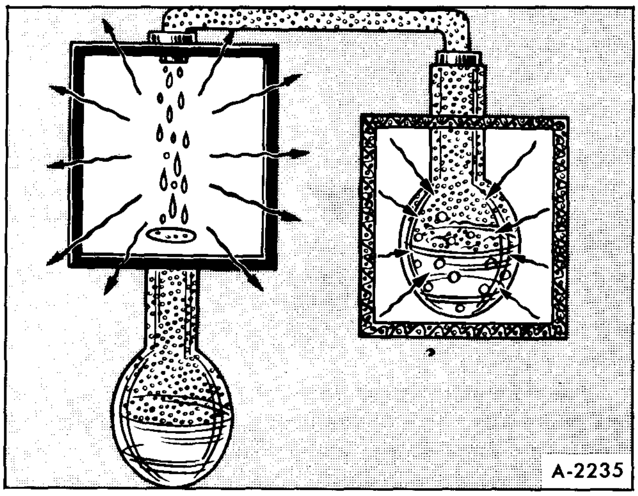


Figure 8—Reusing Refrigerant

That is where we find the biggest difference between the old icebox and the modern refrigerator. We used to put in new ice to replace that lost by melting. Now we use the same refrigerant over and over again.

We can change a vapor back into a liquid by chilling it, or do the same thing with pressure. When we condense a vapor we will find that the heat removed just exactly equals the amount of heat that was necessary to make the substance vaporize in the first place.

This is called the latent heat of vaporization - the heat that apparently disappeared when a liquid boiled into a vapor — again reappears - when that same vapor reverts back into a liquid. It is just like putting air into a balloon to expand it and then letting the same amount of air out again to return the balloon to its original condition.

We know that any substance will condense at the same temperature at which it boiled. This temperature point is a clear-cut division like a fence. On one side, a substance is a liquid. Immediately on the other side it is a vapor. Whichever way a substance would go, from hot to cold or cold to hot, it will change its character the moment it crosses over the fence.

Water will boil at 212°F. (100°C.) under normal conditions. Naturally, we expect steam to condense at the same temperature. But whenever we put pressure on steam, it doesn't. It will condense at some temperature higher than 212°F (100°C.). The greater the pressure, the higher the boiling point and the temperature at which a vapor will condense. This is the reason why pressure cookers cook food faster, since the pressure on the water permits it to boil out at a higher temperature.

We know that R-12 **boils** at 21.7°F. (-5.7°C.) below zero. A thermometer will show us that the rising vapors, even though they have soaked up lots of heat, are only slightly warmer. But the vapors must be made warmer than the room air if we expect heat to flow out of them. The condensing point temperature must be above that of room air or else the vapors won't condense.

This is where pressure helps, with pressure, we can compress the vapor, thereby concentrating the heat it contains. When we concentrate heat in a vapor that way, we increase the intensity of the heat or, we increase the temperature, because temperature is merely a measurement of heat intensity (figure 9).

Pressure in Refrigeration

Because we must use pressures and gauges in air conditioning service, the following points are mentioned so that we will all be talking about the same thing when we speak of pressures.

All pressure, regardless of how it is produced, is measured in pounds per square inch (psi).

Atmospheric Pressure is pressure exerted in every direction by the weight of the atmosphere. At sea level atmospheric pressure is 14.7 psi. At higher altitudes air has less weight (lower psi).

Any pressure less than atmospheric (14.7) is known as a partial vacuum or commonly called a vacuum. A perfect vacuum or region of no pressure has never been mechanically produced.

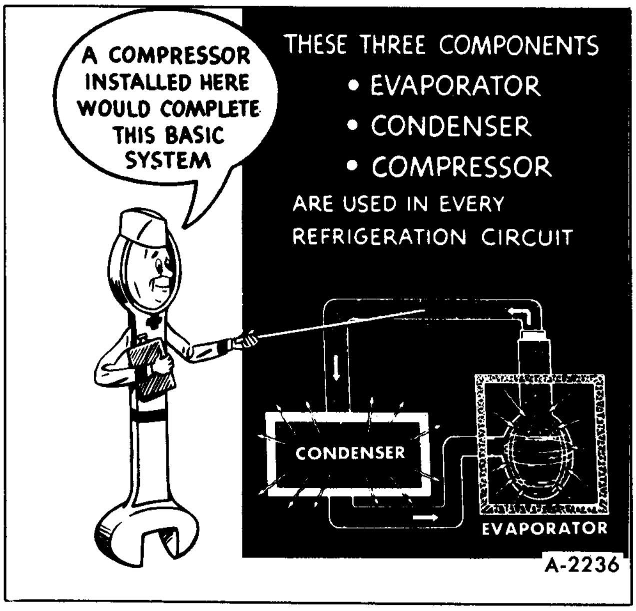


Figure 9—Basic Refrigerant Circuit

Gauge pressure is used in refrigeration work. Gauges are calibrated in pounds (psi) of pressure and inches of Mercury for vacuum. At sea level, "O" lbs. gauge pressure is equivalent to 14.7 lbs. atmospheric pressure. Pressure greater than atmospheric is measured in pounds (psi) and pressure below atmospheric is measured in inches of vacuum. The "O" on the gauge will always correspond to the surrounding atmospheric pressure, regardless of the elevation where the gauge is being used.

Pressure-Temperature Relationships of R-12

A definite pressure and temperature relationship exists in the case of liquid refrigerants and their saturated vapors. Increasing the temperature of a substance causes it to expand. When the substance is confined in a closed container, the increase in temperature will be accompanied by an increase in pressure, even though no mechanical device was used. For every temperature, there will be a corresponsing pressure within the container of refrigerant. A table of the temperature-pressure relationship of R-12 is presented below. Pressures are indicated in gauge pressure, either positive pressure (above atmospheric) in pounds or negative pressure (below atmospheric) in inches of vacuum.

Thus if a gauge is attached to a container of R-12 and the room temperature is 70°F. (21.1°C.), the gauge will register approximately 70 psi pressure; in a 100°F. (37.8°C.) room, the pressure would be 117 psi.

°F.	°C.	Pressure (psi)
-40	-40	11.0*
-35	-37.2	8.3*
-30	-33.3	5.5*
-25	-31.7	2.3*
-20	-29	0.6
-15	-26.1	2.4
-10	-23.3	4.5
-5	-20.6	6.8
0	-17.8	9.2
+5	-15	11.8
+10	-12.2	14.7
+15	-9.4	17.7
+20	-6.7	21.1
+25	-3.9	24.6
+30	-1.1	28.5
+32	0	30.1
+35	+1.7	32.6
+40	+4.4	37.0
+45	+7.2	41.7

°F.	°C.	Pressure (psi)
+50	+10	46.7
+55	+12.8	52.0
+60	+15.6	57.7
+65	+18.3	63.7
+70	+21.1	70.1
+75	+23.9	76.9
+80	+26.7	84.1
+85	+29.4	91.7
+90	+32.2	99.6
+95	+35	108.1
+100	+37.8	116.9
+105	+40.6	126.2
+110	+43.3	136.0
+115	+46.1	146.5
+120	+49	157.1
+125	+51.7	167.5
+130	+54.4	179.0
+140	60	204.5
+150	+65.6	232.0
* Inches of Vacuum		

Pressure and Flow

When we use a tire pump to inflate an automobile tire, we are creating pressure only because we are "pushing" against the air already entrapped inside the tire. If a tire has a puncture in it, you could pump all day, and still not be able to build up any pressure. As fast as you would pump the air in, it would leak out through the puncture. Unless you have something to push against — to block the flow of air — you can't create more than a mere semblance of pressure.

The same situation holds true in an air conditioning system. The compressor can pump refrigerant vapor through the system, but unless it has something to push against, it cannot build up pressure. All the compressor would be doing would be to circulate the vapor without increasing its pressure.

We can't just block the flow through the system entirely. All we want to do is put pressure on the refrigerant vapor so it will condense at normal temperatures. This must be done sometime after the vapor leaves the evaporator and before it returns again as a liquid. High pressure in the evaporator would slow down the boiling of the refrigerant and penalize the refrigerating effect.

Controlling Pressure and Flow

Pressure and flow can be controlled with a float valve, or with a pressure-regulating valve.

The float valve type will give us a better idea of pressure and flow control, let's look at it first.

It consists simply of a float that rides on the surface of the liquid refrigerant. As the refrigerant liquid boils and passes off as a vapor, naturally the liquid level drops lower and lower. Correspondingly, the float, because it rides on the surface of the refrigerant, also drops lower and lower as the liquid goes down.

By means of a simple system of mechanical linkage, the downward movement of the float opens a valve to let refrigerant in. The incoming liquid raises the fluid level and, of course, the float rides up along with it. When the surface level of the refrigerant liquid reaches a desired height, the float will have risen far enough to close the valve and stop the flow of refrigerant liquid.

We have described the float and valve action as being in a sort of definite wide open or tight shut condition. Actually, the liquid level falls rather slowly as the refrigerant boils away. The float goes down gradually and gradually opens the valve just a crack. At such a slow rate of flow, it raises the liquid level in the evaporator very slowly.

It is easy to see how it would be possible for a stablized condition to exist. By that, we mean a condition wherein the valve would be opened enough to allow just exactly the right amount of refrigerant liquid to enter the system to take the place of that leaving as a vapor.

Refrigerator Operation

We've now covered all the scientific ground-rules that apply to refrigeration. Try to remember these main points. All liquids soak up lots of heat without getting any warmer when they boil into a vapor, and, we can use pressure to make the vapor condense back into a liquid so it can be used over again. With just that amount of scientific knowledge, here is how we can build a refrigerator.

We can place a flask of refrigerant in an icebox. We know it will boil at a very cold temperature and will draw heat away from everything inside the cabinet (figure 9).

We can pipe the rising vapors outside the cabinet and thus provide a way for carrying the heat out. Once we get the heat-laden vapor outside, we can compress it with a pump. With enough pressure, we can squeeze the heat out of "cold" vapor even in a warm room. An ordinary radiator will help us get rid of heat.

By removing the heat, and making the refrigerant into a liquid, it becomes the same as it was before. So, we can run another pipe back into the cabinet and return the refrigerant to the flask to be used over again.

That is the way most mechanical refrigerators work today. Now, let's look at air conditioning to see the benefits of air conditioning and how an air conditioner works.

AIR CONDITIONING

Because air-conditioning has always been very closely allied with mechanical refrigeration, most of us are apt to think of it only as a process for cooling room air.

Air Conditioning goes beyond the mere cooling of the air. It controls the humidity, cleanliness and circulation of the air.

Whenever it gets warm and muggy in the summertime, someone is almost sure to say, "It's not the heat...it's the humidity." But that is only partly right. Actually it is a combination of the two that makes us feel so warm...temperature alone is not the only thing that makes us uncomfortable.

Humidity is the moisture content of the air. To a certain extent, it is tied in with the temperature of the air. Warm air will hold more moisture than will cold air. When air contains all the moisture it can hold, it is saturated, and the relative humidity is 100%. If the air contains only half as much water as it could hold at any given temperature, we say that the relative humidity is 50%. If it contains only a fifth of its maximum capacity, we say that the relative humidity is 20%. This amount of water vapor, or relative humidity, affects the way we perspire on hot days.

Nature has equipped our bodies with a network of sweat glands that carry perspiration to the skin surfaces. Normally, this perspiration evaporates and absorbs heat just like a refrigerant absorbs heat when it is vaporized in a freezer. Most of the heat is drawn from our bodies, giving us a sensation of coolness. A drop of alcohol on the back of your hand will demonstrate this principle convincingly. Alcohol is highly volatile, and will evaporate very rapidly and absorb quite a bit of heat in doing so, making the spot on your hand feel cool.

The ease and rapidity with which evaporation takes place, whether it be alcohol or perspiration, governs our sensation of coolness and to a certain extent, independently of the temperature. The ease and rapidity of the evaporation are directly affected by the relative humidity or comparative dampness of the air. When the air is dry, perspiration will evaporate quite readily. But when the air contains a lot of moisture, persipiration will evaporate more slowly; consequently less heat is carried away from our body.

From the standpoint of comfort, air-conditioning should control the relative humidity of the air as well as its temperature.

By reducing the humidity, we oftentimes can be just as "cool" in a higher room temperature than otherwise would be comfortable. Laboratory tests have shown that the average person will feel just as cool in a temperature of 79°F. (26.1°C.) when the relative humidity is down around 30%F. (22.2°C.) as he will in a cooler temperature of 72° with a high relative humidity of 90%.

There are practical limits though within which we must stay when it comes to juggling humidity. For comfort, we can't go much below a relative humidity of 30% because anything lower than that would cause an unpleasant and unhealthy dryness in the throat and nasal passages.

Summertime temperatures of 85°F. (29.4°C.) sometimes bring with them relative humidities around 75% to 80%. To gain maximum human comfort, an air conditioning system should cool the air down and reduce the humidity to comfortable limits.

Along with the cooling job it does, the evaporator unit also removes much of the moisture from the air. Everyone is familiar with the sight of thick frost on the freezer of a refrigerator. That frost is simply frozen moisture that has come out of the air.

The evaporator unit as an air conditioning system does the same thing with this one exception. Because its temperature is above the freezing point, the moisture remains fluid and drips off the chilling unit. A further advantage of air conditioning is that dust and pollen particles are trapped by the wet surfaces of the evaporator core and then drained off along with the condensed moisture. This provides very clean, pure air for breathing.

BASIC AIR CONDITIONER

When we look at an air conditioning unit, we will always find a set of coils or a finned radiator core through which the air to be cooled passes. This is known as the "evaporator". It does the same job as the flask of refrigerant we spoke about previously. The refrigerant boils in the evaporator. In boiling, of course, the refrigerant absorbs heat and changes into a vapor. By piping this vapor outside the vehicle we can bodily carry out the heat that caused its creation.

Once we get vapor out of the evaporator, all we have to do is remove the heat it contains. Since heat is the only thing that expanded the refrigerant from a liquid to a vapor in the first place, removal of that same heat will let the vapor condense into a liquid again. Then we can return the liquid refrigerant to the evaporator to be used over again.

Actually, the vapor coming out of the evaporator is very cold. We know the liquid refrigerant boils at temperatures considerably below freezing and that the vapors arising from it are only a shade warmer even though they do contain quantities of heat. Consequently, we can't expect to remove heat from sub-freezing vapors by "cooling" them in air temperatures that usually range between 60°F. (15.6°C.) and 100°F. (37.8°C.)...heat refuses to flow from a cold object toward a warmer object.

But with a pump, we can squeeze the heat-laden vapor into a smaller space. And, when we compress the vapor, we also concentrate the heat it contains. In this way, we can make the vapor hotter without adding any heat. Then we can cool it in comparatively warm air.

That is the only responsibility of a compressor in an air conditioning system. It is not intended to be a pump just for circulating the refrigerant. Rather, its job is to exert pressure for two reasons. Pressure makes the vapor hot enough to cool off in warm air. At the same time, the compressor raises the refrigerant's pressure above the condensing point at the temperature of the surrounding air so it will condense.

As the refrigerant leaves the compressor, it is still a vapor although it is now quite hot and ready to give up the heat that it absorbed in the evaporator. One of the easiest ways to help refrigerant vapor discharge its heat is to send it through a radiator-like component known as a condenser.

The condenser really is a very simple device having no moving parts. It does exactly the same job as the familiar radiator in a typical home steam-heating system. There,the steam is nothing more than water vapor. In passing through the radiator, the steam gives up its heat and condenses back into water.

The purpose of the condenser, as the name implies, is to condense the high pressure, high temperature refrigerant vapor discharged by the compressor into a high pressure liquid refrigerant. This occurs when the high pressure, high temperature refrigerant is subjected to the considerably cooler metal surfaces of the condenser. This is due to the fundamental laws, covered earlier, which state that "heat travels from the warmer to the cooler surface," and that "when heat is removed from vapor, liquid is produced."

When the refrigerant condenses into a liquid, it again is ready for boiling in the evaporator. So, we run a pipe from the condenser back to the evaporator.

SYSTEM COMPONENTS AND THEIR FUNCTIONS

The air conditioning system used on the GMC Motor Home utilizes components in the following catagories:

1. The Refrigeration Components

2. The Electrical Components

3. The Vacuum Components

It is important that the operation of these components be fully understood in order to properly diagnose and repair air conditioning problems.

REFRIGERATION COMPONENTS

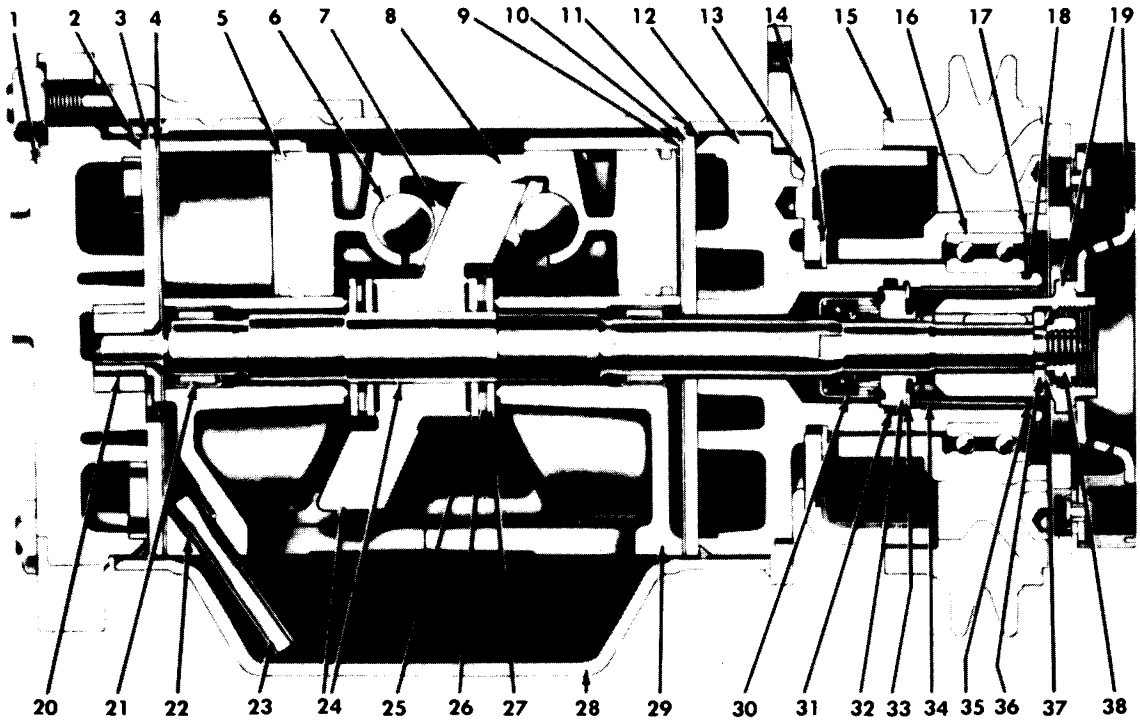
The refrigeration components are those which come in contact with and effect or are effected by the Refrigerant-12. They move it, cool it, warm it and regulate it.

COMPRESSOR

The prime purpose of the compressor (figure 10) is to take the low pressure refrigerant vapor produced by the evaporator and compress it into a high pressure, high temperature vapor which will be sent on to the condenser.

It utilizes the principle that "when a vapor is compressed, both its pressure and temperature are raised" which we have already discussed. The compressor is mounted above the engine in a special mounted bracket and is belt driven from the engine through an electromagnetic clutch pulley on the compressor.

The compressor has three double-acting pistons, making it a six cylinder compressor. The compressor has a 1.5 inch bore and 1.1875 inch stroke, giving it a total displacement of 12.6 cu. in. Identification of the compressor is by model and serial number stamped on a plate on top of the compressor.



1 Rear Head
2 Rear Head to Shell O-ring
3 Rear Discharge Valve Plate
4 Rear Suction Reed Plate
5 Piston Ring (Teflon)
6 Piston Drive Ball
7 Shoe Disc
8 Piston
9 Front Suction Reed Plate
10 Front Discharge Valve Plate
11 Front Head to Shell O-ring
12 Front Head
13 Coil and Housing Assembly
14 Coil Housing Retainer Ring
15 Pulley and Bearing Assembly
16 Pulley Bearing
17 Pulley Bearing Retainer Ring
18 Pulley and Bearing Retainer Ring
19 Clutch Hub and Drive Plate Assembly
20 Oil Pump Gears
21 Mainshaft Bearing (Rear)
22 Oil Inlet Tube O-ring
23 Oil Inlet Tube
24 Axial Plate and Mainshaft Assembly
25 Thrust Race
26 Thrust Bearing
27 Thrust Race
28 Compressor Shell
29 Cylinder Assembly
30 Shaft Seal
31 Shaft Seat Seat O-ring
32 Shaft Seal Seat
33 Shaft Seal Seat Retainer Ring
34 Felt Sleeve
35 Felt Sleeve Retainer
36 Spacer
37 Clutch Hub Retainer Ring
38 Shaft Nut

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Figure 10—Compressor Cross Sectional View

Clutch-Pulley

The movable part of the clutch drive plate is in front of the pulley and bearing assembly. The armature plate, the movable member, is attached to the drive hub through driver springs and is riveted to both members. The hub of the drive plate is pressed over a square drive key located in the compressor shaft. A spacer and retainer ring are assembled to the shaft and the assembly is held in place with a self-locking nut. The pulley rim, power element ring and pulley hub are formed into a final assembly by molding a frictional material between the rim and the hub with the power element ring imbedded in the forward face of the assembly.

A two-row ball bearing is pressed into the pulley hub and held in place by a retainer ring. The entire pulley and bearing assembly is then pressed over the front head of the compressor and secured by a retainer ring.

Clutch Coil

The coil is molded into the coil housing with a filled epoxy resin and must be replaced as a complete assembly. Three protrusions on the rear of the housing fit into alignment holes in the compressor front head. A retainer ring secures the coil and housing in place. The coil has 3.85 ohms resistance at 80°F. (26.7°C.) ambient temperature and will require no more than 3.2 amperes at 12 volts D.C. Since the clutch coil is not grounded internally, a ground lead is required as well as a "hot" lead. This will be discussed in greater detail in the Electrical Component discussion in this section.

Shaft Seal

The main shaft seal, located in the neck of the compressor front head, consists of the seal assembly with its ceramic seal face in a spring loaded cage. An "O" ring seal, located within the ceramic seal, provides a seal to the shaft surface. The contact surface of the shaft seal seat is finished to a high polish and must be protected against nicks, scratches and even fingerprints. Any surface damage will cause a poor seal. An "O" ring, located in an internal groove in the neck of the front head provides a seal with the outer diameter of the seal seat. A retainer ring, tapered side away from the seat, secures the seat in place. The hub and armature plate must be removed to gain access to the seal. A shaft seal kit contains all necessary replacement parts for field service.

After removing the clutch drive, pulley-bearing and coil housing assemblies, the rear head and internal mechanism (figure 10) may be removed from the compressor shell. Four threaded studs, welded to the compressor shell, locate the rear head and four lock nuts secure it in place.

Rear Head

The rear head (figure 11) has a machined cavity in the center for the oil pump gears. This cavity, in all compressors, is machined so that the eccentricity of the bore is approximately .042 inch to the LEFT of the centerline of the cavity. The counterclockwise rotation compressor used in some other systems has the eccentricity machined approximately .042 inch to the RIGHT of the cavity centerline. A small diameter hole is drilled in the head between the two. The unit number is stamped on a plate attached to the counterclockwise rotation head and a decal arrow indicates the direction of rotation.

Mainshaft

The central mainshaft, driven by the clutch-pulley when the coil is energized, extends through the front head to the rear head and oil pump cavity of the compressor. The shaft revolves in needle roller bearings located in the front and rear halves of the cylinder assembly. 3/16" internally drilled passage extends through the shaft from the rear oil pump cavity to the shaft seal cavity in the front compressor head. Four .078 inch holes, drilled at 90° to the main passage, direct oil under pump pressure to the shaft seal surfaces, thrust bearings and shaft-cylinder bearings.

Axial Plate

The axial plate is an angular shaped member pressed onto the mainshaft forming the mainshaft and wobble plate assembly (figure 11). A woodruff key prevents movement of the plate around the shaft. Location of the plate on the shaft is factory set and must not be changed. The very smooth angular faces of the plate are ground to be parallel within .0003 inches of each other. The plate changes the rotating action of the shaft into the reciprocating driving force for three pistons. The driving force is applied, through the drive balls and ball seats (shoe discs) to the midpoint of each of the double end pistons.

Cylinder Block

The cylinder block consists of a front and a rear half. Three piston bores are line bored in each half during production to assure proper alignment and parallelism. The two halves must be serviced as an assembly to assure correct relationship of parts.

Pistons

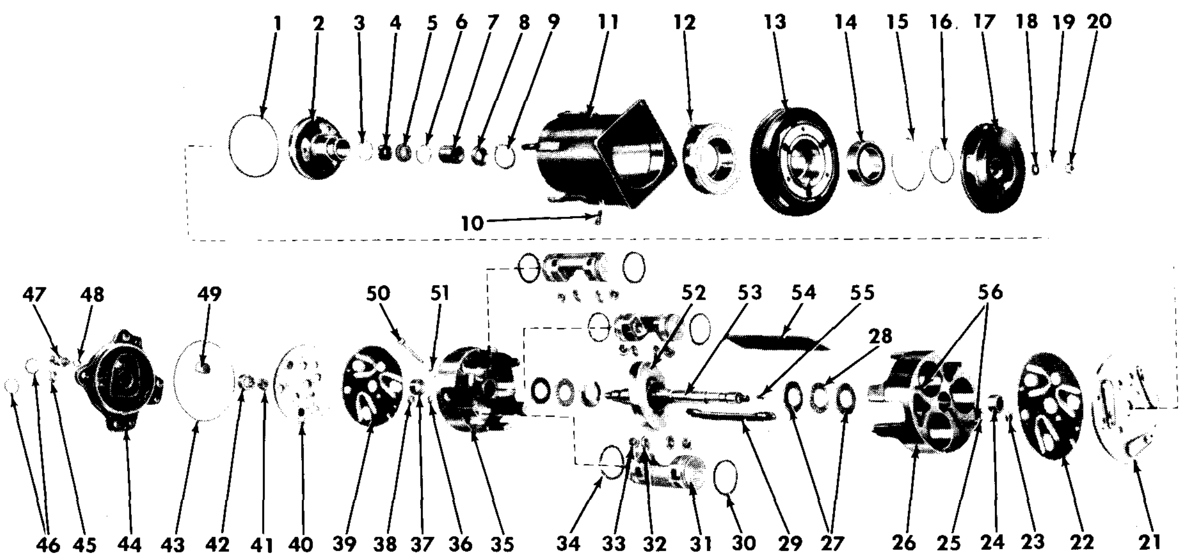
The cast aluminum double end pistons (figure 11), have special grooves to receive teflon piston rings. A notch in the casting web of each piston identifies the end of the piston which should be positioned toward the front end of the compressor. A spherical cavity is located on both inner faces of each piston to receive the piston drive balls.

Drive Balls

The hardened steel drive balls have a micro-finish. They are manufactured to a .0001 inch spherical tolerance and a .6248 - .6250 inch diameter tolerance.

Shoe Discs

The bronze shoe discs have one flat side, which contacts the axial plate, and one concave surface into which the drive ball fits. Ten discs are provided in



1 O-Ring
2 Front Head
3 O-Ring
4 Shaft Seal Assembly
5 Seal Seat
6 Seal Seat Retainer Ring
7 Absorbent Sleeve
8 Seal Retainer
9 Clutch Coil Retainer Ring
10 Oil Drain Plug
11 Compressor Shell
12 Clutch Coil and Housing Assy.
13 Pulley
14 Bearing
15 Bearing Retainer
16 Pulley Retainer Ring
17 Clutch Plate and Hub Assy.
18 Spacer
19 Retainer Ring
20 Lock Nut
21 Front Discharge Valve Plate Assembly
22 Front Suction Reed
23 Bushing
24 Needle Bearing
25 O-Ring
26 Front Cylinder Half
27 Thrust Races
28 Thrust Bearing
29 Discharge Crossover Tube
30 Teflon Piston Ring
31 Teflon Ring Type Piston
32 Shoe Disc
33 Ball
34 Teflon Piston Ring
35 Rear Cylinder Half
36 O-Ring
37 Needle Bearing
38 Bushing
39 Rear Suction Reed
40 Rear Discharge Valve Plate Assembly
41 Inner Oil Pump Gear
42 Outer Oil Pump Gear
43 O-Ring
44 Rear Head
45 Lock Nut
46 O-Rings
47 Pressure Relief Valve
48 O-Ring
49 Suction Screen
50 Oil Pick-Up Tube
51 O-Ring
52 Axial Plate
53 Shaft
54 Suction Crossover Cover
55 Key
56 Dowel Pins

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Figure 11—Compressor Exploded View

.0005 inch thickness variations including a basic ZERO disc for simple field gauging operations. Discs are marked with their size which corresponds to the last three digits of the piece part number.

Selection from this group must be made to provide .0005 inch to .0010 inch total clearance between the shoe discs and the axial plate at the tightest place throughout its 360° rotation (figure 12).

Thrust Bearings

The thrust bearings, sandwiched between two thrust races (see below) are located between the shoulders of the axial plate and the shoulders of both the front and rear cylinder hubs.

Thrust Races

The steel thrust races are ground to fixed thicknesses. A total of 14 races in increments of .0005 inch thickness are available for field service. As in the case of the ball seats the thrust races will be identified on the part by their thickness, the number on the race corresponding to the last three digits of the piece part number. The FRONT combination of a race, bearing and race is selected to provide the proper head clearance between the top of the cylinder and the underside of the suction and discharge valve plates. The REAR end combination of bearing and races is selected to obtain .0005 inch low limit to .0015 inch high limit running clearance between the hub surfaces of the axial plate and the front and rear hubs

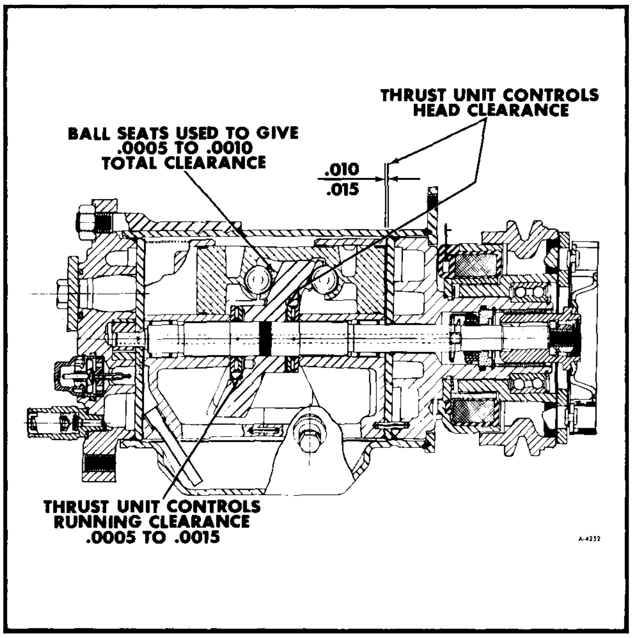


Figure 12—General Running Clearances

of the cylinder (figure 12). This allows .001 inch tolerance between the high and low limits.

Oil Pump Gears

The oil pump gears are made of sintered iron. The inner, or driver gear has a "D" shaped hole in the center which fits over a similar area on the rear of the mainshaft.

Shell

The compressor shell has a mounting flange on the front end and four threaded studs welded to the outside of the rear end. The oil sump is formed into the shell and a baffle plate is welded over the sump on the inside of the shell.

Heads

Both front and rear heads have an irregular shaped casting web. These webs provide the necessary seals to the surfaces of the discharge plates and prevent high pressure vapor from flowing into the low pressure cavity.

Suction Screen

A fine mesh inlet (or suction) screen is located in the low pressure cavity of the rear head. Its purpose is to stop any material which could damage the compressor mechanism.

Suction Cross-Over Cover

The suction cross-over cover is assembled into the dove-tail cavity in the front and rear cylinder castings to form a passage for the low pressure vapor to flow the rear head of the compressor to the front head.

Discharge Cross-Over Tube

Since the double acting pistons supply high pressure vapor at both ends of the compressor the discharge tube is needed to supply a path for the high pressure vapor to pass from the front to the rear head. Should the cylinder halves be separated during service operations a service type discharge tube, bushings and "O" rings must be substituted.

Suction Reed Valves

A separate three-reed suction valve disc is assembled to both front and rear heads. These reeds open when the piston is on the intake portion of the stroke to allow the low pressure vapor to flow into the cylinder. When the piston reverses and begins the compression portion of its stroke the reed valves close against their seats, thus preventing the high pressure vapor from being forced back into the low side of the system.

Discharge Valves

The two discharge valve plate assemblies act to direct high pressure vapor into the head castings. When the piston reverses into its suction stroke the high pressure on the opposite sideof the plate causes the reeds to close thus maintaining the differential of pressure between high and low pressure areas. The discharge plates include the valves and the retainers which prevent the high pressure from distorting the valves during the pressure stroke of the piston.

Head to Shell Seals

Two large diameter "O" rings internally seal the front and rear heads to the shell. A chamfered edge on the head castings creates a squeezing action between the discharge valve plates, the compressor, and the inside surface of the shell.

Compressor Connector

Compressor connectors, are attached to the compressor rear head by means of a single bolt and lock washer. All have inlet and outlet connections connected by a strap to form an integral unit.

Pressure Relief Valve

The pressure relief valve, located on the compressor rear head, is simply a safety valve designed to open automatically if the system pressure should reach a predetermined level high enough to cause system damage. After the pressure drops to a safe level the valve will close. After such an occurrence, the system should be thoroughly checked to discover and correct the cause of the abnormal pressure increase, and then should be purged, evacuated and charged.

REFRIGERANT LINES

Special refrigerant hose lines are required to carry the refrigerant liquid and vapor between the various system components. The hose line with the smallest diameter is called the high pressure liquid line. It is routed from the condenser or receiver-dehydrator to the evaporator or thermostatic expansion valve. The large diameter hose line connecting the compressor and evaporator is the low pressure vapor line. The large diameter hose between the compressor and condenser is the high pressure vapor discharge line.

These hoses are constructed with a synthetic material core covered with a woven metal mesh which is, in turn, covered by a woven fabric and coated for extra protection. This hose is so constructed to withstand the extreme pressures and temperatures found in the modern refrigeration system. **None but special refrigerant type hoses should be used.**

All systems make use of swaged type connections (hose to metal fittings) with metal to metal fittings being made using "O" rings. Care must be taken when making these connections that they not be turned down too tightly or damage to the "O" rings may result.

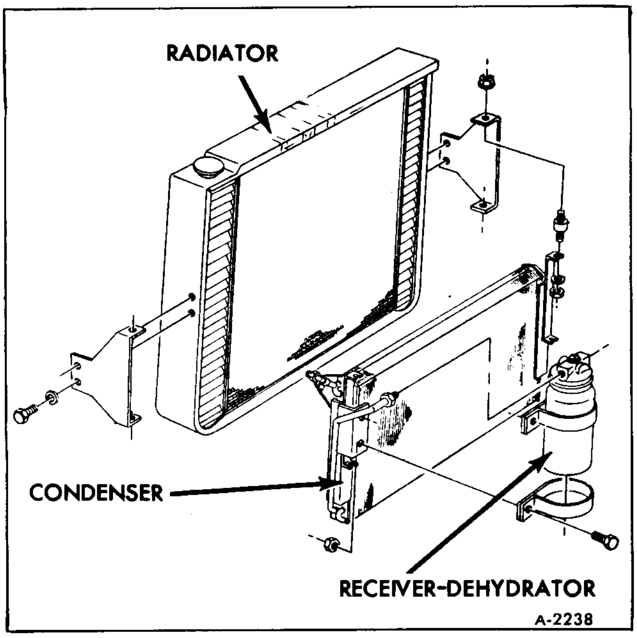


Figure 13—Condenser and Receiver-Dehydrator, Type 1

Flexible refrigerant hoses should not be permitted to contact the hot engine manifold nor should they be bent into a radius of less than 10 times their diameter.

FAN SLIP CLUTCH

A special engine fan is used. It is a seven bladed fan, limited by means of a viscous clutch to a maximum speed of 3200 rpm, regardless of the speed of the engine. The silicone fluid in the clutch transmits only enough torque to drive the fan at this limited speed, thus avoiding excessive noise and power consumption by the fan at higher engine speeds. A temperature modulating device further limits fan speed to 1000 rpm until ambient temperature at the modulating device reaches 140°F. at which time fan speed will be allowed to increase to 3200 rpm. Some adjustment of the modulating device is possible.

CONDENSER

The condenser receives the high pressure, high temperature gas which is pumped from the compressor and condenses it into a high pressure high temperature liquid. The heated gas which enters near the top of the condenser is cooled by giving off heat to the metal surfaces of the condenser. The heat is then extracted from these metal surfaces by the ram air passing over the condenser.

The condenser is located in front of the engine cooling system radiator so that it receives a high volume of air from the movement of the vehicle and from the engine fan.

The condenser is similar in design to the ordinary radiator but is designed to withstand much higher pressures (figure 13).

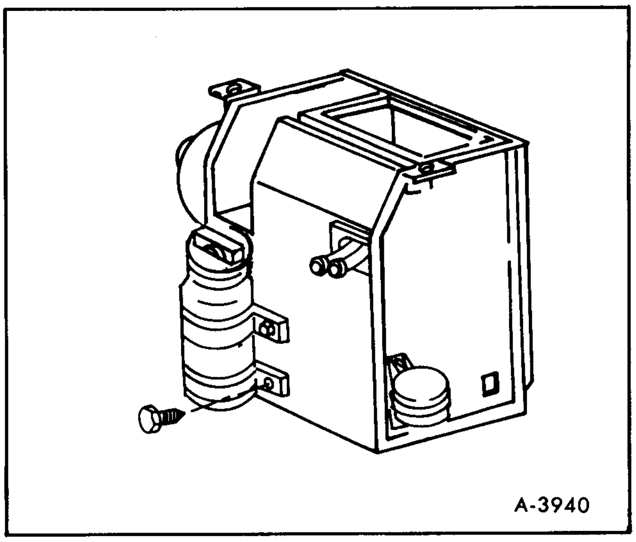


Figure 14—Location of Receiver Dehydrator, Type 2

RECEIVER-DEHYDRATOR

The receiver-dehydrater (figures 13 and 14), sometimes called the receiver-drier or just drier, is so called because of its function of receiving liquid refrigerant from the condenser and, by means of a dehydrating agent, removes any water present from it. This chemical compound is called a desiccant. The desiccant is held in place in a felt bag in the drier. Average receiver-drier desiccants collect and hold about 50 drops of water. This may not seem like much until you realize that one drop of water can block the whole air conditioning system.

The drier also filter-traps any foreign matter which may have entered the system during assembly or during any service work. This is accomplished by means of a fine wire screen.

Still another function of the receiver dehydrator is to act as a reservoir to furnish a constant column of liquid refrigerant to the expansion valve at all times. Since the entering liquid refrigerant may have some gas in it, the tank acts as a separator. The gas will tend to rise and the liquid will drop to the bottom. This is why the pick-up tube extends to the bottom of the tank insuring gas free liquid R-12 to the expansion valve. The storage of the refrigerant is temporary, and is dependent on the demand placed on it by the expansion valve.

While having no real function to perform in the system, the sight glass is a valuable aid in determining whether or not the refrigerant charge is sufficient and for eliminating some guess work in diagnosing difficulties. The sight glass, is built into the receiver-dehydrator outlet connection and is designed and located so that a shortage of refrigerant at this point will be indicated by the appearance of bubbles beneath the glass. The dust cap provided should be kept in place when the sight glass is not in use.

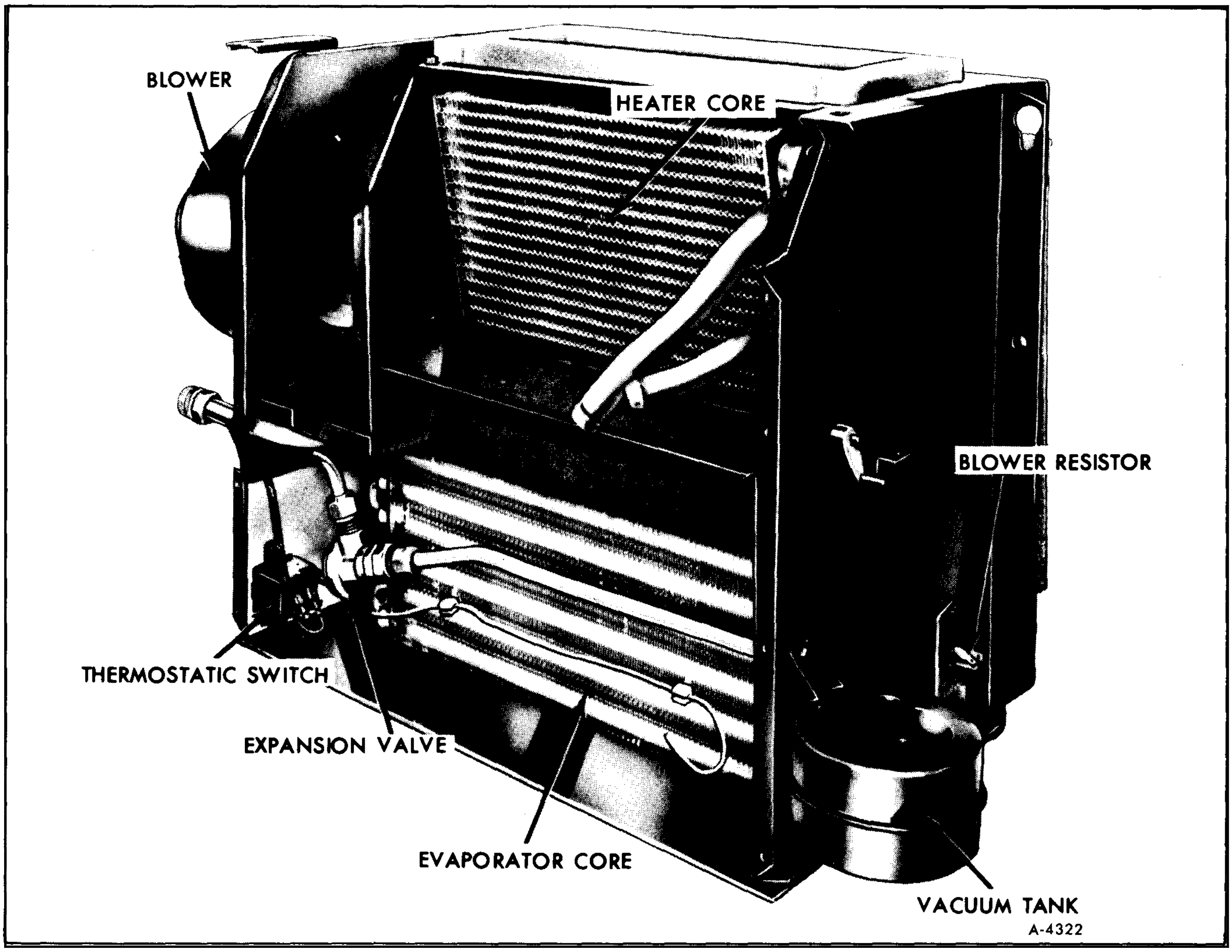


Figure 15—Evaporator Housing Components, Type 1

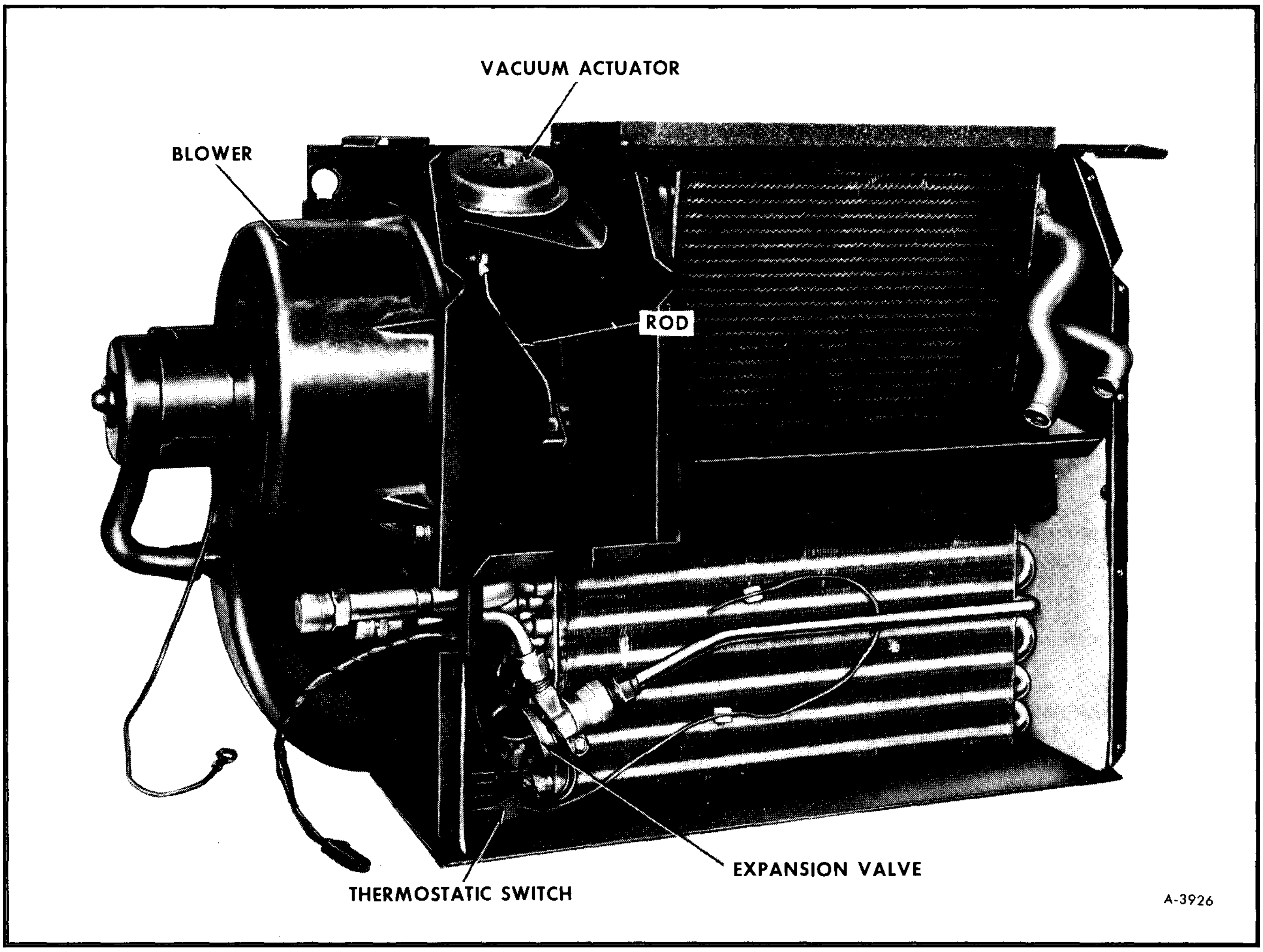


Figure 16—Evaporator Housing Components, Type 2

THERMOSTATIC EXPANSION VALVE

The valve consists primarily of the power element, body, actuating pins, seat and orifice. At the high pressure liquid inlet, is a fine mesh screen which prevents dirt, filings or other foreign matter from entering the valve orifice.

The valve is located inside the evaporator housing (See figures 15 and 16).

When the valve is connected in the system, high pressure liquid refrigerant enters the valve through the screen from the receiver-dehydrator or condenser and passes on to the seat and orifice. Upon passing through the orifice the high pressure liquid becomes low pressure liquid. The low pressure liquid leaves the valve and flows into the evaporator core where it absorbs heat from the evaporator core and changes to a low pressure vapor, and leaves the evaporator core as such. The power element bulb is clamped to the low pressure vapor line just beyond the outlet of the evaporator (figure 17).

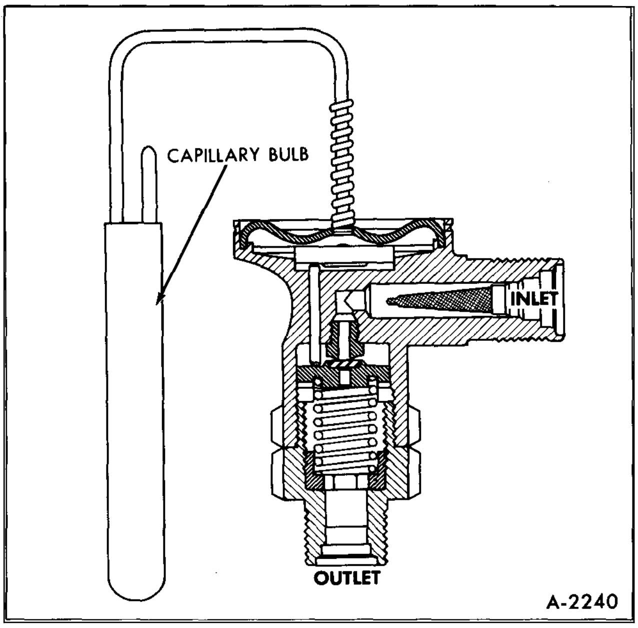


Figure 17—Expansion Valve Cross-Section

The operation of the valve is quite simple. It is a matter of controlling opposing forces produced by a spring and the refrigerant pressures. For example: The pressure in the power element is trying to push the seat away from the orifice, while the adjusting spring is trying to force the seat toward the orifice. These opposing pressures are established in the design of the valve so that during idle periods the adjusting spring tension and the refrigerant pressure in the cooling coil are always greater than the opposing pressure in the power element. Therefore, the valve remains closed. When the compressor is started, it will reduce the pressure and temperature of the refrigerant in the cooling coil to a point where the vapor pressure in the power element becomes the stronger. The seat then moves off the orifice and liquid starts to flow through the valve orifice into the cooling coil.

The purpose of the power element is to help determine the quantity of liquid that is being metered into the cooling coil. As the temperature of the low pressure line changes at the bulb, the pressure of the vapor in the power element changes, resulting in a change of the position of the seat. For example, if the cooling coil gets more liquid than is required, the temperature of the low pressure line is reduced and the resultant lowering of the bulb temperature reduces the pressure of the vapor in the power element, allowing the seat to move closer to the orifice. This immediately reduces the amount of liquid leaving the valve. Under normal operation, the power element provides accurate control of the quantity of refrigerant to the cooling coil.

To employ our tire pump analogy once more for clarity, it is the same situation that would exist if you were inflating a tire with a very slow leak. Providing you pumped the air into the tire as fast as it leaked out, you would be able to maintain pressure even though the air would merely be circulating through the tire and leaking out through the puncture.

EVAPORATOR

The function of the evaporator (figures 15 and 16) is to cool and dehumidify the air flow before it enters the passenger compartment. The evaporator assembly consists of an aluminum core enclosed in a sheet metal housing located in the front of the vehicle chassis. Two water drain holes are located in the bottom of the housing. Two refrigerant lines are connected to the sides of the evaporator core: the small inlet line on the right, and the larger outlet line on the left.

The temperature sensing bulb of the expansion valve is clamped to the outlet pipe of the evaporator core. The high pressure liquid refrigerant, after it is metered through the expansion valve, passes into the evaporator core where it is allowed to expand under reduced pressure. As a result of the reduced pressure the refrigerant begins to expand and return to the original gaseous state. To accomplish this transformation it begins to boil.

The boiling action of the refrigerant demands heat. To satify the demand for heat, the air passing over the core gives up heat to the evaporator and is subsequently cooled.

Figure 16 shows the evaporator housing on vehicles equipped with the additional air conditioning outlets shown in Figure 25. The vacuum actuator rod operates an auxiliary air flow door.

LOW REFRIGERANT CHARGE PROTECTION SYSTEM

The compressor discharge pressure switch (figure 18) performs the function of shutting off the compressor when it senses low refrigerant pressure. The switch is located in the evaporator inlet line (high pressure). The switch electrically is wired in series between the compressor clutch, the thermostatic switch, and the master switch on the control. When the switch senses low pressure it breaks contact and opens the circuit to the compressor clutch, thus shutting off the A/C system and preventing compressor failure or seizure.

The compressor discharge pressure switch also performs the function of the ambient switch as the pressure at the switch varies directly with ambient temperatures. The compressor should **not** run below 25°F. (-3.9°C.) ambient or 37 psi at the switch. The

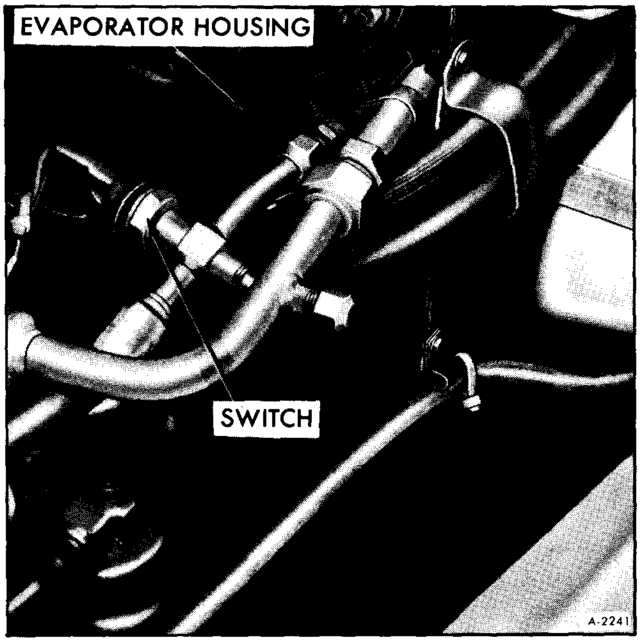


Figure 18—Compressor Discharge Pressure Switch, Typical

compressor should run in A/C modes above 45°F. (7.2°C.) ambient or 42 psi at the switch.

The switch interacts with other switches so that in an A/C system where the compressor will **not** operate above 45°F. (7.2°C.) ambient the following components should be checked for continuity:

1. Compressor discharge pressure switch.
2. Master switch (on control head).
3. Thermostatic switch.

If both switches show proper continuity, check the harness for shorts or improper ground conditions. The switch also contains the high pressure line service ports.

ELECTRICAL COMPONENTS

COMPRESSOR CLUTCH ASSEMBLY

The clutch assembly (figure 10) consists of the coil, pulley and armature. The coil is basically an electro-magnetic device charged by the battery. When energized, it sends a magnetic force through the soft iron in the pulley, which is constantly turning as a result of being belt driven by the engine, to the armature. The armature is keyed to the compressor shaft. When magnetically energized the armature is pulled into the pulley causing the compressor to be activated.

BLOWER

The blower (figure 19) is simply a device for moving air. The blower used in this vehicle is a centrifugal type fan which forces air across the evaporator and/or heat cores to the vehicle interior.

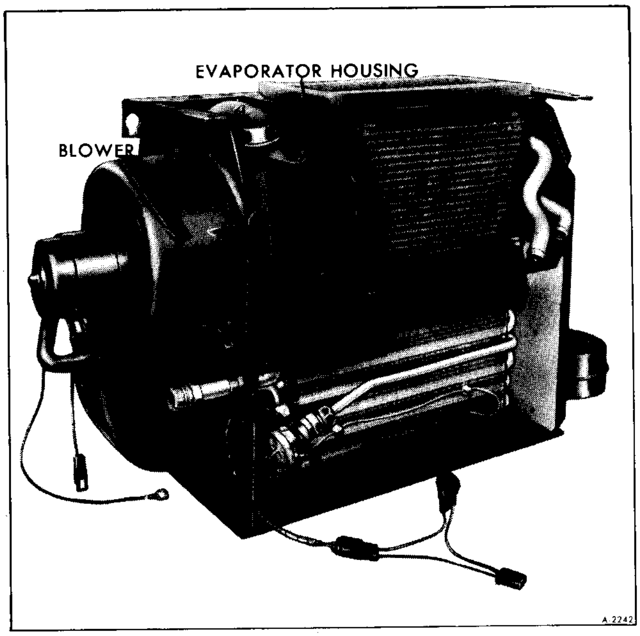


Figure 19—Blower Location, Typical

THERMOSTATIC SWITCH

The thermostatic switch (figures 15 and 16) is basically a bimetal switch which is controlled by a sensing tube across the outlet of the evaporator core. As the evaporator cools the sensing tube the bimetal switch turns off the clutch and disengages the compressor until the tube becomes warm enough to turn the compressor back on.

BLOWER SWITCH, RELAY & RESISTOR

The blower switch, blower relay and the blower resistor must be discussed together because of their interrelations with each other. The blower switch located on the instrument panel regulates low, medium and high blower speeds through a blower resistor system. This resistor (figure 15) regulates the amount of current fed to the blower thereby regulating the blower speed. The blower relay (figure 20) provides the proper connections for the low and medium speeds through the resistor assembly and direct battery current to the blower for high speed.

VACUUM COMPONENTS

The vacuum system (figure 21) consists of three basic components:

1. Vacuum tank.
2. Modes or vacuum switches.
3. Control Panel.

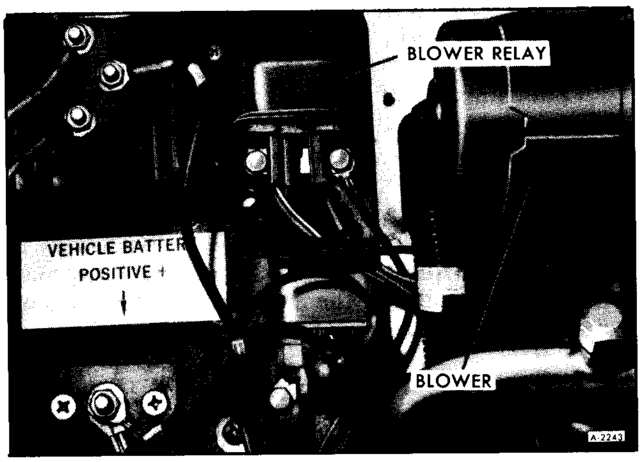


Figure 20—Blower Relay

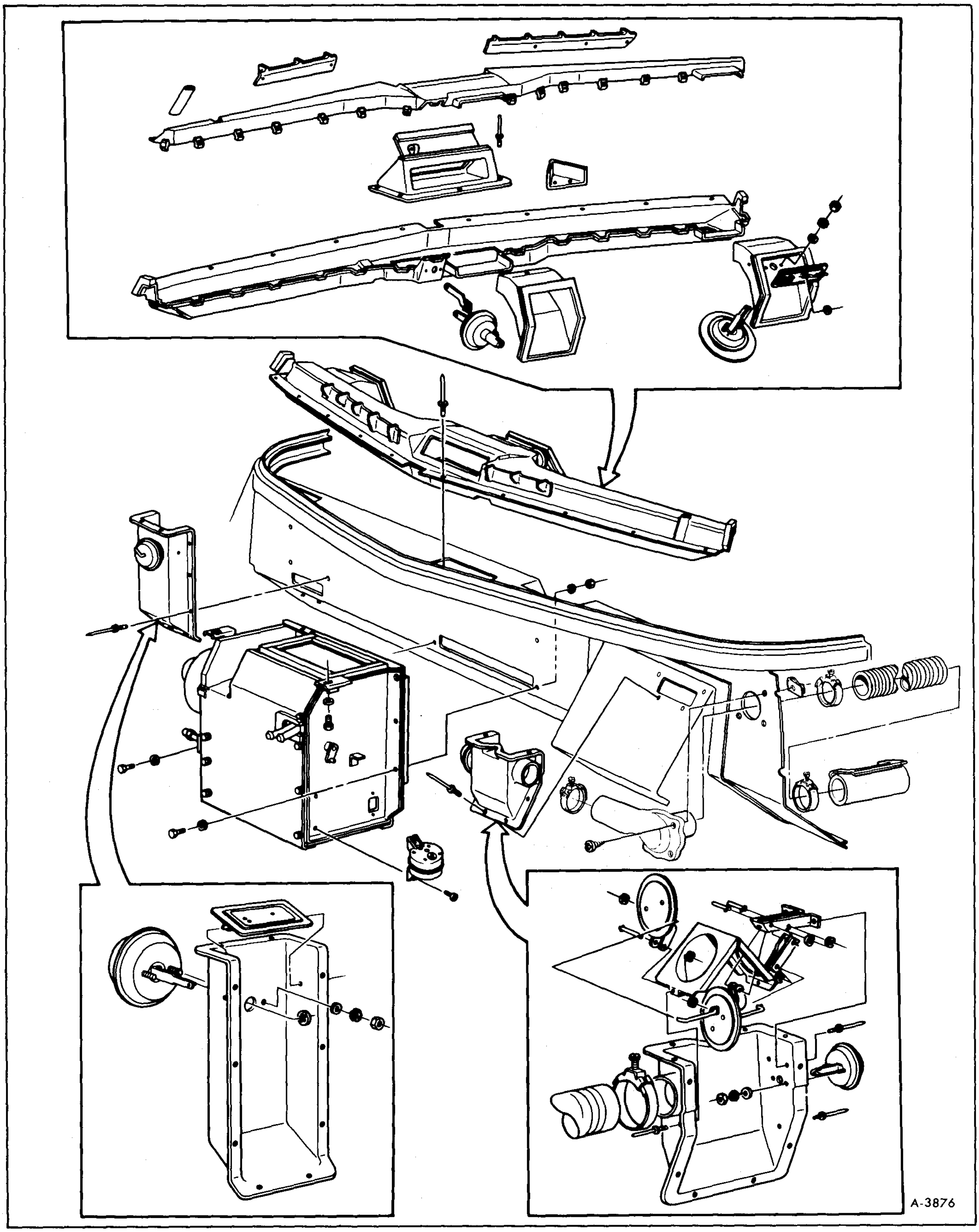


Figure 21—Vacuum Ducts and Controls

The vacuum tank is simply a reservoir of vacuum to be utilized when engine vacuum drops too low to effectively actuate the vacuum components.

The modes are diaphragm switches which open and close the various doors in the air movement system allowing "Heat" "Air Conditioning", "Defrost" and "Vent" as shown on the control panel (figures 23 and 24).

The control panel consists of a temperature valve and a select valve (See figure 22). This is the control center for directing vacuum through vacuum lines to the different modes to achieve the temperatures desired for passenger and driver comfort. More information concerning the vacuum system and the routing of the lines and operation of the modes will be covered later in this section.

PRIMARY CAUSES OF SYSTEM FAILURE

Leaks

A shortage of refrigerant causes oil to be trapped in the evaporator. Oil may be lost with the refrigerant at point of leakage. Both of these can cause compressor seizure.

Oil circulates in the globules with the vapor. It leaves the compressor by the action of the pistons and mixes with the refrigerant liquid in the condenser. The oil then enters the evaporator with the liquid and, with the evaporator properly flooded, is returned to the compressor through the low pressure line. Some of the oil returns as globules in the vapor but more importantly, it is swept as a liquid along the walls of the tubing by the velocity of the vapor. If the evaporator is starved, the oil cannot return in sufficient quantities to keep the compressor properly lubricated.

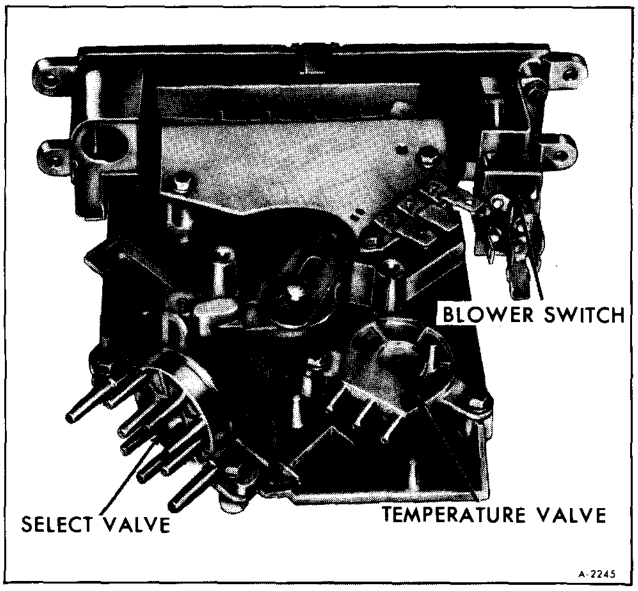


Figure 22—Control Panel Components

High Temperature and Pressure

An increase in temperature causes an increase in pressure. This accelerates chemical instability in clean systems. Other results are brittle hoses, "O" ring gaskets, and by-pass valve diaphragms with possible decomposition, broken compressor discharge reeds, and seized compressor bearings.

A fundamental law of nature accounts for the fact that when a substance, such as a refrigerant, is increased in temperature, its pressure is also increased.

Any chemical reactions caused by contaminants already in the system are greatly accelerated as the temperature increases. A 15°F. (9.4°C.) rise in temperature doubles the chemical action.

While temperature alone can cause the synthetic rubber parts to become brittle and possibly to decompose, the increased pressure can cause them to rupture or blow.

As the temperature and pressure increases, the stress and strain on the discharge reeds also increases. This can result in broken reeds. Due to the effect of the contaminants caused by high temperature and pressure, compressor bearings can be caused to seize.

High temperature and pressure is also caused by air in the system.

Air in the System

Air results from a discharged system or careless servicing procedures. This reduces system capacity and efficiency and causes oxidation of oil into gum and varnish.

When a leak causes the system to become discharged, the resulting vacuum within the system will cause air to be drawn in. Air in a system is a non-condensable gas and will build up in the condenser as it would in an air compressor tank. The resultant heat produced will contribute to the conditions discussed previously.

Many systems are contaminated and also reduced in capacity and efficiency by careless servicing procedures.

Too frequently, systems which have been open to the atmosphere during service operations have not been properly purged or evacuated. Air is also introduced into the system by unpurged gauge and charging lines. Remember that any air in the system is too much air.

Poor Connections

Hose clamp type fittings must be properly made. Hose should be installed over the sealing flanges and with the end of the hose at the stop flange. The hose should never extend beyond the stop flange. Locate the clamp properly and torque as recommended. Be especially careful that the sealing flanges are not nicked or scored or a future leak will result.

When compression fittings are used, over-tightening can cause physical damage to the "O" ring gasket and will result in leaks. The use of torque and backing wrenches is highly recommended. When making a connection with compression fittings, the gaskets should always be first placed over the tube before inserting it in the connection.

Another precaution - inspect the fitting for burrs which can cut the "O" ring.

Restrictions

Restrictions may be due to powdered desiccant or dirt and foreign matter. This may result in starved evaporator and loss of cooling, high temperature at the bypass hose, or a seized compressor.

When the amount of moisture in a system sufficiently exceeds the capacity of the desiccant, it can break down the desiccant and cause it to powder. The powder passes through the dehydrator screen with the refrigerant liquid and is carried to the expansion valve screen. While some of it may pass through the valve screen into the evaporator, it may quickly build up to cause a restriction.

Due to the fact that sufficient oil then cannot be returned to the compressor, it may seize.

Dirt

Dirt, which is any foreign material, may come from cleaner residues, cutting, machining, or preserving oils, metal dust or chips, lint or dust, loose rust, soldering or brazing fluxes, paint or loose oxide scale. These can also cause seized bearings by abrasion or wedging, discharge and expansion valve failure, decomposition of refrigerant and oil, or corrosion of metal parts.

Corrosion

Corrosion and its by-products can restrict valve and drier screens, roughen bearing surfaces or hasten fatiguing of discharge reeds. This can result in high temperature and pressure, decomposition or leaks. In any event, this means a damaged compressor.

From this, we can see the vicious circle that can be produced in a refrigerating system to cause its failure. Corrosion can be the indirect cause of leaks and leaks can be the direct cause of corrosion. We can also see the important role servicemen play in maintaining chemical stability.

The major cause of corrosion is moisture.

Moisture

Moisture is the greatest enemy of refrigerating systems. Combined with metal, it produces oxide, Iron Hydroxide, and Aluminum Hydroxide. Combined with R-12, it produces Carbonic acid, Hydrochloric acid, and Hydro-fluoric acid. Moisture can also cause freeze-up of an expansion valve and powdered desiccant.

Although high temperature and dirt are responsible for many difficulties in refrigerating systems, in most instances it is the presence of moisture in the system that accelerates these conditions. It can be said, therefore, that moisture is the greatest problem of all. The acids that it produces, in combination with both the metals and the refrigerant, causes damaging corrosion. While the corrosion may not form as rapidly with R-12 as with some other refrigerants, the eventual formation is as damaging.

If the operating pressure and temperature in the evaporator is reduced to the freezing point, moisture in the refrigerant can collect at the orifice of the expansion valve and freeze. This temporarily restricts the flow of liquid causing erratic cooling.

As previously mentioned, moisture in excess of the desiccant's capacity can cause it to powder.

Points to Remember

That the inside of the refrigerant system is completely sealed from the outside world. If that seal remains broken at any point — the system will soon be damaged.

That complete and positive sealing of the entire system is vitally important and that this sealed condition is absolutely necessary to retain the chemicals and keep them in a pure and proper condition.

That all parts of the refrigerant system are under pressure at all times, whether operating or idle, and that any leakage points are continuously losing refrigerant and oil.

That the leakage of refrigerant can be so silent that the complete charge may be lost without warning.

That refrigerant gas is heavier than air and will rapidly drop to the floor as it flows from a point of leakage.

That the pressure in the system may momentarily become as high as 480 lbs. per square inch.

That the total refrigerant charge circulates through the entire system at least once each minute.

That the compressor is continually giving up some lubricating oil to the circulating refrigerant and depends upon oil in the returning refrigerant for continuous replenishment. Any stoppage or major loss of refrigerant will therefore damage the compressor.

That the extreme internal dryness of a properly processed system is a truly desert condition, with the drying material in the receiver or accumulator holding tightly onto the tiny droplets of residual moisture.

That the attraction of the drying material for mositure is so powerful that if the receiver or accumulator is left open, moisture will be drawn in from the outside air.

That water added to the refrigerant will start chemical changes that can result in corrosion and eventual breakdown of the chemicals in the system. Hydrochloric acid is one result of an R-12 mixture with water.

That air in the refrigerant system may start reactions that can cause malfunctions.

That the drying agent in the receiver-dehydrator is Activated Silica Alumina.

That the inert gas in the expansion valve-capilary line is carbon dioxide.

CONTROLS (FIGURES 23 AND 24)

Combined air conditioning and heating system controls are located on the instrument panel in the upper right-hand corner. There are three separate controls; "FAN" lever, to control speed of blower; "OFF," "A/C," "VENT," "HEATER," "DEF" lever to control direction of air flow and which system is to be operated; "RECIRC," "COLD," "HOT" lever to control the temperature of the air. The three levers may be placed in many combined positions to deliver the climate conditions most desirable at any given time.

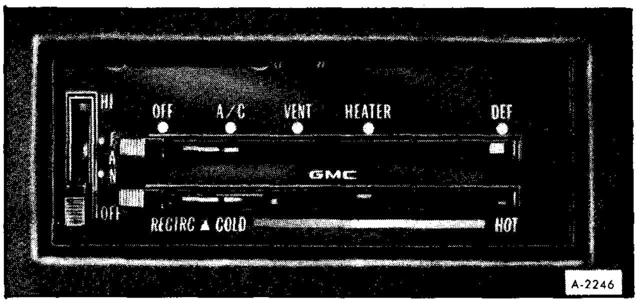


Figure 23—Air Conditioning Controls, Type 1

OPERATION

- "Type 1 Fan" (figure 23) — The fan switch has four positions; "OFF" and three blower speeds ranging from "LO" to "HI." The fan will not operate unless the top lever has been moved from the "OFF" position, and in order to operate the fan in the "HI" position the engine must be running.

- "Type 2 Fan" (figure 24) — The fan switch has four positions; "LO" and three blower speeds ranging to "HI". Fan will operate whenever the key is in the "RUN" or "ACCESSORY" position. In order to operate the fan in the "HI" position the engine must be running.

- "OFF", "A/C", "VENT", "HEATER", "DEF" (figures 23 and 24) — With the lever in the "OFF" position the system is off, except for the blower. With the lever in the "A/C" position the air conditioning system is activated.

With the lever in the "VENT" position, 100% outside air enters the driver's compartment. This setting is for use during periods of less severe heat and humidity, air flow is identical to air flow in "A/C" position, however, the air conditioning compressor is not operating. Temperature of incoming air may be controlled by moving the temperature lever to the desired position. Any one of the blower speeds may be selected.

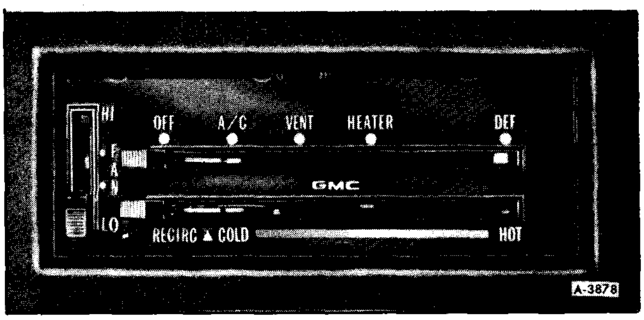


Figure 24—Air Conditioning Controls, Type 2

With the lever in the "HEATER" position, air will flow through the heater floor distributor outlets and the two center instrument panel outlets (with a slight flow of air to the defroster outlet). For maximum heat, move the temperature lever to "HOT" position and "FAN" switch lever to "HI" position.

Heating system output can be varied by moving temperature lever and "FAN" lever to different positions.

With the lever in "DEF" position, system operates the same as in the "HEATER" position except most of the air flow will be through the defroster outlets at the windshield.

- TYPE 1 "RECIRC", "COLD", "HOT" (figures 23 and 24) — This lever, used in conjunction with the system selector lever ("OFF", "A/C", "VENT", "HEATER", "DEF") and the "FAN" switch lever, will control the temperature of the output air being distributed. With the lever in the "RECIRC" position (and the upper lever in the "A/C" position) the blower automatically goes to "HI" speed providing the engine is running. This position uses 80% recirculated air. This setting will provide maximum cooling. In combination with "A/C" setting moving the temperature lever to the "COLD" position provides 100% outside air. Further movement of the temperature lever to the right (toward "HOT" position) will heat the dehumidified air to the desired temperature. The "FAN" switch can be set to meet air flow requirements.

- TYPE 2 "RECIRC", "COLD", "HOT" (figure 25) — The Type 2 lever differs in function, though not in appearance from the Type 1 lever. The Type 2 system is identified by additional air outlets, located below the instrument panel (as shown). With the lever in the "RECIRC" position, the additional air outlets are activated to provide maximum cooling. 100% outside air is used exclusively, regardless of lever position. The blower speed may be varied by moving the "FAN" switch position. The "COLD" and "HOT" positions allow for temperature modulation using the standard air outlets, as in the Type 1 system.

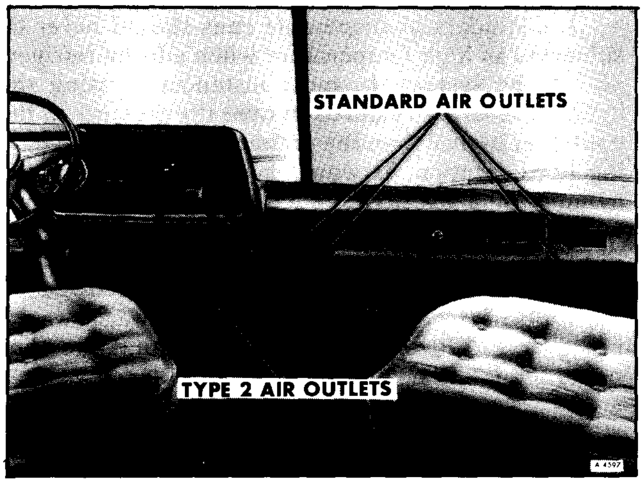


Figure 25—Location of Additional Air Conditioning Outlets

CAUTION: *Operate in "DEF" position for 30 seconds before switching to "A/C". This will remove humid air from the system and minimize rapid fogging of the glass which can occur if humid air is blown onto a cool windshield.*

- Clear windshield, rear window, outside mirrors, and all side windows of ice and snow before driving vehicle.

- Operate blower on "HI" for a few seconds before moving the vehicle, to clear the air intake of snow to further reduce the possibility of fogging on inside of windshield.

GENERAL INFORMATION

In any vocation or trade, there are established procedures and practices that have been developed after many years of experience. In addition, occupational hazards may be present that require the observation of certain precautions or use of special tools and equipment. Observing the procedures, practices and precautions of servicing refrigeration equipment will greatly reduce the possibilities of damage to the customers' equipment as well as virtually eliminate the element of hazard to the serviceman.

PRECAUTIONS IN HANDLING REFRIGERANT-12

Refrigerant-12 is transparent and colorless in both the gaseous and liquid state. It has a boiling point of 21.7°F below zero and, therefore, at all normal temperatures and pressures it will be a vapor. The vapor is heavier than air, and is nonflammable, nonexplosive, nonpoisonous (except when in contact with an open flame) and noncorrosive (except when in contact with water).

WARNING: THE FOLLOWING PRECAUTIONS IN HANDLING R-12 SHOULD BE OBSERVED AT ALL TIMES.

1. Refrigerant should not be exposed to the radiant heat from the sun since the resulting increase in pressure may cause the safety valve to release or the cylinder or can to burst.

2. Cylinders or disposable cans should never be subjected to high temperature when adding refrigerant to the system. In most instances, heating the cylinder or can is required to raise the pressure in the container higher than the pressure in the system during the operation. It would be unwise to place the cylinder on a gas stove, radiator or use a blow torch while preparing for the charging operation, for a serious accident can result. Remember, high pressure means that great forces are being exerted against the walls of the container. A bucket of warm water, not over 125°F, or warm wet rags round the container is all the heat that is required.

3. Do not weld or steam clean on or near the system. Welding or steam cleaning can result in a dangerous pressure buildup in the system.

4. Discharging large quantities of R-12 into a room can usually be done safely as the vapor would produce no ill èffects; however, in the event of an accidental rapid discharge of the system, it is recommended that inhalation of large quantities of R-12 be avoided. This caution is especially important if the area contains a flame producing device such as a gas heater. While R-12 normally is nonpoisonous, heavy concentrations of it in contact with a live flame will produce a toxic gas. The same gas will also attack all bright metal surfaces.

5. Protection of the eyes is of vital importance! When working around a refrigerating system, an accident may cause liquid refrigerant to hit the face. If the eyes are protected with goggles or glasses, no serious damage can result. Just remember, any R-12 liquid that touches you is at least 21.7°F below zero. If R-12 liquid should strike the eyes, here is what to do:

A. Keep calm.

B. Do not rub the eyes. Splash the affected area with quantities of cold water to gradually get the temperature above the freezing point. The use of mineral, cod liver or an antiseptic oil is important in providing a protective film to reduce the possibility of infection.

C. As soon as possible, call or consult an eye specialist for immediate and future treatment.

PRECAUTIONS IN HANDLING REFRIGERANT LINES

CAUTION: *The following precautions should be observed when handling refrigerant lines:*

1. All metal tubing lines should be free of kinks, because of the restriction that kinks will offer to the flow of refrigerant. The refrigeration capacity of the entire system can be greatly reduced by a single kink.

2. The flexible hose lines should never be bent to a radius of less than 10 times the diameter of the hose.

3. The flexible hose lines should never be allowed to come within a distance of 2-1/2" of the exhaust manifold.

4. Flexible hose lines should be inspected at least once a year for leaks or brittleness. If found brittle or leaking they should be replaced with new lines.

5. Use only new lines that have been sealed during storage.

6. When disconnecting any fitting in the refrigeration system, the system must first be discharged of all refrigerant. However, proceed very cautiously regardless of gauge readings. Open very slowly, keeping face and hands away so that no injury can occur if there happens to be liquid refrigerant in the line. If pressure is noticed when fitting is loosened, allow it to bleed off as described under "Purging the System" in this section.

WARNING: ALWAYS WEAR SAFETY GOGGLES WHEN OPENING REFRIGERANT LINES.

7. In the event any line is opened to atmosphere, it should be immediately capped to prevent entrance of moisture and dirt.

8. The use of the proper wrenches when making connections on "O" ring fittings is important. The use of improper wrenches may damage the connection. The opposing fitting should always be backed up with a wrench to prevent distortion of connecting lines or components. When connecting the flexible hose connections it is important that the swagged fitting and the flare nut, as well as the coupling to which it is attached, be held at the same time using three different wrenches to prevent turning the fitting and damaging the ground seat.

9. "O" rings and seats must be in perfect condition. A burr or piece of dirt may cause a leak.

10. Sealing beads on hose clamp connections must be free of nicks and scratches to assure a perfect seal.

MAINTAINING CHEMICAL STABILITY IN THE REFRIGERATION SYSTEM

The metal internal parts of the refrigeration system and the refrigerant and oil contained in the system are designed to remain in a state of chemical stability as long as pure R-12 and uncontaminated refrigeration oil is used in the system.

However, when abnormal amounts of foreign materials, such as dirt, air or moisture are allowed to enter the system, the chemical stability may be upset. When accelerated by heat, these contaminants may form acids and sludge and eventually cause the breakdown of components within the system. In addition, contaminants may affect the temperature-pressure relationship of R-12, resulting in improper operating temperature and pressures and decreased efficiency of the system.

The following general practices should be observed to ensure chemical stability in the system:

1. Whenever it becomes necessary to disconnect a refrigerant or gauge line, it should be immediately capped. Capping the tubing will also prevent dirt and foreign matter from entering.

2. Tools should be kept clean and dry. This also includes the gauge set and replacement parts.

3. When adding oil, the container should be exceptionally clean and dry due to the fact that the refrigeration oil in the container is as moisture-free as it is possible to make it; therefore, it will quickly absorb any moisture with which it comes in contact. For this same reason the oil container should not be opened until ready for use and then it should be capped immediately after use.

4. When it is necessary to open a system, have everything you will need ready and handy so that as little time as possible will be required to perform the operation. Don't leave the system open any longer than is necessary.

5. Finally, after the operation has been completed and the system sealed again, air and moisture should be evacuated from the system before recharging.

CHARGING STATION J-24410

This portable air conditioner service station (figure 26) features the new J-24364 High Capacity Vacuum Pump. Utilization of J-24364 enables the J-24410 service station to out-perform all competitive stations in the automotive field today.

The capacity of the J-24364 is three cubic feet per minute; four times that of the J-5428-03 which pumps at a rate of .8 cubic feet per minute. A vented exhaust aids in the removal of moisture at a much faster rate.

With the added increases in capacity the new J-24410 will enable a serviceman to perform the evacuation procedure in an automotive air conditioning system in one third less time. This of course is a money saving feature.

The J-24410 incorporates two compound gauges. The second compound gauge is used to permit checking of other Motor Home manufacturer's systems at the evaporator pressure release valve. The CMN fast flow manifold incorporates a new O ring stem which permits the manifold to be opened or closed in two and a half turns.

This station is equipped with a controlled heated cylinder which assures a complete charge into the high pressure side of the compressor. This feature reduces the charging time considerably and enables a complete and accurately measured charge without running the engine!

The line from the manifold to the pump is 3/8" I.D. copper tube which is a larger I.D. for less restriction on pull down. The cylinder is graduated for Refrigerant-12 and Refrigerant-22. Refrigerant-22 is used in some of the refrigerant systems on recreational vehicles. Also the cylinder has a heating ele-

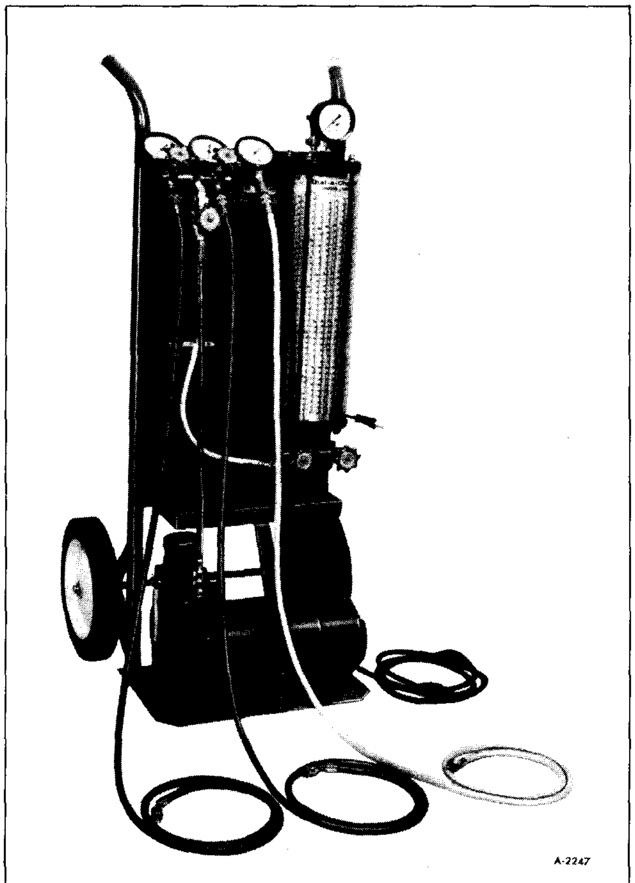


Figure 26—Charging Station J-24410

ment to provide a positive pressure advantage to overcome system pressure equalization.

GAUGE SET

The gauge set is an integral part of the Charging Station. It is used when purging, evacuating, charging or diagnosing trouble in the system. The gauge at the left is known as the low pressure gauge. The face is graduated into pounds of pressure and, in the opposite direction, in inches of vacuum. This is the gauge that should always be used in checking pressures on the low pressure side of the system. When all parts of the system are functioning properly the refrigerant pressure on the low pressure side never falls below 0 pounds pressure. However, several abnormal conditions can occur that will cause the low pressure to fall into a partial vacuum. Therefore, a low pressure gauge is required.

The high pressure gauge is used for checking pressures on the high pressure side of the system.

The hand shutoff valves on the gauge manifold do not control the opening or closing off of pressure to the gauges. They merely close each opening to the center connector and to each other. During most diagnosing and service operation, the valves must be closed. Both valves will be open at the same time during purging, evacuating and charging operations.

The charging station provides two flexible lines for connecting the gauge set to the system components.

VACUUM PUMP

A vacuum pump should be used for evacuating air and moisture from the air conditioning system.

The vacuum pump (figure 26), is a component part of Charging Station described previously.

CAUTION: *The following precautions should be observed relative to the operation and maintenance of this pump:*

1. Make sure dust cap on discharge outlet of vacuum pump is removed before oerating.

2. Keep all openings capped when not in use to avoid moisture being drawn into the system.

3. Oil should be changed after every 250 hours of normal operation.

To change oil, simply unscrew hex nut located on back side of pump, tilt backward and drain out oil. Recharge with 8 ounces of vacuum pump oil Frigidaire 150 or equivalent. If you desire to flush out the pump, use this same type clean oil. Do not use solvent. Improper lubrication will shorten pump life.

4. If this pump is subjected to extreme or prolonged cold, allow it to remain indoors until oil has reached approximate room temperature. Failure to warm oil will result in a blown fuse.

5. A five ampere time delay cartridge fuse has been installed in the common line to protect the windings of the compressor. The fuse will blow if an excessive load is placed on the pump. In the event the fuse is blown, replace with a five ampere time delay fuse. **Do not use a substitute fuse** as it will result in damage to the starting windings.

6. If the pump is being utilized to evacuate a burnt-out system, a filter must be connected to the intake fitting to prevent any sludge from contaminating the working parts, which will result in malfunction of the pump.

7. Do not use the vacuum pump as an air compressor.

LEAK TESTING THE SYSTEM

Whenever a refrigerant leak is suspected in the system or a service operation performed which results in disturbing lines or connections, it is advisable to test for leaks. Common sense should be the governing factor in performing any leak test, since the necessity and extent of any such test will, in general, depend upon the nature of the complaint and the type of service performed on the system.

LEAK DETECTOR

Tool J-6084 (figure 27) is a propane gas-burning torch which is used to locate a leak in any part of the system. Refrigerant gas drawn into the sampling tube attached to the torch will cause the torch flame to change color in proportion to the size of the leak.

Propane gas fuel cylinders used with the torch are readily available commercially throughout the country.

WARNING: DO NOT USE LIGHTED DETECTOR IN ANY PLACE WHERE COMBUSTIBLE OR EXPLOSIVE GASES, DUSTS OR VAPORS MAY BE PRESENT.

OPERATING DETECTOR

1. Determine if there is sufficient refrigerant in the system for leak testing.

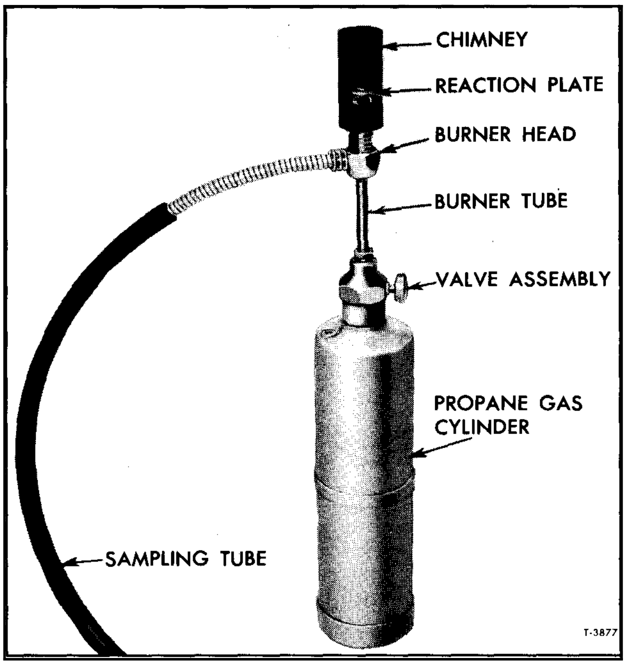


Figure 27—Leak Detector J-6084

2. Open control valve only until a low hiss of gas is heard, then light gas at opening in chimney.

3. Adjust flame until desired volume is obtained. This is most satisfactory when blue flame is approximately 3/8" above reactor plate. The reaction plate will quickly heat to a cherry red.

4. Explore for leaks by moving the end of the sampling hose around possible leak points in the system. Do not pinch or kink hose.

NOTE: Since R-12 is heavier than air, it is good practice to place open end of sampling tube immediately below point being tested, particularly in cases of small leaks.

WARNING: DO NOT BREATHE THE FUMES THAT ARE PRODUCED BY THE BURNING OF R-12 GAS IN THE DETECTOR FLAME, SINCE SUCH FUMES CAN BE TOXIC IN LARGE CONCENTRATIONS.

5. Watch for color changes. The color of the flame which passes through the reaction plate will change to green or yellow-green when sampling hose draws in very small leaks of R-12. Large leaks will be indicated by a change in color to a brilliant blue or purple; when the sampling hose passes the leaks, the flame will clear to an almost colorless pale-blue again. Observations are best made in a semidarkened area. If the flame remains yellow when unit is removed from leak, insufficient air is being drawn in or the reaction plate is dirty.

NOTE: A refrigerant leak in the high pressure side of the system may be more easily detected if the system is operated for a few minutes, then shut off and checked immediately (before system pressures equalize). A leak on the low pressure side may be more easily detected after the engine has been shut off for several minutes (system pressures equalized); this applies particularly to the front seal.

AVAILABILITY OF REFRIGERANT-12

Refrigerant-12 is available in 30 lb. and in 15 oz. disposable containers.

Normally, air conditioning systems are charged making use of the Charging Station which uses the 30 lb. container. Evacuating and charging procedures are noted later in this section.

The 15 oz. disposable cans are generally used for miscellaneous operations such as flushing.

WARNING: THE FOLLOWING PRECAUTIONS SHOULD BE OBSERVED WHEN ADDING REFRIGERANT TO A SYSTEM USING 15 OZ. DISPOSABLE CANS:

1. Do not charge while compressor system is hot.

2. Empty container completely before disposing.

3. Use opening valves designed for use with container - follow valve manufacturer's directions carefully.

4. Always use pressure gauges before and during charging.

5. NEVER connect on high pressure side of system or to any system having a pressure higher than indicated on refrigerant containers.

6. If inexperienced, seek professional assistance.

COMPRESSOR OIL

Special refrigeration lubricant should be used in the system. This oil is as free from moisture and contaminants as it is possible to attain by human processes. This condition should be preserved by immediately capping the bottle when not in use.

See "Air Condtiioning System Capacities" for the total system oil capacity.

Due to the porosity of the refrigerant hoses and connections, the system refrigerant level will show a definite drop after a period of time. Since the compressor oil is carried throughout the entire system mixed with the refrigerant, a low refrigerant level will cause a dangerous lack of lubrication. Therefore the refrigerant charge in the system has a definite tie-in with the amount of oil found in the compressor and an insufficient charge may eventually lead to an oil build-up in the evaporator.

COMPRESSOR SERIAL NUMBER

The compressor serial number is located on the serial number plate on top of the compressor. The serial number consists of a series of numbers and letters. This serial number should be referenced on all forms and correspondence related to the servicing of this assembly.

INSPECTION AND PERIODIC SERVICE

PRE-DELIVERY INSPECTION

1. Check that engine exhaust in suitably ventilated.

2. Check the belt for proper tension.

3. With controls positioned for operation of the system, operate the unit for five minutes at approximately 2000 rpm. Observe the clutch pulley bolt to see that the compressor is operating at the same speed as the clutch pulley. Any speed variation indicates clutch slippage.

4. Before turning off the engine, check refrigerant charge (see "Refrigerant Quick Check Procedure").

5. Check refrigerant hose connections:

"O" Ring Connections — Check torque of fittings as charted later in this section under "Refrigerant Line Connections;" retorque if required. Leak test the complete system.

6. If there is evidence of an oil leak, check the compressor to see that the oil charge is satisfactory.

NOTE: A slight amount of oil leakage at the compressor front seal is considered normal.

7. Check the system controls fpr proper operation.

6000 MILE INSPECTION

1. Check unit for any indication of a refrigerant leak.

2. If there is an indication of an oil leak, check the compressor for proper oil charge.

NOTE: A slight amount of oil leakage at the compressor front seal is considered normal.

3. Check refrigerant charge (see "Refrigerant Quick Check Procedure").

4. Tighten the compressor brace and support bolts and check the belt tension.

5. Check refrigerant hose connections as in Step 5 of "Pre-Delivery Inspection."

PERIODIC SERVICE

1. Inspect condenser regularly to be sure that the fins are not plugged with leaves or other foreign material.

Also check to be sure fins are not folded over blocking air flow. Fins may be straightened.

2. Check evaporator drain tubes regularly for dirt or restrictions.

3. At least once a year, check the system for proper refrigerant charge and the flexible hoses for brittleness, wear or leaks.

4. Every 6000 miles check for low refrigerant level.

5. Check belt tension regularly.

EVACUATING AND CHARGING PROCEDURES

AIR CONDITIONING SYSTEM CAPACITY

The vehicle automotive air conditioning system has a refrigerant capacity of 3.5 lbs.

INSTALLING CHARGING STATION

1. High and low pressure gauge line fittings are provided in the air conditioning system for attaching the Charging Station. The compressor inlet line and the high pressure fitting is on the compressor outlet line.

2. With the engine stopped, remove the caps from the cored valve gauge fittings.

3. Install Gauge Adapters J-5420 and J-9459 onto the high and low pressure lines of the Charging Station.

4. Be certain all the valves on the Charging Station are closed.

5. Connect the high pressure gauge line to the high pressure fitting on the system.

6. Referring to Figure 28, turn the high pressure control one turn counterclockwise (open). Crack open the low pressure control and allow refrigerant gas to hiss from the low pressure gauge line for three seconds, and then connect the low pressure line to the low pressure fitting on the system.

WARNING: WHEN REMOVING THE GAUGE LINES FROM THE FITTINGS, BE SURE TO REMOVE THE ADAPTERS FROM THE SYSTEM FITTINGS RATHER THAN THE GAUGE LINES FROM THE ADAPTER.

7. The system is now ready for purging or performance testing.

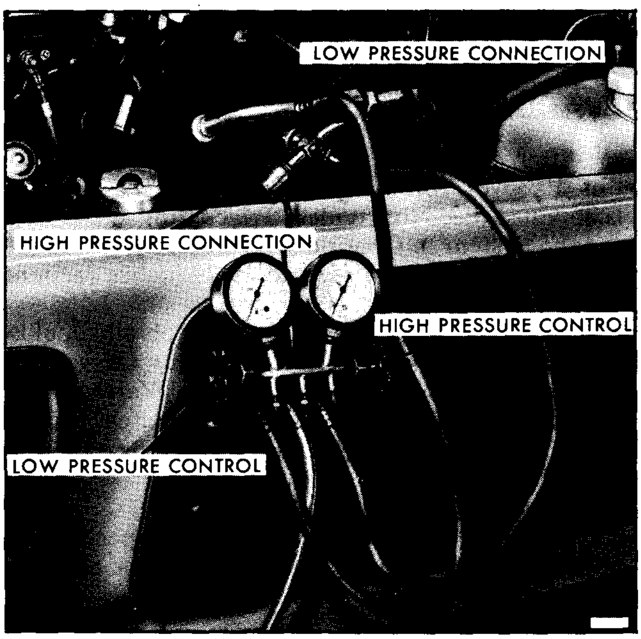


Figure 28—Charging Station Installed

PURGING THE SYSTEM

In replacing any of the air conditioning components, the system must be completely purged or drained of refrigerant. The purpose is to lower the pressure inside the system so that a component part can be safely removed.

1. With the engine stopped, install high and low pressure lines of Charging Station gauge set to the proper high and low pressure gauge fittings (See "Installing The Charging Station").

CAUTION: *Before installing lines, be sure that all four controls on the gauge set are closed.*

2. Disconnect vacuum line at Charging Station vacuum pump and put the line in a covered can.

NOTE: An empty 3 lb. coffee can with a plastic cover which has been cross-slit (X'ed), to allow home entry, works well for this purpose.

3. Fully open high (2) and low (1) pressure control valves, and allow refrigerant to purge from system at a rapid rate into the covered can.

4. Oil loss will be minimal. It may be added to the system during evacuation as described later.

5. Toward the end of the purge stage, Tool J-24095 should be flushed with refrigerant to eliminate possible contamination.

a. Disconnect refrigerant line at supply tank.

b. Flush Tool J-24095 by cracking open valve on refrigerant tank. After flushing for approximately three seconds, close valve.

c. Temporarily refasten the tool.

d. Reconnect refrigerant line to supply tank.

EVACUATING AND CHARGING THE SYSTEM

NOTE: In all evacuating procedures shown below, the specification of 28-29 inches of Mercury vacuum is used. These figures are only attainable at or near Sea Level Elevation. For each 1000 feet above sea level where this operation is being, performed, the specifications should be lowered by 1 inch. Example: at +5000 ft. elevation, only 23 to 24 inches of vacuum can normally be obtained.

Whenever the air conditioning system is open for any reason, it should not be put into operation again until it has been evacuated to remove air and moisture which may have entered the system.

The following procedures are based on the use of the J-24410 Charging Station:

ADDING OIL

If necessary, refrigeration oil may be added to the system by the following method:

1. Install charging station and purge system as previously described.

2. After system has been purged, connect the vacuum line to the vacuum pump.

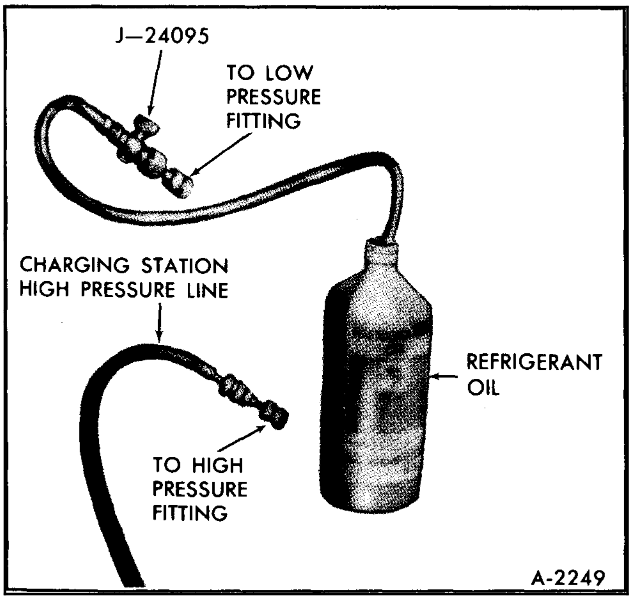


Figure 29—Adding Refrigeration Oil

3. Measure oil loss collected as a result of purging the system.

a. Disconnect the Charging Station low pressure line. Install Tool J-24095 (with valve closed) onto the system low pressure fitting. Insert pickup tube into graduated container of clean refrigerant oil (figure 29).

NOTE: Tool J-24095 will hold 1/2 of an ounce of oil in the tool itself. So if 1 oz. has to be added, the level of the oil in the bottle should decrease 1-1/2 ounces to add 1 oz. to the system.

CAUTION: *When removing the gauge lines from the fittings, be sure to remove the adapters from the system fittings rather than the gauge lines from the adapter.*

b. Turn on vacuum pump, and open vacuum control valve (slowly open high pressure side of manifold gauge set to avoid forcing oil out of refrigerant system and pump).

NOTE: When valve on Tool J-24095 is opened, the vacuum applied to the discharge side of the system will suck oil into system from container. Therefore, close observation of oil level in the container is necessary.

c. Note level of oil in container. Open valve on oil adding tool until oil level in container is reduced by an amount equal to that lost during discharge of system plus 1/2 ounce, then close valve. **Take care not to add more oil than was lost.**

d. Disconnect and cap Tool J-24095 and reinstall charging station low pressure line to the system. Open low pressure valve.

EVACUATION

After oil has been added to the system (as outlined above), run pump until 28-29 inches vacuum is obtained (See Note under "Evacuating and Charging the System"). Continue to run pump for 10 minutes after the system reaches 28-29 inches vacuum.

NOTE: If 28-29 inches cannot be obtained, close Vacuum Control Valve and shut off vacuum pump. Open Refrigerant Control Valve and allow 1/2 pound of R-12 to enter system. Locate and repair all leaks. Purge this 1/2 pound and re-evacuate for 10 minutes.

1. During the ten minute evacuation period, prepare for charging the system by filling the charging cylinder as follows:

a. Open valve on bottom of charging cylinder allowing refrigerant to enter cylinder.

NOTE: It will be necessary to close bleed valve periodically to allow boiling to subside to check level in the sight glass of Charging Station cylinder.

b. Bleed cylinder valve on top (behind control panel) as required to allow refrigerant to enter. When refrigerant reaches desired level (see "System Capacity"), close valve at bottom of cylinder and be certain bleed valve is closed securely.

2. Continue to evacuate for remainder of 10 minute period.

3. Turn hand shut-off valves at low and high pressure gauges of gauge set to full clockwise position with vacuum pump operating, then stop pump. Carefully check low pressure gauge for approximately two minutes to see that vacuum remains constant. If vacuum reduces, it indicates a leak in the system or gauge connections; locate and repair all leaks.

CHARGING THE SYSTEM

1. Only after evacuating as above, is system ready for charging. Note reading on sight glass of charging cylinder. If it does not contain a sufficient amount of refrigerant for a full charge, fill to the proper level.

2. With High and Low Pressure Valves open, close Vacuum Control Valve, turn off vacuum pump, open refrigerant control valve and allow refrigerant to enter system.

NOTE: If the charge will not transfer completely from the station to the system, close the high pressure valve at the gauge set, set the air conditioning controls for cooling, check that the engine compartment is clear of obstructions, and start the engine. Compressor operation will decrease the low side pressure in the system.

System is now charged and should be checked as outlined below:

CHECKING SYSTEM OPERATION

1. Operate system for a maximum of five minutes at maximum cooling, high blower speed and with engine operating at 2000 RPM (exhaust should be vented if inside).

2. When system is stabilized, the pressure gauges on the charging station should read pressures corresponding to values listed under PERFORMANCE DATA.

3. When correct system pressures are observed, check system charge as described under "Refrigerant Quick Check Procedure".

4. Feel outlet air distribution to ensure that cold air is being distributed.

5. Disconnect gauge lines and cap fittings.

CAUTION: *When removing gauge lines from fittings, be sure to remove the adapters from the fittings rather than the gauge lines from the adapters.*

PERFORMANCE TEST

Under normal circumstances, it will not be necessary to Performance Test a system as outlined below; however, in certain instances, the following procedure may be advantageous in diagnosing system malfunction.

NOTE: The following performance test and data do not apply to vehicles equipped with the additional air conditioning outlets shown in Figure 25.

The following fixed conditions must be adhered to in order to make it possible to compare the performance of the system being tested with the standards below:

1. Windows and curtains open. (Vehicle inside or in shade).

2. Vehicle in NEUTRAL with engine running at 2000 rpm.

3. Air Conditioning controls set for -

- Upper control on A/C.
- Lower control on cold.
- High blower speed.

4. Disconnect temperature sensor on engine cooling fan.

5. Gauge set installed.

6. System settled out (run-in approximately 10 minutes).

7. A thermometer placed in front of vehicle grille and another in the center diffuser outlet.

NOTE: Higher temperatures and pressures will occur at higher ambient temperatures. In areas of high humidity it is possible to have thermometer and gauge readings approach but not reach the figures listed in the performance table and still have a satisfactory operating unit. However, it is important to remember that low pressure has a direct relationship to nozzle outlet temperature. If pressure is too low, ice will gradually form on the evaporator fins, restricting air flow into the passenger area and resulting in insufficient or no cooling.

PERFORMANCE DATA

The following Performance Data define normal operation of the system under the above conditions.

REFRIGERANT CHARGE — 3.5 LBS.

ENGINE RPM — 2000 RPM

HEAD PRESSURE (EVAP. "IN" CHARGE PORT)*

Temp. of Air Entering Condensor Relative Humidity	70°F (21.1°C)	80°F (26.7°C)	90°F (32.2°C)	100°F (37.8°C)	110°F (43.3°C)
30%				230 - 245	270 - 285
40%			190 - 205	237 - 252	283 - 298
60%		157 - 172	202 - 217	242 - 257	
80%	127 - 142	167 - 182	210 - 225		

SUCTION PRESSURE (EVAPORATOR "OUT" CHARGE PORT)*

Temp. of Air Entering Condensor Relative Humidity	70°F (21.1°C)	80°F (26.7°C)	90°F (32.2°C)	100°F (37.8°C)	110°F (43.3°C)
30%				14.0 - 29.0	18.0 - 33.0
40%			11.0 - 26.0	15.5 - 30.5	20.5 - 35.5
60%		9.5 - 24.5	13.8 - 28.8	19.0 - 34.0	
80%	6.5 - 21.5	11.0 26.0	16.2 - 31.2		

DISCHARGE AIR TEMP. AT RIGHT UPPER OUTLET*

Temp. of Air Entering Condensor Relative Humidity	70°F (21.1°C)	80°F (26.7°C)	90°F (32.2°C)	100°F (37.8°C)	110°F (43.3°C)
30%				60 - 64	68 - 72
40%			57 - 61	65 - 69	74 - 78
60%		52 - 56	63 - 67	71 - 75	
80%	45 - 50	57 - 61	65 - 69		

*Just prior to compressor clutch disengagement.

CHECKING OIL

In the six cylinder compressor it is not recommended that the oil be checked as a matter of course. Generally, compressor oil level should be checked only where there is evidence of a major loss of system oil such as might be caused by:

- A broken refrigerant hose
- A severe hose fitting leak
- A very badly leaking compressor seal
- Collision damage to the system components

As a quick check on compressor oil charge, operate the engine at **idle** on maximum cold for approximately 10 minutes, turn off the engine and momentarily crack open the oil drain plug on bottom of the compressor letting a slight amount of oil drain out. Retighten plug. Again slightly crack open the plug. If oil comes out, the compressor has the required amount of oil.

NOTE: The oil may appear foamy. This is considered normal.

To further check the compressor oil charge, should the above test show insufficient oil, it is necessary to remove the compressor from the vehicle, drain and measure the oil as outlined under "Checking Compressor Oil Charge."

CHECKING COMPRESSOR OIL CHARGE

1. Run the system for 10 minutes at 600 engine rpm with controls set for maximum cooling and high blower speed.

2. Turn off engine, discharge the system, remove compressor from vehicle, place it in a horizontal position with the drain plug downward. Remove the drain plug and, tipping the compressor back and forth and rotating the compressor shaft, drain the oil into a clean container, measure and discard the oil.

3. Add new refrigeration oil to the compressor as follows.

a. If the quantity drained was 4 fluid oz. or more, add the same amount of new refrigeration oil to the replacement compressor.

b. If the quantity drained was less than 4 fluid oz., add 6 fluid oz. of new refrigeration oil to the replacement compressor.

c. If a new service compressor is being installed, drain all oil from it and replace only the amount specified in Steps 3a and 3b above.

d. If a field repaired compressor is being installed, add an additional 1 fluid oz. to the compressor.

e. If the oil contains chips or other foreign material, flush or replace all component parts as necessary. Add the full 10 fluid oz. of new refrigeration oil to the replacement compressor.

4. Add additional oil in the following amounts for any system components being replaced.

Evaporator Core	3 fluid oz.
Condenser	1 fluid oz.
Receiver-Dehydrator	1 fluid oz.

CAUTION: *When adding oil to the compressor, it will be necessary to tilt the rear end of the compressor up so that the oil will not run out of the suction and discharge ports. Do not set the compressor on the shaft end.*

REFRIGERANT QUICK-CHECK PROCEDURE

The following procedure can be used to quickly determine whether or not an air conditioning system has a proper charge of refrigerant. This check can be made in a manner of minutes thus facilitating system diagnosis by pinpointing the problem to the amount of charge in the system or by eliminating this possibility from the overall checkout.

Start engine and place on fast idle. Set controls for maximum cold with blower on high.

Bubbles present in sight glass. System low on charge. Check with leak detector. Correct leak, if any, and fill system to proper charge.	No bubbles. Sight glass clear. System is either fully charged or empty. Feel high and low pressure pipes at compressor. High pressure pipe should be warm; low pressure pipe should be cold.
No appreciable temperature differential noted at compressor. System empty or nearly empty. Turn off engine and connect Charging Station. Induce 1/2# of refrigerant in system (if system will not accept charge, start engine and draw 1/2# in through low pressure side). Check system with leak detector.	Temperature differential noted at compressor. Even though a differential is noted, there exists a possibility of overcharge. An overfilled system will result in poor cooling during low speed operation (as a result of excessive head pressure), An overfill is easily checked by disconnecting the compressor clutch connector while observing the sight glass.
If refrigerant in sight glass remains clear for more than 45 seconds (before foaming and then setting away from sight glass) an overcharge is indicated. Verify with a performance check.	If refrigerant foams and then settles away from sight glass in less than 45 seconds, it can be assumed that there is a proper charge of refrigerant in system. Continue checking out system using performance checks outlined previously.

MAINTENANCE AND ADJUSTMENTS

THERMOSTATIC SWITCH

The system makes use of a thermostatic switch with an air sensing capillary. This capillary controls the switch by sensing the temperature of the air leaving the fins.

CHECKING FOR PROPER OPERATION

1. Install the gauge set and set up the vehicle as described under "Performance Test".

2. Set the control at A/C, HI blower, max COLD and run the engine at 2000 rpm.

a. The thermostatic switch should cycle the compressor off when the low limit of the outlet air temperature is reached (see Performance Data). If it does not, the switch points are fused which will lead to evaporator freeze up. Replace the switch.

b. If the compressor does not operate, a loss of power element charge is indicated (provided that it has been established that power is supplied to the switch). This, of course, results in no cooling. Replace the switch.

c. Check the switch adjusting screw for stripped or otherwise damaged threads.

ADJUSTING SWITCH

If, after the above checks, the switch seems to be operating properly, adjust for proper setting if necessary, as follows:

1. Vehicle must be set up as described in "Performance Test."

2. The suction side of the system, read on the low pressure gauge, should pull down to the pressure shown in the chart in "Performance Data" under the ambient temperature at the time the switch is being set.

3. Remove the switch as outlined in the "General Repair Procedures" section.

4. Remove the switch non-metal end plate to gain access to the switch adjusting screw.

5. If the outlet temperature was less than the prescribed temperature at the end of each cooling cycle, turn the adjusting screw a partial turn counterclockwise (figure 30). If the outlet temperature was more than prescribed temperature, turn the adjusting screw clockwise.

NOTE: One turn of the adjusting screw will

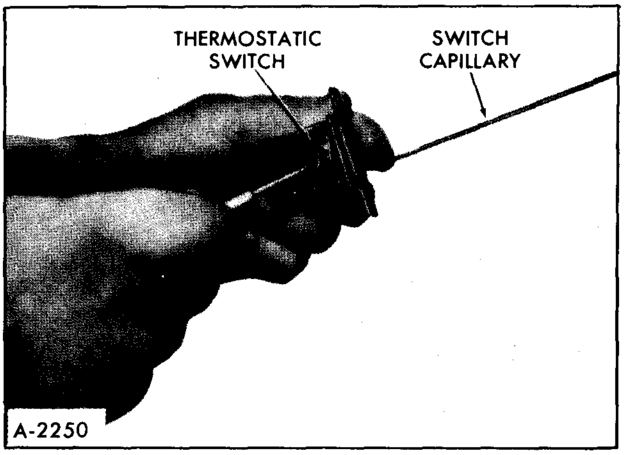


Figure 30—Adjusting Thermostatic Switch

change the outlet temperature **approximately** 4 degrees.

6. Reinstall switch end plate and reinstall switch. Be sure that the air sensing capillary has been replaced properly.

7. Check system performance. If further adjustment is needed, repeat Steps 3 through 6 until the prescribed pressure is reached.

NOTE: Do not attempt to run a Performance Check with the system disassembled since inaccurate readings would be the result. ALWAYS reinstall switch and capillary and any duct work before running a performance check.

EXPANSION VALVE (FIGURES 15 & 16)

A malfunction of the expansion valve will be caused by one of the following conditions; valve stuck open, valve stuck closed, broken power element, a restricted screen or an improperly located or installed power element bulb.

Attachment of the expansion valve bulb to the evaporator outlet pipe is very critical. The bulb must be attached tightly to the pipe and must make good contact with the pipe along the entire length of the bulb. A loose bulb will result in high "high side" pressures and poor cooling. On bulbs located outside the evaporator case, insulation must be properly installed.

Indications of expansion valve trouble provided by the Performance Test are as follows:

VALVE STUCK OPEN

Noisy Compressor.

No Cooling - Freeze Up.

VALVE STUCK CLOSED, PLUGGED SCREEN OR BROKEN POWER ELEMENT

Very Low Suction Pressure.

No Cooling.

POORLY LOCATED POWER ELEMENT BULB

Normal Pressure.

Poor Cooling.

CHECK FOR DEFECTIVE VALVE

The following procedure must be followed to determine if a malfunction is due to a defective expansion valve.

1. Check to determine if the system will meet the performance test as outlined previously. If the expansion valve is defective, the low pressure readings will be above specification.

2. The loss of system performance is not as evident when the high side pressure is below 200 PSI. Therefore, it may be necessary to increase the system high side pressure by partially blocking the condenser. Disconnect the blower lead wire and repeat the "Performance Check" to determine if the low side pressure can be obtained.

GENERAL REPAIR PROCEDURES AND COMPONENT REPLACEMENT

PREPARING SYSTEM FOR REPLACEMENT OF COMPONENT PARTS

Air conditioning, like many other things, is fairly simple to service once it is understood. However, there are certain procedures, practices and precautions that should be followed. For this reason it is strongly recommended that the preceding information in this section be studied thoroughly before attempting to service the system.

Great emphasis must be placed upon keeping the system clean. Use plugs or caps to close system components and hoses when they are opened to the atmosphere. Keep your work area clean.

In removing and replacing any part which requires unsealing the refrigerant circuit the following operations, which are described in this section, must be performed in the sequence shown.

1. Purge the system by releasing the refrigerant to the atmosphere.

2. Remove and replace the defective part.

3. Evacuate,charge and check the system.

WARNING: ALWAYS WEAR PROTECTIVE GOGGLES WHEN WORKING ON REFRIGERATION SYSTEMS. GOGGLES J-5453 ARE INCLUDED IN THE SET OF AIR CONDITIONING SPECIAL TOOLS. ALSO, BEWARE OF THE DANGER OF CARBON MONOXIDE FUMES BY AVOIDING RUNNING THE ENGINE IN CLOSED OR IMPROPERLY VENTILATED GARAGES.

FOREIGN MATERIAL IN THE SYSTEM

Whenever foreign material is found in the system, it must be removed before restoring the system to operation.

In the case of compressor mechanical failure, perform the following operations:

1. Remove the compressor.

2. Remove the receiver-dehydrator or expansion tube and discard the unit.

3. Flush the condenser to remove foreign material which has been pumped into it.

4. Disconnect the line at the evaporator core inlet or inlet line to the expansion valve.

Inspect the expansion tube or inlet screen of the expansion valve for the presence of metal chips or other foreign material. If the tube or screen is plugged, replace it. Reconnect the line to the evaporator core or expansion valve.

5. Install the replacement compressor.

6. Add the necessary quantity of oil to the system. Remember to add the one ounce for the new receiver-dehydrator.

7. Evacuate, charge and check system.

REFRIGERANT LINE CONNECTIONS

"O" RINGS

Always replace the "O" ring when a connection has been broken. When replacing the "O" ring, first dip it in clean refrigeration oil. Always use a backing wrench on "O" ring fittings to prevent the pipe from twisting and damaging the "O" ring. Do not over-tighten. Correct torque specifications are as follows:

CAUTION: *Where steel to aluminum connections are being made, use torque for aluminum tubing.*

Metal Tube O.D.	Thread and Fitting Size	Steel Tubing Torque*	Alum. Tubing Torque*
1/4	7/16	13	6
3/8	5/8	33	12
1/2	3/4	33	12
5/8	7/8	33	20
3/4	1-1/16	33	25

* Foot Pounds

HOSE CLAMPS

When hose clamp connections are encountered, special procedures are necessary for both removal and installation.

Removal

1. Carefully, with a sharp knife, make an angle cut in the hose as shown in Figure 31. This should loosen the hose so that it may be worked off the fitting.

2. Cut off slit end of hose.

CAUTION: *Use only approved refrigeration hose. Never use heater hose. Use extreme care not to nick or score the sealing beads when cutting off the hose. Cutting the hose lengthwise may result in this problem.*

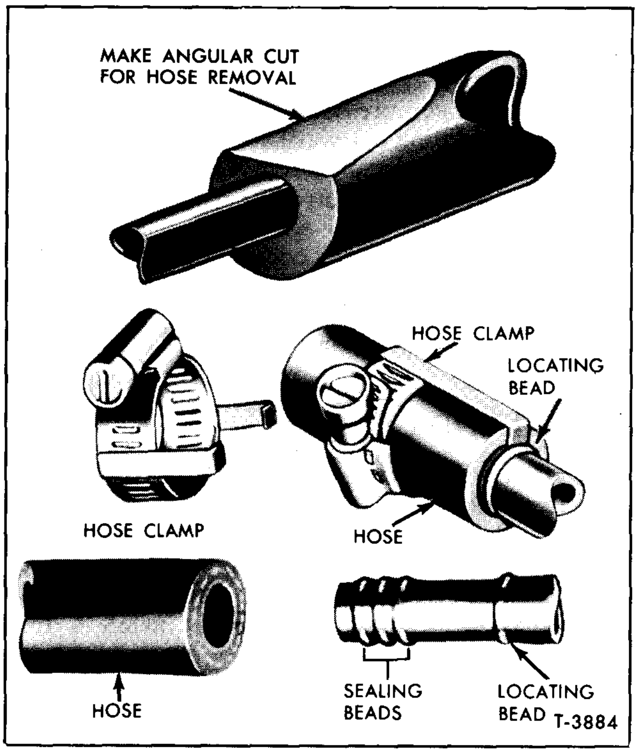


Figure 31—Hose Clamp Connections

Installation

1. Coat tube and hose with clean refrigeration oil.

2. Carefully insert hose over the three beads on the fitting and down as far as the fourth, or locating bead. Hose must butt against this fourth bead.

CAUTION: *Use no sealer of any kind.*

3. Install clamps on hose, hooking the locating arms over the cut end of the hose.

4. Tighten the hose clamp screw to 35-42 in. lbs. torque. DO NOT RETORQUE. The clamp screw torque will normally decrease as the hose conforms to the force of the clamp. The screw should be retorqued only if its torque falls below 10 in. lbs. In this case, retorque to 20-25 in. lbs. Further tightening may damage the hose.

REPAIR OF REFRIGERANT LEAKS

Any refrigerant leaks found in the system should be repaired in the manner given below:

LEAKS AT "O" RING CONNECTION

1. Check the torque on the fitting and, if too loose, tighten to the proper torque. Always use a backing wrench to prevent twisting and damage to the "O" ring. Do not overtighten. Again leak test the joint.

2. If the leak is still present, discharge the refrigerant from the system as described under "Evacuating and Charging Procedures."

3. Inspect the "O" ring and the fitting and replace if damaged in any way. Coat the new "O" ring with clean refrigeration oil and install carefully.

4. Retorque the fitting, using a backing wrench.

5. Evacuate, charge and check the system.

LEAKS AT HOSE CLAMP CONNECTION

1. Check the tightness of the clamp itself and tighten if necessary. Recheck for leak.

2. If leak has not been corrected, discharge the system and loosen clamp and remove hose from connection. Inspect condition of hose and connector. Replace scored or damaged parts.

3. Dip end of new hose in clean refrigeration oil and carefully reinstall over connector. Never push end of hose beyond the locating bead. Properly torque the clamp.

4. Evacuate, charge and check the system.

COMPRESSOR LEAKS

If leaks are located around the compressor shaft seal or shell, replacement of necessary seals should be made.

NOTE: A slight amount of oil leakage past the compressor front seal is considered normal.

REFRIGERANT HOSE FAILURE

After a leak or rupture has occurred in a refrigerant hose, or if a fitting has loosened and caused a considerable loss of refrigerant and oil, the entire system should be flushed and recharged after repairs have been made.

Because of the length of the hoses on these systems, hose leaks may be repaired using the following procedure:

1. Locate the leak.

2. Discharge the system.

3. Cut out the leaking portion of the hose, making

sure that all of the failed portion is removed. If only a very small portion of the hose was removed, it may be possible to splice the two ends together, using a special hose connector and two hose clamps. If several inches of hose must be removed, a new piece of hose should be spliced in using two connectors and four hose clamps. Dip the ends of the hoses in clean refrigeration oil before installing the hoses onto the connector. Never push the end of the hose beyond the locating bead of the connector. Torque the clamp to 35-42 in. lbs.

NOTE: Be sure to replace the hose in the body in the same manner as when removed. If the hose protective grommets are badly mutilated, they should be replaced.

4. Evacuate, charge and check the system.

COMPRESSOR

REMOVAL

1. Purge the refrigerant from the system.

2. Remove engine cover to gain access to engine components

3. Remove connector attaching bolt and hose connector (figure 32). Seal connector outlets.

4. Disconnect electrical lead to clutch actuating coil (figure 32).

5. Disconnect the hose holding clamp at the clutch pulley shield.

6. Loosen brace and pivot bolts and detach belt.

7. Remove the nuts and bolts attaching the compressor brackets to the mounting bracket.

8. Remove compressor and attaching brackets and shield by sliding rearward and dropping out bottom. Be sure compressor is removed with attaching brackets as shown in Figure 29.

9. Before beginning any compressor disassembly, drain and measure oil in the compressor. Check for evidence of contamination to determine if remainder of system requires servicing.

INSTALLATION

1. If oil previously drained from the compressor upon removal shows no evidence of contamination, replace a like amount of fresh refrigeration oil into the compressor before reinstallation. If it was necessary to service the entire system because of excessive contamination in the oil removed, install a full charge of fresh refrigeration oil into the compressor.

2. Position compressor on the mounting bracket and install all nuts, bolts and lock washers.

3. Install the connector assembly to the compressor rear head, using new "O" rings coated with clean refrigeration oil.

4. Connect the electrical lead to the coil and install and adjust compressor belt.

5. Evacuate, charge and check the system.

IMPORTANT: Adjust compressor belt, using belt tension gauge BT-33-73-F or other suitable gauge. Tension should be within 70-80 lbs. (used belt), or 110-140 lbs. (new belt). For complete

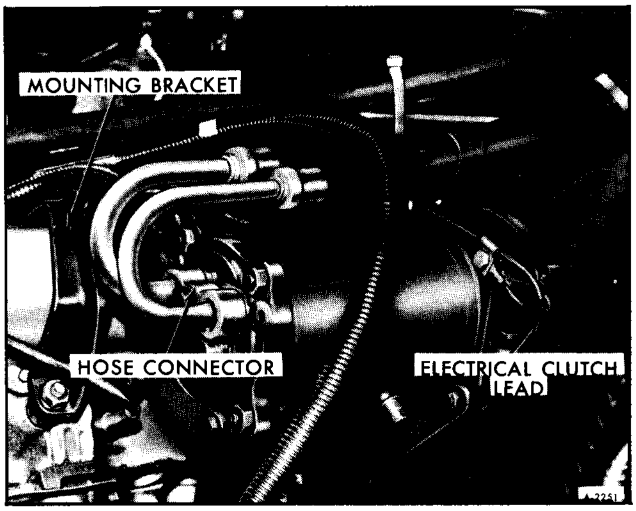


Figure 32—Compressor Installation

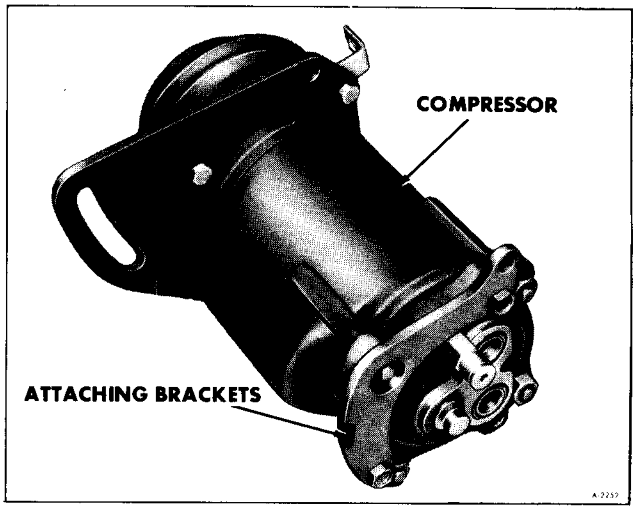


Figure 33 —Compressor Removed From Vehicle

discussion of belt tensioning or replacement, refer to "Belt Tension", SECTION 6K, ENGINE COOLING.

COMPRESSOR FAILURE

If the compressor has failed mechanically to the extent that metal chips and shavings are found in it, the system should be checked for foreign material and cleaned as described under Foreign Material in the System.

FALSE COMPRESSOR SEIZURE

Slipping or broken air conditioning drive belts and/or scored clutch surfaces may be experienced on initial start up of an air conditioning compressor after an extended period of storage or non-operation of the compressor. This would indicate a seized compressor; however, an overhaul or replacement of the compressor may not be necessary.

During extended periods of non-operation, changes in temperature cause the refrigerant in the air conditioning compressor to expand and contract. During this movement, lubricating oil carried by the refrigerant tends to migrate from highly polished surfaces in the compressor such as the ball seats and axial plate. Without lubricating oil at these polished surfaces, they "wring" together and appear to be seized.

Before the time and expense of an overhaul is invested, use the following check to determine if the compressor is actually seized. With a wrench on the compressor shaft lock nut or Spanner Wrench J-9403 on the clutch drive plate, "rock" the shaft in the opposite direction of normal rotation. After the compressor is broken loose, "rock" the shaft back and forth. This should be sufficient to return lubricating oil to the "wrung" surfaces and allow the compressor shaft to be turned by hand. Once the compressor turns freely, rotate the compressor at least three complete turns. Start the engine and operate the compressor for a minimum of one minute.

This procedure will not affect a compressor that is actually seized but should be attempted before overhauling a compressor known to be idle for a month or longer.

COLLISION PROCEDURE—ALL SYSTEMS

Whenever a vehicle equipped with an air conditioning unit is involved in a collision or wreck, it should be inspected as soon as possible. The extent or damage to any of all of the component parts and the length of time the system has been exposed to the atmosphere will determine the replacement of parts and processing that will be required. The greater the length of time of exposure to the atmosphere, the greater will have been the chances for air, moisture and dirt to have entered and damaged the system. Every case may be entirely different so it is not possible to establish a hard and fast procedure to follow each time. Good judgment must be used to determine what steps should be taken in each specific case.

The following procedure is presented as a guide for use when inspecting a damaged vehicle equipped with air conditioning.

1. Remove the drive belt.

2. Visually inspect the condenser, receiver-dehydrator, compressor, mounting brackets, conditioning unit, all connecting lines and all controls to determine the extent and nature of the damage.

a. No repairs, such as soldering, welding or brazing, should be attempted on the condenser because of its construction. If the vapor passages in the horizontal tubes or return bends or manifolds have been damaged in any way, the condenser should be replaced with a new one.

b. The receiver-dehydrator should be replaced if there is any evidence of its having sustained either internal damage or a fracture at any of the lines or welded joints or if the system has been exposed to the atmosphere for an undetermined period of time.

c. Examine the compressor for any visible external damage.

d. The evaporator should be examined for damage and, if necessary, removed or replaced or the entire unit processed where damaged or exposed to the atmosphere.

e. All connecting lines and flexible hoses should be examined throughout their entire length for damage. If damaged in any manner, replace with new lines.

f. Check all controls and connecting wires for damage and replace with new parts where needed.

g. Check the clutch pulley for proper operation and freedom from damage.

3. Install Charging Station.

4. Purge the system.

5. Remove the compressor from mounting and remove the oil test fitting.

6. Pour out the oil into a clean glass container and examine it for any foreign substance such as dirt, water, metal particles, etc. If any of these are present, the compressor, expansion tube, and accumulator or receiver-dehydrator should be replaced and the other system components should be flushed with liquid refrigerant.

7. If the oil is clean and free of any harmful substance, replace oil with Frigidaire 525 Viscosity Oil, or equivalent.

NOTE: If the system components have been replaced or flushed, replace the full charge of oil. If not, add no more fresh oil than was drained in Step 6.

8. Charge up the compressor to cylinder or can pressure. Leak test the compressor seals prior to installation of compressor.

9. Reinstall the compressor and evacuate the system by following the Evacuating Procedure.

10. Introduce R-12 vapor at cylinder (room) temperature and pressure.

11. Leak test all fittings and connections and give particular attention to a leak test at the compressor shaft seal if compressor has not been leak tested on the bench.

12. Complete system processing and charge system.

CONDENSER

REPLACEMENT

1. Disconnect battery ground cables.

2. Purge the system of refrigerant.

3. Remove grill assembly.

4. Disconnect the condenser inlet and outlet lines. Cap or plug all open connections at once.

5. Remove the receiver-dehydrator (Type 1) and its holding straps (See figure 13). '

6. Remove the condenser to radiator mounting screws (figure 34).

7. Remove the condenser assembly by pulling it forward and then lowering it from the vehicle through grille.

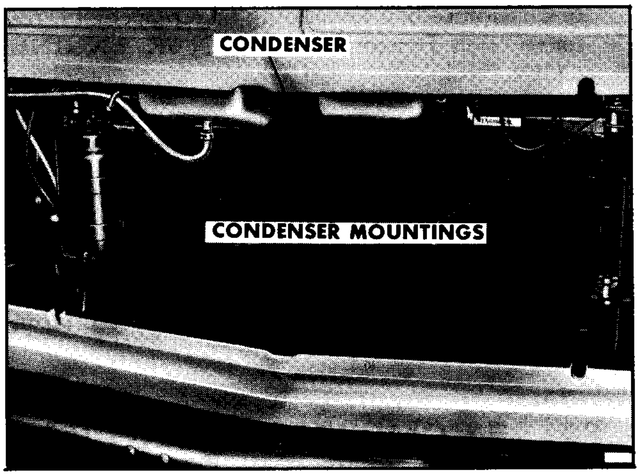


Figure 34—Condenser Mounting, Typical

8. To install a new condenser, reverse Steps 1-6 above. Add one fluid ounce of clean refrigeration oil to a new condenser.

NOTE: Use new"O" rings, coated with clean refrigeration oil, when connecting all refrigerant lines.

9. Evacuate, charge and check the system.

RECEIVER-DEHYDRATOR

REPLACEMENT

1. Disconnect the inlet and outlet lines being sure to use a wrench on the square portion of the receiver

Figure 35—Disconnecting Lines to Receiver-Dehydrator, Type 1

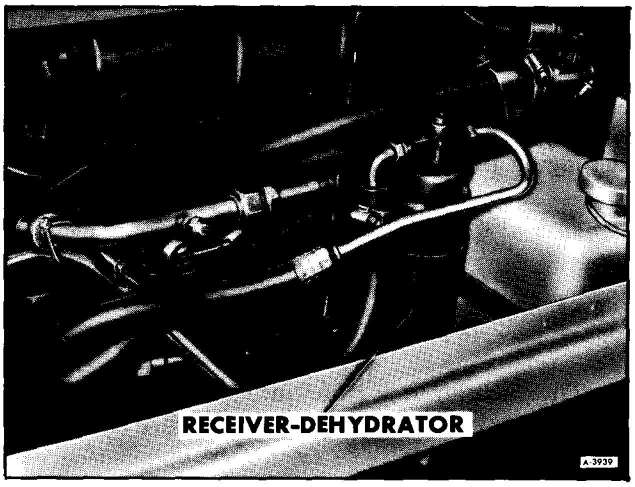


Figure 36—Disconnecting Lines to Receiver Dehydrator, Type 2

dehydrator for support. This will prevent twisting and possible breaking of the aluminum lines (See figures 35 and 36).

2. Loosen holding straps and slide out receiver-dehydrator.

3. To install, reverse steps 1 and 2 being sure to add 1 ounce of clean refrigeration oil and install new "O" rings.

BLOWER ASSEMBLY (FIGURE 37)

REPLACEMENT

1. Disconnect the battery ground cables.

2. Disconnect the blower motor lead and ground wires.

3. Disconnect the blower motor cooling tube.

4. Remove the blower to case attaching screws and remove the blower assembly. Pry the blower flange away from the case carefully if the sealer acts as an adhesive.

5. Remove the nut attaching the blower wheel to the motor shaft and separate the assemblies.

6. To install, reverse Steps 1-5 above; replace sealer as necessary.

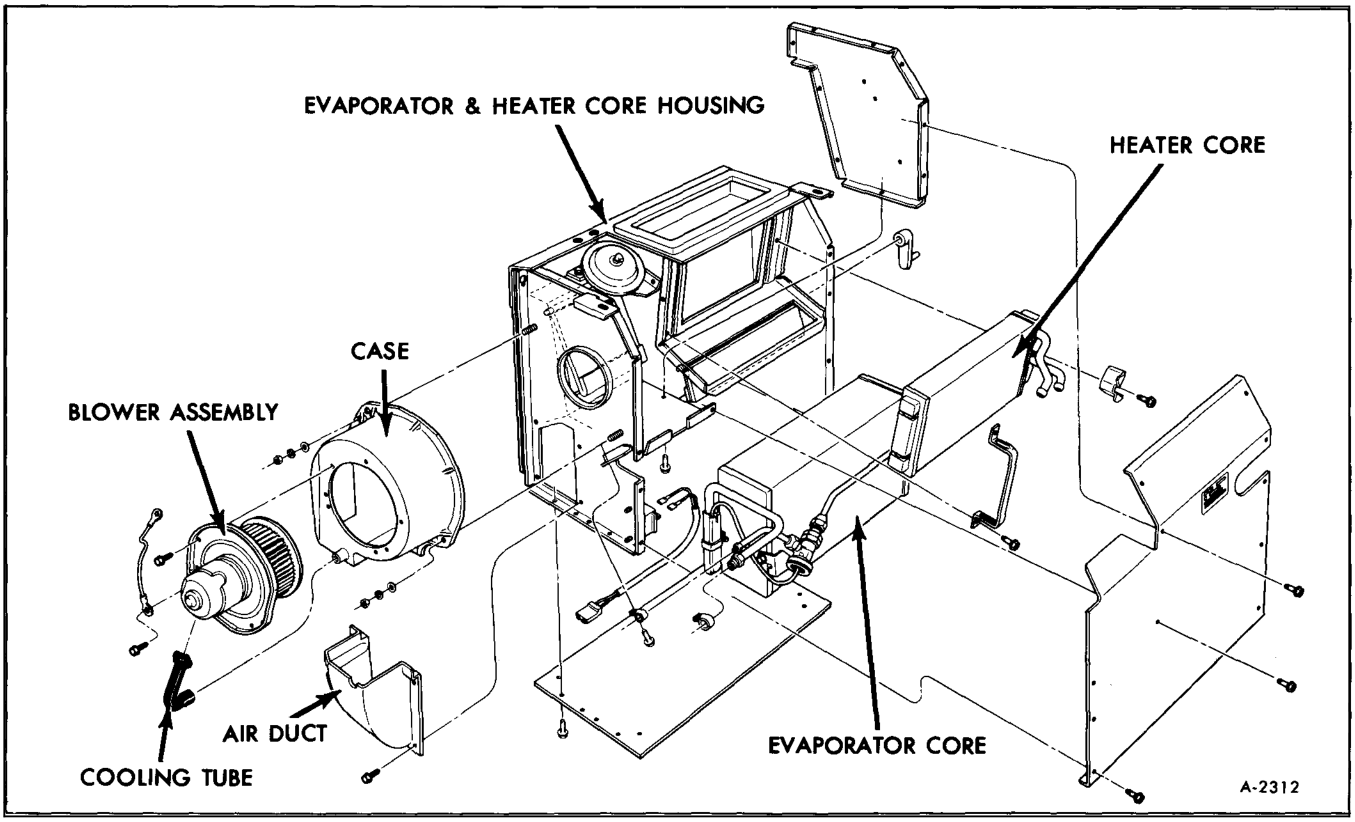


Figure 37—Evaporator and Heater Housing Components, Typical

EVAPORATOR AND HEATER CORE ASSEMBLY

REPLACEMENT (FIGURE 15)

1. Purge system.

2. Disconnect air conditioning lines from evaporator.

3. Disconnect heater hoses from heater core.

4. Disconnect all vacuum lines, wires and cables connected to the box assembly.

5. Remove windshield washer reservoir.

6. Remove coolant recovery reservoir and bracket.

7. Disconnect windshield wiper arms.

8. Remove attaching bolts and remove through front access door.

9. To install, reverse steps 1 through 8.

EVAPORATOR CORE AND EXPANSION VALVE

REPLACEMENT (FIGURE 15)

CAUTION: *When repair or replacement of the evaporator core or expansion valve is necessary, be sure to remove both as the method of attaching the sensing tube to the evaporator outlet line will cause it to be damaged if you try to remove only one item.*

1. Purge the system of refrigerant.

2. Remove all attaching items to the evaporator and heater core assembly necessary to remove the assembly front cover.

3. Remove assembly front cover exposing evaporator core, expansion valve, thermostat switch, heater core and selector door.

9$NOT After removing all the cover screws, be sure to remove the cover retaining clip.

4. Remove evaporator inlet and outlet hoses.

5. Carefully remove thermostatic switch probe from front of evaporator held by plastic clips. Do not bend this tube excessively.

6. Remove four attaching screws and gently pull out evaporator core.

7. When core and expansion valve are removed the expansion valve may easily be removed without damaging the sensing tube.

8. To install, reverse steps 1-7.

VACUUM TANK

The vacuum tank is mounted to the right side of the evaporator and heater core assembly (See figure 15).

REPLACEMENT

1. Disconnect the vacuum lines at the tank.

2. Remove the tank to dash panel screws and remove the tank.

3. To install, reverse Steps 1 and 2 above.

BLOWER MOTOR RESISTOR

The blower motor resistor is located opposite the blower side of the blower-evaporator case (figure 15).

REPLACEMENT

1. Disconnect battery ground cables and the wiring harness at the resistor.

2. Remove the resistor to case attaching screws and remove the resistor.

3. Place the new resistor in position and install the attaching screws.

4. Connect the resistor wiring harness battery cables.

THERMOSTATIC SWITCH (FIGURE 15)

The thermostatic switch is mounted to the blower side of the blower-evaporator case. The switch sensing capillary extends across the evaporator core.

REPLACEMENT

1. Disconnect the battery ground cables.

2. Disconnect the wiring harness at the switch.

3. Remove the switch to case screws and remove the switch carefully so as not to damage the capillary tube.

NOTE: Note capillary tube position across the core so that the capillary may be reinstalled in the same position.

4. Place the new switch in position, installing the capillary in the core in the same manner as at switch removal.

5. Install the switch mounting screws, connect the wiring harness and the battery ground cables.

DISCHARGE PRESSURE SWITCH

The discharge pressure switch is located in the condenser to evaporator line (figure 18).

REPLACEMENT

1. Disconnect the battery ground cables.

2. Purge the system of refrigerant.

3. Disconnect the wiring harness at the switch.

4. Remove the switch from the refrigerant line.

5. To install, reverse Steps 1-4 above.

NOTE: Be sure to use new "O" rings, coated with clean refrigeration oil, when installing the switch.

6. Evacuate charge and check system operation.

FUSE

A 25 amp fuse, located in the junction block protects the entire air conditioning system except for the blower when operating at HI.

BLOWER MOTOR RELAY

The blower motor relay is located on the firewall on the blower side of the blower-evaporator case (figure 20).

REPLACEMENT

1. Disconnect battery ground cables and the wiring harness at the relay.

2. Remove the relay to case attaching screws and remove the relay.

3. Place the new relay in position and drive the mounting screws.

4. Connect the relay wiring harness and battery ground cables.

CONTROL ASSEMBLY (FIGURES 23 and 24)

REPLACEMENT

1. Disconnect the battery ground cables.

2. Remove instrument panel bezel.

NOTE: For details on instrument panel bezel removal refer to "Instrument Panel Bezel Replacement" contained in CHASSIS ELECTRICAL (SECTION 12) of this manual.

3. Remove four screws holding control assembly to instrument panel (figure 38).

4. Pull panel forward to gain access to rear of control assembly.

CAUTION: *Be careful not to kink the bowden cable.*

5. Disconnect the bowden cable, vacuum harness and electrical harness at the control.

6. If a new unit is being installed, transfer all

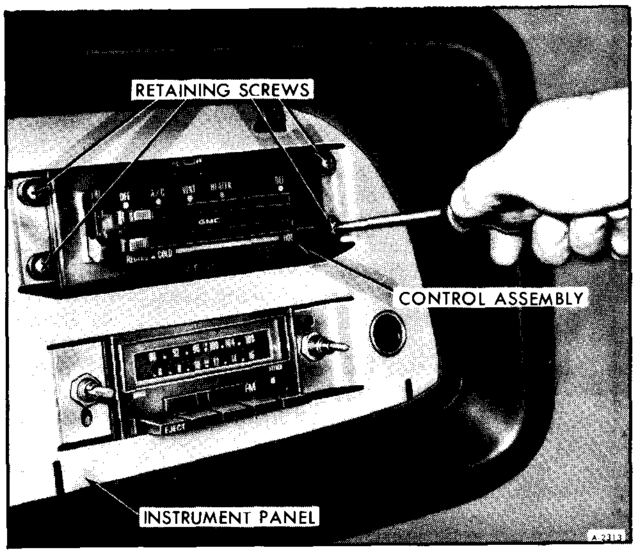


Figure 38—Removing Control Assembly

electrical switches and vacuum valves to the new control.

BLOWER SWITCH (FIGURE 22)

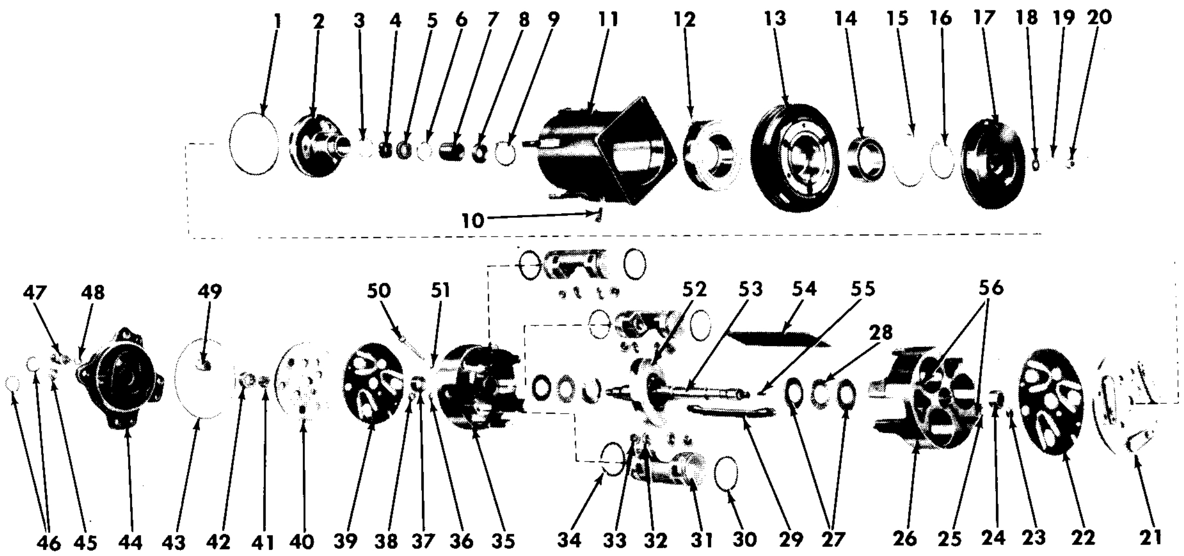
REPLACEMENT

1. Remove the control assembly as described above.

2. Disconnect wires to switch and remove two attaching screws.

3. Installation of switch is the reverse of Steps 1 and 2.

COMPRESSOR MINOR OVERHAUL PROCEDURES



1 O-Ring
2 Front Head
3 O-Ring
4 Shaft Seal Assembly
5 Seal Seat
6 Seal Seat Retainer Ring
7 Absorbent Sleeve
8 Seal Retainer
9 Clutch Coil Retainer Ring
10 Oil Drain Plug
11 Compressor Shell
12 Clutch Coil and Housing Assy.
13 Pulley
14 Bearing
15 Bearing Retainer
16 Pulley Retainer Ring
17 Clutch Plate and Hub Assy.
18 Spacer
19 Retainer Ring
20 Lock Nut
21 Front Discharge Valve Plate Assembly
22 Front Suction Reed
23 Bushing
24 Needle Bearing
25 O-Ring
26 Front Cylinder Half
27 Thrust Races
28 Thrust Bearing
29 Discharge Crossover Tube
30 Teflon Piston Ring
31 Teflon Ring Type Piston
32 Shoe Disc
33 Ball
34 Teflon Piston Ring
35 Rear Cylinder Half
36 O-Ring
37 Needle Bearing
38 Bushing
39 Rear Suction Reed
40 Rear Discharge Valve Plate Assembly
41 Inner Oil Pump Gear
42 Outer Oil Pump Gear
43 O-Ring
44 Rear Head
45 Lock Nut
46 O-Rings
47 Pressure Relief Valve
48 O-Ring
49 Suction Screen
50 Oil Pick-Up Tube
51 O-Ring
52 Axial Plate
53 Shaft
54 Suction Crossover Cover
55 Key
56 Dowel Pins

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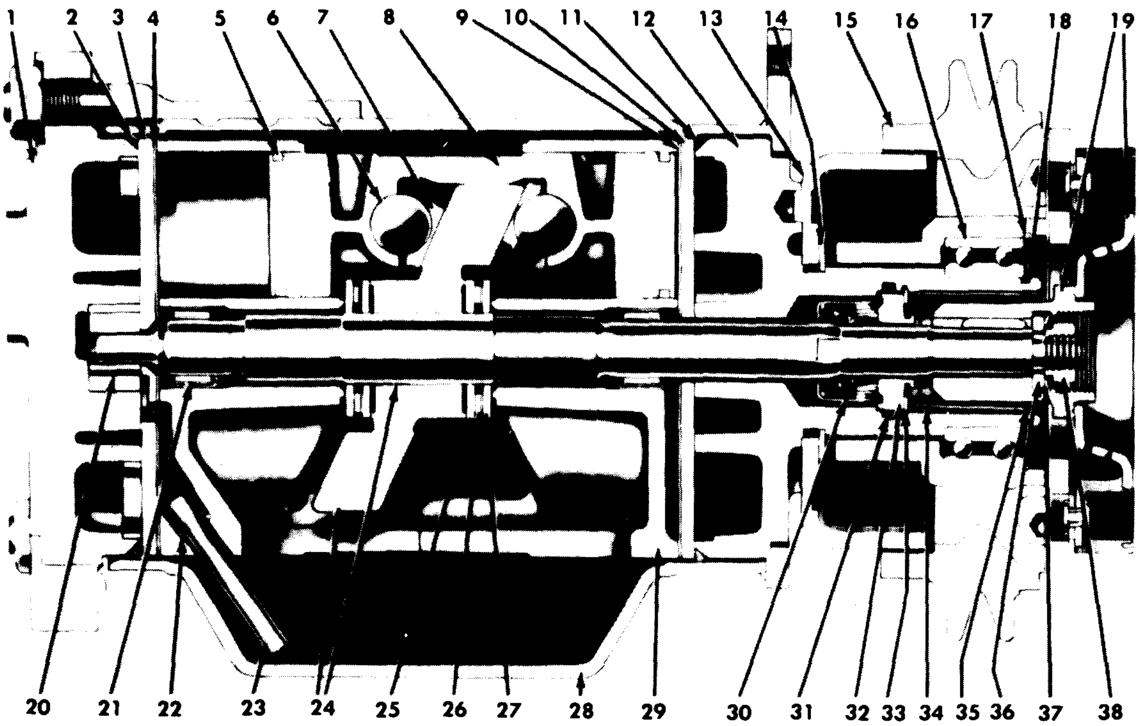
Figure 39—Exploded View of Compressor

The following operations to the Compressor Clutch Plate and Hub, Pulley and Bearing, and Coil Housing are covered as "Minor" because they may be performed WITHOUT FIRST PURGING THE SYSTEM OR REMOVING THE COMPRESSOR from the vehicle.

The Compressor Shaft Seal assembly may also be serviced WITHOUT REMOVING THE COMPRESSOR from the vehicle but this operation is covered later in this section as "Major Repair Procedures" because the system MUST FIRST BE PURGED of Refrigerant.

Illustrations used in describing these operations show the compressor removed from the vehicle only to more clearly illustrate the various operations.

When servicing the compressor, remove only the necessary components that preliminary diagnosis in-



1 Rear Head
2 Rear Head to Shell O-ring
3 Rear Discharge Valve Plate
4 Rear Suction Reed Plate
5 Piston Ring (Teflon)
6 Piston Drive Ball
7 Shoe Disc
8 Piston
9 Front Suction Reed Plate
10 Front Discharge Valve Plate
11 Front Head to Shell O-ring
12 Front Head
13 Coil and Housing Assembly
14 Coil Housing Retainer Ring
15 Pulley and Bearing Assembly
16 Pulley Bearing
17 Pulley Bearing Retainer Ring
18 Pulley and Bearing Retainer Ring
19 Clutch Hub and Drive Plate Assembly
20 Oil Pump Gears
21 Mainshaft Bearing (Rear)
22 Oil Inlet Tube O-ring
23 Oil Inlet Tube
24 Axial Plate and Mainshaft Assembly
25 Thrust Race
26 Thrust Bearing
27 Thrust Race
28 Compressor Shell
29 Cylinder Assembly
30 Shaft Seal
31 Shaft Seat Seat O-ring
32 Shaft Seal Seat
33 Shaft Seal Seat Retainer Ring
34 Felt Sleeve
35 Felt Sleeve Retainer
36 Spacer
37 Clutch Hub Retainer Ring
38 Shaft Nut

A-3941

Figure 40—Compressor Cross Sectional View

dicates are in need of service. Refer to Figure 39 and Figure 40.

Removal and installation of external compressor components and disassembly and assembly of internal components must be performed on a clean workbench. **The work area, tools, and parts must be kept clean at all times.** Parts Tray J-9402 (See figure 72) should be used for all parts being removed, as well as for replacement parts.

Although certain service operations can be performed without completely removing the compressor from the vehicle, the operations described herein are based on bench overhaul with the compressor removed from the vehicle. They have been prepared in sequence in order of accessibility of the components.

CAUTION: *Do not kink or place excessive tension on lines or hoses.*

When a compressor is removed from the vehicle for servicing, the amount of oil remaining in the compressor should be drained **and measured.** This oil should than be discarded and new 525 viscosity refrigerant oil added to the compressor (See figure 41).

COMPRESSOR CLUTCH PLATE AND HUB ASSEMBLY

REMOVE

1. Place Holding Fixture J-9396 in a vise and clamp the compressor in the Holding Fixture.

UNIT	ADD OIL
CONDENSOR	1 OUNCE
EVAPORATOR	3 OUNCES

COMPRESSOR CONDITION	AMOUNT OF OIL DRAINED FROM COMPRESSOR	AMOUNT OF OIL TO INSTALL
REPLACING COMPRESSOR WITH A NEW COMPRESSOR.	MORE THAN – 4 OZ.	*DRAIN NEW COMPRESSOR, REFILL WITH NEW OIL (SAME AMOUNT AS DRAINED FROM OLD COMPRESSOR).
	LESS THAN – 4 OZ.	**DRAIN NEW COMPRESSOR. INSTALL NEW OIL IN NEW COMPRESSOR – 6 OZ.
REPLACING COMPRESSOR WITH A SERVICE REBUILT COMPRESSOR.	MORE THAN – 4 OZ.	*SAME AS ABOVE PLUS AN ADDITIONAL OUNCE (MORE OIL IS RETAINED IN A DRAINED COMPRESSOR THAN ONE THAT HAS BEEN REBUILT).
	LESS THAN – 4 OZ.	**SAME AS ABOVE PLUS AN ADDITIONAL OUNCE.
UNABLE TO RUN COMPRESSOR BEING REPLACED, PRIOR TO REMOVAL.	MORE THAN – 1-1/2 OZ. AND SYSTEM APPEARS TO HAVE LOST LITTLE OR NO OIL	*SAME AS ABOVE.
	LESS THAN – 1-1/2 OZ OR SYSTEM APPEARS TO HAVE LOST MAJOR AMOUNT OF OIL.	**SAME AS ABOVE.
CONTAMINATED OIL DRAINED FROM SYSTEM.	ANY AMOUNT	DRAIN AS MUCH OIL AS POSSIBLE FROM SYSTEM. FLUSH SYSTEM WITH REFRIGERANT-11. REPLACE DRIER DESSICANT AND INSTALL NEW 525 VISCOSITY OIL IN NEW COMPRESSOR: 10-1/2 OZS.

A-4317

Figure 41—Compressor Oil Charge

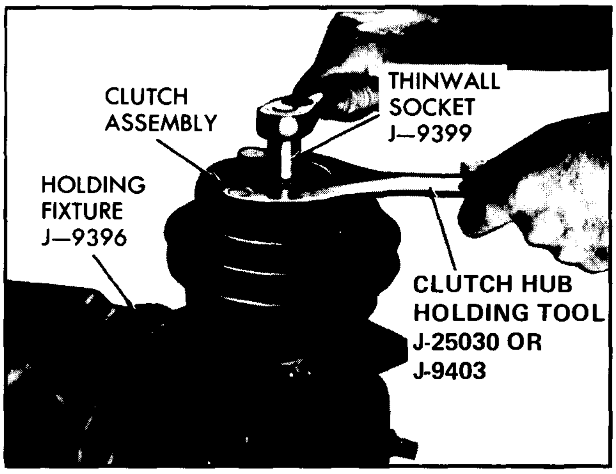


Figure 42—Removing Shaft Locknut

2. Keep clutch hub from turning with Clutch Hub Holder J-25030 or J-9403, and remove locknut from end of shaft using Thin Wall Socket J-9399 (figure 42).

CAUTION: *To avoid internal damage to the compressor, DO NOT DRIVE OR POUND on the Clutch Plate and Hub assembly OR on the end of the shaft. If proper tools to remove and replace clutch parts are not used, it is possible to disturb the position of the axial plate (keyed to the main shaft), resulting in compressor damage and seal leakage due to shifting of the crankshaft.*

4. Remove square drive key from shaft or drive plate hub.

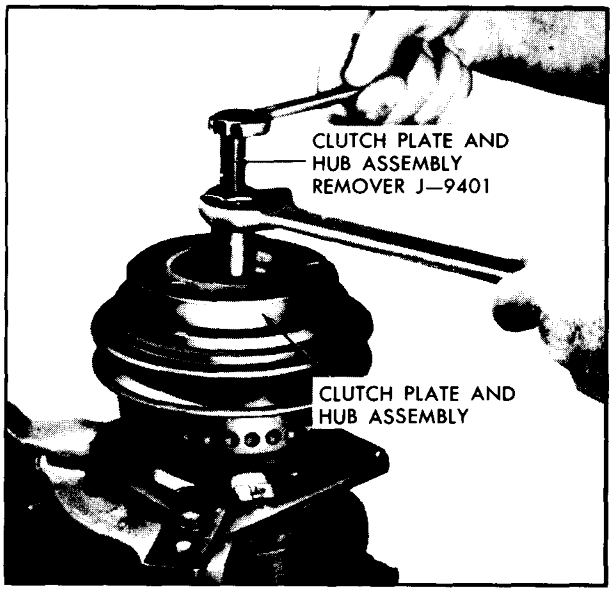


Figure 43—Removing Clutch Plate and Hub Assembly

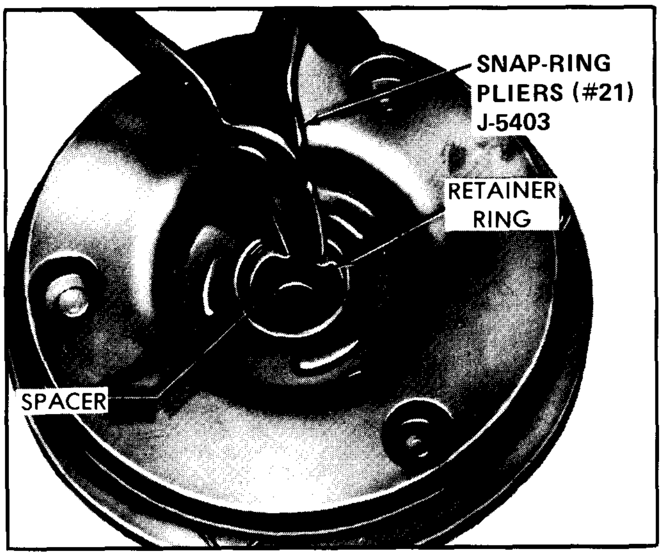


Figure 44—Removing or Installing Retainer Ring in Clutch Drive Plate

5. Remove hub spacer retainer ring using Snap-Ring Pliers J-5403(#21), and then remove hub spacer (figure 44).

6. Inspect driven plate for cracks or stresses in the drive surface. Do not replace driven plate for a scoring condition. (figure 45).

If the frictional surface shows signs of damage due to excessive heat, the clutch plate and hub and pulley and bearing should be replaced. Check further for the underlying cause of the damage (i.e. low coil voltage - coil should draw 3.2 amps at 12 volts - or binding of the compressor internal mechanism, clutch air gap too wide, broken drive plate to hub assembly springs, etc.

REPLACE

1. Insert the square drive key into the hub of driven plate; allow it to project approximately 3/16″ out of the keyway.

2. Line up the key in the hub with keyway in the shaft (figure 46).

3. Position the Drive Plate Installer J-9480-1 on the threaded end of the shaft. The Spacer J-9480-2 should be in place under the hex nut on the tool. This tool has a left hand thread on the body. (figure 47).

4. Press the driven plate onto the shaft until there is approximately 3/32″ space between the frictional faces of the clutch drive plate and pulley.

CAUTION: *Make certain key remains in place when pressing hub on shaft.*

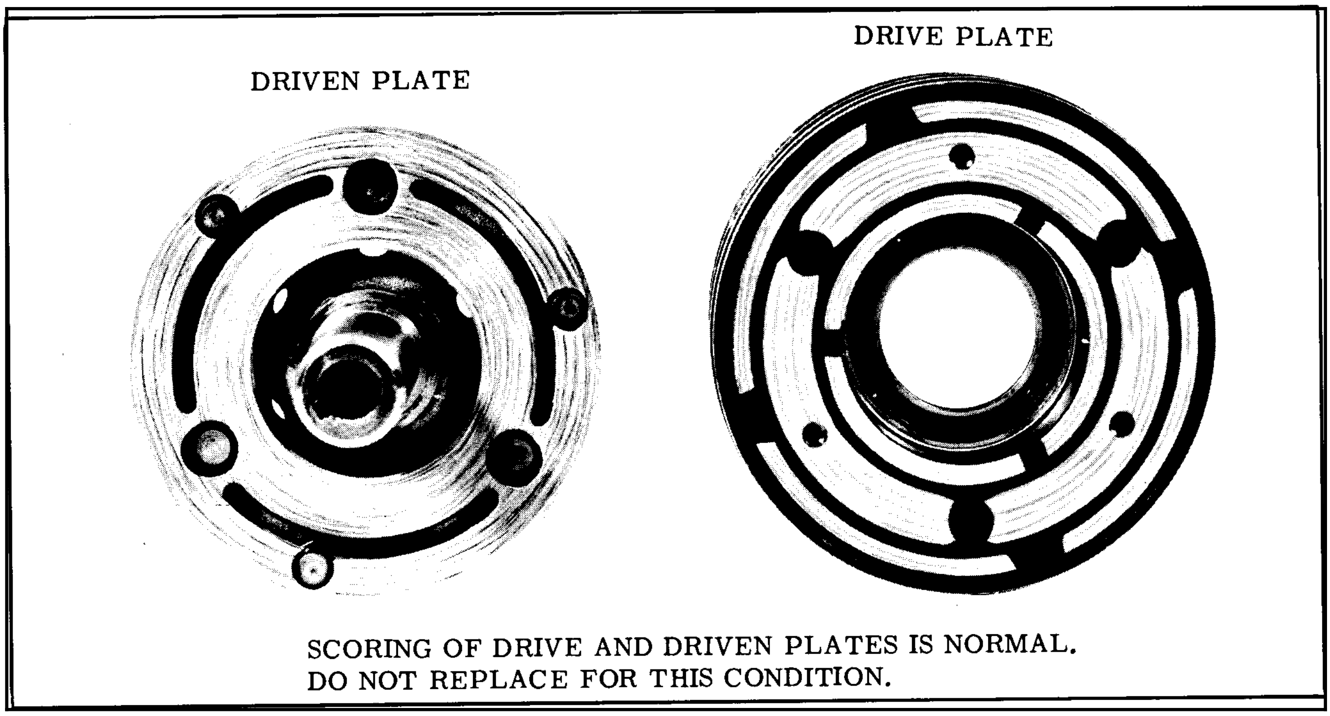


Figure 45—Clutch Driven Plate and Drive Plate

A ZERO thrust race is approximately 3/32" thick and may be used to roughly gage this operation. Use Clutch Hub Holder J-25030 or J-9403 to hold clutch plate and hub if necessary.

5. Install the hub spacer and, using Snap-Ring Pliers J-5403 (#21), install the retainer ring (see installed Retainer Ring in inset of Figure 40), with convex side of ring facing spacer.

6. Use Thin-Wall Socket J-9399 and Clutch Hub Holder J-25030 or J-9403 to install a new shaft locknut **with shoulder or circular projection on the locknut facing towards retainer ring.** Tighten the nut to 14-26 lb. ft. torque. Air gap between the frictional faces should now be .002" to .057" (figure 48). If not, check for mispositioned key or shaft.

7. The pulley should now rotate freely.

8. Operate the refrigeration system under MAXimum load conditions and engine speed at 2000 RPM. Rapidly cycle the cluty by turning the air conditioning on-and-orr at least 15 times at approximately one second intervals to burnish the mating parts of the clutch.

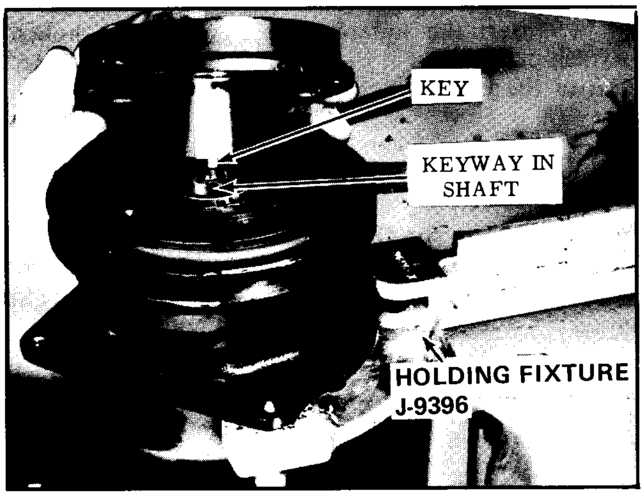


Figure 46—Aligning Drive Plate Key

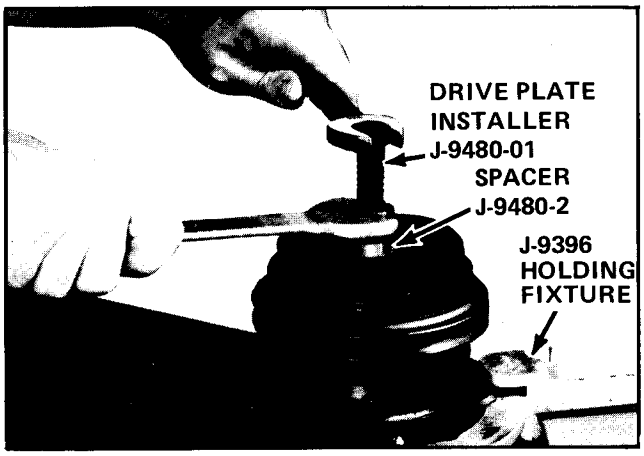


Figure 47—Installing Drive Plate

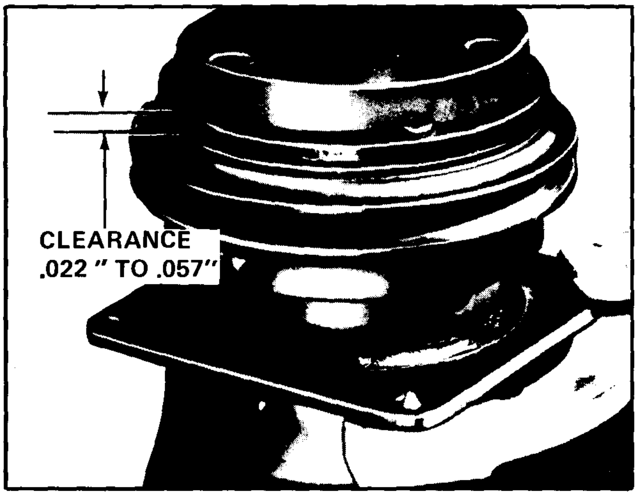


Figure 48—Checking Air Gap

PULLEY AND BEARING ASSEMBLY

REMOVE

1. Remove clutch plate and hub assembly as described in "Compressor Clutch Plate and Hub Assembly" Removal procedure.

2. Remove pulley retainer ring using Snap-Ring Pliers J-6435 (#26), Figure 49.

3. Pry out absorbent sleeve retainer, and remove absorbent sleeve from compressor neck.

4. Place Puller Pilot J-9395 over end of compressor shaft.

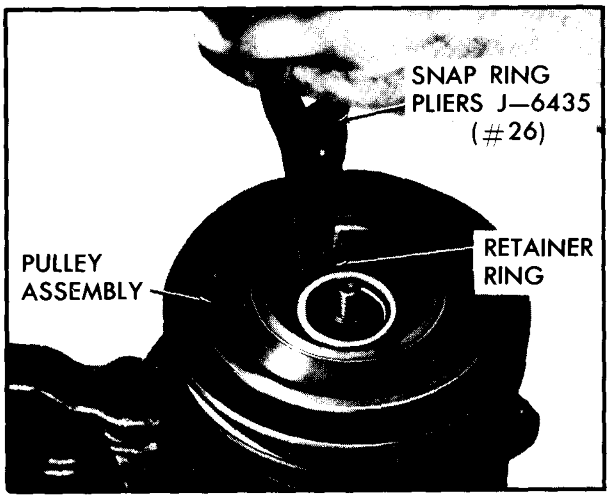


Figure 49—Removing Pulley Retainer Ring

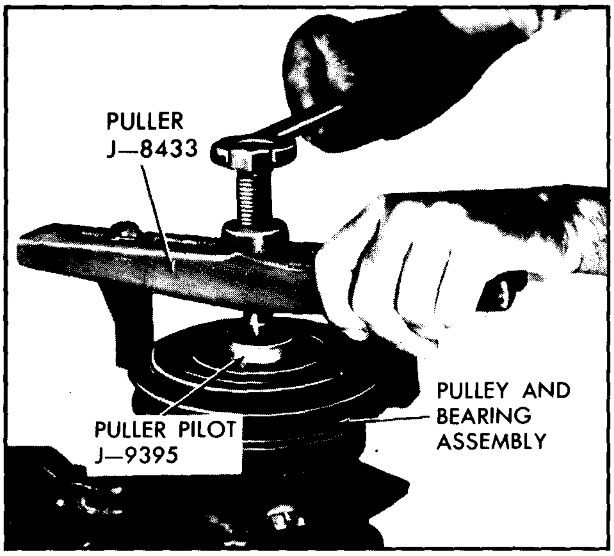


Figure 50—Removing Pulley and Bearing Assembly

CAUTION: *It is important that Puller Pilot J-9395 be used to prevent internal damage to compressor when removing pulley.* **Under no circumstances should Puller be used DIRECTLY against drilled end of shaft.**

5. Remove Pulley and Bearing Assembly using Pulley Puller J-8433 (figure 50).

INSPECTION

Check the appearance of the pulley and bearing assembly. See Figure 45. The frictional surfaces of the pulley and bearing assembly should be cleaned with suitable solvent before reinstallation.

REPLACE

1. If original pulley and bearing assembly is to be reinstalled, wipe frictional surface of pulley clean. If frictional surface of pulley shows any indication of damage due to overheating, the pulley and bearing should be replaced.

2. Check bearing for brinelling, excessive looseness, noise, and lubricant leakage. If any of these conditions exist, bearing should be replaced. See "Compressor Pulley Bearing" Replacement Procedure.

3. Press or tap pulley and bearing assembly on neck of compressor until it seats, using Pulley and Bearing Installer J-9481 with Universal Handle J-8092 (figure 51). The Installer will apply force to inner race of bearing and prevent damage to bearing.

4. Check pulley for binding or roughness. Pulley should rotate freely.

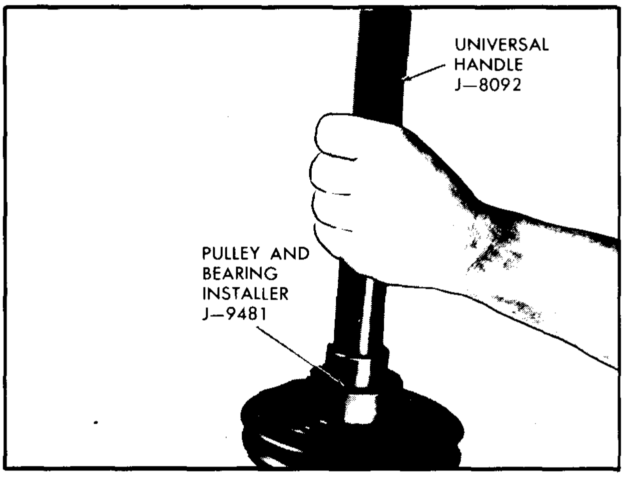


Figure 51—Installing Pulley and Bearing Assembly

5. Install retainer ring, using Snap Ring Pliers J-6435 (#26).

6. Install absorbent sleeve in compressor neck.

7. Install absorbent sleeve retainer in neck of compressor. Using sleeve from Seal Seat Remover-Installer J-23128, install retainer so that outer edge is recessed 1/32" from compressor neck face.

8. Install clutch plate and hub assembly as described in "Compressor Clutch Plate and Hub Assembly" Replacement Procedure.

COMPRESSOR PULLEY BEARING

REMOVE

1. Remove clutch plate and hub assembly as described in "Compressor Clutch Plate and Hub Assembly" Removal procedure.

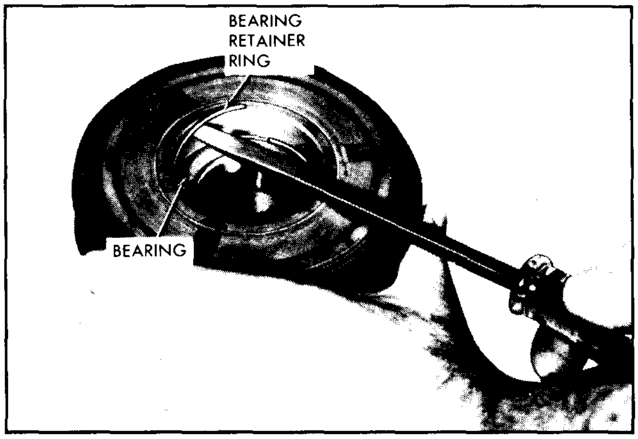


Figure 52—Removing Pulley and Bearing Retainer Ring

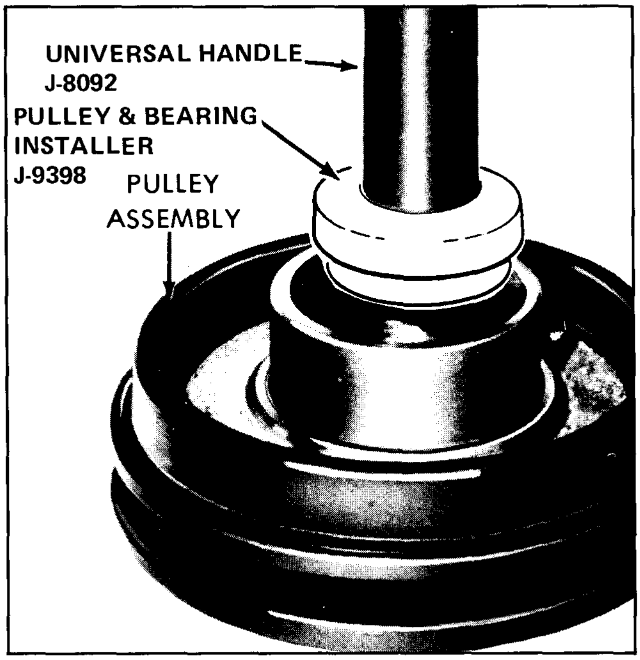


Figure 53—Removing Bearing from Pulley Assembly

2. Remove pulley and bearing assembly as described in "Compressor Pulley and Bearing Assembly" Removal procedure.

3. Remove pulley bearing retainer ring with a small screwdriver or pointed tool (figure 52).

4. Place pulley and bearing assembly on inverted Support Block J-21352 and, using Pulley Bearing Remover J-9398 with Universal Handle J-8092, drive Bearing assembly out of pulley (figure 53).

REPLACE

1. Install new bearing in pulley using Pulley and Bearing Installer J-9481 with Universal Handle J-8092 (figure 54). The Installer will apply the force to the outer race of the bearing.

CAUTION: *DO NOT CLEAN NEW BEARING ASSEMBLY WITH ANY TYPE OF SOLVENT. Bearing is supplied with correct lubricant when assembled and requires no other lubricant at any time.*

2. Install bearing retainer ring, making certain that it is properly seated in ring groove.

3. Install pulley and bearing assembly as described in "Compressor Pulley and Bearing Assembly" Replacement procedure.

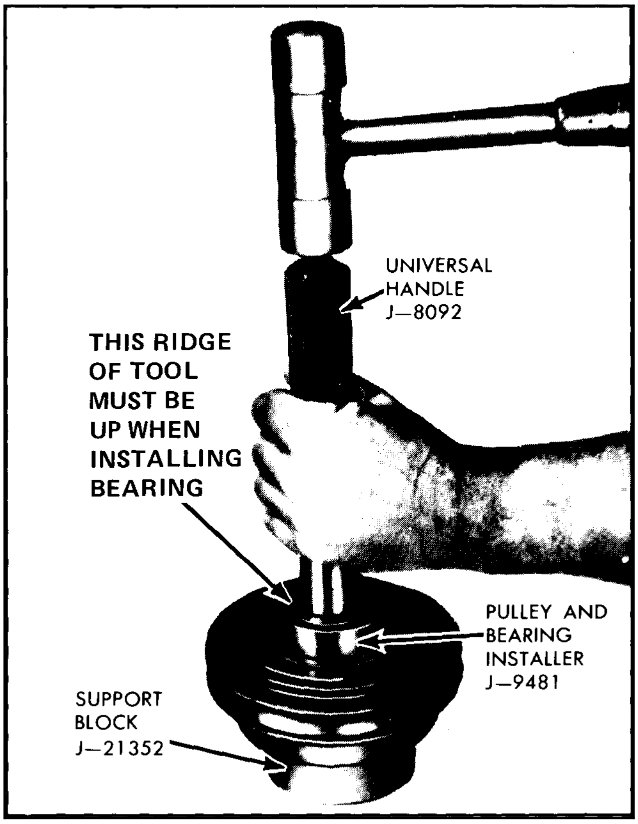


Figure 54—Installing Bearing on Pulley

4. Install clutch plate and hub assembly as described in "Compressor Clutch Plate and Hub Assembly" Replacement procedure.

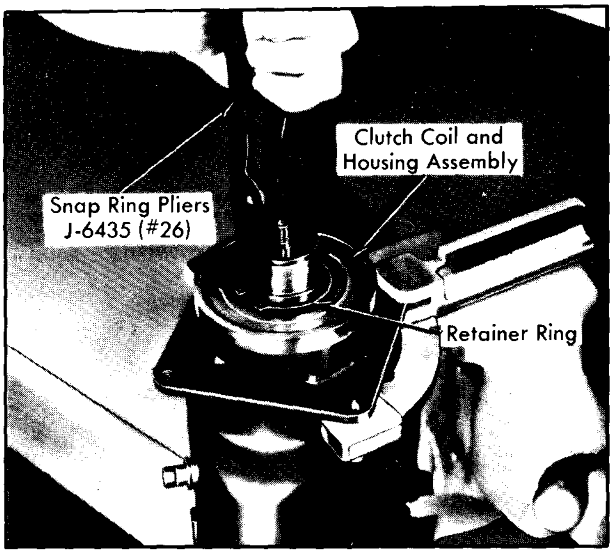


Figure 55—Removing Coil Housing Retainer Ring

COMPRESSOR CLUTCH COIL AND HOUSING ASSEMBLY

REMOVE

1. Remove clutch plate and hub assembly as described in "Compressor Clutch Plate and Hub Assembly" Removal procedure.

2. Remove pulley and bearing assembly as described in "Compressor Pulley and Bearing Assembly" Removal procedure.

NOTE: Position of terminals on coil housing and scribe location on compressor front head casting.

3. Remove coil housing retaining ring using Snap-Ring Pliers J-6435 (figure 55).

4. Lift Coil and Housing assembly off compressor.

REPLACE

1. Position coil and housing assembly on compressor front head casting so that electrical terminals line up with marks previously scribed on compressor (figure 56).

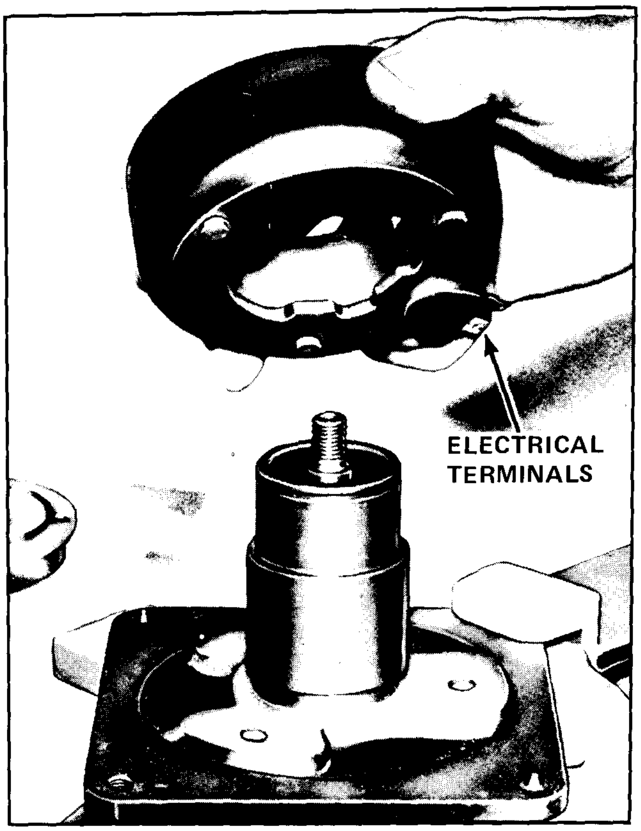


Figure 56—Installing Coil Housing

2. Align locating extrusions on coil housing with holes in front head casting.

3. Install coil housing retainer ring **with flat side of ring facing coil,** using Snap-Ring Pliers J-6435.

4. Install pulley and bearing assembly as described in "Compressor Pulley and Bearing Assembly" Replacement procedure.

5. Install clutch plate and hub assembly as described in "Compressor Clutch Plate and Hub Assembly" Replacement Procedure.

COMPRESSOR MAJOR OVERHAUL PROCEDURES

Service repair procedures to the Compressor Shaft Seal, or disassembly of the Internal Compressor Mechanism are considered "MAJOR" SINCE THE REFRIGERATION SYSTEM MUST BE COMPLETELY PURGED OF REFRIGERANT before proceeding and/or because major internal operating and sealing components of the compressor are being disassembled and serviced.

A clean workbench, preferably covered with a sheet of clean paper, orderliness in the work area and a place for all parts being removed and replaced is of great importance, as is the use of the proper, clean service tools. Any attempt to use make-shift or inadequate equipment may result in damage and/or improper compressor operation.

These procedures are based on the use of the proper service tools and the condition that an adequate stock of service parts is available.

All parts required for servicing are protected by a preservation process and packaged in a manner which will eliminate the necessity of cleaning, washing or flushing of the parts. The parts can be used in the mechanism assembly just as they are removed from the service package.

Piston shoe discs and shaft thrust races will be identified by "number" on the parts themselves for reference to determine their size and dimension (See figure 80).

COMPRESSOR SHAFT SEAL

SEAL LEAK DETECTION

A SHAFT SEAL SHOULD NOT BE CHANGED BECAUSE OF AN OIL-LINE ON THE HOOD INSULATOR. The seal is designed to seep some oil for lubrication purposes. Only change a shaft seal when a leak is detected by the following procedure.

When refrigerant system components other than the compressor are replaced, the compressor must be removed and oil drained from the compressor if oil was sprayed in large amounts due to leaks or a broken shaft seal.

Compressor shaft seals, unless replaced during a compressor overhaul, are to be replaced only on the basis of actual refrigerant leakage as determined by test with an electronic-type leak detector.

WHEN REPLACING THE SHAFT SEAL ASSEMBLY, even if the compressor remains on the vehicle during the operation, IT WILL BE NECESSARY TO PURGE THE SYSTEM OF REFRIGERANT as outlined earlier in this manual.

REMOVE

1. After first purging the system of refrigerant, remove the clutch plate and hub assembly and shaft key as described in "Compressor Clutch Plate and Hub Assembly" Removal procedure.

2. Pry out the sleeve retainer and remove the absorbent sleeve. Remove the shaft seal seat retaining ring, using Snap-Ring Pliers J-5403 (#21). See Figure 57.

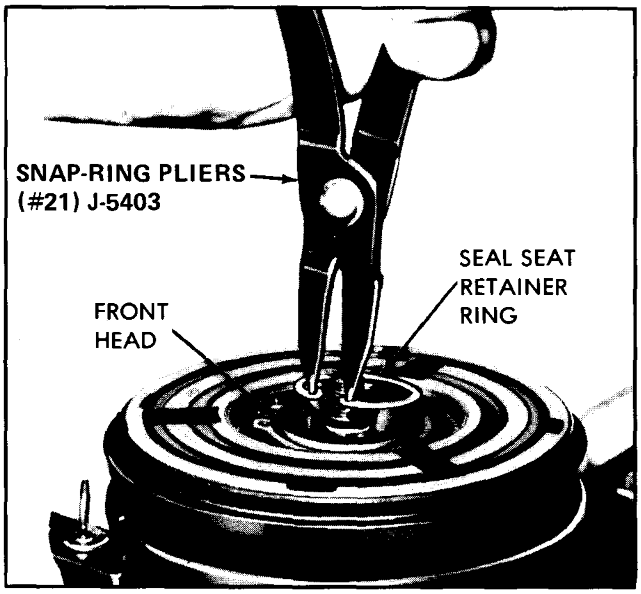


Figure 57—Removing or Installing Shaft Seal Seat Retaining Ring

3. Thoroughly clean inside of compressor neck area surrounding the shaft, the exposed portion of the seal seat and the shaft itself. **This is absolutely necessary to prevent any dirt of foreign material from getting into compressor.**

4. Place Seal Protector J-22974 over the end of the shaft to prevent chipping the ceramic seal. Fully engage the knurled tangs of Seal Seat Remover-Installer J-23128 into the recessed portion of the seal seat by turning the handle **clockwise.** Lift the seat from the compressor with a rotary motion (figure 58).

CAUTION: *DO NOT tighten the handle with a wrench or pliers; however, the handle must be hand-tightened securely to remove the seat.*

5. With Seal Protector J-22974 still over the end of the shaft, engage the tabs on the seal assembly with the tangs on Seal Installer J-9392 by twisting the tool **clockwise, while pressing the tool down.** Then lift the seal assembly out (See figure 59).

Remove the seal seat O-ring from the compressor neck using O-Ring Remover J-9533 (See figure 58).

7. Recheck the shaft and inside of the compressor neck for dirt or neck foreign material and be sure these areas are perfectly clean before installing new parts.

INSPECTION

SEALS SHOULD NOT BE REUSED. ALWAYS USE A NEW SEAL KIT ON REBUILD. Be extremely careful that the face of the seal to be installed is not scratched or damaged in any way. Make sure that the seal seat and seal are free of lint and dirt that could damage the seal surface or prevent sealing.

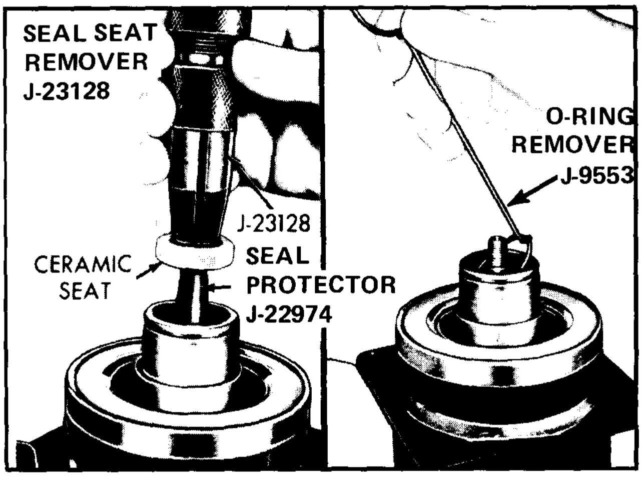


Figure 58—Removing Shaft Seal Seat and O-Ring

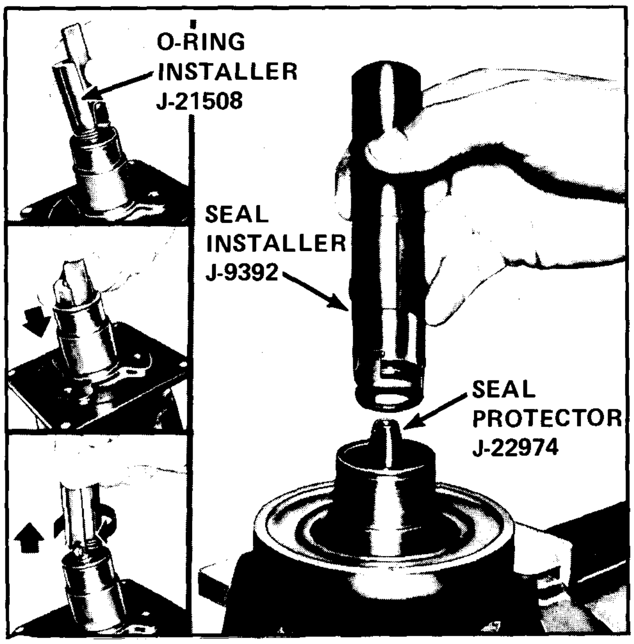


Figure 59—Replacing Seal and O-Ring

REPLACE

1. Coat new seal seat O-ring with clean 525 viscosity refrigerant oil and install in compressor neck, **making certain it is installed in bottom groove** (figures 59 and 60). Top groove is for retainer ring. Use O-Ring Installer J-21508.

2. Coat the O-ring and seal face of the new seal assembly with clean 525 viscosity refrigerant oil. Carefully mount the seal assembly to Seal Installer J-9392 by engaging the tabs of the seal with the tangs of the tool (figure 59).

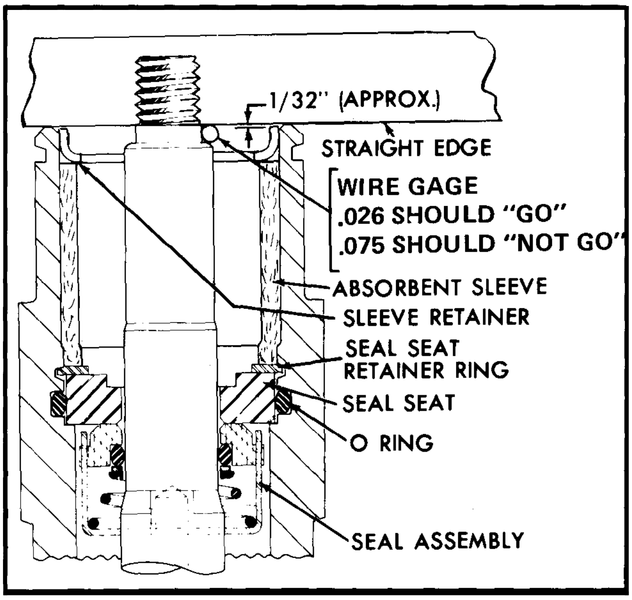


Figure 60—Compressor Shaft and Seal

3. Place Seal Protector J-22974 (figure 59) over end of shaft and **carefully slide the new seal assembly onto the shaft. Gently twist the tool CLOCKWISE, while pushing the seal assembly down the shaft** until the seal assembly engages the flats on the shaft and is seated in place. Disengage the tool by pressing downward and twisting tool counterclockwise.

4. Coat the seal face of the new seal seat with clean 525 viscosity refrigerant oil. Mount the seal seat on Seal Seat Remover-Installer J-23128 and install it in the compressor neck, taking care not to dislodge the seal seat O-ring and being sure the seal seat makes a good seal with the O-ring. Remove Seal Protector J-22974 from the end of the shaft (See figure 58).

5. Install the new seal seat retainer ring **with its flat side against the seal seat,** using Snap-Ring Pliers J-5403 (#21). See Figure 57. Use the sleeve from Seal Seat Remover-Installer J-23128 (figure 58) to press in on the seal seat retainer ring so that it snaps into its groove.

6. Install Compressor Leak Test Fixture J-9625 on rear head of compressor and connect gage charging lines as shown for bench test in Figure 61 or pressurize SUCTION SIDE of compressor on car with Refrigerant-12 vapor to equalize pressure to the drum pressure. Temporarily install the shaft nut and, with compressor in horizontal position and oil sump down, rotate the compressor shaft in normal direction of rotation several times by hand. Leak test the seal with an electronic-type Leak Detector. Correct any leak found. Remove and discard the shaft nut.

7. Remove any excess oil, resulting from installing the new seal parts, from the shaft and inside the compressor neck.

8. Install the new absorbent sleeve by rolling the material into a cylinder, overlapping the ends, and then slipping the sleeve into the compressor neck with the overlap towards the top of the compressor.

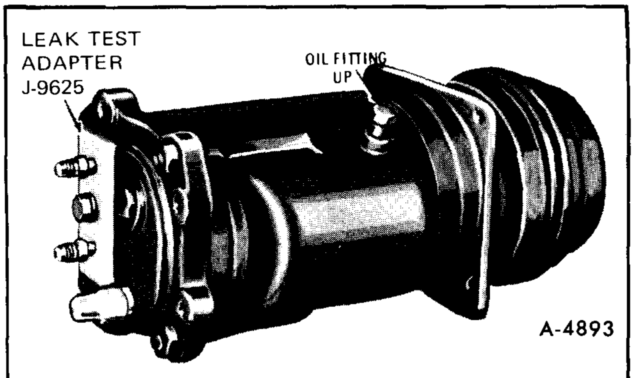


Figure 61—Leak Testing Compressor

With a small screwdriver or similar instrument, carefully spread the sleeve until the ends of the sleeve butt at the top vertical centerline.

9. Position the new metal sleeve retainer so that its flange face will be against the front end of the sleeve. Pulley Puller Pilot J-9395 (See figure 50) may be used to install the retainer. Press and tap with a mallet, setting the retainer and sleeve into place (retainer should be recessed approximately 1/32" from the face of the compressor neck). (See figure 60).

10. Reinstall the clutch plate and hub assembly as described in "Compressor Clutch Plate and Hub Assembly" Replacement procedure.

Some compressor shaft seal leaks may be the result of mispositioning of the axial plate on the compressor shaft. The mispositioning of the axial plate may be caused by improper procedures used during pulley and driven plate removal, pounding, collisions or dropping the compressor. If the axial plate is mispositioned, the carbon face of the shaft seal assembly may not contact the seal seat and the rear thrust races and bearing may be damaged.

If there appears to be too much or insufficient air gap between the drive and driven plates, dislocation of the shaft should be suspected. If the carbon seal is not seating against the seal seat, it will not be possible to completely evacuate the system as outlined under "Evacuating the Refrigeration System".

To check for proper positioning of the axial plate on the shaft, remove the clutch driven plate and measure the distance between the front head extension and the flat shoulder on the shaft as shown in Figure 60. To measure this distance, use a wire gage **(the clearance should be between .026" and .075").** If the shaft has been pushed back in the axial plate (measurement greater than .075"), disassemble the compressor and replace the shaft and axial plate assembly rear thrust races and thrust bearing.

11. Evacuate and charge system as outlined under "Evacuating and Charging the Refrigeration System".

COMPRESSOR PRESSURE RELIEF VALVE

When necessary to replace the pressure relief valve, located in the compressor rear head casting, the valve assembly should be removed after PURGING THE SYSTEM OF REFRIGERANT and a new valve and gasket installed. The entire system should then be "Evacuated and Recharged". (figure 62).

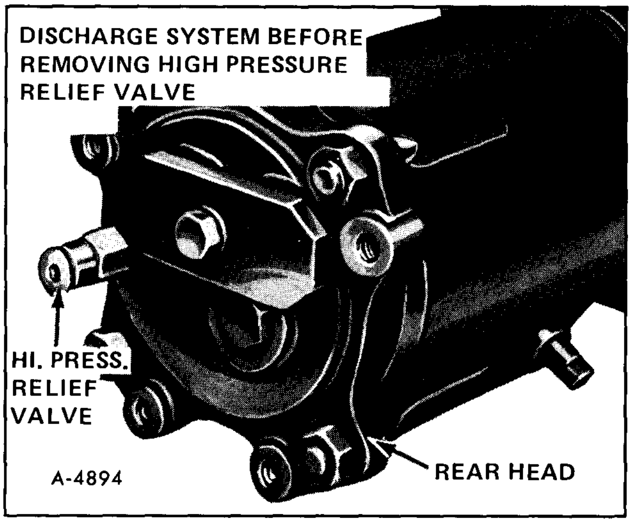


Figure 62—High Pressure Relief Valve Location

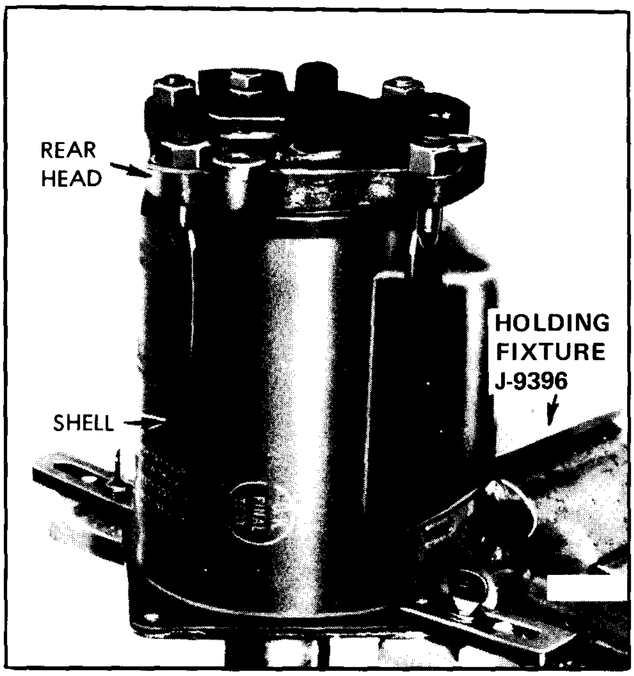


Figure 63—Compressor Installed in Holding Fixture

COMPRESSOR INTERNAL MECHANISM

Service operations to the rear head or internal mechanism of the compressor **should be performed with the compressor removed from the vehicle** to insure that the necessary degree of cleanliness may be maintained. Clean hands, clean tools and a clean bench, preferably covered with clean paper, are of extreme importance.

An inspection should be made of the internal mechanism assembly to determine if any service opeations should be performed. A detailed inspection of parts should be made to determine if it is economically feasible to replace them.

REMOVE

1. Before proceeding with disassembly, wipe exterior surface of compressor clean.

2. All oil in compressor should be drained and measured. Assist draining by positioning compressor with oil drain plug down. **Record the amount of oil drained from the compressor.**

3. Invert compressor and Holding Fixture J-9396 with front end of compressor shaft facing downward. (figure 63).

Additional oil may leak from compressor at this time. All oil must be drained into a container so that TOTAL amount can be measured. A liquid measuring cup may be used for this purpose. Drained oil should then be discarded.

4. Remove four locknuts from threaded studs on compressor shell and remove rear head. Tap uniformly around rear head if head is binding. (figure 63).

Wipe excess oil from all sealing surfaces on rear head casting webs, and examine sealing surfaces (figure 64). If any damage is observed, the head should be replaced.

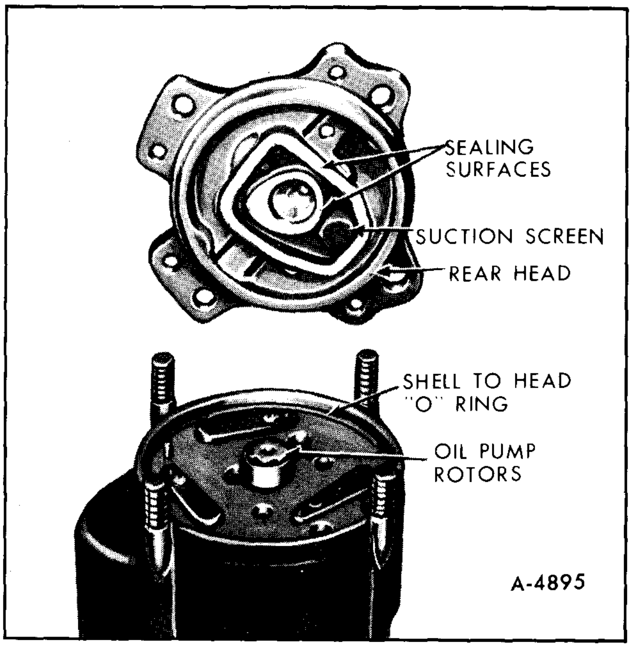


Figure 64—Rear Head Removal

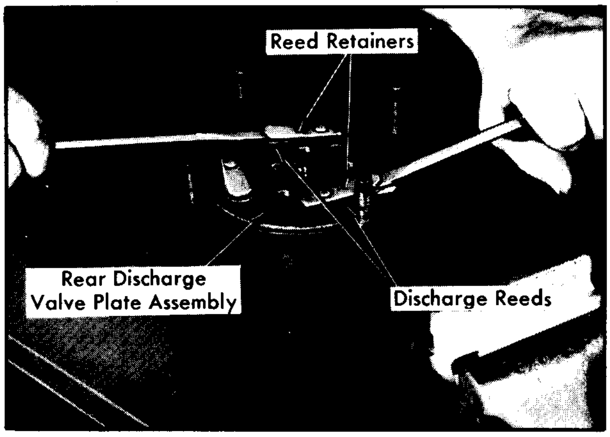


Figure 65—Removing Rear Discharge Valve Plate

6. Remove suction screen and examine for any damage or contamination. Clean or replace if necessary.

7. Paint an identifying mark on exposed face of inner and outer oil pump gears and then remove gears. Identifying marks are to assure that gears, if reused, will be installed on identical position.

8. Remove and discard rear head to shell O-ring.

9. Carefully remove rear discharge valve plate assembly. Use two small screwdrivers under reed retainers to pry up on assembly (figure 65). **Do not position screwdrivers between reeds and reed seats.**

10. Examine valve reeds and seats. Replace entire assembly if any reeds or seats are damaged.

11. Using two small screwdrivers, carefully remove rear suction reed (figure 66). **Do not pry up on horseshoe-shaped reed valves.**

12. Examine reeds for damage, and replace if necessary.

13. Using Oil Pick-Up Tube Remover J-5139

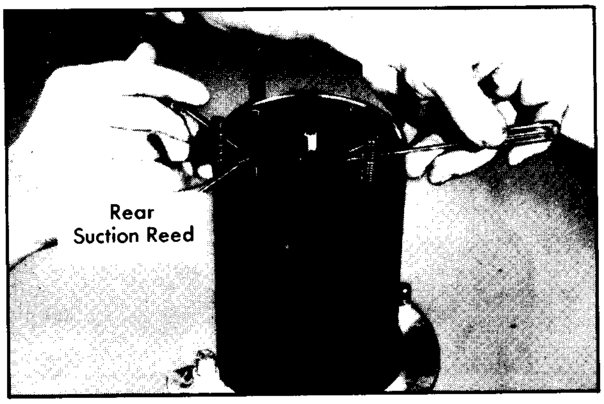


Figure 66—Removing Rear Suction Head

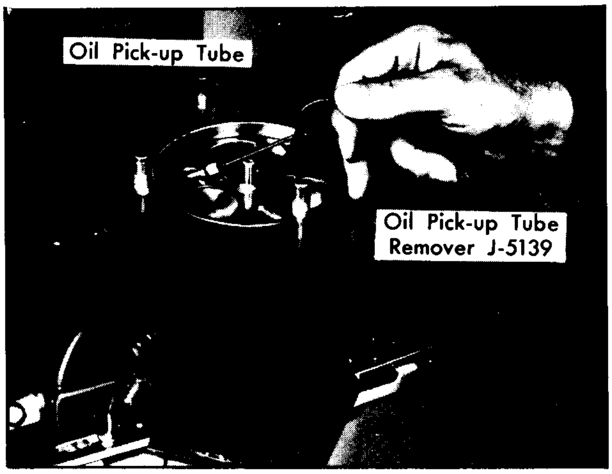


Figure 67—Removing Oil Pick-Up Tube

(figure 67), remove oil pick-up tube. Remove O-ring from oil inlet.

14. Loosen compressor from Holding Fixture J-9396, place Internal Assembly Support Block J-21352 over oil pump end of shaft and, holding Support Block in position with one hand, lift compressor from Holding Fixture with other hand. Invert compressor and position on bench with Internal Assembly Support Block resisting on bench.

15. Lift front head and compressor shell assembly up, leaving internal mechanism resting on Internal Assembly Support Block.

CAUTION: *To prevent damage to shaft, DO NOT TAP ON END OF COMPRESSOR SHAFT to remove internal mechanism. If mechanism will not slide out of compressor shell, tap on front head with a plastic hammer.*

16. Rest compressor shell on its side and push front head assembly through compressor shell, **being careful not to damage sealing areas on inner side of front head.** Discard O-ring.

It may be necessary to tap on outside of front head, using a plastic hammer, to overcome friction of O-ring seal between front head and compressor shell.

17. Wipe excess oil from sealing surfaces on front head casting webs and examine sealing surface. If any surface damage is observed, the head should be replaced.

18. Remove front discharge valve plate assembly and front suction reed plate. Examine reeds and seats. Replace necessary parts.

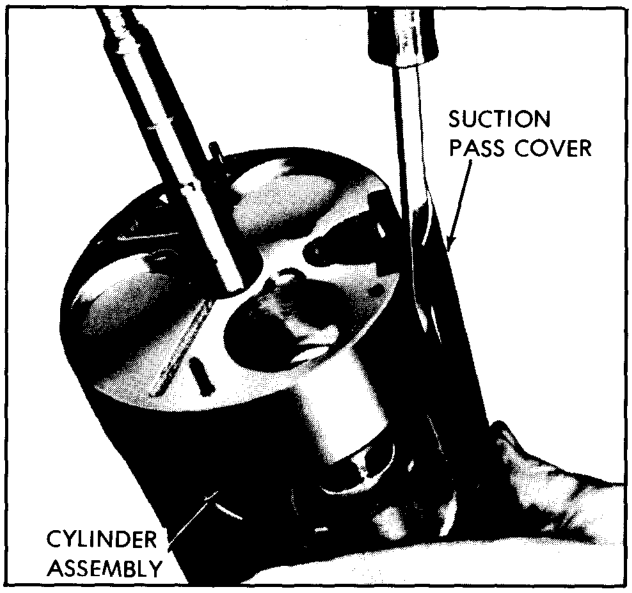


Figure 68—Removing Suction Crossover Cover

19. Remove suction cross-over cover by prying with screwdriver between cylinder casting and cover (figure 68).

20. Examine internal mechanism for any obvious damage. If internalmechanism has sustained major damage, due to loss of refrigerant or oil, it may be necessary to use the Service internal mechanism Assembly rather than replace individual parts.

DISASSEMBLY

Use Parts Tray J-9402 (figure 72) to retain compressor parts during disassembly.

1. Remove internal mechanism from compressor

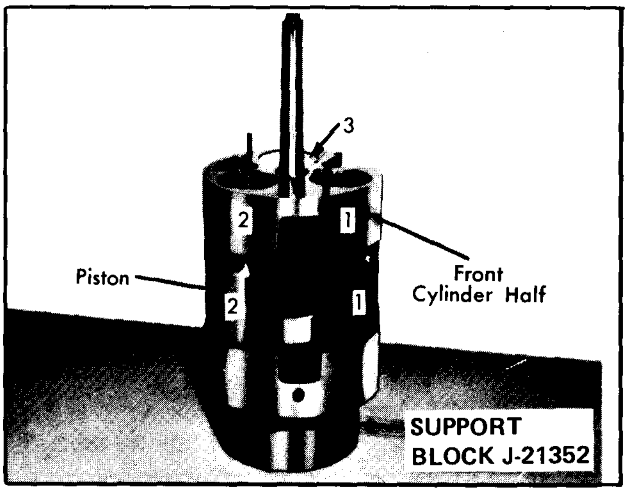


Figure 69—Numbering Piston and Cylinder Bores

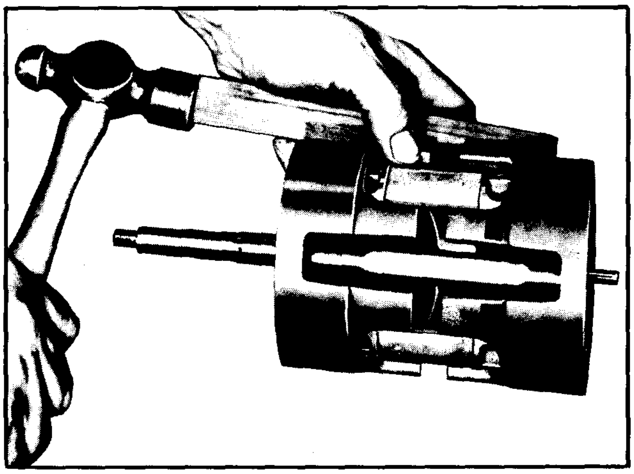


Figure 70—Separating Cylinder Halves

as described in "Compressor Internal Mechanism" Removal procedure.

2. Identify by pancil mark, or some other suitable means, each piston numbering them as 1, 2, and 3 (figure 69).

Number the piston bores in the front cylinder half in like manner, so that pistons can be replaced in their original locations.

3. Separate cylinder halves, using a wood block and mallet (figure 70). Make certain that discharge cross-over tube does not contact axial plate when separating cylinder halves (a new Service discharge cross over tube will be installed later).

CAUTION: *UNDER NO CIRCUMSTANCES SHOULD SHAFT BE STRUCK AT EITHER END in an effort to separate upper and lower cylinder halves because the shaft and the axial plate could be damaged.*

4. Carefully remove the rear half of the cylinder from the pistons and set the front cylinder half, with the piston, shaft and axial plate is Compressing Fixture J-9397.

5. Pull up on compressor shaft and remove piston previously identified as No. 1, with balls and shoe discs, from axial plate.

1. **Inspect the Teflon piston rings** for nicks, cuts or metal particles imbedded in exposed ring surface and replace the piston rings as required if either condition exists. See "Teflon Piston Ring" Replacement procedure.

6. Remove and discard the piston shoe discs.

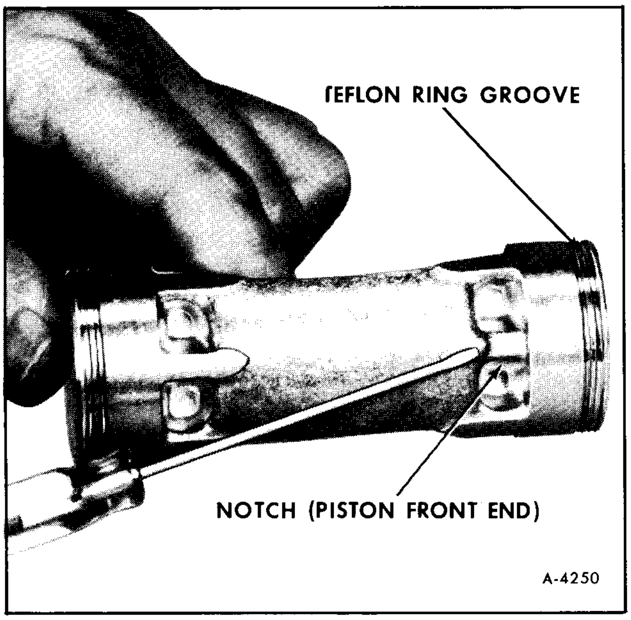


Figure 71—Notch Identifying Front End of Piston

7. Remove and examine piston balls, and if satisfactory for re-use, place balls in No. 1 compartment of Parts Tray J-9402 (figure 72).

8. Place piston in No. 1 compartment of Parts Tray J-9402, with notch in casting web at front end of piston (figure 71) into the dimpled groove of Parts Tray compartment.

9. Repeat Steps 5 through 9 for Pistons No. 2 and No. 3.

10. Remove rear combination of thrust races and thrust bearing from shaft. Discard races and bearing.

11. Remove shaft assembly from front cylinder hald. If the discharge cross-over tube remained in the front cylinder half, it may be necessary to bend discharge cross-over tube slightly in order to remove shaft.

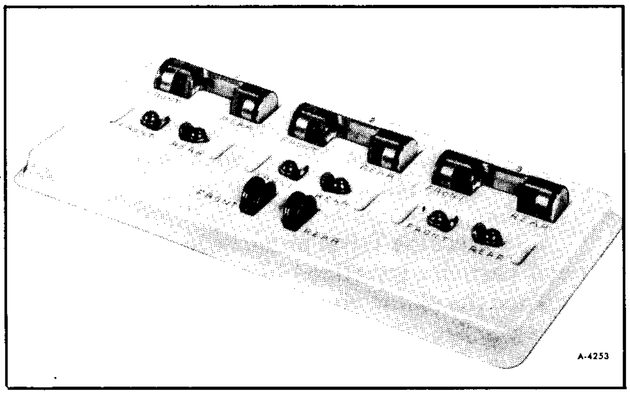


Figure 72—Parts Tray

12. Remove front combination of thrust races and bearing from shaft. Discard races and bearing.

13. Examine surface of axial plate and shaft. Replace **as an assembly,** if necessary.

A certain amount of shoe disc wear on axial plate is normal, as well as some markings indicating load of needle bearings on shaft.

14. Remove discharge cross-over tube from cylinder half, using self-clamping pliers.

This is necessary only on original factory equipment, as ends of the tube are swedged into cylinder halves. The discharge cross-over tube in internal mechanism assemblies that have been **previously** serviced have an O-ring and bushing at EACH END of the tubee, and can be easily removed by hand (See figure 92).

15. Examine piston bores and needle bearings in front and rear cylinder halves. Replace front and rear cylinders if any cylinder bore is deeply scored or damaged.

16. Needle bearings may be removed if necessary by driving them out with special Thin-Wall Socket J-9399. Insert socket in hub end (inner side) of cylinder head and drive bearing out. To install needle bearing, place cylinder half on Support Block J-21352, and insert bearing in end of cylinder head with bearing **identification marks UP.** Use Needle Bearing Installer J-9432 and drive bearing into cylinder head (figure 74), until tool bottoms on the cylinder face.

Two different width needle bearings are used in Production compressors - a 1/2" size and a 5/8" size. **The bearings ARE interchangeable.** Service replacement bearings are all 1/2".

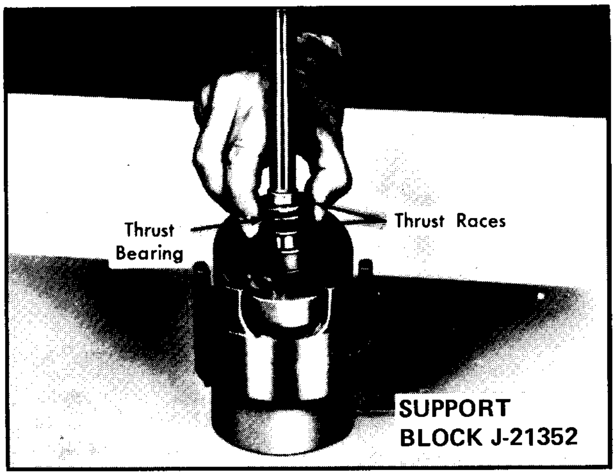


Figure 73—Removing Front Thrust Races and Bearings

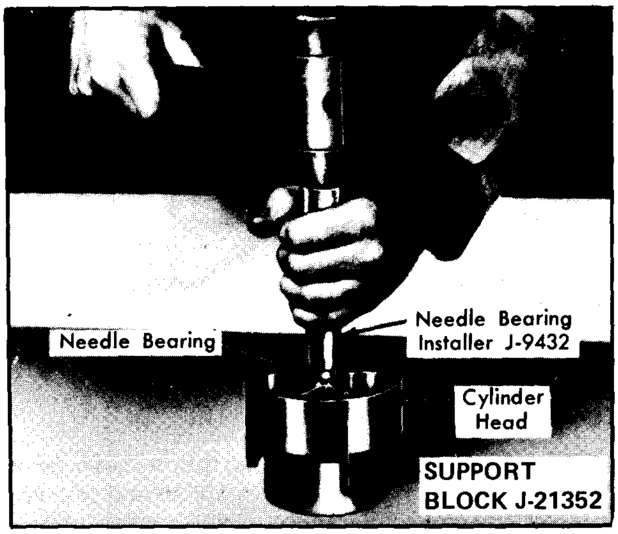


Figure 74—Installing Needle Bearing

17. Wash all parts to be re-used with trichlorethylene, naphtha, stoddard, kerosene, or a similar solvent. Air-dry parts using a source of clean, dry air.

Compressor internal components may be identified by referring to Figures 39 and 40.

GAGING OPERATION

1. Install Compressing Fixture J-9397 on Holding Fixture J-9396 in vise. Place front cylinder half in Compressing Fixture, flat side down. Front cylinder half has long slot extending out from shaft hole.

2. Secure from Service parts stock **four** ZERO thrust races and **three** ZERO shoe discs.

Install a ZERO thrust race, thrust bearing, and a second ZERO thrust race on front end of compressor shaft. Lubricate races and bearing with petrolatum.

4. Insert threaded end of shaft through needle bearing in front cylinder half, and allow thrust race and bearing assembly to rest on hub of cylinder.

5. Now install a ZERO thrust race on rear end of compressor shaft (figure 75), so that it rests on hub of axial plate. Then install thrust bearing and a second ZERO thrust race. Lubricate races and bearing with petrolatum.

6. Lubricate ball pockets of the No. 1 Piston with 525 viscosity refrigerant oil and place a ball in each socket. Use balls previously removed if they are to be re-used.

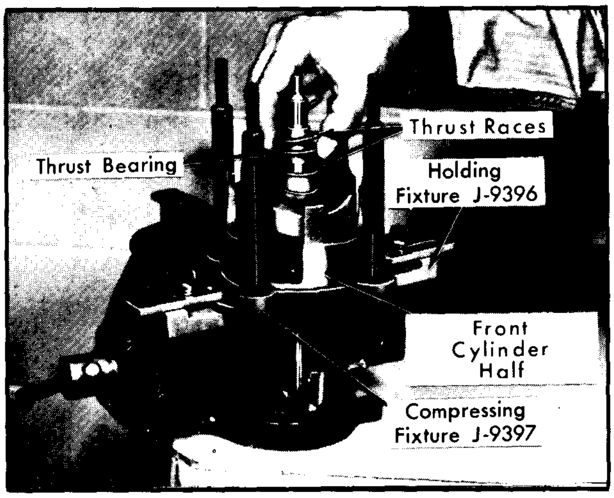


Figure 75—Installing Rear Thrust Races and Bearings

7. Lubricate cavity of a ZERO shoe disc with 525 viscosity refrigerant oil and place shoe disc over ball in **front end** of piston (figure 76). **Front end of piston has an identifying notch in casting web** (figure 71).

> **CAUTION:** *Exercise care in handling the Piston and Ring Assembly, particularly during assembly into and removal from the cylinder bores to prevent damage to the Teflon piston rings.*

Shoe discs should not be installed on rear of piston during following "Gaging" operation.

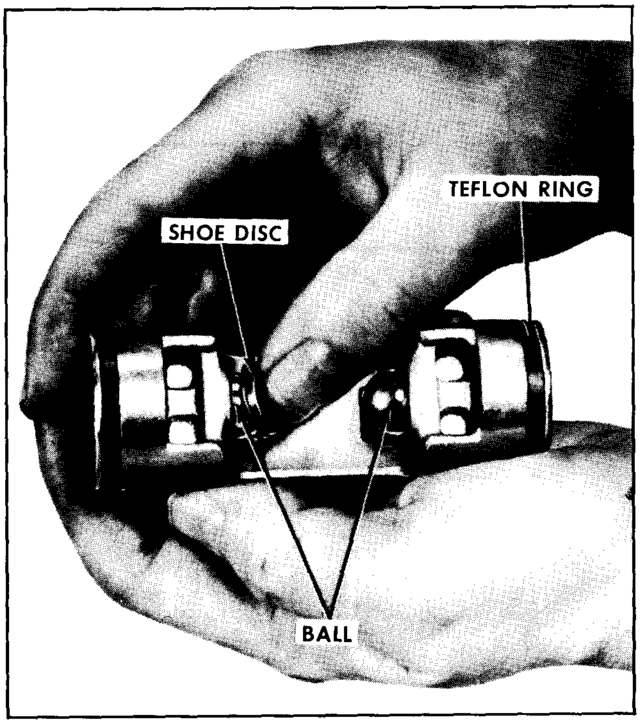


Figure 76—Installing Front Shoe Disc

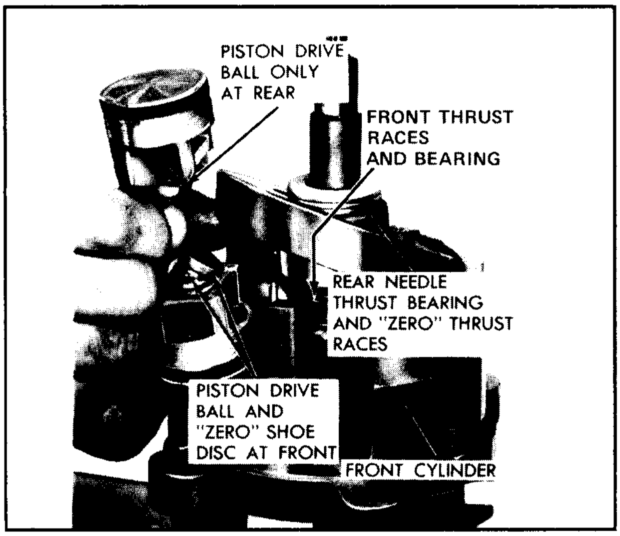


Figure 77—Installing Piston During Gaging Operation

8. Rotate shaft and axial plate until high point of axial plate is over the No. 1 Piston cylinder bore.

9. Lift shaft assembly up and hold front thrust race and bearing assembly against axial plate hub.

10. Position piston over No. 1 cylinder bore (notched end of piston being on bottom and piston straddling axial plate) and lower the shaft to allow piston to drop into its bore (figure 77).

11. Repeat Steps 6 through 10 for Pistons No. 2 and No. 3.

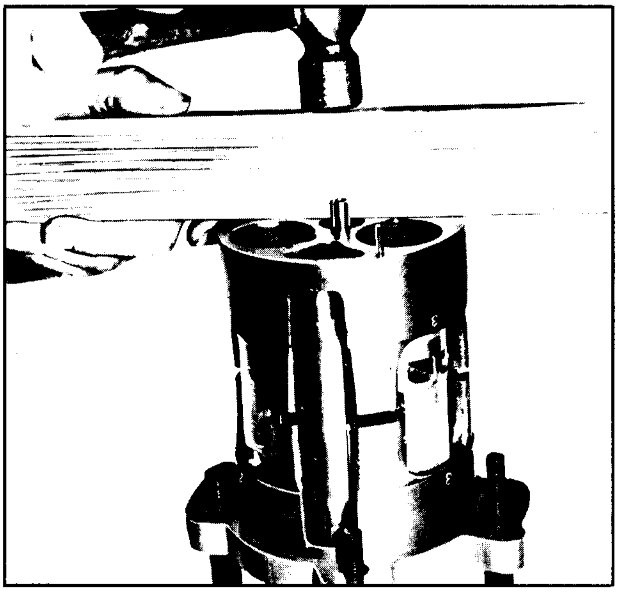


Figure 78—Assembling Cylinder Halves

12. Install rear cylinder half on pistons, aligning cylinder with discharge cross-over tube hole in front cylinder. Tap into place using a plastic mallet or piece of clean wood and hammer (figure 78).

13. Position discharge cross-over tube opening between a pair of Compressing Fixture bolts to permit access for feeler gage.

14. Install top plate on Compressing Fixture J-9397. Tighten nuts to 15 lb. ft. torque using a 0-25 lb. ft. torqud wrench.

Gaging Procedure (Steps 15 thru 18)

The gaging operations which follow have been worked out on a simple basis to establish and provide necessary running tolerances. Two gaging procedures are necessary.

The first is made to choose the proper size shoe discs to provide, at each piston, a .0016" to .0024" total preload between the seats and the axial plate at the tightest place through the 360-degree rotation of the axial plate at the tightest plate. The bronze shoe discs are provided in .0005" variations, including a basic ZERO shoe.

The second, performed at the rear shaft thrust bearing and race pack, is designed to obtain .0025" to .0030" preload between the hub surfaces of the axial plate and the front and rear hubs of the cylinder. A total of 14 steel thrust races, including a basic ZERO race, are provided in increments of .0005" thickness to provide the required fit.

Feeler Gage Set J-9564 or J-9661-01 may be used for gaging proper shoe disc size. Feeler Gage Set J-9564-01 or Dial Indicator Set J-8001-3 may be used to determine proper thrust race size.

PROPER SELECTION OF THRUST RACES AND BALL SEATS IS OF EXTREME IMPORTANCE.

15. Measure clearance between rear ball of No. 1 Piston and axial plate, in following manner:

a. Select a suitable combination of well-oiled Feeler Gage leaves to fit snugly between ball and axial plate.

b. Attach a spring scale, reading in 1-ounce increments, to the feeler gage. A distributor point checking scale or Spring Scale J-544 may be used.

c. Pull on Spring Scale to slide Feeler Gage stock out from between ball and axial plate, and note reading on Spring Scale as Feeler Gage is removed (figure 79). **Reading should be between 4 and 8 ounces.**

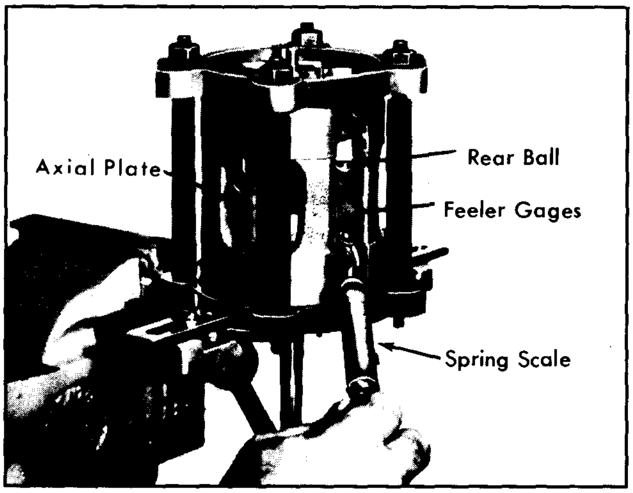


Figure 79—Gaging Rear Piston Ball

d. If reading in Step c. above is under 4 OR over 8 ounces, reduce or increase thickness of Feeler Gage leaves and repeat Steps 1. through c. above until a reading of 4 to 8 ounces is obtained. Record clearance between ball and axial plate that results in the 4 to 8-ounce pull on Spring Scale.

16. Now rotate shaft 120° and repeat Step 15 between same ball and axial plate. Record this measurement. If shaft is hard to rotate, install shaft nut onto shaft and turn shaft with wrench.

17. Rotate shaft another 120° and again repeat Step 15 between these same parts and record measurements.

SHOE DISC			THRUST BEARING RACE		
Part No. Ending In	Identi-fication Stamp	Min. Feeler Gage Reading	Part No. Ending In	Identi-fication Stamp	Dial Indi-cator Reading
000	0	.0000	000	0	.0000
175	17-1/2	.0175	050	5	.0050
180	18	.0180	055	5-1/2	.0055
185	18-1/2	.0185	060	6	.0060
190	19	.0190	065	6-1/2	.0065
195	19-1/2	.0195	070	7	.0070
200	20	.0200	075	7-1/2	.0075
205	20-1/2	.0205	080	8	.0080
210	21	.0210	085	8-1/2	.0085
215	21-1/2	.0215	090	9	.0090
220	22	.0220	095	9-1/2	.0095
			100	10	.0100
			105	10-1/2	.0105
			110	11	.0110
			115	11-1/2	.0115
			120	12	.0120

Figure 80—Available Service Shoes and Thrust Races

	POSITION 1	POSITION 2	POSITION 3	SELECT AND USE SHOE NO.
PISTON NO. 1	.019"	.0195"	.019"	19
PISTON NO. 2	.020"	.020"	.020"	20
PISTON NO. 3	.021"	.021"	.022"	21

Figure 81—Selection of Proper Shoe Disc

18. Select a "numbered" shoe disc corresponding to minimize feeler gage reading recorded in the three checks above. (See example in figure 81). Place shoe discs in Parts Tray J-9402 compartment corresponding to Piston No. 1 and rear ball pocket position.

Shoe discs are provided in .0005" (one-half thousandths) variations. There are a total of 11 sizes available for field servicing. All shoe discs are marked with the shoe size, which corresponds to the last three digits of the piece part number. (See Shoe Disc size Chart in figure 80 above).

Once a proper selection of the shoe has been made, THE MATCHED COMBINATION OF SHOE DISC TO REAR BALL AND SPHERICAL CAVITY IN PISTON MUST BE KEPT IN PROPER RELATIONSHIP during disassembly after gaging operation, and during final assembly of internal mechanism.

19. Repeat in detail the same gaging procedure outlined in Steps 15 through 18 for Piston No. 2 and No. 3.

20. Mount Dial Indicator J-8001-3 on edge of Compressing Fixture J-9397 with Clamp J-8001-1 and Sleeve J-8001-2 (figure 81). Position Dial Indicator on rear end of shaft and adjust to "zero".

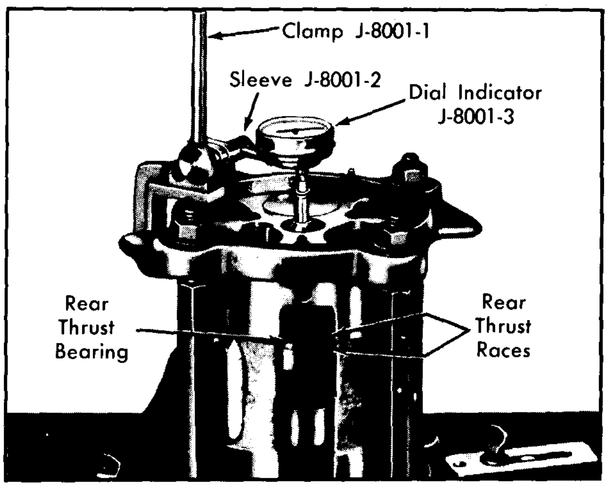


Figure 82—Gaging Rear Thrust Race

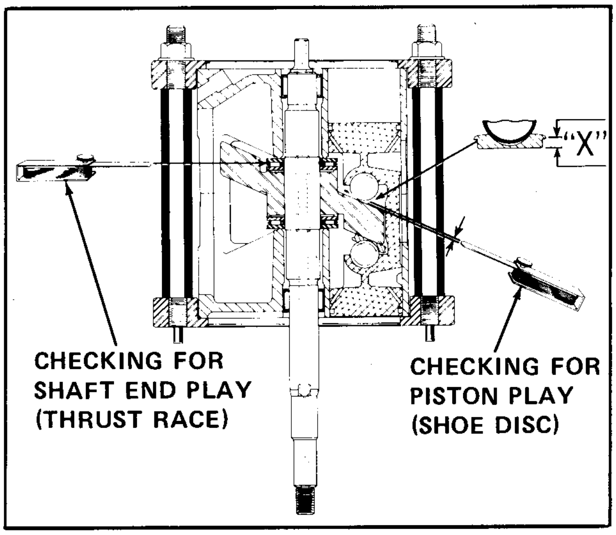


Figure 83—Checking Piston and Shaft End Play

Apply full hand-force at end of mainshaft a few times before reading clearance. This will help squeeze the oil out from/ between mating parts. Push upward and record measurement. Dial Indicator increments are 001"; therefore, reading must be estimated to nearest .0005".

An alternate method of selecting a proper race is to use Gage Set J-9661-01, selecting a suitable feeler gage leaf until the result is a 4 to 8 ounce pull on the scale between the rear thrust bearing and upper (or outer rear) thrust race (figure 83). If the pull is just less than 4 ounces, add .0005" to the thickness of the feeler stock used to measure the clearance. If the pull on the scale reads just over 8 ounces, then subtract .0005" from the thickness of the feeler stock. **Select a race TWO (2) FULL SIZES LARGER than feeler gage thickness** (If feeler gage is .007", select a No. 9 or 090 race).

21. **Select a thrust race with a "number" corresponding to TWO (2) FULL SIZES LARGER than Dial Indicator or feeler gage measurement of the amount of end play shown.** (If measurement is .007", select a No. 9 or 090 race). **Place thrust race in right-hand slot at bottom center of Parts Tray J-9402.**

Fifteen (15) thrust races are provided in increments of .0005" (one-half thounsandths) thickness and one ZERO gage thickness, providing a total of 16 sizes available for field service. Thrust races are identified on the part by their thickness in thousandths, in excess of the thickness of the ZERO thrust race.

This "number" also corresponds to the last three digits of the piece part number. See Thrust Race size Chart in Figure 80.

22. Remove nuts from top plate of Compressing Fixture J-9397, and remove top plate.

23. Separate cylinder halves while unit is in Fixture. It may be necessary to use a wood block and mallet.

24. **Remove rear cylinder half and carefully remove one piston at a time from axial plate and front cylinder half. DO NOT LOSE THE RELATIONSHIP of the front ball and shoe disc and rear ball. Transfer each piston, ball, and shoe disc to its proper place in Parts Tray J-9402.**

25. Remove rear outer ZERO thrust race from shaft and install thrust race just selected.

The ZERO thrust race may be put aside for reuse in additional gaging or rebuilding operations.

TEFLON PISTON RING REPLACEMENT

The Teflon piston ring installing, sizing and gaging tools are shown in Figure 84.

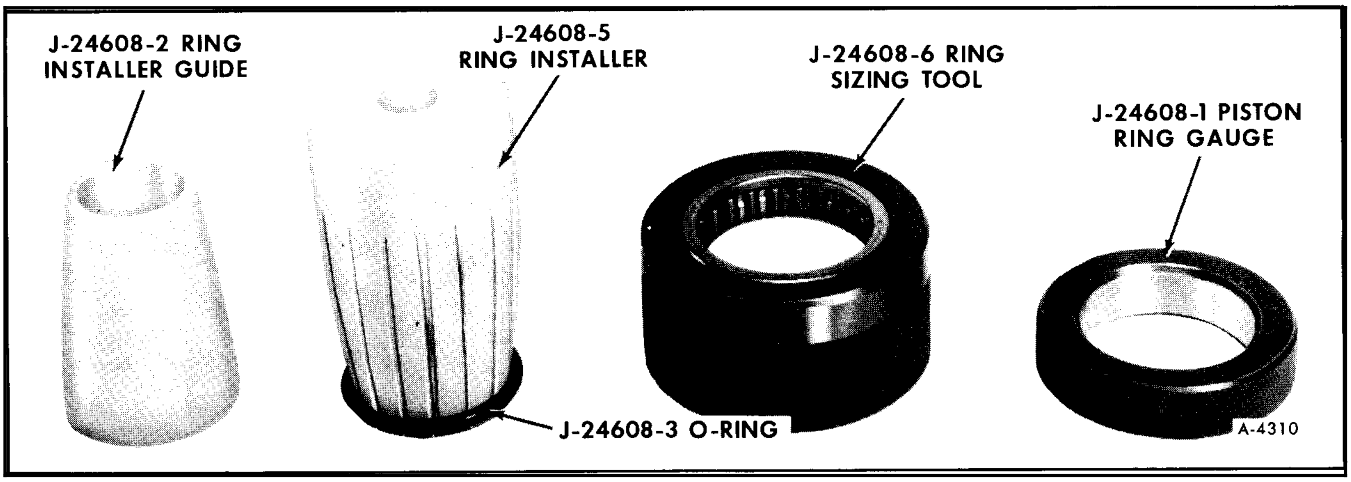


Figure 84—Teflon Piston Ring Installing, Sizing , and Gaging Tools

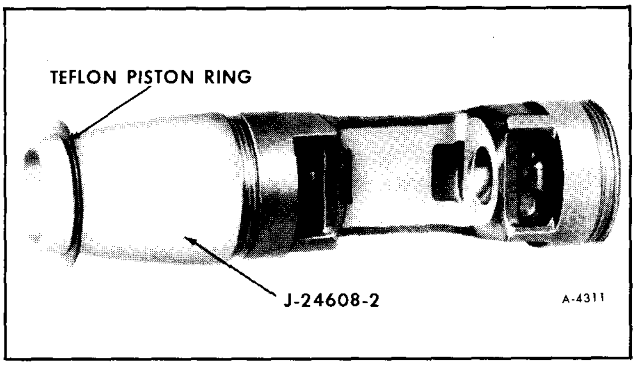


Figure 85—Teflon Piston Ring Positioned on Ring Installer Guide

1. Remove the old piston rings by CAREFULLY slicing through the ring with a knife or sharp instrument, holding the blade almost flat with the piston surface. Be fareful not to damage the aluminum piston OF piston groove in cutting to remove the ring.

WARNING: EXERCISE PERSONAL CARE IN CUTTING THE PISTON RING FOR REMOVAL.

2. Clean the piston and piston ring grooves with a recommended cleaning solvent and blow the piston dry with dry air (Trichlorethylene, naphtha, stoddard solvent, kerosene, or equivalent).

3. Set the piston on end on a clean, flat surface and install the Ring Installer Guide J-24608-2 on the end of the piston (figure 89).

4. Install a Teflon ring on the Ring Installer Guide J-24605-2 as shown in Figure 85, **with the dished or dull-side down and glossy-side up.**

5. Push the Ring Installer J-24608-5 down over the Installer Guide J-24608-2 to install the Teflon ring in the piston ring groove (figure 86). If the Teflon ring is slightly off position in the ring groove, it can be positioned into place by fingernail or blunt-edged tool that will not damage the piston.

The Ring Installer J-24608-5 will retain the Installer Guide J-24608-2 internally when the Teflon ring is installed on the piston. Remove the Installer Guide from the Ring Installer and **DO NOT STORE THE INSTALLER GUIDE IN THE RING INSTALLER, as the Ring Installer Segment Retainer O-Ring J-24608-3 will be stretched and possibly weakened during storage.** This could result in the O-Ring J-24608-3 not holding the Ring Installer segments tight enough to the Installer Guide J-24608-2 to peroperly install the Teflon ring on the piston.

6. Lubricate the piston ring area with 525 viscosity refrigerant oil and rotate the Piston and Ring

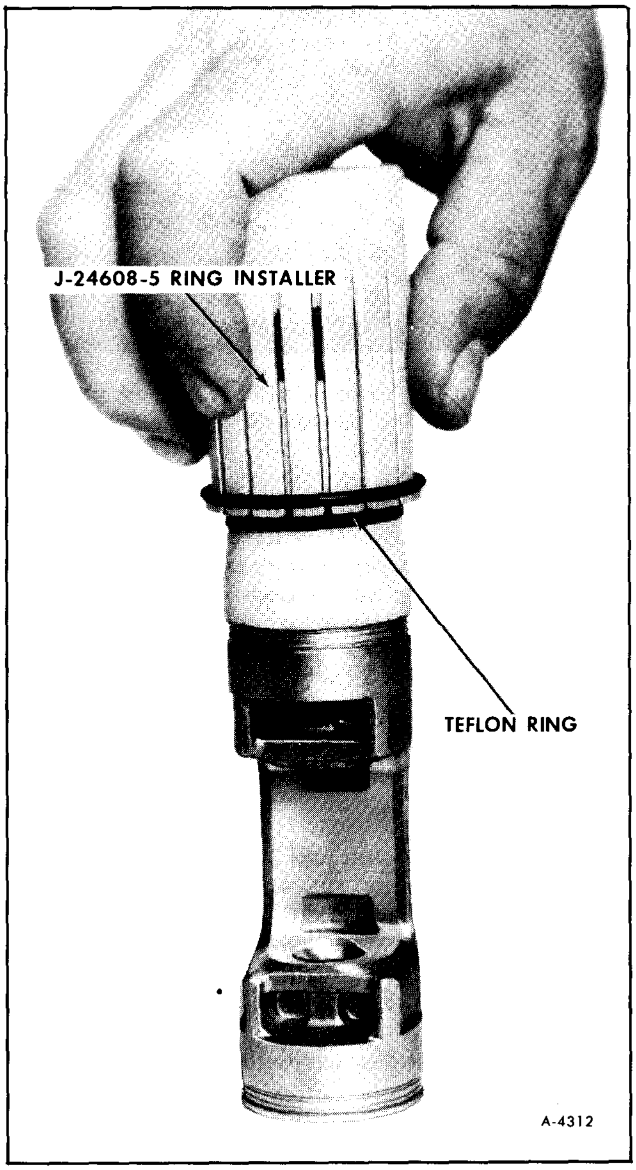


Figure 86—Installing Teflon Piston Ring

Assembly into the Ring Sizer J-24608-6 **at a slight angle** (figure 88). Rotate the piston, while pushing inward, until the piston is inserted against the center stop of the Ring Sizer J-23608-6.

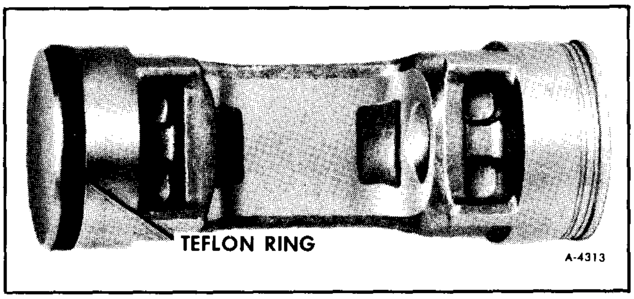


Figure 87—Teflon Piston Ring Installed on Piston Groove

Figure 88—Turning Piston and Ring Assembly into Ring Sizing Tool

CAUTION: *DO NOT push the Piston and Ring Assembly into the Ring Sizer J-24608-6 without proper positioning and rotating as described above, as the ends of the needle bearings of the Ring Sizer may damage the end of the piston.*

7. Rotate the Piston and Ring Assembly in the Ring Sizer J-24608-6 several COMPLETE turns, until the Assembly rotates relatively free in the Ring Sizer (figure 88).

8. Remove the Piston and Ring Assembly, wipe the end of the piston and ring area with a clean cloth and then push the Piston and Ring Assembly into the Ring Gage J-24608-1 (figure 87). The piston should go through the Ring Gage with a 6-lb. force or less without lubrication. If not, repeat Steps 6 and 7.

9. Repeat the procedure for the opposite end of the piston.

CAUTION: *DO NOT lay the piston down on a dirty surface where dirt or metal chips might become imbedded in the Teflon ring surface.*

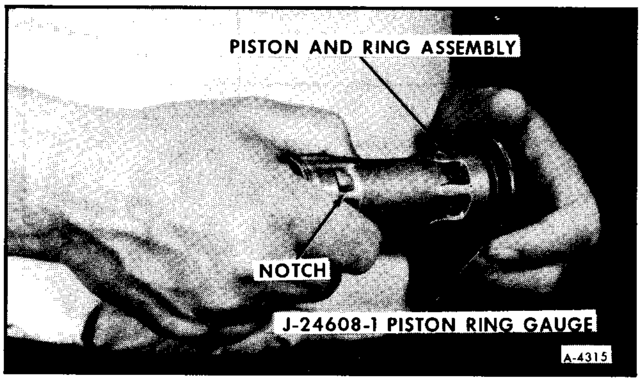


Figure 89—Gaging Piston Ring Size

10. Lubricate BOTH ENDS of the piston with 525 viscosity refrigerant oil before inserting the piston into the cylinder bore.

CAUTION: *Reasonable care should be exercised in installing the piston into the cylinder bore to prevent damage to the Teflon ring.*

ASSEMBLY

After properly performing the "Gaging Procedure", choosing the correct shoe discs and thrust races, and installing any needed Teflon Piston Rings, the cylinder assembly may now be reassembled. Be sure to install all NEW seals and O-rings. All are included in the compressor O-Ring Service Kit.

Assembly procedure is as follows:

1. Support the FRONT half of the cylinder assembly on Compressing Fixture J-9397. Install the shaft and axial plate, threaded end **down**, with its front bearing race pack (ZERO race, bearing NUMBERED race), if this was not already done at the end of the "Gaging Procedure".

2. Apply a light smear of petroleum jelly to the "numbered" shoe discs chosen in the gaging procedure and install all balls and shoe discs in their proper place in the piston assembly.

3. Rotate the axial plate so that the high point is above cylinder bore No. 1. Carefully assemble Piston No. 1, complete with ball and ZERO shoe disc on the

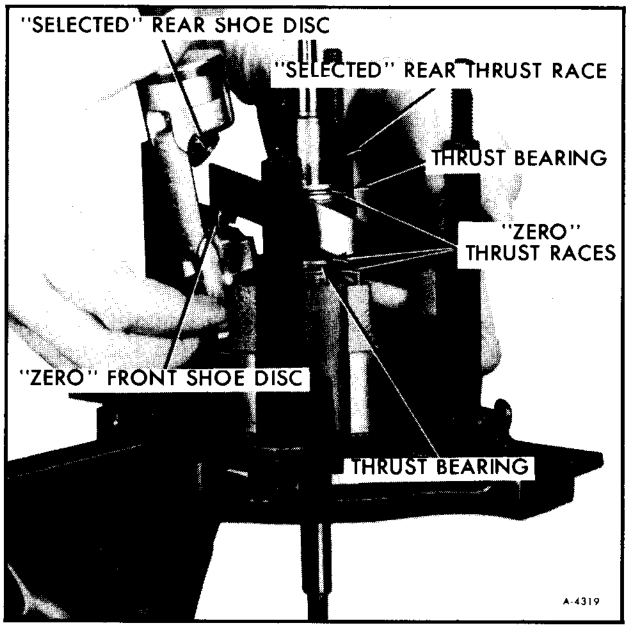


Figure 90—Installing First Piston Assembly Into Front Cylinder Half

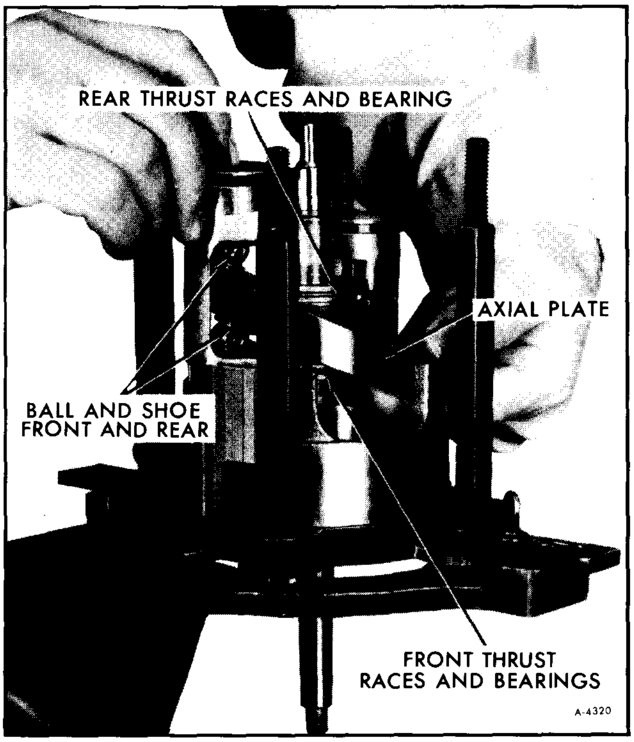


Figure 91—Installing Second Piston

front AND ball and NUMBERED shoe disc on the **rear**, over the axial plate. Hold front thrust bearing pack tightly against axial plate hub while lifting hub. Insert the Piston Assembly into the front cylinder half (figure 90).

4. Repeat this operation for Pistons No. 2 and No. 3 (figure 91).

5. Without installing any O-rings or bushings, assemble one end of the new Service discharge cross-over tube into the hole in the front cylinder half (figures 92 and 93).

Be sure the flattened portion of this tube faces the **inside** of the compressor to allow for axial plate clearance (figure 93).

6. Now rotate the shaft to position the pistons in a stair-step arrangement; then **carefully** place the rear

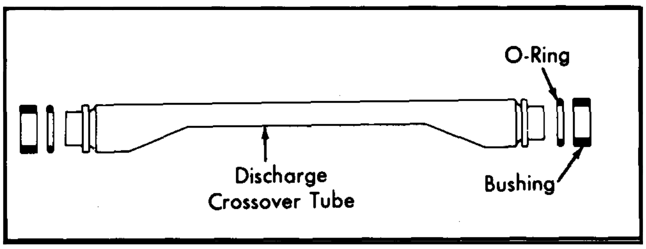


Figure 92—Service Type Discharge Cross-Over Tube

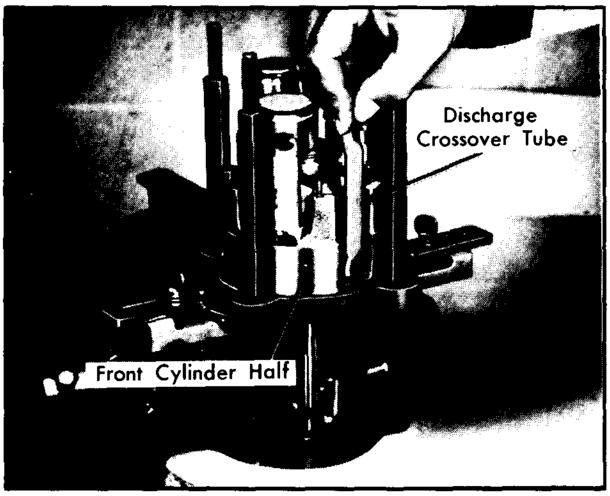


Figure 93—Installing Discharge Cross-Over Tube

cylinder half over the shaft and start the pistons into the cylinder bores (figure 94).

7. When all three Piston and Ring assemblies are in their respective cylinders, align the end of the discharge cross-over tube with the hole in the rear half of the cylinder.

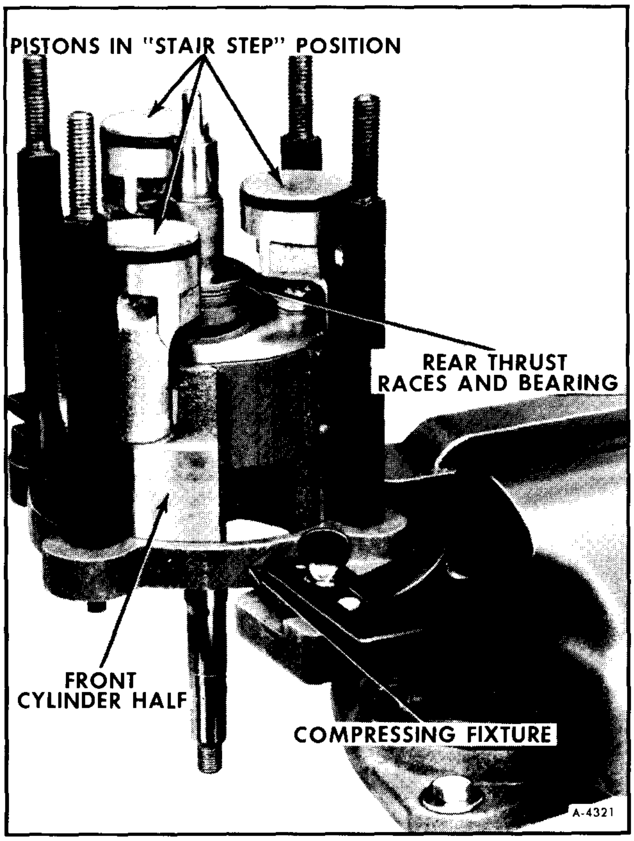


Figure 94—Pistons Postioned in Stair-Step Arrangement

8. When all parts are in proper alignment, tap with a clean wood block and mallet to seat the rear half of the cylinder over the locating dowel pins. If necessary, clamp the cylinder in Compressing Fixture J-9397, to complete drqwing the cylinder halves together.

9. Generously lubricate all moving parts with clean 525 viscosity refrigerant oil and check for free rotation of the parts.

10. Replace the suction cross-over cover (figure 95). Compress the cover as shown to start it into the slot, and then press or carefully tap it in until flush on both ends.

RE-INSTALL

1. Place internal mechanism on Internal Assembly Support Block J-21352, with **rear-end** of shaft in block hole.

2. Now install new O-ring and bushing on **front-end** of discharge cross-over tube (figure 96). The O-ring and bushing are Service parts only for internal mechanisms that have been disassembled in the field (See figure 92).

Install front suction reed plate on front cylinder half. Align with dowel pins, suction ports, oil return slot, and discharge cross-over tube (figure 97).

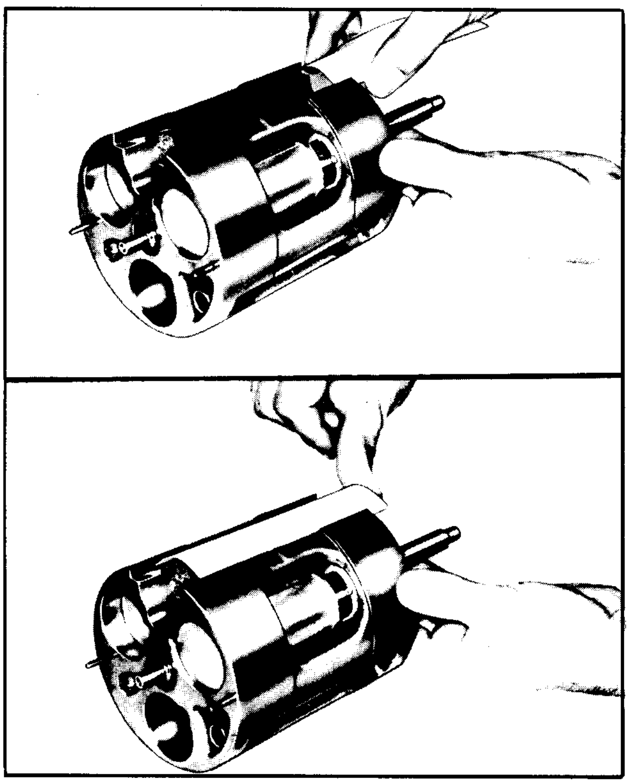


Figure 95—Installing Suction Cross-Over Cover

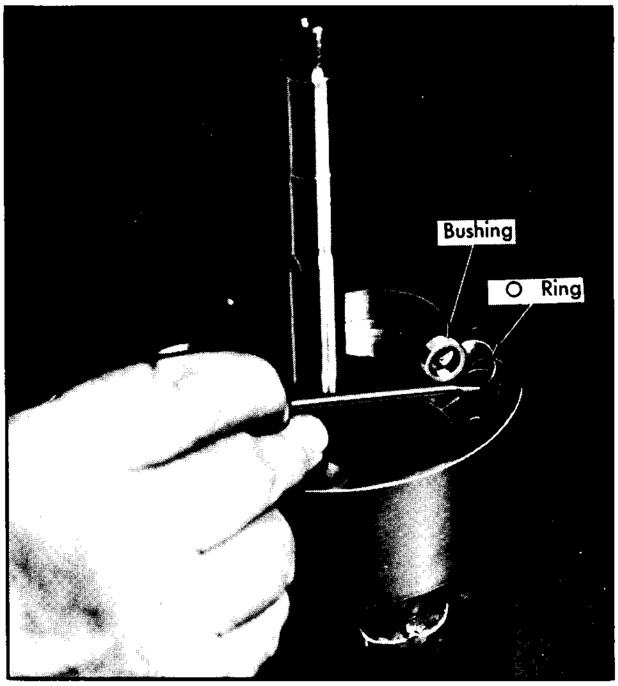


Figure 96—Installing O-Ring on Discharge Cross-Over Tube

5. Install front discharge valve plate assembly, aligning holes with dowel pins and proper openings in front suction reed plate (figure 98).

Front discharge plate has a large diameter hole in the center (figure 99).

6. Coat sealing surfaces on webs of compressor front ehad casting with 525 viscosity refrigerant oil.

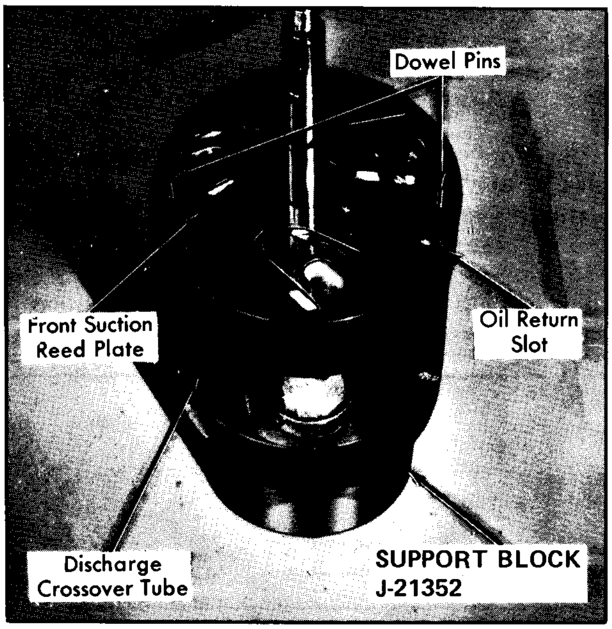


Figure 97—Installing Front Suction Reed

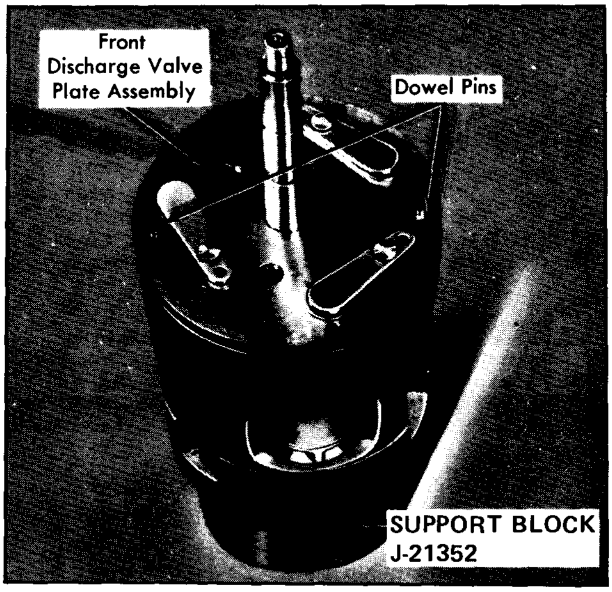


Figure 98—Installing Front Discharge Valve Plate

7. Determine **exact** position of front head casting in relation to dowel pins on internal mechanism. Mark position of dowel pins on sides of front head assembly and on sides of internal mechanism with a grease pencil. Carefully lower front head casting into position (figure 100), **making certain that sealing area around center bore of head assembly does not contact shaft** as head assembly is lowered. **Do not rotate head assembly** to line up with dowel pins, as the sealing areas would contact reed retainers.

8. Generously lubricate new O-ring and angled groove at lower edge of front head casting with 525 viscosity refrigerant oil and install new O-ring into groove (figure 101).

9. Coat inside machined surfaces of compressor

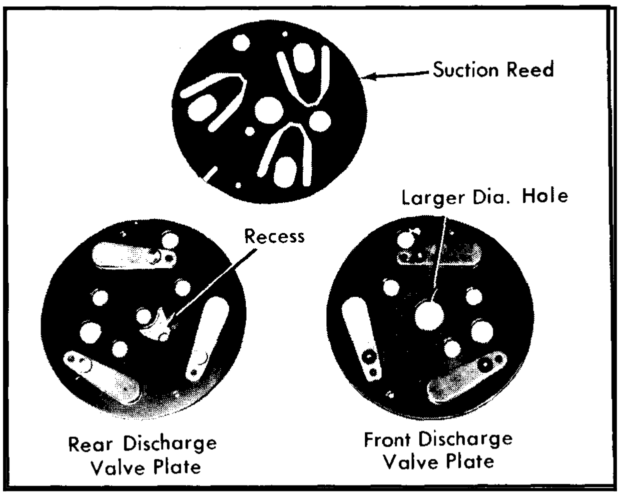


Figure 99—Front and Rear Discharge Valve Plate

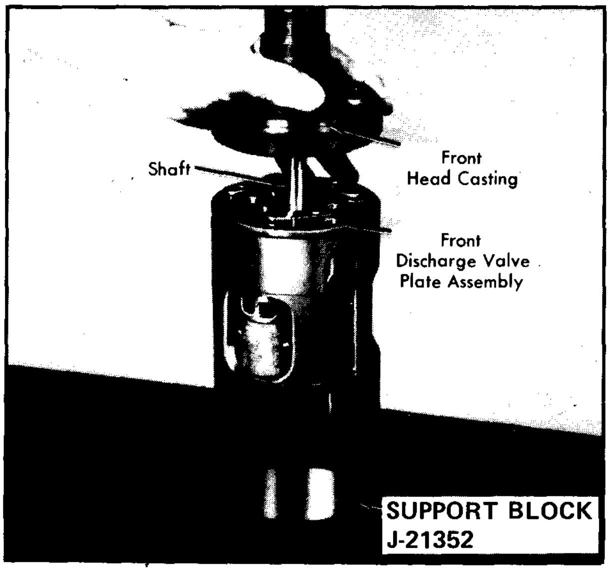


Figure 100—Installing Front Head Casting

shell with 525 viscosity refrigerant oil and position shell on internal mechanism, resting on O-ring seal.

10. Using flat-side of a small screwdriver, gently position O-ring in a round circumference of internal mechanism until compressor shell slides down over internal mechanism. As shell slides down, line up oil sump with oil intake tube hole (figure 102).

11. Holding Support Block, invert assembly and place back into Holding Fixture with front end of shaft down. Remove Support Block.

12. Install new dowel pins in rear cylinder half, if previously removed.

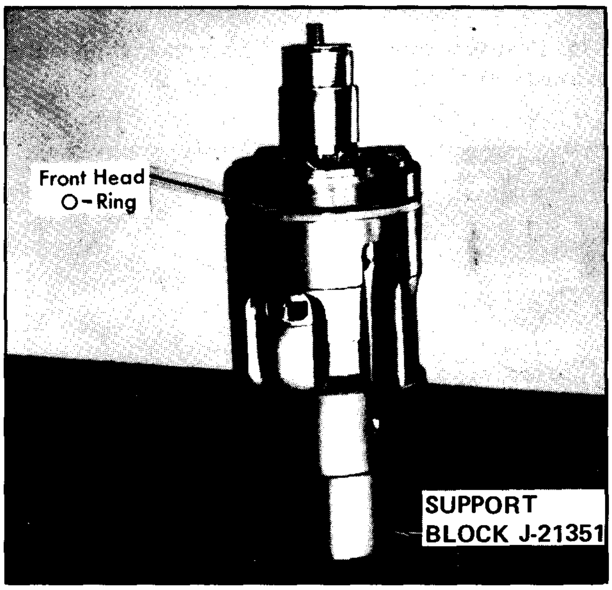


Figure 101—Front Head O-Ring Installed

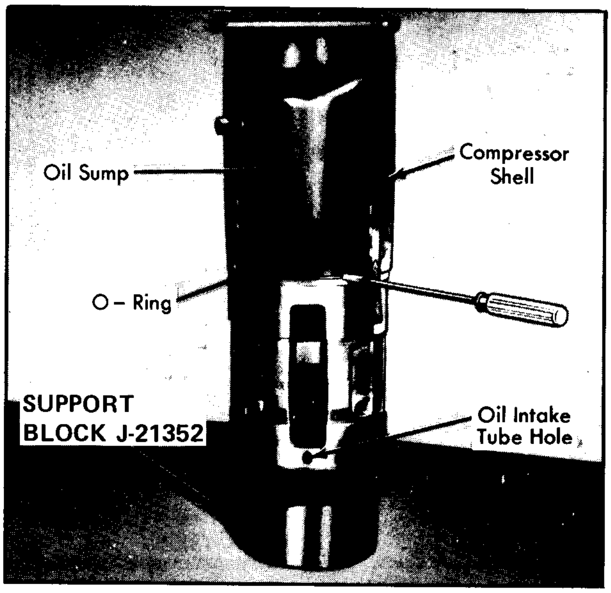


Figure 102—Installing Compressor Shell

13. Install new O-ring in oil pick-up tube cavity.

14. Lubricate oil pick-up tube with 525 viscosity refrigerant oil and install into cavity, rotating compressor mechanism to align tube with hole in shell baffle (figure 103).

15. Install new O-ring and bushing on **rear-end** of discharge cross-over tube (See figure 92).

16. Install rear suction reed over dowel pins, **with slot TOWARDS sump.**

17. Install rear discharge valve plate assembly over dowel pins, **with reed retainers UP.**

18. Position inner oil pump gear over shaft with previously applied identification **mark UP.**

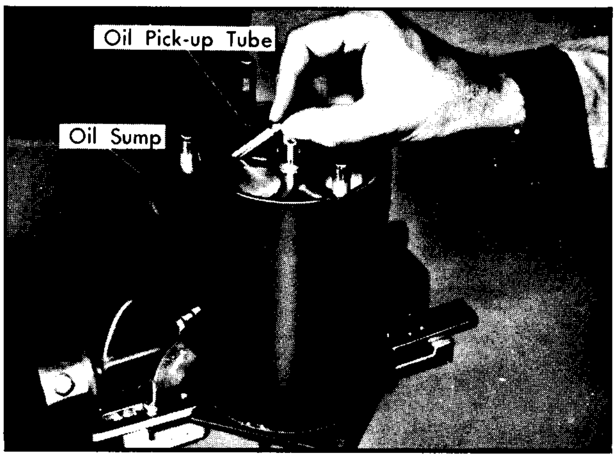


Figure 103—Installing Oil Pick-Up Tube

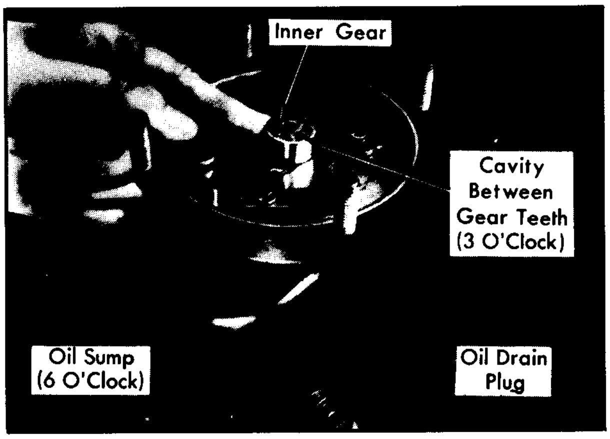


Figure 104—Positioning Oil Pump Gears

19. Position outer oil pump gear over inner gear with previously applied identification **mark UP** and, when standing facing oil sump, position outer gear so that it meshes with inner gear at the 9-o'clock position, and resulting cavity between gear teeth is then at 3-o'clock position (figure 104).

20. Generously oil rear discharge valve plate assembly with 525 viscosity refrigerant oil around outer edge where large diameter O-ring will be placed. Oil the valve reeds, pump gears, and area where sealing surface will contact rear discharge valve plate.

21. Using the 525 oil, lubricate new head to-shell O-ring and install on rear discharge valve plate, in contact with shell (figure 105).

22. Install suction screen in rear head casting, using care not to damage screen.

24. Coat sealing surface on webs of compressor rear head casting with 525 viscosity refrigerant oil.

24. Install rear head assembly over studs on compressor shell. **The two lower threaded compressor mounting holes should be in alignment with the compressor sump.**

Make certain that suction screen does not dop out of place when lowering rear head into position (figure 106).

If rear head assembly will not slide down over dowels in internal mechanism, twist front head assembly back-and-forth very slightly by-hand until rear head drops over dowel pins.

25. Install nuts on threaded whell studs and tighten evenly to 25 lb. ft. torque using a 0-50 lb. ft. torque wrench.

26. Invert compressor in Holding Fixture and

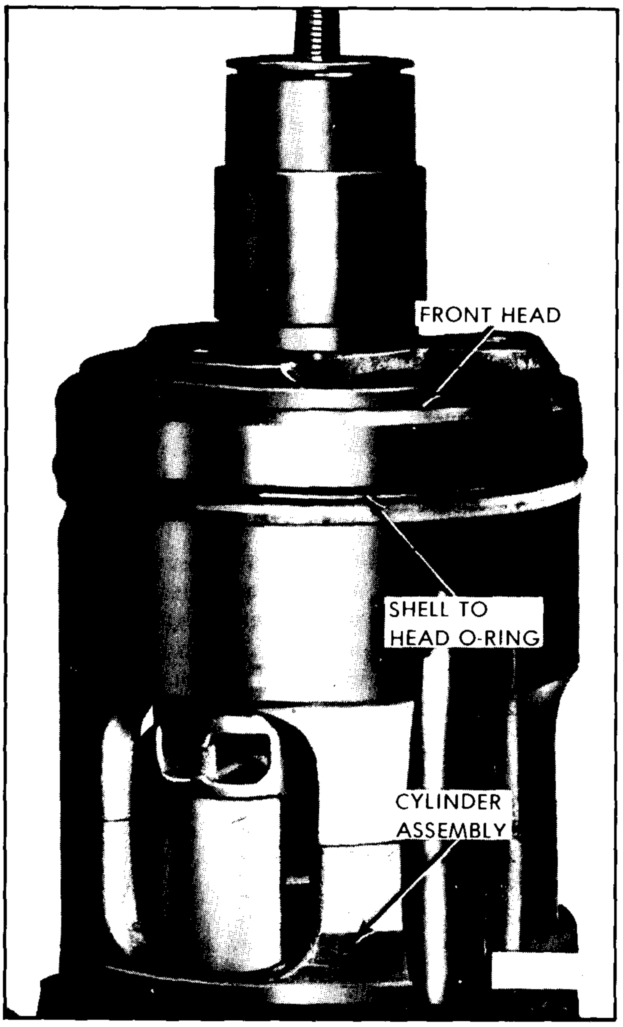


Figure 105—Shell-to-Front Head O-Ring Installation

install compressor shaft seal as described in "Compressor Shaft Seal" Replacement procedure.

27. Install compressor clutch coil and housing assembly as described in "Compressor Clutch Coil and Housing Assembly" Replacement procedure.

28. Install compressor pulley and bearing assembly as described in "Compressor Pulley and Bearing" Replacement procedure.

29. Install compressor clutch plate and hub assembly as described in "Compressor Clutch Plate and Hub Assembly" Replacement procedure.

30. Add required amount of 525 viscosity refrigerant oil (See figure 41).

31. Check for external and internal leaks as described in the following "Compressor Leak Testing" procedure.

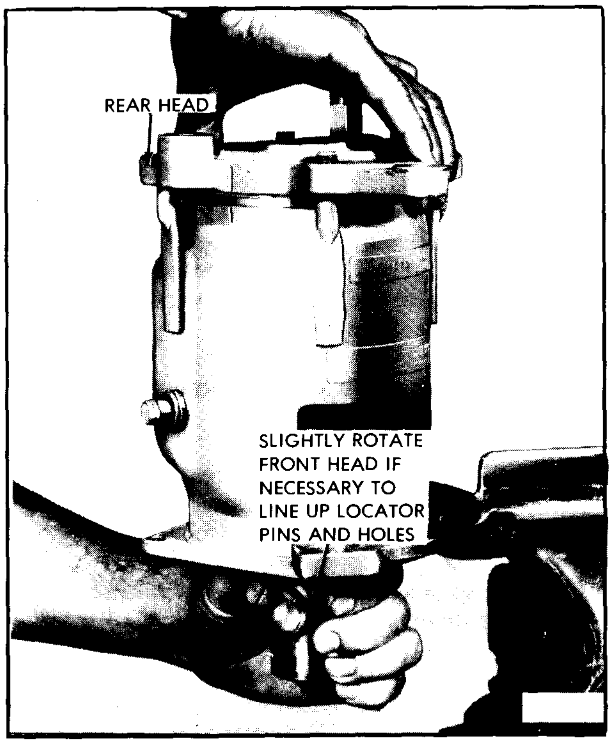


Figure 106—Installing Rear Head

COMPRESSOR LEAK TESTING — EXTERNAL AND INTERNAL

COMPRESSOR BENCH-CHECK PROCEDURE

1. Install Test Plate J-9625 on rear head of compressor.

2. Attach center hose of gage manifold set on Charging Station to a refrigerant drum standing in an upright position and open valve on drum.

3. Connect Charging Station HIGH and LOW pressure lines to corresponding fittings on Test Plate J-9625, using J-5420 Gage Adapters.

> **NOTE:** Suction port of compressor has large internal opening. Discharge port has small internal opening into compressor.

4. Open LOW pressure control, HIGH pressure control and REFRIGERANT control on Charging Station to allow refrigerant vapor to flow into compressor.

5. Using electronic-type Leak Detector, check for leaks at pressure relief valve, compressor shell to cylinder, compressor front head seal, rear head seal

and oil charge port, and compressor shaft seal. After checking, shut off LOW pressure control and HIGH pressure control on Charging Station.

If an external leak is present, perform the necessary corrective measures and recheck for leaks to make certain the leak has been corrected.

7. Loosen the manifold gage hose connections to the Gage Adapters J-5420 connected to the LOW and HIGH sides and allow the vapor pressure to release from the compressor.

8. Disconnect both Gage Adapters J-5420 from the Test Plate J-9625.

9. Rotate the complete compressor assembly (**not the crankshaft or drive plate hub**) slowly several turns to distribute oil to all cylinder and piston areas.

10. Install a shaft nut on the compressor crankshaft if the drive plate and clutch assembly are not installed.

11. Using a box-end wrench or socket and handle, rotate the compressor crankshaft or clutch drive plate on the crankshaft several turns to ensure piston assembly to cylinder wall lubrication.

12. Connect the Charging Station HIGH pressure line or a HIGH pressure gage and Gage Adapter J-5420 to the Test Plate J-9625 HIGH side connector.

13. Attach a Adapter J-5420 to the suction or LOW pressure port of the Test Plate J-9625 to open the schrader-type valve.

NOTE: Oil will drain out of the compressor suction port adapter if the compressor is positioned with the suction port down.

14. Attach the compressor to the Holding Fixture J-9396, and clamp the fixture in a vise so that the compressor can be manually turned with a wrench.

15. Using a wrench, rotate the compressor crankshaft or drive plate hub 10 complete revolutions at a speed of approximately one revolution per second.

NOTE: Turning the compressor at less than one revolution per second can result in a lower pump-up pressure and disqualify a good pumping compressor.

16. Observe the reading on the HIGH pressure gage at the completion of the tenth revolution of the compressor. The pressure reading for a good pumping compressor should be 60 psi or above.

A pressure reading of less than 50 psi would indicate one or more suction and/or discharge valves leaking, an internal leak, or an inoperative valve and the compressor should be disassembled and checked for cause of leak. Repair as needed, reassemble and repeat the pump-up test. Externally leak test with the electronic-type Leak Detector.

17. When the pressure pump-up test is completed, release the air pressure from the HIGH side and remove the Gage Adapters J-5420 and Test Plate J-9625.

18. Remove oil charge screw and drain the oil sump.

19. Allow the compressor to drain for 10 minutes, then charge with the proper amount of oil. The oil may be poured into the suction port.

NOTE: If further assembly or processing is required, a shipping plate or Test Plate J-9625 should be installed to keep out air, dirt and moisture until the compressor is installed.

AIR CONDITIONING DIAGNOSIS

NOTE: Refer to Figures 107-109 for diagnosis details.

REFRIGERANT SYSTEM

The following is a description of the type of symptom each refrigerant component will evidence if a defect occurs:

COMPRESSOR

A compressor defect will appear in one of four ways: Noise, seizure, leakage, or low discharge pressure.

NOTE: Resonant compressor noises are not cause for alarm; however, irregular noise or rattles may indicate broken parts or excessive clearances due to wear. To check seizure, deenergize the magnetic clutch and check to see if drive plate can be rotated. If rotation is impossible, compressor is seized (See "False Compressor Seizure"). To check for a leak, refer to leak testing earlier in this section. Low discharge pressure may be due to a faulty internal seal of the compressor, or a restriction in the compressor.

Low discharge pressure may also be due to an insufficient refrigerant charge or a restriction elsewhere in the system. These possibilities should be checked prior to servicing the compressor. If the compressor is inoperative, but is not seized, check to see if current is being supplied to the magnetic clutch coil terminals.

CONDENSER

A condenser may be defective in two ways: it may leak, or it may be restricted. A condenser restriction will result in excessive compressor discharge pressure. If a partial restriction is present, sometimes ice or frost will form immediately after the restriction as the refrigerant expands after passing through the restriction. If air flow through the condenser or radiator is blocked, high discharge pressures will result. During normal condenser operation, the outlet pipe will be slightly cooler than the inlet pipe.

RECEIVER-DEHYDRATOR

A defective receiver-dehydrator may be due to a restriction inside the body of the unit. A restriction at the inlet to the receiver-dehydrator will cause high head pressures. Outlet tube restrictions will be indicated by low head pressures and little or no cooling. An excessively cold receiver-dehydrator outlet may be indicative of a restriction.

EXPANSION VALVE

A malfunction of the expansion valve will be caused by one of the following conditions: Valve stuck open, valve stuck closed, broken power element, a restricted screen or an improperly located or installed power element bulb. The first three conditions require valve replacement. The last two may be corrected by replacing the valve inlet screen and by properly installing the power element bulb.

Attachment of the expansion valve bulb to the evaporator outlet line is very critical. The bulb must be attached tightly to the line and must make good contact with the line along the entire length of the bulb. A loose bulb will result in high low side pressures and poor cooling.

Indications of expansion valve trouble are provided by Performance Test; consult Diagnostic Charts.

VALVE STUCK OPEN

Noisy Compressor.

No Cooling — Freeze Up.

VALVE STUCK CLOSED, BROKEN POWER ELEMENT OR PLUGGED SCREEN

Very Low Suction Pressure.

No Cooling.

POORLY LOCATED POWER ELEMENT BULB

Normal Pressure.

Poor Cooling.

Diagnosis for Defective Valve

The following procedure must be followed to determine if a malfunction is due to a defective expansion valve.

1. Check to determine if the system will meet the performance test as outlined previously. If the expansion valve is defective, the low pressure readings (evaporator pressure) will be above specifications.

2. The loss of system performance is not as evident when the compressor head pressure is below 200 psi. Therefore, it may be necessary to increase the system head pressure by partially blocking the condenser. Disconnect the blower lead wire and repeat the "performance check" to determine if the evaporator pressure can be obtained.

3. The system will also indicate a low refrigerant charge by bubbles occurring in the sight glass.

EVAPORATOR

When the evaporator is defective, the trouble will show up as an inadequate supply of cool air. A partially plugged core due to dirt, a cracked case, or a leaking seal will generally be the cause.

REFRIGERANT LINE RESTRICTIONS

Restrictions in the refrigerant lines will be indicated as follows:

1. Suction Line — A restricted suction line will cause low suction pressure at the compressor, low discharge pressure and little or no cooling.

2. Discharge Line — A restriction in the discharge line generally will cause the pressure relief valve to open.

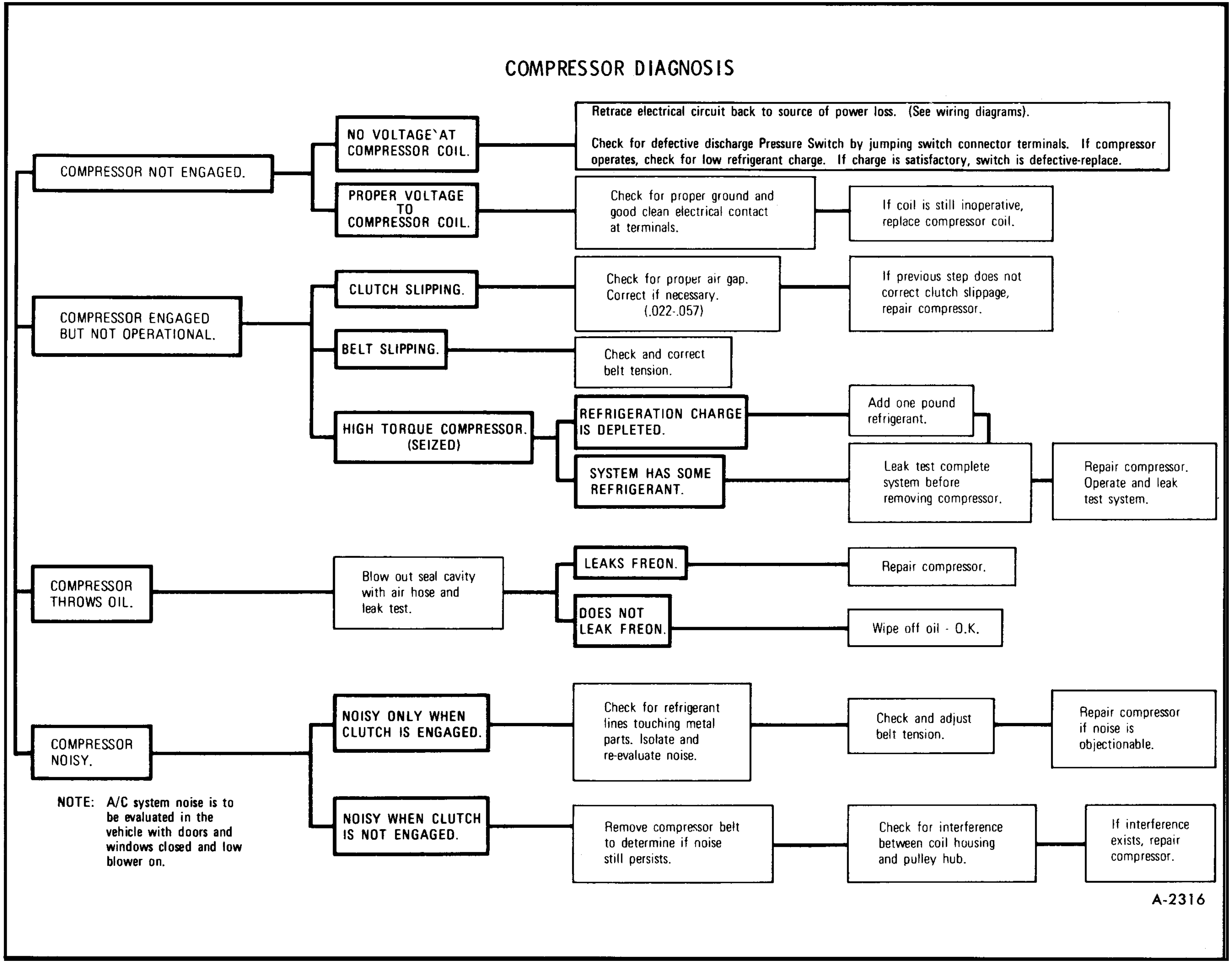


Figure 107—Compressor Diagnosis

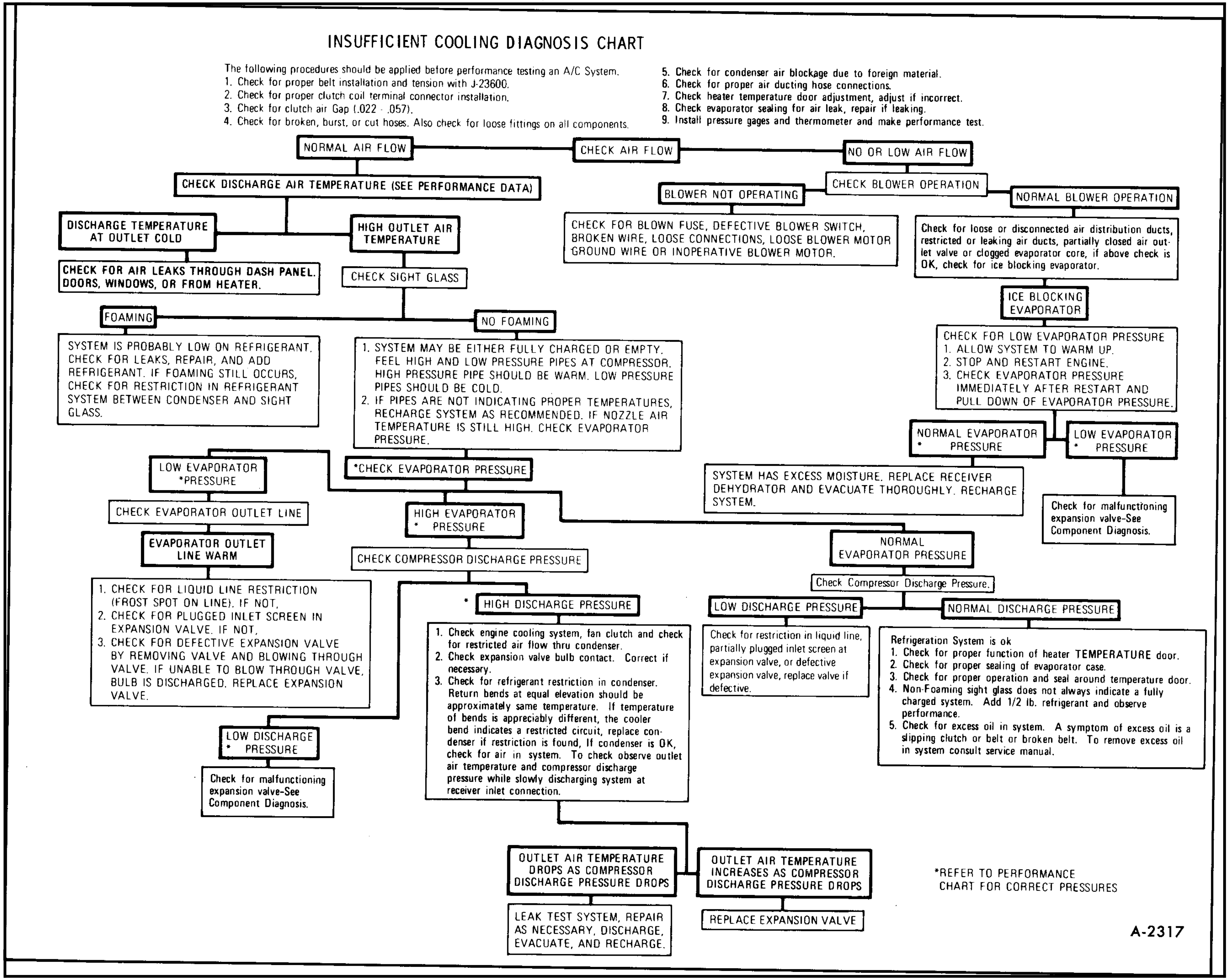


Figure 108—Insufficient Cooling Diagnosis

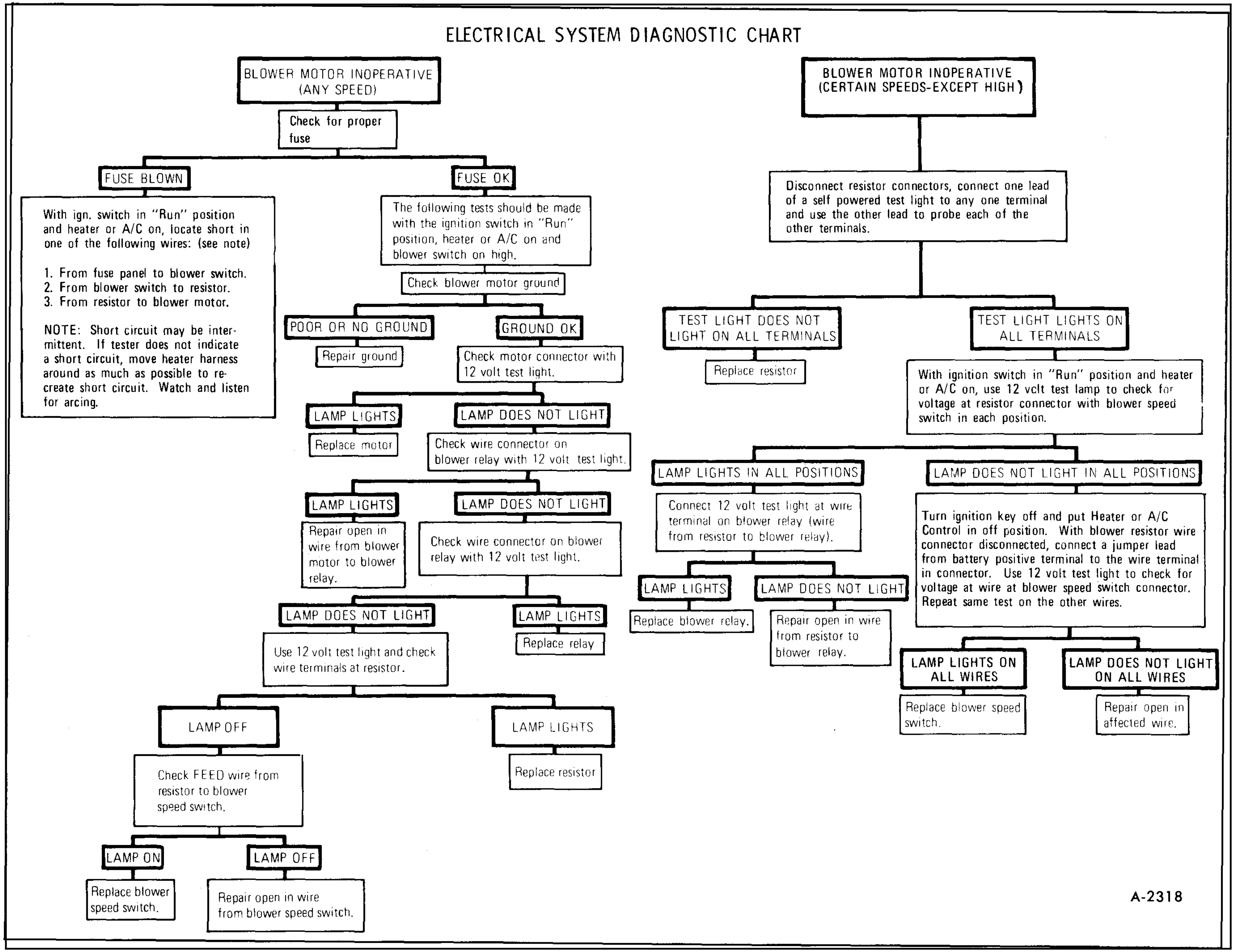


Figure 109—Electrical System Diagnosis

3. Liquid Line — A liquid line restriction will be evidenced by low discharge and suction pressure, and insufficient cooling.

SIGHT GLASS DIAGNOSIS

At temperatures higher than 70°F. (21.1°C.), the sight glass may indicate whether the refrigerant charge is sufficient. A shortage of liquid refrigerant is indicated after about five minutes of compressor operation by the appearance of slow-moving bubbles (vapor) or a broken column of refrigerant under the glass. Continuous bubbles may appear in a properly charged system on a cool day. This is a normal situation. If the sight glass is generally clear and performance is satisfactory, occasional bubbles do not indicate refrigerant shortage.

If the sight glass consistently shows foaming or a broken liquid column, it should be observed after partially blocking the air to the condenser. If under this condition the sight glass clears and the performance is otherwise satisfactory, the charge shall be considered adequate.

In all instances where the indications of refrigerant shortage continues, additional refrigerant should be added in 1/4 lb. increments until the sight glass is clear. An additional charge of 1/2 lb. should be added as a reserve after the glass clears. In no case should the system be overcharged.

ELECTRICAL SYSTEM

For electrical connections and routings, refer to the wiring diagram at the end of the manual. Also see Figure 109.

VACUUM SYSTEM DIAGNOSIS

Start the engine and allow it to idle — move the selector lever to each position and refer to the vacuum diagrams and operational charts for proper airflow, air door functioning and vacuum circuits. If airflow is not out of the proper outlets at each selector lever position, then proceed as follows:

1. **Check for good hose connection** — at the vacuum actuators, control head valve, reservoir, tees, etc.

2. **Check the vacuum source circuit as follows:**

Install vacuum tee and gauge (with restrictor) at the vacuum tank outlet (see Vacuum Diagram). Idle the engine and read the vacuum (a normal vacuum is equivalent to manifold vacuum) at all selector lever positions.

a. **Vacuum Less Than Normal At All Positions —**

Remove the tee and connect the vacuum gauge line directly to the tank — read the vacuum. If still low, then the problem lies in the feed circuit, the feed circuit to the tank or in the tank itself. If vacuum is now normal, then the problem lies downstream.

b. **Vacuum Less Than Normal at Some Positions —**

If vacuum was low at one or several of the selector lever positions, a leak is indicated in these circuits.

c. **Vacuum Normal at All Positions —**

If vacuum was normal and even at all positions, then the malfunction is probably caused by improperly connected or plugged lines or a defective vacuum valve or valves.

3. **Specific Vacuum Circuit Check**

Place the selector lever in the malfunctioning position and check for vacuum at the pertinent vacuum actuators. If vacuum exists at the actuator but the door does not move, then the actuator is defective or the door is mechanically bound. If low or no vacuum exists at the actuator, then the next step is to determine whether the cause is the vacuum harness or the vacuum valve. Check the vacuum harness first.

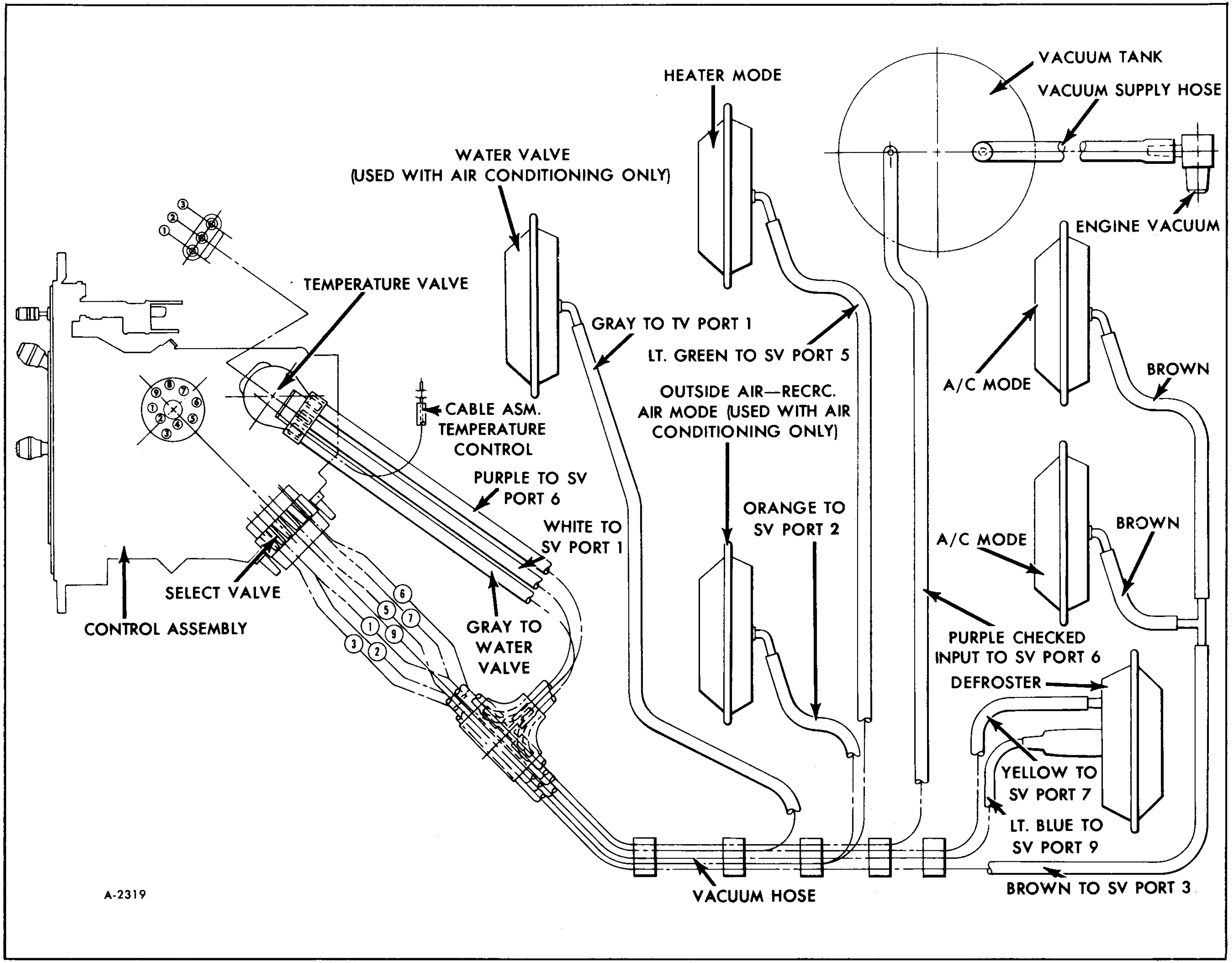


Figure 110—Vacuum Control Diagram

VACUUM CONTROL CHARTS (USE WITH FIGURE 110)

TEMPERATURE VALVE OPERATING CHART

3	VACUUM INPUT	VAC	VAC	SEAL	PURPLE
2	R. A. OVERRIDE	VAC	VENT	VENT	WHITE
1	HOT WATER VALVE	VAC	VAC	VENT	GRAY
PORT NO.	CONNECTION	RECIRC.	COLD	HOT	COLOR

SELECT VALVE OPERATING CHART

9	Defrost. Outlet	Vent	Vent	Vent	Vent	Vent	Vac	Lt. Blue
8	No. Connection							
7	Defrost. Bleed	Vent	Vent	Vent	Vac	Vent	Vac	Yellow
6	Checked Input	Seal	Vac	Vac	Vac	Vac	Vac	Purple
5	Htr. Outlet	Vent	Vent	Vac	Vac	Vac	Vac	Lt. Green
4	No Connection							
3	A/C Outlet	Vent	Vac	Vac	Vent	Vac	Vent	Brown
2	O.A. - R.A.	Vent	Conn. 1	Vent	Vent	Vent	Vent	Orange
1	R. A. Over ride	Seal	Conn. 2	Seal	Seal	Seal	Seal	White
Port No.	Connection	Off	A/C	Vent	Heater		Def.	Color

SPECIAL TOOLS

J-5139	Oil Pick-Up Tube Remover
J-5403	Snap Ring Pliers
J-5420	Gauge Adapter
J-6084	Leak Detector
J-6435	Snap Ring Pliers
J-8001-3	Dial Indicator Set
J-8092	Handle
J-8433	Pulley Puller
J-9392	Seal Remover
J-9395	Puller Pilot
J-9396	Compressor Holding Fixture
J-9397	Compressing Fixture
J-9398	Pulley Bearing Remover
J-9399	9/16″ Thin Wall Socket
J-9401	Clutch Plate and Hub Remover
J-9402	Parts Tray
J-9403	Spanner Wrench
J-9432	Needle Bearing Installer
J-9459	Gauge Adapter
J-9480	Hub and Drive Plate Assembly Installer
J-9481	Pulley and Bearing Installer
J-9521	Support Block
J-9527	Pressure Test Connector
J-9553-01	O-Ring Remover
J-9564-01	Feeler Tension Gauge Set
J-9625	Compressor Leak Test Fixture
J-9661-01	Feeler Gauge Set
J-21303	Shaft Seal Protector
J-21352	Internal Assembly Support Block
J-21508	Seal Seat O-Ring Installer
J-22974	Seal Protector
J-23128	Seal Seat Remover
J-23500	Charging Station
J-23600	Belt Tension Gauge
J-24095	Oil Inducer
J-24410	Charging Station
J-24608-1	Piston Ring Gauge
J-24608-2	Ring Installer Guide
J-24608-5	Ring Installer
J-24608-6	Ring Sizing Tool
J-25030	Clutch Hub Holder

HEATING SYSTEM (WITHOUT AIR CONDITIONING)

CONTROL OPERATION

The heating system controls (figure 1) are located on the instrument panel to the right of the steering column. There are three separate controls:

"FAN" lever to control speed of blower operation; "RECIRC," "COLD," "HOT" lever to control temperature of air; "OFF," "VENT," "HEATER," "DEF" lever to control direction of air flow. The "FAN" lever works vertically and the other two levers work horizontally. The three levers may be placed in any combined position to deliver the climate conditions most desirable at any given time.

"Type 1 Fan" (figure 1) — The fan switch has four positions; "OFF" and three blower speeds ranging to "HI" and two unmarked positions between "OFF" and "HI." The fan will not operate unless the top lever has been moved from the "OFF" position, and in order to operate the fan in the "HI" position the engine must be running.

"Type 2 Fan" (figure 2) — The fan switch has four positions; "LO" and three blower speeds ranging to "HI". Fan will operate whenever the key is in the "RUN" or "ACCESSORY" position. In order to operate the fan in the "HI" position the engine must be running.

"OFF," "VENT," "HEATER," "DEF" — With the lever in the "OFF" position the system is off. With the lever in the "VENT" position 100% outside air enters the driver's compartment. The air enters through the dash mounted outlets and through the heater outlets. Temperature of incoming air may be controlled by moving the "RECIRC," "COLD," "HOT" (temperature) lever to desired position. Any one of the three blower speeds may be selected.

With the lever in the "HEATER" position, air will flow through the heater floor distributor outlet (with slight flow of air to the defroster outlet). For maximum heat, move temperature lever to "HOT" position and "FAN" switch lever to "HI" position. Heating system output can be varied by moving temperature lever and "FAN" lever to different positions.

With the lever in the "DEF" position, the system operates the same as in the "HEATER" position except most of the air flow will be through the defroster outlets at the windshield.

"RECIRC," "COLD," "HOT" — This lever, used in conjunction with the system selector lever ("OFF," "VENT," "HEATER," "DEF") and the "FAN" switch lever, will control the temperature of the output air being distributed.

Clear windshield, rear window, outside mirror, and all side windows of ice and snow before driving vehicle.

Operate blower on "HI" for a few seconds before moving the vehicle, to clear the air intakes of snow.

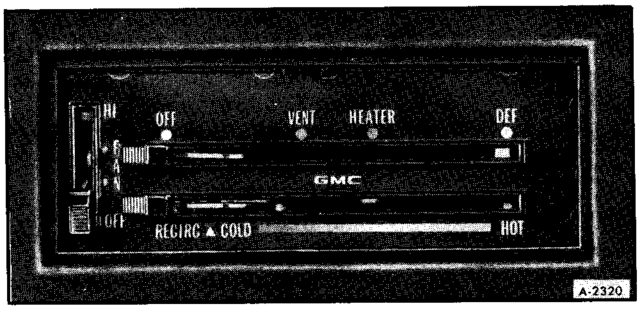


Figure 1—Heating System Controls, Type 1

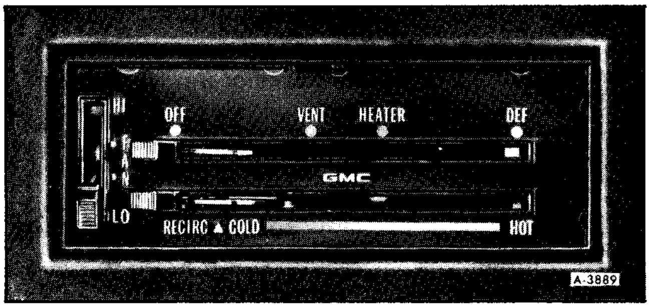


Figure 2—Heating System Controls, Type 2

COMPONENT REPLACEMENT

CONTROL ASSEMBLY

Procedures for the replacement of the heating system control assembly is the same as models equipped with air conditioning. See "Control Assembly Replacement" under air conditioning portion of this section.

BLOWER COMPONENTS

Replacement procedures for the blower motor, blower relay, and blower resister are the same as described in the air conditioning portion of this section.

HEATER CORE

Replacement procedures for the heater core is the same as for models equipped with air conditioning See "Evaporator and Heater Core Replacement" in air conditioning portion of this section.

VACUUM CONTROLS

Before replacing any vacuum control components check system for proper operation. Controls are the same as air conditioned models, except for the deletion of the water valve and "Outside Air-Recirc. Air mode". Lines to these components are simply plugged. For details see vacuum control charts and Figure 110 in air conditioning portion of this section.

SECTION 2
FRAME

Contents of this section are listed below:

SUBJECT	PAGE NO.
General	2-1
Frame Alignment	2-2
Frame Material	2-2
Replacing Frame Extension	2-2
Body Mounting	2-4

GENERAL

The 23 foot and 26 foot vehicle chassis uses a channel type frame with a front frame extension, bolted cross members and a rear frame extension. An exploded view of the frame components is shown in Figure 1. A 26-foot vehicle frame is shown, the 23-foot vehicles frame differs in the length of the side rail and one less crossmember.

When supporting the vehicle for servicing on a floorjack or jackstands the vehicle should not be supported at the extreme ends of the frame or at the center of a frame rail. Refer to Section 0 for hoisting and jacking instructions.

In the event the vehicle is damaged in a collision, carefully check for proper frame alignment in addition to steering geometry and wheel alignment.

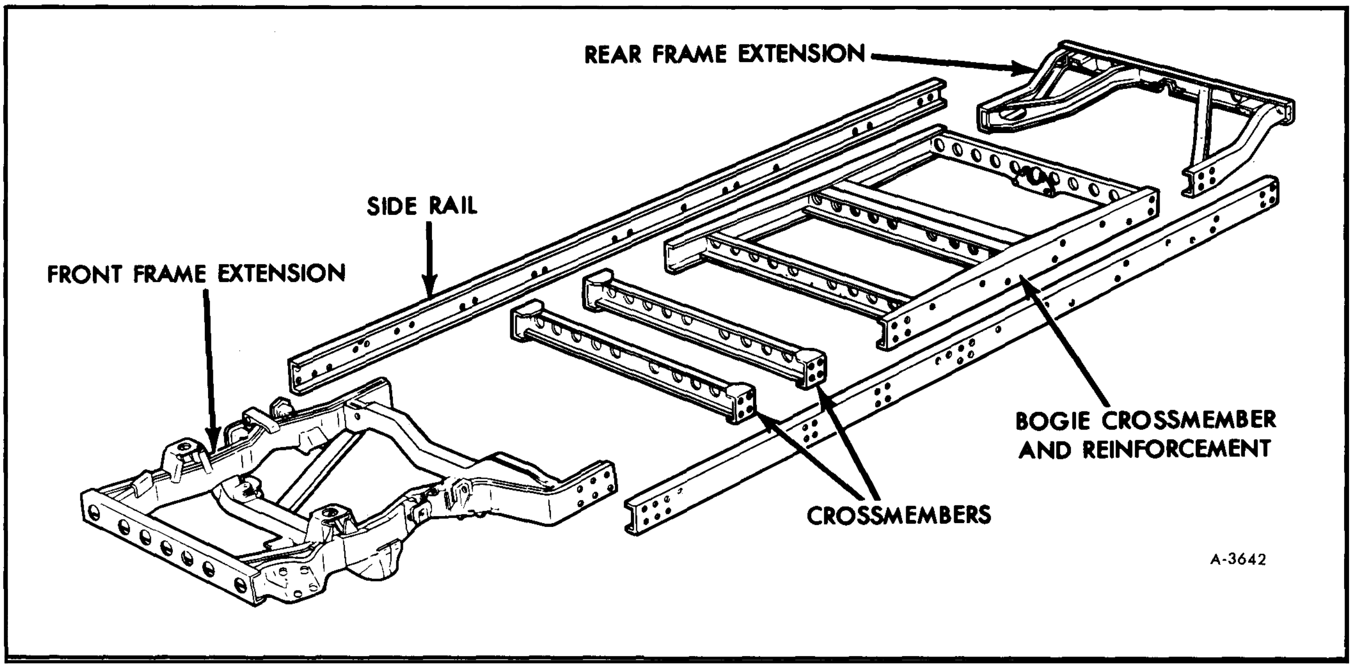


Figure 1—Frame Components

FRAME ALIGNMENT

The most convenient way to check frame alignment is to select various corresponding points of measurement on the outside of each side rail and then, by use of a plumb bob, transfer these points to a layout on a level floor. (Note: Flange width may vary and should not be used as a reference point.)

Since the frame is basically made of three different sections, the procedure for checking the frame is as follows:

CHECKING ALIGNMENT

The diagram shown in Figure 2 can be used to check the alignment of a vehicle frame that has been distorted.

Corresponding measurements must be equal within 1/4".

1. Measure A-B. If not equal, front end of frame is misaligned.

2. Measure B-C. If not equal, center portion of frame is misaligned.

3. Measure C-D. If not equal, then rear suspension crossmember is misaligned.

FRAME REPAIR

In case of collision, frame members can often be satisfactorily straightened to the required limits. However, the front suspension crossmember is made to unusually close limits necessary for proper front wheel alignment; therefore, straighetning of this unit may not be successful.

It is possible that the ordinary straightening methods will suffice for minor damage to the front suspension crossme ber; however, in case of serious damage or fracture, t e entire front suspension crossmember or front frame extension must be replaced. Before the member is replaced, it is essential that the frame alignment be checked, and corrected if necessary.

Finished bolts snugly fitted in reamed holes should be used. The nuts should be securely tightened and lockwashers used, care being taken that washers do not spread.

FRAME MATERIAL

The frame material is 950-1023-1080 steel. The frame may be welded if necessary using electrodes noted in table 1.

> **NOTE:** It is NOT recommended that the frame be welded to repair alignmennt. If there is substantial frame damage — from collisions, etc. — replacement of major components is recommended.

ELECTRODE USAGE WITH FRAME MATERIAL

Material .... 1023-950 steel
Type or Electrode .... E6013 or E7018

REPLACING FRAME EXTENSION

The purpose of this section is to enable a technician to change a front or rear frame extension due to extensive damage from a collision, etc. It is not recommended that this procedure be used until it is

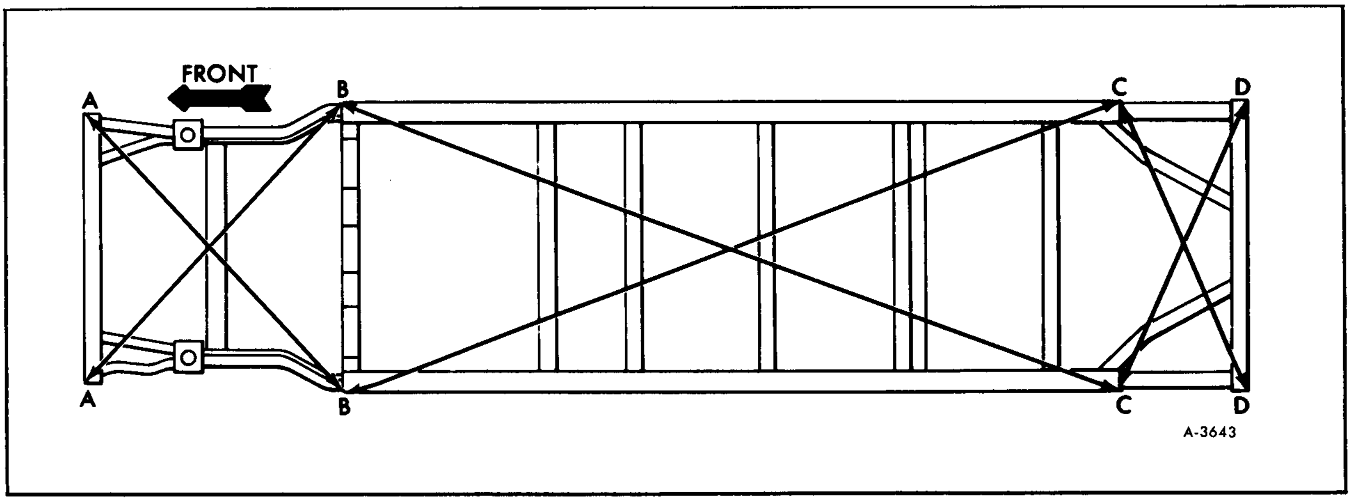


Figure 2—Frame Alignment

determined that the frame is definitely out of alignment and is unable to be fixed by the usual frame straightening operations.

FRONT FRAME EXTENSION REMOVAL

The front frame extension should only be replaced if absolutely necessary due to the complexity and amount of labor involved.

> **NOTE:** To drain, disconnect, or remove certain components it may be necessary to refer to additional sections in this maintenance manual (such as, draining gas tanks; Refer to Section 8 "Fuel Tank and Exhaust".

Drain

1. Drain power steering fluid.

2. Drain brake fluid.

3. Release freon from A/C system.

4. Drain gas tanks.

5. Drain engine cooling system.

Disconnect

1. Fuel Filler hose at front elbow.

2. Hose from tube going to charcoal canister.

3. If two canister are used, disconnect hoses from the one mounted on the stepriser.

4. Rear brake line from combination valve.

5. Heater hoses and pre-heater at engine.

6. Vacuum lines at cruise control.

7. Power brake vacuum line.

8. Hose to thermasan switch.

9. Speedometer cable at cruise control (at transmission without cruise control).

10. Accelerator cable at carburetor.

11. Transmission shift cable at transmission.

12. Oil filler tube at front end.

13. Vacuum line at vacuum tank mounted on the side of the heater.

14. Brake lines at master cylinder.

15. Hydraulic lines to windshield wiper motor.

16. Air lines.

Remove

1. Remove Engine Transmission and Final Drive Assembly.

2. Remove mufflers and Y-pipe.

3. Remove torsion bars and rear torsion bar support.

4. Take steering gear off of frame.

5. Remove batteries and battery box with air tank.

6. Remove parking brake cable from front frame section.

7. Remove thermasan hose from unit on exhaust pipe (if used).

8. Remove front body mount bolts.

9. Remove frame section bolts.

10. Air conditioning compressor and hoses (cap all A/C hoses).

11. Front wheels.

12. Front fender wells.

13. Grille.

14. Lower fiberglass section below grille.

15. Radiator.

16. After the bolts holding the front frame extension are removed it will be possible to pull it forward and down clearing the body. A high capacity floor jack should be used to move the front frame extension forward and down.

FRONT FRAME EXTENSION INSTALLATION

Installation of the front frame extension is accomplished by reversing the removal procedures.

> **NOTE:** The front frame extension to frame assembly retaining nuts should be tightened to 50-60 foot-pounds torque.

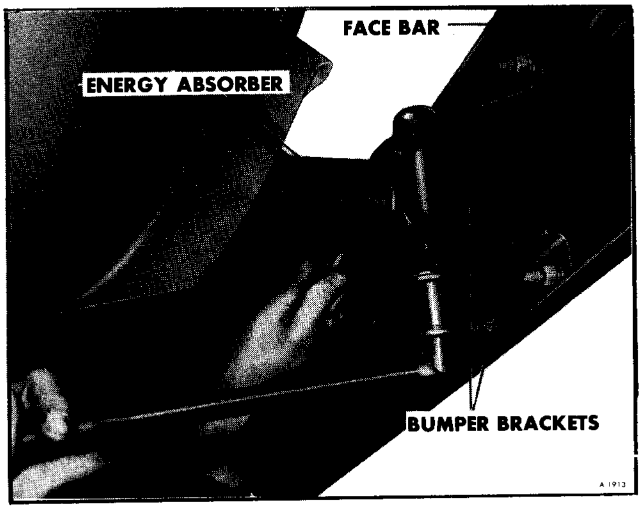


Figure 3—Removing Rear Bumper

REAR FRAME EXTENSION REMOVAL

1. Remove rear bumper by removing both bumper bracket thru bolts as shown in Figure 3. Then remove face bar assembly.

2. Remove the 4 bolts and nuts securing energy absorbers to the frame.

3. Remove spare tire carrier from rear crossmember by removing 8 bolts and nuts.

4. Using a small hydraulic or screw jack and a 3 foot wood 2x4, place jack in the middle of floor section using the 2x4 to support the floor weight, lengthwise.

5. Remove the bolt in each rear mounting pad. Location of mounts are shown in Figure 4.

NOTE: To reach bolt head inside rear of vehicle some interior components may have to be removed.

6. Remove tailpipe from rear section by loosening clamp at slip joint.

7. Drain water from water supply tank.

8. Remove holding tank dump pipe from retaining clamp on rear crossmember.

9. Remove motor generator assembly (if so equipped).

10. Remove 8 nuts and bolts securing rear frame extension to side rails.

11. Slide out rear frame extension.

REAR FRAME EXTENSION INSTALLATION

Installation of the rear frame extension is accomplished by reversing the removal procedures.

NOTE: The rear frame extension to frame assembly retaining nuts should be tightened to 50-60 foot-pounds torque.

BODY MOUNTING

Should it become necessary to replace any body mounting components, refer to figure 4. Front and rear body mount nut torque is 50 - 60 foot-pounds.

If any of the insulators between the frame and body must be replaced, be sure the old insulator is entirely removed. Then using a waterproof adhesive attach new insulator to frame in locations shown in Figure 4.

IMPORTANT: Some vehicles are equipped with insulators different than shown in Figure 4. Late model vehicles are equipped with 21 six-inch insulators located beneath the lateral crossmembers of the floor substructure.

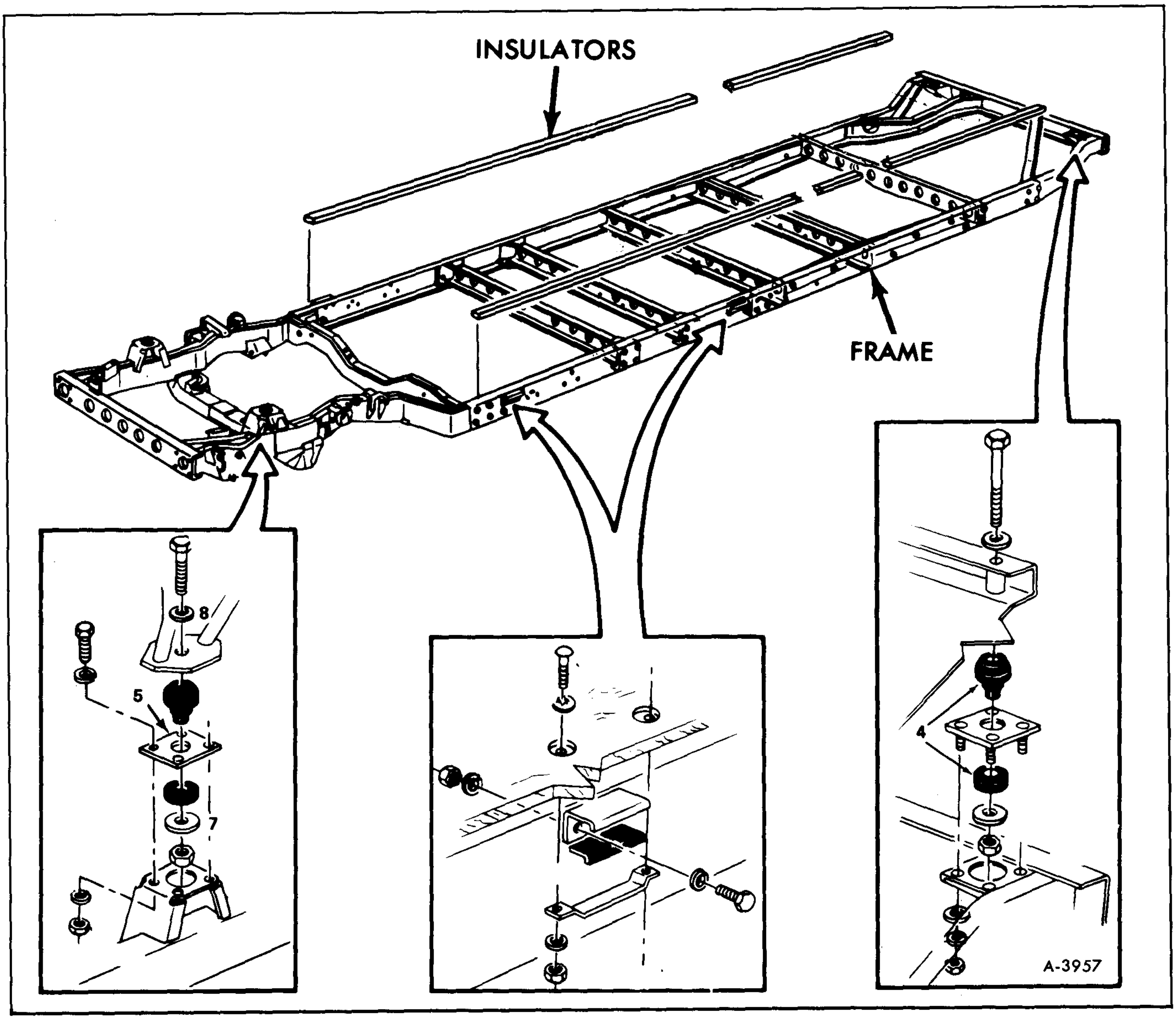


Figure 4—Body Mountings

SECTION 3
FRONT SUSPENSION AND FINAL DRIVE

SECTION 3A

FRONT SUSPENSION

CAUTION: *Front suspension fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.*

NOTE: Never attempt to heat, quench or straighten any front suspension component. Replace it with a new part.

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FRONT SUSPENSION TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
Hard Steering.	1. Ball joints and steering linkage need lubrication. 2. Low or uneven front tire pressure. 3. Power steering partially or not operative. 4. Steering gear not properly adjusted.	1. Lubricate ball joints and linkage. 2. Inflate tires to the proper recommended pressure. 3. Check power steering components for proper operation. 4. Adjust steering gear. See Section 9.
Front Wheel Shimmy (Smooth Road Shake).	1. Tire and wheel out of balance, or out of round. 2. Worn tire rod ends. 3. Worn ball joints 4. Malfunctioning shock absorber.	1. Balance tires, check run-out. 2. Replace tire rod end. 3. Replace ball joints. 4. Diagnose shock absorbers.
Vehicle Pulls to One Side (No Braking Action).	1. Low or uneven tire pressure. 2. Broken or sagging torsion bar. 3. Incorrect front wheel alignment (Camber).	1. Inflate tires to the proper recommended pressure. 2. Replace torsion bar. 3. Check and align front suspension.
Poor Directional Stability	1. Ball joints and steering linkage need lubrication. 2. Low or uneven front or rear tire pressure. 3. Steering Gear not on high point. 4. Incorrect front wheel alignment (caster). 5. Broken torsion bar. 6. Malfunctioning shock absorber. 7. Broken stabilizer bar, or missing link.	1. Lubricate at proper intervals. 2. Inflate tires to the proper recommended pressure. 3. Adjust steering gear. See Section 9. 4. Check and align front suspension. 5. Replace torsion bar. 6. Diagnose shock absorbers. 7. Replace stabilizer or link.
Excessive Play in Steering.	1. Incorrect steering gear adjustment. 2. Worn steering gear parts.	1. Adjust steering gear. See Section 9. 2. Overhaul Gear. See Section 9.

Problem	Possible Cause	Correction
Noise in Front End	1. Ball joints and steering linkage lubrication. 2. Shock absorber loose or bushings worn. 3. Worn control arm bushings. 4. Worn tie rod ends. 5. Loose stabilizer bar. 6. Loose wheel nuts. 7. Loose suspension bolts.	1. Lubricate at recommended intervals. 2. Tighten bolts and/or replace bushings. 3. Replace bushings. 4. Replace tie rod ends. 5. Tighten all stabilizer bar attachments. 6. Tighten the wheel nuts to proper torque. 7. Torque to specifications or replace.
Tire Thump	1. Tire and wheel out of balance. 2. Tire and wheel out of round. 3. Blister or bump on tire. 4. Improper shock absorber action.	1. Balance wheels. 2. Replace tire. 3. Replace tire. 4. Replace shock absorber.
Excessive or Uneven	1. Underinflated or overinflated tires. 2. Improper toe-in. 3. Wheels out of balance. 4. Hard Driving. 5. Over loaded vehicle.	1. Inflate tire to proper recommended pressure. 2. Adjust toe-in. 3. Balance wheels. 4. Instruct driver. 5. Instruct driver.
Scuffed Tires	1. Toe-in incorrect. 2. Excessive speed on turns. 3. Tires improperly inflated 4. Suspension arm bent or twisted.	1. Adjust toe-in to specifications. 2. Advise driver. 3. Inflate tires to proper recommended pressure. 4. Replace arm.
Cupped Tires	1. Front shock absorbers defective. 2. Worn ball joints. 3. Wheel and tire out of balance. 4. Excessive tire or wheel runout.	1. Replace shock absorbers. 2. Replace ball joints. 3. Balance wheel and tire. 4. Compensate for runout.

Problem	Possible Cause	Correction
Shock Absorber—Weak.	1. Low or uneven tire pressure. 2. Excessive or incorrect vehicle loading. 3. Worn out shock absorber. Front. 4. Worn out shock absorber. Rear.	1. Inflate tires to the proper recommended pressure. 2. Instruct driver. 3. Perform on vehicle test. Push down and lift up at end of bumper nearest front shock in question. right and left shocks must be comparable in rebound resistance to compression ration (usually 2 to 1). If in doubt compare with vehicle having acceptable ride quality. 4. Disconnect the lower shock mountings. Stroke shocks at various rates of speed through maximum travel in both directions. Compare side to side for rebound and compression resistance. Rebound resistance is normally stronger than compression (approximately 2 to 1). It is mandatory that right and left shocks feel comparable. If in doubt about condition, compare with a known good shock.
Shock Absorber—Noisy.	1. Loose mounting. 2. Faulty shock absorber	1. Check all shock mounting torques (bolt and/or nut). 2. Observe hoisting instructions and instructions for removal of front shock absorbers. Clamp shock upside down. Clamp vise on top mount with shock vertical in vise (do not clamp on reservoir tube). Rear shocks may be tested on the vehicle by disconnecting the lower mount. Completely extend to full rebound then exert an extra pull. If a "GIVE" is felt a loose piston is indicated and the shock should be replaced. A hissing noise (orifice swish) is normal, however, replace shock absorber for any of the following: 1. A skip or lag at reversal near mid-stroke. b. A seize (except at either extreme end of travel). c. A noise such as a grunt or squeal after completing one full stroke in both directions. d. A clicking noise at fast reversal.

Problem	Possible Cause	Correction
Shock Absorber—Leaks.	1. Faulty shock absorber.	1. A slight trace of shock fluid is NOT cause for replacement as the seal permits some seepage for lubrication of the piston rod. The shock contains a fluid reverse to compensate for seepage. A shock that is truly leaking is easily detected as there will be evidence of shock fluid around the seal cover and on down the reservoir tube and should be replaced.

THEORY AND OPERATION

FRONT-END GEOMETRY

The term "FRONT-END GEOMETRY" refers to the angular relationship between the front wheels, the front suspension attaching parts and the ground. The angle of the knuckle (now called steering axis inclination) away from the vertical, the pointing in or "toe-in" of the front wheels, the tilt of the front wheels from vertical (when viewed from the front of the vehicle) and the tilt of the suspension members from vertical (when viewed from the side of the vehicle) - all these are front end geometry. These items have an effect on steering ease, steering stability riding qualities and tire wear. Each item is covered under a separate heading.

CAMBER (FIGURE 1)

Camber is the tilting of the front wheels from the vertical. When the wheels tilt outward at the top, the camber is said to be positive (+). When the wheels tilt inward at the top, the camber is said to be negative (-). The amount of tilt is measured in degrees from the vertical and this measurement is called the camber angle.

CASTER (FIGURE 1)

Caster is the tilting of the front steering axis either forward or backward from the vertical. A backward tilt is said to be positive (+) and a forward tilt is said to be negative (-). You cannot see caster angle

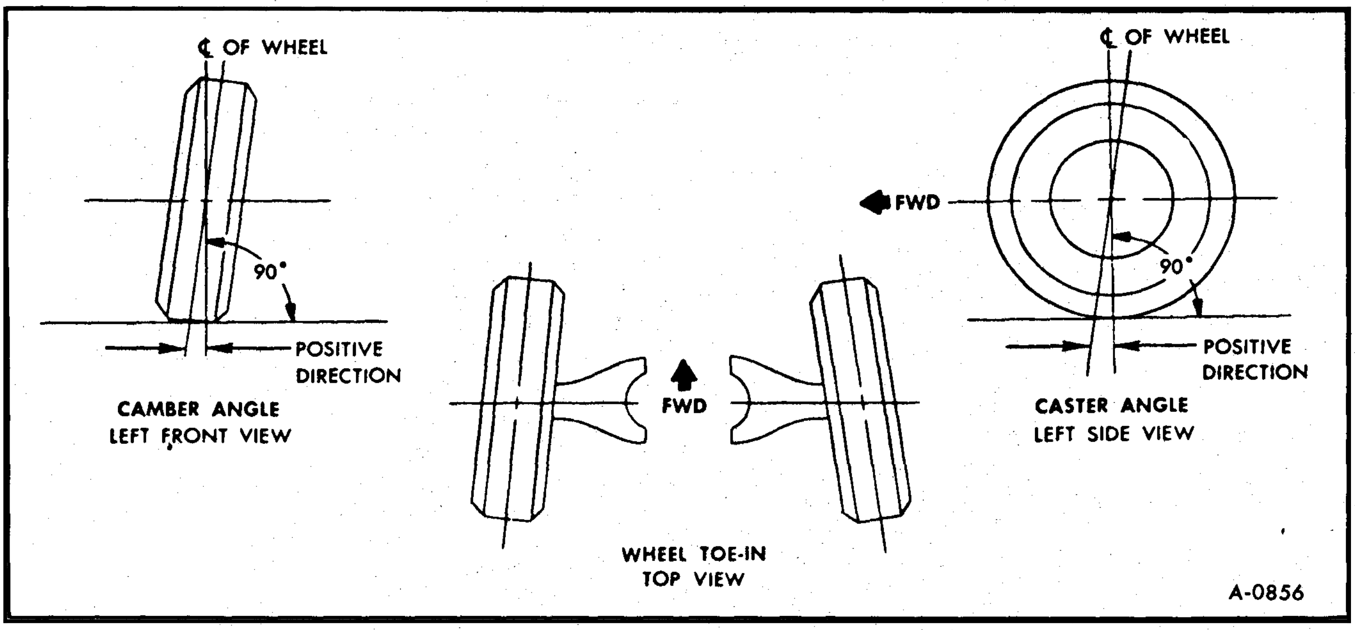


Figure 1—Caster, Camber and Toe-In

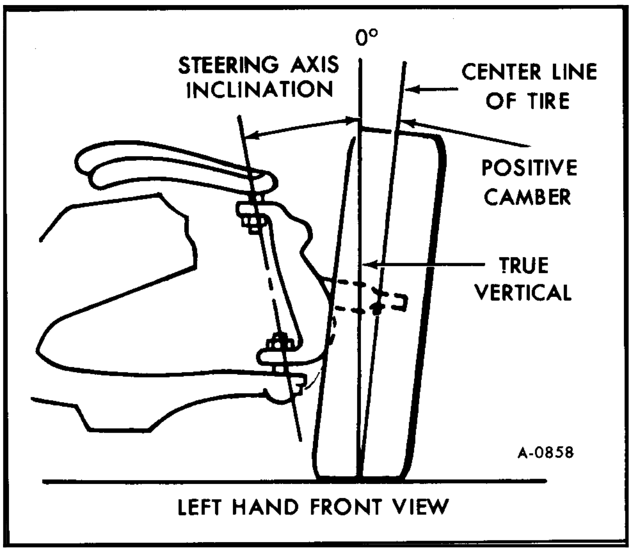


Figure 2—Steering Axis Inclination

without a special instrument, but if you look straight down from the top of the upper control arm to the ground you would find that the ball joints do not line up (fore and aft) when a caster angle other than "O" is present. If you had a positive caster angle the lower ball joint would be slightly ahead of the upper ball joint center line. In short then: caster is the forward or backward tilt of the steering axis.

STEERING AXIS INCLINATION (FIGURE 2)

Steering axis inclination is the inward tilt (at the top) of the steering knuckle from the vertical. The inward tilt, or inclination, of the knuckle tends to keep the wheels straight ahead. This is desirable because, it helps return the steering wheel straight ahead after a turn. This steering wheel return comes about because the vehicle is actually "lifted" when the wheels are swung away from the straight ahead position. Then the weight of the vehicle tends to return the wheels straight ahead after a turn is completed.

TOE ADJUSTMENT (FIGURE 3)

Toe-in is the turning in of the front wheels; toe-out is the turning out of the front wheels. The actual amount of toe-in or -out is only a fraction of an inch. The purpose of the toe adjustment is to ensure parallel rolling of the front wheels. (Excessive toe adjustment will cause tire wear). Toe adjustment also serves to offset the small deflections of the wheel support system which occurs when the vehicle is rolling forward. In other words, even when the wheels are set to toe-in or toe-out slightly when the vehicle is standing still, they tend to roll parallel on the road when the vehicle is moving.

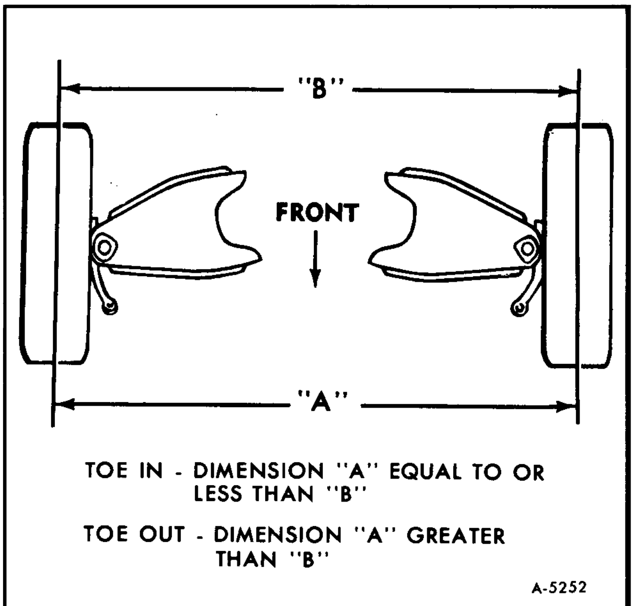


Figure 3—Toe Adjustment

TOE-OUT ON TURNS

Toe-out on turns refers to the difference in angles between the front wheels and the car frame during turns. Since the inner wheel turns a smaller radius than the outer wheel, when rounding a curve, it must be at a sharper angle with respect to the vehicle frame. It must toe-out more than the outside wheel toes-in. This condition allows the front wheels to turn in a concentric circle. Toe-out on turns is non-adjustable.

GENERAL DESCRIPTION

The front suspension consists of control arms, stabilizer bar, shock absorbers and a right and left torsion bar. Torsion bars are used instead of the conventional coil springs. The front end of the torsion bar is attached to the lower control arm. The rear of the torsion bar is mounted into an adjustable arm at the torsion bar crossmember. The carrying height of the vehicle is controlled by this adjustment. (figure 4).

DISC AND HUB (FIGURE 6)

REMOVAL

1. Siphon approximately two-thirds of the brake fluid from the front reservoir of the master cylinder. Discard fluid.

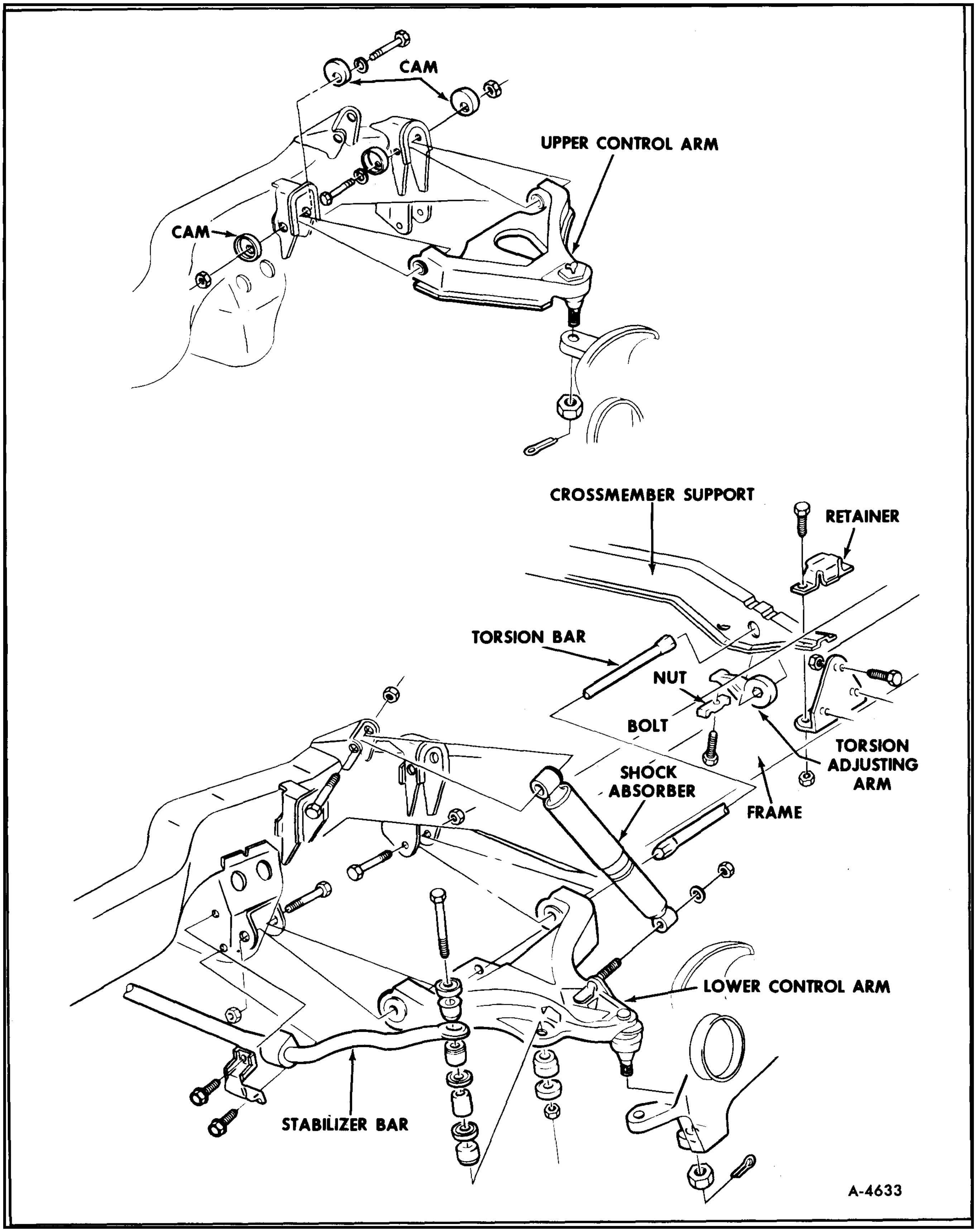


Figure 4—Front Suspension

NOTE: Do not empty front reservoir or it will be necessary to bleed the brake system.

2. Hoist vehicle. Remove light nuts from wheel studs and remove wheel.

3. Remove cotter pin, drive axle nut and washer.

4. Position Tool J-22269 on caliper as shown in Figure 5.

5. Tighten screw of tool until caliper moves outboard far enough to push piston to bottom of piston bore. This will allow the shoes to back off from disc surface. Remove Tool J-22269.

6. Remove the two caliper to knuckle attaching bolts. (figure 5).

7. Carefully lift caliper assembly from disc and reposition so that brake hose is not kinked or stretched.

8. Loosen uniformly and remove the three bolts securing the retainer to the knuckle (figure 7).

9. Position Tool No. J-24717 on hub as shown in Figure 8.

10. Operate slide hammer Tool No. J-2619, until assembly is free of knuckle. See Figure 8.

11. Remove slide hammer and Tool No. J-24717.

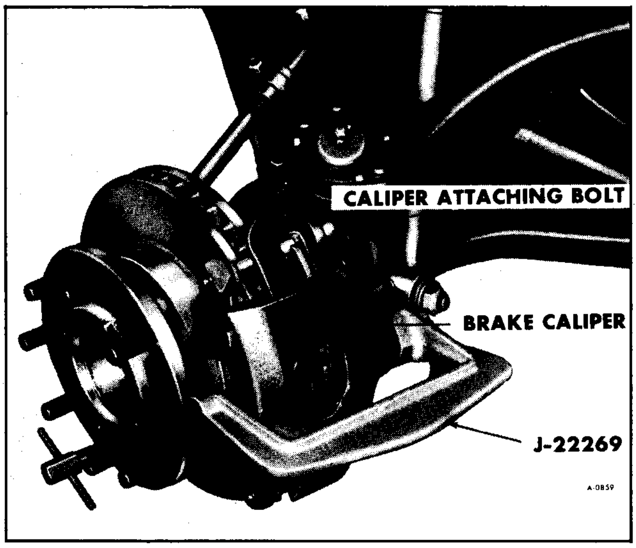


Figure 5—Caliper Removal

INSTALLATION

See CAUTION on Page 3A-1 of this section.

1. Lubricate O.D. of bearing with chassis grease. Clean bearing seat of knuckle where rust or dirt may fall during removal.

2. The outer race of the bearing is a snug fit into the knuckle. Light tapping on the hubs outer surface (not the disc) will aid assembly. Care must be used when installing hub assembly over drive axle splines so that splines are in correct alignment.

3. Install three bolts attaching bearing retainer to knuckle Torque to 35 ft. lbs.

4. Install drive axle washer and nut. Torque nut to 140 ft. lbs. If necessary to align cotter pin slot, tighten nut and install NEW cotter pin and crimp. Torque not to exceed 280 ft. lbs.

NOTE: Do not back off nut to install cotter pin.

5. Replace wheel and secure with eight nuts on studs. Refer to Section 10 for tightening sequence and torque. Refill master cylinder with new brake fluid.

HUB BEARING

REMOVAL

1. Remove disc hub assembly. Refer DISC HUB ASSEMBLY-Removal.

2. Assemble Tool No. J-23345 to Tool No. J-8433-1

3. Position tool assembly as shown in Figure 9.

CAUTION: *The gripping or pulling edge of the tool must be under the inner race. If the tool slips up to the bearing cage, the bearing will be seriously damaged and need to be replaced.*

4. With Tool No. J-22214-6 in place, and a clamp in position as shown in Figure 9, tighten center screw until bearing is free of hub.

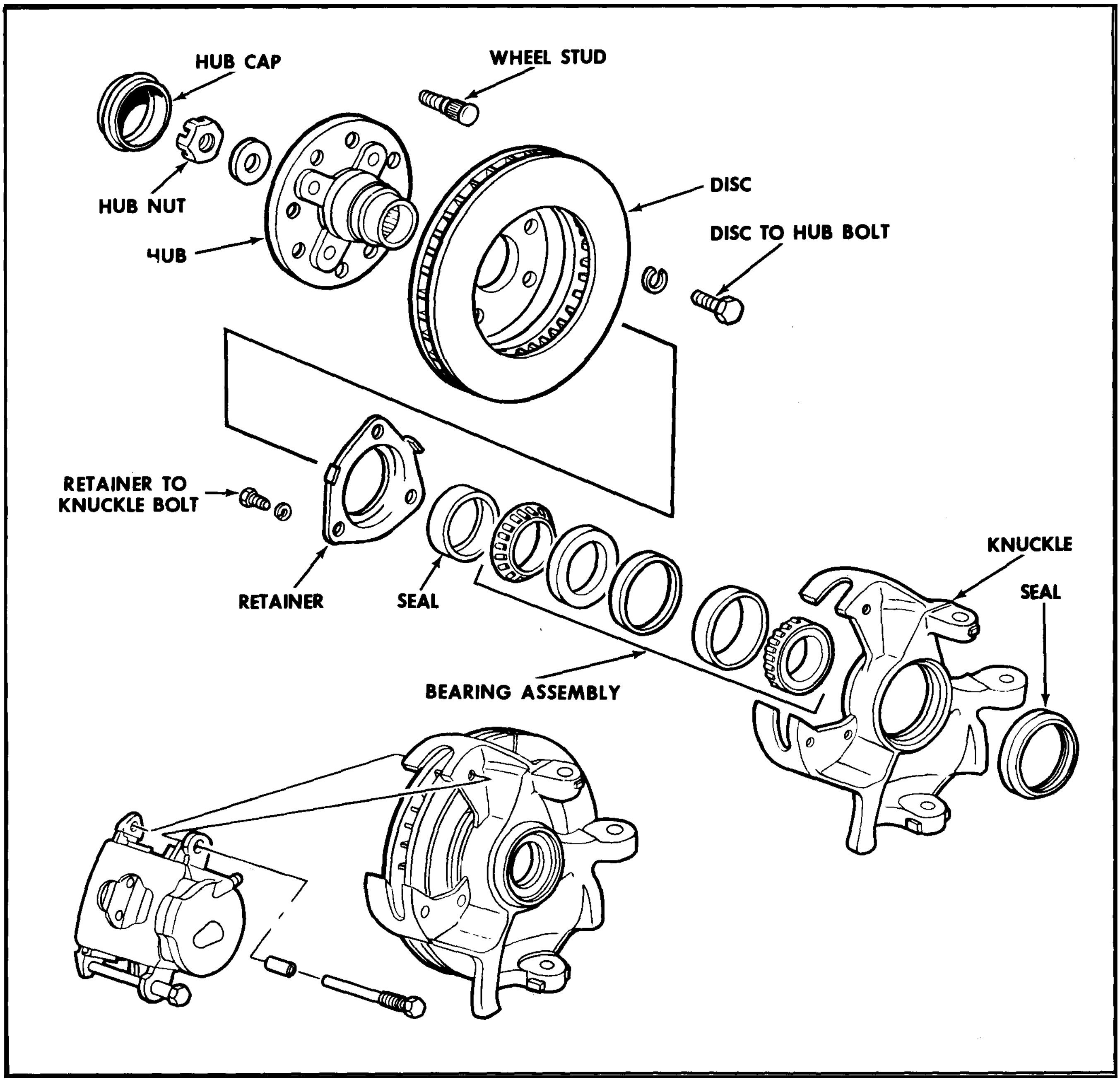


Figure 6—Disc and Hub Assembly

5. Remove seal and retainer.

6. Clean bearing and inspect for wear or damage. If bearing condition is good repack with bearing grease. Use GM part No. 1051344 or equivalent, a premium high melting point lubricant.

INSTALLATION

See CAUTION on Page 3A-1 of this section.

1. Position retainer over hub.

2. Lubricate seal lips with Special Seal Lubricant No. 1050169 or equivalent then position seal over hub with metal end toward retainer.

3. Install bearing as shown in Figure 11.

4. Install disc hub assembly. Refer to DISC AND HUB ASSEMBLY- Installation.

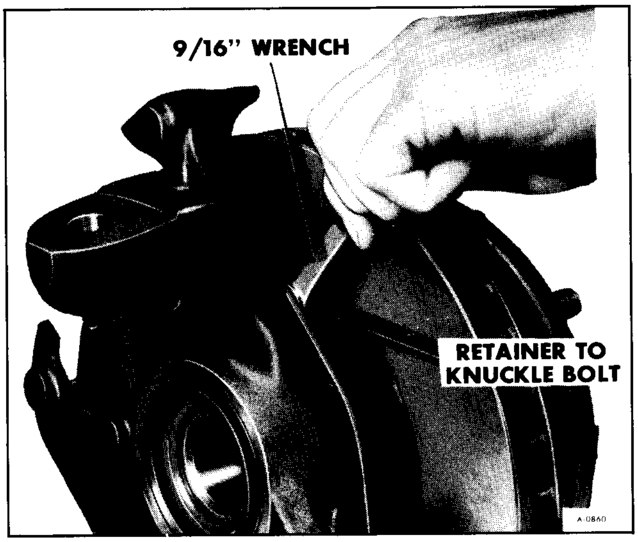


Figure 7—Retainer Bolt Removal

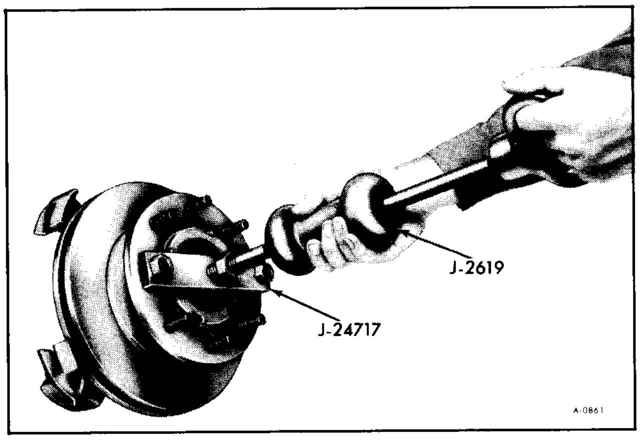


Figure 8—Hub and Disc Removal

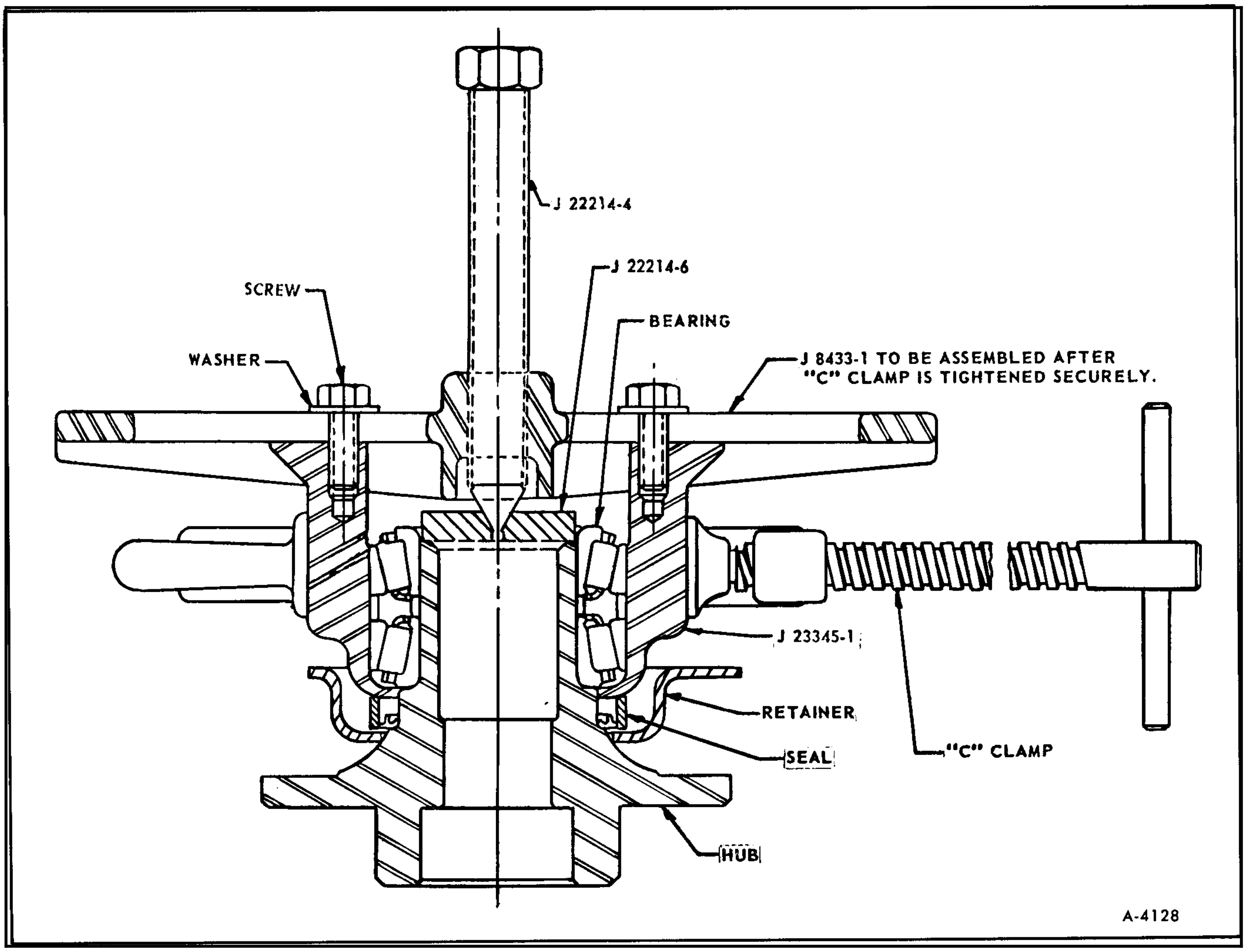


Figure 9—Bearing Removal

DISC

REMOVAL (FIGURE 10)

1. Remove disc and hub assembly. Refer to DISC AND HUB ASSEMBLY-Removal.

2. Remove hub bearing. Refer HUB BEARING-Removal.

3. Remove (4) bolts and seperate disc from hub as shown in Figure 10.

INSTALLATION

1. Install four attaching bolts and torque to 35 ft. lbs.

2. Install hub bearing. Refer HUB BEARING-Installation.

3. Install disc and hub assembly. Refer DISC and HUB ASSEMBLY-Installation.

KNUCKLE SEAL

REMOVAL

1. Remove disc and hub (See DISC AND HUB REMOVAL, Section 3A).

2. Pry seal from knuckle.

INSTALLATION

1. Place knuckle seal on Tool J-26485. Insert tool as far as possible into knuckle and then drive it in with a hammer until it bottoms (figure 12). Remove tool.

2. Install disc and hub (See DISC AND HUB INSTALLATION, Section 3A).

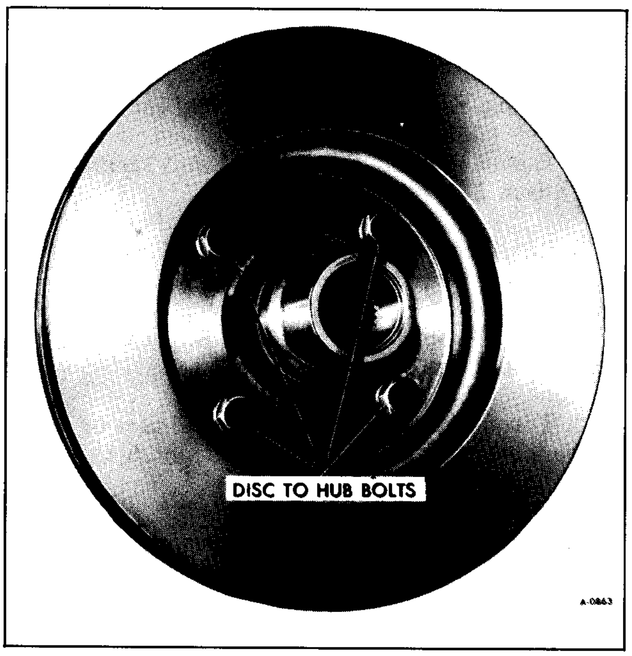


Figure 10—Disc Removal

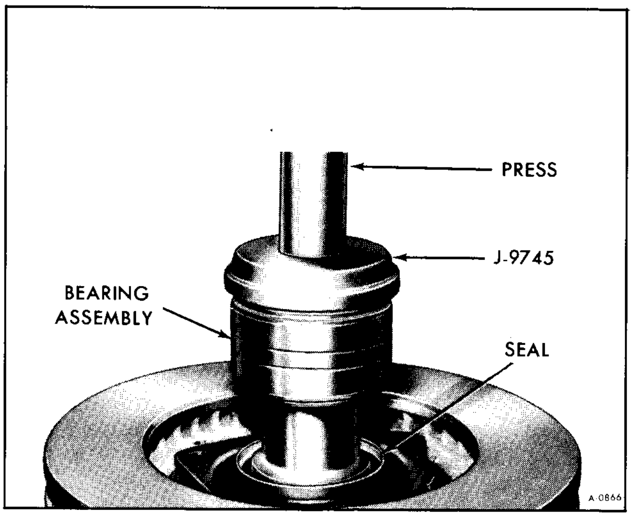


Figure 11—Installing Bearing

KNUCKLE

REMOVAL

1. Remove disc hub assembly (refer to DISC HUB ASSEMBLY, REMOVAL).

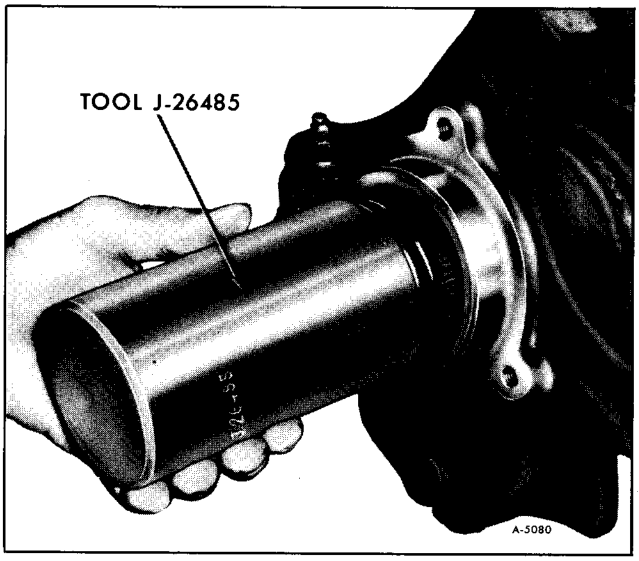


Figure 12—Installing Knuckle Seal

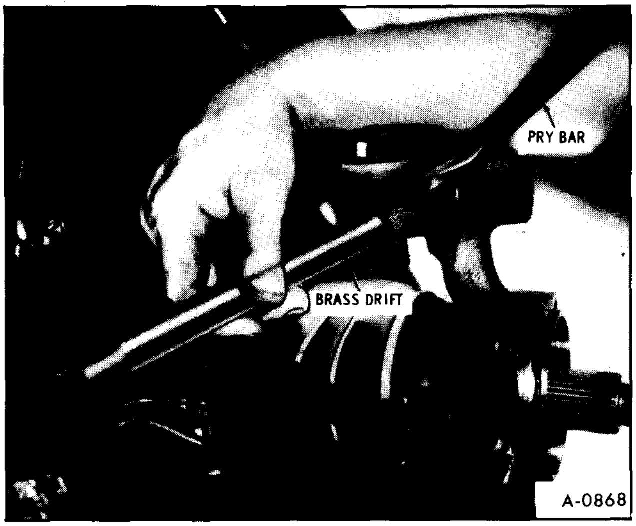


Figure 13—Removing Upper Ball Joint

2. Remove upper ball joint cotter pin and nut.

3. Remove brake line hose clip from ball joint stud.

NOTE: Do not loosen ball joint stud.

4. Using a brass drift and hammer, Figure 13, loosen upper ball joint stud.

5. Remove cotter pin and nut from tie rod end.

6. Using Tool J-21319 remove tie rod end as shown in Figure 14.

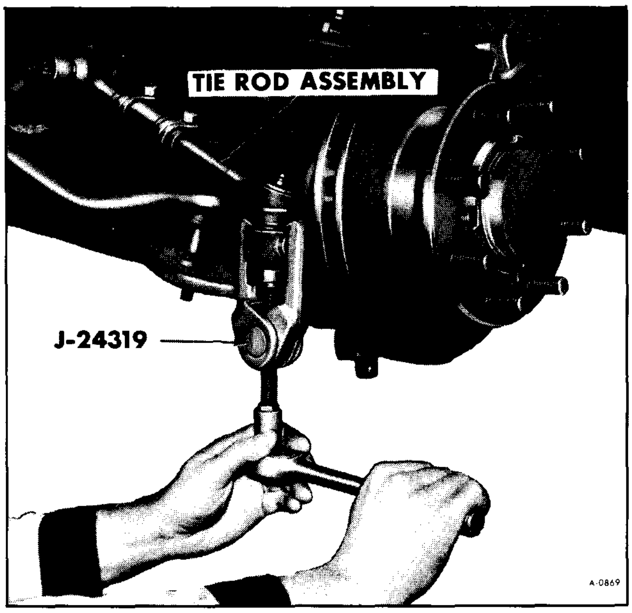


Figure 14—Removing Tie Rod End

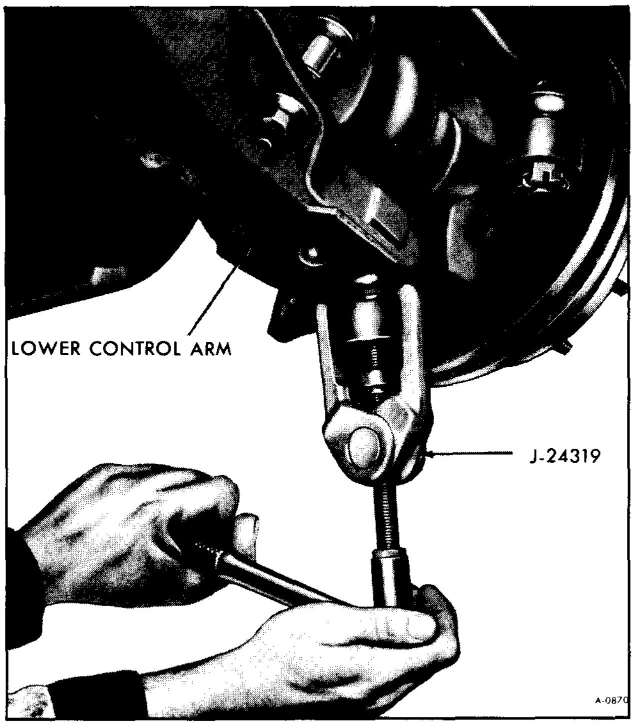


Figure 15—Removing Lower Ball Joint

7. Remove cotter pin and nut from lower ball joint.

8. Using Tool J-24319, remove lower ball joint from knuckle (figure 15).

9. Remove knuckle. Pry seal from knuckle.

INSTALLATION

See CAUTION on Page 3A-1 of this section.

1. Using Tool J-23115 install seal into knuckle.

2. Install lower ball joint stud into knuckle and attach nut. Do not torque.

3. Install tie rod end stud into knuckle and attach nut. Do not torque.

4. Install upper ball joint stud into knuckle and attach brake line hose clip. Install nut.

5. Torque ball joint nut to a minimum or 40 ft. lbs. (upper), 100 ft. lbs. (lower). Tighten to install NEW cotter pins.

> **CAUTION:** *Cotter pin on upper ball joint must be bent up only to prevent interference with C.V. joint seal.*

6. Torque tie rod end nut. See specifications for torque value and procedure.

NOTE: Do not back off nut to install NEW cotter pin.

7. Install disc hub assembly (refer to DISC HUB ASSEMBLY INSTALLATION).

UPPER CONTROL ARM

REMOVAL

1. Hoist vehicle and remove wheel, and place a floor stand on each side under and firmly against the lower control arm.

2. Remove upper shock attaching bolt.

3. Remove cotter pin and nut from upper ball joint.

4. Disconnect brake hose clamp from ball joint stud.

5. Using hammer and a drift, Figure 13, drive on spindle until upper ball joint stud is disengaged.

6. Remove upper control arm cam assemblies and remove control arm from vehicle by guiding shock absorber through access hole.

IMPORTANT: While cam is removed check cam adjustment surface of bracket for weld splatter. Weld splatter in this area will affect front end alignment. Remove weld splatter before reassembly.

INSTALLATION

See CAUTION on Page 3A-1 of this section.

NOTE: Service upper control arm assemblies have plugs instead of grease fittings in ball joints. Remove plugs and install grease fittings before installing control arm.

1. Guide upper control arm over shock absorber and install bushing ends into frame bracket.

2. Install cam assemblies as shown in Figure 4.

3. Install ball joint stud into knuckle.

4. Install brake hose clip on ball joint stud.

5. Install ball joint nut. See specifications for torque value and procedure.

NOTE: Do not back off nut to install NEW cotter pin.

CAUTION: *Cotter pin must be crimped toward upper control arm to prevent interference with outer C.V. joint seal.*

6. Install upper shock attaching bolt and nut.

7. Install wheel and remove floor stands.

8. Lower hoist.

9. Check camber, caster and toe-in and adjust if necessary. Refer to FRONT END ALIGNMENT.

UPPER CONTROL ARM BUSHING

Upper control arm bushings can be removed and installed while control arm is installed on vehicle.

REMOVAL

1. Hoist vehicle, place floor stands under and firmly against the lower control arm, and remove wheel.

2. Disconnect upper shock absorber attaching bolt. (figure 18)

3. Remove cam assemblies from control arm.

4. Move control arm out of frame brackets and attaching bushing removal tools as shown in Figure 19.

INSTALLATION

See CAUTION on Page 3A-1 of this section.

1. Install tools as shown in Figure 20 and press bushings into control arm.

2. Move control arm into frame brackets and install cam assemblies. The cams are installed with the bolts in the lower position. Torque nut to 80-95 ft. lbs.

3. Connect upper shock attaching bolt. Torque nut to 90 ft. lbs.

4. Replace wheel, remove floor stands, lower hoist.

5. Align front wheels. Refer to FRONT END ALIGNMENT.

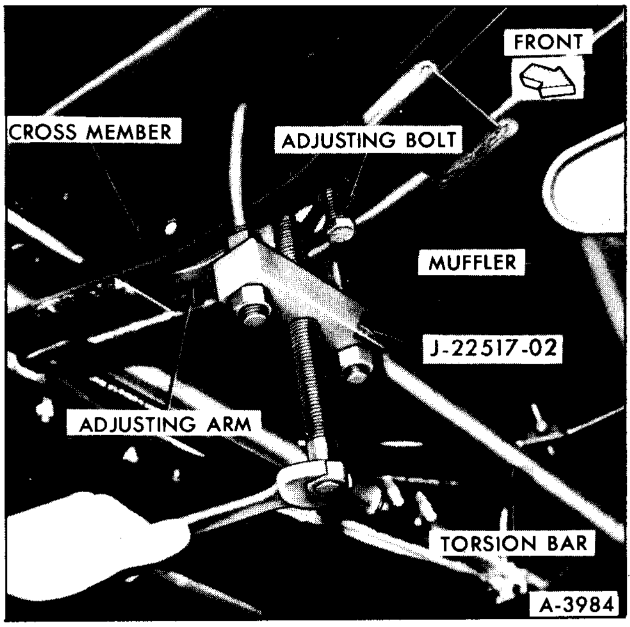


Figure 16—Removing Torsion Bar

LOWER CONTROL ARM

REMOVAL

1. Hoist vehicle and remove wheel assembly.

2. Before using Tool J-22517-02, remove two nuts and center screw, then place tool over cross-member support. Align pin of tool into hole in cross-member. Install two nuts on tool and center screw: Turn center screw until seated in dimple of torsion adjusting arm. (figure 16).

3. Using a socket on the torsion bar adjusting bolt, turn counterclockwise, counting the number of turns necessary to remove.

NOTE: The number of turns to remove the adjusting bolt will be used when installing, to obtain the original carrying height.

4. Remove adjusting bolt and nut.

5. Turn center screw of Tool J-22517-02 until torsion bar is completely relaxed and remove torsion bar noting which end is front.

6. Disconnect shock absorber and stabilizer link from lower control arm.

7. Remove drive axle nut.

8. Remove cotter pin and nut from lower ball joint stud.

9. Install Tool J-24319 and remove ball joint stud from knuckle. (figure 15)

10. Remove bolts from lower control arm to frame and remove torsion bar.

11. Push inboard on drive axle and pull outward on knuckle to gain clearance, then remove lower control arm from knuckle.

INSTALLATION

See CAUTION on Page 3A-1 of this section.

1. Install lower control arm making certain shock absorber is guided onto lower control arm shock absorber mount. Guide ball joint stud into knuckle. Install but do not torque stud nut.

2. Install lower control arm to frame bracket bolts. Install nuts and torque to 90 ft.-lbs.

3. Torque lower ball joint stud to 100 ft. lbs.

NOTE: Do not back off nut to install NEW cotter pin.

4. Install shock absorber nut and torque to 90 ft. lbs. Install stabilizer link and torque nut to 15 ft. lbs.

5. Apply a liberal amount of chassis grease to both ends and place front end of torsion bar into control arm. Push torsion bar all the way forward into the control arm.

6. Insert adjusting arm into the crossmember and position 1-3/4" - 2" below the centerline of the crossmember (See figure 17). Slide torsion bar rearward until it is flush with the rear face of the adjusting arm.

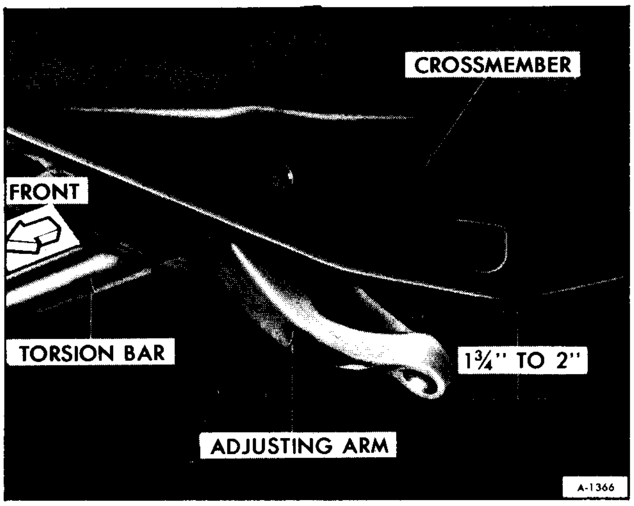


Figure 17—Positioning of Adjusting Arm

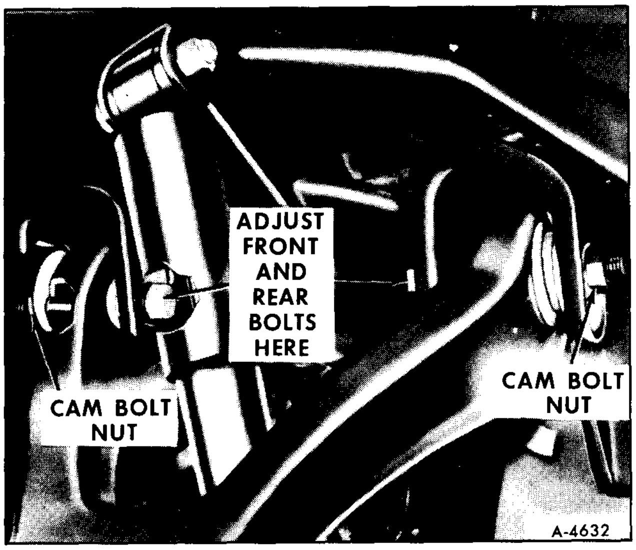


Figure 18—Upper Control Arm Attachment

7. Reposition Tool J-22517-02 making sure pin of tool is in hole in crossmember. Turn center screw of Tool J-22517-02 until adjusting arm is in position to allow installation of the adjusting nut.

8. Apply a liberal amount of chassis grease and install adjusting bolt and turn number of turns previously recorded to obtain original ride height.

9. Turn center screw until torsion is relaxed and remove tool.

10. Lower vehicle.

11. Check ride height (see figure 31) Adjust if necessary refer to "RIDE HEIGHT" in this section.

LOWER CONTROL ARM BUSHINGS

REMOVAL

1. Hoist vehicle.

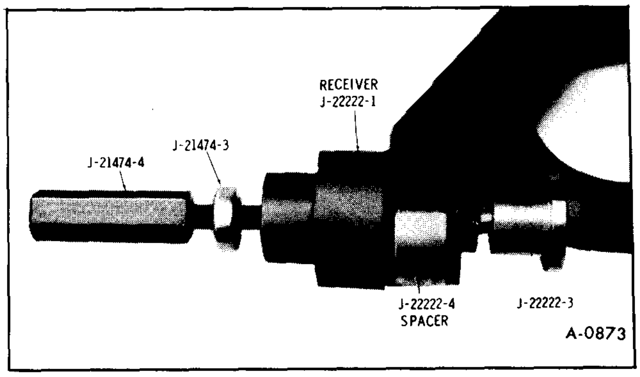


Figure 19—Removing Upper Control Arm Bushing

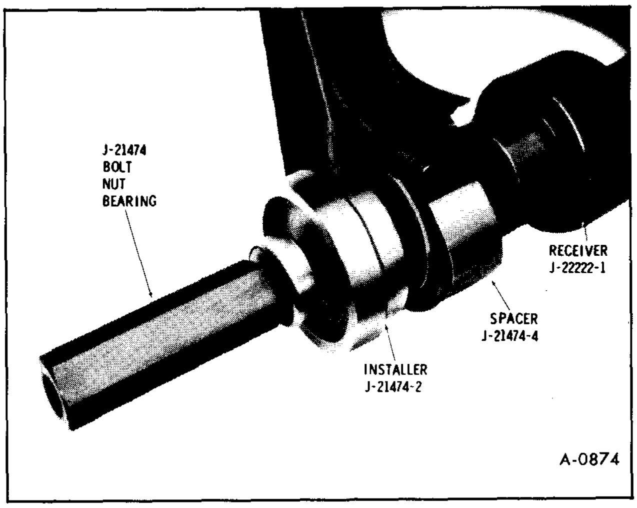


Figure 20—Installing Upper Control Arm Bushing

2. Remove stabilizer link bolt, grommets, spacer, and attaching hardware. Discard bolt.

3. Place floor stands under frame horn, and under points where frame sections are bolted. Lower front lift to floor.

4. Install Tool J-22517-02. Method for attaching, refer to TORSION BAR REMOVAL, Item 2 through 6.

5. Remove lower control arm bushing bolts and pull control arm down until free of frame brackets.

6. Install Tools through rear bushing and press out bushing as shown in Figure 21.

NOTE: Due to the torsion bar anchor attachment to the lower control arm, it will be necessary to use a hardened 1/2" x 20 nut as shown in Figure 22 to remove the front bushing.

