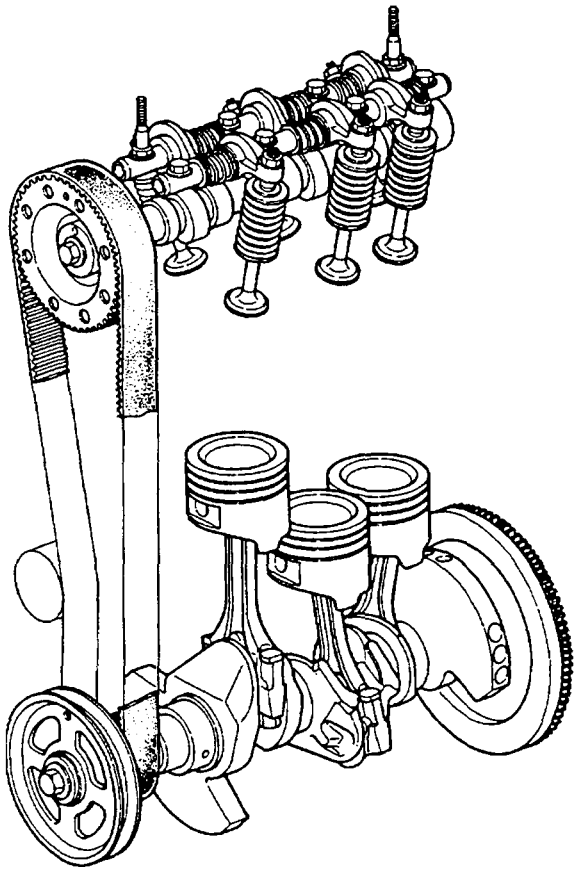
CUSHMAN®

Service Manual

for
Liquid Cooled
Gasoline Engine
Haulster®/Turf-Truckster®



PART NO. 836278

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IMPORTANT

To make sure you are fully aware of safety and service information, the following two symbols are used throughout this instruction.

This symbol  **(SAFETY WARNING) appears next to information (in bold type) which may help keep you and others from being hurt.**

This symbol 

(NOTE) appears next to information or instructions which may help you install, operate and maintain your equipment the properly.

LOCATION OF ENGINE TYPE AND ENGINE NUMBER

The engine type and number is stamped on the front side of the cylinder block.

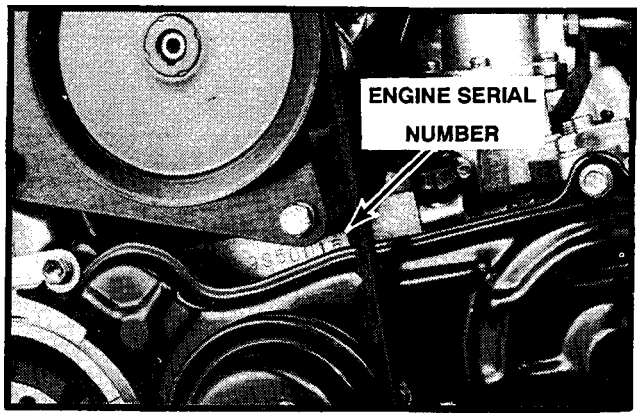


Figure 1. Engine Serial Number

ENGINE SPECIFICATIONS

Item				Engine type: MODEL 327
Engine Proper	Type			Gasoline, 4–cycle
	Cylinder No. and arrangement			3 cylinder–in–line, mounted longitudinally
	Combustion chamber type			Multi–sphere
	Valve mechanism			Belt driven, overhead camshaft
	Bore X stroke			2.62 x 3.19 in. (66.6 x 81 mm)
	Compression ratio			9.5
	Compression pressure			175 psi @ 400 rpm (1200kPa @ 400 rpm)
	Number of piston rings	Compression ring		2
		Oil ring		1
	Valve timing	Intake	Open	28° BTDC
			Close	62° BTDC
		Exhaust	Open	62° BTDC
			Close	28° ATDC
	Valve clearance [Hot]		Intake	.010 in. (.25 mm)
			Exhaust	.012 in. (0.30 mm)
	Idling speed rpm			1000 to 1300 RPM except Calif. Mod. 1300 RPM
	Blow–by gas recirculating system			Closed
Lubricating System	Lubricating method			Fully–forced feed method
	Oil Pump type			Trochoid
	Oil filter type			Full–flow filter
	Oil capacity			2.7 qts. (2.8 L)

Item \ Engine type					MODEL 327	
Cooling System	Cooling method				Water cooled, fan	
	Radiator type				Corrugation forced circulation	
	Water pump type				Centrigugal "V" belt driven	
	Thermostat type				Wax pellet	
Fuel System	Fuel pump type				Mechanical	
	Carburetor	Manufacturer			AISAN	
		Style			Side–draft, single barrel	
		Choke valve			Auto choke	
Engine Electrical System	Ignition System	Voltage V			12 (Negative ground)	
		Type			Battery ignition	
		Ignition Timing			10° BTDC/900 rpm Calif. Mod. only–5°	
		Firing order			1–2–3	
		Distributor	Distributor		Conventional	
			Breaker .017 in. (0.45 mm)		Contact point	
		Spark plug	Manufacturer	CHAMPION	DENSO	NGK
			Number	RN10YC	W20EXR–U	BPR6EY
			Thread	M14S (ISO)	M14S (ISO)	M14S (ISO)
			Spark plug gap	.032 in. (0.8 mm)	.032 in. (0.8 mm)	.032 in. (.08 mm)
	Starter	Type			Magneto engaging	
		Output V–KW			12–0.8	
		Manufacturer			NIPPON DENSO	

INSTRUCTIONS ON SERVICE OPERATIONS

1. Make sure that only the specified bolts and nuts are used. Also, where specified, be sure to employ a torque wrench to tighten bolts or nuts to specifications.

2. Use only genuine parts for every replacement operation.

3. For increased working efficiency and improved accuracy, use SSTs (Special Service Tools) effectively.

4. When front or rear part of the vehicle is jacked up, make certain to place chocks at the wheels correctly in order to assure safe operation.

5. Before any repair work is made on the electrical system or the engine is removed or installed, first be sure to disconnect the negative (–) terminal of the battery.

6. Disassembly.
   (1) When complicated parts are disassembled, put stamped marks or mate marks on suitable nonfunctional sections of the parts in the correct original positions.
   (2) Replacements of the cylinder block or crankshaft, etc. should be carried out after the engine assembly has been removed from the motor vehicle.

7. Checks to be performed during disassembly.
   Each time a part is removed, check conditions under which the part has been assembled. Also, check to see if the part exhibits any evidence of distortion, breakage, wear or scores, etc.

8. Arrangement of disassembled parts.
   Put disassembled parts in order. Moreover, divide disassembled parts into two groups: those parts to be replaced and those parts which can be reused.

9. Washing disassembled parts.
   As for those parts which can be reused, thoroughly clean or wash them.

10. Inspection and measurement.
    Those parts which are to be reused must be carefully inspected or measured, as required.

11. Assembly of parts.
    Those satisfactory parts only should be assembled in accordance with the prescribed standards (e.g. specified adjustment values, tightening torques and so forth).
    Furthermore, seal packing or grease should be applied, as required.
    Furthermore, in respect to packings, gaskets, cotter pins and similar items, be certain to install new parts.

12. Adjustments and checking of service operations.
    Service operations must be carried out correctly by means of gauges or testers, if the use of these instruments is required.

SECTION 2 TUNE-UP

Special tools required in this section:

Timing light
Compression tester
5/8 inch spark–plug socket
Spark-plug feeler gage (wire)
Feeler gage
Tachometer
Oil filter wrench
Drain pan

General Information

There are three fundamentals to be considered in doing an engine tune-up. They are ***compression***, ***ignition*** and ***carburetion***. Since compression does not depend on either carburetion or ignition, it is advisable that the compression always be checked before performing ignition and carburetion checks.

Before making the actual compression test, it is essential that the battery is completely charged so that the engine rotates at maximum rpm.

It is likewise essential that the engine be warmed up to approximate operating temperature before making the test. After warming up the engine, remove all spark plugs and block the carburetor throttle and choke in a wide open position. Insert the compression tester in the spark plug hole of one cylinder, operate the starter and observe the gauge reading.

Repeat the same test on the other cylinders. If the compression on any cylinder is less than 140 pounds, it indicates leaking valves, leaking or worn piston rings or possibly both, in which case it will be necessary to repair or replace as necessary. At no time should the compression vary more than 15 pounds between the three cylinders.

Engine Tune-Up Procedure

SAFETY WARNING

- **The cooling fan is thermostatically controlled and MAY start at any time. Disconnect fan at the switch on the engine. DO NOT attempt service without disconnecting.**

1. Clean engine and check for oil leaks, damaged parts, etc.

2. Check cylinder head and manifold screws for proper torque.

Cylinder head torque	36 to 43 ft/lbs (47 to 56 N·m)
Manifold torque	11 to 16 ft/lbs (14 to 22 N·m)

3. Check valve tappet clearances.
   Ref. page 2.2 **Valve Tappet Adjustment**

Intake	.006 (0.152 mm) – Cold
Exhaust	.008 (0.203 mm) – Cold

4. Check cylinder compression pressure.

Specification	175 psi (1200 kPa) @ 400 rpm
It is not recommended to exceed 15 psi (103kPa) difference between cylinders	

5. Install new sparkplugs.

TYPE	NUMBER	GAP
NGK	BPR4EY	0.032 Inch (0.800 mm)

6. Install new ignition points and condenser.

Point gap	0.017 inch (0.45 mm)

7. Check and adjust ignition timing:
   Ref. page 2.2. **Ignition Timing.**

Standard Vehicle	5° ± 2° (900 ± 50 rpm)
California Modification	10° ± 2° (900 ± 50 rpm)

8. Adjust governor.

Maximum engine speed ..... (Models 898466, 898630 & 898632)	3600 rpm
Maximum engine speed ..... (Models 898467)	3850 rpm
Maximum engine speed ..... (Models 898464 & 898465)	4290 rpm

SAFETY WARNING

- **To prevent speeds greater than design limits, NEVER alter the governor controls in any manner to increase engine speed beyond the MAXIMUM engine speed of the model you are working on.**

9. Install new fuel filters.

10. Check air cleaner. Install new air filter.

11. Check and adjust idle speed and idle mixture. Ref. page 2.3. **Carburetor Adjustment.**

Standard Vehicle	1000 – 1300 rpm
California Modification	1300 rpm

12. Drain oil, change filter. Fill crankcase with recommended oil for the season.

13. Check coolant level.

If additional coolant is needed, a 50 – 50 mixture of a good grade of ethylene glycol antifreeze and clean water is recommended. Mix in a separate container before adding. NEVER add straight antifreeze to the radiator.

SAFETY WARNING

- **To avoid burning yourself, never remove the radiator cap while the engine is hot.**

NOTE

- Reconnect cooling fan after tune-up is completed.

Main Points of Engine Tune-up

Valve Tappet Adjustment

1. Remove the valve cover.

2. **The COLD valve setting is:**

Intake	**0.006 inch (0.150 mm)**
Exhaust	**0.008 inch (0.203 mm)**

3. When the number 1 piston is at TDC, of the compression stroke, adjust the intake valves on number 1 and 3 piston, and the exhaust valves on number 1 and 2 cylinders.

4. Turn the engine one revolution (360°) and adjust the intake valve on number 2, and the exhaust valve on number 3 cylinder.

Ignition Timing

1. Using a timing light, check the ignition timing:

Standard Vehicle	**5° ± 2°/900 rpm**
California Modification	**10° ± 2°/900 rpm**

NOTE

- Warm engine to operating temperature.
- Disconnect vacuum advance hose and plug before checking and adjusting timing. See Figure 1.
- Adjust idle speed to 900 rpm.

2. The ignition timing can be adjusted by loosening the retaining screw of the distributor flange and turning the distributor body. Retighten screw after proper timing has been set. See Figure 1.

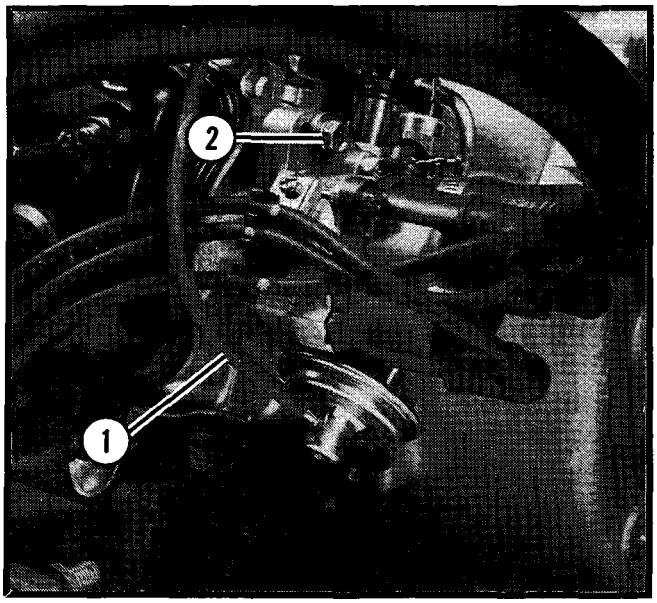


Figure 1.
1. Vacuum Advance Hose
2. Distributor Retaining Screw

NOTE

- When the distributor body is turned counter-clockwise, the ignition timing will be advanced, when the distributor body is turned clockwise, the ignition timing will be retarded.

3. After the adjustment has been completed, reconnect the vacuum hose to the vacuum advance. The engine revolution speed should rise about 50 to 100 rpm when the vacuum hose is reconnected.

Carburetor Adjustment

NOTE

- Warm engine to operating temperature.
- Do not perform the engine idling speed adjustment while the fan motor is running.
- Turn off all lights and any accessories.

1. **Idle mixture adjustment:**
   Remove plastic limitor. Turn idle mixture screw 3 1/2 turns open from the fully closed position. Adjust from there for smoothest running condition. See Figure 2.

2. **Idle speed adjustment:**
   Adjust idle by turning adjustment screw clockwise to increase idle rpm. See Figure 2.
   Idle rpm: 1000 – 1300 rpm Standard Vehicle
   1300 California Modification

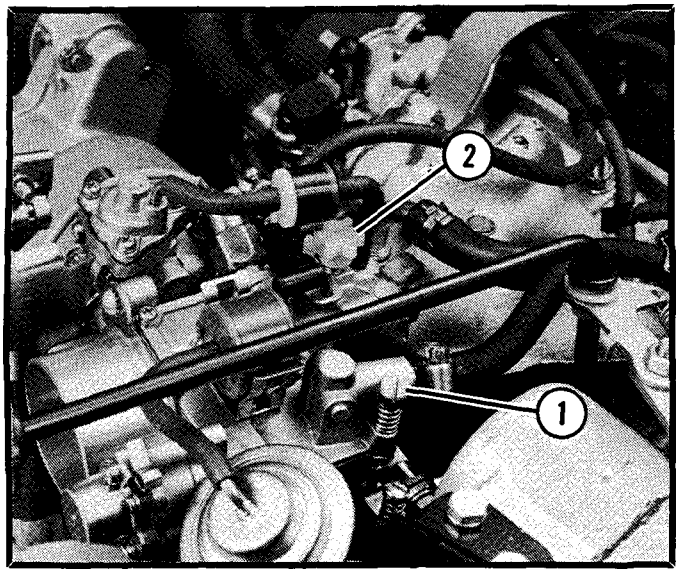


Figure 2.
1. Idle Speed Adjusting Screw
2. Idle Mixture Screw

Battery Servicing

1. Visually inspect the battery for the following:
   Corrosion
   Frayed or broken cables
   Cracked case or cell covers
   Low or overfilled liquid

SAFETY WARNING

- **Do not allow open flames or sparks near a battery when connecting for jump starting or while recharging the battery with a charger. Hydrogen gas is generated during the charging process and can be explosive. Provide adequate ventilation to prevent possible danger.**
- **UNTRAINED/UNAUTHORIZED persons should NEVER attempt to service or recharge the battery.**
- **Battery electrolyte is an acidic solution and should be handled with care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid immediately.**

2. Clean the battery top and terminals by washing with a solution of ammonia or baking soda. Keep vent plugs tight so that solution does not enter the cells. After washing, flush top of the battery with clean water.

3. Keep battery terminal connections tight and free from corrosion, If corroded, clean cable terminals and battery posts separately with a soda solution and a wire brush. Inspect cables for fraying or broken strands.

4. Keep the battery fully charged at all times. Check the state of charge at frequent intervals by making specific gravity readings with a battery hydrometer. Note that a hydrometer reading is not accurate if water has been added recently due to the fact that the water may not be mixed with the electrolyte.

NOTE

- DISCONNECT one of the battery leads before attaching battery charger to the battery.

Jump Starting With Booster Battery

Both booster and discharged battery should be treated carefully when using jumper cables. Follow **exactly the procedure outlined, being careful not to cause sparks.**

1. Set parking brake and put transmission in neutral. Turn off lights and other electrical loads.

2. Attach one end of one jumper cable to the positive terminal of the booster battery and the other end to the positive terminal of the discharged battery. **Do not permit the vehicles to touch each other.**

3. Attach one end of the remaining cable to the negative terminal of the booster battery and the other end to a good ground on the vehicle or engine **away from the discharged battery. Do not lean over the battery when making this connection.**

4. Reverse this sequence **exactly** when removing the jumper cables.

NOTE

- This is a negative ground wiring system, reversing battery connection will damage alternator rectifier.
- Booster batteries used for starting must be connected with proper polarity.
- Vehicle battery cables should be disconnected before using a "Fast Charger".

RECORD ALL MAINTENANCE PERFORMED ON YOUR VEHICLES IN THE CHART BELOW

Date	Vehicle Serial No.	Mechanic	Supervisor	Work Performed

Figure 3.

SECTION 3 ENGINE

Special tools required in this section:

- **Gasket Cutter**
  CU40001
- **Valve Guide Remover/Installer**
  CU40003
- **Valve Stem Seal Remover**
  CU40004
- **Valve Stem Seal Installer**
  CU40005
- **Cam Seal Installer**
  Cu40006
- **Piston Pin Remover/Installer**
  Cu40007

General Information

This is a liquid cooled, four stroke (cycle), overhead cam, constructed of cast iron block and aluminum head.

The engine serial number is stamped on the front of the cylinder block. See Figure 1.

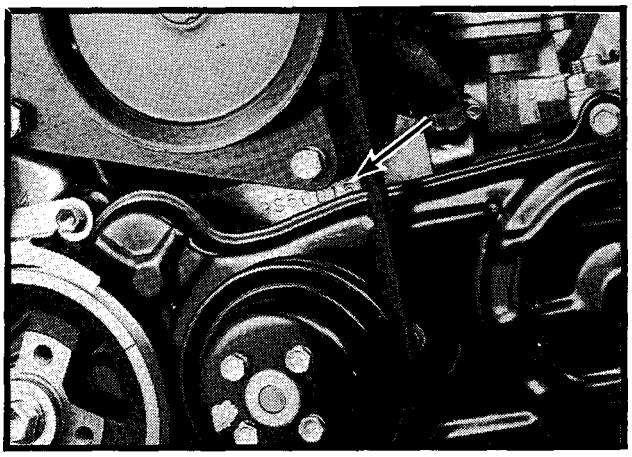


Figure 1.
Engine Serial Number

SAFETY WARNING

- **When replacement parts are required, use genuine Cushman parts or parts with equivalent characteristics including type, strength and material. Failure to do so may result in product malfunction and possible injury to the operator and/or bystanders.**

Disassembly

1. When parts are disassembled, make sure to put stamped marks or mate marks in order that the parts may be easily assembled in the correct original position.
2. Each time a part is removed, check if for evidence of distortion, breakage, wear, scores, etc.
3. Put disassembled parts in order for ease of reassemble.

Cleaning

If the part is to be reused, thoroughly clean and inspect.

Inspection and Measurement

Replace any parts that are defective or out of allowable limit.

Assembly

Be sure to use a torque wrench to tighten bolts or nuts to specified torque values. Use new gaskets, cotter pins, oil seals and similar items when reassembling engine.

SAFETY WARNING

- **Before starting service work, be sure to disconnect the negative wire from the battery. Accidental shorting of wires may occur while disconnecting engine wiring.**
- **Consider the hazards of the job at hand and wear protective gear such as safety glasses, safety shoes, etc. to provide adequate protection.**
- **When lifting the engine, make sure the device is fastened securely. Be sure the item to be lifted does not exceed the capacity of the lifting device.**
- **When working on an engine that is running, accidental contact with the hot exhaust manifold can cause severe burns.**
- **The cooling fan is thermostatically controlled and MAY start at any time. DO NOT attempt to service without disconnecting.**
- **ALWAYS make sure the engine is stopped and cool before removing the radiator cap. To prevent scalding by hot water, NEVER remove cap when the radiator is hot.**
- **The vehicle seat is a machinery guard. To avoid injury, use extreme caution and DO NOT place hands or clothing near moving parts (belts, fan, etc.)**

Engine

Removal

1. Drain antifreeze solution from radiator.

2. Drain oil from engine.

3. Remove coolant overflow bottle.

4. **Models with hydraulic system.**
Remove hydraulic pump from engine.

NOTE

- Do not remove or loosen hose connections at the hydraulic pump.

5. Disconnect the radiator hoses at the radiator. If a heater is part of your vehicle, disconnect any heater hoses connected to the engine. Plug hoses to prevent leakage.

6. Disconnect air cleaner inlet hose at the air cleaner.

7. Disconnect fuel supply and return lines at the fuel pump. Plug all fuel lines to prevent fuel spillage.

8. Disconnect throttle linkage at the engine bellcrank.

9. Disconnect the engine wire harness from the main harness near the rear of the engine. Disconnect the ignition resistor, coil, starter, radiator fan, and starter solenoid. Remove ground wire from the transmission. Remove battery positive cable from the starter solenoid.

10. Disconnect clutch safety switch return spring and unplug wiring from clutch safety switch. Remove clutch safety switch from transmission (2 screws).

11. Disconnect clutch linkage at clutch bell housing.

12. Disconnect transmission shift linkage at frame mounting and transmission mounting. Note position of hardware.

13. Remove muffler at manifold and emergency brake bracket.

14. Disconnect emergency brake cable at emergency brake bracket.

15. Attach hoist or lifting device to engine and apply upward pressure.

16. Unbolt transmission mounting at rear cross member.

17. Unbolt front cross member at frame. **Leave cross member mounted to the engine. It can be used as a stand for partial disassembly.**

18. Using a hoist or similar lifting device remove the engine with front cross member attached, and transmission as one unit .

19. Set engine in a secure place for disassembly.

20. Remove air cleaner and hose.

21. Disconnect governor linkage at carburetor connector link

22. Loosen alternator, and remove alternator belt, alternator, and governor.

23. Remove alternator-governor bracket from the engine.

24. Remove the transmission and emergency brake as one unit.

25. Remove the starter. Remove the clutch housing.

26. Remove the radiator hoses and drain all coolant from the engine.

Disassembly

1. Remove the water pump pulley, crankshaft pulley, timing belt cover, valve cover, and timing pointer and spacers. See Figure 2.

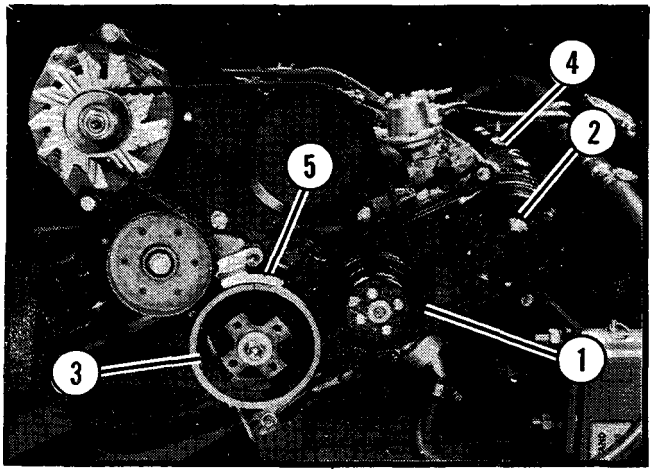


Figure 2.
1. Water Pump Pulley 3. Crankshaft Pulley
2. Timing Belt Cover 4. Valve Cover
5. Timing Pointer

2. Remove the fuel pump with push rod, carburetor, and intake manifold.

3. Remove the distributor, clutch, pressure plate, and flywheel.

4. Remove the exhaust manifold, water bypass pipe, and oil filter.

5. Loosen **all** valve tappet adjusting screws (intake and exhaust).

NOTE

- This must be done BEFORE removing the timing belt. The valves will be bent if the camshaft or crankshaft are turned after the belt is removed.

6. Remove the timing belt idler pulley and timing belt. See Figure 3.

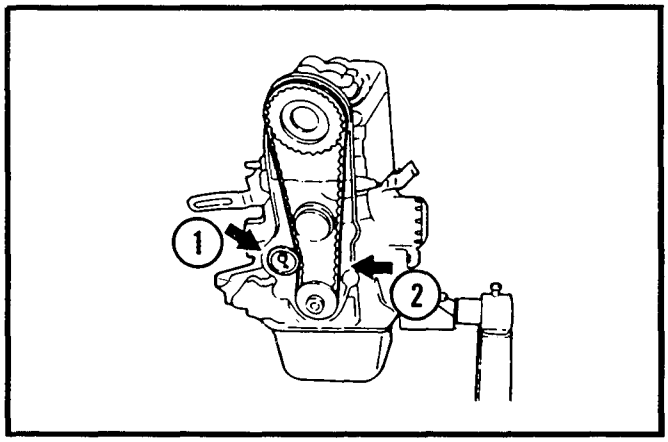


Figure 3.
1. Timing Belt Idler Pulley
2. Timing Belt

NOTE

- If the timing belt is in good condition and can be reused, keep it free of oil and water and do not allow it to kink or bend sharply.

7. Remove the camshaft pulley, and crankshaft timing belt pulley.

8. Remove the rear timing belt cover. See Figure 4.

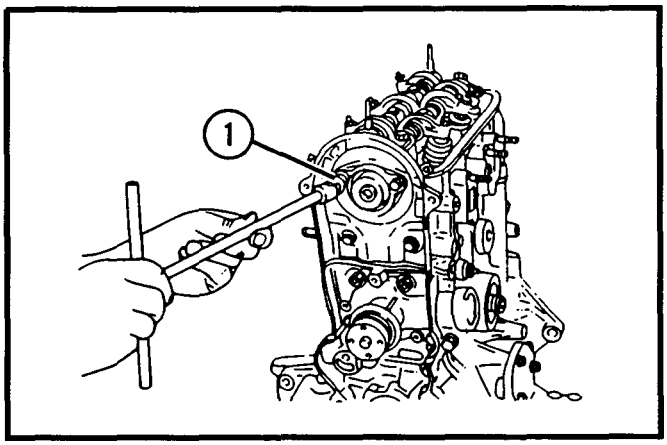


Figure 4.
Rear Timing Belt cover

9. Remove the cylinder head assembly.

NOTE

- Loosen the cylinder head bolts a little at a time in two or three steps, in the specified numerical sequence. See Figure 5.

- If this step is not followed the head may warp.

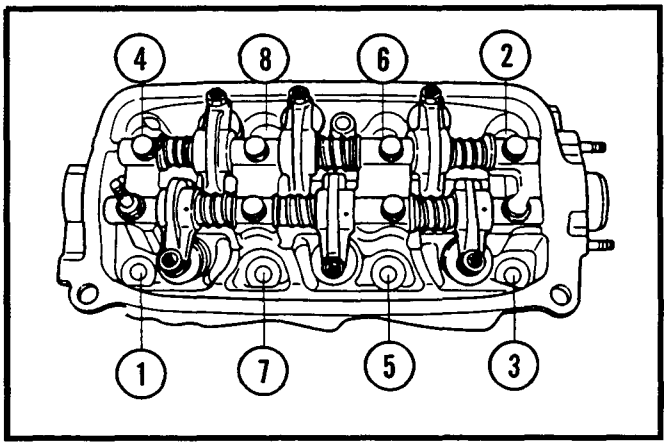


Figure 5.
Cylinder Head Removal

Disassembly of Cylinder Block

NOTE

- Before starting this section the cross member mounted to the engine must be removed.

1. Remove the water pump.

2. Remove the oil pan. After removing all screws and nuts use tool CU40001 to remove gasket material from the block. See Figure 6.

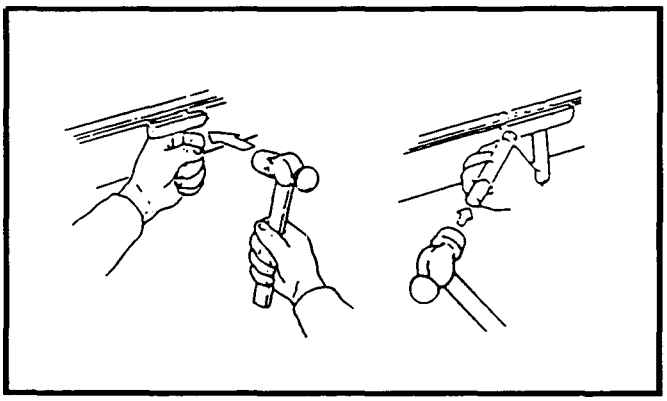


Figure 6.
Tool CU40001

3. Remove the oil strainer and oil pick-up tube.

4. Remove the oil pump, and front seal retainer.

5. Remove the connecting rod caps. Gently push the the connecting rod and piston assembly out the top of the block.

NOTE

- ASSEMBLY NOTE:
The piston, rings, piston pin, connecting rod and rod cap must be maintained as a set for the cylinder from which they were removed. Mark each set (No. 1, No. 2, and No. 3) as it is removed from the block.

6. Remove the crankshaft bearing caps.

NOTE

- ASSEMBLY NOTE;
The bearing caps are marked No. 1, No. 2 and No. 3. They must be returned to the same position in the block that they were removed from. The bearing caps are also marked with an arrow that is to face the front of the engine. See Figure 7.

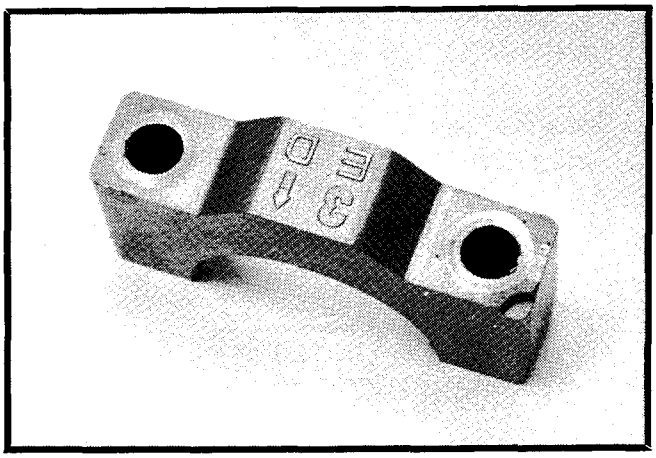


Figure 7.
Bearing Cap Arrow and Number Stamp

7. Remove the engine crankshaft.

8. Clean all parts thoroughly.

Cylinder Block Inspection

1. **Crankshaft**
Measure crankshaft main journal and crank pin diameters.
Main journal, Std.: 1.8101 to 1.8110 inch (45.976 to 46.00 mm)
Main journal undersize: 1.8005 to 1.8009 inch (45.732 to 45.742 mm)
Crank pin, Std.: 1.5739 to 1.5748 inch (39.976 to 40.00 mm)
Crank pin undersize: 1.5613 to 1.5646 inch (39.732 to 39.742 mm)

2. Inspect the main and crankpin journals of the crankshaft for damage or uneven wear (out-of-roundness and taper). See Figure 8.
Uneven wear (out of roundness and taper limit): 0.0008 inch (0.02 mm)

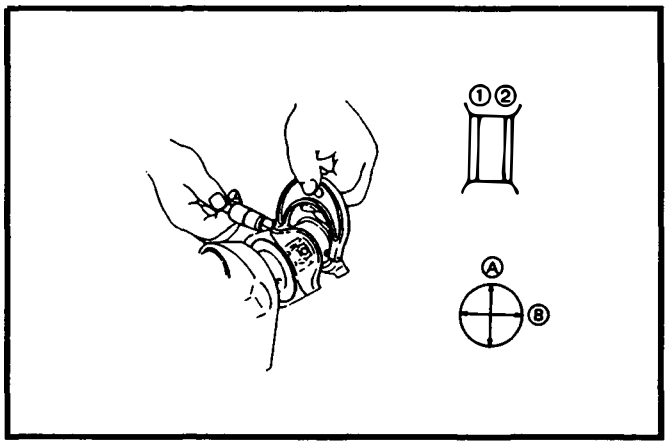


Figure 8.
Journal Check

3. Check the crankshaft and connecting rod bearing oil clearance . Install new bearings. Install new thrust washers. Lay the crankshaft into the cylinder block. Lay a strip of plastigage across the journal and pin, but not over the oil hole. See Figure 9.

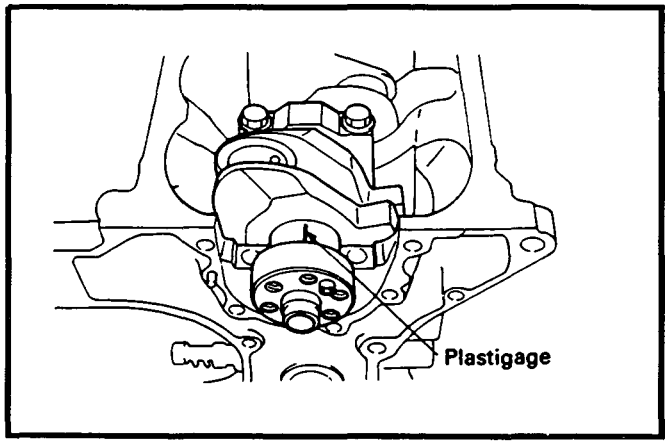


Figure 9.
Oil Clearance Measurement

4. Tighten the crankshaft bearing cap bolts to specific torque.
   Tightening torque:
   Crankshaft bearing cap
   39 to 48 ft lbs (53 to 65 N·m)
   Connecting rod bearing cap
   15 to 21 ft lbs (20 to 28 N·m)

5. Remove the bearing cap. Measure the plastigage at its widest point. If the clearance is not within specification, replace the bearings.
   Oil clearance (crankshaft journal and wrist pin journal):
   0.0008 to 0.0028 inch (0.020 to 0.07 mm)

6. With the bearing caps removed, check the crankshaft thrust clearance. If the clearance exceeds the limits, replace the thrust washer.
   Thrust clearance:
   0.0007 to 0.0118 inch (0.022 to 0.30 mm)

7. Remove the crankshaft, crankshaft bearings and thrust washers.

8. Check the cylinder block for cracks, damage, and distortion. See Figure 10.
   Distortion Limit: 0.0031 inch (0.08 mm)

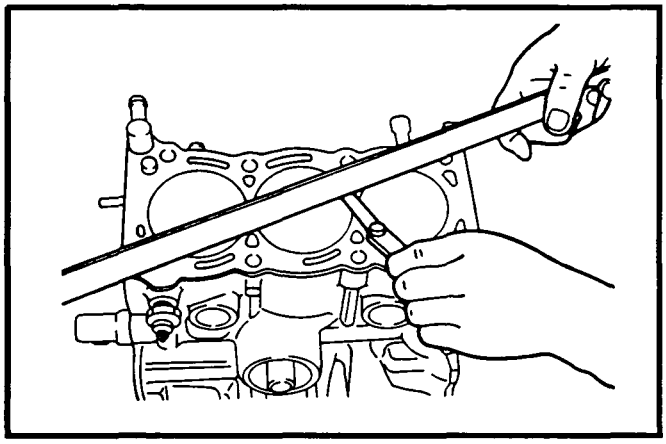


Figure 10.
Cylinder Block Check

9. If the cylinder block must be re-surfaced, a height of **9.2835 inches (235.8 mm)** must be maintained. SeeFigure 11.

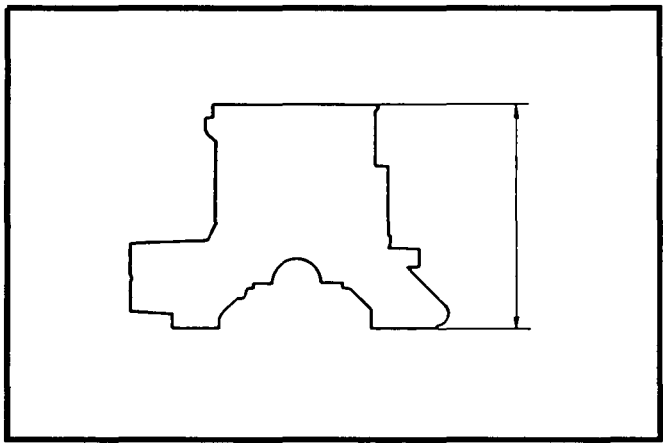


Figure 11.
Cylinder Block Height

10. Check the piston-to-piston pin oil clearance. See Figure 12.
    Allowable limit:
    0.0002 to 0.0020 inch (0.005 to 0.05 mm)

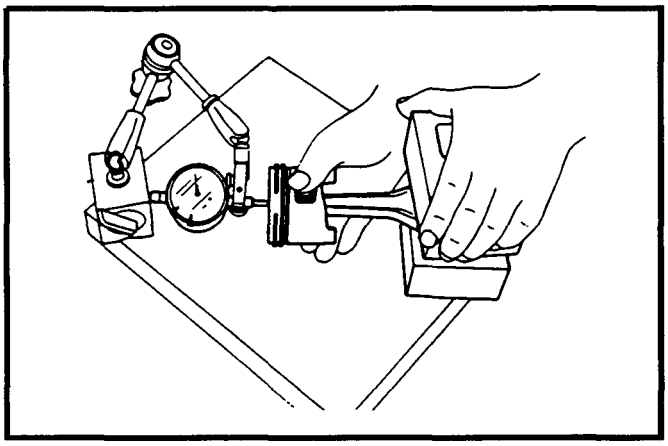


Figure 12.
Oil Clearance Check

11. Remove the piston pin using tool CU40007. See Figure 13.

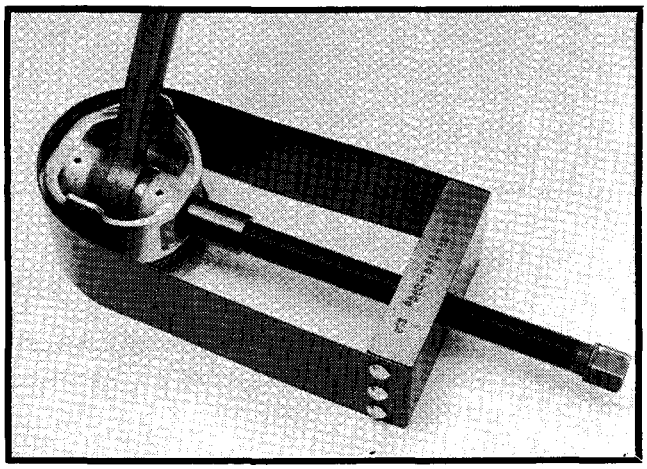


Figure 13.
Piston Pin Removal

12. Check the cylinder-to-piston clearance. Measure the cylinder bores in axial and thrust directions at the top, middle and bottom. See Figure 14.
    Standard Bore: 2.6220 to 2.6232 inches (66.60 to 66.63 mm)
    Limit (Difference between Max. dia. and Min. Dia.): 0.0039 inch (0.1 mm)
    Out of roundness and taper: 0.0012 inch (0.03 mm)

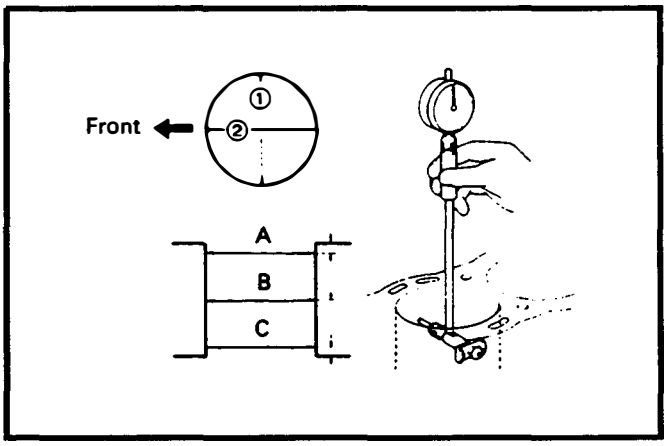


Figure 14.
1. Axial Direction
2. Thrust Direction

13. Measure the piston diameter in the thrust direction. Calculate the cylinder-to-piston clearance. See Figure 15.
    Piston clearance: 0.0014 to 0.0043 inch (0.035 to 0.11mm)

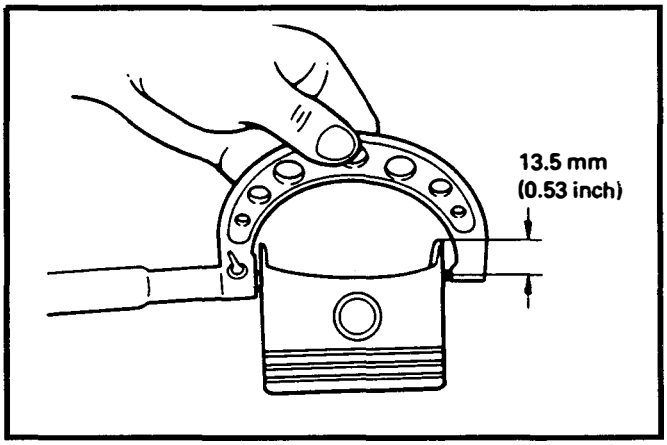


Figure 15.
Piston Diameter Measurement

14. If these specifications are not met the cylinder must be bored oversized and oversized pistons, and rings used for assembly.