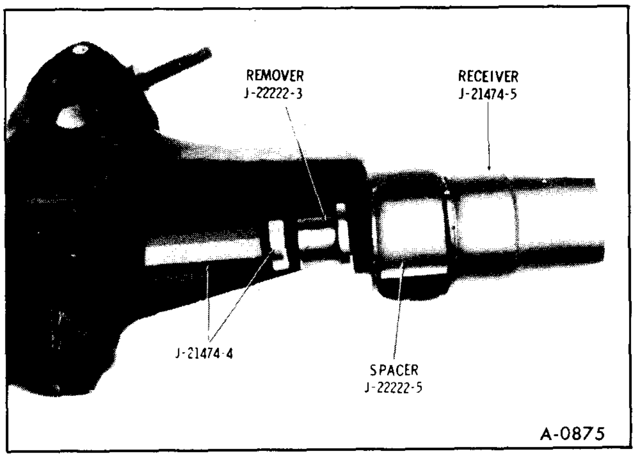


Figure 21—Removing Lower Control Arm Rear Bushing

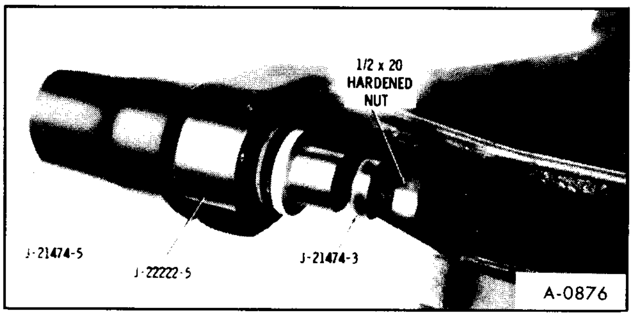


Figure 22—Removing Lower Control Arm Front Bushing

INSTALLATION

See CAUTION on Page 3A-1 of this section.

1. Install Tools as shown in Figure 24 and press rear bushing into lower control arm.

NOTE: Due to the torsion bar anchor attachment to the lower control arm, it will be necessary to use a hardened 1/2" x 20 nut as shown in Figure 23 to install the front bushing.

2. Raise lower control arm into frame brackets and install bushing bolts and nut. Do not torque.

3. Using Tool J-22517-02, refer to TORSION BAR INSTALLATION, item 10 through 13.

4. Raise front lift and remove floor stands.

5. Using a new bolt with grommets, spacer, and attaching hardware, attach stabilizer link bolt to lower control arm. Torque nut to 15 ft. lbs. Cut bolt off 1/4" below nut.

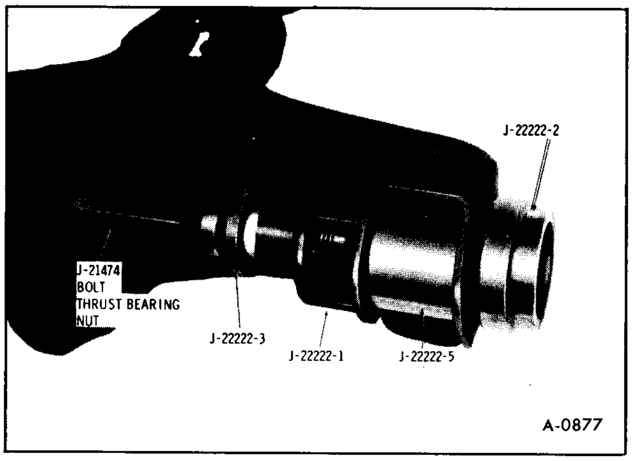
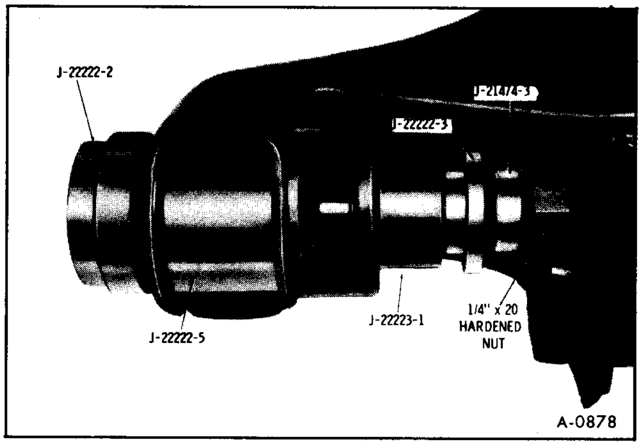


Figure 23—Installing Lower Control Arm Front Bushing



CP1 Figure 24—Installing Lower Control Arm Rear Bushing

6. Lower and torque lower control arm bushing nuts to 90 ft. lbs.

BALL JOINT

Ball joint lubrication and seal inspection is important, refer to Section 0 of specifications and maintenance intervals.

BALL JOINT CHECKS

VERTICAL CHECKS

1. Raise the vehicle and position floor stands under the left and right lower control arms as near as

Figure 25—Ball Joint Vertical Check

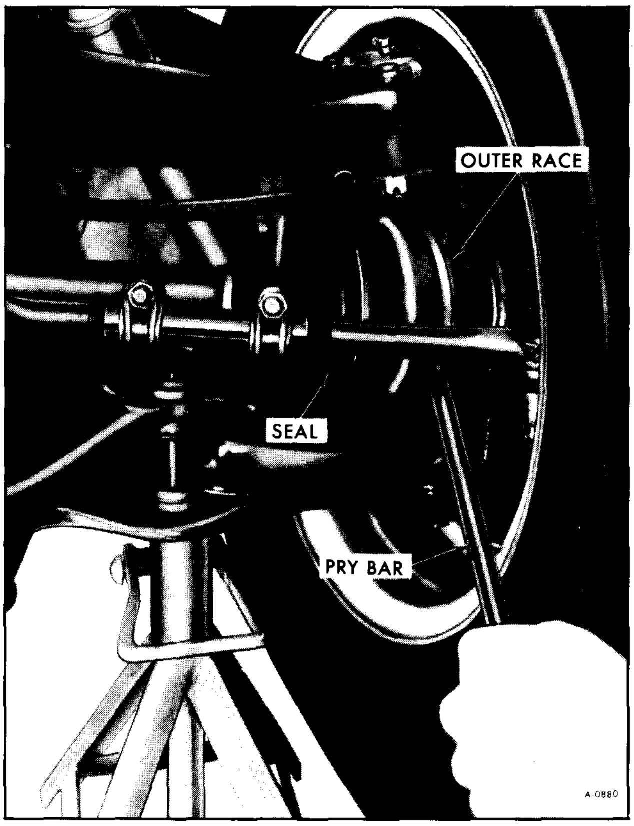


Figure 26—Pry Bar Installation

possible to each lower ball joint. Vehicle must be stable and should not rock on the floor stands. Lower front hoist.

2. Position dial indicator as shown in Figure 25.

3. Place a pry bar as shown in Figure 26 and pry down on bar. Care must be used so that drive axle seal is not damaged. Reading must not exceed .125"

LOWER CONTROL ARM BALL JOINT

REMOVAL

1. Remove knuckle. Refer to KNUCKLE REMOVAL.

2. Drill side rivets 1/2" deep using 1/4" (figure 27) drill bit. Drill same rivets again with 1/2" drill bit just deep enough to remove head of rivet.

3. Drive out rivets with hammer and punch.

4. Drill center rivet using 5/8" drill bit just deep enough to remove rivet head.

5. Using hammer and punch, drive center rivet of joint out of control arm.

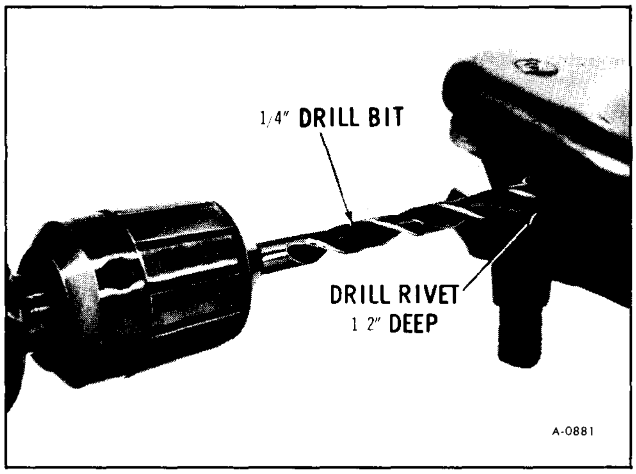


Figure 27—Drilling Ball Joint Rivets

INSTALLATION

See CAUTION on Page 3A-1 of this section.

1. Install service ball joint into control arm and torque bolts and nut as shown in Figure 28.

2. Install knuckle - Refer to KNUCKLE INSTALLATION.

3. Check clearance from ball joint nut to drive axle outer joint as shown in Figure 29. If no clearance is obtained, it may be necessary to grind off nut but not more then 1/16".

UPPER CONTROL ARM BALL JOINT

REMOVAL

1. Hoist vehicle under lower control arms and remove wheel.

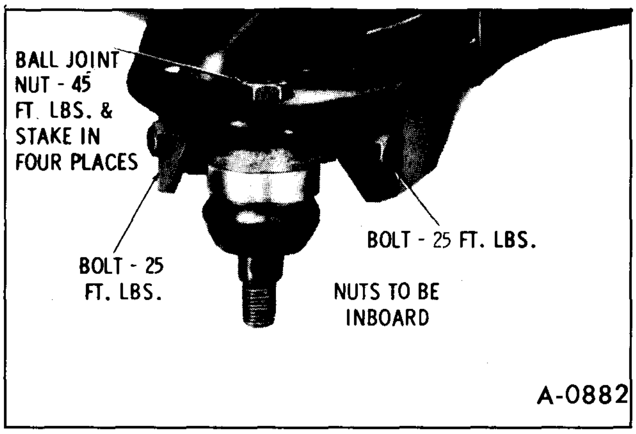


Figure 28—Installing Service Ball Joints

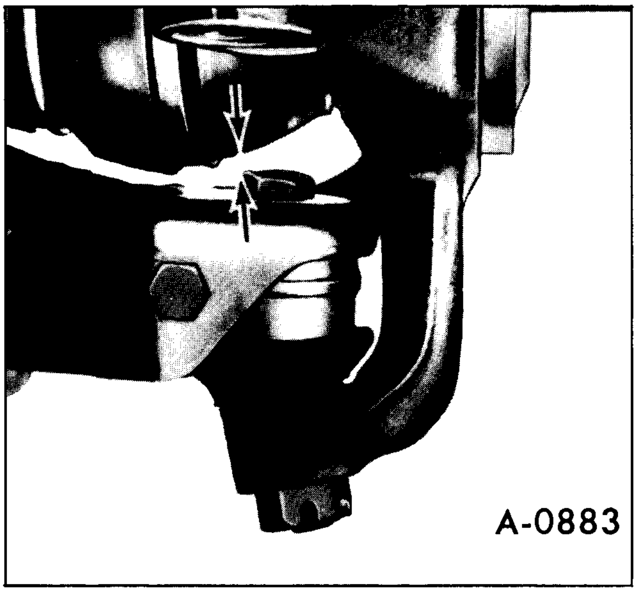


Figure 29—Checking Clearance

2. Remove cotter pin and nut from upper ball joint stud.

3. Disconnect brake hose clip from upper ball joint stud.

4. Using hammer and a brass drift similar to Figure 13 drive on spindle until upper ball joint stud is disengaged from spindle.

5. Raise control arm up and drill rivets with a 1/8" drill bit 3/8" deep.

NOTE: It may be necessary to use a block of wood between frame and control arm for support.

6. Drill off rivets using a 1/2" drill bit. Do not drill into control arm.

7. Using a punch, drive out rivets and remove ball joint.

INSTALLATION

See CAUTION on Page 3A-1 of this section.

1. Install service ball joint into control arm (bolts must be installed from top side). Torque nuts to 20 ft. lbs.

2. Install ball joint stud into knuckle and position brake hose clip over stud.

3. Install ball joint stud nut. See specifications for torque value and procedure.

CAUTION: *Cotter pin must be bent up to prevent interference with outer C.V. Joint Seal.*

4. Install wheel and lower hoist.

STABILIZER BAR

REMOVAL

1. Remove link bolts, nuts, grommets, spacers and retainers from lower control arm. Discard bolts.

2. Remove two bolts attaching dust shield to frame (both sides).

3. Remove bracket to frame attaching bolts and remove stabilizer bar from front of vehicle.

INSTALLATION

See CAUTION on Page 3A-1 of this section.

Reverse removal procedure.

NOTE: New link nuts are torqued to 15 ft. lbs. then bolt is cut off 1/4" below nut.

SHOCK ABSORBER (FIGURE 4)

REMOVAL

1. Raise vehicle and place a safety stand under and firmly against the lower control arm.

CAUTION: *This must be done to prevent the lower control arm from shifting and damaging the tie rod.*

2. Remove wheel.

3. Remove upper shock attaching bolt.

4. Remove lower shock attaching nut and carefully guide shock through upper control arm.

INSTALLATION

1. Guide shock absorber through upper control arm and onto lower shock mounting stud.

2. Extend shock towards upper mount as necessary and install bolt. Torque to 90 ft. lbs.

3. Install lower shock mounting nut and torque to 90 lbs.

4. Install wheel and replace wheel nuts finger tight.

5. Remove safety stands and lower vehicle. Torque wheel nuts 280 ft. lbs.

TORSION BAR AND/OR CROSSMEMBER SUPPORT

REMOVAL

1. Raise vehicle on a two post hoist.

2. Remove two nuts and center screw from Tool J-22517-02. Position tool over crossmember installing pin of tool into hole in crossmember. Install two nuts on tool, install counter screw. Grease center screw threads and the rounded end of the screw with chassis grease.

3. Turn center screw until seated in dimple of torsion bar adjusting arm. See Figure 16.

4. Remove torsion bar adjusting bolt and nut. Count the number of turns necessary to remove and record.

NOTE: The number of turns to remove the adjusting bolt will be used when installing to obtain the original carrying height.

5. Turn center screw of Tool J-22517-02 until torsion bar is completely relaxed.

6. Remove Tool J-22517-02.

7. Repeat steps 2, 3, 4, 5 and 6 on opposite torsion bar.

8. Remove bolts and retainer from torsion bar crossmember at frame (figure 4).

9. Disconnect exhaust pipe hanger from crossmember and loosen pipe saddle and "U" clamp. Slide hanger backward.

10. Move crossmember rearward until torsion bars are free and adjusting arms are removed.

11. Move torsion bar crossmember sideways to the extreme left. Move crossmembers upward and outward until opposite end clears exhaust pipe.

12. Remove torsion bars. Mark accordingly to insure proper installation.

INSTALLATION

1. Install torsion bars. New torsion bars are stamped on one end with an "R" for right or an "L" for left side. Apply a liberal amount of chassis grease to both ends.

2. Install crossmember insulators on the crossmembers.

3. Install crossmember and position approximately two inches rearward of its normal position.

4. Raise torsion bars and align with hole in crossmember. Move crossmember forward so torsion bars rest on edge of hole.

5. Insert torsion bar adjusting arm into crossmember, position so the arm will engage the torsion bar and the end of the arm will be 1-3/4"-2" below the crossmember (See figure 17). Tap crossmember forward enough to engage bar into arm.

6. Repeat step 5 for the other side of vehicle.

7. Position crossmember to its normal position. Torsion bars should be through and flush with rear face of the adjusting arm. If not repeat steps 5 and 6 after pulling torsion bar slightly out from the lower control arm.

8. Install retainer over each insulator and torque nut to 10 ft. lbs.

9. Reposition and connect exhaust pipe hanger to crossmember and tighten saddle and "U" clamp. Torque nuts 15 ft. lbs.

10. Position Tool J-22517-02 over crossmember installing pin of tool into hole in crossmember. Install two nuts on tool, install center screw.

11. Turn center screw until adjusting arm is in a position to allow installation of adjusting nut. See Figure 16.

12. Install nut and turn adjusting bolt the recorded number of turns to obtain previous ride height.

13. Turn center screw until torsion is completely relaxed. Remove tool and repeat steps 10, 11, 12, 13 on the opposite side.

14. Lower hoist.

15. If ride height requires adjustment refer to "RIDE HEIGHT" following this procedure.

RIDE HEIGHT

When checking front ride height, have the vehicle parked on a known level surface, and tire pressure at specified psi.

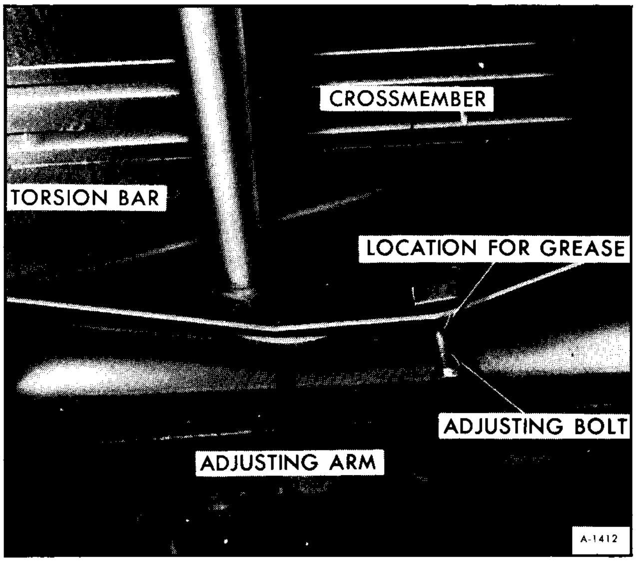


Figure 30—Location For Front Ride Height Adjustment

NOTE: For details on adjusting rear ride height refer to Section 4, REAR SUSPENSION. If vehicle is equipped with the optional Power Level System, be sure power level control knobs are set in the "TRAVEL" position prior to adjusting front ride height.

Measurements must be taken from the top of oval hole in the frame rail to the floor (figure 31). NOTE: Never attempt to increase the ride height of the vehicle using the adjusting bolt only, (figure 30). The bolt will turn but will strip threads and will necessitate replacement of the bolt. Always use special tool.

RIDE HEIGHT ADJUSTMENT

NOTE: Tool J-22517-02 (shown in figure 16) must be used the reset ride height. This tool will raise or lower the torsion bar rear anchor arm so that the adjusting bolt is not loaded.

1. Install Tool J-22517-02 with pin of tool aligned into hole in crossmember. Seat center screw in dimple of torsion bar adjusting arm.

2. If vehicle must be raised, turn tool until proper adjustment level is reached, then turn the adjusting bolt until it makes contact with the adjusting arm. Remove tool.

3. If vehicle is to be lowered, raise adjusting arm from contact with adjusting bolt. Lower bolt then lower arm with tool until proper ride height level is reached. Raise bolt to contact adjustment arm. Remove tool.

FRONT END ALIGNMENT

	Check	Set
Caster	+ 1-1/2° to + 2-1/2°	+ 2°
Camber—L.H.	+ 1/2° to 1°	+ 3/4°
Camber—R.H.	+ 1/4° to 3/4°	+ 1/2°
Toe	0 to -1/4" (toe out)	-1/8" (toe out)

Make adjustments as required. Refer to "ALIGNMENT ADJUSTMENT" below.

ALIGNMENT ADJUSTMENT

Camber

1. Loosen nuts on inboard side of upper control arm cam bolts. (figure 4).

2. Turn front cam bolt (inboard or outboard) to correct for 1/2 of incorrect setting found in checking.

3. Turn rear cam bolt (same way front bolt was turned) to correct for remaining 1/2 of incorrect setting found in checking.

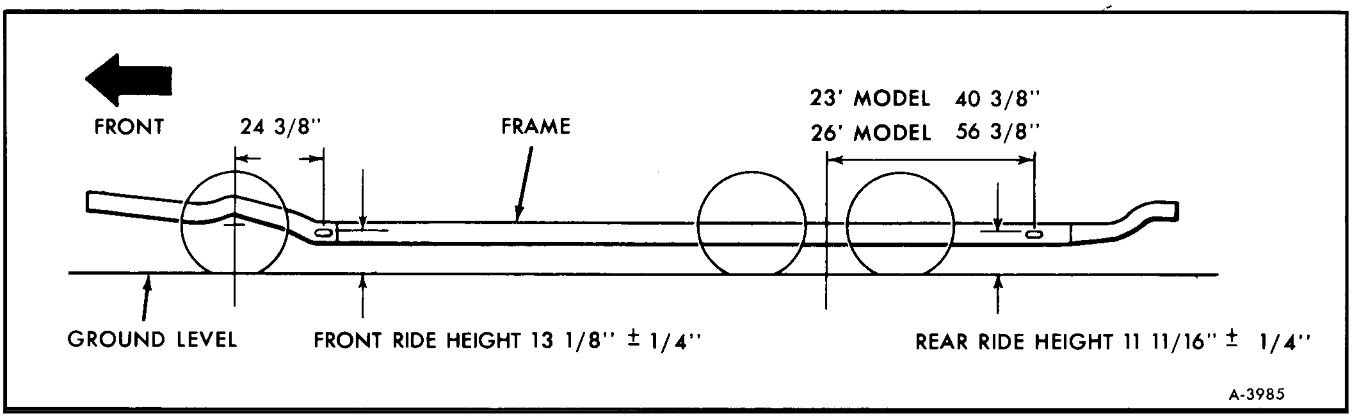


Figure 31—Vehicle Ride Height

Example:

Camber Reading (Checking).......... +1-1/4°
Amount To Be Corrected .... 1/2°
1/2 of 1/2° = 1/4° Front Cam Bolt
Remaining 1/4° Rear Cam Bolt

4. Tighten front and rear cam nuts (torque to 80-95 ft. lbs.) while holding bolts with back-up wrench so that camber is not changed. Check caster, do not reset unless caster exceeds specifications.

IMPORTANT: Check cam adjustment surface for weld splatter. Weld splatter in this area will affect front end alignment. Remove weld spatter if found.

Caster

1. Loosen front and rear cam nuts while holding bolts with back-up wrench so that camber is not changed.

2. Turn front cam bolt so that camber changes 1/4 of the desired amount of caster to be corrected.

Example:

Caster Reading (Checking) .... +5°
Amount To Be Corrected .... 3°
1/4 of 3° = 3/4° Front Cam Bolt

3. Turn rear cam bolt so that camber now returns to corrected setting.

4. Recheck caster setting.

This is a location to start from and a correct setting can be obtained with the above procedure.

NOTE: Torque upper control arm cam nuts to 90 ft. lbs. Hold head of bolt securely, any movement of the cam will effect the final setting and caster camber adjustment must be rechecked.

Toe-In Adjustment (Figure 32)

1. Loosen the clamp bolts at each end of the steering tie rod adjustable sleeves. Tie rod assembly must be decreased in length in order to increase toe-in.

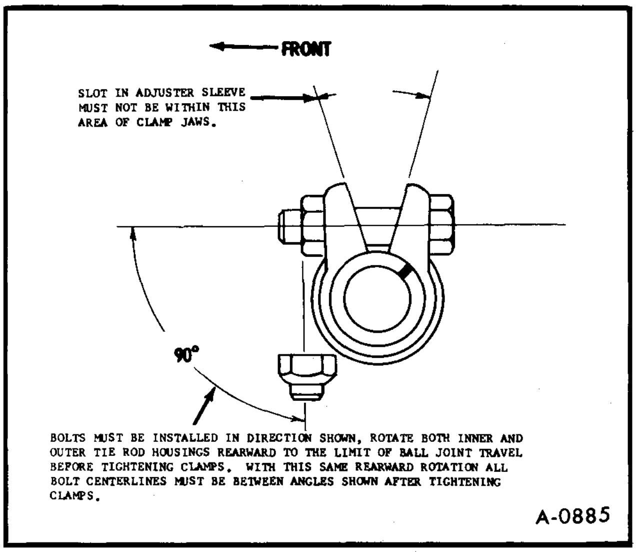


Figure 32—Positioning Tie Rod Clamp

NOTE: Tie rod adjuster components often become rusted in service. In such cases, it is recommended that if the torque required to remove the nut from the bolt (after breakaway) exceeds 7 ft. lbs., discard the nuts and bolts. Apply penetrating oil between the clamp and tube and rotate the clamps until they move freely. Install new bolts and nuts to assure proper clamping at the specified nut torque.

2. With steering wheel set in straight ahead position, turn tie rod adjusting sleeves to obtain the proper toe-in adjustment at curb load.

3. When adjustment has been completed according to the recommended specifications, check to see that the number of threads showing on each end of sleeve are equal and that the tie rod end housings are at right angles to steering arm. Position inner and outer tie rod clamps as shown in Figure 32. Torque nuts to 20 ft. lbs.

TORQUE SPECIFICIATIONS

APPLICATION	FT. LBS.
Drive axle Nut*	140-280
Hub to Disc Bolts	35
Stabilizer Link Nut	15
Stabilizer Bracket to Frame Screw	28
Torsion Bar Crossmember Retainer Bolts	25
Shock Absorber	
Upper Nut	90
Lower Nut	90
Lower Control Arm Bushing Nuts	85
Upper Control Arm Bushing Nuts	95
Ball Joint - Upper*	40-60
Ball Joint - Lower*	100-125
Tie Rod to Knuckle Nut*	40-50
Inner C.V. Joint to Output Shaft Bolts	75
Bearing Retainer to Knuckle Bolts	35

NOTE: All stud tapers on all ball joints must be kept sufficiently free of lubricant to prevent excessive pull in mating tapered holes.

*NOTE: After reaching minimum torque required, nut must always be tightened to insert cotter pin. Never back nut off.

SPECIAL TOOLS

J-2619	Slide Hammer
J-8433-1	Bearing Puller
J-9745	Front Hub Bearing Installer
J-21474-3-4-5	Control Arm Bushing Remover and Installer
J-22214-4-6	Front Hub Bearing Screw and Adapter
J-23345	Front Hub Bearing Puller
J-22269	Brake Caliper Collapser
J-22517-02	Torsion Bar Unloader
J-23115	Front Hub Seal Installer
J-24319	Pitman Arm, Idler Arm, Ball Joint Puller
J-24717	Front Hub Puller
J-26485	Knuckle Seal Installer

SECTION 3B

DRIVE AXLES

CAUTION: *The drive axle fasteners are an important attaching part in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.*

Contents of this section are listed below:

SUBJECT **PAGE NO.**
Trouble Diagnosis 3B-1
General Description 3B-2
Drive Axle Assembly (Right Hand) 3B-2
Drive Axle Assembly (Left Hand) 3B-3
Constant Velocity Joint Disassembly 3B-5
Drive Axle 3B-11
Torque Specifications 3B-12
Special Tools 3B-12

TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
Clicking noise in turns.	Excessive wear or broken outboard joint.	Inspect and replace outboard joint if necessary.
Coast to drive "clunk".	1. Loose inboard joint flange bolts. 2. Inoperative rubber damper (RH side). 3. Loose spline. (RH damper to shaft).	1. Tighten to specified torque. 2. Replace RH shaft and damper assembly and inboard and outboard seals (use seal service kits). 3. Same as "2" above.
Shudder or vibration on acceleration.	1. Incorrect U-joint angle. 2. Excessive wear on inboard joint housing. 3. Worn spider assembly. 4. Sticking spider assembly.	1. Check front end curb height and correct if necessary. 2. Check for brinelling of housing bores and replace if necessary. 3. Check for wear or free rotation of balls on spider. Replace spider assembly if necessary. 4. Check spider ball to housing bore clearance (ball should slide freely in housing). Replace housing or spider assembly as required.
Shimmy vibration at highway speeds.	Tires out of balance or out of round.	Balance front wheels, true for out of round.

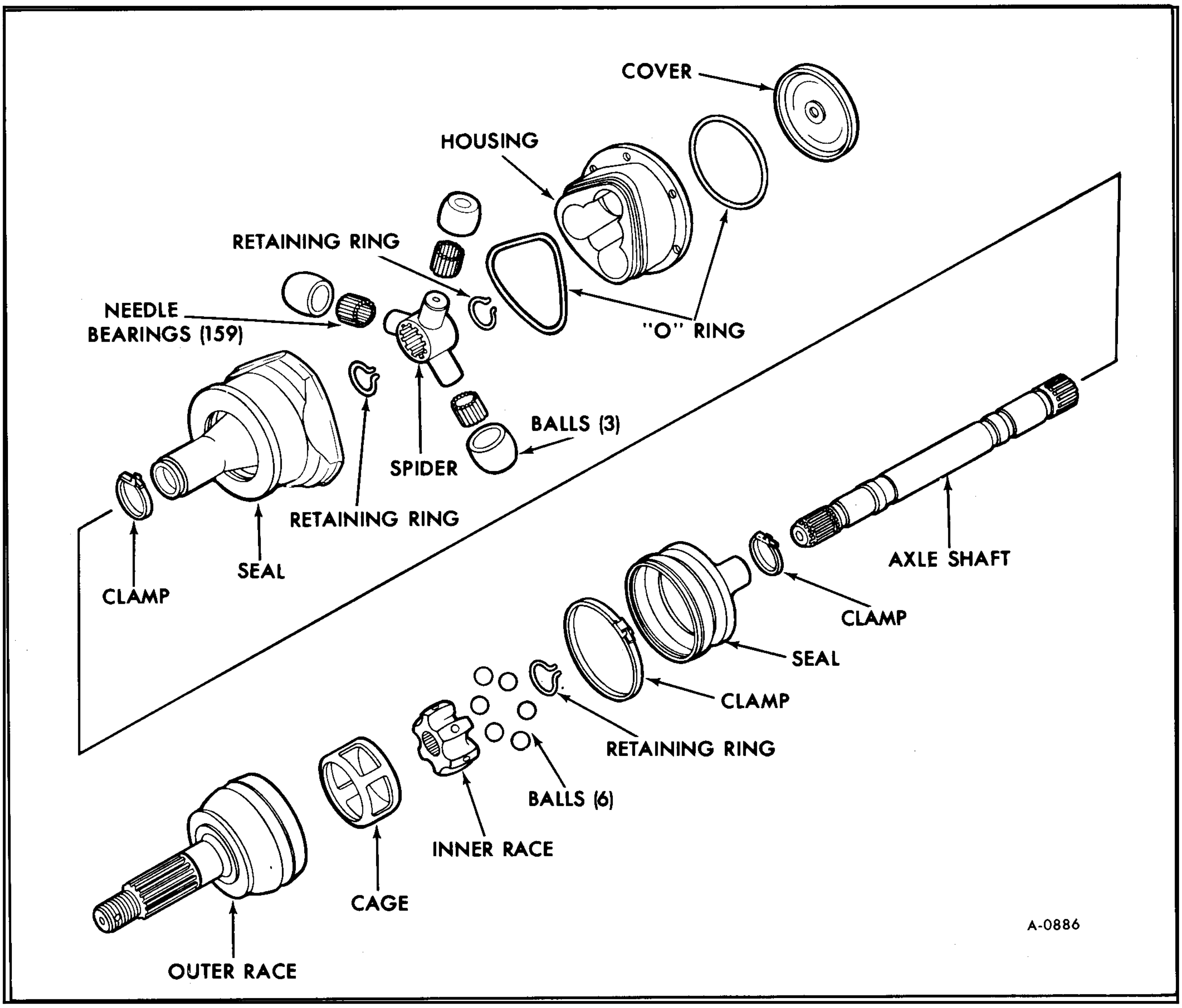


Figure 1—Drive Axle Assembly

GENERAL DESCRIPTION

Drive axles on the vehicle are completely flexible assemblies and consist of an axle shaft and an inner and outer constant velocity joint. (figure 1). The inner constant velocity joint (spider type) has complete flexibility plus inward and outward movement. The outer constant velocity joint (cage type) has complete flexibility only.

CAUTION: *Whenever any operations call for disconnecting, removal or installation of the drive axles, care must be exercised to prevent damage to constant velocity joint seals. Seals may be wrapped with floor mat rubber or old innertube, etc. Make sure any rubber protective covers that are used are removed before vehicle is started or driven.*

DRIVE AXLE ASSEMBLY (RIGHT HAND)

REMOVAL

1. Hoist vehicle under lower control arms.

2. Remove drive axle cotter pin, nut and washer. (figure 2)

3. Remove inner C.V. joint attaching bolts. (figure 3)

4. Push inner C.V. joint outward enough to disengage from R.H. final drive output shaft and move rearward.

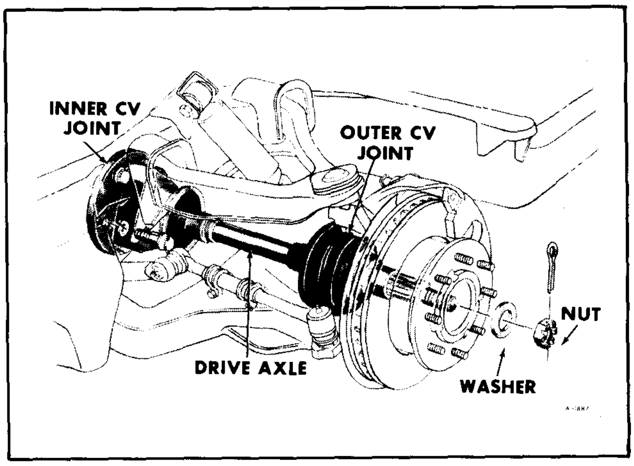


Figure 2—Drive Axle Installed

5. Remove R.H. output shaft support bolts to engine and final drive. (figure 2).

6. Remove R.H. output shaft.

7. Remove drive axle assembly.

CAUTION: *Care must be exercised so that C. V. joints do not turn to full extremes and that seals are not damaged against shock absorber or stabilizer bar.*

INSTALLATION

See CAUTION on Page 3B-1 of this section.

1. Carefully place R.H. drive axle assembly into lower control arm and enter outer race splines into knuckle.

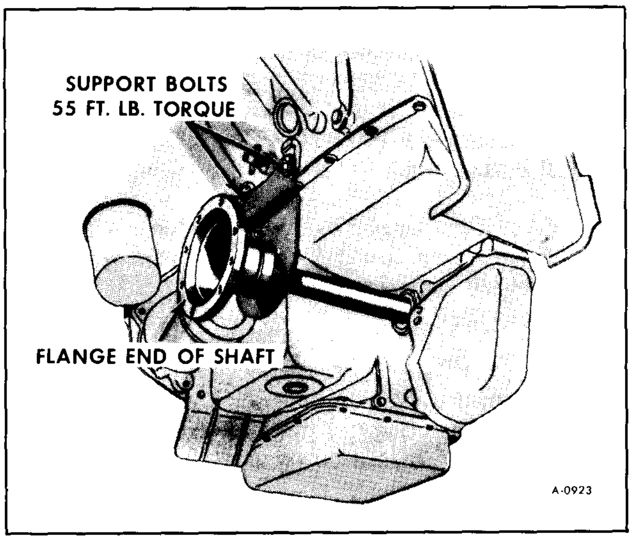


Figure 3—Aligning R.H. Output Shaft

2. Lubricate final drive output shaft seal with Special Seal Lubricant, No. 1050169 or equivalent.

3. Install R.H. output shaft into final drive and attach support bolts to engine.

IMPORTANT: When attaching the right hand output shaft to the engine bracket, do not let the shaft hang. Referring to Figure 3, assemble bracket bolts loosely, and by moving the flange end of the shaft up and down, and back and forth, find the center location. Hold the shaft in this position and then torque the bolts to 55 ft. lbs. on support.

4. Move R.H. drive axle assembly toward front of vehicle and align with R.H. output shaft. Install NEW attaching bolts and torque to 75 ft. lbs.

5. Install washer and nut on drive axle. Torque to 200 ft. lbs. Insert cotter pin and crimp. Tighten nut to insert cotter pin.

6. Lower hoist.

DRIVE AXLE ASSEMBLY (LEFT HAND)

REMOVAL

1. Hoist vehicle under lower control arms.

2. Remove wheel.

3. Remove drive axle cotter pin, nut and washer.

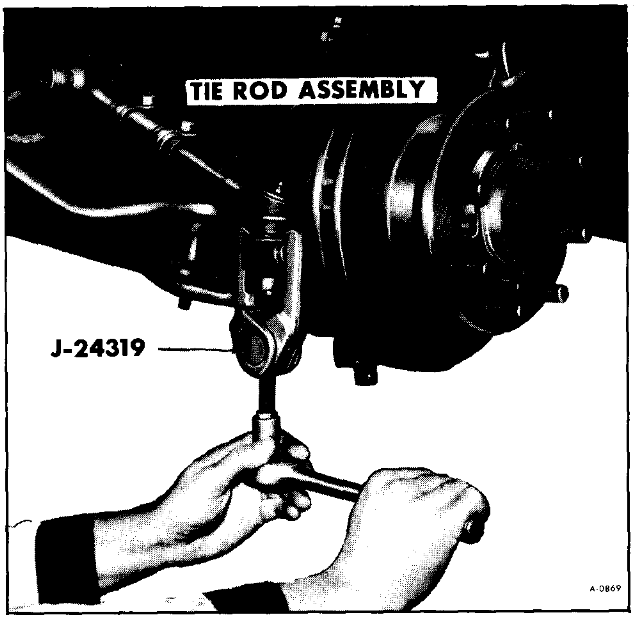


Figure 4—Removing Tie-Rod End

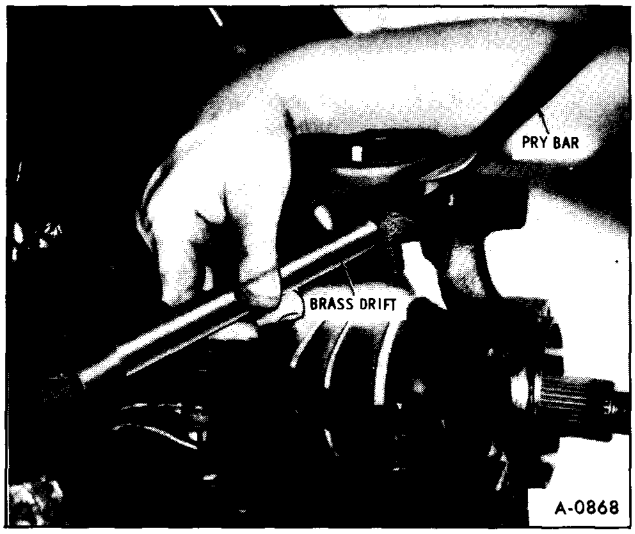


Figure 5—Removing Upper Ball Joint

4. Remove tie rod end cotter pin and nut.

5. Using Tool J-24319 as shown in Figure 4, remove tie rod end from spindle.

6. Remove bolts from drive axle assembly to left output shaft.

7. Remove upper control arm ball joint cotter pin and nut. Remove brake hose clip from ball joint stud.

8. Using hammer and brass drift, drive on knuckle until ball joint stud is free. (figure 5).

9. Using Tool J-24319 (figure 6) remove lower ball joint from knuckle. Care must be exercised so that ball joint doesn't damage drive axle seal.

10. Remove knuckle. Support knuckle so that brake hose is not damaged.

11. Carefully guide drive axle assembly outboard.

CAUTION: *Care must be exercised so that C. V. joints do not turn to full extremes and that seals are not damaged against shock absorber or stabilizer bar.*

INSTALLATION

See CAUTION on Page 1 of this section.

1. Carefully guide L.H. Drive axle assembly onto lower control arm.

2. Insert lower control ball joint stud into knuckle and attach nut. Do not torque.

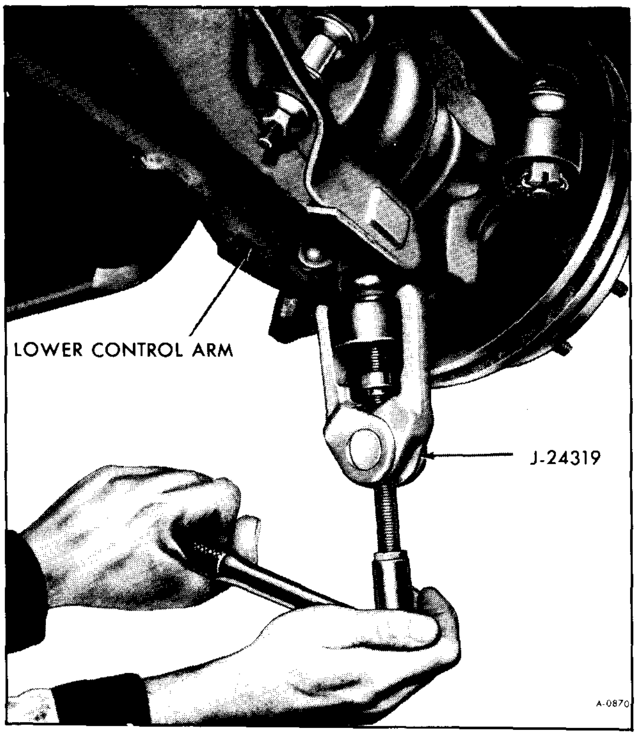


Figure 6—Removing Lower Ball Joint

3. Center L.H. drive axle assembly in opening of knuckle and insert upper ball joint stud.

4. Place brake hose clip over upper ball joint stud and install nut. Do not torque.

5. Insert tie rod end stud into knuckle and attach nut. Torque to 40 ft. lbs. Install cotter pin and crimp. Tighten nut to install cotter pin.

6. Align inner C.V. joint with output shaft and install NEW attaching bolts. Torque to 75 ft. lbs.

7. Torque upper and lower ball joint stud nuts to 40 ft. lbs. (upper); 100 ft. lbs. (lower). Tighten nut to install cotter pins.

CAUTION: *Upper ball joint cotter pin must be crimped toward upper control arm to prevent interference with outer C. V. joint seal.*

8. Install drive axle washer and nut. Torque to 200 ft. lbs. Install cotter pin and crimp. Tighten nut, if necessary to install cotter pin.

9. Install wheel.

10. Remove floor stands and lower hoist.

CONSTANT VELOCITY JOINT (C.V. JOINT OUT OF VEHICLE)

The C.V. joints are to be replaced as a unit and are only disassembled for repacking and replacement of damaged seals.

DISASSEMBLY (OUTER C.V. JOINT)

1. Refer to "DRIVE AXLE ASSEMBLY (LEFT HAND) OR (RIGHT HAND)."

2. Insert axle assembly in vise. Clamp on mid-portion of axle shaft.

NOTE: Protect against jaw marks, do not over-clamp.

3. Remove inner and outer seal clamps. (figure 7)

4. Slide seal down axle shaft to gain access to C.V. joint.

NOTE: Seal may need to be rolled back or cut away on R.H. drive axle.

5. Using Tool J-5586, spread retaining ring until C.V. joint can be removed from axle spline. (figure 8)

6. Remove retaining ring (figure 20).

7. Slide seal from axle shaft and discard.

8. Remove excess grease from C.V. joint.

9. Insert C.V. joint in vise, clamping on shank.

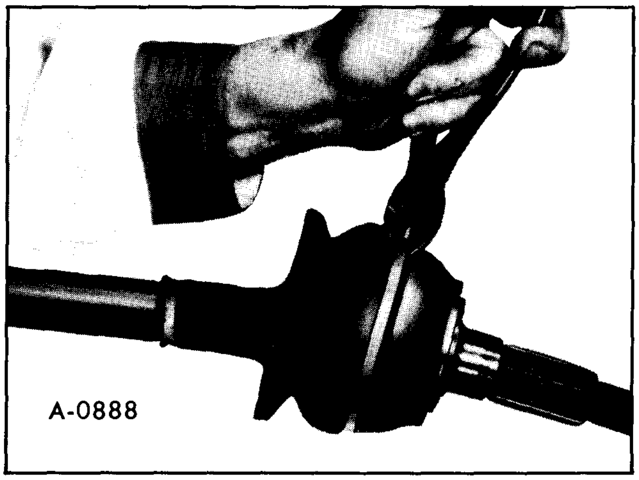


Figure 7—Cutting Seal Clamp

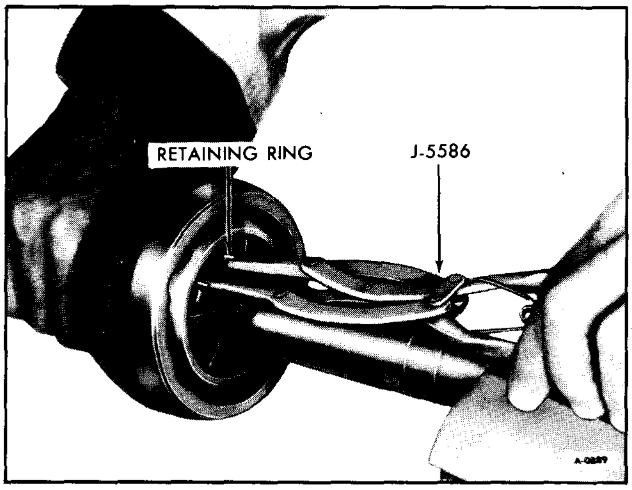


Figure 8—Spreading Retaining Ring

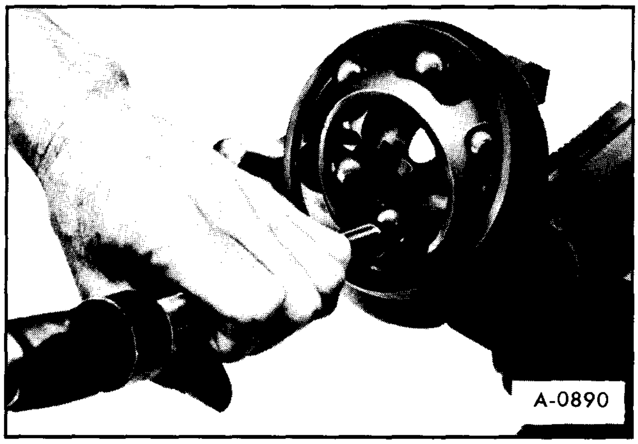


Figure 9—Tapping on Inner Race

NOTE: Use jaw blocks to prevent damage to the joint shank.

10. Carefully place a brass drift against one of the lobes of the inner race and tap gently as shown in Figure 9. Tip the race far enough to remove the first ball. The rest of the balls should be removed one at a time, with the cage tipped as shown in Figure 10. It may be necessary to carefully pry the last ball out of the cage with a screwdriver.

11. Turn cage 90° and with slot in cage aligned with land in outer race lift out inner race and cage. (figure 11).

12. While holding cage and inner race, turn inner race 90°. Line up short land of inner race with slot in cage. Move short land through cage and turn inner race up and out of cage. (figure 12)

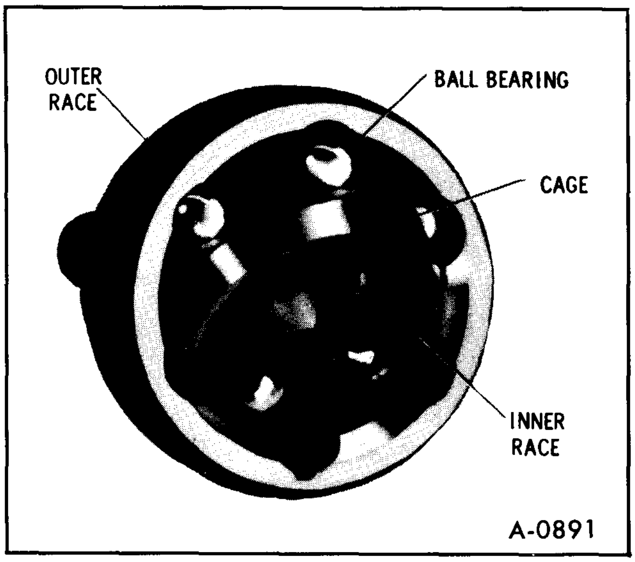


Figure 10—Removing Ball Bearings

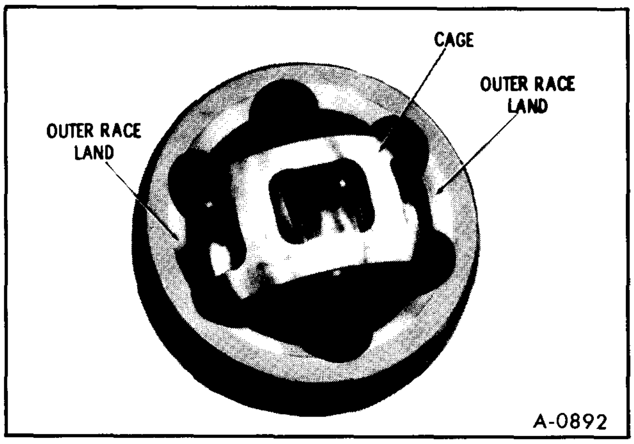


Figure 11—Positioning Cage

CLEANING AND INSPECTION (OUTER)

Wash all metallic parts thoroughly in a cleaning solvent. Dry with compressed air. Rubber seal must be replaced whenever C.V. joint is disassembled for service.

NOTE: Outer and inner race may show a definite polished area where the balls travel. The C.V. joint should not be replaced for this reason. However, if this wear pattern is suspected to be the cause of a noisy or vibrating C.V. joint, the joint should be replaced.

1. Inspect outer race for excessive wear or scoring in the ball grooves. Inspect shaft splines and threads for damage.

2. Inspect balls (six) for nicks, cracks, breaks or scores.

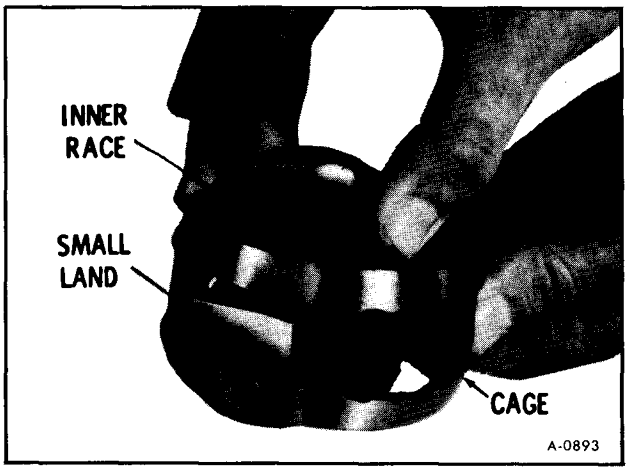


Figure 12—Removing or Installing Inner Race from Cage

NOTE: Slight scuffing or nicking is considered normal.

3. Inspect cage for cracks, breaks or excessive brinelling of the window flats. Some wear and slight brinelling from ball contact is normal.

4. Inspect inner race for excessive wear, scores or breaks.

5. Inspect retaining ring for breaks.

NOTE: If any of the above defects, except Item 5 are found, the C.V. joint assembly will have to be replaced as a unit. Retaining ring may be replaced separately.

ASSEMBLY

1. Insert short land of inner race through bore of cage and pivot to install in cage. (figure 12).

2. Insert outer race in vise, clamping on shank. Protect shank from damage. Do not tighten too tight. Put a light coat of lubricant GM 1050802 or equivalent on ball grooves of inner and outer races.

3. Insert cage and inner race into outer race by aligning windows on cage with lands on outer race. (figure 11). Pivot cage and inner race 90°, being certain that step on cage bore is positioned to inside of joint and snap ring groove in inner race is facing outside. (figure 13).

4. Insert balls into outer race one at a time by rocking assembly to each subsequent ball groove until all six balls are installed. (figure 13)

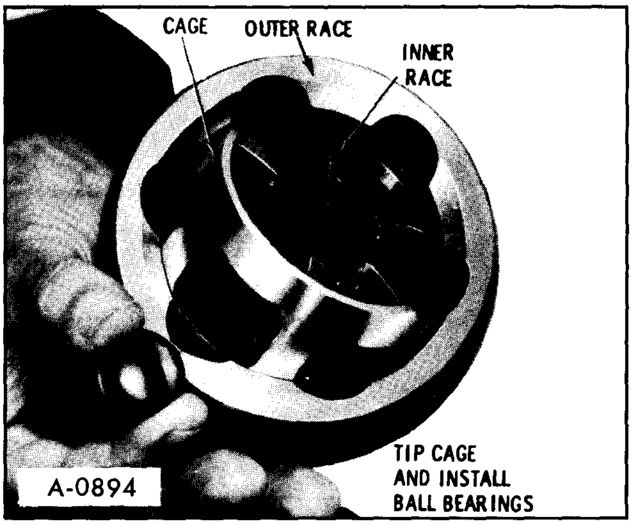


Figure 13—Installing Balls in Outer Race

NOTE: If a brass drift is used to install the sixth ball, make certain metallic chips from drift do not enter assembly.

5. Pack C.V. joint full of Lubricant No. 1050802 or equivalent.

6. Pack inside of seal with Lubricant No. 1050802 or equivalent until folds of seal are full.

7. Place service clamp on axle shaft. Two wraps of band are required.

8. Install seal onto axle shaft.

9. Install retaining ring into inner race with tangs protruding into relieved area. (figure 16)

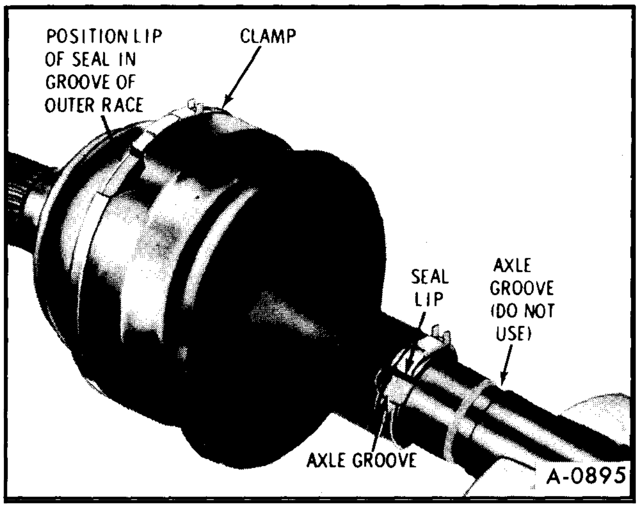


Figure 14—Positioning Seal

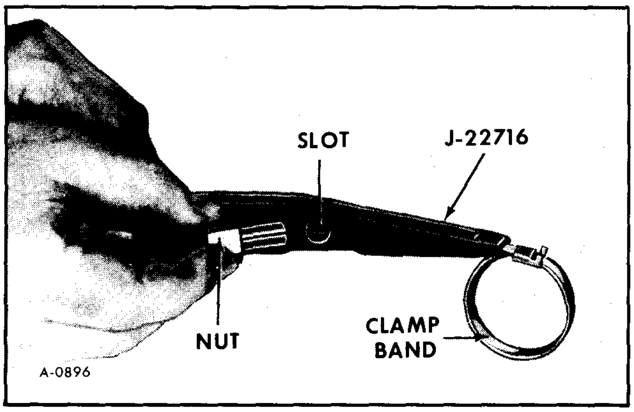


Figure 15—Assembly of J-22716 to Band

10. Insert axle shaft into splines of outer C.V. joint until retaining ring secures shaft in second snap ring groove.

11. Position seal in groove of outer race. (figure 14)

12. Position small end of seal in nearest joint groove on axle shaft. (figure 14)

NOTE: After seal is in position on axle shaft make sure no lubricant is in grooves of seal before installing seal clamp band.

13. With service clamps over seals in correct position, follow procedures listed below.

a. Pull clamp to desired size and insert band into Tool J-22716. Then insert nut into tool with band in slot of nut as shown in Figure 15.

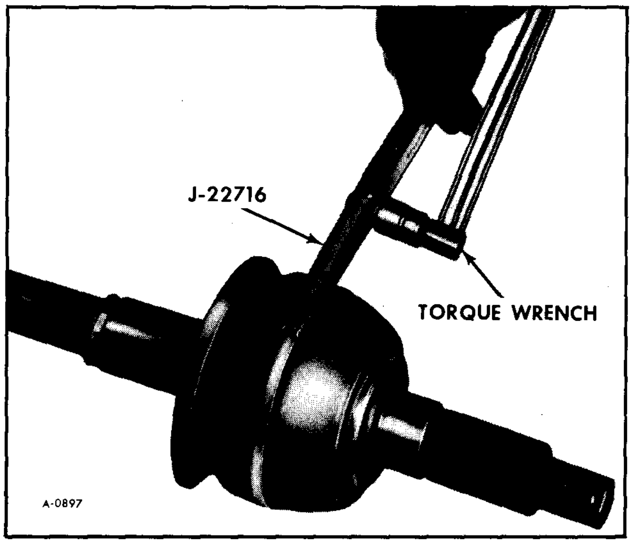


Figure 16—Tightening Band

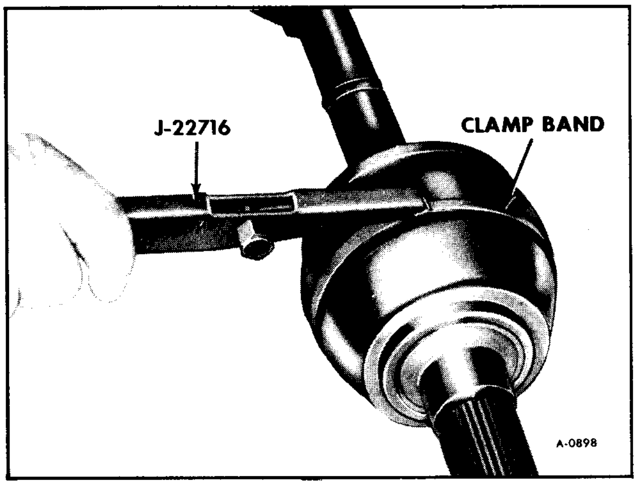


Figure 17—Bending Band Over Lock Tangs

b. Loop seal clamp band around seal end twice with strap passing through its own retainer each time a loop is completed.

c. After completion of second loop, feed extra length of strap into small end of Seal Clamp Band Installer, J-22716.

NOTE: Be sure to have the open side of the tool facing up.

d. Slide bolt through holes in side of tool and at the same time, secure strap in slot in the nut.

e. Lift end of strap up and out of the open side of tool.

f. Place a wrench on nut and draw band up tight, then torque nut to 65 in. lbs. (See figure 16). After desired torque is obtained, turn tool over to

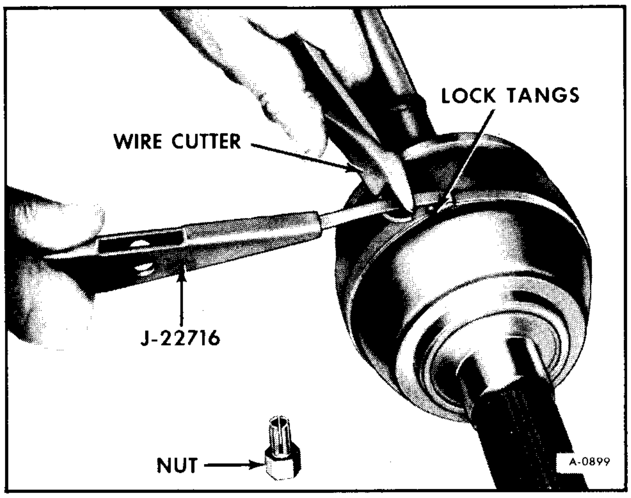


Figure 18—Cutting Off Band

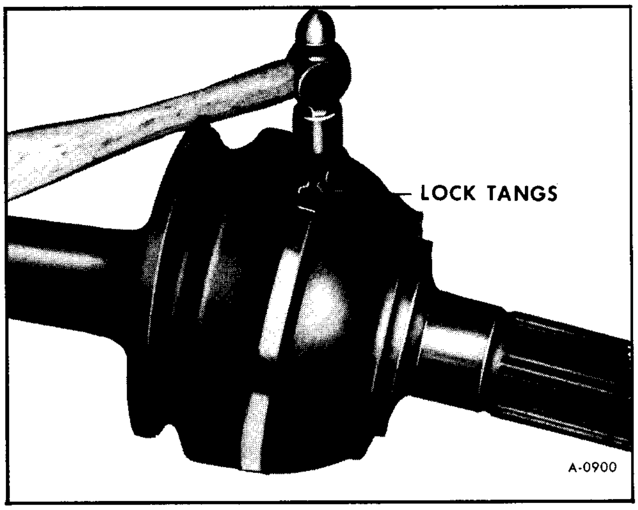


Figure 19—Bending Lock Tangs

bend band over lock tangs of clamp, do not let band slip back through tool as this will decrease clamping force (Refer to figure 17).

g. Back tool off just enough to permit tapping band with a hammer until it lies flat across top of retainer. Unwind the excess strap and cut it off close to retainer as shown in Figure 18. Tap the tabs down until they retain strap. Tap lightly as excessive force will damage seal (See figure 19).

DISASSEMBLY (INNER C.V. JOINT)

1. With axle assembly on a bench, pry up staked areas on seal retainer and drive seal off housing with hammer and chisel. (figure 21)

2. Grasp axle assembly with one hand and joint housing with the other and stand both vertically on the bench. Carefully withdraw axle from housing, being certain not to lose the balls and needles from the axle. (figure 22)

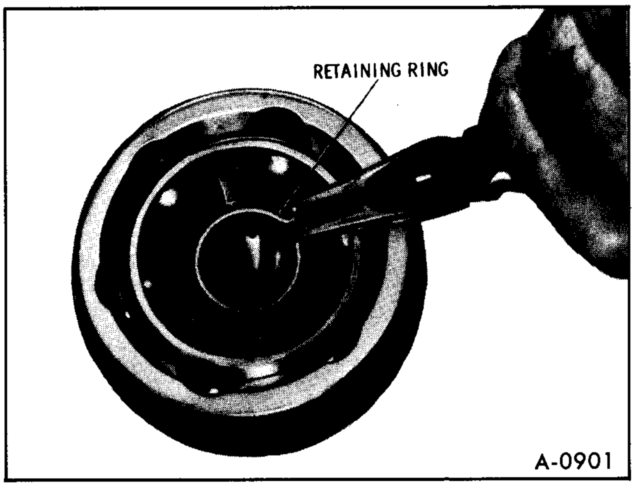


Figure 20—Removing Retaining Ring

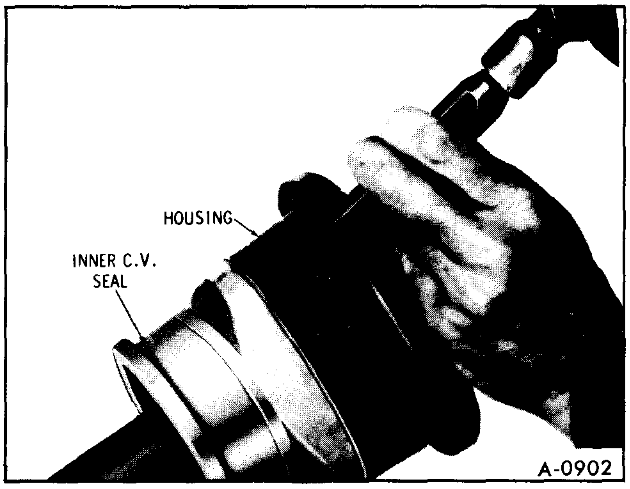


Figure 21—Removing Inner C.V. Joint Seal

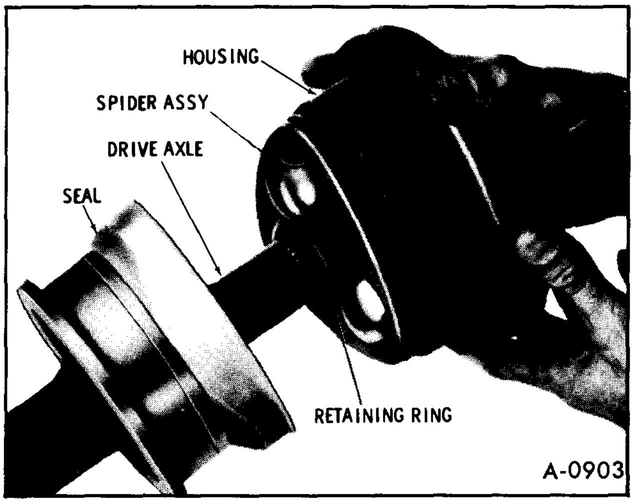


Figure 22—Removing Housing Assembly

NOTE: Place a rubber band over ends of spider to retain the three balls and needle bearings. Wipe all excess grease from C.V. parts joint. Remove housing "O" ring seal and discard. Set housing aside.

3. Insert axle assembly in vise. Clamp on mid-portion of axle shaft. Protect against jaw marks.

4. Using Tool J-5586, remove retaining ring from end of axle shaft.

5. Slide spider assembly from axle shaft. (figure 23)

6. Remove retaining ring (inner) from axle shaft using Tool J-5586. (figure 24)

7. Remove small seal clamp.

8. Slide boot seal off axle shaft and discard seal.

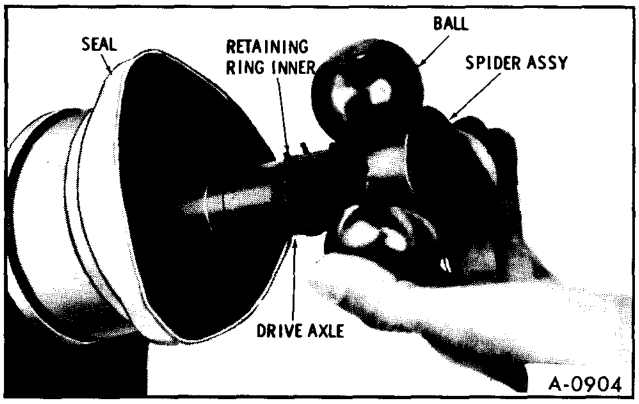


Figure 23—Removing Spider Assembly

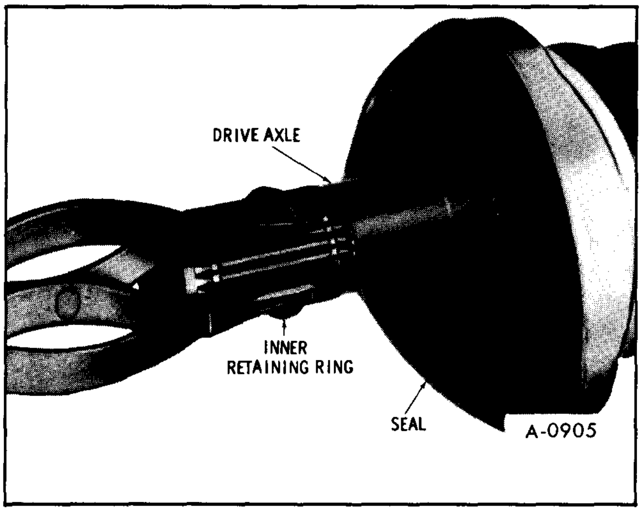


Figure 24—Removing Inner Retaining Ring

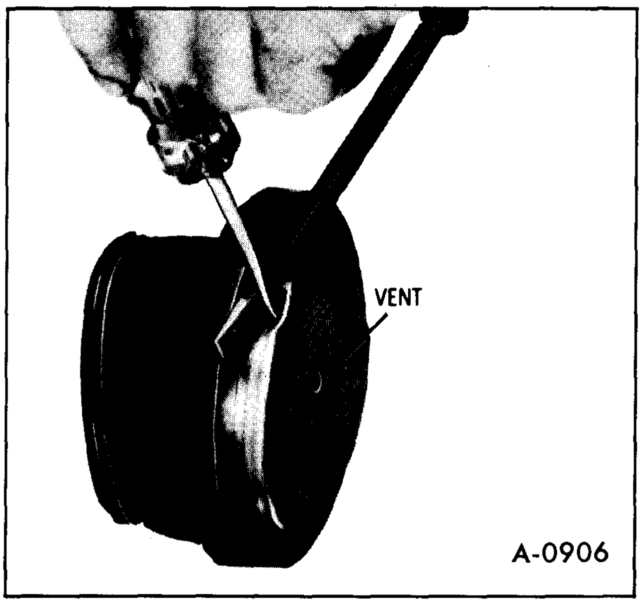


Figure 25—Removing Cover from Housing

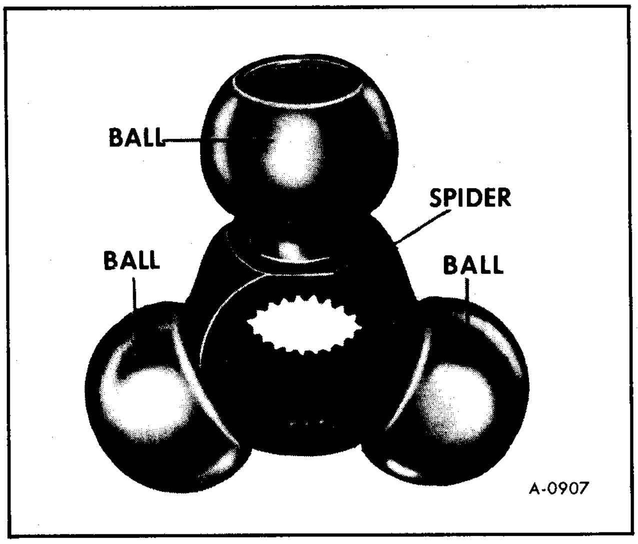


Figure 26—Spider Assembly

NOTE: If there is no leakage or apparent damage to rear cup, it is not necessary to remove it from housing.

9. If necessary to remove cover, proceed as shown in Figure 25 and discard cover.

10. Remove "O" ring from housing and discard.

11. Remove balls (three) from spider, (figure 26) being careful not to lose any of the 53 needle bearings in each of the balls. (figure 27)

CLEANING AND INSPECTION

Wash all metallic parts thoroughly in a cleaning solvent. Dry with compressed air.

Rubber boot seal, "O" rings and clamp should be replaced whenever C.V. joint is disassembled for service.

NOTE: Housing may show a definite polished area where the balls travel but C.V. joint need not be replaced. However, if this wear pattern is suspected to be the cause of a noisy or vibrating C.V. joint, then the housing should be replaced.

1. Inspect housing for excessive wear, brinneling, cracks or chips in housing bore.

2. Inspect retaining rings for cracks or bends.

3. Inspect balls (three) for excessive wear, cracks, nicks, scores or breaks.

4. Inspect needle bearings for wear breaks or bends.

5. Inspect spider for excessive wear, chips or cracks.

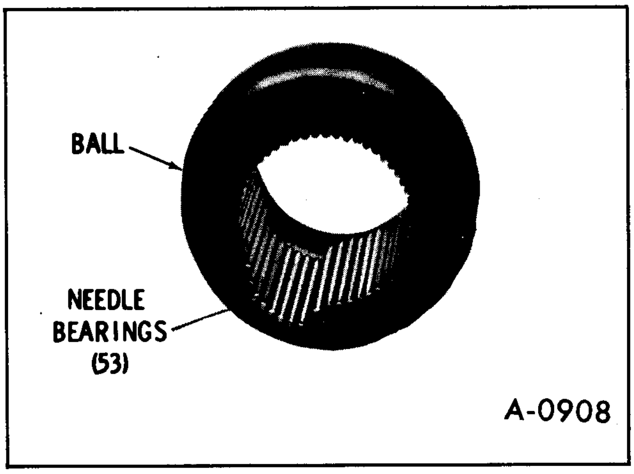


Figure 27—Spider Ball Needle Bearings

ASSEMBLY

1. Slide new clamp on axle shaft, to be used after seal positioning.

2. Slide seal onto axle shaft.

3. Position retaining ring on axle shaft in the inner groove. (figure 28)

4. Using Lubricant, No. 1050802, or equivalent load balls (three) with the needle bearings (53 to each ball). (figure 23)

5. Carefully install balls on each of the spider journals. (figure 26)

NOTE: A rubber band may be used to retain balls in position until spider assembly is installed in housing.

6. Position spider assembly on axle shaft and retain with retaining ring.

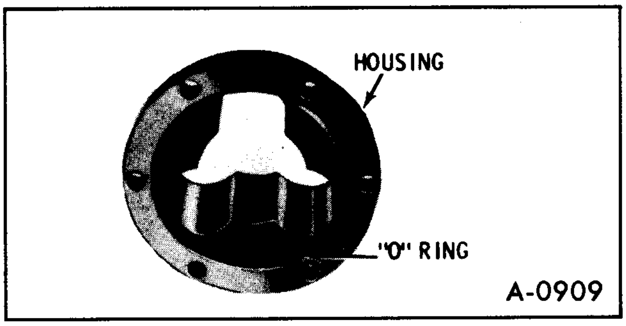


Figure 28—Installing "O" Ring in Housing

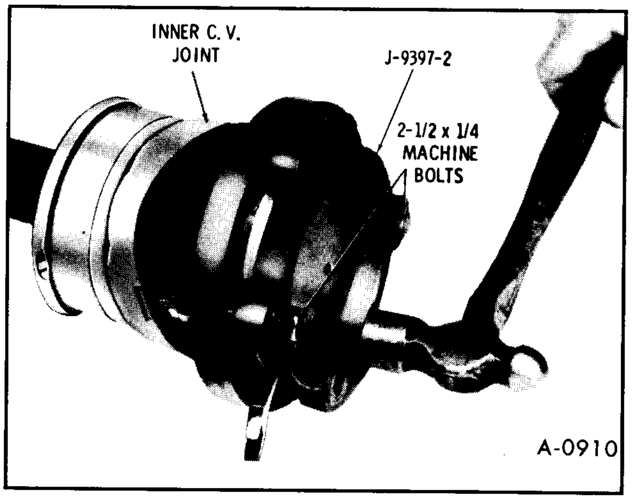


Figure 29—Installing Cover Into Housing

7. If rear cover was removed, install new "O" ring in housing and lubricate "O" ring with 1050802 lubricant or equivalent. (figure 28)

8. Install cover into housing using existing A/C Tool No. J-9397-2. Attach two machine bolts (1/4" x 2-1/4" Lg.) as shown in Figure 29 and tighten bolts alternately while tapping lightly with hammer until cover bottoms.

CAUTION: *Be careful that seal is positioned correctly so that "O" ring is not cut.*

9. Install new "O" ring in outer groove in housing. (figure 30)

10. Pack housing approximately one-half full with lubricant 1050802 or equivalent.

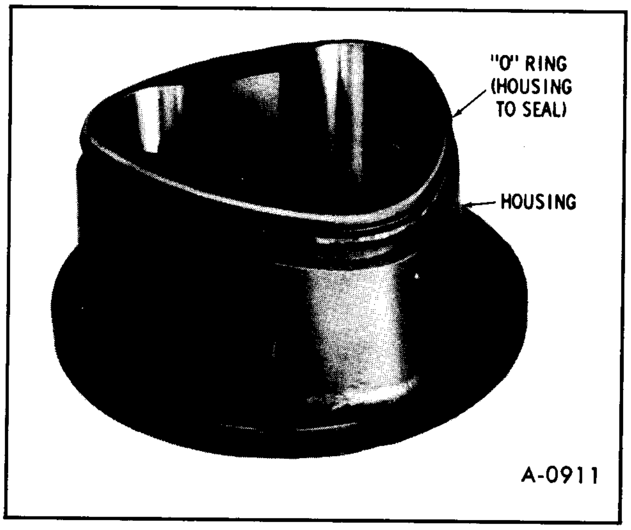


Figure 30—Installing "O" Ring on Housing

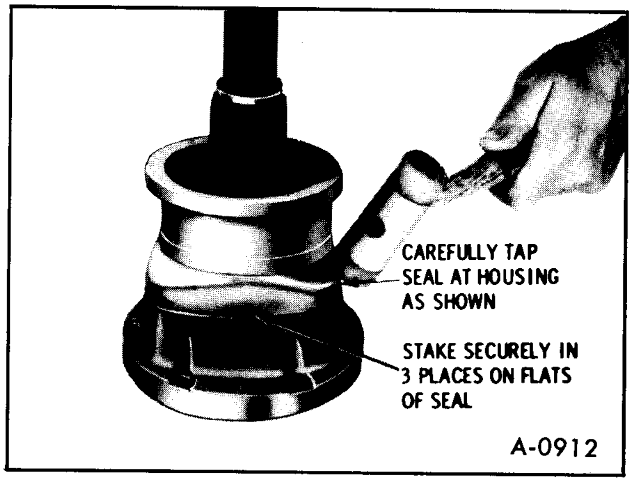


Figure 31—Installing Seal to Housing

11. Remove rubber band, if used, from spider assembly.

12. Position spider assembly in line with housing assembly and push into housing until bottomed. (figure 22)

13. Fill housing with lubricant 1050802 or equivalent.

14. Lubricate inside of boot seal retainer and housing outer groove "O" ring with 1050802 lubricant or equivalent.

CAUTION: *Be careful that seal retainer is positioned so that "O" ring is not cut.*

15. With housing positioned as shown in Figure 31 tap seal retainer on three lobes alternately with plastic hammer as shown until firmly bottomed, then stake three places into staking groove.

16. Extend inboard joint to maximum length and position seal into furthest groove from joint in axle.

17. Install clamp following procedure outlined in Figures 15, 16, 17, 18, 19, and Outer C.V. Joint-Assembly-Step 13.

DRIVE AXLE

DISASSEMBLY

1. Remove drive axle assembly (Refer to DRIVE AXLE ASSEMBLY—R. or L. Removal).

2. Remove outer C.V. joint. Refer to Outer C.V. Joint-Disassembly.

3. Remove inner C.V. joint. Refer to Inner C.V. Joint-Disassembly.

ASSEMBLY

1. Assemble inner C.V. joint. Refer to Inner C.V. Joint Assembly.

2. Assemble outer C.V. joint. Refer to Outer C.V. Joint - Assembly.

3. Install drive assembly. (Refer to DRIVE AXLE ASSEMBLY - RIGHT OR LEFT INSTALLATION).

TORQUE SPECIFICATIONS

Application	Ft. Lbs.
R.H. Output Shaft Support to Engine Bolts	55
Drive Axle to Output Shaft Bolts	75
Drive Axle Nut at Wheel Hub	200
Tie Rod End to Knuckle Nut	40
Ball Joint Stud Nuts	60

Nut must be tightened to insert cotter pin.

SPECIAL TOOLS

J-5586	Snap Ring Pliers
J-9397-2	C.V. Joint Cover Installer
J-22716	C.V. Joint Boot Clamp Tool
J-24319	Pitman Arm, Idler Arm, Ball Joint Puller

SECTION 3C
FINAL DRIVE

CAUTION: *Final drive axle fasteners are an important attaching part in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.*

Contents of this section are listed below:

SUBJECT	PAGE NO.
Trouble Diagnosis	3C-1
General Description	3C-3
R.H. Output Shaft Bearing and Seal	3C-3
L.H. Output Shaft and Seal	3C-6
Transmission Filler Tube	3C-7
Final Drive	3C-7
Pinion Housing Seals	3C-8
Pinion Bearings	3C-12
Final Drive Case	3C-12
Final Drive Specifications	3C-20
Torque Specifications	3C-21
Special Tools	3C-21

TROUBLE DIAGNOSIS

Many noises reported as coming from the final drive actually originate from other sources such as tires, road surfaces, engine, transmission, muffler or body drumming. A thorough and careful check should be made to determine the source of the noise before disassembling the final drive. Noise which originates in other places cannot be corrected by adjustment or replacement of parts in the final drive. Final drive gears are not absolutely quiet and are acceptable unless some abnormal noise is present.

To make a systematic check for final drive noise under standard conditions, observe the following:

1. Select a level tarvia or asphalt road to reduce tire noise and body drumming.

2. Check final drive lubricant to assure correct level, then drive car far enough to thoroughly warm up the lubricant.

3. Note speed at which noise occurs. Then stop vehicle and with automatic transmission in neutral, run engine slowly up and down through engine speeds, corresponding to vehicle speed at which noise was most pronounced, to determine if it is caused by exhaust muffler roar or other engine conditions.

AXLE NOISES

Gear Noise

After the noise has been determined as being in the final drive by following the above appraisal procedure, the type of final drive noise should be determined to aid in making repairs if necessary.

Gear noise (whine) is audible from 20 to 65 mph under four driving conditions.

1. Drive - Acceleration or heavy pull.

2. Road load - Vehicle driving load or constant speed.

3. Float - Using enough throttle to keep the vehicle from driving the engine - vehicle slows down gradually but engine still pulls slightly.

4. Coast - Throttle closed and vehicle in gear. Gear has periods when noise is more prominent, usually 30 to 40 mph and 50 to 60 mph.

Bearing Noise

Bad bearings produce a rough growl or grating sound, rather than the whine typical of gear noise. Defective pinion or differential side bearing frequently causes a bearing "WOW-WOW" noise.

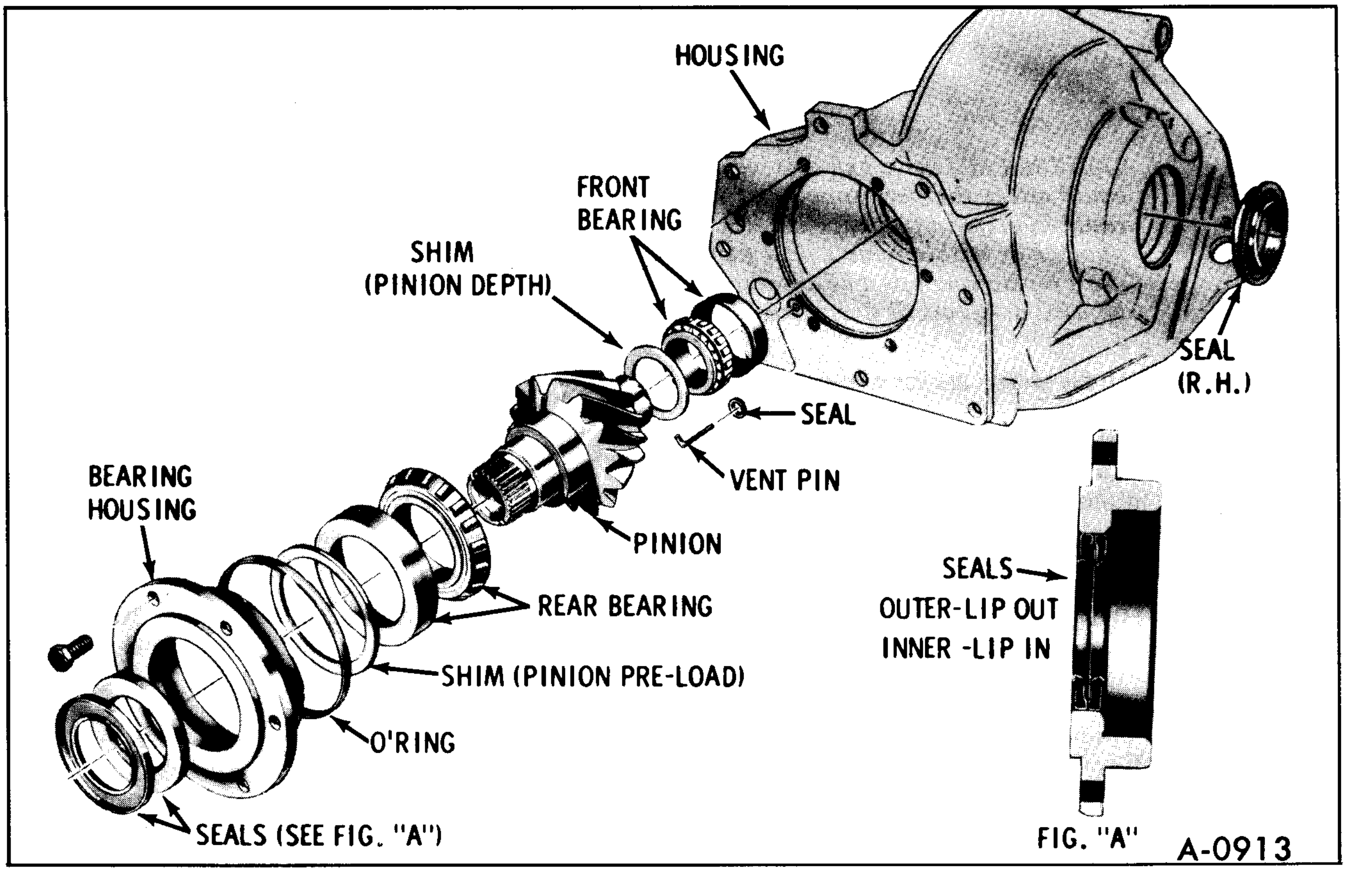


Figure 1—Final Drive Pinion Assembly

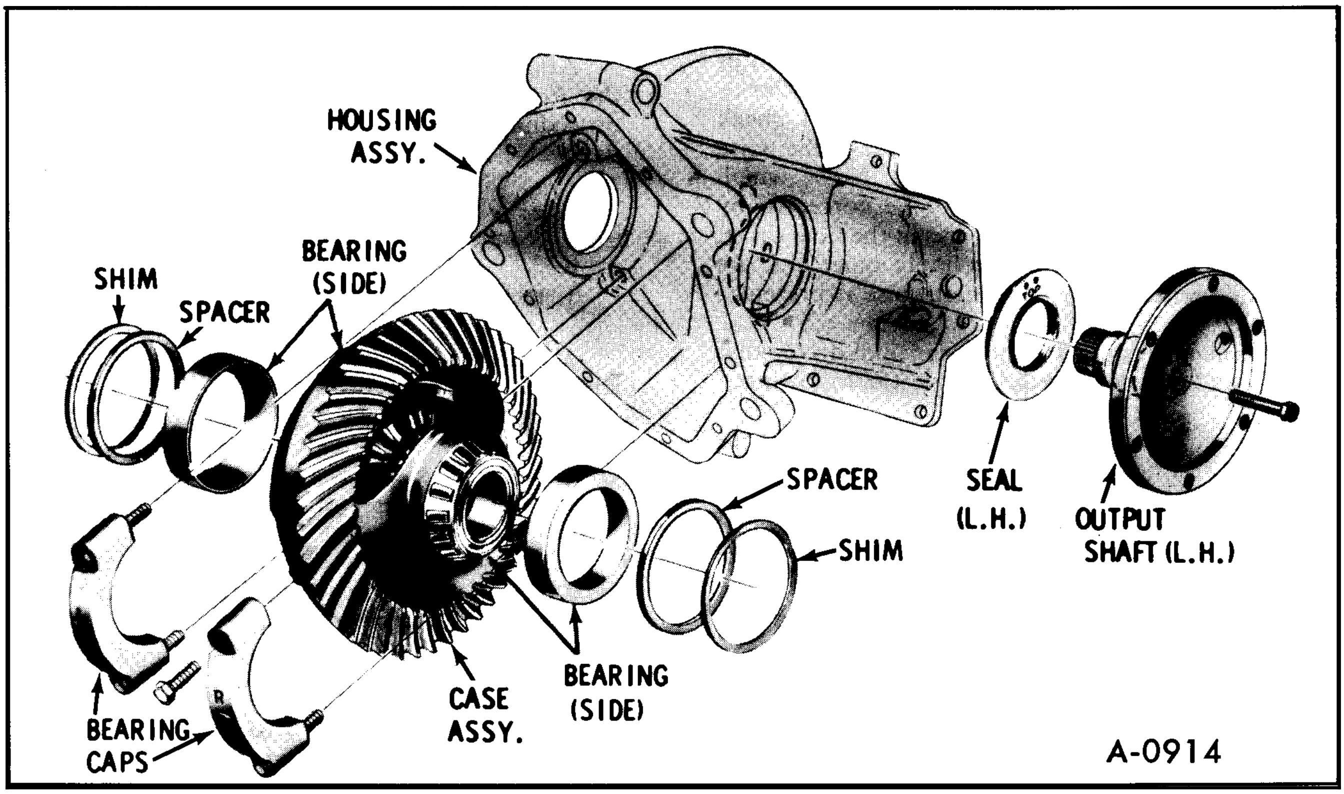


Figure 2—Final Drive Case Assembly

GENERAL DESCRIPTION (Figures 1, 2 and 3)

The final drive assembly, mounted and splined directly to the automatic transmission, consists of a pinion drive and ring gear set (with a ratio of 3.07:1), case assembly with two side gears and two pinion gears which are retained to the case with a pinion shaft. A lock pin is used instead of a bolt to lock the pinion shaft to the case. There are thrust washers used behind the side gears and shims behind the pinion gears the same as the conventional differential. The left side gear is different than the right side. It has a threaded retainer plate that the left output shaft bolts to. The two side bearings are the same and the pre-load shims are identical for the right and left side.

The left output shaft retainer bolt goes through the shaft to the side gear. The right output shaft has a vent hole in the flange.

CAUTION: *When removing or installing the right drive axle, be sure to disconnect the negative battery cable. It is possible to short out the starter motor by making contact between the wrench and the starter motor terminals.*

RH OUTPUT SHAFT, BEARING AND SEAL

REMOVAL

1. Disconnect negative battery cables.

2. Hoist vehicle.

3. Remove attaching bolts, R.H. drive axle to R.H. output shaft. Then move drive axle rearward until free from output shaft.

4. Disconnect support from engine. (figure 4)

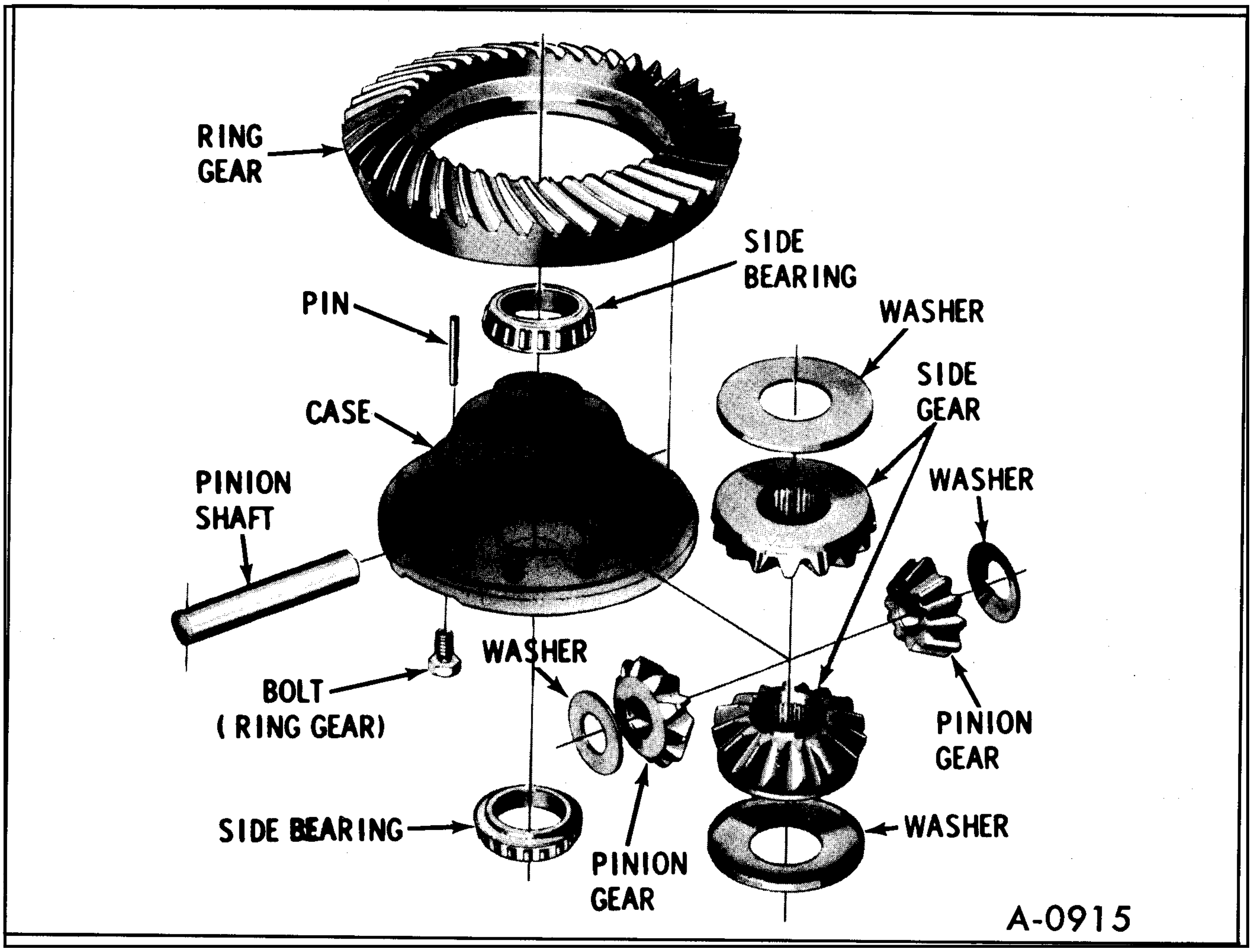


Figure 3—Final Drive Case Assembly (Exploded View)

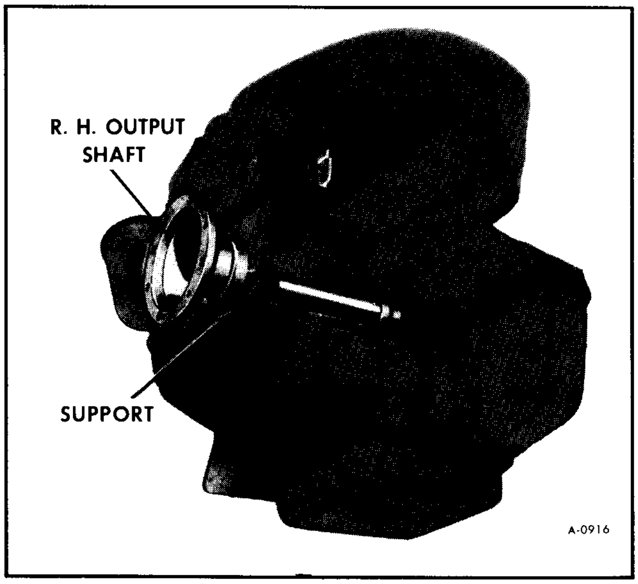


Figure 4—R.H. Output Shaft Attachment

5. Remove output shaft assembly.

6. If output shaft seal is to be replaced, install Seal Remover J-23129 into seal and drive seal out with a hammer. (figure 5)

7. If output shaft bearing is to be replaced, it can be removed with a press as shown in Figure 6.

INSTALLATION

See CAUTION on Page 3C-1 of this section.

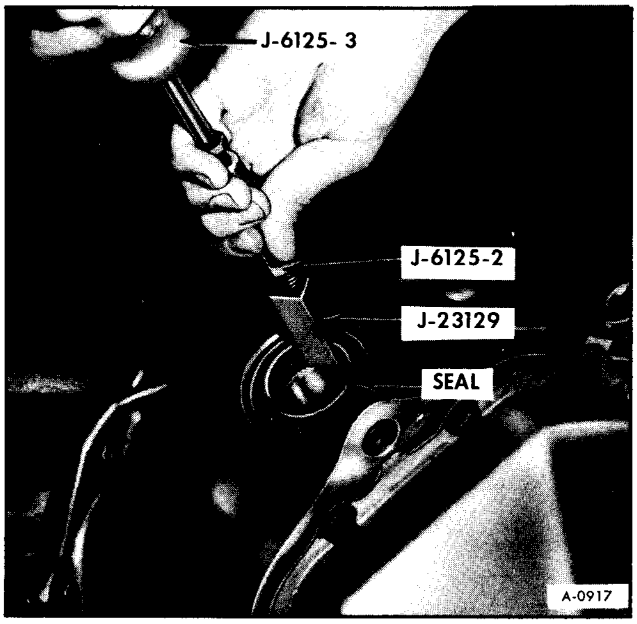


Figure 5—Removing R.H. Output Shaft Seal

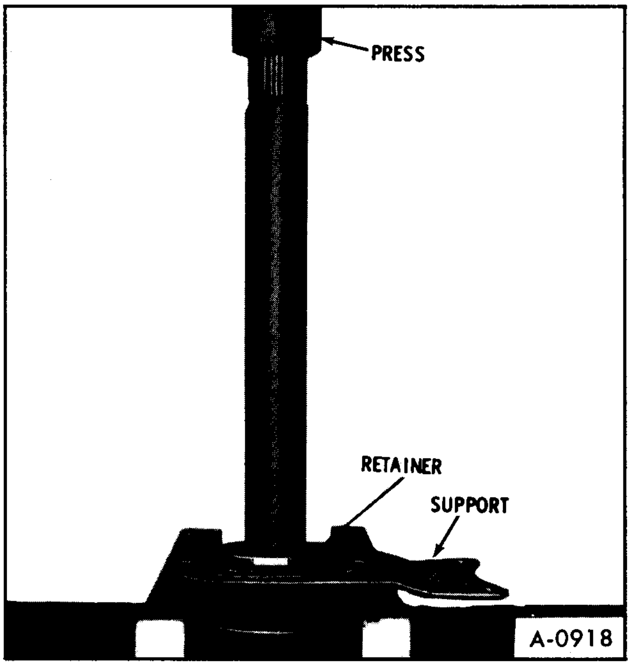


Figure 6—Removing R.H. Output Shaft Bearing

1. If output shaft bearing was removed, assemble parts as shown in Figure 7.

2. Position assembly in a press and install bearing until seated as shown in Figure 8.

3. Pack area between bearing and retainer with wheel bearing grease, then install slinger as shown in Figure 9.

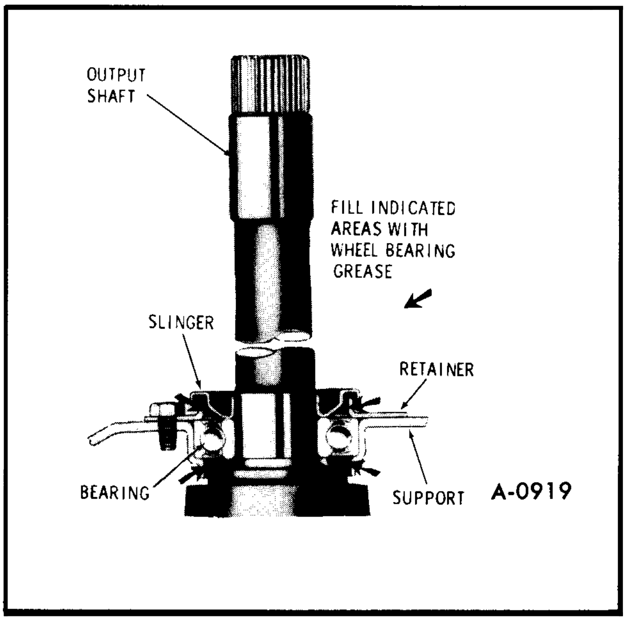


Figure 7—R.H. Output Shaft Assembly

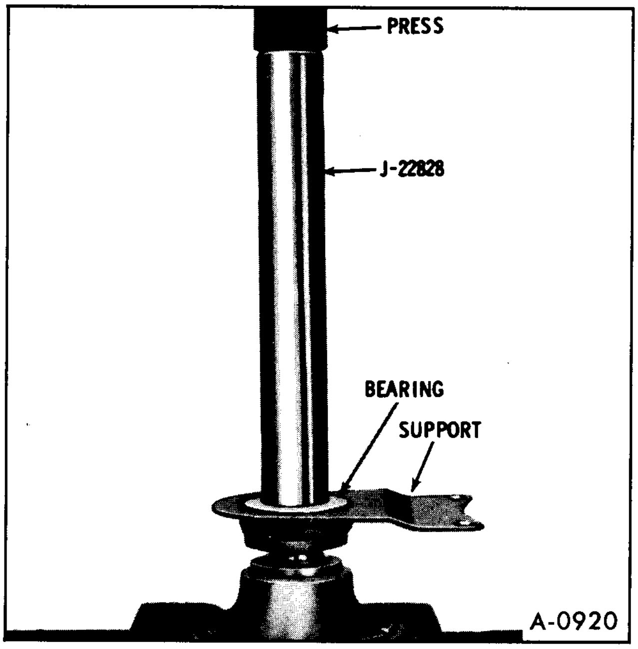


Figure 8—Installing R.H. Output Shaft Bearing

4. If output shaft seal was removed, new seal can be installed as shown in Figure 10.

5. Apply Special Seal Lubricant No. 1050169 or equivalent to output shaft seal, then install output

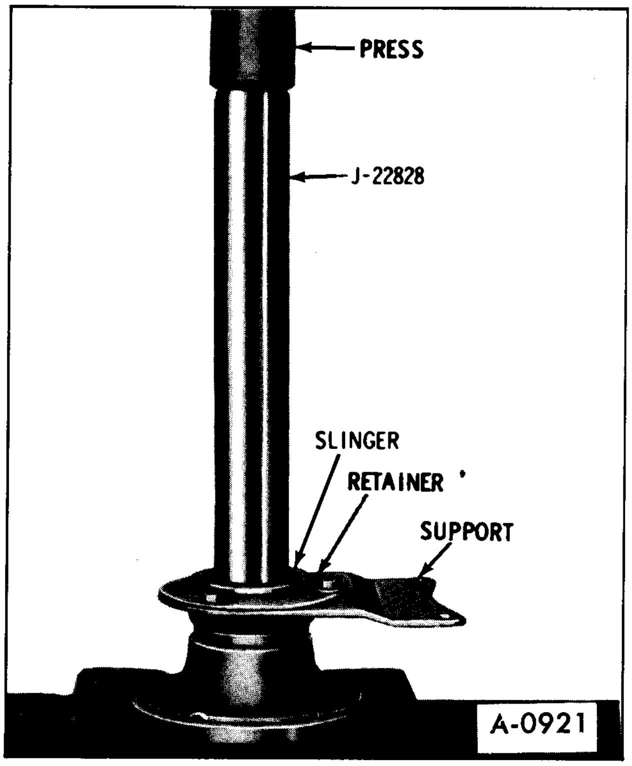


Figure 9—Installing Slinger

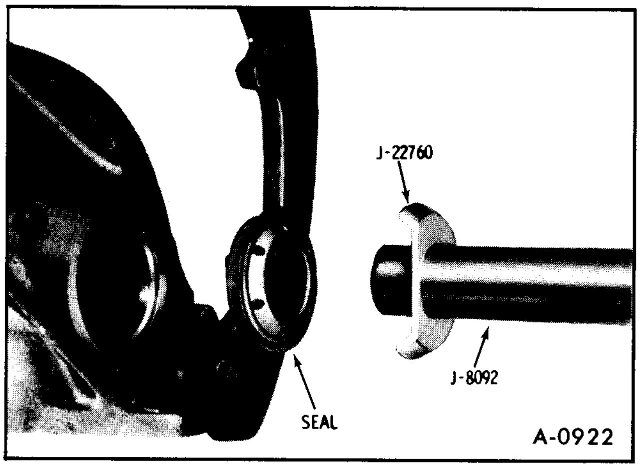


Figure 10—Installing R.H. Output Shaft Seal

shaft into final drive indexing splines of output shaft with splines in side gear.

6. Install support to engine and brace. (figure 4)

NOTE: When attaching the right hand output shaft to the engine, do not let the shaft hang. Assemble support bolts loosely, and by moving the flange end of the shaft up and down, and back and forth, find the center location. Hold the shaft in this position and then torque the bolts to 55 ft. lbs. on support. Figure 11.

7. Move drive axle forward until it aligns with output shaft. Install NEW attaching bolts. Torque to 75 ft. lbs.

8. Connect negative battery cables.

9. Check final drive oil level and check for oil leaks.

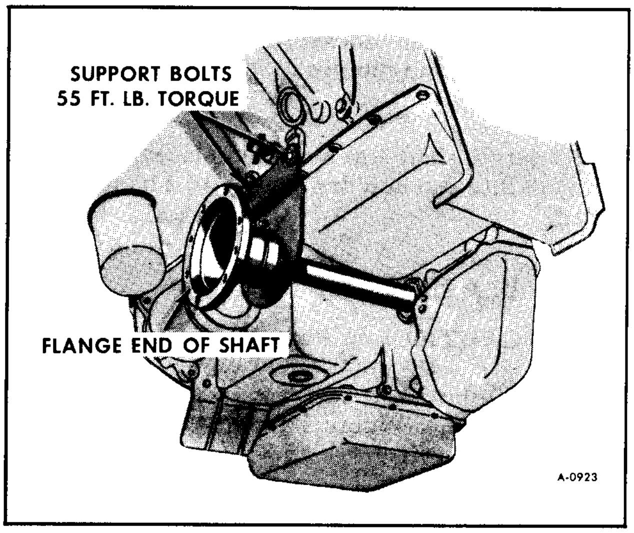


Figure 11—Aligning R.H. Output Shaft

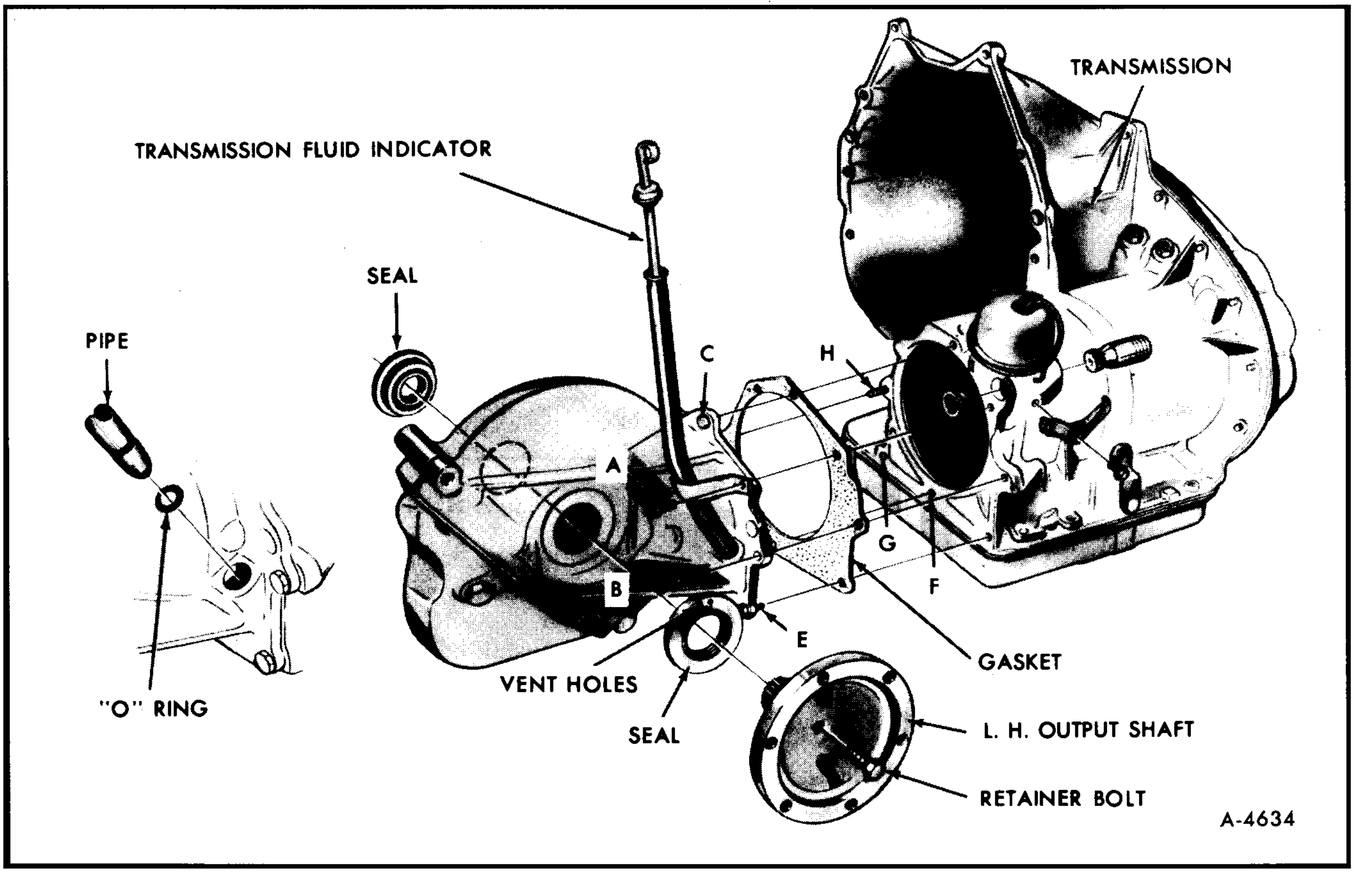


Figure 12—Final Drive Attachment

LH OUTPUT SHAFT AND SEAL

REMOVAL

1. Remove L.H. Drive axle. Refer to Section 3B "DRIVE AXLE ASSEMBLY (LEFT HAND)", Steps 1 through 12 under "REMOVAL".

2. Using a 9/16" socket remove L.H. output shaft retaining bolt and remove L.H. output shaft. (figure 12)

If output shaft seal is to be replaced, insert Tool J-23129 into seal and drive out with a hammer. (figure 13)

INSTALLATION

See CAUTION on Page 3C-1 of this section.

1. If output shaft seal was removed, install new seal as shown in Figure 14.

NOTE: Left output shaft seal is installed with vent hole toward top of final drive housing in the in-vehicle Position.

2. Apply Special Seal Lubricant No. 1050169 or equivalent to the seal; then, insert output shaft into

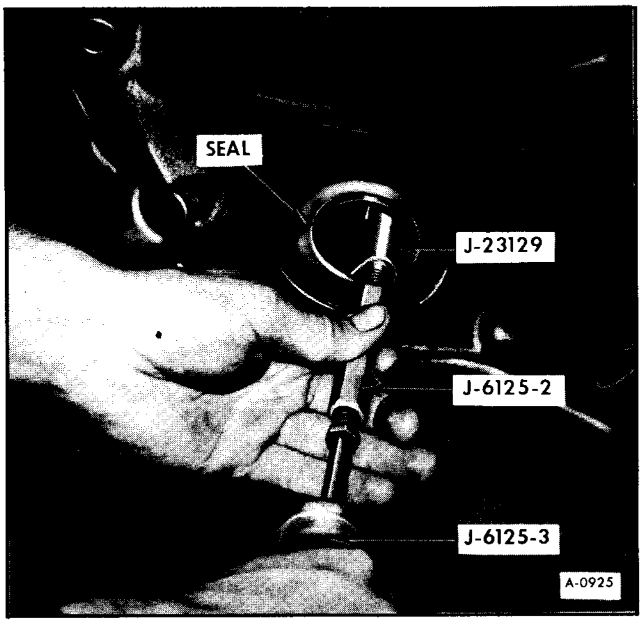


Figure 13—Removing L.H. Output Shaft Seal

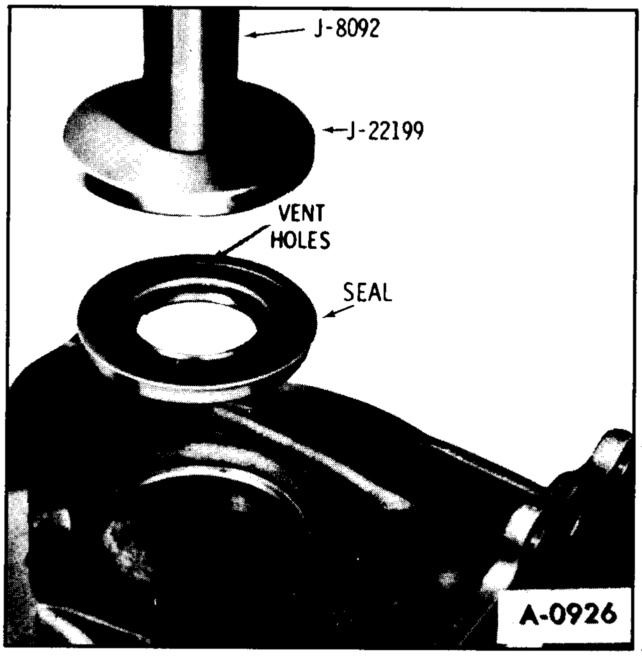


Figure 14—Installing L.H. Output Shaft Seal

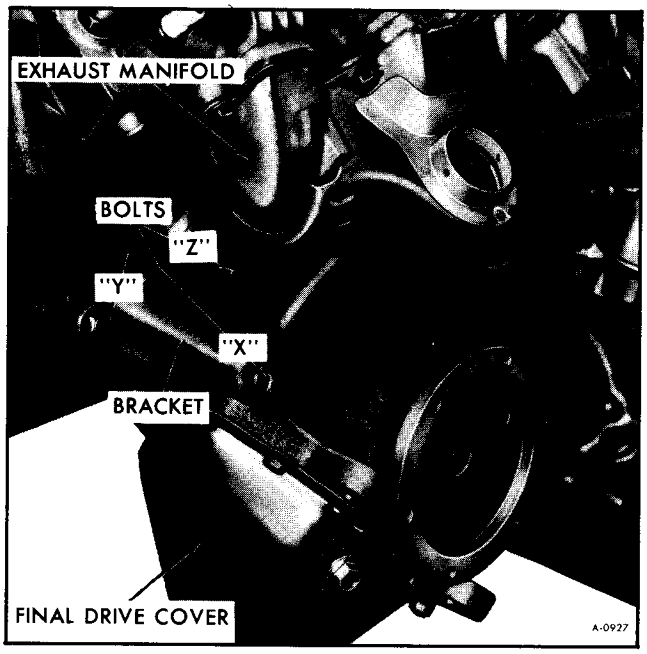


Figure 15—Disconnecting Final Drive From Engine

final drive assembly, indexing splines of output shaft with splines in side gear.

3. Install L.H. output shaft retaining bolt and torque to 45 ft. lbs. (figure 12)

4. Install L.H. drive axle. Refer to Section 3B, DRIVE AXLE ASSEMBLY (LEFT HAND), Steps 1 through 10 under INSTALLATION.

TRANSMISSION FILLER TUBE

REMOVAL AND INSTALLATION

The automatic transmission filler tube is located on the final drive. The filler tube can be removed by removing bolt "A", Figure 12 and then pulling the filler tube out of the housing. To install, position a new "O" ring seal on the filler tube. Coat seal with Special Seal Lubricant No. 1050169 or equivalent and install filler tube into housing. Install bolt "A" and torque to 25 ft. lbs.

FINAL DRIVE

REMOVAL

1. Disconnect battery.

2. Hoist vehicle.

3. Remove bolts "A", "B", and "C". (Figure 12)

4. Disconnect right and left drive axles from the output shafts.

5. Move R.H. Drive axle rearward until R.H. output shaft is clear to be removed from final drive.

6. Disconnect R.H. output shaft support from engine (figure 4) and remove from final drive.

7. Remove bolt "X" and "Y" and loosen "Z". (figure 15)

8. Remove final drive cover and allow lubricant to drain.

9. Position transmission jack with adapter for final drive as shown in Figure 16. Install an anchor bolt through final drive housing and lift pad.

NOTE: Adapters for removing final drive assemblies are available from most transmission jack manufacturers.

10. Remove bolts "E", "F" and "G" and nut "H" (figure 12).

11. Move transmission lift toward front of vehicle to disengage final drive splines from transmission.

NOTE: As the final drive is disengaged from transmission, some transmission fluid will be lost. Provide a container to prevent oil from running on floor.

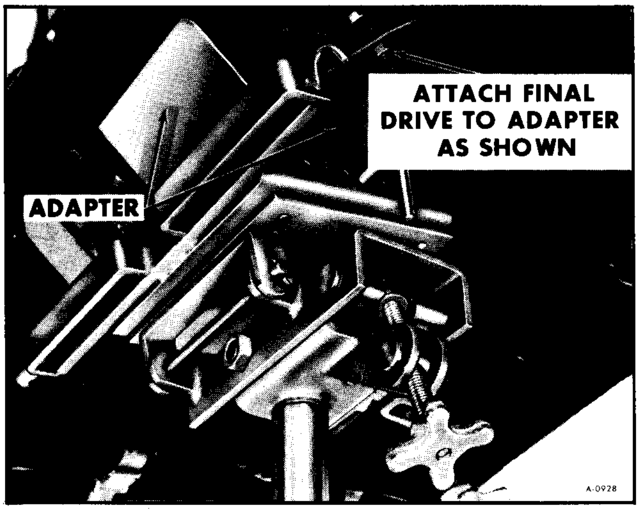


Figure 16—Connecting Lift to Final Drive

12. Pivot final drive support bracket upward for clearance.

13. Lower transmission lift and remove final drive from lift.

14. Using a 9/16" socket remove the left output shaft retainer bolt, then pull output shaft from final drive. (figure 12)

15. Remove transmission to final drive gasket.

INSTALLATION

See CAUTION on Page 3C-1 of this section.

1. Apply Special Seal Lubricant No. 1050169 or equivalent to both output shaft seals.

2. Install the left output shaft into the final drive. Retain with bolt. Torque bolt to 45 ft. lbs. (figure 12)

3. Position final drive on transmission lift and install an anchor bolt through housing and lift pad. (figure 16)

4. Apply a thin film of Special Seal Lubricant No. 1050169 or equivalent on the transmission side of a new final drive to transmission gasket, then position gasket on transmission.

5. Raise transmission lift. Align the bolt stud "H" on the transmission with the mating hole in the final drive. Move final drive until it mates with the transmission. (Figure 12)

NOTE: It may be necessary to rotate the left output shaft so that the splines of the final drive pinion engage the splines of the transmission output shaft. Do not allow gasket to become mispositioned while engaging splines.

6. Install bolts "E", "F" and "G" and nut "H" (figure 12). Install bolts "A", "B" and "C". (figure 12) Torque all final drive to transmission bolts to 30 ft. lbs. Torque nut to an approximate 30 ft. lbs.

7. Install bolt "X" and torque to 110 ft. lbs. Tighten and torque bolts "Y" and "Z" to 55 ft. lbs. (figure 15)

8. Loosen and remove lift from final drive.

9. Position a new cover gasket on the final drive, then install cover. Torque cover bolts to 30 ft. lbs.

10. Install right output shaft into final drive indexing splines of output shaft with splines of side gear. Install support bolts.

NOTE: When attaching the right hand output shaft to the engine, do not let the shaft hang. Assemble support bolts loosely, and by moving the flange end of the shaft up and down, and back and forth, find the center location. Hold the shaft in this position and then torque the bolts to 55 ft. lbs. on support. (Figure 11).

11. Connect drive axles to output shafts using NEW bolts. Torque bolts to 75 ft. lbs.

12. Raise hoist, remove floor stands and lower vehicle.

13. Install a new "O" ring and install filler tube.

14. Connect battery.

15. Fill final drive with four pints of Lubricant No. 1051022 or equivalent. Fluid level should be maintained at "Fill Level" stamped on final drive cover.

16. Start engine and check transmission fluid level. Add fluid as necessary.

17. Check for any oil leaks.

PINION HOUSING SEALS

REMOVAL

1. Remove final drive. Refer to final drive removal steps 1-13.

2. Remove the bearing housing bolts. Remove the drive pinion and housing as shown in Figure 24.

Remove housing from drive pinion. Remove "O" ring seal from O.D. of bearing housing.

3. Using a punch, drive seals out of housing on the opposite side of the rear pinion bearing outer race.

INSTALLATION

See CAUTION on Page 3C-1 of this section.

1. Position seals as shown in Figure 45 and using Tool J-22212, drive seals into housing until tool bottoms.

2. Position drive pinion into final drive and install Seal Protector J-22236 over end of pinion.

CAUTION: *Seal protector must be used or inner seal lip will fold between seal case and pinion shaft resulting in a leak.*

3. Install new "O" ring over O.D. of bearing housing and install bearing housing over seal protector into position on the housing. Torque bearing housing attaching bolts alternately to 45 ft. lbs. Remove seal protector.

4. Apply Special Seal Lubricant No. 1050169 or equivalent to right output shaft seal.

5. Install final drive. Refer to FINAL DRIVE—INSTALLATION steps 3-17.

FINAL DRIVE (REMOVED FROM VEHICLE)

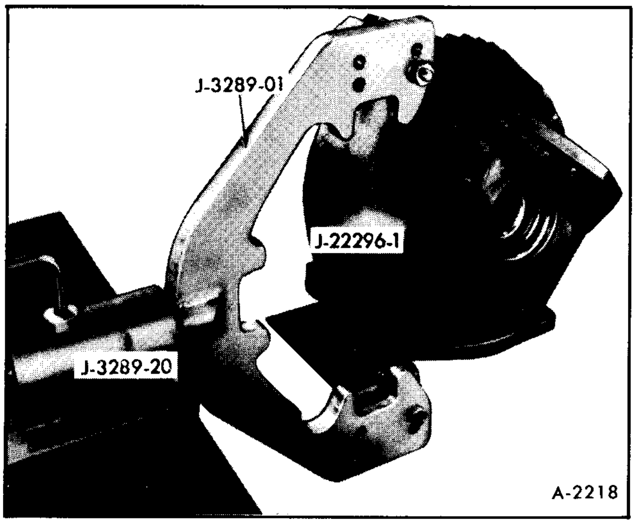


Figure 17—Final Drive Holding Fixture

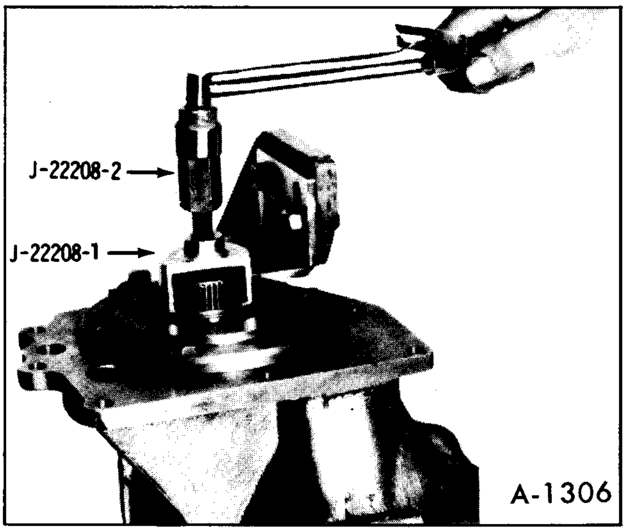


Figure 18—Checking Pinion and Side Bearing Pre-Load

DISASSEMBLY

1. Install adapter J-22296-1 on Differential Holding Fixture J-3289. Mount final drive in holding fixture as shown in Figure 17.

2. Rotate housing so that pinion is up. Install tools as shown in Figure 18, and turn torque wrench several turns and record torque reading. This combined pinion and side bearing pre-load reading will be helpful in determining cause of final drive failure. Remove tools and rotate carrier so that pinion is down.

3. Rotate differential case several times to seat bearings, then mount dial indicator as shown in Figure 19. Use a small button on the indicator stem so

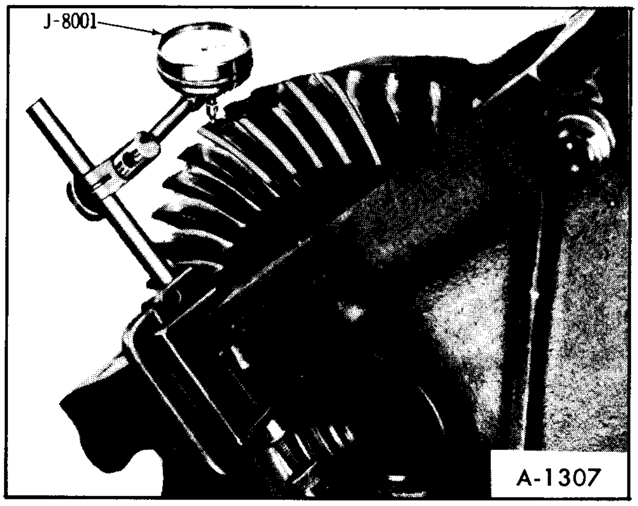


Figure 19—Checking Ring Gear to Pinion Gear Backlash

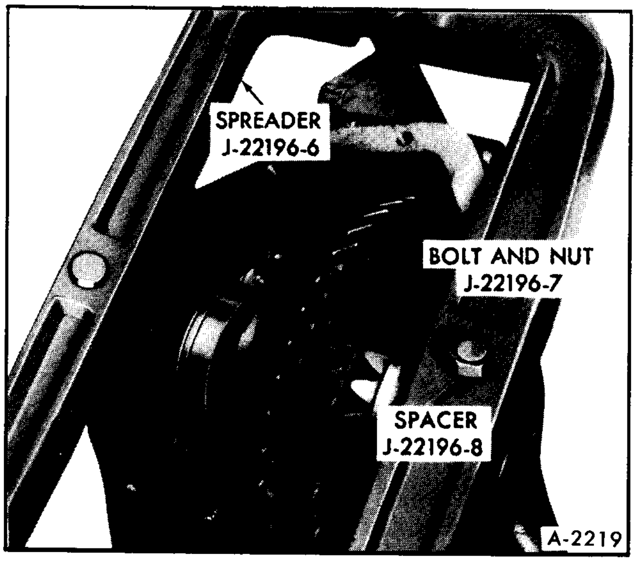


Figure 20—Spreader Installation

that contact can be made near heel end of tooth. Set dial indicator so that stem is in line as nearly as possible with gear rotation and perpendicular to tooth angle for accurate backlash reading.

4. Check backlash at three of four points around ring gear. Lash must not vary over .002" around ring gear.

NOTE: Pinion must be held stationary when checking backlash. If variation is over .002" check for burrs, uneven bolting conditions or distorted case and make corrections as necessary.

5. Remove side bearing cap bolts.

NOTE: Bearing caps are of same size and must be installed in their original position. Mark right and left bearing caps to identify for reassembling. Keep the original bearing outer races with their corresponding caps.

6. Install spreader on housing as shown in Figure 20.

NOTE: Spreader must be modified with Tools J-22196-7-8.

7. Turn the spreader screw to expand spreader until the spacer and shim(s) can be removed from between the right side bearing and the housing. Retain spacers and shims for reassembly.

NOTE: Spread housing only enough to relieve tension on the spacer and shims. The shims may be removed with Tool J-22608 as shown in Figures 21 and 22.

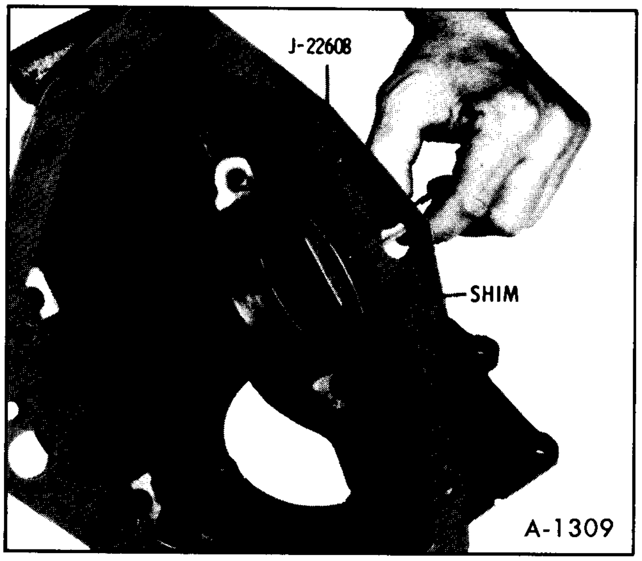


Figure 21—Removing Shims

8. Remove spreader from housing.

9. Remove the spacer and shims, then slide the case assembly to the left, away from the pinion gear. Remove case assembly from housing.

10. Rotate housing so that the pinion is up. Check pinion bearing pre-load as shown in Figure 23. Record the pinion bearing pre-load.

11. Remove the bearing housing bolts. Remove the drive pinion and housing as shown in Figure 24. Remove housing from drive pinion. Remove "O" ring seal from bearing housing.

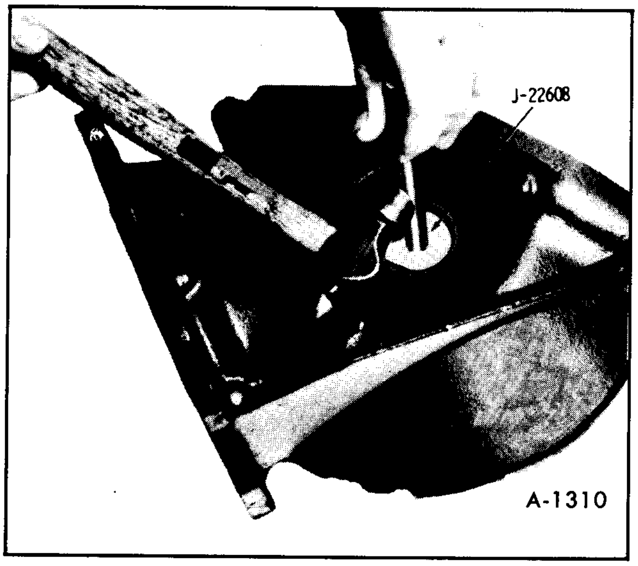


Figure 22—Positioning Tool J-22608

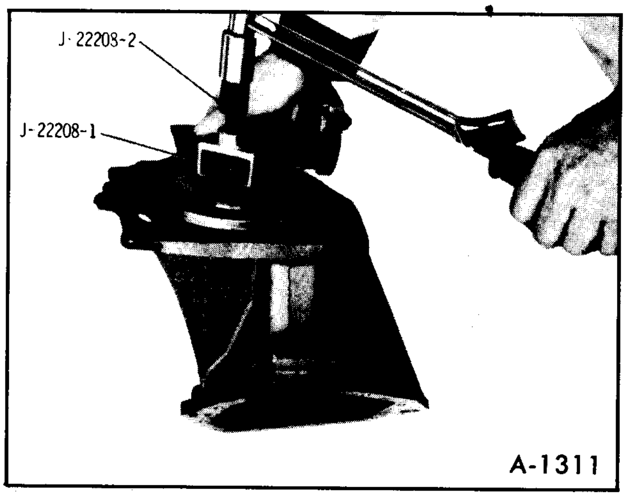


Figure 23—Checking Pinion Pre-Load

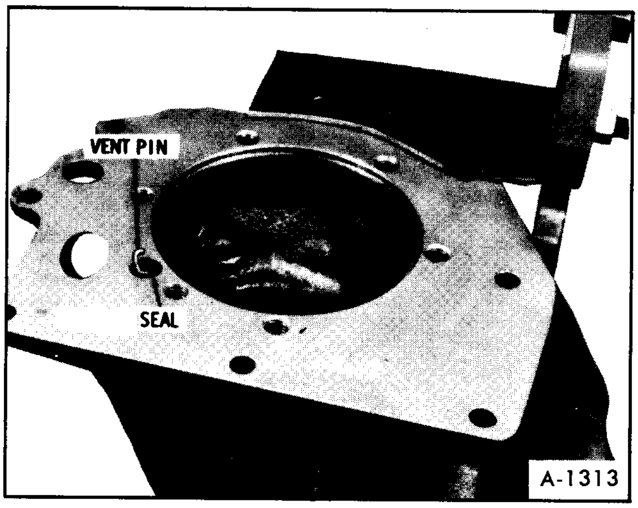


Figure 25—Removing Vent Pin And Seal

12. Remove seal and vent pin from housing. (figure 25)

13. Install Tool J-22201 on Slide Hammer J-2619. Position Tool J-22201 as shown in Figure 26, and tighten screw. Remove pinion front bearing outer race.

14. Remove the output shaft oil seals as shown in Figures 5 and 13.

15. Remove the two oil seals from the pinion bearing housing as shown in Figure 27.

16. If necessary to remove the pinion rear outer race, it can be removed as shown in Figure 28.

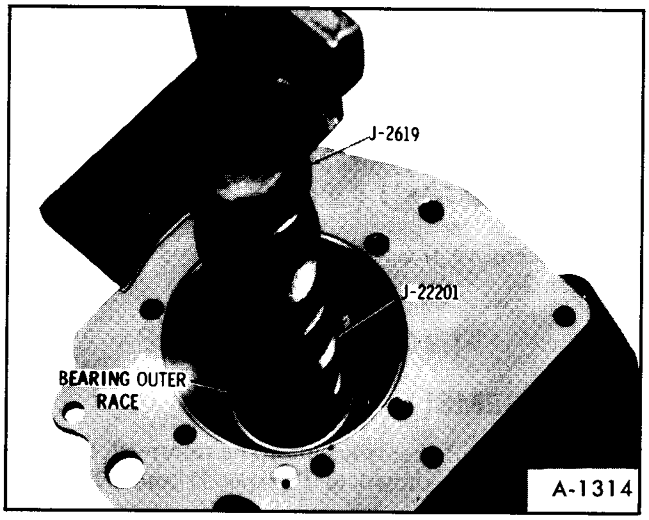


Figure 26—Removing Pinion Front Bearing Outer Race

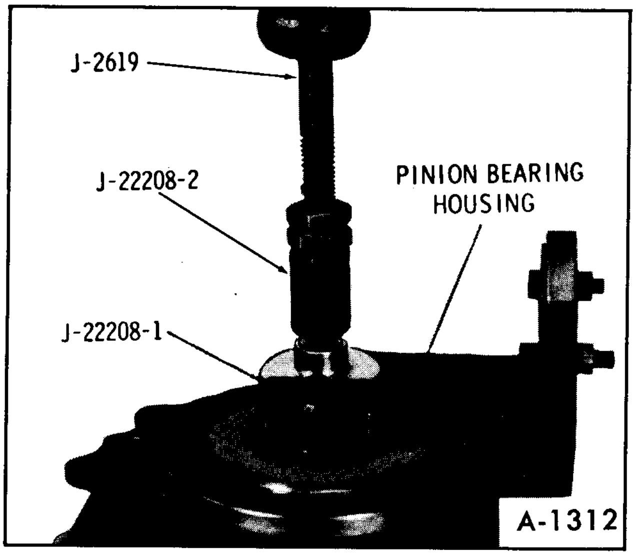


Figure 24—Removing Pinion And Bearing Housing

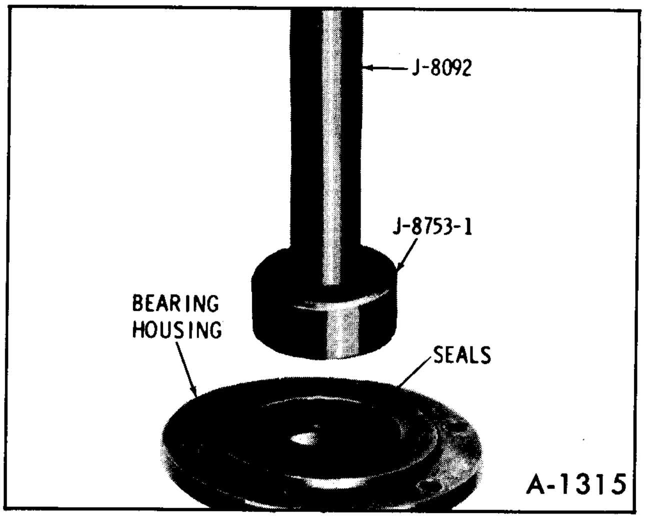


Figure 27—Removing Oil Seals From Pinion Bearing Housing

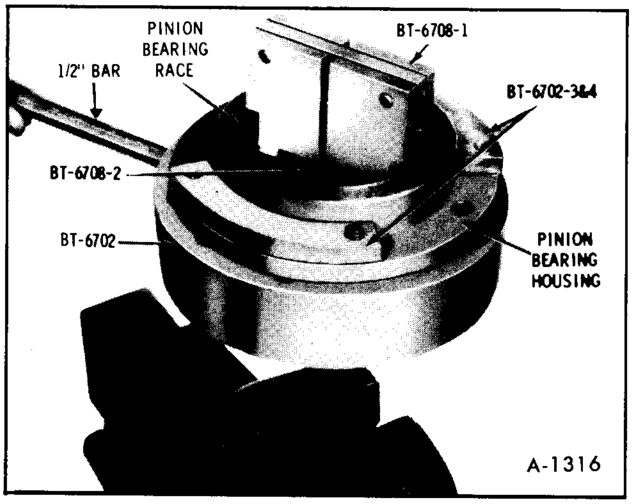


Figure 28—Removing Pinion Rear Bearing Outer Race

PINION BEARINGS

REMOVAL

1. Remove the pinion front bearing and selective shim as shown in Figure 29. Bearing can be removed without Tool J-8433-1 if a press is available.

2. Remove the pinion rear bearing as shown in Figure 30.

FINAL DRIVE CASE

DISASSEMBLY

1. If the side bearings are to be removed, they can be removed as shown in Figures 31 and 32.

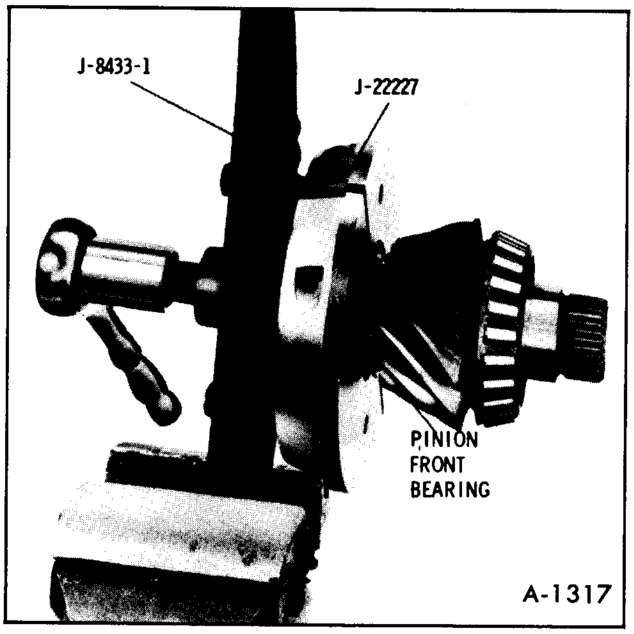


Figure 29—Removing Pinion Front Bearing

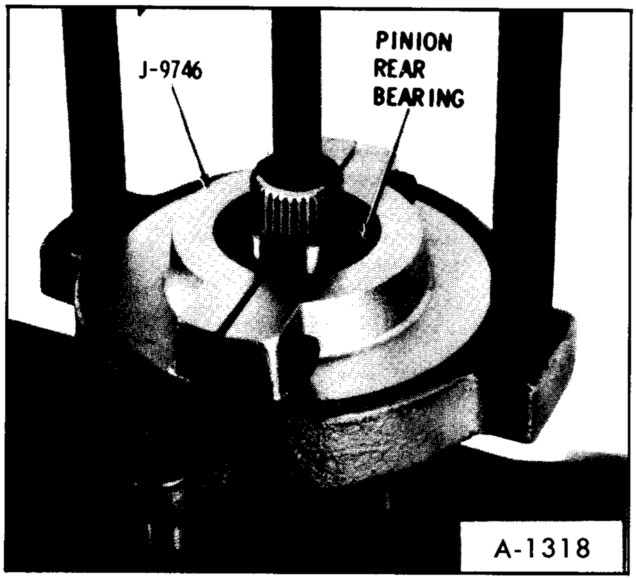


Figure 30—Removing Pinion Rear Bearing

2. Mark ring gear and case, then remove all but two of the case to ring gear bolts. Leave two of the bolts, 180° apart, loose.

NOTE: Ring gear must be removed to remove pinion and side gears.

3. Position case as shown in Figure 33 and tap lightly on a bench to separate the case from ring gear.

4. Remove the two remaining ring gear bolts and separate ring gear from case.

5. Drive lock pin from pinion shaft with a 3/16" punch (figure 34).

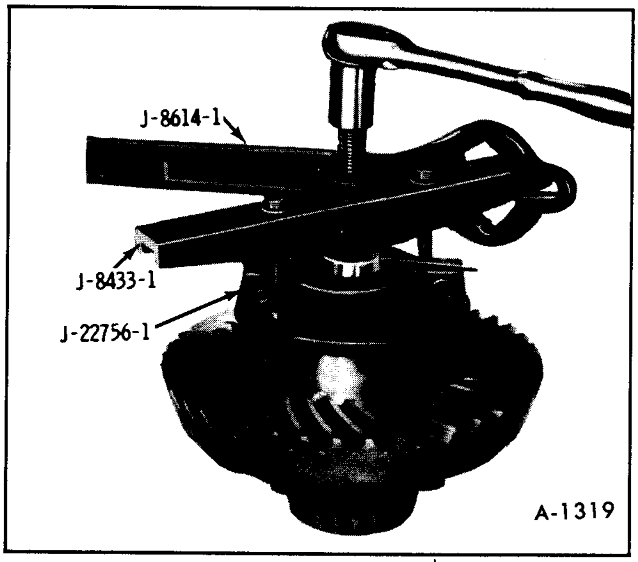


Figure 31—Removing Left Side Bearing

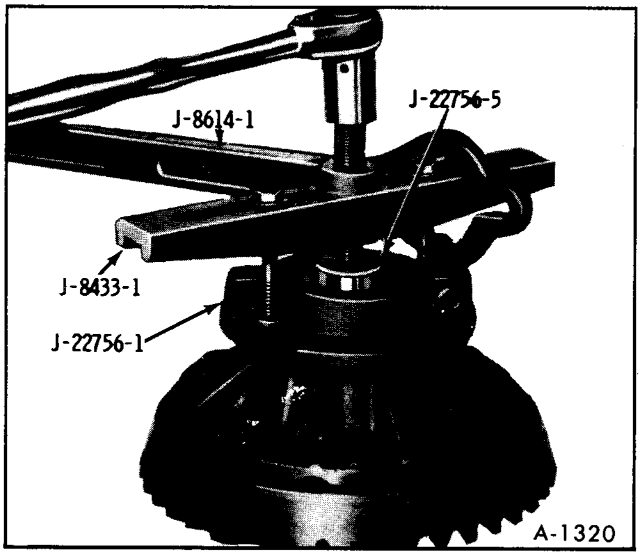


Figure 32—Removing Right Side Bearing

6. Push pinion shaft out of case.

7. Rotate one pinion gear and shim towards access hole in case and remove.

NOTE: Keep the corresponding shims and pinion gear together for correct assembly.

8. Remove the other pinion gear and shim.

9. Remove side gears keeping the same thrust washer with the side gear it is mated with. Inspect thrust washers and shims for wear and replace as necessary.

NOTE: The left side gear has the threaded retainer that retains the (short) left output shaft.

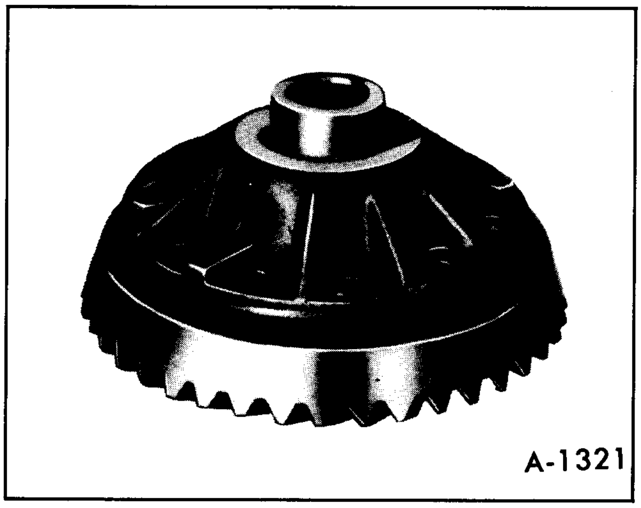


Figure 33—Separating Ring Gear From Case

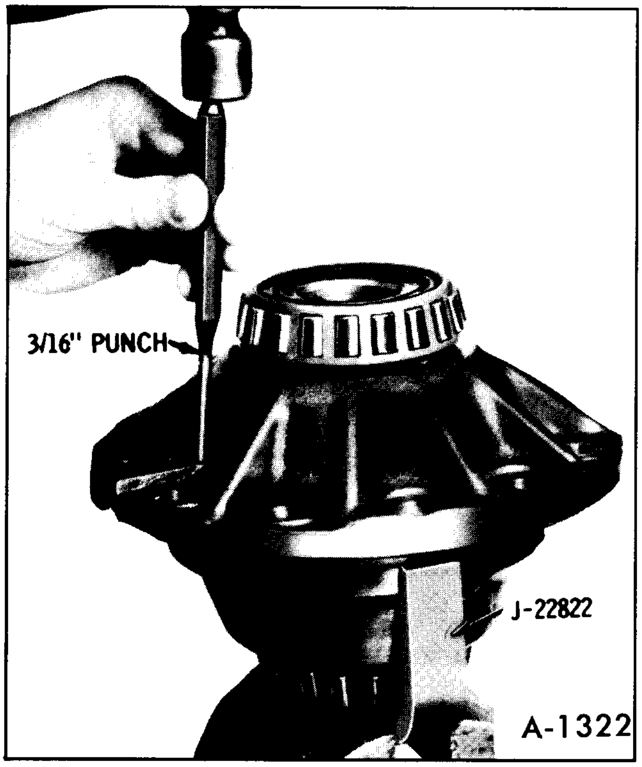


Figure 34—Removing Lock Pin From Pinion Shaft

If threaded retainer is to be removed, use a brass drift and hammer to remove from left side gear.

CLEANING AND INSPECTION

1. Clean all bearings throughly in clean solvent. (Do not use a brush). Examine bearings visually and by feel. All bearings should feel smooth when oiled

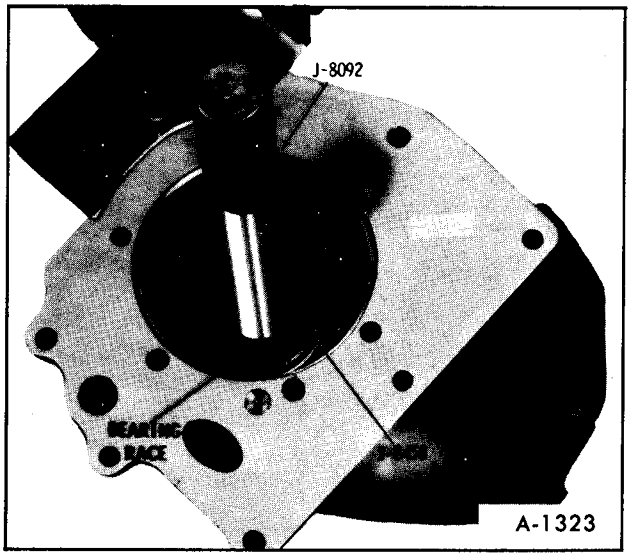


Figure 35—Installing Pinion Front Bearing Outer Race

and rotated while applying as much hand pressure as possible.

NOTE: Minute scratches and pits that appear on rollers and races at low mileage are due to the initial pre-load and bearings having these marks should not be rejected.

2. Examine the ring gear and drive pinion teeth for excessive wear and scoring. Any of these conditions will require replacement of the gear set.

3. Examine housing bores and remove any burrs that might cause leaks around the OD of the seal.

4. Inspect the differential pinion shaft for unusual wear; also check the pinion and side gears and thrust washers.

5. Side beatings must be a tight press fit on the hub.

6. Diagnosis of a differential failure such as chipped bearings, loose (lapped-in) bearings, chipped gears etc. is a warning that some foreign material is present; therefore, the housing must be thoroughly cleaned and inspected.

CHECKING PINION DEPTH

1. Install pinion front outer race as shown in Figure 35. Drive race until it bottoms.

2. Lubricate front bearing with final drive lubricant and install into front outer race.

3. Position Tool J-21777-10 on front bearing. Install Tool J-21579 on final drive housing and retain

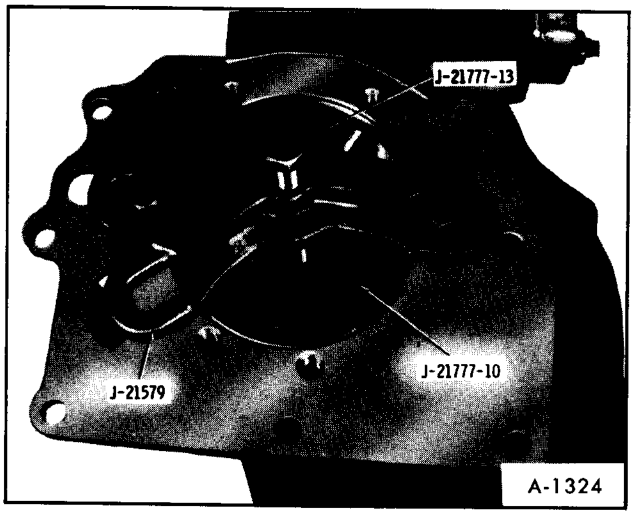


Figure 36—Pre-Loading Pinion Front Bearing

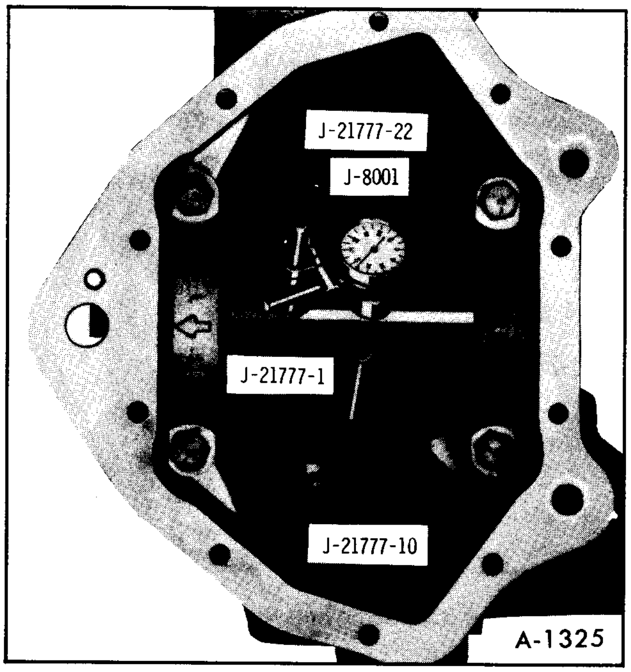


Figure 37—Pinion Depth Gauge Tool Installation

with two bolts. Thread screw J-21777-13 into J-21579 until tip of screw engages Tool J-21777-10. Torque screw J-21777-13 to 20 in. lbs. to pre-load bearing. (figure 36)

4. Remove dial indicator post from Tool J-21777-1 and install Discs J-21777-22 as shown in Figure 37. Reinstall dial indicator post.

5. Place the gauging discs in the side bearing bores and install the side bearing caps. Torque cap bolts to 75 ft. lbs.

6. Position the dial indicator, J-8001 on the mounting post of the gauge shaft and with the contact rod OFF the gauging area of J-21777-10. Set dial indicator on ZERO, then depress the dial indicator until the needle rotates 3/4 turn clockwise. Tighten the dial indicator in this position. RESET DIAL INDICATOR ON ZERO.

7. Position the gauge shaft assembly in the housing so that the dial indicator contact rod is directly in line with the gauging area BUT NOT ON and the discs seated fully in the side bearing bores.

8. Rotate the gauge shaft assembly until the dial indicator rod contacts the gauging area of J-21777-10. Rotate gauge shaft slowly back and forth until the dial indicator reads the greatest deflection.

9. At the point of greatest deflection, read the dial indicator directly for pinion depth.

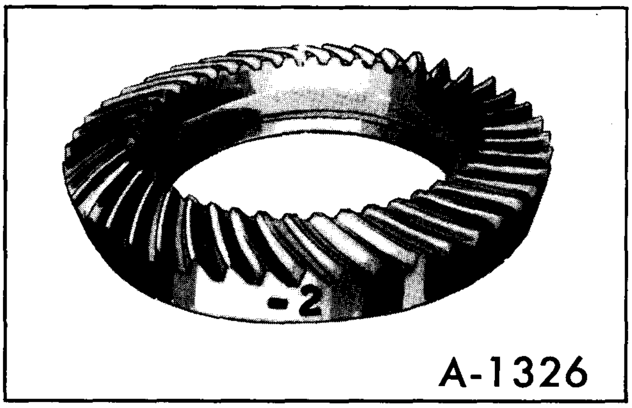


Figure 38—Location of Pinion Marking

10. Select the correct pinion shim to be used during pinion reassembly on the following basis:

a. If a service gear set or a production gear set with no paint marking, on outer circumference of ring gear is being used, the correct shim will have a thickness equal to the indicator gauge reading found in Step 9. (figure 38)

b. If the gear set being used is painted "+" or "-", the correct shim will be determined as follows.

Ring gear painted "+" (plus), the shim thickness indicated by the dial indicator on the pinion setting gauge must be INCREASED by the amount painted on the ring gear. (figure 38)

Ring gear painted "-" (minus), the shim thickness indicated by the dial indicator on the pinion setting gauge must be DECREASED by the amount painted on the ring gear. (figure 38)

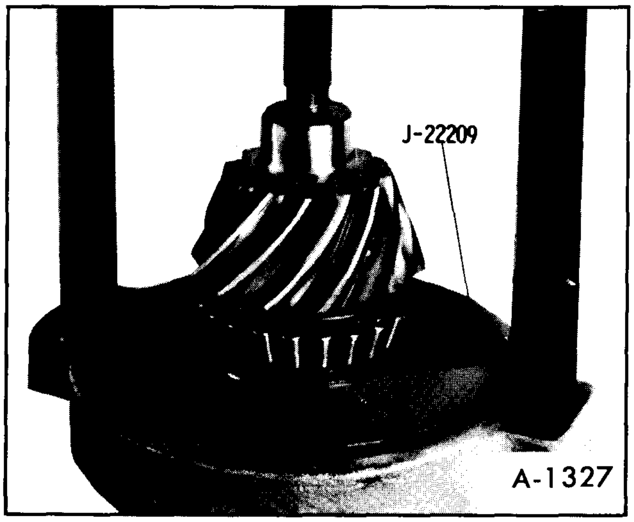


Figure 39—Installing Pinion Rear Bearing

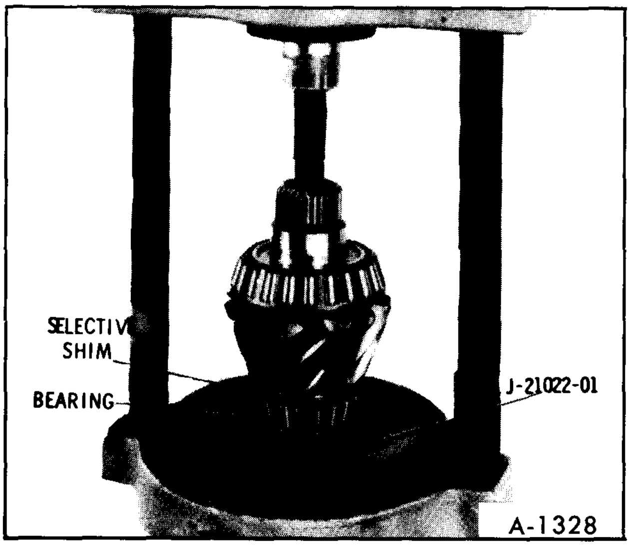


Figure 40—Installing Pinion Front Bearing And Shim

11. Remove pinion depth checking tools and front bearing from housing.

12. Install rear pinion bearing as shown in Figure 39.

NOTE: Shims are available from .040" to .070" in increments of .002".

13. Position correct shim on drive pinion and install the drive pinion front bearing as shown in Figure 40.

PINION BEARING PRE-LOAD ADJUSTMENT

1. The pre-load shim will have to be changed or

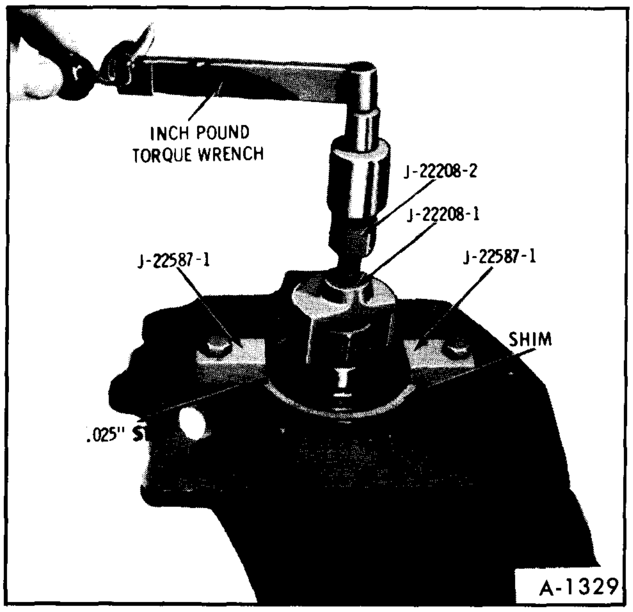


Figure 41—Checking Shim Thickness for Pinion Bearing

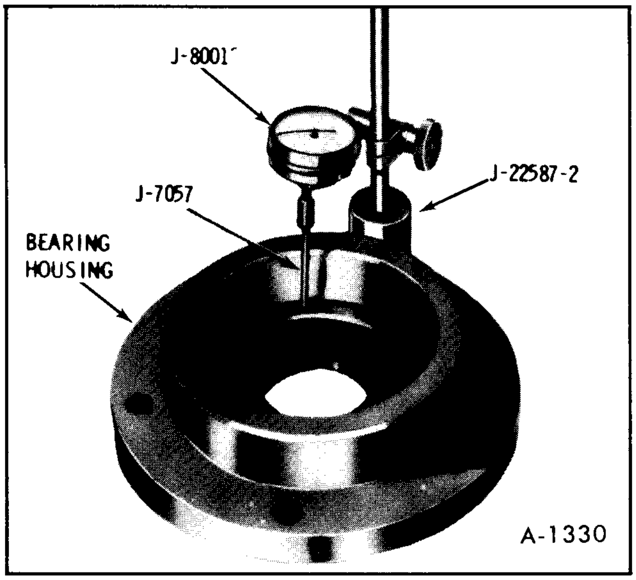


Figure 42—Checking Inner Flange Of Housing

checked any time the following parts have been replaced:

a. Ring gear and pinion.

b. Pinion bearings (front or rear).

c. Rear bearing retainer.

d. Final drive housing.

2. Position pinion bearing race on pinion bearing and install Tool J-22587-1 as shown in Figure 41. Using a feeler gauge check thickness between bearing race and Tool J-22587-1. Loosen bolts holding Tool

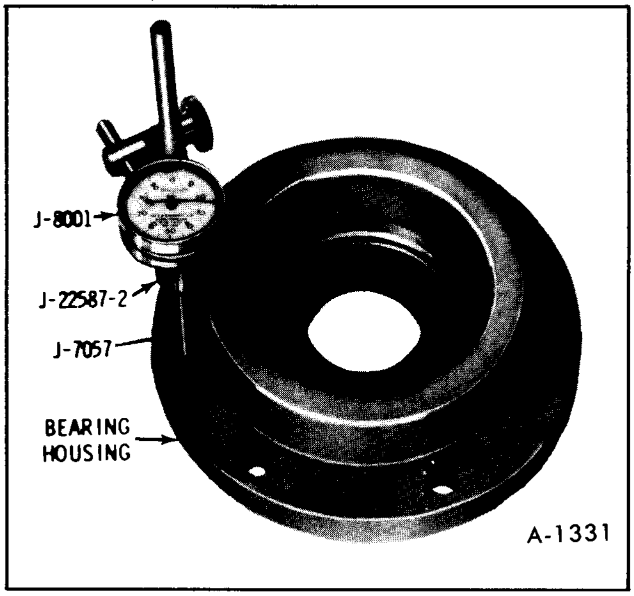


Figure 43—Checking Outer Flange Of Housing

J-22587-1 so that pinion bearing shim can be installed. Shims are available in sizes from .036" to .070" in increments of .002". Add shims until a preload of 2 to 5 in. lbs. for used bearings, 2 to 5 in. lbs. for new bearings is obtained. RECORD FINAL SHIM THICKNESS.

3. Remove Tool J-22587-1.

4. With dial indicator J-8001 and extension J-7057, attach existing dial indicator post to Tool J-22587-2. (figure 42) While holding contact studs (three) of Tool J-22587-2 firmly against shoulder of bearing housing, position dial indicator as shown in Figure 42 and rotate dial to ZERO.

5. Carefully lift dial indicator assembly over flange of bearing housing and position assembly as shown in Figure 43. With the three contact studs held firmly against shoulder of bearing housing, read the dial indicator deflection. RECORD THIS DEFLECTION.

The following is an example of finding the correct pinion bearing pre-load with information obtained above.

(Shims recorded in Step 2)	.053"
(Diff. in housing - Step 5)	+.024"
	.077"
(Built in step in Tool J-22587-1)	-.025"
	.052"
(To compensate for increase in pre-load when installing housing)	-.002"
(Actual pinion bearing pre-load shim required)	.050"

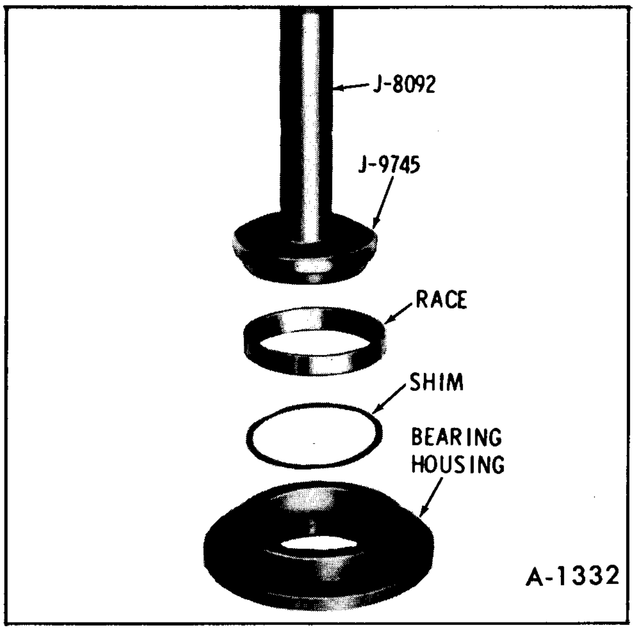


Figure 44—Installing Pinion Rear Bearing Outer Race

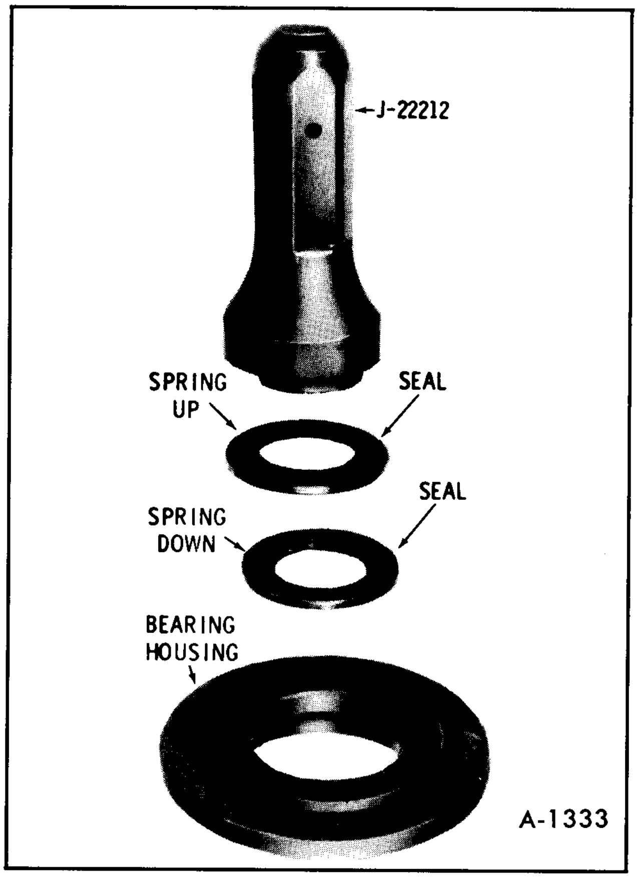


Figure 45—Installing Seals Into Bearing Housing

6. Position shim into bearing housing and install pinion rear bearing outer race as shown in Figure 44.

7. Install seals into bearing housing as shown in Figure 45.

8. Install a new "O" ring seal on the bearing housing.

9. Install seal and vent pin on face of housing. (figure 25)

10. Install seal protector J-22236 over drive pinion and install bearing housing over seal protector and position on the final drive housing. Torque the attaching bolts to 45 ft. lbs. (figure 46). Remove Tool J-22236.

> **CAUTION:** *Seal protector must be used or inner seal lip will fold between seal case and pinion shaft resulting in a leak.*

11. Reinstall Tool J-22208-1-2 and recheck pinion pre-load. Must be two to five in. lbs. for used bearings, two to 15 in. lbs. for new bearings (figure 23).

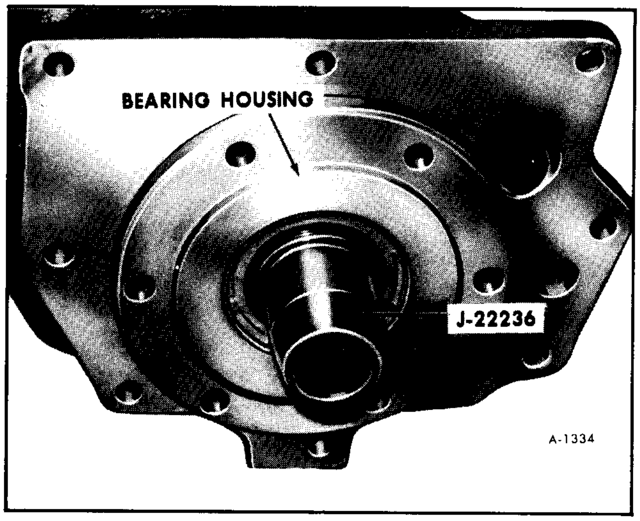


Figure 46—Installing Bearing Housing Into Final Drive Housing

CASE ASSEMBLY

Side Bearing

Installation

1. Install the side bearings as shown in Figures 47 and 48. Drive evenly until seated.

> **NOTE:** Do not let the bearing cock as it is being driven on. Excess metal could be wiped off the mounting surfaces and the bearing could become loose on the case.

SIDE AND PINION GEARS

Installation

Before assembling the differential case, lubricate all parts with Lubricant No. 1051022 or equivalent.

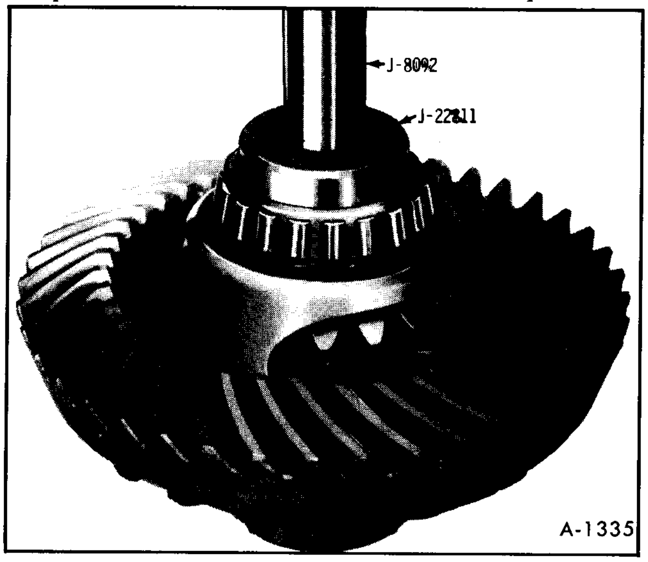


Figure 47—Installing Left Side Bearing

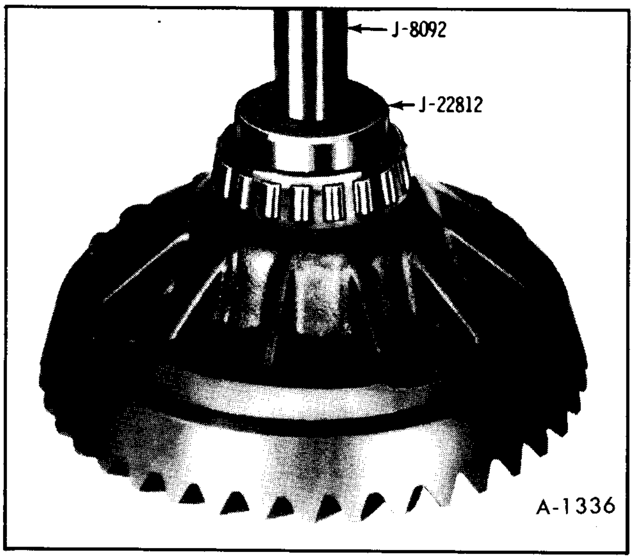


Figure 48—Installing Right Side Bearing

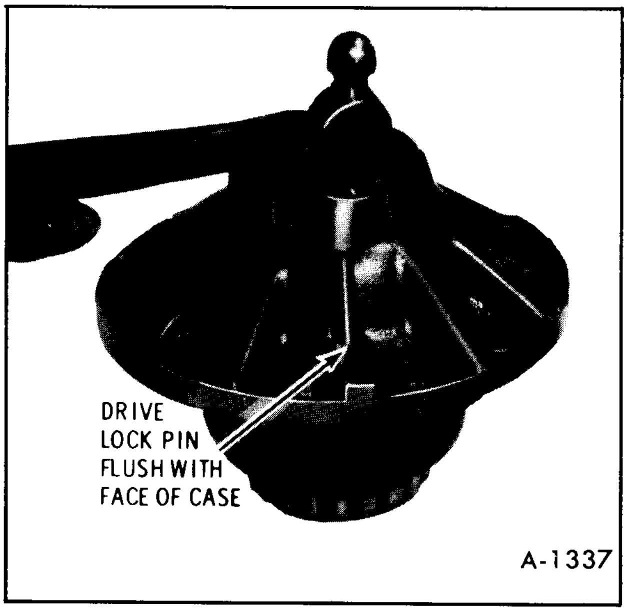


Figure 49—Installing Lock Pin

1. Place side gear thrust washers over side gear hubs and install side gears in case. If same parts are reused, install in original sides.

NOTE: Position side gear with threaded retainer on left side of case.

2. Position one pinion (without shims) between side gears and rotate gears until pinion is directly opposite from loading opening in case. Place other pinion between side gears so that pinion shaft holes are in line; then rotate gears to make sure holes in pinions will line up with holes in case.

3. If holes line up, rotate pinions back toward loading opening just enough to permit sliding in pinion gear shims.

4. Install pinion shaft. Drive pinion shaft retaining lock pin into position. (figure 49)

RING GEAR

Installation

1. After making certain that mating surfaces of case and ring gear are clean and free of burrs, install three 7/16-20 x 1-3/4 in. bolts as shown in Figure 50 to correctly position ring gear.

2. Install Tool J-22822 into a vise and place case assembly over tool as shown in Figure 51. Install NEW ring gear attaching bolts in remaining holes and then remove three 7/16-20 x 1-3/4 in. bolts. Install remaining three NEW bolts into ring gear and torque bolts alternately in progressive stages to 85 ft. lbs.

NOTE: Tool J-22822 must be used to correctly torque ring gear bolts.

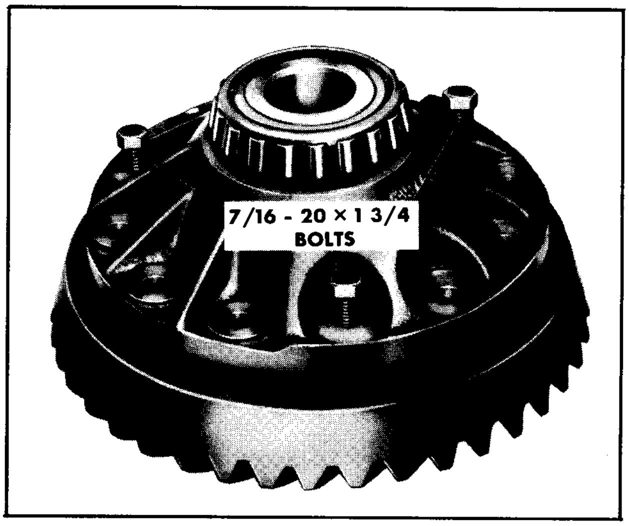


Figure 50—Installing Ring Gear to Case

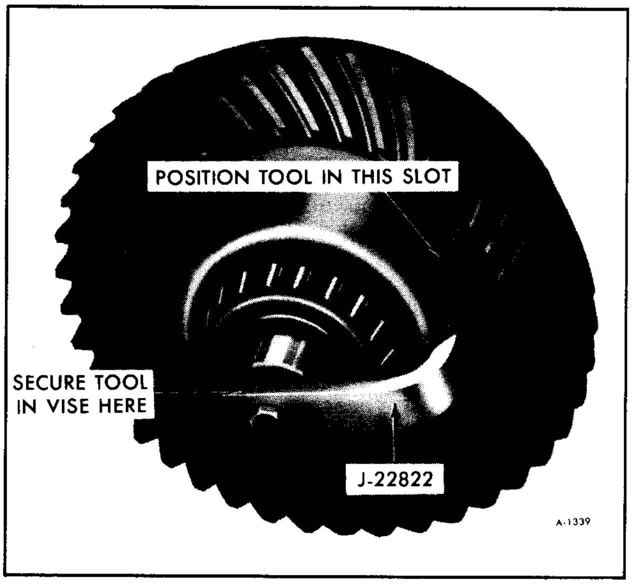


Figure 51—Installing Tool J-22822

SIDE BEARING PRE-LOAD ADJUSTMENT

Differential side bearing pre-load is adjusted by means of shims placed between the side bearing and housing. Shims are used on both sides and 19 shims are available in increments of .002" from .038" to .074". Two spacers .140" ±.005", are used one on the right side and one on the left side. By adding or subtracting the same amount of shims from both sides, the ring gear to pinion backlash will not change.

1. Before installing the case assembly, make sure that side bearing surfaces in the housing are clean and free of burrs. Side bearings must be oiled with Lubricant No. 1051022 or equivalent. Turn fixture and housing so cover side is up.

2. Place differential case and bearing assemblies in position in housing.

3. Install the original spacers on left and right side. If the recorded side bearing pre-load was correct on disassembly, the original shims may be used.

4. Install Spreader J-22196 on housing and spread housing just enough so that shim can be inserted between the spacer and the housing. (figure 52)

5. Release tension on spreader tool install side bearing caps, and torque cap bolts to 75 ft. lbs., then check pre-load as shown in Figure 53. Pre-load should be 10 to 15 in. lbs. for new bearings, 5 to 7 in. lbs. for old bearings over the pinion bearing pre-load.

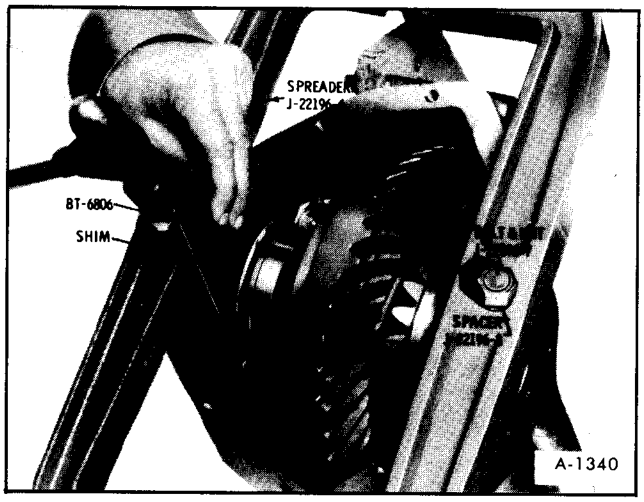


Figure 52—Spreading Housing For Shim Installation

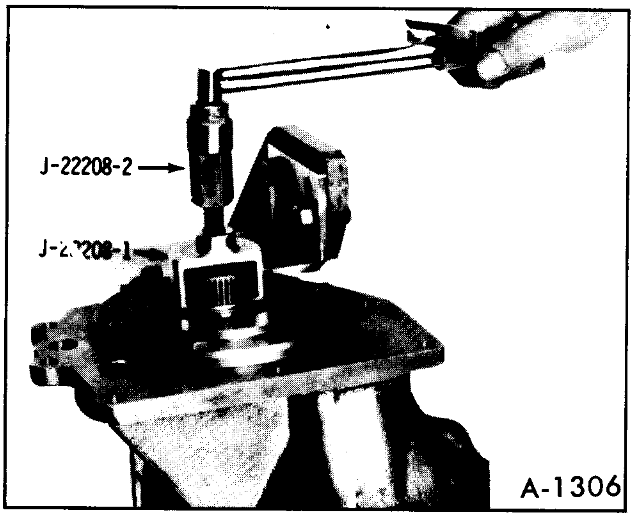


Figure 53—Checking Pinion And Side Bearing Pre-Load

6. If pre-load is not within specifications, obtain proper combination of shims, either thicker or thinner, until side bearing pre-load is 10 to 15 in. lbs. for new bearings, 5 to 7 in. lbs. for old bearings over the pinion bearing pre-load.

BACKLASH ADJUSTMENT

1. Rotate differential case several times to seat bearings, then mount dial indicator as shown in Figure 54. Use a small button on the indicator stem so that contact can be made near heel end of tooth. Set dial indicator so that stem is in line as nearly as possible with gear rotation and perpendicular to tooth angle for accurate backlash reading.

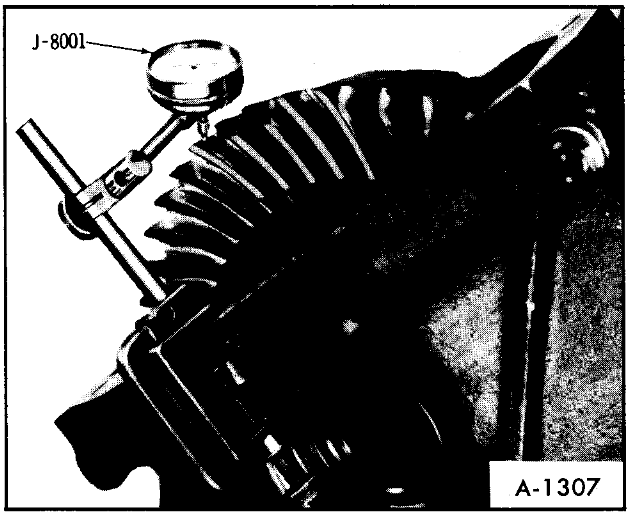


Figure 54—Checking Ring Gear To Pinion Gear Backlash

2. Check backlash at three or four points around ring gear. Lash must not vary over .002" around ring gear.

NOTE: Pinion must be held stationary when checking backlash. If variation is over .002" check for burrs, uneven bolting or distorted case and make corrections as necessary.

3. Backlash at the point of minimum lash should be between .005" and .009" for all new gears. If original ring gear and pinion was installed, backlash should be set at the same reading obtained in Step 4 of the Final Drive Disassembly procedure, provided reading was within specifications.

4. If backlash is not within specifications, correct by increasing thickness of one differential shim and decreasing thickness of other shim the same amount. This will maintain correct differential side bearing pre-load.

For each .001" change in backlash desired, transfer .002" in shim thickness. To decrease backlash .001" INCREASE thickness of right shim .002" and DECREASE thickness of left .002". To increase backlash .002" DECREASE thickness of right shim .004" and INCREASE thickness of left shim .004".

5. When backlash is correctly adjusted, remove spreader. Install the bearing caps and bolts. Torquer to 75 ft. lbs.

6. Install new output shaft seals as shown in Figure 10 and 14.

NOTE: Left output shaft seal in installed with vent hole toward top of final drive housing in the in-car position.

7. Install new gasket on housing. Install cover, torque cover bolts to 30 ft. lbs.

Fill final drive with fluid to "FILL LEVEL" line stamped on cover near fill hole.

Use only Gear Lubricant No. 1051022 or equivalent.

NOTE: If final drive was removed without removing the transmission, do not install gasket, cover or lubricant until final drive has been installed in vehicle.

FINAL DRIVE SPECIFICATIONS

LUBRICATION

Capacity .... 4 Pints
Replenish .... Special Lubricant No. 1051022 or equivalent

ADJUSTMENTS

Backlash .... .005" to .009"
Pinion Bearing Pre-load
New Bearings .... 2 to 15 in. lbs.
Old Bearings .... 2 to 5 in. lbs.
Side Bearing Pre-load
New Bearings .... 10 to 15 in. lbs. over Pinion Bearing Pre-load
Old Bearings .... 5 to 7 in. lbs. over Pinion Bearing Pre-load

GEAR RATIO 3.07:1

TORQUE SPECIFICATIONS

APPLICATION	FT. LBS.
Final Drive Cover Bolts	30
Side Bearing Cap Bolts	75
Bearing Housing Bolts	45
Ring Gear Bolts	85
Drive Axle to Output Shaft Bolts	75
Final Drive Support Bracket to Engine Bolt	55
Final Drive to Support Bolt	110
RH Output Shaft Support to Engine Bolts	55
LH Output Shaft Retainer Bolt	45
Final Drive to Transmission Bolts and Nut	30

SPECIAL TOOLS

J-2619	Slide Hammer
J-3289-01	Holding Fixture
J-6125-2-3	Slide Hammer
BT-6708-1	Pinion Bearing Cup Remover
BT-6708-2	Pinion Bearing Cup Remover
BT-6806	Side Bearing Shim Inst.
J-7057	Extension
J-8001	Dial Indicator
J-8092	Driver Handle
J-8433-1	Puller
J-8458	Race Installer
J-8614-1	Companion Flange Holder
J-8753-1	Timing Case Cover Seal Installer
J-9745	Race Installer
J-9746	Pinion Rear Bearing Remover
J-21022-01	Front Pinion Bearing Installer
J-21777-1-50	Pinion Setting Tools
J-22196-6-7-8	Housing Spreader
J-22199	Left Output Shaft Seal Installer
J-22201	Front Pinion Bearing Race Remover
J-22208-1-2	Adapter
J-22209	Pinion Bearing Inst.
J-22212	Pinion Seal Inst.
J-22227	Front Pinion Bearing Remover
J-22236	Pinion Oil Seal Protector
J-22296-1	Holding Fixture Adapter
J-22587-1-2	Pinion Bearing Preload Gauge Set
J-22608	Side Bearing Shim Remover
J-22756-1-5	Side Bearing Remover
J-22760	R.H. Output Shaft Seal Inst.
J-22811	R.H. Side Bearing Inst.
J-22812	L.H. Side Bearing Inst.
J-22822	Carrier Holder
J-22828	Axle Brg. and Slinger Inst.
J-23129	Seal Remover
J-26485	Knuckle Seal Installer

SECTION 4

REAR SUSPENSION

Contents of this section are listed below:

SUBJECT	PAGE NO.
General Description	4-1
Trouble Diagnosis	4-4
Rear Suspension Trouble Diagnosis Chart	4-5
Component Removal	4-6
Compressor Overhaul	4-13
Height Control Valve Overhaul	4-21
Component Installation	4-26
On-Vehicle Adjustments	4-32
Periodic Maintenance	4-34
Rear Suspension Torque Specifications	4-35

GENERAL DESCRIPTION

The rear suspension system (figure 1) on the vehicle consists mainly of air bellows, height control valves, control arms, and shock absorbers. The system operates automatically as load varies, to retain frame at proper ride height.

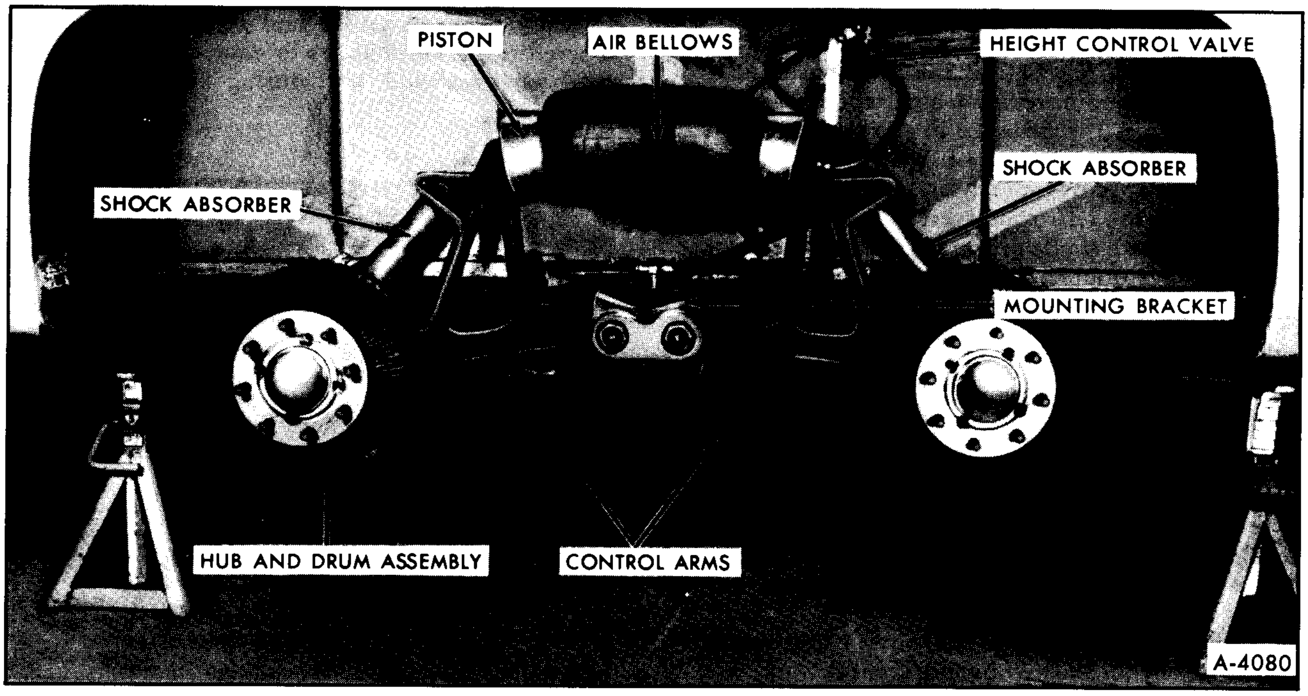


Figure 1—Rear Suspension (Left-Side View)

Figure 2—Air Compressor Location (Brown)

AIR BELLOWS

The air bellows are mounted between the control arms, for the tandem rear wheels. On each side of the air bellows is a piston which is connected directly to the control arm.

AIR COMPRESSOR

Compressed air for the system is supplied by an electric compressor which operates when the ignition key is in the "ON" or "ACCESSORY" position. It is a demand-type compressor which will start compressing air when the pressure in the system drops below 100 psi, and will shut off when the pressure reaches 120 psi. Air compressor for the system is located behind the left-front access door. There are two models used, a single piston Brown Compressor, (figure 2) and a double piston Dana (figure 3).

AIR RESERVOIR

The purpose of the air reservoir is to provide a place to store compressed air for the rear suspension. The reservoir is located behind the left front access door. The reservoir allows the rear suspension to adjust without the air compressor operating.

Another purpose of the reservoir is to provide a place where the air, heated during compression, can cool and the water vapor can condense. Drain reservoir monthly.

AIR BELLOWS

The air bellows serve as a flexible connection between the two control arms on each side of suspension bracket. The flexing of the air bellows allows the control arms to move up and down in relation to the frame. This action absorbs road shocks in the same manner as an inflated rubber tire cushions shock caused by road roughness.

SHOCK ABSORBERS

A double acting shock absorber is used at each wheel on the rear suspension. The shocks are mounted to the top of the control arms and to the frame at the bottom.

The shock absorbers are gas filled cell type shocks. They are filled with a calibrated amount of fluid and sealed during production. They are non-adjustable, non-refillable and cannot be disassembled. The only service they require is replacement if they have lost their resistance, are damaged or leaking fluid.

HEIGHT CONTROL VALVE

(FIGURE 4)

Height control valve automatically maintains a constant vehicle height by controlling the flow of compressed air into or out of suspension system air bellows. A delay piston in each valve provides a momentary delay in intake and exhaust valve action. Therefore, air in bellows is exhausted only during load changes and not during intermittent road bumps.

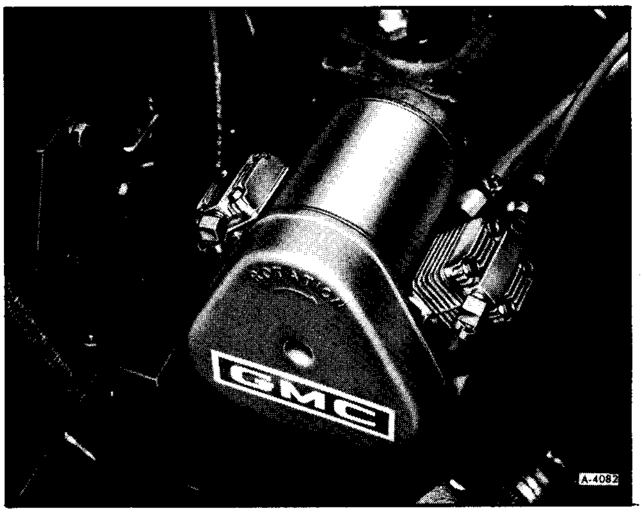


Figure 3—Air Compressor Location (Dana)

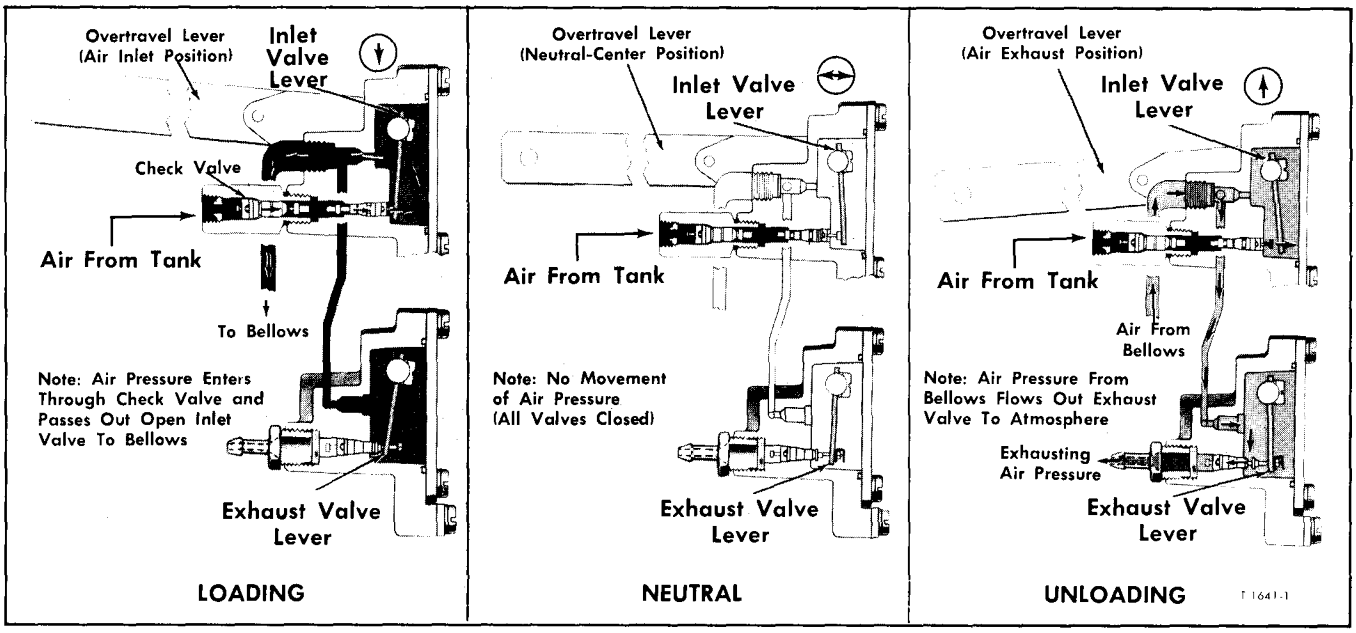


Figure 4—Operation of Height Control Valve

The height control valve contains an intake valve, air bellows outlet, exhaust valve, delay piston, and overtravel control body. The overtravel control body contains a spring-loaded nylon piston which protects valve parts if overtravel lever is moved beyond normal operating range.

HEIGHT CONTROL VALVE OPERATION

Loading

When vehicle is being loaded, frame tends to settle. Since valve is linked to control arm, and valve is bolted to wheel well, valve moves downward with frame as vehicle is loaded. As valve arm and control shaft turns, a force is applied to the delay piston which moves slowly and allows the intake valve lever to move against the intake valve core. As pin is pushed in, air pressure flows through height control valve into bellows. Increased air pressure expands the bellows and raises frame.

Inlet valve is "PROTECTED" by check valve in inlet adapter. Light spring in core freely admits reservoir air, but return flow of air is blocked.

Neutral Position

As increased air pressure expands bellows and lifts frame, the height control valve moves upward with frame. As frame is returning to normal ride height, valve arm and shaft return to a neutral position. Inlet valve lever also moves away from inlet valve core and inlet valve closes. This stops the flow of the air into bellows. The exhaust valve remains closed. Since the exhaust valve is closed, and the check valve in the inlet adapter prevents compressed air from returning to air reservoir, air is trapped in bellows and in valve. No further valve action or air pressure change takes place until load is increased or decreased, moving valve arm out of neutral position for four seconds or more to actuate intake valve or exhaust valve.

Unloading

When part of load is removed, air pressure in bellows lifts frame. Valve arm, linked to axle, is pulled downward from neutral position. This applies a force on the delay piston, which moves it slowly. The exhaust valve lever moves with the delay piston. The outer end of exhaust valve lever fits around stem of exhaust valve core. As soon as lever moves beyond free-travel range, lever pulls on stem and opens exhaust valve. Inlet valve remains closed. Compressed air from bellows then flows through the open exhaust valve and out exhaust fitting to atmosphere. As the compressed air is exhausted from bellows, the frame lowers until overtravel lever and shaft are again in normal (neutral) position.

Valve Arm Free Travel

With vehicle in motion and frame at normal ride height, control valve arm and shaft are in neutral position. Small irregularities in road causes slight up and down movement of valve arm. Clearances are provided between operating levers and cores of inlet and exhaust valves to permit 3/8-inch up or down movement of valve arm, from neutral position without causing valve action. This compensates for small road bumps. The bumps are absorbed by tires and bellows without causing movement of compressed air either into or out of suspension system.

Hydraulic Delaying Action

Operation of delay piston in height control valve prevents change of bellows air pressure as a result of momentary road shocks, conserves air supply, and adds life to valve. The nylon piston moves inside cylinder containing a silicone type fluid. A flapper valve on either end of piston allows displacement of fluid or acts as a check valve, depending on direction piston moves. Delay piston is moved by piston pin, that is threaded into overtravel shaft. A 4 to 18 second delay results from the closing of one valve to the opening of other valve.

Overtravel piston is held against flat side of overtravel shaft by two springs inside piston. Piston keeps overtravel shaft in proper position relative to valve arm. Piston also allows valve arm to rotate through a complete circle, if necessary, without damaging parts inside valve.

POWER LEVEL OPERATION

The power level option consists of two, in-line valves which override the height control valve. These valves allow the operator to raise or lower each side of the rear suspension from the driver's seat. This is accomplished by bypassing the height control valve and adding or expelling air directly from the bellows. For a diagram of air lines see figure 65.

TROUBLE DIAGNOSIS

AIR LEAKS

With the air system at normal operating pressure coat all suspension air line connections with soap and water solution. Air leakage will produce soap bubbles. No leakage is permissible. Leakage at air line connections can sometimes be stopped by tightening connection. If this does not stop the leak replace the affected fittings.

1. Cut end of hose (tube) off square.

2. Place brass insert into end of tube and put appropriate fitting over it (figure 5).

3. Crimp fitting in place with Special Tool J-25520. This tool is designed so that crimp must be completed before tool will release (figure 6).

4. Air line leaks can be repaired with the coupling illustrated in Figure 7.

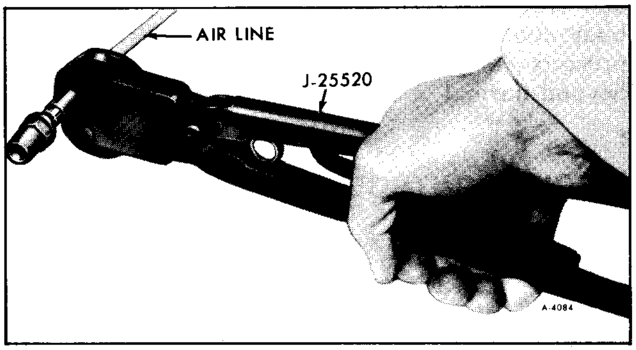


Figure 6—Special Tool J-25520 Crimping Air Line

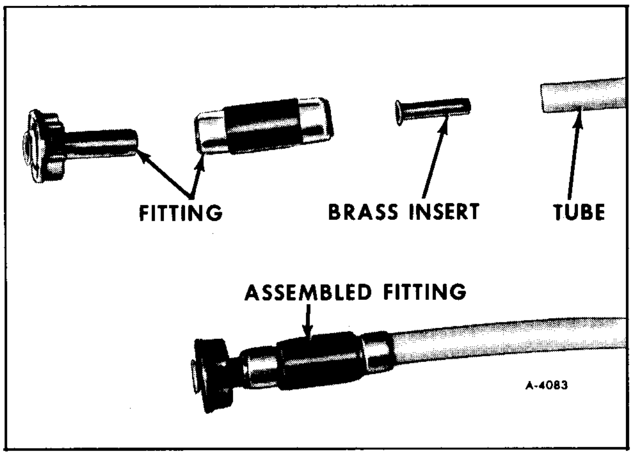


Figure 5—Coupling Assembly

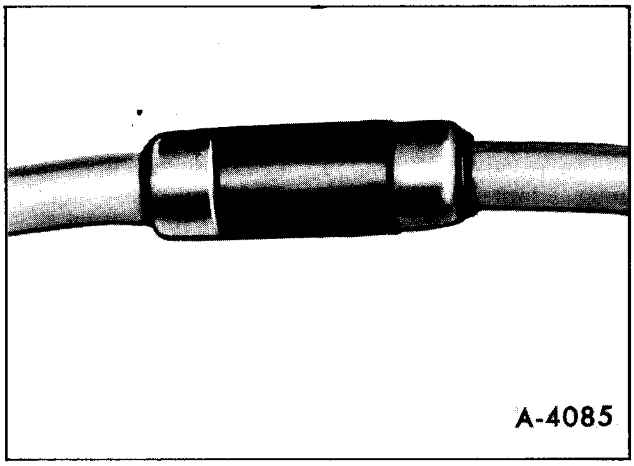


Figure 7—Air Line Repair Coupling

SHOCK ABSORBERS

See Section 3A "FRONT SUSPENSION" for trouble diagnosis of shock absorbers.

HEIGHT CONTROL VALVE AIR LEAKAGE CHECK

NOTE: Air leakage check can be performed for air line connections, only when valve is installed on vehicle. The following instructions explain procedure for performing air leakage check on valve when removed from vehicle.

1. Clean exterior of valve assembly.

2. Connect air pressure line to air inlet port, then open the air pressure (90-120 psi).

3. Submerge valve assembly in a container of water, then watch for air bubbles when the valve arm is in center (neutral) position. No air should escape from any point of valve assembly.

4. If bubbles appear from the bellows port, this is an indication the air inlet valve assembly is defective and must be replaced.

5. Remove air pressure line from air inlet fitting and connect it to the bellows port. If bubbles appear at the air inlet check valve port, this is an indication that check valve unit is defective and must be replaced.

6. If bubbles appear at the exhaust port it is an indication the exhaust valve assembly is defective and must be replaced.

7. If bubbles appear around edge of valve cover plate, the cover plate gasket must be replaced.

8. If no leaks are detected, remove valve assembly from water, then with air pressure still connected to bellows port, actuate valve arm to expel any water which may have entered exhaust valve chamber. Remove air line and connect it to air inlet port and repeat operation to remove water from air inlet valve chamber.

REAR SUSPENSION TROUBLE DIGNOSIS CHART

Problem	Possible Cause	Correction
No air pressure in air reservoir-unit not operating.	1. Open circuit breaker.	1. Find cause of circuit breaker being "OPEN" and correct it. Circuit breaker is located behind the glove box door.
	2. Faulty wiring.	2. Check to see that wiring is intact.
	3. Low battery.	3. The compressor runs off the automotive battery, check its condition and correct as necessary.
	4. Faulty or pitted contacts on pressure switch.	4. Replace pressure switch.
	5. Motor has developed an open circuit.	5. Motor brushes or commutator worn out. Replace motor.

Problem	**Possible Cause**	**Correction**
No air pressure in air reservoir-unit is operative.	1. Air leak in system.	1. Eliminate air leaks in system as explained earlier in this section.
	2. Compressor valve seat or valve spring worn or broken.	2. Replace valve seat and/or valve spring.
	3. Piston rings are worn-air leaks heavily at rings.	3. Replace piston rings.
	4. Pressure switch contacts are pitted causing improper compressor action.	4. Replace pressure switch.
	5. Pressure switch not properly adjusted	5. Adjust pressure switch settings to operate at the 100-120 psi range.
Air pressure in tank-unit operating erratically-pump takes too long to pressurize tank.	1. Air leak in system.	1. Eliminate air leaks in system as described earlier in this section.
	2. Compressor valve seat valve broken or worn.	2. Replace valve seat and/or valve spring.
	3. Piston rings are worn-air leaks heavily by rings.	3. Replace piston rings.
	4. Pressure switch contacts are pitted causing improper compressor action.	4. Replace pressure switch.
	5. Battery voltage too low to operate motor.	5. Charge battery.
	6. Bearing failure may cause unit to seize occasionally and break loose if galling occurs.	6. Replace bearings or parts with bearings.

COMPONENT REMOVAL

CAUTION: *Whenever it is necessary to support the rear suspension with jack stands or other supporting equipment, as shown in Figure 1, be sure jack stands are used only at a junction point(s) of the frame rail and crossmember. Failure to locate jack stand as instructed could result in damage to frame of vehicle.*

PRESSURE SWITCH REMOVAL

1. Release pressure in air reservoir through Schrader valve.

2. Remove one screw at top of switch cover and remove switch cover (figure 8).

3. Disconnect two electrical wires held by screws inside switch body.

4. Disconnect air line elbow below switch and remove switch assembly.

AIR COMPRESSOR REMOVAL

(BROWN, SINGLE PISTON)

1. Release pressure in air reservoir through Schrader valve.

2. Remove air line from piston dome (figure 2).

3. Disconnect hose at back of compressor.

4. Disconnect electrical wire at overheat switch in top of compressor body.

5. Remove four screws that secure compressor frame to mounting bracket and remove compressor from vehicle.

AIR COMPRESSOR

(DANA, DOUBLE PISTON)

1. Disconnect electrical wires at back of compressor motor (figure 3).

2. Release pressure in air reservoir through Schrader valve.

3. Disconnect air lines at back of compressor and at head of one piston.

4. Remove three bolts that secure compressor to mounting bracket and remove compressor.

AIR RESERVOIR REMOVAL

(FIGURE 9)

1. Disconnect pressure switch wiring. See PRESSURE SWITCH REMOVAL steps 2 and 3.

2. Release pressure in air reservoir through Schrader valve, or drain cock.

3. Disconnect two air lines on same side of reservoir.

4. Remove two bolts and nuts from front air reservoir bracket, then two nuts and bolts from rear bracket and remove air reservoir.

5. Disconnect pressure switch from reservoir.

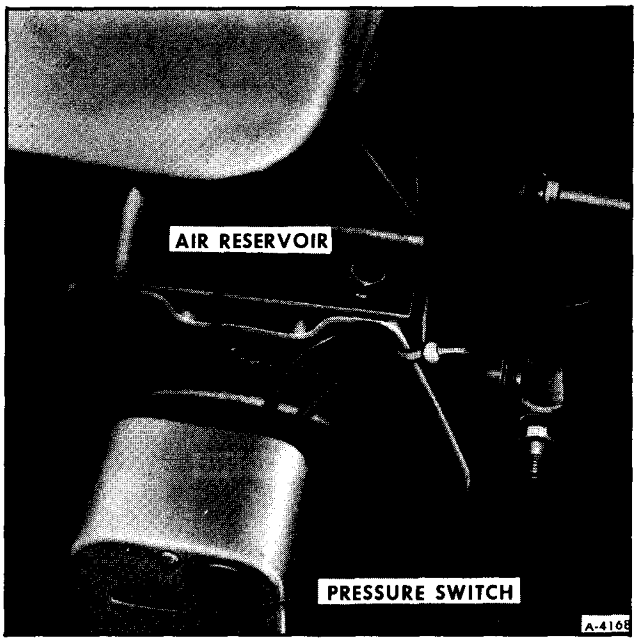


Figure 8—Pressure Switch Installed

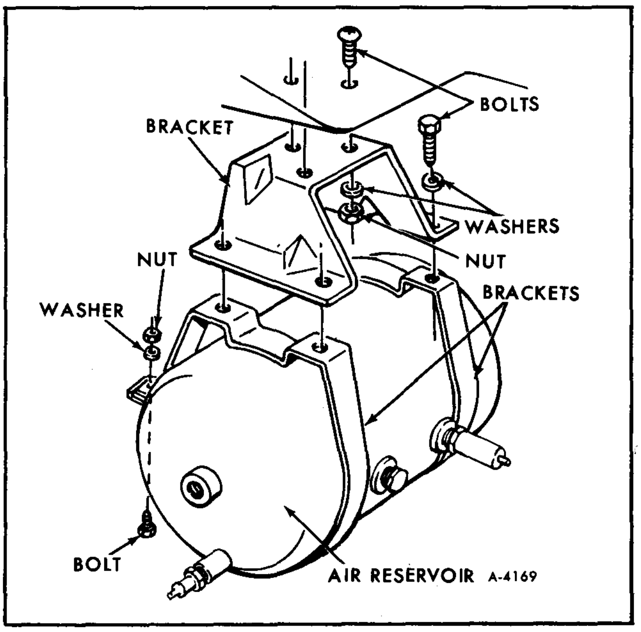


Figure 9—Air Reservoir Installed

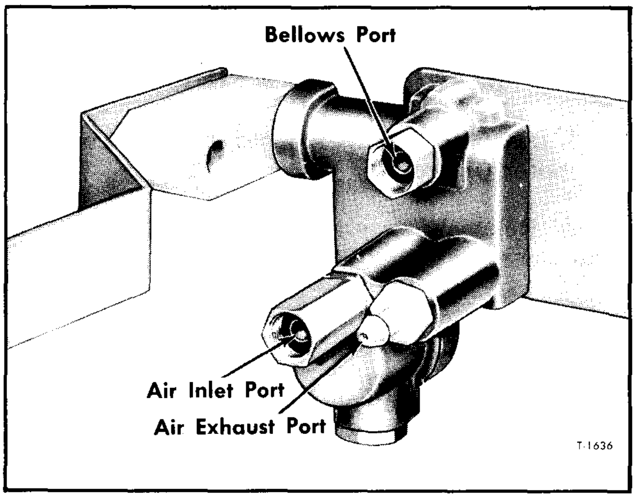


Figure 10—Height Control Valve Ports

6. Remove mounting brackets, safety valve, and Schrader valve. Remove drain cock if reservoir is so equipped.

HEIGHT CONTROL VALVE REMOVAL

Before disconnecting any height control valve air lines, securely support frame to prevent it from lowering as air is released from suspension. Exhaust air from air supply system by opening schrader valve on air reservoir. After the above precautions have been taken, remove height control valve as follows:

1. Disconnect height control valve overtravel lever from valve link. Pull lever downward and hold several seconds to overcome time delay feature; This will release compressed air from bellows.

2. Referring to Figure 10, disconnect air supply line and bellows air line from height control valve. Tape ends of lines to prevent foreign material from entering.

3. Remove two nuts attaching height control valve to wheel well and remove valve assembly.

AIR BELLOWS REMOVAL

1. Support vehicle on jack stands.

2. Referring to Figure 11, disconnect leveling valve link and move arm down to open exhaust valve and let air out of bellows.

3. Referring to Figure 12, disconnect air line to bellows.

4. Referring to Figure 13, remove retaining nuts and washers.

5. Remove air bellows from vehicle.

CONTROL ARM REMOVAL

1. Raise vehicle until rear wheels are off the floor.

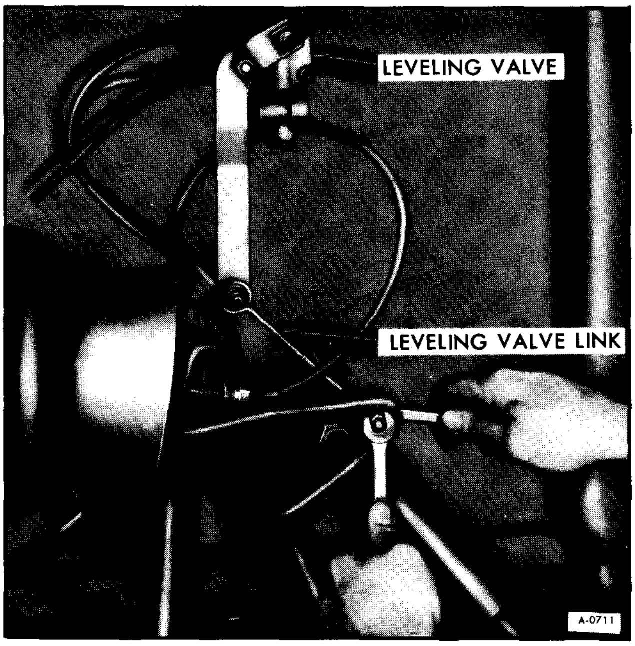


Figure 11—Disconnecting Height Control Valve Link

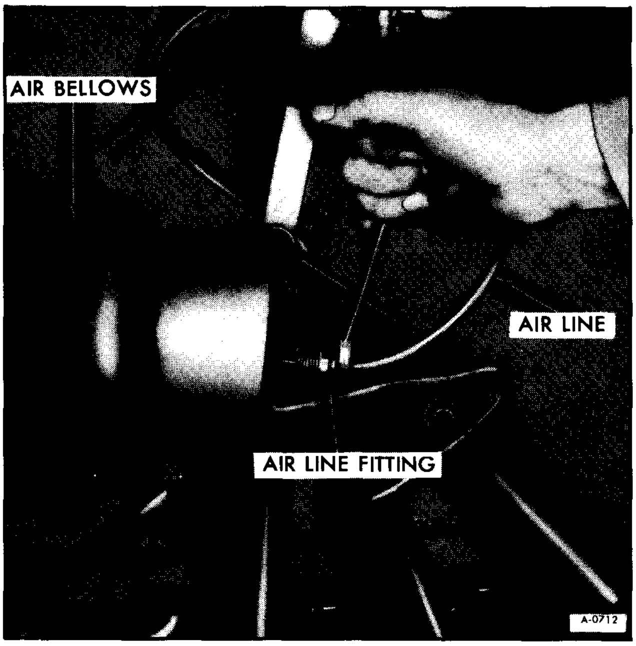


Figure 12—Disconnecting Bellows Air Line

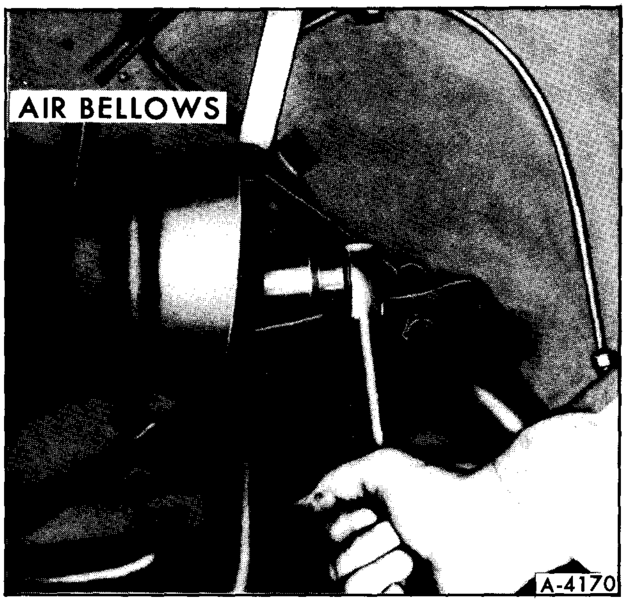


Figure 13—Removing Bellows Retaining Nut

2. Remove wheels.

3. Disconnect leveling valve link at control arm. Remove air from bellows by moving valve arm down. Disconnect air line at the bellows as shown in Figure 12.

4. Remove bellows retaining nuts, located at either end of air bellows, as shown in Figure 13.

Figure 14—Disconnecting Brake Line

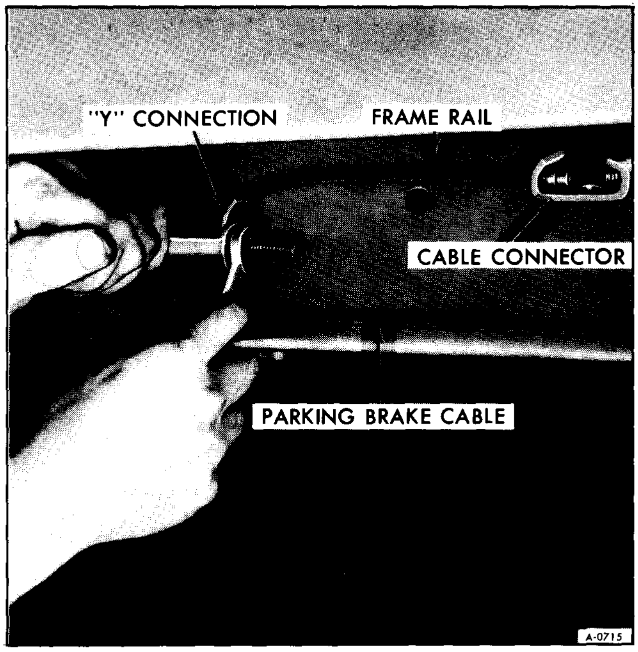


Figure 15—Disconnecting Parking Brake Cable

5. Disconnect shock absorbers from control arm mounting.

6. Referring to Figure 14, disconnect brake line at center mounting bracket and at each brake backing plate. Remove brake lines from control arms by unbolting all mounting points.

7. Disconnect parking brake cable at "Y" connection as shown in Figure 15.

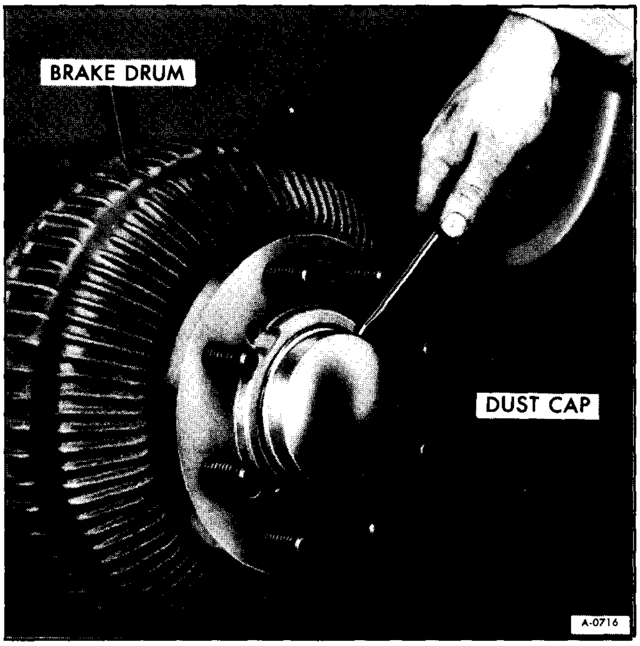


Figure 16—Outer Dust Cap Removal

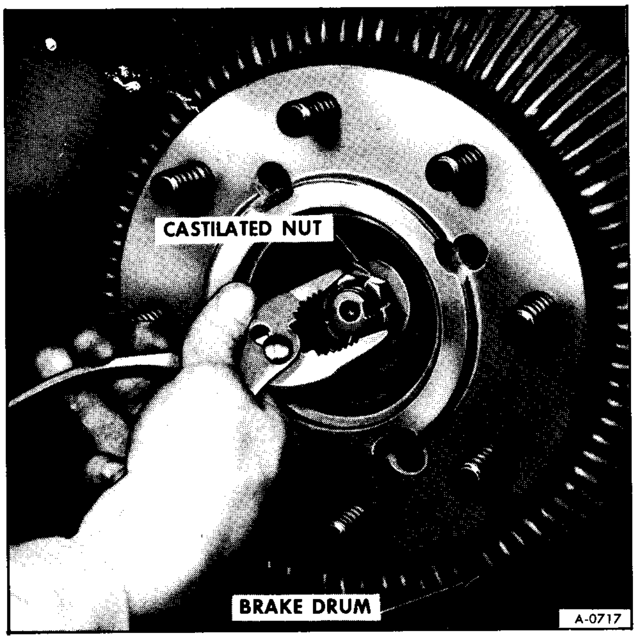


Figure 17—Castilated Nut Removal

8. Remove brake drums, then—

A. Remove outer dust cap (figure 16) and then remove inner cap.

B. Remove cotter pin and castilated nut (figure 17).

C. Remove drum, hub, and bearings as a unit (figure 18).

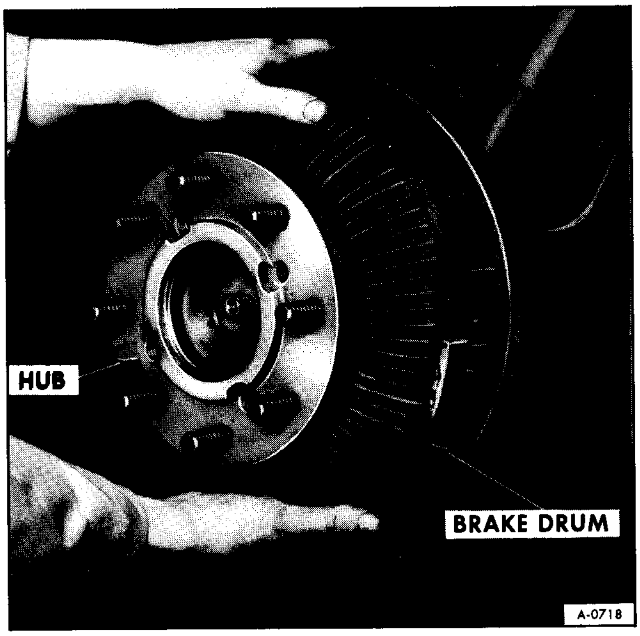


Figure 18—Removing Hub and Drum

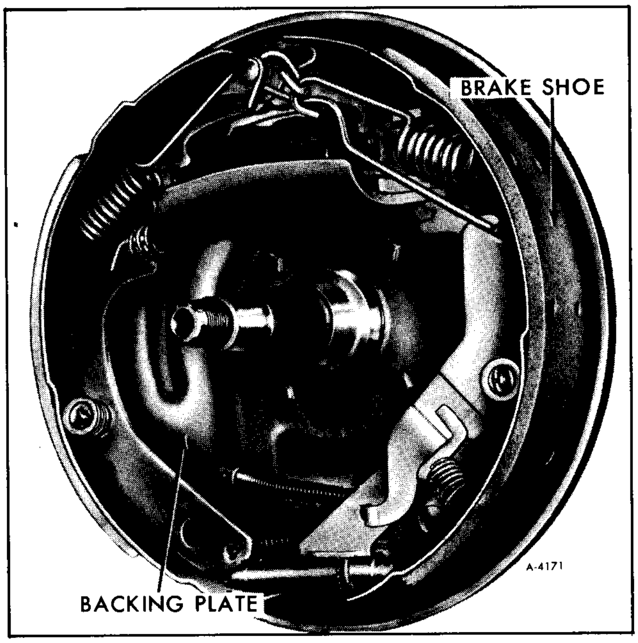


Figure 19—Removing Brake Backing Plate and Brake Shoe Assembly

9. Referring to Figure 19, remove four bolts and nuts retaining brake backing plate to control arm. Repeat procedure on opposite wheel.

10. Support mounting bracket with floor jack. Referring to Figure 20, remove two bolts holding mounting bracket to crossmember. Remove four bolts holding mounting bracket to frame rail.

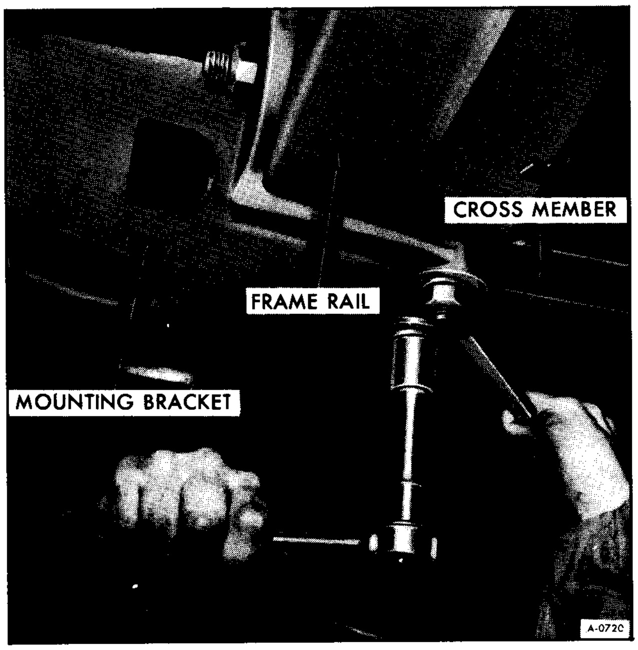


Figure 20—Removing Mounting Bracket Retaining Bolts

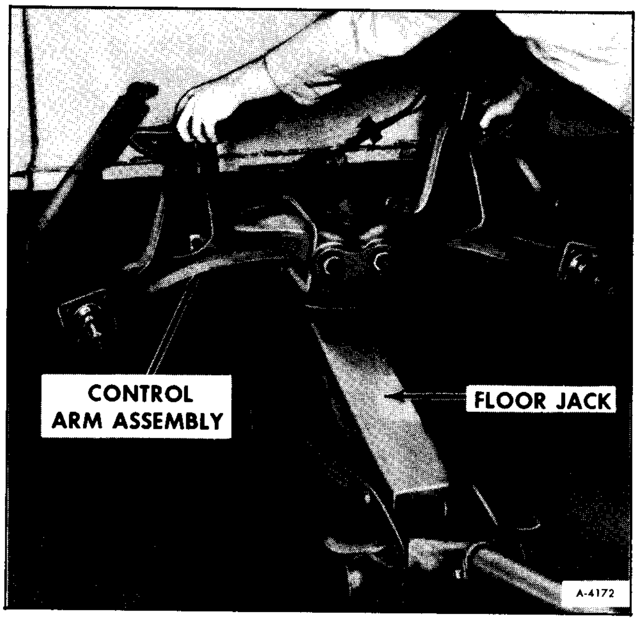


Figure 21—Lowering Control Arm Assembly from Vehicle

11. Lower rear suspension unit to floor as shown in Figure 21.

12. Referring to Figure 22, remove two nuts on mounting bracket. Remove Allen head retainer screws on back of mounting bracket as shown in Figure 23.

13. Press out control arm mounting pins, then remove control arms.

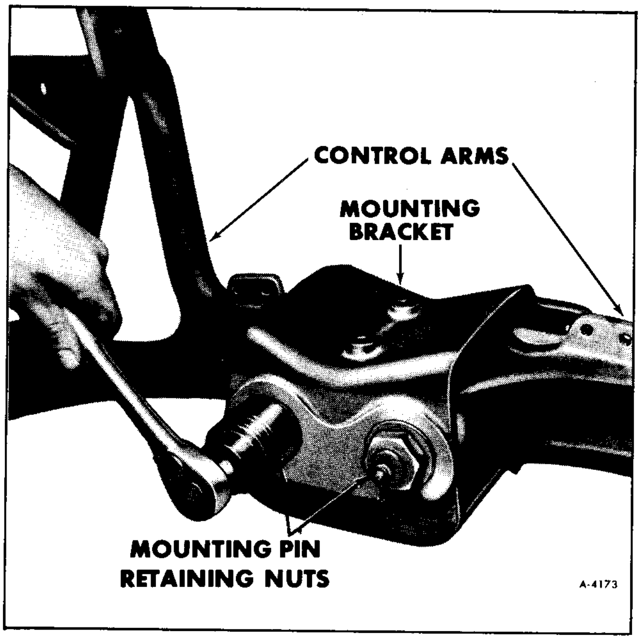


Figure 22—Removing Mounting Bracket Nuts

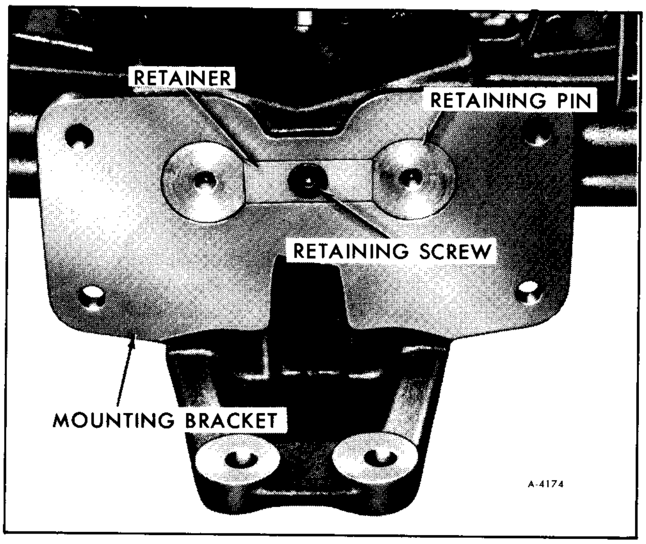


Figure 23—Location of Retainer

14. Apply penetrating oil to wheel spindle and suspension arm mating surfaces. Position screw pad J-25265-6 as shown in Figure 24.

15. Install spindle removing tool as shown in Figure 25.

16. Tighten tool through bolts and then reaction set screw as shown in Figures 25 and 26.

17. Press out spindle by turning forcing screw, (it may be necessary to tap spindle end lightly after preloading screw).

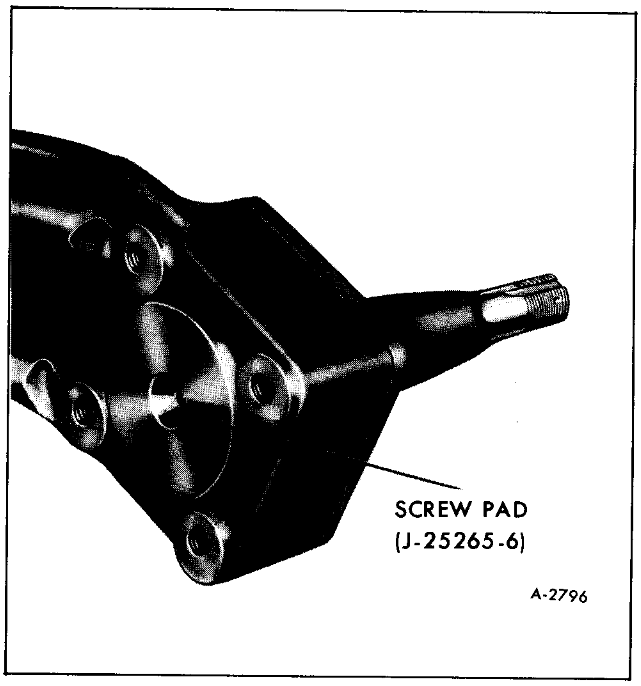


Figure 24—Special Tool J-25265-6

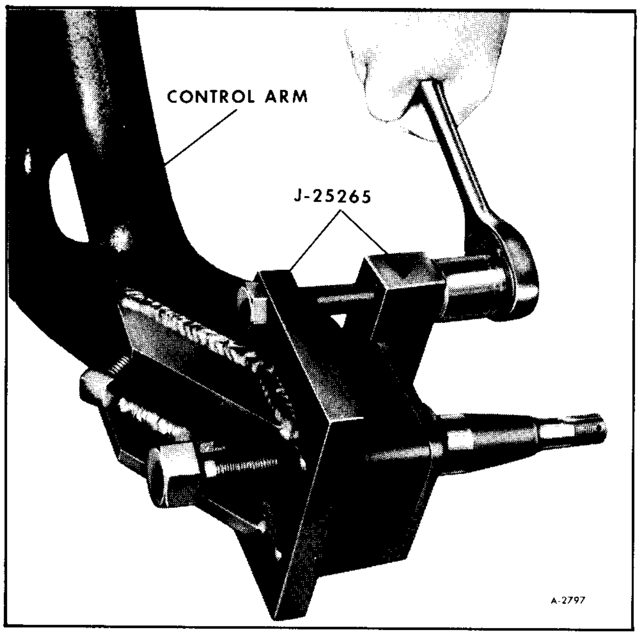


Figure 25—Special Tool J-25265

SHOCK ABSORBER REMOVAL

Block control arms in an up position with a wooden block about one inch in thickness as shown in Figure 27.

Remove nut at top of shock absorber as shown in Figure 28, and remove shock from control arm. Remove nut from bottom of shock and remove shock from mounting bracket.

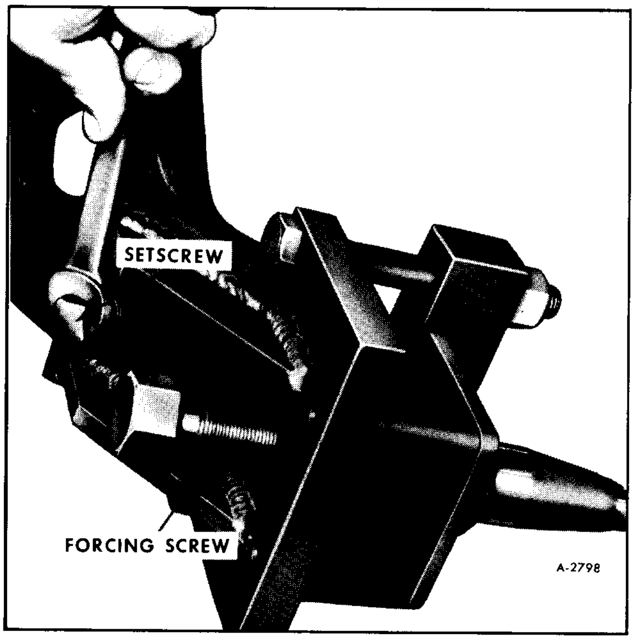


Figure 26—Spindle Removal

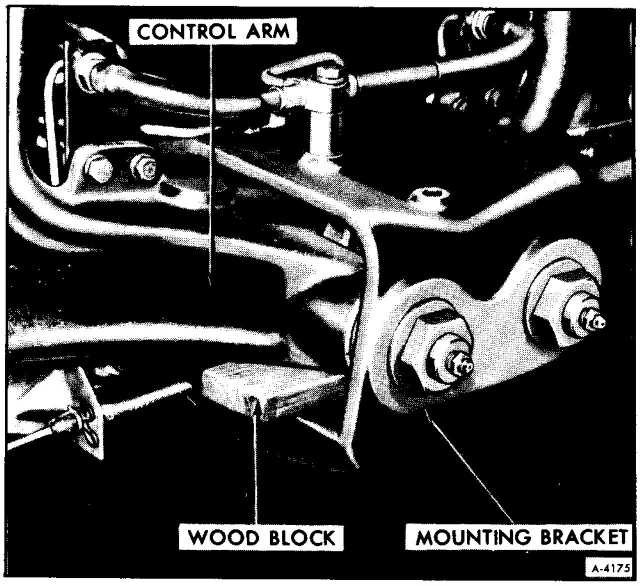


Figure 27—Positioning Wood Block Under Control Arm

POWER LEVEL VALVE REMOVAL

1. Bleed air from reservoir tank and place valve in lower position.

2. Remove four screws on mounting panel.

3. Remove control knobs by removing Allen head screw in center of knobs (See figure 29).

4. Remove two screws holding each valve to mounting panel.

5. Disconnect three fittings from the back of each valve as shown in Figure 30 and remove valves.

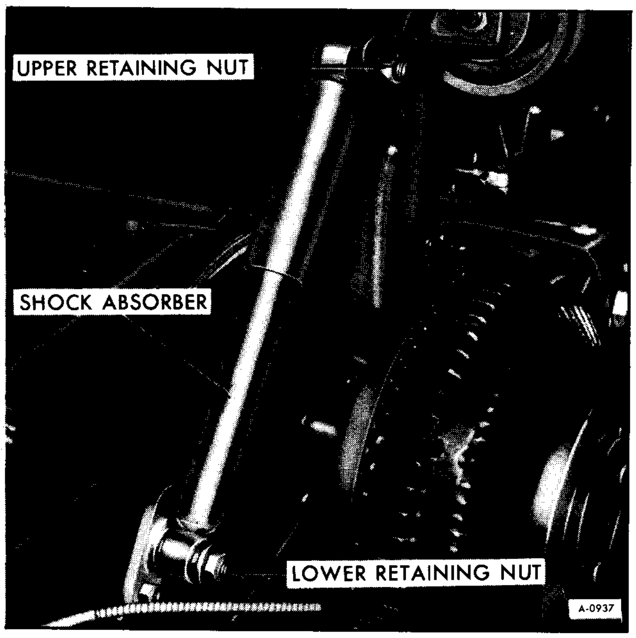


Figure 28—Removing Shock Absorber Retaining Nuts

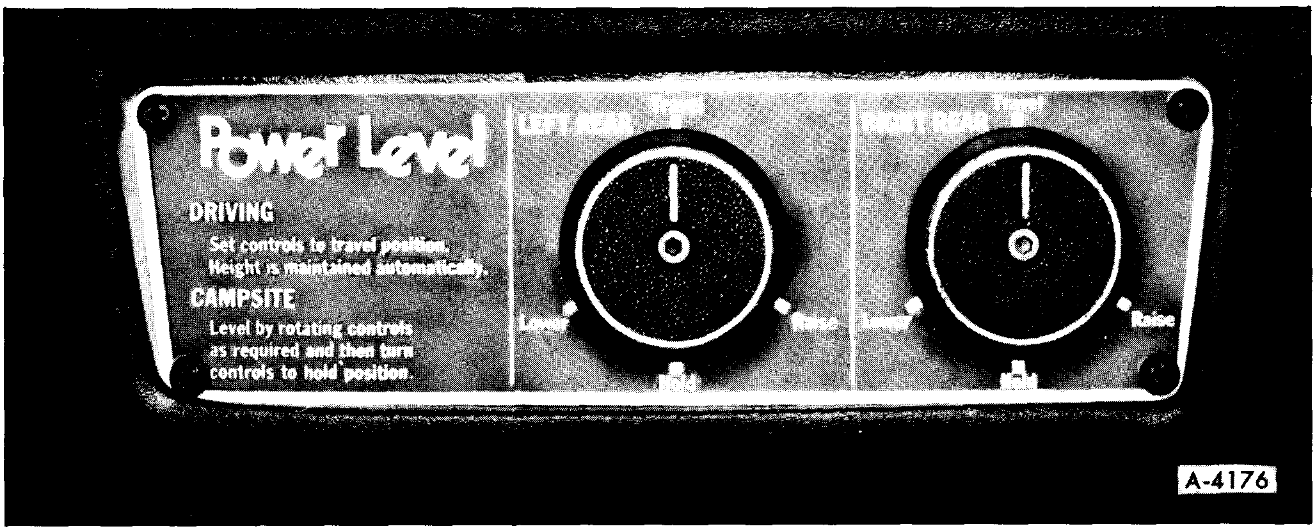


Figure 29—Power Level Control Panel

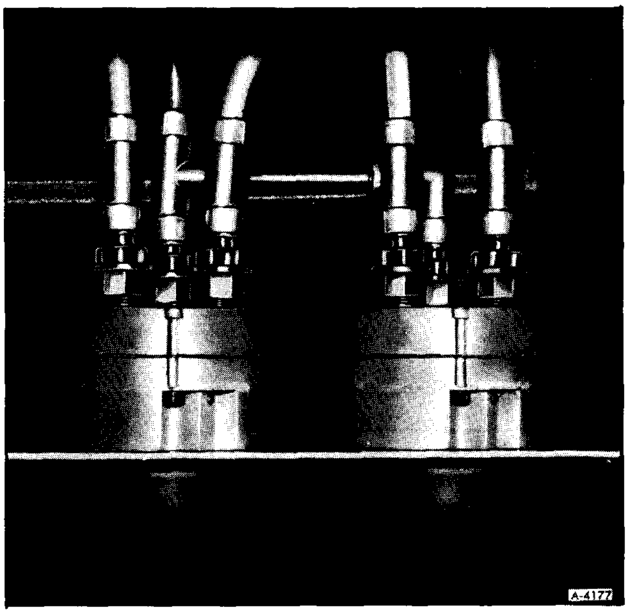


Figure30—Power Level Valves and Fittings

COMPRESSOR OVERHAUL

(BROWN, SINGLE PISTON)

(FIGURE 31)

PISTON RING REPLACEMENT

It is recommended that when the piston rings are replaced, the sleeve and expander rings be replaced also.

1. Remove compressor from vehicle.

2. Remove four screws from piston dome as shown in Figure 32. Remove piston dome and its gasket. Remove valve plate and its gasket.

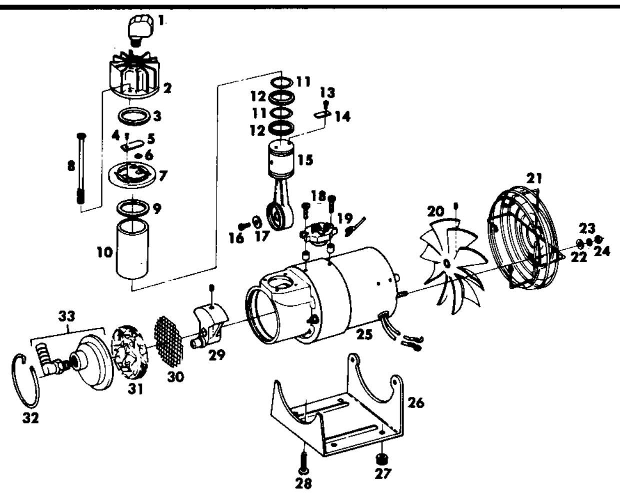


Figure 31—Brown Compressor Exploded View

3. Referring to Figure 33, remove piston sleeve.

4. Remove and replace piston rings and expanders.

NOTE: There is an expander located under each piston ring. The expander is an O-ring.

5. Install new piston sleeve.

6. Install valve plate and new gasket.

7. Install piston dome and new gasket, and retain in position with four screws.

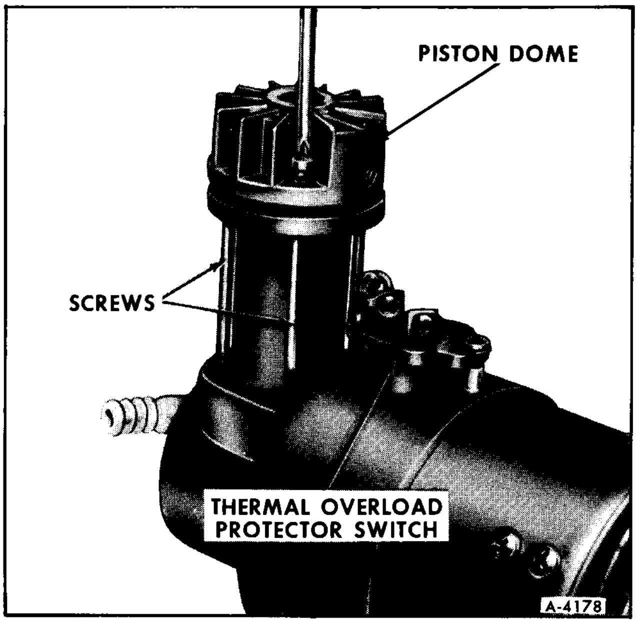


Figure 32—Removing Screws From Piston Dome

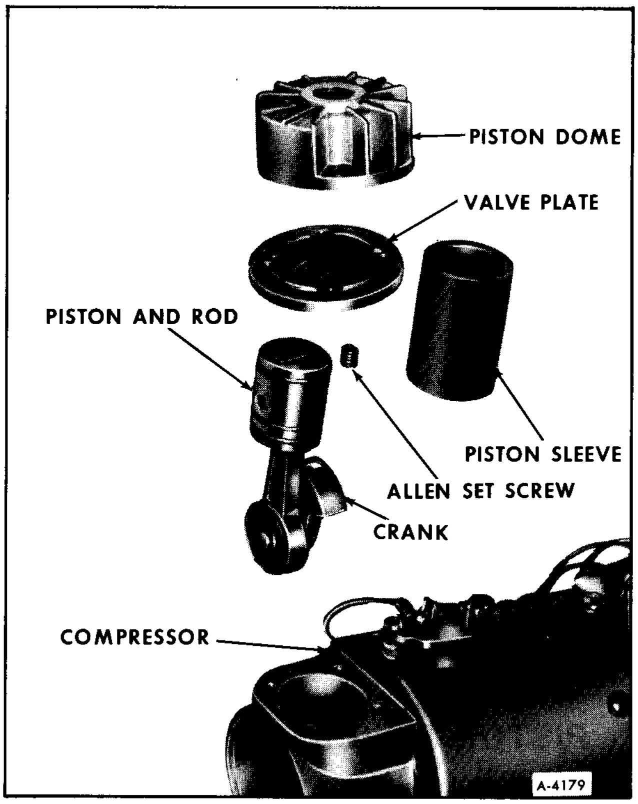


Figure 33—Compressor Components

INTAKE VALVE REPLACEMENT

REMOVAL

1. Remove air compressor from vehicle.

2. Remove four screws from piston dome. Remove piston dome and its gasket, then remove valve plate and its gasket.

3. Remove piston sleeve.

4. Remove screw from valve on top of piston and remove valve.

INSTALLATION

1. Install valve and screw retaining it on the piston.

2. Install piston sleeve.

3. Install valve plate and its gasket and install piston dome and its gasket. Install four screws in piston dome.

EXHAUST VALVE REPLACEMENT

REMOVAL

1. Remove air compressor from vehicle.

2. Remove four screws from piston dome. Remove piston dome and its gasket. Remove valve plate and its gasket.

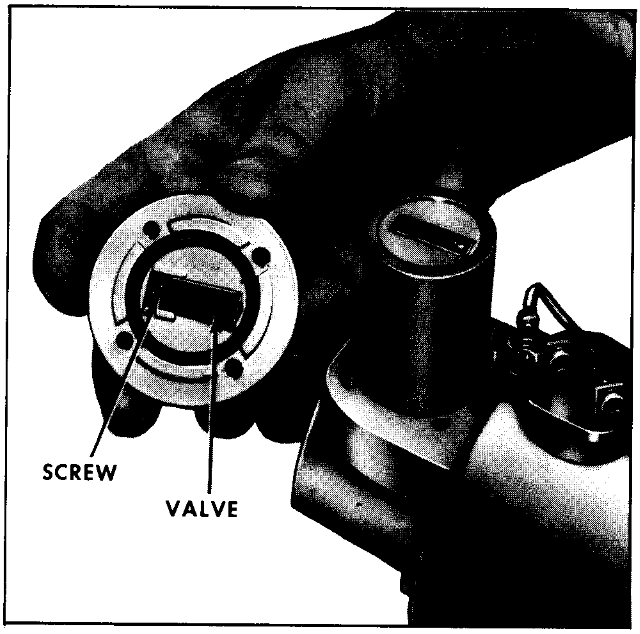


Figure 34—Removing Retaining Screw From Exhaust Valve

Figure 35—Loosening Allen Screw on Eccentric

3. Remove retaining screw from exhaust valve and remove valve as shown in Figure 34.

4. Remove "O" ring under valve.

INSTALLATION

1. Install "O" ring by first applying a small amount of silicone rubber cement or equivalent in recess for "O" ring. Then set "O" ring in place.

2. Install valve and retain in position on valve plate with screw.

3. Install valve plate and its gasket, and install piston dome and its gasket. Replace four screws in piston dome.

PISTON REPLACEMENT

REMOVAL

1. Remove air compressor from vehicle.

2. Remove four screws from piston dome. Remove piston dome and gasket. Remove valve plate and gasket.

3. Remove piston sleeve.

4. Remove air filter.

5. Rotate eccentric (figure 36) until piston is at the bottom of its stroke.

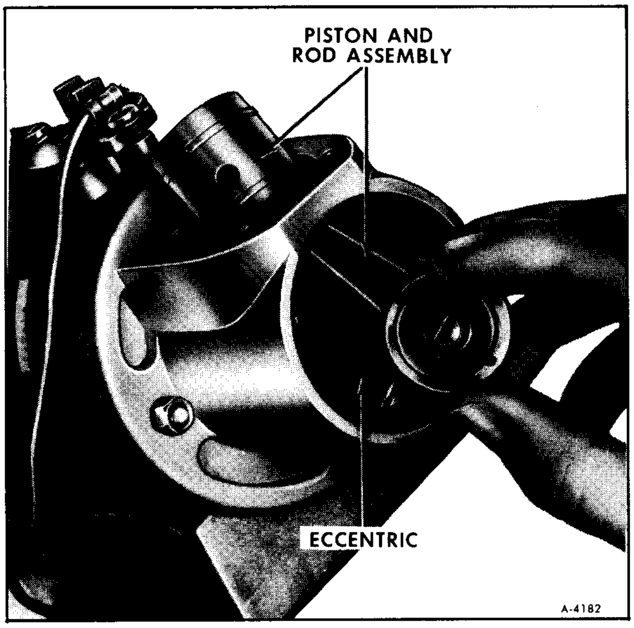


Figure 36—Removing Compressor Piston

6. Referring to Figure 35, loosen Allen Head set screw which is at top of eccentric.

7. Remove eccentric from motor output shaft, and remove piston assembly through air filter opening as shown in Figure 35.

8. Remove piston rings and piston ring expanders.

INSTALLATION

1. Install piston rings and piston ring expanders.

2. Place piston assembly in position with eccentric on motor output shaft. The eccentric must be positioned to contact the bearing on the motor.

3. Tighten Allen Head set screw on eccentric to at least 5 ft. lbs. torque.

4. Install piston sleeve.

5. Install valve plate and gasket, and install piston dome and gasket.

6. Install four screws in piston dome.

7. Install air filter.

MOTOR REPLACEMENT

REMOVAL

1. Remove air compressor from vehicle.

2. Remove four screws from piston dome. Remove piston dome and its gasket. Remove valve plate and its gasket.

3. Remove piston sleeve.

4. Remove air filter.

5. Rotate eccentric until it is at the bottom of its stroke.

6. Referring to Figure 35, loosen Allen Head set screw which is at top of eccentric.

7. Remove eccentric from motor output shaft, and remove piston assembly through air filter opening as shown in Figure 36.

8. Remove two nuts holding on fan blade guard and remove the guard.

9. Loosen Allen Head set screw in fan hub, and remove fan blades.

INSTALLATION

1. Install fan blades and tighten Allen Head set screw.

2. Install fan blade guard.

3. Place piston assembly in position with eccentric on motor output shaft. The eccentric must be positioned to contact the bearing on the motor.

4. Tighten Allen Head set screw, on eccentric to at least 5 ft. lbs. torque.

5. Install piston sleeve.

6. Install valve plate and its gasket, and install piston dome and its gasket.

7. Install four screws in piston dome.

8. Install air filter.

9. Install compressor in vehicle.

FAN REPLACEMENT

REMOVAL

1. Remove two nuts from fan guard and remove guard.

2. Loosen Allen Head set screw at center of fan hub. Remove fan from motor shaft.

INSTALLATION

1. Install fan on motor shaft, tighten Allen Head set screw.

2. Install fan guard and install two nuts.

THERMAL OVERLOAD PROTECTOR SWITCH (FIGURE 32)

The Brown compressor has a thermal overload protector switch mounted in the top of the compressor body. The switch is designed to turn the compressor off in the event that its temperature reaches a level where the motor can be damaged. When the temperature drops to a safe level the switch allows the compressor to operate.

COMPRESSOR OVERHAUL

(DANA, DOUBLE PISTON FIGURE 37)

TIMING BELT

REMOVAL

1. Remove one screw located above label on face of belt guard and remove belt guard (figure 38).

2. Rotate the compressor by hand and gradually work the belt off the two pulleys installed with flanges toward the mounting bracket.

INSTALLATION

NOTE: While installing the timing belt, time the compressor as follows:

1. Remove intake assembly. See "Intake Assembly - Removal" later in this section.

2. Rotate the compressor pulleys to position one piston and rod assembly at the top of its stroke and the other piston and rod assembly at the bottom of its stroke (figure 39).

3. Place the timing belt on the pulley with the flange to the front and gradually work the belt onto the other two pulleys (figure 40).

4. Rotate the compressor by hand until the timing belt is completely onto the pulleys.

NOTE: Following installation of belt, check timing of pistons (See figure 39).

5. Replace belt guard and secure with one screw. Replace intake assembly (following section).

INTAKE ASSEMBLY

REMOVAL

1. Remove air intake tubes from intake assemlies at back of housings (figure 41).

2. Remove two spring wire filter retainers.

3. Remove intake assemblies with "O" rings. The air filter is in the assembly.

4. Pinch the air filter between the thumb and forefinger and remove it from behind the retaining ring still in place. Replace the filter or clean with soap and water and squeeze dry. Install the air filter through the retaining ring and work into place with light finger pressure (figure 42).

INSTALLATION

1. Install air intake assemblies and "O" rings.

2. Install two spring wire filter retainers.

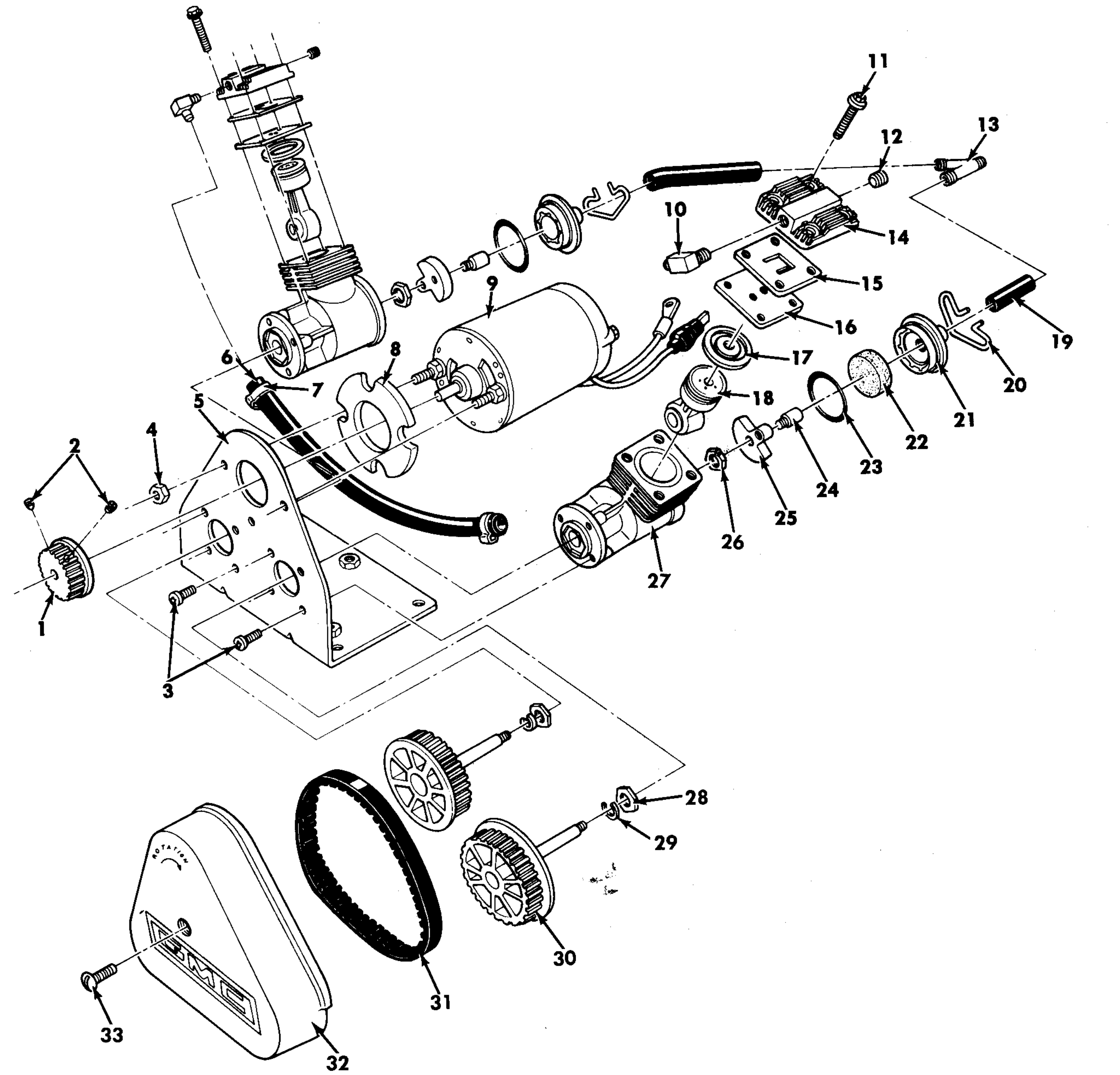
3. Install air intake tubes to intake assemblies at back of housings.

MOTOR ASSEMBLY

REMOVAL

1. Remove belt guard and timing belt.

2. Loosen two headless set screws in pulley and slide pulley off motor shaft.



1 Motor Pulley
2 Screw
3 Screw
4 Nut
5 Mounting Bracket
6 Hose
7 Clamp
8 Spacer
9 Motor
10 Connector
11 Screw
12 Plug
13 Tee
14 Head
15 Exhaust Valve
16 Head Plate
17 O-Ring
18 Piston and Rod Assembly
19 Tubing
20 Filter Retainer
21 Intake
22 Filter
23 O-Ring
24 Crank Pin
25 Crank
26 Thrust Washer
27 Housing Assembly
28 Thrust Washer
29 Retaining Ring
30 Pulley
31 Belt
32 Belt Guard
33 Screw

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Figure 37—Dana Compressor Exploded View

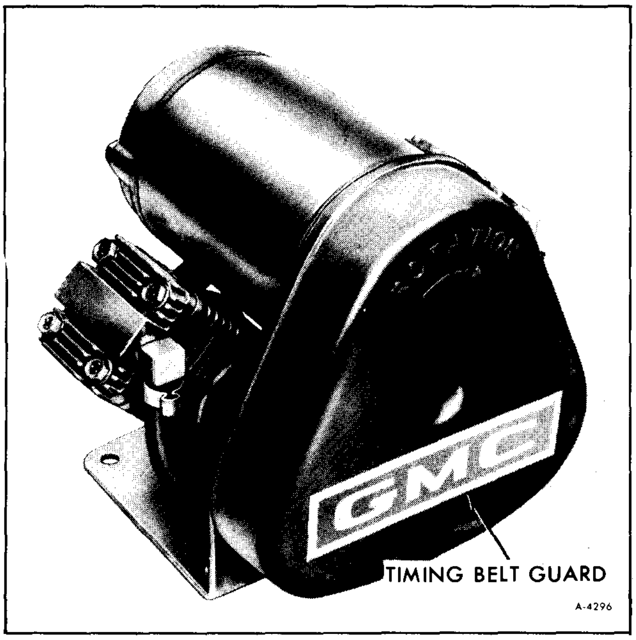


Figure 38—Compressor Belt Guard

3. Remove two hex nuts that hold motor to bracket and remove motor (figure 43).

INSTALLATION

1. Install motor on bracket and secure with two hex head nuts.

2. Slide pulley on motor shaft and secure with two headless set screws.

3. Install belt guard and timing belt.

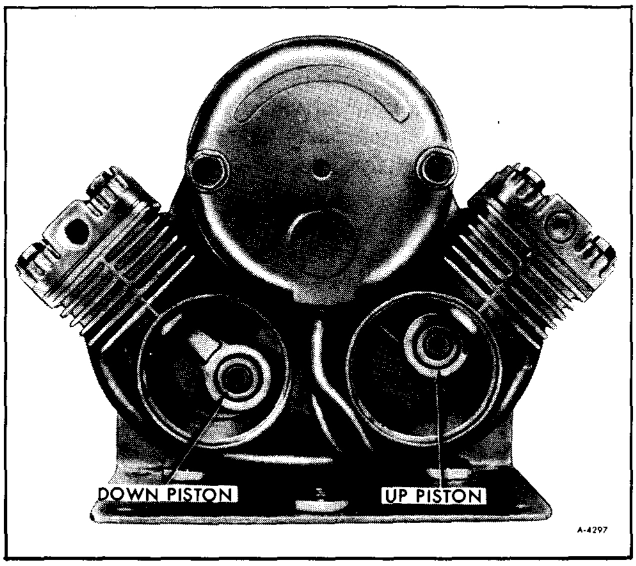


Figure 39—Timing Position

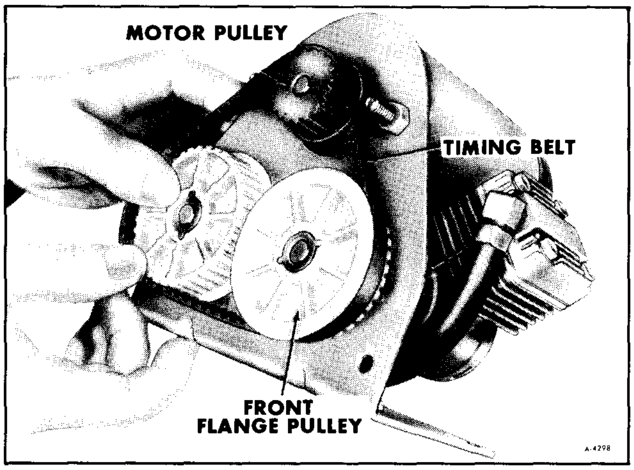


Figure 40—Replacing Timing Belt

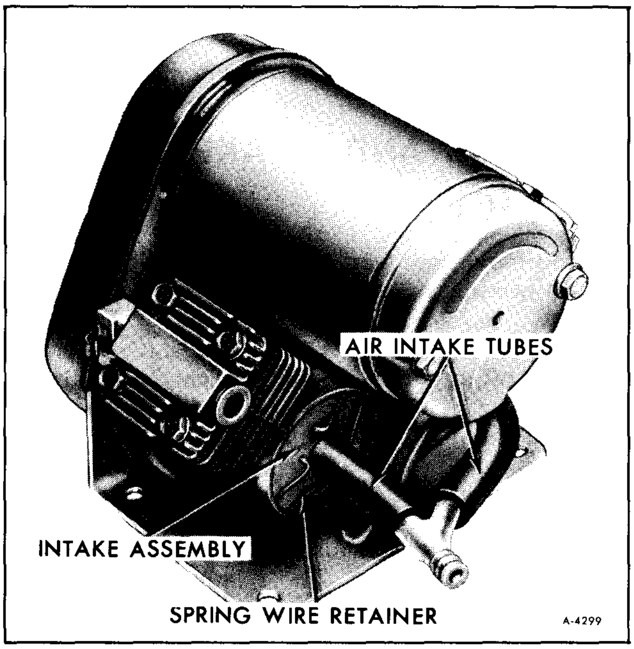


Figure 41—Back of Compressor

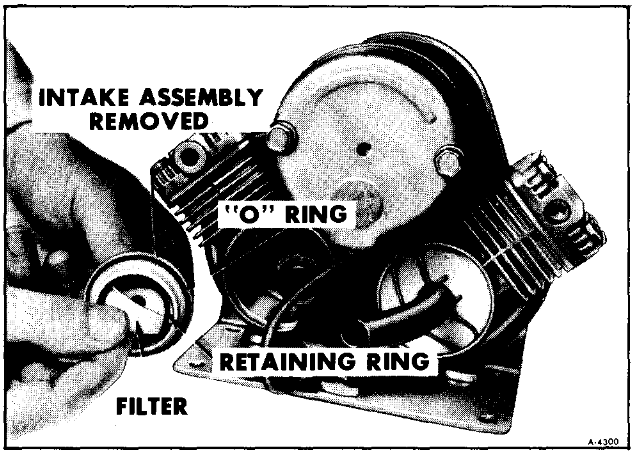


Figure 42—Air Filter Removal

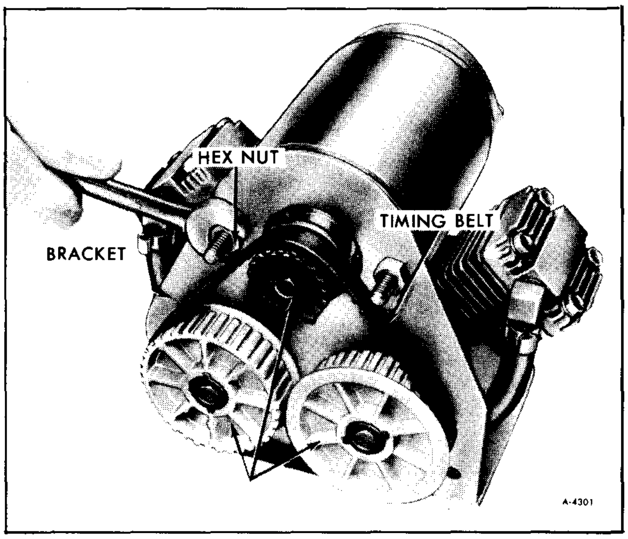


Figure 43—Motor Removal

EXHAUST AND INTAKE VALVES

REMOVAL

1. Remove four hex head screws holding valve head to housing assembly (figure 44).

2. The head, exhaust valve, and head plate usually come off as a unit. These parts can be gradually worked apart by inserting a knife blade between the head and exhaust valve (figure 45).

IMPORTANT: Note the relationship of the red silicone rubber exhaust valve reed to the valve holes in head plate. The relationship must be maintained to insure the proper compressor operation.

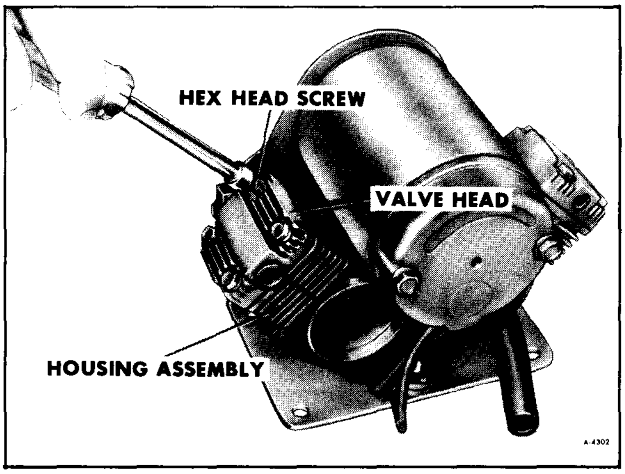


Figure 44—Valve Head Removal

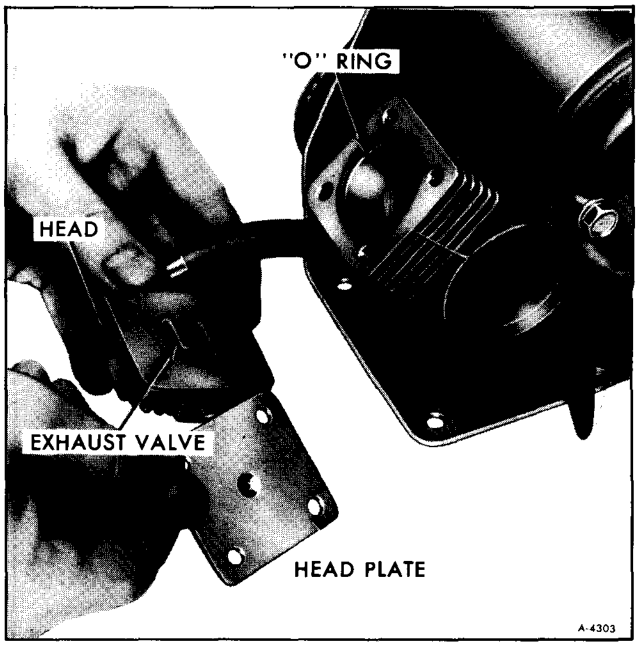


Figure 45—Valve Components

3. Lift the "O" ring seal out of recess on top of housing assembly.

4. Remove the round red silicone rubber intake valve on top of piston by working it off the center rivet.

INSTALLATION

1. To install round red silicone rubber intake valve put a slight amount of engine oil on the center rivet of piston. The valve will rotate freely when it is completely installed.

2. Replace "O" ring seal in recess on top of housing assembly.

3. Install head, exhaust valve, and head plate. It is important that these parts be reassembled in the correct relationship for proper compressor operation.

4. Install head assembly to housing assembly with four hex head screws.

PISTON AND ROD, SHAFT AND PULLEY

REMOVAL

1. Remove belt guard and timing belt.

2. Remove intake assembly.

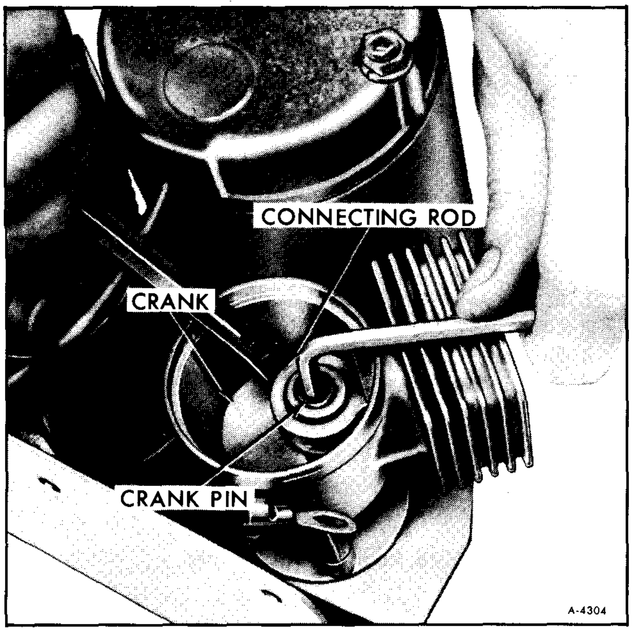


Figure 46—Crank Pin Removal

3. Remove exhaust and intake valves.
4. Remove crankpin, centered in lower end of connecting rod, with a hex key wrench. Hold the appropriate compressor pulley by hand or screwdriver while loosening crank pin (figure 46).

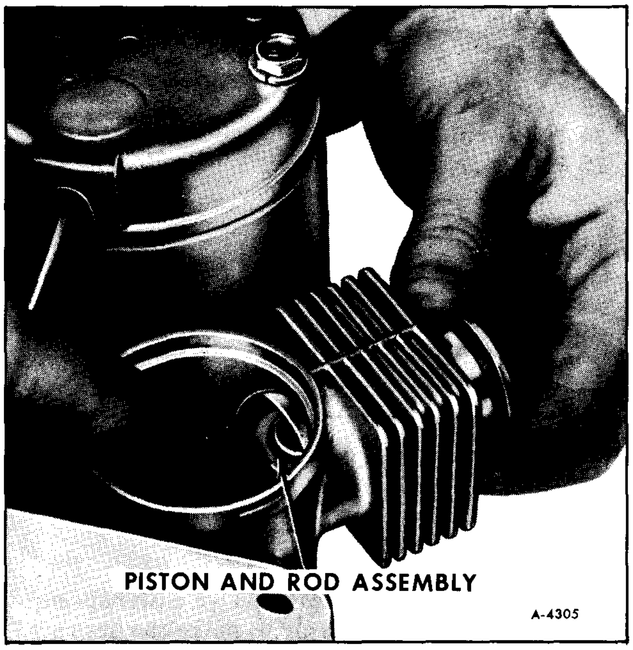


Figure 47—Piston and Rod Assembly Removal

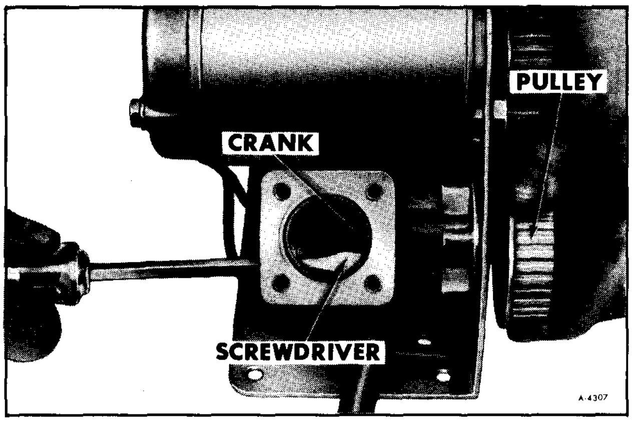


Figure 48—Removing Pulley Shaft From Crank

5. Push the piston and rod assembly through top of housing assembly (figure 47).

6. Use a screwdriver to wedge the crank inside the crankcase and unscrew the shaft and pulley assembly (figure 48).

7. Slide pulley and shaft assembly out of housing.

INSTALLATION

1. Install pulley and shaft assembly in housing with two black plastic hex thrust washers in respective recesses, inside and outside the housing.

2. Put piston and rod assembly through top of housing assembly. Bearing in lower end of connecting rod must be installed with printing outward. This is necessary for clearance.

3. Hold appropriate compressor pulley by hand and secure crank pin to lower end of connecting rod with hex key wrench.

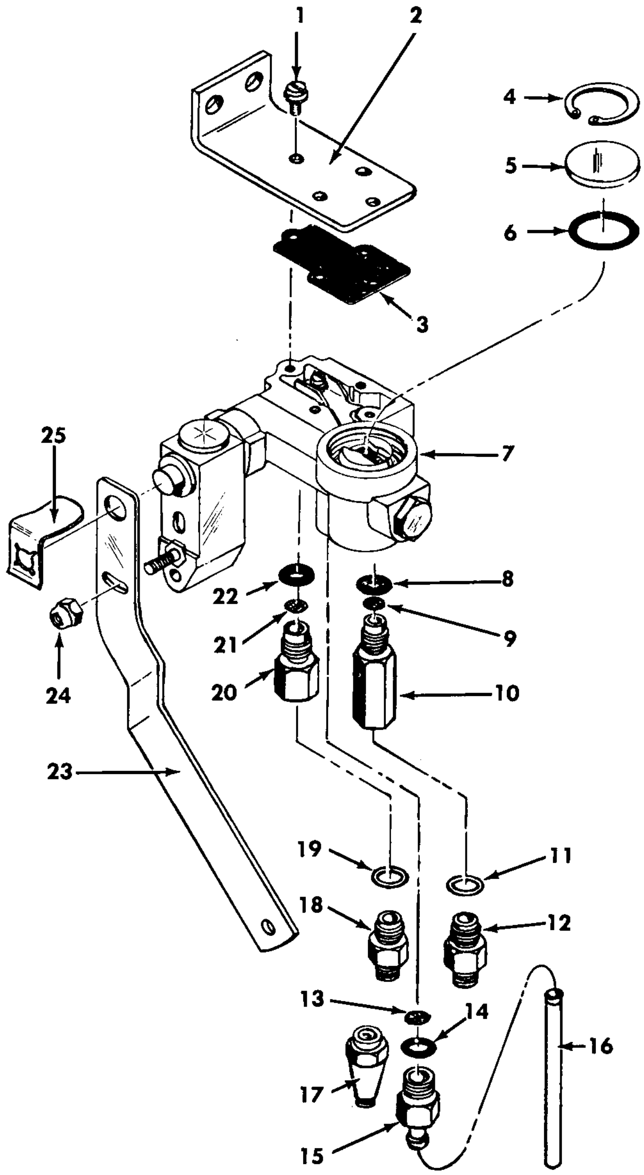
4. Install exhaust and intake valves.

5. Install intake assembly.

6. Install timing belt and belt guard.

HEIGHT CONTROL VALVE OVERHAUL

IMPORTANT: Height control valve-overhaul will be limited as shown in Figure 49. If repair procedures require replacement of valve body be sure to install new "O" rings and screens, as shown in Figure 49.



1 Screw, Cover Plate & Mounting Bracket
2 Cover Plate and Mounting Bracket
3 Gasket, Cover Plate & Mounting Bracket
4 Retaining Ring
5 Retainer, Delay Piston
6 "O" Ring
7 Valve Body
8 "O" Ring
9 Screen
10 Intake Valve Adapter Assembly
11 Gasket
12 Adapter
13 Screen
14 "O" Ring
15 Check Valve - Exhaust
16 Exhaust Tube
17 Tube Fitting
18 Adapter
19 Gasket
20 Adapter Assembly
21 Screen
22 "O" Ring
23 Arm
24 Nut, Arm Retaining
25 Fastener, Plug Retaining

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Figure 49—Height Control Valve

HEIGHT CONTROL VALVE ADJUSTMENTS

GENERAL

To properly adjust the height control valve, it is ESSENTIAL that the following procedures be followed and in the sequence mentioned:

Three main adjustments are required:

1. Overtravel lever center position adjustment.

2. Air intake and exhaust valve lever gap adjustments.

3. Time delay check.

NOTE: The height control valve assembly must be removed from vehicle to make the above adjustments.

Instructions for checking the ride height dimensions are explained under "Ride Height Check and Adjustment."

IMPORTANT: The silicone fluid should be drained from control valve assembly before making the first two adjustments.

OVERTRAVEL LEVER CENTER POSITION ADJUSTMENT

1. Clean exterior of control valve assembly.

2. Remove cover and rubber O-ring from valve assembly, then drain off the Silicone fluid.

3. Remove exhaust fitting (15, figure 49) and exhaust screen (13, figure 49) from control valve.

4. Referring to Figure 51, scribe a line 1-3/8 inch from plug end of overtravel lever control body.

5. Place control valve assembly in vise as shown in Figure 53.

6. If vacuum source is available, attach supply hose to valve exhaust port (figure 50) using Sun Tester fitting #115-3 or equivalent. Do not apply vacuum at this time.

7. Attach air pressure supply hose to air inlet port (figure 50). Do not apply pressure at this time.

8. Locate dial indicator in position as shown in Figure 51. Move overtravel lever to full air exhaust position — TOP OF DELAY PISTON FLUSH WITH TOP OF BORE - without overtraveling (position "C," figure 52). Relocate indicator push rod to just contact 1-3/8-inch mark on control body and reset indicator dial to zero at this point (position "C", figure 42).

9. Move overtravel lever to full air intake position without overtraveling (position "A", figure 52) (delay piston at bottom of bore). Take indicator reading which may vary from 0.160" to 0.190".

10. Repeat Steps 8 and 9 above to recheck this reading.

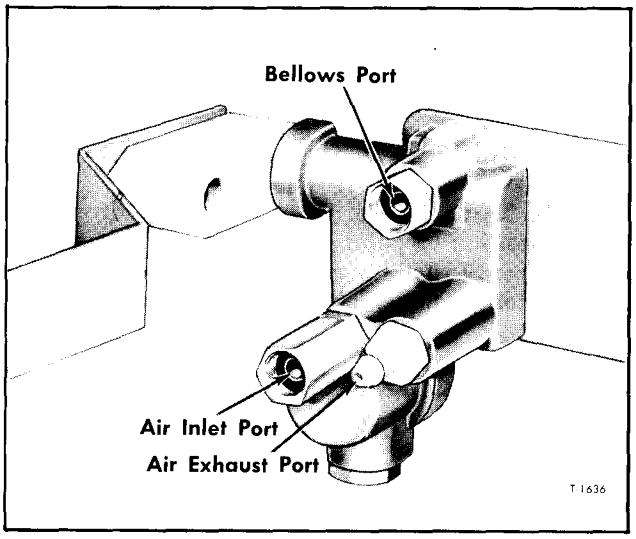


Figure 50—Height Control Valve Port Identification

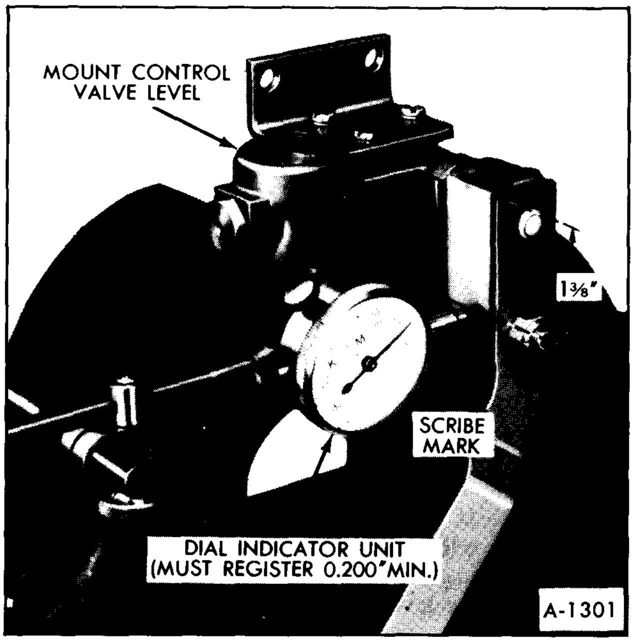


Figure 51—Dial Indicator Properly Installed

11. Divide the total travel dimension by two (example: 0.170" ÷ 2 = 0.085"), then move overtravel lever back this amount (0.085") to the center (position "B," figure 52).

IMPORTANT: Without disturbing lever center position, reset indicator dial to zero, which actually is 0.100" on indicator of type registering

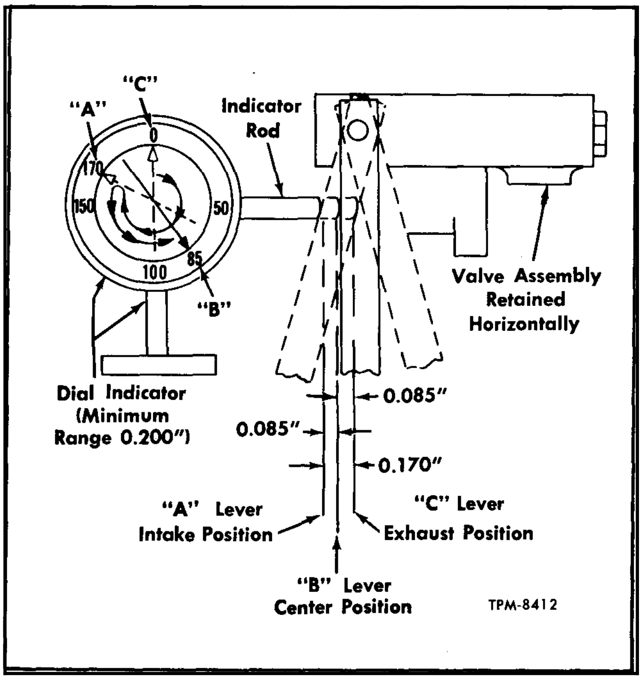


Figure 52—Locating Valve Overtravel Lever Center Position

0.100" for each revolution of indicator needle, then proceed with valve lever gap adjustments following:

AIR INTAKE AND EXHAUST VALVE LEVER ADJUSTMENTS

IMPORTANT: Before making these adjustments the overtravel lever must be centered as explained previously.

Two methods of adjustment are available:

1. Using Both Air Pressure and Vacuum.

NOTE: If vacuum source is available, this method will take less time to perform adjustment. Vacuum source is used to make the exhaust valve lever gap check only.

2. Using Air Pressure Only.

NOTE: When this method is used, it will take longer to perform adjustments as the valve cover must be in place each time air pressure is applied and then removed to permit adjustment of exhaust valve lever.

Method Using Air Pressure and Vacuum

1. If air supply and vacuum lines were not connected to control valve assembly as directed previously when centering valve overtravel lever, connect lines.

2. Apply air pressure and regulate it to 80 to 110 psi. Apply vacuum and regulate it at approximately 15 inches.

3. Move overtravel lever fore and aft several times and then back to true center position.

4. Starting at true center position, slowly move lever to where air intake valve just begins to open. Listen for escaping air. Note reading on dial at this point. Reading should be 0.025" to 0.027" from lever center position. Bend lever to correct setting. Refer to Figure 53.

5. Return overtravel lever to center position. Slowly move lever to exhaust side and at same time note the vacuum gauge reading. When vacuum just begins to fall off, the exhaust valve has opened. Valve should open when overtravel lever is moved 0.035" to 0.037" from center position. On both front and rear control valves, bend lever to correct setting. Refer to Figure 53.

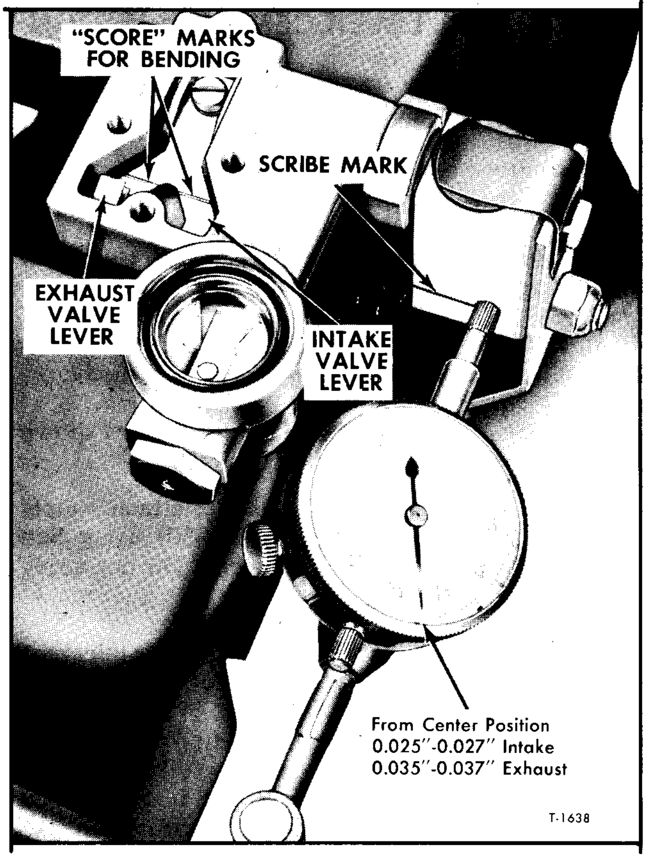


Figure 53—Method of Adjusting Air Valve Lever Gaps

6. Recheck intake and exhaust valve lever gaps, then proceed with "TIME DELAY CHECK" explained later.

Method Using Air Pressure Only

NOTE: This method may be performed when a vacuum source is not available.

1. Connect air supply hose (80 to 110 psi) to air inlet port (figure 50).

2. To adjust air intake valve lever gap:

a. Move the overtravel lever slowly from true center position to point where intake valve just begins to open. Listen for escaping air. Note reading to dial at this point which should register 0.025" to 0.027".

b. Bend lever to correct setting. Refer to Figure 53.

3. To adjust air exhaust valve lever gap:

a. Install valve cover on the valve using the rubber gasket and four attaching screws.

b. Being careful not to disturb indicator setting, disconnect air supply from the air inlet port and connect it to the bellows port (figure 50).

c. Move overtravel lever slowly to open exhaust port while observing the indicator dial. Air should start to escape from exhaust port when indicator registers 0.035" to 0.037". If adjustment is necessary, shut off air pressure supply and remove valve cover. Bend lever to correct setting, then install cover and recheck valve opening dimension.

d. Recheck valve lever gaps, then proceed with "TIME DELAY CHECK" following:

TIME DELAY CHECK

Preliminary Procedures

After the valve lever gaps have been adjusted, do the time delay check. A 4 to 18 seconds delay from the closing of one valve to the opening of the other is recommended. Also, valves should close from full-open position within 4 seconds.

1. Pour 5.5 cc $\pm$ 0.25 cc of Silicone fluid (3,000 Centistokes viscosity at 25°C.) into delay piston bore. With valve body tilted slightly, as shown in Figure 54, carefully operate overtravel lever fore and aft to vent air from fluid. When all air has been expelled from piston pin cavity, check fluid level (figure 55).

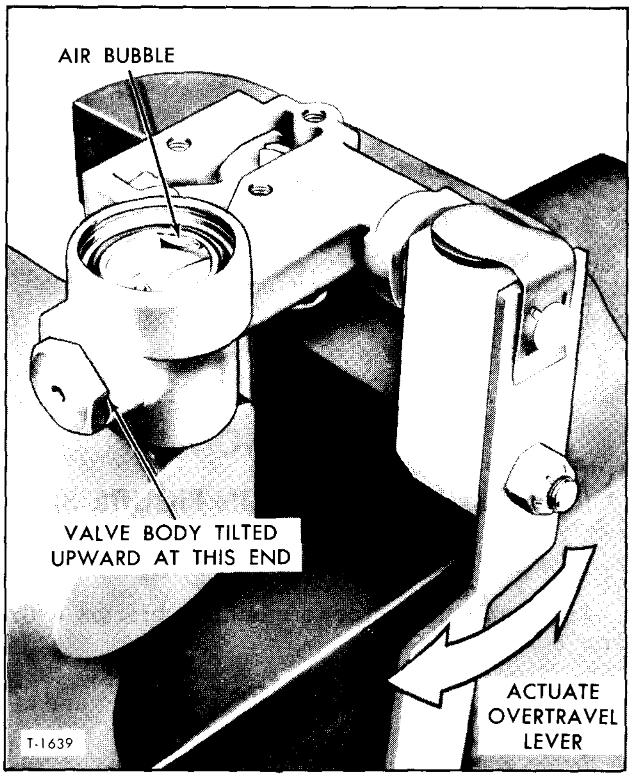


Figure 54—Venting Air From Silicone Fluid

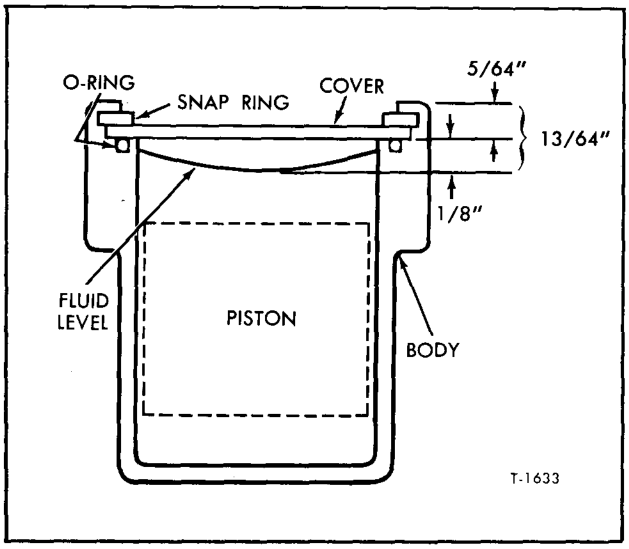


Figure 55—Silicone Fluid Level

IMPORTANT: With valve assembly level, take measurement from center of bore only. Add or Remove fluid to bring fluid to dimension shown in Figure 55. An eyedropper will serve for this purpose.

2. Place new delay piston cover O-ring in groove of valve body. Install cover with retainer.

3. Place valve assembly vertically in holding vise (figure 56).

4. Cycle arm up and down for approximately one minute.

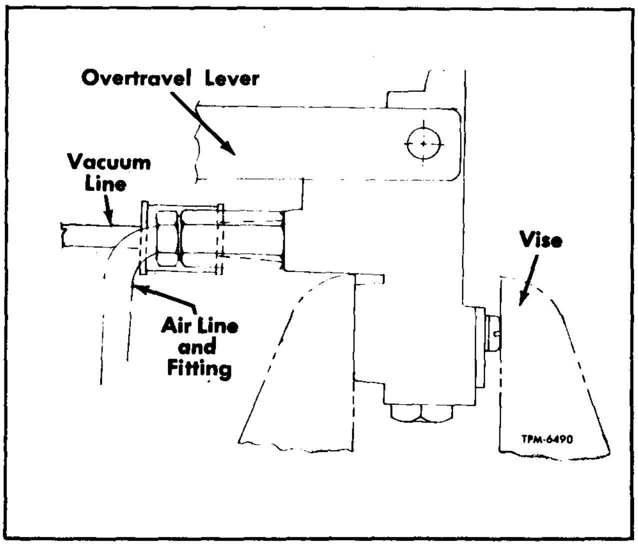


Figure 56—Valve Positioned for Time Delay Check

Air Inlet Time Delay Check

1. Connect air pressure supply hose to valve air inlet port (figure 50).

2. Move overtravel lever upward (quickly) approximately two inches and simultaneously start counting the number of of seconds before air starts to escape from bellows port. A delay of four to eighteen seconds should exist. Repeat this check.

Air Exhaust Time Delay Check

To time the delay for exhaust, two methods can be used; one using vacuum source and one using air pressure.

1. Method Using Vacuum

a. Connect vacuum hose to air exhaust port (figure 50). Adjust vacuum to 15 inches.

b. Move the overtravel lever downward (quickly) approximately two inches and simultaneously start counting the number of seconds before the vacuum gauge starts to drop off. A delay of ten to fifty seconds should exist. Repeat this check.

2. Method Using Air Pressure

a. Install valve cover with rubber gasket on valve assembly.

b. Connect air pressure supply hose to bellows port (figure 50).

c. Move overtravel lever downward (quickly) approximately two inches and simultaneously start counting the seconds before air starts to escape from the exhaust port. A delay of ten to fifty seconds should exist.

IMPORTANT: A time delay over fifty seconds could mean too large a valve lever gap adjustment and a time delay under ten seconds would mean too small a valve lever gap adjustment. If the time delay is not within ten to fifty seconds, first recheck the fluid level. If fluid level is satisfactory, the valve lever gap adjustment must be repeated, step by step.

NOTE: (Refer to figure 49.) After obtaining proper valve adjustments, install valve cover using new rubber gasket (3). Install new screen (21), in bellows port, then using new O-ring (22), install outlet adapter (20) into bellows port. If screen (13) was removed from exhaust port, install new screen and exhaust fitting (15).

NOTE: Place tape over ends of air line ports until such time valve assembly is installed on the vehicle.

COMPONENT INSTALLATION

PRESSURE SWITCH INSTALLATION (FIGURE 8)

1. Connect switch to air line elbow on vehicle.

2. Connect two electrical wires to screws inside switch body.

3. Install switch cover and secure with screw.

AIR COMPRESSOR INSTALLATION (BROWN, SINGLE PISTON FIGURE 2)

1. Secure compressor frame to mounting bracket with four screws.

2. Connect electrical wire at overheat switch in top of compressor body.

3. Connect hose at back of compressor.

4. Connect air line to piston dome.

AIR COMPRESSOR INSTALLATION (DANA, DOUBLE PISTON FIGURE 3)

1. Secure compressor to mounting bracket with three bolts.

2. Connect air lines at back of compressor and at head of one piston.

3. Connect electrical wires at back of compressor motor.

AIR RESERVOIR INSTALLATION
(FIGURE 9)

1. Install mounting brackets, safety valve, and Schrader valve on air reservoir body. Install drain cock if used.

2. Install pressure switch to air line at front of air reservoir.

3. Install air reservoir in vehicle with two bolts and nuts through the front mounting bracket and two nuts and bolts through the rear mounting bracket.

4. Connect two air lines to side of reservoir.

5. Connect pressure switch wiring, and install switch cover.

HEIGHT CONTROL VALVE INSTALLATION

Before installing height control valve assembly, see that air line fittings are clean and undamaged.

> **NOTE:** DO NOT USE SEALING COMPOUND ON THREADS. Sealer is unnecessary, and if used, may cause valves to stick. Absolute cleanliness is essential when installing height control valves. Dirt and sealing compound must be kept out of valves. Even minute particles of foreign matter may become lodged in valve cores or flapper valves and may seriously affect operation of suspension system.

1. Position height control valve at mounting studs on wheelwell. Attach with two nuts and tighten to 80-120 in. lbs. torque.

2. Connect air supply line to intake adapter, connect bellows air line to outlet adapter. Tighten air line connector nuts firmly.

3. Connect height control valve overtravel lever to valve link and tighten to 60-90 ft. lbs. Build up air pressure in system and test for leaks. Check ride height dimension and adjust if necessary as described later in this section.

AIR BELLOWS INSTALLATION

1. Place air bellows piston on floor, cone section pointing up. Place air bellows in piston, with open end pointing up.

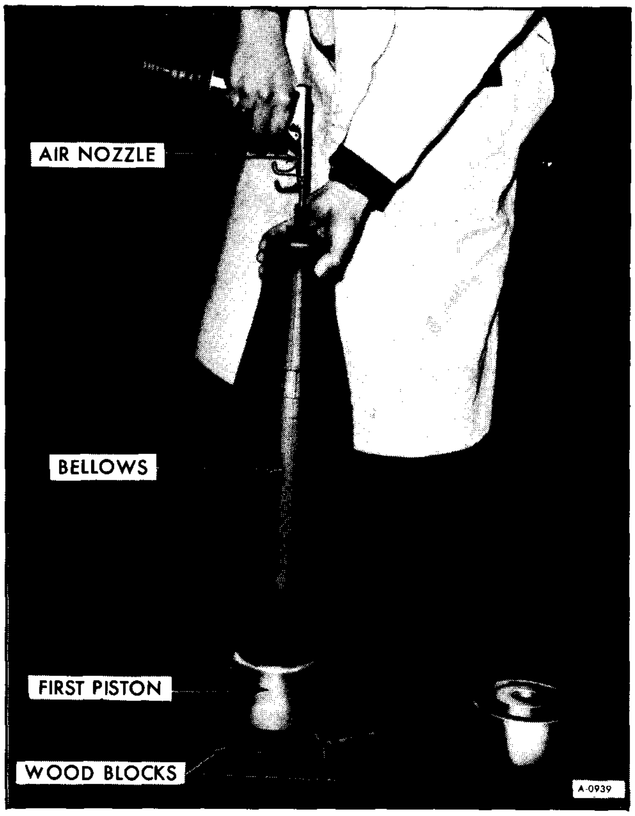


Figure 57—Applying Shop Air to Air Bellows

2. Referring to Figure 57, apply shop air to bellows while pushing down on bellows, release air pressure. The bellows will fold over the piston.

3. Place second piston over top of bellows and apply shop air again as shown in Figure 58. Push down on bellows and release air pressure. Bellows will fold over piston. Completed bellows assembly should appear as shown in Figure 39.

4. Raise rear wheels to bring top of control arms close together. Block control arm is shown in Figure 70. Place air bellows in position. Install star washers and lock nuts. Torque lock nuts to 50-60 ft.-lbs.

5. Connect air line and move height control valve arm up to apply air to bag.

6. Connect leveling valve link. Lower vehicle to ground and allow leveling valve to bring it to proper ride height.

CONTROL ARM INSTALLATION

1. With the aid of hammer as shown in Figure 60, tap two back hat section spacers in mounting bracket to provide more room for control arms in bracket.

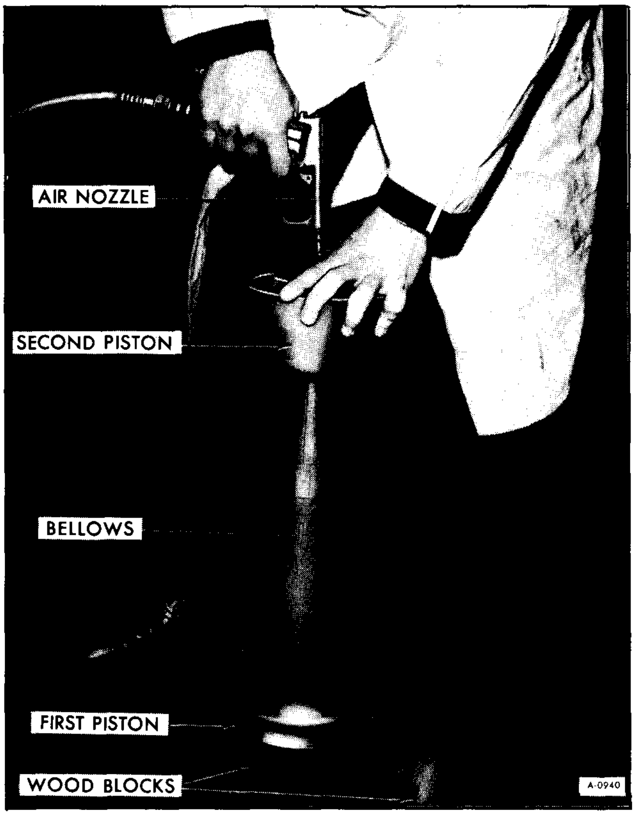


Figure 58—Installing Second Piston on Air Bellows

2. Place control arm in position in mounting bracket. Position thrust pack journal bearing between control arm and mounting bracket. (See figure 63).

3. Press bracket pins into proper position.

4. Install control arm lock nuts.

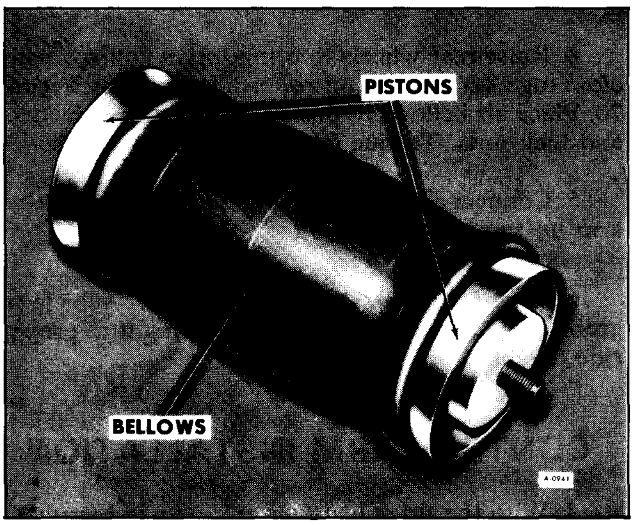


Figure 59—Air Bellows Assembly

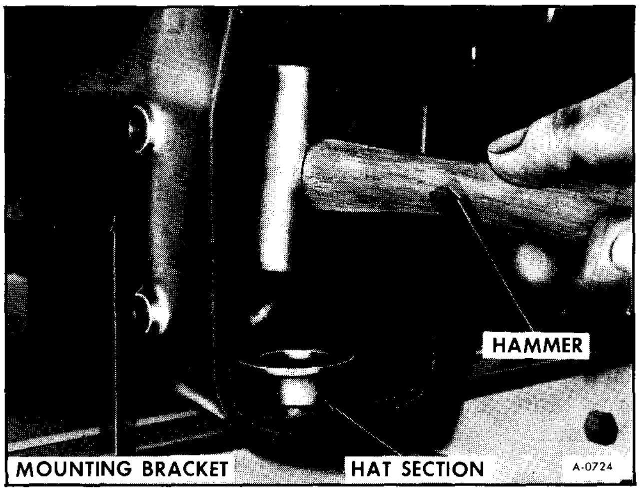


Figure 60—Repositioning Hat Section

5. Tighten control arm lock nuts until hat section spacers are firmly seated, then back off nut until control arm moves freely, and retorque nuts to 15-20 ft. lbs.

6. Install spindle with keyway up as shown in Figure 61 using bolts and nuts to draw spindle into suspension arm.

7. Remove spindle bolts and nuts.

8. Install backing plate assembly, new bolts, washers and nuts as shown in Figure 62. Torque bolts 35-45 ft. lbs.

9. Referring to Figure 21, position unit on vehicle and install four bolts from mounting bracket to frame rail. Install two bolts from mounting bracket to frame crossmember (See figure 20).

10. Referring to Figure 20, install brake backing plate by installing four bolts and nuts that secure plate to control arm.

11. Referring to Figure 18, install brake drums and hubs on spindle. Tighten castilated nut (figure 17) to 25-30 ft. lbs., back nut off one half turn and then finger tighten until cotter pin can be installed.

12. Install shock absorbers to control arms.

13. Install brake lines. Connect all mounting brackets and connect lines at brake backing plates and at control arm mounting bracket.

14. Referring to Figure 13, install air bellows.

15. Referring to Figure 11, connect leveling valve link and torque nut to 60-90 in. lbs.

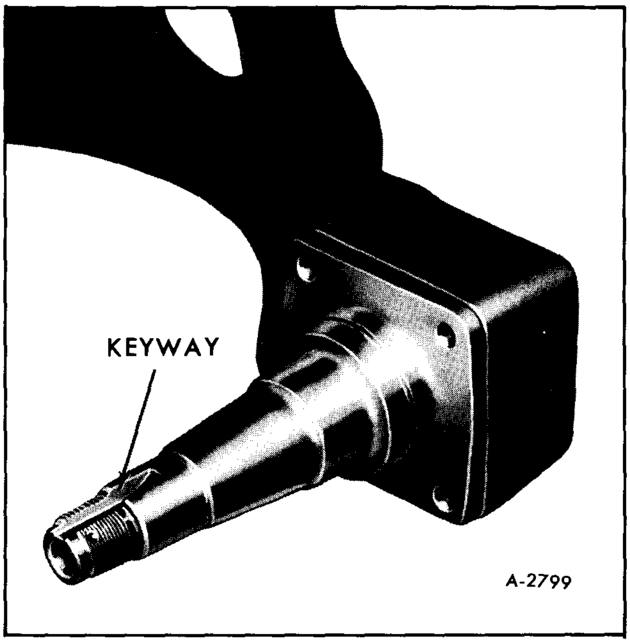


Figure 61—Spindle Installed

16. Apply air to bellows.

17. Install tire and wheels.

18. Lower vehicle to floor and allow leveling valve to bring vehicle to ride height.

19. Bleed brakes as described in Section 5 Brakes.

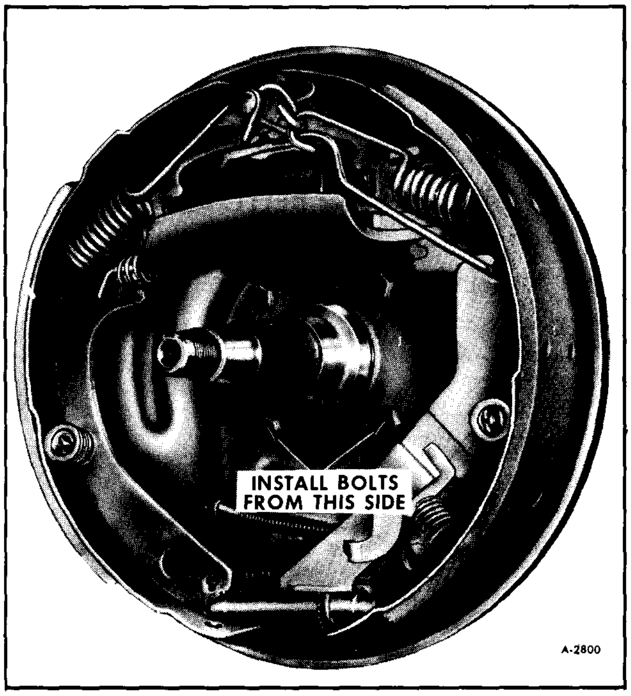


Figure 62—Backing Plate Installation

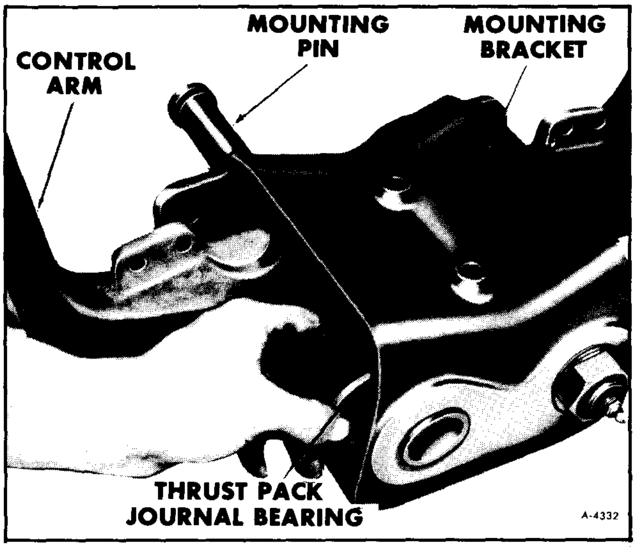


Figure 63—Installing Thrust Bearings

SHOCK ABSORBER INSTALLATION

Block control arms in an up position with a wooden block about one inch in thickness as shown in Figure 27. Install top of shock in upper control arm and secure with nut. Install bottom of shock on mounting bracket on frame rail, and secure with nut.

POWER LEVEL VALVE INSTALLATION

1. Wrap threads on air line fittings with teflon tape.

2. Install lines to back of valves, referring to Figure 66. On the right valve, red line goes to the port marked "MAN.," blue line goes to the port marked "OUT," and yellow lines goes to the port marked "AUTO." On left valve, red line goes to the port marked "MAN.," gray line goes to the port marked "OUT," purple line goes to the port marked "AUTO."

3. Install two screws holding valve to mounting panel (See figure 29).

4. Install four screws holding mounting panel to dash.

5. Install control knob using Allen Head screw in center of knob.

6. Close drain cock on air reservoir, place control knob in travel position, and operate compressor until suspension comes up to ride height. Check for air leaks.

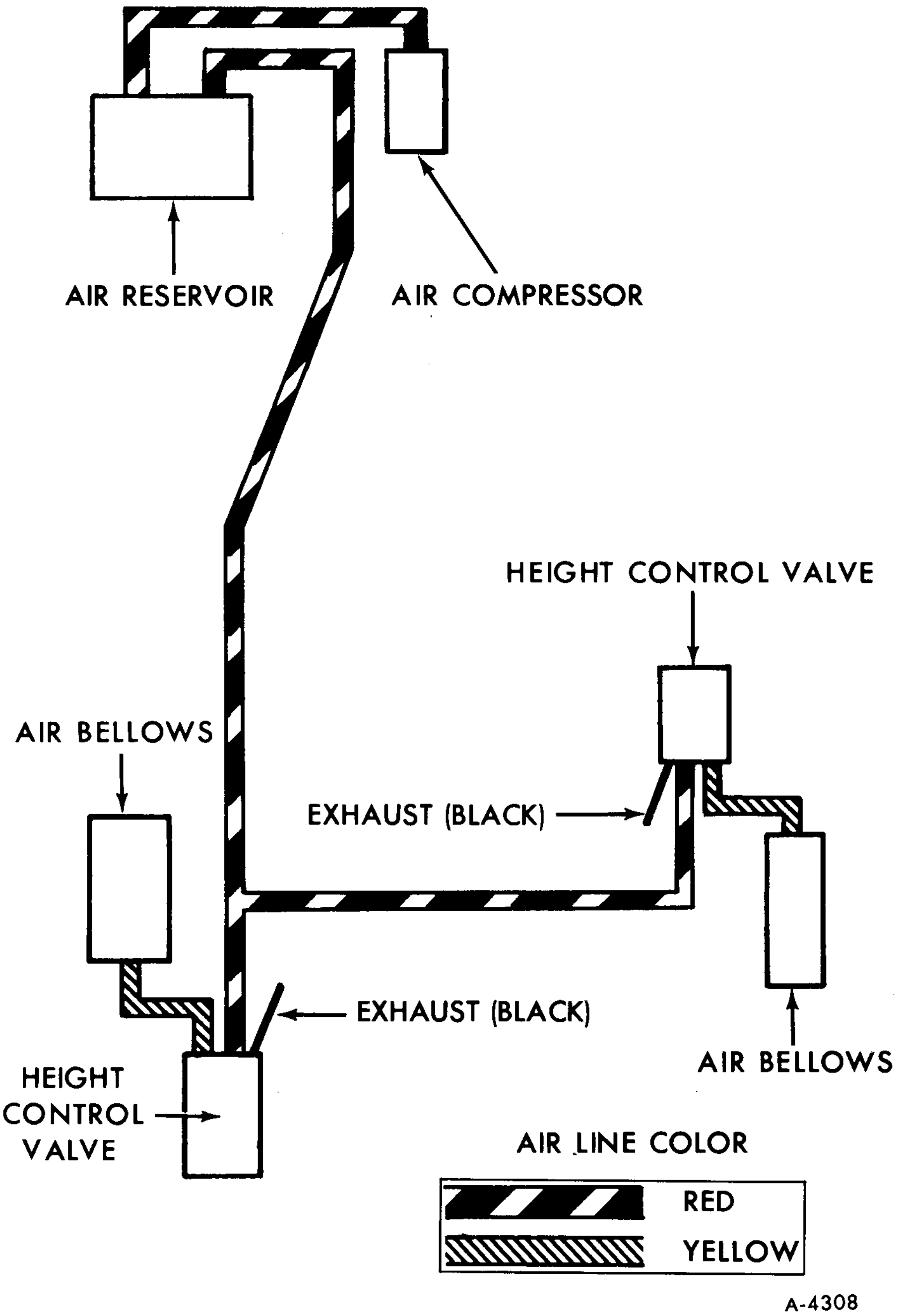


Figure 64—Standard Rear Suspension Schematic

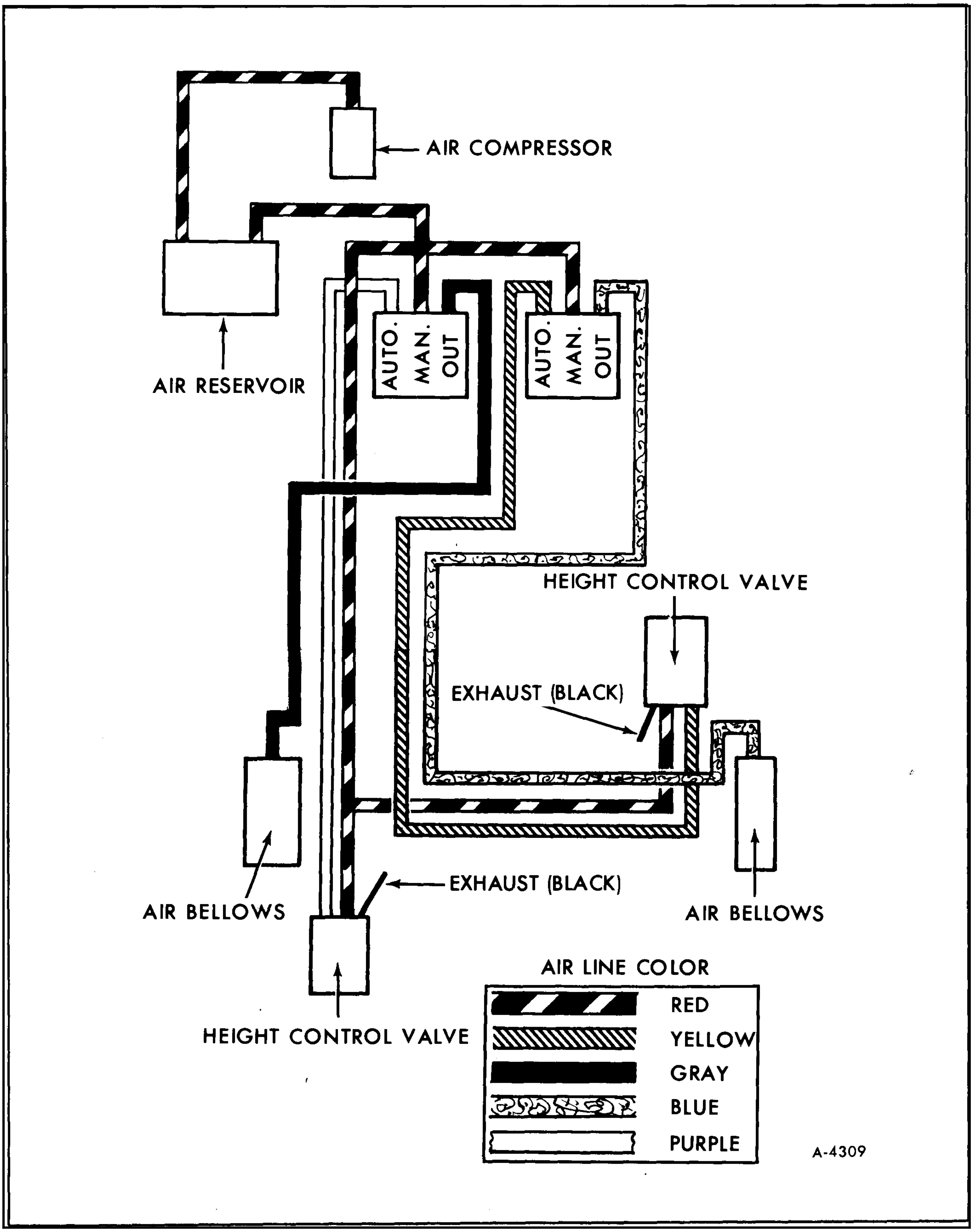


Figure 65—Rear Suspension Schematic (With Power Level)

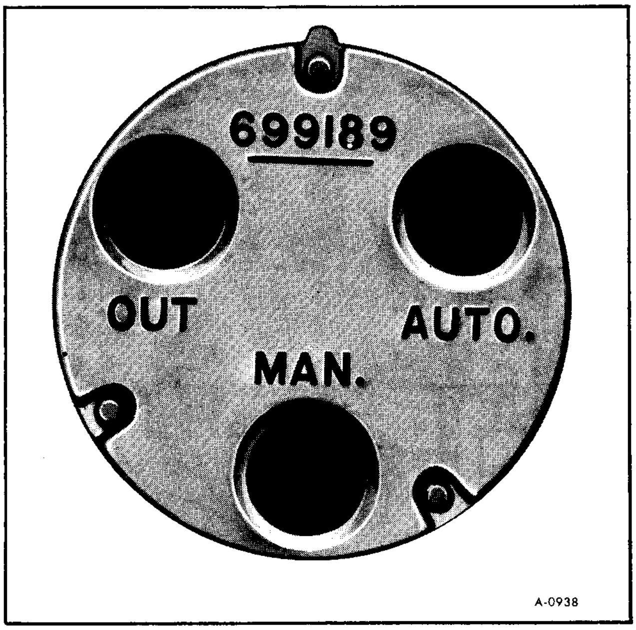


Figure 66—Power Level Valve Port Identification

AIR LINE INSTALLATION

Nylon tubing is used throughout the vehicle for rear suspension air lines as shown in schematics, Figures 64 and 65. It is flexible, durable and weather-resistant.

When installing nylon tubing make sure it is not routed close to a heat source, such as exhaust manifold or muffler. Tubing must be cut to required length and related fittings assembled.

IMPORTANT: Whenever threaded fittings on the rear suspension (excluding the height control valve, itself) are disassembled for any reason, be sure threads on male portion of fitting are wrapped with teflon tape or equivalent to avoid leakage.

1. Cut nylon tube to required length and be sure components are free of nicks or scratches.

2. Position nut and sleeve over tube.

3. Push tube insert into tube, then push tube and insert into fitting until firmly seated.

4. Seat sleeve into fitting, then tighten nut securely.

5. Install fitting at other end of nylon tube using the above procedure, then check for leaks.

6. If any trouble symptoms, such as slow suspension operation, indicates a restricted or clogged air line, disconnect suspected tube or hose at both ends and blow through it to make sure the passage is clear. Inspect tubing and hose for partial restrictions such as dents or kinks. If such condition is found, replace the tubing.

ON-VEHICLE ADJUSTMENTS

REAR WHEEL ALIGNMENT

Proper rear wheel alignment must be maintained to ensure correct handling and satisfactory tire life.

Before checking alignment the following inspections should be made.

1. Check that tires are inflated to 60 psi.

2. Check wheel bearing adjustment and correct if necessary.

NOTE: Rear wheel alignment requires the vehicle to be level while being checked. Full weight must be on wheels with vehicle empty.

TOE-IN MEASUREMENT

Toe-in may be measured from center of tire tread or from inside tires or rims. Measurements at both wheels must be made in same relationship (See "G" and "F," figure 67).

If measurement is to be made from center of tire treads, first hoist vehicle and spin wheels to obtain a center line on tire tread. Roll vehicle ahead several feet to where the inspection is to be made. This will remove any slack caused by looseness in wheel bearings.

Measure at point "F" and "G". The toe-in should follow the relationship: $G = F \pm .06''$.

TOE-IN ADJUSTMENT

If toe-in is not correct it must be shimmed as shown in Figure 68. Follow this procedure for adjustment.

1. Raise vehicle off floor.

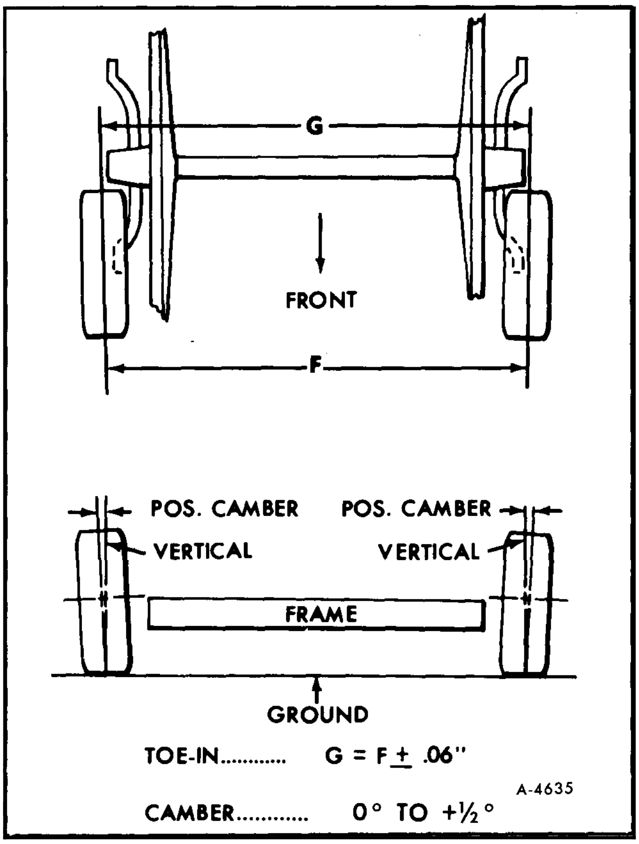


Figure 67—Rear Wheel Alignment Chart

2. Loosen six bolts on mounting bracket.

3. Insert proper shim as shown in Figure 68.

4. Tighten 4 retaining nuts on frame rail to 65-85 ft. lbs. torque. Tighten two retaining nuts on crossmember to 50-60 ft. lbs. torque.

5. Lower vehicle to floor and recheck alignment.

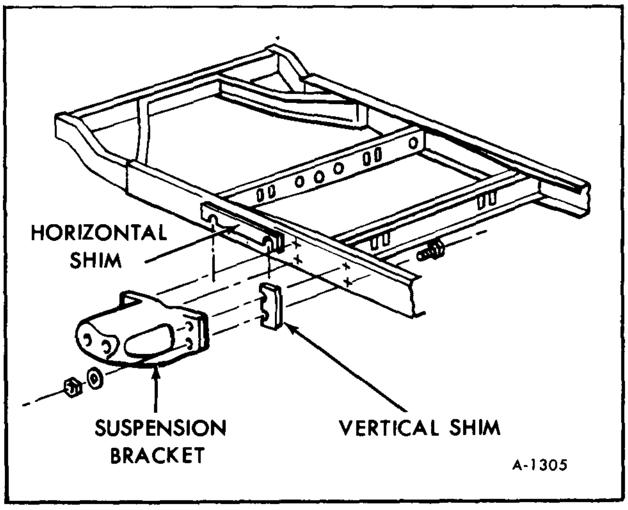


Figure 68—Rear Wheel Shim Location

REAR WHEEL CAMBER

The rear wheels are set with positive camber. Positive camber is outward inclination of wheels at top.

In checking camber, it is recommended that an accurate gauge be used. The camber should be set at 0° to +1/2° (See figure 67).

Excessive positive camber results in irregular wear of tires at outer shoulder. Negative or reverse camber causes wear at inner shoulders.

Camber is adjusted by shimming as shown in Figure 68. Following the same shimming procedure as that used before to set toe-in.

AIR COMPRESSOR PRESSURE SWITCH ADJUSTMENT

The switch is designed to maintain air pressure in the air reservoir between 100 and 120 psi. If the pressure in the reservoir drops to 100 psi the contact points will close and this will complete the circuit supplying electricity to the compressor. If the pressure raises above 120 psi the contact point will open the circuit to the compressor. This setting may be adjusted at the nut which is located on the end of the spring inside the cover, refer to Figure 69. The pressure will rise by tightening the spring. Both the cut-in pressure and the cut-out pressure will be affected by

Figure 69—Air Compressor Pressure Switch Adjustment

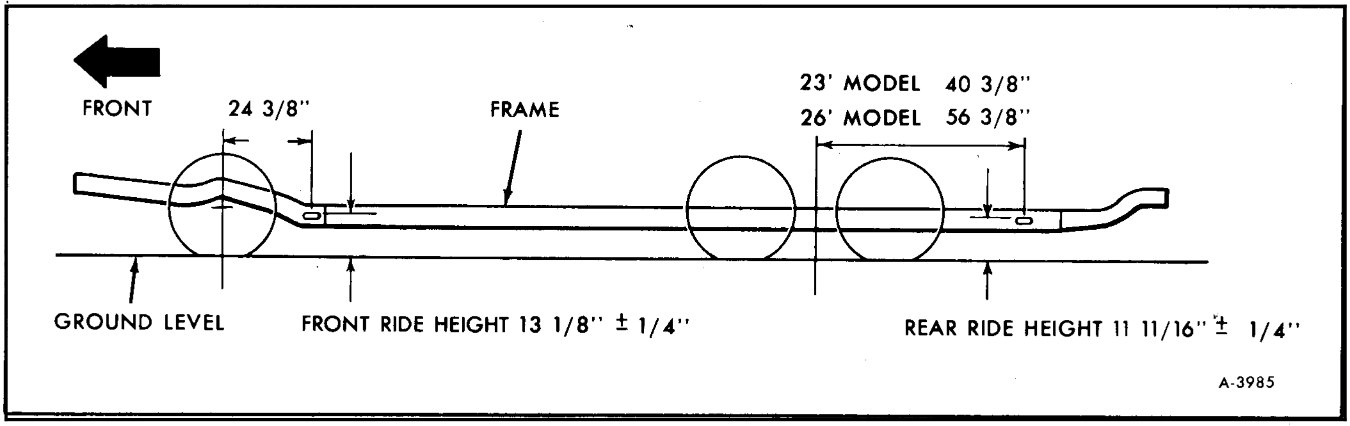


Figure 70—Checking Vehicle Ride Height

this adjustment. The pressure can be measured at the schrader valve on the reservoir.

RIDE HEIGHT ADJUSTMENT

Measure the rear suspension ride height at the elongated slot on the frame rail. Refer to Figure 70.

To adjust ride height loosen adjustment nut on height control valve (See figure 71). The valve arm has an elongated hole at the adjustment nut. This allows the valve arm to move in relation to the valve itself, and thus allows the ride height to change. Intake and exhaust valves of height control valve can then be operated independently of linkage. When proper ride height is reached tighten nut to 70-80 in. lbs.

Height control valve lever will move 3/16 inch up or down from neutral position (free travel) without causing any valve action. If amount of adjustment required falls within these limits, adjust lever the required amount. However, frame will not raise or lower until load is increased or decreased to actuate height control valve.

If any one of the height control valves does not function properly with the lever correctly adjusted, check for restricted air lines. If valve still does not hold frame at normal ride height with lever properly adjusted, and with no restriction in air line, valve should be overhauled or replaced with a new or rebuilt unit.

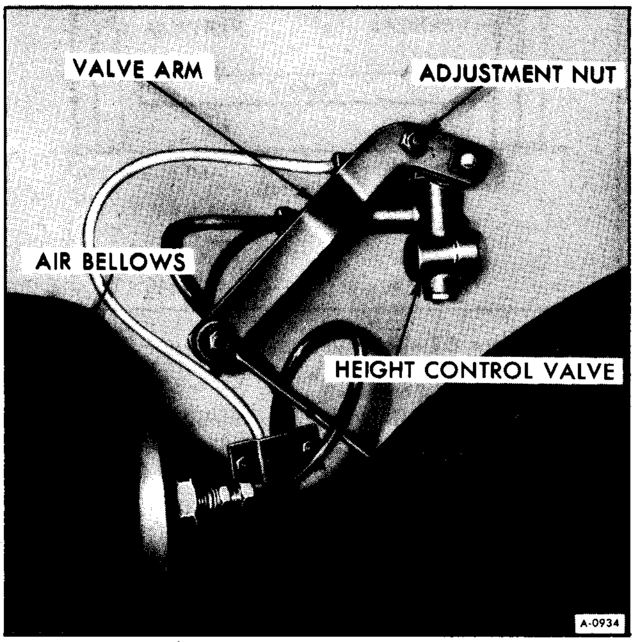


Figure 71—Location for Rear Ride Height Adjustment

PERIODIC MAINTENANCE

AIR COMPRESSOR FILTER REPLACEMENT

BROWN, SINGLE PISTON

The air filter on the compressor should be cleaned or replaced every six months or 6,000 miles.

Remove retainer at end of compressor to remove filter screen and element. Wash element in soap and water, and dry completely before replacing.

DANA, DOUBLE PISTON

The air filter on the compressor should be cleaned or replaced every six months or 6,000 miles.

Remove tubing at back of each housing assembly. Remove filter retainer and pull intake assembly off and carefully take filter out from behind inside retainer (figure 42). Wash filter with soap and water, and dry completely before replacing.

AIR RESERVOIR

Condensation should be drained at least once a month. To drain reservoir properly, leave Schrader valve or drain cock if so equipped, open until all air escapes and draining stops.

Air tank mounting bolts, and brackets should be checked at regular intervals for looseness. Tighten if necessary. Air reservoir may be cleaned inside using steam or hot water. If corrosion or other damage has weakened tank it must be replaced.

LUBRICATION

Details on lubrication of rear suspension components are covered in Section 0 at the beginning of this manual.

REAR SUSPENSION TORQUE SPECIFICATIONS

LOCATION	TYPE OF PART	TORQUE
Center mounting bracket to frame rail nuts (4)	Nut	65-85 lbs.-ft.
Center mounting bracket to crossmember nuts (2)	Nut	50-60 ft.-lbs.
Height control valve mounting Bolt	Bolt	80-120 in.-lbs.
Height control valve link		
Link to arm nut	Nut	60-90 ft.-lbs.
Link to control arm nut	Nut	60-90 ft.-lbs.
Control arm lock nut	Nut	15-20 ft.-lbs.

SPECIAL TOOLS

J-25520	Air Line Crimp Tool

SECTION 5
BRAKES

Contents of this section are listed below:

SUBJECT PAGE NO.

General Information 5-1
Brake System Trouble Diagnosis 5-4
On-Vehicle Servicing 5-14
Component Removal 5-17
Component Overhaul 5-25
Major Component Inspection 5-37
Component Installation 5-40
Specifications 5-46
Torque Specifications 5-46
Special Tools 5-46

CAUTION: *All brake system fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.*

GENERAL INFORMATION

The vehicle is equipped with disc brakes on the front wheels, and has drum brakes on the rear wheels. They are hydraulically powered by a split hydraulic system.

When the brake pedal is depressed, the piston in the master cylinder forces fluid under pressure to a wheel cylinder at each wheel, which in turn, pushes the brake shoes against the brake drum. As the shoes contact the drum, the friction between the shoes and the rotating drum moves the primary shoe downward against the adjusting screw which acts as a link to transmit the force of the primary shoe to the lower end of the secondary shoe. With the upper end of the secondary shoe being held by the stationary anchor pin, the secondary shoe is wedged against the drum. This wedging action, due to frictional force impacts the self-energizing action to the braking effort and thereby decreases the effort required by the driver to stop the vehicle.

SELF-ADJUSTING BRAKE

The vehicle is equipped with self-adjusting brakes. The self-adjusting brake mechanism consists of an actuating link, adjuster lever, adjuster lever return spring, override spring and override pivot.

OPERATION (DRUM TYPE)

The self-adjusting brake mechanism operates only when the brakes are applied while the vehicle is moving rearward and only when the secondary shoe moves a predetermined distance toward the brake drum.

As the vehicle moves rearward and the brakes are applied, friction between the primary shoe and the drum forces the primary shoe against the anchor pin. Hydraulic pressure in the wheel cylinder forces the upper end of the secondary shoe away from the anchor pin. As the secondary shoe moves away from the anchor pin, the upper end of the adjuster lever is prevented from moving by the actuating link. This causes the adjuster lever to pivot on the secondary shoe forcing the adjuster lever against the adjusting screw sprocket. If the brake linings are worn enough to allow the secondary shoe to move the predetermined distance, the adjuster lever will turn the adjusting screw sprocket one or two teeth, depending on lining wear. If the secondary shoe does not move the predetermined distance, movement of the adjuster lever will not be great enough to rotate the adjusting screw sprocket.

When the brakes are released, the adjusting lever return spring will move the adjuster lever into the adjusting position on the sprocket.

An override feature is built into the self-adjusting brake which allows the secondary shoe to be applied in reverse in the event the adjusting screw becomes "frozen" preventing the self-adjuster from operating.

When the vehicle is moving forward and the brakes are applied, the upper end of the secondary shoe is forced against the anchor pin due to the self-energizing action of the brakes and the self-adjuster does not operate.

OPERATION (DISC TYPE)

The significant feature of the single piston caliper operation is that it is free to slide on the two mounting bolts which thread into the support bracket.

At application of the brakes, the hydraulic pressure behind the piston increases. Pressure is exerted equally against the bottom of the piston and also against the bottom of the piston bore. The pressure applied to the piston is transmitted to the inboard shoe and lining, forcing the lining against the inboard disc surface. The pressure applied to the bottom of the piston bore forces the caliper to slide or move inboard on the mounting bolts. Since the caliper is one piece, this movement toward the vehicle causes the outboard section of the caliper to apply pressure against the back of the outboard shoe and lining assembly, forcing the lining against the outboard disc surface. As hydraulic pressure builds up, the shoe and lining assemblies are pressed against the disc surfaces with increased force, bring the vehicle to a stop.

In actual practice, the application and release of the brake pressure causes a very slight movement of the piston and caliper. Upon release of the braking effort, the piston and caliper merely relax into a released position. In the released position, the shoes do not retract any appreciable distance from the disc surfaces.

As the brake lining wears, the piston moves out of the caliper bore and the caliper repositions itself on the mounting bolts and equal distance inboard. In this manner the caliper assembly maintains the inboard and outboard shoe and lining in the same relationship with the disc surface throughout the full life of the lining.

MASTER CYLINDER

DESCRIPTION

The dual master cylinder is designed so that the front and rear brakes have separate hydraulic systems. The hydraulic pressure developed in both systems is equal at all times since the front piston is balanced between the hydraulic pressure in each system.

Malfunction in either system has no effect on the other system but is immediately evident to the driver because of the additional pedal travel required to actuate the remaining half of the dual brake system. Also, a pressure differential sensing switch in the system actuates a warning light on the instrument panel.

OPERATION

Two brake fluid reservoirs are cast integrally with the master cylinder and supply fluid to the areas ahead of the primary seals through the compensating ports and between the primary and secondary piston seals through by-pass ports in the casting.

Within the bore of the master cylinder is the rear piston assembly, which is composed of the piston, return spring, retainer, spacer and screw. Also in the bore is the front piston with a primary and two secondary piston seals are a front piston return spring and retainer.

Fluid is directed to the wheels through two hydraulic outlets, one for the front brakes and one for the rear brakes.

In the event the engine stalls, the vacuum chambers within the power cylinder provide adequate vacuum reserve for two or three brake applications. If the vacuum check valve is defective or braking has depleted the vacuum reserve, the driver can still operate the brakes in a conventional manner but more effort is required due to the loss of power assist.

WHEEL CYLINDER

OPERATION

Each wheel cylinder contains two pistons and two rubber cups which are held in contact with the pistons by a central coil spring with cup expanders to provide a fluid-tight seal. The wheel cylinder cups are of a special heat resisting rubber. Cups of this material must have an expander to hold the lips of the cup out against the wheel cylinder bore. These cup expanders are crimped on each end of the wheel cylinder spring. The inlet port for brake fluid is located between the pistons so that when fluid pressure is applied, both pistons move outward toward the ends of wheel cylinders. The pistons impart movement to the brake shoes by means of connecting links which seat in the pistons and bear against webs of the shoes. Rubber boots enclose both ends of the cylinder to exclude foreign matter. A valve for bleeding the brake pipes and wheel cylinder is located above the inlet port.

COMBINATION VALVE

A combination is incorporated into the brake system. It performs three functions; a balance function, a metering function, and a warning switch.

METERING VALVE FUNCTION

The metering section of the combination valve operates to "hold off" hydraulic flow (pressure) until about 130 psi has been built up in the system before applying the front brakes. The pressure then blends to full line pressure at approx. 400-600 psi line pressure. There is no flow restriction when the brakes are released.

BALANCE FUNCTION OR WARNING SWITCH

The fluid from front and rear systems is separated by a hydraulically balanced sealed piston. A spring loaded switch plunger rides in a groove in the switch piston. Any pressure differential sufficient to overcome the switch plunger spring and friction causes a shift of the piston in the direction of reduced pressure, causing the switch plunger to ride up out of its groove and the switch to make contact and light the warning light. (100-300 psi differential is required).

In addition, this piston is designed to hydraulically recenter itself once the pressure balance is restored (leak is fixed.)

PARKING BRAKE

OPERATION

The parking brake control system, which applies the four rear brakes, uses a hand operated lever, cables and brake shoe levers and struts. The front cable runs from the hand lever along the underbody to the front equalizer. The intermediate cable then runs to outside of each frame rail, and back to an intermediate equalizer. From this point a cable runs to each of the four brake drums. Each of these cables connects to the free lower end of a brake shoe lever. These levers (one in each rear brake shoe assembly) pivot on the secondary shoes. Struts are mounted between the brake shoe lever and the primary shoes. When the parking brake lever is raised, all cables are put in tension and the rear brake shoes are expanded against the drums.

POWER CYLINDER

The Power Brake Unit is a self-contained hydraulic and vacuum unit, utilizing manifold vacuum and atmospheric pressure for its power.

This unit permits the use of a low brake pedal as well as less pedal effort than is required with the conventional (nonpower) hydraulic brake system. The unit is mounted on the front side of the dash panel and directly connected to the brake pedal.

A power brake is used with the brake system to reduce the braking effort required by the driver. A combined vacuum and hydraulic unit, which utilizes engine manifold vacuum and atmospheric pressure, is used to provide power assisted application of vehicle brakes.

The unit is used in conjunction with a conventional brake system. From the master cylinder connection outward to the wheel units, there is no other change in the brake system.

In addition to the master cylinder connections, the unit requires a vacuum connection to the engine intake manifold (through a vacuum check valve) and a mechanical connection to the brake pedal. This unit is self-contained.

The vacuum power unit contains the power piston assembly, which houses the control valve and reaction mechanism, and the power piston return spring. The control valve is composed of the air valve (valve plunger), the floating control valve assembly, and the push rod. The reaction mechanism consists of a hydraulic piston reaction plate and a series of levers. An air filter, air silencer, and filter retainer are assembled around the valve operating rod filling the cavity inside the hub of the power piston. The push rod or valve operating rod, which operates the air valve, projects out of the end of the power unit housing through a rubber dust guard. A vacuum check valve assembly is mounted in the front housing assembly for connection to the vacuum source.

BRAKE SYSTEM TROUBLE DIAGNOSIS

TESTING FOR LEAK IN HYDRAULIC SYSTEM

NOTE: If there is any evidence of air in system, brakes must be bled before making this test.

1. Apply brakes manually, holding as steady a force as possible.

2. If pedal sinks slowly toward floor, a leak is indicated. Check for location of the leak by examining all lines, connections and wheel cylinders. If external leak is not found, remove master cylinder, disassemble and inspect parts. Leaks will usually be past primary piston cup due to porous or damaged cup or cylinder bore.

MASTER CYLINDER, WHEEL CYLINDER AND DRUM BRAKES TROUBLE DIAGNOSIS CHART

SPRINGY, SPONGY PEDAL

Cause	Remedy
Air trapped in hydraulic system.	Remove air by bleeding (check compensating port for clearance of cup to provide full open port).
Brake adjustment not correct.	Adjust brakes.
Bent shoes	Replace.
Compensating port closed.	See ALL BRAKES DRAG.
Improper brake fluid.	Flush and bleed system using GM Hydraulic Brake Fluid Supreme No. 11 (or equivalent).
Improper lining thickness or location.	Install new lining or replace shoe and lining.
Drums worn too thin.	Replace drums.
Master cylinder filler vent clogged.	Clean vent or replace cap; bleed brakes.

LOW PEDAL

Cause	Remedy
Hydraulic System Failure.	Check master cylinder for empty reservoir. Check for leak at master cylinder, wheel cylinder, hoses, metal pipes, and all connections.
Self adjustors not working.	Inspect for incorrect installation or frozen adjuster screw and correct as necessary.
Low fluid level in master cylinder reservoir.	Low fluid level in reservoir will permit air to be pumped into hydraulic lines. This necessitates refilling reservoir and bleeding lines. Find cause of low fluid and correct.
External leak in hydraulic system, or leak past master cylinder primary piston cup.	Check for leak in system as outlined above.
Air trapped in hydraulic system.	Air trapped in hydraulic system gives pedal a very soft feel at the beginning of travel. Bleed brakes.
Incorrect fluid.	Incorrect fluid may boil at high temperature. Flush system and refill with Brake Fluid No. 5464831 or equivalent.
Excessive clearance between linings and drum.	Adjust brakes.

*BRAKES FADE

Cause	Remedy
1. Incorrect lining. 2. Thin drum. 3. Dragging brakes.	1. Replace with new lining. 2. Replace drums. 3. Adjust or correct cause.

*Fade is a temporary reduction of brake effectiveness resulting from heat.

ONE WHEEL DRAGS

Cause	Remedy
Improperly adjusted parking brake cables or stuck cable.	Adjust parking brake cables and lubricate.
Weak or broken brake shoe return springs.	Replace defective brake shoe springs and lubricate brake shoe ledges and shoe contact at anchor pin with brake lubricant No. 1050110 or equivalent.
Brake shoe to drum clearance too small.	Readjust brakes.
Wheel cylinder piston cups swollen or distorted or piston stuck.	Replace inoperative or damaged parts. Look for evidence of dirt in hydraulic system which could cause damage to the cylinders or cups. See first item under ALL BRAKES DRAG.
Obstruction in line.	Obstruction in line may be caused by foreign material or flattened or kinked tube. If dirt is found in line, remove obstruction and flush hydraulic system with fresh brake fluid. If tube is flattened or kinked, replace damaged parts.
Backing plate shoe pad grooved.	Grind or file pads smooth and lubricate with brake lubricant No. 1050110 or equivalent.
Incorrect brake shoe radius.	Replace malfunctioning brake shoe.

BRAKES DO NOT AUTOMATICALLY ADJUST

Cause	Remedy
Worn, bent or distorted adjuster lever.	Replace adjuster lever.
Improper secondary lining to drum clearance.	Adjust clearance.
Brake linings excessively worn.	Install new linings.

VEHICLE PULLS TO ONE SIDE

Cause	Remedy
Grease or fluid on lining.	Replace with new linings. Linings with even a slight trace of grease or fluid may effect the operation of the brakes and can seldom be salvaged by cleaning. Correct cause of grease or fluid reaching linings.
Improper lining contact with drum.	Grind or replace lining.
Wheel bearings excessively loose.	Adjust wheel bearings.
Loose backing plate.	Tighten backing plate.
Linings not to specifications, or primary and secondary shoes reversed. New and used linings mixed on one end of vehicle.	Various kinds of linings have different frictional effects on the drums and on each other. Each wheel must have similar linings. The primary and secondary linings must not be interchanged. Use only factory specified linings.
Tires not properly inflated or unequal wear of tread. Different tread design.	Inflate tires to specified pressures. Rearrange tires so that a pair with non-skid tread surfaces of similar design and equal wear will be installed on front wheels and pairs with like tread will be installed on rear wheels.
Linings charred or drums scored.	Sand surfaces of linings and drums. Remove particles of metal that have become embedded in surfaces of linings. Seriously charred linings should be replaced.
Wheel cylinder link off shoe.	Check boot for holes. Check for burrs on wheel cylinder piston caused by piston forced against stop. Reinstall link.
Defective wheel cylinder.	Repair or replace as required.
Obstruction in line.	Clear or replace as required.
Water, mud, etc., in brakes.	Remove any foreign material from all brake parts and the inside of drums. Lubricate shoe ledges and rear brake cable ramps with grease. Examine support assembly for damage.
Loose steering gear, etc.	Adjust steering gear, etc.
Incorrect geometry setting of front suspension.	Adjust geometry so that vehicle does not have a tendency to lead when driven on a level road.
Weak or broken retracting springs.	Check springs-replace bent, open-coiled or cracked springs.
Out-of-round drums.	Resurface or replace drums in left and right hand pairs (both front and both rear).
Clogged or crimped hydraulic line.	Repair or replace line.

EXCESSIVE PEDAL PRESSURE REQUIRED TO STOP VEHICLE

Cause	Remedy
Brake adjustment not correct.	Adjust brakes.
Improper lining.	Install factory specified shoes.
Improper shoes.	Install factory specified shoes.
Grease or fluid soaked linings.	Correct cause and replace linings, if necessary.
Rusted wheel cylinder.	Replace.
Wheel cylinder link incorrectly aligned.	Check wheel cylinder piston and boot for damage. Install link.
Compensating port not cleared.	Check pedal linkage, stop light switch adjustment.
Brake pedal binding on shaft.	Lubricate with Delco Brake Lube #5450032 (or equivalent).
Glazed linings.	Sand surface of linings.
Bellmouthed, barrel-shaped or scored drums.	Replace or resurface drums in left and right hand pairs.

CRUNCH OR GROAN, HOLDING VEHICLE ON HILL

Cause	Remedy
Brake dust and possibly linings which have been overheated.	Sand linings and remove dust from brakes.

HIGH PITCH SQUEAK WHILE BRAKES OPERATE

Cause	Remedy
New linings not yet fully burnished.	Burnish further or sand off high spots of linings.
Persistent squeak-no apparent cause.	Sand linings for temporary cure or mild cases. Install drum springs for stubborn cases of high pitch squeak.

REAR BRAKES DRAG

Probable Cause	Remedy
1. Maladjustment.	1. Adjust brake shoes and parking brake mechanism.
2. Parking brake cables frozen.	2. Lubricate with Delco Brake Lube #5450032 (or equivalent).

ALL BRAKES DRAG OR PEDAL BUILDS UP WITH USE AFTER ADJUSTMENT IS CHECKED AND FOUND TO BE CORRECT

Cause	Remedy
Mineral oil, etc., in system.	The presense in the hydraulic system of any mineral oil, kerosene, gasoline, shock absorber or transmission fluid, or carbon tetrachloride will cause swelling of rubber piston cups, and valves, so they become inoperative. This is first noticed in the master cylinder. Brakes will not release freely if master cylinder primary piston cup has swollen sufficiently to obstruct the compensating port. Flush system thoroughly with a good grade of clean brake fluid and replace all internal rubber parts in brake system.
Pedal does not return freely.	Lubricate pedal linkage and make certain no bind exists. See that stop light switch is not defective, incorrectly adjusted, or that switch plunger is not binding on pedal due to lack of lubrication.
Compensating port of master cylinder closed.	The compensating port in master cylinder must be completely clear when pedal is in released position. 1. See that pedal returns freely and is not stopped by contact with stop light switch body or pedal bracket. 2. See that compensating ports are not plugged by dirt. To check compensating port, remove master cylinder reservoir cover and watch the fluid in the cylinder as the brake pedal is moved. A "geyser" should be seen as the pedal is first depressed. If no geyser is seen, the compensating port is blocked. 3. Inspect master cylinder primary piston cup and if found to be swollen or elongated, flush system and replace damaged parts.

LOUD LOW PITCH SQUEAL AT END OF HIGH RATE STOP

Cause	Remedy
New linings not fully burnished.	Check adjustment. Sand lining high spots.
Angle on shoe web at adjusting screw notch.	File straight.
Bent backing plate. Top of shoe webs should be in line with each other looking down on them. Check after pushing shoes toward backing plate at top.	Straighten or replace.
Incorrect adjustment.	Adjust brakes. (NOTE: Drum springs not effective against low pitch squeal or howl.)

PEDAL THROB AT LIGHT APPLICATIONS AT LOW SPEED

Cause	Remedy
Drum out-of-round or off center.	Turn drum.

ROUGH FEEL DURING HIGH RATE STOPS FROM MODERATE SPEED

Cause	Remedy
Tool chatter. Look for faint light and darker stripes running across the braking surface.	Turn drum.

LIGHT PEDAL PRESSURE— BRAKES TOO SEVERE

Cause	Remedy
Brake adjustment not correct.	Adjust brakes.
Loose support assembly.	Tighten rear backing plates. Adjust brakes.
Small amount of grease or fluid on linings.	Correct cause and replace linings.
Charred linings or scored drums.	Sand surfaces of linings and drums. Clean loose dust from brake. In severe cases replace shoes. Warn owner regarding abuse of brakes. Remove all particles that have become imbedded in surfaces of linings. Slightly scored drums do not require replacing or turning.
Improper linings.	Install factory specified linings.

SQUEAK IN BRAKE WITH VEHICLE STATIONARY (SOMETIMES MISTAKEN FOR PEDAL SQUEAK)

Cause	Remedy
Shoe pads on backing plates dry and rusty.	Pry shoes out with screwdriver-apply grease sparingly to shoe pads with feeler stock.

CREAK WHEN BRAKES ARE APPLIED AT LOW VEHICLE SPEED

Cause	Remedy
Anchor pins dry.	Grease anchor pins where shoes bear.

SCRAPE IN BRAKES AS PEDAL IS APPLIED, VEHICLE STATIONARY

Cause	Remedy
Hold-down nail heads dry.	Lubricate. Although adjusting brakes temporarily changes these noises, lubrication will remedy.

PEDAL SQUEAK

Cause	Remedy
Dry pedal bushings or stop light switch rubbing pedal.	Lubricate.

CLICKS DURING HIGH RATE STOPS, USUALLY ONCE PER WHEEL REVOLUTION IN ONE WHEEL ONLY

Cause	Remedy
Threaded drum.	Cross sand.

CHATTER AT HIGH SPEED

Cause	Remedy
Drum out-of-round with two or more distinct high spots in circumference.	Turn drum.

CLICK FIRST APPLICATION AFTER REVERSING

Cause	Remedy
Shoes out from anchor pins.	File shoe pads on backing plates; lubricate. Although adjusting brakes temporarily changes these noises, lubrication will remedy.

SINGLE PISTON DISC BRAKES TROUBLE DIAGNOSIS CHART

PULLS

Cause	Correction
Incorrect tire pressures.	Inflate evenly on both sides to the recommended pressures.
Front end out of line.	Check and align to specifications.
Unmatched tires on front of vehicle.	Tires with approximately the same amount of tread should be used on the same axle.
Restricted brake tubes or hoses.	Check for soft hoses and damaged lines. Replace with new hoses and new double-walled steel brake tubing.
Malfunctioning caliper assembly.	Check for stuck or sluggish pistons, proper lubrication.
Defective or damaged shoe and lining (grease or brake fluid on lining or bent shoe).	Install new shoe and lining in complete axle sets.
Malfunctioning rear brakes.	Check for inoperative auto adjusting mechanism, defective lining (grease or brake fluid on lining) or defective wheel cylinders. Repair as necessary.
Loose suspension parts.	Check all suspension mountings.
Loose calipers.	Check and torque bolts to specifications.

BRAKE ROUGHNESS OR CHATTER (PEDAL PULSATES)

Cause	Correction
Excessive lateral runout.	Check and replace or machine the rotor, if not within specifications.
Parallelism not within specifications.	Check and replace or machine the rotor, if not within specifications.
Rear drums out of round.	Check runout and, if not within specifications, turn the drums (not over maximum of 0.060" on the diameter).
Shoe reversed (steel against iron).	Replace shoe and lining and machine rotor within specifications.

EXCESSIVE PEDAL EFFORT

Cause	Correction
Malfunctioning power brake.	Check power brake and repair if necessary.
Partial system failure.	Check front and rear brake system and repair, if necessary. Also check brake warning light, if a failed system is found and light did not function, repair as necessary.
Excessively worn shoe and lining.	Check and replace in axle sets.
Piston in caliper stuck or sluggish.	Remove caliper and rebuild or replace.
Fading brakes due to incorrect lining.	Remove and replace with original equipment lining.

EXCESSIVE PEDAL TRAVEL

Cause	Correction
Partial brake system failure.	Check both front and rear system for a failure and repair. Also, check warning light. It should have indicated a failure.
Insufficient fluid in master cylinder.	Fill reservoirs with approved brake fluid. Check for leaks. Check warning light.
Air trapped in system.	Bleed system.
Rear brake not adjusting.	Adjust rear brakes and repair adjusters.
Bent shoe and lining.	Replace axle set of shoe and lining.

GRABBING OR UNEVEN BRAKING ACTION

Cause	Correction
All conditions listed under "PULLS."	All corrections listed under "PULLS."
Malfunction of combination valve.	Replace and bleed system.
Malfunction of power brake unit.	Check operation and repair, if necessary.

DRAGGING BRAKES

(NOTE: A very light drag is present in all disc brakes immediately after pedal is released.)

Cause	Correction
Master cylinder pistons not returning correctly.	With reservoir cover off, check for fluid spurt at bypass holes as pedal is depressed. Check power cylinder push rod, if necessary, or rebuild master cylinder.
Restricted brake tubes or hoses.	Check for soft hoses or damaged tubes and replace with new hoses and new double-walled steel brake tubing.
Incorrect parking brake adjustment on rear brakes.	Check and readjust to correct specifications.

POWER CYLINDER TROUBLE DIAGNOSIS CHART

Before checking the power brake system for the source of trouble, refer to the trouble diagnosis of drum and disc brakes. After these possible causes have been eliminated, check for the cause as outlined in the following chart:

BRAKES FAIL TO RELEASE

Cause	Correction
Blocked passage in diaphragm plate	Inspect and repair or replace as necessary.
Air valve sticking shut.	Check for proper lubrication of air valve "O" ring.
Broken piston return spring.	Replace.
Broken air valve spring.	Replace.
Tight pedal linkage.	Repair or replace as necessary.

HARD PEDAL

Cause	Correction
Broken or damaged hydraulic brake lines.	Inspect and replace as necessary.
Vacuum Failure.	Check for: Faulty vacuum check valve or grommet-replace. Collapsed or damaged vacuum hose-replace. Plugged or loose vacuum fitting-repair. Faulty air valve seal or support plate seal-replace. Damaged control valve-replace. Bad stud welds on front or rear housing or power head-replace, unless easily repaired.
Defective diaphragm.	Replace.
Restricted air filter element.	Replace.
Worn or badly-distorted reaction disc.	Replace reaction disc.
Incorrect reaction disc.	Replace with correct disc.

GRABBY BRAKES (Apparent Off-On Condition)

Cause	Correction
Broken or damaged hydraulic brake lines.	Inspect and replace as necessary.
Insufficient fluid in master cylinder	Fill reservoirs with approved brake fluid, check for leaks.
Defective master cylinder seals.	Repair or replace as necessary.
Cracked master cylinder casting.	Replace.
Leaks at front disc brake calipers or rear wheel cylinders in pipes or connections.	Inspect and repair as necessary.
Air in hydraulic system.	Bleed system.

ON-VEHICLE SERVICING

BLEEDING BRAKE SYSTEM

A bleeding operation is necessary to remove air whenever it is introduced into the hydraulic brake system. Since air is compressible and hydraulic fluid is not, the presence of air in the system is indicated by a springy, spongy feeling of the brake pedal accompanied by poor braking action.

Air can be introduced into the hydraulic system if the brake pedal is operated when the fluid is too low in master cylinder reservoir. Air will also enter the system whenever any part of hydraulic system is disconnected.

It may be necessary to bleed the hydraulic system at all six wheels if air has been introduced through low fluid level or by disconnecting brake lines at master cylinder. If the brake line is disconnected at any wheel cylinder, then only that wheel cylinder need be bled. If lines are disconnected at any fitting located between master cylinder and wheel cylinders, then all wheel cylinders served by the disconnected line must be bled.

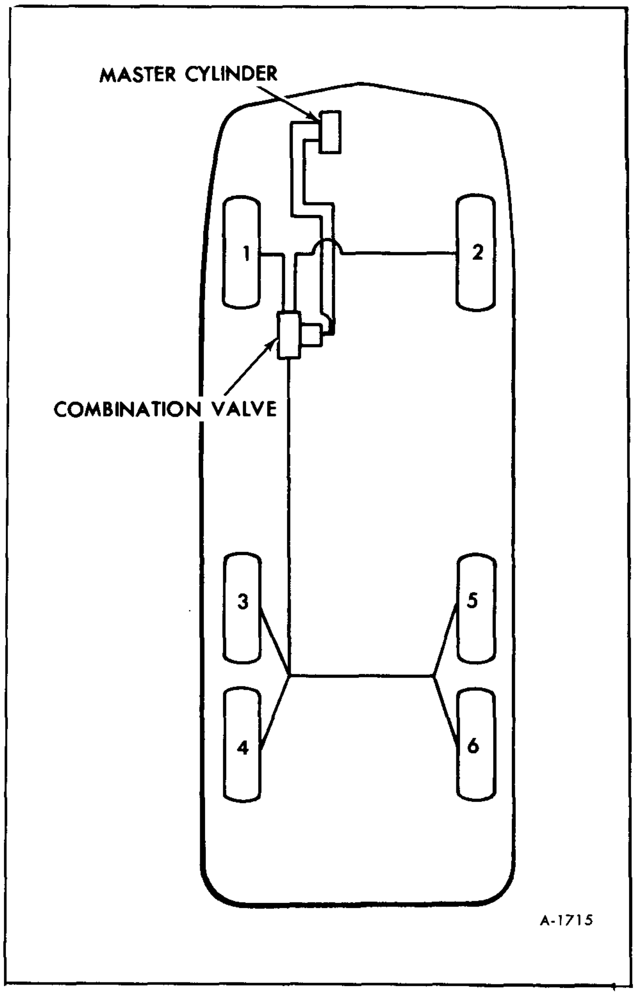


Figure 1—Brake Bleeding Sequence

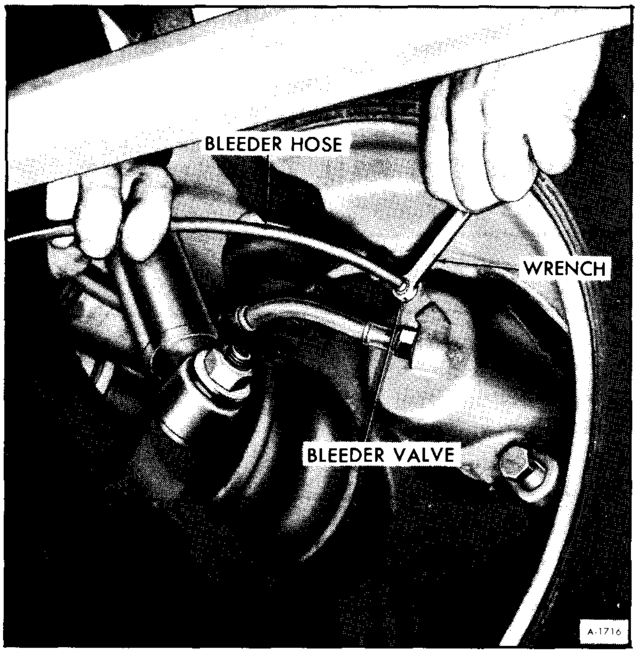


Figure 2—Brake Bleeder Wrench and Hose

SEQUENCE FOR BLEEDING WHEEL CYLINDERS

It is advisable to bleed one wheel cylinder at a

Figure 3—Tool J-23709 Installed

time to avoid allowing fluid level in reservoir to become dangerously low. For the proper sequence refer to Figure 1.

Do not perform bleeding operation while any brake drum or disc pad is removed.

BLEEDING WHEEL CYLINDER WITHOUT PRESSURE TANK

1. Fill master cylinder.

2. Install bleeder wrench on bleeder valve. Slip a brake bleeder hose over ball of wheel cylinder bleeder valve (See figure 2). Place lower end of bleeder tube in a glass jar that is partially filled with clean brake fluid. Position end of tube so that it will remain submerged under fluid during bleeding operation. Unscrew bleeder valve 3/4 of a turn.

Attach J-23709 to the combination valve (figure 3) to hold the push rod in and allow the pressure in the line to flow through the valve requiring less pressure to bleed the front cylinders.

3. Depress brake pedal a full stroke, close bleeder valve, then allow pedal to return slowly to released position. Allowing pedal to return quickly may draw air into system. Continue operating pedal in this manner until fluid flows from bleeder tube into glass jar in a solid stream that is free of air bubbles, then close the bleeder valve securely and remove bleeder tube and wrench.

4. Frequently check master cylinder to make sure that it contains fluid. Allowing reservoir to be emptied will cause air to be drawn into hydraulic system.

5. When bleeding operation is completed at all wheel cylinders where needed, make sure that fluid level is no more than 1/4" below lip of reservoir, then install rubber diaphragm and cover.

6. Discard the brake fluid deposited in glass jar during bleeding operation.

BLEEDING WHEEL CYLINDER WITH PRESSURE TANK

When using a pressure tank, air bubbles may form in the tank and enter the brake hydraulic system. To avoid this, observe the following points when handling a pressure tank: (1) Do not shake or agitate the pressure tank after air pressure has been added or is being added. (2) Allow pressure tank to stand in one position as much as possible and bring air hose over to tank when adding head of air. (3) Make certain the valves on the pressure tank lines are not defective, allowing air to be sucked in when fluid passes through the lines. (4) Pressure tank should be kept at least 1/3 full of fluid to avoid air bubbles forming. (5) If pressure tank is full of air bubbles, release air pressure and those bubbles will increase in size, be forced to top of fluid and escape.

It is recommended that pressure bleeding equipment must be of the diaphragm type; that is, it must have a rubber diaphragm between the air supply and the brake fluid to prevent air, moisture, oil, and other contaminants from entering the hydraulic system.

1. Thoroughly clean master cylinder reservoir cover and surrounding area; then remove cover and diaphragm.

2. Make sure that pressure tank is at least 1/3 full of specified brake fluid and that hose and master cylinder reservoir are filled with fluid. Attach hose to master cylinder reservoir adapter.

3. Install Bleeder Wrench on bleeder valve. Slip a brake bleeder tube over ball of wheel cylinder bleeder valve (figure 2). Place lower end of bleeder tube in a clean glass jar. Unscrew bleeder valve 3/4 of a turn.

Attach J-23709 to the combination valve to hold the push rod in and allow the pressure in the line to flow through the valve (figure 3).

4. Open pressure tank hose valve to apply fluid to master cylinder under pressure that does not exceed 35 pounds. It is not necessary to pump the brake pedal when using pressure tank.

5. When fluid flows from bleeder tube into glass jar in a solid stream that is free of air bubbles, that particular cylinder and line are bled; tighten bleeder valve securely and remove bleeder tube.

6. When bleeding operation is completed at all wheel cylinders, where needed, make sure that fluid level is 1/4" from the lowest portion of the top of each reservoir. Install rubber diaphragm and cover.

FLUSHING BRAKE HYDRAULIC SYSTEM

It is recommended that the entire hydraulic system be thoroughly flushed with clean brake fluid whenever new parts are installed in the hydraulic system.

Flushing is also recommended if there is any doubt as to the grade of fluid in the system or if fluid has been used which contains the slightest trace of mineral oil.

Flushing is performed at each wheel cylinder in turn, and in the same manner as the bleeding operation except that bleeder valve is opened 1-1/2 turns and the fluid is forced through the pipes and wheel cylinder until it emerges clear in color. Approximately two quarts of fluid is required to flush the hydraulic system thoroughly.

When flushing is completed at all wheel cylinders, make certain that master cylinder reservoir is filled to proper level.

PARKING BRAKE ADJUSTMENT

Normal driver adjustment of the parking brake can be done at the parking brake lever. The knob on top of the lever can be used to increase or decrease the tension on the cable (figure 4).

If the tension on the cable cannot be adjusted at the lever it should be adjusted at the intermediate equalizer.

1. Turn the adjusting knob on top of parking brake lever counterclockwise until it comes up against stop.

2. Apply and release parking brake lever.

3. Jack up rear wheels.

4. Loosen lock nut at intermediate cable equalizer as shown in Figure 5.

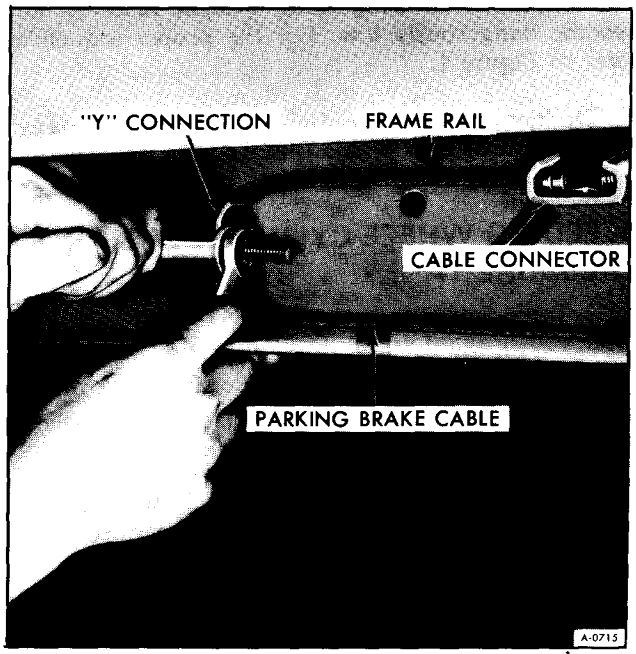


Figure 5—Loosening Intermediate Adjusting Nuts

5. Back off front nut until drag is just removed and lock.

6. Apply lever and re-adjust parking brake lever knob to give a definite snap-over-center feel.

7. Fully release parking brake and rotate rear wheels. No drag should be present.

8. Lower vehicle to floor.

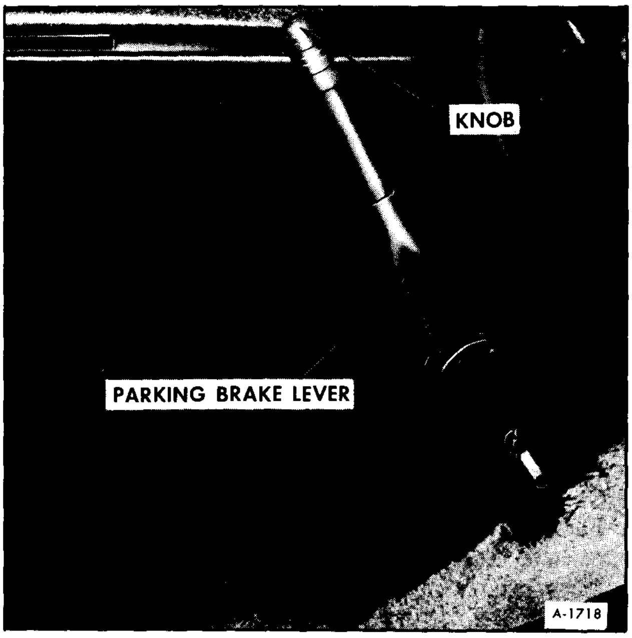


Figure 4—Parking Brake Lever Knob

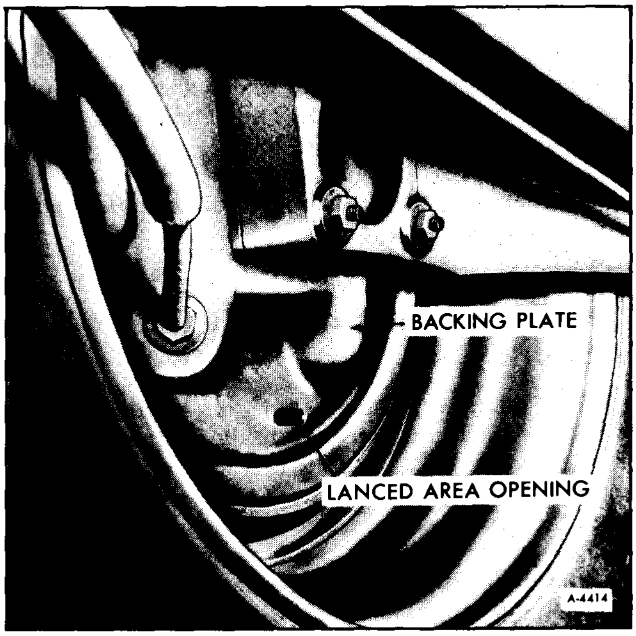


Figure 6—Lanced Area in Backing Plate

BRAKE SHOE ADJUSTMENT (DRUM INSTALLED)

1. If shoes are being adjusted for the first time, use a suitable punch to knock out lanced area in brake backing plate, refer to Figure 6. If done with drum installed, the drum must then be removed and all metal cleaned out of the brake assembly. Be sure to install a new hole cover in the backing plate after adjustment to prevent dirt and water from getting into brakes. Use J-4735 to turn brake adjusting screw; expand brake shoes at each wheel until the wheel can just be turned by hand. The drag should be equal at all wheels.

2. Back off brake adjusting screw (figure 7) at each wheel 30 notches. If shoes drag lightly on drum, back off adjusting screw one or two additional notches.

NOTE: Brake should be free of drag when screw has been backed off approximately 12 notches. Heavy drag at this point indicates tight parking brake cables.

3. Install adjusting hole cover in brake backing plate when adjustment is completed.

4. Check parking brake adjustment as described earlier in this section.

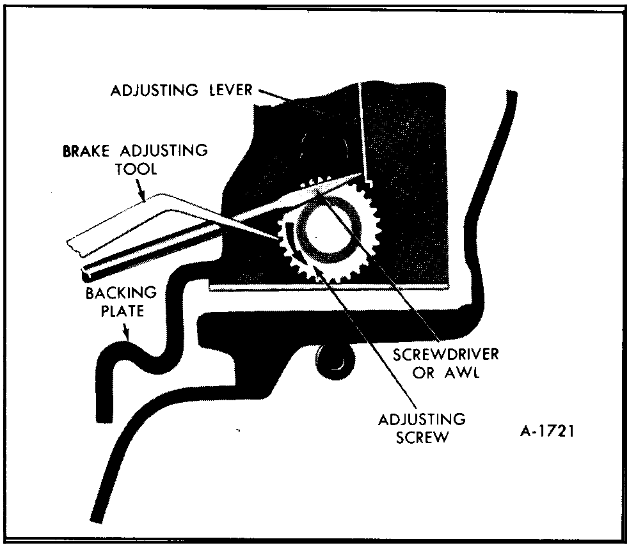


Figure 7—Backing Off Brake Adjustment

DISC BRAKE ADJUSTMENT

The disc brakes on the front of the vehicle require no periodic adjustment. They are adjusted with each brake application. As the piston in the caliper compensates for wear of the brake lining it requires more fluid. For this reason the master cylinder fluid level should be checked frequently.

COMPONENT REMOVAL

BRAKE DRUM REMOVAL

1. Hoist rear wheels off ground.

NOTE: It may be necessary to back off the brake shoe adjustment before the brake drum can be removed. To back off brake shoe adjustment, refer to Figure 7.

2. Remove wheel and tire.

3. Remove outer dust cap as shown in Figure 8, and then inner cap.

4. Remove cotter pin and castillated nut from hub as shown in Figure 9.

5. Hub and drum assembly can now be removed. See Figure 10.

Figure 8—Removing Dust Cap

Figure 9—Removing Castillated Nut

Figure 10—Removing Hub and Drum

REAR BRAKE SHOE REMOVAL (FIGURE 11)

1. Hoist vehicle. Remove wheel and brake drum.

2. Remove the brake shoe return springs actuating link and guide.

3. Remove the brake shoe hold-down springs, adjuster lever, return spring and parking brake lever strut and spring.

4. Spread shoes to clear wheel cylinder links then remove the brake shoes as an assembly.

5. Disconnect the parking brake cable from the operating lever.

DISC BRAKE SHOE REMOVAL

1. Remove caliper as described later in this section under "Disc Removal."

2. Remove inboard shoe.

3. Remove outboard shoe.

4. Remove pad support spring from inboard shoe.

5. Remove sleeves from inboard ears of caliper.

6. Remove the rubber bushing from the grooves in each of the four caliper ears (figure 12).

COMBINATION VALVE REMOVAL (FIGURE 13)

No attempt should be made to disassemble or repair the valve. If any failure should occur, the complete valve should be replaced.

1. Disconnect all brake lines at valve. Plug lines to prevent loss of fluid and entrance of dirt.

2. Disconnect warning switch wiring connector from valve switch terminal.

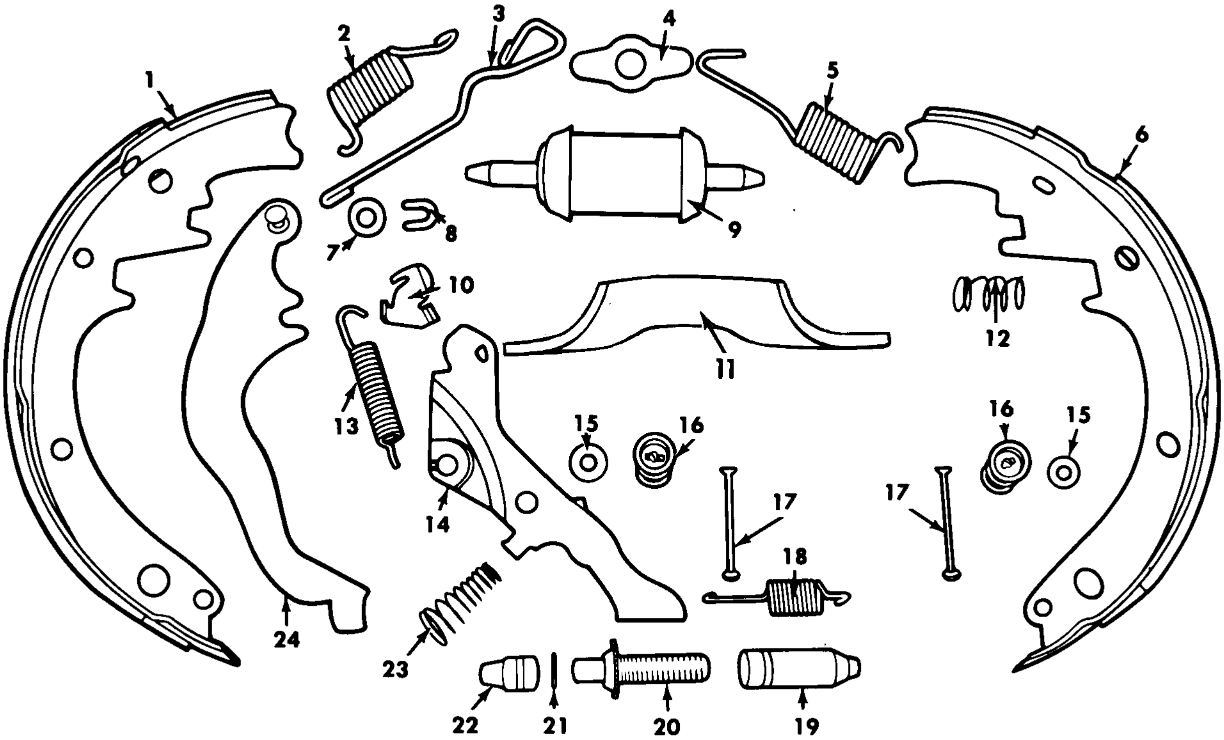
3. Remove valve assembly from mounting bracket.

MASTER CYLINDER REMOVAL

The master cylinder can be removed without removing the power cylinder.

1. Be sure area around master cylinder is clean, then disconnect the hydraulic lines at the master cylinder (Refer to figure 14). Plug or tape ends of lines to prevent entrance of dirt or loss of brake fluid.

2. Remove two master cylinder attaching nuts and remove master cylinder as shown in Figure 15.



1. Secondary Shoe And Lining
2. Return Spring
3. Actuating Link
4. Guide Plate
5. Return Spring
6. Primary Shoe And Lining
7. Washer
8. Clip
9. Wheel Cylinder
10. Pivot
11. Strut
12. Spring
13. Override Spring
14. Adjuster Lever
15. Washer
16. Hold Down Spring
17. Pin
18. Spring
19. Nut
20. Adjusting Screw
21. Washer
22. Socket
23. Return Spring
24. Lever

A-4129

Figure 11—Brake Assembly (Rear)

DISC REMOVAL

1. Siphon approximately two-thirds of the brake fluid from the front reservoir of the master cylinder. Discard fluid.

NOTE: Do not empty front reservoir or it will be necessary to bleed the brake system.

2. Hoist vehicle and remove wheel.

3. Remove cotter pin, and drive axle nut and washer.

4. Position Tool J-22269 on caliper as shown in Figure 16.

5. Tighten screw of tool until caliper moves outboard far enough to push piston to bottom of piston bore. This will allow the shoes to back off from disc surface. Remove Tool J-22269.

6. Remove the two caliper to knuckle attaching bolts.

7. Carefully lift caliper assembly from disc and position so that brake hose is not kinked or stretched.

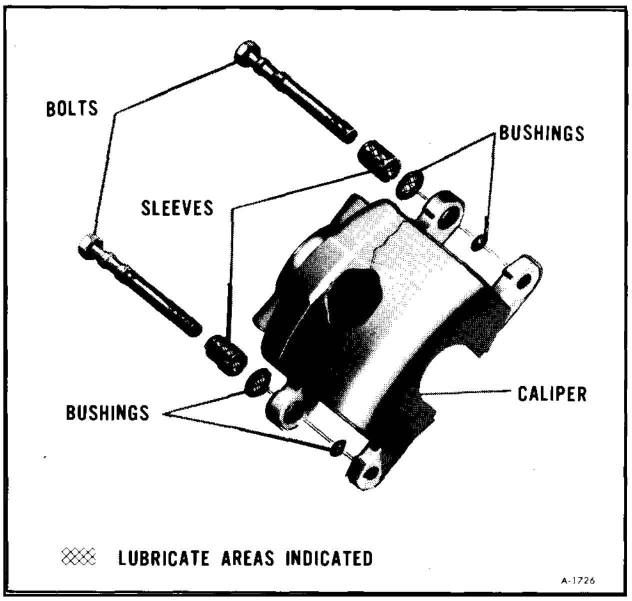


Figure 12—Caliper Sleeve and Bushing Location

8. Loosen uniformly and remove the three bolts securing the retainer to the knuckle (figure 17).

9. Position tool No. J-24717 on hub as shown in Figure 18.

10. Operate slide hammer, tool No. J-2619, until assembly is free of knuckle.

11. Remove slide hammer and tool No. J-24717.

12. Assemble tool No. J-23345 to tool No. J-8433-1.

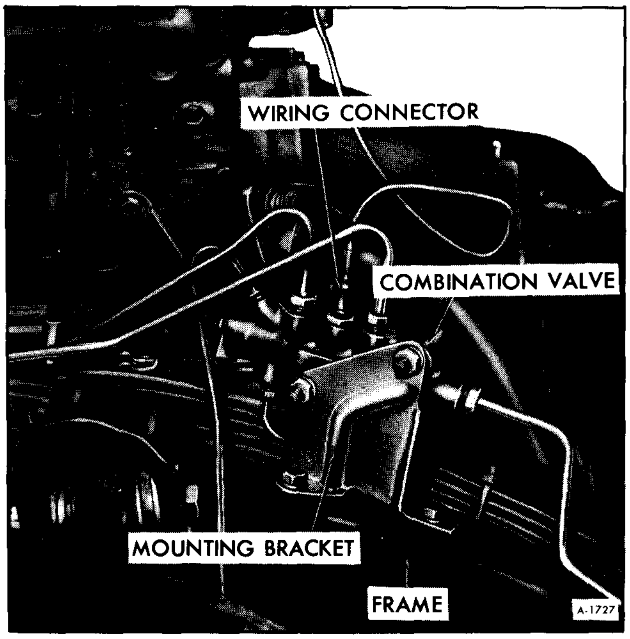


Figure 13—Combination Valve Mounting

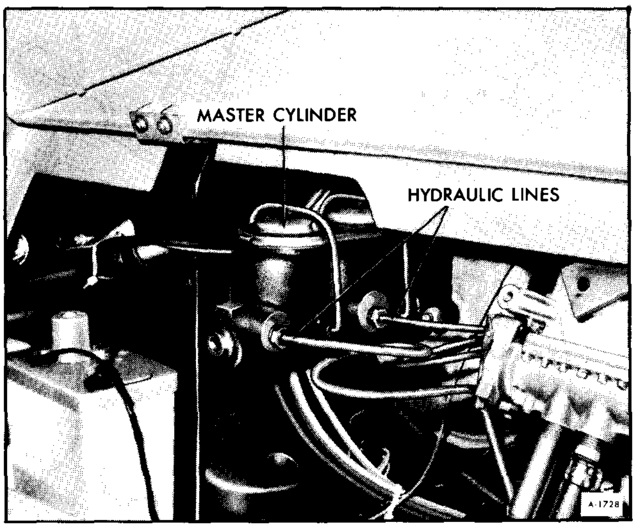


Figure 14—Hydraulic Lines at Master Cylinder

13. Position tool assembly as shown in Figure 19.

CAUTION: *The gripping or pulling edge of the tool must be under the inner race. If the tool slips up to the bearing cage, the bearing will be seriously damaged and need to be replaced.*

14. With tool No. J-22214-6 in place, and a clamp in position tighten center screw until bearing is free of hub.

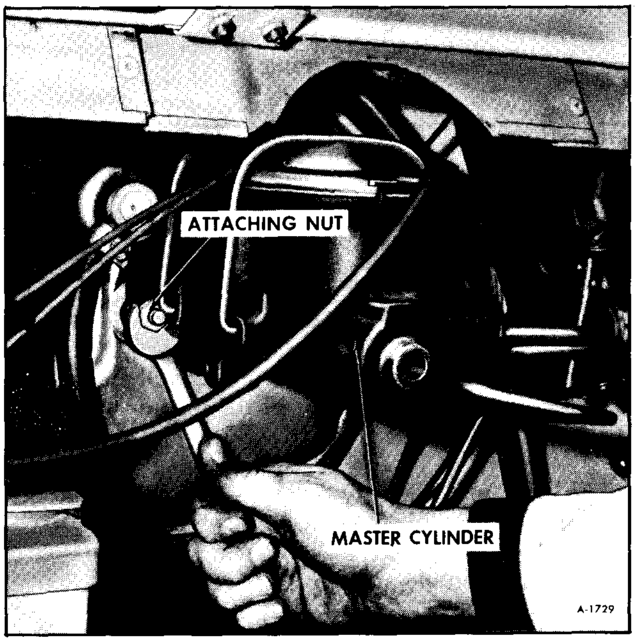


Figure 15—Removing Master Cylinder

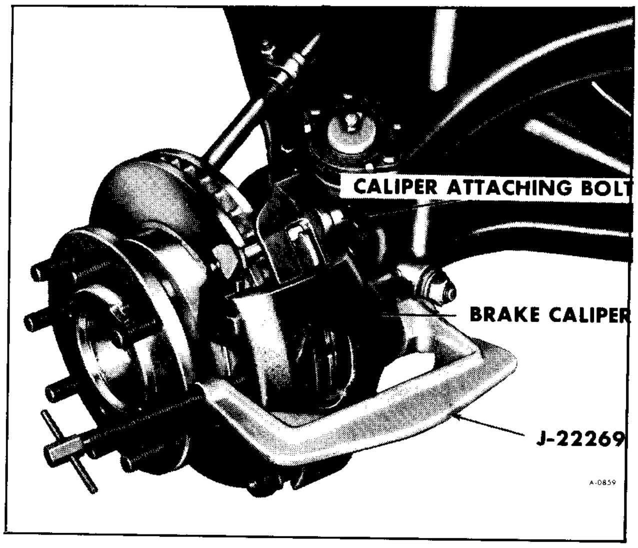


Figure 16—Tool J-22269 on Caliper

15. Clean bearing then inspect for wear or damage. If bearing condition is good repack with bearing grease GM No. 1051344 or equivalent.

16. Remove seal and retainer.

17. Remove four bolts and separate disc from hub as shown in Figure 58.

POWER BRAKE BOOSTER REMOVAL

1. Remove four screws from power level control panel.

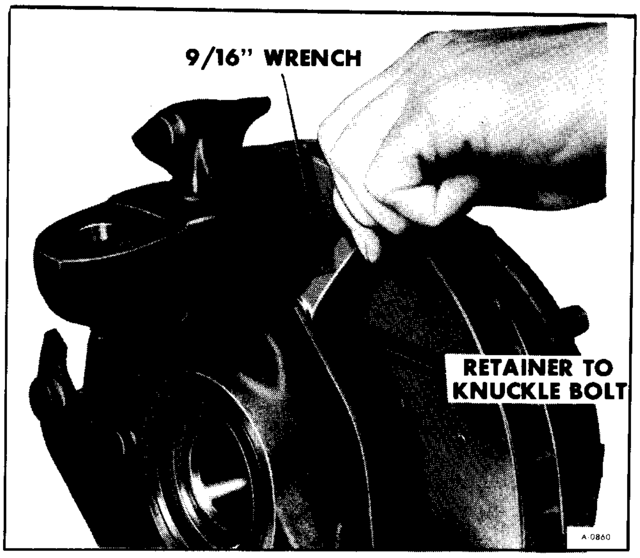


Figure 17—Removing Retainer from Knuckle

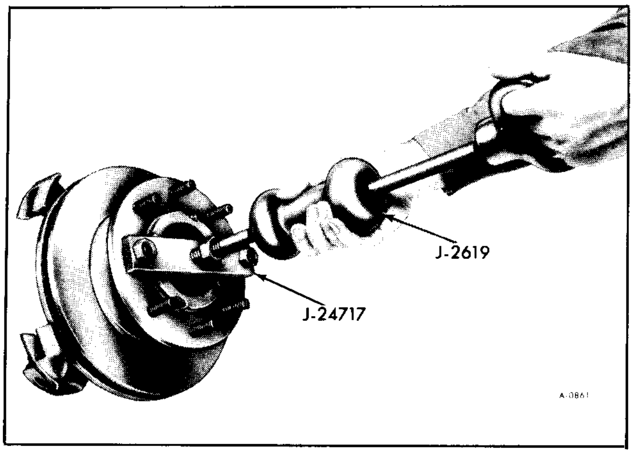


Figure 18—Installing Tool J-24717

2. Pull panel and valve assemblies out of the way, as shown in Figure 20.

3. Remove clevis pin from brake pedal (Refer to figure 21).

4. Remove master cylinder, see "Master Cylinder Removal" earlier in this section.

5. Remove master cylinder bracket by removing two bolts from top of bracket.

6. Remove vacuum line to power brake booster.

7. Remove four nuts retaining booster assembly to firewall, as shown in Figure 22.

8. Remove booster assembly through left front access door.

PARKING BRAKE LEVER REMOVAL

1. Remove four nuts and bolts retaining lever to toe board (Refer to figure 23).

2. Remove two nuts and bolts on cable retaining bracket, as shown in Figure 24.

3. Remove pin from bracket retaining cable end.

4. Remove one screw holding switch to parking brake lever.

5. Remove lever.

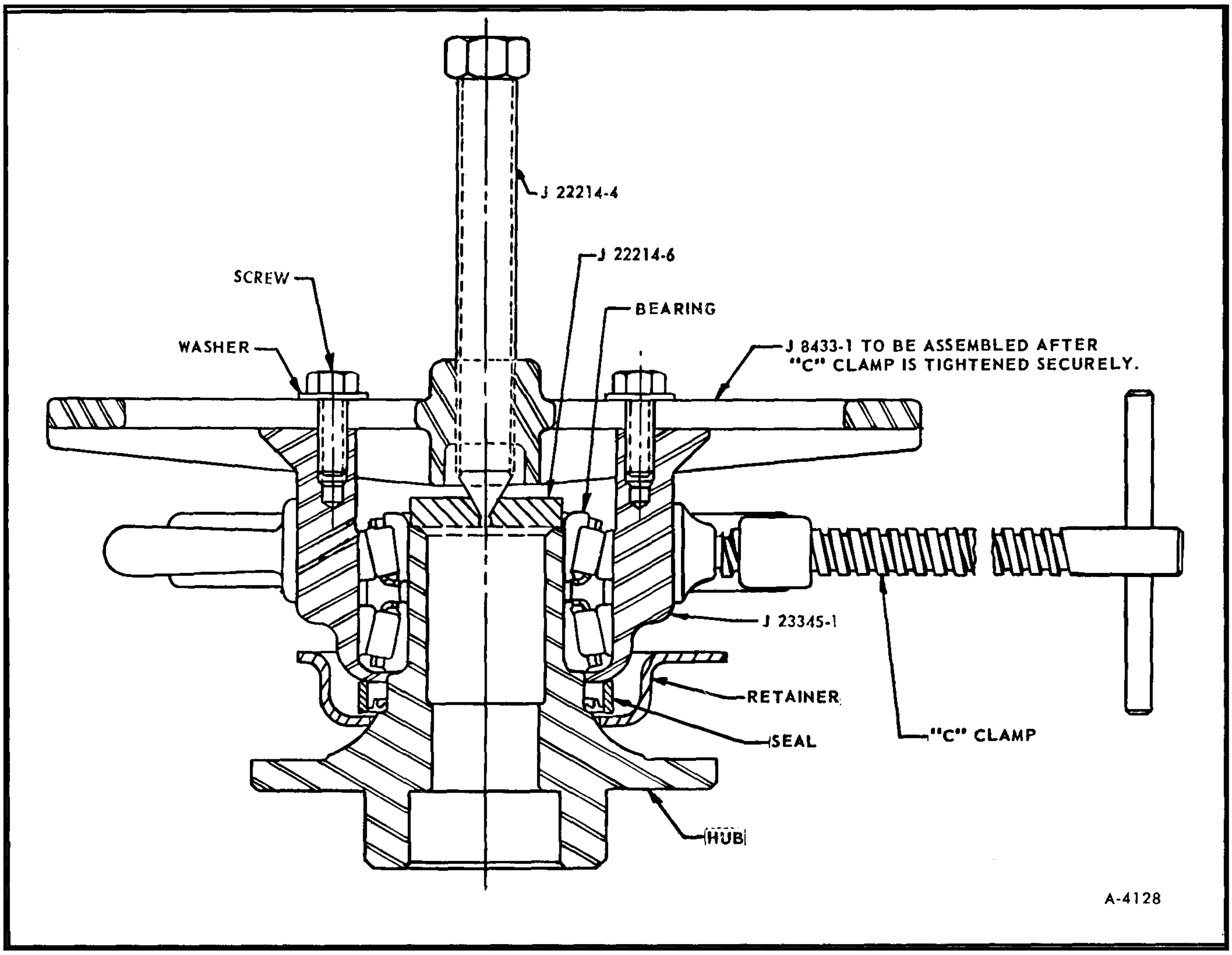


Figure 19—Bearing Removal

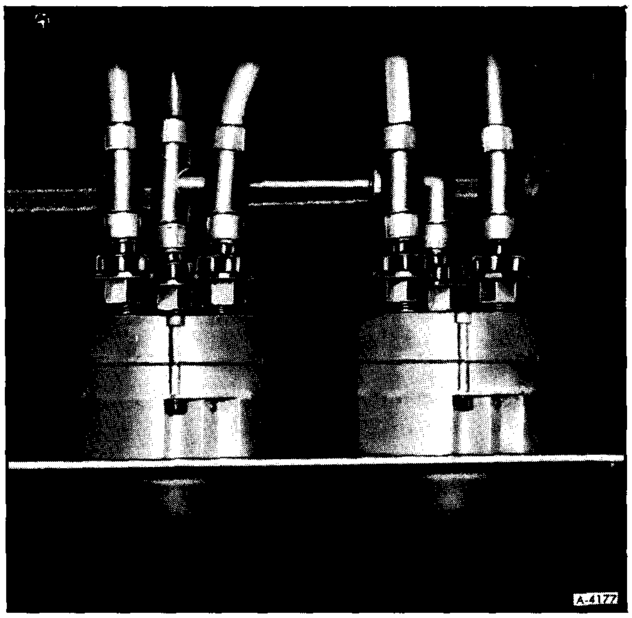


Figure 20—Power Level Panel Removed

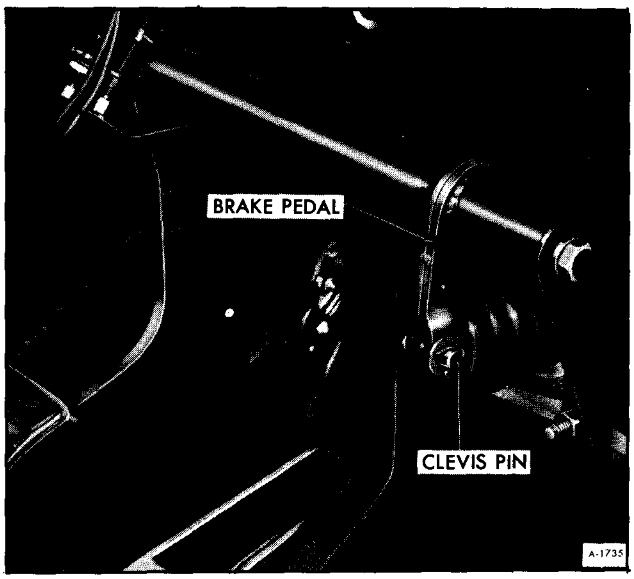


Figure 21—Clevis Pin Location

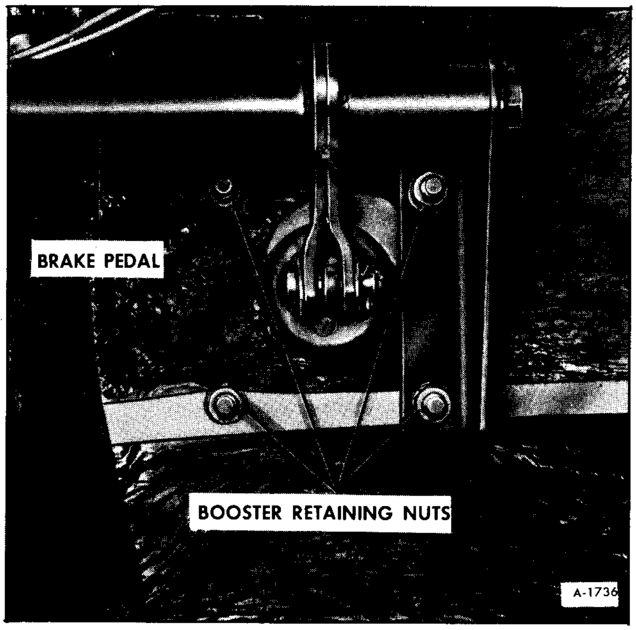


Figure 22—Booster Assembly Retaining Nuts

FRONT PARKING BRAKE CABLE REMOVAL

1. Raise vehicle with suitable lifting device.

2. Remove lock nut and adjusting nut from front equalizer (Refer to figure 25).

3. Remove cable clip at shift relay bracket.

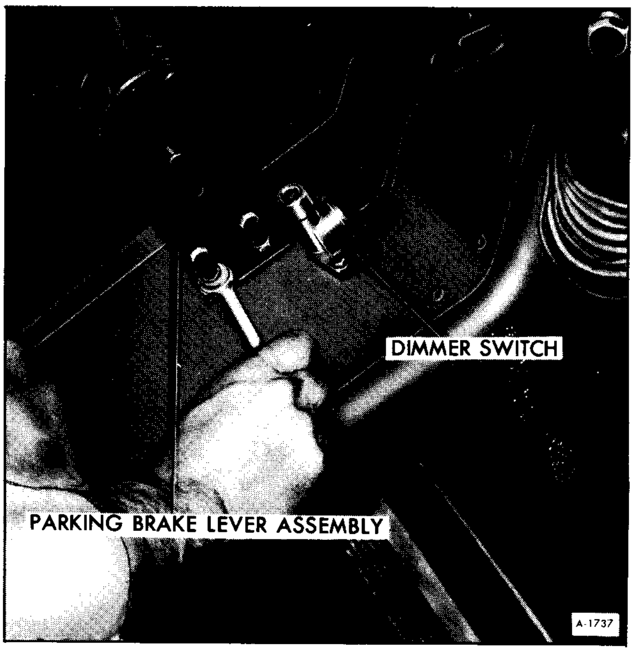


Figure 23—Removing Parking Brake Lever Retaining Nuts

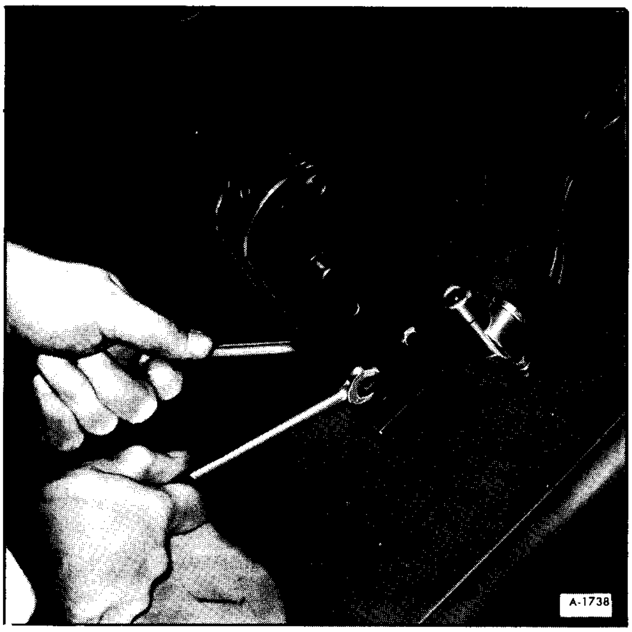


Figure 24—Removing Cable Retaining Bracket

4. Remove retaining pin in parking brake lever.

5. Remove cable.

INTERMEDIATE PARKING BRAKE CABLE REMOVAL

1. Hoist vehicle.

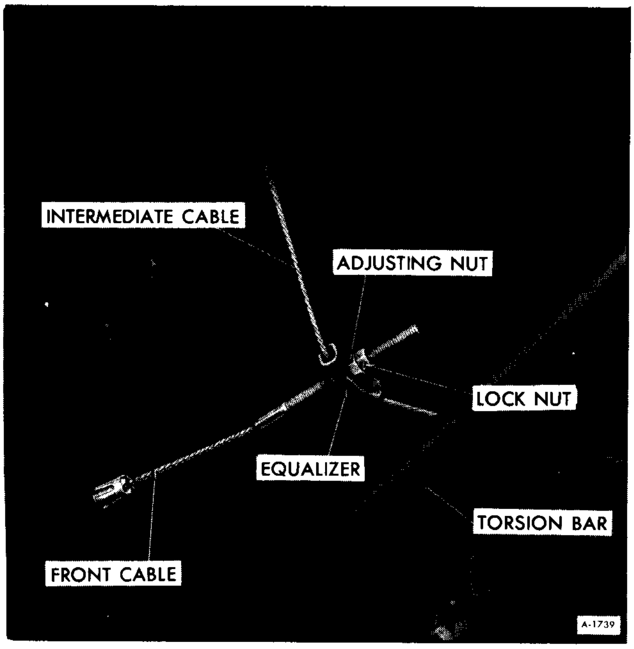


Figure 25—Parking Brake Cable

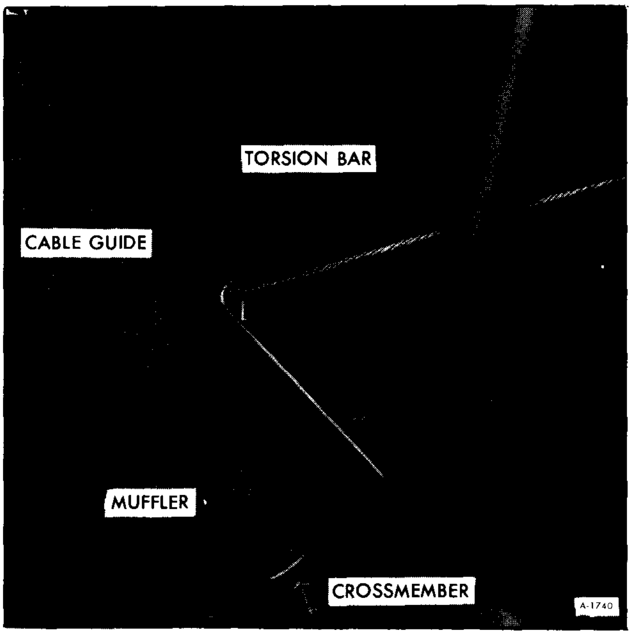


Figure 26—Cable Guide on Crossmember

2. Remove lock nut and adjusting nut from two intermediate equalizers on the outside of each frame rail (Refer to figure 5).

3. Remove lock nut and adjusting nut from front equalizer as shown in Figure 25.

4. Disconnect cable from guide on frame crossmember (figure 26).

5. Disconnect cable from guides at points where cable passes through frame rails as shown in Figure 27.

6. Remove cable.

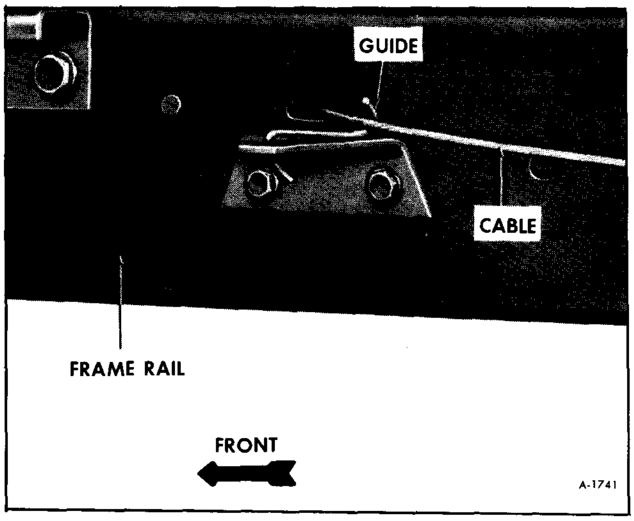


Figure 27—Cable Guide on Frame Rail

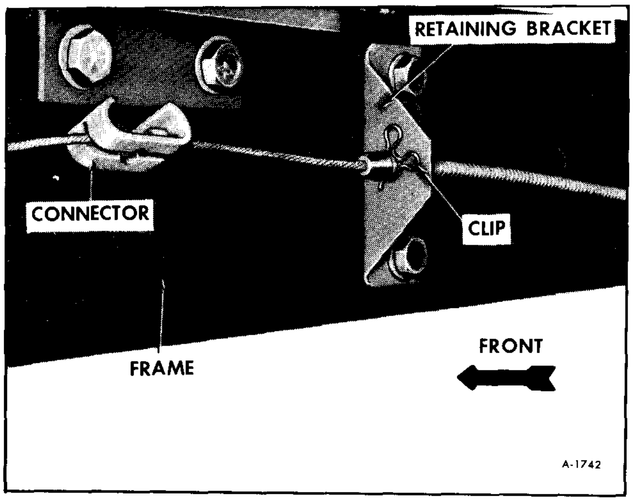


Figure 28—Clip on Frame Rail Retaining Bracket

REAR PARKING BRAKE CABLE REMOVAL

1. Disconnect intermediate equalizer by removing locking and adjusting nuts (figure 5).

2. Pull wire clips at retainers on frame rails (See figure 28).

3. Remove ends of cables from cable connectors. Feed ends of cables through retainers on frame rails.

4. Remove hubs and drums.

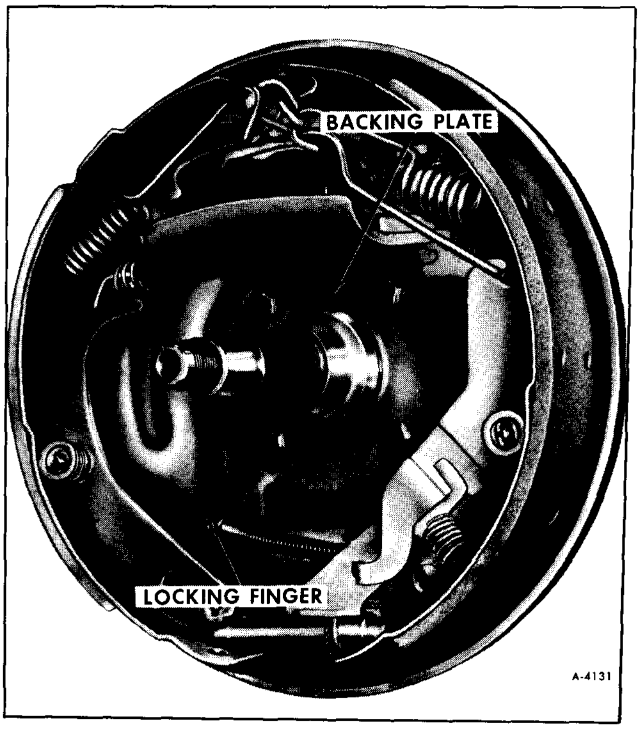


Figure 29—Locking Finger

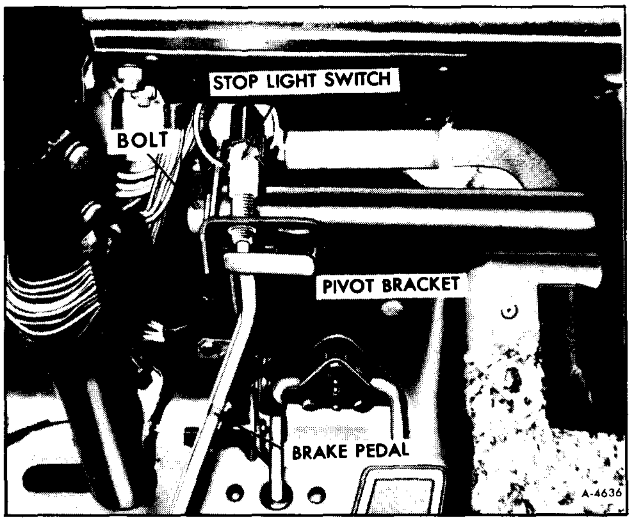


Figure 30—Brake Pedal Assembly (Left Side)

5. Release end of cable from parking brake lever.

6. Compress the locking fingers and pull the rear cable from the backing plate refer to Figure 29.

BRAKE PEDAL REMOVAL

1. Remove four screws from power lever control mounting panel, and pull valves and panel out (figure 20).

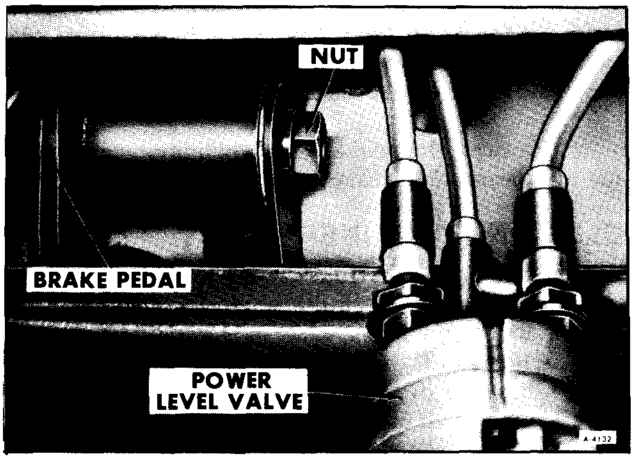


Figure 31—Brake Pedal Assembly (Right Side)

2. Remove stop light switch from top of brake pedal. If equipped with cruise control remove the switch next to the stop light switch (figure 30).

3. Remove cotter pin from pin retaining power booster clevis to brake pedal. Remove clevis pin (figure 21).

4. Remove bolts from each end of pedal assembly (figure 31).

5. Loosen left-hand brake lever pivot bracket.

6. Remove brake pedal assembly.

COMPONENT OVERHAUL

MASTER CYLINDER OVERHAUL

DISASSEMBLY (FIGURE 32)

1. Remove the small secondary piston stop screw from the bottom of the front fluid reservoir of the master cylinder.

2. Place the master cylinder in the vise so that the lock ring can be removed from the small groove in the I.D. of the bore. Remove the lock ring and primary piston assembly. Remove the secondary piston, secondary piston spring and retainer by blowing air through the stop screw hole. If air is not available, a piece of wire may be used. Bend approximately 1/4" of one end of the wire into a right angle. Hook this end under the edge of the secondary piston and pull the secondary piston from the bore.

NOTE: The brass tube-fitting insert need not be removed unless visual inspection indicates the insert is damaged.

3. To replace a defective insert or check valve, the following procedure should be practiced:

a. Place the master cylinder in a vise, so that the outlet holes are up. Enlarge the outlet holes in the tube seats using a 13/64" drill. Tap a 1/4"—20 thread in these holes. Place a heavy washer over the outlet on the master cylinder and thread a 1/4"—20 x 3/4" hex head bolt into the tube seat. Tighten the bolt until the tube seat is unseated.

b. A more preferable way to remove a defective insert involves use of a self-tapping screw and a claw hammer. With a box-end or socket wrench, thread a #6—32 x 5/8" long self-tapping screw into the tube-fitting insert. Using the claw end of the hammer, remove the screw and insert.

4. Remove the casting from the vise and inspect the bore for corrosion, pits and foreign matter. Be

sure the outlet ports are clean. Inspect the fluid reservoirs for foreign matter. Check the bypass and compensating ports to the master cylinder bore to determine if they are restricted.

5. Remove the primary seal, primary seal protector and secondary seals from the secondary piston.

CLEANING AND INSPECTION

Use clean brake fluid to thoroughly clean all reusable brake parts. Immerse in the cleaning fluid and brush metal parts with hair brush to remove foreign matter. Blow out all passages, orifices and valve holes. Air dry and place cleaned parts on clean paper or lint free clean cloth. If slight rust is found inside either the front or rear half housing assemblies, polish clean with crocus cloth or fine emery paper, washing clean afterwards.

CAUTION: *Be sure to keep parts clean until reassembly. Re-wash at re-assembly if there is any occasion to doubt cleanliness—such as parts dropped or left exposed for eight hours or longer.*

IF there is any suspicion of contamination or any evidence of corrosion, completely flush the vehicle hydraulic brake system. Failure to clean the hydraulic brake system can result in early repetition of trouble. Use of gasoline, kerosene, anti-freeze, alcohol or any other cleaner, with even a trace of mineral oil, will damage rubber parts.

Rubber Parts

Wipe fluid from the rubber parts and carefully inspect each rubber part for cuts, nicks or other damage. These parts are the key to the control of fluid or air flow. If the unit is in for overhaul, or if there is any question as to the serviceability of rubber parts, REPLACE them! Inspect in accordance with the following table. The table is organized by power brake unit groups. Badly damaged items, or those which would take extensive work or time to repair, should be replaced. In case of doubt, install new parts. Do not rely on the brake unit being overhauled at an early or proper interval. New parts will provide more satisfactory service, even if the brake unit is allowed to go beyond the desired overhaul period.

MASTER CYLINDER INSPECTION CHART

Part	Inspect For:	Corrective Action:
Master cylinder body.	Scratches, scores, pits, other damage affecting sealing or sliding action of piston seals in master cylinder bore.	Polish light damage smooth with crocus cloth; replace piece, if damage does not clean up quickly.
	Damaged threads.	Clean up or replace.
	Cracks, structural damage.	Replace.
	By-pass and compensating holes to be open.	Open and clean passage.
Spring retainers.	Check for cracks, deformation.	Replace.
Master cylinder primary and secondary pistons.	Nicks, scratches, corrosion on finished O.D. surfaces.	Do not repair; replace.
	Small holes in end open.	Clean.
	Try fit in master cylinder to be free with slight play.	Replace piston cylinder or both if tight or sloppy.
Master cylinder reservoir diaphragm.	Hardness, holes, punch marks, cuts or abrasion.	Replace.

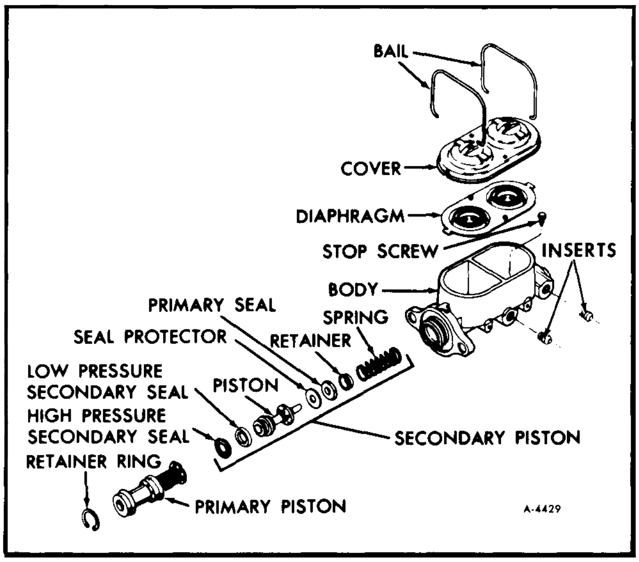


Figure 32—Master Cylinder (Exploded View)

ASSEMBLY (FIGURE 32)

If the brass tube inserts were removed, place the master cylinder in a vise so that the outlet holes are up. Position the new brass tube inserts in the outlet holes, making sure they are not cocked. The recommended method of seating these inserts is to thread a spare brake line tube nut into each outlet hole and turn the nuts down until the insert bottoms. (Remove the tube nut and check the outlet hole for loose brass burrs, which might have been turned up when the insert was pressed into position.)

Each vehicle application of these cylinders is designed to produce the correct displacement of fluid from both the front and rear chambers under normal, failed and partially failed conditions. Delco Moraine dual cylinders are designed so that this variable displacement requirement is controlled within each bore size by the dimensions A and C on the secondary piston.

Because the pistons vary in length, it is necessary to mark them with identification rings. It is imperative that exact replacements be made when servicing the master cylinders.

With all of the variables to be found in master cylinders, which look similar externally, it is important that the complete assemblies be properly identified. For this purpose a two-letter metal stamp will be found on the end of each master cylinder. This two-letter stamp indicates the displacement capabilities of a particular master cylinder. It is, therefore, mandatory that when master cylinders are replaced, they are replaced with cylinders bearing the same two-letter stamp.

1. Place new secondary seals in the two grooves in the flat end of the secondary piston assembly. The seal which is nearest the flat end will have its lips facing toward this flat end. The seal in the second groove should have its lips facing toward the end of the secondary piston which contains the small compensating holes.

2. Assemble a new primary seal and primary seal protector over the end of the secondary piston opposite the secondary seals, so that the flat side of the seal seats against the flange of the piston which contains the small compensating holes.

3. In order to insure correct assembly of the primary piston assembly, a complete primary piston assembly is included in the repair kits.

4. Coat the bore of the master cylinder with clean brake fluid. Coat the primary and secondary seals on the secondary piston with clean brake fluid. Insert the secondary piston spring retainer into the secondary piston spring. Place the retainer and spring down over the end of the secondary piston so that the retainer locates inside the lips of the primary seal.

5. Holding the master cylinder with the open end of the bore up or down, push the secondary piston into the bore so that the spring will seat in against the closed end of the bore. Use a small wooden rod to push the secondary piston to seat.

6. Place the master cylinder in a vise with the open end of the bore up. Coat the primary and secondary seals on the primary piston with clean brake fluid. Push the primary piston, secondary piston stop first, into the bore of the master cylinder. Hold the piston down and snap the lock ring into position in the small groove in the I.D. of the bore.

7. Continue to hold the primary piston down. This will also move the secondary piston forward and will insure that the secondary piston will be forward far enough to clear the stop screw hole, which is in the bottom of the front fluid reservoir. The stop screw is now positioned in its hole and tightened to a torque of 25-40 inch-pounds.

8. Install a new reservoir diaphragm in the reservoir cover and install the cover on the master cylinder. Assemble the bail wires into position to retain the reservoir cover.

WHEEL CYLINDER OVERHAUL

DISASSEMBLY

1. Pull boots from cylinder ends and discard boots.

2. Remove and discard pistons and cups.

CLEANING AND INSPECTION

1. Inspect cylinder bore for scoring or corrosion. It is best to replace a corroded cylinder.

> **NOTE:** Staining is not to be confused with corrosion. Corrosion can be identified as pits or excessive roughness.

2. Polish any discolored or stained area with crocus cloth by revolving cylinder on cloth supported by a finger. Do not slide cloth in a lengthwise manner under pressure.

Do not use any other form of abrasive or abrasive cloth.

3. Rinse cylinder in Declene or equivalent.

4. Shake excessive rinsing fluid from cylinder. Do not use a rag to dry cylinder, as lint from the rag cannot be kept from cylinder bore surfaces.

ASSEMBLY

1. Lubricate cylinder bore and counterbore with clean brake fluid and insert spring expander assembly.

2. Install new cups. (Be sure cups are lint and dirt free). Do not lubricate cups prior to assembly.

3. Install new pistons in the "as received" condition—do not lubricate pistons with brake fluid.

4. Press new boots into cylinder counterbores by hand. Do not lubricate boots prior to assembly.

CALIPER OVERHAUL

DISASSEMBLY

Before beginning disassembly, thoroughly clean the exterior of the caliper using clean Declene or equivalent. Place the caliper on a clean work surface.

Remove the brake hose from the caliper, discarding the copper gasket. Check the hose for worn spots, cracks or other signs of deterioration. Discard the hose, if damaged, replace with a new hose at reassembly. Drain brake fluid from the caliper.

> **WARNING: DO NOT PLACE THE FINGERS IN FRONT OF THE PISTON IN AN ATTEMPT TO CATCH OR PROTECT IT WHEN APPLYING COMPRESSED AIR. THIS COULD RESULT IN SERIOUS INJURY.**

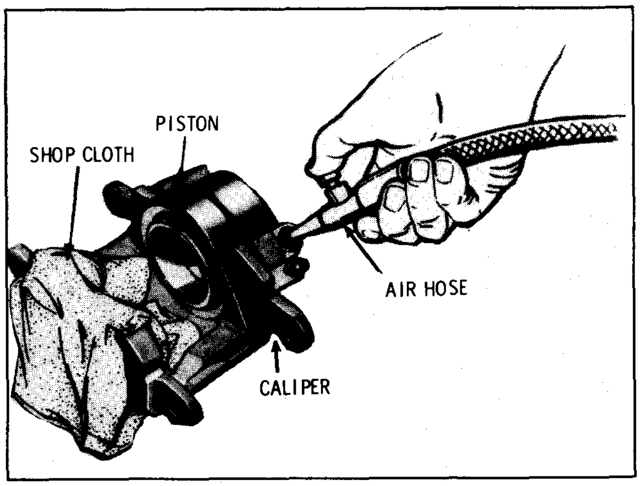


Figure 33—Removing Piston

Remove the piston by directing compressed air into the caliper inlet hole. As shown in Figure 33.

> **CAUTION:** *Use just enough air pressure to ease the piston out of the bore. If the piston is blown out-even with padding provided—it may become damaged.*

Use a screwdriver to pry the boot out of the caliper. Extend the screwdriver across the caliper bore, under the boot, and pry up. Be careful not to scratch the caliper bore (figure 34).

Use a piece of wood or plastic to remove the piston seal from its groove in the caliper bore. DO NOT USE A METAL TOOL OF ANY TYPE FOR THIS OPERATION.

Remove the bleeder valve from the caliper.

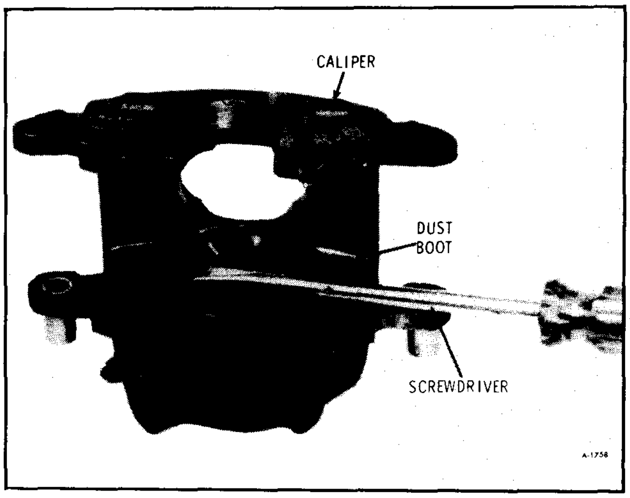


Figure 34—Removing Boot from Caliper

CLEANING AND INSPECTION

The boot, piston seal, rubber bushings and sleeves are to be replaced each time the caliper is overhauled.

Clean all other parts in clean Declene or equivalent. Use dry, filtered compressed air to dry parts and blow out all passages in the caliper and bleeder valve.

WARNING: THE USE OF LUBRICATED SHOP AIR WILL LEAVE A FILM OF MINERAL OIL ON THE METAL PARTS. THIS MAY DAMAGE RUBBER PARTS WHEN THEY COME IN CONTACT AFTER REASSEMBLY.

Check the mounting bolts for corrosion, breaks in the plating or other damage. Do not use abrasives in an attempt to clean the bolts. If bolts are damaged, replace them.

Carefully examine the piston OD for scoring, nicks, corrosion and worn or damaged chrome plating. If any surface defects are detected, replace the piston.

NOTE: The piston OD is the primary sealing surface in the caliper assembly. It is manufactured and plated to close tolerances. Refinishing by any means or the use of any abrasive is not acceptable.

Check the bore in the caliper for the same defects as the piston. The piston bore is not plated and stains or minor corrosion can be polished with crocus cloth. Do not use emery cloth or any other form of abrasive. Thoroughly clean the caliper after the use of crocus cloth. If the bore can not be cleaned up in this manner, replace the caliper.

ASSEMBLY

Lubricate the bore in the caliper and the new piston seal with clean brake fluid. Position the seal in the caliper bore groove. Lubricate the piston with clean brake fluid and assemble a new boot into the groove in the piston so that the fold faces the open end of the piston. Insert the piston into the caliper bore, using care not to unseat the seal and force down to the bottom in the bore. This will require a force of 50 to 100 pounds.

Position the OD of the boot in the caliper counterbore and seat with Tool J-22904 (figure 35).

Check the boot installation to make sure that the retaining ring molded into the boot is not bent and that the boot is installed fully-below the caliper face —and evenly all around. Otherwise dirt or moisture may enter the bore and cause damage or corrosion.

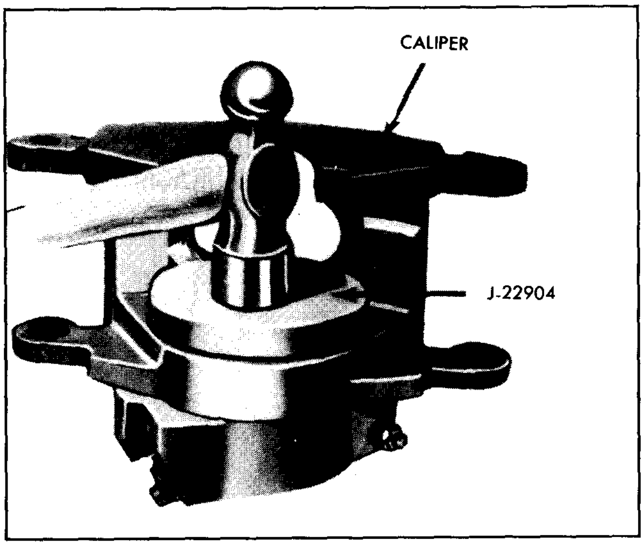


Figure 35—Boot Installation

Install the brake hose in the caliper inlet using a NEW copper gasket.

POWER BRAKE BOOSTER OVERHAUL

DISASSEMBLY

CAUTION: *Care must be used in handling the diaphragm of power piston assembly. Guard diaphragm against grease, oil, foreign matter and nicks or cuts.*

1. Scribe front and rear housing.

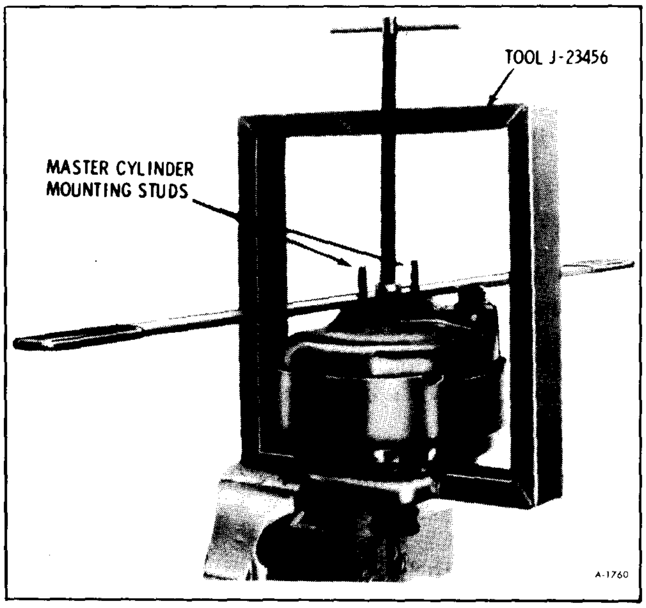


Figure 36—Separating Halves

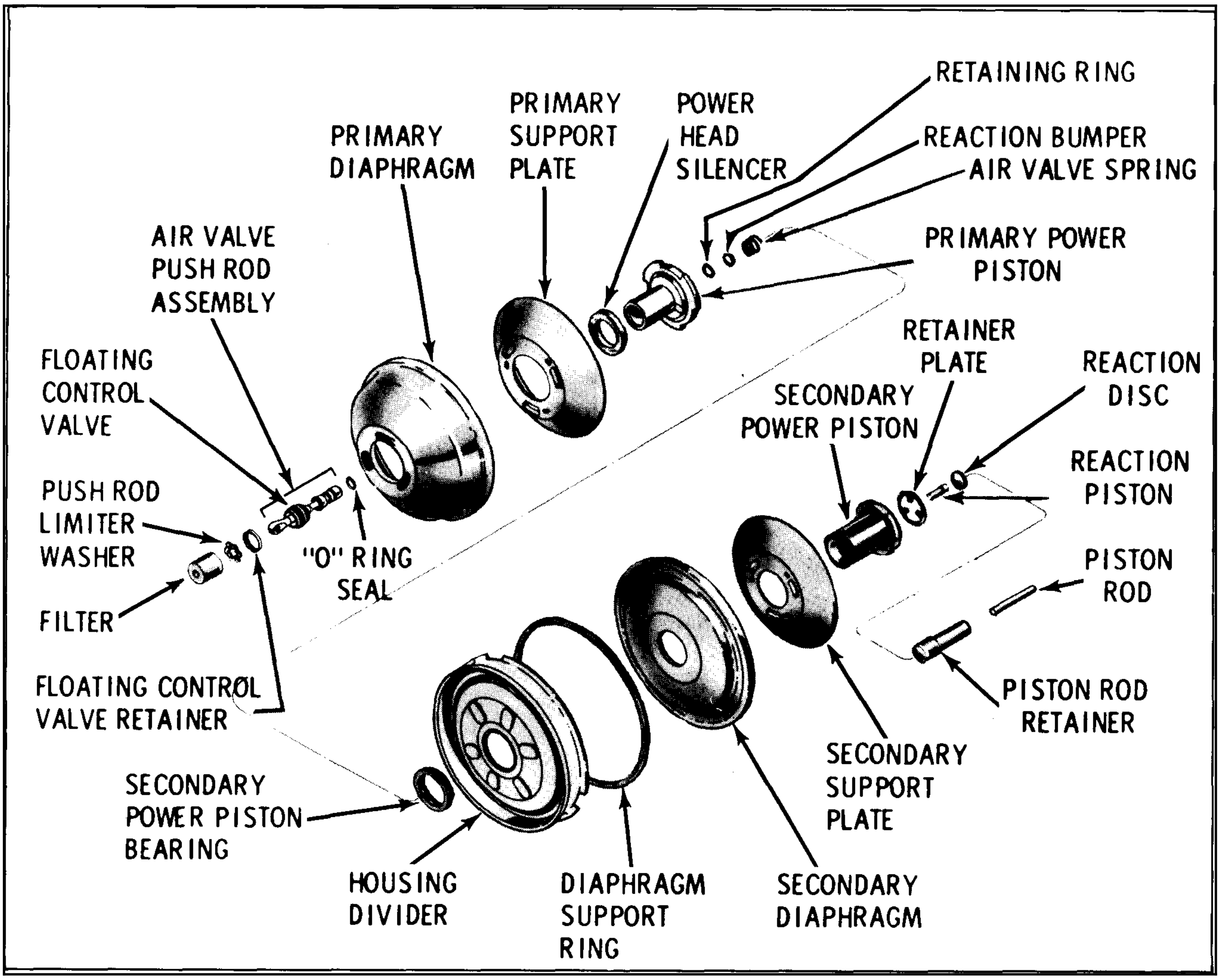


Figure 37—Exploded View of Power Piston

2. Remove master cylinder attaching nuts and remove master cylinder from front housing.

3. Remove front housing seal and master cylinder piston push rod.

4. Install Tandem Diaphragm Separating Tool J-23456 as shown in Figure 36.

5. With cylinder clamped slightly, rotate bar counterclockwise and unlock shells.

6. Back off hold down sufficiently to remove front shell, return spring retainer plate and piston rod retainer.

7. Remove assembly from tool and remove tool from vise.

8. Remove the dust boot retainer and boot from the rear housing and push rod. Remove the felt silencer from inside the boot.

9. Remove the power piston assembly from the rear shell and remove the primary power piston bearing from the center opening of the rear shell.

10. Lift the bead on the outside diameter of the secondary diaphragm and remove the support ring. (figure 37)

11. Mount Piston Unlocking Tool, J-23101, in a vise with wide jaws up. Position the secondary power piston so that the two radial slots in the piston fit over the jaws of the tool. (figure 38)

12. Fold back primary diaphragm from the outside diameter of the primary support plate. Grip the edge of the support plate and rotate counterclockwise to unscrew the primary power piston from the secondary power piston. (figure 39)

NOTE: It is possible that the primary support plate will unlock from the primary piston before

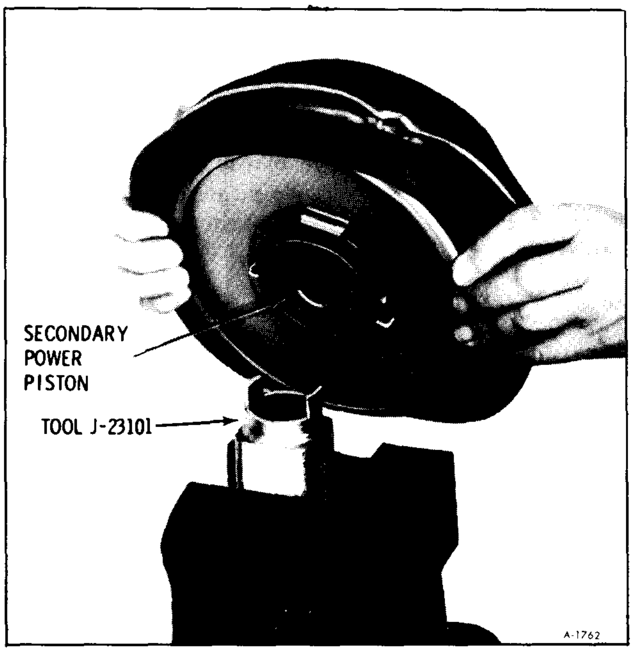


Figure 38—Positioning Secondary Power Piston

the primary piston unscrews from the secondary piston. If this happens, continue to turn the primary support plate counterclockwise. Tabs ("stops") on the primary support plate will temporarily lock the primary support plate to the primary power piston and permit continued counterclockwise rotation to unscrew the primary power piston from the secondary power piston.

13. Remove the housing divider from the secondary power piston. Remove the secondary power piston bearing from the housing divider.

14. The secondary power piston should still be positioned on Tool J-23101. Fold back secondary diaphragm from O.D. of secondary support plate. Grip the edges of the support plate and rotate clockwise to unlock the secondary support plate from the secondary power piston. (figure 40).

15. Remove the secondary diaphragm from the secondary support plate.

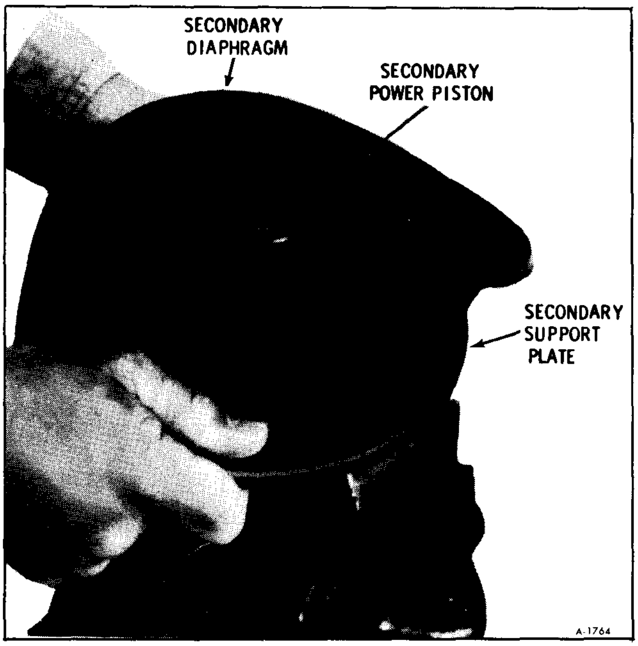


Figure 40—Removing Secondary Diaphragm

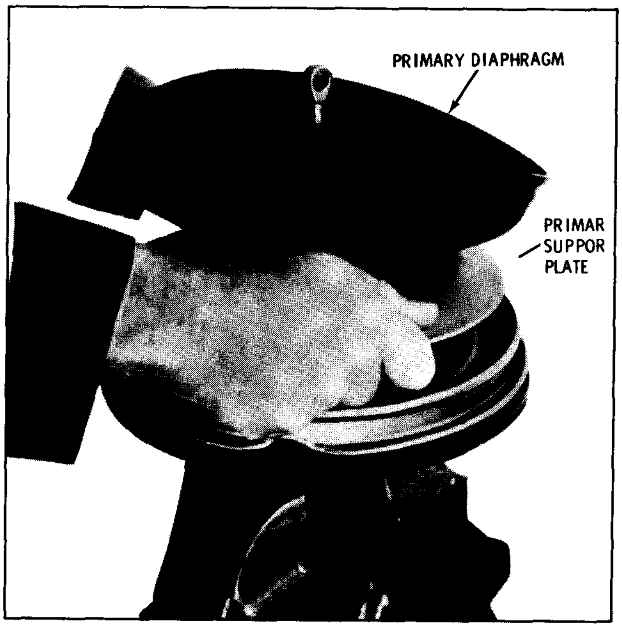


Figure 39—Unlocking Power Piston

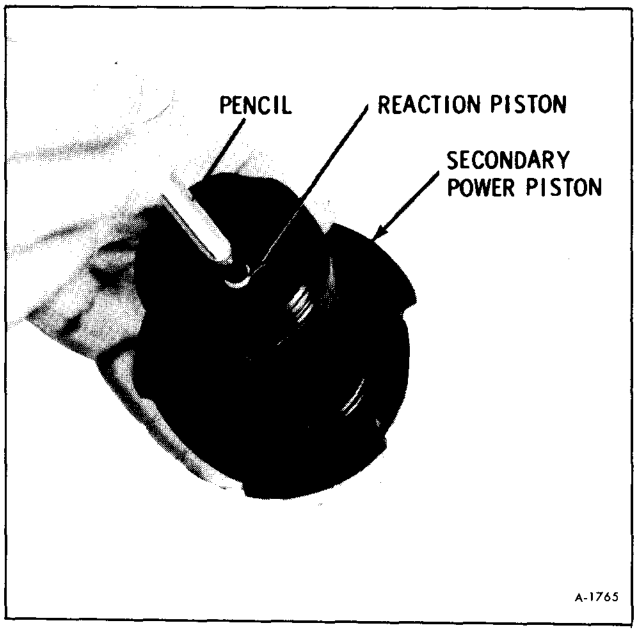


Figure 41—Removing Reaction Piston

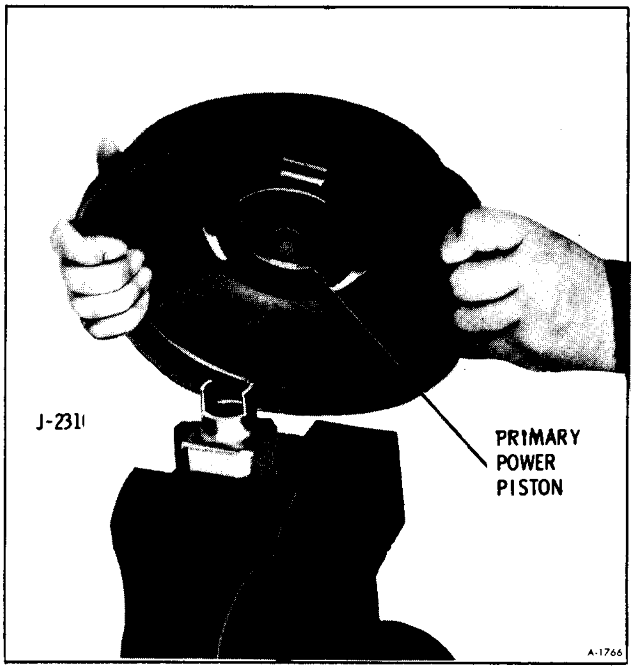


Figure 42—Positioning Primary Power Piston

16. Remove the reaction piston and reaction disc from the center of the secondary power piston by pushing down on the end of the reaction piston with a small object, such as a pencil, wooden dowel or metal rod. (figure 41)

17. Remove the air valve spring from the end of the air valve.

18. Mount Tool J-23101 in a vise with small jaws up. Position the primary power piston so that the two radial slots in the piston fit over the jaws of the tool. (figure 42)

19. Fold back primary diaphragm from the support plate. Grip the edge of the support plate and rotate in a counterclockwise direction to unlock the primary support plate from the primary power piston. (figure 43)

20. Remove the primary diaphragm from the primary support plate.

21. Remove the air filter and push rod limiter washer from the tubular section of the primary power piston.

22. Remove the power head silencer from the neck of the power piston tube.

23. Remove the rubber reaction bumper from the end of the air valve.

24. Remove the snap ring from the air valve. (figure 44)

25. Remove the air valve-push rod assembly from the tube end of the primary power piston by pulling on the primary power piston. (figure 45)

26. Removal of the air valve push rod assembly will disassemble the floating control valve retainer.

27. Remove the "O" ring seal from the air valve.

28. The air valve push rod assembly will be ser-

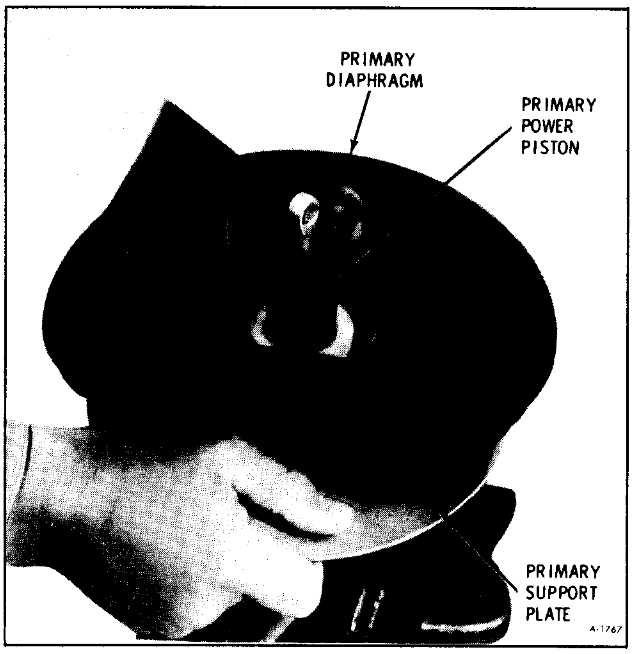


Figure 43—Removing Primary Diaphragm

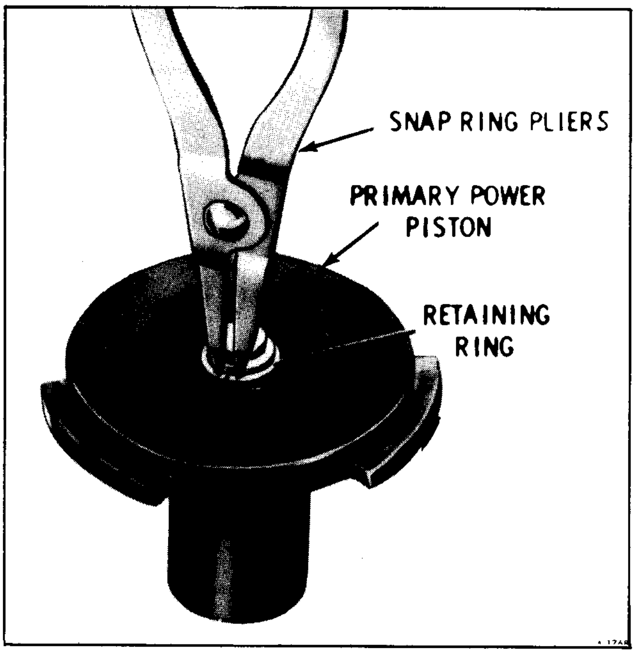


Figure 44—Removing Snap Ring from Air Valve

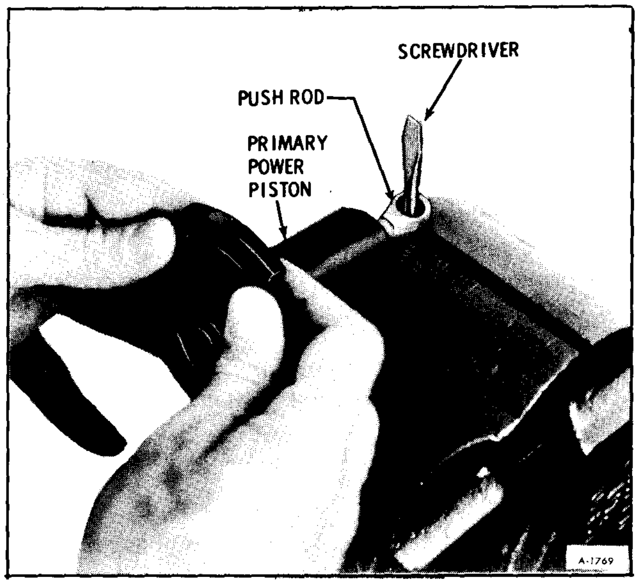


Figure 45—Removing Air Valve Push Rod Assembly

viced using a complete assembly, since the floating control valve cannot be removed over the eye end of the push rod.

CLEANING AND INSPECTION

CAUTION: *If there is any suspicion of contamination or any evidence of corrosion, completely flush the hydraulic brake system. Failure to clean hydraulic brake system can result in early repetition of trouble. Do not use gasoline, kerosene, anti-freeze alcohol or any other cleaner with even a trace of mineral oil.*

After disassembly, immerse all metal parts in metal cleaner. Plastic parts, as well as the rubber power diaphragms, should be cleaned in Declene or equivalent. Care should be taken to avoid chipping or damaging plastic parts in handling. After parts have been thoroughly cleaned, those parts which come in contact with hydraulic brake fluid (that is, all master cylinder parts and the power section push rod) should be thoroughly washed in Declene or equivalent before assembly. Use air to blow out dirt and cleaning solvent from recesses and internal passages. DISCARD ALL RUBBER PARTS EXCEPT THE POWER DIAPHRAGMS.

ASSEMBLY

NOTE: During assembly, when a lubricant is specified, use either the lubricant furnished with the repair kit or Seal Lubricant No. 1050169 or equivalent.

1. Lubricate the "O" ring seal, Figure 37 and place on the air valve.

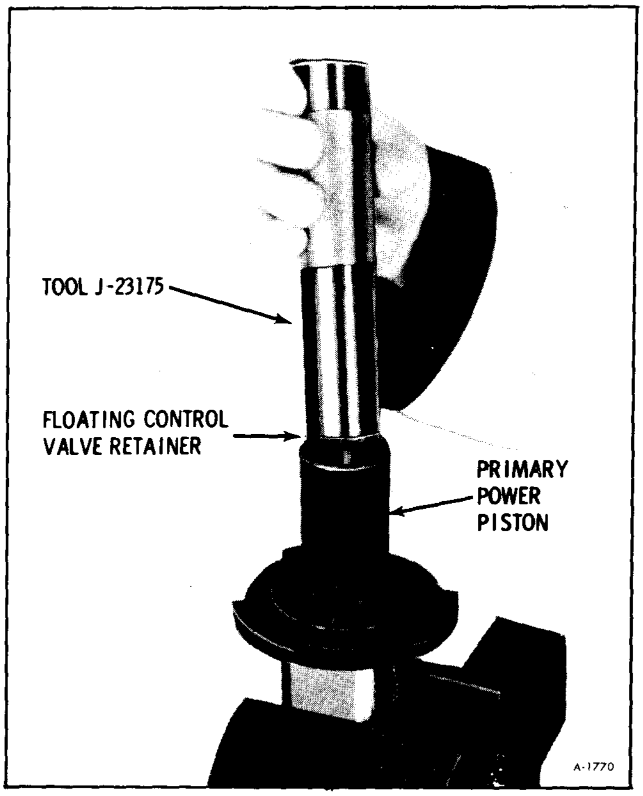


Figure 46—Installing Retainer Ring

2. Wipe a thin film of lubricant on the large and small O.D. of the floating control valve.

3. If the floating control valve needs replacement, replace the complete air valve push rod assembly.

4. Place the air valve end of the air valve push rod assembly into the tube of the primary power piston. Manually press the air valve push rod assembly so that the floating control valve bottoms on the tube section of the primary power piston.

5. Place lip of retainer on the O.D. of Tool J-23175. (figure 46) Manually press the retainer until seated in the primary power piston tube. (figure 47)

6. Place the push rod limiter washer over the push rod and position on the floating control valve.

7. Install filter element over the push rod eye and press into the primary power piston tube.

8. Using snap ring pliers, place the snap ring into the groove in the air valve.

9. Install the rubber reaction bumper on the air valve.

NOTE: Tolerances of component parts affecting output of the tandem power brake are very critical. To maintain correct power brake output, the

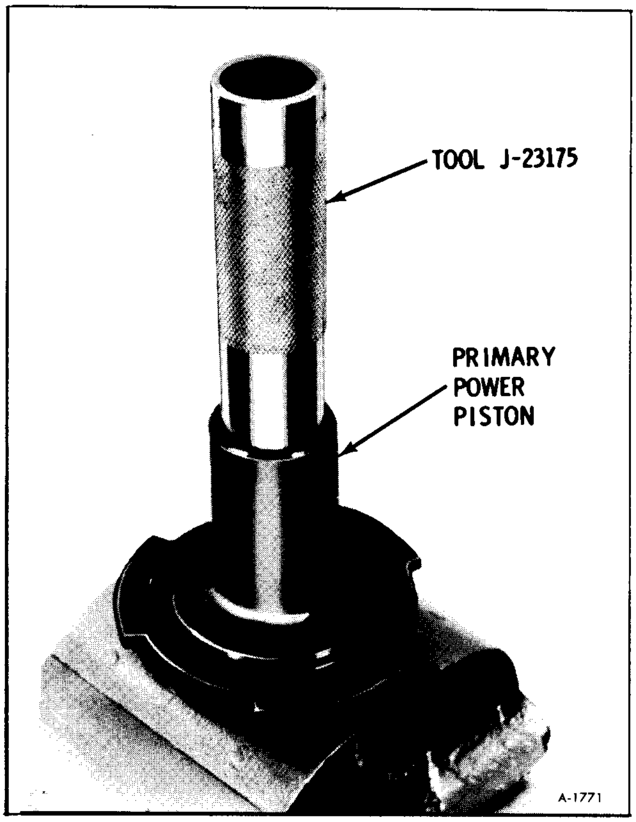


Figure 47—Retainer Ring Seated

power piston assembly is serviced as an assembly which includes a pre-selected REACTION PISTON, PRIMARY POWER PISTON, and SECONDARY POWER PISTON. NO gauging operation is required when power piston service package is used.

10. Assemble the primary diaphragm to the primary support plate from the side of the support plate opposite the locking tangs. Press the raised flange on the I.D. of the diaphragm through the center hole of the support plate. Be sure that the edge of the support plate center hole fits into the groove in the raised flange of the diaphragm. Lubricate the diaphragm I.D. and the raised surface of the flange (that fits into a groove in the primary power piston) with a light coat of lubricant.

11. Mount Tool J-23101, in a vise, small jaws up. Position the primary power piston so that the two radial slots in the piston fit over the jaws of the tool. (figure 42)

12. Fold the primary diaphragm away from the O.D. of the primary support plate.

13. Holding the edges of the support plate, with the locking tangs down, place the primary support plate and diaphragm assembly over the tube of the primary power piston. The flange on the I.D. of the primary diaphragm will fit into a groove in the primary power piston.

14. Grip the edges of the primary support plate, press down, and rotate clockwise until the tabs on the primary power piston contact the stops on the support plate. (figure 43)

15. Place the power head silencer on the tube of the primary power piston so that the holes at the base of the tube are covered.

16. Apply a very light film of lubricant to the O.D. of the primary power piston tube.

17. Remove the primary piston assembly from Tool J-23101.

18. Assemble the secondary diaphragm to the secondary support plate from the side of the support plate opposite the locking tangs. Press the raised flange on the I.D. of the diaphragm through the center hole of the support plate. Be sure that the edge of the support plate center hole fits into the groove in the raised flange of the diaphragm. Apply a thin coat of lubricant to the I.D. of the secondary diaphragm and the raised surface of the flange (that fits into a groove in the secondary power piston.)

19. Mount Tool J-23101 in a vise with large jaws up. Position the secondary power piston so that the radial slots in the piston fit over the jaws of the tool. (figure 38) Apply a light coat of lubricant to the tube of the secondary power piston.

20. Fold the secondary diaphragm away from the O.D. of the secondary support plate.

21. Holding the edges of the support plate, with the locking tangs down, place the secondary diaphragm and support plate assembly over the tube of the secondary power piston. The flange on the I.D. of the secondary diaphragm will fit into the groove in the secondary piston.

22. Grip the edges of the secondary support plate, press down, and rotate counterclockwise until the tabs on the secondary power piston contact the stops on the support plate. (figure 40) Fold the secondary diaphragm back into position on the secondary support plate. Leave the secondary power piston assembly on Tool J-23101 in the vise.

23. Apply a light coat of lubricant to the bead on the O.D. of the secondary diaphragm. This will facilitate assembly of front and rear housings.

24. Place the secondary diaphragm support ring on the secondary power piston assembly so that it rests on the edge of the diaphragm.

25. Hold the housing divider so that the formed lip (that holds the primary diaphragm) of the divider faces down. Place the secondary bearing in the I.D. of the divider so that the extended lip of the bearing faces up. (figure 48)

26. Lubricate the I.D. of the secondary bearing.

27. Position Tool J-23188, on the threaded end of the secondary power piston. (figure 49)

28. Hold the housing divider with the formed lip (that holds the primary diaphragm) facing up. Press the divider down over the tool and onto the secondary power piston tube where it will rest against the diaphragm support ring. Remove Tool J-23188 from secondary power piston. Do not remove the secondary power piston subassembly from Tool J-23101.

29. Pick up the primary power assembly and position the small end of the air valve return spring on the air valve so that it contacts the air valve retaining ring.

30. Fold the primary diaphragm away from the O.D. of the primary support plate.

31. Position the primary power piston on the tubular portion of the secondary power piston, making sure that the air valve return spring seats down over the raised center section of the secondary piston.

32. Grip the edge of the primary support plate, press down, and start the threads on the secondary power piston into the threaded portion of the primary power piston by rotating in a clockwise direction. (figure 39)

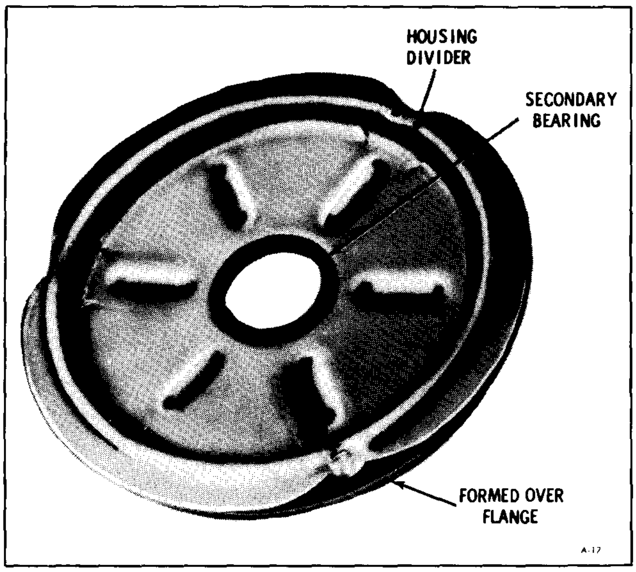


Figure 48—Installing Secondary Bearing

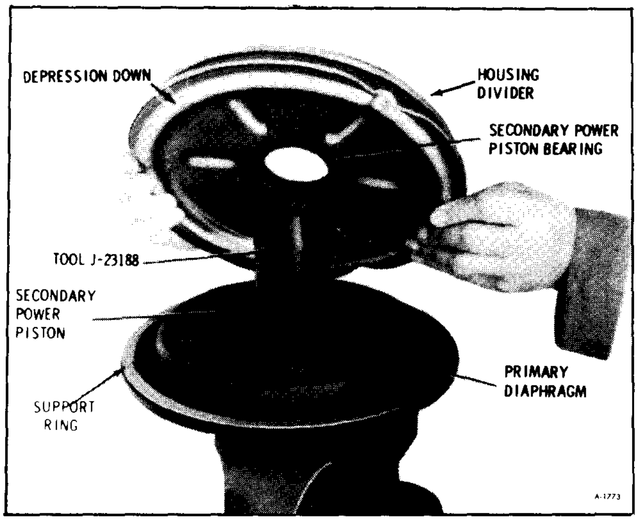


Figure 49—Installing Housing Divider

33. Continue to tighten the primary power piston until it is securely attached to the secondary power piston.

34. Fold the primary diaphragm back into position on the primary support plate and pull the diaphragm O.D. over the formed lip of the housing divider. Check that the bead on the diaphragm is seated evenly around the complete circumference.

35. Wipe a thin film of lubricant on the O.D. of the piston rod retainer. Insert the master cylinder piston rod retainer into the cavity in the secondary power piston so that the flat end bottoms against the rubber reaction disc in the bottom of the cavity.

36. Place the primary power piston bearing in rear housing center hole so that the formed flange of

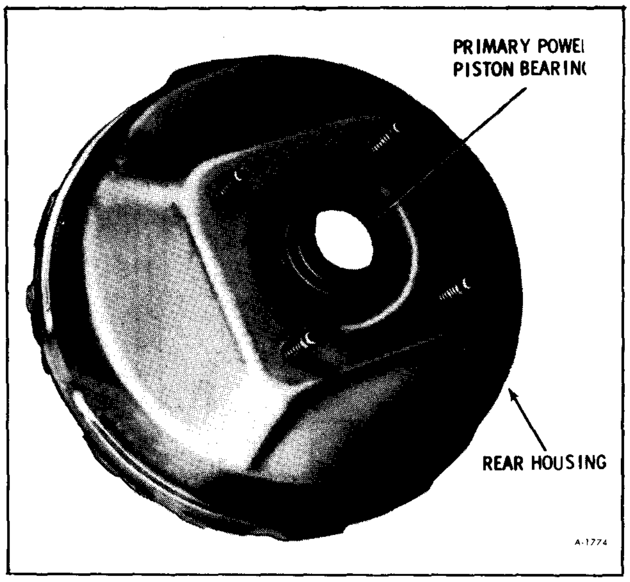


Figure 50—Installing Primary Power Piston Bearing

the housing center hole fits into the groove of the primary power piston bearing. The thin lip of the bearing will protrude to the outside of the housing. (figure 50)

37. Coat the I.D. of the primary power piston bearing with a thin film of lubricant.

38. Assemble the power piston assembly to the rear shell by pressing the tube of the primary power piston through the rear housing bearing. Press down until the housing divider seats in the rear shell and the primary power piston bottoms against the shell.

39. Mount Tool J-23456 in vise and position rear shell in tool.

40. Place piston rod retainer plate on the end of the power piston and install power piston return spring.

41. Lower front shell over rear shell and position bar on front shell with bearing.

42. Tighten down on front shell and fit the tangs in the appropriate slots on the rear shell.

43. Rotate the bar clockwise into the locked position and remove power head from Tool J-23456.

44. Place the filter in the power head boot. Stretch the boot over the push rod and over the flange of the rear housing and install boot retainer.

45. Place the power head assembly in a vise with the front shell facing up. Insert the master cylinder piston rod, flat end first, into the piston rod retainer.

46. Press down on the master cylinder piston rod to be sure it is properly seated.

> **NOTE:** To assure that no vacuum is in the power head while gauging, front housing seal must not be installed at this time.

47. Place gauge J-23337 over the piston rod in a position which will allow the gauge to be moved to the left or right without contacting the studs. (Figure 51)

48. Position gauge over piston rod. The adjustment is correct if the lower step contacts the piston rod and the upper step clears the piston rod.

49. If the push rod is not within specifications and the push rod does not have an adjusting screw, a new service adjustable push rod must be installed and adjusted to specification. If the push rod being checked has an adjusting screw, adjust the push rod to specification.

50. Wipe a thin film of lubricant on the I.D. of the front housing seal and position seal in the depression in the housing.

51. Position the master cylinder assembly on the front housing. Install the locknuts on the studs and torque to 28 ft. lbs.

52. Install power unit into vehicle.

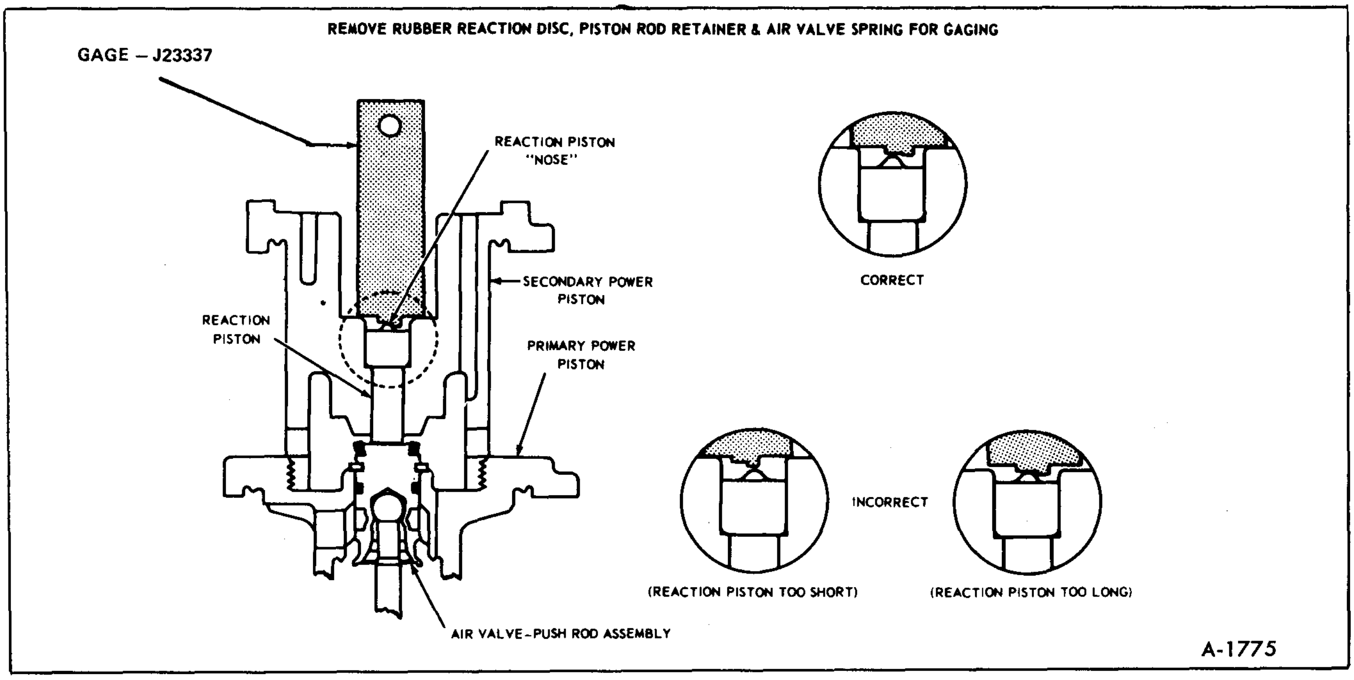


Figure 51—Gauging Piston Rod

TESTING OF POWER BRAKE UNIT

1. Road test brakes by making a brake application at about 20 mph to determine if vehicle stops evenly and quickly. If pedal has a spongy feel when applying brakes, air may be present in hydraulic system. Bleed system as described in BLEEDING SYSTEM.

2. With engine stopped and transmission in neutral, apply brakes several times to deplete all vacuum reserve in system. Depress brake pedal, hold light-foot pressure on pedal and start engine. If vacuum system is operating, pedal will tend to fall away under foot pressure and less pressure will be required to hold pedal in applied position. If no action is felt, vacuum system is not functioning.

3. Stop engine. Again deplete all vacuum reserve in system. Depress brake pedal and hold foot pressure on pedal. If pedal gradually falls away under foot pressure, hydraulic system is leaking internally or externally.

4. If brake pedal travels to within one inch of toeboard, brake shoes are not adjusting or require relining.

5. Start engine with brakes off and transmission in neutral. Run engine to medium speed and turn off ignition. Immediately close throttle. This builds up vacuum. Wait no less than 90 seconds, then try brake action. If not vacuum-assisted for two or more applications, vacuum check is faulty or there is a leak in vacuum system.

MAJOR COMPONENT INSPECTION

COMBINATION VALVE

No attempt should be made to disassemble or repair either valve. If any failure should occur, the complete valve should be replaced.

REAR BRAKE SHOES AND BACKING PLATE

1. Inspect linings for wear. If linings are worn nearly flush with rivets new linings should be installed.

2. Check wheel cylinder for leakage by removing the link. If leak exists, remove wheel cylinder for service or replacement.

3. Clean inner surfaces of brake backing plates and all shoe contacting points.

4. Clean exposed portions of parking brake cables.

5. Disassemble the adjusting screw assembly. Clean and inspect as follows:

a. Check thrust washer and mating surfaces for burrs of excessive wear.

b. Inspect teeth on sprocket for wear.

c. Remove all foreign material from adjusting screw and nut. Nut must rotate freely on threads.

6. Check the foot of the adjuster lever for wear. Replace if necessary.

7. Check the override pivot for wear or deformed parts.

8. Check brake drum inner diameter for build-up of rust and dirt. Remove build-up so that drums can be installed over pre-adjusted linings. Check drum for cracks and out-of round condition.

DISC BRAKE SHOE AND LINING

LINING INSPECTION

Inspect the brake linings any time that the wheels are removed (tire rotation, etc.). Check both ends of the outboard shoe by looking in at each end of the caliper. These are the points at which the highest rate of wear normally occurs. At the same time, check the lining thickness on the inboard shoe to make sure that it has not worn prematurely. Look down through the inspection hole in the top of the caliper to view the inboard shoe. Whenever the thickness of any lining is worn to the approximate thickness of the metal shoe, all shoe and lining assemblies should be replaced.

Front disc brakes have a wear indicator that makes a noise when the linings wear to a degree where replacement is required. (figure 52) The spring clip is an integral part of the inboard shoe and lining. When the lining is worn the clip contacts the rotor and produces a warning noise.

Check flatness of brake pads. Place inboard and outboard pad surfaces together and check for gap between pad surfaces. If more than .005" gap is measured at middle of pad (midway between attaching lugs), pad must not be used. This applies to new or used brake pads.

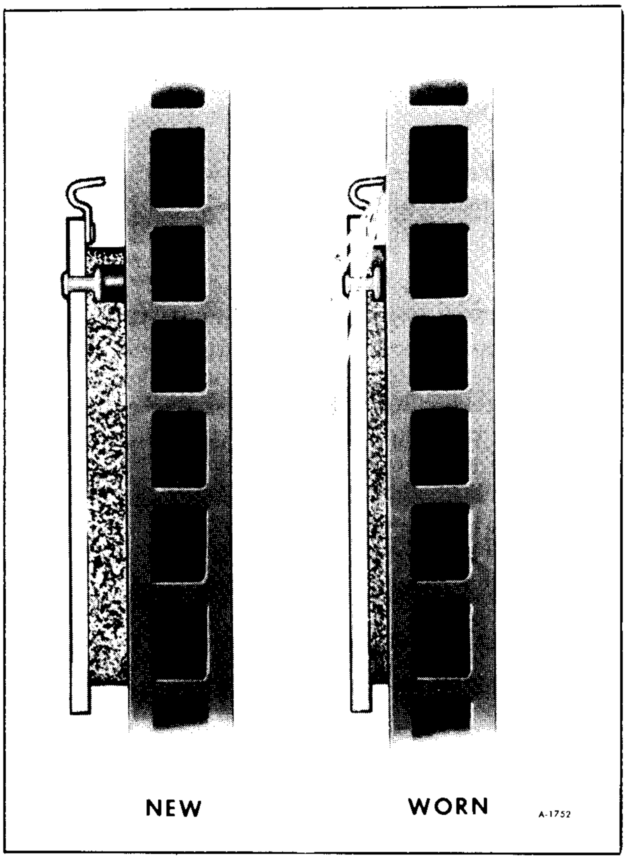


Figure 52—Wear Indicators

CLEANING AND INSPECTION

1. Thoroughly clean the holes and the bushing grooves in the caliper ears. Wipe all dirt from the mounting bolts. Do not use abrasives on the bolts since this will damage the plating. If the bolts are corroded, or damaged, they should be replaced.

2. Examine the inside of the caliper for evidence of fluid leakage. If leakage is noted, the caliper should be overhauled. Wipe the inside of the caliper clean, including the exterior of the dust boot. Check the boot for cuts, cracks or other damage. Make sure that the boot is properly engaged in the groove in the piston and also in the caliper counter-bore. (figure 53)

CAUTION: *Do not use compressed air to clean the inside of the caliper since this may cause the dust boot to become unseated.*

DISC INSPECTION

Light scoring .010-.020 inch deep, of the disc braking surface will normally occur during brake application, turning is not required unless they are severely scored. It is not necessary to remove all score marks when turning. Precision equipment must be used when turning discs and the following specifications must be carefully observed. DO NOT reduce total thickness of the braking surface anymore than the turning dimension of 1.185". If too much is removed, even maximum pedal travel will not apply the brakes if pads are worn.

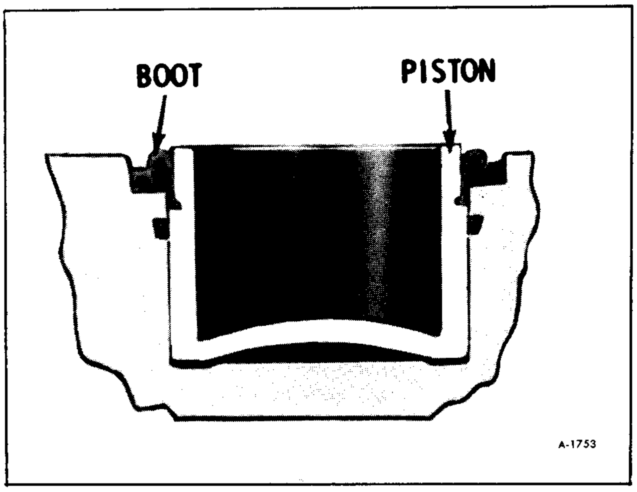


Figure 53—Boot Installation

Disc runout can be checked by clamping a dial indicator to the caliper or plain arm so that the stylus touches the disc about an inch from its outer edge. Rotate disc and check indicator reading. If the lateral runout exceeds specifications the disc should be replaced or refinished.

After turning, brake surface thickness must not vary more than .0005". Lateral runout must not exceed specifications. Surface finish must be non-directional and smoothness maintained at 30-50 micro inches.

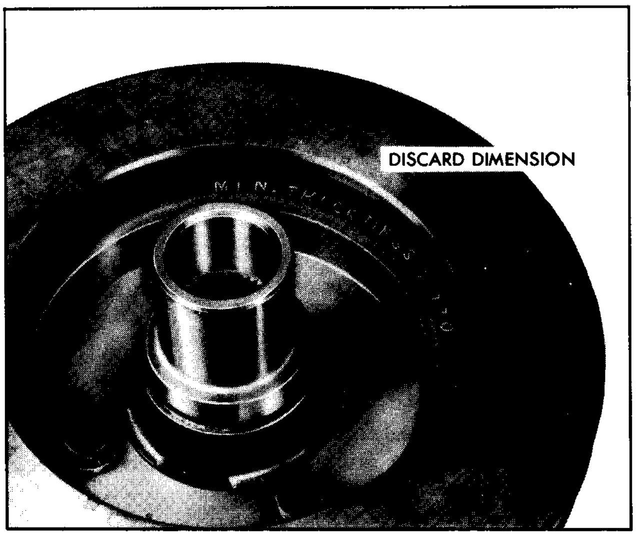


Figure 54—Discard Dimension (Disc)

If only one disc requires turning, the disc on the opposite wheel should be sanded with 60 or 80 grit emery cloth to give braking surfaces a non-directional surface.

A discard dimension 1.170" is stamped on all production installed brake disc's (See figure 54). This is the allowable wear dimension and NOT the allowable turning dimension. There must be .015" left for wear after turning disc's.

BRAKE DRUMS

INSPECTING AND RECONDITIONING BRAKE DRUMS

Whenever brake drums are removed, they should be thoroughly cleaned and inspected for cracks, scores, deep grooves and out-of-round. Any of these conditions must be corrected since they can impair the efficiency of brake operation and cause premature failure of other parts.

CRACKED, SCORED, OR GROOVED DRUM

NOTE: A cracked drum is unsafe for further service and must be replaced. Do not attempt to weld a cracked drum.

Smooth up any slight scores by polishing with fine emery cloth. Heavy or extensive scoring will cause excessive brake lining wear, and it will probably be necessary to rebore in order to true up the braking surface.

If the brake linings are slightly worn and the drum is grooved, the drum should be turned just enough to remove grooves. The ridges in the lining should be lightly removed with a lining grinder.

If brake linings are to be replaced, a grooved drum should be turned for use with oversize linings. A grooved drum, if used with new lining, will not only wear the lining, but will make it difficult, if not impossible to obtain efficient brake performance.

OUT-OF-ROUND OR TAPERED DRUM

An out-of-round drum makes accurate brake shoe adjustment impossible and is likely to cause excessive wear of other parts of brake mechanism due to its eccentric action. An out-of-round drum can also cause severe and irregular tire tread wear as well as a pulsating brake pedal. When the braking surface of a brake drum exceeds the factory specification limits in taper (and/or) being out-of-round, the

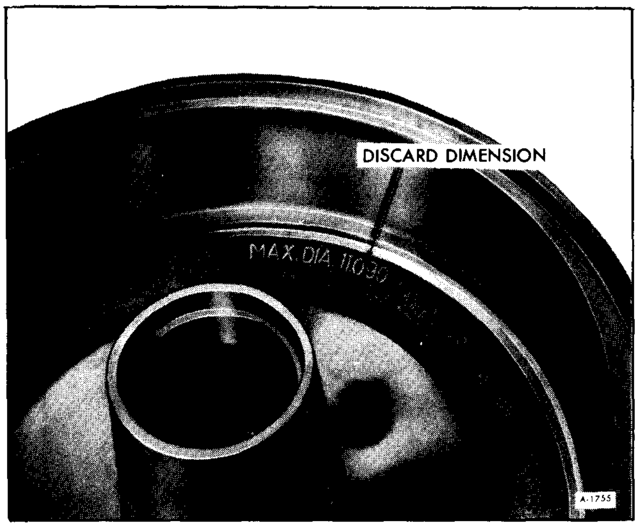


Figure 55—Discard Dimension (Drum)

drum should be turned to true up the braking surface.

Drum out-of-round can be measured with a dial indicator and extension rod. Out-of-round measurements exceeding .006", (total indicator reading) require turning or replacement of drum.

TURNING DRUMS

If irregularities in the braking surface of the drum cannot be removed with emery cloth or out-of-round exceeds .006" (total indicator reading), the drum can be turned to .060" greater than the original inside diameter. If a drum has smooth score marks .010" to .020", it is serviceable without turning.

If a drum is turned to a diameter less than .030" standard replacement linings may be used. Over .030" oversize linings should be used.

A discard dimension 11.090" (figure 55) is stamped on all production installed brake drums. This is the allowable wear dimension and NOT the allowable turning dimension. There must be .030" left for wear after turning drums. The maximum turning diameter is 11.060".

REPLACING DRUMS

Whenever new drums are to be installed, the braking surface of the drum must be thoroughly cleaned with lacquer thinner to remove the rust-proof coating.

COMPONENT INSTALLATION

BRAKE DRUM INSTALLATION

1. Install hub and drum assembly (figure 10).

2. Install flat washer and castillated nut on hub while rotating hub and drum assembly.

3. Tighten castillated nut to 25-30 lbs. ft. torque to position bearings. (Be sure drum is rotating while tightening nut).

4. Back off nut 1/2 turn.

5. Retighten nut finger tight, secure if possible with cotter pin.

6. If unable to secure at finger tight, back off nut to first securing position.

7. Check end play between hub and spindle it should be .001 to .005 inch.

8. Replace inner and outer dust caps.

REAR BRAKE SHOE INSTALLATION

1. Lubricate the adjusting screw threads, thrust washer mating surfaces and backing plate ledges with brake lubricant, such as Part No. 1050110 or equivalent.

2. Assemble the adjusting screw.

3. Attach the primary to secondary shoe spring to the shoes and install the adjusting screw. The primary to secondary shoe spring must not contact the adjusting screw sprocket.

4. Position shoe assembly on the backing plate. Be sure wheel cylinder links are properly positioned in the shoe notches.

5. Position the upper end of the actuating link on the brake shoe guide.

6. Engage the actuating link with the override pivot. Then position the adjuster lever and return spring on the secondary shoe. Position sleeve in the hole in secondary shoe and fasten to backing plate with hold-down spring assembly and pin.

7. Install the remaining primary hold-down spring, washer and pin.

8. Install the primary and secondary brake shoe return springs.

9. Adjust brake shoes as outlined under BRAKE SHOE ADJUSTMENT.

10. Install the hub and drum assembly. Adjust wheel bearings.

11. If wheel cylinder was removed, bleed brakes.

12. Check fluid level in master cylinder. Fluid level should be no more than 1/4" below the reservoir opening at rear.

DISC BRAKE SHOE INSTALLATION

1. Using Silicone Lube, No. 1050018, or equivalent, lubricate new sleeves, on all surfaces. Lubricate new rubber bushings, bushing grooves and the small ends of bushings in all four caliper ears. Install rubber bushings in all four caliper ears.

CAUTION: *It is essential that the new sleeves and rubber bushings be used and that lubrication instructions be followed in order to insure the proper functioning of the sliding caliper design.*

2. Install the sleeves. Position the sleeves so that the end toward the shoe and lining assemblies is flush with the machined surface of the ear.

3. Install the shoe support spring by placing the single tang end of the spring over the notch in the

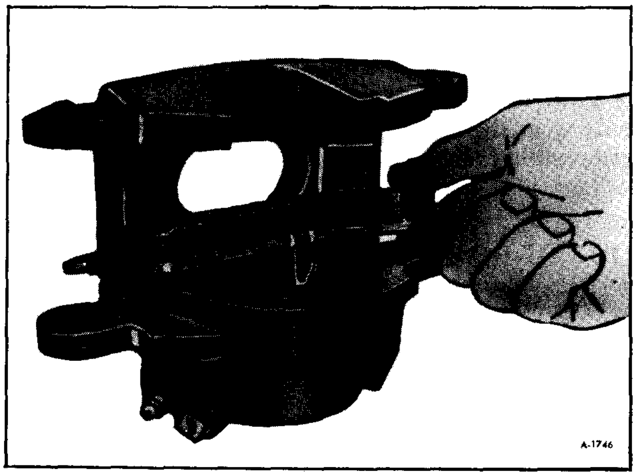


Figure 56—Installing Inboard Shoe

center of the edge of the shoe. Then press the two tangs at the spring end of the inboard shoe spring over the bottom edge of the shoe so that they engage the shoe securely.

4. Position the new inboard shoe and lining assembly (with spring attached) in the caliper so that the ear end of the shoe and lining is down and the bottom end up at an angle with the spring resting on the piston I.D. (figure 56). Press down on both ends of the shoe until the shoe is in a flat position, resting on the piston. The spring end of the inboard shoe support spring should be resting on the I.D. of the piston.

NOTE: If the shoe support spring is not installed correctly, a low or no brake pedal could occur.

5. Insert new outboard shoe into caliper with no clearance between shoe and caliper face. (figure 57)

6. Position the caliper over the disc, aligning the holes in the caliper ears with the holes in the mounting bracket.

Make sure that the brake hose is not twisted or kinked. Start the bolts through the sleeves in the inboard caliper ears and through the mounting bracket making sure that the ends of the bolts pass under the retaining ears on the inboard shoe. Push bolts on through to engage the holes in the outboard shoes and the outboard caliper ears at the same time threading the bolts into the mounting brackets. Torque the bolts to 35 ft. lbs.

7. Fill master cylinder reservoir with new brake fluid No. 5464831 or equivalent to within 1/4" of top of reservoir.

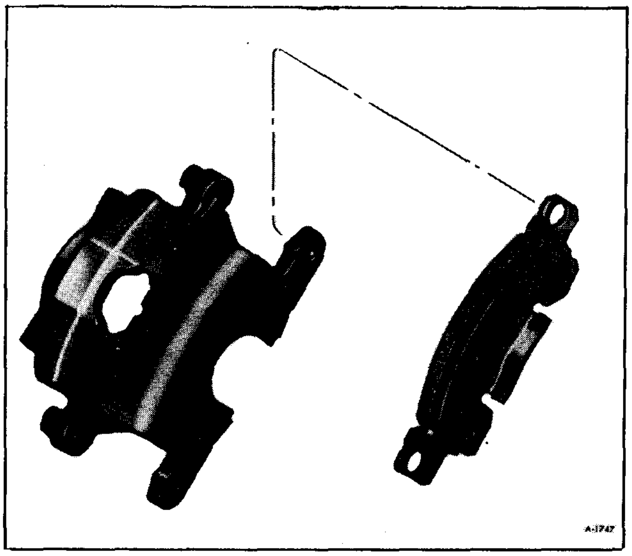


Figure 57—Installing Outboard Shoe

8. Depress brake pedal to seat linings against rotor.

9. Clinch upper ears of outboard shoe by positioning channel lock pliers with one jaw on top of upper ear and one jaw in notch on bottom of shoe, opposite upper ear.

10. After clinching, ears must be flat against caliper housing with no radial clearance.

11. If radial clearance exists, repeat clinching procedure.

12. Replace the shoe and linings on the other front wheel disc brake in the same manner. Relining is to be done in full sets only.

NOTE: Right and left calipers must not be interchanged. When installed properly, the bleed screw will be on top.

13. When completed, reinstall the wheel and tire assemblies. Lower the vehicle to the floor. Add brake fluid to the master cylinder reservoirs to bring the level up to within 1/4" of the top.

NOTE: Do not move vehicle until firm brake pedal is obtained.

Whenever the front wheel disc brakes are relined, the rear drum brakes should be checked also.

COMBINATION VALVE INSTALLATION (FIGURE 13)

1. Install valve on mounting bracket.

2. Connect wiring to switch terminal on valve.

3. Connect all brake lines to valve.

4. Bleed entire brake system. Refer to "BLEEDING BRAKE SYSTEM" as described earlier in this section.

MASTER CYLINDER INSTALLATION

1. Position master cylinder on power cylinder so push-rod enters cavity in master cylinder piston.

2. Install two attaching nuts (figure 15).

3. Connect two hydraulic lines to master cylinder and tighten fittings securely. (figure 14).

4. Fill master cylinder reservoir with brake fluid, No. 5464831, and bleed all wheel cylinders as outlined under "BLEEDING BRAKE SYSTEM".

DISC INSTALLATION

1. Install four hub to disc attaching bolts, and torque to 35 ft. lbs. (figure 58). See caution on page 1 of "FRONT SUSPENSION" section 3A.

2. Position retainer over hub.

3. Lubricate seal lips with Special Seal Lubricant No. 1050169 or equivalent then position seal over hub with metal end toward retainer.

4. Install bearing as shown in Figure 59.

Lubricate O.D. of bearing with E.P. chassis grease.

The outer race of the bearing is a snug fit into knuckle. Light tapping on the hubs outer surface, not the disc, will aid assembly. Clean bearing seat on knuckle of rust and dirt that may fall in during removal.

Care must be used when installing hub assembly over drive axle splines so that splines are in correct alignment.

5. Install three bolts attaching bearing retainer to knuckle. Torque to 35 ft. lbs.

6. Install drive axle washer and nut. Torque nut to 110 ft. lbs. If necessary to align cotter pin slot, tighten nut and install NEW cotter pin and crimp. Torque not to exceed 280 ft. lbs.

NOTE: Do not back off nut to install cotter pin.

Figure 58—Hub to Disc Bolts

POWER BRAKE BOOSTER INSTALLATION

1. Position booster assembly on firewall and install four retaining bolts. (figure 22).

2. Connect vacuum line to booster assembly.

3. Install master cylinder mounting bracket from booster assembly to firewall.

4. Install master cylinder, refer to "Master Cylinder Installation".

5. Install clevis pin retaining brake pedal to brake booster assembly clevis. Secure with cotter pin refer to Figure 21.

6. Install power level control panel and secure with four screws.

PARKING BRAKE LEVER INSTALLATION

1. Position lever on toe board.

2. Position cable in its retaining bracket and install pin.

3. Install parking brake switch.

4. Install two nuts and bolts holding cable retaining bracket to lever base (figure 24).

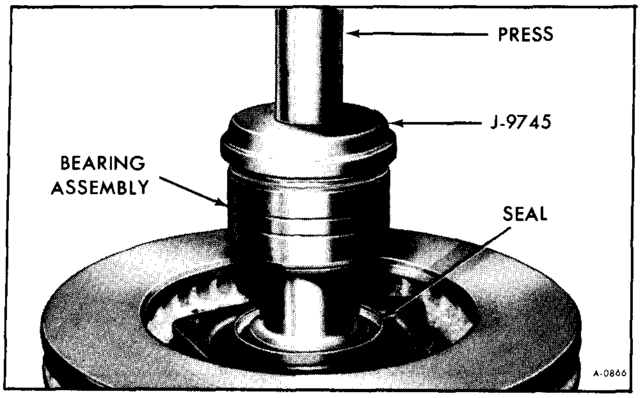


Figure 59—Installing Bearing

5. Install four nuts and bolts holding lever to toe board (figure 23).

FRONT PARKING BRAKE CABLE INSTALLATION

1. Position cable through toe board.

2. Install retainer and retainer pin on end of cable through lever.

3. Install clip to retain cable at shift relay bracket.

4. Install end of cable in front equalizer with front cable on top of intermediate cable. Install adjusting nut and lock nut (figure 25).

5. Adjust parking brake as described earlier in this section.

INTERMEDIATE PARKING BRAKE CABLE INSTALLATION

1. Position cable through frame rails.

2. Place cable in guides at frame rails (figure 27).

3. Place cable in guide at crossmember (figure 26).

4. Install cable at front equalizer with intermediate cable under front cable. Install adjusting nut and lock nut (figure 25).

5. Install intermediate equalizers including adjusting and lock nuts (figure 5).

6. Adjust parking brake as described earlier in this section.

REAR PARKING BRAKE CABLE INSTALLATION

1. Install the rear cable through the backing plate and connect the ball to the lever. Make sure the locking fingers are fully expanded on the backing plate (figure 29).

2. Install hubs and drums as described under "Brake Drum Installation".

3. Feed ends of cables through brackets on frame rails and install clips (figure 28).

4. Connect ends of cables and install intermediate equalizer, with intermediate cable on top of rear cable (figure 25).

5. Adjust parking brake as described earlier in this section.

BRAKE PEDAL INSTALLATION

1. Properly position brake pedal assembly.

2. Install two bolts (torque 30-35 ft. lbs.), one at each end of pedal assembly (figure 30 & 31).

3. Tighten left hand brake lever pivot bracket.

4. Insert clevis pin into clevis and brake pedal assembly. Secure with a cotter pin (figure 21).

5. Install brake light switch.

6. Install power level valve mounting panel and secure with four screws.

BRAKE LINE TUBING INSTALLATION

WARNING: DOUBLE FLARING TOOL MUST BE USED AS SINGLE FLARING TOOLS CANNOT PRODUCE A FLARE STRONG ENOUGH TO HOLD THE NECESSARY PRESSURE.

Hydraulic brake tubing is a double layer annealed steel terne plate tubing which resists corrosion and has the physical strength to stand up under

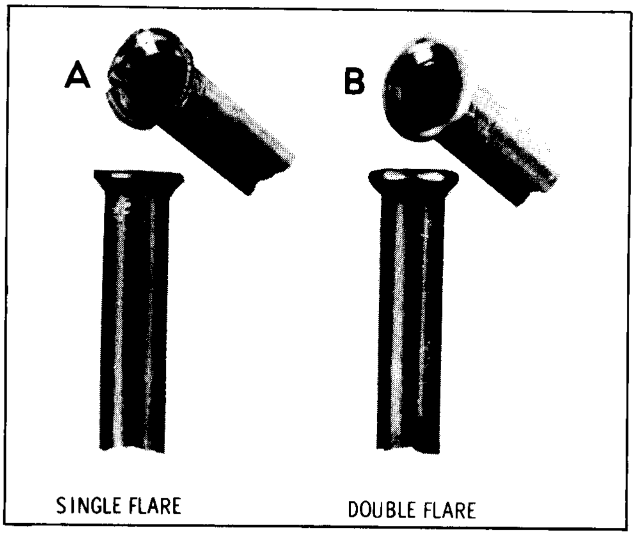


Figure 60—Single and Double Lap Flare

the high pressures which are developed when applying the brakes. In making up hydraulic brake pipes, it is important that the proper flaring tool be used to flare the ends of tubing for the compression couplings. Unless the tubing is properly flared, the connections will leak and the brakes will become ineffective.

WARNING: NEVER USE COPPER TUBING BECAUSE COPPER IS SUBJECT TO FATIGUE CRACKING WHICH WOULD RESULT IN BRAKE FAILURE.

Steel tubing must be double-lap flared at the ends in order to produce a strong leakproof joint.

Special tools are available from tool companies for making double-lap flares. Do not attempt to flare steel tubing without proper tools. Figure 60 shows a single and a double-lap flare, note the split in the single-lap flare. The double-lap is well formed and unbroken due to the reinforcement of the double wall.

Refer to Figure 61 for brake line routing and attachment.

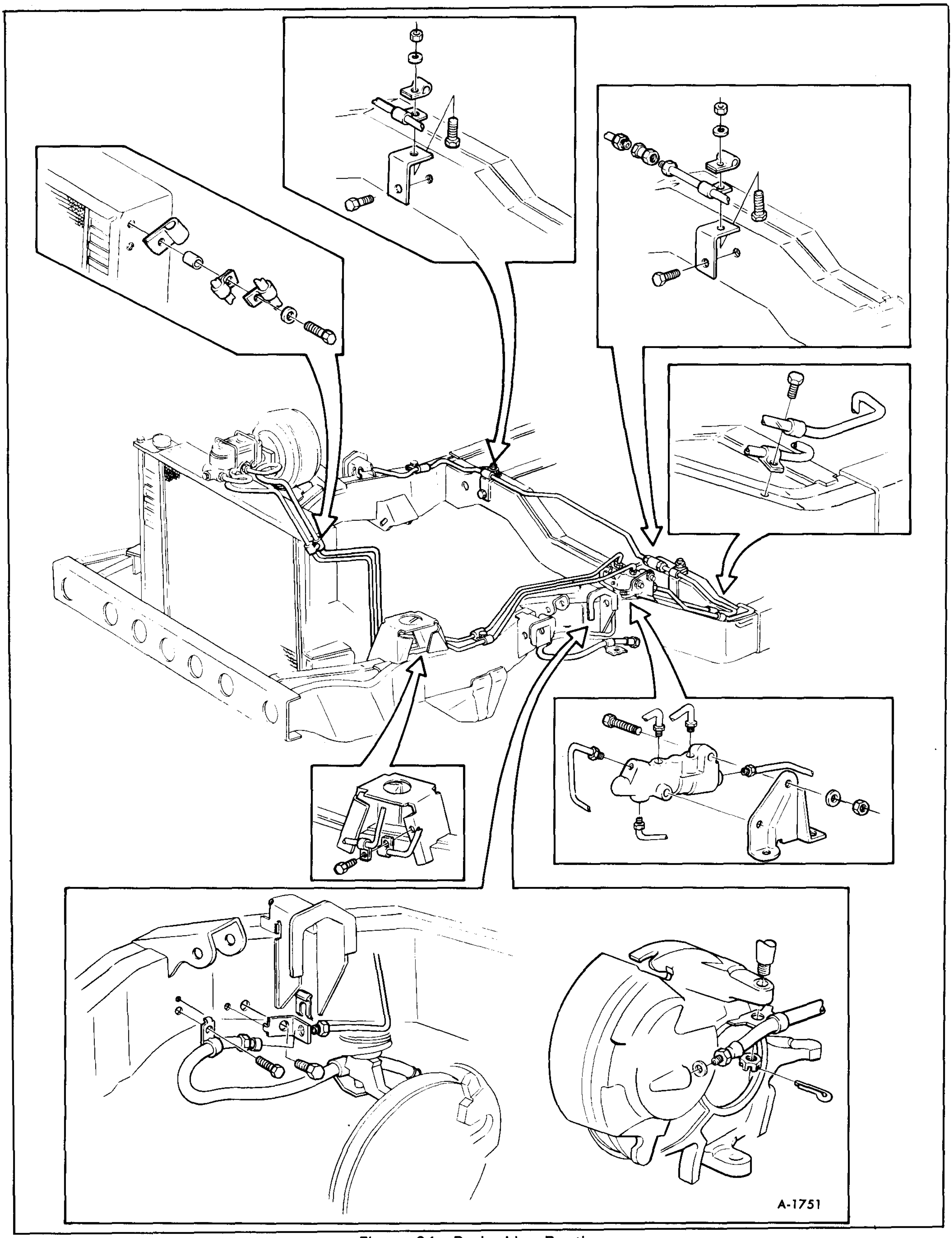


Figure 61—Brake Line Routing

SPECIFICATIONS

Drums
- Inside Diameter
  - Original .... 11″
  - Maximum .... 11.090″
  - Max. Out-of-Round .... (Total Indicator Reading .006″)

Discs
- Outside Diameter .... 11″
- Lateral Runout .... .005″
- Thickness Variation .... .0005″
- Disc Thickness
  - Original .... 1.200″
  - Minimum .... 1.170″

Linings
- Drums
  - Length-Primary .... 8.90″
  - Length-Secondary .... 11.60″
  - Width .... 2.0″
  - Thickness-Primary .... .200″
  - Thickness-Secondary .... .290″
- Discs
  - Length .... 5.4″
  - Thickness-Inner .... .43″
  - Thickness-Outer .... .40″

Fluid Type .... Delco Supreme 11 or DOT-3 fluid or equivalent

TORQUE SPECIFICATIONS

Combination Valve to Mounting Bracket
- Nut Torque .... 8-12 ft. lbs.

Combination Valve Mounting Bracket to Frame Rail
- Screw Torque .... 72 in. lb. min. (Fully Driven not Stripped)

Power Cylinder to Firewall
- Nut Torque .... 12-16 ft. lbs.

Master Cylinder Bracket to Firewall
- Bolt Torque .... 15-20 ft. lbs.

Brake Lever Pivot Bolt
- Bolt Torque .... 30-35 ft. lbs.

Brake Lever Pivot Bracket to Firewall
- Nut Torque .... 25-30 ft. lbs.

Power Cylinder to Master Cylinder
- Nut Torque .... 28 ft. lbs.

Hub to Drum Bolt Torque .... 70-85 ft. lbs.

Drum to Spindle Nut Torque .... 25-30 ft. lbs.

BRAKE SPECIAL TOOLS

J-22904	Dust Boot Seal Installer
J-23101	Diaphragm Plate Separator
J-23175	Control Valve Installer
J-23188	Secondary Power Piston Bearing Seal Protector
J-23337	Reaction Piston Gauge
J-23456	Brake Booster Separating Fixture
J-23518	Tandem Brake Bleeder Adapter
J-23709	Combination Valve-Metering Valve Actuator

SECTION 6A
ENGINE

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6A

GENERAL INFORMATION

DESCRIPTION

This section of manual provides instructions for servicing the various items and tuning the engine. To adequately accomplish a satisfactory tune-up, reliable test equipment in the hands of trained personnel is necessary.

A definite, systematic maintenance program is required to assure satisfactory economical performance of engine. Included in maintenance program must be the servicing of related units and systems as well as regular servicing of engine.

ENGINE MAINTENANCE AND STORAGE

Refer to SECTION O at the beginning of this manual for recommendations pertaining to engine servicing intervals. Winterization and storage are also covered in SECTION 24A.

ENGINE LUBRICATION SYSTEM (FIGURE 1)

The engine oil pan forms a reservoir for engine oil to provide lubrication and also hydraulic fluid to operate the valve lifters. Oil pressure for lubrication is furnished by a gear type oil pump that is bolted to the rear main bearing cap and driven by the camshaft gear through a hexagonal drive shaft.

Oil enters the pump through a screened inlet located near the bottom rear of the oil pan. The pressurized oil from the pump passes through the engine oil cooler located in the radiator tank then to the oil filter located on the right rear side of the engine block, see Figure 2. The oil filter base has a by-pass valve which in the event of filter restriction will open at 5.3 to 6.3 psi. It then enters the right oil gallery where it is distributed to the five main bearings. The right bank valve lifters receive oil from this gallery from eight feed holes that intersect the gallery.

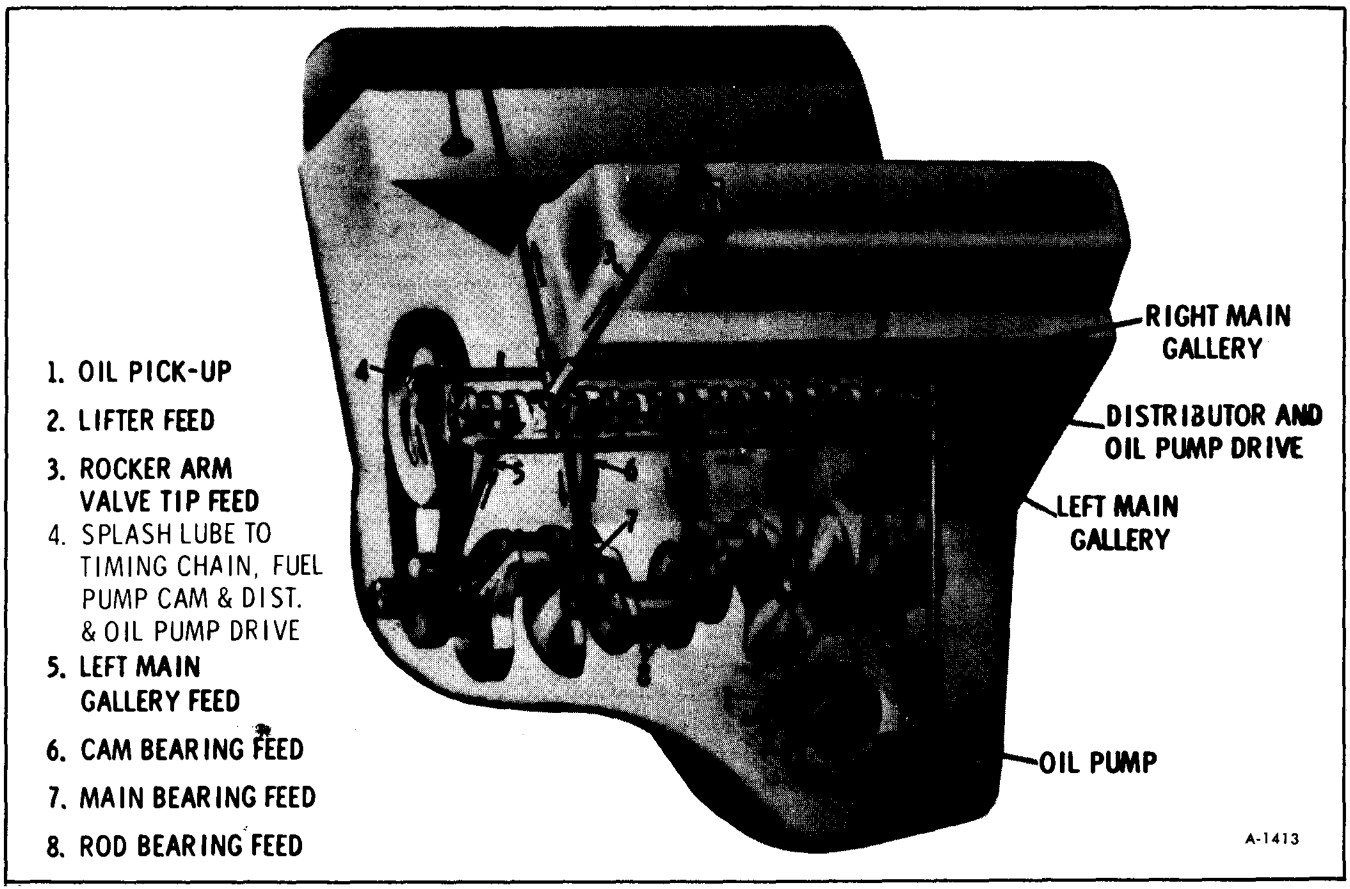

Figure 1—Engine Lubrication

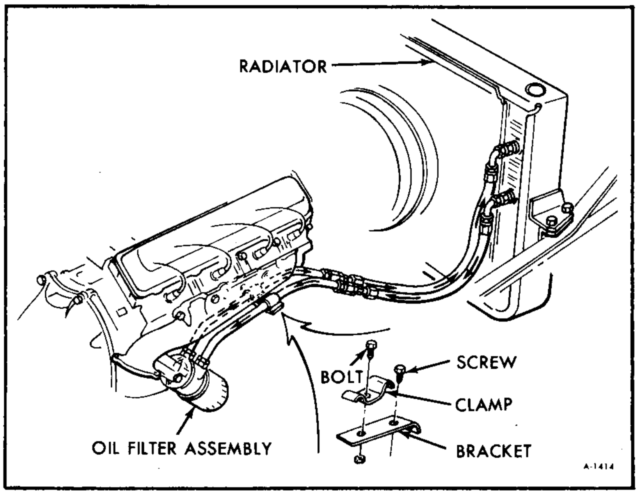

Figure 2—Oil Lines to Cooler

The five camshaft bearings are lubricated from vertical passages intersecting the main bearing oil passages. At the front main bearing a third passage connects the right main oil gallery to the left gallery which then feeds the left bank of valve lifters.

The engine oil pressure warning light switch is connected to the front of the left oil gallery. The switch is calibrated to turn on the instrument panel warning light when engine oil pressure is too low. The switch, normally closed, is set to open at 2-6 psi. The rear oil gallery plug has a .040" orifice to help purge contaminants from the gallery.

At the front end of the right gallery, a small orifice sprays oil to lubricate the fuel pump eccentric cam and the timing chain.

The oil pump and distributor drive gear are lubricated by splash from the rear cam bearing and connecting rod bearings.

The rocker arms and valve tips are lubricated by means of oil furnished through the hydraulic lifters and hollow push-rods. A disc valve in the lifter meters oil to the push rods.

The connecting rod bearings are oiled by constant oil flow from passages drilled through the crankshaft connecting the main journals to the rod journals. A groove around each main bearing furnished oil to the drilled crankshaft passages.

Oil returns to the oil pan reservoir from the rocker arms through passages at each end of the cylinder heads. Oil from the valve lifter compartment returns through clearance holes in the lower portion of the compartment near the camshaft. The timing chain compartment drains directly into the oil pan.

ENGINE DIAGNOSIS

NOTE: The numbers in parenthesis refer to GENERAL ENGINE CHECKS at the end of Engine Diagnosis.

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ENGINE WILL NOT TURN OVER

IMPORTANT - Delcotron generator equipped vehicles cannot be push-started when battery or starter are inoperative, because unlike a conventional generator, there is no residual magnetism in the rotor.

GENERAL

Neutral safety switch (Automatic Transmission).

Check dipstick for congealed oil, improper viscosity, or presence of water in oil.

Remove spark plugs to check for hydrostatic lock (liquid in combustion chamber).

ELECTRICAL

Check ignition switch and wiring.

BATTERY

See "Battery Diagnosis Charts".

STARTER

See "Starter Diagnosis Charts".

MECHANICAL

Seized bearings, rings, and or pistons.

ENGINE TURNS OVER SLOWLY BUT DOES NOT START

GENERAL

Bad or corroded connections.
Undersized battery cable.
Poor ground.
Oil viscosity too heavy.

MECHANICAL

Tight bearings, rings, pistons, etc.

BATTERY

See "Battery Diagnosis Charts".

STARTER

See "Starter Diagnosis Charts".

ENGINE TURNS OVER AT NORMAL SPEED—STARTS HARD WHEN COLD (2) (7)

NOTE: Most conditions under "Does Not Start" may also cause hard starting when cold.

IGNITION

Engine timing and dwell.

FUEL (3) (4) (8)

If condition occurs only when ambient temperature is below 32°F., check for ice restriction in the fuel supply system. If necessary, thaw system and add anti-icing additive to the fuel. (5)

NOTE: In cold weather cranking speed is reduced by thickening of oil and reduction of battery efficiency.

ENGINE TURNS OVER AT NORMAL SPEED (1)—STARTS HARD WHEN HOT (7) (11)

NOTE: This condition is usually caused by an over-supply of fuel due to any of the items listed under "Does Not Start" due to excessive fuel supply.

GENERAL

Check proper starting procedure (setting choke, accelerator pumping, accelerator position, etc.).

Engine timing and dwell.

Air cleaner dirty.

Engine overheating. Refer to ENGINE OVERHEATS in this section.

MECHANICAL

Choke mechanism binding, sticking and/or improper adjustment. (3)

FUEL

Vapor lock.
Flooding. (4)
Accelerator pump. (8)
Carburetor faulty.
Fuel pump faulty.
Fuel restricted.

IGNITION

Check for faulty spark plugs. (6)

ENGINE STARTS — FAILS TO KEEP RUNNING OR STALLS HOT OR COLD (7)

GENERAL

Vapor lock. (11)

*Engine overheats.

*Engine runs too cool.

Idle speed too low.

Positive crankcase ventilation valve.

Leak in intake manifold (vacuum line faulty or disconnected). (9)

Exhaust crossover in intake manifold plugged.

Exhaust system restricted.

Air intake restricted.

Carburetor icing. (5)

Engine timing and dwell.

MECHANICAL

Throttle linkage defective or improperly adjusted.

Valve train faulty.

Valve lifter or valve clearance.

Low compression.

Choke valve faulty, stuck, or binding. (3)

Head cracked or gasket leaking.

Excessive engine friction.

FUEL

Dirt and/or water in fuel system.
Faulty fuel pump.
Float level too high. (4)
Idle adjustment incorrect.
Idle compensator valve faulty.
Needle valve seat faulty.
Mixture too rich or too lean.
Faulty carburetor.

IGNITION

Spark plugs damp or dirty and/or gap incorrectly set or not installed properly.

Faulty coil or condenser.

Distributor points incorrectly set, burned, pitted or dirty.

Distributor advance mechanism faulty or timing improperly set.

Worn rotor or distributor cap loose, corroded, poor connections, or incorrect wiring.

*Refer to ENGINE OVERHEATS in this section.

ENGINE TURNS OVER AT NORMAL SPEED BUT DOES NOT START OR STARTS HARD (7)

NOTE: If ignition is set too far advanced, spark may occur too early when engine is cranked. The first (and only) explosion runs the engine backward. A kickback may jam the starter or break the starter drive housing.

IGNITION (2)

OPEN PRIMARY

Burned or oxidized ignition points.
Coil resistance unit burned out or open.
Starting switch ignition coil resistance by-pass circuit open.
Ignition points not closing.
Breaker arm binding on pivot post, preventing closing of points.
Breaker arm spring weak or broken.
Breaker arm distorted or bent.
Dirty ignition points.
Primary lead connection loose at distributor or coil.
Primary windings in coil broken.
Open ignition switch circuit.

GROUNDED PRIMARY

NOTE: A grounded coil primary winding, a grounded ignition switch, or a grounded switch-to-coil primary lead will cause excessive current flow and will usually cause wires to burn.

Ignition points not opening or closing due to wear or improper adjustment.
Faulty bushing in breaker arm.
Cracked or faulty insulator at distributor primary terminal.
Grounded or faulty condenser.
Distributor-to-coil lead grounded.
Primary coil winding grounded.
Broken or loose ignition wire or faulty switch.

MECHANICAL

Choke binding, sticking, or improper adjustment.
Low or erratic compression. (Check valve train mechanism, rings, blown head gasket, etc.)

FAULTY SECONDARY (6)

Corroded spark plug cable terminals.
Chafed or cracked cable insulation.
Ignition coil weak or inoperative.
Moisture on ignition coil, terminals, distributor cover, spark plug procelains, or in distributor.
Improper type of spark plugs.
Cracked distributor cap or a burned carbon track from distributor cap center terminal to housing.
Improper installation of spark plug cables (not correct for firing order).
Spark plugs damaged, dirty, or wet, porcelains cracked, or gaps improperly spaced.
Rotor contact spring bent or broken.
Distributor rotor grounded.
Distributor cap center terminal (inner) broken or missing.
Broken or burned out radio suppressor in distributor cap.

FUEL (11)

Hot engine vapor lock.
No fuel or insufficient fuel.
Water and/or dirt (Fuel System).
Excessive fuel. (4)
Accelerator pump faulty. (8)
Fuel pump worn or defective.
Fuel filter dirty.
Carburetor dirty or defective.
Vent in fuel tank clogged or restricted.
Carburetor mounting bolts loose.

GENERAL

Check proper starting procedure (setting choke, accelerator pumping, accelerator position etc.).
Air cleaner dirty.
Engine timing.
Restricted exhaust.
Poor ground or faulty wiring.

ENGINE STALLS AT IDLE — ENGINE COLD (OK WHEN HOT)

CARBURETOR (3) (5)

Idle too low.
Choke high idle too low.

MECHANICAL

Linkage improperly adjusted or damaged.

ENGINE STALLS AT IDLE — ENGINE HOT (OK WHEN COLD)

GENERAL

Vapor lock. (11)

Engine overheats. (Refer to "Engine Overheats" in this section.)

Positive crankcase ventilation valve.

CARBURETOR (3) (4)

Idle set too low.

MECHANICAL

Throttle linkage improperly adjusted or faulty.

ROUGH ENGINE IDLE (1)

GENERAL

Check all vacuum hoses for proper routing, broken or disconnected hoses and/or caps. Also vaçuum leaks. (9)

Restricted air cleaner (Remove air cleaner with engine running and note engine rpm.).

Incorrect timing and dwell.

Positive crankcase ventilation valve dirty or stuck.

Restricted exhaust.

Cold engine (Faulty thermostat).

Fuel volatility too high or low.

IGNITION (6)

Improper plug or plug gap.

Faulty plugs.

Improper point setting, worn or damaged.

Defective condenser and coil.

Faulty rotor or cap.

Loose wiring.

Damaged or corroded coil wiring or spark plug cables.

Moisture on wiring or in distributor cap.

Cracked distributor cap.

FUEL

Engine idle speed improper.

Mixture too rich or lean. (4)

Float level.

Dirt and water in fuel system.

Carburetor mounting bolts loose.

MECHANICAL

Choke linkage, secondary throttle plates sticking, binding or damaged. (3)

Low compression.

Valve train faulty (Burnt or sticky valves, broken spring, bent push rod etc.).

Loose engine mounts or worn insulation.

Improperly torqued cylinder head.

Leaking or worn valve guides.

NOTE: When repairs have been made it may be necessary to re-adjust idle speed.

ENGINE HAS INCONSISTENT IDLE SPEED (LOPES) (1)

NOTE: If idle speed is slow, unstable, rolling, frequent stalling, and oily engine compartment, the positive crankcase ventilation valve may be completely plugged, or the valve may be stuck in the "OPEN" position. A valve stuck in the "CLOSED" position is indicated by breather back-flow at heavy throttle and oily engine compartment. If the valve is stuck in the intermediate position it will be indicated by rough, fast idle and stalling.

GENERAL

Restricted exhaust.
Vacuum leak (Intake valve stem leaking, carburetor mounting gasket leaking, cabruetor throttle shaft in carburetor leaking, intake manifold or vacuum hoses leaking). (9)
Timing and dwell not correct.
Restricted air cleaner.
Overheated engine (Refer to "Engine Overheats" in this section). (11)
Blown head gasket.
Low compression.
Quality of fuel.
Lean idle mixture. (1)

FUEL

Dirt and/or water infuel system.
Too rich or lean mixture.
Filter restricted.
Faulty fuel pump. (4)
Faulty carburetor.

MECHANICAL

Throttle shaft, accelerator pedal and/or throttle linkage sticking or binding.
Timing chain or gears and/or camshaft lobes worn.
Burned, warped, pitted, leaky or sticking valves.
Inoperative choke.
Sticking hydraulic lifter.

IGNITION

Excessive oil or dirt on ignition system.
Spark plugs damp or gap incorrectly set.
Excessive moisture on ignition wires and caps.
Leaks in ignition wiring (Dirty, corroded, or faulty wiring).
Ignition wires making poor contact.
Burned, pitted, or incorrectly set contact points.
Faulty coil or condenser.
Worn distributor cam, or cracked distributor cap, radial contacts in distributor cap burned or worn.
Faulty spark advance mechanism.

ENGINE RUNS - MISSES AT IDLE ONLY (1)

GENERAL

Vacuum leak. (9)
Timing not correct.
Exhaust restriction.
Blown head gasket.
Low compression.
Fuel quality poor.
Air cleaner dirty.

MECHANICAL

Leaky or incorrect valve.
Worn or leaky valve guide.
Worn timing chain, gears, sprocket or camshaft lobe.
Dirt in hydraulic lifter.

IGNITION (2)

Spark plugs faulty or wrong gap.
Incorrect, worn, or gap incorrectly set.
Leaks in ignition wiring.
Burned, pitted, or incorrectly set contact points.
Faulty coil and/or condenser.
Faulty spark advance mechanism.
Defective or worn rotor and/or cap.

FUEL (4)

Flooding in carburetor.
Refer to "Engine Has Inconsistent Idle Speeds" above.

ENGINE RUNS - MISSES AT HIGH SPEED ONLY (1)

GENERAL

Overheating (Refer to "Engine Overheats" in this section).
Detonation or pre-ignition.
Sub-standard fuel.
Faulty or dirty air cleaner.
Valve train faulty or worn.
Mild vapor lock.
Exhaust vapor lock.
Exhaust manifold clogged or restricted.
Air cleaner plugged.

FUEL

Faulty fuel pump.
Restricted fuel filter.
Choke valve not completely closed.
Carburetor throttle lever loose on shaft.
Exhaust manifold clogged with carbon.
Exhaust manifold, muffler, or tail pipe restricted.
Intermittent delivery of fuel to carburetor so that momentarily the mixture is too weak for combustion.

IGNITION (2)

Clean, gap, and/or replace spark plugs, as necessary.
Too hot spark plugs—change to colder type, but note that a hot plug may be due to loose installation or lack of plug gasket (if gasket is called for).
Ignition point gap much too wide or pitted.
Breaker arm binding or sticking.
Breaker arm weak.
Weak spark, coil, or condenser.
Improper ignition timing and/or dwell.
Centrifical advance not functioning properly.
Distributor cam lobe or shaft worn.
Worn rotor or damaged distributor cap.

MECHANICAL

Incorrect valve timing.
Sticking hydraulic lifters.
Valve springs broken.
Valve springs shimmy.
Valve springs too weak to close valves promptly.

ENGINE RUNS - MISSES ERRATICALLY AT ALL SPEEDS (1)

GENERAL

Restricted exhaust.
Compression low.
Internal coolant leakage.
Engine overheating. (11)
Timing improperly set.

MECHANICAL

Compression leak at head gasket or between cylinders (This can be noted when missing occurs in two adjacent cylinders).
Intermittently sticking valves.
Broken valve spring.
Valve(s) held open slightly by faulty mechanism.

IGNITION (2)

Wrong type spark plugs.
Fouled spark plug or broken porcelain.
Faulty spark plug cables.
Low battery voltage.
Low generator voltage.
Burned or pitted ignition points.
Incorrect ignition point gap.
Faulty condenser or coil.
Weak spark or no spark in one or more cylinders.
Faulty distributor cap or rotor.
Primary circuit restricted or open intermittently.
Primary circuit detoured by short intermittently.
Secondary circuit restricted or open intermittently.
Secondary circuit detoured by short intermittently.

FUEL

Fuel pump faulty.
Needle valve in carburetor sticking.
Improper float lever. (4)
Mixture too rich or too lean.
Passage in carburetor dirty.

ENGINE RUNS - MISSES STEADILY AT ALL SPEEDS (1)

GENERAL

Worn camshaft lobes.
Compression low.
Vacuum leak in intake manifold. (9)
Dwell and timing off.
Fuel poor quality.

FUEL

Dirty jets in carburetor.
Water or dirt in fuel.
Fuel filter plugged.
Fuel pump worn or diaphragm faulty.

IGNITION (2)

Dirty or incorrectly set points.
Worn, dirty, or gap set too wide in spark plugs.
Worn distributor shaft.
Cam worn or burned distributor rotor.
Faulty coil or condenser.
Insufficient spring tension on points.

MECHANICAL

Valve train faulty.

ENGINE RUNS - BUT MISSES ON ONE CYLINDER

GENERAL

Compression leaking.
Vacuum leak at intake manifold. (9)
Timing and/or dwell improperly set.
Overheated engine. (Refer to "ENGINE OVERHEATS" in this section).
Clogged exhaust.

IGNITION (2)

Defective spark plug or spark plug wire.
Distributor cap defective.
Distributor cam worn.
Points worn or improperly aligned.

MECHANICAL

Valve train defective.
Stuck hydraulic lifter.
Defective rings or piston.

ENGINE RUNS - BUT MISSES ON DIFFERENT CYLINDERS

GENERAL

Compression leaking.
Vacuum leak at intake manifold or carburetor. (9)
Defective head gasket.
Dwell, timing off.
Poor grade fuel.
Carbon in engine.
Restricted exhaust.

FUEL

Fuel pump faulty.
Carburetor faulty.

IGNITION (2)

Spark plugs faulty.
Coil wire or distributor cap faulty.
Distributor cam worn.
Points worn or improperly set.
Distributor rotor faulty.

MECHANICAL

Faulty rings.
Faulty valve train.

ENGINE HESITATES OR STALLS DURING ACCELERATION (1) (SPITBACK THROUGH CARBURETOR)

GENERAL

Vapor lock. (11)
Carburetor icing. (5)
Restricted exhaust.
Compression low.
Intake manifold leaking (Carburetor attaching bolts loose). (9)
Partly blocked or dragging brake shoes (Refer to "Brake" chart).
Air cleaner dirty.
Engine timing.
Excessive carbon in engine.
Heavy oil in engine.
Wrong or poor grade fuel.
Excessive rolling resistance from low air in tires, applied brakes, wheel alignment, overloading etc.

IGNITION (2)

Distributor faulty.
Wiring oily or faulty.
Condenser or coil faulty.
Faulty plugs.
Vacuum advance faulty.

MECHANICAL

Accelerator pump stroke or throttle linkage improperly adjusted.
Stuck hydraulic lifters.
Intake manifold loose or leaking.
Carburetor mounting loose or leaking.
Valve train damaged or faulty.

ENGINE SURGES (1)

GENERAL

Exhaust system restricted or faulty.
Cylinder(s) not firing properly.
T.V.S. switch faulty. (1)
Vacuum leaks. (9)

IGNITION

Check out complete ignition system. (2)
Faulty spark plug wires.

FUEL (4)

Fuel pump faulty.
Faulty needle valve and seat.
Float level setting wrong.
Defective parts in carburetor.
Restrictions in fuel lines or filter.

LACK OF POWER OR HIGH SPEED PERFORMANCE

NOTE: It should be noted that the altitude of operation has a decided effect on performance. An engine adjusted for normal altitudes will lack performance at high altitudes, whereas an engine when operating normally at high altitudes may have a lean carburetor adjustment and show signs of pre-ignition when operated at sea level.

IGNITION (2)

Ignition timing or dwell incorrect.
Centrifugal governor advance not operating properly.
Vacuum advance not operating properly.
Ignition points burned, pitted, sticking, or bouncing. (Due to weak breaker arm spring).
Faulty spark plugs.
Faulty ignition cables.
Faulty ignition coil or condenser.
Worn or burned distributor rotor.
Worn distributor shaft or cam.
Poor ground.

GENERAL

Pre-ignition.
Engine overheating. (Refer to "Engine Overheats"" in this section).
Sub-standard fuel.
Overloading vehicle.
Excessive carbon in engine.
Converter defective.
Excessive rolling resistance (Dragging brakes, tight wheel bearings, underinflated tires).
Restricted exhaust.
Dirty air cleaner.
Transmission or power steering faulty.

MECHANICAL

Choke mechanism faulty.
Lack of engine compression.
Incorrect valve timing.
Inaccurate speedometer (Gives impression of lack of performance).
Valve spring weak, broken valves or valves sticking when hot.
Valve timing incorrect.
Worn camshaft lobes.
Blown cylinder head gasket.
Burned, warped or pitted valves.

ENGINE FAILS TO REACH OPERATING TEMPERATURE

GENERAL

Thermostat removed.

COOLING

Defective thermostat (stuck open).
Faulty temperature sending unit or dash unit.

ENGINE OVERHEATS

NOTE: Coolant is used to cool the engine and air is used to cool the coolant. Anything which prevents the coolant air system from working properly will cause engine to overheat. (Air, oil or grease in the coolant will reduce the ability of the coolant to absorb heat from the block and to transfer heat to the coolant in the radiator.)

GENERAL

Scale or rust deposits.
Slipping fan belt.
Low coolant. (Leaky system—internal or external.)
Pre-Ignition.
Detonation.
Excessive friction in engine or elsewhere in power transmitting units. (Brakes dragging, etc.)
Excessive back pressure in exhaust system.
Overloading vehicle.
High altitude.
Hot climate operation.
Insufficient oil in crankcase.

FUEL

Carburetor mixture too lean.

MECHANICAL

Cylinder head bolts loose.
Warped or damaged head or block.
Wrong head gasket.

IGNITION

Timing late.
Distributor advance faulty.
Valve timing off or late.

COOLING

Restricted flow of coolant. (Defective components—dirt, rust and scale.)
Leaking head gasket. (Permits air in cooling system and coolant in engine.)
Thermostat fails or wrong thermostat.
Hoses defective.
Exterior of radiator clogged with dirt, leaves, or insects.
Water pump defective or loose.
Wrong type of coolant.
Wrong fan or hydraulic fan inoperative, or defective.
Wrong pressure cap or faulty cap.
Radiator fins bent or mutilated.

SPARK KNOCK, PING, OR DETONATION

NOTE: A sharp metallic knock due to instantaneous abnormal combustion.

GENERAL

Low octane fuel.
Too high compression.
Timing advanced too far.
Heavy carbon deposits.
Manifold heat control valve faulty.
Faulty distributor advance mechanism.
Breaker point dwell (or gap) too low.

COOLING

Overheated engine. (See "Engine Overheats" in this section.)
Hot weather.
High altitude.

ENGINE CONTINUES TO RUN AFTER IGNITION IS TURNED OFF (DIESELING)

NOTE: When the engine won't stop as the ignition is turned off, the cause is often due to red hot carbon particles resting on heavy carbon deposit in a very hot engine.

GENERAL

Improper idle speed (too high). (1)
High engine temperature.
Poor grade fuel (octane too low).
Improper timing and dwell.
Quick shut-down of hot engine.

MECHANICAL

Improper valve timing.

IGNITION

Advanced timing.
Improper heat range or improperly installed spark plugs.
Electrical feed through ignition system (faulty switch).

FUEL

Carburetor too lean.
Throttle plates misaligned.

PRE-IGNITION

NOTE: Hot spot in combustion chamber ignites fuel before spark occurs. May not be noticed unless severe.

GENERAL

Overheated engine.
Carbon deposits.
Spark plugs not tight.
Spark plugs with wrong heat range.
Timing and dwell improperly set.

MECHANICAL

Leak at valve due to clearance, valve sticking, weak or broken spring.
Valve timing.

FLAT SPOT (SAG, STRETCHINESS)

NOTE: Does not respond promptly when throttle is opened quickly.

GENERAL

Poor fuel quality.
Vapor lock. (11)
Late ignition timing.

MECHANICAL

Accelerator pump linkage adjustment incorrect.

Accelerator linkage faulty or improperly adjusted.

FUEL

Low fuel pump pressure.
Accelerator pump piston or diaphragm leaks.
Accelerator pump valves leak or passages restricted.
Float level incorrect.
Defective fuel pump.
Carburetor defective or improperly set.
Fuel filter plugged.
Dirt in carburetor jets.

BACKFIRES, POPPING BACK OR SPITBACK THROUGH CARBURETOR (SUBDUED EXPLOSION IN INTAKE MANIFOLD)

GENERAL

Cold engine and choke too lean.
Loose carburetor mounting bolts. (9)
Loose intake manifold bolts. (9)
Incorrect timing and dwell.
Vacuum leaks (hoses etc.). (9)

IGNITION

Leaking distributor cap may cause backfire to occur in cylinder on intake stroke.

Two crossed spark plug wires may also cause backfire through carburetor.

FUEL

Lean mixture.
Dirt or water in fuel.
Faulty accelerator pump.

MECHANICAL

Leaky or sticky intake valve.
Weak or broken intake valve spring.
Faulty heat valve.
Plugged heat crossover passage.
Improper camshaft timing.
Improper valve lash.

AFTER-BURNING OR MUFFLER EXPLOSION (BACK FIRE)

NOTE: A subdued put-putting at the exhaust tailpipe may be due to leaky exhaust valves which permit the mixture to finish combustion in the muffler. If exhaust pipe or muffler is red hot, better let it cool, as there is some danger of setting the vehicle on fire. Most likely to occur when mixture is lean.

GENERAL

Late timing.
Burnt exhaust valve.
Air cleaner restricted.
Air leak in exhaust manifold or pipe.

MECHANICAL

Late valve timing.
Worn or broken exhaust valve spring.
Tight exhaust valve.
Choke stuck closed.

IGNITION

Intermittent open circuit in primary. (Ammeter needle swings further away from zero when generator is charging.)

Intermittent short in primary. (Ammeter swings toward zero when generator is charging.)

Short in coil or secondary coil wire.

If just a couple of explosions are heard and then no more for a time (even for days) the trouble may be due to a gradually failing condenser.

FUEL

Carburetor flooding.

SMOKE

WHITE

Condensing water vapor which is a normal product of combustion—no problem— usually seen on cold days.

BLACK

Excessively rich fuel mixture.
(See "Excessive Fuel Comsumption".)

BLUE

(Or Bluish White)

Excessive oil consumption
(See "Excessive Oil Consumption")

EXCESSIVE FUEL CONSUMPTION (1)

GENERAL

"Jack Rabbit" starts.
High speed.
Short drives.
Restricted Choke (partly closed).
Clogged air cleaner.
Loss of compression.
Excessive rolling resistance from low tires, dragging brakes, wheel misalignment, etc.
Restricted exhaust.
Engine overheating.
Crankcase ventilating system faulty.
Trailer towing.
Worn-out or badly tuned engine.

IGNITION

Faulty ignition system.

FUEL

Excessive fuel pump pressure.
Float level high. (4)
Faulty carburetor.
Leakage or loose fittings.
Idle speed settings incorrect.
Accelerator pump improperly adjusted.

MECHANICAL

Faulty valves or valve train.
Faulty rings.
Choke mechanism binding or improperly adjusted.
Accelerator linkage binding or improperly adjusted.
Fuel tank cap missing.

LOW OIL PRESSURE

GENERAL

Low oil level.
Clogged oil filter.
Thin or diluted oil (frequent stops in cold weather).
Viscosity (too light grade).
Oil has foam from water (condensation or leaking head gasket).
Overheating.

MECHANICAL

Faulty pressure sending unit, line, or gauge.
Worn oil pump.
Excessive bearing clearance.
Oil pump relief valve dirty, worn, spring weak or worn.
Oil pump suction tube loose or cracked.
Screen clogged (ice, gummy, sludge or dirt).
Air leak in oil pump (loose cover or too thick gasket).
Loose connections in oil lines.

HIGH OIL PRESSURE

GENERAL

Oil too heavy (viscosity).
Main oil passage on pressure side of pump clogged.

MECHANICAL

Faulty gauge.
Oil pressure relief valve adjustment too heavy.
Relief valve spring too stiff.
Oil pressure passage clogged.

NO OIL PRESSURE WHILE IDLING

GENERAL

Faulty oil gauge sending unit.
Leakage at internal oil passage.

MECHANICAL

Oil pump not functioning properly. (Valve stuck by foreign material.)
Excessive clearance at bearings (camshaft, rod or main).

NO OIL PRESSURE WHILE ACCELERATING

GENERAL

Low oil level in oil pan.

MECHANICAL

Leakage at internal oil passages.

NO OIL PRESSURE

GENERAL

Suction loss.
Oil pressure gauge faulty.
Not enough oil in pan.
Pipe to oil pressure gauge stopped up.
Oil passage on discharge side of pump stopped up.
Oil screen or passages on intake side of pump stopped up.

MECHANICAL

Oil pump inoperative.
Relief valve stuck open.

BURNED, STICKING OR BROKEN VALVES

GENERAL

Over-speeding engine.
Deposits on valve seats and/or gum formation on stems or guides.
Warped valves or faulty valve forgings.
Exhaust back pressure.
Improper ignition timing.

MECHANICAL

Weak valve springs.
Improper valve clearance.
Improper valve guide clearance and/or worn valve guides.
Out-of-round valve seats or incorrect valve seat width.

EXCESSIVE OIL CONSUMPTION

NOTE: Check the PCV valve for proper operation before checking causes of leak. A clogged crankcase vent valve can build up pressure in the crankcase which will cause seals and gaskets to leak.

EXTERNAL LEAKAGE

Oil pan drain plug loose or gasket missing.

Crack or hole in oil pan.

Oil pan gasket leaks due to:
(a) Loose screws; (b) Damaged gasket;
(c) Improperly installed gasket;
(d) Bent oil pan flange.

Oil pan gasket leaks due to:
(a) Loose screws; (b) Damaged gasket;
(c) Improperly installed gasket:
(d) Bent oil pan flange.

Timing case cover gasket leaks due to:
(a) Loose screws; (b) Damaged gasket;
(c) Improperly installed gasket;
(d) Bent cover flange;

Front crankshaft oil seal leaks due to:
(a) Worn oil seal; (b) Seal not properly installed; (c) Rough surface on crankshaft, or fan pulley or damper;
(d) Damper or pulley loose; (e) Seal or cover not centered on crankshaft; (f) Oil return passage to crankcase clogged up.

Rear main bearing oil seal leaks due to:
(a) Worn oil seal; (b) Improper oil seal installation; (c) Worn rear main bearing;
(d) Rough crankshaft. Oil passage to crankcase clogged.

Expansion plug in block at rear of camshaft leaks due to poor fit, careless installation, or corrosion.

Leakage at any external piping.

Plugs at ends of oil passages in cylinder block leak.

Oil filter leaks.

Leakage at distributor housing.

Valve cover leaks due to loose screws, defective gasket, improperly installed gasket or bent cover flange.

Rocker arm cover or push rod cover leaks due to loose screws, defective gasket, improper gasket installation or bent cover flange.

Pipe connections loose on oil gauge or oil filter lines.

Improperly seated or broken fuel pump gasket.

Broken push rod cover gasket, oil filter gasket, or timing chain cover gasket.

Worn timing chain cover oil seal.

Worn or improperly seated rear main bearing oil seal.

Loose oil line plugs.

Rear camshaft bearing drain hole plugged.

Loose rocker arm cover, gasket broken, or cover distorted or bent.

Rear main bearing side seal improperly installed.

INTERNAL LEAKAGE

Carbon in oil ring slot.

Rings fitted too tight in grooves.

Leaky piston rings due to wear, scuffs or broken.

Leaky piston rings due to sticking caused by gummy deposit. Try to free up with suitable solvent poured in fuel tank, Blue smoke at tail pipe indicates badly leaking rings.

Worn pistons and cylinders.

Cylinder block distorted by tightening cylinder head bolts unevenly.

Excessive clearance between intake valve stems and guides allows oil mist to be sucked into cylinders.

Worn main or rod bearings allow excessive leakage from bearings.

Result in cylinder walls are flooded with oil.

Oil pressure too high due to faulty action of oil pressure relief valve, or clogged relief passage.

If pressure lubricated, loose piston pins may permit excessive leakage to cylinder walls.

Grade of oil used is too light. A poor quality oil may become far too thin when engine is hot. Hard driving on hot days will also consume more oil.

Clogged crankcase ventilator system.

Intake valve seals damaged or missing.

Plugged drain back holes in head.

Intake manifold gasket leak in conjunction with rocker cover gasket leak.

Ring grooves or oil return slots clogged.

Rings sticking in ring grooves of piston.

Ring grooves worn excessively in piston.

Compression rings installed upside down.

Excessively worn or scored cylinder walls.

Cylinder walls not properly honed or finished.

Oil too thin (diluted).

Oil level too high.

Excessive main or connecting rod bearing clearance.

Piston ring gaps not staggered.

Incorrect size rings installed.

Piston rings out-of-round, broken or scored.

Insufficient piston ring tension due to engine overheating.

ENGINE NOISY

NOTE: When diagnosing engine noise problems, be careful that noises caused by accessories are not mistaken for engine noises. Removal of accessory drive belts will eliminate any noises caused by these units.

In general, engine noises are either synchronized to engine speed or one-half engine speed. Those that are timed to engine speed are sounds that have to do with the crankshaft, rods, pistons, and wrist pins. The sounds emitted at one-half engine speed are valve train noises.

The use of a stethoscope will often aid in locating an engine noise. Caution must be exercised, however, because noise will travel to other metal parts not involved in the problem. A timing light will aid in determining if the noise is synchronized with engine speed or at one-half engine speed.

Engine noise sometimes may be isolated by grounding the spark plug leads one at a time. If the noise lessens appreciably or disappears, it is confined to that particular cylinder.

No definite rule or test can be listed that will positively determine the source of a noise complaint.

Fuel pumps, distributors, flywheels, water pumps, drive belts, or carbon built up in the combustion chamber may contribute to noisy engine operation. The following information can therefore, be used only as a general guide to noise diagnosis. There is no substitute for experience.

A. NOISY MAIN BEARINGS

NOTE: A loose main bearing is indicated by a powerful, but dull, thud or knock when the engine is pulling. If all main bearings are loose a noticeable clatter will be audible.

The thud occurs regularly every other revolution. The noise is loudest when the engine is "lugging" or under heavy load. The sound is heavier and duller than a connecting rod noise. Low oil pressure also accompanies this condition. The knock can be confirmed by shorting spark plugs on cylinders adjacent to the bearing. Knock will disappear or be less when plugs are shorted. This test should be made at a fast idle equivalent to 15 mph. If bearing is not quite loose enough to produce a knock if oil is too thin or if there is no oil at the bearing.

Regular noise: worn main bearings; irregular; worn end-thrust bearings.

GENERAL

Insufficient oil supply.
Low oil pump pressure.
Thin or diluted oil.

MECHANICAL

Excessive bearing clearance.
Excessive crankshaft end play.
Eccentric or out-of-round crankshaft journals.
Sprung crankshaft.
Excessive belt tension.
Loose harmonic balancer.
Loose flywheel or torque converter.

IMPORTANT: Crankshaft End Play - Intermittent rap or knock that is sharper than a loose main bearing. Repeated disengagements of the transmission may cause a change in the rap.

B. NOISY ROD BEARINGS

NOTE: Rods with excessive clearance knock under all speeds and under both idle and load conditions. At the early stage of looseness, rod noise may easily be confused with piston slap or loose pins. Rod knock noise increases in intensity with engine speed. Low oil pressure also accompanies this condition.

GENERAL

Excessive bearing clearance.
Worn crankpin.
Lack of oil (thin or diluted).
Low oil pressure.
Journals out-of-round.
(A metallic knock which is usually loudest at about 30 mph with throttle closed. Knock can be reduced or even eliminated by shorting spark plug. If bearing is not loose enough to produce a knock by itself, the bearing may knock if oil is too thin or if there is no oil at the bearing.)

MECHANICAL

Misaligned rod.
Connecting rod bolts not tightened correctly. (Should connecting rod misalignment be suspected, check for a diagonal wear pattern on the piston skirt, and for excessive wear on the opposite edges of the connecting rod bearings.)

IMPORTANT: Automatic transmission coupling noise caused by loose transmission-to- engine bolts sounds like rod bearing noise.

C. NOISY TIMING GEARS

NOTE: A high frequency light knock difficult to isolate without a sound detecting device. It is about the same intensity whether the engine is idling or at high speeds or under load.

GENERAL

Gears misaligned.
Excessive backlash.
Chipped tooth—usually camshaft gear.

MECHANICAL

Gears loose on hubs or shafts.
Eccentric gear, usually due to high keys.
Teeth meshed too tight (new oversize gear).
Too much end play in camshaft or crankshaft.
Front camshaft bearing clearance excessive.

D. NOISY TIMING CHAIN

GENERAL

Chain loose due to wear.
Sprocket teeth worn.
Sprockets misaligned.
Loose vibration damper or drive pulley.

MECHANICAL

Sprocket loose on hubs or shaft.
Front camshaft bearing clearance excessive.
Front main bearing clearance excessive.

E. NOISY PISTONS

NOTE: Piston pin, piston and connecting rod noises are difficult to tell apart. A loose piston pin causes a sharp double knock which is usually heard when engine is idling. Severity of knock should increase when spark plug to this cylinder is short-circuited. However, on some engines the knock becomes more noticeable at 25 to 35 mph on the rod.

GENERAL

Worn or loose piston pin or bushing.

Improper fit of pin.

(Listen for a light ticking or tapping noise. More noticeable with no load on engine. May disappear completely under load. Generally piston pin noise can be noticed on deceleration of the engine.)

Piston-to-cylinder bore clearance excessive.

(Sounds very similar to tappet or lifter noise. Removing one spark plug wire at a time may be helpful in determining which cylinder is noisy. One indication of piston slap is a decrease in noise as the engine warms up. Piston slap is always louder when the engine is cold. Retard timing slightly, noise should decrease.)

Lack of lubrication.

Carbon deposits on top of piston strikes cylinder head.

Worn or broken piston ring land. (Most noticeable during acceleration.)

Broken or cracked piston.

Engine overheating.

Fuel of too low octane rating.

Operating without air cleaner.

MECHANICAL

Excessive rod bearing clearance.

Misaligned connecting rods.

Worn rings, cylinder walls, low ring tension, broken rings, out-of-round or tapered bores.

Top of piston strikes ridge at top of cylinder bore.

Piston rubs against cylinder head gasket.

Excessive side clearance of rings in groove, clearance between ring and groove and/or ring gap.

Undersize pistons installed.

Wrong type and/or size rings installed.

Cylinder bores tapered or eccentric.

Pins improperly assembled.

Insufficient ring gap clearance.

Pistons 180° out of position.

F. NOISY VALVE MECHANISM

GENERAL

Sticking or warped valves.

Bent push rods.

Dirty, worn, or scored parts.

Broken or weak springs.

Damaged valve lifter and/or camshaft lobes.

Insufficient or poor oil to valve mechanism. (Thin, foaming, or diluted.)

Excessive valve stem-to-guide clearance.

Valve lifter incorrectly fitted to bore size.

Pulled or loose rocker arm bolts.

MECHANICAL

Hydraulic lifter not working properly or faulty. (Faulty lifter can usually be located with the aid of a stethoscope.)

Hydraulic lifter :ıpumped up" from excessive speed—temporary noise.

G. NOISY WATER PUMP

NOTE: Listen for a ratchety or grinding sound which increases with engine rpm. In the early stages, the grinding noise may disappear at higher engine rpm. Disconnect the fan belt, and run engine. If noise disappears, trouble most likely is the water pump bearing. Bearing failure or start of failure can be detected by grasping the water pump pulley with both hands and moving it in a sidewise motion. If sloppiness is present, the bearing is unserviceable.

GENERAL

Rough bearing.
Pump seal too hard.

MECHANICAL

Shaft pulley loose.
Impeller loose on shaft.
Too much end play in pump shaft.
Too much clearance between shaft and bearings.
Impeller blades rubbing against pump housing.
Impeller pin sheared off.
Impeller broken.

H. NOISY GENERATOR
(Refer to Generator Diagnosis Charts)

GENERAL

Brush squeal.
Bearings.
Faulty diode or stator.

MECHANICAL

Loose mounts.
Belt too tight.

I. NOISY FAN

GENERAL

Fan blades bent.
Fan out-of-balance when made.
Fan shaft end play excessive.

MECHANICAL

Fan blades loose on clutch.
Fan blades strike shroud.

J. NOISY FUEL PUMP

NOTE: Diagnosis of fuel pumps suspected as noisy, requires that some form of sounding device be used. Judgment by ear alone is not sufficient, otherwise a fuel pump may be needlessly replaced in attempting to correct noise contributed by some other component. Use of a stethoscope, a long screwdriver, or a sounding rod is recommended to locate the area or component causing the noise. The sounding rod can easily be made from a length of copper tubing 1/4 to 3/16 inch in diameter. Dowel rods are also good.

If the noise has been isolated to the fuel pump, remove the pump and run the engine with the fuel remaining in the carburetor bowl. If the noise level does not change, the source of the noise is elsewhere and the original fuel pump should be reinstalled.

K. NOISY FAN BELT

GENERAL

Belt worn or burned.
Wrong belt. Does not fit pulley grooves properly.
Belt or pulley dirty or sticky with gummy oil.
Pulley bent, cracked or broken.

MECHANICAL

Belt too tight. Squeaks.
Belt pulleys misaligned.
Belt loose; squeaks when engine is accelerated.

L. MISCELLANEOUS NOISE

(Rattles, squeaks, etc., from loosely mounted accessories; generator, horn, oil pan, etc.)

LOOSE FLYWHEEL

A thud or click which is usually irregular. To test, idle the engine at about 20 mph and shut off the ignition. If thud is heard, the flywheel may be loose.

EXCESSIVE CRANKSHAFT END PLAY

A rather sharp rap which occurs at idling speed but may be heard at higher speeds also.

FAN SHROUD

Loose shroud or radiator.

ENGINE VIBRATION

Unequal compression in cylinders.
Missing at high speed.
Unbalances fan or loose fan blade.
Incorrect adjustment of engine mounts, or damaged mounts.
Loose engine mounts.
Engine support loose on frame or cylinder block.
Unbalanced or sprung crankshaft.
Excessive engine friction due to tight piston etc.
Defective vibration damper.

LOOSE ENGINE MOUNTINGS

Occasional thud with vehicle in operation. Most likely to be noticed at the moment the throttle is opened or closed.

M. PRE-IGNITION OR SPARK KNOCK

(Most noticable under heavy acceleration)

GENERAL

Low octance fuel being used.
Muffler or exhaust passage restricted.
Excessive carbon deposit in combustion chamber.
Hot spot in head—possibly caused by foreign matter clogging small water passages between head and block.
Engine lugging—produces unbalanced heat.
Compression too high for octane rating of fuel being used.
Overheated spark plug due to being too "hot" for the application, not seated properly, or not torqued to specifications.

IGNITION

Faulty ignition system or timing advance beyond specifications.
Dwell angle (or gap) too low.

FUEL

Carburetor mixture lean.
Operating with standard specifications at high altitudes allowing rich fuel mixture.

GENERAL ENGINE CHECKS

1. EMISSION CONTROL CHECK

To diagnose Emission Control Systems, refer to "Emission Control Charts" in this manual.

2. BATTERY CHECK

The battery must be fully charged before proceeding with engine diagnosis. When the battery has a low charge, determine and repair the cause of the low charge before proceeding with further diagnosis. Refer to "Battery Diagnosis Charts" in this manual.

3. CHOKE CHECK

Freedom of operation may be checked by holding the throttle in the open position and manually operating the automatic choke linkage. When possible, choke linkage should be checked on a cold carburetor. Refer to "Carburetor Diagnosis Charts" in this manual.

4. FLOODING CHECK

Flooding occurs when an excessive amount of fuel enters the cylinders and prevents ignition. If flooding is suspected, look for wet throttle plates, external leakage around the throttle plate shaft, external leakage at the bowl gasket and/or wet spark plugs. If the engine is running, a flooding condition will be indicated by a rough engine idle, poor acceleration, and heavy, black smoke from the exhaust system. Flooding is usually caused by improper operation of the carburetor fuel inlet system or a high float level setting. Additional causes are listed in "-Carburetor Diagnostic Procedures" in this manual.

5. CARBURETOR ICING CHECK

Carburetor icing generally occurs when ambient temperatures range from 30°F. to 50°F. (-1.1°C. to 10°C.), and the relative humidity is above 60%. Moisture from in-rushing air collects and freezes between the throttle plates and the throttle base, cutting off the air supply to the engine, and stalling the engine.

If icing occurs after the engine is at normal operating temperature, allow the engine to stand for a short period of time. The carburetor casting will absorb enough heat from the engine to thaw the ice. If the icing occurs while the engine is still cold, the ice may be melted by pouring a small amount of anti-icing additive directly into the carburetor. Neither of the above procedures will prevent a recurrence of the icing condition.

The most effective way to prevent icing is to add an anti-icing additive to the fuel.

6. SPARK INTENSITY CHECK

Disconnect a spark plug wire and install a terminal adapter in the terminal of the wire to be checked. Hold the adapter approximately 1/8" away from the exhaust manifold and crank the engine. The spark should jump the gap regularly and be blue in color. A good spark indicates that the ignition primary and secondary circuits are functioning properly. A weak spark (usually a pale orange color) or an intermittant spark indicates trouble within the primary and/or secondary ignition circuits.

7. HARD STARTING ENGINE CHECK

The problem of an engine that cranks normally but starts hard when cold can usually be traced to an excessively lean fuel mixture. Excessively lean fuel mixtures are usually caused by an improper choke setting or as insufficient amount of fuel being delivered to the cylinders.

If the engine starts OK cold, but is hard to start when hot, the problem may be due to an excessive amount of fuel being discharged through the carburetor. A hot engine hard start or no start condition may also be due to the coil breaking down after it becomes heated. Hard starting occurring only after a hot engine has been shut down for a few minutes, indicates carburetor percolation or vapor lock which causes a rich fuel condition. Refer to "Carburetor Diagnosis Charts" in this manual, for individual fuel problems. (Corroded or loosened terminal could be the cause.)

If the engine starts hard regardless of whether it is hot or cold, the problem can usually be traced to engine compression, fuel system, or ignition system. Refer to "Ignition System" or "Fuel System Diagnosis" charts in this manual for ignition and/or fuel problems.

8. ACCELERATING PUMP DISCHARGE CHECK

Remove the air cleaner and manually operate the throttle linkage while observing the fuel discharge from the accelerator pump nozzles. When the throttle plates are opened, a quick steady stream of fuel should be discharged into the carburetor. Failure of the accelerator pump to discharge a sufficient amount of fuel usually indicates a problem in the fuel delivery system between the supply tank and the carburetor. Refer to "Fuel Pump and/or Carburetor Diagnosis" charts in this manual. Insufficient fuel discharge, however, may also be due to the operation of the accelerator pump circuit within the carburetor.

9. VACUUM LEAKAGE CHECK

With the engine at idle speed, squirt a mixture of kerosene and 10W motor oil around areas where vacuum leakage may occur. A noticeable change in the engine idle when the mixture is squirted on a given point indicates a vacuum leak at that point.

CAUTION: *Kerosene and oil mixture is flammable. Careless application may result in fire. DO NOT use gasoline.*

10. EXCESSIVE FUEL CONSUMPTION CHECK

There are a number of factors, other than engine or carburetor problems, that will contribute to excessive fuel consumption. One of the most important of these is the driving habits of the operator.

When the operator habitually makes "jack-rabbit" starts and stops, "rides" the brake pedal, overloads the vehicle, drives at excessively high speeds for prolonged periods, fails to hold a consistent throttle position. (continuously accelerates, then coasts) and/or operates the vehicle under short run conditions (cold engine) the majority of the time, this could be the problem.

Vehicle air resistance at high speeds has a major affect on fuel consumption. Head winds, excessively high speeds, or added protrusions to the vehicle profile will cause an increase in fuel consumption.

When it has been determined that the operator is not at fault, make a fuel consumption test using a calibrated fuel measuring device. The amount of fuel used to drive the vehicle a measured distance should be recorded. Then record the amount of fuel used to return to the starting point. An average of the two readings should be used in determining the existence of a fuel consumption problem. While making the fuel consumption test, the vehicle odometer should be checked over a measured mile for proper calibration.

If the results of the fuel consumption test indicate that a fuel consumption problem does exist, the diagnostic procedures outlined in this manual under "Excessive Fuel Consumption in Carburetor" and/or "Ignition Diagnosis" charts should be followed.

11. VAPOR LOCK CHECK

The term "vapor lock" means the flow of fuel to the mixing chamber in the carburetor has been stopped (locked) by the formation of vaporized fuel pockets or bubbles caused by overheating the fuel by hot fuel pump, hot fuel lines or hot carburetor.

The more volatile the fuel the greater the tendency for it to vapor lock. Vapor lock is encouraged by high atmospheric temperature, hard driving, defective engine cooling and high altitude.

A mild case of vapor lock will cause missing and hard starting when engine is warm; also a "sag" during an acceleration or surge during cruise. Somewhat more severe vapor lock will stop the engine which cannot be started again until it has cooled off enough so that any vaporized fuel has condensed to a liquid.

IMPORTANT: Percolation means simply that gasoline in the carburetor bowl is boiling over into the intake manifold. This condition is most apt to occur immediately after a hot engine is shut off. The carburetor has provision for relieving the vapor pressure of overheated fuel in the carburetor bowl by means of internal vents. If, however, percolation should take place, the engine may be started by allowing it to cool slightly and then holding the throttle wide open while cranking to clear the intake manifold of excess fuel.

Some causes of vapor lock may be due to winter grade fuel used in summer (most vapor lock occurs in April due to this), or temperature under hood is too high.

NOTE: Applying wet cloths to fuel lines, fuel pump and/or carburetor can cause fuel to condense and permit engine to run.

IN-VEHICLE SERVICE OPERATIONS

ENGINE OIL PRESSURE TEST (FIGURE 3)

1. Remove oil pressure warning light switch from the left front of the engine.

2. Install oil pressure gauge in hole.

3. Set parking brake. Put transmission selector in "N", neutral position.

4. Start engine and run until normal operating temperature is obtained.

5. Oil pressure should be at idle - 7psi min. 1500-3000 rpm - 35psi min.

OIL FILTER (FIGURE 4)

REMOVAL

1. Hoist vehicle.

2. Remove oil filter.

3. Loosen oil cooler line clamp bolt. See Figure 2.

4. Loosen oil cooler line fittings from the adapter and slide lines forward approximately one inch.

5. Remove oil filter extension fitting and adaptor.

6. Remove three (3) bolts securing base to engine block.

7. Remove filter base and gasket.

INSTALLATION

1. Install gasket and filter base to engine block. Torque bolts to 35 ft. lbs.

2. Install adaptor and oil filter extension fitting to 55 ft. lbs.

3. Reposition oil cooler lines and attach to adaptor.

4. Torque cooler line clamp bolt to 9 ft. lbs.

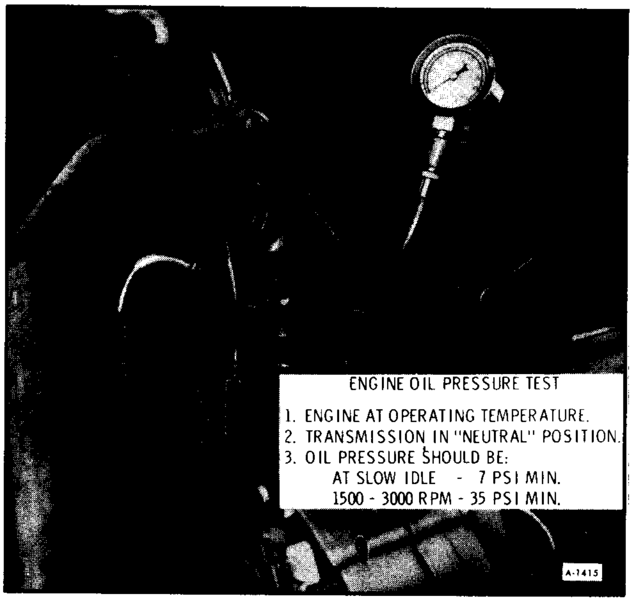


Figure 3—Checking Engine Oil Pressure

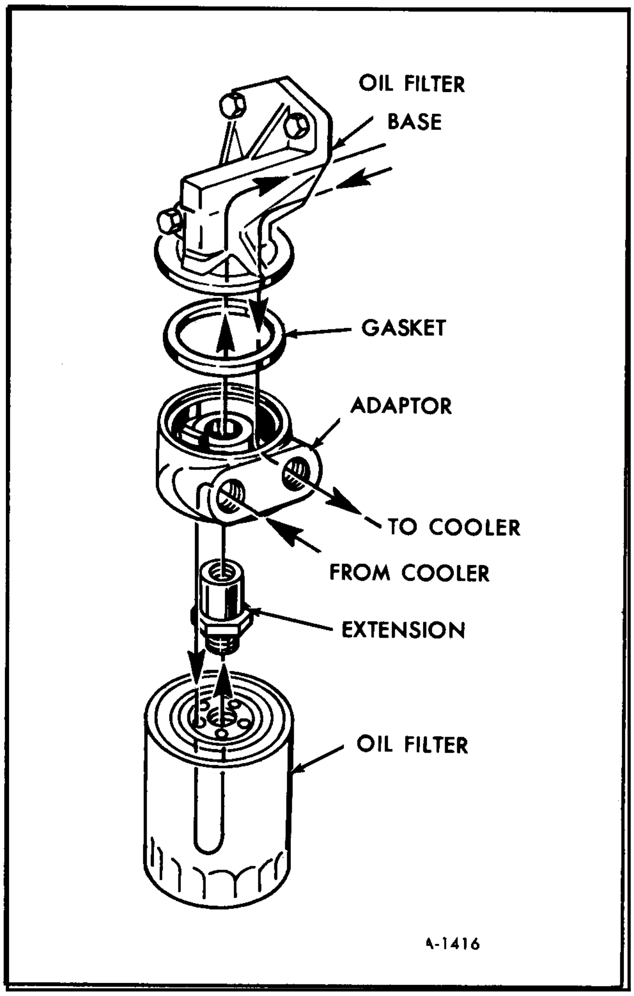


Figure 4—Oil Filter

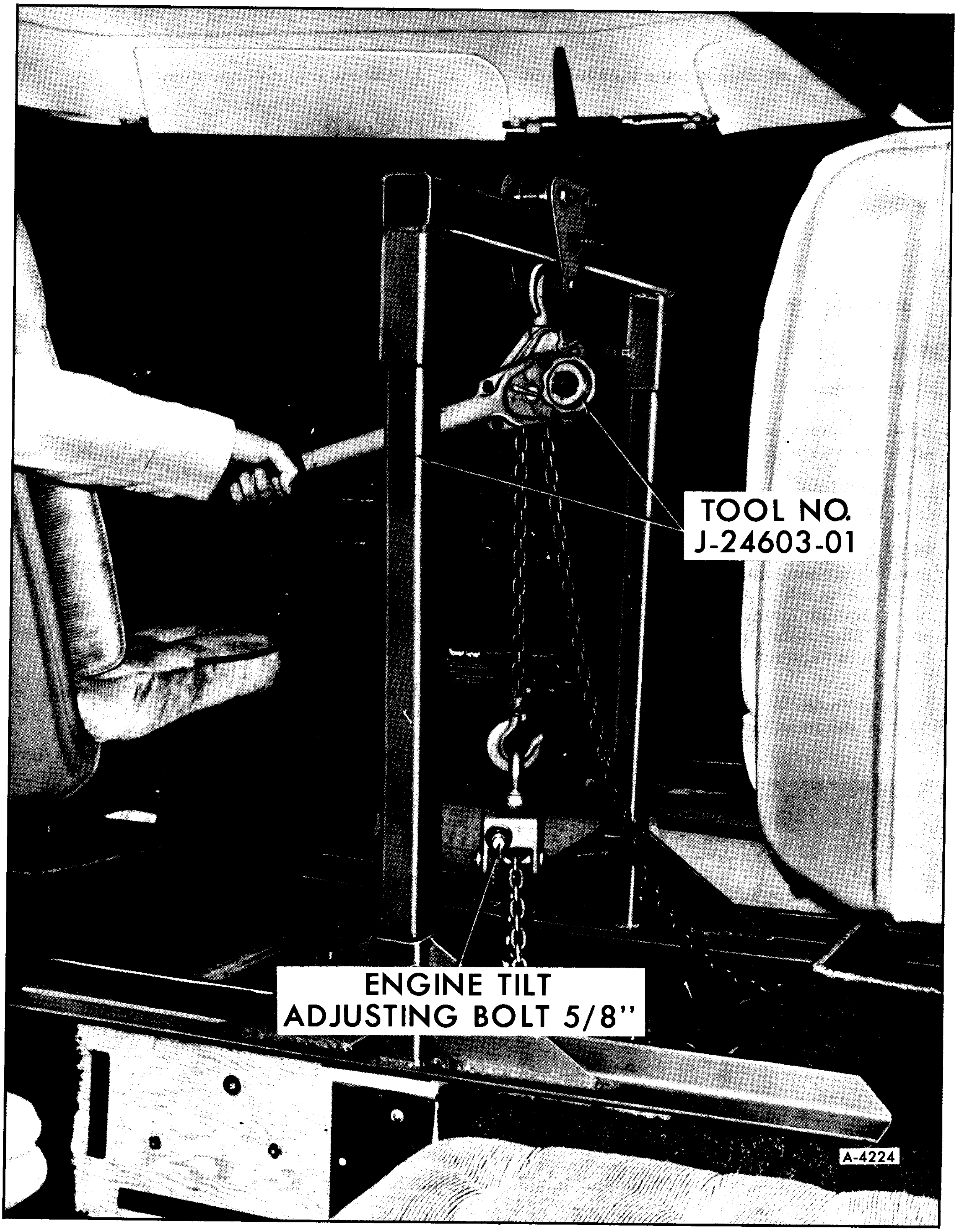


Figure 5—Attaching Engine Removal Tool

5. Apply a film of engine oil to the filter gasket and install torque by tightening 2/3 turn after gasket contacts adaptor.

NOTE: If a new oil filter is being installed, add one quart of oil.

6. Start engine, check for possible leaks. Stop engine and after several minutes check for proper engine oil level.

FRONT ENGINE MOUNTS

REMOVAL

1. Disconnect coil bracket from engine.

NOTE: There is no coil bracket on engines equipped with high energy ignition systems.

2. Attach engine lift Tool No. J-24603-01 as shown in Figure 5.

NOTE: To properly position engine removal tool, remove seat belt plate and anchor bolt assembly. Attach load adjuster chain to front and rear engine lift locations as shown in Figures 6 and 7. Then install support braces and winch hoise as in Figure 5.

3. Remove bolts "A" and "B". Remove nuts "C" and "D" as shown in Figure 6.

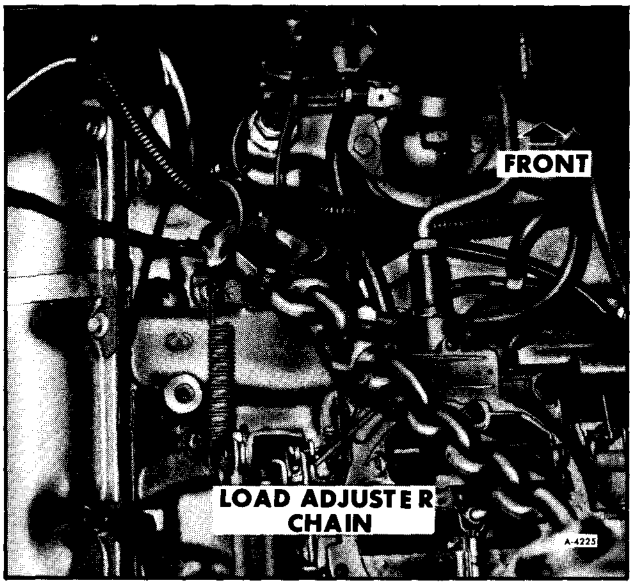


Figure 6—Front Engine Lift Location

4. Adjust tool No. J-24603-01 so that the front of the egine is raised just enough to enable removal of support cushion.

5. Remove engine support cushion.

INSTALLATION

1. Install new studs into engine support cushion and torque to 30 ft. lbs.

2. Install engine support cushion into place.

3. Lower engine making sure holes in engine support line up with holes in engine support cushion.

4. Install bolts "A" and "B" and torque nuts to 45 ft. lbs.

5. Install nuts "C" and "D" and torque to 30 ft. lbs.

6. Remove tool No. J-24603-01, connect coil bracket to engine. Install air cleaner and engine cover.

REAR ENGINE MOUNTS

REMOVAL

1. Disconnect coil bracket from engine.

2. Attach engine lift tool No. J-24603-01 as shown in Figure 5.

3. Remove bolts "A", "B" and "C" on both sides of the engine/transmission rear support (See figure 7).

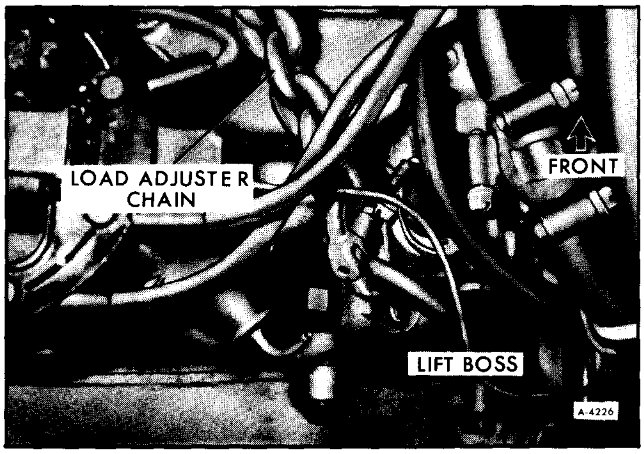


Figure 7—Rear Engine Lift Location

4. Adjust tool No. J-24603-01 so that the rear of the transmission is raised and there is enough clearance to remove the engine restrictor and transmission mount.

INSTALLATION

1. Install engine restrictor and transmission mount.

2. Lower engine.

3. Install all bolts and nuts finger tight to insure proper alignment.

4. Torque bolts "A" and "B" to 50 ft. lbs. Torque bolt "C" to 55 ft. lbs.

IMPORTANT: In late model vehicles, placement of the transmission mount is the reverse shown in Figure 9. Tab fits into the opposite slot. Observe placement of mount before removal and assemble mount with tab positioned as required by hole pattern.

5. Remove tool No. J-24603-01, connect coil bracket replace air cleaner, install engine cover.

INTAKE MANIFOLD

REMOVAL

1. Disconnect battery negative cables from both batteries.

2. Remove air cleaner assembly.

3. Drain radiator, then disconnect upper radiator hose and thermostat by-pass hose from water outlet. Disconnect heater hose at rear of manifold.

4. Remove both upper venturi ring braces on vehicles with air conditioning as shown on Figure 10. Vehicles without air conditioning require removal of L.H. upper venturi ring only.

NOTE: Generator bracket removal is not required, however, generator mounting is shown in Figure 11.

5. Remove air conditioning compressor bracket (if so equipped). See Figure 12.

6. Remove engine oil filler lower tube and flexible elbow.

7. Disconnect temperature gauge wire.

8. Disconnect throttle cable, and cruise control rod (if equipped) from carburetor throttle lever. (See figure 13). Remove cruise control rod.

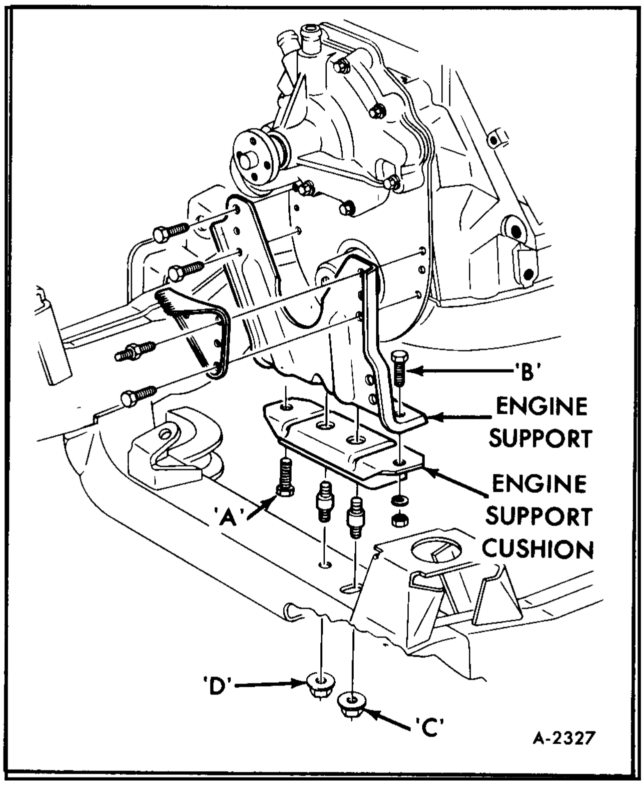


Figure 8—Front Engine Mounting

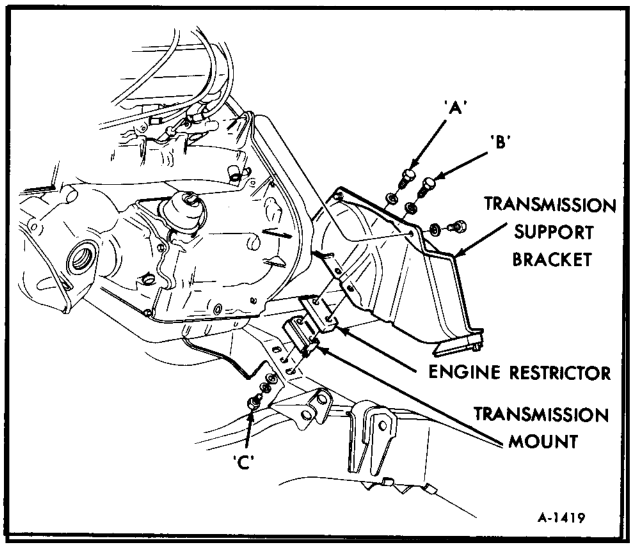


Figure 9—Rear Engine Mounting

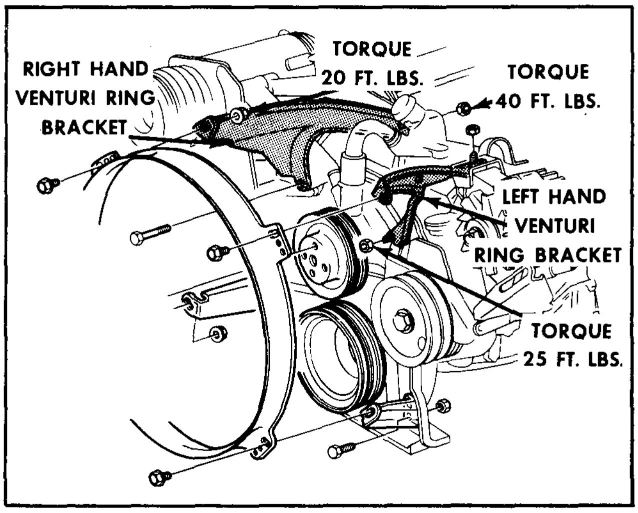


Figure 10—Upper Venturi Ring Brackets

9. Remove fuel line from fuel pump to carburetor.

10. Disconnect vacuum lines from the distributor and tee as shown in Figure 14. Disconnect vacuum line from the front of the carburetor which leads to the carbon canister. Referring to Figure 13, disconnect from the intake manifold—vacuum lines to the brake booster (B), heater control (C) and cruise control (A) (if so equipped).

11. Pull PCV valve from grommet in the right valve cover.

12. Disconnect spark plug cables that lead to cylinders No. 2, 4, 6 and 8 all on the right side, from the spark plugs. Disconnect distributor cap and carefully position cap and cables to the left and free of the work area.

13. Remove coil mounting bolts, if so equipped. Wires may be left connected to the coil if desired.

14. Remove intake manifold bolts, then remove manifold with carburetor attached.

15. Clean machined surfaces of cylinder head and intake manifold with a putty knife. Use care not to gouge or scratch machined surfaces.

INSTALLATION

1. Coat both sides of gasket sealing surface that seal the intake manifold to the head with 1050026 sealer or equivalent and position intake manifold gasket. (See figure 15).

2. Install front and rear end seals, making sure that ends are positioned under cylinder heads as shown in Figures 15 and 16.

3. Install intake manifold. Lubricate bolts entirely with engine oil, install and torque to 15 ft. lbs. in sequence. See Figure 17. Retorque in sequence to 40 ft. lbs.

4. Install coil mounting bolt, if so equipped, and torque to 15 ft. lbs.

5. Install distributor cap and secure. Connect spark plug cables 2, 4, 6 and 8 on the spark plugs.

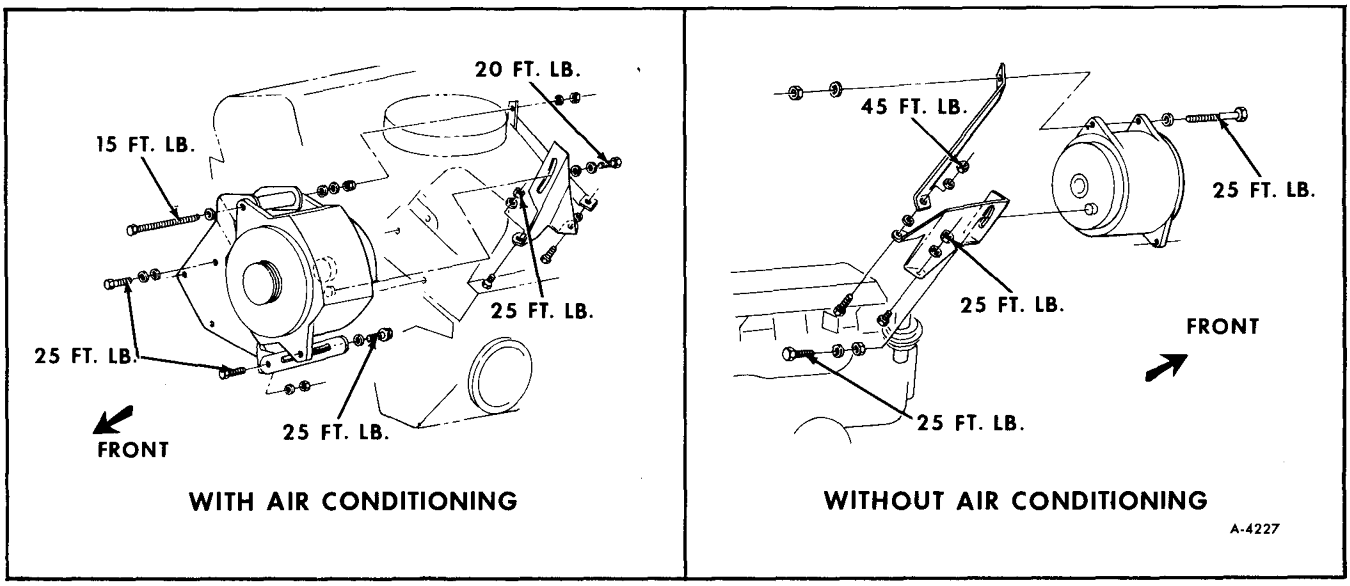


Figure 11—Generator Mounting

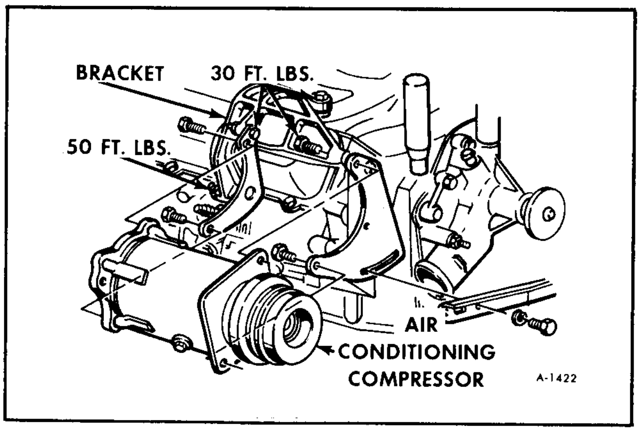


Figure 12—Air Conditioning Compressor Mounting

6. Install PCV valve into grommet on R.H. valve cover.

7. Connect vacuum lines to the distributor and tee as shown in Figure 14. Connect vacuum line to front of carburetor (from the carbon canister). Connect to the intake manifold vacuum lines, to the brake booster, heater control and cruise control (if equipped). See Figure 13.

8. Connect throttle cable, and cruise control (if equipped). See Figure 13.

9. Install fuel line.

10. Connect temperature gauge wire.

11. Install air conditioning bracket (if equipped). See Figure 12.

12. Install oil fill tube and flexible elbow.

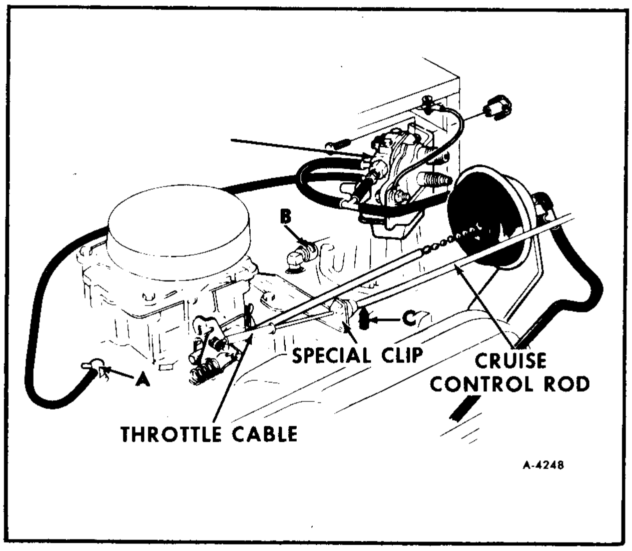


Figure 13—Location for Disconnecting Vacuum Hoses and Throttle Cable

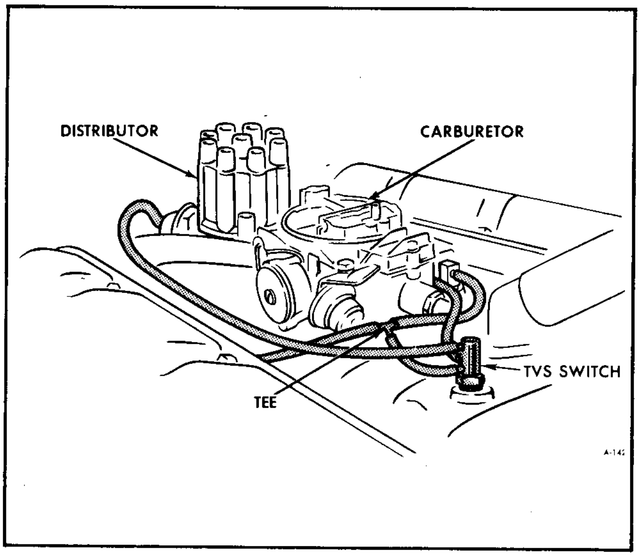


Figure 14—Distributor and Transmission Vacuum Lines (Typical)

13. Install generator mounting bracket, if removed. See Figure 11.

14. Adjust belt tension. Refer to "Belt Tension" later in this section.

15. Install venturi ring brace(s). See Figure 10.

16. Connect upper radiator hose, thermostat and by-pass hose to the water outlet. Connect heater hose at rear of manifold.

17. Install air cleaner.

18. Connect battery negative cables to the batteries.

19. Fill radiator. Start engine and check for leaks.

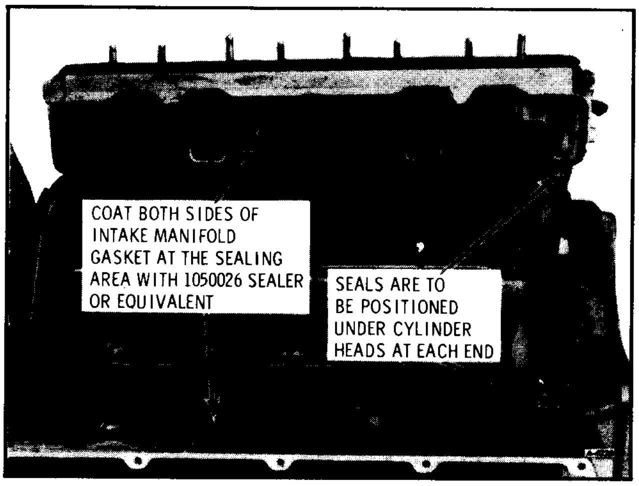
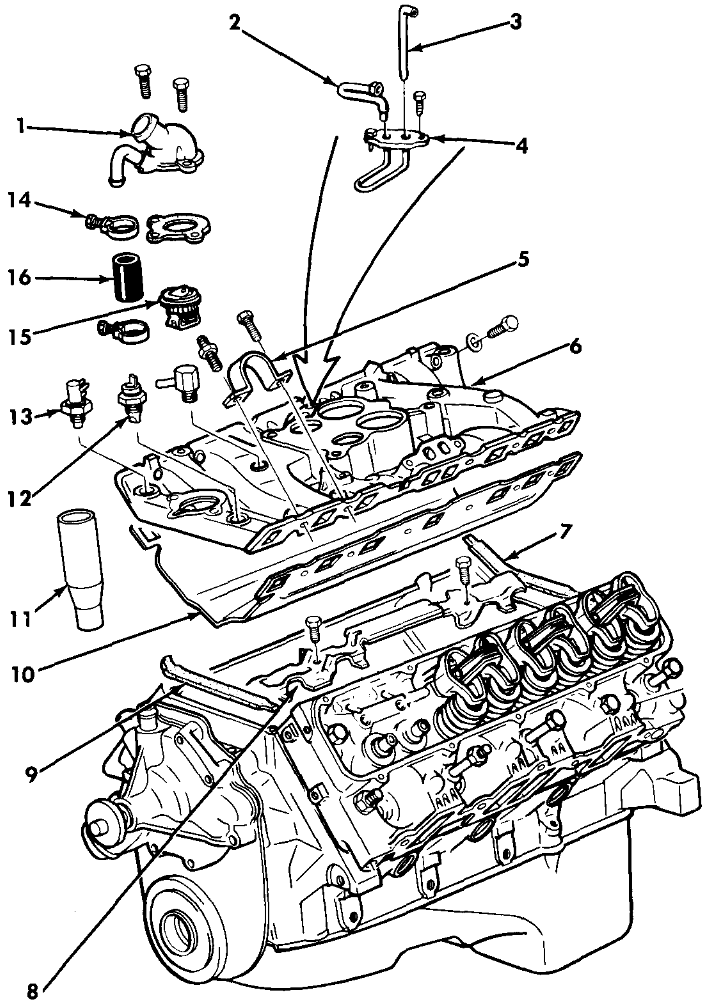


Figure 15—Intake Manifold Gasket



1 Engine Water Outlet
2 Choke Hot Air Pipe
3 Choke Clean Air Pipe
4 Choke Heater
5 Engine Lift Strap
6 Intake Manifold
7 Rear Seal
8 Intake Manifold Baffle
9 Front Seal
10 Intake Manifold Gasket
11 Oil Filler Lower Tube
12 Engine Water Temperature Switch
13 Thermal Vacuum Switch
14 Clamp
15 Thermostat
16 Thermostat By-Pass Hose

A-1425

Figure 16—Intake Manifold and Gasket

L.H. EXHAUST MANIFOLD

REMOVAL

1. Remove air cleaner.

2. Remove hot air shroud as shown in Figure 18.

NOTE: Shroud is attached to exhaust manifold by bolts No. 2 and 5.

3. Hoist vehicle.

4. Remove power steering or generator brackets as required.

5. Disconnect exhaust pipe.

6. Remove exhaust manifold.

INSTALLATION

1. Position exhaust manifold on engine and install bolts No. 3 and 4 finger tight. (See figure 18).

2. Position hot air shroud, power steering and generator braces (as required). Torque braces (as required) Torque bolts to 25 ft. lbs. and bend tabs around bolt heads.

3. Install power steering and generator brackets, using stud "A". Torque to 25 ft. lbs.

4. Connect exhaust pipe and tighten pipe to manifold bolts until they bottom on spacer.

5. Lower vehicle.

6. Install air cleaner.

R.H. EXHAUST MANIFOLD

REMOVAL

1. Hoist vehicle.

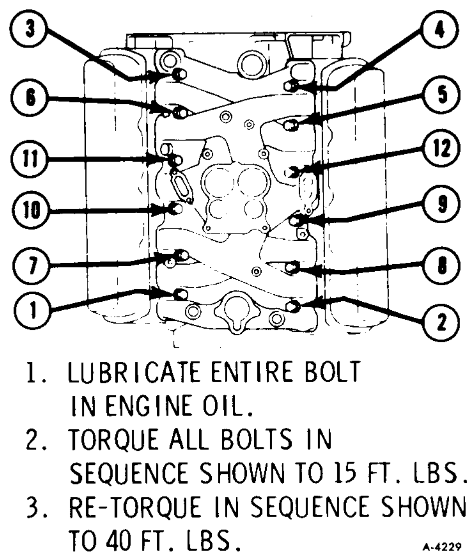


Figure 17—Intake Manifold Torque Sequence

2. Disconnect exhaust pipe.

3. Remove exhaust manifold.

INSTALLATION

1. Install exhaust manifold and torque bolts to 25 ft. lbs. Bend tabs around bolt heads.

2. Connect exhaust pipe and tighten pipe to manifold bolts bottom on spacers.

3. Lower vehicle.

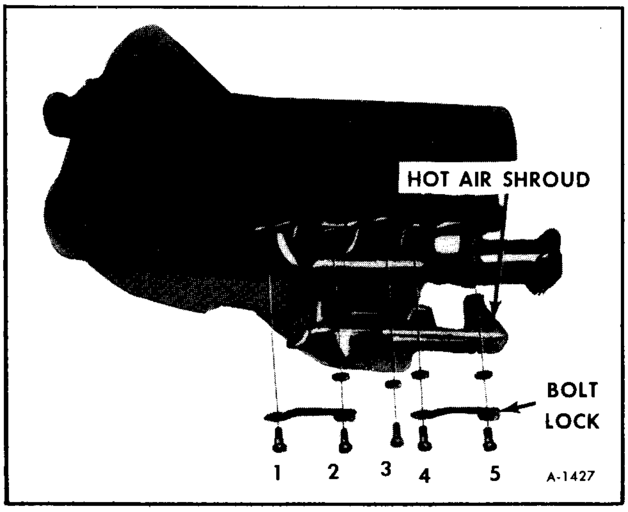


Figure 18—Hot Air Shroud

VALVE COVER

REMOVAL

1. Remove air cleaner.

2. Disconnect positive crankcase ventilation from valve cover (R.H. only).

3. Disconnect spark plug cables from spark plugs and move back and out of the way.

4. Loosen belts and remove accessories and mounting brackets as necessary. Vehicles with air conditioning, it will be necessary to wire the air conditioning compressor up for support after removing its bracket. See Figure 12.

NOTE: Freon lines do not have to be disconnected from the compressor.

5. Remove valve cover to cylinder head attaching screws as shown in Figure 16.

6. Clean gasket surfaces on cylinder head and valve cover.

INSTALLATION

1. Thoroughly clean the head and valve cover gasket surface. Then apply 1051435 R.T.V. (Room Temperature Vulcanizing) sealer or equivalent to the valve cover. See Figure 19.

IMPORTANT: In both production and service, a silastic sealer, GM No. 1051435, replaces the rubber gasket shown in Figure 20. Though the rubber service gasket is available, the silastic sealer makes a better oil seal. A tube wringer, Tool J-25027, insures uniform application.

2. Install valve cover and torque attaching screws as shown in Figure 20.

3. Install accessories and mounting brackets as

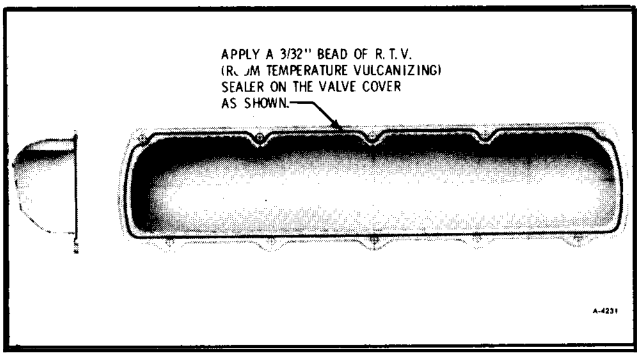


Figure 19—Applying Sealer on Valve Cover

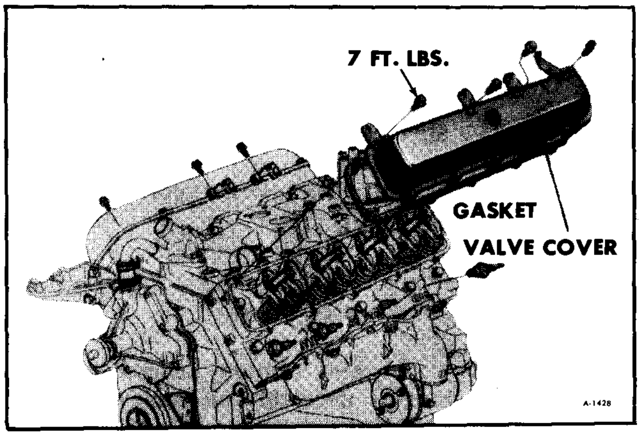


Figure 20—Valve Cover.

necessary. Adjust belt tension. Refer to "Belt Tension" later in this section.

4. Connect spark plug cables, and connect positive crankcase ventilation valve to cover (R.H. only).

5. Install air cleaner.

ROCKER ARM ASSEMBLIES (FIGURE 21)

REMOVAL

1. Remove valve cover. Refer to "Valve Cover" earlier in this section.

2. Remove rocker arm, flanged bolts, pivot and rocker arms. See Figure 22.

NOTE: Remove each set (one set per cylinder) as a unit.

INSTALLATION

1. Position a set of rocker arms (for one cylinder) in the proper location.

2. Lubricate wear points with 1050169 Lubricant or equivalent and install the pivots.

3. Install the hardened flanged bolts and tighten alternately. Torque bolts to 25 ft. lbs.

VALVE LIFTERS

OPERATION

Oil is supplied to the lifter through a hole in the side of the lifter body which indexes with a groove

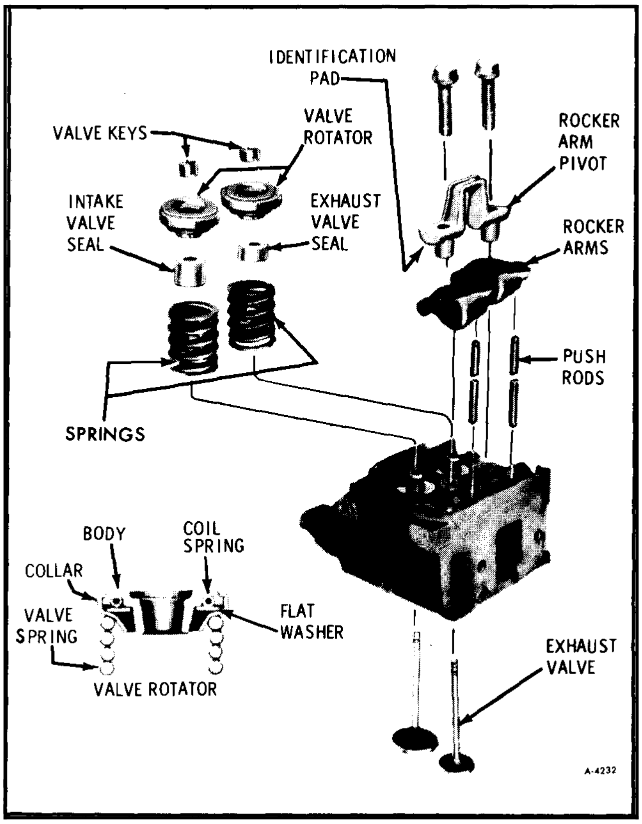


Figure 21—Cylinder Head—Exploded View

and hole in the lifter plunger. Oil is then metered past the oil metering valve in the lifter, through the pushrods to the rocker arms.

When the lifter begins to ride up the cam lobe, the ball check is held against its seat in the plunger by the ball check spring which traps the oil in the base of the lifter body below the plunger. The plunger and lifter body then raise as a unit, pushing

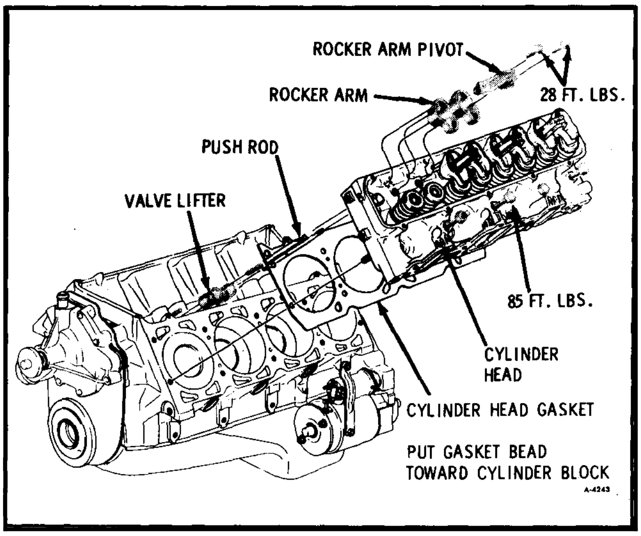


Figure 22—Removing Rocket Arms

up the push-rod to open the valve. The force of the valve spring which is exerted on the plunger through the rocker arm and push-rod causes a slight amount of leakage between the plunger and lifter body. This "leak-down" allows a slow escape of trapped oil in the base of the lifter body. As the lifter rides down the other side of the cam lobe and reaches the base circle or "valve closed" position, the plunger spring quickly moves the plunger back (up) to its original position. This movement causes the ball check to open against the ball spring and oil from within the plunger is drawn into the base of the lifter. This restores the lifter to zero lash. See Figure 23.

Valve Lifter Diagnosis

1. Momentarily Noisy When Vehicle Is Started:

This condition is normal. Oil drains from the lifters which are holding the valves open when the engine is not running. It will take a few seconds for the lifter to fill after the engine is started.

2. Intermittently Noisy on Idle Only, Disappearing When Engine Speed is Increased:

Intermittent clicking may be an indication of a flat or pitted ball, or it may be caused by dirt.

Correction: Clean the lifter and inspect. If ball is defective, replace lifter.

3. Noisy At Slow Idle or With Hot Oil, Quiet With Cold Oil or As Engine Speed is Increased:

Insert a .015" feeler gauge between the rocker arm and valve stem. If noise momentarily disappears and then reappears after a few seconds with the feeler still inserted, it is an indication that the lifter leak-down rate is too fast.

Correction: The lifter must be replaced.

4. Noisy at High Vehicle Speeds and Quiet at Low Speeds.

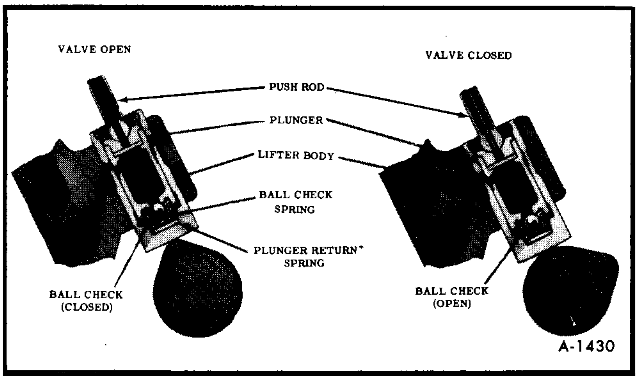


Figure 23—Valve Lifter Cutaway

a. High oil level - Oil level above the "Full" mark allows crankshaft counterweights to churn the oil into foam. When foam is pumped into the lifters, they will become noisy since a solid column of oil is required for proper operation.

Correction: Drain oil until proper level is obtained. See Section O in the beginning of this manual.

b. Low oil level - Oil level below the "Add" mark allows the pump to pump air at high speeds which results in noisy lifters.

Correction: Fill until proper oil level is obtained. See Section O in the beginning of this manual.

5. Noisy at Idle Becoming Louder as Engine Speed is Increased to 1500 rpm.

a. This noise is not connected with lifter malfunction. It becomes most noticeable in the vehicle at 10 to 15 mph "L" range, or 30 to 35 mph "D" range and is best described as a hashy sound. At slow idle, it may be entirely gone or appear as a light ticking noise in one or more valves. It is caused by one or more of the following:

1. Badly worn or scuffed valve tip and rocker arm pad.

2. Excessive valve stem to guide clearance.

3. Excessive valve seat runout.

4. Off square valve spring.

5. Off square rocker arm pad.

6. Excessive valve face runout.

7. Valve spring damper clicking on rotator.

Correction: Remove valve covers and while listening with a stethoscope, locate noisy valves by increasing engine speed slightly above idle, about 1500 rpm. With gloved hand, push side-ways on valve spring. Noise will change, either becoming louder or disappearing completely. Some noise will be present in all valve locations. It is necessary to determine which are actually responsible for the noise.

a. Occasionally this noise can be eliminated by rotating the valve spring and valve. Crank engine until noisy valve is off its seat. Rotate spring. This will also rotate valve. Repeat until valve becomes quiet. If correction is obtained, check for an off square valve spring. If spring is off square more than 1/16" in free position, replace spring. See Figure 24.

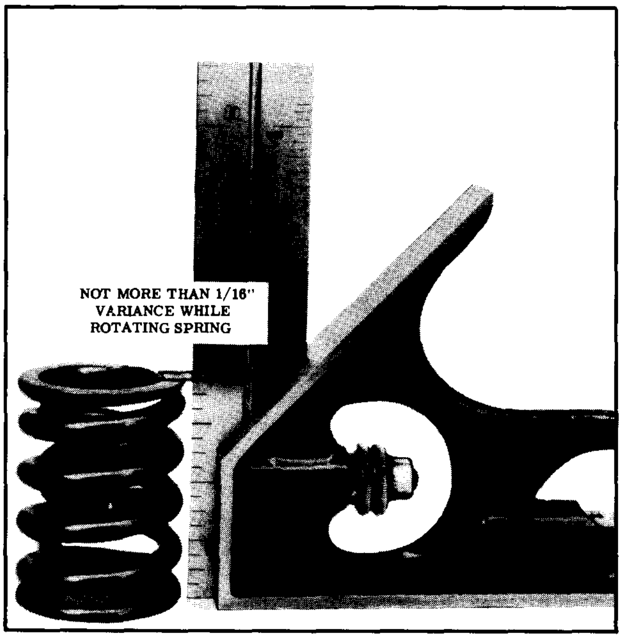


Figure 24—Checking Valve Spring

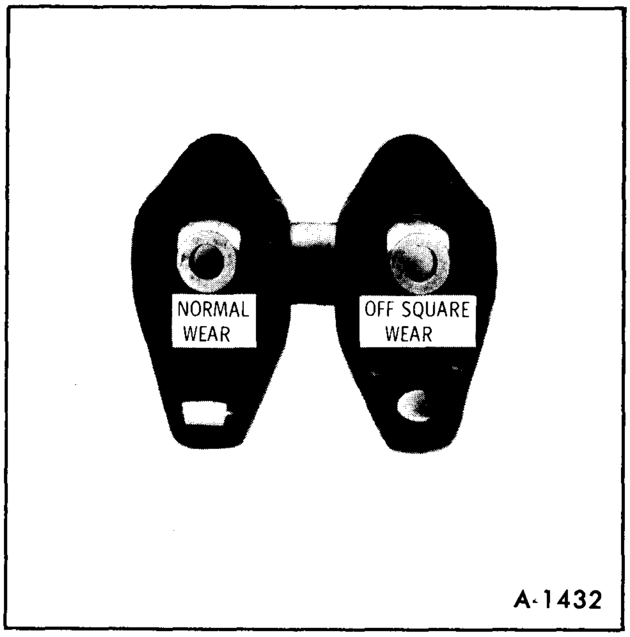


Figure 25—Rocker Arm Wear

b. Observe rocker arm pad for excessive wear or excessive off square. Replace as required. See Figure 25.

c. Check for excessive valve stem to guide clearance. If necessary, correct as required.

6. Valves Noisy Regardless of Engine Speed.

This condition can be caused by foreign particles or excessive valve lash.

Correction: a. With transmission in "park" and parking brake on, run the engine at a moderate speed.

If this method does not quiet the lifter, strike the rocker arm above the push-rod with a mallet while the engine is idling. This method of correction has proven successful for dislodging a foreign particle which is preventing the ball from seating properly.

b. Check for valve lash by turning engine so the piston in that cylinder is on top dead center of firing stroke. If valve lash is present, the push-rod can be freely moved up and down a certain amount with rocker arm held against valve.

Valve lash indicates one of the following:

1. Worn push-rod.

2. Worn rocker arm.

3. Lifter plunger stuck in down position due to dirt or varnish.

4. Defective lifter.

Checking of the above four items:

1. Observe upper end of push-rod. Excessive wear of the spherical surface indicates one of the following conditions.

a. Improper hardness of the push-rod ball. The push-rod and rocker arm must be replaced.

b. Improper lubrication of the push-rod. The push-rod and rocker arm must be replaced. The oiling system to the push-rod should be checked.

2. If push-rod appears in good condition and has been properly lubricated, replace rocker arm and recheck valve lash.

3. If valve lash exists and push-rod and rocker arm are okay, trouble is in the lifter. Lifter should be replaced.

REMOVAL

NOTE: Valve lifters and push-rods should be kept in order so they can be reinstalled in their original position. Some engines will have both standard and .010" oversize valve lifters, the .010" oversize lifter is etched "O" on the side of the lifter. The cylinder block will also be marked if the oversize lifter is used.

1. Remove intake manifold and gasket. Refer to "Intake Manifold" earlier in this section.

2. Remove valve covers, rocker arm assemblies and push-rods. Refer to those areas earlier in this section.

3. If lifters are varnished, apply carburetor cleaning solution to lifter body. Allow five minutes for solution to remove varnish. Remove valve lifters.

CAUTION: *Carburetor cleaning solvent should be used in a well ventilated room. Avoid contact with skin and prolonged breathing of fumes.*

DISASSEMBLY

1. Remove retainer ring with a small screwdriver.

2. Remove push-rod seat and oil metering valve.

3. Remove plunger and plunger spring. If plunger is stuck tight, allow lifter to soak in carburetor cleaning solvent for approximately five minutes, then remove.

4. Remove ball check retainer from plunger, then remove ball and spring.

CLEANING AND INSPECTION

After lifters are disassembled, all parts should be cleaned in clean solvent. A small particle of foreign material under the ball check valve will cause malfunctioning of the lifter. Close inspection should be made for nicks, burrs or scoring of parts. If either the body or plunger is defective, replace with a new lifter assembly.

NOTE: Do not condemn valve lifters that have a slight gap or show evidence of leakage where the lifter foot is welded to the lifter body.

Whenever lifters are removed, check the lifter foot for abnormal wear as follows:

1. Place a straight edge across the lifter foot.

NOTE: Lifter foot must be clean and dry.

2. While holding the lifter at eye level check for light between the straight edge and lifter foot.

3. If light indicates a flat or concave surface of the lifter foot, the lifter should be replaced and the camshaft inspected for wear. Wear at the CENTER of the cam base circle is NORMAL. The camshaft should be replaced ONLY when wear is present across FULL WIDTH of cam base circle.

ASSEMBLY

1. Assemble ball check, spring and retainer into plunger. See Figure 26. Make sure retainer flange is pressed tight against bottom of recess in plunger.

2. Install plunger spring over ball check retainer.

3. Hold plunger with spring up and insert into lifter body. Hold plunger vertically to prevent cocking spring.

4. Assemble oil metering valve and push rod seat and seat retaining ring in groove.

INSTALLATION

1. Install lifters and push-rods into original position in cylinder block. See note under Removal.

2. Install baffle as shown in Figure 27. Install manifold gaskets and manifold. Refer to "Intake Manifold" earlier in this section.

3. Position rocker arms, pivots and bolts on cylinder head as shown in Figure 21.

4. Install valve covers. Refer to "Valve Cover" earlier in this section.

CYLINDER HEAD AND GASKET

REMOVAL

1. Drain radiator. Drain cock located at lower left side of radiator. By raising the rear wheels ap-

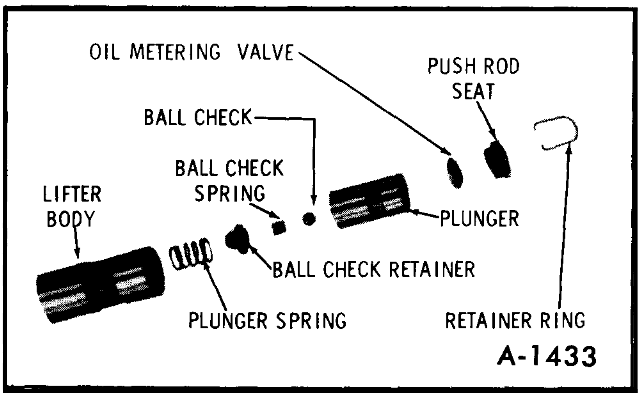


Figure 26—Valve Lifter—Exploded View

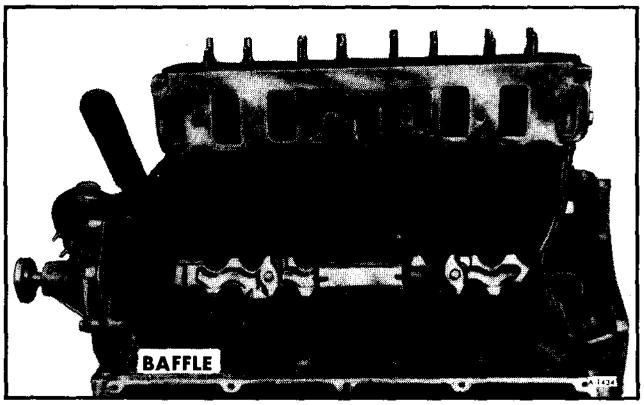


Figure 27—Baffle Installation

proximately 2-1/2 feet high, enough engine coolant will drain from the engine block to allow removal of the heads.

NOTE: To avoid overloading the front suspension raise front of the vehicle enough so front wheels are just off the ground.

2. Remove intake manifold. Refer to "Intake Manifold" earlier in this section.

3. Loosen exhaust pipe clamp at muffler. Remove exhaust manifold bolts and position exhaust manifold away from head.

4. Loosen or remove any accessory brackets which interfere with head removal.

5. Remove valve cover. Refer to "Valve Cover" earlier in this section.

6. Remove rocker arm bolts, pivots, rocker arms and push-rods as shown in Figure 21.

NOTE: Scribe pivots and keep rocker arms separated so they can be installed in their original locations.

7. Remove cylinder head bolts, then remove cylinder head.

NOTE: If a clearance problem is encountered for number 7 or 8 cylinder head bolts or push rods, pull these out far enough to clear the block, secure with rubberbands, and remove or install with the cylinder heads.

CAUTION: *Gasket surfaces on both the head and the block must be clean of any foreign matter and free of nicks or heavy scratches. The cylinder head bolt threads in the block and threads on cylinder head bolt must be cleaned. Dirt will affect bolt torque.*

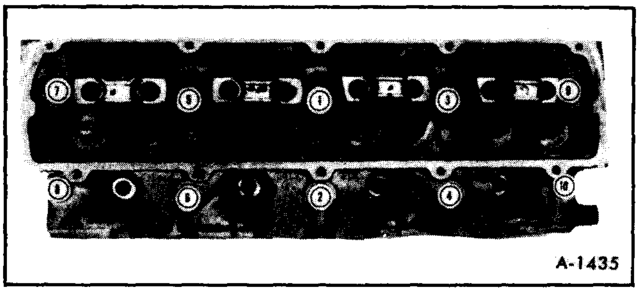


Figure 28—Cylinder Head Torque Sequence

INSTALLATION

1. Use a new head gasket and coat both sides with part No. 1050026 sealer or equivalent. Install gasket with bead facing cylinder.

2. Clean and dip cylinder head bolts in engine oil.

3. Install cylinder head and torque bolts to 60 ft. lbs. in sequence as shown in Figure 28. Then retorque in sequence to 85 ft. lbs.

NOTE: Torque head bolts before installing rocker arms and pivots if a clearance problem is encountered.

4. Install push rods, pivots, rocker arms and bolts. Torque rocker arm pivot bolts to 25 ft. lbs., tighten by alternating from side to side.

NOTE: Be sure to replace rocker arms and pivots to their original locations.

5. Install valve cover. Refer to "Valve Cover" earlier in this section.

6. Install intake manifold. Refer to "Intake Manifold" earlier in this section.

7. Install any accessory brackets that were removed previously.

8. Install exhaust manifold. Torque bolts to 25 ft. lbs. Bench tabs around bolt heads. Torque clamp on exhaust pipe at muffler to 20 ft. lbs.

9. Add engine coolant.

10. Start engine and check for leaks.

VALVES AND SPRINGS WITH HEAD REMOVED

REMOVAL

1. Remove spark plugs.

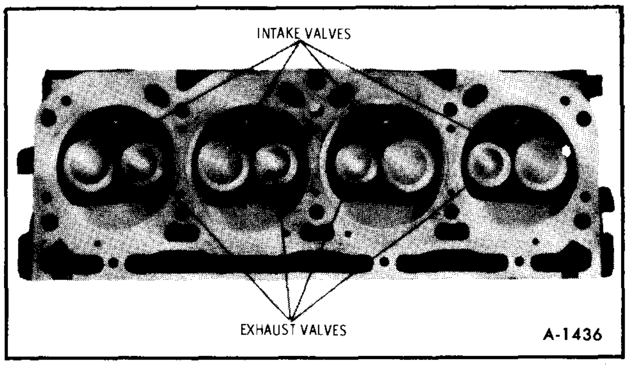


Figure 29—Valve Location

2. Remove valve keys by compressing valve spring with a tool J-5892-1.

3. Remove valve spring rotators or retainers and springs.

4. Remove oil seals from valve stems.

5. Remove valves. Keep valves separated so they can be installed in their original locations. See Figure 29.

INSTALLATION

1. Install valves in their respective guides.

2. Install new oil seals over valve stem, using Tool J-24725. See Figure 30.

Position seals down as far as possible on valve stem. The seals will correctly position themselves when the engine is started.

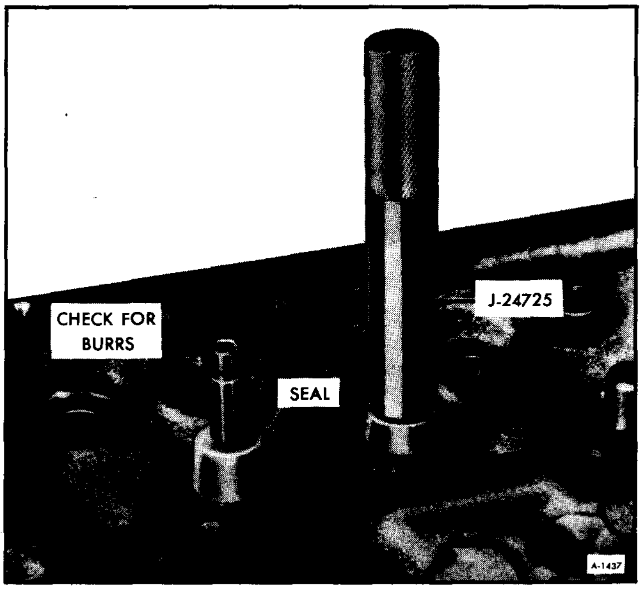


Figure 30—Valve Seal Installation

NOTE: Inspect seal for cracks after installation.

3. Position valve springs over valve stems.

4. Install valve rotators then compress springs with a tool J-5892-1 and install valve stem keys.

5. Check valve springs and keys to be sure they are properly seated.

6. Set spark plug gap. Lubricate plug threads with one drop of engine oil and re-install plugs. Torque to 35 ft. lbs. for vehicles equipped with breaker point ignition systems, and 25 ft. lbs. for high energy ignition systems.

Reconditioning Valves

When reconditioning valves and valve seats, clean carbon from cylinder heads and valves using care not ot gouge or scratch machined surfaces. A soft wire brush is suitable for this purpose. Whenever valves are replaced or new valves installed, the valve seats must be reconditioned.

Figure 31 shows the relation of valve angle and valve seat angle. Arc "A" should be 44° on the intake valve and 30° on the exhaust valve. Arc "B" should be 45° on the intake valve seat and 31° on the exhaust valve seat.

Narrow the valve seats to the specified width.

NOTE: This operation is done by grinding the portside with a 30° stone to lower the seat and a 60° stone to raise the seat.

See "Engine Specification" Chart for valve seat width.

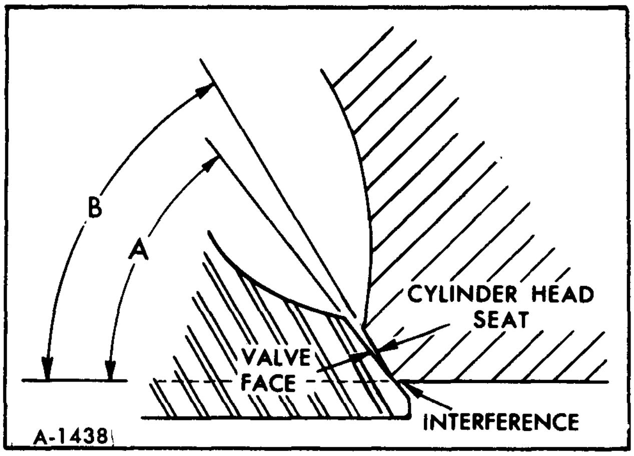


Figure 31—Relation of Valve and Seat Angles

NOTE: Exhaust valve seats are induction hardened and must be ground, Not cut.

If valve guide bores are worn excessively, they can be reamed oversize. This will require replacement of the valves with oversize valves (stems). The guide bores should be reamed before grinding the valve seats. Valve clearance in guide bore should be .001" to .004".

Measuring Valve Stem Height

Whenever a new valve is installed, or after grinding valves, it will be necessary to measure valve stem height. Install Gauge BT-6428. There should be at least .015" clearance on all valves between gauge surface and end of valve stem. (Valve stem can be gauged with or without the valve rotator on the valve). If clearance is less than .015", remove valve and grind tip of valve stems as required on a valve tachment to insure a smooth 90° end. Also be certain to break sharp edge on ground valve tip. Observe an original valve to determine chamfer.

After all valve keys have been installed on valves, tap each valve stem end with a hammer to seat valve rotators and keys. Re-gauge all valves between valve stem and gauge (.015" minimum) and valve rotator and gauge (.030" minimum). If any valve stem end is less than .005" above rotator, the valve is too short and a new valve must be installed.

NOTE: There must be a minimum of .030" clearance between valve rotator and gauge. Failure to maintain this clearance will cause rocker arm and valve rotator interference. Example:

Valve Rotator to Gauge Clearance................. .038"
Minus Valve Stem to Gauge Clearance .... -.035"
.003"

This is less than .005" and a new valve should be installed.

VALVE GUIDE BORES

As previously stated, if the valve guide bores are worn excessively, they can be reamed oversize. The following reamers are available:

.003" Oversize Valve Guide Reamer

.005" Oversize Reamer

.013" Oversize Valve Guide Reamer

If a standard valve guide bore is being reamed, use the .003" or .005" oversize reamer. For the .010" oversize valve guide bore, use the .013" oversize reamer. If too large a reamer is used and the spiraling is removed, it is probable that the valve will not receive the proper lubrication.

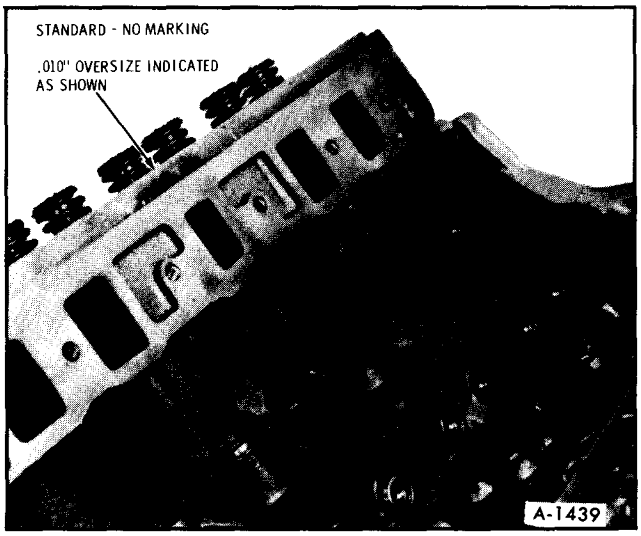


Figure 32—Valve Guide Bore Marking

Occasionally a valve guide bore will be oversize as manufactured. These are marked on the inboard side of the cylinder heads on the machined surface just above the intake manifold surface (figure 32). These markings are visible without removing any parts other than the air cleaner assembly. Before removing the cylinder heads to perform service to either the valves or valve guide bores, the cylinder heads should be inspected to determine if these markings are present. If no markings are present, the guide bores are standard. If oversize markings are present, any valve replacement will require an oversize valve. If the oversize marking is present, only

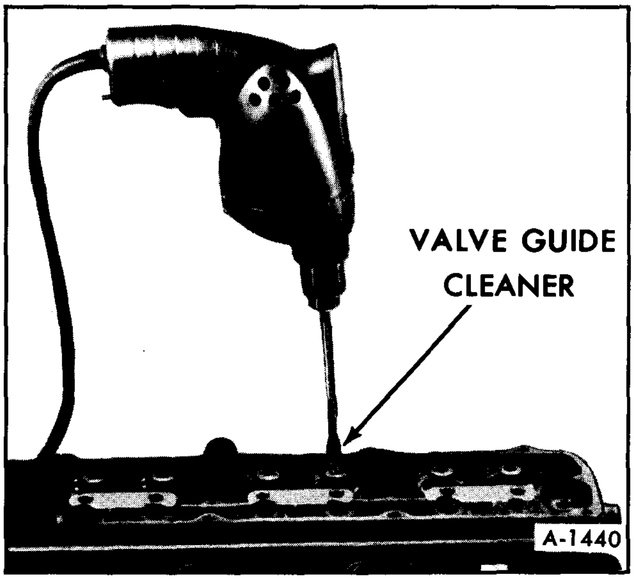


Figure 33—Cleaning Valve Guide Bores

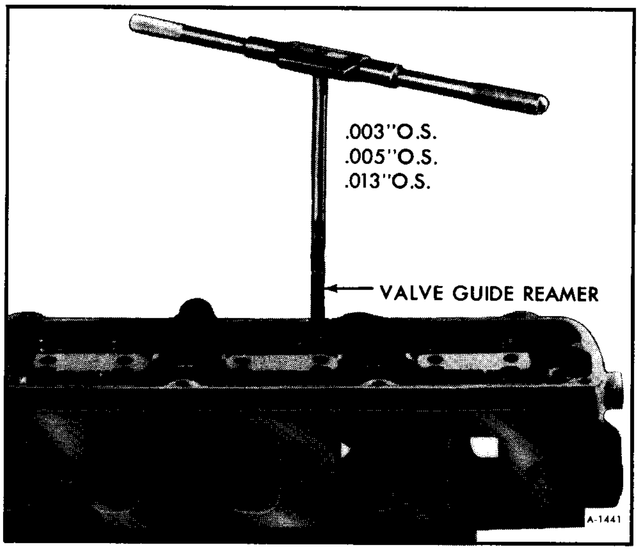


Figure 34—Reaming Valve Guide Bores

that particular bore would be oversize, not all bores in that cylinder head. Service valves are available in five different stem diameters: Standard, .003" oversize, .005" oversize, .010" oversize, and .013" oversize.

Reaming Procedure

Before attempting to ream the valve guide bores they should be cleaned using a tool as shown in Figure 33.

This procedure to ream valve guide bores using a reamer is shown in Figure 34. Use care to hold reamer straight in valve guide bore.

REPLACING VALVE SPRING (HEAD ON ENGINE)

To replace a worn or broken valve spring without removing the cylinder head proceed as follows:

REMOVAL

1. Remove valve covers. Refer to "Valve Cover" earlier in this section.

2. Remove rocker arm assemblies.

3. Remove spark plug and install Tool J-22794 into spark plug hole and attach to an air hose to hold the valve against its seat. (See figure 35).

4. Install Tool J-5892-1. See Figure 35. Compress

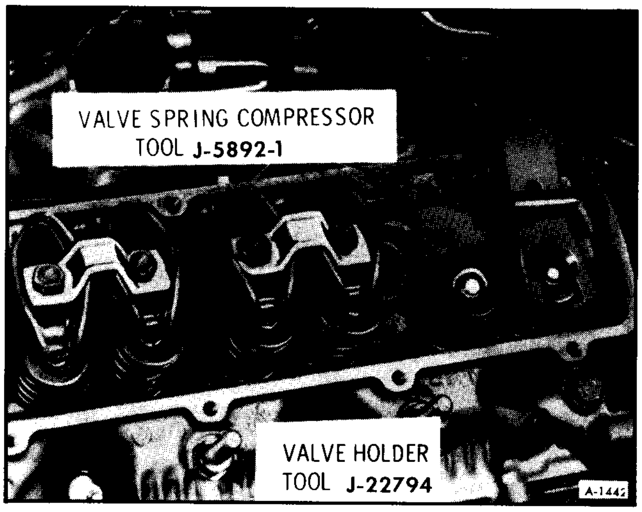


Figure 35—Removing Valve Spring

the valve spring until valve keys are accessible, then remove keys, valve rotators and springs.

> **NOTE:** If valve spring does not compress, tap tool with a hammer to break bind at rotator and keys.

CHECKING ROTATORS

The rotators cannot be disassembled and require replacement only when they fail to rotate the valve.

Rotator action can be checked by applying a daub of paint across the top of the body and down the collar. Run engine approximately 1500 rpm, there should appear to be motion between the body and collar, the body will appear to "walk" around the collar. Rotator action can be either clockwise or counterclockwise, sometimes on removal and reinstallation; the direction of rotation will change but this does not matter so long as it rotates.

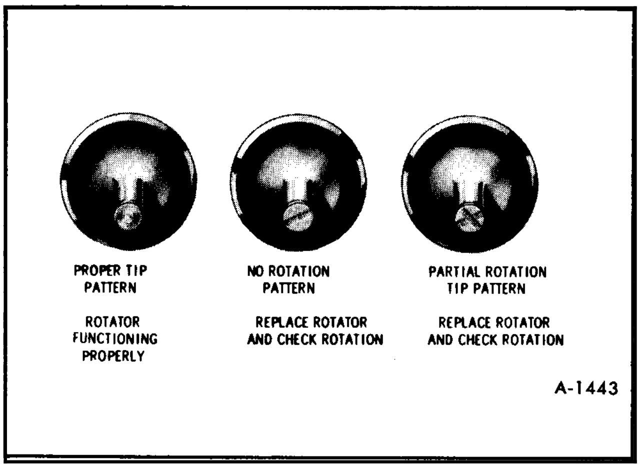


Figure 36—Valve Stem Wear

Anytime the valves are removed for service the tips should be inspected for improper pattern which could indicate valve rotator malfunction. See Figure 36.

INSTALLATION

1. Install valve spring and rotator. Using Tool J-5892-1, compress the valve spring until the valve keys can be installed.

2. Remove tool No. J-22794 and install spark plugs. Torque 35 ft. lbs. for vehicles equipped with breaker point ignition system, and 25 ft. lbs. for high energy ignition systems.

3. Install rocker arm assemblies.

4. Install valve covers. Refer to "Valve Cover" earlier in this section.

OIL PAN

REMOVAL

1. Remove transmission and final drive. Refer to "Engine Removal" later in this section.

2. Remove oil pan drain plug and drain oil.

3. Disconnect relay tie rod from the idler arm and the relay lever. Also disconnect steering shock absorber from crossmember bracket.

4. Remove L.H. lower venturi ring bracket.

5. Disconnect power steering pump.

6. Remove four (4) front support bolts and front motor mount bolts. Position support forward. (See figure 6).

7. Remove flywheel.

8. Remove oil pan bolts.

9. Raise front of engine enough so the oil pan can be removed (approximately one inch).

10. Clean gasket surfaces on the engine block and the oil pan.

INSTALLATION

1. Apply sealer 1050026 or equivalent to both sides of gaskets. Position all gaskets on engine block. See Figure 37.

2. Position oil pan on engine. Start all bolts and install until finger tight. Torque oil pan bolts to 10 ft. lbs.

3. Replace flywheel and torque bolts to 60 ft. lbs.

4. Lower engine to position. Install four (4) front support bolts and torque to 50 ft. lbs. See Figure 8.

5. Torque engine front support to 50 ft. lbs. (See figure 6).

6. Install power steering pump.

7. Install L.H. lower venturi ring bracket.

8. Connect relay tie rod and torque nuts to 50 ft. lbs., then insert cotter pin. Connect steering shock absorber to bracket at crossmember, torque nut to 40 ft. lbs.

9. Install oil pan drain plug. Torque to 30 ft. lbs.

10. Install transmission and final drive. Refer to "Engine Replacement" later in this section.

11. Lower vehicle.

12. Add engine oil. Refer to Section "O" for proper viscosity and quanity.

13. Start engine and check for leaks.

OIL PUMP

REMOVAL

1. Remove oil pan. Refer to "Oil Pan" earlier in this section.

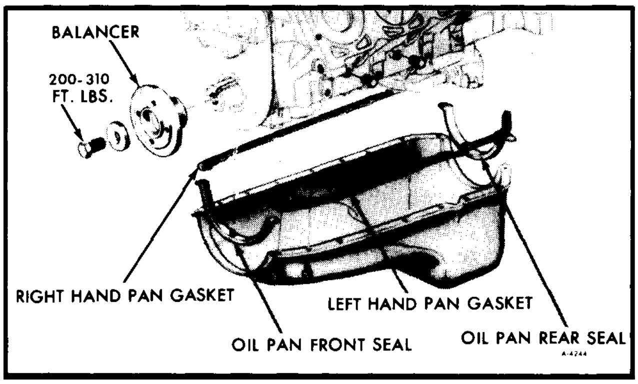


Figure 37—Oil Pan Assembly

2. Remove the oil pump to rear main bearing cap attaching bolts, then remove rear oil deflector, then remove pump and drive shaft extension.

DISASSEMBLY (FIGURE 38)

1. Remove the oil pump drive shaft extension.

NOTE: Do not attempt to remove the washers from the drive shaft extension. The drive shaft extension and washers must be serviced as an assembly. See Figure 39.

2. Remove the cotter pin, spring and the pressure regulator valve.

NOTE: Position thumb over pressure regulator bore before removing cotter pin, as the spring is under pressure.

3. Remove the oil pump cover attaching screws and remove the oil pump cover and gasket.

4. Remove the drive gear and idler gear from the pump body.

INSPECTION

Check the gears for scoring or other damage. If they are damaged, new gears should be installed. During assembly, the gear end clearance should be gauged. Proper end clearance is .0025" to .0065". Also check the pressure regulator valve, valve spring and bore for damage. Proper valve to bore clearance is .0025" to .0050".

ASSEMBLY

1. Install the drive gear into the pump with the hex ID of the drive shaft toward the oil pump mounting pad, then install the idler gear.

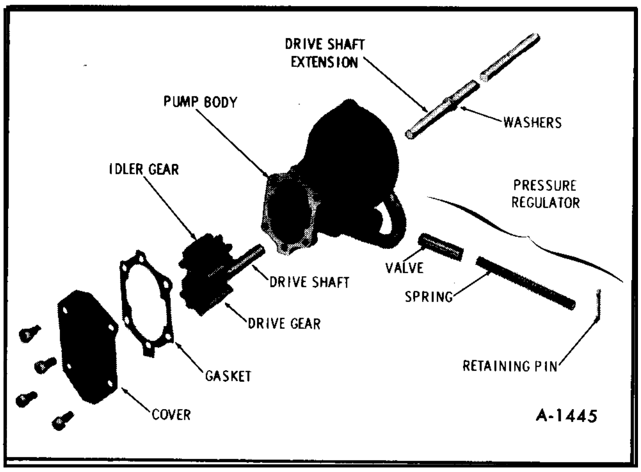


Figure 38—Oil Pump Exploded View

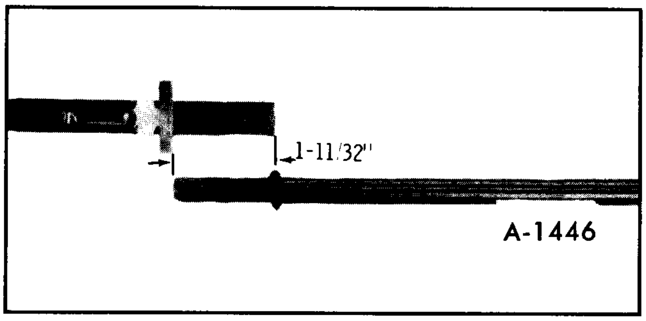


Figure 39—Oil Pump Shaft Extension

2. Position a new gasket on the pump body and install the oil pump cover. Tighten the cover screws to 8 ft. lbs.

3. Position the pressure regulator valve into the pump cover, closed end first, then install the spring and retaining pin.

NOTE: When assembling the drive shaft extension to the drive shaft, the END OF THE EXTENSION NEAREST THE WASHERS MUST BE INSERTED INTO THE DRIVE SHAFT.

INSTALLATION

1. Insert the drive shaft extension through the opening in the main bearing cap and block until the shaft mates into the distributor drive gear.

2. Position pump onto the rear main bearing cap replace rear oil deflector and install attaching bolts. Torque bolts to 35 ft. lbs. See Figure 40.

3. Install the oil pan. Refer to "Oil Pan" installation earlier in this section.

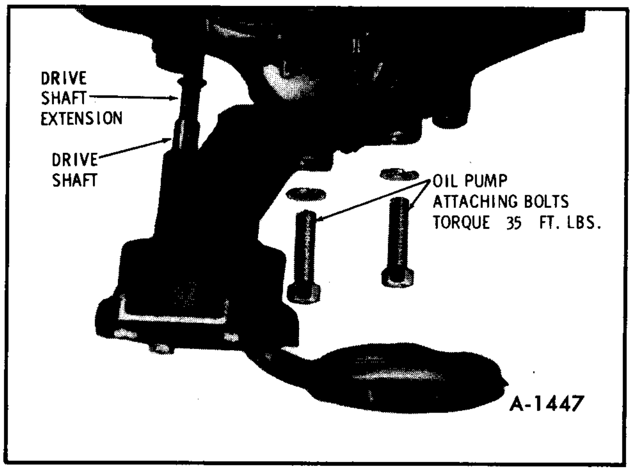


Figure 40—Oil Pump Installation

CONNECTING ROD AND PISTON ASSEMBLY

REMOVAL

1. Remove intake manifold. Refer to "Intake Manifold" earlier in this section.

2. Remove head or heads, oil pan and oil pump. Refer to those areas earlier in this section.

NOTE: Stamp cylinder number on the machined surfaces of the bolt bosses of the connecting rod and cap for identification when reinstalling. If the pistons are to be removed from the connecting rod, mark cylinder number on piston with a silver pencil or quick drying paint for proper cylinder identification and cap to rod location. The right bank is numbered 2-4-6-8, left bank 1-3-5-7.

Examine the cylinder bore above ring travel. If ridge exists, remove ridge with ridge reamer before attempting to remove the piston and rod assembly.

3. Remove rod bearing cap and bearing.

4. Install guide hose over threads of rod bolts. This is to prevent damage to bearing journal and rod bolt threads. See Figure 41.

5. Remove rod and piston assembly through the top of the cylinder bore.

6. Remove other rod and piston assemblies in the same manner.

ROD BEARINGS

The connecting rod bearings are designed to have a slight projection above the rod and cap faces to insure a positive contact.

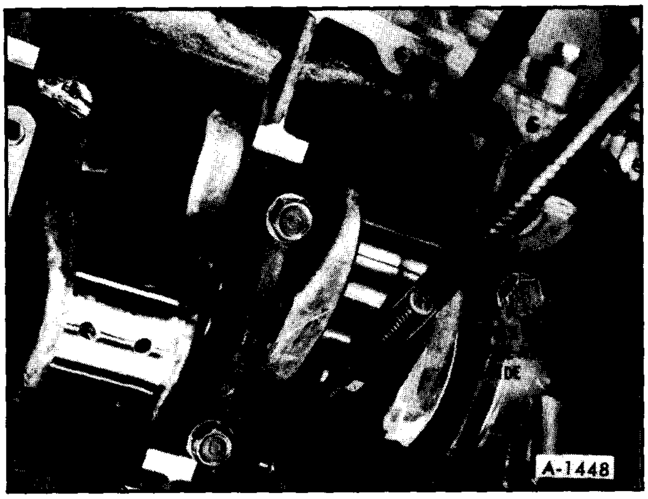


Figure 41—Connecting Rod Bolt Guide

Connecting rod bearings can be replaced without removing the rod and piston assembly from the engine.

REMOVAL

1. Remove oil pan. Refer to "Oil Pan" earlier in this section.

NOTE: It may be necessary to remove oil pump to provide access to rear connecting rod bearings.

2. With connecting rod journal at the bottom, stamp cylinder number on machined surfaces of connecting rod and cap for identification when reinstalling, then remove caps.

3. Inspect journals for roughness and wear. Slight roughness may be removed with a fine grit polishing cloth saturated with engine oil. Burrs may be removed with a fine oil stone by moving the stone on the journal circumference. Do not move the stone back and forth across the journal. If the journals are scored or ridged, the crankshaft must be replaced.

4. The connecting rod journals should be checked for out-of-round and correct size with a micrometer. Maximum out-of-round must not exceed .0015".

NOTE: Refer to "Engine Specifications" later in this section.

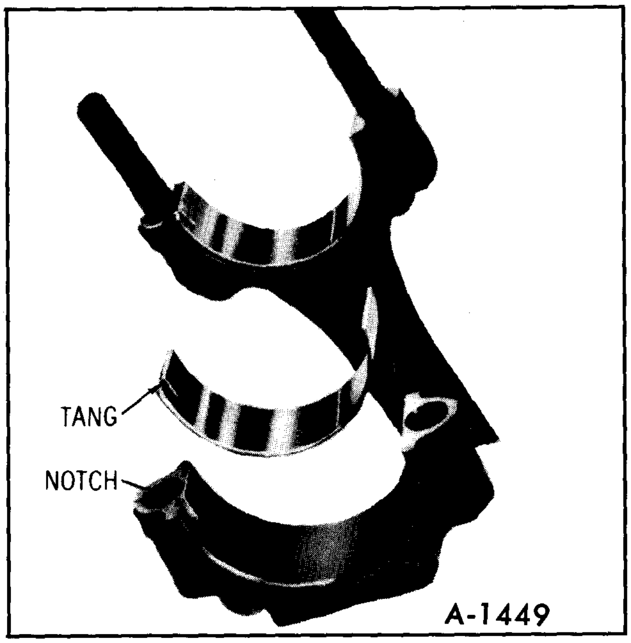


Figure 42—Bearing Tang and Notch

If Plastigauge is to be used:

5. Clean oil from journal bearing cap, connecting rod and outer and inner surface of bearing inserts. Position insert so that tang is properly aligned with notch in rod and cap. See Figure 37.

6. Place a piece of plastigauge in the center of lower bearing shell.

7. Reinstall bearing cap and torque to 42 ft. lbs.

8. Remove bearing cap and determine bearing clearances by comparing the width of the flattened plastigauge at its widest point with the graduation on the plastigauge container. The number within the graduation on the envelope indicates the clearance in thousandths of an inch. If this clearance is greater than .0035", replace the bearing and recheck clearance with plastigauge.

NOTE: Lubricate bearing with engine oil before installation. Repeat Steps 2 through 8 on remaining connecting rod bearings. All rods must be connected to their journals when rotating the crankshaft to prevent engine damage.

NOTE: Bearings are identified as shown in Figure 38.

9. Spread rods with screwdriver and measure the rod side clearance as shown in Figure 39. Clearance should be .006" to .020".

NOTE: If a rod is twisted or bent, a new rod must be installed. NO ATTEMPT SHOULD BE MADE TO STRAIGHTEN CONNECTING RODS.

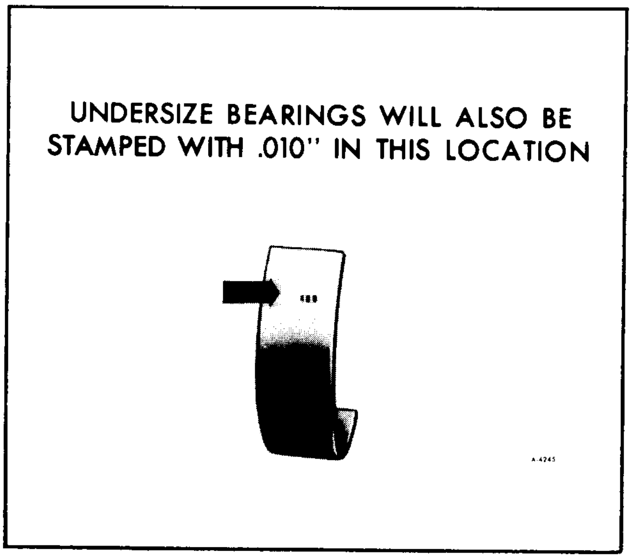


Figure 43—Bearing Identification

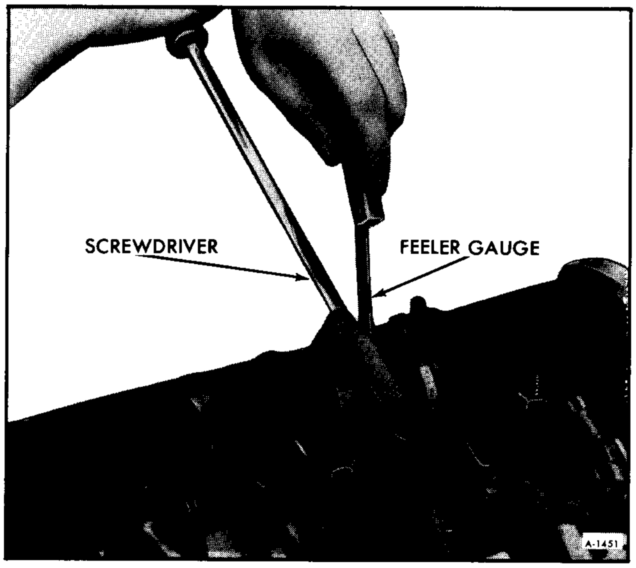


Figure 44—Connecting Rod Side Clearance

PISTON

MEASURING PISTON

NOTE: Refer to PISTON INFORMATION Chart. When replacing pistons, the original cylinder size is stamped with a code letter on the block near each cylinder on the cylinder head surface. See Figure 40.

When measuring piston for size or taper, measurement must be made on skirt 90° from piston pin hole (with the piston pin removed). See Figure 41.

When measuring taper, the largest reading must be at the bottom of the skirt. Allowable taper is .000" to .001".

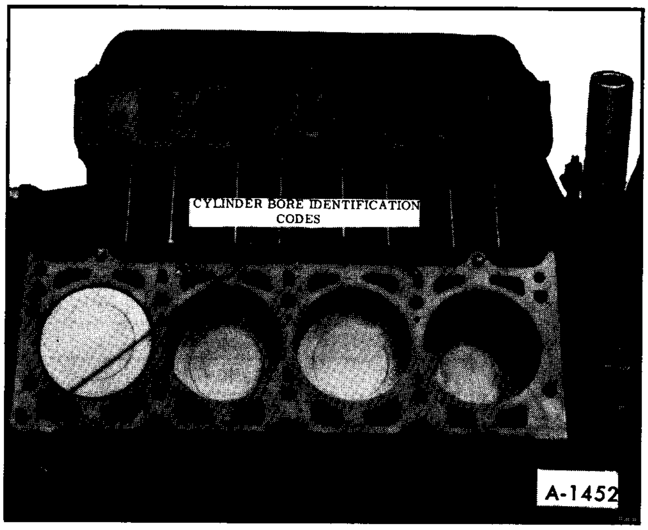


Figure 45—Cylinder Bore Marking

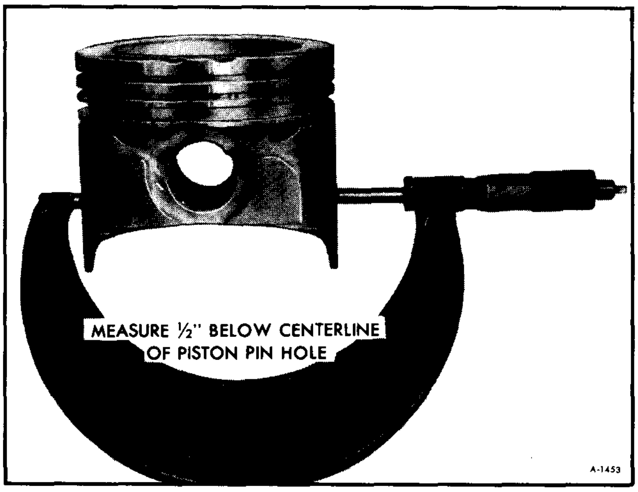


Figure 46—Measuring Piston

The piston and cylinder bore must be free of oil and at the same temperature.

NOTE: In some engines, oversize pistons may be found. These pistons will be .010" oversize.

1. Place a strip of .0015" feeler gauge against the upper side of the bore, at 90° to the normal piston pin location. Attach a scale which measures in pounds to a feeler gauge. See Figure 42.

2. Insert piston upside down with pin and rings removed, into bore.

3. While holding the piston in the center of its normal travel, slowly pull the scale in a straight line and note the reading on the scale. The reading should be between 3 to 12 pounds while pulling the feeler gauge out of the bore.

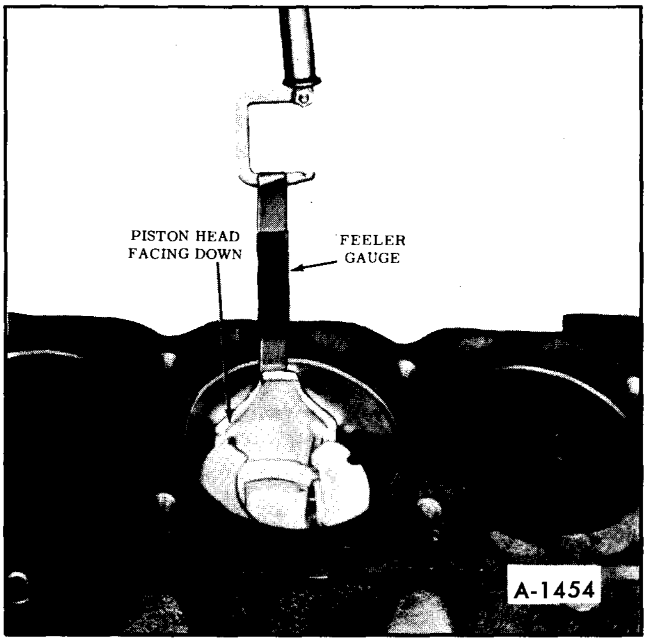


Figure 47—Checking Piston Clearance

Each piston should be fitted to its individual cylinder and marked for that cylinder.

CLEANING PISTON

Clean the pistons by scraping carbon off the top of the piston. Deposits in the ring grooves should be removed with a suitable ring groove cleaning tool. It is important that the ring grooves be completely free of deposits.

PISTON INFORMATION CHART

BORE DIAMETER	CYLINDER BORE SELECTION	BORE SIZES	PISTON SELECTION	PISTON SIZE	PISTON DIAMETER	PISTON TO CYL. BORE CLEARANCE	RING SIZE
4.1250-4.1270 Std.	A	4.1250-4.1255	A	4.1240-4.1235	4.1255-4.1235 Std.	.001 to .002	Std.
	B	4.1255-4.1260	B	4.1245-4.1240			
	C	4.1260-4.1265	C	4.1250-4.1245			
	D	4.1265-4.1270	D	4.1255-4.1250			
4.1350-4.1370 .010 O.S.	J	4.1350-4.1355	J	4.1340-4.1335	4.1355-4.1355 .010 O.S.		.010" O.S.
	K	4.1355-4.1360	K	4.1345-4.1340			
	L	4.1360-4.1365	L	4.1350-4.1345			
	M	4.1365-4.1370	M	4.1355-4.1350			

CHECKING CYLINDER BORE

NOTE: Refer to PISTON INFORMATION Chart.

Cylinder bore size can be measured with inside micrometers or a cylinder gauge. Maximum allowable taper of the cylinder bore is .001". The most wear will occur at the top of the ring travel.

Reconditioned cylinder bores should be held to not more than .001" out-of-round and .001" taper.

If the cylinder bores are smooth, the cylinder walls should not be deglazed. If the cylinder walls are scored the walls may have to be honed before installing new rings. It is important that reconditioned cylinder bores be thoroughly washed with a soap and water solution to remove all traces of abrasive material to eliminate premature wear.

RINGS (FIGURE 48)

The pistons have three rings (two compression rings and one oil ring). The oil ring consists of two rails and an expander.

RING TOLERANCES

When installing new rings, ring gap and side clearance should be checked as follows:

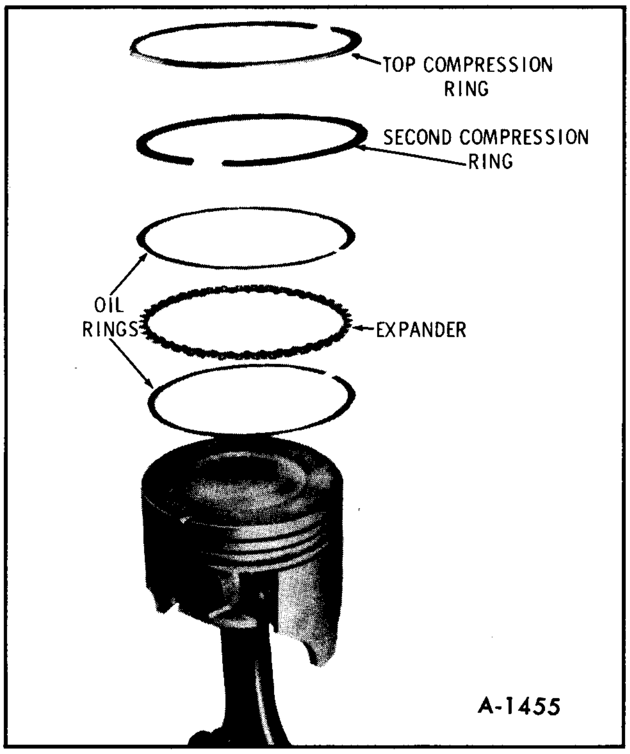


Figure 48—Piston Rings

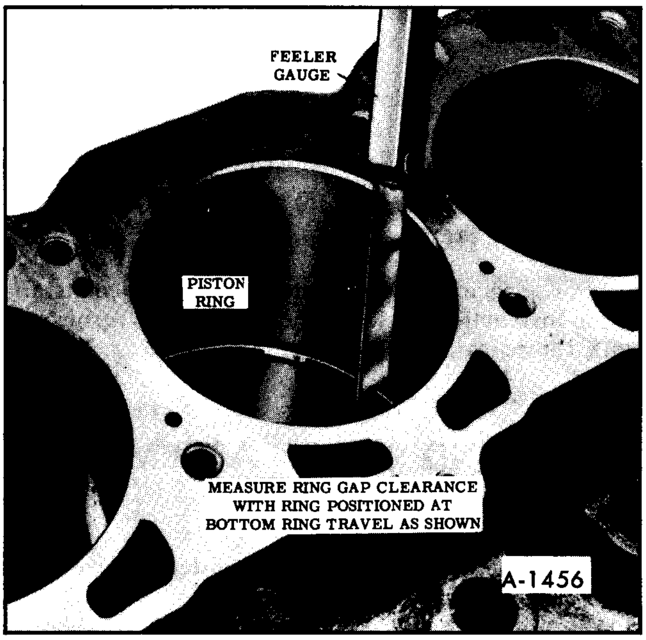


Figure 49—Measuring Piston Ring Gap

PISTON RING AND RAIL GAP

Each ring and rail gap must be measured with the ring or rail positioned squarely and at the bottom of the ring-travel area of the bore. See Figure 49.

The gap measurement should be .013" to .023" for compression rings and .015" to .055" for oil rings.

SIDE CLEARANCE

Each ring must be checked for side clearance in its respective piston groove by inserting a feeler gauge between the ring and its upper land. See Figure 50. The Piston grooves must be cleaned before checking ring for side clearance.

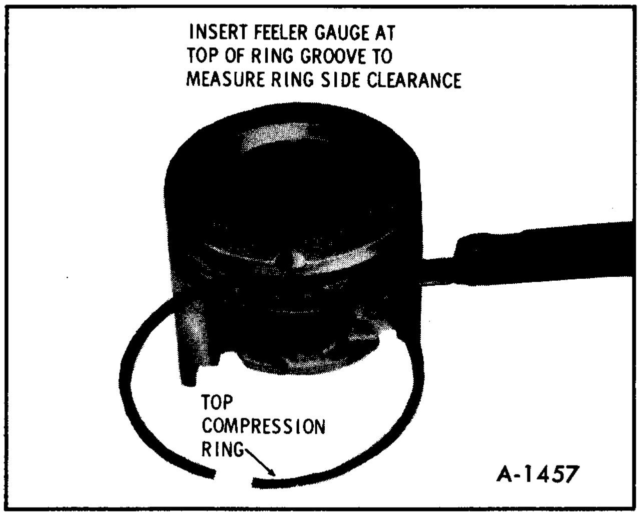


Figure 50—Piston Ring Side Clearance

NOTE: To check oil ring side clearance, the oil rings must be installed on the piston.

Allowable side clearance is:

Compression Rings	.002″ to .004″
Oil Ring	.002″ to .008″

RING IDENTIFICATION AND INSTALLATION

For service ring specifications and detailed installation instructions, refer to the instructions furnished with the parts package.

ROD AND PISTON ASSEMBLY

INSTALLATION

1. Install connecting rod bolt guide hose over rod bolt threads. (See figure 41).

2. Apply engine oil to rings and piston, then install piston ring compressing tool on piston. See Figure 51.

3. Install assembly in its respective cylinder bore so notch cast in top of piston is towards the front of engine.

4. Lubricate the crankshaft journal with engine oil and install connecting rod bearing and cap, with bearing index tang in rod and cap on same side.

NOTE: When more than one rod and piston assembly is being installed, the connecting rod cap attaching nuts should only be tightened enough to keep each rod in position until all have been installed. This will facilitate installation of remaining piston assemblies.

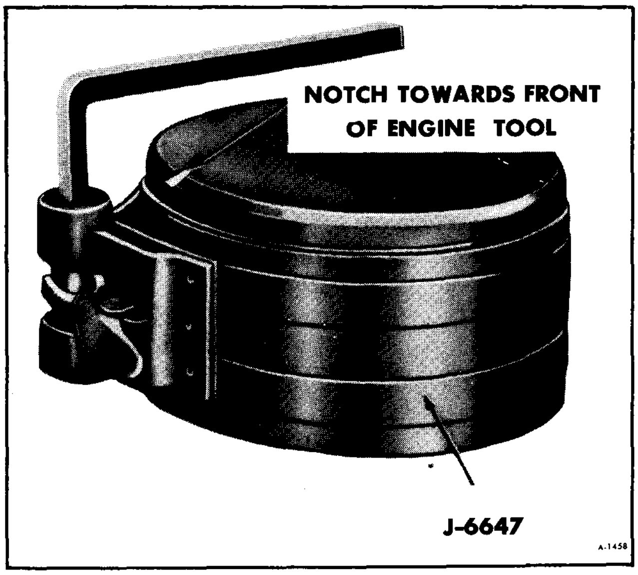


Figure 51—Piston Ring Compressor

The clearance between the adjacent rods, when checked with a feeler gauge on each crankpin, should be from .006″ to .020″. Refer to Figure 44.

5. Torque rod bolt nuts to 42 ft. lbs.

PISTON PINS

The correct piston pin fit in the piston is .0003″ to .0005″ loose. If the pin to piston clearance is to the high limit (.0005″), the pin can be inserted in the piston with very little hand pressure and will fall through the piston by its own weight. If the clearance is .0003″, the pin will not fall through. It is important that the piston pin hole be clean and free of oil when checking pin fit. The pin is a press fit in the connecting rod.

Whenever the replacement of a piston pin is necessary, use the following procedure.

REMOVAL

1. Place piston on piston pin remover with notch on piston facing up.

2. Press out piston pin.

INSTALLATION

1. Place piston on piston pin installer with notch on piston facing up.

2. Coat piston pin and hole with engine oil. Press in piston pin. Piston pin to connecting rod fit is .0008″ to .0018″ interference fit.

CRANKSHAFT PULLEY

REMOVAL

1. Loosen all belts enough so they may be slipped off crankshaft pulley.

2. Hoist motor home.

3. Remove four (4) pulley bolts and pulley.

INSTALLATION

1. Install pulley and four (4) bolts. Torque bolts to 10 ft. lbs.

2. Install belts. Refer to "Belt Tension" next in this section.

BELT TENSION

NOTE: All belt tension checks must be taken midway on the greatest span of that belt.

1. Using belt tension checking gauge BT-33-73F (Burroughs Tool) or other suitable gauge check power steering belt (vehicles equipped with automotive air conditioning MUST have power steering belt checked and adjusted if necessary first). A used power steering belt should be adjusted to 70-80 lbs. A new power steering belt should be adjusted to 110-140 lbs.

2. Check and adjust as required the generator and air conditioning compressor (if equipped) belts. Belt tension should be the same as above.

HARMONIC BALANCER

REMOVAL

1. Remove engine cover.
2. Loosen all accessory drive belts.
3. Raise vehicle.

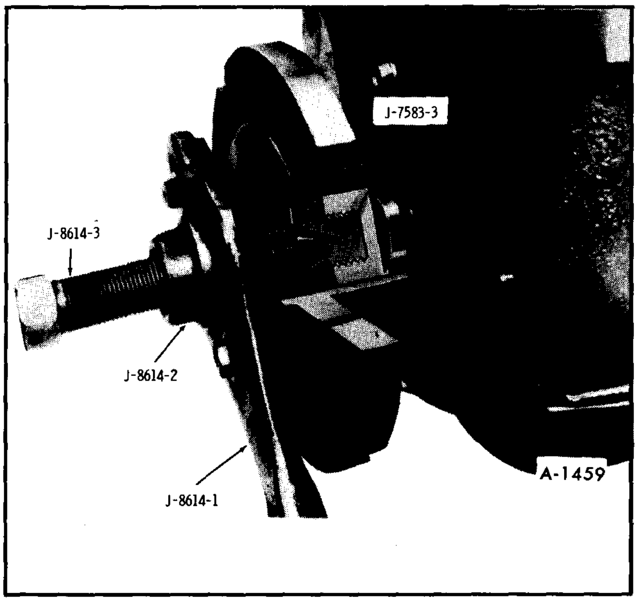


Figure 52—Removing Harmonic Balancer

4. Remove venturi ring seal retainer strap. Push seal forward and over shroud.

5. Slip belts off crankshaft pulley.

6. Remove four (4) crankshaft pulley bolts and remove pulley.

7. Remove harmonic balancer hub bolt and washer.

8. Using balancer puller, remove balancer as shown in Figure 47.

CAUTION: *Use of any other type puller such as a universal claw type which pulls on the outside of the hub can destroy the balancer. The outside ring of the balancer is bonded in rubber to the hub; by pulling on the outside, rather than the hub, it is possible to break the bond. The timing mark is on the outside ring of the balancer; if the bond between the hub and the outside ring is broken, the outside ring could slip which would change the location of the timing mark.*

If it is suspected that the bond has been broken and the timing mark changed, it can be visually checked as shown in Figure 48. Keyway should be approximately 16° from timing slot. In addition there are chisel aligning marks between the weight and hub. These marks should be aligned.

INSTALLATION

1. Apply sealer 1050026 or equivalent, to inside diameter of pulley hub and to crankshaft key to prevent possible oil leakage. Coat outside area of crankshaft pulley hub which enters seal with Special Seal Lubricant No. 1050169, or equivalent.

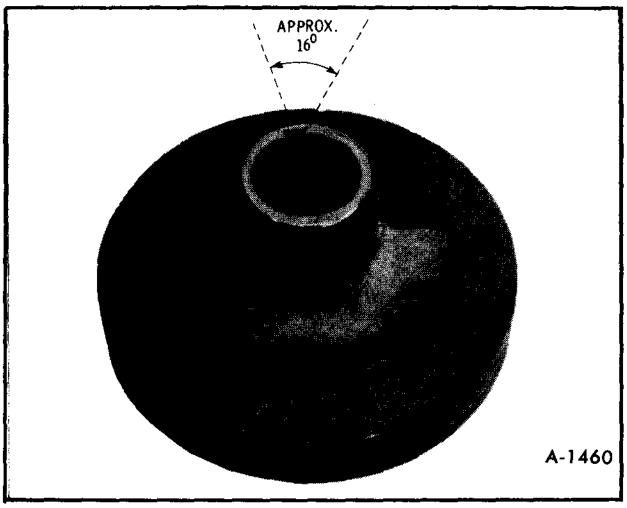


Figure 53—Harmonic Balancer

2. Install harmonic balancer on crankshaft (Figure 49). Use tool J-24724.

NOTE: Balancer to crankshaft fit is .001″ tight to .0007″ loose.

3. Install washer and bolt. Torque bolt to 160 ft. lbs.

4. Install crankshaft pulley and torque four (4) bolts to 10 ft. lbs.

5. Position belts over pulley.

6. Reposition venturi ring seal and install seal retainer strap.

7. Lower vehicle.

8. Tension drive belts. Refer to "Belt Tension" earlier in this section.

9. Install engine cover.

FRONT COVER OIL SEAL

REMOVAL (FRONT COVER INSTALLED)

1. Raise vehicle.

2. Loosen belts so they may be slipped off crankshaft pulley.

3. Remove crankshaft pulley and harmonic balancer. Refer to "Crankshaft Pulley" and "Harmonic Balancer" earlier in this section.

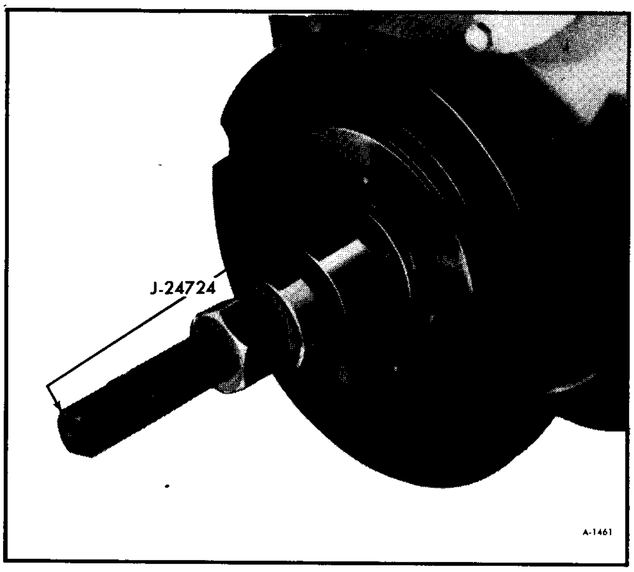


Figure 54—Installing Harmonic Balancer

4. Pry seal out of cover from the front with a large screwdriver, being careful not to damage the surface on the crankshaft.

INSTALLATION

1. Apply 1050026 sealer or equivalent to outside diameter of seal.

2. Using Tool J-5154-01, install oil seal as shown in Figure 55. Tighten until .005″ feeler gauge will fit between front cover and tool.

3. Install crankshaft pulley and harmonic balancer. Refer to "Crankshaft Pulley" and "Harmonic Balancer" earlier in this section.

4. Install belts. Refer to "Belt Tension" earlier in this section.

5. Lower vehicle.

FRONT COVER

REMOVAL

1. Raise vehicle.

2. Drain cooling system. Disconnect radiator hoses, heater hoses, and by-pass hose from the water pump and radiator.

3. Drain oil.

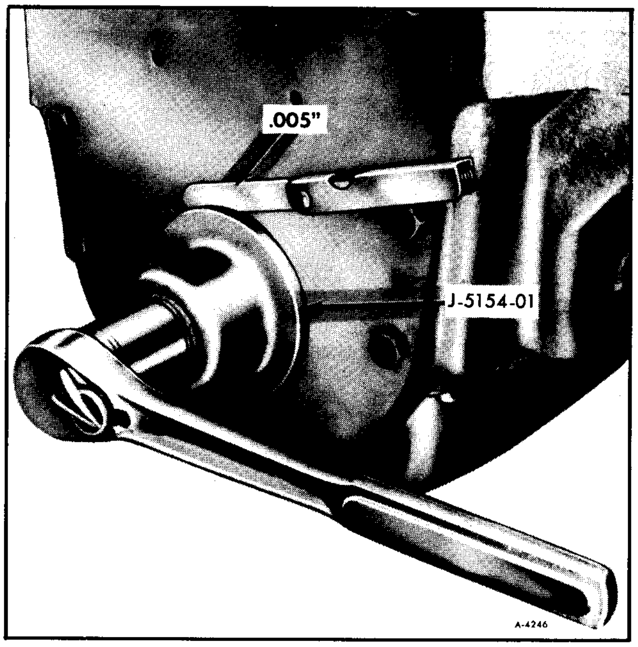


Figure 55—Front Cover Oil Seal Installation

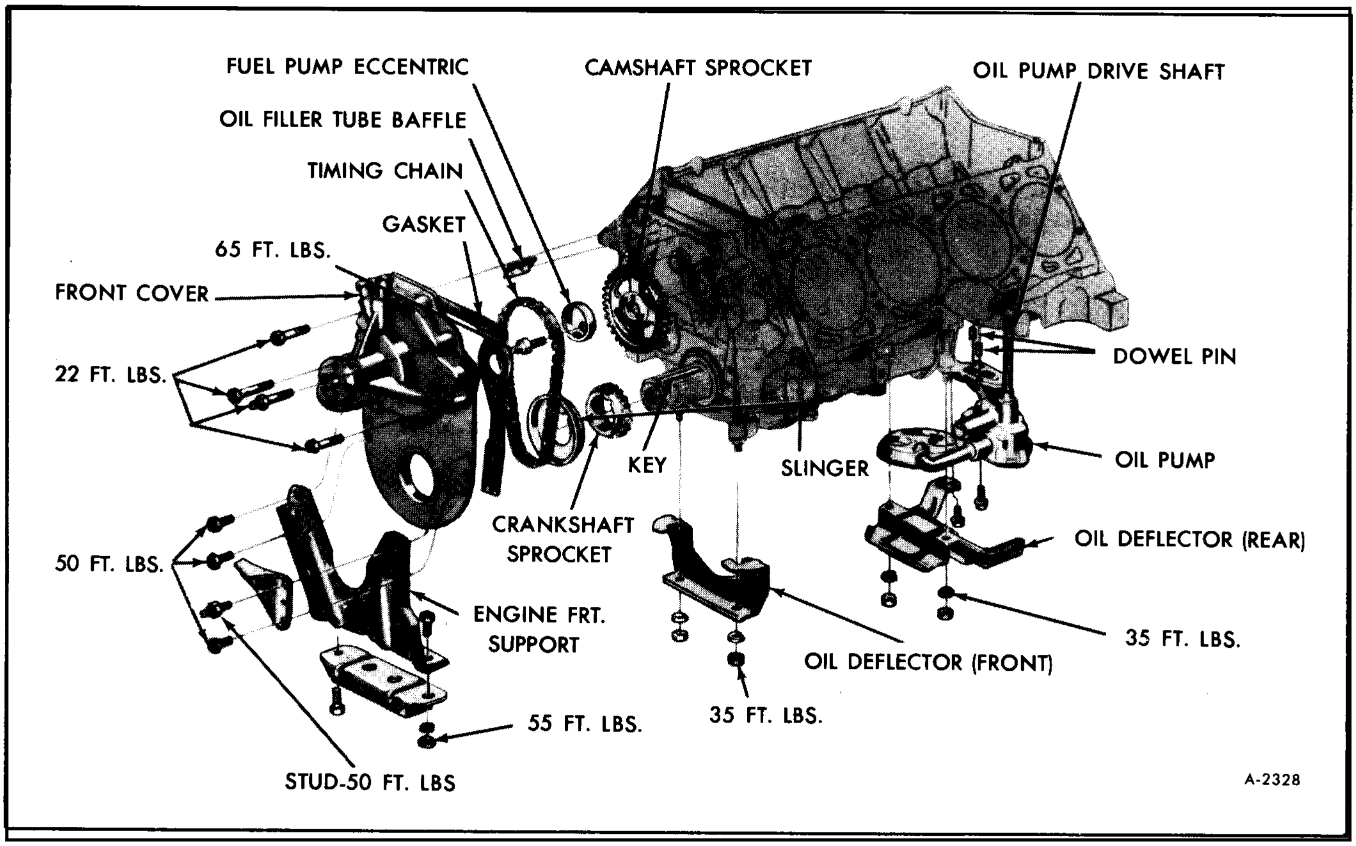


Figure 56—Engine Front Cover Exploded View

4. Remove shroud seal retainer strap.

5. Roll shroud to venturi ring seal over shroud.

6. Remove fan clutch assembly.

7. Remove venturi ring.

8. Remove engine drive belts.

9. Remove crankshaft pulley and harmonic balancer. See "Crankshaft Pulley" and "Harmonic Balancer" earlier in this section.

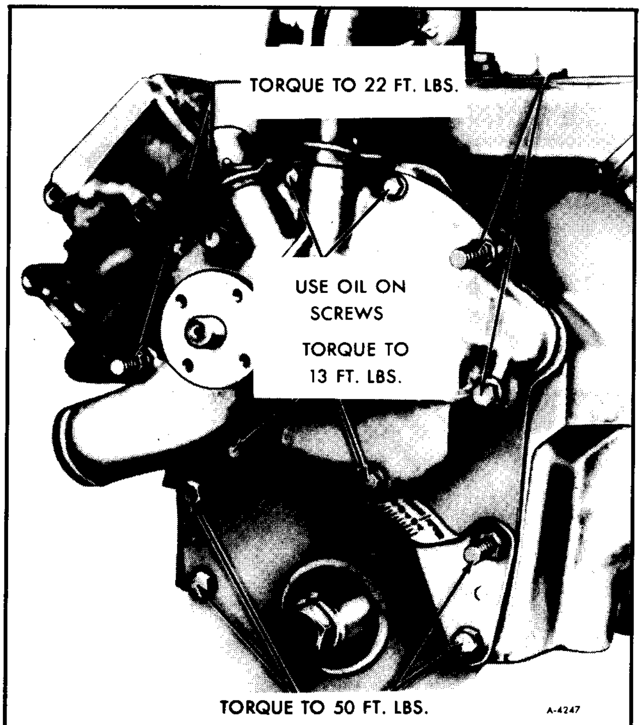
10. Remove oil pan. Refer to "Oil Pan" earlier in this section.

11. Remove front cover to block attaching bolts and remove front cover, timing indicator and water pump assembly (See figure 56).

INSTALLATION

1. Install new cover gasket. Apply 1050026 or equivalent, sealer to gasket around water holes and place gasket on block.

2. Install front cover, timing indicator and water pump assembly. Apply engine oil to bolts and torque bolts as shown in Figure 57.



@1-3.80 A-4247

Figure 57—Engine Front Cover Bolts

3. Apply lubricant 1050169 or equivalent, on pulley hub seal surface.

4. Install oil pan. See "Oil Pan" earlier in this section.

5. Install harmonic balancer and crankshaft pulley. Refer to "Harmonic Balancer" and "Crankshaft Pulley" earlier in this section.

6. Install belts. Refer to "Belt Tension" earlier in this section.

7. Install venturi ring and torque nuts to 20 ft. lbs.

8. Install fan clutch assembly and torque nuts to 15 ft. lbs.

9. Roll shroud-to-venturi ring seal off of shroud and install shroud seal retainer strap.

10. Connect radiator hoses, heater hoses and by-pass hose to water pump and radiator.

11. Replace oil drain plug and shut radiator drain cock.

12. Lower vehicle.

13. Fill radiator and crankcase. Start engine and check for leaks.

TIMING CHAIN AND GEARS

REMOVAL

1. Raise vehicle.

2. Removė front cover. See "Front Cover" earlier in this section.

3. Remove fuel pump eccentric.

4. Remove oil slinger, camshaft and timing chain.

5. Remove key then crankshaft gear.

NOTE: Gear to crankshaft fit tolerances may be such that a puller is necessary. (See figure 58).

CAUTION: *Remove crankshaft key, if possible before using puller; if not, align puller so that it does not overlap end of key when using puller, keyway is machined only part way in crankshaft gear and breakage would occur.*

INSTALLATION

1. Install camshaft gear crankshaft gear and timing chain together, and then align timing marks as shown in Figure 59.

NOTE: When the timing marks are in alignment (Figure 59), number six is at T.D.C. To obtain T.D.C. for number one cylinder, slowly rotate crankshaft one rotation, this will bring the cam mark to the top, number one will then be in the firing position.

2. Install fuel pump eccentric with flat side rearward. See Figure 60. Torque bolt to 65 ft. lbs.

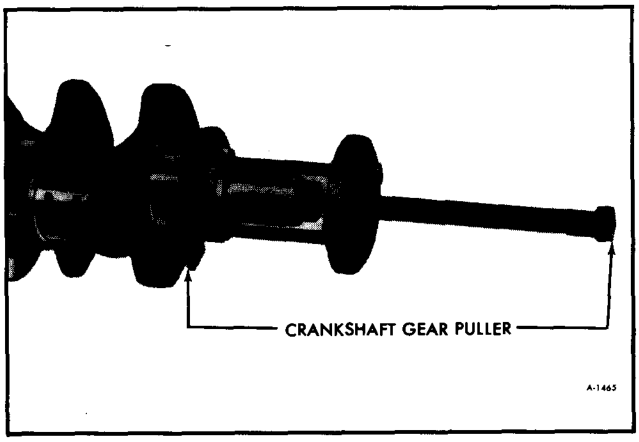


Figure 58—Crankshaft Gear Removal

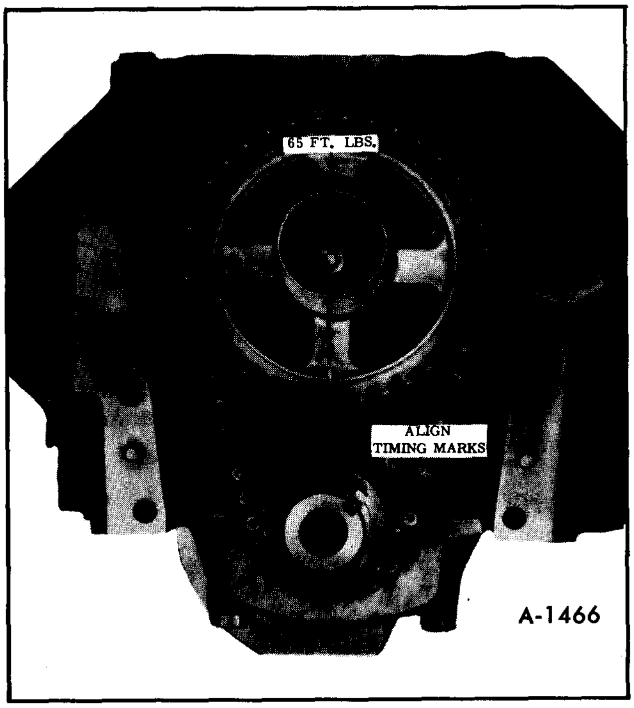


Figure 59—Timing Gear Position

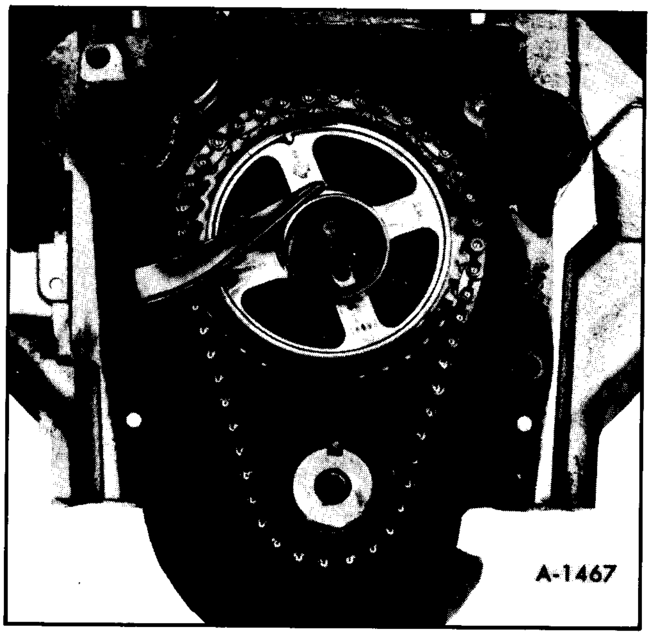


Figure 60—Fuel Pump Eccentric

3. Drive crankshaft gear key in with a brass hammer until it bottoms.

4. Install oil slinger.

5. Install front cover. See "Front Cover" earlier in this section.

6. Lower vehicle.

CHECKING VALVE TIMING WITHOUT REMOVING FRONT COVER

1. Remove distributor cap, right valve cover, No. 4 cylinder intake and exhaust rocker arms and pivot.

2. Ground coil wire to engine.

3. Turn ignition switch on. Crank engine until rotor is in line with No. 4 spark plug wire position. No. 4 piston will be approximately at the top of the cylinder.

4. Measure from pivot boss on head surface to top of No. 4 intake push-rod. Record measurement. See Figure 61.

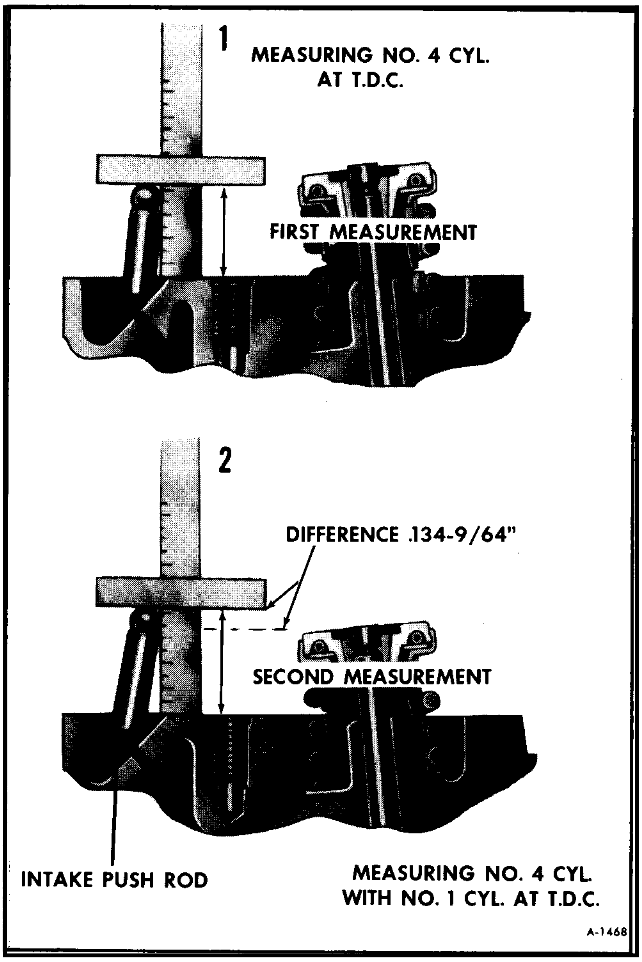


Figure 61—Checking Valve Timing

5. Slowly turn engine 1-1/2 revolutions until rotor approaches No. 1 spark plug wire position. Continue to turn engine until timing mark on crank pulley is aligned with O on indicator. This is top dead center of No. 1 piston.

6. Again measure from pivot boss surface to top of No. 4 cylinder intake push-rod. See Figure 61.

7. Measurement should increase over the first measurement as shown in Figure 61.

8. If measurement increase is not within 1/32" of that shown on chart, camshaft is advanced or retarded.

ENGINE REPLACEMENT

The engine assembly may be removed with or without the transmission and final drive attached.

NOTE: It is recommended to remove the transmission and final drive from the vehicle before the engine.

In some situations repair to the engine (ie. piston replacement, oil pan gasket replacement, oil pump repair etc.) requires removal of the engine oil pan. If this is the case, refer to "Oil Pan" earlier in this section.

Refer to steps 1 through 20 for removal of transmission and final drive with engine remaining in vehicle.

Refer to steps 21 through 46 for removal of engine after the transmission and final drive have been removed.

WARNING: A VEHICLE OF THIS SIZE AND WEIGHT COMBINED WITH THE WEIGHT AND BULKINESS OF THE ENGINE AND/OR TRANSMISSION AND FINAL DRIVE DURING REMOVAL PRESENTS A POTENTIALLY DANGEROUS SITUATION TO PERSONNEL. ENGINE, TRANSMISSION AND FINAL DRIVE REMOVAL EITHER AS A UNIT OR SEPARATE COMPONENTS SHOULD BE PERFORMED WHILE USING A "TWIN POST" HOIST.

REMOVAL

1. Disconnect negative (—) battery cables from both the automotive and living area batteries.

NOTE: Drain radiator before raising vehicle.

2. Remove engine cover, remove air cleaner, disconnect coil bracket (only on vehicles equipped with breaker point ignition systems), and position engine removal Tool No. J-24603-01 to the engine. Adjust lift mechanism until all slack is removed from the cable. (See figure 5).

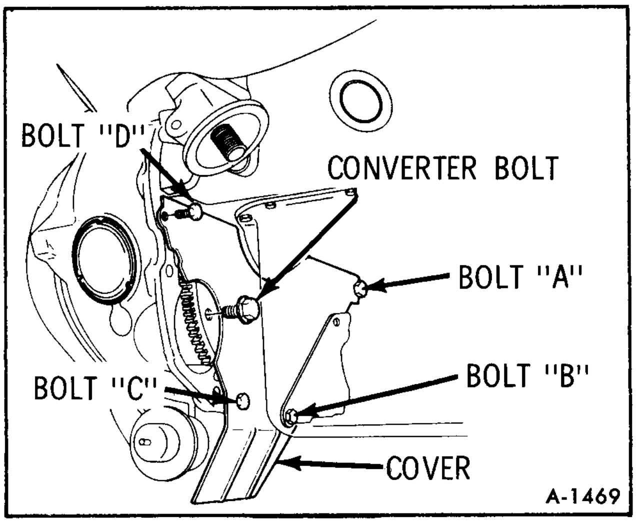


Figure 62—Flywheel Cover Removal

NOTE: To properly position engine removal tool, remove seat belt plate and anchor bolt assembly. Attach load adjustor chain to front and rear engine lift locations as shown in Figures 6 and 7. Then install support braces and chain fall as shown in Figures 5, 6 and 7.

3. Raise vehicle. See WARNING at the beginning of "Engine Replacement".

4. Disconnect wires from starter solenoid.

5. Remove starter motor.

6. Referring to Figure 62, remove flywheel cover bolts "B", "C" and "D". Loosen bolt "A" and pivot cover out of the upper L.H. bolt "A" slot.

7. Disconnect transmission shift linkage and speedometer cable from transmission and position to one side.

8. Disconnect transmission fluid cooler lines, detent solenoid wire and modulator tube from the transmission. Position all to the side.

9. Disconnect R.H. drive axle from the final drive output shaft. (Refer to Section 3B). Move drive axle rearward.

10. Remove lower R.H. venturi ring bracket.

11. Remove output shaft bracket from engine and remove R.H. output shaft assembly from final drive.

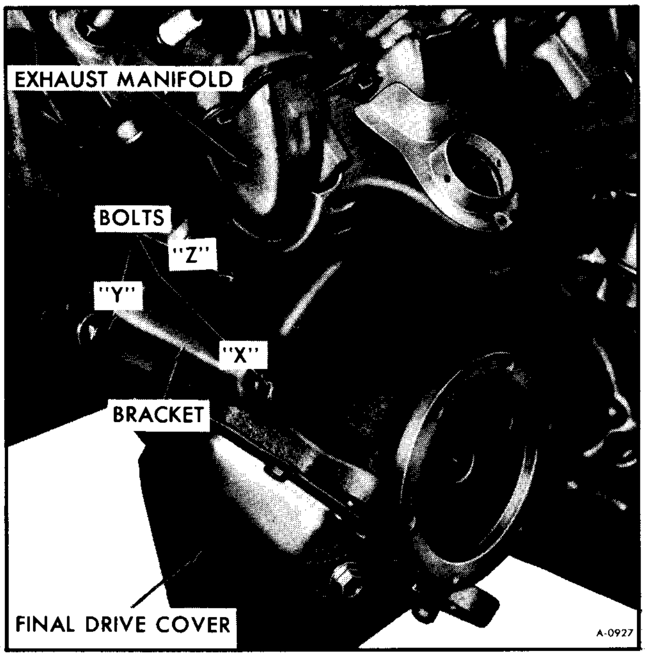


Figure 63—Disconnecting Final Drive From Engine

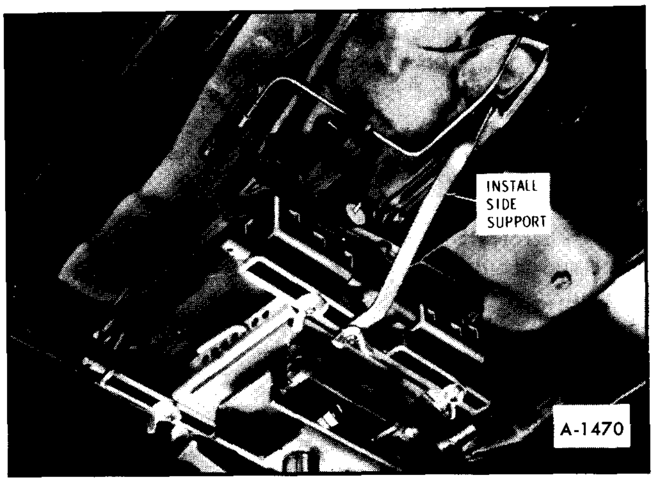


Figure 64—Transmission Jack Installation

12. Disconnect L.H. drive axle from flange at final drive and reposition axle forward and clear of the flange.

13. Remove bolt "Z". (See figure 63).

14. Remove three (3) bolts that secure the converter to the flywheel.

NOTE: Rotate flywheel to gain access (Refer to figure 62).

15. Remove three (3) transmission to support bracket bolts (Figure 9).

16. Remove support bracket to crossmember bolts.

17. Position transmission jack under transmission as shown in Figure 64.

18. Remove six (6) bolts that attach the flywheel housing to the engine.

19. Slide transmission rearward.

NOTE: Reposition transmission support bracket upward as required to obtain clearance between transmission and floor.

20. Remove transmission and final drive.

21. Lower vehicle.

22. Remove engine oil dipstick.

23. Disconnect vacuum lines to the brake booster and heater controls from the intake manifold. Disconnect the vacuum line to the carbon canister from the front of the carburetor.

24. Disconnect throttle linkage (See figure 13).

25. Disconnect coil bracket, if so equipped, from engine and position on top of intake manifold. Disconnect wire from the negative coil terminal.

26. Disconnect heater hoses.

27. Disconnect wire from brake combination valve.

28. Disconnect engine harness.

29. Remove engine oil filler upper tube.

30. Remove engine oil dipstick tube.

31. Disconnect upper radiator hose from engine.

32. Disconnect air conditioning compressor (if equipped) from bracket and with wire support it up and out of the way.

NOTE: Freon lines do not have to be disconnected.

33. Remove generator.

34. Remove both upper venturi ring brackets.

35. Raise vehicle.

36. Disconnect both R.H. and L.H. exhaust pipes at exhaust manifolds.

37. Disconnect engine oil cooler tubes from tube to hose union.

38. Disconnect fuel line from fuel pump.

39. Disconnect lower radiator hose.

40. Remove lower L.H. venturi ring bracket.

41. Remove venturi ring retainer strap. Remove venturi ring and radiator shroud.

42. Disconnect lower radiator hose.

43. Disconnect power steering hoses from the power steering pump.

44. Remove engine front mounting bolts.

45. Remove hub cap from L.H. hub. Remove cotter pin and axle nut. Tap lightly on outboard end of L.H. axle until splines are free. Remove L.H. drive assembly.

46. Raise engine assembly using engine removing tool J-24603-01.

47. Gradually remove engine assembly by alternately raising, tilting and lowering the engine assembly. Use care when supporting engine on dolly to prevent damage to oil pan.

INSTALLATION

1. Using tool J-24603-01 as shown in Figures 5, 6, and 7, raise engine assembly adjusting and tilting until engine front mount lines up so bolts may be installed. Install nuts finger tight.

2. Install L.H. drive axle into knuckle and torque axle nut to 110 ft. lbs. Advance nut to next castellation if necessary and install cotter pin.

NOTE: Do not allow drive axle to hang unsupported. Use a piece of wire to support drive axle.

3. Raise transmission and final drive using the transmission jack. Position transmission support bracket while raising the transmission.

4. Position transmission and install six (6) bolts that attach flywheel housing to engine torque bolts to 25 ft. lbs.

5. Position transmission support bracket and referring to Figure 7 torque bolts "A", "B" and "C" to 55 ft. lbs. Torque bolts "D" and "E" to 55 ft. lbs.

6. Install three (3) converter to flywheel bolts. Torque to 30 ft. lbs.

NOTE: Rotate flywheel to gain access. Refer to Figure 62.

7. Referring to Figure 63, install bolt "Z" and torque to 105 ft. lbs.

8. Properly position L.H. drive axle and torque NEW attaching bolts to 65 ft. lbs.

9. Install R.H. output shaft into final drive and attach support bolts to engine.

IMPORTANT: When attaching the right hand output shaft to the engine bracket, do not let the shaft hang. Assemble bracket bolts loosely, and by moving the flange end of the shaft up and down, and back and forth, find the center location. Hold the shaft in this position and then torque the bolts to 55 ft. lbs. on support.

10. Install lower R.H. venturi ring bracket. Torque nut on engine stud to 45 ft. lbs. Torque nut at venturi ring attachment to 20 ft. lbs.

11. Position R.H. drive axle and torque NEW attaching bolts to 65 ft. lbs.

12. Connect transmission cooler lines and tighten fittings to 20 foot-pounds and then connect detent solenoid wire and modulator tube.

13. Connect transmission shift linkage and speedometer cable.

14. Referring to Figure 62, install flywheel cover and tighten bolts "A", "B", "C" and "D" to 5 ft. lbs. torque.

15. Install starter and torque bolts to 30 ft. lbs. Connect wires to starter.

16. Tighten engine front mounting nuts to 50 ft. lbs. torque.

17. Connect power steering lines to the power steering pump.

18. Install fan shroud and torque bolts to 15 ft. lbs.

19. Install engine fan and clutch assembly. Torque nuts to 15 ft. lbs.

20. Install L.H.lower venturi ring bracket. Torque nuts to 20 ft. lbs.

21. Install venturi ring. Make sure seal overlaps the venturi ring.

22. Secure venturi ring to brackets by installing nuts and bolts finger right. Install shroud seal retainer strap.

23. Connect lower radiator hose. Torque clamp to 17 in. lbs.

24. Connect fuel line to fuel pump.

25. Connect engine oil cooler lines.

26. Connect R.H. and L.H. exhaust pipes. Tighten pipe to exhaust manifold bolts until they bottom on spacer.

27. Lower vehicle and remove engine removal tool J-24603-01.

28. Install both upper venturi ring brackets. Torque nuts to 25 ft. lbs.

29. Install generator. See Figure 11 for torque values. Refer to "Belt Tension" earlier in this section.

30. Install air conditioning compressor. See Figure 10 for torque values. Refer to "Belt Tension" earlier in this section.

31. Connect upper radiator hose to engine. Torque clamp to 17 in. lbs.

32. Install engine oil dipstick tube.

33. Install engine oil filler upper tube.

34. Connect engine harness.

35. Connect wire to the brake combination valve.

36. Connect heater hoses.

37. Connect coil bracket (if so equipped) to engine. Connect wire to negative coil terminal.

38. Connect throttle linkage.

39. Connect vacuum lines to the brake booster and heater controls to the intake manifold. Connect the vacuum line from the carbon canister to the front of the carburetor.

40. Add engine oil and transmission fluid, as required. Add engine coolant. Refer to "Engine Cooling" later in this manual. Refer to SECTION 7 for details on "Checking and Adding Transmission Fluid".

41. Connect battery negative(—) ground cables.

42. Check transmission shift linkage. Refer to SECTION 7 under "Linkage Adjustment".

43. Shut engine off. After several minutes check engine oil level.

OUT OF VEHICLE SERVICE OPERATIONS

CAMSHAFT

REMOVAL

1. Remove engine. Refer to "Engine Replacement" earlier in this section.

2. Remove oil pan. Refer to "Oil Pan" earlier in this section.

3. Remove crankshaft pulley and harmonic balancer. Refer to "Crankshaft Pulley" and "Harmonic Balancer" earlier in this section.

4. Remove front cover. Refer to "Front Cover" earlier in this section.

5. Remove valve covers. Refer to "Valve Covers" earlier in this section.

6. Remove spark plug cables and distributor cap intact.

7. Remove intake manifold. Refer to "Intake Manifold" earlier in this section.

8. Remove rocker arms, push rods and valve lifters. Refer to those items earlier in this section for removal.

NOTE: Parts position should be noted so they will be installed in their original location.

9. Remove bolt securing fuel pump eccentric, remove eccentric, camshaft gear, oil slinger and timing chain. Refer to "Timing Chain and Gears" in this section.

10. Remove camshaft by carefully sliding it out the front of the engine.

NOTE: Do not force shaft as damage can occur to camshaft bearings.

INSTALLATION

1. Coat camshaft and bearings liberally with Part No. 1051396 or equivalent before installing.

2. Slide camshaft into block.

NOTE: Do not force shaft as damage may occur to camshaft bearings.

3. Install gears, timing chain, eccentric and oil slinger. Refer to "Timing Chain and Gears" eariler in this section.

4. Install valve lifters, push rods and rocker arms. Refer to "Rocker Arm Assemblies" earlier in this section.

5. Install intake manifold. Refer to "Intake Manifold" earlier in this section. Install belts and adjust. Refer to "Belt Tension" as described earlier in this section.

6. Install distributor as described in SECTION 6Y of this manual.

7. Install valve covers. Connect spark plug cables.

8. Install front cover. Refer to "Front Cover" earlier in this section.

9. Install crankshaft pulley and harmonic balancer. Refer to "Harmonic Balancer" and "Crankshaft Pulley" earlier in this section.

10. Install oil pan. Refer to "Oil Pan" as described earlier in this section.

11. Install engine. Refer to "Engine Replacement" earlier in this section.

CAMSHAFT BEARINGS

The camshaft bearings must be replaced in complete sets. All bearings must be removed before any can be installed. No. 1 bearing must be removed first, then No. 2, then 3, 4, and 5. When installing the bearings, No. 5 must be installed first, then, 4, 3, 2 and 1.

REMOVAL

1. Remove camshaft as described in "Camshaft" earlier in this section.

NOTE: Each cam bearing is different in diameter and the correct sequence must be used both for removal and installation.

2. Using a cam bearing remover set drive out camshaft bearings starting with No. 1.

3. When removing No. 5 drive out rear cup plug, located behind No. 5 camshaft bearing. See Figure 60.

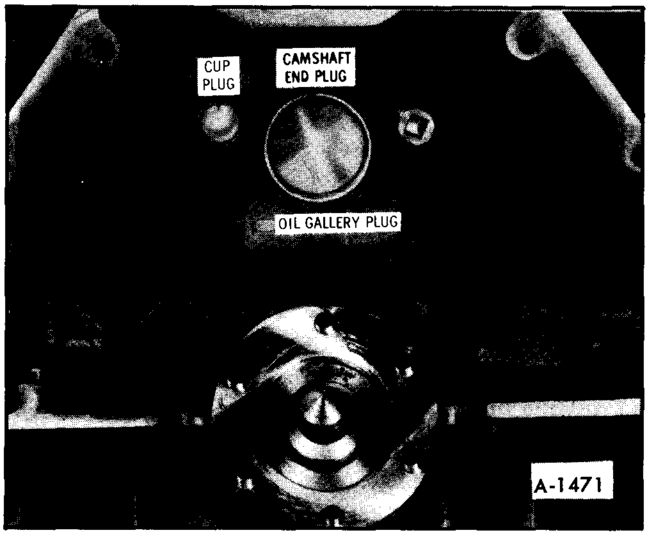


Figure 65—Camshaft and Oil Galley Plug

INSTALLATION

1. Install new cup plug in rear of No. 5 bearing bore and seal with a permanent type sealer.

NOTE: To aid aligning bearings with oil passages, place each bearing in the front bore with tapered edge toward block and align the oil hole in the bearing with the center of the oil slot in the bore. Mark top of bearing. When installing the bearings the mark will act as a guide.

2. Drive No. 5 camshaft bearing into place and check oil hole alignment as shown in Figure 66.

3. Install remaining bearing checking for proper alignment of oil holes. Wire must enter hole or the bearing will not receive sufficient lubrication.

Camshaft and Oil Gallery Plugs

(Figure 65)

The left hand rear oil gallery plug is not shown. It is a threaded plug in the end of the left gallery just rearward of the distributor. A small hole is provided in the plug for distributor lubrication. The cup plug shown provides access to the threaded plug.

The front oil gallery plugs (not shown) are threaded. The plug on the right side has a small hole which provides lubrication for the timing chain and gears.

To find out if the camshaft plug at the rear of the engine is properly installed: Place a straight edge

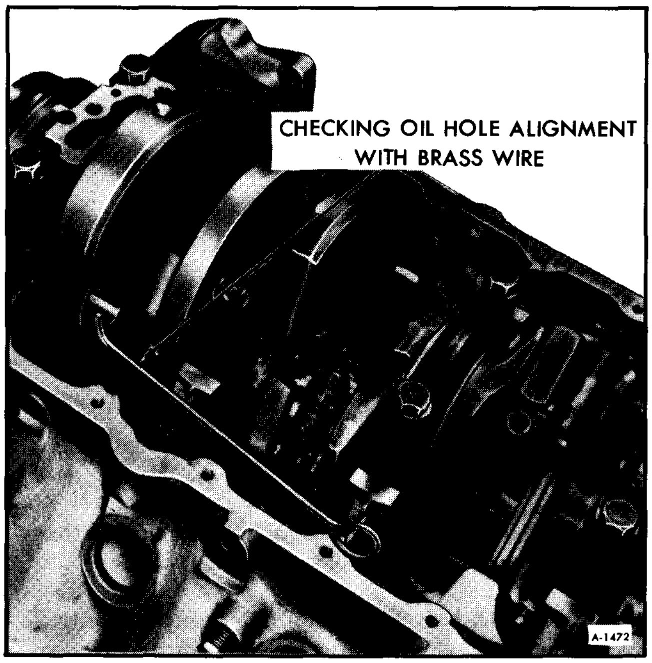


Figure 66—Checking Oil Hole Alignment

across the machined surface of the rear of the block and measure from the straight edge to the lip of the plug. Dimension should be .250" maximum to .160" minimum.

CRANKSHAFT

REMOVAL

1. With engine on stand and oil pan, oil pump and front cover removed, rotate crankshaft to the position where the connecting rod nuts are most accessible. Figure 67 shows No. 3 and No. 4 rods in the fully extended position.

2. Remove main bearing caps.

3. Remove connecting rod caps and install thread protectors.

4. Note position of keyway in crankshaft so it can be installed in the same position.

5. Lift crankshaft out of block. Rods will pivot to the center of the engine when the crankshaft is removed.

Do not allow pistons to move in their bore during or after crankshaft removal.

INSTALLATION

1. Install sufficient oil pan bolts in pan rails to align rods with rubber bands as shown in Figure 67.

Align rods so that the inner thread protectors of adjacent rods overlap approximately one inch as shown. Alignment can be adjusted by increasing tension on rubber bands with additional turns around the pan bolts or thread protectors.

2. Position upper half of main bearings in block and lubricate with engine oil.

3. Install a new rear main bearing seal.

4. After oil passages in crankshaft have been checked for being open and shaft is clean, place shaft in block. Lubricate thrust flanges of the center bearing with 1050169 Lubricant or equivalent. Install caps with lower half of bearing lubricated with engine oil. Lubricate cap bolts with No. 1050125 or equivalent, and install, but do not tighten.

5. With a block of wood (figure 68) bump shaft in each direction to align thrust flanges of center main bearing.

NOTE: After bumping shaft in each direction, wedge the shaft to the front and hold it while torquing No. 3 cap bolts.

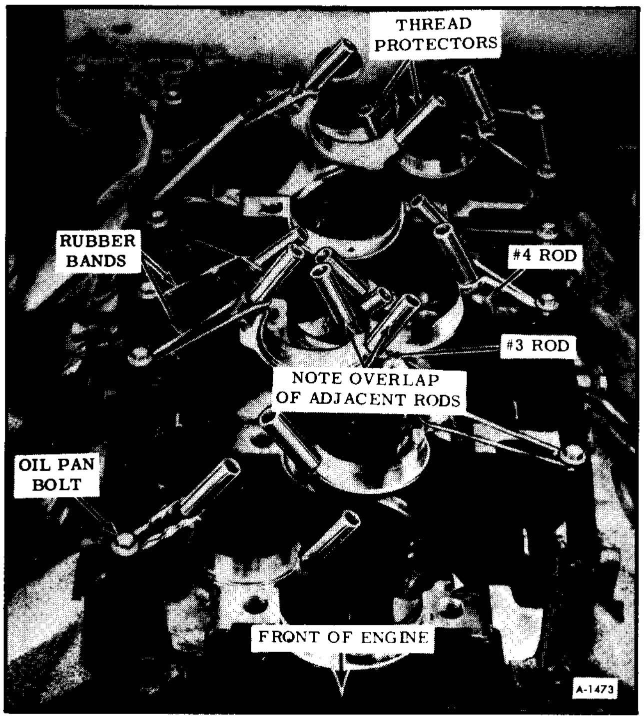


Figure 67—Crankshaft Removal

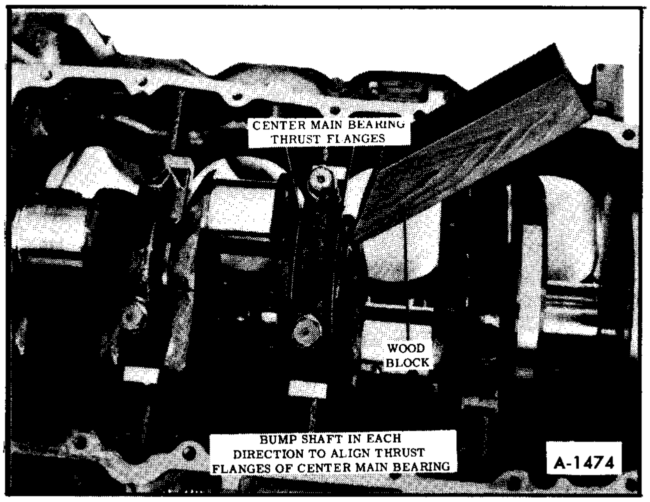


Figure 68—Aligning Center Main Bearing Flanges

6. Remove rubber bands, thread protectors and oil pan bolts.

7. Install main bearing caps and torque bolts to 120 ft. lbs.

8. Reassemble engine.

MAIN BEARINGS

Main bearing clearance must not exceed .0035" on all bearings. The .0035" clearance is permissible only if the engine is disassembled for other than a bearing noise condition. If bearings are noisy or if a visual inspection indicates defective bearings, new bearings must be installed within the specifications outlined under "Main Bearings".

Bearings which fall within the .0035" specifications should not be rejected if the bearings show a normal wear pattern or slight radial grooves, unless it has been established to be defective.

CHECKING BEARING CLEARANCES

1. If not already removed, remove oil pan. Refer to "Oil Pan" earlier in this section.

2. Remove bearing cap and wipe oil from crankshaft journal and outer and inner surfaces of bearing shell.

3. Place a piece of plastigauge in the center of bearing.

4. Use a floor jack or other means to hold crankshaft against upper bearing shell. This is necessary to obtain accurate clearance readings when using plastigauge.

5. Reinstall bearing cap and bearing. Place Lubricant No. 1050125 or equivalent on cap bolts and install.

Torque to 120 ft. lbs. cap bolts.

6. Remove bearing cap and determine bearing clearance by comparing the width of the flattened plastigauge at its widest point with graduation on the plastigauge container. The number within the graduation on the envelope indicates the clearance in thousandths of an inch. (figure 69) If this clearance is greater than .0035" REPLACE BOTH BEARING SHELLS AS A SET. Recheck clearance after replacing shells.

NOTE: Main bearing end thrust clearance should be .004" to .008" as checked with a dial indicator.

MAIN BEARING REPLACEMENT

Main bearing clearance must be corrected by the use of selective upper and lower shells. UNDER NO CIRCUMSTANCES should the use of shims behind the shells, to compensate for wear, be attempted.

NOTE: The upper and lower shells must be installed in pairs (figure 70). Sizes of the bearings are located on the tang (figure 71). It is possible to have more than one bearing size in the same engine.

To install main bearing shells, proceed as follows:

1. Remove bearing cap and remove lower shell.

2. Insert a flattened cotter pin, roll out pin or tool J-8080 (if available) in the oil passage hole in the

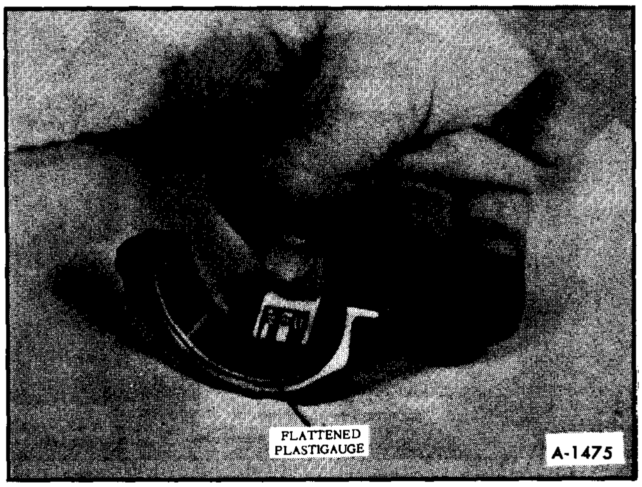


Figure 69—Checking Bearing Clearance

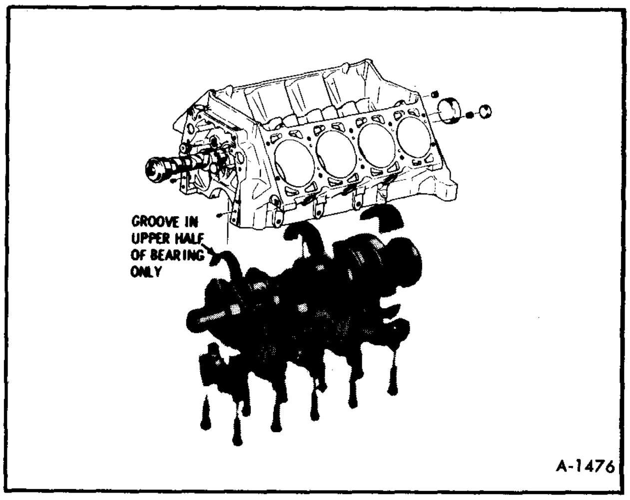


Figure 70—Crankshaft Exploded View

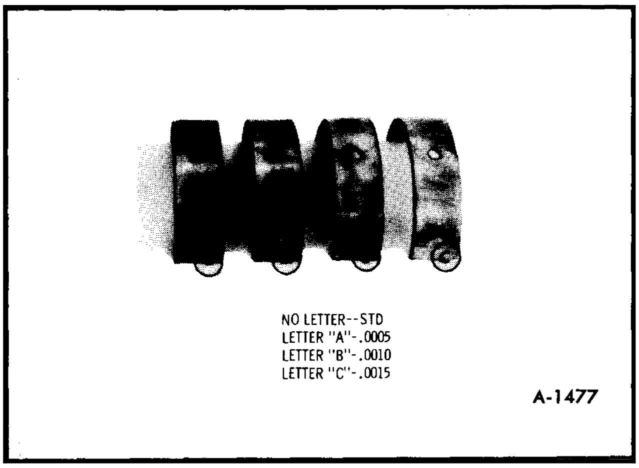


Figure 71—Main Bearing

crankshaft, then rotate the crankshaft in the direction opposite to cranking rotation. The pin will contact the upper shell and roll it out.

3. The main bearing journals should be checked for roughness and wear. Slight roughness may be removed with a fine grit polishing cloth saturated with engine oil. Burrs may be removed with a fine oil stone. If the journals are scored or ridged, the crankshaft must be replaced.

> **NOTE:** The journals can be measured for out-of-round with the crankshaft installed by using a crankshaft caliper and inside micrometer or a main bearing micrometer. The upper bearing shell must be removed when measuring the crankshaft journals. Maximum out-of-round of the crankshaft journals must not exceed .0015".

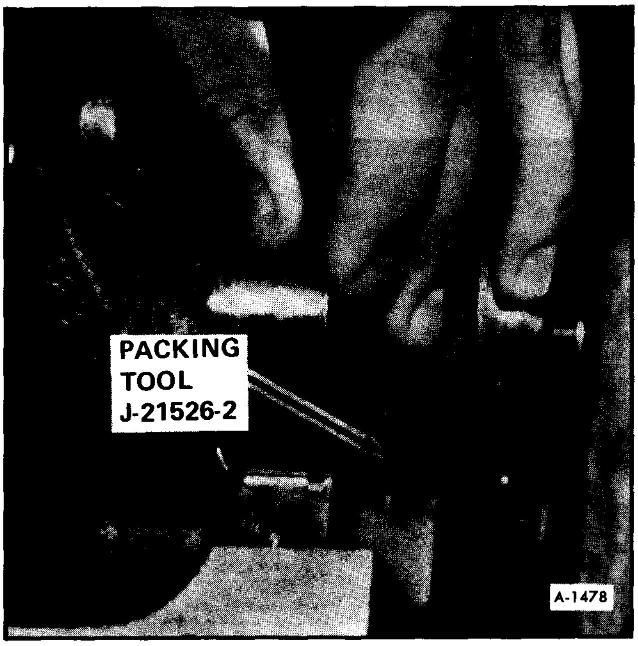


Figure 72—Packing Seal Into Cylinder Block

4. Clean crankshaft journals and bearing caps thoroughly before installing new main bearings.

5. Apply Special Lubricant, No. 1050169 or equivalent to the thrust flanges of bearing shells on No. 3 bearing.

6. Place new upper shell on crankshaft journal with locating tang in correct position and rotate shaft to turn it into place using cotter pin or roll out pin as during removal.

7. Place new bearing shell in bearing cap.

8. No. 5 bearing - Install new asbestos oil seal in the rear main bearing cap as described later in this section. Install sealer on cap as shown.

9. Install bearing caps, lubricate bolt threads with No. 1050125 Lubricant or equivalent, and install.

Torque cap bolts to 120 ft. lbs.

10. Install oil pan. Refer to "Oil Pan" earlier in this section.

REAR MAIN BEARING UPPER OIL SEAL

REPAIR

Tool J-21526 is available to provide a means of correcting engine rear main bearing upper seal leaks with the necessity of removing the crankshaft. Replacement of the rear main bearing upper oil seal requires crankshaft removal. The procedure for seal leak correction is listed below.

1. Drain oil and remove oil pan and rear main bearing cap.

2. Insert Packing Tool J-21526-2 against one end of seal in cylinder block and drive the old seal gently into the groove until it is packed tight. This varies from 1/4" to 3/4" depending on the amount of pack required. See Figure 72.

3. Repeat this on the other end of the seal in the cylinder block.

4. Measure the amount the seal was driven up on one side; add 1/16", then cut this length, from the old rear main lower oil seal removed from the cap,

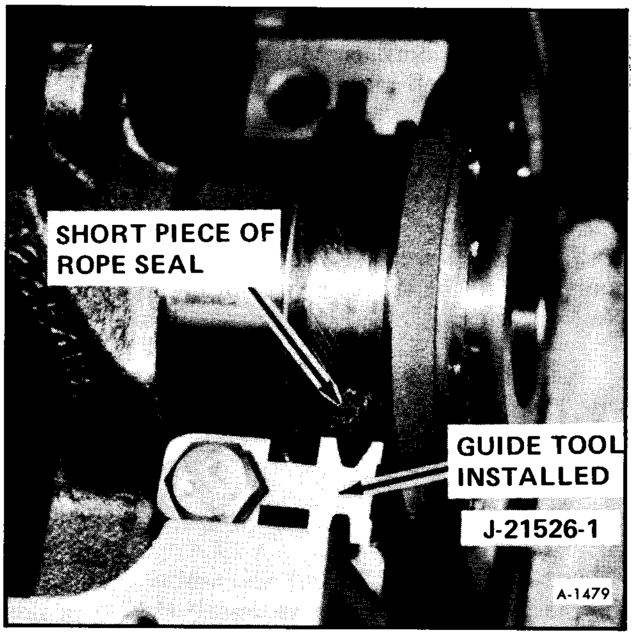


Figure 73—Guide Tool Installed

with a single edge razor blade. Measure the amount the seal was driven up on the other side. Add 1/16" and cut another length from old seal. Use main bearing cap as a holding fixture when cutting seal.

5. Place a drop of 1050026 Sealer or equivalent, on each end of seal and cap as indicated.

6. Work these two pieces of seal into the cylinder block (one piece on each side) with two small screwdrivers. Use guide tool J-21526-1 as shown in Figure 73. Using packing tool, pack these short pieces up into the block. See Figure 74.

NOTE: Place a piece of shim stock between seal and crankshaft to protect bearing surface before trimming.

7. Form a new rope seal in the rear main bearing cap. Refer to "Rear Main Lower Oil Seal" next in this section.

8. Assemble the cap to the block and torque to 120 ft. lbs.

REPLACEMENT

1. Remove crankshaft. Refer to "Crankshaft" earlier in this section.

2. Remove upper oil seal.

3. Install a new rear main bearing upper seal. Use tool J-26484 as shown in Figure 75.

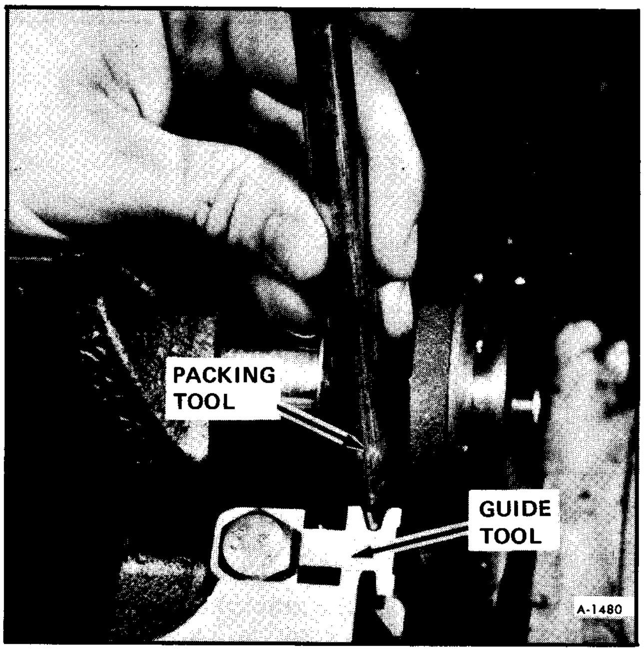


Figure 74—Packing Seal Into Guide and Cylinder Block

4. After correctly positioning seal, rotate tool slightly and cut off each end of seal flush with block.

5. Install crankshaft as described earlier in this section under "Crankshaft".

REAR MAIN LOWER OIL SEAL

REMOVAL

1. Remove oil pan. Refer to "Oil Pan" earlier in this section.

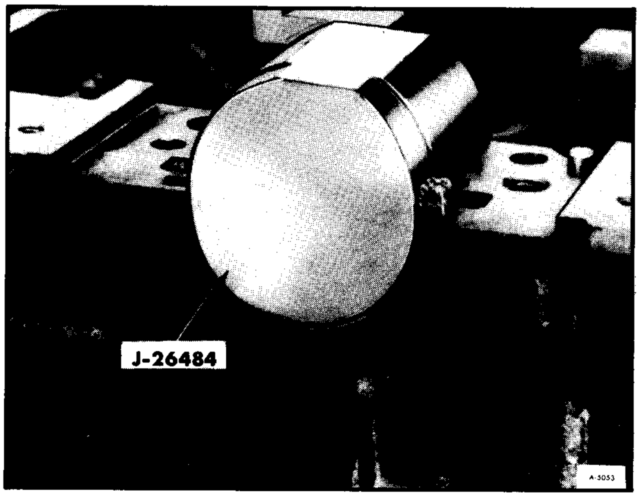


Figure 75—Installing Rear Main Seal-Upper Half

2. Remove the rear main bearing cap.

3. Remove rear main bearing insert and old seals.

4. Clean bearing cap and seal grooves and inspect for cracks.

INSTALLATION

1. Install seal into bearing cap, packing by hand.

2. Using seal installer J-26484 hammer seal into groove. (See figure 76).

NOTE: To check if seal is fully seated in the bearing cap, slide the tool away from seal. With tool fully seated in the bearing cap, slide tool against the seal. If undercut area of tool slides over the seal, the seal is fully seated. If tool butts against the seal, the seal must be driven further into the seal groove. Rotate tool before cutting off excess seal packing.

3. With tool slightly rotated, cut seal flush with mating surface. With screwdriver, pack seal end fibers towards center, away from edges. Rotate seal installer when cutting seal to avoid damage to tool.

4. Apply sealer on shaded areas of Figure 71.

5. Clean bearing insert and install in bearing cap.

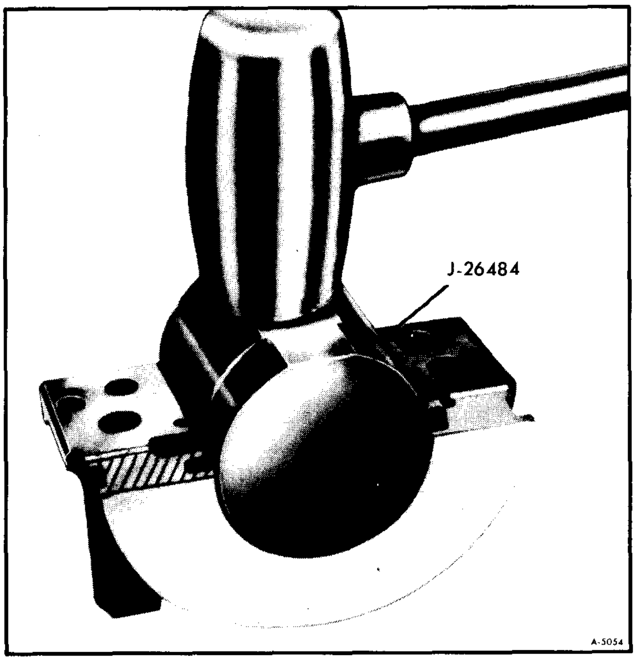


Figure 76—Installing Rear Main Seal-Lower Half

6. Clean crankshaft bearing journal and seal contact. Install sealer on cap as shown.

7. Install bearing caps, lubricate bolt threads with No. 1050125 Lubricant or equivalent and install. Torque bearing cap bolts to 120 ft. lbs.

8. Install oil pan. Refer to "Oil Pan" earlier in this section.

ENGINE SPECIFICATIONS

CYLINDER BLOCK	
Engine Type	90° V-Type
No. of Cylinders	8
Bore and Stroke	4.126" x 4.250"
Piston Displacement-455 cu. in.	
Compression	8.5:1
Firing Order	1-8-4-3-6-5-7-2
Main Bearing Bore (I.D.)	3.188" - 3.189"
CRANKSHAFT	
Diameter-Main Bearing Journal	3.0003" - 2.9993"
Width-Main Bearing Journal (with fillets)	
No. 1	1.185"
No. 2 & 4	1.156" - 1.166"
No. 3	1.199" - 2.001"
No. 5	1.882"
Diameter-Connecting Rod Bearing Journal	2.4998" - 2.4988"
Width-Connecting Rod Bearing (with fillets)	1.877" - 1.887"
Length-Overall Crankshaft	26.470"
Diameter - Oil Holes in Crankshaft	.201" - .223"
Clearance - Crankshaft End	.004" - .008"

MAIN BEARINGS
- Bearing Clearance - Crankshaft 1,2,3, & 4 ..... .0005" - .0021"
  - (Vertical)5 ..... .0020" - .0034"
- Width-Bearing Shell
  - No. 1,2, and 4 ..... .970" - .980"
  - No. 3 ..... 1.193" - 1.195"
  - No. 5 ..... 1.624"

CONNECTING RODS
- Length-Center to Center ..... 6.733" - 6.737"
- Diameter-Connecting Rod Bore ..... 2.6243" - 2.6250"
- Diameter-Pin Bore ..... .9789" - .9795"
- Bearing Clearance - (Vertical) ..... .0004" - .0033"
- Side Clearance - Big End ..... .006" - .020"

PISTON
- Diameter Nominal Outside ..... 4.1245"
- Length Overall ..... 3.490"
- Top of Piston to Center of Pin ..... 1.738" - 1.742"
- Clearance at Thrust Surface (selective) ..... .001" - .002"
- Weight Less Pin Rings ..... 24.057 oz.
- Skirt Taper ..... .0005" - .0015" Larger at Bottom
- Ring Width (2 compression) ..... .0798" - .0808"
- Ring Width (1 oil) ..... .1881" - .1891"

PISTON PINS
- Diameter ..... .9803" - .9807"
- Length Overall ..... 2.980"
- Pin to Piston Clearance ..... .0003" - .0005"
- Pin to Rod Fit ..... .0008" - .0018" Press

PISTON RINGS
- No. of Compression Rings (per piston) 2
- Width of Compression Rings (top bottom) ..... .0770" - .0780"
- Gap Clearance Compression Rings ..... .010" - .023"
- Clearance in Groove Compression Rings-Upper ..... .0020" - .0040"
  - Lower ..... .0020" - .0040"
- No. of Oil Rings (per piston) 1
- Gap Clearance, Oil Ring ..... .015" - .055"

CAMSHAFT
- Bearing Journal Diameters
  - No. 1 ..... 2.0365" - 2.0357"
  - No. 2 ..... 2.0165" - 2.0157"
  - No. 3 ..... 1.9965" - 1.9957"
  - No. 4 ..... 1.9765" - 1.9757"
  - No. 5 ..... 1.9565" - 1.9557"
- Width (including chamfers)
  - No. 1 ..... .810"
  - No. 2, 3 and 4 ..... .741"
  - No. 5 ..... .788"
- Journal Clearance in Bearing (all) ..... .0020" - .0058"
- End Clearance ..... .011" - .077"
- Push Rod - Length ..... 9.570"

VALVE - INTAKE
- Diameter Head ..... 2.000" - 1.990"
- Diameter - Stem ..... .3425" - .3432"
- Angle - Valve (A°) See Fig. 26 ..... 44°
- Angle - Valve Seat (B°) See Fig. 26 ..... 45°
- Width - Valve Seat (Cylinder Head) ..... .037" - .075"
- Overall Length ..... 4.667"
- Clearance in Guide ..... .0010" - .0027"
- Lash ..... Hydraulic

VALVE EXHAUST
- Diameter - Head ..... 1.627" - 1.617"

Diameter - Stem .... .3420" - .3427"
Angle - Valve (A°) See Fig. 31 .... 30°
Angle - Valve Seat (B°) See Fig. 31 .... 31°
Width - Valve Seat (Cylinder Head) .... .050" - .090"
Overall Length .... 4.675"
Clearance In Guide .... .0015" - .0032"
Lash .... Hydraulic

VALVE SPRINGS
Length .... 1.96"
Diameter - Wire .... .192"
Inside Diameter .... 1.065" - 1.041"
Load .... 76 - 84 Lbs. @ 1.620"
Load @ 1.270" .... 180 - 194 Lbs.

VALVE LIFTERS
*Diameter - Body .... .8422" - .8427"
Length - Overall .... 2.000"
Clearance in Boss .... .0005" - .0020"
*Also available in .010" Over Size

CAMSHAFT SPROCKET
Width of Sprocket .... .400" - .420"
Pitch .... .500"
No. of Teeth 36

CRANKSHAFT SPROCKET
Width of Sprocket .... .400" - .410"
Overall Width of Gear .... 1.001" - .991"
Pitch .... .500"
No. of Teeth 18

TIMING CHAIN
Width .... Morse-.627, Linkbelt-.720" - .750"
No. of Links 48
Pitch .... .500"

FLYWHEEL
No. of Teeth on Starter Gear 166
No. of Teeth on Starter Pinion 9

LUBRICATION SYSTEM
Crankcase Capacity Drain and Refill .... 5 Qts.
Drain Refill with Filter Change .... 6 Qts.
Oil Pump
Clearance Pressure Relief Valve in Bore .... .0025" - .0050"
End Clearance-Gear .... .0025" - .0065"

TORQUE SPECIFICATIONS

Specified torque is for installation of parts only. Checking of torque during inspection may be 10% below specification.

APPLICATION .... FT. LBS.

FUEL PUMP
Fuel Pump to Block Bolt and Nut 25
Fuel Pump to Eccentric to Camshaft 65

EXHAUST SYSTEM 15-20

ENGINE
Crankshaft Bearing Cap Bolts 120
Flywheel to Crankshaft 60
Oil Pump to Bearing Cap Bolts 35
Oil Deflector to Bearing Cap 35
Oil Pump Cover to Pump Bolts 8
Rocker Arm Pivot Bolt to Head 25

Valve Cover Bolts	7
Oil Pan Bolts	10
Oil Pan Drain Plug	30
Crankshaft Balancer or Hub to Crankshaft Bolt	160 Min.
Oil Filter Element to Base	20
Oil Filter Assembly to Cylinder Block Bolts	35
Oil Filter Extension Fitting	55
Support/Front Cover Block	50
Fan Driving Pulley to Balancer Bolts	10
Fan Clutch Assembly to Pulley Nuts	15
Water Pump to Front Cover Bolts	13
Water Outlet to Manifold Bolts	20
*Intake Manifold to Cylinder Head Bolts	40
Exhaust Manifold to Cylinder Head Bolts	25
Carburetor to Intake Manifold Bolts	15
Choke Tube and Plate to Intake Manifold Bolts	15
Air Cleaner to Carburetor Stud	5
Engine Front Support Cushion Studs	30
Engine Support to Mount	45
Engine Mount to Crossmember Mount	30
Transmission Rear Mount to Crossmember	55
Transmission Rear Mount to Support	50
Starter to Cylinder Block Bolts	35
Distributor Clamp to Cylinder Block Bolt	17
Spark Plugs (High Energy Ignition)	25
Spark Plugs (Breaker Point Ignition)	35
Coil to Intake Manifold Bolt	15
*Cylinder Head Bolts	85
Connecting Rod Nuts	42

*Clean and dip entire bolt in engine oil before tightening to obtain a correct torque reading.

SPECIAL TOOLS

J-5154-01	Timing Cover Oil Seal Installer
J-5892-1	Valve Spring Compressor
J-6647	Piston Ring Compressor (3-7/8")
J-7583-3	Pilot (used with J-8614-01 Harmonic Balancer Remover)
J-8080	Main Bearing Shell Remover
J-21526-1	Rope Seal Repair Guide Tool
J-21526-2	Rope Seal Repair Packing Tool
J-22794	Valve Holder
J-24603-01	Engine Removal Fixture
J-24724	Crankshaft Harmonic Balancer Installer
J-24725	Valve Stem Seal Installer
J-26484	Rear Main Bearing Oil Seal Installer
BT-33-73F	Belt Tension Gauge
BT-6428	Valve Stem Height Gauge

SECTION 6K
ENGINE COOLING

Contents of this section are listed below:

SUBJECT	PAGE NO.
General Description	6K-1
Cooling System Trouble Diagnosis	6K-3
Draining, Flushing and Refilling Cooling System	6K-4
Water Pump	6K-5
Thermostat	6K-6
Fan/Fan Clutch	6K-7
Belt Tension	6K-9

IMPORTANT: For maintenance recommendations and cooling system capacities, refer to section 0 of this manual.

6

GENERAL DESCRIPTION

The engine cooling system is the closed-pressure type with thermostatic control of coolant circulation. The radiator is equipped with separate coolers in the right tank which aid in cooling engine oil and automatic transmission fluid (See figure 1).

The cooling system is sealed by a pressure type radiator filler cap which causes the system to operate at higher than atmospheric pressure. The higher pressure raises the boiling point of the coolant and increases the cooling effeciency of the radiator. The 9 pound pressure cap used raises the coolant boiling point approximately 22°F. (-5.5°C.)

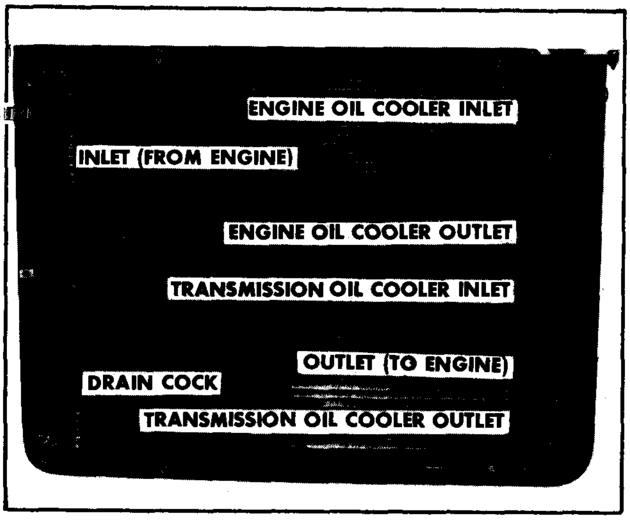


Figure 1—Radiator Core

The pressure type radiator filler cap contains a blow off or pressure valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring of predetermined strength which protects the radiator by relieving the pressure if the pressure should exceed that for which the radiator is designed.

The vacuum valve is held against its seat by a light spring which permits opening of the valve to relieve vacuum created when the system cools off.

A pressure-vacuum valve radiator cap is used which allows the coolant to expand through the pressure valve in the center of the cap without building unnecessary pressure. The expanding coolant flows into the coolant reservoir (See figures 2 and 3). The vent valve closes due to expansion and coolant flow. The nominal 9 pound pressure will not be reached until the system is working at maximum capacity.

Any air or vapor in the cooling system will be forced to the coolant reservoir under the liquid level and leave through the vent tube at the top of the reservoir. As the system cools, the extra coolant in

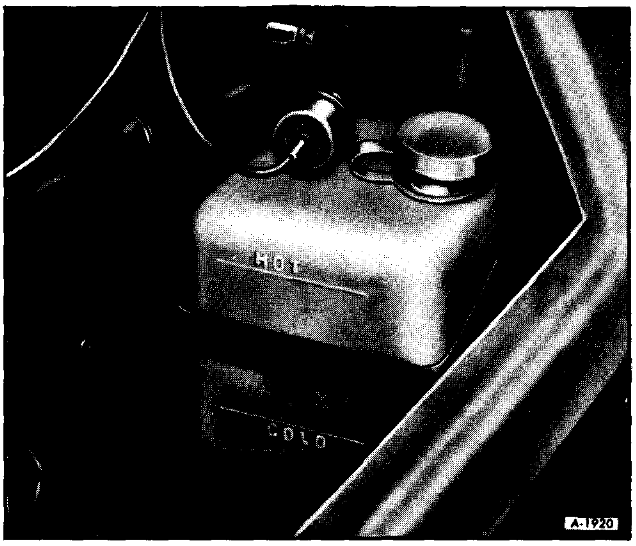


Figure 2—Coolant Recovery Reservoir Type I

the reservoir will be drawn back to the radiator through the vent valve. In this manner, the radiator will keep itself full at all times. The need for additional coolant can be detected by observing the level of coolant in the reservoir at the "COLD" level line the engine is cold.

In vehicles equipped with a "Coolant Level" indicator system, the indicator light is designed to glow when additional coolant is required. For service and diagnosis of "Coolant Level" indicator system, refer to CHASSIS ELECTRICAL (SECTION 12).

COOLING SYSTEM CIRCULATION (FIGURE 4)

The coolant is circulated by a centrifugal pump mounted on the front engine cover which forms the outlet side of the pump. The engine fan and pulley(s) are bolted to the pump shaft hub at its forward end. Thus both the fan and pump are belt driven by a crankshaft pulley bolted to the harmonic balancer. The pump shaft and bearing assembly is pressed in the water pump cover. The bearings are permanently lubricated during manufacture and sealed to prevent loss of lubricant and entry of dirt. The pump is sealed against coolant leakage by a packless non-adjustable seal assembly mounted in the pump in position to bear against the impeller hub. The inlet pipe cast in the pump body feeds into the passage formed by the cover and the front face of the impeller, which is mounted on the bearing shaft with the vanes facing forward. Coolant flows through the inlet passage to the low pressure area at the center where it then flows radially through six openings in the impeller. Vanes on the rotating impeller cause the coolant to flow rearward through two discharge passages cast in the engine block. These passages deliver an equal quantity of coolant to each cylinder bank water jacket.

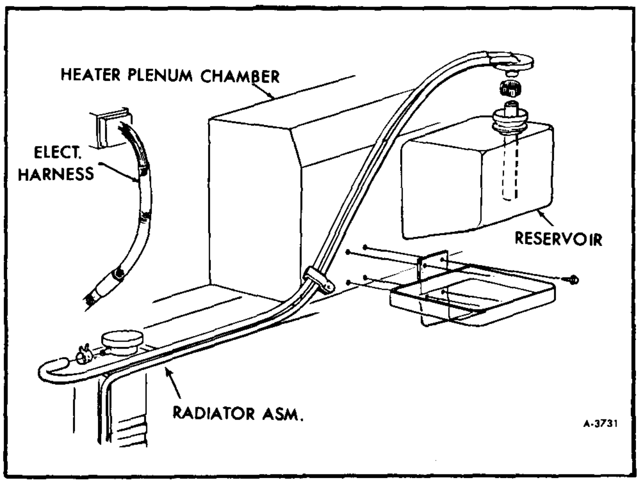


Figure 3—Coolant Recovery Reservoir, Type II

The coolant then flows rearward through the water jacket which surrounds each cylinder barrel and extends below the lower limit of piston ring travel. After flowing the full length of the cylinder banks, the coolant flows up through openings to the rear of the cylinder bank into the cylinder heads. The coolant flows forward in the cylinder heads to cool the combustion chamber areas.

Next, the coolant flows into the intake manifold water passage from the forward port of the cylinder heads to the thermostat housing and thermostat by-pass. A nipple in the pump body allows connection of the heater hose.

A pellet type thermostat housed in the forward (outlet) end of the intake manifold controls the circulation of water through the engine radiator. During cold engine operation when the thermostat is closed, a thermostat by-pass, open at all times, allows recirculation of coolant through the engine to provide rapid warm-up. When the thermostat opens, (195°F., 90.6°C.) coolant is directed to the left tank of the radiator, through the radiator core and right tank to the water pump inlet where the cycle is repeated.

COOLING SYSTEM TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
Engine overheats (Engine temperature gauge indicates coolant temperature is HOT or coolant overflows from reservoir onto ground while engine is running).	Loss of coolant.	See "Loss of Coolant" condition below. Pressure check system with suitable checking equipment. Correct as necessary.
	Low coolant protection (should be -34°F.) (-36°C.) Belt tension too low.	Test solution. Add 50/50 coolant/ water solution as required. Check with BT-33-73F. Adjust if loose.
	Ignition timing retarded.	Set timing to specifications. See "Engine Electrical" later in this manual.
	Timing retarded by sticking or inoperative vacuum or mechanical advance.	Check and correct. See "Engine Electrical" later in this section.
	Thermal Vacuum Switch (T.V.S.) not switching.	Test and replace if necessary. See "Thermal Vacuum Switch" later in this section.
	Radiator fins obstructed.	Clean away bugs, leaves, etc. Flush system—add fresh coolant.
	Cooling system passages blocked by rust or scale.	Flush system—add fresh coolant.
	Reservoir hose pinched or kinked (especially at radiator filler neck).	Relieve kinks by re-routing. Replace if permanently kinked.
	Lower radiator hose collapses.	Check for hose spring position by squeezing lower end of hose. Replace if necessary.
	Defective fan clutch.	Replace fan clutch.
Loss of coolant.	Leaking radiator.	Inspect cooling system. Repair or replace as required.
	Radiator cap defective, or filler neck distorted.	Pressure check radiator and cap with suitable testing equipment. If neck upper sealing area is distorted, use wood block and mallet to reform evenly so cap will fit.
	Leaking coolant reservoir or hose.	Replace reservoir or hose.
	Loose or damaged hoses or connections.	Reseat or replace hoses or clamps. Include hoses to pre-heater if equipped.
	Water pump seal leaking.	Replace water pump.
	Water pump gasket leaking.	Replace gasket.
	Improper cylinder head bolt torque.	Torque bolts to 85 ft. lbs.

COOLING SYSTEM TROUBLE DIAGNOSIS (Cont'd.)

Problem	Possible Cause	Correction
	Cylinder head or gaskets, cylinder block or core plug, heater core or heater water valve leaking.	Repair or replace as necessary to correct.
Engine fails to reach normal operating temperature. Indicated by cool air blown from heater.	Thermostat stuck in closed position.	Replace thermostat.
	Thermostat stuck open or wrong type thermostat.	Install new thermostat of correct type and heat range.
	Coolant below add mark.	Add coolant (50/50-coolant/water solution).
HOT reading indicated on temperature gauge with no loss of coolant.	Defective engine temperature switch.	Replace switch.

IMPORTANT: If the level of the coolant in the coolant recovery tank is not changing from HOT to COLD, check for a leak in the upper portion of the engine cooling system.

DRAINING, FLUSHING AND REFILLING COOLING SYSTEM

Before draining the cooling system, inspect the system and perform any necessary service to insure that it is clean, does not leak and is in proper working order.

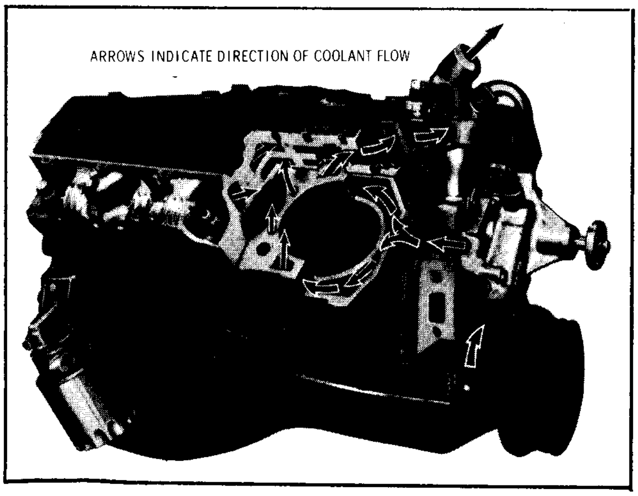


Figure 4—Cooling System Circulation

CAUTION: *To avoid the danger of being burned, and prevent loss of coolant, do not remove the radiator cap while the engine and radiator are still hot, because the cooling system will blow out scalding fluid and steam under pressure.*

1. Run engine, with radiator cap removed, until normal operating temperature is reached. On air conditioned models (automotive type), open water temperature control valve by moving the heater temperature control to maximum temperature position.

2. With engine stopped, drain radiator coolant by opening radiator drain valve located at the lower left corner of the radiator as shown in Figure 4. Remove engine block drain plug on right lower side of block if desired.

3. Close radiator drain valve, install block drain plug, if removed, add sufficient water to fill system.

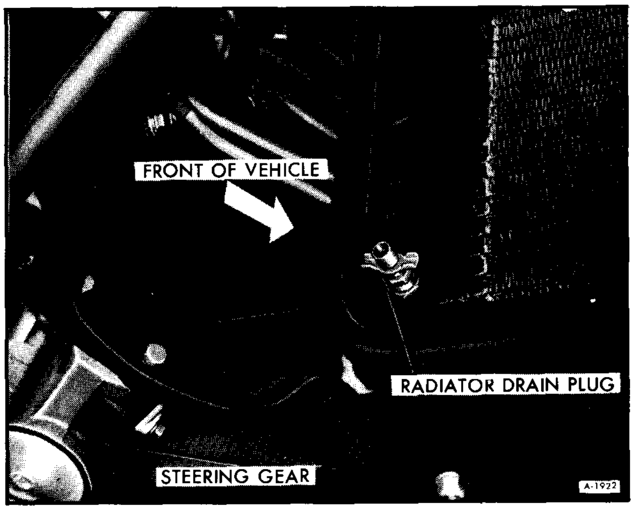


Figure 5—Radiator Drain Plug

4. Run engine, drain and refill the system, as described in Steps 1, 2 and 3, a sufficient number of times until the drained liquid is nearly colorless.

5. Allow system to drain completely and install block drain plugs, if removed.

6. Fill radiator to filler neck with coolant meeting GM Specification 1899-M (for ease and speed of filling use a 20-inch length of rubber hose and funnel to add coolant at radiator cap), to provide the required freezing and corrosion protection (at least a 50 percent solution for -34°F (-36°C). Install radiator cap. Make certain arrow on cap lines up with overflow tube. See Figure 5.

7. Fill reservoir to "COLD" level mark. See Figure 2.

8. Add anti-foam GM-1050531 to vehicles equipped with automotive air conditioning. Run engine with heater controls in "HEATER" and "HOT" position until normal operating temperature is reached.

9. Check and adjust coolant to proper level. Install coolant reservoir cap.

CAUTION: *Vehicles equipped with water heater pre-heat must have coolant checked at reservoir and coolant added as necessary after checking several times. The additional heater hose used for the pre-heat requires a longer period to normalize the cooling system.*

WATER PUMP

REMOVAL

1. Drain radiator. Disconnect bypass and remove heater hose from water pump. Loosen all belts.

2. Raise Motor Home. Disconnect lower radiator hose from water pump.

3. Remove venturi ring seal strap.

4. Fold venturi ring to shroud seal forward and over shroud.

5. Remove four (4) nuts attaching fan clutch to water pump hub. See Figure 6. Position fan and fan clutch assembly forward in the shroud. Be careful not to allow the assembly to damage the radiator core.

6. Remove the venturi ring.

7. Remove water pump pulley.

8. Disconnect the power steering pump and L.H. upper venturi ring bracket.

9. Remove water pump attaching bolts. Remove water pump.

10. Clean engine block of old gasket at sealing surfaces.

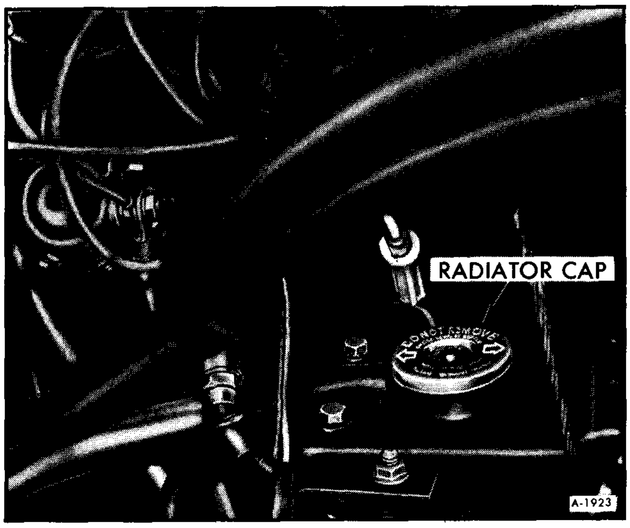


Figure 6—Radiator Cap

INSTALLATION

1. Apply a thin coat of 1050026 Sealer or equivalent to the pump housing to retain the new gasket, then position on the housing.

2. Install the pump assembly. Coat all bolts with engine oil and torque the self-tapping bolts to 13 ft. lbs. and torque the others to 25 ft. lbs.

3. Connect the power steering pump bracket and the L.H. upper venturi ring bracket. Torque nut to 22 ft. lbs.

4. Install venturi ring and torque nuts to 25 ft. lbs.

5. Install water pump pulley. Reposition all belts.

6. Install fan and fan clutch assembly. Torque four (4) nuts to 15 ft. lbs. (See figure 6).

7. Reposition shroud to venturi ring seal over venturi ring.

8. Install venturi ring seal strap.

9. Connect lower radiator hose to water pump.

10. Lower motor home.

11. Secure clamp on bypass hose and install heater hose to water pump.

12. Tension belts. Refer to "Belt Tension" later in this section.

13. Refill radiator. If new coolant is used refer to Section 0.

THERMOSTAT

The thermostat consists of a restriction valve actuated by a thermostatic element. A 195° thermostat is used and the use of thermostats rated above 195 degrees F (90°C) control temperatures are not recommended. This is mounted in the housing at the cylinder head water outlet above the water pump. The thermostat should be installed with the word FRONT up and toward the radiator. This way the coolant has a smooth unobstructed flow through the thermostat and water outlet. See Figure 7.

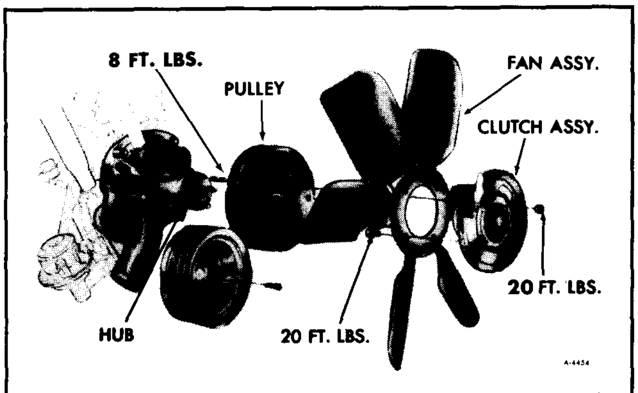


Figure 7—Fan Installation

When the thermostat is incorrectly installed, as in "B" shown in Figure 7, the thermostat valve acts as a baffle, forcing the coolant to change direction to pass around the valve. This change in direction interrupts the smooth unobstructed flow of coolant to the radiator and can possibly result in overheating conditions.

Thermostats are designed to open and close at predetermined temperatures and if not operating properly should be removed and tested.

An operational check of the thermostat can be made by hanging thermostat on a hook in a 33% glycol solution at 220°F (104.4°C). Submerge the valve completely and agitate the solution thoroughly. Under this condition the valve should open. Remove the thermostat and place in a solution of 33% glycol solution at 185°F (85°C). With the valve completely submerged and the solution agitated thoroughly, the valve should close completely.

FAN AND FAN CLUTCH

REMOVAL

1. Raise vehicle.

2. Remove shroud to venturi ring seal retainer strap.

3. Fold venturi ring to shroud seal forward and over shroud.

4. Remove the four (4) nuts attaching fan clutch to water pump hub (See figure 6).

5. With assembly in the shroud area and removed from the hub, remove the four (4) attaching bolts that secures fan clutch.

6. Remove fan and fan clutch after they are separated.

WARNING: IF A FAN BLADE IS BENT OR DAMAGED IN ANYWAY, NO ATTEMPT SHOULD BE MADE TO REPAIR AND REUSE THE DAMAGED PART. A BENT OR DAMAGED FAN ASSEMBLY SHOULD ALWAYS BE REPLACED WITH A NEW FAN ASSEMBLY. IT IS ESSENTIAL THAT FAN ASSEMBLIES REMAIN IN PROPER BALANCE AND PROPER BALANCE CANNOT BE ASSURED ONCE A FAN ASSEMBLY HAS BEEN BENT OR DAMAGED. A FAN ASSEMBLY THAT IS NOT IN PROPER BALANCE COULD FAIL AND FLY APART DURING SUBSEQUENT USE CREATING AN EXTREMELY DANGEROUS CONDITION.

INSTALLATION

1. Install fan and fan clutch separately into the area in the shroud between the water pump and the radiator. Be careful not to damage the radiator core.

2. Install four (4) attaching bolts that secure the fan to the fan clutch and torque to 20 ft. lbs. (See figure 6).

3. Position the assembly over the water pump hub studs and torque the attaching nuts to 20 ft. lbs.

4. Fold venturi ring to shroud seal back over the venturi ring.

5. Install seal retainer strap.

6. Lower vehicle.

FAN CLUTCH

Automatic fan clutches, Figure 8, are hydraulic devices used to vary the fan speed in relation to the engine temperature. Automatic fan clutches permit the use of a high delivery fan to insure adequate cooling at reduced engine speeds while eliminating overcooling, excessive noise, and power loss at high speeds.

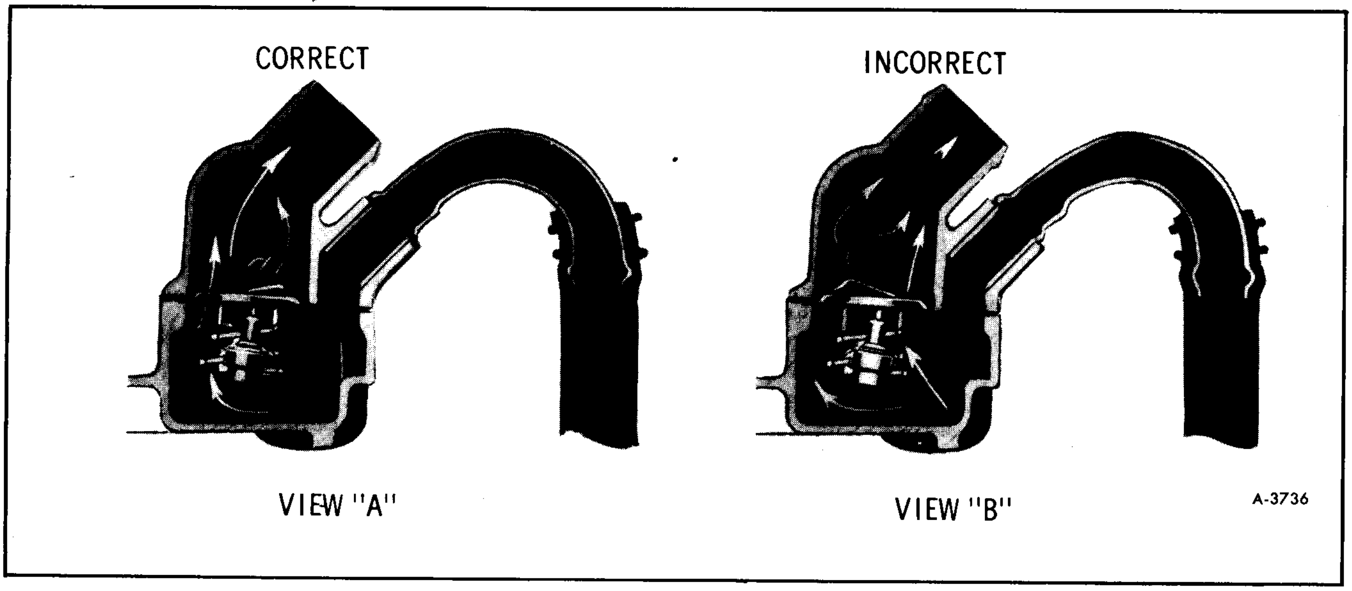


Figure 8—Thermostat Installation

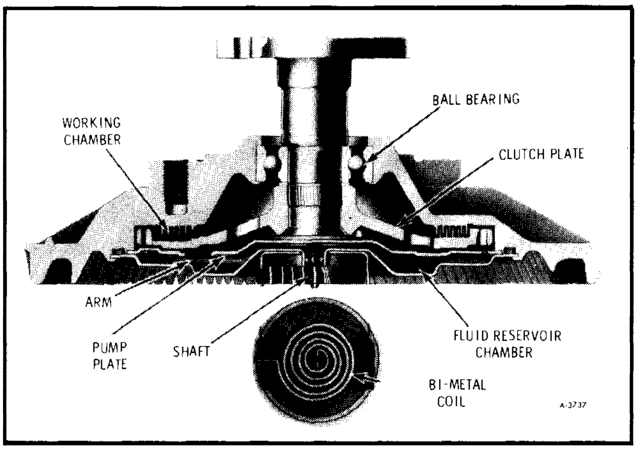


Figure 9—MotorHome Fan Clutch Assembly

The automatic fan clutch has two modes of operation, the engaged mode and the disengaged mode. The disengaged mode (engine cold or high speed driving) occurs when the silicone fluid is contained in the reservoir area of the fan clutch. As the temperature of the engine rises so does the temperature of the bimetallic coil. This bimetallic coil is connected to the arm shaft in such a way that as the temperature rises the shaft moves the arm exposing and opening the pump plate. This opening allows the silicone fluid to flow from the reservoir into the working chamber of the automatic fan clutch. The silicone fluid is kept circulating through the fan clutch by wipers located on the pump plate. A hole is located in front of each wiper.

The speed differential between the clutch plate and the pump plate develops high pressure areas in front of the wipers, thus the fluid is forced back into the reservoir. But as the temperature rises the arm uncovers more of the large opening and allows more of the silicone fluid to re-enter the working chamber. The automatic fan clutch becomes fully engaged when the silicone fluid, circulating between the working chamber and the reservoir, reaches a sufficient level in the working chamber to completely fill the grooves in the clutch body and clutch plate. The resistance of the silicone fluid to the shearing action caused by the speed differential between the grooves transmits torque to the clutch body. The reverse situation occurs when the temperature drops. The arm slowly closes off the return hole thus blocking the fluid flow from the reservoir into the working chamber. The continuous action of the wipers removes the silicone fluid from the grooves in the working chamber and reduces the shearing action. Thus, less torque is transmitted to the clutch body and the speed of the fan decreases.

The temperature at which the automatic fan clutch engages and disengages is controlled by the setting of the bimetallic coil. This setting is tailored to satisfy the cooling requirement of the vehicle ... Trans Mode fan clutch, not shown, is similar to the MotorHome fan clutch but, provides a greater cooling capacity required for commercial use.

FAN CLUTCH TROUBLE DIAGNOSIS

1. NOISE

Fan noise is sometimes evident under the following normal conditions:

a. When clutch is engaged for maximum cooling.

b. During first few minutes after start-up until the clutch can re-distribute the silicone fluid back to its normal disengaged operating condition after overnight setting.

However, fan noise or an excessive roar will generally occur continuously under all high engine speed conditions (2500) rpm and up) if the clutch assembly is locked up due to an internal failure. If the fan cannot be rotated by hand or there is a rough grating feel as the fan is turned, the clutch should be replaced.

2. LOOSENESS

Under various temperature conditions, there is a visible lateral movement that can be observed at the tip of the fan blade. This is normal condition due to the type of bearing used. Approximately 1/4" maximum lateral movement measured at the fan tip is allowable. This is not cause for replacement.

3. SILICONE FLUID LEAK

The operation of the unit is generally not affected by small fluid leaks which may occur in the area around the bearing assembly. However, if the degree of leakage appears excessive, proceed to item 4.

4. ENGINE OVERHEATING

a. Start with a cool engine to insure complete fan clutch disengagement.

b. If the fan and clutch assembly free-wheels with no drag (revolves over 5 times when spun by hand), the clutch should be replaced. If clutch performs properly with a slight drag go to Step C.

NOTE: Testing a fan clutch by holding the small hub with one hand and rotating the aluminum housing in a clockwise/counterclockwise motion will cause the clutch to free-wheel, which is normal condition when operated in this manner. This should not be considered a test by which replacement is determined.

c. Position thermometer so that it is located between the fan blades and radiator. This can be achieved by inserting the sensor through one of the existing holes in the fan shroud or fan guard, or by placing between the radiator and the shroud. On some models, it may be necessary to drill a 3/16" hole in the fan shroud to insert thermometer.

CAUTION: *Check for adequate clearance between fan blades and thermometer sensor before starting engine.*

d. With thermometer in position, cover radiator grille sufficiently to induce a high engine temperature. Start engine and turn on A/C if equipped, operated at 2,000 rpm.

e. Observe thermometer reading when clutch engages. It will take approximately 5 to 10 minutes for the temperature to become high enough to allow engagement of the fan clutch. This will be indicated by an increase or roar in fan air noise and by a drop in the thermometer reading of approximately 5-15 degrees F. If the clutch did not engage between 150-190°F (65.6-87.8°C) the unit should be replaced.

NOTE: Be sure fan clutch was disengaged at beginning of test.

If no sharp increase in fan noise or temperature drop was observed and the fan noise level was constantly high from start of test to 190°F (87.8°C), the unit should be replaced. Do not continue test past a thermometer reading of 190°F (87.8°C) to prevent engine overheating.

f. As soon as the clutch engages, remove the radiator grille cover and turn off the A/C to assist in engine cooling. The engine should be run at approximately 1500 rpm.

g. After several minutes the fan clutch should disengage, as indicated by a reduction in fan speed and roar.

If the fan clutch fails to function as described, it should be replaced.

BELT TENSION (FIGURE 10)

NOTE: All belt tension checks must be taken midway on the greatest span of that belt.

A belt that has been previously tensioned is considered to be a used belt and should be tightened to 70 to 80 pounds. A belt that has never been tensioned is considered to be a new belt and should be tightened to 110 to 140 pounds.