O/S Boring Dimensions for Cylinder Block

Oversize	Cylinder Block
0.25 mm	2.6319 inches to 2.6331 inches
0.50 mm	2.6417 inches to 2.6429 inches
0.75 mm	2.6516 inches to 2.6528 inches
1.00 mm	2.6614 inches to 2.6626 inches

15. Check the piston ring gaps. See Figure 16.

No. 1 ring	**0.0098 to 0.0256 inch (0.25 to 0.65 mm)**
No. 2 ring	**0.0079 to 0.0138 inch (0.20 to 0.80 mm)**
Oil ring	**0.0079 to 0.0394 (0.20 to 1.00 mm)**

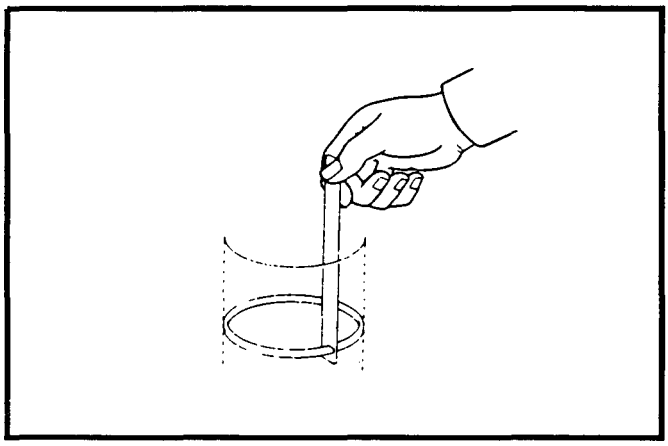


Figure 16.
End Gap Measurement

16. Check the No.1 and No.2 ring side clearances. See Figure 17.

Side Clearance:	**inch (mm)**
No. 1 ring	**0.0012 to 0.0047 (0.03 to 0.12)**
No. 2 ring	**0.0008 to 0.0043 (0.02 to 0.11)**

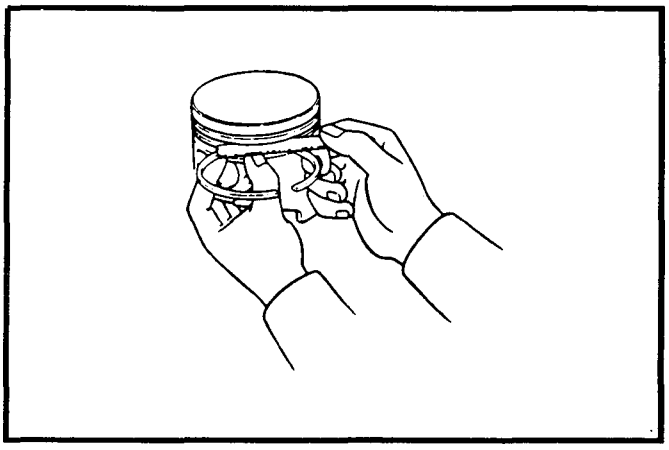


Figure 17.
Side Clearance Measurement

17. Check the connecting rod for twisting and bending, while clamping the large end. See Figure 18.

Twist limit:	**0.0020 inch (0.05 mm)**
Bend limit:	**0.0020 inch (0.05 mm)**

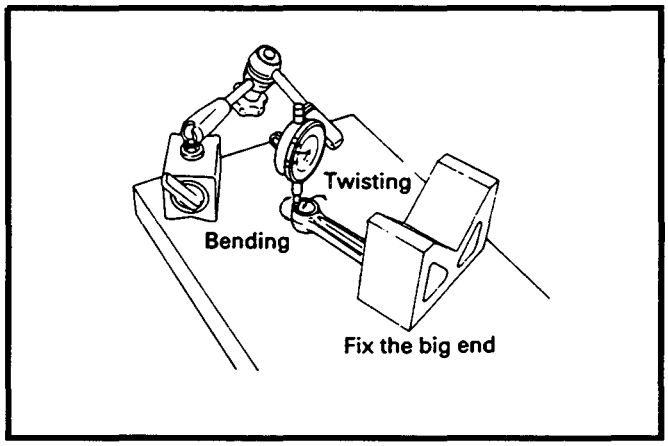


Figure 18.
Twisting and Bending Check

18. Check the crankshaft for bending at the No. 3 main journal. See Figure 19.
Allowable limit: 0.0012 inch (0.03 mm)

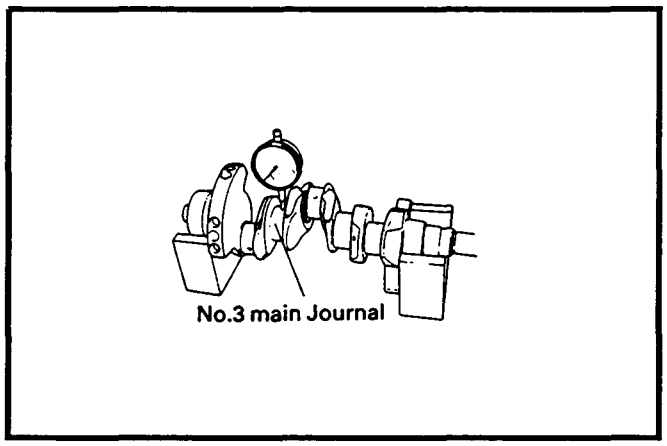


Figure 19.
Run-out Measurement

19. Check the crankshaft timing belt pulley for wear. See Figure 20.
Allowable limits:
2.151 to 2.158 in. (54.64 to 54.80 mm)

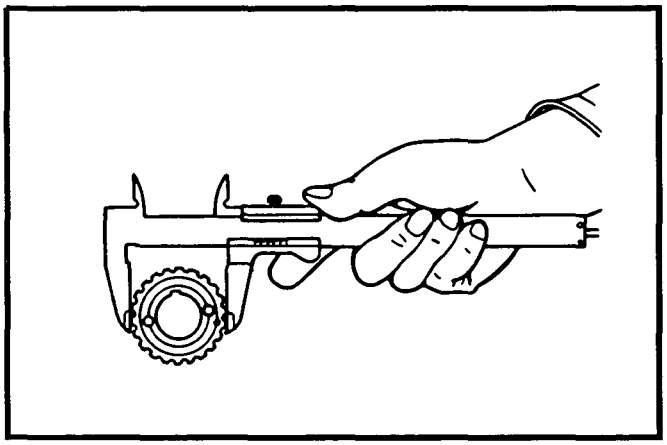


Figure 20.
Crankshaft Timing Belt Pulley Check

Cylinder Block Assembly

1. Install the crankshaft upper bearings into the block. Apply a small amount of assembly grease to the bearing surface.

2. Install the crankshaft thrust washers.

3. Install the crankshaft.

4. Install the crankshaft bearing cap with crankshaft lower bearings. Apply a small amount of assembly grease to the threaded portion of each mounting bolt. Install the bearing cap with its front mark facing toward the front side. Torque bearing caps in sequence shown. See Figure 21.
   Bearing cap mounting screw torque:
   39 to 48 ft lbs (53 to 65 N·m)

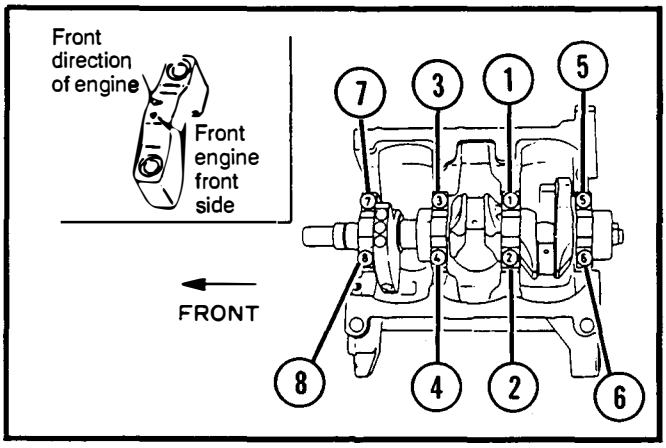


Figure 21.
Bearing Cap Installation

5. Prepare the connecting rod and piston for assembly. The top of the piston has an arrow that must face the same direction as the front mark on the connecting rod. See Figure 22.

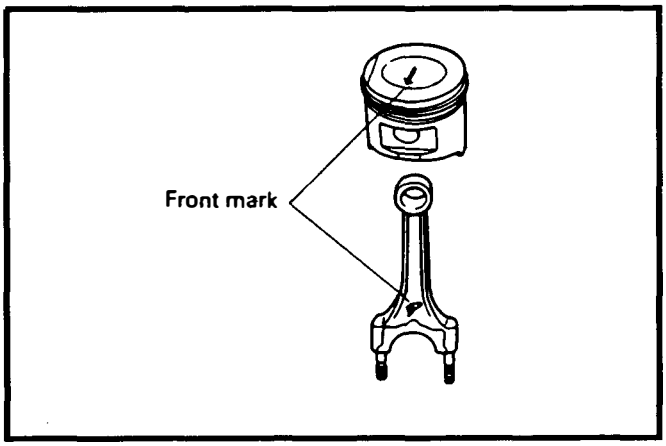


Figure 22.
Front Marks

6. Assemble the connecting rod and piston, using tool CU40007. Coat the piston pin with a film of engine oil. See Figure 23.

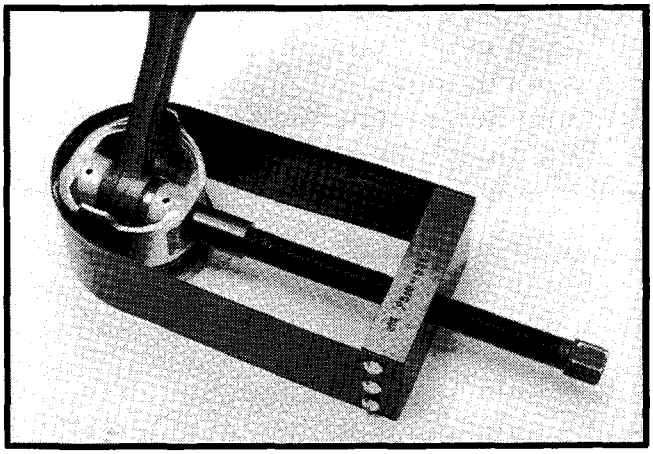


Figure 23.
Tool CU40007

NOTE

- After the piston pin has been assembled in the piston, ensure that the piston can pivot easily on the rod.

7. Assemble the piston oil expander and rail rings by hand.

8. Install the piston ring No. 1 and 2 using a ring expander.

NOTE

- Make sure that the stamped marks "T" or "N" are on the top side. See Figure 24.

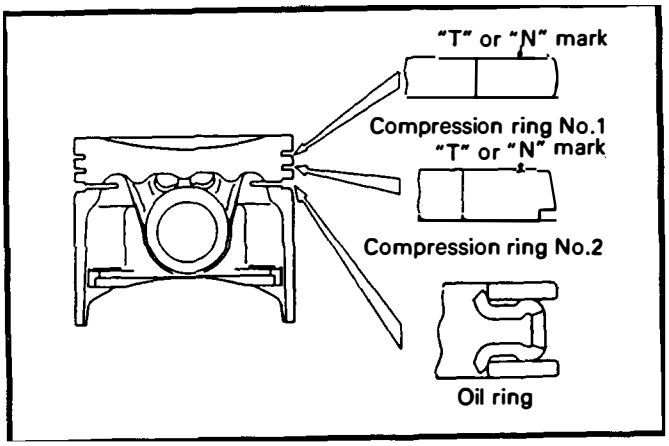


Figure 24.
Piston Ring Installation

9. Place the ends of each piston ring at the respective positions as indicated in Figure 25.

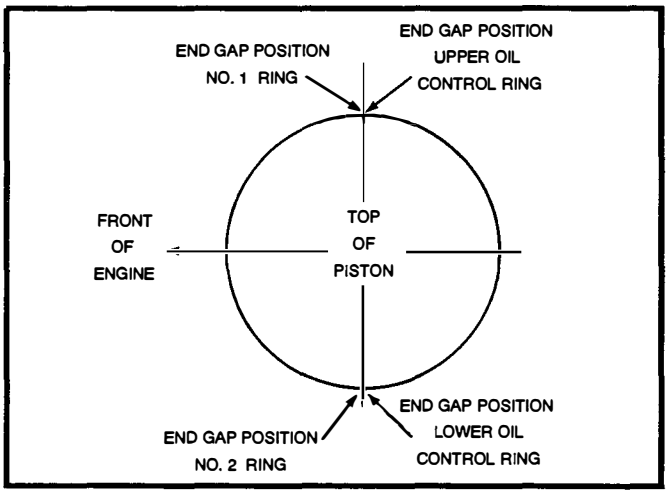


Figure 25.
Piston Ring Positions

10. Apply engine oil to the cylinder wall, the piston's outer surface and the inner surface of each bearing. Using a ring compressor, install the piston and connecting rod into the cylinder bore, making sure that the front marks point to the front of the engine.
11. Apply assembly grease to the inner surface of the bearing (the sliding surface relative to the crankshaft journal) as well as to the nut seating surface. Then, install the connecting rod cap with its front mark facing toward the front side. After each connecting rod has been installed, ensure that the crankshaft turns freely. See Figure 26.
    Torque: **17 to 22 ft lbs (23 to 30 N·m)**

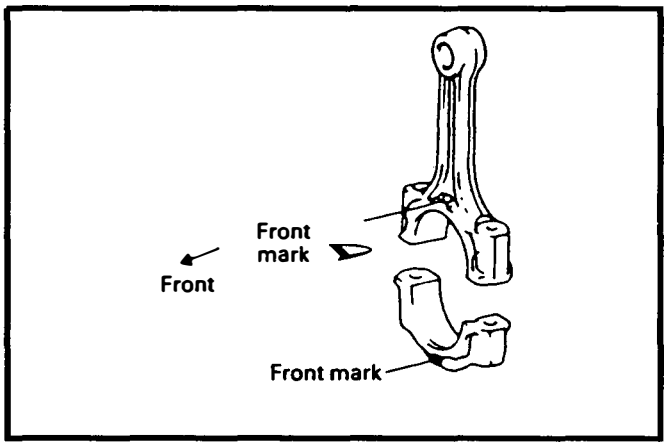


Figure 26.
Front Marks

12. Install the oil pump assembly.
    Torque: **7 to 11 ft lbs (9.5 to 15 N·m)**
13. Install rear oil seal retainer.
    Torque: **11 to 17 ft lbs (15 to 23 N·m)**
14. Install the oil strainer and pickup tube.
    Torque: **5 to 7 ft lbs (7 to 10 N·m)**
15. Install the oil pan assembly using Permatex, **Ultra Blue #77C** material. Apply according to Figure 27.
    Torque: **5 to 7 ft lbs (7 to 10 N·m)**

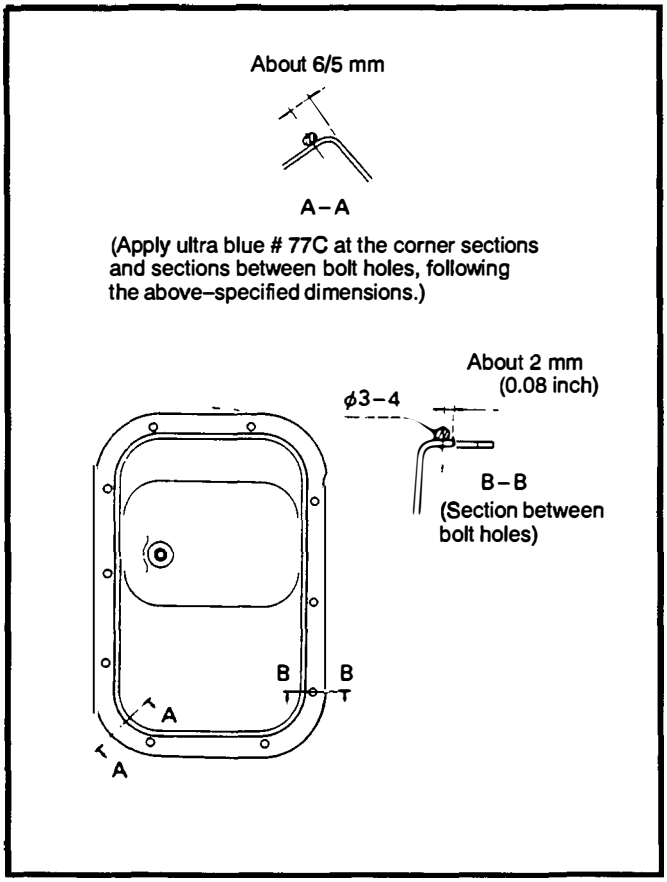


Figure 27.
Oil Pan Installation

16. Install the water pump assembly.
Torque: 11 to 17 ft lbs (15 to 23 N·m)

Cylinder Head Disassembly

1. Remove the valve rocker shafts.

2. Remove the flange bolt for the camshaft thrust ring. See Figure 28.

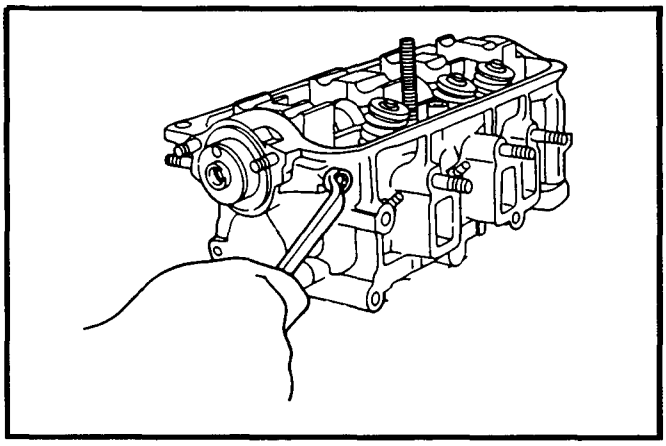


Figure 28.
Flange Bolt

3. Remove the camshaft, using a wooden dowel at the rear end of the camshaft.

4. Using a valve spring compressor, remove the valves.

5. Remove the spark plugs.

6. Using tool CU40004 remove the valve stem oil seals. See Figure 29.

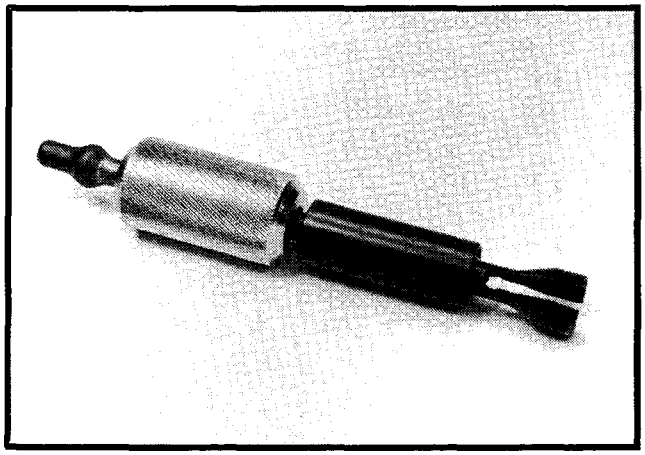


Figure 29.
Tool CU40004

Inspection of Cylinder Head

NOTE

- Thoroughly clean the head and all related parts. All carbon, and dirt must be removed before proper inspection can be performed

1. Thoroughly check the cylinder head for crack or damage. Measure the cylinder head surface for distortion. **Allowable limit: 0.004 inch (0.1 mm).** See Figure 30.

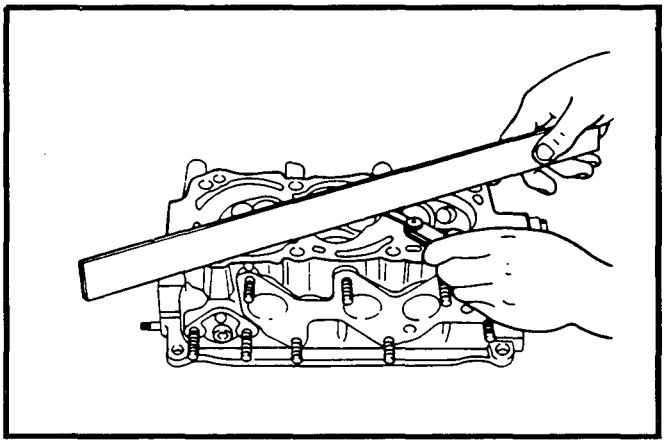


Figure 30.
Cylinder Head Check

2. If the cylinder head must be re-surfaced, a minimum height of **3.929 inches (99.8 mm)** must be maintained. See Figure 31.

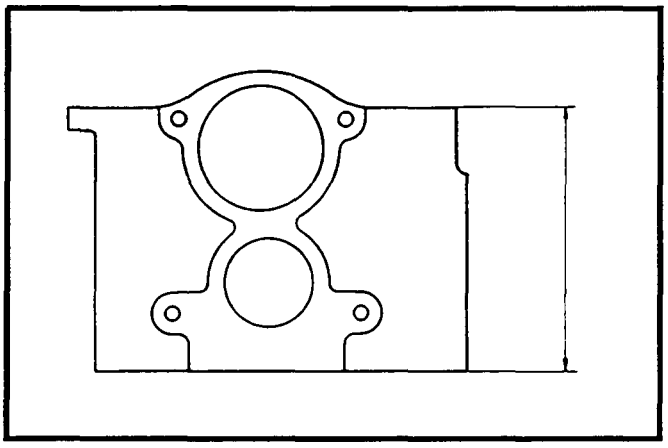


Figure 31.
Cylinder Head Grinding Tolerance
3.929 inches (99.8 mm)

3. Measure the distortion of the intake and exhaust manifold mounting surface. **Allowable limit: 0.004 inch (0.1 mm).** See Figure 32.

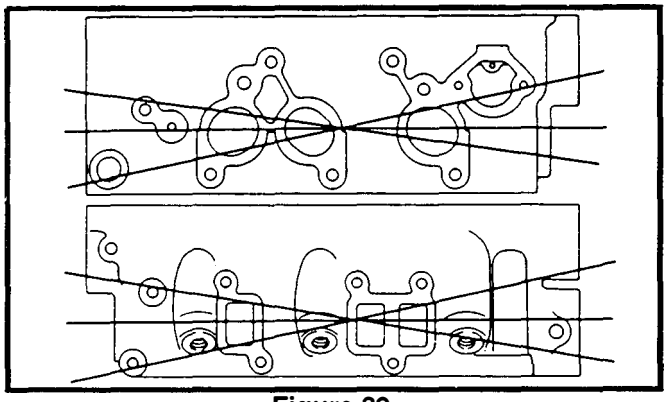


Figure 32.
Manifold Check

4. Measure the inside diameter of the valve guide for wear. **Allowable limit: 0.2774 inch (7.045 mm) for both intake and exhaust valve guides.** See Figure 33.

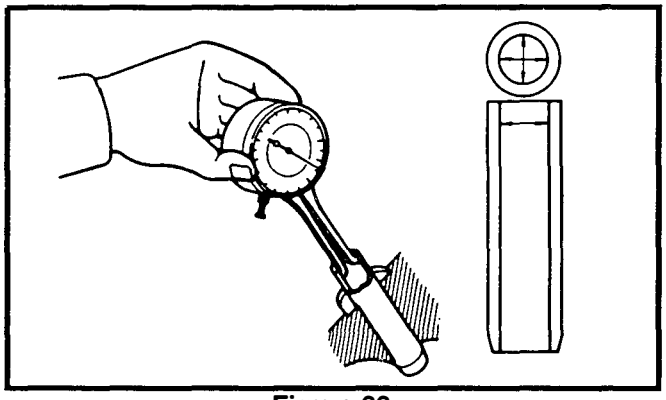


Figure 33.
Valve Guide Check

5. If the valve guide measurement is more than .02774 inch (7.045 mm) the valve guide must be replaced. Use tool number CU40003 and drive the valve guide out from the top side. See Figure 34.

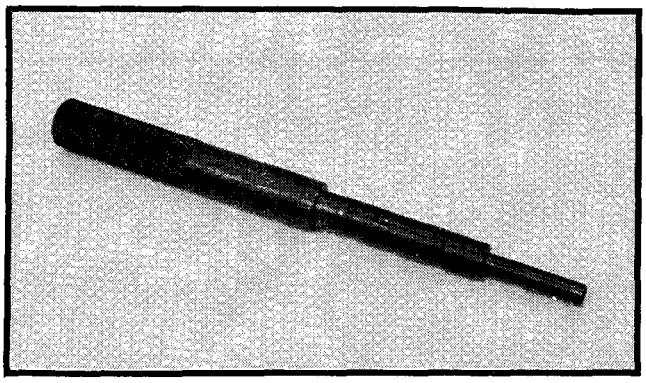


Figure 34.
Tool CU40003

NOTE

- The valve guides may be replaced only once.
- The original valve guide has no stop ring. The replacement valve guide has a stop ring that positions the valve guide at a depth of 0.598 to 0.622 inch (15.2 to 15.8 mm).
- Be sure to install an oversized, .0012 inch (0.03 mm), valve guide for replacement.

6. Install new valve guide using tool CU40003. See Figure 34.

Valve Inspection:

1. Measure the valve stem outer diameter.
   Allowable limits:
   Intake: .2732 to .2746 in. (6.940 to 6.975 mm)
   Exhaust: .2730 to .2744 in. (6.935 to 6.970 mm)

2. Check the width of the contact surface of the valve. See Figure 35.
   Allowable limits:
   Contact width: .0472 to .0910 inch (1.2 to 2.3 mm)

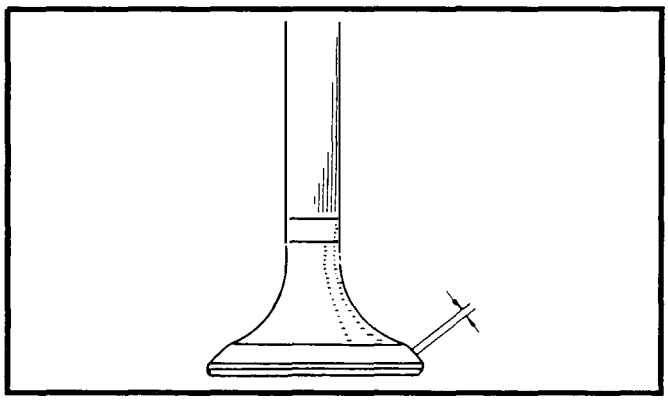


Figure 35.
Valve Contact Width Check

3. Check the valve head margin. See Figure 36.
   Allowable limits:
   Intake: .0354 to .0551 inch (0.9 to 1.4 mm)
   Exhaust: .0433 to .0669 inch (1.1 to 1.7 mm)

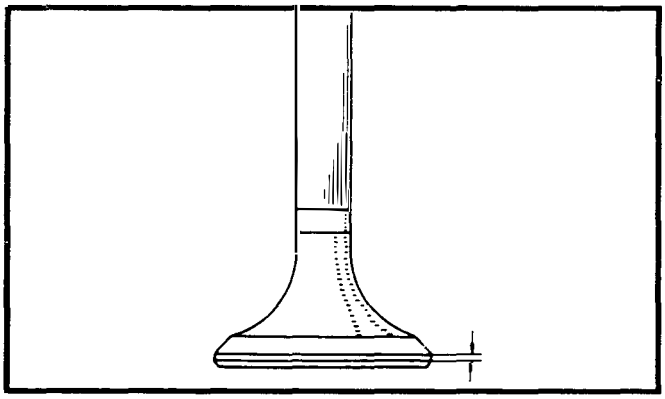


Figure 36.
Valve Head Margin Check

4. Check the valve stem head for wear. See Figure 37.
   Allowable limit: .008 inch (0.22 mm)

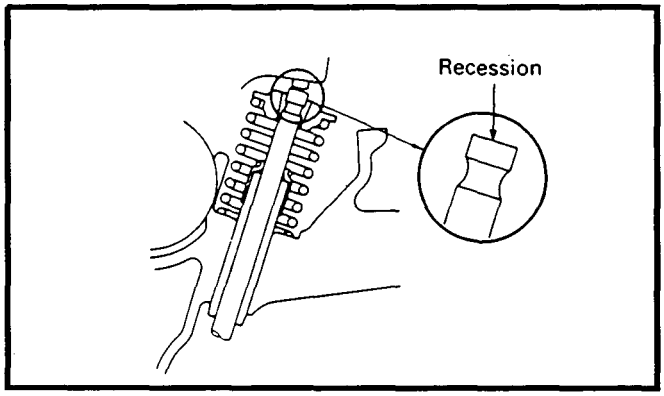


Figure 37.
Wear Check

5. Inspect the valve seats for cracks, burns, pitting, ridges or improper angle. If any of these conditions are noted, the seats must be re-ground. **The valve seats are not replaceable.**

6. The valve seat re-face operation should be performed as follows: See Figure 38.
   First, use a 45° cutter to smooth seat surface.
   Next use a 30° cutter (20° cutter for the exhaust valve seat) **or** a 70° so the seat face area contacts the center of the valve face and the contact width becomes the specified value at this point.
   Last, lap the valves using a valve grinding compound.
   Valve seat width:
   Intake and Exhaust
   .047 to .063 in (1.2 to 1.6 mm)

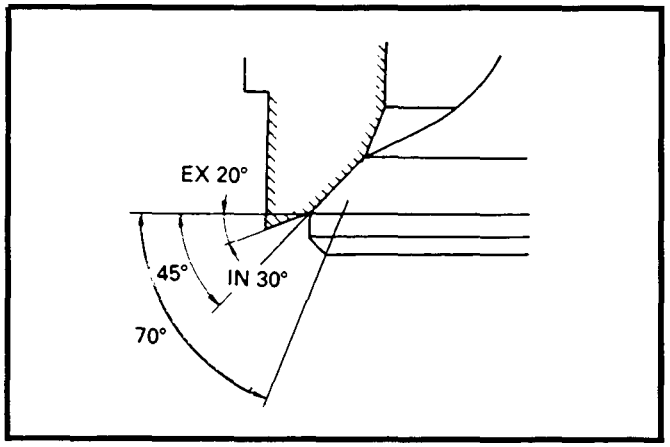


Figure 38.
Valve Grinding Operation

7. Check the valve spring squareness with a square and measure the free length. See Figure 39.
   Squareness limit: .0629 inch (1.6 mm)
   Free length limit: 1.7441 inch (44.3 mm)

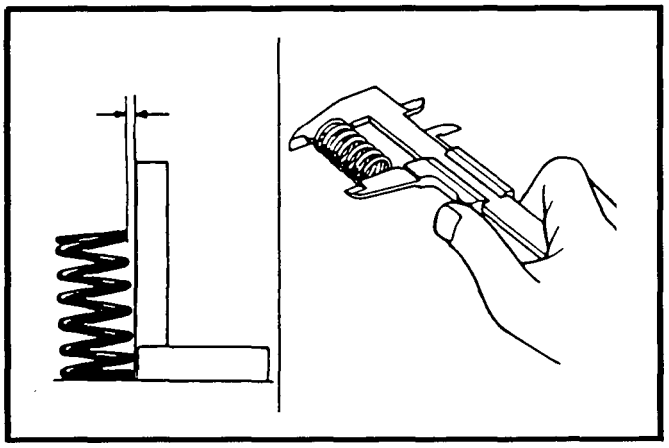


Figure 39.
Valve Spring Check

8. Using a spring tester, measure the spring tension at the specified installed length.
   Installed length: 1.4961 inch (38.0 mm)
   Installed load: 50.7 to 64.8 lb
   (23.0 to 29.4 kg)

9. Check the rocker arm-to-shaft clearance. See Figure 40.
   Arm inner diameter: .6299 to .6313 inch
   (16.000 to 16.035 mm)
   Shaft outer diameter: .6281 to .6294 inch
   (15.955 to 15.988 mm)

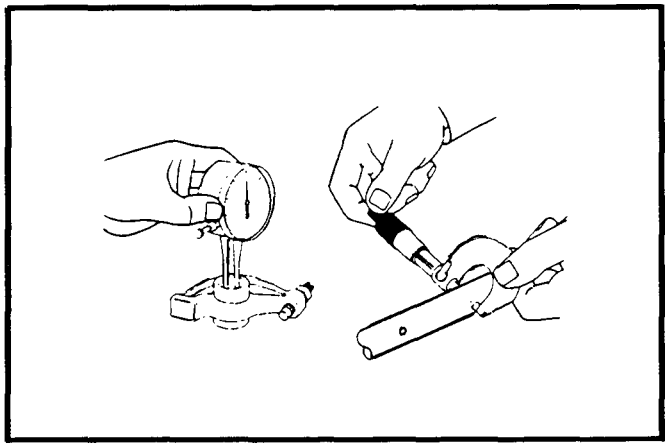


Figure 40.
Rocker Arm and Shaft Check

Camshaft Inspection

1. Measure the cam lobe height.
   Allowable limits:
   Intake: 1.3701 to 1.3807 inch (34.80 to 35.07 mm)
   Exhaust: 1.3681 to 1.3783 inch (34.75 to 35.01 mm)

2. Measure the camshaft for bending. See Figure 41.
   Bend limit: 0.0018 inch (0.03mm)
   (Measure the run-out, and calculate the bend amount)

3. Measure the camshaft-to-cylinder head bearing clearance. See Figure 42.

	Cam Journal	Head Bearing	Clearance
Front	1.6709 to 1.6717 inch (42.44 to 42.46 mm)	1.6732 to 1.6742 inch (42.500 to 42.525 mm)	0.0016 to 0.0051 inch (0.04 to 0.13 mm)
Center	1.6512 to 1.6520 inch (41.94 to 41.96 mm)	1.6535 to 1.6152 inch (42.000 41.025 mm)	0.0016 to 0.0051 inch (0.04 to 0.13 mm)
Rear	1.1787 to 1.1795 inch (29.94 to 29.96 mm)	1.1811 to 1.1819 inch (30.000 to 30.021 mm)	0.0016 to 0.0047 inch (0.04 to 0.12 mm)

Figure 42.