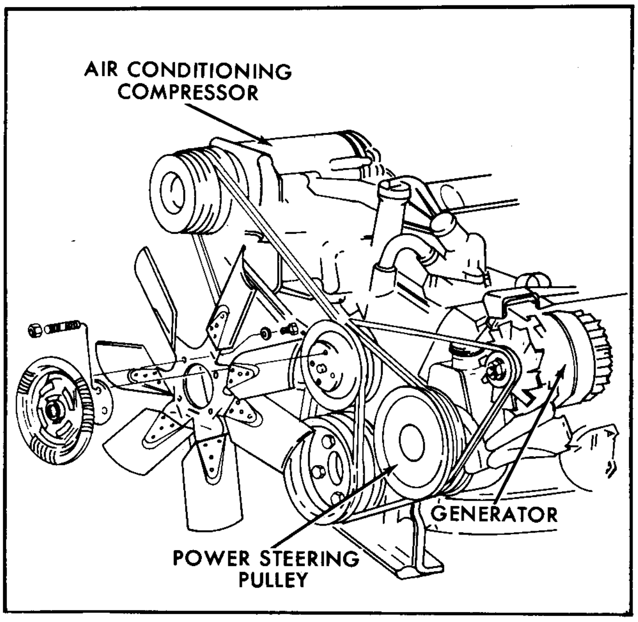


Figure 10—Fan and Drive Belts

Vehicles equipped with automotive air conditioning MUST have power steering belt checked and adjusted if necessary first. Then check and adjust as required the generator and air conditioning compres-

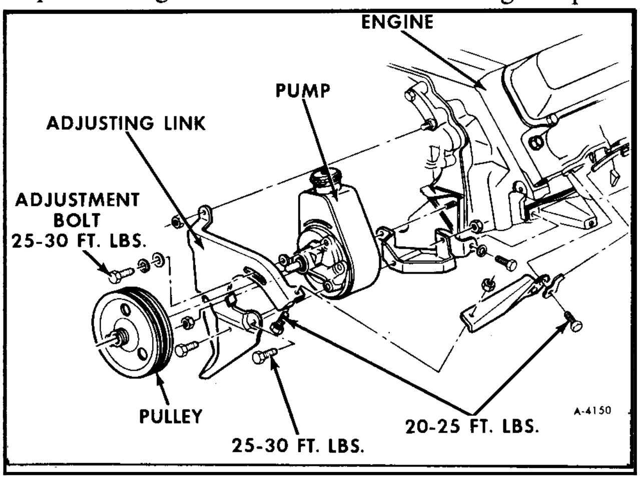


Figure 11—Power Steering Pump Mounting

sor (if equipped) belts. Use belt tension gauge (Burroughs Tool) BT-33-73F. If the belt tension is incorrect, proceed as follows:

ADJUSTING BELT TENSION

When adjusting a power steering pump belt, never pry against the pump reservoir or pull against the filler neck. To increase belt tension move the pump outward by prying against the bracket pry lugs or against the pump housing casting extension directly behind the pump drive pulley.

1. When power steering pump is driven by a single belt.

a. Loosen the pump attaching bolts and adjust the belt to correct tension by moving the pump outward, away from the engine.

b. Snug all pump mounting bolts and remove pry bar.

c. Tighten all pump mounting bolts to specified torque (figure 11).

d. Check belt tension and remove the belt tension gage.

2. When the power steering pump pulley is driven by one primary belt and is used as an idler for a second belt driving some other auxiliary:

a. Follow same checking and adjusting procedure for the primary power steering pump drive belt as for 1 above.

b. Recheck and adjust as necessary the pump belt tension after adjusting tension on belt driving the auxiliary.

3. To adjust generator or air conditioning compressor belts.

a. Loosen bolts at support bracket.

b. Move generator or air conditioning compressor away from engine to increase belt tension.

c. Tighten mounting bolts to specified torque (figures 12 and 13).

d. Check belt tension and remove belt tension gauge.

BELT REPLACEMENT

POWER STEERING PUMP BELT

Removal

a. Loosen generator attaching bolts. Loosen air conditioning compressor bolts (if so equipped).

b. Remove power steering pump belt.

Installation

a. Install belt.

b. Adjust belt tension, tighten bolts to specified torque (figure 11).

c. Check pump fluid level, add fluid as necessary.

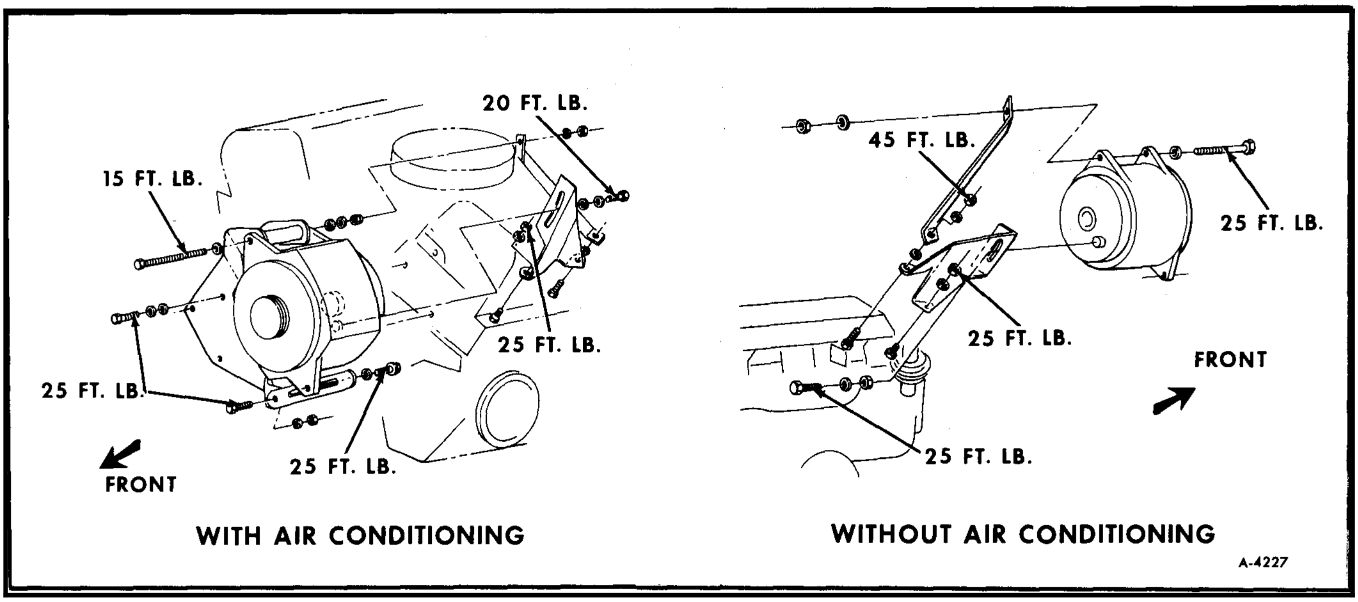


Figure 12—Generator Mounting

GENERATOR BELT

Removal

1. Loosen bolts at generator adjusting arm and loosen pivot bolt at generator support bracket.

2. Move generator toward engine until belt can be removed from pulley.

Installation

1. To install new belt, position belt on pulley and move generator away from engine until required tension is measured.

2. Tighten generator adjusting arm bolts and pivot bolt to specified torque (figure 12).

NOTE: Removal and installation of air conditioning compressor belt is accomplished in the same manner as described above. Refer to Figure 13 for specified torque of compressor mounting bolts.

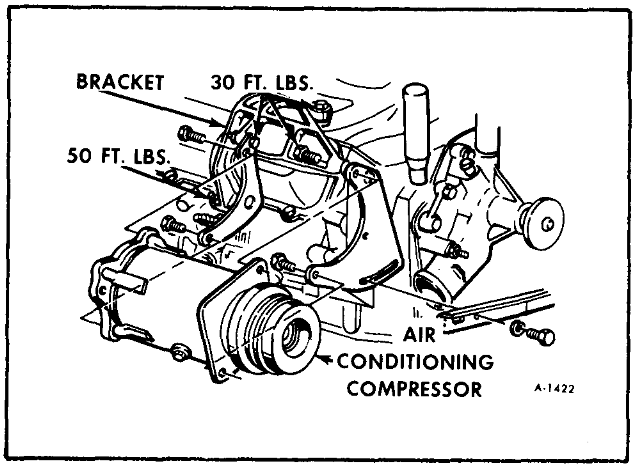


Figure 13—Air Conditioning Compressor Mounting

SECTION 6M
ENGINE FUEL SYSTEM

Contents of this section are listed below:

SUBJECT	PAGE NO.
Carburetor	6M-1
General Description	6M-1
Theory of Operation	6M-2
Carburetor Diagnosis	6M-6
Carburetor Replacement	6M-14
Carburetor Adjustments	6M-21
Accelerator Linkage	6M-26
Fuel Pump	6M-26
Air Cleaner	6M-27

CARBURETOR

6M

GENERAL DESCRIPTION

The Model 4MC (Quadrajet) is a 4 barrel carburetor having two stages of operation.

The primary (fuel inlet) side has two small bores each with a triple venturi which are equipped with a discharge nozzle. Fuel is metered to the primary bores by two tapered metering rods connected to a power piston which is actuated by manifold vacuum.

The secondary side has two very large bores which have greatly increased air capacity to meet engine demands. The air valve opens as air velocity increases and thereby controls the air/fuel mixture in the secondary bores. This mixture combines with the fuel mixture in the primary side. Using the air valve principle, fuel is metered in direct proportion to the air passing through the secondary bores.

The fuel reservoir is centrally located and uses a single float pontoon.

A pleated paper fuel filter is mounted in the fuel inlet casting of the float bowl and is easily removed for replacement.

Carburetor identification information is located as shown on Figure 1. If replacing a float bowl assembly, follow the directions received in the service package to transfer the information.

The primary side of the carburetor has six systems of operation. They are float, idle, main metering, power, pump, and choke. The secondary side has one metering system for controlling the air/fuel mixture which combines with the primary side. The primary and secondary side receive fuel from a common float bowl.

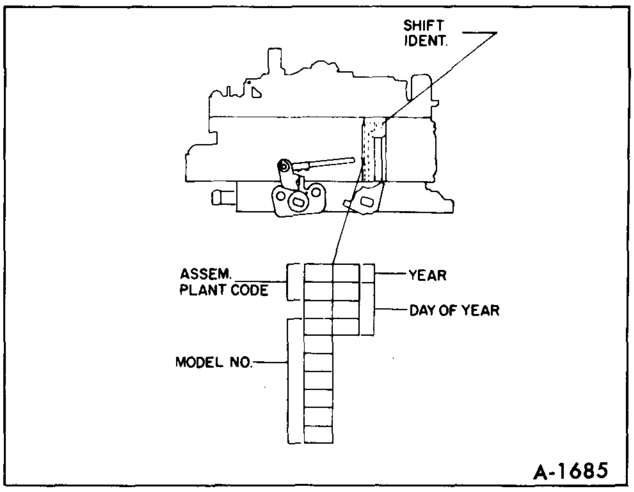


Figure 1–Carburetor Identification

THEORY OF OPERATION

FLOAT SYSTEM (FIGURE 2)

The float system consists of a float chamber, plastic float pontoon assembly, float hinge pin and retainer combination, a float valve and needle assembly and a needle valve pull clip. The float system operates as follows:

Fuel from the engine fuel pump enters the carburetor fuel inlet passage. It passes through the filter element and on into the float inlet valve chamber. The open needle valve allows fuel to enter the float bowl.

As incoming fuel fills the float bowl to the prescribed fuel level, the float pontoon rises and forces the fuel inlet valve closed, shutting off all fuel flow. As fuel is used from the float bowl, the float drops and allows more incoming fuel to enter the float bowl until the correct fuel level is reached. This cycle continues constantly maintaining a positive fuel level in the float bowl.

A needle valve pull clip is used to assist in lifting the needle valve off its seat whenever fuel pump pressure or the fuel level in the float bowl is low.

A plastic filler block is located in the top of the float chamber in the area just above the float valve. This block prevents fuel slosh on severe brake applications maintaining a more constant fuel level to prevent stalling.

The carburetor float bowl is internally vented. Internal vent tubes are located in the primary side of the carburetor air horn just above the float bowl. The purpose of the internal vents is to equalize the air pressure on the fuel in the float bowl with the air pressure within the air cleaner. Therefore, a balanced air/fuel mixture ratio can be maintained during part throttle and power operation because the same pressure acting upon the fuel in the float bowl will be balanced with the air flow through the carburetor bores. The internal vent tubes allow the escape of fuel vapors in the float bowl during hot engine operation. This prevents fuel vaporization from causing rich mixtures due to excessive pressure in the float bowl.

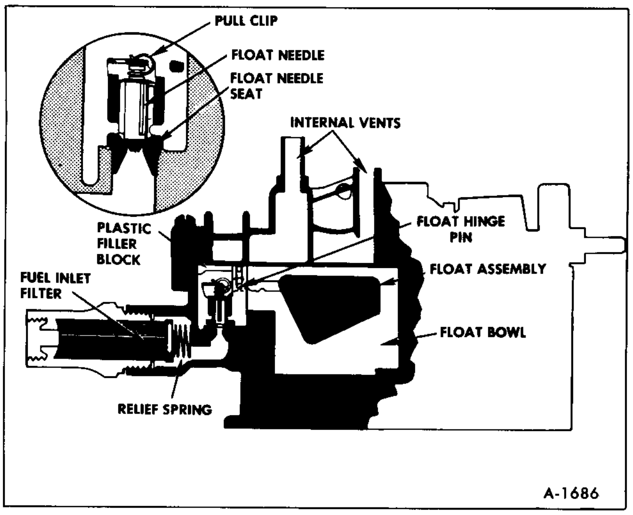


Figure 2–Float System

IDLE SYSTEM (FIGURE 3)

The idle system is only used in the two primary bores of the carburetor. Each bore has a separate idle system. They consist of: Idle tubes, idle passages, idle air bleeds, idle channel restrictions, idle mixture needles, and idle discharge holes. Idle mixture screw limiter caps are installed on all carburetors. The screws are preset at the factory and **SHOULD NOT BE REMOVED.**

During curb idle, the primary throttle valves are held slightly open by the throttle stop screw to give the engine the desired idle speed. Since the engine requires very little air for idle and low speeds, the idle discharge holes below the throttle valves are exposed directly to engine manifold vacuum. With the idle discharge holes in a very low pressure area and the fuel in the float bowl vented to atmosphere (high pressure), the idle system operates as follows:

Engine manifold vacuum at the idle discharge ports causes fuel to flow from the float bowl through the primary metering jets into the main fuel wells. The fuel is picked up and metered at the lower tip of the idle tubes. It passes up through the idle tubes, then through a cross channel in the air horn casting to the idle down channels where it is mixed with air at a side idle bleed located just above the idle channel restriction. The mixture continues downward

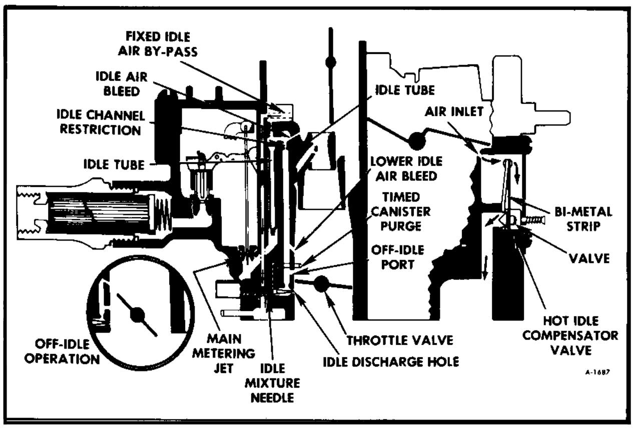


Figure 3–Idle System

through the calibrated idle channel restrictions, past the lower idle air bleeds and off-idle discharge ports, where it is further mixed with air. The air fuel mixture moves down to the idle mixture needle discharge holes where it enters the carburetor bores and blends with air passing the slightly open throttle valves. The combustible mixture then passes through the intake manifold to the engine cylinders.

A fixed idle air by-pass system is used to supplement the idle air passing by the slightly open throttle valves. The purpose of the idle air by-pass is to reduce the amount of air going through the carburetor bores and still maintain sufficient air for the correct idle speed. This reduces the amount of air passing through the venturi system to prevent the main fuel nozzles from feeding at idle. The venturi system is very sensitive to air flow and where large amounts of air is needed to maintain idle speeds, the fixed idle air by-pass system is used.

The fuel tank will not vent to atmosphere, all fuel vapors are collected in a vapor collection canister. A timed purge port is provided in the carburetor throttle body above the throttle valves adjacent to the off-idle discharge ports. The timed bleed purge holes provide adequate purge to remove all vapors that will be collected in the vapor canister. They will bleed constantly during off-idle and part throttle operation of the engine.

OFF-IDLE OPERATION

As the primary throttle valves are opened from curb idle, additional fuel is needed to combine with the extra air entering the engine. This is accomplished by the slotted, off-idle discharge ports. The primary throttle valves open gradually exposing the off-idle ports to high engine vacuum below the throttle valves. The additional fuel added from the off-idle ports mixes with the increasing air flow past the opening throttle valves to meet increased engine air and fuel demands.

Further opening of the throttle valves causes low pressure at the lower idle air bleeds. As a result, fuel begins to discharge from the lower idle air bleed hole and continues to do so from part throttle to wide open throttle.

MAIN METERING SYSTEM (FIGURE 4)

The main metering system consists of main metering jets, vacuum operated metering rods, main fuel well, main well air bleeds, fuel discharge nozzles, and triple venturi. The system operates as follows:

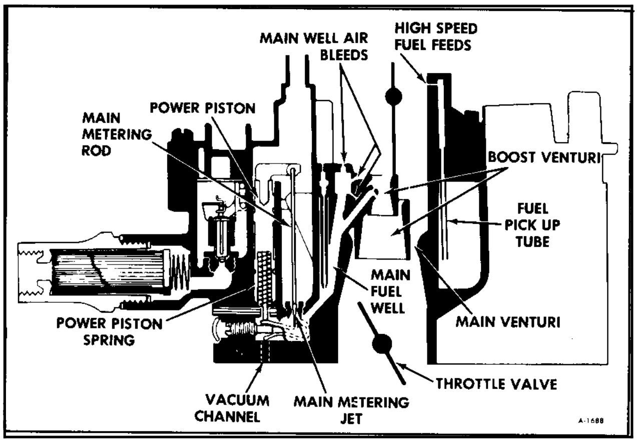


Figure 4–Main Metering System

During cruising speeds and light engine loads, engine manifold vacuum is high. Manifold vacuum holds the main metering rods down in the main metering jets against spring tension. Manifold vacuum is supplied through a channel to the vacuum operated power piston connected to the primary main metering rods. Fuel flow from the float bowl is metered between the metering rods and main metering jet orifice.

Primary throttle valves opened beyond off-idle range allows more air to enter the manifold which increases air velocity in the venturi. This causes a drop in pressure in the large venturi and a much greater drop in pressure in the small venturi. Low pressure in the small boost venturi causes air fuel to flow from the main discharge nozzle.

Fuel flows from the float bowl through the main metering jets into the main fuel well. The fuel in the main fuel well is mixed with air from the main well air bleeds then passes through the main discharge nozzles into the boost venturi.

The fuel mixture is combined with air in the boost venturi into a combustible mixture and passes through the throttle bores into the intake manifold.

CAUTION: *An adjustable part throttle feature is incorporated in all carburetors. This adjustment is made at the factory and no attempt should be made to adjust it in the field.*

The adjustable part throttle features a power piston with a pin pressed into it, which protrudes through the float bowl and gasket and contacts the adjustable link in the throttle body. The primary main metering rods have a double taper on the metering tip and can be identified by the suffix "B" stamped after the diameter on the rod. The purpose is to improve control of fuel during the main metering range.

Two calibrated holes, one in each primary bore are located just above the choke valve and feed fuel from the float bowl. During high carburetor air flows, low pressure created in the air horn bore pulls fuel from the high speed fuel feeds, supplementing fuel flow from the main metering system. The pull over enrichment system begins to feed fuel at approximately 8 lbs. of air per minute, and contines to feed at higher engine speeds to provide extra fuel necessary for good engine performance.

POWER SYSTEM (FIGURE 5)

The power system in the Quadrajet carburetor provides an extra rich mixture under heavy acceleration or high speed operation. The richer mixture is supplied through the main metering system in the primary and secondary sides of the carburetor.

The power system located in the primary side consists of a spring loaded power piston located in a cylinder which is exposed to manifold vacuum. The spring loaded power piston tends to push upward against manifold vacuum.

On part throttle and cruising ranges, manifold vacuum is sufficient to hold the power piston down against spring tension so that the larger diameter of the metering rod tip is held in the main metering jet orifice. When engine load is increased to a point where an extra rich mixture is required, the spring tension overcomes the vacuum pull on the power piston and the tapered primary metering rod tip moves upward in the main metering jet orifice. The smaller diameter of the metering rod tip allows more fuel to pass through the main metering jet and enrich the mixture flowing into the primary main wells and out the main discharge nozzles. When the engine

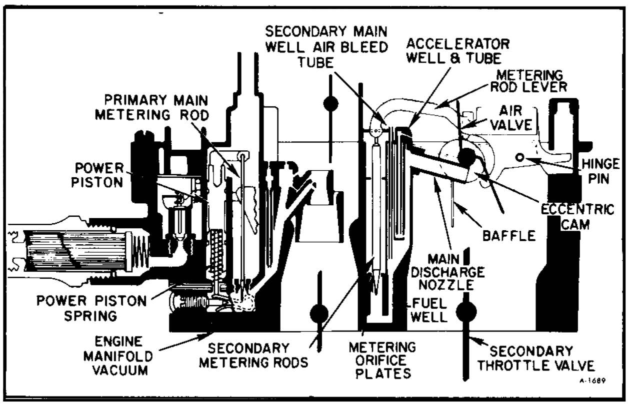


Figure 5–Power System

operation is returned to part throttle and cruising ranges, increased manifold vacuum overcomes the power piston spring and returns the larger portion of the metering rod into the metering jet orifice giving a leaner mixture.

When engine speed is increased to a point where the primary side of the carburetor cannot supply sufficient air and fuel requirements, the secondary side of the carburetor is used.

The secondary throttle valves are actuated by a connecting linkage to the primary throttle lever. With the throttle valves opened, a low pressure (vacuum) is created beneath the air valve. Atmospheric pressure on top of the offset spring loaded air valve forces the valve open allowing the required air to flow through the throttle bores to meet engine demands.

As the air valve opens, the upper edge passes the accelerating well port causing a low pressure (vacuum) at that point. Fuel starts flowing immediately and continues to flow until the well is empty.

The fuel from the accelerating ports prevents a momentary hesitation and provides an immediate charge of fuel until air/fuel begins to flow from the secondary discharge nozzles.

The secondary main discharge nozzles (one for each secondary bore) are located just below the air valve and above the secondary throttle valves in the area of lowest pressure. As the air valve opens, it rotates a plastic cam attached to the center of the main air valve shaft. The cam lifts a lever attached to the secondary main metering rods out of the secondary orifice plates. Fuel flows from the float bowl through the secondary orifice plates into secondary main wells, where it is mixed with air from the secondary mail well air bleed tubes. The air/fuel mixture travels from the main wells to the secondary discharge nozzles and is expelled into the secondary bores. The air/fuel mixture is mixed with more air traveling through the secondary bores and combined with the air/fuel mixture delivered from the primary bores enters the engine cylinders as a combustible mixture.

As the secondary throttle valve is opened further, the increase in air flow through the throttle bores opens the air valve which rotates the eccentric cam lifting the tapered secondary metering rods further out of the metering orifice discs, increasing fuel flow in direct portion to air passing through the secondary throttle bores. By using this principle a correct air/fuel ratio can be maintained throughout the operation of the secondary side of the carburetor.

A baffle plate is used in each secondary bore extending up and around the secondary fuel dis-

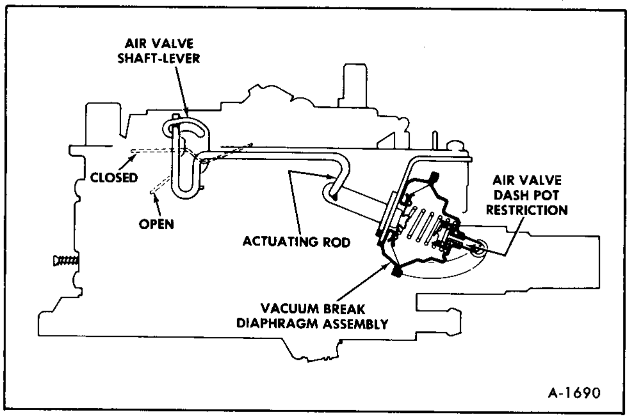


Figure 6–Air Valve Dashpot

charge nozzles. Their purpose is to provide good fuel distribution at lower air flows by preventing too much fuel from going to the front of the engine.

The depth of the secondary metering rods in the orifice plates in relation to the air valve position are factory adjusted to meet the air/fuel requirements for the specific engine model. No further adjustment should be required.

AIR VALVE DASHPOT (FIGURE 6)

The secondary air valve is connected to the vacuum break unit by a rod, to control the opening rate of the air valve and prevent any fuel lag from the secondary discharge nozzle.

Whenever manifold vacuum is above 5″ to 6″ vacuum, the vacuum break diaphragm stem is seated and pulls the rod to the end of the slot in the air valve shaft lever, holding the air valve closed. However, when the secondary valves are opened and manifold vacuum drops below 5″ to 6″ vacuum, the spring in the vacuum break unit will force the diaphragm off its seat and allow the air valve to open. The rate of movement of the air valve spring is controlled by a restriction in the internal check valve in the vacuum break unit.

ACCELERATING PUMP SYSTEM (FIGURE 7)

During quick acceleration when the throttle valves are opened rapidly, the sudden increase in air flow passing the fuel discharge nozzles tends to leave the fuel behind, which is heavier, causing a momentary leanness. The accelerator pump provides an additional charge of fuel during this time.

The accelerating pump system is located in the primary side of the carburetor consisting of a spring loaded pump plunger and pump return spring, located in the pump bore. The pump plunger is operated by a pump lever on the air horn which is connected directly to the throttle lever by a pump rod.

As the throttle is returned from an open to a closed position, the pump return spring pushes the pump plunger upward against the pump lever. As the pump begins to move up, the discharge check ball immediately seats in the pump discharge passage so that no air will be drawn into the passage, which could cause a hesitation. The pump well is always filled with fuel from the float bowl through a slot in the top of the pump well which is lower than the fuel level. When the pump plunger moves up, the floating pump cup unseats (moves down) from the flat surface on the plunger head and allows free flowing of fuel through the inside of the cup into the bottom of the pump well. This also vents any vapors which may be in the bottom of the pump well so that a solid charge of fuel can be maintained in the fuel well. When the primary throttle valves are opened, the connecting linkage forces the pump plunger down instantly seating the pump cup against the plunger forcing fuel through the discharge passage unseating the discharge check ball. The fuel is then forced up through a passage to the pump jets located in the air horn and sprayed into the venturi area of each primary bore.

It should be noted that the pump plunger is spring loaded. The top pump duration spring is calibrated so as to deliver a smooth charge of fuel from the pump jets by applying a pressure on the fuel that remains constant through pump travel regardless of speed or distance the throttle linkage is moved. When the throttle valves are opened instantly to wide open position, the spring loaded plunger will continue to supply fuel until the plunger reaches the

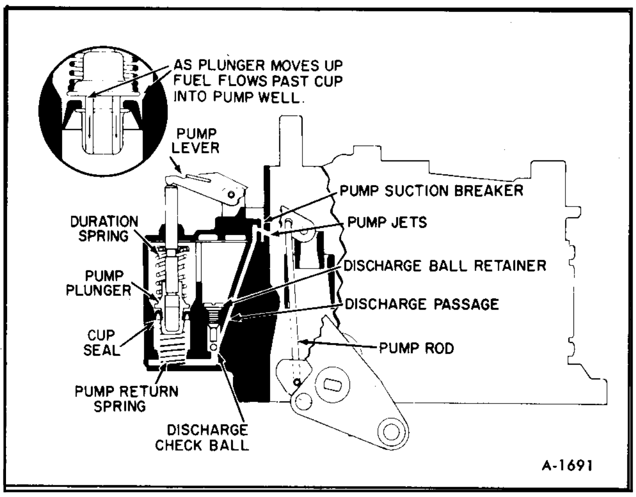


Figure 7–Accelerating Pump System

bottom of the pump well insuring an adequate fuel supply until the fuel starts to flow from the main discharge nozzle.

Due to vacuum at the pump jets during high speed operation, the pump discharge passage has been vented to the top of the air horn, outside the carburetor bores to balance the air pressure on the fuel in the pump discharge passage with the fuel in the float bowl. This prevents fuel from being pushed out of the pump jets when the pump is not in use.

CHOKE SYSTEM (FIGURE 8)

The choke system consists of a choke valve, a vacuum break diaphragm, a choke housing and coil located on the side of the float bowl, fast idle cam, connecting linkage and air valve lockout lever. The thermostatic coil holds the choke valve closed when the engine is cold. Opening the throttle valves allows the choke to close and move the fast idle cam to the high step. When the choke valve is closed, the air valve lockout lever keeps the air valve closed.

During engine cranking, the choke valve is held closed by the tension of the thermostatic coil. This restricts air flow through the carburetor to provide a richer starting mixture. When the engine starts, manifold vacuum applied to the vacuum diaphragm opens the choke valve to a point where the engine will run without loading or stalling. The vacuum diaphragm unit has an internal bleed check valve which delays the diaphragm action a few seconds before it becomes seated allowing the engine manifold to be wetted and engine friction to decrease so that when the vacuum break point is reached, the engine will run without loading or stalling. When the choke valve moves to the vacuum break position, the fast idle cam follower will drop from the high step on the fast idle cam to the next lower step when the

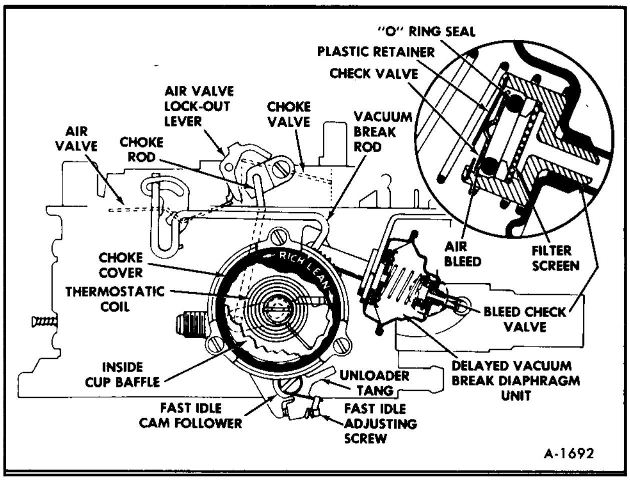


Figure 8–Choke System

throttle is opened. This gives the engine sufficient fast idle speed and correct fuel mixture for running until the engine begins to warm up and heat the thermostatic coil in the choke housing. Engine vacuum pulls heat from the manifold heat stove into the choke housing and gradually relaxes choke coil tension which allows the choke valve to continue opening through inlet air pressure pushing on the off set choke valve. Choke valve opening continues until the thermostatic coil is completely relaxed, at which point the choke valve is wide open and the engine is thoroughly warm.

During the last few degrees of choke valve opening, a tang on the choke lever contacts the secondary air valve lockout lever and rotates the lever counterclockwise so that the tang over the air valve will move completely away from the valve, allowing the air valves to open and operate.

The choke system is equipped with an unloader mechanism which is designed to partially open the choke valve, should the engine become loaded or flooded. To unload the engine the accelerator pedal must be depressed so that the throttle valves are held wide open. A tang on a lever on the choke side of the primary throttle shaft contacts the fast idle cam and through the intermediate choke shaft forces the choke valve slightly open. This allows extra air to enter the carburetor bores and pass on into the engine manifold and cylinders to lean out the fuel mixture so that the engine will start.

CARBURETOR DIAGNOSIS

Before proceeding with carburetor diagnosis it should be noted that proper carburetor operation is dependent upon the following:

1. Fuel supply.
2. Linkage and emission control systems.
3. Engine compression.
4. Ignition system firing voltage.
5. Ignition spark timing.
6. Secure intake manifold.
7. Engine temperature.
8. Carburetor adjustments.

ANY PROBLEMS IN THE ABOVE AREAS CAN CAUSE THE FOLLOWING:

1. No start or hard starting - (hot or cold)

2. Rough engine idle and stalling
3. Hesitation on acceleration
4. Loss of power on acceleration and top speed
5. Engine to run uneven or surge
6. Poor fuel economy
7. Excessive emissions

ENGINE CRANKS (TURNS OVER) WILL NOT START OR STARTS HARD WHEN COLD

Possible Cause	Corrective Action
Improper starting procedure used.	Check with the customer to determine if proper starting procedure is used, as outlined in the operating manual.
No fuel in gas tank.	Add fuel. Check fuel gauge for proper operation.
Choke valve not closing sufficiently when cold.	Adjust the choke thermostatic coil.
Choke valve or linkage binding or sticking.	Realign the choke valve or linkage as necessary. If caused by dirt and gum, clean with automatic choke cleaner. Do not oil choke linkage. If parts are replaced, check adjustments.
Vacuum leaks in carburetor base or intake manifold.	Check all manifold vacuum hoses for proper connection and location. Check manifold and carburetor base gaskets for leaks. Tighten or replace as necessary. Torque carburetor to manifold bolts to 15 ft. lbs.
No fuel in carburetor.	1. Remove fuel line at carburetor. Connect hose to fuel line and run into metal container. Remove the high tension coil wire from center tower on distributor cap and ground. Crank over engine - if there is no fuel discharge from the fuel line, check for kinked or bent lines. Disconnect fuel line at tank and blow out with air hose, reconnect line and check again for fuel discharge. If none, replace fuel pump. Check pump for adequate flow. 2. If fuel supply is o.k.: a. Inspect fuel filter. If plugged, replace. b. If filter is o.k., remove air horn and check for a bind in the float mechanism or a sticking float needle. If o.k., adjust float.

Possible Cause	Corrective Action
Engine flooded. NOTE: To check for flooding, remove air cleaner with engine off, and look into carburetor bores. Fuel will be dripping off discharge nozzles and carburetor bores will be very wet.	1. Check to determine if customer is using proper carburetor unloading procedure. Depress the accelerator to the floor and check carburetor to determine if the choke valve is opening. If not, adjust throttle linkage and unloader. 2. If choke unloader is working properly - check for carburetor flooding. NOTE: Before removing the carburetor air horn, use the following procedure which may eliminate the flooding. Remove the fuel line at carburetor and plug. Start and run the engine until the fuel bowl runs dry. Turn off engine and connect fuel line. Then restart and run engine. This will usually flush dirt past the carburetor float needle and seat. 3. If dirt is in the fuel system, clean the system and replace fuel filter as necessary. If excessive dirt is found, remove the carburetor unit. Disassemble and clean. 4. Check float needle and seat for proper seal. If a needle and seat tester is not available, apply mouth suction needle seat with needle installed. If needle and seat is defective, replace with factory matched set. 5. Check for fuel leaks into float, bent float arm or binds in the float hanger. Free up or replace parts as necessary. NOTE: A solid float can be checked for fuel absorption by lightly squeezing between fingers. If wetness appears on surface or float feels heavy (check with known good float), replace float assembly. 6. After making preceding checks, adjust float assembly.

ENGINE STARTS AND STALLS

Possible Cause	Corrective Action
Engine does not have enough fast idle speed when cold.	Check and reset fast idle screw and fast idle cam.
Choke vacuum break unit is not adjusted to specification or is defective.	1. Adjust choke vacuum break assembly to specifications. 2. If adjusted O.K., check the vacuum break unit for proper operation as follows. Connect a piece of hose to the nipple on the vacuum break unit and apply suction by mouth or vacuum source. Diaphragm plunger should move inward and hold vacuum. If not, replace diaphragm unit. NOTE: Always check fast idle cam (choke rod) adjustment first before adjusting vacuum break unit.

Possible Cause	Corrective Action
Choke coil rod out of adjustment.	Adjust choke coil rod.
Choke valve and/or linkage sticking or binding.	1. Clean and align choke valve and linkage. Replace if necessary. 2. Re-adjust if part replacement is necessary.
Idle speed setting.	Adjust idle speed to specifications on decal in engine compartment.
Not enough fuel in carburetor.	1. Test fuel pump pressure and volume, as outlined in service manual. 2. Check for partially plugged fuel inlet filter. Replace, if dirty. 3. Check fuel tank lines and tank vent lines for blockage. Clean as necessary. 4. Remove air horn and check float adjustment.
Carburetor flooding NOTE: Check for flooding by using procedure outlined under "Engine cranks - will not start - engine flooded" Page 8.	1. Check all fuel filters for dirt. Clean and replace as necessary. 2. If carburetor still floods, remove air horn and check float needle and seat for proper seal. If a needle seat tester is not available, mouth suction can be applied to the needle seat with needle installed. If needle seat leaks, replace with a factory matched set. 3. Check for fuel leaks into float, bent float arms or binds in float hanger. NOTE: A solid float can be checked for fuel absorption by lightly squeezing between fingers. If wetness appears on surface or float feels heavy (check with known good float), replace float assembly. 4. Check float adjustments. 5. If excessive dirt is found in the carburetor, clean fuel system and carburetor.

ENGINE IDLES ROUGH AND STALLS

Possible Cause	Corrective Action
Idle speed setting.	Re-set idle speed per instructions on decal in engine compartment.
Manifold vacuum hoses disconnected or improperly installed.	Check all vacuum hoses leading into the manifold or carburetor base for leaks or disconnection. Install or replace as necessary.
Carburetor loose on intake manifold.	Torque carburetor to manifold bolts (to 15 ft. lbs.).

Possible Cause	Corrective Action
Intake manifold is loose or gaskets are defective.	Using a pressure oil can, spray light oil or kerosene around manifold legs and carburetor base. If engine RPM changes, tighten or replace the manifold gaskets or carburetor base gaskets as necessary.
Hot idle compensator not operating (where used).	Normally the hot idle compensator should be closed when engine is running cold and open when engine is hot (approx. 140°F at comp.) replace if defective.
Air leaks into carburetor idle channels.	Tighten all carburetor screws. If gaskets are hard or cracked, replace as necessary.
Poor secondary throttle valve alignment.	If mis-aligned, loosen screws, align valves, tighten screws and re-stake as necessary.
Carburetor flooding. NOTE: Check by using procedure outlined under "engine flooded". Page 6M-8.	1. Remove air horn and check float adjustments. 2. Check float needle and seat for proper seal. If a needle seat tester is not available, mouth suction can be applied to the needle seat with needle installed. If needle and seat are defective, replace with factory matched set. 3. Check float for fuel leaks, bent float arm or binding float hanger. NOTE: A solid float can be checked for fuel absorption by lightly squeezing between fingers. If wetness appears on surface or float feels heavy (check with known good float), replace float assembly.
Dirt in idle channels.	If excessive dirt is found in carburetor or idle channels, clean fuel system and carburetor. Replace fuel filter as necessary.

ENGINE HESITATES ON ACCELERATION

Possible Cause	Corrective Action
Defective accelerator pump system. NOTE: A quick check of the pump system can be made as follows. With the engine off, remove air cleaner and look into carburetor bores and observe pump shooters, while briskly opening throttle valves. A full stream should emit from each pump jet and enter the center of the carburetor bore.	1. Remove carburetor air horn and check pump cup. If cracked, scored or distorted, replace pump plunger. Check pump discharge ball for proper seating and location. To check discharge ball for proper seating, fill cavity above discharge ball with fuel. If "leak down" occurs remove discharge ball and clean check ball seat and pump passages and jets. If clean, stake discharge ball seat by tapping ball lightly against seat with drift punch and small hammer. Replace with new discharge ball.

Possible Cause	Corrective Action
Dirt in pump passes or pump jet.	Clean and blow out with compressed air.
Float level	Check for sticking float needle or binding float. Free up or replace parts as necessary. Check and reset float level to specification.
Leaking air horn to float bowl gasket.	Torque air horn to float bowl using proper tightening procedure.
Carburetor loose on manifold.	Torque carburetor to manifold bolts (to 15 ft. lbs.).
Air valve binding (sticks open)	1. Torque air horn screws evenly using proper tightening sequence. 2. Free-up air valve shaft and align air valves. 3. Check air valve spring for closing tension. If defective, replace with spring kit part number 7035344.
Air valve lockout.	1. Free-up and check for proper operation. 2. Adjust air valve lockout.

NO POWER ON HEAVY ACCELERATION OR AT HIGH SPEED

Possible Cause	Corrective Action
Carburetor throttle valve not going wide open. (Check by pushing accelerator pedal to floor	Adjust throttle linkage to obtain wide open throttle in carburetor.
Dirty or plugged fuel filter.	Replace as necessary.
Air valves not unlocking after engine warms up.	Free-up and adjust air valve lockout.
Air valves binding, stuck closed or open.	1. Free-up air valve shaft and align air valves. 2. Torque air horn screws evenly using proper tightening sequence. 3. Check air valve spring for closing tension. If defective, replace with spring kit, part number 7035344.
Power system not operating.	1. Check power piston for free up and down movement. Proceed as follows. Use a .300 plug gauge or 19/64" drill and insert in front air horn vent stack. Push gently downward on top of power piston with engine off. Power piston should move downward approximately 1/4" and return to up position under spring tension. If power piston is sticking, remove the carburetor air horn and check power piston and cavity for dirt or scores. Check power piston spring for distortion.

Possible Cause	Corrective Action
Float level too low.	Check and reset float level.
Float not dropping far enough in bowl.	Check for bind in float hanger and float arm, float alignment in bowl and needle pull clip for sufficient clearance on float arm.
Main metering jets or metering rods dirty, plugged or incorrect part.	1. If the main metering jets are plugged or dirty or excessive dirt is in fuel bowl, the carburetor should be completely disassembled and cleaned. 2. If the jets or rods are incorrect size, consult the parts list for proper usage. The last two digits stamped on the primary rods and jets are the last two digits of the part number.

ENGINE STARTS HARD WHEN HOT

Possible Cause	Corrective Action
Choke valve not opening completely.	1. Check for binding choke valve and/or linkage. Clean and/or replace as necessary. Do not oil choke linkage. 2. Check and adjust choke thermostatic coil.
Engine flooded, carburetor flooding.	See procedure under "Engine cranks, will not start engine flooded."
No fuel in carburetor.	1. Check fuel pump. Run pressure and volume test. 2. Check float needle for sticking in seat, or binding float. 3. Check and adjust float level.
Leaking float bowl.	Fill bowl with fuel and look for leaks.

ENGINE RUNS UNEVEN OR SURGES.

Possible Cause	Corrective Action
Fuel restriction.	Check all hoses and fuel lines for bends, kinks or leaks. Straighten and secure in position. Check all fuel filters, if plugged or dirty - replace.
Dirt or water in fuel system.	Clean fuel tank, lines and filters. Remove and clean carburetor.
Fuel level.	Adjust float. Check for free float and float needle valve operation. Free up or replace as necessary.
Metering rods bent or incorrect part. Main metering jets dirty, defective, loose or incorrect part	Clean or replace as necessary.

Possible Cause	Corrective Action
Power system in carburetor not functioning properly. Power piston sticking.	Free up or replace as necessary.
Vacuum leakage.	It is absolutely necessary that all vacuum hoses and gaskets are properly installed with no air leaks. The carburetor and manifold should be evenly tightened to specified torque. Carburetor to manifold (to 15 ft. lbs.).
Secondary throttle valves sticking open or not seating properly.	Loosen secondary throttle valve screws. Align valves in carburetor bores and tighten securely.

POOR FUEL ECONOMY

Possible Cause	Corrective Action
Engine needs complete tune up.	Check engine compression, examine spark plugs, (if dirty or improperly gapped, clean and re-gap or replace), ignition point dwell, condition, re-adjust ignition points if necessary and check and reset ignition timing. Clean or replace air cleaner element if dirty. Check for restricted exhaust system and intake manifold for leakage. Make sure all vacuum hoses are connected correctly.
Choke valve not fully opening.	1. Clean choke and free-up linkage. 2. Check choke coil for proper adjustment.
Fuel leaks.	Check fuel tank, fuel lines and fuel pump for any fuel leakage.
High fuel level in carburetor or carburetor flooding.	1. Check for dirt in the needle and seat. Test using suction by mouth or needle seat tester. 2. Check for loaded float. 3. Re-set carburetor float. 4. If excessive dirt is present in the carburetor bowl, the carburetor should be cleaned.
Power system in carburetor not functioning properly. Power piston sticking in up position.	Free-up or replace as necessary.
Metering rods bent or incorrect part. Main metering jets, defective, loose or incorrect part	Clean or replace as necessary.
Fuel being pulled from accelerator system into venturi through pump jets.	Run engine at RPM where nozzles are feeding fuel. Observe pump jets. If fuel is feeding from jets, check pump discharge ball for proper seating by filling cavity above ball with fuel to level of casting. No "leak down" should occur with discharge ball in place, Re-stake or replace leaking check ball.
Air bleeds or fuel passages in carburetor dirty or plugged.	Clean carburetor or overhaul as necessary.

CARBURETOR REPLACEMENT

REMOVAL

1. Remove engine cover.

2. Remove air cleaner. Refer to "Air Cleaner" later in this section.

3. Disconnect vacuum hoses. Disconnect fuel inlet line.

4. Disconnect throttle cable. Disconnect cruise control rod if equipped.

5. Remove air cleaner stud.

6. Disconnect choke housing pipe.

7. Remove four carburetor to manifold attaching bolts.

8. Remove carburetor.

INSTALLATION

1. Install a new carburetor to manifold gasket.

2. Install carburetor. Torque attaching bolts diagonally to 48-96 in. lbs., then after all four are torqued, retorque diagonally to 12-17 ft. lbs. The sequence in Figure 9 is one, three, two, four.

3. Connect choke housing pipe.

4. Install air cleaner stud.

5. Connect throttle cable. Connect cruise control rod if removed.

6. Connect vacuum lines. Connect fuel inlet line. Hold fuel inlet nut while connecting fuel line to avoid damaging inlet nut nylon gasket.

7. Install air cleaner.

8. Install engine cover.

CARBURETOR OVERHAUL

NOTE: Before performing any service on the carburetor it is essential that the carburetor be placed on a holding fixture. The secondary throttle valves in the wide open position extend below the throttle body casting. Without the use of the carburetor fixture it is possible to bend or nick the aluminum throttle valves.

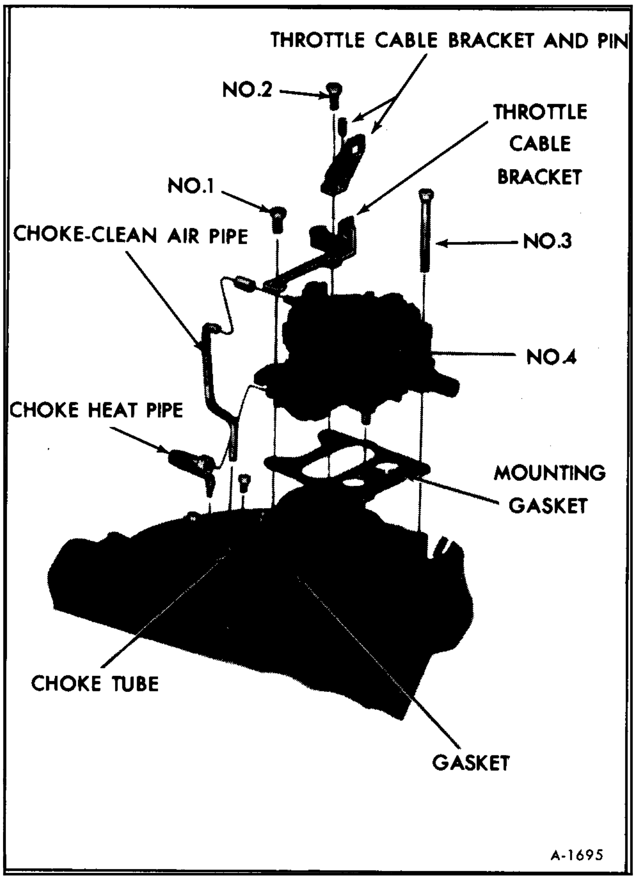


Figure 9—Carburetor Installation

AIR HORN REMOVAL

1. Remove air cleaner assembly.

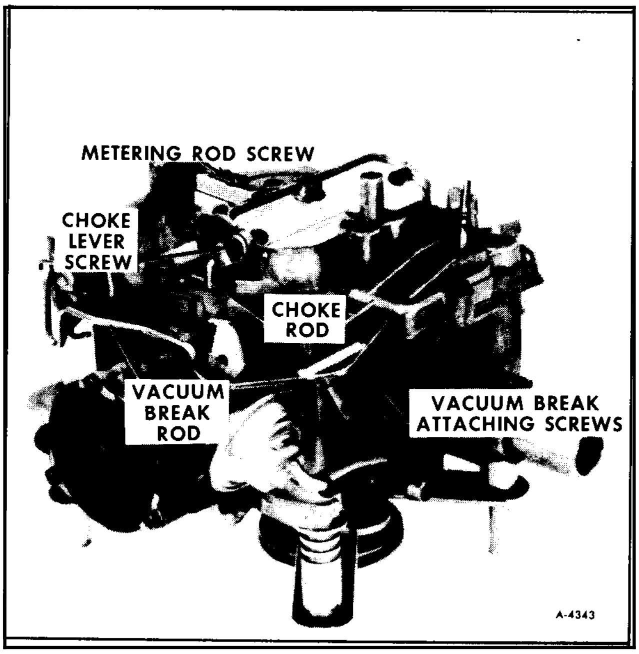


Figure 10—Carburetor Assembly

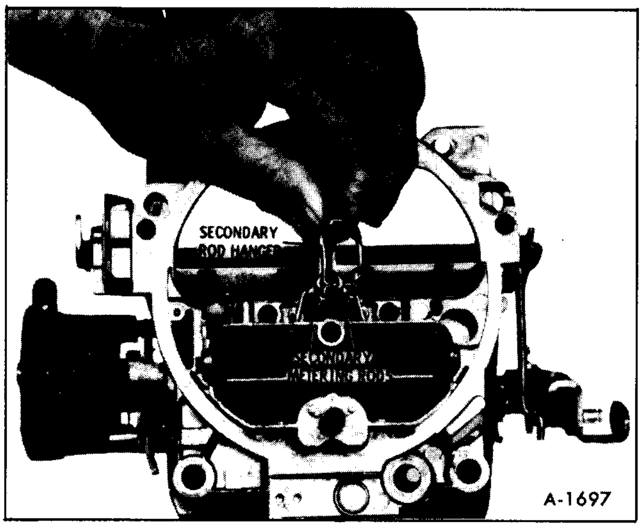


Figure 11—Secondary Metering Rods

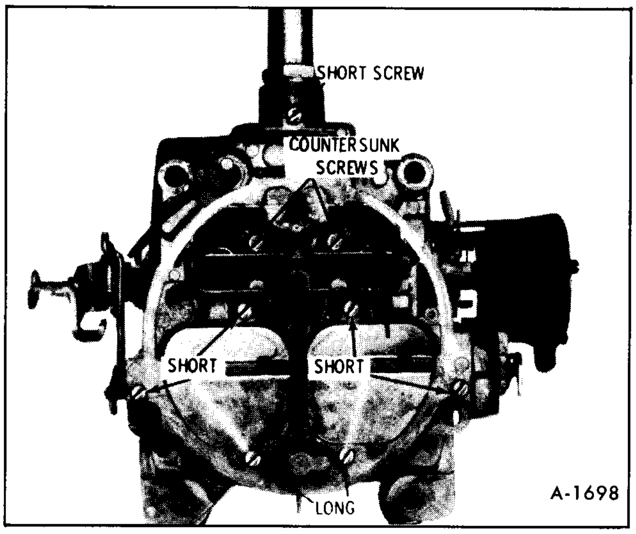


Figure 12—Air Horn Attaching Screws

2. Remove upper choke lever from the end of choke shaft by removing retaining screw (figure 10). Then remove the upper choke lever from the end of choke rod and choke rod from lower lever inside the float bowl casting.

> **NOTE:** Remove rod by holding lower lever outward with small screwdriver and twisting rod counterclockwise.

3. Remove vacuum break hose, remove vacuum break bracket attaching screws. The diaphragm assembly may now be removed from the dashpot rod and the dashpot rod from the air valve lever.

4. Remove secondary metering rods by removing the small screw in the top of the metering rod hanger. Lift upward on metering rod hanger until the secondary metering rods are completely out of the air horn. Metering rods may be disassembled from the hanger by rotating ends out of the holes in the end of the hanger (See figure 11).

5, Remove nine air horn to bowl attaching screws; two attaching screws are located next to the primary venturi. (Two long screws, five short screws, two countersunk screws.) See Figure 12.

6. The air horn assembly may now be removed from the float bowl by opening the throttle valve wide open and lifting up on the air horn and turning sideways until the pump rod disengages from the upper pump lever as shown in Figure 15.

> **CAUTION:** *Care must be taken not to bend the small bleed tubes and accelerating tubes in air horn casting. These are permanently pressed into casting. Do Not Remove.*

AIR HORN DISASSEMBLY

Further disassembly of the air horn is not recommended for cleaning purposes. If part replacement is required, proceed as follows:

1. Remove choke valve attaching screws, then remove choke valve and shaft from air horn.

> **NOTE:** Air valves and air valve shaft should not be removed. However, if it is necessary to replace the air valve closing spring or center plastic eccentric cam, a repair kit is available. Instructions for assembly are included in the repair kit.

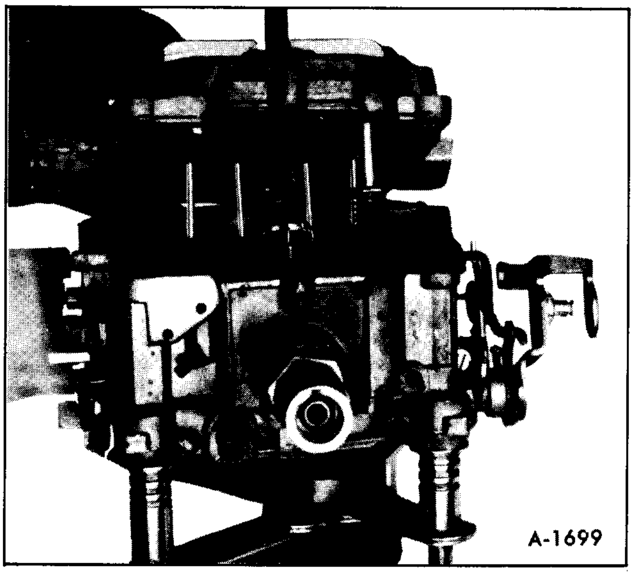


Figure 13—Removing Air Horn

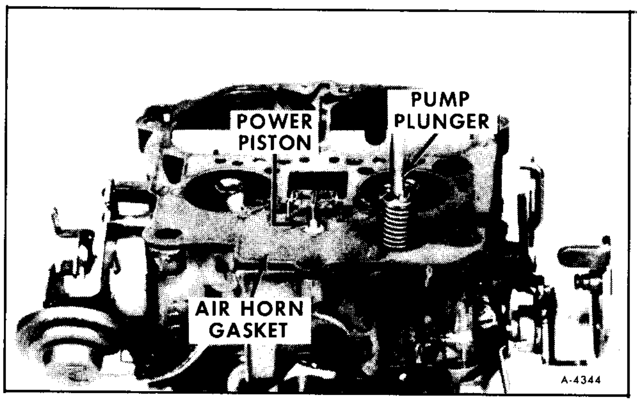


Figure 14—Float Bowl Assembly

FLOAT BOWL DISASSEMBLY

1. Remove pump plunger from pump well. See Figure 14.

2. Remove air horn gasket from float bowl.

3. Remove pump return spring from pump well.

4. Remove plastic filler over float valve.

5. Remove power piston and primary metering rods by depressing piston stem and allowing it to snap free. Remove power piston spring from well.

NOTE: Piston may require several snaps to come free.

6. Remove metering rods from power piston by disconnecting tension spring from top of each rod then rotating rod to remove from hanger as shown in Figure 15.

7. Remove float assembly and float needle by pulling up on retaining pin. Remove float needle seat and gasket (figure 16).

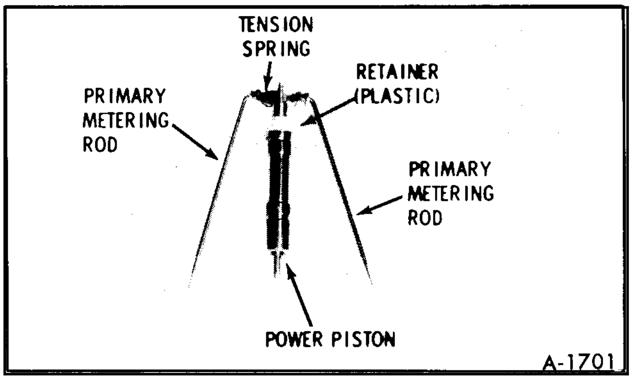


Figure 15—Power Piston and Metering Rod

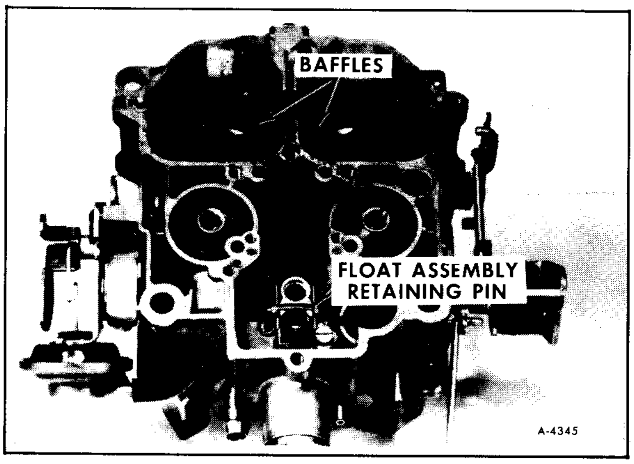


Figure 16—Float Assembly

8. Remove primary metering jets. No attempt should be made to remove secondary metering plates (figure 18).

9. Remove pump discharge check ball retainer and check ball.

10. Remove baffle from secondary side of bowl.

CAUTION: *Do not place vacuum break assembly in carburetor cleaner. Remove choke assembly. If further disassembly is necessary, spread the retaining ears on bracket next to vacuum break assembly, then remove vacuum break from bracket.*

CHOKE DISASSEMBLY

1. Remove three retaining screws and retainers from choke cover and coil assembly. Then pull straight outward and remove cover and coil assembly from choke housing. See Figure 18.

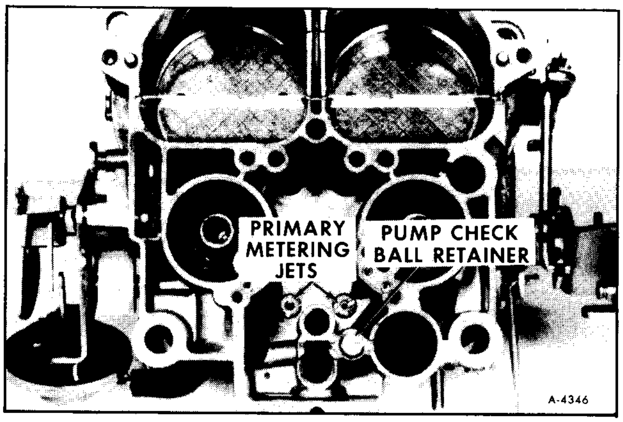


Figure 17—Primary Metering Jets

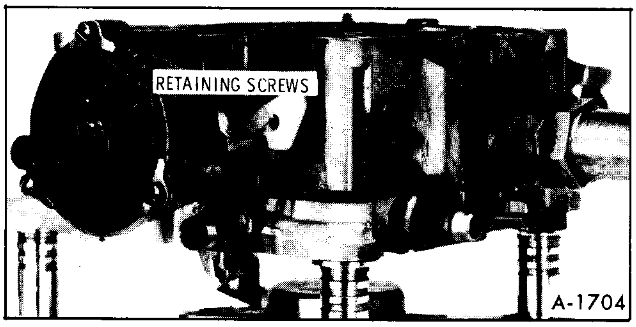


Figure 18—Choke Housing

NOTE: It is not necessary to remove baffle plate beneath the thermostatic coil. Distortion of the thermostatic coil may result if forced off the center retaining post on the choke cover.

2. Remove choke housing assembly from float bowl by removing retaining screw and washer inside the choke housing (figure 19). The complete choke assembly can be removed from the float bowl by sliding outward. Remove plastic tube seal from choke housing. Remove lower choke lever from inside float bowl cavity by inverting bowl.

CAUTION: *Plastic tube seal should not be immersed in carburetor cleaner.*

3. To disassemble intermediate choke shaft from choke housing, remove coil lever retaining screw at end of shaft inside the choke housing (figure 20). Then remove thermostatic coil lever from flats on intermediate choke shaft. Remove intermediate choke shaft from the choke housing by sliding outward. The fast idle cam can now be removed from the intermediate choke shaft. See Figure 21.

CAUTION: *Remove the cup seal from inside choke housing shaft hole, if the housing is to be immersed in carburetor cleaner. Also,*

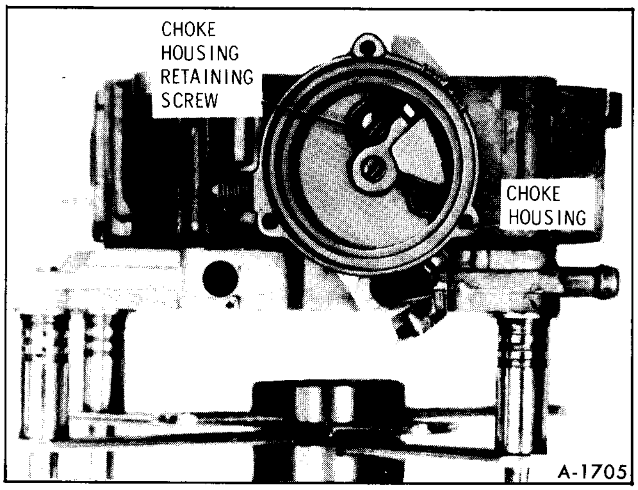


Figure 19—Choke Housing Attachment

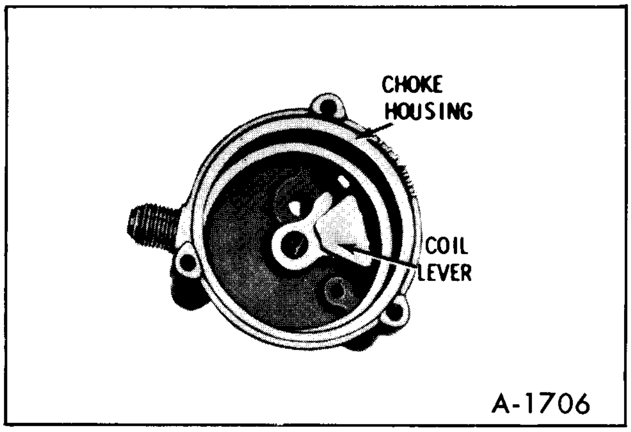


Figure 20—Choke Coil Lever

remove the cup seal from the float bowl plastic insert for bowl cleaning purposes. Do not attempt to remove plastic insert.

DISASSEMBLY OF REMAINING FLOAT BOWL PARTS

1. Remove fuel inlet nut, gasket and filter. See Figure 22.

2. Remove screws attaching throttle body to bowl as shown in Figure 23.

3. Remove throttle body to bowl insulator gasket. See Figure 25.

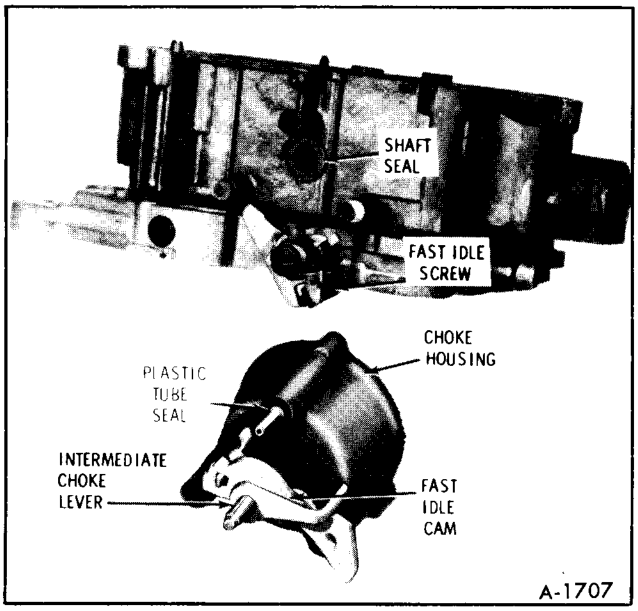


Figure 21—Choke Housing Sealing

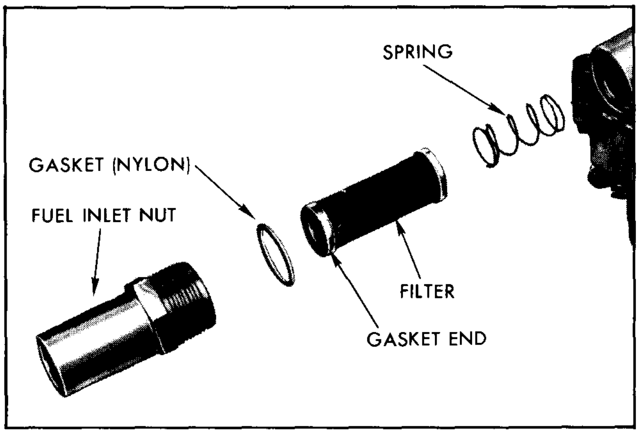


Figure 22—Fuel Filter

THROTTLE BODY DISASSEMBLY

1. Remove pump rod from throttle lever.

2. DO NOT REMOVE idle mixture limiter caps, unless it is necessary to replace the mixture needles or normal soaking and air pressure fails to clean the idle passages. If the idle mixture needles are removed, adjustment procedures will be covered in the "Carburetor Adjustment" chart. If necessary to remove the idle mixture needle, destroy plastic limiter cap. Do not install a replacement cap as a bare mixture screw is sufficient to indicate that the mixture has been readjusted.

CLEANING AND INSPECTION

1. Thoroughly clean carburetor castings and metal parts in an approved carburetor cleaner.

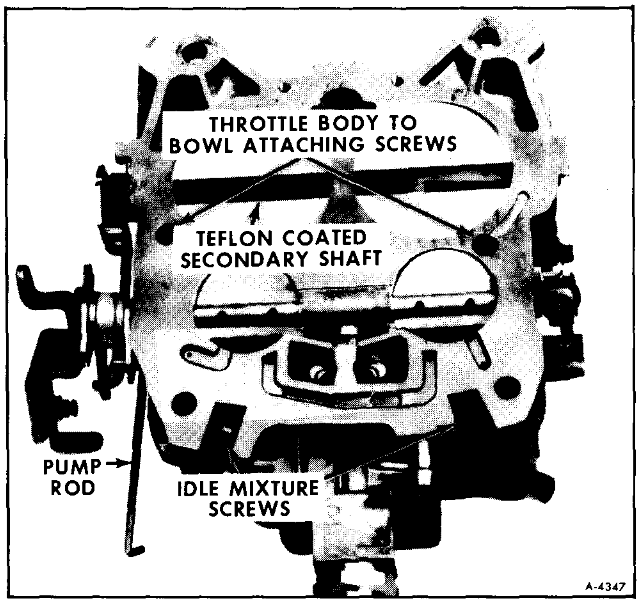


Figure 23—Throttle Body Attaching Screws

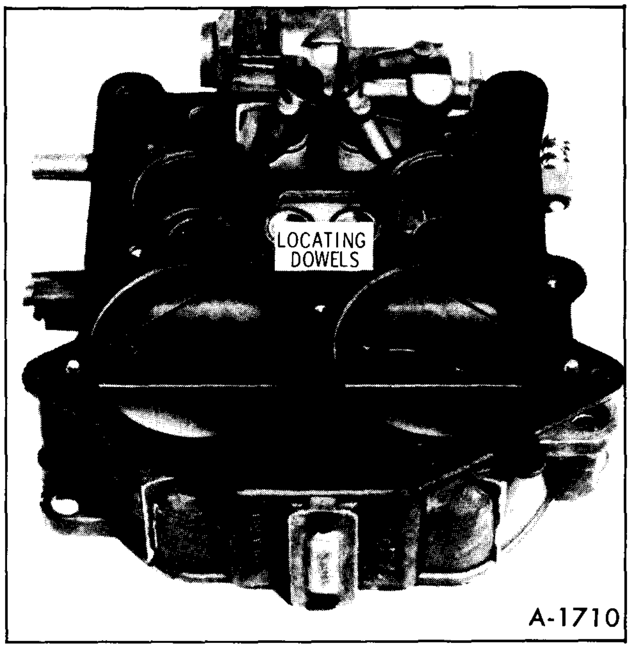


Figure 24—Throttle Body Gasket

CAUTION: *Rubber parts, plastic parts, and pump plungers should not be immersed in carburetor cleaner. However, the delrin cam on the air valve shaft and the throttle valve shafts will withstand normal cleaning in carburetor cleaner.*

2. Blow out all passages in castings with compressed air.

CAUTION: *Do not pass drills through jets or passages.*

3. Examine float needle and seat for wear. Replace if necessary with float needle assembly.

4. Inspect upper and lower surfaces of carburetor castings for damage.

5. Inspect holes in levers for excessive wear or out of round conditions. If worn, levers should be replaced.

6. Examine fast idle cam for wear or damage.

7. Check air valve for binding conditions. If air valve is damaged air horn assembly must be replaced.

8. Check all throttle levers and valves for binds or other damage.

THROTTLE BODY

1. If removed, install idle mixture needles and

springs until seated. Back out the mixture needles six turns as a preliminary idle adjustment. Final adjustment must be made on the engine using the procedure described under slow idle adjustment.

2. Install lower end of pump rod in throttle lever by aligning tang on rod with slot in lever. End of rod should point outwards towards throttle lever.

FLOAT BOWL ASSEMBLY

1. Install new throttle body to bowl gasket over two locating dowels on the bowl as shown in Figure 24.

2. Install throttle body, properly located over dowels on float bowl then install throttle body to bowl screws and tighten evenly. See Figure 23.

3. Install fuel inlet filter spring, new gasket and inlet nut (figure 22). Tighten nut (18 ft. lbs.).

> **CAUTION:** *Tightening beyond specified torque can damage nylon gasket.*

CHOKE HOUSING ASSEMBLY TO FLOAT BOWL

1. Install new cup seal into plastic insert on side of float bowl for intermediate choke shaft. Lip on cup seal faces outward.

2. Install fast idle cam onto the intermediate choke shaft (steps on fast idle cam face downward) as shown in Figure 21.

3. Install new rubber cup seal inside choke housing. Lips on seal face inward, towards inside of housing.

4. Carefully install fast idle cam and intermediate choke shaft assembly through seal in choke housing; then install thermostatic coil lever onto flats on intermediate choke shaft. Inside thermostatic choke coil level is properly aligned when both inside and outside levers face towards fuel inlet. Install inside lever retaining screw into end of intermediate choke shaft. Tighten securely.

5. Install lower choke rod lever into cavity in float bowl. Install plastic tube seal into cavity on choke housing before assembling choke housing to bowl. Install choke housing to bowl sliding intermediate choke shaft into lower choke lever. See Figure 25.

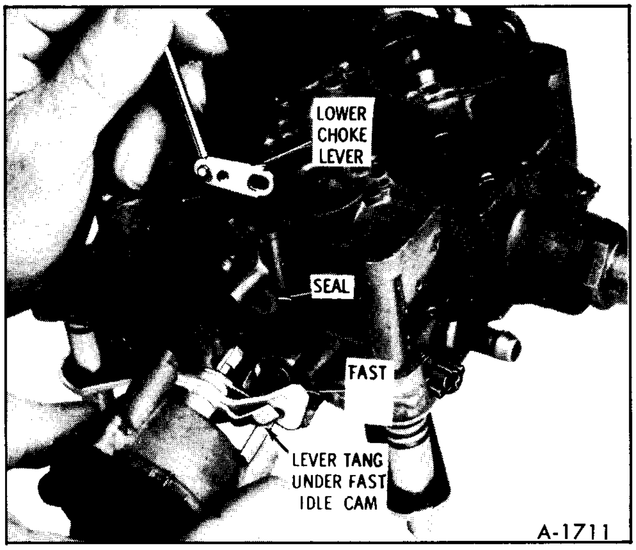


Figure 25—Lower Choke Lever

6. Install choke housing retaining screw and washer and tighten securely.

> **NOTE:** The intermediate choke shaft lever and fast idle cam are in correct relation when the tang on lever is beneath the fast idle cam. Do not install choke cover and coil assembly until inside coil lever is adjusted.

COMPLETION OF FLOAT BOWL ASSEMBLY

1. Install baffle in secondary side of float bowl with notches toward top of bowl.

2. Install pump discharge check ball and retainer in passage next to pump well. Tighten retainer securely.

3. Install primary metering jets. See Figure 17.

4. Install new needle seat and gasket assembly.

> **NOTE:** To make adjustment easier, bend float arm upward at notch in arm before assembly.

5. Install float needle by sliding float lever under pull clip from front to back. With float lever in pull clip, hold float assembly at toe and install retaining pin from pump well side.

> **NOTE:** Do not install float needle pull clip into holes in float arms.

6. Float level adjustment:

a. With adjustable T-scale, measure from top of float bowl gasket surface (gasket removed) to top of float at toe. Locate gauging point 1/16" back from toe.

Make sure float retainer is held firmly in place and arm of float is seated on float needle.

b. Bend float arm as necessary for proper adjustment by pushing on pontoon. Refer to adjustment chart for specification.

7. Install power piston spring into power piston well. If primary main metering rods were removed from hanger, reinstall making sure that tension spring is connected to top of each rod (figure 15). Install power piston assembly in well with metering rods properly positioned in metering jets. Press down firmly on plastic power piston retainer to make sure the retainer is seated in recess in bowl and the top is flush with the top of the bowl casting.

8. Install plastic filler block over float needle, pressing downward until properly seated.

9. Install pump return spring in pump well.

10. Install air horn gasket around primary main metering rods and piston. Position gasket over two dowels on secondary side of bowl.

11. Install pump plunger in pump well.

AIR HORN ASSEMBLY

If removed, install choke shaft, choke valve and two attaching screws. Tighten screws securely and stake lightly in place.

AIR HORN TO BOWL INSTALLATION

1. Holding the primary throttle valves wide open, rotate the air horn assembly so that the pump rod slides into inner hole in pump lever and then carefully lower air horn assembly onto the float bowl. Make sure that the bleed tubes and accelerating well tubes are positioned properly through the holes in the air horn gasket. Do not force the air horn assembly onto the bowl, but rather lightly lower in place.

2. Install two long air horn screws, five short screws, and two countersunk screws into primary venturi area. All screws must be tightened evenly and securely. See Figure 26.

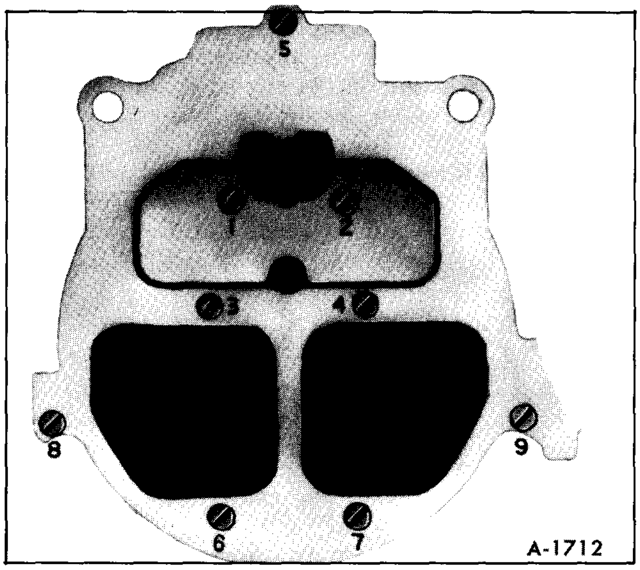


Figure 26—Air Horn Tightening Sequence

3. Install vacuum break diaphragm combination rod into the slot in lever on the end of the air valve shaft. Then install the other end of rod into hole in the vacuum diaphragm plunger. Install vacuum diaphragm assembly to float bowl using two retaining screws through bracket. Tighten securely.

4. Install rubber hose between the vacuum diaphragm and vacuum tube on float bowl.

5. Connect choke rod into lower choke lever inside bowl cavity; then install upper end of rod into upper choke lever and retain the choke lever to the end of choke shaft with attaching screw. Tighten securely.

NOTE: Make sure that the flats on the end of the choke shaft align with flats in the choke lever.

6. Install the secondary metering rods to the secondary metering rod hanger. The ends of the secondary metering rods point inward. Lower secondary metering rods into float bowl cavity and place hanger on actuating lever. Install small retaining screw and tighten lightly and securely.

NOTE: The thermostatic coil lever inside the choke housing has to be indexed properly before installing the choke thermostatic coil cover baffle and gasket assembly. Refer to adjustment charts (figures 27, 28, 29 and 30) for adjustment information.

After the inside thermostatic coil lever is adjusted, the thermostatic coil, cover and gasket assembly should be installed and rotated counterclockwise until the choke valve just closes. At this point, the index cover should be set as shown on adjustment chart (Choke Coil Adjustment). Install three choke cover retainers and screws and tighten securely.

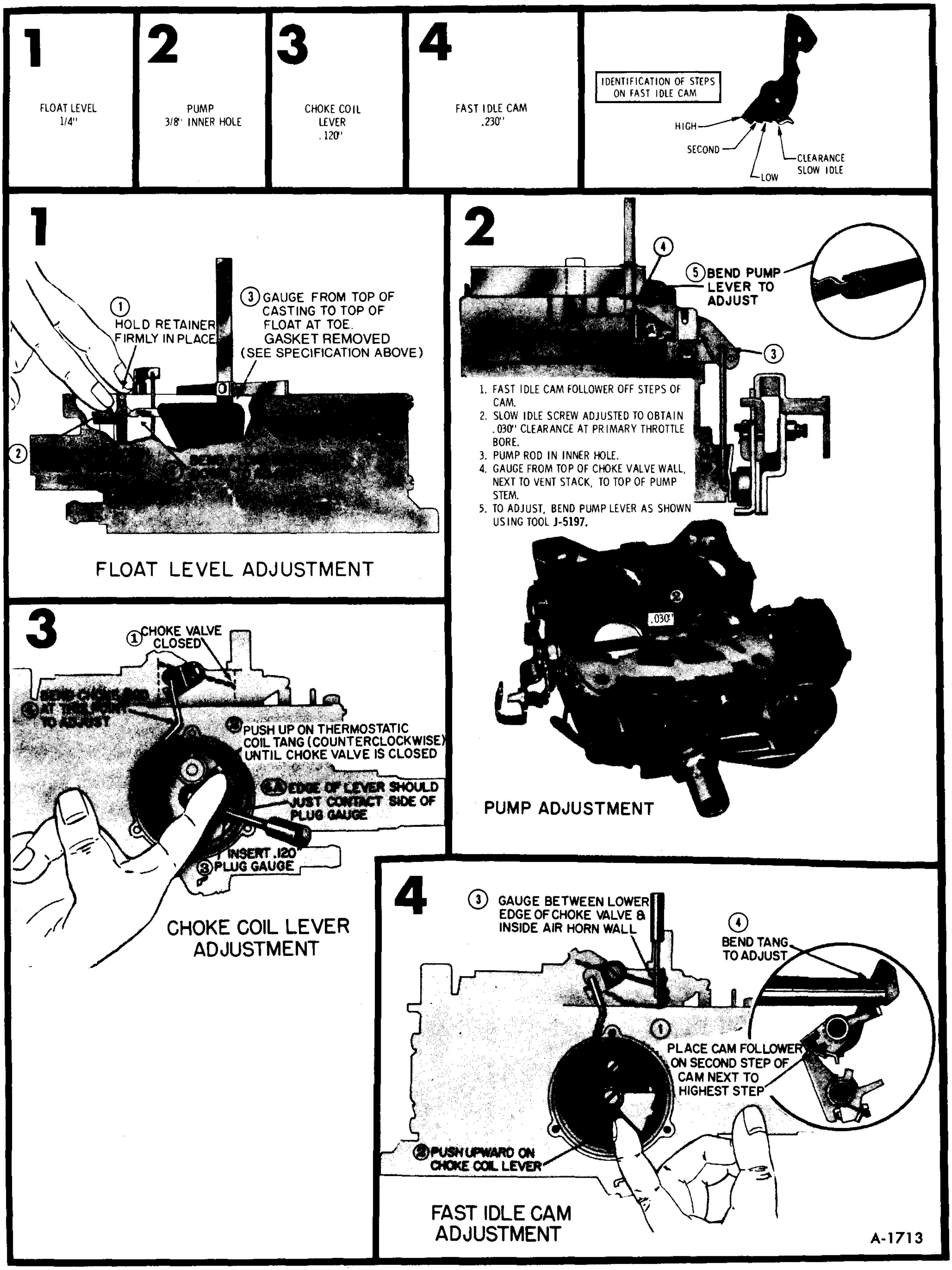


Figure 27—Carburetor Adjustments

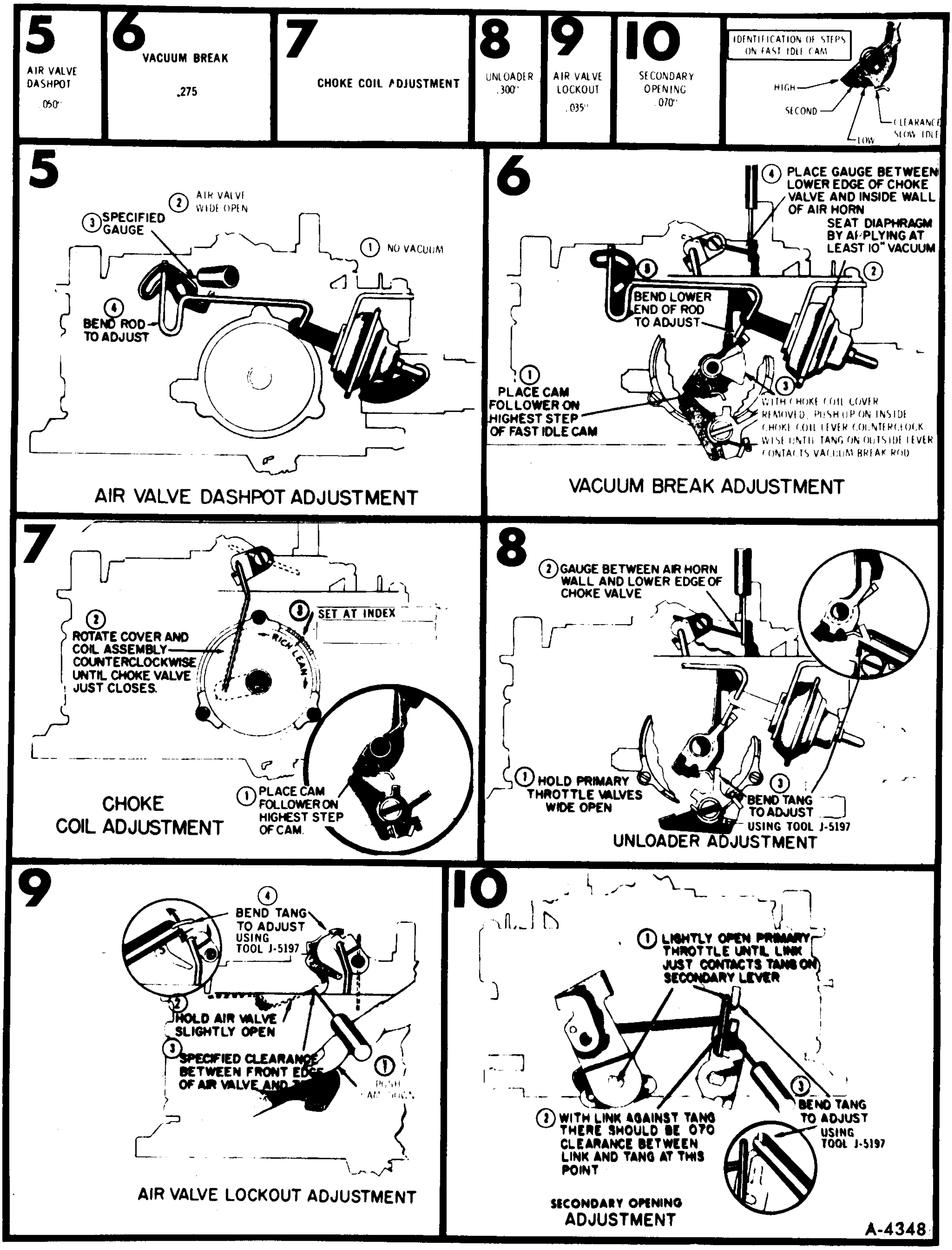
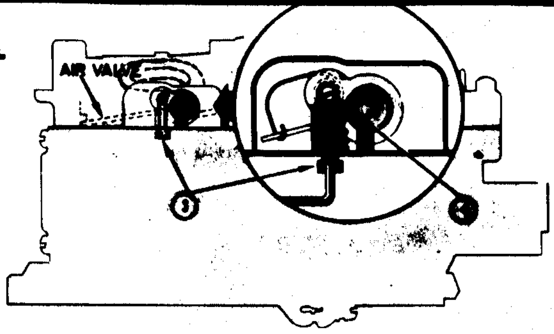


Figure 28—Carburetor Adjustments

11 AIR VALVE SPRING 3/4 TURN	12 SLOW IDLE SEE STEP 12 BELOW	13 FAST IDLE SEE STEP 13 BELOW	

11



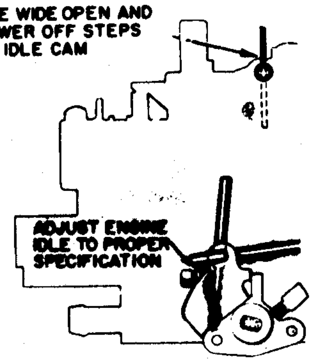
AIR VALVE SPRING ADJUSTMENT

1. REMOVE VACUUM BREAK DIAPHRAGM, AND ROD.
2. OPEN CHOKE VALVE.
3. LOOSEN LOCK SCREW (ALLEN HEAD).
4. TURN TENSION ADJUSTING SCREW COUNTER-CLOCKWISE UNTIL AIR VALVE OPENS PART WAY.
5. TURN TENSION ADJUSTING SCREW CLOCKWISE WHILE TAPPING LIGHTLY ON CASTING WITH HANDLE OF A SCREWDRIVER.
6. WHEN AIR VALVE JUST CLOSES, TURN TENSION ADJUSTING SCREW CLOCKWISE AN ADDITIONAL AMOUNT AS SPECIFIED ABOVE.
7. TIGHTEN LOCK SCREW AND REPLACE VACUUM BREAK DIAPHRAGM, AND ROD.

12

CHOKE VALVE WIDE OPEN AND CAM FOLLOWER OFF STEPS OF FAST IDLE CAM

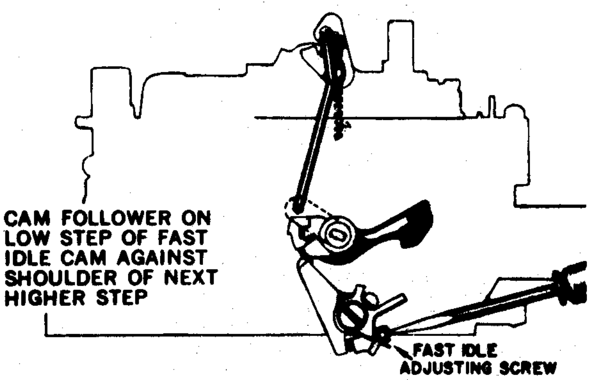
SLOW IDLE ADJUSTMENT



1. ENGINE AT NORMAL OPERATING TEMPERATURE. REMOVE AIR CLEANER, DISCONNECT AIR CLEANER VACUUM HOSE AT INTAKE MANIFOLD, THEN PLUG FITTING.
2. CHOKE OPEN AND AIR CONDITIONING OFF.
3. SET PARKING BRAKE AND BLOCK DRIVE WHEELS.
4. DISCONNECT CARBURETOR HOSE FROM VAPOR CANISTER (PLUG HOSE).
5. DISCONNECT DISTRIBUTOR VACUUM HOSE AT DISTRIBUTOR AND PLUG.
6. WITH DWELL AND TIMING PROPERLY ADJUSTED AND TRANSMISSION IN DRIVE ADJUST IDLE SPEED TO OBTAIN 600 R.P.M.
7. CONNECT DISTRIBUTOR VACUUM HOSE, CONNECT CARBURETOR HOSE TO VAPOR CANISTER, CONNECT AIR CLEANER HOSE AND INSTALL AIR CLEANER.

13

CAM FOLLOWER ON LOW STEP OF FAST IDLE CAM AGAINST SHOULDER OF NEXT HIGHER STEP



FAST IDLE ADJUSTMENT (ON VEHICLE)

1. ENGINE AT NORMAL OPERATING TEMPERATURE. REMOVE AIR CLEANER, DISCONNECT AIR CLEANER VACUUM HOSE AT INTAKE MANIFOLD, THEN PLUG FITTING.
2. CHOKE OPEN AND AIR CONDITIONING OFF.
3. SET PARKING BRAKE AND BLOCK DRIVE WHEELS.
4. DISCONNECT CARBURETOR HOSE FROM VAPOR CANISTER AND PLUG
5. DISCONNECT DISTRIBUTOR VACUUM HOSE AT DISTRIBUTOR AND PLUG.
6. WITH DWELL AND TIMING PROPERLY ADJUSTED, PLACE CAM FOLLOWER ON LOW STOP AND AGAINST SHOULDER OF NEXT HIGHER STEP. ADJUST FAST IDLE SCREW TO OBTAIN 1100 RPM (TRANS. IN PARK).
7. UNPLUG DISTRIBUTOR VACUUM HOSE AND RECONNECT TO DISTRIBUTOR. UNPLUG VACUUM FITTING AT INTAKE MANIFOLD AND RECONNECT AIR CLEANER HOSE. CONNECT CARBURETOR HOSE TO CANISTER. INSTALL AIR CLEANER AND RECHECK IDLE RPM.

A-4349

Figure 29—Carburetor Adjustments

14 IDLE MIXTURE ADJUSTMENT

ENGINES CERTIFIED FOR 1974-1975-1976

(REFER TO LABEL ON R.H. VALVE COVER FOR YEAR OF CERTIFICATION)

IN THE CASE OF HIGH IDLE CO (OVER .5%) MAJOR CARBURETOR OVERHAUL, THROTTLE BODY REPLACEMENT, OR WHEN POOR IDLE QUALITY EXISTS, IDLE MIXTURE MAY BE ADJUSTED. TO PROPERLY SET IDLE MIXTURE TO ACHIEVE THE SMOOTHEST IDLE WHILE MAINTAINING EMISSION LEVELS WITHIN THE STANDARDS PRESCRIBED BY FEDERAL LAW, THE FOLLOWING PROCEDURES MUST BE FOLLOWED:

(HOWEVER)

BEFORE SUSPECTING THE CARBURETOR TO BE THE CAUSE OF POOR ENGINE PERFORMANCE OR ROUGH IDLE, CHECK IGNITION INCLUDING DISTRIBUTOR, CHECK TIMING, PLUGS AND WIRES, CHECK AIR CLEANER, EVAPORATIVE EMISSION SYSTEM, PCV SYSTEM AND COMPRESSION. ALSO, CHECK VACUUM HOSES FOR LEAK.

IF ACCURATE CO METER IS AVAILABLE.

1. WITH ENGINE AT NORMAL OPERATING TEMPERATURE, REMOVE AIR CLEANER AND DISCONNECT AIR CLEANER VACUUM HOSE AT INTAKE MANIFOLD, THEN PLUG FITTING.
2. CHOKE OPEN AIR CONDITIONING OFF.
3. SET PARKING BRAKE AND BLOCK FRONT DRIVE WHEELS.
4. DISCONNECT CARBURETOR HOSES FROM VAPOR CANISTER, DISTRIBUTOR, AND PLUG HOSES.
5. CONNECT CO METER TO EXHAUST SYSTEM TAILPIPE.
6. SET IDLE SPEED TO 600 RPM.
7. TURN EACH IDLE MIXTURE CAP IN EQUAL AMOUNTS (MAXIMUM ADJUSTMENT IS ONE HALF) UNTIL IDLE CO IS AT OR BELOW .2%. RESET IDLE SPEED, IF NECESSARY, WITH AIR CLEANER IN PLACE.
8. RECONNECT CARBURETOR TO CANISTER HOSE AND DISTRIBUTOR VACUUM ADVANCE HOSE. INSTALL AIR CLEANER AND CONNECT VACUUM HOSE.

NOTE: CO METER MUST BE CAPABLE OF LOW LEVEL, ACCURATE READINGS. METERS SHOULD BE ACCURATE WITHIN ± .1% CO IN THE SETTING RANGE SPECIFIED. THE METER SCALE SHOULD HAVE DIVISIONS OF .2% CO OR LESS.

IF ACCURATE CO METER IS NOT AVAILABLE.

1. WITH ENGINE AT NORMAL OPERATING TEMPERATURE, REMOVE AIR CLEANER AND DISCONNECT AIR CLEANER VACUUM HOSE AT INTAKE MANIFOLD, THEN PLUG FITTING.
2. CHOKE OPEN AIR CONDITIONING OFF.
3. SET PARKING BRAKE AND BLOCK FRONT DRIVE WHEELS.
4. DISCONNECT CARBURETOR HOSES FROM VAPOR CANISTER, DISTRIBUTOR AND PLUG HOSES.
5. SET DWELL. SET TIMING AT SPECIFIED RPM.
6. BREAK TABS OFF FROM IDLE MIXTURE SCREW CAPS.
7. CONNECT AN ACCURATE VACUUM GAUGE TO THE INTAKE MANIFOLD.
8. WITH TRANSMISSION IN DRIVE, ADJUST IDLE SPEED SCREW TO OBTAIN 600 RPM.
9. EQUALLY RICHEN (TURN OUT) MIXTURE SCREWS UNTIL MAXIMUM IDLE SPEED IS ACHIEVED. NOTE MANIFOLD VACUUM READING.

   NOTE: IF MIXTURE SCREWS ARE APPARENTLY OUT-OF-BALANCE OR CARBURETOR IS BEING OVER-HAULED, LIGHTLY SEAT IDLE MIXTURE SCREWS, THEN BACK OUT 4 FULL TURNS. ADJUST IDLE SPEED SCREW TO OBTAIN 650 RPM.
10. EQUALLY LEAN (TURN IN) MIXTURE SCREWS UNTIL THE IDLE SPEED IS 600 RPM. MANIFOLD VACUUM READING SHOULD NOT BE REDUCED BY MORE THAN 2 INCHES OF MERCURY FROM READING OBTAINED IN STEP 9. IF READING IS REDUCED MORE THAN 2 INCHES, REPEAT PROCEDURE.
11. RECONNECT DISTRIBUTOR AND CANISTER HOSES.
12. INSTALL AIR CLEANER AND AIR CLEANER VACUUM HOSE.
13. IDLE CO SHOULD BE .2% MAXIMUM.

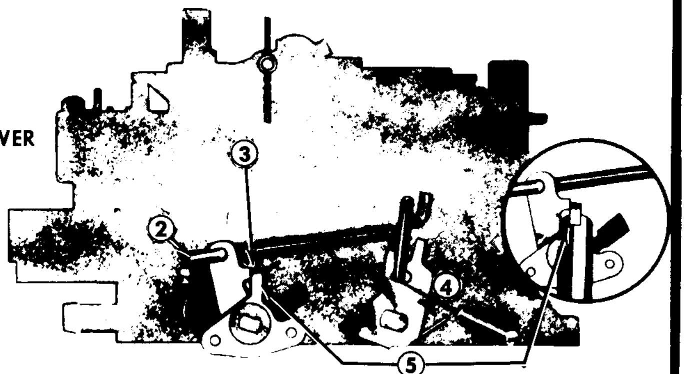
A-4350

Figure 30—Carburetor Adjustments

15 SECONDARY CLOSING .020"	**16** DOWNSHIFT SWITCH ADJUSTMENT

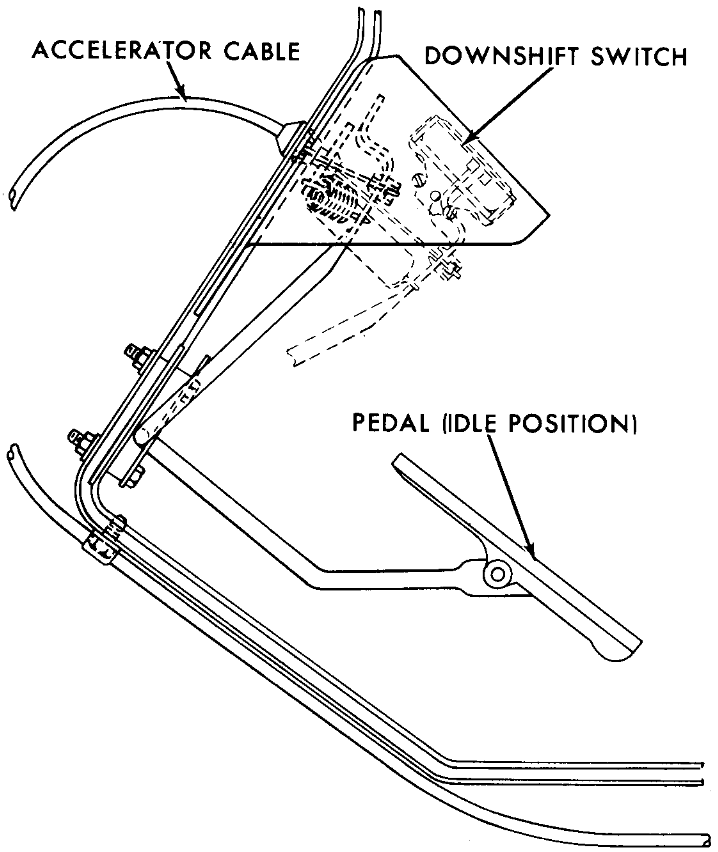
15

1. CHOKE FULLY OPEN AND FAST IDLE CAM FOLLOWER OFF STEPS OF FAST IDLE CAM.
2. SLOW IDLE PROPERLY SET.
3. MAKE SURE THROTTLE LEVER TANG IS AGAINST SECONDARY THROTTLE ROD OPERATING LEVER AS SHOWN IN 3.
4. GAUGE BETWEEN ROD AND END OF SLOT AS SHOWN IN 4. SEE SPECIFICATION ABOVE.
5. TO ADJUST OPEN THROTTLE SLIGHTLY AND BEND TANG WITH J-5197 AS SHOWN.



SECONDARY CLOSING ADJUSTMENT
(ON VEHICLE)

16



SWITCH ADJUSTMENT PROCEDURE

AFTER INSTALLING SWITCH PRESS PLUNGER AS FAR FORWARD AS POSSIBLE. THIS PRESETS SWITCH FOR ADJUSTMENT. SWITCH WILL ADJUST ITSELF PROPERLY WHEN PEDAL IS DEPRESSED TO FULL THROTTLE.

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Figure 31—Carburetor Adjustments

ACCELERATOR LINKAGE

The accelerator control system is a cable type. The pedal is mounted to a lever which is connected to the cable above the pedal, under the dash. As the pedal is depressed the lever moves back pulling the cable and engaging a transmission down shift switch. There is no adjustment on the pedal or lever, and it is important that the cable assembly NOT be lubricated.

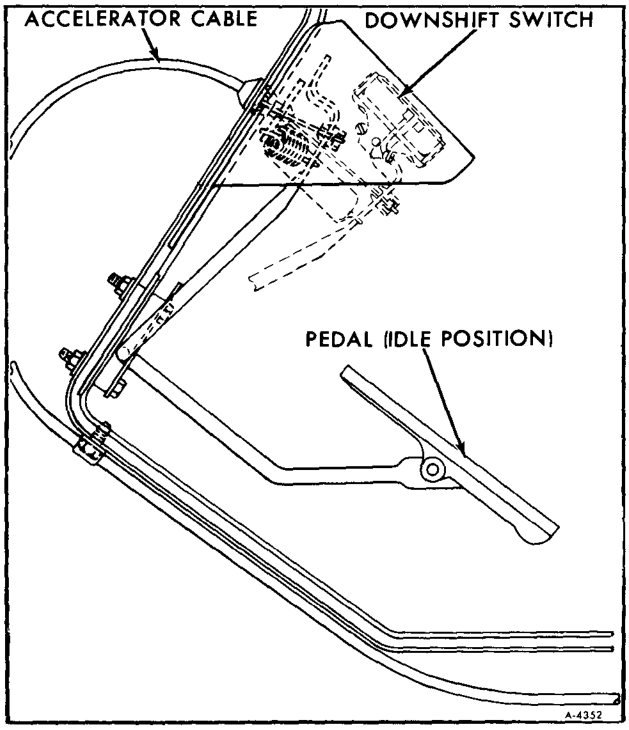

Figure 32—Accelerator Linkage

FUEL PUMP

The fuel pump rocker arm is held in constant engagement with the eccentric on the camshaft by the rocker arm spring. As the end of the rocker arm which is in contact with the eccentric moves upward, the fuel link pulls the fuel diaphragm downward. The action of the diaphragm enlarges the fuel chamber drawing fuel from the tank through the inlet valve and into the fuel chamber.

The pump delivers fuel to the carburetor only when the pressure in the outlet line is less than the pressure maintained by the diaphragm spring. Therefore, when the carburetor float needle valve opens, the spring will expand to move the diaphragm upward to force fuel past the outlet valve to the carburetor. When the carburetor float needle valve closes, the pump builds up pressure in the fuel chamber until the diaphragm spring is again compressed. The diaphragm will then remain stationary until more fuel is required by the carburetor.

INSPECTION AND TEST

There are three tests that can be preformed to evaluate the fuel pump without removing the pump from the engine. It is important that the pump performs properly using all three tests.

1. Be sure there is gasoline in the tank.

2. Check for loose line connections. A leak at the pressure side of the system (line from pump to carburetor) will be indicated by dripping fuel. A leak in the suction side of the system (line from gas tank to pump) will not be apparent except in its effect of reducing volume of fuel on the pressure side of the system.

3. Look for bends or kinks in lines or hoses which will reduce flow. Check the fuel pump inlet hose routing to be sure it is not bent or kinked.

Fuel Flow Test

a. Remove coil secondary wire from distributor and ground to block so that engine can be cranked without starting.

b. Disconnect fuel line at the carburetor inlet fitting. Install a rubber hose approximately 8-10" long over the end of the fuel line.

c. Place suitable container at end of the hose and crank engine a few revolutions.

NOTE: If little or no gasoline flows from open end of line, then the fuel line is restricted, gas tank filter restricted or the pump is inoperative. Before removing pump, disconnect fuel lines at fuel pump and at gas tank and blow through them with an air hose to make sure they are clear. Reconnect fuel lines to pump and gas tank.

d. Reconnect fuel line at the carburetor, tighten line fitting while holding carburetor fuel inlet nut. Start engine and check for leaks.

Pump (Inlet) Vacuum

Low vacuum or complete loss of vacuum provides insufficient fuel to the carburetor to operate the engine throughout normal speed range.

a. Disconnect hose from fuel tank to fuel pump at the fuel pump. Fasten hose in an up position so that fuel will not run out.

b. Connect one end of a short hose to the fuel pump inlet and attach a vacuum gauge to the other end. Start engine, gauge should register not less than 15 in. vacuum. If less than 15 in. of vacuum, replace pump.

Pump (Outlet) Pressure

Even if fuel flows in good volume from line at carburetor, it is advisable to make certain that pump is operating within limits.

a. Disconnect fuel line at the carburetor inlet fitting. Install a rubber hose approximately 8/10" long over the line and attach a low reading pressure gauge. Hold the gauge up so that it is approximately 16" above the fuel pump.

b. Start engine and run at slow idle (using gasoline in carburetor bowl) and note reading on pressure gauge.

c. If pump is operating properly, the pressure should be 5-1/2 to 6-1/2 constant. If pressure is too high or too low or varies materially at different engine speeds, the pump should be replaced.

FUEL PUMP REPLACEMENT

Removal

1. Raise vehicle.

2. Disconnect fuel line to carburetor and fuel hose from fuel tank.

3. Loosen nut securing top of fuel pump to block.

4. Remove bolt securing bottom of fuel pump to block.

5. Remove pump.

Installation

1. Install fuel pump with new gasket.

2. Install bolt and tighten alternately with nut to assure an even draw down of pump to block.

3. Connect fuel hose and line to fuel pump. Tighten fuel fittings to carburetor and fuel pump. Hold nut at carburetor inlet while applying torque.

4. Lower vehicle.

AIR CLEANER

REMOVAL

1. Remove engine cover.

2. Remove wing nut on top of air cleaner.

3. Disconnect P.C.V. pipe from the air cleaner housing. See Figure 33.

4. Lift air cleaner housing off carburetor high enough to reach underneath it and disconnect the vacuum hose from the intake manifold. See Figure 33.

5. Remove air cleaner housing.

6. Inspect air cleaner housing gasket on carburetor, replace gasket as needed.

NOTE: : To install new gasket:

1. Completely remove old gasket.

2. Remove protective paper from adhesive side of new gasket.

3. Install new gasket adhesive side down, on carburetor air horn.

INSTALLATION

1. While installation the air cleaner housing connect the vacuum hose to the intake manifold.

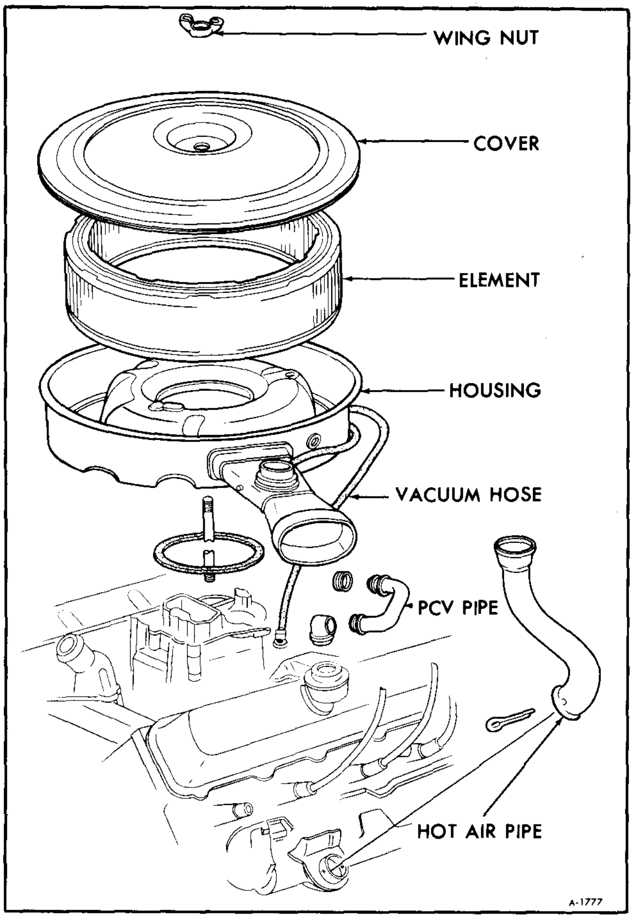

Figure 33–Air Cleaner

2. Position hot air pipe so it enters the air cleaner properly.

3. Connect P.C.V. pipe to the air cleaner housing.

4. Install wing nut and tighten.

5. Install engine cover.

AIR CLEANER ELEMENT

The air cleaner element should be replaced regularly according to the maintenance information in Section 0 of this manual.

The element is accessible by removing the wing nut and the air cleaner cover.

CARBURETOR PART NUMBER

	Federal	California
1974	7043254	7045554
1975	7045254	7045554
1976	7045254	7045554

SECTION 6T
EMISSION CONTROL SYSTEMS

Contents of this section are listed below:

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Controlled Combustion System (C.C.S.)	
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6

POSITIVE CRANKCASE VENTILATION (P.C.V.)

DESCRIPTION (FIGURE 1)

At idle or normal road speeds, intake manifold vacuum causes fresh air to be drawn through the engine air filter, then to the left valve cover where it joins with the crankcase vapors. This mixture is then drawn through the P.C.V. valve to the base of the carburetor where the vapors are mixed with normal fuel air mixture and burned.

When the engine is running at idle or the vehicle is traveling at normal speeds, intake manifold vacuum is sufficient to draw crankcase vapors caused by engine blow-by through the spring loaded P.C.V. valve.

At high road speeds or heavy acceleration, the engine blow-by is increased and at the same time, intake manifold vacuum decreased. When this occurs, there is a reverse action, crankcase vapors released through the crankcase filter are returned back into the intake manifold through the carburetor. When operating the engine under zero vacuum or a manifold pressure condition such as a backfire or during engine cranking, the check valve is closed by spring tension to prevent fuel vapor from entering the crankcase. The valve is also closed under wide-open throttle condition but since this is for a very short duration of time, no irregularity will exist.

NOTE: If vehicle has encountered dusty conditions, be sure PCV filter is cleaned immediately.

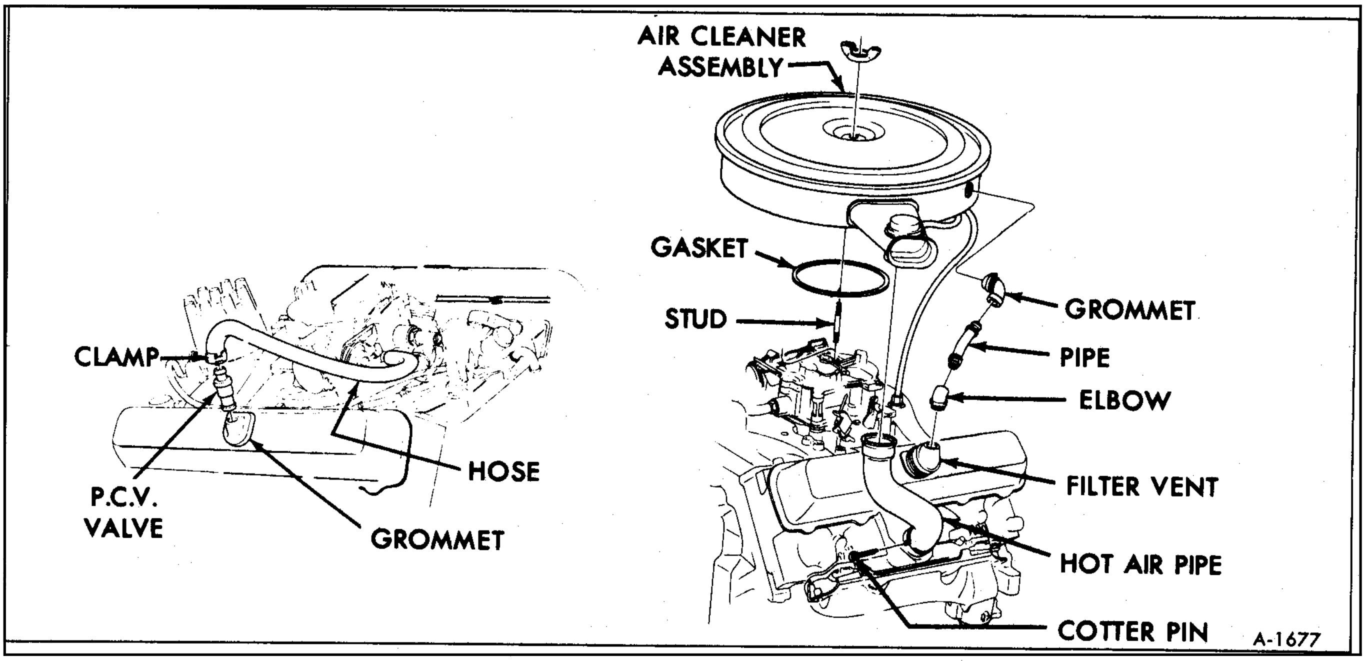


Figure 1—Positivie Crankcase Ventilation System

P.C.V. SYSTEM TESTING

The CT-3 tester is an extremely sensitive vacuum-pressure gauge designed to accurately indicate the small amount of vacuum or pressure in the system. The tester is also used to test the P.C.V. valve after it has been removed.

INSTRUCTIONS FOR TESTING P.C.V. VALVE

1. Disconnect P.C.V. valve from crankcase — leave valve connected to hose.

2. Adjust tester selector knob to "E".

3. Connect hose to tester body and vent valve adapter CT-18.

4. With engine at operating temperature, at idle and transmission in "PARK," hold the vent valve adapter CT-18 against the crankcase end of the vent valve.

5. Hold the tester upright and look directly into the test window and observe the color. Be sure the adapter is firmly sealed against the valve, there are no leaks and hose is not kinked.

6. An all "GREEN" window reading indicates valve is OK. Any "YELLOW" showing indicates the valve needs replacing.

INSTRUCTIONS FOR TESTING COMPLETE SYSTEM

1. Remove oil dipstick and plug hole with dipstick hole plug CT-12 (part of CT-3 tester).

2. Remove tube from elbow at air cleaner and plug tube with CT-11.

3. Adjust tester selector knob to "K".

4. Connect hose to tester body and tester adapter CT-14

5. Remove oil filler cap and place tester adapter CT-14 into opening.

6. With engine at operating temperature, running at idle and transmission in "PARK," hold tester upright and look directly into tester window and note the color, it should be green. If not, be sure there are no leaks and hose is not kinked. Refer to P.C.V. Diagnosis Chart for other items to look for.

P.C.V. DIAGNOSIS CHART (USING CT-3 TESTER)

WINDOW READING	PROBABLE CAUSE	CORRECTION
GREEN	System satisfactory. Vent valve partially plugged. Blow-by close to capacity of valve.	Check Valve.
YELLOW	Tester hose kinked or blocked. Crankcase not sealed properly. Tester "selector knob" set incorrectly. Vent-valve partially plugged. Slight kink in CT-3 tester hose.	Reposition or clean hose. Check tester plugs and other seal-off points. Check setting. Check vent valve. Reposition tester hose.
YELLOW-GREEN	Slight engine blow-by. Crankcase not sealed properly. Tester "selector knob" set incorrectly. Vent-valve partially or fully plugged.	Check vent valve. Check tester plugs and other seal-off points. Check setting. Check vent valve.
RED-YELLOW	Engine blow-by exceeds valve capacity. Rubber vent hose collapsed or plugged.	Engine overhaul indicated. Clean or replace hose.
RED	Vent-valve plugged. Vent-valve stuck at engine off position. Rubber vent hose collapsed or plugged. Extreme engine blow-by.	Check vent valve. Check vent valve. Replace hose. Engine requires major overhaul.

CONTROLLED COMBUSTION SYSTEM (C.C.S.)

A Controlled Combustion System is standard equipment on the engine. The Controlled Combustion System consists of an air cleaner assembly which includes a temperature sensor, vacuum motor, control damper assembly and connecting vacuum hoses. The motor is controlled by the temperature sensor. The vacuum motor operates the air control damper assembly to control the flow of pre-heated and non pre-heated air. The pre-heated air is obtained from the hot air pipe and shroud on the exhaust manifold.

PURPOSE

At underhood temperatures below 79 degrees F. the Control Combustion System directs heated air into the air cleaner. This system provides the most desirable emission control throughout the operating range of the engine and results in improved fuel economy, improved engine warm-up and eliminates tendency for ice to form in the carburetor.

OPERATION (FIGURES 2, 3 & 4)

During engine warm-up with engine compartment temperature at 79°F. (26.1°C.) the temperature sensor is closed. This allows engine vacuum to be directed to the vacuum motor closing the damper assembly to outside air. With the damper closed, the cool air will flow through the openings at the ends of the shroud where it is heated. The heated air then flows up through the hot air pipe and adapter into the air cleaner. As the temperature inside the air cleaner reaches approximately 123°F. (50.6°C.) the sensor bleeds off vacuum to the vacuum motor causing the control damper to open allowing underhood air to be mixed with the heated air as needed to keep the air temperature approximately 123°F. (50.6 C.) if the ambient temperature is 123°F. (50.6°C.) or below.

Under full throttle or below 3 in. Hg. to 7 in. Hg., the vacuum motor will no longer hold the valve open to hot air. The hot air pipe is closed off allowing only outside air to enter the air cleaner.

DIAGNOSIS

VACUUM MOTOR AND DAMPER ASSEMBLY

1. With the engine off, remove air cleaner cover and tape thermometer J-5421 in air cleaner next to sensor (See figure 5).

NOTE: If temperature is below 79 degrees F. (26.1°C.) continue to Step 2. If temperature is above 79 degrees F. (26.1°C.) remove air cleaner and allow to cool to at least 72 degrees F. (22.2°C.).

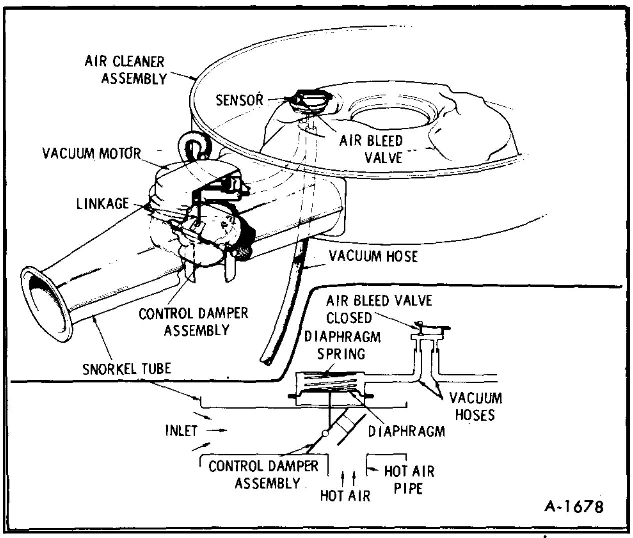


Figure 2—Hot Air Delivery Mode

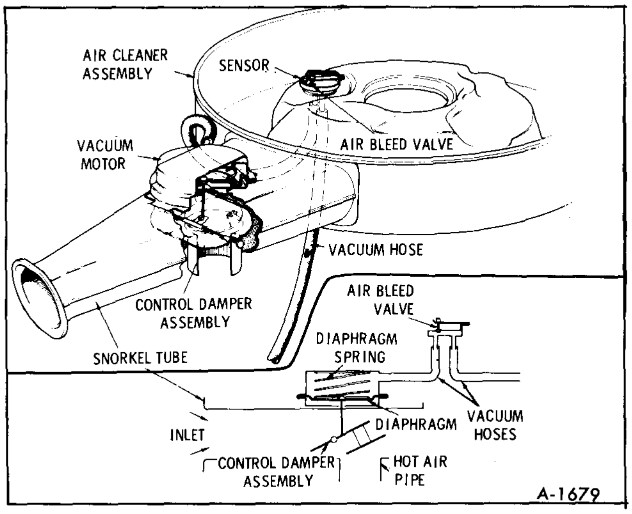


Figure 3—Regulating Mode

2. Install a tee in vacuum line at vacuum motor and connect a vacuum gauge in line.

3. With the engine off, the control damper should be open.

4. Install the cover on air cleaner without the wing nut and start the engine.

5. With engine at idle speed, the control damper should be closed with the ambient temperature at or below 79 degrees F. (26.1°C.).

6. Using a small mirror observe the control damper snorkel; when it reaches the full open position (outside air), quickly remove cover on air cleaner and record reading on thermometer and vacuum gauge.

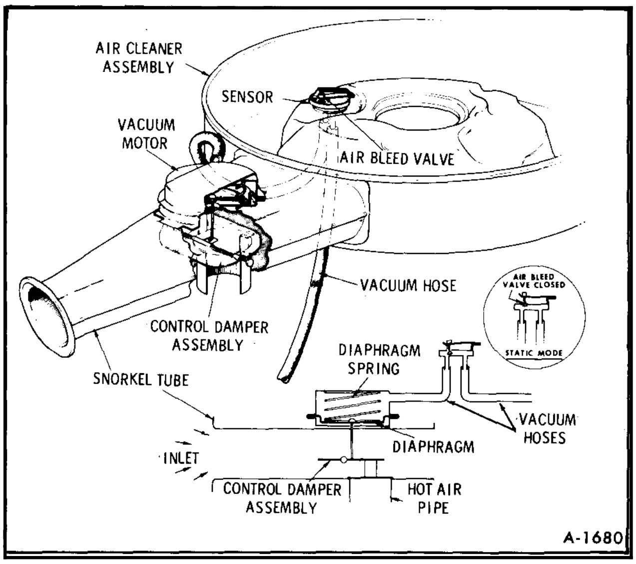


Figure 4—Cold Air Delivery Mode

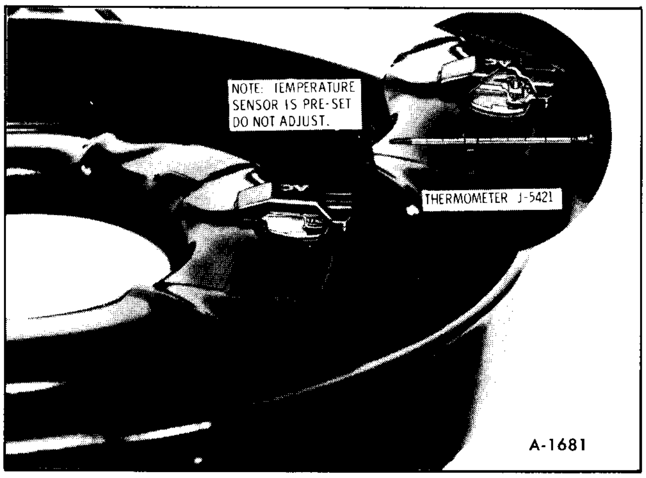


Figure 5—Checking Sensor

SPECIFICATIONS FOR DAMPER OPERATION

Temperature:	79 degrees F. (26.1°C.) or lower, damper fully closed. 123 degrees F. (50.6°C.) or higher, damper fully open.
Vacuum:	3 in. hg. of vacuum or lower, damper fully open below 79 degrees F. (26.1°C.) 7 in. hg. of vacuum or higher, damper fully closed below 79 degrees F. (26.1°C.)

1. If temperature is within specifications, Controlled Combustion System is functioning properly.

2. If temperature is out of specifications and vacuum is correct, replace sensor.

3. If both temperature and vacuum are within specifications and damper is not operating correctly, replace vacuum motor.

4. If both temperature and vacuum are not within specifications it is an indication that the vacuum motor diaphragm is leaking.

VACUUM MOTOR REPLACEMENT

REMOVAL

1. Remove air cleaner.

2. Disconnect vacuum hose from motor.

3. Drill out the two spot welds initially with a 1/16" drill, then enlarge as required to remove the retaining strap. Do not damage the snorkel tube (See figure 6.).

4. Remove motor retaining strap.

5. Lift up motor, cocking it to one side to unhook the motor linkage at the control damper assembly.

INSTALLATION

1. Drill a 7/64" hole in snorkel tube at point "A" as shown in Figure 6.

2. Insert vacuum motor linkage into control damper assembly.

3. Use the motor retaining strap and sheet metal screw provided in the motor service package to secure the retaining strap and motor to the snorkel tube.

4. Make sure the screw does not interfere with the operation of the damper assembly. Shorten screw if required.

5. Connect vacuum hose to motor and install air cleaner.

SENSOR REPLACEMENT

REMOVAL

1. Remove air cleaner.

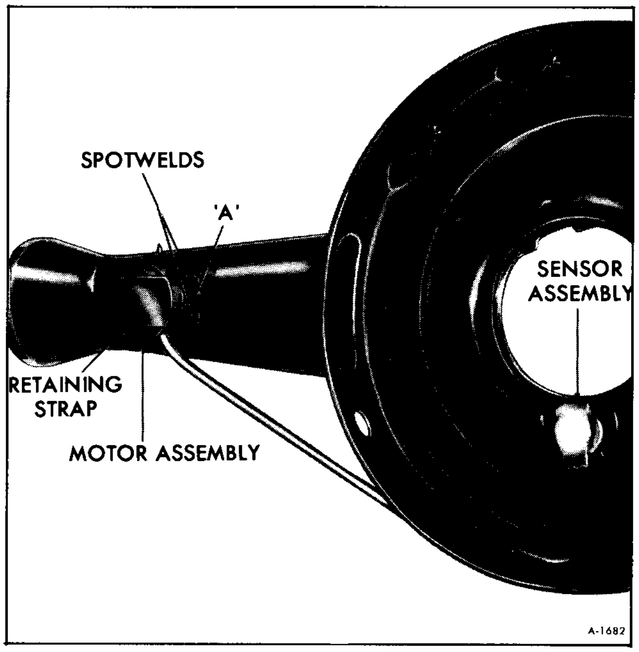


Figure 6—Air Cleaner Spot Welds

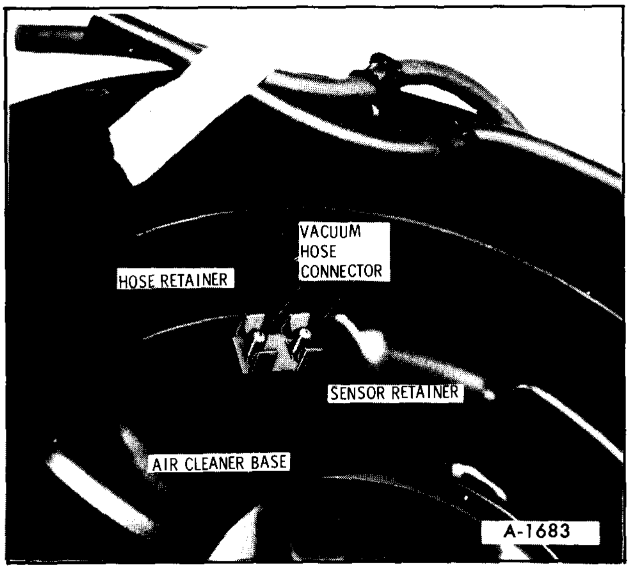


Figure 7—Sensor Retainer

2. Detach hoses at sensor.

3. Pry up tabs on sensor retaining clip and remove clip and sensor from air cleaner. Note position of sensor for installation (See figure 7).

INSTALLATION

1. Install sensor and gasket assembly in original position.

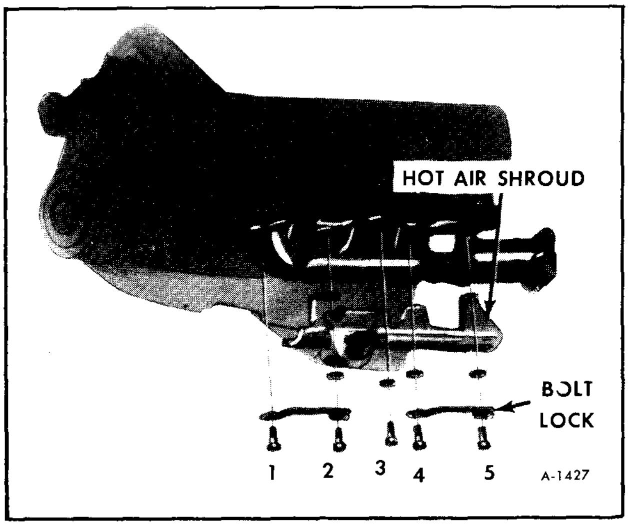


Figure 8—Hot Air Shroud

2. Press retainer clip on hose connectors.

3. Connect vacuum hoses and install air cleaner on engine.

EXHAUST MANIFOLD SHROUD

Exhaust manifold hot air shroud is shown in Figure 8. Refer to Section 6A for replacement procedures.

EVAPORATION CONTROL SYSTEM

This system is designed to reduce fuel vapor emissions that normally vent to atmosphere from the gasoline tank and carburetor fuel bowl. The air cleaner filter mounted at the bottom of the canister requires replacement at intervals specified in Section 0. All other parts are serviced as outlined in Section 8 of this manual.

THERMAL VACUUM SWITCH (T.V.S.)

DESCRIPTION

The retarded spark setting at idle speeds required for effective emission control makes engines tend to run hotter during idle or low speed conditions.

To protect against overheating, the engine is equipped with a thermostatic vacuum switch (T.V.S.). The temperature-sensitive switch and valve assembly is mounted in the engine cooling jacket near the right front of the engine, see Figure 9, and connected into the vacuum advance system.

OPERATION

When the engine coolant reaches a specified high temperature (224-230°F.) (106.7-110°C.), the valve opens against spring pressure and directs manifold vacuum to the advance mechanism. This advances

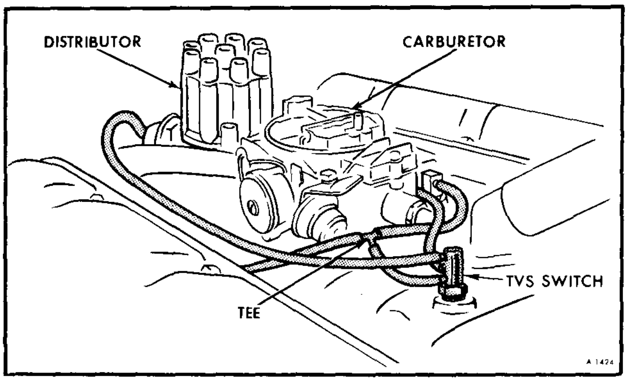


Figure 9—T.V.S. Location (Typical)

the spark timing slightly and speeds up the engine. The result is less heat rejected to the coolant together with higher fan speeds for better cooling action. When the engine has cooled down, 216°F. (102.2°C.) the TVS switch moves the valve back to retard spark timing.

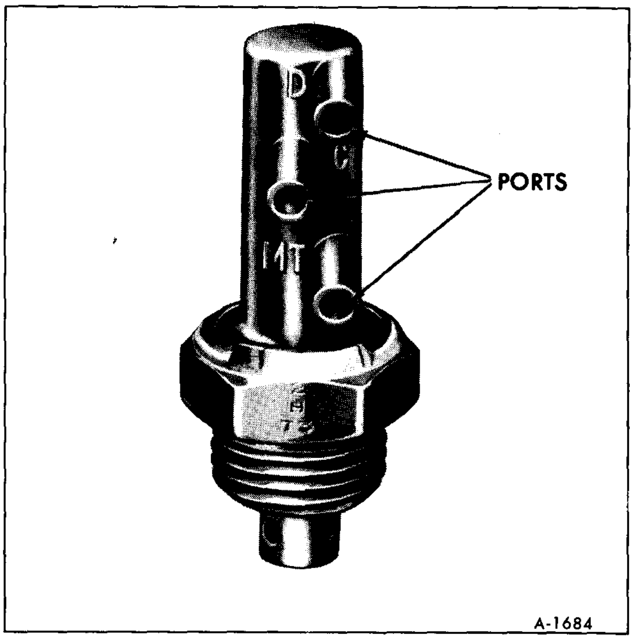


Figure 10—Thermostatic Vacuum Switch

VACUUM HOSE ROUTING TO T.V.S. SWITCH (FIGURE 9)

Port "D"	Vacuum hose to the distributor vacuum advance.
Port "C"	Vacuum hose to the carburetor ported spark port.
Port "MT"	Vacuum hose to intake manifold elbow.

FUNCTIONAL CHECK

To test the switch function, disconnect the distributor vacuum hose at port "D" of the T.V.S. switch, see Figure 10, connect a vacuum gauge and check for vacuum with the engine idling at normal operating temperature. If more than 5 in. Hg. of vacuum is present and the hoses are connected to the proper ports, check further with instruments designed to test the switch such as BT-7002.

The switch must be installed with a soft setting sealant on the threads.

THROTTLE RETURN CONTROL (TRC) (CALIFORNIA ONLY)

The Throttle Return Control system is designed to reduce hydrocarbon emissions during deceleration by controlling the rate of throttle closing, causing a more complete burning. The system consists of: throttle lever actuator; vacuum control valve; solenoid valve (figure 11).

THROTTLE LEVER ACTUATOR

The Throttle Lever Actuator is mounted as part of the carburetor assembly. This device controls the position of the primary throttle plates a preset amount in excess of curb idle when engine vacuum is applied. This actuating vacuum is controlled by a separate vacuum control valve.

The Throttle Lever Actuator bracket is secured by two bolts torqued to 20-25 ft. lbs. The actuator is mounted to the bracket by a single nut. This nut can be used to adjust the stem to a travel requirement of .260 inch (See "Throttle Actuator Adjustment").

VACUUM CONTROL VALVE

The Vacuum Control Valve is crimped to a

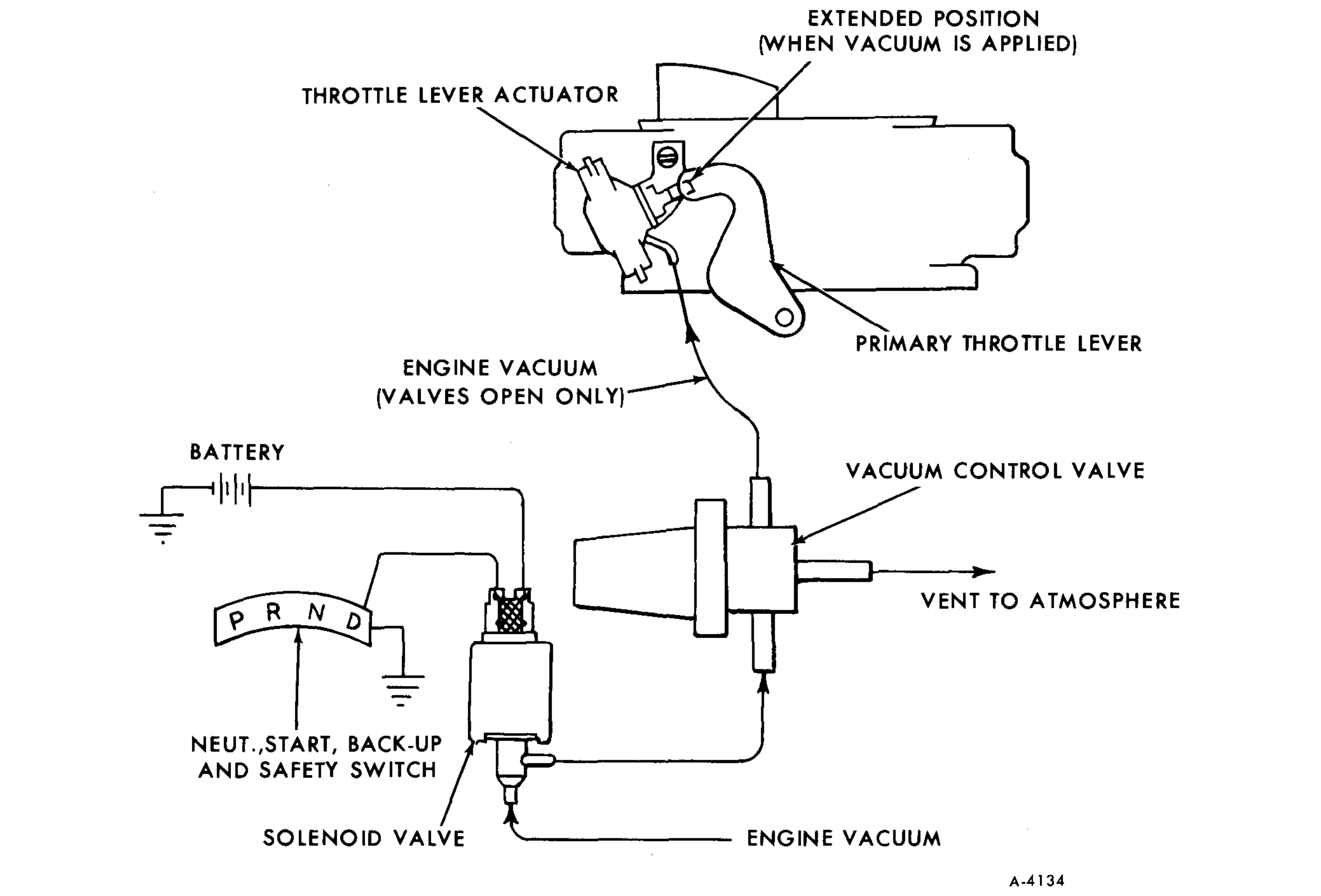


Figure 11—Throttle Return Control System

mounting bracket and mounted separately from the carburetor by one bolt turqued to 25-30 ft. lbs. This on/off valve senses engine vacuum when the solenoid valve is open, and opens above a preset high vacuum level. The valve, when open, allows a vacuum signal to be applied to the throttle lever actuator as long as the preset vacuum level is exceeded.

SOLENOID VALVE

The Solenoid Valve is mounted separately from the carburetor by one bolt torqued to 95-120 in. lbs. This on/off valve opens when the transmission selector lever is in a forward drive position, allowing engine vacuum to be applied to the vacuum control valve.

TRC SYSTEM DIAGNOSIS

CONTROL VALVE — CHECKING PROCEDURE:

1. Disconnect valve to carburetor hose at the carburetor and connect to an external vacuum source equipped with a vacuum gauge.

2. Disconnect the valve to actuator hose at the actuator and connect to a vacuum gauge. (figure 12).

3. Place finger firmly over the end of the bleed fitting (the foam air filter need not be removed).

4. Apply 23 in. Hg. vacuum to the control valve and seal off the vacuum source. The gauge on the actuator side should read the same as the source gauge. If not, then the valve is sticking or needs adjustment. A sticking valve must be replaced. If the vacuum drops off on either gauge (finger still on the bleed fitting), the valve is leaking and must be replaced.

5. With a 23 in. Hg. vacuum level in the valve, remove finger from bleed fitting. The vacuum reading on the actuator side will drop to zero and the reading on the source gauge will drop to a value which will be designated as the valve set point. If this

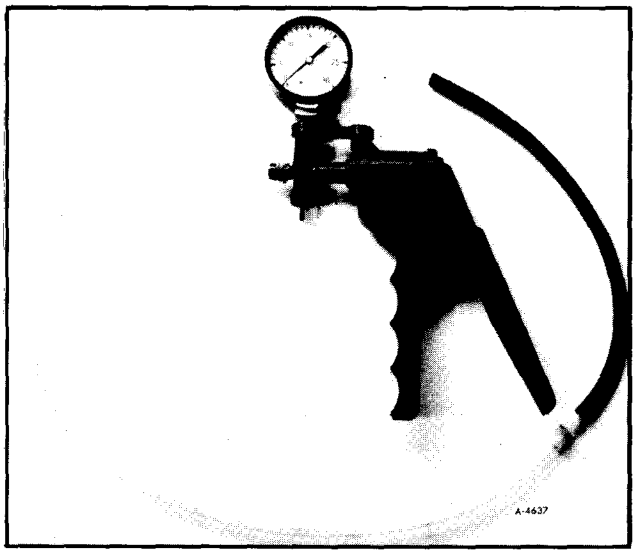


Figure 12—Vacuum Gauge (J-23738)

value is not within .50 in. Hg. of the specified valve set point, then the valve must be adjusted per the Control Valve Adjusting Procedure.

THROTTLE LEVER ACTUATOR — CHECKING PROCEDURE

1. Disconnect valve to actuator hose at valve and connect to an external vacuum source equipped with a vacuum gauge.

2. Apply 20 in. Hg. vacuum to the actuator and seal off the vacuum source. If the vacuum gauge reading drops, then the actuator is leaking and must be replaced.

3. To check the actuator for proper operation:

a. Check the throttle lever, shaft, and linkage to be sure that they operate freely without binding or sticking.

b. Start engine and run until warmed up and idle is stable. Note idle RPM.

c. Apply 20 in. Hg. vacuum to the actuator. Manually open the throttle slightly and allow to close against the extended actuator plunger. Note the engine RPM.

d. Release and reapply 20 in. Hg. vacuum to the actuator and note the RPM to which the engine speed increases (do not assist the actuator).

e. If the RPM obtained in step 3d is not within 150 RPM of that obtained in step 3c, then the actuator plunger may be binding due to dirt, corrosion, varnish, etc. or the actuator diaphragm may be too weak. If binding is not indicated or cannot be corrected then the actuator must be replaced.

f. Release the vacuum from the actuator and the engine speed should return to within 50 RPM of the idle speed noted in step 3b. If it does not, the plunger may be binding due to dirt, corrosion, varnish, etc. If the problem cannot be corrected, the actuator must be replaced.

CONTROL VALVE — ADJUSTING PROCEDURE: REFER TO (FIGURE 13)

1. Disconnect valve to carburetor hose at the carburetor and connect to an external vacuum source equipped with a vacuum gauge.

2. Disconnect the valve to actuator hose at the actuator and connect to a vacuum gauge.

3. Place finger firmly over the end of the bleed fitting (the foam air filter need not be removed).

4. Apply 23 in. Hg. vacuum to the control valve and seal off the vacuum source. Remove finger from bleed fitting. The vacuum reading on the actuator side will drop to zero and the reading on the source gage will drop to a value which will be designeated as the valve set point. If this value is not within .50 in. Hg. of the specified valve set point (22 in. Hg.), then the valve must be adjusted.

5. To adjust the valve set point:

a. Gently pry off the conical plastic cover.

b. Turn the adjusting screw in (clockwise) to raise the set point or out (counterclockwise) to lower the set point value.

c. Recheck the valve set point per steps No. 3 & 4.

d. Repeat steps 5b & c as necessary to obtain 20 in. Hg. value within .50 in. Hg.

e. Reinstall plastic cover.

THROTTLE LEVER ACTUATOR — ADJUSTING PROCEDURE (FIGURE 14)

1. Disconnect valve to actuator hose at valve and connect to an external vacuum source equipped with a vacuum gauge.

2. Check the throttle lever, shaft, and linkage to be sure that they operate freely without binding or sticking.

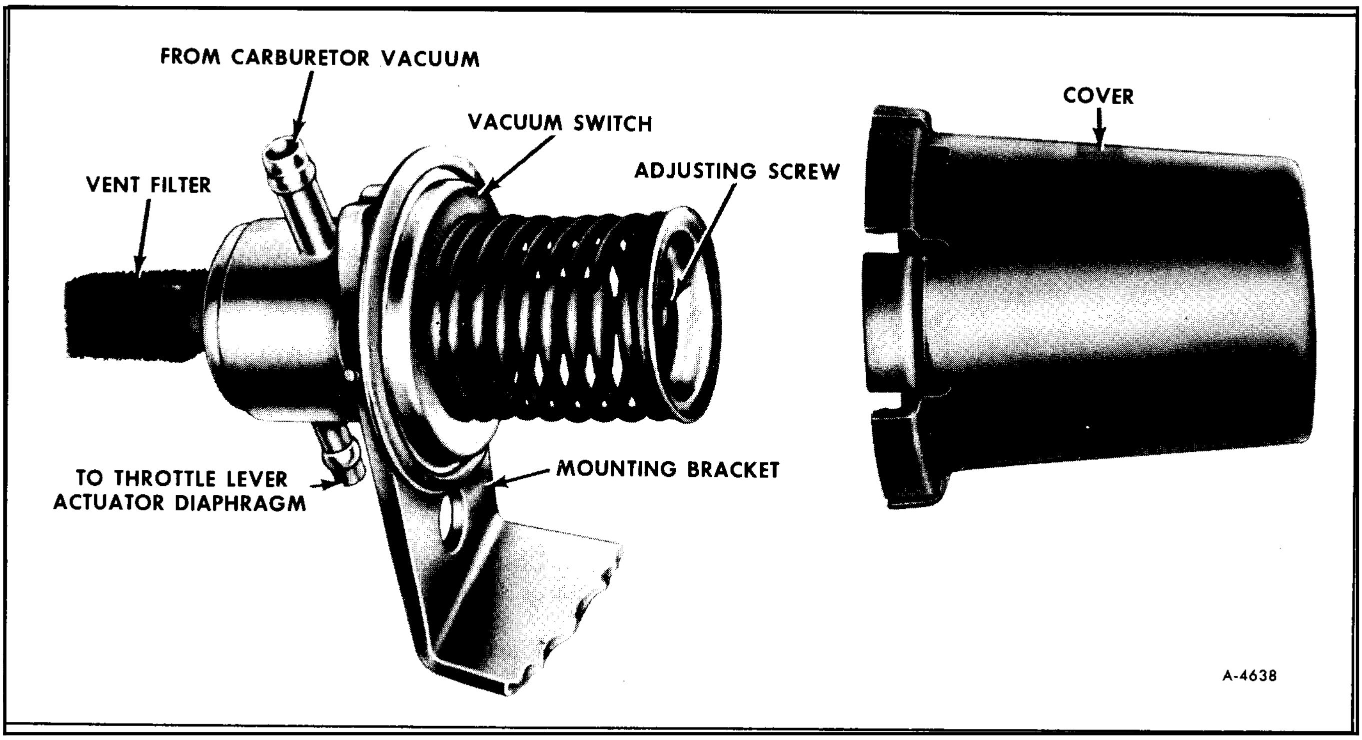


Figure 13—Control Valve Adjustment

3. Adjustment should be made with engine cold, and not running.

4. Apply 20 in. Hg. vacuum to the actuator. Manually open the throttle to allow the choke to set (top step on fast idle cam). The choke will set only if the engine is cold. If the engine is too warm and choke won't set, it can be set by hand.

5. Loosen stem nut. Adjust actuator by rotating until plunger tip contacts throttle lever.

6. Tighten stem nut, remove vacuum pump and complete hose connections.

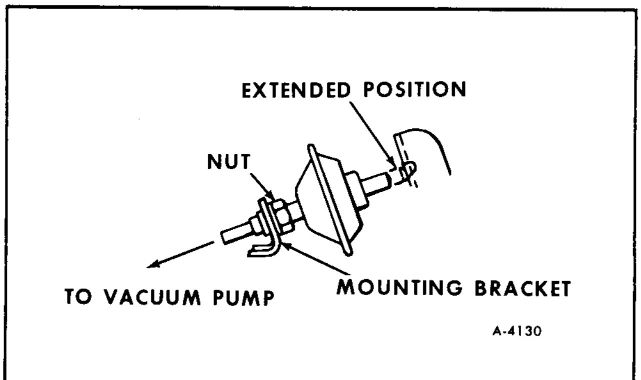


Figure 14—Throttle Actuator Adjustment

SECTION 6Y
ENGINE ELECTRICAL

Contents of this section are listed below:

SUBJECT	PAGE NO.
Batteries	6Y-1
Battery Specifications	6Y-16
Generating System	6Y-17
Generator Specifications	6Y-29
Breaker Point Ignition System	6Y-29
Breaker Point Ignition System Specifications	6Y-45
High Energy Ignition System	6Y-46
High Energy Ignition System Specifications	6Y-59
Starting System	6Y-60
Starter Specifications	6Y-68

BATTERIES

CAUTION: *Never expose battery to open flame or electric spark—battery action generates hydrogen gas which is flammable and explosive. Don't allow battery fluid to contact skin, eyes, fabrics, or painted surfaces—fluid is a sulfuric acid solution which could cause serious personal injury or property damage. Wear eye protection when working with battery.*

CAUTION: *Remove rings, metal watchbands and other metal jewelry before jump starting or working around a battery, and be careful in using metal tools—if such metal should contact the positive battery terminal (or metal in contact with it) and any other metal on the vehicle a short circuit may occur which could cause personal injury.*

Each vehicle is equipped with two batteries; the main (automotive) battery and an auxiliary battery. The GMC Dual Battery System provides power from two batteries to the vehicle 12-volt electrical system either in combination or singularly. The components used to provide charging and/or switching are conventional, except for a diode assembly with which both batteries will receive charging current whenever the vehicle is running. The diode assembly has separate outputs to the two batteries and provides isolation between the batteries and their associated circuits whenever the engine is not running.

6

- MotorHome—The main (automotive) battery (figure 1) is located behind the right front access door. The auxiliary (living area) battery is located in the storage or motor generator compartment.

- TransMode—The main (automotive) battery and the auxiliary battery are both located behind the right front access door. The main (automotive) battery sits in front of the auxiliary battery, Figure 2. Vehicles equipped with the optional motor generator include a cranking battery located in the motor generator or storage compartment, Figure 3.

In addition, two types of batteries are used; batteries with vent cap flame arrestor feature shown in Figure 4, or maintenance-free batteries shown in Figure 5.

Early model vehicles are entirely equipped with flame arrestor type filler/vent cap batteries. Later model MotorHomes have a maintenance-free main

Figure 1—MotorHome Automotive Battery

(automotive) battery and a flame arrestor type filler/vent cap auxiliary (living area) battery. Later model TransModes have maintenance-free main and auxiliary batteries. TransModes equipped with the motor generator option include a maintenance-free cranking battery located in the motor generator compartment along with the motor generator hour meter.

Follow maintenance and testing procedures applicable to the particular type battery being serviced.

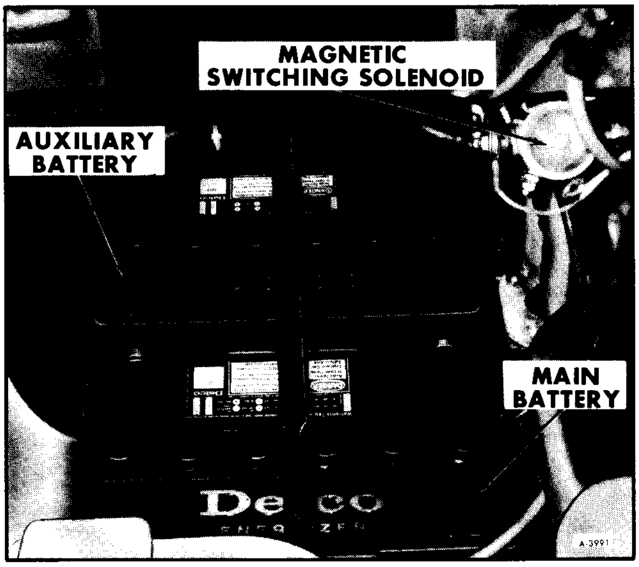


Figure 2—TransMode Main and Auxiliary Batteries

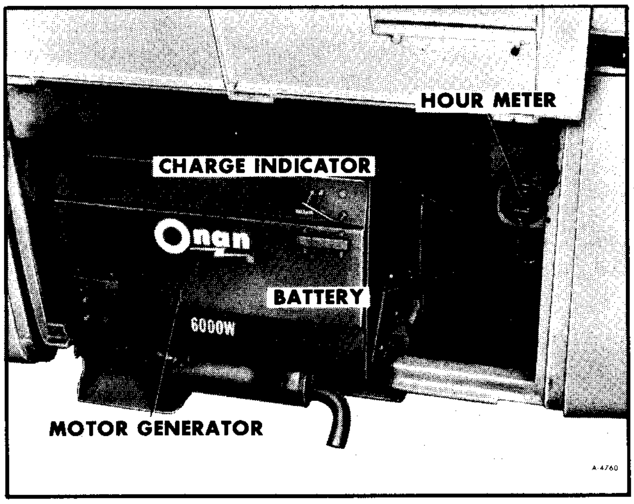


Figure 3—TransMode Motor Generator Cranking Battery (Optional)

BATTERY DESCRIPTION

BATTERIES WITH FLAME ARRESTOR VENT CAPS

Batteries with flame arrestor type filler/vent caps are identified by the small grey disc in the cap, as shown in Figure 4. This centered carbide section disperses battery fumes and acts as a screen to protect the battery from flame entry. These batteries require regular checking electrolyte level discussed later in this section under "Charging Guide".

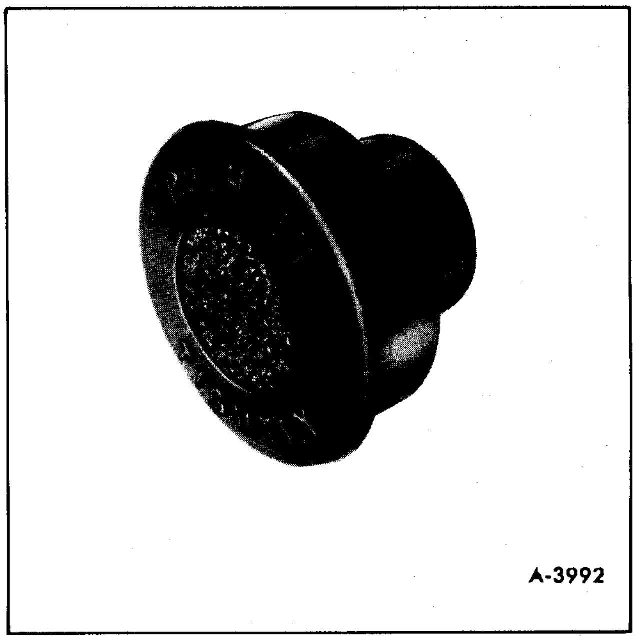


Figure 4—Flame Arrestor Cap

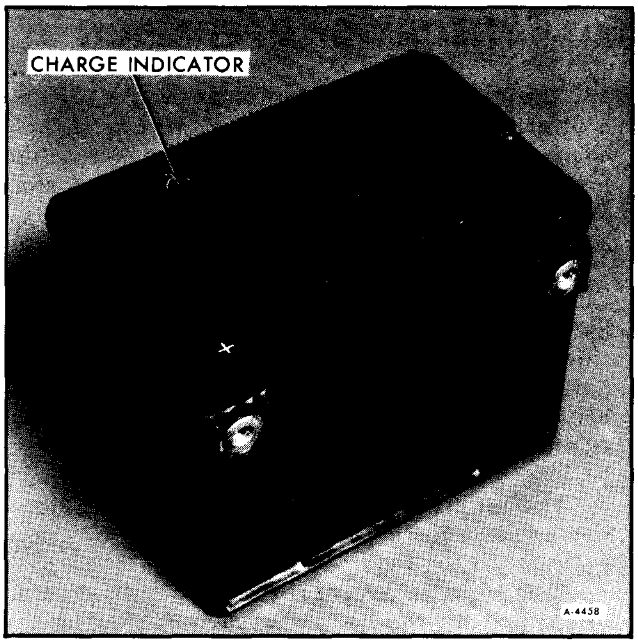


Figure 5—Maintenance-Free Battery

MAINTENANCE FREE BATTERIES

The maintenance-free batteries are identified by the absence of vent plugs on the cover (figure 5). The battery is completely sealed except for small vent holes on the sides. These vent holes allow what small amount of gases are produced in the battery to escape. The special chemical composition in the battery grid design reduces the production of gas to an extremely small amount at normal charging voltages. Water never needs to be added to the maintenance-free battery. A charge indicator in the cover indicates state of charge. This feature is discussed later in this section under "Charging Guide".

GENERAL DESCRIPTION

The battery is made up of a number of separate elements, each located in an individual cell in a hard rubber case. Each element consists of an assembly of positive plates and negative plates containing dissimilar active materials and kept apart by separators. In the maintenance-free battery these separators are replaced with negative plate envelopes. The elements are immersed in an electrolyte composed of dilute sulfuric acid. Plate straps located on the top of each element connect all the positive plates and all the negative plates into groups.

The elements are connected in series electrically by connectors that pass directly through the case partitions between cells. The battery top is a one piece cover. The cell connectors, by passing through the cell partitions, connect the elements along the shortest practical path (figure 6). With the length of the electrical circuit inside the battery reduced to a minimum, the internal voltage drop is decreased resulting in improved performance, particularly during engine cranking at low temperatures.

The terminals of this type battery, passing through the side of the case, are positioned out of the "wet" area surrounding the vent wells. Normal spillage, spewing, condensation and road splash are not as likely to reach or remain on the vertical sides where the terminals are located. This greatly decreases the cause of terminal corrosion. Also, construction of the terminals is such that the mating cable connector seals the junction and provides a permanently tight and clean connection. Power robbing resistance in the form of corrosion is thereby eliminated at these maintenance-free connections.

The hard, smooth, one piece cover greatly reduces the tendency for corrosion to form on the top of the battery. The cover is bonded to the case forming an air-tight seal between the cover and case.

Electrical energy is released by chemical reactions between the active materials in the two dissimilar plates and the electrolyte whenever the battery is being "discharged." Maximum electrical energy is released only when the cells are being discharged from a state of full charge.

As the cells discharge, chemical changes in the active materials in the plates gradually reduce the potential electrical energy available. "Recharging" the battery with a flow of direct current opposite to that during discharge reverses the chemical changes within the cells and restores them to their active condition and a state of full charge.

There are two types of batteries, the "dry charge" type and the "wet charge" type. The difference in types depends on the method of manufacture. A "dry charge" battery contains fully charged elements which have been thoroughly washed and dried. This type of battery contains no electrolyte until it is activated for service in the field and, therefore, leaves the factory in a dry state. Consequently, it is called a "dry charge" battery.

Each vent well in a "dry charge" battery has a hard rubber seal to prevent the entrance of air and moisture which would oxidize the negative active materials and reduce the freshness of the battery (figure 7). The hard rubber seals and the bonding between the case and one-piece cell cover make possible a vacuum sealed assembly which can be stored for very long periods of time without detrimental effects.

Before activating the "dry charge" battery, the hard rubber seals are broken simply by pushing the

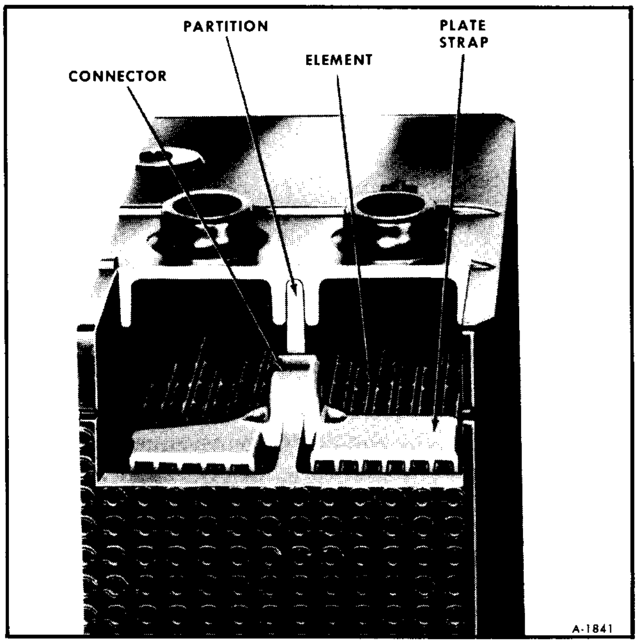


Figure 6—Internal View of Battery with Vent Wells

special vent plug down into each vent well. The seals drop into the cells, and can remain there since they are not chemically active and will cause no harm.

A wet charged battery contains fully charged elements which are filled with electrolyte before being shipped from the factory. The flame arrestor type filler/vent cap batteries can be wet or dry charged on shipping. The maintenance-free battery, which has no vent wells, is wet charged.

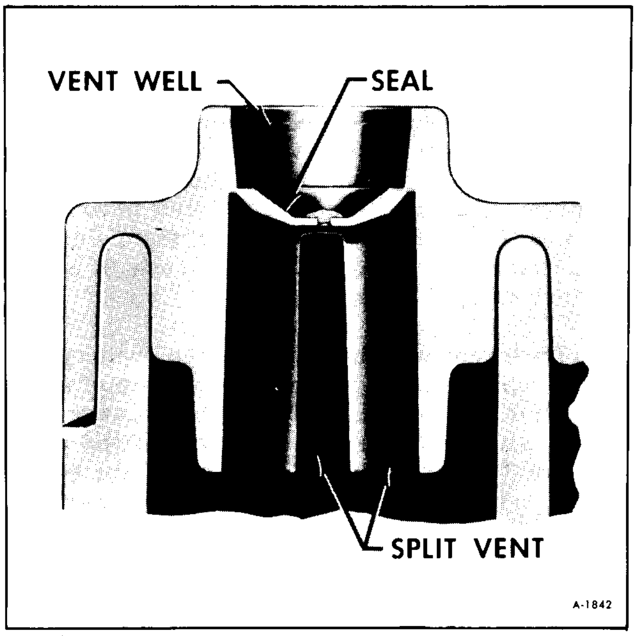


Figure 7—Vent Well Construction

THEORY OF OPERATION

The lead-acid battery or storage battery (figure 1) is an electrochemical device for converting chemical energy into electrical energy. It is not a storage tank for electricity as is often believed, but instead, stores electrical energy in chemical form.

Active materials within the battery react chemically to produce a flow of direct current whenever lights, radio, cranking motor, or other current consuming devices are connected to the battery terminal posts. This current is produced by chemical reaction between the active materials of the PLATES and sulfuric acid of the ELECTROLYTE.

The battery performs three functions in automotive applications:

1. It supplies electrical energy for the cranking motor and for the ignition system as the engine is started.

2. It supplies current for the lights, radio, heater, and other accessories when the electrical demands of these devices exceed the output of the generator.

3. The battery acts as a voltage stabilizer in the electrical system. Satisfactory operation of the vehicle is impossible unless the battery performs each of these functions.

The simplest unit of a lead-acid storage battery is made up of two unlike materials, a positive plate and a negative plate, kept apart by a porous separator. This assembly is called an "ELEMENT" (figure 8).

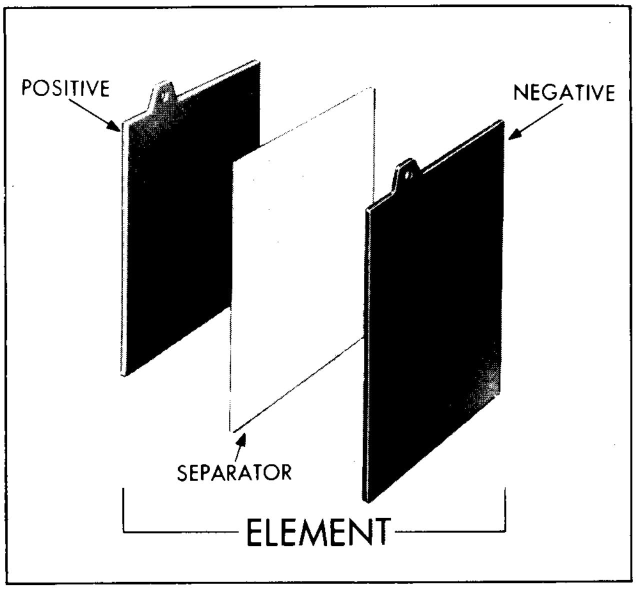


Figure 8—Battery Element

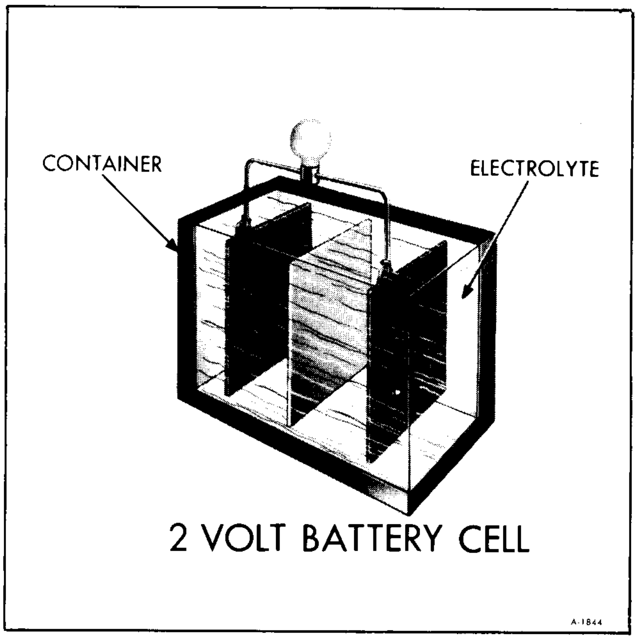


Figure 9—Two Volt Battery Cell

When this simple element is put in a container filled with a sulphuric acid and water solution called "electrolyte", a two-volt "cell" is formed. Electricity will flow when the plates are connected to an electrical load (figure 9).

An element made by grouping several positive plates together and several negative plates together with separators between them also generates two-volts but can produce more total electrical energy than a simple cell (figure 10).

When six cells are connected in series, a "battery" of cells is formed which produces six times as

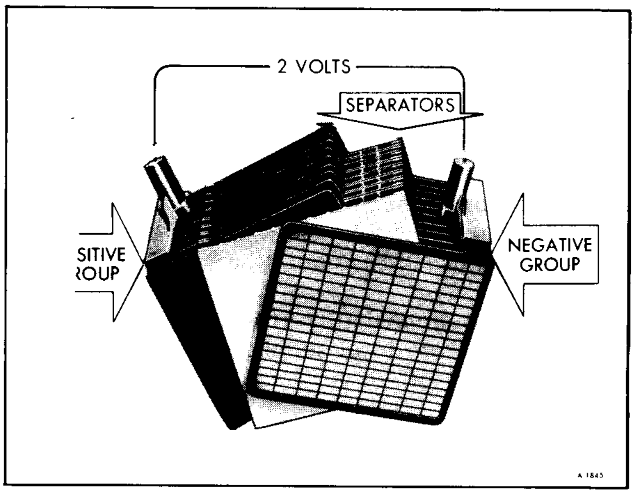


Figure 10—Battery Element (Compound)

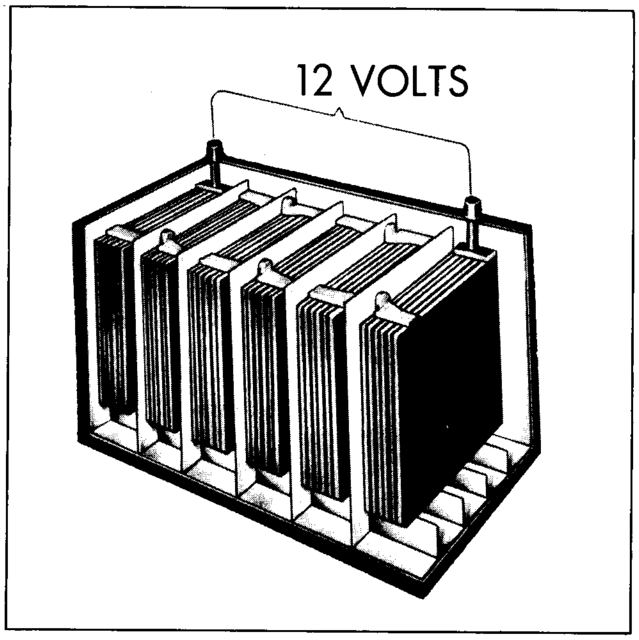


Figure 11—Typical 12-Volt Battery Cell Arrangement

much electrical pressure as a simple cell, or a total of 12 volts (figure 11).

If the battery continuously supplies current, it becomes run-down or discharged. This is where the generator gets into the act. The generator restores the chemical energy to the battery. This is done by sending current through the battery in a direction opposite to that during discharge. The generator current reverses the chemical actions in the battery and restores it to a charged condition.

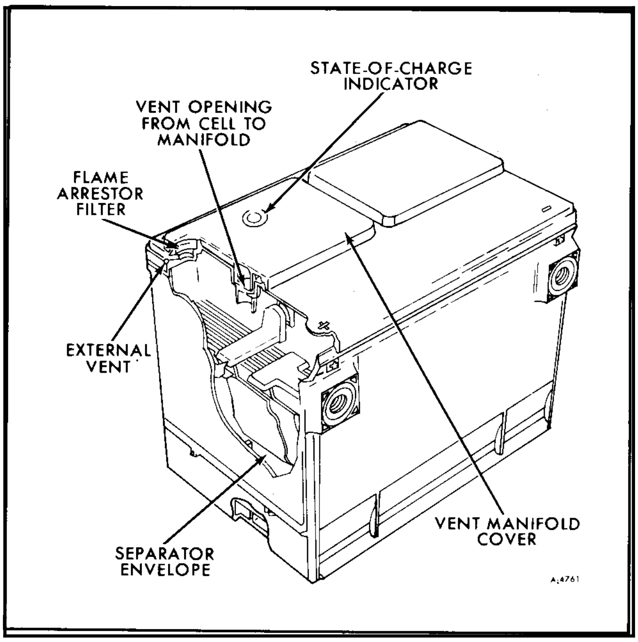


Figure 12—Internal View of Maintenance-Free Battery

The maintenance-free battery (figure 12) operates in the same manner as the standard battery, however, it differs slightly in construction. Negative plate envelopes replace the traditional flat separators greatly reducing the possibility of internal shorting.

The active plates in the maintenance-free battery utilize lead-calcium grids rather than the standard lead-antimony grid. This difference in grid construction results in a reduction of battery self-discharge, gassing, overcharging and the rate at which electrolyte is lost. The plates sit on the bottom of the case and are covered by a greater volume of electrolyte than in the standard battery. A vapor separator in the cover traps any liquid that accumulates and returns it to the battery. The battery cover is sealed on so that nothing can be added to contaminate or damage internal components.

BATTERY RATING

Each battery generally has two classifications of ratings: (1) a 20 hour rating at 80°F. (26.7°C.) and, (2) a cold rating at 0°F. (-17.8°C.) which indicates the cranking load capacity. The Ampere/Hour rating found on batteries was based on the 20 hour rating. That is, a battery capable of furnishing three (3) amperes for 20 hours while maintaining a specified average individual cell voltage would be classified as a 60 ampere hour battery (e.g. 3 amperes x 20 hours = 60 A.H.) a PWR (Peak Watt Rating) has been developed as a measure of the battery's cold cranking ability. The numerical rating is embossed on each case at the base of the battery. This value is determined by multiplying the max. current by the max. voltage. The PWR should not be confused with the ampere hour rating since two batteries with the same ampere hour rating can have quite different watt ratings. For battery replacement, a unit of at least equal power rating must be selected.

BATTERY DIAGNOSIS

TESTING PROCEDURES

Testing procedures are used to determine whether the battery is (1) good and usable, (2) requires recharging or (3) should be replaced. Refer to test procedures applicable to the battery in this vehicle.

BATTERIES WITH FLAME ARRESTOR VENT CAPS

Visual Inspection

The first step in testing the battery should be a visual inspection, which very often will save time and expense in determining battery condition.

- Check the outside of the battery for a broken or cracked case or a broken or cracked cover. If any damage is evident, the battery should be replaced.

- Note the electrolyte level. Levels that are too low or too high may cause poor performance, as covered in the section entitled "General Information".

- Check for loose cable connections. Correct as required before proceeding with tests.

Full Charge Hydrometer Test

This test should be used only on batterys which test good with testing equipment or "Specific Gravity Cell Comparison Test" but which subsequently fail in service.

- Remove the battery from the vehicle, and adjust the electrolyte level as necessary, by adding colorless, odorless, drinking water.

- Fully charge the battery at the Slow Charging rate as covered in the section entitled "Charging Procedures".

- Measure the specific gravity of the electrolyte in each cell and interpret as follows:

Hydrometer Reading Less Than 1.230—Full charge hydrometer readings less than 1.230 corrected for temperature indicate the Battery is defective and should be replaced.

Hydrometer Readings Above 1.310—Full charge hydrometer readings above 1.310 corrected for temperature indicate that the cells have been improperly filled (activation) or improperly serviced. Poor service and short Battery life will result.

Load Test

In addition to the instrument test and full charge hydrometer test, the following load test may also be performed to check the condition of the battery.

NOTE: Equipment to perform this test may be procured from local suppliers of testing equipment.

To begin, charge the battery, if necessary, until all cells are at least 1.200 specific gravity.

1. If unable to obtain specific gravity 1.200 @ 80°F. (26.7°C.), in all cells, replace battery.

BATTERY TEST PROCEDURE

STEP 1 - VISUAL INSPECTION

Check For Obvious Damage Such As A Cracked Or Broken Case That Shows Loss Of Electrolyte

Obvious Damage
Replace Battery

No Obvious Damage
Check Electrolyte Level

Below Top Of Plates In One Or More Cells
Add Water To proper Level
1. Charge For 15 Min. @ 15-25 Amps
Flame Arrestor Caps In Place
2. Connect 300 Amp Load For 15 Sec.
- Proceed To Step 2

Electrolyte Level Above Top Of Plates
In All Cells - Proceed To Step 2

STEP 2 - SPECIFIC GRAVITY (HYDROMETER TEST)

50 Points Or More Variation
Between Highest And Lowest Cell
Replace Battery

Less Than 50 Points Variation
Between Highest And Lowest Cell

Specific Gravity Of Lowest Cell
(Temperature Corrected)*
1.200 Or More
Battery Satisfactorily Charged
Proceed To Step 3

Specific Gravity Of Lowest Cell
(Temperature Corrected)*
Less Than 1.200
Battery Required Charging
Proceed To Step 3

STEP 3 - BATTERY LOAD TEST

Charge Battery, If Necessary, Until All Cells Are At Least 1.200 Specific Gravity

If Unable To Obtain Specific Gravity Of
1.200 Or More (Temperature Corrected)
In All Cells - Replace Battery

Specific Gravity Of 1.200 Or More
(Temperature Corrected)*
In All Cells - Remove Vent Caps
Connect 300 Amp Load For 15 Sec.

"Smoke" In One Or More Cells
Replace Battery

"No Smoke"

1. Place Thermometer In One Cell
2. Apply Specified Load From Specifications
3. Read Voltage At 15 Seconds With Load Connected
4. Remove Load And Read Electrolyte Temperature, Then Compare Temperature And Voltage Readings With Chart 1

Less Than Voltage On Chart 1
Replace Battery

Same As Or Greater Than
Voltage On Chart 1

Fully Charge, Clean, And
Return Battery To Service

NOTE: Chart No. 1 is in "Specifications."

* For temperature correction refer to "Specific Gravity Readings" earlier in this section.

Battery Test Procedure

2. If able to obtain a specific gravity of 1.200 or more @ 80°F. (26.7°C.) in all cells, remove the vent caps and connect a 300 amp. load for 15 seconds.

a. If smoke occurs in one or more cells, replace the battery.

b. If smoke does not occur proceed to step 3.

3. Place a thermometer in one cell and apply a specified load from specifications. Read the voltage at 15 seconds with load connected, then remove load and read electrolyte temperature. Compare temperature and voltage readings with voltage-temperature chart in "Battery Specifications".

a. If reading is less than voltage on chart, replace battery.

b. If reading is same as or greater than voltage on chart, fully charge, clean and return battery to service.

Specific Gravity Readings (Figure 13)

A hydrometer can be used to measure the specific gravity of the electrolyte in each cell.

The hydrometer measures the percentage of sulphuric acid in the battery electrolyte in terms of specific gravity. As a battery drops from a charged to a discharged condition, the acid leaves the solution and enters the plates, causing a decrease in specific gravity of electrolyte. An indication of the concentration of the electrolyte is obtained with a hydrometer.

When using a hydrometer, observe the following points:

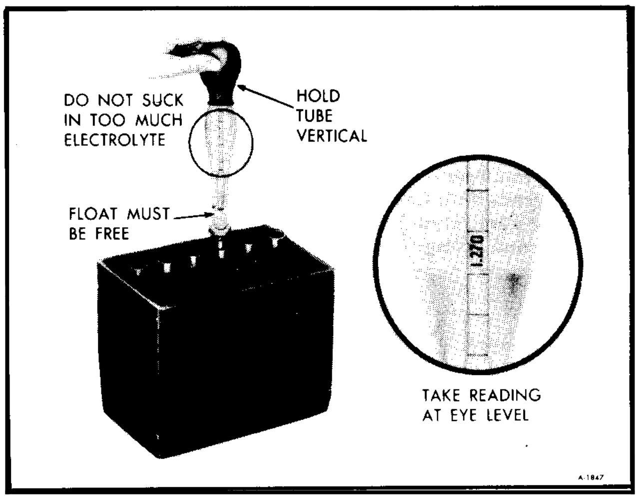


Figure 13—Checking Specific Gravity

1. Hydrometer must be clean, inside and out, to insure an accurate reading.

2. Hydrometer readings must never be taken immediately after water has been added. The water must be thoroughly mixed with the electrolyte by charging for at least 15 minutes at a rate high enough to cause vigorous gassing.

3. If hydrometer has built-in thermometer, draw liquid into it several times to insure correct temperature before taking reading.

4. Hold hydrometer vertically and draw in just enough liquid from battery cell so that float is free floating. Hold hydrometer at eye level so that float is vertical and free of outer tube, then take reading at surface of liquid. Disregard the curvature where the liquid rises against float stem due to surface tension.

5. Avoid dropping battery fluid on vehicle or clothing as it is extremely corrosive. Any fluid that drops should be washed off immediately with baking soda solution.

The specific gravity of the electrolyte varies not only with the percentage of acid in the liquid but also with temperature. As temperature increases, the electrolyte expands so that the specific gravity is reduced. As temperature drops, the electrolyte contracts so that the specific gravity increases. Unless these variations in specific gravity are taken into account, the specific gravity obtained by the hydrometer may not give a true indication of the concentration of acid in the electrolyte.

A fully charged Battery will have a specific gravity reading of approximately 1.270 at an electrolyte temperature of 80°F. (26.7°C.) If the electrolyte temperature is above or below 80°F. (26.7°C.), additions or subtractions must be made in order to obtain a hydrometer reading corrected to the 80°F. (26.7°C.) standard. For every 10° above 80°F. (26.7°C.), add four specific gravity points (.004) to the hydrometer reading. Example: A hydrometer reading of 1.260 at 110°F. (43.3°C.) would be 1.272 corrected to 80°C. (26.7°C.), indicating a fully charged battery. For every 10° below 80°F. (26.7°C.), subtract four points (.004) from the reading. Example: A hydrometer reading of 1.272 at 0°F. (-17.8°C.) would be 1.240 corrected to 80°F. (26.7°C), indicating a partially charged battery.

Specific Gravity Cell Comparison Test

To perform this test measure the specific gravity of each cell, regardless of state of charge, and interpret the results as follows:

• If specific gravity readings show a difference between the highest and lowest cell of .050 (50 points) or more, the Battery is defective and should be replaced.

Since the battery is a perishable item which requires periodic servicing, a good maintenance program will insure the longest possible Battery life. If the battery tests good but fails to perform satisfactorily in service for no apparent reason, the following are some of the more important factors that may point to the cause of the trouble.

1. Vehicle accessories inadvertently left on overnight to cause a discharge condition.

2. Slow speed driving of short duration, to cause an undercharged condition.

3. A vehicle electrical load exceeding the generator capacity.

4. Defect in the charging system such as high resistance, slipping fan belt, faulty generator or voltage regulator.

5. Battery abuse, including failure to keep the Battery top clean, cable attaching bolts clean and tight, and improper addition of water to the cells.

TESTING MAINTENANCE-FREE BATTERIES

Step 1—Visual Inspection

Check for obvious damage, such as cracked or broken case or cover that could permit loss of electrolyte. If obvious physical damage is noted, replace battery. Determine cause of damage and correct as needed.

Step 2—Charge Indicator

Check the charge indicator. For a detailed discussion on how to read the charge indicator, refer to "Charging Guide" later in this section.

a. Green dot visible. If the charge indicator is dark and has a green dot in the center, the battery is sufficiently charged for testing. Proceed to Step 3.

b. Dark green dot not visible. Battery must be charged before testing. Refer to "Chargine Guide" later in this section. Once battery is charged, proceed to Step 3.

NOTE: Battery should be charged until green dot appears, but not more than 60 ampere hours (for example—15 amperes for four hours). Some chargers are constant current chargers, but if a constant voltage charger is used, to get the green dot to appear after prolonged charging may require tipping the battery slightly from side to side a few times.

c. Light. DO NOT attempt charging or testing when charge indicator is light. Refer to "Charging Guide" later in this section.

CAUTION: *To avoid explosion hazard, NEVER attempt to charge or jump-start a maintenance-free battery which exhibits a light indicator condition. Departures from this procedure could result in serious personal injury or property damage.*

Step 3—Remove Surface Charge

Connect 300 ampere load across terminals for 15 seconds to remove surface charge from battery.

Step 4—Load Test

a. Connect voltmeter and 230 ampere load across terminals.

b. Read voltage after 15 seconds with load connected, then disconnect load.

c. If minimum voltage agrees with Chart (given in Specifications) battery is good.

d. If minimum voltage is less than given in Chart replace battery.

INSTALLING BATTERIES

To install a battery properly, it is important to observe the following precautions:

• Connect grounded terminal of Battery last to avoid short circuits which may damage the electrical system.

Do not connect primary lead until secondary negative cable wire has been grounded to sheet metal.

• Be sure there are no foreign objects in the carrier, so that the new Battery will rest properly in the bottom of the carrier.

• Tighten the hold-down evenly until snug (5-6 ft. lbs.). Do not draw down tight enough to distort or crack the case or cover.

• Be sure the cables are in good condition and the terminal bolts are clean and tight. Make sure the ground cable is clean and tight at engine block or frame.

- Check polarity to be sure the battery is not reversed with respect to the charging system.

- Torque cable connections at battery to 6 foot-pounds.

EMERGENCY STARTING

- Engine cannot be started by towing or pushing the vehicle.

- If only main (automotive) battery is discharged, hold battery switch on instrument panel momentarily in "BAT BOOST". This supplies current from the auxiliary battery. After use, switch on MotorHome is designed to return to the "BAT NORMAL" position. Switch on TransMode must be manually returned to the "BAT NORMAL" position.

NOTE: If the battery boost switch is left in the "BATTBOOST" position for extended periods, both batteries will become discharged.

- A vehicle with discharged batteries may be jump started. See "Jump Starting" procedure.

JUMP STARTING WITH AUXILIARY (BOOSTER) BATTERY

Both booster and discharged battery should be treated carefully when using jumper cables. Follow exactly the procedure outlined below, being careful not to cause sparks:

CAUTION: *Departures from these conditions or the procedure below could result in: (1) serious personal injury (particularly to eyes) or property damage from such causes as battery explosion, battery acid, or electrical burns; and/or (2) damage to electronic components of either vehicle.*

Never expose battery to open flame or electrical spark—batteries generate a gas which is flammable and explosive. Do not allow battery fluid to contact eyes, skin, fabrics, or painted surfaces—fluid is a corrosive acid. FLUSH ANY CONTACTED AREA WITH WATER IMMEDIATELY AND THOROUGHLY. Be careful that metal tools, or jumper cables do not contact the positive battery terminal (or metal in contact with it) and any other metal in the other vehicle, because a short circuit could occur. Batteries and battery acid should always be kept out of the reach of children.

- The battery in the other vehicle must be 12-volt and NEGATIVELY GROUNDED, like the batteries in THIS vehicle. (Check the other vehicle's owner's manual to see if it is).

- The batteries in THIS vehicle must be equipped with FLAME ARRESTOR TYPE FILLER/VENT CAPS on ALL filler openings (as was the original-equipment Delco batteries), or it must be a sealed-type battery which does not have filler openings or caps such as the Maintenance-Free batteries. (Each Delco battery flame arrestor cap has a grey disc rather than a small hole, see Figure 5).

- If the battery is a Delco sealed-type battery without filler openings or caps, its charge indicator MUST BE DARK, with or without green dot showing, see Figure 21. DO NOT attempt jump starting if the charge indicator has a light or bright center.

JUMP START PROCEDURE

1. WEAR EYE PROTECTION and remove rings, metal watch bands, and other metal jewelry.

2. Set parking brake firmly, and place automatic transmission in "PARK" in both vehicles (don't let vehicles touch); and turn ignition key to LOCK in vehicle with discharged battery (Neutral and "OFF" in vehicles with manual transmission). Also turn off lights, heater, and all unnecessary electrical loads.

3. Attach one end of a jumper cable to the positive terminal (identified by a red color, "+", or "P" on the battery case, post, or clamp), of the battery in the other vehicle and the other end of the same cable to positive terminal junction block stud, marked "VEHICLE BATTERY POSITIVE". This is located behind the right access door above the main (automotive) battery as shown in Figure 14.

4. Attach one end of the remaining jumper cable FIRST to the negative terminal (black color, "—", or "N") of the OTHER vehicle's battery, (regardless of which vehicle has the discharged battery) and THEN to the right radiator mounting bracket in THIS vehicle—thus taking advantage of your battery's flame arrestor feature, should a spark occur (figure 15).

5. Start the engine in the vehicle that is providing the jump start (if it was not running). Let run a few minutes, then start the engine in the vehicle that has the discharged battery.

6. Reverse the above sequence EXACTLY when removing the jumper cables, taking care to remove

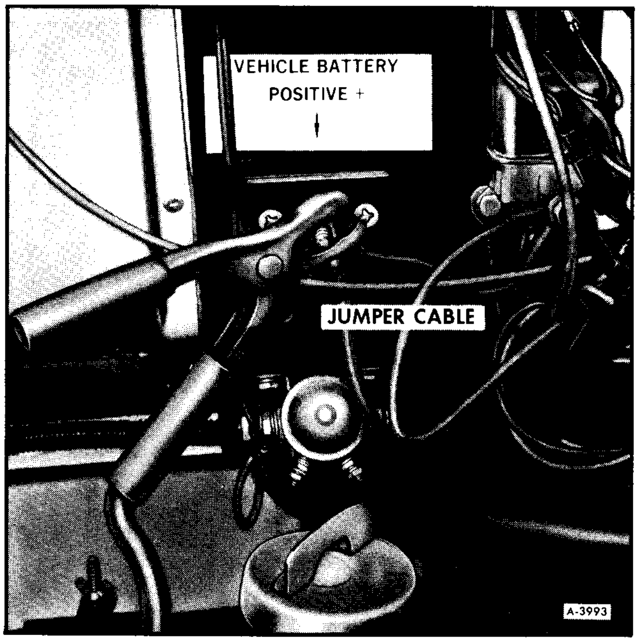


Figure 14—Connecting Jumper Cable to "Vehicle Battery Positive" Stud

the cable from the right radiator mounting bracket in THIS vehicle as the FIRST step.

SAFETY PRECAUTIONS

When batteries are being charged, an explosive gas mixture forms in each cell. Part of this gas escapes through the holes in the vent plugs and may form an explosive atmosphere around the battery itself if ventilation is poor. This explosive gas may remain in or around the battery for several hours after it has been charged. Sparks or flames can ignite this gas causing an internal explosion which may shatter the battery.

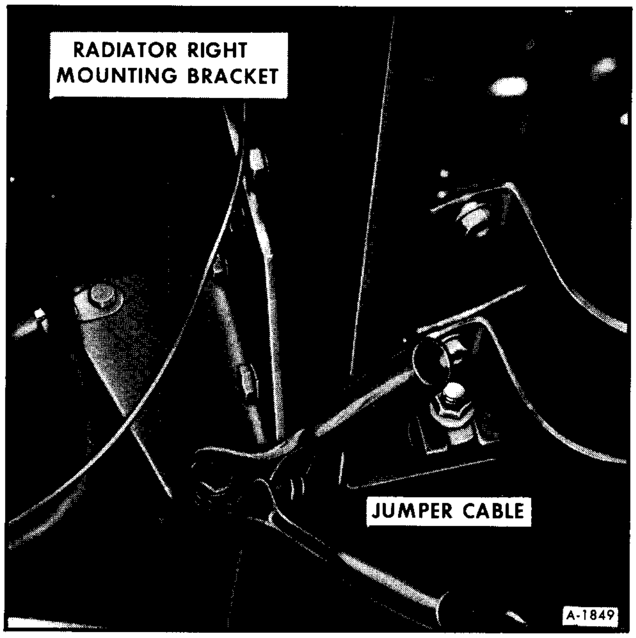


Figure 15—Connecting Jumper Cable to Right Radiator Mounting Bracket

The following precautions should be observed to prevent an explosion:

1. Do not smoke near batteries being charged or which have been very recently charged.

2. Do not break live circuits at the terminals of batteries because a spark usually occurs at the point where a live circuit is broken. Care must always be taken when connecting or disconnecting booster leads or cable clamps on fast chargers. Poor connections are a common cause of electrical arcs which cause explosions.

CHARGING PROCEDURES

Before charging batteries equipped with flame arrestor type filler/vent caps, the electrolyte level must be checked and adjusted if need. If charging maintenance-free battery, do not charge more than 60 ampere hours (for example-15 amperes for four hours). Some chargers are constant current chargers, but if a constant voltage charger is used, to get the green dot to appear on the charge indicator, may require tipping the battery slightly from side to side a few times. A battery that required charging before testing may indicate a need to check the charging system of the vehicle.

Battery charging consists of applying a charge rate in amperes for a period of time in hours. Thus, a 10 ampere charge rate for seven hours would be a 70 ampere-hour (A.H.) charging input to the battery. Charging rates in the three to 50 ampere range are generally satisfactory. No particular charge rate or time can be specified for a energizer due to the following factors:

1. The size, or electrical capacity in ampere-hours (A.H.), of the battery.

EXAMPLE: A completely discharged 70 A.H. battery requires almost twice the recharging as a 40 A.H. BATTERY.

2. Temperature of the battery electrolyte.

EXAMPLE: About two hours longer will be needed to charge a 0°F. (-17.8°C.) battery than an 80°F. (26.7°C.) battery.

3. Battery state-of-charge at the start of the charging period.

EXAMPLE: A completely discharged battery requires twice as much charge in ampere-hours as a one-half charged battery.

EXAMPLE: A battery that has been subjected to severe service will require up to 50% more ampere-hour charging input than a relatively new battery.

A battery may be charged at any rate in amperes for as long as spewing of electrolyte due to violent gassing does not occur, and for as long as electrolyte temperature does not exceed 125°F. (49°C.) If spewing of electrolyte occurs, or if electrolyte temperature exceeds 120°F. (49°C.), the charging rate in amperes must be reduced or temporarily halted to avoid energizer.

The battery is fully charged when over a two-hour period at low charging rate in amperes all cells are gassing freely (not spewing liquid electrolyte), and no change in specific gravity occurs. The full charge specific gravity is 1.260-1.280, corrected for electrolyte temperature with the electrolyte level at the split ring, unless electrolyte loss has occurred due to age or overfilling in which case the specific gravity reading will be lower. For the most satisfactory charging, the lower charging rates in amperes are recommended.

Maintenance-Free batteries should not be charged more than 60 ampere-hours.

If after prolonged charging a specific gravity of at least 1.230 on all cells cannot be reached, the battery is not in an optimum condition and will not provide optimum performance; however, it may continue to provide additional service if it has performed satisfactorily in the past.

An "emergency boost charge", consisting of a high charging rate for a short period of time, may be applied as a temporary expedient in order to crank an engine. However, this procedure usually supplies insufficient battery reserve to crank a second and third time. Therefore, the "emergency boost charge" must be followed by a subsequent charging period of sufficient duration to restore the battery to a satisfactory state of charge. Refer to the charging guide in this section.

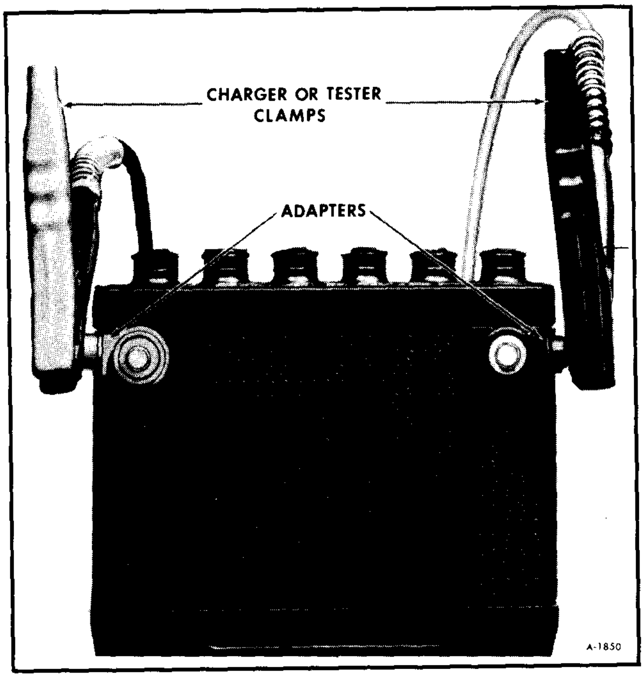


Figure 16—Charging Lead Adapters

When out of the vehicle, the sealed side terminal battery will require adapters (figure 16) for the terminals to provide a place for attachment of the charging leads. Adapters are available through local parts service.

When the side terminal battery is in the vehicle, the studs provided in the wiring harness are suitable for attachment of the charger's leads.

CAUTION: *Exercise care when attaching charger leads to side terminal studs to avoid contact with vehicle metal components which would result in damage to the battery.*

CHARGING GUIDE

BATTERY MAINTENANCE

CARE OF BATTERY

Energizer Storage

Since the "dry charge" battery is vacuum sealed against the entrance of moisture, it may be stored for very long periods of time without detrimental effects so long as the seals remain unbroken. When storing a "dry charge" battery, the following procedures should be followed:

1. Keep the battery in its shipping carton until activated.

2. Do not stack the "dry charge" battery in cartons more than four high.

3. Rotate stocks regularly.

RECOMMENDED RATE* AND TIME FOR FULLY DISCHARGED CONDITION

CAUTION: EXERCISE CARE WHEN ATTACHING CHARGER LEADS TO SIDE TERMINAL STUDS TO AVOID CONTACT WITH VEHICLE METAL COMPONENTS WHICH COULD RESULT IN DAMAGE TO THE ENERGIZER.

Watt Rating	5 Amperes	10 Amperes	20 Amperes	30 Amperes	40 Amperes	50 Amperes
Below 2450	10 Hours	5 Hours	2-1/2 Hours	2 Hours		
2450-2950	12 Hours	6 Hours	3 Hours	2 Hours	1-1/2 Hours	
Above 2950	15 Hours	7-1/2 Hours	3-1/4 Hours	2 Hours	1-3/4 Hours	1-1/2 Hours

* Initial rate for constant voltage taper rate charger.
To avoid damage, charging rate must be reduced or temporarily halted if:
1. Electrolyte temperature exceeds 125°F.
2. Violent gassing or spewing of electrolyte occurs.

Battery is fully charged when over a two hour period at a low charging rate in amperes all cells are gassing freely and no change in specific gravity occurs. For the most satisfactory charging, the lower charging rates in amperes are recommended. Full charge specific gravity is 1.260-1.280 corrected for temperature with electrolyte level at split ring.

4. Maintain the storage area at 60°F. (15.6°C.), or higher to aid activation.

A wet charged battery will not maintain its charged condition during storage, and must be recharged periodically. During storage, even though the battery is not in use, a slow reaction takes place between the chemicals inside the battery which causes the battery to lose charge and "wear out" slowly. This reaction is called "self-discharge." The rate at which self-discharge occurs varies directly with the temperature of the electrolyte.

Note that an battery stored in an area at 100°F. (37.8°C.) for 60 days has a much lower specific gravity and consequently a lower state of charge than one stored in an area at 60°F. (15.6°C.) for the same length of time.

To minimize self-discharge, a wet battery should be stored in as cool a place as possible, provided the electrolyte does not freeze.

A wet battery which has been allowed to stand idle for a long period of time without recharging may become so badly damaged by the growth of lead sulfate crystals (sulfation) in the plates that it can never be restored to a normal charged condition. An battery in this condition not only loses its capacity but also is subject to changes in its charging characteristics. These changes, due to self-discharge, are often serious enough to prevent satisfactory performance in a vehicle.

Periodic recharging, therefore, is necessary to maintain a wet charged battery in a satisfactory condition while in storage. See paragraph "Charging Wet battery in Storage."

Charging Wet Battery in Storage

Before placing a battery on charge, always check the electrolyte level and add water, as necessary, to bring the electrolyte up to the bottom of the split vent.

The battery should be brought to a fully charged condition every 30 days by charging as covered under heading of "Battery Charging Procedures".

Trickle charging should not be used to maintain on battery in a charged condition when in storage. The low charge rate method applied every 30 days is the best method of maintaining a wet charged battery in a fully charged condition without damage.

Electrolyte Freezing

The freezing point of electrolyte depends on its specific gravity. The following table gives the freezing temperatures of electrolyte at various specific gravities.

Value of Specific Gravity Corrected to 80°F. (26.7°C.)	Freezing Temp. Deg. F. (Deg. C.)	Value of Specific Gravity Corrected to 80°F. (26.7°C.)	Freezing Temp. Deg. F. (Deg. C.)
1.100	18 (-7.8)	1.220	-13(-25)
1.120	13 (-10.6)	1.240	-50 (-45.6)
1.140	8 (-13.3)	1.260	-75 (-60)
1.160	1 (-17.2)	1.280	-92 (-68.9)
1.180	-6 (-21.1)	1.300	-95 (-70.6)
1.200	-17 (-27.2)		

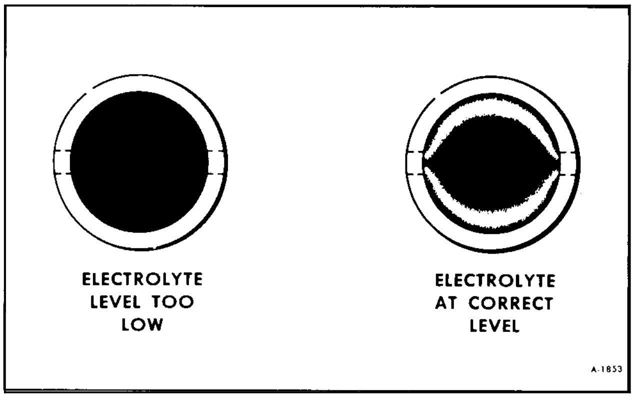


Figure 17—View Inside Vent Well

Electrolyte Level — Battery with Flame Arrestor Vent Caps

To check the electrolyte level, remove the vent plug and visually observe the electrolyte level in the vent well. The bottom of the vent well features a split vent which will cause the surface of the electrolyte to appear distorted when it makes contact. The electrolyte level is correct when the distortion first appears at the bottom of the split vent (figure 17).

The electrolyte level in the battery should be checked regularly. In hot weather, particularly during trip driving, checking should be more frequent because of more rapid loss of water. If the electrolyte level is found to be low, then colorless, ordorless, drinking water should be added to each cell until the liquid level rises to the split vent located in the bottom of the vent well. DO NOT OVERFILL because this will cause loss of electrolyte resulting in poor performance, short life, and excessive corrosion.

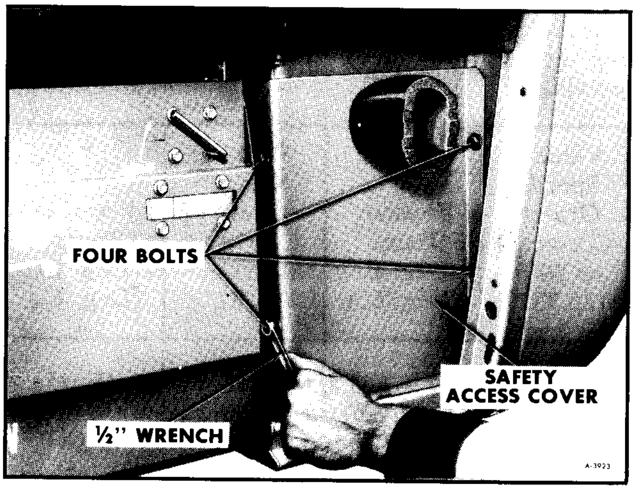


Figure 18—Removing MotorHome Living Area Battery Access Cover

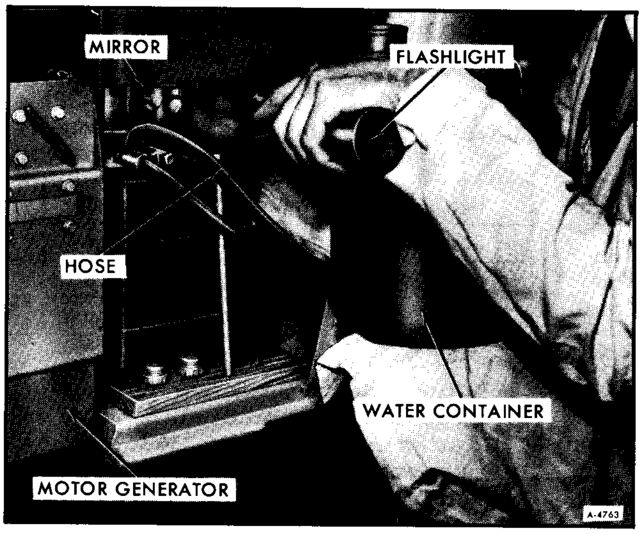


Figure 19—Checking and Adding Water to Living Area Battery

CAUTION: *During service only water should be added to the Battery, not electrolyte.*

The liquid level in the cells should never be allowed to drop below the top of the plates, as the portion of the plates exposed to air may be permanently damaged with a resulting loss in performance.

To service MotorHome auxiliary (living area) battery located in motor generator compartment, use a 1/2-inch wrench or socket to remove four bolts from safety access cover as shown in Figure 18. Remove cover. Position flashlight, mirror, water container, and hose as shown in Figure 19. Check fluid level and add water as required.

Water Usage

Excessive usage of water indicates the battery is being overcharged. The most common causes of overcharge are high battery operating temperatures, too high a voltage regulator setting, poor regulator ground wire connection. Normal battery water usage is approximately one to two ounces per month per battery.

Charge Indicator — Maintenance-Free Batteries

When reading the charge indicator on a maintenance-free battery while installed in the vehicle, a small hand mirror may be helpful. Hold the mirror as shown in Figure 20.

a. GREEN DOT VISIBLE—Figure 21. If the charge indicator is dark and has a green dot in the center, the battery is sufficiently charged.

b. DARK—GREEN DOT NOT VISIBLE—Figure 21. If the charge indicator is dark and the

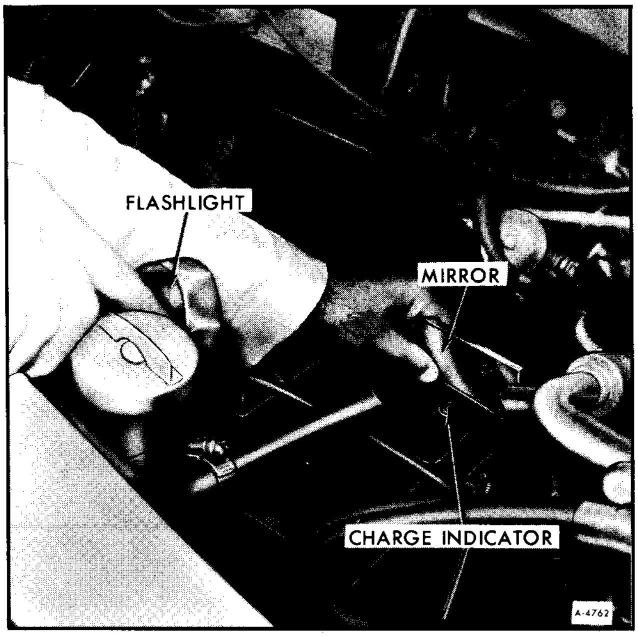


Figure 20—Checking Automotive Maintenance-Free Battery

green dot is not visible, charge battery until green dot appears, but not more than 60 ampere-hours—(for example—15 amperes for four hours).

c. LIGHT—Figure 21. If the charge indicator has a light or bright center and a cranking complaint has been experienced, replace battery (DO NOT attempt charging or testing when indicator has a light or bright center.

NOTE: A battery that failed prematurely, and exhibited a light indicator condition may indicate a need for checking the charging system of the vehicle.

Carrier and Hold-Down

The battery carrier and hold-down should be clean and free from corrosion before installing the Battery. The carrier should be in sound mechanical condition so that it will support the Battery securely and keep it level.

To prevent the Battery from shaking in its carrier, the wing nuts should be tight (60-80 in. lbs.). However, the wing nuts should not be tightened to the point where the Battery case or cover will be placed under a severe strain.

Cleaning

The external condition of the battery should be checked periodically for damage such as cracked cover, case and vent plugs or for the presence of dirt and corrosion. The battery should be kept clean. An accumulation of acid film and dirt may permit current to flow between the terminals, which will slowly discharge the Battery. For best results when cleaning batteries, wash first with a diluted ammonia or a soda solution to neutralize any acid present; then flush with clean water. Care must be taken to keep vent plugs tight, so that the neutralizing solution does not enter the cells.

SELECTING A REPLACEMENT BATTERY

Long and troublefree service can be more assured when the capacity or wattage rating of the replacement battery is at least equal to the wattage rating of the battery originally engineered for the application by the manufacturer.

The use of an undersize battery may result in poor performance and early failure. battery power

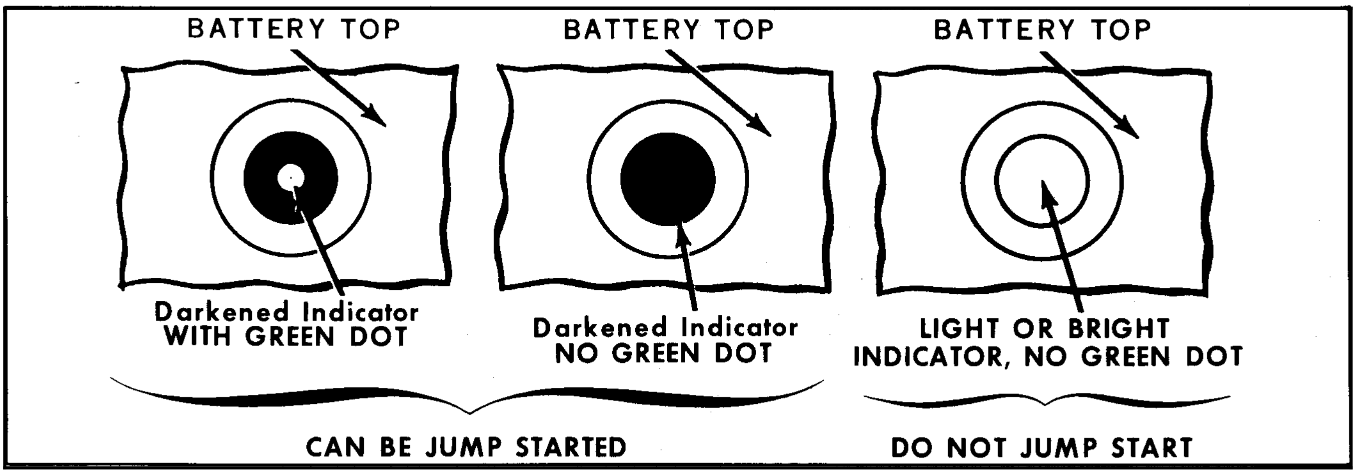


Figure 21—Charge Indicator Conditions

shrinks while the need for engine cranking power increases with falling temperatures. Sub zero temperatures reduce capacity of a fully charged battery to 45% of its normal power and at the same time increase cranking load to 3-1/2 times the normal warm weather load.

Hot weather can also place excessive electrical loads on the battery. Difficulty in starting may occur when cranking is attempted shortly after a hot engine has been turned off or stalls. In fact, modern high compression engines can be as difficult to start under such conditions as on the coldest winter day. Consequently, good performance can be obtained only if the battery has ample capacity to cope with these conditions.

A battery of greater capacity should be considered if the electrical load has been increased through the addition of accessories or if driving conditions are such that the generator cannot keep the battery in a charged condition.

On applications where heavy electrical loads are encountered, a higher output generator that will supply a charge during low speed operation may be required to increase battery life and improve battery performance.

BATTERY SPECIFICATIONS

BATTERIES - FLAME ARRESTOR TYPE FILLER/VENT CAP

	Type
MotorHome	
Main (Automotive) Battery	E5000 Catalog No. R91
Auxiliary (Living Area) Battery	Extra Duty Catalog No. 758
TransMode	
Main Battery	E5000 Catalog No. R91
Auxiliary Battery	E5000 Catalog No. R91

Part No.	1980224	1980231
Make	Delco-Remy	Delco-Remy
Model No.	E5000	Extra Duty
Catalog	R91	758
Volts	12	12
Watt Rating @0°F.(-17.8°C.)	3350 Watts	4500 Watts
Cold Cranking Rating @0°F. (-17.8°C.)	430 Amps	640 Amps
Cold Cranking Raging @-20°F. (-29°C.)	330 Amps	450 Amps
Minutes Reserve Capacity @ 25 Amps	140	285
Amps for Load Test	220	450

BATTERIES—MAINTENANCE-FREE

	Type
MotorHome	
Main (Automotive) Battery	Freedom Catalog No. R89-5
TransMode	
Main Battery	Freedom Catalog No. R89-5
Auxiliary Battery	Freedom Catalog No. R89-5
M.G. Cranking Battery (Optional)	Freedom Catalog No. R85-5

Part No.	1980402	1980400
Make	Delco-Remy	Delco-Remy
Model No.	Freedom Battery	Freedom Battery
Catalog No.	R89-5	R85-5
Volts	12	12
Watt Rating @0°F.(-17.8°C.)	4000	3200
Cold Cranking Rating @0°F. (-17.8°C.)	465	350
Cold Cranking Rating @-20°F. (-29°C.)	375	270
Minutes Reserve Capacity @ 25 Amps	125	80
Amps for Load Test	230	230

VOLTAGE AND TEMPERATURE CHART									
Electrolyte Temperature	80°F 26.7°C	70°F 21.1°C	60°F 15.6°C	50°F 10°C	40°F 4.4°C	30°F 1.1°C	20°F −6.7°C	10°F −12.2°C	0°F −17.8°C
Voltage Minimum	9.6	9.6	9.5	9.4	9.3	9.1	8.9	8.7	8.5

GENERATING SYSTEM

GENERAL DESCRIPTION

The 80 amp. (27 SI type 100) generator illustrated in Figure 22 feature a solid state regulator mounted inside the generator slip ring end frame. All regulator components are enclosed in a solid mold. This unit, along with the brush holder assembly, is

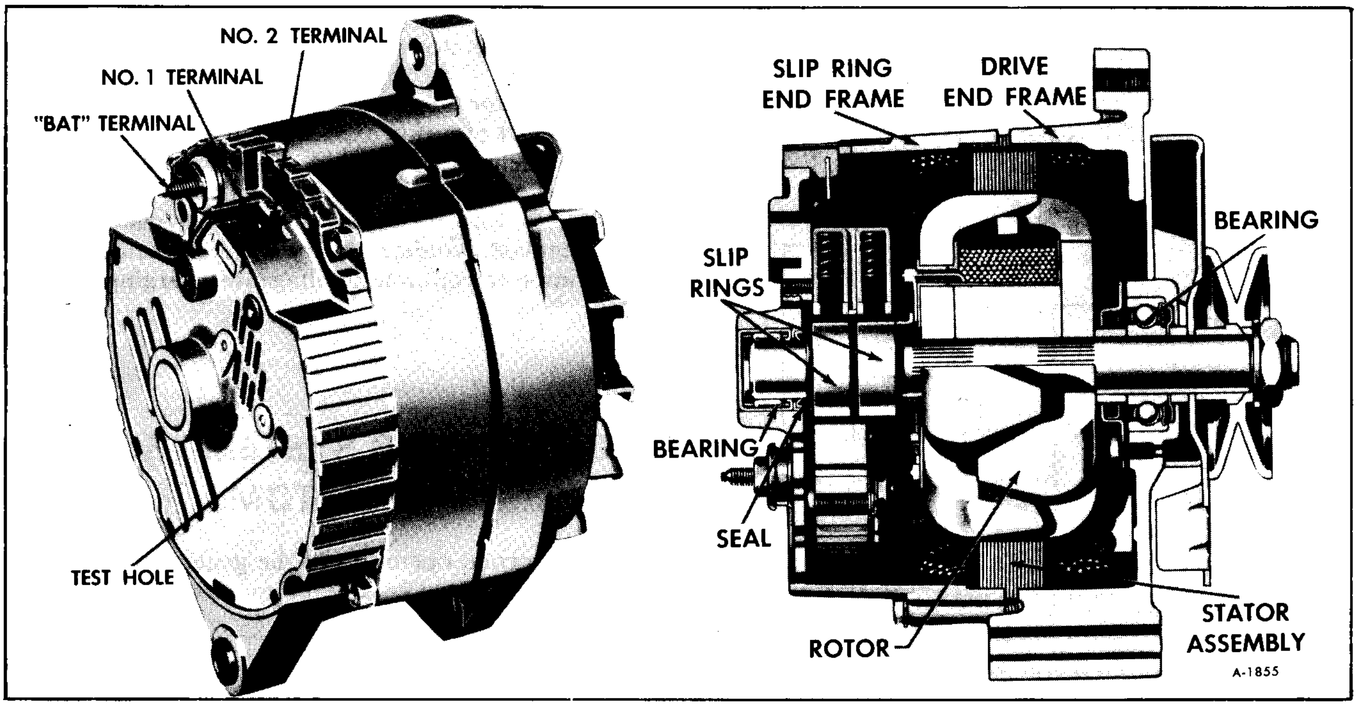


Figure 22—80 - Amp. Integral Type AC Generator

attached to the slip ring end frame. The regulator voltage setting is not adjustable.

The generator rotor bearings contain a supply of lubricant sufficiently adequate to eliminate the need for periodic lubrication. Two brushes carry current through two slip rings to the field coil. The stator windings are assembled on the inside of a laminated core that forms part of the generator frame. A rectifier bridge connected to the stator windings contains six diodes, and electrically changes the stator A.C. voltages to a D.C. voltage which appears at the generator output terminal. Generator field current is supplied through a diode trio connected to the stator windings. A capacitor, or condenser, mounted in the end frame protects the rectifier bridge and diode trio from high voltages, and suppresses radio noise.

OPERATING PRINCIPLES

A typical schematic wiring diagram of the 80-amp integral type charging system is shown in Figure 23. The basic operating principles are explained as follows:

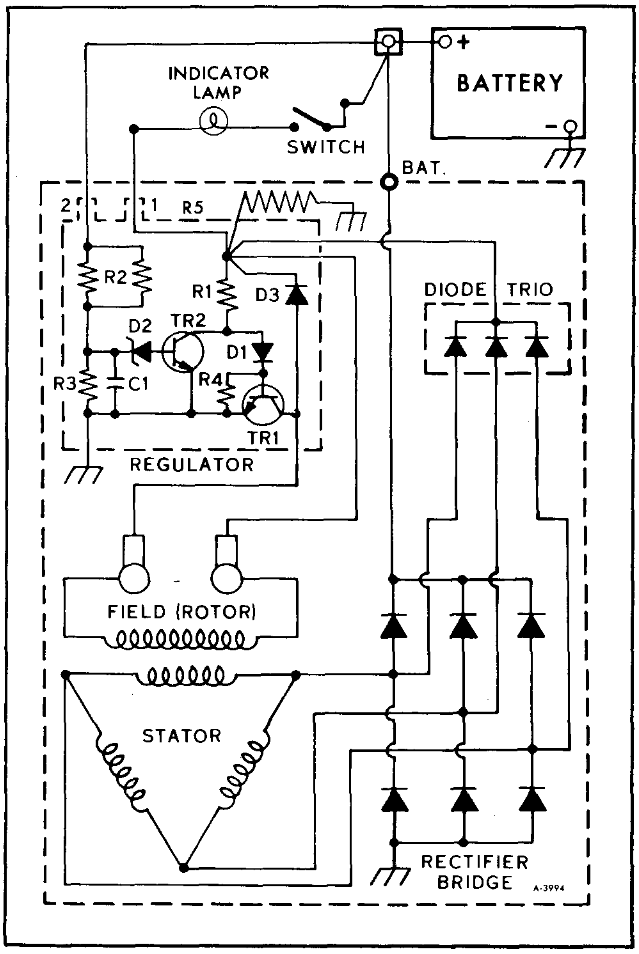


Figure 23—Schematic Diagram of Generating System (Typical)

When ignition switch is closed, current from the battery flows through the indicator lamp to generator No. 1 terminal, through resistor R1, diode D1, and the base-emitter of transistor TR1 to ground, then back to the battery. This turns on transistor TR1, and current flows through the generator field coil and TR1 back to the battery. The indicator lamp then turns on. Resistor R5 carries some of the indicator lamp current and is identified in Figure 23.

With generator operating, A.C. voltages are generated in the stator windings, and the stator supplies D.C. field current through the diode trio, the field, TR1, and then through the grounded diodes in the rectifier bridge back to the stator. The six diodes in the rectifier bridge change the stator A.C. voltages to a D.C. voltage which appears between ground and generator "BAT" terminal. As generator speed increases, current is provided for charging the battery and operating electrical accessories. Also, with the generator operating, the same voltage appears at the "BATT" and No. 1 terminals, and the indicator lamp goes out to indicate the generator is producing voltage.

The No. 2 terminal on the generator is always connected to the battery, but the discharge current is limited to a negligible value by the high resistances of R2 and R3. As generator speed and voltage increase, the voltage between resistors R2 and R3 increases to the point where zener diode D2 conducts. Transistor TR2 then turns on and TR1 turns off. With TR1 off, field current and system voltage decrease, and D2 blocks current flow, causing TR1 to turn back on. The field current and system voltage increase. This cycle repeats many times per second to limit generator voltage to a pre-set value.

Capacitor C1 smooths out the voltage across R3, resistor R4 prevents excessive current through TR1 at high temperatures, and diode D3 prevents high induced voltages in the field windings when TR1 turns off. Resistor R2 is a thermister which causes the regulated voltage to vary with temperature, thus providing the optimum voltage for charging the battery.

GENERATING SYSTEM TROUBLE SYMPTOMS

Abnormal operation of the generating system is usually indicated by one or more of the following symptoms:

1. Battery undercharged (low specific gravity of electrolyte).

GENERATING SYSTEM DIAGNOSIS

FAULTY INDICATOR LAMP OPERATION

Check the indicator lamp for normal operation as shown below:

Switch	Lamp	Engine
OFF	OFF	STOPPED
ON	ON	STOPPED
ON	OFF	RUNNING

If the indicator lamp operates normally, proceed to "Undercharged Battery" or "Overcharged Battery" section. Otherwise, proceed to either one of the following three abnormal conditions:

Switch On, Lamp On, Engine Running - Check for a blown fuse (where used) between indicator lamp and switch. The other possible causes of this condition are covered in "UNDERCHARGED BATTERY" on this page.

Switch Off, Lamp On - In this case, disconnect the two leads from the generator No. 1 and No. 2 terminals. If the lamp stays on, there is a short between these two leads. If the lamp goes out, replace the rectifier bridge as covered in the "GENERATOR REPAIR." This condition will cause an undercharged battery.

Switch On, Lamp Off, Engine Stopped - This condition can be caused by the defects listed in "Switch Off, Lamp On" under "GENERATOR TROUBLESHOOTING," or by an open in the circuit.

To determine where an open exists, check for a blown fuse, a burned out bulb, defective bulb, or an open in No. 1 lead circuit between generator and ignition switch.

If no defects are found, proceed to "UNDERCHARGED BATTERY" above.

UNDERCHARGED BATTERY

This condition, as evidenced by slow cranking and low specific gravity readings, can be caused by one or more of the following conditions even though the indicator lamp may be operating normally. The following procedure also applies to circuits with an ammeter:

1. Insure that the undercharged condition has not been caused by accessories having been left on for extended periods.
2. Check the drive belt for proper tension.
3. If a battery defect is suspected, see "Battery Service And Diagnosis" earlier in this section.
4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the generator and firewall, and the cable clamps and battery posts.
5. With ignition switch on, connect a voltmeter from:
   a. Generator "BAT" terminal to ground.
   b. Generator No. 1 terminal to ground.
   c. Generator No. 2 terminal to ground.
   A zero reading indicates an open between voltmeter connection and battery.
6. If previous Steps 1 through 5 check satisfactorily, check Delcotron Generator as follows:
   a. Disconnect battery ground cable.
   b. Connect an ammeter in the circuit at the "BAT" terminal of the generator.
   c. Reconnect battery ground cable.
   d. Turn on radio, windshield wipers, lights high beam and blower motor high speed. Connect a carbon pile across the battery.
   e. Operate engine at moderate speed as required, and adjust carbon pile as required, to obtain maximum current output.

If ampere output is within 10 amps of rated output as stamped on generator frame, generator is not defective; recheck Steps 1 through 5.

If amperes output is not within 10 amps of rated output, determine if test hole is accessible.

If test hole is accessible, ground the field winding by inserting a screwdriver into the test hole.

CAUTION: Tab is within 3/4-inch of casting surface. Do not force screwdriver deeper than 1-inch into end frame.

Operate engine at moderate speed as required, and adjust carbon pile as required to obtain maximum current output.

If test hole is not accessible, disassemble generator and make tests listed in "GENERATOR REPAIR."

If output is not within 10 amps of rated output, check the field winding, diode trio, rectifier bridge, and stator as covered in "GENERATOR REPAIR."

If output is within 10 amps of rated output, test regulator with an approved regulator tester, and check field winding as covered in "GENERATOR REPAIR."

OVERCHARGED BATTERY

1. To determine battery condition, see "Battery Service And Diagnosis" earlier in this section.
2. Connect a voltmeter from generator No. 2 terminal to ground. If reading is zero, No. 2 lead circuit is open.
3. If battery and No. 2 lead circuit check good, but an obvious overcharge condition exists as evidenced by excessive battery water usage, proceed as follows:
   a. Separate end frames as covered in "Disassembly" under heading of "GENERATOR REPAIR." Check field winding for grounds and shorts. If defective, replace rotor and test regulator with an approved regulator tester.
   b. Connect ohmmeter using lowest range scale from brush lead clip to end frame; then reverse lead connections.
   c. If both readings are zero, either the brush lead clip is grounded or regulator may be defective.
   d. A grounded brush lead clip can result from omission of insulating washer, omission of insulating sleeve over screw, or damaged insulating sleeve. Remove screw to inspect sleeve. If satisfactory, test regulator with an approved regulator tester.

Generating System Diagnosis

2. Battery using an excessive amount of water, indicating an extremely high charging rate.

3. Excessive generator noise or vibration.

4. Failure of indicator lamp to illuminate when ignition switch is turned on (engine not running).

5. Indicator lamp continues to glow with engine running.

6. Indicator lamp fails to go out when ignition or control switch is turned off.

The following is a list of the most common generator defects encountered:

1. Open or shorted generator diodes.

2. Open, shorted, or grounded stator winding.

3. Open, shorted, or grounded field winding.

4. Worn generator brushes.

5. Excessive generator noise.

Generator diodes and stator windings should be checked as explained under "Generator on Vehicle Output Test" in Steb b, later in this section. If a defect is indicated by this test, remove generator and repair.

Excessive generator noise is usually the result of one or more of the following:

1. Brush "squeal" caused by a hard spot on one of the brushes of rough or dirty slip rings. To check for brush "squeal," remove generator drive belt and spin generator drive pulley by hand. Lift brushes off slip rings and spin drive pulley again. If noise disappears, clean and inspect slip rings and replace brushes if worn.

2. Dry or rough bearings in end frame.

CAUTION: *Dry or rough bearings may be the result of over-tightening generator drive belt(s), loose generator mountings, or an unbalanced generator fan or pulley.*

3. A defective diode or stator resulting in an electrical unbalance.

STATIC CHECK

Before making any electrical checks, visually inspect all connections, including slip-on connectors, to make sure they are clean and tight. Inspect all wiring for cracked, frayed, or broken insulation. Be sure generator mounting bolts are tight and unit is properly grounded. Check for loose fan belt.

PRECAUTIONS

Observe the following precautions when performing service operations on the alternating current generating system. Failure to observe these precautions may result in serious damage to the charging system.

NOTE: A basic wiring diagram showing lead connections is shown in Figure 24.

1. Electrical system is NEGATIVE GROUND. Connecting the battery with positive terminal grounded will result in severe damage to generator, battery and battery cables.

2. DO NOT ground the field circuit at generator.

3. Never operate generator with open circuit, that is, with output wire disconnected from terminal and with field circuit externally energized. Be absolutely sure all connections in circuit are secure.

4. When using a booster battery, connect leads as explained under "Jump Starting with Auxiliary (Booster) Battery" in BATTERY (Sec. 6Y).

5. Disconnect battery leads while charging batteries. Do not use a fast charger as a booster for starting the engine. When attaching battery charger leads to battery, connect charger positive lead to battery positive terminal and connect charger negative lead to battery negative terminal.

6. Do not short across or ground any of the terminals in the charging circuit.

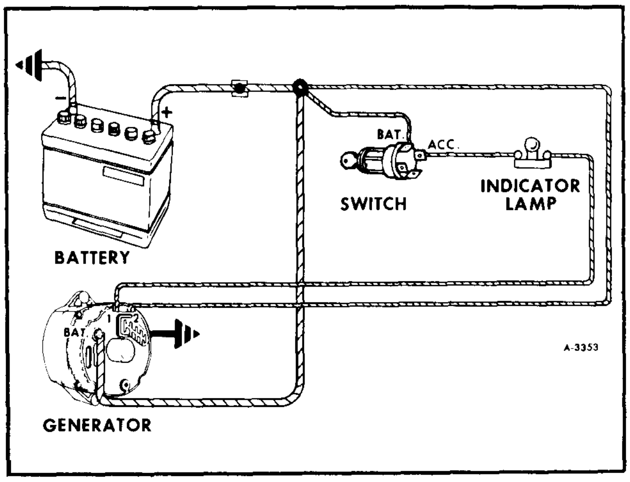


Figure 24—Typical Lead Connections

7. Do not attempt to polarize the generator.

8. When working near generator or regulator, disconnect battery cable to prevent accidental grounding at generator terminals.

9. Always disconnect battery negative cables when replacing electrical system components. This eliminates accidental shorting at generator terminals where battery voltage is available.

10. Disconnect battery negative cables before welding on vehicle, since a reverse current from the welder may damage generator diodes as well as other electrical components.

11. Never replace the special resistance wire in harness connected to the ignition switch unless it is of same material and of same length (approx. 60 inches long). Generating system will not function without this wire. Wire is identified in Engine and Chassis Wiring Diagram (Back of Manual).

NOT Close adherence to the Troubleshooting Procedures in order presented will lead to location and correction of charging system malfunctions in the shortest time possible. Only a portion of the procedures need to be performed in order to locate the trouble.

ON VEHICLE TESTS

FAULTY INDICATOR LAMP OPERATION

Check the indicator lamp for normal operation as shown below.

Switch	Lamp	Engine
OFF	OFF	STOPPED
ON	ON	STOPPED
ON	OFF	RUNNING

If the indicator lamp operates normally, proceed to "Undercharged Battery" or "Overcharged Battery" section. Otherwise, proceed to either one of the following three abnormal conditions.

1. **Switch Off, Lamp On**—In this case, disconnect the two leads from the generator No. 1 and No. 2 terminals. If the lamp stays on, there is a short between these two leads. If the lamp goes out, replace the rectifier bridge as covered in the "GENERATOR REPAIR" section. This condition will cause an undercharged battery.

2. **Switch On, Lamp Off, Engine Stopped**—This condition can be caused by the defects listed in Part 1 above, or by an open in the circuit. To determine where an open exists, proceed as follows:

a. Check for a blown fuse, a burned out bulb, defective bulb socket, or an open in No. 1 lead circuit between generator and ignition switch.

b. If no defects have been found, proceed to "Undercharged Battery" section.

3. **Switch On, Lamp On, Engine Running**—Check for a blown fuse (where used) between indicator lamp and switch. The other possible causes of this condition are covered in the "UNDERCHARGED BATTERY" section.

If a defect has been found and corrected at this point, no further checks need be made.

UNDERCHARGED BATTERY

This condition, as evidenced by slow cranking and low specific gravity readings, can be caused by one or more of the following conditions even though the indicator lamp may be operating normally.

1. Insure that the undercharged condition has not been caused by accessories having been left on for extended periods.

2. Check the drive belt for proper tension.

3. If a battery defect is suspected, check per applicable battery service and diagnosis given earlier in this section.

4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the generator and firewall, and the cable clamps and battery posts.

5. With ignition switch on and all wiring harness leads connected, connect a voltmeter from:

a. generator "BAT" terminal to ground

b. generator No. 1 terminal to ground

c. generator No. 2 terminal to ground

A zero reading indicates an open between voltmeter connection and battery. NOTE: An open No. 2 lead circuit on early production generators caused uncontrolled voltage, battery overcharge and possible damage to battery and accessories. Generators supplied for later applications have a built-in feature which avoids overcharge and accessory damage by preventing the generator from turning on if there is an **open** in the wiring harness connected to the No. 2 generator terminal. Opens in the wiring harness connected between the No. 2 generator terminal and battery may be between the terminals, at the crimp between the harness wire and terminal, or in the wire.

Generator on Vehicle Output Test

6. If previous Steps 1 through 5 check satisfactorily, check Delcotron generator as follows:

a. Disconnect battery ground cable.

b. Connect an ammeter in the circuit at the "BAT" terminal of the generator.

c. Reconnect battery ground cable.

d. Turn on radio, windshield wipers, lights high beam and blower motor high speed. Connect a carbon pile across the battery.

e. Operate engine at moderate speed as required, and adjust carbon pile as required, to obtain maximum current output.

f. If ampere output is within 10 amperes of rated output as stamped on generator frame, generator is not defective; recheck Steps 1 through 5.

g. If ampere output is not within 10 amperes of rated output, determine if test hole (figure 25) is accessible.

If accessible go to Step h. If not accessible go to Step l.

h. Ground the field winding by inserting a screwdriver into the test hole (figure 25). CAUTION: Tab is within 3/4 inch of casting surface. Do not force screwdriver deeper than one inch into end frame.

i. Operate engine at moderate speed as required, and adjust carbon pile as required to obtain maximum current output.

j. If output is within 10 amperes of rated output, check field winding as covered in "GENERATOR REPAIR" section, and test regulator with an approved regulator tester.

k. If output is not within 10 amperes of rated output, check the field winding, diode trio, rectifier bridge, and stator as covered in "GENERATOR REPAIR" section.

l. If test hole is not accessible, disassemble generator and make tests listed in "GENERATOR REPAIR" section.

OVERCHARGED BATTERY

1. To determine battery condition, check per applicable battery device and diagnosis given earlier in this section.

2. Connect a voltmeter from generator No. 2 terminal to ground. If reading is zero, No. 2 lead circuit is open.

3. If battery and No. 2 lead circuit check good, but an obvious overcharge condition exists as evidenced by excessive battery water usage, proceed as follows:

a. Separate and flames as covered in "Disassembly" section under heading of "GENERATOR REPAIR".

Check field winding for grounds and shorts. If defective replace rotor, and test regulator with an approved regulator tester.

b. Connect ohmmeter using lowest range scale from brush lead clip to end frame as shown in Step 1, Figure 26, then reverse lead connections.

c. If both readings are zero, either the brush lead clip is grounded or regulator may be defective.

d. A grounded brush lead clip can result from omission of insulating washer (figure 26), omission of insulating sleeve over screw, or damaged insulating sleeve. Remove screw to inspect sleeve. If satisfactory, test regulator with an approved regulator tester.

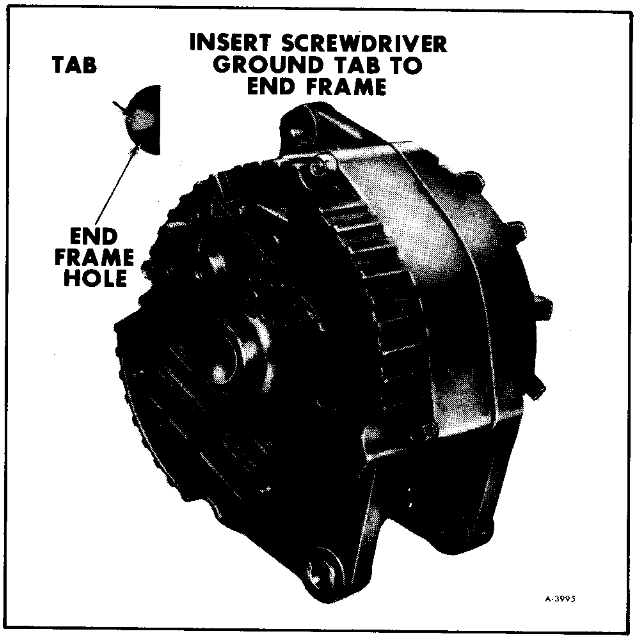


Figure 25—End View of Generator (Typical)

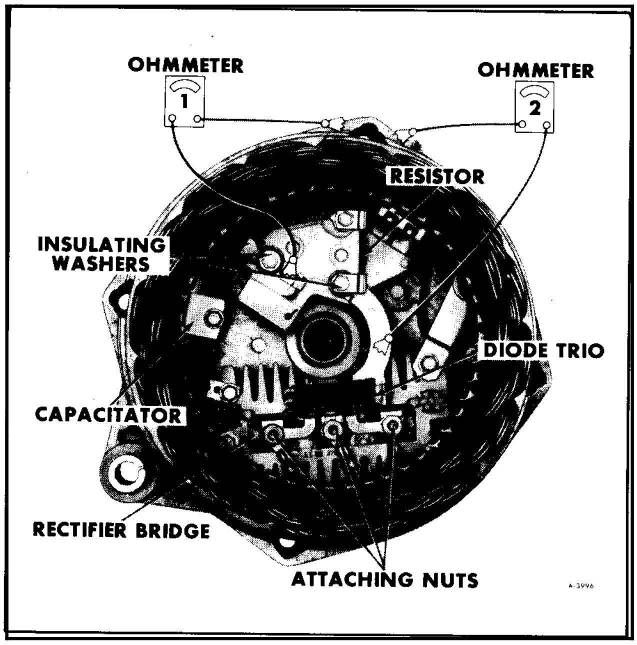


Figure 26—Slip Ring End Frame

Figure 27—SI Delcotron Tester Tool J-26290

SI CHARGING SYSTEM DIAGNOSTIC TESTER J-26290

NOTE: For use on 120 volt negative ground vehicles only. Perform test with lights and all accessories off. After diagnosis has been made and the problem corrected, use GO/No-Go Test Light Indicator J-26290 again to verify proper operation of charging system.

With the engine stopped, detach field and sensing leads connector from the SI Delcotron and plug into tester. Next plug the tester leads into the SI Delcotron and attach tester ground clip to ground, as shown in Figure 27.

Engine Off

1. If tester light flashes, go to engine fast idle.

2. If tester light remains on, the tester itself is faulty.

3. If the tester light remains off, pull tester connector plug from Delcotron.

a. If tester light flashes, replace rectifier bridge.

b. If tester light remains off, faulty tester or no voltage to tester (broken or faulty connection).

Engine at Fast Idle (1000 RPM or More)

4. If tester light remains off Delcotron system is ok.

5. If tester light remains on, remove and check the Delcotron.

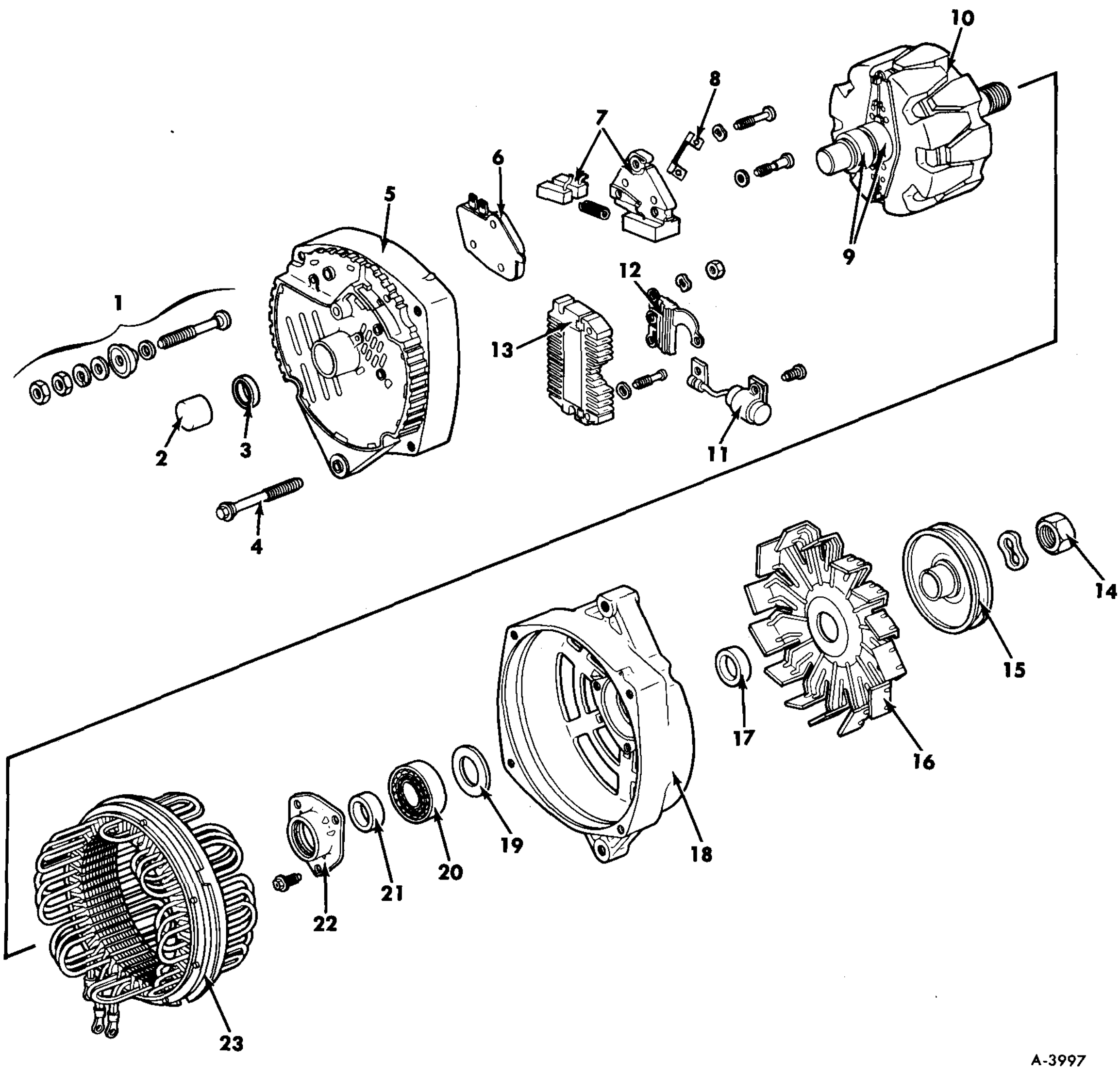
6. If the tester light flashes, remove Delcotron and check regulator, rotor field coil, brushes, and slip rings.

GENERATOR REMOVAL

NOTE: Due to variations in design and equipment, the replacement procedures will vary accordingly. The removal and installation instructions following are intended only as a guide. Additional operations will be required on some vehicles to remove other equipment to permit access to generator, belts, and/or brackets.

1. Disconnect negative cables from batteries.

2. Depress lock on connector and pull connector out of socket on generator. Pull rubber boot off "BAT" terminal and remove terminal nut. Disconnect ground (GRD) terminal and remove wiring clip.



1 Battery Terminal	9 Slip Rings	17 Drive Shaft Collar (Outside)
2 Bearing-Roller, Slip Ring End	10 Rotor	18 Frame-Drive End
3 Seal	11 Capacitor	19 Washer-Grease Slinger
4 Bolt-Thru	12 Diode (Trio)	20 Bearing-Drive End
5 Frame-Slip Ring End	13 Bridge-Rectifier	21 Drive Shaft Collar (Inside)
6 Regulator	14 Drive Shaft Nut	22 Retainer Plate
7 Brush Holder	15 Pulley	23 Stator
8 Resistor	16 Fan	

Figure 28—Delcotron Generator Exploded View

3. Loosen bolt in adjusting arm and mounting bracket. Move generator to loosen drive belt (or belts); remove belt(s) from generator pulley.

4. Remove the bolt attaching the generator to mounting bracket, remove adjusting arm bolt, then remove generator from engine.

GENERATOR REPAIR

To repair the generator, observe the following procedure:

DISASSEMBLY (FIGURE 28)

To disassemble the generator, take out the four thru-bolts, and separate the drive end frame and rotor assembly from the stator assembly by prying apart with a screwdriver at the stator slot. A scribe mark will help locate the parts in the same position during assembly. After disassembly, place a piece of tape over the slip ring end frame bearing to prevent entry of dirt and other foreign material, and also place a piece of tape over the shaft on the slip ring end. If brushes are to be reused, clean with a soft dry cloth.

CAUTION: *Use pressure sensitive tape and not friction tape which would leave a gummy deposit on the shaft.*

To remove the drive end frame from the rotor, place the rotor in a vise and tighten only enough to permit removal of the shaft nut. CAUTION: Avoid excessive tightening as this may cause distortion of the rotor. Remove the shaft nut, washer, pulley, fan, and the collar, and then separate the drive end frame from the rotor shaft.

ROTOR FIELD WINDING CHECKS

To check for opens, connect the test lamp or ohmmeter to each slip ring. If the lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open (figure 28). Connect test lamp or ohmmeter from one slip ring to shaft. If lamp lights, or reading is low, the rotor winding is grounded.

The winding is checked for short circuits or excessive resistance by connecting a battery and ammeter in series with the edges of the two slip rings. Note the ammeter reading and refer to Generator Specifications. An ammeter reading above the specified value indicates shorted windings; a reading below the specified value indicates excessive resistance. An alternate method is to check the resistance of the field by connecting an ohmmeter to the two slip rings (figure 28). If the resistance reading is below the specified value, the winding is shorted; if above the specified value the winding has excessive resistance.

The specified resistance value can be determined by dividing the voltage by the current given in Generator Specifications. Remember that the winding resistance and ammeter readings will vary slightly with winding temperature changes. If the rotor is not defective, but the generator fails to supply rated output, the defect is in the diode trio, rectifier bridge or stator.

DIODE TRIO CHECK

The diode trio is identified in Figure 26. First, connect an ohmmeter using lowest range scale from diode trio long connector to end frame as shown in Step 2, Figure 26, then reverse lead connections. If both readings are the same, check for grounded brush lead clip caused by omission of insulating washer (figure 26), omission of insulating sleeve over screw, or damaged insulating sleeve. Remove screw to inspect sleeve. **If screw assembly is correct, and both ohmmeter readings are the same, replace regulator.**

To check the diode trio, remove it from the end frame assembly by detaching the three nuts, the attaching screw, and removing the stator assembly. Note that the insulating washer on the screw is assembled over the top of the diode trio connector. Connect an ohmmeter having a 1-1/2 volt cell, and using the lowest range scale, to the single connector and to one of the three connectors (figure 29). Observe the reading. Then reverse the ohmmeter leads to the same two connectors. If both readings are the same, replace the diode trio. A good diode trio will give one high and one low reading. Repeat this same

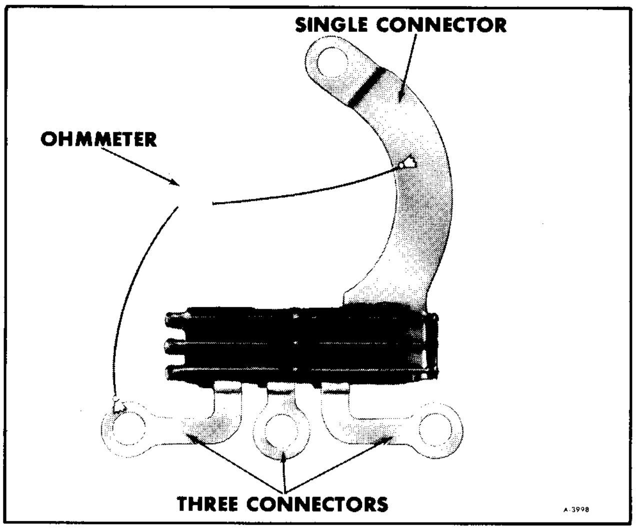


Figure 29—Diode Trio Check

test between the single connector and each of the other two connectors. Also, connect the ohmmeter to each pair of the three connectors (not illustrated). If any reading is zero, replace the diode trio.

RECTIFIER BRIDGE CHECK

Note that the rectifier bridge has a grounded heat sink and an insulated heat sink connected to the output terminal.

To check the rectifier bridge, connect the ohmmeter to the grounded heat sink and one of the three terminals, (figure 30). Connect to flat metal connector, and not onto threaded stud. Then reverse the lead connections to the grounded heat sink and same terminal. If both readings are the same, replace the rectifier bridge. A good rectifier bridge will give one high and one low reading. Repeat this same test between the grounded heat sink and the other two terminals, and between the insulated heat sink and each of the three terminals. This makes a total of six checks, with two readings taken for each check.

The ohmmeter check of the rectifier bridge, and of the diode trio as previously covered, is a valid and accurate check. **Do not** replace either unit unless at least one pair of readings is the same.

CAUTION: *Do not use high voltage to check these units such as a 110 volt test lamp.*

To replace the rectifier bridge, remove the attaching screws, and disconnect the capacitor lead. Rectifier bridges may vary in appearance but are completely interchangeable in these generators.

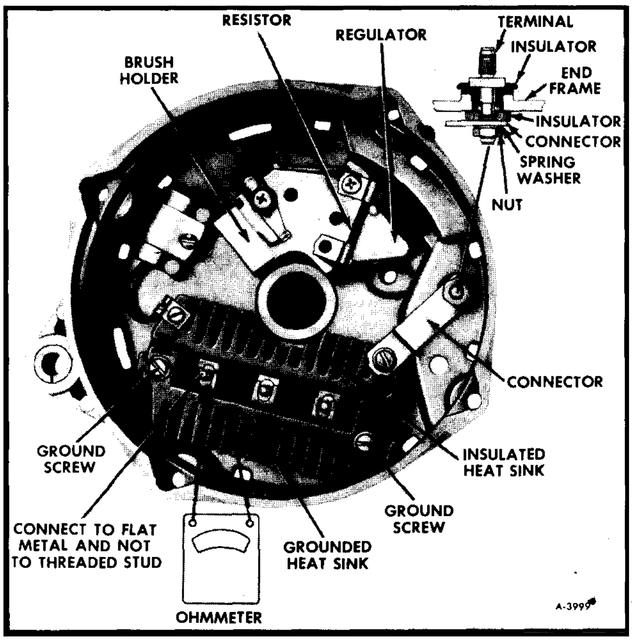


Figure 30—Rectifier Bridge Check

STATOR CHECKS

The stator windings may be checked with a 110-volt test lamp or an ohmmeter. If the lamp lights, or if the meter reading is low when connected from any stator lead to the frame, the windings are grounded.

NOTE: Delta windings on 80-amp. generator cannot be checked for opens.

A short circuit in the stator windings is difficult to locate without laboratory test equipment due to the low resistance of the windings. However, if all other electrical checks are normal and the generator fails to supply rated output, shorted stator windings or an open delta winding on 80-amp. generator is indicated. Also, a shorted stator can cause the indicator lamp to be on with the engine at low speed.

BRUSH HOLDER AND REGULATOR REPLACEMENT

After removing the three attaching nuts, the stator, and diode trio screw (figure 30) the brush holder and regulator may be replaced by removing the two remaining screws. Note the two insulators located over the top of the brush clips in Figure 26, and that these two screws have special insulating sleeves over the screw body above the threads. The third mounting screw may or may not have an insulating sleeve. If not, this screw must not be interchanged with either one of the other two screws, as a ground may result, causing no output or uncontrolled generator output. Regulators may vary in appearance but are completely interchangeable in these generators.

SLIP RING SERVICING

If the slip rings are dirty, they may be cleaned and finished with 400 grain or finer polishing cloth. Spin the rotor, and hold the polishing cloth against the slip rings until they are clean.

CAUTION: *The rotor must be rotated in order that the slip rings will be cleaned evenly. Cleaning the slip rings by hand without spinning the rotor may result in flat spots on the slip rings, causing brush noise.*

Slip rings which are rough or out of round should be trued in a lathe to .002 inch maximum indicator reading. Remove only enough material to make the rings smooth and round. Finish with 400 grain or finer polishing cloth and blow away all dust.

BEARING REPLACEMENT AND LUBRICATION

The bearing in the drive end frame can be removed by detaching the retainer plate screws, and then pressing the bearing from the end frame. If the bearing is in satisfactory condition, it may be reused, and it should be filled one-quarter full with Delco-Remy Lubricant No. 1948791 or before reassembly.

CAUTION: *Do not overfill, as they may cause the bearing to overheat.*

To install a new bearing, press in with a tube or collar that just fits over the outer race, with the bearing and slinger assembled into the end frame. It is recommended that a new retainer plate be installed if the felt seal in the retainer plate is hardened or excessively worn. Fill the cavity between the retainer plate and bearing with 1948791 lubricant.

The bearing in the slip ring end frame should be replaced if its grease supply is exhausted. No attempt should be made to re-lubricate and reuse the bearing. To remove the bearing from the slip ring end frame, press out with a tube or collar that just fits inside the end frame housing. Press from the outside of the housing towards the inside.

To install a new bearing, place a flat plate over the bearing and press in from the outside towards the inside of the frame until the bearing is flush with the outside of the end frame. Support the inside of the frame with a hollow cylinder to prevent breakage of the end frame. Use extreme care to avoid misalignment or otherwise placing undue stress on the bearing.

If the seal is separate from the bearing, it is recommended that a new seal be installed whenever the bearing is replaced. Press the seal in with the lip of the seal toward the rotor when assembled, that is, away from the bearing. Lightly coat the seal lip with oil to facilitate assembly of the shaft into the bearing.

GENERATOR BENCH OUTPUT TEST

To check the generator in a test stand, proceed as follows:

1. Make connections as shown in Figure 31, except leave the carbon pile disconnected. IMPORTANT—Ground polarity of battery and generator must be the same. Use a fully charged battery, and a 10 ohm resistor rated at six watts or more between the generator No. 1 terminal and the battery.

2. Slowly increase the generator speed and observe the voltage.

3. If the voltage is uncontrolled with speed and increases above 15.5 volts on a 12-volt system, check for a grounded brush lead clip as covered under heading of "OVERCHARGED BATTERY" Step 3. If not grounded, test regulator with an approved regulator tester, and check field winding. NOTE: The battery **must** be fully charged when making this check.

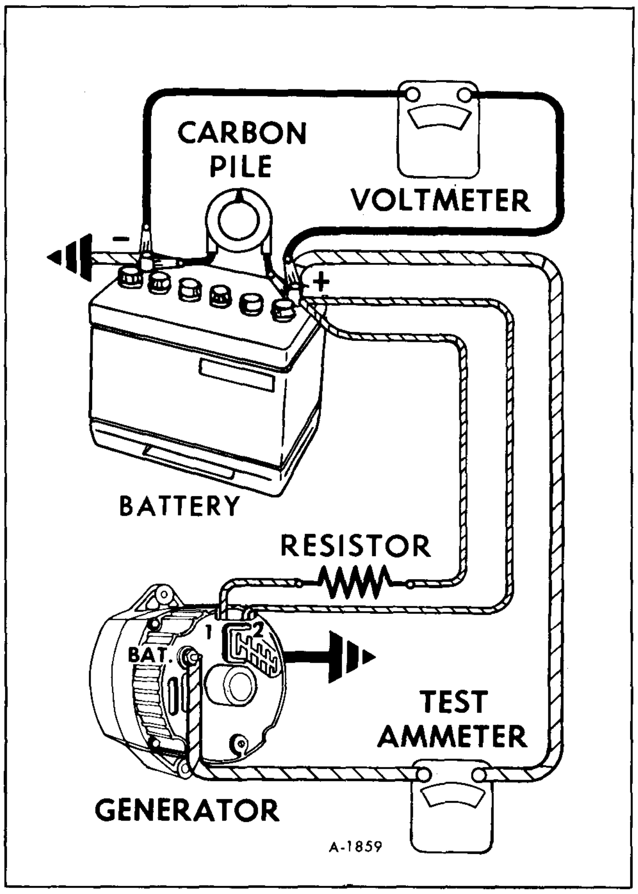


Figure 31—Connections for Testing Generator Output

4. If voltage is below 15.5 bolts on a 12-volt system, connect the carbon pile as shown.

5. Operate the generator at moderate speed as required and adjust the carbon pile as required to obtain maximum current output.

6. If output is within 10 amperes of rated output as stamped on generator frame, generator is good.

7. If output is not within 10 amperes of rated output, keep battery loaded with carbon pile, and ground generator field (figure 25).

8. Operate generator at moderate speed and adjust carbon pile as required to obtain maximum output.

9. If output is within 10 amperes of rated output, test regulator with an approved regulator tester, and check field winding.

10. If output is not within 10 amperes of rated output, check the field winding, diode trio, rectifier bridge, and stator as previously covered.

ASSEMBLY

Assembly is the reverse of disassembly.

Remember when assembling the pulley to secure the rotor in a vise only tight enough to permit tightening the shaft nut to 40-60 lb. ft. If excessive pressure is applied against the rotor, the assembly may become distorted. To install the slip ring end frame assembly to the rotor and drive end frame assembly, remove the tape over the bearing and shaft, and make sure the shaft is perfectly clean after removing the tape. Insert a pin through the holes to hold up the brushes. Carefully install the shaft into the slip ring end frame assembly to avoid damage to the seal. After tightening the thru-bolts remove the brush retaining pin to allow the brushes to fall down onto the slip rings.

GENERATOR INSTALLATION

1. Attach generator to mounting bracket and install adjusting arm. Tighten flange-type lock nuts securely.

2. Place drive belt(s) over generator drive pulley and adjust belt tension. Tighten mounting bolts and adjusting arm bolt when belt tension adjustment has been made. Refer to "Generator Drive Belt Tension Adjustment" later in this section.

3. Push the wiring harness connector into the socket making sure the lock on the connector engages the end frame. Place harness clip on ground terminal marked "GRD" and connect the ground wire to terminal.

4. Attach red wire to "BAT" terminal on generator and fit boot on terminal.

5. Perform "Generator Output Test" described earlier in this section to determine if generator is operating properly.

GENERATOR DRIVE BELT

TENSION ADJUSTMENT

Because of the higher inertia and load capacity of rotor used with A.C. generators, PROPER BELT TENSION MUST BE MAINTAINED.

All generators are pivot-base mounted with the belt tension adjustment arm at the top or bottom using belt tension Tool BT-33-73F (Burroughs Tool) or other suitable tool to check tension on each individual belt. If tension is not within 70-80 lbs. (used belts) or 110-140 lbs. (new belts), loosen adjustment arm clamp bolt and move generator to obtain recommended tension.

CAUTION: *When adjusting belt tension, apply pressure at center of generator, never against either end frame.*

NOTE: On a new vehicle, or after having installed new belts, check tension of belt(s) twice in first 200 miles of operation. When making adjustment, examine belt(s) and replace if necessary.

A loose or broken drive belt will affect operation of generator. A drive belt that is too tight will place too much strain on bearings.

GENERATING SYSTEM MAINTENANCE

Most charging system troubles show up as an undercharged or overcharged battery. Since the battery itself may be defective, it should be checked first to determine its condition. In the case of undercharged battery, check for battery drain caused by ground or by accessories being left on.

At regular intervals, inspect generating system to locate and correct potential causes of trouble before generating system performance is affected.

1. Check generator drive belt tension and adjust if necessary. See procedure earlier under "Generator Drive Belt Tension Adjustment."

2. Check generator mounting and adjusting arm bolts and tighten as necessary.

3. Check all electrical connections for tightness and corrosion. Clean and tighten connections as necessary. Be sure wiring insulation is in good condition, and that all wiring is securely clipped to prevent chafing the insulation.

4. With engine running, listen for noise and check generator for vibration. If generator is noisy or vibrates excessively, it should be removed for inspection and repair.

5. Check battery electrolyte level and specific gravity. Replenish electrolyte level, as necessary.

GENERATOR SPECIFICATIONS

Generator Model	(80 Amp.) 1101016	(80 Amp.) 1101015
Make	Delco-Remy	Delco-Remy
Series	27 SI	27 SI
Type	100	100
Rotation (Viewing Drive End)	Clockwise	Clockwise
Field Current at 80°F. (26.7°C.)		
Amps.	4.4-4.9	4.4-4.9
Volts	12	12
Cold Output		
Specified Volts	(a)	(a)
Amps.	76	76
Generator RPM (Approx.)	5000	5000
Rated Hot Output (Amps.) (b)	80	80

(a) Voltmeter not needed for cold output check. Load battery with a carbon pile to obtain maximum output.

(b) Rated hot output at maximum operating speed.

BREAKER POINT IGNITION SYSTEM

IMPORTANT: Identify ignition system before servicing. 1975 vehicles with 1974 certified engines are equipped with standard breaker point ignition system. 1975 and 1976 certified engines are equipped with high energy ignition systems. To determine year engine was certified, refer to decal on engine valve cover.

GENERAL DESCRIPTION

The ignition system used on the 1974 certified engine is the standard breaker point type consisting of a coil, condenser, distributor, switch, wiring, spark plugs and a source of electrical energy. The distributor contact points set, condenser, cam lubricator and spark plugs are the only system components that require periodic service. The remainder of the ignition system requires only periodic inspection to check the operation of the components, tightness of electrical connections, and condition of the wiring.

The distributor used is an external adjustment type and its function is to (1) cause a higher voltage surge from coil, (2) time these surges with regard to engine requirements through use of centrifugal and vacuum advance mechanisms, and (3) direct high voltage surges through distributor rotor, cap, and high tension wiring to the spark plugs.

The distributor houses the contact points that make and break the primary circuit, and also directs high voltage and current in proper sequence to the spark plugs. The contact point set is replaced as a complete assembly. The breaker lever spring tension and point alignment on the replacement set are factory adjusted, leaving only the dwell angle to be adjusted after installation.

The rotor located above the breaker plate assembly serves as a cover for the centrifugal advance mechanism, and distributes high voltage and current to fire the spark plugs. When the rotor is removed, the centrifugal advance mechanism should be inspected for lubricant. If necessary, a small amount of cam and bearing lubricant should be applied to the advance weights.

The ignition coil is an oil filled, hermetically sealed unit designed specifically for use with an external resistance. The number of turns in the primary winding results in a high inductance in this winding, which makes it possible for the coil to provide a higher secondary voltage output throughout the speed range. The primary current from the ignition switch passes through a resistance wire which lowers the voltage to approximately 8 volts. This lower voltage provides for longer contact life.

For optimum starting performance, the resistance is bypassed during cranking, thereby connecting the ignition coil directly to the battery. This provides full battery voltage at the coil and keeps ignition voltage as high as possible during cranking. The resistance is bypassed automatically through the ignition and starting switch when the switch is in the "Start" position.

The secondary ignition cables in the secondary or high tension system (coil to distributor and distributor to plugs) are resistant to grease, battery acid and road salt, and offers resistance to corona breakdown. Ignition cables have a multiple cloth thread core impregnated with a graphite solution to give the correct conductivity.

The spark plugs used are a resistor type plug. The plugs have a type number on the insulator which designates thread size as well as relative position of the plug in the heat range. The last digit of the type number indicates the heat range position of the plug. The higher the number the hotter the plug. Spark plugs should be replaced at least every 12 months or 12,000 miles depending on driving conditions with unleaded fuels or at 6 months or 6,000 miles with leaded fuels.

THEORY OF OPERATION

The basic ignition system consists of the ignition coil, condenser, ignition distributor, ignition switch, low and high tension wiring, spark plugs, and a source of electrical energy (battery or generator). The ignition system has the function of producing high voltage surges and directing them to the spark plugs in the engine cylinders. The sparks must be timed to appear at the plugs at the correct instant near the end of the compression stroke with relation to piston position. The spark ignites the fuel-air mixture under compression so that the power stroke follows in the engine.

There are two separate circuits through the ignition system. One of these is the primary circuit which includes the ignition switch, primary winding of the ignition coil, distributor contact points and condenser. The other is the secondary or high tension circuit which includes the secondary winding of the ignition coil, the high tension lead, distributor cap, rotor and spark plugs.

The basic operation is described as follows: With the switch closed, current flows through the primary circuit, that is from the battery through the primary winding of the ignition coil and closed distributor contacts to ground, and then back to the battery. A cam mounted on the rotating distributor shaft causes the distributor contacts to open and close. When the contacts open, the current decreases very rapidly in the ignition coil primary winding, and a high voltage is induced in the coil secondary winding.

This high voltage is impressed through the distributor cap and rotor across one of the spark plugs. As the voltage establishes an arc across the spark plug electrodes, the air-fuel mixture in the cylinder is ignited to provide the power stroke.

The secondary electrons flow from the coil secondary winding, across the distributor rotor gap and spark plug gap, and then back to the secondary winding through ground, the battery and switch. The distributor contacts then reclose, and the cycle repeats. The next-firing spark plug then will be the one connected to the distributor cap insert that is aligned with the rotor when the contacts separate. With the engine running, current flows through the coil primary calibrated resistance wire; the other lead connected between the coil and solenoid terminal is a by-pass feature that will be covered in the section entitled "Ignition Coils".

When the contacts separate, a high voltage is induced in the coil primary winding. This voltage may be as high as 250 volts, which causes an arc to form across the distributor contacts. To bring the primary current to a quick controlled stop, and in order to greatly reduce the size of the arc and thereby insure prolonged contact point life, a capacitor (condenser) is connected across the distributor contacts.

DISTRIBUTOR

The distributor has three jobs. First, it opens and closes the low tension circuit between the source of electrical energy and the ignition coil so that the primary winding is supplied with intermittent surges of current. Each surge of current builds up a magnetic field in the coil. The distributor then opens its circuit so that the magnetic field will collapse and cause the coil to produce a high voltage surge. The second job that the distributor has is to time these surges with regard to the engine requirements. This is accomplished by the centrifugal and vacuum advance mechanisms. Third, the distributor directs the high voltage surge through the distributor rotor, cap and high tension wiring to spark plug which is ready to fire.

The typical contact point type ignition distributor consists of a housing, shaft, centrifugal advance assembly, vacuum advance assembly, breaker plate assembly, capacitor or condenser, and rotor.

The cap, rotor, and high voltage leads in a distributor form a distribution system that conveys the high voltage surges to the spark plugs in correct sequence.

The breaker plate contains the breaker lever, contact support, and capacitor. When the breaker cam rotates, each cam lobe passes by and contacts the breaker lever rubbing block, separating the contact points and producing a high voltage surge in the ignition system. With every breaker cam revolution, one spark will be produced for each engine cylinder. Since each cylinder fires every other revolution in a four-cycle engine, the distributor rotates at one-half engine speed.

The shaft and weight base assembly is fitted in suitable bearings made of such materials as cast iron, bronze, or iron. Centrifugal advance weights are pivoted on studs in the weight base, and are free to move against calibrated weight springs which connect them to the breaker cam assembly. The breaker cam assembly fits on the top of the shaft (slip fit) and rotates with the shaft, being driven by the weight springs actuated by the advance weights.

Outward movement of the weights advances the cam assembly in relation to the shaft as engine speed is increased, providing an earlier spark.

It is possible to improve fuel economy on engines operating under part-throttle conditions by supplying additional spark advance. Vacuum advance mechanisms are provided on distriubtors for this purpose. The mechanism used rotates the breaker plate in order to time the spark earlier when the engine is operating at part throttle.

Centrifugal Advance

The centrifugal advance mechanism times the high voltage surge produced by the ignition coil so that it is delivered to the engine at the correct instant, as determined by engine speed.

When the engine is idling, the spark is timed to occur in the cylinder just before the piston reaches top dead center. At higher engine speeds, however, there is a shorter interval of time available for the fuel-air mixture to ignite, burn, and give up its power to the piston. Consequently, in order to obtain the maximum amount of power from the mixture, it is necessary at higher engine speeds for the ignition system to deliver the high voltage surge to the cylinder earlier in the cycle.

To illustrate this principle, assume that the burning time of a given gas mixture in an automotive engine is .003 of a second. To obtain full power from combustion, maximum pressure must be reached while the piston is between 10 degrees and 20 degrees past top dead center. At 1,000 engine rpm, the crankshaft travels through 18 degrees in .003 of a second, at 2,000 rpm, the crankshaft travels through 36 degrees. Since maximum pressure point is fixed, it is easy to see why the spark must be delivered into the cylinder earlier in the cycle in order to deliver full power, as engine speed increases.

As previously mentioned, the timing of the spark to engine speed is accomplished by the centrifugal advance mechanism, which is assembled on the distributor shaft. The mechanism, consists primarily of two weights and a cam assembly. The weights throw out against spring tension as engine speed increases. This motion of the weights turns the cam assembly so that the breaker cam is rotated in the direction of shaft rotation to advanced position with respect to the distributor drive shaft. The higher the engine speed, the more the weights throw out and the further the breaker cam is advanced.

The centrifugal advance required varies considerably between various engine models. In order to determine the advance for a given engine, the engine is operated on a dynamometer at various speeds with a wide-open throttle. Spark advance is varied at each speed until the range of advance that gives maximum power is found. The cam assembly, weights and springs are then selected to give this advance. Timing, consequently, varies from no advance at idle to full advance at high engine speed where the weights reach the outer limits of their travel.

Vacuum Advance

Under part-throttle operation a high vacuum develops in the intake manifold and a smaller amount of air and gasoline enters the cylinder. Under these conditions, additional spark advance (over and above advance provided by the centrifugal advance mechanism) will increase fuel economy. In order to realize maximum power, ignition must take place still earlier in the cycle.

To provide a spark advance based on intake manifold vacuum conditions, many distributors are equipped with a vacuum advance mechanism. The mechanism has a spring-loaded diaphragm connected by linkage to the distributor. The spring-loaded side of the diaphragm is air-tight, and is connected in many cases by a vacuum passage to an opening in the carburetor. This opening is on the atmospheric side of the throttle when the throttle is in the idling position. In this position, there is no vacuum in the passage.

When the throttle is partly opened, it swings past the opening of the vacuum passage. Intake manifold vacuum then can draw air from the air-tight chamber in the vacuum advance mechanism and this causes the diaphragm to be moved against the spring. This motion is transmitted by linkage to the distributor breaker assembly rotation is governed by the amount of vacuum in the intake manifold up to the limit imposed by the design of the vacuum advance mechanism.

When the distributor breaker plate assembly is rotated, the contact points are carried around the breaker cam to an advanced position, so that the breaker cam contacts the rubbing block and closes and opens the points earlier in the cycle. This provides a spark advance based on the amount of vacuum in the intake manifold. Thus, for varying compressions in the cylinder the spark advance will vary, permitting greater economy of engine operation. It should be recognized that the additional advance provided by vacuum control is effective in providing additional economy only on PART-THROTTLE operation.

At any particular engine speed there will be a certain definite advance resulting from operation of the centrifugal advance mechanism, plus a possible additional advance resulting from operation of the vacuum advance mechanism. For example, an initial timing advance of 5 degrees, plus a centrifugal advance of 10 degrees, makes a total of 15 degrees advance at 40 miles an hour. If the throttle is only partly opened, an additional vacuum advance of up to 15 degrees more may be obtained, making a total of 30 degrees. When the throttle is wide open there is no appreciable vacuum in the intake manifold, so this additional advance will not be obtained. All advance then is based on engine speed alone and is supplied by the centrifugal advance mechanism.

The vacuum advance mechanism is an economy device which will increase fuel economy when properly used. The driver who drives with wide-open throttle whether in low or high gear will not obtain this additional advance with its resulting increased fuel economy.

Cam Angle

The cam angle, often referred to as contact angle or dwell angle, is the number of degrees of cam rotation during which the distributor contact points remain closed. It is during this period of cam rotation that the current in the primary winding increases. Although the cam angle may not change, the length of time the contacts remain closed becomes less and less as the engine speed increases. At higher engine speeds, the ignition coil primary current does not reach its maximum value in the short length of time the contacts are closed. In order to store the maximum amount of energy obtainable on the coil, and consequently obtain sufficient energy to fire the plug, it is necessary to design a breaker lever assembly that will operate properly at high speeds. The distributor is equipped with a special-high rate-of-break cam and a special high speed breaker lever which is capable of following the cam shape at high speeds without bouncing. The high rate-of-break cam separates the contact points faster for each degree of rotation and permits closing earlier, thus increasing cam angle. With the special cam and breaker lever combination, it is possible to obtain the maximum cam angle and consequently optimum ignition performance at high speeds.

The point opening is the maximum distance that occurs between the separated contacts as the cam rotates. If the cam angle is properly set, the point opening most likely will also be according to specifications. In some cases, it may be necessary to measure point opening in addition to cam angle to insure that the contacts are properly set. A feeler gauge on new contacts, or a dial indicator on used contacts may be used to measure point opening.

Ignition Condenser (Capacitor)

The capacitor consists of a roll of two layers of thin metal foil separated by a thin sheet or sheets of insulating material. This assembly is sealed in a metal can with a flat spring washer providing a tight seal.

The high voltage induced in the coil primary causes the capacitor plates to charge when the contacts first separate; the capacitor acts initially like a short circuit and current flows into the capacitor to minimize arching at the contacts.

IGNITION COIL

An ignition coil is a pulse transformer that steps up the low voltage from the battery or generator to a voltage high enough to ionize the spark plug gap and ignite the air-fuel mixture in the cylinder. A typical coil is made up of a primary winding, consisting of a few hundred turns of relatively large wire, and a secondary winding, consisting of many thousand turns of a very small wire. These windings are assembled over a soft iron core and are enclosed by a soft iron shell. This assembly is inserted into a one-piece, steel or diecast aluminum coil case, which is filled with oil and hermetically sealed by a coil cap made of molded insulating material. The cap contains the primary and secondary high voltage terminals.

The ignition coils are hermetically sealed to prevent the entrance of moisture, which would cause coil failure. During manufacture, the coil case also is filled with oil at a high temperature. As the oil temperature decreases to more nearly match the temperature of the surrounding air, the oil contracts to occupy less volume thus allowing room for expansion when the coil heats up during normal operation. The oil acts as an insulator to prevent high voltage arc-over within the coil.

In the design of an ignition system, sufficient primary circuit resistance must be present to protect the distribution contacts from excessive arcing and burning. In some ignition systems, part of this resistance may take the form of a separate resistor or a calibrated resistance wire connected between the ignition switch and the coil primary terminal. Since the value of this resistor along with the resistances of the other components in the entire primary circuit affects the coil performance at higher engine speeds.

During cranking, the external resistance on most applications is by-passed to provide full battery voltage to the coil for improved performance and easier starting. The by-pass wire may be connected to an "R" terminal on the cranking motor solenoid which contacts the contact disk during cranking, or to a separate terminal on the ignition switch, as shown in the previous section. The higher currents during cranking are not sufficient to cause distributor contact deterioration because of the short periods of time in the life of contacts spent during cranking. Also, the lowered battery voltage during cranking causes a lower primary current, so the resistor by-pass feature is an offsetting factor. By-passing the resistor with the engine operating will cause very rapid failure of the distributor contacts.

SPARK PLUGS

The spark plug consists of a metal shell in which is fastened a porcelain insulator and an electrode extending through the center of the insulator. The metal shell has a short electrode attached to one side and bent in toward the center electrode. There are threads on the metal shell that allow it to be screwed into a tapped hole in the cylinder head. The two electrodes are of special heavy wire, and there is a specified gap between them. The electric spark jumps this gap to ignite the air-fuel mixture in the combustion chamber, passing from the center, or insulated, electrode. The seals between the metal base, porcelain, and center electrode as well as the porcelain itself, must be able to withstand the high pressure and temperature created in the combustion chamber during the power stroke.

Some spark plugs have been supplied with a built-in resistor which forms part of the center electrode. The purpose of this resistor is to reduce radio and television interference from the ignition system as well as to reduce spark-plug-electrode erosion caused by excessively long sparking. We have been talking of the high-voltage surge from the ignition-coil secondary as though it were a single powerful surge that almost instantly caused the spark to jump across the spark plug gap. Acutally, the action is more complex than that. There may be a whole series of preliminary surges before a full-fledged spark forms. At the end of the sparking cycle the spark may be quenched and may reform several times. All this takes place in only a few ten-thousandths of a second. The effect is that the ignition wiring acts like a radio transmitting antenna; the surges of high voltage send out impulses that causes radio and television interference. However, the resistors in the spark plugs tend to concentrate the surges in each sparking cycle, reduce their number, and thus reduce the interference and also the erosive effect on the plug electrodes.

Heat Range System

The "heat range" of a spark plug is determined primarily by the length of the lower insulator. The longer this is, the hotter the plug will operate; the shorter it is, the cooler the plug will operate.

Spark plugs, to give good performance in a particular engine, must operate within a certain temperature range (neither too hot or too cool). If the spark plug remains too cool: oil, soot, and carbon compounds will deposit on the insulator causing fouling and missing. If the plug runs too hot, electrodes will wear rapidly, and under extreme conditions, premature ignition (pre-ignition) of the fuel mixture may result.

Frequently, the wrong type of spark plugs, one with an improper heat range for the engine, may have been installed when replacing spark plugs originally fitted by the engine manufacturer and such misapplication may lead to poor performance. The heat range system makes it possible to select the type of spark plug that will operate within the correct temperature range for each specific engine.

Where abnormal operating conditions cause chronic carbon or oil fouling of the plugs, the use of a type one number higher (a "hotter" type) than recommended will generally remedy the trouble; and by the same formula, where chronic pre-ignition or rapid electrode wear is experienced, a type with one number lower (a "cooler" type) will generally be found satisfactory.

The last digit of the type number indicates the heat range position of the plug in the heat range system. Read the numbers as you would a thermometer—the higher the last digit, the "hotter" the spark plug will operate in the engine; the lower the last digit, the "cooler" the spark plug will operate.

Spark Plug Reach and Threads

Spark plugs are manufactured in a number of thread sizes and "reaches." Reach is the distance from the gasket seat to the end of the shell. Spark Plugs have a type number on the insulator which designates plug thread size as well as the relative position in the heat range system as previously explained.

SECONDARY IGNITION CABLES (FIGURE 32)

The secondary wiring consists of the high tension cables connected between the distributor cap, the spark plugs, and the high tension terminal of the ignition coil. These cables carry the high voltage surges to the spark plugs and are heavily insulated to contain the high voltages. The cables are neoprene jacketed and have a multiple cloth thread core impregnated with a graphite solution to give the correct conductivity and proper resistance for suppression of radio and television interference.

IGNITION SWITCH

The electrical switching portion of the assembly is separate from the key and lock cylinder. However, both are synchronized and work in conjunction with each other through the action of the actuator rod assembly. For a complete explanation of the key and lock cylinder, and the actuator rod assembly, refer to the Steering section of this manual.

The ignition switch is key operated through the actuator rod assembly to close the ignition primary circuit and to energize the starting motor solenoid for cranking. The ignition switch has five positions: OFF, LOCK, ACCESSORY, RUN and START. OFF is the center position of the key-lock cylinder, and LOCK is the next position to the left. ACCESSORY is located one more detent to the left of LOCK. Turning the key to the right of the OFF position until spring pressure is felt will put the ignition switch in the RUN position, and when turned fully to the right against spring pressure, the switch will be in the START position.

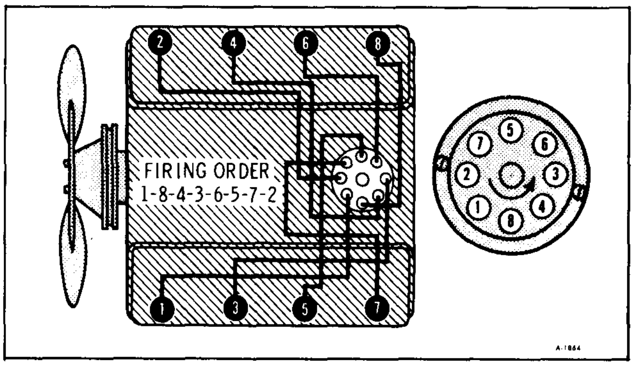


Figure 32—Secondary Wiring

In the RUN position, the ignition primary circuit is activated through a resistance wire. The ignition resistor wire is used in the ignition running circuit to reduce the voltage to the ignition coil. The resistor wire is bypassed when the engine is being started. The purpose of this is to compensate for the drop in voltage which occurs as the result of the heavy drain on the battery during starting, and to provide a hotter spark for starting.

All ignition switches have five terminals which are connected in different combinations for each of the three operating positions. A brass plate, inside the switch, has three contacts which connect these terminals, shows the positions of the contacts in all positions as viewed from the key side of the switch. There is also a ground pin in the switch which contacts the "ground" terminal when the ignition switch is in the START position. This pin contacts the IGN. terminal when in the OFF position.

Ignition Start and Run Circuit

The ignition switch is fed from a junction at the horn relay to the BAT. terminal of the switch. When the ignition switch is in the OFF position, no current flows through the switch. When the ignition switch is turned to the ACC. position, the BAT. terminal is connected to the ACC. terminal. This permits operation of accessories when the engine is not running.

When the ignition switch is turned to the START position, the BAT. terminal is connected to the SOL. and IGN. terminals. When the clutch or automatic transmission neutral start switches are closed, current flows to the starter solenoid. This energizes the solenoid windings. The solenoid has two sets of windings: a "pull-in" winding and a "hold-in" winding. Both windings are used to create the magnetic field to actuate the solenoid plunger and move the starter pinion into engagement with the flywheel. As the solenoid plunger reaches the end of its travel, it closes a switch which connects battery voltage to the starter motor. With battery voltage applied to both terminals of the "pull-in" windings, the "pull-in" winding is no longer energized, so that only the "hold-in" winding keeps the starter solenoid engaged.

During cranking, current is directed from the battery through the brass disc in the starter solenoid housing to the "B" terminal on the solenoid and then to the ignition coil, bypassing the ignition resistor wire.

NOTE: The instrument panel warning lights are fed from the ignition terminal of the ignition switch and have battery voltage applied to them when the ignition switch is in the START and RUN position. These circuits are explained in Chassis Electrical, Section 12.

When the ignition switch is released from the START to the RUN position, the IGN. terminal is still connected to the BAT. terminal, but the solenoid is no longer energized and so the feed for the coil from the IGN. terminal on the ignition switch, through the ignition resistor wire and to the coil, dropping the battery voltage at the coil to approximately nine volts. With the ignition switch in the RUN position, the BAT. terminal is connected to the IGN. terminal and the ACC. terminal. This permits operation of all accessories and the ignition system.

TROUBLE DIAGNOSIS

IGNITION SYSTEM

A. Engine Will Not Start But Cranks O.K.

1. Disconnect a spark plug wire and hold 1/4" away from the engine block, then crank engine.

a. If strong spark is seen, check timing. Adjust as necessary. If timing is correct, trouble is not in ignition system.

b. If no spark or an intermittent spark is seen, reconnect plug wire and proceed to step 2.

2. Disconnect distributor cap-to-coil lead from coil and place screwdriver blade across coil tower to engine block and crank engine.

a. If strong spark is seen between coil tower and metal bar, check distributor cap and rotor for cracks or carbon tracking. Check lead between distributor and coil for broken or burned terminals or cracks in insulation. Replace defective parts.

b. If no spark or intermittent spark is seen, proceed to step 3.

3. Connect jumper wire from battery plus (+) terminal to coil plus (+) terminal. Place a screwdriver blade across coil tower to engine block and crank engine.

a. If strong spark is seen, remove jumper wire and check wiring connections and switches between battery plus (+) terminal and coil (+) terminal. Opens, high resistance or intermittent contact will require repair or replacement.

b. If no spark or intermittent spark is seen, remove jumper wire and proceed to step 4.

4. Disconnect distributor lead from coil minus (—) terminal and connect test light from coil minus (—) terminal to engine block. Turn ignition switch to crank position.

a. If lamp does not light, replace coil.

b. If lamp lights proceed to step 5.

5. Connect test light from battery plus (+) terminal to distributor lead which is still detached from the coil. If necessary, rotate distributor until points close.

a. If lamp lights, check condenser and points. Replace defective parts.

b. If lamp does not light, proceed to step 6.

6. Connect test lamp from battery plus (+) terminal to connection of distributor lead and contact points. Make sure points are closed.

a. If lamp lights, replace distributor lead to coil.

b. If lamp does not light, proceed to step 7.

7. Connect test lamp from battery plus (+) terminal to screw holding points in place.

a. If lamp lights, replace points and check capacitor.

b. If lamp does not light, breaker plate or distributor is not grounded. Check plate-to-distributor ground wire or distributor-to-engine block connector.

B. Engine Starts But Will Not Continue to Run

1. Connect jumper wire from battery plus (+) terminal to ignition coil plus (+) terminal and start engine.

a. If engine does not continue to run, problem is not ignition.

b. If engine runs, proceed to step 2.

2. Remove jumper and disconnect leads from battery plus (+) terminal and coil (+) terminal. Connect ohmmeter and measure resistance between the ends of the leads just detached. Ignition switch should be in the run position.

a. If resistance exceeds 2.5 ohms, check wires and connections for loose or intermittent contact. Check by-pass resistor and ignition switch for opens.

b. If resistance is 1.0 to 2.5 ohms, check the output of the ignition coil.

c. If resistance is less than 1.0 ohm, replace shorted by-pass resistor and replace contact points.

C. Engine Runs Rough, Poor Power or Gas Mileage

1. Check all tune-up specifications (timing, dwell, carburetion, fouled plugs, etc.) If settings are improper, correct as required.

2. If settings are O.K. check both centrifugal and vacuum advance of distributor and correct with replacement parts, if necessary.

3. If distributor advance mechanisms are within specifications, check coil available voltage and plug required voltage.

a. High requirements or low availability of voltage will require a replacement of parts.

b. If coil and plugs are O.K., the problem is not in the ignition system.

IGNITION COIL TEST

A. Weak Coils

Most ignition coils that are replaced are classified as weak. Many coils rejected as weak actually test up to specifications and give normal performance. A coil that actually is weak will first effect engine performance when the ignition reserve is at a minimum. This may be in starting, low speed acceleration or top speed. Eventually the engine will fail to start.

High resistance connections in either the primary or secondary circuit wiring will react the same as a weak coil. Wide spark plug gaps, which require higher voltage than the coil can produce, put the coil under suspicion. High compression and lean carburetor increase the voltage requirements and lead to many needless coil changes. Leakage of high tension current through moisture on an unprotected coil terminal may produce carbon tracks which weaken the coil output voltage. For this reason the nipple on coil high tension terminal must be properly installed and in good condition.

When an ignition coil is suspected of being defective it should be tested as described below before being replaced.

B. Testing Coil for Open and Grounded Circuits

Before using a coil test instrument, the coil should be tested for open and grounded circuits, using a 110-volt test lamp and test points.

1. Apply test points to both primary terminals of coil. If test lamp does not light, the primary circuit is open.

2. Apply one test point to the high tension terminal, and the other test point to one of the primary terminals. If secondary circuit is not open, the lamp will not light but tiny sparks will appear at test points when they are rubbed over terminals. If secondary circuit is open, no sparks will occur.

3. Apply one test point to a clean spot on the metal coil case and touch the other point to the primary and high tension terminals. If the lamp lights, or tiny sparks appear at the points of contact, the coil windings are grounded.

4. A coil with open or grounded windings must be replaced since internal repairs cannot be made. It is unnecessary to test such a coil with instruments. If windings are not open or grounded, a test for short circuits and other internal defects should be made with a reliable coil test instrument.

C. Coil Test Instruments

Two general type of instruments are used in testing ignition coils. One type makes use of an open or protected spark gap, while the other reports the condition of the coil on a meter.

The spark gap type of tester should always be used comparatively, that is, the questionable coil should be compared with a coil of same model that is known to be good. Both coils must be at the same temperature and identical test leads must be used.

Certain variables caused by altitude, atmosphere or spark gap electrode conditions are usually present in the spark gap type of test.

The meter type testers are usually designed to permit testing the coil without making any connection to the secondary terminal. This eliminates the variables usually present in the spark type of test and avoids the necessity for comparison with a good coil.

Some different makes and models of coil testers differ in their methods of use, as well as in the markings on meters, the instructions of the manufacturer must be carefully followed when using any coil tester. The instrument must be frequently checked to make certain that it is accurately calibrated.

Regardless of instrument or method used, the coil must be tested at normal operating temperature because internal defects often fail to show up on a cold test.

DISTRIBUTOR CONDENSER TEST

When a condenser is suspected of being faulty it should be tested with a reliable condenser tester to determine whether it is actually the cause of ignition trouble. The condenser should be tested for (a) high series resistance (b) insufficient or excessive capacity (c) low insulation resistance.

A special condenser tester is required to make these tests. When using a condenser tester the instructions of the manufacturer must be carefully followed.

NOTE: The condenser must be at normal operating temperature when it is being tested.

A. High Series Resistance

High series resistance in the condenser causes the condenser to be slow in taking the charge and, consequently, a higher than normal voltage is developed across the contact points when they first start to open. The higher voltage causes more disturbance at the contact points, which in turn causes more rapid wear and more tendency toward oxidized surfaces. The condition can become severe enough to cause complete failure of the ignition system. It would first show up during starting and low speed operation.

High series resistance may be caused by internal resistance in condenser or by resistance in the connections. Any defect caused by internal resistance should show up at low mileage since this does not change very much with time or use. The damaging changes are in the connections, in which looseness, corrosion, or broken strands may develop.

New condensers may have a series resistance as low as .05 ohm. Some condenser testers are set to reject condensers which have a resistance of .3 ohm; however, test show that the resistance can go to .5 ohm before ignition performance is affected.

B. Insufficient or Excessive Capacity

The condenser specified for use in the ignition system has a capacity of .18 to .23 microfarads.

If a condenser is used which does not have the specified capacity of .18 to .23 microfarads, excessive pitting of one contact point and a corresponding buildup of metal on the other contact point will result. A condenser having insufficient capacity will cause build-up of metal on the breaker arm (positive) point. A condenser having excessive capacity will cause build-up of metal on the contact support (negative) point.

In exceptional cases, pitting and metal buildup on contact points may be experienced even when condenser capacity is within the specified limits. In such cases the life of contact points will be improved by installing a condenser of high-limit capacity if metal build-up is on breaker arm point, or a condenser of low-limit capacity if metal build-up is on contact support point. There is usually sufficient variation in the capacities of stock condensers to permit selection of a high or low limit condenser by testing the available stock.

C. Low Insulation Resistance

A weak or leaking condenser is usually one that has absorbed water so that the insulation resistance of the winding is lowered to the extent that the condenser will not hold a charge satisfactorily. A condenser with low insulation resistance will drain sufficient energy from the ignition system to lower the secondary voltage seriously. The condenser specified for use in the ignition system is sealed to prevent absorption of water, and no other type should be used.

A leaky condenser usually does not affect engine performance except when hot. It is unlikely that a condenser with low insulation resistance would cause missing at low or medium speeds under conditions where the condenser does not get hot. A condenser that has low enough resistance to affect engine performance when cold would probably be indicated as broken down on most condenser testers.

Condenser testers equipped to check condensers for low insulation resistance usually give a reading megohms, a megohm being one million ohms. The scale is marked to indicate whether the condenser is good or bad.

When testing a condenser for low insulation resistance the lead should always be disconnected from the distributor. Since the distributor terminals and the connected circuit have much lower insulation resistance than the condenser, failure to disconnect the condenser lead will give a reading much too low.

IGNITION SYSTEM RESISTANCE TEST

Check for proper functioning of the resistance in the primary ignition circuit by turning on the ignition. With the engine not running, a voltmeter connected from the battery side of the coil to ground should read approximately 5 to 5.5 volts. If the reading is a full 12 volts, the ignition points may be open; "bump" the starter a few times until the engine comes to rest with the ignition points closed and again check for a 5.5 volt reading. A reading of 12 volts or over for all engine positions would indicate that the shorting switch is making contact all the time; this condition must be corrected immediately or ignition point life will be very short.

Check for proper closing of the shorting switch and also for proper functioning of the complete starting circuit by grounding the secondary coil wire so the engine won't start. With the engine cranking, a voltmeter connected from the battery side of the coil to ground should read at least 9 volts. A reading of under 5 volts would indicate that the shorting switch is not closing; this condition would result in hard cold starting.

Briefly, the advantages of our resistance with shorting switch system are: it sends full battery voltage to the coil for good cold weather starting, and it cuts down the voltage to the coil with the engine running for long ignition point life.

> **NOTE:** Discourage any attempts to measure voltage at the coil with the engine running; because of variations in current flow at high speeds and in regulated voltage, this check would be meaningless. Voltage readings on a perfectly-functioning ignition system may go over 11 volts.

SPARK PLUGS

Under normal operating conditions, spark plugs wear out due to the destructive action, under intense heat, of sulphur and lead compounds in the fuel and the bombardment of the electric spark on the electrodes.

The same type of spark plug used in two different engines of the same make and model may frequently show wide variation in appearance. The cause of such differences lies in the condition of the engine, its piston rings, carburetor setting, kind of fuel used, and under what conditions the engine is operated, namely, sustained high speeds or heavy loads; or continual low speed, stop-and-go driving or light loads.

Spark Plugs are frequently blamed for faulty engine operation which they do not cause. Replacement of old spark plugs by new may temporarily improve poor engine performance because of the lessened demand new plugs make on the ignition system. This cannot permanently cure poor engine performance caused by worn rings or cylinders, weak coil, worn contact points, faulty carburetion or other engine ills.

IGNITION TIMING

The ignition timing marks are located on the engine front cover. A saw slot on the balancer indicates engine top dead center. (figure 33)

To adjust ignition timing, proceed as follows:

1. Remove air cleaner and plug manifold vacuum fitting.

2. Disconnect vacuum hoses at carburetor and plug fittings.

3. Connect tachometer and adjust engine speed to 1100 rpm with transmission in neutral.

4. With the use of a timing light, set timing to 8°BTDC by loosening the distributor clamp bolt and rotating the distributor until the specification is obtained.

> **NOTE:** The indicator has four "V" slots, each representing 4°.

5. Tighten the distributor clamp bolt and recheck timing to make sure distributor was not moved during tightening of bolt.

> **NOTE:** If a tuned engine detonates with this setting, the cause is low octane fuel or excessive carbon build-up in the combustion chamber. If

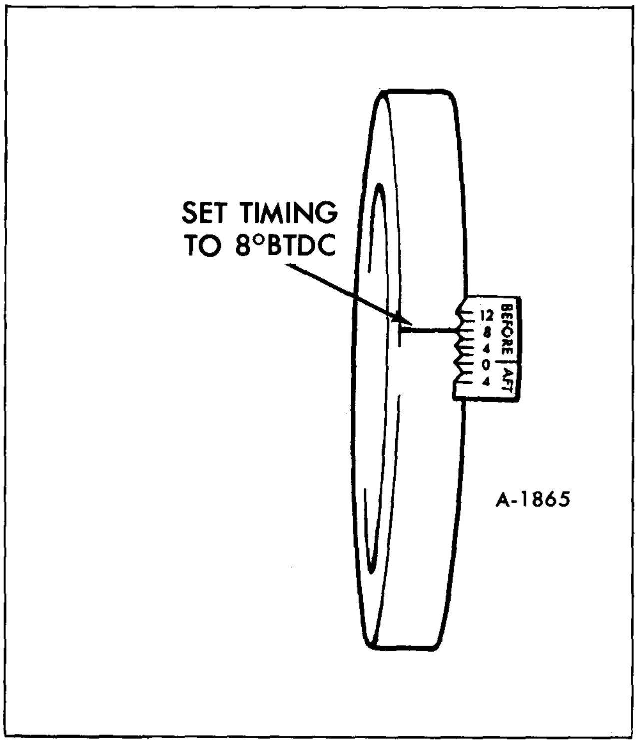


Figure 33—Engine Ignition Timing

these factors are not corrected, the timing should be retarded 2 degrees from the specified setting.

6. Remove plug from fittings and connect hoses to carburetor. Remove tape from manifold fitting and connect vacuum hose, install air cleaner.

DISTRIBUTOR (FIGURE 34)

DESCRIPTION

The distributor cap has a window for adjusting point opening (dwell angle) while the cap is mounted and the engine is running. The contact point set is replaced as one complete assembly. The service replacement contact set has the BREAKER LEVER SPRING TENSION AND POINT ALIGNMENT pre-adjusted. Only the POINT OPENING requires adjusting after replacement.

Under part throttle operation when the transmission is in high gear, intake manifold vacuum actuates the vacuum control diaphragm, thus advancing the spark and increasing fuel economy. During fast acceleration or when the engine is pulling heavily, vacuum is not sufficient to actuate the diaphragm; therefore, the movable breaker plate is held so that the ignition timing is retarded.

The centrifugal advance mechanism consists of a cam actuated by two centrifugal weights controlled by springs. As the speed of the distributor shaft increases with engine speed, centrifugal advance weights move outward which advances the cam, causing the contact points to open earlier, thus advancing the spark.

CONTACT POINT REMOVAL

1. Remove distributor cap and rotor. (figure 35)

2. Remove two piece metal shield attaching screws and shields. Figure 36.

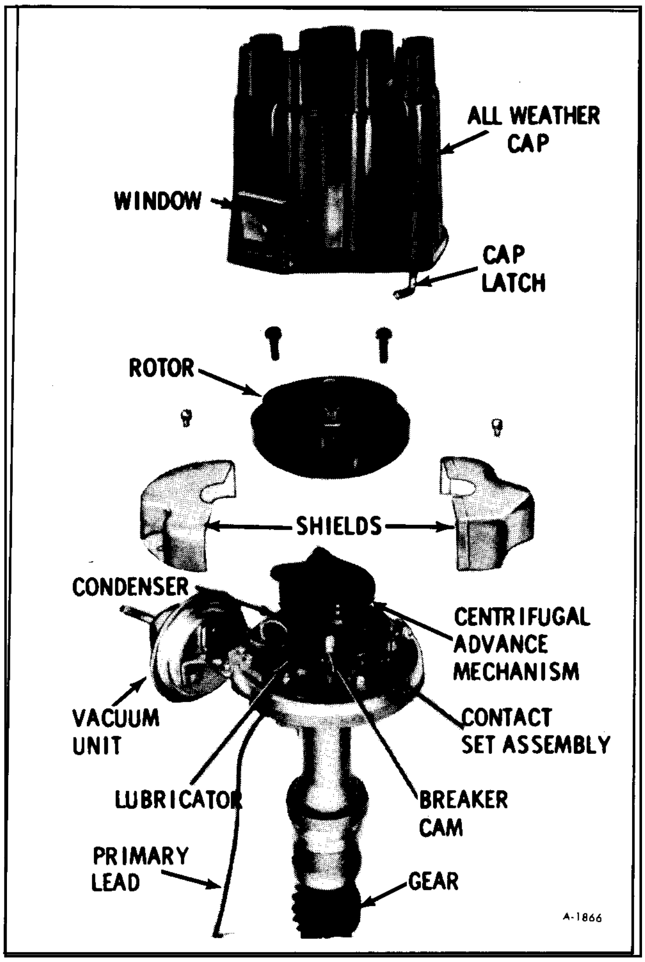


Figure 34—Distributor Components

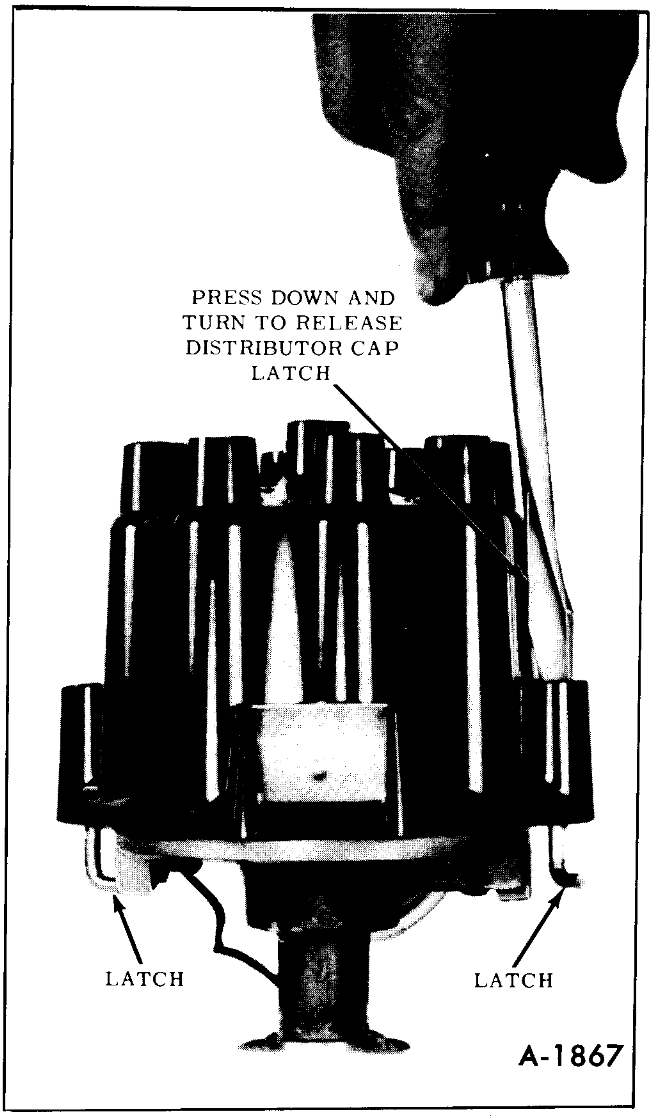


Figure 35—Removing Distributor Cap

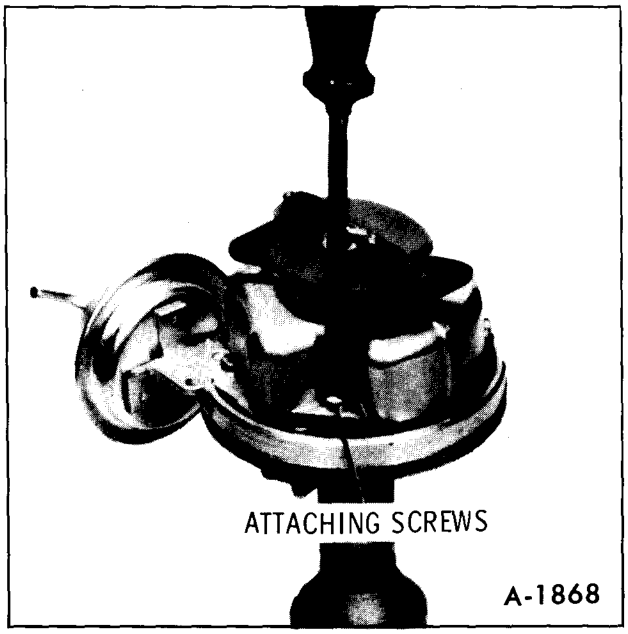


Figure 36—Removing Point Shield

3. Lift the two wiring terminals out of the snap-lock retainer, Figure 37, and remove the two screws and contact points.

ADJUSTING DWELL ANGLE

1. Remove the distributor cap, rotor, and shields. Inspect contact points; clean if necessary. Check cam lubricator for sufficient lubricant, if necessary apply a thin film of lubcitant No. 1948792 or equivalent to the breaker cam. Install shields, rotor and cap.

2. Connect a dwell meter to the distributor primary distributor negative lead terminal on the coil and ground.

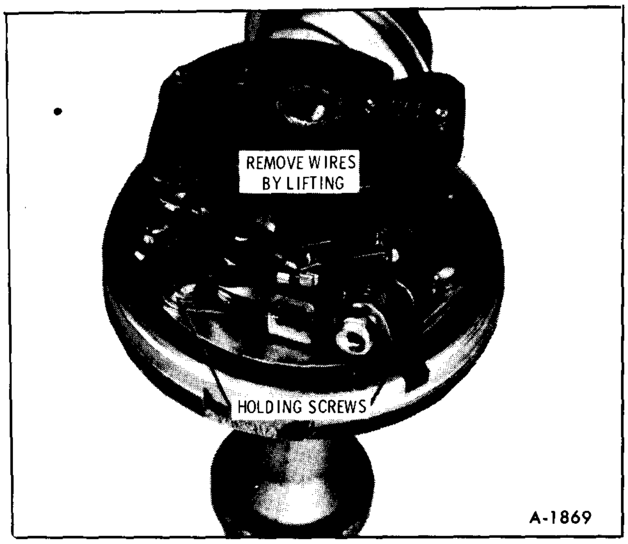


Figure 37—Removing Contact Points

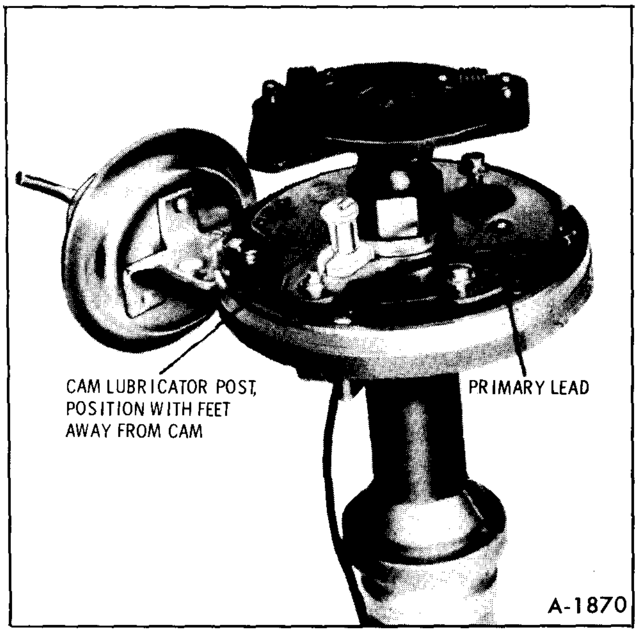


Figure 38—Cam Lubrication

3. Raise window on side of distributor cap.

4. With the engine running at idle speed, insert

CONTACT POINT INSTALLATION

NOTE: The two-piece shield suppresses radio interference and must be installed and screws tightened securely. Snap-lock (push in) terminal contact points have sufficient clearance between the shield and wire terminals to prevent accidental short circuiting. Screw terminal contact point sets may not have sufficient clearance. Wire terminals must be firmly pushed in and bent slightly toward cam to prevent them from touching the shield.

1. Install contact points on breaker plate.

2. Install primary and condenser wire terminals in snap-lock terminals. Seat them firmly and bend them slightly toward cam. Position wires to prevent interference with weights, rotor or distributor cap.

3. The cam lubricator is mounted on breaker plate with feet away from cam. Figure 38. Apply a thin film of lubricant 1948792 or equivalent to cam, not the wick.

4. Place one-half of shield over contact points, Figure 39, align screw hole, install and firmly tighten screw. Make sure wire terminals are not touching shield.

5. Install other half of shield, align screw hole, install and firmly tighten screw.

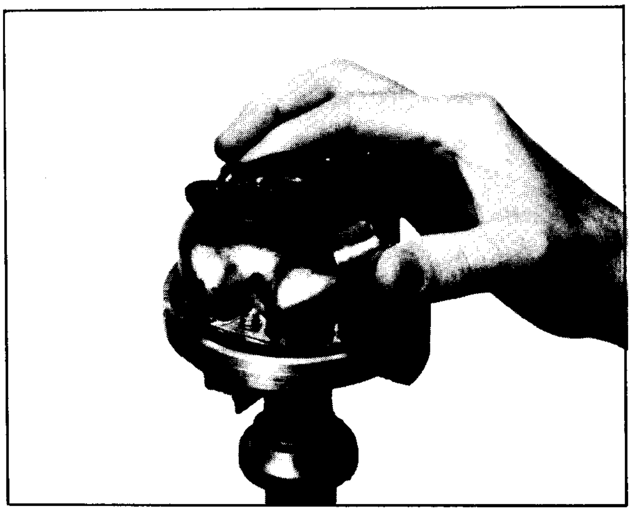


Figure 39—Installing Point Shield

6. Install rotor, Figure 40.

7. Install distributor cap.
1/8" Allen wrench into the head of the adjusting screw as shown in Figure 41 and adjust dwell angle to 30 degrees.

NOTE: If the dwell angle reading is erratic, check the contact points and condenser.

The dwell angle variation should not exceed 3 degrees at engine speeds between idle and 1750 rpm. Excessive variation indicates distributor wear.

Figure 40—Installing Rotor

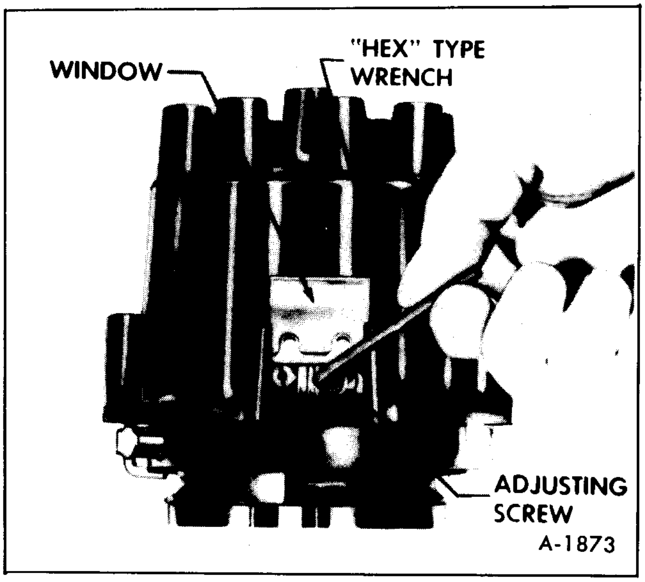


Figure 41—Adjusting Dwell Angle

MECHANICAL ADVANCE

The mechanical advance weights and springs are accessible by removing the rotor. The mechanical advance plate is assembled to the breaker cam. In order to remove the breaker cam and advance plate, follow the procedure for DISTRIBUTOR—DISASSEMBLY and ASSEMBLY.

VACUUM ADVANCE UNIT

Removal

1. Remove the distributor cap, shield and the two vacuum advance attaching screws. (figure 42)

2. Turn the breaker plate clockwise and push the rod end of the vacuum advance down so that it will disengage and clear the breaker plate. Remove vacuum advance unit.

Installation

1. Position the rubber sleeve over the rod end of the vacuum advance.

2. Insert the rod end of the unit between the housing and the breaker plate.

3. Turn the breaker plate clockwise so that the rod end can be inserted into the hole in the breaker plate.

4. Install the attaching screws with the ground lead terminal under the inner mounting screw. (figure 42) Install the shield and distributor cap.

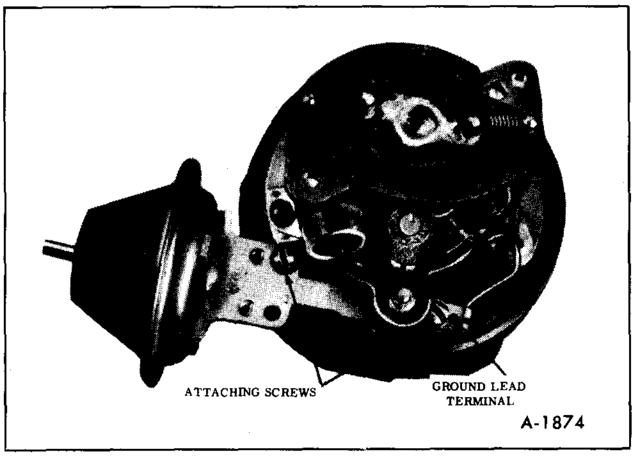


Figure 42—Vacuum Advance Unit

DISTRIBUTOR REMOVAL

1. Disconnect the distributor wire from coil.

2. Remove distributor cap as shown in Figure 35.

NOTE: If necessary to remove secondary wires from cap, note position on cap tower for lead to No. 1 cylinder. This will aid in installation of leads. (figure 32)

3. Remove vacuum hose line from vacuum advance unit.

4. Remove distributor clamp screw and hold-down clamp.

5. Note position of rotor, then pull distributor up until rotor just stops turning counterclockwise and again note position of rotor.

NOTE: To insure correct timing of the distributor, the distributor must be INSTALLED with the rotor correctly positioned as noted in Step 5.

If the engine has been turned after the distributor was removed, it will be necessary to install a jumper wire and crank engine until the timing mark on the harmonic balancer indexes with the 0 degree timing mark on the engine front cover. If both valves of the No. 1 cylinder are closed, the piston will be on top dead center in either the firing or exhaust stroke. Install distributor so that the rotor is pointing to No. 1 spark plug terminal in the cap when the distributor is fully seated. Install clamp and bolt, start engine. If engine fails to start or runs uneven, distributor is 180 degrees out of time. Lift up distributor, turn rotor one half revolution and install distributor.

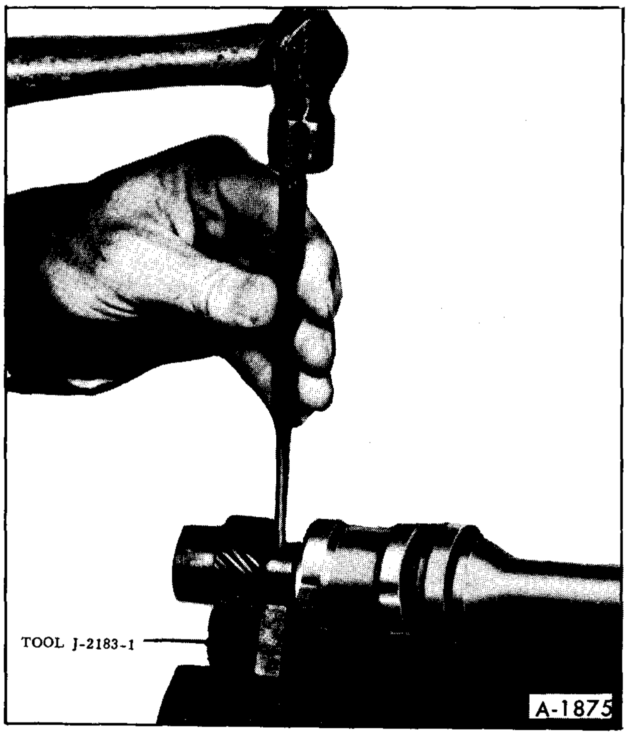


Figure 43—Removing Roll Pin

DISTRIBUTOR DISASSEMBLY

1. Mark distributor shaft and gear so that they may be reassembled in the same position.

2. Drive out the roll pin. (figure 43)

3. Pull the distributor assembly from the gear and pull the distributor shaft and breaker cam from the housing.

4. Remove the retaining ring from the upper bushing and lift the breaker plate and felt wick from the bushing. (figure 44)

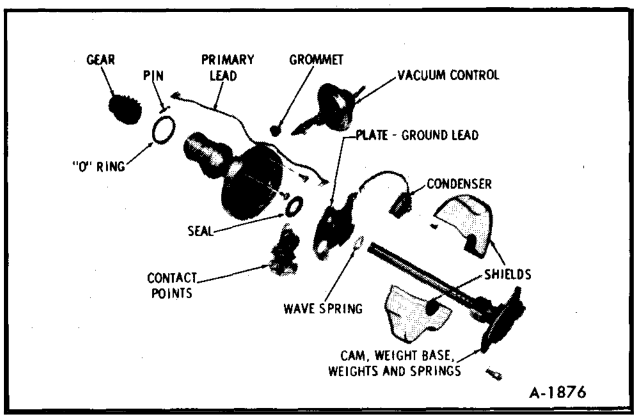


Figure 44—Distributor Disassembled

5. Remove the two retaining screws and the vacuum advance unit.

CLEANING AND INSPECTION

1. Wash all parts in cleaning solvent except cap, rotor, condenser, breaker plate assembly and vacuum control unit. Degreasing compounds may damage insulation of these parts or saturate the lubricating felt in the case of the breaker plate assembly.

2. Inspect the breaker plate assembly for damage or wear and replace if necessary.

3. Inspect the shaft for wear and check its fit in the bushings in the distributor body. If the shaft or bushings are worn, the parts should be replaced.

4. Mount the shaft in "V" block and check the shaft alignment with a dial gauge. The runout should not exceed .002".

5. Inspect the advance weights for wear or burrs and free fit on their pivot pins.

6. Inspect the cam for wear or roughness. Then check its fit on the end of the shaft. It should be absolutely free without any roughness.

7. Inspect the condition of the distributor points. Dirty points should be cleaned and badly pitted points should be replaced.

8. Test the condenser for series resistance, microfarad capacity (.18 to .23) and leakage or breakdown, following the instructions given by the manufacturer of the test equipment used.

9. Inspect the distributor cap and spark plug wires for damage and replace if necessary.

DISTRIBUTOR ASSEMBLY

1. Install the vacuum advance with the ground lead terminal under the inner mounting screw. (figure 42)

2. Place the felt wick on the upper bushing then place the breaker plate over the upper bushing and vacuum advance link.

3. Install the retaining ring on the upper housing.

4. Slide the distributor shaft through housing bushings.

5. Push the driven gear onto the distributor shaft with the holes aligned.

6. Install the roll pin.

7. Check and adjust dwell angle, vacuum advance and the mechanical advance. Refer to SPECIFICATIONS (Distributor).

ADJUSTING DISTRIBUTOR DWELL ANGLE

1. With distributor mounted in distributor testing machine, connect the dwell meter to the distributor primary lead.

2. Turn the adjusting screw to set the dwell angle at 30 degrees.

If a distributor tester is not available, the dwell angle may be adjusted as follows:

1. Mount distributor in a vise.

2. Connect a test lamp between the primary lead and ground.

3. Rotate the shaft until one of the breaker cam lobes is under the center of the rubbing block on the moveable point.

4. Turn the adjusting screw clockwise until the lamp lights, then turn the screw one-half turn in the opposite direction.

When distributor has been installed in vehicle, point opening must be reset by connecting a dwell meter to the primary distributor lead negative terminal on the coil and ground. The dwell angle must be set at 30 degrees with the engine running at idle speed.

ROTOR

The rotor is retained by two screws and is provided with round and square lugs which engage with the mechanical advance plate so that the rotor may be installed in only one position. (figure 40)

DISTRIBUTOR INSTALLATION

Engine Not Disturbed

1. Turn the rotor about 1/8 turn in a clockwise direction past the mark previously placed on the distributor housing to locate rotor.

2. Push the distributor down into position in the block with the housing in a normal "installed" position.

NOTE: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place.

3. Tighten the distributor clamp bolt snugly and connect vacuum line. Connect primary wire to coil terminal and install cap. Also install spark plug and high tension wires if removed.

NOTE: It is important that the spark plug wires be installed in their proper location in the supports and also in the cap. (figure 32).

4. Time ignition as previously described.

Installation—Engine Disturbed

1. Locate No. 1 piston in firing position by either of two methods described below.

a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in the No. 1 cylinder. Continue cranking until timing mark on crankshaft pulley lines up with timing tab attached to engine front cover.

b. Remove rocker cover (left bank) and crank engine until No. 1 intake valve closes and continue to crank slowly about 1/3 turn until timing mark on pulley lines up with timing tab.

2. Position distributor to opening in block in normal installed attitude, noting position of vacuum control unit.

3. Position rotor to point toward front of engine (with distributor housing held in installed attitude), then turn rotor counter-clockwise approximately 1/8 turn more toward left cylinder bank and push distributor down to engine camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.

4. While pressing firmly down on distributor housing, kick starter over a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.

5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.

6. Place distributor cap in position and check to see that rotor lines up with terminal for No. 1 spark plug.

7. Install cap, check all high tension wire connections and connect spark plug wires if they have been removed.

8. Connect vacuum line to distributor and distributor primary wire to coil terminal.

9. Start engine and set timing.

COIL REPLACEMENT

1. Disconnect battery ground cables.

2. Disconnect ignition switch and distributor leads from terminals on coil.

3. Pull high tension wire from center terminal of coil.

4. Remove the coil support mounting bolt or loosen friction clamp screw and remove coil.

5. Place new coil in position and install attaching bolt or tighten clamp screw.

6. Place high tension lead securely in center terminal of coil and connect ignition switch and distributor primary leads to terminals on coil.

7. Connect battery ground cables.

8. Start engine and check coil operation.

SPARK PLUGS

1. Remove foreign material from around the spark plug holes and remove the spark plugs.

2. Clean exterior of plugs and inspect for cracked insulators, poor sealing gaskets or excessively burned electrodes.

3. Clean all serviceable plugs with an abrasive type cleaner. File center electrode flat. (figure 45) Do not file center electrode on new plugs.

4. Adjust spark plug gap to .040" using a round feeler gauge.

5. Install plugs and torque to 35 ft. lbs.

NOTE: The spark plug gaskets are the captive type and are not to be replaced each time the plug is removed. The same gasket will usually seat even if the plug is removed up to four times.

HIGH AND LOW TENSION WIRES

High tension wires include the wires connecting the distributor cap to the spark plugs, and the wire connecting the center electrode of the distributor cap

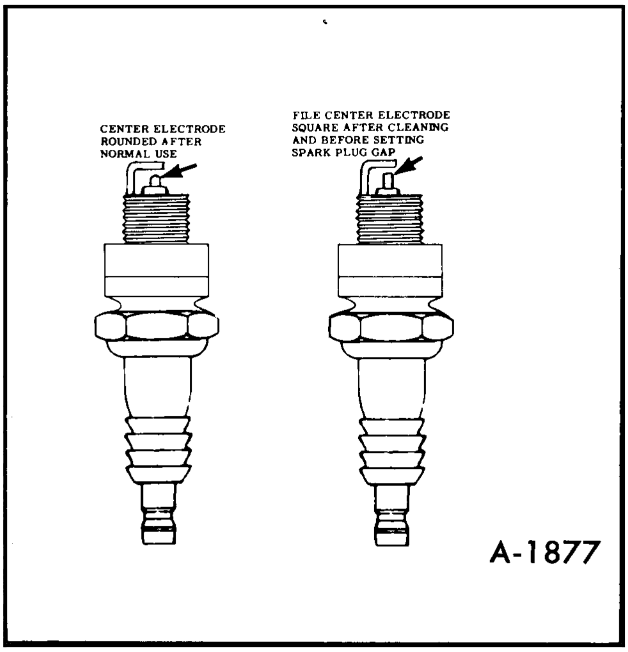


Figure 45—Spark Plug Electrodes

to the center terminal of the ignition coil. Low tension wires are the small wires connected to the primary terminals on the coil, and to the primary terminal at the distributor.

High tension wires have a built-in resistance of approximately 4,000 ohms per foot except coil wire which is 8,000 ohms per foot.

At regular intervals wires should be inspected for damage. If insulation is cracked or swollen, wires should be replaced.

IGNITION SWITCH

The electrical switching portion of the assembly is separate from the key and lock cylinder. However, both are synchronized and work in conjunction with each other through the action of the actuator rod assembly. For a complete explanation of the key and lock cylinder, and the actuator rod assembly, refer to the Steering section of this manual.

The ignition switch is key operated through the actuator rod assembly to close the ignition primary circuit and to energize the starting motor solenoid for cranking. The ignition switch has five positions: OFF, LOCK, ACCESSORY, RUN and START. OFF is the center position of the key-lock cylinder, and lock is the next position to the left. ACCESSORY is located one more detent to the left of LOCK. Turning the key to the right of the OFF position until spring pressure is felt will put the ignition in the RUN position, and when turned fully to the right against spring pressure, the switch will be in the START position.

In the RUN position, the ignition primary circuit is activated through a resistance wire. The ignition resistor wire is used in the ignition running circuit to reduce the voltage to the ignition coil. The resistor wire is bypassed when the engine is being started. The purpose of this is to compensate for the drop in voltage which occurs as the result of the heavy drain on the battery during starting, and to provide a hotter spark for starting.

BREAKER POINT IGNITION SYSTEM SPECIFICATIONS

DISTRIBUTOR	
Make	Delco-Remy
Model No.	1112172
Rotation (Viewed at Rotor)	Counterclockwise
Point Opening (In.)	.016
Cam Angle (Degrees)	30
Centrifugal Advance	
Start Distributor (Degrees)	0-2
R.P.M.	575
Intermediate Distributor (Degrees)	3.5-5.5
R.P.M.	1000
Maximum Advance Degrees	7-9
R.P.M.	1700
Firing Order	1-8-4-3-6-5-7-2

(*) Set with Vacuum in Retard Position.

IGNITION TIMING	
Idle Speed (R.P.M.)	1100
Distributor Setting	8° BTDC
(*) With Distributor Vacuum Ports on Carburetor Plugged.	
DISTRIBUTOR VACUUM CONTROL	
Model No.	1973408
Inches of Mercury to Start Advance	8-10
Inches of Mercury for Maximum Advance	18.5-20.5
Maximum Advance (Distributor Degrees)*	12.5
(*) Plus or Minus one Degree.	
IGNITION COIL	
Model No.	1115221
SPARK PLUGS	
Make	AC
Type	R-45S
Size	18MM
Point Gap	.040"
Torque (Ft. Lbs.)	35
Hex Size	13/16"
Distributor Clamp to Block Bolt (Ft. Lbs.)	12-17

HIGH ENERGY IGNITION SYSTEM

IMPORTANT: Identify ignition system before servicing 1975 vehicles with 1974 certified engines are equipped with standard breaker point ignition systems. 1975 certified engines are equipped with high energy ignition systems. To determine year engine was certified, refer to decal on engine valve cover.

GENERAL DESCRIPTION (FIGURE 46)

The eight cylinder HEI distributor combines all ignition components in one unit. The ignition coil is in the distributor cap and connects directly to the rotor. HEI operates basically in the same manner as a conventional ignition system except the module and pick-up coil of the HEI system replace the contact points of the conventional system.

The High Energy Ignition is a pulse triggered, transistor controlled, inductive discharge ignition system. The magnetic pick-up assembly located inside the distributor contains a permanent magnet, a pole piece with internal teeth, and a pick-up coil. When the teeth of the timer core rotating inside the pole piece line up with teeth of the pole piece, an induced voltage in the pick-up coil signals the all electronic module to open the coil primary circuit. The primary current decreases and a high voltage is induced in the ignition coil secondary winding which is directed through the rotor and high voltage leads to fire the spark plugs. The capacitor in the distributor is for radio noise suppression.

The module automatically controls the dwell period, stretching it with increasing engine speed. The HEI system also features a longer spark duration, made possible by the higher amount of energy stored in the coil primary. This is desirable for firing lean and EGR diluted mixtures.

IGNITION COIL

In the 8 cylinder HEI system, the ignition coil is built into the distributor cap. The coil is somewhat smaller physically than a conventional coil, but has more primary and secondary windings. It is built more like a true transformer with the windings surrounded by the laminated iron core. A conventional coil has the iron core inside the windings. Although the HEI coil operates in basically the same way as a conventional coil, it is more effective in generating higher secondary voltage when the primary circuit is broken.

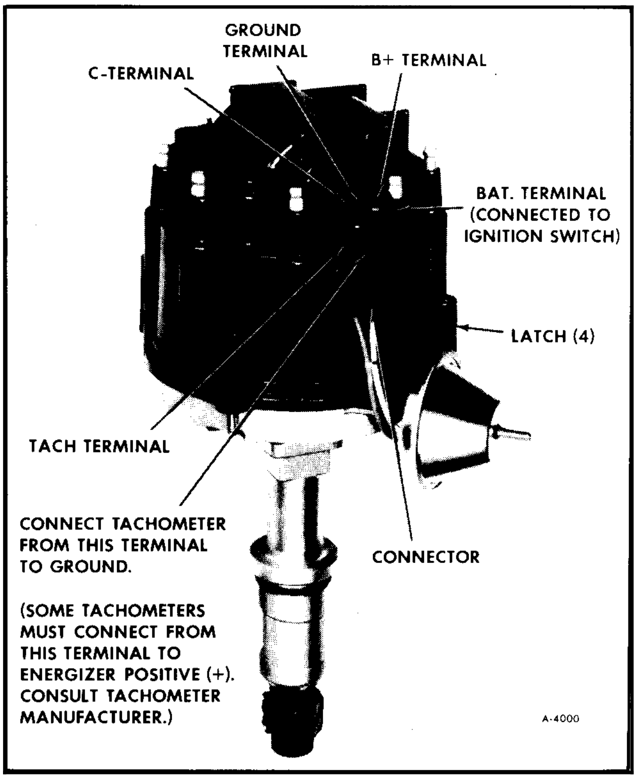


Figure 46—Typical High Energy Ignition

ELECTRONIC MODULE

The electronic module is a solid state unit containing five complete circuits which control spark triggering, switching, current limiting, dwell control and distributor pick-up. Dwell angle is controlled by a transistor circuit within the module and is varied in direct relation to engine speed.

POLE PIECE AND PLATE ASSEMBLY

The pole piece and plate assembly (often referred to as the pick-up coil assembly) consists of the following:

1. A stationary pole piece with internal teeth.

2. A pick-up coil and magnet which are located between the pole piece and a bottom plate.

CENTRIFUGAL AND VACUUM ADVANCE

The centrifugal and vacuum advance mechanisms are basically the same types of units that provide spark advance in the breaker-type system. Centrifugal advance is achieved through the rotation of the timer core in relation to the distributor shaft. Vacuum advance is achieved by attaching the pick-up coil and pole piece to the vacuum advance unit actuating arm.

THEORY OF OPERATION

The pick-up coil is connected to transistors in the electronic module. The electronic module is connected to the primary windings in the coil. As the distributor shaft turns the timer core teeth out of alignment with the teeth of the pole piece a voltage is created in the magnetic field of the pick-up coil.

The pick-up coil sends this voltage signal to the electronic module, which determines from RPM when to start current building in the primary windings of the ignition coil.

Each time the timer core teeth align with the pole piece teeth the pick-up coil magnetic field is changed creating a different voltage. The pick-up coil sends this different voltage signal to the electronic module which electronically shuts off the ignition coil primary circuit. This in turn collapses the coil magnetic field, induces high secondary voltage and fires one spark plug. A typical HEI schematic and basic wiring diagram are shown in Figures 47 and 48.

The electronic module delivers full battery voltage to the ignition coil which is limited to five to six amperes. There is no primary resistance wire in the HEI system. The electronic module triggers the closing and opening of the primary circuit instantaneously with no energy lost due to breaker point arcing or capacitor charging time lag. The capacitor in the HEI unit functions only as a radio noise suppressor.

The instantaneous and efficient circuit triggering enables the HEI system to deliver up to approximately 35,000 volts through the secondary wiring to the spark plugs.

An exploded view of the HEI system is shown in Figure 49.

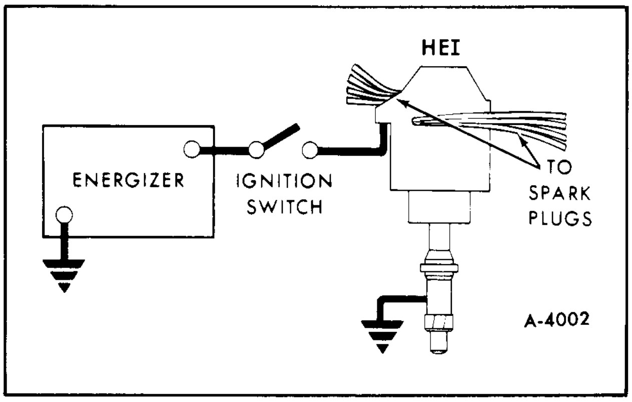


Figure 47—HEI Schematic

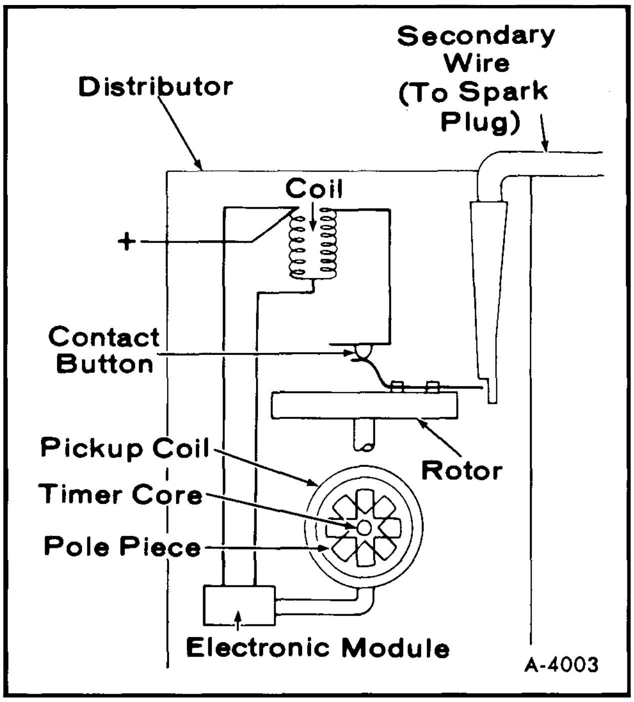


Figure 48—HEI Basic Wiring Diagram

SERVICE OPERATIONS

ROUTINE MAINTENANCE

The HEI system is designed to be free from routine maintenance. No periodic lubrication is required. Engine oil lubricates the lower bushing and an oil-filled reservoir provides lubrication for the upper bushing. There is no dwell adjustment as this is controlled by the module. Timing can be set in the same manner as the standard distributor. For proper operation, however, it is necessary to keep ignition wires and distributor clean and free of any corrosion. If component part replacement should become necessary, several items specific to the HEI system should be noted.

Electronic Module

The electronic module is serviced by complete replacement only. When replacing the module a liberal coating of special silicone grease MUST be applied to the metal mounting surface on which the module will be installed. If this grease is not applied the module will not cool properly which can cause the module to malfunction. A tube of this special silicone grease is supplied with each replacement module. Make certain the replacement module is the correct part number.

CAUTION: *When connecting battery, as in jump starting, reversing connections or polarity, can result in damage to the electronic module.*

Pole Piece and Plate Assembly

The pole piece and plate assembly (often referred to as the pick-up coil assembly) is also serviced by complete replacement only. Make certain the replacement assembly is the correct part number. The pole piece and plate assembly should not be unnecessarily disassembled as the polarity of the assembly could be changed and effect proper operation of the vehicle.

Spark Plug Wires (Figure 50)

Because of the higher voltage, the HEI system has larger diameter (8 millimeter) spark plug wires with silicone insulation. The silicone wire is gray in color, more heat resistant than standard black wire and less vulnerable to deterioration. Silicone insultaion is soft, however, and must not be mishandled.

The spark plug wire boots seal more tightly to the spark plugs. Twist the boot about a half turn in either direction to break the seal before pulling on the boot to remove the wire.

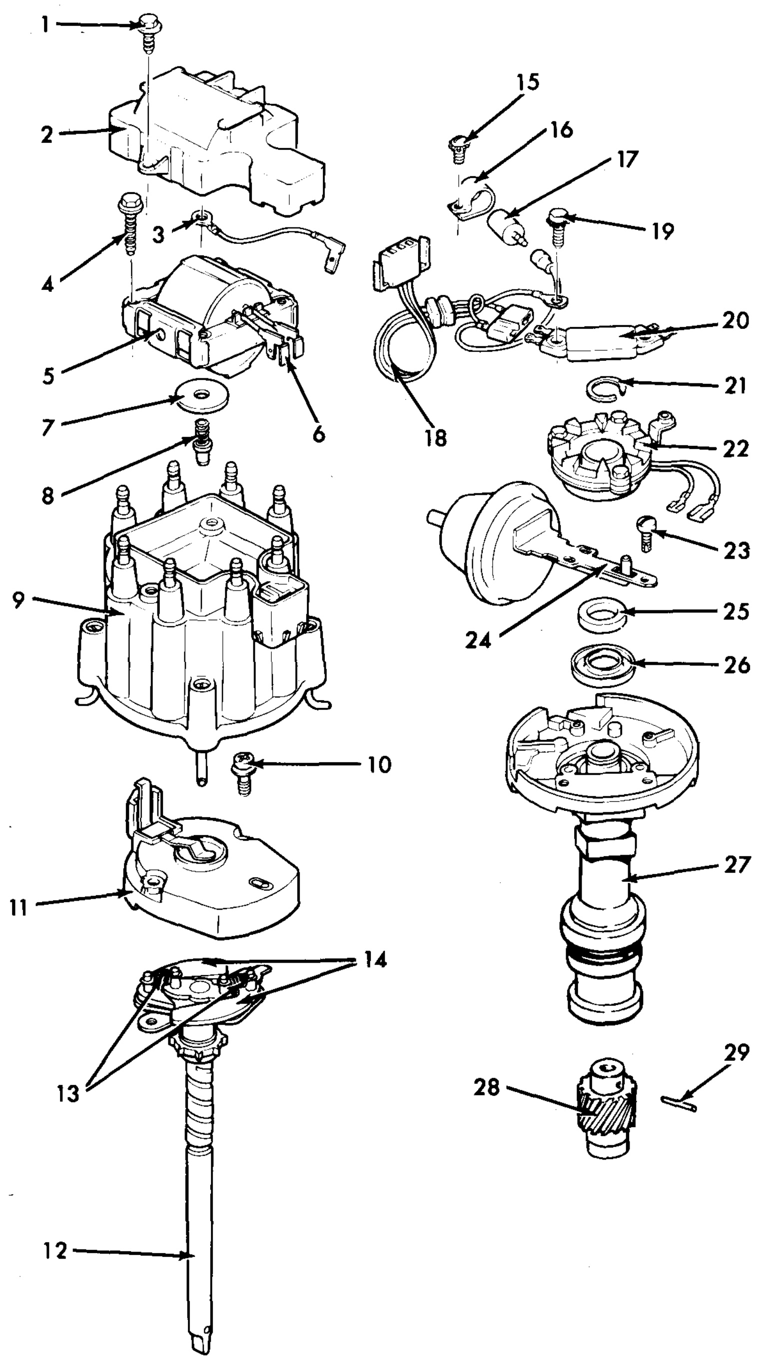
The spark plug cable retainer is designed to hold the wires firmly to prevent chafing or cutting. The wires cannot be repositioned until the cable retainer is unlocked. To unlock the cable retainer use a small screwdriver between the tub and the lock.

To remove wiring harness from cap, release wiring harness latch and remove wiring harness both right and left side (figure 51).

The eight spark plug wires and holder are replaceable only as an assembly. However, if it is necessary to remove an individual wire from the wiring harness assembly, hold grommet of wire down and press retainer tub out of wire holder. To reinstall, lightly lubricate tub end of spark plug wire with silicone. Rotate wire until seated in holder.

WARNING: DO NOT REMOVE SPARK PLUG WIRES WITH THE ENGINE RUNNING. THE HIGHER SECONDARY VOLTAGE IS CAPABLE OF JUMPING AN ARC OF GREATER DISTANCE AND COULD CAUSE AN ELECTRIC SHOCK. OPERATING THE ENGINE WITH ONE OR MORE SPARK PLUG WIRES DISCONNECTED CAN ALSO RESULT IN DAMAGE TO THE DISTRIBUTOR CAP.

Resistance specifications for both 7mm wires used with standard systems and 8mm wires used with HEI systems are identical (3,000 to 5,000 ohms per foot). Inspect all spark plug wires for high resistance and continuity with an ohmmeter. Ohmmeter should be set on high scale. Connect ohmmeter leads to the terminals at each end of the cable being tested.



1. Cover Attaching Screw (2)
2. Cover
3. Ground Lead
4. Coil Attaching Screw (4)
5. Ignition Coil
6. Coil Terminals
7. Rubber Seal
8. Brush (Spring and Button)
9. Cap
10. Rotor Attaching Screw (2)
11. Rotor
12. Shaft Assembly
13. Springs
14. Weights
15. Bracket Attaching Screw
16. Capacitator Bracket
17. Capacitator
18. Wiring Harness
19. Module Attaching Screw (2)
20. Electronic Module
21. Retainer (Thin "C" Washer)
22. Pole Piece and Plate Assembly (Pick-up Coil)
23. Vacuum Advance Attaching Screw (2)
24. Vacuum Advance Control
25. Felt Washer
26. Plastic Seal
27. Housing
28. Gear
29. Pin

A-4001

Figure 49—HEI Distributor Exploded View

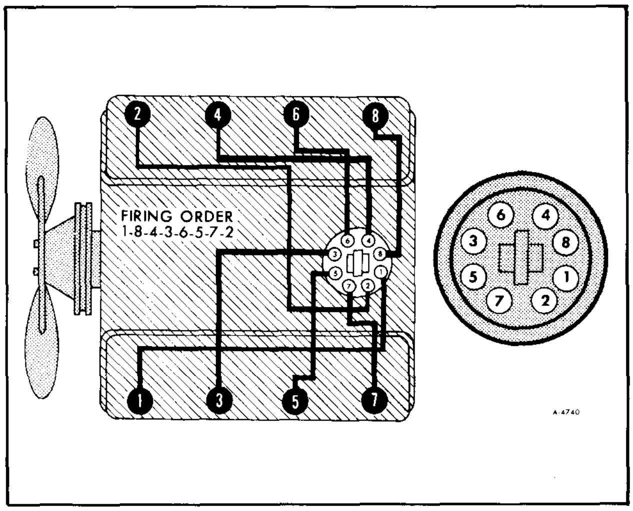


Figure 50—Secondary Wiring

Twist wire gently while observing ohmmeter. If the resistance of the assembly is not within the specified range, or if the ohmmeter reading fluctuates from infinity to any value, replace the cable.

Timing Light Connections

When using a timing light, connect an adapter between the No. 1 spark plug and the No. 1 spark plug wire (figure 50). Connect the timing light to the adapter. Do not pierce the plug bead. Once the insulation of the spark plug cable has been broken, voltage will jump to the nearest ground, and the spark plug will not fire properly. The timing procedure remains the same as the conventional breaker point ignition system.

Compression Check

When making compression checks on engines equipped with HEI, disconnect the ignition switch connector at the battery terminal of the distributor (figure 52).

Tachometer Connections

The tachometer terminal is next to the ignition switch connector on the distributor cap (figure 52). Most tachometers can be used, however, be sure the equipment is compatible with the HEI system. The tachometers without a relay cannot be used. If there is any doubt as to whether you have the right tachometer, a check can be made as follows:

a. Note reading on 1000 RPM scale.

b. Note reading on 5000 RPM scale.

c. Readings should be approximately the same. If they are not, get another tachometer.

Connect the tachometer to the distributor cap tachometer terminal and to ground. Some tachometers must connect from the tachometer terminal to the battery positive (+) terminal. Follow tachometer manufacturer's instructions.

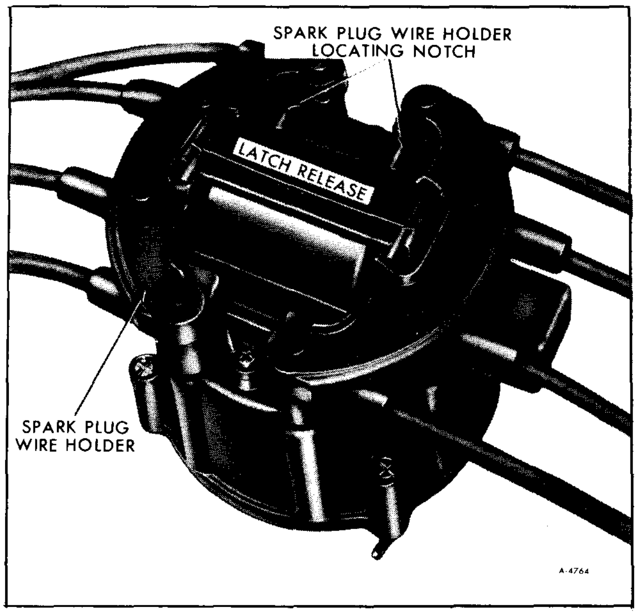


Figure 51—Distributor Cap Wiring

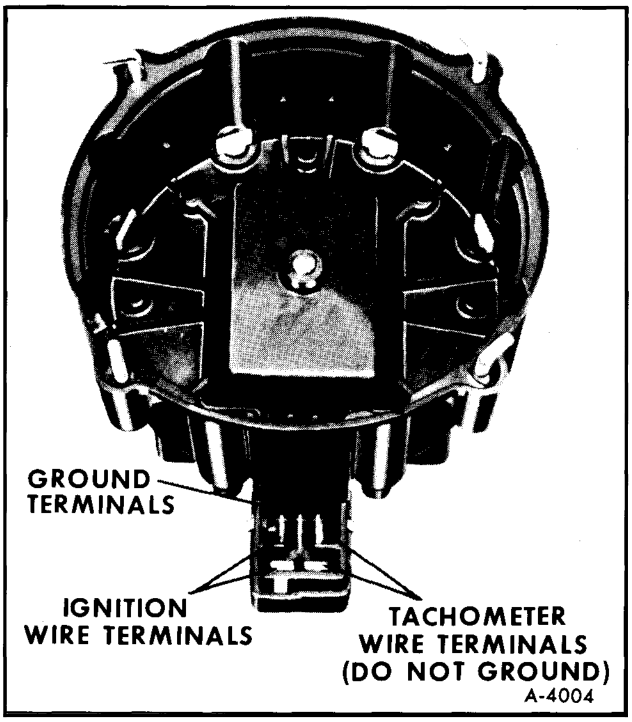


Figure 52—Terminals on Distributor Cap

CAUTION: *Grounding the distributor tachometer terminal could damage the HEI electronic module.*

Other Test Equipment

Oscilliscopes require special adapters. Distributor machines require a special amplifier. The equipment manufacturers have instructions and details necessary to modify test equipment for HEI diagnosis.

Vacuum and Centrifugal

Advance Specifications

Vacuum and centrifugal advance specifications are listed in Specifications at the end of this section.

Ignition Timing

The ignition timing marks are located on the engine front cover. A saw slot on the balancer indicates engine top dead center. (figure 53).

To adjust ignition timing, proceed as follows:

1. Remove air cleaner and plug manifold vacuum fitting.

2. Disconnect vacuum hoses at carburetor and plug fittings.

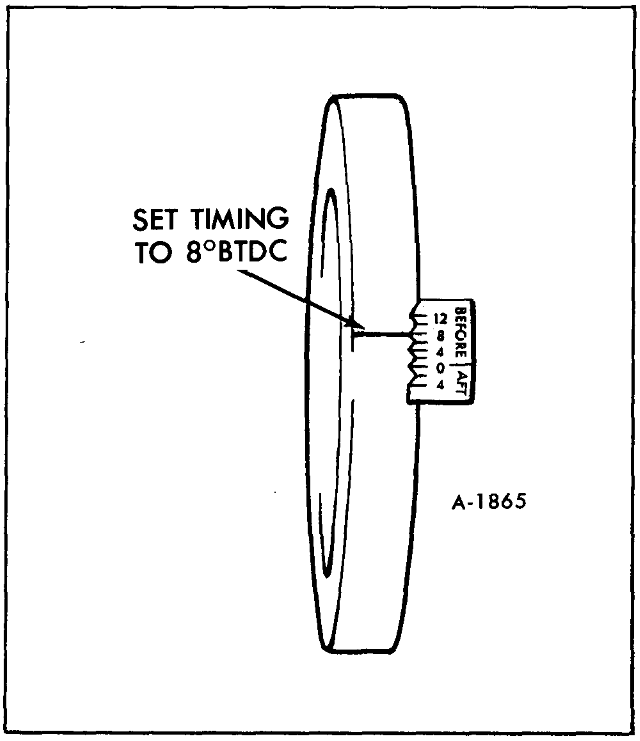


Figure 53—Engine Ignition Timing

3. Connect tachometer and adjust engine speed to 1100 rpm with transmission in neutral.

4. With the use of a timing light, set timing to 8°BTDC by loosening the distributor clamp bolt and rotating the distributor until the specification is obtained.

NOTE: The indicator has four "V" slots, each representing 4°.

5. Tighten the distributor clamp bolt and recheck timing to make sure distributor was not moved during tightening of bolt.

NOTE: If a tuned engine detonates with this setting, the the cause is low octane fuel or excessive carbon build-up in the combustion chamber. If these factors are not corrected, the timing should be retarded 2 degrees from the specified setting.

6. Remove plug from fittings and connect hoses to carburetor. Remove tape from manifold fitting and connect vacuum hose, install air cleaner.

Spark Plugs (Figure 54)

1. Remove foreign material from around the spark plug holes and remove the spark plugs.

2. Clean exterior of plugs and inspect for cracked insulators, poor sealing or excessively burned electrodes.

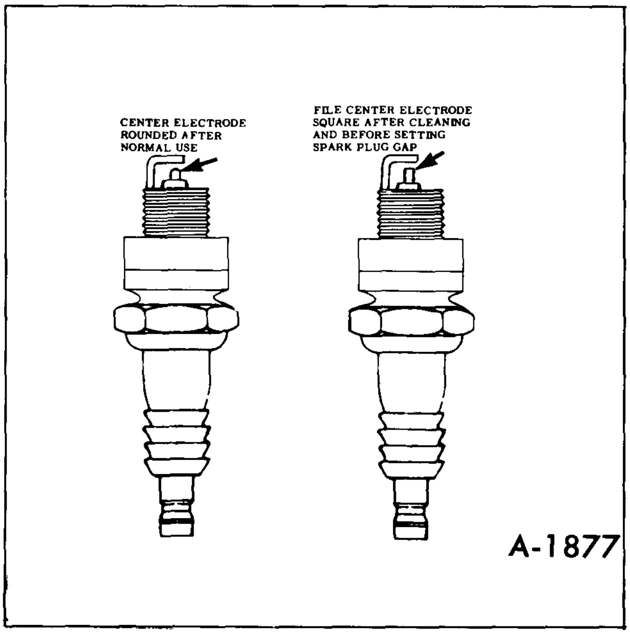


Figure 54—Spark Plug Electrodes

3. Clean all serviceable plugs with an abrasive type cleaner. File center electrode flat. Do not file center electrode on new plugs.

4. Adjust spark plug gap to .080" using a round feeler gauge.

5. Install plugs and torque to 25 ft. lbs.

DIAGNOSING HIGH ENERGY IGNITION SYSTEM

(Using Voltmeter or Test Light, Ohmmeter, and Module Tester J-24642).

NOTE: Careful adherence to the following procedures will lead to the location and correction of H.E.I. System problems. Normally, only a portion of the procedures need be performed.

Engine Will Not Start:

1. Insure that wiring connector is properly attached to connector at side of distributor.

2. Insure that all spark plug leads are properly connected at distributor and spark plugs.

3. Connect voltmeter or test light from "BAT" terminal lead on distributor to ground (figure 52).

4. Turn on ignition switch. If voltage is zero or test light does not come on, repair open circuit between "BAT" terminal and battery.

5. When reading is battery voltage, or test light lights, remove one spark plug lead by twisting spark plug boot to loosen. Insert extension, hold spark plug lead with insulating pliers so extension is 1/4 in. away from dry area or engine block while cranking engine, or install any good spark plug with .080 gap in lead and lay on engine block while cranking engine.

6. If sparking occurs trouble is not ignition distributor. Check fuel system and spark plugs. Check timing. Distributor may have shifted.

7. If no spark, make Test No. 1 with Module Tester J-24642 or equivalent as follows:

NOTE: Use Test No. 1 only in an engine no-start situation.

a. Disconnect module harness connector from the distributor cap (figure 55).

b. Connect J-24642 three-way connector to the module harness connector.

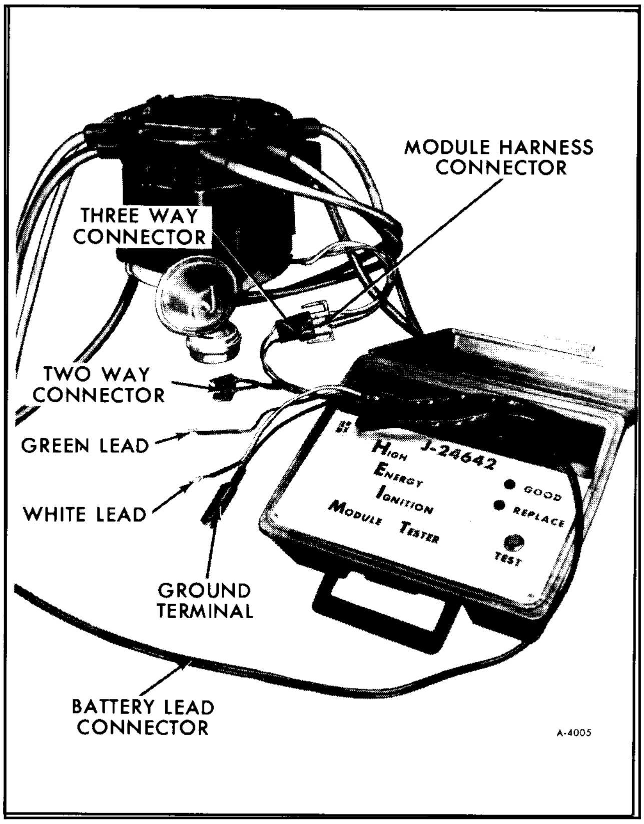


Figure 55—Test No. 1 Using Tool J-24642

NOTE: The three-way connector should connect only one way to the harness connector. Match wire colors between module harness connector and tester three way connector.

c. Connect red lead of J-24642 tester to battery positive terminal and black lead to battery negative terminal.

d. Press and hold test button of J-24642 tester while cranking engine.

NOTE: During cranking, battery voltage must be nine volts or more and engine speed 100 rpm or more for tester to be accurate.

e. Momentary if red light and then green light on Tester J-24642 comes on and stays on green. Module and pickup coil are both good. If red light stays on go to step 8 Test No. 2.

f. If pickup coil and module test good, remove distributor cap and coil assembly by turning four latches.

g. Check primary of ignition coil in cap for continuity (step 1, figure 56). Reading should be zero or near zero. If not, replace ignition coil.

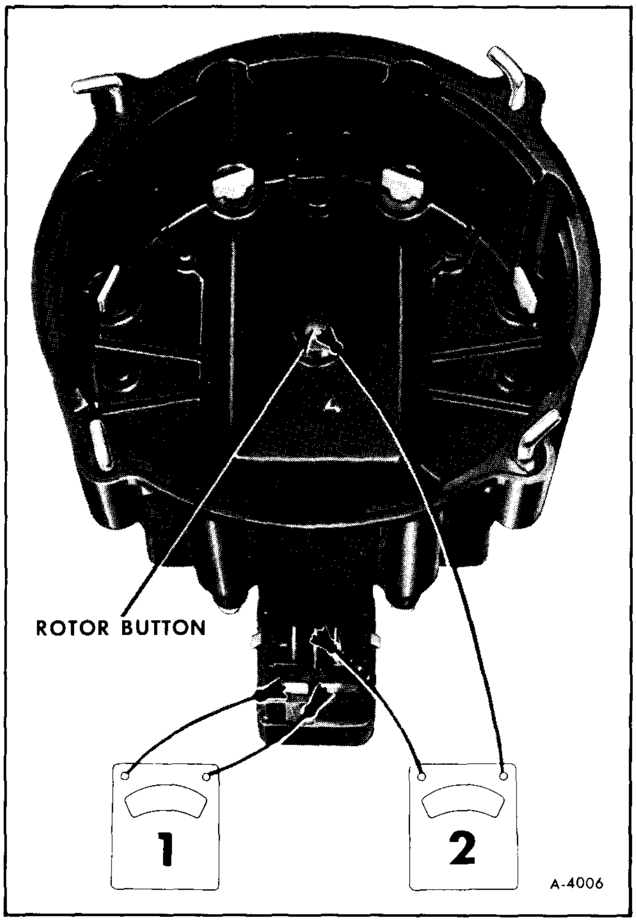


Figure 56—Ohmmeter Check of Ignition Coil

h. Check secondary of coil (step 2, figure 56). Use high scale. Reading should not be infinite.

i. If reading is infinite, check cap and rotor button for arced or burned condition. If necessary, replace cap. If cap and carbon button do not appear defective, replace ignition coil.

8. If red light on module tester J-24642 stays on, either the module or the pickup coil is defective. To determine which is defective, continue with Test No. 2 (figure 57).

a. With distributor cap removed and J-24642 module tester three-way connector and battery leads connected as in Test No. 1 connect green and white leads to module (figure 57).

NOTE: Green and white leads will connect only one way. Test connections now will test module only.

b. Press and hold test button on J-24642 tester. If green light now comes on, the module is

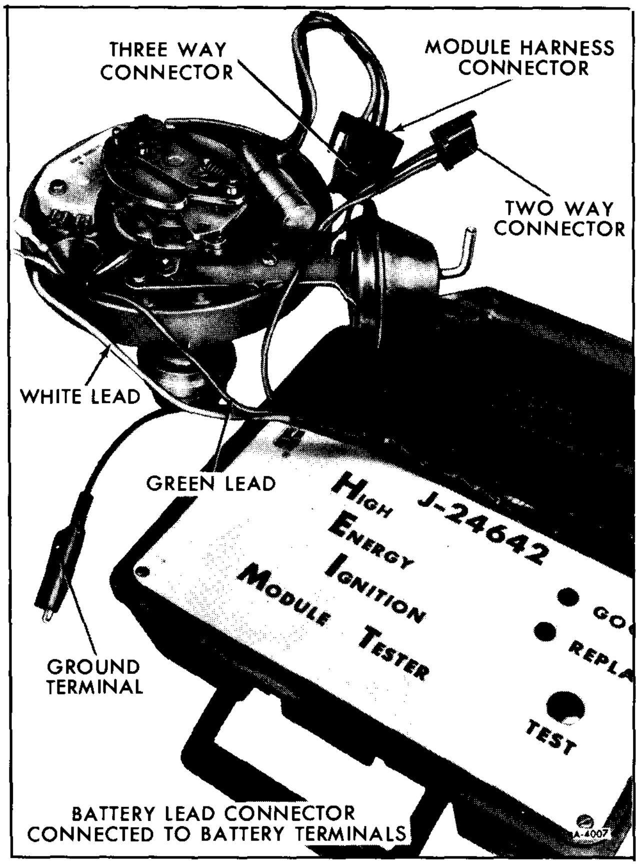


Figure 57—Test No. 2 Using Tool J-24642

okay, so the pick-up coil is defective. If the red light stays on, the module is defective.

NOTE: If necessary to replace pick-up coil, remove distributor from engine, drive pin from gear, remove rotor and shaft assembly from housing and remove thin "C" washer; to replace pick-up coil as described in this section under distributor disassembly.

If necessary to replace module, remove connector, white and green leads, to attaching screws and replace module. Special silicone grease as supplied with new module must be applied to distributor and module to dissipate heat.

c. Remove J-24642 test leads, replace parts as required, if removed, replace distributor and cap assembly.

9. Module may be tested on bench using Tester J-24642 (figure 58).

Connect the two-way connector of the analyzer to the module and the green and white analyzer leads to the corresponding green and white terminals of the module. Connect red elad of tester to 12 volt

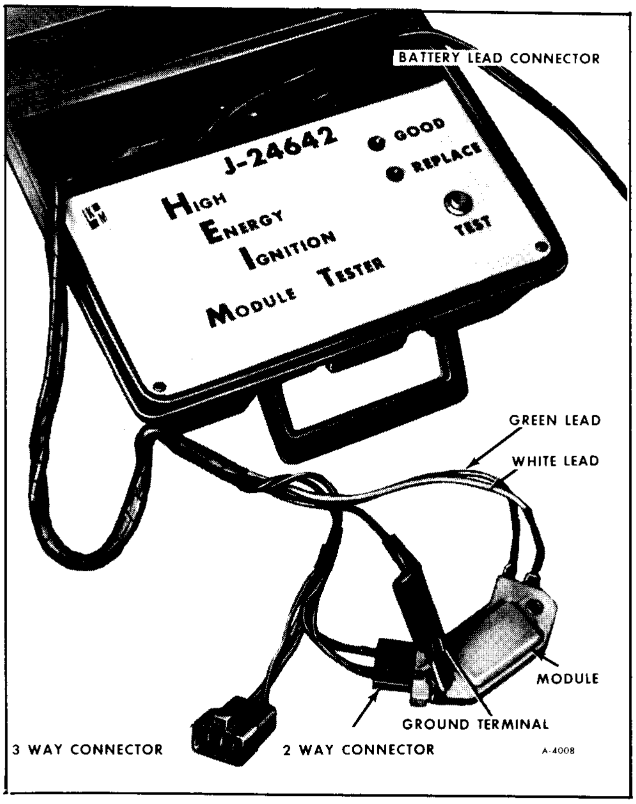


Figure 58—Bench Test of Module Using Tool J-24642

battery positive. Terminal and black lead to battery negative terminal. Connect ground terminal of analyzer to module ground as shown in (figure 58).

Press and hold test button momentary - red then green, module good; light stays red module is defective.

Engine Runs Rough:

1. Insure that proper fuel is being delivered to carburetor.

2. Check all vacuum hoses for leakage.

3. Visually inspect and listen for sparks jumping to ground.

4. Check initial timing, distributor may have shifted.

5. Check centrifugal advance on engine.

6. Remove all spark plugs and check for usual defects-proper gap, fouling, cracked insulators inside and out, etc.

7. Check spark plug wiring.

8. Remove distributor cap and coil assembly by turning four latches. Inspect cap, coil assembly and rotor for spark arc-over.

a. Check primary of ignition coil in cap for continuity (step 1, figure 56). Reading should be zero or near zero. If not, replace ignition coil.

b. Check secondary of coil (step 2, figure 56). Use high scale. Reading should not be infinite.

c. If reading is infinite, check cap and rotor button for arced or burned condition. If necessary, replace cap. If cap and carbon button do not appear defective, replace ignition coil.

9. If trouble has not been located, proceed with Test No. 2 using J-24642, step 8 (a thru c).

DISTRIBUTOR COMPONENT REPLACEMENT

Following is the complete distributor disassembly of which part or all can be used as required. When necessary to remove the distributor from the engine, the procedure is the same as for the standard distributor.

DISTRIBUTOR REMOVAL

1. Disconnect wiring harness connectors at side of distributor cap.

2. Remove distributor cap from housing by releasing four cap retaining latches. Position cap out of way.

> **NOTE:** Be careful not to damage latches. Position screwdriver at top of latch and turn.

3. Disconnect vacuum advance hose from vacuum advance mechanism.

4. Scribe a mark on engine in line with rotor. Note approximate position of distributor housing in relation to engine.

> **NOTE:** To insure correct timing of the distributor, the distributor must be installed with the rotor correctly positioned.

5. Remove distributor clamp screw and hold-down clamp.

6. Lift distributor from engine. Again note position of distributor housing in relation to engine.

DIAGNOSING HIGH ENERGY IGNITION SYSTEM WITHOUT USE OF MODULE TESTER J-24642

Careful adherence to the following procedures will lead to the location and correction of HEI system problems. Normally only a portion of the procedures need be performed.

1. Insure that wiring connector is properly attached to connector at side of distributor.
2. Insure that all spark plug leads are properly connected at distributor and spark plugs.

SYSTEM CHECKS ON THE VEHICLE

A. ENGINE WILL NOT START. USE VOLTMETER OR TESTLIGHT.

A-1. Connect voltmeter from "BAT" terminal lead on distributor to ground.

A-2. Turn on ignition switch.

A-3. If voltage is zero, repair open circuit between "BAT" terminal and battery.

A-4. If reading is Battery voltage, twist spark plug boot to loosen, remove lead, insert extension, hold spark plug lead with insulating pliers so extension is ¼" away from dry area of engine block while cranking engine or remove one spark plug lead. Install any good spark plug with .080 gap in lead and lay on engine block while cranking engine.

A-5. If sparking occurs trouble is not ignition distributor.

A-6. Check fuel system and spark plugs and secondary wiring. Check timing (distributor shifted).

A-7. Proceed to Component Checks.

B. ENGINE RUNS ROUGH.

B-1. Insure that proper fuel is being delivered to carburetor.

B-2. Check all hoses for leakage.

B-3. Visually inspect and listen for sparks jumping to ground.

B-4. Check initial timing (distributor shifted).

B-5. Check centrifugal advance on engine.

B-6. Twist boots to loosen, remove all spark plugs and check for usual defects — proper gap, fouling, cracked insulators, inside and out, etc. Check secondary wiring.

B-7. If no defects are found follow procedure under Component Checks.

C. COMPONENT CHECKS USING OHMMETER.

C-1. Remove cap and coil assembly by turning four locking latches.

C-2. Inspect cap and coil assembly and rotor for spark arc-over.

C-3. Check primary coil. Connect ohmmeter, Step 1, Figure 56. Use low scale. Reading should be zero. If not, replace coil.

C-4. Check secondary of coil. Connect ohmmeter, Step 2, Figure 44. Use high scale. Reading should not be infinite.

C-5. If reading is infinite, check cap and carbon button for arced or burned condition. If necessary, replace cap. If cap and rotor button do not appear defective, replace ignition coil.

C-6. Connect test stand vacuum source to vacuum unit.

C-7. If vacuum unit is inoperative, replace.

C-8. Check pick-up coil for broken wire or open. Connect ohmmeter, Step 1, Figure 59. Use middle scale. If ohmmeter reads less than 500 ohms or more than 1500 ohms (while flexing leads) replace pick-up coil. (C-10 below).

C-9. If Step 1 is ok, check pick-up coil for ground with ohmmeter, Step 2, Figure 59. Use high scale. If reading is not infinite (no deflection on meter) replace coil. (C-10 below).

C-10. Remove unit from engine, remove rotor and shaft assembly from housing and remove thin "C" washer to replace pick-up coil (refer to distributor component repair earlier in this section).

C-11. If no defects have been found, remove connector and two attaching screws and replace module.

Diagnosing HEI

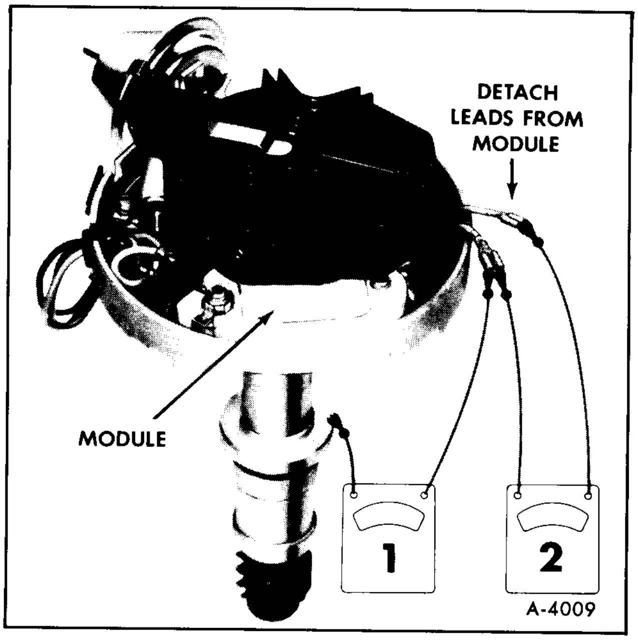


Figure 59—Ohmmeter Check of Pick-Up Coil

DISTRIBUTOR INSTALLATION

1. Push the distributor down into position in the engine block.

2. Install distributor hold-down clamp and tighten clamp screw snugly.

3. Move distributor housing to approximate position relative to engine as noted during removal.

4. Position distributor cap to housing with tab in base of cap aligned with notch in housing and secure with four latches.

5. Connect wiring harness connector to terminals on side of distributor cap. Connector will fit only one way. Connect battery ground cable.

6. Adjust ignition timing as described earlier in this section.

Installation—Engine Disturbed

NOTE: To insure correct timing of the distributor, the distributor must be installed with the rotor correctly positioned.

If the engine was accidentally cranked after the distributor was removed, the following procedure can be used for installing the distributor.

1. Remove No. 1 spark plug.

2. Disconnect feed wire connector at the "BAT" terminal from distributor to prevent engine from starting.

3. Place finger over No. 1 spark plug hold and crank engine slowly until compression is felt.

4. Align timing mark on crankshaft pulley to "0" on engine timing indicator.

5. Turn rotor to point between No. 1 and No. 8 spark plug towers on distributor.

6. Install distributor and connect feed wire.

7. Install distributor cap and spark plug wires.

8. Check engine timing.

DISTRIBUTOR DISASSEMBLY (FIGURE 49)

1. Remove distributor from engine as described above.

2. Remove rotor (figure 60) from distributor shaft by removing two screws.

3. Before removing gear from distributor shaft, scratch a mark on geat and shaft for correct reassembly. If gear is assembled 180° from original position, the timing will be changed one half tooth.

4. Using a small drift, drive out roll pin retaining gear to shaft.

> **CAUTION:** *Distributor gear should be supported in push a way that no damage will damage will occur to the distributor shaft while removing pin.*

5. Remove driven gear. Some distributors may have washers between gear and distributor housing, or on the housing itself. Remove and replace washers as required.

6. Check role pin hole on shaft for burrs. Remove shaft and weight assembly from housing (figure 61).

7. If necessary, remove two advance springs, weight retainer, and advance weights.

8. Disengage plastic wiring insulator from housing. Disconnect wiring leads from module where connector may be removed from "B" and "C" terminals. Remove wires from "W" and "G" module terminals.

9. Remove retainer from upper end of distributor housing.

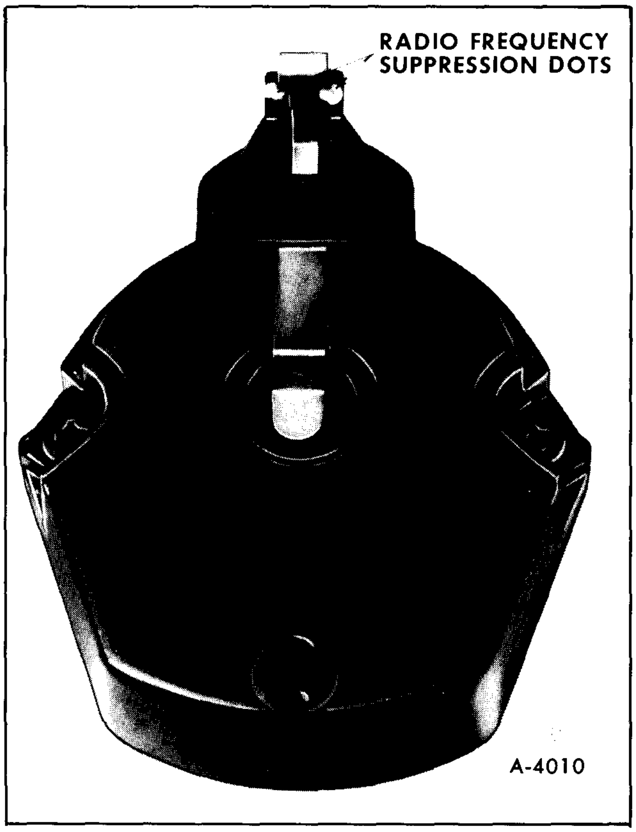


Figure 60—HEI Rotor

10. Remove pole piece and plate assembly from housing. Do not remove three securing screws (figure 62).

NOTE: Pole piece and plate assembly is serviced as an assembly. It should not be unnecessarily disassembled as the polarity of the assembly could be changed and effect proper operation of the vehicle.

NOTE: Do not wipe lubricant from module or distributor unless replacing module. Special lubricant is provided with new modules.

13. Remove capacitor attaching screw and disconnect wiring lead. Remove capacitor and bracket from housing.

14. Remove wiring harness connector from distributor.

15. Remove felt washer and plastic seal.

NOTE: No attempt should be made to secure the shaft bushings in the housing.

16. Inspect and replace parts as required.

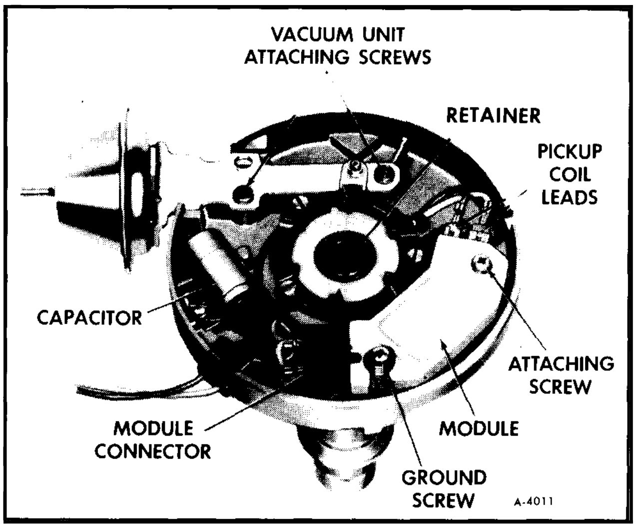


Figure 61—Top View of Distributor Housing with Shaft Removed

DISTRIBUTOR ASSEMBLY

1. Repack lube cavity in housing with Delco Distributor lubricant or equivalent.

2. Replace plastic seal and felt washer.

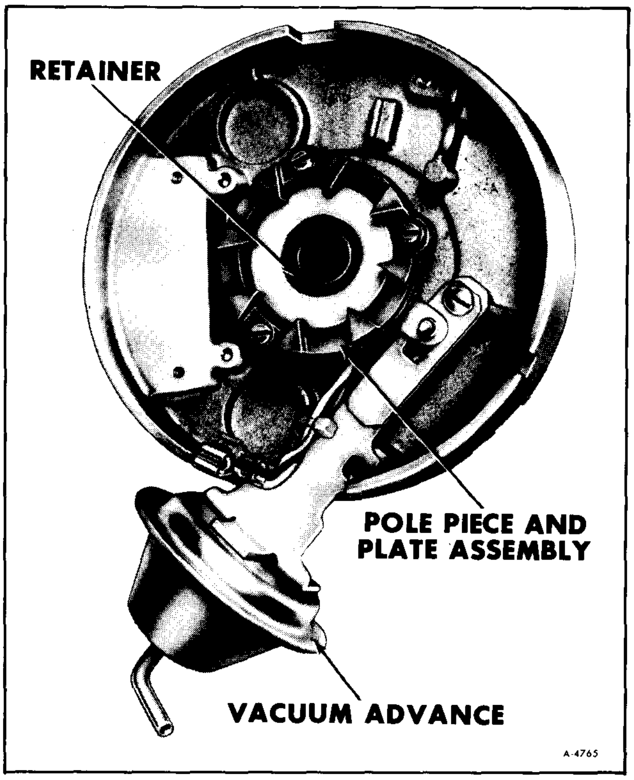


Figure 62—Pole Piece and Plate Assembly

3. Reinstall wiring harness assembly with frommet in distributor housing notch. Engage plastic wiring insulator to housing.

4. Attach lead wire from wiring harness to capacitator, if disassembled. Install capacitator and bracket securing ground wire from wiring harness with capacitator attaching screw.

NOTE: Lead wire attaching to capacitator is a fusible link.

5. Install module with two attaching screws.

NOTE: Apply a layer of special silicone lubricant between module and housing to improve heat transfer. Lubricant is included with new modules. If installing a new module, be sure part number is correct for this particular distributor.

6. Install vacuum advance unit, pin side up, with two attaching screws.

7. Position pole piece and plate assembly with arm over pin of vacuum advance unit.

NOTE: If arm of pole piece and plate assembly is not properly installed on pin of vacuum advance unit, the arm can float and cause timing to vary. If installing a new pole piece and plate assembly, be sure part number is correct for this particular distributor.

8. Install retainer to secure position of pole piece and plate assembly.

9. Install connector to "B" and "C" terminals on module with tab on top. Connect green wire to "G" terminal and white wire to "W" terminal.

10. Install distributor shift and rotate to check for even clearance all around between teeth on pick-up coil of pole piece and plate assembly and teeth on distributor shaft.

NOTE: If necessary to adjust for proper clearance, loosen three screws on pole piece and plate assembly. Move pole piece teeth to provide even clearance. Tighten three screws (figure 62).

11. Install washers between gear and housing, if distributor is so equipped. Slide gear onto shaft in same position as marked when removed.

12. Install roll pin into gear and shaft.

NOTE: To prevent damage to the permanent magnet in the pole piece and plate assembly, support the driven gear when installing the roll pin.

13. If removed, carefully reassemble advance weights and springs on advance weight plate.

14. Position rotor to advance weight plate and tighten retaining screws.

15. Position cap on housing making sure cap is properly seated (notch in housing matches tab in cap). Engage four locking latches.

IGNITION COIL REMOVAL

1. Disconnect battery, ground cable from automotive battery and harness connector from distributor cap.

2. Remove three screws securing coil cover to distributor cap.

3. Remove four screws securing ignition coil to distributor cap (figure 63).

4. Remove ground wire from coil, if coil is equipped with ground wire.

5. Push coil leads from underside of connectors and remove ignition coil from distributor cap.

6. Check condition of seal and resistor brush (spring and button) (figure 64).

NOTE: Do not wipe silicone lubricant from seal.

IGNITION COIL INSTALLATION

1. Position resistor brush (spring and button) and seal in distributor cap.

NOTE: Make sure seal is coated with silicone lubricant and properly positioned in place.

2. Position coil into distributor cap with terminals over connector at side of cap.

NOTE: If replacing ignition coil, be sure part number is correct.

3. Push coil lead wires into connector on side of cap.

4. Secure ignition coil with four screws. Place ground wire, if so equipped, under coil mounting screw.

5. Install coil cover onto distributor cap and secure with three screws.

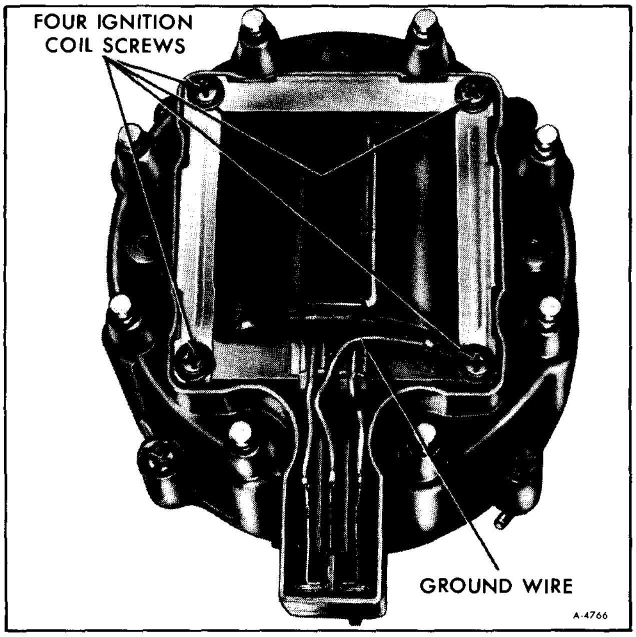


Figure 63—Ignition Coil (Typical)

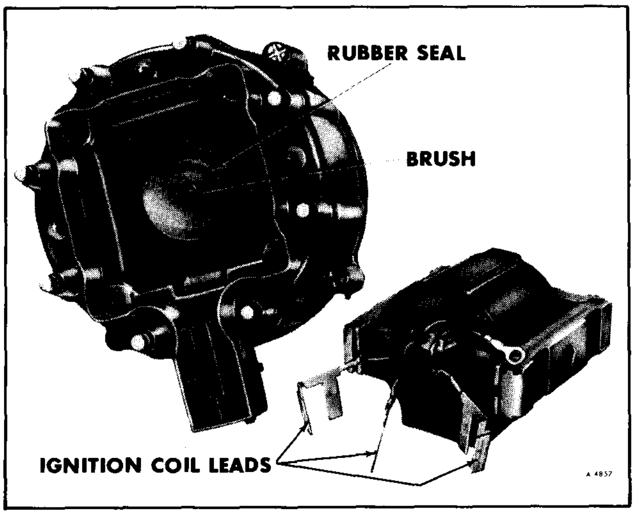


Figure 64—Ignition Coil and Seal (Typical)

6. Connect harness connector to distributor cap and ground cable to automotive battery.

HIGH ENERGY IGNITION SYSTEM SPECIFICATIONS

	Federal	California
DISTRIBUTOR		
Make	Delco-Remy	Delco-Remy
Model No.	1112893	1112945
Rotation (Viewed at Rotor)	Clockwise	Clockwise
Dwell	Electronic	Electronic
Centrifugal Advance		
Start Distributor (Degrees)	0	0
RPM	900	900
Intermediate Distributor (Degrees)	9	9
RPM	2000	2000
Maximum Advance Degrees	16	16
RPM	3400	3400
Firing Order	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2

(*) Set with Vacuum in Retard Position.

IGNITION TIMING		
Idle Speed (RPM)	1100	1100
Distributor Setting	8°BDTC	8°BDTC

* With Distributor Vacuum Ports on Carburetor Plugged.

DISTRIBUTOR VACUUM CONTROL		
Model No.	1973523	1973560
Inches of Mercuty to Start Advance	8-10	14-15
Inches of Mercury for Maximum Advance	19-20	18-19
Maximum Advance (Distributor Degrees)*	12°	5°

*Plus or Minus one Degree.

SPARK PLUGS		
Make	AC	AC
Type	R46SX	R46SX
Size	14MM	14MM
Point Gap	.080"	.080"
Torque (Ft. Lbs.)	25	25
Hex Size	13/16	13/16
Distributor Clamp to Block Bolt (Ft. Lbs.)	17	17

STARTING SYSTEM

GENERAL DESCRIPTION

The cranking circuit consists of the battery, the starting motor which includes a drive assembly for engaging the flywheel ring gear during cranking, the starter solenoid, mounted on the starting motor for shifting the drive assembly and closing the motor circuit, the ignition or control switch which, when in the "START" position connects a lead from the battery to the solenoid switch and related electrical wiring. During cranking, the ignition switch also connects the battery directly to the ignition coil.

The solenoid operated overrunning clutch type starting motor, shown in Figure 65 is used on all vehicles.

The drive end housing is extended to enclose the shift lever mechanism and solenoid plunger. The solenoid flange is mounted on drive end housing and sealing compound is used between the flange and field frame. A compression type shift lever return spring located inside the solenoid case is used to operate the overrunning clutch. The primary circuit to the ignition coil is fed from the solenoid while the starter is operating.

With conventional ignition, to provide full battery voltage to the coil, the ignition resistor is by-passed during cranking. The resistor is by-passed at the "R" terminal or ignition terminal (See figure 78) on the starting motor.

With high energy ignition, there is no resistor, so there is no resistor by-pass wire from the starter motor. Since there is no longer any requirement for the electrical lead from the starter solenoid to the ignition coil, the "R" terminal (or ignition terminal) of the starter solenoid has been removed.

The solenoid contains two coil windings; the pull-in winding and the hold-in winding. Both windings are energized when ignition switch is closed to pull the plunger in and shift the drive pinion into mesh. The main contacts in the solenoid switch are closed to connect the battery directly to the cranking motor. Closing the main switch contacts will short out the pull-in winding. The magnetism produced by the hold-in winding is sufficient to hold the plunger in. When ignition switch is opened, the hold-in winding is disconnected from the battery; the shift lever spring withdraws the plunger from the solenoid opening the solenoid switch contacts while at the same time withdrawing the drive pinion from mesh.

STARTING SYSTEM OPERATION

When starter circuit is energized, the solenoid

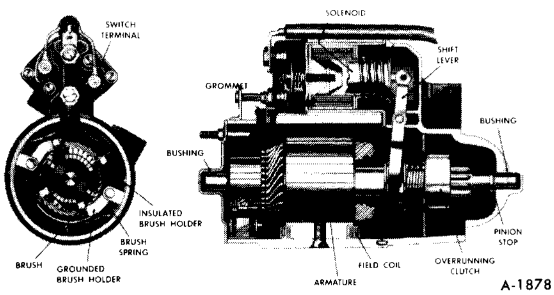


Figure 65—Starter Assembly

operated shift lever slides the pinion into mesh with the flywheel ring gear teeth. The rotary motion between the pinion and ring gear, provided by spiral splines on armature shaft, normally relieves tooth abutment on the first attempt to engage pinion and the engine flywheel ring gear. When the engine is started, pinion overrun protects the armature from excessive speed until the ignition or control switch is released, at which time the solenoid shift lever return spring causes the pinion to disengage. To prevent excessive overrun on vehicles equipped with these starting motors, the ignition or control switch must be released immediately when engine starts.

TROUBLE DIAGNOSIS

Wiring: Inspect the wiring for damage. Inspect all connections to the cranking motor, solenoid or magnetic switch, ignition switch or any other control switch, and battery, including all ground connections. Clean and tighten all connections as required.

Magnetic Switch or Solenoid and Control Switches: Inspect all switches to determine their condition. Connect a jumper lead around any switch suspected of being defective. If the system functions properly using this method, repair or replace the bypassed switch.

Motor: If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, remove the motor and follow the test procedures outlined.

Never operate the cranking motor more than 30 seconds at a time without pausing to allow it to cool for at least two minutes. Overheating, caused by excessive cranking will seriously damage the cranking motor.

STARTER REMOVAL

1. Disconnect batteries by removing ground straps and hoist vehicle.

2. Remove two attaching bolts and move starter for easier access to wires.

3. Note the position of the wires and disconnect the wires from starter.

4. Remove the starter.

CRANKING MOTOR TESTS

With the cranking motor removed from the engine, the pinion should be checked for freedom of operation by turning it on the screw shaft. The armature should be checked for freedom of rotation by prying the pinion with a screwdriver. Tight bearings, a bent armature shaft, or a loose pole shoe screw will cause the armature to not turn freely. If the armature does not turn freely the motor should be disassembled immediately. However, if the armature does rotate freely, the motor should be given a no-load test before disassembly.

NO-LOAD TEST (FIGURE 66)

Connect a voltmeter from the motor terminal to the motor frame, and use an rpm indicator to measure armature speed. Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch in the open position from the solenoid battery terminal to the solenoid switch terminal. Close the switch and compare the rpm, current, and voltage readings with the specifications at the end of this section.

It is not necessary to obtain the exact voltage specified, as an accurate interpretation can be made by recognizing that if the voltage is slightly higher the rpm will be proportionately higher, with the current remaining essentially unchanged. However, if the exact voltage is desired, a carbon pile connected across the battery can be used to reduce the voltage to the specified value. If the specified current draw does not include the solenoid, deduct from the ammeter reading the specified current draw of the solenoid hold-in winding. Make disconnections only with the switch open. Interpret the test results as follows:

1. Rated current draw and no-load speed indicates normal condition of the cranking motor.

2. Low free speed and high current draw indicates:

a. Too much friction—tight, dirty, or worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.

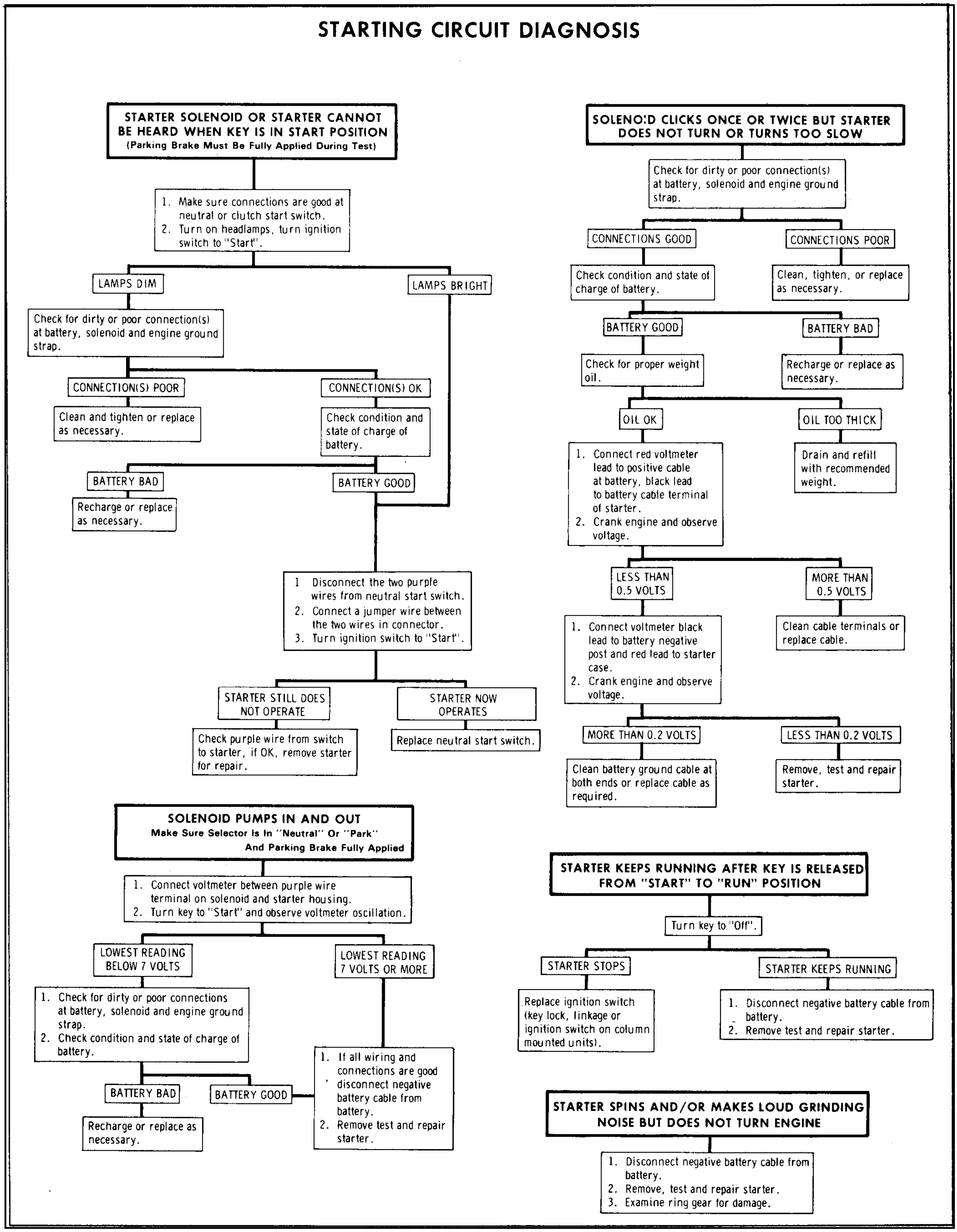
b. Shorted armature. This can be further checked on a growler after disassembly.

c. Grounded armature or fields. Check further after disassembly.

3. Failure to operate with high current draw indicates:

a. A direct ground in the terminal or fields.

b. "Frozen" bearings (this should have been determined by turning the armature by hand).



Starting Circuit Diagnosis

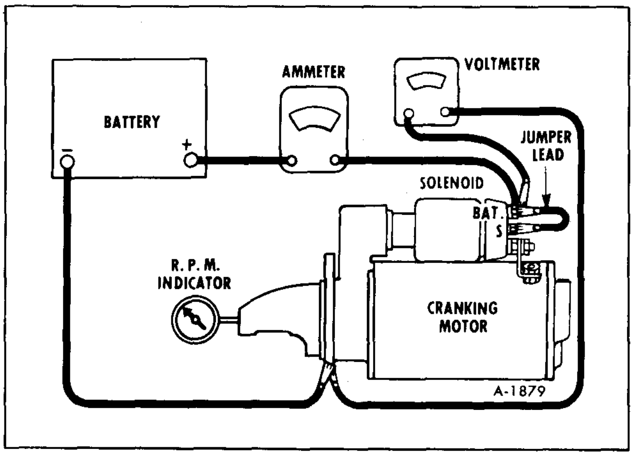


Figure 66—No-Load Test

4. Failure to operate with no current draw indicates:

a. Open field circuit. This can be checked after disassembly by inspecting internal connections and tracing circuit with a test lamp.

b. Open armature coils. Inspect the commutator for badly burned bars after disassembly.

c. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.

5. Low no-load speed and low current draw indicates:

a. High internal resistance due to poor connections, defective leads, dirty commutator and causes listed under Number 4.

6. High free speed and high current draw indicate shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

DISASSEMBLY (FIGURE 67)

If the motor does not perform in accordance with published specifications, it may need to be disassembled for further testing of the components. Normally the cranking motor should be disassembled only so far as is necessary to make repair or replacement of the defective parts. As a precaution, it is suggested that safety glasses be worn when disassembling or assembling the cranking motor. Following are general instructions for disassembling a typical overrunning clutch drive cranking motor:

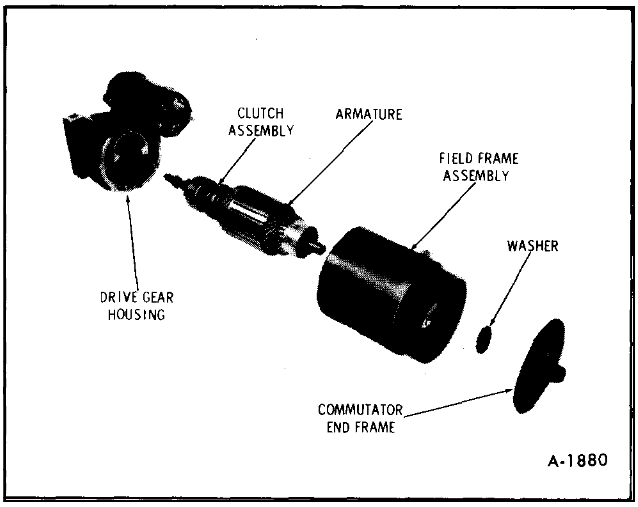


Figure 67—Starter Assembly Components

1. Disconnect the field coil connector from the motor solenoid terminal.

2. Remove through-bolts, then remove commutator end frame and washer.

3. Remove field frame assembly, armature, and clutch assembly from drive gear housing.

4. If necessary to remove overrunning clutch from armature shaft, proceed as follows:

a. Remove thrust collar from armature shaft. (figure 68)

b. Slide a standard half-inch pipe coupling or other metal cylinder of suitable size (an old pinion can be used if available) over shaft against retainer to be used as a driving tool. (figure 69) With armature shaft supported on wood block, tap end of driving tool until retainer clears snap ring.

c. Remove snap ring from groove in shaft

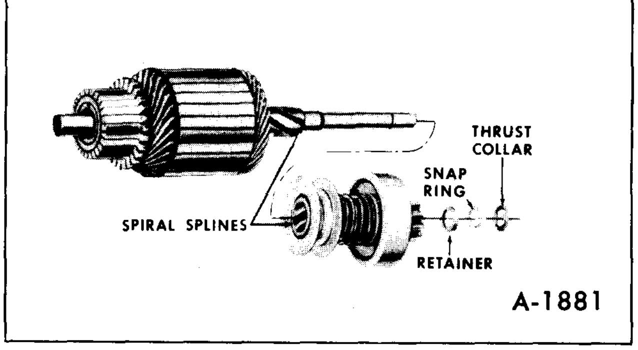


Figure 68—Starter Clutch

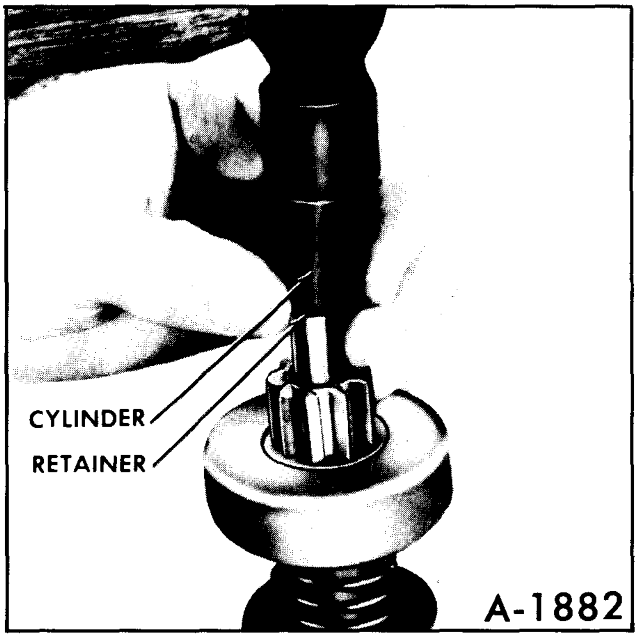


Figure 69—Removing Pinion Retainer

using pliers or other suitable tool. If the snap ring is distorted during removal, it will be necessary to use a new one upon reassembly.

d. Remove retainer and clutch assembly from armature shaft.

5. If necessary to replace brush holder parts, refer to Figure 70, then proceed as follows:

a. Remove brush holder pivot pin which positions one insulated and one grounded brush.

b. Remove brush spring.

c. Replace brushes as necessary.

6. If necessary to remove solenoid assembly or shift lever, proceed as follows:

a. Remove solenoid to drive gear housing attaching screws, then remove solenoid assembly. (figure 71)

b. To remove shift lever and/or plunger, remove shift lever pivot bolt (figure 72).

c. Disassemble shift lever from plunger.

CLEANING, INSPECTION AND TESTS

1. Clean all starting motor parts, but DO NOT USE GREASE DISSOLVING SOLVENTS FOR CLEANING THE OVERRUNNING CLUTCH, ARMATURE, AND FIELD COILS, since such solvent would dissolve the grease packed in the clutch mechanism and would damage armature and field coil insulation.

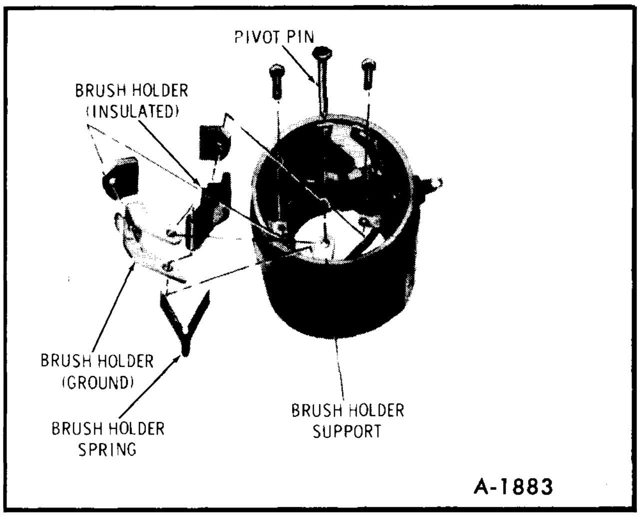


Figure70—Brush Installation

2. Test overrunning clutch action. The pinion should turn freely in the overruning direction. Check pinion teeth to see that they have not been chipped, cracked, or excessively worn. Replace clutch if worn or damaged.

3. Check brush holders to see that they are not deformed or bent and will properly hold brushes against the commutator.

4. Check fit of armature shaft in bushing in drive

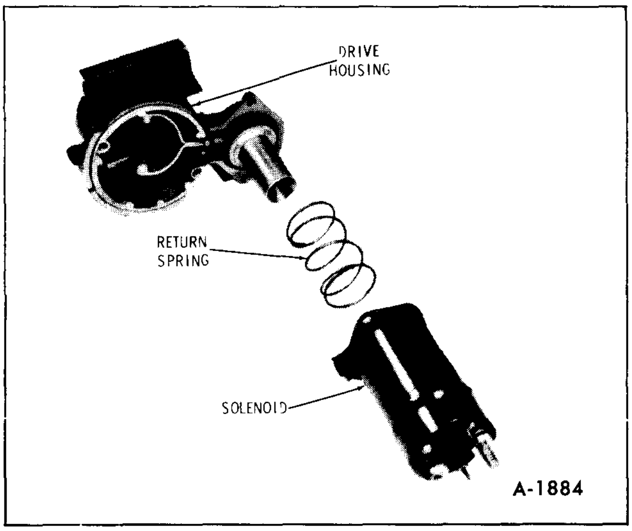


Figure 71—Solenoid Removal

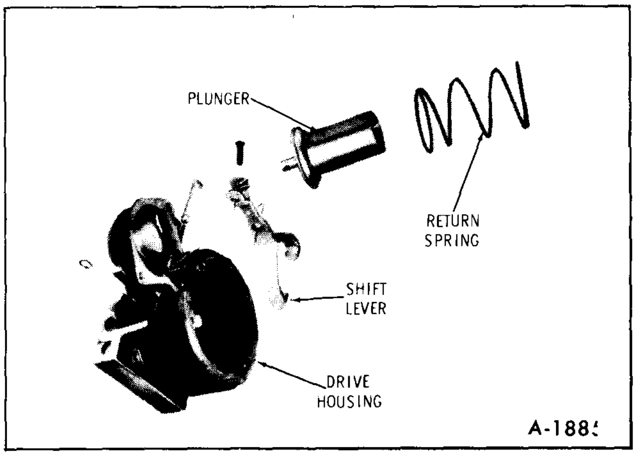


Figure 72—Shift Lever Removal

housing. Shaft should fit snugly in the bushing. If the bushing is worn, it should be replaced.

5. Inspect armature commutator. If commutator is rough or out-of-round, it should be turned down, do not undercut or turn to less than 1.650" O.D. Inspect the points where the armature conductors join the commutator bars to make sure they have a good connection. A burned commutator bar is usually evidence of a poor connection.

6. If test equipment is available:

a. Check the armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. If saw blade vibrates, armature is shorted. Recheck after cleaning between the commutator bars. If saw blade still vibrates, replace the armature.

b. Using a test lamp, place one lead on the shunt coil terminal and connect the other lead to a ground brush. (figure 73).

NOTE: This test should be made from both ground brushes to insure continuity through both brushes and leads. If the lamp fails to light, the field coil is open and will require repair or replacement.

c. Using a test lamp, place one lead on the series coil terminal and the other lead on the insulated brush. (figure 74) If the lamp fails to light, the series coil is open and will require repair or replacement.

NOTE: This test should be made from each insulated brush to check brush and lead continuity.

d. Using a test lamp, place one lead on the grounded brush holder and the other lead on either

Figure 73—Checking Shunt Field Coil

insulated brush. (figure 75) If the lamp lights, a grounded series coil is indicated and must be repaired or replaced.

e. Check the current draw of the solenoid winding as follows: (figure 76).

If solenoid is not removed from starting motor, the connector strap must be removed from the terminal on the solenoid before making these tests. Complete tests in a minimum of time to prevent overheating of the solenoid.

To check hold-in winding, connect an ammeter and a variable resistance in series with a 12-volt battery and the "switch" terminal on the solenoid. Connect a voltmeter to the "switch" terminal and to ground. Adjust the voltage to 10 volts and note the ammeter reading. It should be 14.5 to 16.5 amperes.

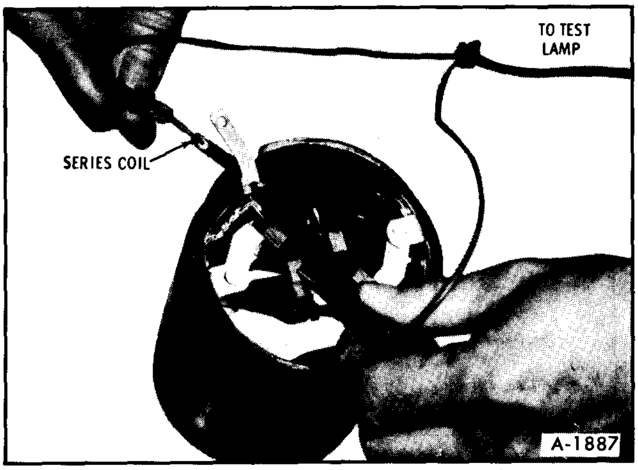


Figure 74—Checking Series Field Coil

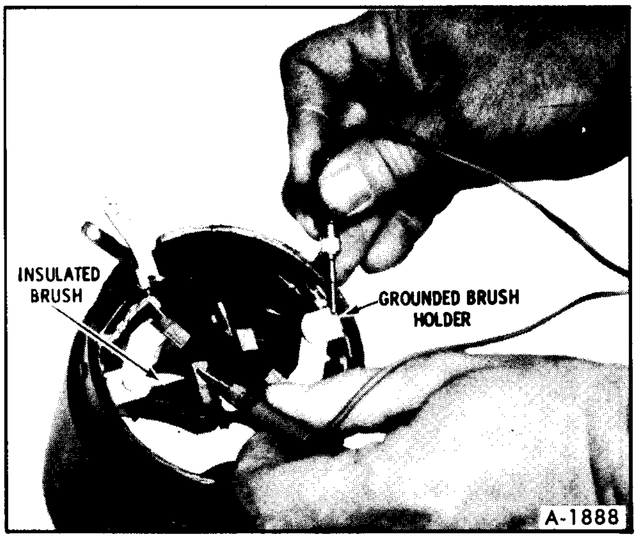


Figure 75—Checking Field Coil for Ground

To check both windings, connect the ammeter, variable resistance and voltmeter as for previous test. Ground the solenoid motor terminal. Adjust the voltage to 10 volts and note the ammeter reading. It should be 41 to 47 amperes for all starting motors.

Current draw readings that are over specifications indicate shorted turns or a ground in the windings of the solenoid and the solenoid should be replaced. Current draw readings that are under specifications indicate excessive resistance. No reading indicates an open circuit. Check connections then replace solenoid if necessary.

ASSEMBLY

1. If the solenoid assembly or shift lever was removed, proceed as follows:

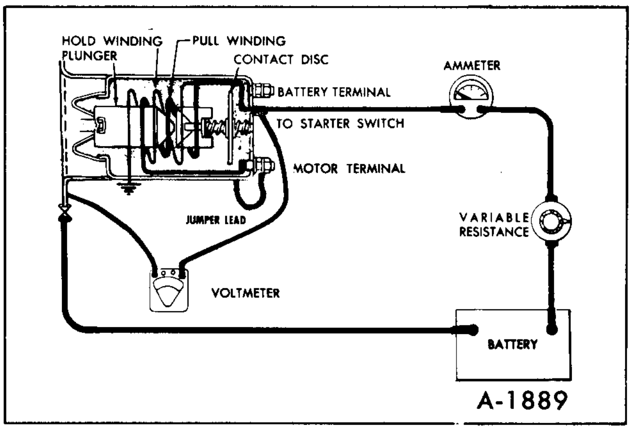


Figure 76—Checking Solenoid Wiring

a. Assemble shift lever and plunger.

b. Position shift lever and plunger assembly in drive gear housing and install lever pivot bolt. (figure 72)

c. Install solenoid assembly to drive gear housing. (figure 71)

2. If the overrunning clutch was removed from the armature shaft, assemble as follows:

a. Lubricate drive end of armature shaft with lubricant 1960954 or equivalent.

b. Slide clutch assembly onto armature shaft with pinion away from armature. (figure 68)

c. Slide retainer onto shaft with cupped surface facing away from clutch assembly.

d. Install snap ring into groove on armature shaft.

e. Assemble thrust collar onto shaft with shoulder next to snap ring.

f. Position retainer and thrust collar next to snap ring. Using two pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer and is held securely in groove in armature shaft. (figure 77)

3. Lubricate drive gear housing bushing with lubricant 1960954 or equivalent.

4. With thrust collar in place against snap ring and retainer, slide armature and clutch assembly into

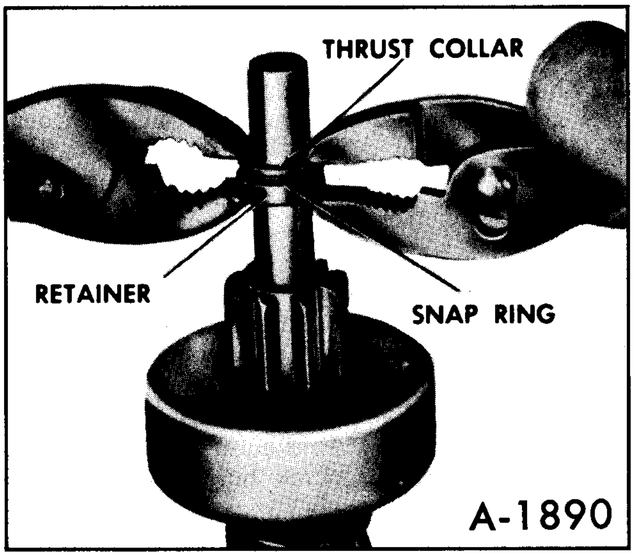


Figure 77—Installing Retainer and Snap Ring

drive gear housing and engage clutch with shift lever yoke.

5. Apply sealer, No. 1050026 or equivalent on solenoid flange as shown in (figure 78).

6. Position field frame against drive gear housing using care to prevent damage to brushes.

7. Lubricate commutator end-frame bushing with lubricant 1960954 or equivalent.

8. Install washer on armature shaft and slide end frame onto shaft then install and tighten through-bolts.

9. Connect the field coil connector to the motor solenoid terminal.

10. Check pinion clearance as outlined under PINION CLEARANCE.

PINION CLEARANCE

Whenever the cranking motor has been disassembled or the solenoid has been replaced, it is necessary to check the pinion clearance. Pinion clearance must be correct to prevent the buttons on the shift lever yoke from rubbing on the clutch collar during cranking.

To check, connect a voltage source of approximately 6 volts between the solenoid switch terminal and ground. (figure 78)

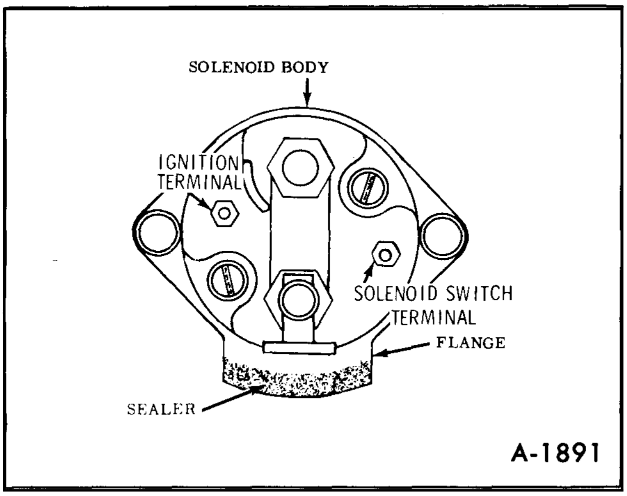


Figure 78—Solenoid Terminals and Sealing

NOTE: If a 6-volt battery is not available, a 12-volt battery may be used PROVIDING ONLY THREE CELLS ARE CONNECTED IN SERIES. TO PREVENT MOTORING, CONNECT A HEAVY JUMPER LEAD FROM THE SOLENOID MOTOR TERMINAL TO GROUND.

Energize the solenoid to shift the clutch, push the pinion back as far as possible to take up any movement, and check the clearance with a feeler gauge. (figure 79). The clearance should be .010" to .140".

Means for adjusting pinion clearance is not provided on the starter motor. If the clearance does not fall within limits, check for improper installation and replace all worn parts.

STARTER INSTALLATION

1. Connect the wires to the starter solenoid.

2. Position starter motor and secure with two bolts.

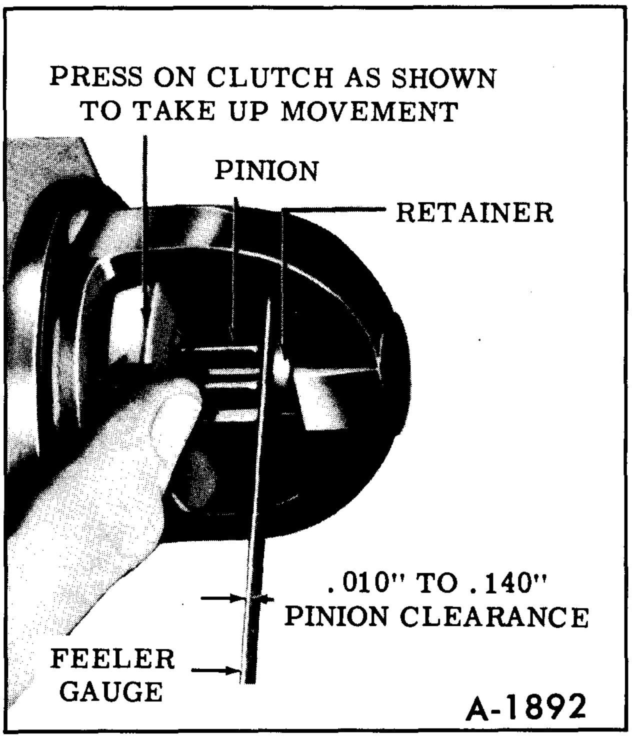


Figure 79—Checking Pinion Clearance

STARTER SPECIFICATIONS

STARTER MODEL	1108761	1108522
Make	Delco-Remy	Delco-Remy
Series	10MT	10MT
Type	100	100
Rotation (Viewed at Drive End)	CW	CW
No Load Test		
Volts	9	9
Minimum Amps*	65*	65*
Maximum Amps*	95*	95*
Minimum RPM	7,500	7,500
Maximum RPM	10,500	10,500
Pinion Clearance	010"-.140"	.010"-.140"
*Includes Solenoid		
STARTER SOLENOID		
Model	1114356	1114356
Rated Voltage	12	12
Current Consumption		
Pull-In Winding		
Amps	13.0-15.5	13.0-15.5
Volts	5	5
Hold-In Winding		
Amps	14.5-16.5	14.5-16.5
Volts	10	10
STARTER MODEL		1108522

IMPORTANT: 1975 vehicles with 1974 certified engines are equipped with starter model 1108522. 1975 and 1976 certified engines are equipped with starter model 1108761.

SPECIAL TOOLS

J-24642	HEI Module Tester
J-26290	SI Delcotron Tester
BT-33-73F	Belt Tension Gauge

425 TRAN
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SECTION 7
TRANSMISSION

Contents of this section are listed below:

SUBJECT	PAGE NO.
General Information	7-1
Trouble Diagnosis	7-10
On Vehicle Servicing	7-25
Transmission Replacement	7-29
Transmission Overhaul	7-32
Transmission Specifications	7-74
Special Tools	7-74

GENERAL INFORMATION

DESCRIPTION

The Turbo Hydra-Matic transmission, Figure 1, is a fully automatic transmission used for front wheel drive applications.

The Turbo Hydra-matic transmission consists primarily of a three-element hydraulic torque converter, a dual sprocket and link assembly and a compound planetary gear set. Three multiple-disc clutches, a sprag unit, a roller clutch unit, and two bands provide the friction elements required to obtain the desired functions of the compound planetary gear set.

The torque converter, the dual sprocket and link, the clutches, the sprag and roller clutch, couple the engine to the planetary gears, providing three forward speeds and one reverse. The torque converter when required will supplement the gears by multiplying engine torque.

The torque converter is of welded construction and is serviced as an assembly. The unit is made up of two vaned sections, or halves, that face each other in an oil filled housing. The pump half of the converter is connected to the engine and the turbine half is, in effect, connected to the transmission.

The torque converter couples the engine to the planetary gear set through the use of a drive sprocket, a link assembly, and a driven sprocket. Clockwise engine torque turns the drive sprocket clockwise, which, in turn, drives the driven sprocket in a clockwise direction. This in effect is a reverse in the direction of engine torque due to the side mounting of the gear unit.

When the engine makes the converter pump revolve, it sends oil against the turbine, making it revolve also. The oil then returns in a circular flow back to the converter pump, continuing this flow as long as the engine is running.

The converter also has a smaller vaned section, called a stator, that funnels the oil back to the converter pump through smaller openings, at increased speed. The speeded up oil directs additional force to the engine-driven converter pump, thereby multiplying engine torque.

A hydraulic system pressurized by an internal-external type gear pump provides the working pressure required to operate the friction elements and automatic controls.

External control connections to the transmission are:

Manual Linkage—To select the desired operating range.

Engine Vacuum—To operate a vacuum modulator unit.

12 Volt Electrical Signal—To operate an electrical detent solenoid.

Gear or Torque ratios of the transmission are as follows:

First = 2.48:1 gear ratio

Second = 1.48:1 gear ratio

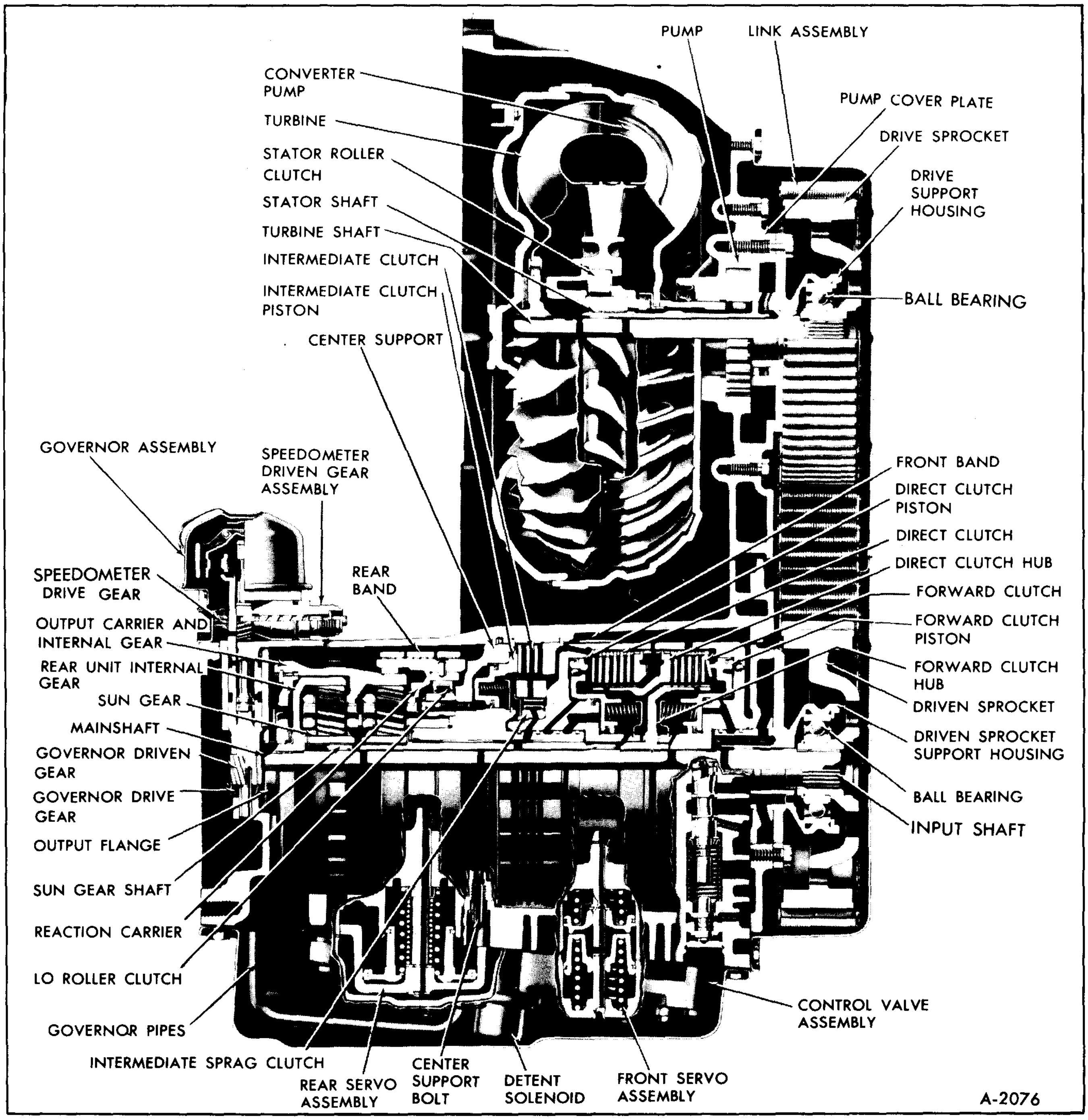


Figure 1—Turbo Hydra-matic Transmission

Third = 1.0:1 gear ratio

Reverse = 2.08:1 gear ratio

First and reverse gears can be multiplied by as much as 2.2:1, depending upon the slip speed of the converter pump and turbine.

A vacuum modulator is used to sense engine torque input to the transmission automatically. The vacuum modulator transmits this signal to the pressure regulator, which controls line pressure, so that all torque requirements of the transmission are met and proper shift spacing is obtained at all throttle openings.

The downshift solenoid is activated by an adjustable switch at the accelerator pedal. When the throttle is opened sufficiently to close this switch, the solenoid in the transmission is activated, causing a downshift at speeds below approximately 70 miles per hour. At lower speeds, downshifts will occur at lesser throttle openings without use of the switch.

The oil cooler is located in the right hand tank of the radiator. The transmission is cooled by directing oil from the converter to the radiator. Oil returning from the radiator feeds the transmission lubrication system.

The oil system incorporates an intake pipe and filter assembly. The transmission fluid and filter assembly should be replaced after each 12,000 miles or 12 months. In addition, in the event of a transmission malfunction that resulted in metal shavings or clutch plate material, the filter and fluid should be changed; and the oil cooler and cooler lines should be flushed.

The transmission quadrant has six selector positions that enable the driver to control the operation of the transmission under various driving conditions. The six selector positions appear on the quadrant in the following sequence, from left to right; PARK-park, R-reverse, N-neutral, D-drive, S-super, L-lo.

PARK—Park position positively locks the output flange to the transmission case by means of a locking pawl and prevents the vehicle from rolling either forward or backward. For this reason, it is recommended that the engine be started with transmission selector lever in Park position. If it is necessary to re-start the engine with vehicle rolling, place selector lever in Neutral and start the engine.

R—Reverse enables the vehicle to be operated in a reverse direction.

N—Neutral position enables the engine to be started and run without driving the vehicle. It is recommended that Neutral be used to start the engine only if it is necessary to re-start the engine with the vehicle rolling. At all other times use Park.

D—Drive is used for all normal driving conditions and maximum economy. Drive has three gear ratios from starting to direct drive. Downshifts are available for safe passing by depressing the accelerator pedal.

S—Super adds performance for congested traffic or engine braking in hilly terrain. The Super range has the same starting gear ratio as Drive, but prevents the transmission from shifting above second speed to retain acceleration when extra performance is desired.

L—Lo range permits operation at a lower gear ratio, and should be used where maximum engine braking is desired, such as in descending a steep grade. When selector lever is moved from Drive to Lo range at normal highway speeds, the transmission will shift to second gear and remain in second gear until vehicle speed is reduced to approximately 45 mph. The transmission will then shift to first gear and remain in first gear regardless of vehicle or engine speed, until selector lever is moved back into either Super or Drive position.

HYDRAULIC SYSTEM

PRESSURE CONTROL

The transmission is controlled automatically by a hydraulic system, Figure 2. Hydraulic pressure is supplied by the transmission oil pump, which is engine driven. Main line pressure is controlled by a pressure regulator valve train located in the transmission case and by the vacuum modulator which is connected to engine vacuum. The pressure regulator controls line pressure automatically, in response to a pressure signal from a modulator valve in such a way that the torque requirements of the transmission clutches are met and proper shift spacing is obtained at all throttle openings and vehicle speeds.

To control line pressure properly, modulator pressure is used which varies in the same manner as torque input to the transmission. Since the torque input to the clutches is the product of engine torque and converter ratio, modulator pressure must compensate for changes in either or both of these.

To meet these requirements, modulator pressure is regulated by engine vacuum, which is an indicator of engine torque, (Governor pressure also controls modulator pressure). It will decrease with an increase in vehicle speed to compensate for the changing converter torque ratio, by virture of the governor pressure influence.

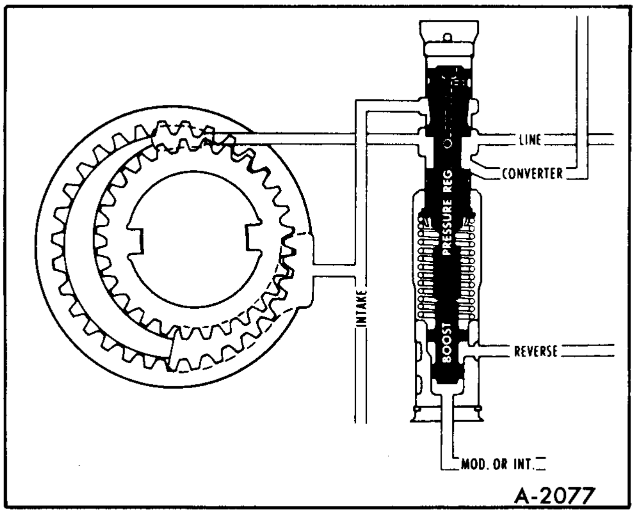


Figure 2—Pressure Control

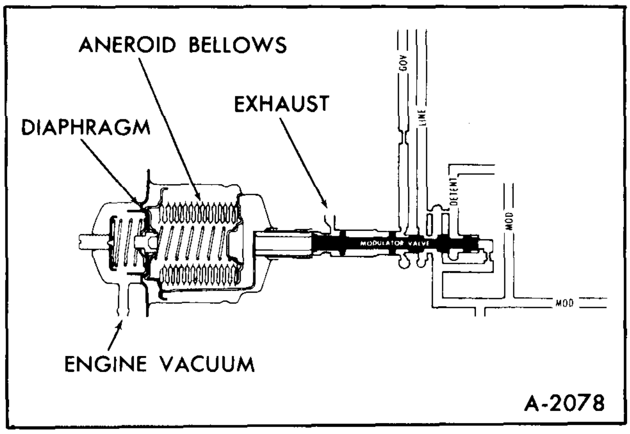


Figure 3—Vacuum Modulator Assembly

VACUUM MODULATOR ASSEMBLY

The engine vacuum signal is received by the vacuum modulator, Figure 3, which consists of an evacuated metal bellows, a diaphragm and a spring. These are so arranged that the bellows and spring apply a force that acts on the modulator valve so that it increases modulator pressure.

Engine vacuum and the enclosed spring oppose the bellows and spring to control modulator pressure.

To reduce the effect of altitude on shift points, the effective area of the diaphragm is different than that of the bellows. Atmospheric pressure acts on the resulting differential area to reduce modulator pressure.

GOVERNOR ASSEMBLY

The vehicle speed signal to the transmission is supplied by the governor, which is driven by the output flange. The governor consists of flyweights and a regulator valve. Centrifugal force of the flyweights is imposed on the regulator valve, causing it to regulate a pressure signal that increases with speed.

Governor pressure acts on the modulator valve to cause modulator pressure to decrease as vehicle speed increases.

FUNCTIONS OF VALVES AND HYDRAULIC CONTROL UNITS

Line Pressure Regulator

Regulates line pressure to satisfy engine torque.

Manual Valve

Establishes the range of transmission operation, PARK, R, N, D, S, or L, as selected by the vehicle operator through the manual selector lever.

Governor Assembly

Generates a speed sensitive oil pressure that increases with output shaft or vehicle speed. Governor pressure is used to control the shift points and modulator pressure regulation.

Vacuum Modulator Valve

Provides modulator pressure that senses engine torque and vehicle speed. The vacuum modulator is used to vary the shift points according to throttle opening and to raise line pressure proportional to input torque to the transmission.

1-2 Shift Valve

Activates the 1-2 and 2-1 shifts.

1-2 Regulator Valve

Controls the flow of modulator pressure to the 1-2 shift valve to regulate the minimum shift point.

1-2 Detent Valve

Senses regulated modulator pressure tending to hold 1-2 shift valve downshifted and provides an area for detent pressure for detent 2-1 shifts.

2-3 Shift Valve

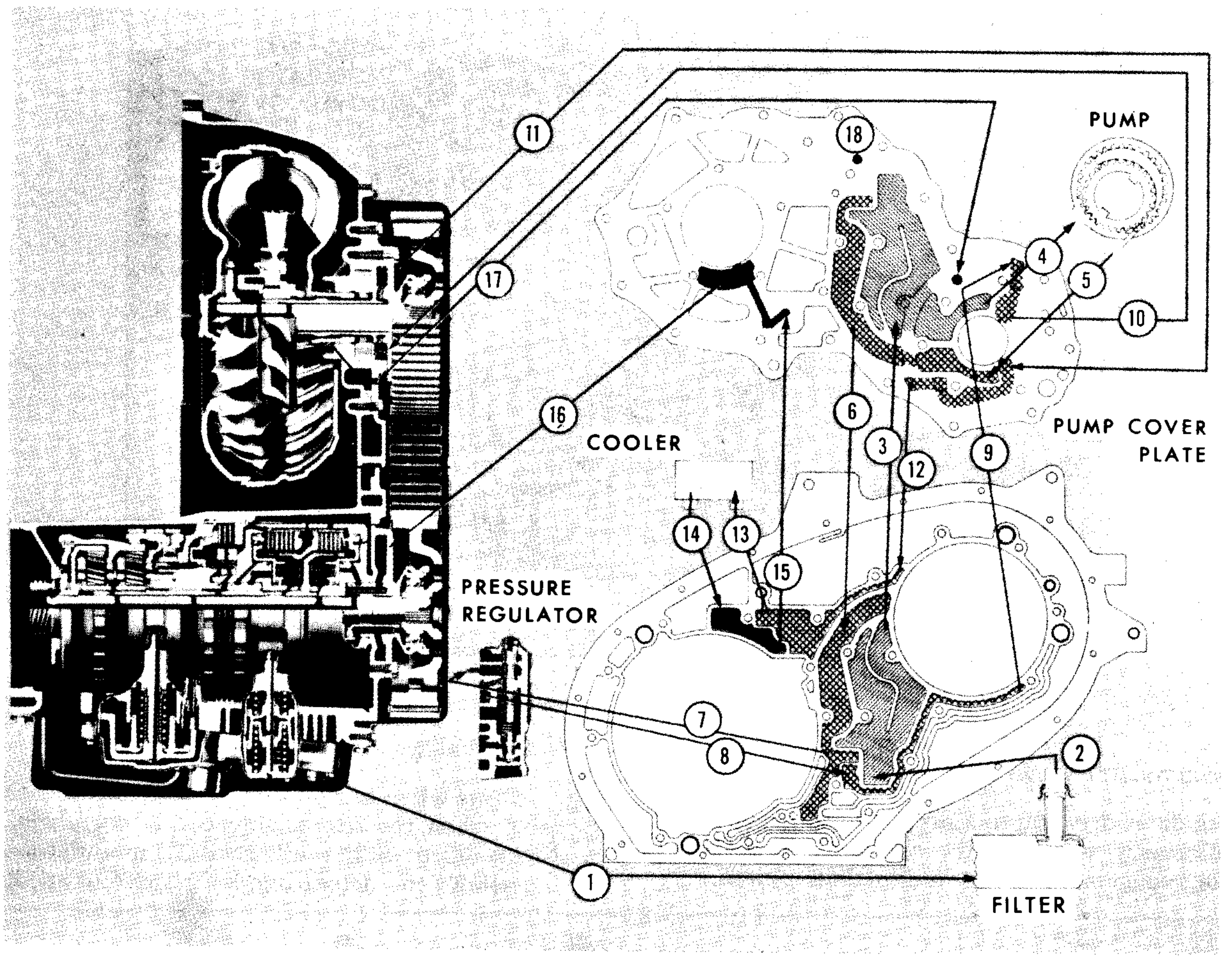
Activates the 2-3 and 3-2 shifts.

2-3 Modulator Valve

Senses modulator pressure to apply a variable force that tends to hold the 2-3 shift valve downshifted.

3-2 Valve

Shuts off modulator pressure from acting on the shift valves after the direct clutch has been applied. This allows fairly heavy throttle operation in third speed without downshifting. In third speed, detent pressure or modulator pressure above 87 psi can be directed to the shift valves to provide the downshift forces.



1 OIL FROM SUMP TO FILTER
2 FILTER TO CASE PASSAGE
3 CASE PASSAGE TO PUMP COVER PLATE PASSAGE
4 PUMP COVER PLATE PASSAGE TO PUMP
5 PUMP TO PUMP COVER PLATE PASSAGE
6 PUMP COVER PLATE PASSAGE TO CASE PASSAGE
7 CASE PASSAGE TO PRESSURE REGULATOR VALVE
8 PRESSURE REGULATOR VALVE TO CASE PASSAGE
9 CASE PASSAGE TO PUMP COVER PLATE PASSAGE
10 PUMP COVER PLATE PASSAGE TO CONVERTER
11 CONVERTER TO PUMP COVER PLATE PASSAGE
12 PUMP COVER PLATE PASSAGE TO CASE PASSAGE
13 CASE PASSAGE TO COOLER
14 COOLER RETURN TO CASE PASSAGE
15 CASE PASSAGE TO PUMP COVER PLATE PASSAGE
16 PUMP COVER PLATE PASSAGE TO TRANSMISSION POWER TRAIN (ALL INTERNAL LUBRICATION)
NOTE: THE NUMBERS IN THE CROSS SECTION INDICATE THAT THERE ARE ADDITIONAL LUBRICATION HOLES IN THIS AREA THAT ARE NOT SHOWN IN THE CROSS SECTION
17 FRONT SEAL DRAIN BACK HOLE
18 PRESSURE REGULATOR VENT HOLE

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Figure 4—Lubrication Chart

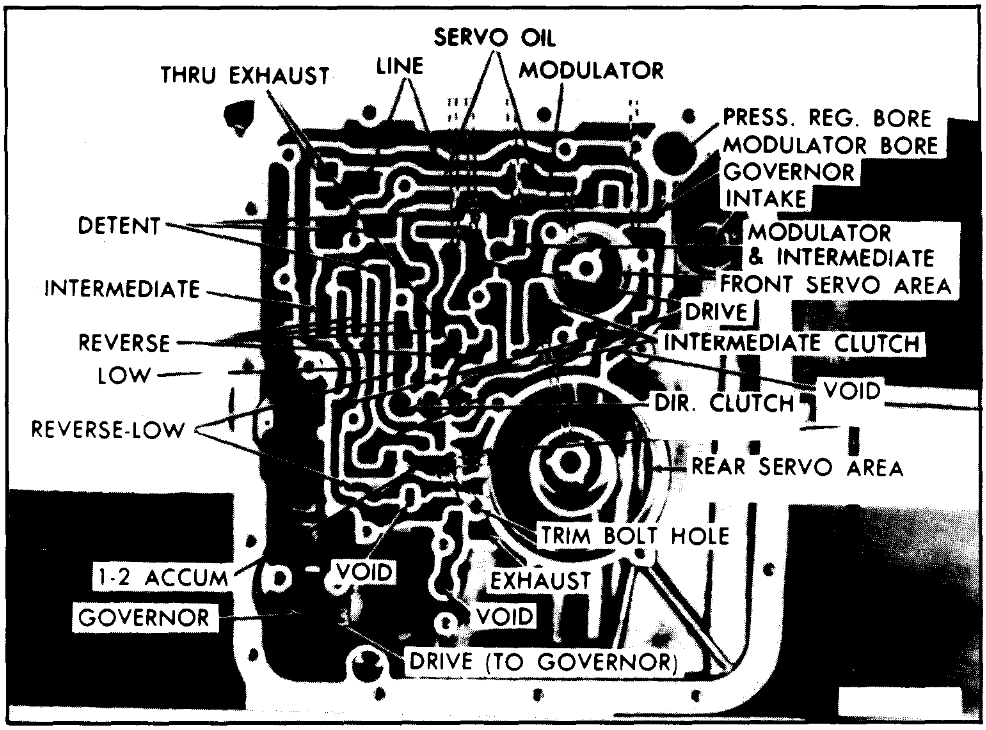


Figure 5—Case Oil Passages—Bottom

1-2 Accumulator Valve

Regulates drive oil to a proportional lesser value that increases as modulator pressure increases, to control engagement of the intermediate clutch.

Detent Valve

Shifts when line oil is exhausted at the end of the valve when the detent solenoid is energized. This directs detent oil to the 1-2 and 2-3 modulator valves and allows the detent regulator valve to regulate.

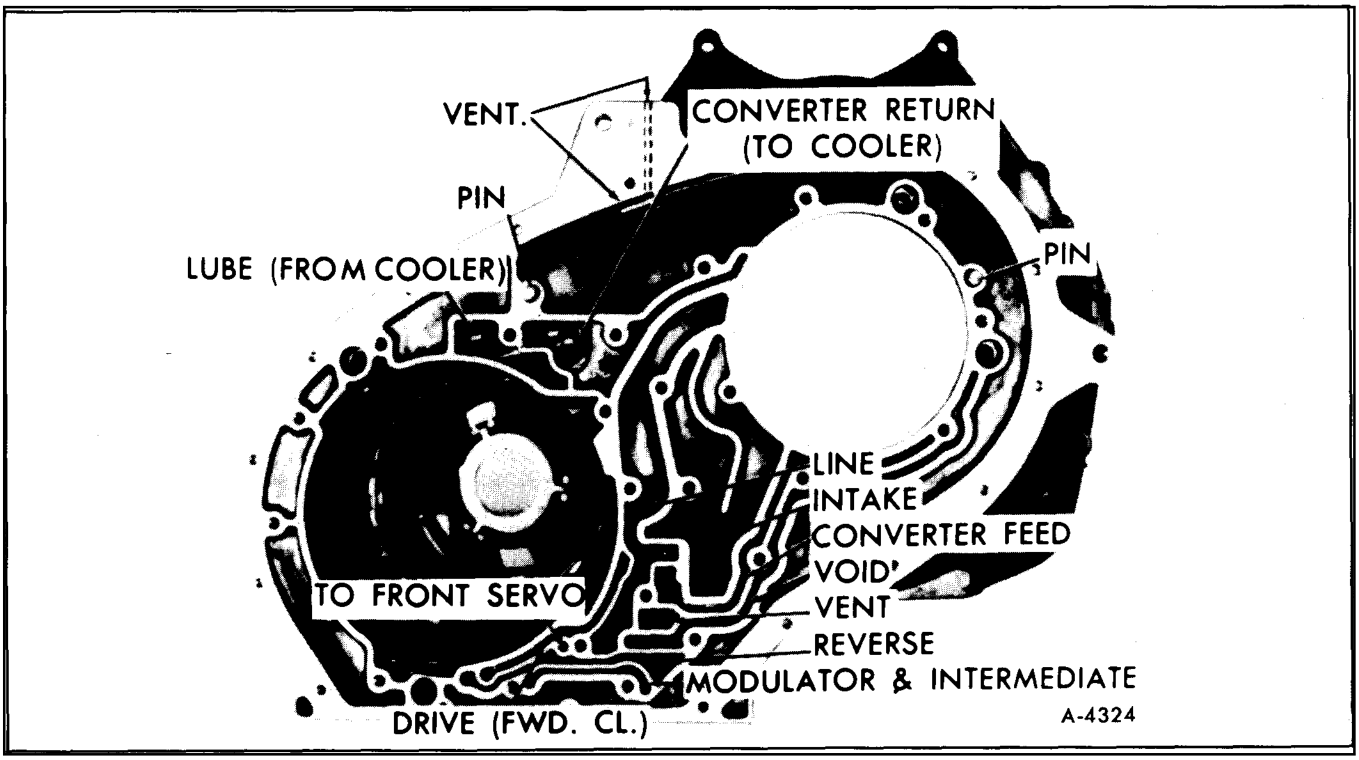


Figure 6—Case Oil Passages—Rear

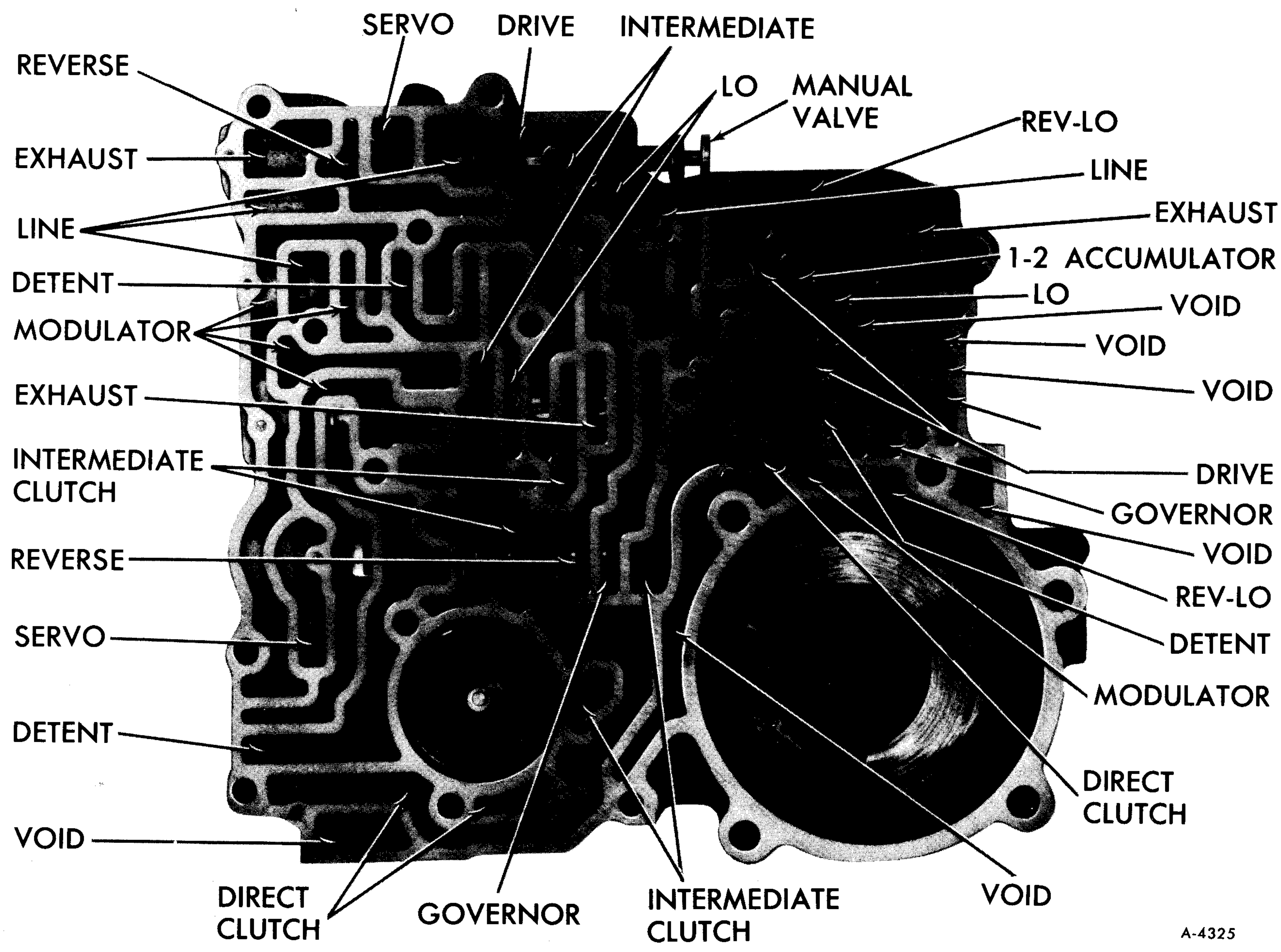


Figure 7—Control Valve Body

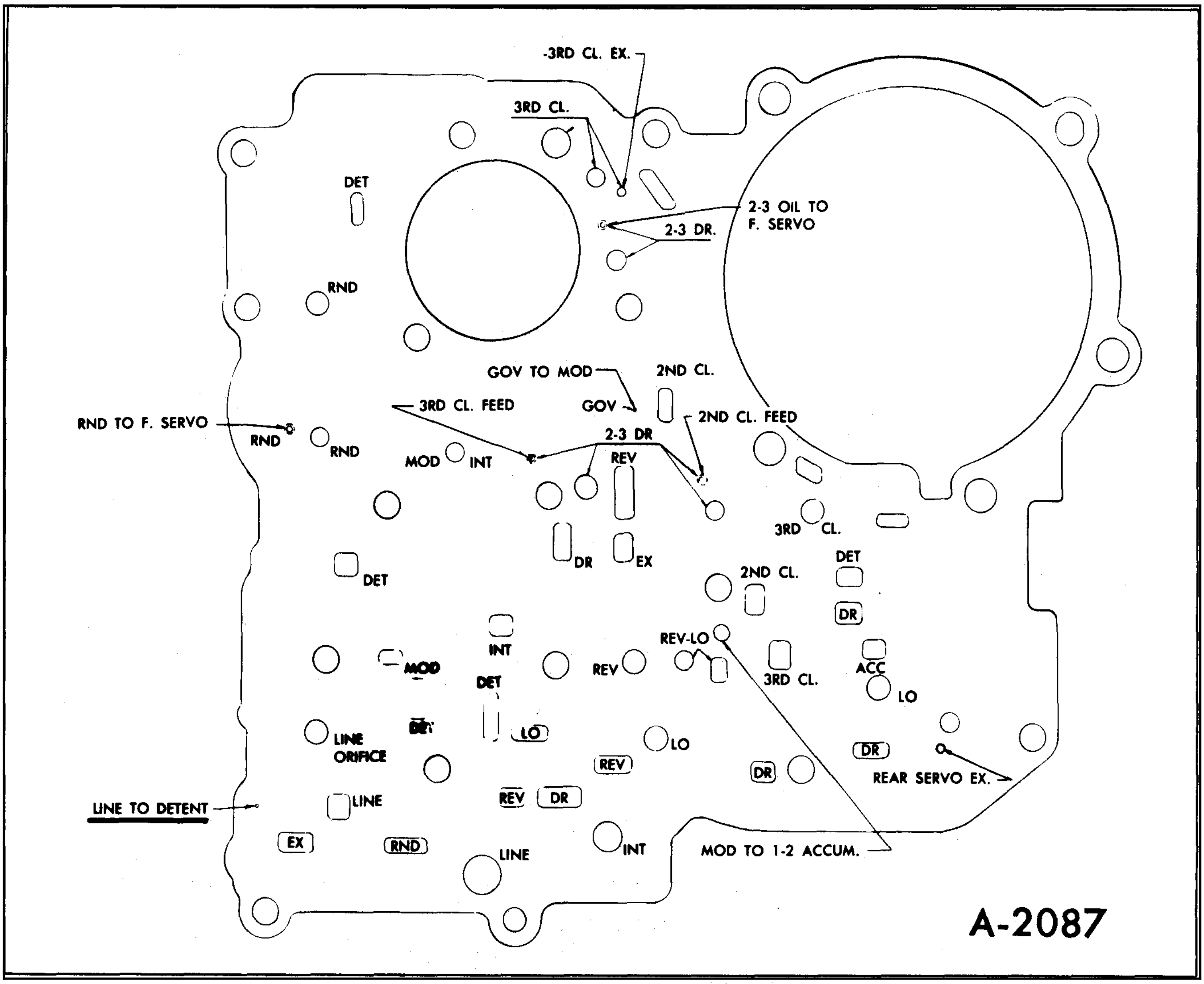


Figure 8—Spacer to Control Valve Assembly

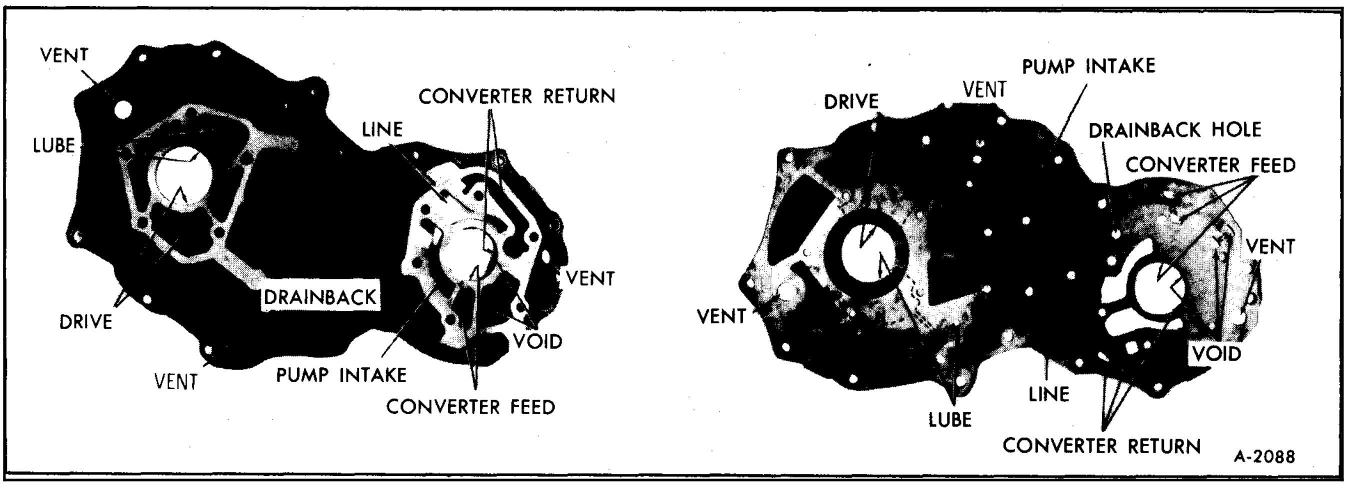
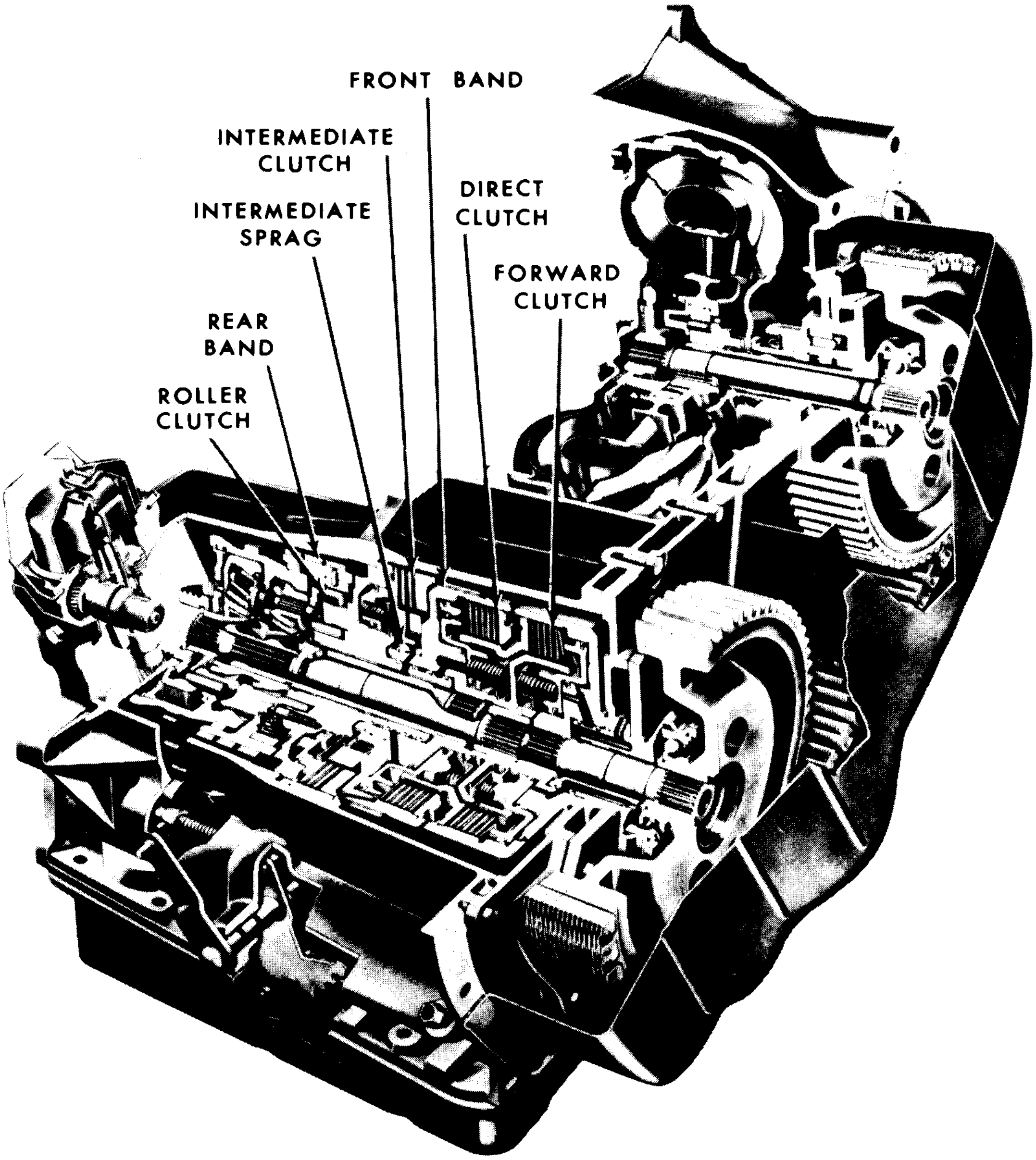


Figure 9—Pump Cover Oil Passages



SELECTOR POSITION	FORWARD CLUTCH	DIRECT CLUTCH	FRONT BAND	INT. CLUTCH	INT. SPRAG	ROLLER CLUTCH	REAR BAND
PARK—NEUT.	OFF	OFF	OFF	OFF	OFF	OFF	OFF
DRIVE 1 LEFT 2 3	ON ON ON	OFF OFF ON	OFF OFF OFF	OFF ON ON	OFF ON OFF	ON OFF OFF	OFF OFF OFF
DRIVE 1 RIGHT 2	ON ON	OFF OFF	OFF ON	OFF ON	OFF ON	ON OFF	OFF OFF
LO 1 2	ON ON	OFF OFF	OFF ON	OFF ON	OFF ON	ON OFF	ON OFF
REV.	OFF	ON	OFF	OFF	OFF	OFF	ON

Figure 10—Clutch, Band and Sprag Application

Detent Regulator Valve

When the detent valve shifts, the detent regulator is freed to allow drive oil to enter the detent passage and thus becomes regulated at 70 psi. Detent pressures will also flow into the modulator passage which flows to the shift valves. Detent pressure acting on the modulator valve limits the low limit of modulator pressure to the value of detent pressure.

Rear Servo and Accumulator Assembly

The rear servo piston applies the rear band for engine braking in Lo range 1st gear. It applies the band in Reverse to hold the reaction carrier to provide the reverse gear ratio.

On the 1-2 shift in Drive or Super, the rear accumulator piston serves as an accumulator for the intermediate clutch to provide a smooth shift.

Front Servo

The front servo piston applies the front band to provide engine braking in 2nd gear in Super and Lo ranges. The front accumulator piston cushions the apply of the direct clutch, and in conjunction with a series of check balls controlling orifices, is a part of the timing for the release of the direct clutch.

To prevent the apply of the front band in Neutral, Drive and Reverse ranges, oil is directed from the manual valve to the release side of the servo piston.

In Drive the servo release oil from the manual valve is used to charge the servo in preparation for the apply of the direct clutch.

Direct clutch oil is directed to the front servo accumulator piston where spring force plus direct clutch pressure stroke the piston up against the force of servo release oil. This lowers the clutch apply pressure for a smooth engagement.

The release of the direct clutch and the exhausting of the front servo accumulator is slowed down by the three check balls and three orifices which permits a soft return of the drive load to the intermediate roller clutch and also allows engine rpm to increase during a detent 3-2 downshift in preparation for the lower gear ratio, which results in a smooth shift and better acceleration.

IMPORTANT: Oil flow circuits and power flow charts are the same as used in 1974 and are not included in this manual.

TROUBLE DIAGNOSIS

FLUID LEAKAGE PRECAUTIONS

The precautions that must be observed to prevent fluid leaks are as follows:

1. Use new gaskets and O-ring seals whenever there is a disassembly.

2. Use a very small amount of petrolatum to hold gaskets and thrust washers in place during assembly, or to seal gaskets. Never use gasket paste or shellac.

3. Make sure that composition cork and paper gaskets are not wrinkled or creased when installed. Make sure that gaskets have not stretched or shrunk during storage.

4. Make sure the square type O-ring seals are installed squarely and are not twisted during assembly.

5. Make sure that mating surfaces of castings are flat and smooth, free of deep scratches, chips, and burrs.

6. Torque bolts to proper torque.

POINTS OF POSSIBLE OIL LEAKS

When checking for oil leaks, first determine whether leak originates from transmission or engine. The original factory fill fluid in the transmission is formulated with a red aniline dye to assist in locating leaks. However, the fluid color will change after a short time in service. Red dye appearing in the leaking oil will give positive identification as to the location of the leak.

If oil leak is found to be in transmission, check for leak in following areas:

REAR END

It will be necessary to remove converter cover to determine location of leaks at rear end. To correct leaks at rear end, it will be necessary to remove transmission from vehicle.

1. Pump oil seal leak — Check pump oil seal to make certain it is correctly installed and not damaged.

When installing a new pump oil seal, make certain that bore is free from foreign material and that garter spring on seal is correctly positioned. Check finish of converter neck and bearing surface in pump body.

2. Pump assembly-to-case O-ring damaged. Also check case bore.

3. Converter — Inspect converter for indications of leakage.

4. Vent fitting damaged.

5. Pump attaching bolts loose.

6. Porous casting (pump or case).

7. Pump drainback hole not open.

COVER AND PLATE ASSEMBLY SPROCKET HOUSING LEAK

1. Attaching bolts not correctly torqued.

2. Housing to case gasket improperly installed or damaged.

3. Housing to case gasket face not flat.

FINAL DRIVE TO TRANSMISSION LEAK

1. Attaching bolts not correctly torqued.

2. Final drive to transmission gasket improperly installed or damaged.

3. Mounting surfaces not flat.

TRANSMISSION CASE

1. Speedometer driven gear housing retainer attaching screw loose. Tighten to 18 foot-pounds.

2. Speedometer driven gear housing O-ring or lip seal damaged. Leak at speedo hole.

3. Governor cover bale-type attaching retainer not tight.

4. Damaged governor O-ring.

5. Governor drainback in case not open.

6. Solenoid connector terminal O-ring damaged or improperly installed.

7. Manual shaft O-ring damaged or improperly installed.

8. Vacuum modulator damaged.

9. Vacuum modulator retainer screw loose. Tighten to 18 foot-pounds.

10. Vacuum modulator diaphragm damaged, (not an external oil leak).

NOTE: A ruptured diaphragm would allow transmission oil to be drawn into intake manifold and vacuum line. Usually the exhaust will be excessively smoky due to transmission oil added to the combustion. Oil level of transmission will also be low.

11. Modulator assembly O-ring seal damaged or improperly installed.

12. Bottom pan gasket damaged.

13. Bottom pan attaching screws loose. Tighten to 12 foot-pounds.

14. Line pressure plug not tight. Tighten to 10 foot-pounds. Also, plug stripped, shy sealer compound.

15. Porous or cracked casting. Case cracked at pressure plug boss.

16. Vent pipe.

a. Transmission over-filled.

b. Water in oil.

c. Pump to case gasket mispositioned.

d. Foreigh material between pump and case, or between pump cover and body.

e. Case — Porous, pump face improperly machined.

f. Pump — Shy of stock, porous.

g. Filter O-ring damaged or improperly assembled causing oil to foam.

h. Hole in intake pipe.

i. Drainback hole in case plugged or restricted. See Figure 6 for location.

OIL COOLER PIPE CONNECTIONS

1. Outside oil cooler pipe connections improperly installed or damaged. Also connectors in radiator and transmission.

2. Oil cooler pipe connections not tight. Tighten to 20 foot-pounds.

3. Flare on oil cooler pipes damaged at radiator or transmission.

FILLER PIPE

1. O-ring damaged or improperly installed on pipe.

2. Filler Pipe not fully seated in case.

INTERNAL LEAKS

It will be necessary to remove bottom pan to determine location of internal leaks.

1. Governor pipes damaged.

2. Control valve assembly-to-spacer or case gaskets damaged.

3. Control valve assembly attaching screws loose. Tighten to 8 foot-pounds.

4. Solenoid gaskets damaged.

5. Solenoid attaching screws loose. Tighten to 8 foot-pounds.

6. Intake pipe O-ring damaged.

7. Rear servo square cut O-ring improperly installed or damaged.

FUNCTIONAL DIAGNOSIS PROCEDURE

Dependability of the diagnosis charts depends upon:

1. Careful analysis of symptoms so that proper malfunction on the charts will be used.

2. Accurate oil pressure check with accurate gauge is made as indicated on the chart and these readings recorded so that they can be compared with the diagnosis chart.

3. Oil pressure readings must be made with transmission oil at normal operating temperatures.

4. Refer to detailed diagnosis charts for additional diagnosis on 1-2 and 2-3 shift malfunction diagnosis.

5. Engine must be properly tuned to specifications.

ROAD TEST

Check All Shifts In The Following Manner:

DRIVE RANGE:

Position selector lever in DRIVE RANGE and accelerate the vehicle from 0 mph. A 1-2 and 2-3 shift should occur at all throttle openings. (The shift points will vary with the throttle opening). As the vehicle decreases in speed to 0 mph, the 3-2 and 2-1 shifts should occur.

SUPER RANGE:

Position the selector lever in SUPER RANGE and accelerate the vehicle from 0 mph. A 1-2 shift should occur at all throttle openings. (No 2-3 shift can be obtained in this range). The 1-2 shift point will vary with throttle opening. As the vehicle decreases in speed to 0 mph, a 2-1 shift should occur. NOTE: The 1-2 shift in SUPER RANGE is somewhat firmer than in DRIVE RANGE. This is normal.

LO RANGE:

Position the selector lever in LO RANGE and accelerate the vehicle from 0 mph. No upshift should occur in this range, except in some vehicles which have a high numerical axle ratio and/or high engine rpm.

2ND GEAR — OVERRUN BRAKING:

Position the selector lever in DRIVE RANGE, and with the vehicle speed at approximately 35 mph, move the selector lever to SUPER RANGE. The transmission should downshift to 2nd. An increase in engine rpm and an engine braking effect should be noticed. Line pressure should change from approximately 70 psi to approximately 150 psi in 2nd.

1st GEAR — OVERRUN BRAKING:

Position the selector lever in SUPER RANGE at approximately 30 to 40 mph, with throttle closed, move the selector lever to Lo. A 2-1 downshift should occur in the speed range of approximately 40 to 20 mph, depending on axle ratio and valve body calibration. The 2-1 downshift at closed throttle will be accompanied by increased engine rpm and an engine braking effect should be noticed. Line pressure should be approximately 150 psi. Stop vehicle.

REVERSE RANGE:

Position the selector lever in REVERSE POSITION and check for reverse operation.

PRELIMINARY CHECKING PROCEDURE

CHECK TRANS OIL LEVEL

CHECK OUTSIDE MANUAL LINKAGE AND CORRECT

CHECK ENGINE TUNE

CAUTION: TOTAL RUNNING TIME FOR THIS COMBINATION NOT TO EXCEED 2 MINUTES.

INSTALL OIL PRESSURE GAGE

CONNECT VACUUM GAGE WITH "T" FITTING INTO MODULATOR LINE & TACHOMETER TO ENGINE.

CHECK OIL PRESSURES IN FOLLOWING MANNER

RANGE	OIL PRESSURE	NORMAL P.S.I.
DRIVE—BRAKES APPLIED ENGINE AT 1000 RPM		60 TO 90
SUPER OR LO—BRAKES APPLIED ENGINE AT 1000 RPM		135 TO 160
REVERSE—BRAKES APPLIED ENGINE AT 1000 RPM		95 TO 150
NEUTRAL—BRAKES APPLIED ENGINE AT 1000 RPM		55 TO 70
DRIVE IDLE SET ENGINE IDLE TO SPECIFICATIONS		60 TO 85
DRIVE—30 MPH CLOSED THROTTLE OR ON HOIST*		55 TO 70

*THE DRIVE—30 MPH CLOSED THROTTLE PRESSURE READING MAY BE TAKEN DURING A ROAD TEST OR:

1. VEHICLE ON HOIST—DRIVING WHEELS OFF GROUND, FOOT OFF BRAKE, IN DRIVE RANGE.
2. Engine 2000 RPM.
3. CLOSE THROTTLE (FOOT OFF ACCELERATOR) AND TAKE PRESSURE READING ENGINE 2000-1200 RPM.

NOTE: WITH CLOSED THROTTLE AND DRIVING WHEELS OFF THE GROUND, ENGINE RPM WILL DROP RAPIDLY. PRESSURE READING MUST BE TAKEN WITHIN RPM'S INDICATED AND WITH CLOSED THROTTLE.

Preliminary Checking Procedure

Transmission Malfunction Related to Oil Pressure

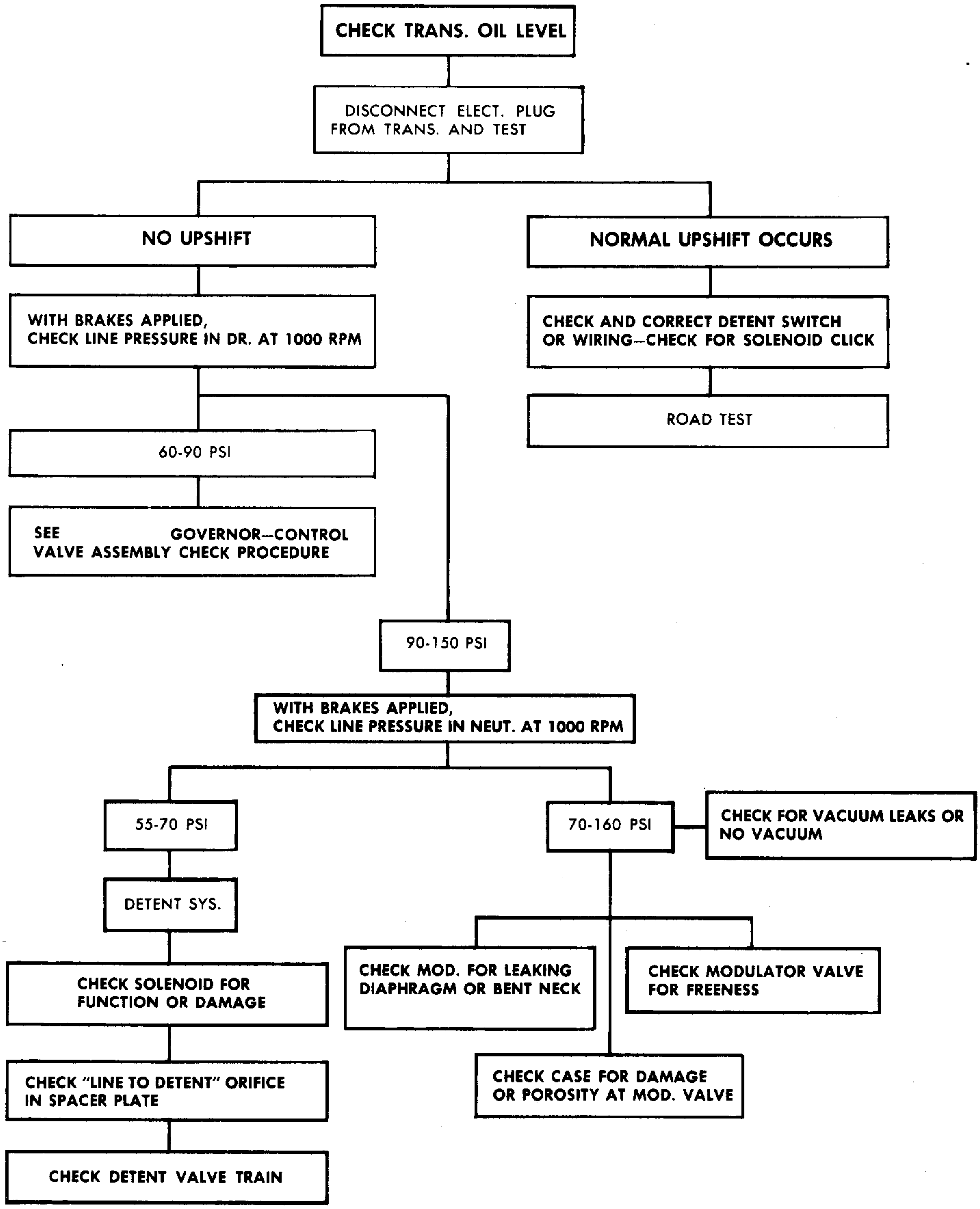
TRANSMISSION MALFUNCTION RELATED TO OIL PRESSURE

(PRESSURES OBTAINED BY THE PRELIMINARY CHECKING PROCEDURE)

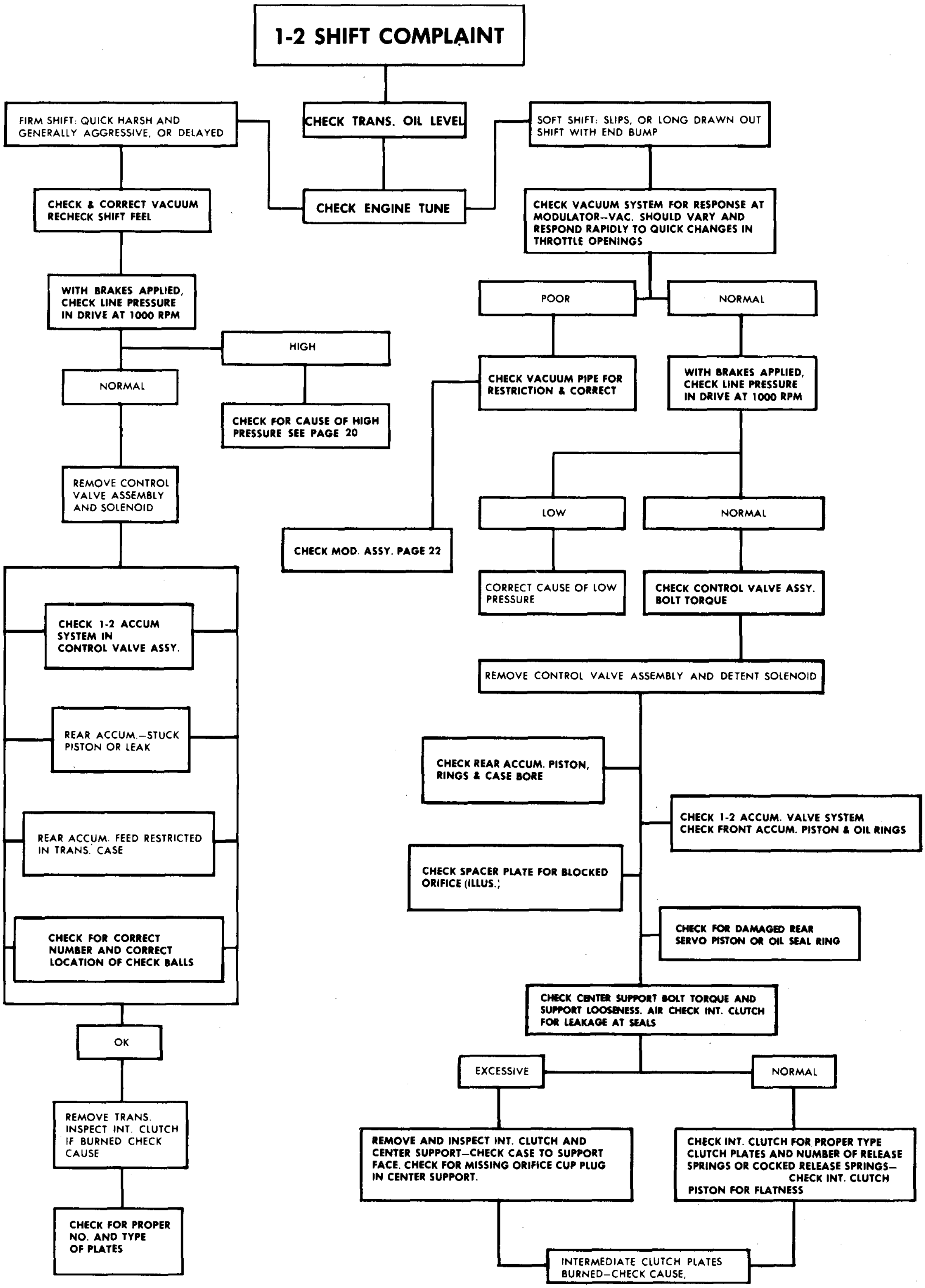
MALFUNCTION	DRIVE BRAKES APPLIED 1000 RPM	REVERSE BRAKES APPLIED 1000 RPM	SUPER OR LO BRAKES APPLIED 1000 RPM	NEUTRAL BRAKES APPLIED 1000 RPM	DRIVE 30 MPH CLOSED THROTTLE	DRIVE IDLE	PRESSURE DROP OCCURS WHILE ENGINE RPM INCREASES FROM 1000 TO 3000 RPM WHEELS FREE TO MOVE*	POSSIBLE CAUSE OF MALFUNCTION
	OIL PRESSURE	OIL PRESSURE	OIL PRESSURE	OIL PRESSURE	OIL PRESSURE	OIL PRESSURE		
NO 1-2 UPSHIFT AND/OR DELAYED UPSHIFT	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	DROP	MALFUNCTION IN CONTROL VALVE ASSY.
	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NO DROP	MALFUNCTION IN GOVERNOR OR GOVERNOR FEED SYSTEM
	HIGH	NORMAL	NORMAL	NORMAL	HIGH	—	—	MALFUNCTION IN DETENT SYSTEM
	HIGH	HIGH	NORMAL	HIGH	—	—	—	MALFUNCTION IN MODULATOR OR VACUUM FEED SYSTEM TO MODULATOR
SLIPPING—REVERSE	NORMAL	LOW	NORMAL	NORMAL	NORMAL	—	—	OIL LEAK IN FEED SYSTEM TO THE DIRECT CLUTCH
SLIPPING—1ST GEAR	LOW	NORMAL	LOW TO NORMAL	NORMAL	LOW TO NORMAL	—	—	OIL LEAK IN FEED SYSTEM TO THE FORWARD CLUTCH

* DRIVE RANGE, VACUUM LINE DISCONNECTED TO MODULATOR

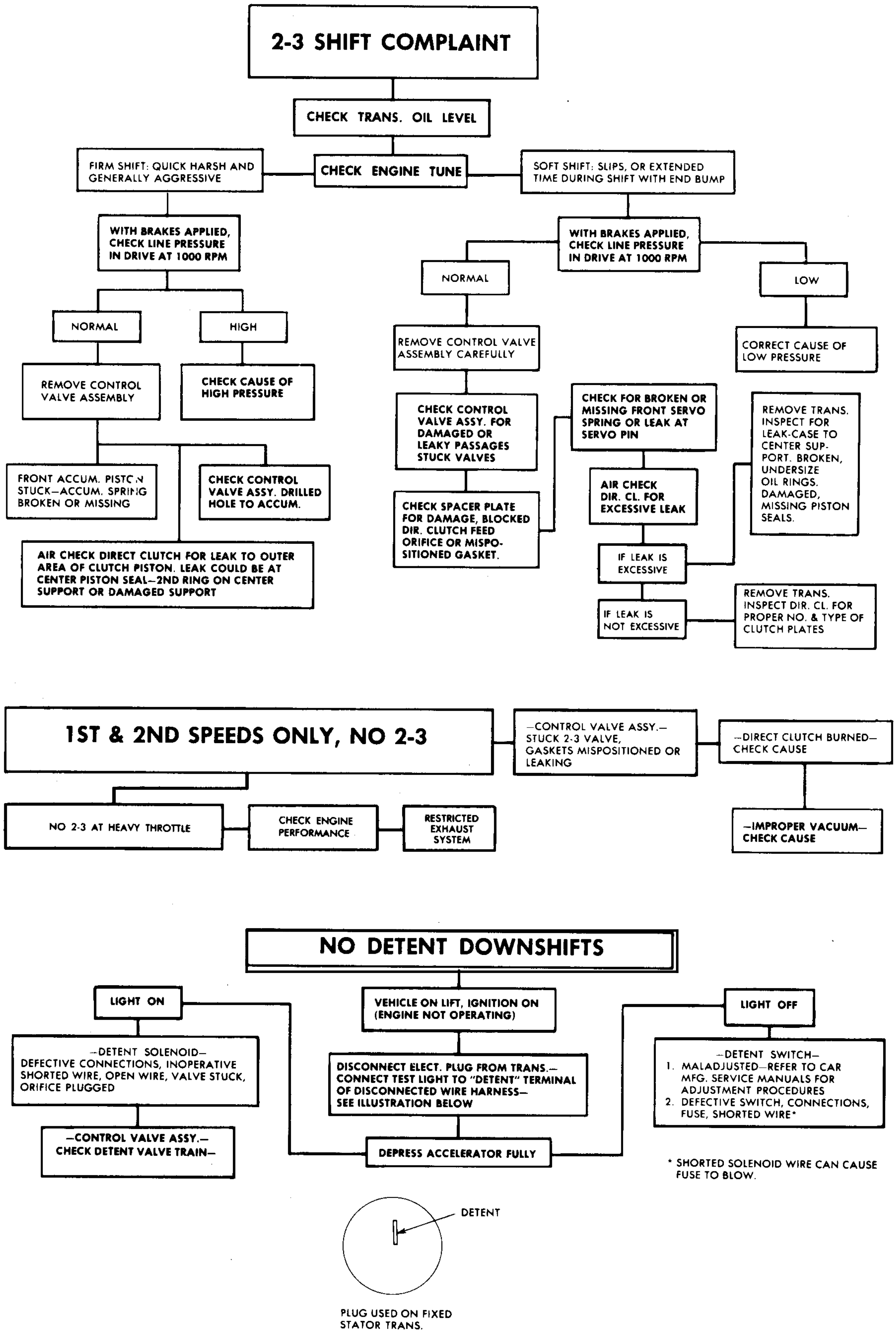
NO 1-2 UPSHIFT AND/OR DELAYED UPSHIFT OR 1-2 & 2-3 UPSHIFT—FULL THROTTLE ONLY



No. 1-2 Upshift



1-2 Shift Complaint



2-3 Shift, 1st & 2nd Speeds, No Detent

NO DRIVE IN DRIVE RANGE

CHECK TRANS. OIL LEVEL

CHECK OUTSIDE MANUAL LINKAGE & CORRECT

WITH BRAKES APPLIED, CHECK LINE PRESSURE IN DRIVE AT 1000 R.P.M.

NORMAL

—PUMP ASSY—
FORWARD CLUTCH FEED PASSAGE NOT DRILLED OR RESTRICTED

—FORWARD CLUTCH BURNED— CHECK CAUSE

CHECK LO ROLLER CLUTCH OR LO SPRAG CLUTCH FOR DAMAGE OR LO SPRAG INSTALLED BACKWARDS

LOW

CORRECT CAUSE OF LOW PRESSURE

NO REVERSE OR SLIPS IN REVERSE

CHECK TRANS. OIL LEVEL

CHECK OUTSIDE MANUAL LINKAGE & CORRECT

WITH BRAKES APPLIED, CHECK LINE PRESSURE IN REVERSE AT 1000 RPM

LOW

CORRECT CAUSE

NORMAL

CONTROL VALVE ASSEMBLY
1. 2-3 Valve Train Stuck Open (This Will Also Cause A 1-3 Upshift In Drive Range)
2. Reverse Feed Passage—Cross Channel Leak, Porosity In Case Or Valve Body Passage, Gaskets leaking.

REAR SERVO & ACCUMULATOR
1. Servo Piston Seal Ring Damaged or Missing.
2. Short Band Apply Pin (This May Also Cause No Overrun Braking Or Slips In Overrun Braking—Lo Range) Refer To Shop Manual For Pin Selection
3. Defective Rear Servo Piston or Bore.

FORWARD CLUTCH
Clutch Does Not Release (Will also cause Drive in Neutral)

DIRECT CLUTCH BURNED CHECK CAUSE

REAR BAND
Broken, Burned, Loose Lining, Apply Pin or Anchor Pins Not Engaged.

CENTER SUPPORT
OIL SEAL RINGS OR GROOVES DAMAGED OR WORN

No Drive, No Reverse

NO ENGINE BRAKING—INTERMEDIATE RANGE—SECOND GEAR

—FRONT SERVO & ACCUMULATOR—
OIL RINGS AND/OR BORES LEAKING OR FRONT SERVO PISTON COCKED OR STUCK

INCORRECT COMBINATION OF FRONT SERVO AND ACCUMULATOR PARTS.

—FRONT BAND—
BROKEN, BURNED (CHECK FOR CAUSE), NOT ENGAGED ON ANCHOR PIN AND/OR SERVO PIN.

NO ENGINE BRAKING— LO RANGE— 1ST GEAR

—CASE ASSEMBLY—
LO—REVERSE CHECK BALL MISPOSITIONED OR MISSING. CASE DAMAGED AT LO—REVERSE CHECK BALL AREA.

—REAR SERVO—
OIL SEAL RING, BORE OR PISTON DAMAGED
REAR BAND APPLY PIN SHORT,
IMPROPERLY ASSEMBLED

—REAR BAND—
BROKEN, BURNED (CHECK FOR CAUSE), NOT ENGAGED ON ANCHOR PINS AND/OR SERVO PIN.

DRIVE IN NEUTRAL

CHECK OUTSIDE MANUAL LINKAGE & CORRECT

—INTERNAL LINKAGE—
MANUAL VALVE DISCONNECTED OR END BROKEN, INSIDE DETENT LEVER PIN BROKEN.

—PUMP ASSEMBLY—
TRANS. LUBE PRESSURE LEAKING INTO FORWARD CLUTCH APPLY PASSAGE.

—FORWARD CLUTCH—
BURNED PLATES—CHECK CAUSE

INCORRECT CLUTCH PLATE USAGE

WON'T HOLD IN PARK OR WON'T RELEASE FROM PARK

CHECK OUTSIDE MANUAL LINKAGE & CORRECT

—INTERNAL LINKAGE—

1. Parking Brake Rod Assy. (Check Actuator For Chamfer)
2. Parking Pawl Broken, Chamfer Omitted.
3. Parking Brake Bracket Loose, Burr Or Rough Edges, or Incorrectly Installed.
4. Parking Pawl Return Spring Missing, Broken or Incorrectly Hooked.

No Engine Braking

CAUTION: BEFORE CHECKING TRANSMISSION FOR WHAT IS BELIEVED TO BE "TRANS. NOISE," MAKE CERTAIN THE NOISE IS NOT FROM THE WATER PUMP, ALTERNATOR, AIR CONDITIONER, POWER STEERING, ETC. THESE COMPONENTS CAN BE ISOLATED BY REMOVING THE PROPER BELT AND RUNNING THE ENGINE NOT MORE THAN TWO MINUTES AT ONE TIME.

TRANSMISSION NOISY

PARK, NEUTRAL & ALL DRIVING RANGES

—PUMP CAVITATION—
OIL LEVEL LOW
PLUGGED OR RESTRICTED FILTER.*
WRONG FILTER
INTAKE PIPE "O" RING DAMAGED.
INTAKE PIPE SPLIT, POROSITY IN CASE INTAKE PIPE BORE.
WATER IN OIL.
POROSITY OR VOIDS AT TRANS. CASE TO PUMP COVER PLATE.

—PUMP ASSEMBLY—
GEARS DAMAGED, OR DEFECTIVE,
DRIVING GEAR ASSEMBLED BACKWARDS.
CRESCENT INTERFERENCE.
BUZZING NOISE—ORIFICE CUP PLUG IN PRESSURE REGULATOR DAMAGED OR MISSING.
SEAL RINGS DAMAGED OR WORN.

—CONVERTER—
LOOSE BOLTS (CONVERTER TO FLYWHEEL)
CONVERTER DAMAGE.
CRACKED OR BROKEN FLEX PLATE

DURING ACCELERATION—ANY GEAR

TRANSMISSION OR COOLER LINES GROUNDED TO UNDERBODY.
MOTOR MOUNTS LOOSE OR BROKEN.

DRIVE LINK ASSEMBLY, WORN OR DAMAGED, MAY SOUND LIKE POPCORN POPPING.

SQUEAL AT LOW VEHICLE SPEEDS

SPEEDOMETER DRIVEN GEAR SHAFT SEAL—SEAL REQUIRES LUBRICATION OR REPLACEMENT.

FIRST, SECOND AND/OR REVERSE

—PLANETARY GEAR SET—
GEARS OR THRUST BEARINGS DAMAGED.
FRONT INTERNAL GEAR RING DAMAGED.

* There is no approved way of checking or cleaning the filter. If the filter is suspected of being plugged or restricted, it must be replaced.

Transmission Noisy

CAUSES OF LOW LINE PRESSURE

1. Low Transmission Oil Level.

2. Modulator Assembly

3. Filter.

a. Blocked or restricted.*

b. "O" Ring on intake pipe omitted or damaged.

c. Split or leaking intake pipe.

d. Wrong filter assembly.

4. Pump.

a. Pressure regulator or boost valve stuck.

b. Gear clearance, damaged worn. (Pump will become damaged if drive gear is installed backwards, or if converter pilot does not enter crankshaft freely).

c. Pressure regulator spring, too weak.

d. Not enough spacers in pressure regulator.

e. Pump cover plate to case gasket mispositioned.

f. Pump body and/or pump cover plate. Machining error or scoring of pump gear pocket.

g. Mismatch pump cover/pump body.

5. Internal Circuit Leaks.

a. Forward clutch leak (pressure normal in neutral and reverse-pressure low in drive).

1. Check rings on driven sprocket support housing for damages.

2. Check forward clutch seals for damage.

3. Check turbine shaft journals for distress.

4. Check stator shaft bushings for damage.

b. Direct clutch leak (pressure normal in neutral, low, intermediate, and drive—pressure low in reverse).

1. Check center support oil seal rings.

2. Check direct clutch outer seal for damage.

3. Check rear servo and front accumulator pistons and rings for damage or missing.

6. Case Assembly.

a. Porosity in intake bore area.

b. Lo-reverse check ball mispositioned or missing (this will cause no reverse and no overrun braking in Lo range).

*There is no approved service procedure for checking or cleaning the filter. If the filter is suspected of being plugged or restricted, it must be replaced.

CAUSES OF HIGH LINE PRESSURE

1. Vacuum Leak.

a. Full leak (vacuum line disconnected).

b. Partial leak in line from engine modulator.

c. Improper engine vacuum.

d. Vacuum operated accessory leak. (Hoses, vacuum advance, etc.).

2. Damaged Modulator.

a. Stuck valve.

b. Water in modulator.

c. Not operating properly.

d. Orifice at end of modulator valve sleeve plugged or not drilled.

3. Detent System.

a. Detent switch actuated (plunger stuck) or shorted.

b. Detent wiring shorted.

c. Detent solenoid valve stuck open. Solenoid cover may be bent causing solenoid valve to be open.

d. Detent feed orifice in spacer plate blocked.

e. Detent solenoid loose.

f. Detent valve bore plug damaged.

g. Detent regulator valve pin short.

4. Pump.

a. Pressure regulator and/or boost valve stuck.

b. Incorrect pressure regulator spring.

c. Too many pressure regulator valve spacers.

d. Pump casting bad.

e. Pressure boost valve installed backwards or defective.

f. Wrong type pressure regulator valve.

IMPORTANT: Use only pressure regulator valve which has an orifice cup plug in it.

g. Pressure boost bushing broken or otherwise defective.

5. Control Valve Assembly.

a. Spacer plate-to-case gasket off location.

b. Wrong spacer plate-to-case gasket, or gaskets installed in reverse order.

CAUSES OF IMPROPER VACUUM AT MODULATOR

1. Engine.

a. Requires tune up.

b. Loose vacuum fittings.

c. Vacuum operated accessory leak (hoses, vacuum advance, etc.)

d. Engine exhaust system restricted.

2. Vacuum Line to Modulator.

a. Leak.

b. Loose fitting.

c. Restricted orifice, or incorrect orifice size.

d. Carbon build up at modulator vacuum fitting.

e. Pinched line.

f. Grease or varnish material in pipe (no or delayed up-shift-cold).

CONTROL VALVE ASSEMBLY— GOVERNOR LINE PRESSURE CHECK

1. Install line pressure gage.

2. Disconnect vacuum line to modulator.

3. With vehicle on hoist (front wheels off ground), foot off brake, in drive, check line pressure at 1000 rpm.

4. Slowly increase engine rpm to 3000 rpm and determine if a line drop occurs (7 psi or more).

5. If pressure drop occurs, disassemble, clean and inspect control valve assembly.

6. If no pressure drop occurs:

a. Inspect governor.

1. Stuck valve.

2. Weight freeness.

3. Restricted orifice in governor valve.

4. Check governor valve entry and exhaust (.020″ min.).

b. Governor feed system.

1. Check screen in governor feed pipe hole in case assembly.

2. Check for restrictions in governor pipe.

3. Check for fit of governor pipes in cast holes.

CAUSES OF BURNED CLUTCH PLATES

NOTE: Burned clutch plates can be caused by incorrect usage of clutch plates. Also, anti-freeze in transmission fluid can cause severe damage, such as large pieces of composition clutch material peeling off.

1. Forward Clutch.

a. Check ball in clutch housing damaged, stuck or missing.

b. Clutch piston cracked, seals damaged or missing.

c. Low line pressure.

d. Manual valve mispositioned.

e. Restricted oil feed to forward clutch (Examples: Clutch housing to inner and outer areas not drilled, restricted or porosity in pump).

f. Pump cover oil seal rings missing, broken or undersize; ring groove oversize.

g. Case valve body face not flat or porosity between channels.

h. Manual valve bent and center land not ground properly.

2. Intermediate Clutch.

a. Rear accumulator piston oil ring, damaged or missing.

b. 1-2 accumulator valve stuck in control valve assembly.

c. Intermediate clutch piston seals damaged or missing.

d. Center support bolt loose.

e. Low line pressure.

f. Case valve body face not flat or porosity between channels.

g. Manual valve bent and center land not ground properly.

3. Direct Clutch.

a. Restricted orifice in vacuum line to modulator (poor vacuum response.)

b. Check ball in direct clutch piston damaged, stuck or missing.

c. Defective Modulator bellows.

d. Center support bolt loose. (Bolt may be tight in support but not holding support tight to case).

e. Center support oil rings or grooves damaged or missing.

f. Clutch piston seals damaged or missing.

g. Front and rear servo pistons and seals damaged.

h. Manual valve bent and center land not cleaned up.

i. Case valve body face not flat or porosity between channels.

j. Intermediate sprag clutch installed backwards.

k. 3-2 valve, 3-2 spring or 3-2 spacer pin installed in wrong location in 3-2 valve bore.

l. Incorrect combination of front servo and accumulator parts.

m. Replace intermediate clutch piston seals.

NOTE: If direct clutch plates and front band are burned, check manual linkage.

VACUUM MODULATOR ASSEMBLY

The following procedure is recommended for checking Turbo Hydra-matic modulator assemblies in the field before replacement is accomplished.

1. Vacuum Diaphragm Leak Check. Insert a pipe cleaner into the vacuum connector pipe as far as possible and check for the presence of transmission oil. If oil is found, replace the modulator.

CAUTION: *Gasoline or water vapor may settle in the vacuum side of the modulator. If this is found without the presence of oil, the modulator should not be changed.*

2. Atmospheric Leak Check. Apply a liberal coating of soap bubble solution to the vacuum connector pipe seam, the crimped upper to lower housing seam, and the threaded screw seal. See Figure 11. Using a short piece of rubber hose, apply air pressure to the vacuum pipe by blowing into the tube and looking for bubbles. If bubbles appear, replace the modulator.

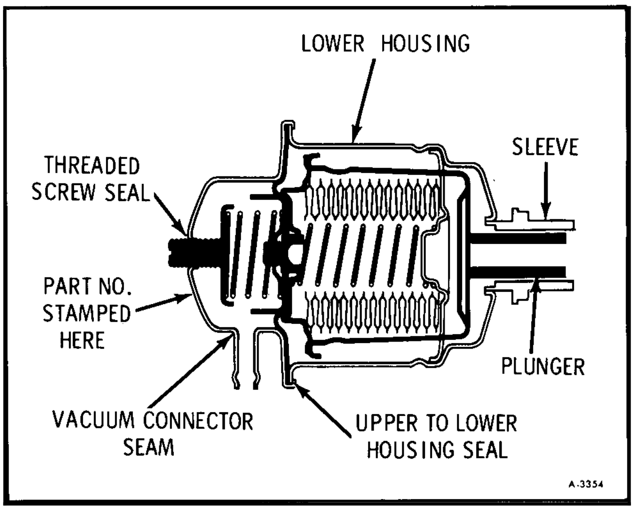


Figure 11—Modulator Assembly

CAUTION: *Do not use any method other than human lung power for applying air pressure, as pressures over 6 psi may damage the modulator.*

3. Bellows Comparison Check. Make a comparison gauge, as shown in Figure 12, and compare the load of a known good Hydra-matic modulator with the assembly in question. Modulator Tension Tester such as J-24466 may also be used for this purpose.

a. Install the modulator that is known to be acceptable on either end of the gauge.

b. Install the modulator in question on the opposite end of the gauge.

c. Holding the modulators in a horizontal position, bring them together under pressure until either modulator sleeve end just touches the line in the center of the gauge. The gap between the opposite modulator sleeve end and the gauge line should then be 1/16" or less. If the distance is greater than this amount, the modulator in question should be replaced.

4. Sleeve Alignment Check. Roll the main body of the modulator on a flat surface and observe the sleeve for concentricity to the can. If the sleeve is concentric and the plunger is free, the modulator is acceptable.

Once the modulator assembly passes all of the above tests, it is an acceptable part and should be re-used.

DOWNSHIFT SOLENOID CIRCUIT CHECK

NOTE: Before checking the downshift solenoid circuitry, make certain that the transmission downshift switch is properly adjusted.

1. With transmission shift lever in Park, turn ignition switch to "ON" positon, but do not start vehicle. Leave ignition switch "ON" throughout checking procedure.

2. With the engine cover removed, slowly advance throttle linkage to wide open position. One click should be heard from transmission.

3. Allow throttle to return to closed position. One click should be heard from transmission.

4. If system performed as described above, downshift circuit is operating properly. If system does not perform as described above, proceed to step 5.

5. Use test light to check orange wire at connector on side of transmission case. Test light should light with throttle wide open and go out when throttle is released.

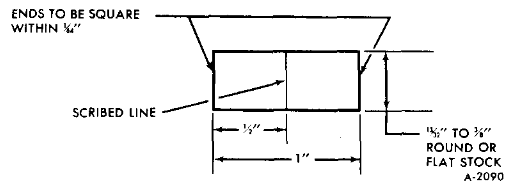


Figure 12—Vacuum Modulator Test Gauge

a. If system operates as described above, but did not perform properly during steps 1-3, replace solenoid after first checking to see that internal wiring is operational.

b. If light fails to light with throttle in wide open position, the circuit is open, proceed to step 6.

c. If light lights with throttle closed, the circuit is shorted. Proceed to step 9.

6. At transmission downshift switch, use test light to check from the top terminal at switch with throttle wide open.

a. If test light lights, recheck system.

b. If test light fails to light, proceed to step 7.

7. Check lower feed wire at transmission downshift switch with test light.

a. If test light lights, replace transmission downshift switch. Recheck system.

b. If test light fails to light, proceed to step 8.

8. Check 10 amp. (gauges and transmission control fuse) in fuse panel.

a. If necessary to replace fuse, recheck system.

b. If fuse is all right, it will be necessary to locate the open in the wiring. Test the circuit continuity from the lower wire at the downshift switch to the battery.

9. At the transmission downshift switch, use test light to check from the disconnected top terminal at switch with throttle closed.

a. If test light fails to light, orange wire is shorted. Correct shorting condition.

b. If test light lights, proceed to step 10.

10. With throttle in closed position, check lower feed wire at transmission downshift switch.

a. If test light fails to light, replace transmission downshift switch. Recheck system.

b. If test light lights, it will be necessary to locate the short in the wiring. Test the circuit from the lower wire at the downshift switch to the battery.

CLUTCH PARTS

Clutch	No. of Flat Steel Clutch Plates	No. of Waved Steel Clutch Plates
Forward Clutch	5	1*
Direct Clutch	5	1
Intermediate Clutch	3	—
*Clutch Plate Dished		
Clutch	No. of Clutch Composition Plates	No. of Piston Release Springs
Forward Clutch	5	16
Direct Clutch	6	14
Intermediate Clutch	3	6

ON VEHICLE SERVICING

FLUSHING OIL COOLER

The oil cooler is located in the side tank of the radiator and its purpose is to cool the oil in the event excessive temperature tends to develop. (figure 13)

In a major transmission failure, where particles of metal have been carried with the oil throughout the units of the transmission. It will be necessary to flush out the oil cooler and connecting lines. The oil cooler is a sealed container providing a passage for oil to flow from the inlet to the outlet. Clean solvent can be flushed through the cooler with air pressure. (An engine desludge gun may be used.) The cooler should be back-flushed first through the return line to remove all foreign material possible. Then flush through the inlet line and finish by flushing through the return line. Clean remaining solvent from cooler with compressed air applied to the return line and flush with transmission fluid.

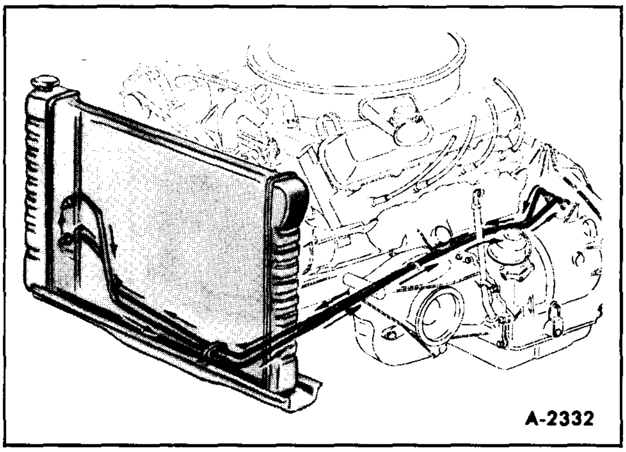


Figure 13—Oil Cooler and Lines

LINKAGE ADJUSTMENT (FIGURE 14)

CAUTION: *Block vehicle wheels and apply parking brake before attempting transmission linkage adjustment.*

1. Place steering column shift lever in neutral against stop in column, (a detent will hold it there).

2. Loosen relay rod clamp screw.

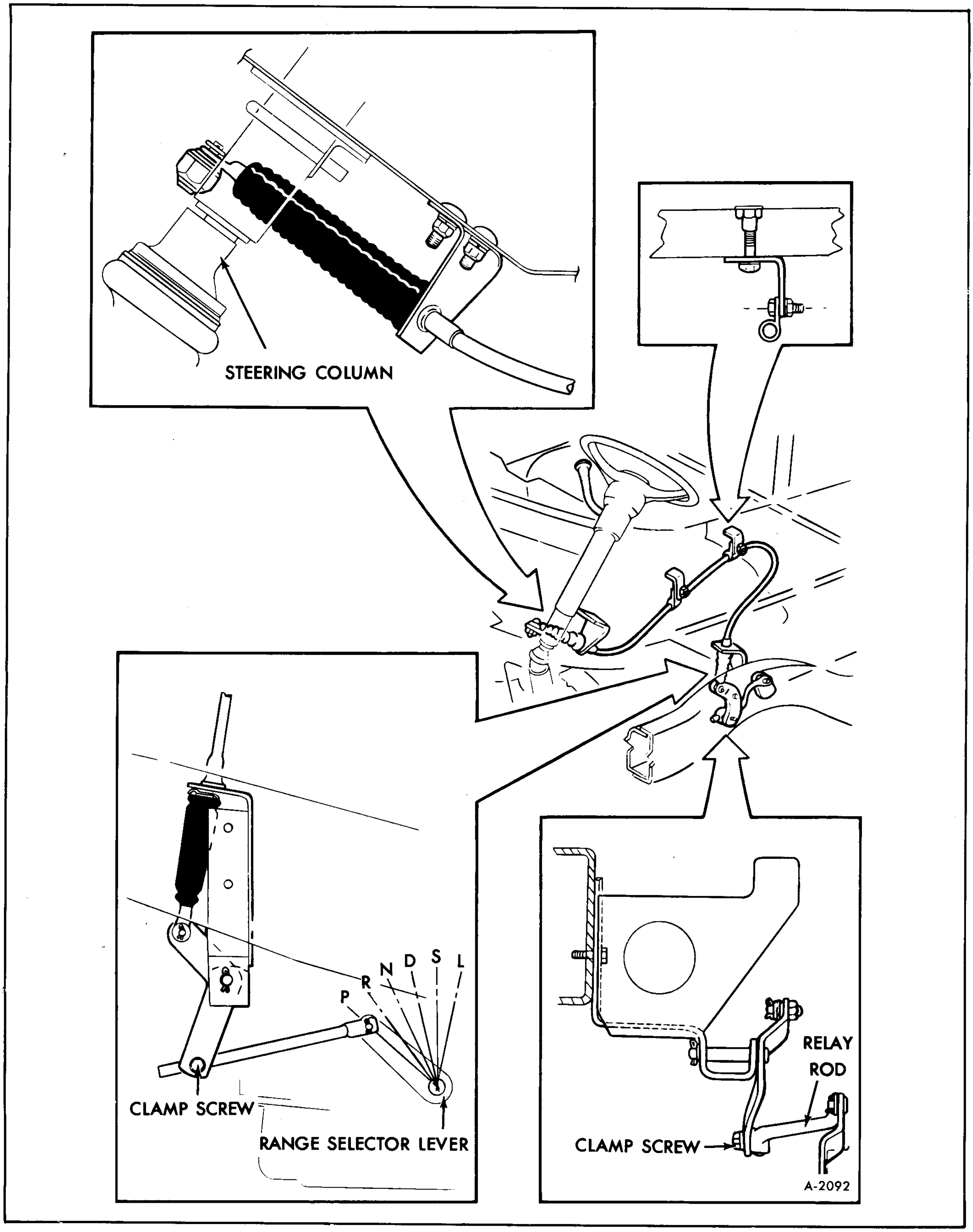


Figure 14—Transmission Manual Linkage

3. Position range selector lever in the neutral detent position.

4. Tighten relay rod clamp screw to 20 ft. lbs., making sure shift lever is held against Neutral stop while this operation is being performed.

5. Check operation of selector lever by performing the following steps:

a. Lift lever and move to Neutral detent. (This is the detent in the transmission.) Release the lever and check to make sure that the lever fits into the neutral notch in the steering column.

b. Move lever to Drive detent. There should be a slight travel of the lever beyond this detent until the drive stop in the steering column is reached.

c. Move lever to Reverse detent and check as in b above.

6. Check for proper operation of neutral safety switch and back-up lights, (be sure vehicle has positive "PARK" engagement and "LO" range engagement).

DOWNSHIFT SWITCH ADJUSTMENT

The procedure for adjusting the downshift switch is described in SECTION 6M under "Accelerator Control".

CHECKING AND ADDING FLUID

NOTE: Vehicle level and oil temperature are particularly important when checking fluid level on a Turbo Hydra-matic transmission. Careful attention to the following procedures is necessary in order to determine the actual fluid level.

Oil Recommendations

Whenever fluid is added to the transmission use only DEXRON ® II type transmission fluid, or fluids of equivalent quality that have been especially formulated and tested for use in the Turbo Hydra-matic transmission.

Oil Level

The transmission dipstick and filler tube are located under the engine access cover at the left center side of the engine. The "FULL" and "ADD" dimple marks on the transmission dipstick indicate one pint difference. Correct fluid level is determined at normal engine coolant operating temperature, 190-200°F. (88-93°C.). Automatic transmissions are frequently overfilled because fluid level is checked when the fluid is cold and dipstick indicates fluid should be added. However, the low reading is normal as proper fluid level at low operating temperature will be below the "ADD" mark on the dipstick, as shown in Figure 15, and proper fluid level at higher operating temperatures will rise above the "FULL" mark. Fluid level rises as the fluid temperature increases. A fluid level change of over 3/4" will occur as temperature rises 60°F. (15.6°C.) to 190°F. (88°C.).

Overfilling can cause foaming and loss of fluid through the vent. Slippage and transmission failure can result.

Fluid level too low can cause slipping, particularly when the transmission is cold or the vehicle is on a hill.

Check the transmission fluid level with the engine running, the shift lever in Park, and the vehicle LEVEL. DO NOT RACE ENGINE.

NOTE: If the vehicle has recently been operated for an extended period at high speed or in city traffic in hot weather or the vehicle is being used to pull a trailer, an accurate fluid level cannot be determined until the fluid has cooled down — usually about 30 minutes after the vehicle has been parked.

Remove the dipstick and touch the transmission end of the dipstick cautiously to find out if the fluid is cool, warm, or hot.

Wipe the dipstick clean and re-insert until cap seats. Remove dipstick and note reading.

- If the fluid feels cool, about room temperature, 65°F. (18.3°C.) to 85°F. (29.4°C.), the level should be 1/8 to 3/8 inch below the "ADD" mark.

- If the fluid feels warm the level should be close to the "ADD" mark (either above or below).

- If the fluid feels hot (cannot be held comfortably) the level should be between the "ADD" and "FULL" marks.

NOTE: DO NOT OVERFILL. It takes only one pint to raise level from ADD TO FULL with a hot transmission.

Draining Bottom Pan and Replacing Intake Pipe and Filter Assembly

To drain bottom pan only, eliminate steps 5 and 6.

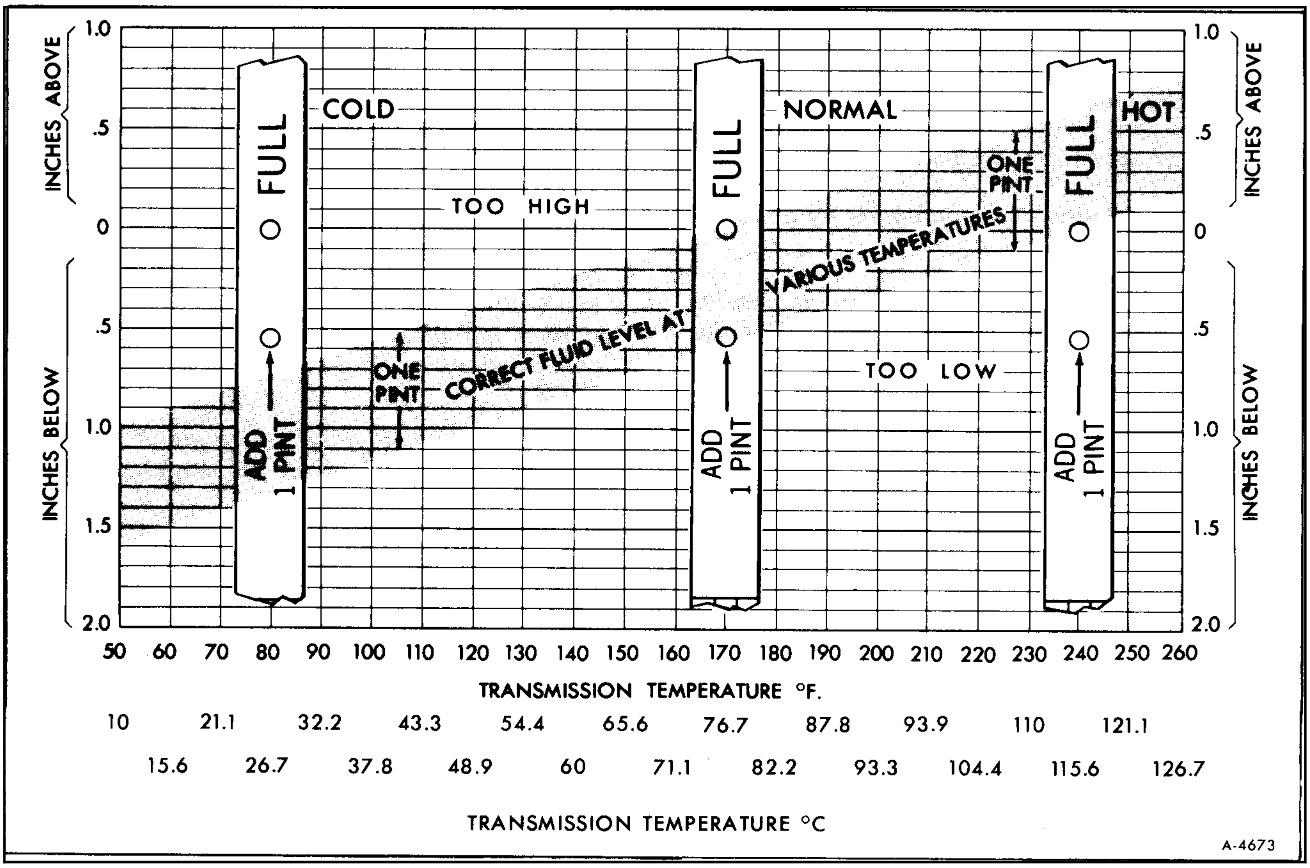


Figure 15—Transmission Oil Level

1. Remove dipstick from filler tube and insert a length of hose secured to a suction gun down the dipstick. Remove enough transmission fluid so that bottom pan will not overflow when removed.

2. Raise vehicle on hoist or place on jack stands, and provide container to collect draining oil.

3. Remove bottom pan and gasket. Discard gasket.

4. Drain fluid from bottom pan. Clean pan with solvent and dry thoroughly with clean compressed air.

5. Remove intake pipe and filter assembly. Remove and discard intake pipe O-ring.

6. Install new intake pipe O-ring into pipe bore in transmission case and install new intake pipe and filter assembly.

7. Install new gasket on bottom pan and install bottom pan. Tighten bottom pan attaching screws to 12 foot-pounds.

8. Lower vehicle and add five quarts of transmission fluid through filler tube when replacing intake pipe and filter assembly. When draining bottom pan only, add four quarts of transmission fluid.

9. Operate engine at 800 rpm for approximately 1-1/2 minutes with selector lever in park "P" position.

10. Reduce engine speed to slow idle and check fluid level. Add fluid to bring to proper level, Figure 15.

Adding Fluid to Dry Transmission and Converter Assembly

The fluid capacity of the Turbo Hydra-matic transmission and converter assembly is approximately 13 quarts, but correct level is determined by mark on dipstick rather than by amount added. It is important that proper level be maintained. In cases of transmission overhaul, when a complete fill is required, including converter, proceed as follows:

1. Add 9 quarts of transmission fluid through filler tube.

2. Operate engine at 800 rpm for approximately 1-1/2 minutes with selector lever in park "P" position.

3. Reduce engine speed to slow idle.

4. Check fluid level and add additional fluid to bring to proper level, Figure 15.

Sprocket Housing Cover Removal

If the sprocket housing cover is removed, add transmission oil as described under "OIL LEVEL".

TOWING INSTRUCTIONS

Refer to SECTION 0 for towing instructions.

UNITS THAT CAN BE REMOVED WITH TRANSMISSION IN VEHICLE

The following units can be removed from the transmission without removing transmission from vehicle.

While the detailed procedure for removing each of the units is not outlined separately, the procedures covered under the transmission overhaul will apply.

1. Oil pan and pan to case gasket.
2. Pressure regulator valve assembly.
3. Valve body assembly.
4. Rear servo and accumulator assembly.
5. Front servo and accumulator assembly.
6. Governor pipes.
7. Detent solenoid.
8. Solenoid connector.
9. Parking linkage.
10. Valve body to case spacers and gaskets.
11. Check balls.
12. Detent roller and spring assembly.
13. Filter assembly.

TRANSMISSION REPLACEMENT

REMOVAL OF TRANSMISSION

Due to the power train configuration, it is easier to remove the transmission and final drive as an assembly. The following is the procedure to remove the transmission and final drive assembly.

1. Disconnect negative battery cables.

2. Remove engine access cover.

3. Position engine holding fixture as shown in Figure 16 and adjust mechanism to remove slack from cable.

NOTE: To properly position engine removal tool. Remove seat belt plate and anchor bolt assembly. Attach load adjuster chain to front and rear engine. Lift locations as shown in Figures 17 and 18. Then install support braces and chain hoist as in Figure 16.

4. Raise vehicle.

5. Disconnect starting motor wires.

6. Remove starting motor.

7. Remove flywheel cover behind starter.

8. Disconnect manual shift linkage at transmission.

9. Disconnect speedometer cable.

10. Disconnect oil cooler lines at transmission and position out of the way. Cap lines and connectors.

11. Disconnect detent wire and vacuum modulator tube.

12. Disconnect right axle shaft at output shaft flange.

13. Remove right output shaft and support assembly, (includes disconnecting radiator fan venturi ring bracket).

14. Disconnect left axle shaft at left output flange.

15. Remove final drive to support bracket through bolt, washers and nut.

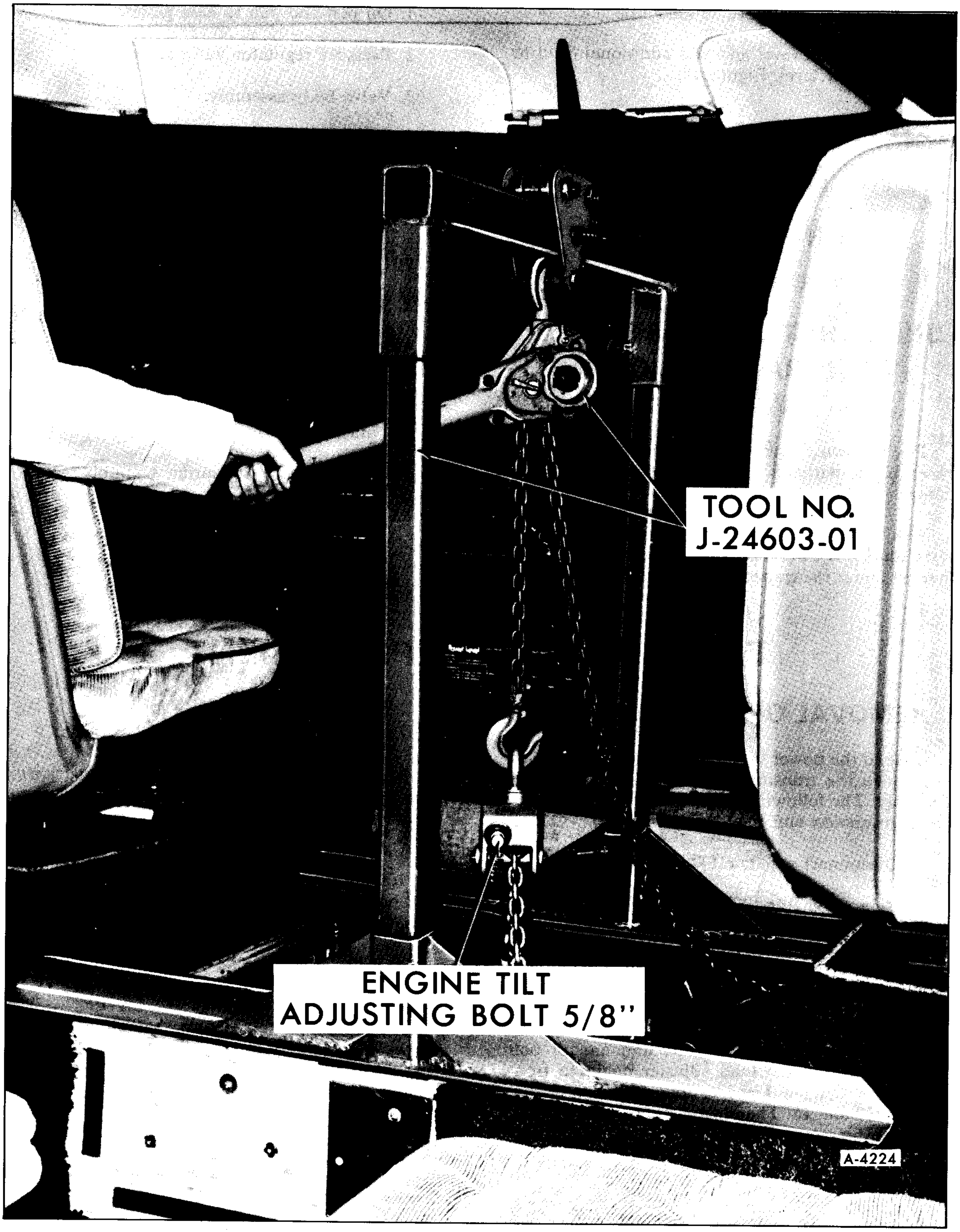


Figure 16—Attaching Engine Removal Tool

16. Remove three (3) converter to flywheel bolts by rotating crankshaft at harmonic balancer.

17. Remove three (3) rear support bracket to transmission bolts.

18. Remove two (2) rear motor mount to support bracket bolts.

19. Position transmission jack under transmission and secure with safety chain around transmission gear case.

20. Remove six (6) transmission converter housing to engine bolts.

21. Move transmission and final drive assembly rearward 1/2"-3/4" and lower from vehicle, installing converter holding clamp, such as J-21366, as soon as transmission is low enough.

INSTALLATION OF TRANSMISSION

1. Position transmission and final drive on jack secured with a safety chain, under the vehicle.

2. Remove converter holding clamp.

3. Raise transmission into place.

4. Loosely install top two (2) converter housing to engine bolts.

5. Slide transmission forward and engage converter pilot into flywheel.

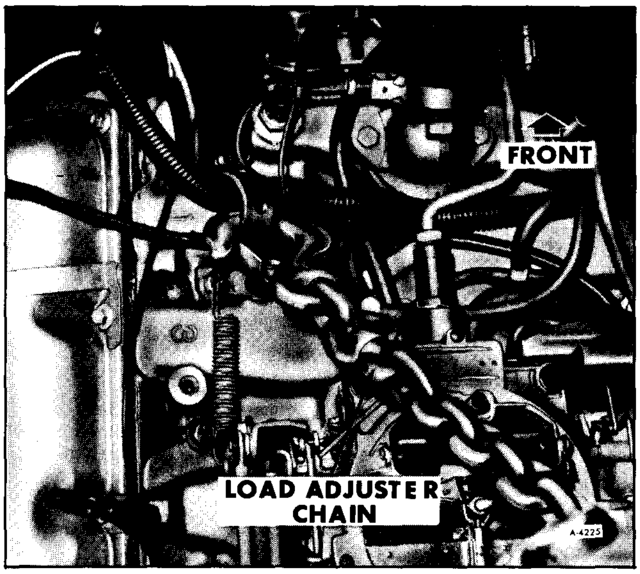


Figure 17—Front Engine Lift Location

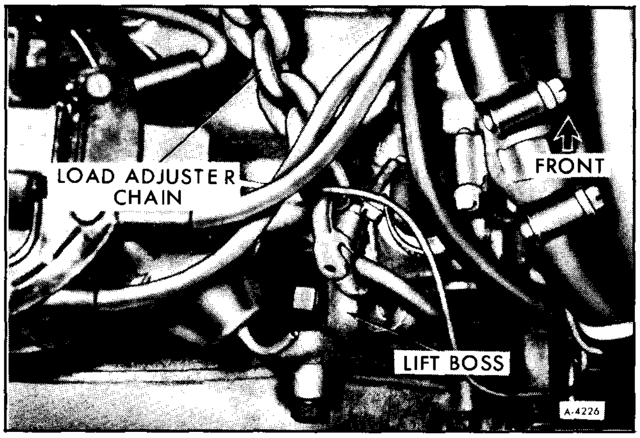


Figure 18—Rear Engine Lift Location

6. Install remaining converter housing to engine bolts. Torque six (6) bolts to 30 ft. lbs.

7. Shift transmission to neutral to align weld nuts to the flywheel. Rotate the crankshaft to install three (3) attaching bolts and torque to 30 ft. lbs. (Note: Weld nuts must be flush to flywheel).

8. Remove safety chain and jack from transmission.

9. Install three (3) rear support bracket to transmission bolts. Torque to 55 ft. lbs.

10. Install two (2) rear motor mount to support bracket bolts. Torque to 55 ft. lbs.

11. Install final drive to support bracket through bolt, washers and nut. Torque bolt to 105 ft. lbs.

12. Connect left axle shaft to output flange using new bolts. Torque bolts to 65 ft. lbs.

13. Install right output shaft and support assembly and fan venturi bracket. Torque bolt to 50 ft. lbs.

14. Connect right axle shaft to output flange using new bolts. Torque bolts to 65 ft. lbs.

15. Connect detent wire and vacuum modulator hose.

16. Connect oil cooler lines. Torque fitting to 20 ft. lbs.

17. Connect speedometer cable.

18. Connect manual shift linkage using a new cotter pin.

19. Install flywheel cover behind starter. Torque bolts to 5 ft. lbs.

20. Connect wires to starting motor.

21. Install starting motor. Torque bolts to 30 ft. lbs.

22. Lower vehicle.

23. Remove engine holding fixture.

24. Connect negative battery cables.

25. Fill transmission with fluid as described under CHECKING AND ADDING FLUID in this SECTION.

26. Check manual linkage and adjust if necessary.

TRANSMISSION OVERHAUL

REMOVE FINAL DRIVE (FIGURE 19)

1. Remove bolt "A" and transmission dipstick and tube assembly.

2. Remove bolts "B, C, E, F and G" and nut "H". (NOTE: One bolt is omitted between nut "H" and bolt "C".)

3. Remove final drive from transmission, (about 1 quart of transmission fluid will drain).

REMOVE TORQUE CONVERTER

With transmission on portable jack, remove Converter Holding Clamp, J-21366, and then remove converter assembly from transmission by pulling converter straight out of housing.

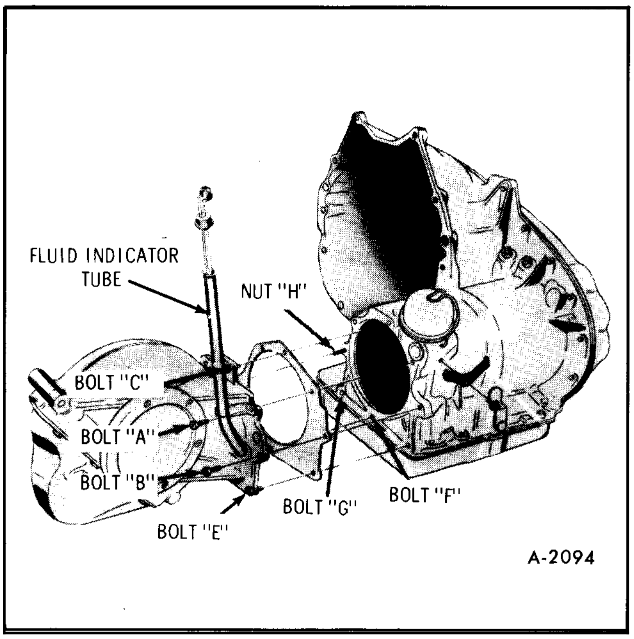


Figure 19—Final Drive Attachment

CAUTION: *Converter with oil weighs approximately 50 pounds. Be careful not to drop or damage converter when removing it.*

ARRANGE TRANSMISSION FOR OVERHAUL

1. Install two 3/8 x 8 bolts with nuts into the case to engine mounting face. (figure 20)

2. Remove the speedometer driven gear attaching screw and retainer clip. (figure 21)

3. Remove speedometer driven gear assembly from case bore. Remove and discard "O" ring seal.

4. Remove the governor attaching bail wire.

5. Remove governor assembly and "O" ring seal from case bore. (figure 22)

6. Remove stud from output end of case and place a piece of plywood under output end of case, place transmission on work bench with bottom pan facing the outside edge of work bench. (Let pan over-

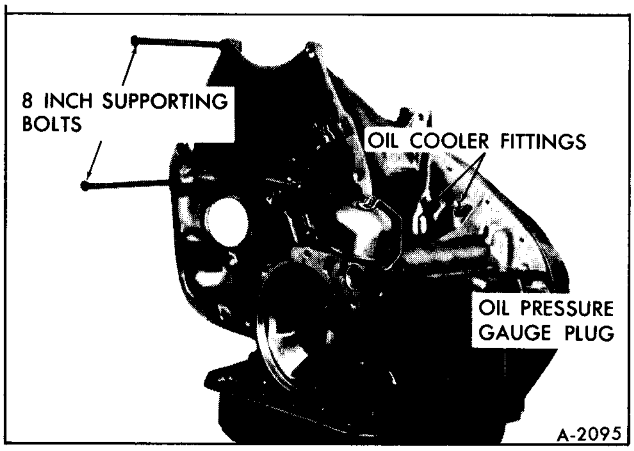


Figure 20—Transmission Support Bolts

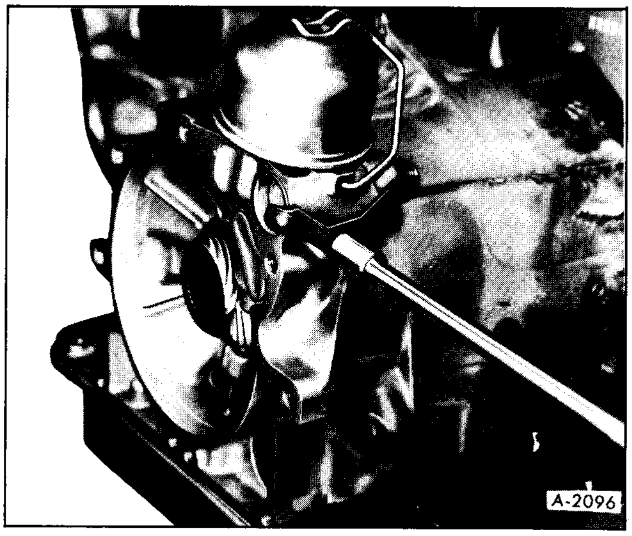


Figure 21—Removing Speedometer Driven Gear Retainer

hang edge of bench.) Stand transmission on the two eight inch bolts and the output flange end of the transmission case. (figure 23)

REMOVE VACUUM MODULATOR AND VALVE

NOTE: Unit may be removed without removing transmission or bottom pan, after removing vacuum hose.

1. Remove vacuum modulator attaching screw and retainer from transmission case.

2. Remove modulator assembly and O-ring from transmission case. Remove and discard O-ring from vacuum modulator, Figure 24.

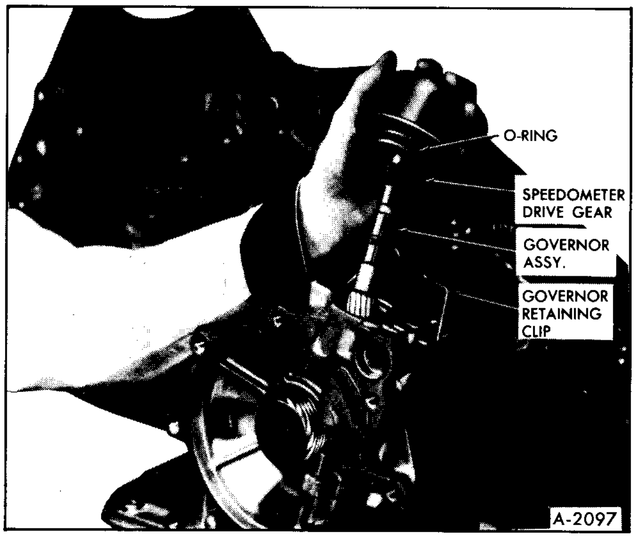


Figure 22—Governor Removal

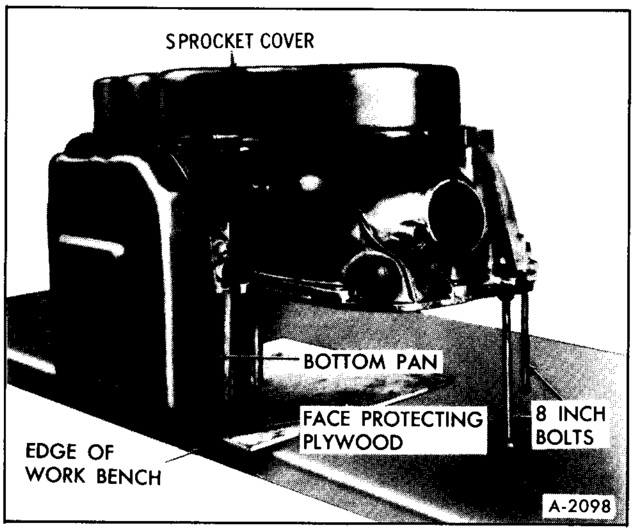


Figure 23—Arrangement of Transmission on Bench

3. Remove modulator valve from transmission case.

NOTE: Modulator bushing is a snug fit in transmission case and should not be removed forcibly unless it is damaged, scored, or otherwise deformed.

REMOVE INTAKE PIPE AND FILTER ASSEMBLY AND BOTTOM PAN

NOTE: Units may be removed with transmission in vehicle. In cases of transmission malfunction, intake pipe and filter must be replaced.

1. Remove thirteen bottom pan attaching screws.

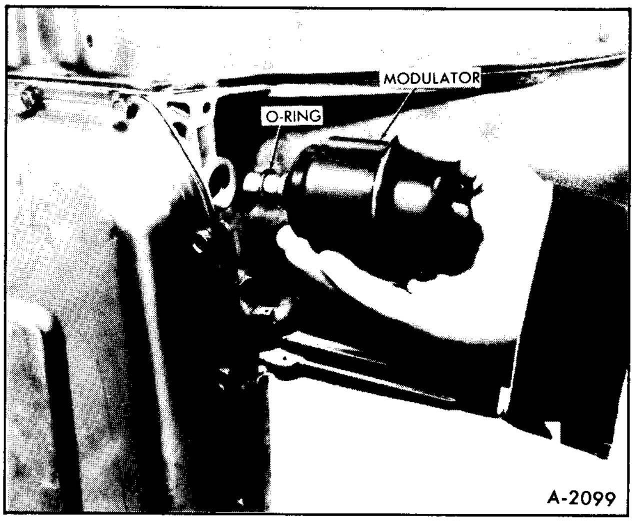


Figure 24—Removing Vacuum Modulator

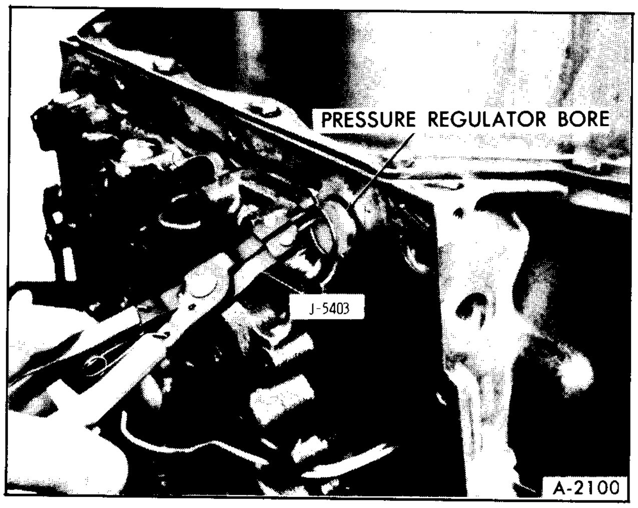


Figure 25—Removing Pressure Regulator Valve

2. Remove bottom pan and discard gasket.

3. Remove oil filter assembly.

4. Remove and discard the intake pipe to case "O" ring seal from the oil filter assembly or from the case counterbore.

REMOVE PRESSURE REGULATOR VALVE

NOTE: Unit may be removed with transmission in vehicle after removing bottom pan.

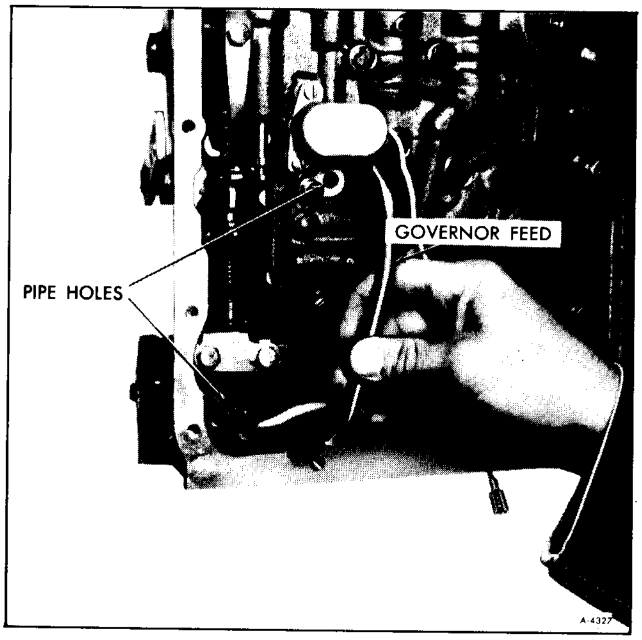


Figure 26—Removing Governor Feed Pipe

1. Compress regulator boost valve bushing against pressure regulator spring and remove snap ring using Snap Ring Pliers, J-5403 (#21), Figure 25.

WARNING: PRESSURE REGULATOR SPRING IS UNDER CONSIDERABLE COMPRESSION.

2. Remove regulator boost valve bushing and valve.

3. Remove pressure regulator spring.

4. Remove regulator valve, spring retainer, and spacer or spacers if present.

REMOVE CONTROL VALVE ASSEMBLY, GOVERNOR PIPES, DETENT SPRING, ROLLER ASSEMBLY, CHECK BALLS, AND ELECTRICAL CONNECTOR

NOTE: Units may be removed with transmission in vehicle, after removing bottom pan.

1. Remove attaching screw and remove detent roller and spring assembly.

2. Disconnect detent solenoid from electrical connector.

3. Remove governor feed pipe from transmission case and valve body by lifting straight out. Figure 26.

4. Remove nineteen remaining control valve assembly attaching screws. Do not remove detent solenoid attaching screws at this time.

NOTE: If the transmission is in the vehicle, the front servo piston assembly may drop down as the control valve assembly and governor pipe are removed.

5. Remove control valve assembly with remaining governor pipe attached.

CAUTION: *Do not allow manual valve to fall out of its bore in control valve assembly.*

6. Remove remaining governor pipe from valve body.

7. Remove control valve assembly to spacer gasket.

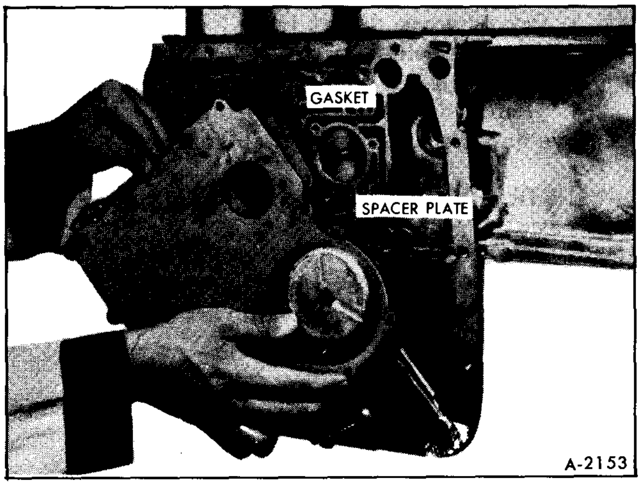


Figure 27—Removing Control Valve Spacer

8. Remove control valve spacer and spacer-to-transmission case gasket, Figure 27.

> **CAUTION:** *If control valve is removed in vehicle, seven check balls will come down with spacer.*

9. Remove seven check balls from cored passages in transmission case, Figure 28.

> **NOTE:** The eighth check ball is held in by a retainer and should not be removed unless replacement is required.

10. Remove electrical connector from case. Discard "O" ring from connector.

REMOVE FRONT SERVO PISTON AND REAR SERVO PISTON

NOTE: Units may be removed with transmission in vehicle after removing bottom pan and control valve assembly.

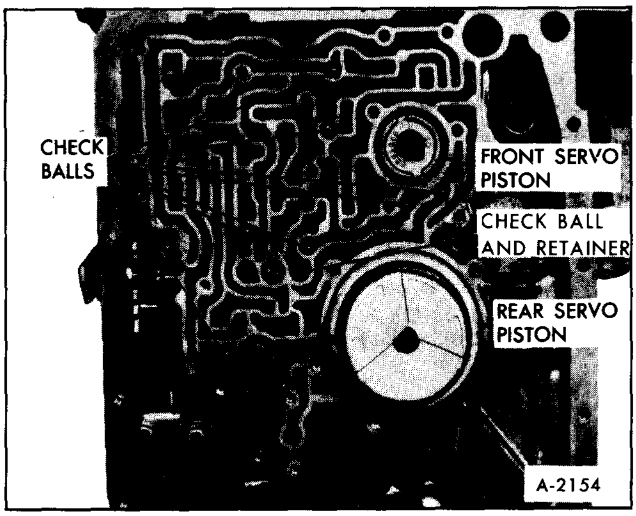


Figure 28—Location of Check Balls

1. Lift front servo piston retainer ring, pin, spring retainer and spring out of transmission case, Figure 28.

2. Remove rear servo assembly from transmission case, Figure 28.

3. Remove rear servo accumulator spring.

4. Make band apply pin selection check to determine proper size pin to use at time rear servo is assembled. Proceed as described in the following.

BAND APPLY PIN SELECTION CHECK (FIGURE 29)

NOTE: Check may be made with transmission in vehicle. Remove bottom pan, control valve assembly, and rear servo.

1. Position Adapter Plate, J-21370-8, on transmission case over rear servo bore, and, using screws provided with Adapter Plate, attach Band Apply Pin Selector Gauge, J-21370-6 to Adapter Plate.

2. Position Band Apply Pin Selector Gauge, J-21370-6, with hex nut on side of gauge facing toward converter housing, and smaller diameter end of Gauge Pin, J-21370-7, in servo pin bore.

3. Secure Adapter Plate to transmission case with two 5/16-18 x 1 inch screws, tightening screws to 18 foot-pounds and secure Selector Gauge to Adapter Plate, tighten attaching screws to 18 foot-pounds.

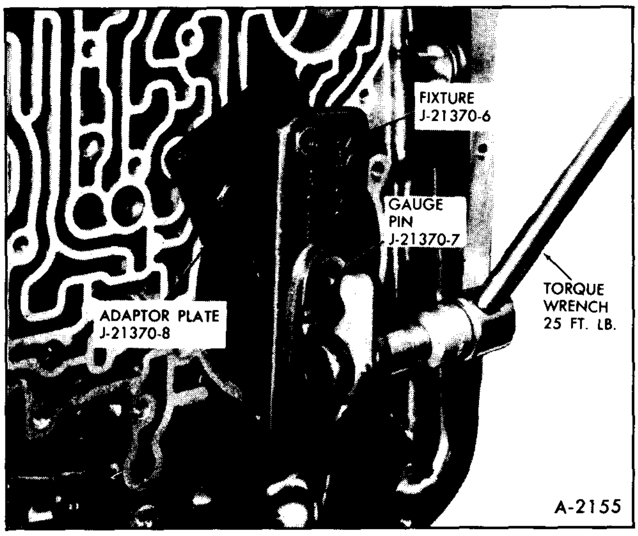


Figure 29—Checking Rear Band Apply Pin Length

Make certain that stepped gauge pin is free to move up and down in both tool and servo pin bore. Stepped side of pin must face rear of transmission case.

Band apply pins are available in three sizes as shown in the following chart:

Identification	Length
Three Rings	Long
Two Rings	Medium
One Ring	Short

Identification ring is located on band lug end of pin. Selecting the proper pin is equivalent to adjusting band.

4. To determine proper size pin to use, apply 25 foot-pounds torque on hex nut on side of gauge. This will cause lever on top of gauge to depress stepped gauge pin into servo pin bore, simulating actual operating conditions. Note relation of steps on gauge pin and machined surface on top of gauge. Determine proper size pin as follows:

a. If machined surface on top of gauge is even with or above upper step on gauge pin, long size pin (three rings) is required.

b. If machined surface on top of gauge is between steps on gauge pin, medium size pin (two rings) is required.

c. If machined surface on top of gauge is even with or below lower step on gauge pin, short size pin (one ring) is required.

5. If new pin is required, make note of pin size required, and remove gauge from transmission case.

REMOVE DETENT LEVER, MANUAL SHAFT, AND PARKING LINKAGE (FIGURE 30)

NOTE: Units may be removed with transmission in vehicle after removing bottom pan and detent roller and spring assembly from control valve assembly.

1. Remove pin securing manual shaft to case by pulling straight out, (Be careful not to damage the case or pin).

2. Loosen locknut securing detent lever to manual shaft.

3. Pry or work detent lever loose from ground flats on manual shaft.

4. Remove manual shaft from case bore and remove and discard O-ring seal from manual shaft.

NOTE: Be careful not to drop jam nut inside of case.

5. Remove detent lever and parking brake actuator assembly from case and remove actuator assembly from detent lever.

6. Remove parking brake bracket attaching screws and remove bracket.

7. Remove retainer pin securing parking pawl shaft to transmission case by pulling straight out.

8. Remove parking pawl shaft, parking pawl and return spring.

REMOVE SPROCKET COVER, LINK ASSEMBLY, DRIVE AND DRIVEN SPROCKETS

1. Remove eighteen cover attaching screws.

2. Remove cover and gasket and discard gasket.

3. Install Snap Ring Pliers, J-4646, into sprocket bearing retaining snap rings located under the drive and driven sprockets, and remove snap rings from retaining grooves on support housing, Figure 31.

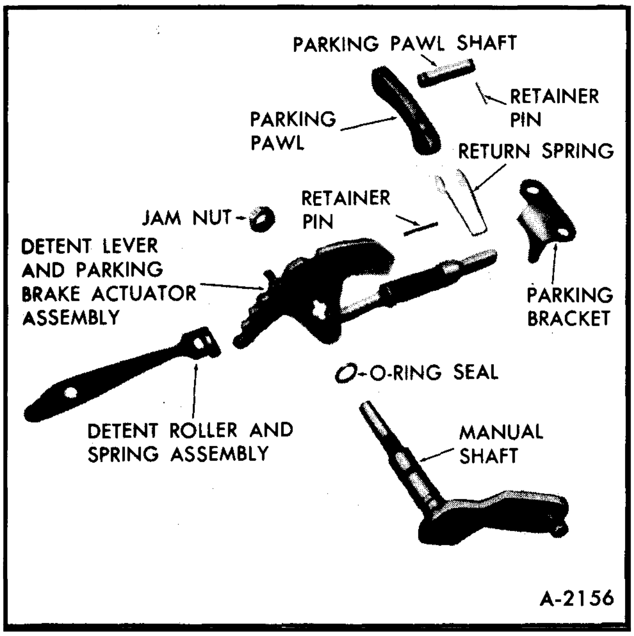


Figure 30—Manual and Parking Linkage

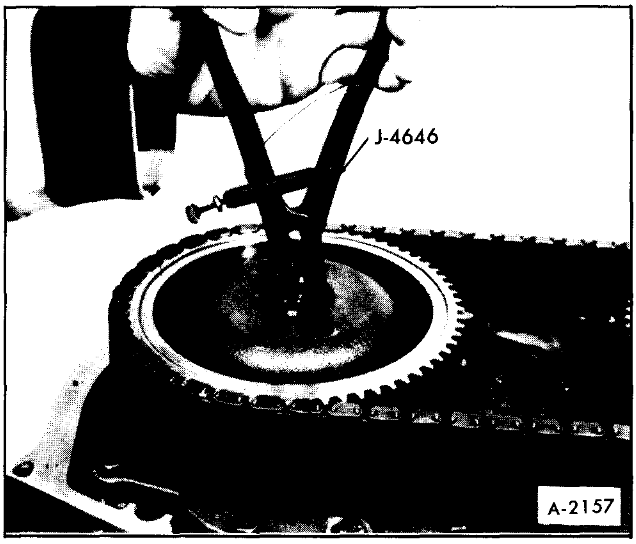


Figure 31—Removing Sprocket to Housing Snap Rings

NOTE: Leave snap rings in a loose position between sprockets and bearing assemblies.

4. Remove drive and driven sprockets, link assembly, bearings, and shafts simultaneously by alternately pulling upwards on the drive and driven sprockets until the bearings are out of the drive and driven support housings, Figure 32.

NOTE: If the sprockets are difficult to remove, place a small piece of fiberboard between the sprocket and sprocket support cover. Using a 1/2 x 9 inch pry bar, alternately pry upward under each sprocket on sprocket support cover. Do not pry on the guide links or the aluminum case. Pry only on the sprockets, Figure 33.

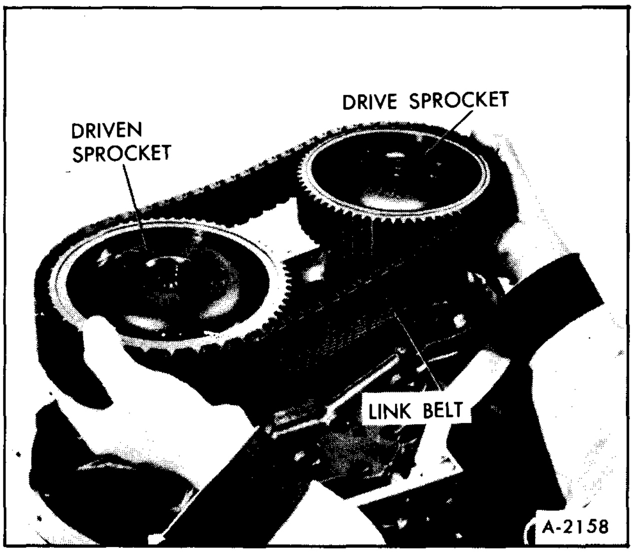


Figure 32—Removing Sprocket & Link Assembly

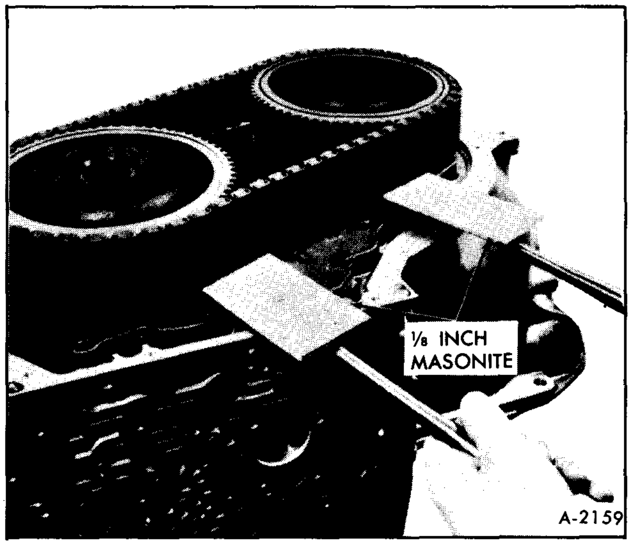


Figure 33—Removing Tight Sprockets

5. Remove link assembly from drive and driven sprockets.

6. Remove teflon oil seal ring from turbine shaft only if the ring requires replacement. For service, the ring is hook type cast iron.

7. Inspect drive and driven sprocket bearing assemblies for rough or defective bearings.

NOTE: Do not remove bearing assemblies from drive and driven sprockets unless they need replacement.

8. If removal of bearing assembly from drive and/or driven sprockets is necessary, proceed as follows:

a. Remove sprocket to bearing assembly retaining snap ring using Snap Ring Pliers, J-5586, Figure 34.

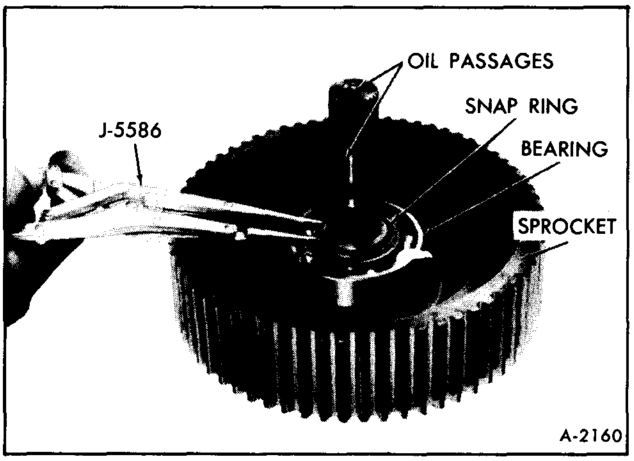


Figure 34—Removing Sprocket Bearing Snap Ring

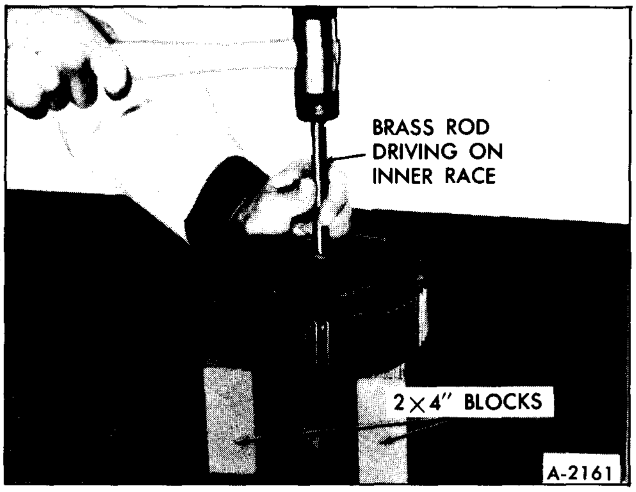


Figure 35—Removing Sprocket Bearing

b. Mount sprocket, with turbine or input shaft placed down between two 2" x 4" x 10" wood blocks.

NOTE: Wood blocks are positioned on sides or ends, depending on which bearing is to be replaced.

c. With a hammer and brass rod, drive the inner race, alternately through each of the access openings, until the bearing assembly is removed from the sprocket hub, Figure 35.

INSPECT DRIVE SPROCKET, TURBINE SHAFT, AND LINK ASSEMBLY

1. Inspect drive sprocket teeth for nicks, burrs, scoring, galling, and excessive wear.

NOTE: Wear pattern at bottom of tooth form is normal.

2. Inspect drive sprocket to ball bearing retaining snap ring for damage.

3. Inspect drive sprocket ball bearing inner race mounting surface for damage.

4. Inspect turbine shaft for open lubrication passages. Run a tag wire through the passages to be sure they are open. See lubrication chart for passage location, Figure 4.

5. Inspect spline for damage.

6. Inspect the ground bushing journals for damage.

7. Inspect the oil seal groove for damage or excessive wear.

8. Inspect turbine shaft oil seal ring for damage. Do not remove unless replacement of ring is required. The service ring is hook type cast iron.

9. Inspect the turbine shaft for cracks or distortion.

10. Inspect the link assembly for damage or loose links.

NOTE: Check the guide links. Guide links are the wide outside links on each side of the link assembly.

INSPECT DRIVEN SPROCKET AND INPUT SHAFT

1. Inspect driven sprocket teeth for nicks, burrs, scoring, galling, and excessive wear.

NOTE: Wear pattern at bottom of tooth form is normal.

2. Inspect sprocket to ball bearing retaining snap ring for damage.

3. Inspect ball bearing inner race mounting surface for damage.

4. Inspect input shaft for open lubrication holes. Run a tag wire through the holes to be sure they are open. See Figure 4 for location of holes.

5. Inspect spline for damage.

6. Inspect ground bushing journal for damage.

INSTALL SPROCKET BEARINGS

1. Turn sprocket so that turbine or input shaft is pointing upward.

2. Install new sprocket bearing as follows:

a. Install support snap ring, letter side down onto shaft.

b. Assemble bearing assembly on turbine or input shaft.

c. Using a piece of pipe, drive the bearing assembly onto the hub of the sprocket until it is resting on the bearing seat of the sprocket.

CAUTION: *Use pipe that closely fits I.D. of bearing assembly but does not contact shaft.*

d. Install sprocket to bearing assembly retaining snap ring into groove in sprocket hub.

3. If necessary, install new hook type oil seal ring on turbine shaft, (Note: original ring is plastic).

NOTE: Turbine and/or input shaft may appear not to be pressed fully into the sprocket. Do not attempt pressing shaft further as a specific length dimension is held during initial assembly.

FRONT UNIT END PLAY CHECK

1. Install Front Unit End Play Checking Tool, J-22241, into driven sprocket housing so that the urethane on the tool can engage the splines in the forward clutch housing. Let the tool bottom on the mainshaft and then withdraw it approximately 1/8 inch and tighten nut on tool, Figure 36.

2. Remove two of the 5/16" bolts from the driven support housing.

Install 5/16" threaded slide hammer bolt with jam nut into one bolt hole in driven support housing.

NOTE: Do not thread slide hammer bolt deep enough to interfere with forward clutch housing travel.

3. Mount Dial Indicator, such as J-8001, on slide hammer bolt and index indicator to register with the Front Unit End Play Checking Tool, J-22241, Figure 36 and push tool down to remove slack.

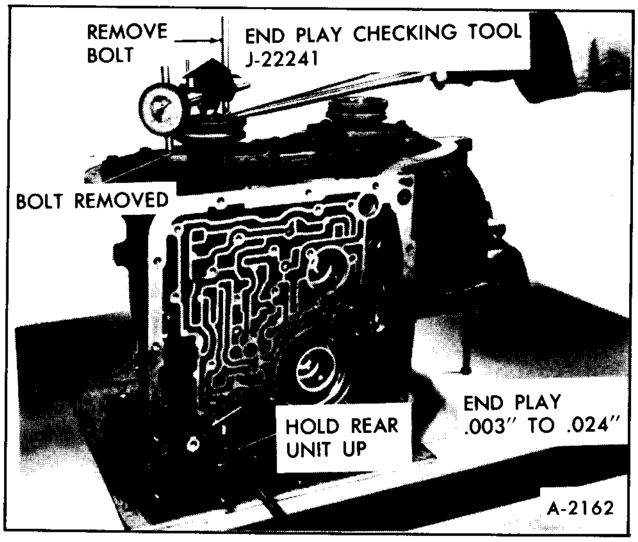


Figure 36—Checking Front Unit End Play

4. Push and hold output flange upward. Place a screw driver in case opening at parking pawl area and push upward on output carrier.

5. Place another screw driver between the metal lip of the end play tool and the driven sprocket housing and push upward on the metal lip of the end play tool and read the resulting end play, which should be between .003" and .024".

The selective washer controlling this end play is the thrust washer located between the pump cover plate and the forward clutch housing. If more or less washer thickness is required to bring the end play within specifications, select the proper washer from the chart below:

THICK-NESS	COLOR
.060-.064	Yellow
.071-.075	Blue
.082-.086	Red
.093-.097	Brown
.104-.108	Green
.115-.119	Black
.126-.130	Purple

NOTE: An oil soaked washer may tend to discolor so that it will be necessary to measure the washer with a set of one inch micrometers to determine its actual thickness.

6. Remove end play tool from transmission and remove dial indicator and slide hammer bolt from transmission.

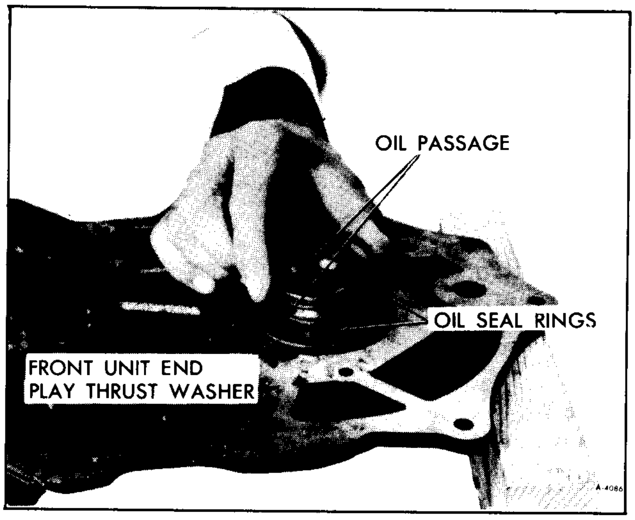


Figure 37—Removing or Installing Oil Seal Rings

REMOVE OIL PUMP

1. Remove two opposite pump attaching bolts from the drive support housing.

2. Install two 5/16-18 x 4" guide pins in holes from previously removed bolts.

3. Remove the remaining pump attaching bolts from the drive support housing.

4. With one hand hold the underside of the pump and gently tap the guide pins until the pump is removed from the case.

REMOVE PUMP COVER PLATE, CONVERTER OUT CHECK VALVE AND DRIVE AND DRIVEN SUPPORT HOUSING ASSEMBLIES

1. Remove the twenty-three pump cover plate-to-case attaching screws and remove pump cover plate. Do not remove sprocket support housing bolts at this time.

2. Remove pump cover plate and plate-to-case face gasket. Discard gasket.

NOTE: Drive and driven support housing assemblies are pressed into and removed with the pump cover plate. Do not remove them unless it is necessary.

3. If necessary, remove oil seal rings from the driven support housing. See Figure 37.

4. Remove the front unit end play selective thrust washer from the hub of the driven support housing.

5. If necessary to remove the drive and driven sprocket support housing assemblies, proceed as follows:

a. Remove the remaining sprocket support to pump cover plate attaching bolts.

b. Support cover plate on wooden blocks and using a plastic mallet, vigorously strike the stator shaft of the drive sprocket support, Figure 38, and the hub of the driven sprocket support, until they are removed from their pump cover plate bores.

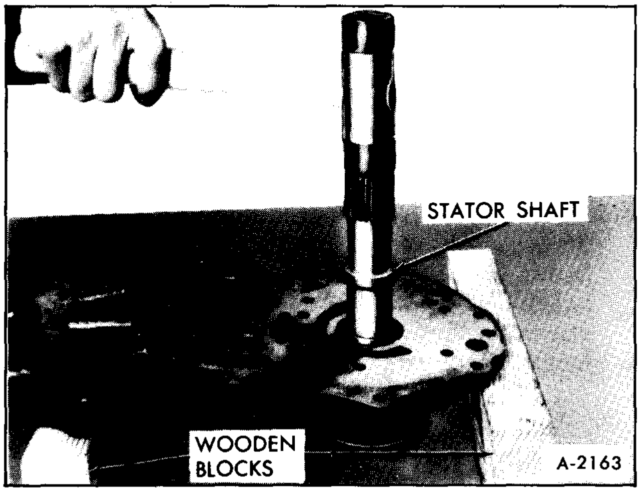


Figure 38—Removing Drive Sprocket Support

CAUTION: *When driving the housings out of the pump cover plate, avoid damaging or distorting the stator shaft or the ring grooves in the hub of the driven housing by striking the shaft or hub centrally.*

c. Remove and discard housing to pump cover plate gaskets.

d. Remove converter out check valve, Figure 39.

e. Install converter out check valve.

f. Install drive sprocket support housing to pump cover plate gasket.

g. Install drive sprocket support housing into pump cover plate by using a plastic mallet to seat the housing. Use bolts for guides, Figure 40.

h. Install driven sprocket support housing to pump cover plate gasket.

i. Install driven sprocket support housing to pump cover plate attaching bolts for gasket guides.

j. Install driven sprocket support housing into pump cover plate by using a plastic mallet to seat the housing.

k. Install all but one driven support housing to pump cover plate attaching bolts. Torque to 20 ft. lbs.

6. Install proper front unit end play selective thrust washer on the hub of the driven sprocket support housing. Use micrometer to determine the actual thickness of the thrust washer.

7. If necessary, install oil seal ring into the grooves in the hub of the driven sprocket support housing. See Figure 37.

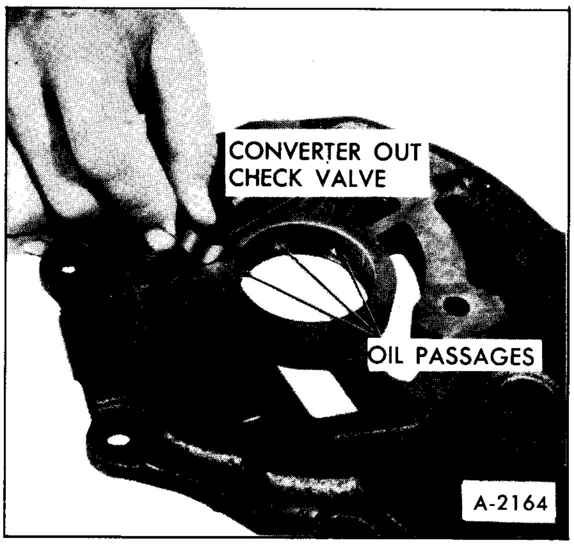


Figure 39—Converter Out Check Valve

NOTE: If teflon rings are being used, make sure slit ends are assembled in same relation as cut, see Figure 41. Also, make sure oil seal rings are seated in ring grooves to prevent damage to rings during reassembly of mating parts over rings.

REMOVE FORWARD CLUTCH ASSEMBLY, DIRECT CLUTCH ASSEMBLY, SUN GEAR SHAFT, AND FRONT BAND

1. Remove forward clutch assembly from transmission, Figure 42, by installing Front End Play Checking Tool, J-22241, into forward clutch and lifting forward clutch straight out.

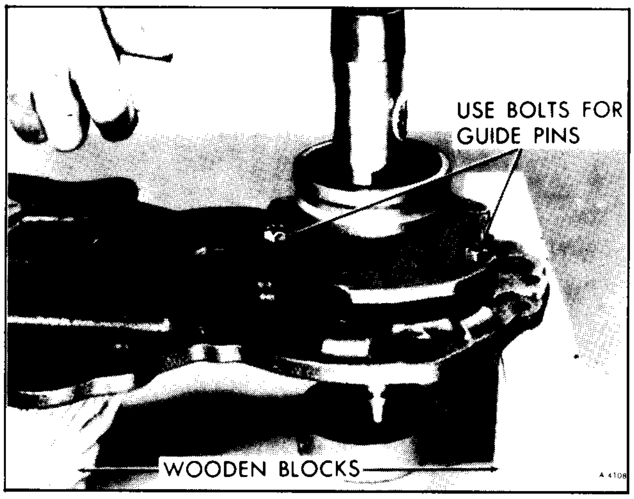


Figure 40—Installing Drive Sprocket Support

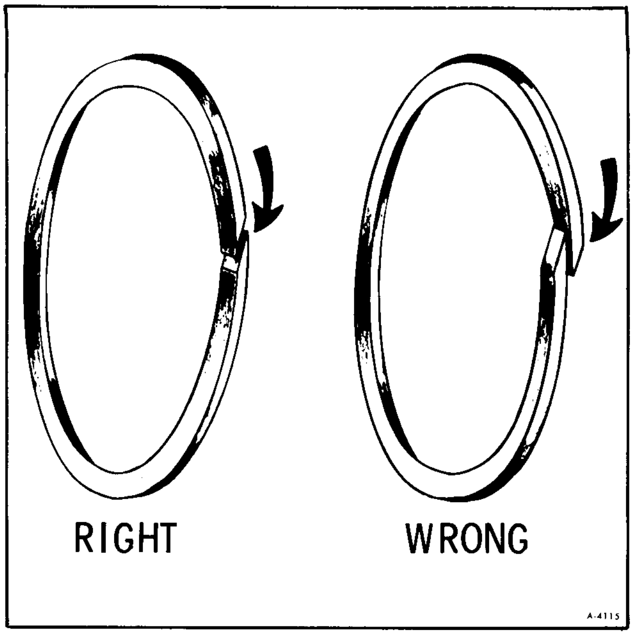


Figure 41—Installing Teflon Oil Seal Rings

2. Remove forward clutch hub to direct clutch housing thrust washer if it did not come out with forward clutch assembly.

3. Remove direct clutch and intermediate sprag assembly by lifting straight out. Sun gear shaft may come out with direct clutch assembly.

4. Remove sun gear shaft if not previously removed.

5. Remove front band assembly.

NOTE: Check rear unit end play at this time.

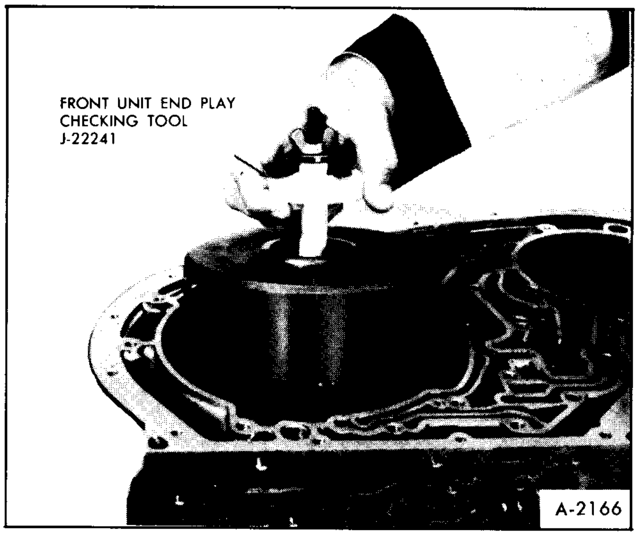


Figure 42—Removing Forward Clutch

REAR UNIT END PLAY CHECKING PROCEDURE

Make rear unit end play check as follows:

1. Rotate transmission in holding fixture base so that forward end of transmission is up.

2. Install Speedometer Puller Bolt, J-21797, in one of the differential mounting bolt holes on end of transmission case.

3. Mount Dial Indicator, J-8001, on Bolt J-21797, and index indicator to register with flat surface on end of output flange, Figure 43.

4. Set dial indicator to zero.

5. Using two screwdrivers (180° apart) more output flange in and out. Note resulting travel or end play for selection of washer for use at time of transmission assembly. End play should be .007 inch-.019 inch.

(NOTE: Use of two screwdrivers avoids an angled condition and insures greater accuracy).

The selective washer controlling this end play is the steel washer with the three tabs, located between thrust washer and rear face of transmission case. Notches and/or numerals on the tabs serve to identify washer thickness.

If a different washer thickness is required to bring end play within specifications, it can be selected from the following chart. The tabs will show identification notches, numerals or both.

Thickness	Identification Notch and/or Numeral	
.074 — .078	None	1
.082 — .086	On Side of 1 Tab	2
.090 — .094	On Side of 2 Tabs	3
.098 — .102	On End of 1 Tab	4
.106 — .110	On End of 2 Tabs	5
.114 — .118	On End of 3 Tabs	6

6. Remove Dial Indicator, J-8001, and Bolt, J-21797, from transmission and rotate transmission so that rear end of transmission is up.

REMOVE REMAINING COMPONENTS

1. Remove center support bolt from transmission case, Figure 44, using a 3/8 inch 12-point thin wall deep socket.

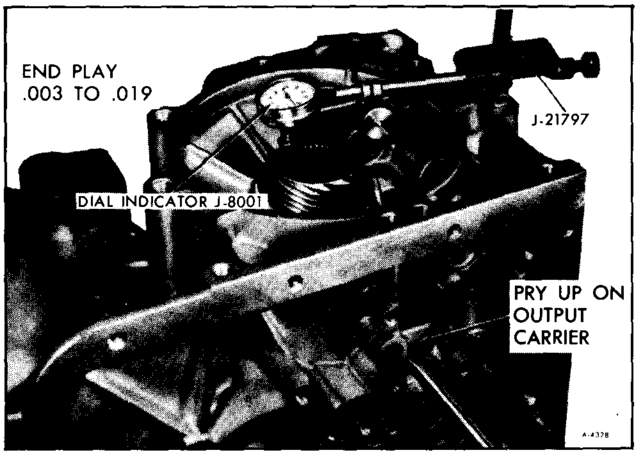


Figure 43—Checking Rear Unit End Play

2. Remove intermediate clutch backing plate to case snap ring, Figure 45.

3. Remove intermediate clutch backing plate, and three composition and three steel clutch plates.

4. Using a needle-nose pliers, or screwdriver, remove center support to case snap ring, Figure 46.

5. Install Gear Assembly Remove and Installer Adapter, J-21795, on end of main shaft so that tangs engauge groove in shaft. Using Slide Hammer Handle, such as J-6125, and Speedometer Puller Bolt, J-21797, tighten bolt on tool to secure tool on shaft, Figure 47.

6. Remove complete gear unit assembly from case, by lifting straight up.

CAUTION: *Be careful not to drop or bump assembly in transmission case during removal.*

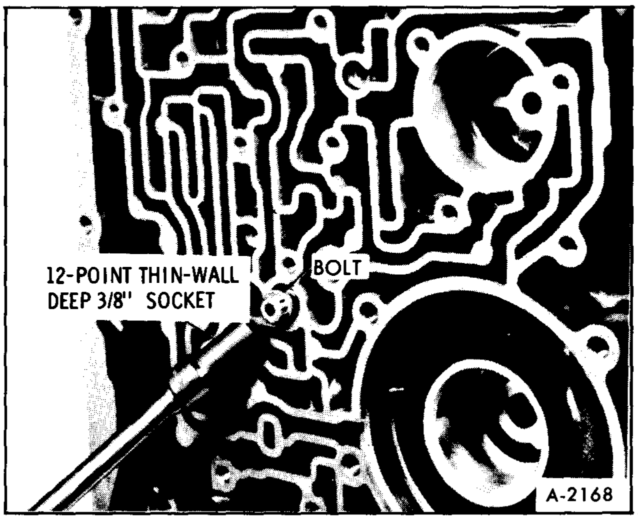


Figure 44—Remove Center Support Bolt

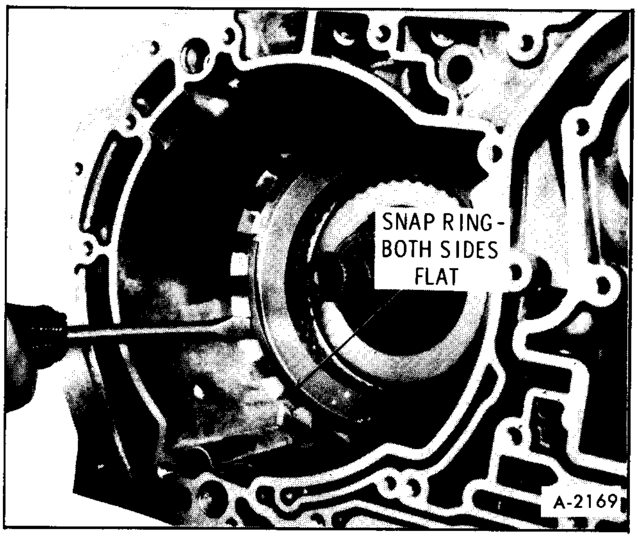


Figure 45—Intermediate Clutch Snap Ring

7. Remove output flange to case metal thrust washer from output flange or case.

8. Place gear unit assembly on bench with output flange down, Figure 48. Remove Tool J-21795.

9. Remove support to case spacer.

10. Remove rear band assembly. To facilitate removal , rotate band lugs away from pins and pull band assembly out of transmission case.

11. Remove rear unit selective washer from transmission case.

INSPECTION OF TRANSMISSION CASE

NOTE: If the case assembly requires replacement, make sure the center support to case

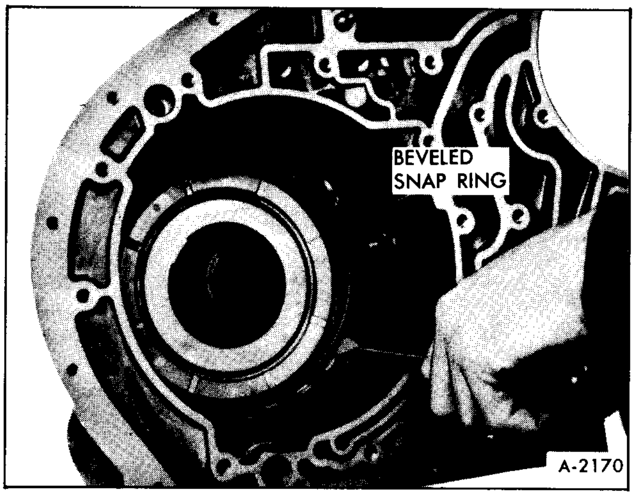


Figure 46—Center Support Snap Ring

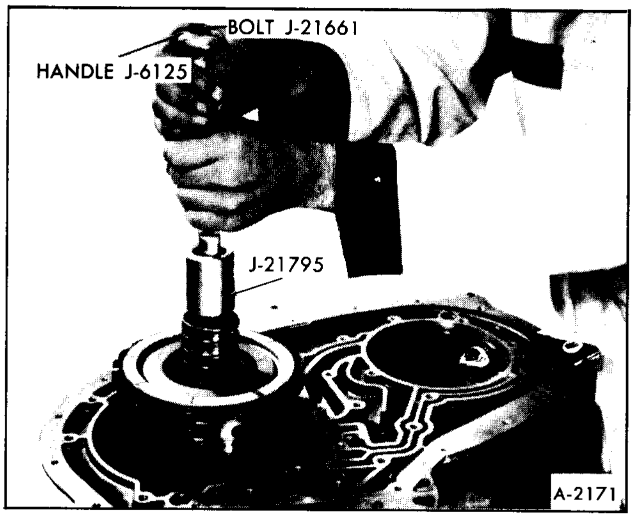


Figure 47—Gear Unit Removal

spacer is removed from the old case and reinstalled in the new case. Also, remove the nameplate from the old case and reinstall it onto the new case, using the truss head nameplate attaching screw that is serviced with the case.

1. Inspect case assembly for cracks, porosity or interconnected passages, Figure 5.

2. Check for good retention of band anchor pins.

3. Inspect all threaded holes for thread damage. (use insert to rebore threads if necessary).

4. Inspect intermediate clutch driven plate lugs for damage or brinelling.

5. Inspect snap ring grooves for damage.

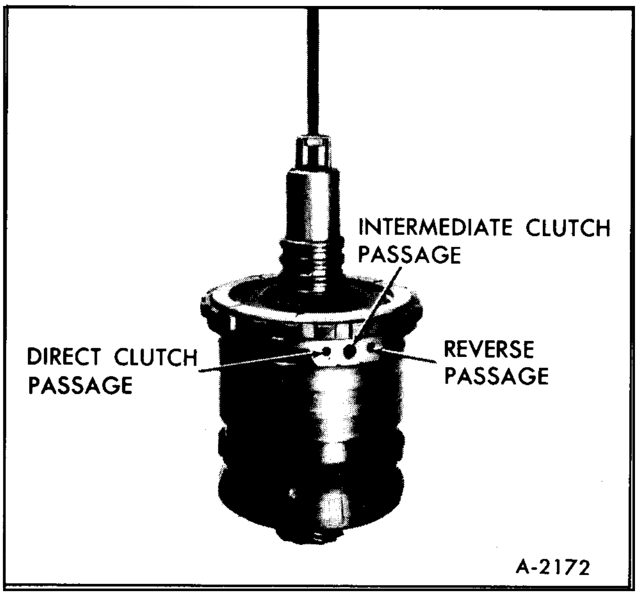


Figure 48—Gear Unit on Bench

6. Inspect governor assembly bore for scratches or scoring.

7. Inspect governor pipes screen assemblies (located in governor pipe holes in case) for plugging or damage.

8. Inspect modulator valve bore for scoring or damage.

9. Inspect output flange bushing for wear, galling and open lubrication groove.

CENTER SUPPORT AND GEAR UNIT

DISASSEMBLY

1. Remove center support assembly from reaction carrier by lifting center support straight up.

2. Remove center support to reaction carrier thrust washer.

NOTE: Thrust washer may have stuck to back of center support. If so, remove from center support.

3. Remove reaction carrier and roller clutch assembly from output carrier, Figure 49, and remove roller clutch assembly from reaction carrier.

4. Remove center support to sun gear races and thrust bearing from sun gear.

NOTE: One of the races may have stuck to back of center support.

5. Remove front internal gear ring from output carrier assembly, Figure 50.

6. Remove sun gear from output carrier assembly.

7. Remove reaction carrier to output carrier plastic thrust washer from output carrier.

NOTE: The service thrust washer is metal.

8. Invert gear unit and place in Rear Unit Holding Fixture, J-6116, with main shaft pointing downward.

9. Remove snap ring securing output flange to output carrier and remove output flange.

10. Remove thrust bearing and races from rear internal gear.

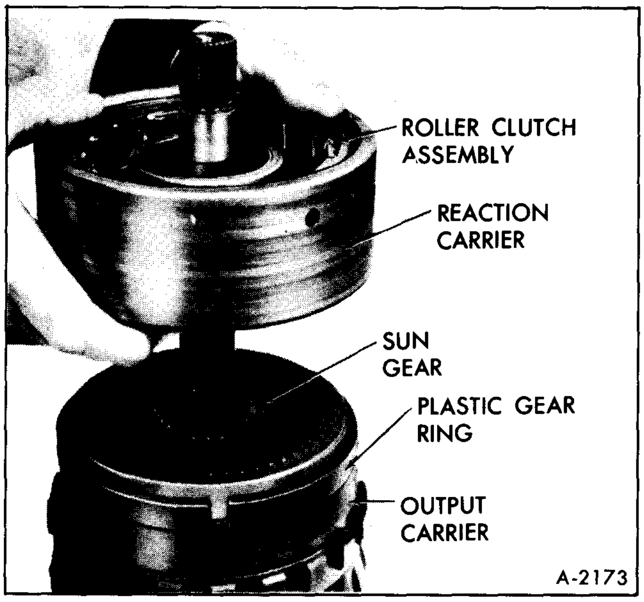


Figure 49—Removing Reaction Carrier

11. Lift rear internal gear and main shaft out of output carrier and remove thrust bearing and races from inner face of rear internal gear.

12. Remove snap ring from end of main shaft and remove rear internal gear.

13. Remove output carrier from holding fixture.

INSPECT OUTPUT FLANGE

1. Inspect bearing and thrust washer surfaces for damage.

Figure 50—Removing Gear Ring

2. Inspect drive lugs for damage.

3. Inspect splines for damage.

4. Inspect lubrication passages.

INSPECT MAIN SHAFT

1. Inspect shaft for cracks or distortion.

2. Inspect splines for damage.

3. Inspect ground bushing journals for damage.

4. Inspect snap ring groove for damage.

5. Inspect lubrication passages.

INSPECT REAR INTERNAL GEAR

1. Inspect gear teeth for damage or wear.

2. Inspect splines for damage.

3. Inspect gear for cracks.

4. Inspect bearing and thrust surfaces for wear or galling.

INSPECT OUTPUT CARRIER

1. Inspect front internal gear for damaged teeth.

2. Inspect pinion gears for damage, rough bearings or excessive tilt.

3. Check pinion end play. Pinion end play should be .009 inch-.024 inch, Figure 51.

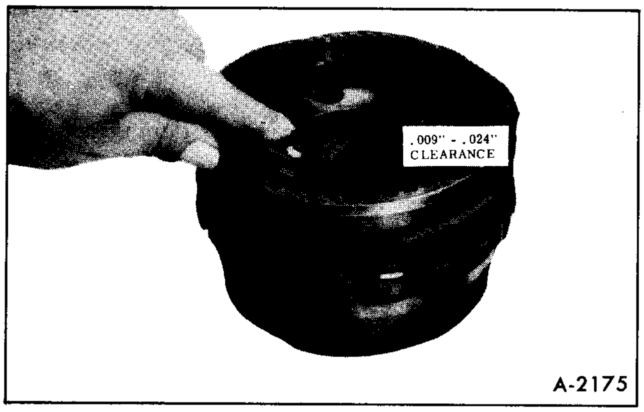


Figure 51—Check-Pinion End Play

4. Inspect parking gear lugs for cracks or damage.

5. Inspect output flange locating splines for damage.

6. Inspect front internal gear ring for flaking or cracks.

INSPECT REACTION CARRIER

1. Inspect band surface on reaction carrier for signs of burning or scoring.

2. Inspect roller clutch outer cam for scoring or wear.

3. Inspect thrust washer surfaces for signs of scoring or wear.

4. Inspect bushing for damage. If bushing is damaged, carrier must be replaced.

5. Inspect pinion gears for damage, rough bearings or excessive tilt.

6. Check pinion end play. Pinion end play should be .009 inch-.024 inch.

7. If the reaction carrier has a spacer ring in an undercut at the bottom of the roller cam vamps, inspect it for damage, Figure 52.

NOTE: The reaction carrier with the undercut and spacer ring is used optionally and inter-

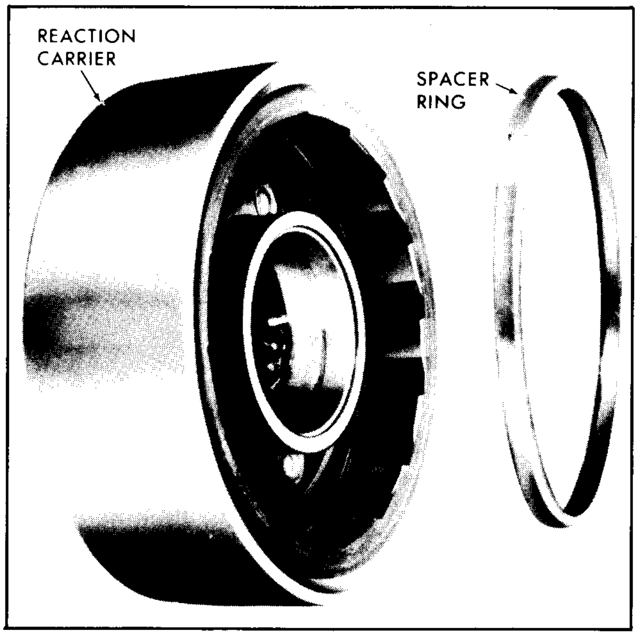


Figure 52—Reaction Carrier with Spacer Ring

changeably with the reaction carrier which does not have an undercut and spacer ring.

PINION GEAR REPLACEMENT—REACTION AND OUTPUT CARRIER ASSEMBLIES

1. Support carrier assembly on its FRONT face.

2. Using a 1/2 inch diameter drill, remove the stake marks from the end of the pinion pin, or pins, to be replaced. This will reduce the probability of cracking the carrier when the pinion pins are pressed out.

CAUTION: *Do not allow drill to remove any stock from the carrier, as this will weaken the part, and could cause the carrier to break.*

3. Using a tapered punch, drive or press pinion pins out of carrier.

4. Remove pinion gears, thrust washers, and roller needle bearings.

5. Inspect pinion pocket thrust faces for burrs and remove if present.

6. Install eighteen needle bearings into each pinion gear using petrolatum to hold bearings in place. Use a pinion pin as a guide.

7. Place a bronze and steel thrust washer on each side of pinion gear with steel washers against gear, Figure 53. Hold washers in place with petrolatum.

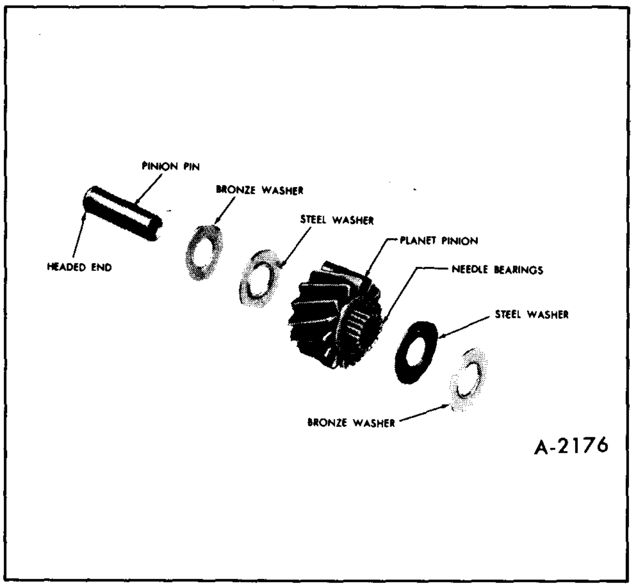


Figure 53—Planet Pinion Components

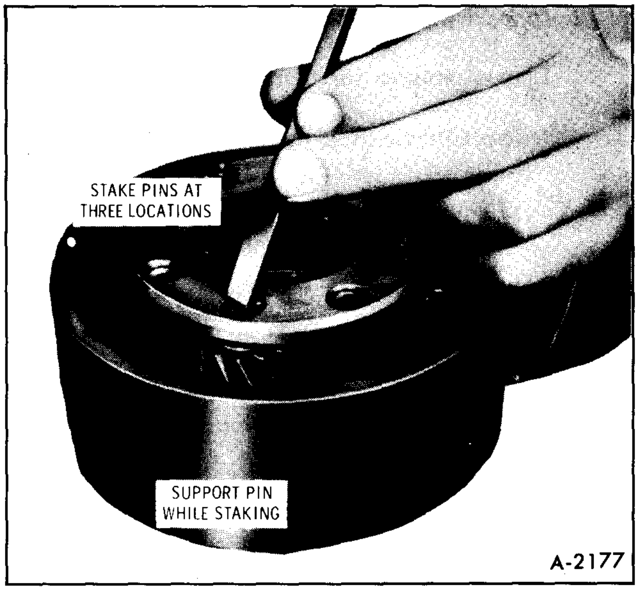


Figure 54—Staking Pinion Pin

8. Place pinion gear assembly in position in carrier and install a pilot shaft through rear face of assembly to hold parts in place.

9. Drive a new pinion pin into place from the front, while rotating pinion gear. Be sure that headed end is flush or below face of carrier.

10. Using a punch in bench vise for an anvil, stake opposite end of pinion pin in three places with a blunt radius chisel, Figure 54.

NOTE: Both ends of pinion pins must lie below face of carrier or interference may occur.

11. Repeat installation procedure for each pinion gear.

INSPECT ROLLER CLUTCH

1. Inspect roller clutch for damaged rollers or springs.

2. Inspect roller clutch cage for damage.

INSPECT SUN GEAR

1. Inspect gear teeth for damage or wear.

2. Inspect splines for damage.

3. Be sure oil lubrication hole is open.

INSPECT SUN GEAR SHAFT

1. Inspect shaft for cracks or splits.

2. Inspect splines for damage.

3. Inspect bushings for scoring or galling.

4. Inspect ground bushing journals for damage.

5. Be sure oil lubrication hole is open.

ASSEMBLE GEAR UNIT (FIGURE 55)

1. Install rear internal gear on end of main shaft that has snap ring groove and install snap ring.

2. Install races and thrust bearing on inner face of rear internal gear, retaining races and bearing with petrolatum. Proceed as follows:

a. Install large diameter race first, with flange facing up, Figure 56.

b. Install thrust bearing in race.

c. Install small diameter race on bearing with inner flange facing down.

3. Lubricate pinion gears in output carrier with transmission fluid and install output carrier on main shaft so that pinion gears mesh with rear internal gear.

4. Place the above portion of the build-up through hole in bench so that the mainshaft hangs downward.

5. Install the rear internal gear to output flange thrust races and bearings as follows: (Retain with petrolatum) (figure 57).

a. Place the small diameter race against the internal gear with the center flange facing up.

b. Place the bearing on the race.

c. Place the second race on the bearing with the outer flange cupped over the bearing.

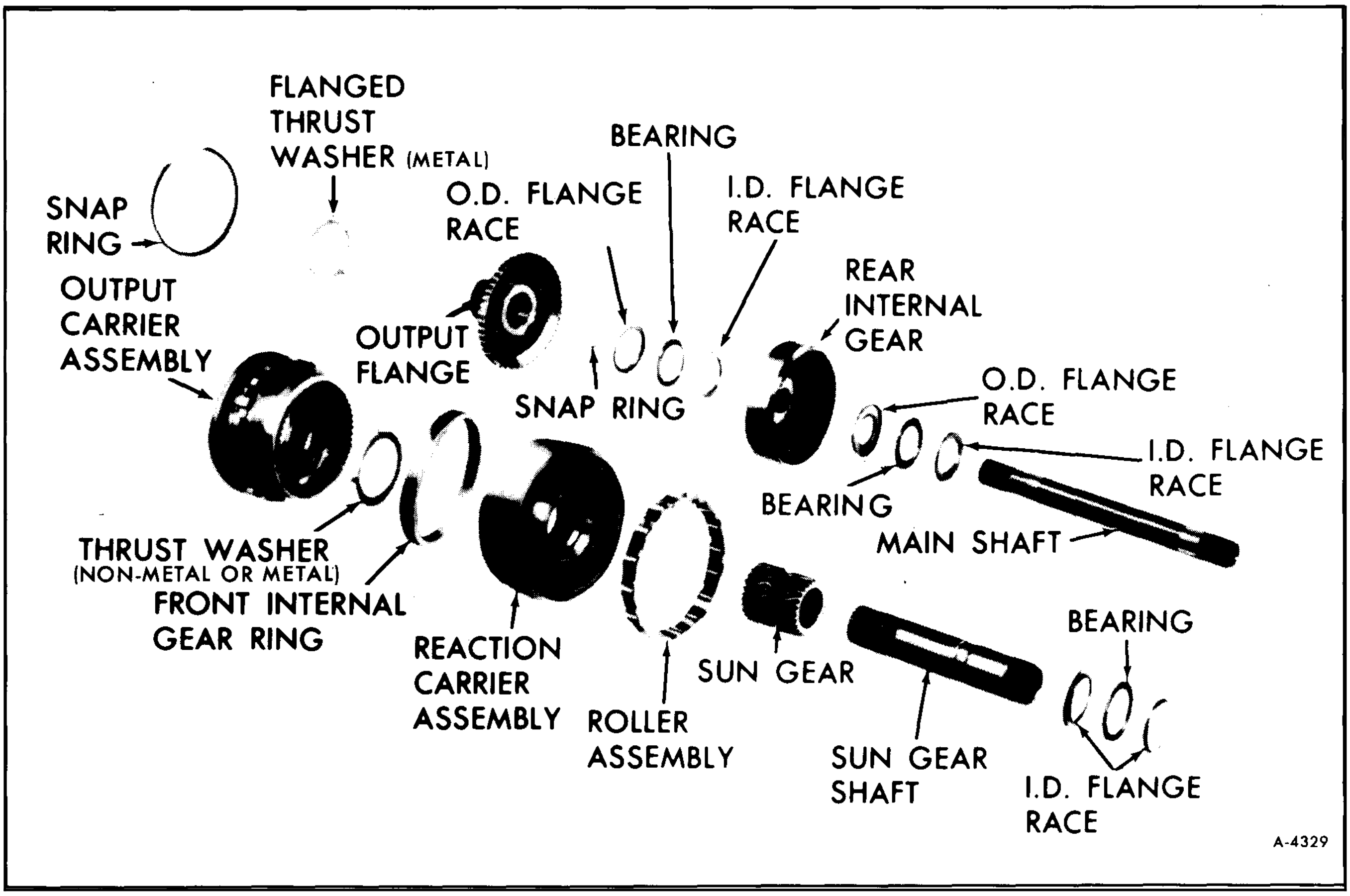


Figure 55—Gear Unit Components

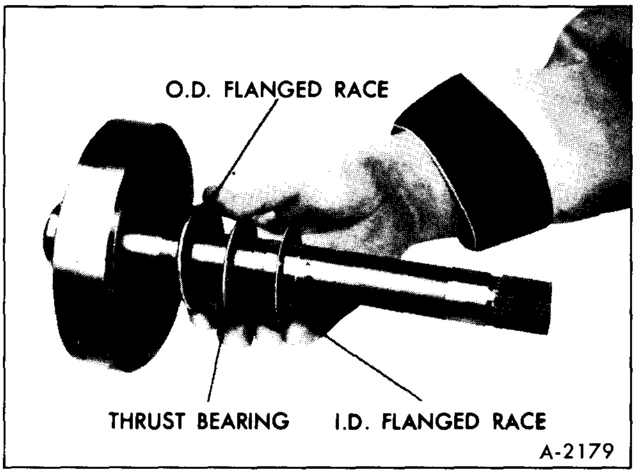


Figure 56—Thrust Bearing Installation

6. Install the output flange into the output carrier assembly.

7. Install the output flange to the output carrier snap ring.

8. Invert assembly and place on bench with output flange downward.

9. Lubricate tab side of reaction carrier to output carrier thrust washer (metal or non-metal) with petrolatum and install thrust washer in output carrier with tabs in tab pockets.

NOTE: The production built transmissions use a non-metal washer here. However, the service replacement washer is made of metal.

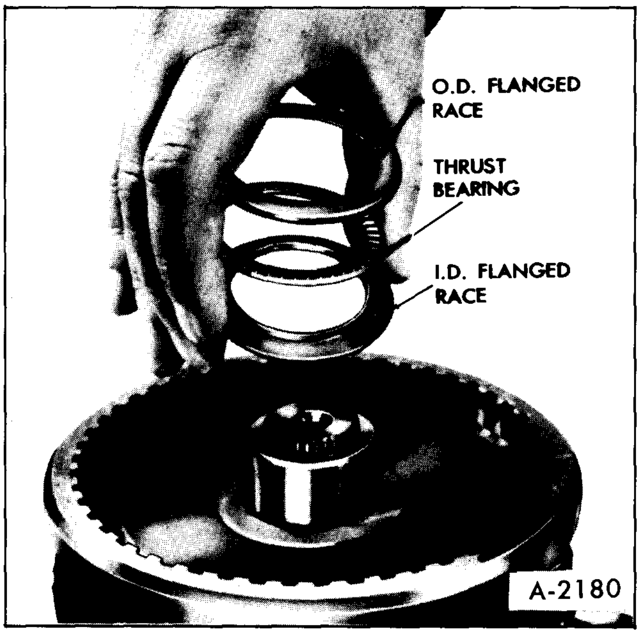


Figure 57—Installing Output Flange Thrust Bearing

10. Install sun gear with end having chamfered I.D. facing down.

11. Install sun gear shaft with longer splined end down.

12. Install gear ring over output carrier.

13. Lubricate pinion gears in reaction carrier with transmission fluid and install reaction carrier on output carrier so that pinion gears mesh with front internal gear.

NOTE: When a new output carrier and/or reaction carrier is being installed, and if the front internal gear ring prevents assembly of the carriers, replace the front internal gear ring with the service ring. The front internal gear ring is a selective fit at the factory, but not in service.

14. Install the center support to sun gear thrust races and bearings as follows: (See figure 58)

a. Install the large race, center flange up over the sungear shaft.

b. Install the thrust bearing against the race.

c. Install the second race, center flange up.

15. Install rollers that may have come out of roller clutch cage, by compressing energizing spring with forefinger and inserting roller from outer side.

NOTE: Make certain that energizing springs are not distorted, and that curved end leaf of springs are positioned against rollers.

16. Install roller clutch assembly in reaction carrier, Figure 59.

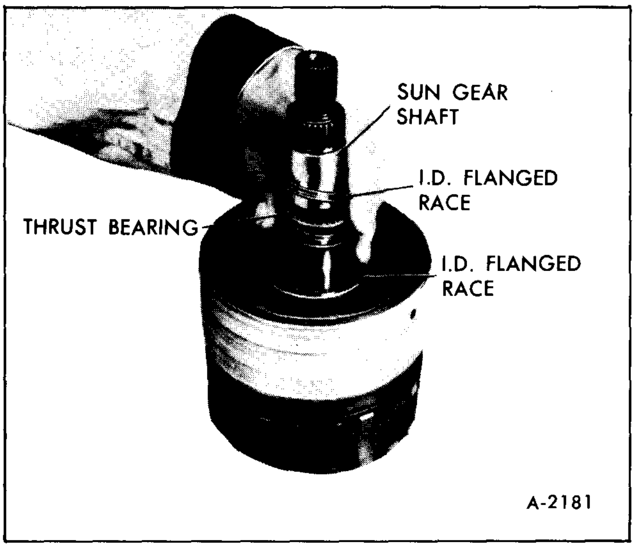


Figure 58—Installing Thrust Bearing over Sun Gear Shaft

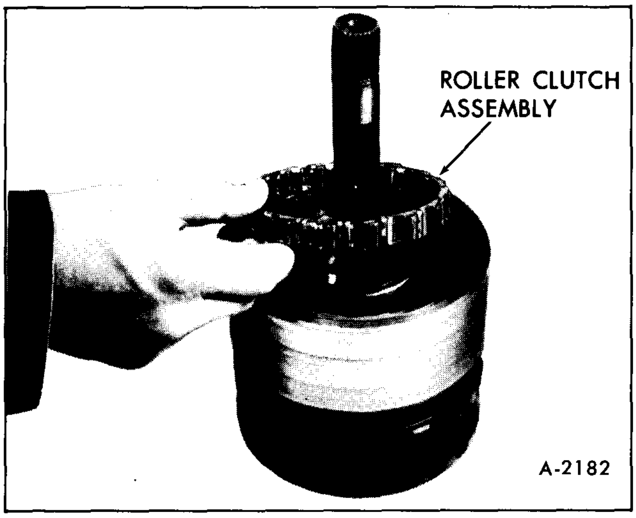


Figure 59—Roller Clutch Installation

DISASSEMBLE CENTER SUPPORT AND INTERMEDIATE CLUTCH PISTON

1. Remove center support to reaction carrier thrust washer from recess in center support.

2. If replacement is required, remove oil seal rings from the center support. All service center support oil seal rings are hook type cast iron or teflon, Figure 60.

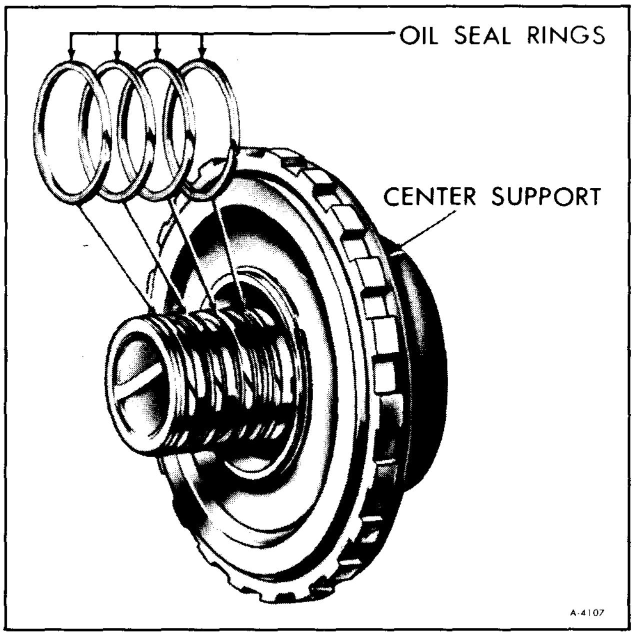


Figure 60—Removing Oil Seal Rings

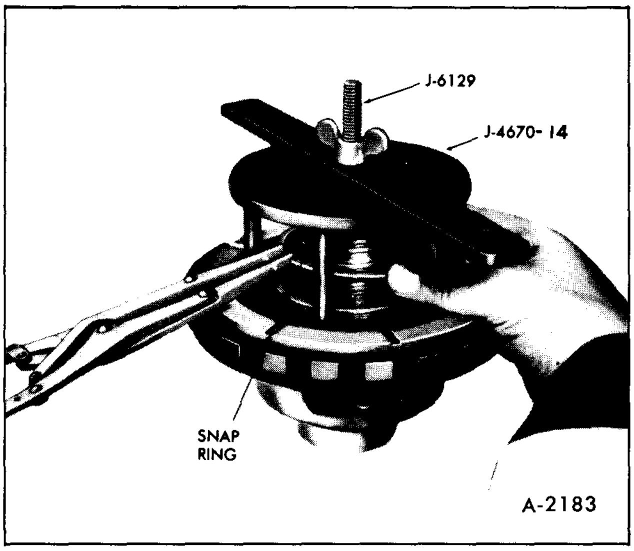


Figure 61—Removing Intermediate Clutch Retaining Snap Ring

3. Using Clutch Spring Compressor, J-4670, and Rear Clutch Spring Compressor, J-6129, Figure 61, compress spring retainer and remove snap ring with Snap Ring Pliers, J-8059 or J-5586.

4. Remove spring retainer, six intermediate clutch release springs, and spring guide. Figure 62.

5. Remove intermediate clutch piston from center support.

6. Remove inner and outer seals from clutch piston.

NOTE: Do not remove the three screws retaining roller clutch inner race to center support.

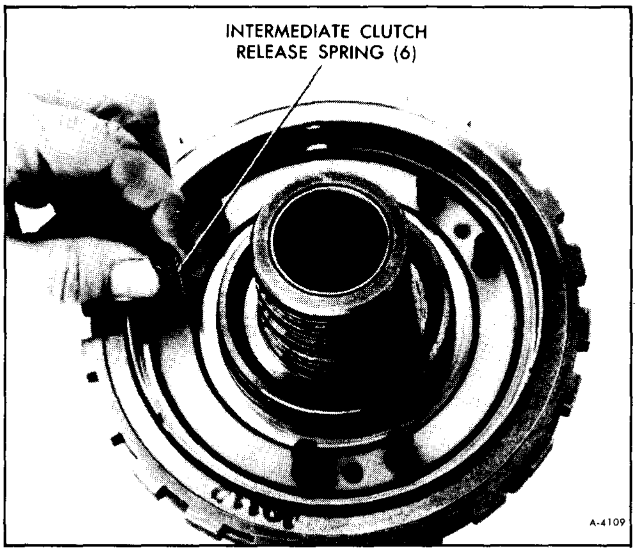


Figure 62—Removing Intermediate Clutch Springs

INSPECT CENTER SUPPORT

1. Inspect roller clutch inner race for scratches or indentations. Be sure lubrication hole is open.

2. Inspect bushing for scoring, wear or galling.

3. Check oil ring grooves for damage.

4. Air check oil passages to be sure they are open and not interconnected.

5. Inspect piston sealing surfaces for scratches.

6. Inspect piston seal grooves for nicks or other damage.

7. Inspect piston for cracks.

8. Inspect springs for collapsed coils or signs of distortion.

9. Inspect oil seal rings for damage.

NOTE: All service center support oil seal rings are hook type cast iron or teflon.

ASSEMBLE CENTER SUPPORT AND INTERMEDIATE CLUTCH PISTON ASSEMBLY (FIGURE 63)

1. Lubricate new inner and outer clutch piston seals with transmission fluid. Lubricate seal grooves in intermediate clutch piston and install seals with lips facing away from spring guide, Figures 64 and 65.

2. Place Intermediate Clutch Inner Seal Protector, J-21363, over center support hub and install intermediate clutch piston. Figure 66.

3. Install plastic spring guide. Figure 67.

4. Install six clutch release springs equally spaced into spring holes in spring guide.

5. Place spring retainer and snap ring over springs.

6. Using Clutch Spring Compressor, J-4670, and Rear Clutch Spring Compressor, J-6129, Figure 61, compress spring retainer, being careful that retainer

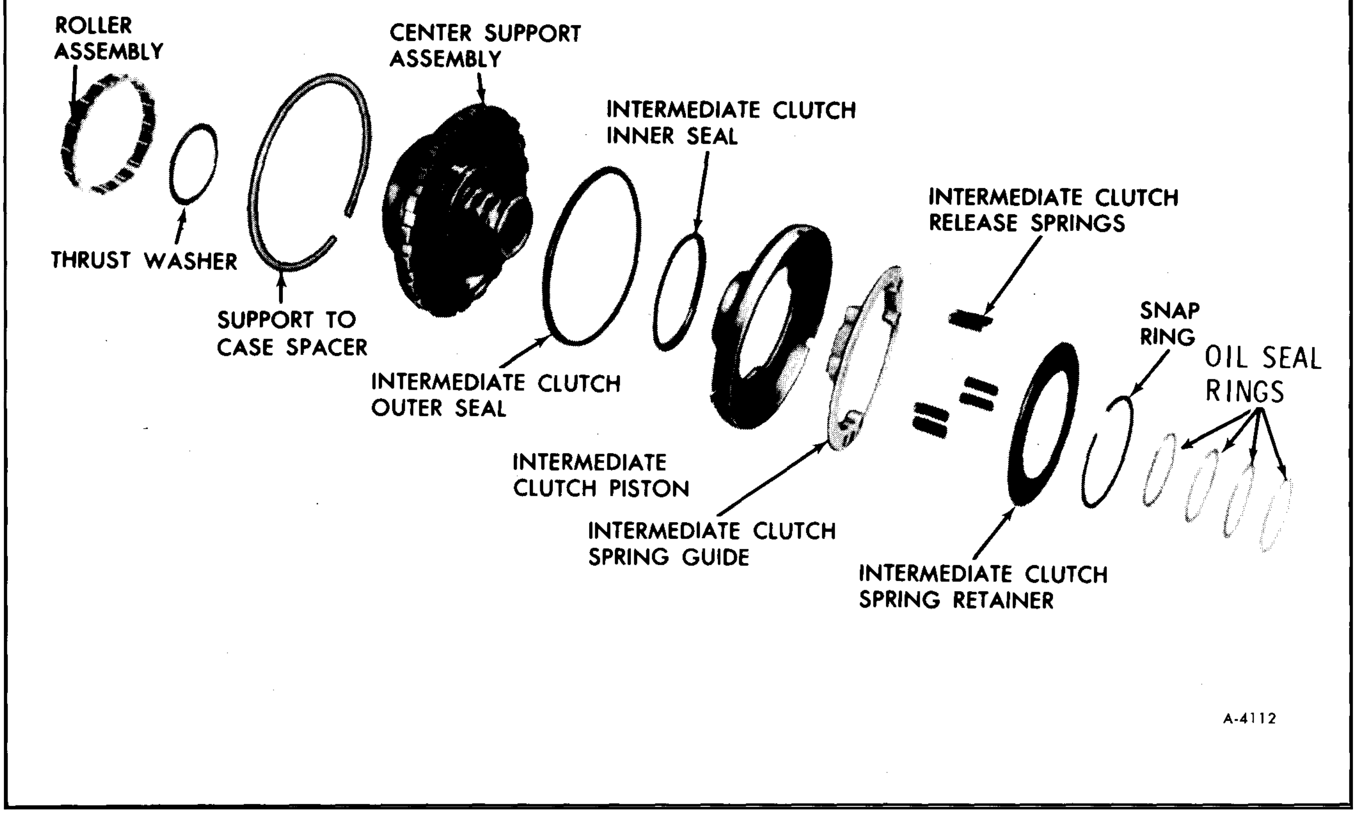


Figure 63—Center Support Assembly

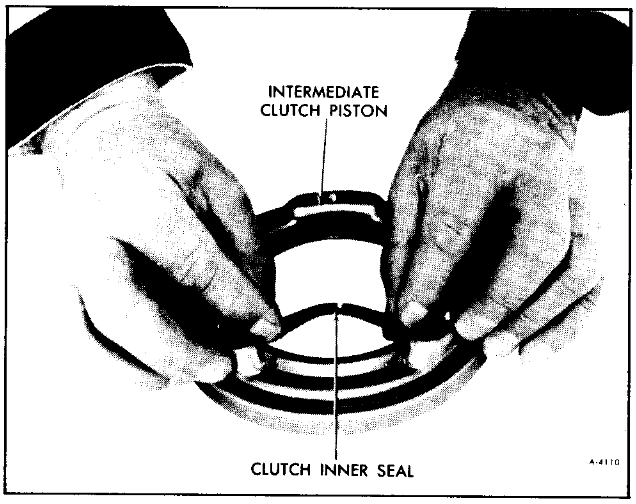


Figure 64—Removing or Installing Inner Seal

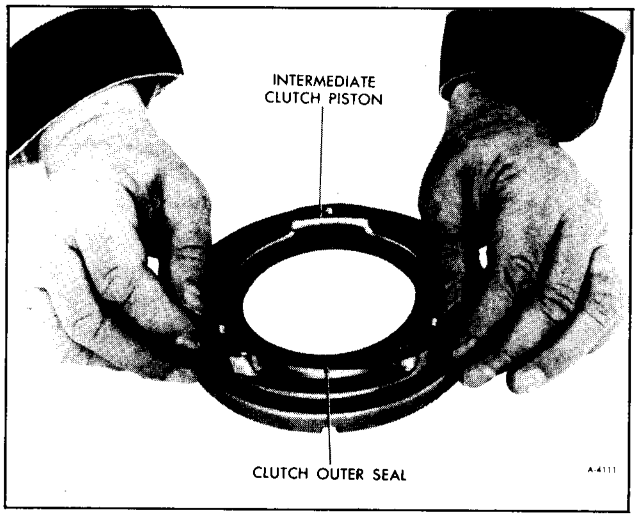


Figure 65—Removing or Installing Outer Seal

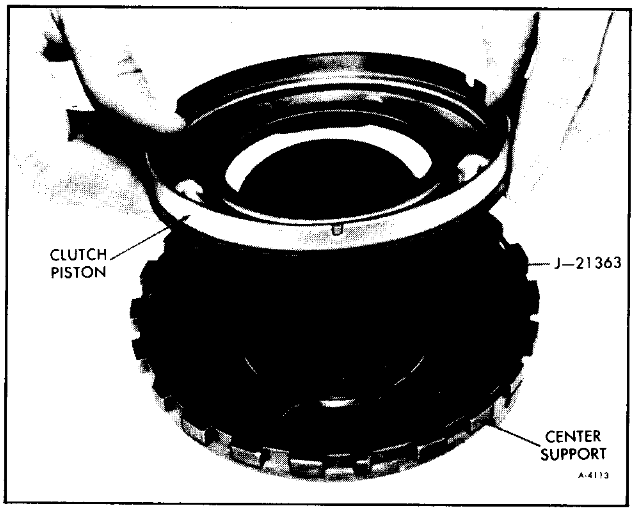


Figure 66—Installing Intermediate Clutch Piston

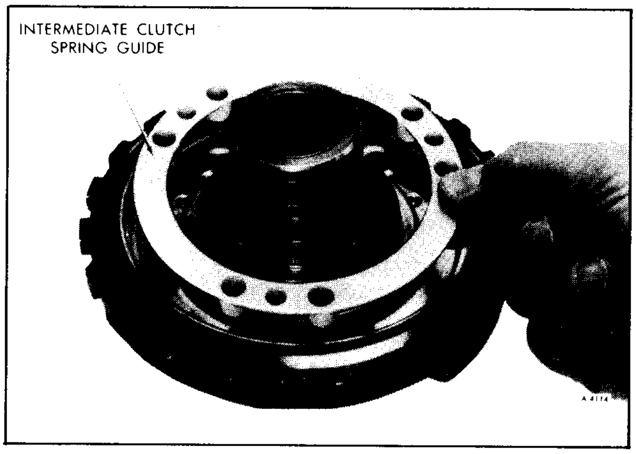


Figure 67—Installing Nylon Spring Guide

does not get caught in snap ring groove, and install snap ring with Snap Ring Pliers. J-8059 or J-5586. Remove tools.

7. If necessary, install four oil seal rings on the center

> **NOTE:** If teflon rings are being used, make sure slit ends are assembled in same relation as cut, Figure 68. Also, make sure oil seal rings are scated in ring grooves to prevent damage to rings during reassembly of mating parts over rings.

8. Air check operation of intermediate clutch and piston. Apply air through center oil feed hole to actuate clutch piston, Figure 69.

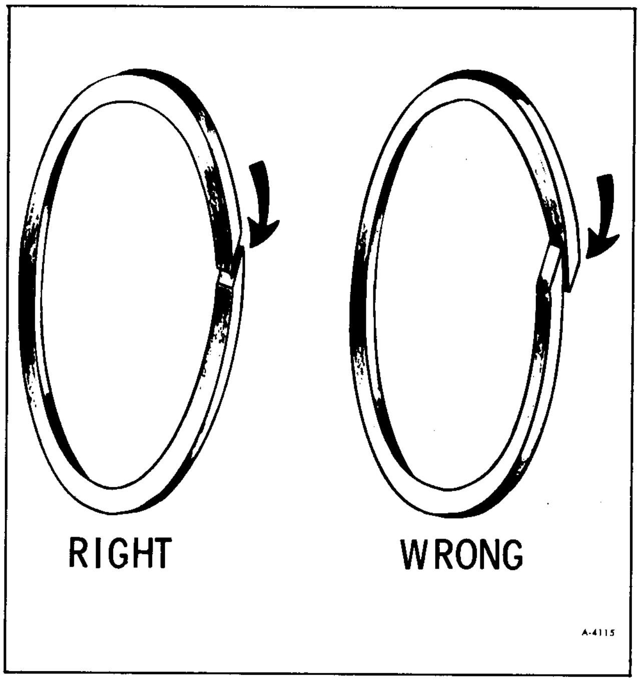


Figure 68—Installing Teflon Oil Seal Rings

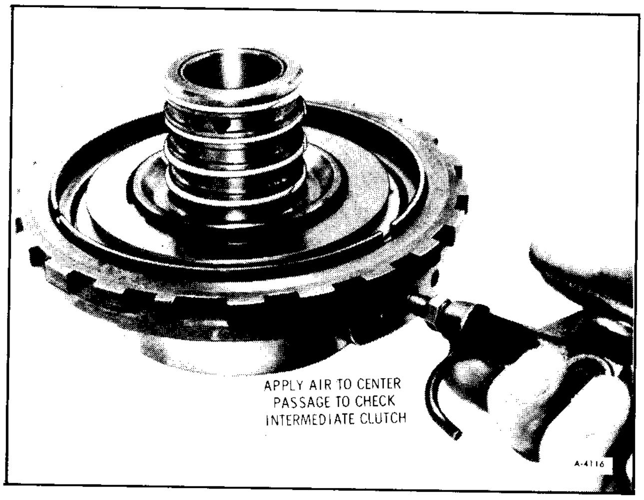


Figure 69—Air Checking Intermediate Clutch & Piston support.

9. Lubricate center support to reaction carrier thrust washer with petrolatum and install washer in recess of center support, Figure 70.

10. Install center support assembly into roller clutch in reaction carrier, Figure 71.

NOTE: With reaction carrier held, center support should turn clockwise only.

11. Install Gear Assembly Remover and Installer Adapter, J-21795, on end of main shaft so that tangs

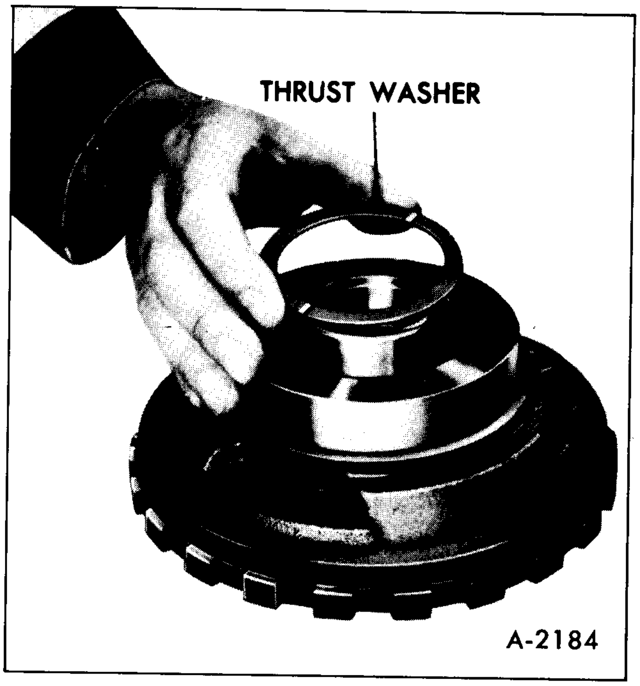


Figure 70—Center Support to Reaction Carrier Thrust Washer

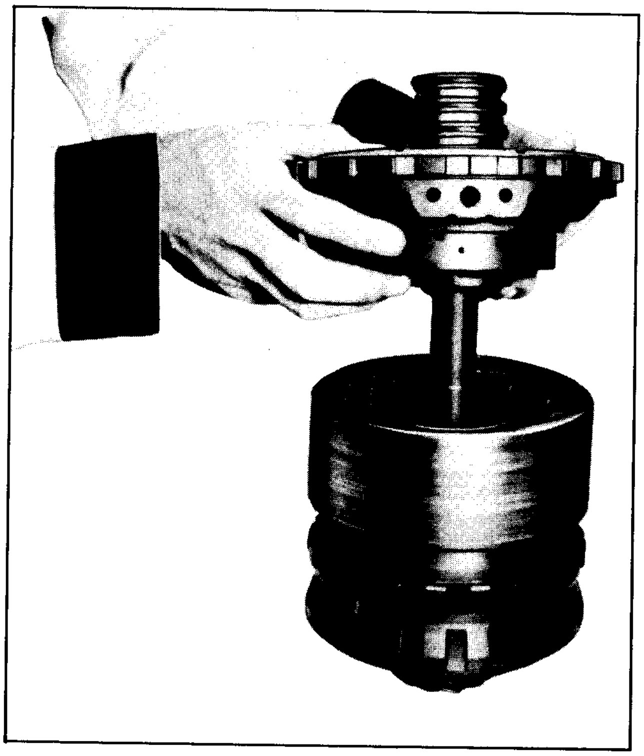


Figure 71—Center Support Installation

engauge groove in shaft. Using Slide Hammer Handle, J-6125, and Speedometer Puller Bolt, J-21797, tighten bolt on tool to secure tool on shaft and prevent movement of the roller clutch during installation of the gear unit assembly, Figure 47.

INSTALL REAR BAND AND COMPLETE GEAR UNIT ASSEMBLY

1. Inspect rear band for cracks or distortion and band ends for damage to anchor lugs and apply lug. Also inspect lining for cracks, flaking, burning and looseness.

2. Install rear band assembly in transmission case so that band lugs index with anchor pins.

3. Inspect support to case spacer for burrs or raised edges. If present, remove with a stone or fine sandpaper.

4. Install the support case spacer against the shoulder at the bottom of case splines and the gap located adjacent to the band anchor pin, Figure 72.

CAUTION: *Do not confuse this spacer (.040" thick and both sides flat) with either the*

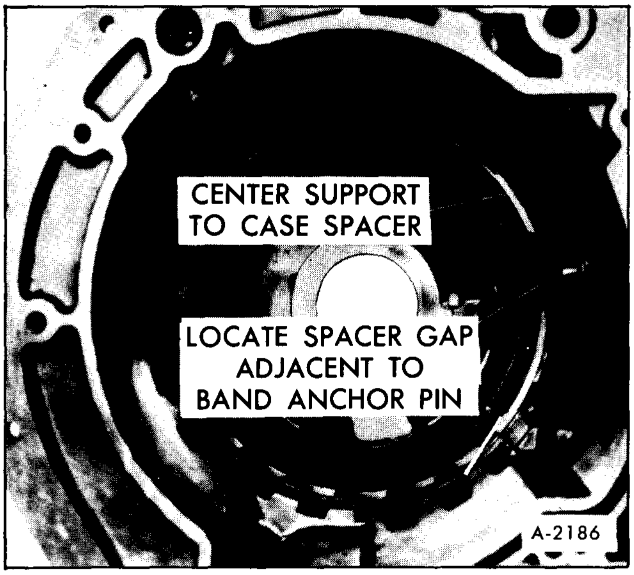


Figure 72—Installing Support-to-Case Spacer

center support to case snap ring (one side beveled) or the intermediate clutch backing plate to case snap ring (.093" thick and both sides flat).

5. Install previously selected rear unit selective washer into slots provided inside rear of transmission case. Retain washer with petrolatum, Figure 73.

NOTE: Proper washer size was determined at time of rear unit end play check.

6. Laying gear unit on its side, install metal thrust washer on output flange washer on output flange with bent tabs in tab pockets. Retain thrust washer with petrolatum, Figure 74.

IMPORTANT: This must be a metal thrust washer.

CAUTION: *Be careful not to drop or bump gear unit assembly in transmission case during installation.*

7. Install gear unit, with center support and reaction carrier, by lining up center support bolt hole with hole in case and carefully guiding complete assembly into transmission case, Figure 47.

8. Lubricate center support to case snap ring with transmission fluid and install snap ring in transmission case with beveled side up, (flat side against center support) locating gap adjacent to front band anchor pin. Make certain ring is properly seated in groove.

9. Install case to center support bolt.

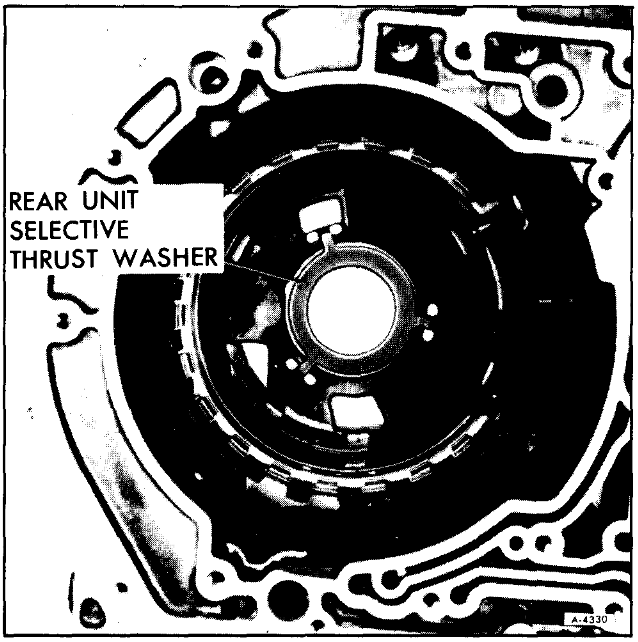


Figure 73—Removing and Installing Rear Unit Selective Thrust Washer

NOTE: To correctly perform this operation, it will be necessary to make the tool shown in Figure 75. Then follow procedure outlined below:

Place center support locating tool into the case direct clutch passage, with the handle of the tool pointing to the left, as viewed from the front of transmission and parallel to the bell housing mounting, Figure 76.

Lift upward on the tool which will tend to rotate the center support counterclockwise as viewed from the front of transmission. While holding the center support firmly counterclockwise against case splines, torque case to center support bolt to 23 ft. lbs., using a 3/8" 12-point thin-wall deep socket.

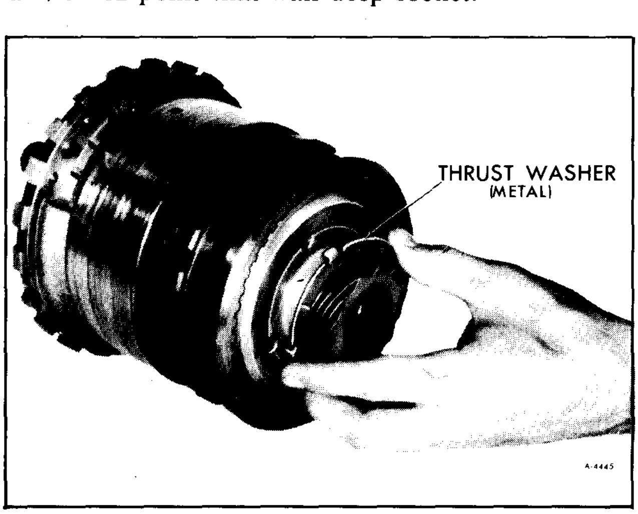


Figure 74—Installing Metal Thrust Washer

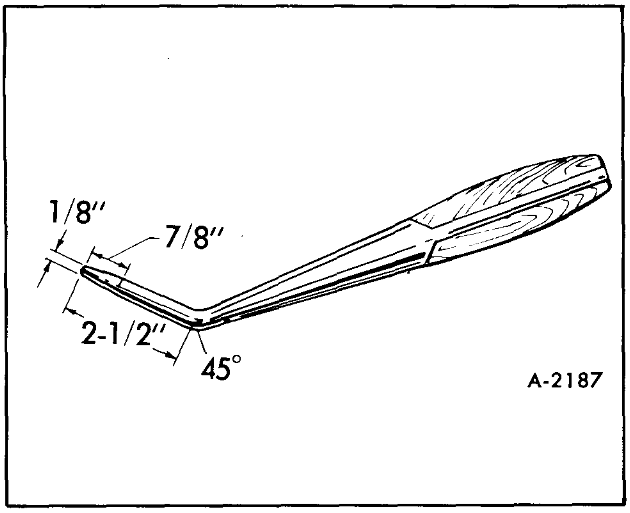


Figure 75—Center Support Locating Tool

CAUTION: *When using the locating tool, care should be taken not to raise burrs on the case valve mounting face.*

10. Before installing intermediate clutch plates, inspect plates for signs of burning, scoring, and wear.

11. Lubricate three steel and three composition intermediate clutch plates with transmission fluid and install clutch plates in transmission case, Figure 77. Start with steel plate and alternate composition and steel plates.

12. Install intermediate clutch backing plate with flat machine surface against clutch plates.

13. Install backing plate to case snap ring with snap ring gap on side of case opposite front band anchor pin.

NOTE: Both sides of this snap ring are flat, and it is approximately .093" thick.

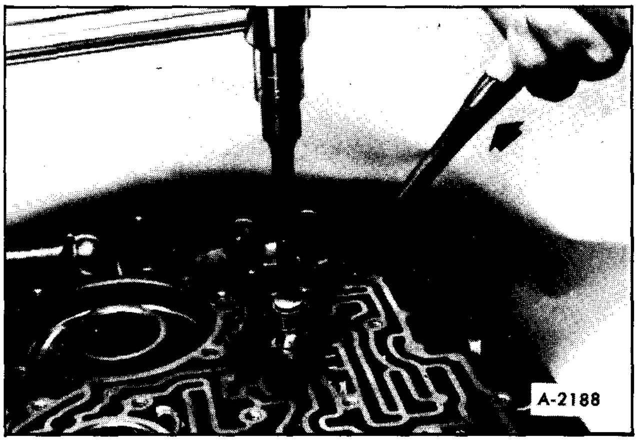


Figure 76—Locating Center Support

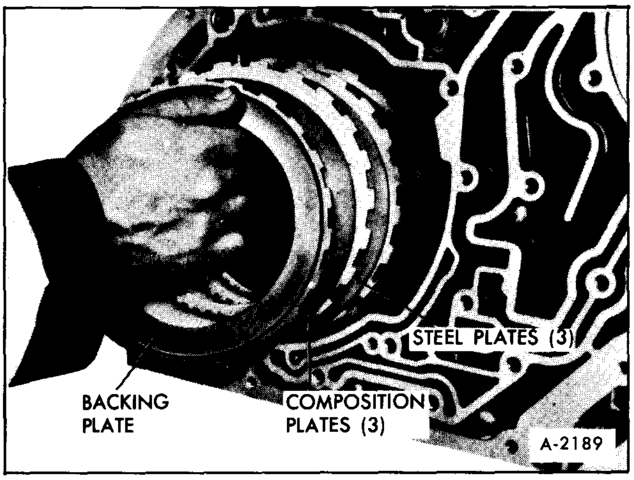


Figure 77—Installing Intermediate Clutch

14. Air check operation of intermediate clutch piston. Apply air through center oil feed hole to actuate clutch piston.

15. Recheck rear unit end play as described previously.

DIRECT CLUTCH AND INTERMEDIATE SPRAG ASSEMBLY (FIGURE 78)

DISASSEMBLY

1. Remove sprag retainer snap ring, and remove clutch retainer.

2. Remove sprag outer race and bushings, and remove sprag assembly from outer race.

3. Turn unit over and remove direct clutch backing plate to clutch housing snap ring.

4. Remove direct clutch backing plate and six composition and six steel clutch plates.

5. Using Clutch Spring Compressor, J-4670, Rear Clutch Spring Compressor, J-6129, or an arbor press, and Adapter, J-21664, compress spring retainer and remove snap ring with Snap Ring Pliers, J-8059 or J-5586, Figure 79.

6. Remove tools, spring retainers, and clutch release springs.

7. Remove direct clutch piston from direct clutch housing.

NOTE: The 1975 and 1976 transmissions now use a direct clutch piston without a check ball.

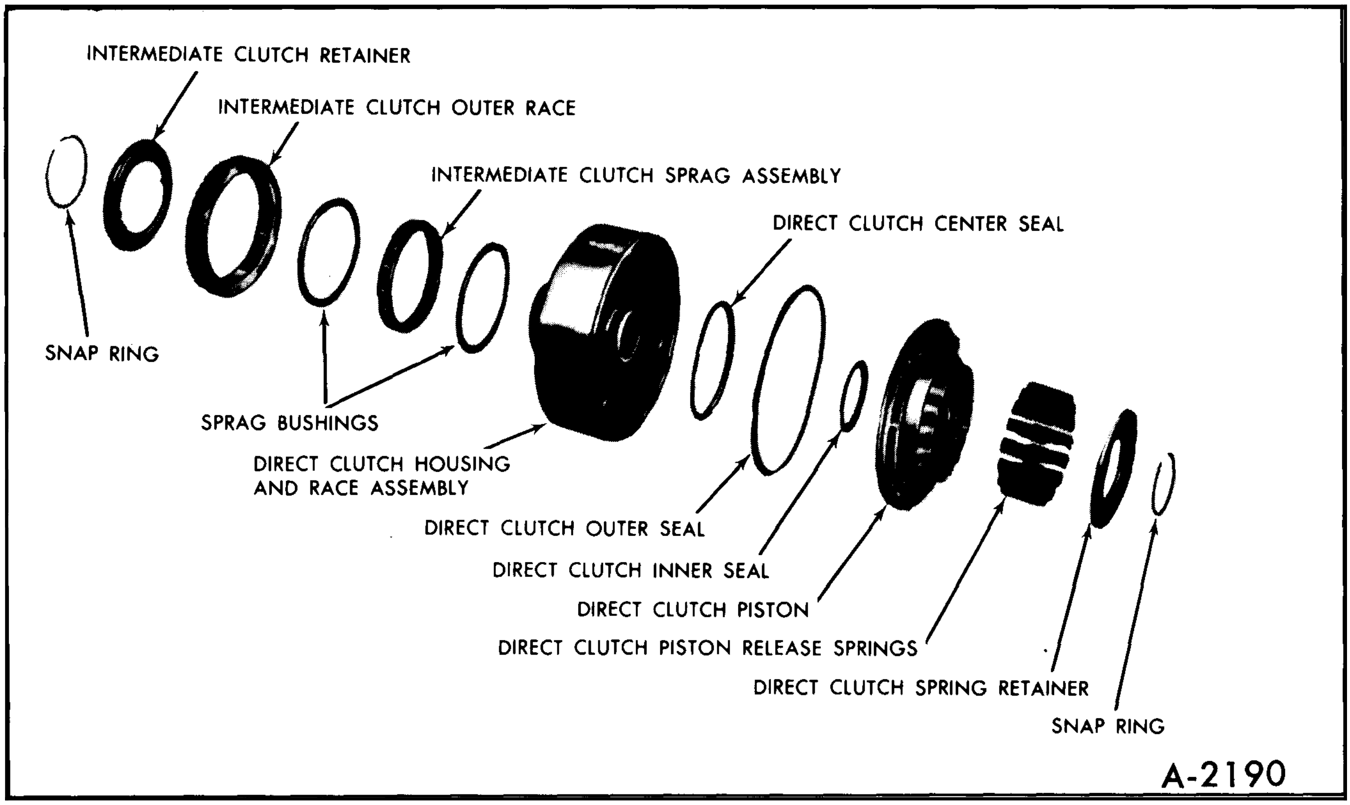


Figure 78—Direct Clutch and Piston

The forward and direct clutch pistons look almost the same. Make sure the direct clutch piston is identified during disassembly so it will be re-assembled into the direct clutch housing. The service replacement direct clutch piston contains a check ball. The production built direct clutch piston will be aluminum or stamped steel.

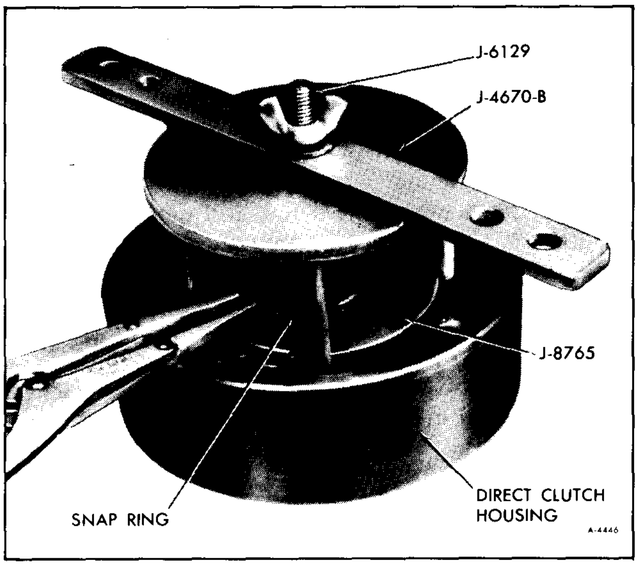


Figure 79—Removing Direct Clutch Snap Ring

8. Remove inner and outer seals from clutch piston.

9. Remove center piston seal from direct clutch housing.

INSPECTION

1. Inspect sprag assembly for popped or loose sprags.

2. Inspect sprag bushing for wear or distortion.

3. Inspect inner and outer races for scratches or wear.

4. Inspect clutch housing for cracks, wear, proper openings of oil passages and wear on clutch plate drive lugs.

5. Inspect composition faced and steel clutch plates for sign of wear or burning.

6. Inspect backing plate for scratches or other damage.

7. Inspect piston for cracks and/or other damage.

8. Inspect springs for collapsed coils or signs of distortion.

> **NOTE:** The 14 direct clutch release springs are not serviced individually. If one or more of these springs require replacement, discard all of them and install the 16 service direct clutch release springs.

9. Inspect clutch housing for free operation of check ball.

ASSEMBLY

1. Lubricate new inner and outer clutch piston seals with transmission fluid. Lubricate seal grooves in direct clutch piston and install seals with lips facing away from spring pockets.

> **IMPORTANT:** 1975 and 1976 transmissions now use a direct clutch housing with a check ball, see Figure 80. If the housing requires replacement and the replacement housing does not contain a check ball, replace the direct clutch piston with the service piston which as a check ball. EITHER THE DIRECT CLUTCH HOUSING AND/OR THE PISTON MUST CONTAIN A CHECK BALL.

2. Lubricate new center seal with transmission fluid. Lubricate seal groove in direct clutch housing and install seal in clutch housing with lip facing up.

3. Place Forward and Direct Clutch Inner Seal Protector, J-21362, over direct clutch hub. Install clutch piston inside Forward and Direct Clutch Piston Installer, J-21409, insert assembly in direct

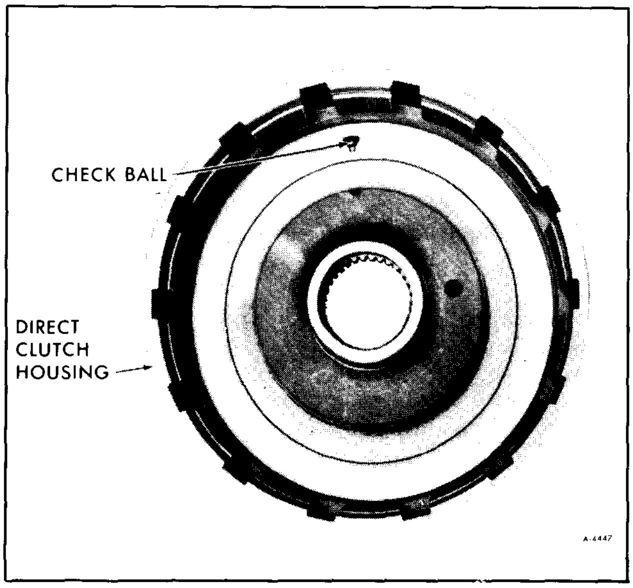


Figure 80—Direct Clutch Housing

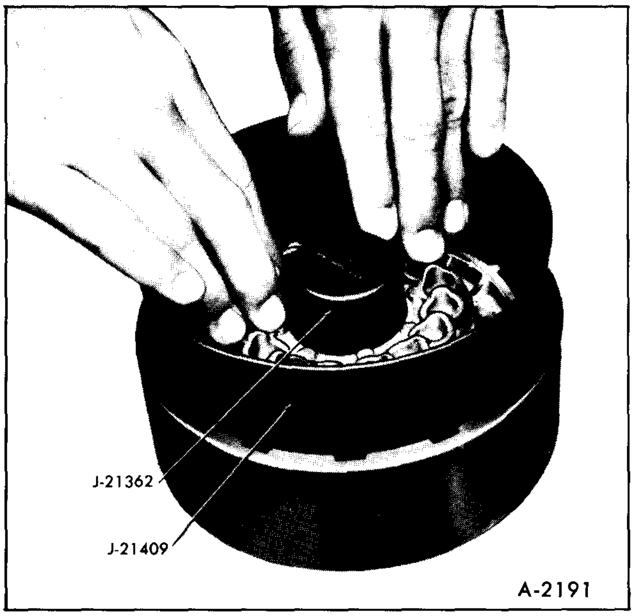


Figure 81—Installing Direct Clutch Piston

clutch housing Figure 81 and install clutch piston by rotating it slightly, in a clockwise direction.

4. Install 14 clutch release springs into spring pockets in clutch piston leaving two pockets directly opposite with no springs.

5. Place spring retainer and snap ring over springs.

6. Using Clutch Spring Compressor, J-4670, Rear Clutch Spring Compressor, J-6129, or an arbor press, and Adapter, J-21664, compress spring retainer, being careful that retainer does not get caught in snap ring groove, and install snap ring with Snap Ring Pliers, J-8059 or J-5586, Figure 79. Remove tools.

> **NOTE:** Make certain clutch release springs are not leaning. If necessary, straighten springs with a small screwdriver.

7. Lubricate the five flat and one waved (plate with "U" notch) and steel and six composition clutch plates with transmission fluid and install clutch plates in direct clutch housing. Sta^rt with waved steel plate and alternate composition and flat steel clutch plates.

8. Install direct clutch backing plate over clutch plates and install backing plate snap ring.

9. Invert clutch housing and install one sprag bushing, cup side up, around sprag inner race.

10. Install sprag assembly into clutch outer race.

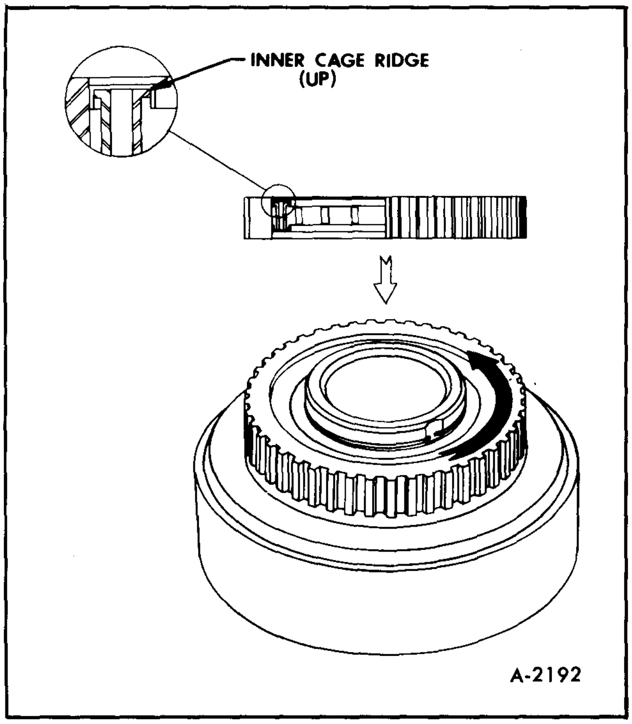


Figure 82—Sprag Rotation

11. With ridge on inner cage of sprag facing up install sprag and outer race on inner race with counterclockwise turning motion.

> **NOTE:** When installed, outer race should turn only counterclockwise, Figure 82.

12. Install sprag bushing, cup side down, over sprag assembly.

13. Install sprag retainer and snap ring.

INSTALL FRONT BAND AND DIRECT CLUTCH ASSEMBLY

1. Inspect front band for cracks or distortion and band ends for damage at anchor lug and apply lug. Also inspect lining for cracks, flaking, burning, and looseness.

2. Install front band with band anchor hole over band anchor pin, and apply lug facing servo hole, Figure 83.

3. Install direct clutch housing and intermediate sprag assembly. Make certain that clutch housing hub bottoms on sun gear shaft and splines on forward end of sun gear shaft are flush with splines in direct clutch housing.

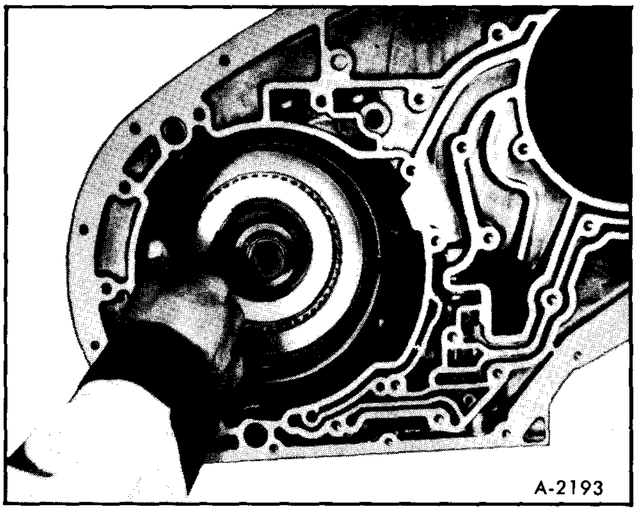


Figure 83—Front Band Installation

> **NOTE:** It will be necessary to rotate clutch housing to allow sprag outer race to index with intermediate composition clutch plates. Removal of direct clutch composition-faced and steel plates may be helpful, and applying air pressure through the center support screw to apply the intermediate clutch plates may facilitate assembly.

4. Check operation of direct clutch by applying air pressure through direct clutch passage next to center support bolt.

> **NOTE:** If air is applied through reverse passage (right oil feed hole), it will escape from direct clutch passage (left oil feed hole). This is considered normal. Apply air through left oil feed hole to actuate piston and move direct clutch plates. Refer to Figure 48.

FORWARD CLUTCH ASSEMBLY

DISASSEMBLY (FIGURE 84)

1. Remove forward clutch housing to direct clutch hub snap ring.

2. Remove direct clutch hub.

3. Remove forward clutch hub and one thrust washer from inner side of hub.

4. Remove five composition and five flat and one dished steel clutch plates.

5. Using Clutch Spring Compressor, J-4670, and Adapter, J-21664, compress spring retainer with arbor press and remove snap ring using Snap Ring Pliers, J-8059 or J-5586, Figure 85.

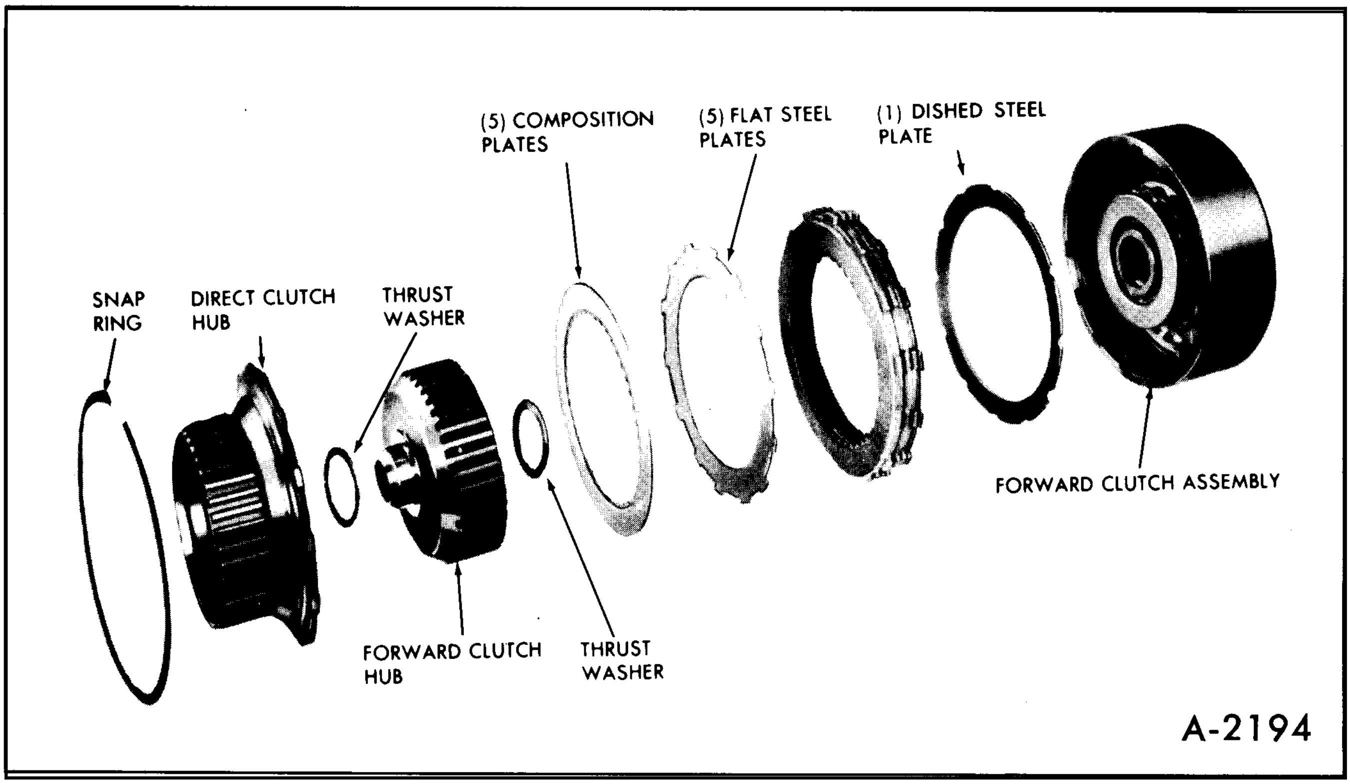


Figure 84—Forward Clutch Components

6. Remove tools, spring retainer and 16 clutch release springs. Keep springs separate from direct clutch springs.

7. Remove forward clutch piston from forward clutch housing.

8. Remove inner and outer seals from clutch piston.

9. Remove center piston seal from forward clutch housing.

INSPECTION

1. Inspect composition-faced and steel clutch plates for signs of burning, scoring or wear.

2. Inspect release springs for collapsed coils or signs of distortion.

3. Inspect clutch hubs for worn splines, proper lubrication holes, and thrust faces.

4. Inspect piston or cracks.

5. Inspect clutch housing for wear, scoring, cracks and open oil passages.

ASSEMBLY (FIGURE 86)

1. Lubricate new inner and outer clutch piston seals with transmission fluid. Lubricate seal grooves in forward clutch piston with petrolatum and install seals with lips facing away from spring pockets.

IMPORTANT: The transmissions now use a direct clutch piston without a check ball. The forward

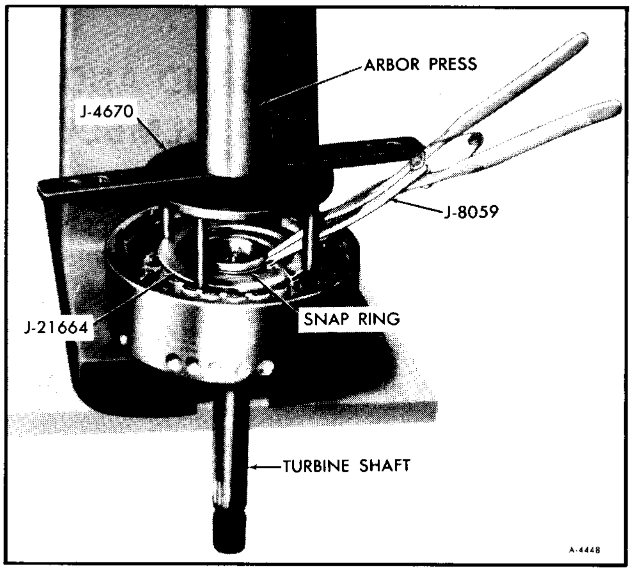


Figure 85—Removing Forward Clutch Snap Ring

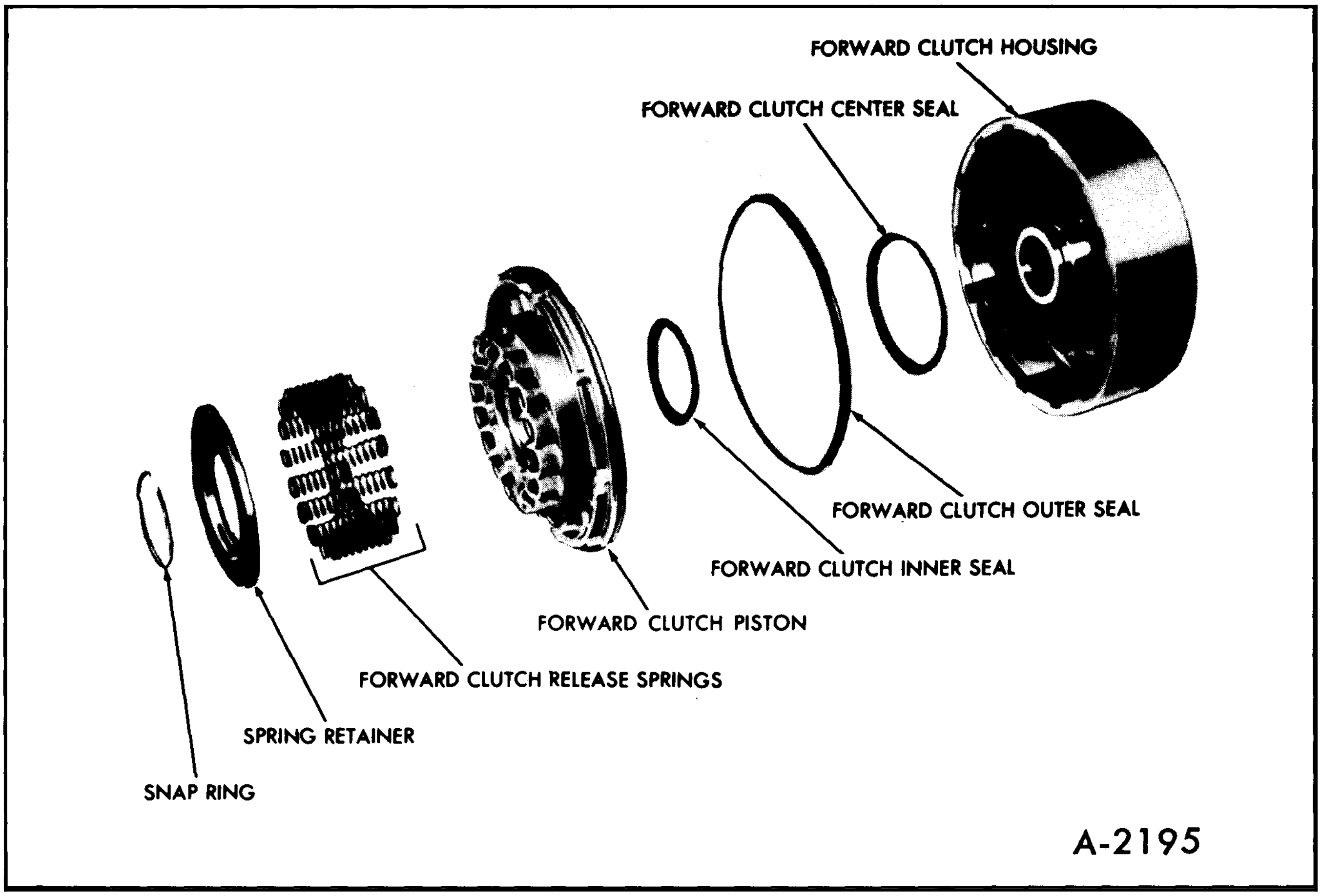


Figure 86—Forward Clutch Piston Components

and direct clutch pistons look almost the same. Make sure the forward clutch piston is identified during disassembly so it will be reassembled into the forward clutch housing. The production built forward clutch piston can be aluminum or stamped steel.

2. Lubricate new center piston seal with transmission fluid. Lubricate seal groove in forward clutch housing with petrolatum and install seal into clutch housing with lip facing up.

3. Place Forward and Direct Clutch Inner Seal Protector, J-21362, over forward clutch hub. Install clutch piston inside Forward and Direct Clutch Piston Installer, J-21409, insert assembly in forward clutch housing, and install clutch piston by rotating it slightly in a clockwise direction until seated.

4. Install sixteen clutch release springs into spring pockets in clutch piston.

5. Using Clutch Spring Compressor, J-4670, and Adapter, J-21664, compress spring retainer with arbor press, being careful that retainer does not catch in snap ring groove, and install snap ring using Snap Ring Pliers, J-8059 or J-5586. See Figure 85. Remove tools.

CAUTION: *Make certain clutch release springs are not leaning. If necessary, straighten with a small screwdriver.*

6. Remove forward clutch assembly from arbor press and place on work bench.

7. Install the forward clutch hub thrust washers on the forward clutch hub. Retain with petrolatum.

8. Install forward clutch hub in forward clutch housing.

9. Lubricate the dished and five flat steel and five composition clutch plates with tansmission fluid and install clutch plates in forward clutch housing. Start with dished steel plate (O.D. up) and place a flat steel plate on top of the dished steel plate. Then alternate composition and flat steel clutch plates.

10. Install direct clutch hub in forward clutch housing over clutch plates, and install snap ring.

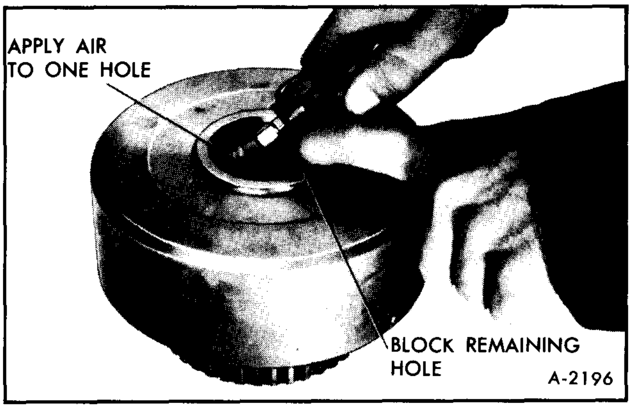


Figure 87—Air Check Forward Clutch Piston

11. Air check forward clutch and piston operation, Figure 87.

INSTALL FORWARD CLUTCH

1. Install Front Unit End Play Checking Tool, J-22241 into forward clutch, Figure 36.

2. Install forward clutch assembly into transmission, making certain main shaft goes into forward clutch hub. It will be necessary to rotate clutch housing to allow direct clutch driving hub to index with direct clutch composition-faced plates.

3. Remove Front Unit End Play Checking Tool, J-22241.

INSTALL PUMP COVER PLATE

1. Install new pump cover plate gasket on transmission.

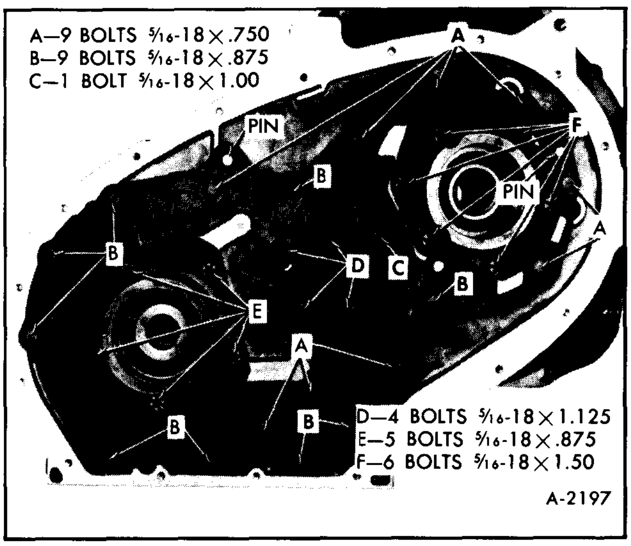


Figure 88—Pump Cover Plate Screws

2. Install pump cover plate on transmission and install attaching bolts per bolt chart, Figure 88.

> **NOTE:** Do not install pump attaching bolts (F) or single bolt (E) in pump cover plate at this time.

3. Using the driven sprocket as a driver rotate the forward clutch.

> **NOTE:** If the forward clutch housing cannot be rotated as the pump cover plate is being pulled into place, the forward or direct clutch housings have not been properly installed to index with all the clutch plates. This condition must be corrected before the pump cover plate is pulled fully into place.

4. Torque all bolts to 20 foot-pounds.

5. Repeat front unit end play check as described.

6. Install remaining bolt (E) in driven support housing, tightening to 20 foot-pounds.

OIL PUMP

DISASSEMBLY

1. Mark drive and driven gears for reassembly in same position and remove the pump body.

> **NOTE:** Installing the gears in the same position as removed will assure the quietest operation, as the gear teeth will mesh in the established wear pattern.

2. Remove drive and driven gears from pump body.

3. Remove and discard pump body to case square-cut O-ring seal.

INSPECTION

1. Using tip of finger, inspect gear pocket and crescent for nicks, burrs, scoring or galling.

2. Inspect drive gear for nicks, burrs, scoring, or galling.

3. Inspect driven gear for nicks, burrs, scoring, or galling.

4. Place pump gears in pump body and check pump body face to gear face clearance. Clearance should be .0013"-.0035".

5. Check face of pump body for nicks, burrs, scoring, or galling.

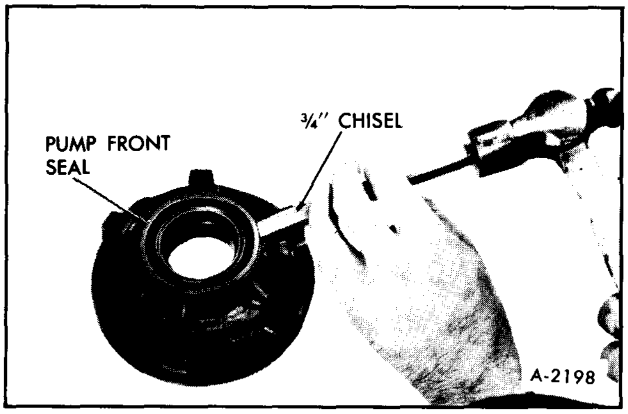


Figure 89—Removing Pump Front Seal

6. Check pump body face flatness. Overall flatness should be .000" to .002".

7. Inspect bushing for nicks, burrs, scoring, galling, out-of-round, or excessive wear.

NOTE: To check for out-of-round, install pump body on the converter hub and look for eccentricity between pump bushing and converter hub.

8. Check for damaged pump cover plate bolt holes.

9. Inspect front seal for damage. If replacement of front seal is necessary, use a standard 3/4" cold chisel and pry front seal from pump body, Figure 89.

ASSEMBLY

1. If necessary, install a new front seal, using Pump Oil Seal Installer, J-21359, to drive seal into place. Use a non-hardening sealer on outside of seal before installing into pump, Figure 90.

2. Install new pump to case square-cut O-ring seal.

3. Install driven gear into pump body with alignment mark up.

4. Install drive gear into pump body with drive tangs up, Figure 91.

NOTE: Drive gear should always be installed with counterbore down.

INSTALLATION

1. Rotate transmission in holding fixture base so that cored oil passages are up.

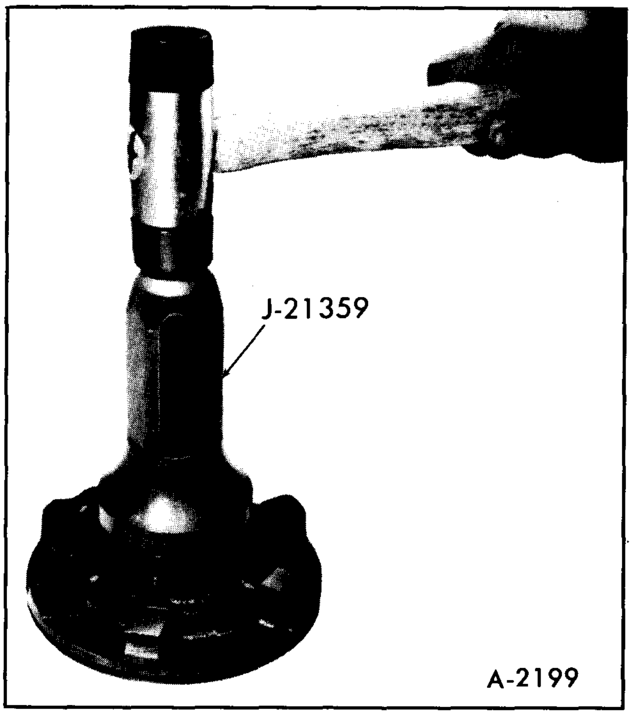


Figure 90—Installing Pump Front Seal

2. Install pump assembly over stator shaft and position to drive support housing, rotating pump as necessary to align holes in pump cover plate with pump attaching bolt holes.

3. Install six retaining bolts (F), finger tight, Figure 88.

4. Tighten pump attaching bolts to 20 ft. lbs.

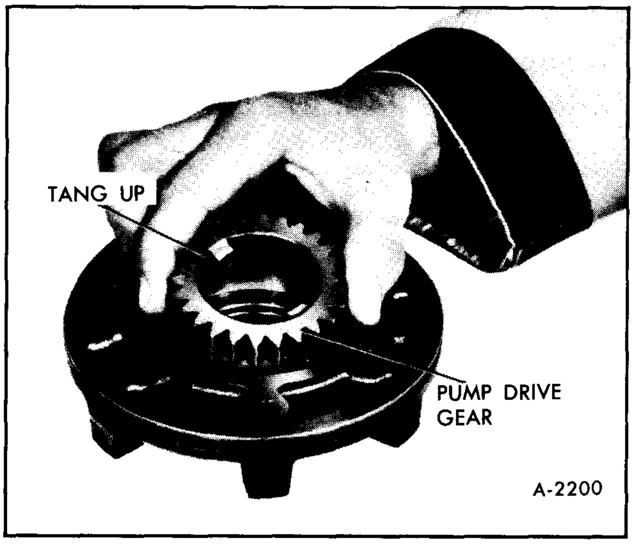


Figure 91—Installing Pump Drive Gear

INSTALL SPROCKETS, LINK ASSEMBLY AND SPROCKET COVER

1. Place link belt around the drive and driven sprockets so that the links engauge the teeth of the sprockets, colored guide link which has etched numerals facing link cover.

2. Simultaneously place link belt, drive and driven sprockets into support housing.

3. Using a plastic mallet, gently seat the sprocket bearing assemblies into the support housings.

4. Install sprocket assembly to support housing snap rings using J-4646 snap ring pliers.

5. Install new case to cover and plate assembly sprocket housing gasket.

6. Install sprocket housing cover and plate assembly and eighteen attaching bolts. Torque bolts to 8 ft. lbs.

NOTE: One sprocket cover housing attaching bolt is 1/4 inch longer. This bolt must be installed in the tapped hole located directly over the cooler fittings on the transmission case.

DETENT LEVER, MANUAL SHAFT, PARKING LINKAGE, REAR SERVO, FRONT SERVO, CHECK BALLS, AND CONTROL VALVE SPACER

INSPECT DETENT LEVER, MANUAL SHAFT, AND PARKING LINKAGE

1. Inspect parking actuator rod for cracks, or broken spring retainer lugs.

2. Inspect actuator spring for damage.

3. Inspect actuator for a free fit on actuator rod.

4. Inspect parking pawl for cracks or wear.

5. Inspect manual shaft for damaged threads.

6. Inspect inside detent lever for cracks or a loose pin.

7. Inspect parking pawl return spring for deformed coils or ends.

8. Inspect parking bracket for cracks or wear.

9. Inspect detent spring and roller assembly.

INSTALL DETENT LEVER, MANUAL SHAFT AND PARKING LINKAGE

1. Install parking pawl (tooth toward inside of case), pawl return spring and parking pawl shaft into case, Figure 92.

2. Install parking pawl shaft retaining pin into case hole.

3. Install parking bracket into case, tightening attaching screws to 18 ft. lbs.

4. Install a new manual shaft O-ring seal on manual shaft.

5. Install the actuator rod plunger under the parking bracket and over the parking pawl and through hole in detent lever. Position detent lever in transmission case.

6. Install the manual shaft assembly through the retaining lock nut on manual shaft, Figure 93.

7. Install manual shaft retaining pin into case, long smooth end first.

8. Torque lock nut to 18 ft. lbs.

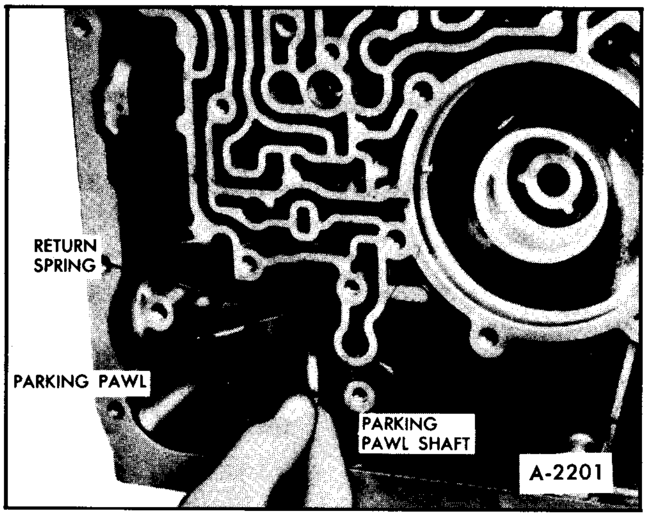


Figure 92—Installing Parking Pawl

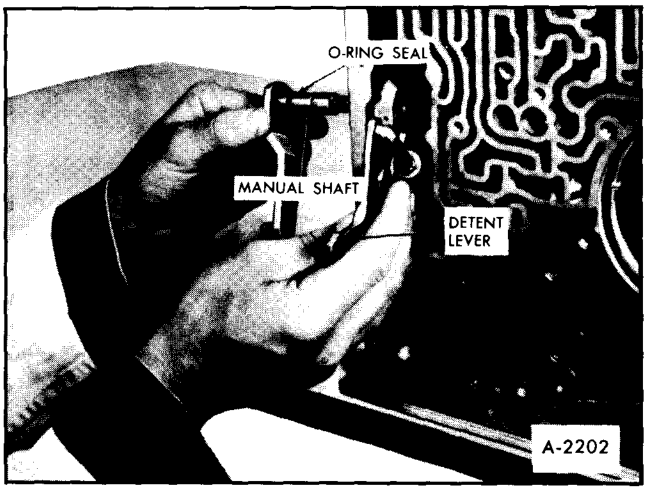


Figure 93—Installing Manual Shaft

DISASSEMBLE REAR SERVO ASSEMBLY (FIGURE 94)

1. Remove rear accumulator piston from rear servo piston.

2. Remove E-ring retaining rear servo piston to band apply pin.

3. Remove rear servo piston and seal from band apply pin.

4. Remove washer, spring and retainer.

INSPECT REAR SERVO

1. Check freeness of oil seal rings in accumulator piston grooves.

> **NOTE:** Do not remove the teflon oil seal rings from the rear accumulator piston, unless the oil seal rings require replacement.

If the teflon inner oil seal ring. (small diameter) requires replacement, for service, use the aluminum oil seal ring.

The rear accumulator piston, large diameter ring groove depth, is machined shallower to take the large teflon oil seal ring; if this requires replacement, use only the teflon oil seal ring.

2. Inspect fit of band apply pin in servo piston.

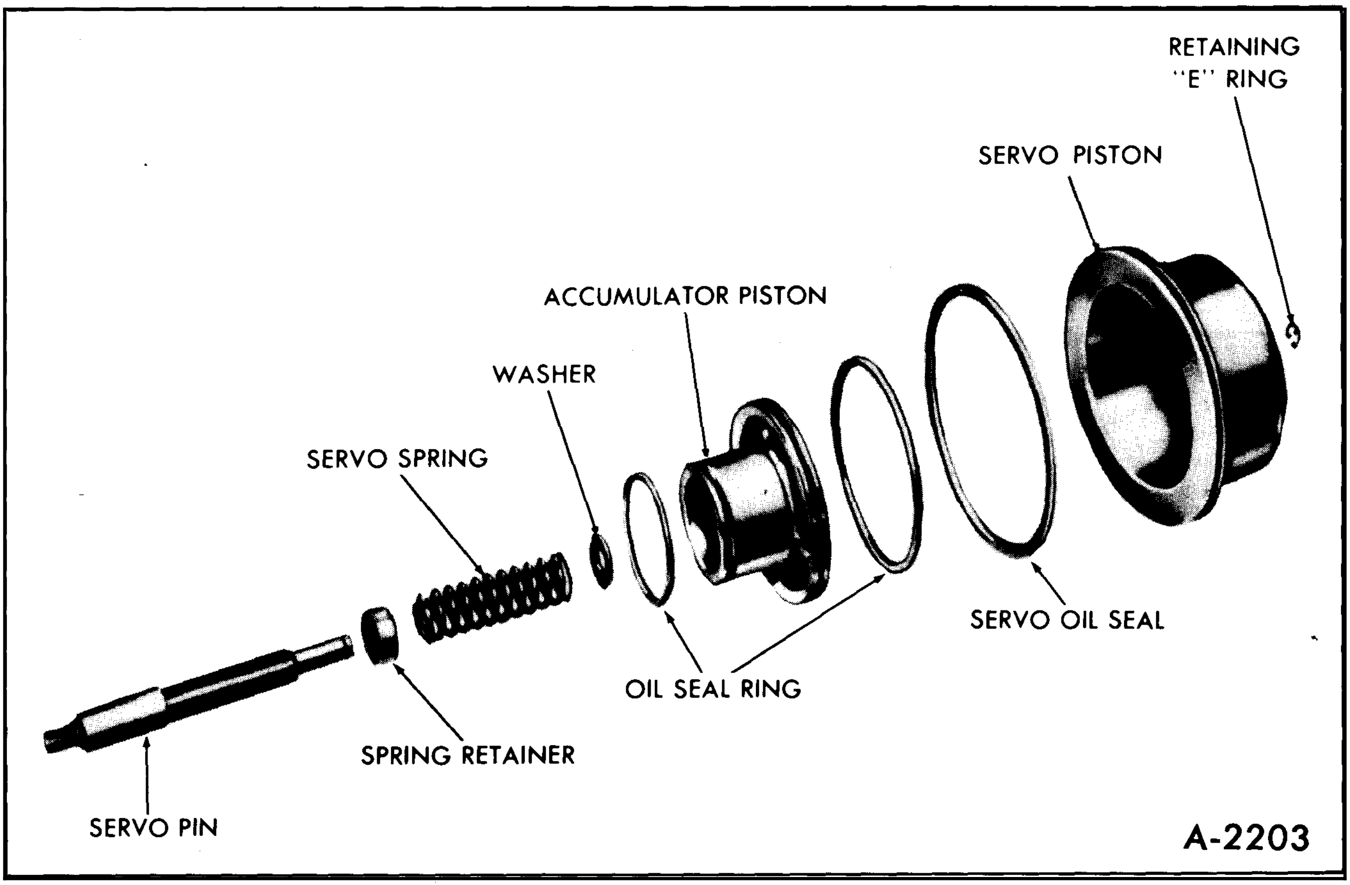


Figure 94—Rear Servo and Accumulator

3. Inspect band apply pin for scores or cracks.

4. Inspect band apply pin for proper size as determined by pin selection check.

ASSEMBLE REAR SERVO

1. Install spring retainer, cup side first, servo pin spring and washer on servo pin.

2. Install servo piston on pin and secure with E-ring retainer.

3. If removed, install oil seal ring on servo piston.

4. If removed, install inner and outer oil rings on accumulator piston.

5. Install accumulator piston into bore of servo piston.

INSTALL REAR SERVO

NOTE: If the transmission is in the vehicle, a sheet metal bracket will be required to hold the rear servo assembly, front servo assembly, check balls, valve body to spacer plate gasket and valve body spacer plate, until the control valve assembly is installed. See Figure 95.

1. Lubricate inner and outer rear servo bores in transmission case with transmission fluid and install rear accumulator spring in servo inner bore.

NOTE: Before installing rear servo assembly, make certain that rear band apply lug is aligned with servo pin bore in transmission case. Otherwise servo pin will not apply band.

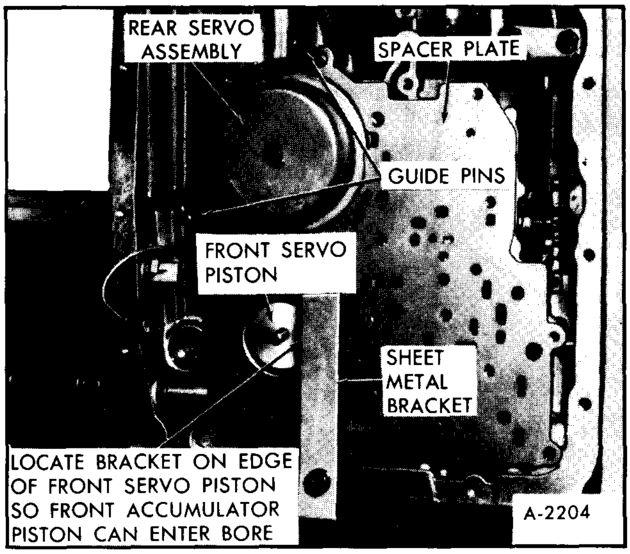


Figure 95—Spacer Plate Holding Bracket

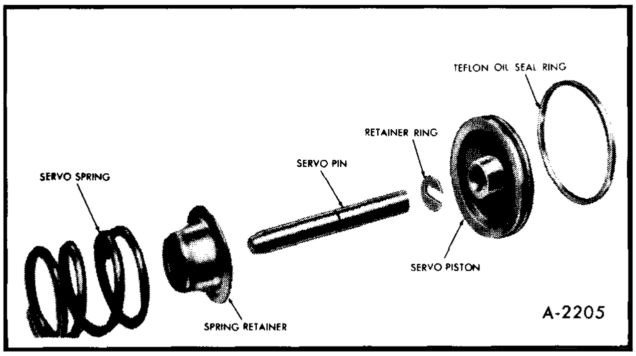


Figure 96—Front Servo Components

2. Position rear servo assembly in transmission case bore.

3. Press down on rear servo assembly, making certain oil seal ring is properly seated in case bore.

INSPECT FRONT SERVO

NOTE: See Figure 96. Do not remove the teflon oil seal ring from the front accumulator piston unless the oil seal ring requires replacement. For service, the oil seal ring will be aluminum.

IMPORTANT: The spring retainer, servo pin, retaining ring, and servo piston for 1971 thru 1976 are not interchangeable with pre-1971 parts.

1. Inspect servo pin for damage.

2. Inspect piston oil ring for damage.

3. Inspect piston for cracks or porosity.

4. Check fit of servo pin in piston.

INSTALL FRONT SERVO ASSEMBLY

Reassemble parts of front servo, making sure tapered end of servo pin is pointed through the spring and spring retainer, and install in bore in case. Make sure the retainer ring is installed in the servo pin groove.

NOTE: The teflon ring allows the front servo piston to slide very freely in the case. The free fit of the ring in the bore is a normal characteristic and does not indicate leakage during operation. The teflon ring should only be replaced if it shows damage or if evidence of leakage during operation exists.

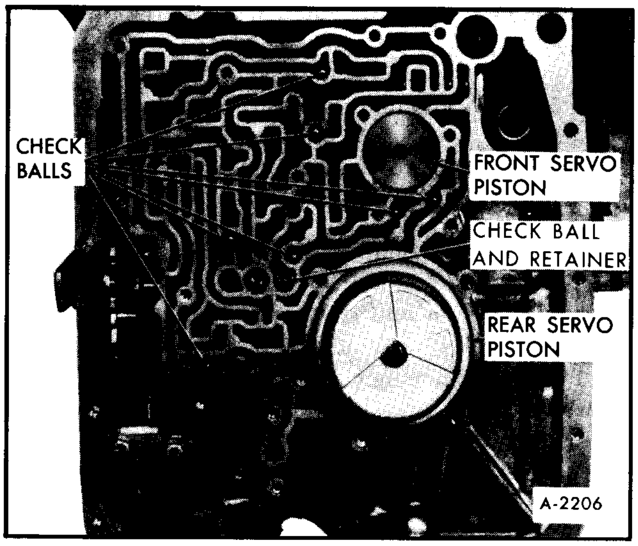


Figure 97—Check Ball Location

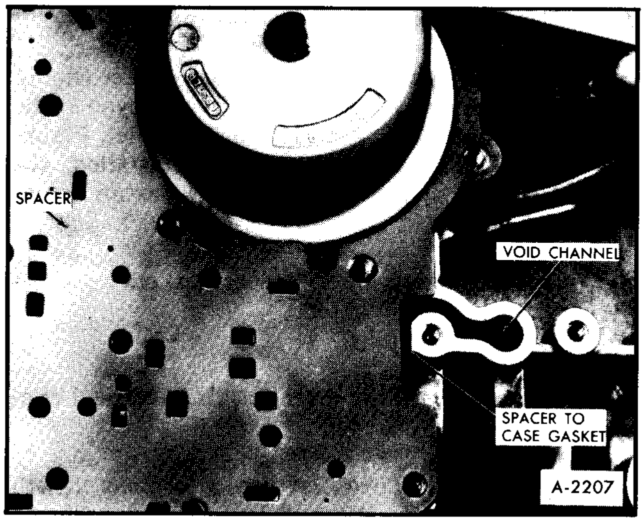


Figure 98—Valve Body Spacer-to-Case Gasket

INSTALL CHECK BALLS AND CONTROL VALVE SPACER

1. Install seven check balls in cored passages, Figure 97. (Use petrolatum to retain balls in case.)

NOTE: If transmission is in vehicle, place check balls into ball seat pockets on spacer plate.

2. Install valve body spacer to case gasket on transmission case.

1. MANUAL VALVE
2. DETENT SOLENOID
3. GASKET
4. FRONT ACCUMULATOR SPRING
5. OIL RING
6. ACCUMULATOR PISTON
7. E-RING
8. 3-2 VALVE PIN
9. 3-2 VALVE SPRING
10. 3-2 VALVE
11. 3-2 BORE PLUG
12. RETAINER PIN
13. 2-3 VALVE
14. 3-2 INTERMEDIATE SPRING
15. 2-3 MODULATOR VALVE
16. 2-3 MODULATOR BUSHING
17. 2-3 VALVE SPRING
18. RETAINER PIN
19. 1-2 VALVE
20. 1-2 DETENT VALVE
21. 1-2 SPRING REGULATOR
22. 1-2 REGULATOR VALVE
23. 1-2 MODULATOR BUSHING
24. RETAINER PIN
25. DETENT REGULATOR PIN
26. DETENT REGULATOR SPRING
27. DETENT REGULATOR VALVE
28. DETENT VALVE
29. VALVE BORE PLUG
30. RETAINER PIN
31. VALVE BORE PLUG
32. RETAINER PIN
33. 1-2 ACCUMULATOR PRIMARY SPRING
34. 1-2 ACCUMULATOR VALVE
35. 1-2 ACCUMULATOR VALVE PLUG
36. RETAINER PIN

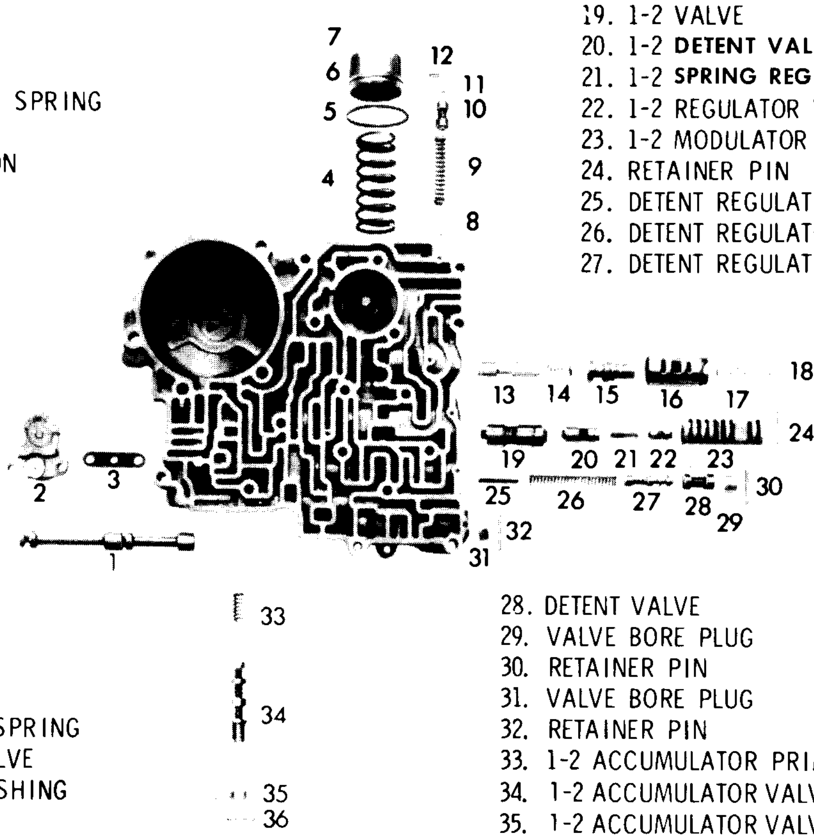


Figure 99—Control Valve

3. Install valve body spacer on transmission.

NOTE: Valve body spacer to case gasket should extend approximately 1/8 inch beyond the spacer plate, over the void case channel, Figure 98. If service gaskets are being installed, the valve body spacer to case gasket has an extension which will cover the void case channel.

4. Install valve body to spacer gasket.

5. Install guide pins.

6. Install the "O" ring seal on the electrical connector.

7. Lubricate and install electrical connector with lock tabs facing into case, positioning locator tabs up on side of case.

CONTROL VALVE ASSEMBLY (FIGURE 99)

DISASSEMBLY

When disassembling control valve, make certain that springs are accurately identified so that they can be properly reassembled.

1. Position control valve assembly with cored face down.

2. Remove two screws securing detent solenoid to control valve body and remove downshift solenoid and gasket.

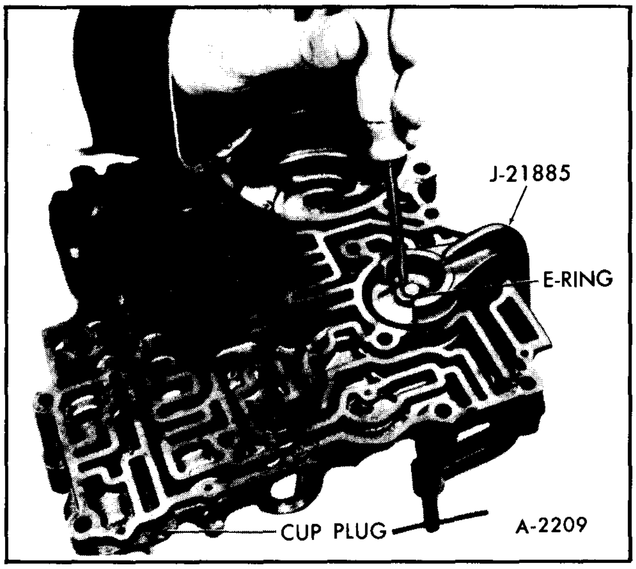


Figure 100—Removing Front Accumulator

3. Position control valve assembly with cored face up and accumulator pocket on bottom.

4. Remove manual valve from upper bore.

5. Install Control Valve Accumulator Piston Installer, J-21885, on accumulator piston, compress piston and remove E-ring retainer, Figure 100.

6. Remove Installer, J-21885, and remove accumulator piston and spring.

7. Using pin punch, remove retaining pin from lower left bore, pressing on pin from outer side of valve body. Remove 2-3 modulator bushing, 2-3 shift valve spring, 2-3 modulator valve, 3-2 intermediate spring and 2-3 shift valve from left bore.

NOTE: 2-3 modulator valve will be inside of 2-3 modulator bushing.

8. Using pin punch, remove retaining pin from lower center left bore, pressing on pin from outer side of valve body. Remove 1-2 modulator bushing, 1-2 regulator spring, 1-2 detent valve, and 1-2 regulator valve from lower left center bore.

NOTE: 1-2 regulator valve and spring and 1-2 detent valve may be inside of 1-2 modulator bushing.

9. Using pin punch, remove retainer pin from upper left center bore by pressing on outer side of valve body.

WARNING: HOLD HAND OVER BORE WHEN REMOVING RETAINER PIN AS DETENT REGULATOR VALVE SPRING MAY FORCE OTHER COMPONENTS OUT OF BORE.

10. Remove bore plug, detent valve, detent regulator valve, spacer and detent regulator valve spring from upper left center bore.

11. Remove retaining pin from bottom bore on left side by prying out with a pair of long nose pliers.

WARNING: HOLD HAND OVER BORE WHEN REMOVING RETAINER PIN AS 3-2 VALVE SPRING MAY FORCE BORE PLUG OUT.

12. Remove bore plug, 3-2 valve, spring and spacer from bottom left bore.

13. Remove retaining pin from top bore by prying out with long nose pliers from outer side of valve body.

14. Remove bore plug, 1-2 accumulator valve and the 1-2 accumulator primary spring.

INSPECTION

NOTE: Do not remove the teflon oil seal ring from the front accumulator piston unless the oil seal ring requires replacement. For service, the oil seal ring will be aluminum.

1. Wash control valve body, valves, and other parts in clean solvent.

CAUTION: *Do not allow valves to bump together, as this might cause nicks and burrs.*

2. Inspect all valves and bushings carefully to make sure that they are free from dirt and are not damaged in any respect. If burrs are present, they should be removed with a fine stone or fine grade of crocus cloth and light oil. Be careful not to round off shoulders of valves.

3. All valves and bushings should be tested in their individual bores to make certain that free movement can be obtained. All valves should fall freely of their own weight with a slight tapping action on the body. In checking be careful to prevent valve damage in any way.

4. The manual valve is the only valve that can be serviced separately. If other valves are damaged beyond repair, a new control valve assembly should be installed.

5. Inspect body for cracks or scored bores.

6. Check all springs for distortion or collapsed coils.

7. Inspect piston and oil ring for damage.

ASSEMBLY (FIGURE 99)

1. Position control valve body and cored face up and accumulator pocket on bottom.

2. Install the 1-2 accumulator primary spring into top bore.

3. Install the 1-2 accumulator valve, stem end out into the top bore.

4. Install the 1-2 bore plug, hole end out, into the top bores.

5. Install grooved retaining pin, grooved end entering hole last from outer side of valve body, pressing pin flush with valve body.

6. Insert spacer inside of 3-2 valve spring and install spring and spacer in bottom left bore.

7. Install 3-2 valve in bottom left bore.

8. Compressing 3-2 valve spring, install bore plug, hole end out, and secure with grooved retaining pin from cored side of valve body.

9. Insert spacer inside of detent regulator valve spring and install spring and spacer into upper left center bore, making certain spring seats in bottom of bore.

10. Compress detent regulator valve spring and hold with a small screwdriver placed between end of spring and wall on cored side of valve body.

11. Install detent regulator valve, stem end out, and detent valve, small land first, into upper left center bore.

12. Insert bore plug, hole out, into upper left center bore and, pressing inward on bore plug, remove screwdriver and install remaining pin from cored side of valve body.

13. Install 1-2 shift valve, longer stem end first, in lower left center bore, making certain valve seats in bottom of bore.

14. Install 1-2 regulator valve, large stem first, spring and 1-2 detent valve, hole end first, into 1-2 modulator bushing, aligning spring in bore of 1-2 detent valve. Install assembly into lower left center bore of control valve body, open end of bushing first.

15. Compress bushing against spring and secure with retaining pin from cored side of control valve body.

16. Install 3-2 intermediate spring in open end of 2-3 shift valve, and install valve and spring, valve first, into lower left bore. Make certain valve seats in bottom of bore.

17. Install 2-3 modulator valve, hole end first, into 2-3 modulator bushing and install both parts in lower left bore.

18. Install 2-3 shift valve spring into hole in 2-3 modulator valve, and compressing spring, secure with retaining pin from cored side of control valve.

19. Position front accumulator spring and piston into valve body and install Control Valve Accumulator Piston Installer, J-21885, on piston. Compress spring and piston, aligning spring and piston with bore, Figure 100.

CAUTION: *Make certain that piston pin is correctly aligned with hole in piston and that oil seal ring does not catch on lip of bore when installing piston.*

20. Secure piston and spring with E-ring retainer and remove Installer, J-21885.

21. Install manual valve into top bore.

22. Placing control valve assembly on cored surface, position downshift solenoid gasket and detent solenoid on valve body.

23. Install downshift solenoid attaching screws.

24. Install governor drive pipe into control valve body in bore by rear servo cover.

25. Install two governor screen assemblies with open end up into case, Figure 101.

INSTALL CONTROL VALVE ASSEMBLY AND GOVERNOR FEED PIPE

1. Using two guide pins, install control valve assembly and governor pipe on transmission. Make certain gaskets and spacer do not become mispositioned.

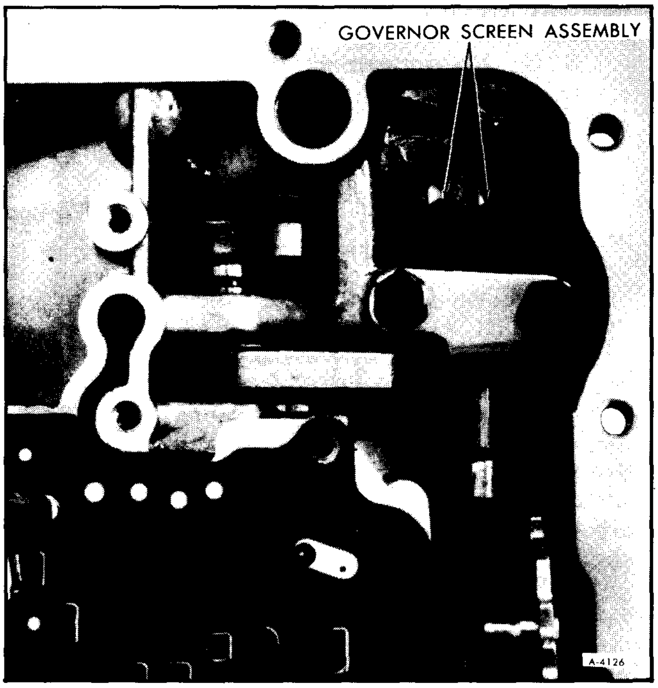


Figure 101—Installing Governor Screens

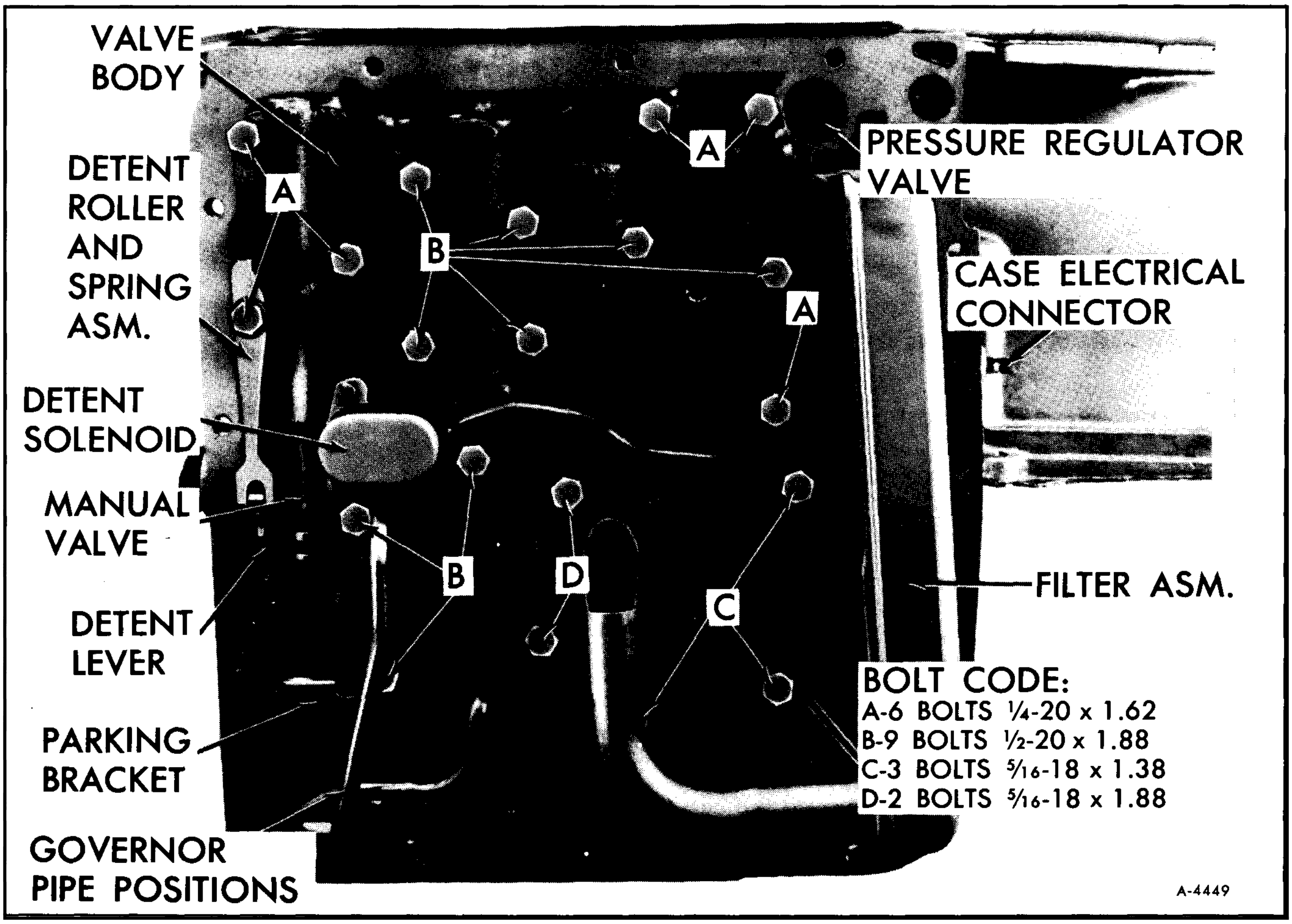


Figure 102—Control Valve Bolts

NOTE: Check manual valve to make sure it is indexed properly with pin on detent lever and governor pipe to make certain it is properly seated in case hole.

2. Remove guide pins and install control valve assembly attaching screws, eliminating detent roller and spring assembly attaching screw. Torque bolts to 8 foot-pounds, Figure 102.

3. Install detent roller and spring assembly and attaching screw. Tighten screw to 8 foot-pounds.

4. Install governor feed pipe in transmission case and control valve body.

NOTE: Make certain that governor feed pipe is seated in bores in case and valve body.

5. Connect detent solenoid wire to electrical connector.

PRESSURE REGULATOR VALVE, INTAKE PIPE AND FILTER ASSEMBLY, BOTTOM PAN, MODULATOR VALVE AND MODULATOR

INSTALL PRESSURE REGULATOR VALVE

1. Install spring retainer on pressure regulator spring. Also install spacers if previously removed, Figure 103.

2. Install pressure regulator valve on spring, stem end first.

3. Install boost valve into bushing, stem end out, and stack parts so that pressure regulator spring is against valve bushing.

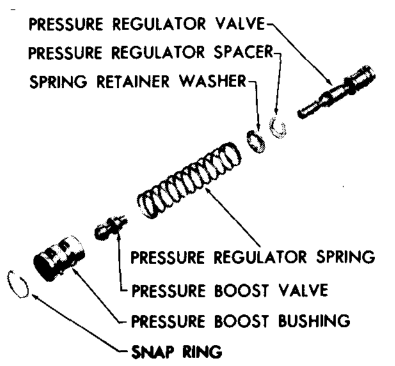


Figure 103—Pressure Regulator Valve

4. Install complete assembly, pressure regulator valve first, into pressure regulator valve bore, being careful not to drop parts during installation.

5. Using a screwdriver or steel rod, compress regulator boost valve bushing against pressure regulator spring until it is beyond snap ring groove, and install snap ring using Snap Ring Pliers, J-5403 (#21), Figure 25.

NOTE: To facilitate installation of snap ring, encircle it around screwdriver or steel rod, compress tangs with snap ring pliers, and slide snap ring into ring groove in valve bore.

INSTALL INTAKE PIPE AND FILTER ASSEMBLY AND BOTTOM PAN

1. Install new intake pipe O-ring into pipe bore in transmission case and install intake pipe and filter assembly.

2. Install new bottom pan gasket on transmission case and install bottom pan.

3. Install 13 bottom pan attaching screws. Tighten screws to 12 foot-pounds.

INSPECT VACUUM MODULATOR AND VALVE

Refer to Diagnosis Section for complete modulator inspection.

1. Inspect vacuum modulator for any signs of bending or distortion.

2. Inspect O-ring seat for damage.

3. Inspect modulator valve for nicks or damage.

4. Check freeness of valve operation in case bore.

5. Check modulator for damaged bellows. Modulator plunger is under approximately 16 pounds pressure. If bellows is damaged, plunger will have very little pressure.

INSTALL MODULATOR VALVE AND VACUUM MODULATOR

1. Install modulator valve into case with stem end out.

2. Install new O-ring on vacuum modulator.

3. Install vacuum modulator into case with vacuum hose pipe facing electrical connector.

4. Install modulator retainer with curved side of tangs inboard and install attaching screw. Tighten screw to 18 foot-pounds.

GOVERNOR ASSEMBLY

NOTE: All components of the governor assembly, with the exception of the driven gear, are a select fit and each assembly is factory calibrated. The governor, including the driven gear, is serviced as a complete assembly. However, the driven gear can also be serviced separately.

GOVERNOR INSPECTION

1. Wash in cleaning solvent, and blow out all passages.

2. Inspect governor sleeve for nicks, burrs, scoring or galling.

3. Check governor sleeve for free operation in bore of transmission case.

4. Check governor valve for free operation in bore of governor sleeve.

5. Inspect governor driven gear for nicks, burrs, or damage.

6. Check governor driven gear for looseness in governor sleeve.

7. Inspect speedometer drive gear for nicks, burrs, or damage.

8. Check speedometer drive gear for looseness on governor sleeve.

9. Inspect governor springs for distortion or damage.

10. Check governor weights for free operation in their retainers.

11. Check valve opening at entry and exhaust (.020" minimum).

GOVERNOR DRIVEN GEAR REPLACEMENT

To facilitate governor repair in the field, governor driven gear and replacement pins are available for service use. The service package contains a nylon driven gear and one governor gear retainer split pin. Replacement of gear must be performed with care in the following manner:

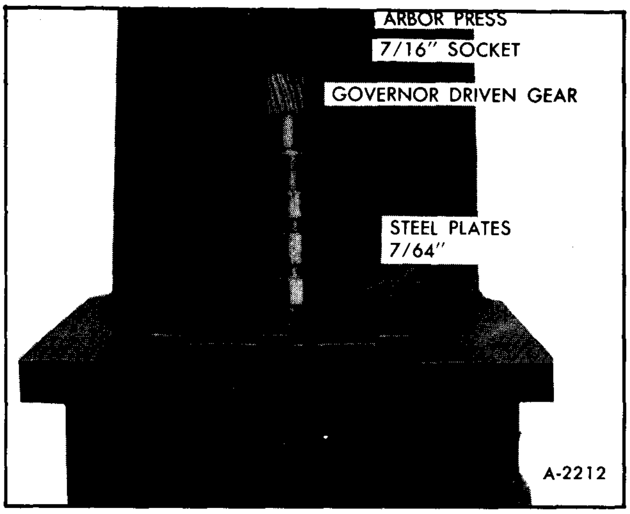


Figure 104—Installing Governor Gear

1. Place governor sleeve on a block of wood and drive retaining pin out, using a small punch or 1/8" drill rod.

2. Remove governor driven gear as follows:

a. Insert governor driven gear in a vice.

b. Firmly grip governor sleeve with hands and twisting and pulling at the same time, pull governor sleeve away from the governor driven gear.

c. Discard governor driven gear.

3. Remove governor valve and wash all parts in cleaning solvent and blow off parts.

4. Install governor valve, end with holes last, into governor sleeve.

5. Support governor on 7/64" plates, installed in exhaust slots of sleeve, position new gear in sleeve and with a 7/16" socket, press gear into sleeve until seated. See Figure 104.

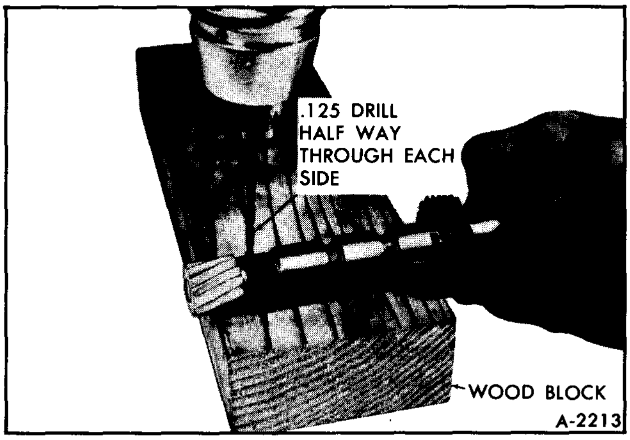


Figure 105—Drilling Governor Gear Shaft

6. Place governor sleeve on a block of wood and with a 1/8" drill, drill half way through each side of gear; drill through existing hole. See Figure 105.

7. Install split retaining pin, making sure each end is slightly below top of hole.

CAUTION: *Extreme care must be taken to prevent damaging the parts.*

8. Stake both ends of pin hole, two places.

9. Thoroughly wash governor assembly in cleaning solvent and blow out all passages.

INSTALL GOVERNOR

1. Rotate transmission in Holding Fixture Base so that governor bore is up.

2. Install new square cut O-ring seal on governor assembly and install assembly into transmission case.

3. Position retaining clip on top of governor assembly.

INSPECT SPEEDOMETER DRIVEN GEAR ASSEMBLY

1. Inspect gear for damaged teeth or shaft.

2. Inspect sleeve for scores, damaged threads or cracks.

INSTALL SPEEDOMETER DRIVEN GEAR

1. Install new O-ring seal on speedometer driven gear assembly.

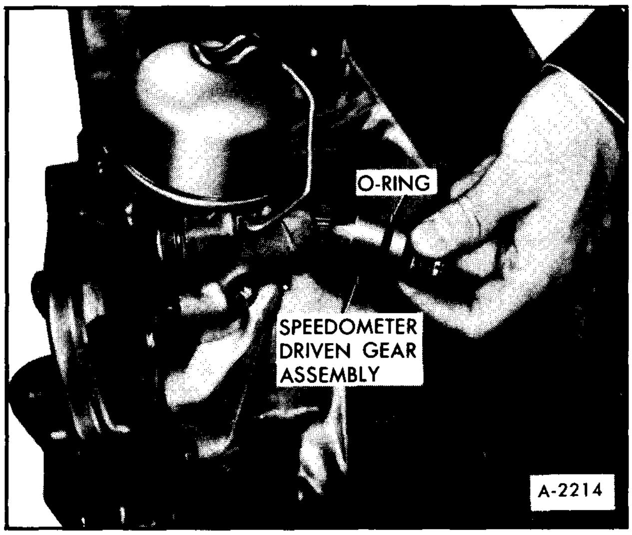


Figure 106—Installing Speedometer Driven Gear

2. Lubricate housing lip with a thin coat of Dexron transmission fluid.

3. Install speedometer housing and seal assembly and white nylon driven gear into transmission case, Figure 106.

4. Position retaining clip to transmission and driven gear assembly and secure with one attaching bolt, tightening bolt to 6 ft. lbs.

CONVERTER

INSPECT TORQUE CONVERTER

1. Inspect inside of bell housing. If covered with oil, a converter leak may be indicated. Converter should be leak tested as follows:

a. Drain oil out of converter.

b. Install Fixture J-21369 and tighten.

c. Fill converter with 80 psi of air, Figure 107.

d. Submerge in water and check for bubbles indicating leaks.

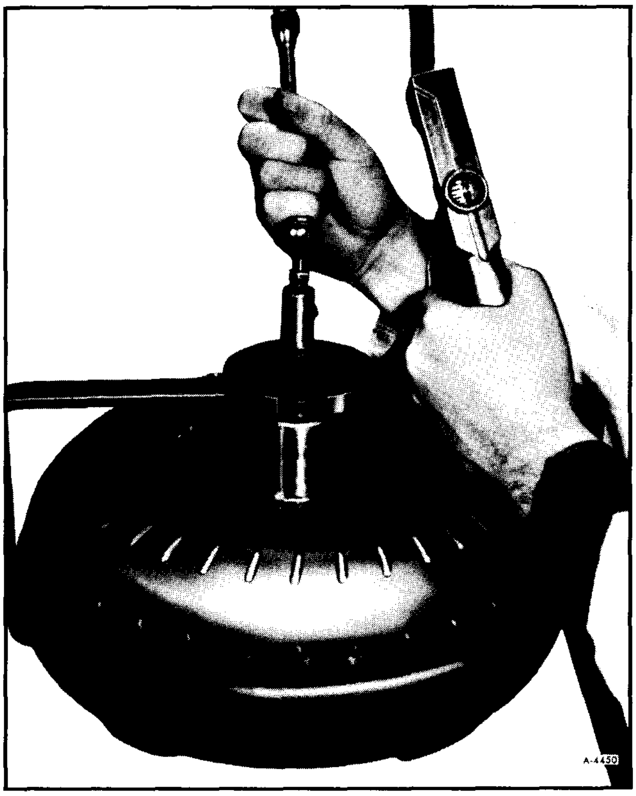


Figure 107—Leak Checking Converter

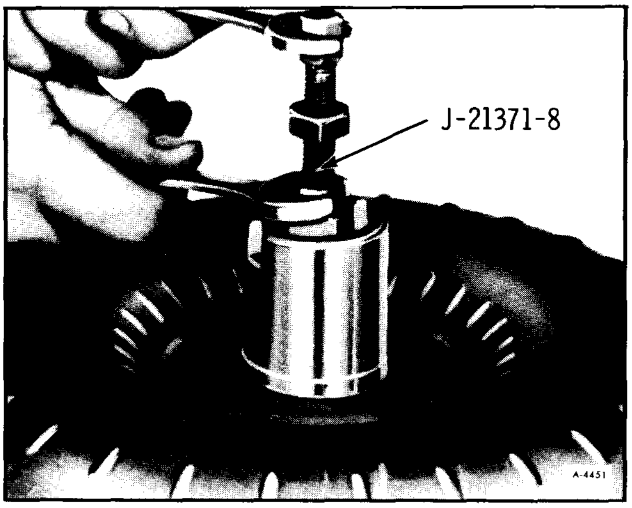


Figure 108—Installing Fixture J-21371-8

WARNING: ALWAYS RELEASE AIR PRESSURE BEFORE REMOVING VALVE, AS A DEFINITE HAZARD EXISTS SHOULD VALVE BLOW OUT DURING REMOVAL.

e. Thoroughly dry converter.

2. Check converter hub surfaces for signs of roughness, scoring, or wear that could damage the oil pump front seal. If roughness can be felt with a fingernail, seal could be damaged.

3. Check converter for loss of balance weight or a broken converter-to-crankshaft pilot. If balance weight is off or pilot is broken, replace the converter.

4. Check converter end play as follows:

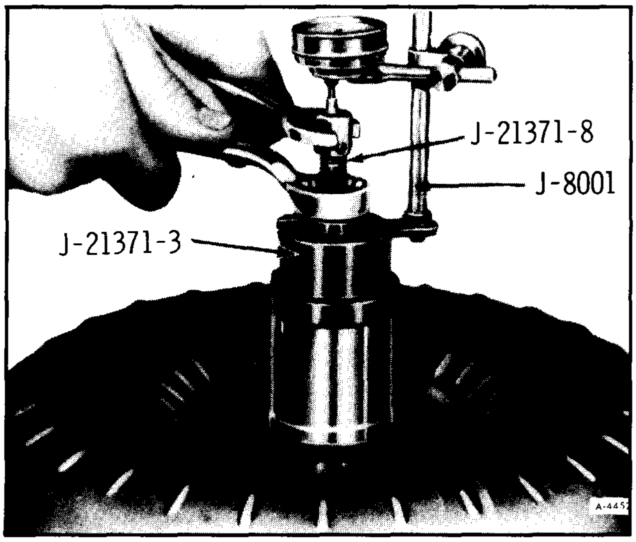


Figure 109—Checking Converter End Play

a. Fully release collet end of Fixture J-21371-8 by turning its cap nut clockwise.

b. Install collet end of Fixture J-21371-8 into converter hub until it bottoms, then tighten its cap nut to 5 lb. ft., Figure 108.

c. Install Fixture J-21371-3 and tighten the hex nut to 3 lb. ft.

d. Install Indicator J-8001 and set it for "zero" while its plunger rests on the cap nut of Fixture J-21371-8.

e. Loosen hex nut while holding cap nut stationary, allowing converter internal assembly to

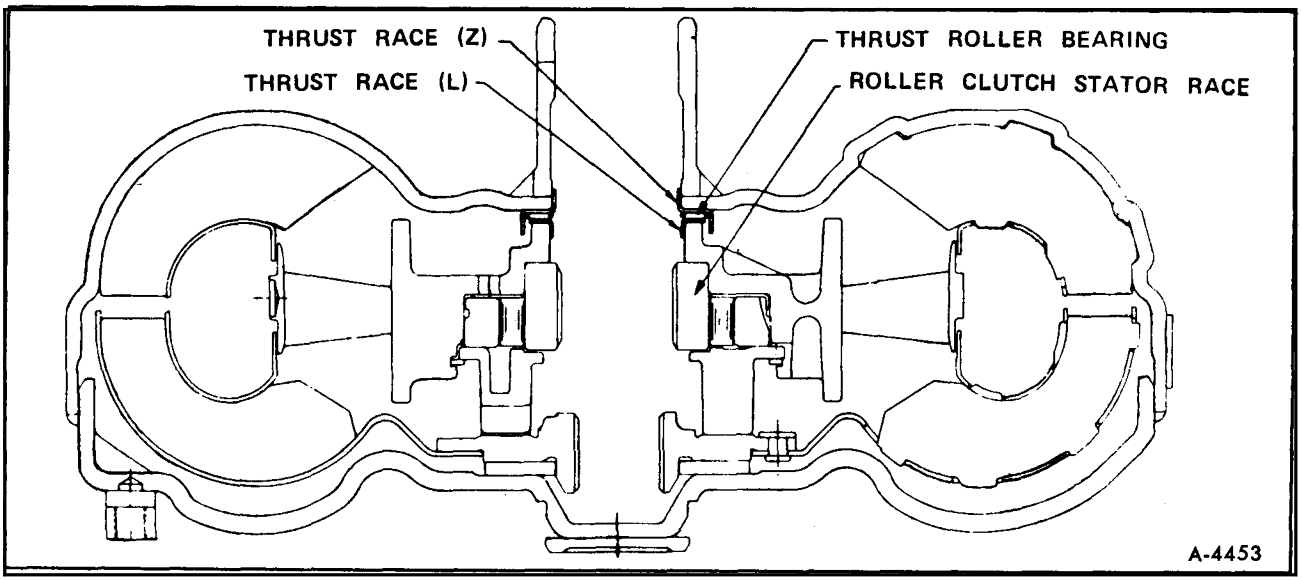


Figure 110—Converter Assembly - Cross Section

lower, until dial indicator shows that internal assembly has bottomed, Figure 109.

f. The reading obtained on dial indicator represents converter end clearance. If clearance is less than .050", the converter is acceptable. If clearance is .050" or more, replace the converter.

5. If fluid in the converter has the appearance of having been mixed with "aluminum paint", converter is damaged internally and must be replaced.

6. Do not change the converter if some other part of the transmission has resulted in the converter containing dark, discolored fluid. The full flow filter is designed to remove all harmful residue from non-conforming parts, other than converter and/or pump non-conformities before the oil is pumped into the converter.

7. Check the converter internally for damage to its roller bearings, thrust races, and the roller clutch, Figure 110.

a. The thrust roller bearings and thrust races can be checked by viewing them when looking into the converter neck or feeling through the opening to make sure they are not cracked, broken, or mispositioned.

b. The stator roller clutch can be checked by inserting a finger into the splined inner race of the roller clutch and trying to turn the race in both directions. The inner race should turn freely in the clockwise direction, but not turn, or should be very difficult to turn, in the counterclockwise directions.

IMPORTANT: Do not use such items as the pump cover or stator shaft to turn the race as the results may be misleading.

8. Check for stripped converter bolt holes. If found stripped, inspect for cause (such as damaged bolt threads), heli-coil the damaged bolt holes and install new bolt(s).

INSTALL TORQUE CONVERTER

1. Position transmission jack to transmission and install transmission on jack using safety chain.

2. Carefully position converter on turbine shaft, making certain converter is properly aligned. Long screws or eyebolts can be threaded into the weld nuts on the converter and used as handles.

3. Rotate converter until the shafts are piloted and the converter lugs are indexed in the pump gear.

4. If difficulty is experienced in alignment, tap on outer diameter of converter with plastic-headed hammer, while turning converter.

5. Install Converter Holding Clamp, J-21366, on transmission case.

6. Remove two (2) 8" bolts from case to engine mounting face, Figure 20.

INSTALLING FINAL DRIVE (FIGURE 19)

1. Install new gasket, on final drive, after first soaking with transmission fluid.

2. Align final drive to transmission and secure with bolts "B, C, E, F, G" and nut "H", torque to 25 ft.-lbs.

3. Install new O-ring on filler tube assembly and assembly to final drive. Torque bolt "A" to 25 ft.-lbs.

NOTE: Install transmission and final drive in vehicle as described earlier in this section.

TRANSMISSION SPECIFICATIONS

TORQUE CHART

Material Number	Application	Thread Size	Foot Pounds
280M	Transmission to Engine Bolts	3/8—16	35
300M	Torque Converter to Flywheel	3/8—16	30
1010	Flywheel Housing Cover	5/16—18	5
300M	Final Drive to Transmission	3/8—16	25
280M	Solenoid to Control Valve Assembly	1/4—20	3
Special	Line Pressure Plug	1/8 Pipe	10
260M	Vacuum Modulator Retainer to Case	5/16—18	18
260M	Valve Body to Case	1/4—20	10
	Valve Body to Case	5/16—18	10
300M	Center Support to Case	3/8—16	23
286M	Manual Shaft to Inside Lever	3/8—24	18
280M	Pump Body to Cover Plate	5/16—18	20
280M	Parking Brake Bracket to Case	5/16—18	18
1010—1020	Oil Pan to Case	5/16—18	12
280M	Sprocket Cover to Case	1/4—20	10
260M	Support Housing to Cover Plate	5/16—18	20
260M	Speedometer Driven Gear Retainer	5/16—18	18

SPECIAL TOOLS

J 4646	Snap Ring Pliers
J 4670-01	Forward Clutch Spring Compressor (Use with J-6129 & J-21664)
J-5586	Snap Ring Pliers
J 5907	Pressure Gauge Set (0-300 psi-9' hose)
J 6116-01	Clutch Unit Holding Fixture
J 6129	Direct Clutch Spring Compressor
J 6133-01	Rear Oil Pump Bearing & Speedo Gear Installer
J 8001	Dial Indicator Sleeve Clamp and Hole Attachment
J 8763	Transmission Holding Fixture
J 21359	Front Pump Oil Seal Installer
J 21362	Forward & Direct Clutch Inner Seal Protector
J 21363	Second Clutch Inner Seal Protector
J 21369	Converter Leak Test Fixture
J 21370-6	Band to Apply Pin-Body Arm Assembly (Use with J-21370-7 & 8)
J 21370-7	Band to Apply Pin Gauge (Used with J-21370-6 & 8)
J 21370-8	Band to Apply Pin Selector Plate (Used with J-21370-6 & 7)
J 21371	Converter End Play Checking Fixture
J 21409	Forward & Direct Clutch Outer Seal Protector
J 21661	Speedometer Drive Gear Remover Bolts
J 21664	Clutch Compressor Adapter
J 21795-02	Gear Unit Holding Tool
J 21795	Gear Assembly Remover and Installer Adapter
J 21797	Speedometer Drive Gear Removal Bolt
J 22241	Forward Clutch End Play Checking Tool
J 22269-01	Control Valve Direct Clutch Accumulator Piston Compressor

SECTION 8
FUEL TANK AND EXHAUST

Contents of this section are listed below:

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EVAPORATION CONTROL SYSTEM (E.C.S)

DESCRIPTION

In order to limit gasoline vapor discharge into the atmosphere, the following features are incorporated in the fuel system. The E.C.S. system (figure 1) is designed to trap fuel vapors which normally escape from the fuel tank. Vapor arrest is accomplished through the use of a charcoal canister(s) which adsorbs the fuel vapors and stores them until they can be removed to be burned in the engine. Removal of vapors from the canister(s) to the engine is accomplished by a calibrated purge orifice in the carburetor. In addition to the carburetor modifications and the canister(s), the fuel tank requires a special pressure-vacuum gas cap and extra vents to liquid/-vapor separator. The liquid/vapor separator prevents liquid gasoline from entering the vapor system to the canister(s). Thus, as vapors are generated in the fuel tank, they flow through the liquid/vapor separator and to the canister(s) where they are stored. From the canister(s) the vapors are routed to the carburetor where they will be burned during normal combustion.

On vehicles sold in California an additional canister is used along with two shields between the fuel tanks and exhaust pipe.

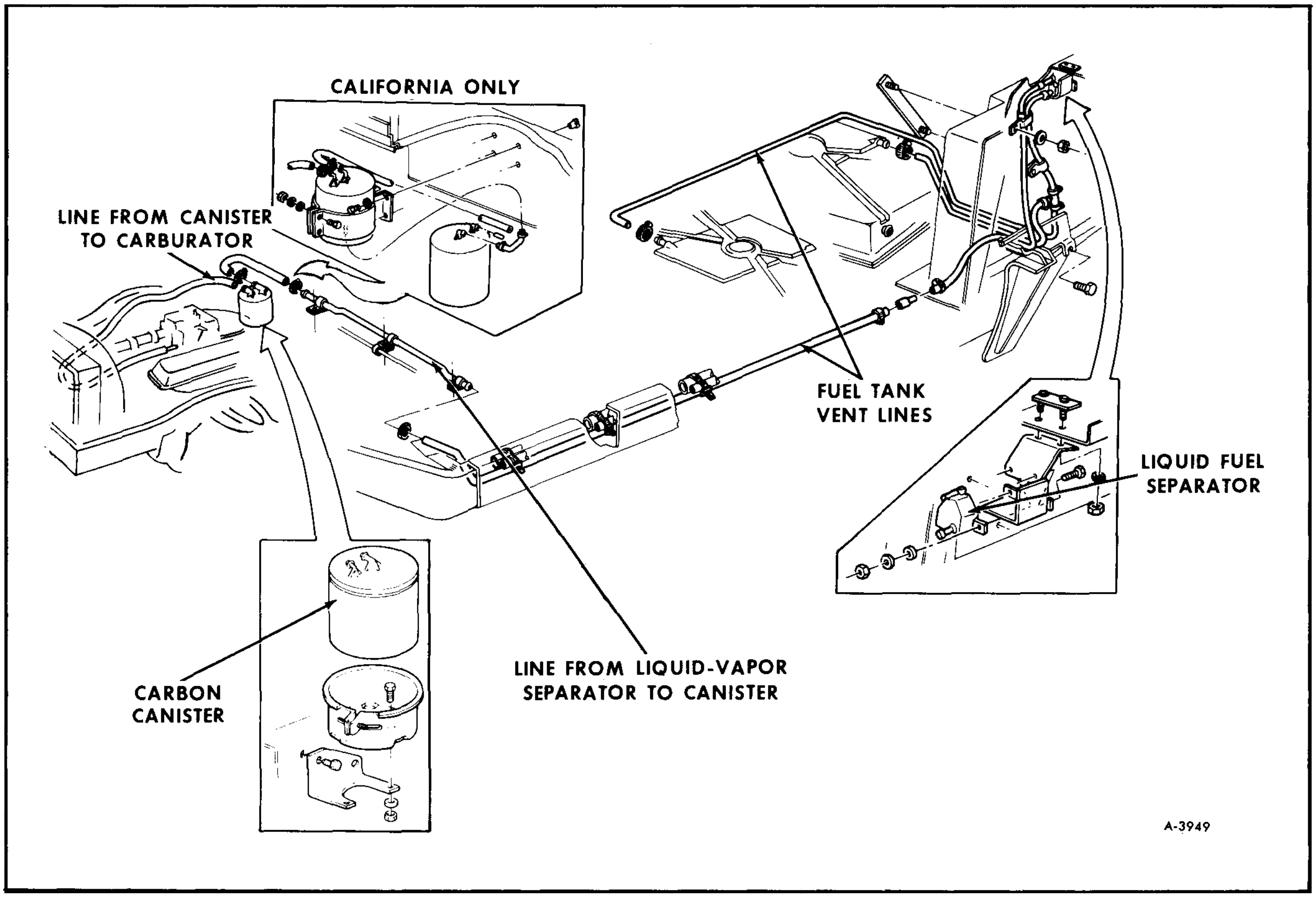


Figure 1—Evaporation Control System

TROUBLE DIAGNOSIS

Condition	Possible Cause	Correction
Fuel odor or loss of fuel rough idle.	Leak in fuel line(s) or hose(s). Purge hose improperly routed. Disconnected purge hose. Plugged canister filter. High volatility fuel.	Replace line or hose. Route hose correctly. Connect hose to proper fitting. Replace filter. Change brand of fuel.
Collapsed tank or pressure in tank.	Plugged or pinched vent line(s). Defective canister. Faulty valve in special tank filler cap.	Remove obstruction or replace line. Replace canister. Install specified replacement cap.

SERVICING E.C.S.

CANISTER(S)

The plastic canister is filled with charcoal which adsorbs and stores fuel vapors. When fuel is drawn from the tank during engine operation, a fuel cap tank relief valve opens allowing air to be drawn into the tank. When the engine is running, air is drawn in through the bottom of the canister. This air picks up vapors which are being held in the charcoal and carries them through the carburetor into the engine where they are burned.

REMOVAL

1. Vehicle may be raised if desired.

2. If vehicle is equipped with one canister loosen clamp screw and lift canister up and out.

3. If vehicle is equipped with two canisters remove the lower canister clamp from bracket and slide canister and clamp out. See Figure 1.

4. Disconnect hoses from canister(s).

5. If vehicle is equipped with a second canister loosen clamp and lower canister enough to disconnect hoses so it may be removed.

INSTALLATION

1. If the vehicle is equipped with two canisters connect hoses to the upper canister and install. Tighten clamp.

2. Connect hoses to remaining canister and install. Tighten clamp as required.

CANISTER FILTER

REMOVAL

1. Remove canister. Refer to "Canister—Removal" earlier in this section.

2. Filter is located in the bottom of the canister. If vehicle is equipped with two canisters the filter is in the lower canister.

3. Remove filter.

INSTALLATION

1. Install filter. See Figure 2.

2. Install canister. Refer to "Canister—Installation" earlier in this section.

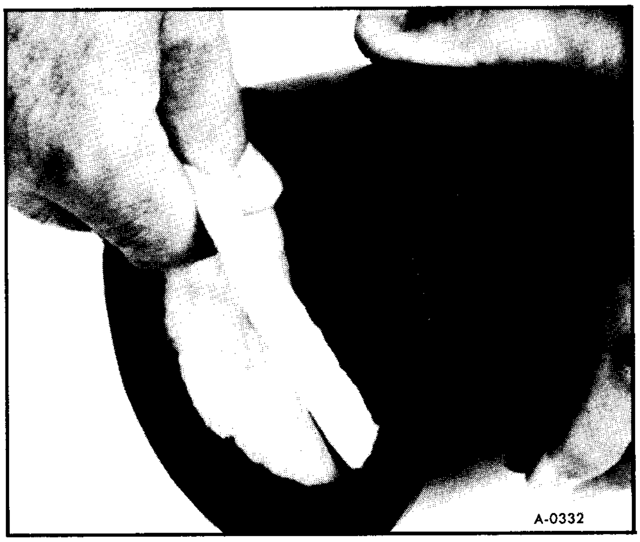


Figure 2—Replacing Canister Filter

HOSES AND LINES

Conventional steel tubing, vapor resistant hose and hose clamps are used to connect the various components of the system. It is extremely important that all pipes and hoses are not kinked, are properly connected, and that all connections are tight. This is necessary to assure a vent through the system for the fuel tank to prevent restriction of vapors to the canister. Thorough visual inspection is and will remain one of the most important checks of the system.

IMPORTANT: Use only hose marked "EVAP" or "GM 6107M" if necessary to replace an E.C.S. hose. Gasoline vapors will deteriorate other types of hoses.

LIQUID/VAPOR SEPARATOR

DESCRIPTION

An external liquid-vapor separator is mounted to left rear wheel opening liner. It's purpose is to stop fuel that has drained out of tanks when the vehicle is parked off level. Once a level position is assumed the fuel in the separator will drain back into the tank.

Any vapors collected in the separator are routed to the canister by a hose. The separator can not be serviced. If damaged it must be replaced.

REMOVAL

1. Clean threads of dirt and remove attaching nuts.

2. Move separator off studs. Mark hoses with some identification to assure proper matching of hoses and outlets.

3. Disconnect hoses and remove separator.

INSTALLATION

1. Connect hoses to proper ports.

2. Install separator and tighten nuts.

FUEL TANKS AND LINES

DESCRIPTION

The fuel tanks in the vehicle are dual 25 gallon capacity tanks for a total of 50 gallons. The tanks are located between the frame rails forward of the bogey crossmember.

The filler neck and tubes are constructed of steel tubing with rubber connecting hoses secured by worm-type hose clamps as shown in Figures 3 and 4.

The fuel pickup pipe is built integrally with the tank gauge sending unit, located at the top of the tank. A large area, fine mesh screen is located on the bottom of the fuel pickup pipe. This screen is designed to prevent the entrance of dirt or water into the fuel system, and operates with a self-cleaning action.

The tanks consist of an upper and lower half each with a wide flange. The two tank sections are seam welded at the flange to assure leak proof construction. Exceptional stiffness is obtained by the combination of the welded flanges and depressed ribs in both upper and lower tank sections.

DRAINING FUEL TANKS

WARNING: BEFORE ATTEMPTING TO DRAIN FUEL TANK, ALWAYS; REMOVE BATTERY NEGATIVE CABLES, PLACE "NO SMOKING" SIGNS AND A CO2 FIRE EXTINGUISHER NEAR WORK AREA, WEAR SAFETY GLASSES, AND SIPHON OR PUMP FUEL FROM TANK INTO AN EXPLOSIVE PROOF CONTAINER.

The fuel tanks incorporate a drain plug in the left front corner of the tanks. (See figure 5)

To drain the tank remove the drain plug in the tank with the correct size Allen wrench.

Always drain gasoline from complete fuel system including carburetor, fuel pump, all fuel lines and fuel tank if the vehicle is to be stored for any appreciable length of time. This precaution will prevent accumulation of gum formation and resultant poor engine performance.

FUEL TANK REPLACEMENT

WARNING: BEFORE ATTEMPTING FUEL TANK REMOVAL, ALWAYS; REMOVE BATTERY NEGATIVE CABLES, PLACE "NO SMOKING" SIGNS AND A CO2 FIRE EXTINGUISHER NEAR WORK AREA, WEAR SAFETY GLASSES, AND SIPHON OR PUMP FUEL FROM TANK INTO AN EXPLOSIVE PROOF CONTAINER.

1. Drain tanks as previously described.

2. Disconnect fuel filler tubes by loosening worm clamps and slide rubber connectors off ends.

3. Remove 3 bolts from angle at front of tank as shown in Figure 6. If both tanks are to be removed, the forward tank should be completely removed.

4. Slowly lower tanks to allow removal of vent lines and fuel feed lines, label or mark lines to allow reconnection of lines with the same outlet.

5. Using Tool J-24187 as illustrated in Figure 7. Remove fuel tank gauge unit.

6. Reverse steps 1—5.

FUEL TANK GAUGE REPLACEMENT

1. Follow steps outlined in Fuel Tank Removal.

2. Remove fuel gauge retaining cam, using Tool J-24187 (figure 7).

3. Test gauge unit if required according to the diagnosis check list for fuel tank gauge in Section 12.

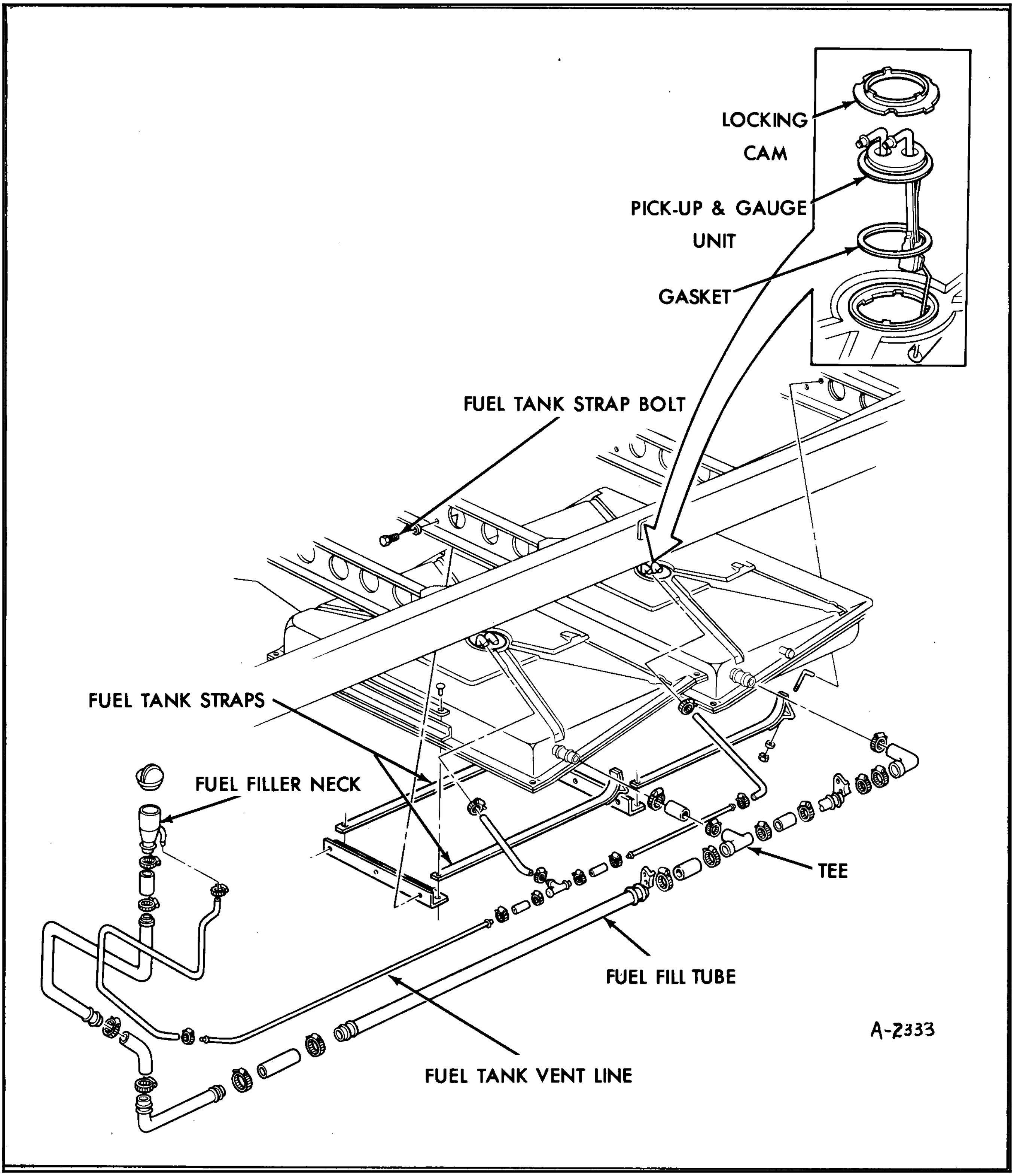


Figure 3—Type 1 Fuel Tanks and Lines

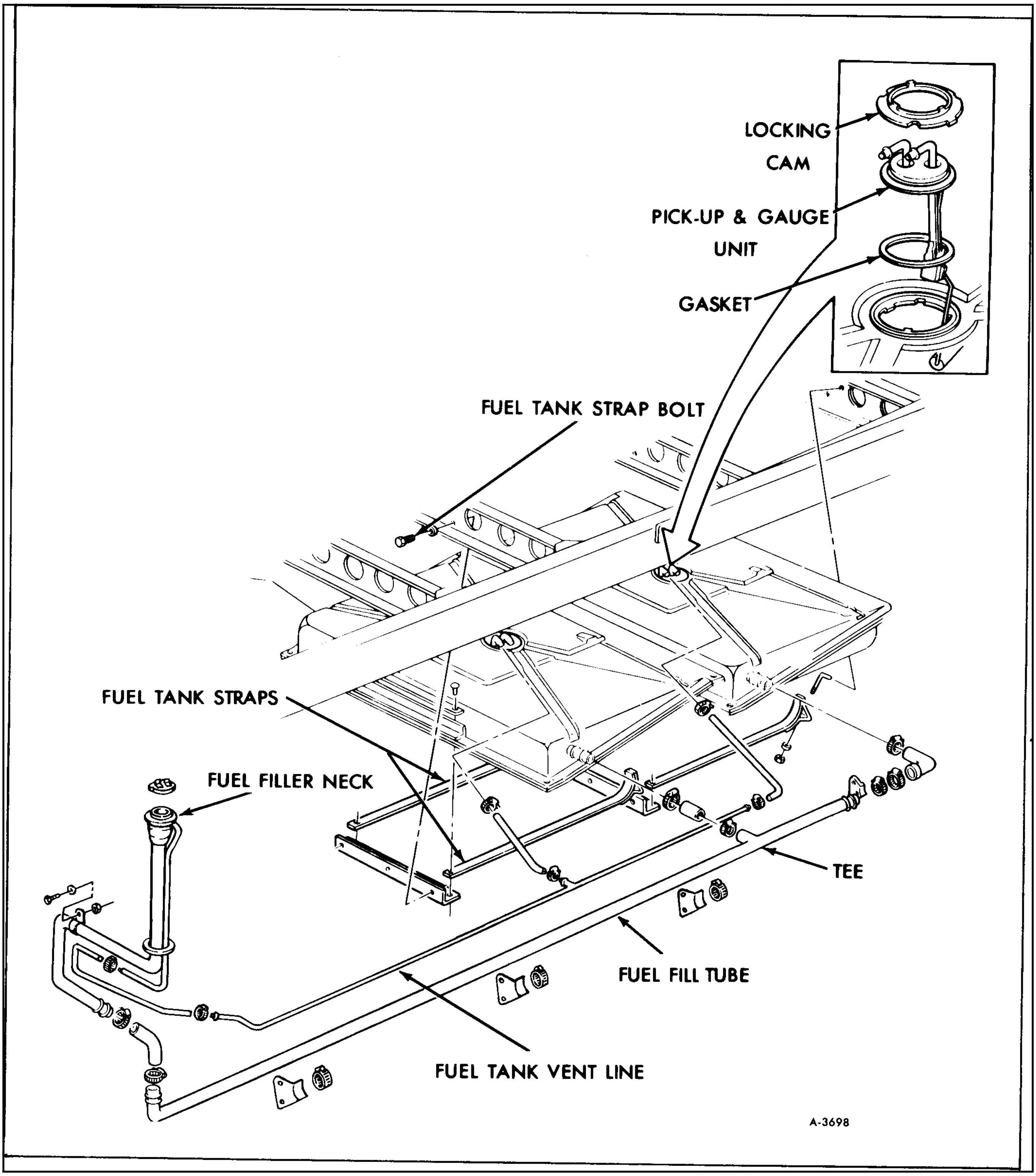


Figure 4—Type 2 Fuel Tanks and Lines

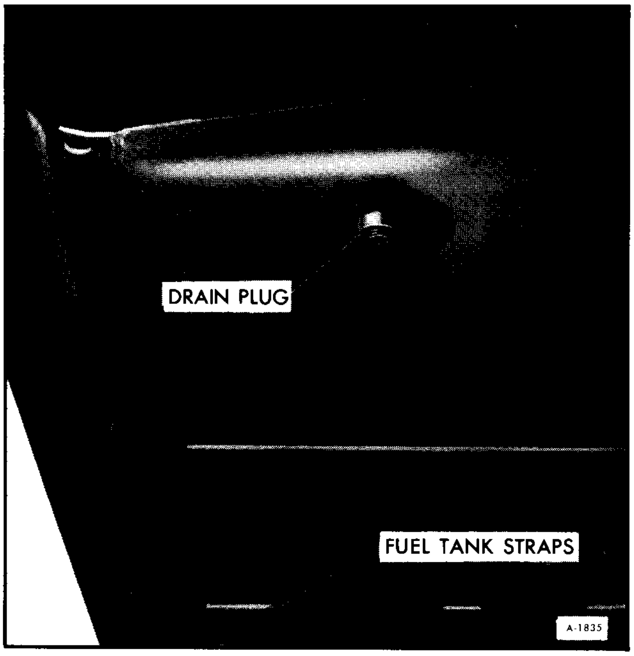


Figure 5—Fuel Tank Drain Plug

4. Reverse steps 1—3, and check operation of gauge.

CLEANING FUEL SYSTEMS

If trouble is due to contaminated fuel or foreign material that has been put into the tank, it can usually be cleaned. If tank is rusted internally, it should be replaced.

1. Disconnect battery ground cables and ignition coil primary wire (+ wire on ignition coil).

2. Drain fuel tank. (See DRAINING FUEL TANK).

3. Remove fuel tank. (See FUEL TANKS — REPLACEMENT).

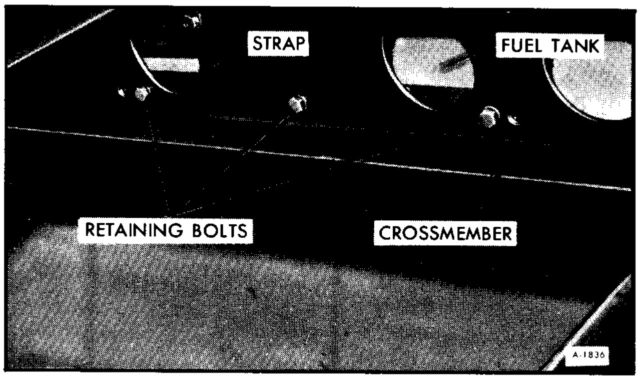


Figure 6—Removing Fuel Tank Strap Bolts

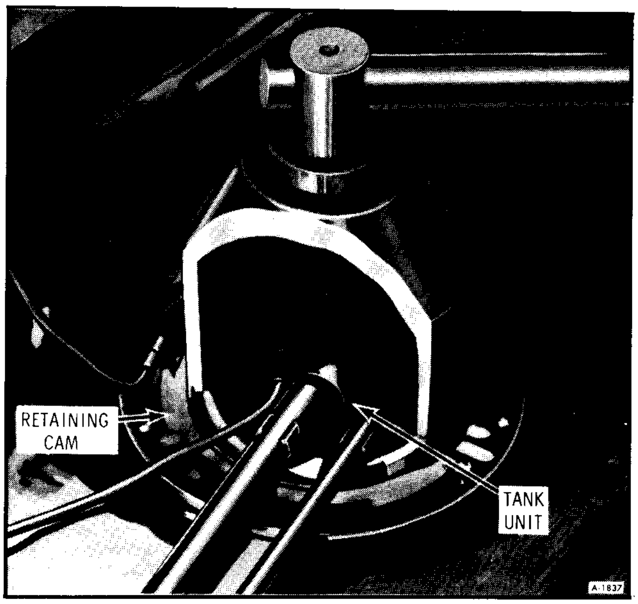


Figure 7—Removing Fuel Tank Gauge Unit

4. Remove fuel inlet filter at carburetor and inspect for contamination. If filter is plugged, replace. (Leave fuel line disconnected.)

5. Locate tank away from heat, flame or other source of ignition. Remove fuel gauge tank unit and inspect condition of filter. If filter is contaminated, a new filter should be installed upon reassembly.

6. Complete draining of tank by rocking it and allowing fuel to run out of tank unit hole.

7. Purge fuel tank with steam or running hot water for at least five minutes. Pour water out of tank unit hole. (Rock tank to assure complete removal of water.)

> **IMPORTANT:** This procedure will not remove fuel vapor. Do not attempt any repair on tank or filler neck where heat or flame is required.

8. Disconnect inlet fuel line at pump and use air pressure to clean fuel line and fuel return line (if equipped). Apply air pressure in the direction fuel normally flows through line.

9. Use low air pressure to clean pipes on tank unit.

10. Install new filter on fuel tank unit if required. Install fuel tank unit with new gasket into tank and install tank. Connect tank unit wires and all fuel lines except pump to carburetor line. (See REMOVAL OF TANK for proper procedure).

11. Connect a hose to fuel line at carburetor, insert other end of hose into a one gallon fuel can.

12. Connect battery cable. MAKE SURE IGNITION COIL PRIMARY WIRE (+TERMINAL) IS DISCONNECTED.

13. Put six gallons of clean fuel in tank and operate starter to pump two quarts of fuel into fuel can. This will purge fuel pump.

14. Remove hose and connect fuel line to carburetor.

15. Connect coil primary wire.

16. Connect battery ground cables.

FUEL LINE REPAIR PROCEDURE

1. DO NOT use rubber hose within four inches of any part of the exhaust system.

2. Cut out damaged portion of fuel line.

3. In repairable areas cut a piece of fuel hose four inches longer than the portion of the line removed.

4. Slide clamps onto pipe and push hose two inches onto each portion of fuel pipe.

5. Clamp hose to pipe on each side of repair.

FUEL TANK PURGING PROCEDURE

1. Remove fuel gauge unit and drain all remaining fuel from tank.

2. Visually inspect interior cavity of tank; if any fuel is evident, drain again.

3. Move tank to flushing area (wash rack).

4. Pour gasoline emulsifying agent and water solution into the tank and agitate mixture for 2 to 3 minutes, wetting all interior surfaces.

NOTE: For correct gasoline emulsifying agent — water mixture, refer to the emulsifying agent manufacturer's specifications. Use an available emulsifying agent such as "Product -Sol No. 913" or equivalent.

5. Fill tank (with water) to capacity and agitate again.

6. Empty contents.

7. When empty, refill to overflowing with water to completely flush out remaining mixture and then empty tank.

8. If any vapor is present, repeat Steps 4 thru 8. Repeat as necessary until there is no evidence of fuel vapor.

9. Dry tank with compressed air and perform required service work.

FUEL TANK LEAK TEST PROCEDURE

1. Plug all outlets as follows:

a. Use a known good filler cap for filler neck.

b. Install tank unit using Tool J-24187 and replace gasket. Then plug fuel line.

c. Plug two (2) of the three (3) tank vent tubes using a single short piece of fuel line hose.

d. Install another short piece of fuel line hose on third vent tube.

2. Apply air pressure to tank through open vent tube. Use extreme caution to prevent rupturing the tank. When air can be heard escaping from the filler neck cap (approximately 1 to 1-1/2 lbs. of pressure) pinch the fuel line hose to retain pressure.

3. Test repaired area for leaks with soap solution or by submersion. If leak is noted, make repair and retest.

4. Pressure test entire fuel system by applying 1.5 psi air pressure thru charcoal cannister inlet hose.

EXHAUST SYSTEM

DESCRIPTION

The exhaust system on the models 23' and 26' are essentially identical except for a longer length tail pipe on the 26' model. The exhaust manifolds empty into a muffler for each bank of cylinders which are Y'ed as shown in Figure 8. The tail pipe continues to rear of the vehicle. All exhaust system connections are of the split joint coupled design, secured with U-Bolt clamps.

On all exhaust and tail pipe clamp installations locate centerline of clamp to end of slot in pipe as shown.

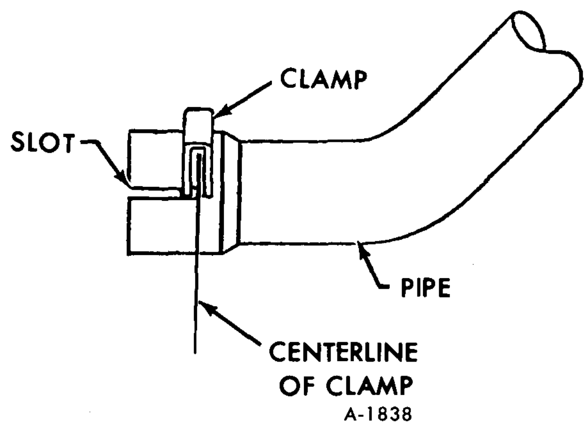


Figure 8—Exhaust System and Clamps

MAINTENANCE

EXHAUST RESTRICTION AND LEAKS

Exhaust system should be inspected periodically for restrictions and leaks. Restrictions such as kinked or crimped pipes result in excessive back pressure which can lead to increased fuel consumption, power loss, and possible damage to engine combustion chamber components. Exhaust leaks are commonly the result of loose clamp assemblies, defective exhaust pipe to manifold packing, or corroded pipes. In addition to objectionable noise, a leaking exhaust system could allow toxic gases to enter vehicle.

Damaged or corroded exhaust system components should be replaced without delay. If it is absolutely necessary to operate vehicle when an exhaust leak exists, use extreme caution and keep vehicle well ventilated.

EXHAUST SYSTEM ALIGNMENT

During installation of a new exhaust pipe, muffler or tail pipe, care should be taken to properly position components in relation to each other.

On all joints except exhaust manifold, apply sealer (GM 9985020) or equivalent, to prevent possible leaks.

Incorrectly assembled parts of exhaust system are frequently the cause of annoying noises and rattles due to improper clearances. Exhaust components must have 3/4" clearance from floor to avoid possible overheating. Therefore, leave all clamp assemblies and muffler strap bolts loose temporarily until the entire system has been inspected to determine if there is adequate clearance between exhaust components and frame members. The weight of the exhaust system should be properly distributed on all supporting brackets and hangers. If the load is not properly balanced, reposition pipes at connecting joints to relieve any concentrated loads. After adjusting hangers, aligning pipes, and repositioning muffler, check entire system for adequate clearance and then tighten all clamps, working from front to rear. (See figure 9) Start engine and inspect all connections for leakage.

NOTE: When installing exhaust pipe to manifold, always use new packing.

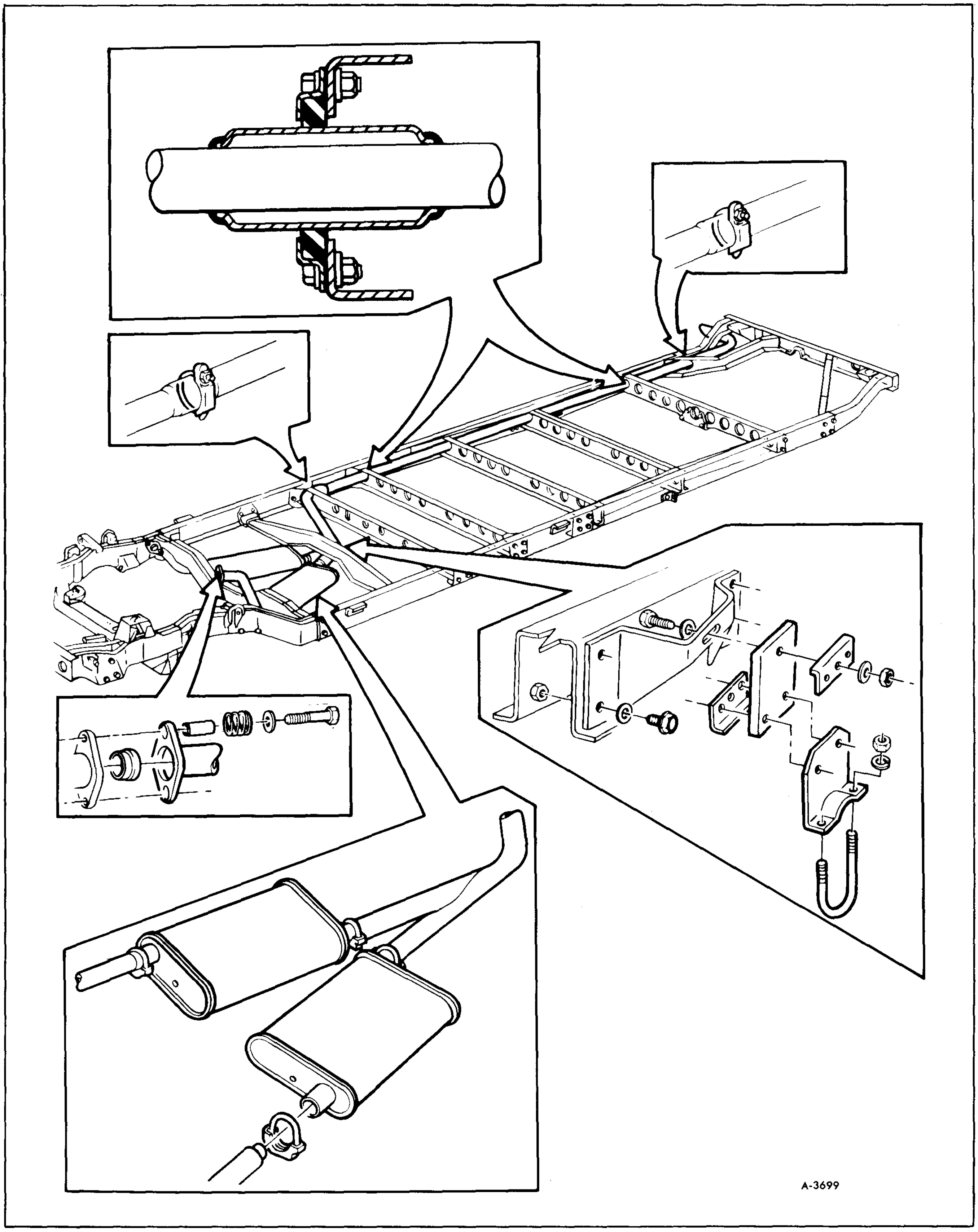


Figure 9—Exhaust Pipe Clamp Installation

SECTION 9
STEERING

Contents of this section are listed below.