4. Check the camshaft timing belt pulley for wear. SeeFigure 43.
   Allowable limits:
   4.353 to 4.363 in. (110.57 to 110.81 mm)

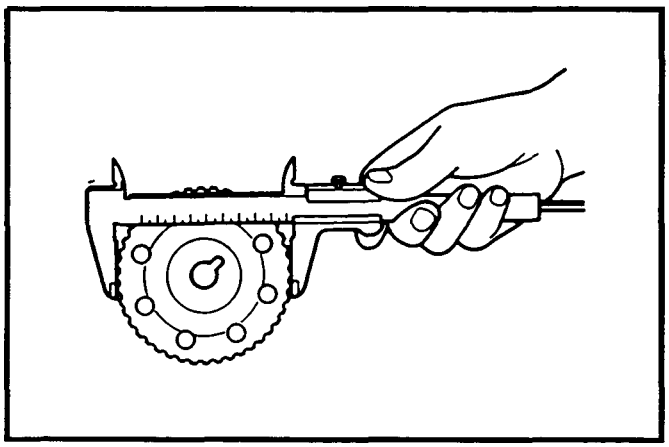


Figure 43.
Camshaft Timing Belt Pulley Check

Assembly of The Head

NOTE

- All parts must be clean and all carbon deposits removed from the head.
- All worn or damaged parts must be replaced.

1. Install the new valve stem oil seal using tool CU40005. See Figure 44.

NOTE

- Apply engine oil to the inner surface and lip section of the valve stem oil seal and to the valve stem.

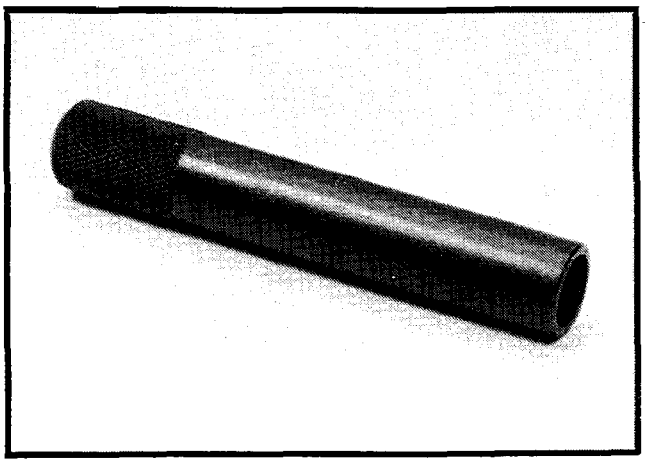


Figure 44.
Valve Stem Oil Seal Installation

2. Using a valve spring compressor, assemble the valve, valve spring, spring retainer and spring locks.

NOTE

- The valve spring coils are closer together on the bottom than on the top. Ensure that they are installed with the closer coils on the bottom. (Normally the top of the spring will be painted) See Figure 45.

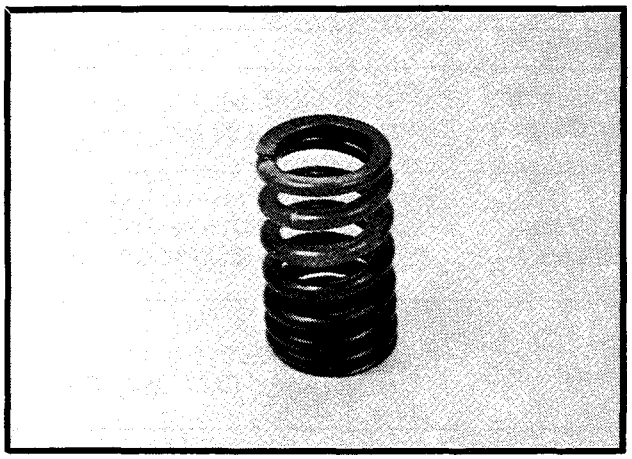


Figure 45.
Valve Spring

3. Insert the camshaft into the cylinder head.

4. Install the thrust ring. Align the flange bolt installing hole of the camshaft thrust ring and flange bolt hole of the cylinder block. Insert the thrust ring and temporarily tighten. See Figure 46. (Make sure that the flange bolt gasket is installed.)
   Torque: 10 to 15 ft lbs (7 to 11 N·m)

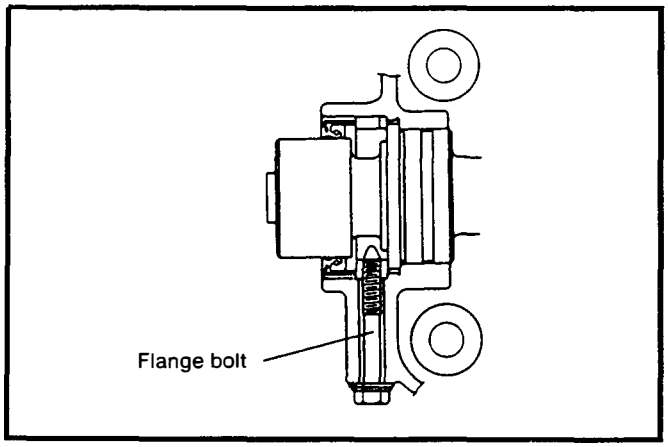


Figure 46.
Thrust Ring Installation

5. Apply engine oil to the lip portion of the camshaft oil seal, and drive the oil seal into position using tool CU40006. See Figure 47.

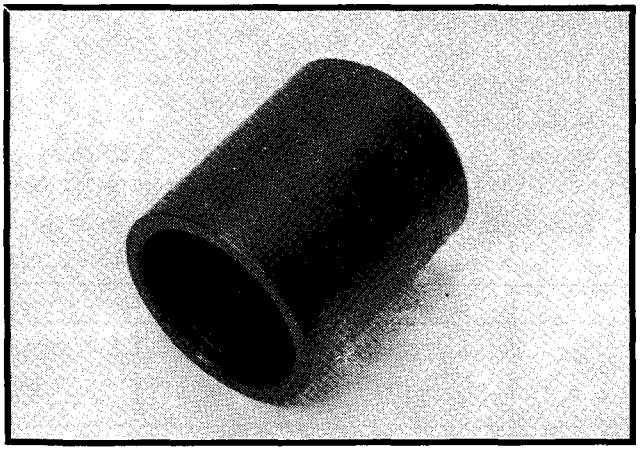


Figure 47.
Tool CU40006

NOTE

- The camshaft oil seal must fit flush with the surface of the head.

6. Assemble the valve rocker arm shaft and related parts. Apply engine oil to the valve rocker arm inner surface pad surface and valve contact position of the valve adjusting screw. Then assemble the plate washer, compression spring and valve rocker arm to the valve rocker shaft.
   Torque for valve rocker shaft:
   12.2 to 18.2 ft. lbs (16.3 to 24.4 N·m)

NOTE

- It should be noted that the rocker arm positioning for the intake side differs from that for the exhaust side. Be sure the valve rocker arm and plate is assembled correctly for each side. See Figure 48.
- DO NOT adjust the valves at this time.
- If valves are adjusted before the timing belt is installed you may bend a valve stem.

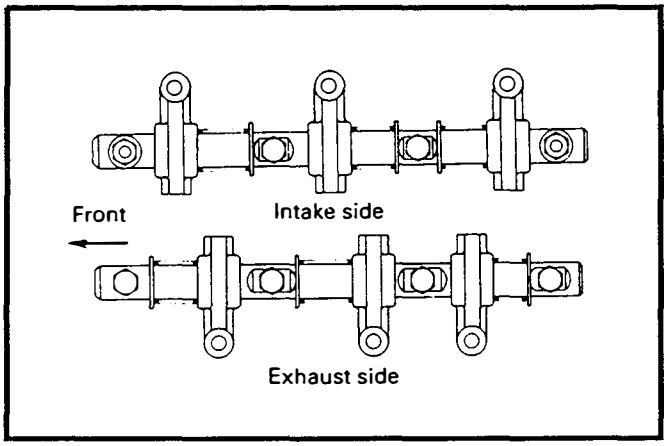


Figure 48.
Rocker Shaft Installation

7. Install the cylinder head gasket. Ensure that all holes in the cylinder block are open and not covered by the head gasket.

8. Install the cylinder head. Apply a light coating of engine oil on the bolt threads and under the bolt heads. Tighten the cylinder head bolts in the sequence as indicated in Figure 49. evenly and progressively in 2 or 3 steps.
   Torque: 36 to 43 ft lbs (49 to 58 N·m)

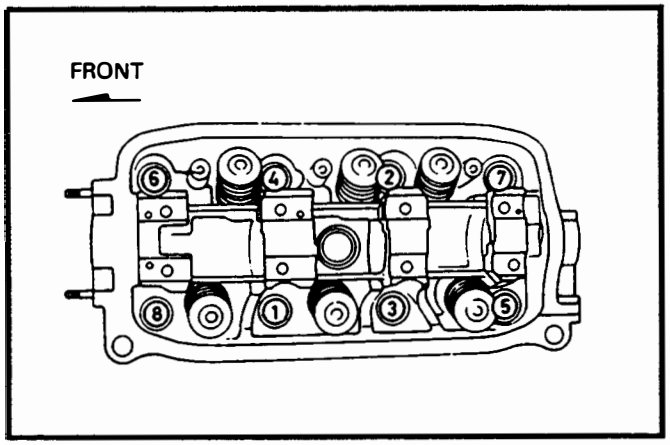


Figure 49.
Cylinder Head Bolt Torque

Assembly of Front Parts

1. Install the oil seal plate over the front camshaft seal. Install the rear timing belt cover with grommet onto the head assembly. See Figure 50.
   Torque: 63 to 94 in lbs (7 to 11 N·m)

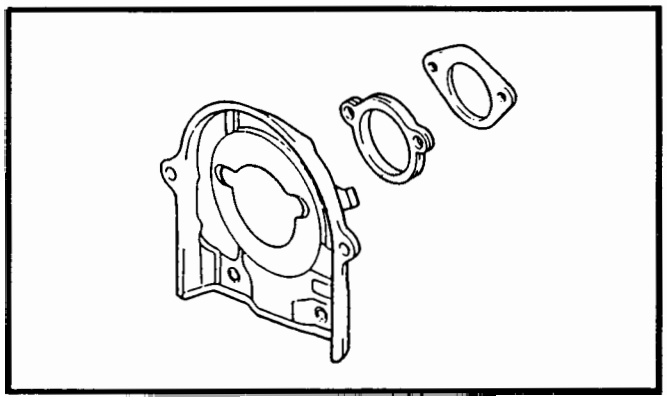


Figure 50.
Rear Timing Belt Cover

2. Install the camshaft pulley. Align the knock pin in the plate washer with the hole in the camshaft pulley. See Figure 51.

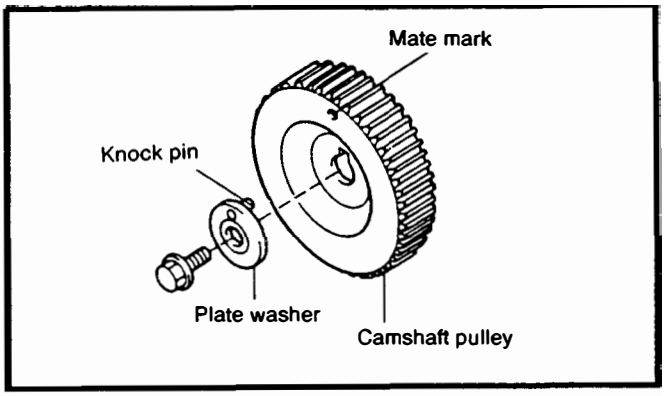


Figure 51.
Camshaft Pulley Installation

3. Install the crankshaft inner flange and crankshaft timing belt pulley, and outer flange.

NOTE

- Be sure to install the crankshaft timing belt pulley so the "F" mark stamped on the pulley is to the front. See Figure 52.

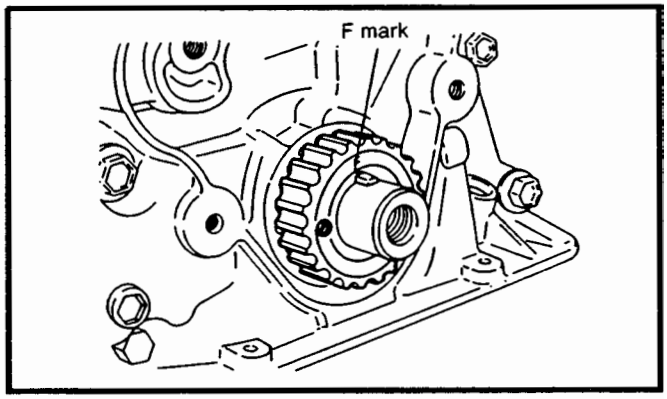


Figure 52.
Crankshaft Pulley Installation

Timing Belt Installation

NOTE

- To prevent valve damage when turning the camshaft or crankshaft, the valve tappet adjustment screws must be loosened completely.
- The timing belt tensioner must not be installed.
- Be careful not to kink the timing belt.
- The timing belt is to be kept completely free from oil and water.

1. Align the cut-off section of rear timing belt cover and the camshaft pulley timing mark. See Figure 53.

2. Align the timing mark on the crankshaft pulley with the timing mark on the oil pump case. See Figure 53.

3. The timing marks on the belt must be aligned with the marks on the respective pulley and the marks on the timing cover and oil pump case. See Figure 53.

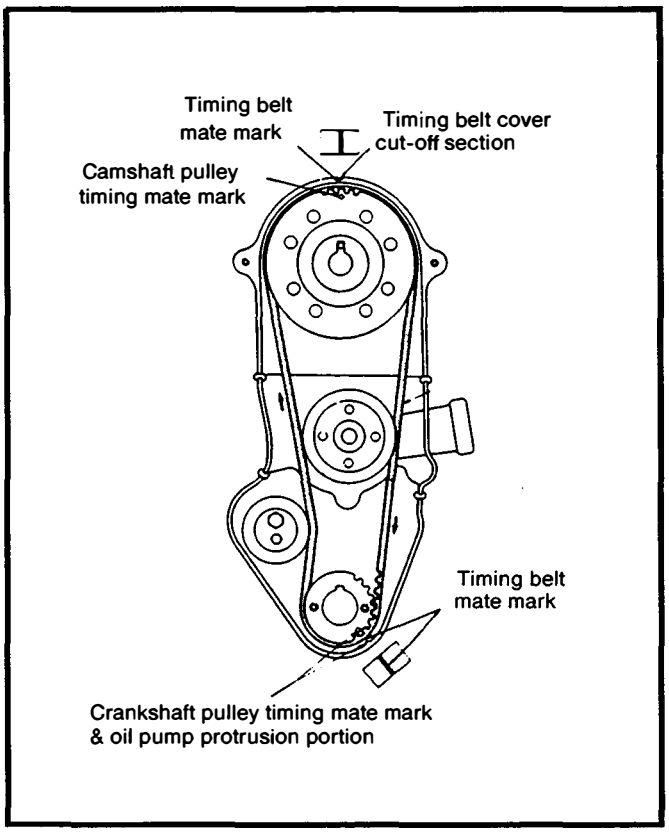


Figure 53.
Timing Belt Installation

Timing Belt Adjustment

1. Install the timing belt tensioner. **Do not tighten the mounting bolt.**

2. Remove the plastic cap installed in the oil pump body.

3. Install a M6 screw (pitch: 1mm, 20 to 30 mm in length) into the place where the plastic cap was removed. Tighten the screw using only thumb and index finger pressure. See Figure 54.

NOTE

- To protect the surface of the timing belt tensioner pulley place a feeler gauge between the screw and the pulley surface. See Figure 54.

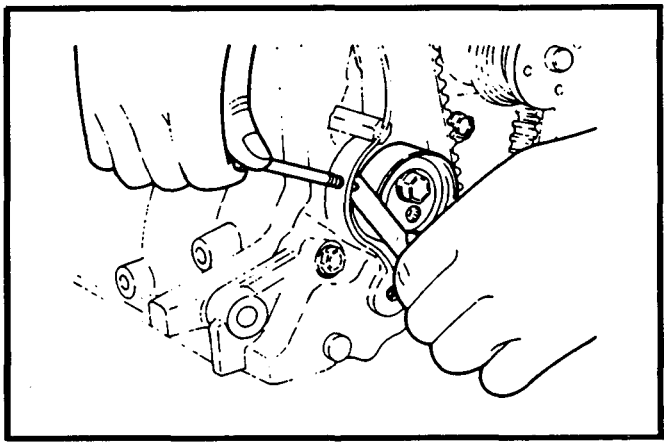


Figure 54.
Adjusting Timing Belt Tension

4. Tighten the tensioner mounting screw.
   Torque: **23 to 35 ft lbs (31 to 47 N·m)**

5. Remove the M6 screw, thickness gauge, and install the plastic cap.

NOTE

- After adjusting the timing belt tension this cap must be reinstalled to keep dirt, water and oil from contaminating the timing belt. If the plastic cap is damaged and not re-useable seal the hole with silicone sealer.

Engine Assembly

1. Install the crankshaft outer flange and timing belt cover.
   Torque: **38 to 57 in lbs (4 to 7 N·m)**

2. Install new oil filter. Install water by-pass pipe.

3. Install the exhaust manifold.
   Torque: **11 to 17 ft lbs (15 to 23 N·m)**

4. Install fly wheel.
   Torque: **29 to 36 ft lbs (39 to 49 N·m)**

5. Install clutch and clutch disc.
   Torque: **11 to 16 ft lbs (15 to 22 N·m)**

6. Install the intake manifold.
   Torque: 11 to 17 ft lbs (15 to 23 N·m)

7. Install the fuel pump with push rod.
   Torque: 11 to 17 ft lbs (15 to 23 N·m)

8. Install the Carburetor assembly.
   Torque: 90 to 136 in lbs (10.8 to 15 N·m)

9. Install and route vacuum hoses. See Section 8.

10. Install the crankshaft pulley.
    Torque: 36 to 43 ft lbs (49 to 58 N·m)

11. Install water pump pulley.
    Torque: 38 to 57 in lbs (4 to 7 N·m)

12. Install the timing pointer with collars.

Valve Tappet Adjustment

1. **The COLD valve setting is**
   Intake 0.006 inch (0.150 mm)
   Exhaust 0.008 inch (0.203 mm)

2. When the number 1 piston is at TDC of the compression stroke adjust the intake valves on number 1 and 3 cylinder, and the exhaust valves on number 1 and 2 cylinders.

3. Turn the engine crankshaft one revolution and adjust the intake valve on number 2, and the exhaust valve on number 3 cylinders.

4. Install the valve cover.
   Torque: 35 to 60 in lbs (4 to 7 N·m)

Distributor Installation

1. Turn the engine so that No. 1 piston is at TDC of the compression stroke. The slit in the end of the camshaft is off center to the right when viewed from the rear of the engine. See Figure 55.

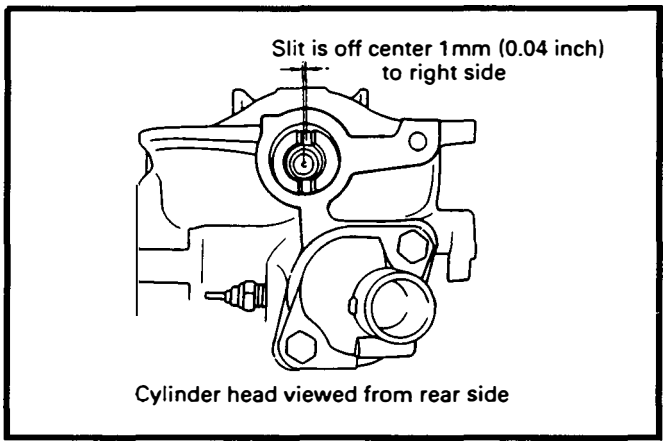


Figure 55.
Distributor installation.

2. Apply assembly grease to the "O" ring and the end of the distributor shaft. Install into the engine. The distributor shaft may need to be turned slightly to align with camshaft. **Do not force into the camshaft.**

Engine Installation

1. Install engine cross member.

2. Install the radiator hoses.

3. Install clutch housing, starter and transmission with emergency brake.

4. Install alternator-governor bracket.

5. Install alternator, governor, and v-belt. Adjust v-belt tension at the alternator to allow 3/16" to 1/4" (5 to 6.35 mm) deflection midway between the alternator and governor pulleys.

6. Connect governor linkage to carburetor arm linkage.

7. Install air cleaner, and hose. Connect engine breather hose to the air cleaner hose.

8. Using a hoist or similar lifting device install the engine with front cross member attached, into the vehicle. Align drive shaft halves together as engine is lowered into the vehicle.

9. Bolt front cross member at the frame.

10. Bolt the transmission to the rear cross member.

11. Disconnect the hoist.

12. Connect emergency brake cable at emergency brake bracket. See Section 14 for adjustment.

13. Install muffler at manifold and emergency brake bracket.

14. Connect transmission shift linkage at frame and transmission.

15. Connect clutch linkage at clutch bell housing. See section 10 for clutch free-play adjustment

16. Install clutch safety switch bracket to the transmission. Connect clutch safety switch, and safety switch spring. Plug main wiring harness into clutch safety switch. Adjust safety switch so that the engine will not start unless the clutch pedal is disengaged.

SAFETY WARNING

- **Improper adjustment of the clutch safety switch can cause unexpected vehicle movement or attached accessory operation when the vehicle engine is started. Operator or bystanders may be hurt.**

17. Connect the engine wire harness near the rear of the engine. Connect the ignition resistor, coil, starter, radiator fan, and starter solenoid.

18. Connect the throttle linkage at the engine bellcrank.

19. Connect the fuel supply and return lines at the fuel pump.

20. Connect the air cleaner inlet hose at the air cleaner.

21. Connect the radiator hoses at the radiator. If a heater is part of your vehicle connect the heater hoses.

22. If a hydraulic system is part of your vehicle install the hydraulic pump.

23. Install coolant overflow bottle.

24. Fill the engine with recommended oil for the season.

25. Install antifreeze solution. Purge all air from the cooling system. See Section 6.

26. Install the negative, and positive battery cables.

27. Check all hardware, electrical, and fuel connections for proper torque.

28. Start engine and make proper governor, and timing adjustments. See Section 3.

SECTION 4 FUEL SYSTEM

Special tools required in this section:

- **Metric Hand Tools**
- **Carburetor Tool Kit**
  Part No. CU40002
- **Vacuum Pump**
- **Choke Plate Angle Tool**

General Information

Fuel Pump. A mechanical type fuel pump is installed to the cylinder head, and is driven by the fuel pump cam on the camshaft through a push rod, delivering fuel to the carburetor. See Figure 1.

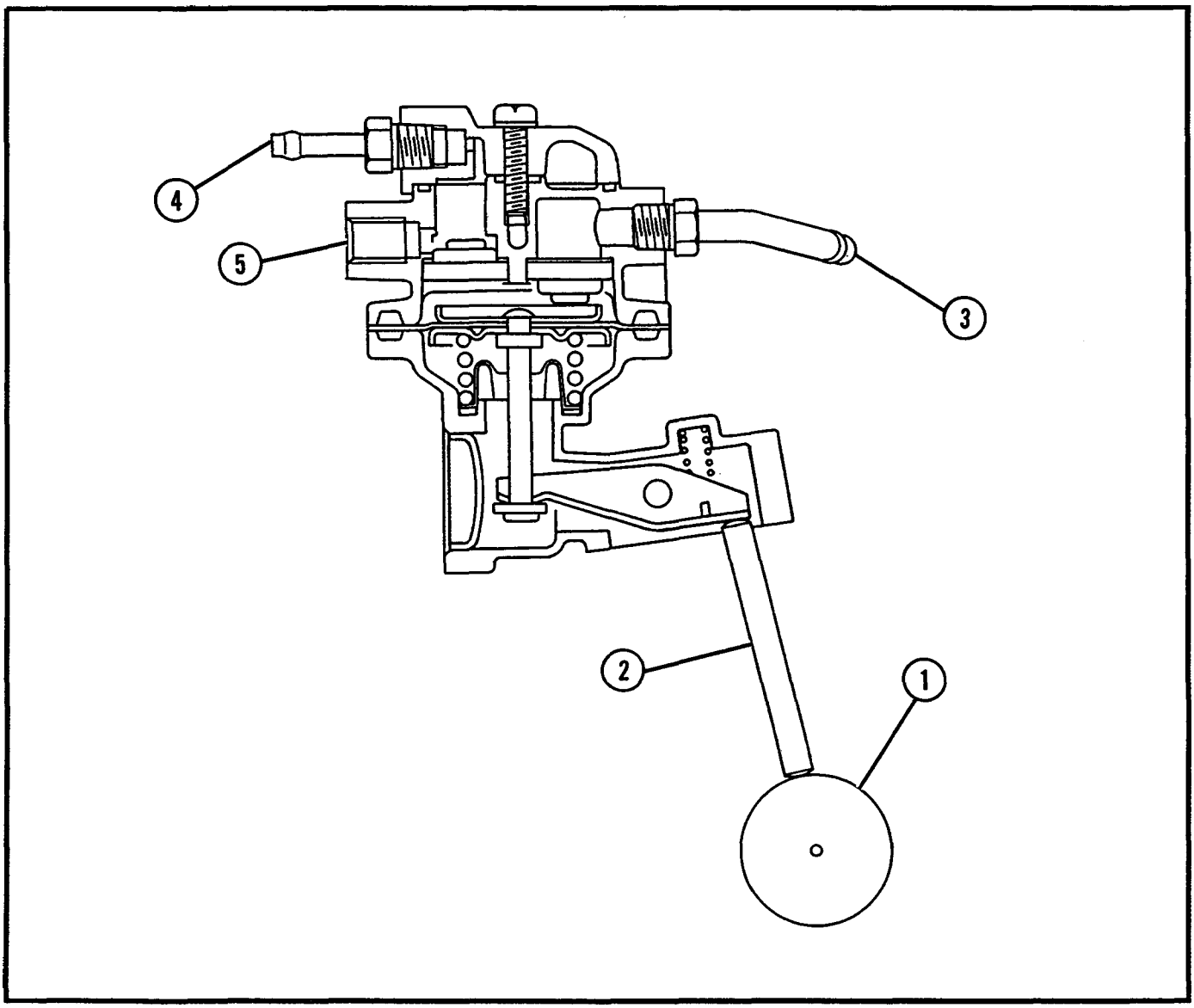


Figure 1.

1. Fuel Pump Cam	**4. Return**
2. Push Rod	**5. Outlet**
3. Inlet	

Carburetor, Main System. The fuel arrives at the carburetor bowl and is metered by the main jet. The fuel is mixed with air entering from the main air bleed. Fuel is then discharged into the small venturi from the main nozzle. See Figure 2.

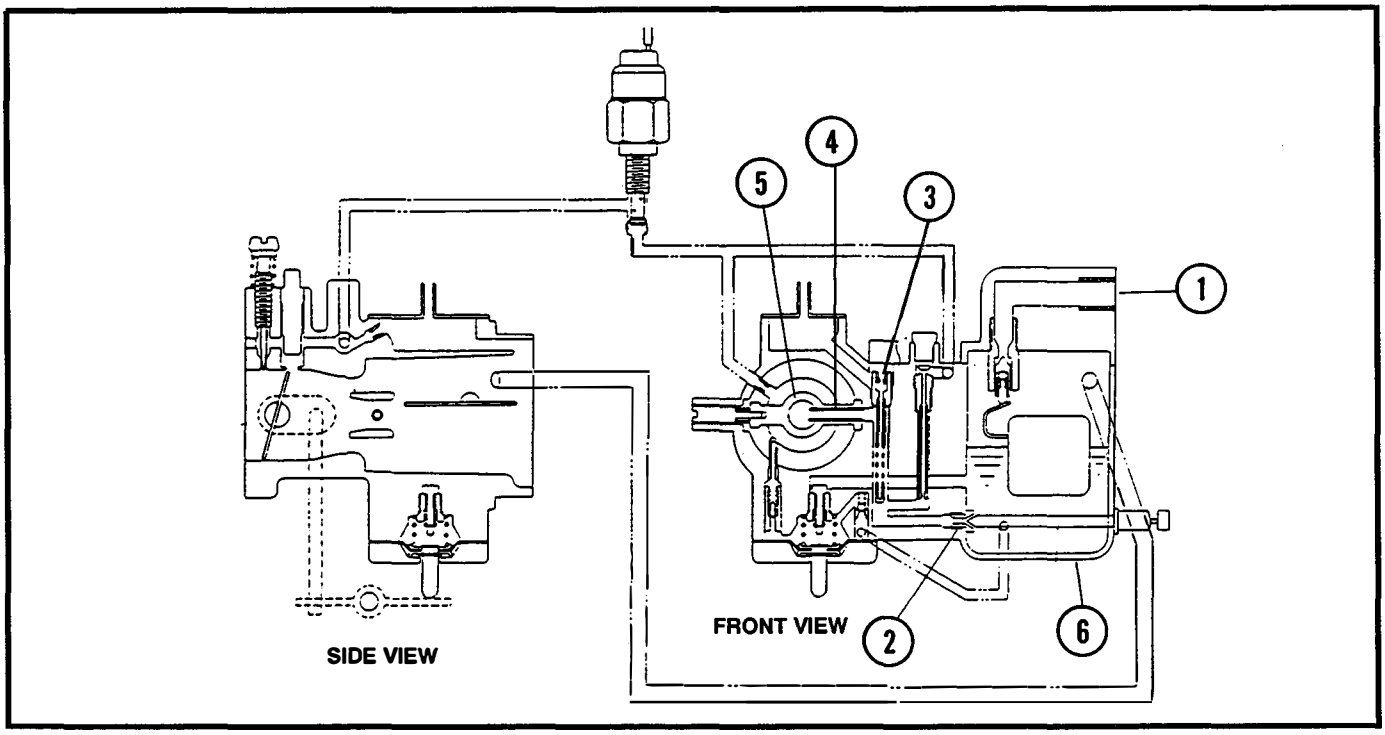


Figure 2.

1. Inlet	**4. Main Nozzle**
2. Main Jet	**5. Small Venturi**
3. Main Air Bleed	**6. Bowl**

Carburetor, Slow System. The fuel metered by the main jet is further metered by means of the slow jet. Then, the fuel is mixed with the air entering from the slow air bleed, and will be sucked from the idle port. The throttle valve solenoid shuts this system off when the key switch is off to prevent running on of the engine . See Figure 3.

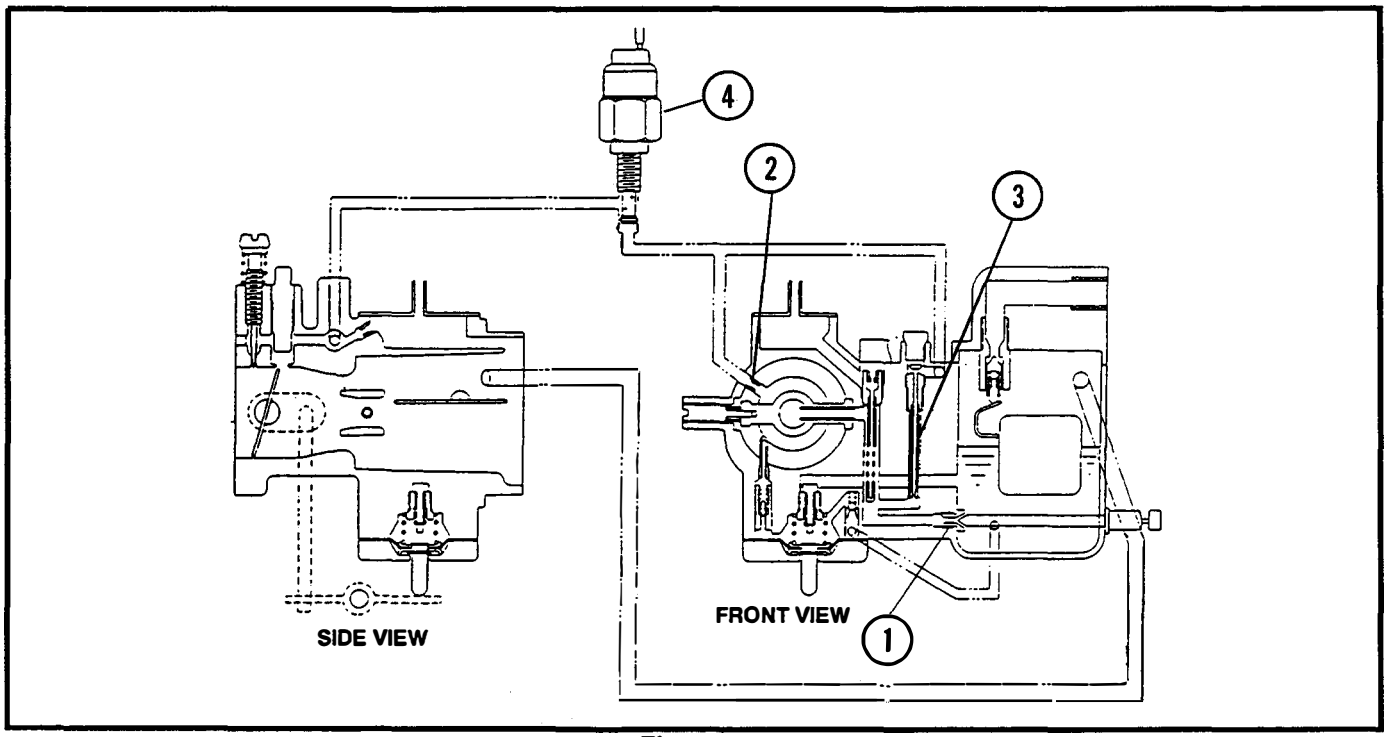


Figure 3.

1. Main Jet	**3. Slow Jet**
2. Slow Air Bleed	**4. Throttle Valve Solenoid**

Carburetor, Acceleration Pump System. When the throttle is opened suddenly, the acceleration diaphragm is pushed by means of the pump lever. Then the fuel inside the acceleration pump is injected from the pump jet via the discharge check valve. When the throttle valve is returned to the original position, the fuel in the float chamber enters into the acceleration pump via the check valve. See Figure 4.

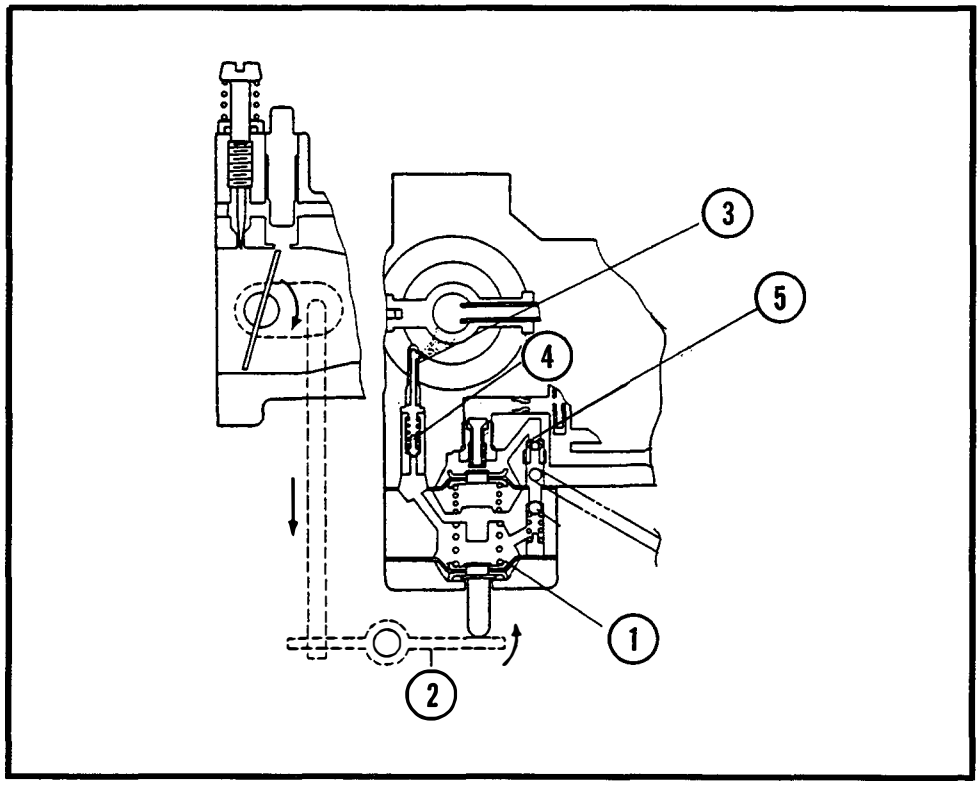


Figure 4.
1. Acceleration Diaphragm
2. Pump Lever
3. Pump Jet
4. Discharge Check Valve
5. Check Valve

Carburetor, Automatic Choke System. The automatic choke mechanism regulates the opening of the choke plate and throttle plate in accordance with the temperature of the coolant. This regulation is performed automatically, using wax pellet. See Figure 5.