SUBJECT	PAGE NO.
Steering Linkage	9-1
Power Steering Pump	9-4
Steering Gear	9-22
Steering Column	9-41
Torque Specifications	9-62
Special Tools	9-63

CAUTION: *All steering linkage fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.*

STEERING LINKAGE

GENERAL INFORMATION

A parallelogram type steering linkage connects both front wheels to the steering gear through the pitman arm (See figure 1). The right and left tie rods are attached to steering arms at the wheels and to a forged intermediate rod by ball studs.

The left end of the intermediate rod is supported by the relay lever which is driven by the drag link connected to the pitman arm on the steering gear. The right end of the intermediate rod is supported by an idler arm which pivots on a support attached to the frame. The rear portion of the relay lever and the idler arm are always parallel to each other and move through symmetrical arcs.

The steering linkage is equipped with a linkage shock absorber connected from the intermediate rod to the frame. This is designed to absorb much of the shock to the steering system.

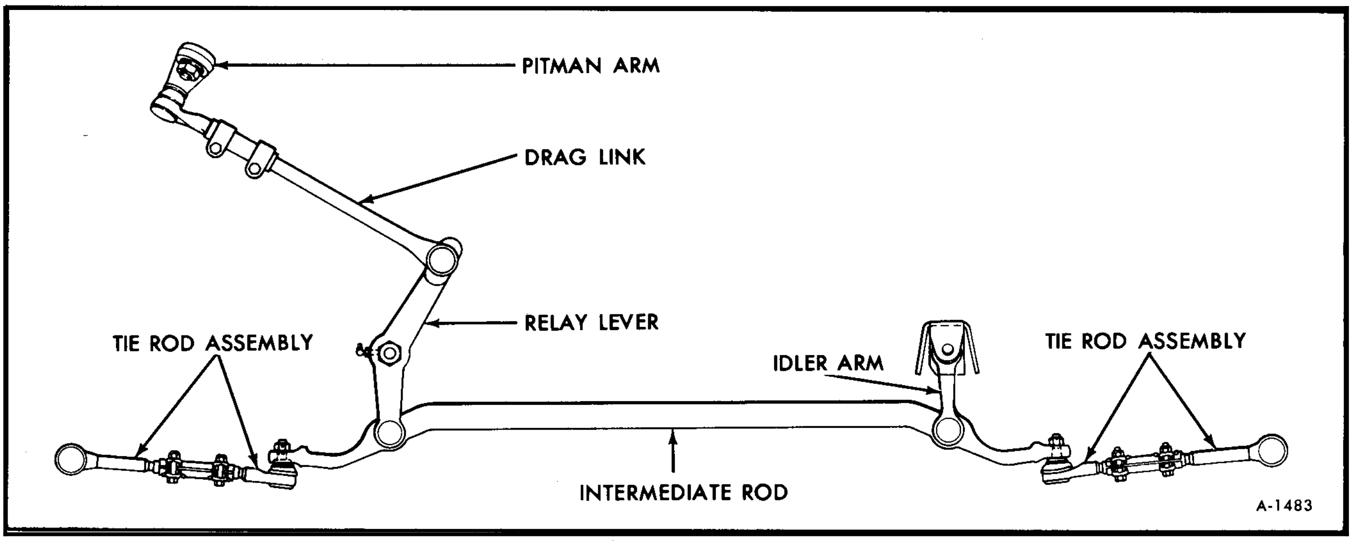


Figure 1—Steering Linkage

STEERING LINKAGE TROUBLE DIAGNOSIS

Condition	Possible Cause	Correction
A. Excessive Play or Looseness in Steering System	1. Front wheel bearings loosely adjusted. 2. Worn couplings or steering shaft U-joints. 3. Worn upper ball joints. 4. Steering wheel loose on shaft. 5. Steering gear worm bearings loosely adjusted. 6. Excessive pitman shaft to ball nut lash in steering gear. 7. Loose pitman arm, tie rods, steering arms or steering linkage ball studs. Worn intermediate rod or tie rod sockets.	1. Adjust bearings or replace with new parts as necessary. 2. Replace. 3. Replace. 4. Tighten to specified torque. 5. Adjust preload to specification. 6. Adjust preload to specification. 7. Replace loose or worn parts.
B. Excessive looseness in tie rod or intermediate rod pivots, or excessive vertical lash in idler support.	1. Seal damage and leakage resulting in loss of lubricant, corrosion and excessive wear.	1. Replace damaged parts as necessary.
C. Hard Steering—Excessive Effort Required at Steering Wheel.	1. Low or uneven tire pressure. 2. Steering linkage or ball joints need lubrication. 3. Tight or frozen intermediate rod, tie rod or idler socket. 4. Steering gear to column misalignment. 5. Steering gear adjusted too tightly. 6. Front wheel alignment incorrect.	1. Inflate to specified pressures. 2. Lube with specified lubricant. 3. Lube or replace as necessary. 4. Align column. 5. Adjust preload to specification. 6. Check alignment and correct as necessary.
D. Poor Returnability.	1. Steering linkage or ball joints need lubrication. 2. Steering gear adjusted too tightly. 3. Steering gear to column misalignment. 4. Front wheel alignment incorrect.	1. Lube with specified lubricant. 2. Adjust preload to specifications. 3. Align column. 4. Check alignment and correct as necessary.

STEERING LINKAGE COMPONENT REPLACEMENT

IMPORTANT: Lubricate the steering linkage sockets whenever servicing the linkage.

TIE RODS

The vehicle employs two three-piece tie rods connecting left and right steering arms (See figure 1). The tie rod assembly consists of a tube and two socket end assemblies. The socket end assemblies are threaded into the tube and locked in place with clamps. Right and left hand threads are provided to facilitate toe-in adjustment.

The tie rod ends require no attention in service other than periodic lubrication and inspection to see that the ball studs are tight. Socket ends should be replaced when excessive up and down motion or any lost motion or end play at ball end of studs exists.

REMOVAL (FIGURE 1)

1. Raise vehicle.

2. Remove front wheels.

3. Remove cotter pin from ball studs and remove castellated nuts.

4. Disconnect tie rod from steering arm by using Tool J-24319 or similar puller.

5. Remove inner ball stud from intermediate rod using procedure described in Step 3 and 4.

6. To remove tie rod ends from the adjuster tube, loosen clamp bolts and unscrew end assemblies.

INSTALLATION

1. If the tie rod ends were removed, lubricate the threads with chassis lube. Thread both ends of the rod an equal distance into the adjuster tube.

2. Make sure that threads on ball studs and in ball stud nuts are perfectly clean and smooth. The ball stud must have no nicks on the taper.

NOTE: If threads are not clean and smooth, ball studs may turn in tie rod ends when attempting to tighten nut.

3. Install ball studs in steering arms and intermediate rod.

4. Install ball stud nuts and torque. See specifications for torque value and procedure.

5. Lubricate linkage sockets.

6. Lower vehicle.

7. Adjust toe-in (See section 3A of this manual).

DRAG LINK (FIGURE 1)

The procedures for the removal and installation of the drag link are the same as those given for the tie rods, earlier in this section. If the drag link was disassembled or a new unit is installed the adjustment on the drag link should coincide with the steering wheel at the center of its' travel and the wheels pointing straight ahead.

NOTE: Later production vehicles are equipped with a non-adjustable drag link.

RELAY LEVER (FIGURE 1)

REMOVAL

1. Place vehicle on hoist.

2. Remove cotter pins and castellated nuts from both ends of the relay lever.

3. Disconnect drag link from relay lever by using Tool J-24319 or similar puller.

4. Disconnect intermediate rod from relay lever using puller as in step 3.

5. Remove bolt securing relay lever to frame.

INSTALLATION

1. Secure relay lever to frame with bolt and torque bolt to 250 to 300 foot-pounds.

2. Connect relay lever ball stud to intermediate rod.

3. Install drag link ball stud to relay lever.

4. Install ball stud nuts, making sure threads are clean, and torque the intermediate rod, and the drag link stud nuts.

5. Lubricate all steering linkage sockets.

6. Lower vehicle.

IDLER ARM

REMOVAL (FIGURE 1)

1. Raise vehicle.

2. Remove cotter pin and castellated nut from idler arm ball stud at intermediate rod.

3. Disconnect idler arm from intermediate rod using Tool J-24319 or similar puller.

4. Remove bolt and nut securing idler arm to frame.

INSTALLATION

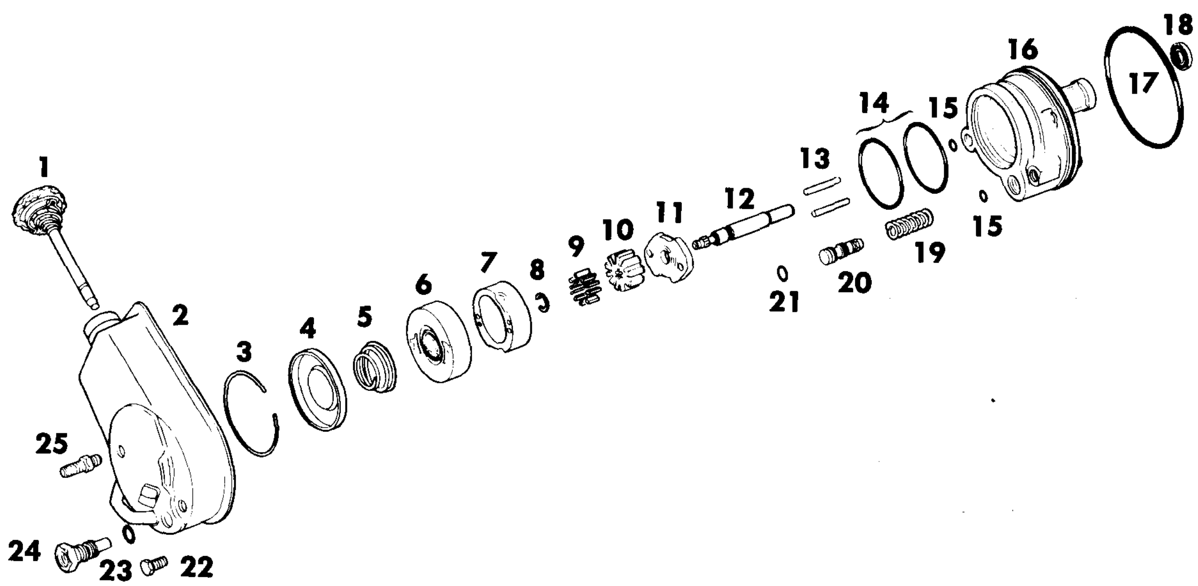
1. Secure idler arm to frame using bolt and lock nut. Torque nut to 85 to 110 foot pounds.

2. Connect idler arm ball stud to intermediate rod. Install ball stud nut making sure threads are clean, and torque. See specifications for torque value and procedures.

3. Lubricate all steering linkage sockets as described in SECTION 0 of this manual.

4. Lower vehicle.

POWER STEERING PUMP



1 Cap	8 Retaining Ring	14 Seal	20 Valve
2 Reservoir	9 Vanes	15 Seal	21 Seal
3 Ring	10 Rotor	16 Housing	22 Bolt
4 Plate	11 Thrust Plate	17 Seal	23 Seal
5 Spring	12 Shaft	18 Seal	24 Fitting
6 Pressure Plate	13 Pin	19 Spring	25 Stud
7 Ring			

A-4146

Figure 2—Power Steering Pump (Exploded)

GENERAL INFORMATION

The housing and internal parts of the pump are inside the reservoir so that the pump parts operate submerged in oil. The reservoir is sealed against the pump housing, leaving the housing face and the shaft hub exposed. The reservoir has a filler neck fitted with a cap. A shaft bushing and seal are pressed into the housing from the front. The drive shaft is inserted through this seal and bushing. A large hole in the rear of the housing contains the functional parts; namely ring, rotor, vanes and plates. A smaller hole contains the control valve assembly and spring.

The thrust plate (figure 2) is located by two dowel pins on the inner face of the housing. This plate has four central blind cavities for undervane oil pressure. The two outer blind cavities direct discharge oil through the two cross-over holes in the pump ring (figure 3), through the pressure plate, and into cavity 1 (figure 4). The two outside indentations in the thrust plate are for intake of the oil from the suction part of the pump.

The pump ring (figure 3) is a plate having the mating surfaces ground flat and parallel. The center hole is a two lobed cam in which the rotor and vanes operate. The ring is placed next to the thrust plate, and located with the same dowel pins.

The pressure plate is fitted against the ring and located with the same two dowel pins. This plate has six through ports. The four central through ports

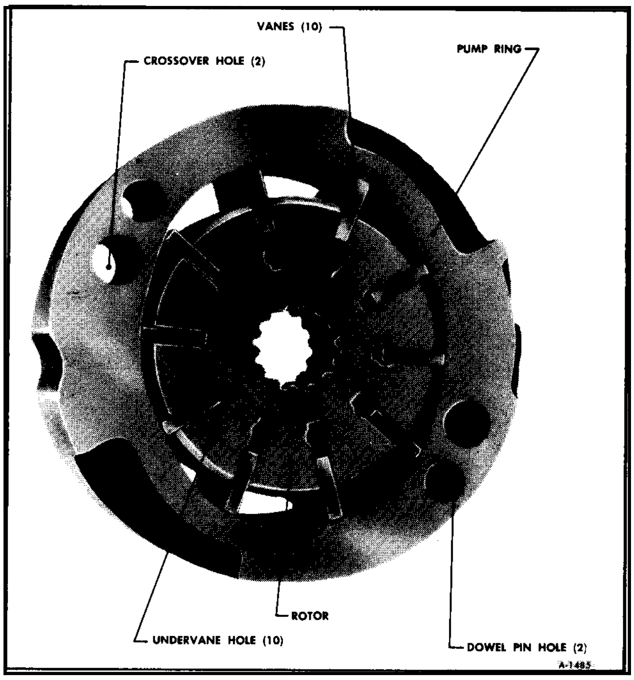


Figure 3—Pump Ring and Rotor

connect from cavity 1 (figure 4) to supply undervane oil pressure. The two outer ports pass oil under discharge pressure to cavity 1. The two indentations are for oil intake from the suction part of the pump, cavity 7 (figure 4) into the rotor.

The reservoir is for oil storage. It receives and directs the return oil back to the make-up passage of the pump.

The drive shaft is fitted with a pulley and is belt driven from the crankshaft. The rotor is loosely splined to the drive shaft and secured with a retaining ring. It is located centrally within the ring and between the thrust and pressure plates. The ten vanes are mounted in radial slots in the rotor (figure 3).

OPERATION

The mode of operation of the power steering pump is based upon the demand of the power steering gear. The various major modes of operation are: slow cornering, moderate to high speed straight ahead driving, and cornering against the wheel stop. The pump is designed to recognize these conditions as required by the steering gear valve and compensates for them internally.

As the drive shaft turns the rotor, the vane tips follow the inner cam surface of the pump ring, moving outward and inward twice during each revolution. This results in a complete pumping cycle every 180 degrees of rotation (figure 3). Oil is moved in the spaces between the vanes. As the vane tips move outward, oil is sucked into the intervane spaces through four suction ports in the pressure and thrust plates. The pressure of the oil is raised, and the oil is discharged from the pump ring, as the vane tips move inward. High pressure oil discharges into cavity 1, (figure 4), through two open ports in the pressure plate, and through two blind ports in the thrust plate, which are connected to cavity 1 by the cross-over holes in the ring. A portion of this oil is circulated through the central port system in the pressure plate, forcing the vanes to follow the cam surface of the ring. The ring-rotor leakage oil (12) is used for bushing lubrication and then bled to the reservoir.

Slow Cornering (Figure 4)

During slow cornering maneuvers, the oil pressure required will usually not exceed 400 psi. The RPM of the pump is not high enough to require internal bypassing of oil, therefore, the pump bypass port to (5) remains closed. The high pressure discharge oil (7) is slightly lower in pressure than the internal high pressure oil (1). The drop in pressure occurs as oil flows through the flow control orifice (2). This reduces the pressure at the bottom end of the pump control valve (9) because the orifice (11) is

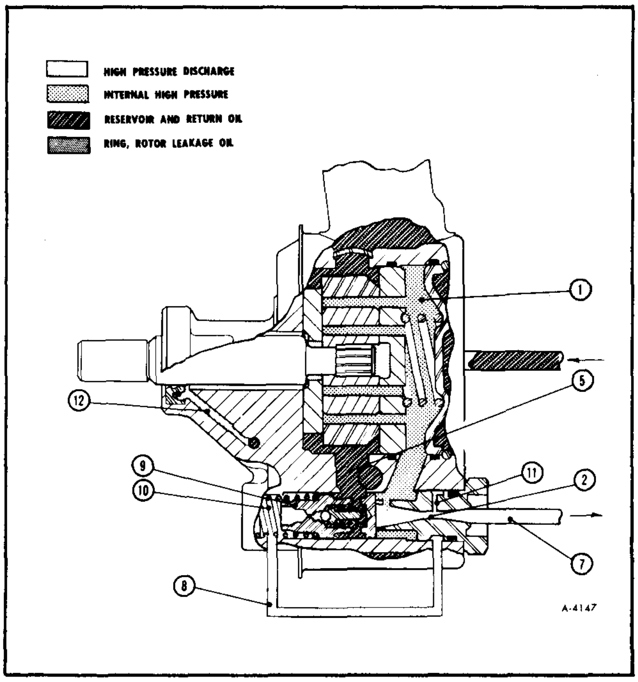


Figure 4—Slow Cornering

connected by passage (8) to (9) resulting in a pressure unbalance on the valve. The flow control valve moves away from the discharge fitting, but due to the force of the flow control spring (10) the valve remains closed to the bypass hole (5). The oil pressure does not build up high enough to cause the pressure relief valve to actuate, because the oil pump through the steering gear is allowed to recirculate through the entire system.

Moderate To High Speed Operation (Figure 5)

When operating at moderate to high speed, it is desirable to limit the temperature rise of the oil. This is done by flow controlling. The control valve in the steering gear is an open center rotary valve. When this valve is in the straight ahead position, oil flows from the pump through the open center valve and back to the pump reservoir without traveling through the power cylinder. When this flow exceeds the predetermined system requirements, oil is bypassed within the pump. This is accomplished by the pressure drop which occurs across the flow control orifice (2). The pressure is reduced at the bottom of the flow control valve (9) because the orifice (11) is connected by (8) to the bottom of valve (9).

The pressure unbalance of the valve is sufficient to overcome the force of the spring (10), allowing the valve to open the bypass hole (5), and diverting oil into the intake chamber (6). Supercharging of the intake chamber occurs under these conditions. Oil at high velocity discharging past the valve into the intake chamber picks up make-up oil at hole (4) from the reservoir on the jet pump principle. By reduction of velocity, velocity energy is converted into supercharge pressure in cavity (6). During this straight ahead driving conditon, the discharge pressure should not exceed 100 psi.

Cornering Against Wheel Stops (Figure 6)

When the steering gear control valve is actuated in either direction to the point of cut-off, the flow of oil from the pump is blocked. This condition occurs

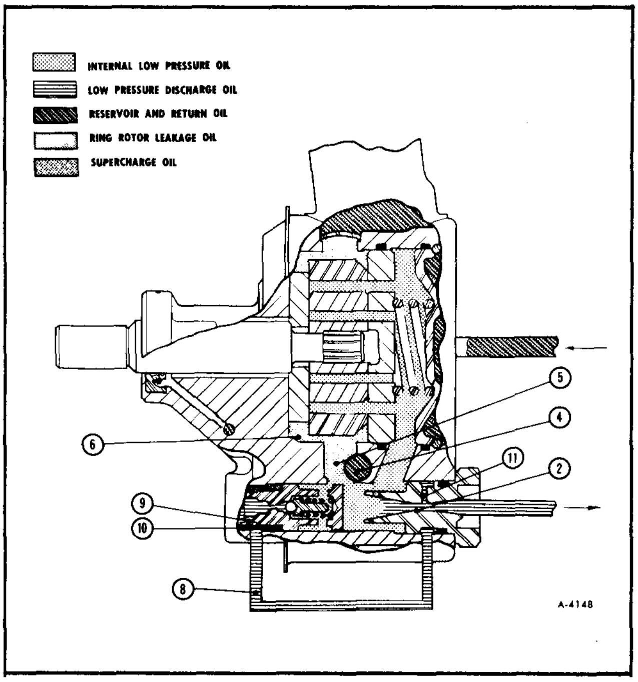


Figure 5—Moderate To High Speed Operation

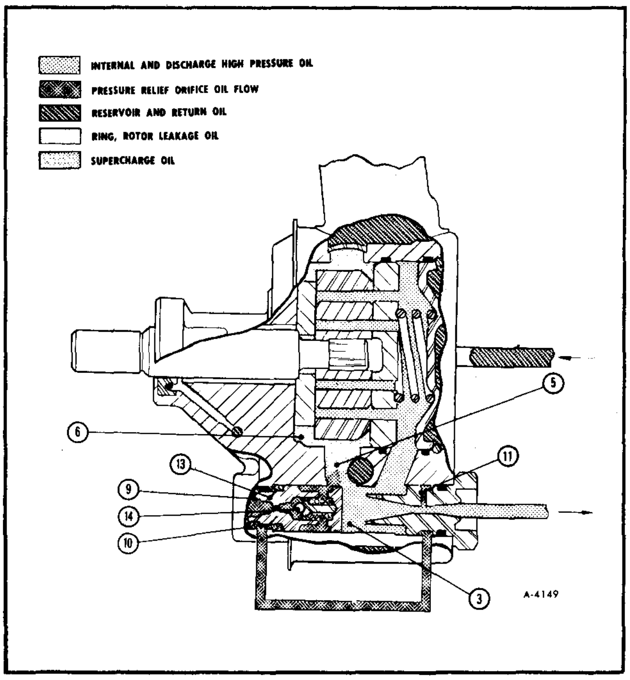


Figure 6—Pressure Relief

when the front wheels meet the wheel stop, or when the wheel movement is otherwise blocked by a curb or deep sand or mud. The pump is equipped with a pressure relief valve. The relief valve is contained inside the flow control plunger (13). When the pressure exceeds a predetermined pressure, (greater than maximum system requirements) the pressure relief ball (14) opens, allowing a small amount of oil to flow into the bypass hole (5). This flow of oil passing through the pressure relief orifice (11) causes a pressure drop and resulting lower pressure on the bottom end of the control valve (9).

The pressure unbalance then causes the valve to compress the spring (10) allowing the major portion of the oil to bypass into the intake chamber (from 3 to 6) in the same manner as is accomplished by flow controlling. Relief pressures are usually between 750 and 1450 psi depending on the vehicle requirements.

TROUBLE DIAGNOSIS

NOTE: The following diagnostic procedures apply to the steering system with the exception of the steering column (For steering column trouble diagnosis see "STEERING COLUMN" later in this section.)

LEAKAGE CHECK

The purpose of the diagnostic procedure is to pinpoint the location of the leak. The method outlined in this manual can be followed to locate the leak and repair it.

In some cases you will be able to locate the leak easily. However, seepage type leaks may be more difficult to isolate. For seepage leaks, the following method is recommended.

a. With the vehicle's engine off, wipe the complete power steering system dry (gear, pump, hoses, and connections).

b. Check oil level in pump's reservoir and adjust as directed in service manual.

c. Start engine and turn steering wheel from stop to stop several times. Do not hold in corner for any length of time as this can damage the power steering pump. It is easier if someone else operates the steering wheel while you search for the seepage.

d. Find the exact area of leakage.

e. Replace seal, fitting, gasket, or component as necessary to stop leak.

An overfilled pump reservoir can be a cause for leakage complaint. The oil in the steering system expands as heated during normal usage. If overfilled the excess is forced through the breather cap hole and may be sprayed over the engine by air blast. Operate the engine and steering system until normal operating temperature is obtained. Remove the reservoir cap and check the graduated level on the dipstick. Adjust the oil level as required.

Seepage at the hose connections can be a cause for leakage complaint and can be due to loose connection nuts. If leakage is observed at the hose connections, and the nut is not cross threaded, tighten the nuts at the gear to 30 foot pounds.

The nut at the power steering pump should be tightened to 40 foot pounds (maximum). If tightening to this torque does not stop the leak, refer to the diagnostic chart.

If either the return hose or the pressure hose leaks, replace the hose.

SEAL REPLACEMENT RECOMMENDATIONS

Lip seals, which seal rotating shafts, require special treatment. This type of seal is used on the steering gear at the pitman shaft, at the stub shaft, and on the drive shaft of the pump. When leakage occurs in one of these areas, always replace the seal or seals, after inspecting and thoroughly cleaning the sealing surfaces. Replace the shaft only if very severe pitting is found. If the corrosion in the lip seal contact zone is slight, clean the surface of the shaft with crocus cloth. Replace the shaft only if the leakage cannot be stopped by smoothing with crocus cloth first.

Housing or Cover Seepage—Both the power steering gear and pump assemblies are leakage checked before shipment. However, occasionally oil seepage may occur from the gear or pump other than the seal areas. If this type of leakage is found, replace the leaking part.

STEERING GEAR AND PUMP DIAGNOSIS CHART

Condition	Possible Cause	Correction
Hissing noise in steering gear.	1. There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. There is no relationship between this noise and performance of the steering. "Hiss" may be expected when steering wheel is at end of travel or when slowly turning at standstill.	1. Slight "hiss" is normal and in no way affects steering. Do not replace valve unless "hiss" is extremely objectionable. A replacement valve will also exhibit slight noise and is not always a cure for the objection. Investigate clearance around flexible coupling rivets. Be sure steering shaft and gear are aligned so flexible coupling rotates in a flat plane and is not distorted as shaft rotates. Any metal-to-metal contacts through flexible coupling will transmit valve "hiss" into passenger compartment through the steering column.
Rattle or chuckle noise in steering gear.	1. Gear loose on frame.	1. Check gear-to-frame mounting screws. Tighten screws to 70-foot-pounds.
	2. Steering linkage looseness.	2. Check linkage pivot points for wear. Replace if necessary.
	3. Pressure hose touching other parts of vehicle.	3. Adjust hose position. Do not bend tubing by hand.
	4. Loose pitman shaft over center adjustment NOTE: A slight rattle may occur on turns because of increased clearance off the "high point.". This is normal and clearance must not be reduced below specified limits to eliminate this slight rattle.	4. Adjust to specifications.
	5. Loose pitman arm.	5. Tighten pitman arm nut to specifications.
Squawk noise in steering gear when turning or recovering from a turn.	1. Damper "O" ring on valve spool cut.	1. Replace damper "O" ring.
	2. Improper fluid in system.	2. Flush and refill using power steering fluid (GM 105007).
Chirp noise in steering pump.	1. Loose belt.	1. Adjust belt tension to specification.
Belt squeal (Particularly noticeable at full wheel travel and stand still parking).	1. Loose belt.	1. Adjust belt tension to specification.

STEERING GEAR AND PUMP DIAGNOSIS CHART (Cont'd.)

Condition	Possible Cause	Correction
Growl noise in steering pump.	1. Excessive back pressure in hoses or steering gear caused by restriction.	1. Locate restriction and correct. Replace part if necessary.
Growl noise in steering pump. (Particularly noticeable at stand still parking).	1. Scored pressure plates, thrust plate or rotor. 2. Extreme wear of cam ring.	1. Replace parts and flush system. 2. Replace parts.
Groan noise in steering pump.	1. Low oil level. 2. Air in the oil. Poor pressure hose connection.	1. Fill reservoir to proper level. 2. Tighten connector to specified torque. Bleed system by operating steering from right to left—full turn.
Rattle or knock noise in steering pump.	1. Loose pump pulley nut.	1. Tighten nut to specified torque.
Rattle noise in steering pump.	1. Vanes not installed properly. 2. Vanes sticking in rotor slots.	1. Install properly. 2. Free up by removing burrs, varnish or dirt.
Swish noise in steering pump.	1. Defective flow control valve.	1. Replace part.
Whine noise in steering pump.	1. Pump shaft bearing scored.	1. Replace housing and shaft. Flush system.
Poor return of steering wheel to center.	1. Lack of lubrication in linkage and ball joints. 2. Lower coupling flange rubbing against steering gear adjuster plug. 3. Steering gear to column misalignment. 4. Tires not properly inflated. 5. Improper front wheel alignment.	1. Lube linkage and ball joints. 2. Loosen pinch bolt and assemble properly. 3. Align steering column. 4. Inflate to specified pressure. 5. Check and adjust as necessary. With front wheels still on alignment pads of front end machine, discon-nect pitman arm of linkage from pitman shaft of gear. Turn front wheels by hand. If wheels will not turn or are difficult to turn, determine if linkage or ball joints are binding.

STEERING GEAR AND PUMP DIAGNOSIS CHART (Cont'd.)

Condition	Possible Cause	Correction
	6. Steering linkage binding.	6. Replace pivots.
	7. Ball joints binding. (Turn steering wheel and listen for internal rubbing in column—check causes listed and correct as directed).	7. Replace ball joints.
	8. Steering wheel rubbing against directional signal housing.	8. Adjust steering jacket.
	9. Tight or frozen steering shaft bearings.	9. Replace bearings.
	10. Rubber spacer binding.	10. Make certain spacer is properly seated. Lubricate inside diameter with silicone.
	11. Sticky or plugged valve spool.	11. Remove and clean or replace valve.
	12. Steering gear adjustments over specifications.	12. Check adjustment with gear out of vehicle. Adjust as required.
Vehicle wanders. (Keep in mind road condition and wind. Test vehicle on flat road going in both directions).	1. Front end misaligned.	1. Adjust to specifications.
	2. Unbalanced steering gear valve. NOTE: If this is cause, steering effort will be very light in direction of lead and heavy in opposite direction.	2. Replace valve.
Momentary increase in effort when turning wheel fast to right or left.	1. Low oil level in pump.	1. Add power steering fluid as required.
	2. Pump belt slipping.	2. Tighten or replace belt.
	3. High internal leakage.	3. Check pump pressure. (See pump pressure test).

STEERING GEAR AND PUMP DIAGNOSIS CHART (Cont'd.)

Condition	Possible Cause	Correction
Steering wheel surges or jerks when turning with engine running especially during parking.	1. Low oil level.	1. Fill as required.
	2. Loose pump belt.	2. Adjust tension to specification.
	3. Steering linkage hitting engine oil pan at full turn.	3. Correct clearance.
	4. Insufficient pump pressure.	4. Check pump pressure. (See pump pressure test). Replace relief valve if defective.
	5. Sticky flow control valve.	5. Inspect for varnish or damage, replace if necessry.
Excessive wheel kickback or loose steering.	1. Air in system.	1. Add oil to pump reservoir and bleed by operating steering. Check hose connectors for proper torque and adjust as required.
	2. Steering gear loose on frame.	2. Tighten attaching screws to specified torque.
	3. Steering gear flexible coupling loose on shaft or rubber disc mounting screws loose.	3. Tighten flange pinch bolts to 30 foot-pounds, if serrations are not damaged. Tighten upper flange to coupling nuts to specified torque.
	4. Steering linkage joints worn enough to be loose.	4. Replace loose pivots.
	5. Worn poppet valve (Gear).	5. Replace poppet valve.
	6. Loose thrust bearing preload adjustment. (Gear).	6. Adjust to specification with gear out of vehicle.
	7. Excessive "over-center" lash.	7. Adjust to specification with gear out of vehicle.
Hard steering or lack of assist.	1. Loose pump belt.	1. Adjust belt tension to specification.
	2. Low oil level in reservoir.	2. Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage. Tighten loose connectors to 30-ft-lbs.
	NOTE: Low oil level will also result in excessive pump noise.	
	3. Steering gear to column misalignment.	3. Align steering column.
	4. Lower coupling flange rubbing against steering gear adjuster plug.	4. Loosen pinch bolt and assemble properly.

STEERING GEAR AND PUMP DIAGNOSIS CHART (Cont'd.)

Condition	Possible Cause	Correction
NOTE: If checks 1 through 5 do not reveal cause of hard steering, follow the procedure below to determine fault.	5. Tires not properly inflated. Further possible causes could be: 6. Sticky flow control valve. 7. Insufficient pump pressure output. 8. Excessive internal pump leakage. 9. Excessive internal gear leakage.	5. Inflate to recommended pressure. In order to diagnose conditions such as listed in 6, 7, 8, 9 a test of the entire power steering system is required.

POWER STEERING SYSTEM TEST PROCEDURE

1. Disconnect pressure hose at union of pump, use a small container to catch any fluid which might leak.
2. Connect a spare pressure hose to pump union.
3. Using pressure gage J 5176-1, adapter fitting J 22326, connect gage to both hoses.
4. Open hand valve on gage.
5. Start engine, allow system to reach operating temperatures and check fluid level adding any fluid if required. When engine is at normal operating temperature, the initial pressure read on the gage (valve open) should be in the 80-125 psi range. Should this pressure be in excess of 200 psi—check the hoses for restrictions and the poppet valve for proper assembly.
6. Close gate valve fully 3 times. Record the highest pressures attained each time. (Note: do not leave valve fully closed for more than 5 seconds as the pump could be damaged internally).
   (a) If the pressures recorded are within 1250-1350 psi and the range of readings are within 50 psi, the pump is functioning within specs.
   (b) If the pressures recorded are high, but do not repeat within 50 psi, the flow controlling valve is sticking. Remove the valve, clean it and remove any burrs using crocus cloth or fine hone. If the system contains some dirt, flush it. If it is exceptionally dirty, both the pump and the gear must be completely disassembled, cleaned and reassembled before further usage.
   (c) If the pressures recorded are constant, but more than 100 psi, below the low listed spec., replace the flow control valve and recheck. If the pressures are still low, replace the rotating group.

STEERING GEAR AND PUMP DIAGNOSIS CHART (Cont'd.)

7. If the pump checks to specs., leave the valve open and turn (or have turned) the steering wheel into both corners. Record the highest pressures and compare with the maximum pump pressure recorded. If this pressure cannot be built in either (or one) side of the gear, the gear is leaking internally and must be disassembled and repaired.
8. Shut off engine, remove testing gage, spare hose, reconnect pressure hose, check fluid level or make needed repairs.

Alternate Power Steering System Test Procedure

> **NOTE:** If power steering analyzer J-25325 is available, use it and the following procedure to determine fault.

1. Connect Analyzer J-25323 into steering system. Remove pressure fitting from gear and connect into female analyzer adapter. Thread male adapter of analyzer into gear. Connect analyzer to adapters. Tighten both connections to 40 ft. lbs. Add power steering fluid to pump if required.
2. Start engine. Set engine idle to specification. Run engine for approximately five minutes. Check power steering fluid level and add if required.
3. Record flow and pressure at idle with gate valve fully open. If flow is below 2gpm, the pump appears to be in need of repair, but continue diagnosis. If pressure is above 200 psi check hoses for restrictions and check steering gear for poppet valve functions.
4. Partially close gate valve to build 700 psi. Observe and record flow. If flow drops more than 1 gpm, disassemble pump and replace ring, rotor, and vanes. If pressure or thrust plates are cracked or worn, replace.
5. Completely close and partially open gate valve three times (do not allow valve to remain closed more than 5 seconds. If pressures recorded are 100 psi lower than 1250-1350 psi specifications, replace flow control valve in pump. If pressures recorded vary more than 50 psi, the flow control valve should be removed and cleaned. Also check control valve bore for dirt, chips, etc. Clean as required. If system fluid appears contaminated, both the gear and the pump must be completely disassembled and cleaned.
6. Increase engine speed from idle to approximately 1500 rpm. If the flow varys more than 1 gpm, the flow control valve should be removed and cleaned as in step 5 above.

STEERING GEAR AND PUMP DIAGNOSIS CHART (Cont'd.)

	7. Turn steering wheel left and right against wheel stops. If the pressure in the corners does not reach maximum output or the flow drops below 1 gpm, excessive internal leakage is occuring. Remove and disassemble steering gear. Replace damaged or broken parts. Pay particular attention to rack piston and valve body ring damage. 8. Turn the steering wheel slightly in both directions and release quickly, watching the pressure gauge. The needle should move from the normal backpressure reading and snap back as the wheel is released. If it comes back slowly, or sticks, the rotary valve in the steering gear is sticking. Remove, disassemble, and clean the rotary valve. If the system oil is severely contaminated, both gear and pump must be completely disassembled and cleaned.

Condition	Possible Cause	Correction
Foaming milky power steering fluid, low fluid level and possible low pressure.	1. Air in the fluid, and loss of fluid due to internal pump leakage causing overflow.	1. Check for leak and correct. Bleed system. Extremely cold temperatures will cause system aeriation should the oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from housing. Check welsh plug and housing for cracks. If plug is loose or housing is cracked, replace housing.
Low pressure due to steering pump.	1. Flow control valve stuck or inoperative. 2. Pressure plate not flat against cam ring. 3. Extreme wear of cam ring. 4. Scored pressure plate, thrust plate or rotor. 5. Vanes not installed properly. 6. Vanes sticking in rotor slots. 7. Cracked or broken thrust or pressure plate.	1. Remove burrs or dirt or replace. 2. Correct. 3. Replace parts. Flush system. 4. Replace parts. (If rotor, replace with rotating group kit). Flush system. 5. Install properly. 6. Free-up by removing burrs, varnish or dirt. 7. Replace part.
Low pressure due to steering gear.	1. Pressure loss in cylinder due to worn piston ring or badly worn housing bore. 2. Leakage at valve rings, valve body to worm seal.	1. Remove gear from vehicle for disassembly and inspection of ring and housing bore. 2. Remove gear from vehicle for disassembly and replace seals.

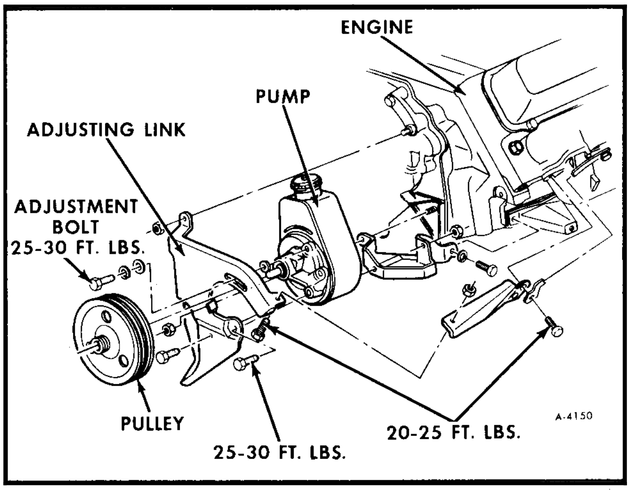


Figure 7—Pump Installation

REMOVAL OF PUMP (FIGURE 7)

1. Loosen power steering and Delcotron belts.

2. Disconnect pressure line and return hose from pump. (Install caps at both pump fittings to prevent drainage of oil from pump).

3. Remove power steering pump mounting bolts and nuts, and upper left venturi bracket. (See figure 7).

4. Remove power steering pump with adjusting link attached.

5. Remove adjusting link from pump.

6. Remove pulley from shaft using puller tool J-25034 (figure 8).

CAUTION: *Do not hammer pulley off shaft as this will damage pump.*

PUMP DISASSEMBLY

Before disassembly of pump, remove reservoir filler cap and drain oil from reservoir by inverting the pump so oil may drain out the filler hole.

After oil is drained from reservoir, cap should be replaced and the entire pump assembly washed in a non-toxic solvent to remove all dirt and prevent any foreign matter from contaminating pump components.

CAUTION: *Examine exposed part of drive shaft. If it is corroded, use crocus cloth to remove corrosion before disassembling pump. This will prevent damage to the shaft bushing.*

1. Clamp front hub of pump in vise so that the extending portion of shaft is directed downward, being careful not to clamp vise too tight as this may distort the bearing (figure 9).

2. Using proper sized wrenches, remove union and "O" ring assembly and both mounting studs

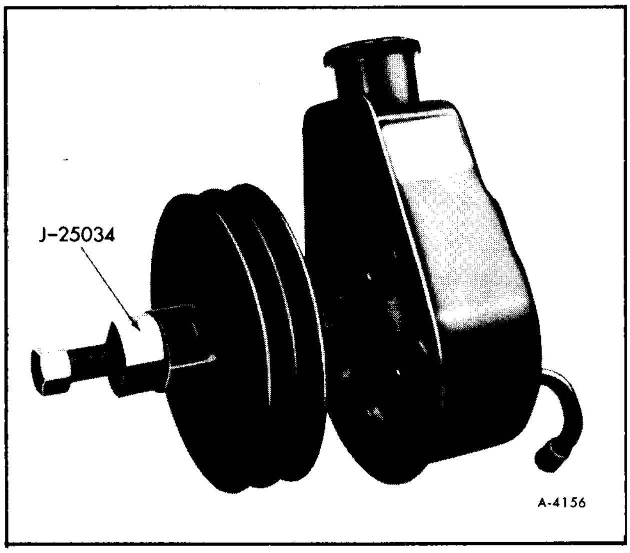


Figure 8—Pulley Removal - Special Tool J-25034

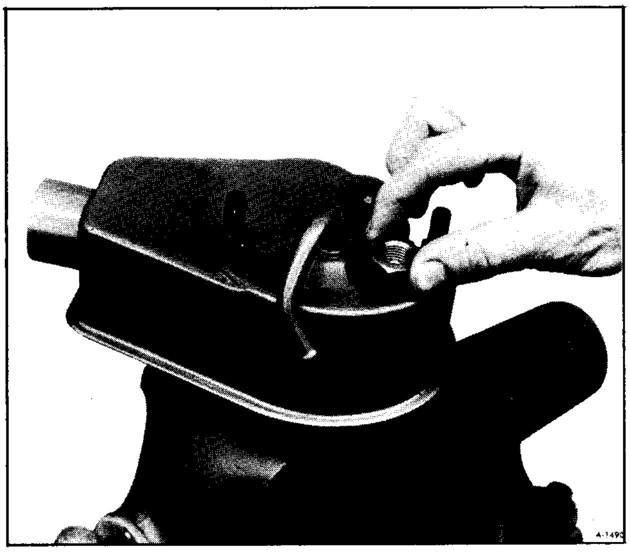


Figure 9—Studs & Union Being Removed

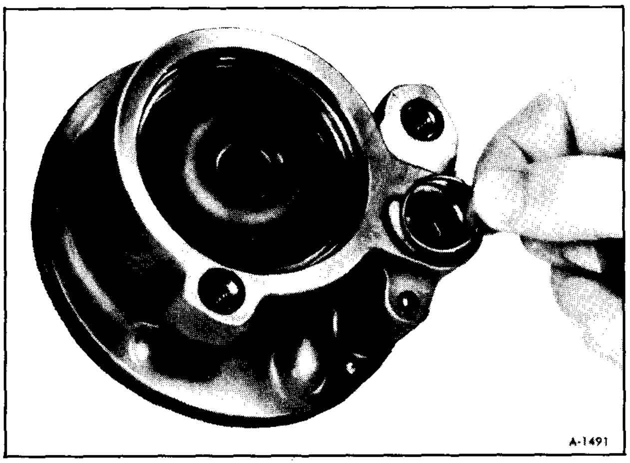


Figure 10—Removal of Stud & Union Seals

from back of reservoir. Discard all seals and "O" rings. (figure 9).

3. Reservoir may then be removed from housing by rocking it slightly back and forth to unseat the "O" ring. Remove "O" ring and discard.

4. Remove both mounting stud and union seals from counterbored spaces between reservoir and housing. Discard these seals also. (figure 10).

5. Remove the end plate retaining ring by inserting a small punch in the 1/8 inch diameter hole in the housing side opposite the flow control valve hole. Compress the retaining ring with the punch and

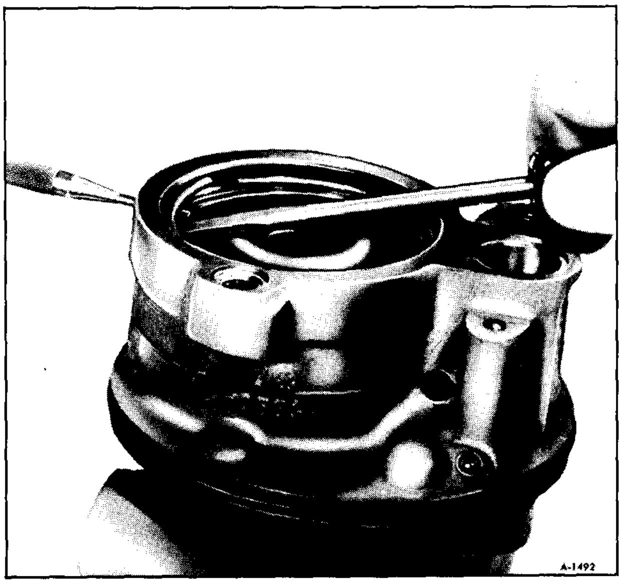


Figure 11—Removal of End Plate Retaining Ring

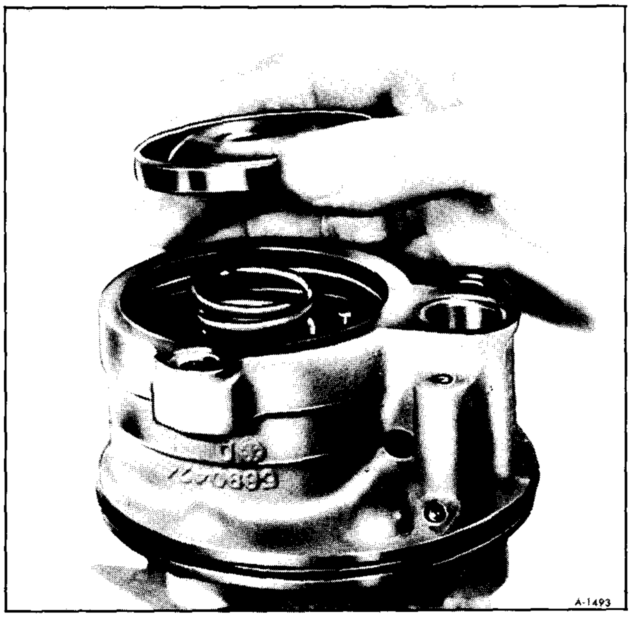


Figure 12—Removal of End Plate

remove by inserting a screwdriver under the ring and twisting the screwdriver. (figure 12).

6. Remove end plate and end plate "O" ring. End plate is spring loaded and will generally sit above the housing level for ease of removal. If sticking should occur, a slight rocking action of the end plate should be used to free it. (figure 12).

7. Remove pump from vise and invert. Flow control valve and valve spring will fall free. (figure 13).

8. Remove key from shaft end where pulley was mounted.

9. With end cover "O" ring and shaft key removed, tap very lightly on end of shaft, only until pressure plate falls free. (figure 14).

10. Remove pressure plate, shaft, pump ring, vanes and rotor. (figure 15).

11. Remove shaft retaining ring and discard. (Some models do not have retaining rings).

12. Remove rotor and thrust plate from shaft and both dowel pins from housing. (figure 16).

13. Pry shaft seal out of housing, being careful

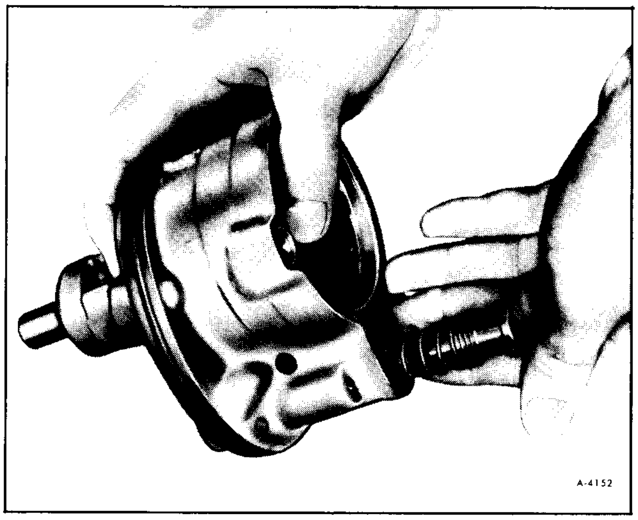


Figure 13—Removal of Relief Valve

not to damage the housing bore; discard the shaft seal.

CLEANING AND INSPECTION

Carefully clean all pump parts in non-toxic cleaning solvent. Replace any damaged or worn parts.

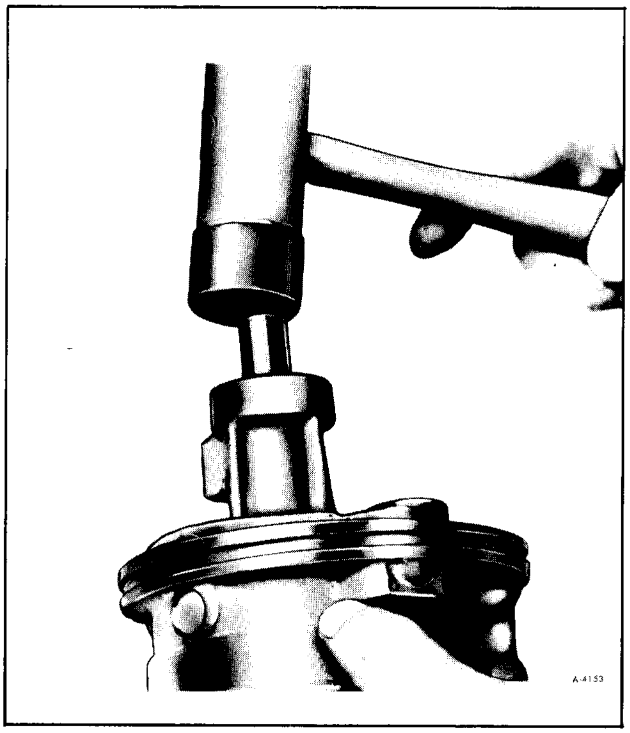


Figure 14—Tapping Shaft to Unseat Pressure Plate

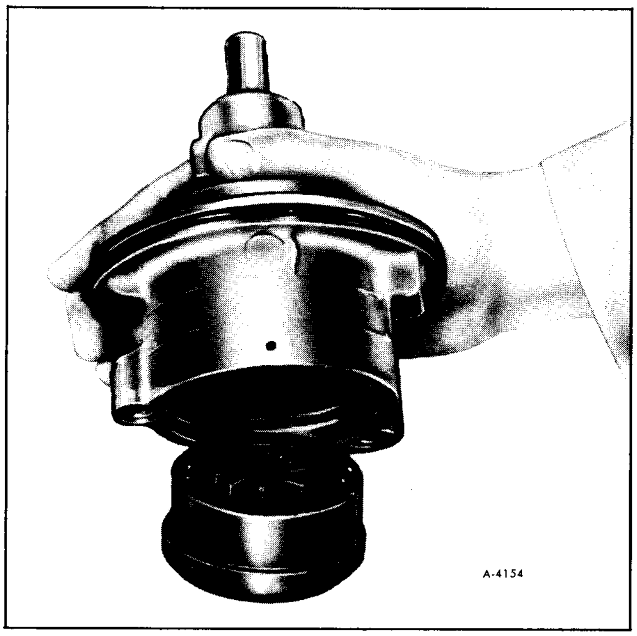


Figure 15—Removal of Shaft, Pressure Plate, Pump Ring, Vanes and Rotor

1. Inspect flow control valve assembly for score marks, wear, burrs, or other damage.

2. Inspect castings for cracks or other visual evidences of damage. Check machined surfaces, especially mating surfaces on "O" ring seats, for scratches or burrs that might permit leaks. Examine

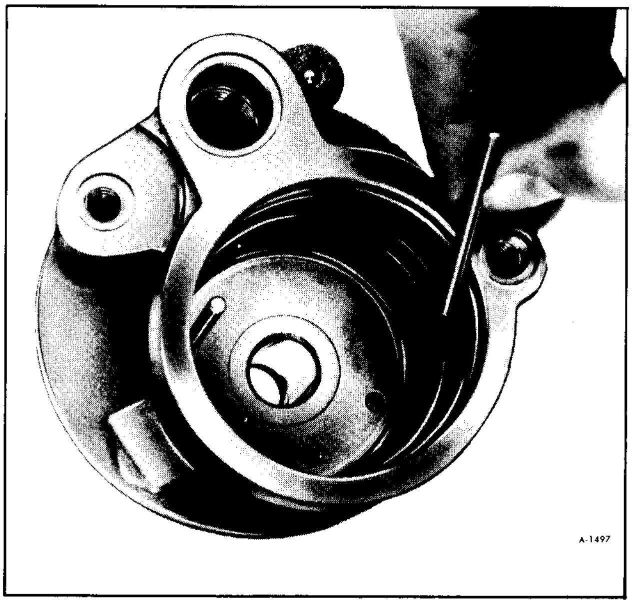


Figure 16—Removing Dowel Pins From Housing

the V-shaped notches at edges of discharge ports on pressure plate. These notches must be clean and undamaged if pump noise is to be avoided, as they cushion the hydraulic shock when each vane passes the port.

3. Inspect pump ring end surfaces for score marks.

NOTE: Because pump ring is treated, it leaves a dull gray-black finish on wear surface. Wavy grain appearance inside pump ring is normal.

4. Inspect pump shaft for score marks, excessive wear, or damage—particularly at splines, at keyway, and at bearing and seal surfaces. Separate and inspect rotor and vanes for wear and general condition.

5. Inspect shaft bushing in pump housing. Replace pump housing if bushing is scored or excessively worn.

6. If any internal parts are found to be worn or damaged, flush steering gear or disassemble gear and clean internal parts.

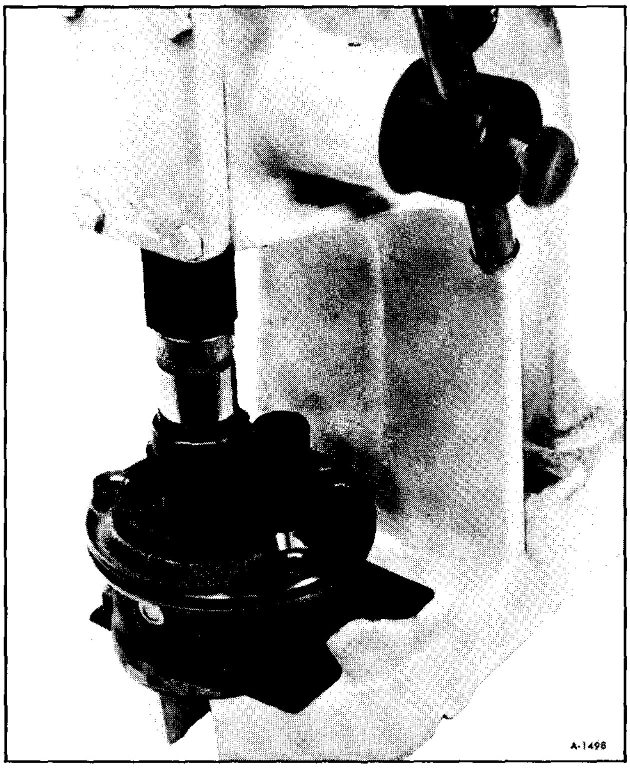


Figure 17—Installing Shaft Seal

ASSEMBLY OF PUMP

1. Install new pump shaft seal using seal protector J-22616 and seal installer J-7728 or a 1 inch socket with an arbor press or hammer (figure 17).

CAUTION: *DO not use any more force than necessary to seat the seal.*

2. Lubricate new pressure plate "O" ring with Power Steering Fluid, and install in third groove from rear of housing.

3. Clamp end hub of housing in vise in same position as before and insert both dowel pins. (figure 16).

CAUTION: *Do not over tighten. The vice-damage to the bearing could occur.*

4. Insert shaft through thrust plate and rotor, and install new snap ring on shaft. Open the snap ring just enough to slide over the end of shaft. (Rotor must have counter sunk side toward thrust plate). (figure 18).

5. Insert shaft in housing, making sure thrust plate slides properly on dowel pins.

6. Install pump ring on dowel pins with the arrow toward rear of housing (figure 19).

7. Install all ten vanes in rotor slots with rounded edge of vanes outward (figures 3 and 20). Vanes should slide freely.

8. Lubricate pressure plate with Power Steering Fluid to protect pressure plate "O" ring.

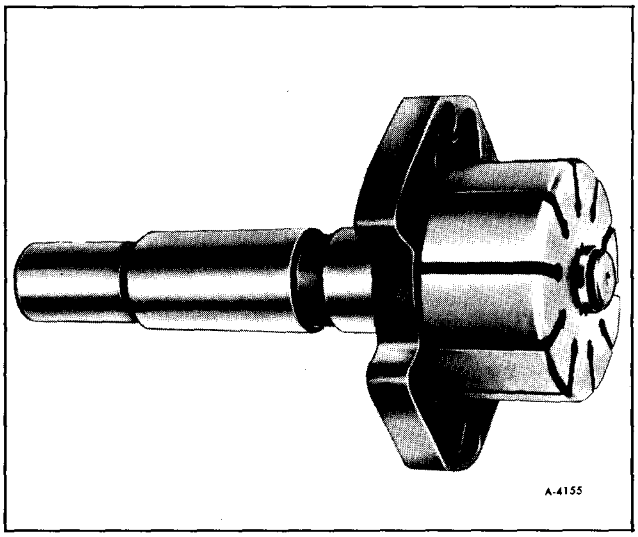


Figure 18—Shaft With Thrust Plate and Rotor

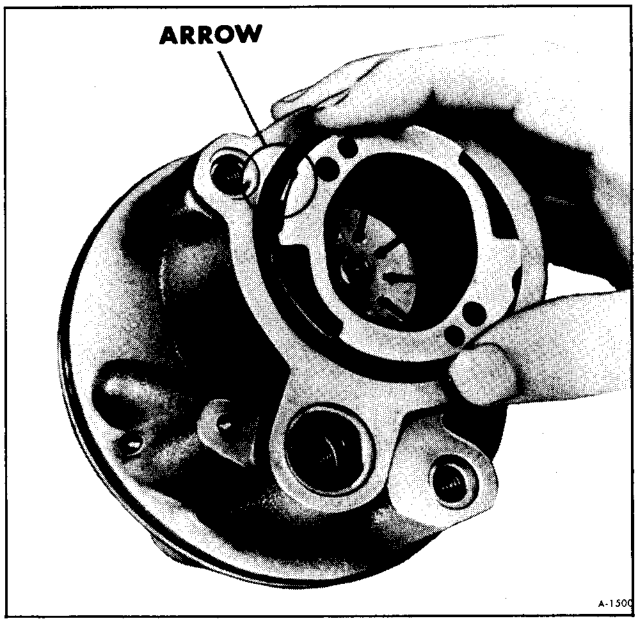


Figure 19—Pump Ring Showing Arrow

9. Install pressure plate on dowel pins with circular depression for spring toward rear of housing. Pressure plate must be pressed about 1/16 inch over the "O" ring to seat (figure 21).

10. Lubricate new end plate "O" ring with Power Steering Fluid and install in second groove from rear of housing.

Figure 20—Replacement of Pump Vanes

Figure 21—Installing Pressure Plate

11. Install end plate spring in groove provided in pressure plate (figure 12).

12. Lubricate end plate with Power Steering Fluid to protect "O" ring and press into housing with an arbor press (figure 22). Depress only far enough to enable retaining ring to seat properly in groove.

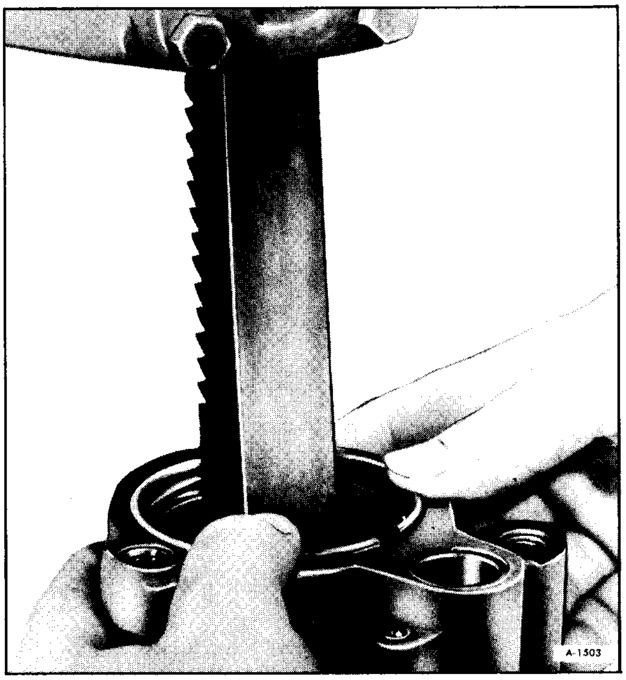


Figure 22—Installation of End Plate Retaining Spring

13. Install end plate retaining ring and release arbor press.

14. Place flow control valve spring in hole first and then insert flow control valve with screened end toward front of housing.

15. Install new stud seals and union seals in counter sunk holes, and lubricate with Power Steering Fluid and install new reservoir "O" ring on housing (figure 10).

16. Lubricate inside edge of reservoir with Power Steering Fluid and install on housing. Align holes at the same time.

17. Insert both stud bolts and tighten (25-40 ft. lb.) (figure 9).

18. Install new "O" ring on union and lubricate with Power Steering Fluid. Make sure "O" ring is in the groove next to the head hex. Insert union in flow control valve hole in back of reservoir and tighten (25-40 ft. lbs.) (figure 9).

19. Install key in shaft end. Support the shaft on the opposite side of the key way and lightly tap the key into place with plastic hammer.

PUMP SHAFT OIL SEAL REPLACEMENT (WITHOUT DISASSEMBLING PUMP)

The pump shaft oil seal can be replaced without disassembling the pump as follows:

1. Remove the pulley as previously described. Bend a piece of .005 inch shim stock (approximately 2-1/2 inches long) into a cylindrical shape, then push the shim stock past seal until it bottoms in pump body.

CAUTION: *The use of shim stock around the pump shaft will prevent damage to the machined surfaces of the shaft when removing seal.*

2. Cut metal body of seal with a small chisel.

3. Tear metal body approximately 1 inch with diagonals. Force an awl between the pump body and the OD of seal to collapse the seal, then pry seal from pump body. Remove shim stock.

4. Apply special seal lubricant No. 1050169 or equivalent to the sealing lip of a new seal, then install seal over pump shaft with metal side of seal outboard.

5. Slide Tool J-7132-2 over pump shaft, then drive seal into pump body.

6. Install pump pulley.

INSTALLATION OF PUMP (FIGURE 7)

1. Install adjusting link on pump.

2. Draw pulley on shaft using Tool J-25033.

CAUTION: *Do not hammer pulley on, as this will damage internal pump parts (figure 23).*

3. Install pump assembly on engine and secure with bolts and nuts (torque to 25-30 ft. lbs.) and install venturi bracket (torque to 20-25 ft. lbs.)

4. Connect and tighten hose fittings to 30-40 foot-pounds.

5. Fill reservoir with fluid. Bleed pump by turning pulley backward (counterclockwise as viewed from front) until air bubbles cease to appear.

6. Install pump belts over pulley.

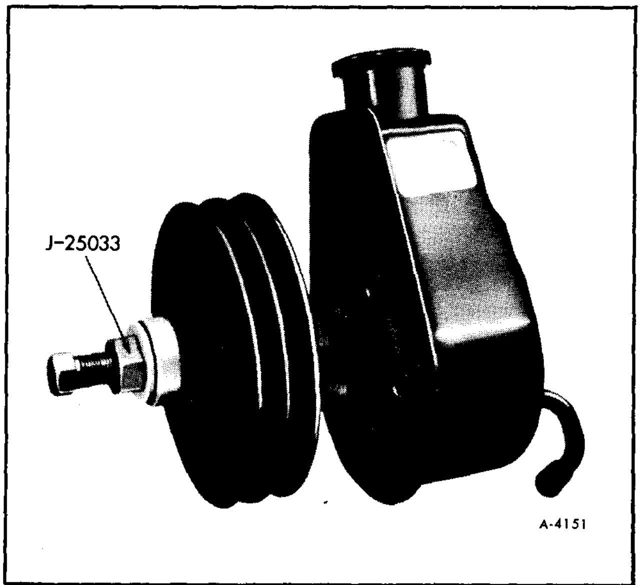


Figure 23—Pulley Installation - Special Tool J-25033

7. Move pump until belts are tight, then tighten adjusting screws. Do not pry on reservoir or pull on filler neck.

8. Adjust belts. (Refer to ADJUSTMENTS).

9. Bleed system. (Refer to FLUID LEVEL under ADJUSTMENTS).

SERVICING OF THE FLOW CONTROL VALVE (WITHOUT REMOVING PUMP ASSEMBLY FROM VEHICLE)

REMOVAL

1. Disconnect high pressure hose from pump union and drain oil.

2. Remove union and withdraw flow control valve and spring with a magnet.

INSPECTION

1. Flow control valve must slide freely in housing bore. If sticking occurs, check for dirt or burrs.

2. Check cap screw in the end of valve for looseness; if loose, tighten, being careful not to damage machined surfaces.

3. If the flow control plunger is suspected of being faulty, install new valve. This is serviced as a unit and is factory calibrated.

INSTALLATION

To install, reverse the "Removal" procedure and install a new "O" ring seal on the union.

ADJUSTMENTS

FLUID LEVEL

1. Run engine until Power Steering Fluid reaches normal operating temperature, approximately 170°F., then shut engine off. Remove reservoir filler cap and check oil level on dipstick.

2. If oil level is low, add Power Steering Fluid to proper level on dipstick and replace filler cap.

NOTE: When adding or making a complete fluid change, always use special power steering fluid available from servicing parts warehouses.

3. When checking fluid level after the steering system has been serviced, air must be bled from the system. Proceed as follows:

a. With wheels turned all the way to the left, add power steering fluid to "Cold" mark on dipstick.

b. Start engine, run at fast idle, and recheck fluid level. Add fluid if necessary to "Cold" mark on dipstick.

c. Bleed system by turning wheels from side to side without hitting stops. Maintain fluid level just above internal pump casting. Fluid with air in it will have a cloudy appearance. This air must be eliminated from fluid before normal steering action can be obtained.

d. Return wheels to center position and continue to run engine for two or three minutes then shut engine off.

e. Road test car to make sure steering functions normally and is free from noise.

f. Recheck fluid level as described in steps 1 and 2, making sure fluid level is between "Cold" and "Hot" marks on dipstick after the system has stabilized at its normal operating temperature.

BELT ADJUSTMENT

When adjusting a power steering pump belt, never pry against the pump reservoir or pull against the filler neck. To increase belt tension move the pump outward by prying against the bracket pry lugs or against the pump housing casting extension directly behind the pump drive pulley.

A belt that has been previously tensioned is considered to be a used belt and should be tightened to 70 to 80 pounds. A belt that has never been tensioned is considered to be a new belt and should be tightened to 110 to 140 pounds.

Place belt tension gauge (Borroughs Tool BT-33-73F) or equivalent midway between the pulleys on drive belt being checked. If the belt tension is incorrect proceed as follows:

ADJUSTING BELT TENSION

1. When power steering pump is driven by a single belt.

a. Loosen the pump attaching bolts and adjust the belt to correct tension by moving the pump outward, away from the engine.

b. Snug all pump mounting bolts and remove pry bar.

c. Tighten all pump mounting bolts to specified torque.

d. Check belt tension and remove the belt tension gage.

2. When the power steering pump pulley is driven by one primary belt and is used as an idler for a second belt driving some other auxiliary:

a. Follow same checking and adjusting procedure for the primary power steering pump drive belt as for 1 above.

b. Recheck and adjust as necessary the pump belt tension after adjusting tension on belt driving the auxiliary.

OIL LINE FILTER

The steering gear oil is circulated by the pump through the steering gear and the windshield wiper motor before it returns to the pump. In the line at the windshield wiper motor is an oil filter. In the event that the oil pump is overhauled or replaced, this filter should be replaced. For filter replacement procedure, refer to "Windshield Wiper Motor Filter Replacement" of SECTION 1, BODY, HEATING AND AIR CONDITIONING.

STEERING GEAR

GENERAL INFORMATION

The integral power steering gear has an open center, rotary type, three-way control valve, which directs oil to either side of the rack piston. The rack piston converts hydraulic power into mechanical output. The steering gear is mounted on the left frame rail by four mounting bolts. The steering shaft is joined to the steering gear through a flexible coupling, which reduces the transmission of hydraulic noise to the steering wheel.

A constant displacement pump provides hydraulic pressure for the steering system. The pump is a pulley driven vane type having an oil reservoir, which is part of the pump. It is attached to the front of the engine by a bracket, and is belt driven from an engine crank shaft pulley.

OPERATION

NEUTRAL (STRAIGHT AHEAD POSITION)

When turning effort is not being applied at the steering wheel, the slots in the spool valve are positioned so that oil entering the valve body from the housing pressure port passes through the slots in the spool valve to the oil return port in the housing. The chambers at both ends of the rack-piston and around the pitman shaft are always full of oil, which acts as a cushion to absorb road shock so that they are not transferred to the driver. In addition, this oil lubricates all the internal components of the gear.

RIGHT TURN

When the steering wheel is turned to the right, the worm resists being turned because of the resistance offered by the front wheels. The valve body also resists turning because it is pinned to the worm. Driver force exerted at the steering wheel turns the stub shaft and spool valve a slight amount in relation to the valve body because of the twisting action of the torsion bar. This slight amount of turning of the spool valve is sufficient to position the slots in the valve body and spool valve for power assist.

The right turn slots in the spool valve are closed off from the return (wide) slots in the valve body and opened more to the pressure (narrow) slots in the valve body. The left turn slots in the spool valve are closed off from the pressure slots in the valve body and opened more to the return slots in the valve body.

Pressure immediately begins to build up against the lower end of the rack-piston, forcing it upward to apply turning effort to the pitman shaft. The oil in the chamber at the upper end of the rack-piston is then forced out through the valve body and spool valve through the oil return port to the pump reservoir.

The instant the driver stops applying turning effort to the steering wheel, the spool valve is forced back into its neutral position by the torsion bar. Oil pressure on the lower end of the rack-piston then decreases so that pressure is again equal on both sides of the rack-piston, and the front wheels return to the straight ahead position, when the vehicle is moving.

Under normal driving conditions, oil pressure does not exceed 200 psi except when turning corners where it does not ordinarily exceed 450 psi. Oil pressure, when parking, ranges from 900 to 1,300 psi depending upon road conditions and weight of the vehicle. The steering effort during normal driving, ranges from 1 to 2 lbs. and during parking from 2 to 3-1/2 lbs. again depending upon road conditions.

A check valve located under the high pressure connector seat hydraulically dampens the shock transmitted to the steering gear when driving on washboard roads.

LEFT TURN

When the steering wheel is turned to the left, the relationship between the spool valve slots and valve body slots is again changed through twisting of the torsion bar. Pressure immediately builds up against the upper end of the rack-piston, forcing it downward to apply turning effort to the pitman shaft. The oil in the chamber at the lower end of the rack-piston is forced out through the valve body and spool valve to the pump reservoir.

TROUBLE DIAGNOSIS

For complete power steering trouble diagnosis see TROUBLE DIAGNOSIS under POWER STEERING PUMP earlier in this section.

STEERING GEAR REMOVAL

1. Disconnect the power steering hoses from the steering gear and cap the hose fittings.

2. Remove the pitman arm shaft nut. Mark the relation of the pitman arm to the pitman shaft. Disconnect the pitman arm from the pitman shaft using tool number J-24319 or similar puller.

3. Loosen steering shaft yoke cinch bolt.

4. Remove the four bolts attaching the gear to the frame side rail, permit the steering shaft yoke to slide free of the steering gear stub shaft and remove the gear.

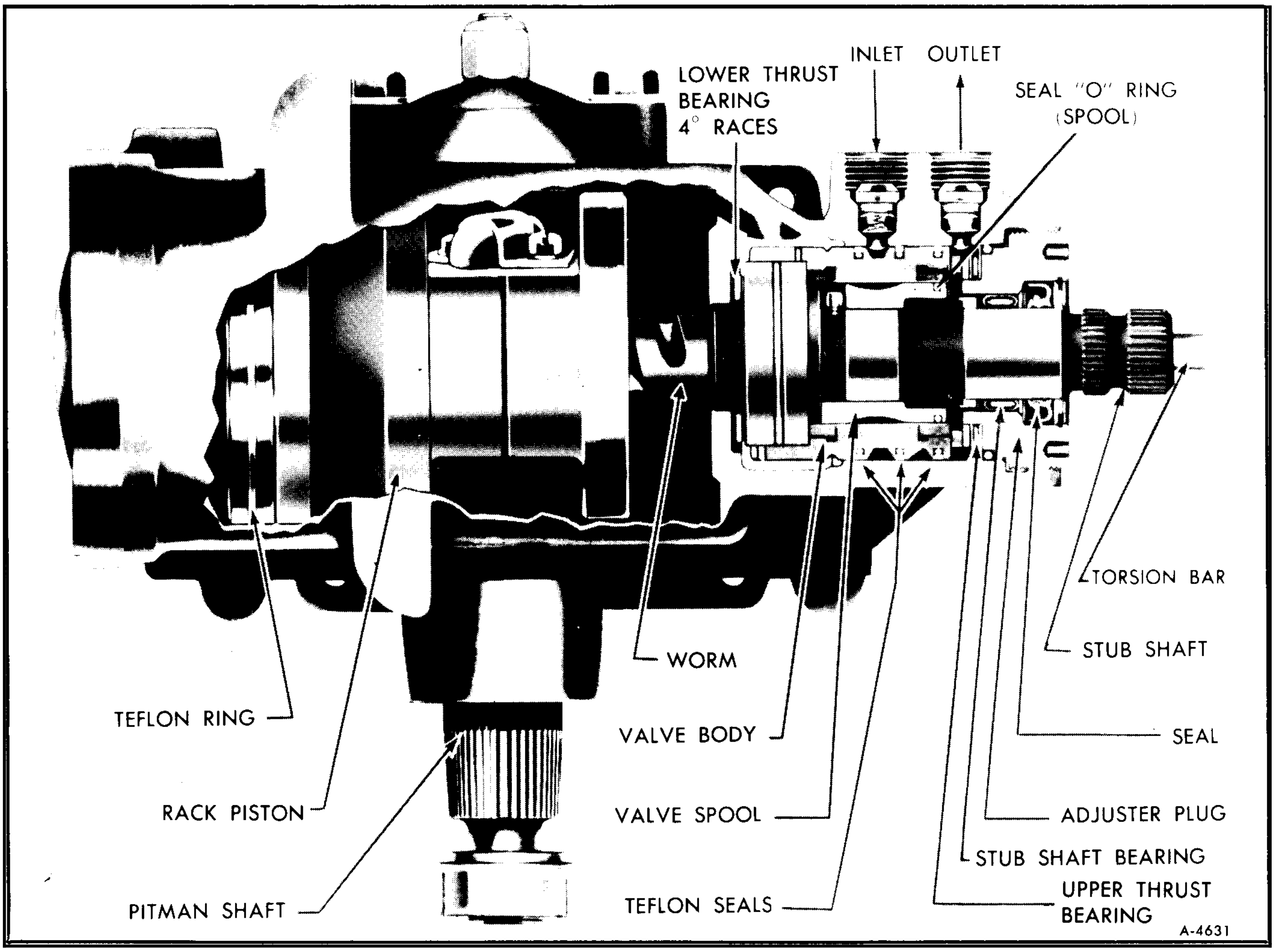
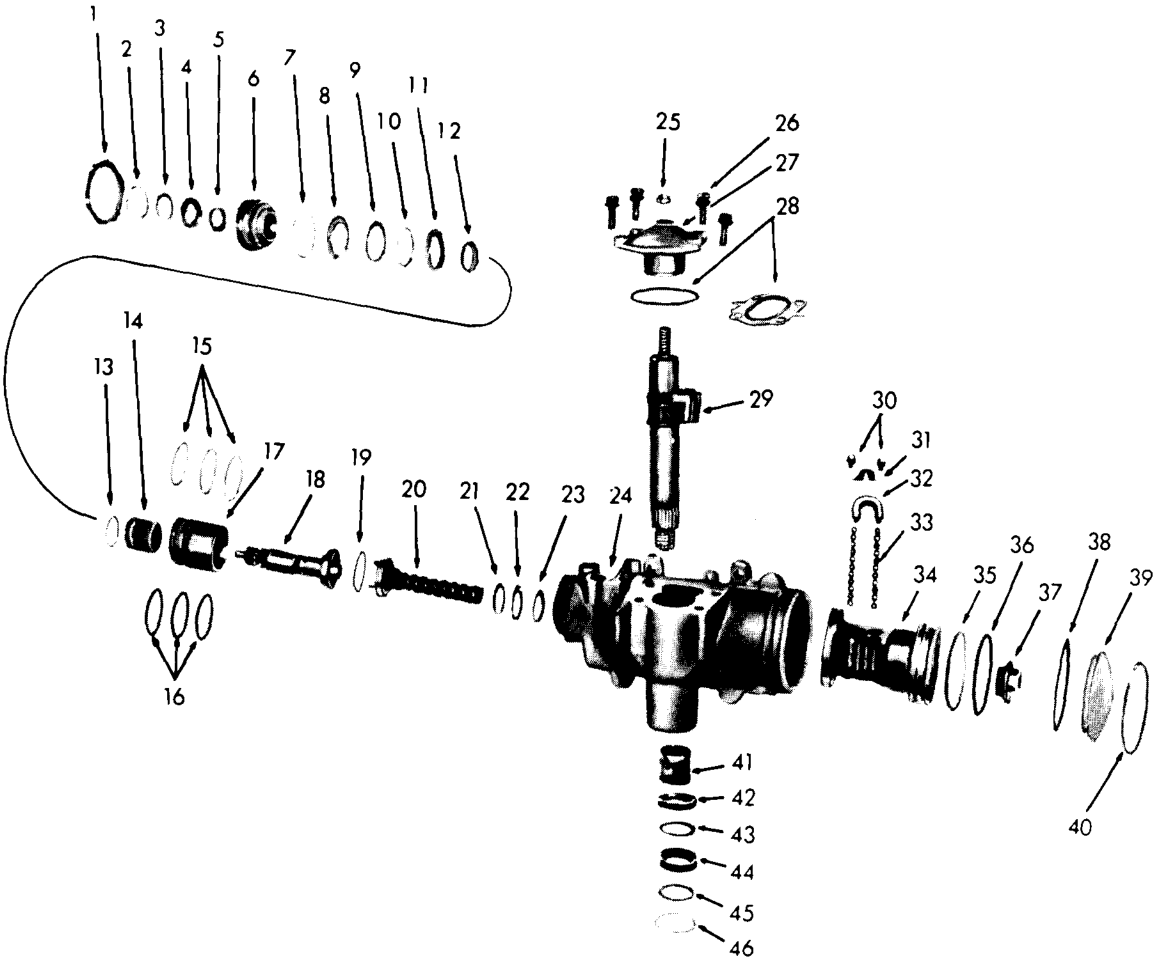


Figure 24—Power Steering Gear



1 Locknut
2 Retaining Ring
3 Dust Seal
4 Oil Seal
5 Bearing
6 Adjuster Plug
7 "O" Ring
8 Thrust Washer (Large)
9 Thrust Bearing
10 Thrust Washer (Small)
11 Spacer
12 Retainer
13 "O" Ring
14 Spool Valve
15 Teflon Oil Rings
16 "O" Rings
17 Valve Body
18 Stub Shaft
19 "O" Ring
20 Wormshaft
21 Thrust Washer
22 Thrust Bearing
23 Thrust Washer
24 Housing
25 Locknut
26 Attaching Bolts and Washers
27 Side Cover
28 "O" Ring
29 Pitman Shaft
30 Screws and Lock Washers
31 Clamp
32 Ball Return Guide
33 Balls
34 Rack-Piston
35 Teflon Oil Seal
36 "O" Ring
37 Plug
38 "O" Ring
39 Housing End Cover
40 Retainer Ring
41 Needle Bearing
42 Oil Seal
43 Back Up Washer
44 Oil Seal
45 Back Up Washer
46 Retaining Ring

A-1505

Figure 25—Steering Gear (Exploded View)

NOTE: If mounting threads are stripped, do not repair. Replace housing.

STEERING GEAR OVERHAUL

Disassembly of the major components within the gear must be performed on a clean work bench. The work area, tools, and parts must be kept clean at all times. Refer to Figures 24 and 25 for parts nomenclature and location.

NOTE: Most service kits are purposely designed to replace not only a worn part, but also adjacent parts which should be replaced at the same time. To ensure an effective repair, use all parts supplied in the kit.

STEERING GEAR DISASSEMBLY

1. Rotate end cover retainer ring so that one end of the ring is over the hole in the side of the housing. Force the end of the ring from its groove and remove ring (figure 26).

2. Turn the coupling flange counter-clockwise until the rack-piston just forces end cover out of housing. Remove cover and discard "O" ring.

CAUTION: *Do not turn stub shaft any further than absolutely necessary to remove the end plug, or balls from rack-piston and worm circuit may escape and lay loose inside the rack-piston chamber.*

3. Remove the rack-piston end plug as shown in Figure 27.

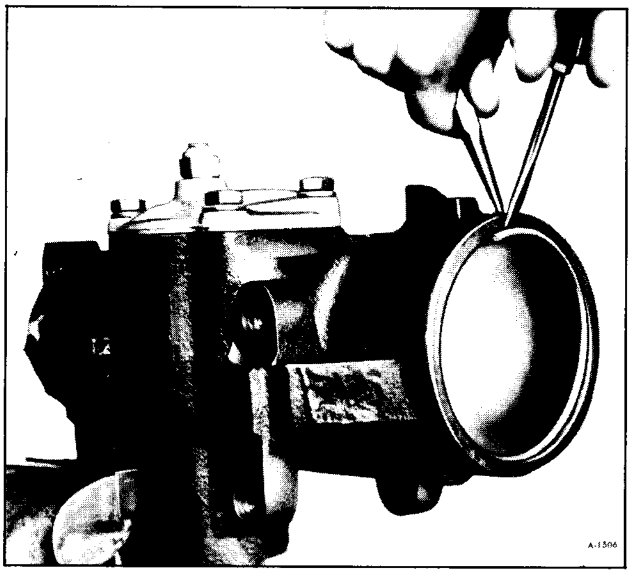


Figure 26—Removing End Cover

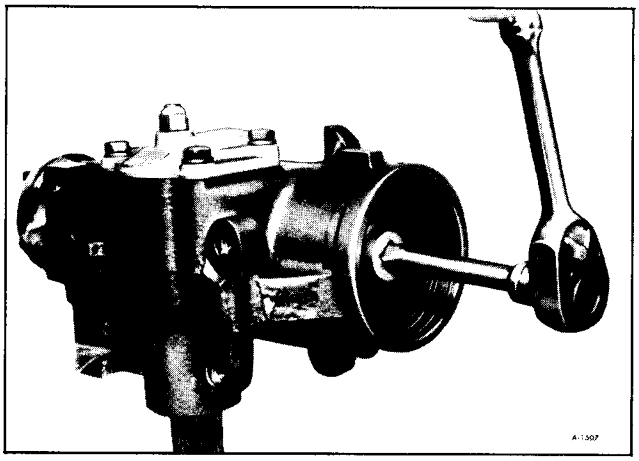


Figure 27—Removing Rack-Piston End Plug

NOTE: To aid in loosening the aluminum end plug (female square drive) strike sharply using 1" or larger diameter brass drift and hammer.

4. Remove the pitman shaft and side cover as follows:

a. Loosen the over-center adjusting screw locknut and remove the four side cover attaching bolts.

b. Rotate the side cover until the rack-piston and pitman shaft teeth are visible, then turn the coupling flange until the pitman shaft teeth are centered in the housing opening. Tap the pitman shaft with a soft hammer and remove the pitman shaft and side cover from the housing. Remove the side cover "O" ring and discard. If gasket seal is used, inspect, discard only if damaged.

5. Remove the rack-piston as follows:

a. Insert Ball Retainer Tool J-21552 into the rack-piston bore with pilot of tool seated in the end of the worm (figure 28). Turn stub shaft counter-clockwise while holding tool tightly against worm. The rack-piston will be forced onto the tool. Hold tool and pull rack-piston farther onto tool to prevent end circuit balls from falling out.

b. Remove the rack-piston with Ball Retainer Tool J-21552 from gear housing.

6. Remove the adjuster plug as follows:

a. Loosen the adjuster plug locknut and remove.

b. Remove adjuster plug assembly with Spanner Wrench J-7624 (figure 29). Remove and discard the adjuster plug "O" ring.

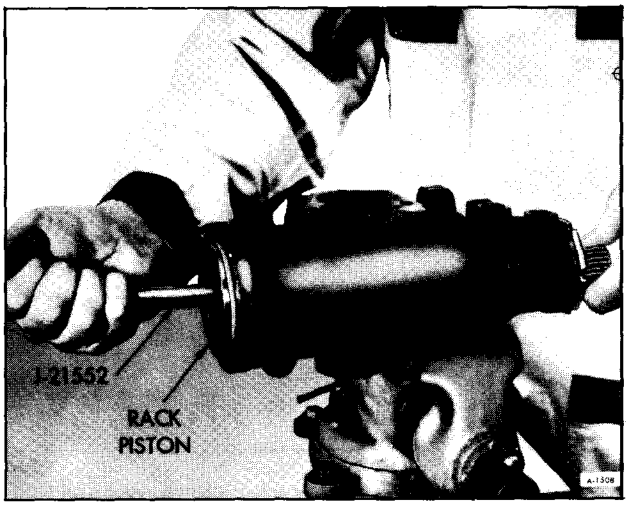


Figure 28—Removing Rack Piston

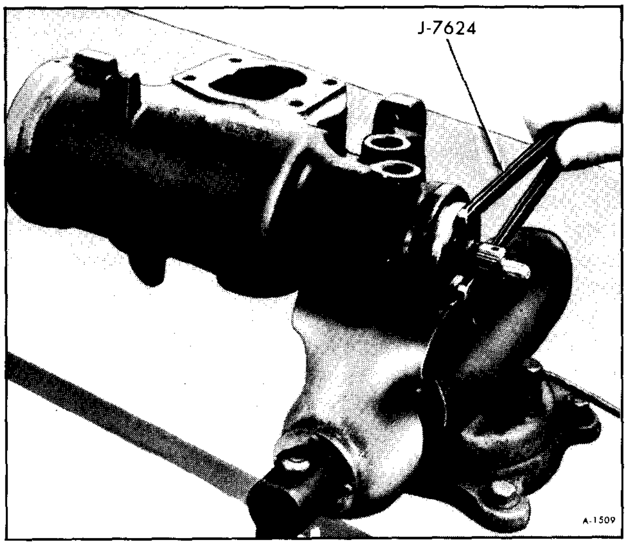


Figure 29—Removing Adjuster Plug

7. Grasp the stub shaft and pull the valve assembly from the housing bore. Separate worm and valve and remove the lower shaft cap "O" ring and discard.

8. If the worm or the lower thrust bearing and race remained in the gear housing, remove them at this time.

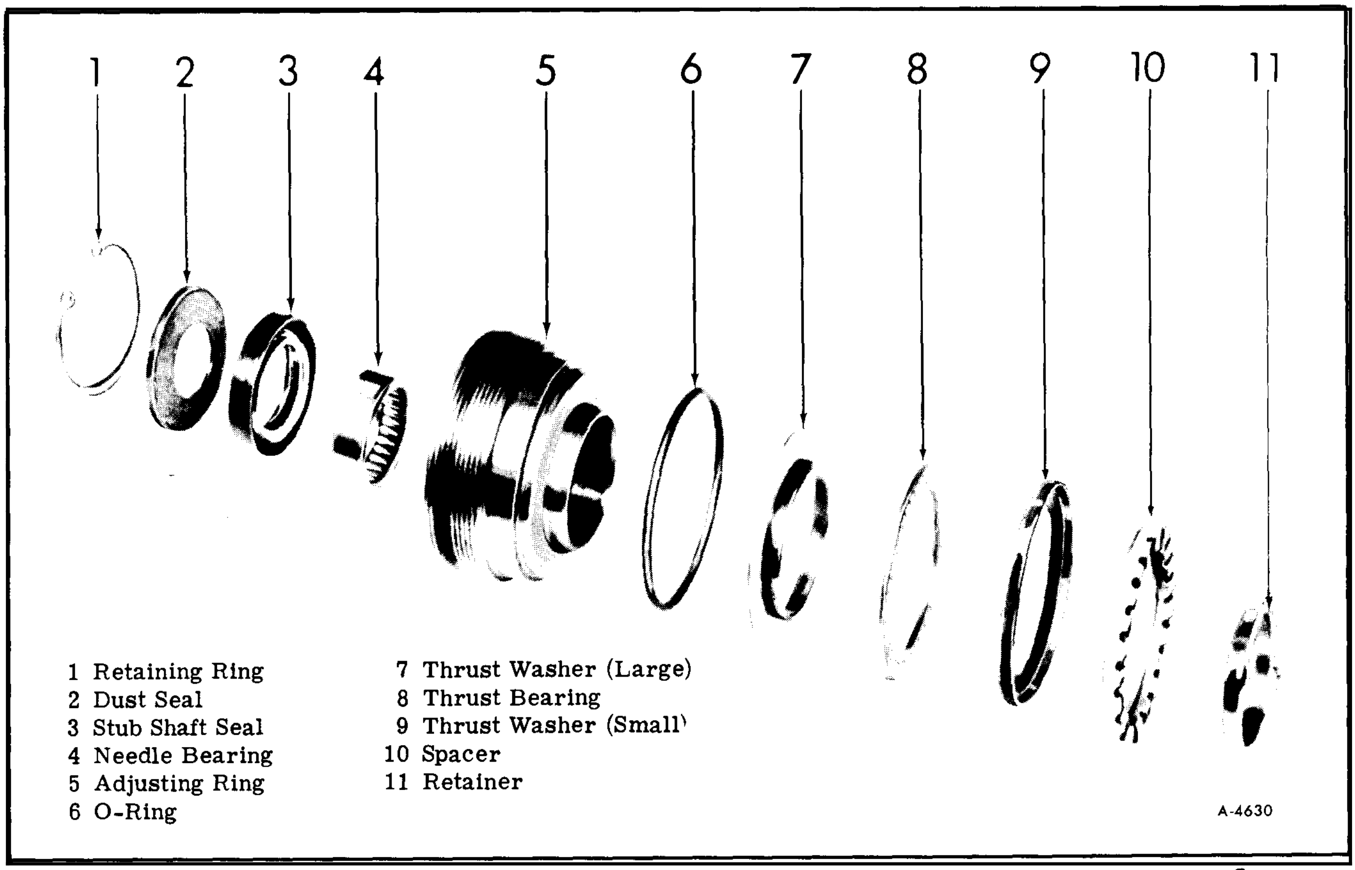


Figure 30—Adjuster Plug (Exploded View)

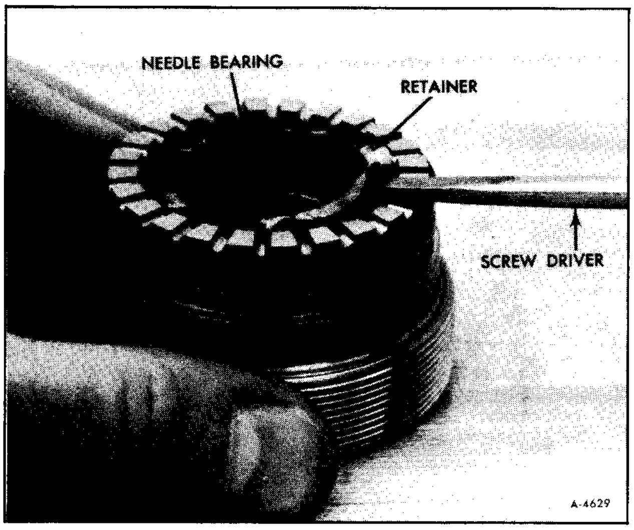


Figure 31—Removing Retainer

ADJUSTER PLUG ASSEMBLY

Disassembly

1. If the oil seal ONLY is to be replaced, and not the needle bearing, install the adjuster plug (figure 30) loosely in the gear housing. Remove the retaining ring with Internal Pliers J-4245. With a screw driver, pry the dust seal and oil seal from the bore of the adjuster plug being careful not to score the seal bore. Discard the oil seal.

2. If ONLY the thrust bearing is to be removed, pry the thrust bearing retainer at the two raised areas with a small screwdriver (figure 31). Remove the spacer, thrust bearing washer, thrust bearing and washer.

3. If the needle bearing is to be replaced, remove the retaining ring using Internal Pliers J-4245. Remove thrust bearing as outlined in Step 2 above. Drive needle bearing, dust seal and oil seal from adjuster plug using Bearing Remover J-8524-2 and Driver J-7079-2 as shown in Figure 32. Discard the seals.

4. Wash all parts in clean solvent and dry parts with compressed air.

5. Inspect thrust bearing spacer for wear or cracks. Replace if damaged.

6. Inspect thrust bearing rollers and thrust washers for wear, pitting or scoring. If any of these conditions exist, replace the bearing, thrust washers, spacer, and retainer.

Assembly

1. If the needle bearing was removed, place new needle bearing over Tool J-8524-1 and J-7079-2, with the bearing manufacturer's identification against the tool, and drive the bearing into the adjuster plug until the tool bottoms in the housing (figure 33).

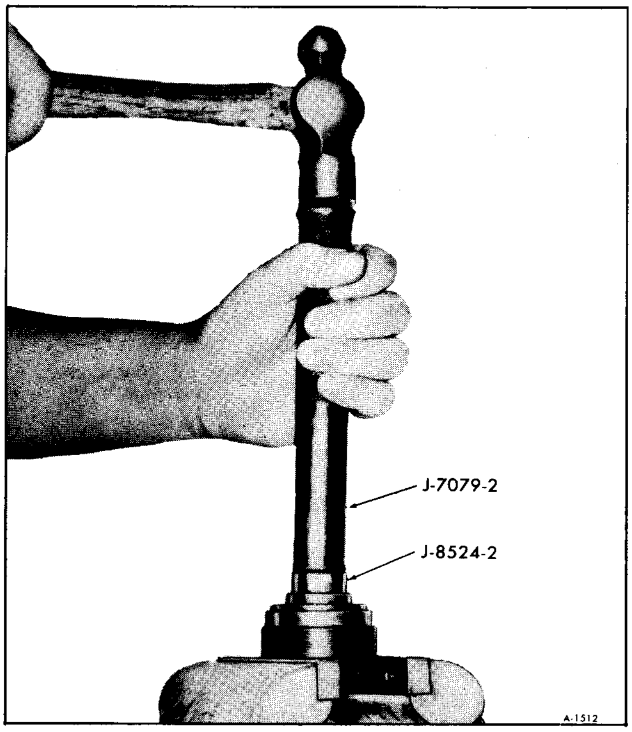


Figure 32—Removing Bearing and Seal

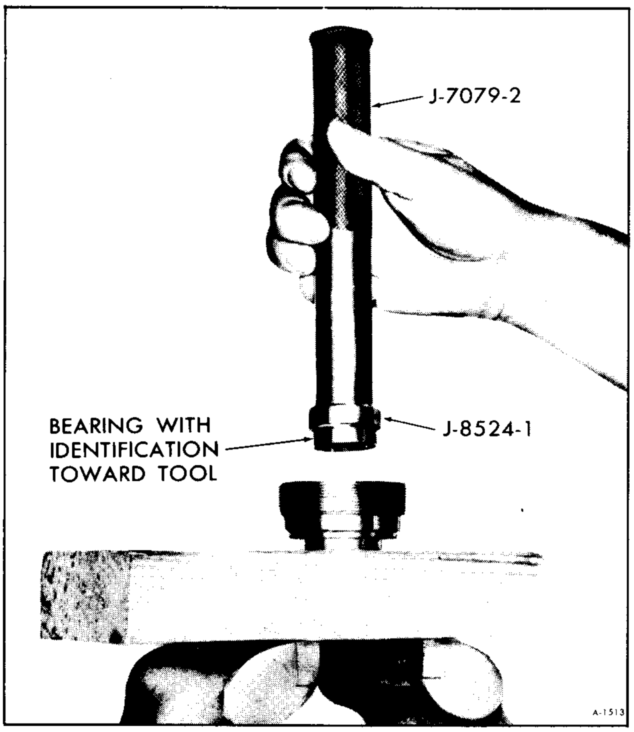


Figure 33—Installing Bearing

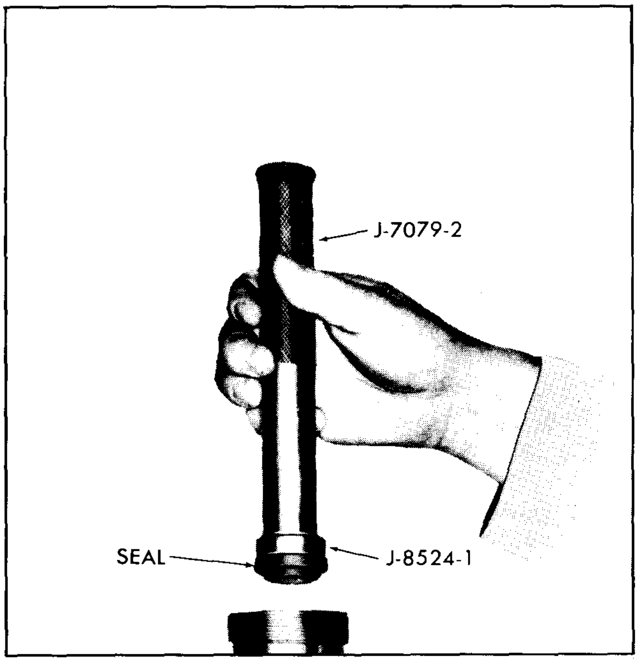


Figure 34—Installing Adjuster Plug Seal

CAUTION: *Place a block of wood under the adjuster plug to protect it during driving of the bearing.*

2. Place dust seal and a new stub shaft seal on Tool J-8524-1 (face of seal with part number against seal). Lubricate seal with Power Steering Fluid and drive or press seals into adjuster plug until seated (figure 34). When properly installed the oil seal is under the dust seal.

3. Install retaining ring with Internal Pliers J-4245.

4. Lubricate the thrust bearing assembly with Power Steering Fluid. Place the flanged thrust bearing race on the adjuster plug hub, then install the upper thrust bearing, small bearing race (flanged edge up) and spacer (grooves of spacer away from bearing washer).

5. Install bearing retainer on the adjuster plug by carefully tapping on the flat surface of the retainer (figure 35).

CAUTION: *The projections must not extend beyond the spacer when the retainer is seated to prevent interference with valve body. The spacer must be free to rotate.*

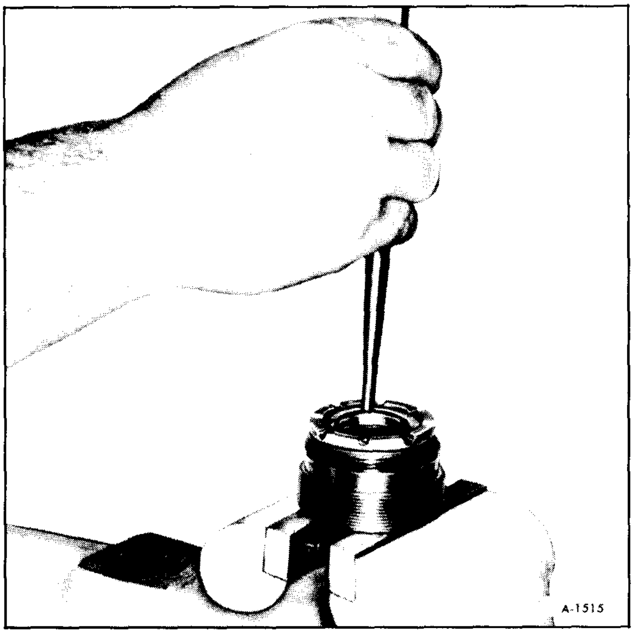


Figure 35—Install Retainer

VALVE AND STUB SHAFT ASSEMBLY

Disassembly

1. Remove and discard "O" ring in the shaft cap end of the valve assembly.

2. To remove the stud shaft assembly from the valve body, proceed as follows:

a. While holding the assembly (stub shaft down), lightly tap the stub shaft against the bench until the shaft cap is free from the valve body (figure 36).

b. Pull the shaft assembly until the shaft cap clears the valve body approximately 1/4".

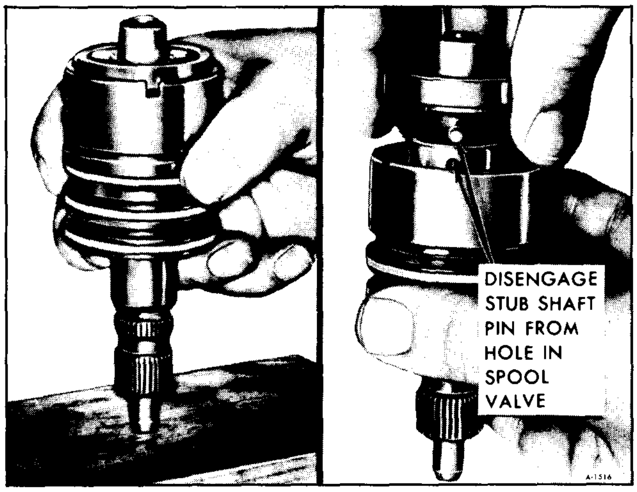


Figure 36—Removing Shaft Cap from Valve Body

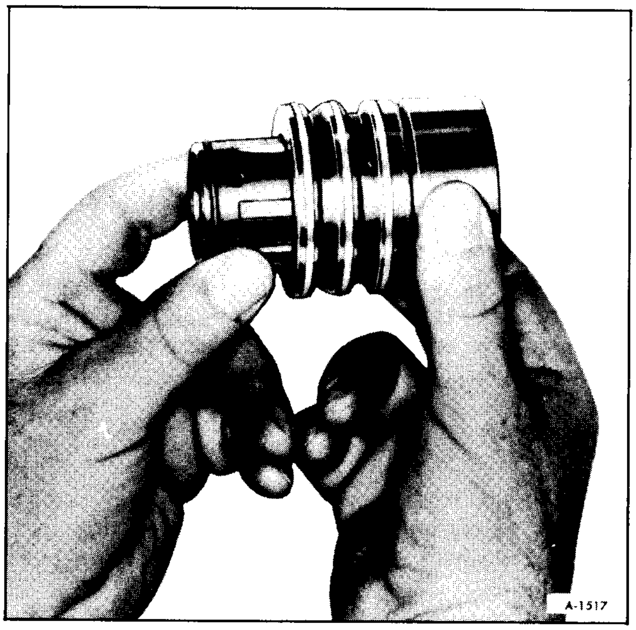


Figure 37—Removing Spool Valve

CAUTION: *Do not pull the shaft assembly out too far or the spool valve may become cocked in the valve body.*

c. Carefully disengage the shaft pin from the valve spool and remove the shaft assembly (figure 36).

3. Push the spool valve out of the flush end of the valve body until the dampener "O" ring is exposed then carefully pull the spool from the valve body, while rotating the valve (figure 37). If the spool valve becomes cocked, carefully realign the spool valve, then remove.

4. Remove the dampener "O" ring from the spool valve and discard.

5. If the teflon oil rings are to be replaced, cut the three teflon oil rings and "O" rings from the valve body and discard.

Cleaning and Inspection (Figure 38)

1. Wash all parts in clean solvent and blow out all oil holes with compressed air.

2. If the drive pin in the stub shaft or valve body is cracked, excessively worn or broken, replace the complete valve and shaft assembly.

3. If there is evidence of leakage between the torsion bar and the stub shaft or scores, nicks, or burrs on the ground surface of the stub shaft that cannot be cleaned up with crocus cloth, the entire valve assembly must be replaced.

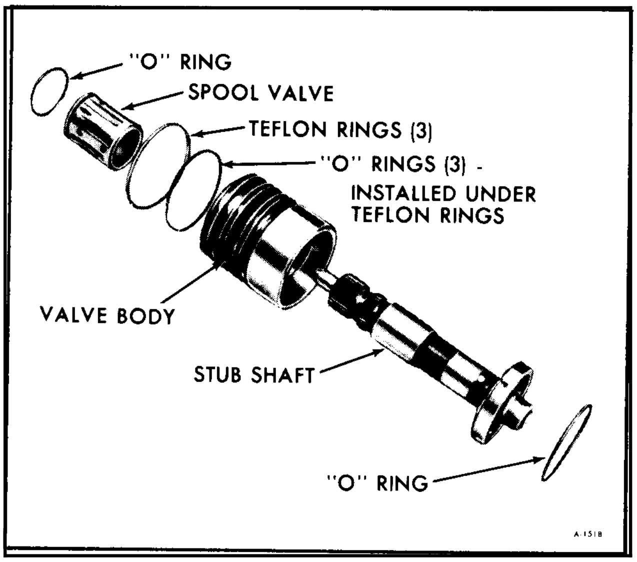


Figure 38—Valve Body and Shaft Assembly

4. Check the outside diameter of the spool valve and the inside diameter of the valve body for nicks, burrs, or bad wear spots. If the irregularities cannot be cleaned up by the use of crocus cloth, the complete valve and shaft assembly will have to be replaced.

5. If the small notch in the skirt of the valve body is excessively worn, the complete valve assembly will have to be replaced. See Figure 39.

6. Lubricate the spool valve with Power Steering Fluid and check the fit of the spool valve in the valve body (with the spool valve dampener "O" ring removed). If the spool valve does not rotate freely without binding, the complete valve and shaft assembly will have to be replaced.

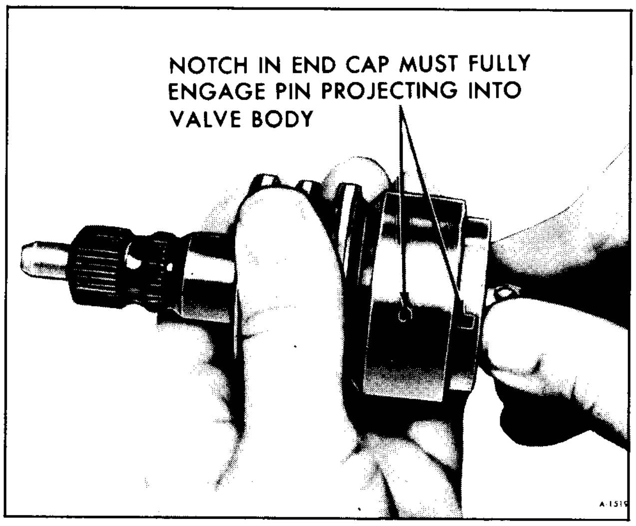


Figure 39—Installing Stub Shaft Assembly

Assembly

1. If valve body "O" rings and teflon rings were removed, install three new "O" rings in the oil ring grooves and lubricate with Power Steering Fluid.

2. Lubricate the three new teflon oil rings with Power Steering Fluid and install in grooves over "O" rings.

NOTE: The teflon rings may appear to be distorted, but the heat of the oil during operation of the gear will straighten them out.

3. Lubricate the spool valve dampener "O" ring with Power Steering Fluid and install over the spool valve.

4. Lubricate the spool valve and valve body with Power Steering Fluid and slide the spool valve into the valve body. Rotate the spool valve while pushing it into the valve body being careful not to cut the dampener "O" ring. Push the spool valve on through the valve body until the shaft pin hole is visible from the opposite end (spool valve flush with shaft cap end of valve body).

5. Lubricate the shaft assembly with Power Steering Fluid and carefully install it into the spool valve until the shaft pin can be placed into the spool valve.

6. Align the notch in the shaft cap with the pin in the valve body and press the spool valve and shaft assembly into the valve body (figure 39).

CAUTION: *Make sure that the shaft cap notch is mated with the valve body pin before installing valve body into the gear assembly to insure proper valve function.*

7. Lubricate a new cap to body "O" ring with Power Steering Fluid and install it in the shaft cap end of the valve body assembly.

PITMAN SHAFT AND SIDE COVER

Disassembly

Remove the locknut and unscrew the side cover from the adjusting screw. Do not attempt to disassemble pitman shaft. Discard locknut.

Cleaning and Inspection

1. Wash all parts in clean solvent and dry with compressed air.

2. Check pitman shaft bearing surface in the side cover for scoring. If badly worn or scored, replace the side cover assembly.

3. Check the sealing and bearing surfaces of the pitman shaft for roughness, nicks, etc. If minor irregularities in surface cannot be cleaned by use of crocus cloth, replace the pitman shaft.

4. Replace pitman shaft assembly if teeth are damaged or if the bearing surfaces are pitted or scored.

5. Check pitman shaft lash adjusting screw. It must be free to turn with no perceptible end play. If adjusting screw is loose replace the pitman shaft assembly.

Assembly

Thread the side cover onto the pitman shaft adjusting screw until it bottoms and then turn in 1/2 turn. Install a new adjusting screw locknut, but do not tighten.

RACK-PISTON

Cleaning and Inspection

1. Wash all parts in clean solvent and dry with compressed air.

2. Inspect the worm and rack-piston grooves and all the balls for scoring. If either the worm or rack-piston needs replacing, both must be replaced as a matched assembly.

3. Inspect ball return guide halves, making sure that the ends where the balls enter and leave the guides are not damaged.

4. Inspect lower thrust bearing and washers for scoring or excessive wear. If any of these conditions are found, replace the thrust bearing and washers.

5. Inspect rack-piston teeth for scoring or excessive wear. Inspect the external ground surfaces for wear, scoring or burrs. If any of these conditions exist and are excessive, both the rack-piston and worm must be replaced.

Assembly

1. If the teflon oil seal and "O" ring were removed, lubricate a new "O" ring and seal with Power Steering Fluid and install in groove on rack-piston. The teflon ring may be slightly loose after assembly, but will tighten up when subjected to the hot oil in the system (figure 40).

2. Slide the worm all the way into the rack-piston. It is not necessary to have the thrust bearing assembly on the worm at this time.

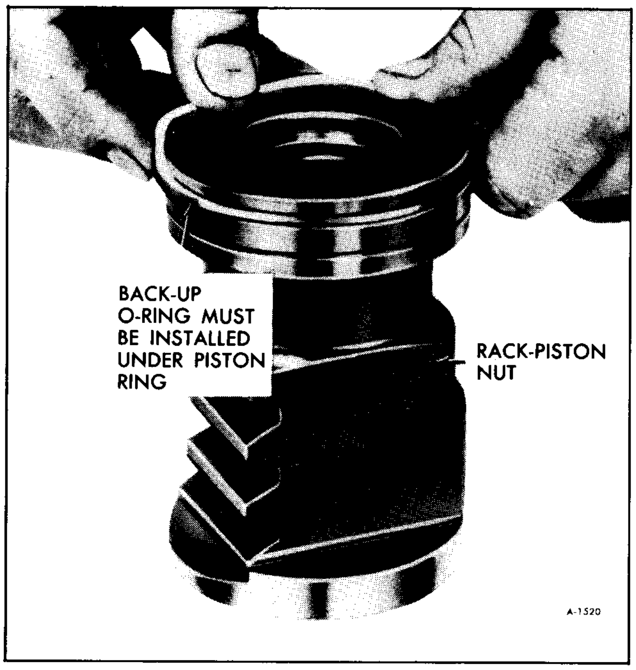


Figure 40—Installing Ring on Rack-Piston

3. Turn the worm until the worm groove is aligned with the lower ball return guide hole (figure 41).

4. Lubricate the balls with Power Steering Fluid, then feed 17 balls into the rack-piston, while slowly rotating the worm counterclockwise.

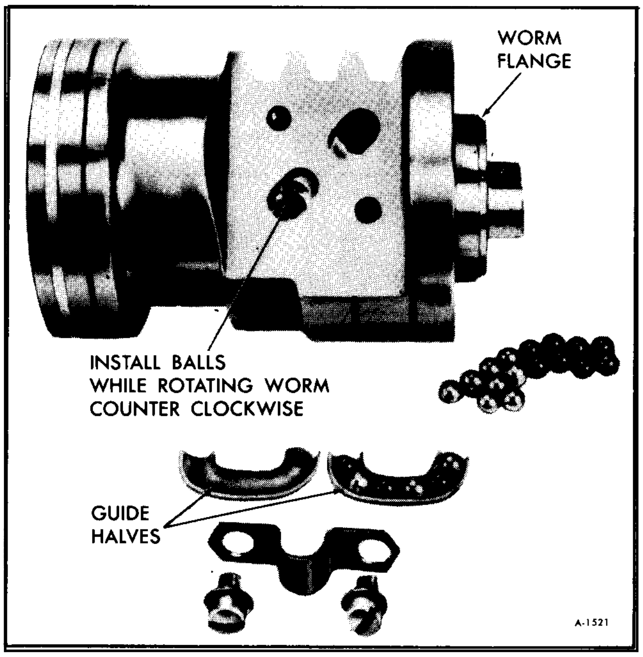


Figure 41—Installing Balls in Rack-Piston

CAUTION: *The black balls are .0005" smaller than the silver balls. The black and silver balls must be installed alternately into the rack-piston and return guide.*

5. Alternately install five balls into the return guide and retain with grease at each end of guide. Install the return guide clamp and tighten the two clamp screws to six foot pounds.

STEERING GEAR HOSE CONNECTOR AND POPPET CHECK VALVE REPLACEMENT

The following procedure can be performed on vehicle as well as on bench.

1. Disconnect pressure and return line hoses at steering gear and secure hose ends in a raised position to prevent loss of fluid.

2. To prevent metal chips from becoming lodged in valve assembly, pack inside of connector seats of pressure and return ports with petrolatum.

3. Tap threads in connector seats, using a 5/16-18 tap.

CAUTION: *Do not tap threads too deep in pressure hose connector seat as tap will bottom poppet valve against housing and damage it. It is necessary to tap only two or three threads deep.*

4. Thread a 5/16-18 bolt with a nut and flat washer into tapped hole (figure 42).

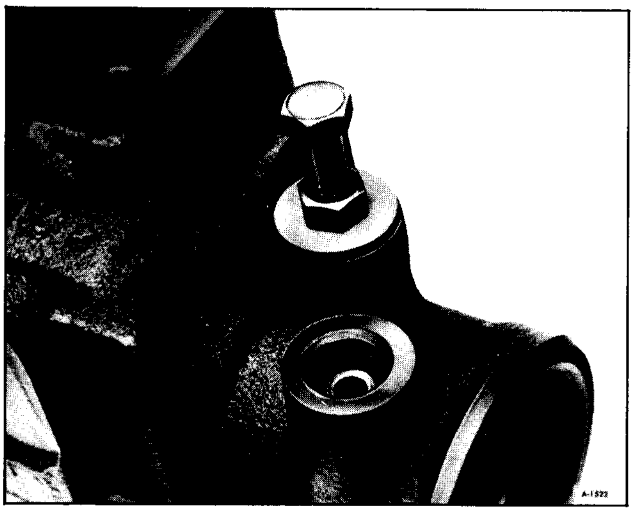


Figure 42—Removing Hose Connector Seat

5. To pull connector seat, hold bolt from rotating while turning nut off bolt. This will pull connector from housing. Discard connector seat.

NOTE: It is also possible to remove connector by using a No. 4 screw extractor. (Easy out).

6. Wipe petrolatum from housing and clean housing thoroughly to remove any metal chips or dirt.

7. Remove poppet check valve and spring from pressure port and discard.

8. Install new check valve spring in pressure port with large end down. Make sure spring is seated in counterbore in pressure port (figure 43).

9. Install new check valve over spring with tangs pointing down. Make sure valve is centered on small end of spring.

10. Install new connector seats, using petrolatum to hold connector seat on check valve in pressure port. Drive connector seats in place using Valve Connector Seat Installer, J-6217 (figure 43).

11. Check operation of valve by pushing lightly against valve with a small punch or small rod. Valve should reseat itself against connector seat when pressure is removed from spring.

12. Connect pressure and return line hoses on steering gear. Tighten hose fittings to 30 foot-pounds.

13. Check fluid level in pump reservoir and add if necessary.

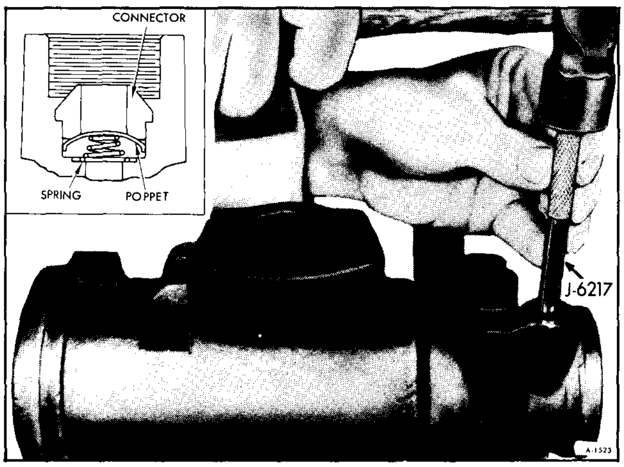


Figure 43—Installing New Connector

Figure 44—Prying Out Inner Seal

PITMAN SHAFT NEEDLE BEARING AND SEALS

Removal

CAUTION: *When prying out seals, be extremely careful not to score the housing bore.*

1. If ONLY pitman shaft seals are to be replaced, remove the seal retaining ring with Internal Pliers J-4245 and remove back-up washer. Using screw driver under lip of seal pry out the outer seal. Remove the back-up washer, then pry out the inner seal (figure 44). Discard seals.

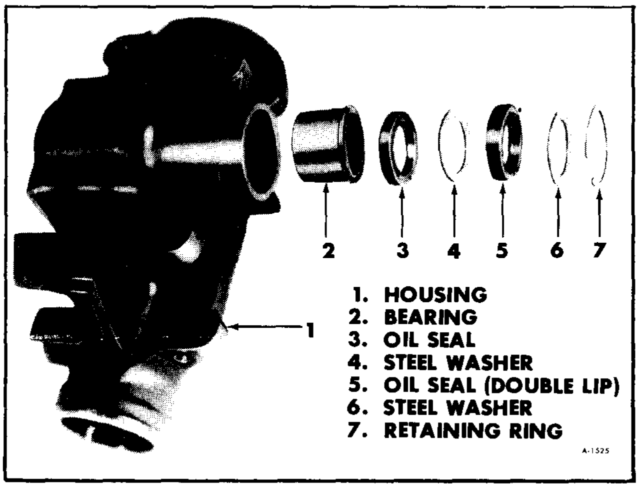


Figure 45—Pitman Shaft Bearing and Seals

2. If pitman shaft needle bearing replacement is necessary, remove with Tool J-6278. Since this bearing is shouldered, it must be pressed out of the pitman shaft end of the housing.

Assembly

1. Thoroughly clean all parts (figure 45) and lubricate with Power Steering Fluid.

2. Install pitman shaft needle bearing on Bearing Installer J-22407, with shoulder on bearing against tool. Position bearing and tool in housing and press bearing into housing until bottom edge of bearing is flush with the inner housing bore surface (figure 46).

> **CAUTION:** *Do not drive the bearing further into the housing after removing Tool J-22407, since damage to the bearing would result.*

3. Lubricate the lips of the oil seals with Power Steering Fluid.

4. Install the pitman shaft oil seals as follows:

a. Place Adapter J-6278-2 over Tool J-6278, then install the outer seal (double lip), backup washer, and inner seal with the lips of the seals facing away from the adapter. (Seal identification toward adapter).

b. Drive the seals into the housing until the top of Adapter J-6278-2 is flush with the housing (figure 47).

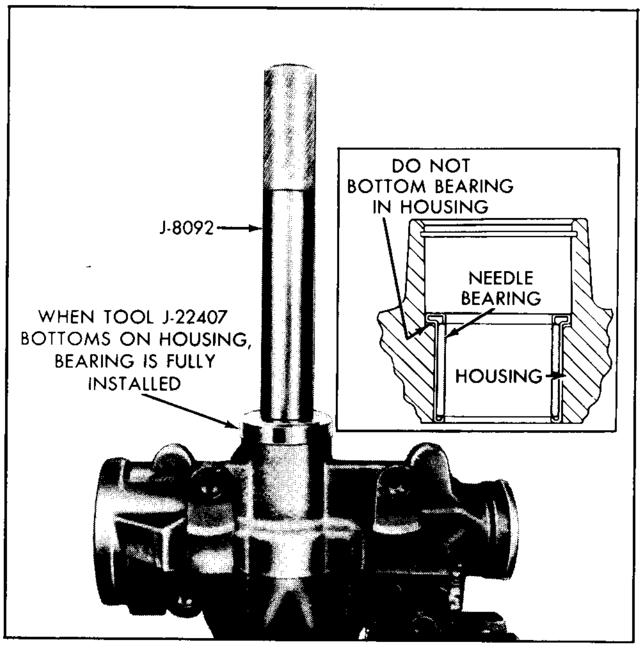


Figure 46—Installing Pitman Shaft Bearing

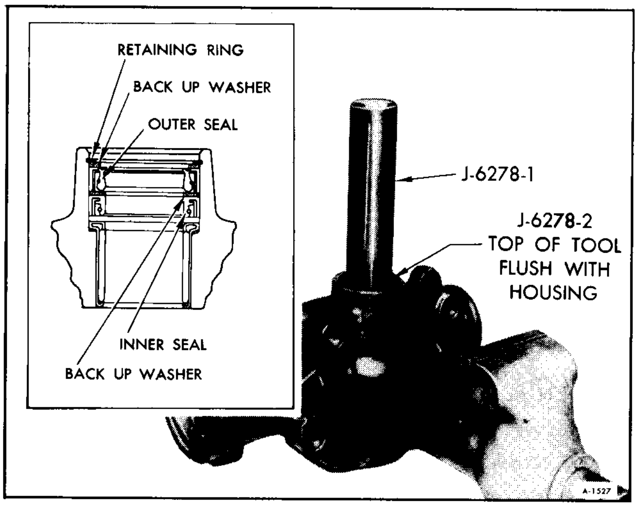


Figure 47—Installing Pitman Shaft Seals

c. Remove the tool and adapter, then install the back-up washer and seal retaining ring. The retaining ring will not seat in the groove at this time.

d. Reinsert Tool J-6278 with Adapter J-6278-2 and continue driving the seals until the retaining ring seats in its groove (Refer to inset , figure 47), then remove the tool and adapter.

REPLACEMENT OF PITMAN SHAFT SEALS WITH STEERING GEAR IN VEHICLE

If oil leaks at the pitman shaft seals, the seals may be replaced without removing the gear assembly from the vehicle as follows:

1. Remove pitman nut and disconnect pitman arm from pitman shaft using Puller J-24319. Do not hammer on end of puller.

2. Thoroughly clean end of pitman shaft and gear housing, then tape splines on end of pitman shaft to insure that seals will not be cut by splines during assembly.

> **CAUTION:** *Only one layer of tape should be used; an excessive amount of tape will not allow the seals to pass over it, due to the close tolerance between the seals and the pitman shaft.*

3. Remove pitman shaft seal retaining ring with Snap Ring Pliers J-4245.

4. Start engine and turn steering wheel fully to the left so that oil pressure in the housing can force out pitman shaft seals. Turn off engine.

CAUTION: *Use suitable container to catch oil forced out of gear. This method of removing the pitman shaft seals is recommended, as it eliminates the possibility of scoring the housing while attempting to pry seals out.*

5. Inspect seals for damage to rubber covering on O.D. If O.D. appears scored, inspect housing for burrs and remove before attempting new seal installation. Check seal surface of pitman shaft for roughness or pitting. If pitted replace pitman shaft.

6. Clean the end of housing thoroughly so that dirt will not enter housing with the installation of the new seals.

7. Lubricate the seals thoroughly with Power Steering Fluid to install seals with Installer J-6219 (figure 48). Install the inner single lip seal first, then a back-up washer. Drive seal in far enough to provide clearance for the outer seal, back-up washer and retaining ring. Make sure that the inner seal does not bottom on the counterbore. Install the outer double lip seal and the second back-up washer in only far enough to provide clearance for the retaining ring. Install retaining ring.

8. Fill pump reservoir to proper level with Power Steering Fluid. Start engine and allow engine to idle for at least three minutes without turning steering wheel. Turn wheel to left and check for leaks. Add Power Steering Fluid as required.

9. Remove tape and reconnect pitman arm.

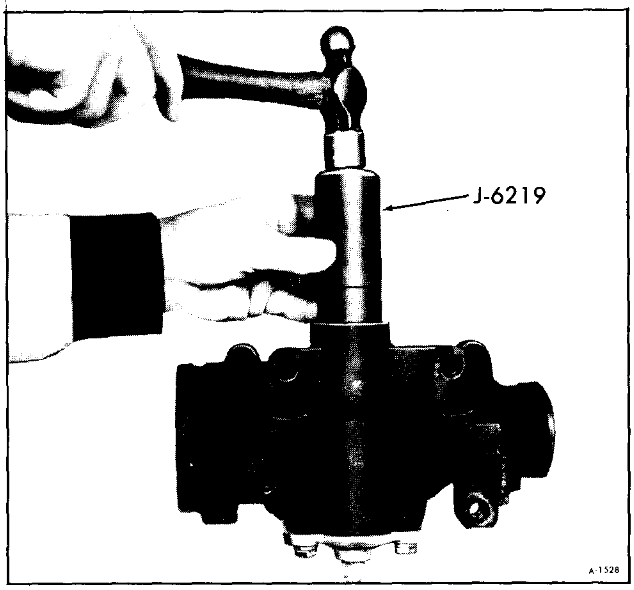


Figure 48—Installing Pitman Shaft Seals

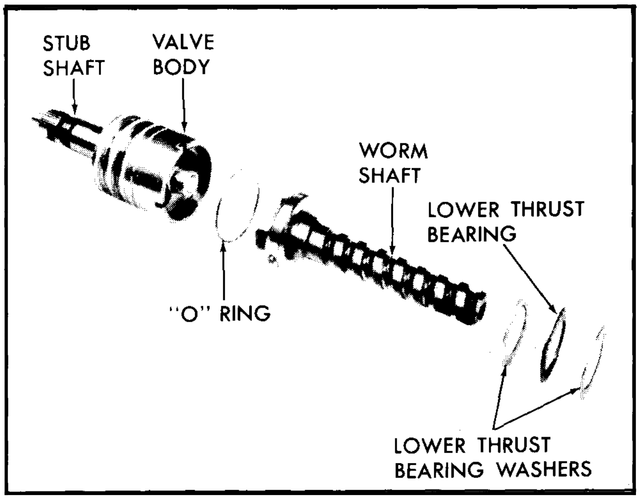


Figure 49—Worm and Valve Body

NOTE: The pitman arm to steering gear nut and washer are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with the same part numbers or with equivalent parts if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention.

STEERING GEAR ASSEMBLY

1. Lubricate the worm, lower thrust bearing and the two thrust washers with Power Steering Fluid, then install one thrust washer, the bearing, and the other thrust washer over the end of the worm (figure 49).

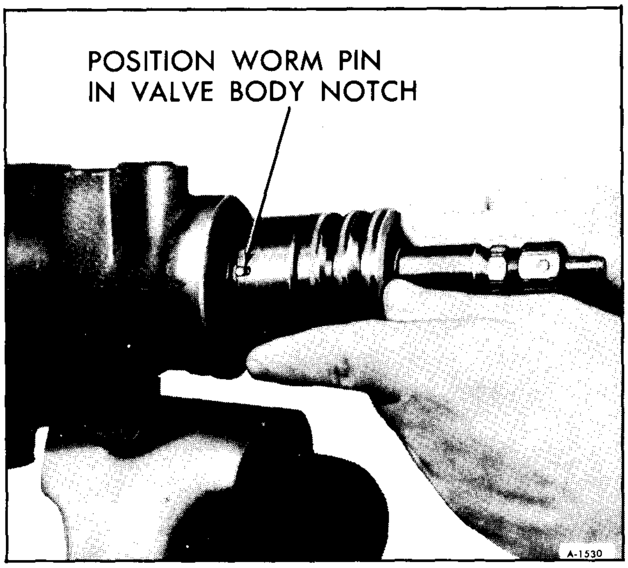


Figure 50—Valve to Worm Alignment

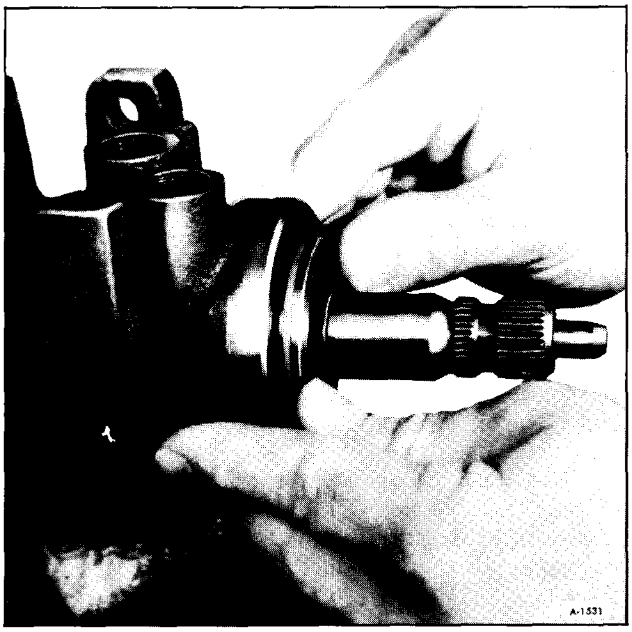


Figure 51—Installing Valve Body

2. Lubricate the valve body teflon rings and a new cap to body "O" ring with Power Steering Fluid. Install the cap to body "O" ring in the valve body so it is seated against the lower shaft cap. Align the NARROW NOTCH in the valve body with pin in the worm, then install the valve and shaft assembly in the gear housing (figure 50). Apply pressure to the VALVE BODY when installing. If pressure is applied to the stub shaft during installation, the shaft may be forced out of the valve body (figure 51).

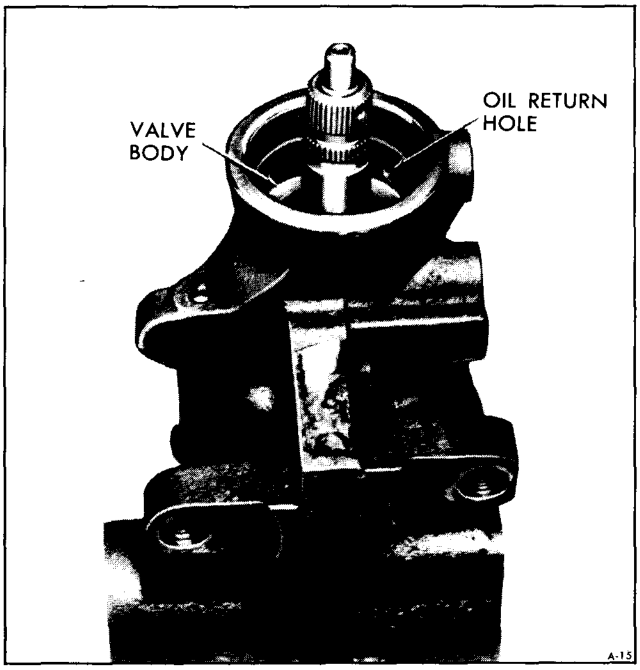


Figure 52—Valve Body in Housing

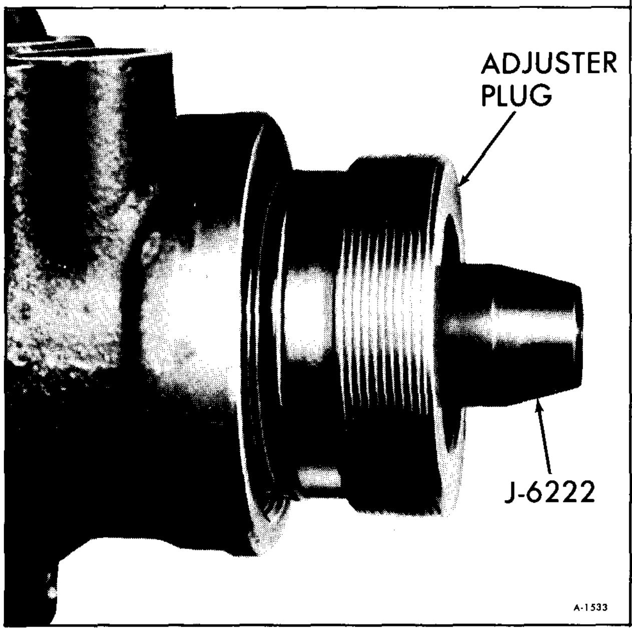


Figure 53—Installing Adjuster Plug

NOTE: The valve body is properly seated when the oil return hole in the housing is entirely uncovered (figure 52).

3. Lubricate a new adjuster plug "O" ring with Power Steering Fluid and install in groove on adjuster plug. Place Seal Protector J-6222 over stub shaft, then install the adjuster plug assembly in the housing until it seats against the valve body (figure 53). Remove Seal Protector.

4. Adjust thrust bearing preload as follows:

a. Using spanner wrench J-7624, turn adjuster plug in (clockwise) until the plug and thrust bearing are firmly bottomed (approximately 20 ft. lbs.) (figure 58.) b. Place a mark on the housing even with one of the holes in the face of the adjuster plug (figure 59).

c. Measure back (counterclockwise) 1/2 inch and place a second mark on the housing (figure 60).

d. Turn the adjuster plug counterclockwise until the hole in the face of the plug, which was even with the first mark, is even with the second mark (figure 61).

e. Tighten lock nut securely. Hold adjuster plug to be sure that it does not move when the lock nut is tightened (figure 62).

f. Using torque wrench J-7754 with a 3/8"-12 point socket, turn the stub shaft and measure the

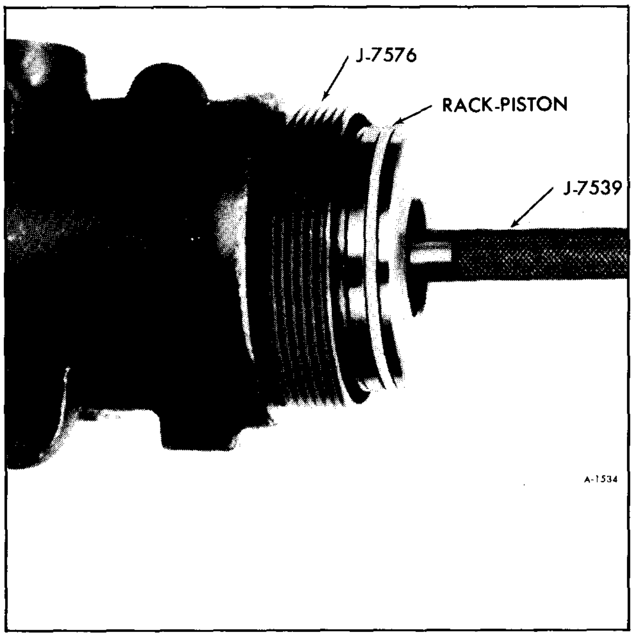


Figure 54—Installing Rack-Piston

torque. Torque reading should be between 4 and 6 in. lbs. If torque is not within these specifications, loosen lock nut and turn the adjuster until the proper torque is obtained. Retighten nut as described in 4e. With adjuster secured in place, coat junction of dust seal and stub shaft with anhydrous calcium based grease (included with repair kits).

5. Install the rack-piston as follows:

a. Lubricate the rack-piston teflon seal with Power Steering Fluid.

b. Position Seal Compressor J-7576 against the shoulder in the housing.

c. With Ball Retainer J-7539 in place in the rack-piston, push the rack-piston (with teeth toward pitman shaft opening), into the housing until Tool J-7539 contacts the center of worm (figure 54).

d. Turn the stub shaft clockwise with a 3/4" twelve point socket or box end wrench to thread the rack-piston onto the worm while holding Tool J-7539 against the end of the worm.

e. When the rack-piston is completely threaded on the worm, remove Ball Retainer J-7539 and Seal Compressor J-7576.

6. Install the pitman shaft and side cover as follows:

a. Install a new "O" ring in the side cover and retain with heavy grease.

b. Turn the stub shaft until the rack-piston teeth are centered in the pitman shaft opening, then install the pitman shaft and side cover so that the center tooth of thepitman shaft engages the center groove of the rack-piston.

c. Install the side cover bolts and tighten to 45 foot pounds.

7. Install the rack-piston plug in the rack-piston and torque to 75 foot pounds.

8. Install a new housing end cover "O" ring and lubricate it with Power Steering Fluid. Install the end cover and retaining ring.

9. Adjust the over-center preload as follows:

a. Make sure the over-center adjusting screw is backed all the way out. Then turned back in 1/2 turn.

b. Install an inch-lb. torque wrench with a 3/4" 12-point socket on the stub shaft splines.

c. Rotate the stub shaft from one stop to the other. Count the number of turns and locate the center of travel, then check the combined ball and thrust bearing preload by rotating the torque wrench through the center of travel. Note the highest reading.

d. Tighten the pitman shaft over center adjusting screw until the torque wrench reads 4-8 in. lbs. (for a "new" gear) or 4-5 in. lbs. (for an "old" gear) higher than the reading noted in step c. The total reading should not exceed 20 in. lbs. (for a "new" gear) or 16 in. lbs. (for an "old" gear).

e. While holding the adjusting screw, tighten the locknut to 35 foot pounds using Adapter J-5860 (figure 55) and recheck the adjustment.

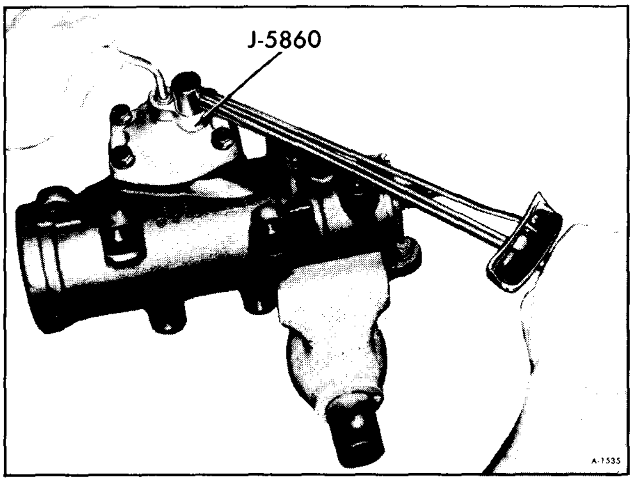


Figure 55—Torquing Over-Center Locknut

STEERING GEAR INSTALLATION

See CAUTION on page 9-1 of this section.

1. Before installing the steering gear, apply a sodium soap fine fiber grease to the gear mounting pads to prevent squeaks between the gear housing and the frame. Make certain there is a minimum of .040" clearance between coupling yoke and steering gear upper seal.

2. Be sure the steering wheel is properly aligned in relation to the wheels, and tighten the yoke cinch bolt to 30 foot pounds. Tighten the steering gear to frame bolts to 70 foot pounds.

3. Install pitman arm on steering gear, secure with nut torqued to 160-210 foot-pounds.

4. Connect fluid pressure lines and bleed system. (Refer to ADJUSTMENTS under POWER STEERING PUMP earlier in this section).

Figure 57—Removing Adjuster Plug Nut

STEERING GEAR ADJUSTMENTS

Adjustment of the steering gear in the vehicle is discouraged because of the difficulty encountered in adjusting the worm thrust bearing preload and the confusing effects of the hydraulic fluid in the gear. Since a gear adjustment is made only as a correction and not as a periodic adjustment, it is better to take the extra time and make the adjustment correctly the first time.

Since a handling stability complaint can be caused by improperly adjusted worm thrust bearings as well as an improper gear over-center adjustment, it is necessary that the steering gear assembly be removed from the vehicle and both thrust bearing and over-center preload be checked and corrected as necessary. An in-vehicle check of the steering gear will not pin-point a thrust bearing adjustment error.

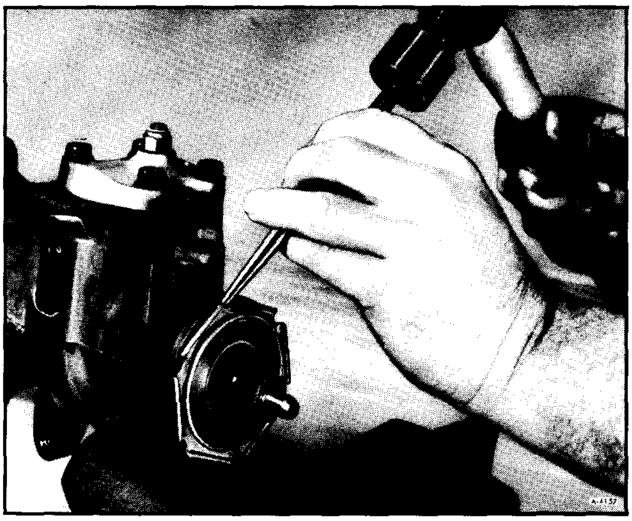


Figure 56—Loosening Adjuster Plug Nut

THRUST BEARING ADJUSTMENT

1. Drain power steering fluid from gear by rotating the stub shaft full travel in both directions several times.

2. Loosen and remove adjuster plug locknut (figures 56 and 57).

3. Turn the adjuster plug in (clockwise) until the plug and thrust bearing are firmly bottomed — approximately 20 ft. lb. (figure 58).

4. Mark the housing even with one of the holes in the adjuster plug (figure 59).

5. Measure back (CCW direction) 1/2 inch and mark housing (figure 60).

6. Rotate adjuster (CCW) until hole in adjuster is in line with second mark (figure 61).

7. Tighten locknut securely. Hold (or have held) adjuster plug to maintain alignment of hole with mark (figure 62).

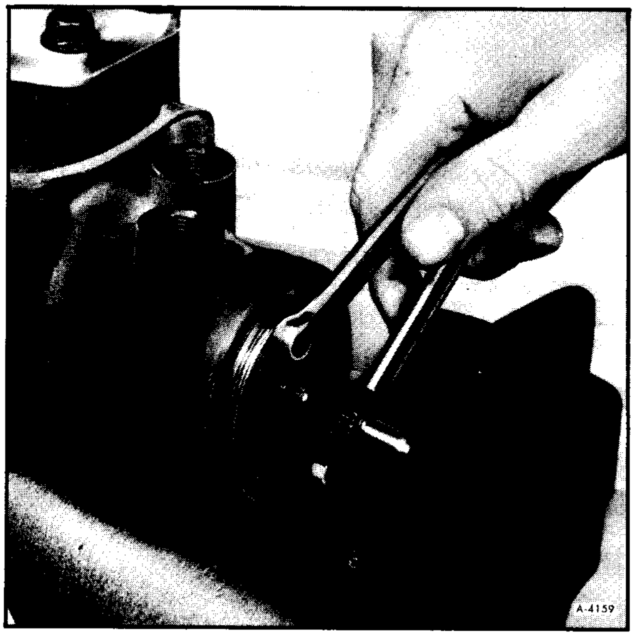


Figure 58—Turning Adjuster Plug

8. Using an in. lb. torque wrench, turn the stub shaft to the right stop and then back 1/4 turn. Measure the torque. Reading should be taken with beam of torque wrench near vertical while turning CCW at an even rate (figure 63). If reading is less than 4, or more than 10 in. lbs., use other adjustment procedure listed.

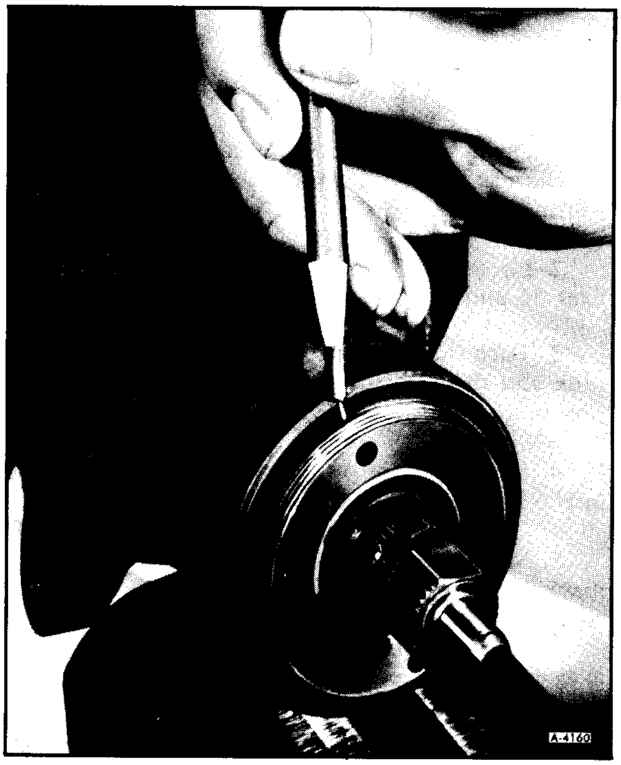


Figure 59—Housing Marks

Figure 60—Marking Rotation Distance

PITMAN SHAFT "OVER-CENTER" SECTOR ADJUSTMENT

1. Using an in. lb. torque wrench, turn the stub shaft to the right stop, then back 1/4 turn. Measure the torque. Reading should be taken with beam of torque wrench near verticle while turning counter-clockwise at an even rate (figure 63).

2. Turn the stub shaft from stop to stop, counting the total number of turns. Divide this number by two. Starting at either stop, turn the stub shaft 1/2

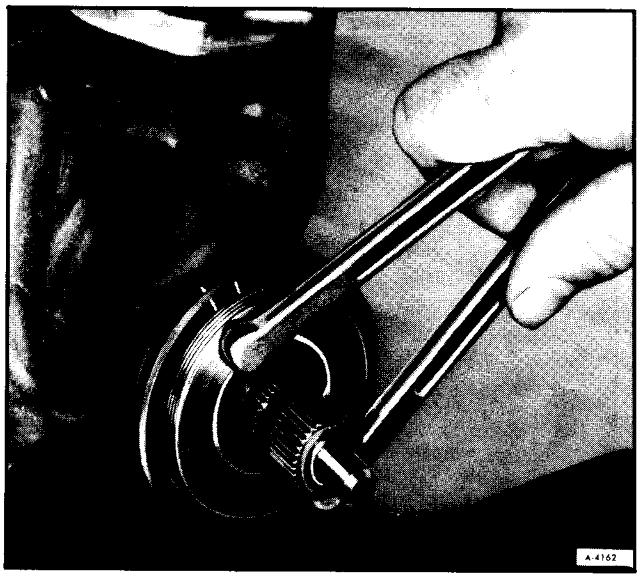


Figure 61—Adjuster Rotation

Figure 62—Tightening Nut

Figure 63—Torque Wrench Reading

Figure 64—Stub Shaft Flat Alignment

the total number of turns. This is the "center" of the gear. (The flat on the stub shaft is normally up and parallel with the side cover when the gear is "on center" (figure 64) and the block tooth on the pitman shaft is in line with the over-center preload adjuster (figure 65).

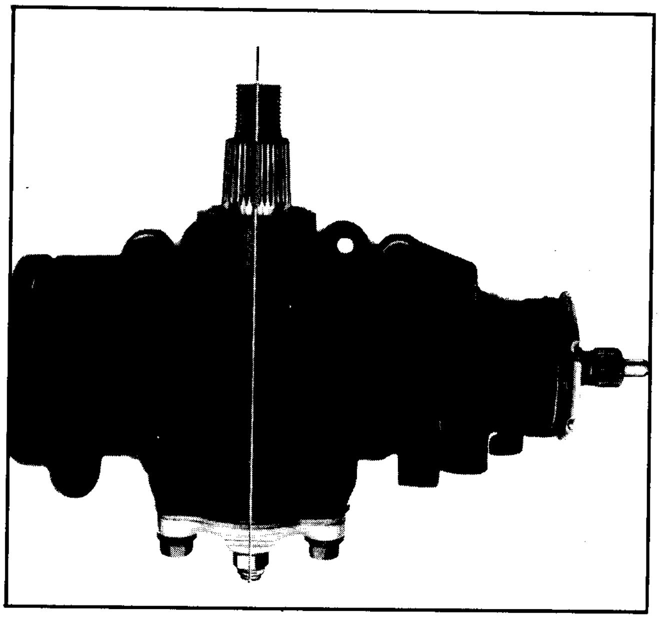


Figure 65—Over-Center Alignment

Figure 66—Torque Wrench Reading

3. Rotate the torque wrench approximately 45 degrees each side of center and "read" near or on center (highest reading) (figure 66). Loosen the locknut and turn the preload adjusting screw CW until the correct "O" center torque, in excess of the reading just taken, is obtained (figure 66).

4. Limits for "new" and "used" gears are different, as follows:

a. "New" gear over-center torque to be 4-8 in. lbs. additional torque.

b. "Used" gear (400 or more miles). Over-center torque to be 4 to 5 in. lbs. additional torque.

Tighten the locknut to 35 ft. lbs. while holding the preload adjuster screw. Recheck the "O" center adjustment.

BLEEDING POWER STEERING SYSTEMS

When a power steering pump or gear has been installed, the air that has entered the system must be bled out before the vehicle is again operated. If air is allowed to remain in the power steering fluid system, noisy and unsatisfactory operation of the system will result. Bleed air from the hydraulic system as follows:

NOTE: Add only new power steering fluid (GM 1050017 or equivalent) to power steering system.

1. Fill oil reservoir to proper level and let oil remain undisturbed for at least two minutes.

2. Start engine and run momentarily.

3. Add oil if necessary.

4. Repeat above procedure until oil level remains constant after running engine.

5. Raise front end of vehicle so that wheels are off the ground.

6. Turn the wheels (off ground) right and left, lightly contacting the wheel stops.

7. Add oil if necessary.

8. Lower the vehicle and turn wheels right and left on the ground.

9. Check oil level and refill as required.

10. If oil is extremely foamy, allow vehicle to stand a few minutes with engine off and repeat above procedure.

11. The presence of trapped air in the system will cause the fluid level in the pump to rise when the engine is turned off. Continue to bleed system until this condition no longer occurs.

STEERING COLUMN

CAUTION: *All column fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with parts of the same part numbers or with equivalent parts if replacement becomes necessary. Do not use replacement parts of lesser quality or substitute design. Torque values must be used as specified during re-assembly to assure proper retention of these parts.*

GENERAL INFORMATION AND OPERATION

The function locking energy-absorbing steering column includes three important features in addition to the steering function:

I. The column is energy-absorbing, designed to compress up to 8.25 inches in a front-end collision to minimize the possibility of injury to the driver of the vehicle.

II. The ignition switch and lock are mounted conveniently on the column.

III. With the column mounted lock, the ignition, steering and gearshifting operation can be locked to inhibit theft of the vehicle.

The function locking energy-absorbing steering column assembly is used on all vehicles. When a vehicle is being driven, the forward movement of the vehicle and the forward movement of the driver both constitute a form of kinetic energy. When a vehicle is involved in a frontal collision, the primary force (forward movement of the vehicle) is suddenly halted, while the secondary force (the driver) continues its forward direction. A severe frontal collision generally involves these two forces—the primary and the secondary forces. Thesecondary impact occurs when the driver is thrust forward onto the steering wheel and column.

The function locking energy-absorbing column is designed to absorb these primary and secondary forces to the extent that the severity of the secondary impact is reduced.

The tilt function locking columns are designed for ease of entry and driver comfront. These columns have six or seven different steering wheel angle positions.

The tilt mechanism consists of an upper and lower steering shaft assembly with a universal joint between them. A support assembly is held to the mast jacket by a lock plate, and a hearing housing assembly is positioned over the upper steering shaft and secured to the support by two pivot pins. Two lock shoes are pinned to the housing assembly and engage a pin in the support assembly. When the release lever is pulled up and the lock shoes disengage the support pin, the steering wheel is pushed up by a spring compressed between the support and housing assemblies.

The operation of the lock is the same as in other GM vehicles. To start the vehicle, you insert the key in the lock, turn the unit clockwise to "start" and let the switch return to the "on" position. The "off", "lock" and "accessory" positions are also the same as in other GM vehicles When you engage the shift lever in "park" and lock the ignition, the steering wheel locks and the gearshift locks.

The function locking energy-absorbing column may be easily disassembled and reassembled. The serviceman should be aware that it is important that only the specified screws, bolts and nuts be used as designated and that they are tightened to their specified torque. This precaution will insure the energy absorbing action of the assembly. Overlength bolts should not be used, as they may prevent a portion of the assembly from compressing under impact. Equally as important is correct torque of bolts and nuts. Care should be taken to assure that the bolts or nuts securing the column mounting bracket to the instrument panel are torqued to the proper specification in order that the bracket will break away under impact.

When the column is removed, special care must be taken in handling this assembly. Only the specified wheel puller should be used. When the column is removed from the vehicle, such actions as a sharp blow on the end of the steering shaft or shift lever, leaning on the column assembly, or dropping of the assembly could shear or loosen the plastic fasteners that maintain column rigidity. It is, therefore, important that the removal and installation and the disassembly and reassembly procedures be carefully followed when servicing the assembly.

STEERING COLUMN TROUBLE DIAGNOSIS

LOCK SYSTEM DIAGNOSIS

Condition	Possible Cause	Correction
Will not unlock.	A. Shear flange on sector shaft collapsed. B. Lock bolt damaged. C. Defective lock cylinder. D. Damaged housing. E. Damaged sector. F. Damaged rack.	A. Replace sector. B. Replace lock bolt. C. Replace lock cylinder. D. Replace housing. E. Replace sector. F. Replace rack.
Will not lock.	A. Lock bolt spring broken or defective. B. Damaged sector tooth. C. Defective lock cylinder. D. Burr on lock bolt or housing. E. Damaged housing. F. Transmission linkage adjustment incorrect. G. Damaged rack. H. Interference between bowl and rack coupling. I. Ignition switch stuck. J. Acutator rod restricted.	A. Replace lock bolt spring. B. Replace sector. C. Replace lock cylinder. D. Remove burr. E. Replace housing. F. Readjust. G. Replace rack. H. Replace bowl or actuator rod as required. I. Replace ignition switch. J. Readjust.
High effort.	A. Lock cylinder defective. B. Ignition switch defective. C. Rack preload spring broken or deformed. D. Burrs on sector, rack, housing, support or acuator rod coupling. E. Bent sector shaft. F. Defective rack. G. Extreme misalignment of housing to cover. H. Distorted coupling slot in rack. I. Bent actuator rod. J. Ignition switch mounting bracket bent.	A. Replace lock cylinder. B. Replace ignition switch. C. Replace preload spring. D. Remove burr. E. Replace shaft. F. Replace rack. G. Replace either or both. H. Replace rack. I. Straighten or replace. J. Straighten or replace.
Will stick in "start".	A. Actuator rod deformed. B. Any high effort condition.	A. Straighten or replace. B. Check items under high effort section.
Key can not be removed in "off-lock".	A. Ignition switch is not set correctly. B. Defective lock cylinder.	A Readjust. B. Replace lock cylinder.

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
Lock cylinder can be removed without depressing retainer.	A. Lock cylinder with defective retainer. B. Lock cylinder without retainer. C. Burr over retainer slot in housing cover.	A. Replace lock cylinder. B. Replace lock cylinder. C. Remove burr.

IGNITION SYSTEM DIAGNOSIS

Condition	Possible Cause	Correction
Electrical system will not function.	A. Poor battery connection. B. Connector body loose or defective. C. Defective wiring. D. Defective ignition switch. E. Ignition switch not adjusted properly.	A. Connect securely. B. Tighten or replace. C. Repair or replace. D. Replace ignition switch. E. Readjust.
Switch will not actuate mechanically.	A. Defective ignition switch.	A. Replace.
Switch can not be set correctly.	A. Switch actuator rod deformed. B. Sector to rack en- in wrong tooth.	A. Repair or replace. B. Engage correctly.

STEERING COLUMN

Condition	Possible Cause	Correction
Noise in column.	A. Coupling bolts not tightened. B. Column not correctly aligned. C. Coupling pulled apart. D. Broken lower joint. E. Horn contact ring	A. Tighten pinch bolts to 40-45 foot pounds. B. Realign column. C. Realign column and replace coupling. D. Repair joint using kit #7810077 and realign column. E. Lubricate with lubriplate.

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
	not lubricated. F. Lack of grease on bearings or bearing surfaces. G. Loose sight shields. H. Lower shaft bearing worn or broken. I. Upper shaft bearing worn or broken. J. Shaft lock plate cover loose. K. Shaft lock snap ring not seated. L. One click when in "off-lock" position and the steering wheel is moved.	F. Lubricate. G. Bend to eliminate rattle. H. Replace bearing. Check shaft and replace if scored. I. Replace bearing assembly. J. Tighten three screws to 15 in.-lbs., or if missing, replace. **Caution:** Use specified screws. K. Replace snap ring. Check for proper seating in groove. L. Normal—lock bolt is seating.
High steering shaft effort.	A. Column assembly mis-aligned. B. Improperly installed or deformed dust seal. C. Defective upper or lower bearing. D. Flash on I.D. of shift tube from plastic joint. E. Tight steering uni-versal joint.	A. Realign. B. Install new seal. C. Replace. D. Replace shift tube. E. Repair or replace.
High shift effort.	A. Column not aligned correctly in vehicle. B. Wave washer with burrs. C. Improperly installed dust seal. D. Lack of grease on seal or bearing. E. Improper screws used for ignition switch, neutral start switch or mounting bracket. F. Burr on upper or lower end of shift tube.	A. Realign. B. Replace. C. Remove and replace. D. Lubricate. E. Use correct fasteners. F. Remove burr.
Improper transmission shifting.	A. Sheared shift tube joint or lower shift lever weld. B. Improper transmission linkage adjustment.	A. Replace tube assembly. B. Readjust.

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
Miscellaneous.	A. Housing loose on jacket—will be noticed with ignition in "off-lock" and a torque applied to the steering wheel.	A. Tighten four mounting screws 60 in.-lbs.
Lash in mounted column assembly.	A. IP to column bracket mounting bolts loose. B. Broken weld nuts on jacket. C. IP bracket capsule sheared. D. Loose shoes in housing. E. Loose tilt head pivot pins. F. Loose shoe lock pin in support. G. Loose support screws. H. Column bracket to jacket bolts loose.	A. Tighten to 20 foot pounds. B. Replace jacket assembly. C. Replace bracket assembly. D. Replace shoes. E. Replace pivot pins. F. Replace pin. G. Tighten to 60 in.-lbs. H. Tighten to 15 foot pounds.
Housing scraping on bowl.	A. Bowl bent or not concentric with hub.	A. Replace bowl.
Steering wheel loose.	A. Excessive clearance between holes in support or housing and pivot pin diameters. B. Defective or missing anti-lash spring in spheres. C. Upper bearing not seating in bearing. D. Upper bearing inner race seat missing. E. Improperly adjusted tilt locking knob. F. Loose support screws. G. Bearing preload spring missing or broken.	A. Replace either or both. B. Add spring or replace both. C. Replace both. D. Install seat. E. Readjust. F. Tighten 60 in.-lbs. G. Replace preload spring.
Steering wheel loose—every other tilt position.	A. Loose fit between shoe and shoe pivot pin.	A. Replace both.
Steering column not locking in any tilt position.	A. Shoe seized on its pivot pin. B. Shoe grooves may have burrs or dirt. C. Shoe lock spring weak or broken.	A. Replace both. B. Replace shoe. C. Replace lock spring.

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
Steering wheel fails to return to top tilt position.	A. Pivot pins are bound up. B. Wheel tilt spring is defective. C. Turn signal switch wires too tight.	A. Replace pivot pins. B. Replace tilt spring. C. Readjust.
Noise when tilting column.	A. Upper tilt bumpers worn. B. Tilt spring rubbing in housing.	A. Replace tilt bumper. B. Lubricate.

SIGNAL SWITCH DIAGNOSIS

Condition	Possible Cause	Correction
Turn signal will not cancel.	A. Loose switch mounting screws. B. Switch or anchor bosses broken. C. Broken, missing or out of position detent, return or cancelling spring. D. Uneven or incorrect cancelling cam to cancelling spring interference. (.120)/side.	A. Tighten to specified torque (25 in.-lbs.). B. Replace switch. C. Reposition or replace springs as required. D. Adjust switch position. 1. If interference is correct and switch will still not cancel, replace switch. 2. If interference cannot be corrected by switch adjustment, replace cancelling cam.
Turn signal difficult to operate.	A. Actuator rod loose. B. Yoke broken or distorted. C. Loose or misplaced D. Foreign parts and/or materials. E. Switch mounted loosely.	A. Tighten mounting screw (12 in.-lb.). B. Replace switch. C. Reposition or replace springs. D. Remove foreign parts and/or material. E. Tighten mounting screws (25 in.-lbs.).

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
Turn signal will not indicate lane change.	A. Broken lane change pressure pad or spring hanger. B. Broken, missing or mis-placed lane change spring. C. Jammed base or wires.	A. Replace switch. B. Replace or reposition as required. C. Loosen mounting screws, reposition base or wires and retighten screws (25 in.-lbs.).
Turn signal will not stay in turn position.	A. Foreign material or loose parts impeding movement of yoke. B. Broken or missing de-tent or cancelling springs. C. None of the above.	A. Remove material and/or parts. B. Replace spring. C. Replace switch.
Hazard switch cannot be turned off.	A. Foreign material be-tween hazard support can-celling leg and yoke.	A. Remove foreign material. No foreign material impeding function of hazard switch—replace turn signal switch.
Hazard switch will not stay on or difficult to turn off.	A. Loose switch mounting screws. B. Interference with other components. C. Foreign material. D. None of the above.	A. Tighten mounting screws (25 in.-lbs.). B. Remove interference. C. Remove foreign material. D. Replace switch.
No turn signal lights.	A. Defective or blown fuse. B. Inoperative turn signal flasher. C. Loose chassis to column connector. D. *Disconnect column to chassis connector. Connect new switch to chassis and operate switch by hand. If vehicle lights now operate normally, signal switch is inoperative. E. If vehicle lights do not operate check chassis wiring for opens, grounds, etc.	A. Replace fuse. B. Replace turn signal flasher. C. Connect securely. D. Replace signal switch. E. Repair chassis wiring as required using manual as guide.
Turn indicator lights on, but not flashing.	A. Inoperative turn flasher.	A. Replace turn flasher. Note: There are two flashers in the system. Consult manual for location.

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
	B. Loose chassis to column connection. C. Inoperative turn signal switch. D. To determine if turn signal switch is defective, substitute new switch into circuit and operate switch by hand. If the vehicle's lights operate normally, signal switch is inoperative. E. If the vehicle's lights do not operate, check light sockets for high resistance connections, the chassis wiring for opens, grounds, etc.	B. Connect securely. C. Replace turn signal switch. D. Replace signal switch. E. Repair chassis wiring as required using manual as guide.
Front or rear turn signal lights not flashing.	A. Burned out or damaged turn signal bulb. B. High resistance connection to ground at bulb socket. C. Loose chassis to column connector. D. Disconnect column to chassis connector. Connect new switch into system and operate switch by hand. If turn signal lights are now on and flash, turn signal switch is inoperative. E. If vehicle lights do not operate, check chassis wiring harness to light sockets for opens, grounds, etc.	A. Replace bulb. B. Remove or repair defective connection. C. Connect securely. D. Replace turn signal switch. E. Repair chassis wiring as required using manual as guide.
Stop light not on when turn indicated	A. Loose column to chassis connection. B. Disconnect column to chassis connector. Connect new switch into system without removing old. Operate switch by hand. If brake lights work with switch in the turn position, signal switch is defective. C. If brake lights do not work check connector to stop light sockets for grounds, opens, etc.	A. Connect securelv. B. Replace signal switch. C. Repair connector to stop light circuits using manual as guide.

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
Turn indicator panel lights not flashing.	A. Burned out bulbs. B. High resistance to ground at bulb socket. C. Opens, grounds in wiring harness from front turn signal bulb socket to indicator lights.	A. Replace bulbs. B. Replace socket. C. Locate and repair as required. Use shop manual as guide.
Turn signal lights flash very slowly.	A. Inoperative turn signal flasher. B. System charging voltage low. C. High resistance ground at light sockets. D. Loose chassis to column connection. E. Disconnect column to chassis connector. Connect new switch into system without removing old. Operate switch by hand. If flashing occurs at normal rate, the signal switch is defective. F. If the flashing rate still extremely slow, check chassis wiring harness from the connector to light sockets for grounds, high resistance points, etc.	A. Replace turn signal flasher. B. Increase voltage to specification. Use manual. C. Repair high resistance grounds at light sockets. D. Connect securely. E. Replace signal switch. F. Locate and repair as required. Use manual as guide.
Hazard signal lights will not flash—turn signal functions normally.	A. Blown fuse. B. Inoperative hazard warning flasher. C. Loose chassis to column connection. D. Disconnect column to chassis connector. Connect new switch into system without removing old. Depress the hazard warning button and observe the hazard warning lights. If they now work normally, the turn signal switch is defective.	A. Replace fuse. B. Replace hazard warning flasher. C. Connect securely. D. Replace the turn signal switch.

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
	E. If the lights do not flash, check wiring harness "K" lead (brown) for open between hazard flasher and harmonica connector. If open, fuse block is defective.	E. Replace fuse block.

KEY BUZZER DIAGNOSIS

Condition	Possible Cause	Correction
Buzzer does not sound with key fully inserted in lock cylinder with the entrance door open.	A. Defective buzzer.	A. Replace buzzer.
	B. Bad connection at buzzer.	B. Connect securely.
	C. Power not available to buzzer.	C. Check continuity of chassis wiring and repair as required.
	D. Door jamb switch misadjusted or inoperative.	D. Readjust or replace—as required.
	E. Short in chassis wiring.	E. Check by separating chassis to column connector. Connect "E" (black) and "F" (black w/pink stripe) female contacts on the chassis side (figure 67). Bent paper clip will work if buzzer sounds. continue diagnosis. If not, locate, and repair chassis wiring, use manual as guide.

NOTE 1: If the buzzer fault has not yet been detected, connect a continuity meter (light) to the male "E" and "F" connector contacts (figure 68). Insert the key the full depth into the lock cylinder.

If contact is made with the key in, and is not made with it out, the function is normal. Retrace initial diagnostic steps.

If contact is not established, the fault is in the column. Proceed to Note 2.

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
NOTE 2: With the fault isolated in the column, disassemble the upper end of the column until the signal switch mounting screws have been removed. Lift the switch and check the probes of the buzzer switch to insure good contact with the pads on the signal switch. Bend probes, if required, then reseat the signal switch and drive the three screws. Check the function, as in Note 1.		
Buzzer does not sound with key fully inserted in lock cylinder with the entrance door open.	F. Short or fault in signal switch wiring.	F. Connect male "E" and "F" contacts of connector with jumper (figure 69). Check buzzer switch pads with continuity meter. If contact is made, function is normal. If not, replace signal switch.
NOTE 3: If the fault has not yet been isolated and repaired, connect a continuity meter to the buzzer switch probes (figure 70). Fully insert and remove the key from the lock cylinder. If contact is made with the key in, and is broken with it out, the function is normal. Retrace diagnostic steps starting at Note 2. If contact is not made, the fault is in the lock cylinder or buzzer switch.		

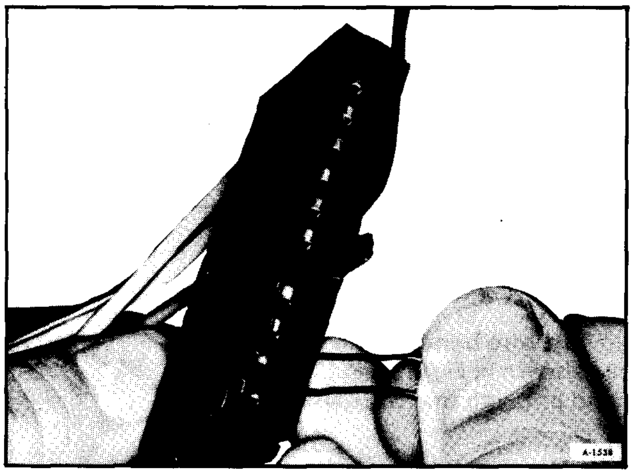


Figure 67—Checking For Short In Chassis Wiring

Figure 69—Checking Buzzer Switch Pads

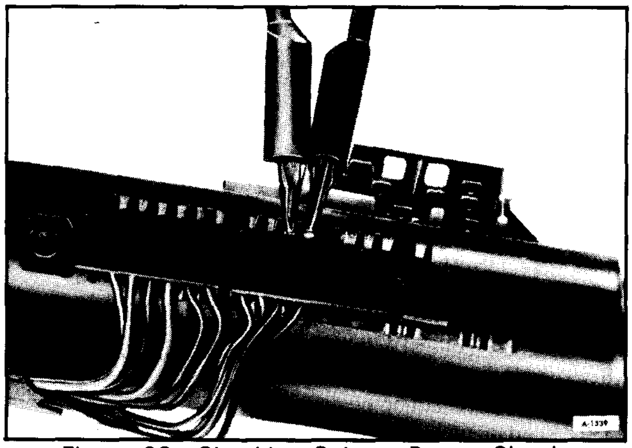


Figure 68—Checking Column Buzzer Circuit Continuity

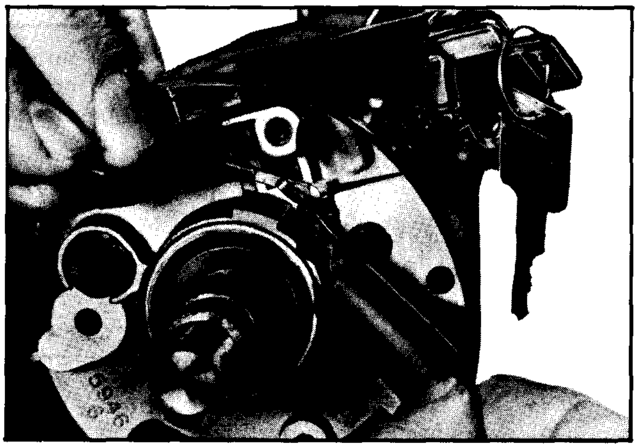


Figure 70—Checking Buzzer Switch Continuity

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
Buzzer does not sound with the key fully inserted in lock cylinder with the entrance door open.	G. Chips, burrs, foreign material preventing actuator tip function. **Caution:** Key must be removed or cylinder in "run" position before removing lock cylinder.	G. Remove chips, burrs, etc. Reassemble and re-check ref. note 3.
	H. Defective lock	H. With the lock cylinder out (observing caution under G), fully insert and remove the key. The actuator (figures 71 and 72) should extend and retract smoothly. Total extension of tip should be .050 in. If not, replace lock cylinder.
	I. Chips, foreign material affecting buzzer switch operation.	I. Remove and clean as required—reassemble and re-check per note 3.
	J. Damaged or broken buzzer switch.	J. Replace buzzer switch.
	K. Switch appears good but will not make buzzer switch function check.	K. Connect continuity meter leads to the buzzer switch probes. Press on the actuator pad until the interior points contact. (figure 73). If contact is not made, replace buzzer switch.
	L. Buzzer switch contact gap too large.	L. Reset contact gap.

NOTE 4: Setting the contact gap. Press a .030 wire type spark plug gap wire with flat piece of stock on the actuator pad. (figure 74) If contact is not made adjust switch as shown in Figure 75, until positive contact is made. (Use continuity meter).
With positive contact at .030, use a .025 plug gap wire beneath the flat stock (figure 76). No contact should occur. Adjust as shown in Figure 77. When the switch will make contact with the .030 wire and not with the .025, the buzzer switch is set at the low limit.

Condition	Possible Cause	Correction
Buzzer continues to operate with key in the lock cylinder with the entrance door either opened or closed and ceases when key is removed.	A. Door jamb switch misadjusted or inoperative. or inoperative.	A. Adjust or replace as required.
	B. Wire from signal switch to door jamb switch shorted.	B. If on signal switch side, replace signal switch. If on chassis side, find and repair—use manual.

NOTE 5: This condition indicates the lock cylinder or buzzer switch is at fault. To verify, check for continuity at the "E" & "F" male connector contacts with the key removed from the cylinder (figure 68). If continuity exists, the fault is in the column.

STEERING COLUMN TROUBLE DIAGNOSIS (Cont'd.)

Condition	Possible Cause	Correction
Buzzer continues to operate with key out, but stops when door is closed.	A. Turn lock towards "start" position if buzzer stops in "run" position or when turned past "run" towards "start", the problem is a sticky lock cylinder actuator.	A. Replace lock cylinder.
	B. Chips, foreign material in lock cylinder bore.	B. Remove, reassemble and recheck function.
	C. Sticky lock cylinder actuator tip.	C. Replace lock cylinder.
	D. Damaged or broken buzzer switch.	D. Replace buzzer switch.
	E. Buzzer switch contact gap too close.	E. Adjust as specified.

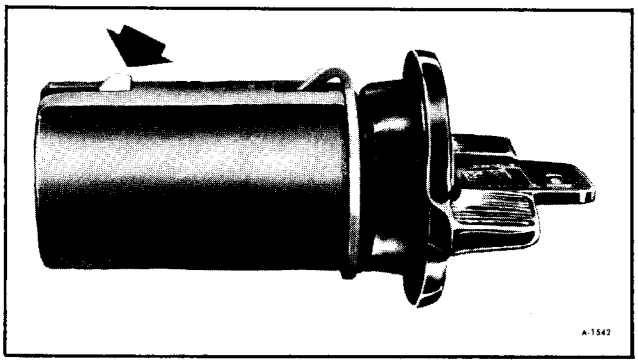


Figure 71—Actuator Extended

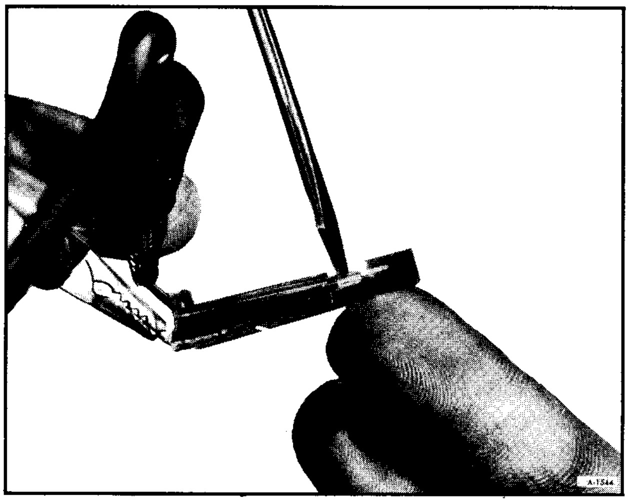


Figure 73—Checking Buzzer Switch Continuity

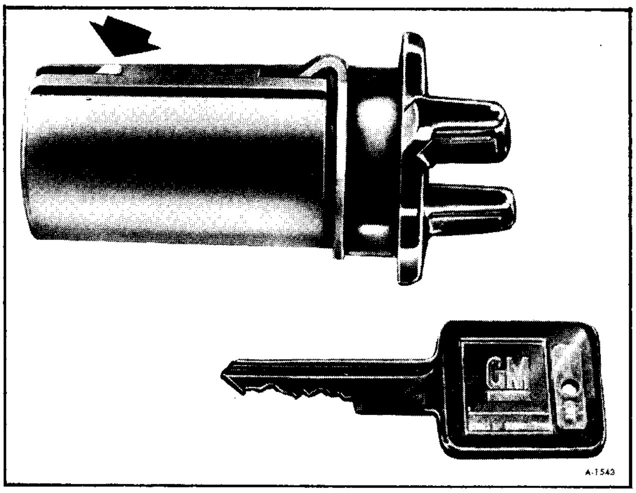


Figure 72—Acutator Retracted

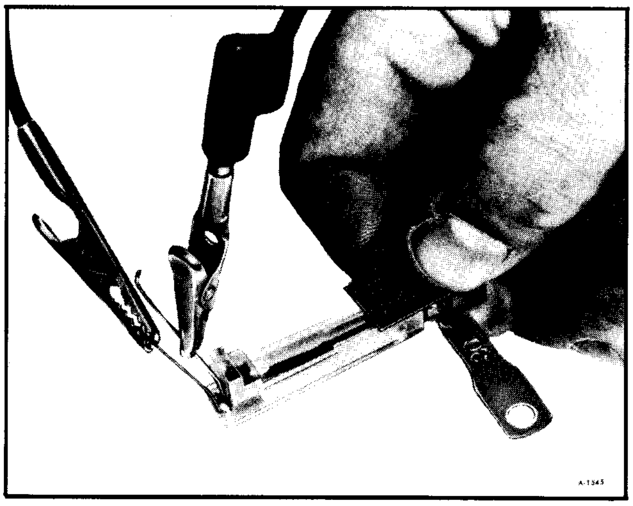


Figure 74—Checking Contact Gap

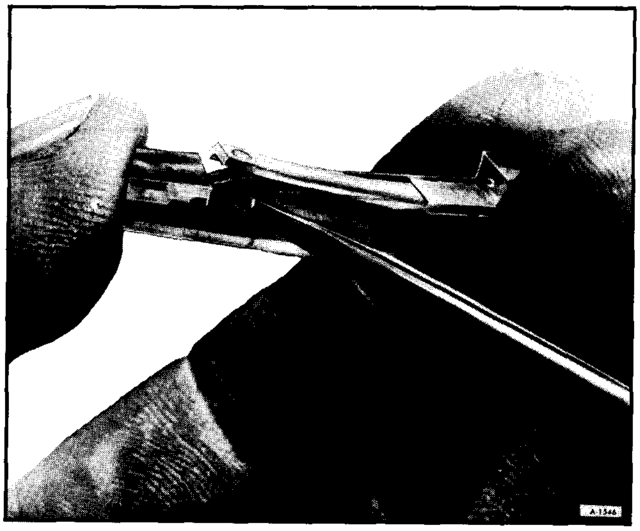


Figure 75—Adjusting Buzzer Switch

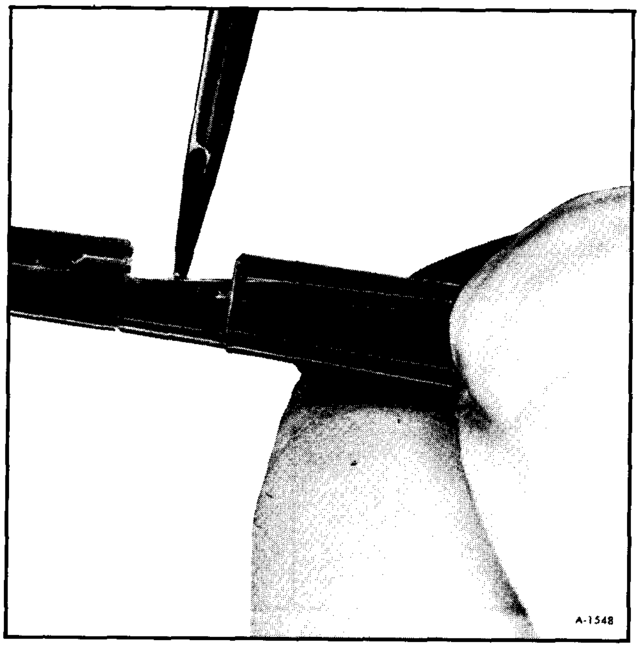


Figure 77—Adjusting Buzzer Switch

REMOVAL OF STEERING COLUMN

NOTE: Once the steering column is removed from the vehicle, the column is extremely susceptible to damage. Dropping the column assembly on its end could collapse the steering shaft or loosen the plastic injections which maintain column rigidity. Leaning on the column assembly could cause the jacket to bend or deform. Any of the above damage could impair the column's collapsible design. If it is necessary to remove the steering wheel, use standard wheel puller. Under no conditions should the end of the shaft be hammered upon as hammering could loosen plastic injections which maintain column rigidity.

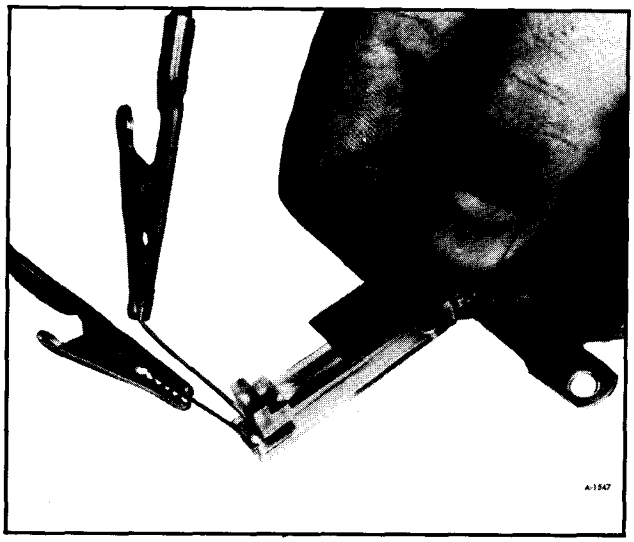


Figure 76—Checking Contact Gap

1. Disconnect column from lower steering shaft at cinch clamp.

2. Disconnect the shift linkage from the shift lever.

3. Remove screws securing toe pan cover to firewall and loosen cover.

4. Remove bolts securing bracket to instrument panel and disconnect "PARK RNDSL" pointer on the automatic shift column.

5. Disconnect all electrical connectors from the steering column assembly. Carefully withdraw column.

TILT COLUMN OVERHAUL

DISASSEMBLY OF STEERING COLUMN

1. Disconnect column from lower steering shaft at cinch clamp.

2. Remove column mounting bracket from column and SET ASIDE TO PROTECT BREAKAWAY CAPSULES.

3. Mount assembly in vise using tool No. J-23074.

4. Remove steering wheel using wheel puller. DO NOT HAMMER ON END OF STEERING SHAFT.

Figure 78—Removing Wire Protector

5. Remove signal switch wire protector. DO NOT DAMAGE WIRES. (figure 78). Wrap a piece of tape around the upper connector and wires to prevent snagging when removing the switch. (figure 79)

6. Remove three cover screws. Remove shaft lock cover.

7. Remove tilt release lever and signal switch lever. Push hazard warning plunger in and remove hazard warning knob. Remove upper shift lever from bowl. Remove indicator wire, if automatic transmission column. Remove neutral start switch.

8. Depress lock plate with finger and pry retaining ring out of groove with screwdriver (figure 81). Tool J-23653 can be used (figure 80) but the full load of the upper bearing spring should not be relieved as then the retaining ring will turn easily making removal more difficult. Remove lock plate, cancelling cam and upper bearing spring.

9. Remove the three signal switch mounting screws.

10. Position shift bowl in "low" shift position. Pull the switch straight up (figure 82).

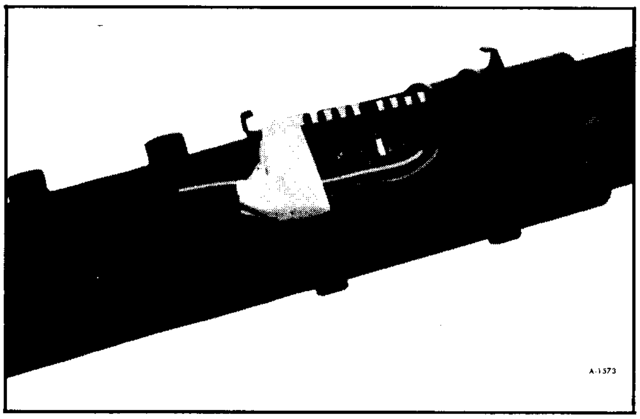


Figure 79—Connector and Wires Taped

Figure 80—Removing Retaining Ring

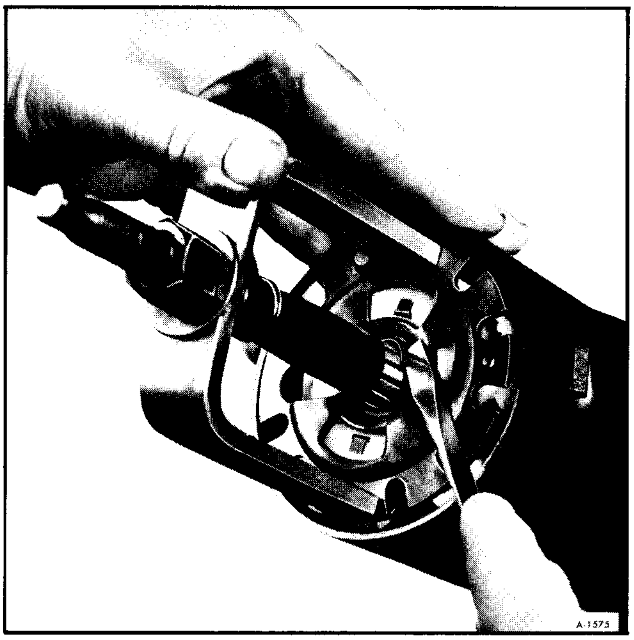


Figure 81—Using Tool to Remove Retaining Ring

Figure 82—Removing Signal Switch

11. The lock cylinder should be removed in the "Run" position.

12. Insert a thin tool (small screw driver or knife blade) into the slot next to the switch mounting screw boss (right-hand slot) and depress retainer at bottom of slot, which releases lock. Remove lock (figure 83).

13. The buzzer switch can be pulled straight out of the housing (figure 84). A flat spring wedges the switch toward the lock cylinder (figure 85).

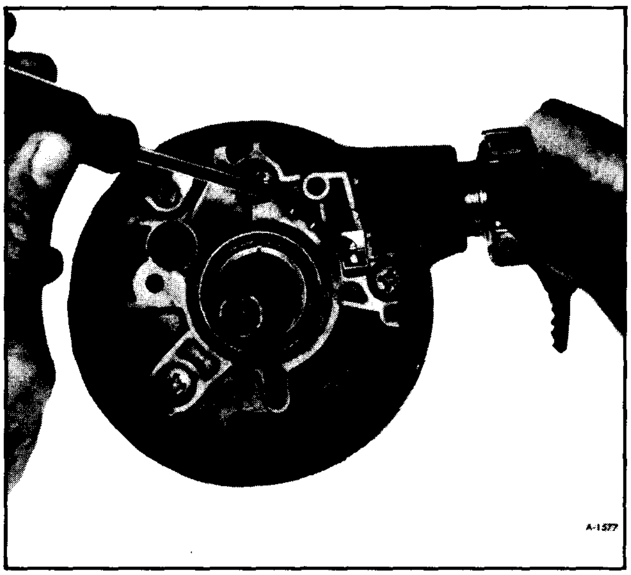


Figure 83—Removing Lock

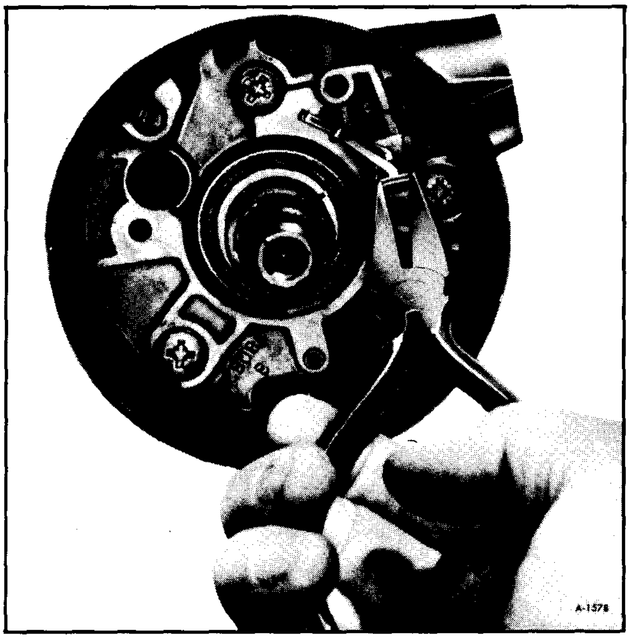


Figure 84—Removing Buzzer Switch

14. Remove three housing cover screws and remove housing cover.

15. Reinstall tilt release lever and place column in full tilt "up" position. Remove tilt spring retainer using screwdriver blade that just fits into slot opening. Insert screwdriver in slot, press in approximately 3/16 in., turn approximately 1/8 turn counterclockwise until ears align with grooves in housing and remove spring and guide (figure 86).

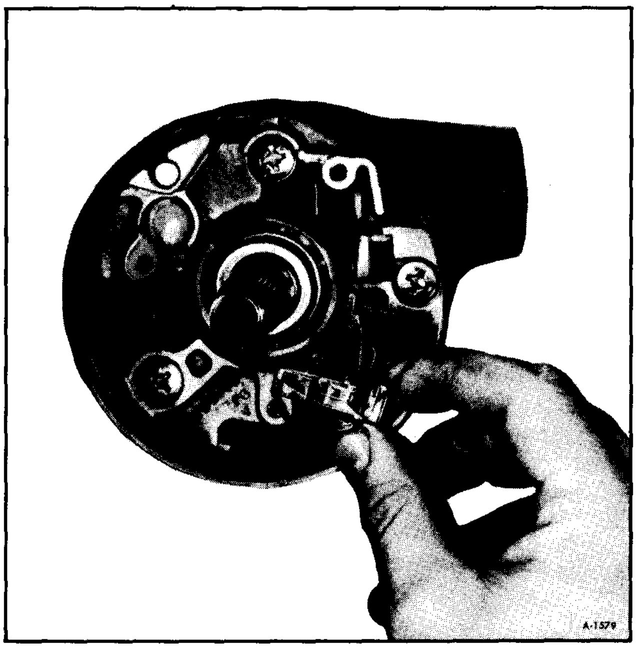


Figure 85—Buzzer Switch and Spring Retainer

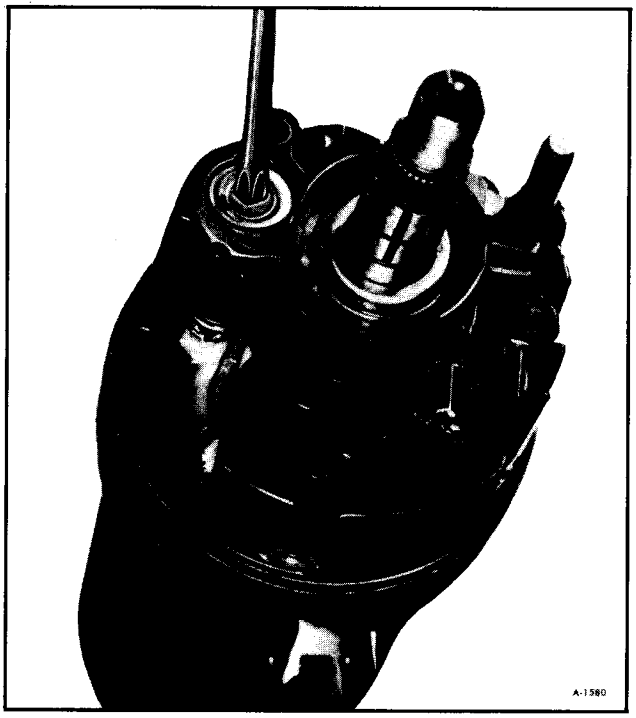


Figure 86—Removing Tilt Spring Retainer

16. With the ignition switch in "acc" position, remove two ignition switch mounting screws and ignition switch. Remove two neutral-start switch screws and neutral-start switch.

17. Remove two pivot pins with tool No. J-21854-1 (figure 87). Remove intermediate shaft assembly or lower flange so shaft can be pulled up through column.

Figure 87—Removing Pivot Pins

18. Disengage lock shoes by pulling on release lever. Remove bearing housing assembly by pulling upward to extend rack full downand moving housing assembly to the left to disengage rack from actuator. Remove actuator rod assembly.

19. Remove steering shaft assembly. Remove upper bearing seat and inner race.

20. Disassemble steering shaft assembly by removing center spheres and anti-lash spring.

21. Remove four support screws and remove support assembly.

22. Remove shift tube retaining ring with screw driver. Remove thrust washer.

If service is required on upper end only, steps 1 thru 22 may be performed in the vehicle. It is necessary to remove the mounting bracket and loosen toe plate to prevent bending of jacket and toe plate to service the signal switch.

23. Remove clip, bearing adapter retainer and bearing adapter assembly from lower end of jacket.

24. Remove shift tube from bowl (use tool No. J-23072) (figure 88). Insert bushing on end of tool in shift tube and force tube out of bowl. Care should be taken not to jam lower shift lever into lower jacket. Lever must be aligned with "T" slot to remove shift tube. DO NOT HAMMER OR PULL ON LOWER OR UPPER SHIFT TUBE BECAUSE PLASTIC JOINT MAY BE SHEARED.

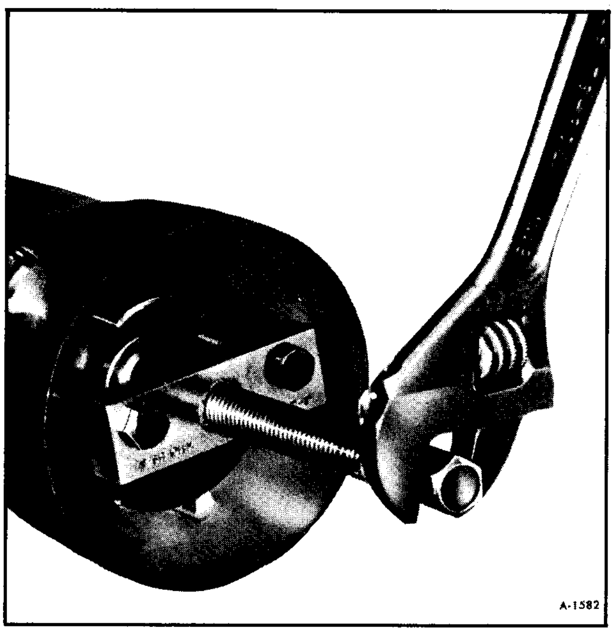


Figure 88—Removing Shift Tube From Bowl

A-1583

Figure 89—Removing Tilt Lever Shield

25. Remove shift tube assembly from jacket from lower end.

26. Remove lock plate by sliding out of jacket notches and tipping down toward bowl hub at 12 o'clock position and under jacket opening. Remove wave washer.

27. Remove bowl from jacket. Remove shift lever spring from bowl by winding spring up with pliers and pulling out.

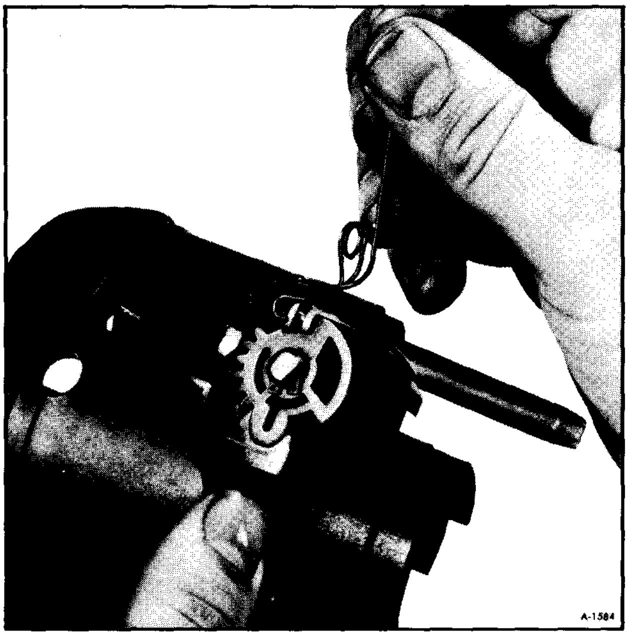


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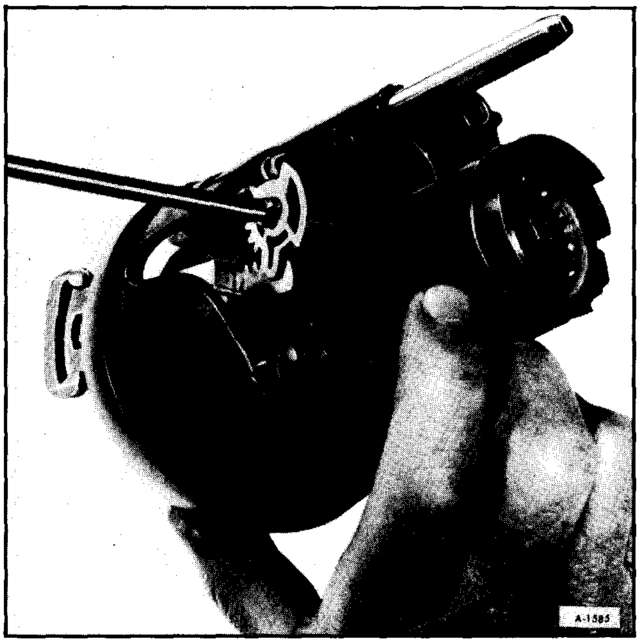
Figure 90—Removing Lock Bolt Spring



A-1585

Figure 91—Removing Drive Shaft

28. Remove tilt lever opening shield from housing (figure 89).

29. Remove lock bolt spring by removing spring retaining screw and moving spring clockwise to remove from bolt (figure 90).

30. If there is a snap ring, remove it from sector drive shavt. With small punch lightly tap drive shaft from sector (figure 91). Remove drive shaft. Remove rack and rack spring (also shim, if there is one). Remove sector and bolt.

31. Remove tilt release lever pin with pin punch and hammer. Remove lever and release lever spring. (To relieve load on release lever, hold shoes inward and wedge block between top of shoes (over slots and bearing housing) (figure 92).

32. Remove lock shoe pin with punch and hammer. Remove lock shoes and lock shoe springs.

33. Remove bearings from bearing housing **only if they are to be replaced.** Remove separator and balls from bearing. Place housing on work surface. With a pointed punch against back surface of race, carefully hammer race out of housing until bearing puller can be used. Repeat for other race. Do not re-use bearings.

ASSEMBLY OF STEERING COLUMN

Apply thin coat of lithium grease to all wear surfaces except lock, bolt and lock bolt hole.

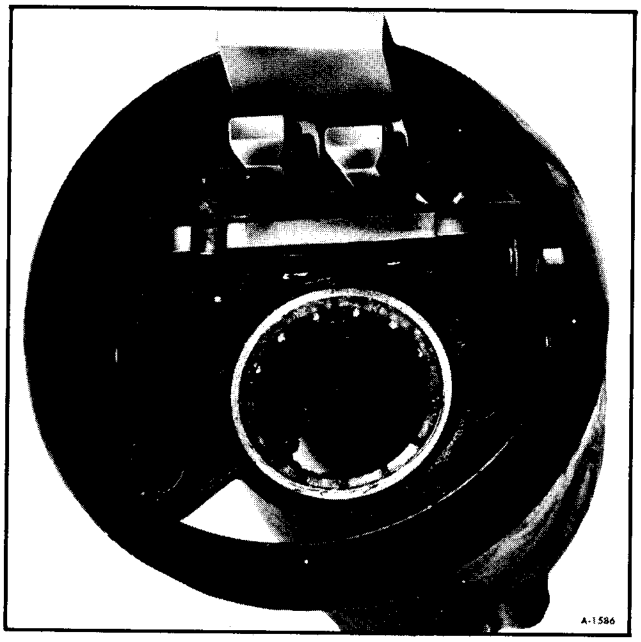


Figure 92—Removing Load on Release Lever

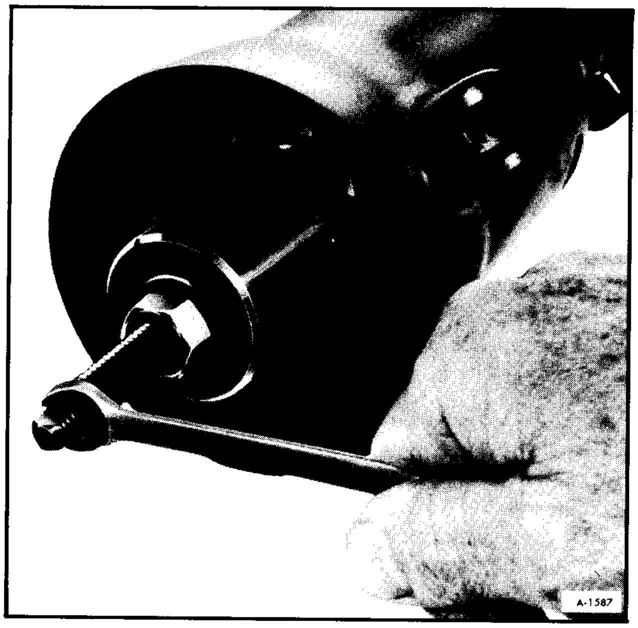


Figure 93—Installing Shift Tube

1. Install new bearings in bearing housing, if removed.

2. Install lock shoe springs, lock shoe and shoe pin in bearing housing. Use approximately .180 rod to line up shoes for pin installation.

3. Install spring, release lever and pin in bearing housing. (Again, relieve load on release lever as in step 31 of "Disassembly of Steering Column".

4. Install drive shaft in housing. Lightly tap sector onto the shaft far enough to expose snap ring groove. Replace snap ring if it was removed.

5. Install lock bolt and engage with sector cam surface (figure 90).

6. Install rack and spring. (Replace shim if one was removed). Block tooth on rack to engage block tooth on sector (figure 90). Install external tilt release lever.

7. Install bolt spring and spring retaining screw. Tighten to 35 inch-pounds.

8. Install shift lever spring in bowl by winding up with pliers and pushing in. Slide bowl into jacket.

9. Install wave washer and lock plate into place. Work lock plate into notches in jacket by tipping lock plate toward bowl hub at 12 o'clock position and under jacket opening. Slide lock plate into notches in jacket.

10. Carefully install shift tube in lower end of jacket. Align key in tube with keyway in bowl and use Tool No. J-23073 to pull shift tube into bowl (figure 93).

CAUTION: *DO NOT PUSH OR TAP ON END OF SHIFT TUBE. Install thrust washer and retaining ring by pulling bowl up to compress wave washer.*

11. Install support by aligning "V" in support with "V" notch in jacket. Insert screws through support in lock plate. Tighten screws to 60 inch-pounds torque.

12. Align lower bearing adapter notches in jacket and push in lower end of jacket. Shift tube should pilot in adapter while this is done. Install adapter retainer and clip.

13. Install centering spheres and anti-lash spring in upper steering shaft. Install lower steering shaft from same side of spheres that spring ends protrude.

14. Install steering shaft assembly in shift tube from upper end. Carefully guide shaft through shift tube and bearing.

15. Install ignition switch actuator rod through bowl from bottom and insert in slot in support. Extend rack downward from bearing housing. Assemble bearing housing over steering shaft and engage rack over end of actuator rod (figure 94).

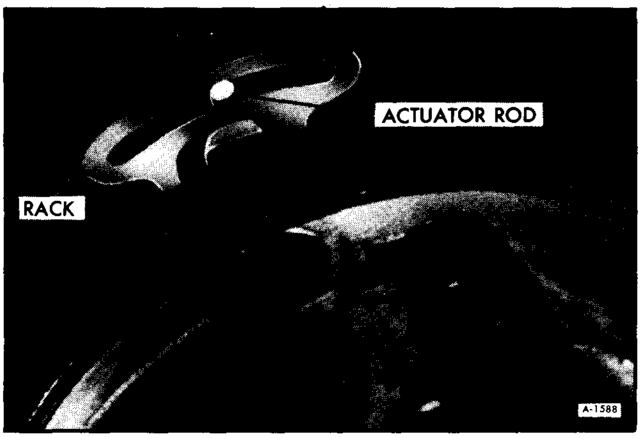


Figure 94—Engaging Rack

16. Holding lock shoes in disengaged position, assemble bearing housing over steering shaft until the pivot pin holes line up with the holes in the support.

17. Install pivot pins—assemble as far as possible using palm pressure of hand to prevent broaching of support pivot hole. Once started, tap home with a small hammer and punch.

18. Place housing in full "up" position, install guide, make sure there is grease between the guide and peg on support, tilt spring and tilt spring retainer, using screwdriver in retainer slot. Turn retainer clockwise to engage (figure 86).

19. Install tilt lever opening shield in housing (figure 89).

20. Remove tilt release lever, install housing cover and seat screw at 12 o'clock position first. Tighten to 100 inch-pounds, three screws.

21. Assemble buzzer switch to spring clip with formed end of clip under end of switch and spring bowed away from switch on side opposite contact (figure 85). Push switch and spring into hole in cover to the step with the contacts toward lock cylinder bore.

22. Install signal switch wires and connector through cover, bearing housing and bowl. Push hazard warning knob in, install switch and tighten screws to 25 inch-pounds.

23. Install wave washer (if one is used) and lower steering shaft flange or intermediate shaft assembly. Tighten pinch bolt to specified torque.

24. Install hazard warning knob and pull knob out. Install bearing inner race, seat, bearing preload spring, cancelling cam and lock plate.

Figure 95—Installing Retaining Spring

25. Depress lock plate and install new retaining ring using Tool J-23653 (figure 95).

26. Reinstall tilt release lever, signal switch lever (15 inch-pounds) and hazard warning knob (5 inch-pounds). Install upper shift lever and drive in pivot pin.

27. To install lock, hold lock cylinder sleeve and rotate knob clockwise against stop. Insert cylinder into cover bore with key on cylinder sleeve aligned to keyway in housing. Push in to abutment of cylinder and sector. Rotate knob counterclockwise, maintaining a light push inward on cylinder, until drive section of cylinder mates with drive shaft. Push in until retainer pops into groove. This locks cylinder into cover. Check freedom of rotation.

28. Install shaft lock cover and tighten three screws to 15 inch-pounds.

29. When replacing ignition switch, place the lock in "Acc" position. Place the switch in "acc" by the following procedure:

A. Position the switch as it is shown in Figure 96.

B. Move the slider to the extreme right, to the "acc" position.

Fit the actuator rod into the slider hole and assemble to the column with two screws. Lightly push the switch down the column (away from the steering wheel), to take out lash in the actuator rod, and

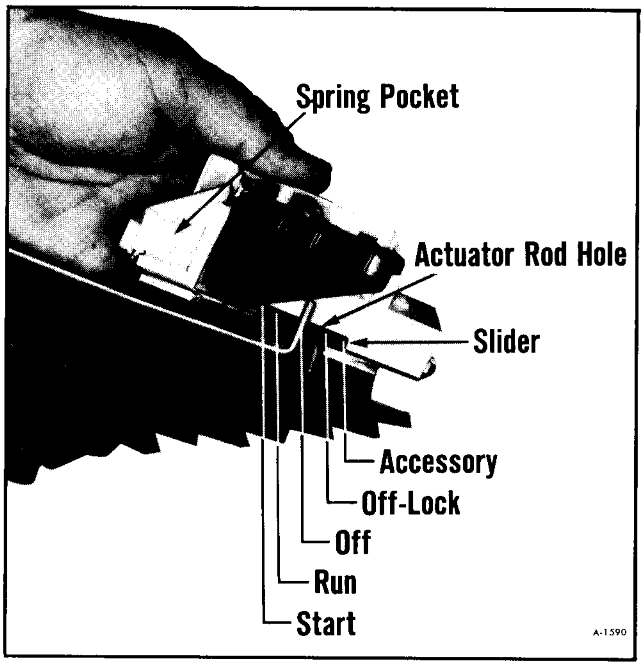


Figure 96—Installing Ignition Switch

tighten mounting screws. Caution should be exercised to prevent moving the switch out of detent. Use only the correct screws. Tighten to 35 inch-pounds.

30. Install neutral-start switch and back-up light switch. Do not tighten screws. Neutral-start switch will be adjusted in the car and should be tightened to 20 inch-pounds.

DO NOT SUBSTITUTE SCREWS.

31. Install lower wire protector over wires and on jacket (figure 78).

32. Install mounting bracket. DO NOT SUBSTITUTE BOLTS. (Mounting bracket torque, 15 foot-pounds).

33. Install steering wheel. Torque steering wheel nut to 30 foot-pounds.

34. Install horn parts.

STEERING COLUMN INSTALLATION

Make sure this procedure is followed in exactly this order.

1. Reconnect all electrical connections.

2. Install column into position and loosely attach mounting bracket to instrument panel with two mounting bolts.

CAUTION: *Do not use longer bolts or over-torque bolts. The correct bolts and torque are necessary to insure the breakaway action of the bracket and capsules in the event of a collision.*

3. Attach column at coupling. Tighten fasteners to specified torque.

4. Attach column bolts to instrument panel with specified torque.

5. Slide dash mounting plate firmly against dash and install mounting screws.

CAUTION: *Make certain that column instrument mounting panel is never unsupported when either dash mounting or gear mounting is connected.*

TORQUE SPECIFICATIONS

STEERING LINKAGE

Part	Location	Torque (Ft. Lbs.)
Nut	Steering Arm to Tie Rod End*	40—50
Nut	Tie Rod Clamp Nuts	19—24
Nut	Tie Rod to Intermediate Rod*	40—50
Nut	Idler Arm To Intermediate Rod*	40—50
Nut	Idler Arm To Frame	85—110
Nut	Relay Lever To Intermediate Rod*	40—60
Bolt	Relay Lever To Frame	250—300
Nut	Drag Link To Relay Lever*	100—125
Nut	Drag Link To Pitman Arm*	100—125
Nut	Pitman Arm To Steering Gear	160—210

NOTE: All stud tapers on all ball joints must be kept sufficiently free of lubricant to prevent excessive pull in mating tapered holes.

*NOTE: After reaching minimum torque required, nut must always be tightened to insert cotter pin. Never back nut off.

POWER STEERING PUMP

Part	Torque (Ft. Lb.)
Pump Mounting Bolts	35
Reservoir Bolt	35
Flow Control Fitting Assm.	35
Pressure Hose	35

STEERING GEAR

Part	Torque (Ft. Lb.)
Gear to Frame Bolts	70—80
High Pressure Line Fitting (At Gear)	40
Oil Return Line Fitting (At Gear)	40
Adjusting Screw Locknut	35
Side Cover Bolts	35
Adjuster Plug Locknut	80
Coupling Flange Nuts	20
Return Guide Clamp Screws	5
Rack-Piston Plug	75
Pitman Shaft Nut	160—210
Coupling Flange Bolt	30

STEERING COLUMN

Intermediate Steering Shaft	Ft. Lb.
Pinch Bolt, to Steering Shaft	40—45
Pinch Bolt, to Steering Gear	40—45
	In. Lb.
Spring Retaining Screw	35
Support Screws	60
Housing Screws	100
Signal Switch Mounting Screws	25
Shaft Lock Cover Screws	15
Ignition Switch Mounting Screws	35
Neutral Start Mounting Switch Screws	20
Tilt Release Lever Screw	30

Hazard Warning Knob	5
Steering Wheel Nut	30
Signal Switch Lever Screw	15

SPECIAL TOOLS

BT-33-73F	Belt Tension Gauge
J-1859-03	Steering Wheel Puller
J-5176-01	Checking Gauge
J-5860	Torque Wrench Adapter
J-6217	Connector Seat Installer
J-6219	Pitman Shaft Seal Installer
J-6222	Stub Shaft Seal Protector
J-6278-1	Pitman Shaft Bearing Remover
J-6278-2	Pitman Shaft Bearing Installer
J-7079-2	Handle
J-7132-2	Seal Driver
J-7576	Rack Piston Seal Compressor
J-7624	Spanner Wrench
J-7728	Seal Installer
J-7754	Torque Wrench
J-7786	Gauge Adapter
J-8058	Torque Wrench
J-8092	Handle
J-8524-1	Adjuster Plug Bearing Installer
J-8524-2	Adjuster Plug Bearing Remover
J-21552	Ball Retainer
J-21854-01	Pivot Pin Remover
J-22407	Pitman Shaft Bearing Installer
J-22616	Pump Shaft Seal Protector
J-23063	Spring Remover
J-23072	Shift Tube Remover
J-23073-01	Shift Tube Installer
J-23653	Lock Plate Compressor
J-24319	Ball Stud Puller
J-25033	Pulley Installer
J-25034	Pulley Remover
J-25323	Power Steering Analyzer

SECTION 10
WHEELS AND TIRES

Contents of this section are listed below:

SUBJECT	PAGE NO.
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Tire Traction	10-1
Tread Wear	10-2
Maintenance	10-2
Wheel Studs	10-2
Freezing of Nut	10-2
Wheel Maintenance	10-2
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GENERAL DESCRIPTION

The factory installed tires on the vehicle are designed to provide the best all-around performance for normal vehicle operation. They are tubeless type, 8.75-16.5, load range D, steel belted tires. Only tires of this size and construction should be used as replacements. Replacement wheels should be equivalent to those removed in diameter, rim width and off-set.

TIRE TRACTION

A decrease in driving, cornering, and braking traction occurs when water, snow, ice, gravel, or other material is on the road surface. Driving practices and vehicle speed should be adjusted to the road conditions.

When driving on wet or slushy roads, it is possible for a wedge of water to build up between the tire and road surface. This phenomenon, known as hydroplaning, may cause partial or complete loss of traction, which adversely affects vehicle control and stopping ability. To reduce the possibility of traction loss, the following precautions should be observed:

1. Slow down during rain-storms or when roads are slushy.

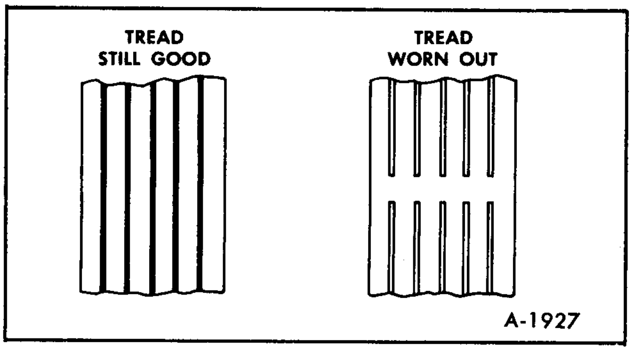

Figure 1—Tread Wear Indicators

2. Slow down if road has standing water or puddles.

3. Replace tires when tread wear indicators are visible.

4. Keep tires properly inflated.

TREAD WEAR (FIGURE 1)

The original equipment tires incorporate built-in tread wear indicators to assist in determining when tires have worn to the point of needing replacement. These indicators appear as 1/2-inch wide bands when tire tread depth is 1/16-inch or less. When the indicators appear in two or more adjacent grooves, tire replacement due to tread wear is recommended.

MAINTENANCE

WHEEL STUDS

TIGHTENING WHEEL STUD NUTS

When vehicle is new or after wheels have been replaced, check wheel stud nuts at 500 miles and after every wheel removal thereafter. Nuts should be tightened to 250 foot-pounds torque in sequence shown in Figure 2.

WARNING: IF ANY WHEEL EXPERIENCES A SINGLE STUD FAILURE CAUSED BY A LOOSE-RUNNING WHEEL, ALL WHEEL STUDS SHOULD BE REPLACED. A LOOSE-RUNNING WHEEL MAY CAUSE ONLY ONE STUD TO BREAK, BUT SEVERAL MORE STUDS MAY BECOME FATIGUED TO THE POINT OF FAILURE, BUT NOT ACTUALLY BREAKING. REPLACING ONLY THE BROKEN STUD AND REMOUNTING WHEEL WILL THEN SET THE STAGE FOR A SECOND AND POSSIBLY MORE SERIOUS FAILURE. IF HOLES IN THE WHEEL HAVE BECOME ELONGATED OR ENLARGED, REPLACE WHEEL.

Tighten wheel stud nuts as follows:

1. Install all nuts loosely, then finger-tighten only the nuts marked by arrows (figure 2).

2. Tighten all nuts to specified torque in sequence illustrated. Never use oil or grease on studs or nuts.

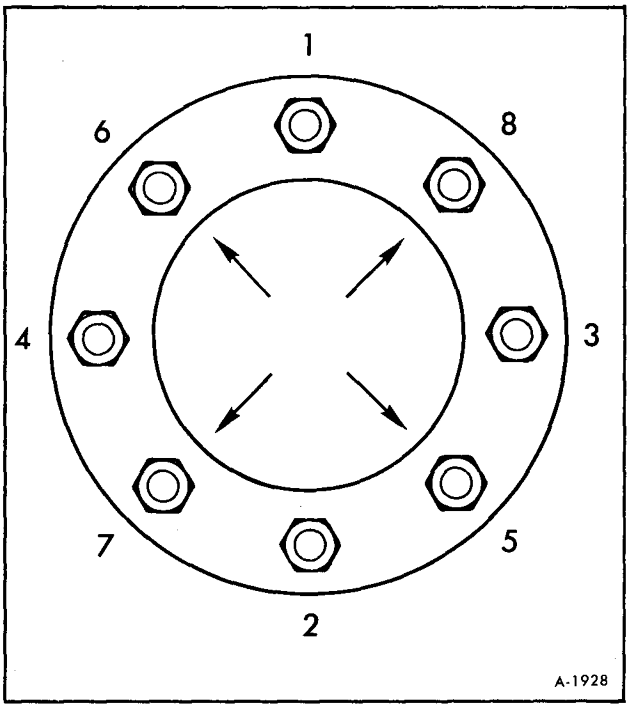

Figure 2—Wheel Stud Tightening Sequence

FREEZING OF NUT

Corrosion or galling of the stud and nut assembly can reach a point where removal of cap nuts is difficult. If this is a persistent problem, the threads of the stud and the threads of the inner cap nut should be cleaned with a wire brush.

WHEEL MAINTENANCE

Thoroughly remove rust, dirt, and other foreign materials from all surfaces. Hand or electric wire brushes, sand blasting or chemical baths may be used.

Bead seat areas of rim should be free of rust and rubber deposits. This is especially important for drop-center tubeless rims, because the 15° bead seat is the air-sealing element.

Paint rim by brush or spray with a fast-drying metal primer. Surfaces should be clean and dry prior to painting. Ensure that bare metal areas on outside or tire side of rim are covered. This is especially important on drop-center tubeless rims, because warm and sometimes moist air is in constant contact with the metal surface on the tire side of the rim.

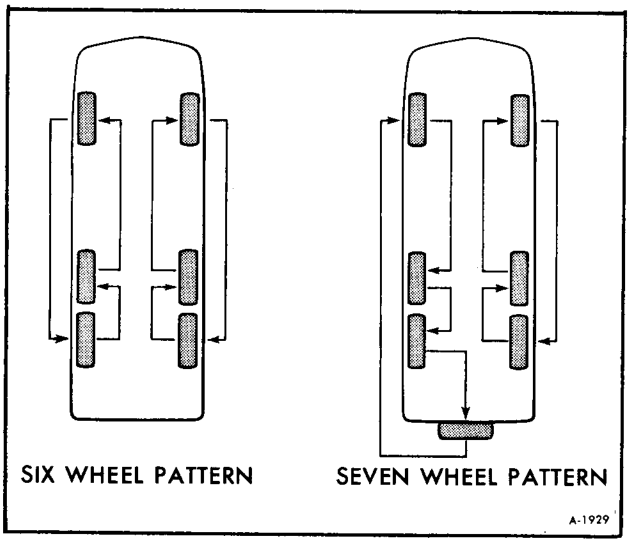

Figure 3—Tire Rotation Diagram

TIRE ROTATION

Rotation of the tires will minimize tire trouble and produce longer tire life. With rotation, accelerated and irregular tire wear on any one particular tire will be spread out over several tires, and replacement frequency will be reduced. Tire wear may also contribute to such trouble as poor handling and shimmy.

If desired, the tires should be rotated every 6,000 miles following one of the patterns shown in Figure 3.

INFLATION OF TIRES (FIGURE 4)

Inflate to correct pressure when tires are cool. If tires are continually carrying less than the recommended maximum load, adjust air pressure downward to correspond to the actual load carried.

Never "bleed" tires to relieve build-up of pressure. Tire temperature will increase when the tire is in service and allows for the normal build-up in air pressure. Tire temperature and air pressure will remain within limits that are not harmful to the tire when used in accordance with the recommendations for load and air pressure.

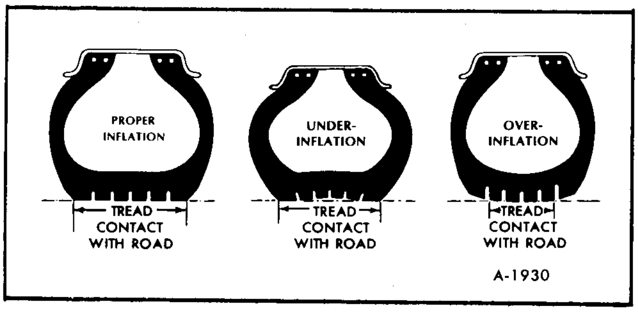

Figure 4—Inflation of Tires

If excessive build-up of air pressure occurs, overload, under-inflation, speed, or a combination of these is responsible. Use the size and type of tire that has the capacity to carry the load at recommended cold starting pressure.

The fabric, rubber, bead, contour, and size of tires used on these vehicles are designed to obtain maximum length of service under normal operating conditions. TIRES ARE DESIGNED TO OPERATE EFFICIENTLY ONLY ON A PRESCRIBED AMOUNT OF AIR. Unless the correct air pressure is consistently maintained, the tires will not function as they should; consistently safe economical operation of vehicle will be materially affected.

An under-inflated tire runs sluggishly, heats up quickly because of the greater flexing, and is subjected to more frequent bruising.

On the other hand, over-inflation may weaken the tire, causing a blow-out. In addition to the deteriorating effect improperly inflated tires may have on the tire life, this condition will affect steering, riding comfort, and safe driving.

For correct inflation pressure refer to Specifications later in this section.

BALANCED INFLATION

The efficiency of the vehicle will be upset if air pressure in the tires are out-of-balance. Balanced inflation may be expressed as: All tires should always carry the same air pressure. A 5-pound under-inflation in one front tire not only can destroy ease of steering, but creates steering hazards which generally point to a potential accident. An under-inflated rear tire can destroy the value of the most efficient brakes. Balance tires for ease of steering, comfort in riding, safety in driving, as well as for minimum fuel consumption and maximum tire mileage.

PRESSURE LOSS

At periodic intervals, each tire should be gauged for pressure loss with an accurate gauge before tires are brought to correct operating pressure. The purpose of this check is to determine the exact pressure loss in each tire. In other words, if at the time this check is made, a definite pressure loss is noted in any one of the tires, an inspection should be made of the tire showing the loss and the cause of loss corrected.

This method should definitely establish a "danger signal" on the condition of the tires. The pressure loss check should be made consistently with the same gauge, so that any element of inaccuracy in the gauge will be the same for all tires.

WHEEL AND TIRE BALANCING

It is desirable from the standpoints of tire wear and vehicle handling ease to maintain proper balance of front wheel and tire assemblies. All wheels intended for use on front of vehicle, such as those switched during periodic tire rotation and those installed as new or repaired replacement equipment should be accurately balanced. This may be accomplished by either of two types of balancing systems in current use which balance wheels either on the vehicle or off. The "on-the-vehicle" type, however, is the more desirable in that all rolling components (brakes, bearings, seals, etc.), are included in the balancing procedure and thereby have any existing unbalance corrected.

Wheel balance is the equal distribution of the weight of the wheel and tire assembly around the axis of rotation. There are two ways in which wheels can be balanced —statically and dynamically.

STATIC BALANCE

Static balance (sometimes called still balance) is the equal distribution of weight of the wheel and tire assembly about the axis of rotation in such a manner that the assembly has no tendency to rotate by itself, regardless of its position. For example: A wheel with a chunk of dirt on the rim will always rotate by itself until the heavy side is at the bottom. Any wheel with a heavy side like this is statically out-of-balance. Static unbalance of a wheel causes a hopping or pounding action (up and down) which frequently leads to wheel "flutter" and quite often to wheel "tramp."

DYNAMIC BALANCE

Dynamic balance (sometimes called running balance) means that the wheel must be in static balance, and also run smoothly at all speeds on an axis which runs through the center line of the wheel and tire and is perpendicular to the axis of rotation.

To ensure successful, accurate balancing, the following precautions must be observed:

Wheel and tire must be clean and free from all foreign matter. The tires should be in good condition and properly mounted with the balance mark on the tire, if any, lined up with the valve.

Bent wheels that have run-out over 3/32" should be replaced.

Inspect tire and wheel assembly to determine if an eccentric or out-of-round condition exists. Note that this condition, if severe, cannot be "balanced out." An assembly which has an out-of-round condition exceeding 5/16" is not suitable for use on the front of the vehicle. Its use on the rear should be governed by its general condition and whether the roundness defect seriously detracts from overall ride quality.

WARNING: WHEN BALANCING TIRES ON THE VEHICLE, FOLLOW THE EQUIPMENT MANUFACTURER'S INSTRUCTIONS CAREFULLY. DRIVE WHEEL SPIN SHOULD BE LIMITED TO 35 MPH AS INDICATED ON THE SPEEDOMETER. THIS LIMIT IS NECESSARY BECAUSE THE SPEEDOMETER ONLY INDICATES ONE-HALF OF THE ACTUAL WHEEL SPEED WHEN ONE DRIVE WHEEL IS SPINNING AND THE OTHER DRIVE WHEEL IS STOPPED. UNLESS CARE IS TAKEN IN LIMITING DRIVE WHEEL SPIN, THE SPINNING WHEEL CAN REACH EXCESSIVE SPEEDS, RESULTING IN POSSIBLE TIRE DISINTEGRATION OR DIFFERENTIAL FAILURE, WHICH COULD CAUSE PERSONAL INJURY OR EXTENSIVE VEHICLE DAMAGE.

TIRE REPLACEMENT

When tires are mounted on dirty or corroded rims, or when they are not properly centered on rims, the tire bead may "bind" on the rim, and refuse to seat. Allowing pressure to continue to build up within the assembly in an attempt to seat the tire bead is a DANGEROUS PRACTICE which can result in a broken tire bead, and serious injury to the serviceman. All of the following safety precautions should be observed:

1. Make sure that rim flanges and bead ledge (especially hump and radius) areas are smooth and clean. Remove any oxidized rubber, dried soap solu-

tion, rust, heavy paint, etc., with a wire brush, or in extreme cases, a file.

NOTE: Repaint bare metal with a good grade of aluminum paint or equivalent, to prevent rust.

2. Lubricate tire beads, rim flanges, and bead ledge areas with a liberal amount of thin vegetable oil soap solution, or approved rubber lubricant.

3. Ensure that air pressure build-up during the bead seating process is not allowed to exceed 100 pounds pressure.

IMPORTANT: If beads have not seated by the time pressure reaches 80 pounds, assembly should be deflated, repositioned on rim, relubricated, and re-inflated.

4. Make sure valve core is inserted in valve stem prior to inflating.

5. Use an extension gauge with clip on chuck so air pressure build-up can be closely watched and so that you can stand well back from the assembly during the bead seating process to avoid possibility of personal injury.

MOUNTING

1. Inspect rim to insure bead seats are clean and smooth. Then place rim on floor with wide side down

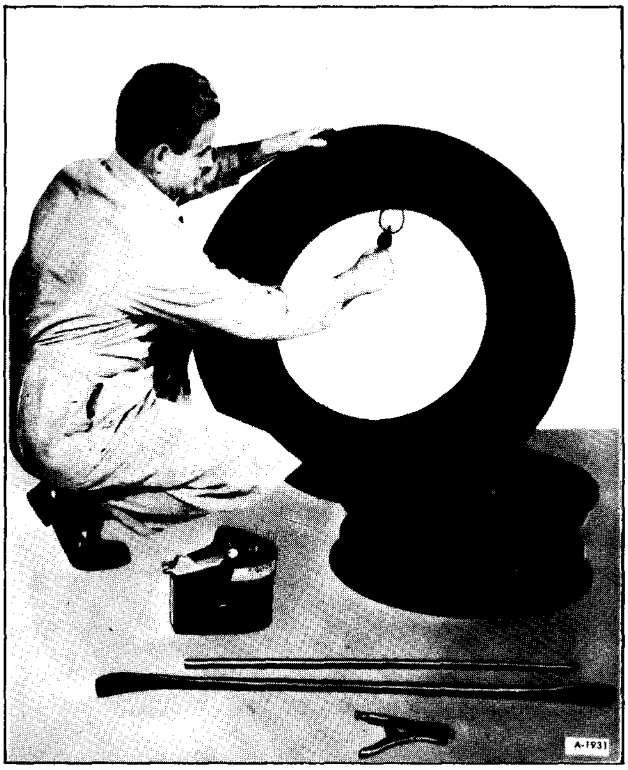

Figure 5—Lubricating Tire Bead

Figure 6—Working Bead Onto Rim

Figure 7—Working Second Bead Onto Rim

Figure 8—Inserting Tire Iron to Lift Bead

Figure 10—Inserting Tire Iron in Second Bead

Figure 9—Lifting Bead Over Rim

Figure 11—Prying Second Bead from Rim

and lubricate first bead of tire and upper bead seat of rim (figure 5).

2. Push first bead into well of rim and onto rim as far as possible. Using straight end of tire iron and with stop resting on rim flange, work remaining section of first bead over rim (figure 6).

3. Hold second bead in well by standing on tire. When necessary, push section of bead into rim well and anchor with vise-grip pliers by pinching pliers on rim flange. Using spoon end of tire iron with stop toward rim, work progressively around bead using small bites until bead slips over flange onto rim base. If necessary, insert second tire iron and lubricate last 6" of bead before completing mounting (figure 7).

4. Check valve to be certain that hex nut at the valve base is tight. Inflate tire to recommended operating pressure. Check assembly for air leaks.

DEMOUNTING

1. Remove valve core to completely deflate tire. With tire lying flat on floor, loosen beads from rim seats by walking around on tire with heels at points close to rim. With wide side of rim down, apply tire lubricant to top bead. With stops toward rim, insert spoon ends of two tire irons about 10" apart. While standing on tire to hold bead in gutter, pull one tool toward center of rim (figure 8).

2. Hold one iron in position with foot and pull second iron toward center of rim. Progressively work bead off rim, taking additional bites if necessary (figure 9).

3. Stand assembly in vertical position. Lubricate second bead. At top of assembly insert straight end of tire iron between bead and back flange of rim at about a 45 degree angle (figure 10).

4. Turn iron so that it is perpendicular to rim. Pry second bead off (figure 11).

WHEEL AND TIRE INSPECTION

WHEEL AND TIRE WEAR

CORRECTING IRREGULAR TIRE WEAR

Heel and Toe Wear — This is a saw-toothed effect where one end of each tread block is worn more than the other. The end that wears is the one that first grips the road when the brakes are applied.

Heel and toe wear is less noticeable on front tires than on rear tires, because the propelling action of the front wheels creates a force which tends to wear the opposite end of the tread blocks. The two forces, propelling and braking, make for more even wear of the front tires, whereas only the braking forces act on the rear wheels, and the saw-toothed effect is more noticeable.

A certain amount of heel and toe wear is normal. Excessive wear is usually due to high speed driving and excessive use of brakes. The best remedy, in addition to cautioning the owner on his driving habits, is to rotate tires regularly.

Side Wear — This may be caused by incorrect wheel camber, underinflation, high cambered roads or by taking corners at too high a rate of speed.

The first two causes are the most common. Camber wear can be readily identified because it occurs only on one side of the treads, whereas underinflation causes wear on both sides. Camber wear requires correction of the camber first and then interchanging tires. There is, of course, no correction for high cambered roads. Cornering wear is discussed further on.

Misalignment Wear — This is wear due to excessive toe-in or toe-out. In either case, tires will revolve with a side motion and scrape the tread rubber off. If misalignment is severe, the rubber will be scraped off of both tires; if slight, only one will be effected.

The scraping action against the face of the tire causes a small feather edge of rubber to appear on one side of the tread and this feather edge is certain indication of misalignment. The remedy is readjusting toe-in, or rechecking the entire front end alignment if necessary.

Cornering Wear — When a vehicle makes an extremely fast turn, the weight is shifted from an even load on all wheels to an abnormal load on the tires on the outside of the curve and very light load on the inside tires, due to centrifugal force. This unequal loading may have two unfavorable results.

First, the front tire on the inside of the curve may be relieved of so much load that it is no longer geared to the road and it slips, grinding off the tread on the inside half of the tire at the excessive rate. This type of tire shows much the same appearance of tread wear as tire wear caused by negative camber.

Second, the transfer of weight may also overload the outside tires so much that they are laterally distorted resulting in excessive wear on the outside half of the tire, producing a type of wear like that caused by excessive positive camber.

Cornering wear can be most easily distinguished from abnormal camber wear by the rounding of the outside shoulder or edge of the tire and by the roughening of the tread surface which denotes abrasion.

Cornering wear often produces a fin or raised portion along the inside edge of each row in the tread pattern. In some cases this fin is almost as pronounced as a toe-in fin, and in others, it tapers into a row of tread blocks to such an extent that the tire has a definite "step wear" appearance.

The only remedy for cornering wear is proper instruction of operations. Driving more slowly on curves and turns will avoid grinding rubber off tires. To offset normal cornering wear as much as possible, tires should be rotated at regular intervals.

Uneven Wear — Uneven or spotty wear is due to such irregularities as unequal caster or camber, bent front suspension parts, out-of-balance wheels, brake drums out-of-round, brakes out of adjustment or other mechanical conditions. The remedy in each case consists of locating the mechanical defect and correcting it.

Power and Speed — Excessive speed has always been harmful to tires. Speed creates heat — heat softens tires.

Stops and Starts — Quick stops and starts grind off tread in a hurry, may cause flat spots which continue to grow for the life of the tire.

Temperature — Considerably less mileage can be expected from a tire used in all warm weather driving as compared to all cool weather driving, or from a tire first put into service in warm weather.

MECHANICAL IRREGULARITIES

Following are some wheel or vehicle irregularities which may cause rapid or uneven tread wear:

Toe-In — The wheels on the same axle are closer together in the front than they are in the rear. When toe-in is excessive the tire wear shows feathered edges on inside edge of the skid design.

Toe-Out — The wheels on the same axle are closer together in the rear than they are in the front. Tire wear shows feathered edges on outside edge of the skid design.

Camber — This designates the tilt of the wheel. Positive camber is when wheels are closer together at point of road contact. Negative camber is when wheels are closer together at top. Too much camber results in excessive wear on one side of tire.

Caster — This is the backward tilt of the axle or inclination of the kingpin at the top. Too little caster causes wheel to wander or weave — result, spotty wear. Excessive caster may cause wheel "flight" or shimmy wear. Unequal caster causes wheel to pull to one side, resulting in excessive and uneven wear.

Sprung or Twisted Frame — Will cause rapid or uneven tread wear.

Grabbing Brakes — Brakes out of adjustment and out-of-round brake drums or discs cause tire treads to wear rapidly in spots. Out-of-round brake drums usually wear out tires in a single spot. Improperly adjusted brakes produce several worn places.

Worn wheel bearings, unbalanced wheels, or wobbly wheels all result in uneven and irregular tread wear.

At first sign of uneven tire tread wear, check and correct all mechanical irregularities.

WHEEL INSPECTION

Do not use wheels with bent rims. The continued use of such wheels will result in excessive tire wear and, if wheel is mounted on front of vehicle, difficulty in steering will be experienced. Wheels that are thought to be distorted may be checked as follows, referring to Figure 12 for checking points:

1. Raise wheel at side to be checked and safely support underneath.

2. Tool for checking run-out may be readily improvised as follows:

Secure block of wood approximately 6" x 6" x 14" or material with suitable base so it will remain positioned. Secure thin piece of wood or suitable material 10 inches long, such as ruler or yardstick, and fasten to wood block to a height in relation to rim surfaces as shown in Figure 12. Tighten screw sufficiently so pointer will hold its position when adjusted.

3. Position pointer at crown of rim (A, figure 12). Slowly revolve wheel and move pointer toward wheel until it contacts wheel at nearest point.

4. Continue to revolve wheel and check amount of lateral run-out (amount of wheel side wobble). This should not exceed 3/32-inch.

5. Place point of marker at inside of wheel at point "B", in Figure 12. Follow the previous procedure to check radial run-out (out-of-round condition); this should not exceed 3/32-inch. If wheel is distorted beyond these dimensions it should be replaced.

6. If doubt exists whether the wheel or hub is distorted, hub may be checked as follows: Replace the existing wheel with a wheel known to be true. Revolve the wheel and make the previously, mentioned tests. If tests are within limits, the hub is satisfactory, but wheel is sprung.

7. A dismounted wheel may be checked for side wobble by placing a straight-edge on face or hub of wheel. Measure distance from straight-edge to edge of wheel rim, this should be checked at four equally spaced locations. If distance is the same at all positions wheel is not distorted. (See figure 13) A dismounted wheel may also be checked for radial, and lateral run-out if desired, by temporarily mounting it to a hub on vehicle. Follow the previous Steps 2, 3, 4, and 5.

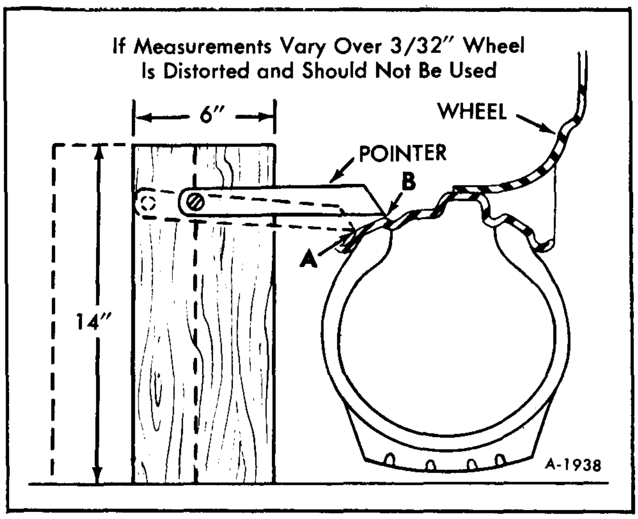

Figure 12—Method of Checking Distorted Wheels

The studs may have turned in the hub and worn the stud groove or the studs may have actual cracks or breaks resulting from this condition. The wheel may have worn ball seats in the stud holes. All these possibilities must be checked and all damaged parts replaced.

WORN WHEEL STUD HOLES (FIGURE 14)

This condition will usually be accompanied by appearance of a shiny worn surface on wheel face, indicating that loose wheels were moving against each other. If the stud holes are out of shape — oval or egg shaped — and where a build-up of metal is around them, these wheels must be replaced.

CRACKED DISC WHEELS (FIGURE 14)

Cracks running from hand-hole to stud-hole or bolt-hole to center-hole or hand-hole to hand-hole, or hand-hole to rim. or stud-hole to stud-hole, are a direct result of overloading. Check working loads of vehicle, discard damaged wheels, check wheel studs and complete assembly.

The hub assembly may have a worn mounting face as a result of moving of the wheel on the hub.

RUST STREAKS ON DISCS EMANATING FROM STUD HOLES

This is a positive indication that the cap nuts are, or have been, loose. In this case, the assembly should be checked carefully because damage to hub, studs, or wheel may have been caused by running in this condition.

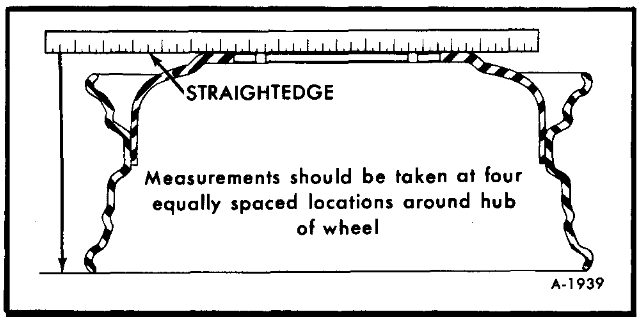

Figure 13—Wheel Checking Diagram

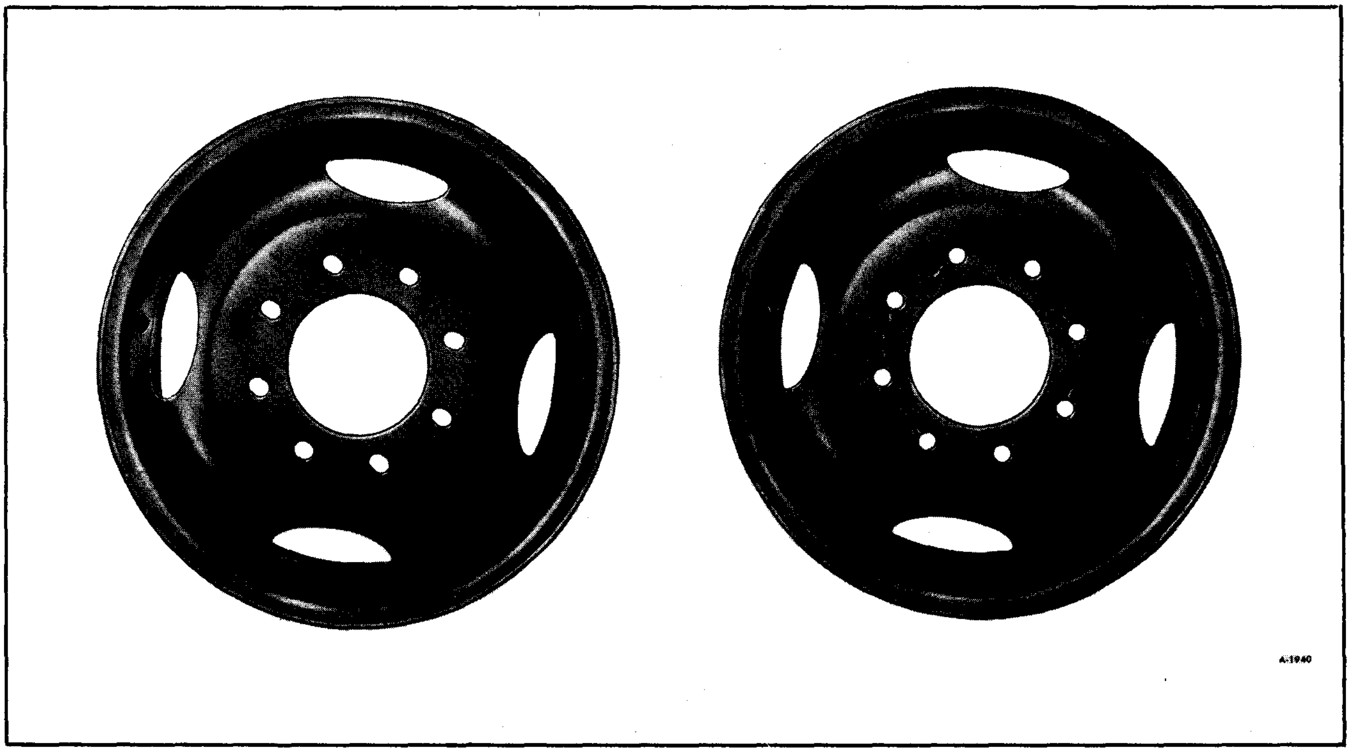

Figure 14—Worn Stud Holes and Cracked Disc Wheels

SPECIFICATIONS

Inflation Pressure (Cold) .... 60 PSI
  For Sustained Speeds Over 65 MPH .... 70 PSI
Tires
  Size .... 8.75—16.5
  Load Range .... D
  Construction .... Bias-Ply Steel Belted
Wheels
  Diameter .... 16.5″
  Width .... 6.0″
  Off Set .... 4.67″
  Bolt Circle Diameter .... 6.50″
  Number of Studs 8

SECTION 12
CHASSIS ELECTRICAL

Contents of this section are listed below:

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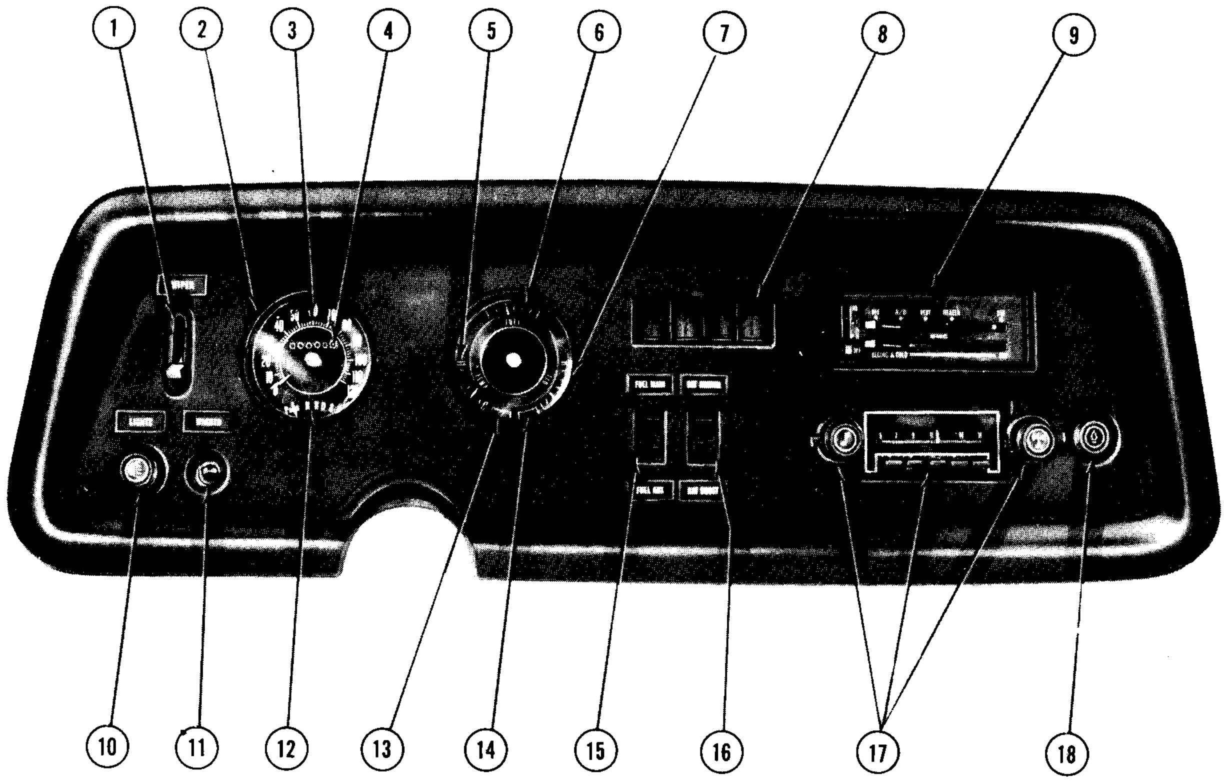
12

INSTRUMENTS AND GAUGES

All instruments and gauges are installed in the instrument cluster as shown in Figure 1.

The instrument panel gauges utilize printed circuits. They are connected to the vehicles wiring through multiple terminal connectors which are plugged into the back side of the gauges.

Instruments and gauges can be serviced in the vehicle by removing the instrument bezel as de-



1. WINDSHIELD WIPER CONTROL
2. SPEEDOMETER
3. HIGH BEAM INDICATOR
4. ODOMETER
5. TEMPERATURE GAUGE
6. FUEL GAUGE
7. OIL PRESSURE GAUGE
8. WARNING LIGHTS
9. HEATER/A.C. CONTROLS
10. LIGHT SWITCH
11. WINDSHIELD WASHER
12. SHIFT INDICATOR
13. GENERATOR LIGHT
14 BRAKE SYSTEM WARNING LIGHT
15. FUEL SELECTOR SWITCH
16. BATTERY BOOST SWITCH
17. RADIO & CONTROLS
18. CIGAR LIGHTER

A-1778

Figure 1—Instrument Panel

scribed later in this section. Illumination and indicator lamps can be replaced without removing the gauges and are of a 1/2 turn locking type with printed circuit connections. Regular maintenance is not required on the instrument cluster other than maintaining clean, tight electrical connections, replacing defective parts and keeping the speedometer cable properly lubricated. Figure 2 shows instrument panel component installation.

COMPONENT REPLACEMENT

INSTRUMENT PANEL BEZEL REPLACEMENT

1. Remove the radio knobs and control rings.

2. Remove the headlight switch knob as described under "HEADLIGHT SWITCH REPLACEMENT" later in this section. Then remove wiper control knob.

3. Disengage the fiber optic ribbon from the source bulb assembly located on the lower left side of the instrument panel assembly. This can be serviced from below the dash panel.

4. Remove the (4) upper bezel edge retaining screws and remove bezel from instrument panel.

5. To install, hook lower edge of the bezel on instrument panel edge and reverse steps 1—4 above.

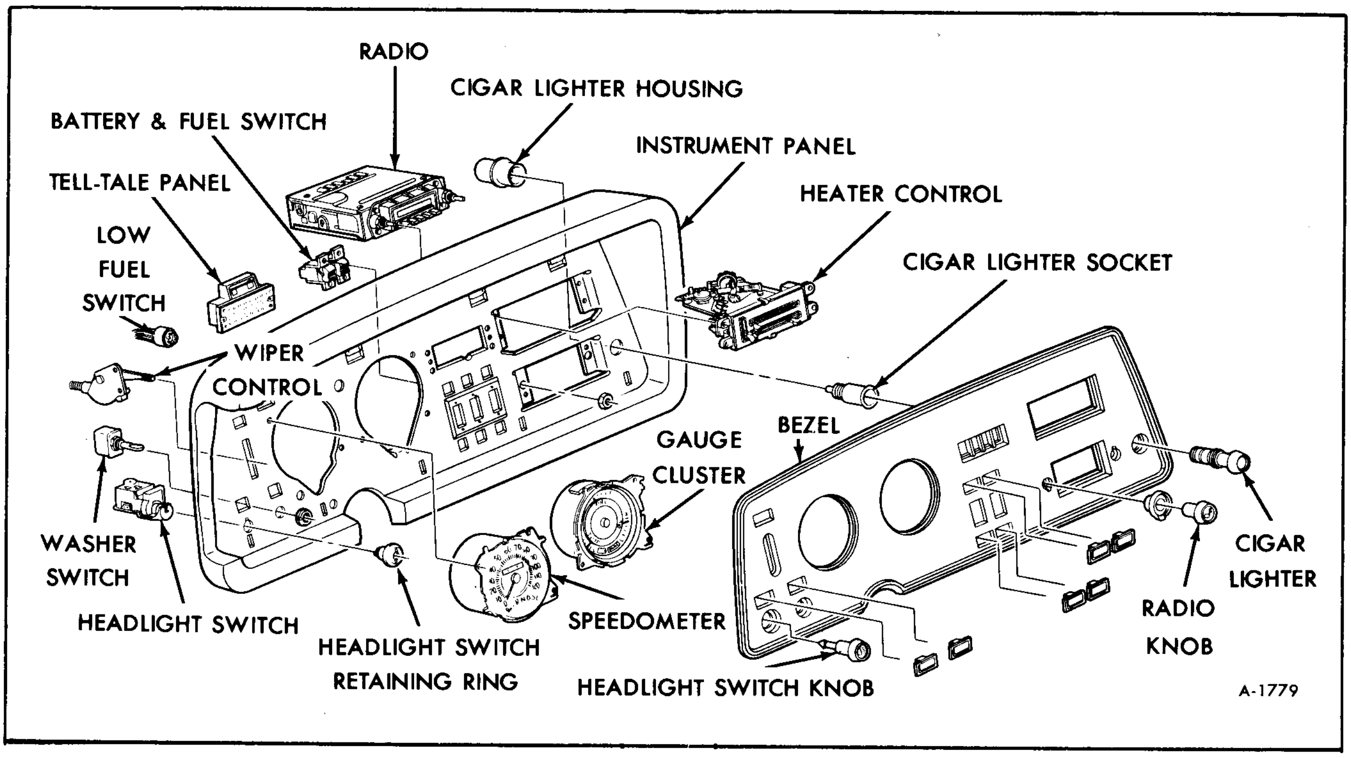


Figure 2—Instrument Panel Components

INSTRUMENT PANEL REAR COVER REPLACEMENT

1. Remove the (2) cover retaining screws on each side of the cover.

2. Lift cover straight up and work from behind the cluster assembly.

3. To install, reverse steps 1—2.

SPEEDOMETER HEAD REPLACEMENT

1. Disconnect battery ground cables.

2. Remove instrument panel bezel.

3. Remove instrument panel rear cover.

4. Remove the (3) speedometer retaining screws (See figure 3) and ground wire.

5. Hold the speedometer cable spring retaining clip down and pull cable away from speedometer head.

6. Disconnect (4) wire electrical connector from the back of the speedometer head.

7. Pull the speedometer head out and disconnect the transmission gear indicator cable.

8. Remove the speedometer head from the instrument panel.

9. When installing new or repaired speedometer head, the gear indicator cable should be routed around the metal post on the back side of the instrument panel. (See figure 4)

10. Reverse steps 1—8 to install speedometer head and test operation.

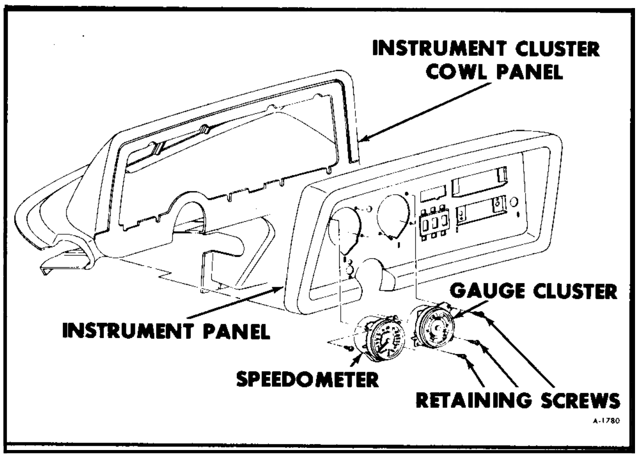


Figure 3—Speedometer and Gauge Cluster

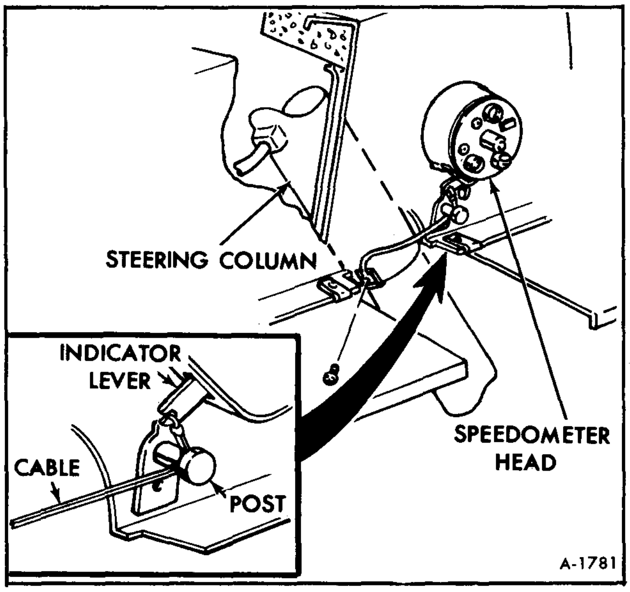


Figure 4—Gear Indicator Cable Connection

GAUGE CLUSTER REPLACEMENT (FIGURE 3)

1. Disconnect battery ground cables.

2. Removal the instrument panel bezel.

3. Remove the (3) gauge retaining screws and pull gauge out as far as possible. (See figure 3)

4. Disconnect the 7 wire pin connector from the gauge and remove gauge.

5. To install, reverse steps 1—4 above and check operation.

BATTERY SELECTOR SWITCH REPLACEMENT

1. Disconnect battery ground cables and remove instrument panel bezel.

2. Remove the (2) switch retaining screws shown in Figure 5.

3. Pull switch out as far as possible and disconnect the connector from the switch.

4. To install switch, reverse steps 1—3.

FUEL SELECTOR SWITCH REPLACEMENT

1. Disconnect battery ground cables and remove instrument panel bezel.

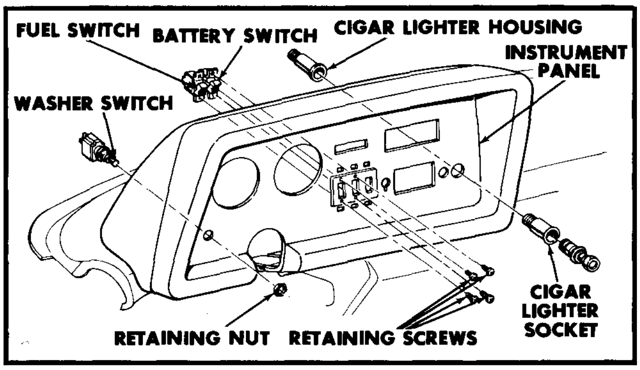


Figure 5—Battery and Fuel Switch Installation

2. Remove the (2) switch retaining screws shown in Figure 5.

3. Pull switch out as far as possible and disconnect the connector from the switch.

4. To install switch, reverse steps 1—3.

TELL-TALE LIGHT PANEL REPLACEMENT

1. Disconnect the battery ground cables.

2. Remove the instrument panel rear cover.

3. Disconnect the tell-tale light panel electrical connector.

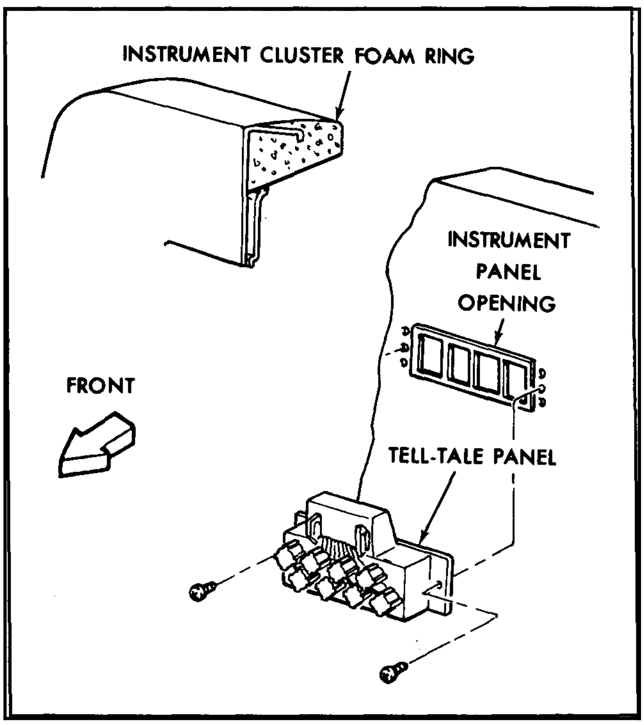


Figure 6—Tell-Tale Light Panel

4. Remove the (2) panel retaining screws and remove the panel (See figure 6).

5. To install, reverse steps 1—4.

CIGAR LIGHTER REPLACEMENT

1. Remove the element portion of the lighter from the instrument panel.

2. Disconnect the battery ground cables.

3. Remove the rear instrument panel cover by removing the (2) screws at each side of the rear panel cover. Lift rear panel cover up and work out of instrument panel.

4. Locate the cigar lighter connector and remove from lighter housing.

5. Turn the lighter housing (rear) counter-clockwise while holding the front portion, remove the lighter assembly when the (2) pieces disengage. (See figure 5)

6. To install lighter, reverse steps 1—5 and check operation.

SPEEDOMETER CABLE

The speedometer and odometer are driven by a gear train in the speedometer head, which is driven through a flexible shaft that is connected to the transmission. With cruise control, the speedometer cable is a two piece cable running from the speedometer head to the regulator unit and from there to the transmission.

Replacement

1. Disconnect the battery ground cables.

2. Remove rear instrument panel cover.

3. Disconnect speedometer cable from head by depressing spring clip and pulling cable core out of speedometer end of conduit.

NOTE: If cable is broken, it will be necessary to remove lower portions of cable from transmission end of conduit.

4. Lubricate cable with lubricant, then push cable into conduit. Connect upper end of cable to speedometer head and road test vehicle.

NOTE: Speedometer cable should be lubricated with AC Speedometer Cable lube ST-700 Part No. 6478535 or equivalent.

CIRCUIT BREAKERS, FUSES, AND FUSIBLE LINKS

GENERAL DESCRIPTION

All electrical circuits are protected against excessive loads which might occur due to shorts or overloads in the wiring system. Such protection is provided by either a circuit breaker, fuse or fusible link. Each of these protective devices is explained following:

CIRCUIT BREAKER

A circuit breaker is a protective device designed to open the circuit when a current load is in excess of rated breaker capacity. If there is a short or other type of overload condition in the circuit, the excess current will open the circuit breaker terminals, thus, indicating there is something wrong in the system. The circuit breaker will remain open until the trouble is found and corrected.

FUSE

A common method of protection is to use a fuse in the circuit. Whenever there is an excessive current through the circuit, the fusible element will melt and open the circuit. The fuse is a one-time protection, and replacement is required.

FUSIBLE LINK (FIGURE 7)

In addition to circuit breakers and fuses, the wir-

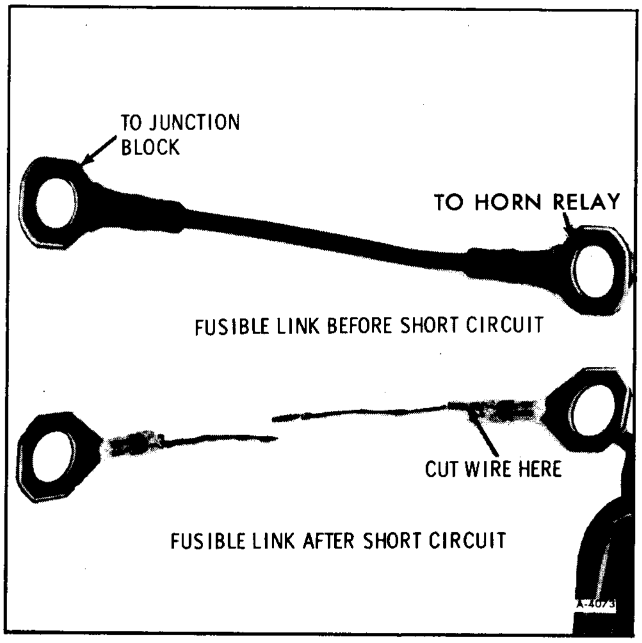


Figure 7—Fusible Link

ing harness incorporates fusible links to protect the wiring. Links are used rather than a fuse in wiring circuits that are not normally fused. Each link is four gauge sizes smaller than the cable it is designed to protect and are marked on the insulation with wire gauge size because the heavy insulation makes the link appear a heavier gauge than it actually is.

Fusible Link Replacement (Figure 8)

A new fusible link can be installed, after the short circuit is located and repaired, as follows:

1. Disconnect battery ground cable.

2. Disconnect fusible link from junction block or wiring harness.

3. Cut harness directly behind connector to remove damaged fusible link (figure 8).

4. Strip harness wire approximately 1/2".

5. Position clip around new fusible link and harness wire, crimp so that all wires are securely fastened.

6. Solder connection using rosin core solder. Use sufficient heat to obtain a good solder joint.

7. Tape all exposed wires with plastic electrical tape to prevent corrosion and shorting.

8. Connect fusible link to junction block.

9. Connect battery ground cable.

CIRCUIT DIAGNOSIS

Failures in a circuit are usually caused by short or open circuits. Open circuits are usually caused by breaks in the wiring, faulty connections or mechanical failure in a component such as a switch or circuit breaker. Short circuits are usually caused by wires from different components of the circuit contacting one another or by a wire or component grounding to the metal of the body due to a screw driven through the wires, insulation cut through by a sharp metal edge, etc.

The following information may aid in locating and correcting a failure in the body wiring electrical system.

- If a major portion of the electrical circuit becomes inoperative simultaneously, the failure may be due to improper connections between the front and rear harness, or between the front harness and the chassis wiring connector on top of fuse block.

- If only one of the circuits is inoperative, the failure is due to an open circuit or short in the affected circuit. Short circuits usually result in blown fuses or in the case of power equipment circuits, in the circuit breaker opening the circuit. If the fuse is not blown and the circuit affected is a lamp circuit, check the bulb before proceeding with any checking procedures.

Location

The fuse panel, Figure 9, is mounted on the bulkhead panel behind the glove box assembly. To gain access to the fuse panel, open the glove box and unscrew the cover plate. Fuses and circuit breakers located on this panel are illustrated in Figure 10. Protective circuit devices exterior to the fuse panel are listed in the following chart:

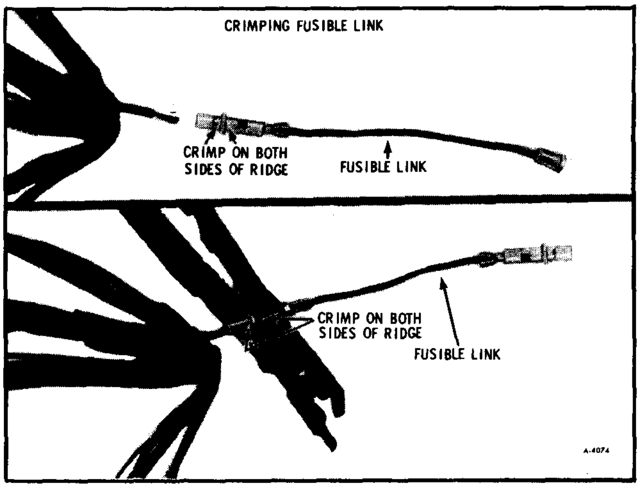


Figure 8—Fusible Link Replacement

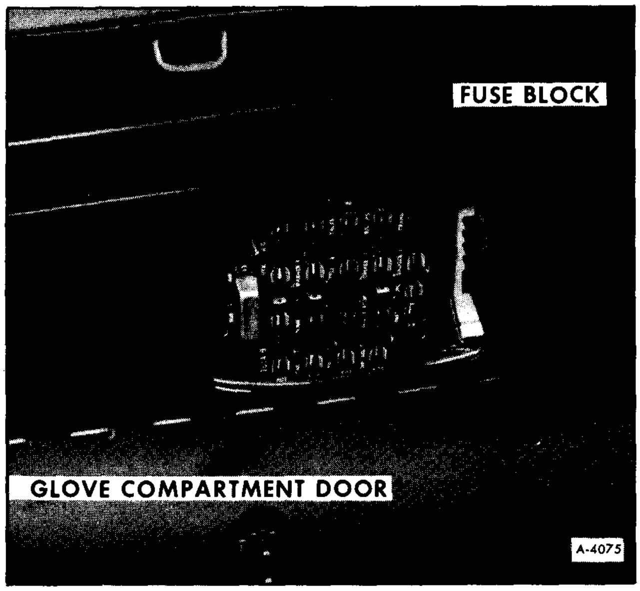


Figure 9—Fuse Panel Location

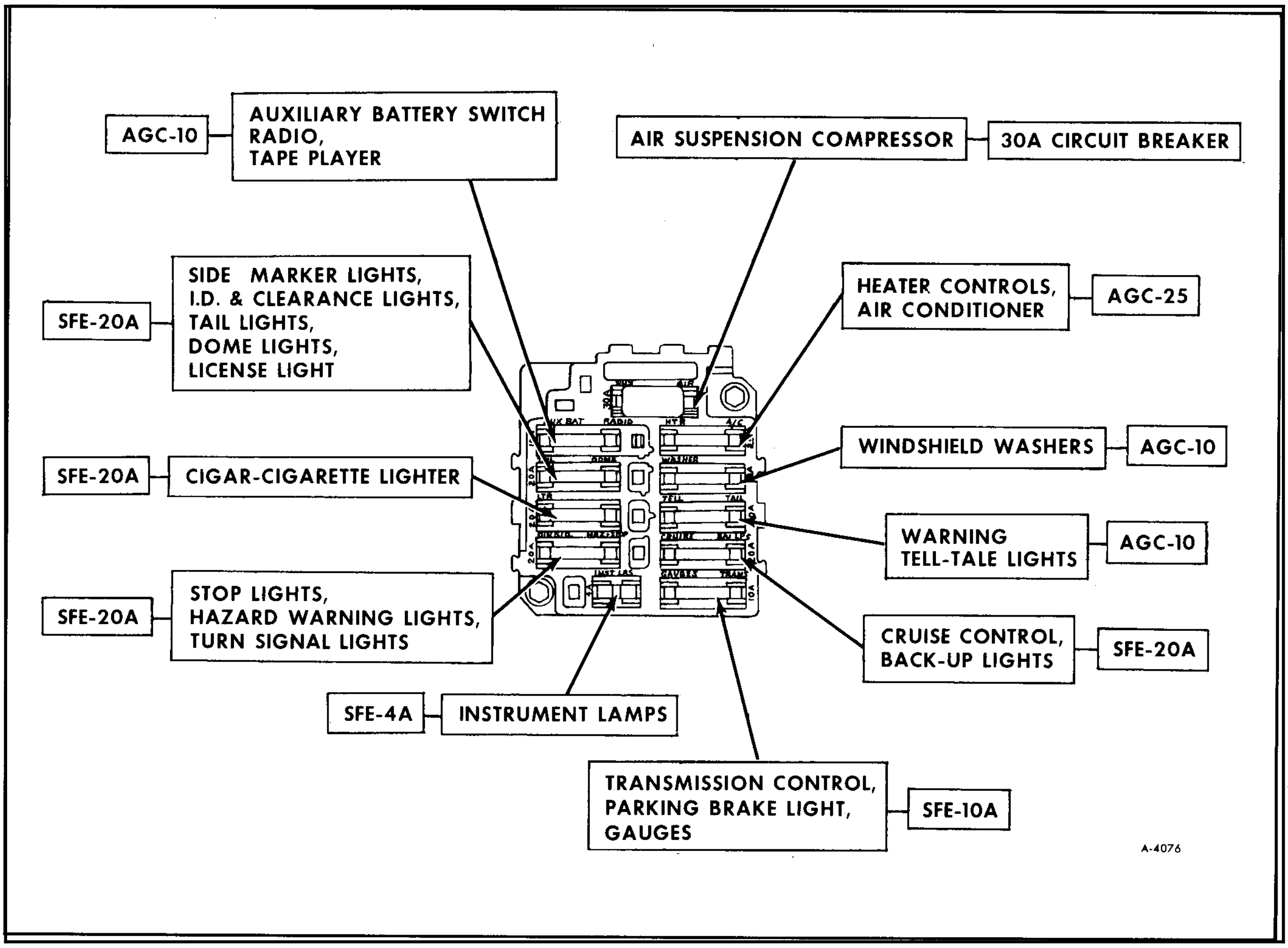


Figure 10—Fuse Panel

NOTE: Use of fuses or circuit breakers having other than the specified amperage may result in damage to the circuit.

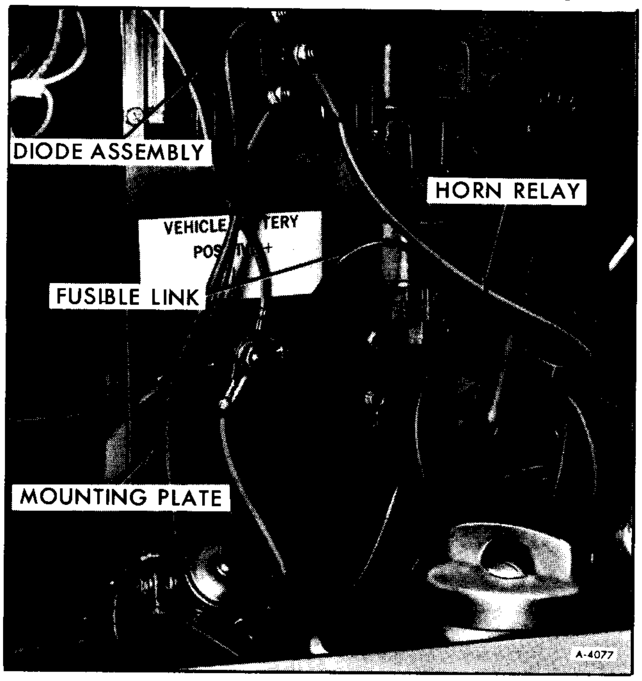


Figure 11—MotorHome Electrical Component Mounting Plate

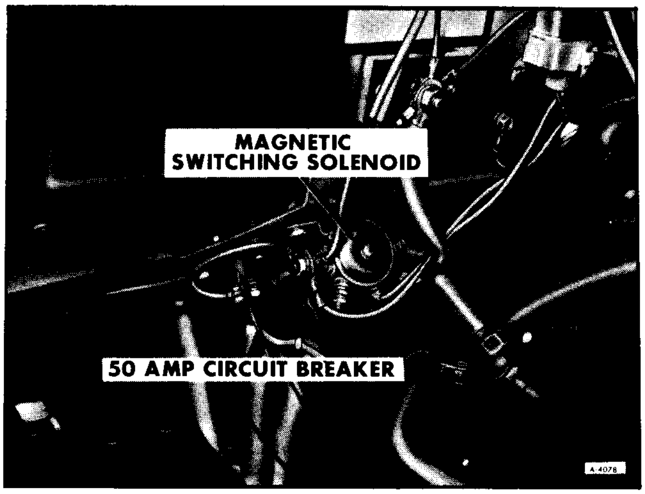


Figure 12—TransMode Electrical Component Mounting Plate

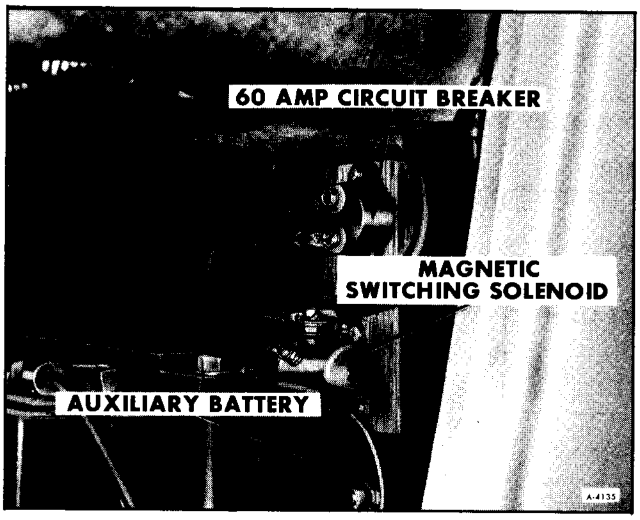


Figure 13—MotorHome Motor Generator Compartment

FUSES, CIRCUIT BREAKERS, FLASHERS EXTERNAL TO FUSE PANEL

Circuit	Location	Device
Headlight	Built into light switch.	Circuit Breaker.
Heater Blower Relay	Built into line at right access door near heater blower relay.	30 amp. fuse or fusible link
Warning and signal flasher	In clip behind instrument panel. Figure 28.	GM No. 673499
Vehicle trouble light	In line, behind access door, near light.	10 amp. fuse
Horn power feed circuit	In line, behind access door, near horn relay. Figure 11.	Fusible link
Auxiliary Battery (TransMode Only)	Engine compartment, dash, panel, upper right hand side. Figure 12.	50 amp. circuit breaker
Auxiliary (Living Area) battery (MotorHome Only)	Motor generator compartment. Figure 13.	60 amp. circuit breaker

PRINTED CIRCUITS

Printed circuits are used on the tell-tale lamp assembly, the speedometer and the gauge cluster to provide current for operation and illumination.

CHECKING CIRCUITS USING PRINTED CIRCUIT TELL-TALE LIGHT PANEL

Tell-tale printed circuit (figure 14) provides electrical contacts for illumination of various warning lights. Bulbs used in the tell-tale panel are listed in Specifications at the end of this section. To check the various tell-tale circuits proceed as follows:

a. Cruise control circuit (Refer to ENGINE & CHASSIS WIRING DIAGRAM).

1. Remove the instrument panel rear cover.

2. Remove the tell-tale light panel connector and remove the tell-tale panel.

3. With a continuity light, connect one probe of the test light to "41" of the printed circuit and the other probe to "920" with the cruise bulb in place. If the test light lights, the bulb and the circuit are good. If the test light does not light proceed to step 4.

4. If the test light does not light, remove the "920" bulb, "cruise" and check bulb, if bulb is good, problem is in the cruise tell-tale printed circuit board.

b. Door ajar.

1. With the tell-tale panel removed jump across the "925" and "41" terminals of the printed circuit with a self-powered test light.

2. If the test light lights, the circuit is good, if it does not proceed to step 3.

3. If the test light does not light, remove the "DOOR" bulb and check, if good, problem is in the printed circuit board.

c. Low air.

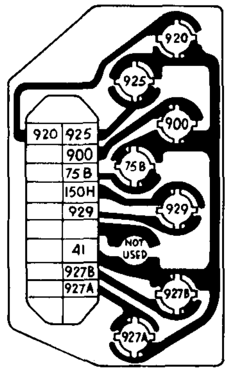
1. Follow the same procedure as described under "DOOR AJAR" circuit but use terminals "900" and "41".

d. Park Brake 1. Follow the same procedure as described under "DOOR AJAR" circuit but use terminals "75B" and "41".

e. Low Fuel

1. With the tell-tale panel removed, connect the test light probes between "929" and "150H", if test light lights circuit is good, if it does not, follow the same procedures explained under "DOOR AJAR" tell-tale.

f. Set Power Lever To Travel



LEGEND-CIRCUIT CONNECTOR	
925	DOOR
900	LOW AIR
75B	PARK BRAKE
150H	GROUND
929	LOW FUEL
	BLANK
41	FEED (ACC. BUS BAR)
927B	SET POWER
927A	LEVER TO TRAVEL
920	CRUISE

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Figure 14—Tell-Tale Printed Circuit

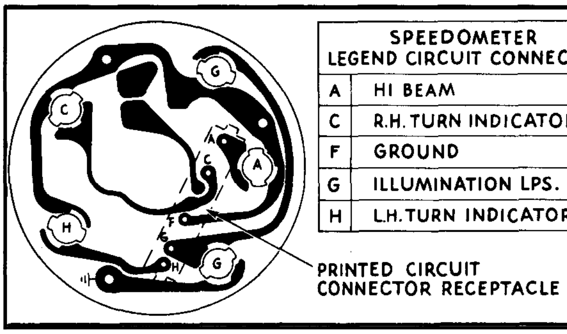
1. Follow the same procedure outlined for "DOOR AJAR" circuit but use both "927B" and "927A" to check for continuity to terminal "41".

SPEEDOMETER CIRCUIT

The speedometer printed circuit shown in Figure 15 provides electrical paths for the hi-beam, turn indicator and illumination lamp. As can be seen from Figure 15 the "F" terminal of the circuit provides an illumination lamp and turn indicator lamp ground. In addition to the "F" terminal ground a separate L.H. side illumination lamp ground is provided through a printed circuit trace to the speedometer case. Illumination bulbs can be removed by turning them 1/4 turn and pulling out. They are accessible by removing the instrument panel lower access panel and reaching up to the speedometer head.

GAUGE CLUSTER

The fuel, engine temperature and oil pressure gauges are located in the gauge cluster. Connection is made to this gauge by a (7) pin connector which feeds a printed circuit shown in Figure 16.



SPEEDOMETER LEGEND CIRCUIT CONNECTOR	
A	HI BEAM
C	R.H. TURN INDICATOR
F	GROUND
G	ILLUMINATION LPS.
H	L.H. TURN INDICATOR

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Figure 15—Speedometer Printed Circuit

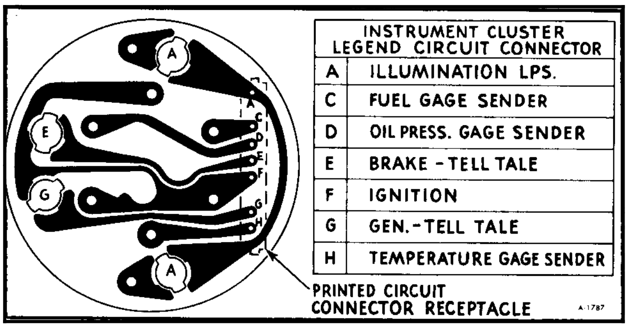


Figure 16—Gauge Cluster Printed Circuit

FUEL GAUGE

When checking the fuel gauge circuit, first determine whether the tank units, wiring, or fuel gauge is faulty. To check fuel gauge wiring, refer to Figure 19 for appropriate wiring harness connections. Connection at the gauge head is made through a printed circuit located at the rear of the gauge head.

The fuel tank selector switch position determines which tank level is being measured. When the fuel selector switch is moved to the "FUEL AUX" position, a coil in the fuel selector valve (figure 17) is energized. The energized coil closes off the fuel supply from the main fuel tank to the carburetor, and opens the fuel supply from the auxiliary tank to the carburetor. Simultaneously, the main fuel tank sending unit is switched to the auxiliary tank sending unit.

> **CAUTION:** *When checking fuel tank gauge wiring, never apply 12-volt current directly to the fuel tank float unit body feed wire as this will destroy the units' resistive element.*

The fuel gauge shows the approximate fuel level in the main tank when fuel selector switch is in the "FUEL MAIN" position, and the fuel level in the auxiliary tank when fuel selector switch is in the "FUEL AUX" position. The pointer will indicate the correct levels, only when the ignition is in the "ON" position. Since both fuel tanks are interconnected the gauge is designed to read the same (with the switch in either position) until approximately 60% of the total fuel capacity has been used.

If a condition is present where the vehicle is run in the "MAIN" position and allowed to deplete fuel supply on gauge, then switching to "AUX" does not provide the reserve 7 to 9 gallon amount, it is possible the wiring connector (figure 17) near the frame rail and tanks has the wires crossed in connection. The wires in this connection should be color to color from each side of the connector. This condition can also be detected by running the vehicle with the switch in the "AUX" position, ---- the fuel supply is

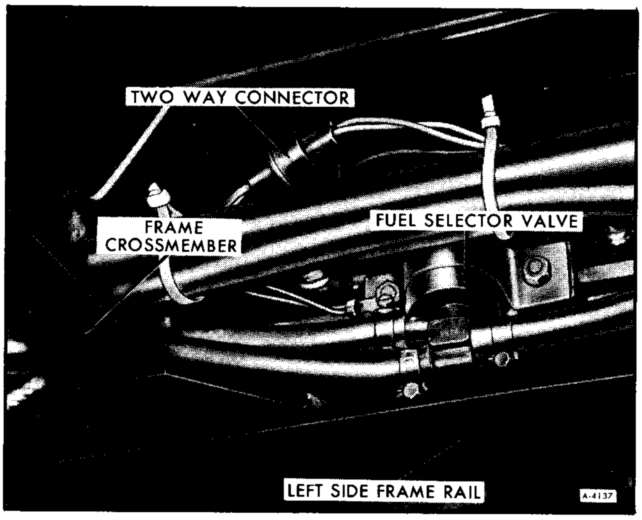


Figure 17—Fuel Selector Valve

almost depleted. Switching to the "MAIN" position provides a gauge reading of a greater amount.

Changing the fuel selector switch position changes the fuel selector valve and fuel gauge sending unit from the main tank, as it goes empty, to the auxiliary tank, which will contain approximately 7 to 9 gallons of fuel. The fuel selector valve is used only when the switch is moved from the "MAIN" to the "AUX" position. The valve is located inside the left frame rail, Figure 17, in front of the main fuel tank. Should the selector valve malfunction, it can be replaced as a unit.

FUEL GAUGE SYSTEM DIAGNOSIS

The following checks of the fuel indicator system will determine quickly whether incorrect fuel gauge readings are the result of an improperly operating fuel gauge, fuel tank sending unit or circuit wires. Refer to Figures 18 and 19 and also "Fuel Gauge Diagnosis Details" for fuel gauge system diagnosis.

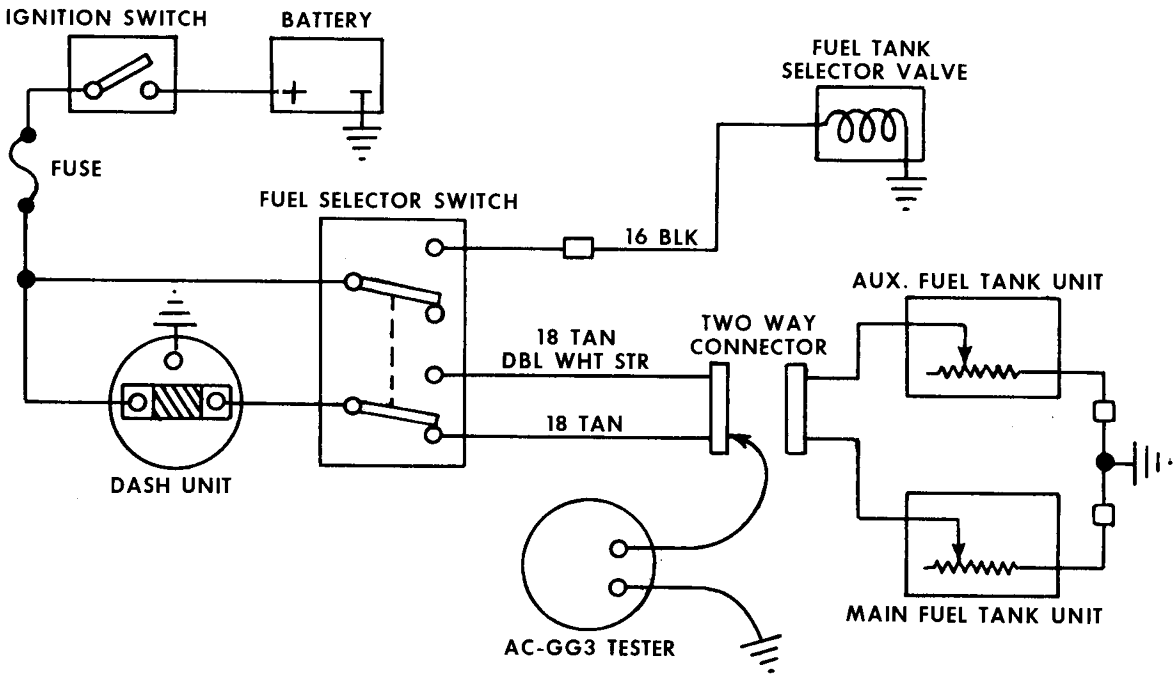
> **NOTE:** The vehicle is equipped with two fuel tanks so be sure to diagnose the entire system. After "FUEL MAIN" portion of the circuit is checked, move the selector switch to "FUEL AUX." position and repeat the test.

GAUGE DIAGNOSIS DETAILS

ERRATIC FUEL GAUGE READINGS

Inspect all circuit wiring for damage to insulation or wire, also carefully check for proper electrical connection at the following locations:

1. Terminal connections at two-way connector to tanks.



With vehicle on a level surface, disconnect 2-way connector (located at left frame rail by fuel tanks). With fuel selector switch in "FUEL MAIN" position, insert GG3 Tester between wire to dash unit (18 Tan) and ground. Then perform the following test:

Position ignition switch in "ON." DO NOT START ENGINE.

1. With tester knob set at "Continuity," lamp should glow.
2. With tester knob set at "0," dash unit should indicate "EMPTY."
3. With tester knob set at "90," dash unit should indicate "FULL."

4. If 1, 2, and 3 above are OK, inspect tank unit ground and wire to tank unit. Repair as necessary to insure good electrical connections and no shorts throughout.
5. If fuel gauge system is still not functioning properly after completing Step 4, replace tank unit.
6. If any one of 1, 2, or 3 are not OK, inspect wiring from ignition switch to the rear wiring connector (including grounds). Repair as necessary to insure good electrical connections and no shorts throughout.
7. If any one of 1, 2, or 3 are still not OK after completing Step 6, replace dash unit.

NOTE: After "FUEL MAIN" portion of circuit is checked, move selector switch to "FUEL AUX" position and connect GG3 to other side of 2-way connector (18 tan double white stripe) and repeat test.

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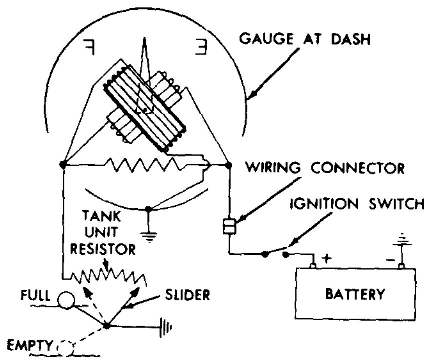
Figure 18—Fuel Gauge Switch Diagnosis (Method Using AC-663 Tester)



POSSIBLE COMPLAINT

PROBABLE CAUSE	Reads 1/4 when empty or won't read empty	Reads accurately between "E" and 1/4; above 1/4 reads "F"	Needle does not move	Reads "E" all the time	Reads "F" all the time	Reads 3/4 when full or won't read full	Reads 1/4 when full	Reads too high for amount in tank	Erratic reading	SUGGESTED REMEDIES
1. Loose connection anywhere in circuit									x	Inspect and, if necessary, clean and tighten all connections in circuit
2. Poor dash fuel gauge calibration								x		Install new dash fuel gauge
3. Poor tank unit calibration								x		Install new tank unit*
4. Circuit grounded in resistor of tank unit						x	x			Install new tank unit*
5. Circuit grounded between tank unit resistor and dash gauge				x						Insulate grounded circuit
6. Circuit within dash gauge grounded.								x		Install new dash fuel gauge
7. Circuit grounded between battery and dash gauge.			x							Insulate grounded circuit
8. Open circuit between ignition switch and dash gauge			x							Clean and tighten appropriate terminals or repair broken wire
9. Open circuit between ground terminal on gauge and ground				x						Clean and tighten mounting bracket where contact is made between dash gauge and ground
10. Open circuit between sending unit terminal on dash gauge and resistor terminal on tank unit					x					Clean and tighten appropriate terminals or repair broken wire
11. Open circuit in resistor of tank unit at 1/4 full position		x								Install new tank unit*
12. Open circuit between tank unit slider resistor and ground					x					Install new tank unit*
13. Needle rubbing on face of gauge			x	x	x	x	x			Position needle to prevent contact with face or install new gauge
14. Fuel tank float hang-up	x		x	x	x	x	x			Free binding float or install new tank unit*
15. Top of fuel tank deformed						x				Straighten tank top or replace tank
16. Bottom of fuel tank deformed	x									Straighten bottom of tank or replace tank
17. Tank unit mounting flange bent	x					x	x			Straighten mounting flange or replace tank unit*

* Ignition switch must be "OFF" before removing tank sending unit, otherwise full battery voltage may destroy unit or ignite fuel vapors. For maximum safety, remove cable from negative battery terminal. A-1790

Figure 19—Fuel Gauge System Diagnosis

2. Ground connection—one-way connector from tank to ground.

3. Body harness connector—10-way connector at instrument panel.

4. Body harness connector to printed circuit at gauge.

5. Mounting screws holding gauge to panel.

6. Make sure gauge pointer is not contacting face of gauge or lens.

7. Fuel selector switch connections.

GAUGE ALWAYS REGISTERS FULL (WITH IGNITION SWITCH ON)

Most probable cause is an open circuit in wiring or tank unit.

1. Check ground wires from tank units to ground. If loose, clean terminals, reinstall and check gauge reading.

2. Connect a spare tank unit to tank wiring. Raise and lower the float arm slowly, observing the dash unit (Be sure selector switch is in the appropriate position).

a. If dash unit does not function an open circuit at dash or tank unit is indicated.

b. If dash unit follows the arm movement proceed to step 3.

3. Inspect the wire terminals at the tank unit after lowering the fuel tank. If connection is loose, clean terminals and reinstall wires. If gauge continues to register "FULL" (with tank empty), remove the tank unit. Reconnect the wiring with unit out of tank, including the ground and move float arm. If dash unit does not follow arm movement, replace the tank unit.

GAUGE ALWAYS REGISTER EMPTY (WITH IGNITION SWITCH ON)

Most probable cause is a grounded circuit in the wiring due to a pinched or cut wire, or shorted fuel gauge dash unit. Disconnect the tank unit feed wire at the tank. The dash unit gauge should now register FULL.

Gauge Continues To Read Empty

1. Remove the instrument panel rear cover.

2. Remove the fuel gauge wire from the 7-wire connector on the gauge head (GRAY/DBL BLACK STR).

3. Gauge should now read FULL. If the gauge continues to read EMPTY, replace the dash unit.

Gauge Now Registers Full

1. Connect a spare tank unit to the tank feed wire at the body harness connector and ground unit at flange to chassis with a jumper wire.

2. Raise and lower float arm assembly while observing the dash unit.

a. If dash unit still does not operate, replace the dash unit after a continuity check of printed circuit has been made.

b. If the dash gauge follows the float arm movement, check tank unit feed wire for insulation breakdown. If wire is okay, replace the tank unit.

3. Check tank unit for improper installation of fuel filter screen which could restrict float movement.

4. If dash unit still does not follow the tank unit arm movement, replace the tank unit.

WATER TEMPERATURE GAUGE

When checking the water temperature gauge circuit, determine whether engine temperature sending unit, wiring, dash unit or printed circuit is faulty.

To check the engine water temperature sending unit, proceed as follows:

1. Disconnect wire at engine unit.

2. Connect a test light consisting of a 12V-2 candle power bulb and a pair of test leads in circuit by clipping one lead to battery positive terminal and other lead to body of engine gauge unit. If bulb lights, unit is properly grounded. If bulb does not light, check for presence of sealing compound around threads of unit. Remove compound and repeat test.

3. Remove test lead from body of unit and connect lead to terminal of unit. If bulb lights, engine unit is internally shorted and should be replaced.

4. Remove test light and reinstall wire on terminal.

5. If engine unit tests satisfactory under previous conditions, check the following items according to nature of difficulty:

a. If gauge does not register with ignition on: this may be caused by a break in the circuit between the gauge and the switch through the printed circuit or a short between the connector lead and the ground (See figure 16).

6. If gauge shows high temperature under all conditions, wire leading from gauge to engine unit is shorted to ground.

7. If gauge registers a low temperature reading under all conditions, wire between gauge and engine unit is broken.

8. Dash unit replacement should be made after the previous checks have been made for trouble source.

Do not attempt to repair either the engine unit or the gauge. When installing new engine unit, do not use thread compound on unit threads, as this will increase electrical resistance of unit and cause faulty reading on gauge.

OIL PRESSURE GAUGE

An electric oil pressure gauge is used on all vehicles covered in this manual. A variable resistance sending unit is connected to an engine oil pressure gallery to vary the amount of resistance to ground with changes in engine oil pressure. Current is fed through the printed circuit on the back of the gauge (figure 16) from the wiring harness.

The oil pressure gauge can be checked for cause of difficulty using the following procedure:

1. Connect test lamp of not more than 2 candle power between battery positive terminal and the body of the sending unit. If lamp fails to light, the unit is not grounded, the threaded hole and threads on the unit should be checked for metal-to-metal contact. If the lamp lights the unit can be considered properly grounded. When replacing sending unit do not use compound on threads.

2. Remove the wire from the unit terminal and connect the test lamp between the unit terminal and the battery positive terminal. If the lamp lights, start engine and observe if the lamp changes intensity. A satisfactory unit will change the lamp intensity with changes in engine oil pressure. (DO NOT USE A LAMP OF OVER 2 candle power).

3. Connect the wire and check wiring for open circuit between unit and connector at the back of gauge head.

4. Check for continuity in printed circuit trace.

5. If no defective wiring or connections exist and sending unit checks out satisfactory, replace dash unit.

NOTE: No attempt should be made to repair either the gauge or the sending unit.

6. Refer to Figure 20 for further gauge diagnosis information.

LOW-FUEL INDICATOR CIRCUIT

The optional low fuel tell-tale indicator used on vehicles covered by this manual is activated by a voltage sensitive switch. As the fuel tank float changes position, a change in the tank unit circuit voltage is sensed by the low fuel switch. At a predetermined value, the switch will turn the low fuel light on, alerting the operator of the low fuel level. The low fuel switch is replaced from the rear of the instrument panel and is connected to the wiring harness through a 4 wire connector. Low fuel switch wiring is shown in Figure 21.

The low fuel switch can be checked for satisfactory operation by using the following procedure:

1. Locate the fuel tank unit feed wire and connect to ground.

2. Turn ignition switch to "ON".

3. Fuel gauge should read "EMPTY" and "low fuel" light in the tell-tale panel should be on. A low fuel condition is considered at approximately 1/16 to 1/8 tank level.

4. If light does not come on, check tell-tale bulb and replace if necessary.

5. If light still does not come on, check fuse panel (figure 10) for possible blown fuse at the "GAUGES" location.

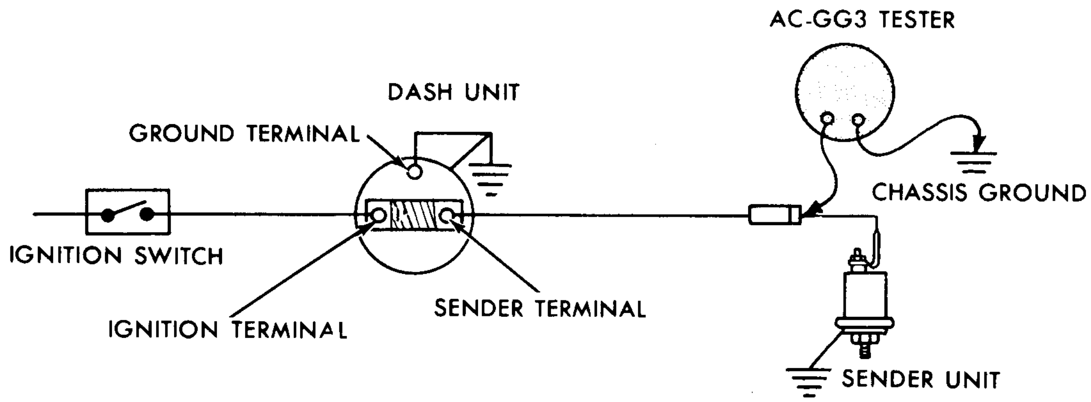
6. Check switch wiring to fuel selector switch and to ground, if wiring is satisfactory and light still does not light, replace low fuel switch.

If low fuel indicator light remains on at all times when tank level is above the 1/16 to 1/8 level, replace the low fuel switch.

MISCELLANEOUS

DOME LIGHT SWITCH

The dome light switch, located on the speaker-



Disconnect wire from sender unit and attach AC-GG3 tester between this wire and chassis ground.

Position ignition switch to "ON." DO NOT START ENGINE.

1. With tester knob set at "Continuity," lamp should glow.
2. With tester knob set at "0," dash unit should indicate "0" psi.
3. With tester knob set at "90," dash unit should indicate "full scale" pressure.

4. If 1, 2, and 3 above are OK, clean sender terminal to insure good electrical contact with wire and make sure sender unit is grounding to engine.

5. If pressure gauge system is still not functioning properly after completing Step 4, replace sender unit.

6. If any one of 1, 2, and 3 are not OK, check wiring and all connections (including grounds).

7. If any one of 1, 2, and 3 are still not OK after completing Step 6, replace dash unit.

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Figure 20—Engine Oil Pressure Gauge Diagnosis (Method Using AC-663 Tester)

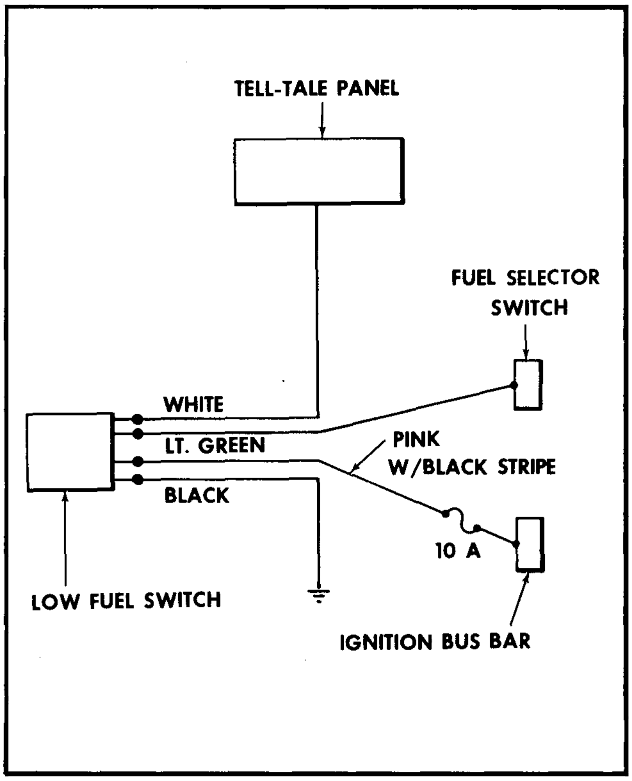


Figure 21—Low-Fuel Indicator Switch Circuit

dome light panel is a three position switch with the following functions:

1. Lamp operation (for that particular side) controlled by the headlight switch.

2. Lamp off, regardless of headlight switch position.

3. Lamp on, regardless of headlight switch position.

Switch Replacement

1. Disconnect the battery ground cables.

2. Remove the (4) dome light panel retaining screws.

3. Remove the (2) switch retaining screws.

4. Disconnect the dome lamp switch harness connector.

5. Remove the dome light switch.

6. To install, reverse steps 1—5 and check operation.

WINDSHIELD WASHER SWITCH

The windshield washer switch is a spring loaded switch which returns to the off position when the toggle is released. This switch supplies power to the windshield washer pump for pumping of washer solvent onto the windshield.

Switch Replacement

1. With a flat blade screwdriver engage the switch ring with the screwdriver blade while holding the back side of the switch (See figure 2).

2. Remove the retaining ring from the switch and bring the switch down to a more accesible position.

3. Disconnect the wiring harness connector from the switch.

4. Remove the switch from the panel.

5. To install, reverse steps 1—4, and check operation.

IGNITION SWITCH

The ignition switch is mounted on the right-side of the steering column. In addition to the steering column and shift lever lock feature, when the entrance door is open a buzzer located behind the left-hand engine access door would remind the driver to remove the key from the ignition switch. Replacement procedures for the ignition switch are covered in STEERING (SECTION 9) of this manual.

LOW AIR WARNING LIGHT AND BUZZER

The power level option consists of two, in-line

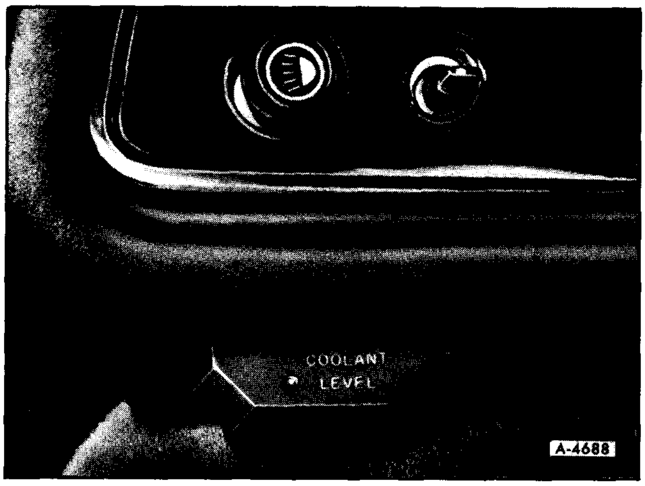


Figure 22—"Coolant Level" Indicator, Module Location

valves which override the height control valve. These valves allow the operator to raise or lower each side of the rear suspension by adjusting the controls located to the right of the steering wheel at the lower portion of the dash panel. A warning light (located in the tell-tale warning light panel) and buzzer (located behind the instrument panel, Figure 26, remind the operator to set the power level controls to the "TRAVEL" position before driving the vehicle. A 30 amp circuit breaker, located in the fuse panel, protects the electrical system. For diagnosis and repair procedures, see Section 4, Rear Suspension.

HEATING AND AIR CONDITIONING

The heating and air conditioning control circuit is protected by a 25 amp fuse located in the fuse panel. The heater blower uses either a 30 amp fuse or a fusible link (later models). Both the fuse or the fusible link are installed as part of the heater wiring harness. The heater blower relay is mounted above the horn relay on the electrical component mounting plate, refer to Figure 42. Diagnosis and component replacement are discussed in Section 1, Body, Heating and Air Conditioning.

"COOLANT LEVEL" INDICATOR DIAGNOSIS

Light Does Not Glow — Coolant Level Low

Disconnect Coolant Level Probe Sensor at Radiator. Ignition switch in "RUN" position, engine not running.

- Light Glows
  - Module OK. Check for grounded probe sensor wire.
- Light Does Not Glow
  - Check tell-tale indicator fuse and replace if necessary.
  - Check for grounded circuit between probe sensor and module. If grounded circuit is found, repair. If no defect in wiring is found, replace module.

Light Glows All The Time — Coolant Level OK

Remove lead from probe sensor at radiator and connect to a good ground.

- Light Out
  - Replace Probe Sensor at Radiator
- Light Still Glows
  - Replace Module

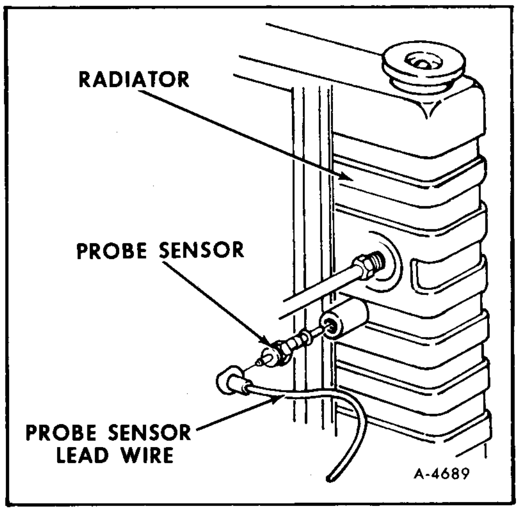


Figure 23—"Coolant Level" Indicator Diagnosis

DIODE ASSEMBLY

The GMC Dual Battery System provides power from two batteries to the vehicle's 12-volt electrical system either in combination or singularly. The components used to provide charging and/or switching are conventional, except for the diode assembly with which both batteries will receive charging current whenever the vehicle is running. The diode assembly has separate outputs to the two batteries and provides isolation between the batteries and their associated circuits whenever the engine is not running. The diode assembly is located above the battery junction block stud on the electrical component mounting plate. See Figure 11.

Testing the Diode Assembly

With the engine running, measure the voltage at the generator terminal of the diode assembly (voltmeter connections from terminal to graound). This reading should be between 13.6 and 15.0 volts. Now measure the voltage from each battery terminal to ground. These two battery terminal readings should be within .3 volts to .5 volts of the generator terminal reading. If they are not, replace the diode assembly.

"COOLANT LEVEL" INDICATOR

In MotorHomes equipped with a "Coolant Level" indicator, the indicator module is located to the lower left of the dash panel, as shown in Figure 22. The indicator light is designed to glow when a cooling system low water condition occurs in the radiator of the vehicle. See servicing details before refilling coolant as discussed in Section 13, RADIATOR AND COOLANT RECOVERY SYSTEM. If "Coolant Level" indicator system malfunctions, refer to "Coolant Level" Indicator Diagnosis chart, Figure 23.

Module Replacement

1. Remove module from dash panel by removing two securing screws.

2. Disconnect electrical connector from module.

3. Installation of replacement module is reverse sequence of removal.

Probe Sensor Replacement

1. Disconnect lead wire from probe sensor.

2. Unscrew probe sensor from radiator.

3. Install replacement probe sensor in reverse sequence of removal. Torque probe sensor to 25-30 in. lbs.

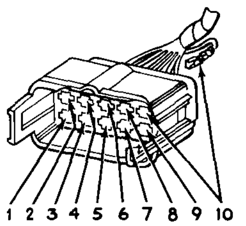
WIRING

GENERAL MAINTENANCE

Loose or corroded connections may cause a discharged battery in addition to difficult starting, dim lights and possible generator or regulator damage. A periodic check for clean and tight connections is important for dependable electrical system operation.

Wires and/or harnesses must be replaced if insulation becomes burned, cracked or deteriorated. Whenever it is necessary to splice a wire or repair one that is broken, always use rosin flux solder to join the wires and insulating tape to cover the spice on bare wires. Circuit tests for continuity can be made by referring to ENGINE AND CHASSIS WIRING DIAGRAM.

When replacing wire, it is important that the correct gauge be used.



1	AUX. FUEL TANK SENDER
2	MAIN FUEL TANK SENDER
3	FUEL TANK TRANSFER VALVE
4	SPARE WIRE
5	L.H. STOP, DIRECTIONAL
6	R.H. STOP, DIRECTIONAL
7	TAIL, CLEARANCE, MARKER (SIDE), LICENSE
8	BACK-UP LAMPS
9	L.H. REAR RADIO SPEAKER
10	R.H. REAR RADIO SPEAKER

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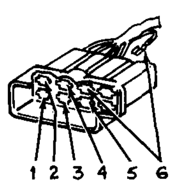
Figure 24—Left-Side Body Wiring Connector



1	DOME LIGHT FEED (BAT BUS BAR)
2	DOME LIGHT FEED (FROM HEADLIGHT SW.)
3	DOME LIGHT GROUND
4	FRT. I.D. AND CLEARANCE LPS.
5	HEADLIGHT (LO BEAM)
6	HEADLIGHT (HI BEAM)

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Figure 25—Front Roof Wiring Connector

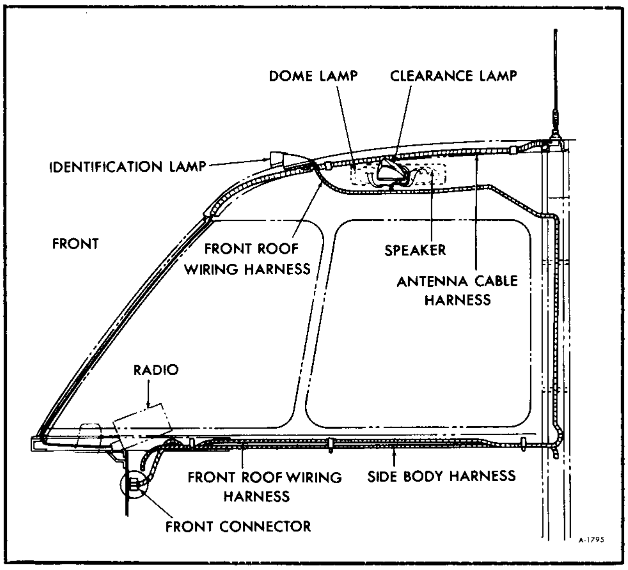


Figure 26—Front Wiring (Roof)

NOTE: Never replace a wire with one of a smaller size. Fusible links in the wiring are four gauge sizes smaller than the wire it is designed to protect.

Fusible links are marked on the insulation with wire gauge size because of the heavy insulation which makes the link appear a heavier gauge than it actually is.

Each harness and wire must be held securely in place by clips or other holding devices to prevent chafing or wearing away the insulation due to vibration.

By referring to the wiring diagram, circuits may be tested for continuity or shorts with a conventional test lamp or voltmeter.

LEFT-SIDE BODY WIRING

Wiring for rear lighting, fuel tanks and rear speakers passes through a (10) way multiple connector located in the front L.H. corner of the instrument panel. Rear lighting circuits can be checked for continuity through the female portion of this connector. Figure 24 shows the (10) way multiple connector and the appropriate wire position in the connector body. Refer to the vehicle wiring diagram for wire size and code used in the rear end wiring.

FRONT WIRING

Dome lights, headlamps and front clearance lights are fed through an (8) way multiple connector located under the instrument panel. The front lighting wiring is part of the instrument panel wiring harness. Figure 25 shows the female portion of the front lighting harness and the appropriate wire position in the connector body.

Front wiring for front clearance, indentification, dome lamps and front speakers is shown in Figure 26. Door jamb switch wiring is found on the right hand side of the vehicle and is shown in Figure 27.

INSTRUMENT PANEL WIRING

Wiring to the instrument panel is made through multiple terminal connectors at the tell-tale panel,

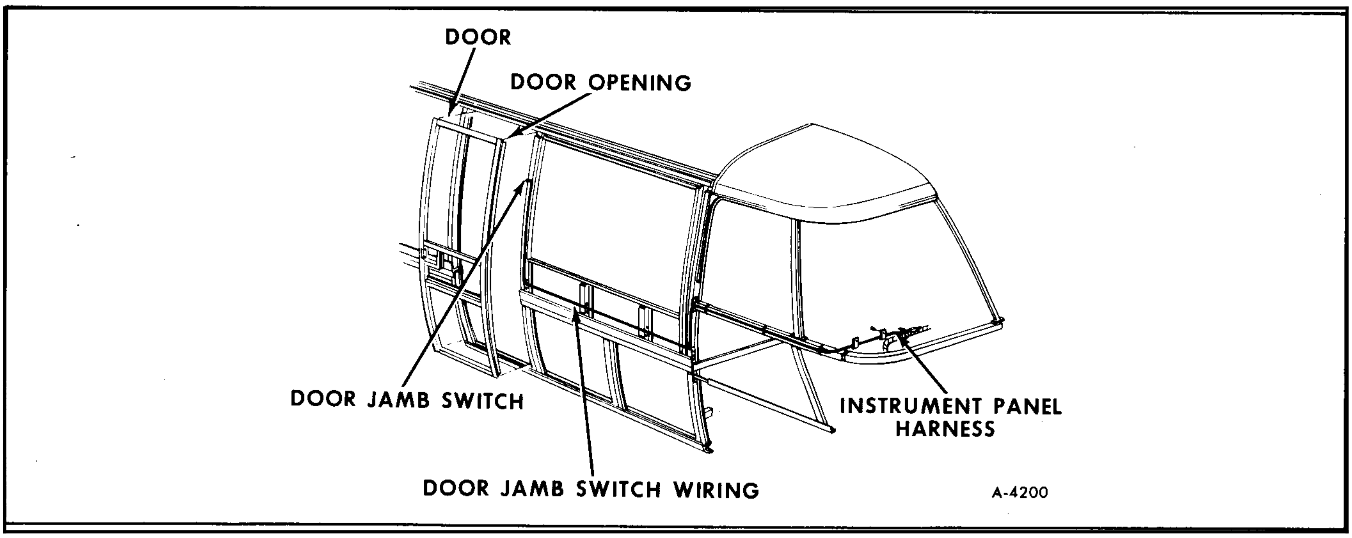


Figure 27—Door Jamb Switch Wiring

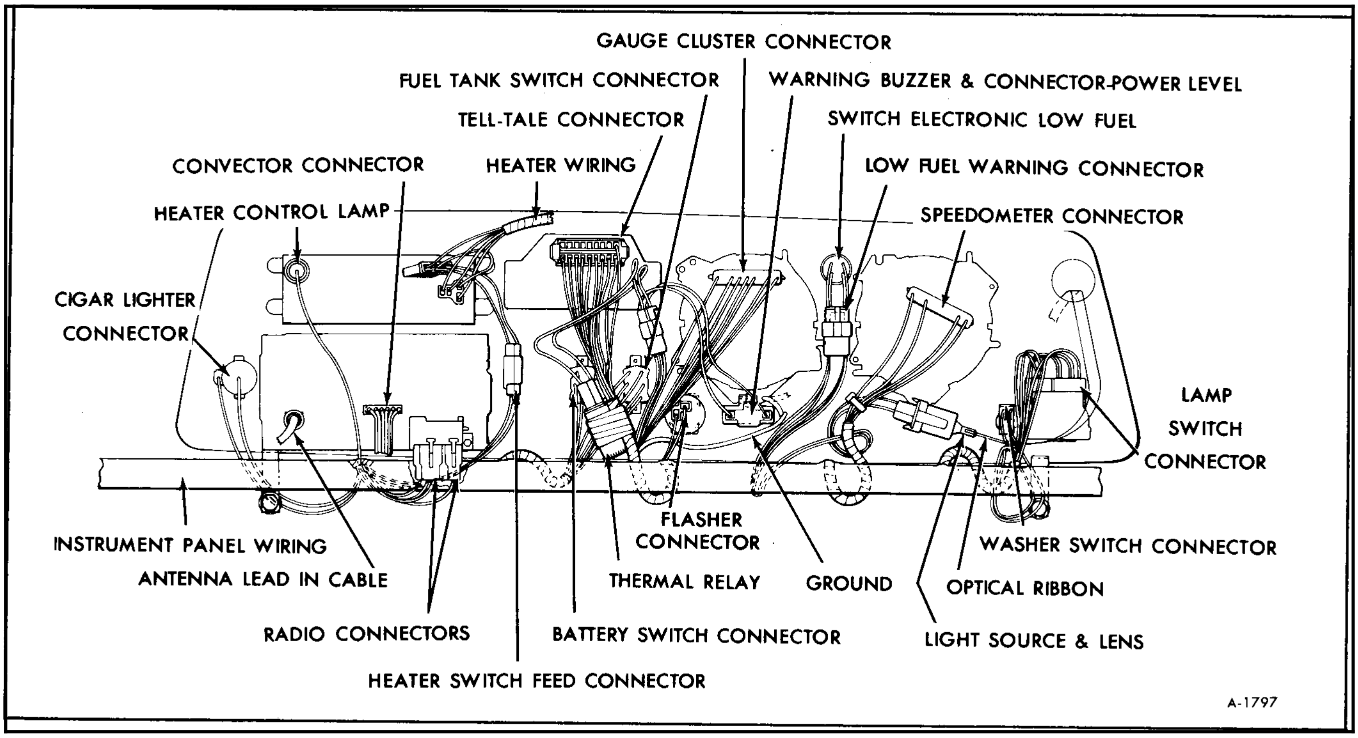


Figure 28—Instrument Panel Wiring (Typical)

speedometer, headlight switch and cluster gauge. Figure 28, instrument panel, shows instrument wiring and proper connector location.

Radio wiring for AM and AM-FM Mono models is shown in Figure 29. Refer to ENGINE AND CHASSIS WIRING DIAGRAM for wire size and color application for instrument panel wiring.

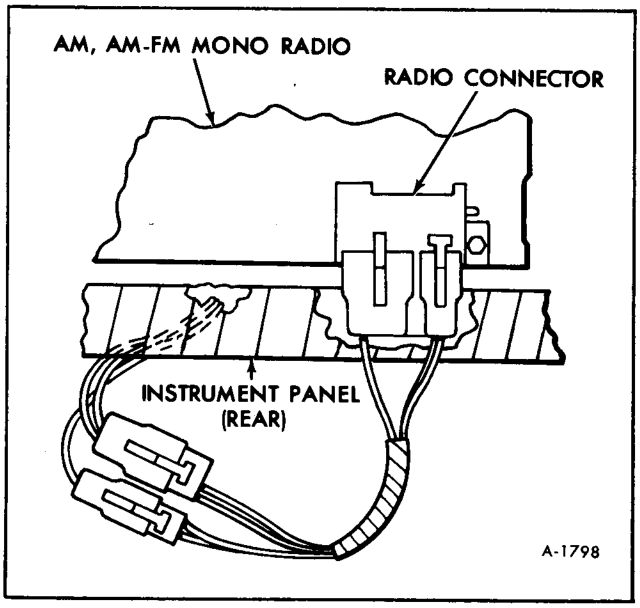


Figure 29—AM, AM-FM Mono Radio Connector

STEERING COLUMN WIRING

Connections for directional signals, ignition switch, neutral safety switch, back-up lamps and power leveler warning are shown in Figure 30. These connectors are located on the steering column. Refer to vehicle wiring diagram for applicable wire size and color.

REAR BODY WIRING

Wiring for rear identification and clearance lamps along with rear speakers is fed around the rear of the body through a plastic loom. This harness is connected to the side body through a 6-way multiple connector located in the L.H. rear corner of the vehicle (See figure 31). Refer to ENGINE AND CHASSIS WIRING DIAGRAM for applicable wire size and color code.

TRAILER WIRING

The optional trailer wiring is installed as shown in Figure 32. This connection is made between the L.H. side body harness and the rear body harness at the L.H. rear corner of the vehicle.

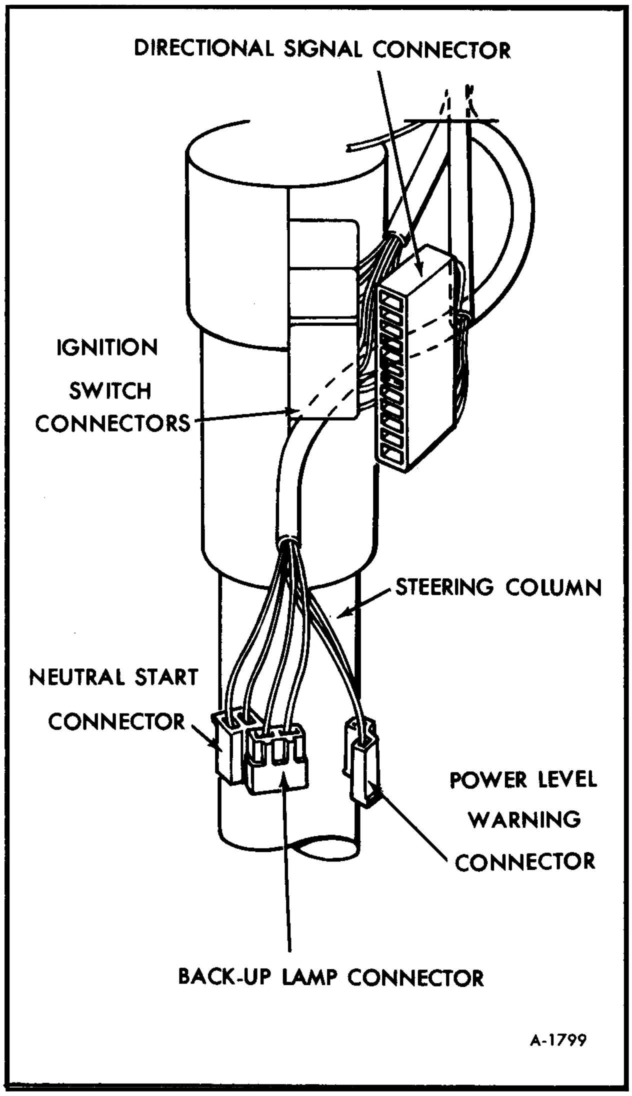


Figure 30—Steering Column Wiring

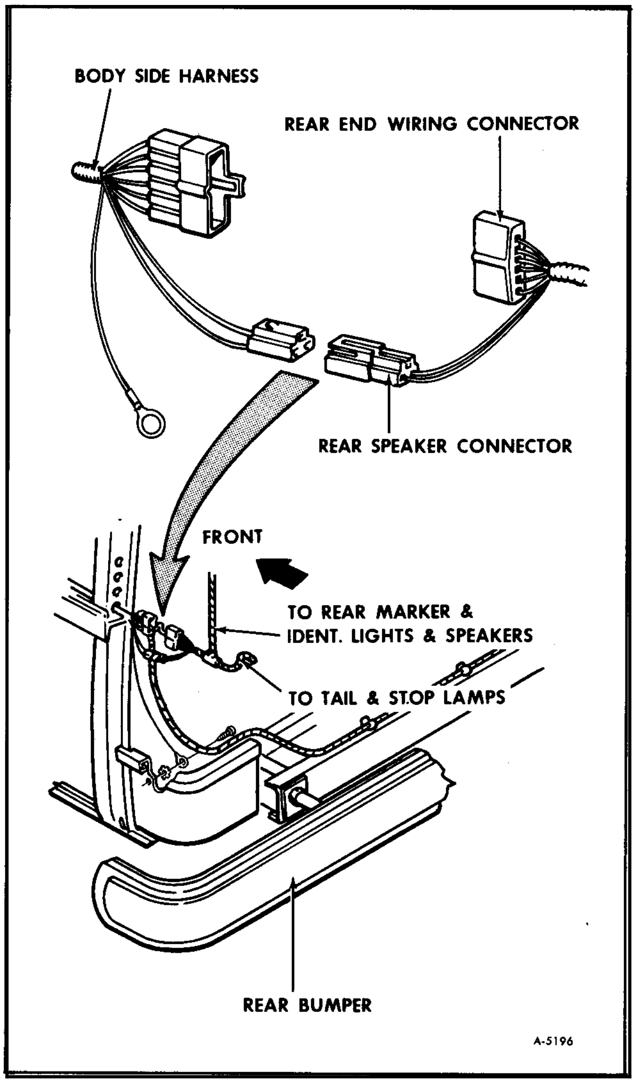


Figure 31—Rear Body Wiring

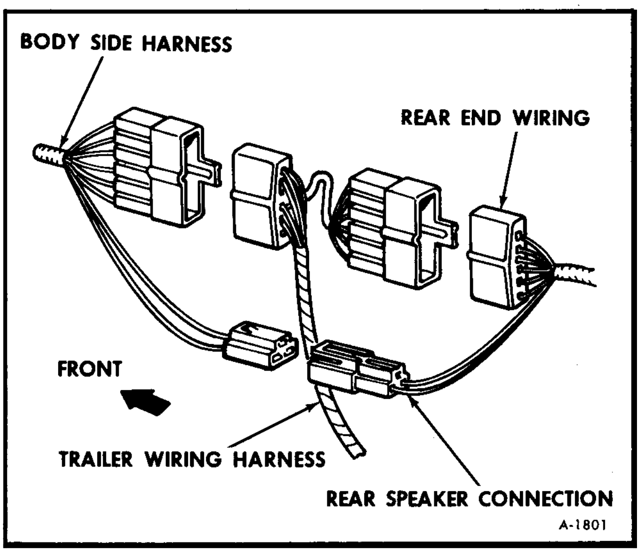


Figure 32—Trailer Wiring

LIGHTING SYSTEM

GENERAL INFORMATION

The lighting system includes the main light switch, stop light switch, dimmer and back-up lamp switchs, head and parking lamps, stop, tail, side marker, clearance and identification lamps, porch light; instrument illumination, directional signal and indicator lamps and necessary wiring to complete the various circuits.

All vehicle models use a single 7-inch single sealed-beam unit type headlight, all other lights are a replaceable bulb type. Refer to "Light Bulb Specifications" at the end of this section for bulb number.

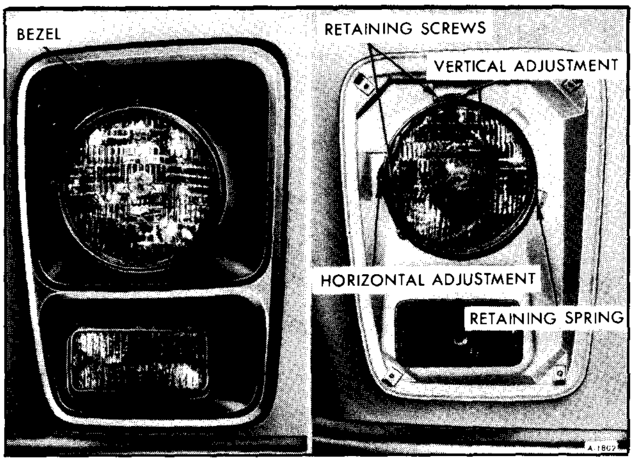


Figure 33—Headlamp Adjustment

HEADLAMP ADJUSTMENT

The headlamps must be properly aimed to obtain maximum road illumination. Proper aiming should be checked whenever a sealed beam unit is replaced or after any repair of the headlamp socket assembly. Regardless of the method used for checking headlamp aim, the vehicle must be at normal ride height, that is with gas, water and passenger weight most frequently traveled with.

NOTE: Some states have special headlamp aiming requirements which must be known and followed.

Horizontal and vertical aiming of each sealed beam is provided by two adjusting screws which move the mounting ring against the retaining spring tension (figure 33).

HEADLAMP REPLACEMENT (FIGURE 34)

1. Remove (4) headlamp bezel retaining screws.

2. Disengage spring from retaining ring.

3. Turn headlamp unit to disengage assembly from headlamp adjusting screws.

4. Disconnect wiring harness connector located at the rear of the sealed beam assembly.

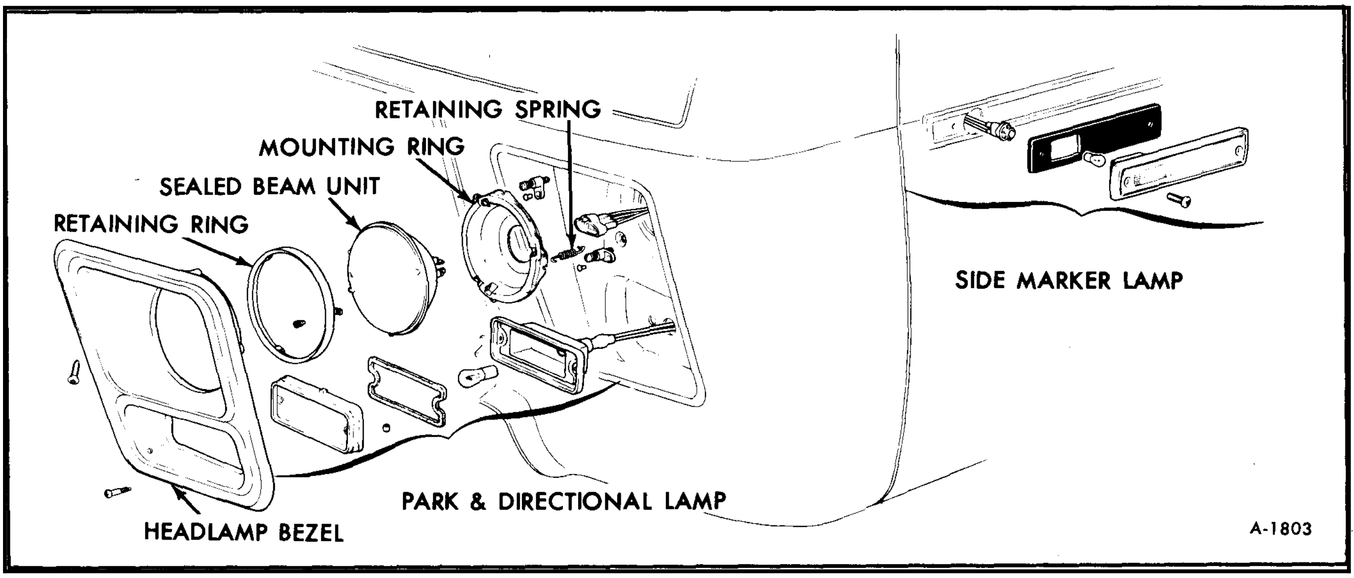


Figure 34—Headlamp and Side Marker Lamp Installation

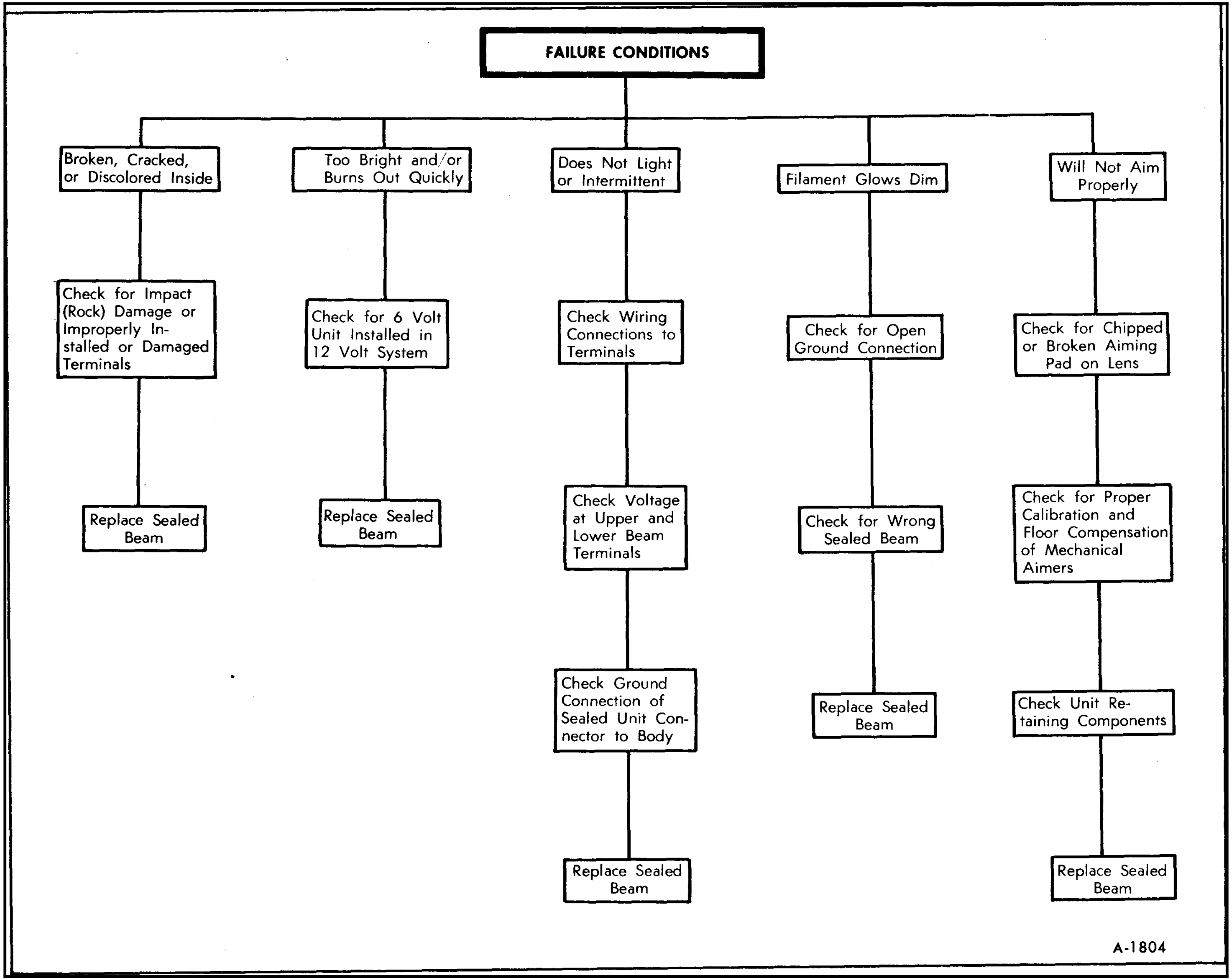


Figure 35—Headlamp Diagnosis

NOTE: Do not disturb adjusting screw setting.

5. Remove retaining ring and headlamp from mounting ring.

6. Position new sealed beam unit in mounting ring and install retaining ring.

NOTE: The number molded into lens face must be at the top of the bulb.

7. Attach wiring harness connector to unit.

8. Install headlamp assembly in panel opening, turning slightly to engage mounting ring tabs with adjusting screws.

9. Install headlamp retaining ring spring and check lamp aiming if adjusting screws have been turned.

10. Install headlight bezel with the (4) retaining screws.

HEADLAMP DIAGNOSIS

For details on headlamp diagnosis, refer to Figure 35. Additional diagnosis information is covered later in this section under "Headlight Switch".

COMPONENT REPLACEMENT

PARKING AND DIRECTIONAL SIGNAL BULB (FRONT) REPLACEMENT (FIGURE 34)

1. Remove (2) lens retaining screws and remove lens from housing.

2. Replace bulb and check operation. See Specifications at the end of this section for bulb No.

3. Install lens and retaining screws.

SIDE MARKER LAMP BULB (FRONT AND REAR) REPLACEMENT (FIGURES 34 and 36)

1. Remove (2) marker lamp retaining screws and remove lens.

2. Replace bulb and check operation. See Specifications at the end of this section for bulb No.

3. Install lens and retaining screws.

TAIL, STOP, BACK-UP AND DIRECTIONAL SIGNAL BULB REPLACEMENT (FIGURE 36)

1. Remove (4) lens retaining screws and remove defective bulb.

2. Replace bulb and check operation. See Specifications at the end of this section for bulb No.

3. Install lens and retaining screws.

NOTE: Check for proper positioning of lamp assembly felt drain plug (See figure 36).

LICENSE PLATE BULB REPLACEMENT (FIGURE 36)

1. Remove (2) outermost screws in license lamp lens.

2. Replace bulb and check operation by turning parking lamp on. See chart for bulb No.

3. Install lens with the (2) retaining screws.

CLEARANCE AND IDENTIFICATION BULB (FRONT AND REAR) REPLACEMENT (FIGURE 37)

1. Remove lens, retaining screw, and then remove lens.

2. Replace bulb and check operation. See Specifications at end of this section for bulb No.

3. Install lens and retaining screw.

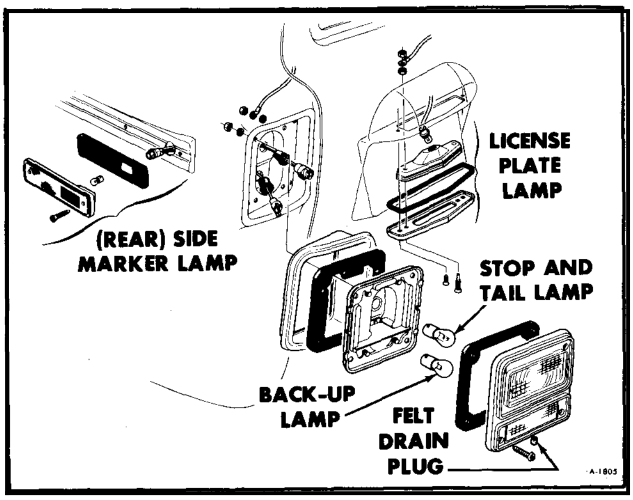


Figure 36—Tail, Stop, License and Rear Side Marker Lamps

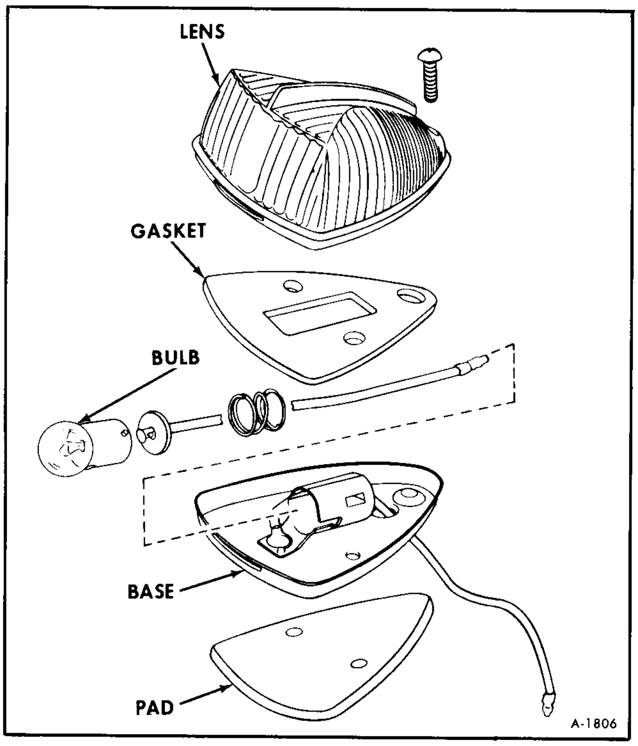


Figure 37—Clearance and Identification Lamp

DOME LAMP BULB REPLACEMENT (FIGURE 38)

1. Remove dome lamp lens by gently prying with flat blade screwdriver between lens and housing.

2. Replace bulb and check operation. See chart for bulb No. at the end of this section.

3. Snap dome lamp lens back into position by pushing lens as far as possible in housing, locking tabs will hold the lens in place.

ENGINE COMPARTMENT LAMP BULB REPLACEMENT

1. Remove the (2) lens retaining screws and then remove lens.

2. Replace bulb and check operation.

3. Install lens and retaining screws.

FIBER OPTIC RIBBON

Lighting for windshield wiper control, main light switch and washer switch is transmitted through a fiber optic ribbon from a main source bulb located on the L.H.side of the lower instrument panel cover. The ribbon should remain with the instrument panel bezel when the bezel is removed. The source bulb housing can be separated from the wiring harness to free the optic ribbon and permit bezel removal (See figure 39). Bulb number is listed in "Specifications" at the end of this section.

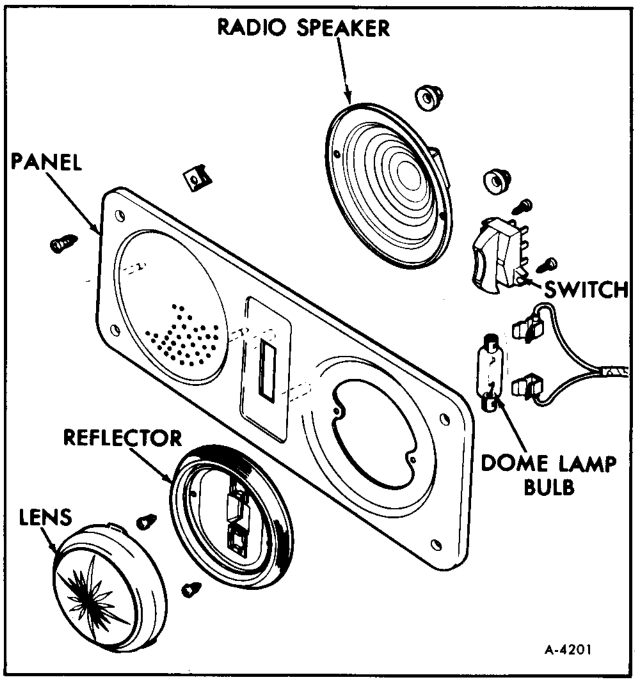


Figure 38—Dome Lamp Installation

Figure 39—Fiber Optic Ribbon

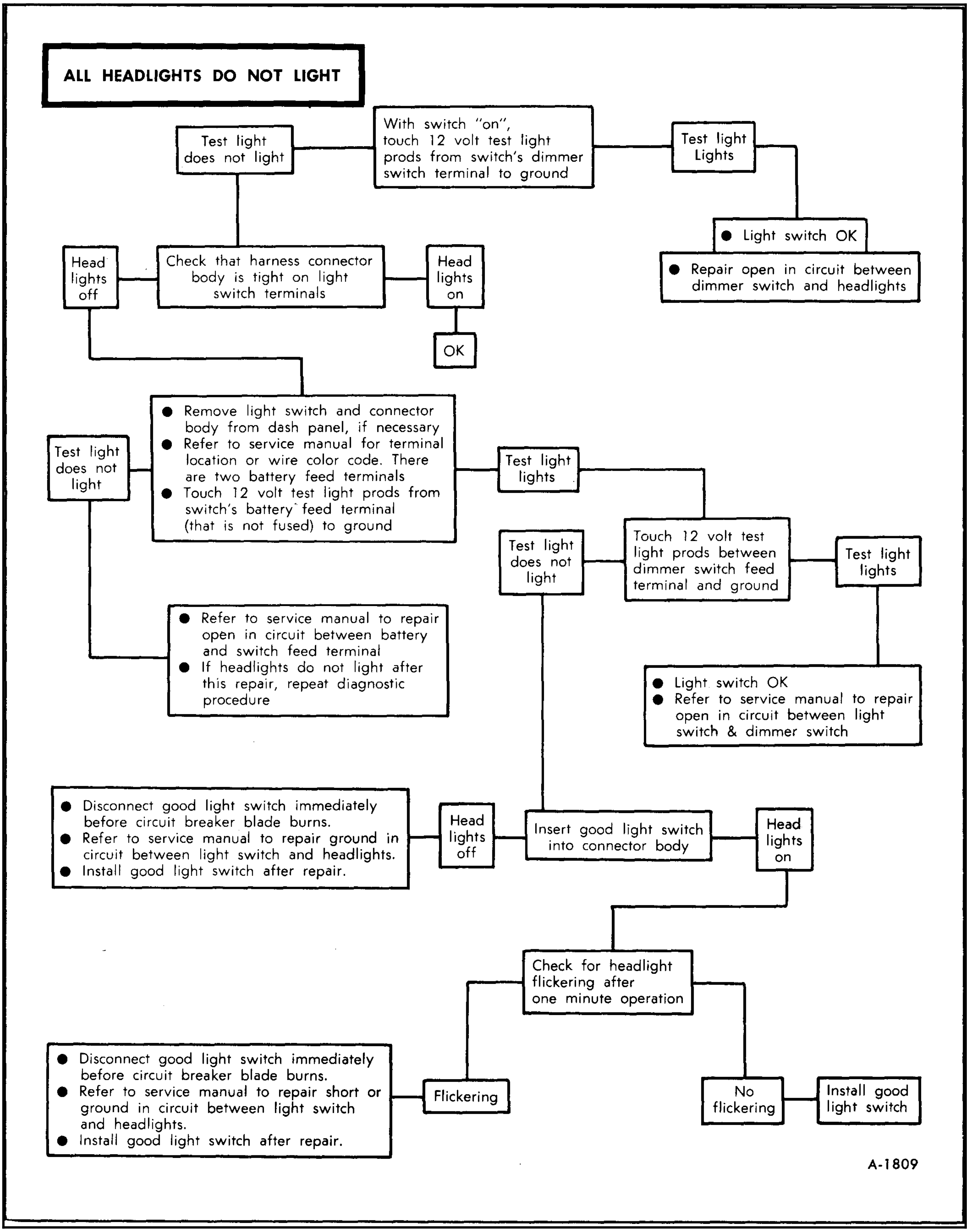


Figure 40—Headlight Switch Diagnosis

ONE HEADLIGHT INOPERATIVE OR INTERMITTENT	
POSSIBLE CAUSE	**CORRECTION**
Loose Connection	Secure Connections to Sealed Beam Including Ground (Black Wire)
Defective Sealed Beam	Replace
ONE OR MORE HEADLIGHTS ARE DIM	
Open Gr. Connection at Headlight	Repair Black Wire Connection Between Sealed Beam & Body Ground
Black Ground Wire Mislocated in Headlight Connection (Type 2 Sealed Beam)	Relocate as Shown in Service Circuit
ONE OR MORE HEADLIGHTS—SHORT LIFE	
Voltage Regulator Misadjusted	Check and Adjust if Necessary to Specifications.
ALL HEADLIGHTS INOPERATIVE OR INTERMITTENT	
Loose Connection	Check and Secure Connections at Foot Switch and Light Switch
Defective Foot Switch	Check Voltage at Foot Switch With 12-Volt Test Bulb. If Bulb Lights Only at Lt. Blue Wire Terminal, Replace Foot Switch.
Open Wiring - Light Switch to Foot Switch	Check Voltage at Lt. Blue Wire With Test Bulb. If Bulb Lights at Light Switch Lt. Blue Wire Terminal But Not at Foot Switch, Repair Open Wire.
Open Wiring - Light Switch to Battery	Check Voltage at Light Switch Red Wire Terminal With 12-Volt Test Bulb. If Bulb Fails to Light, Repair Open Red Wire Circuit to Battery (Possible Open Fusible Link)
Circuit Shorted to Ground	If, After a Few Minutes Operation, Headlights Flicker On and Off and/or a Thumping Noise Can be Heard From the Light Switch (Circuit Breaker Opening and Closing), Repair Short to Ground in Circuit Between Light Switch and Headlights. After Repairing Short, Check For Headlight Flickering After One Minute Operation. If Flickering Occurs, the Circuit Breaker Has Been Damaged and Light Switch Must be Replaced.
Defective Light Switch	Check Voltage at Light Switch Red and Blue Wire Terminals With Test Bulb. If Bulb Lights at Red Wire Terminal But Not at Lt. Blue, Replace Light Switch.
UPPER OR LOWER BEAM WILL NOT LIGHT OR INTERMITTENT	
Open Connection or Defective Foot Switch	Check Voltage at Foot Switch Headlight Terminals With Test Light. If Bulb Lights at Headlight Terminals (Lt. Green - U.B., Tan - L.B.), Repair Open Wiring Between Foot Switch and Headlights. If Bulb Will Not Light at One of the Foot Switch Headlight Terminals, Replace Foot Switch.
Circuit Shorted to Ground	Follow Diagnosis Shown Above Under "All Headlights Inoperative or Intermittent" A-1810

Figure 41—Headlight Circuit Diagnosis

HEADLIGHT SWITCH

The headlight switch controls the headlamps, parking lamps, tail lamps, marker and clearance lamps, instrument and dome lamps as well as instrument light intensity. The dome lamps are actuated by turning the headlamp switch fully counterclockwise. The headlamps are protected by a 25 amp. circuit breaker in the headlamp switch which is an automatic reset type. Before replacing the light switch, make sure the trouble is in the switch and not elsewhere in the lighting system by checking circuits as described in Figures 40 and 41.

HEADLIGHT SWITCH REPLACEMENT

1. Disconnect negative battery cables.

2. Pull the switch knob out to the full "ON" position, then reaching up behind the instrument panel, press the spring-loaded release button on the bottom of the switch. Remove the switch rod and knob by pulling straight out with button depressed.

3. Remove the switch retaining nut by inserting a flat-blade screwdriver into the nut while holding the switch from behind the instrument panel.

4. Remove the switch from the instrument panel and disconnect the multiple wire connector from the switch.

5. Reverse steps 1—4 for switch installation.

DIRECTIONAL SIGNALS

For diagnosis of hazard warning and directional signal systems, refer to STEERING (SECTION 9) of this manual.

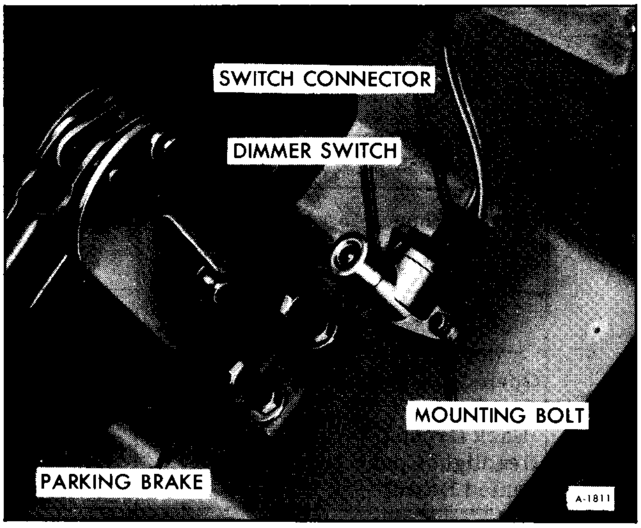


Figure 42—Dimmer Switch

DIMMER SWITCH

The foot-operated dimmer switch (figure 42) is used to select headlight high or low beam. The switch is mounted on the left hand side of the drivers area floorboard and is operative when the headlights are illuminated. See Figure 41 for diagnosis details.

DIMMER SWITCH REPLACEMENT

1. Fold back the carpeting or floor mat in the area of the switch (See figure 42).

2. Disconnect the wiring harness connector from the switch and remove the switch screws.

3. Push the wiring harness connector onto the replacement switch and check operation.

4. Position the switch on the floor panel or toeboard area and attach with (2) screws. Re-position floor mat.

HORN

Two air-tone "S" type vibrating electric horns (figure 43) are mounted behind the left front access door. The electric air-tone "S" type horn is carefully adjusted and inspected during manufacture and should operate indefinitely without attention. The horn assembly should not be adjusted or repaired.

The horn relay-buzzer (figure 44) includes both the horn relay and door buzzer. The horn relay-buzzer operates when the vehicle door is open with the ignition key in the switch and the switch in the "off" position. Closing the door or removing the key will stop buzzer operation. The relay is located behind the right front access door.

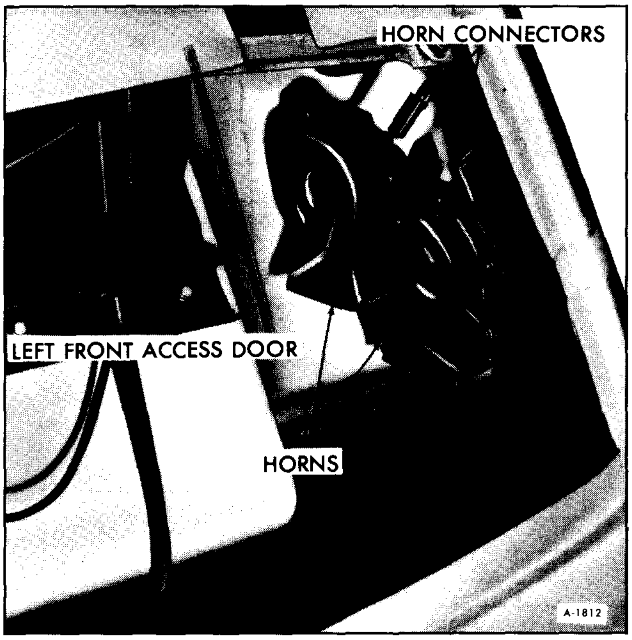


Figure 43—Horn Installation (Typical)

Figure 44—Horn Relay-Buzzer Installation

Refer to ENGINE AND CHASSIS WIRING DIAGRAM for horn and door buzzer wiring circuit.

HORN DIAGNOSIS

For diagnosis of horn system refer to Figure 45.

COMPONENT REPLACEMENT

HORN

1. Disconnect battery ground cables, then open left front engine access door and remove the dark green wires and connectors from the horn assembly.

2. Remove the horn mounting bolts and remove horns (See figure 43).

3. Reverse steps to install horns and check operation.

HORN RELAY-BUZZER

1. Disconnect battery ground cables.

2. Remove horn relay buzzer connector (figure 44).

3. Remove mounting bolt which attaches relay-buzzer to panel.

4. Install buzzer by reversing steps 1-3, making sure that headlamp ground wire is placed under relay mounting tab.

RADIO AND TAPE PLAYER

Radio options include an AM radio, AM-FM, AM-Tape, AM-FM Stereo and AM-FM-Tape Stereo unit. There are two 3-1/2 inch speakers (figure 38) located in each of the front dome light panels and two in each of the rear corners of the vehicle. The antenna is roof mounted with coaxial cable running down the center windshield pillar to the radio.

On AM-FM receivers, a frequency band selector bar is used to change from the AM to FM reception. Moving the band selector bar to the left, engages the FM band and all preset FM stations. Conversely, moving the selector bar to the right engages the AM band. Any preset AM or FM station can be mechanically tuned by depressing the appropriate push button located directly below the band selector bar.

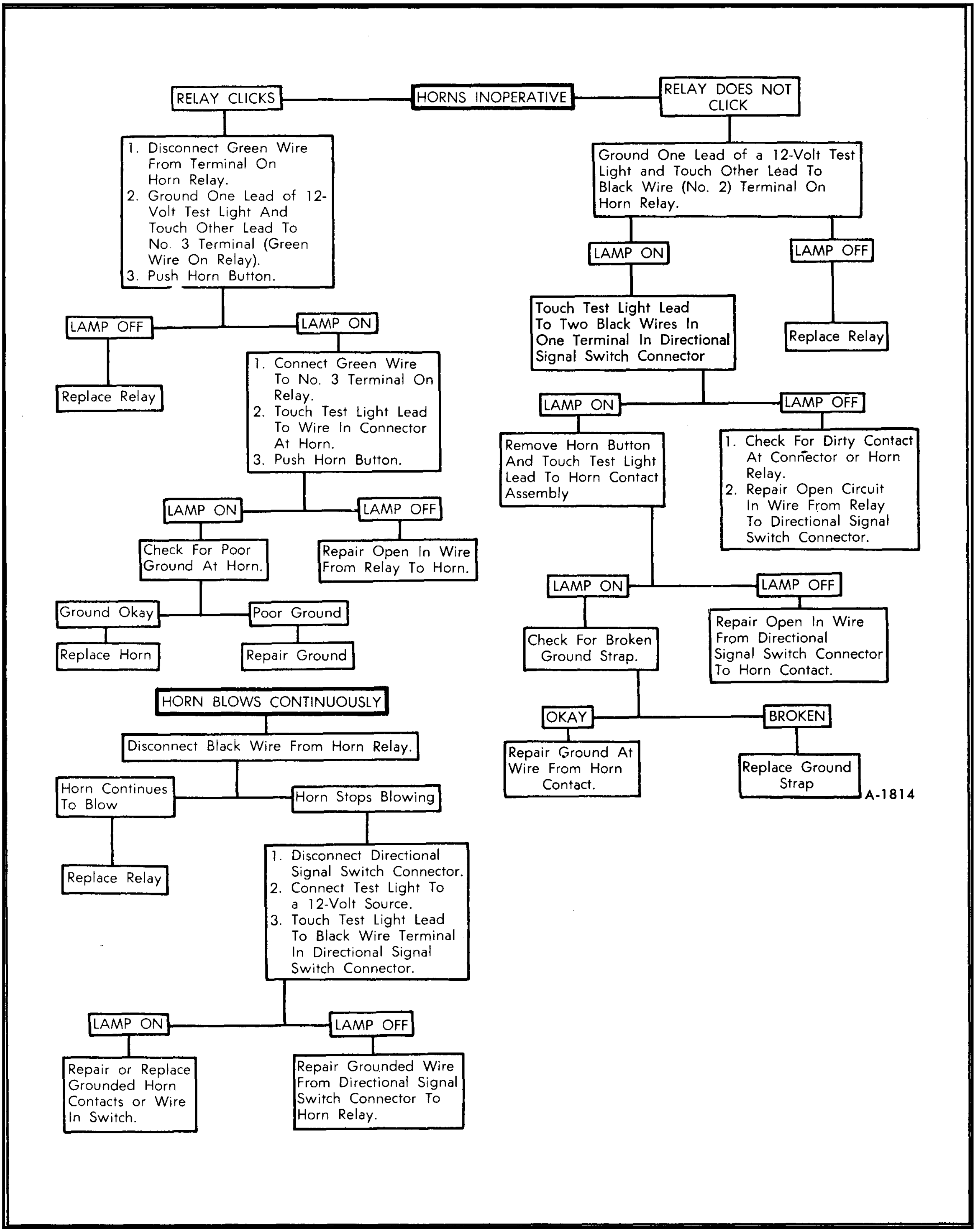


Figure 45—Horn Diagnosis Chart

The FM section of the AM-FM and AM-FM Stereo radios is equipped with automatic frequency control, which aids tuning to a station. The FM receiver should be tuned directly on station frequency for minimum noise interference, however, the automatic frequency control will tune directly to and lock on station frequency when slight mistuning is encountered.

Another feature of FM tuning is signal separation. When two FM stations are close in frequency, the FM tuner selects the stronger signal, rejecting the weaker one. This is in contrast to AM performance, where it is not always possible to separate two stations.

The AM-FM radio incorporates an AM receiving circuit and an FM receiving circuit. The audio system is common to both receiving circuits.

On stereo radios, an indicator light on the right side of the dial, will indicate when the FM station tuned is capable of transmitting stereo programs.

With the AM/FM stereo radio and eight-track tape player, the operator may insert a tape cartridge into the opening behind the face of the receiver dial. When the dial face swings up, this automatically removes power from the radio and switches control of the speakers to the tape player. To change tape programs, momentarily depress the volume control knob. To eject the tape cartridge from the engaged position, depress the "EJECT" pushbutton. A cartridge should not be left inserted in the tape player due to possible tape damage.

SPEAKER CONTROL

The right radio knob is used to tune stations manually. The ring around the knob is the speaker control. When the ring is turned all the way counterclockwise, 90% of the volume will be shifted to the front speakers. Turning the ring progressively clockwise will shift volume to the rear. When the radio is tuned to an FM-Stereo program, stereo separation will be from side to side.

PUSH BUTTON TUNING

Each one of the five push buttons may be preset to a favorite AM station when on the AM band. Each one of these same five push buttons may be set to a favorite FM or stereo station, giving a total of 10 preset favorite stations. To preset push buttons, proceed as follows:

Select the desired band (AM or FM) and manually tune a favorite station until maximum signal is received. Pull push button out and then push all the way in to relatch. Ten favorite stations (5-AM and 5-FM) can be obtained in this manner.

CAUTION: *Do not move the AM-FM slide bar band selector while any push button is pulled out. Damage to the tuner mechanism may result.*

RADIO NOISE SUPPRESSORS

Various types of ignition suppressors are used to prevent spark noise from interfering with radio reception.

1. Ignition noise is suppressed by use of resistance core ignition cables. The resistance of these cables is 2000 to 6000 ohms-per foot.

2. Make sure resistance spark plugs are being used to minimize ignition noise.

3. It is particularly important that the terminals in the ignition secondary cables make good mechanical contact with the spark plug terminals and distributor cap terminals. A loose connection at these points will result in excessive ignition noise, seriously reducing FM performance.

4. A capacitor mounted on the outside of the ignition coil may be checked by running the engine at medium speed and then quickly turning the ignition switch to the Accessory position. If the noise is eliminated, while the engine is coasting to a stop, replace faulty coil capacitor.

5. A capacitor is mounted on the blower motor assembly for suppressing radio noise at high blower speeds. If a whine is eliminated when the blower is switched from HI to LO, this capacitor should be replaced.

RADIO AND TAPE DIAGNOSIS

Many conditions that affect radio operation may be corrected without removing set from vehicle. If the checks in Figures 46 and 47 are performed and problem cannot be found, the radio should be removed and repaired at an authorized radio service station.

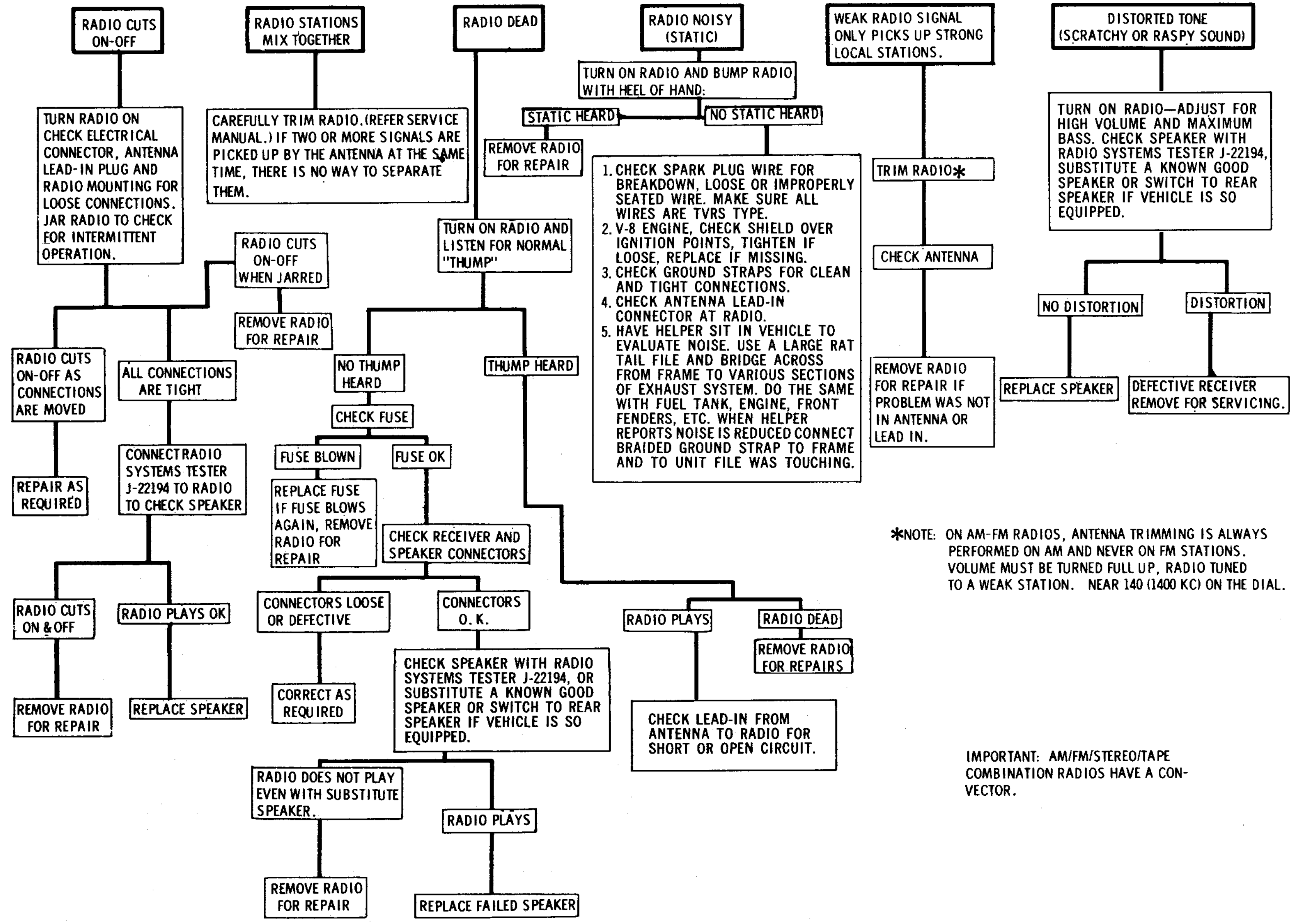
CAUTION: *Do not turn on radio with any speaker disconnected, as the radio transistor may be permanently damaged.*

SERVICING

ANTENNA TRIMMER ADJUSTMENT

NOTE: If antenna is not trimmed, the set will have weak and fading AM reception. Antenna trimming should always be performed after any radio or antenna repair work.

RADIO TROUBLE DIAGNOSIS



*NOTE: ON AM-FM RADIOS, ANTENNA TRIMMING IS ALWAYS PERFORMED ON AM AND NEVER ON FM STATIONS. VOLUME MUST BE TURNED FULL UP, RADIO TUNED TO A WEAK STATION. NEAR 140 (1400 KC) ON THE DIAL.

IMPORTANT: AM/FM/STEREO/TAPE COMBINATION RADIOS HAVE A CONVECTOR.

A-1815

Figure 46—Radio Diagnosis

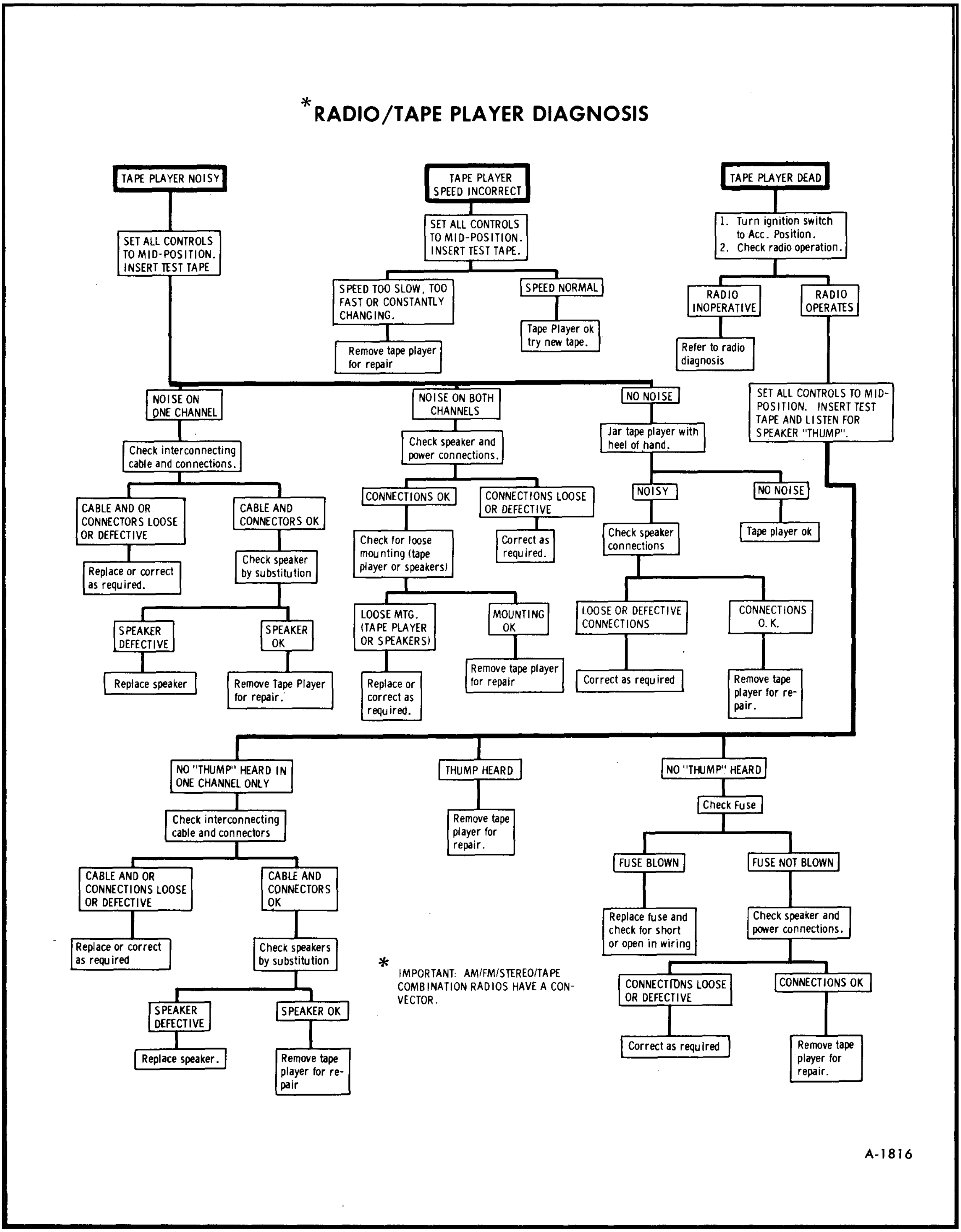


Figure 47—Tape Player Diagnosis

1. Turn radio on. Switch to AM band if radio is AM-FM.

2. Tune in a weak station at approximately 1400 kilohertz on the AM band and turn volume control to maximum.

3. Adjust antenna trimmer, located behind right control knob ring, for maximum volume. Access to antenna trimmer is gained by removing right control knob and ring and inserting screwdriver to adjust screw (figure 48).

NOTE: If, during adjustment, the station becomes strong so that a change in volume cannot be heard with further screw rotating, tune to a weaker station and continue the adjustment.

ANTENNA MAST REPLACEMENT

If it becomes necessary to remove the antenna mast assembly, refer to Figure 49 for proper part positioning of mast components.

NOTE: Antenna cable passes through center windshield support as shown in Figure 27.

BALANCE ADJUSTMENT (AM-FM STEREO MODELS ONLY)

If the sound appears to be louder on one side of the vehicle than the other, and adjustment to the audio balance may be made.

NOTE: On some stereo programming, it is normal for one side to be louder than the other for a short time. This is done purposely for stereo effect. The only positive method to tell if the balance control needs adjustment is to tune in a non-stereo program and make a critical evaluation.

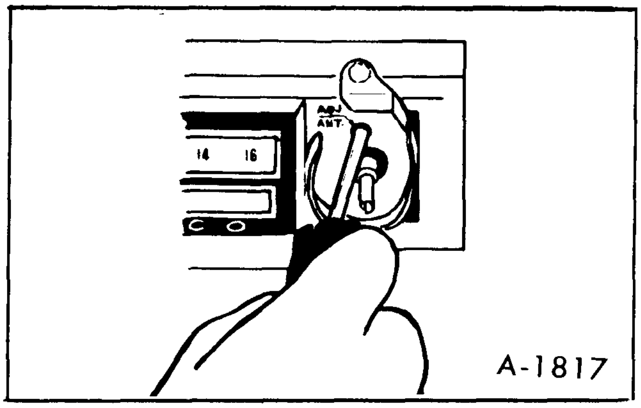


Figure 48—Antenna Trimmer Adjustment

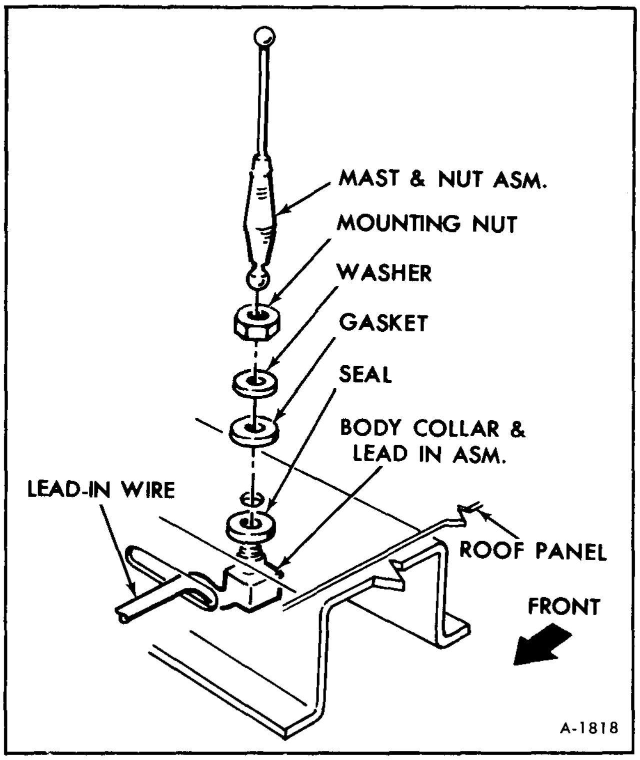


Figure 49—Antenna Mast Installation

If adjustment is needed proceed as follows:

1. Turn radio on. Switch to AM band.

2. Remove left knob, spring and control ring to gain access to stereo balance screw.

3. With fader control turned fully clockwise, insert screwdriver into balance screw.

4. Rotate balance control adjustment clockwise or counterclockwise until the sound in the left and right speakers appears to have equal volume.