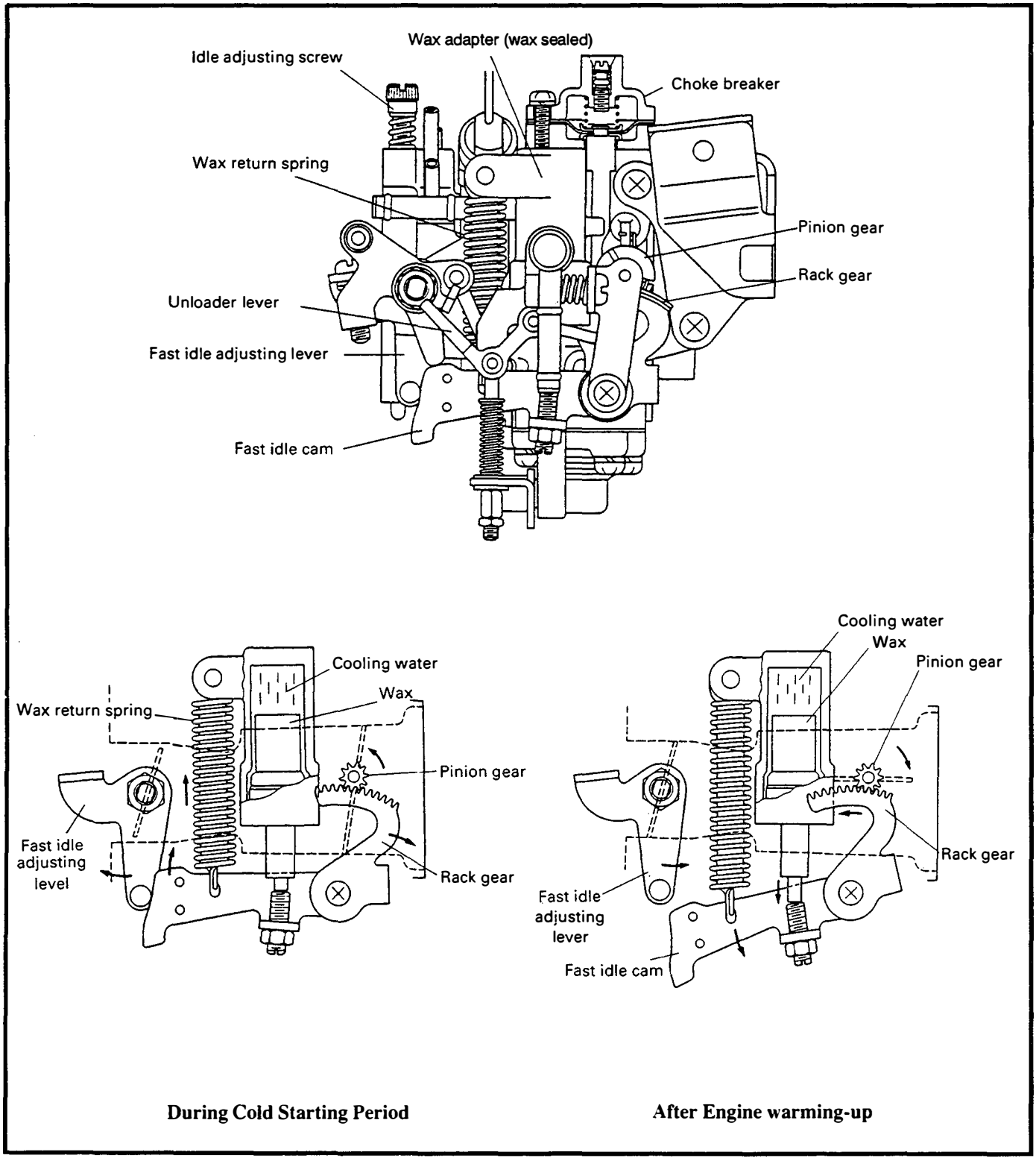
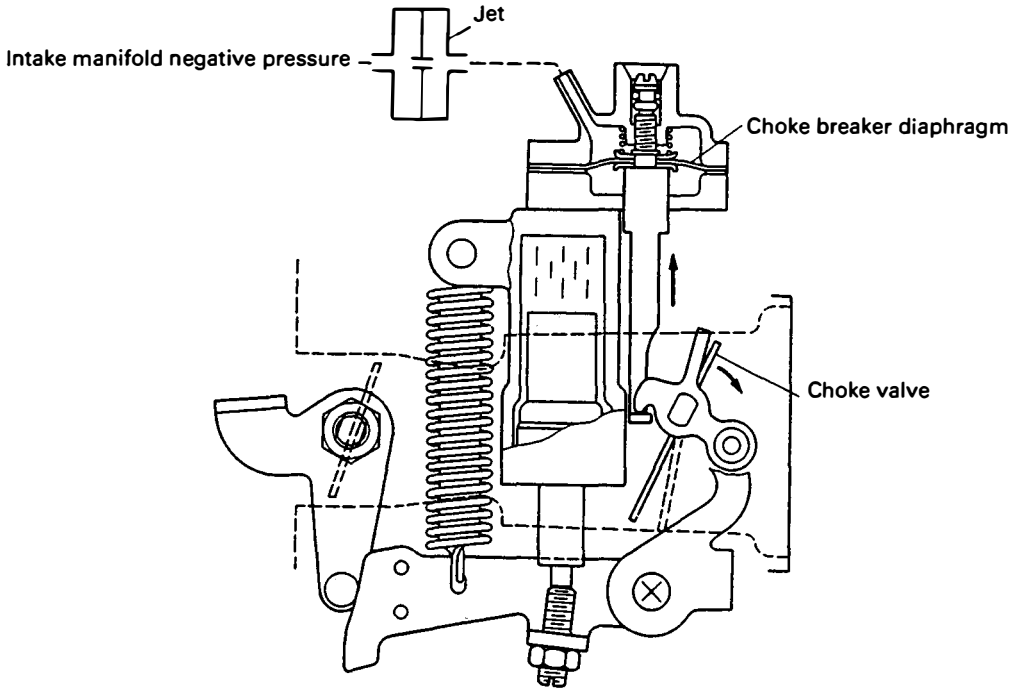


Figure 5.

Choke Pull–Off. The negative pressure of the intake manifold actuates the choke breaker diaphragm during a period immediately after starting. As a result, the choke valve is forcibly opened so as to prevent the fuel and air mixture from becoming too rich. A limiter provided between the intake manifold and the choke breaker prevents the choke valve from being opened too suddenly. See Figure 6.



After Engine Start–Up

Figure 6.

Fuel Pump

SAFETY WARNING

- **The fuel hose and carburetor will be full of gasoline and some spillage will occur when the fuel components are removed. Gasoline is extremely flammable and highly explosive under certain conditions. Do not allow open flames or sparks when performing any maintenance function or repair involving gasoline.**
- **Do not attempt to run the engine with any fuel system component disconnected or removed. Fuel leakage could contribute to a fire or explosion.**

Removal

1. Remove fuel and vacuum hoses from the fuel pump, mounting nut. Remove fuel pump from engine.

NOTE

- Note position of fuel pump push rod. DO NOT BEND.

Inspection

1. **Check for pump operation:**
   Apply pressure (2 psi) to the inlet while plugging the outlet. There should be no air flow from the mounting area or where the pump halves are bolted together. See Figure 7.
2. Apply pressure (2 psi) to the outlet. There should be no air flow from the inlet, mounting area or where the pump halves are bolted together. If there are leaks replace the fuel pump. See Figure 7.

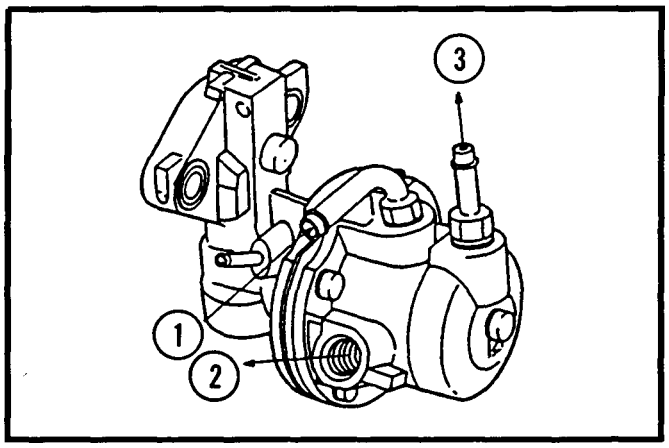


Figure 7.
1. Inlet **3. Return**
2. Outlet **4. Mounting area**

3. Measure the overall length of the push rod. Minimum length for proper operation is 2.264 inches (57.50 mm).

Install

1. Install the parts in the numerical order shown in Figure 8. Tighten mounting bolts 11 to 17 ft. lbs. (15 to 23 N·m) torque.

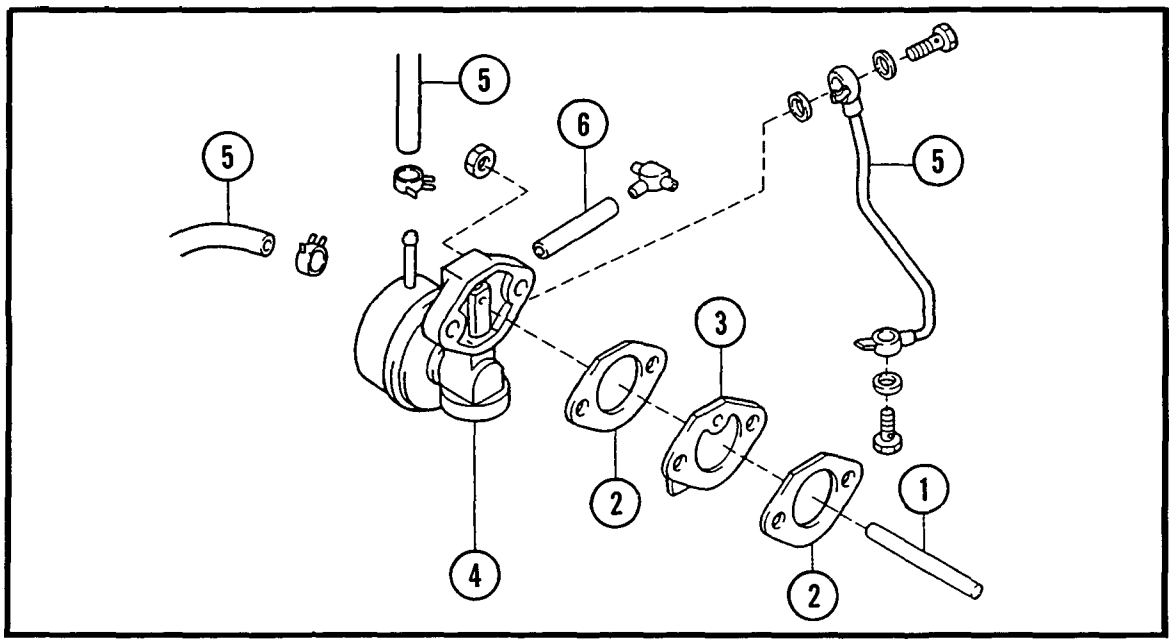


Figure 8.

1. Fuel Pump Push Rod
2. Fuel Pump Gasket
3. Fuel Pump Insulator
4. Fuel Pump Assembly
5. Fuel Hoses
6. Vacuum Hose

Standard Carburetor (49 State)

Carburetor Removal

1. Disconnect air cleaner hose at carburetor inlet.
2. Remove fuel supply line from carburetor.
3. Disconnect vacuum hoses (2), and water lines (2) at carburetor.
4. Unplug electrical wire connector at main engine harness.
5. Disconnect throttle link from carburetor to governor linkage.
6. Remove carburetor mounting bolts and remove carburetor from the vehicle.

NOTE

- Cover the intake manifold inlet to prevent dirt from entering the engine.

NOTE

- *Be certain not to disassemble or adjust the parts shown in Figure 9. Carburetor performance will be adversely affected.*

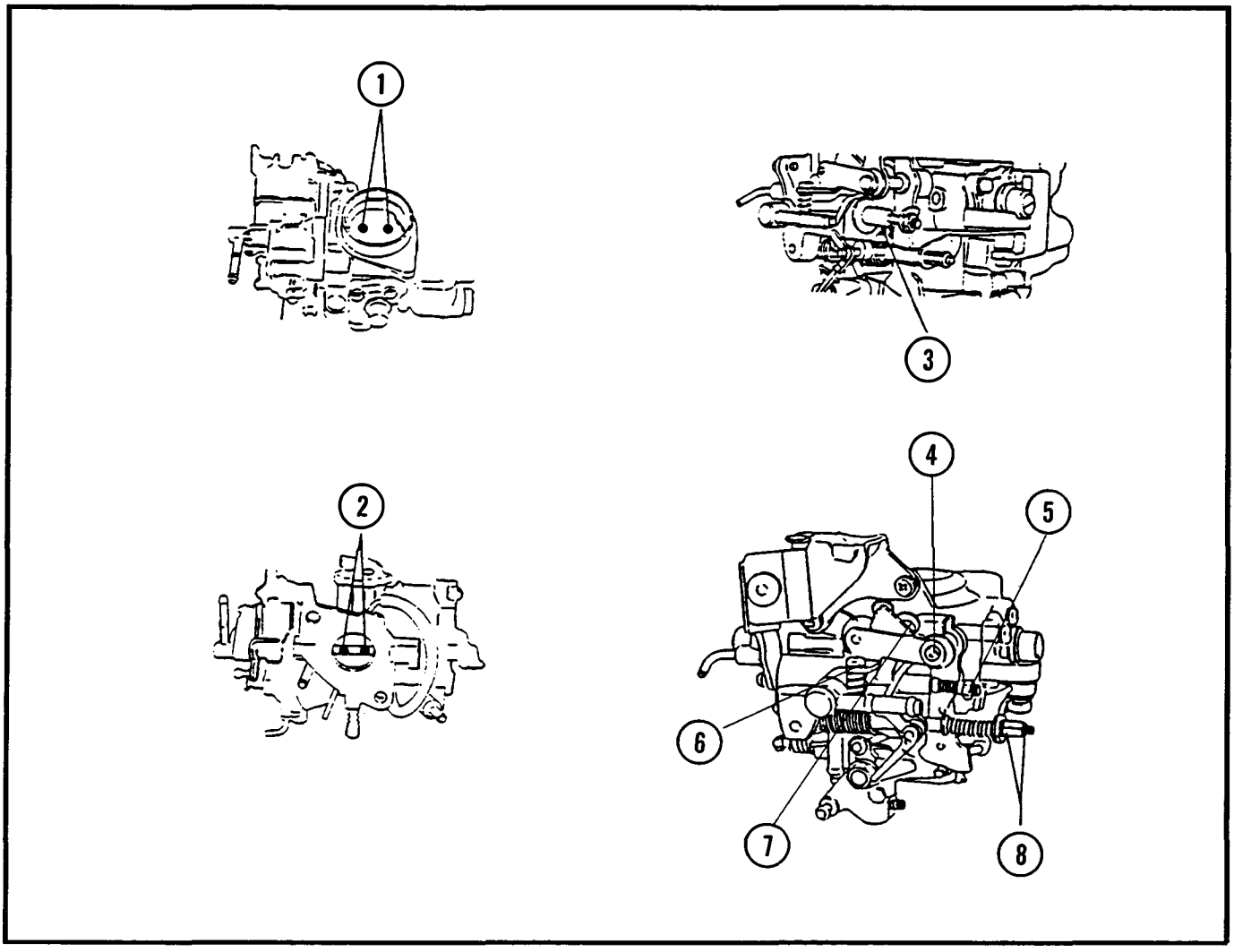


Figure 9.

1. Choke Plate Screw
2. Throttle Valve Screw
3. Small Venturi Screw
4. Pinion Bracket Screw
5. Fast Idle Screw
6. Pinion Bracket Screw
7. Choke Adapter Screw
8. Connected Section of the Acceleration Pump Link and Pump Lever.

Carburetor, Disassemble and Inspection

Bowl, float and related parts

1. Disassemble float bowl cover mounting screws. See Figure 11.

NOTE

- One mounting screw is shorter than the other two. Failure to return screw to their proper location may cause damage to the carburetor body. See Figure 10.

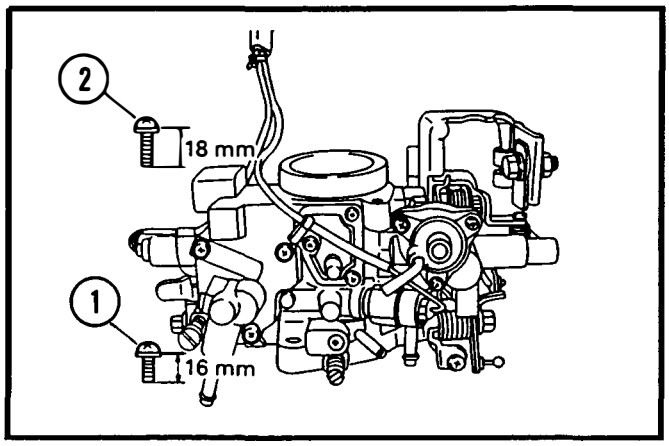


Figure 10.
1. .630 inch (1 screw) (16 mm)
2. .709 inch (2 screws) (18 mm)

2. Disassemble float lever pin, float, needle valve and gasket. See Figure 11.

3. Remove needle valve seat and screen assembly from the float bowl cover.

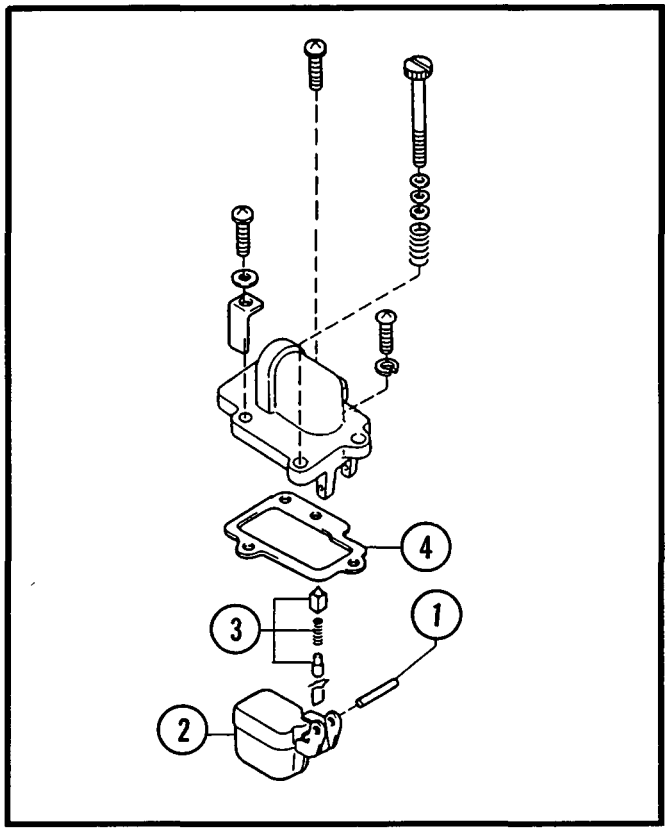


Figure 11.
1. Float Lever Pin
2. Float
3. Needle Valve
4. Gasket

Float bowl inspection

1. Inspect for distortion and wear. Check float for signs of oil or gasoline saturation.

2. Needle valve operation check.
   (A) Check the needle valve spring for wear. Be sure the needle valve moves freely up and down.
   (B) Check the needle seat area for wear.

Disassemble main air bleed, and slow jet

1. Disassemble main air bleed, slow jet plug, slow jet and idle mixture screw. See Figure 12.

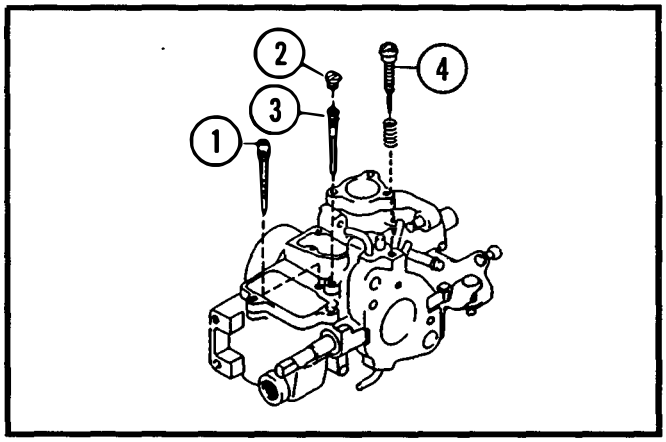


Figure 12.
1. Main Air Bleed
2. Slow Jet Plug
3. Slow Jet
4. Idle Mixture Screw

Air Chamber Cover

1. Remove air chamber cover and gasket.

Choke breaker and related parts

1. Remove three cover mounting screws, disassemble the cover, spring, diaphragm, and gasket. See Figure 13.

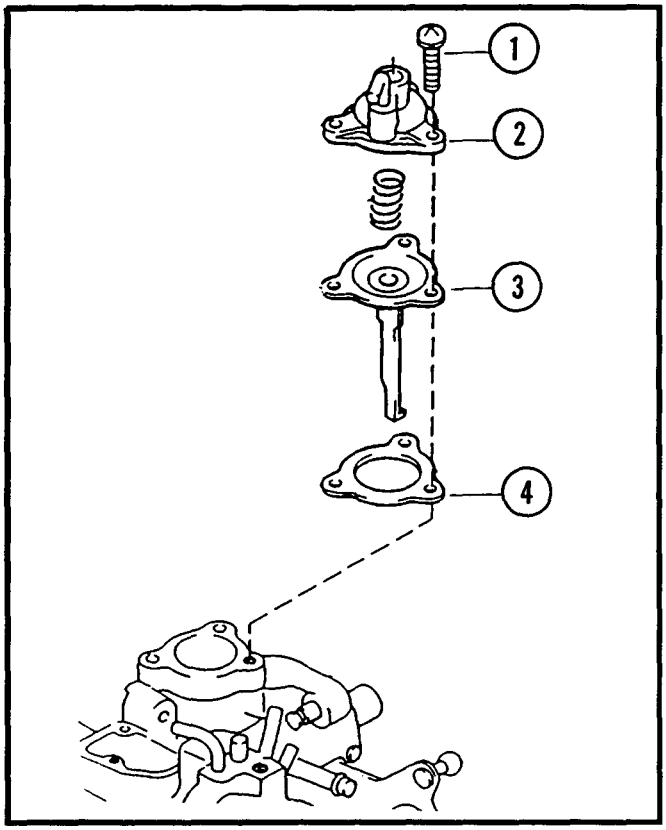


Figure 13.
1. Mounting Screws
2. Cover
3. Diaphragm
4. Gasket

Acceleration Pump, Power Valve, and Related Parts

1. Remove acceleration pump lever pivot bolt, and pivot arm. See Figure 14.

2. Remove diaphragm cover mounting bolts and disassemble diaphragm cover. See Figure 14.

3. Remove gasket, diaphragm, and spring. See Figure 14.

4. Remove discharge check valve, inlet check valve, and power valve. See Figure 14.

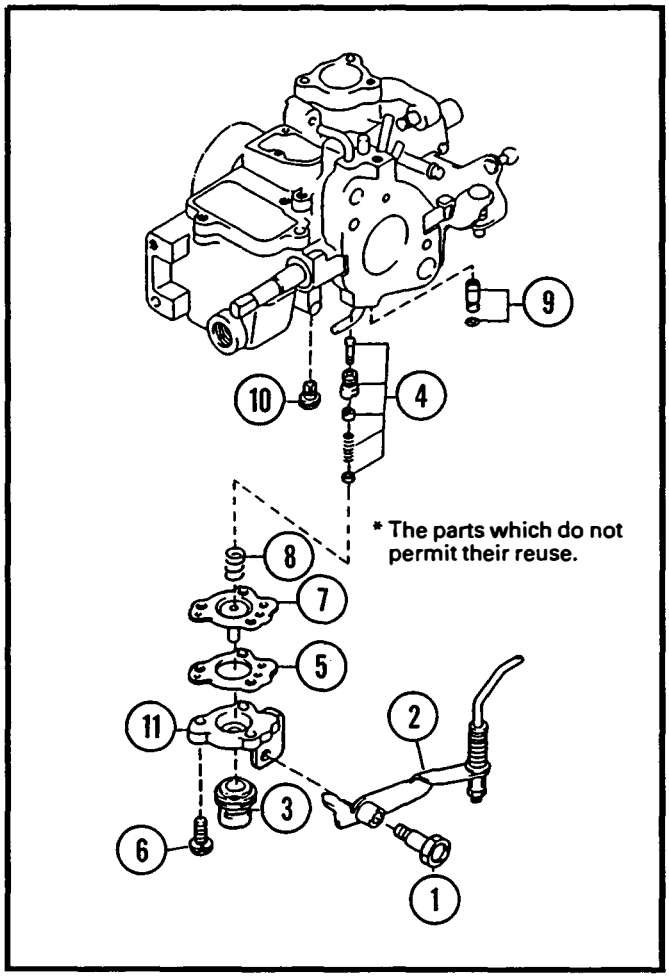


Figure 14.

1. Pivot Bolt	**7. Diaphragm**
2. Pivot Arm	**8. Spring**
3. Boot	**9. Discharge Check Valve**
4 Power Valve	**10. Inlet Check Valve**
5. Gasket	**11. Diaphragm Cover**

6. Diaphragm Mounting Bolts (3).

Acceleration Pump Inspection

1. Check the "O" ring of the discharge check valve for damage

2. Check the diaphragm for damage.

3. Check rod sliding surface for damage or wear.

4. Check power valve for damage or rust.

Solenoid, Main Jet Removal

1. Disassemble the throttle valve solenoid, and main fuel solenoid valve. See Figure 15.

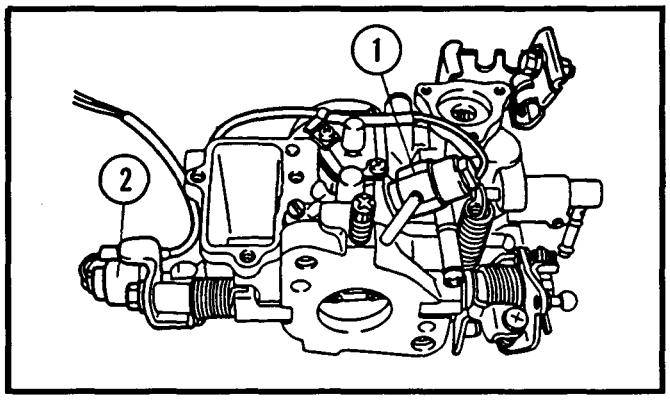


Figure 15.
1. Throttle valve Solenoid 2. Main Fuel Solenoid

Solenoid Inspection

1. **Throttle valve solenoid:**
   To check operation of the solenoid, connect wire to the battery positive terminal and ground the body. The needle valve should make and audible "click" indicating that it is functioning properly.

2. **Main fuel solenoid valve:**
   To check operation of the solenoid valve, connect one wire to the positive terminal on a battery and the other wire to a negative terminal. The needle valve should make and audible "click" indicating that it is functioning properly. See Figure 16.

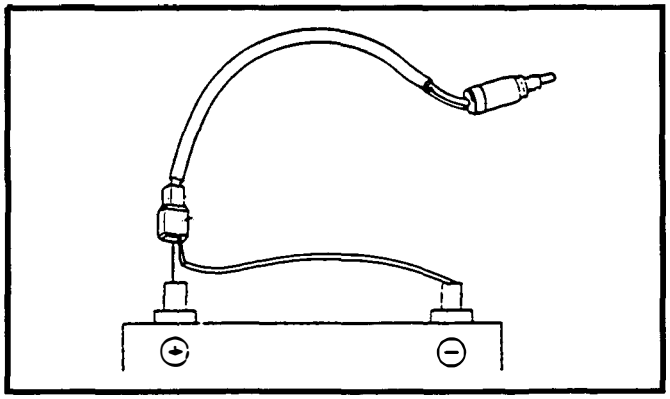


Figure 16.

Cleaning

NOTE

- Care must be used in cleaning the carburetor. Plug the water inlet and outlet to prevent the cleaning solution from entering the carburetor and damaging the automatic choke.
  See Figure 17.
- Never clean a carburetor by submerging or soaking it in a hot tank or carburetor cleaner. Do not expose plastic or rubber parts to any carburetor cleaner.

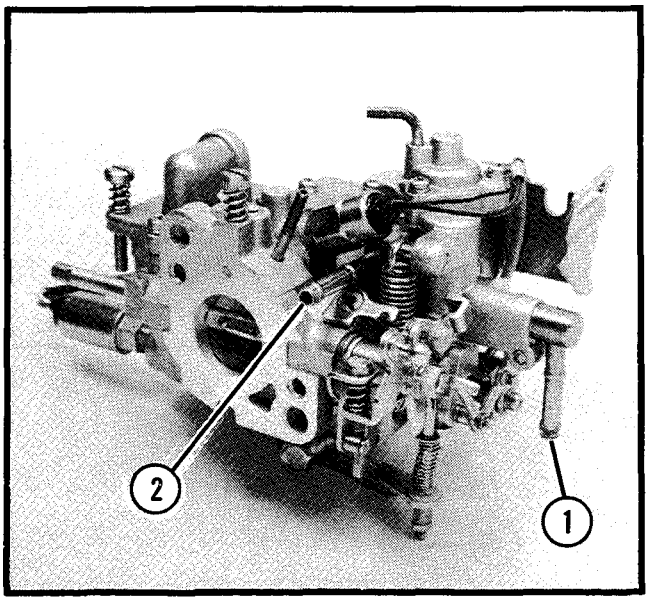


Figure 17.
1. Water Inlet 2. Water Outlet

1. Clean all parts thoroughly with a mild aerosol solvent. Use a clean bristle brush to remove gum or varnish deposits.

2. Blow dry with shop air of not more than 25 psi (172 kPa).

3. Inspect for wear and corrosion. Replace all worn or damaged parts.

Carburetor, Assemble

Solenoids, Main Jet

1. Assemble the throttle valve solenoid and main fuel solenoid valves. See Figure 15.

Acceleration Pump

1. Assemble the power valve, check valve and discharge check valve. See Figure 14.

2. Assemble the spring, diaphragm and gasket. See Figure 14.

3. Assemble the boot and diaphragm cover. See Figure 14.

4. Connect the acceleration pump lever, tighten the pivot bolt. See Figure 14.

Choke Pull–Off

1. Install the diaphragm with new gasket. Install the spring and cover with original hardware. See Figure 18.

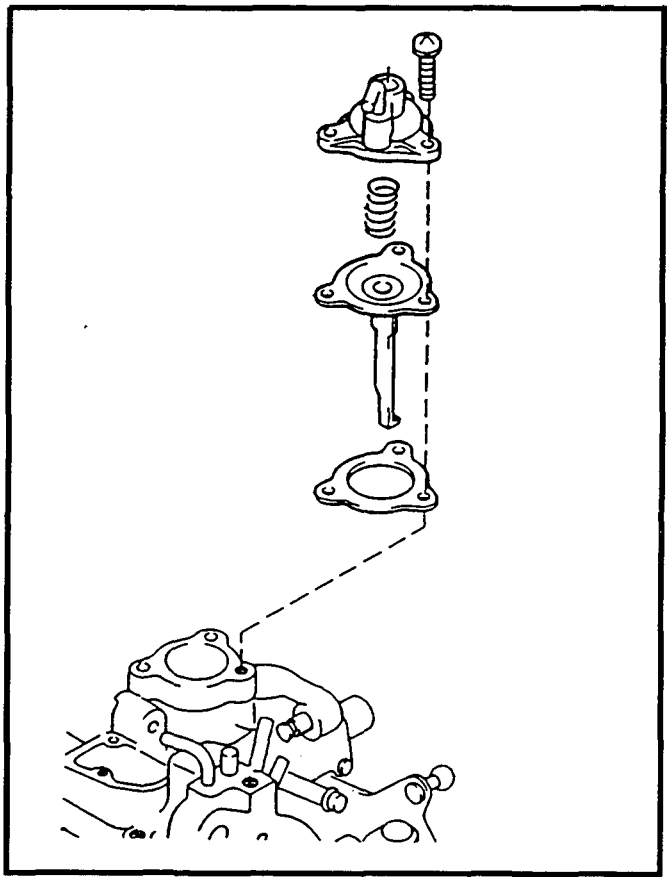


Figure 18.

Air Bleed, Slow Jet, and Idle Adjusting Screw

1. Assemble the idle adjusting screw, slow jet, slow jet plug and main air bleed. See Figure 19.

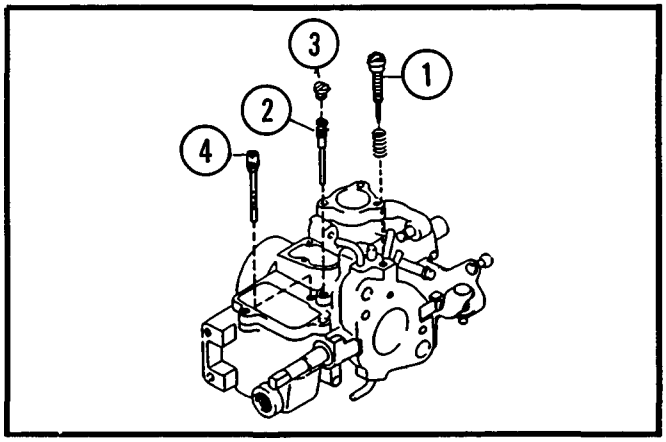


Figure 19.
1. Idle Adjusting Screw
2. Slow Jet
3. Slow Jet Plug
4. Main Air Bleed

Air Chamber Cover

1. Assemble the air chamber cover and new gasket.

Bowl, Float, and Related Parts

1. Assemble the needle valve, and clip. See Figure 20.

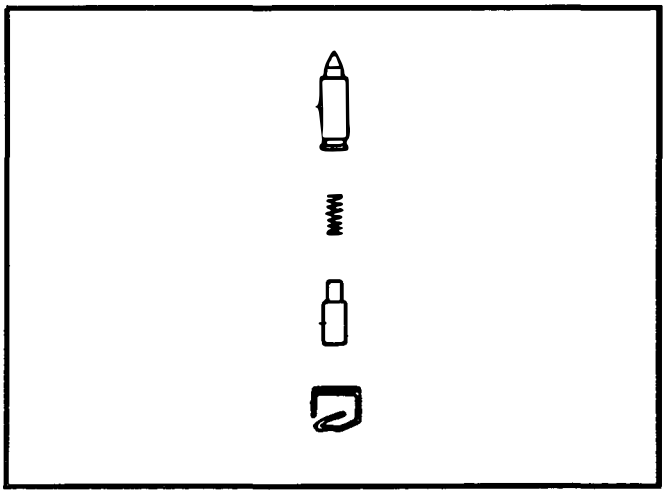


Figure 20.

2. Assemble the float to the float bowl cover with the float lever pin. See Figure 21.

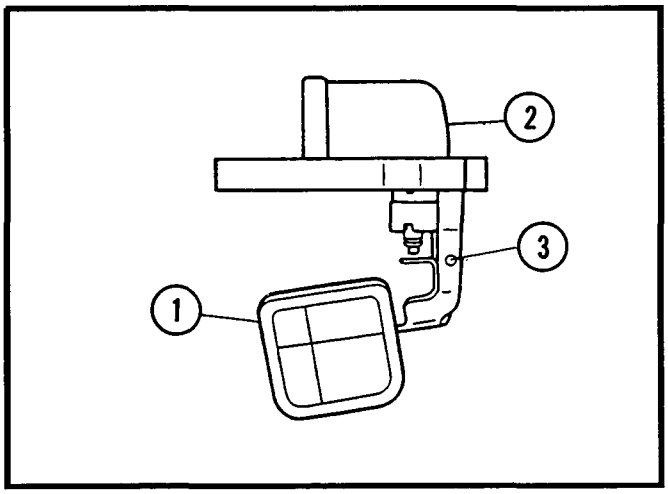


Figure 21.
1. Float 2. Bowl Cover
3. Float Lever Pin

Adjust the Float Position

1. Invert the float bowl assembly cover and allow the float to hang down by its own weight. The distance between the float and bowl cover should be 0.575 inch (14.6 mm). Adjust by bending the tab on the float. See Figure 22.

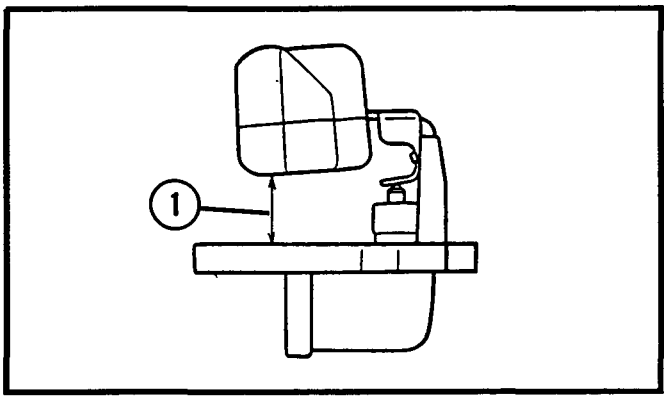


Figure 22.
1. .575 inch (14.6 mm)

2. Assemble the float bowl cover onto the carburetor main body.

NOTE

- One mounting screw is shorter than the other two. Failure to return screws to their proper location may cause damage to the carburetor body. See Figure 23.

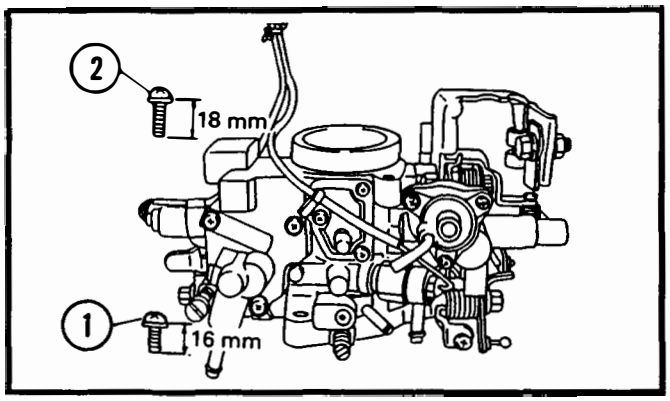


Figure 23.
1. .630 inch (1 screw) (16 mm)
2. .709 inch (2 screws) (18 mm)

Carburetor Adjustments

Idle Mixture Screw

1. Back off the idle mixture adjusting screw 3 1/2 turns from the fully closed position. See Figure 24.

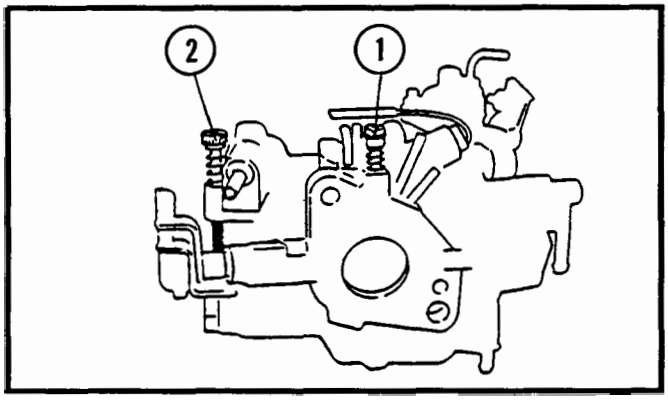


Figure 24.
1. Idle Speed Adjusting Screw
2. Idle Mixture Screw

Choke Pull–Off

1. Make sure that the choke pull–off is fully closed (no vacuum applied).

2. Apply 15 inches of mercury vacuum to the diaphragm. Check the choke plate opening angle. Specified choke plate opening angle is 35° to 41° from horizontal plane. See Figure 25.

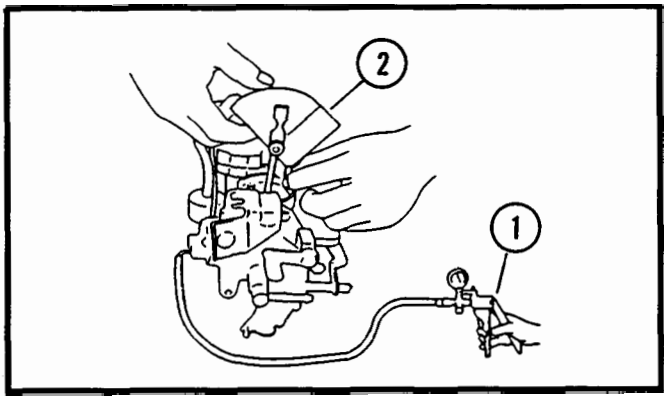


Figure 25.
1. Apply 15 inches of mercury vacuum
2. Check angle, 35° to 41° from horizontal plane

3. Adjust choke plate angle by turning the adjusting screw. See Figure 26.

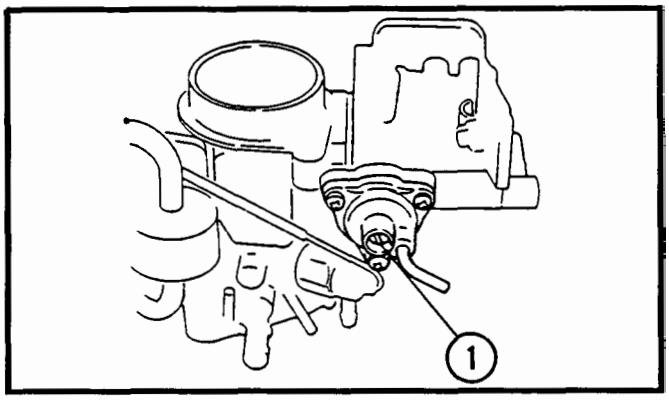


Figure 26.
1. Adjusting Screw

Choke Unloader

1. With the throttle fully opened, check the choke plate opening angle. Specified angle is 44° from horizontal plane. See Figure 27.

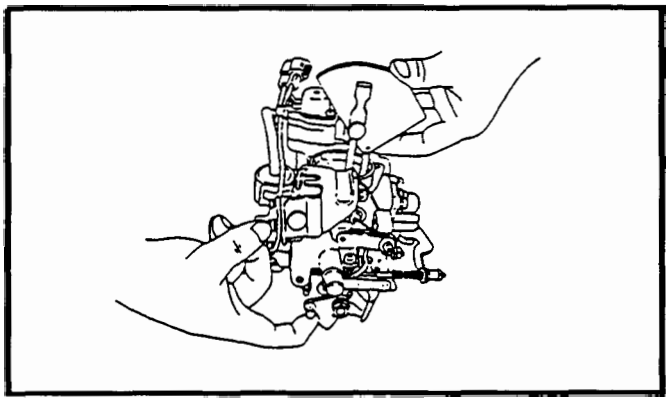


Figure 27.
1. Choke Unloader Check

2. Adjust by bending the adjusting lever. See Figure 28.

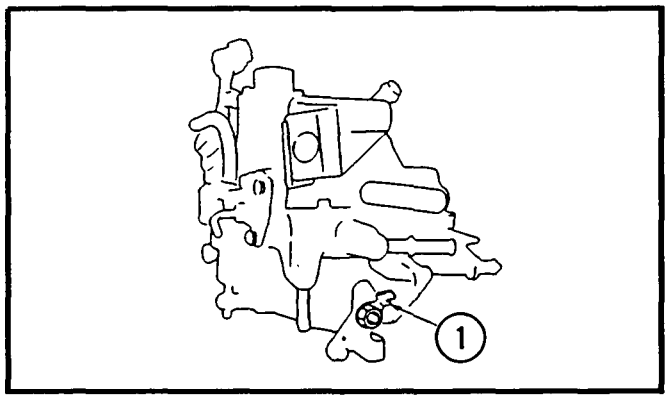


Figure 28.
1. Choke Unloader Adjustment

Carburetor, California Specifications

General Information

1. The California carburetor has few differences from the standard carburetor. Those differences are:

2. The main jet solenoid is replaced with a jet, accessible by removing a plug in the bottom of the carburetor bowl. See Figure 29.

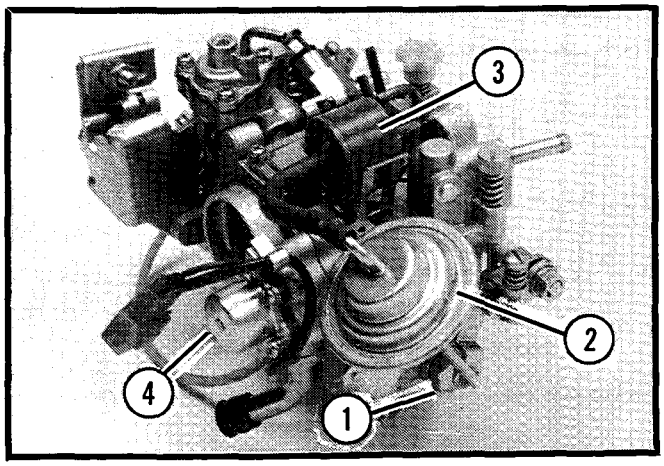


Figure 29.
1. Plug
2. Throttle Positioner
3. Jet
4. Vent Solenoid

3. The California carburetor has a throttle positioner assembly. See Figure 29. The function of the throttle positioner is to hold the engine on high idle for a short period of time after the carburetor throttle plate is returned to idle after running at operating speeds, (2000–3600 rpm). The restrictor in the vacuum line ensures that it takes 1 to 15 seconds to return to idle speeds.

4. The California carburetor has a vent solenoid valve located on the bowl cover. See Figure 29. The function of this solenoid is to allow the fumes from the carburetor bowl to be sucked into the vacuum canister.

Inspection and adjustment of throttle positioner

1. With the engine warmed up and the choke plate fully open, disconnect the vacuum hose from the throttle positioner. SeeFigure 30.

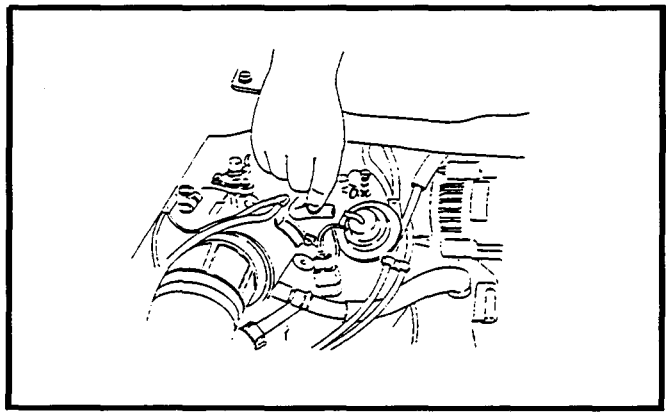


Figure 30.

2. The engine idle speed must increase. With the vacuum hose disconnected from the throttle positioner the idle speed should be 1700 to 1900 rpm.

3. Use the adjustment screw to obtain the correct rpm. See Figure 31.

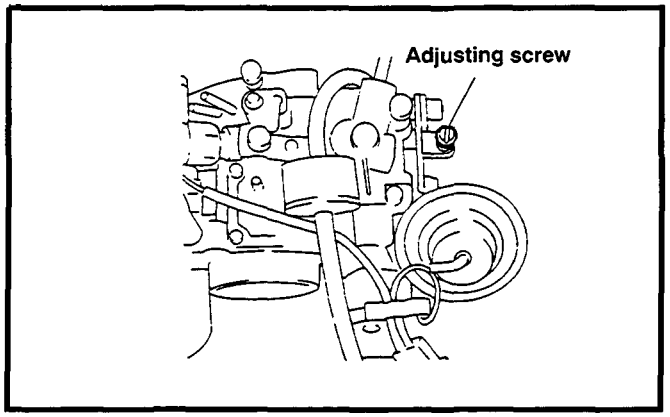


Figure 31.

4. Reconnect the vacuum hose to the throttle positioner. It should take from 1 to 15 seconds to return to normal idle speed, 1300 rpm.

Carburetor Installation

1. Attach carburetor to intake manifold with original mounting bolts. **Tighten to 90 to 136 inch pounds (1.04 to 1.56 kg-m) torque.**

2. Connect throttle link from carburetor to governor linkage.

3. Connect Electrical wire connector at main engine harness.

4. Connect vacuum hoses (2), and water lines (2) at carburetor. See Figure 32.

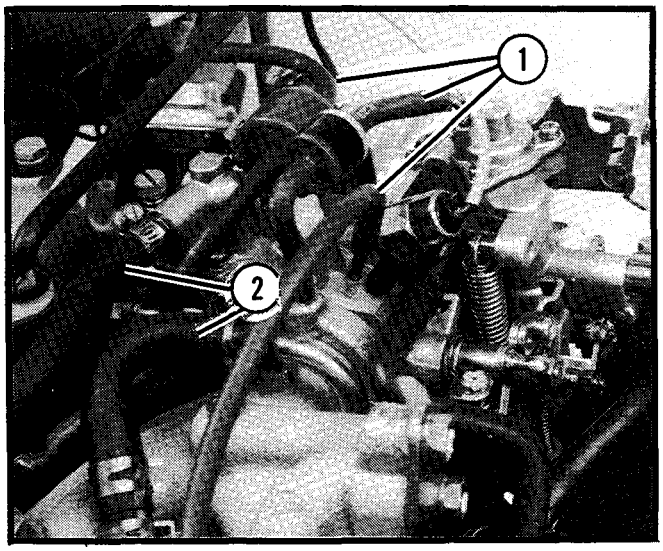


Figure 32.
1. Vacuum Hoses 2. Water Lines

5. Connect fuel supply line from fuel pump to carburetor.
6. Connect air cleaner hose at carburetor inlet.

SECTION 5 LUBRICATION SYSTEM

OIL PRESSURE CHECK

1. Oil level should be between the two small marks on the level gauge. If low, check for leakage and add oil up to the upper mark.

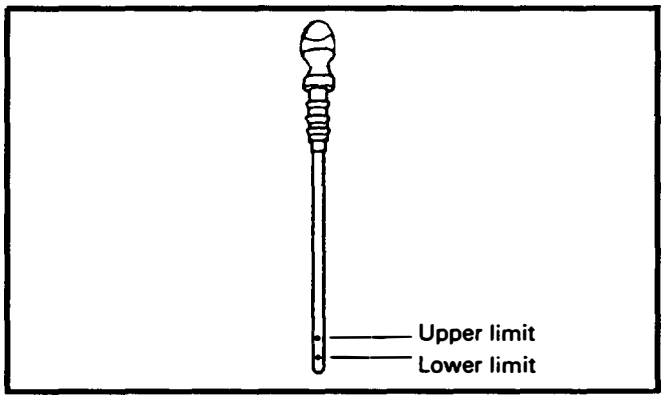


Figure 1. Oil Level Check

2. Remove the oil pressure switch.
3. Install the oil pressure gauge.
4. Start the engine and warm it up to normal operating temperature.
5. Measure the oil pressure.

Oil Pressure: 49.77 to 61.15 psi (3.5 to 4.3 kg/cm²)
(Engine revolution speed: About 2000 rpm)
(Engine oil temperature: About 212°F)

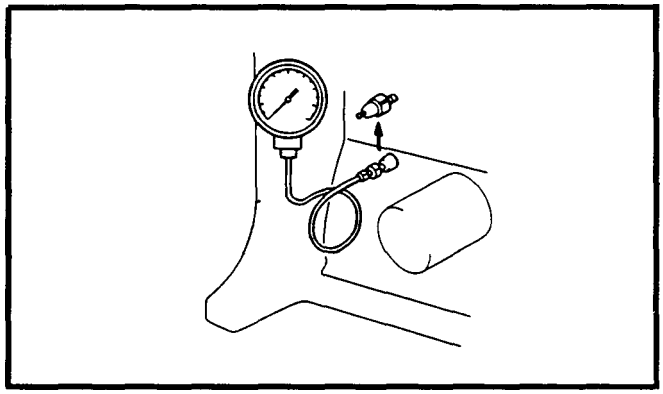


Figure 2. Oil Pressure Check

ENGINE OIL AND OIL FILTER REPLACEMENT

1. Remove the oil drain plug and drain the oil.
2. Remove the oil filter using a oil filter wrench. Coat the seal on the new filter with engine oil and install it on the engine.

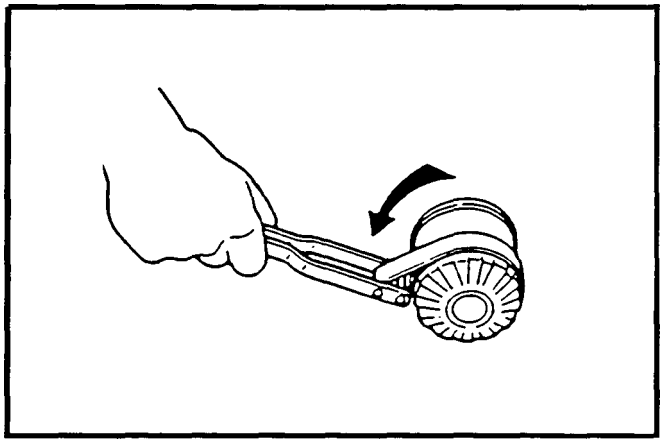


Figure 3. Oil Filter Replacement

NOTE

- Hand tighten only.

3. Fill with engine oil using SAE 10W30 SF or SG for all temperature ranges.

Capacity: 2.8 U.S. qts. (2.7 liters)

Do not overfill. Check and maintain oil level regularly.

OIL PUMP

COMPONENTS

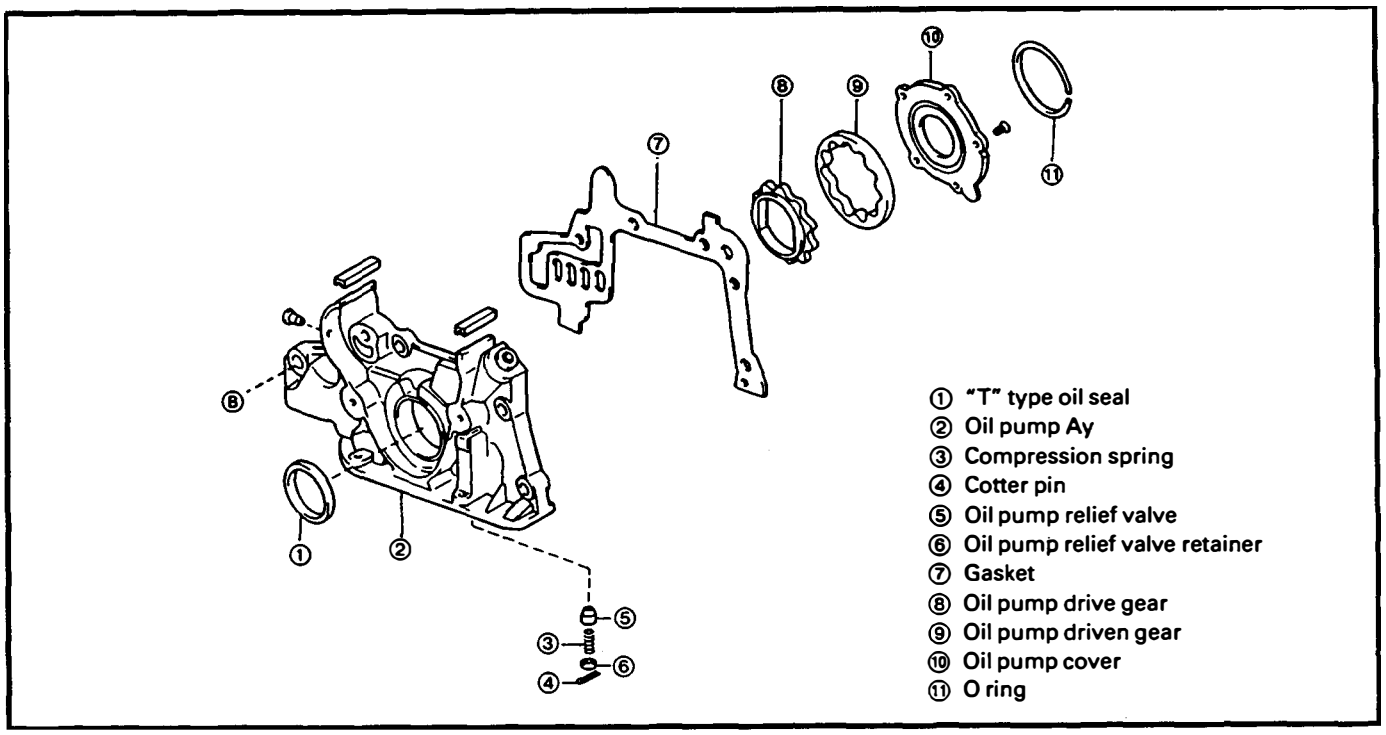


Figure 4. Oil Pump Components

DISASSEMBLY

1. Remove the relief valve.
   (1) Using a pair of pliers, remove the cotter pin.
   (2) Remove the retainer, spring and relief valve.

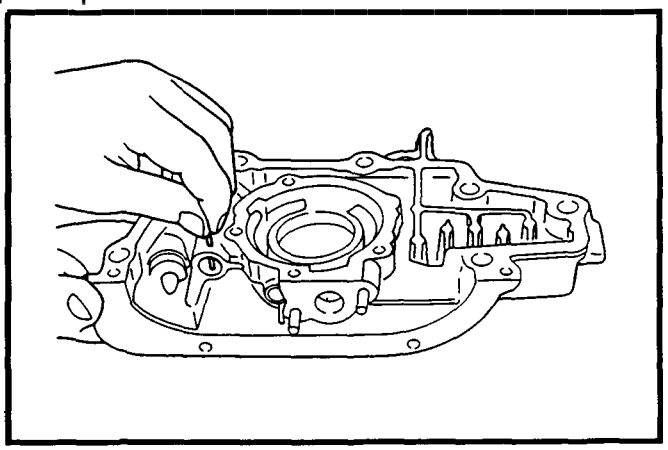


Figure 5. Relief Valve Removal

2. Remove the drive and driven gear.
   (1) Remove the 5 screws and oil pump cover.
   (2) Remove the drive and driven gear.

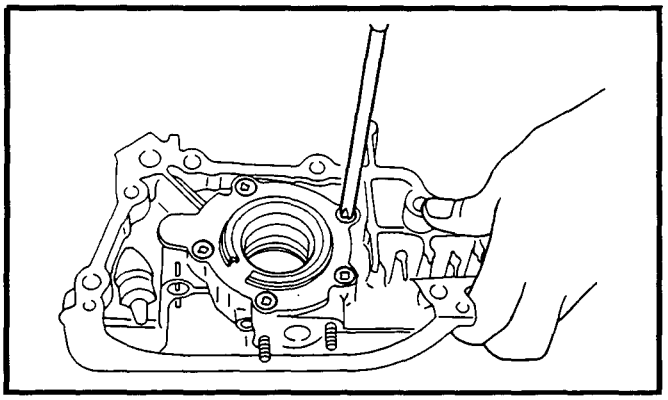


Figure 6. Pump Disassembly

GEAR INSPECTION

1. Measure the tip clearance of the drive and driven gears with a thickness gauge.

   Tip Clearance:
   .0067 to .0138 in. (0.17 to 0.35 mm)

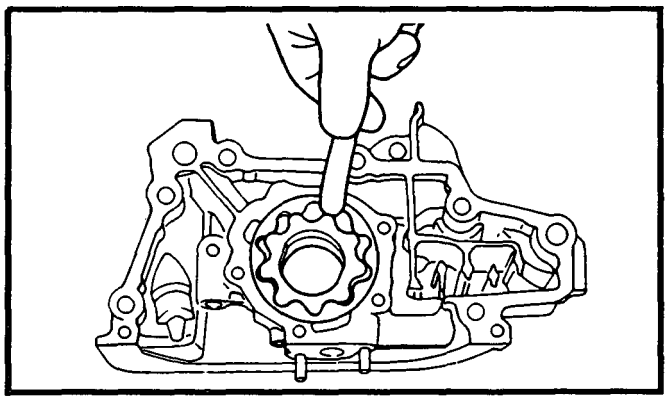


Figure 7. Tip Clearance Measurement

2. Measure the side clearance as shownwith a thickness gauge and flat block.

   Side Clearance:
   .0014 to .0059 in. (0.035 to 0.15 mm)

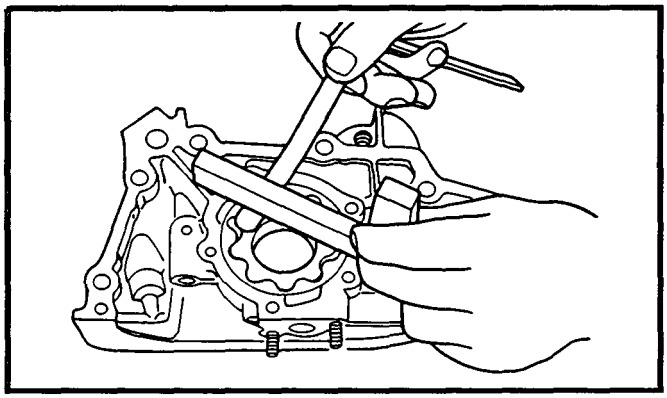


Figure 8. Side Clearance Measurement

3. Measure the clearance between drive gear and body.

   .0024 to .0098 in. (0.06 to 0.25 mm)

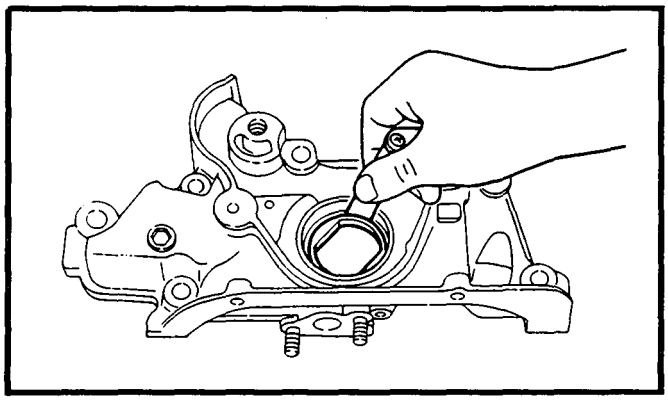


Figure 9. Drive Gear & Body Clearance Measurement

NOTE

- Replace all worn or damaged parts.

SEAL REPLACEMENT

1. Using a flat screwdriver, pry out the oil seal.

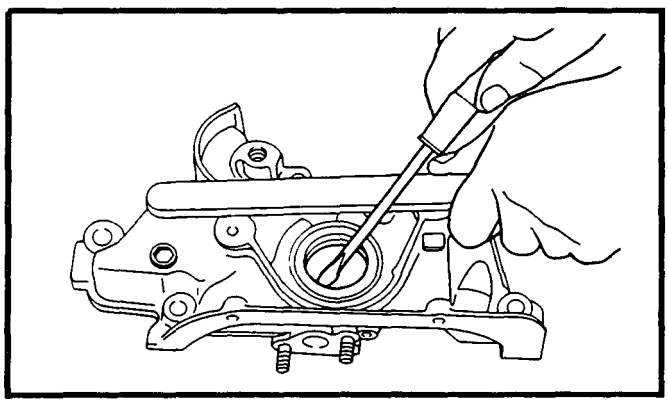


Figure 10. Oil Seal Replacement

2. Install the new oil seal.

   (2) Install the new oil seal using a seal driver.

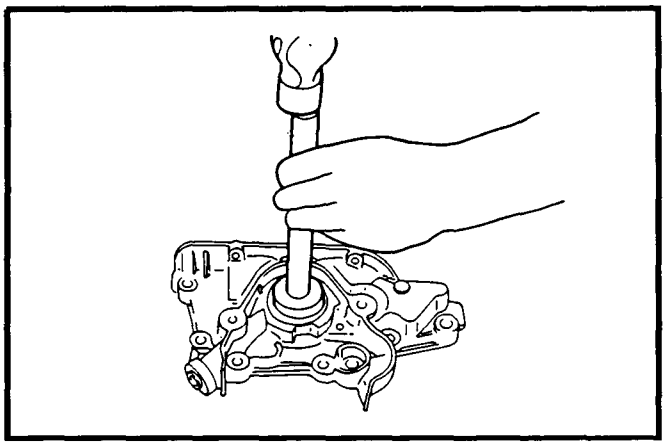


Figure 11. Oil Seal Installation

NOTE

- The new oil seal must be installed straight.

   (2) Coat the oil seal lightly with grease.

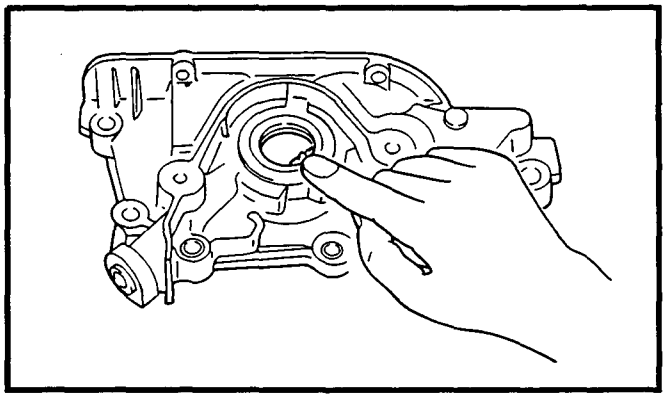


Figure 12. Grease Coating

ASSEMBLY OF OIL PUMP

1. Relief valve.
   (1) Install the relief valve, spring and retainer to the pump body.
   (2) Install the cotter pin.

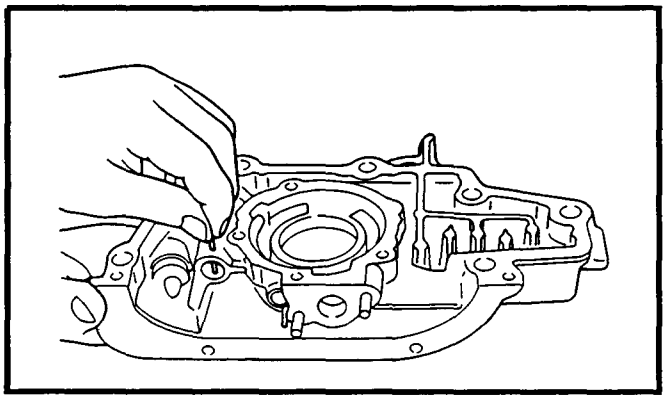


Figure 13. Relief Valve Installation

2. Pump gears.
   (1) Insert the drive and driven gear to the body.
   (2) Install the pump cover, tighten the mounting screws in the sequence as shown.

Tightening Torque: 5.8 to 9.4 ft.–lb. (0.8 to 1.3 kg–m)

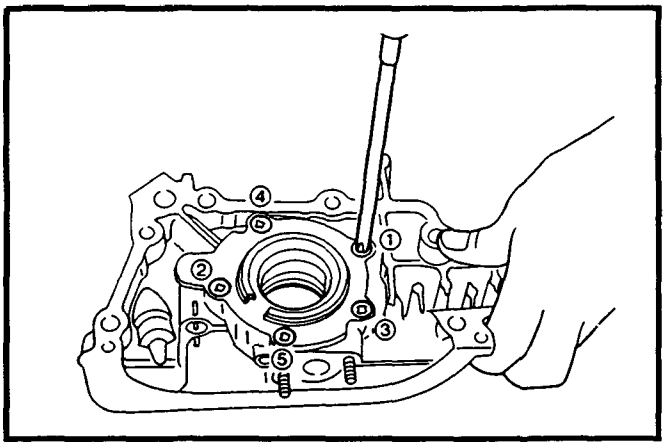


Figure 14. Drive & Driven Gear Installation

3. Insert the "O" ring onto the groove provided at the oil pump cover.

   Then press the "O" ring at the three points of embossed marks on the cover (for fixing the "O" ring).

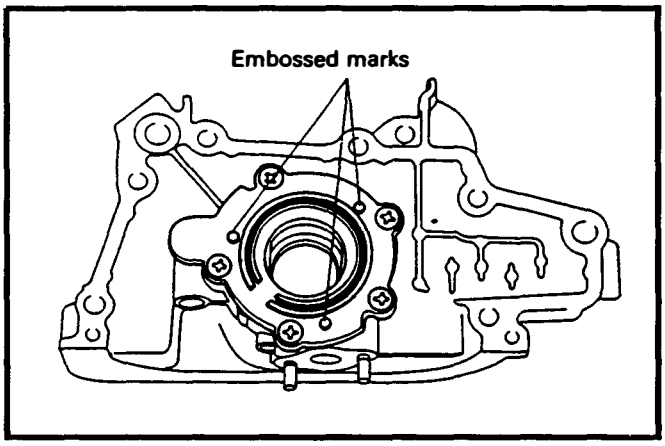
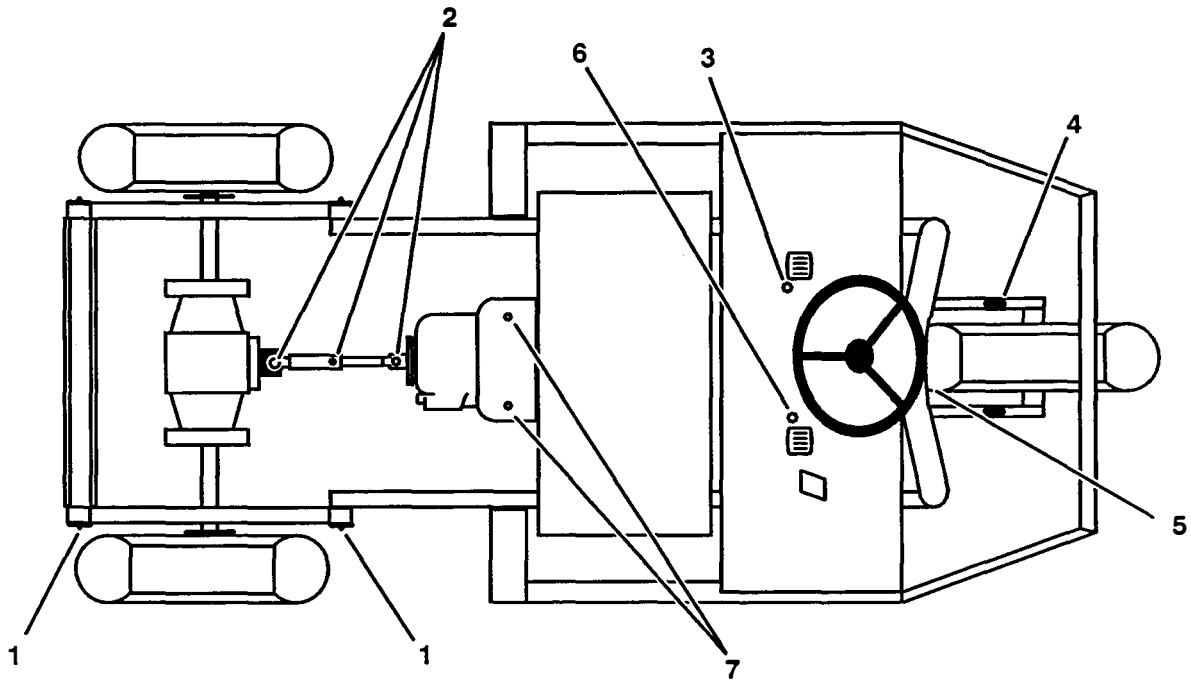


Figure 15. 'O' Ring Installation

CHASSIS LUBRICATION CHART
MODELS: 898464, 898465
898466, 898467



CHASSIS LUBRICATION GUIDE
Perform every 100 hours or 1000 miles

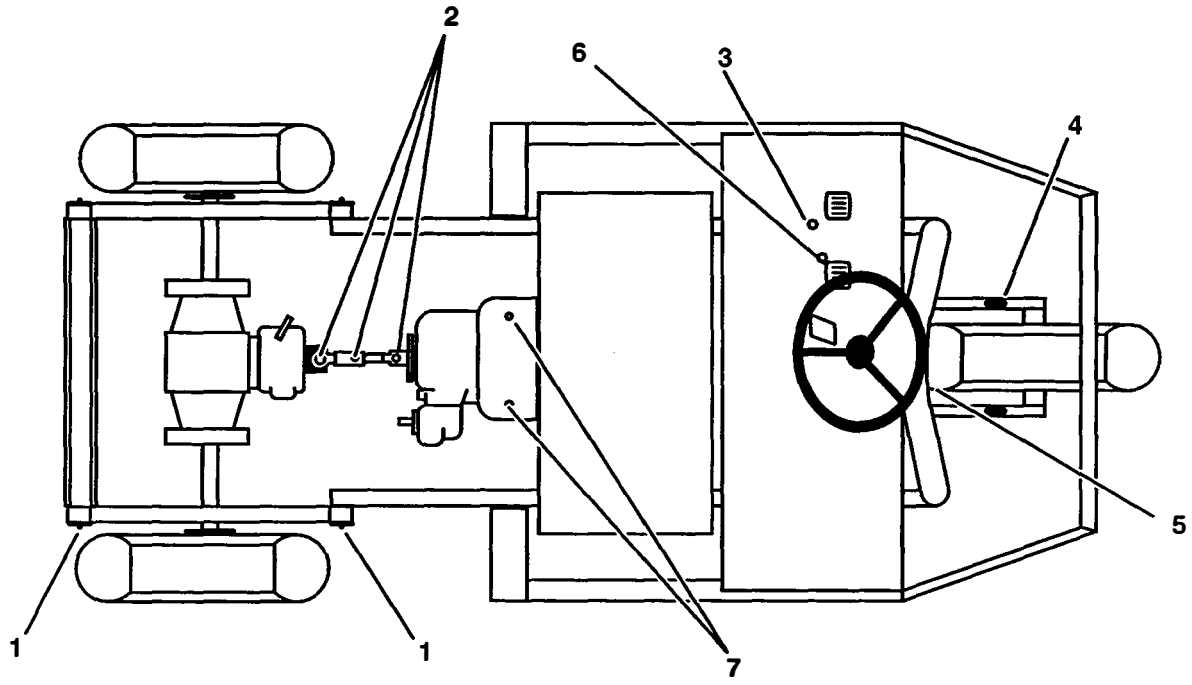
LUBRICATION AREA	NUMBER OF GREASE FITTINGS*
1. Rear spring shackles	6
2. Drive shaft	3
3. Clutch bellcrank (pivot bushing)	1
4. Leading link bushinngs	2
5. Lower fork pivot bearing	1
6. Brake bellcrank (pivot bushing)	1
7. Clutch arm	2

* Use a lithium base pressure gun grease on all grease fittings.

NOTE

- Too much grease can damage the seals on item 2.

CHASSIS LUBRICATION CHART
MODEL 898630



CHASSIS LUBRICATION GUIDE
Perform every 100 hours or 1000 miles

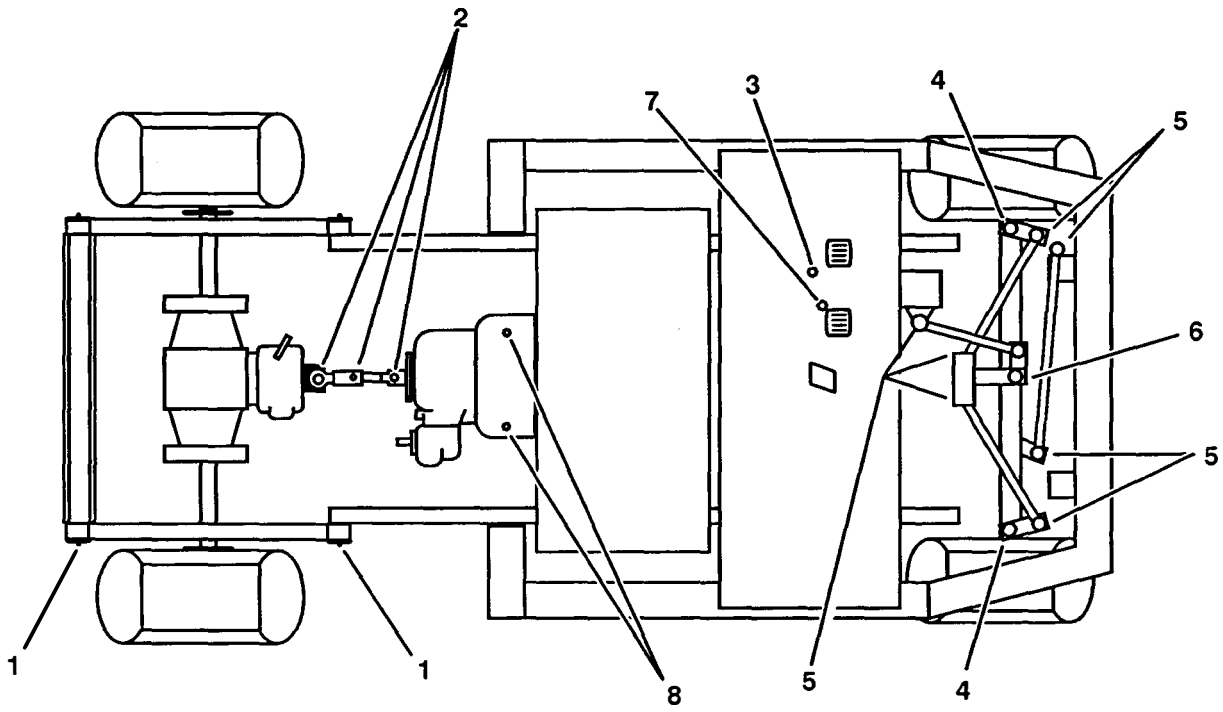
LUBRICATION AREA	NUMBER OF GREASE FITTINGS*
1. Rear spring shackles	6
2. Drive shaft	3
3. Clutch bellcrank(pivot bushing)	1
4. Leading link bushings	2
5. Lower fork pivot bearing	1
6. Brake bellcrank (pivot bushing)	1
7. Clutch arm	2

* Use a lithium base pressure gun grease on all grease fittings.