5. Install left control ring, spring and knob.

STEREO TAPE PLAYER

The only required maintenance on tape players is periodic cleaning of the tape player head. This service should be performed approximately every 100 hours of operation. If the tape slips and runs slowly, the capstan (revolving metal post), head and tape guide should be cleaned with a cotton swab moistened with alcohol. To clean capstan, trip the on-off switch at the rear of the receptacle and hold the swab against the rotating capstan.

No lubricants should be used since they will cause the player to operate improperly, especially at extreme temperatures.

Do not bring any magnetized tools near the tape head. If the head becomes magnetized, every cartridge played in the player will be degraded.

STEREO TAPE PLAYER CONVECTOR (FIGURE 50)

On units equipped with a stereo tape player, power transistors are located on a remote heat convector due to space limitations. The convector assembly is located behind the glove box door. Connection is made to the convector by means of a 6 wire harness and plug connector running parallel to the fuse block wiring harness from the tape player.

If radio is to be removed for repairs, test the convector, USM radio repair stations do not need the convector to repair the radio if the convector is good.

CONVECTOR TEST (FIGURE 51)

1. Remove the convector harness plug from the rear of the radio.

2. Connect 12 volt test light to 12 volt source.

3. Connect jumper wire to good ground, touch test light probe to jumper to test connections. Test light should light.

4. Touch test light probe to blue wire; jumper to yellow wire.

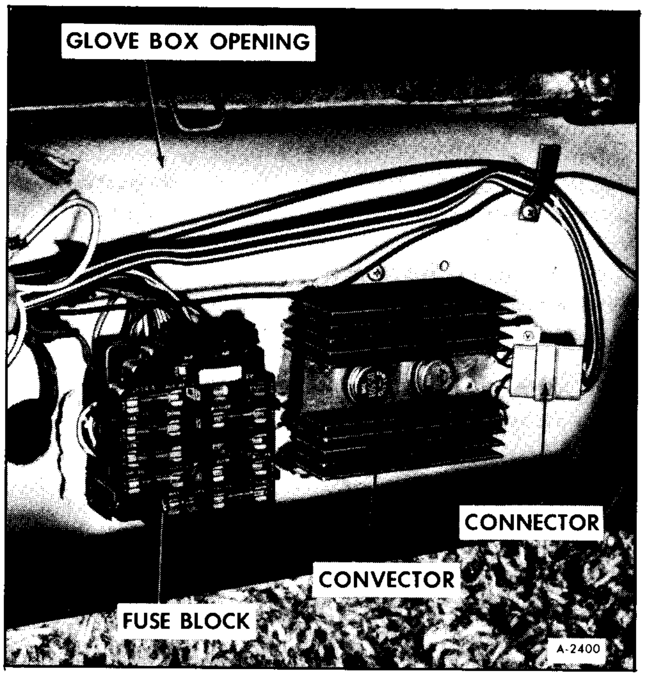


Figure 50—Convector Installation

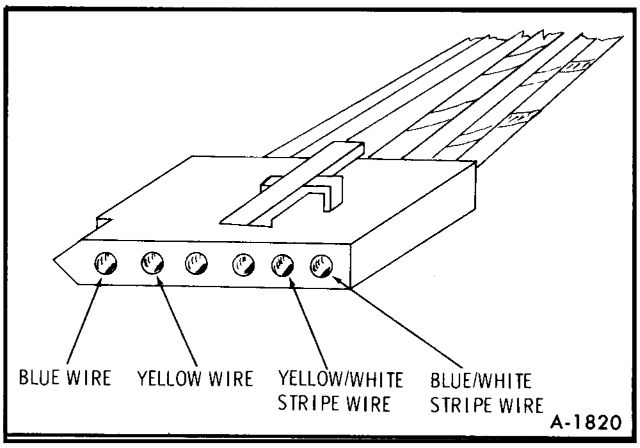


Figure 51—Convector Connector

5. Touch test light probe to blue/white stripe wire; jumper to yellow/white stripe wire.

6. If test light lights in either of the above tests, remove the convector for repair. If the test light is off in both tests, it will not be necessary to send the convector with the radio for repair.

CONVECTOR REPLACEMENT

1. Convector is located behind glove box on vehicle bulbhead panel.

2. Remove the convector harness connector.

3. Remove the (2) retaining screws and remove convector (See figure 44).

4. To install, reverse steps 1-3.

RADIO DIAL LAMP REPLACEMENT

Radio dial lamp replacement can be made using the following procedures:

All Radio Models

1. Disconnect battery ground cables.

2. Remove the instrument panel bezel and rear cover.

3. Remove the radio knobs and rings.

4. Disconnect the wiring connectors from the rear of the radio and remove radio unit from the instrument panel.

5. Remove the (5) radio case top retaining screws and remove cover.

6. Remove the dial lamp bulb from the holder and replace.

7. To assemble, reverse steps 1-6 above.

Stereo Indicator Lamp Replacement

In cases of a failed stereo indicator lamp on stereo radio models, remove radio and have service performed by an authorized Delco radio repair facility.

MOBILE RADIO TRANSMITTERS

Mobile radio transmitting equipment is subject to Federal Communications Commission regulations and must be installed by a qualified radio technician. The specific installation instructions for radio transmitters will vary depending upon the radio equipment used. Mobile telephone equipment installed by your local telephone company, citizens band radios and electronic garage door openers will not adversely affect vehicle operation. In the event any other type of mobile radio transmitter is to be installed, further instructions are required so that vehicle operation will not be adversely affected. Contact GMC Truck Coach Division, General Motors Corporation, Technical Service Department, Pontiac, Michigan 48053 (or in Canada, contact General Motors of Canada Limited, Product Service Department, Oshawa, Ontario).

CRUISE CONTROL

GENERAL DESCRIPTION

The Cruise Control is a speed control system which employs engine manifold vacuum to power the throttle servo unit. The servo moves the throttle when speed adjustment is necessary by receiving a varying amount of controlled vacuum from the transducer unit. The speedometer cable from the transmission drives the transducer, and a cable from the transducer drives the instrument panel speedometer. The engagement of the transducer unit is controlled by an engagement switch located at the end of the turn signal lever. Two brake release switches are provided: an electric switch disengages the transducer unit and a vacuum switch decreases the vacuum in the servo unit to quickly return the throttle to idle position.

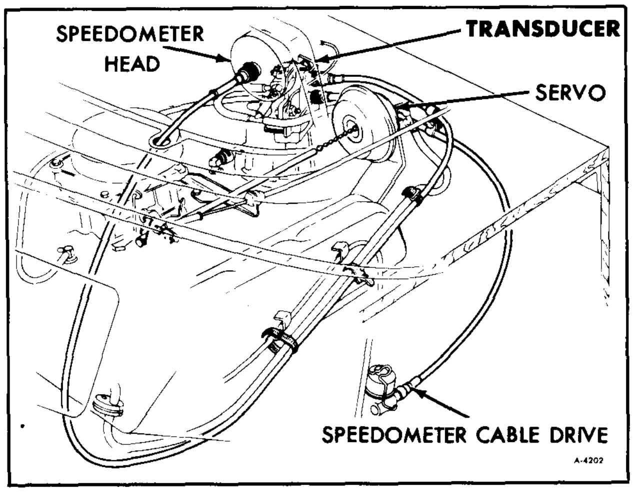


Figure 52—Cruise Control Component Location

The operation of each unit of the system and the operation of the entire system under various circumstances is described below. Figure 52 shows the location of the system components within the vehicle. See "Cruise Control System Diagnosis" chart for cruise control system checks.

COMPONENT OPERATION

ENGAGEMENT SWITCH

This switch, located within the turn signal knob, has three positions. In the fully released position, the switch passes current through resistance wire to effect a "hold in" magnetic field in the transducer solenoid. This current is sufficient only to hold the solenoid in place once it has been actuated by the "pull in" circuit. Depressing the button partially allows current to flow to the transducer solenoid at full voltage which causes the solenoid to pull in. Depressing the button fully opens the circuit to both the resistance and standard solenoid feed wires and the solenoid becomes de-activated.

During vehicle operation the three switch positions have the following functions:

RELEASED

a. System not engaged: No function of the system will occur although a small current is flowing through the solenoid via the resistance wire.

b. System engaged: The small current flowing through the resistance wire is holding the solenoid in the engaged position.

PARTIALLY DEPRESSED

Full voltage is applied to the solenoid (vehicle speed over 31 mph) which sets the transducer to maintain the vehicle speed at the time of transducer engagement.

FULLY DEPRESSED

No electricity flows to the solenoid and the transducer is inactive. This position is used by the driver when he desires to raise or lower his controlled speed. He may accelerate to his new speed, press the button fully (transducer releases previously set speed) and release the button. Upon releasing the button, it passes through the partially depressed position and the solenoid is "pulled in", then into released position which provides "hold in" current. The driver may also press the button fully with no pressure on the accelerator pedal. In this case the transducer releases control of the throttle which returns to idle and the vehicle slows. When the button is released the solenoid is pulled in and held in respectively and the transducer resumes speed control at the speed of the vehicle during the moment of button release (at vehicle speeds over 31 mph).

BRAKE RELEASE SWITCHES

Two brake release switches are employed in the Cruise Control System. When the brake pedal is depressed; an electric release switch cuts off the voltage supplied to the engagement switch, hence cuts off power to the transducer unit. The transducer is then disengaged and requires engagement switch operation to return it to operation. A vacuum release switch operates simultaneously with the electric release switch whenever the brake pedal is depressed. This switch opens a port to atmospheric pressure which rapidly bleeds down the vacuum in the servo unit thereby returning the throttle to the idle position.

SERVO UNIT

The servo unit is a vacuum actuated, variable position diaphragm assembly, which operates the carburetor throttle when the system is in operation. It is powered by controlled vacuum from the transducer and operates the throttle chainage via the adjustable link. (See figures 53 and 55). The servo has a port on the sealed side of the diaphragm housing. When controlled vacuum is applied to this port, atmospheric pressure moves the diaphragm which pulls on the adjustable chain opening the carburetor throttle.

TRANSDUCER

The transducer, Figures 54 and 55 is a device which has two primary functions. First, it is a vacuum switch which, when engaged by the driver, supplies vacuum to a "Tee" fitting. Second, it meters a small variable quantity of air to the "Tee" fitting where it blends with vacuum, thus providing the power unit with controlled vacuum which will maintain the selected speed. If the transducer begins to supply less bleed air (vehicle speed decreasing) the vacuum in the chamber increases and the diaphragm moves toward the vacuum port. If the transducer

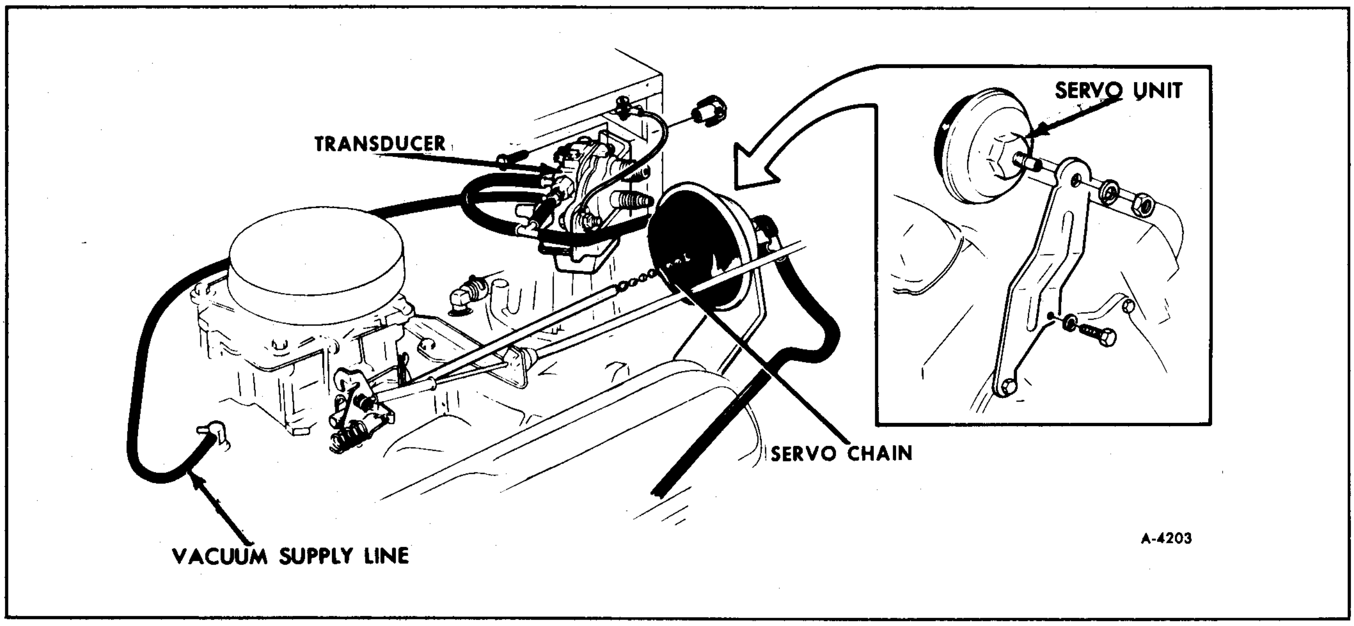


Figure 53—Servo Unit Installation

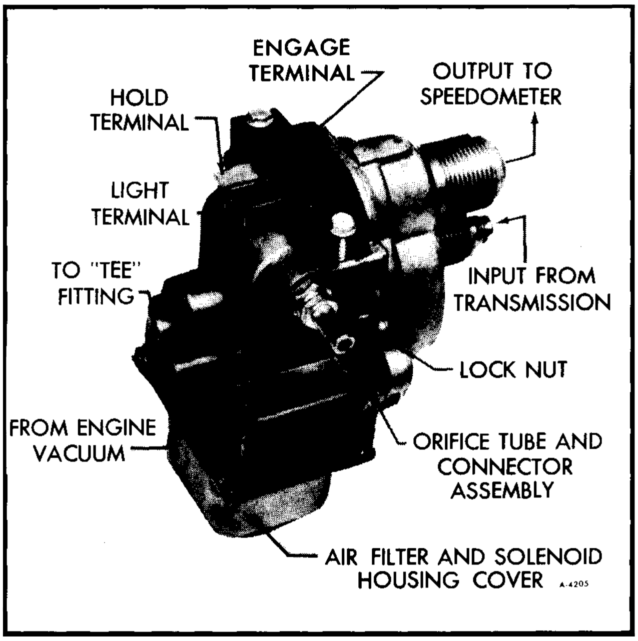


Figure 54—Transducer

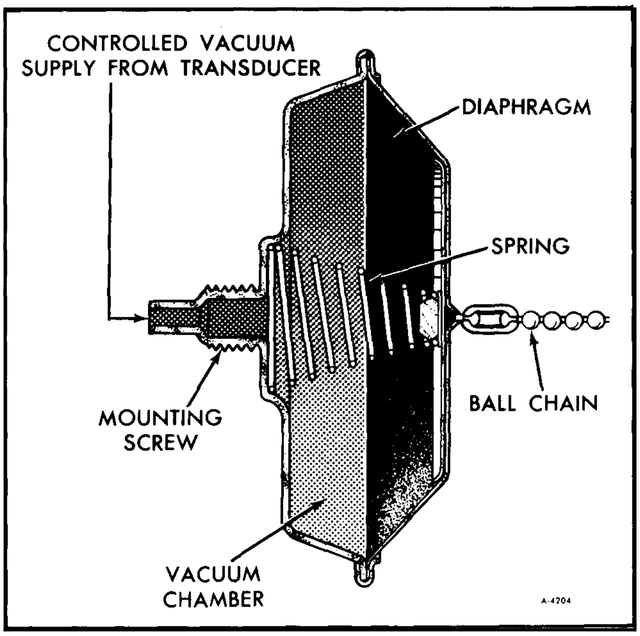


Figure 55—Servo Unit

begins to supply more bleed air (vehicle speed increasing), the vacuum in the chamber drops and the diaphragm moves away from the vacuum port. In operation, at cruise speed, a proper balance of air and vacuum is blended at the "Tee" fitting and is imposed upon the servo unit to maintain and "on speed" cruise condition.

An additional function of the transducer is to drive the speedometer. Since the vehicle speed is sensed by a speedometer-like mechanism within the unit, the speedometer cable from the transmission drives the regulator which drives a second cable (at a one to one ratio) to the speedometer.

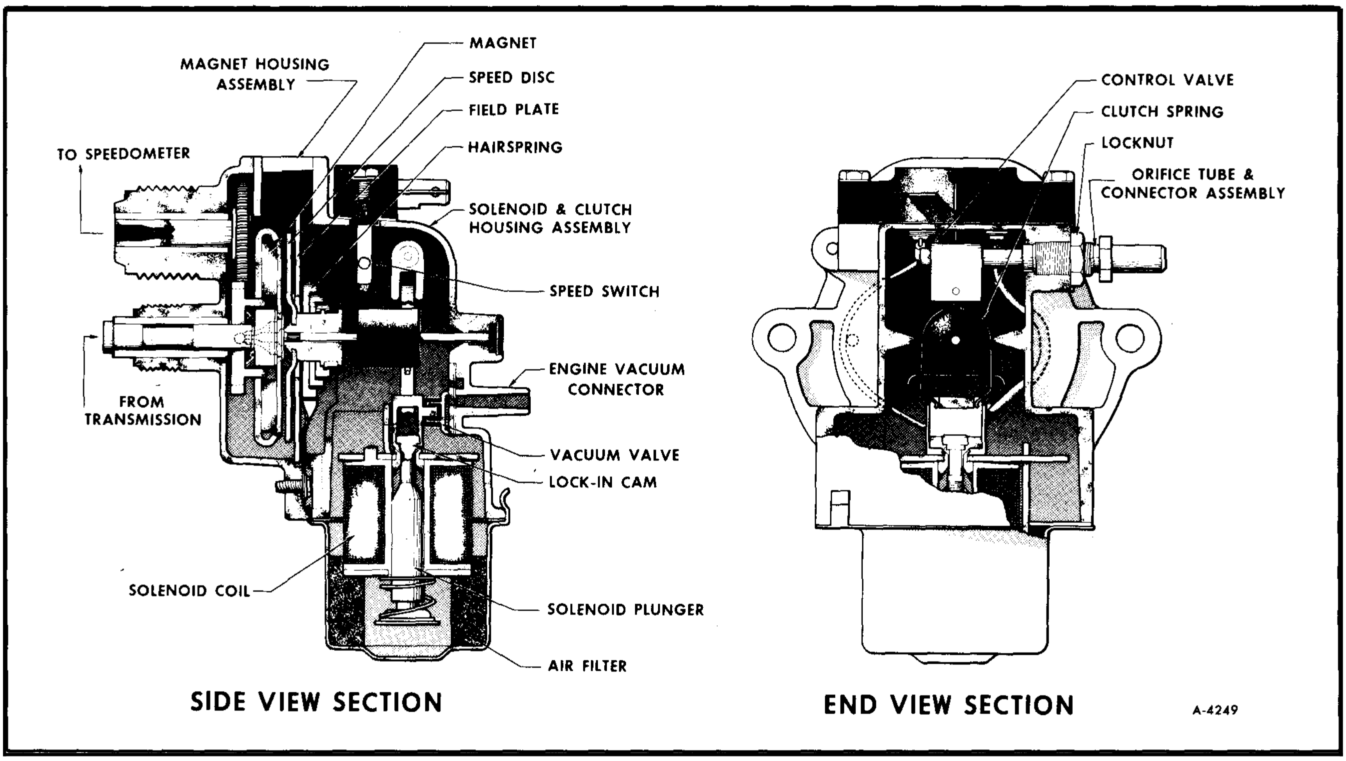


Figure 56—Transducer Cross Section

The transducer is electrically engaged and disengaged through operation of the engagement switch and the electric brake release switch. It has two subassemblies which make up the unit: one being the magnetic speed sensing assembly and the other being the solenoid actuated vacuum switch, air bleed and filter, and low limit speed switch assembly.

Magnetic Speed Sensing Assembly

The speed sensing assembly operates in the same manner as a speedometer unit except that instead of rotating a needle through an angle proportional to the vehicle speed, it rotates a rubber drum which is clutched to the air bleed valve when the system is in operation. The assembly is driven by the speedometer cable from the transmission which turns a disk shaped ferrite magnet.

Facing the magnetic disk is the driven copper disk mounted on a shaft with the rubber drum mounted on the same shaft. A spiral hairspring connects the shaft to the housing and allows it to rotate through an angle which is proportional to vehicle speed. If the vehicle doubled its speed, the shaft would rotate to twice its previous angle as may be seen by noting the operation of a speedometer. The driven disk is sandwiched between the magnetic disk and a field plate. The field plate forms a returning path for the magnetic field from the magnetic disk.

The input shaft drives both the magnetic disk and the speedometer drive cable.

Vacuum Switch, Air Bleed and Filter, and Low Limit Speed Switch

The end of the shaft from the speed sensing assembly with the rubber drum extends into the air bleed metering assembly. This rubber drum has a tang extending from its surface which allows a set of points to close at a specific speed. When the vehicle reaches about 31 mph, the rubber drum has rotated far enough (moved by the brass driven disk in the magnetic field) so that its tang has allowed a spring loaded electrical point to contact another point. These points are in series with the solenoid coil so that under 24 mph, no transducer operation is possible.

Surrounding the rubber drum is a "U" shaped spring clip which is held spread away from the drum by the nose or cam of the solenoid when the solenoid is in the relaxed position. The rubber drum and this clip comprise the speed clutch of the transducer. When the solenoid is energized, the solenoid nose moves toward the drum and releases the ends of the clip. The clip springs inward and attaches itself by friction to the drum. Now, any change in vehicle speed will rotate the drum and move the "U" clip just as a speedometer moves its needle. The top of the "U" clip is attached to the air bleed valve. The clip moves a sleeve which slides on the orifice tube thereby covering and uncovering air ports in the wall of the tube (the tube inner end is plugged) whenever vehicle speed changes from the speed at which the solenoid was energized. The direction of drum rotation is such that resulting bleed valve operation will cause the servo to decrease engine power if the vehicle exceeds the preset speed and increase engine power if vehicle speed decreases. The air which passes out the orifice tube enters the transducer through the openings in the solenoid housing, passes through the oil wetted polyurethane filter, and then enters the orifice tube ports.

When the solenoid is de-energized, the nose retracts and cams the ends of the "U" clip outward so that it releases the rubber drum.

The solenoid also operates a vacuum switch simultaneously with the clutching and declutching of the "U" clip. The solenoid operated vacuum valve slides over two ports in the transducer wall. One port is connected to manifold vacuum and the other is connected to a "Tee" fitting. When the solenoid is de-energized, the valve closes the manifold vacuum port and opens the "Tee" port to the inside of the transducer case. When the solenoid is energized, the valve connects manifold vacuum to the "Tee" fitting, at which point air is blended to the proper proportion and impressed upon the servo unit according to the dictates of the transducer.

During system operation the following events occurs:

1. Vehicle speed below 24 mph — no function of the pull-in circuit because the rubber drum has not rotated far enough to close the solenoid points. No pull-in current can flow through the solenoid coil. The solenoid coil is receiving a small current via the 40 ohm resistance wire unless the brake pedal is depressed, engagement switch fully depressed, or the ignition switch is "off".

2. Vehicle speed above 31 mph — the tang on the rubber drum has closed the solenoid points. The pull-in cirucit is now ready for engagement.

3. Driver partially presses engagement switch — full voltage flows through the solenoid to pull it into operation. Solenoid cam tension on the "U" clip is released and the clip grips the rubber drum. Simultaneously, the vacuum switch applys manifold vacuum to the "Tee" fitting. Here the vacuum is blended with air being introduced from the transducer. The balance of air and vacuum is impressed upon the servo to provide for initial throttle positioning.

4. Driver releases the engagement switch — current flows to the solenoid through the 40 ohm wire and since the solenoid is "pulled in", the reduced current flow is sufficient to hold it in position.

5. The vehicle begins to ascend a hill — vehicle speed drops slightly (very slightly) and the magnetic force on the driven disk of the speed sensor is decreased. The disk rotates slightly (as would a speedometer shaft because of hairspring tension) turning the rubber drum. Since the "U" clip is gripping the drum, it moves the air bleed valve in that direction which covers the air bleed ports more. With less air bleeding into the "Tee" fitting a higher vacuum level is achieved at the Servo diaphragm, opening the throttle angle to correct for the underspeed condition.

6. The vehicle begins to descend a hill — vehicle speed increases slightly and the air bleed valve moves in that direction which uncovers the air bleed ports. With more air bleeding into the "Tee" fitting, a lower vacuum level is achieved at the servo diaphragm decreasing the throttle angle to correct for the overspeed condition.

7. Driver accelerates by pressing accelerator pedal — vehicle speed increases and the system responds by moving the diaphragm to decrease throttle opening. Since an adjustable chain is used, the chain merely slips through the hole in the servo unit and has no effect on throttle operation. After the driver releases pressure from the pedal, the throttle will close until vehicle speed decreases to the pre-set speed. At that point the transducer bleeds less air to the "Tee" fitting which opens the throttle enough to maintain the pre-set speed. The system returns to a stable condition.

8. Driver desires higher controlled speed, presses accelerator until new speed is reached, and depresses engagement switch fully and releases button — speed sensing assembly tries to turn in a direction that would decrease the throttle opening until the driver fully depresses the engagement switch. Then the current is cut off to the solenoid which retracts; the solenoid cam expands the "U" clip releasing its grip on the rubber drum. The drum and disk assembly then rotates to a new position because of the higher vehicle speed. When the solenoid retracts, it also shuts off vacuum to the "Tee" fitting and opens the vacuum port to atmospheric pressure within the transducer thereby bleeding down the servo toward the relaxed position. As the driver releases the engagement switch, "pull-in" and "hold-in" of the solenoid occurs, respectively. The system is now engaged to maintain the vehicle speed at the time of engagement switch release.

9. Driver desires lower cruising speed, presses engagement switch fully, waits until vehicle speed decreases to desired speed then releases switch — when the engagement switch is fully depressed the solenoid is de-energized causing the vacuum switch to bleed down the servo to idle throttle position and the "U" clip of the air bleed valve is released from the rubber drum. The drum and disc assembly is free to rotate to a position which corresponds to vehicle speed as the vehicle slows. When the driver releases the engagement switch, the unit "pulls in" and "holds-in" in the normal manner. The air bleed valve is clutched to the rubber drum at the vehicle speed corresponding to switch release. Vacuum is again applied to the "Tee" fitting and throttle control is assumed by the transducer to maintain the vehicle speed at the time of switch release.

10. With system is operation, driver applies brakes — simultaneously the vacuum release and electric release switches operate. The vacuum switch bleeds air into the servo. The vacuum is reduced in the servo and the throttle returns to idle position. The electric release switch cuts off power to the entire system and the solenoid is de-energized. If the driver removes his foot from the brake pedal the electric switch again feeds voltage to the engagement switch and the vacuum switch seals the air bleed line. The unit will not re-engage since it receives only a small current through the 40 ohm resistance wire. If vehicle speed is below 24 MPH the system may not be re-engaged since the tang on the rubber drum has opened the low limit switch points in the transducer.

DIAGNOSIS

For details on cruise control diagnosis refer to Diagnosis Chart.

SERVICING

The components of the Cruise Control system are designed to be replaced should they become inoperative.

The transducer is calibrated in such a manner during manufacturing that overhaul operations are impractical. However, one adjustment may be made to the transducer to correct speed drop or increase at the time of engagement.

BRAKE RELEASE SWITCHES

ELECTRIC

Service—An inoperative switch must be replaced. Switch replacement is identical to standard brake lamp switch replacement.

CRUISE CONTROL SYSTEM DIAGNOSIS

PROBLEM	CAUSE	CORRECTION
Will Not Engage - System Inoperative	Brake switch circuit open. Clutch switch circuit open.	Check connections - adjust or replace the switch. Refer to Electrical Check Out.
	Fuse blown.	Replace fuse - if it blows again, check for: 1. Engage switch stuck in the center of travel - Refer to Electrical Check Out. 2. Incorrect wiring - Refer to Electrical Check Out. 3. Short to ground - Refer to Electrical Check Out. Make necessary corrections.
	Defective Engage switch.	Replace as needed - Refer to Electrical Check Out.
	Vacuum leak in Servo and/or Brake switch and connecting lines. Vacuum hose not connected to vacuum switch.	Vacuum test and repair or replace as needed. Refer to Servo and Vacuum System Check Out.
	Vacuum Release switch misadjusted (always open).	Readjust switch.
	Crossed hoses at transducer.	Reroute hoses.
	Open in wiring harness.	Repair or replace as needed.
	Pinched or plugged hose that is connected to the Servo.	Free or replace hose.
	Defective transducer.	Replace transducer.
	Chain from Servo to carburetor disconnected.	Connect chain.
Does Not Cruise at Engagement Speed	Orifice tube misadjusted.	Adjust as required.
System Hunts, Pulses or Surges	Kinked or deteriorated hoses (air leak).	Repair or replace.
	Defective and/or improperly positioned drive cables and/or casing assemblies.	Repair or replace as needed.
	Defective transducer.	Replace transducer.
System Does Not Disengage - With Brake Pedal	Brake and/or Vacuum switch misadjusted or defective.	Adjust or replace as required. Refer to Servo and Vacuum System Check Out and Electrical Check Out.
	Wires which should be connected to the pedal switch(es) connected to the fuse block.	Reroute wires to stop light switch.
System Steadily accelerates or Applies Full Throttle When Engaged	Manifold vacuum connected directly to Servo.	Reroute hose.
	Defective transducer.	Replace transducer.
Cannot Adjust Speed Downward With Engage Button	Defective Engagement switch or wiring.	Replace as needed. Refer to Electrical Check Out.
Does Not Engage or Engages Lower Than Limits Referred To In "Driver Operation." Low Speed Engagement Can BE as Low As 20 MPH.	Defective transducer.	Replace transducer.
Slow Throttle Return to Idle After Brake is Depressed	Pinched air hose at vacuum release switch.	Free or replace hose.
System Operates Correctly, But Constant Vacuum Bleed When System is Disengaged	Crossed vacuum hoses at transducer.	Reroute hoses.
High Engine Idle Speed - Independent of Carburetor Adjustments. Constant Air Bleed Through System	Tight Servo chain.	Loosen adjustment.
Constant Drain on Battery	Power lead connected to "Fused Battery" terminal of fuse block.	Reroute to "Fused Ignition" terminal.
System Can Be Engaged At Idle By Depressing Switch, But Will Drop Out When Switch Is Released. Solenoid Can Be Heard When Switch Is Depressed When Vehicle Is Standing Still	Wires reversed at transducer.	Reverse wires.

Adjustment—The brake switch plunger must clear the pedal arm when the arm is moved 1/4 inch measured at the switch. (figure 57)

VACUUM

Service—An inoperative (sticking, plugged, or leaking) switch must be replaced. Switch replacement is similar to brake switch replacement. Be certain that the hose to the switch is connected firmly and is not cracked or deteriorated.

Adjustment—The vacuum switch should be pushed all the way into the retaining clip. Pulling the brake pedal up to the stop will automatically adjust the switch.

ENGAGEMENT SWITCH

NOTE: The engagement is serviced only by replacement.

REMOVAL

1. Disconnect battery ground cables.

2. Pry the engagement button out of the turn signal knob with a small thin bladed screwdriver.

3. With a small hook or long nosed pliers, remove the switch retaining ring.

4. Remove steering wheel to gain access to turn signal lever attaching screw. Remove screw. Remove turn signal lever from turn signal housing utilizing the slack in the wiring harness.

5. Push slack into turn signal lever slot at base of lever (attachment end). This will force switch out of the other end of the lever.

6. With a small soldering iron, unsolder the wires and resolder them to the correct terminal of the replacement switch. Use only rosin core solder.

INSTALLATION

1. Once a new switch is installed, pull it back into the lever by pulling on the harness at the lever slot.

2. Reinstall retaining ring and button.

3. Push wire slack into turn signal housing; reinstall turn signal lever and steering wheel.

4. Connect battery ground cables.

SERVO

NOTE: If the servo unit is found to be defective, replacement is required. Note the condition of the hoses and replace any which are cracked or deteriorated.

Adjustment—Adjust the servo chain length at the carburetor stud swivel to minimum slack with the carburetor on the slow idle cam and the engine not running (figure 58).

TRANSDUCER

A defective transducer, that is one which is not simply out of adjustment, must be replaced. During replacement, check the hoses which connect to the transducer and replace any which are cracked or deteriorated.

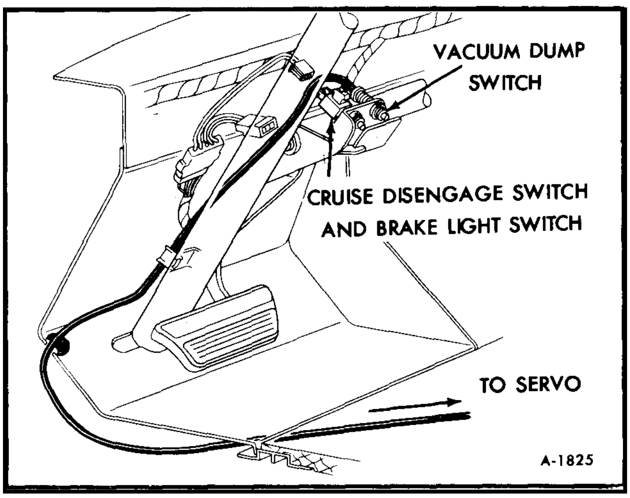


Figure 57—Brake Release Switches

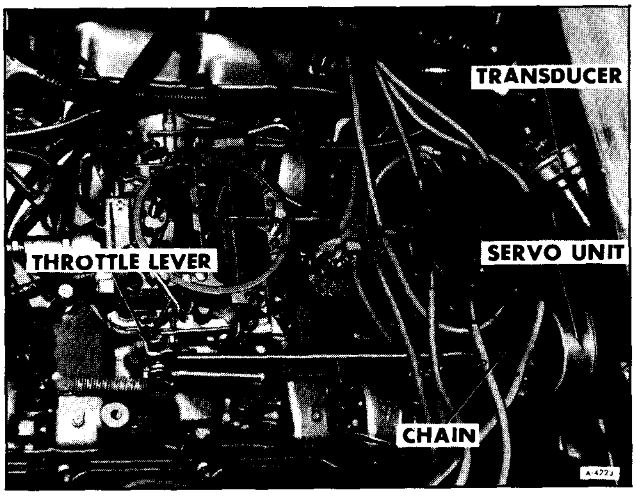


Figure 58—Servo Unit and Chain

ADJUSTMENT

One transducer adjustment is possible: Engagement-cruising speed zeroing (to remove any difference between engagement and cruising speed).

NOTE: No transducer adjustment should be made, however, until the following items have been checked or serviced.

1. Servo chain properly adjusted.

2. All hoses in good condition, properly attached, not leaking, not pinched or kinked.

3. Electric and vacuum release switches properly adjusted.

ENGAGEMENT—CRUISING SPEED ZEROING

If the cruising speed is lower than the engagement speed, loosen the orifice tube locknut and turn the tube outward; if higher, turn the tube inward. Each 1/4 turn will alter the engagement-cruising speed difference one mph. Tighten the locknut after adjustment and check the system operation at 60 MPH.

ELECTRICAL SYSTEM CHECK OUT

(Refer to Figure 59)

1. Check fuse and connector.

2. Check electric brake switch as follows: Unplug connector at switch. Connect ohmmeter at points A and B on brake switch. The ohmmeter must indicate infinity when the pedal is depressed and continuity when pedal is released. The cruise release brake switch (electric) is adjusted as is the standard stop light brake switch. Replace electric brake switch if needed.

3. Check engagement switch and connecting wiring as follows: Unplug engagement switch connector (brown, black) at electrical wiring harness connector and perform the following tests.

Test #1 — Connect ohmmeter between terminal #1 (brown wire) and terminal #2 white (white wire). Continuity shall be maintained until switch is depressed all the way in.

Test #2 — Connect ohmmeter between terminal

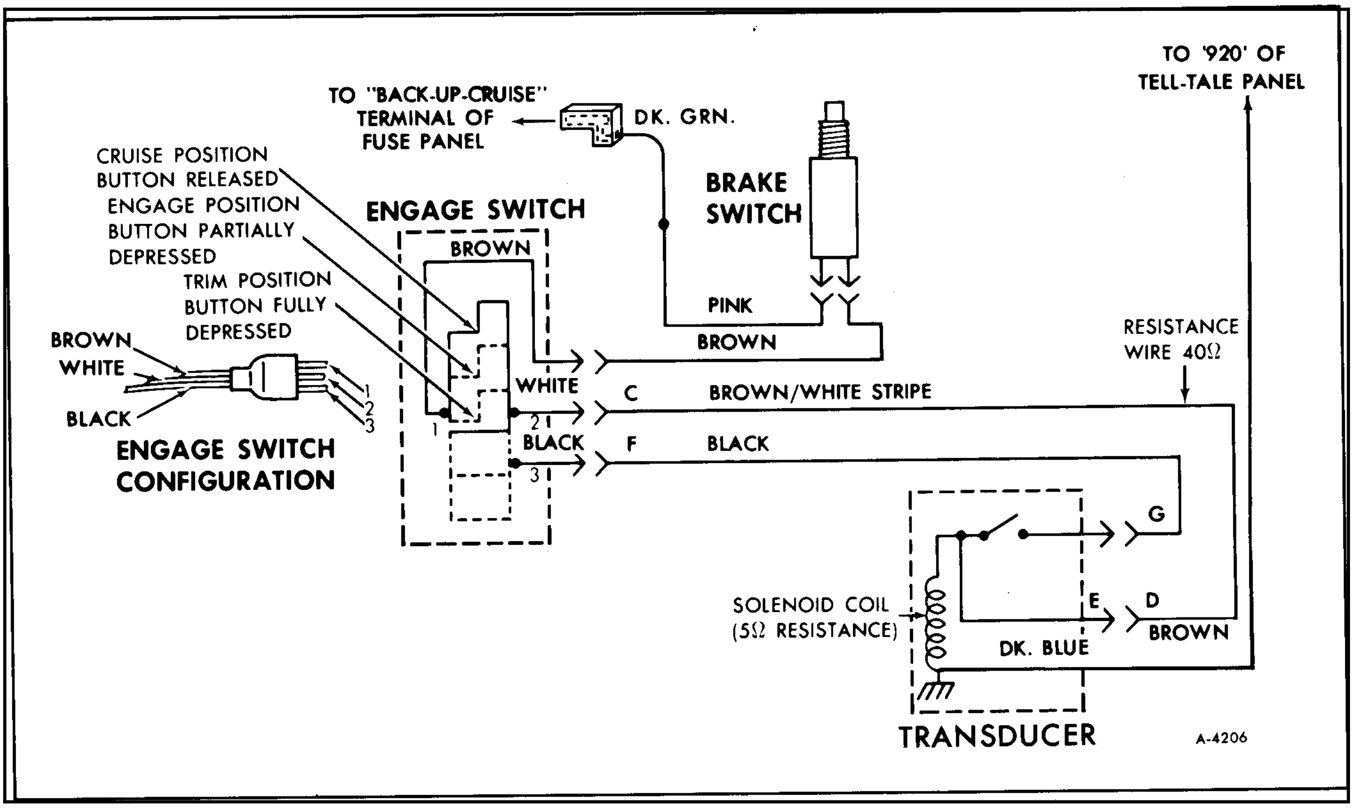


Figure 59—Cruise Control Electrical Diagram

#1 (brown wire) and terminal #3 (black). No continuity shall be shown; however, when the button is depressed halfway, continuity shall be indicated. When the button is pressed all the way down, no continuity shall be shown.

Test #3 — Connect ohmmeter between terminal #2 (white wire) and terminal #3 (black). Button released, no continuity; however, when the button is depressed partially and fully, continuity shall be shown.

4. Disconnect engage switch wire harness connector from the main harness connector (brown, brown/white, black wires). Connect ohmmeter between point C (brown/white stripe wire in main wire harness) and ground. Make sure the transducer is well grounded to the chassis. The ohmmeter should read between 42 and 49 ohms. If a resistance either above or below the value indicated is shown, then disconnect the connector from the transducer and measure the resistance of the brown/white stripe wire from point C to D. It should measure 40 ohms $\pm$ 2 ohms. If a resistance either above or below the value indicated is shown, the main wiring harness should be replaced. Note: When disconnecting or reconnecting the main wiring harness connector from the transducer, care should be exercised so as not to damage the blade connectors or the wiring harness. The disconnect may be facilitated by prying carefully on the plastic connector with a small blade screw driver.

When measuring the solenoid coil circuit resistance between Point E (Hold Terminal) to ground the ideal ohmic resistance should be between 5 and 6 ohms. A reading of less than 4 ohms indicates shorting in the coil circuit. A reading of more than 7 ohms indicates excessive resistance in the coil circuit. Either extremity indicates replacement of the transducer assembly. The white main harness wiring from Point F to G should also be checked for continuity.

ENGAGEMENT SWITCH TEST

	TERMINALS		
BUTTON POSITION	1 TO 2	1 TO 3	2 TO 3
Cruise (released)	closed	open	open
Engage (partially depressed)	closed	closed	closed
Trim (fully depressed)	open	open	closed

SERVO AND VACUUM CHECK OUT

To determine the condition of the diaphragm, remove hose from servo unit and apply 14 inches of vacuum to the tube opening and hold in for one minute. The vacuum shall not leak down more than 5 inches of vacuum in one minute. If leakage is detected, replace servo. To utilize engine as vacuum source, proceed as follows:

1. DISCONNECT SERVO CHAIN and hose from servo then connect engine vacuum directly to the servo fitting.

2. Note position of servo diaphragm.

3. Start engine — the diaphragm should pull in.

4. Clamp off engine vacuum supply line and check for leakage.

The cruise release brake switch (vacuum) and connecting hoses can likewise be checked using a vacuum pump.

LIGHT BULB SPECIFICATIONS

Bulb Application	Quantity	Bulb No.	Part No.
Low Air Tell-Tale	1	74	
Brake System Tell-Tale	1	161	
Generator Tell-Tale	1	161	
Park Brake Tell-Tale	1	74	
Cruise Control Tell-Tale	1	74	
Door Ajar Tell-Tale	1	74	
Low Fuel Tell-Tale	1	74	
Power Level Tell-Tale	2	74	
High Beam Indicator	1	161	
Turn Signal Indicator	2	168	
Instrument Cluster Light	2	194	
Speedo Cluster Light	2	194	
Dome Lights	2	211	9422525
Radio Dial (AM/FM Stereo/Tape)	1	566	
Radio Dial (exc. AM/FM Stereo/Tape)	1	1893	
Heater Control	1	1895	
Clearance and I.D.	10	67	142450
License	1	67	
Side Markers	4	194	9421330
Back Up Lights	2	1156	
Parking and Turn Sig.	2	1157	9428902
Stop and Tail	2	1157	
Headlights	2	6014	5962548
Fiber Optic Bulb	1		9433143

SECTION 13
RADIATOR AND COOLANT RECOVERY SYSTEM

Contents of this section are listed below:

SUBJECT	PAGE NO.
Description	13-1
Maintenance	13-1
Radiator Mountings	13-2
Radiator Replacement	13-2
Pressure Relief Valve and Filler Cap	13-3
Coolant Recovery System	13-3
Engine Coolant	13-4
Cooling System Pressure Relief Valve	13-5
Torque Specifications	13-5

NOTE: *Refer to ENGINE COOLING (SECTION 6K) of this manual for information relative to coolant circulation, temperature indicators, thermostats, and fan belts.*

Refer to GENERAL INFORMATION AND LUBRICATION (SECTION O) for information relative to coolant recommendations and coolant system capacities.

DESCRIPTION

The vehicles are equipped with a cross-flow radiator also a coolant recovery system. The level in the coolant recovery reservoir should be maintained at the "COLD" line when coolant is cold.

At normal operating temperatures, level can reach "HOT" line on reservoir. However, should the coolant level fall below the cold level line, additional coolant, other than for draining and refill should be added through the coolant recovery reservoir.

MAINTENANCE

At regular intervals, cooling system components should be inspected to determine if service is required. Regular systematic checks will reveal faulty condition of various units and indicate necessity of servicing or replacement of such components before failure occurs.

Suggested checks are:

1. Frequently check coolant level. If low, add recommended coolant as required.

2. Check hose connections and tighten clamps if seeping is evident. Cracked, stripped, or corroded clamps should be replaced.

3. Inspect radiator hoses for spongy or checked appearance. Deteriorated hoses should be replaced before bursting occurs which would result in coolant loss and could cause extensive engine damage due to overheating.

4. Check radiator core for leaks and for accumulation of dirt which obstructs air passages and reduces effective heat transfer.

To assist in maintaining effecient heat dissipation, an occasional external flushing with water will remove majority of dirt accumulation and foreign matter from between core fins.

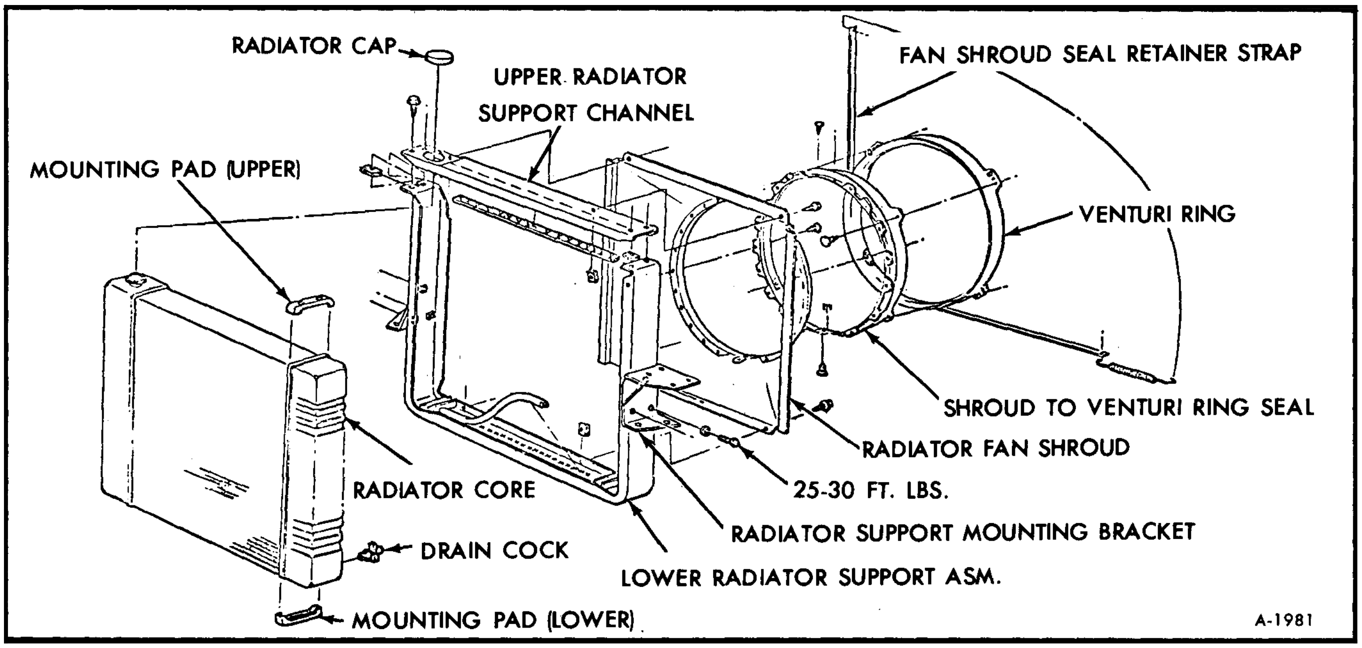


Figure 1—Radiator Assembly (Typical)

Water under moderate pressure should be directed from behind core to force debris out in opposite direction of its entrance. Water should be directed in line with fins, not sideways, to reduce possibility of bending fins.

5. Inspect radiator mounting pads for deterioration and replace as required.

6. Inspect for proper clearance between fan blades, radiator core venturi ring, and shroud. Check fan attaching bolts for tightness and observe alignment of fan blades in relation to each other. Replace fan if any blade is bent. Distance between blades and venturi ring should be equal around entire perimeter of the ring. If adjustment is required, venturi ring attaching bolts may be loosened and the ring shifted as necessary to provide proper clearance.

7. Check radiator filler cap seals for evidence of cracking or separation. Replace as required.

8. When coolant loss is evident or engine overheating occurs, the damaged or clogged radiator should be serviced by a radiator specialist or replaced with a new one. Efficient repair of radiators requires the use of special tools and equipment as well as provisions for making proper tests. If radiator core requires painting, spray with special radiator paint; do not use paint mixed with oil, as oil mixed paint will form an insulation and prevent efficient dissipation of heat.

RADIATOR MOUNTING

Refer to Figure 1 for mounting details of radiator support, radiator core, fan shroud and venturi ring.

RADIATOR REPLACEMENT

1. Drain radiator by opening drain cock assembly at lower corner of radiator assembly (location of drain cock shown in figure 1).

2. If unit is equipped with air conditioning, perform the following:

a. Remove front grille.

b. Disconnect air conditioning condenser from radiator.

3. Disconnect radiator overflow tube and upper radiator hose.

4. Raise vehicle.

5. Disconnect lower radiator hose transmission cooler and engine oil cooler lines.

6. Disconnect upper radiator support channel assembly.

7. Remove upper shroud to support bolts (2) and clips attaching seal and venturi ring.

8. Remove retaining strap and move seal away from venturi ring.

9. Remove (2) lower shroud to support bolts & lower shroud.

10. If vehicle is equipped with "Coolant Level" indicator light, disconnect lead wire to probe sensor and remove probe sensor from radiator.

11. Remove radiator support bolts (3) on each side and lower radiator and support from vehicle.

12. Replace radiator core in radiator support.

13. Install radiator and support in vehicle and torque attaching bolts to 25-30 ft. lbs.

14. If vehicle is equipped with "Coolant Level" indicator, insert probe sensor and torque to 25-30 in. lbs. Connect lead wire.

15. Install lower shroud to support bolts (2).

16. Install upper support channel assembly bolts (2).

17. Connect lower radiator hose, transmission and engine oil cooler lines.

18. Install shroud to venturi ring seal and tighten fan shroud seal retainer strap.

19. Install clips attaching venturi ring seal to shroud.

20. Install upper shroud to support bolts (2).

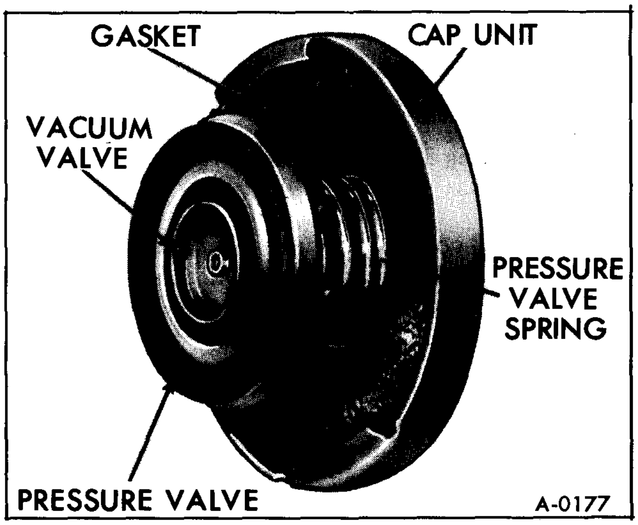


Figure 2—Pressure Cap

21. Lower vehicle.

22. Connect radiator coolant recovery hose and upper radiator.

23. Connect air conditioning condenser attaching bolts (if so equipped).

24. Install front grille.

25. Refill radiator following the procedure described in Section 6K.

NOTE: For service and diagnosis of "Coolant Level" indicator system, refer to CHASSIS ELECTRICAL (Section 12) of this manual.

PRESSURE CAP AND VALVE

A pressure relief valve assembly, integral with the radiator filler cap, incorporates a pressure valve and a vacuum valve. (See figure 2) When pressure in system reaches valve setting (See "Specification" at end of this section), pressure valve opens and liquid is allowed to escape. As liquid in the system cools it contracts; this allows pressure valve to close and also creates a partial vacuum in system. Atmospheric pressure acting through the overflow tube unseats the vacuum valve and allows coolant to enter radiator.

The radiator filler cap is constructed with a spring-loaded rubber seal which is pressed firmly against surface of filler neck seat when cap is installed. Rubber seal must be in good condition and top of radiator filler neck must be clean and smooth in order to form an air-tight seal. Seal of filler cap and operation of pressure relief valve can be checked using a conventional cooling system testing kit.

CAUTION: *When the engine is at normal operating temperature or above, the internal pressure built up in the cooling system will blow out scalding fluid and vapors if the radiator cap is suddenly removed. To prevent loss of coolant and to avoid the danger of being burned, the coolant level should be checked, or coolant added, only to the coolant recovery reservoir. If the radiator cap must be removed when the engine is hot, place a cloth over the cap and rotate the cap slowly counterclockwise to first stop and allow pressure to escape completely. Then turn cap again slowly counterclockwise to remove.*

COOLANT RECOVERY SYSTEM

The coolant recovery system consists of a reservoir, pressure cap and interconnecting hose. The

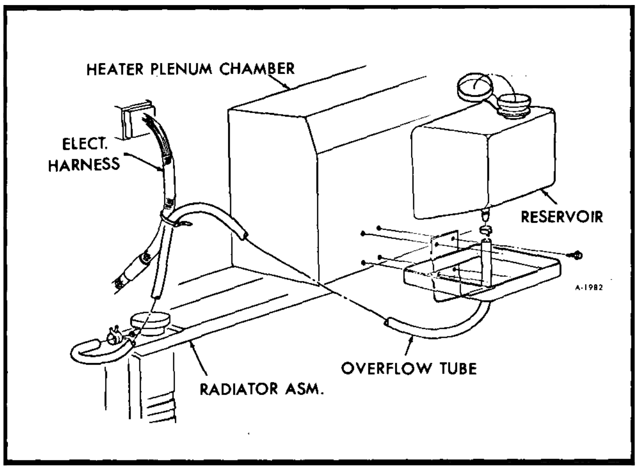


Figure 3—Coolant Recovery System, Type 1

reservoir is mounted above the radiator and is accessible from the front access doors and connected to the radiator filler neck with a hose. The coolant level must be maintained at the "COLD" mark on the side of the reservoir when coolant is cold. A gasket incorporated into the filler cap forms a seal at the radiator filler neck. A leak at this gasket will result in loss of coolant during normal operation. The pressure cap must be installed so that the marking on top of the cap aligns with the overflow tube on the filler neck.

Refer to Figures 3 and 4 for removal and installation of coolant recovery system components.

ENGINE COOLANT

COOLANT RECOMMENDATIONS

For coolant drain and refill procedure, refer to SECTION 6K of this manual. Cooling system maintenance intervals will be found in SECTION O.

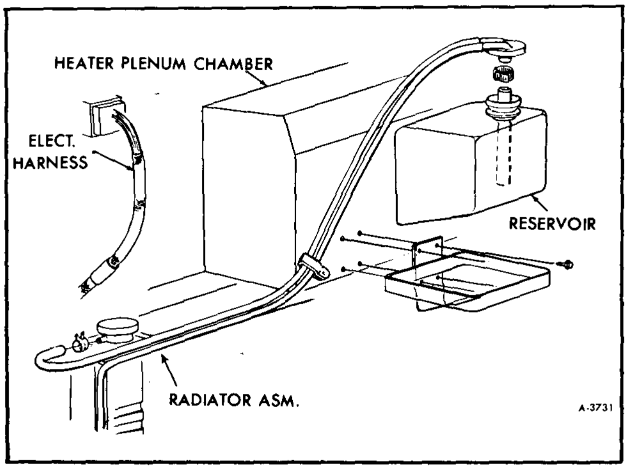


Figure 4—Coolant Recovery System, Type 2

COOLANT TESTING

Always test solution before adding water or anti-freeze. Engine should be warmed up to operating temperature. Fill and empty tester several times to warm tester before using. Keep tester clean inside and out.

Some testers will indicate correct freezing point only when test is made at a specific temperature. Other testers are provided with thermometers and tables and indicate freezing points corresponding to readings made at various temperatures. Disregarding temperatures of solution may cause an error as large as 30°F. Read and be guided by instructions furnished by the tester manufacturer.

In the event coolant freezes solid in extreme cold weather, place vehicle in warm building or improvise some means of thawing coolant before starting engine. Under no circumstance should engine be operated, when coolant is frozen solid. After thawing, refill system with a higher concentration of anti-freeze solution and start engine. Inspect entire system for leakage and then test coolant with hydrometer to determine if adequate anti-freeze protection is provided.

COOLANT PRECAUTIONS

1. Overheating is not always caused by a defective cooling system; incorrect ignition timing, dragging brakes, under-inflated tires, can cause overheating.

2. Keep water pump and fan drive belts at proper tension. Refer to ENGINE COOLING SYSTEM (Section 6K) of this manual.

3. Do not remove radiator filler cap when engine is hot. Wait until system cools off.

4. Do not pour cold water into cooling system when the engine is hot. Wait until system cools off.

5. If cooling system requires frequent refilling, check for leaks.

6. Keep all connections tight, and make sure gasket on radiator filler cap is in good condition.

7. When filling system with anti-freeze solution. Always follow recommendations of anti-freeze manufacturer.

8. Use only Ethylene Glycol base coolant meeting GM Specification 1899M.

9. Drain and flush cooling system every other year, preferably at start or end of winter operation.

COOLING SYSTEM PRESSURE RELIEF VALVE

Models	Valve Stamped	Opening PSI
230 (23') 260 (26')	RC32	9

TORQUE SPECIFICATIONS

Radiator Support Mounting Bracket to Radiator Support Attaching Bolts .... 25-30 ft. lb.

SECTION 14
BUMPERS
ENERGY ABSORBERS

DESCRIPTION

All vehicles have both bumpers mounted to energy absorbers. (figure 1)

The energy absorber is a device which uses hydraulic fluid within the cylinder tube to absorb impact energy and inert gas to restore the bumper to its original position after a low speed collision. Right and left energy absorbers are the same. (figure 1)

During impact (figure 2) the piston tube moves back into the cylinder tube. Hydraulic fluid is forced from the cylinder tube through the orifice around the metering pin into the piston tube. The metering pin controls the rate of fluid flow. Fluid pressure in the piston tube against the floating piston moves it and compresses the gas. After impact (figure 3), gas pressure against the floating piston forces fluid back into the cylinder tube and pushes the bumper back to its original position.

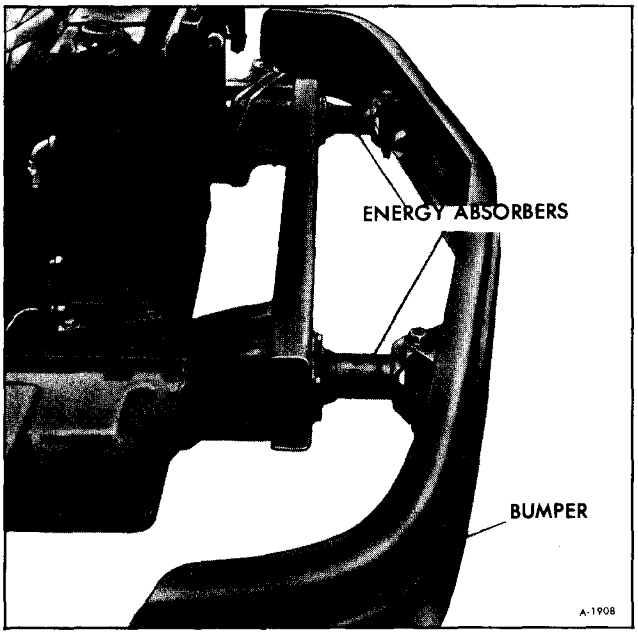


Figure 1—Energy Absorbing Bumper

DIAGNOSIS

LEAKAGE

A trace of oil on the piston tube is normal due to grease packed in the seal area during manufacturing. If oil is dripping from the unit it should be replaced.

DAMAGE

Inspect the bumper bracket, frame bracket, piston tube and cylinder tube for evidence of visible distortion. Scuff marks on the piston tube are normal. If there is obvious damage to the unit it should be replaced.

ON VEHICLE TEST

This test involves compressing EACH unit separately 3/8" or more and observing that the bumper returns to its normal position.

1. Turn off ignition, transmission in park, parking and service brakes set.

2. Use a barrier such as a pillar, wall, post, etc.

3. Align a pressure device, such as a hydraulic jack, with the energy absorber. Make sure it is positioned squarely with the bumper so it will not slip.

4. Apply pressure to compress the unit 3/8". Use a 6" scale to determine travel. Release pressure and note if the bumper returns to its normal position.

5. If either unit fails to return to its normal position, replace it.

BENCH TEST

The bench test may be used to pre-test service

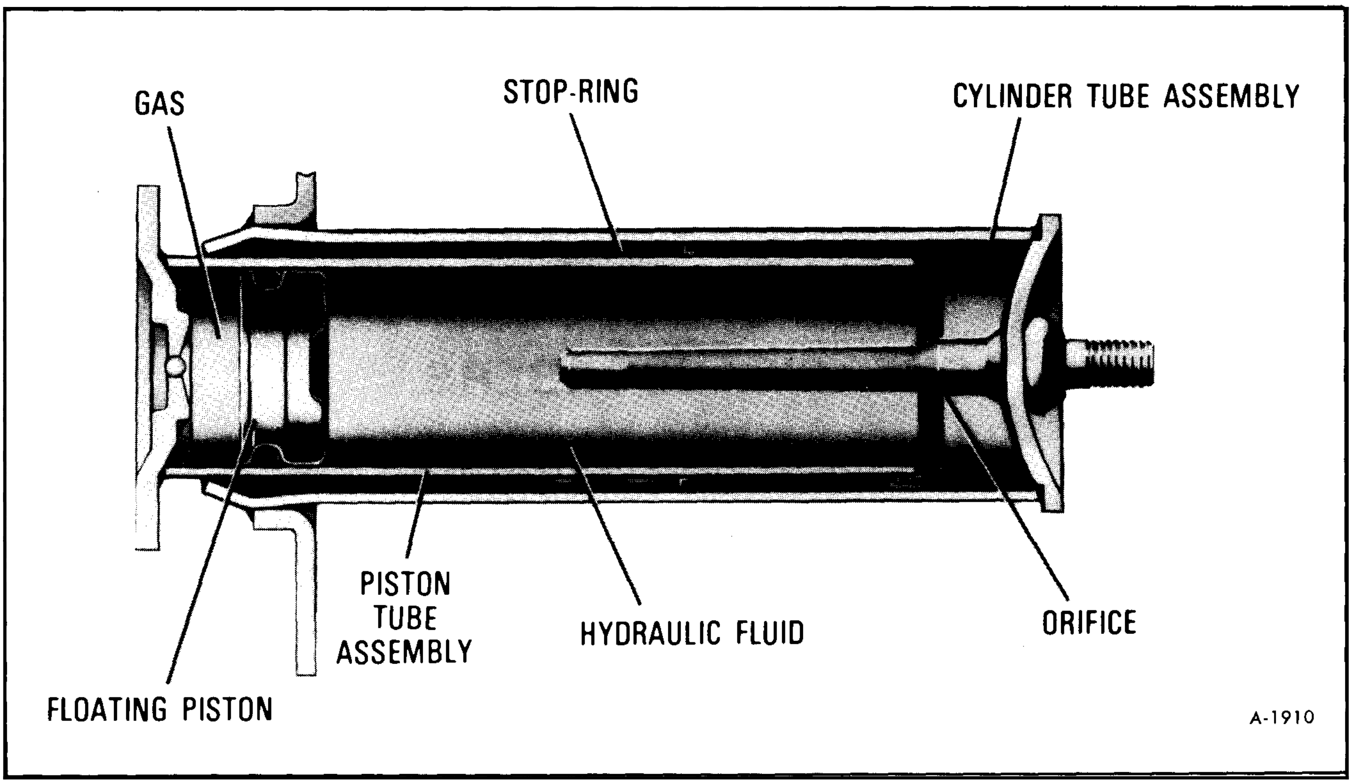


Figure 2–Energy Absorber–Collapsed Position

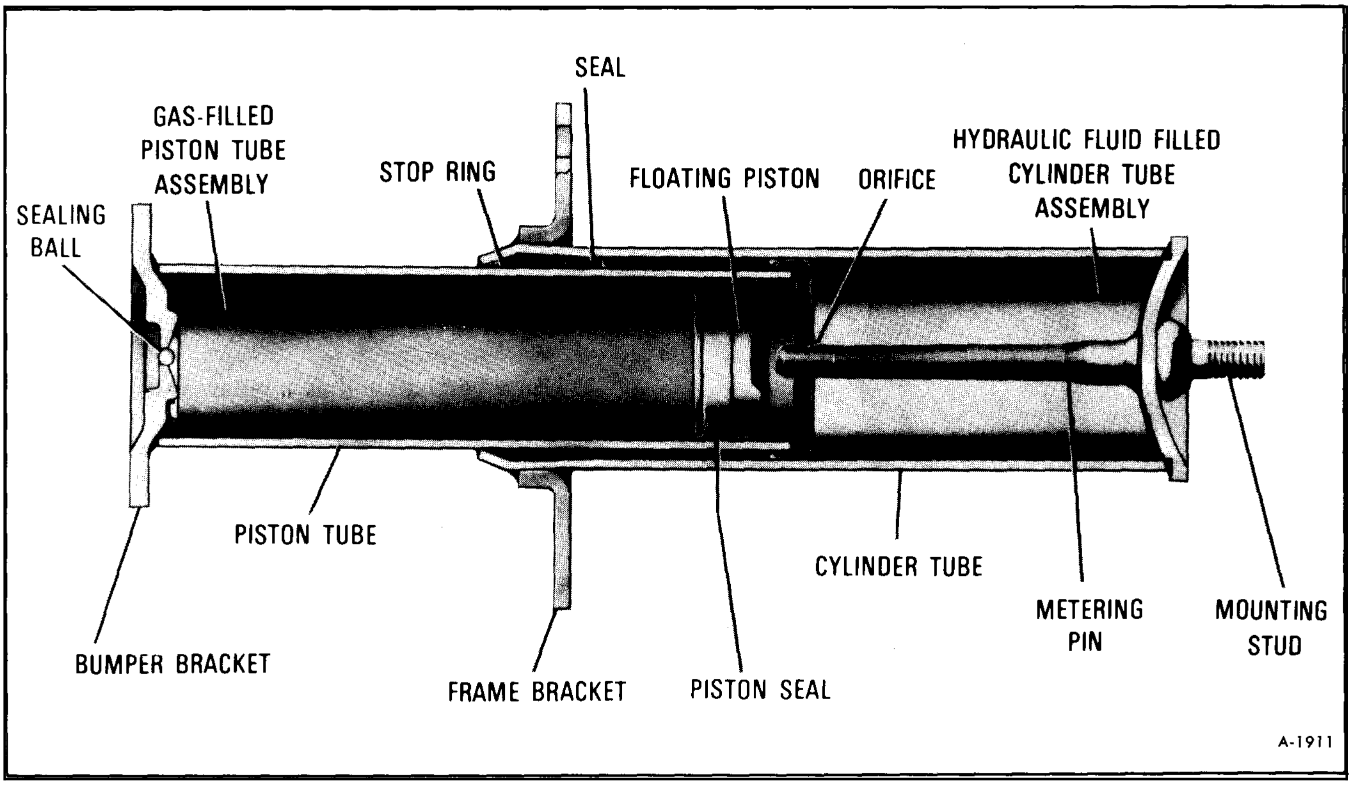


Figure 3–Energy Absorber–Extended Position

units prior to assembly on a vehicle or to check detached units that may have been removed for the purpose of making vehicle repairs after a collision.

A suitable arbor press should be used to compress the unit 3/8". Observe if it returns to its normal position. If not, this unit should be replaced.

INSPECTION

Recommendations for handling energy absorbers are:

1. Do not attempt to repair.
2. Do not weld.
3. Do not apply heat.

WARNING: BE SAFE! PROTECT YOUR EYES. WEAR APPROVED SAFETY GLASSES.

4. Relieve gas pressure prior to disposal of a unit. Make an indentation with a center punch in the small cylinder section of the energy absorber (recommend "WARNING" label on the unit as a target area). Then, use a 1/8-inch drill to penetrate the small cylinder and relieve gas pressure (See figure 4).

INSPECTION AFTER COLLISION

If the collision was so severe that the bumper did not return to its original position, the energy absorber(s) will require replacing.

WARNING: BE SAFE! PROTECT YOUR EYES. WEAR APPROVED SAFETY GLASSES.

1. Stand clear of the bumper.

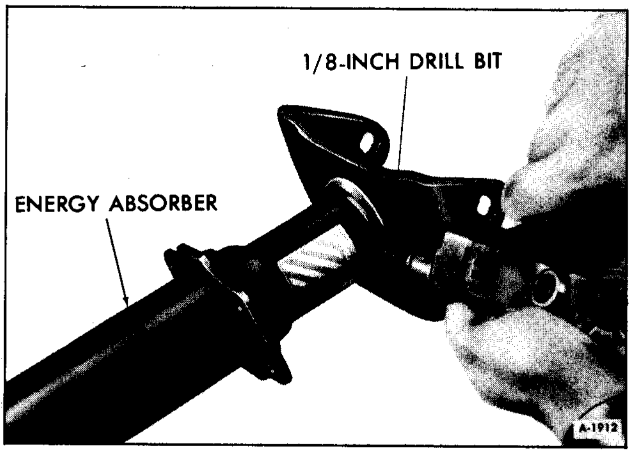


Figure 4—Relieving Pressure from Energy Absorber

2. Provide positive restraint, such as a chain or cable.

3. Relieve the pressure by drilling a 1/8-inch hole in the piston tube near the bumper bracket (See figure 4).

4. Remove the unit from the vehicle as described under "Replacement" only after the gas pressure has been relieved.

REPLACEMENT

IMPORTANT: Prior to replacement, be familiar with procedures given under "INSPECTION" of energy absorbers.

FRONT

1. Remove bumper by removing both bumper bracket thru bolts (See figure 5).

2. Remove the four bolts and nuts securing energy absorber to frame.

3. Secure new energy absorber to frame with bolts and nuts. Nut torque is 25-30 foot-pounds.

4. Install bumper on energy absorbers and secure with thru-bolts. Nut torque is 40-50 foot-pounds.

NOTE: Be sure lower bracket is properly installed (See figure 5) before tightening retaining nut.

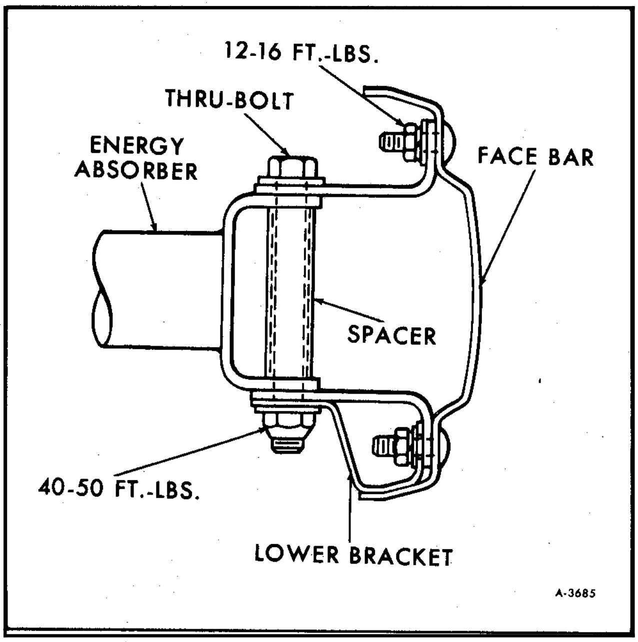


Figure 5—Front Bumper Bracket Mounting

REAR

1. Remove bumper by removing both bumper bracket thru bolts as shown in Figure 6.

2. Remove the four bolts and nuts securing energy absorber to frame.

3. Secure new energy absorber to frame with bolts and nuts. Nut torque is 25-30 foot-pounds.

4. Install bumper on energy absorbers and secure with thru bolts. Nut torque is 40-50 foot-pounds.

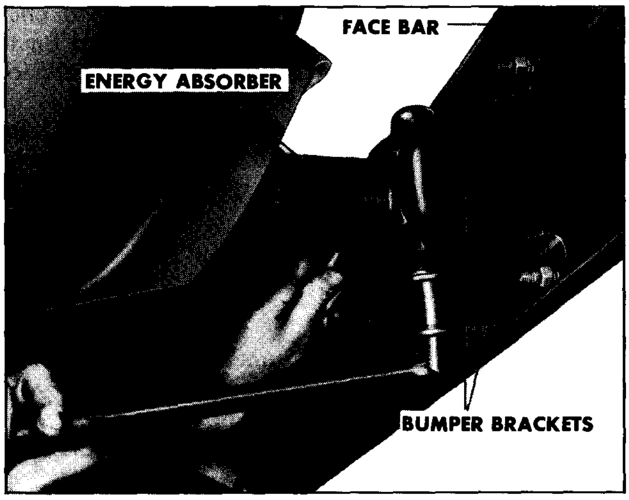


Figure 6—Removing Rear Bumper Bracket Thru-Bolts

BUMPER FACE BARS

NOTE: Front and rear bumper face bars are similarly mounted so replacement procedures are the same for front and rear. Also, due to the fact that both front and rear bumper face bars are two piece assemblies in some cases it may only be necessary to replace half of the face bar.

REPLACEMENT

1. Remove face bars by removing both bumper bracket thru- bolts (See figure 5).

2. Remove brackets and hardware from old face bar(s) and install on new face bar(s). Tighten bumper tie bar retaining nuts to 12-16 foot-pounds.

3. Once it has been determined that the energy absorbers are operative, install the face bar assembly on energy absorbers and secure with thru-bolts.

SECTION 24
MISCELLANEOUS LIVING AREA FACILITIES

The information in this section pertains to components and/or systems found in the GMC MotorHome (ZEO 6581) ONLY.

Contents of this section are listed below:

SECTION	PAGE NO.
24A – Periodic Maintenance and Lubrication	24A-1
24B – Living Area Electrical	24B-1
24C – Motor Generator	24C-1
24D – Refrigerator	24D-1
24E – Roof-Mounted Air Conditioner	24E-1
24F – LP Gas System	24F-1
24G – Furnace	24G-1
24H – Range/Oven	24H-1
24J – Living Area Water System	24J-1
24K – Toilet	24K-1
24L – Holding Tank and Drainage System	24L-1
24N – Cabinets and Furniture	24N-1
24P – Exhaust Vents	24P-1
24Q – Other Equipment	24Q-1

SECTION 24A
PERIODIC MAINTENANCE AND LUBRICATION

PERIODIC MAINTENANCE

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS					
	8	100	200	400	500	1000
General Inspection	4000/6000 Watt					
Check Oil Level	4000/6000 Watt					
Change Crankcase Oil (1)		4000/6000 Watt				
Clean Air Cleaner (1)		4000/6000 Watt				
Check Spark Plugs		4000/6000 Watt				
Fuel Filter—Check (1)				4000/6000 Watt		
Check Breaker Points (2)		4000/6000 Watt				
Check Governor Linkage			4000/6000 Watt			
Clean Cooling Fins (1)			4000/6000 Watt			
Change Oil Filter (1)			4000/6000 Watt			
Replace Breaker Points			4000/6000 Watt			
Replace Air Cleaner (1)			4000 Watt		6000 Watt	
Remove Carbon From Heads				4000/6000 Watt		
Adjust Tappets				4000/6000 Watt		
Check Generator Brushes						4000/6000 Watt
Complete Reconditioning (If Required)						4000/6000 Watt

(1) Perform more often in extremely dusty conditions. (2) Replace if necessary.

A-4998

Figure 1—Onan Motor Generator Maintenance Schedule

MOTOR GENERATOR MAINTENANCE INTERVALS

Regularly scheduled maintenance is the key to lower operating costs and longer service life for the unit. The following schedule (figure 1) can be used as a guide. However, actual operating conditions under which a unit is run should be the determining factor in establishing a maintenance schedule. When operating in very dusty or dirty conditions, some of the service periods may have to be reduced. Check the crankcase oil, the filters, etc., frequently until the proper service time periods can be established.

Additional information about the items on this schedule may be found later in this section.

LIVING AREA WATER PUMP BELT

Check the living area water pump belt for wear and adjust tension as necessary every 3 months or 3,000 vehicle miles, whichever occurs first. See "Living Area Water System" Section 24J for adjusting information.

WATER TANK FILTER

The water tank filter, which is located in the water compartment, is transparent and should be checked periodically and cleaned annually. A helpful sign that filter is dirty is when the transparent filter has become discolored. See "Living Area Water System" Section 24J for filter replacement procedure.

WINTERIZATION

When traveling in winter it is recommended that the water tank not be filled until the destination is reached. This will ensure that the vehicle has thoroughly warmed up. The water and holding tank systems should be drained before leaving for home. Also, an approved plastic pipe non-toxic, non-flammable antifreeze should be put in the sink and shower traps. If equipped with a recirculating toilet the standard winterization is to replace one-half of the charge water with an approved plastic pipe non-toxic, non-flammable antifreeze. This antifreeze added to the holding tank will help keep the tank contents from freezing.

See "Vehicle Storage" for additional information.

VEHICLE STORAGE

The MotorHome may be stored for considerable lengths of time provided the following steps are performed:

1. SHORT TERM STORAGE — UP TO 60 DAYS AND ABOVE 32° F. (0°C.)

a. Fill fuel tanks to reduce excessive build-up of moisture in the fuel tanks.

b. Park MotorHome as level as possible, end for end and side to side.

c. Wash MotorHome. If exposed to road salts the exterior and underside should be thoroughly washed and flushed.

d. Remove all perishables, leave refrigerator door open. Be sure controls are turned off.

e. Ventilate the living area, drawers, cabinets, closets,etc.

f. Drain the holding tank, toilet and living area water system as described earlier in this section. Be sure the water pump and water heater are turned off.

g. Turn off LP gas at tank valve.

h. Make sure range/oven and furnace manual valve and thermostat are set at "OFF," range/oven burners at "OFF," oven at "PILOT OFF" and gas/electric refrigerator control at "GAS OFF."

i. Plug or tape all drains to retard evaporation of residual moisture in drain traps.

j. Tape over vents to prevent insects from entering. Be sure to remove tape before operating LP gas appliances to help avoid poisoning by carbon monoxide.

k. Check MotorHome weekly to ensure that undesirable conditions are not forming (water seepage, mold, odors, etc.). Household air deodorizers or disinfectants in aerosol cans may be used as required, however, do not spray directly on any surface.

l. Maintain tire pressure of 60 psi.

m. Crack one window for ventilation, close all others as well as roof vents.

n. Check batteries (main, auxiliary and motor generator, if equipped) for charge. Specific Gravity reading of 1.255 is required to prevent deterioration. Add colorless, odorless drinking water, if necessary.

o. Turn off radio, exterior lights, and interior lights.

p. If MotorHome is to be moved, run engine at least two minutes with the transmission selector in "PARK."

q. Start and run engine for approximately 15 minutes weekly. Check engine, transmission and motor generator oil levels. Dipsticks should always be properly seated on tubes to prevent moisture from entering.

2. LONG TERM STORAGE — 60 DAYS OR MORE AND ABOVE 32°F. (0°C.)

a. Perform all the above steps except for Step q.

b. MotorHomes without automotive air conditioning; remove spark plugs and squirt each cylinder with "Super Engine Oil Supplement" available at your GMC MotorHome service outlet. Replace spark plugs.

c. MotorHomes with automotive air conditioning; run engine approximately 15 minutes with automotive air conditioning controls turned to "ON" position. Perform this operation every 30 days.

d. Treat all bright metal and rubber surfaces with a wax emulsion applied with a brush. A good liquid floor wax or equivalent is satisfactory.

e. Disconnect batteries, and check Specific Gravity every 30 days. See additional instructions for batteries given in SECTION 6Y, ENGINE ELECTRICAL.

3. WINTER STORAGE — BELOW 32°F. (0°C.)

a. While many of the steps in preparing your MotorHome for storage when temperatures go below 32° F. are the same as preparing for storage above 32° F., freezing temperatures present an additional hazard.

b. Fill fuel tanks to reduce excessive build-up of moisture in the fuel tanks.

c. Check coolant level and add antifreeze if required, to protect to the lowest expected temperature during storage (at least — 20°F.) (-29°C.) (-37°C. in Canada).

d. Change engine oil as shown on the recommended S.A.E. Viscosity Chart to aid cold weather starting.

e. Park MotorHome as level as possible, end for end and side to side.

f. Wash MotorHome. If exposed to road salts, the exterior and underside should be thoroughly washed and flushed.

g. Drain moisture from suspension air reservoir. For additional instructions, refer to SECTION 4, REAR SUSPENSION.

h. Remove all perishables and anything which may freeze (canned goods, medicine, etc.). Leave the refrigerator door open. Be sure controls are turned off.

i. Ventilate the living area, drawers, cabinets, closets, etc.

j. Drain the holding tank, toilet and living area water system as described earlier in this section. Add antifreeze solution (5 gallons non-toxic, non-flammable antifreeze and 5 gallons water) to living area water tank. Open all faucets and turn on water pump. When colored water comes out of the faucets, close faucets. Flush toilet. If equipped with recirculating toilet, charge with antifreeze solution (1-1/2 gallons non-toxic, non-flammable antifreeze and 1-1/2 gallons water). Be sure the water pump and water heater are turned off.

NOTE: Remove water purifier cartridge assembly from the vehicle during winter storage as low temperatures could cause the assembly to crack. After winter storage, do not install water purifier cartridge assembly until non-toxic antifreeze has been flushed from the water system.

k. Turn off LP gas at tank valve.

l. Make sure range/oven and furnace manual valve and thermostat are set at "OFF," range/oven burners at "OFF," oven at "PILOT OFF," and gas/electric refrigerator control at "GAS OFF."

m. Add recreational non-toxic, non-flammable antifreeze (1/2 cup) to the kitchen, bathroom, and shower drains.

n. Tape over drain openings (except toilet) to prevent evaporation if storage is lengthy (6 months or more).

o. Crack one window for ventilation, close all other as well as roof vents.

p. Start and run engine weekly for approximately 20 minutes. If very low temperatures are expected the batteries should be removed and stored in a warmer area.

q. Check engine transmission and motor generator (if equipped) for evidence of oil leaks.

r. Maintain tire pressure of 60 psi.

s. Remove accumulations of snow as often as possible.

t. Turn off radio, exterior lights, and interior lights.

u. Tape over vents to prevent possible entry of snow. Be sure to remove tape before operating LP gas appliances, to help avoid poisoning by carbon monoxide.

v. Before moving, run engine at least two minutes with the transmission selector in "PARK" position.

ONAN MOTOR GENERATOR STORAGE

If the motor generator will be out of service for more than 30 days, the following steps should be taken to protect the unit.

1. Run the unit until thoroughly warm.

2. Disconnect fuel supply and run until unit stops.

3. Drain oil from crankcase while still warm. Refill and attach a warning tag stating oil viscosity used.

4. Remove each spark plug. Pour one ounce of rust inhibitor (or S.A.E. 50 oil) into each cylinder. Crank engine several times. Install spark plugs.

5. Service air cleaner.

6. Clean governor linkage and protect by wrapping with a clean cloth.

7. Plug exhaust outlet to prevent entrance of moisture, dirt, bugs, etc.

8. Wipe entire unit with a clean cloth. Coat rustable parts with a light film of grease or oil.

LUBRICATION

ONAN MOTOR GENERATOR

SERVICE INTERVALS

For service intervals refer to the Maintenance Chart provided earlier in this section.

CHECKING OIL LEVEL

Check the oil level daily, or at least every eight hours of operating time. Check more often on a new unit as oil consumption is generally higher until piston rings seat properly. Do not check oil level while unit is operating.

CHANGING OIL

Initial oil change should be made after the first 25 hours of operation; change every 50 to 100 hours after that. If operating in extremely dusty or cold weather conditions, change oil more frequently.

The 4KW Model has an oil capacity of 3 quarts, 3 1/2 quarts if replacing oil filter.

The 6KW Model has an oil capacity of 4 quarts; 4 1/2 quarts if replacing oil filter.

Do not mix brands or grades of motor oil. Use a good quality oil with the designation SE/CC. If necessary to add oil between changes, use the same brand and grade of oil.

Use the following chart as a guide for the proper oil according to temperature ranges:

Temperature	Recommended Oil
Above 30°F. (-1.1°C.)	SAE 30
(-17.8°C.) 0°F. to 30°F. (-1.1°C.)	SAE 5W30 or 10W40
Below 0°F. (-17.8°C.)	SAE 5W30

NOTE: Fill engine with oil through dipstick tube.

The oil drain plug is located on the bottom side of the engine oil pan. Unit must be pulled out on its slide rail to gain access.

OIL FILTER (FIGURE 2)

Change the crankcase oil filter at least every 200 hours. The filter is located on the right side of the unit (facing the compartment). Remove filter by turning counterclockwise with the filter wrench. Before installing new filter, coat the gasket on the filter's base with a light film of new oil. Install by turning clockwise until a light friction is noted, then turn an additional 1/4 to 1/2 turn.

CAUTION: *Do not over-tighten filter as damage may occur to rubber gasket which will cause filter to leak. Be sure to install sealing ring around filter; this ring is an air seal to prevent cooling air loss.*

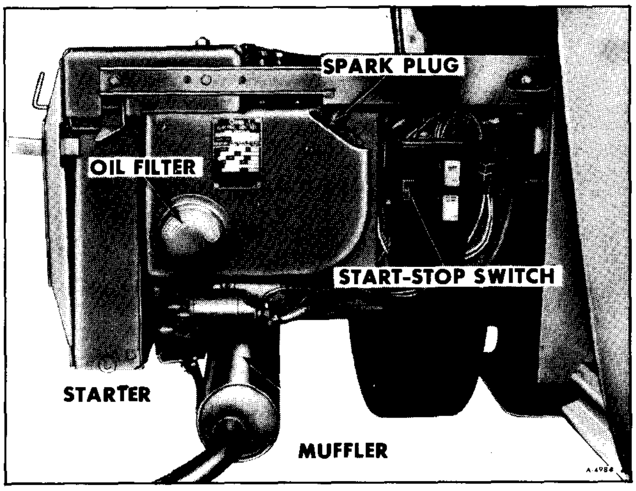


Figure 2—Onan Motor Generator

VEHICLE TRIP PREPARATION

The trip preparation is designed to prepare the Motor Home for an extended trip or vacation. Following the preparation list will aid in providing convenience and proper operation of the vehicle.

SPRING AND/OR SUMMER TRIP PREPARATION

EXTERIOR

a. Fill LP gas tank.

b. Sanitize and fill water tank.

c. Empty and deodorize holding tank.

d. Check that all exterior vents are unobstructed.

e. Drain moisture from suspension air reservoir.

f. Check operation of the following lights:

Headlights

Parking and turn signals

Tail and stop

Emergency flashers

Back-up lights

Marker and clearance

License

g. Check the following fluid levels:

Engine oil

Batteries (If maintenance free battery, check charge indicator)

Engine coolant

Windshield washer reservoir

Motor generator oil

h. Check tires for pressure and wear.

i. Wash MotorHome.

j. Check windshield wipers for wear.

INTERIOR

a. Check the operation of the following:

Power level system

Wipers and washers

All interior lights

Range/Oven

Refrigerator

Air Conditioner

Automotive

Roof-mounted

Vent fans

Water pump

Water heater

Faucets (Includes shower)

Toilet-Charge recirculating toilet

Motor generator

Interior electrical system

12-volt

120-volt

Water purifier

Monitor panel

b. Check the following fluid levels:

Transmission

Power steering

c. Clean the following:

Upholstery

Counter tops

Cabinetry

Range/Oven

Sinks

Toilet

Screens

Windows

Vacuum carpeting

IMPORTANT: In addition to the above items, be sure all scheduled vehicle maintenance has been performed. See Maintenance Schedule folder for details. The folder includes information on required fluids and lubricants for your vehicle.

FALL AND/OR WINTER TRIP PREPARATION

EXTERIOR

a. Fill LP gas tank (Add methyl alcohol).

b. Fill water tank.

c. Empty and deodorize holding tank.

d. Check that all exterior vents are unobstructed.

e. Drain moisture from suspension air reservoir.

f. Check operation of the following lights:

Headlights

Parking and turn signals

Tail and stop

Emergency flashers

Back-up lights

Marker and clearance

License

g. Check the following fluid levels:

Engine oil

Batteries (If maintenance-free battery, check charge indicator)

Engine coolant (test freeze protection level)

Windshield washer reservoir

Motor generator oil

h. Mount snow tires

i. Check tire pressure and wear

j. Wash MotorHome

INTERIOR

a. Check operation of the following:

Power level system

Wipers and washers

All interior lights

Range/Oven

Refrigerator

Air Conditioner

Automotive

Roof-mounted

Vent fans

Motor generator

Interior electrical system

12-Volt

120-Volt

b. Check operation of following (if water system is filled):

Water pump

Water heater

Faucets

Toilet—Recirculating toilet charged with recreational vehicle anti-freeze solution.

c. Add recreational vehicle anti-freeze *(approx. 1/2 cup) to the following P-traps:

Kitchen sink

Bathroom sink

Shower drain

d. Check the following fluid levels:

Transmission

Power steering

*Recreational vehicle anti-freeze means a non-toxic, non-flammable anti-freeze.

e. Clean the following:

Upholstery

Counter tops

Cabinetry

Range/Oven

Sinks

Toilet

Screens

Windows

Vacuum carpets

SECTION 24B
LIVING AREA ELECTRICAL SYSTEM

Contents of this section are listed below:

SUBJECT	PAGE NO.
General Information	24B-1
Electrical Compartment	24B-1
External Power	24B-4
Living Area Lighting System	24B-4
120-Volt Electrical System	24B-5
Monitor Panel	24B-7
Specifications	24B-9

GENERAL INFORMATION

The MotorHome living area electrical system is designed for utmost convenience. It is capable of supplying the vehicle with power from at least two sources (three, if equipped with a motor generator), these are the batteries or external power.

All electrical components except the water heater, the roof mounted air conditioner (if equipped), and the plug receptacles, are powered by the 12 volt living area battery which is automatically charged each time the vehicle's engine is running.

In addition, the vehicle may be plugged into a 120-volt external power source which will supply 120-volt power throughout the living area., power all 12-volt components through a power converter, and charge the living area battery.

If the MotorHome is equipped with a motor generator, the vehicle will be supplied with 120-volt and 12-volt power throughout the living area, and the living area battery will be recharged any time the power converter and motor generator are running.

Both the 12-volt DC and 120-volt AC circuits in the Motor Home living area are designed to be protected by a series of fuses and circuit breakers. The 12-volt living area circuits are protected by automotive-type fuses, and the 120-volt circuits are protected by circuit breakers like those found in modern homes.

ELECTRICAL COMPARTMENT (FIGURE 1)

12-VOLT LIVING AREA FUSE BLOCK

The 12-volt living area fuse block is located in the electrical compartment, next to the hall closet, along with power converter and main circuit breaker panel. (figure 1) In the event of an overloaded circuit, the cause should be corrected and a new fuse of the same capacity installed. For explanation of 12-volt fuse block number code, refer to Figure 2 or the Specifications at the end of this section.

120-VOLT CIRCUIT BREAKER PANEL

The main circuit breaker panel, also located in the living area electrical compartment, contains circuit breakers to protect the 120-volt MotorHome circuits from overloads. These circuit breakers are designed to snap to the center position in the event of an overloaded 120-volt circuit. Once the cause of the overload is corrected the circuit breaker switch may be moved back to the "ON" position.

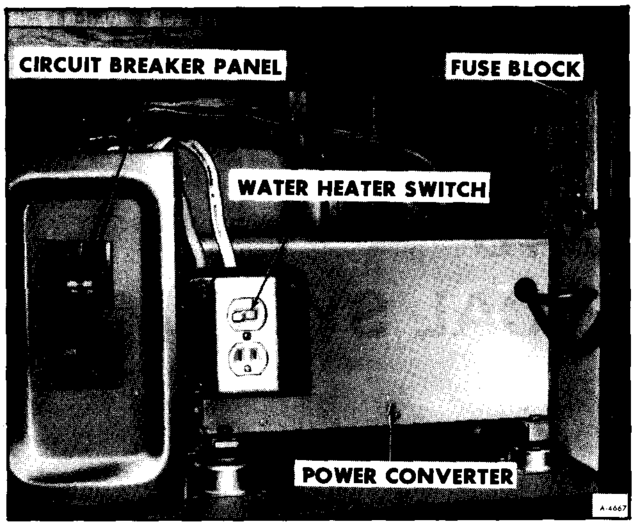


Figure 1—Living Area Electrical Compartment

120-VOLT to 12-VOLT CONVERTER AND BATTERY CHARGER

The MotorHome is equipped with a 120-volt to 12-volt power converter rated at 45 amperes. Its function is to take a portion of the 120-volt current, that is received when the vehicle is plugged into an external power source, or when the motor generator is running and change it to 12-volts which powers much of the MotorHome. It will also charge the auxiliary (living area) battery any time 120-volt current is being received. The unit is located in the living area electrical compartment, next to the hall closet. It should remain plugged at all times.

CAUTION: *Do not use living area electrical compartment as a storage area. The converter must have a force flow of air through and around the unit. If air flow is restricted, the converter could overheat which could result in malfunction and permanent damage. Do not let the unit get wet, but do keep it as clean as possible to help assure its long life. The converter can be cleaned with low pressure air (30 PSI maximum) if necessary.*

The power converter has no moving parts, but should you suspect that the unit is not functioning properly, test it in the following manner.

1. Check the motor generator frequency setting. It should be 63 cycles at 120 volts no load. The converter is sensitive to frequency and will not function properly below 60 cycles. If you plan to bench test the unit, make sure the wall socket is producing 60 cycles. This can also be checked with your frequency meter.

2. Disconnect the converter leads from the MotorHome. This assures that only the converter is being checked.

3. Connect the leads to a good, fully charged, battery and plug in the converter.

4. Using a good calibrated voltmeter, read output voltage across the battery. It should be between 13 to 15 volts.

Converter humming is not considered to be a failure. Humming should be corrected by installing mounting pads.

WATER HEATER SWITCH

An "ON OFF" switch for the water heater is located in the living area electrical compartment. The switch is located in this compartment to prevent the possible hazard of operating the switch with wet hands; i.e., trying to operate the switch after starting to wash or shower.

CAUTION: *Do not operate water heater unless there is water in the living area water system. If unit is operated without water this will result in damage to the heating element.*

NOTE: For details on the water heater, refer to Living Area Water System, Section 24J.

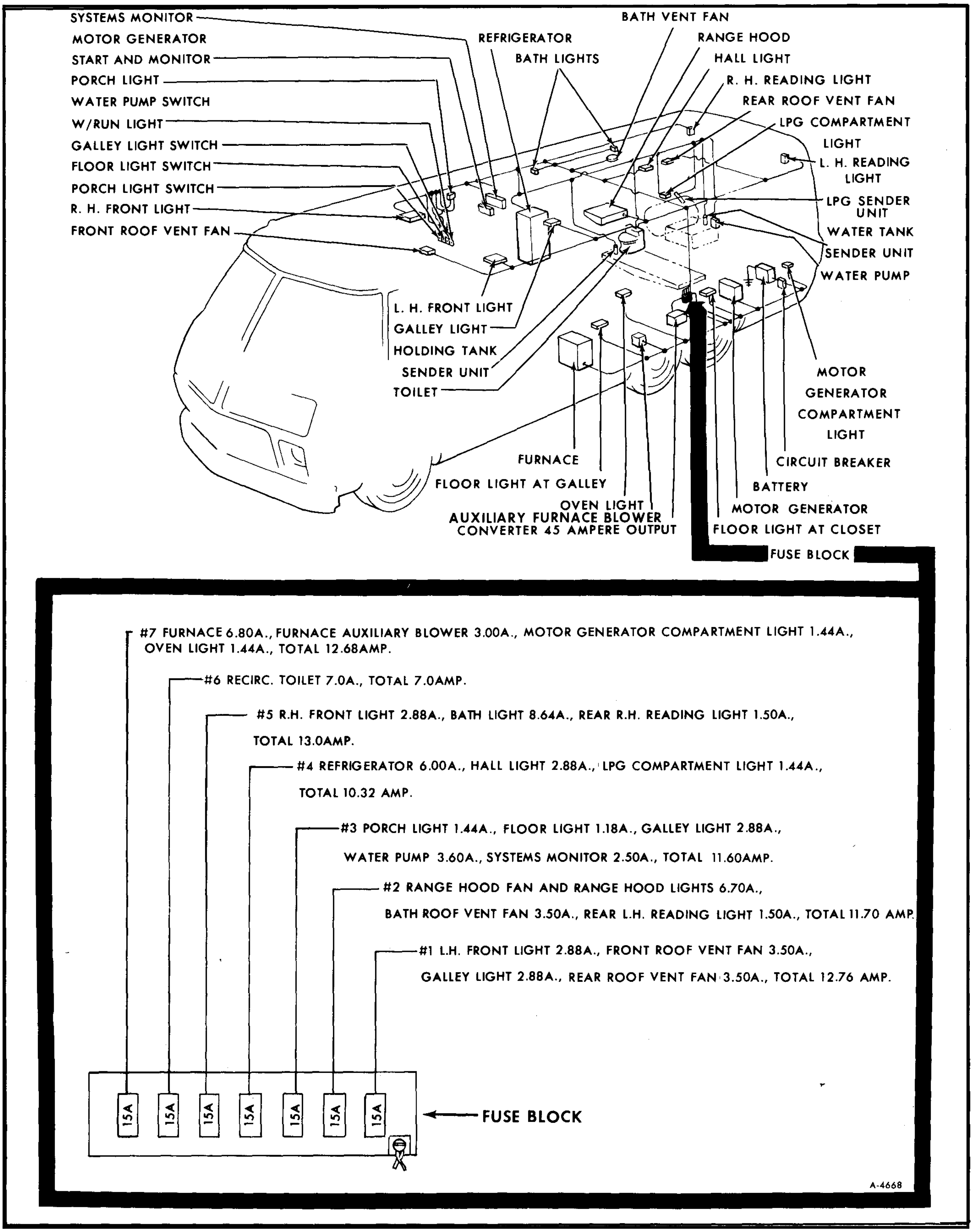


Figure 2—Living Area 12-Volt DC Electrical System (Typical)

EXTERNAL POWER

GENERAL INFORMATION

The external utilities compartment located in the left side of the MotorHome contains the 21 foot power cord used for external power connections (See figure 3).

To make an external power connection, remove the cord from the compartment and plug it into a suitable power receptacle. No internal switching is required. When disconnecting from an external power source the power cord should be plugged into the motor generator receptacle within the external utilities compartment. This connects the motor generator to the MotorHome electrical system. If the vehicle is not equipped with a motor generator simply coil the power cord neatly within the external utilities compartment.

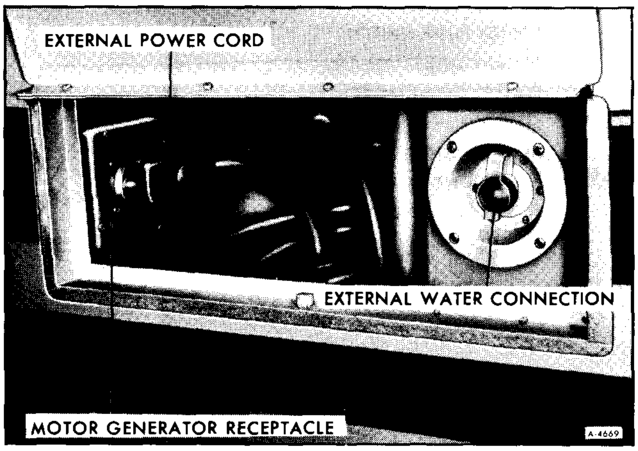


Figure 3—External Utilities Compartment

The MotorHome's external power cord contains two 120-volt circuits, each rated to carry 40 amperes total. The electrical connection to be used must be suitable for these requirements. If the receptacle is designed to mate with the prongs on the power cord plug, the electrical connection can be expected to CARRY RATED LOAD. It is recommended that the power cord not be plugged in if the receptacle is not designed for the plug. In this event use the optional motor generator.

CAUTION: *If the available power supply is other than 120/240 volt, 60 cycle rating, or is not properly grounded, it is essential that no attempt be made to plug in. The MotorHome's electrical system is not designed for such electrical systems and connection could result in serious personal injury or property damage.*

CORD REPLACEMENT

Should it ever become necessary to replace the external power cord for any reason, refer to the 120-volt wiring diagram later in this manual. Care should be taken that the new cord is properly wired to panel.

LIVING AREA LIGHTING SYSTEM

All the lighting throughout the MotorHome is on the 12-volt system and is powered by either the living area battery, the power converter when the vehicle is connected to an external power source, or when the motor generator is running (if the vehicle is so equipped). Some of these lights contain a three-way switch which allows a choice in the amount of light given off. The switches to these lights are located on the light fixture itself.

A panel of light switches is located near the entrance door. These switches operate the porch light, the kitchen sink light, the aisle lights, and the water pump (figure 4). The water pump switch is illuminated when the pump is turned on.

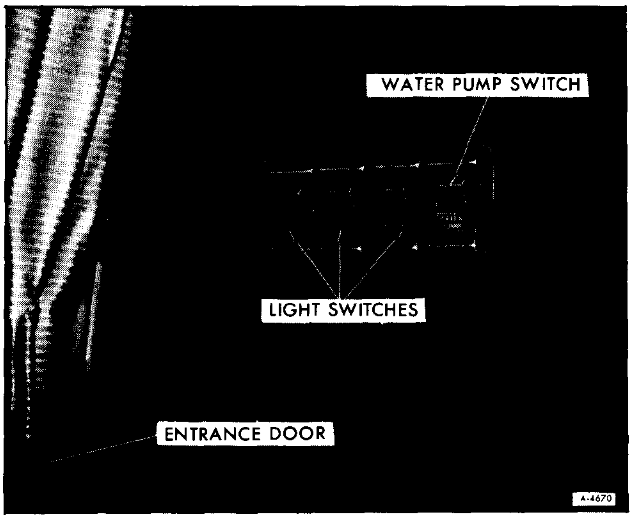


Figure 4—Light Switch Panel

Should any of these lights fail to operate first make sure that the electrical source is sufficient, then check the fuse, next replace the bulb itself, and finally if there is still no operation check the wiring and fixture.

For light bulb specifications or for current draw ratings refer to Specifications at the end of this section.

120-VOLT AC ELECTRICAL SYSTEM

The MotorHome living area is equipped with 120-volt wiring and duplex receptacles (including optional exterior receptacle), like those found in modern homes. These receptacles (including optional exterior receptacle), the power converter and the water heater are operational whenever the MotorHome is connected to an external power source or the motor generator is operating. If the MotorHome is equipped with a roof mounted air conditioner or a vacuum cleaner these will also be run by the 120-volt system. Circuit breakers and the circuits they protect are shown in Figure 6.

For wiring information, location, and specifications refer to Figure 5 and Specifications at the end of this section.

EXTERIOR RECEPTACLE

The optional exterior receptacle includes a ground fault interruted circuit breaker designed to protect the user from the hazards of line to ground electric shock. The exterior receptacle is located on the right side of the vehicle, beside the refrigerator grille, as shown in Figure 7.

The exterior ground fault circuit interruptiong receptacle is designed to protect people using appliances that are plugged into this receptacle.

This receptacle does not protect against overloads, which must be done by circuit breakers located in the living area electrical compartment. If an appliance continuously trips the receptacle, the appliance is defective and should be repaired or replaced.

TESTING THE EXTERIOR RECEPTACLE

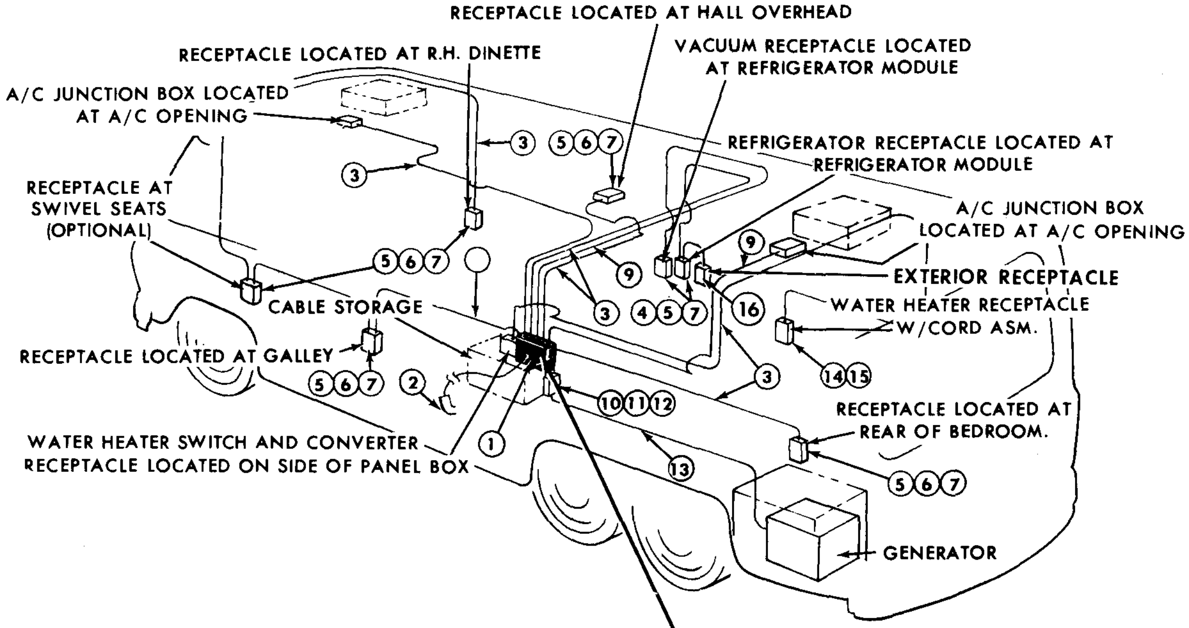
For maximum protection against electrical shock hazard, the exterior receptacle should be tested at least once a month and the test date recorded.

TEST PROCEDURE

1. Push "test" button. The "reset" button should pop up, showing a red line which indicates that power to the protected circuit is discontinued.

CAUTION: *If the "RESET" button does not pop up when test button is pushed, a loss of ground fault protection is indicated. Do not use. Have receptacle serviced by a qualified electrician.*

2. To restore power, push the "reset" button.



ITEM NO.	PART NAME
1	MAIN PANEL BOX
2	#8-4 WIRE CORD TYPE '50' W/PLUG
3	WIRE 12/2 W/GROUND WIRE
4	SINGLE RECEPTACLE
5	OUTLET BOX
6	DUPLEX RECEPTACLE
7	OUTLET PLATE
8	SWITCH & RECEPTACLE
9	14/2 W/GROUND WIRE
10	3 POLE 4 WIRE RECPTACLE
11	OUTLET BOX
12	OUTLET PLATE
13	#6-2 WIRE CORD IN METAL CONDUIT
14	'J' BOX
15	BLANK COVER PLATE
16	EXTERIOR RECETACLE

CIRCUIT BREAKER PANEL				
CIRCUIT #1	CIRCUIT #2	CIRCUIT #3	CIRCUIT #4	CIRCUIT #5
FRONT AIR COND. RECEPT.	WATER HEATER RECEPT.	HALL OVER RECEPT.	VACUUM RECEPT.	REAR AIR COND. RECEPT.
	CONVERTER RECEPT.	BEDROOM RECEPT.		
		GALLEY RECEPT.		
		SWIVEL CHAIR RECEPT.(OPT.)		
		R.H. DINETTE RECEPT.		
		REFRIGERATOR RECEPT.		
		EXTERIOR RECEPT.		

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Figure 5—120-Volt AC Electrical System (Typical)

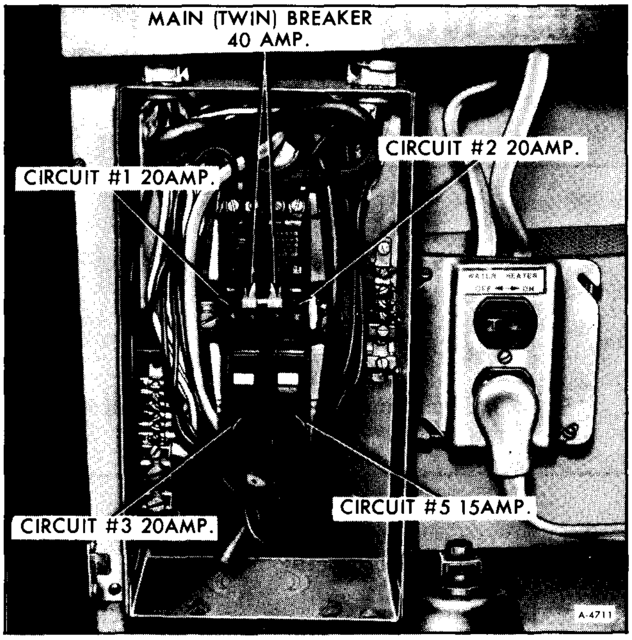

Figure 6—Circuit Breaker Panel, Cover Removed

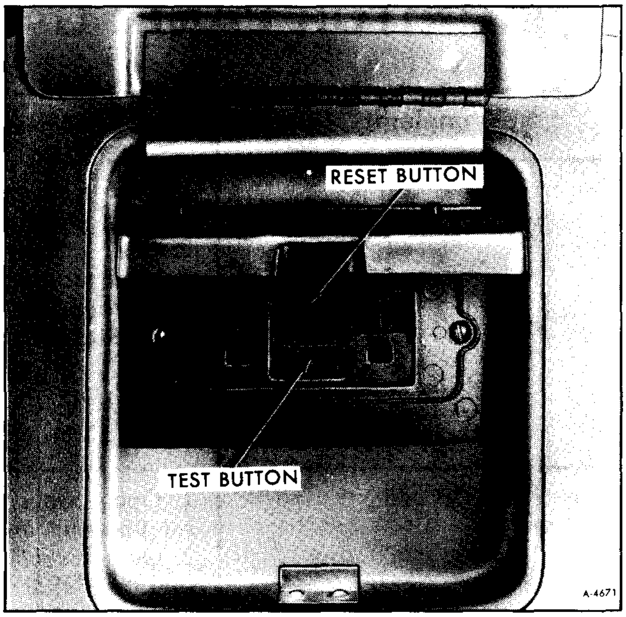

Figure 7—Exterior Receptacle

MONITOR PANEL (FIGURE 8)

DESCRIPTION

The MotorHome Monitor Panel is a series of four gauges located at eye level in the living area. Included are:

• LP GAS — This gauge is designed to indicate the amount of liquid petroleum gas remaining in the tank.

• BATTERY VOLTS — Indicates living area battery voltage. During operation, the indicator should remain in the center segment of the dial to indicate normal battery condition. If the indicator shows less than 11-volts, an under-charge condition exists in the living area battery and a recharge is required.

For information regarding batteries and charging procedures, refer to ENGINE ELECTRICAL, Section 6Y.

• WATER TANK — This gauge is designed to indicate the amount of water remaining in the living area water tank.

• HOLDING TANK — This is designed to indicate content level in the holding tank. Never allow this gauge to reach the "FULL" mark. If the holding tank is overfilled the overflow will back up through the bathroom shower drain.

These gauges are activated by a "ROCKER" switch located on the face of the panel. This switch has three positions; "ON," "OFF," and "MOMENTARY ON." An indicator light glows when gauges are operating.

TROUBLE DIAGNOSIS

TANK GAUGES

Since the L.P. Gas, the Water Tank, and the Holding Tank gauges all operate on the same principle the following trouble diagnosis will pertain to any of the three gauges.

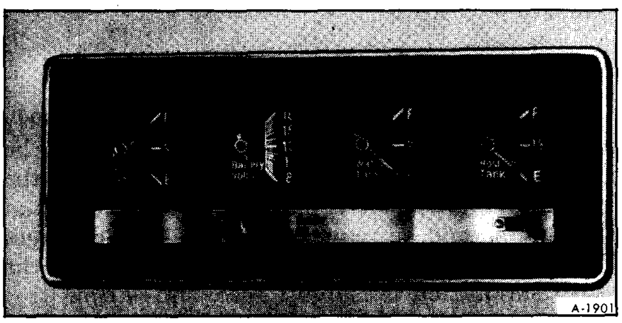

Figure 8—Monitor Panel

MONITOR PANEL GAUGE DIAGNOSIS CHART

Complaint	Possible Cause	Correction
Gauge reads "E" all the time.	1. Circuit grounded between sending unit and tank. 2. Open circuit between ground terminal on gauge and ground. 3. Needle rubbing on face of gauge. 4. Tank float hang-up.	1. Insulate grounded circuit. 2. Clean contact between gauge and ground. 3. Reposition needle. 4. Free binding float or install new tank unit.*
Gauge reads "F" all the time.	1. Open circuit between sending unit and tank. 2. Open circuit between tank unit slider resistor and ground. 3. Needle rubbing on face of gauge. 4. Tank float hang-up.	1. Clean terminals or repair wires. 2. Install new tank unit.* 3. Reposition needle. 4. Free binding float or install new tank unit.*
Erratic reading	1. Loose connection anywhere in circuit.	1. Inspect and if necessary, clean and tighten all connections in circuit.
Needle does not move	1. Lack of 12-volt supply to gauge. 2. Needle rubbing on face of gauge. 3. Tank float hang-up.	1. Check power supply, fuse, and wiring. 2. Reposition needle. 3. Free binding float or install new tank unit.*
Gauge gives other than correct reading.	1. Tank float hang-up or malfunction in sending unit. 2. Malfunction in gauge.	1. Free binding float or install new tank unit.* 2. Replace gauge.

* Electrical power must be off before removing tank sending unit, otherwise full voltage may destroy unit or possibly ignite L.P.G. vapor. Disconnect battery ground cables and remove monitor panel fuse.

"BATTERY VOLTS" GAUGE

If "Battery Volts" gauge fails to operate properly the trouble can usually be quickly isolated. If the other gauges of the monitor panel operate but the "Battery Volts" gauge is inoperative the gauge is at fault and should be replaced. If none of the gauges of the monitor panel operate the trouble is in the power supply...check supply, fuse, and wiring.

GAUGE REPLACEMENT (FIGURE 9)

REMOVAL

To remove any of the four gauges in the monitor panel:

1. Remove monitor panel fuse and disconnect battery ground cables.

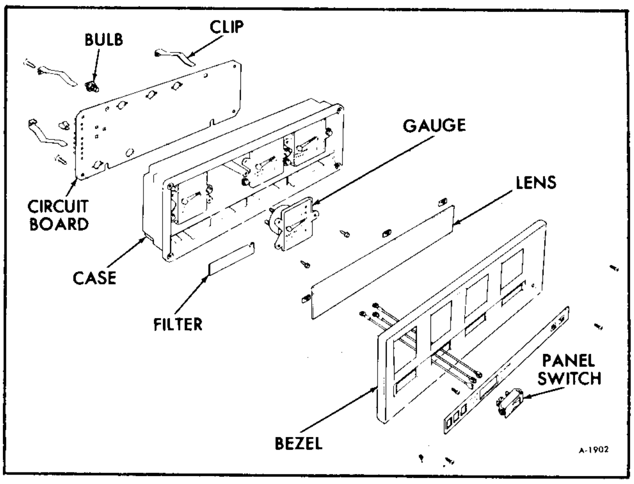

Figure 9—Monitor Panel Components

2. Remove the four screws holding bezel on panel.

3. Remove the two screws holding defective gauge in case and carefully remove gauge.

INSTALLATION

1. Carefully press gauge into position and secure with two screws.

2. Replace monitor panel bezel and secure with four screws.

3. Reconnect electrical power and check gauge operation.

SPECIFICATIONS

LIVING AREA 12-VOLT SYSTEM FUSES

The following are located in the fuse block in the living area electrical compartment, near the hall closet. Do not use fuses of higher amperage rating than those specified below, or damage may result.

Usage	Number on Fuse Block	Fuse Type
L.H. Front Light Front Roof Vent Fan Galley Light Rear Roof Vent Fan	No. 1	AGC-15
Range Hood Vent Fan and Lights Bath Vent Fan Rear L.H. Reading Light	No. 2	AGC-15
Porch Light Aisle Lights Galley Light Water Pump Systems Monitor	No. 3	AGC-15
Refrigerator Hall Light LPG Compartment Light	No. 4	AGC-15
R.H. Front Light Bath Light Rear R.H. Reading Light	No. 5	AGC-15
Toiler (Recirc.)	No. 6	AGC-15

Usage	Number on Fuse Block	Fuse Type
Furnace Furnace Auxiliary Blower Oven Light Motor Generator Compartment Light	No. 7	AGC-15

LIGHT BULB SPECIFICATIONS (LIVING AREA)

Usage	Quantity	Bulb. No.
R.H. Front Light	2	1141
L.H. Front Light	2	1141
Kitchen Light	2	1141
Hall Light	2	1141
Porch Light	1	1141
Compartment Lights	2	1141
Range Hood Lights	2	1156
Rear Compartment Reading Lights	2	1383
Bathroom Lights	6	1141
Aisle Lights	2	67

120-VOLT SYSTEM CURRENT RATING

Water Heater .... 8.7 Amp.
Power Converter .... 6.8 Amp.
Roof Mount Air Conditioner .... 15.0 Amp.
Vacuum Cleaner .... 7.0 Amp.
Refrigerator .... 0.8 Amp.

12-VOLT LIVING AREA COMPONENTS CURRENT RATING

R.H. Dinette Light .... 2.88 Amp.
L.H. Dinette Light .... 2.88 Amp.
Hall Light .... 2.88 Amp.
R.H. Reading Light .... 1.50 Amp.
L.H. Reading Light .... 1.50 Amp.
Kitchen Light .... 2.88 Amp.
Aisle Lights (Per Light) .... 0.59 Amp.
Porch Light .... 1.44 Amp.
Bath Room Lights .... 8.64 Amps.
Range Hood Vent Fan and Lights .... 6.70 Amps.
Furnace Blower .... 6.8 Amp.
Water Pump .... 3.6 Amp.
Recirculating Toilet .... 7.0 Amp.
Monitor Panel .... 2.5 Amp.
Front Vent Fan .... 3.50 Amp.
Rear Vent Fan .... 3.50 Amp.
Bath Vent Fan .... 3.50 Amp.
Refrigerator .... 6.0 Amp.

SECTION 24C
MOTOR GENERATOR

This section includes the following:

SUBJECT	PAGE NO.
General Information	24C-1
Onan Motor Generator Trouble Diagnosis	24C-2
Motor Generator Replacement	24C-8
Engine	24C-9
Oil System	24C-21
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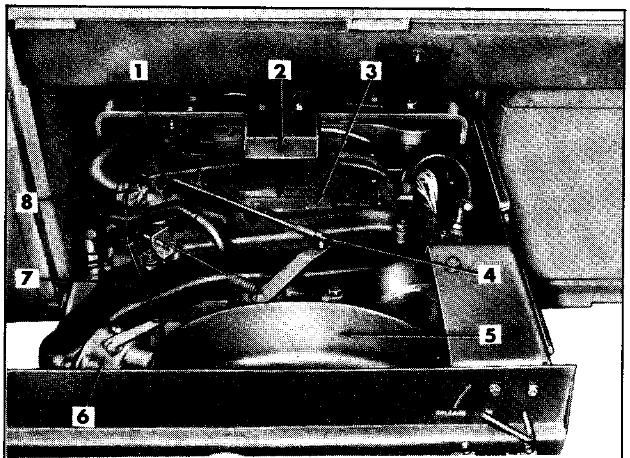
GENERAL INFORMATION

The Onan Motor Generator is powered by a two cylinder horizontally opposed gasoline engine. An automotive type starter is used on the unit. It is powered by the living area battery of the Motor-Home (located in the compartment with the generator); or motor generator cranking battery (located in the compartment with the generator) of the Trans-Mode. A permanent magnet flywheel alternator and solid state voltage regulator-rectifier (See figure 1) are used to charge the battery.

Lubrication is provided by a pressure oil system. A spin-on type oil filter (See figure 2) is utilized.

The motor generator does not have a seperate fuel supply. Fuel is drawn from the vehicle's main fuel tank. An electric fuel pump (See figure 3) is used to supply the unit with gasoline.



1. VOLTAGE REGULATOR-RECTIFIER
2. CIRCUIT BREAKER
3. BREAKER POINT BOX
4. GOVERNOR LINKAGE
5. BLOWER SCROLL
6. ELECTRIC CHOKE
7. CHOKE LINKAGE
8. CARBURETOR

Figure 1—Onan Motor Generator (Top View)

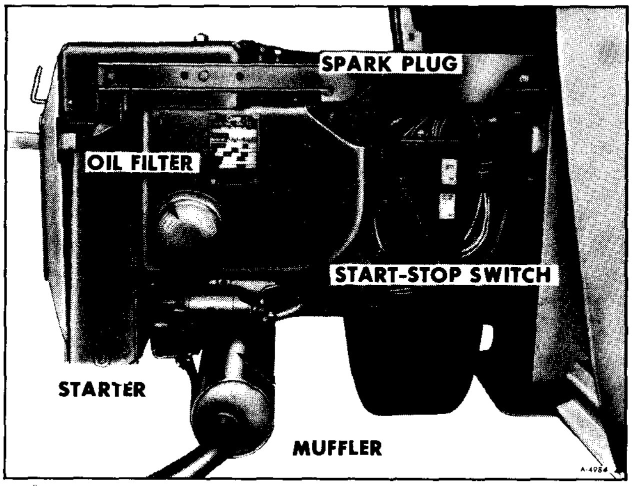


Figure 2—Onan Motor Generator (Right Side View)

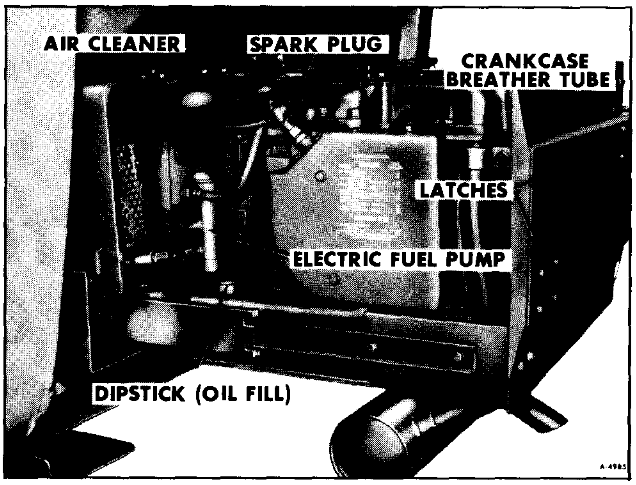


Figure 3—Onan Motor Generator (Left Side View)

ONAN MOTOR GENERATOR TROUBLE DIAGNOSIS

CONTROL SYSTEM TROUBLESHOOTING GUIDE

This troubleshooting section is divided into four parts, A, B, C and D as follows:

A. Engine does not crank.

B. Engine cranks but does not start.

C. Engine runs for 3 or 4 seconds, then stops.

D. Low battery — low charge rate.

IMPORTANT: Always stop the power plant and disconnect the battery leads before removing the cover or printed circuit board. After removing control cover, use a long nose pliers to remove flag connectors from terminals on board. Pull flag connectors straight out to avoid breaking control board terminals. Although dust covers on two relays (K2 and K3) are removable. DO NOT attempt to adjust the contacts on these relays; they are precision set at the factory. The only maintenance required on these relays is blowing out sand and dirt with a low pressure, compressed air source.

To correct a problem, answer the question of the step either YES or NO. Then refer to the number in whichever column question was answered, and proceed to that step next.

A.	ENGINE DOES NOT CRANK	YES	NO
1A.	Check battery. Are battery terminals clean and are cables tight?	2A	—
2A.	Check battery cables for correct polarity. Is 12 volts present across battery terminals with engine stopped and is 8 volts or higher present with engine cranking?	3A	10A
3A.	Remove cover on printed circuit board. Jumper terminal 7 to 3. Press start switch. Does engine crank?	4A	5A

4A.	K2 contact is defective. Replace printed circuit board.	—	—
5A.	Jumper terminal 7 to 1. Does engine crank?	6A	7A
6A.	Start switch S3 is defective. Replace printed circuit board.	—	—
7A.	Jumper from S terminal of B1 starter motor to positive (+). Does engine crank?	8A	9A
8A.	Replace K1 start solenoid.	—	—
9A.	Starter is defective. Remove and perform tests listed in STARTING SYSTEM section and/or replace starter.	—	—
10A.	Replace battery.	—	—
B.	**ENGINE CRANKS BUT DOES NOT START**	**YES**	**NO**
1B.	Is F1 fuse on control board OK?	3B	2B
2B.	Replace with an identical 5 amp fuse. Correct problem which caused fuse to burn. (NOTE: Remote control leads may be shorted or grounded).	—	—
3B.	While engine cranks, check K1-I start solenoid voltage. Is 12 volts present between terminals 10 and 1?	5B	4B
4B.	Replace K1 start solenoid.	—	—
5B.	Jumper terminals 9 to 11. Does engine start when start switch is pushed?	6B	7B
6B.	K2 contacts are defective. Replace printed circuit board.	—	—
7B.	Fuel solenoid K4 must be open during starting and running. Remove fuel line from carburetor. Does fuel pulsate from line when start switch is pushed? **WARNING:** Use extreme care for tests 7B and 8B. Direct the fuel flow into a suitable container and make sure area is well ventilated to prevent accumulation of gasoline fumes.	11B	8B
8B.	Disconnect fuel solenoid from line and check fuel pump E2. Pump will click when operating properly. Does fuel pulsate from pump (solenoid disconnected) when start switch is pushed?	10B	9B
9B.	Fuel pump (or wiring) is defective and must be replaced.	—	—
10B.	Fuel solenoid is defective and must be replaced.	—	—
11B.	Is electric choke closed when engine is cranking?	13B	12B
12B.	Voltage at choke terminal when engine is cranking should be 12 volts. If choke does not move (at room temperature) with 12 volts applied, replace it. Also check wire from choke to control for shorts to ground.	—	—
13B.	The fault is in the ignition system. Check points, plugs, wires and coil. Refer to IGNITION section.	—	—

C.	ENGINE RUNS 3 OR 4 SECONDS - THEN STOPS*	YES	NO
1C.	Check oil level. Refill to FULL mark on dipstick. Does engine now continue to run?	—	2C
2C.	Check voltage from terminal 11 to 12. Is it 12 volts with engine stopped and does voltage drop to zero when engine runs?	—	3C
3C.	Check oil pressure sensor wire for shorts to ground by visually tracing wire from S2 low oil pressure switch to control. Is wire grounded?	4C	5C
4C.	Replace or repair wire making sure it isn't rubbing against anything that may again cause a grounding problem.	—	—
5C.	Replace low oil pressure switch S2.	—	—
	NOTE: Remote control leads may be shorted or grounded.		
D.	**LOW BATTERY - LOW CHARGE RATE**	**YES**	**NO**
1D.	With engine cranking, measure voltage at terminal 8 to BAT terminal of K1 start solenoid. Is 6 volts present?	2D	3D
2D.	Check battery connections. They must be clean and tight.	—	—
3D.	Check flywheel alternator G1 output. Disconnect AC lead that connects to voltage regulator VR1 and connect voltmeter to this lead and BAT terminal of K1 start solenoid. This checks AC open circuit voltage. Start engine. Is AC output voltage approximately 28 volts with unit running at 1800 rpm?	5D	4D
4D.	Replace alternator stator G1.	—	—
5D.	Connect a voltmeter across battery terminals. Start engine. Does DC voltage increase to 13 to 14-1/2 volts after engine is running for a few minutes?	—	6D
6D.	Remove and replace voltage regulator VR1.	—	—

ENGINE TROUBLE DIAGNOSIS

GASOLINE ENGINE TROUBLESHOOTING GUIDE

CAUSE \ TROUBLE	Backfire at Carburetor	Bearing Wear	Black Exhaust	Blue Exhaust	Burned Valves	Connecting Rod Wear	Cranks Slowly	Cylinder Wear	Engine Stops	Failure to Start	Governor Hunting	High Oil Pressure	Low Oil Pressure	Loss of Coolant (Water Cooled)	Mechanical Knocks	Misfiring	Overheating (Air Cooled)	Overheating (Water Cooled)	Piston Wear	Poor Compression	Ring Wear	Sticking Valves
STARTING SYSTEM																						
Loose or Corroded Battery Connection							●			●												
Low or Discharged Battery							●			●												
Faulty Starter							●			●												
Faulty Start Solenoid										●												
IGNITION SYSTEM																						
Ignition Timing Wrong	●				●					●					●	●	●	●				
Wrong Spark Plug Gap										●					●	●						
Worn Points or Improper Gap Setting									●	●						●						
Bad Ignition Coil or Condenser										●						●						
Faulty Spark Plug Wires										●						●						
FUEL SYSTEM																						
Out of Fuel - Check									●	●												
Lean Fuel Mixture - Readjust					●					●	●					●	●	●				
Rich Fuel Mixture or Choke Stuck	●		●							●					●	●						
Engine Flooded	●		●						●	●												
Poor Quality Fuel	●		●		●					●					●	●						
Dirty Carburetor	●								●	●	●					●						
Dirty Air Cleaner	●	●	●					●		●						●			●		●	
Dirty Fuel Filter										●	●					●						
Defective Fuel Pump									●	●	●					●						
INTERNAL ENGINE																						
Wrong Valve Clearance					●					●					●	●				●		
Broken Valve Spring					●					●					●	●				●		●
Valve or Valve Seal Leaking				●	●						●					●				●		
Piston Rings Worn or Broken				●						●					●					●		
Wrong Bearing Clearance		●				●	●						●		●							
COOLING SYSTEM (AIR COOLED)																						
Poor Air Circulation																●	●					
Dirty or Oily Cooling Fins																●	●					
Blown Head Gasket									●	●						●				●		
LUBRICATION SYSTEM																						
Relief Valve Stuck												●	●									
Faulty Oil Pump		●				●		●					●		●				●		●	
Dirty Oil or Filter		●				●		●											●		●	●
Oil Too Light or Diluted		●		●		●		●					●		●		●	●	●		●	
Oil Level Low		●				●		●					●		●		●	●	●		●	
Oil Too Heavy							●					●										
Dirty Crankcase Breather Valve		●		●		●						●										
THROTTLE AND GOVERNOR																						
Linkage Out of Adjustment										●	●											
Linkage Worn or Disconnected											●											
Governor Spring Sensitivity Too Great											●											
Linkage Binding											●											

Motor Generator Engine Troubleshooting Guide

FUEL SYSTEM TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
Fuel leaks from carburetor when fuel shut-off is open.	1. Float level set too high.	1. With fuel bowl removed and carburetor inverted, set float parallel to bowl flange. (3/32" clearance)
	2. Dirt under inlet valve.	2. Remove inlet valve, clean seat by rinsing in clean fuel and blow off with compressed air.
	3. Bowl vent plugged.	3. Remove bowl and blow clean with compressed air.
	4. Collapsed float caused by blowing assembled carburetor with compressed air.	4. Replace float.
	5. Carburetor gummed from storage. Float stuck to screen.	5. Remove fuel bowl and clean.
Engine smokes and runs rich.	1. Dirty air filter.	1. Clean or replace.
	2. Improper adjustment.	2. Set idle & power needles at 1 turn open. After engine starts and runs, set for optimum performance.
	3. Nozzle boss gasket leaks. Engine runs with power needle seated.	3. Remove fuel bowl and replace gasket. Tighten bowl retainer securely.
	4. Air bleeds in carburetor plugged.	4. Remove fuel bowl, idle & power needles. Clean thoroughly with compressed air.
Engine runs lean.	1. Improper adjustment.	1. Set idle & power needles at 1 turn open. After engine starts and runs, set for optimum performance.
	2. Idle holes plugged. Dirt in fuel delivery channels.	2. Remove fuel bowl, idle & power needles. Clean thoroughly with compressed air.
	3. Float level set too low. Low level in fuel bowl.	3. With fuel bowl removed and carburetor inverted, set float parallel to bowl flange (3/32" clearance).
	4. Fuel filter in electric fuel pump dirty.	4. Remove filter and replace.
	5. Fuel filter screen in fuel bowl plugged.	5. Remove fuel bowl. Invert bowl and tap on flat surface. Clean thoroughly and replace.

Engine starts hard.	1. Improper adjustment.	1. Set idle & power needles at 1 turn open. After engine starts and runs, set for optimum performance.
	2. No fuel in carburetor.	2. Check carburetor drain valve. If no fuel in bowl clean tank filter and carburetor. Check electric fuel pump operation, check electric solenoid valve.
	3. Choke valve not closing.	3. Check controls for proper travel.
Governor Surge	1. Throttle shaft and valve binding.	1. Remove and replace shaft if worn. Clean carburetor body. Reassemble throttle shaft assembly into carburetor body as far as possible. Hold firmly in place in this position while assembling throttle valve. Make certain valve does not bind in throttle bore when opening and closing throttle.
	Lean carburetion.	2. Adjust carburetor.

GENERATOR TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
No AC output voltage.	1. Blown fuse or circuit breaker.	1. Replace fuse or reset breaker and look for cause.
	2. Disconnected wire or lead on brushes, bridge rectifier or reactor assembly.	2. Reconnect wire or wires.
	3. Brushes not making contact with collector rings.	3. Check brush springs for free movement or brushes which may be excessively worn.
	4. Open, grounded or short circuit in field or armature winding.	4. Test with series test lamp and repair or replace as necessary.
	5. Defective bridge rectifier assembly.	5. Test with ohmmeter and replace if defective.
	6. Bridge rectifier assembly installed wrong in its case.	6. Reinstall making sure marks on case and rectifier match.

Lights flicker intermittently.	1. Loose or broken lead/ leads in generator.	1. Repair broken lead or reconnect loose lead.
	2. Brushes stuck in holder.	2. Loosen brush and clean or turn rings in lathe.
Low AC output voltage.	1. External short circuit on line.	1. Locate and eliminate short circuit problem.
	2. Generator Overloaded.	2. Remove part of load.
	3. Shorted or grounded circuit in field or armature winding.	3. Test with series test lamp or ohmmeter and replace if defective.
	4. Engine not running properly causing generator to slow down.	4. Refer to Engine Troubleshooting guide.
Noisy generator.	1. Defective bearing in end bell.	1. Replace bearing.
Generator overheats	1. Generator overloaded.	1. Remove part of load.
	2. Windings and parts covered with oil or dirt.	2. Clean generator.
	3. Air intake restricted or incoming air too hot.	3. Take necessary steps to allow for proper cooling.
	4. Shorted, open or grounded circuit in armature or field windings.	4. Test with ohmmeter or series test lamp and replace if defective
	5. Air seals are damaged or missing.	5. Replace air seals or tape over the air leak.
AC output voltage high with no load connected and generator running at 1800 rpm.	1. Compounding reactor defective.	1. Remove, test and replace.

MOTOR GENERATOR REPLACEMENT

REMOVAL

1. Open access door and support in this position.

2. Slide unit out of compartment.

3. Disconnect ground cable (-) at battery.

4. Install lifting eye in manifold on top of unit. A 3/8-16 threaded hole is provided in the manifold for this purpose.

5. Attach a suitable lifting device into lifting eye, and remove slack.

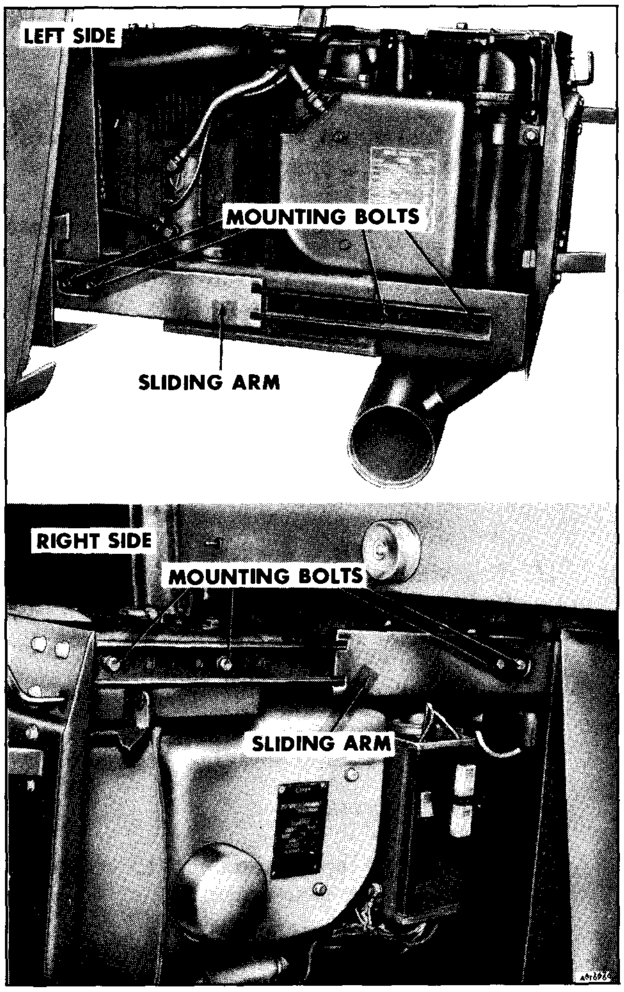


Figure 4—Disconnecting Sliding Arms (Typical)

6. Remove bolts from both sliding arms (figure 4).

7. Disconnect fuel line and all electrical leads.

8. Remove unit from its slide rail and place on a suitable bench or stand.

INSTALLATION

1. Extend slide rails to their full extended position.

2. Supporting the unit with a suitable hoist, position it in the slide rails.

3. Connect fuel line and all electrical wiring.

4. Install mounting bolts in slide rails as shown in Figure 4.

5. Remove hoist and lifting eye.

ENGINE

ENGINE OVERHAUL

The following steps serve only as a guide, when overhauling the engine.

Specific details on individual engine components are covered later in this section.

DISASSEMBLY

1. Drain crankcase oil.

2. Disconnect all exhaust lines, fuel lines and electrical wires (tag all electrical wires).

3. Remove engine from its slide rails and mountings and place on a suitable bench or work stand.

4. Remove all housings, shrouds, mounts, air cleaner, control box, etc.

NOTE: When removing generator and control box, tag all wires according to their respective locations.

5. Remove flywheel, using a puller or pry-bar method.

6. Remove flywheel alternator stator.

7. Remove the gear cover, being careful to protect the oil seal from keyway damage.

8. Remove the crank gear, using a gear puller and ring.

9. Remove fuel pump, oil filter, starter, carburetor, fuel lines, spark plugs, etc.

10. Remove breaker box.

11. Remove oil base, oil pump and cylinder heads.

12. Remove valves, springs, rocker arm, lifters, etc.

13. Remove camshaft and gear assembly.

14. Remove connecting rods, pistons and bearings.

15. Remove rear bearing plate.

16. Remove crankshaft.

17. Remove front main bearing.

NOTE: Keep all parts in their respective orders. Keep valve assemblies together. Return rod caps to their respective pistons. Analyze the reasons for parts failure.

ASSEMBLY

Observe proper clearances throughout the engine. Use a torque wrench to assure proper tightness. Coat the internal engine parts with SAE 30 oil as they are assembled. After the internal engine parts are assembled, the engine should turn over by hand freely.

1. Use the proper bearing driver to install front main bearing after coating it with a light film of oil.

2. Insert rear main bearing in rear bearing plate.

3. Install crankshaft and rear bearing plate.

4. Install connecting rods, pistons and bearings.

5. Install camshaft and gear.

6. Install valve assemblies.

7. Install oil pump, oil base and cylinder heads.

8. Install breaker box.

9. Install fuel pump, oil filter, starter, generator, carburetor, fuel lines, spark plugs, etc.

10. Install crank gear, aligning crank gear mark with camshaft.

11. Install gear cover and oil seal.

12. Install flywheel alternator stator.

13. Install flywheel.

14. Install all housings, air cleaner, control box, etc.

15. Reinstall power plant in vehicle, making proper fuel, battery, electrical and exhaust connections.

16. Fill crankcase with oil.

17. Start engine.

18. Check oil pressure.

19. Run engine approximately 15 minutes to bring up to operating temperature.

20. Check for oil leaks, electrical connections, fuel lines and exhaust connections.

VALVE SYSTEM (FIGURE 5)

Properly seated valves are essential to good engine performance. The aluminum cylinder heads are removable for valve servicing. Do not use a pry bar to loosen the cylinder head; rap sharply on the edge with a soft faced hammer, taking care not to break

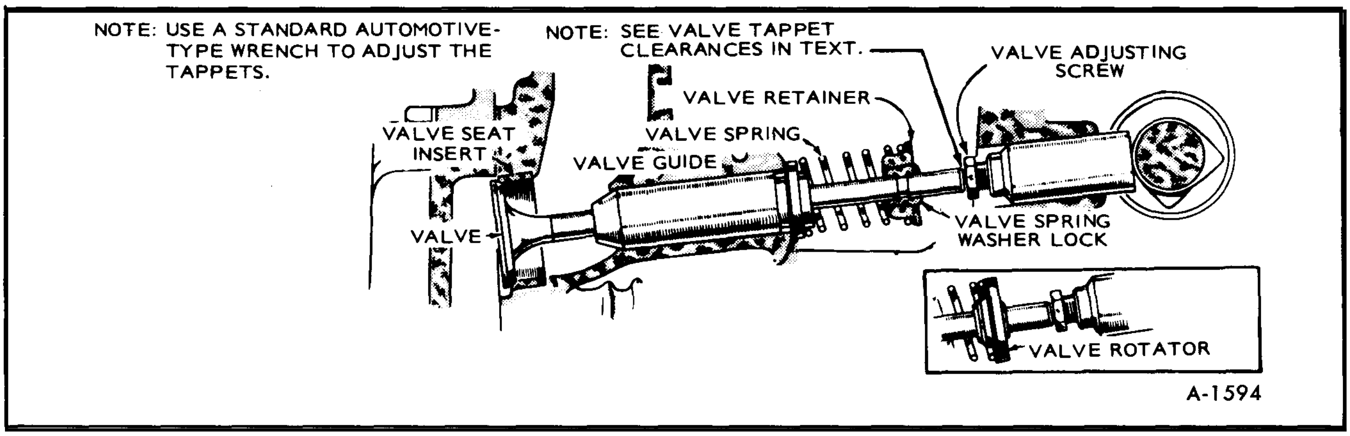


Figure 5—Valve System

any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder heads, piston tops, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Valve locks are split, tapered typed, the smaller diameter of which must face toward the valve head. Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

The valve *face* angle is 44°. The valve *seat* angle is 45° as shown in Figure 6. This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life.

CAUTION: *The valves should not be hand lapped, because the sharp contact may be destroyed. This is especially important where stellite faced valves and seats are used.*

Valve faces should be finished to 44°. Valve seats should be ground with a 45° stone and the width of the seat band should be 1/32" to 3/64" wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

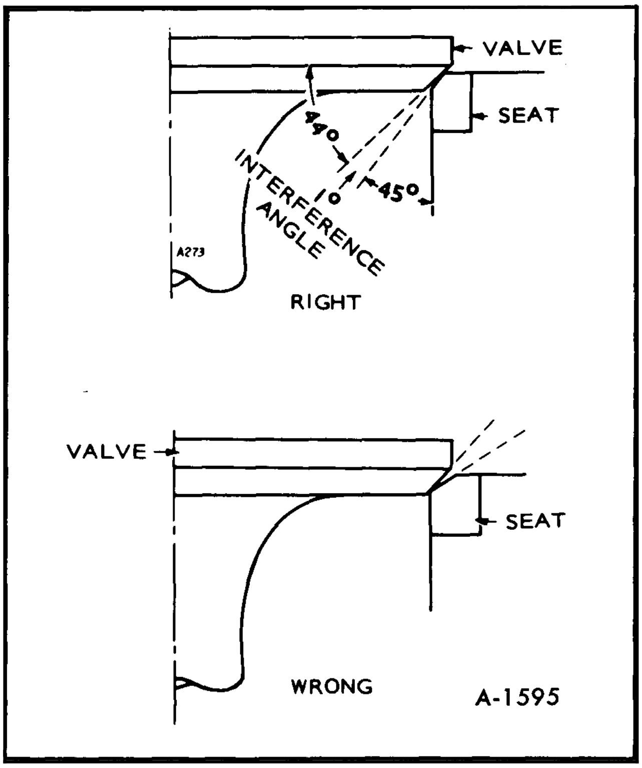


Figure 6—Valve Interference Angle

TAPPET ADJUSTMENT (FIGURE 7)

The engine is equipped with adjustable valve tappets. The valve tappet clearance should be checked and adjusted, when necessary. Adjust the valve clearance only when engine is at ambient temperature. Proceed as follows:

1. Remove all parts necessary to gain access to valve tappets.

2. Remove spark plugs to ease the task of turning the engine over by hand.

3. Use the engine flywheel to turn the engine over slowly by hand until the left hand intake valve opens and closes. Continue turning the flywheel until the TC mark is on the top and lined up with the TC mark on the gear cover. Both valves should be closed. This should place the left hand piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left cylinder.

4. For the intake valve, a .003" thickness gauge should just pass between valve stem and tappet.

5. For the exhaust valve, a .010" thickness gauge (.012" on the 6KW) should just pass between valve stem and tappet.

6. To correct the valve clearance, use a 7/16" open end wrench to turn the adjusting screw to ob-

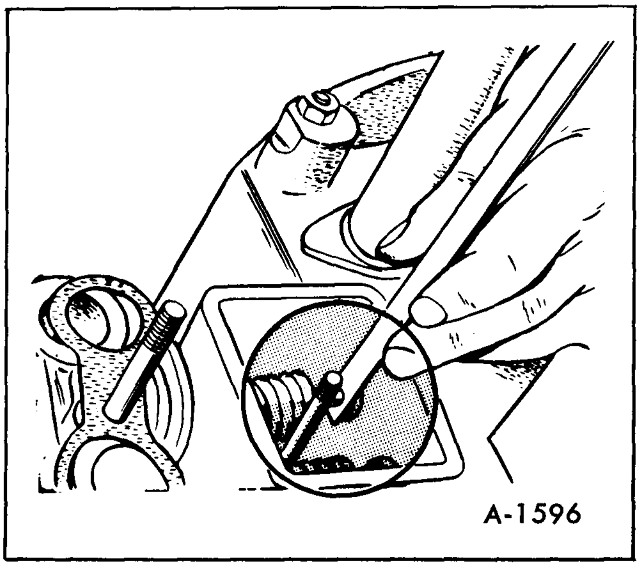


Figure 7—Adjusting Valves

tain the correct clearance. The screw is self-locking and will stay where it is set. A 9/16" open end wrench is required to hold the tappet while turning the adjusting screw.

7. To adjust valves on the right hand cylinder-turn engine one complete revolution and again line up mark on the flywheel and the TC mark on the gear cover. Then follow adjustment procedure given for left hand cylinder.

8. Install all parts removed in Step 1. Tighten all screws securely. Torque manifold bolts to specified torque.

FLYWHEEL

Removing the flywheel is a relatively simple process, but the following procedure must be followed to avoid damage to the gear case and possible personal injury.

1. Turn the flywheel mounting screw outward about two turns.

WARNING: DO NOT REMOVE THE SCREW COMPLETELY SINCE IT ACTS AS A RESTRAINER WHEN THE FLYWHEEL SNAPS LOOSE. IF THE FLYWHEEL IS NOT HELD BY THE SCREW, THE SPRING ACTION IN THE WHEEL WILL CAUSE IT TO FLY OFF WITH GREAT FORCE WHICH CAN CAUSE PERSONAL INJURY.

2. Install a puller bar on the flywheel as shown in Figure 8.

3. Turn the puller bar bolts in, alternately, until the wheel snaps loose on the shaft.

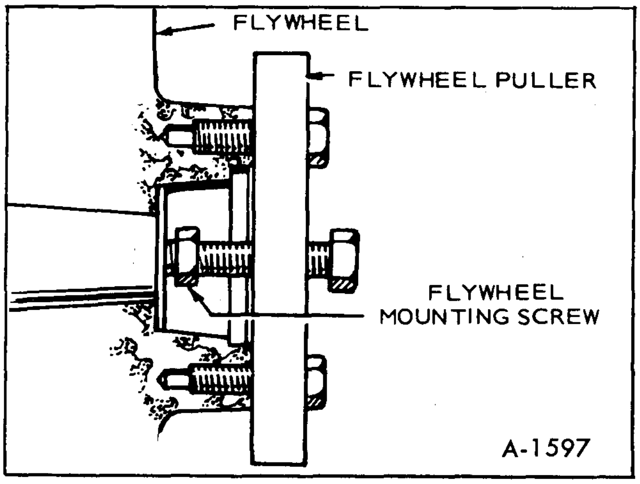


Figure 8—Flywheel Removal

CAUTION: *Do not use a screwdriver or similar tool or pry behind the flywheel against the gear case. The gear case cover is die-cast material and will break if undue pressure is applied in this manner.*

4. Unscrew the puller from the flywheel, remove the flywheel mounting screw and washer and pull the flywheel off the shaft. Take care not to drop the wheel. A bent or broken fin will destroy the balance. Always use a steel key for mounting the flywheel.

FLYWHEEL ALTERNATOR STATOR

After disconnecting stator terminal wires, remove the three screws securing stator to gear cover and pull off.

GEAR COVER (FIGURE 9)

After removing the mounting screws, tap the gear cover gently with a soft faced hammer to loosen it.

When installing the gear cover, make sure that the pin in the gear cover engages the metal lined (smooth) hole in the governor cup. Turn the governor cup so that the metal lined hole is at the three o'clock position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal. Adjust the roll (stop) pin to protrude to a point 3/4" from the cover's mounting surface.

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the flyballs while sliding the cup off.

Replace with a new part, any flyball which is grooved or has a flat spot; the ball spacer if its arms are worn or otherwise damaged; and the governor cup if the race surface is grooved or rough. The governor cup must be a free spinning fit on the camshaft center pin, but without any excessive play.

When installing the governor cup, tilt the engine so the gear is up, then put the flyballs in place. Install the cup and snap ring on the center pin.

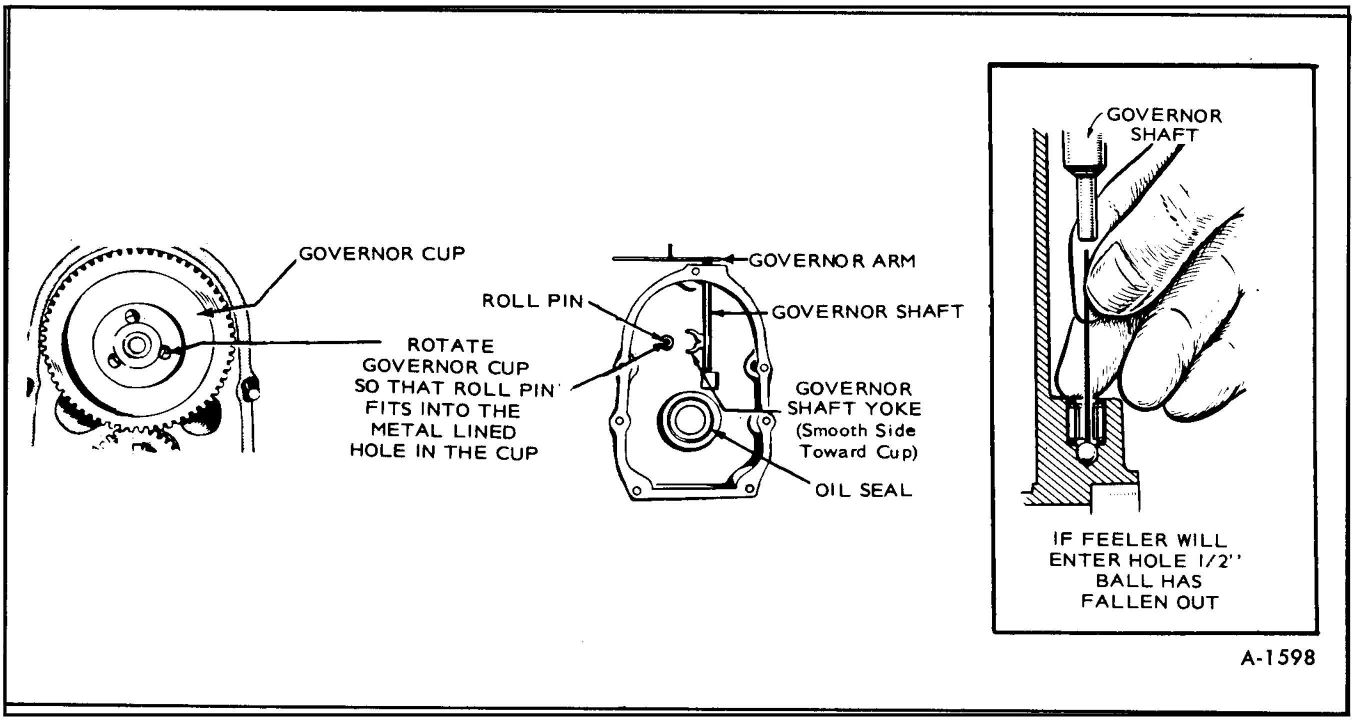


Figure 9—Gear Cover Assembly

The camshaft center pin extends out 3/4" from the end of the camshaft. This distance provides an in and out travel distance of 7/32" for the governor cup, as illustrated in Figure 10. Hold the cup against the flyballs when measuring. If the distance is less (the engine will race especially at no load), replace camshaft. The camshaft center pin cannot be pulled outward or removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

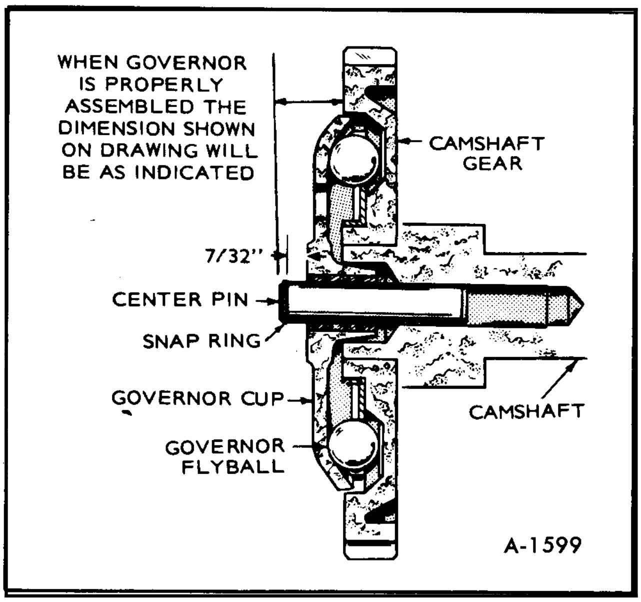


Figure 10—Governor Cup (Cross-Section)

TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, always install both gears new.

To remove the crankshaft gear, first remove the snap ring and retainer washer, then attach the gear pulling ring using two No. 10-32 screws (figure 11). Tighten the screws alternately until both are tight. Attach a gear puller to the puller ring and proceed to remove the gear.

The camshaft and gear must be replaced as an assembly. Before removing the camshaft and gear assembly, remove the cylinder head and valve assemblies. Then remove the operating plunger for the breaker points and tappets.

Each timing gear is stamped with 0 near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine.

When installing the camshaft gear and shaft assembly, be sure that the thrust washer is properly in place behind the camshaft gear. Then install the crankshaft retaining washer and lock ring.

PISTONS AND CONNECTING RODS

REMOVAL

Observe the following procedure when removing pistons and connecting rods from the engine.

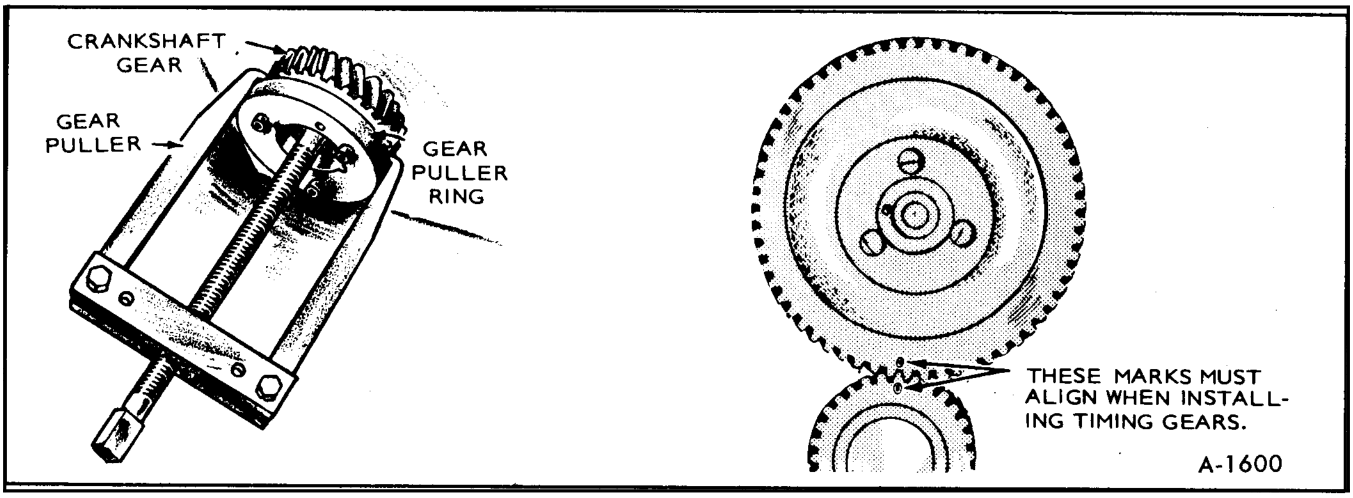


Figure 11—Timing Gear Removal and Installation

1. Drain oil.

2. Remove the cylinder heads and oil base pan from the engine.

3. Remove the ridge from the top of each cylinder with a ridge reamer before attempting piston removal (figure 12). Forcing the piston from the cylinder before reaming may cause damage to the piston lands.

4. Turn the crankshaft until the piston is at the bottom of its stroke and remove the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out through the top of the cylinder using a hammer handle. Avoid scratching the crankpin and cylinder wall when removing the piston and rod.

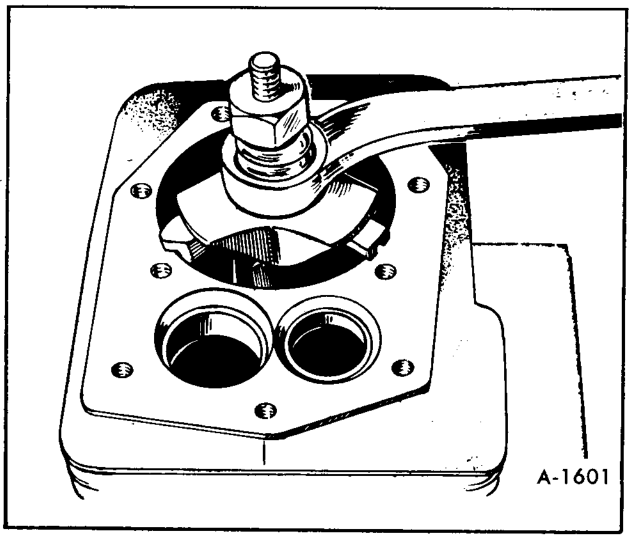


Figure 12—Removing Ridge From The Cylinder

NOTE: Mark each piston and rod assembly so they can be returned to their respective cylinders after overhaul. Keep connecting rod bearing caps with their respective rods.

5. Remove the piston rings from the piston with a piston ring spreader as shown in Figure 13. Remove the piston retainer and push the piston pin out.

CLEANING

Remove dirt and deposits from the piston surfaces with an approved cleaning solvent. Clean the piston ring grooves with a groove cleaner or the end of a piston ring filed to a sharp point (figure 14). Care must be taken not to remove metal from the groove sides.

NOTE: Do not use a caustic cleaning solvent or wire brush for cleaning pistons.

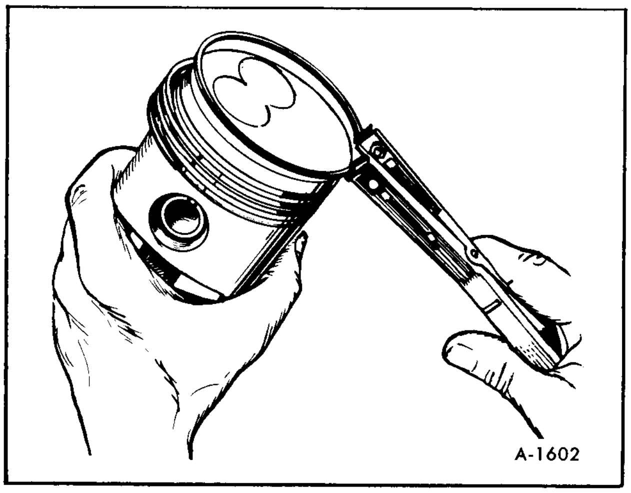


Figure 13—Removing Piston Rings

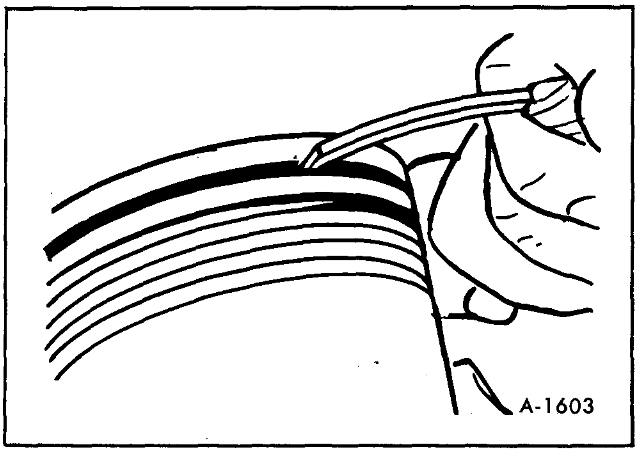


Figure 14—Piston Groove Cleaning

When cleaning the connecting rods in solvent, include the rod bore. Blow out all passages with compressed air.

INSPECTION

The following text contains inspection procedures concerning pistons and connecting rods.

1. Piston Inspection:

a. Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring lands using a new ring and feeler gauge as shown in Figure 15. Replace the piston when the side clearance of the top compression ring reaches 0.008".

b. Replace pistons showing signs of scuffing, scoring, worn ring lands, fractures or damage from preignition. Excessive piston wear near the edge of the top ring land indicates preignition.

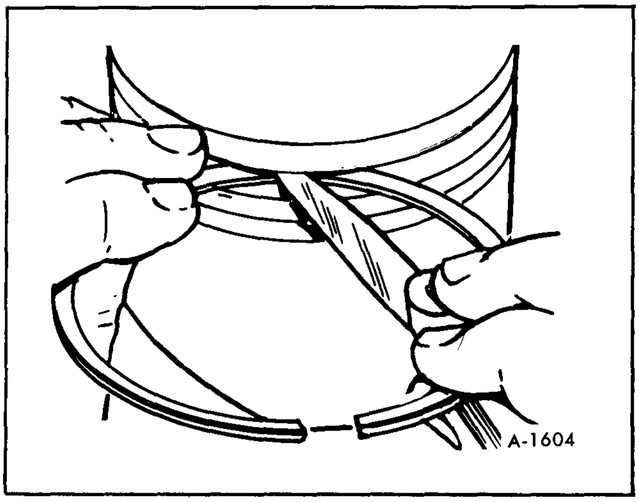


Figure 15—Checking Ring Side Clearance

2. Connecting Rod Inspection

a. Replace connecting rod bolts or nuts with damaged threads. Replace connecting rods with deep nicks, signs of fractures, scored bores or bores out of round more than 0.002".

b. Use a new piston pin to check connecting rod for wear. A push fit clearance is required and varies from engine to engine. If a new piston pin falls through a dry rod pin bore as a result of its own weight, replace the rod.

REPAIR

1. Fitting Pistons:

a. Proper piston tolerances must be maintained for satisfactory operation.

b. Measure the piston as shown in Figure 16 to be sure the total piston-to-cylinder clearance follows specifications.

2. Fitting Piston Rings:

a. Install the piston ring in the cylinder bore. Invert the piston and push the ring to the end of ring travel, about halfway into the bore, which trues the ring end gap. Check the gap with a feeler gauge as shown in Figure 17.

b. The practice of filing ring ends to increase the end gap is not recommended. If the ring end gap does not meet specifications, check for the correct set of rings and correct bore size. A cylinder bore that is 0.001" undersize will reduce the end gap 0.003".

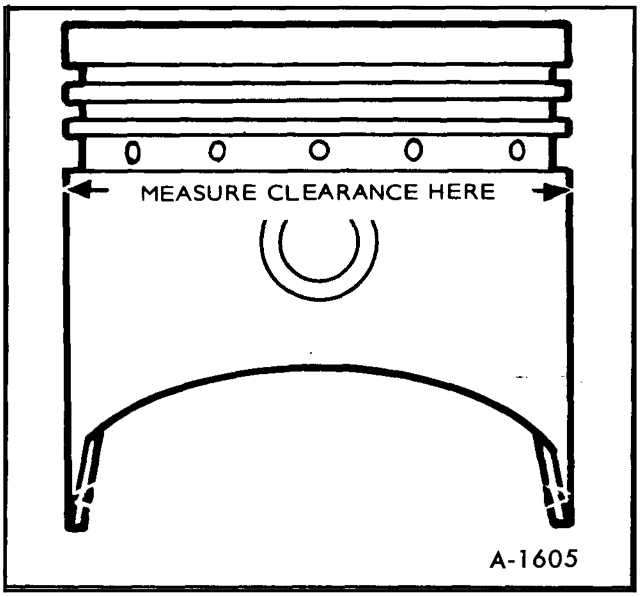


Figure 16—Measuring Diameter of Piston

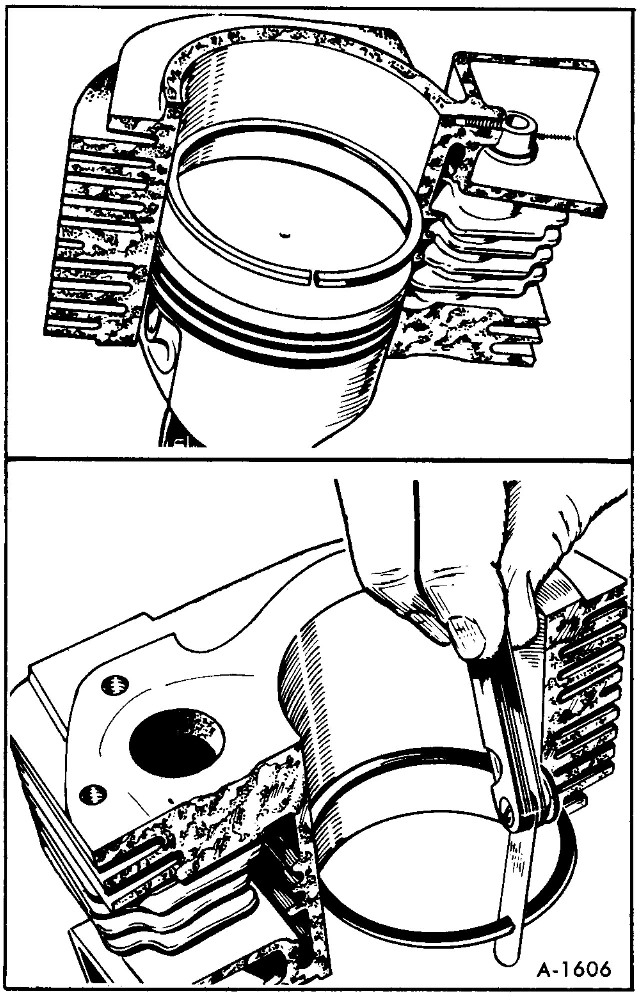


Figure 17—Checking Ring End Gap

CYLINDER BLOCK

INSPECTION:

1. Make a thorough check for cracks. Small cracks may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light motor oil. Wipe the part dry and immediately apply a coating of zinc oxide (white lead) dissolved in wood alcohol. If cracks are present, the white coating will become discolored at the defective area.

2. Inspect the cylinder bore for scoring. Check the Welsh plugs for a tight, even fit and fins for breakage.

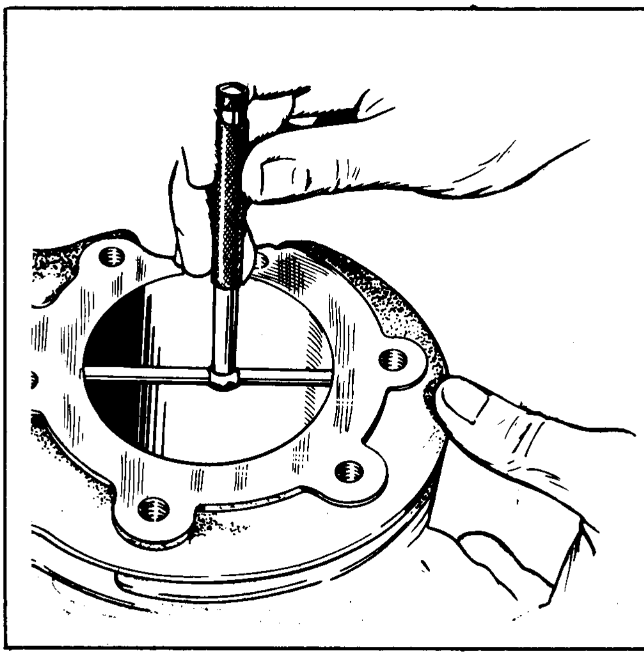
3. Check the cylinder bore for taper, out of round and wear, with a cylinder bore gauge, telescope gauge or inside micrometer (figure 18). These measurements should be taken at four places — the top and bottom of piston ring travel.

4. Record measurements taken lengthwise at the top and bottom of the piston travel as follows:

a. Lengthwise of the block, measure and record as "A" the diameter of the cylinder at the top of the cylinder where greatest ring wear occurs.

b. Also, lengthwise of the block, measure and record as "B" the cylinder diameter at the piston skirt travel.

c. Crosswise of the block, measure and record as "C" the diameter of the top of the cylinder at the greatest point of wear.



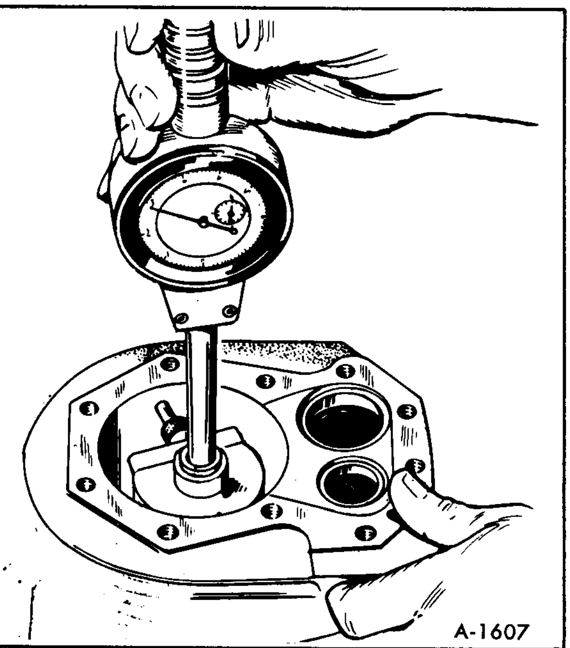


Figure 18—Methods of Measuring The Diameter of a Cylinder

d. Measure and record as "D" the diameter at the bottom of the cylinder bore and crosswise of the block.

e. Reading "A" compared to reading "B" and reading "C" compared to reading "D" indicates cylinder taper.

f. If cylinder taper exceeds 0.005", rebore and hone to accommodate the next oversize piston, Reading "A" compared to reading "C" and reading "B" compared to reading "D" indicates whether or not the cylinder is out of round. If the out of round exceeds 0.002", the cylinders must be rebored and honed for the next oversize piston. A reboring machine is used when going to oversize pistons. The following repair data covers honing to oversize by use of a hone.

REPAIR:

1. A hone can be used to refinish a cylinder.

2. Anchor the block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at approximately 250 to 450 rpm.

3. Connect drill to hone and start drill. Move the hone up and down in the cylinder approximately 40 cycles per minute. Usually the bottom of the cylinder must be worked out first because it is smaller. Then when the cylinder takes a uniform diameter, move the hone up and down all the way through the bore. Follow the hone manufacturer's recommendations for wet or dry honing and oiling the hone.

4. Check the diameter of the cylinder regularly during honing. A dial bore gauge is the easiest method but a telescoping gauge can be used. Check the size at six places in the bore: measure twice at the top, middle and bottom at 90° angles.

5. The cross hatch formed by the scratching of the stones should form an angle of 23° as shown in Figure 19. This can be achieved by moving the hone up and down in the cylinder about 40 cycles per minute.

6. Clean the cylinder block thoroughly with soap, water and clean rags. A clean white rag should not be soiled on the wall after cleaning is complete. Do not use a solvent or gasoline since they wash the oil from the walls but leave the metal particles.

7. Dry the crankcase and coat it with oil.

CRANKSHAFT

Inspect the bearing journals. If they are scored and cannot be smoothed out by dressing down, replace the crankshaft.

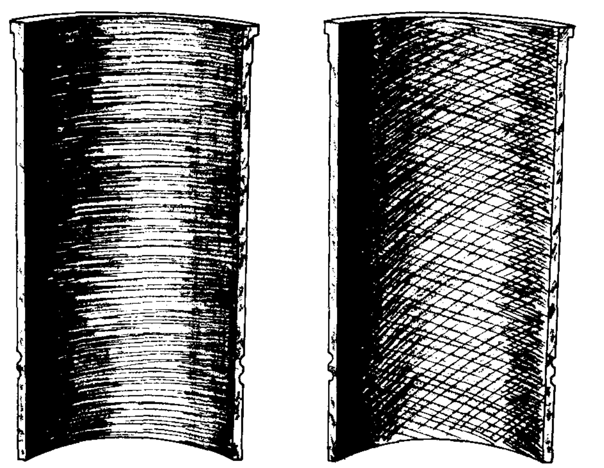


Figure 19—Crosshatching Cylinder Block

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

BEARINGS

Removal

Removing camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable drive plug to remove the bearings. Support the casting to avoid distortion and avoid damaging the bearing bore during removal and installation. Use oil on the bearings to reduce friction when installing and again lubricate with oil after installing.

Installation

Crankshaft main bearings are precision type which do not require line reaming or line boring after installation. They are available in standard size and .002" undersize. Expand the bearing bore by placing the casting in hot water or in an oven heated to 200°F. *If a torch is used, apply only a slight amount of heat.*

To ease assembly, cool the precision bearing to shrink it. Align the oil hole(s) in the bearing with the oil hole(s) in the bearing bore Figure 20. The oil passage must be at least 1/2 open. Lubricate bearings with SAE20 oil before installing. The cold oiled precision bearing should require only light taps to position it with a driving tool. If head of lock pin is damaged, use side cutters or Easy Out tool to remove and install new pin. Apply oil to thrust washer (one used with each bearing) to hold it in place while

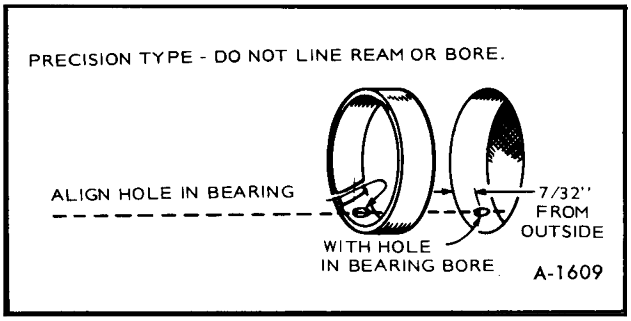


Figure 20—Crankshaft Bearing

installing the crankshaft. Oil grooves in thrust washers must face the crankshaft and washers must be flat (not bent). The two notches on each washer must fit over the two lock pins to prevent riding on the crankshaft.

NOTE: Original front bearing uses a separate thrust washer. Replacement front bearing is a one piece assembly with thrust washer part of the bearing. Do not use a separate thrust washer when installing this replacement part. See Figures 21 and 22.

New camshaft bearings are precision type which *do not* require line reaming or line boring after installation. Coat the bearing with SAE20 to reduce friction. Place the bearing on the crankcase over the bearing bore with the elongated hole in proper position and narrow section facing out (except bores without oil holes install with bearing groove at the top). Be sure to start the bearing straight. Press the front bearing in flush with the outside end of the bearing bore. Press the rear bearing in flush with the bottom of counterbore which received the expansion plug.

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened using the torque recommended in Torque

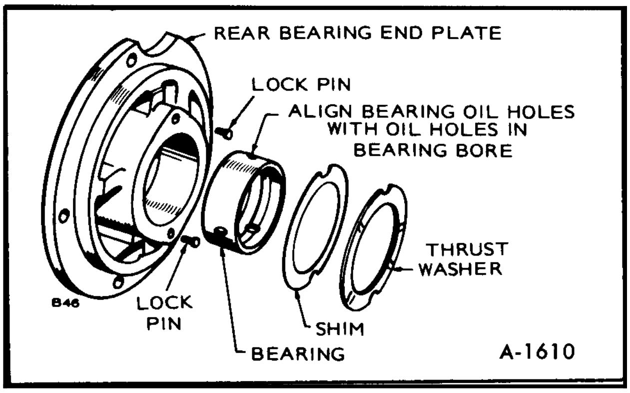


Figure 21—Bearing For Rear Bearing Plate

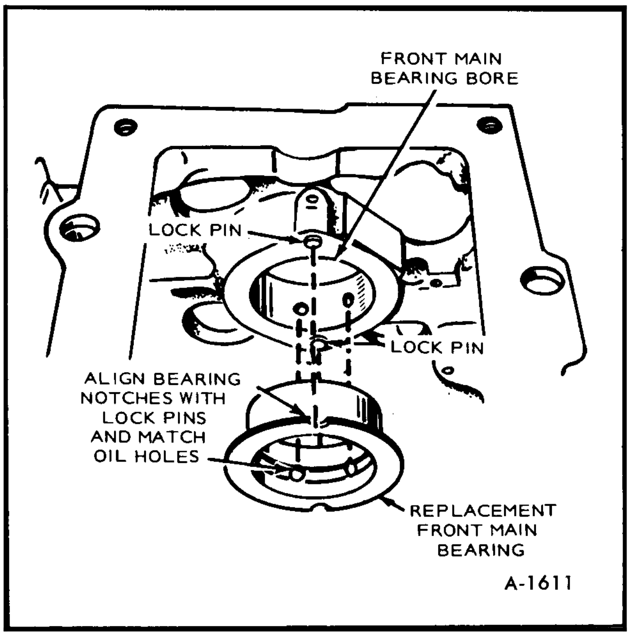


Figure 22—Front Bearing Installation

Specifications check the crankshaft endplay as shown in Figure 23. If there is too much endplay (see Specifications), remove the rear bearing end plate and add a shim between the thrust washer and plate. Reinstall the end plate making sure the thrust washer and shim notches line up with the lock pins. Torque and recheck endplay of the crankshaft.

CHECKING BEARING CLEARANCE WITH PLASTIGAUGE

1. Make certain that all parts are marked or identified so that they are reinstalled in their original positions.

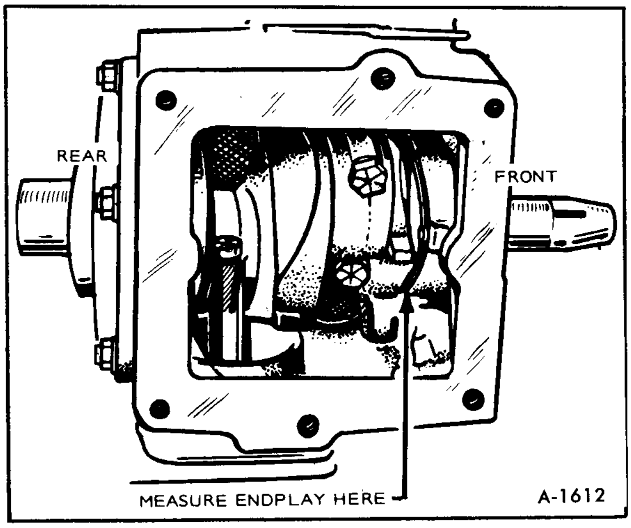


Figure 23—Crankshaft Endplay

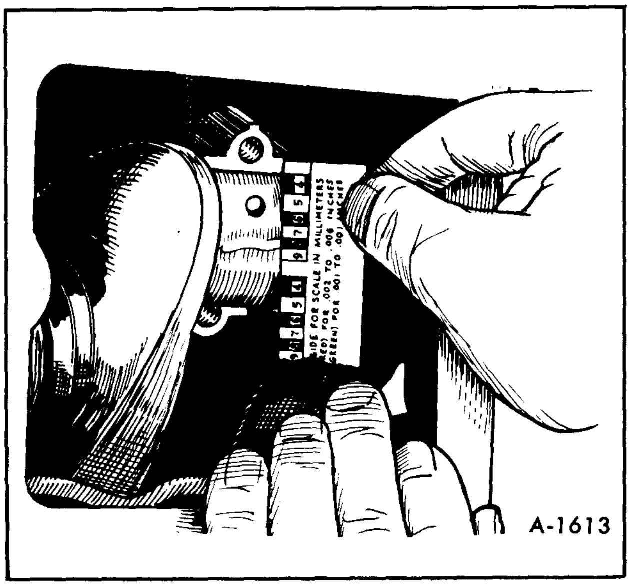


Figure 24—Measuring Bearing Clearance

2. Place a piece of correct size Plastigauge in the bearing cap the full width of the crankshaft rod surface about 1/4 inch off center (figure 24).

3. Rotate the crank about 30° from bottom dead center and reinstall the bearing cap; Tighten the bolts to the torque specified at the end of this section. Do not turn the crankshaft.

4. Remove the bearing cap. Leave the flattened Plastigauge on the part to which it has adhered and compare the widest point with the graduations on the Plastigauge envelope to determine bearing Clearance.

OIL SEALS (FIGURE 25)

The bearing plate must be removed to replace the oil seal. Drive the oil seal out from the inside.

Before installing the seals, fill the space between lips with a multi-purpose grease. This will improve sealing.

When installing the gear cover oil seal, tap the seal inward until it is 31/32" from the mounting face of the cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander or place a piece of shim stock around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

PISTON ASSEMBLY

1. Lubricate all parts with engine oil.

2. Position piston on its respective rod and install the pin.

3. Install the rings on the pistons starting with the oil control ring (figure 26). Use a piston ring spreader

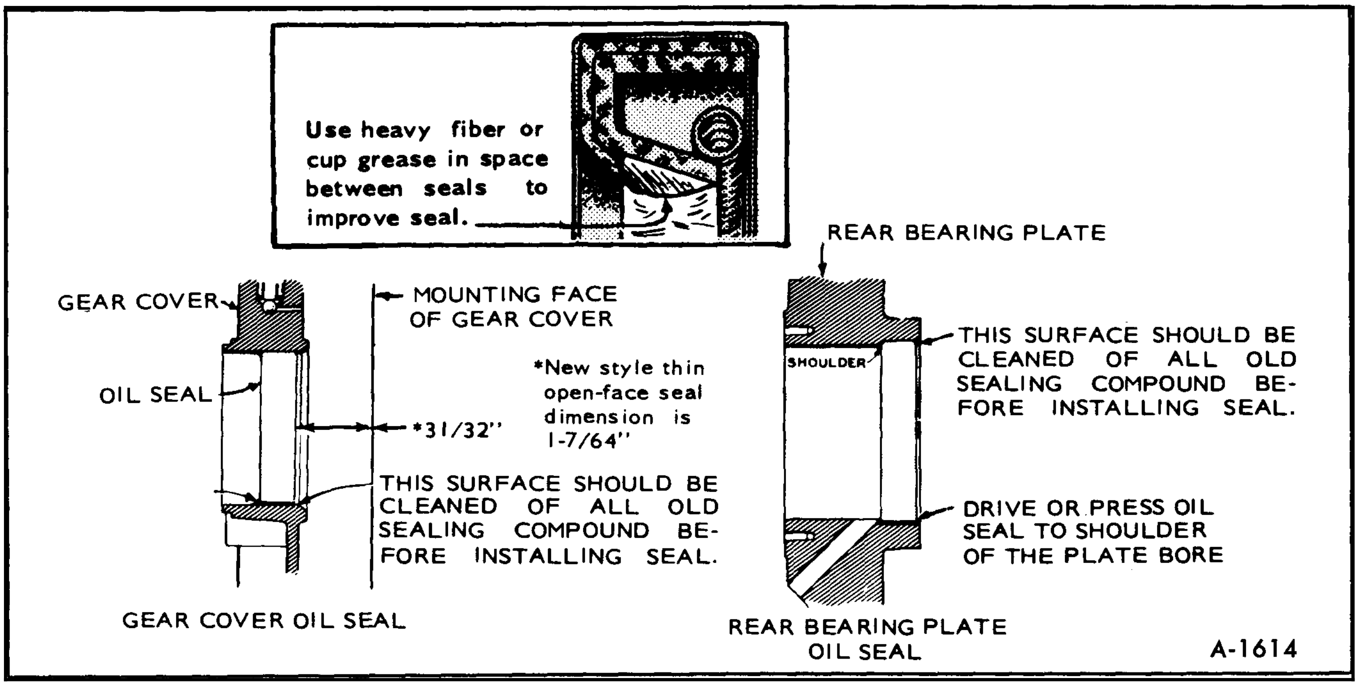


Figure 25—Gear Cover and Rear Bearing Plate Oil Seals

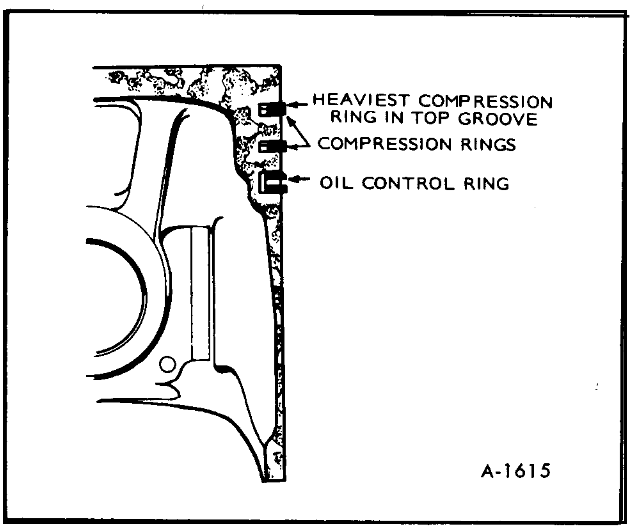


Figure 26—Piston Rings

to prevent twisting or excessive expansion of the ring. Some oil control rings and all compression rings have a dot or the word "top" on one side of the ring to indicate which side faces the top of the piston. Unmarked piston rings can be installed either way. If the oil control ring has a coil expander, install the expander first and then close until the coil ends butt. The joint should be 180° from the gap of that ring.

INSTALLATION OF PISTON IN CYLINDER:

1. Turn the crankshaft to position the number one rod bearing journal at the bottom of its stroke.

2. Lubricate the number one piston assembly and inside of the cylinder. Compress the rings with a ring compressor as shown in Figure 27.

3. Position the piston and rod assembly in the cylinder block.

NOTE: The connecting rod numbers should always face away from the camshaft or bottom side of engine. See Figure 28.

4. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the journal (figure 27). Install the bearing cap on the rod with the witness marks and stamped reference numbers matching the marks on the rod. Install and tighten the bolts to the specified torques.

The bearing cap must be tapped several times to properly align it with the rest of the connecting rod. Clearance varies on the journal if this is not done.

Install the remaining pistons and rods in the same manner. Crank the engine over by hand to see that all bearings are free.

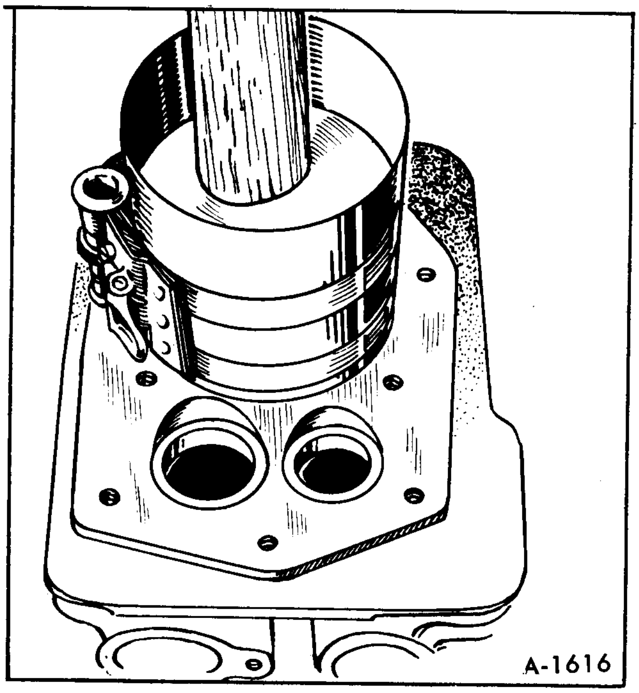


Figure 27—Installing Piston

5. Install the oil base with a new gasket.

Torque oil base thru-bolts to 18-23 ft.-lb.

Install oil pan.

6. Install the cylinder heads and torque 14-16 ft. lb. (17-19 ft. lb. on 6KW).

7. Replace oil and break-in engine.

CYLINDER HEADS

Remove the cylinder heads for cleaning when poor engine performance is noticed.

1. Use a 1/2 inch socket wrench to remove cylinder head nuts. Lift heads off.

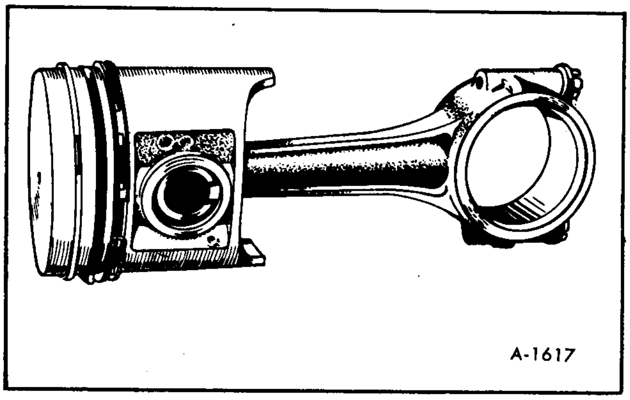


Figure 28—Piston Assembly

CAUTION: *Do not remove heads when they are hot. Warpage may occur.*

2. After removing heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where gaskets fit. The heads are made of aluminum and can be damaged by careless handling.

3. Use new head gaskets and clean both the heads and the cylinder block thoroughly where the head gaskets rest.

4. Place heads in position and follow head torque tightening sequence shown in Figure 29. Start out tightening all Nuts to 5 ft-lb, then 10 ft.-lb, etc., until all Nuts are torqued 14-16 ft - lb. (17-19 ft.-lb. on 6KW).

5. Recheck torque before engine has run a total of 50 hours.

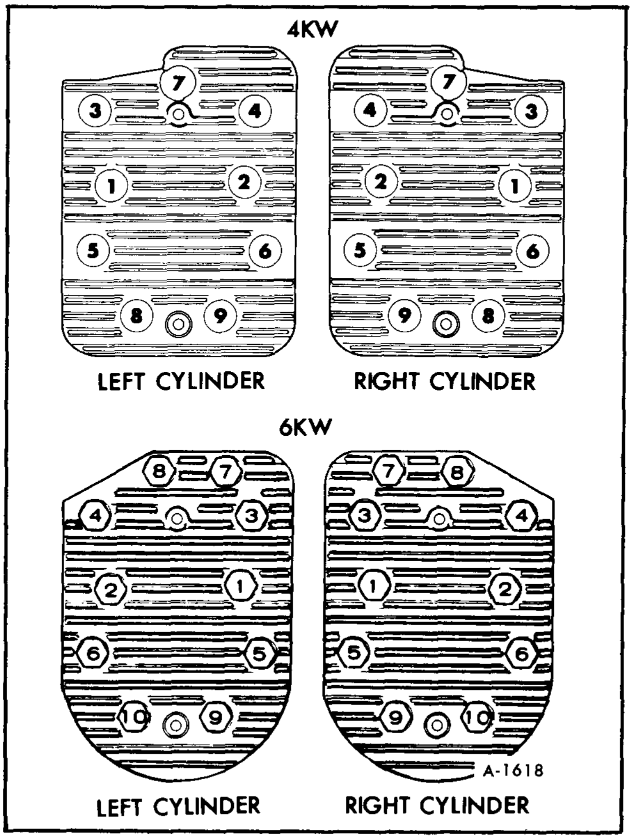


Figure 29—Cylinder Head Tightening Sequence

OIL SYSTEM

CRANKCASE OIL

Change crankcase oil every 100 operating hours and only when engine is warm.

(EXCEPTION: Drain initial oil fill at 25 operating hours.)

To drain, remove the 1/2 inch cap screw (requiring 3/4" socket) on oil pan. After oil drains, replace the cap screw and refill crankcase with a good quality detergent oil. Refer to Section 24A for specific details on oil for the Onan Motor Generator.

OIL FILTER

Change the crankcase oil filter every 200 hours. Filter is located above starter on right side of engine. Remove by turning filter counterclockwise with a filter wrench. Before installing new filter, coat gasket on base of filter with a light film of oil. Install by turning clockwise until friction is noted, then turn an additional 1/4 to 1/2 turn. See Figure 30.

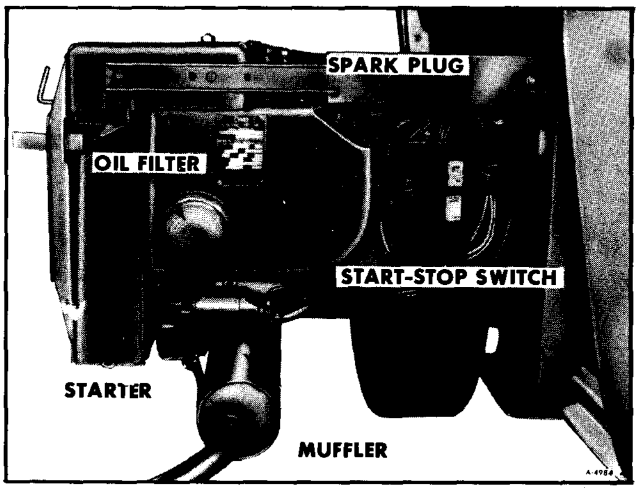


Figure 30—Onan Motor Generator (Right Side View)

CAUTION: *Do not over-torque oil filter. Be sure ring is installed around oil filter. This ring acts as an air seal and prevents loss of cooling air.*

CRANKCASE BREATHER

This engine uses a crankcase breather valve for maintaining crankcase vacuum. No maintenance is generally required. If the crankcase becomes pressurized as evidenced by oil leaks at the seals, clean baffle and valve in a suitable solvent. Crankcase breather disassembly requires removal of exhaust manifold. See Figure 31.

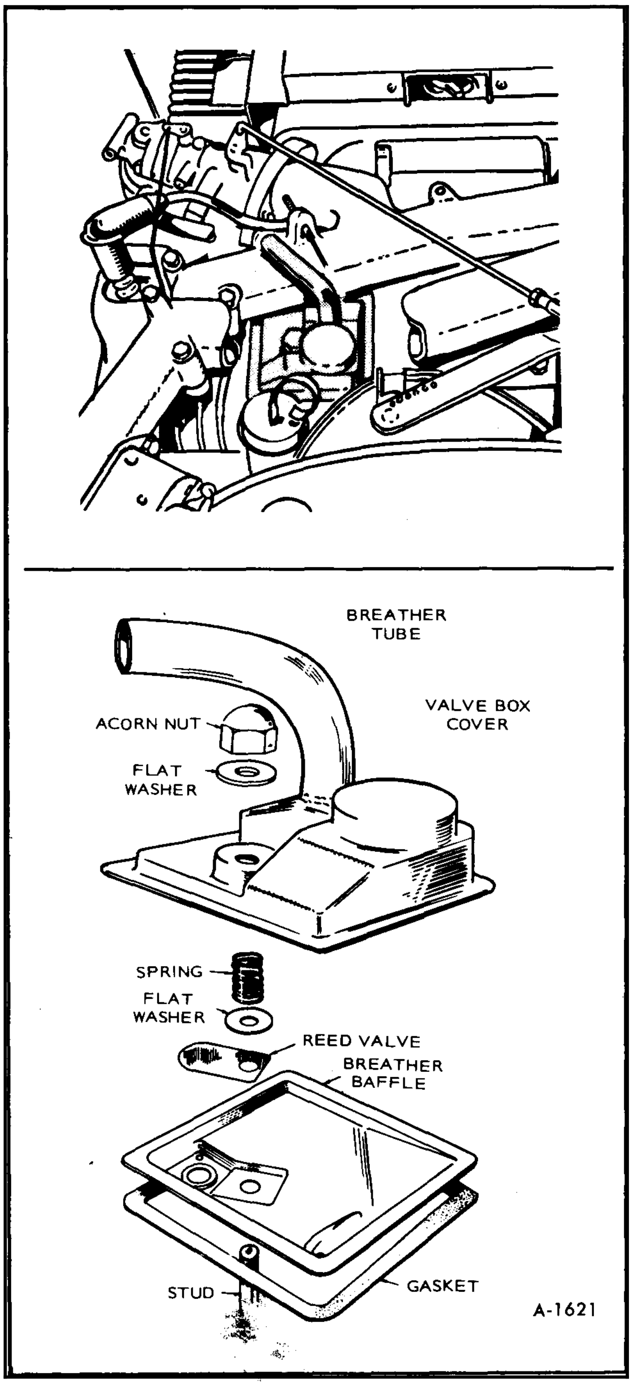


Figure 31—Crankcase Breather

FUEL SYSTEM

CARBURETOR REPAIR (FIGURE 32)

REMOVAL

1. Disconnect fuel inlet hose and crankcase breather hose.

2. Remove air cleaner assembly.

3. Disconnect governor, throttle linkage, and choke control.

4. Remove two-hold down screws and lift carburetor from intake manifold.

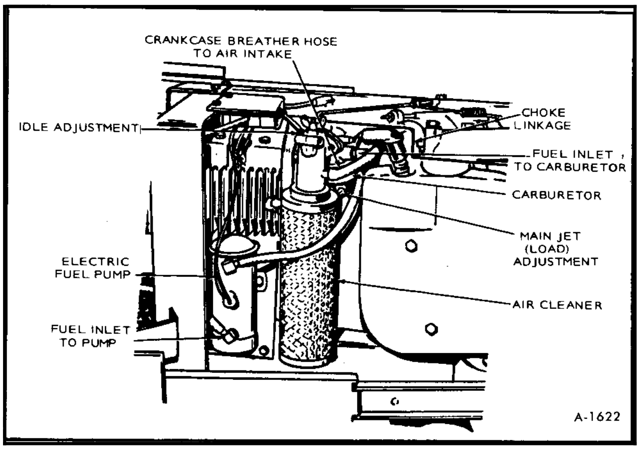


Figure 32—Fuel System (Typical)

REPLACING NEEDLE AND VALVE SEAT (FIGURE 33)

1. Remove 7/16" retainer at base of fuel bowl and lift bowl from carburetor.

2. Push out pin that holds float to carburetor body. Disconnect spring holding needle to float.

3. Remove float and set aside in a clean place. Pull out needle and using a large screwdriver remove needle valve seat.

4. Install new valve seat and needle and replace float.

5. Adjust float.

CARBURETOR CLEANING AND INSPECTION

To clean the carburetor, soak all components thoroughly in a good carburetor cleaner, following the manufacturer's instructions. Be sure to remove all carbon from carburetor bore, especially in the area of the throttle valve. After soaking, clean out all passages with filtered, compressed air.

Check the adjusting needles and nozzle for damage. If float is loaded with fuel or damaged, replace it. The float should fit freely on its pin without binding.

Check the choke and throttle shafts for excessive side play and replace if necessary.

CARBURETOR FLOAT ADJUSTMENT

1. Invert float and casting.

2. With the float resting lightly against the needle and seat, there should be 3/32-inch clearance between base of float and carburetor casting.

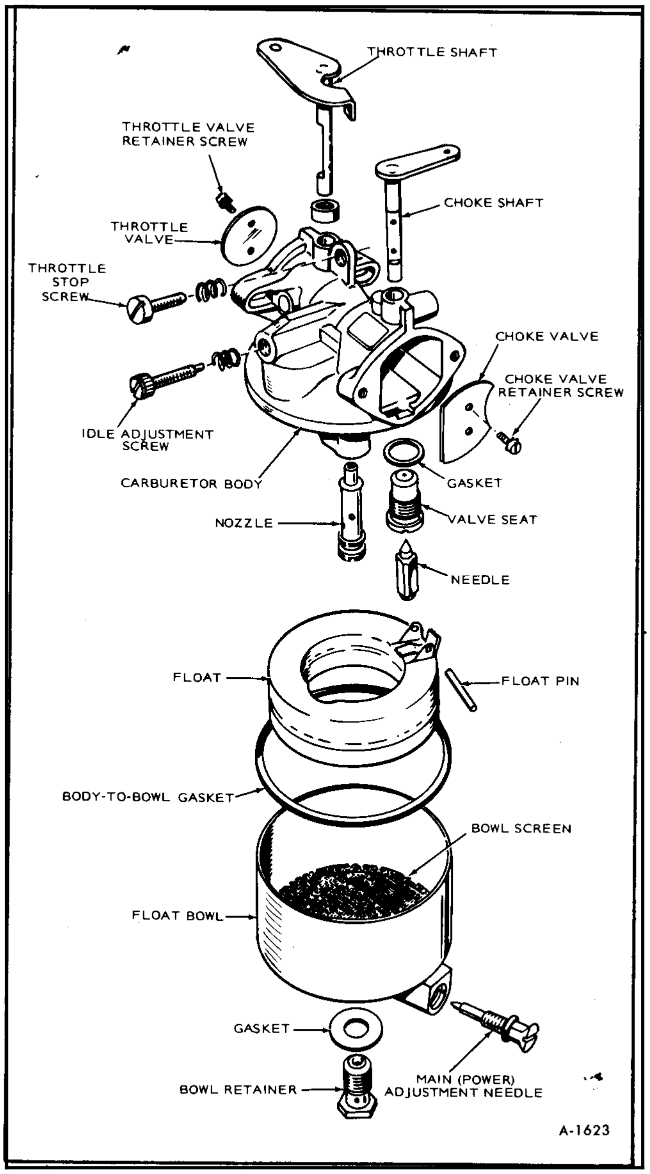


Figure 33—Carburetor Components

NOTE: A drill bit can be used for this measurement as shown in Figure 34. Use a 3/32-inch drill bit.

3. If it is necessary to reset float level, remove the float from carburetor and bend the float tang, near the pin, to obtain correct float level.

CAUTION: *Do not bend the float when installed; doing so may cause deformation of needle or seat.*

4. Check the float closely for signs of leakage. Replace float if damaged or filled with gasoline.

5. Before assembling carburetor, remove filter screen from float bowl and clean both screen and base of float bowl.

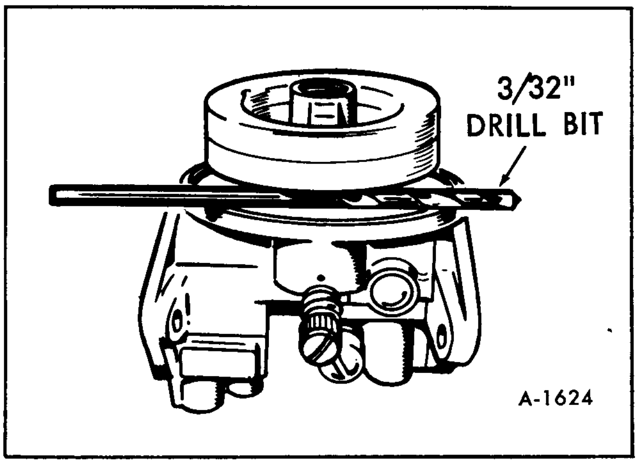


Figure 34—Carburetor Float Adjustment

6. Install new gaskets when reassembling.

FUEL PUMP FILTER ELEMENT (FIGURE 35)

Every 400 hours or sooner, drain fuel pump and check filter element. Remove fuel pump mounting screws and turn off hex nut on base of pump. If element appears dirty, replace with a new one. Be sure to replace gaskets when reassembling.

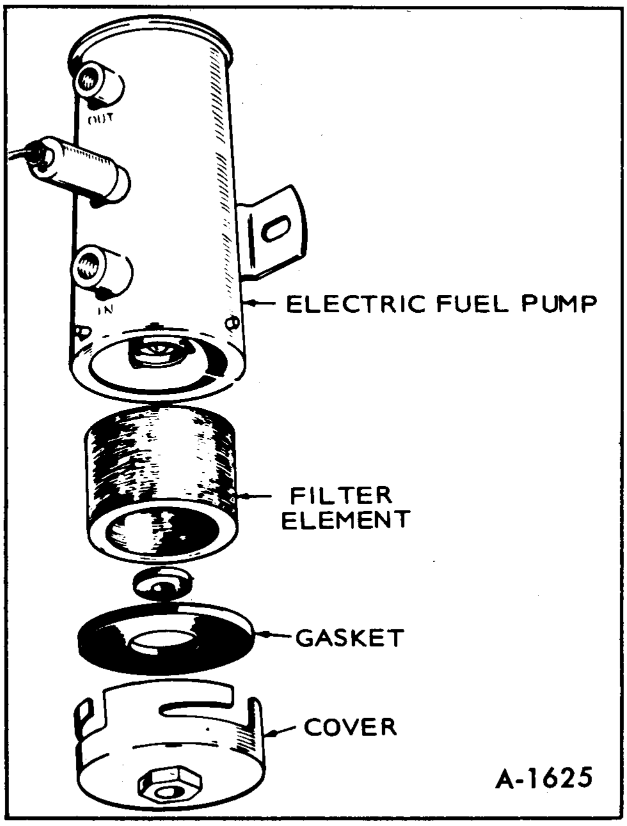


Figure 35—Fuel Pump Filter Element

FUEL SOLENOID

An electric fuel solenoid is mounted on the inlet side of the fuel pump. The solenoid valve is closed when the motor generator is not running, preventing fuel from siphoning out of the pump and back to the tank. The solenoid valve opens during cranking and running. A defective solenoid will not allow the motor generator to start.

AIR CLEANER ELEMENT (FIGURE 36)

Check and clean element at least every 100 hours. Loosen wing nut to remove. Clean by tapping base lightly on a flat surface. Replace element at least every 200 operating hours on the 4KW and every 500 hours on the 6KW; clean or replace more often in dusty conditions.

CARBURETOR ADJUSTMENTS (FIGURE 37)

The carburetor has a main fuel (power) adjustment and an idle fuel adjustment. The main adjustment affects operation under heavy load conditions. The idle adjustment affects operation under light or no-load conditions. Under normal circumstances, adjustments should not be disturbed. If adjustments have been disturbed turn main fuel jet 1-1/4 turn off its seat and idle fuel jet one turn off its seat to permit starting. Then readjust them for smooth operation.

CAUTION: *Forcing the needle against its seat will damage it. The needle does not completely shut off fuel when turned fully in.*

Set the throttle stop screw (located on the carburetor throttle lever), with no load connected to the plant. Turn stop so it just touches adjustment screw; then turn adjustment screw (with stop still touching it) until unit is running at 1500 rpm. When stop is released, governor will then control no-load speed at 1850 to 1890 rpm.

Before final adjustment, allow the engine to warm up. Adjust the idle fuel jet with no load connected. Open the main jet unitl the engine runs smooth under acceleration with no load. Slightly more fuel may be needed (open about 1/4 turn further) when sudden load is applied or if operating in extremely cold weather.

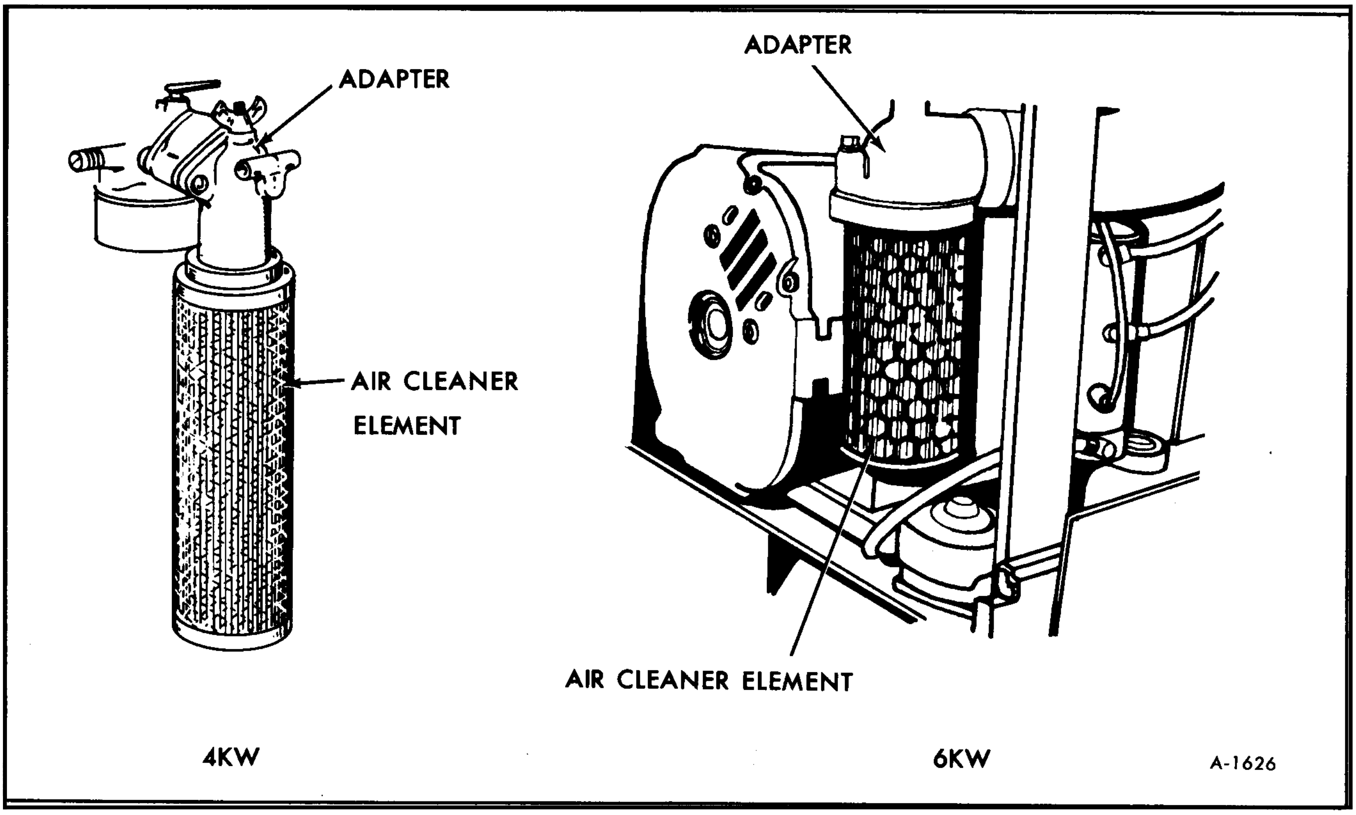


Figure 36—Air Cleaner Element

If the engine develops a "hunting" condition (alternate increase and decrease of engine speed), try correcting by opening the main adjusting needle a little more.

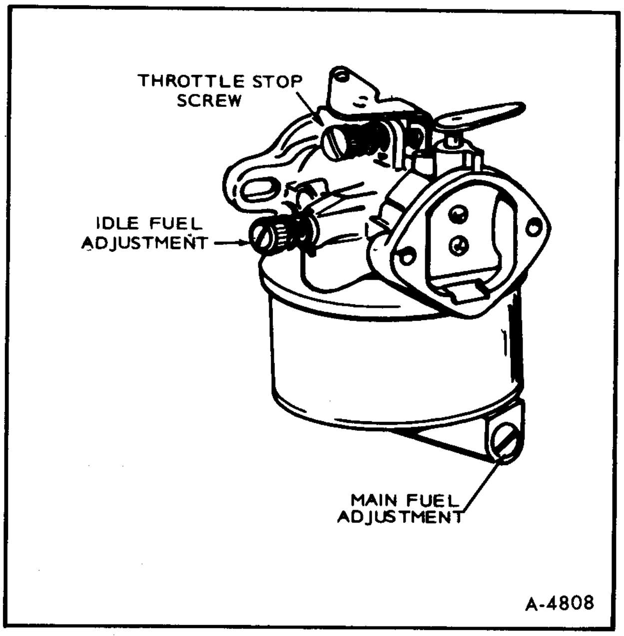


Figure 37—Carburetor Adjustment Screws

CAUTION: *Do not open main fuel jet more than 1/2 turn beyond the maximum power point.*

GOVERNOR

Before making governor adjustments, run the unit about 15 minutes under light load to reach normal operating temperature. (If governor is completely out of adjustment, make a preliminary adjustment at no load to first attain a safe voltage operating range).

Engine speed determines the output voltage and current frequency of the generator. By increasing the engine speed, generator voltage and frequency are increased, and by decreasing the engine speed, generator voltage and frequency are decreased. An accurate voltmeter or frequency meter (preferably both) should be connected to the generator output in order to correctly adjust the governor. A small speed drop not noticeable without instruments will result in an objectionable voltage drop. The engine speed can be checked with a tachometer.

A binding in the bearings of the governor shaft, in the ball joint, or in the carburetor throttle assembly will cause erratic governor action or alternate increase and decrease in speed (hunting). A lean carburetor adjustment may also cause hunting. Springs of all kinds have a tendency to lose their calibrated tension through fatigue after long usage. If all governor and carburetor adjustments are properly made, and the governor action is still erratic, replacing the spring with a new one and resetting the adjustments will usually correct the trouble.

1. Adjust the carburetor idle needle with no load connected.

2. Adjust the carburetor main jet for the best fuel mixture while operating the set with a full rated load connected.

3. Adjust the length of the governor linkage and check linkage and throttle shaft for binding or excessive looseness.

4. Adjust the governor spring tension for rated speed at no load operation.

5. Adjust the governor sensitivity.

6. Recheck the speed adjustment.

7. Set the carburetor throttle stop screw.

LINKAGE

The engine starts at wide open throttle. The length of the linkage connecting the governor arm to the throttle shaft and lever is adjusted by rotating the ball joint. Adjust this length so that with the engine stopped and tension on the governor spring, the stop on the carburetor throttle lever just contacts the stop. This setting allows immediate control by the governor after starting. It also synchronizes travel of the governor arm and the throttle shaft.

SPEED ADJUSTMENT

With the warmed-up unit operating at no load, adjust the tension of the governor spring (See figure 38). Turn the speed adjusting nut to obtain a voltage and speed reading within the limits shown.

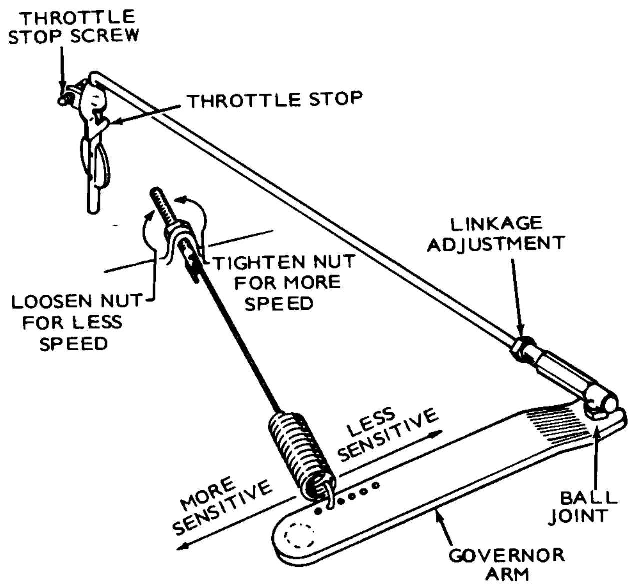
SENSITIVITY ADJUSTMENT

Referring to Figure 38 check the voltage and speed, first with no load connected and again with a full load. Adjust the sensitivity to give the closest regulation (least speed and voltage difference between no load and full load) without causing a hunting condition.

To increase sensitivity (closer regulation), shift the spring toward the governor shaft.

An adjustment for too much sensitivity will cause alternate increase and decrease of engine speed (hunting).

To decrease sensitivity, shift the spring toward the outer end of the governor arm. Too little sensitivity will result in too much difference in speed between no load and full load conditions.



VOLTAGE CHART FOR CHECKING GOVERNOR REGULATION	120 VOLT 1 PHASE 2 WIRE
MAXIMUM NO-LOAD VOLTAGE	126
MINIMUM FULL-LOAD VOLTAGE	110

SPEED CHART FOR CHECKING GOVERNOR REGULATION	
MAXIMUM NO-LOAD SPEED (RPM)	1890
HERTZ (CURRENT FREQUENCY)	63
MINIMUM FULL-LOAD SPEED (RPM)	1770
HERTZ	59

A-1628

Figure 38—Governor Adjustments

Any change in the sensitivity adjustment usually requires a compensating speed (spring tension) adjustment.

GOVERNOR BALL JOINT

Every 200 hours or sooner, check the governor linkage for freedom of movement through its travel. Clean and lubricate ball joint with lubricating graphite.

ELECTRIC CHOKE

Manually check movement of choke travel to be sure it is not stuck open or closed. Voltage at choke should be 12 volts during start and drop to zero during run. If choke does not move at room temperature with 12 volts applied, replace it.

This choke should not require any seasonal readjustment. If adjustment becomes necessary proceed as follows:

1. Loosen choke lever clamp screw.

2. With lever fully forward (away from carburetor), adjust so choke valve is completely closed or not more than 1/4 inch open.

3. Tighten clamp screw.

IGNITION AND BATTERY CHARGING SYSTEM

BREAKER POINTS

To maintain maximum efficiency from the engine, change the breaker points every 200 hours of operation. Proceed as follows:

1. Remove the two screws and the cover on the breaker box.

2. Remove the two spark plugs so engine can be easily rotated by hand. Check condition of spark plugs at this time.

3. Refer to Figure 39, remove mounting nut (A) and pull the points out of the box just far enough so screw (B) can be removed and leads disconnected.

4. Remove screw (C) and replace condenser with a new one.

5. Replace points with a new set but do not completely tighten mounting nut (A).

6. Remove the dot button on blower housing. This provides an access to view timing mark.

7. ON 4KW, rotate the engine clockwise (facing flywheel) by hand until the 26° BTC mark on gear cover aligns with mark on flywheel. Turn another 1/4 turn (90°) to ensure points are fully open.

On 6KW, rotate engine clockwise (facing flywheel) By Hand Until the 20° BTC mark aligns with hole. Turn another 1/4 turn (90°) to ensure points are fully open.

8. Using a screwdriver inserted in notch (D) on the right side of points, turn points until gap measures .025" (.016" on 6KW) with a flat thickness gauge. (Be sure feeler is clean.) Tighten mounting screw and recheck gap. Timing is automatically set.

IGNITION TIMING

The timing on the engine is preset at the factory. A non-movable breaker point box is used, however a slight timing change could be made by adjusting points.

The engine is equipped with an automotive type battery ignition system. Both spark plugs fire simultaneously, thus the need for a distributor is eliminated. Spark advance is set to specifications and should be maintained for best engine performance. Always check timing after replacing ignition points or if noticing poor engine performance. Proceed as follows:

TIMING PROCEDURE (ENGINE RUNNING — HOT SETTING) (4KW)

1. To check the ignition timing with unit running use a timing light. Connect the timing light accord-

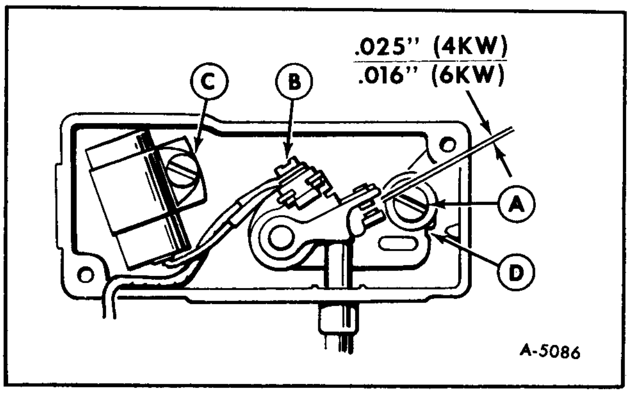


Figure 39—Breaker Point Adjustments

ing to its manufacturer's instructions. Either spark plug can be used as they fire simultaneously.

2. Remove the dot button on blower housing to provide an access to view timing marks (See figure 40).

3. Start the engine and check the timing. The mark on the flywheel should line up with the 21° mark on the cover.

4. Install dot button, breaker box cover and any other hardware removed from engine.

TIMING PROCEDURE (ENGINE RUNNING — HOT SETTING) (6KW)

1. To check the ignition timing with unit running, use a timing light. Connect the timing light according to its manufacturer's instructions. Either spark plug can be used as they fire simultaneously.

2. A small hole on the rear portion of blower housing provides an access to view timing marks (See figure 40). Two marks are provided; one for T/C (top center) and one for 2/0 (20° BTC).

3. Start the engine and check the timing. The 2/0 mark on the flywheel should line up in the middle of the hole.

4. Replace breaker box cover and any other hardware removed from engine.

TIMING PROCEDURE — ENGINE NOT RUNNING — COLD SETTING (4 AND 6 KW)

1. Connect a continuity test lamp set across the ignition breaker points. Touch one test prod to the breaker box terminal to which the coil lead is connected and touch the other test prod to a good ground on the engine.

2. Turn crankshaft against rotation (counterclockwise) until the points close. Then slowly turn the crankshaft with rotation (clockwise).

3. The lamp should go out just as the points break which is the time at which ignition occurs (26° BTC — 4KW and 20° BTC — 6KW).

SPARK PLUGS

Remove both spark plugs and install new ones every 100 hours. Use AC No. R46S or equivalent. Check to be sure spark plug gap is set at .020" as shown in Figure 41.

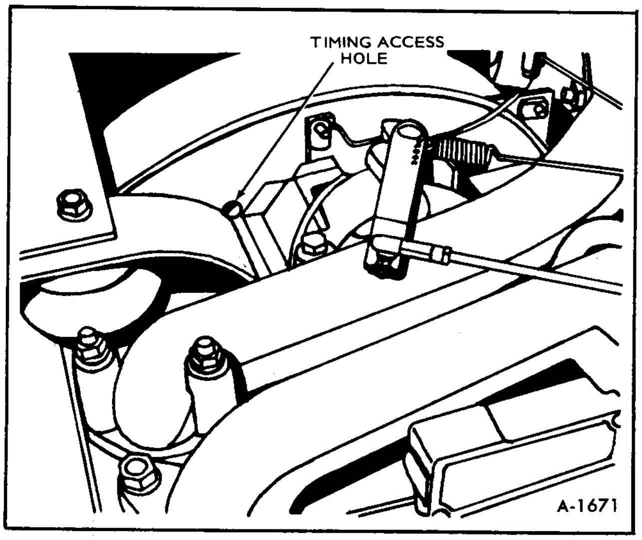


Figure 40—Timing Access Hole Location

IGNITION COIL

To test primary and secondary windings within the ignition coil proceed as follows:

1. Use a Simpson 260 VOM or equivalent.

2. Place black lead on ground (-) terminal of coil and red lead to positive (+) terminal. Primary resistance should read 4.30 (±10%) ohms.

3. Change resistance setting on ohmmeter. Place ohmmeter leads inside spark plug cable holes. Secondary resistance should read 14,000 (±10%) ohms (figure 42).

4. If any of the above conditions are not met, replace coil.

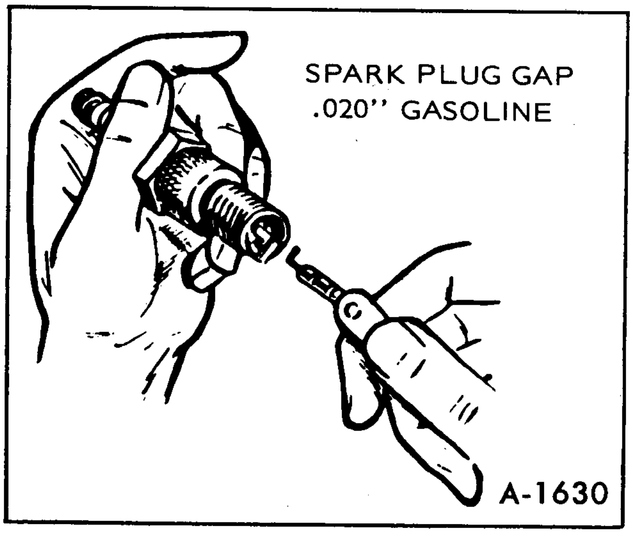


Figure 41—Checking Spark Plug Gap

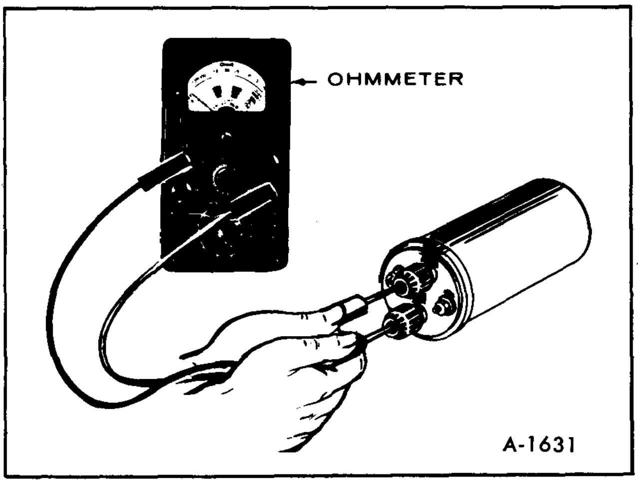


Figure 42—Coil Test

CAUTION: *This engine uses a 12-volt, negative ground system. Alternator must be connected to battery at all times when engine is running. Do not reverse battery cables.*

BATTERY INSPECTION

Check battery cells with a hydrometer. The specific gravity reading should be approximately 1.280 at 80°F. (figure 43).

If one or more cells are low on water, add distilled water and recharge. Follow charging procedures given in "Batteries," SECTION 6Y, ENGINE ELECTRICAL.

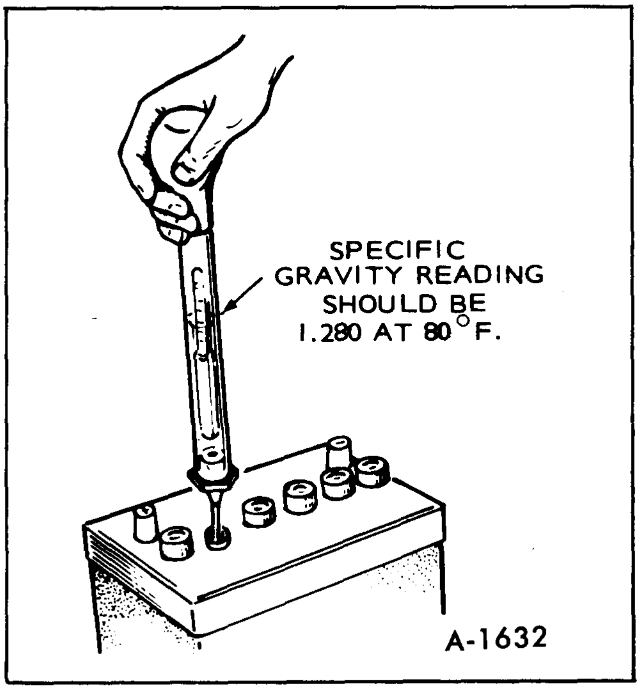


Figure 43—Specific Gravity Test

Keep the battery case clean and dry. An accumulation of moisture will lead to a very rapid discharge and battery failure.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or grease to retard corrosion.

NOTE: For complete discussion of battery service and maintenance, refer to SECTION 6Y, ENGINE ELECTRICAL.

FLYWHEEL ALTERNATOR (FIGURE 44)

This unit is equipped with a permanent magnet flywheel alternator and solid-state voltage regulator-rectifier (output control). As with all solid-state electrical units, precautions are necessary when servicing. Observe the following:

PRECAUTIONS:

1. Do not connect battery cables in the wrong polarity.

2. Do not short together alternator stator leads.

3. Do not run without a battery. Damage will occur to regulator and battery ignition coil.

PRESERVICE CHECKS:

1. Check for a good ground between equipment and regulator-rectifier case.

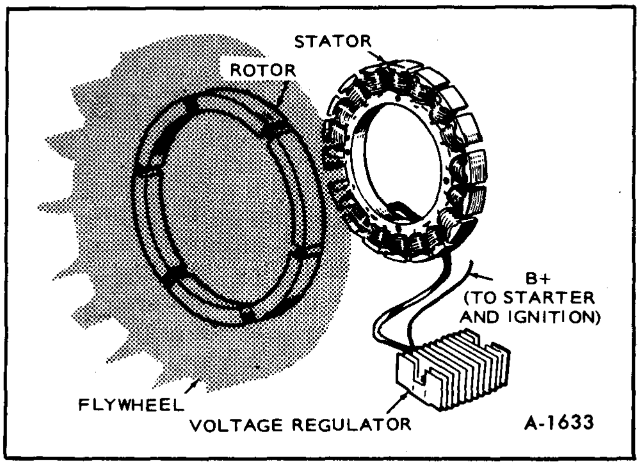


Figure 44—Flywheel Alternator System

2. Be sure output control plug (connector) is properly inserted into stator receptacle to eliminate any resistance due to a poor connection. Keep it clean and tight.

3. Check condition of battery. Be sure cable connections are clean and tight.

NOTE: Charging system tests require a fully charged battery.

TESTING MOTOR GENERATOR BATTERY CHARGING SYSTEM

Basic Test	Procedure	Test Values
1. Battery	Battery Voltage - unit not running.	12 to 12.8 VDC
2. Regulator	Battery Voltage after unit is running 3 to 5 minutes.	13.6 to 14.7 VDC
3. Alternator Stator and Wiring with Fully Charged battery.	Ohmmeter reading from stator output - unit not running. Disconnect wire terminating at AC terminal of voltage regulator and wire terminating at BAT terminal of start solenoid. Insert ohmmeter between these wires.	.2 to .6 Ohms
4. Alternator Stator and Wiring.	Measure AC stator output voltage with unit running. Disconnect wire terminating at AC terminal of voltage regulator. Measure AC voltage (unit running) between this wire and BAT terminal of start solenoid.	25.2 to 30.8 VAC

STARTING SYSTEM

The starter consists of two parts: a low voltage compound DC motor and a means of transmitting motor power to the flywheel ring gear. The constructional difference between this type of starter and others is that the lever spring (figure 45) is located in the central portion of the front bracket. The shift lever, which is operated by solenoid, causes the overrunning clutch assembly to move along the armature shaft toward the flywheel. As the pinion and flywheel teeth make contact, the shift lever continues to move and make electrical contact to spin the armature. The lever spring compresses, holding the pinion gear against the flywheel gear. As soon as the armature rotates and the gear teeth line up, the gears will mesh.

STARTER REMOVAL

1. Disconnect the ground cables at (-) terminals of both automotive and living area batteries.

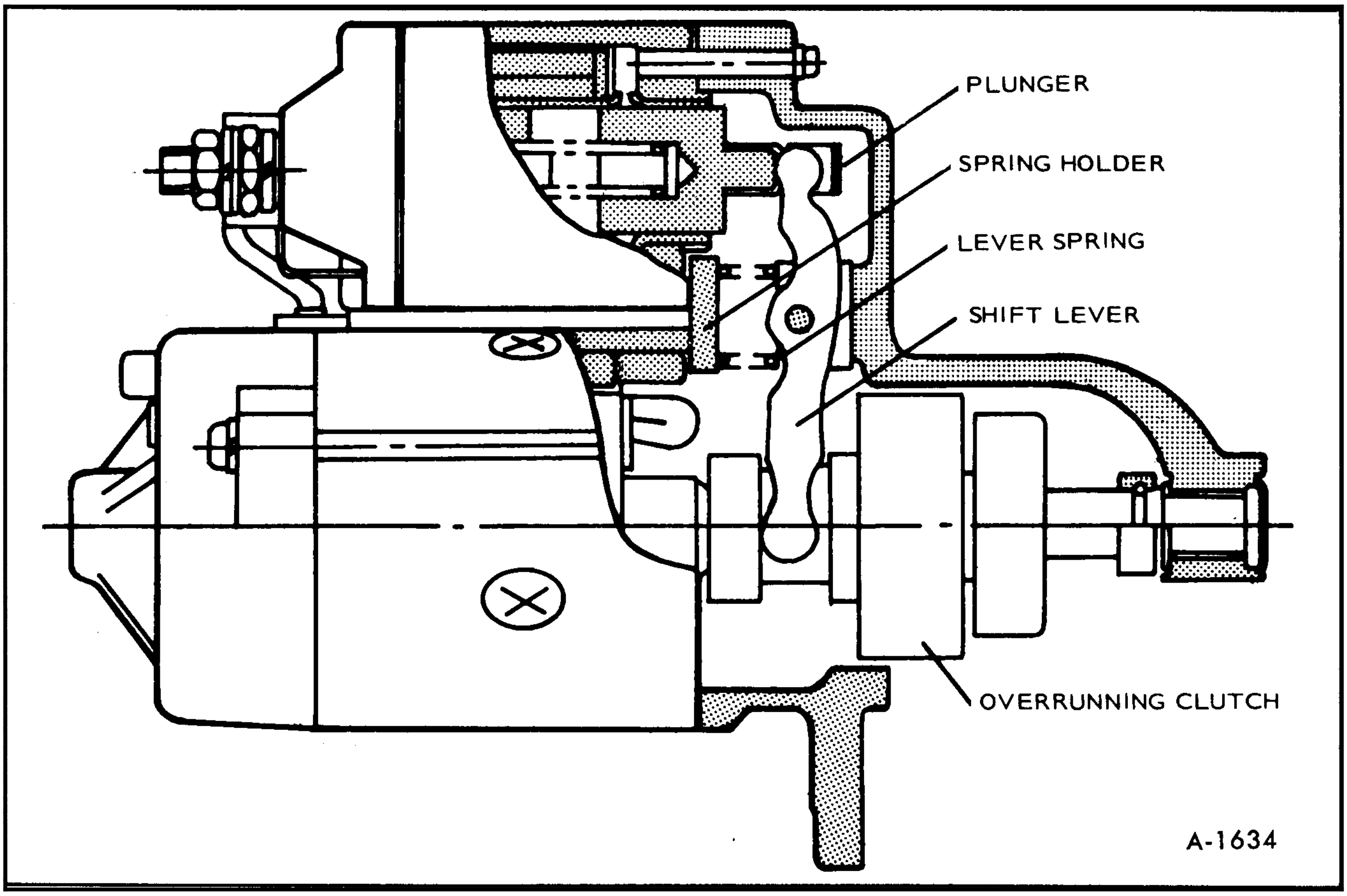


Figure 45—Starter

2. Disconnect the wires from the motor generator starter motor solenoid (See figure 46).

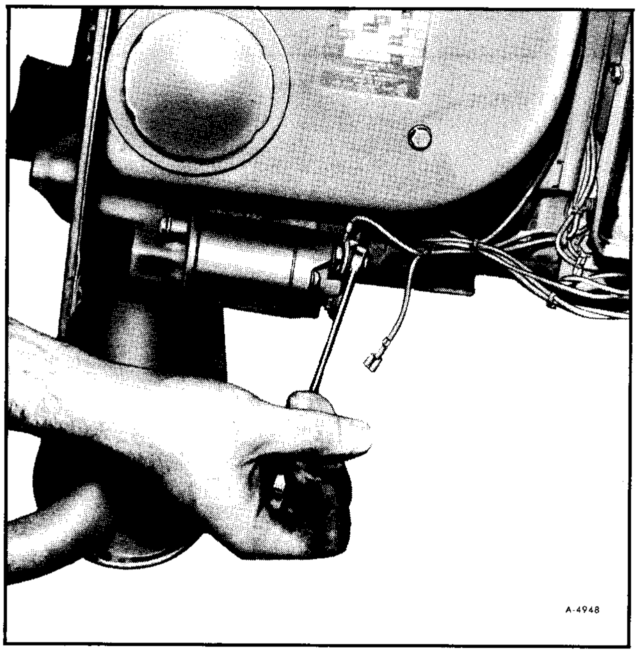


Figure 46—Disconnecting Wires from Starter Motor Solenoid

3. Remove the slide out door by removing the six attaching bolts (See figure 47).

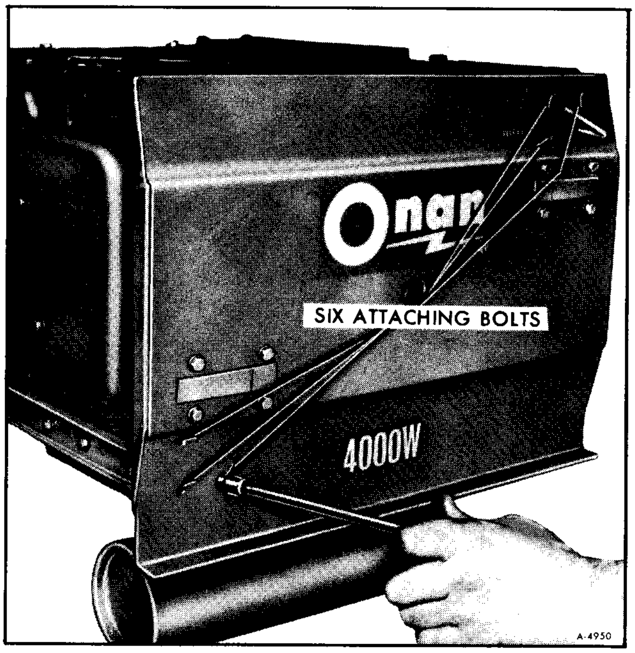


Figure 47—Removing Attaching Bolts from Slide Out Door

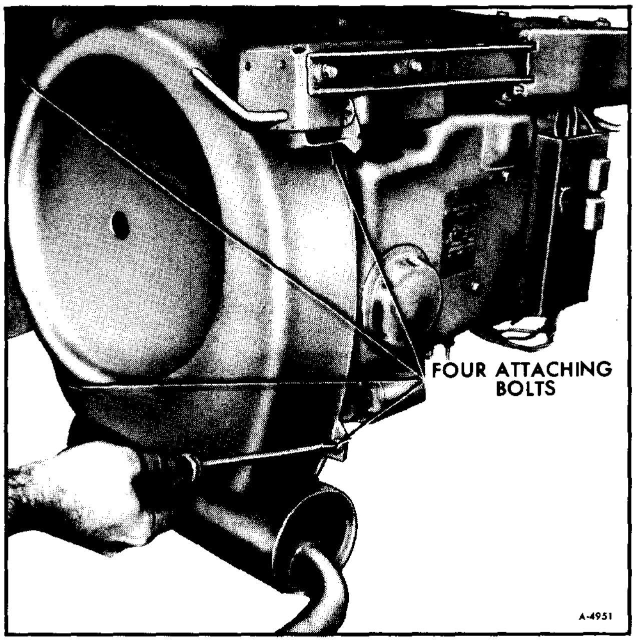


Figure 48—Removing Blower Housing Scroll

4. Remove the blower housing scroll by removing the four attaching bolts (See figure 48).

5. Remove the flywheel center bolt, washer, and lockwasher (See figure 49).

6. Reinstall only the flywheel center bolt.

7. Pull the flywheel with a straight bar puller utilizing the centering hole in the center bolt (See figure 50).

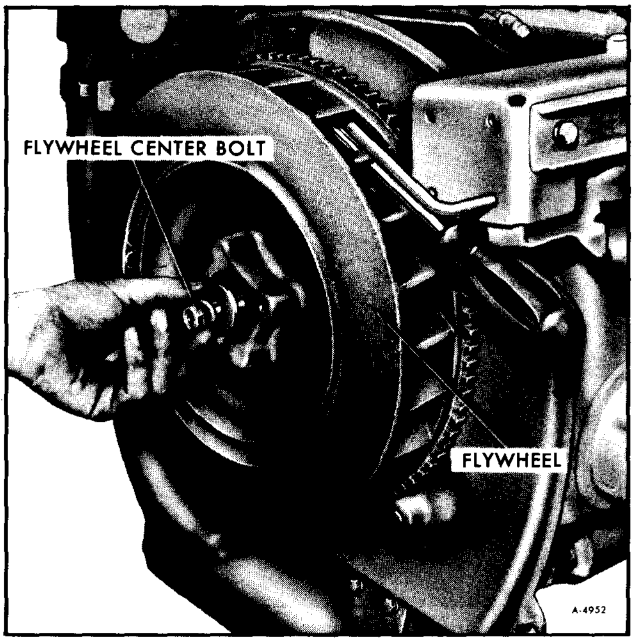


Figure 49—Removing Flywheel Center Bolt

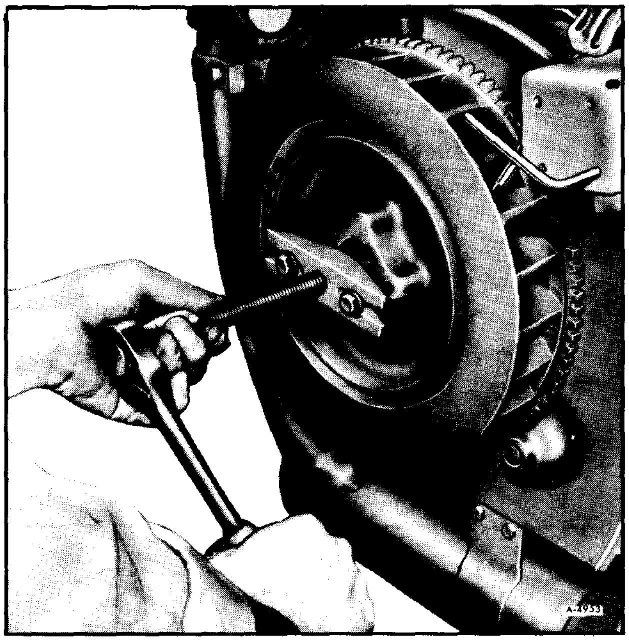


Figure 50—Pulling Flywheel with Straight Bar Puller

8. Pull the flywheel straight off being careful not to contact the alternator stator (See figure 51).

9. Remove the rear muffler mounting bracket by removing the four attaching bolts (See figure 52).

10. Remove the right hand air shroud to expose the starter motor by removing the two attaching bolts (See figure 53).

11. Remove the two starter motor attaching bolts (See figure 54).

Figure 51—Removing Flywheel

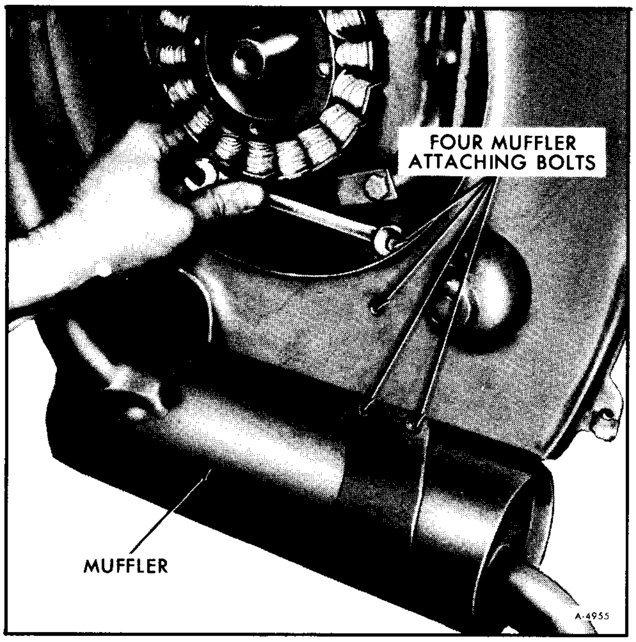


Figure 52—Removing Rear Muffler Mounting Bracket

12. Remove the starter motor assembly.

Reassembly is done in the reverse order of disassembly. When reinstalling the flywheel, be sure to align the starter pinion gear with the ring gear (See figure 55) and torque the flywheel center bolt to 45 ft. lbs. (See figure 56).

STARTER DISASSEMBLY—4KW (FIGURE 57)

1. Loosen the nut that attaches the solenoid motor terminal to the field coil connector lead and take off the connector lead (figure 58).

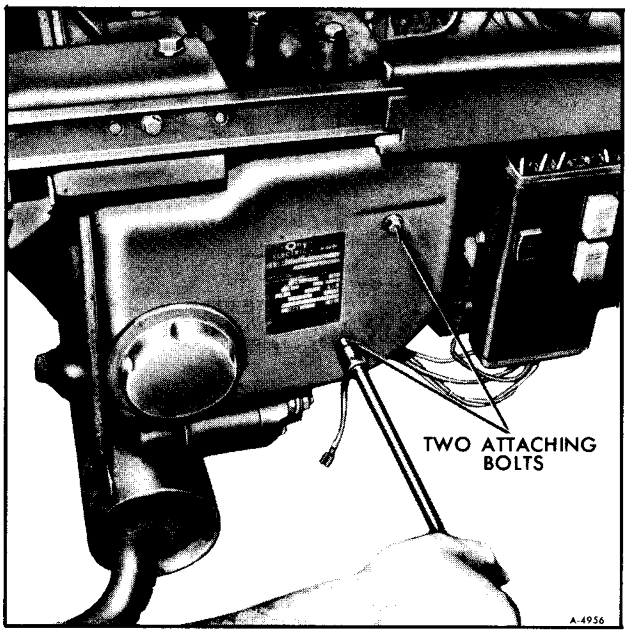


Figure 53—Removing Right Hand Air Shroud

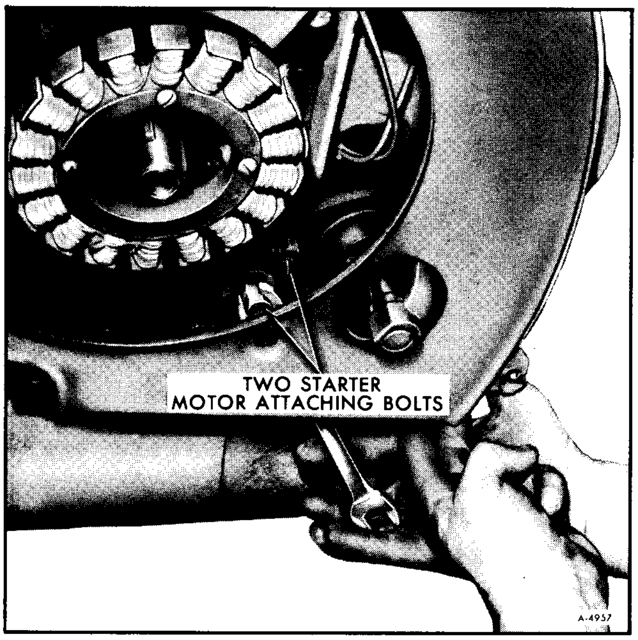


Figure 54—Removing Starter Motor Attaching Bolts

2. Loosen the retaining screws and remove the solenoid from the front bracket. Simultaneously, the fiber washers, the return spring and the solenoid plunger will be removed (figure 56).

3. Unscrew the through bolts and separate the yoke with the rear bracket from the front bracket (figure 60).

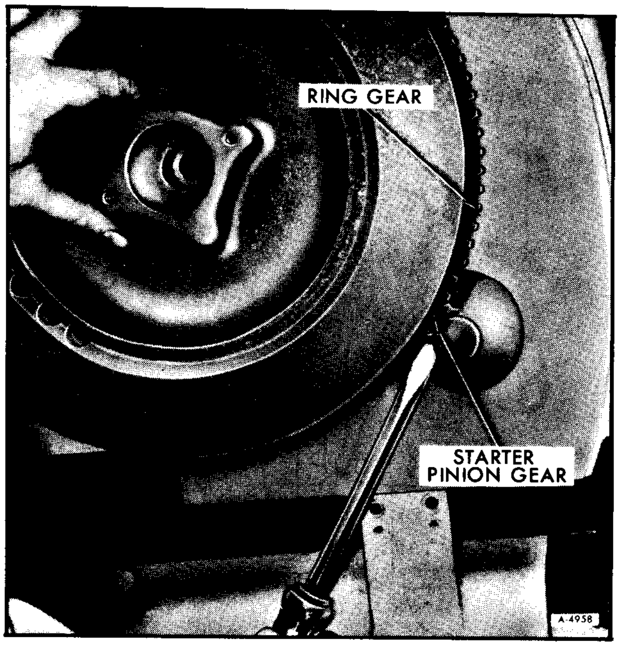


Figure 55—Aligning Starter Pinion Gear with Ring Gear

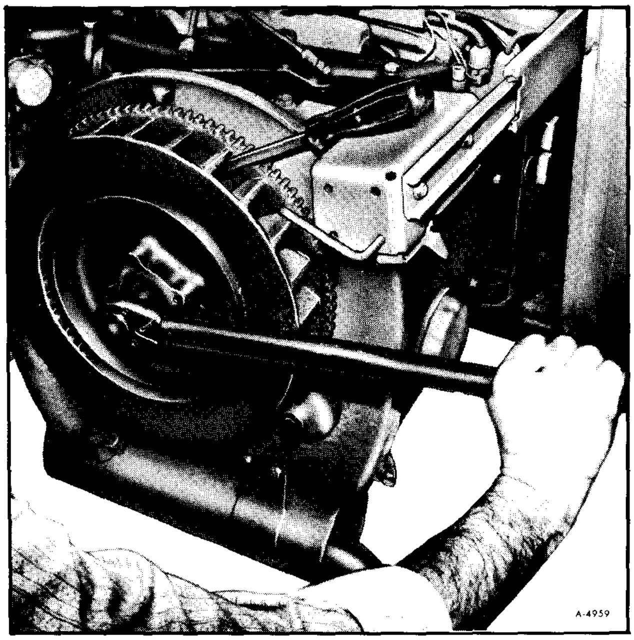


Figure 56—Torquing Flywheel Center Bolt

4. Remove the armature from the front bracket. Simultaneouly, the shift lever the lever spring and the spring holder will be removed (figure 61).

5. Removing the insulated brush from the brush holder permits separation of the rear bracket from the yoke (figure 62).

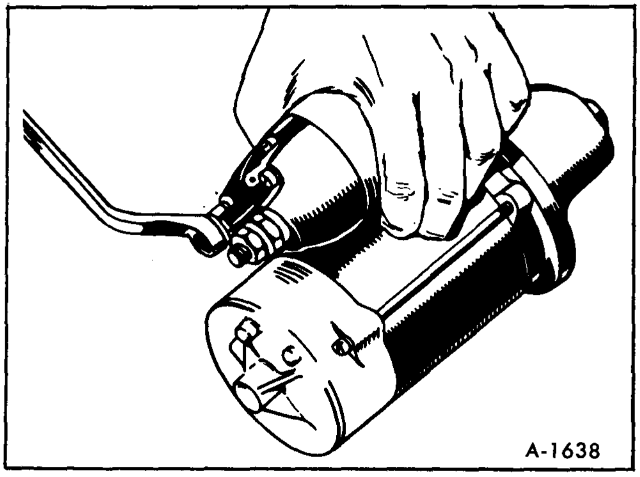


Figure 58—Removing Connector Lead

6. If it is necessary to remove overrunning clutch, first, put a metal cylinder of suitable size over the end of armature shaft so it rests on the stop ring. Then tap the cylinder lightly with a hammer, the stop ring towards armature and lock ring. Remove ring from groove in shaft so the overrunning clutch and the stop ring will be removed from the armature shaft.

STARTER DISASSEMBLY — 6KW (FIGURE 63)

After removing the starter from the engine, disassemble as follows:

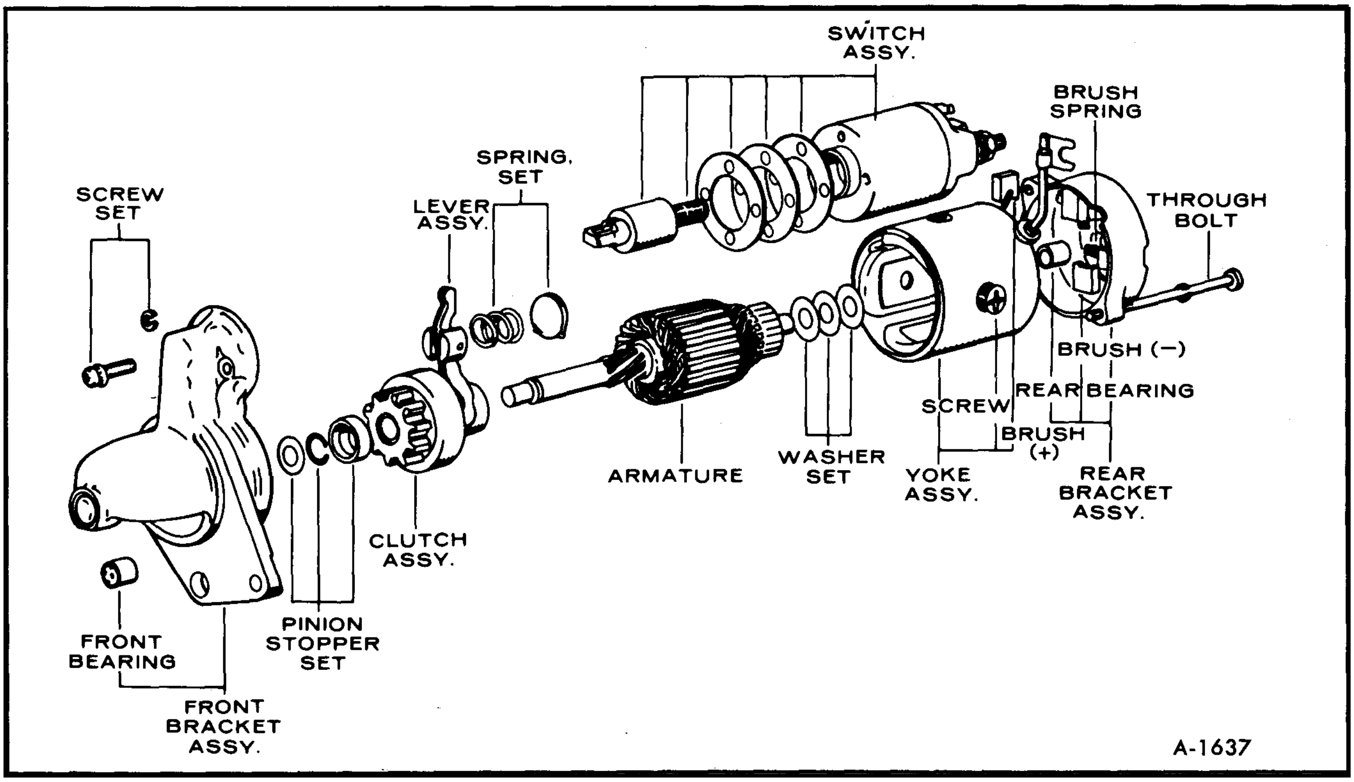


Figure 57—Starter (4 KW)

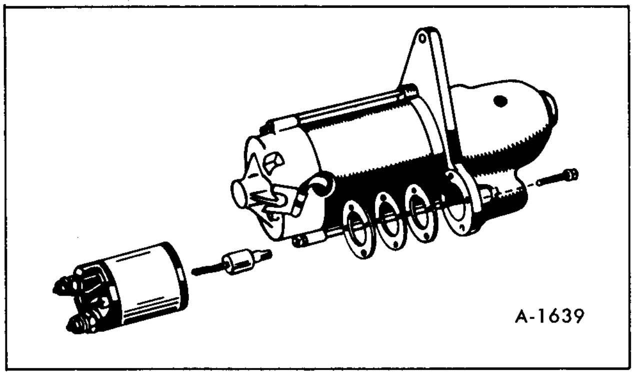


Figure 59–Removing Solenoid

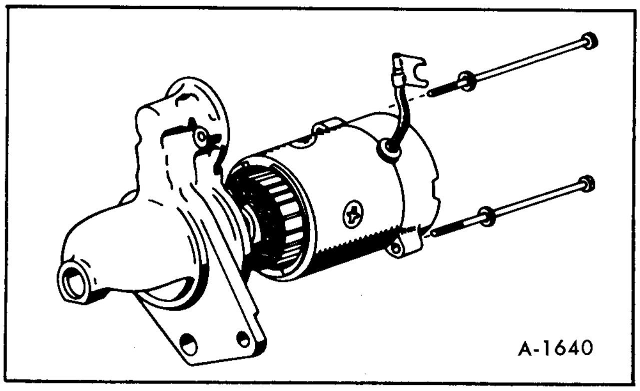


Figure 60—Removing Yoke

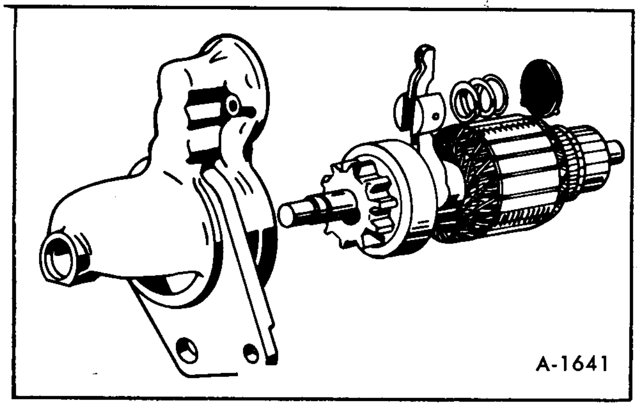


Figure 61—Removing Armature

1. Loosen the nut that attaches the solenoid motor terminal to the field coil connector lead and take off the connector lead (figure 58).

2. Loosen the retaining screws and remove the solenoid from the front bracket. Simultaneouly, the fiber washers, the return spring and the solenoid plunger will be removed (figure 59).

3. Unscrew the through bolts and the screws attaching the brush holder assembly to the rear bracket, so the rear bracket will be removed from the yoke.

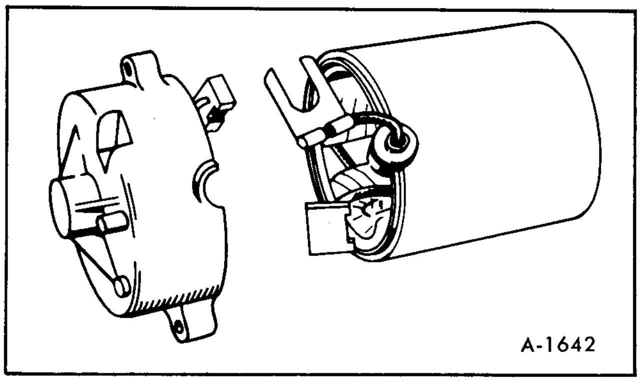


Figure 62—Separating Yoke and Rear Bracket

4. Remove the yoke with the brush holder assembly.

5. Removing the brushes from the brush holders permit separation of brush holder assembly from the field coil.

6. Remove the armature from the front bracket. Simultaneously, the shift lever, the lever spring and the spring holder will be removed.

7. To remove the overrunning clutch, put a metal cylinder of suitable size over the end of armature shaft so it rests on the stop ring. Tap cylinder lightly with hammer, the stop ring sliding toward armature and off ring. Remove the ring from groove in shaft and then slide the overrunning clutch and the stop ring from the armature shaft.

> **CAUTION:** *Do not immerse parts in cleaning solvent. Immersing the field coil, yoke assembly, armature and solenoid will damage the insulation. Wipe these parts with a cloth only. Do not immerse the overrunning clutch in cleaning solvent. The clutch is prelubricated at the factory, and solvent will wash lube from clutch. Wash all other parts in solvent and dry the parts.*

INSPECTION OF PARTS

GROUNDED ARMATURE: Use a 120 volt test lamp set for testing armature for grounds as shown in Figure 64. If lamp lights when one probe of test lamp is touched to commutator with other probe to the core, the armature is grounded and must be replaced.

SHORTED ARMATURE: (figure 65) Use a growler tester for testing armature for a short circuit.

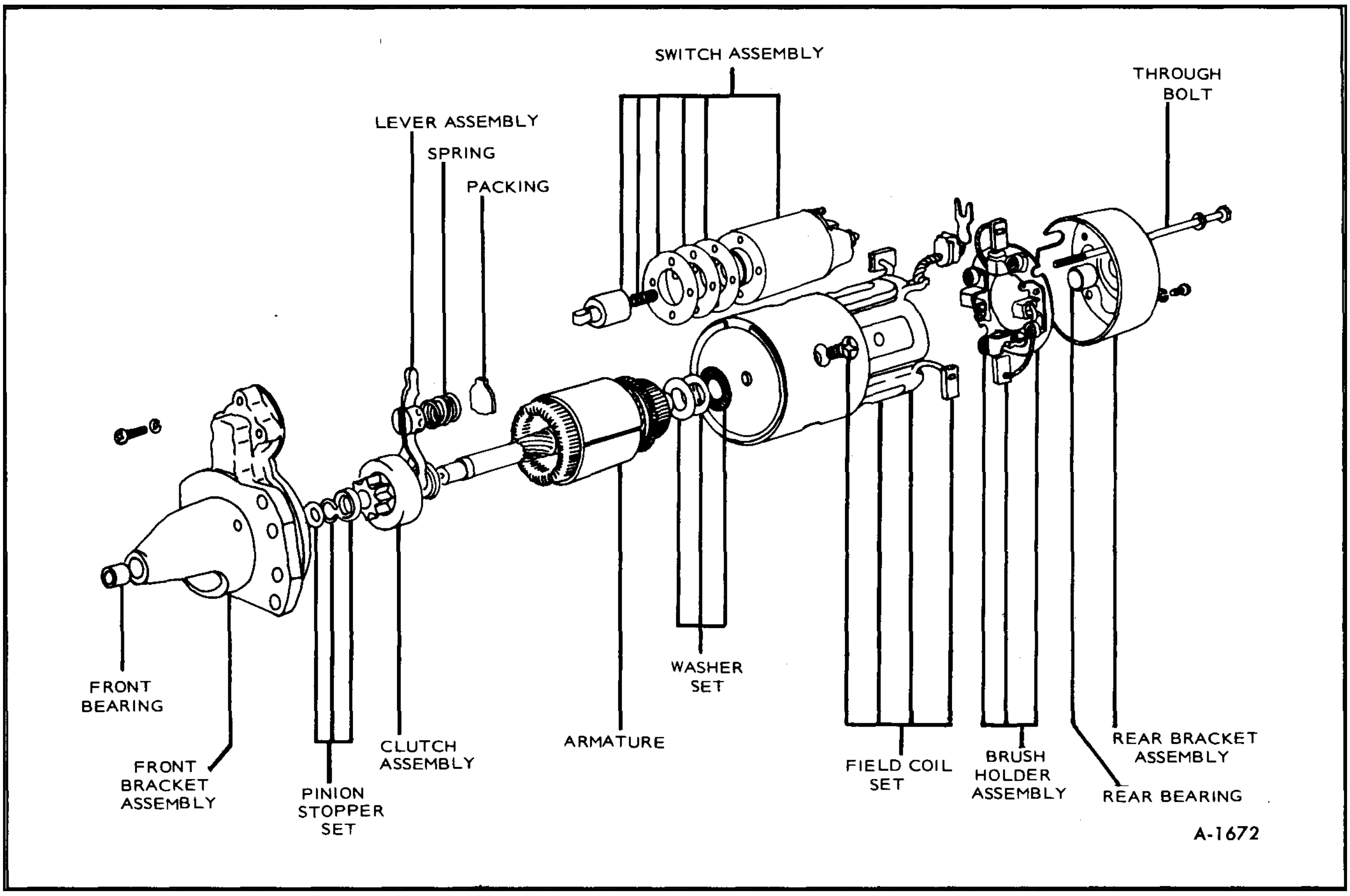


Figure 63—Starter (6KW)

Place armature in growler and hold a thin, steel blade (hacksaw blade) parallel to the core and just above it while slowly rotating armature in growler.

A shorted armature will cause blade to vibrate and be attracted to the core.

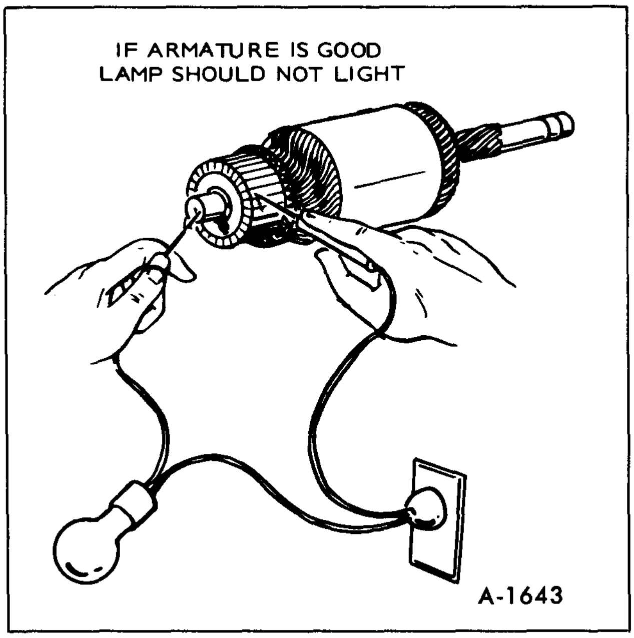


Figure 64—Testing for Grounded Armature

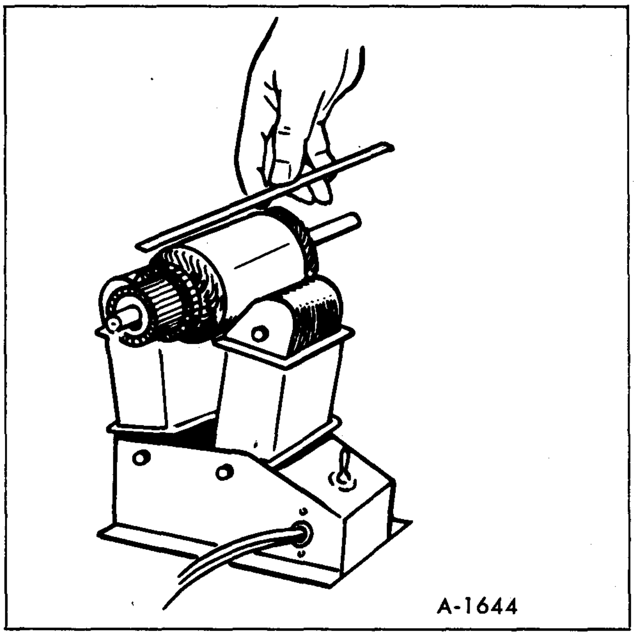


Figure 65—Testing for a Short Circuit

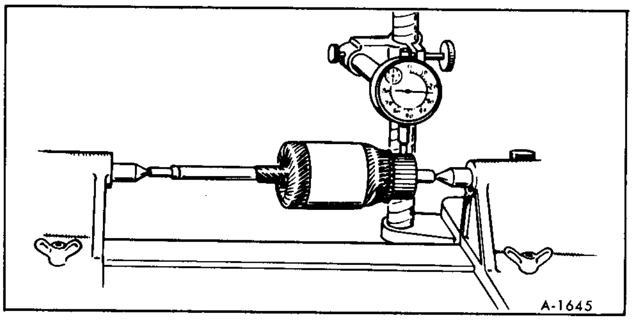


Figure 66—Testing Commutator Runout

OPEN ARMATURE: The most likely place to check for an open circuit is at the commutator riser bars. Inspect for loose connections on points where the conductors are joined to the commutator bars.

COMMUTATOR RUNOUT: Place armature in a pair of v-blocks and measure runout with a dial indicator refer to Figure 66. Measure both shaft and commutator. A bent shaft requires replacement of armature. When runout exceeds a .004 inch, commutator should be refaced. Remove only enough metal to provide a smooth, even surface.

OPEN FIELD COIL: Use a 120 volt test lamp set for this test. Connect one probe of test lamp to the yoke and the other probe to insulated brush. If lamp does not light, the field coil is open.

NOTE: This starter is compound wound, having a series coil and a shunt coil. The grounded end of the shunt coil is soldered inside of the yoke.

GROUNDED FIELD COIL: Use a 120 volt test lamp set for testing for a grounded field coil. First

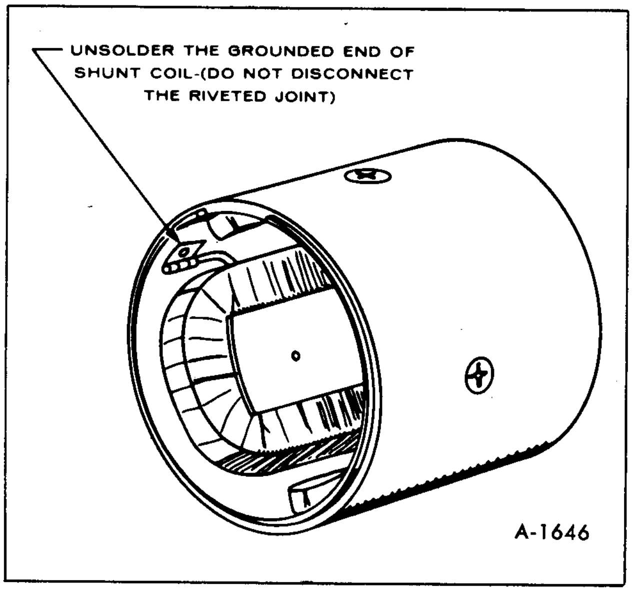


Figure 67—Testing Field Coil

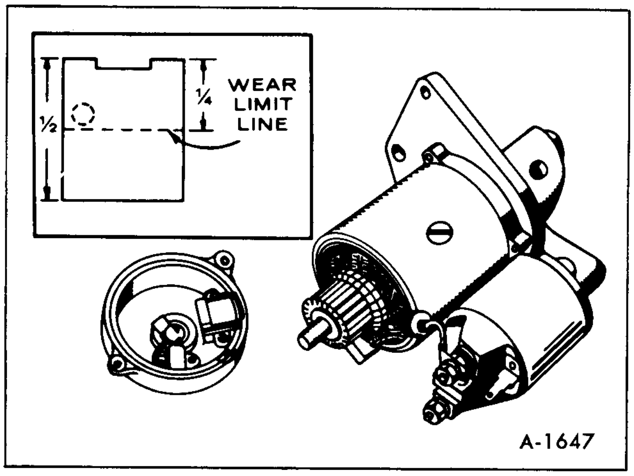


Figure 68—Brush Replacement

disconnect the grounded end of shunt coil as shown in Figure 67. Then connect one probe of test lamp to yoke and the other probe to field coil connector lead. If lamp lights, field coil is grounded.

BRUSH REPLACEMENT: Brushes that are worn out to the wear limit line should be replaced as shown in Figure 68. Brushes can be replaced after removing the rear bracket.

When resoldering the brushes, make a low resistance connection, using a high temperature solder and resin flux.

BRUSH SPRINGS: The spring tension should be taken using a push-type spring scale until the top of a new brush protrudes 1/16 inch from the brush holder. Spring tension should be 36 to 48 ounces on the 4KW and 49 to 59 ounces on the 6KW (See figure 69).

OVERRUNNING CLUTCH: The pinion gear should rotate smoothly in one direction (not necessarily easily), but should not rotate in opposite direction. If pinion gear does not function properly, or if pinion gear is worn or burred, replace the overrunning clutch.

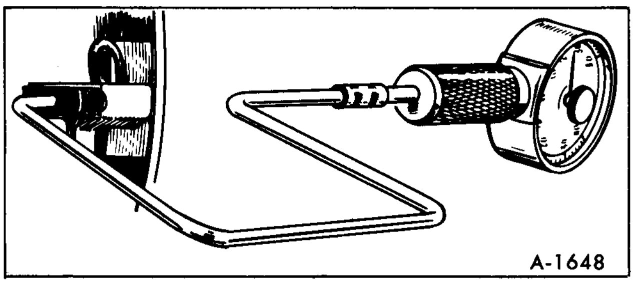


Figure 69—Testing Brush Spring Tension

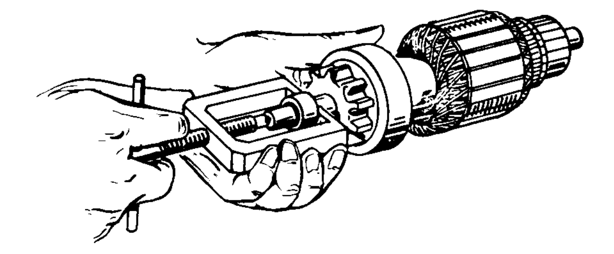


Figure 70—Installing Stop Ring

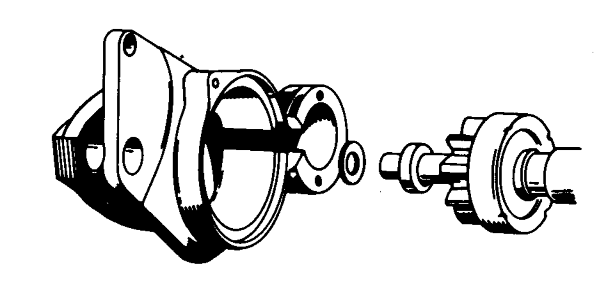


Figure 72—Installing Front Bracket

ASSEMBLY-4KW

1. Lubricate armature shaft and splines with a very light grade oil. A medium or heavy oil and grease may cause the overrunning clutch assembly faulty operation in cold weather.

2. Install the overrunning clutch assembly, the ring and the stop ring on the armature shaft. Drive pinion stopper far enough on shaft to install stop ring. Then using a puller (figure 70) pull stopper against ring.

3. Apply a small amount of lubriplate on the shift lever pivot pin and lever holders.

Install the shift lever over the clutch assembly with position indicated in Figure 71. This is important, if the shift lever is not properly positioned the pinion gear travel will be restricted causing a locking in the clutch mechanism.

4. Place the thrust washer on the drive end of the shaft. Slide the armature with the lever into the front bracket (figure 72).

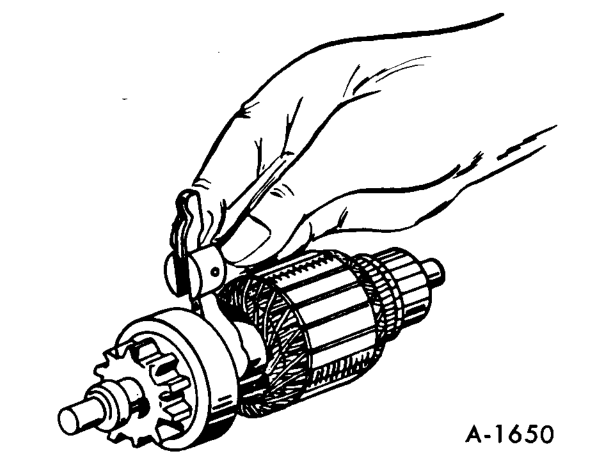


Figure 71—Installing Shift Lever

5. Place the lever spring and the spring holder into the front bracket with the direction shown in Figure 73.

6. Position the Yoke to the front bracket. Be sure that the yoke is properly indexed to the front bracket (figure 74).

7. Place the thrust washer (steel) and washer (fiber) on the commutator end of shaft, and apply a small amount of lubriplate on the shaft (figure 75).

NOTE: In case three washers are used, the fiber washer is placed between the steel washers.

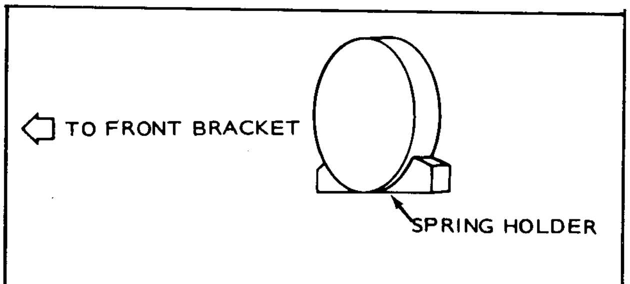


Figure 73—Spring Holder Placement

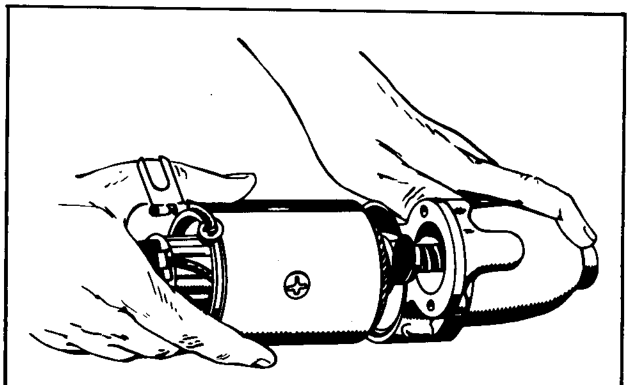


Figure 74—Yoke to Front Bracket Installation

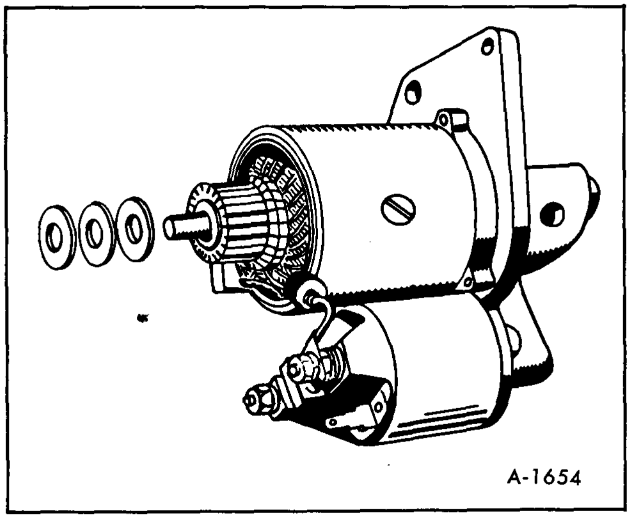


Figure 75—Installing Thrust Washers

8. Insert two brushes and springs in their brush holders and push them against spring tension.

Secure the brushes by iron wires as shown in Figure 76.

9. When securing the brushes, position the rear bracket to the yoke, inserting the rubber gasket to the slot of the rear bracket. After the rear bracket is installed to the yoke, withdraw iron wires so the brushes and the commutator come in contact. Then, insert the bushings into the holes to keep out dirt.

10. Fasten through bolts securely.

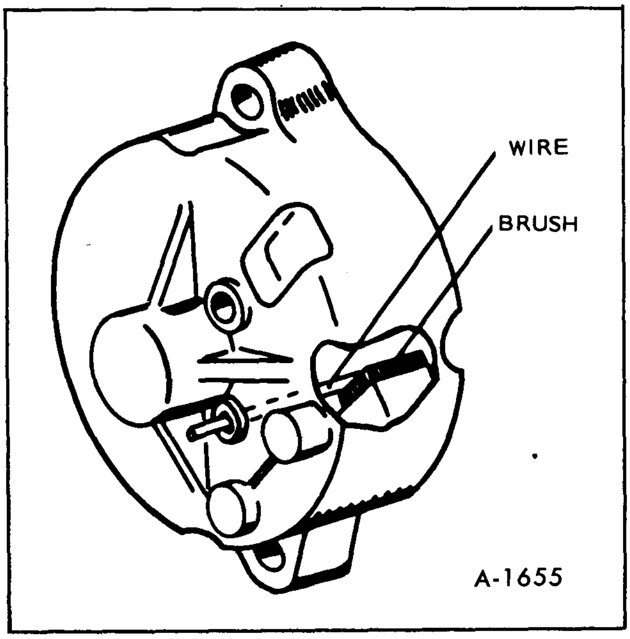


Figure 76—Brush Installation

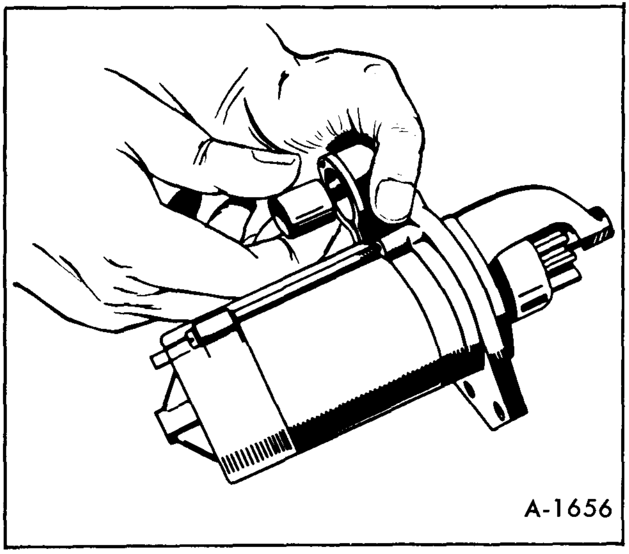


Figure 77—Installing Solenoid Plunger

11. Install the solenoid plunger over the top of the shift lever in the front bracket as shown in Figure 77. Be sure that the pinion gear is moved when the plunger is pulled manually.

12. Install the solenoid.

IMPORTANT: The return spring, in this case, should be straight in the proper position between the bore of the solenoid and the bore of the plunger.

ASSEMBLY — 6KW

1. Lubricate armature shaft splines with a very light grade oil. A medium or heavy oil and grease may cause the overrunning clutch assembly faulty operation in cold weather.

2. Install the overrunning clutch assembly, the ring and the stop ring on the armature shaft.

3. Apply a small amount of lubriplate on the shift lever pivot pin and the lever holders.

Install the shift lever over the clutch assembly with position as indicated in Figure 78. This is important, if the shift lever is not properly positioned the pinion gear travel will be restricted causing a locking in the clutch mechanism.

4. Apply a film of medium engine oil to the drive end of the armature shaft.

Place the thrust washer on the drive end of the shaft. Slide the armature with the lever into the front bracket.

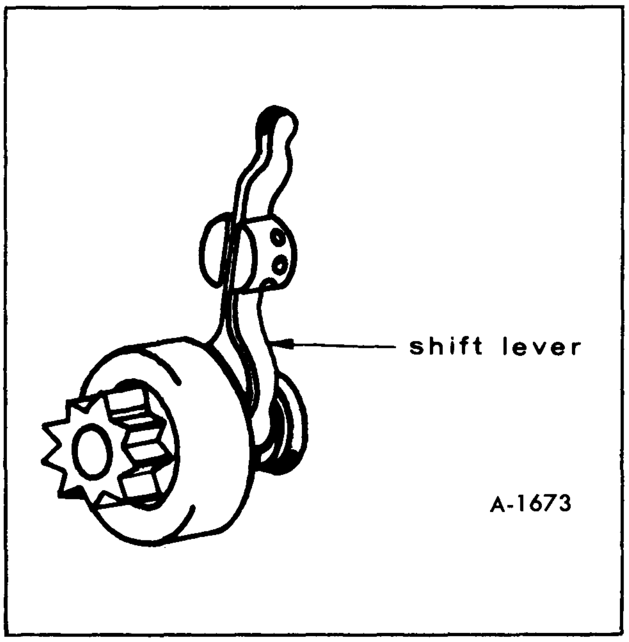


Figure 78—Shift Lever

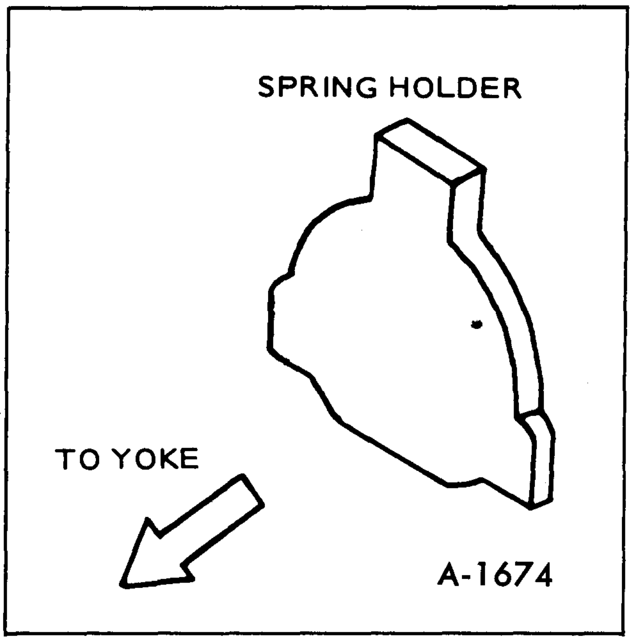


Figure 79—Spring Holder

5. Place the lever spring and the spring holder into the front bracket in the direction shown in Figure 79.

6. Before installing the yoke, note the position of the holes of front bracket in which the through bolts are fastened. Position the yoke to the front bracket. Be sure that the yoke is properly indexed to the front bracket.

7. Position the brush holder assembly indexing the cuts of the brush plate to the holes of the front bracket.

8. Install the brushes in their brush holders. Be sure to center the brush springs on the brushes.

9. Place the thrust washers on the commutator end of the armature shaft and apply a small amount of lubriplate on the shaft.

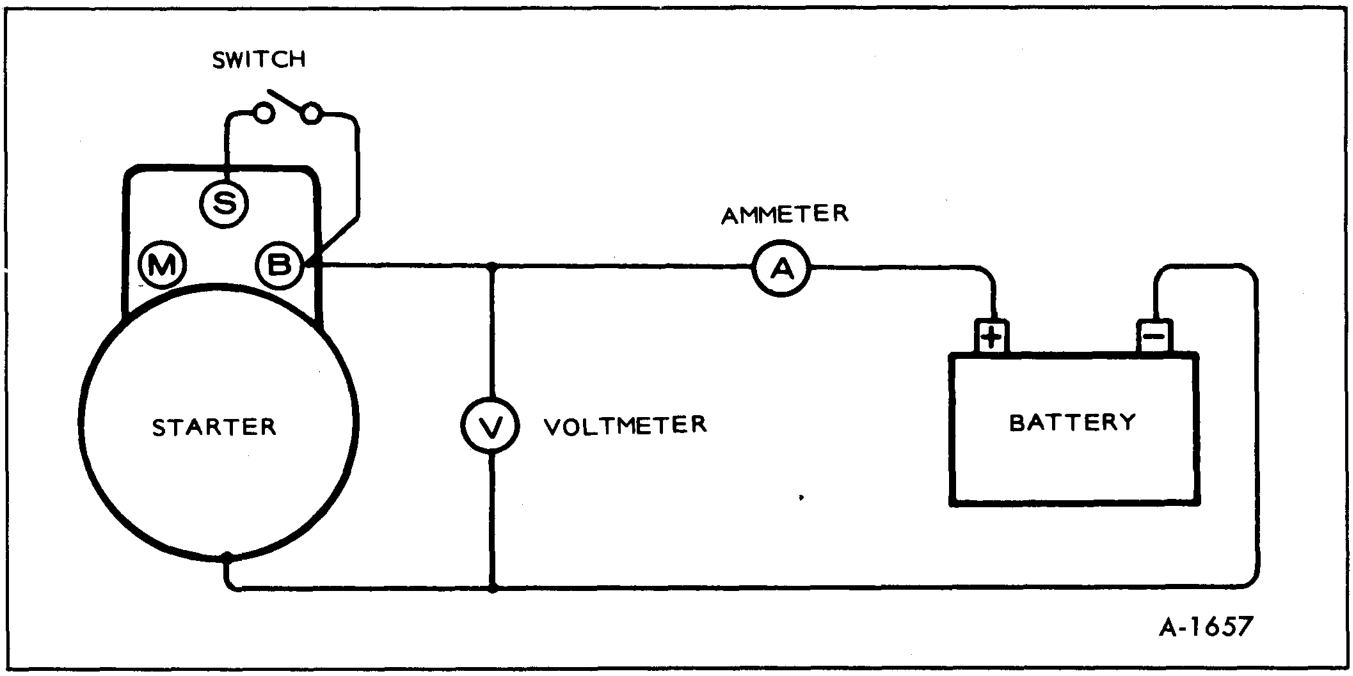


Figure 80—No Load Test

NOTE: The fiber washer is placed between the steel washers.

10. Position the rear bracket to the yoke, inserting the rubber gasket to the slot of the rear bracket.

11. Align the holes in brush plate with holes in the rear bracket and install two screws attaching the brush holder assembly to the rear bracket.

12. Fasten through bolts securely.

13. Install the solenoid plunger over the top of the shift lever in the front bracket. Be sure that the pinion gear is moved when the plunger is pulled manually.

14. Install the solenoid.

NOTE: The return spring, in this case, should be straight in the proper position between the bore of the solenoid and the bore of the plunger.

TESTING AND ADJUSTING STARTER

ADJUSTING PINION CLEARANCE: After the starter is reassembled the pinion clearance must be adjusted to give sufficient clearance between the end of the pinion and the stop ring when the pinion is in mesh with the ring gear of the engine.

1. Connect a battery of the proper voltage between the "Switch" terminal of the solenoid and the bracket of the starter (ground), so the pinion will travel.

2. Then, push the pinion back until play is taken out of the lever and the clutch mechanism.

3. Measure the pinion clearance.

4. The clearance should be 0.02 to 0.08 inch. Adjust by removing the solenoid and increasing or decreasing the number of the fiber washers.

NOTE: Increasing the number of the washers decreases clearance, and decreasing the number of the washers increases clearance.

NO LOAD TEST: For this test connect starter as shown in Figure 80. The values of this test should be as follows:

4KW:	
BATTERY VOLTAGE	11.5 Volts
MINIMUM RPM	6000 RPM
MAXIMUM CURRENT DRAW	55 Amps
6KW:	
BATTERY VOLTAGE	10.5 Volts
MINIMUM RPM	5000 RPM
MAXIMUM CURRENT DRAW	53 Amps

CAUTION: *Before installing the starter, be sure starter and engine mounting surfaces are free of dirt and oil. These surfaces must be clean to make a good electrical contact. Don't operate the starter more than 30 seconds, or serious damage may result. Starters are not designed for continuous operation. When the engine does not rotate, don't hold the starter in a stall condition more than 10 seconds. The wires between the battery and the starter should be of sufficient size to carry the electric load without excessive voltage drop.*

AC GENERATOR

The generator uses a revolving armature and normally needs little care other than a periodic check of the brushes and collector rings.

NOTE: All accessories must be taken off and power plant must be removed from its slide rails for disassembly and repair of the generator.

BRUSH REPLACEMENT

To gain access to brushes, remove plastic end bell screens. Measure brush wear as shown in Figure 81. Using a small, narrow scale inserted into top of brush block. If brushes need replacing remove and tag wires connecting to brush blocks. Then remove brush blocks and lift out of end bell. Pull out the brushes and springs from bottom of brush block. Clean out any dirt or oil from brush block at this time.

New brushes are shaped to fit and seldom need sanding to seat properly. Always replace brushes as a set. Never use a substitute brush which may appear to be the same but may have entirely different electrical characteristics.

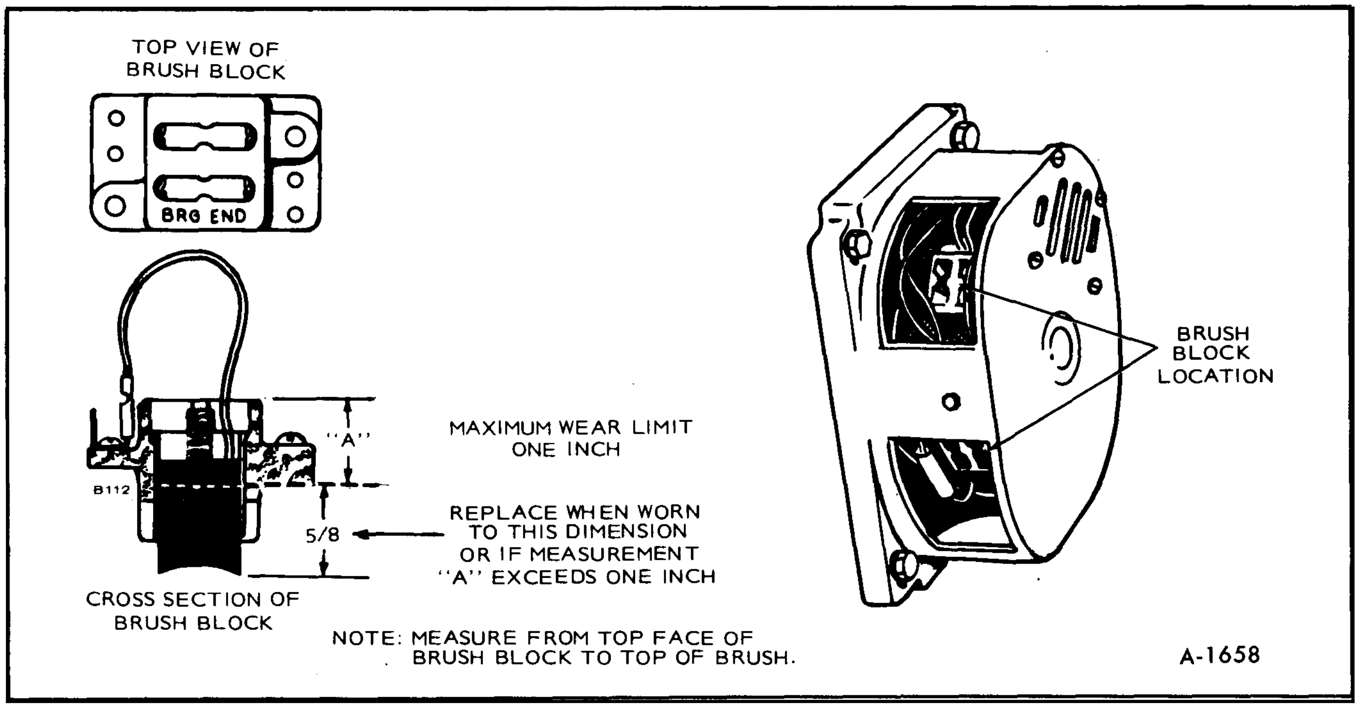


Figure 81—Brush Wear Limits

Note that brush blocks are stamped "BRG END" on one side. Be sure this stamped side faces bearing end of generator for correct brush alignment. Tighten the brush block screws to 40 — 70 in-lb. (4-6 ft-lb.) If some sparking occurs after replacing brushes, run the plant with a light load until brushes seat properly. Check brush springs for freedom of movement.

GENERATOR DISASSEMBLY (FIGURE 82)

1. Remove power plant from its slide rails.

2. Remove all accessories attached to the generator.

3. Tag and remove all leads.

4. Loosen and lift out both brush rigs.

5. Remove four generator through-stud nuts.

6. Lift or pull end bell from frame assembly. Do not pry loose with a screwdriver, use a plastic hammer and tap around edges of end bell to loosen.

7. Remove frame (field) assembly, being careful not to let it rest or drag on the armature.

CAUTION: *Four seals are used between frame (field) assembly and engine-to-generator adapter. These seals must be installed when reassembling generator or the generator will overheat.*

8. Using a square 3/8-inch drive, insert into 12-point (internal wrenching) armature hold-down nut and remove.

9. While pulling outward with one hand under the armature, strike a sharp end-wise blow on armature shaft to loosen armature. The armature has an internal taper which fits onto the external taper of engine adapter. If the armature does not come loose, place a heavy brass rod on the armature shaft near the ball bearing and strike a sharp downward blow on the rod with a hammer. Rotate the armature 1/2 turn before repeating.

CAUTION: *Do not strike the collector rings or bearing.*

GENERATOR TESTING AND REPAIR

ARMATURE GROUND TEST

Use a 120-volt series test lamp set for this test. Armature must be removed from generator for this test.

Place one test prod on one of the collector rings and the other test prod on the armature shaft. Test lamp should not light. If the test lamp lights, the AC

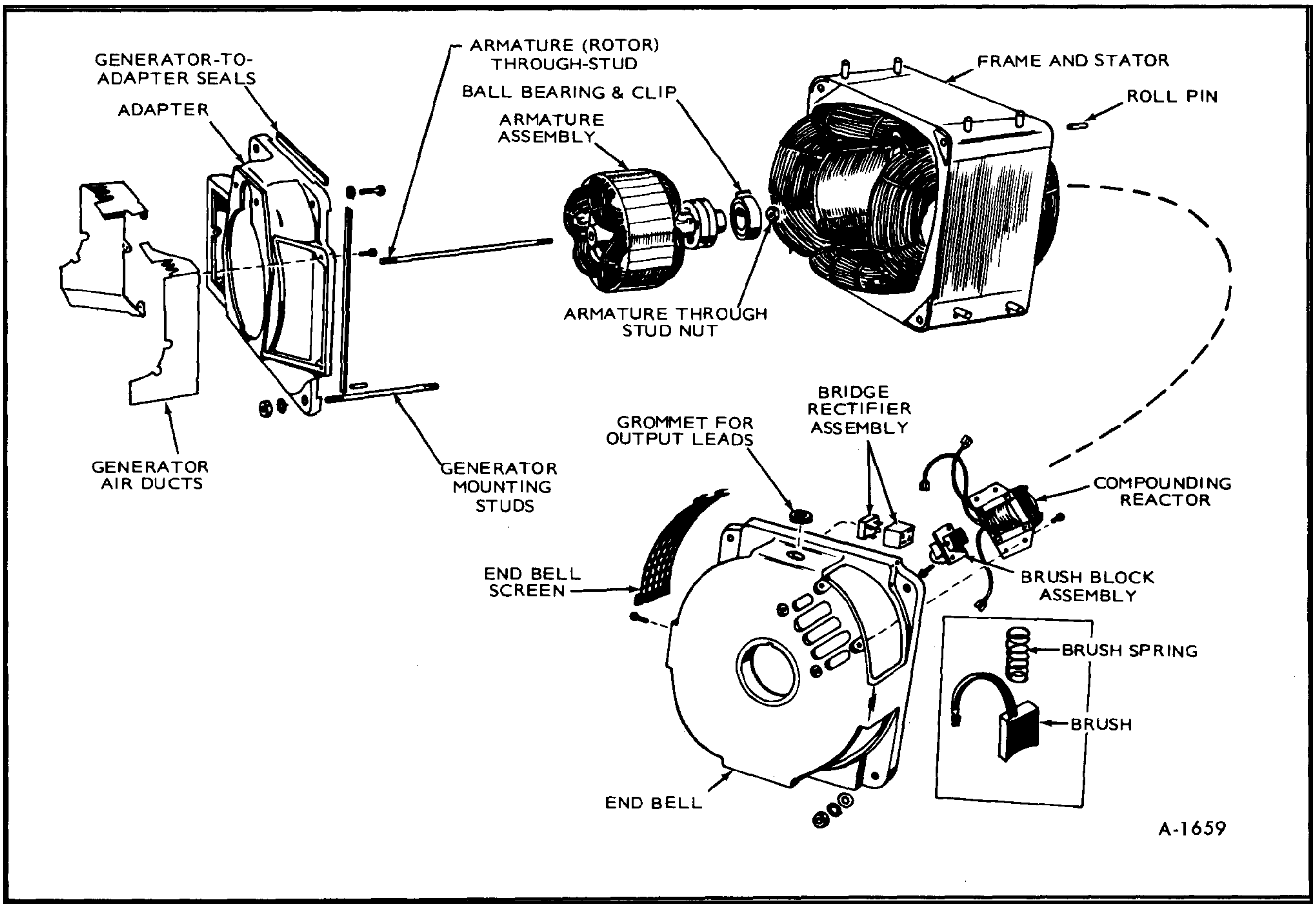


Figure 82—Generator Components

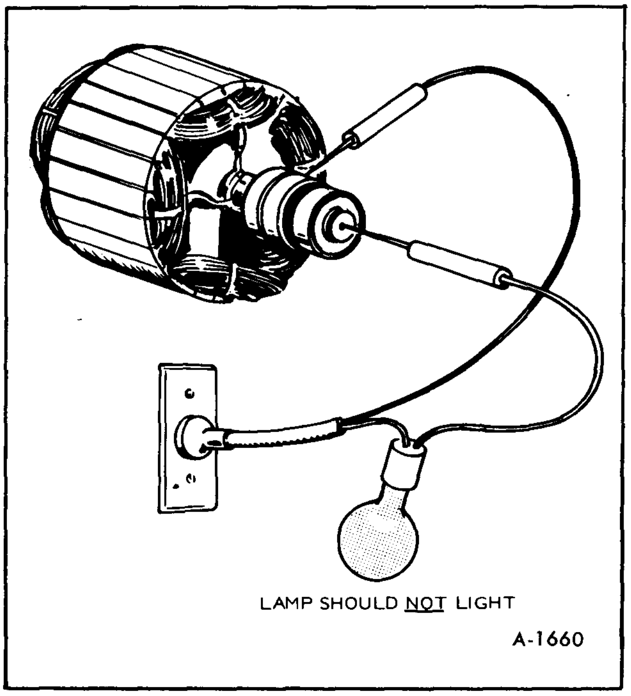


Figure 83—Armature Ground Test

winding or a collector ring is grounded to the shaft. Test both collector rings in this manner, refer to Figure 83.

ARMATURE OPEN TEST (FIGURE 84)

Use a 120-volt series test lamp set for this test. Place one prod on each collector ring. The test lamp should light. If lamp does not light, armature is open and must be replaced.

TESTING FIELD WINDINGS FOR GROUNDS (FIGURE 85)

To test the field assembly for grounds, disconnect all field leads and use a 120-volt series test lamp set. Touch one prod to F1 (+) and the other prod to the frame. Lamp should not light. If lamp lights, field is grounded and must be replaced. (Test F2 lead in the same manner.)

TESTING FIELD WINDINGS FOR AN OPEN CIRCUIT (FIGURE 85)

For this test use either an ohmmeter or a 120-volt series test lamp set.

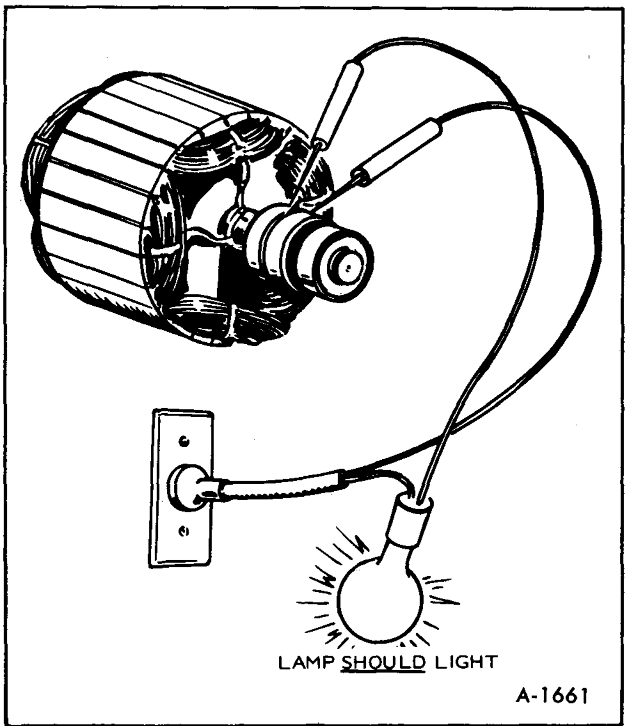


Figure 84—Armature Open Test

Using on Ohmmeter: Disconnect external leads and connect ohmmeter leads to F1 (+) and F2 (-). Resistance in the windings should read 28.8 ohms ($\pm$ 3%) for the 4KW and 38 ohms ($\pm$ 3%) for the 6KW.

Using a Test Lamp Set: Disconnect external leads and touch test prods to F1 and F2. The lamp should light. If not, field winding is open and must be replaced.

Check terminal ends closely for loose connections. These can be fixed easily without replacing the whole assembly.

TESTING BRIDGE RECTIFIER

To accurately test bridge rectifier proceed as follows:

1. Loosen No. 8-32 screw to remove bridge rectifier assembly (See figure 86 for location).

2. Disconnect the nylon connector from bridge rectifier assembly, noting the polarity marking of bridge rectifier assembly and connector.

3. Pull out from end bell and remove bridge rectifier from its case.

CAUTION: *Note that connector can only be mounted in one direction.*

4. Use an ohmmeter to test bridge rectifier. Set the ohmmeter dial to R x 1 scale.

5. Now place meter leads on points shown in Figure 87 and note readings from following table:

BLACK LEAD	RED LEAD	RE-SISTANCE
A	B	*8 ohms
A	D	*8 ohms
B	C	*8 ohms
D	C	*8 ohms
B	A	Infinity
D	A	Infinity
C	B	Infinity
C	D	Infinity

* $\pm$ 10% — Readings taken at 70 F.

6. If any tests do not agree with the above readings, install a new bridge rectifier.

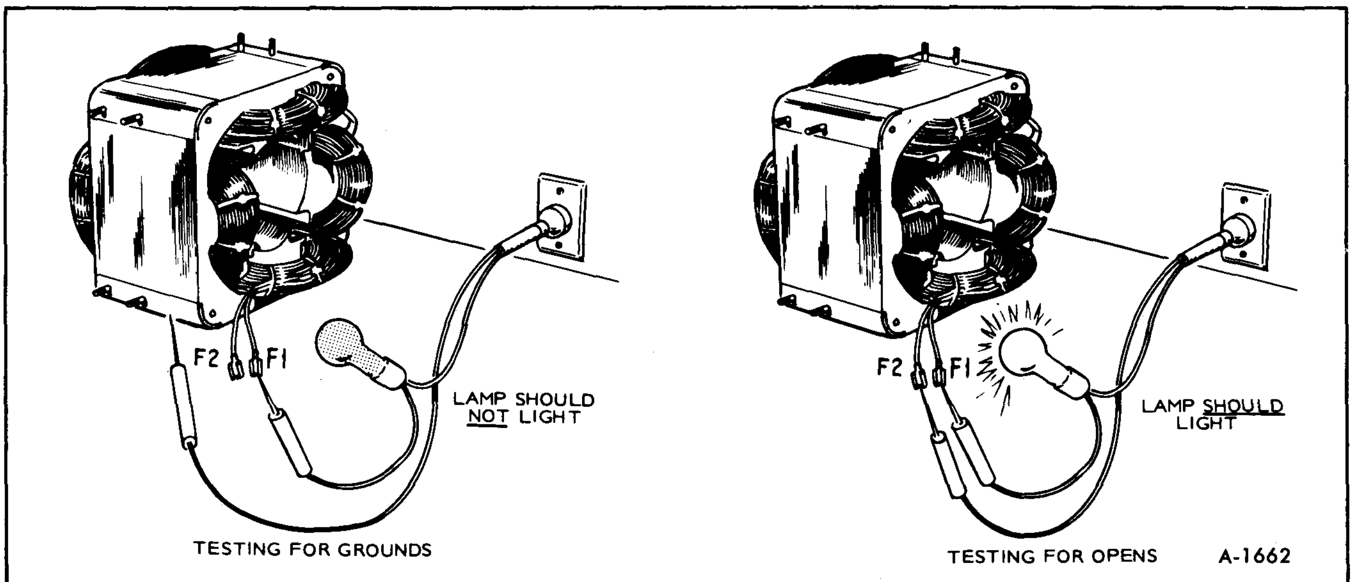


Figure 85—Testing Field Windings

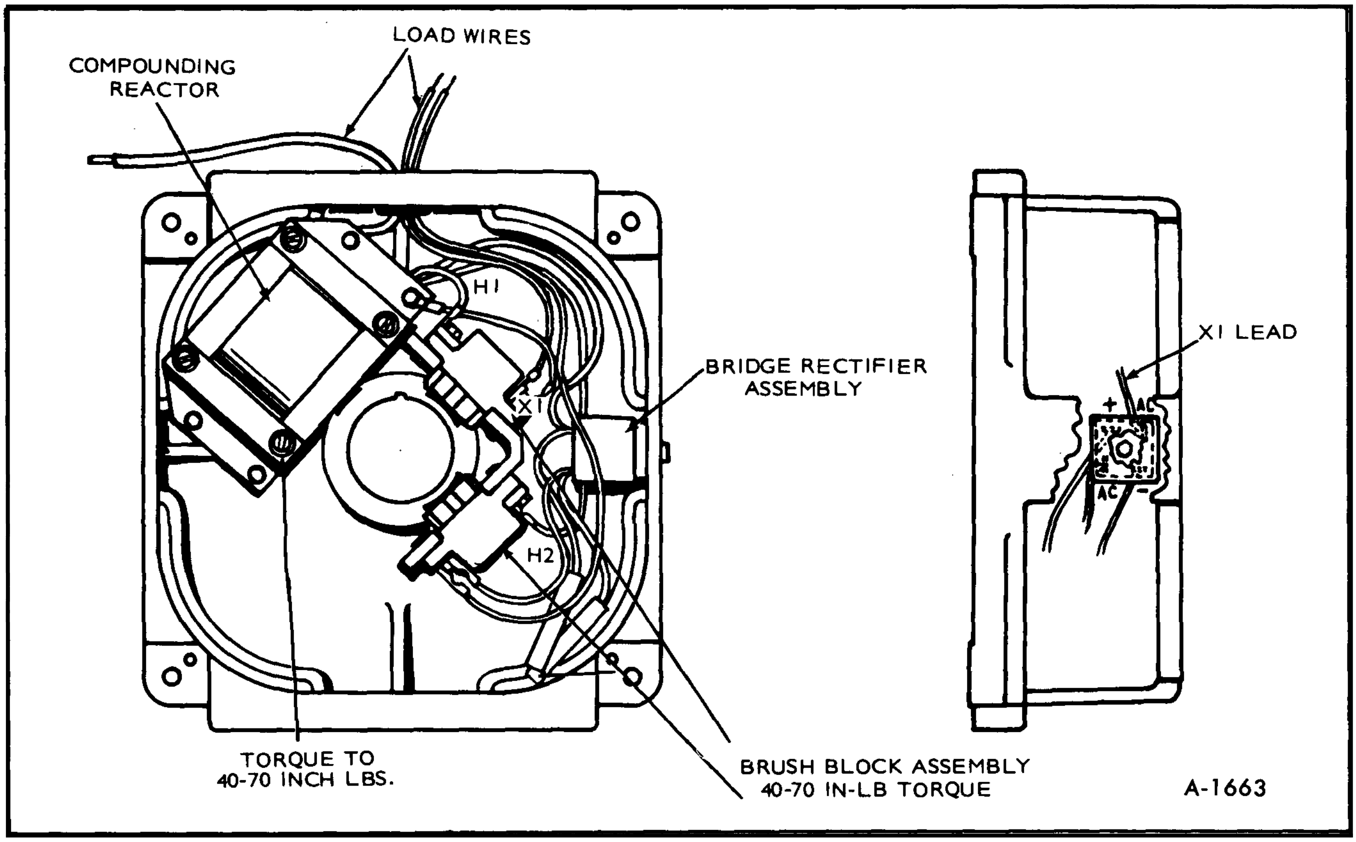


Figure 86—End Bell Assembly

CAUTION: *All terminals are marked on both bridge rectifier and nylon case. Observe proper polarity when installing. If installed wrong, generator voltage will not build up.*

COLLECTOR RINGS

Collector rings acquire a glossy brown finish in normal operation. Do not attempt to maintain a bright, newly machined appearing surface. Ordinary cleaning with a dry, lint-free cloth is usually sufficient. Very fine sandpaper (#240) may be used to remove slight roughness. Use only light pressure on the sandpaper, while the plant is running. Do not use emery or carborundum paper or cloth. Clean out all carbon dust from the generator.

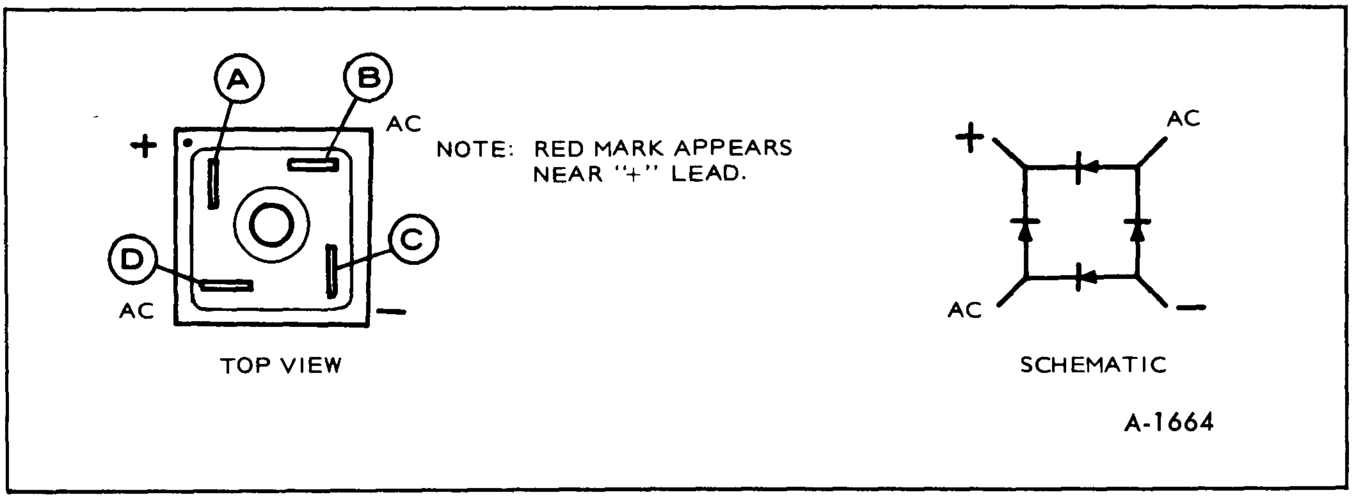


Figure 87—Testing Bridge Rectifier

GENERATOR BEARING

The generator is prelubricated and double-sealed. Replace bearing approximately every 5 years or at each engine overhaul.

COMPOUNDING REACTOR

If output voltage is high with no electrical load connected to the generator, with generator running at 1800 rpm, then the compounding reactor is probably defective. Test as shown in Figure 88, using a Variac.

WITH ONE AMPERE INPUT THE VOLTAGE SHOULD READ	
	VOLTAGE
4KW (315-380)	65-75
6KW (315-378)	60-70

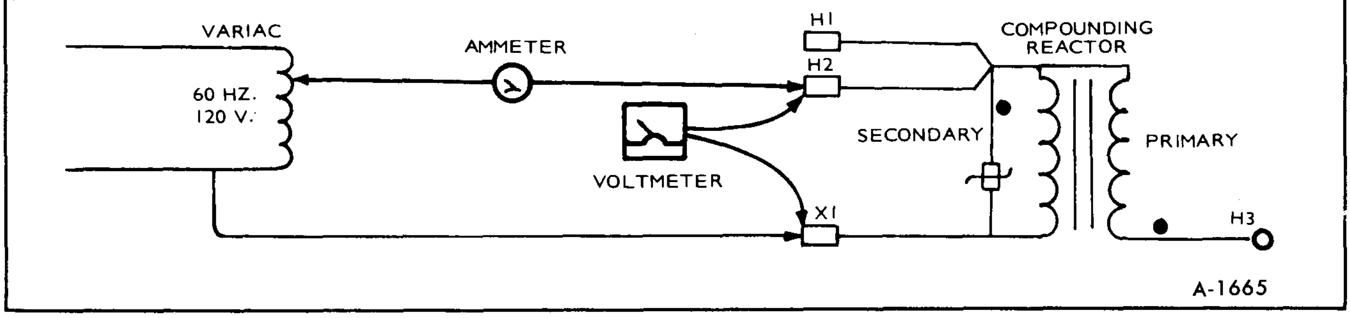


Figure 88—Testing Compounding Reactor

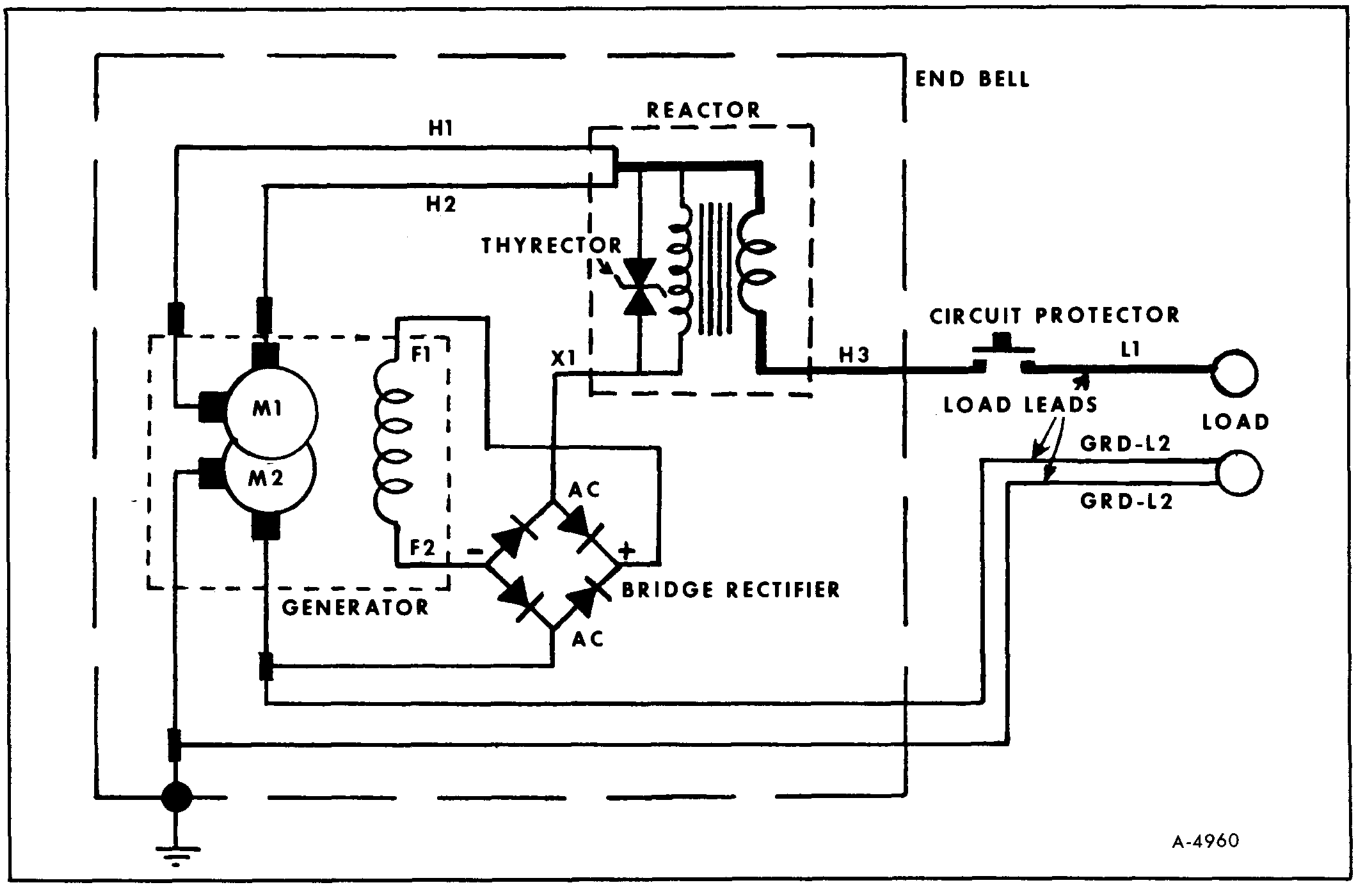


Figure 89—AC Generator Schematic

GENERATOR VALUES FOR 4KW

MODEL	TYPICAL N.L. VOLTS	TYPICAL F.L. VOLTS	N.L. VOLTS X1 to H1	N.L. VOLTS F1 to F2	RESISTANCE F1 to F2	RESISTANCE H1 to X1	CURRENT FULL LOAD
4KW	125	112	100 VAC	40V DC	28 Ohms	0.83 Ohms	33 Amps

GENERATOR VALUES FOR 6KW

MODEL	TYPICAL N.L. VOLTS	TYPICAL F.L. VOLTS	N.L. VOLTS X1 to H1	N.L. VOLTS F1 to F2	RESISTANCE F1 to F2	RESISTANCE H1 to X1	CURRENT FULL LOAD
6KW	123	113	80 VAC	50V DC	38 Ohms	0.85 Ohms	50 Amps

*N.L. — No Load
F.L. — Full Load

CONTROLS

OPERATION (FIGURE 90)

STARTING:

Push start switch S3. Battery current flows thru K1 solenoid, K2 contacts and start switch S3 to battery negative (GND). K1 solenoid closes contacts, feeding current to starter motor and to choke E1 plus K3 relay. K3 relay contacts close the circuit to the ignition coil T1 and fuel pump E2 plus fuel solenoid K4. The engine cranks and the fuel pump, fuel solenoid, and ignition operate to start the engine. The remote start switch is connected as shown in Figure 91.

NOTE: For details on control panel, refer to figures 92 and 93.

ENGINE STARTS:

When the starting rpm increases, the alternator develops a voltage great enough to be rectified and energize relay K2. Relay K2 contacts close to hold relay K3 energized, and K2 normally closed contacts open to drop K1 start solenoid. K3 contacts maintain current to ignition coil, fuel pump, and fuel solenoid. The engine continues running and K2 remains energized.

STOP ENGINE:

Relay K3, energized by K2, maintains ignition. To stop engine, push the stop switch which shorts out K3. Relay K3 drops out to remove power from the fuel pump, fuel solenoid and ignition coil. Resistor R2 absorbs the power that was supplied to K3 during the period the stop switch is held close as the engine slows to a stop.

LOW OIL PRESSURE SHUTDOWN:

The control has a built-in time delay of 2 to 4

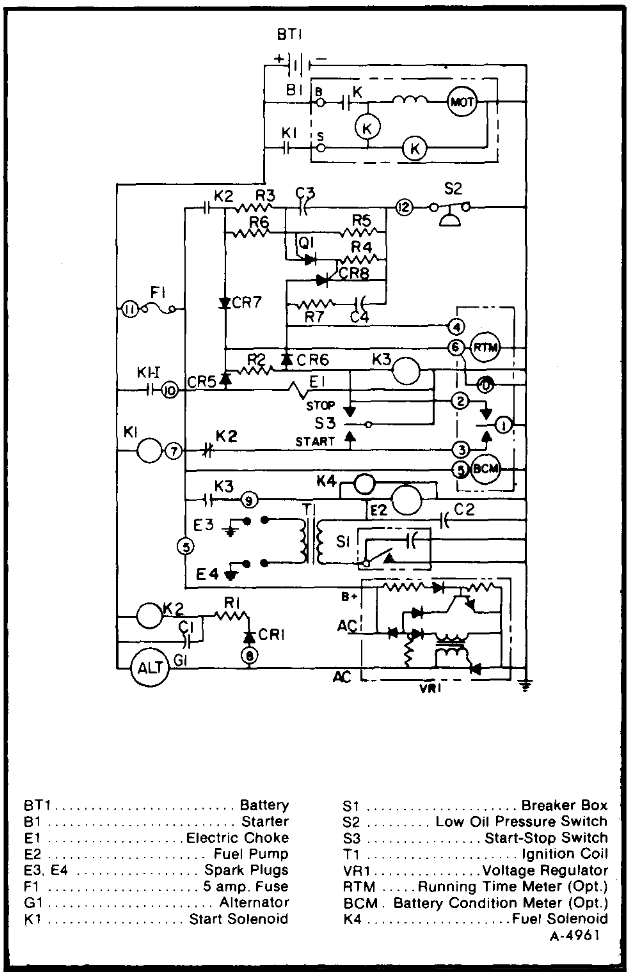
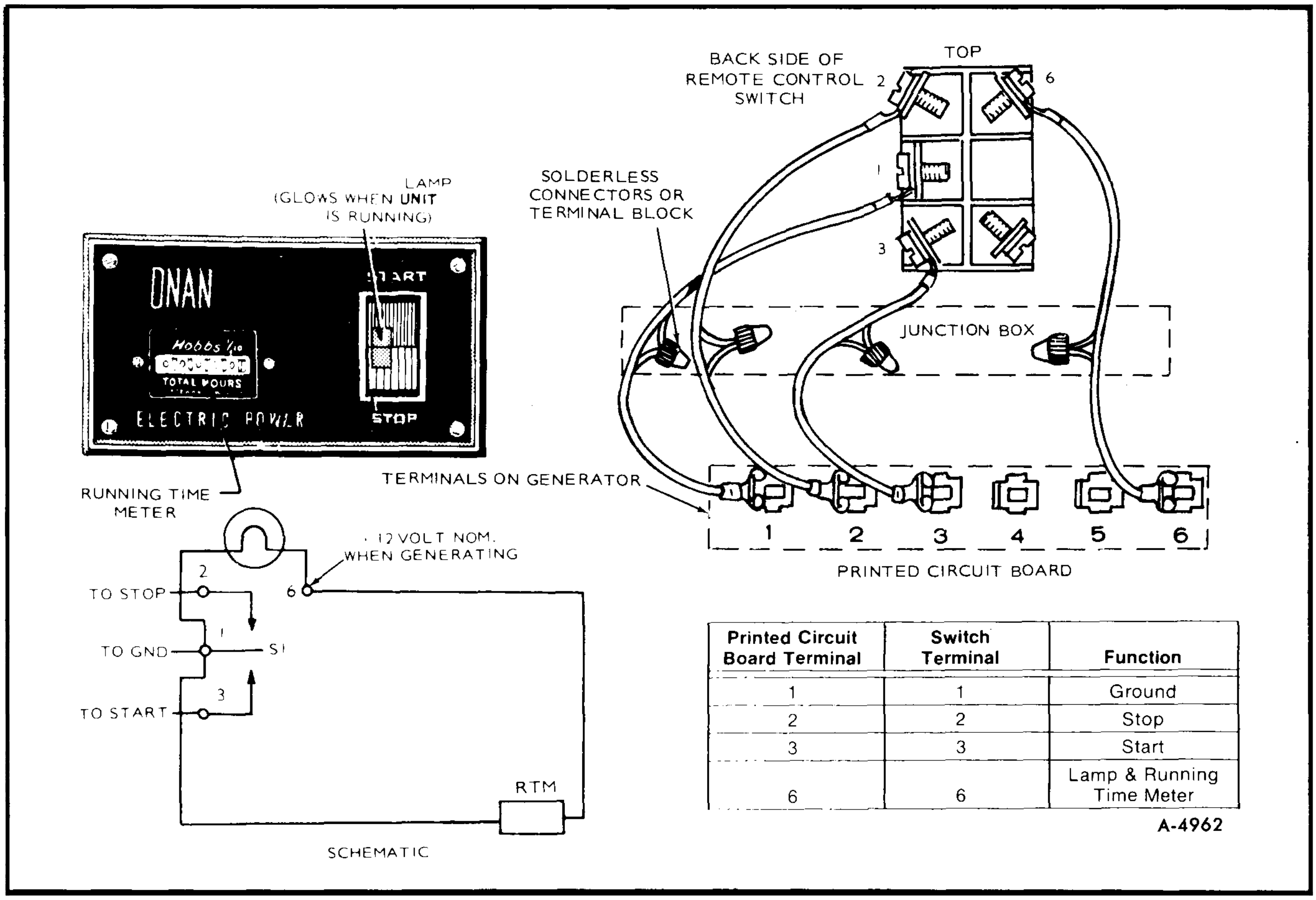


Figure 90—Control System Schematic



Printed Circuit Board Terminal	Switch Terminal	Function
1	1	Ground
2	2	Stop
3	3	Start
6	6	Lamp & Running Time Meter

Figure 91—Remote Control Switch

seconds for a low oil pressure shutdown. If a low oil pressure condition occurs, the low oil pressure

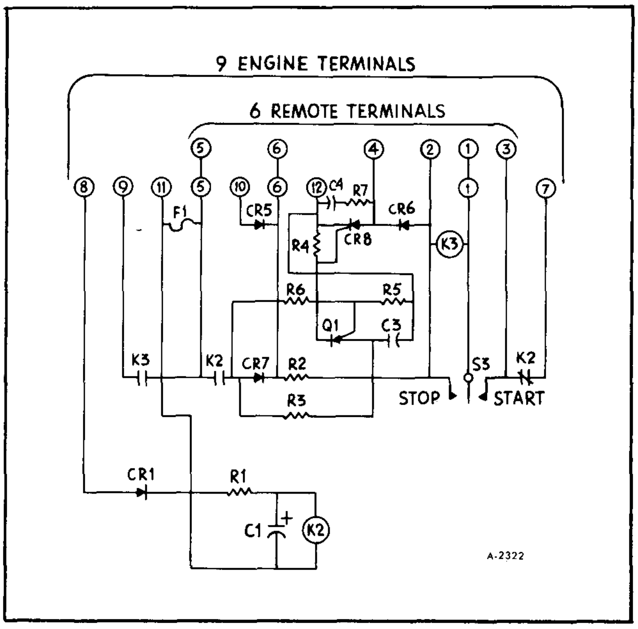


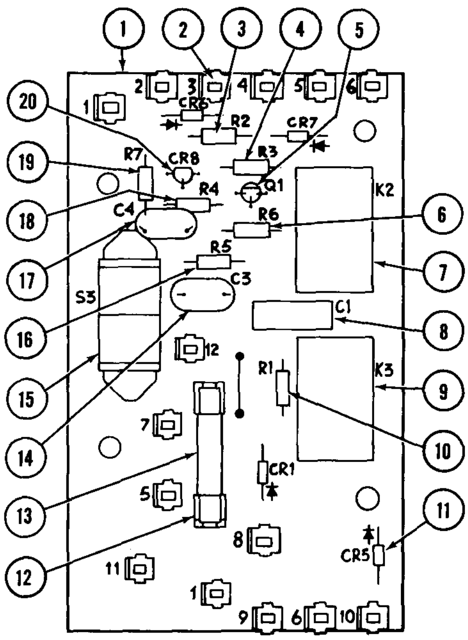
Figure 92—Control Panel Wiring

switch S2 closes to charge capacitor C3 through resistor R3. When the voltage on capacitor C3 matches the voltage of the divider R5-R6, the programmable unijunction transistor Q1 "fires" to trigger CR8. CR8 turns on to de-energize K3 relay. K2 contacts open as the engine stops and CR8 turns off.

EMERGENCY START-STOP OPERATION

In an emergency situation the control board, either normal or defective, can be bypassed to start or stop the unit. To completely bypass all control board functions connect a jumper from terminals 9 to 11. This energizes the ignition and fuel pump. Then temporarily jumper terminals 1 and 7 to energize starter. Remove this jumper as soon as the engine starts and runs. DO NOT reconnect this jumper while the engine is running. To stop, remove the jumper from terminals 9 and 11.

CAUTION: *This emergency operation DOES NOT provide fuse protection, start disconnect or low oil pressure shutdown and should not be used without monitoring the motor generator.*



ITEM	SYMBOL	DESCRIPTION
1		Printed Circuit Board
2		Terminal
3	R2	Resistor—150 Ω, ½W 10%
4	R3	Resistor—470K Ω, ½W 10%
5	Q1	Transistor—Unijunction, 2N6027
6	R6	Resistor—16K Ω, ½W 5%
7	K2	Start Disconnect Relay
8	C1	Capacitor—100 MFD, 25VDC
9	K3	Engine Stop Relay
10	R1	Resistor—200 Ω, ½W 5%
11	CR1-7	Silicon Rectifier—.5A, 100V
12		Fuse Clip
13	F1	Fuse—5A
14	C3	Capacitor—5 MFD, 25V
15	S3	Rocker Switch
16	R5	Resistor—27K Ω, ½W 5%
17	C4	Capacitor—.1 MFD, 100V
18	R4	Resistor—100 Ω, ½W, 10%
19	R7	Resistor—2.7 Ω, ½W 5%
20	CR8	Gate Control Rectifier—.8A, 30V

A-2323

Figure 93—Control Panel

SPECIFICATIONS

4KW MODEL

ENGINE
Engine Manufacturer .... Onan
Engine Design .... Four Cycle, Air Cooled, L Head
Fuel Used .... Unleaded or Low-Lead Regular Grade Gasoline
Number of Cylinders .... Two
Bore .... 3-1/8 inch
Stroke .... 2-5/8 inch
Oil Capacity .... 3 quarts
(With Filter Change) .... 3-1/2 quarts
Battery Voltage .... 12 volt
Starting System .... Solenoid Shift
Battery Charging System .... 9 amp Flywheel Alternator
GENERATOR
60 Hertz Recreational Vehicle Rating .... 4KW (4000 watts)
Voltage 120
Current Rating (Amperes) 33
Phase .... Single
Wire .... Two

TUNE-UP SPECIFICATIONS
Spark Plug Gap .... .020″
Breaker Point Gap (Full Separation — Engine Cold) .... .025″
Ignition Timing (Engine Not Running — Cold Setting) .... 26° BTC
Ignition Timing (Engine Running — Hot) .... 21° BTC
Tappet Adjustment (Engine Cold)
Intake .... .003″
Exhaust .... .010″

STARTER
Engaging System .... Solenoid-operated Overrunning Clutch
Nominal Output .... 0.68 Hp
Rated Voltage .... D.C. 12 V.
Field Connection .... Compound
Direction of Rotation .... Counterclockwise (Viewing from pinion end)
Weight .... 6.76 lbs.

6KW MODEL

ENGINE
Manufacturer .... Onan
Design .... Four Cycle, Air Cooled, L Head
Fuel .... Unleaded or Low-Lead Regular Grade Gasoline
Fuel Pump .... 12V, Electric
Cylinders .... Two
Bore .... 3-9/16 inch
Stroke .... 3 inch
Oil Capacity .... 4 quarts
(With Filter Change) .... 4-1/2 quarts
Battery Voltage .... 12 Volt
Battery Charging System .... 10 Ampere, Flywheel Alternator
Starting System .... Solenoid Shift
GENERATOR
Manufacturer .... Onan
Design .... Revolving Armature, Four Pole, 1800 rpm
60 Hertz Recreational Vehicle Rating .... 6000 Watts (6KW)
Voltage .... 120 Volts
Current Rating .... 50 Amperes
Phase .... Single
Wire .... Two
TUNE-UP SPECIFICATIONS
Spark Plug Gap .... .020 inch
Breaker Point Gap (Full Separation) .... .016 inch
Ignition Timing (Engine Running or Static) .... 20° BTC
Tappet Adjustment (Engine Cold)
Intake .... .003 inch
Exhaust .... .012 inch
STARTER
Engaging System .... Solenoid-operated Overrunning Clutch
Nominal Output .... 1.0 HP
Rated Voltage .... D.C. 12 V.
Field Connection .... Series
Direction of Rotation .... Counterclockwise (Viewing from pinion end)
Weight .... 3.7 lbs.

DIMENSIONS AND CLEARANCES

ALL DIMENSIONS & CLEARANCES GIVEN IN INCHES UNLESS OTHERWISE SPECIFIED.

Readings taken at 70° F.

4KW MODEL

	MINIMUM	INCHES	MAXIMUM
CYLINDER AND PISTON			
Piston to Pin (70°)	.0002	—	.0004
Pin to Connecting Rod Clearances	.0002	—	.0007
Piston Ring Gap in Cylinder	.010	—	.020

	MINIMUM	INCHES	MAXIMUM
Piston Clearance in Cylinder Solid Type-Measured .10 Below Oil Controlling Ring — 90° From Pin	.001	—	.003
Cylinder Bore-Honed Std.	3.1245	—	3.1255
CRANKSHAFT AND CAMSHAFT			
Crankshaft Main Bearing Journal to Bearing Clearance Steel Backed Aluminum	.0025	—	.0038
Crankshaft End Play	.006	—	.012
Camshaft End Play		.003″	
Crankshaft Rod Journal to Rod Bearing Clearance. Aluminum Rod	.0020	—	.0033
Connecting Rod End Play	.002	—	.016
Timing Gear Backlash	.002	—	.003
Oil Pump Gear Backlash	.002	—	.005
TAPPET AND VALVES			
Tappet to Cylinder Block Clearance	.0015	—	.0030
Valve Seat Width	1/32	—	1/8
Valve Stem to Guide — Intake	.0010	—	.0025
Valve Stem to Guide — Exhaust		.0025	
Valve Face Angle		44°	
Valve Seat Angle		45°	
Valve Tappet Clearance — Intake 70° F		.003″	
Valve Tappet Clearance — Exhaust 70° F		.010″	

6KW MODEL

Valve Tappet Clearance			
Intake		0.003″	
Exhaust		0.012″	
Valve Stem in Guide — Intake	0.001″	—	0.0025″
Valve Stem in Guide — Exhaust	0.0025″	—	0.004″
Valve Spring Length			
Free Length		1.662″	
Compressed Length		1.375″	
Valve Spring Tension (lb)			
Open	71	—	79
Closed	38	—	42
Valve Seat Bore Diameter			
Intake	1.5645″	—	1.5655″
Exhaust	1.2510″	—	1.2520″
Valve Seat Diameter			
Intake	1.569″	—	1.570″
Exhaust	1.255″	—	1.256″
Valve Stem Diameter			
Intake	0.3425″	—	0.3430″
Exhaust	0.3410″	—	0.3415″
Valve Guide Diameter (I.D.)	0.344″	—	0.346″
Valve Lifter Diameter	0.7475″	—	0.7480″
Valve Lifter Bore	0.7500″	—	0.7515″
Valve Seat Interference Width	1/32″	—	3/64″

	MINIMUM	INCHES	MAXIMUM
Valve Face Angle		44°	
Valve Seat Angle		45°	
Valve Interference Angle		1°	
Crankshaft Main Bearing	0.0025″	—	0.0038″
Crankshaft End Play	0.005″	—	0.009″
Camshaft Bearing	0.0015″	—	0.0030″
Camshaft End Play		.003″	
Camshaft Lift		.300″	
Camshaft Bearing Diameter	1.3760″	—	1.3770″
Camshaft Journal Diameter	1.3740″	—	1.3745″
Rod Bearing (Forged Rod)	0.0005″	—	0.0023″
Connecting Rod End Play (Ductile Iron)	0.002″	—	0.016″
Timing Gear Backlash	0.002″	—	0.003″
Oil Pump Gear Backlash	0.002″	—	0.005″
Piston to Cylinder, Strut Type (Measured below oil-controlling ring — 90° from pin Clearance	0.0015″	—	0.0035″
Piston Pin Diameter	0.7500″	—	0.7502″
Piston Pin in Piston		Thumb Push Fit	
Piston Pin in Rod	0.0001″	—	0.0005″
Piston Ring Groove Width			
Top 1	0.0955″	—	0.0965″
Top 2	0.0955″	—	0.0965″
Top 3	0.1880″	—	0.1890″
Crankshaft Main Bearing Journal — Standard Size	1.9992″	—	2.000″
Main Bearing Diameter	2.0015″	—	2.0040″
Main Bearing Clearance	0.0025″	—	0.0038″
Crankshaft Rod Bearing Journal — Standard Size	1.6252″	—	1.6260″
Cylinder Bore — Standard Size	3.5625″	—	3.5635″

TORQUE SPECIFICATIONS

4KW MODEL	FT.-LBS.
Connecting Rod Bolt — Aluminum Rod	14-16
Flywheel Mounting Screw	35-40
Oil Pump	7-9
Gearcase Cover	8-10
Rear Bearing Plate	25-27
Oil Base Mounting Screws	18-23
Cylinder Head Nuts	14-16
Manifolds — Intake and Exhaust	8-10
Starter Mounting Bolts	18-20
Spark Plugs	15-20
6KW MODEL	**FT.-LBS.**
Connecting Rod Bolts	27-29
Flywheel Mounting Screw	35-40
Oil Pump	7-9
Gearcase Cover	8-10
Rear Bearing Plate	19-21
Oil Base Mounting Screws	18-23
Cylinder Head Nuts	17-19
Intake Manifold	18-20
Exhaust Manifold	10-12

Oil Pan Screws (18)	8-12
Starter Mounting Bolts	18-20
Spark Plugs	15-20

GENERATOR (4KW and 6KW)	FT.-LBS.
Generator Through Studs (4)	15-18
Armature Hold Down Nut-12 Point	45-50
Compounding Reactor Studs	4-6
Brush Block Assembly Studs	4-6

SECTION 24D
REFRIGERATOR

Contents of this section are listed below:

SUBJECT	PAGE NO.
General Information	24D-1
Norcold Refrigerator Trouble Diagnosis	24D-1
Component Testing	24D-2
Refrigerstor Replacement	24D-4
Component Removal	24D-5
Component Installation	24D-8
Norcold Specifications	24D-9

GENERAL INFORMATION

The Norcold seven and one-half cubic foot refrigerator will operate either on 12-volts D.C. or 120-volts A.C. This dual voltage refrigerator automatically switches from A.C. to D.C. or D.C. to A.C. When a power supply of at least 90 volts. A.C. is present at the refrigerator supply cord, the voltage selection relay is energized and disconnects the unit from D.C. operation. When the A.C. power supply is disconnected, the refrigerator automatically reverts to D.C. operation.

There is a circuit breaker incorporated in the 12-volt circuit of the refrigerator. It is located behind the kick plate below the refrigerator door. When the circuit breaker opens a small light will come on beside the breaker. The circuit breaker is reset by pushing IN on the red button next to the light.

The swing motor type compressor, operates on A.C. voltage only. An inverter-transformer assembly inverts 12-volts D.C. to 11 volts A.C., and then transforms this voltage to 23 volts A.C. This is then supplied to the swing motor compressor.

NORCOLD REFRIGERATOR TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
Compressor does not run.	1. Fuse "blown" in living area fuse block.	1. Correct electrical problem that caused fuse to "blow" and replace fuse.
	2. Circuit breaker in refrigerator has "tripped."	2. Correct electrical problem that caused circuit breaker to trip and reset circuit breaker.
	3. Faulty electrical source.	3. Check A.C. and D.C. voltage source at the point where it enters the inverter assembly. The problem may lie in the source and not in the refrigerator.
	4. Defective thermostat	4. Replace thermostat.
	5. Defective inverter assembly.	5. Replace inverter assembly.
	6. Open or short circuit in swing motor compressor.	6. Replace swing motor compressor.

Problem	Possible Cause	Correction
Insufficient cooling, compressor runs.	1. Improper thermostat setting.	1. Turn thermostat to higher setting. A setting of "3" should be adequate at ambient temperatures of 70° — 90°. When storing frozen food in freezing compartment a setting of "5" is recommended for the above temperature conditions.
	2. Overpacking of cabinet.	2. Space must be left in between food to allow for proper convective heat transfer.
	3. Insufficient heat radiation at condenser.	3a. At ambient temperatures above 110°F. the condenser will not be able to radiate enough heat to maintain sufficient cooling, even with a setting of "5". b. Dust may have collected on condenser restricting air flow and must be removed.
	4. Excess frost build up in freezer compartment.	4. A frost build up of over one quarter inch should be avoided. Defrost refrigerator.
	5. Freon overcharge or undercharge.	5. Can be determined by testing compressor amperage. In either case the entire cooling system must be replaced.
	6. Insufficient voltage source.	6. Check A.C. and D.C. voltage supply.
	7. System "Freeze-up" or clogging. Clogging is indicated by a warm evaporator plate, a condenser at room temperature, and a low amp draw by the compressor.	7. Shut-off system and let it cool down, start-up system let it run for 5 minutes, shut-off system for 5 minutes. Restart system. If system does not function repeat cycling. If this does not relieve the clog replace entire system.
Refrigerator too cold, compressor runs constantly.	1. Thermostat "sticking".	1. Replace thermostat
	2. Thermostat sensing bulb loose on evaporator plate mounting.	2. Tighten mounting screws to make sure bulb has good contact with evaporator plate.

COMPONENT TESTING

COMPRESSOR VOLTAGE

The voltage is checked at the compressor terminals with an A.C. voltmeter (figure 1).

NOTE: A standard A.C. voltmeter will read a high A.C. compressor voltage on D.C. operation. The reason being the inverter does not produce a true sine wave on D.C. operation. The

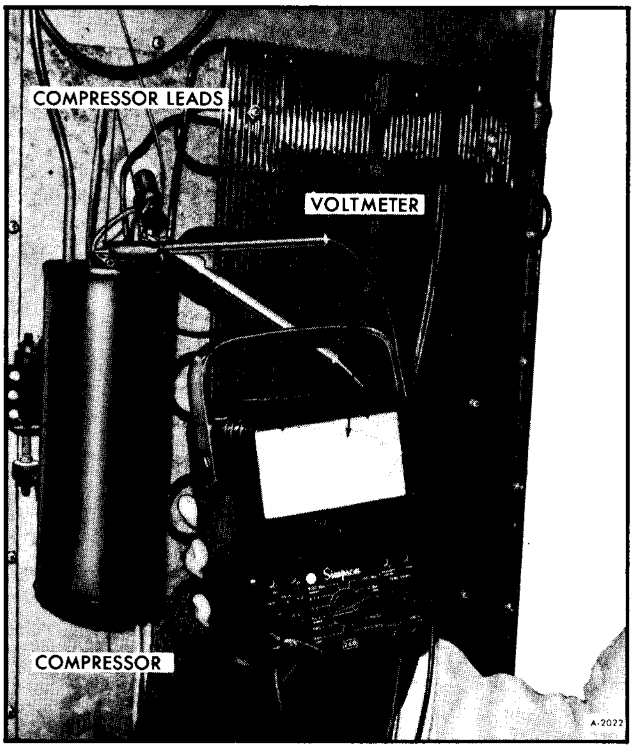


Figure 1—Checking Compressor Voltage

120-volt A.C., 60 cycles/sec., will produce a true sine which an A.C. voltmeter is designed to read.

A.C. OPERATION

Using a standard A.C. voltmeter the voltmeter reading should be 22 to 24 volts.

Figure 2—Checking Compressor Amperage

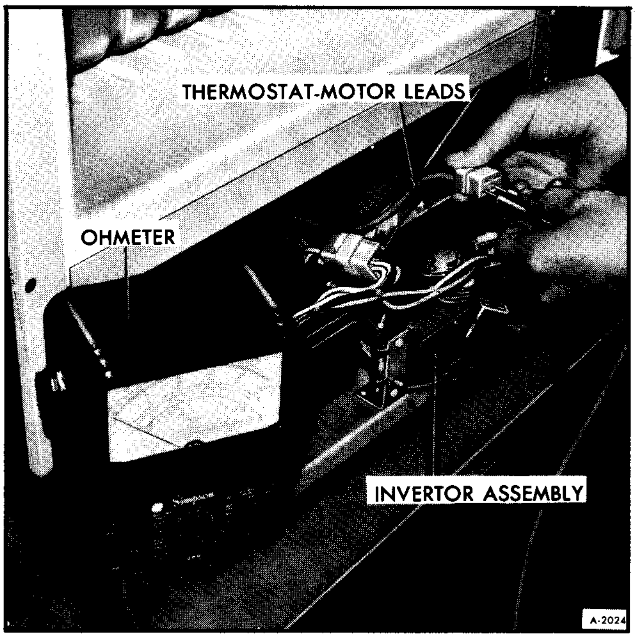


Figure 3—Checking Thermostat at Inverter

If the voltage at the compressor is not adequate the voltage source should be checked.

D.C. OPERATION

Using a standard A.C. voltmeter the voltmeter reading should be 31.5 to 33.5 volts.

COMPRESSOR AMPERAGE

One method of determining whether or not the

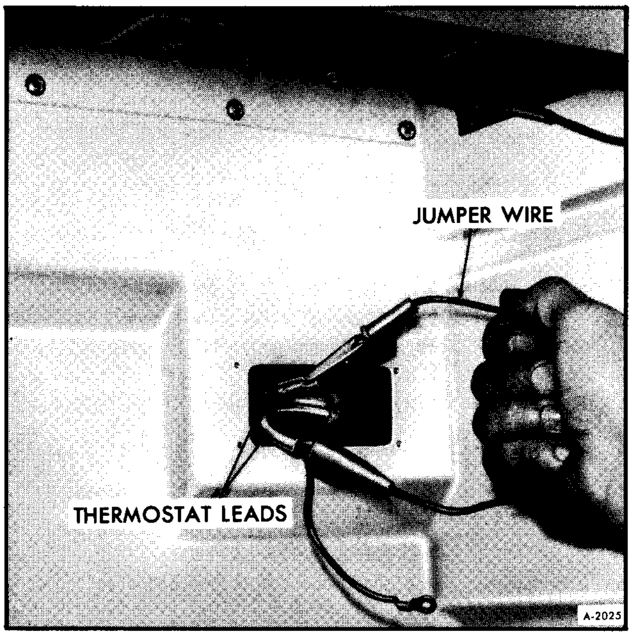


Figure 4—Jumper Wire at Thermostat

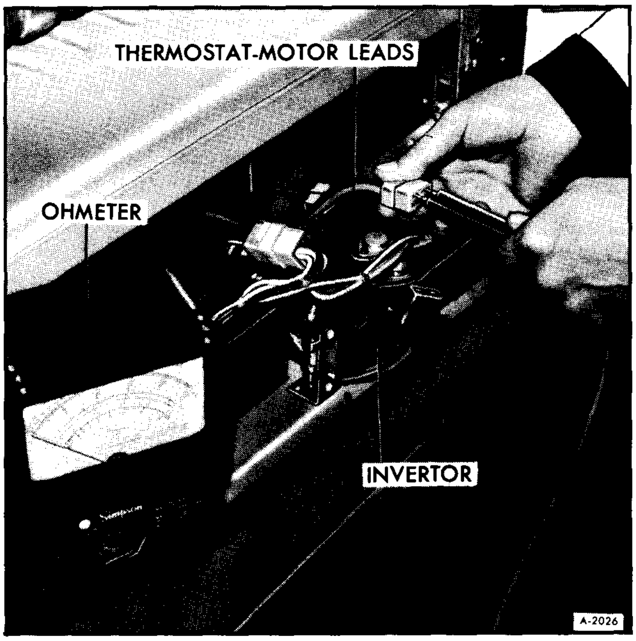


Figure 5—Testing Compressor Resistance

proper amount of freon is in the cooling unit is to measure the number of amps drawn by the compressor when connected to a 120-volt source.

This is done by removing one of the compressor leads and connecting a 0-5 ammeter in series with the compressor (figure 2), a reading of approximately 2.6 amps should be read.

If the amperage reading is high, this is an indication the system is undercharged. If a low reading is obtained the system is overcharged. If it is determined that the system is under or overcharged the entire cooling system must be replaced.

TESTING THERMOSTAT

The thermostat may be tested by two different methods.

The first method is, gain access to the inverter assembly. Pull this assembly from the bottom of the refrigerator and disconnect the gray thermostat motor leads. Connect an ohmeter to the thermostat leads (figure 3) and turn the thermostat to "5". There should be continuity. If not replace thermostat.

Another method is, to remove thermostat assembly from inside cabinet and connect a jumper wire between the two lead wires as shown in Figure 4. If the compressor begins to run replace the thermostat.

INVERTER ASSEMBLY

Remove the inverter assembly from the bottom of the refrigerator. Unplug wiring harness from inverter assembly. Install new inverter assembly, and turn on refrigerator. If refrigerator now functions properly the old inverter assembly was faulty and the new inverter assembly should remain installed in the refrigerator.

SWING MOTOR COMPRESSOR RESISTANCE

At inverter assembly disconnect thermostat-motor leads. Connect a suitable ohmeter across motor leads as shown in Figure 5. A reading of 2-3 ohms should be obtained. If the reading does not fall within this range the motor contains an open or a short. Then, entire cooling unit must be replaced.

REFRIGERATOR REPLACEMENT

REMOVAL

1. Remove door(s).

2. Remove kick plate from front of refrigerator.

3. Disconnect 12-volt source at electrical connector, which is located behind kick plate. Also unplug 120-volt plug from from receptacle.

4. Remove four screws from sides of refrigerator as shown in Figure 6.

5. Slide unit out, and remove from vehicle.

INSTALLATION

1. Position unit in opening.

2. Install four retaining screws (figure 6).

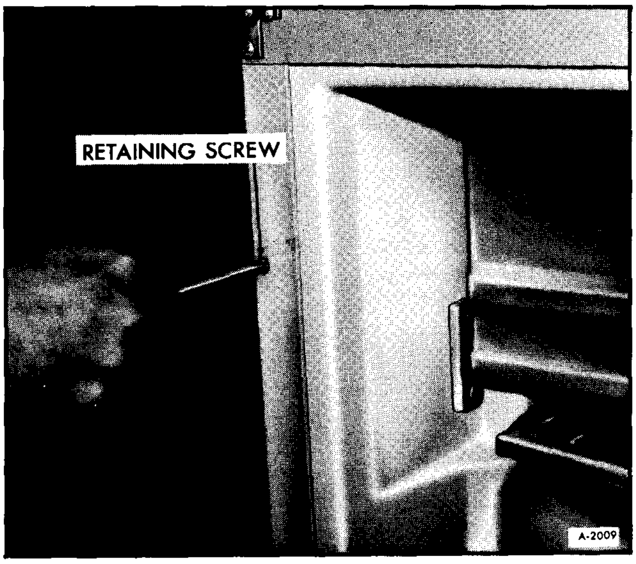


Figure 6—Removing Refrigerator Retaining Screws

3. Reconnect 12-volt electrical connector behind kick plate. Plug 120-volt plug into receptacle.

4. Install kick plate.

5. Install door(s).

COMPONENT REMOVAL

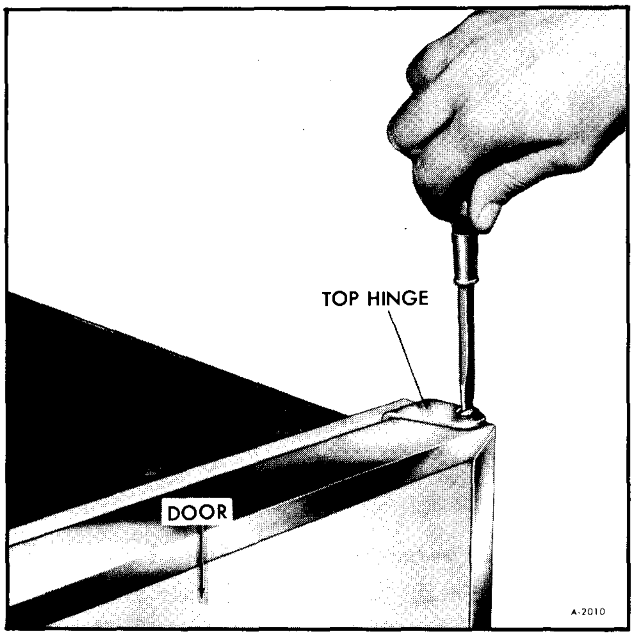


Figure 7—Removing Top Door Hinge

DOOR REMOVAL

1. Remove screw top of freezer door hinge, release travel lock (figure 7).

2. Tilt top of freezer door out and lift door off hinge (figure 8).

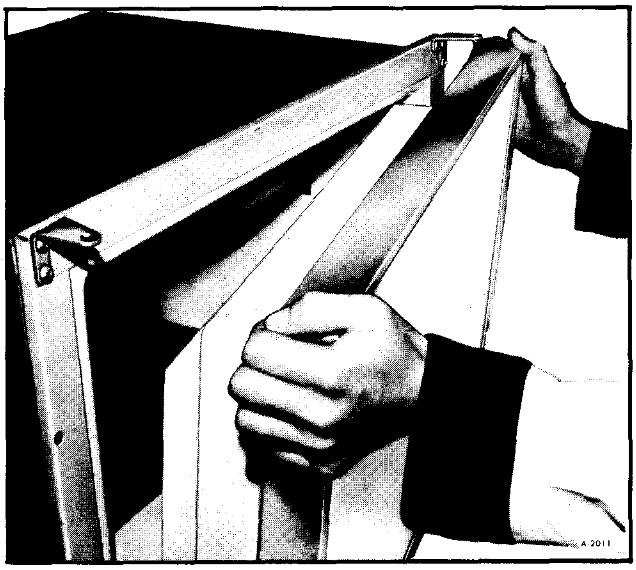


Figure 8—Removihg Door

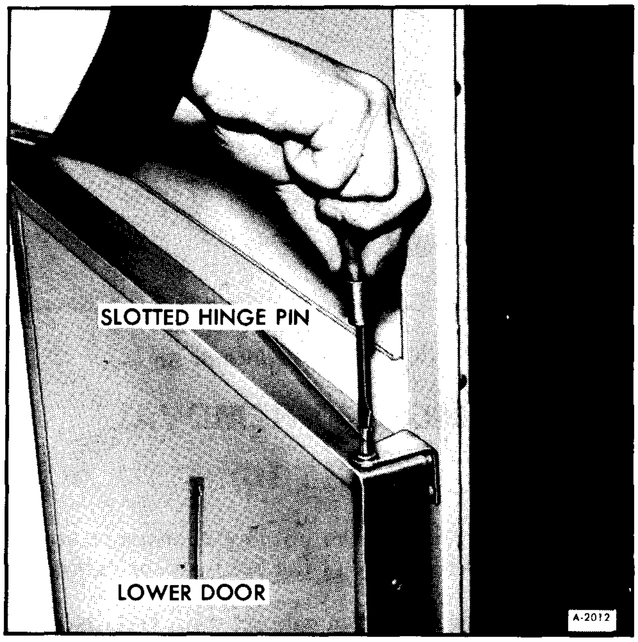


Figure 9—Removing Center Hinge Pin

3. Top of hinge pin is slotted to accept a screw driver. Remove this hinge pin (figure 9).

4. Tilt lower door out at its top and lift off bottom hinge pin.

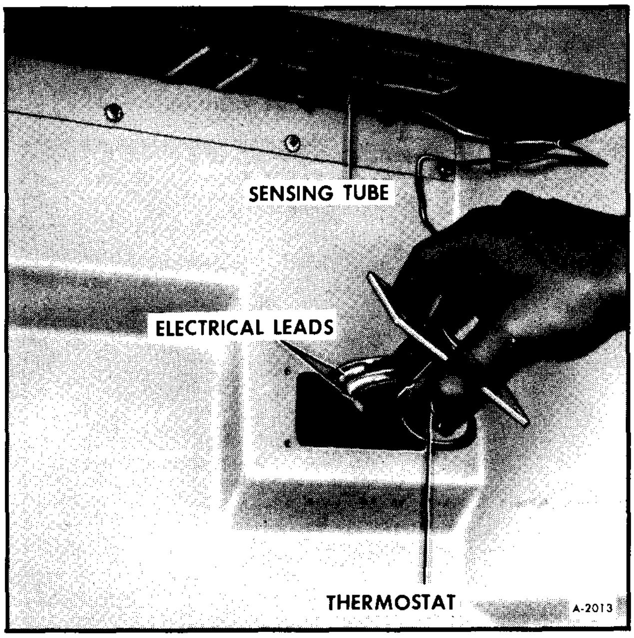


Figure 10—Removing Thermostat

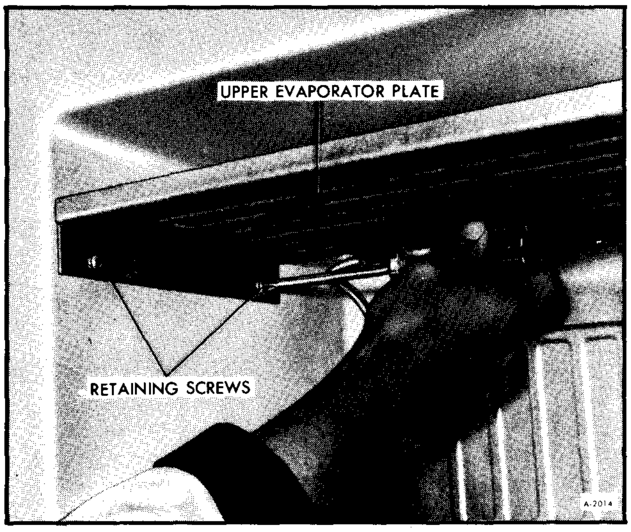


Figure 11—Removing Evaporator Screws

THERMOSTAT REMOVAL (FIGURE 10)

1. Remove four screws holding thermostat and its face plate to the back of the refrigerator cabinet.

2. Pull thermostat from cabinet wall, and disconnect three electrical leads from back of thermostat. Remove sensing tube from freezer tray.

3. Pull control knob off, and remove face plate from thermostat by removing retaining nuts and bolts.

COOLING UNIT REMOVAL

1. Remove refrigerator from vehicle.

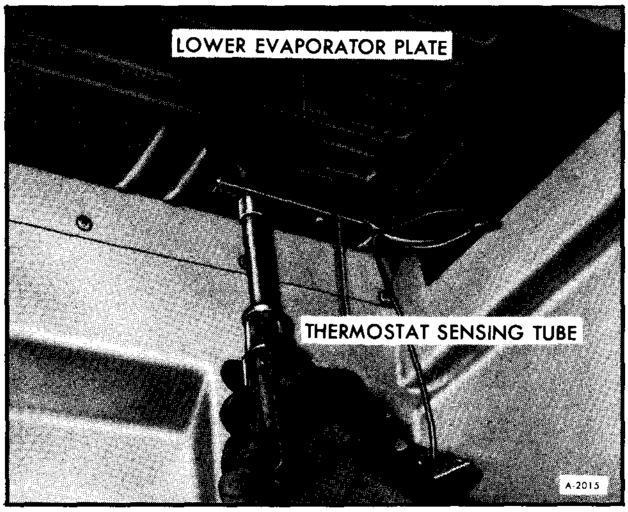


Figure 12—Removing Thermostat Sensing Tube

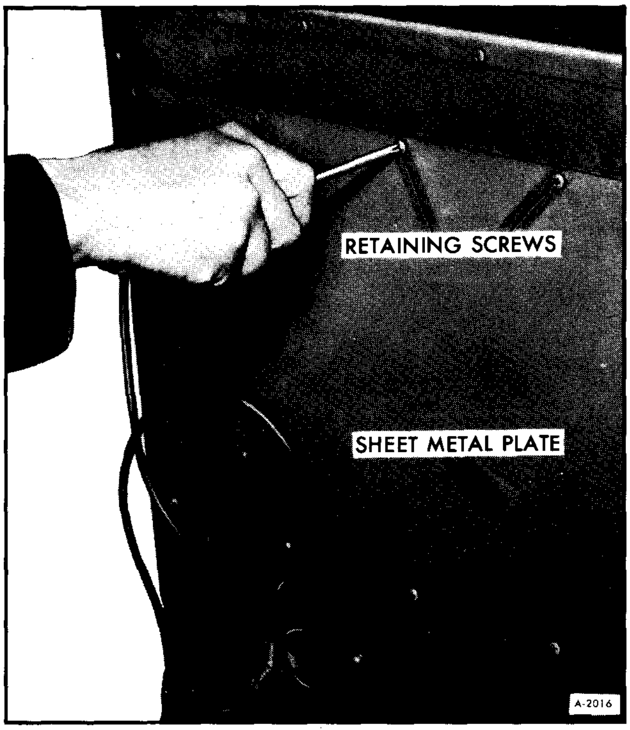


Figure 13—Removing Sheet Metal Plate

2. Remove eight screws from upper and lower evaporator plates, four screws in each (figure 11).

3. Remove thermostat sensing element from lower evaporator plate by removing two screws (figure 12).

4. Disconnect electrical leads to the compressor.

CAUTION: *Care must be taken when removing or installing electrical leads to the compressor. The bottom nuts must not be loosened or tightened as the seals at these points may be damaged.*

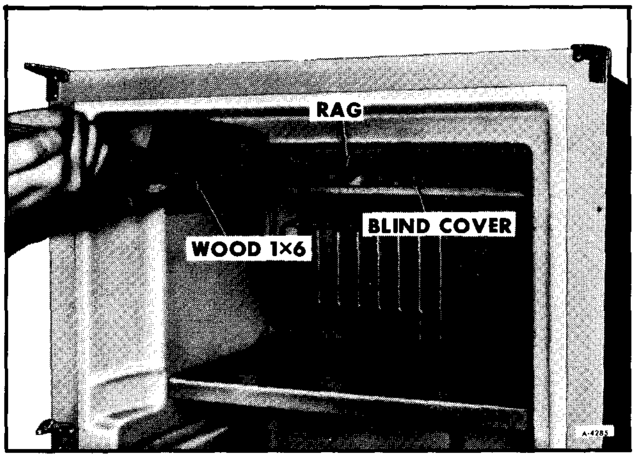


Figure 14—Loosening Cauling Seal on Blind Cover

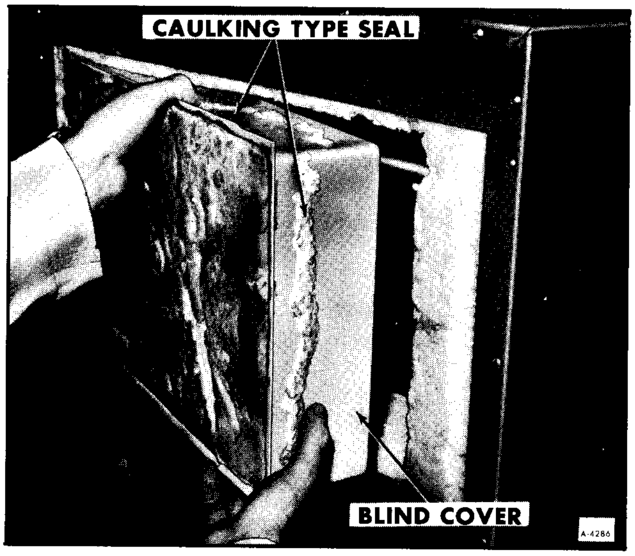


Figure 15—Removing Blind Cover

5. Remove putty from opening where capillary tube and discharge tube pass through back of cabinet.

6. Remove sheet metal plate from back of refrigerator as shown in Figure 13.

7. Remove eight retaining screws from condenser.

8. Remove mounting screws from compressor.

9. Remove blind cover by performing the following:

a. Wrap the end of a 3-foot, wood 1 x 6 with a rag. Then firmly tap on blind cover as shown in Figure 14, to loosen caulking type seal.

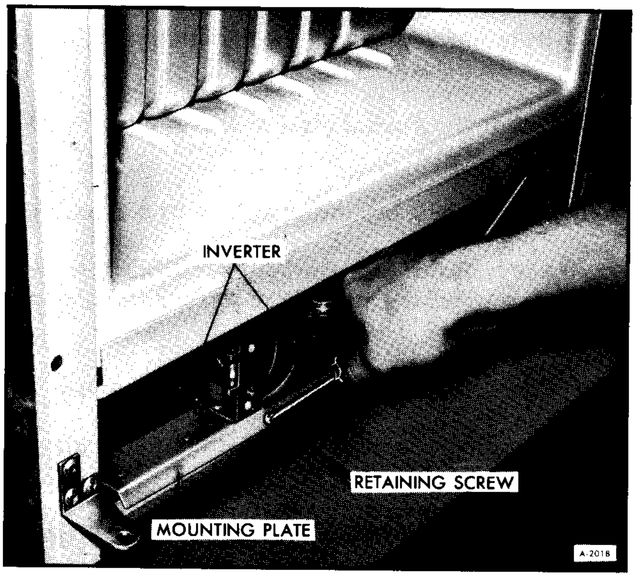


Figure 16—Removing Inverter Assembly

Figure 17—Disconnecting Wiring

b. Then carefully remove blind cover (See figure 15).