NOTE

- Too much grease can damage the seals on item 2.

CHASSIS LUBRICATION CHART
MODEL 898632



CHASSIS LUBRICATION GUIDE
Perform every 100 hours or 1000 miles

LUBRICATION AREA	NUMBER OF GREASE FITTINGS*
1. Rear spring shackles	6
2. Drive shaft	3
3. Clutch bellcrank (pivot bushing)	1
4. King pin bushings	2
5. Steering linkage	1
6. Steering pivot	1
7. Brake bellcrank (pivot bushing)	1
8. Clutch arm	2

* Use a lithium base pressure gun grease on all grease fittings.

NOTE

- Too much grease can damage the seals on item 2.

6 COOLING SYSTEM

Cooling System Check

NOTE

- When adding or replacing coolant a 50-50 mixture of a good grade of ethylene glycol antifreeze and distilled water is recommended. This will provide protection to –34° F (–37° C).
  It is extremely important that the antifreeze and water is mixed in a separate container before adding the mixture to the cooling system. NEVER add straight antifreeze or straight water to the radiator.

Radiator testing

1. Connect a pressurized cooling system tester according to the instructions included with the tester kit.

2. The radiator and cooling system must hold 11 psi (76 kPa).

3. Repair all leaks. Replace all worn or damaged parts.

Radiator cap testing

1. Connect a pressurized cooling system tester according to the instructions included with the tester kit.

2. The radiator cap must open between 8 to 15 psi (55 to 103 kPa).

Thermostat

1. **Removal**
   Remove the thermostat housing . See Figure 1.

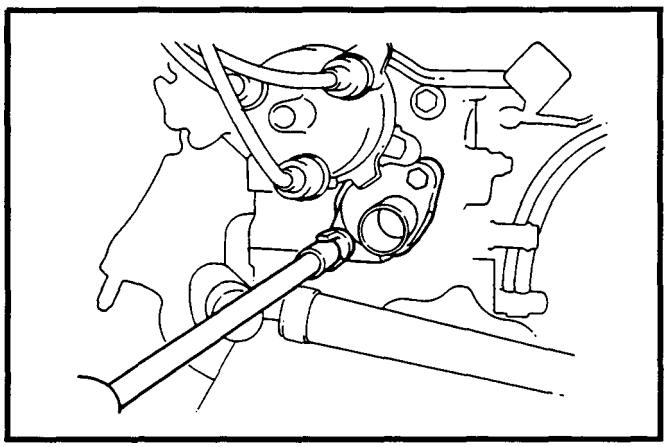


Figure 1.
Thermostat Removal

2. Remove the thermostat mounting screws. Remove the thermostat from the thermostat housing.

3. **Testing**
   Immerse the thermostat in water, and check the valve opening temperature by heating the water gradually.

4. Replace the thermostat if the valve remains open below the specified opening temperature or does not close completely. See Figure 2.
   The thermostat starts to open at:
   180° F ± 2° F(82° C ± 1.5° C)
   The thermostat must be fully open at:
   203° F (95° C).

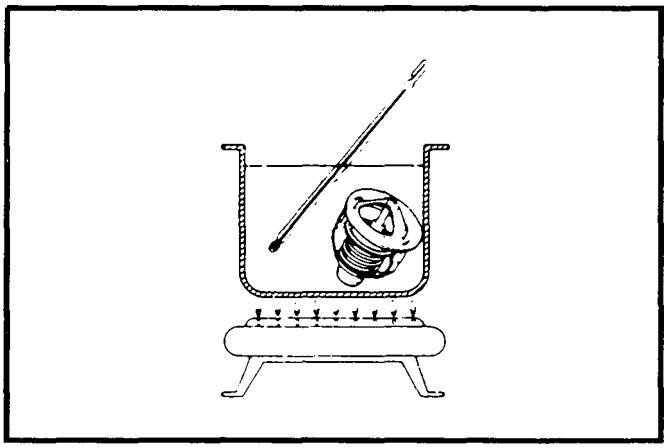


Figure 2.
Thermostat Testing

5. **Installation**
Install the thermostat into the thermostat housing. Install new gasket. Attach housing assembly to the cylinder head. See Figure 3.
Torque: 11 to 17 ft lbs (15 to 23 Nm)

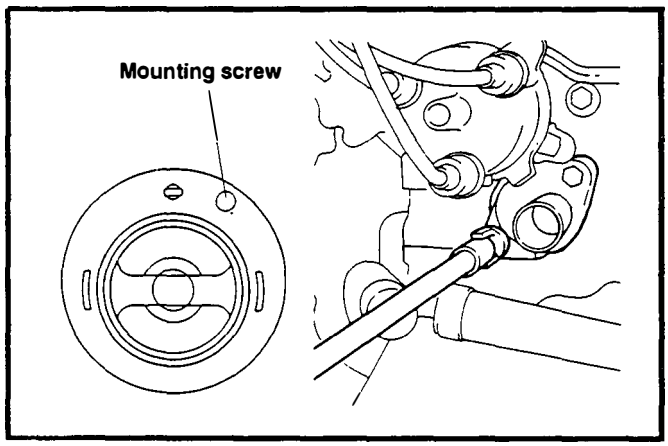


Figure 3.
Thermostat Installation

Cooling Fan Motor

1. **In-vehicle inspection**
Disconnect the electrical connection at the radiator fan control switch mounted on the engine. See Figure 4.

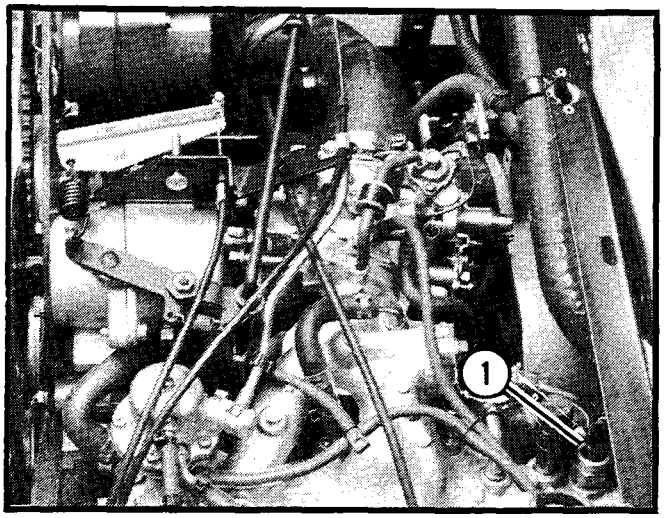


Figure 4.
1. Radiator Fan Control Switch

2. Connect one end of a jumper wire to the fan control switch wire and ground the other end of the jumper wire to the engine. The fan motor should run. If it does not run continue with step 4.

3. The radiator fan control switch may be tested following these procedures: See Figure 5.
(A) Remove the switch from the engine.
(B) Connect a continuity light to the switch
(C)Place the switch in water and watch the meter at various temperatures
(D) As the water temperature reaches 198° F (92° C) the continuity light should light
(E) As the water temperature is lowered to 189° F (87° C) the continuity light should go out

4. Replace the fan control switch if it does not pass this test.

NOTE

- Before installing the radiator fan control switch be sure to apply pipe thread sealer to the threads.

Engine Coolant

NOTE

- Be sure to follow this procedure when changing the engine coolant. (If over-flow bottle coolant is low it will may cause overheating.)

- When adding coolant to the cooling system **always make sure that the radiator is full** and the over-flow bottle is filled to the full mark.

Draining the Cooling System

1. Remove the radiator cap. Open the radiator drain cock and drain the coolant.

NOTE

- To drain the engine completely the bottom radiator hose must be removed at the radiator.

- To prevent burning yourself or bystanders, do not remove the radiator cap when the engine is hot.

2. Drain the coolant from the over-flow bottle.

3. Securely tighten the drain cock.

Filling the Cooling System

1. Loosen the bleeder plug (located near the fuel pump on the intake manifold). See Figure 6.

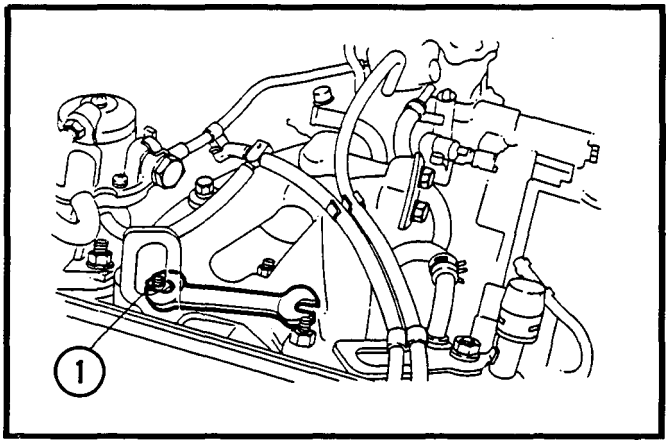


Figure 6.
1. Loosening Bleeder Plug

2. Fill the coolant in the reserve tank until the coolant level reaches the **"FULL"** line.

3. Fill the coolant in the radiator until the coolant flows from the bleeder plug.

4. Tighten the bleeder plug. Continue filling the system until coolant flows into the reserve tank. Install the radiator cap.

5. Start the engine. Allow the engine to warm up so the fan comes on. Continue running the engine until the fan stops and starts again, then stop the engine.

SAFETY WARNING

- **To avoid burning yourself, never remove the radiator cap while the engine is still hot.**

6. Check coolant level at the over-flow bottle. Add coolant up to the **"FULL"** line (hot or cold) of the over-flow bottle.

SECTION 7 ENGINE ELECTRIAL

STARTING SYSTEM

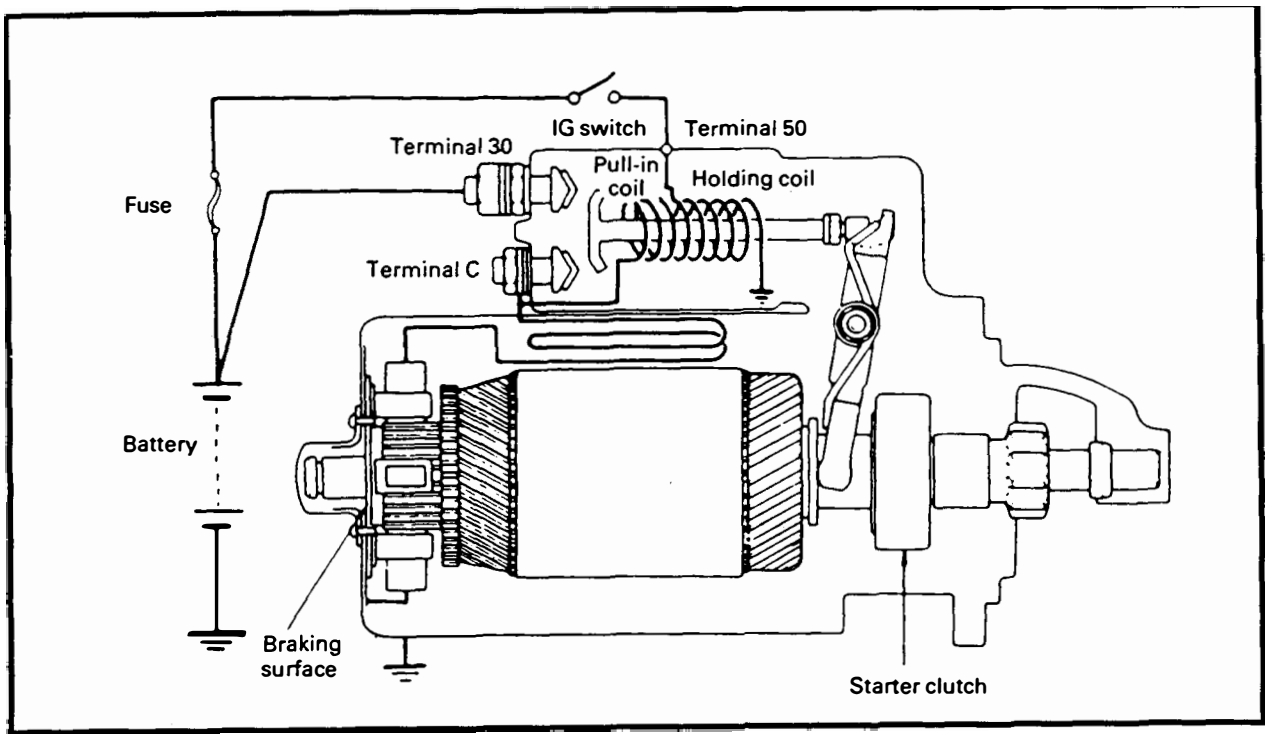


Figure 1. Starting System

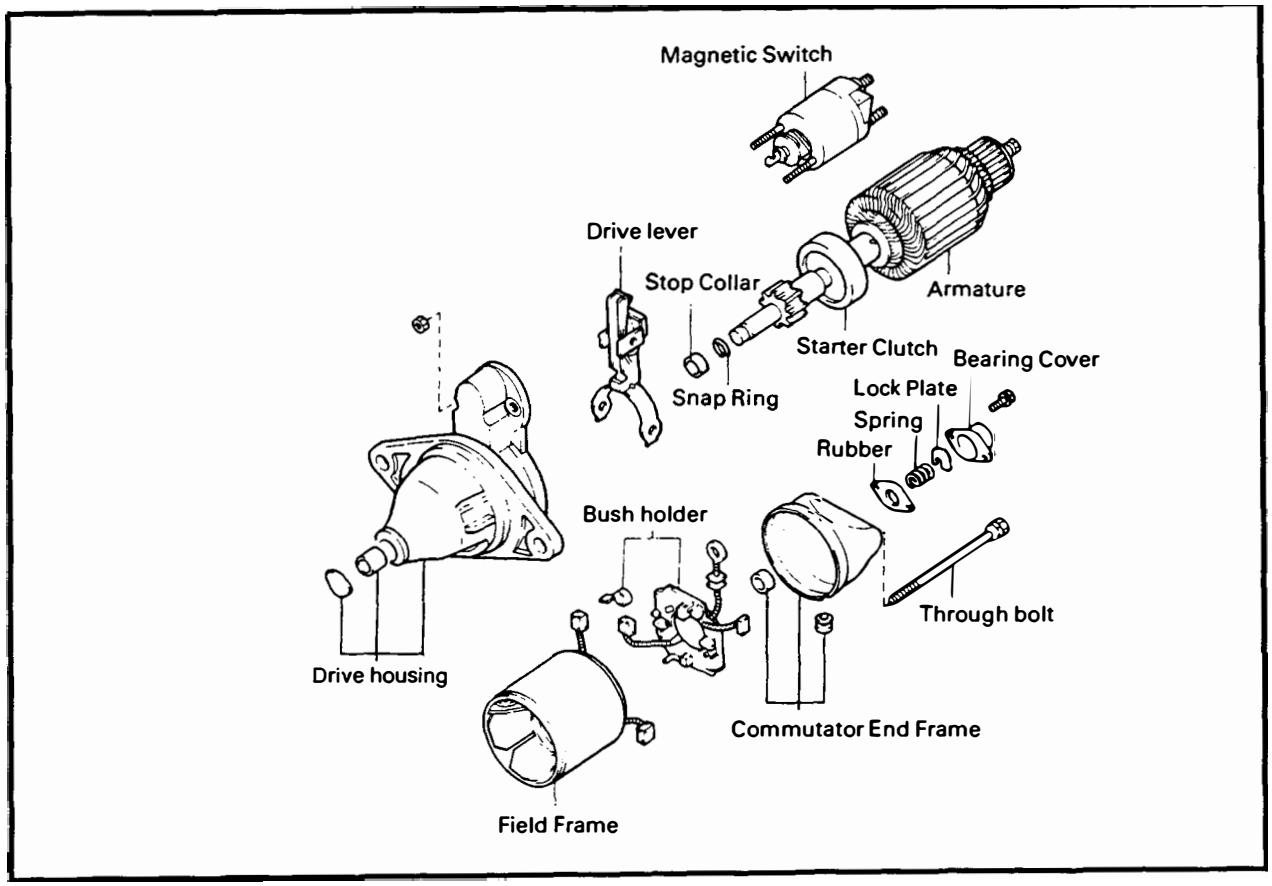


Figure 2. Components

STARTER DISASSEMBLY

1. **Remove solenoid**

   (1) Remove the nut, and disconnect the lead wire from the solenoid terminal.

   (2) Loosen the two nuts holding the solenoid to the starter housing. Lift the solenoid up and out to unhook the plunger from the starter drive lever.

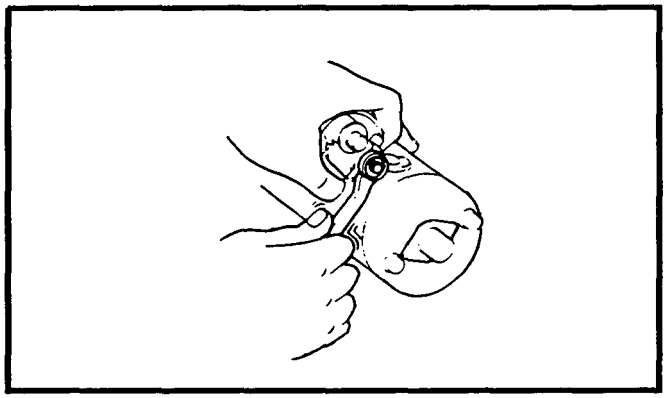


Figure 3. Solenoid Removal

2. **Remove end frame**

   (1) Remove the end frame cover.

   (2) Using a feeler gauge, check the armature shaft end play between the lock plate and end frame.

   End Play: .0020 to .0236 in. (0.05 to 0.06 mm)

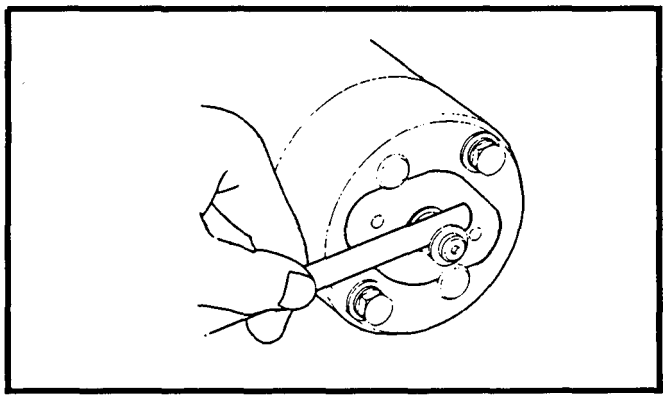


Figure 4. End Play Check

   (3) Remove the lock plate, spring and gasket.

   (4) Remove the two through bolts and remove the commutator end frame .

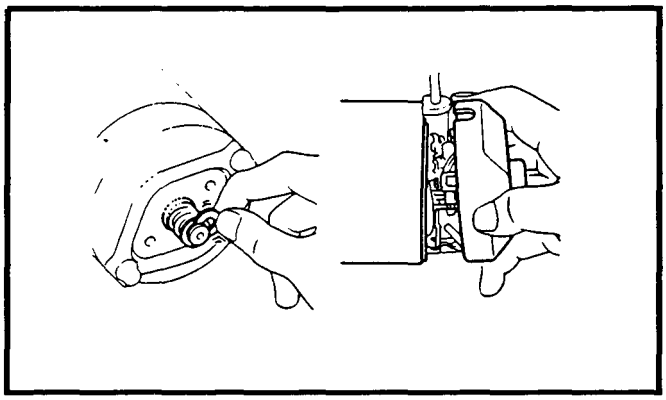


Figure 5. End Frame Removal

3. **Remove brushes and brush holder**

   (1) Using a piece of steel wire, lift up the brush springs and remove the brushes from the brush holder.

   (2) Pull the brush holder off the armature.

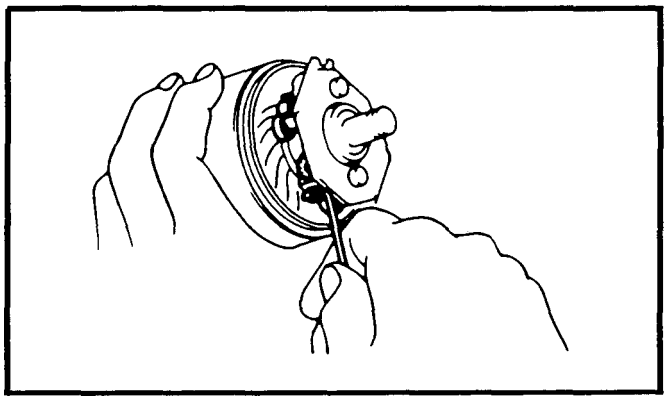


Figure 6. Brush Removal

4. **Remove field frame from drive housing**

   Pull apart by hand.

5. **Remove armature**

   (1) Remove the drive lever from the drive housing.

   (2) Pull the armature from the drive housing.

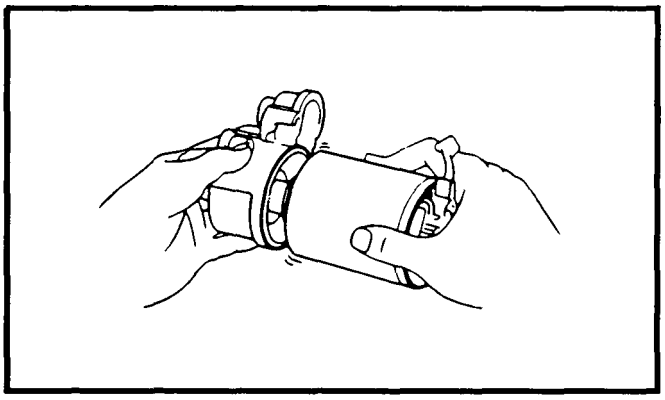


Figure 7. Armature Removal

6. **Remove starter clutch**

   (1) Using a flat blade screwdriver, push the stop collar towards the pinion gear.

   (2) Using a flat blade screwdriver, pry off the retaining ring.

   (3) Remove the collar from the shaft.

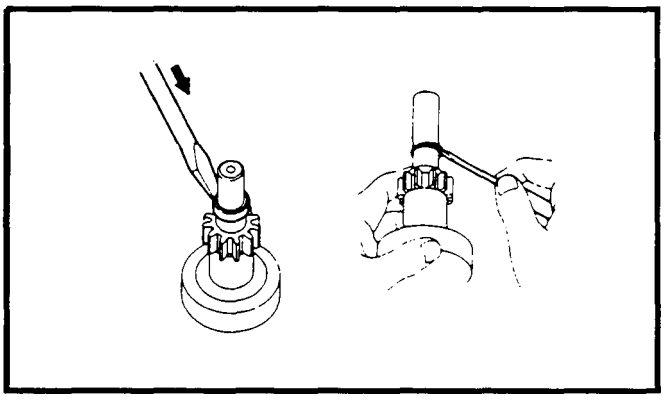


Figure 8. Starter Clutch Removal (1)

   (4) If the pinion does not slide easily on the shaft, smooth the shaft with an emery cloth.

   (5) Remove the starter clutch.

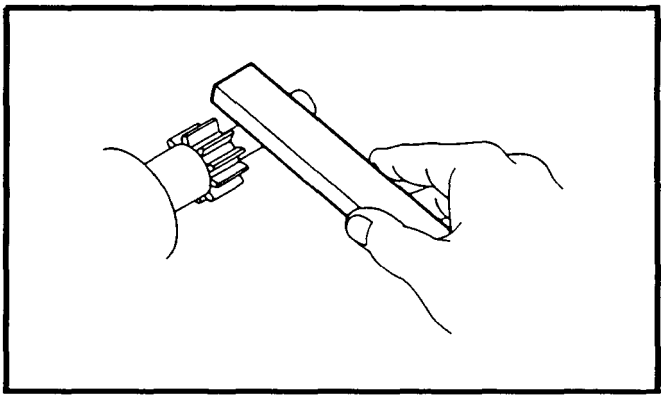


Figure 9. Smooth Starter Shaft (4)

INSPECTION
ARMATURE COIL

1. **Check the commutator for grounding**

   Using an ohmmeter, check the armature coil for continuity between the commutator and armature coil core. If there is continuity, replace the armature.

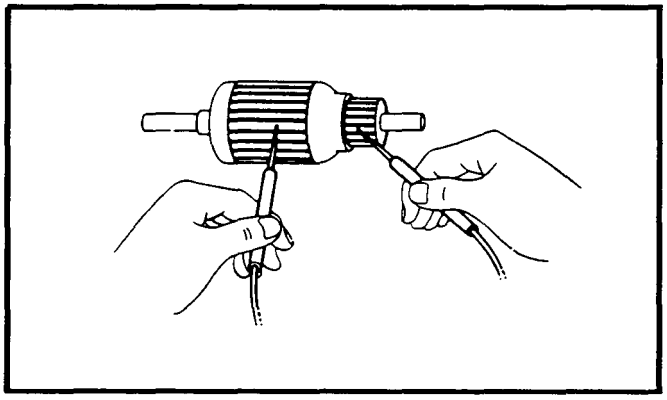


Figure 10. Commutator Check (1)

2. **Check the commutator for open circuit**

Using an ohmmeter, check for continuity between segments of the commutator. If there is no continuity between any two segment; replace the armature.

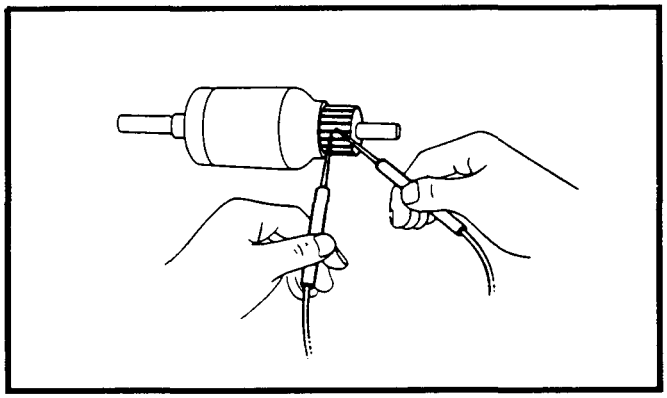


Figure 11. Commutator Check

FIELD COIL

1. **Check field coil for open circuit**

Using an ohmmeter, check for continuity between the field coil brush leads.

If there is no continuity, replace the field coil.

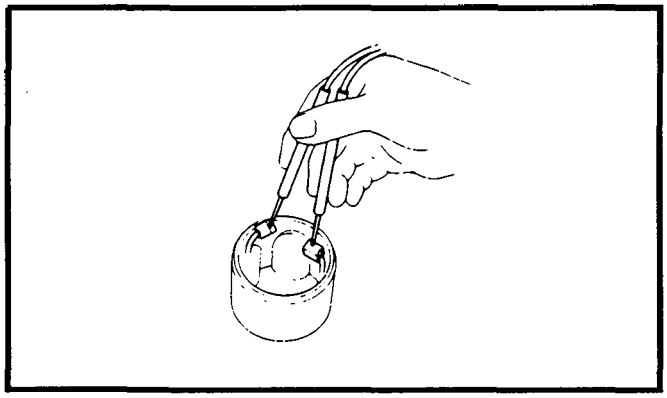


Figure 12. Field Coil Check

2. **Check the field coil for continuity**

Using an ohmmeter, check for continuity between the field coil and the field coil mounting frame.

If there is continuity, replace the field coil.

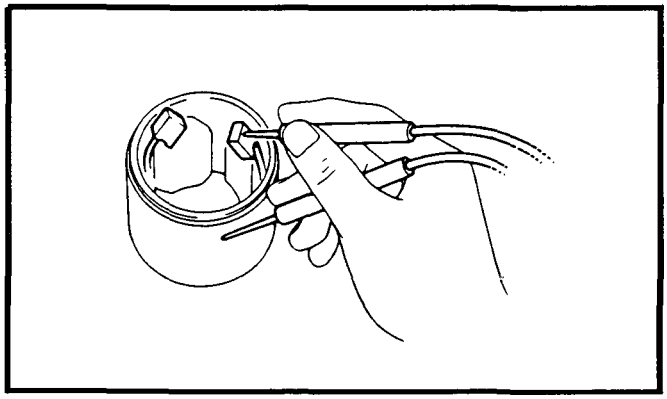


Figure 13. Field Coil Check

Solenoid

1. **Check plunger**

Push the plunger in and release it. Check that it returns freely to its original position

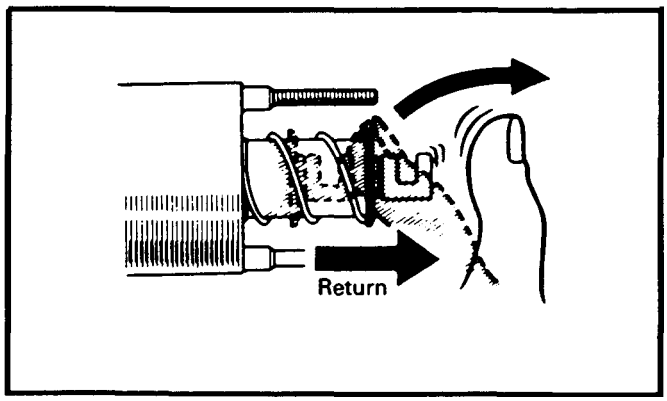


Figure 14. Plunger Check

2. **Perform pull–in coil open circuit test**

Using an ohmmeter, check for continuity between terminal 50 and terminal C.
If there is no continuity, replace the solenoid.

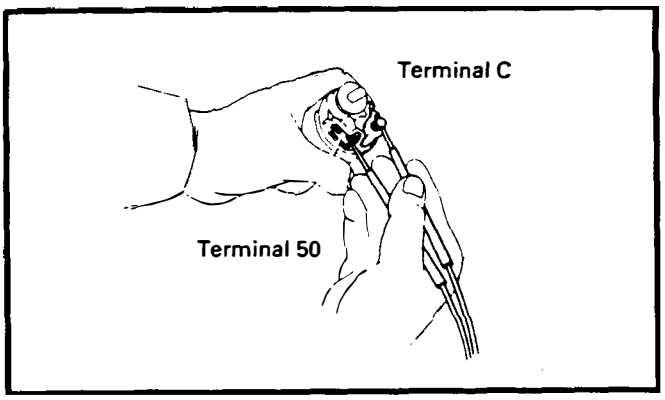


Figure 15. Pull–in Coil Circuit Check

3. **Perform hold–in coil open circuit test**

Using an ohmmeter, check for continuity between terminal 50 and the switch body.
If there is no continuity, replace the solenoid.

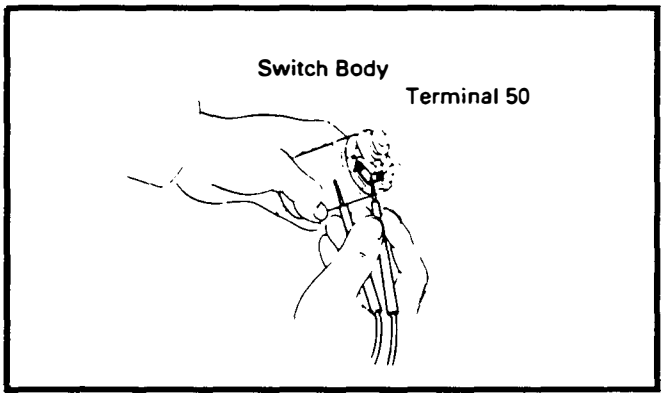


Figure 16. Hold–in Coil Circuit Check

STARTER CLUTCH

1. **Inspect the pinion gear**

Inspect the pinion gear for wear or damage. If damaged, replace.
Check the flywheel ring gear for wear and damage.

2. **Check clutch**

Rotate the pinion clockwise and check that it locks.
Try to rotate the pinion counterclockwise and check that it turns freely.

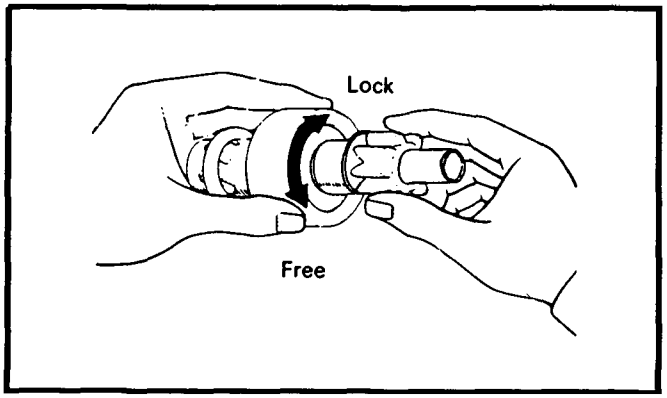


Figure 17. Clutch Check

BRUSH HOLDER

Check continuity of brush holder

Using an ohmmeter, check for continuity between the positive and negative brush holders.
If there is continuity, repair or replace the brush holder.

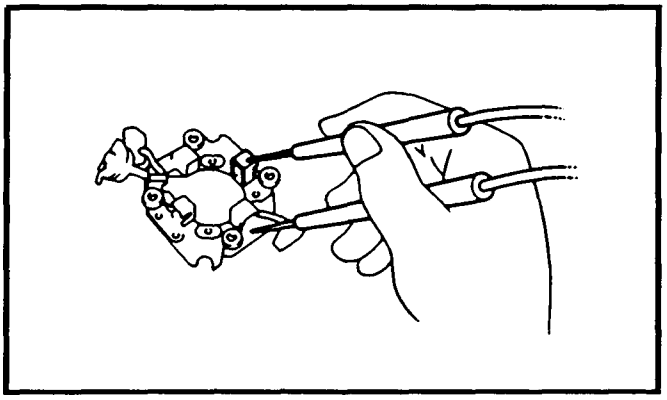


Figure 18. Brush Holder Check

ASSEMBLY

NOTE

- Use high temperature grease to lubricate the bearings and sliding parts when assembling the starter.

2. Assemble starter clutch to armature

(1) Place a new stop collar on the armature.

(2) Push the snap ring onto the shaft with a 1/2 in. (14 mm) socket. Fit the snap ring into the shaft groove.

(3) Using a vise, compress the snap ring. Make sure that the snap ring fits correctly.

(4) Using a flat blade screwdriver, push the pinion to slide the stop collar onto the snap ring.

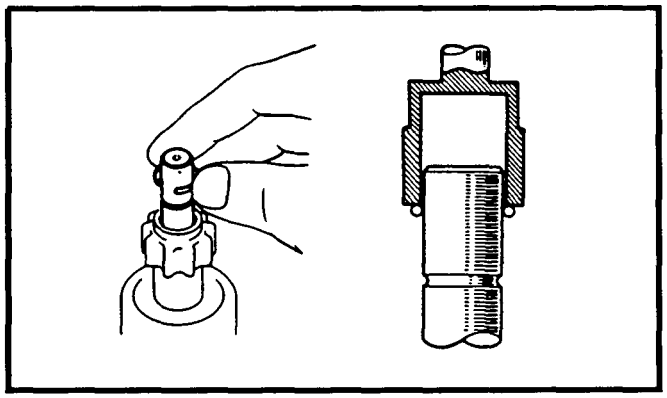


Figure 19. Starter Clutch Assembly (2)

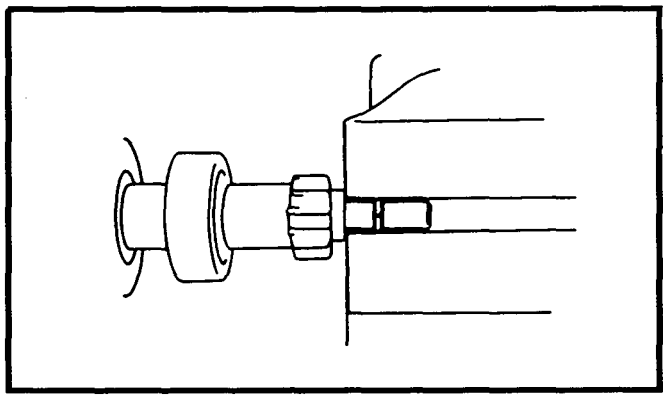


Figure 20. Starter Clutch Assembly (3)

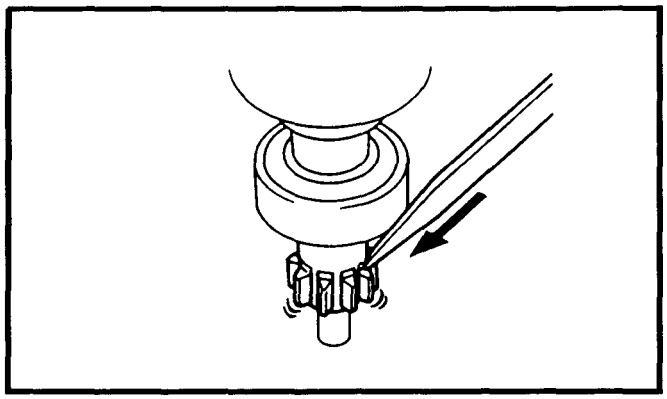


Figure 21. Starter Clutch Assembly (4)

2. Assemble drive housing, drive lever, field coil, and armature

(1) Apply grease to the drive lever and housing bushing.

(2) Install the drive lever to the drive housing.

(3) Install the field coil on the armature.

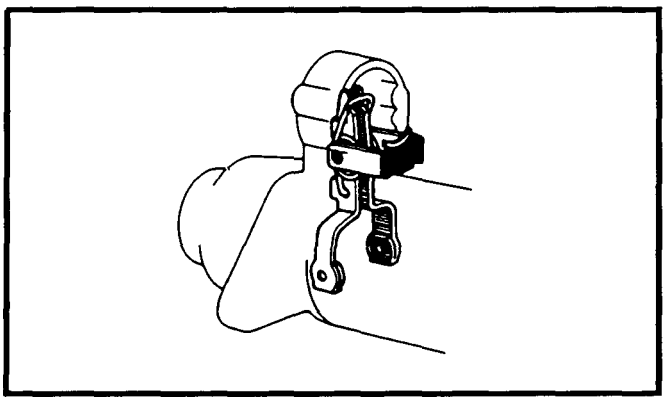


Figure 22. Drive Housing Assembly

3. **Install brush holder and brushes**

   (1) Place the brush holder over the armature shaft.