10. Pull evaporator plates through opening and remove cooling unit as an assembly.

INVERTER ASSEMBLY REMOVAL

1. Remove kick plate.

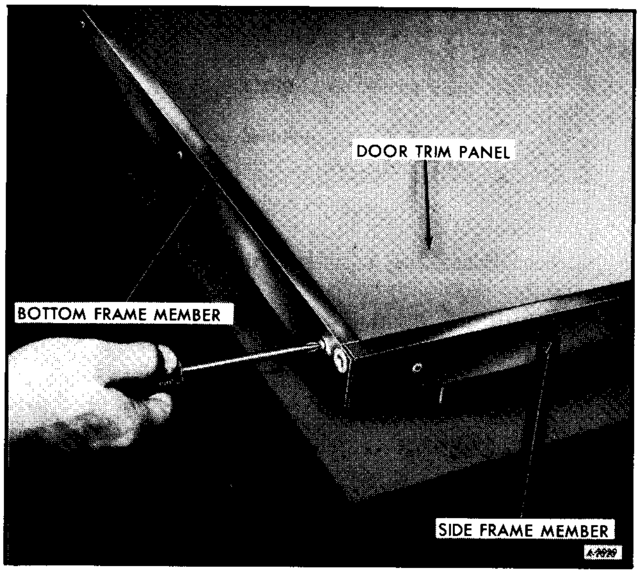


Figure 18—Removing Bottom Frame

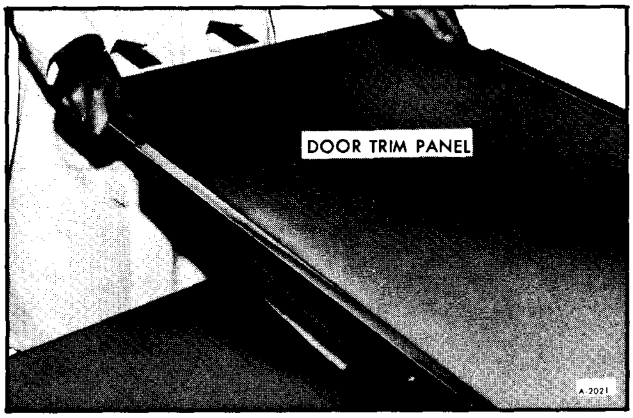


Figure 19—Removing Trim Panel

2. Remove screw at front of inverter assembly mounting plate (figure 16). Lift assembly out of refrigerator.

3. Disconnect wiring from back of assembly (figure 17).

DOOR PANEL REMOVAL

1. Remove door(s) and place door on flat surface liner side down.

2. Remove bottom frame member by removing three screws, as shown in Figure 18.

3. Loosen three screws on both side frame members.

4. Trim panel can now be removed by sliding it out the bottom (figure 19).

COMPONENT INSTALLATION

DOOR INSTALLATION

1. Place lower door on bottom hinge pin and push door to its normal position.

2. Install center hinge pin (figure 9).

3. Place freezer door on its lower hinge pin and push door to its normal position.

4. Install top hinge pin and secure travel lock.

THERMOSTAT INSTALLATION

1. Install face plate to thermostat with two nuts and bolts.

2. Install three electrical leads shown in Figure 10.

3. Install sensing tube to freezer tray.

4. Position thermostat on cabinet wall and secure with four screws.

5. Install control knob.

INVERTER ASSEMBLY INSTALLATION

1. Connect wiring as shown in Figure 17.

2. Place inverter assembly in position and secure with screw at mounting plate, as shown in Figure 16.

3. Install kick plate.

COOLING UNIT INSTALLATION

1. Through opening in back of refrigerator position evaporator plates in cabinet.

2. Install mounting screws in compressor.

3. Install blind cover in rear opening (See figure 15). Tape in place.

4. Install sheet metal plate over rear opening (figure 13).

5. Install eight mounting screws in condenser.

6. Apply sealer (non-hardening caulking) to seal hole where capillary and return tubes pass through.

7. Connect electrical leads to compressor.

8. Install thermostat sensing tube to bottom of lower evaporator plate.

9. Secure evaporators with eight screws (figure 11).

10. Install refrigerator in MotorHome.

DOOR PANEL INSTALLATION

1. Slide panel up into position through the bottom.

2. Tighten screws on side frame member.

3. Install bottom frame member and secure with three screws (figure 18).

4. Mount door(s) back on refrigerator.

NORCOLD SPECIFICATIONS

Model	7.5 Cubic Ft.
Power	60 Watts
Compressor Amps Required	2.6 Amps
Compressor Volts Required (A.C. Operation)	22 to 24 Volts A.C.
Compressor Volts Required (D.C. Operation)	31.5 to 33.5 Volts A.C.
Compressor Motor Resistance	2-3 Ohms
Compressor Motor Speed	60 Strokes/Sec.
Inverter Output	11 Volts A.C.
Transformer Output	23 Volts A.C.
Input Voltage	12 Volts D.C. or 120 Volts A.C.
Refrigerant	R12
Refrigerant Charge	3.17 Ounces

SECTION 24E
ROOF MOUNTED AIR CONDITIONER

Contents of this section are listed below:

SUBJECT	PAGE NO.
General Information	24E-1
Safety Warnings	24E-5
Electrical Diagnosis	24E-6
Refrigeration System Diagnosis	24E-10
Cleaning Air Conditioner	24E-13
Air Conditioner Replacement	24E-13
Refrigeration System Service	24E-13
Special Tools	24E-15
Specifications	24E-15

GENERAL INFORMATION

DESCRIPTION

There are three configurations of roof mounted air conditioners. Two of these are single unit, and the other is a two unit system.

The single units are 1) a Mark IV unit (figure 1) with a 13,500 BTU rating 2) a Duo-Therm (figure 2) with a 13,500 BTU rating.

The two unit system has a Duo-Therm with a 13,500 BTU rating, forward mounted, and another Duo-Therm unit with a 11,000 BTU rating, rear mounted.

The refrigerant system consists of four major components: The compressor, the condenser, the capillary tube, and the evaporator. The components are connected by copper tubing and refrigerant circulates within this closed system.

COMPRESSOR (FIGURE 3)

The compressor pumps the refrigerant through the discharge line toward the condenser, and pulls

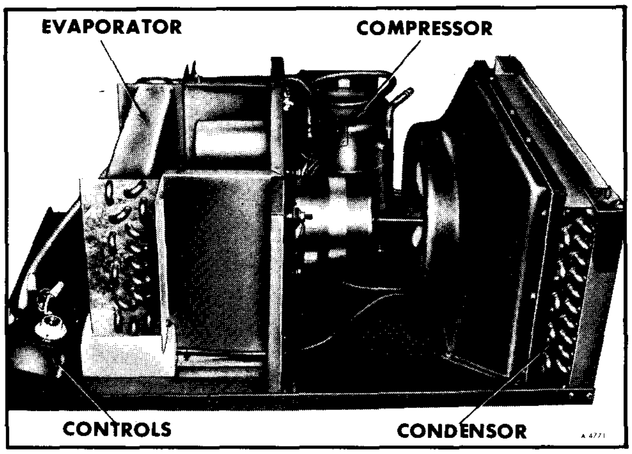


Figure 1—Mark IV Air Conditioner (Shroud Removed)

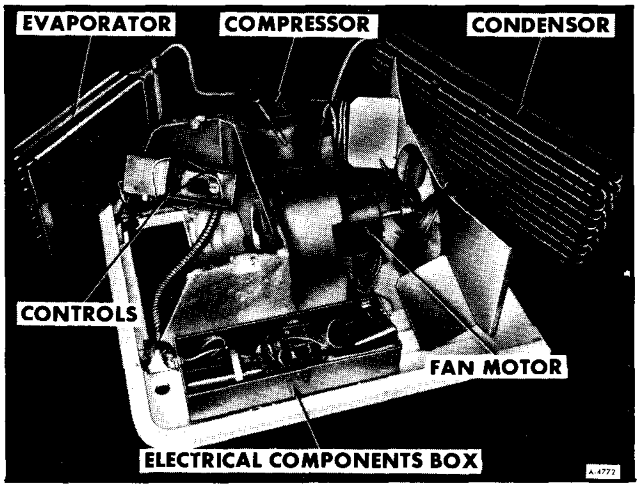


Figure 2—Duo-Therm Air Conditioner (Shroud Removed)

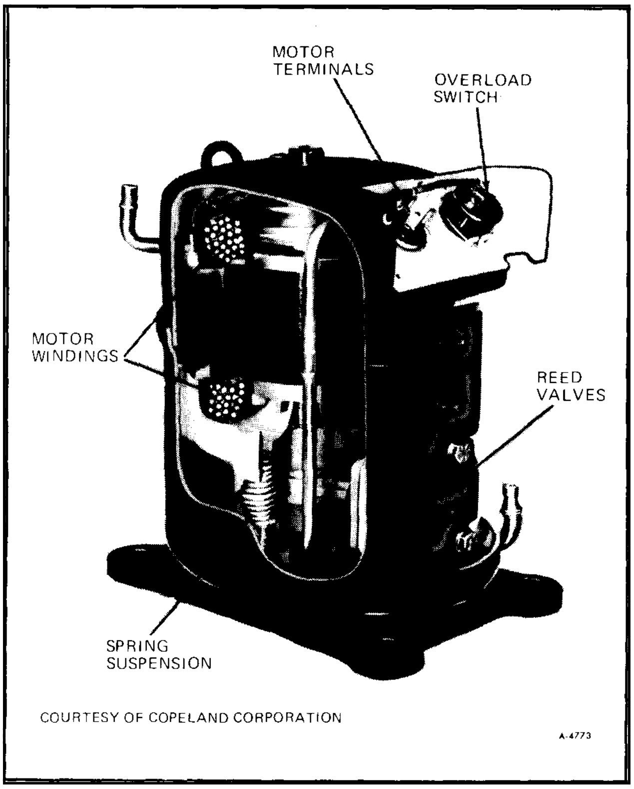


Figure 3—Compressor (Typical)

the refrigerant through the suction line from the evaporator.

It has a piston connected to the motor shaft by a connecting rod. The valves are reed type like those used in two cycle gasoline engines. The oil has been refined for a very low moisture and wax content to make it suitable for use in compressors. The compressor has motor, start, and run windings plus an overload switch.

CONDENSER (FIGURE 2)

The condenser transfers heat from the high pressure, high temperature, refrigerant gas inside the tubes to the outside air flowing across the fins. As the refrigerant gives up heat, its temperature decreases until, at this pressure, it reaches the point at which the gas condenses into a liquid. The liquid refrigerant then leaves the condenser and is forced through the capillary tube into the evaporator coil.

CAPILLARY TUBE (FIGURE 4)

The capillary tube is a metering device for converting high pressure liquid refrigerant into low pressure liquid refrigerant. It is a long thin copper tube from the evaporator to the condenser. The refrigerant charge is critical. Precise charging of an exact amount is required. Excess refrigerant will cause unit

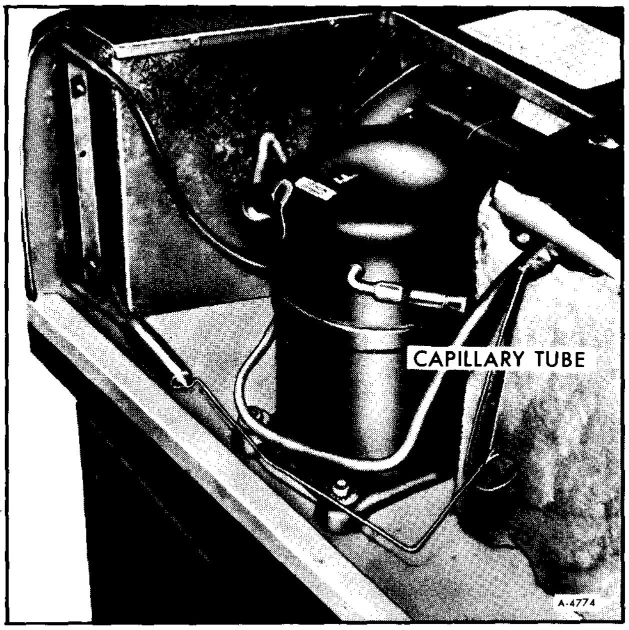


Figure 4—Capillary Tube (Typical)

to frost back on the low or suction side during off cycle.

EVAPORATOR (FIGURE 2)

Refrigerant-22 will boil at low temperature when it is under low pressure. In the evaporator at 70 psi gauge pressure, it will boil or vaporize at about 40°F. (4.4°C.) The vehicle interior air being blown across the fins of the evaporator by a fan or blower will lose its heat to the cold liquid refrigerant as the latter rapidly changes to a gas.

A typical air conditioning system is shown in Figure 5.

ELECTRICAL COMPONENTS (FIGURES 6 and 7)

BLOWER SWITCH (MARK IV)—Rotary type with high fan, low fan, high cool, low cool, and off positions.

BLOWER SWITCH (DUO-THERM)—Rotary type with high fan, medium fan, low fan, high cool, medium cool, low cool, and off positions.

THERMOSTAT—Return air sensing type to control inside vehicle temperature and prevent evaporator freeze up.

POTENTIAL (OR START) RELAY—After starting unit, closed points will open, breaking electrical current

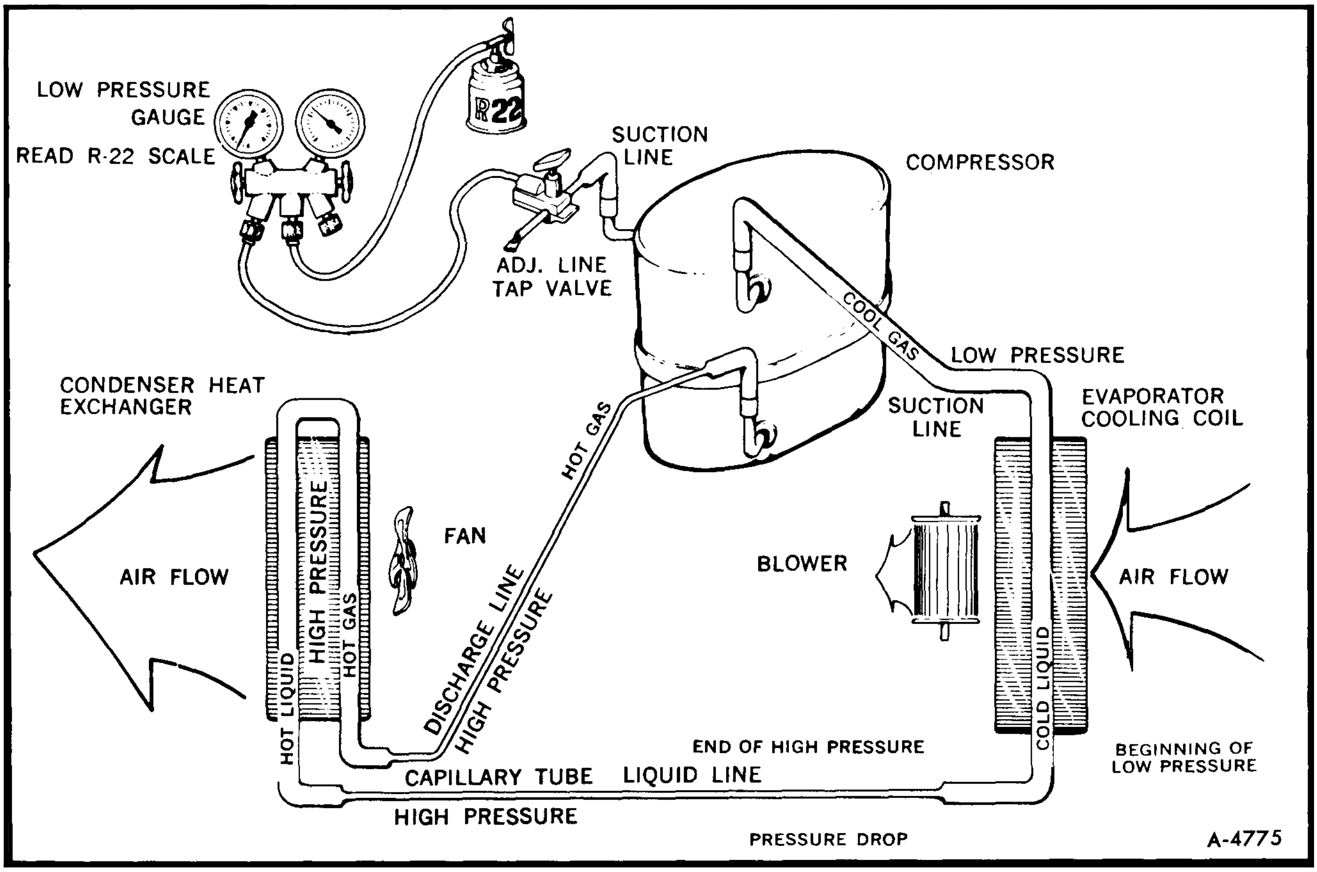


Figure 5—Typical Air Conditioning System

through compressor start capacitor thus causing current to flow only through compressor run capacitor.

COMPRESSOR START CAPACITOR—Is used to throw the start and run windings current out of phase to create the torque required to start the motor. It is designed for intermittent usage and is disconnected when the motor comes up to speed.

COMPRESSOR RUN CAPACITOR—Is designed for continuous duty. It increases motor efficiency while improving power factor and reducing amperage.

OVERLOAD PROTECTOR—External protector is connected in series with compressor and all power to the compressor passes through the protector. The protector is designed to carry normal starting and operating currents. The bi-metal disc is affected by both current and shell temperatures and will disconnect the compressor if either becomes excessive.

FAN MOTOR RUN CAPACITOR—Is designed for continuous duty. It increases motor efficiency while improving power factor and reducing amperage.

TIME DELAY RELAY—(DUO-THERM)—Is designed to energize after an approximately two minute delay, to allow the refrigeration system to equalize before compressor starts.

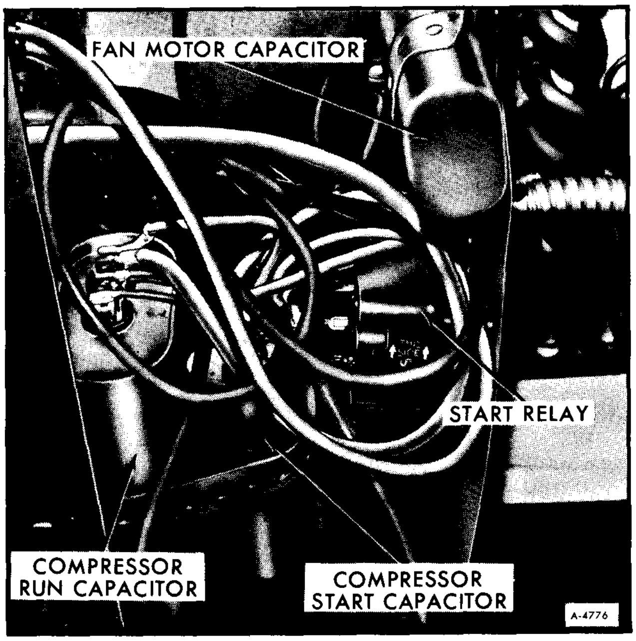


Figure 6—Electrical Components (Mark IV)

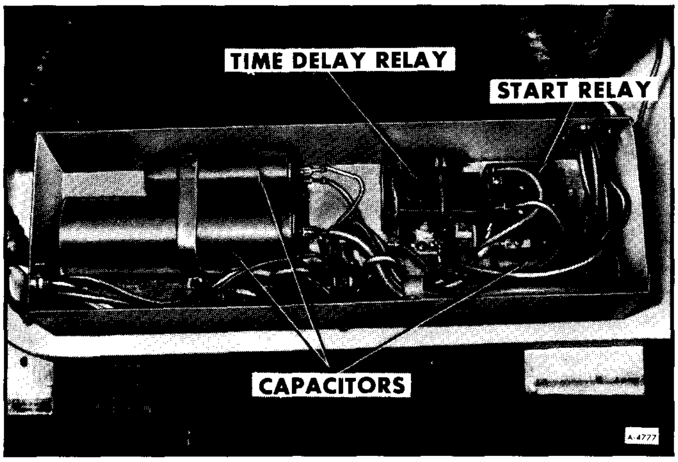


Figure 7—Electrical Components (Duo-Therm)

REFRIGERANT

Refrigerant 22; clean, dry and free from contamination, is the only fluid to be used. It is non-toxic, non-corrosive, non-flammable, non explosive, and odorless under ordinary usage.

TEMPERATURE—PRESSURE CHART

Temp. Deg. C.	Temp. Deg. F.	Pressure PSIG R-22	Temp. Deg. C.	Temp. Deg. F.	Pressure PSIG R-22	Temp. Deg. C.	Temp. Deg. F.	Pressure PSIG R-22	Temp. Deg. C.	Temp. Deg. F.	Pressure PSIG R-22
-6.7	20	43.0	13.9	57	96.1	34.4	94	179.1	55.0	131	300.7
-6.1	21	44.1	14.4	58	97.9	35.0	95	181.8	55.6	132	304.6
-5.5	22	45.3	15.0	59	99.8	35.6	96	184.6	56.1	133	308.6
-5.0	23	46.4	15.6	60	101.6	36.1	97	187.4	56.7	134	312.6
-4.4	24	47.6	16.1	61	103.5	36.7	98	190.2	57.2	135	316.6
-3.9	25	48.8	16.7	62	105.4	37.2	99	193.0	57.8	136	320.7
-3.3	26	50.0	17.2	63	107.3	37.8	100	195.9	58.3	137	324.8
-2.8	27	51.2	17.8	64	109.3	38.3	101	198.8	58.9	138	328.9
-2.2	28	52.4	18.3	65	111.2	38.9	102	201.8	59.4	139	333.1
-1.7	29	53.6	18.9	66	113.2	39.4	103	204.7	60.0	140	337.3
-1.1	30	54.9	19.4	67	115.2	40.0	104	207.7	60.6	141	341.5
-0.6	31	56.2	20.0	68	117.3	40.6	105	210.8	61.1	142	345.8
0	32	57.5	20.6	69	119.4	41.1	106	213.8	61.7	143	350.1
0.6	33	58.8	21.1	70	121.4	41.7	107	216.9	62.2	144	354.5
1.1	34	60.1	21.7	71	122.5	42.2	108	220.0	62.8	145	358.9
1.7	35	61.5	22.2	72	125.7	42.8	109	223.2	63.3	146	363.4
2.2	36	62.8	22.8	73	127.8	43.3	110	226.4	63.9	147	367.8
2.8	37	64.2	23.3	74	130.0	43.9	111	229.6	64.4	148	372.4
3.3	38	65.6	23.9	75	132.2	44.4	112	232.8	65.0	149	376.9
3.9	39	67.1	24.4	76	134.5	45.0	113	236.1	65.6	150	381.5
4.4	40	68.5	25.0	77	136.7	45.6	114	239.4	66.1	151	386.2
5.0	41	70.0	25.6	78	139.0	46.1	115	242.7	66.7	152	390.9
5.5	42	71.5	26.1	79	141.3	46.7	116	246.1	67.2	153	395.6
6.1	43	73.0	26.7	80	143.6	47.2	117	249.5	67.8	154	400.4
6.7	44	74.5	27.2	81	146.0	47.8	118	253.0	68.3	155	405.2
7.2	45	76.0	27.8	82	148.4	48.3	119	256.4	68.9	156	410.0
7.8	46	77.6	28.3	83	150.8	48.9	120	259.9	69.4	157	414.9
8.3	47	79.2	28.9	84	153.2	49.4	121	263.5	70.0	158	419.9
8.9	48	80.8	29.4	85	155.7	50.0	122	267.0	70.6	159	424.8
9.4	49	82.4	30.0	86	158.2	50.6	123	270.6	71.1	160	429.9
10.0	50	84.0	30.6	87	160.7	51.1	124	274.3	71.7	161	434.9
10.6	51	85.7	31.1	88	163.2	51.7	125	278.0	72.2	162	440.1
11.1	52	87.4	31.7	89	165.8	52.2	126	281.7	72.8	163	445.2
11.7	53	89.1	32.2	90	168.4	52.8	127	285.4	73.3	164	450.4
12.2	54	90.8	32.8	91	171.0	53.3	128	289.2	73.9	165	455.7
12.8	55	92.6	33.3	92	173.7	53.9	129	293.0			
13.3	56	94.3	33.9	93	176.4	54.4	130	296.8			

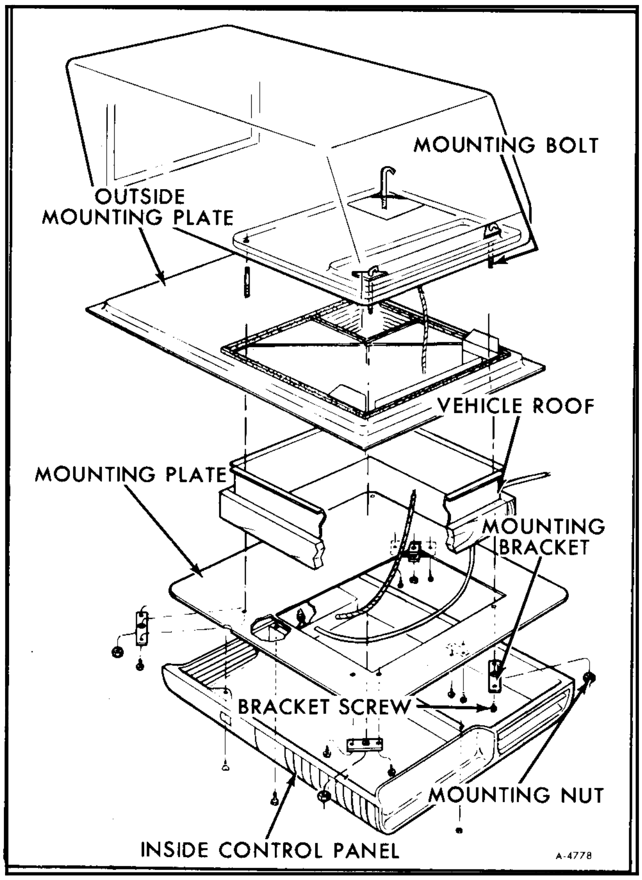


Figure 8—Duo-Therm Air Conditioner Exploded View

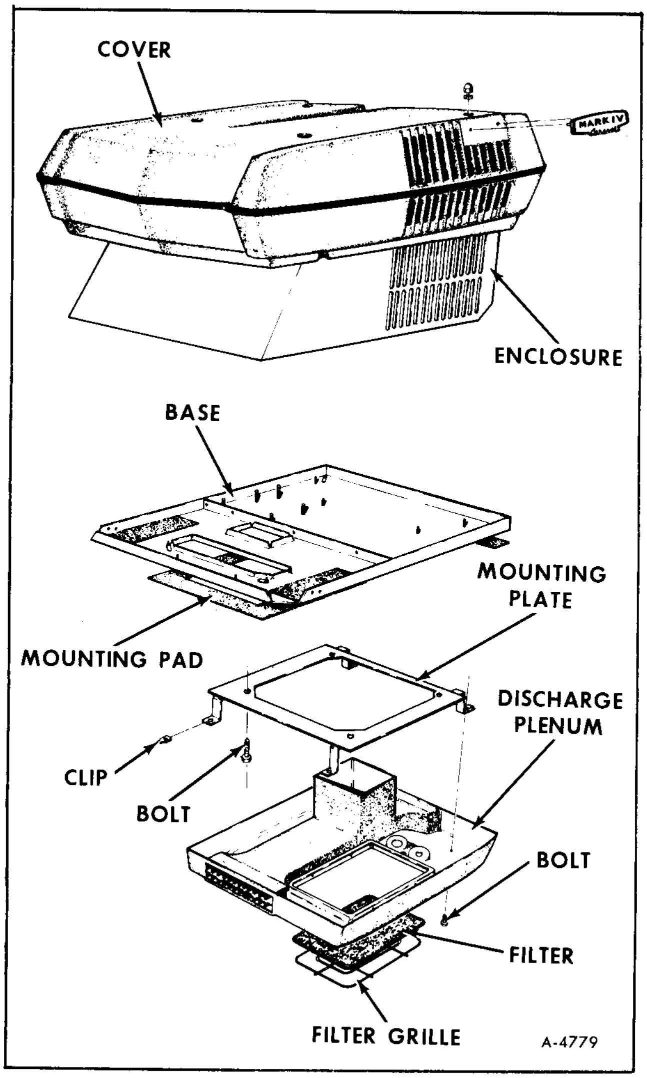


Figure 9—Mark IV Air Conditioner Exploded View

SAFETY WARNINGS

Under some circumstances R-22 can be dangerous. The following warnings describe those circumstances. Careful attention must be paid to these WARNINGS during servicing and testing.

WARNING: ALWAYS WEAR GOGGLES WHEN OPENING THE REFRIGERATION SYSTEM. REFRIGERANT LIQUID OR GAS CAN PERMANENTLY DAMAGE THE EYES.

WARNING: NEVER APPLY HEAT FROM A TORCH TO A SEALED REFRIGERATION SYSTEM. REFRIGERANT WILL EXPAND RAPIDLY WITH HEAT AND COULD CAUSE AN EXPLOSION. (THE PROCESS TUBE MAY BE SILVER SOLDERED AFTER BEING CRIMPED NEAR THE END).

WARNING: REFRIGERANT 22 IN THE PRESENCE OF AN OPEN FLAME PRODUCES PHOSGENE GAS—A TOXIC LUNG IRRITANT—DO NOT BREATH IT. VENTILATE SERVICE AREA IMMEDIATELY WHEN R-22 IS DISCHARGED.

WARNING: DO NOT USE REFRIGERANTS OTHER THAN R-22, NEVER USE METHYL CHLORIDE REFRIGERANTS, WHICH CAUSE A CHEMICAL REACTION WITH ANY ALUMINUM PART OF THE SYSTEM, RESULTING IN THE FORMATION OF PRODUCTS WHICH BURN SPONTANEOUSLY ON EXPOSURE TO AIR OR DECOMPOSE WITH VIOLENCE IN THE PRESENCE OF MOISTURE.

WARNING: HANDS CAN BE PAINFULLY INJURED IN EVAPORATOR FAN, BLOWER WHEELS, AND ON EVAPORATOR COIL FINS.

WARNING: WHEN FLUSHING OR PURGING A CONTAMINATED SYSTEM, CAUSED BY A COMPRESSOR MOTOR BURNOUT, PROTECT EYES AND SKIN FROM CONTACT WITH ACID SATURATED REFRIGERANT OR OIL MIST.

WARNING: IF REFRIGERANT SHOULD COME IN CONTACT WITH THE EYES:

WARNING: 1. DO NOT RUB THE EYES. SPLASH THE EYES WITH COLD WATER GRADUALLY TO GET THE TEMPERATURE ABOVE THE FREEZING POINT.

WARNING: 2. APPLY A PROTECTIVE FILM OF AN ANTISEPTIC OIL OVER THE EYEBALL TO REDUCE THE POSSIBILITY OF INFECTION.

WARNING: 3. CONSULT A DOCTOR OR AN EYE SPECIALIST IMMEDIATELY.

WARNING: SHOULD LIQUID REFRIGERANT COME IN CONTACT WITH THE SKIN, THE INJURY SHOULD BE TREATED THE SAME AS THOUGH THE SKIN HAD BEEN FROSTBITTEN OR FROZEN.

WARNING: KEEP OUT OF REACH OF CHILDREN. INTENTIONALLY INHALING VAPORS TO PRODUCE INTOXICATION IS HARMFUL AND MAY BE FATAL.

ELECTRICAL DIAGNOSIS

WARNING: THIS IS A 120-VOLT SYSTEM. WHERE POSSIBLE, TURN POWER OFF AND USE CONTINUITY CHECKS IN PLACE OF POWER CHECKS. DON'T TOUCH THE TERMINALS OF A CAPACITOR WITHOUT DISCHARGING IT FIRST TO AVOID POSSIBLE PERSONAL INJURY.

COMPRESSOR FAILS TO START

Problem	Remedy
1. Compressor siezed up.	1. Add an extra start capacitor to the compressor start capacitor for a temporary charge boost at start. Compressor may break loose. Remove at once if it starts. If allowed to run with extra capacitor attached, it will burn up.
2. Voltage to compressor (figure 10).	2. Check for voltage at compressor with controls on. Connect negative test probe to the M or R common wire terminal, and positive lead to overload or O terminal. There should be a reading of 110 to 120 volts to the overload, and through the overload to the compressor O terminal.

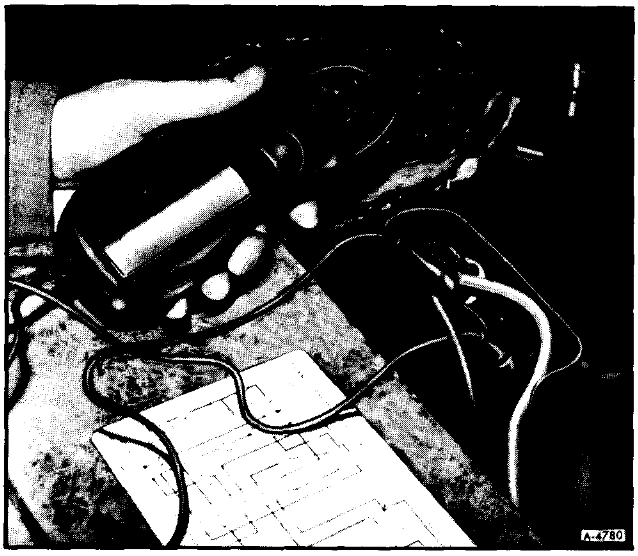


Figure 10—Voltage to Compressor Check

Problem	Remedy
3. Circuit breaker box.	3. If there is no voltage to the compressor, check the circuit breaker box. Be sure there is power to the circuit, then check the circuit back to the power source to find out where it's open. Make these checks with a voltmeter negative (black) probe at any common (white) wire terminal, and the positive (red) probe at the terminal being tested.
a. Overload switch or circuit breaker	a. Check for power to and from the overload. If there is no power from the overload, but power is okay to the overload, the overload is open. Wait 15 minutes for the overload to cool. If it doesn't reset, replace it.
b. Time delay relay (figure 11).	b. If the time delay relay has power in, there should be power out within three minutes. Close the contacts with a stick of wood or insulated handle screwdriver. Hold them closed long enough for the compressor to start. If the compressor starts and stays running after you release the contacts, replace the relay.

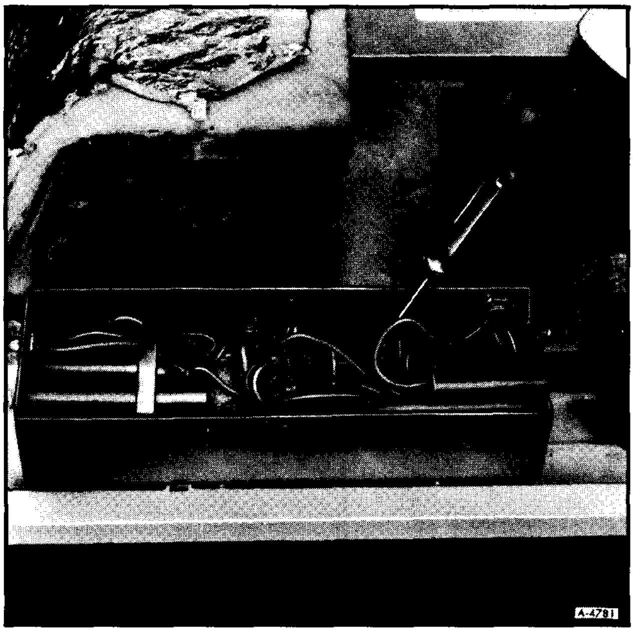


Figure 11—Time Delay Relay Check (Duo-Therm Only)

Problem	Remedy
c. Thermostat (figure 12).	c. The thermostat will open around 70°F. (21.1°C.) so be sure the temperature is warmer than 70°F. (21.1°C.) before checking the power out. If power is available at the black wire terminal, there should be power out of the terminals for each switch position. Power should be received in all cooling positions. With the power off and the leads disconnected, check the switch for continuity with an ohmmeter or self-powered test light. For a positive continuity check of the thermostat, put the sensing probe in warm water (100°F.) (37.8°C.) and check for a closed circuit. Then check for an open circuit at all dial settings with the tube in cold water (50°F.) (10°C.).

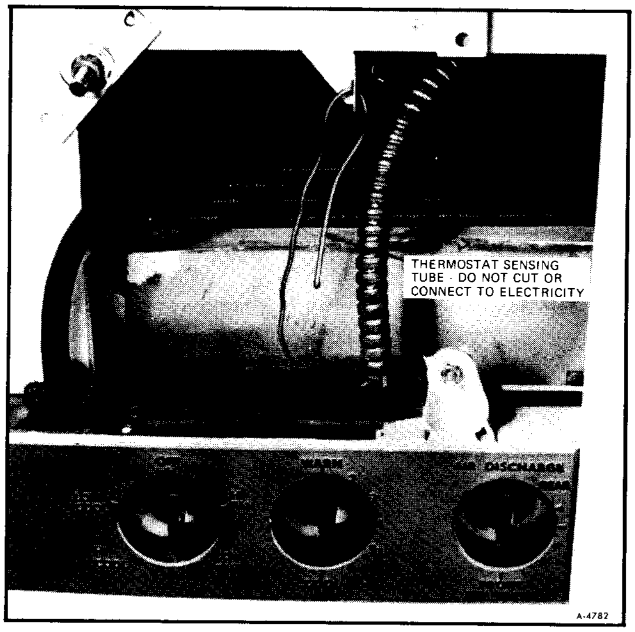


Figure 12—Thermostat Sensing Tube (Typical)

Problem	Remedy
4. Fan Motor (figures 1 and 2).	4. Disconnect the leads to the fan motor at the box and check for continuity from the white wire through each of the other leads. If there is an open circuit through any winding, replace the motor. Check for shorts to the case by connecting the ohmmeter between the case and each power lead. If there is continuity, replace the motor. If the fan runs but not at full speed, check the motor capacitor as described later.

COMPRESSOR STARTS, THEN CUTS OUT

Problem	Remedy
1. Campsite power.	1. One frequent cause is not enough power at the campsite due to inadequate wiring or power availability. The air conditioner is designed to use No. 12 gauge A/C wire cord. The campsite power supply should be 120-volt AC.
2. Vehicle overloading.	2. The air conditioner may cut out when other appliances are operated on the 120-volt vehicle system due to overloading.
3. Compressor winding continuity.	3. Turn power off and disconnect the compressor leads. Use ohmmeter to check start winding continuity between the O and S terminals; run winding continuity between the O and the M or R terminal; then check for continuity between the two winding terminals. If there is an open circuit in any of the checks, replace the compressor.
4. Grounded compressor windings.	4. Connect the ohmmeter between one of the copper tubes and each of the winding terminals. There should be an open circuit in each case. If not the winding is grounded, replace the compressor.
5. Shorted compressor windings.	5. Use a precision ohmmeter with a 0-to-5 and 0-to-25 ohm scale. Check each winding resistance and combined resistance against specifications. Low resistance indicates a shorted winding and the compressor should be replaced.
6. Motor generator.	6. If the unit works when connected to an external power source but not from the generator the problem may be poor motor generator maintenance. Check the generator voltage. The motor generator must be set to 60 cycles plus or minus one. Check with a cycle meter (J-24673). The generator may cut out due to an excess current draw caused by high head pressure. This condition can be created by a high heat load when the vehicle has been in the hot sun all day. The return air to the evaporator may be as high as 150°F (65.6°C.) and the compressor will cut out until it cools.
7. Compressor draw.	7. Put a snap-around amprobe around the power wire. It should read about 16 amps with the compressor running. Too much draw steadily, can indicate an overcharge of refrigerant or a shorted winding. A low draw can indicate an undercharge.

COMPRESSOR IS OKAY, CHECK CAPACITORS AND RELAY

Problem	Remedy
1. Capacitors.	1. With the power off connect the self-powered test light (J-21008) to the capacitor terminals. If the capacitor has an identified terminal, the

	lead with the black tip goes to it. The start capacitor is checked with the tester switch in position "A"; a run or fan motor capacitor in "B". Plug the tester into any 120 volt source. Push the button down and look at the light on top of the tester. If the capacitor is good the light will flash off and on. If the light stays on it indicates a short; if it flickers it indicates a leak; replace the capacitor.
2. Start Relay	2. Remove leads and check with ohmmeter for continuity between start winding terminal and start capacitor terminal. If the contacts are open, replace the relay. Clip amprobe around lead to the start capacitor. Start the compressor. It should show two or three amps for only a couple of seconds, then zero current when the relay cuts out. If current continues after the compressor starts, replace relay.

REFRIGERATION SYSTEM DIAGNOSIS
AIR CONDITIONER FAILS TO COOL

Problem	Remedy
1. Compressor starts and runs.	1. If the compressor starts and runs then the problem is in the refrigeration system and more checks can be made. If the compressor fails to start and/or run steadily, check the electrical system.
2. Temperature check.	2. Place a good refrigeration thermometer close to the center on both the return and blower sides of the evaporator. If the temperature difference is from 18 to 23°F. (9 to 13°C.), the system is okay. It is cooling the air as much as it can. If the temperature difference is less than 18°F. (9°C.), check further before opening the refrigeration system.
3. Clean components, fan motor rotation.	3. Clean any dirt or obstructions that may effect the operation of the air filter, blower wheel, and evaporator fins. Check fan motor rotation. Blower should pull air through evaporator without obstruction.
4. Leaks or kinks	4. Inspect coils, lines, and connections for pinch, kink, or obvious leak indicated by compressor oil.
5. Capillary tube obstruction (figure 13).	5. Feel along the capillary tube for a temperature change. It should be the same temperature at both ends. If not, it is restricted, and must be replaced.

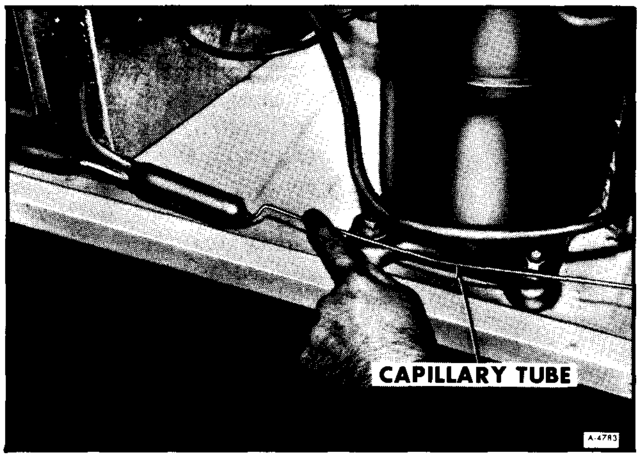


Figure 13—Capillary Tube Obstruction Check

Problem	Remedy
6. Superheat charge test (figure 14).	6. Install manifold gauge set. Tape an accurate thermometer to the suction line about six inches from the compressor. Insulate the thermometer tube and tip so that it will measure the line temperature. Let the system run 10 to 15 minutes with the shroud in place, then read the temperature and pressure. Compare with the temperature pressure chart for R-22 found earlier in this section. Superheat is the difference between actual and chart temperature. It should be from 15 to 25°F. (8 to 14°C.). High superheat indicates an undercharge-charge the system, or it may indicate a restriction. See checks 4 and 5. Low superheat indicates an overcharge-bleed the system.

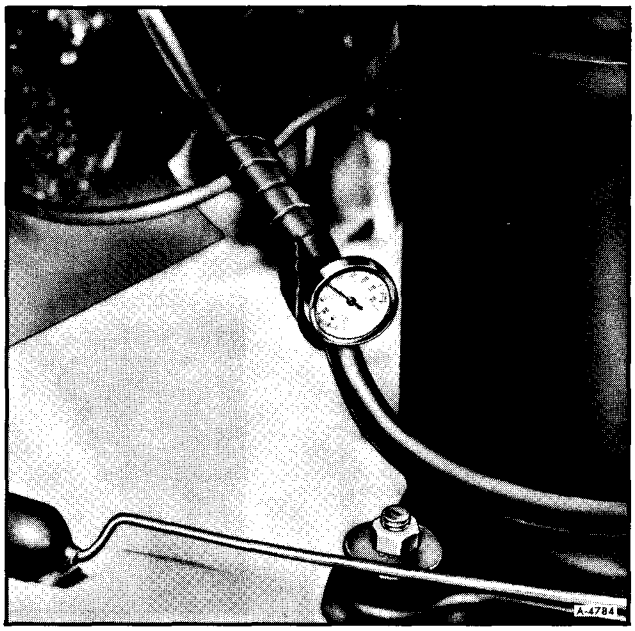


Figure 14—Superheat Charge Test Thermometer

Problem	Remedy
7. Leak test.	7. Shut off the compressor and charge the system with refrigerant to about 150 pounds. If you use the torch type detector J-6084 (figure 15), the reactor plate in the detector must be red hot during use and needs replacement when the copper burns away, about every two weeks under normal use. Move the tester probe slowly around all possible leakage points and watch the flame for a color change. With an electronic detector J-23400-01 (figure 16), listen for the signal. Refrigerant is heavier than air, so it may not be detectable directly above a leak, but only beneath it.
8. Burnout check.	8. During a compressor replacement, check the oil for evidence of an electrical burnout. **WARNING: DO NOT GET OIL ON YOUR HANDS. IF ACID HAS FORMED SEVERE BURNS CAN RESULT.** A dark oil with burnt odor means the system is contaminated. Remove the capillary tube and dryer as well as the compressor. Backflush the evaporator and condenser with a pound of refrigerant or commercial flushing agent such as "purge". Replace any plugged tubes. Then thoroughly evacuate the system before charging it.

Figure 15—Torch Type Leak Detector

Figure 16—Electronic Leak Detector

CLEANING AIR CONDITIONER

For proper operation the unit should be clean. Before any tests or repair work is started, check the filter. The filter should be checked and cleaned regularly as use requires. If filter is dirty, wash in soapy water and allow to dry. Do not use compressed air to dry filter.

Next, open the shroud that covers the air conditioner outside of the vehicle. If dirt, leaves, or other material is lodged inside it will effect the operation of the unit. Clean such debris away. Make sure nothing is blocking the moving parts of the fan or blower.

If the air conditioner still does not operate properly, proceed with further tests.

AIR CONDITIONER REPLACEMENT

The Mark IV and Duo-Therm units (figures 1 and 2) are mounted in similar manner. The inside panel which includes the controls, the filter access, and air directing vents, is bolted through the mounting hole in the roof to the air conditioning unit mounted outside to the roof of the vehicle.

For convenience and safety, it is best to remove the unit from the roof of the vehicle to a shop bench for tests or repair.

WARNING: USE CARE WHEN REMOVING AIR CONDITIONING UNIT FROM ROOF OF VEHICLE, TO AVOID FALL BY SERVICE PERSONNEL, OR DROPPING UNIT.

REMOVAL

1. Turn air conditioner off. Make sure that motor generator and external power source are disconnected. Circuit breaker for air conditioner, located in living area electrical compartment should be turned off.

2. Remove bolts or nuts from inside panel. Remove inside panel.

3. Disconnect vehicle air conditioning electrical harness from air conditioner.

4. Disconnect bolts and nuts that secure unit to roof of vehicle. Remove unit.

INSTALLATION

Reverse the removal procedure.

REFRIGERATION SYSTEM SERVICE

BREAKING INTO THE REFRIGERATION SYSTEM (FIGURE 17)

1. Clamp the tap valve on the process tube as close as possible to the pinched end. Turn the valve handle to puncture the line.

2. Attach the gauge set suction valve to the tap valve.

REPAIRING OR REPLACING REFRIGERATION COMPONENTS

1. When you locate a leak, shut off the refrigerant and attach a discharge hose to the center manifold. Route the hose into an exhaust hose or shop exhaust system.

2. Discharge the refrigerant slowly and watch that the compressor oil doesn't come out with refrigerant. If you see oil, slow down the discharge rate.

3. When the pressure is five pounds or less you can open the system to repair it.

SOLDERING AND BRAZING

All connections are made by brazing. The parts to be brazed, must be clean. Polish with a wire brush or emery cloth until they shine.

The recommended material for connections is Sil-Flos or equivalent. Use just enough heat so it will melt and flow when touched to the metal.

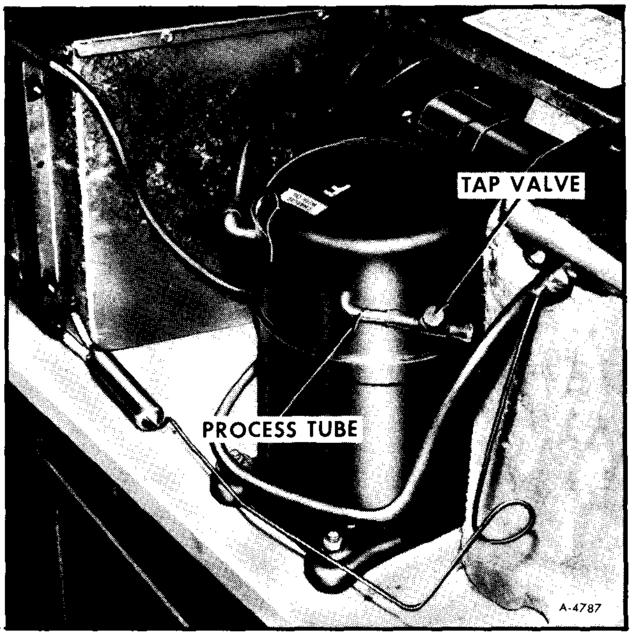


Figure 17—Breaking into the Refrigeration System (Typical)

CAPILLARY TUBE

Never try to repair the capillary tube. It is a metering device and the length and diameter are critical. Install a new tube that exactly duplicates the original. Avoid using too much solder since the open end could be easily plugged.

SAFETY VALVE—DUO THERM

The rectangular piece soldered on the suction line as it comes out of the evaporator is not a patch to cover up an accident.

The patch was soldered in place with a soft solder that will melt in case of fire allowing the refrigerant to escape before the system pressure becomes dangerously high.

COMPRESSOR

The replacement of a compressor because of mechanical failure or very mild electrical burnout is a simple operation.

A severe electrical burnout however usually creates an acid condition throughout the system. If all the acid and other contaminates are not removed the new compressor will be short lived.

A severe burnout will usually be indicated by a characteristic odor of burned insulation when the system is opened. If there is any doubt about the burnout, pour some oil out of the compressor into a shallow pan for observation and testing.

WARNING: DO NOT TOUCH THE OIL WITH YOUR HANDS IF THERE IS A BURNT SMELL, IT MAY HAVE FORMED ACID.

If the oil is clear and free of odor the system is probably free of contamination. If the oil is dark and has an odor, acid has probably formed in the system.

The use of an acid test kit will give you a positive indication of the system condition.

If the system is contaminated discharge all refrigerant from the system. Remove burned compressor, capillary tube and drier. While the system is open flush it, in reverse of normal flow pattern, with either a pound of refrigerant 22 or use "Purge" or equivalent followed by a brief flush of 22.

If the system has been contaminated to the extent that solids have been formed it is a good idea to tie a cloth over one of the open ends to catch the material blown out. This will give you a visual indication if further flushing is necessary.

If the original cap tubes are open they can be reinstalled. If plugged they should be replaced. Install replacement compressor, the filter at the outlet of the condenser and the filter-dryer in the suction line between the compressor and evaporator. Install process tube with charging port at the compressor.

Install the charging port in tubing of sufficient length so it can be removed after evacuation, recharging and leak testing. This will give the customer a hermetically sealed system and one you can be confident will be performing as originally designed.

If the compressor failure was caused by a mechanical failure or if no acid was found when you tested the original oil the flushing operation can be omitted. Most failures are of this nature.

Systems that are contaminated to the point solids have been formed are usually caused by poor prior service where air and/or acids have been left in the system from incomplete evacuation and cleanup.

EVACUATING AND CHARGING SYSTEM (FIGURE 18)

1. Connect a vacuum pump to the manifold. Purge the vacuum hose of charging station (J-24410) before starting the pump. If you have a micron type vacuum pump, run it until the gauge reads 200 to 500 microns. This may take some time, since all the moisture has to boil before the gauge will read. With an automotive pump, pull the system down to about 29-1/2 inches or as close to it as the system will go.

NOTE: Gauge readings at higher altitudes will be less than the sea level rating of 29-1/2 inches Hg. Warming the unit in high altitudes and/or low temperatures will make the air or water in the system vaporize more readily. To warm, place the unit directly in front of a shop heater, or paint drying lights. Do not use any direct flame for warming.

The pump can be tested by connecting it to a clear soft-drink bottle, 3/4 full of water. If the water in the bottle begins to bubble, the pump is functioning.

2. If an automotive pump is used, "break" the evacuation vacuum twice with a charge of R-22 to about 100 psi and repeat the evacuation to be sure to get all air and moisture out. This is not necessary with charging station J-24410.

3. Leak test the system. Stop the vacuum pump and watch the gauge. If the vacuum holds, the system is tight and can be charged.

4. Connect the dial-a-charge or charging station in place of the pump. Purge the line briefly at the gauge port, then admit the specified charge.

CAUTION: *Be sure to measure the charge accurately. The specification is critical with the capillary tube metering system. Each air conditioning unit has an identification tag that specifies the exact charge for that unit.*

5. If necessary during charging, start the compressor and run it until the charge enters. When the charge is in, shut off the refrigerant.

CLOSING THE REFRIGERATION SYSTEM

1. Pinch off the process tube next to the tap valve. Remove the tap valve.

2. Cut off the tube and braze the end to hermetically seal the system before you remove the pinching tool. The pinch off tool acts as a heat sink during the brazing, preventing decomposition of the refrigerant.

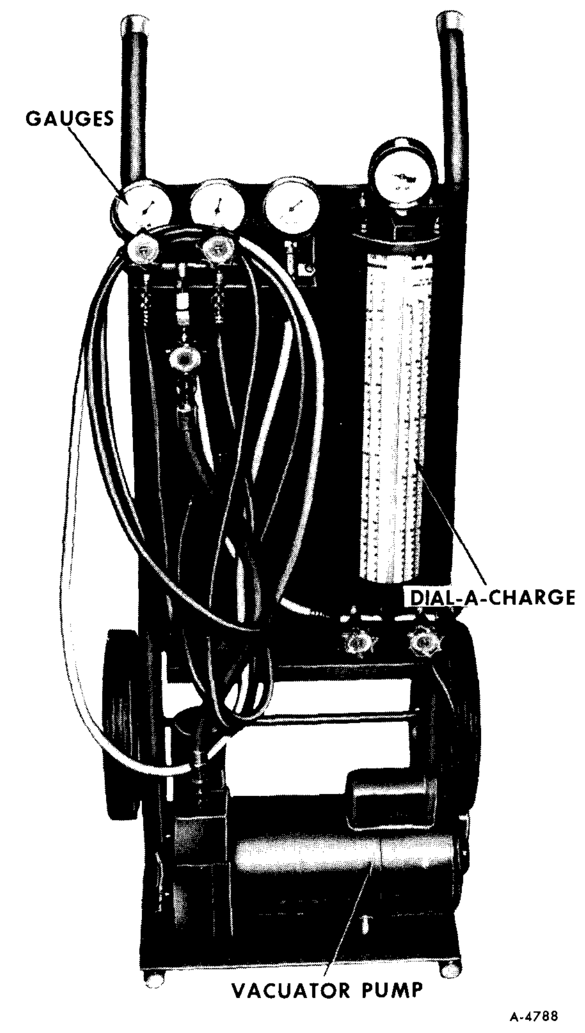


Figure 18—Charging Station J-24410

SPECIAL TOOLS

J-24673	Cycle Tester
J-21008	Self-Powered Test Light
J-6084	Leak Detector, Flame Type
J-23400-01	Leak Detector, Electronic
J-24410	Charging Station

SPECIFICATIONS

COMPRESSOR MOTOR RESISTANCE VALUES

Model	Windings Resistance in Ohms +10% Start	Run
54615	4.83	.378

SECTION 24F
LP GAS SYSTEM

The contents of this section are listed below:

SUBJECT	PAGE NO.
Description	24F-1
Trouble Diagnosis	24F-2
On-Vehicle Adjustment	24F-3
Regulator	24F-5
Component Replacement	24F-5
Fill Valve	24F-5
Liquid Level Outage Valve	24F-6
Vapor POL Valve	24F-6
Regulator	24F-6
Gas Tank Sight Valve Dial	24F-6
Gas Tank Float Assembly	24F-7
LP Gas Tank	24F-7
LP Gas Lines and Fittings	24F-8
LP Gas Tank Purge	24F-8

WARNING: EMPTYING THE LP GAS TANK SHOULD BE DONE BY AN AUTHORIZED LP GAS DEALER.

IMPORTANT: The LP Gas System will not operate correctly if the tank is overfilled. An overfilled tank will not allow proper vapor pressure to develop and the entire system will cycle between near normal pressure (11 inches of water pressure) and a much lower pressure which will not allow the appliances to operate.

DESCRIPTION

The LP (liquid petroleum) gas system supplies fuel for the range/oven and furnace as shown in Figure 1. The LP gas tank, which stores the fuel, is located in the compartment at the right rear of the vehicle. The LP gas tank is 42″ long and holds 62 lbs. of LP gas. The tank is equipped with a fill valve, liquid level outage valve, vapor POL valve, tank float gauge assembly and a regulator.

The gas lines on the MotorHome are laid out so that most connections are outside the vehicle. The lines go inside the vehicle only to reach an appliance.

NOTE: Always leak test the entire LP gas system after performing any service or maintenance on the LP gas system. See "Leak Test" later in this section.

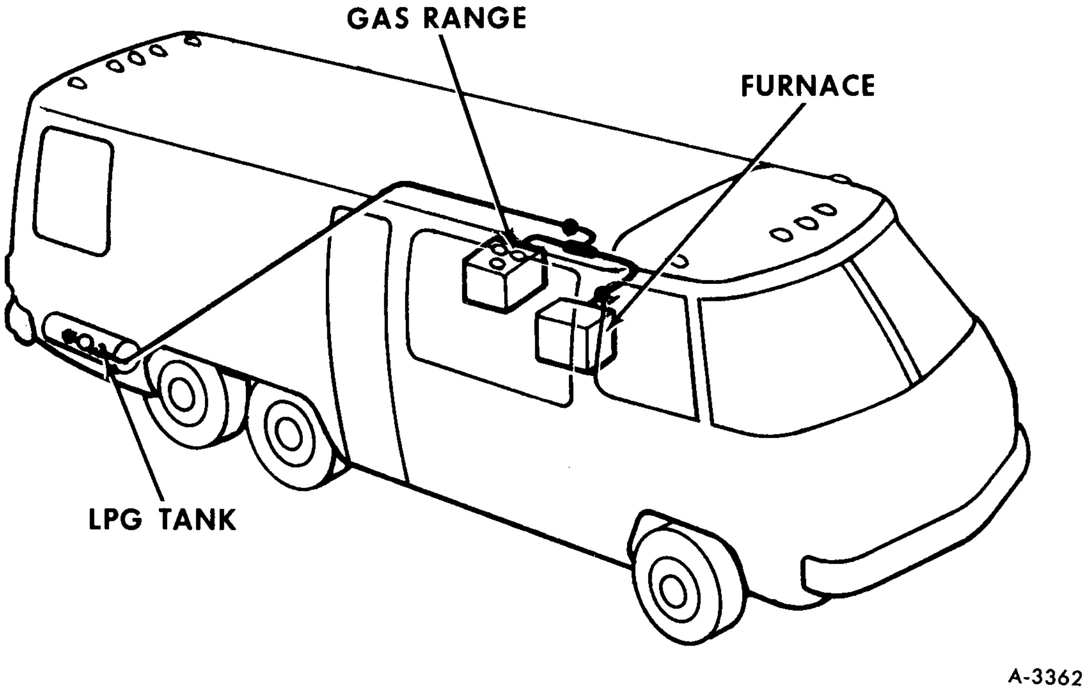


Figure 1—L.P. Gas System

TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
Gas appliances won't operate.	Appliance faulty	Refer to "TROUBLE DIAGNOSIS" in the particular section for correction.
Insufficient gas supply	Vapor POL valve not open completely. Regulator out of adjustment	Open valve completely. Refer to "ON VEHICLE ADJUSTMENTS" for regulator pressure specifications.
	Leak in LP gas system.	Make up a soap solution. Apply to all fittings. If bubbles occur a leak is present. Inspect fitting for damage or cracks. Replace fitting if necessary. Use only A.G.A. (American Gas Approved) fittings. Otherwise tighten fitting.

Condition	Possible Cause	Correction
	LP gas tank has been overfilled and regulator has frozen up.	Empty LP gas tank. Refer to "LP GAS TANK-REMOVAL" later in this section for proper procedure of emptying tank. Refill tank correctly, see "WARNING" at beginning of this section. In freezing weather add 1 pint of suitable tank and gas line anti-freeze. Then using a monometer check regulator. Refer to "ON-VEHICLE ADJUSTMENTS" later in this section.
	In freezing weather, water in the system may freeze and block regulator or lines.	Empty LP gas tank. Refer to "LP GAS TANK-REMOVAL" later in this section for proper emptying and removal of the tank. Flush out tank with a suitable gas system anti-freeze. Add 1 pint of same anti-freeze to tank and fill with LP gas.
Leaking fill valve assembly or liquid level outage valve.	Damaged or dirt in mechanism.	Replace valve or valve seat. Refer to specific subjects later in this section.
Gas tank is known to be full, however, the tank sight valve does not indicate full.	Damaged float or sight valve.	Replace float and/or sight valve as described later in this section.

ON-VEHICLE ADJUSTMENT

REGULATOR

The regulator shown in Figure 2 is adjustable and is set at the factory to deliver LP gas at a rate of 11 $\pm$ 1 inches of water pressure as measured on a manometer.

ADJUSTMENT

WARNING: FAILURE TO PERFORM REGULATOR ADJUSTMENT ACCURATELY COULD RESULT IN IMPROPER OPERATION OF LP GAS APPLIANCES WITHIN MOTOR HOME AND BE A HEALTH AND SAFETY HAZARD TO OCCUPANTS OF VEHICLE.

WARNING: NEVER INCREASE REGULATOR PRESSURE WITHOUT A MANOMETER CHECK. EXCESSIVE LINE PRESSURE COULD RESULT IN AN LP GAS LEAK WHICH IS FLAMABLE AND POTENTIALLY DANGEROUS TO VEHICLE AND PERSONNEL.

Manometer Check

1. Pull range cover up to expose burners.

2. Hang manometer (J-8639) from closet top by

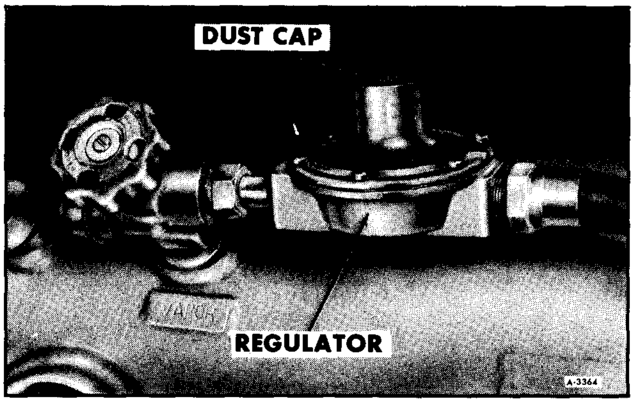


Figure 2—Regulator

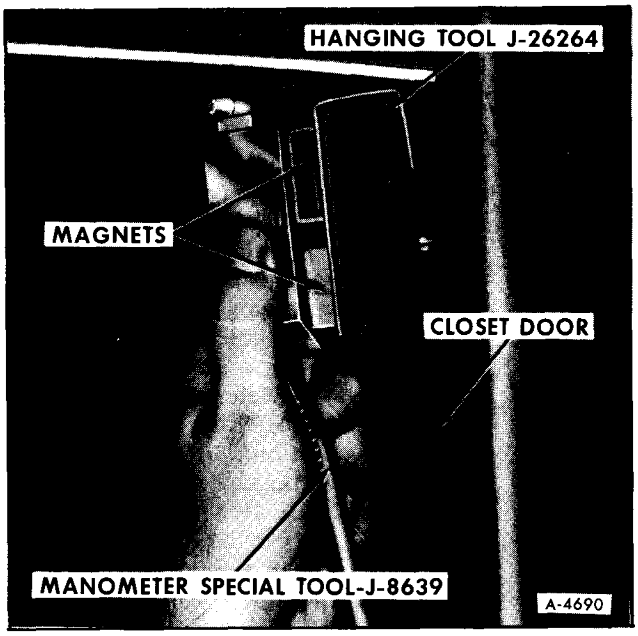


Figure 3—Hanging Manometer

bracket (J-26264) (figure 3). Open the two elbows at top of manometer two turns each so that the fluid levels are equal, then move scale so that "O" matches this level (figure 4).

3. Remove screw holding right hand burner in place and remove burner (figure 5). Connect hose from one manometer elbow to right hand burner speed (figure 6). Position hose away from other burners. Turn one range top burner all the way on, with gas burning.

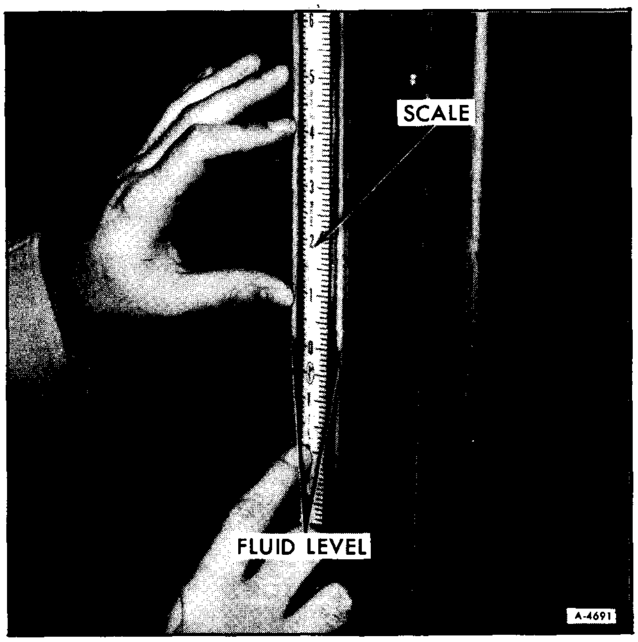


Figure 4—Setting Manometer Scale

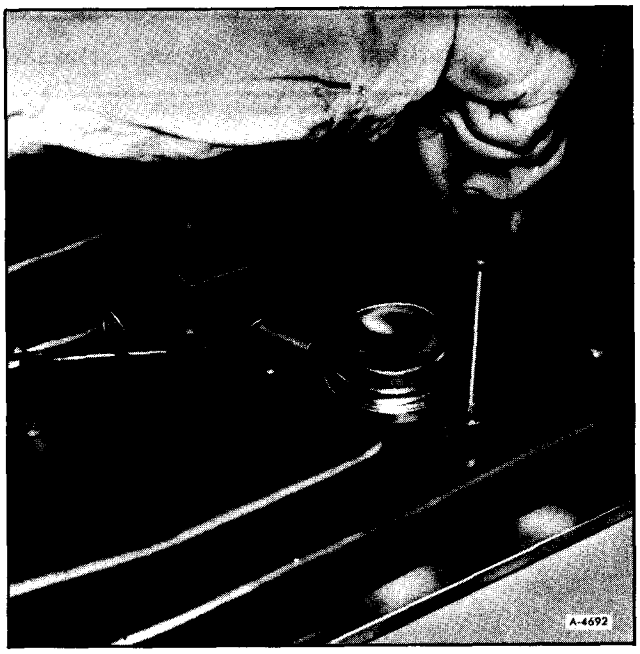


Figure 5—Removing Burner From Stove

WARNING: MAKE SURE THAT RUBBER HOSE IS PLACED CAREFULLY AWAY FROM OPERATING RANGE TOP BURNER.

4. Turn on burner control connected to manometer. Read the high to low difference on the manometer. If the difference is not 11 inches the regulator needs adjusting. Adjust the regulator until a reading of 11.0 inches is obtained. Refer to "Regulator Adjustment". If the reading is outside of an 11 $\pm$ 2 inch range (9 inches to 13 inches), with range/oven and

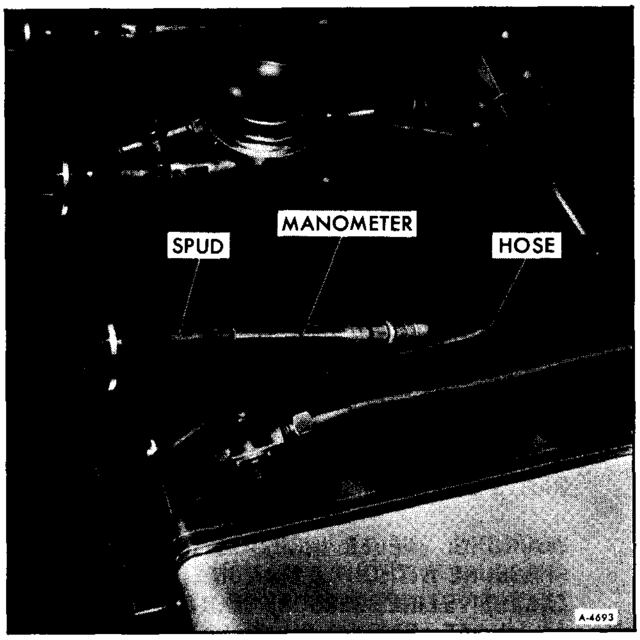


Figure 6—Manometer Connection to Spud

furnace all ON to all OFF, then replace the regulator.

NOTE: If L.P. gas pressure is very high, the fluid in the manometer could be forced out when the gas is turned ON.

Regulator Adjustment

1. Remove the dust cap from the top of the regulator (See figure 2).

2. Turn the adjusting slot clockwise to increase the pressure and counter-clockwise to decrease the pressure (See figure 7).

3. If the correct adjustment can't be made or if the monometer level fluctuates the regulator is defective and needs to be replaced. See "REMOVAL" later in this section.

LEAK TEST

Any fitting or valve suspected of leaking may be tested by applying a soap solution. Bubbles will appear wherever a leak occurs. Tighten fittings or replace components, as necessary. If any fittings require replacement use AGA (American Gas Association) approved components. It is recommended that pipe sealant not be used unless necessary to seal a leaking connection; if necessary use pipe sealant GM Part No. 704133 or equivalent.

WARNING: NEVER CHECK FOR AN LP GAS LEAK WITH A MATCH. AN LP GAS LEAK COULD IGNITE CAUSING INJURY TO VEHICLE AND PERSONNEL.

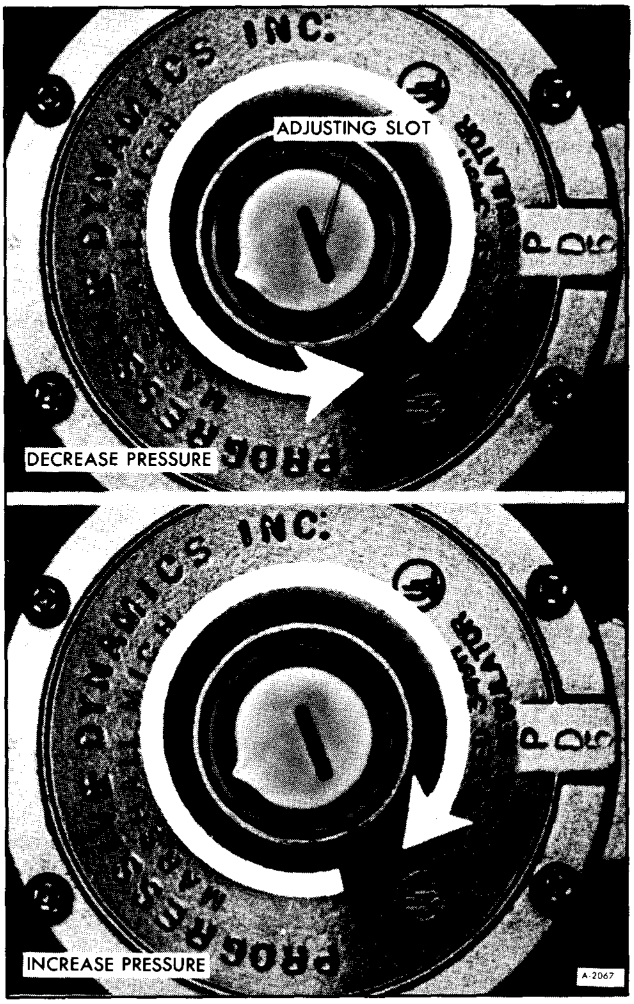


Figure 7—Regulator Adjustment

COMPONENT REPLACEMENT

FILL VALVE (FIGURE 8)

REMOVAL

1. Empty tank. Refer to WARNING at the beginning of this section.

2. Remove the fill valve cap.

3. Remove the fill valve.

INSTALLATION

1. Install fill valve on tank.

2. Tighten all fittings securely and install fill valve cap.

3. Fill tank.

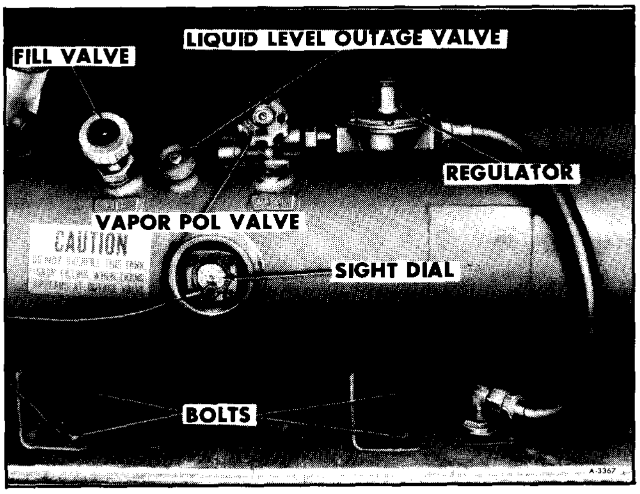


Figure 8—L.P. Gas Tank Valves

LIQUID LEVEL OUTAGE VALVE

REMOVAL (FIGURE 8)

1. Empty tank. Refer to WARNING at the beginning of this section.

2. Remove outage valve.

3. Inspect valve seat.

4. If valve seat is defective replace with a new valve.

INSTALLATION

1. Position stop fill dial over adapter and thread valve into adapter. Tighten with fingers.

2. Fill tank.

VAPOR POL VALVE (FIGURE 8)

REMOVAL

1. Empty tank. Refer to WARNING at beginning of this section.

2. Remove valve handle securing screw. Remove handle (See figure 10).

3. Remove valve stem (See figure 10).

4. Inspect seals. Replace stem if necessary.

INSTALLATION

1. Install valve stem. Tighten securely.

2. Replace handle and securing screw.

3. Fill tank.

REGULATOR

The regulator is adjustable. Refer to "On-Vehicle Adjustment-Regulator" earlier in this section.

REMOVAL

1. Turn off gas at the tank (See figure 9).

2. Remove hose assembly from regulator.

3. Remove regulator from POL valve.

IMPORTANT: The connector attaching the regulator to the vapor POL valve is left-hand threaded (See figure 9).

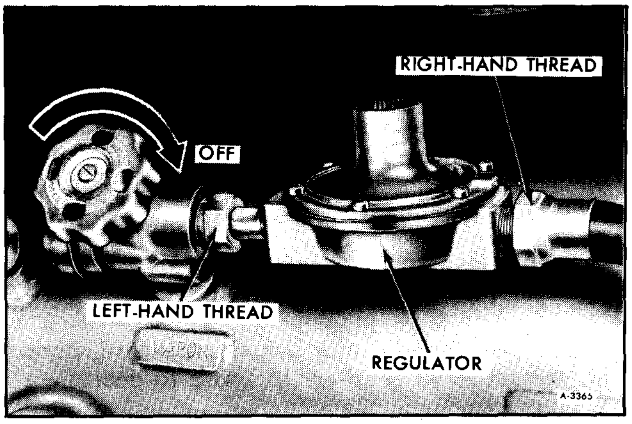


Figure 9—Regulator Attachment

INSTALLATION

1. Install regulator to POL valve.

IMPORTANT: The connector attaching the regulator to the vapor POL valve is left-hand threaded.

2. Connect hose assembly to regulator.

3. Tighten all fittings securely and turn on gas at tank.

L.P. GAS TANK SIGHT VALVE DIAL

REMOVAL

1. Remove wire retaining screw and wire.

2. Remove two retaining screws (See figure 10).

3. Remove sight dial.

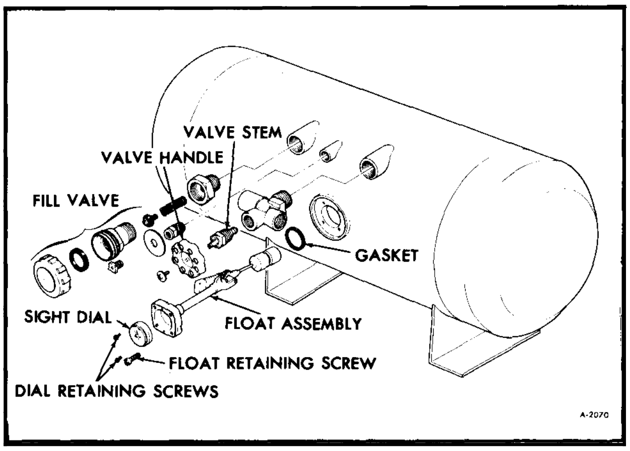


Figure 10—L.P. Gas Tank Components

INSTALLATION

1. Install sight dial.

2. Install two dial retaining screws.

3. Install wire and retainer screw.

GAS TANK FLOAT ASSEMBLY

REMOVAL

1. Empty tank. Refer to WARNING at beginning of this section.

2. Disconnect wire at sight dial.

3. Remove four float retaining screws (See figure 10).

4. Remove float assembly.

NOTE: Position float as shown in Figure 10 while removing from tank.

INSTALLATION

1. Install float assembly.

2. Install and tighten four retaining screws.

3. Connect wire to sight dial.

4. Fill tank.

LP GAS TANK

When filling the tank refer to IMPORTANT at beginning of this section.

REMOVAL

1. Empty tank. Refer to WARNING at beginning of this section.

2. Disconnect hose assembly from regulator and position out of the way.

3. Disconnect wire from sight dial.

4. Remove four nuts and bolts securing tank to vehicle (See figure 8). Ground wire is under one of these bolts.

5. Remove tank.

INSTALLATION

1. Install tank and four bolt and nut assemblies. Secure ground wire under same bolt.

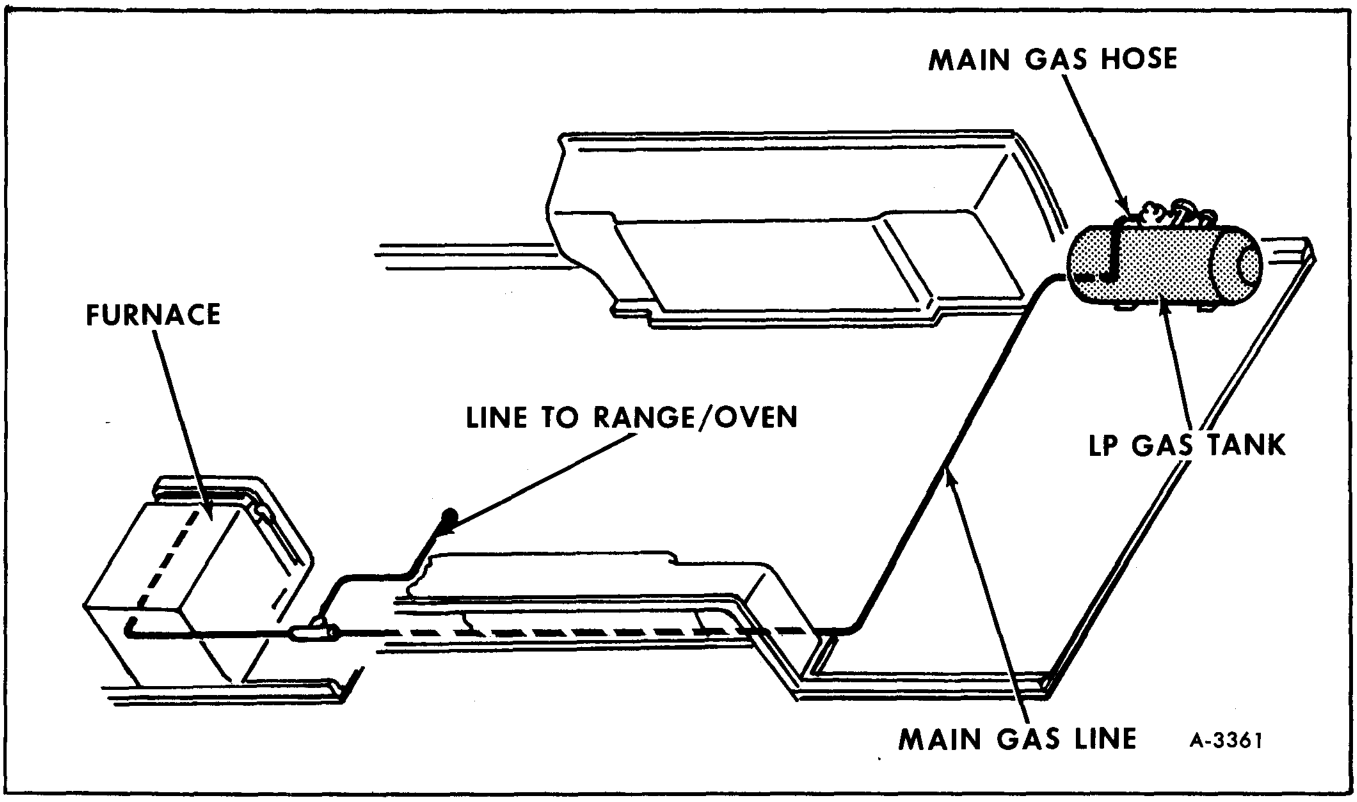


Figure 11—L.P. Gas Lines

Torque nuts to 15-20 ft. lbs.

2. Connect wire to sight dial.

3. Connect hose assembly to regulator.

4. Fill tank.

LP GAS LINES AND FITTINGS (FIGURE 11)

LP gas lines are copper tubing and rubber hose connected with AGA (American Gas Association) fittings. There are three straight and two elbow connections under the vehicle. The lines are replaceable or repairable. A damaged portion of the copper tubing line may be cut out and a brass approved union used to connect a new section of tube to the line. Be sure that the gas is turned off at the tank. Remember there may always be some residual gas in the system that will escape when a fitting is loosened, therefore work in a well ventilated area.

WARNING: NEVER USE ANY RUBBER HOSE FOR LP GAS LINE UNLESS IT HAS BEEN APPROVED FOR LP GAS. NON-APPROVED HOSES COULD LEAK RESULTING IN DANGER TO VEHICLE AND PERSONNEL.

L.P. GAS TANK PURGE

New LP gas tanks that have not yet been filled, have air and moisture inside which can cause problems in the system once it is in use. The LP gas tank should be purged before it is filled for use.

An LP Gas tank that has been allowed to run dry while appliances are in use can have air and moisture enter through the appliances. If an LP gas tank runs dry in such a manner it chould be purged before it is refilled.

NOTE: The LP gas tank should not be allowed to run dry. The regulator can not meter a correct LP gas and air mixture when pressure in the tank has dropped too low.

PURGING

The LP gas tank is purged with vaporized LP gas, not liquid gas used to fill the tank for operation. Gas used to purge the system must be taken from a filled bottle that has a vapor withdrawal system. Purging should be done by an authorized LP gas dealer.

WARNING: PURGING MUST BE DONE WELL AWAY FROM ANY FLAMES OR SOURCE OF SPARKS THAT MIGHT IGNITE LP VAPORS CAUSING DAMAGE TO COMPONENTS AND/OR INJURY TO PERSONNEL.

1. Bleed off all the air that will escape from tank.

2. Put LP gas in vapor form in the tank to raise the internal tank pressure to about 15 psi. Then open the valve and allow LP gas to escape slowly.

3. Repeat 8-10 times. Allow enough time between each filling and releaseing for the gas to dissipate. Properly fill LP tank with LP liquid.

SECTION 24G
FURNACE

Contents of this section are listed below:

SUBJECT	PAGE NO.
General Information	24G-1
Furnace Trouble Diagnosis	24G-5
Operational Checkout	24G-7
Furnace Replacement	24G-8
Component Replacement	24G-9
On Vehicle Adjustment	24G-16
Auxiliary Furnace Blower	24G-17

GENERAL INFORMATION

The furnace in the GMC MotorHome is a 30,000 B.T.U. Sol-Aire furnace. The furnace is located in the compartment under the kitchen sink. The identification plate is located at the right side of the casing as shown in Figure 1. The furnace has no pilot light, but is ignited by a direct spark ignition system.

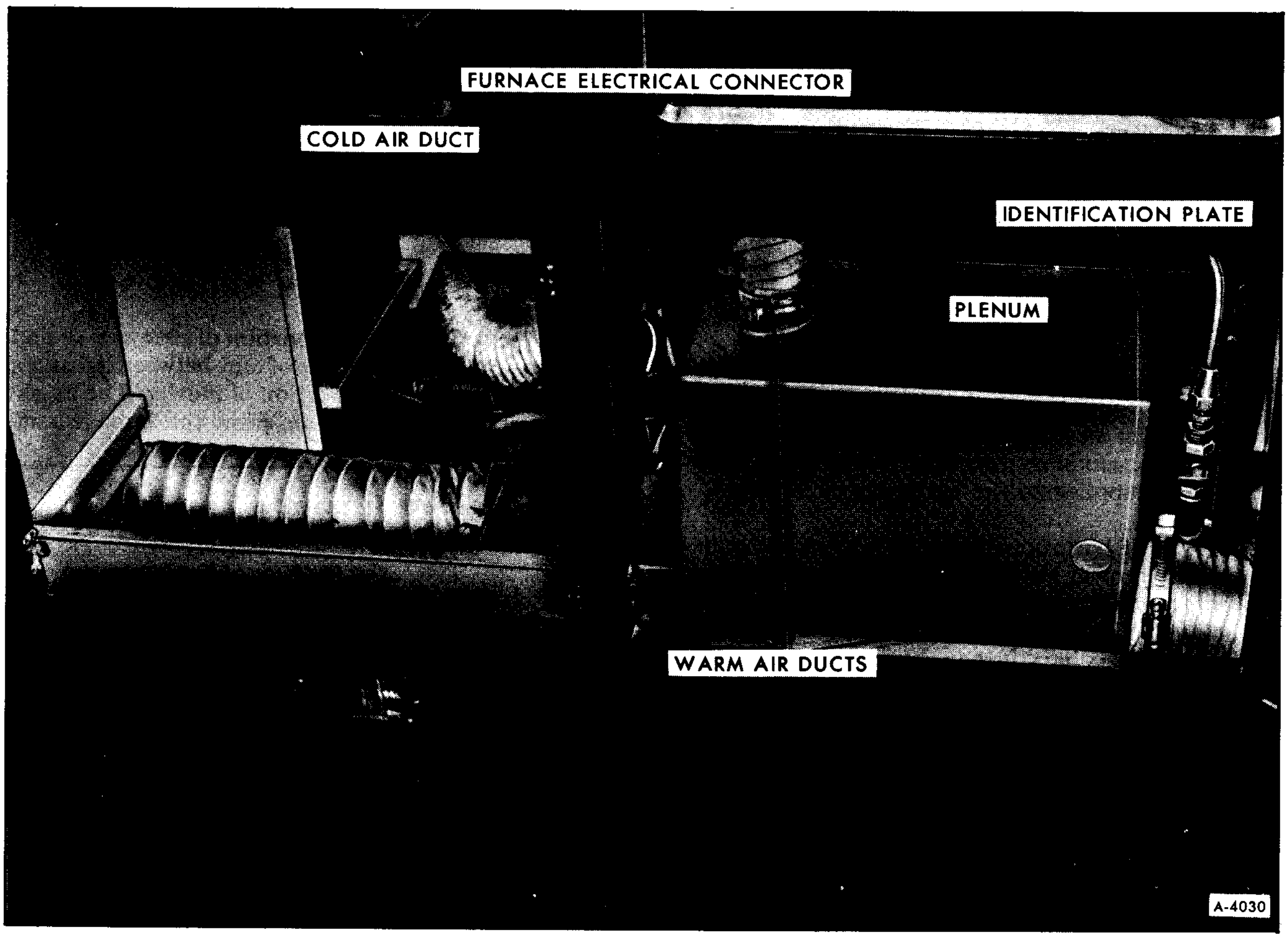


Figure 1—Furnace Installed

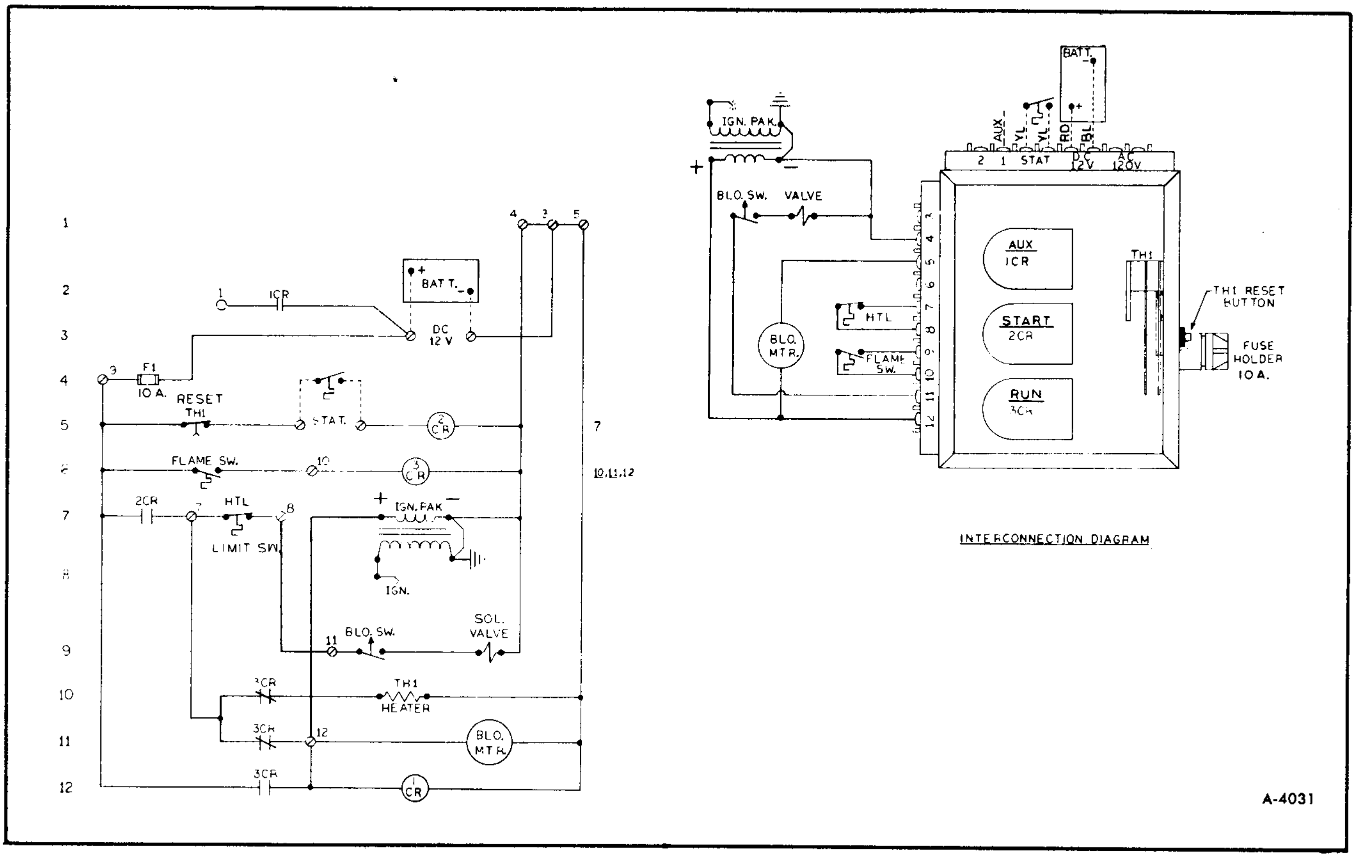


Figure 2—Furnace Wiring

The furnace utilizes a sealed combustion system with an axial blower assembly. Combustion air is drawn in from outside the vehicle, passes through the combustion chamber and returned to the outside. Warm air inside the vehicle is ducted from the plenum on front of furnace to registers located at floor level. Cold air ducts return air to the rear portion of the furnace.

The warm air duct on top of the plenum is connected to an auxiliary furnace blower. This heated air is then supplied to the bathroom module.

NOTE: If bathroom warm air outlet is located beside shower head the auxiliary furnace blower is located in the closet module (See figure 32). If warm air duct is located on wall below bathroom sink the auxiliary furnace blower is installed behind the kitchen range/oven (See figure 33).

The furnace operates on 12-volts D.C. and its wiring diagram is shown in Figure 2.

FURNACE COMPONENTS

CONTROL BOX

The control box contains three control relays, thermal relay with manual reset, and fuse and holder. The unit is located on the left side of the furnace (refer to figures 2 and 3). If a malfunction occurs, the control box is replaced as an assembly.

BLOWER ASSEMBLY (FIGURE 3)

The combustion-air portion of blower is sealed so as to allow no passage of air between it and the circulating room-air portion of blower. The combustion-air blower draws air from the outside atmos-

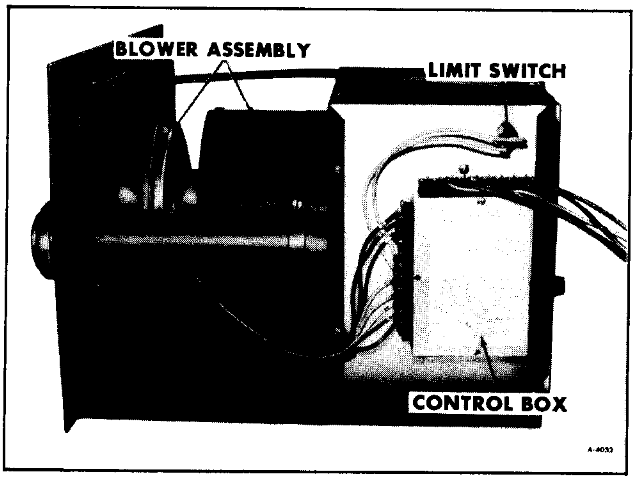


Figure 3—Furnace Components (Left-Side)

phere, discharges it into the combustion chamber, and forces the combustion products out the exhaust tube. The circulating room-air blower pulls return air in and forces it across the heat chamber, discharging into the area to be heated.

LIMIT SWITCH (FIGURE 3)

The limit switch will open if the combustion chamber temperature gets hotter than normal operating temperature. Referring to Figure 2, if HTL (high temperature limit) limit switch opens, this shuts off current flow to the blower switch and results in closing of the gas valve.

A centrifugally operated switch is located inside blower and controls the opening and closing of the gas (solenoid) valve.

GAS VALVE (FIGURE 4)

The gas (solenoid) valve controls the flow of LP gas to the burner assembly.

IGNITION PAK (FIGURE 4)

The ignition pak is basically a step-up transformer that builds up the 12-volt input to approximately 20,000 volts. This voltage is supplied through a high-tension lead to the spark electrode whenever the thermostat contacts are closed (calling for heat).

BURNER ASSEMBLY (FIGURE 4)

The burner assembly contains LP gas spray nozzle, the spark electrode, and a air adjustment feature (See "Primary Air Adjustment" later in this section). The spark electrode will supply a constant wiring to ground through the burner assembly whenever voltage is supplied from the ignition pak.

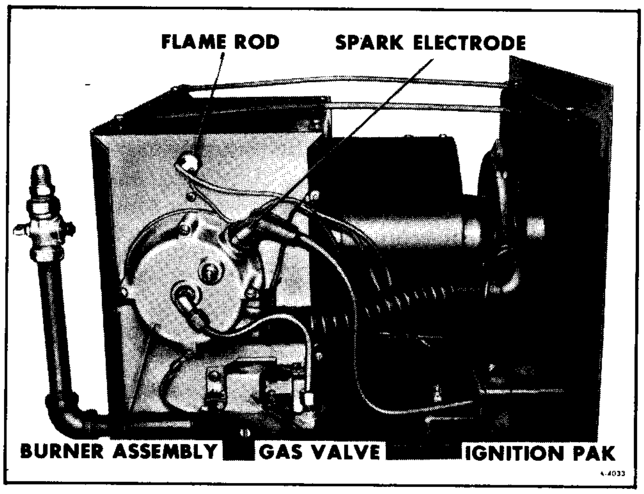


Figure 4—Furnace Components (Right-Side)

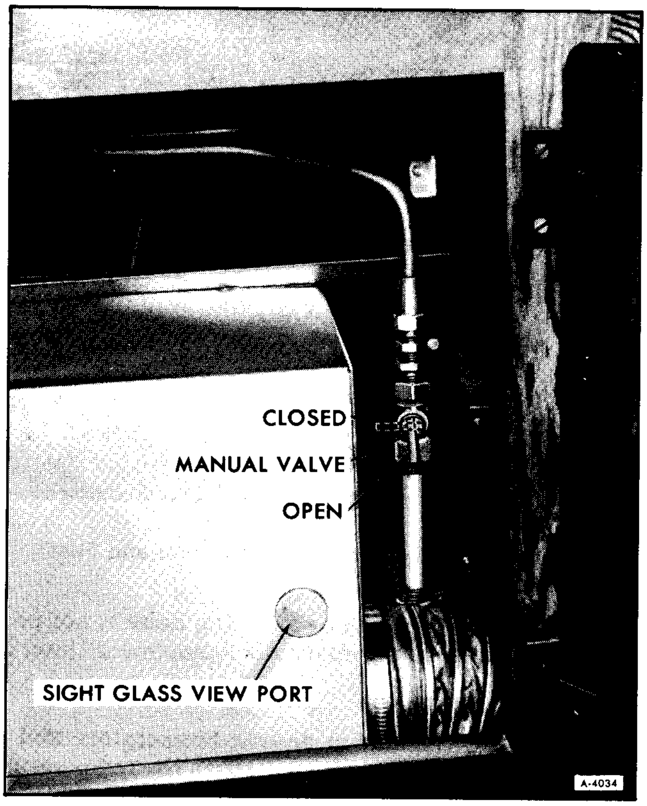


Figure 5—Manual Valve and View Port

FLAME ROD (FIGURE 4)

The flame rod is a switch which closes when the combustion chamber reaches a specified temperature. When the switch closes current is supplied to the coil of control relay 3CR and therby shuts off current flow to the thermal relay heater TH1 (See figure 2) as the normally closed contacts 3CR are opened.

OPERATION

STARTING FURNACE

1. Turn thermostat to "OFF" position.

2. Open LP gas tank valve.

3. Open manual furnace valve (figure 5).

4. Press manual reset button on furnace (figure 6).

5. Turn thermostat (figure 7) to a temperature above room temperature. Furnace should start.

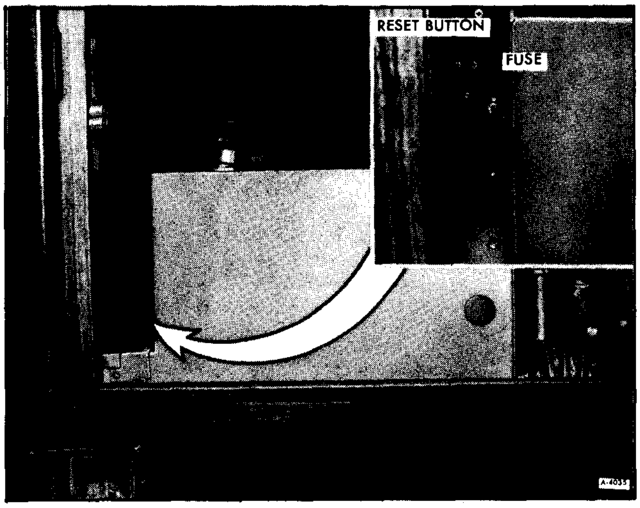


Figure 6—Location of Reset Button and Fuse

NOTE: A rumbling or growling noise is not normal. Refer to "Primary Air Adjustment" later in this section.

6. Set thermostat to desired temperature and it will cycle the furnace on and off as the temperature inside the MotorHome satisfies the thermostat.

SHUTTING OFF FURNACE

1. To shut off furnace set thermostat to "OFF" (See figure 7).

2. Close furnace manual valve (See figure 5).

SEQUENCE OF OPERATION

THERMOSTAT CONTACTS CLOSE, CALLING FOR HEAT (START CYCLE)

1. Control relay 2CR is energized providing power to the ignition pak, thermal relay heater, blower motor, and control relay 1CR. When control relay 1CR is energized power is supplied to the auxiliary furnace blower, through terminal 1 on the control box.

2. When the blower reaches minimum operating speed (approximately 2-3 seconds), the blower switch contacts close providing power to the gas (solenoid) valve.

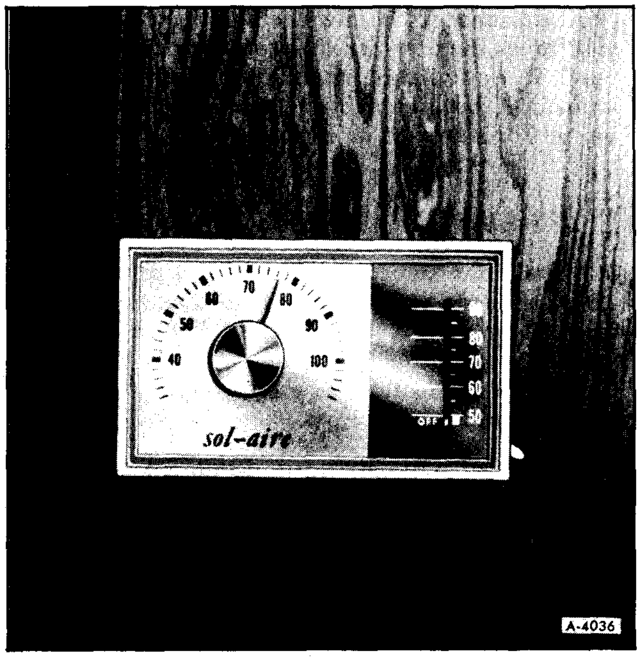


Figure 7 —Furnace Thermostat

BURNER IGNITES (START CYCLE)

1. Approximately 10-15 seconds after ignition the flame rod (switch) contacts close, de-energizing the thermal relay heater TH1 through control relay 3CR. The furnace will continue running until the thermostat is satisfied and its contacts open.

THERMOSTAT CONTACTS OPEN (PURGE CYCLE)

1. The coil of control relay 2CR is de-energized, stopping the flow of power to the ignition pak and the gas valve. Power is maintained to the blower motor through the still closed 3CR contacts.

2. After approximately two minutes the flame switch cools, opening the circuit to control relay 3CR and de-energizing the blower motor. This also opens control relay 1CR contacts and de-energizes the auxiliary furnace blower.

FURNACE TROUBLE DIAGNOSIS

IMPORTANT NOTE: Before any diagnosis is attempted on the furnace, there are two necessary and sufficient external conditions that must be met.

1. With the thermostat calling for heat, there must be 12 volts (absolute minimum of 10.5 volts) present at the furnace.
2. With the thermostat calling for heat, there must be a gas pressure of 11" of water present to the furnace measured at the range/oven.

BURNER WILL NOT LIGHT

No.	Check to Make	Results	Go To	Problem
1.	a. Turn off gas. b. Make sure ignition wire is secure on the spark electrode. c. Remove locking nut from the spark electrode. d. Turn on thermostat. e. Hold spark electrode approx. ½" from the burner and check for sparking.	Spark Present	#2	
		No Spark	#3	
2.	a. Replace the spark electrode. (Turn the locking nut on finger tight.) b. Turn on L.P.G. c. Turn on the thermostat. d. Sniff for L.P. fumes at the right hand exterior furnace vent.	Gas Present		Primary air adjustment too lean.
		No Gas Present	#7	
3.	a. Check to make sure the ignition pak ground is connected to ground at the burner housing and at the ignition pack.	Ground wire not connected.		Loose ground to the ignition pak.
		Ground wire securely connected.	#4	
4.	a. Check for correct polarity at the ignition pak ground (black wire) on right; hot (red wire) on left.	Polarity not correct.		Polarity wrong, switch wires.
		Polarity is correct.	#5	
5.	a. Check the voltage at the hot wire red wire) at the ignition pak with the thermostat on.	12 volts.		Defective ignition pak.
		0 volts.	#6	

No.	Check to Make	Results	Go To	Problem
6.	a. Remove the furnace from the Motor Home. b. Connect the furnace to a 12V power supply.	0 volts.		Defective control box.
	c. Short across the thermostat wires. d. Check the #12 terminal of the control box.	12 volts.		Broken wire between the control box and the ignition pak.
7.	a. With the furnace on, check the voltage at the gas valve.	12 volts.		Defective gas valve.
		0 volts.	#8	
8.	a. Remove the furnace from the vehicle. b. Connect the furnace to a 12V power supply.	12 volts.		Defective centrifugal blower switch.
	c. Short across the thermostat wires. d. Check the voltage at the #11 terminal on the control box.	0 volts.		Defective control box.

FURNACE LIGHTS BUT RESET POPS IN LESS THAN ONE MINUTE

No.	Check to Make	Results	Go To	Problem
1.	a. All thermal relay to completely cool, 3 - 5 minutes.	Less than 35 seconds.		Defective thermal relay in control box. Replace control box.
	b. Press the reset button. c. Turn the thermostat on. d. Check the length of time before the furnace shuts off.	35 - 45 seconds.	#2	
2.	a. Disconnect both wires from the flame rod. b. Connect an ohm meter across the on the flame rod.	Resistance does not drop to 0 ohms.		Defective flame rod.
	c. Allow the thermal relay to cool for 3 - 5 minutes. d. Push the reset. e. Turn on the thermostat. f. Check to see if the resistance of the flame rod goes to approx. 0 ohms before the furnace shuts off.	Resistance does drop to 0 ohms.		Defective control box.

BLOWER DOES NOT COME ON WHEN THERMOSTAT IS CALLING FOR HEAT

No.	Check to Make	Results	Go To	Problem
1.	a. With thermostat calling for heat press in reset button.	Furnace turns on.		Reset was not set.
		Furnace does not turn on.	#2	
2.	a. Check the 10 amp fuse in the furnace.	Fuse OK.	#3	
		Fuse blown.	#5	
3.	a. Short across the two thermostat leads at the control box on furnace.	Furnace starts.		Defective thermostat or broken wire.
		Furnace does not start.	#4	
4.	a. Remove Furnace from vehicle.	Blower runs.		Defective control circuit.
	b. Connect a 12V source across the #11 and #5 terminals on the control box.	Blower does not run.		Defective blower asm.
5.	a. Install a new fuse in the furnace. Turn the thermostat on.	Furnace starts and runs.		Surge current blew fuse, furnace OK.
		Fuse immediately blows again.	#6	
6.	a. Remove furnace from vehicle. b. Disconnect the wires from terminals #11 and #12 on the control box.	Fuse blows immediately.		Defective control box.
	c. Install a new fuse in the furnace. d. Connect the furnace to a 12V source. e. Short across the thermostat wires.	Fuse does not blow.	#7	
7.	a. Reconnect the wire to the #12 terminal on the control box.	Fuse blows.		Defective ignition pak.
	b. Short across the thermostat leads with the furnace connected to a 12V source.	Fuse does not blow.		Defective blower asm.

OPERATIONAL CHECKOUT

The following checkout is given to aid in checking the furnace if it has not been operated for a long period of time or if a suspected problem is encountered.

1. Check LP gas pressure at range/oven using a water manometer with burners turned on. Details for checking and adjusting LP gas pressure is given in Section 24F "LP Gas System." Pressure should be 11 inches of water.

2. Sol-Aire furnace is designed to operate on a minimum of 10.2 Volts D.C. If voltage is less than 10.2 volts, then reset button will trip and shut off furnace. Check voltage at furnace and recharge living area battery, if necessary.

3. Shut off gas manual valve at furnace. Depress reset button.

4. Turn up thermostat and check the number of seconds it takes to pop reset button. This time should be between 35 and 60 seconds.

5. Open manual to furnace and hold in reset button until burner lights. Observe flame through sight glass view port in plenum. It may take several minutes for air to purge from gas line.

NOTE: A rumbling or growling noise is not normal. Refer to "Primary Air Adjustment" later in this section.

6. Allow furnace to set (not heating) for at least 5 minutes to cool reset (thermal heating element TH1).

7. After cooling, depress reset button, and check the number of seconds it takes for the flame rod (switch) to close, which can be heard by listening for control relay 3CR to "click" in the control box. The time must be between 10 to 15 seconds.

8. Set thermostat to a temperature 5° to 10° above outside temperature.

9. After thermostat is satisfied, burner will shut off and blower will continue to run for several minutes.

10. When flame rod (switch) cools to proper temperature, blower will stop.

11. Open door and windows to cool vehicle.

12. When vehicle has cooled, thermostat contact closing with automatically re-light furnace. Allow 2 or 3 cycles of this type.

NOTE: If a problem occurs while proceeding through the furnace checkout, refer to "Furnace Trouble Diagnosis" earlier in this section.

FURNACE REPLACEMENT

WARNING: BEFORE ANY REMOVAL OR DISASSEMBLY PROCEDURES ARE PERFORMED ON THE FURNACE, BE SURE L.P. GAS IS COMPLETELY TURNED OFF AT THE L.P. GAS TANK AND REMOVE FURNACE FUSE FROM FUSE BLOCK IN LIVING AREA ELECTRICAL COMPARTMENT.

WARNING: DUE TO THE POSSIBILITY OF INJURY ON SHARP SHEET METAL, CARE SHOULD BE TAKEN ANY TIME SERVICE IS PERFORMED ON THE FURNACE.

REMOVAL

1. Be sure LP gas is turned off at LP tank and furnace fuse is removed from fuse block in living area electrical compartment.

2. Disconnect furnace electrical connector (See figure 1).

3. Disconnect LP gas supply line from furnace manual valve (See figure 5).

4. Disconnect furnace ducts from right side of furnace.

a. If vehicle is equipped with davo, raise seat and then disconnect ducts from right side of furnace. Then remove two mounting bolts (See figure 8).

b. If vehicle is equipped with swivel chairs, remove screws retaining duct panel assembly to floor and sink module. Carefully raise panels and disconnect ducts from right-side of furnace. Remove panel assembly and also two mounting bolts (See figure 8). Remove swivel chair.

Figure 8—Location Furnace Mounting Bolts (Right-Side)

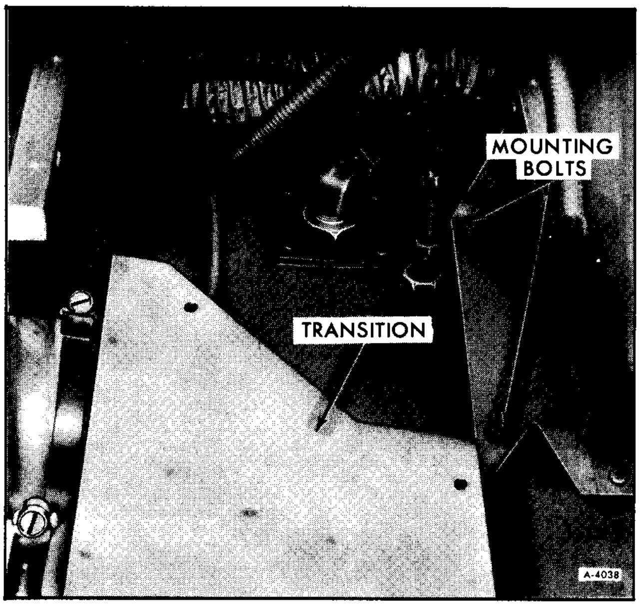


Figure 9—Location Furnace Mounting Bolts (Left-Side)

5. Remove lower shelf from cabinet to left of furnace (as shown in figure 1).

6. Disconnect furnace ducts from left-side of furnace.

7. Remove two mounting bolts from left-side of furnace (figure 9).

NOTE: Figure 9 shows transition removed from plenum to make mounting bolts visible.

8. Disconnect bathroom heat duct located on top of furnace plenum (See figure 10).

9. Remove four upper furnace mounting screws (See figure 10).

10. Carefully slide furnace and plenum towards center aisle of MotorHome, then remove from end of sink module.

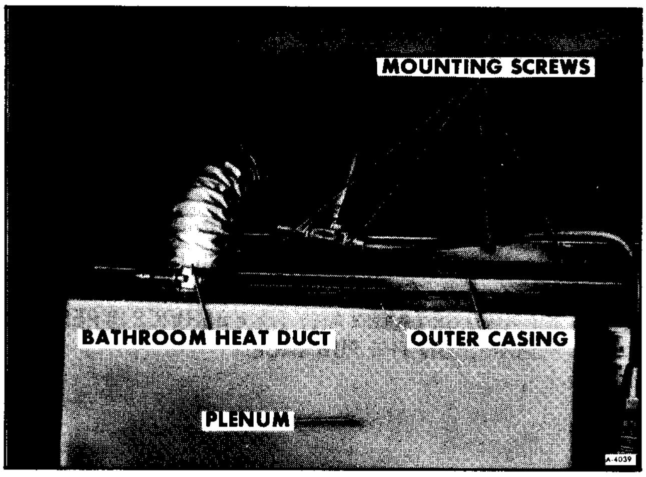


Figure 10—Location of Upper Furnace Mounting Screws

INSTALLATION

1. Slide furnace into sink module.

2. Install two mounting bolts at right-side of furnace (See figure 8).

3. Install two mounting bolts at left-side of furnace (See figure 9). Connect ducts at left-side of furnace. Install lower shelf in cabinet to left of furnace.

4. Install four upper furnace mounting screws (See figure 10). Connect bathroom heat duct to furnace plenum (See figure 10).

5. Connect LP gas supply to furnace manual valve (See figure 5).

6. Connect furnace electrical connector (See figure 1).

7. Connect furnace ducts to right-side of furnace.

8. Install any remaining furniture components, such as: Davo, swivel chair, and trim panels.

COMPONENT REPLACEMENT

The following four components can be inspected or replaced without removing the furnace from the vehicle:

1. Flame Switch

2. Limit Switch

3. Burner Assembly

4. Spark Electrode

Removal of the furnace from the vehicle is required for replacement of other components.

WARNING: BEFORE ANY REMOVAL OR DISASSEMBLY PROCEDURES ARE PERFORMED ON THE FURNACE, BE SURE L.P. GAS IS COMPLETELY TURNED OFF AT THE L.P. GAS TANK AND REMOVE FURNACE FUSE FROM FUSE BLOCK IN LIVING AREA ELECTRICAL COMPARTMENT.

WARNING: DUE TO THE POSSIBILITY OF INJURY ON SHARP SHEET METAL, CARE SHOULD BE TAKEN ANY TIME SERVICE IS PERFORMED ON THE FURNACE.

FLAME SWITCH REPLACEMENT

REMOVAL

1. Gain access to right-side of furnace. Remove access cover (figure 11).

2. Disconnect two wires from flame rod (See figure 12).

3. Using 11/16-inch wrench, unscrew flame rod from heat exchanger.

INSTALLATION

1. Install flame rod in combustion chamber opening. Tighten securely.

2. Connect two wires to flame rod (figure 12).

3. Install access cover (figure 12).

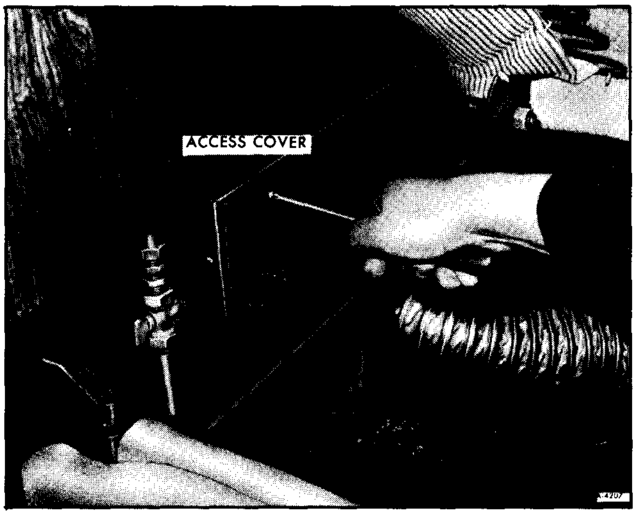


Figure 11—Removing Furnace Access Cover

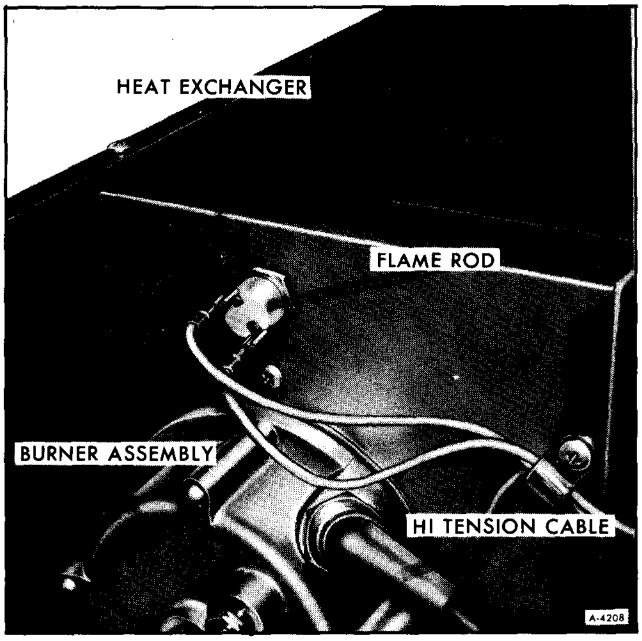


Figure 12—Location of Furnace Flame Rod

SPARK ELECTRODE REPLACEMENT

REMOVAL

1. Gain access to right-side of furnace. Remove access cover (figure 11).

2. Remove hi tension cable (See figure 13) from spark electrode.

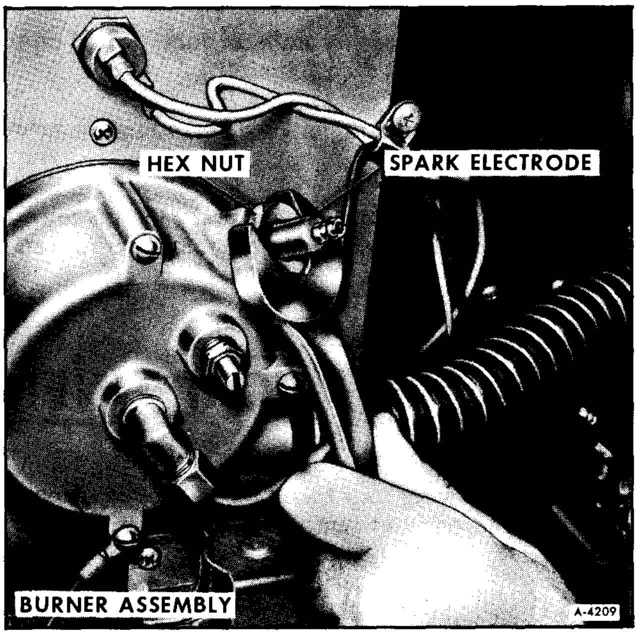


Figure 13—Removing Spark Electrode

3. Loosen hex nut at base of spark electrode.

4. Remove spark electrode from burner assembly.

INSTALLATION

1. Carefully install spark electrode into burner assembly.

> **IMPORTANT:** The hex nut retaining spark electrode in the burner assembly, should be tightened hand-tight. Do not use wrenches to tighten this nut.

2. Install hi tension cable (See figure 13) on spark electrode.

3. Install access cover on furnace (figure 11).

BURNER ASSEMBLY REPLACEMENT

REMOVAL

1. Remove spark electrode. See "Spark Electrode Removal" earlier in this section.

2. Disconnect gas line at burner assembly (See figure 14).

3. Remove four screws retaining burner assembly to heat exchanger (See figure 15).

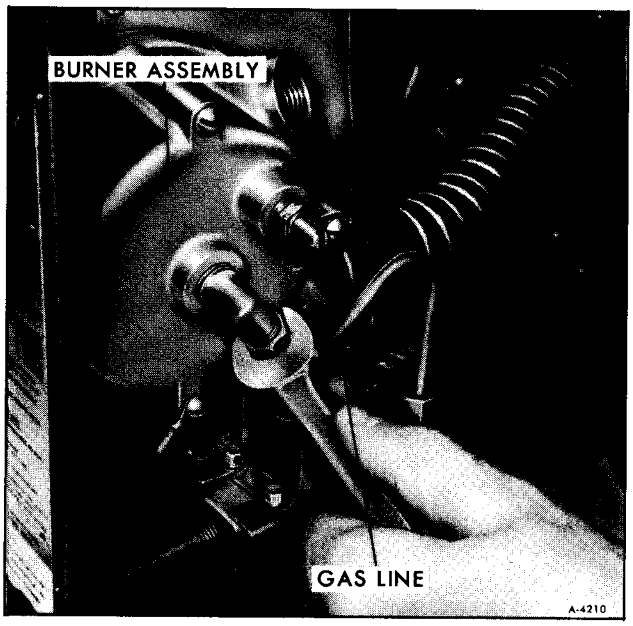


Figure 14—Disconnecting Gas Line from Burner Assembly

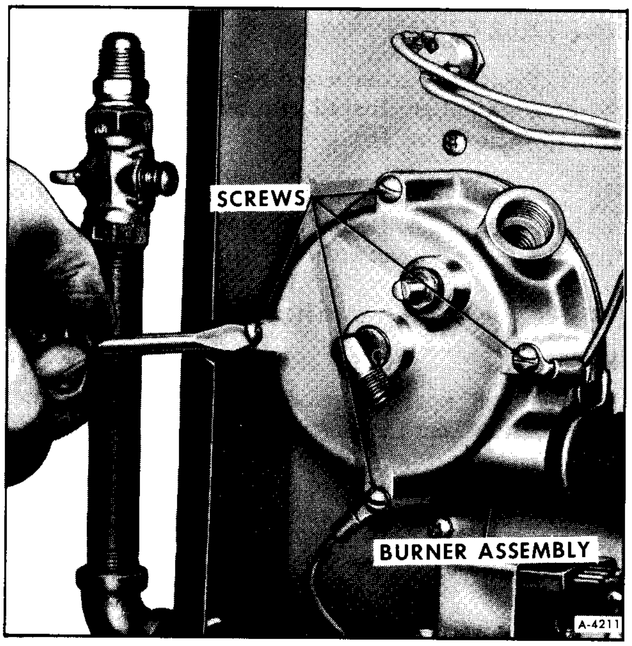


Figure 15—Removing Screws from Burner Assembly

> **NOTE:** Referring to Figure 15, check which screws have ground connections attached so they will be replaced on proper screws.

4. Lift burner assembly away from conbustion chamber. Then using hose clamp pliers, slide clamp about 1" away from burner along tube (See figure 16).

5. Remove burner assembly.

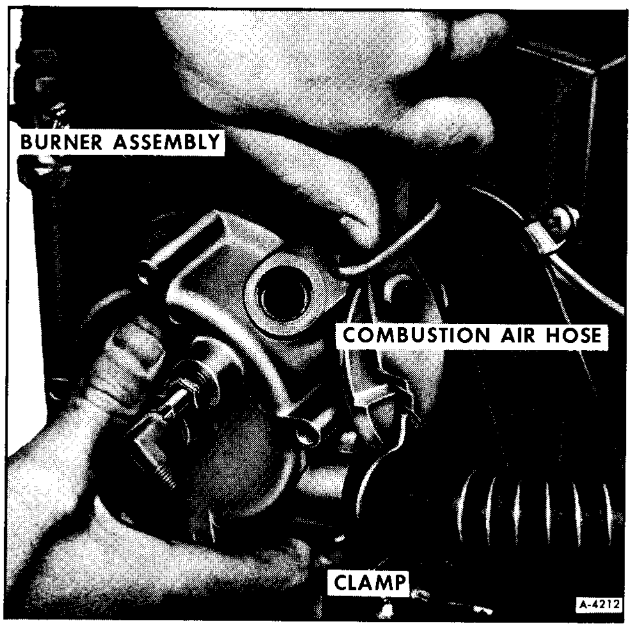


Figure 16—Removing Hose Clamp from Burner Assembly

INSTALLATION

1. Position burner assembly at opening in combustion chamber. Install combustion air hose and clamp (See figure 16).

2. Install four screws retaining burner assembly to heat exchanger. Be sure ground wires are installed under screws as shown in Figure 15.

3. Connect gas line to burner assembly (See figure 14).

4. Install spark electrode. See "Spark Electrode-Installation" earlier in this section.

LIMIT SWITCH REPLACEMENT

REMOVAL

1. Disconnect furnace electrical connector (figure 1) at left-side of furnace.

2. Remove wiring access cover and move rearward, taking care not to damage wires going to control box.

4. Use a magnitized short screwdriver to remove two screws holding limit switch to combustion chamber. Use care to avoid losing screws.

5. Remove limit switch.

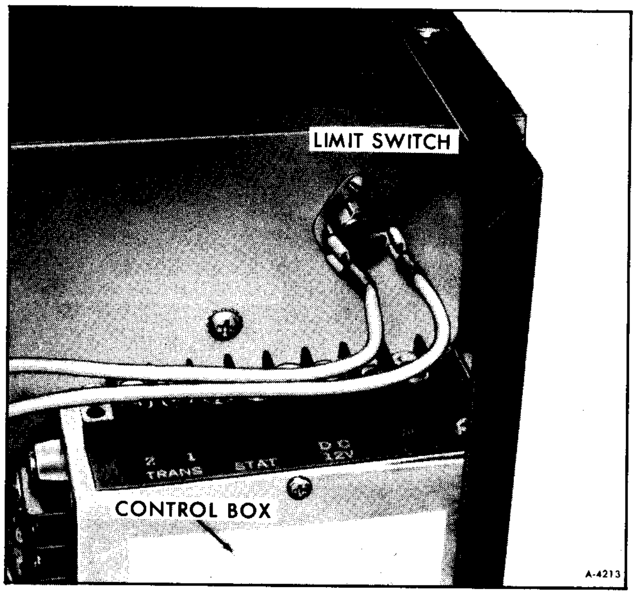


Figure 17—Location of Limit Switch

INSTALLATION

1. Carefully position limit switch in combustion chamber opening.

2. Install two screws retaining limit switch to combustion chamber (See figure 17).

3. Connect two wires to limit switch.

4. Install wiring access cover.

5. Connect furnace electrical connector at left-side of furnace.

GAS VALVE REPLACEMENT

REMOVAL

1. Remove furnace from vehicle. See "Furnace Replacement" earlier in this section.

2. Remove furnace plenum (See figure 18). Remove wiring access cover.

3. Remove furnace from outer casing (See figure 19).

4. Remove gas line between gas valve and main burner (See figure 20). Disconnect two electrical wires from valve. Be sure to note which terminal each wire is removed from, to aid in proper installation.

5. Disconnect gas supply line from gas valve.

6. Remove four gas valve mounting screws.

7. Remove gas valve from furnace.

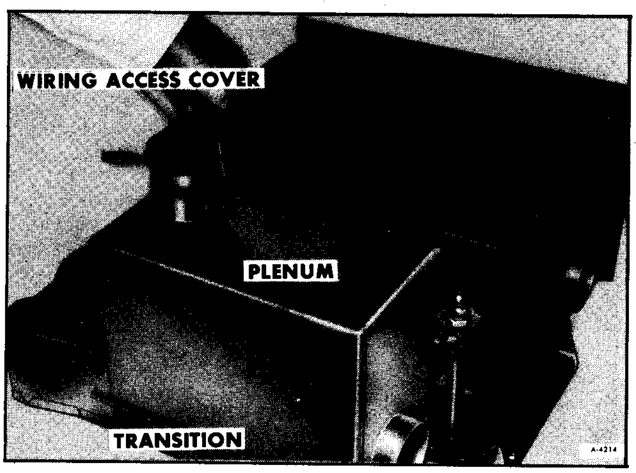


Figure 18—Removing Furnace Plenum

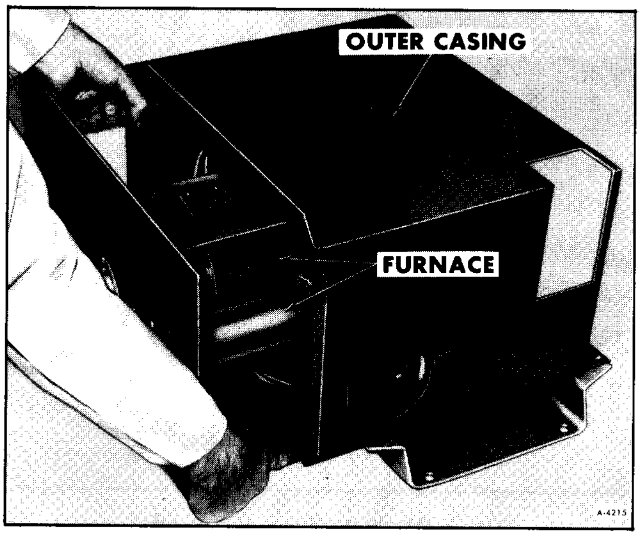


Figure 19—Removing Furnace from Outer Casing

INSTALLATION

1. Referring to Figure 20, connect gas supply line to gas valve.

2. Install four gas valve mounting screws.

3. Install gas line from gas valve to burner assembly.

4. Connect two electrical wires to terminals on gas valve.

5. Install furnace in outer casing (See figure 19).

6. Install furnace plenum (See figure 18). Install wiring access cover.

7. Install furnace in vehicle. See "Furnace Replacement" earlier in this section.

IGNITION PAK REPLACEMENT

REMOVAL

1. Remove furnace from vehicle. Refer to "Furnace Replacement" earlier in this section.

2. Remove wiring access cover (See figure 18).

3. Remove furnace from outer casing (See figure 19).

4. Disconnect hi tension cable from spark electrode.

5. Disconnect two electrical wires from ignition pak (See figure 21). Be sure to note which terminal each wire is removed from, to aid in proper installation.

6. Loosen mounting screw and remove ignition pak.

INSTALLATION

1. Position ignition pak under mounting strap as shown in Figure 21. Tighten mounting screw.

2. Connect two electrical wires to terminals on ignition pak.

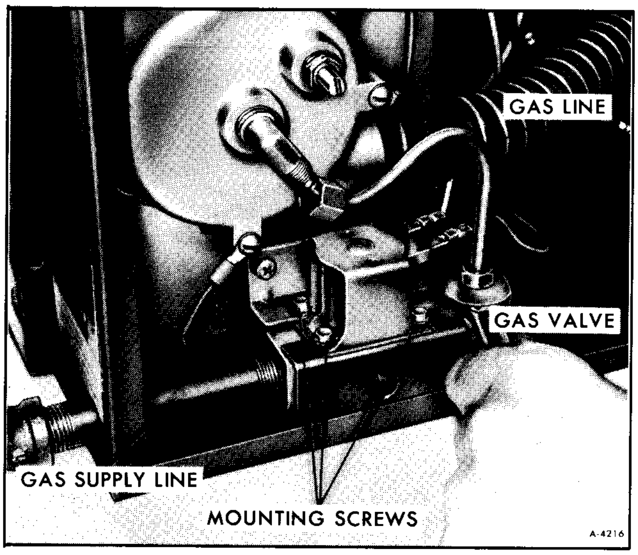


Figure 20—Removing Gas Line from Gas Valve

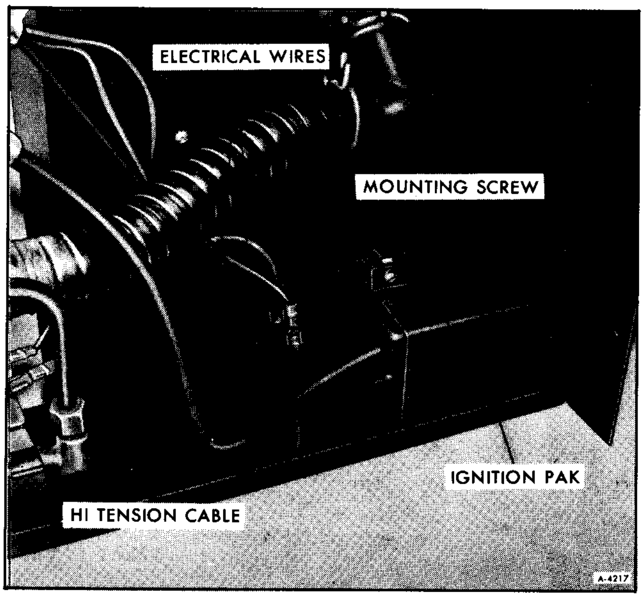


Figure 21—Ignition Pak Installed

3. Connect hi tension cable to spark electrode.

4. Install furnace in outer casing (See figure 19).

5. Install wiring access cover (figure 18).

6. Install furnace in vehicle. See "Furnace Replacement" earlier in this section.

CONTROL BOX REPLACEMENT

REMOVAL

NOTE: If a malfunction occurs in one or more of the relays in the control box (See figure 22) it is to be replaced as an assembly.

1. Remove furnace from vehicle. See "Furnace Replacement" earlier in this section.

2. Remove wiring access cover (figure 18).

3. Remove furnace from outer casing (See figure 19).

4. Disconnect all external electrical wires from control box. Note the number identification on wires, to aid in correct installation, later.

5. Remove two control box mounting screws (See figure 23).

6. Remove control box.

INSTALLATION

1. Position control box as shown in Figure 23. Install two control box mounting screws.

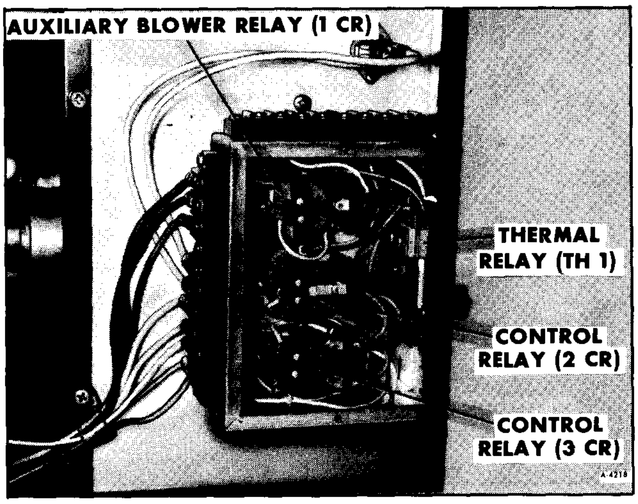


Figure 22—Control Box (Cover Removed)

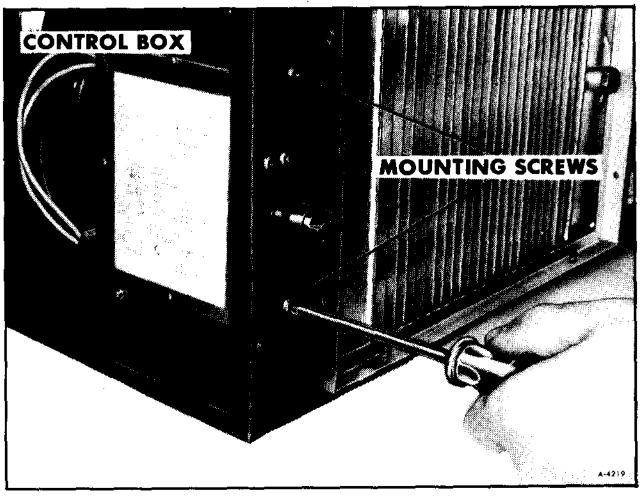


Figure 23—Removing Control Box

2. Connect electrical wires to control box.

3. Install furnace in outer casing (See figure 19).

4. Install wiring access cover (See figure 19).

5. Install furnace in vehicle. See "Furnace Replacement" earlier in this section.

BLOWER REPLACEMENT

REMOVAL

1. Remove furnace from vehicle. See "Furnace Replacement" earlier in this section.

2. Remove wiring access cover (figure 18).

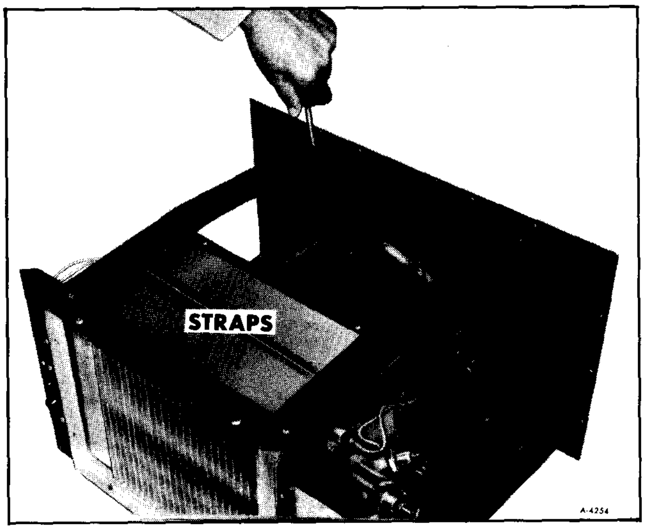


Figure 24—Removing Straps from Furnace

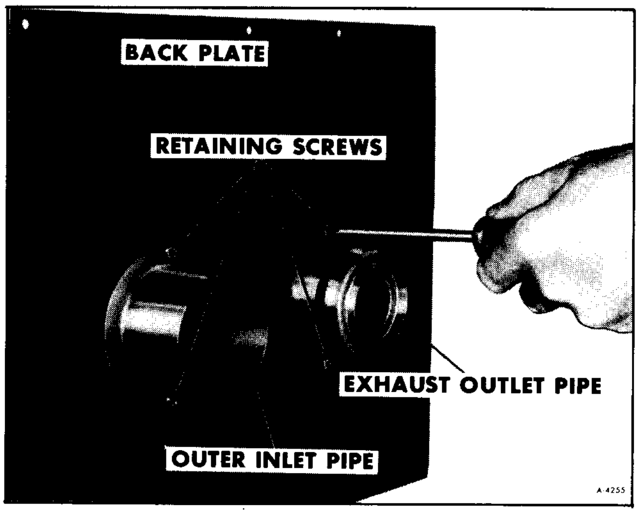


Figure 25—Removing Back Plate Retaining Screws

3. Remove furnace from outer casing (See figure 19).

4. Remove straps from furnace (See figure 24).

5. Remove back plate retaining screws (See figure 25). Then remove outer inlet pipe and back plate.

6. Remove exhaust outlet pipe and inner inlet pipe (See figure 26).

7. Disconnect combustion air tube from blower assembly (See figure 27).

8. Disconnect flue tube from combustion chamber (See figure 28). Remove flue tube.

9. Remove six retaining screws holding blower assembly to combustion chamber (See figure 29).

10. Remove blower assembly (figure 30).

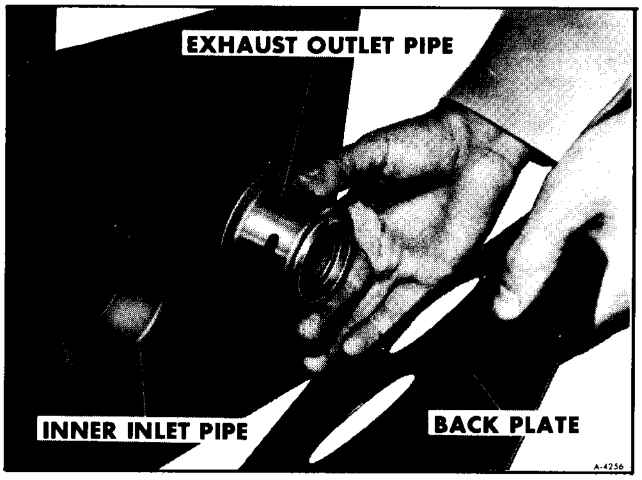


Figure 26—Removing Exhaust Outlet Pipe

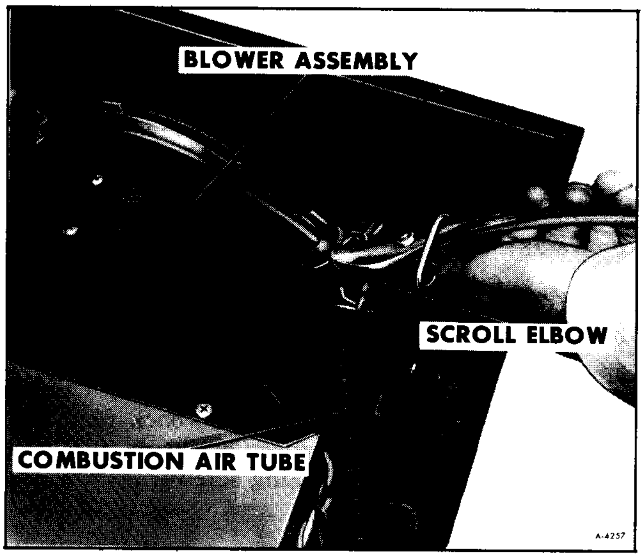


Figure 27—Disconnecting Combustion Air Tube from Blower Assembly

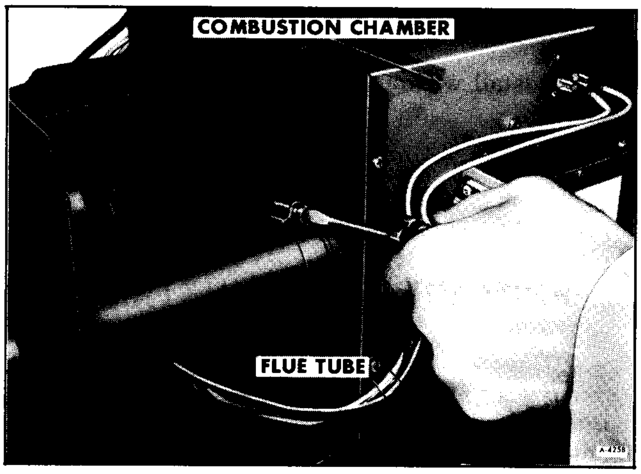


Figure 28—Disconnecting Flue Tube from Combustion Chamber

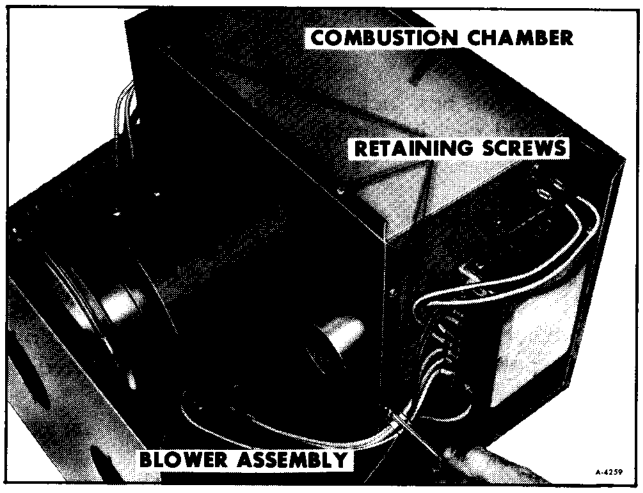


Figure 29—Removing Blower Motor Retaining Screws

INSTALLATION

1. Position blower assembly against combustion chamber. Install six retaining screws (See figure 29).

2. Connect flue tube to combustion chamber (See figure 28).

3. Connect combustion air tube to blower assembly.

4. Position inner inlet pipe and exhaust outlet pipe as shown in Figure 26. Place back plate and outer inlet pipe against furnace as shown in Figure 25. Install back plate retaining screws.

5. Install straps to furnace (See figure 24).

6. Install outer casing on furnace (See figure 19).

7. Install wiring access cover (figure 18).

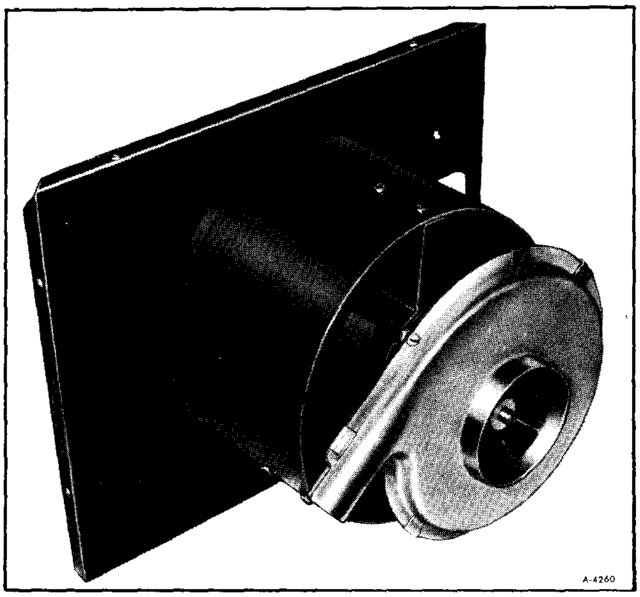


Figure 30—Blower Assembly

8. Install furnace in vehicle. See "Furnace Replacement" earlier in this section.

ON VEHICLE ADJUSTMENT

PRIMARY AIR ADJUSTMENT

Access to the burner assembly to adjust primary air is located at the bottom, right side of the furnace compartment by removing access cover (figure 11).

NOTE: To gain access to right side of furnace, if vehicle is equipped with a davo, squeeze levers located under center of davo seat and raise seat.

1. Loosen hex lock nut slightly until burner adjusting rod can be turned with a screwdriver (See figure 31).

2. Start furnace and watch burner through sight glass view port in plenum (See figure 5). Decrease primary air to give a slightly yellow flame with green cones. The cones are formed at each of the ports in the burner. Then increase air slowly until the yellow disappears and the cones become sharply defined as blue.

NOTE: The total adjustment available, from one extreme to the other, is only about 1/4 turn. Do not force adjusting rod past the stops.

4. Recheck flame to see that it is still properly adjusted.

Hold the adjusting rod in place and tighten the hex nut.

Figure 31—Furnace Primary Air Adjustment

AUXILIARY FURNACE BLOWER

BLOWER LOCATION

The auxiliary furnace blower supplies warm air to the bathroom whenever the furnace is operating.

NOTE: If bathroom warm air outlet is located beside shower head the auxiliary furnace blower is located in the closet module (See figure 32) if warm air duct is located on wall below bathroom sink the auxiliary furnace blower is installed behind the range/oven (figure 33).

AUXILIARY FURNACE BLOWER REPLACEMENT

1. Remove furnace fuse from fuse block in living area electrical compartment.

2. Gain access to auxiliary furnace blower.

a. If blower is located in closet module, open upper door beside closet. Remove rear panel in compartment (See figure 32).

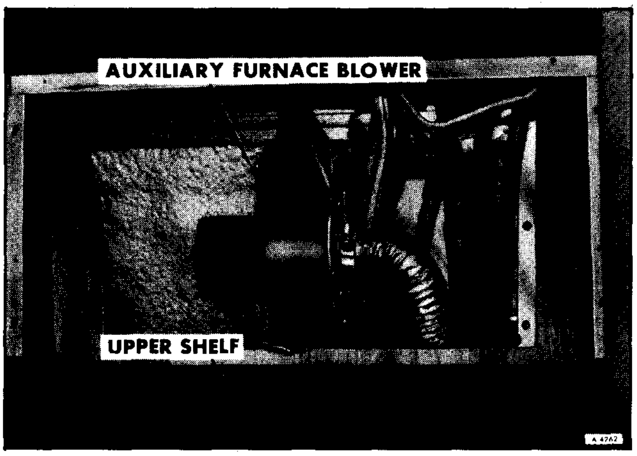


Figure 32—Auxiliary Furnace Blower (Located in Closet Module)

b. If blower is located behind range/oven (See figure 33), remove range/oven. To remove range/oven refer to Section 24H for detailed procedures.

3. Disconnect electrical lead and ducts from from blower.

4. Remove mounting screws retaining blower to MotorHome body member.

5. Install new blower and tighten retaining screws, securely.

6. Connect electrical lead and ducts to blower.

7. Install any components or trim removed to gain access to blower.

8. Install furnace fuse in fuse block in living area electrical compartment.

Figure 33—Auxiliary Furnace Blower (Located Behind Range/Oven)

SECTION 24H
RANGE/OVEN
GENERAL INFORMATION

The 3-burner range/oven (figure 1) used in the MotorHome is designed for operation with liquid petroleum gas (L.P.G.). Never attempt to operate the unit with any other type of fuel.

Recreational vehicle range/ovens differ from conventional residential units in several ways:

1. The units are more compact.

2. The units are equipped with thermostat controls which allow you to manually shut off the gas to the pilots when traveling.

3. Clips are provided for the top burner grates and oven rack to help prevent rattles and dislodgement while traveling.

Any time the range/oven is in operation, the power range hood fan should be operating to help ensure proper ventilation.

In order to operate the range/oven the gas supply must be turned on at the L.P. gas tank.

CAUTION: *The Range/Oven should not be used when the vehicle is moving, and the LP gas should be turned off at the LP gas tank. The burners or pilot lights may blow out creating a fire or explosion hazard. In addition, a sudden movement of the vehicle could throw utensils or scalding liquids from the stove which could result in serious personal injury or property damage.*

OPERATION

The 3 burner range/oven has two pilots—one for the 3 range burners and one for the oven.

Pilots

1. Turn on power range hood fan.

Figure 1—Range/Oven

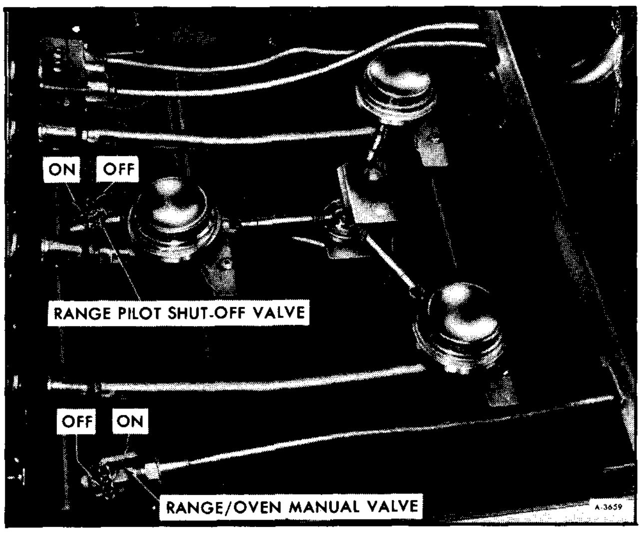


Figure 2—Range/Oven LP Gas Valves

2. Be sure manual control valve at LP gas tank is fully open.

3. Be sure all knobs are in the "OFF" position. The oven thermostat should be in the "PILOT OFF" position.

4. Lift cook top panel and turn range/oven manual valve and range pilot shut off valve to ON position (See figure 2).

5. Light range pilot with a match as shown in Figure 3.

6. Depress the oven thermostat and turn counterclockwise to OFF position.

7. Open the oven door, allow the compartment to ventilate, then light the oven pilot with a match (See figure 4). A small flame should be noted at the top of the pilot burner. After the initial light-up, it may take a minute or so to clear the air from the line so the flame stays lit.

CAUTION: *When lighting pilots, BOTH pilots must be lit, even if plans are to use just one cooking means. Once the oven thermostat is moved from the "PILOT OFF" position and the range pilot shut off valve is in the ON position, gas will issue from both range and oven pilots. Failure to light both pilots could result in fire or explosion caused by accumulating LP gas.*

8. The oven pilot is non-adjustable. The range pilot adjustment screw is located behind the range pilot shut off valve.

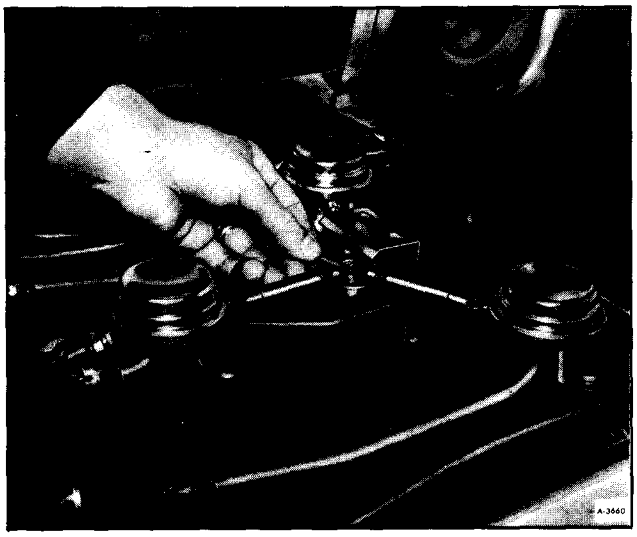


Figure 3—Lighting Range Pilot

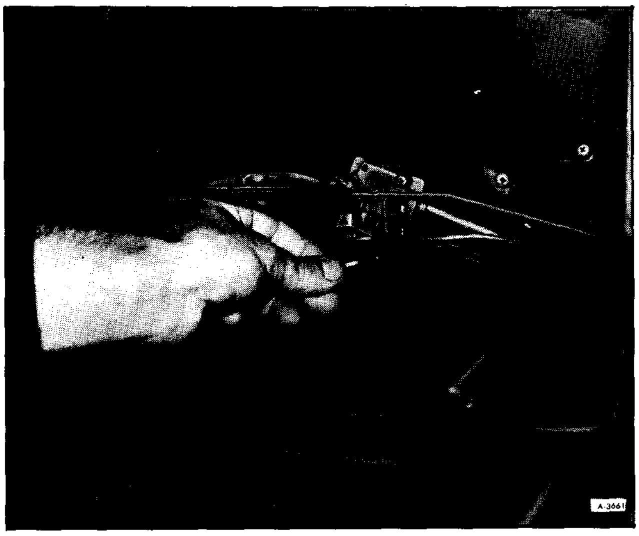


Figure 4—Lighting Oven Pilot

Range

1. Be sure power range hood fan is operating.

2. Push control knob in and turn gas on counterclockwise all the way to get gas to the burner.

3. As soon as the burner lights, flame may be reduced to the desired height.

4. To turn off the burner, turn the control knob clockwise all the way to the "OFF" position. The knob is designed to lock in this position.

Oven

1. Be sure power range hood is operating.

2. To turn on the oven light, push in oven light button located at the right side of the knob panel. Push again to turn out.

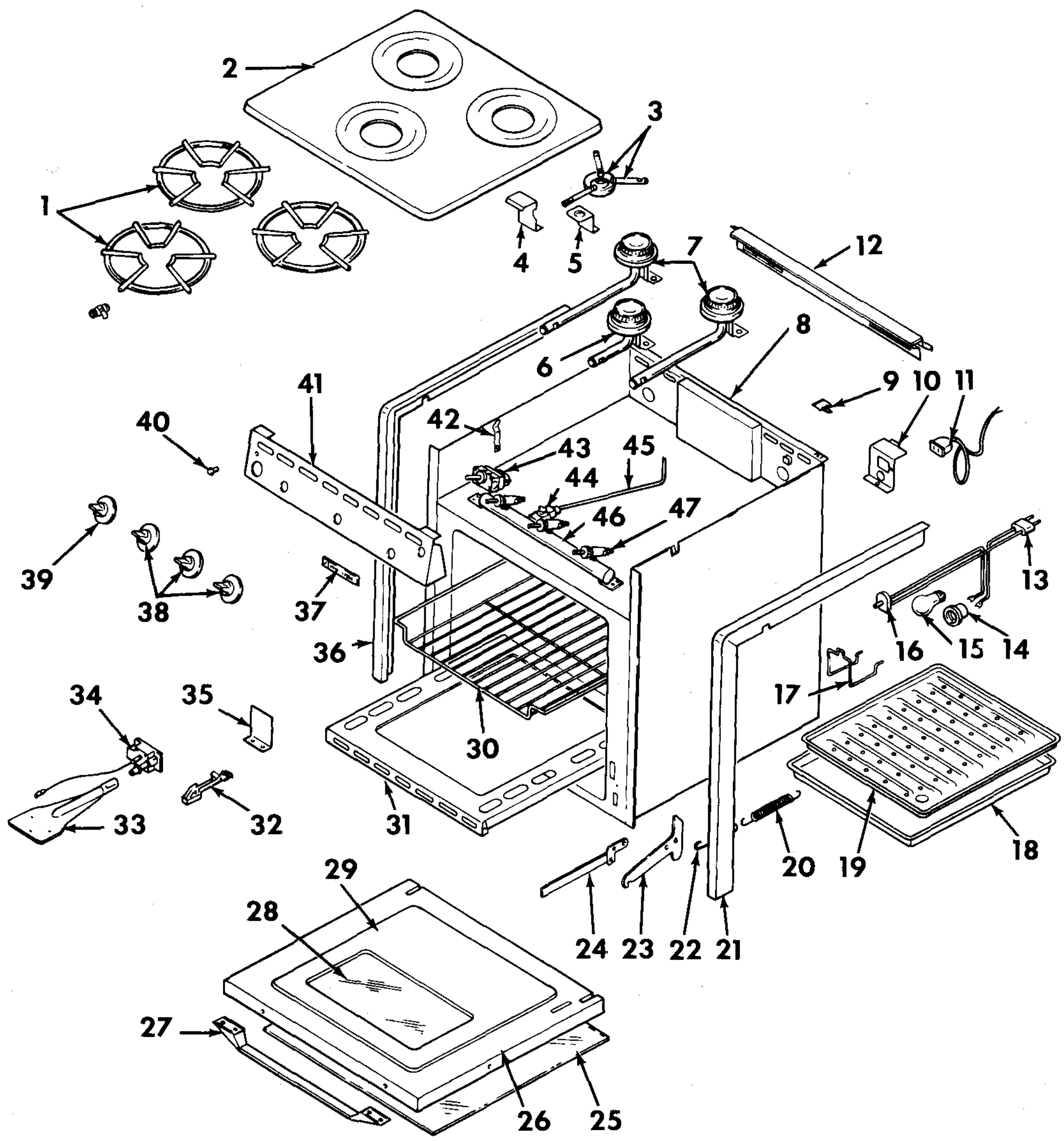
3. To light the oven burner, depress and turn the thermostat dial counterclockwise to the desired temperature setting. It will take approximately 45 seconds before the safety valve will open and the oven burner ignite.

4. When through with oven, turn the thermostat dial to the "OFF" position. In this position the oven pilot will remain lit.

5. When traveling or when the MotorHome is not in operation; return the thermostat dial to the "PILOT OFF" position and turn range/oven manual valve and range pilot shut off valve to OFF position. This should turn off the gas to the range and oven pilots.

RANGE/OVEN TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
No oven burner ignition.	1. Gas supply. 2. Pilot outage. 3. Oven Thermostat Control — You can tell that the thermostat is defective if you fail to get a secondary pilot immediately upon turning thermostat to the desired setting. 4. Oven Safety Valve — This can be determined as faulty if you do get a secondary pilot, upon setting the thermostat control to the desired temperature, but no oven ignition.	1. Be sure main gas valve/s are open and there is fuel in the tank. 2. Check to see that pilot is lit. 3. Replace Oven Thermostat Control. 4. Replace Oven Safety Valve.
No range burner ignition.	1. Gas supply. 2. Pilot outage. 3. Burner ports are clogged. 4. Burner control valve faulty.	1. Be sure main gas supply is on. 2. Check to see that pilot is lit. Also, pilot may be improperly adjusted. 3. Make sure burner ports are not clogged. 4. Replace burner valve.
Pilot outage.	1. Gas supply. 2. Air in the gas lines. 3. Pilot blowout. 4. Plugged orifice.	1. Be sure main gas valve(s) are open and there is fuel in the tank. 2. Bleed lines by holding match to burner and turning gas to that burner on fully. 3. Check for excessive drafts. 4. Carefully clean orifice with toothpick.
Noisy when traveling.	1. Broiler pan. 2. Range burner grates. 3. Oven rack. 4. Cook top. 5. Oven bottom assembly.	1. It may be desirable to store pan in towel drawer adjacent to the oven. 2. Be sure grates are properly clipped. 3. Be sure rack is properly positioned in its clips. 4. Check to make sure top is properly positioned. 5. Check that oven bottom assembly is positioned and clipped.



1. Grates
2. Cook Top
3. Lighter Cup and Flash Tube Assembly
4. Pilot Shield
5. Pilot Support
6. Front Burner
7. Rear Burners
8. Oven Cabinet
9. Cook Top Rear Spring
10. Receptacle Support
11. Service Cord
12. Flue Deflector
13. Oven Light Harness
14. Oven Light Receptacle
15. Oven Light Bulb
16. Oven Light Switch
17. Light Bulb Guard
18. Broiler Pan
19. Broiler Pan Insert
20. Door Spring
21. Side Trim - Right
22. Oven Door Spring Hook
23. Spring Hinge Arm
24. Door Hinge
25. Front Glass
26. Glass Door Frame
27. Door Handle
28. Inner Door Glass
29. Oven Door Liner
30. Oven Rack
31. Oven Bottom
32. Oven Pilot
33. Oven Burner
34. Safety Valve
35. Broiler Pan Stop
36. Side Trim - Left
37. Nameplate
38. Burner Control Knobs
39. Thermostat Knob
40. Indicator Button
41. Manifold Cover
42. Cook Top Clip
43. Oven Thermostat
44. Top Pilot Shut-off Valve
45. Pilot Tube
46. Manifold
47. Burner Control Valve

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Figure 5—Range/Oven Components

Problem	Possible Cause	Correction
Oven burner ignites as soon as thermostat control is turned to desired temperature.	1. Oven Safety Valve — If there is not a 45 second delay before oven burner ignites after the desired oven temperature is set, the Oven Safety Valve is faulty.	1. Replace Oven Safety Valve.

RANGE/OVEN COMPONENT DISASSEMBLY PROCEDURES

WARNING: BEFORE PERFORMING ANY REMOVAL OR DISASSEMBLY PROCEDURES, BE SURE THE LP GAS IS TURNED COMPLETELY OFF AT THE LP GAS TANK.

NOTE: To gain space when working in and/or on range/oven (figure 5) it is often desirable to remove the oven door.

OVEN DOOR REPLACEMENT

1. Place screwdrivers (awls, nails, etc.) through holes in oven door hinge while door is open (figure 6).

2. Lift door (as if to close) and disengage hinges at door (See figure 7).

3. Remove door.

4. To reinstall reverse procedure.

OVEN THERMOSTAT CONTROL REPLACEMENT

1. Remove oven door.

2. Remove cook top and grates (See figure 8).

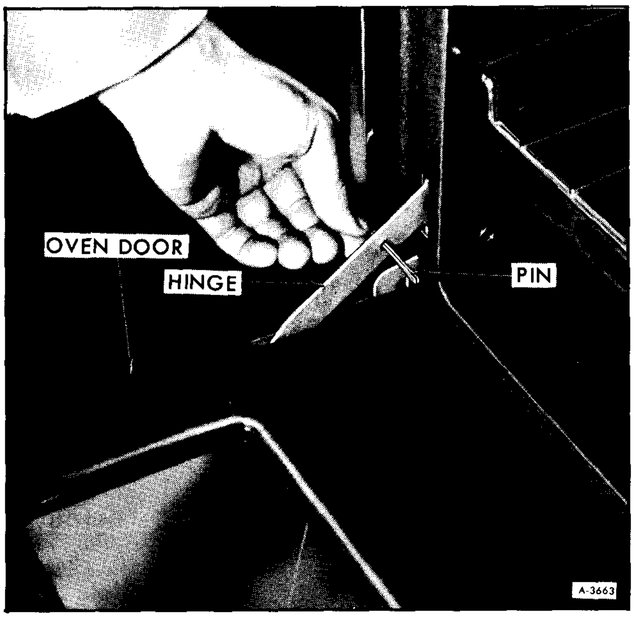


Figure 6—Inserting Pin In Door Hinge

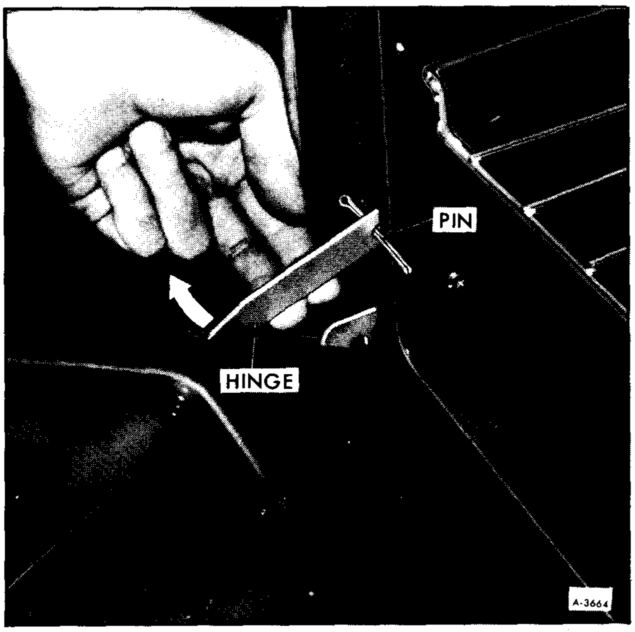


Figure 7—Disengaging Door Hinge

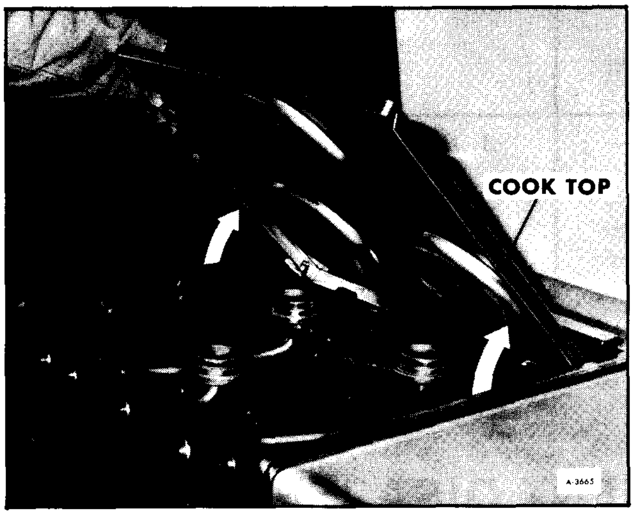


Figure 8—Cook Top Removal

3. Pull control knobs off.

4. Disconnect gas lines from rear of thermostat control as shown in Figure 9.

5. At the top of the oven compartment, remove the thermal sensing element from retaining clips and carefully feed this element up through the hole in the top of the oven compartment (figure 10).

6. Remove two screws holding oven thermostat to manifold (figure 11).

7. Replace oven thermostat control and reassemble by reversing procedure.

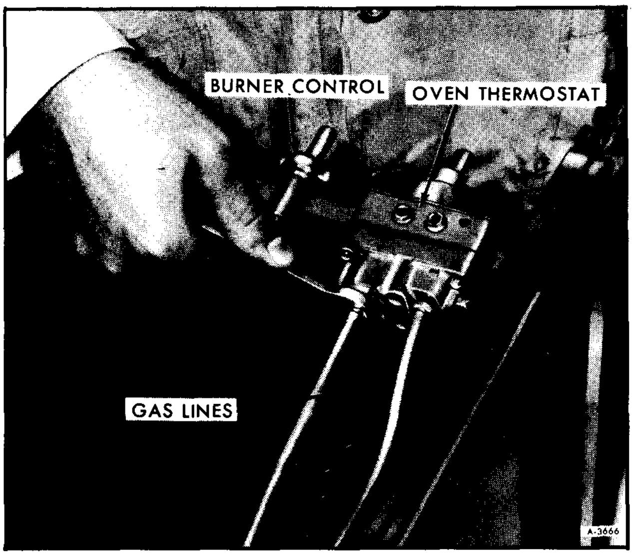


Figure 9—Disconnecting Gas Lines From Rear Of Thermostat

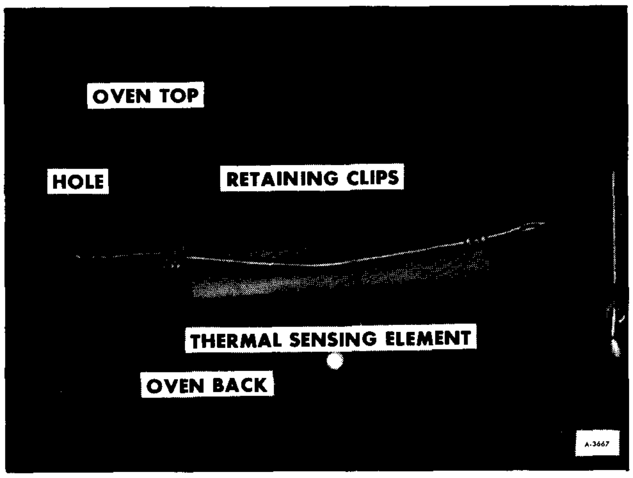


Figure 10—Location of Thermal Sensing Element in Oven

RANGE BURNER CONTROL VALVE REPLACEMENT

1. Close LP control valve on LP gas tank.

2. Remove cook top and grates (figure 8).

3. Pull control knobs off.

4. Disconnect gas lines from manifold (figures 9, 12, and 13).

5. Remove anti-rattle wire shown in Figure 24.

6. Disconnect flash tubes from top burners (figure 14).

Figure 11—Removing Thermostat from Manifold

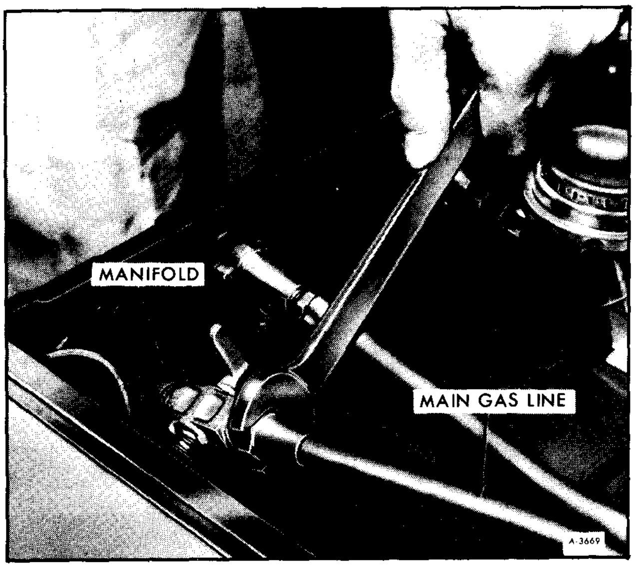


Figure 12—Disconnecting Main LP Gas Line

7. Remove top burners (figure 15).

8. Remove manifold retaining screws (figure 16).

NOTE: Burner control valves are threaded into the manifold. It will be necessary to remove the oven thermostat to replace the control valve at left end of the manifold. Figure 16 shows the thermostat removed.

9. Replace burner control valve(s) and reassemble by reversing procedure.

TOP BURNER REPLACEMENT

Should it become necessary to remove the top burners to clean or replace them, perform the following:

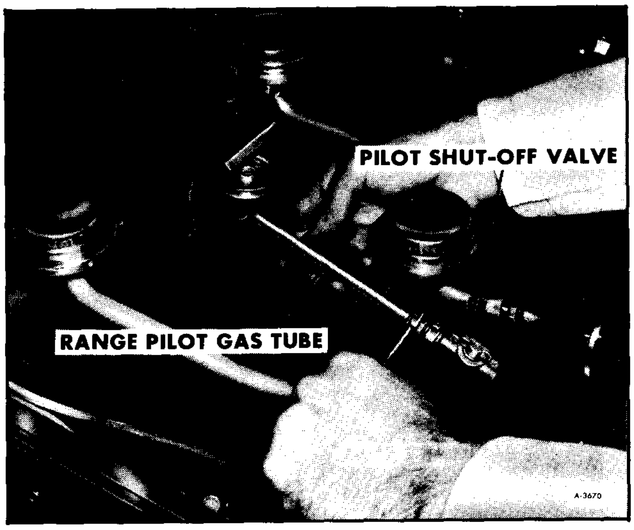


Figure 13—Disconnecting Range Pilot Gas Tube

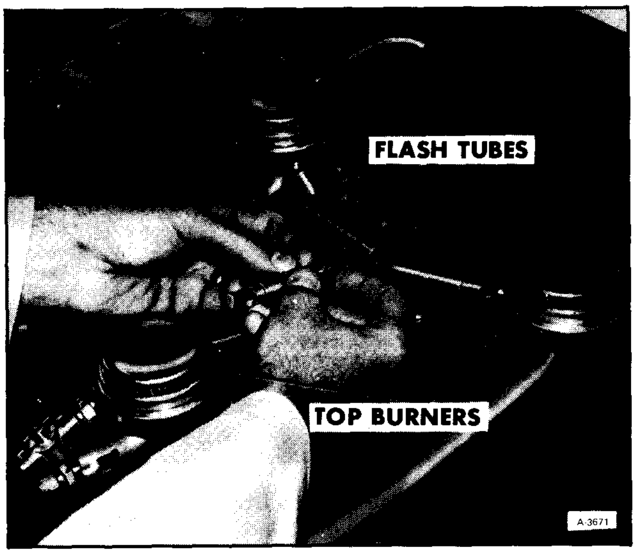


Figure 14—Disconnecting Flash Tubes

1. Remove cook top and grates (figure 8).

2. Unhook flash tube from burner (figure 14).

3. Remove single screw holding burner to range top (figure 15).

4. To install top burner reverse the above procedure.

Figure 15—Top Burner Removal

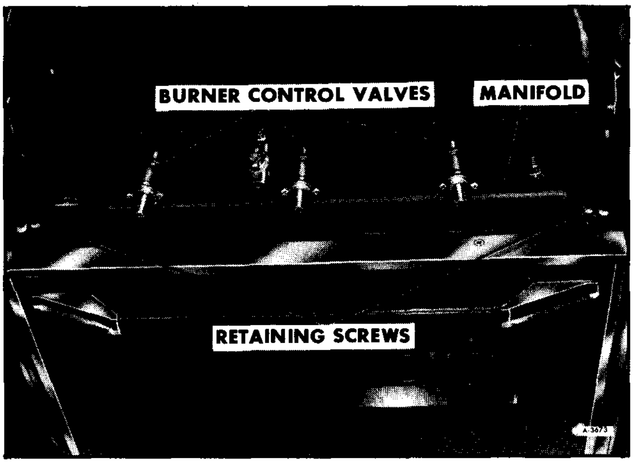


Figure 16—Manifold and Burner Control Valves Installed

Figure 18—Removing Oven Pilot Assembly

OVEN SAFETY VALVE REPLACEMENT

1. Remove oven door (See "Oven Door Replacement").

2. Remove oven rack (Item 30, figure 5).

3. Remove oven bottom assembly (Item 31, figure 5).

4. Disconnect gas line from oven pilot (figure 17) and then remove oven pilot assembly (figure 18).

5. Carefully remove capillary tube from oven pilot (figure 19).

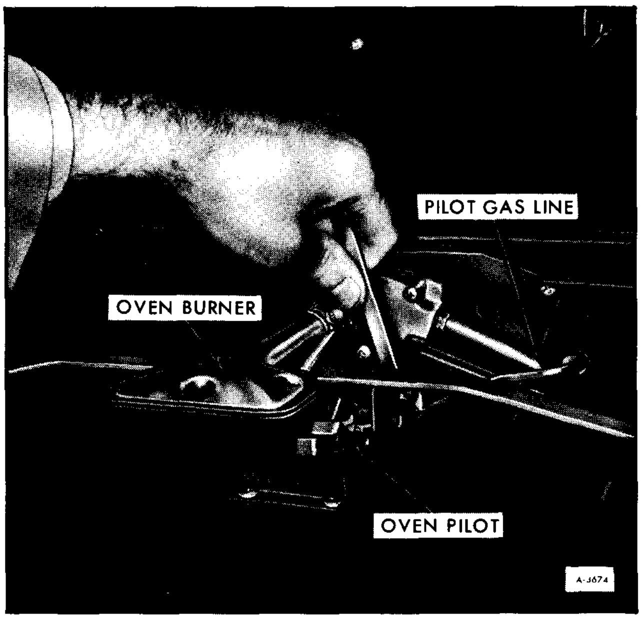


Figure 17—Disconnecting Gas Line From Oven Pilot

NOTE: Capillary tube is attached to the oven safety valve. Use care when handling to avoid damage to capillary tube.

6. Remove main burner retaining screw (figure 20). Then separate the main burner from safety valve. Also remove main burner support strap.

7. Disconnect gas line from oven safety valve (figure 21).

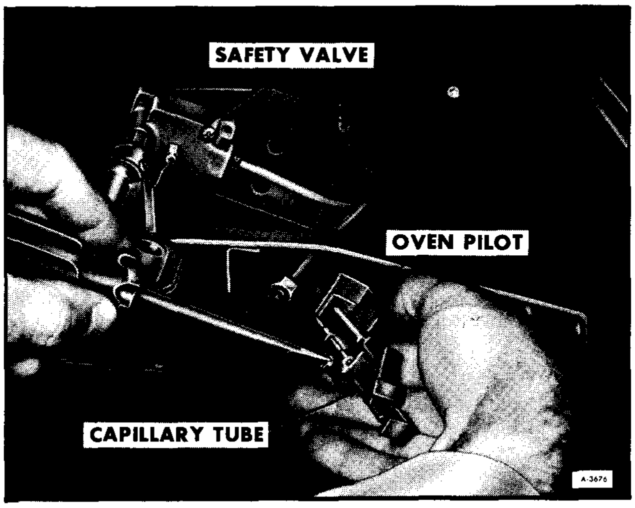


Figure 19—Removing Capillary Tube Retaining Screw

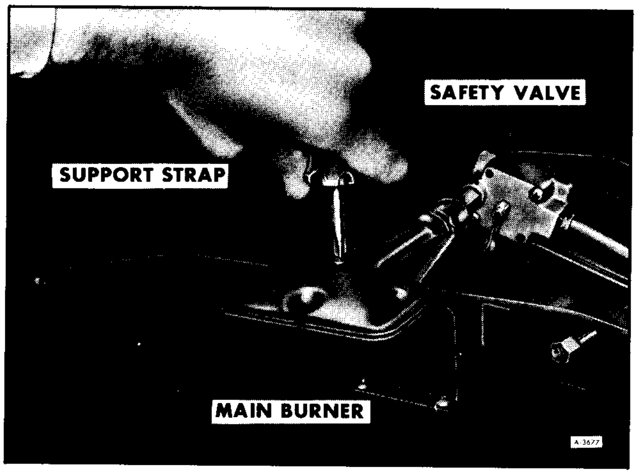


Figure 20—Removing Main Burner Retaining Screws

9. Replace safety valve and reassemble by reversing procedure.

RANGE/OVEN UNIT REPLACEMENT

1. Close LP control valve on LP gas tank.

2. Remove cook top and grates (figure 8).

3. Disconnect main LP gas line from manifold (figure 12).

4. Remove lower mounting screws located inside side trim at bottom of oven door (figure 23).

5. Remove the upper mounting screws that hold unit to the cabinet top (figure 24).

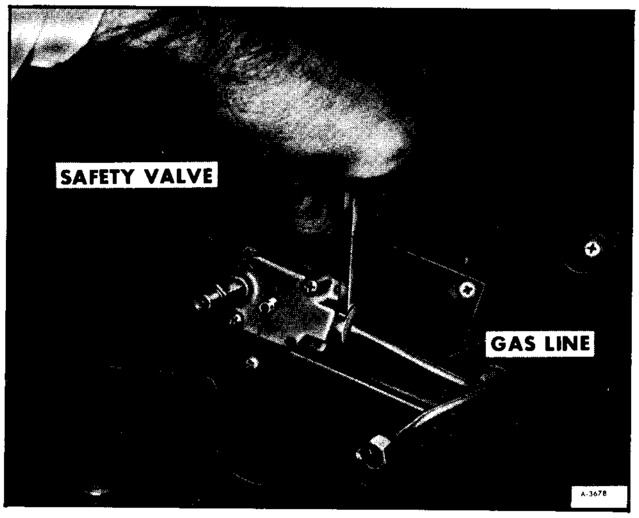


Figure 21—Disconncting Gas Line from Safety Valve

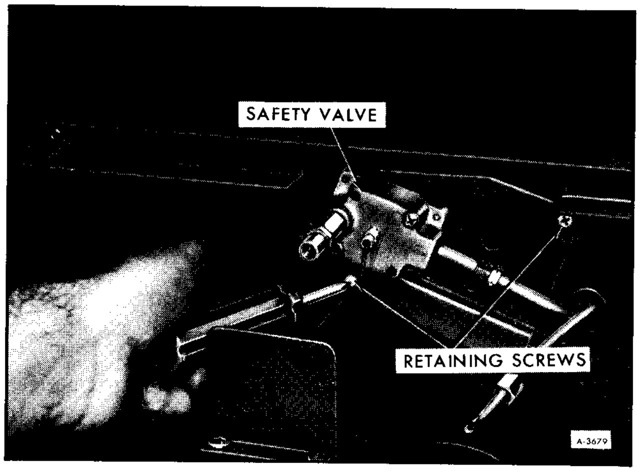


Figure 22—Removing Safety Valve Retaining Screws

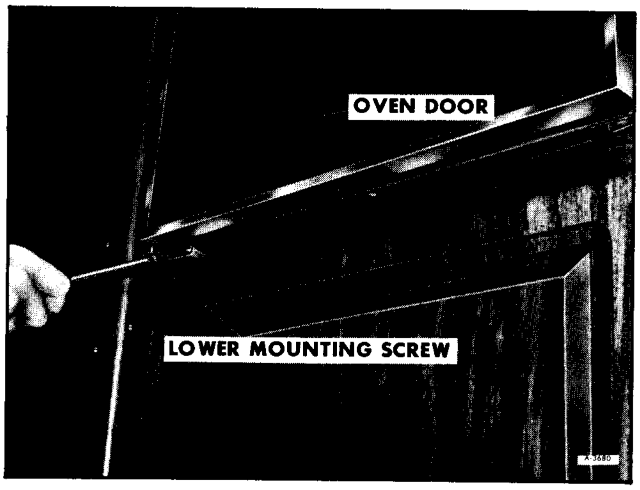


Figure 23—Removing Lower Range/Oven Mounting Screws

6. Move the range/oven forward, far enough to reach behind unit and disconnect the 12-volt service cord (Item 11, figure 5).

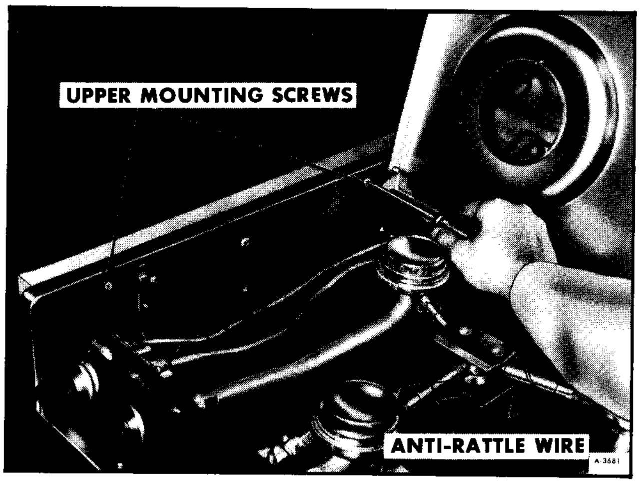


Figure 24—Removing Upper Range/Oven Mounting Screws

7. Remount unit from cabinet module.

8. To install unit reverse the above procedure.

OVEN DOOR HINGE REPLACEMENT

1. Remove range/oven unit from cabinet module (See "Range/Oven Unit Replacement").

2. Remove side trim (Items 21 and 36, figure 5) to avoid damage while servicing hinge.

3. At this point door hinge and spring is accessible for servicing, as necessary.

4. To install reverse above procedure.

OVEN DOOR GLASS REPLACEMENT

1. Remove oven door from range/oven unit (See "Oven Door Replacement").

2. Referring to Figure 5, carefully disassemble door.

3. With oven door disassembled replace glass (Items 25 or 28, figure 5).

4. Install oven door glass by reversing the above procedure.

CARE AND CLEANING

GENERAL

Regular cleaning with warm detergent solution and a soft cloth will keep your range looking bright and new. This should be done as soon as range cools.

Porcelain Enamel— Wipe surface clean immediately. Do not use metal scouring pads or cleanser containing grit or acid.

Chrome — To keep the mirror-bright finish, wipe with damp cloth and dry thoroughly. Stubborn stains may be removed with lemon juice, vinegar or chrome polish.

Glass — Wipe cooled glass with detergent and hot water. Rinse and polish with soft cloth.

BROILER PAN

Remove from oven immediately after use. Drain fat. Sprinkle rack with detergent and cover with wet paper towels and let soak, before washing in hot soapy water.

OVEN

Clean as soon as possible after use and when the oven is cool. Grease splatters that are allowed to become hard and baked on are very difficult to remove.

Care must be taken to avoid bending the tube clipped to the top of the oven. This is the thermal sensing element and could cause a variation between the oven temperature and dial setting.

If oven cleaners are used, be sure to rinse the tube thoroughly and wipe dry.

TOP BURNERS

Top burners may be cleaned with a detergent solution. If any burner port should become clogged, clean with a toothpick. Never use pins or other metal objects to clean the ports, as they may become enlarged. If the burner is washed in a sink, dry immediately by shaking off all excess water and lighting the burner until all water has evaporated.

ON-VEHICLE ADJUSTMENTS

PILOT ADJUSTMENT

The oven pilot is preadjusted and cannot be adjusted.

The range burner pilot (if so equipped) should burn with a blue flame having a slight yellow tip. The tip of the flame should extend to approximately the top of the lighter body. The adjustment screw is located behind the range pilot shut off valve pilot remove dial and insert small screwdriver through the hole (figure 25). Rotate adjustment screw as required.

OVEN MAIN BURNER ADJUSTMENT

CAUTION: *To avoid possible burns to hands or arms, prior to performing adjustment, be sure main burner is turned off and oven components are allowed to cool.*

1. Loosen air deflector retaining screw (figure 26).

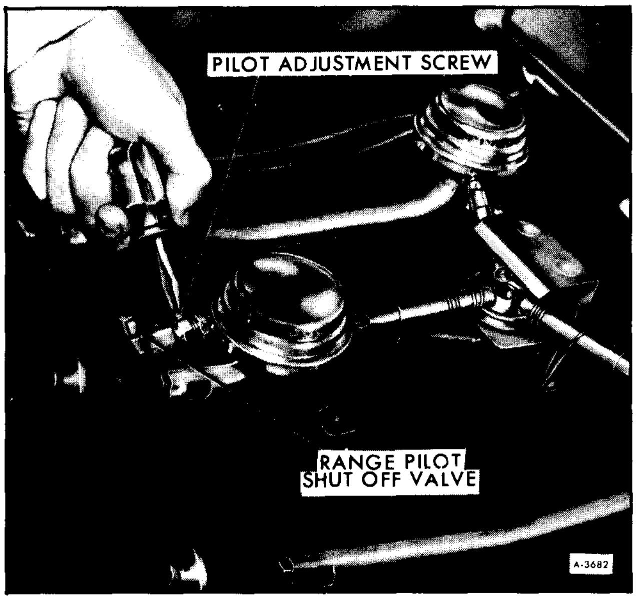


Figure 25—Adjusting Range Pilot

2. Rotate air deflector as necessary to supply more or less air to main burner.

3. Turn on oven and check burner flame. The main burner flame should burn with a blue flame having yellow tips.

4. Readjust position of air deflector if necessary after noting CAUTION at the beginning of "Oven Main Burner Adjustment."

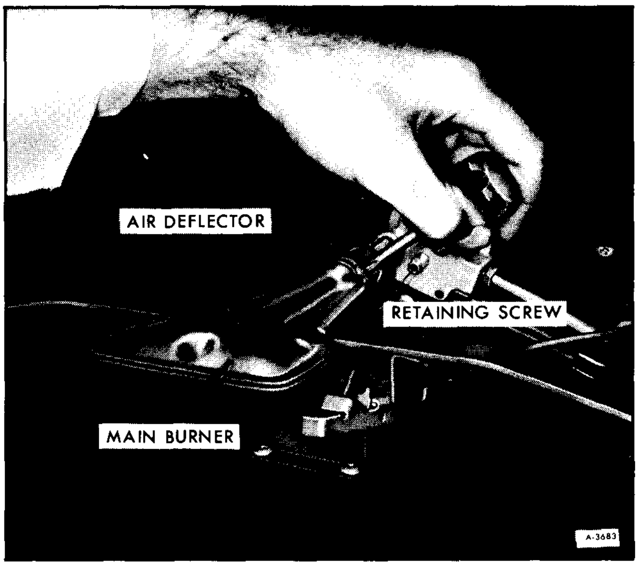


Figure 26—Location for Main Burner Adjustment

SECTION 24J
LIVING AREA WATER SYSTEM

The contents of this section are listed below:

SUBJECT	PAGE NO.
General Description-24J-00	24J-1
Trouble Diagnosis	24J-3
Draining Living Area Water System	24J-4
On-Vehicle Adjustment	24J-6
Water Tank	24J-6
Water Tank Filter-24J-00	24J-7
Water Tank Sending Unit	24J-8
Water Pump	24J-8
Water Heater	24J-19
Bathroom Sink Faucet	24J-22
Shower Head and Hose	24J-24
Galley Sink	24J-25
Water Purifier	24J-27
Winterization	24J-28
City Water Connection	24J-28
Plumbing Lines	24J-28

GENERAL DESCRIPTION

Your GMC MotorHome is equipped with its own self-contained water system (figure 1). The water tank and pressure pumps are located at the right rear corner of the MotorHome. The water pump switch is located near the entrance door.

The living area water system is supplied by either a demand water pump or by a city-water hook-up. There is no pressure tank in the system. Water pressure is maintained by a 12-volt water pump which is designed to automatically maintain enough pressure to ensure a steady water flow.

A pressure switch is located at the water pump to maintain line pressure between 15 psi. and 30 psi.

IMPORTANT: Do not attempt to increase water pressure with high pressure air. Be sure the water pump is turned "OFF" when the water tank is empty.

A 40 gallon water tank stores water to be drawn out by the water pump. The tank can be filled only through its own fill tube connection, located either inside the LP gas storage compartment at the right rear corner of the vehicle or outside at the left rear side of vehicle.

A connection is provided, in the external utilities compartment, to hook-up to a city water supply. When this is done the water pump acts as a check valve and water does not enter the water tank.

The water lines are made of polybutulene and are connected with compression fittings.

There are six drain valves standard on the vehicle. There are seven drain valves on vehicles equipped with an electric (recirculating) toilet.

These valves are used to drain the water system (See figure 1).

They are located at the:

1. water tank.
2. water pump pressure line.
3. water heater.
4. electric toilet (if equipped).
5. hot water line next to galley sink.
6. cold water line next to galley sink.
7. city water connection.

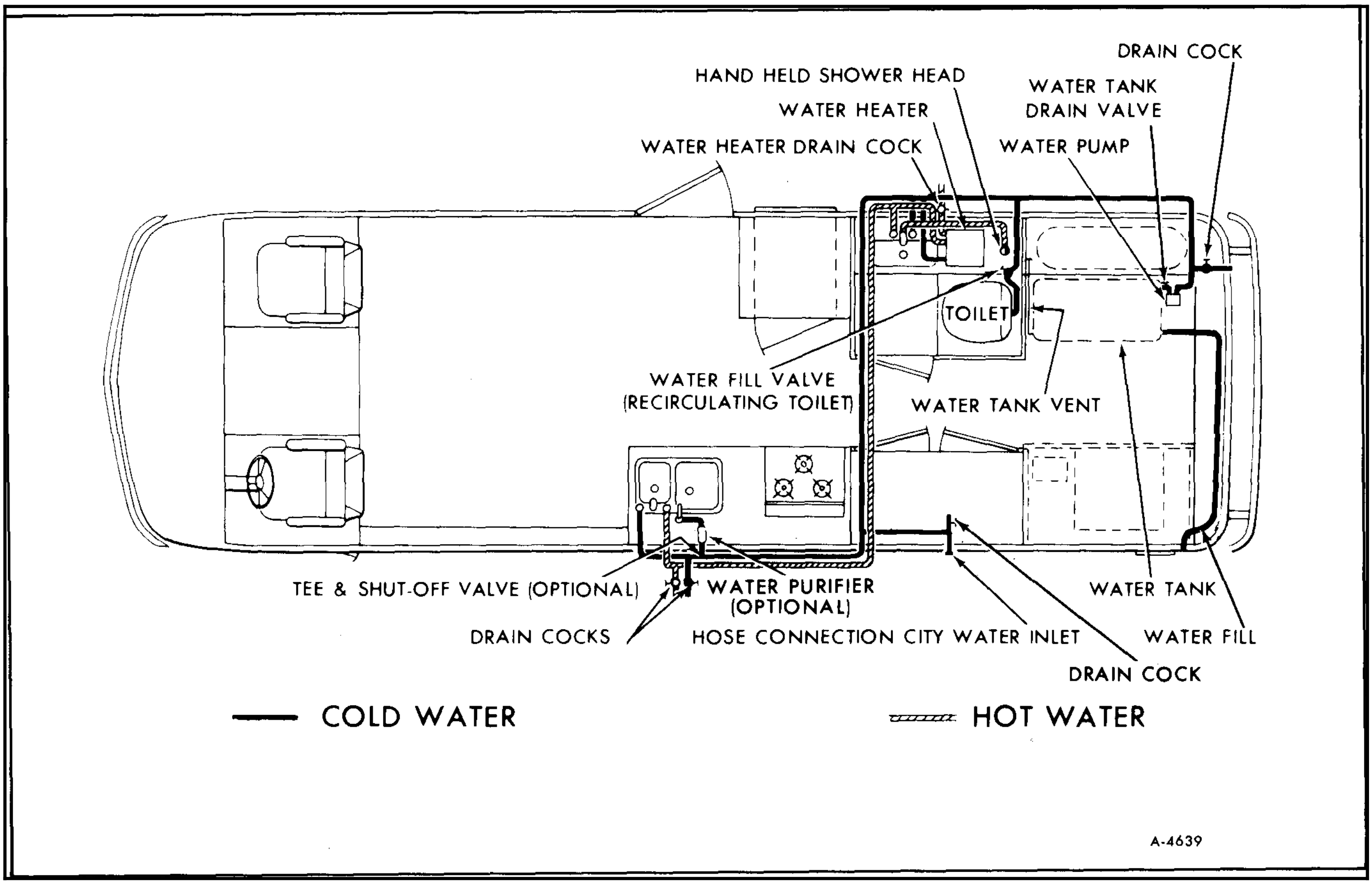


Figure 1—Living Area Water System Schematic

TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
No water.	1. Water pump switch not on.	1. Turn on switch.
	2. No water in tank.	2. Fill tank.
	3. Drain cocks open.	3. Close all drain locks.
	4. Pump belt broken.	4. Replace belt. Refer to "Water Pump Belt Replacement" later in this section. Tension as shown in "On-Vehicle Adjustment—Water Pump Belt", later in this section.
	5. Insufficient or no voltage at pump. (See water pump voltage check).	5. Check fuse panel, replace fuse if required. Check for shorts. Check living area battery for charge. Charge if necessary. Check voltage at water pump wall switch. Voltage at the switch and not at the pump indicates a possible loose or incorrect connection or broken wire between switch and pump. Correct as necessary.
	6. Faulty pressure switch on pump.	6. Check switch. Refer to "Pressure Switch" later in this section.
	7. Pump motor burned out.	7. Replace motor.
	8. Pump is not priming itself or doesn't build up enough pressure to shut-off.	8. Remove pump, dismantle and inspect check valve assemblies. Refer to "Water Pump-Disassembly" later in this section.
No or not enough hot water.	1. Water Heater Switch not on.	1. Turn on switch.
	2. Tank has overheated.	2. Push reset button.
	3. Low voltage.	3. Check source and correct as necessary.
	4. Incorrect wiring.	4. Check wire connections and correct as necessary.
	5. Heater element burned out.	5. Replace element. Refer to "Water Heater—Removal" later in this section.
	6. Thermostat burned out.	6. Replace thermostat. Refer to "Water Heater—Removal" later in this section.
	7. Water pre-heat hose (if equipped) pinched.	7. Check pre-heat hose routings, correct as required.
Leaking water system.	1. Loose or incorrect fittings.	1. Locate leak, determine cause and correct.
Water tank gauge at monitor panel does not operate.	1. Defective sending unit or monitor panel gauge.	1. Refer to "Living Area Electrical" earlier in this section. Refer to "Water Tank—Sending Unit" later in this section.

DRAINING LIVING AREA WATER SYSTEM

1. Remove the water tank fill cap.

2. Open the holding tank dump valve, after making proper connection to approved dumping station.

3. Turn off water heater at switch located in Living Area Electrical Compartment. Open the water heater drain valve. The type 1 water heater drain valve is located at the front of the heater (figure 2). The type 2 water heater drain valve is located under the center of the water heater body (figure 42).

4. Open the water drain valves at the water pump and the water tank (figures 3 and 4), and the two water line drain cocks next to the kitchen sink. To gain access to water line drain cocks for kitchen sink remove the second drawer located to the left of the kitchen sink compartment door.

5. Open kitchen and bathroom faucets.

6. Turn on water pump (if not already running).

7. With the standard toilet, depress the foot pedal until water no longer enters toilet bowl.

8. Allow system to drain.

9. Turn off water pump.

10. Disconnect intake and outlet hoses on water pump.

11. With the recirculating toilet, open the toilet water line fill valve and press the flush button.

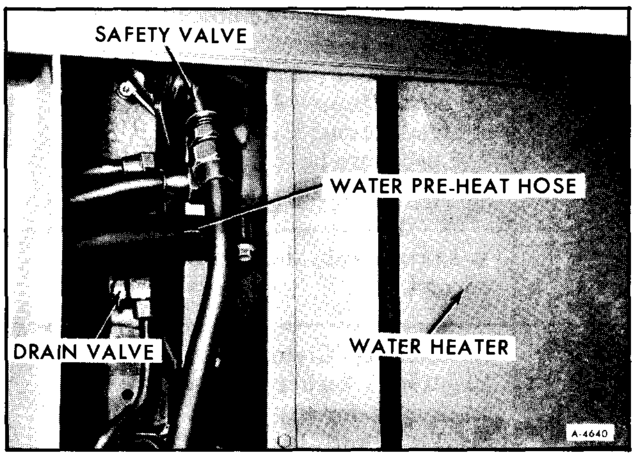


Figure 2—Water Heater - Type 1

12. Open shower head shut-off valve and turn the shower on at the bathroom faucet. Extend shower head toward sink to allow the shower head and flexible hose to drain.

13. Remove access cover near lower shelf in closet. Open drain valve (figure 5) for external water connection (inside external utilities compartment), remove hose connection cover. Depress the button on the check valve (figure 6) to allow this portion of plumbing to drain. Install hose connection cover.

14. Using low pressure (30 psi maximum), blow back through all faucets, forcing water from any low areas.

15. Connect water pump hoses and close all the water line drain cocks and valves including the water heater drain cock. Close kitchen and bathroom faucets, close toilet water line valve (if equipped). Close holding tank dump valve and latch. Stow holding tank tubes and replace dust cap. Replace water tank fill cap.

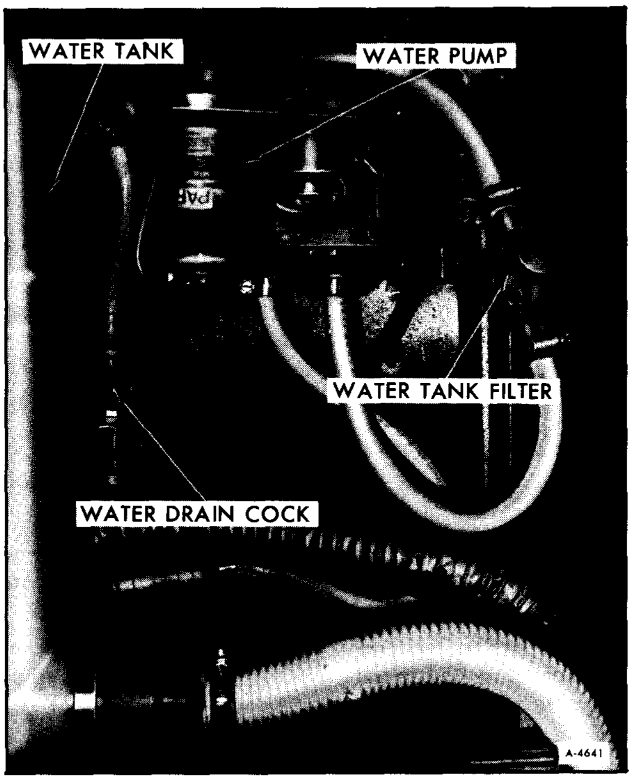


Figure 3—Water Tank Compartment (Typical)

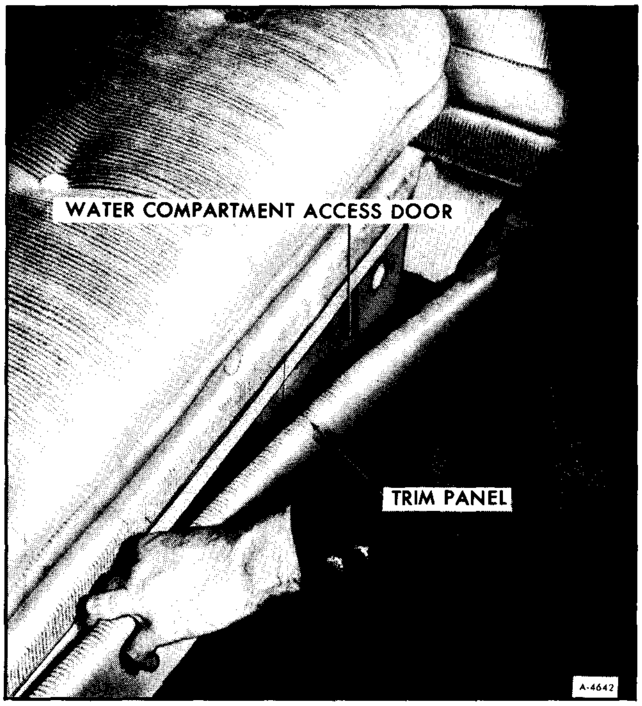


Figure 4—Access to Water Pump and Controls

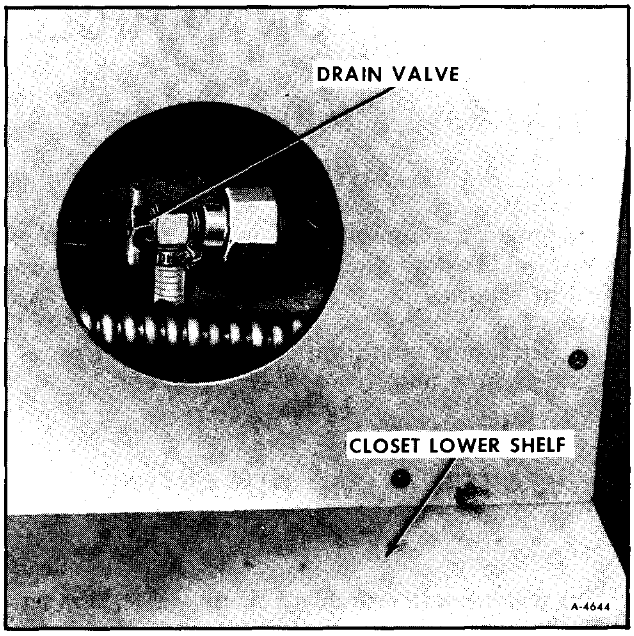


Figure 5—External Water Connection Drain Valve

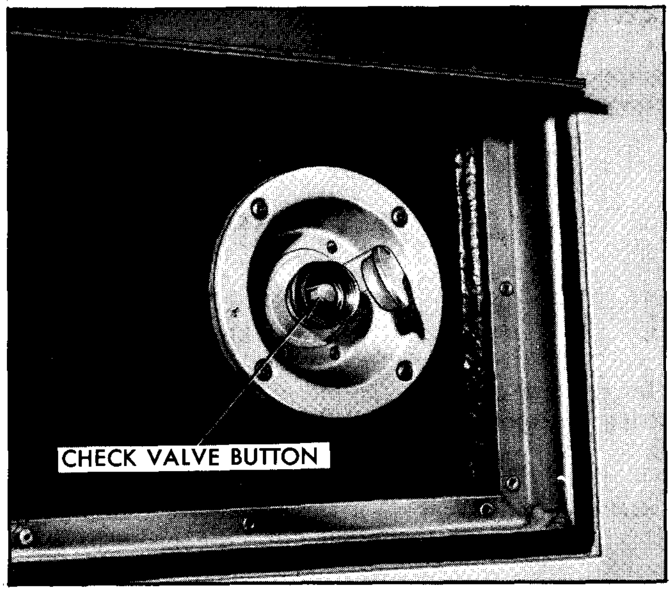


Figure 6—External Water Connection

ON VEHICLE ADJUSTMENT

WATER PUMP BELT (TYPE 1 ONLY)

To obtain maximum life from the water pump belt it should be adjusted to obtain 1/8" deflection as shown in Figure 7.

Loosen motor mounting nuts, tension belt properly and tighten nuts.

WATER PUMP PRESSURE SWITCH

The water pump switch is nonadjustable. It is set at the factory and can not be changed. If it fails, replace it.

The adjustable pressure switch on some type 1 pumps is to be replaced when adjustment beomes necessary or failure occurs, with the nonadjustable switch.

WATER HEATER THERMOSTAT

The water heater has been equipped with a non-adjustable thermostat, it was factory set and no adjustment is possible.

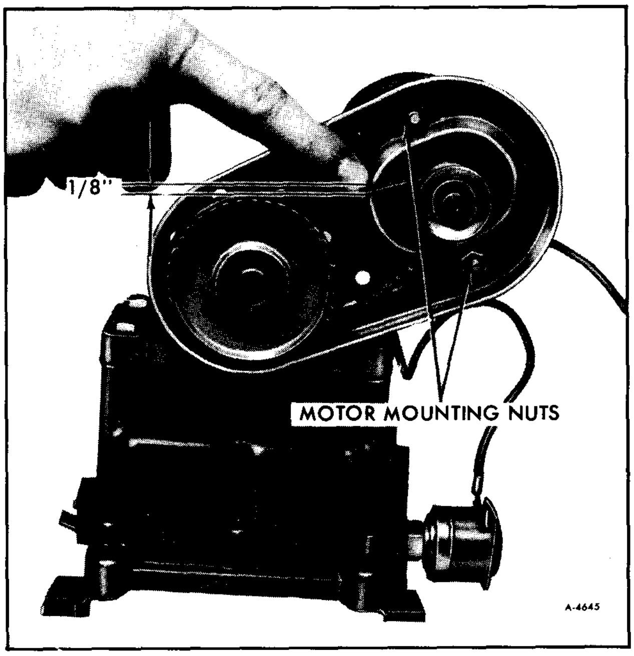


Figure 7—Water Pump Belt Tension

The water heater is equipped with a reset button. In the event the tank becomes overheated a thermal sensing switch will automatically disconnect the heater. To reset the type 1 unit remove the metal cover and push the red reset button. To reset the type 2 unit push the reset button through the hole in access cover.

WATER TANK

REMOVAL

1. Remove kick panel from lower front of seat. The panel is held by Velcro strips or equivalent, simply pull to remove (figure 4).

2. Remove two screws under seat that attach seat to mounting brackets (figure 12).

3. To remove seat pull up and out.

4. The water tank is enclosed by two wood panels, one along the top, the other along the side. The two panels are joined and can be removed together. Remove screws along the back of the top panel and at the floor side of the other panel. Remove wood panels.

5. Turn water pump switch to "OFF" position.

6. Disconnect tank vent hose.

7. Open tank drain valve and allow tank to drain (figure 8).

8. Disconnect water fill inlet tube at tank.

9. Disconnect tank sending unit wires and tank hold down strap brackets.

NOTE: Straps do not have to be cut.

10. Disconnect the suction hose at the pump.

11. Disconnect the drain hose from the tee or valve, whichever is more accessible.

12. Remove tank.

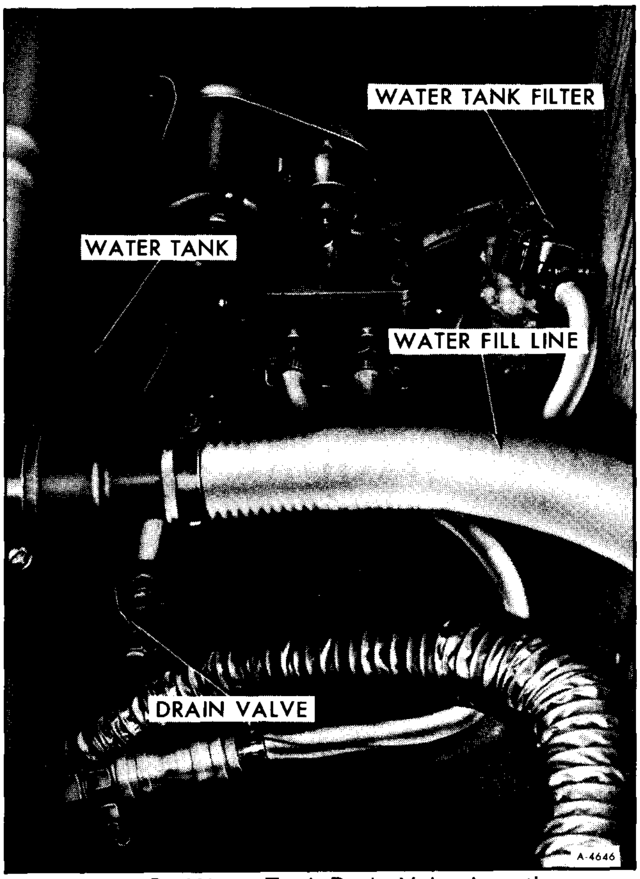


Figure 8—Water Tank Drain Valve Location

WATER TANK REPAIR

The tank is manufactured from polypropylene plastic. Except for small, clean punctures the tank is not repairable. Polypropylene resists all common adhesives that may be used in patching or plugging. However, on small punctures a Well-Nut may be used. Enlarge the hole enough to insert the Well-Nut and tighten enough to close up the hole to make it waterproof.

INSTALLATION

1. Install tank.

2. Connect drain hose to valve or tee. Connect suction hose to water pump. Tighten clamps securely.

3. Position hold-down straps and secure strap brackets to the floor.

4. Connect tank sending unit wires, if equipped.

5. Connect water tank fill inlet tube or elbow. Tighten clamps securely.

6. Inspect dampener for excessive deformation, ruptures and cuts (figure 21).

7. Close drain valve.

8. Fill water tank and turn on pump to pressurize the system. Check for leaks.

9. Replace wood cover over water tank and cushions.

WATER TANK FILTER (FIGURE 8)

When water flows from the fresh water tank, it circulates through the water tank filter before entering the water pump.

The water tank filter, which is located in the water compartment, is transparent and should be checked periodically and cleaned annually.

A helpful sign that filter is dirty is that the transparent filter has become discolored.

REMOVING FILTER FROM WATER LINES

1. Turn water pump and water heater switches to "OFF" position.

2. Drain water tank.

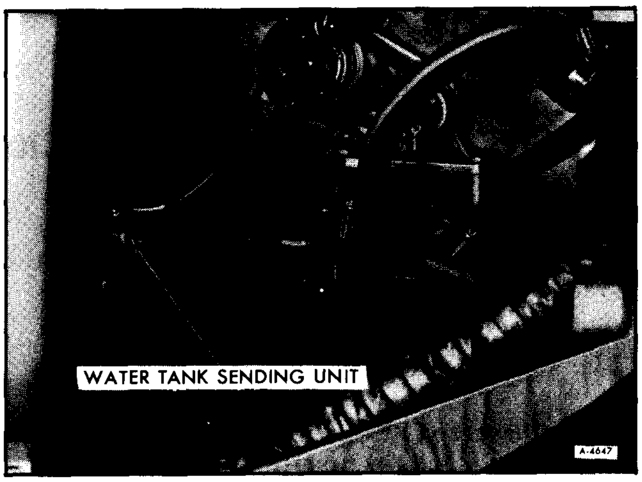


Figure 9—Water Tank Sending Unit

3. Disconnect the two clamps that attach water filter to water line hoses.

4. Separate filter from hoses.

DISASSEMBLY OF WATER FILTER

1. Remove screws which attach filter.

2. Remove filter screen.

3. Clean filter and screen with water and a soft nylon bristle brush.

ASSEMBLY OF WATER FILTER

1. Place filter screen into filter.

2. Assemble filter together with screws.

ASSEMBLY OF WATER TANK FILTER TO WATER LINES

1. Attach filter to water line hose connections.

2. Tighten hose clamps.

3. Refill water tank.

WATER TANK SENDING UNIT (FIGURE 9)

REMOVAL

1. Disconnect battery ground cables.

2. Pull kick panel off. Remove two screws holding seat on. Pull seat up and out to remove.

3. Drain tank until water level is below sending unit opening.

4. Disconnect sending unit wires and remove sending unit nuts.

5. Remove sending unit.

INSTALLATION

1. Install sending unit, tighten nuts securely.

2. Connect sending unit wires.

3. Fill tank and check for leaks.

4. Connect battery ground cables and check for proper operation of sending unit at monitor panel.

5. Install seat and secure to mounting bracket with two screws. Replace kick panel.

WATER PUMP

The water pump (Type 1 or Type 2) is mounted in the water tank compartment at the rear right hand corner of the vehicle. Access to this compartment is from inside the vehicle (See Water Pump Removal).

WATER PUMP VOLTAGE CHECK (FIGURE 10)

1. To check water pump voltage turn off all other electrical fixtures.

NOTE: Make sure there is a full charge on the living area battery.

2. Connect a DC voltmeter to the pressure switch positive lead, and the negative lead from the motor. Fully open a faucet to check for voltage with pump running.

3. Check for voltage in both battery and converter operational modes. The battery mode check is made with power supplied by living area battery. The converter mode check is made with vehicle plugged into an external power supply. Voltage reading at the pump should be 12 to 12.5 volts. It can read higher, but shouldn't read less.

WATER PUMP REMOVAL

1. Remove the front kick panel by simply pulling. Velcro strips hold it in place (figure 11).

2. Remove the two settee seat attaching screws (figure 12).

3. Remove the top cover screws and cover exposing the water pump and tank (figure 13).

4. Open tank drain valve and drain tank.

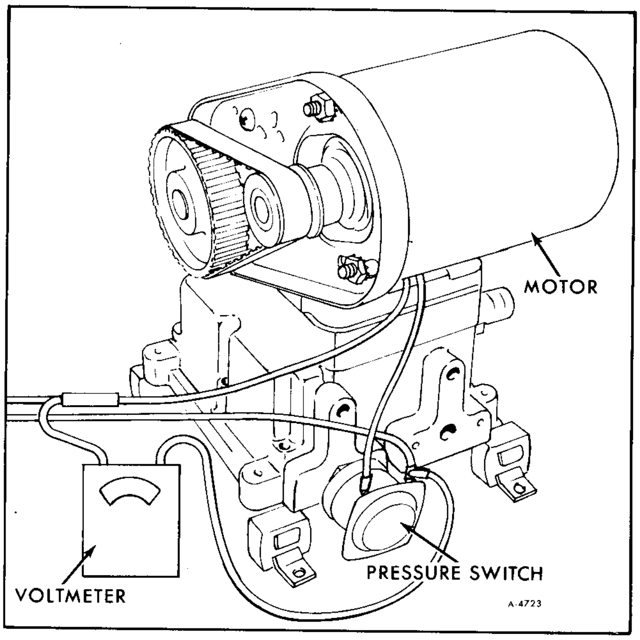


Figure 10—Water Pump Voltage Check

5. Make sure pump wall switch is turned off and remove fuse.

6. Disconnect hoses from water pump.

7. Remove four pump hold down screws.

8. Lift pump assembly out and disconnect wires from the pressure switch.

Figure 11—Removing Kick Panel

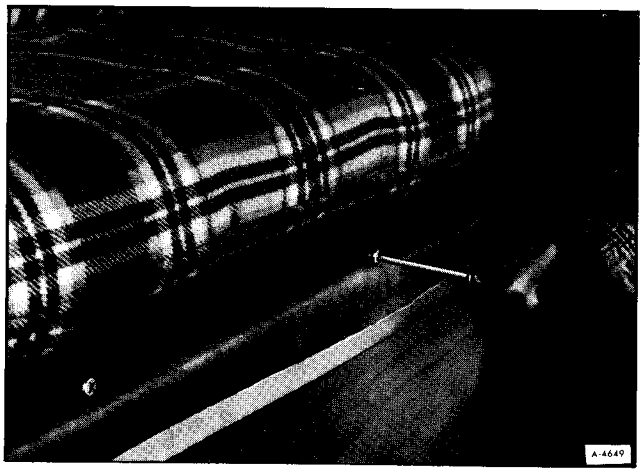


Figure 12—Removing Seat

WATER PUMP INSTALLATION

1. Place pump in mounting position and secure with four hold-down screws. If Type 2 pump is used do not depress rubber feet with mounting screws.

2. Connect wires to the pressure switch.

3. Connect hoses to water pump.

4. Replace fuse.

5. Close tank drain valve and fill tank.

6. Replace top panel and secure with screws.

7. Replace seat and secure with two screws to mounting bracket.

8. Replace front kick panel.

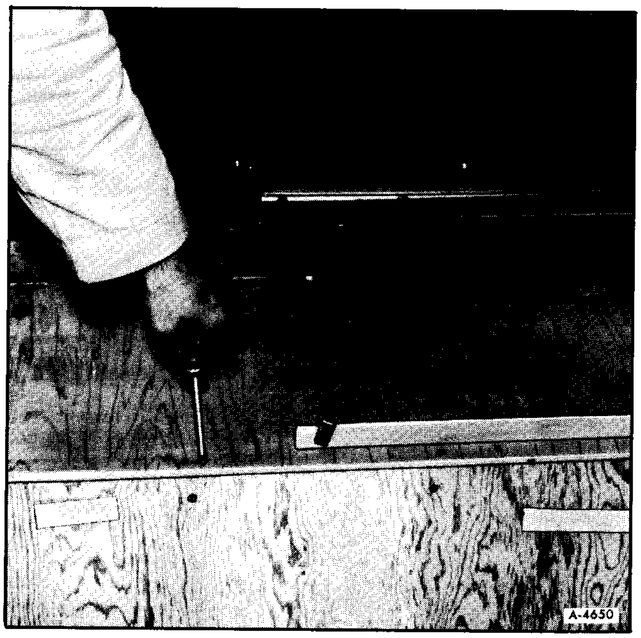


Figure 13—Removing Top Panel

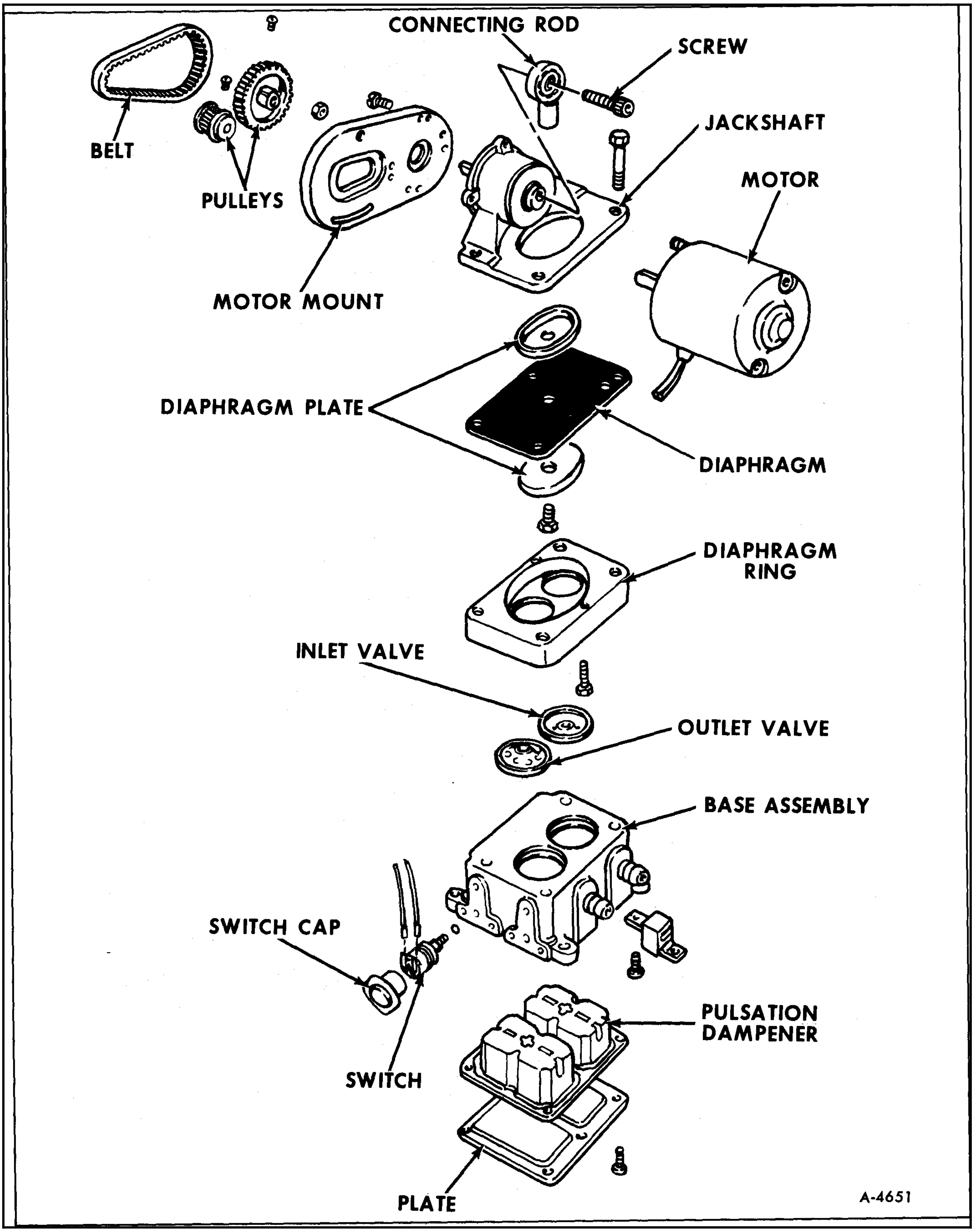


Figure 14—Type 1 Water Pump Exploded View

TYPE 1 WATER PUMP OVERHAUL (FIGURE 14)

VALVES REPLACEMENT

1. Turn off power to pump.

2. If system is filled with water, open a faucet to relieve pressure. Close intake and discharge lines near pump. Remove pump from vehicle.

3. Remove motor and four tie down screws (figure 15).

4. Expose valves by lifting jack shaft and attached diaphragm assembly from pump base. (figure 16).

5. Lift valves from pockets. Clean all foreign materials from valves and seats (figure 17).

6. Reinstall valves into same pockets, being sure rubber valve with small hole is UP on intake and rubber valve without the small hole is DOWN on discharge. NOTE: Do not use valve with small hole in rubber on discharge side of pump.

7. When reassembling, adjust belt tension to 1/8" play.

DIAPHRAGM

1. Turn off power to pump.

2. If system is filled with water, open a faucet to relieve pressure. Close intake and discharge lines near pump. Remove pump from vehicle.

3. Remove motor and four tie down screws then lift jack shaft and attached diaphragm assembly from pump base.

4. Expose diaphragm by removing two diaphragm retain screws and detaching.

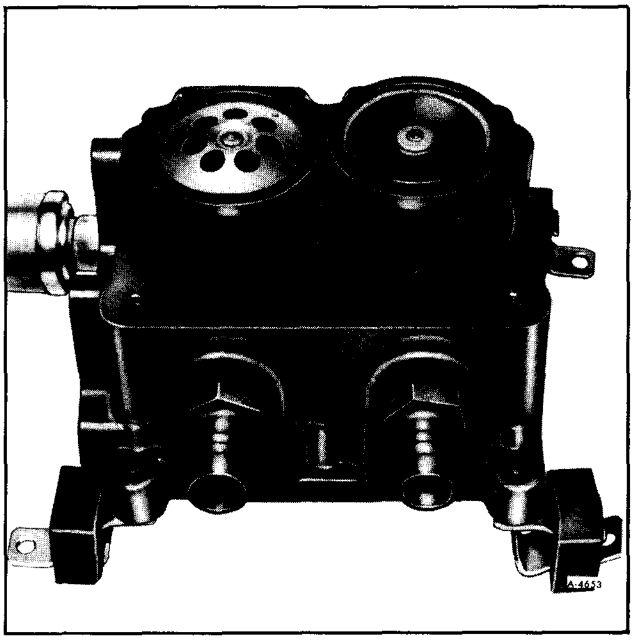


Figure 16—Water Pump Valves

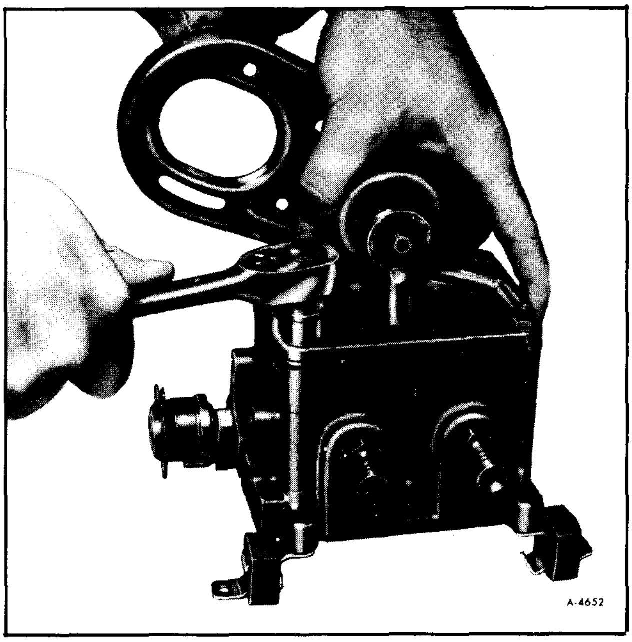


Figure 15—Opening Water Pump

Figure 17—Water Pump Valve Removed

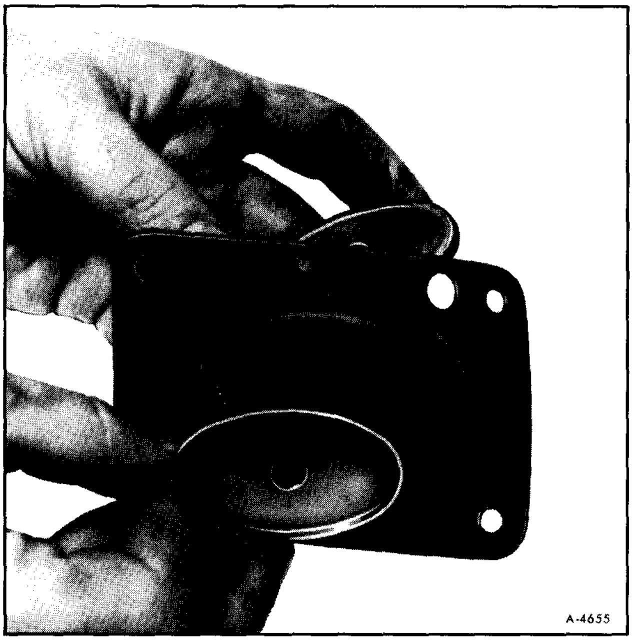


Figure 18—Inspecting Diaphragm

5. Remove diaphragm screw to separate diaphragm and plates from connecting rod. Inspect diaphragm for cuts and ruptures (figure 18).

6. Remove eccentric screw to separate connecting rod from jack shaft (figure 19).

7. When reassembling, be sure to align diaphragm and connecting rod so that rod slips straight onto jack shaft and diaphragm rests squarely on diaphragm retainer. Misalignment will create a strain on diaphragm and significantly shorten its life. Adjust belt tension to 1/8" play.

PULSATION DAMPENER REPLACEMENT

1. Turn off power to pump.

2. If system is filled with water, open a faucet to relieve pressure. Close intake and discharge lines near pump.

3. Remove pump from vehicle.

4. Remove nine screws from bottom of base and bottom plate (figure 20).

5. Pull out rubber pulsation dampener from base.

6. Inspect dampener for excessive deformation, ruptures and cuts (figure 21).

7. When installing new pulsation dampener, make sure flange is well-seated to effect a proper water and air seal.

MOTOR REPLACEMENT

1. Turn off power to pump.

2. Disconnect motor wires from pressure switch terminal.

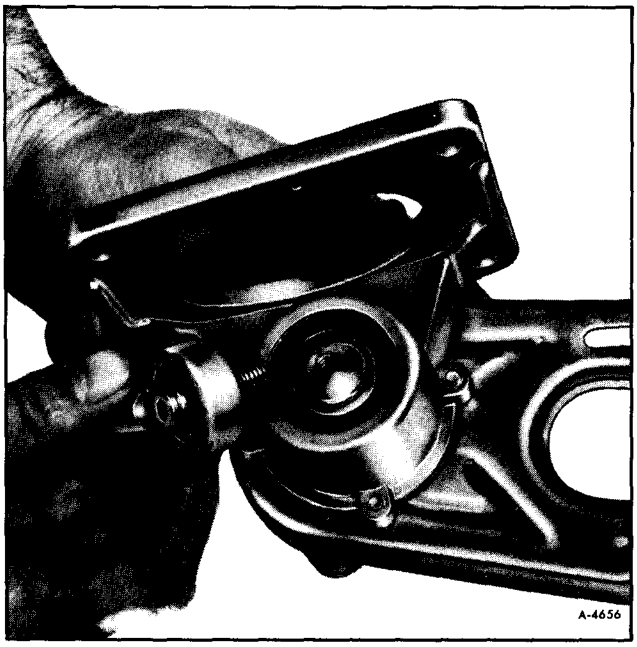


Figure 19—Separating Connecting Rod

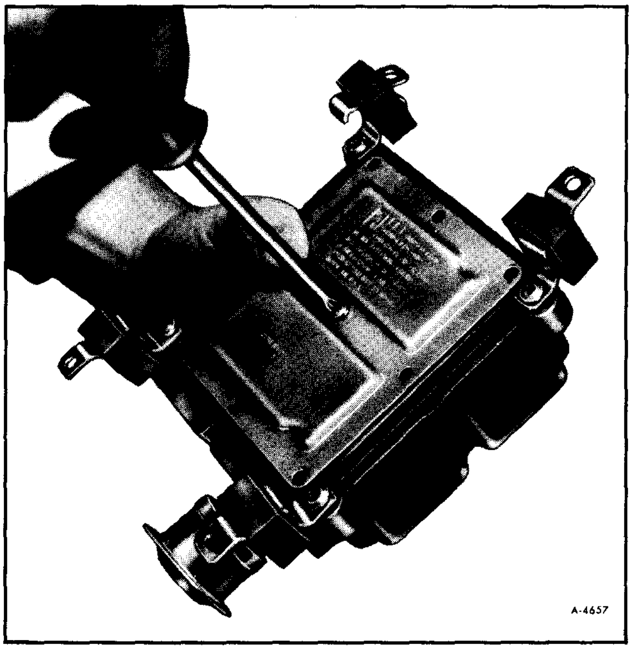


Figure 20—Removing Bottom Plate

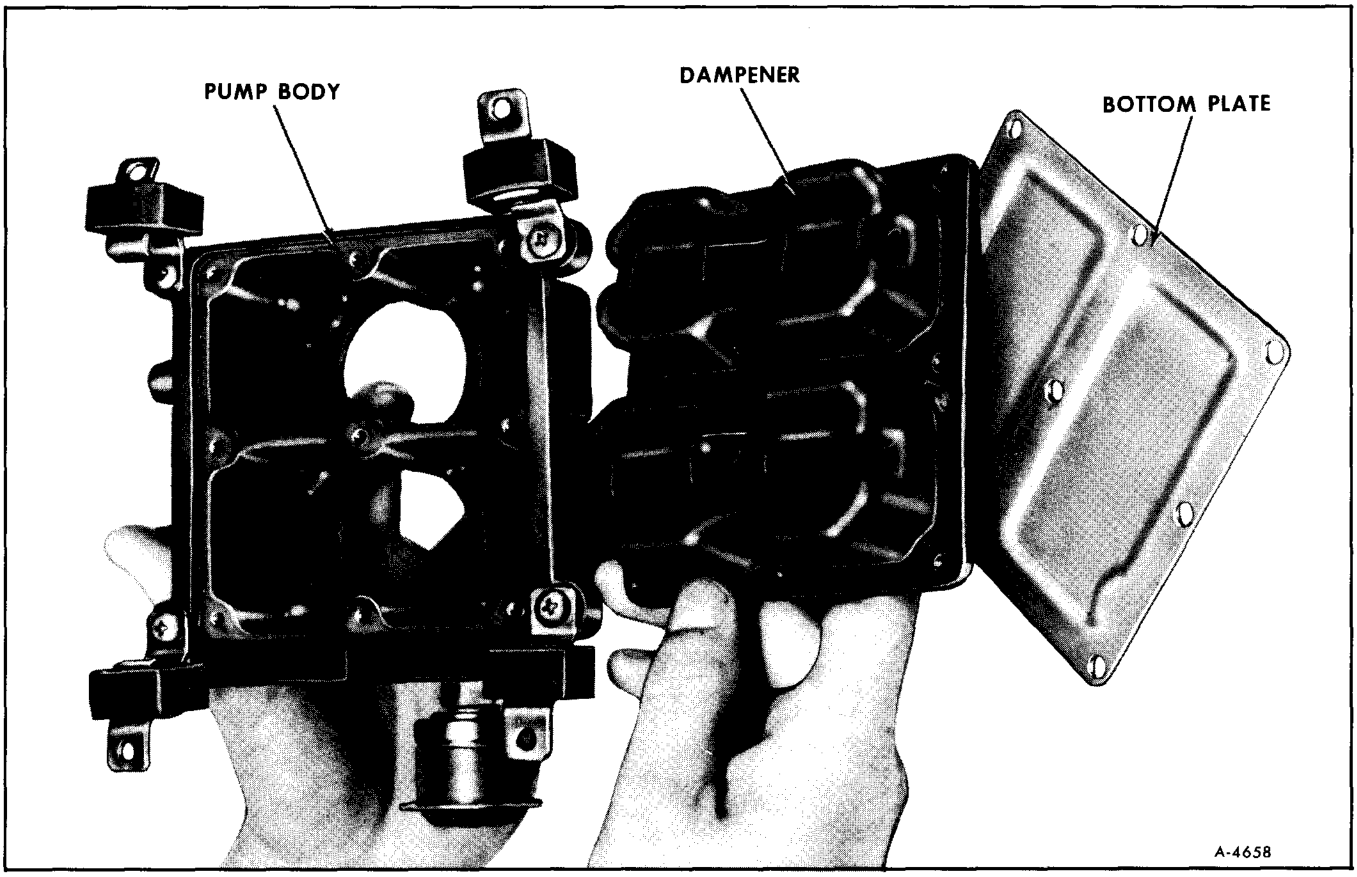


Figure 21—Inspecting Dampener

3. Remove two motor nuts to separate motor.

4. Loosen screw to slide off small pulley from motor shaft.

5. When reassembling, be sure to adjust belt tension before tightening motor nuts. Proper adjustment is made when belt can be depressed 1/8 inch at a point halfway between pulleys.

PRESSURE SWITCH (TYPE 1 WATER PUMP) (FIGURE 22)

The pressure switch, mounted on the type 1 water pump, is non-adjustable. If the switch fails to operate properly, replace it. The pump should operate between 15 psi and 30 psi.

NOTE: If the pump is equipped with an earlier adjustable pressure switch, it should be replaced when it fails or falls out of adjustment. For pump models - 1000 and above no conversion kit is necessary. Pumps below - 1000 require a service conversion kit.

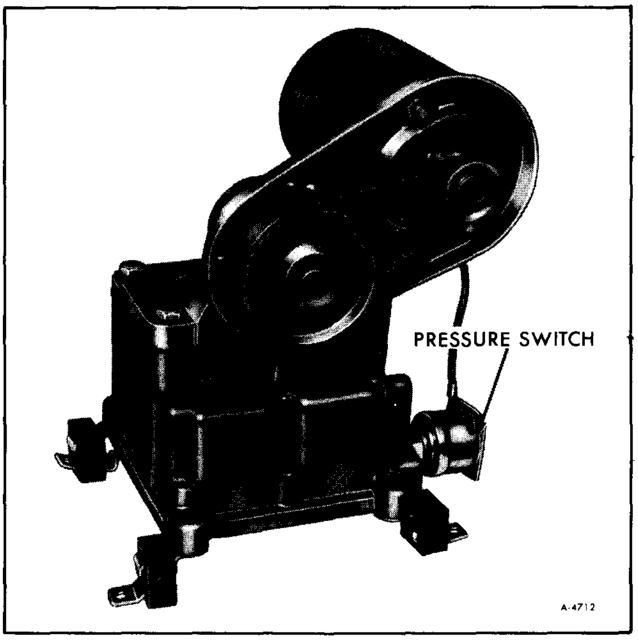
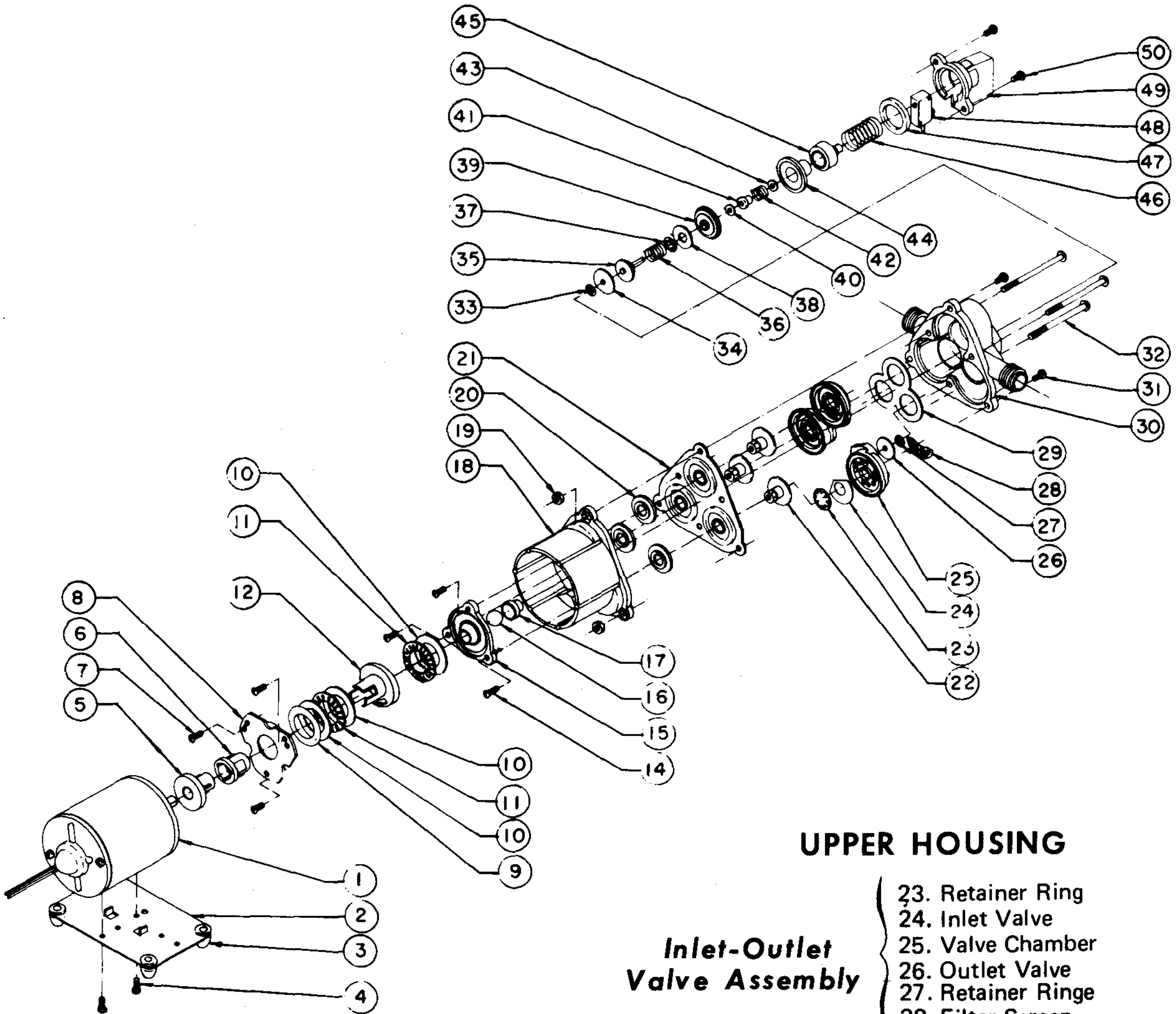


Figure 22—Water Pump With Pressure Switch



1. Motor
2. Base Plate
3. Rubber Foot
4. Screw

LOWER HOUSING

5. Coupling
6. Bushing
7. Screw
8. Support Plate
9. Mylar Shim
10. Bearing Cover
11. Bearing
12. Drive Coupling
14. Screw
15. Wobble Plate
16. Ball, Steel
17. Bushing
18. Lower Housing
19. Nut, Hex

Piston Assembly
20. Piston Bottom
21. Diaphragm
22. Piston Top

UPPER HOUSING

Inlet-Outlet Valve Assembly
23. Retainer Ring
24. Inlet Valve
25. Valve Chamber
26. Outlet Valve
27. Retainer Ringe
28. Filter Screen

29. Gasket
30. Upper Housing

31. Screw
32. Screw

Check Valve Assembly
33. Retainer Ring
34. Check Valve
35. Valve Stem

36. Spring

Valve Assembly
37. Retainer Ring
38. Seal Washer
39. Valve Plate
40. Seal Washer
41. Poppet
42. Spring
43. Seal Washer
44. Diaphragm

45. Plunger
46. Spring
47. Bridge Ring
48. Switch
49. Switch Cap
50. Screw

A-4694

Figure 23—Type 2 Water Pump Exploded View

REMOVAL

1. Turn pump off at light switch panel and open a faucet to relieve pressure from the system.

2. Disconnect all wires from the pressure switch.

3. Use an open end wrench on hex nut base of switch and turn switch out of mounting hole.

INSTALLATION

1. Put fiber metallic supported washer on threaded shaft of switch, with metallic side facing switch.

2. Tighten switch securely onto pump.

3. Connect wires to switch and turn on pump. Check for proper operation.

WINTER STORAGE

The Type 1 water pump will withstand frozen water damage provided the system is not under pressure prior to freezing. To prevent damage, the entire water system must be "winterized" thoroughly for winter storage. See Section 24A.

TYPE 2 WATER PUMP OVERHAUL (FIGURE 23)

DISASSEMBLY (FIGURE 24)

1. Hold switch cap securely (figure 25) while removing two screws because spring inside has enough tension to throw the cap. Pressure switch will drop out of cap after it is removed.

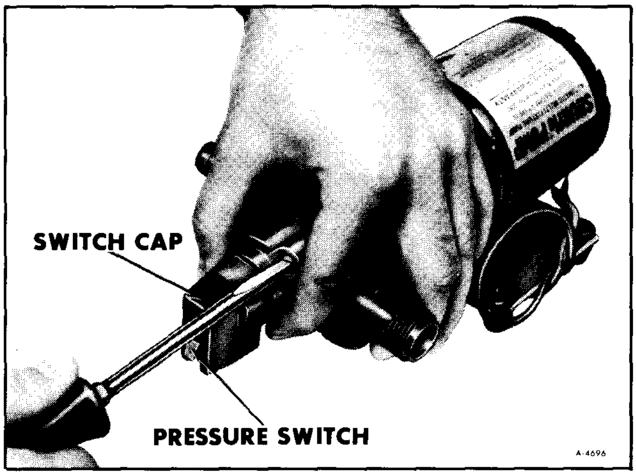


Figure 25—Removing Switch Cap

2. Spring and plunger will drop off (figure 26).

3. Pull rubber diaphragm with valve assembly out of recess, then remove spring and check valve assembly (figure 27).

4. Remove three long screws and three short screws with nuts securing upper housing to lower housing, and lower housing to motor. Separate motor from housings and upper and lower housing from each other (figure 28).

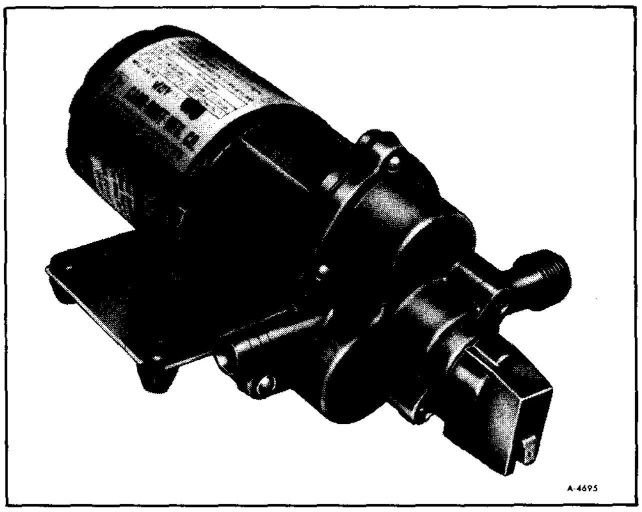


Figure 24—Type 2 Water Pump

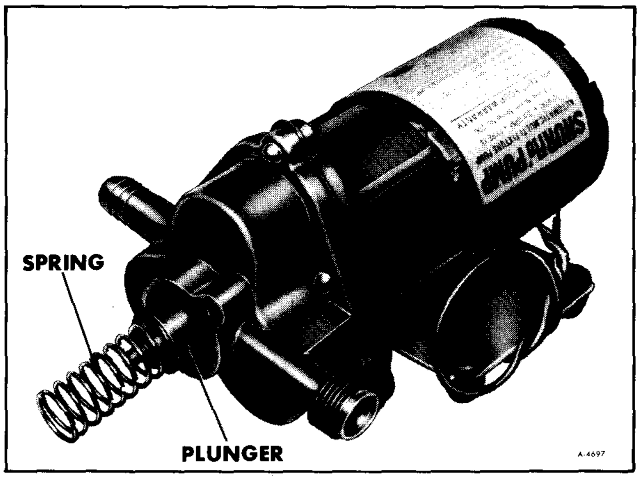


Figure 26—Switch Cap Removed

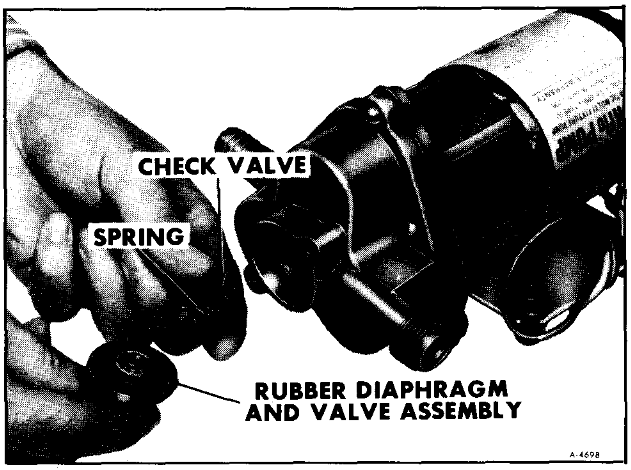


Figure 27—Removing Diaphragm and Valves from Recess

5. Inside the upper housing are three inlet-outlet valve assemblies. They can be removed by hand. After removing all three valve assemblies, remove the rubber gasket by hand (figure 29).

6. The rubber bushing is either on the motor coupling or the drive coupling and can be removed by hand. (figure 30). Remove the support plate in the lower housing by removing three screws (figure 31).

7. Remove three screws that secure the wobble plate to the piston assembly. Remove wobble plate (figure 32), steel ball, and bushing (figure 33). The drive coupling and bearings rest on the wobble plate and will be removed with the plate. Lift the coupling off the plate and lift the bearings off the coupling (figure 34).

8. Remove the piston assembly (held by screws, removed in step 7, to the wobble plate), then take the piston tops and bottoms apart from the diaphragm (figure 35).

ASSEMBLY

1. Place three piston tops through diaphragm and piston bottoms, then position on lower housing (figure 35).

2. Lubricate steel ball and place on bushing. Place bushing with ball into lower housing. Flat on bushing shaft matches flat in housing hole (figure 33).

3. Grease bearings with GM 1051344 or equivalent. Assemble to drive coupling with mylar shim and bearing covers. Place assembled parts on wobble plate (figure 34).

4. Place wobble plate in position in lower housing and secure with three screws to threaded holes in the end of piston top shafts (figure 32).

5. Place support plate over drive coupling and secure with three screws to housing (figure 36).

6. Place rubber bushing over motor coupling (figure 30).

7. Place rubber gasket in upper housing, then place three inlet-outlet valves over gasket (figure 29).

8. Secure upper housing to lower housing with three screws and nuts. Then secure housings to motor with three long screws.

9. Place check valve assembly, spring, and valve with diaphragm assembly in recess of upper housing (figure 27).

10. Place plunger over rubber diaphragm and spring over plunger (figure 26).

11. Place micro switch in switch cap (figure 37) and secure cap to upper housing with two screws. Hold cap securely against spring pressure while turning screws (figure 25).

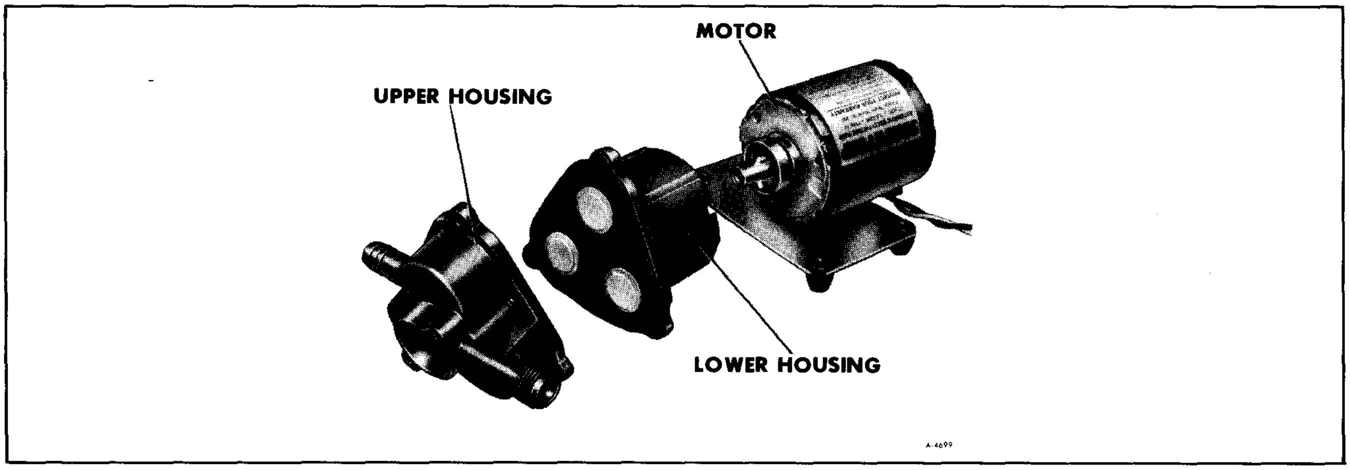


Figure 28—Upper and Lower Housings Separated from Motor

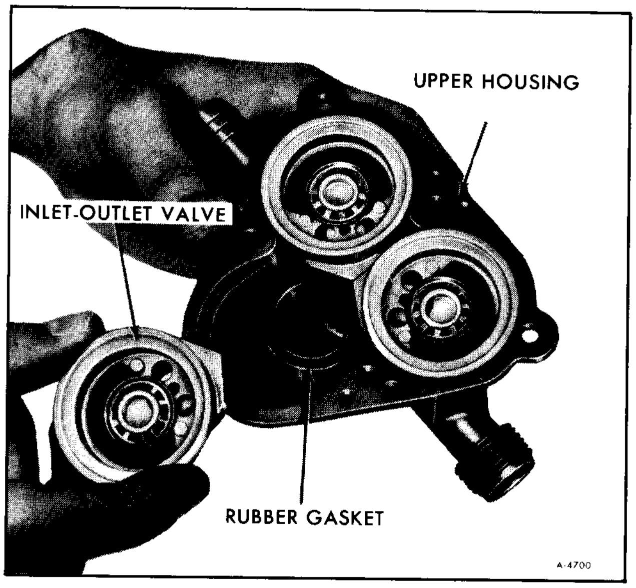


Figure 29—Removing Inlet-Outlet Valves

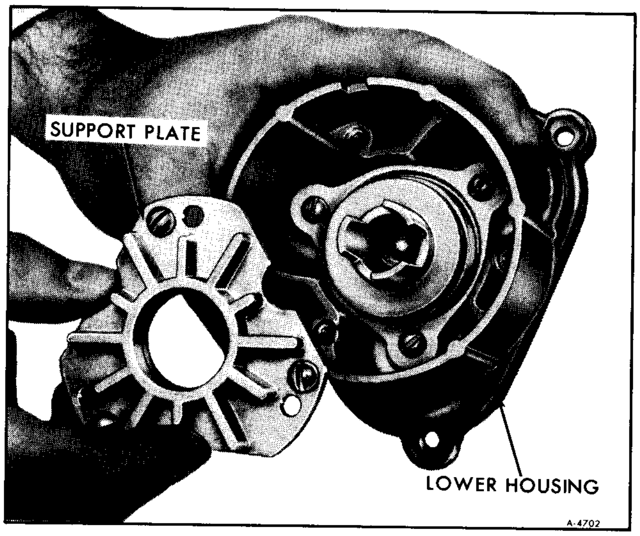


Figure 31—Removing Support Plate

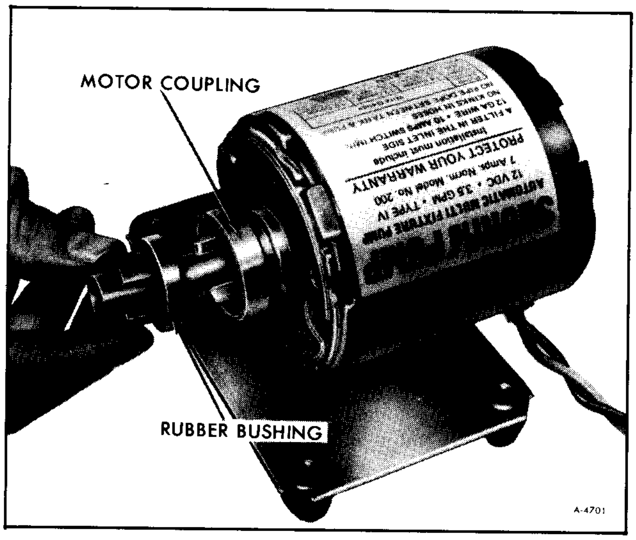


Figure 30—Removing Rubber Bushing from Motor Coupling

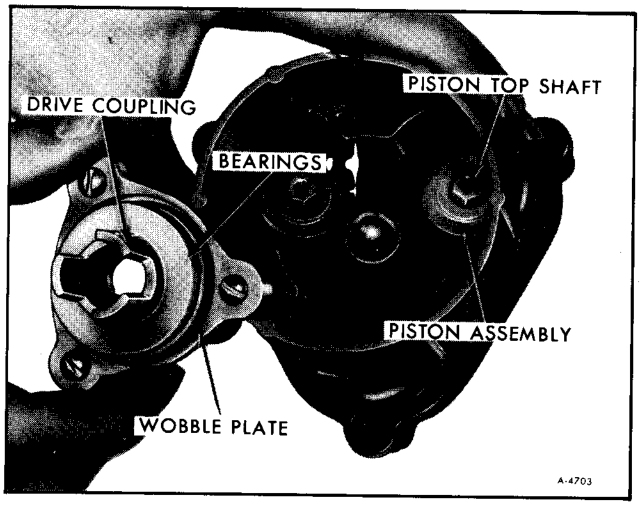


Figure 32—Removing Wobble Plate with Bearings and Drive Coupling

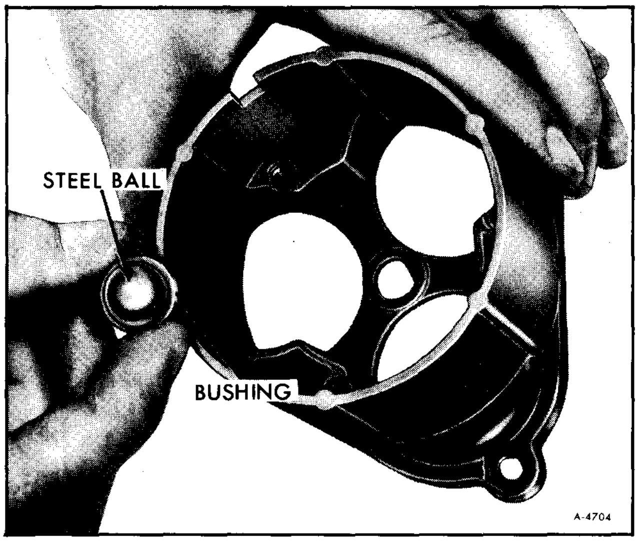


Figure 33—Removing Steel Ball and Bushing

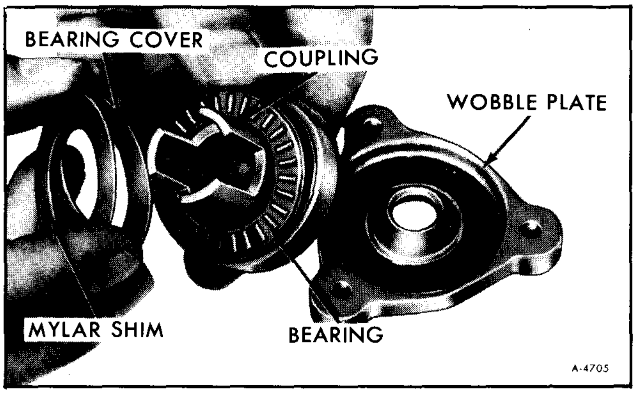


Figure 34—Removing Coupling and Bearings from Wobble Plate

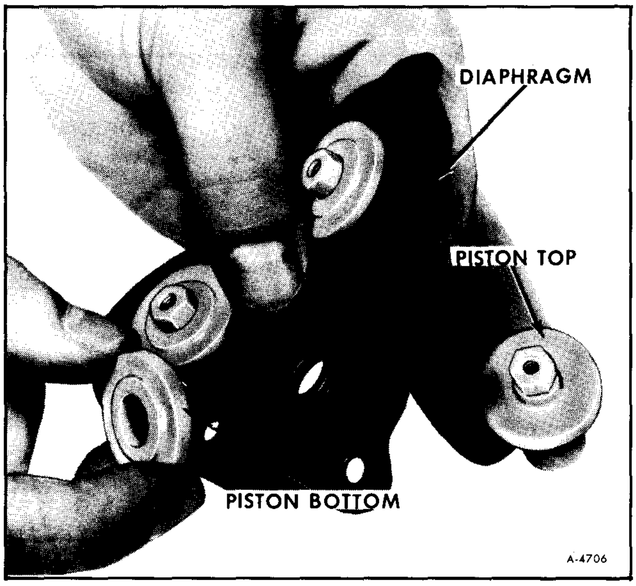


Figure 35—Removing Pistons from Diaphragm

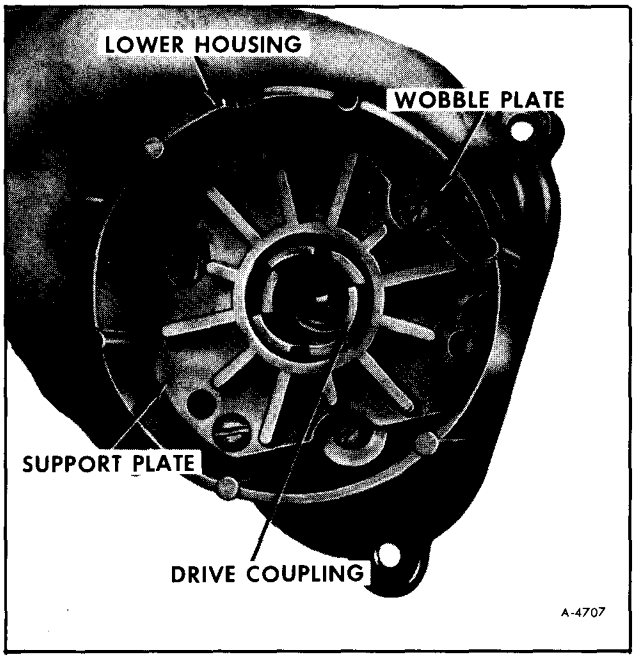


Figure 36—Support Plate, Drive Coupling, and Wobble Plate Assembled in Lower Housing

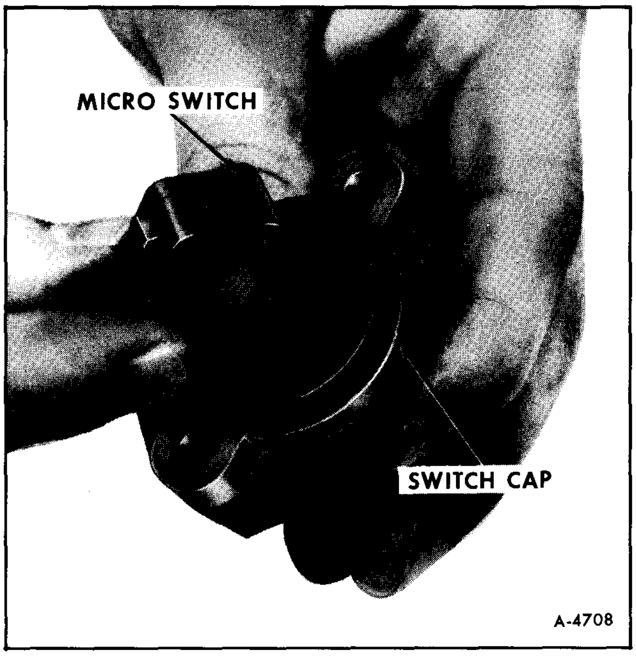


Figure 37—Putting Micro Switch in Switch Cap

WATER HEATER

TYPE 1 WATER HEATER (FIGURE 38)

REMOVAL

1. Turn off water heater switch and water pump switch. If external power connection is in use, disconnect it. Vehicle must not be running and the engine must cool at least 1/2 hour. Check the pressure in the engine cooling system at the radiator cap before the pre-heat hoses are disconnected.

WARNING: TO AVOID THE DANGER OF BEING BURNED, AND PREVENT LOSS OF COOLANT, DO NOT REMOVE THE RADIATOR CAP WHILE THE ENGINE AND RADIATOR ARE STILL HOT, BECAUSE THE COOLING SYSTEM WILL BLOW OUT SCALDING FLUID AND STEAM UNDER PRESSURE.

2. Open drain valve and allow water heater to drain.

3. Remove sliding doors, door frame and shelf liner in the bath vanity.

4. The heater pre-heat hoses can be removed only after engine is cool and system has been checked for pressure at the radiator cap. Disconnect hoses and plug ends.

5. Remove pressure-temperature relief valve tube.

6. Remove drain line.

7. Disconnect wires and armored cable from junction box on wall.

8. Remove inlet (cold) water line.

9. Disconnect outlet (hot) water line and reposition out of the way.

10. Remove banding straps.

11. While supporting heater disconnect heater support bracket and position upward and outward.

12. Toilet seat may have to be raised or removed in order to remove heater.

13. Remove heater.

DISASSEMBLY

1. Remove the pressure-temperature relief valve. Remove drain valve.

2. Remove metal cover and remove red plastic cover over electrical control assembly.

3. Disconnect wire and remove control assembly, Figure 39.

4. Remove heater element as shown in Figure 40 by removing four bolts.

5. Remove four screws attaching front of box to body.

6. Remove front of box.

7. Slide out inner tank assembly.

ASSEMBLY

1. Slide inner tank assembly into box.

2. Install front of box and secure with four screws.

3. Install heater element in the direction specified by the word UP, as shown in Figure 41.

4. Evenly tighten four bolts until element contacts tank.

5. Install electrical control assembly and connect wires.

6. Install red plastic cover and metal cover. Secure metal cover with screw.

7. Install pressure-temperature relief valve and drain valve. Use a thread sealer on all threads.

INSTALLATION

1. Cut two pieces of banding strap five feet long and string through brackets on wall.

2. Position support bracket outward and slide heater into postion.

3. Secure support bracket with screws.

4. Use banding tension tool and clips to secure straps tightly around heater.

5. Connect inlet (cold) and outlet (hot) pipes. Use thread sealer.

6. Connect wires and armored cable to junction box on wall.

7. Install drain line. Use thread sealer.

8. Install pressure-temperature relief valve tube. Use thread sealer.

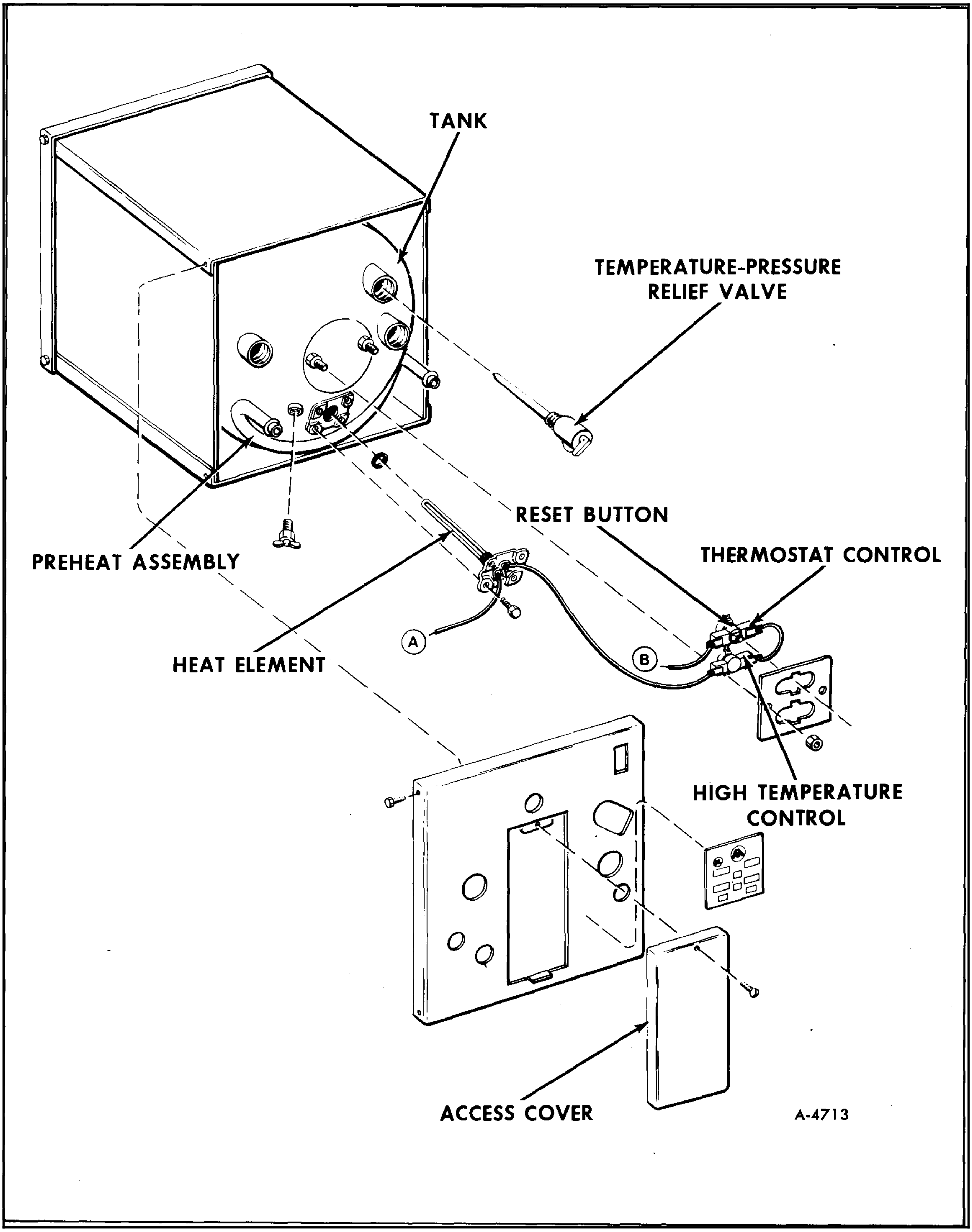


Figure 38—Type 1 Water Heater Exploded View

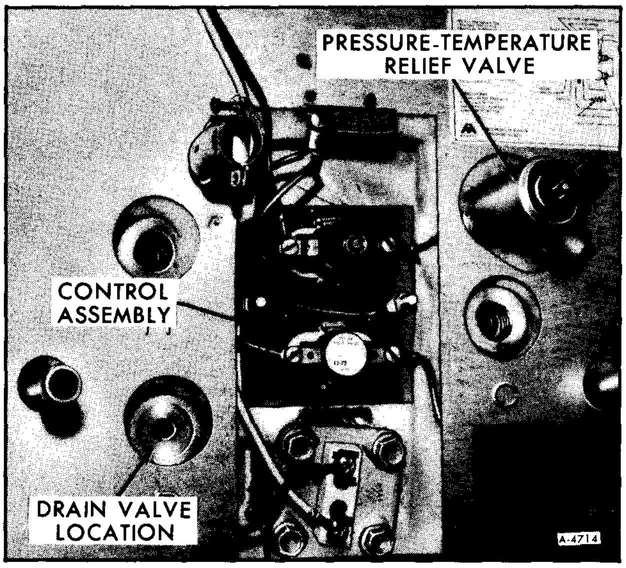


Figure 39—Control Assembly Location

9. Connect heater pre-heat hoses and secure with clamps.

10. Install shelf liner, door frame and sliding doors.

11. Close water heater drain valve.

12. Turn on water pump allow heater tank to fill. Open a hot water faucet to check if tank is filled.

13. Check for leaks.

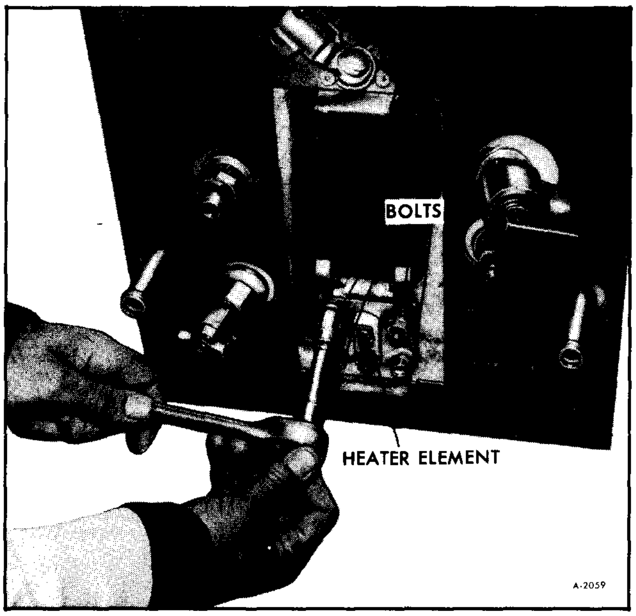


Figure 40—Removing Heater Element

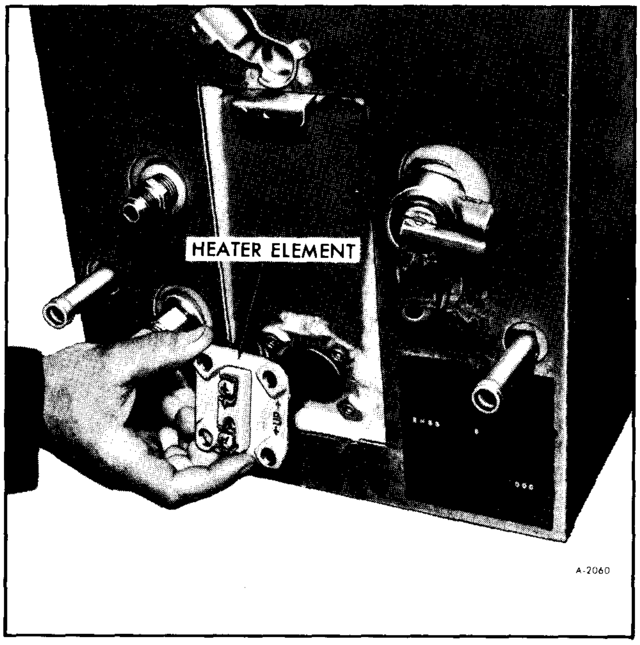


Figure 41—Installing Heater Element

14. Turn on heater switch and check for hot water after approximately 15 minutes. Be sure vehicle is connected to 120-volt AC source by running Motor Generator or external power connection.

TYPE 2 WATER HEATER (FIGURE 42)

REMOVAL

1. Turn off water heater switch and water pump switch.

2. Open drain valve and allow water heater to drain.

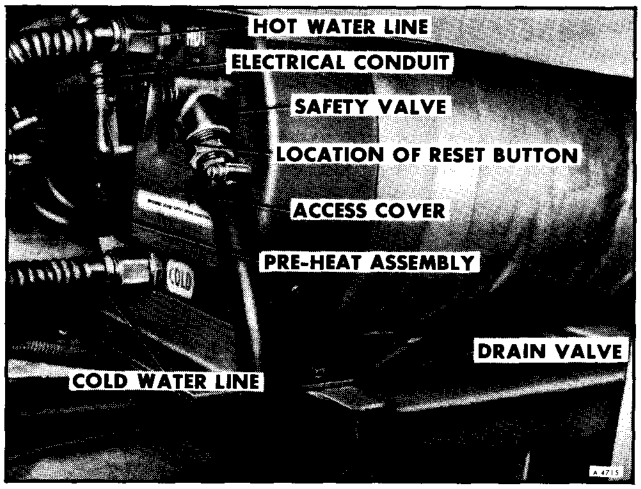


Figure 42—Type 2 Water Heater

3. Remove sliding doors, door frame and shelf liner in the bath vanity.

4. Disconnect strap holding pre-heat hoses to vehicle plumbing lines and pull pre-heat assembly from water heater body.

WARNING: IF VEHICLE HAS BEEN RECENTLY USED AND ENGINE IS HOT, PRE-HEAT HOSE AND ASSEMBLY MAY BE HOT.

5. Disconnect hose from pressure-temperature relief valve.

6. Disconnect drain line hose under water heater body.

7. Remove access panel. Disconnect two electrical wires in lower left of access opening and disconnect electrical conduit.

8. Disconnect inlet (cold) water line and outlet (hot) water line.

9. Remove four bolts and nuts securing water heater to frame.

10. Remove water heater.

DISASSEMBLY (FIGURE 43)

1. Disconnect two wires from heating element. Then remove four bolts and remove heating element.

2. Disconnect two wires to control assembly, then remove two bolts that secure control assembly to heater. Remove control assembly.

3. Remove pressure-temperature relief valve.

ASSEMBLY (FIGURE 43)

1. Replace pressure-temperature relief valve.

2. Secure control assembly with two bolts and attach two wires to assembly.

3. Secure heating element with four bolts. Connect two electrical wires to element.

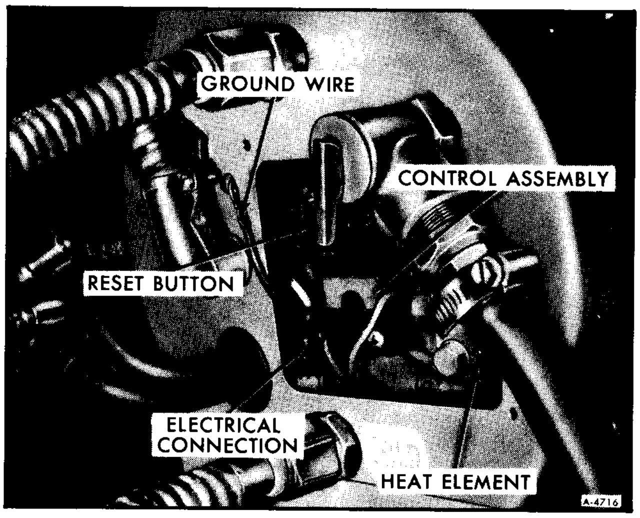


Figure 43—Type 2 Water Heater Controls

INSTALLATION

1. Install water heater and secure to frame with four bolts and nuts.

2. Connect outlet (hot) water line and inlet (cold) water line.

3. Connect electrical conduit and two electrical wires from conduit to terminal inside access. Replace access panel. Be sure ground wire is under the top left screw.

4. Connect hose to pressure-temperature relief valve.

5. Connect drain line hose under water heater body and close drain valve.

6. Install water heater pre-heat assembly and secure with strap to area plumbing.

7. Replace sliding doors, door frame and shelf liner in the bath vanity.

8. Start water pump to fill water heater.

9. Turn on water heater switch and check to see that water heater operates correctly.

BATHROOM SINK FAUCET

REMOVAL

1. Turn off water pump at wall switch. Open faucet to reduce line pressure.

2. Disconnect water lines.

3. Remove lock nuts as shown in Figure 44. Remove steel and fiber washers.

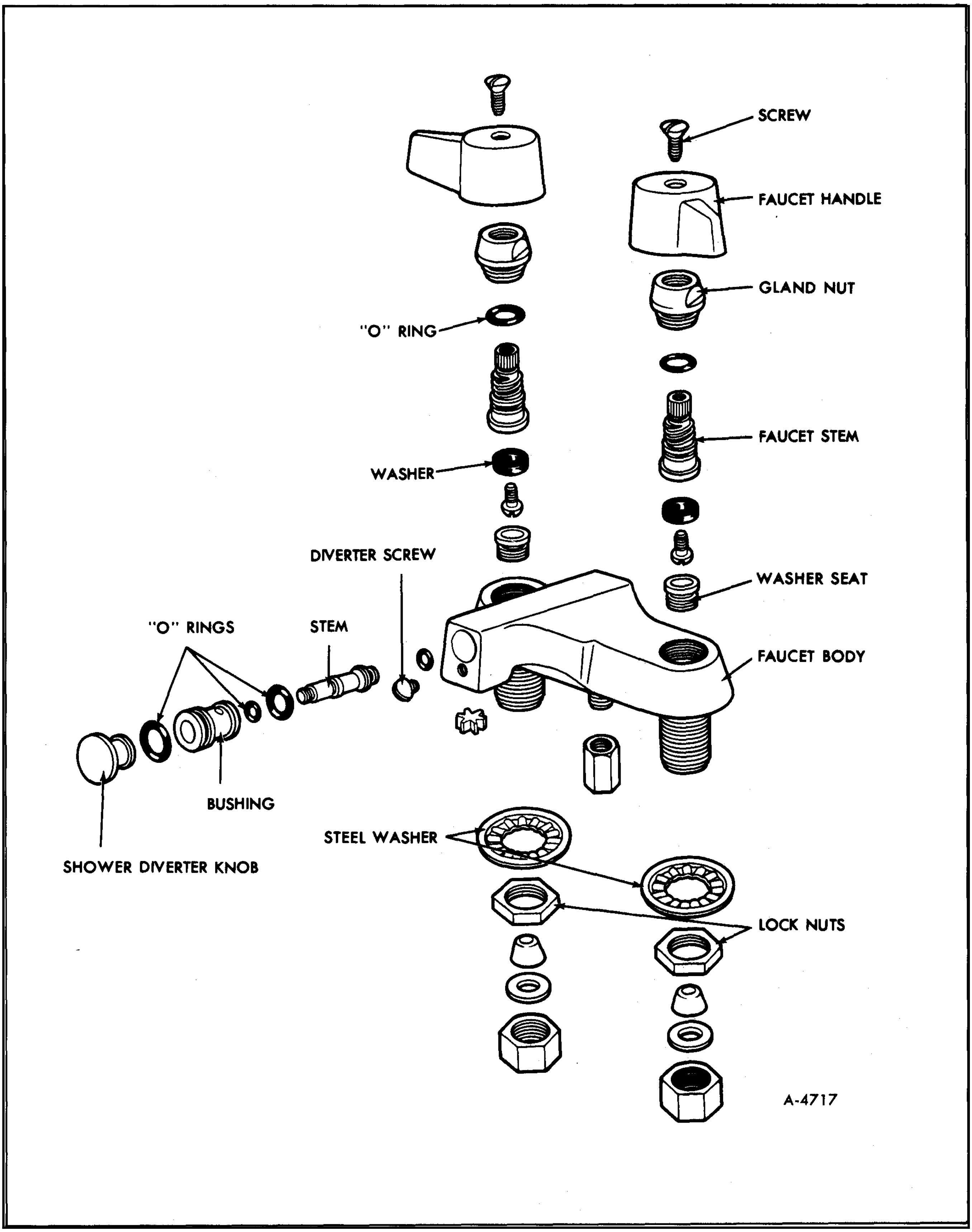


Figure 44—Bathroom Sink Faucet Assembly

4. Disconnect shower line.

5. Remove faucet assembly.

INSTALLATION

1. Install faucet assembly.

2. Connect shower line.

3. Install fiber and steel washers.

4. Install lock nuts and tighten securely.

5. Connect water lines.

6. Turn on water pump switch and operate faucet. Check for leaks.

FAUCET WASHERS (FIGURE 44)

REMOVAL

1. Remove screw and faucet handle.

2. Remove faucet gland nut.

3. Remove faucet stem.

4. Remove screw securing washer, remove washer.

5. Inspect washer seat for excessive roughness. Replace if necessary.

INSTALLATION

1. Install washer on stem and secure with screw.

2. Install faucet stem into faucet.

3. Install gland nut.

4. Install faucet handle and secure with screw. Check for leaks.

SHOWER DIVERTER ASSEMBLY (FIGURE 44)

REMOVAL

1. Turn off water pump at wall switch. Open faucet to reduce line pressure.

2. Remove diverter screw.

3. Pull out diverter assembly.

4. Inspect "O" rings and replace if necessary.

INSTALLATION

1. Install stem, bushing and knob and secure with diverter screw.

2. Turn on water pump at wall switch. Check for leaks.

SHOWER HEAD AND HOSE

REMOVAL

1. Turn off water pump at wall switch. Open faucet to reduce line pressure.

2. Remove shower head hose from wall connection (See figures 45 and 46).

3. Remove hose from shower head connector.

4. Remove shower head from connector.

INSTALLATION

1. Install shower head to connector.

2. Install hose to shower head connector.

3. Connect hose to wall connection.

4. Turn on water pump at wall switch. Operate shower as it is directed into sink and check for leaks.

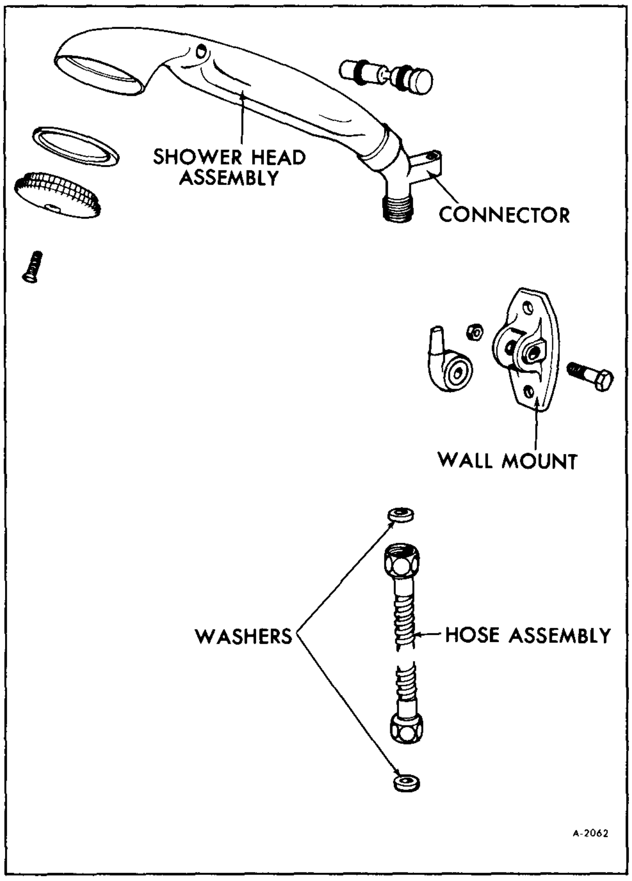


Figure 45—Type 1 Shower Head

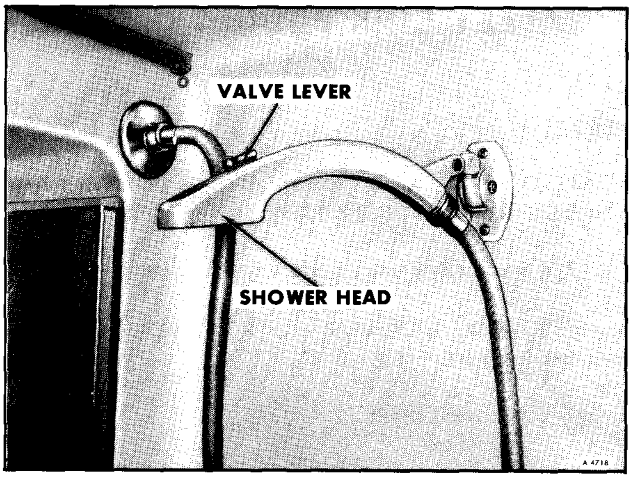


Figure 46—Type 2 Shower Head

GALLEY SINK

REMOVAL

1. Turn off water pump at wall switch. Open faucet to reduce line pressure.

2. Disconnect water lines from faucet. Disconnect water purifier spout, if equipped.

3. Remove sink retaining clips (See figure 47).

4. Disconnect drain lines.

5. Lift sink out.

INSTALLATION

1. Position sink into place and secure with clips (figure 47).

2. Connect all water lines and drain lines.

3. Turn on water pump at wall switch. Operate faucet and water purifier (if equipped) and check for leaks.

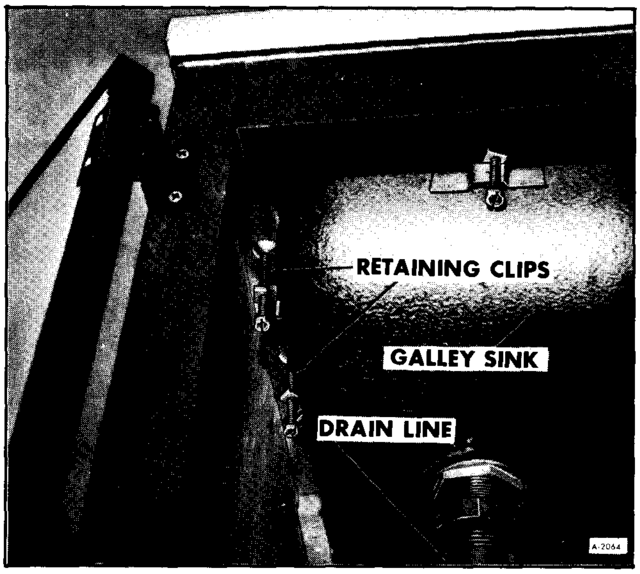


Figure 47—Sink Retaining Clips

GALLEY SINK FAUCET (FIGURE 48)

REMOVAL

1. Turn off water pump at wall switch. Open faucet to reduce line pressure.

2. Disconnect water lines from faucet.

3. Remove locknut spacer and washer from underneath counter top.

4. Remove faucet.

DISASSEMBLY

1. Turn off water pump and open faucet to relieve line pressure.

2. Remove screw at top of handle, and lift off handle, with handle cap and handle body.

3. Remove retainer nut and lift off grooved sleeve.

4. Lift spout off.

5. Pry retainer off with screwdriver.

6. Grasp cartridge stem with pliers and pull stem out of body.

ASSEMBLY

1. Push cartridge stem into body.

2. Insert retainer clip.

3. Replace spout and grooved sleeve and secure with retainer. Tighten snugly.

4. Press cartridge stem down. Holding handle up, hook ring in handle housing into groove on sleeve. Swing handle back and forth until it drops down into place.

5. Replace handle screw. Tighten securely.

INSTALLATION

1. Install faucet with gasket under escutcheon.

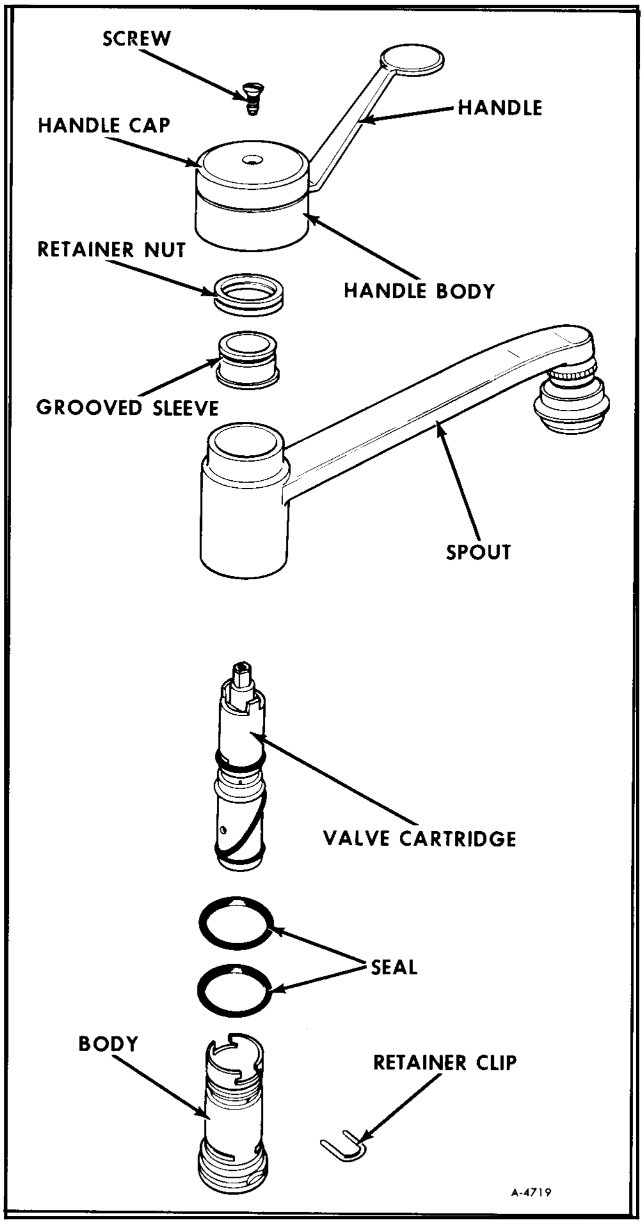


Figure 48—Galley Sink Faucet

2. Secure with spacer washer and locknut under counter top.

3. Connect water lines.

4. Turn on water pump and operate faucet. Check for leaks.

WATER PURIFIER

The optional water purifier consists of (A) three cartridges mounted under the galley sink inside the cabinet and (B) a faucet mounted to the counter top at the rear left corner of the galley sink.

CARTRIDGES (FIGURE 49)

The purification cartridges obtain water from the plumbing line under the galley sink and can be turned on or off by a valve at the connection. They are held in place by a strap.

FAUCET (FIGURE 50)

The faucet is mounted through a hole in the counter top. Water is supplied by a plastic water line from the purification cartridges.

CARTRIDGE REPLACEMENT

If at any time the water flow becomes restricted, replace the top cartridge (figure 49).

1. Shut water off at valve, and at faucet.

2. Remove mounting strap.

3. Disconnect fittings at both ends of top cartridge. Place cartridge in pail or other water tight container to prevent spillage. Keep a towel handy to clean up spillage inside cabinet.

4. Install new cartridge in same position as discarded cartridge with arrow on label pointing to outlet end of unit. Then secure in place with strap assembly. Open water supply valve and turn on water pump. Check for operation and leaks.

NOTE: You may notice a slight gray color in the water the first few minutes. This is normal and is designed to disappear.

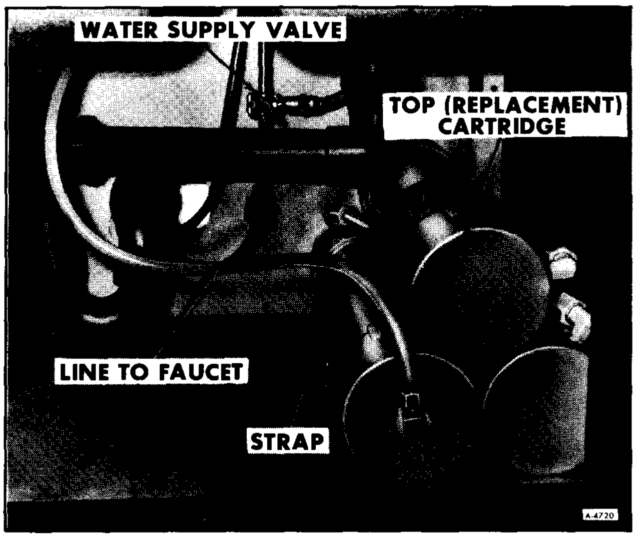


Figure 49—Water Purifier Cartridges

FAUCET REPLACEMENT (FIGURE 51)

REMOVAL

1. Turn off water pump and open faucet to relieve line pressure.

2. Turn off water purifier valve.

3. Disconnect water line from bottom of faucet.

4. Remove nut, lockwasher, flat washer, and fiber washer from bottom of faucet.

5. Remove faucet.

INSTALLATION

1. Place faucet in mounting hole through sink counter top.

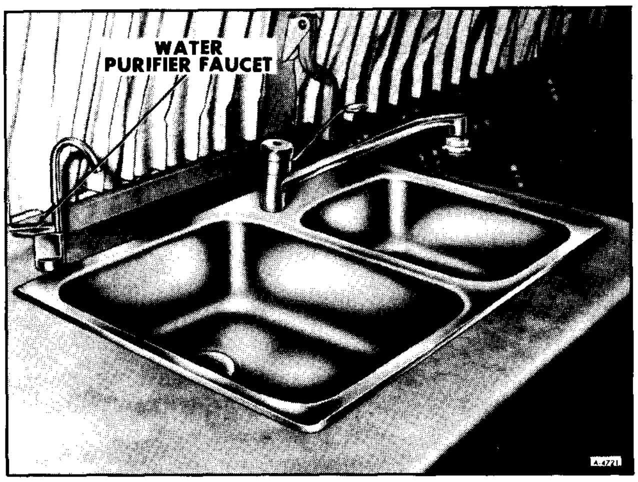


Figure 50—Galley Sink with Water Purifier

2. Secure with fiber washer, flat washer, lock-washer, and nut.

3. Connect water line to faucet.

4. Turn on water valve and water pump switch. Check water purifier for operation and leaks.

WINTERIZATION

A non-toxic anti-freeze is used in the water system when the temperatures may fall below freezing. The water purification system must be removed before the anti-freeze is added to the water. If anti-freeze is used with the purification cartridges installed, the water will taste like the anti-freeze and the purification cartridges will continue to taste like anti-freeze after the system has been purged.

CAUTION: *Freezing can destroy the cartridges. They must be removed and stored in a warm place during freezing weather.*

Before replacing the water purification cartridges, first flush the water system to remove non-toxic anti-freeze and install clean water. For complete winterizing details, refer to Section 24A.

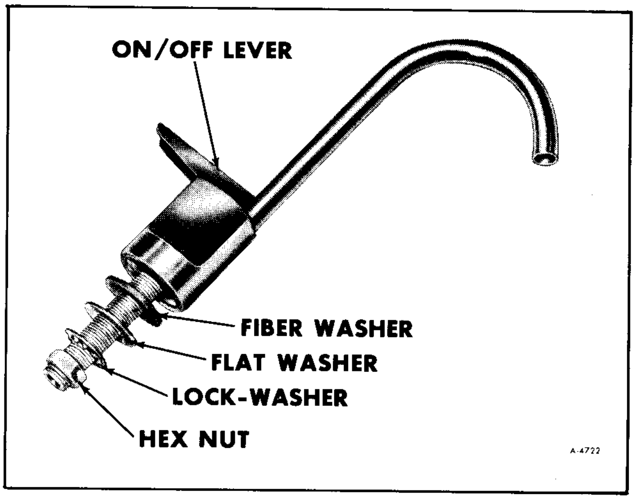


Figure 51—Water Purifier Faucet Removed

CITY WATER CONNECTION

REMOVAL

1. Turn off water pump and open water faucet to reduce line pressure.

2. Carefully remove carpet from city water access panel in closet. Carpet is stapled in place. Remove the staples from the carpet.

3. Remove city water access panel screws and remove panel.

4. Disconnect water line from city water valve.

5. At the external utilities compartment outside the vehicle, remove four outer screws and nuts from city water valve and remove valve (figure 6).

INSTALLATION

1. Install new city water valve and secure with four screws and nuts.

2. Connect water line to city water valve.

3. Install city water valve access panel in closet.

4. Install closet carpet and staple into position.

5. Close faucet and turn pump on.

PLUMBING LINES

The living area water system plumbing consists of 3/8 inch, 1/2 inch, and 5/8 inch polybutulene lines and fittings. Water leaks can be repaired using an appropriate size coupling from the Service Repair Kit 2001630 and cutting the leaking area out of the line.

REPAIR PROCEDURE

1. Cut the line off square, removing section with the leak. Use Special Tool J-26227 to flare the line (figure 52).

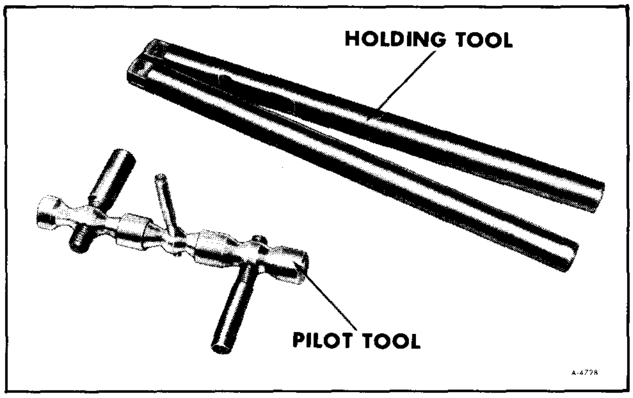


Figure 52—Special Tool J-26227

2. Turn the proper pilot out about 1/2 inch. Put the flare nut on the line and place the line to be flared over the pilot (figure 53).

3. Grasp the line over the pilot with the Holding Tool and screw the pilot into the Flaring Tool making a flare on the end of the line (figure 54).

4. Assemble the flare insert and coupling to the line so that the repaired line appears the same as that in Figure 55.

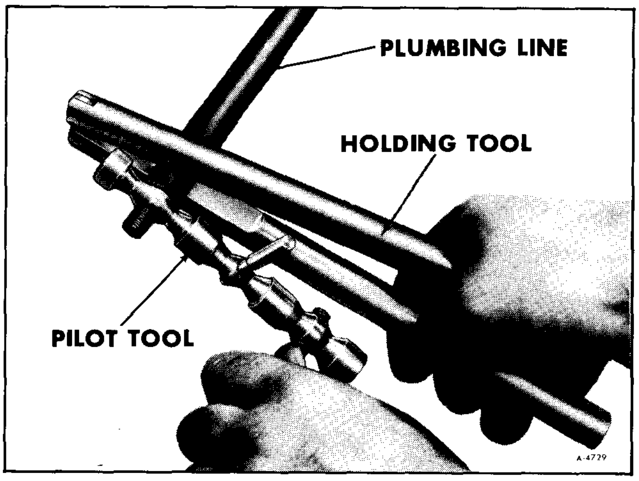


Figure 53—Flaring Plumbing Line

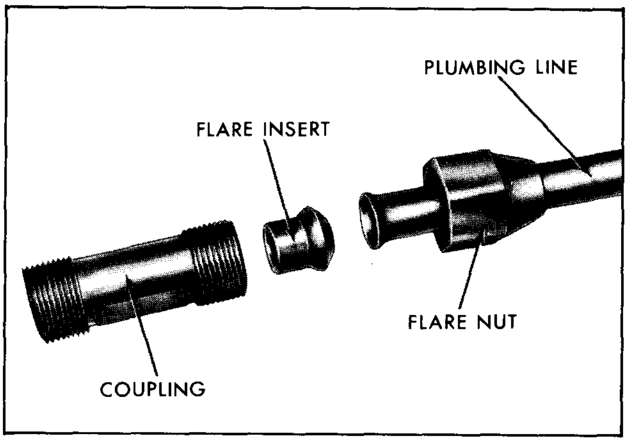


Figure 54—Plumbing Line Ready for Repair

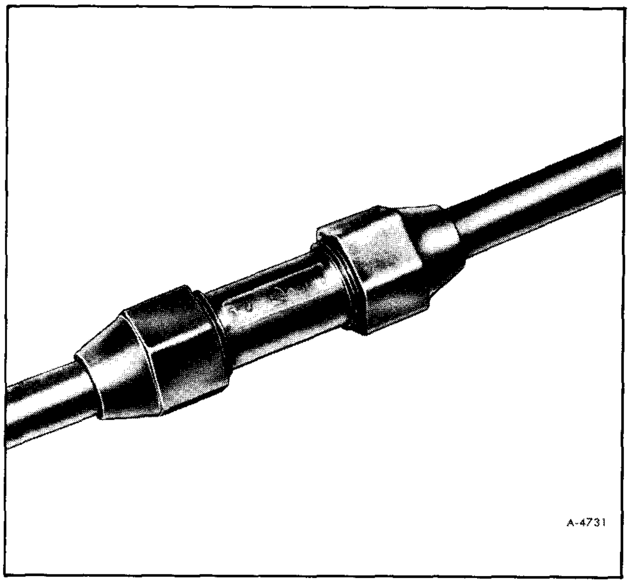


Figure 55—Typical Plumbing Line Repair

PLUMBING LINE TORQUES

Size	Torque
3/8 inch	55-60 in. lbs.
1/2 inch	55-60 in. lbs.
5/8 inch	90-100 in. lbs.

SPECIAL TOOLS

J-26227 Flaring Tool

SECTION 24K
TOILET
STANDARD TOILET (AQUA-MAGIC)

GENERAL INFORMATION

The standard toilet (figure 1) is a fresh water, permanently installed sanitation system. It uses a pressure flushing system. This scours the bowl with each flush. Water injection produces a "swirl effect" and uses a measured amount of water to rinse efficiently. The unit is a self cleaning type with an odor tight, gas tight, teflon seal which closes off the holding tank when not in use. Since every flush uses fresh water, no manditory chemical additives are needed.

STANDARD TOILET TROUBLE DIAGNOSIS

Complaint	Possible Cause	Correction
Water keeps running into the bowl.	The blade in the bottom of the bowl is not closing completely, which in turn keeps the water control valve partially open. The groove into which the blade seats when completely closed is clogged with foreign material.	Insert the end of a coat hanger or similar object into the sealing groove and remove the foreign material. Avoid damaging the rubber seal while cleaning.
Toilet leaks. There is water on the floor.	Specify the symptom. Determine if water is leaking from: a. The vacuum breaker. b. The water control valve. c. Bowl to mechanism seal (if this is the problem, the water would not stay in the bowl).	a. The vacuum breaker—if the vacuum breaker leaks when flushing the toilet, replace the vacuum breaker. b. If the vacuum breaker leaks when the toilet is not in operation, replace the water control valve. c. Leaks at the bowl to mechanism seal—remove mechanism, and replace mechanism seal.

Complaint	Possible Cause	Correction
Contd. from previous page.	d. Closet flange base seal.	d. Leaks at closet flange area—check front and rear closet flange nuts for tightness. If leak continues remove the toilet, check the closet flange height. The height should be between 1/4" and 7/16" above the floor. Adjust closet flange height accordingly and replace closet flange seal.
Foot pedal operates harder than normal or the blade sticks.	This is generally caused by using cleansers or other abrasives to clean the bowl. The foreign material scrapes away the teflon on the blade seal and the amount of friction is increased to the point where dragging occurs. It can also be caused by using water, which contains a high content of suspended foreign material such as sand.	Wipe the blade completely dry, spray with a silicone spray and work the pedal several times. Repeat until blade works freely.

TOILET REMOVAL

1. Turn off water pump and release pressure at any faucet.

2. Disconnect toilet water line.

3. Depress flush pedal and insert block of wood or similar object in slide trap to keep trap open. This holds the flush pedal down for access to front mounting nut.

4. Remove front mounting nut.

5. Depress pedal and remove block.

6. Lift toilet seat lid and remove access cap for the rear mounting nut.

7. Remove rear mounting nut using at least a 12" extension and a universal socket through the access hole.
8. Lift off toilet.

DISASSEMBLY AND REPAIR

The toilet disassembles into four main subassemblies (See figure 1).

1. The seat and cover assembly.

2. The vacuum breaker.

3. The mechanism assembly.

4. The hopper assembly.

Any of these subassemblies may be removed from the toilet in the following manner:

1. Removal of the seat and cover assembly (figure 1):

With seat and cover assembly in the up position use a flat screwdriver or similar tool to pull out the seat hinge pins.

2. Removal of the vacuum breaker (figure 1):

Remove seat and cover assembly as explained in last paragraph. Then turn the toilet up-side-down. To remove water lines from vacuum breaker base, pinch hose clamps with a pair of pliers and slide them up the water line. Water lines may be pulled off. Remove the two vacuum breaker attachment screws.

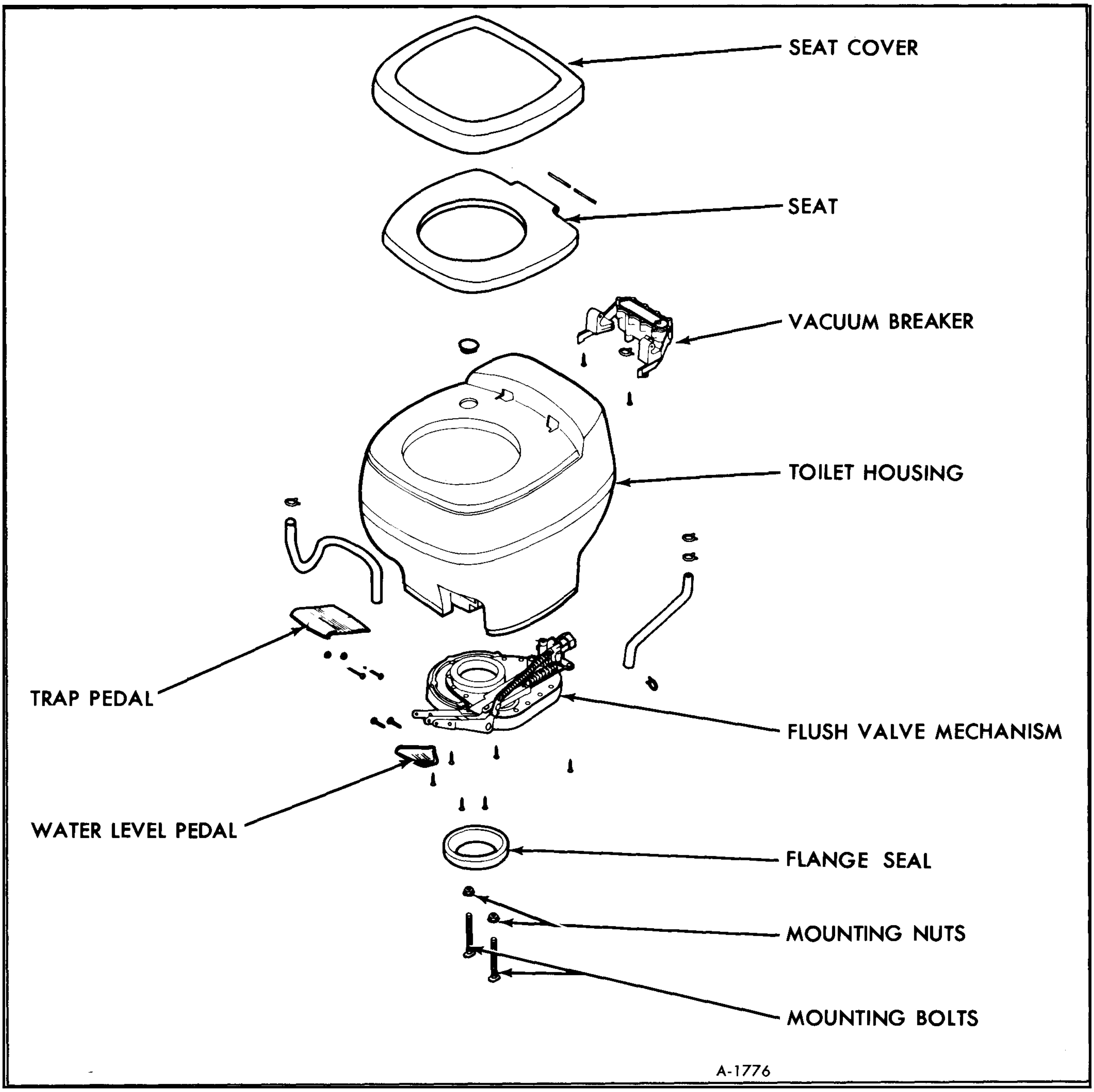


Figure 1—Standard Toilet Components

3. Removal of the mechanism assembly (figure 1):

Turn the toilet up-side-down. Remove the six screws that are now visible. Lift up mechanism to gain access to water line hose clamps. Pinch hose clamps with a pair of pliers and slide them up the water line. Pull water lines off of mechanism.

4. Service and replacement of hopper assembly:

Hopper assembly may be serviced or replaced by removing the above 3 assemblies.

TOILET INSTALLATION

1. Install a new flange seal over mechanism ring found on underside of toilet.

2. Set toilet in place and install rear mounting nut using the 12" extension and universal socket with a small amount of grease in the socket to hold the nut in place.

3. Tighten rear mounting nut.

4. Depress toilet pedal and insert block of wood in slide trap to keep the trap open. This holds the pedal down for access to front mounting bolt. Install nut and tighten.

5. Depress pedal and remove block of wood.

6. Connect toilet water line.

MAINTENANCE

No routine maintenance is required.

If the bowl sealing blade does not operate freely after extended use, it may be restored to its original, smooth operating condition by applying a light film of Silicone spray to the blade.

To clean the toilet, use any high grade, non-abrasive cleaner. Do not use highly concentrated or high acid content household cleaners. They may damage the rubber seals.

RECIRCULATING TOILET (ELECTRA-MAGIC)

GENERAL INFORMATION

The optional recirculating toilet operates by recirculating the liquid present in the toilet and a chemical additive. The advantage is that water is conserved when flushing and also not adding to the volumn of the holding tank. The toilet operates on 12-volt DC.

RECIRCULATING TOILET TROUBLE DIAGNOSIS

Complaint	Possible Cause	Correction
1. Toilet will not flush.	a. Blown living area fuse. b. Blown toilet fuse. c. Pump motor defective. d. Damaged timer.	a. Replace blown fuse in living area electrical compartment. b. Replace toilet fuse under toilet motor cover. c. Replace pump assembly. d. Replace timer assembly.
2. Toilet does not cycle properly (5 to 9 seconds) when button is pressed.	a. Source of power less than 12-volts. b. Damaged timer.	a. Check batteries or power converter. b. Replace timer assembly.
3. Toilet cycles when seat cover is raised.	a. Actuator button protrudes too far from motor cover.	a. Alternately press one side of the button, then the other, to work the button back further into the housing. If button still protrudes too far, replace timer assembly.
4. Flushing action is weak or noisy.	a. Unit cycling without adequate water charge. b. Source of power less than 12-volts. c. Pump damaged by continuous dry operation.	a. Charge unit with water to the proper level. b. Check batteries or power converter. c. Replace pump assembly.

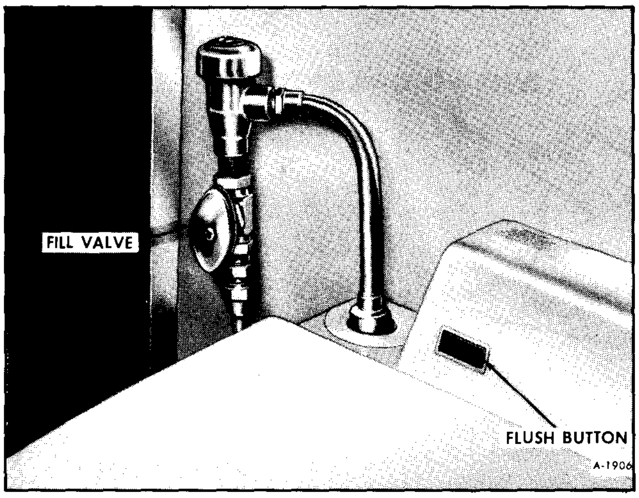


Figure 2—Toilet Water Fill Connection

TOILET REPLACEMENT

REMOVAL

1. Turn off water pump and release pressure at any faucet.

2. Disconnect toilet water fill line shown in Figure 2, and disconnect the toilet wires.

3. Remove base moldings from lower sides of toilet.

4. Remove the two nuts under the toilet securing it to the floor.

5. Lift off toilet.

INSTALLATION

1. Install new flange seal on slide valves.

2. Place toilet on flange making sure bolts line up through mounting brackets.

3. Secure toilet in place with two nuts under toilet at mounting brackets.

4. Connect toilet water fill line and wires (figure 2).

DISASSEMBLY AND REPAIR (FIGURE 3)

FUSE REPLACEMENT

1. Remove two cover mounting screws and motor cover.

2. The fuse is now accessible for checking or changing, see Figure 3.

TIMER REPLACEMENT

1. Disconnect lead wires from power source (figure 3).

2. Remove two cover mounting screws and motor cover (figure 1).

3. Disconnect leads from pump assembly motor (figure 3).

4. Remove two timer bracket mounting screws and timer assembly.

5. Install by reversing steps 1—4.

PUMP REPLACEMENT

1. Disconnect lead wires from power source.

2. Remove two cover mounting screws and motor cover.

3. Disconnect leads from pump assembly motor.

4. Completely evacuate unit.

5. Remove cover and bowl assembly screws (two in rear from top side and two in front from bottom side) and remove cover and bowl assembly (figure 3).

6. Remove four pump mounting screws (figure 3).

7. Disconnect flush tube from pump outlet (figure 3).

8. Remove pump assembly (figure 3).

9. Install by reversing steps 1—8.

SLIDE VALVE REPLACEMENT (FIGURE 3)

1. Remove toilet from module. See "Toilet Replacement" earlier in this section.

2. Turn toilet upside down and remove the four screws and remove valve.

3. Install by reversing steps 1 and 2.

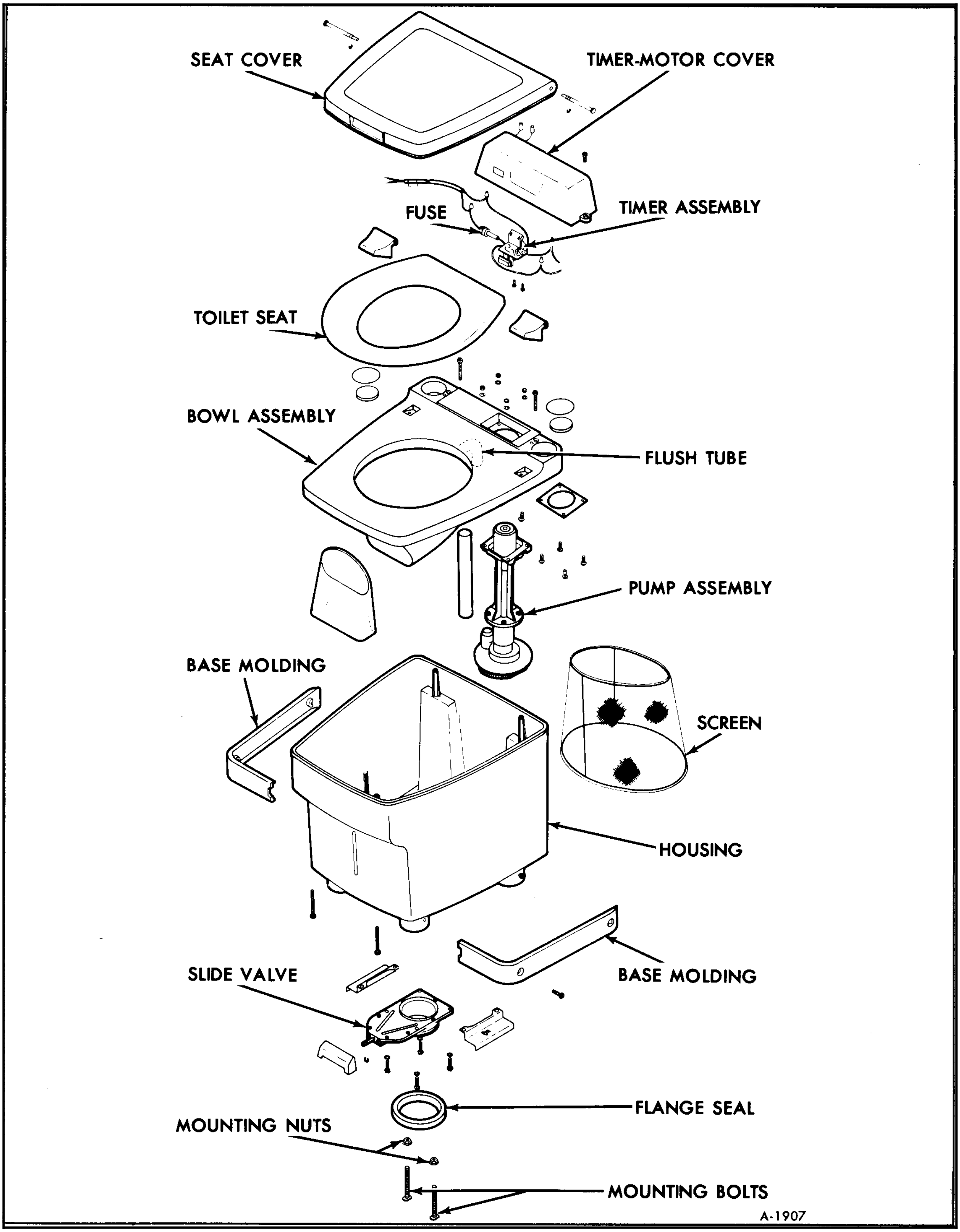


Figure 3—Recirculating Toilet Components

MAINTENANCE

No routine maintenance is required on the recirculating toilet other than "Charging Toilet" which is described as follows:

NOTE: Details on winterizing the recirculating toilet are covered in Section 24A of this manual.

CHARGING TOILET

1. Be sure handle on dump valve is pushed in.

2. Open fill valve, filling toilet to the charge level as indicated by the letter "C" on prism. This will be approximately 3 gallons. Close the fill valve.

3. Add recirculating toilet chemical as recommended by manufacturer of chemical.

SECTION 24L HOLDING TANK AND DRAINAGE SYSTEM

The contents of this section are listed below:

SUBJECT	PAGE NO.
General Description	24L-1
Trouble Diagnosis	24L-2
Holding Tank	24L-3
Drain Pipe and Fittings	24L-6

GENERAL DESCRIPTION

The drainage system (figure 1) consists of ABS plastic pipes and fittings. A holding tank with a capacity of approximately 32 gallons stores waste water from the sinks, shower and toilet.

The tank is vented through three standpipes with roof-mounted vents.

A tube assembly bolted to the holding tank and a detachable sewer hose are provided for dumping the contents of the holding tank.

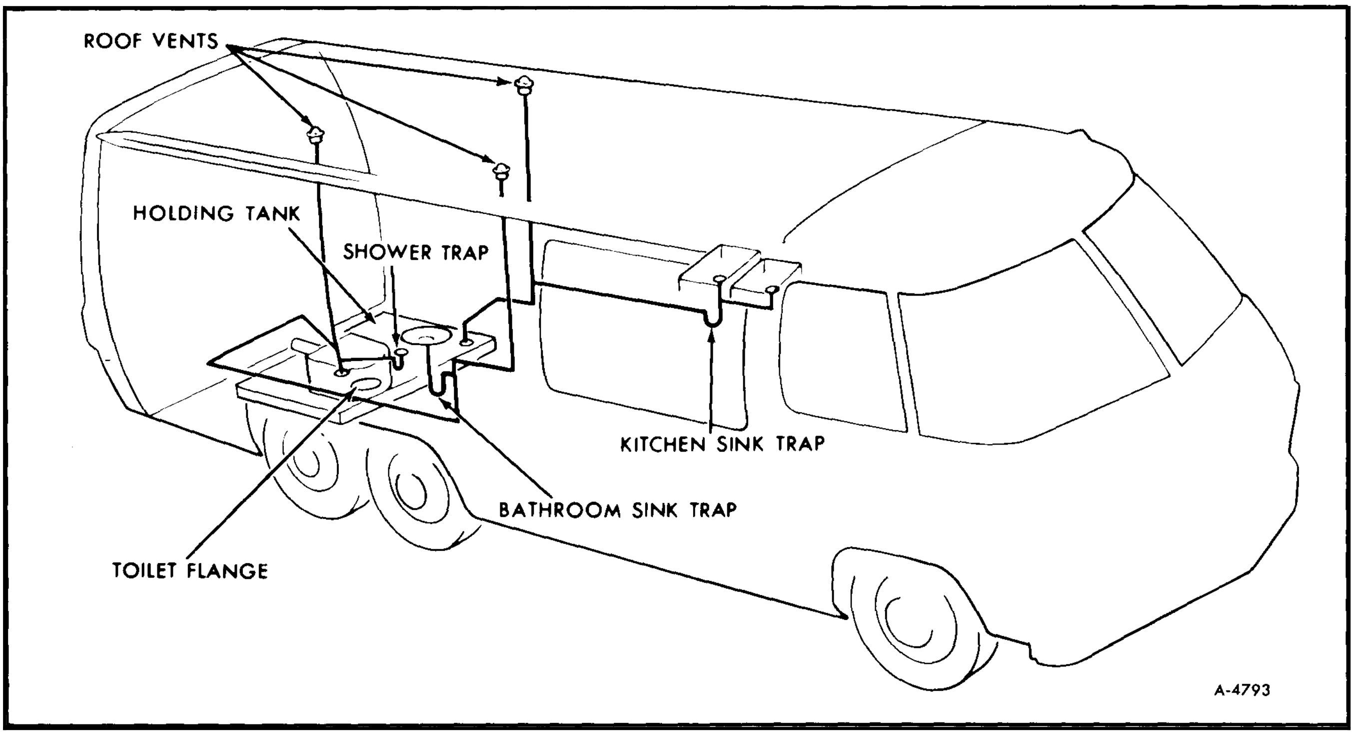


Figure 1—Drainage System

TROUBLE DIAGNOSIS

Problem	Possible Cause	Correction
Monitor panel gauge inoperative.	1. Refer to "Monitor Panel-Trouble Diagnosis" in Section 24B.	1. Refer to "Monitor Panel-Trouble Diagnosis" in Section 24B.
Holding tank leaks.	1. Seal may be damaged or misaligned at the tank sending unit or fullway dump valve. 2. Loose or misaligned fittings on top of tank. 3. Tank has been punctured.	1. Refer to "Holding Tank-Fittings" later in this section. 2. Remove tank and correct. Refer to "Holding Tank-Removal", and "Fittings" later in this section. 3. Refer to "Holding Tank-Repair" later in this section.
Holding tank plugged up and won't empty.	1. Determine if anything was dropped into tank to cause the situation. 2. Sediment has accumulated enough to block fullway valve opening. (The recommended use of bio-degradable should prevent this).	1. Flush tank adequately, add a tank chemical to eliminate odor during final flush. Remove fullway valve. Refer to "Holding Tank" later in this section. Try fishing object out through opening. 2. Use a plumbers flexible probe to break accumulation open. CAUTION: Use a hand turned probe, not a power driven probe. The power driven probe may damage the plumbing lines. NOTE: Once unplugged the contents will quickly drain so be prepared and have dump hose aimed in the desired direction.
Holding tank contents backs up through shower trap and onto bathroom floor.	1. The shower trap is the lowest point of the drainage system and an over full holding tank will back up contents at this point.	1. Caution owner to dump holding tank more frequently. 2. Install drainage plug in shower drain.
Clogged drain.	1. Accumulation of grease, hair, etc.	1. Remove "P" trap and clean. Refer to "Drain Pipes and Fitting".
Drain pipe or fitting leaks.	1. Vehicle vibration may have loosened fitting or a pipe may have a hole rubbed in it from contact with metal. 2. Broken pipe from freezing.	1. Replace pipe or fitting. Refer to "Drain Pipes and Fittings" later in this section. 2. Replace pipe or fittings.

HOLDING TANK

HOLDING TANK REMOVAL

1. Drain holding tank completely and close drain valve.

2. Remove toilet assembly. Refer to the section 24K for removal procedures.

3. Remove toilet mounting flange by removing six flange to floor mounting screws. Unscrew flange from holding tank.

4. Remove dump tube with fullway valve by removing four screws holding valve to mounting area on holding tank.

5. Remove cotter pin from valve rod and remove control rod (See figure 2).

6. Remove two electrical leads from holding tank sending unit.

7. Remove the drain pipe access cover inside the storage compartment below the Living Area Electrical Compartment then use a basin wrench as shown in Figure 3 to loosen pipe fitting from tank.

8.. Remove two retaining nuts from each of the two mounting brackets (See figure 2).

9. Holding tank can now be lowered to floor.

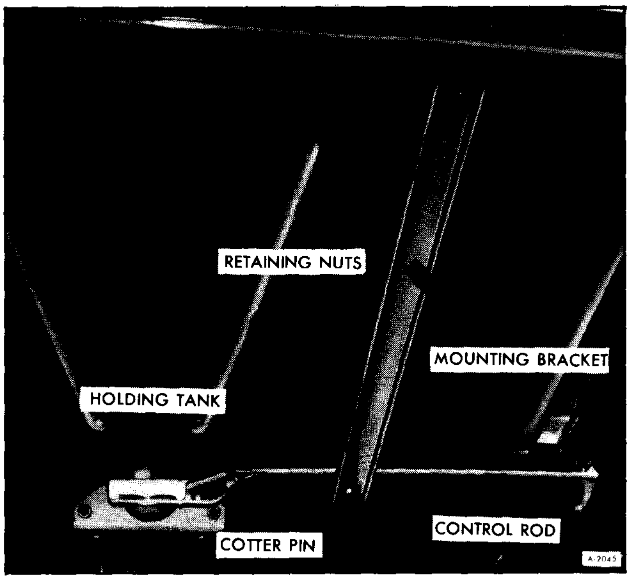


Figure 2—Holding Tank Mounting

HOLDING TANK REPAIR

Except for small, clean punctures the holding tank is not repairable. Polypropylene plastic, used to manufacture the tank, resists all common adhesives. The contents of the tank will quickly corrode any sheet metal, pop-rivets or screws used to plug or patch the tank.

A small puncture may be repaired with a well nut. Enlarge puncture hole with a drill and insert well-nut. Tighten securely.

HOLDING TANK INSTALLATION

1. Position holding tank and secure with two mounting brackets. Install nuts and tighten with fingers. Tighten pipe connector into tank, using a basin wrench as shown in Figure 3. Install drain pipe cover and secure with three screws. Torque holding tank bracket nuts to 95-145 in. lbs.

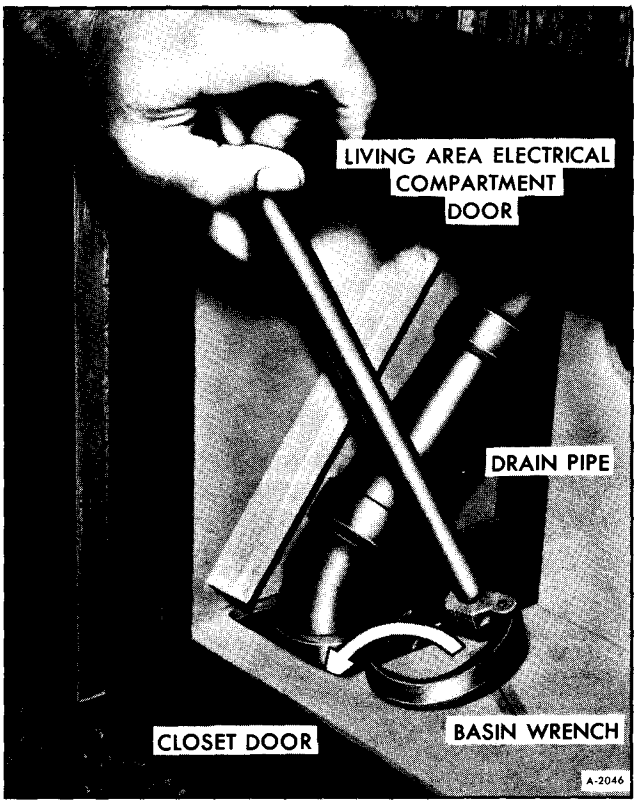


Figure 3—Loosening Pipe Fitting

2. Connect two electrical leads to holding tank gauge sending unit.

3. Install valve rod on drain valve and secure with cotter pin.

4. Install dump tube with fullway valve to holding tank with four screws.

5. Screw toilet mounting flange into holding tank and secure with six screws to floor.

6. Install toilet as described in SECTION 24K.

FULLWAY VALVE

REMOVAL

1. Drain holding tank completely and close fullway valve.

2. At dump tube assembly remove the four screws securing valve to the tank. Remove cotter pin from control rod.

3. Remove six bolts and nuts from dump tube bracket near tank.

4. Remove two bolts, washers, and nuts from clamp that secures dump tube to vehicle at bend in tube.

5. Unhook strap that supports dump tube at cap. Remove the fullway valve and the dump tube assembly.

INSTALLATION

1. At dump tube assembly, apply a film of grease to valve where "O" ring seats against valve. This will hold the new "O" ring in position while installing valve.

2. Position valve at holding tank and assemble enough to loosely install the strap (figure 4). Tighten fullway valve to tank screws.

3. Position valve with dump tube to tank and loosely install clamp to support tube.

4. Tighten fullway valve to tank screws.

5. Install bracket with six bolts and nuts. Torque to 15 ft. lbs. Tighten clamp bolts. Torque to 15-25 in. lbs.

6. Install valve rod and secure with cotter pin. Connect tube support strap.

7. Check tank and valve for leaks.

HOLDING TANK SENDING UNIT

REMOVAL

1. Disconnect two electrical leads to unit as shown in Figure 5.

2. Remove five screws retaining sending unit to holding tank, and remove sending unit.

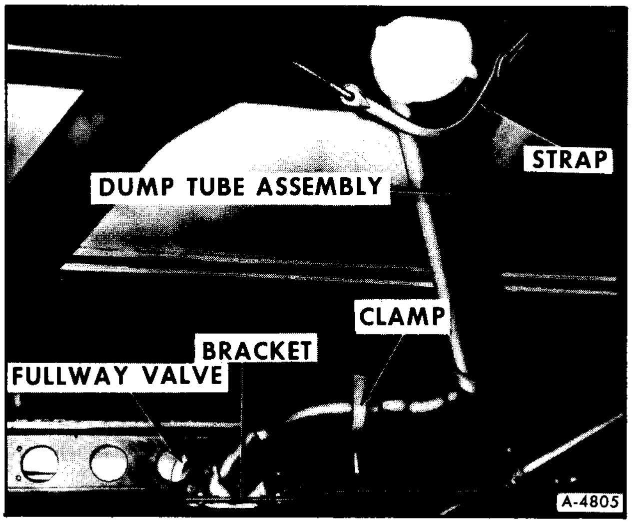


Figure 4—Dump Tube and Valve Assembly

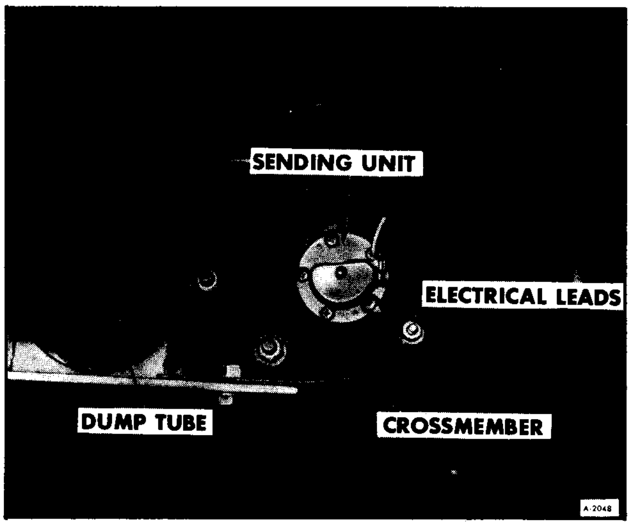


Figure 5—Holding Tank Sending Unit

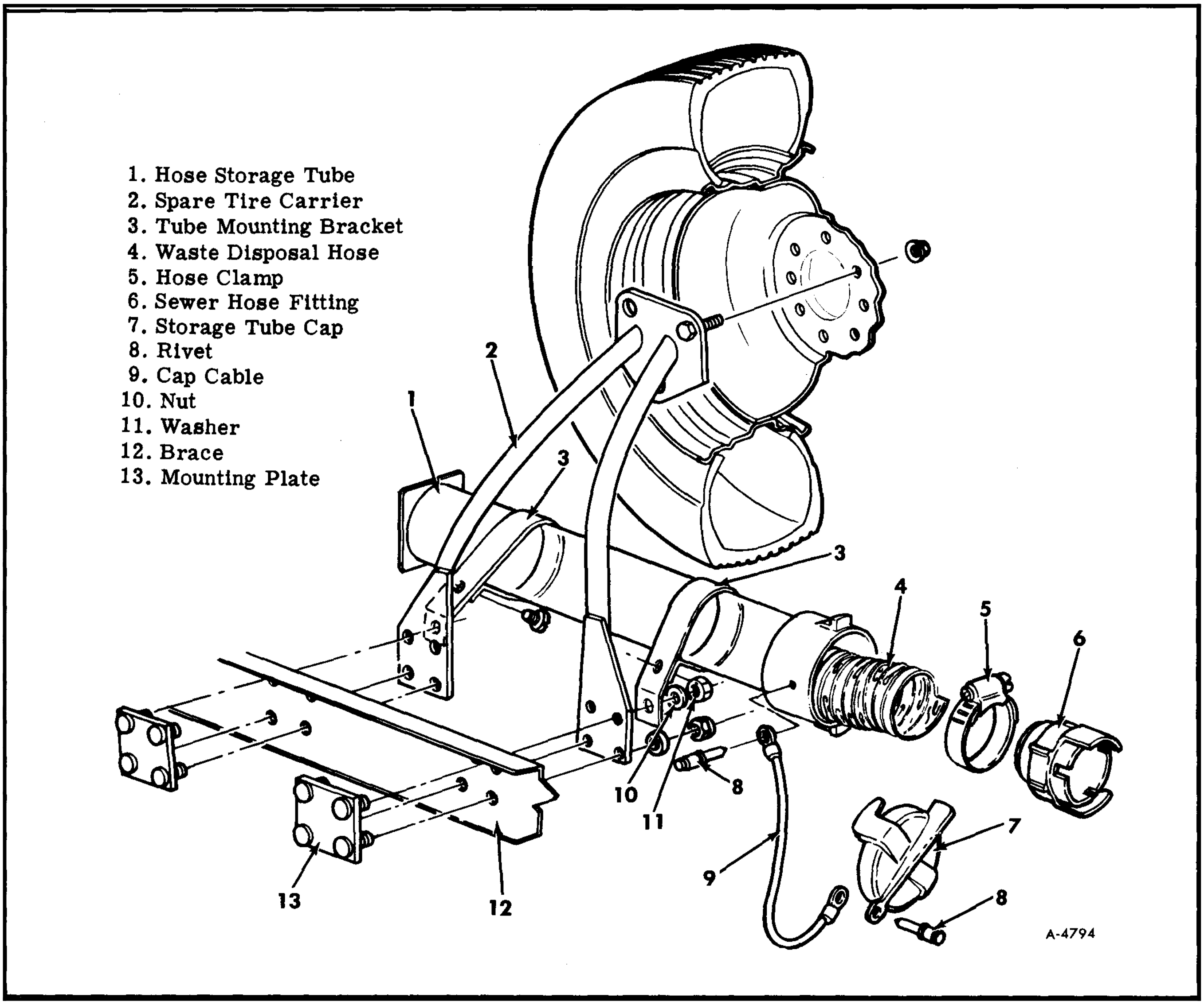


Figure 6—Sewer Hose Storage Tube - Exploded View

INSTALLATION (FIGURE 5)

1. Position sending unit and new gasket at holding tank with lead wire in the three o'clock position.

2. Install five retaining screws and hook up electrical leads.

DUMP TUBE

For dump tube removal, see "Fullway Valve Removal" earlier.

SEWER HOSE ASSEMBLY (FIGURE 6)

REMOVAL

1. Open the storage tube cap (7) and remove the sewer hose assembly (4, 5, and 6).

2. Loosen hose clamp (5) and separate waste disposal tube (4) from sewer hose fitting (6).

3. Remove two upper outside nuts (10) and washers (11), that secure tube mounting brackets (3) to spare tire carrier (2). Remove hose storage tube (1) with tube mounting brackets (3).

INSTALLATION

1. Secure hose storage tube (1) by two tube mounting brackets (3) to spare tire carrier (2) with two upper outside nuts (10) and washers (11).

2. Secure sewer hose fitting (6) to waste disposal tube (4) with hose clamps (5).

3. Store sewer hose assembly in storage tube. Replace storage tube cap (7).

DRAIN PIPES AND FITTINGS

All drain pipes and fittings are made from ABS plastic. Repair using a hacksaw to cut out damaged portion of pipe. Connect a new pipe section with unions. Fittings (elbows, unions, "T's", etc.) may be more difficult to replace and some rerouting may be necessary. Follow the adhesive manufacturers recommendation for preparing the pipe and fittings for assembly.

"P" traps are easily removed for cleaning if they become clogged. To remove a "P" trap loosen compression fitting on either end of the trap as shown in Figure 7. Clean trap, position in vehicle and tighten compression fitting by hand.

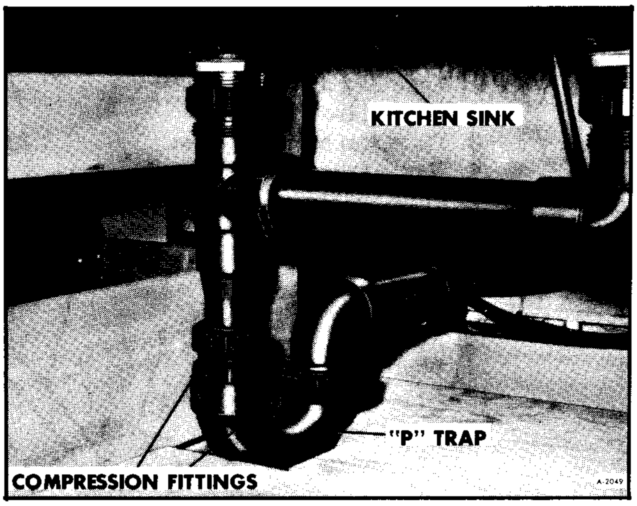


Figure 7—"P" Trap (Typical)

VENT LINE ROOF CAPS

There are three vent lines. Each vent line has a roof mounted cap to help prevent anything from entering the system from the roof which may plug the vent line.

REMOVAL

1. Drill off heads of rivets.

2. Remove vent cap and gasket.

INSTALLATION

1. Replace gasket and vent cap. Check for proper fit, add sealer to gasket (both sides) if required.

2. Pop-rivet vent cap to roof.

SECTION 24N
CABINETS AND FURNITURE
GENERAL INFORMATION

The various cabinetry and furnishings in the GMC MotorHome can be readily replaced or repaired using standard wood working procedures. Generally these units are retained by small screws, standard fasteners, etc. When removing any unit determine the manner of attachment, note the alignment points, and before removing the last fastener, support the weight of the unit to avoid possible damage.

IMPORTANT: Seat belt anchor bolts must be tightened to 35-45 foot-pounds torque.

CARE AND CLEANING

GENERAL INFORMATION

Dust and loose dirt that accumulates on interior fabric trim should be removed frequently with a vacuum cleaner, whisk broom or soft brush. Vinyl or leather trim should be wiped regularly with a clean damp cloth. Normal trim soilage, spots or stains can be cleaned with GM cleaners or equivalent.

Before attempting to remove spots or stains from upholstery, determine as accurately as possible the nature and age of the spot or stain. Some spots or stains can be removed satisfactorily with water or mild soap solution (refer to "Removal of Specific Stains" later in this section). For best results, spots or stains should be removed as soon as possible.

Some types of stains or soilage such as lipsticks, some inks, certain types of grease, mustard, etc., are extremely difficult and, in some cases, impossible to completely remove. When cleaning this type of stain or soilage, care must be taken not to enlarge the soiled area. It is sometimes more desirable to have a small stain than an enlarged stain as a result of attempted cleaning.

The listed cleaners are EXCELLENT CLEANERS when used properly according to directions on containers and are available through most GM Dealerships.

GM Cleaners

PART NO.	QUANTITY	DESCRIPTION
1050244	16 oz. can	GM Fabric Cleaner (Solvent Type)
1050417	Gallon can	GM Fabric Cleaner (Solvent Type)
1050803	16 oz. Container	GM Multi-Purpose Powdered Cleaner (Foam Type)
1050429	6 lb. can	GM Multi-Purpose Powdered Cleaner (Foam Type)

LAP BELT CARE

- Clean only with mild soap solution and lukewarm water.

- Do not bleach or dye belts since this may severely weaken belts.

INTERIOR GLASS

The interior glass surface should be cleaned on a periodic basis for continued good visibility. A commercial household glass cleaning agent containing ammonia will remove normal tobacco smoke and dust films sometimes caused by ingredients used in vinyls, plastics, or other interior trim materials.

KITCHEN SINK

The stainless steel sink should be cleaned with a liquid or finely ground powder. Scouring powder is not recommended for stainless steel and will ruin the finish. Stainless steel cannot be harmed by boiling water. However, salt, mustard, mayonnaise and catsup will cause pitting and should be cleaned off immediately.

DRAPERY CARE

The draperies used in the GMC MotorHome are to be DRY CLEANED ONLY.

CLEANING FABRICS

IMPORTANT: Be sure vehicle is well ventilated while using the following cleaning agents. Follow manufacturer's recommendations in using such products.

CAUTION: *Many cleaners may be toxic or flammable, and their improper use may cause personal injury or may cause damage to the interior. Therefore, when cleaning the interior, do not use volatile cleaning solvents such as: acetone, lacquer thinners, enamel reducers, nail polish removers; or such cleaning materials as laundry soaps, bleaches or reducing agents (except as noted in the adjacent fabric cleaning instructions on stain removal). Never use carbon tetrachloride, gasoline or naphtha for any cleaning purpose.*

CLEANING FABRICS WITH CLEANING FLUID

GM Fabric Cleaner (Solvent Type) is excellent for spot cleaning stains containing grease, oil or fats from fabric type trim. Excess stain should be gently scraped off trim material with a clean DULL knife or scraper. USE VERY LITTLE CLEANER, light pressure, and clean cloths (preferably cheese cloth). Cleaning action should be from outside of stain FEATHERING towards center of stain and constantly changing to a clean section of cloth. When stain is cleaned from fabric, immediately dry area with an air hose, heat dryer or heat lamp to help prevent a cleaning ring (use caution with heat dryer or heat lamp to prevent damage to fabric material). If a ring forms, immediately repeat the cleaning operation over a slightly larger area with special emphasis on FEATHERING towards center of area. If ring still persists, mark off adjacent trim sections and clean entire affected trim panel section with GM Multi-Purpose Powdered Cleaner as described in the following:

CLEANING FABRICS WITH DETERGENT FOAM CLEANERS

GM Multi-Purpose Powdered Cleaner is excellent for this type cleaning and for cleaning a panel section where a minor cleaning ring may be left from spot cleaning.

Vacuum area thoroughly to remove excess loose dirt. **ALWAYS** clean a full trim assembly or complete trim section—mask adjacent trim along stitch or welt lines. Mix Multi-Purpose Powdered Cleaner in strict accordance with directions on label of container—mix proportionally for smaller quantities. **USE STUDS ONLY ON A CLEAN SPONGE or SOFT BRISTLE BRUSH—DO NOT WET FABRIC EXCESSIVELY OR RUB HARSHLY WITH BRUSH. IMMEDIATELY AFTER CLEANING WIPE OFF ANY CLEANER RESIDUE WITH SLIGHTLY DAMP ABSORBENT TOWEL OR CLOTH.**

> **IMPORTANT:** —Immediately after wiping, force-dry fabric with air hose, heat dryer or heat lamp. (Use caution with heat dryer or heat lamp to prevent damage to fabric).

When trim materials with a sheen or luster finish are dry, wipe fabric lightly with a soft, dry clean cloth to restore sheen or luster.

REMOVAL OF SPECIFIC STAINS

CANDY—Chocolate, use cloth soaked in lukewarm water; other than chocolate, use very hot water. Dry if necessary, clean lightly with fabric cleaning fluid.

CHEWING GUM—Harden gum with ice cube and scrape off with dull knife. Moisten with fabric cleaning fluid and scrape again.

FRUIT STAINS, COFFEE, LIQUOR, WINE, SOFT DRINKS, ICE CREAM AND MILK—Wipe with cloth soaked in cold water. If necessary, clean lightly with fabric cleaning fluid. Soap and water is not recommended as it might set the stain.

CATSUP—Wipe with cloth soaked in cool water. If further cleaning is necessary, use a detergent foam cleaner.

GREASE, OIL, BUTTER, MARGARINE AND CRAYON—Scrape off excess with dull knife. Use fabric cleaning fluid.

PASTE OR WAX TYPE SHOE POLISH—Light application of fabric cleaning fluid.

TAR—Remove excess with dull knife, moisten with fabric cleaning fluid, scrape again, rub lightly with additional cleaner.

BALL POINT INK—Try rubbing alcohol. If stain remains after repeated operations, no other measure should be tried.

LIPSTICK—Difficult to remove. Cleaning fluid works on some brands. If stain remains after repeated applications, do not try other measures.

MUSTARD—Damp sponge with warm water, then rub detergent on dampened stain and work into fabric. Rinse with clean damp cloth. Repeat several times. Some discoloration may remain.

BLOOD—Wipe with clean cloth moistened with cold water. Use no soap.

URINE—Sponge stain with lukewarm soap suds from mild neutral soap on clean cloth, rinse with cloth soaked in cold water; saturate cloth with one part household ammonia and five parts water, apply for one minute, rinse with clean, wet cloth.

VOMITUS—Sponge with clean cloth dipped in clean, cold water. Wash lightly with lukewarm water and mild neutral soap. If odor persists, treat area with a water-baking soda solution (one teaspoon baking soda to one cup of lukewarm water). Rub again with cloth and cold water. Finally, if necessary, clean lightly with fabric cleaning fluid.

SECTION 24P
EXHAUST VENTS
DESCRIPTION

The GMC MotorHome is equipped with a number of exhaust vents, these include:

• The range/oven power hood vent to remove cooking odors and gases. The switch is on the fan.

• The power bath vent for ventilation. The control switch is on the vent.

• One or two ceiling vents (depending whether the vehicle is equipped with roof mounted air conditioning) to allow warm air to escape that may accumulate at ceiling level when the vehicle is parked in the sun. The opening of a ceiling vent and a window will aid in removing condensation from the windows.

The vents are crank-operated from inside the MotorHome. In rainy weather it is possible to leave the ceiling vents open slightly for ventilation without entry of water into the MotorHome (depending upon the magnitude and direction of rain).

NOTE: All windows and roof vents must be tightly closed when operating the air conditioner or furnace to obtain maximum cooling or heating.

Power fans are available for the ceiling vents. These will increase the efficiency of the vent. They are operated by the button switch at the corner of the vent.

VENT MOTOR DIAGNOSIS

The range/oven exhaust vent fan, the bath exhaust vent fan, and the ceiling vents with power fans are all operated by 12-volts living area electricity. Should any of these fans refuse to work make sure the living area battery is not dead. Next check the fuses in the living area electrical compartment, then check to see that the motor is receiving power through the switch at the motor. If power is available at the motor but it still refuses to work remove the motor and test it on a direct 12-volt source. Replace motor if necessary.

RANGE/OVEN EXHAUST VENT

MOTOR REPLACEMENT (FIGURE 1)

REMOVAL

1. Remove retaining nuts at light and fan switch on bottom of exhaust hood.

2. Remove exhaust hood bottom assembly.

3. Remove two nuts holding motor mount to vent housing.

4. Disconnect motor wire.

5. Remove motor mount and fan from motor.

INSTALLATION

1. Install fan and mount to motor.

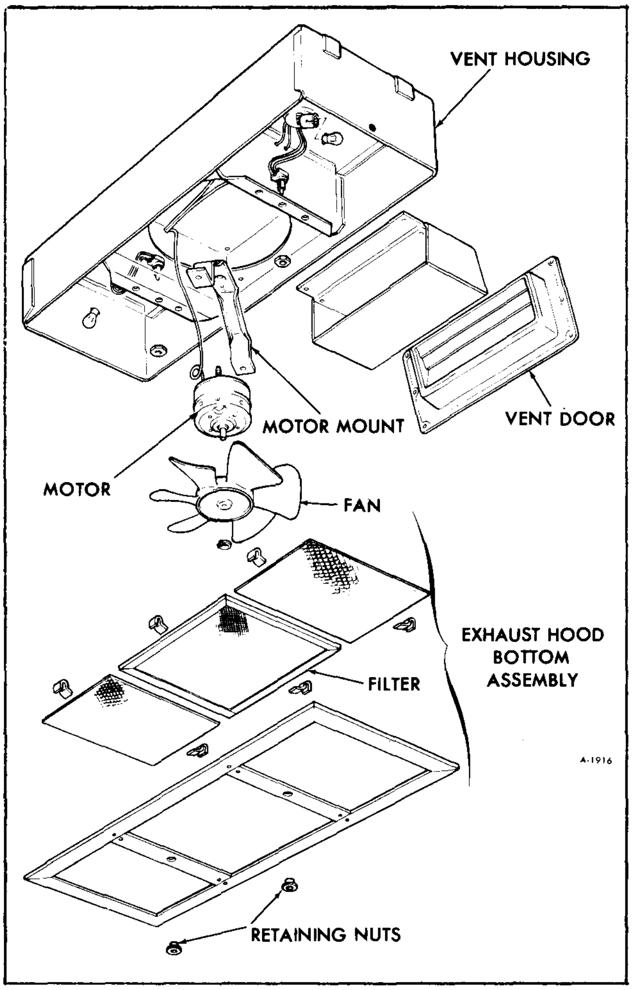


Figure 1—Range Power Vent

2. Connect motor wire to switch wire.

3. Install motor and mount assembly to vent housing and secure with two nuts.

4. Position exhaust hood bottom assembly to bottom of exhaust hood and secure with retaining nuts at switches.

RANGE/OVEN VENT FILTER (SEE FIGURE 1)

It is important that the power range hood filter be inspected frequently and cleaned as needed. To clean filter, remove retaining nuts at power hood switches, remove filter and wash in hot, soapy water. Rinse thoroughly and reinstall.

CEILING VENTS

MOTOR REPLACEMENT (POWER VENTS) (FIGURE 2)

REMOVAL

1. Remove vent crank handles (one screw each).

2. Remove vent screen (six screws).

3. Disconnect motor wires from switch and support.

4. Remove nuts retaining motor and switch to vent housing.

5. Remove fan from motor.

INSTALLATION

1. Install fan on motor.

2. Position motor and switch in vent housing and secure with retaining nuts.

3. Connect 12-volt motor wires to switch and support.

VENT SCREEN REPLACEMENT (FIGURES 2 AND 3)

REMOVAL

1. Remove vent crank handles (one screw each).

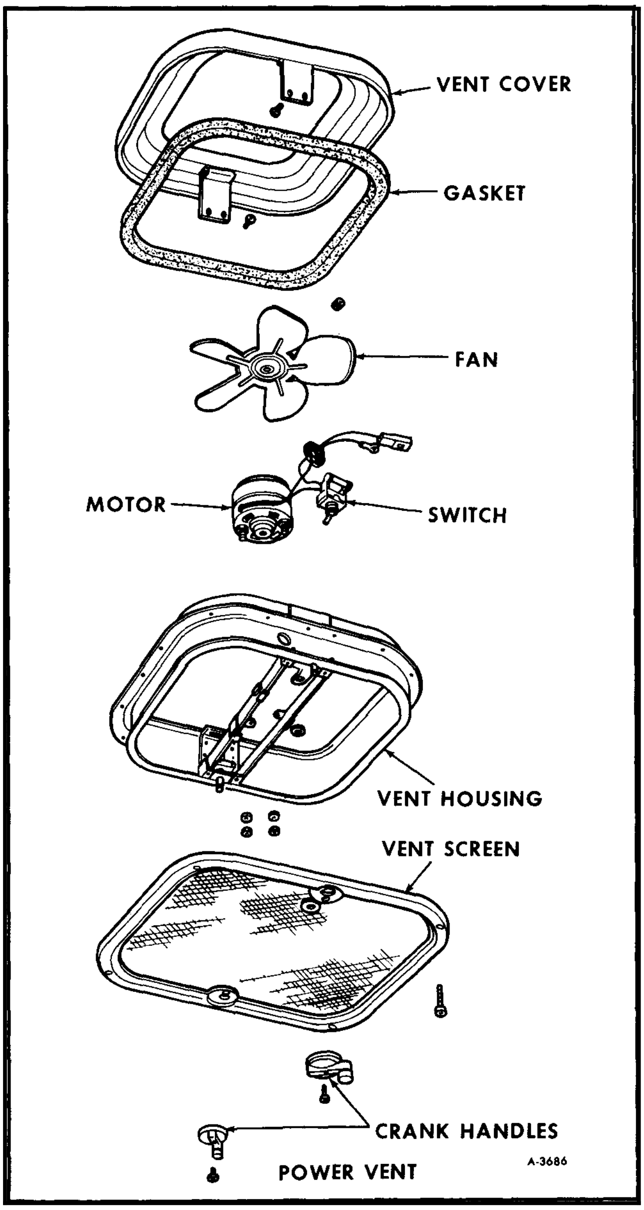


Figure 2—Ceiling Power Vent

2. Remove vent screen (six screws).

NOTE: Use lukewarm water and mild soap solution if necessary to clean vent screen.

INSTALLATION

1. Install vent screen. Tighten six retaining screws securely.

2. Install vent crank handles. Tighten retaining screws securely.

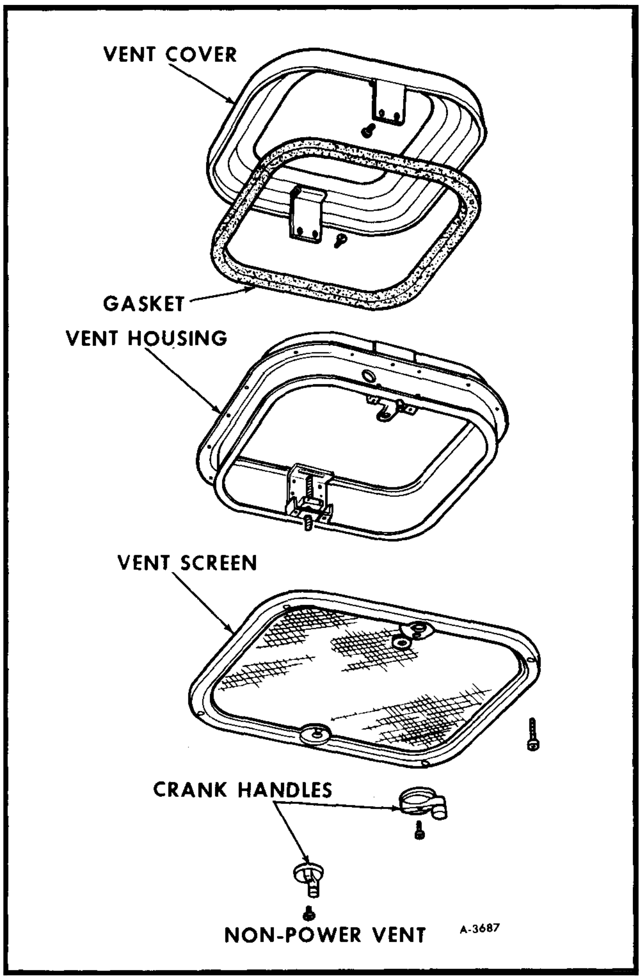


Figure 3—Ceiling Non-Power Vent

VENT GASKET REPLACEMENT

1. Fully open vent.

2. Remove vent cover by removing retaining screws from slide mechanism.

3. Carefully with the aid of a knife or other suitable tool remove gasket from vent cover.

4. Using suitable cement, secure gasket to vent cover.

5. Reinstall cover on slide mechanism. Tighten retaining screws securely.

5. Check for proper operation of vent.

BATH VENT

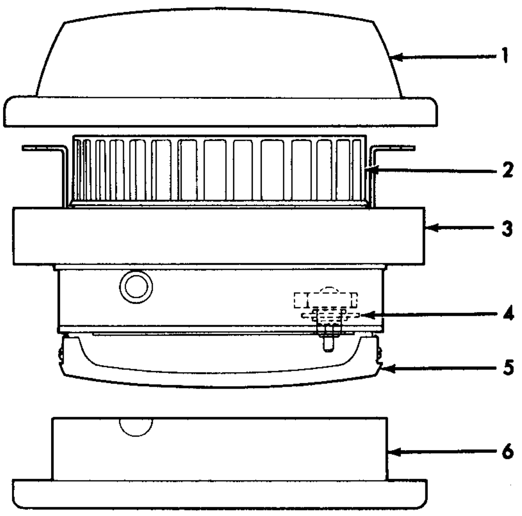
MOTOR REPLACEMENT (FIGURE 4)

REMOVAL

1. Remove vent ring in bath module (three screws).

2. On the roof of the vehicle remove the two screws holding plastic cover on vent.

3. Remove the entire vent assembly from roof by removing the six attaching screws pulling the unit out and disconnecting wires at quick disconnect.



1. PLASTIC VENT COVER
2. FAN
3. VENT HOUSING
4. SWITCH
5. CLOSING HANDLE
6. VENT RING (INSIDE BATH MODULE)

A-1918

Figure 4—Bath Vent

4. With the unit on the bench remove vent closing handle (two screws).

5. Remove filter (two screws & switch nut).

6. Remove two screws at each motor mount.

7. Remove the two nuts at motor mounting.

8. Carefully remove the motor mount brackets.

9. Remove spring clip assemblies.

10. Disconnect wires and remove motor. Pull fan from motor.

INSTALLATION

1. Position motor with fan in housing and connect wires.

2. Position spring clip assemblies to motor studs.

3. Position motor mount brackets on motor studs and secure to vent housing with four screws.

4. Position switch on motor studs and secure motor to mounting bracket with two nuts and washers.

5. Install filter (two screws & switch nut).

6. Install closing handle (two screws).

7. Install vent assembly to roof being sure to use a sealing compound to prevent leaks.

8. Install plastic vent cover.

9. Install vent ring inside of bath module.

SECTION 24Q
OTHER EQUIPMENT

VACUUM CLEANER

GENERAL INFORMATION

The Motor Home integral vacuum cleaner (optional on Model 260) operates on 120-volt current. The vehicle must be connected to an external power source or the motor generator must be in operation in order to operate the vacuum cleaner.

Vacuum cleaner components are stored in the side of the refrigerator module near the entrance door. The vacuum cleaner storage cabinet contains a long flex hose, wand, and a wide assortment of wand attachments including one for shag carpeting (See figure 1).

To operate the vacuum system, remove flex hose from the cabinet, lift vacuum inlet hinge cap, just under the storage cabinet, and insert the proper end of the flex hose (figure 2). At this point the vacuum system will be operating and is used in the same manner as any household vacuum cleaner.

BAG AND FILTER REPLACEMENT

The vacuum cleaner contains two filters – the bag itself which catches the dirt and a secondary filter to keep any residual dirt out of the motor.

1. To remove the filled filter bag, slide cardboard end of bag with rubber seal off intake tube. Pull bag forward and out of cabinet.

2. To replace filter bag, spread new bag and position in cabinet. Slide cardboard end with rubber seal up over intake tube by starting at back of tube and pulling forward and up.

3. The secondary filter is located at the top of the filter bag chamber. The secondary filter should be removed and cleaned often.

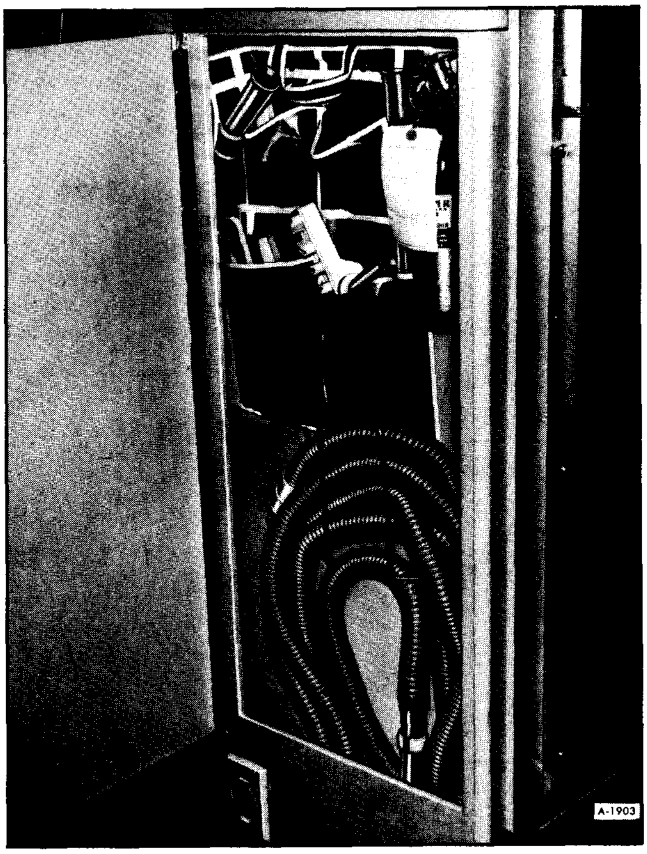


Figure 1–Vacuum Cleaner Components

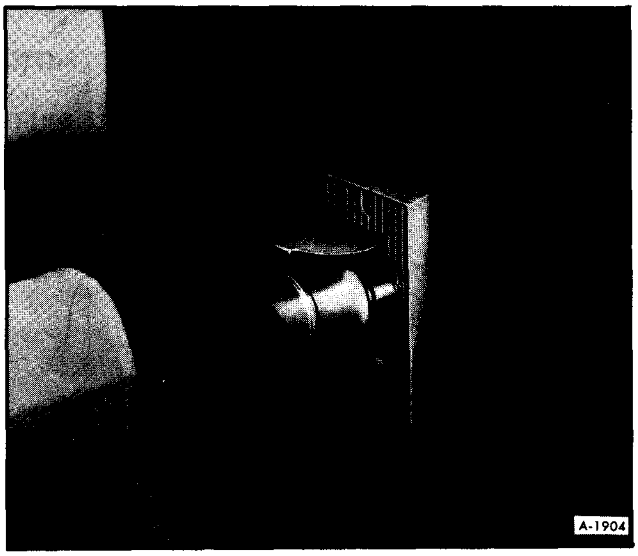


Figure 2–Connecting Flex Hose to Wall Inlet

TROUBLE DIAGNOSIS

If the vacuum cleaner fails to operate the trouble lies in one of three areas; the power source, the low voltage switch system, or the vacuum cleaner motor. This is the order in which the trouble should be examined.

1. Check first that the Motor Home is receiving 120-volt power to the external power cord. Next check the circuit breakers in the living area electrical compartment. Finally make sure the vacuum cleaner is securely plugged into the receptacle under the refrigerator module.

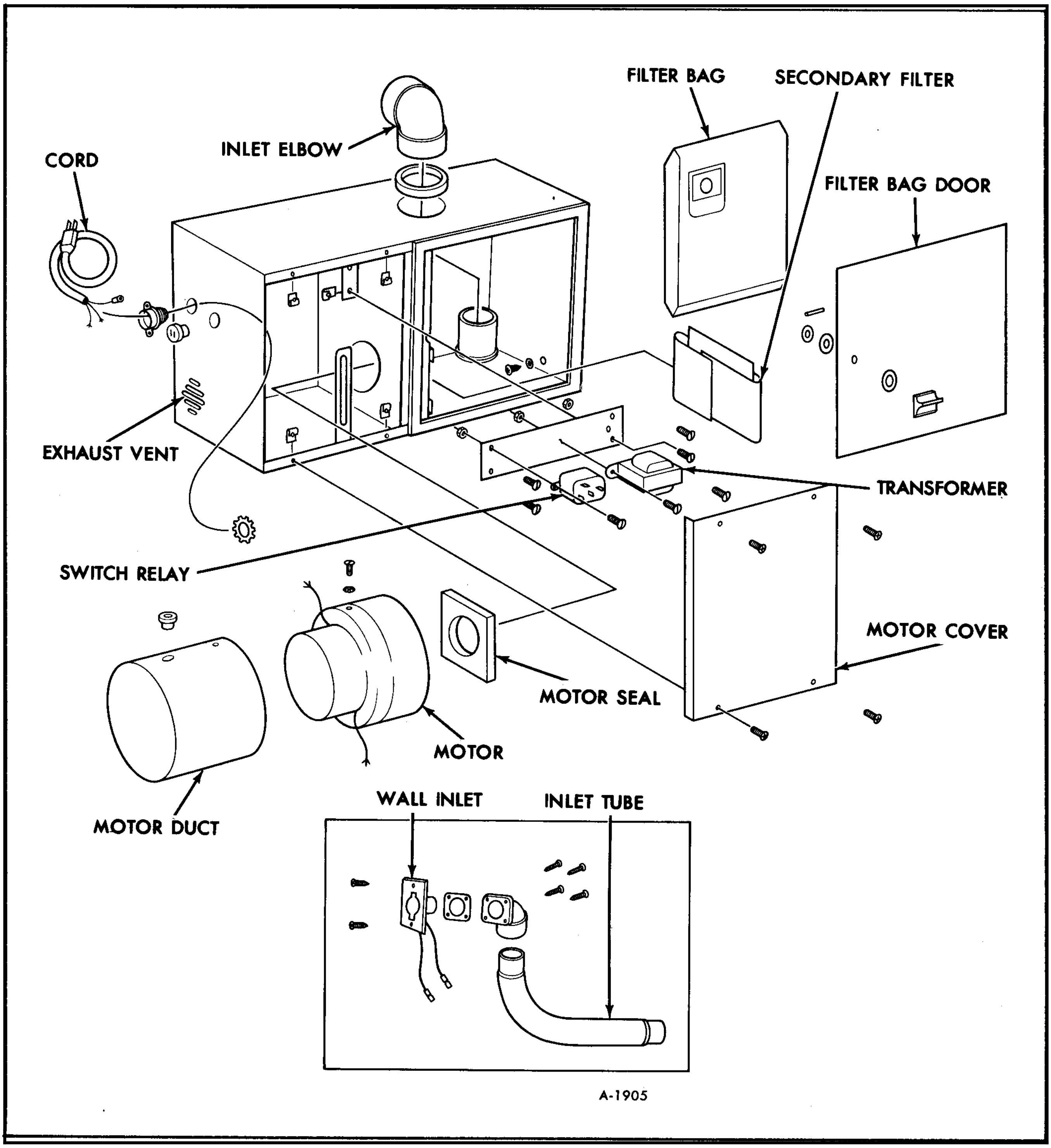


Figure 3–Vacuum Cleaner Components

2. Since the switch operates through two low voltage contacts in the hose inlet, the voltage should be checked here with a voltmeter at approximately 25 VAC. If there is no voltage at these contacts, either the transformer is faulty or or the wiring is loose. If there is voltage at these contacts:

a. Unplug the 120-volt motor wires at the relay (See figure 3).

b. Next insert hose end into vacuum inlet.

c. Now check for continuity at the two terminals on the relay where the motor wires were disconnected. If there is no continuity here the relay is faulty.

d. If there is continuity at these terminals the vacuum motor is faulty and must be replaced. See "Vacuum Motor Replacement".

LOSS OF VACUUM

The reasons for loss of vacuum are usually simple and easily remedied. The following are the most common causes:

1. Hose may be obstructed. Remove from inlet. Insert a blunt object that is slightly smaller in diameter than the hose. A screwdriver (insert handle end first) or steel ball can generally be shaken through the hose to clear obstructions. A garden hose can also be used to clear vacuum hose.

2. Filter bag may be filled.

3. Door to filter area may be open or gasket surrounding door may be damaged. Door must be closed securely for efficient operation of the power unit.

4. Exhaust line may be clogged. Make a visual inspection of exterior opening. Check for lint clogging if a guard screen is being used. Clear exhaust with a probe while unit is running.

5. Something may be clogging the tube line. Start the unit, purge line by covering hose end with hand-release to send a sudden surge of air through.

VACUUM MOTOR REPLACEMENT (FIGURE 3)

REMOVAL

1. Unplug vacuum cleaner assembly from duplex receptacle.

2. Remove motor compartment cover (See figure 3).

3. Disconnect vacuum motor wires at relay and junction.

4. Remove screw at motor securing strap.

5. Remove motor and motor duct from cabinet (figure 3).

6. Remove motor from duct.

INSTALLATION

1. Install motor in duct with motor wires properly routed.

2. Install motor and motor duct in vacuum cabinet making sure motor seal is properly positioned (figure 3).

3. Secure motor with motor securing strap and screw.

4. Connect motor wires at relay and junction.

5. Install motor cover.

6. Plug vacuum cleaner into receptacle and check operation.

BATTERY OPERATED CLOCK

The optional battery-operated wall clock is located above the kitchen range.

BATTERY REPLACEMENT

Remove clock from wall by raising approximately 1/2-inch, then carefully separate clock from wall. Remove and discard used battery. Install new 1-1/2-volt "C" cell battery, being sure that positive (+) end of battery is installed as shown (when viewed from the back of clock).

Figure 4—Removing Clock from Wall

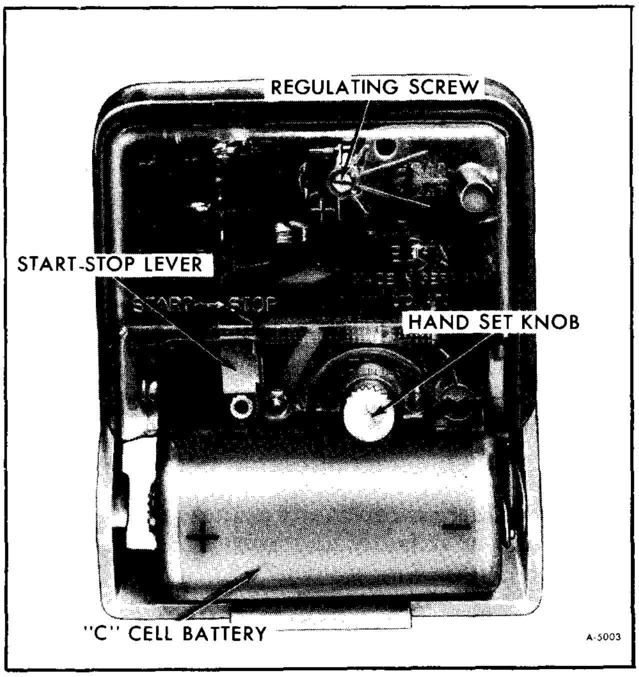


Figure 5—Backside of Clock

SETTING HANDS

To set hands, pull Hand Set Knob slightly outward and rotate it CLOCKWISE ONLY (as viewed from front of clock). NEVER move the hands COUNTERCLOCKWISE as this may damage the mechanism.

START CLOCK

To start clock, simply move the START-STOP lever to the left. If necessary to stop clock, move lever to the right.

TIME REGULATION

If clock is not maintaining proper time, it may be necessary to adjust position of regulating screw. Note the time movement cover is marked (+) and (—). If the clock runs fast, turn screw towards (—). If the clock runs slow, turn screw towards (+). A movement through one section (between slots) will adjust the timekeeping 5 seconds per day.

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Living Area

1975 120v AC

1975 12v DC

1975 / 1976 120v AC (Effective with TZE165V100893) November 1975

1975 / 1976 12v DC (Effective with TZE165V100893) November 1975

Engine Area

1975 with Breaker Points

1975 with HEI

1975 Transmode with Breaker Points

1975 Transmode with HEI

FOREWORD

This manual contains service, maintenance, and repair information on the GMC MotorHome and TransMode vehicles. Operation of the MotorHome and TransMode is contained in separate Operating Manuals which are furnished with each vehicle.

Every effort has been made to include timely and adequate information on the various units and systems used in GMC MotorHomes and TransModes. The procedures given in the various sections are the result of extensive service experience. The information should serve not only as a reference for the experienced mechanical force, but also a comprehensive text for training purposes.

References are made to special tools in the various sections of this manual. These tools, or their equivalent, are necessary and are recommended to readily and efficiently accomplish certain service operations. The tools, however, are not supplied by General Motors Corporation. Information regarding the availability of these tools can be obtained from the Zone Office or from the Service Department at the factory.

All information contained in this manual is based on the latest product information available at the time of publication. GMC Truck and Coach Division reserves the right to make changes in design or add improvements at any time without incurring any obligation to install same on vehicles previously purchased.

GMC

TRUCK & COACH DIVISION
GENERAL MOTORS CORPORATION
PONTIAC, MICHIGAN 48053

X-7525

GMC

1975 & 1976

MAINTENANCE MANUAL

MotorHome

ZEO6581

TransModes

ZEO6083

ZEO6583

GMC TRUCK & COACH

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