   (2) Using a piece of steel wire, hold the brush spring back and install the brush in the brush holder. Install all four brushes.

4. **Install end frame**

   (1) Apply grease to the end frame bushing.

   (2) Install the end frame on the armature shaft and secure with two through bolts.

5. **Install bearing cover**

   (1) Install the gasket, spring, and lock plate.

   (2) Using a feeler gauge, measure the armature end play.

6. **Thrust clearance: .0020 to .0236 in. (0.05 to 0.60 mm)**

   (3) Install the bearing cover with the two screws.

7. **Install solenoid**

   Hook the solenoid lever underneath the drive lever spring. Install the mounting nuts.

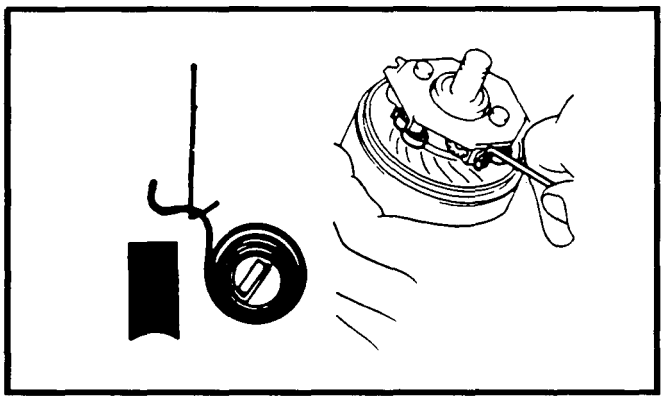


Figure 23. Brush Installation

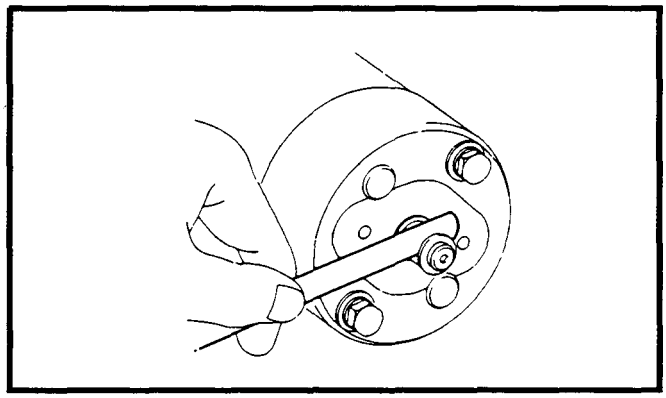


Figure 24. End Play

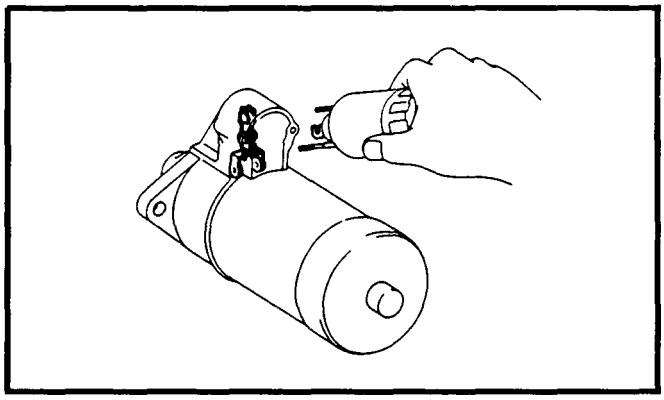


Figure 25. Solenoid Installation

PERFORMANCE TEST

NOTE

- These tests must not be run for more than 3 to 5 seconds to avoid burning out the coil.

1. Perform pull–in test

(1) Disconnect the field coil lead from terminal C.

(2) Connect the battery to the solenoid as shown. Check that the pinion moves.

If the pinion does not move, replace the solenoid.

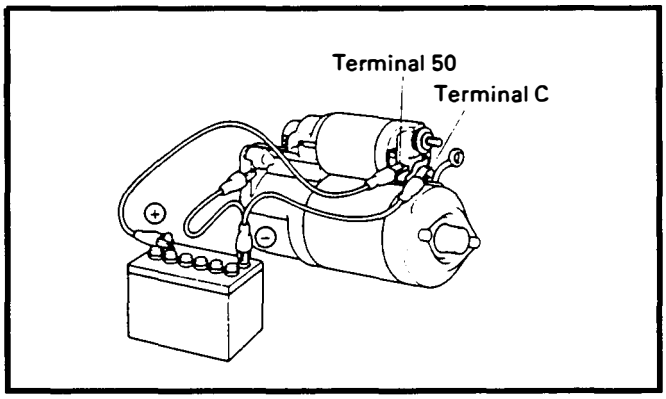


Figure 26. Pull–in Test

2. Perform hold–in test

While still connected as above, disconnect the negative lead from terminal C. Check that the pinion does not return.
If the pinion returns, replace the solenoid.

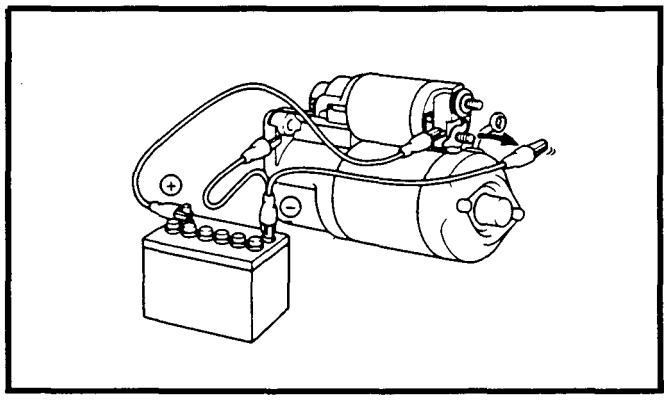


Figure 27. Hold–in Test

3. Check pinion return

Disconnect the negative lead from the switch body. Check that the pinion returns. If the pinion does not return, replace the solenoid.

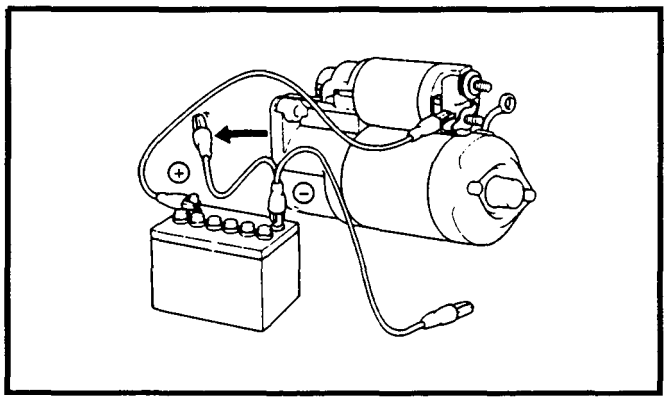


Figure 28. Pinion Return Check

4. Check pinion clearance

(1) Connect the battery to the solenoid as shown.

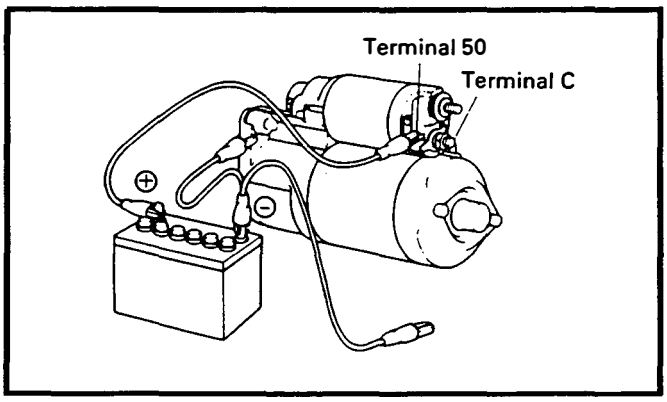


Figure 29. Pinion Clearance Check

(2) Move the pinion gear toward the armature. Measure the clearance between the pinion and the stop collar.
Standard clearance: .004 to .157 in. (0.1 to 4.0 mm)

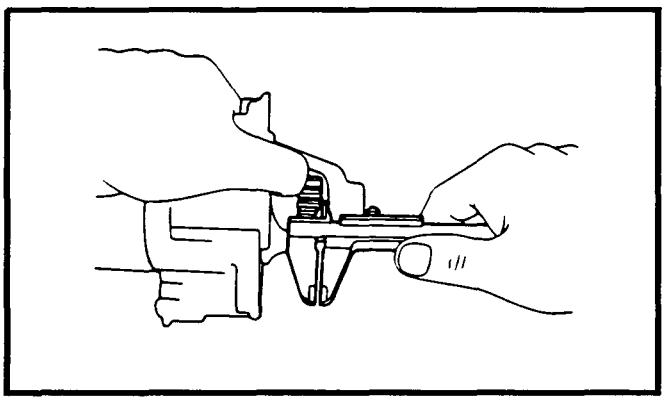


Figure 30. Pinion Clearance Check

5. **No–load performance test**

(1) Connect the field coil lead to terminal C. Make sure the lead is not grounded.

(2) Connect the battery and ammeter to the starter as shown.

(3) Check that the starter rotates smoothly with the pinion engaging.

(4) Check that the ammeter reads the specified current.

Specified current: Less than 50 Amps at 11Volts

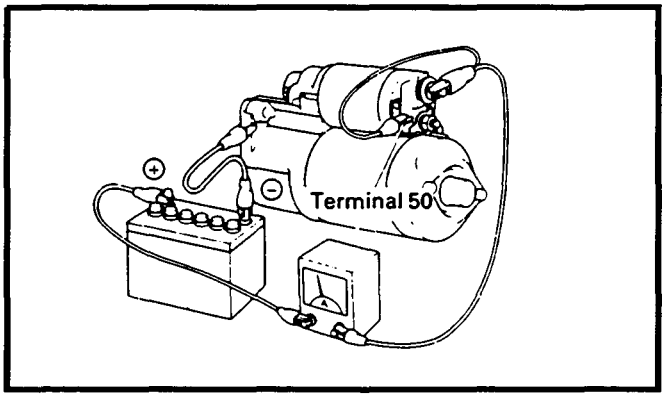


Figure 31. No–Load Performance

IGNITION SYSTEM

IN–VEHICLE INSPECTION

1. **High tension wire check**

(1) Carefully remove the high tension wires.

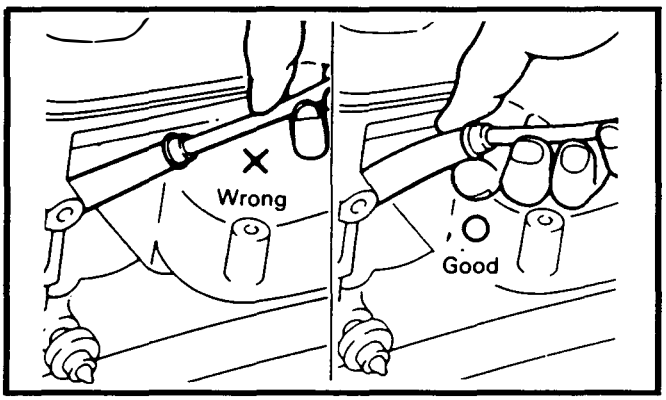


Figure 32. High Tension Wire Removal

NOTE

- Pulling on or bending the wires may damage the conductor inside.

(2) Measure the resistance of high tension wire.

Resistance:
No. 1 wire 6.0 to 13.2 kΩ
No. 2 wire 5.0 to 11.0 kΩ
No. 3 wire 4.7 to 10.3 kΩ
Coil wire 4.5 to to 9.9 kΩ

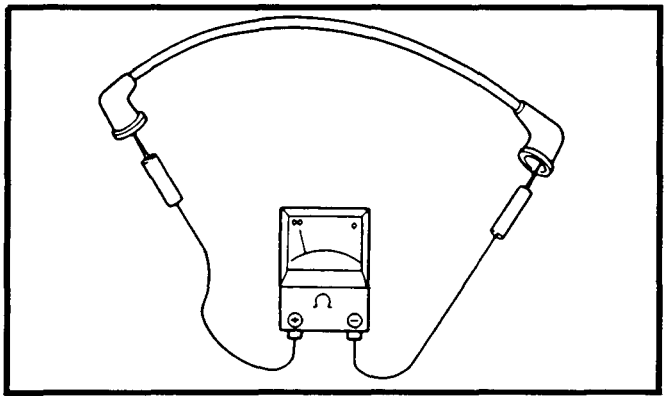


Figure 33. High Tension Wire Check

2. Spark plug

(1) Remove the spark plug.

(2) Inspect the spark plugs for thread damage and insulator damage.

(3) Adjust the electrode gap. Carefully bend the outer electrode to obtain the correct electrode gap.

Electrode Gap: .032 in (0.8 mm)

If any of the spark plugs appear questionable replace all three with new plugs.

(4) Install the spark plugs.

3. Ignition coil

(1) Disconnect high tension wire.

(2) Inspect primary coil resistance. Using an ohmmeter, measure the resistance between the positive (+) and negative (–) terminals.
Primary coil resistance (cold): 1.2±0.12Ω

(3) Inspect secondary coil resistance. Using an ohmmeter, measure the resistance between the positive (+) terminal and high tension terminal.
Secondary coil resistance (cold): 26±3.9 kΩ

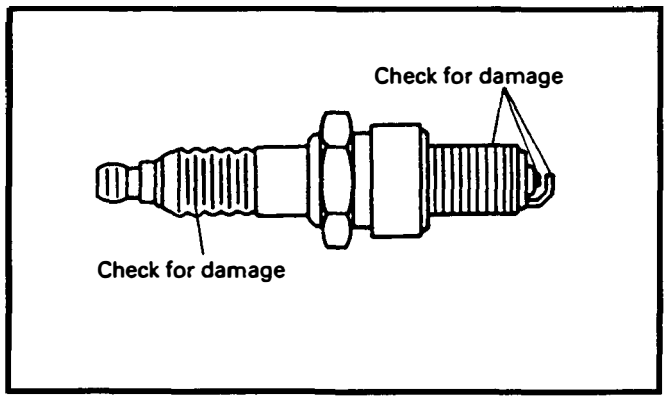


Figure 34. Spark Plug Check

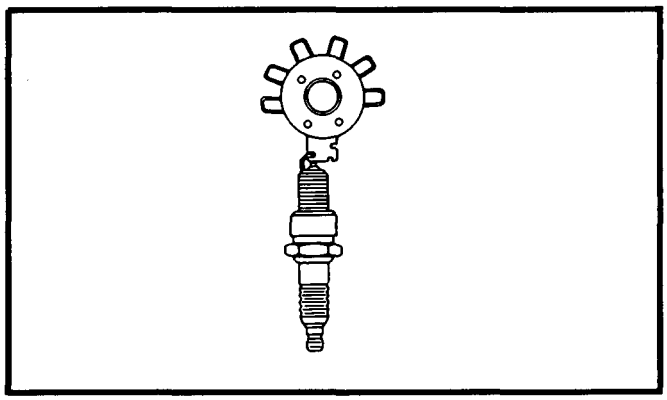


Figure 35. Electrode Gap Adjustment

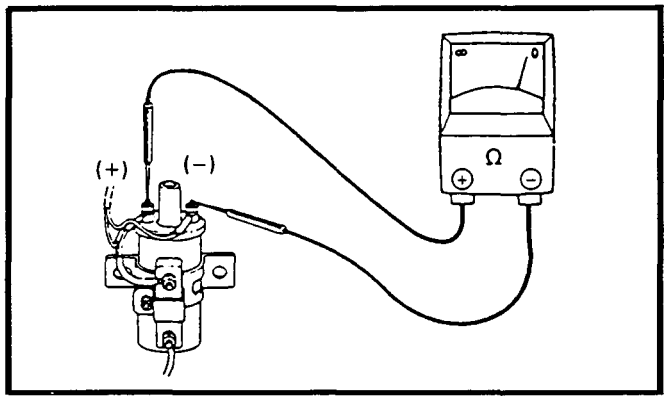


Figure 36. Primary Coil Resistance Check

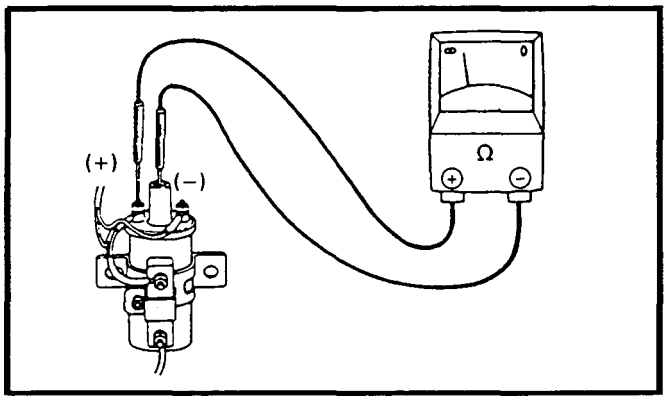


Figure 37. Secondary Coil Resistance Check

(4) Inspect coil case continuity. Using an ohmmeter, measure the resistance between positive (+) terminal and coil case.

Coil case continuity: Infinity

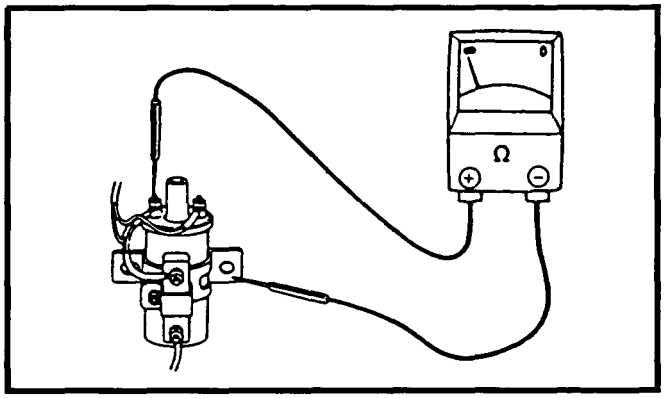


Figure 38. Coil Case Resistance Check

(5) Inspect the ignition resistor resistance. Using an ohmmeter, measure the resistance of the resistor.

Resistor resistance: 1.7±0.17Ω

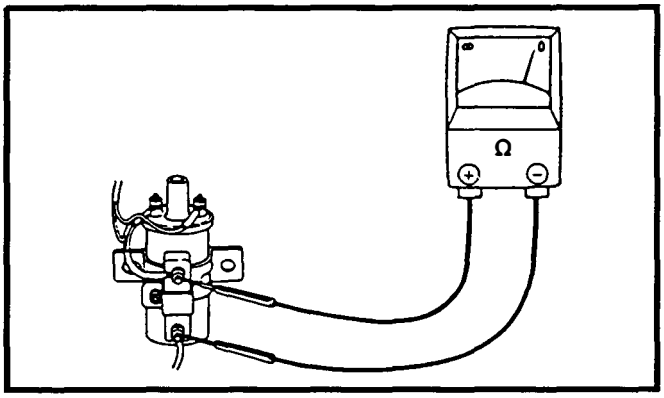


Figure 39. Resistor Resistance Check

4. Distributor Cap

Check for cracks, rust, dirt, corroded or worn terminals, and check the center contact for wear.

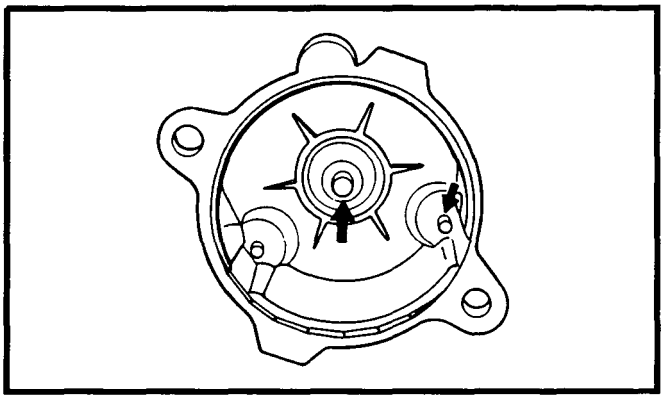


Figure 40. Distributor Cap Check

5. Rotor

Check for cracks, burnt contacts, dirt or corrosion.

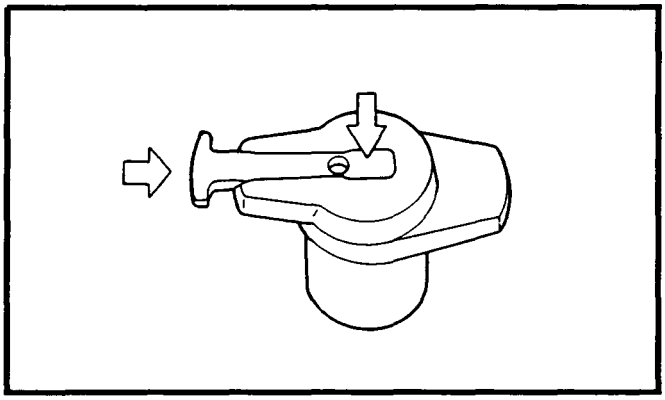


Figure 41. Rotor Check

DISTRIBUTOR

COMPONENTS

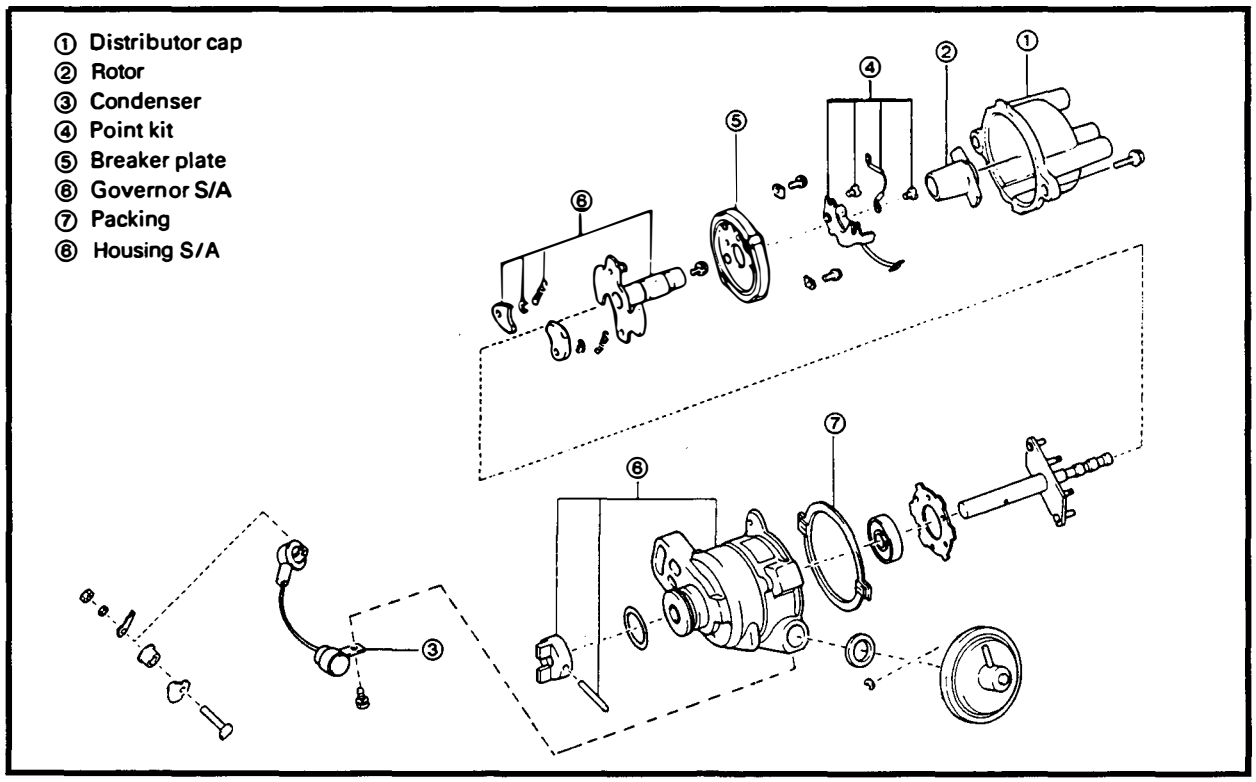


Figure 42. Components

DISASSEMBLY

1. Remove the distributor cap.
2. Remove the rotor.
3. Remove the terminal nut, condenser wire, insulators and terminal. See Figure 43.
4. Remove the breaker point mounting screws and remove the breaker points. See Figure 44.

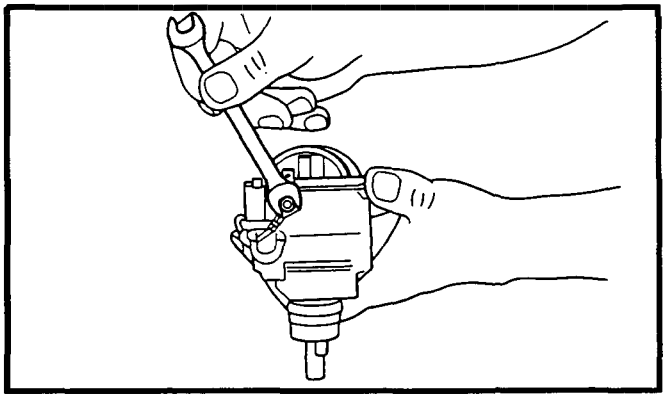


Figure 43. Terminal Nut Removal (3)

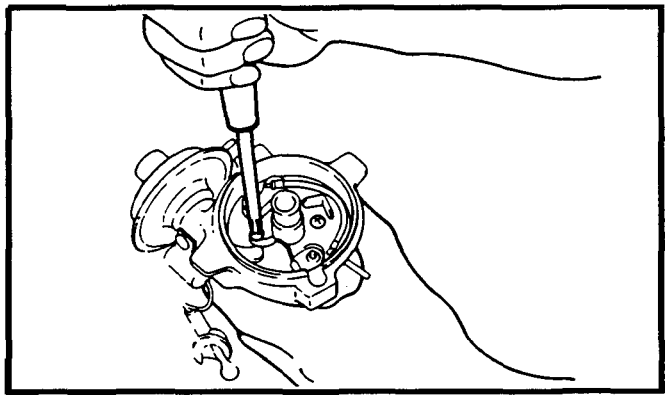


Figure 44. Breaker Point Removal

5. Remove the vacuum advance.

   (1) Remove the condenser mounting screw and condenser from the distributor housing.

   (2) Remove the E–ring. Turn and pull the vacuum advance from the housing.

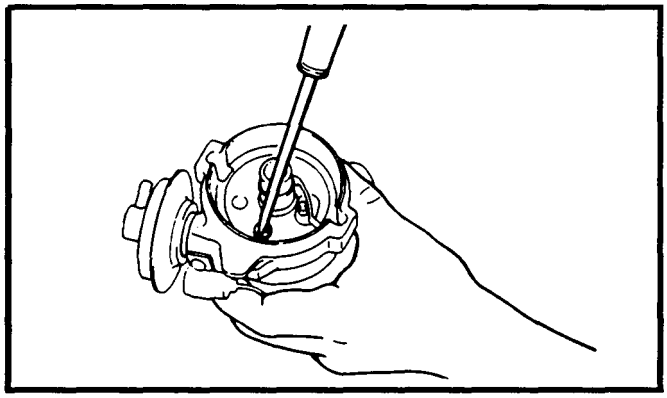


Figure 45. E–Ring Removal

6. Remove the breaker plate.

   (1) Remove the mounting screws, ground wire and advance plate clamps.

   (2) Pull out the advance plate.

7. Remove the advance weight springs.

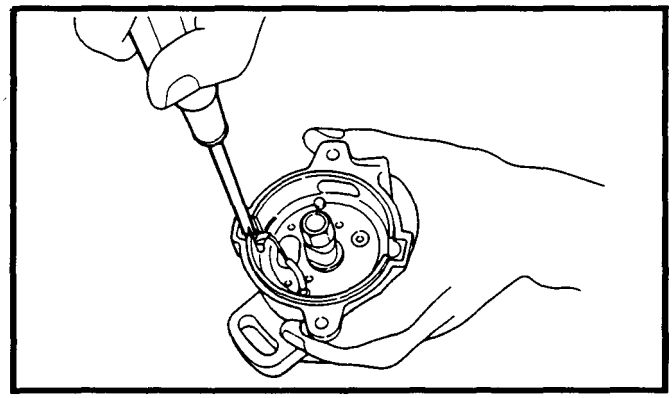


Figure 46. Breaker Plate Removal

8. Remove the cam.

   (1) Pry out the seal.

   (2) Remove the screw at the top of the governor shaft.

   (3) Pull the cam and advance weights from the housing.

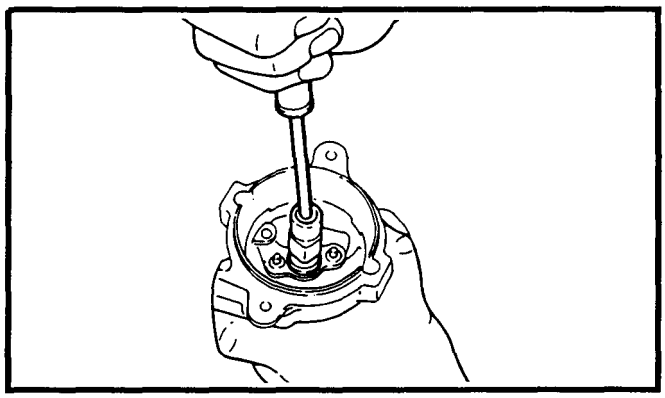


Figure 47. Cam Removal

INSPECTION

1. **Breaker plate**

   Turn the breaker plate and check that it has a free movement.
   If strong resistance or sticking is felt, replace the breaker plate.

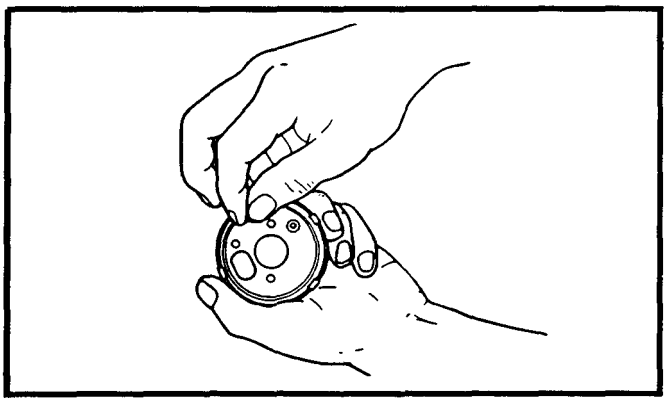


Figure 48. Breaker Plate Check

2. **Governor**

Temporarily install the cam on the shaft and check for looseness.
If necessary, replace the cam.

3. **Distributor shaft and housing**

Check for wear, or damage. If necessary, replace the housing.

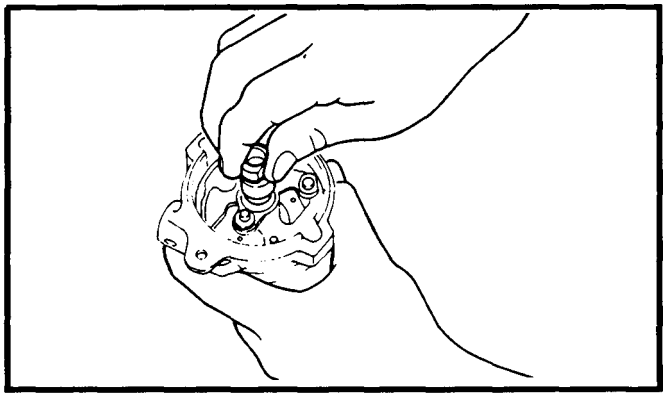


Figure 49. Distributor Check

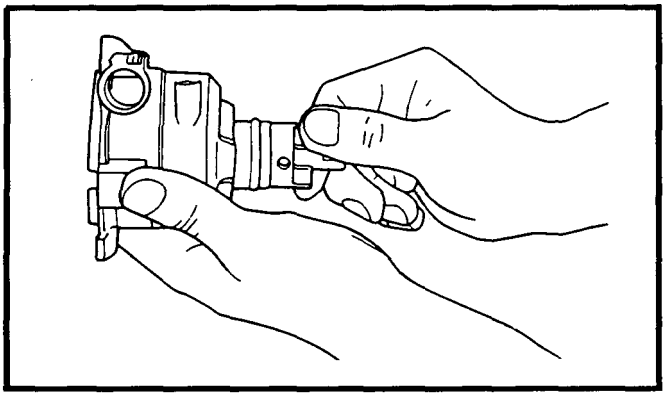


Figure 50. Distributor Shaft and Housing Check

ASSEMBLY

1. Cam and weights.

   (1) Install the cam with advance weights.

   (2) Install the cam retaining screw.

   (3) Pack high–temperature grease into the shaft.

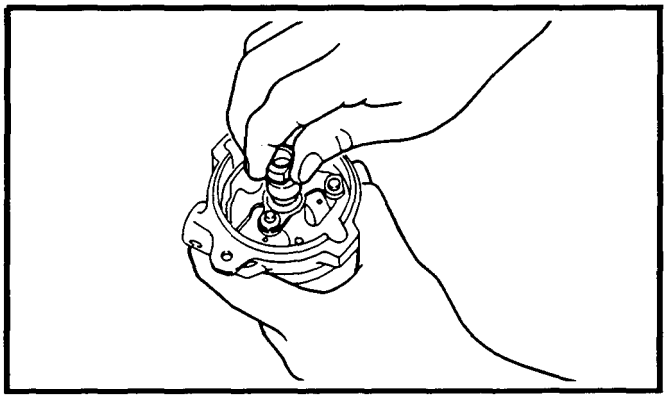


Figure 51. Cam Installation

   (4) Push the seal into place with your finger.

   (5) Install the advance springs.

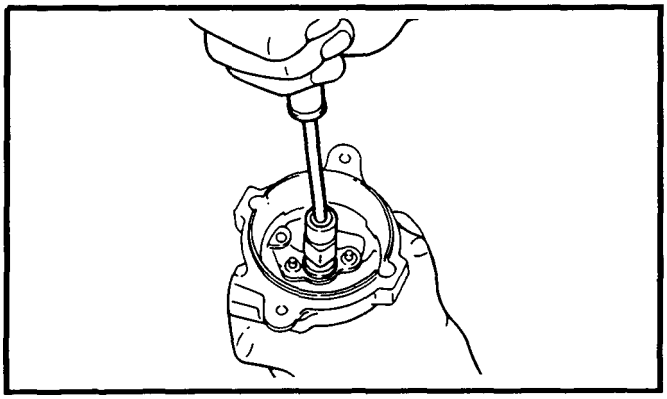


Figure 52. Screw Installation

2. Install the breaker plate.

   (1) Fit the four clips on the breaker plate into the housing slots.

   (2) Install one end of the ground wire and two plate clamps with mounting screws.

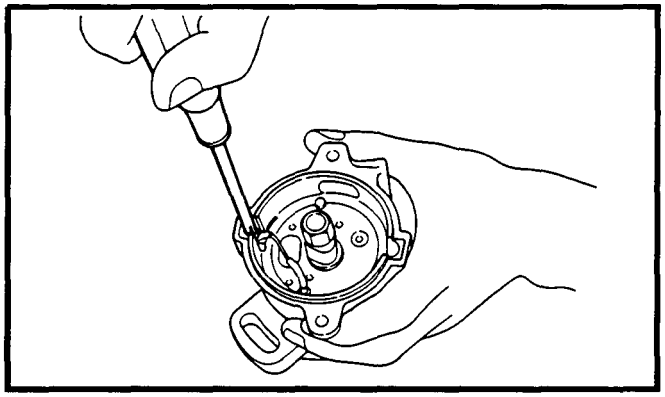


Figure 53. Breaker Plate Installation

3. Install the vacuum advance.

   (1) Insert the advance into the distributor and position the lever hole over the plate pin.

   (2) Install the E–ring on the pin.

   (3) Install the condenser to the distributor body

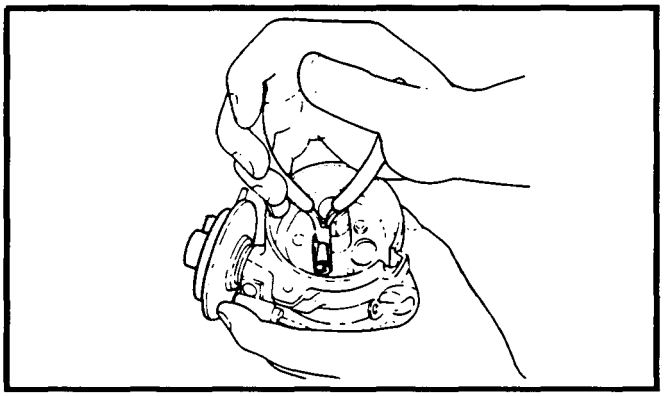


Figure 54. Vacuum Advance Installation

4. Install new breaker points.

   (1) Be sure the contact surfaces of the points are clean. Do not touch the surface of the points with your fingers.

   (2) Loosely install the breaker points with the mounting screws.

   (3) Rotate the cam so the points are open.

   (4) Using a thickness gauge, set the point gap and tighten the mounting screws.

   Heel gap: .017 inch (0.45 mm)

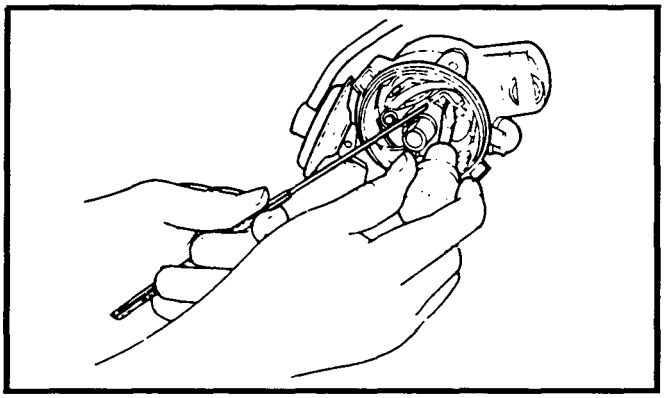


Figure 55. Breaker Point Adjustment

5. Insert the terminal with lead wire and install the insulators, condenser wire and terminal nut.

6. Install the rotor.

7. Install distributor cap.

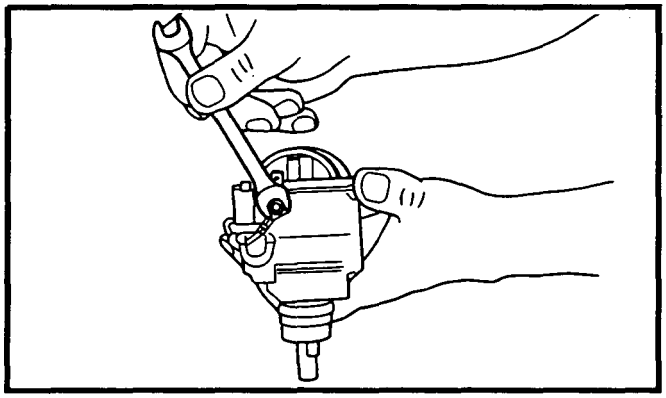
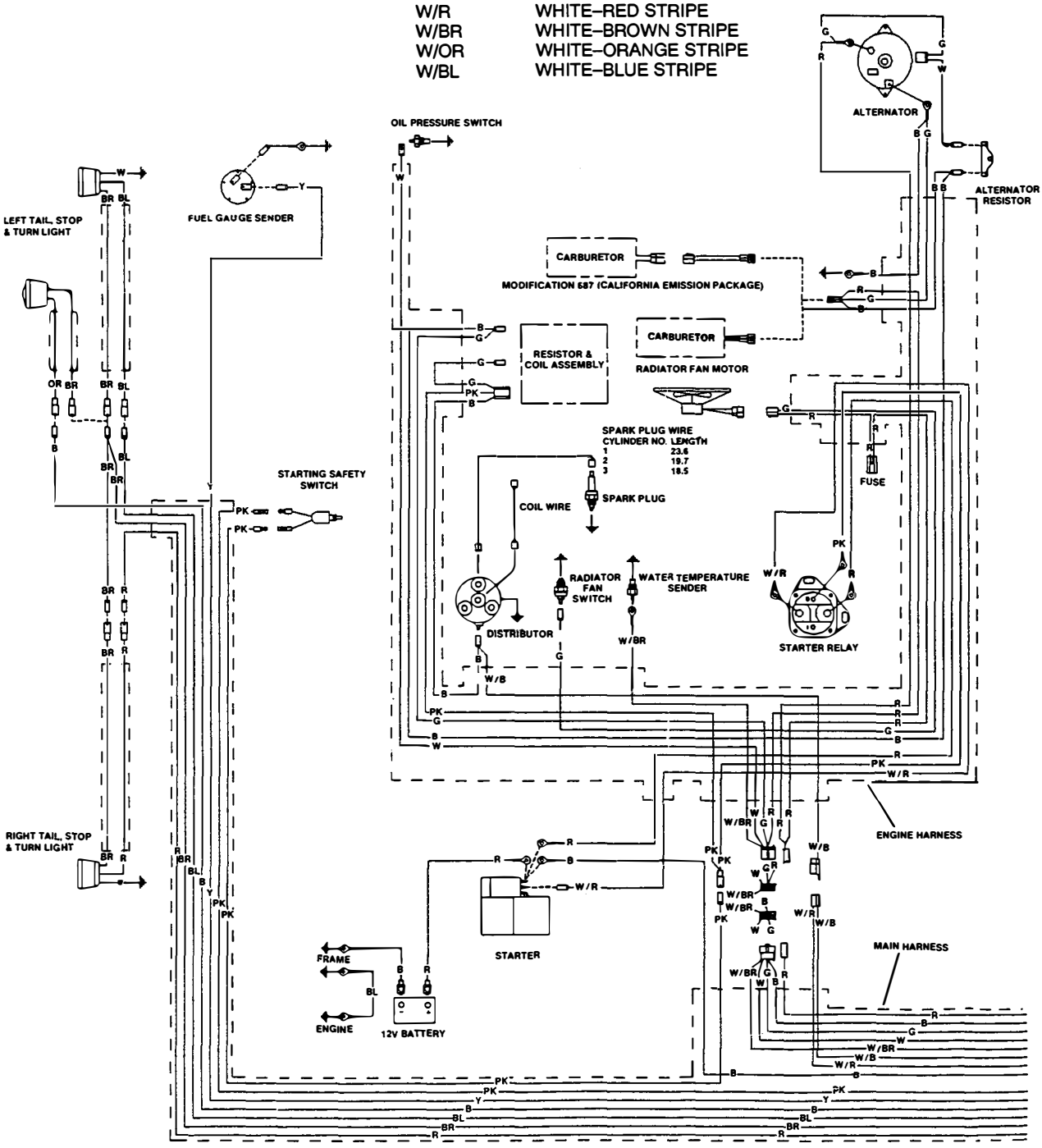


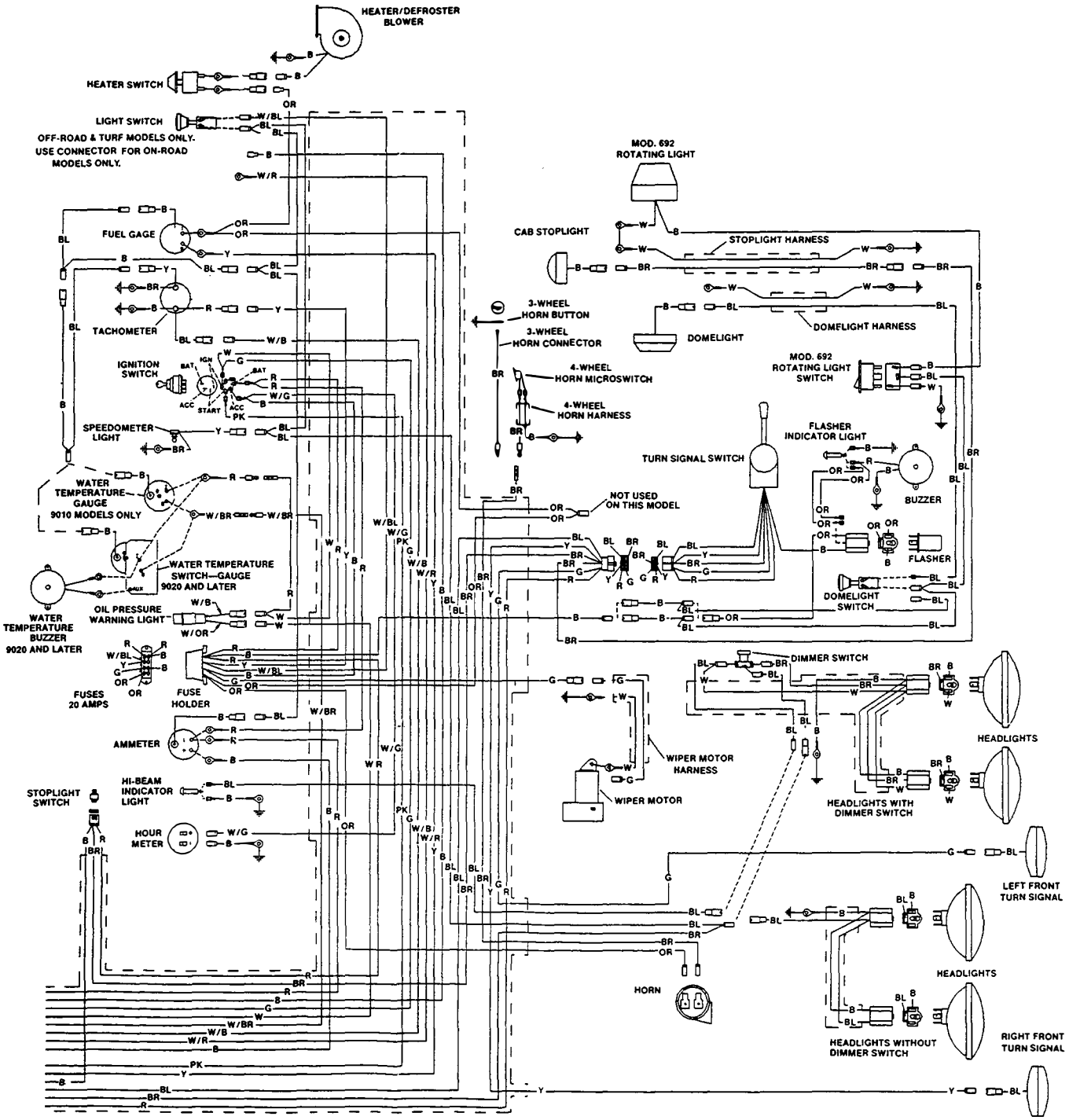
Figure 56. Wire Installation

WIRING DIAGRAM

COLOR CODE

B	BLACK
BL	BLUE
BR	BROWN
G	GREEN
OR	ORANGE
PK	PINK
R	RED
W	WHITE
Y	YELLOW
W/B	WHITE–BLACK STRIPE
W/G	WHITE–GREEN STRIPE
W/R	WHITE–RED STRIPE
W/BR	WHITE–BROWN STRIPE
W/OR	WHITE–ORANGE STRIPE
W/BL	WHITE–BLUE STRIPE




HEATER/DEFROSTER BLOWER
HEATER SWITCH
LIGHT SWITCH
OFF-ROAD & TURF MODELS ONLY.
USE CONNECTOR FOR ON-ROAD MODELS ONLY.
FUEL GAGE
TACHOMETER
IGNITION SWITCH
SPEEDOMETER LIGHT
WATER TEMPERATURE GAUGE
9010 MODELS ONLY
WATER TEMPERATURE SWITCH—GAUGE 9020 AND LATER
WATER TEMPERATURE BUZZER 9020 AND LATER
OIL PRESSURE WARNING LIGHT
FUSES 20 AMPS
FUSE HOLDER
AMMETER
STOPLIGHT SWITCH
HI-BEAM INDICATOR LIGHT
HOUR METER
MOD. 692 ROTATING LIGHT
CAB STOPLIGHT
STOPLIGHT HARNESS
3-WHEEL HORN BUTTON
3-WHEEL HORN CONNECTOR
DOMELIGHT
DOMELIGHT HARNESS
4-WHEEL HORN MICROSWITCH
4-WHEEL HORN HARNESS
MOD. 692 ROTATING LIGHT SWITCH
TURN SIGNAL SWITCH
FLASHER INDICATOR LIGHT
BUZZER
FLASHER
DOMELIGHT SWITCH
NOT USED ON THIS MODEL
DIMMER SWITCH
WIPER MOTOR HARNESS
WIPER MOTOR
HEADLIGHTS
HEADLIGHTS WITH DIMMER SWITCH
LEFT FRONT TURN SIGNAL
HEADLIGHTS
HEADLIGHTS WITHOUT DIMMER SWITCH
RIGHT FRONT TURN SIGNAL
HORN

SECTION 8 EMISSION CONTROL SYSTEM

EXHAUST EMISSION CONTROL SYSTEM

Vacuum Hose Routing

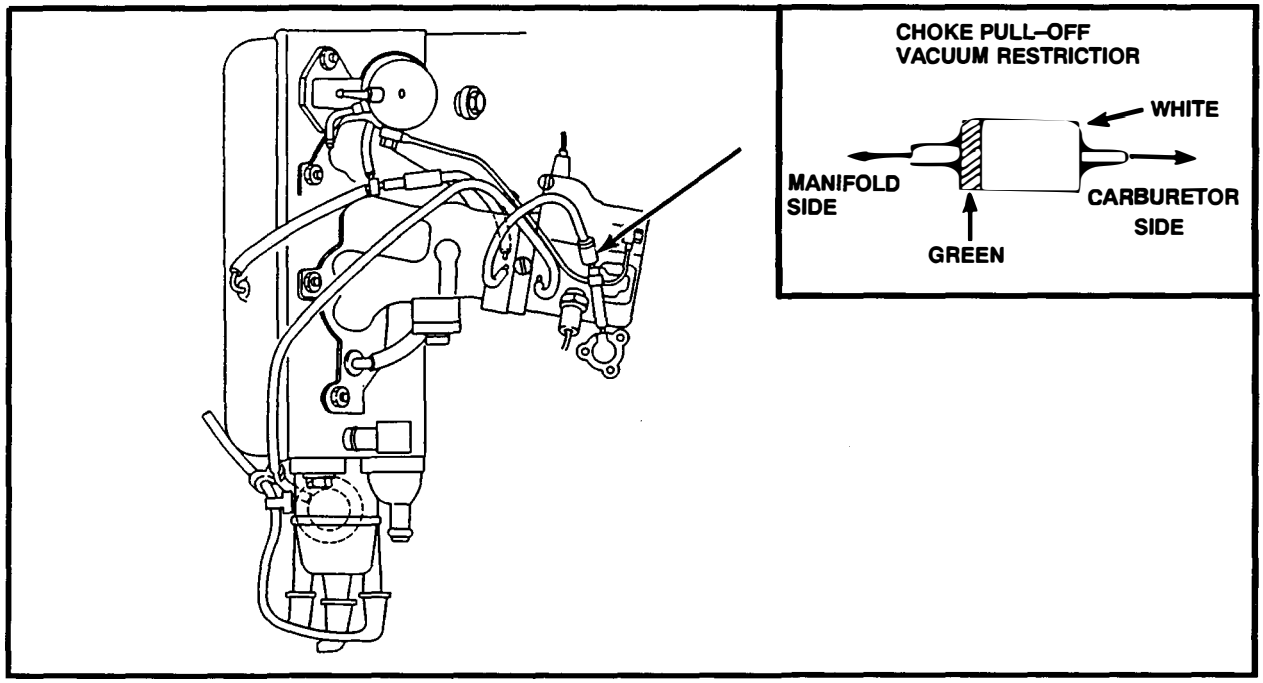


FIGURE 1

BLOW–BY GAS RECIRCULATION SYSTEM

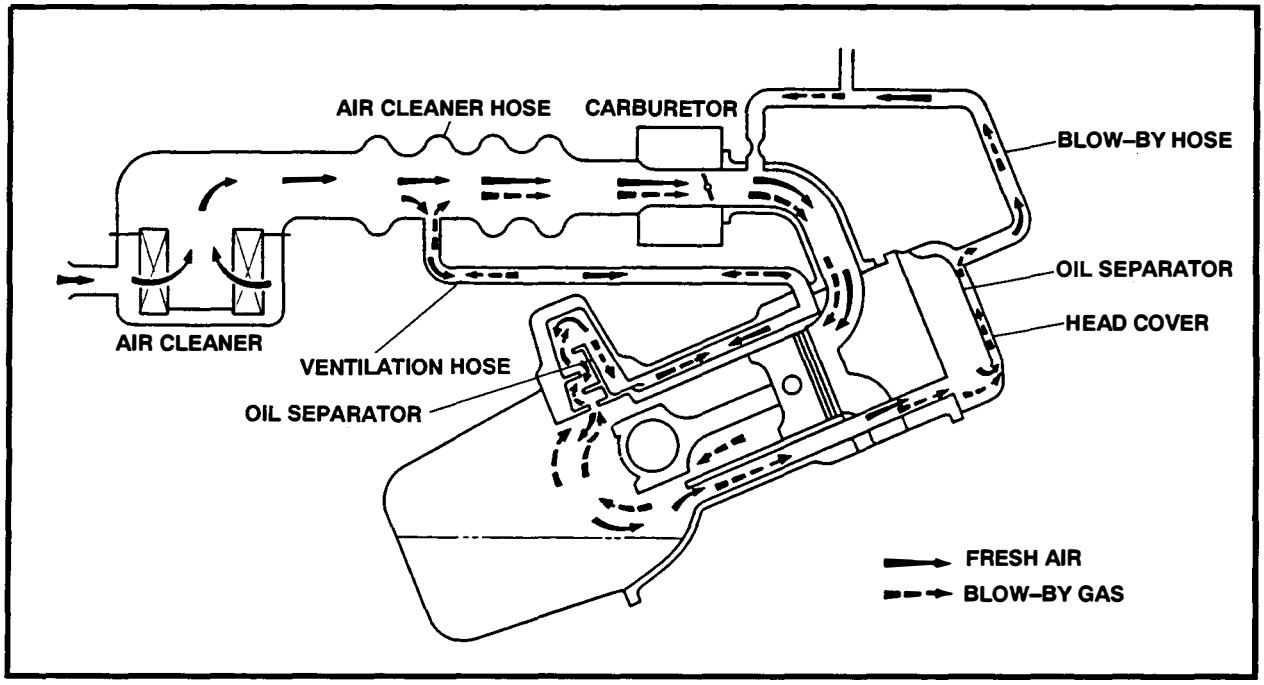


FIGURE 2

Blow–by Gas Recirculating System

Inspection of the Ventilation Hose

1. Check the ventilation hoses to be sure there are no cracks, damage, or restrictions.
2. Check the baffle plate of the cylinder head cover for restrictions.

EXHAUST EMISSION CONTROL SYSTEM

Vacuum Hose Routing (California Modification)

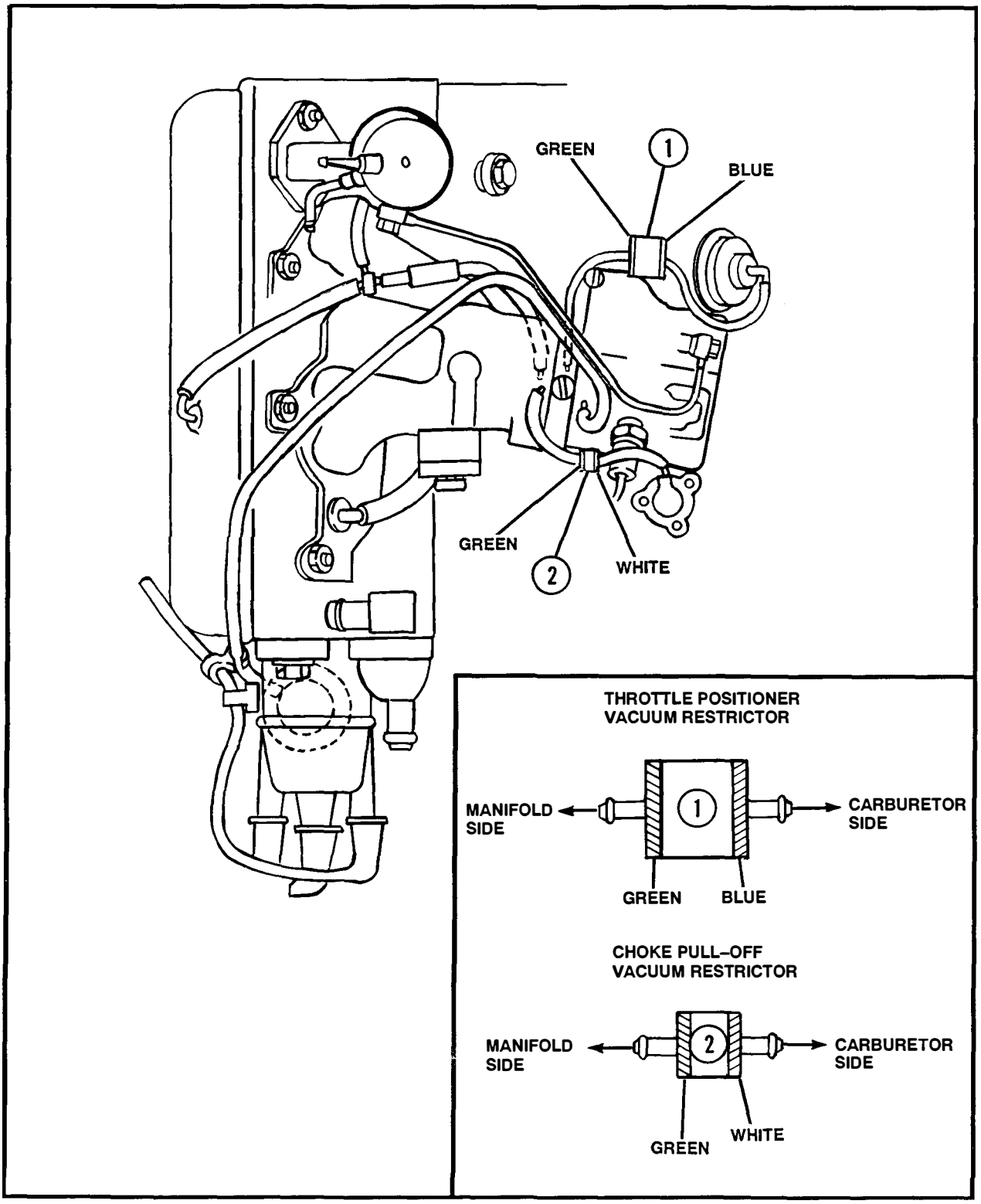


FIGURE 3

SECTION 9 HYDRAULICS

Special tools required in this section:

•Hydraulic flow meter
•Hydraulic pressure gage

General Maintenance

Here are key maintenance problems:

- **Not enough oil in the reservoir**
- **Clogged or dirty oil filters**
- **Loose intake lines**
- **Incorrect oil in the system**

The Importance of Cleanliness

Cleanliness is No. 1 when it comes to servicing hydraulic systems. KEEP DIRT AND OTHER CONTAMINANTS OUT OF THE SYSTEM. Small particles can score valves, seize pumps, clog orifices and cause expensive repair jobs.

How do you keep the hydraulic system clean? Let's put it this way:

- **Keep the oil clean**
- **Keep the system clean**
- **Keep your work area clean**
- **Be careful when you change or add oil**

SAFETY WARNING

- **Escaping fluid under pressure can penetrate the skin causing SERIOUS INJURY. Relieve pressure before disconnecting hydraulic or other lines.**
- **If injured by escaping fluid, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.**
- **Tighten all connections before applying pressure.**
- **Keep hands and body away from pinholes and nozzles which eject fluids under high pressure.**
- **Use a piece of cardboard, wood or paper to search for leaks. DO NOT USE YOUR HAND.**
- **If the system requires repair, make sure the pressure is relieved before disconnecting hoses.**

Cleaning and Flushing the System

1. Place the vehicle on a level surface.
2. Fully retract any hydraulic cylinders that are extended. Stop the vehicle engine.
3. Remove engine cover. Remove the vehicle left side panel located under the control console.
4. Remove the dipstick/breather assembly from the top of the tank. Remove the drain plug from the bottom of the hydraulic tank.
5. After draining the system remove tank , clean any sediment from the reservoir. Reinstall tank, drain plug and replace the filter element.
6. Flush all old oil from the remaining system components by adding the recommended oil for the system.
7. Operate the equipment to cycle the flushing oil through the system.

NOTE

- The cycles necessary to clean the system will vary, depending on the condition of the system. Usually six to twenty cycles are sufficient.

8. Drain out the flushing oil. Remove the filter.
9. Install new filter of the recommended type. Fill the system with clean oil of the recommended type.
10. Wipe the dipstick, then place the threaded flange on the tank (**don't screw in).** Fluid should show on the knurled portion of the dipstick. Add fluid as required.
11. Screw the dipstick/breather assembly securely in place. Reinstall the vehicle side panel and engine cover.

Diagnosis and Testing of System

A good program of diagnosis and testing has seven basic steps:

- **Know the System**
- **Ask the Operator**
- **Operate the Machine**
- **Inspect the Machine**
- **List the Possible Causes**
- **Test your Conclusion**

Examine the system

1. Check the fluid level

2. Check the fluid for discoloration. Extreme discoloration of the fluid can indicate that it has not been changed at the recommended interval.

3. Rub a small sample of the fluid between your thumb and forefinger. It should feel smooth and slippery. If it has a gritty feel, it's a sign of excessive system contamination. If the fluid is contaminated flush the system.

4. Check the fluid for odor. If it has a burnt smell, it's a good indication that the system has been overheated. The system must be flushed.

5. Check all linkages and other mechanical components. Make sure that the various moving parts are not bent or binding, causing excessive loads. Replace all worn or bent parts.

6. Check the control valve linkages to make sure that they properly transmit motion to the valves. Look for excessive wear in the connecting pins that can cause lost motion. Look for hydraulic lines that have been kinked enough to block flow, but still permit some fluid to pass. Replace all worn parts. Replace kinked lines.

7. Operate the machine to simulate the problem.

Checking for internal leaks

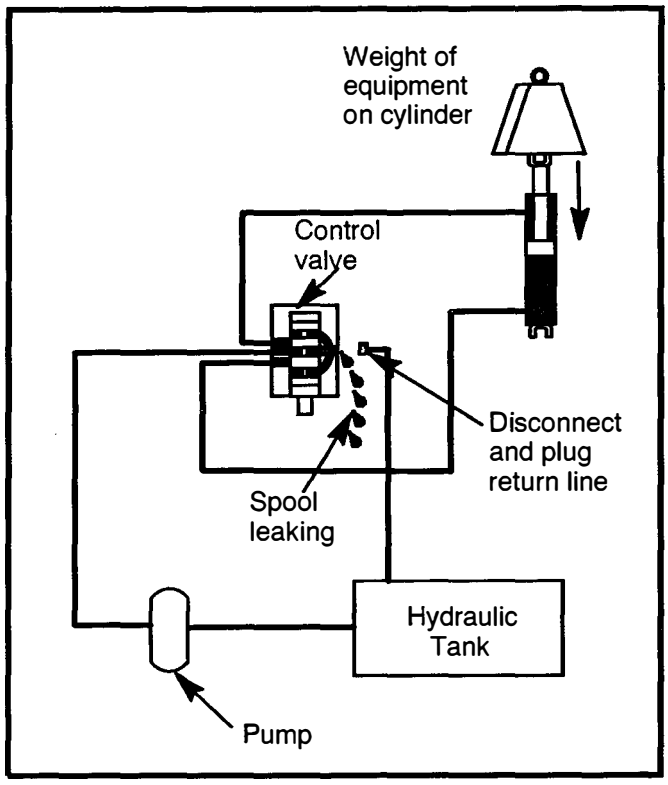
If you suspect the control valve or cylinder is leaking, do the following:

1. Raise the hydraulic equipment a few feet off the ground, return the control lever to neutral and shut the engine off.

SAFETY WARNING

- **Escaping fluid under pressure can penetrate the skin causing SERIOUS INJURY. Relieve pressure before disconnecting hydraulic or other lines.**

2. Notice if the equipment settles toward the ground. If the equipment settles, temporarily support it and disconnect the return line between the control valve and reservoir, then plug the line. See Figure 1.



Checking for internal leaks

Figure 1.

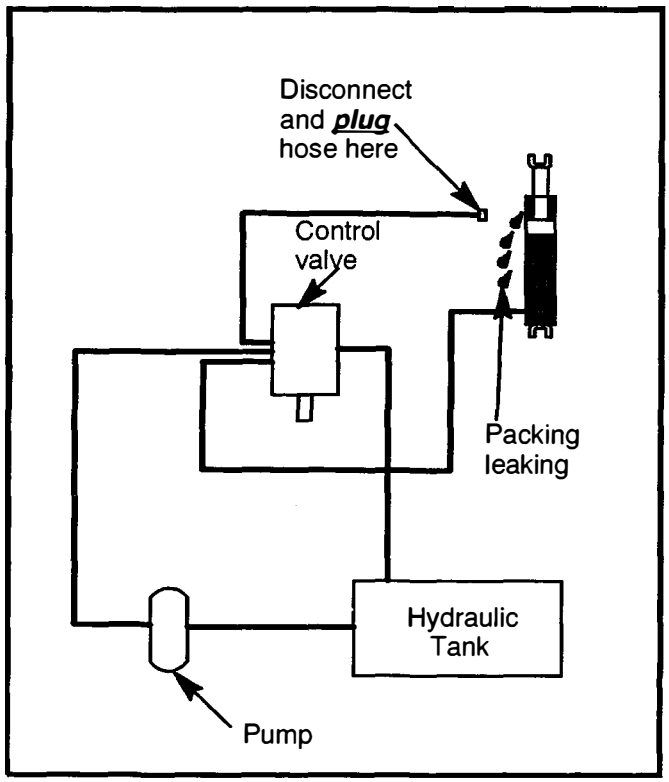
3. Examine the open port in the control valve as the equipment settles. If oil leaks from the port, the control valve spool is leaking.

4. If no oil is leaking from the control valve, check the cylinder.

SAFETY WARNING

- **Escaping fluid under pressure can penetrate the skin causing SERIOUS INJURY. Relieve pressure before disconnecting hydraulic or other lines.**

5. Run the cylinder to one end of its stroke. Support the equipment if it is raised, then shut off the engine. Remove the hose from the end of the cylinder that was not pressurized. See Figure 2.



Checking for internal leaks

Figure 2.

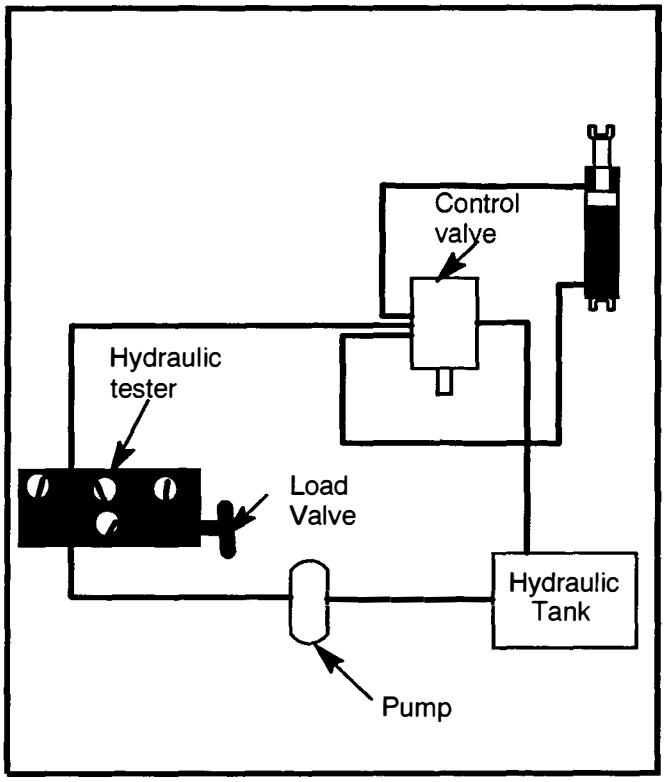
6. Start the engine again, pressurize the cylinder, and see if any oil comes out of the open port. Repeat the test in the opposite cylinder direction since it may be possible for the cylinder to leak in only one direction.

7. If oil leaks out of the open cylinder port, the packings in the cylinder must be replaced.

Pump testing

The pump is the generating force for the whole hydraulic system. This is the place to start testing the system.

1. Connect flow meter and pressure gage. See Figure 3. (Some hydraulic systems may have a selector valve in the system. ***Always connect the hydraulic tester after the pump and before any other components)***.



Testing hydraulic system

Figure 3.

2. Open the hydraulic tester load valve.

3. Start the vehicle, run the hydraulic pump at 3600 rpm, warm fluid to operating temperature.

4. Slowly close the load valve to increase pressure and record the flow at 250 psi increments from zero pressure to maximum system pressure. Write down your test results so you can refer to them later. Use a test form such as the one shown in Figure 4.

		Gallons Per Minute @ PSI										
	PSI	0	250	500	750	1000	1250	1500	1750	2000	2250	2300
Pump test(Gal./min.)		4.0	4.0	4.0	4.0	3.9	3.7	3.7	3.6	3.5	3.5	0
Circuit test												
Cylinder Circuit												
Motor Circuit												

This chart shows the correct readings for the pump.
A blank form that you may copy is at the end of this chapter.

Figure 4.

5. Open the hydraulic tester load valve until maximum pump flow is again at zero pressure.

6. Shut off the engine.

Interrupting pump test results

Pump flow at 2250 psi should be at least 75% of pump flow at zero pressure. A lower reading indicates a badly worn pump.

If pump flow is poor during the free flow test as well as the pressure tests, the pump probably is not getting enough oil. This problem could be caused by low oil supply, air leaks, or a restricted pump inlet line; a dirty reservoir, filter or breather.

System testing

1. Connect flow meter and pressure gage. See Figure 3.

2. Open the hydraulic tester load valve.

3. Start the vehicle, run the engine at 3200 – 3750 rpm, warm fluid to operating temperature.

4. Slowly close the hydraulic tester load valve to pressurize the system.

5. Operate the control valve and hold it in one of its power positions. Record flow readings at pressure increments of 250 psi.

6. Slowly close the hydraulic tester load valve and record flow in 250 psi increments from zero pressure to 2300 psi. See Figure 5.

7. Open the load valve until maximum flow is again at zero pressure and repeat the test in the rest of the control valve power positions.

8. On hydraulic systems with a selector valve, those circuits that the selector valve controls may be tested also by moving the selector to each position.

		Gallons Per Minute @ PSI										
	PSI	0	250	500	750	1000	1250	1500	1750	2000	2250	2300
Pump test (Gal./min.)		4.0	4.0	4.0	4.0	3.9	3.7	3.7	3.6	3.5	3.5	0
Circuit test												
Cylinder Circuit	Raise	4.0	4.0	4.0	4.0	3.9	3.7	3.7	3.6	3.5	3.5	0
	Lower	4.0	4.0	4.0	4.0	2.5	.9	0	0	0	0	0
Motor Circuit	Run	4.0	4.0	4.0	4.0	3.9	3.7	3.7	3.6	3.5	3.5	0

This chart shows what readings may be.
A blank form that you may copy is at the end of this chapter.

Figure 5.

Interrupting pump test results

If flow at each pressure is same as for pump test: ***All components are okay.***

If pressure begins to drop before full load is reached: One of the circuits is bad. (Such as the cylinder lower circuit in Figure 5.)

The pressure drop is caused by leakage. To find out whether the leakage is in the control valve or the cylinder, disconnect the cylinder return line and move the control valve to a power position. If oil leaks from the cylinder return port, the cylinder is at fault and must be repaired. If no oil leaks out, the control valve is probably at fault.

If flow drops the same with the control valve in all positions: The system relief valve is probably at fault. This condition could also indicate a leak in the control valve.

Lift Valve Adjustments *(Turf trucksters only)*

1. ***Float position:*** Place control handle in float position. Maintain downward pressure on handle while tightening two upper control valve mounting screws. Torque screws to 6 to 8 ft lbs (8 to 11 N·m).

NOTE

- Mounting screws for the lift valve must not be torqued more than 6 to 8 ft. lbs (8 to 11 N·m). over-tightening the screw may distort the valve body and prevent free travel of the valve shaft.

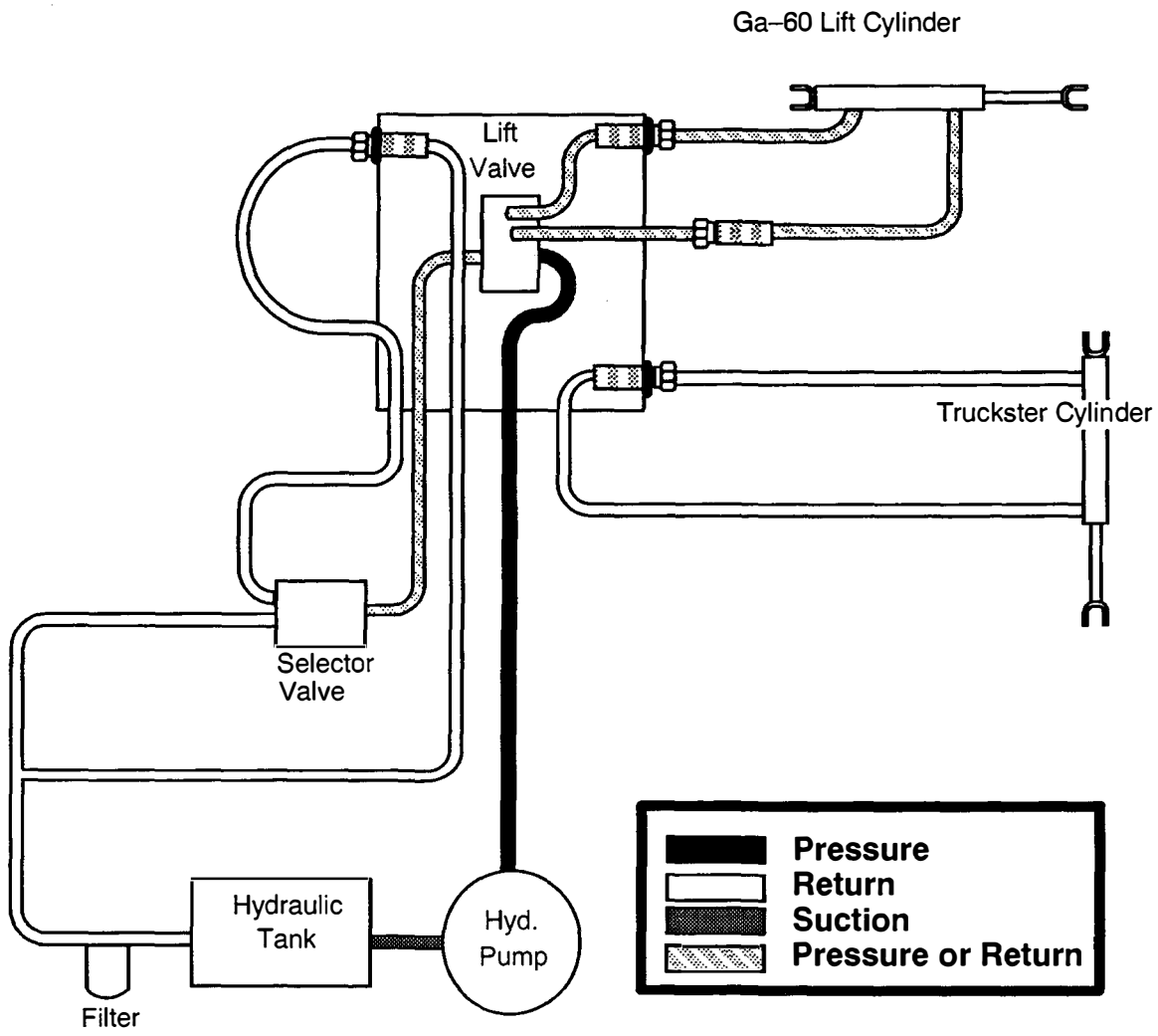
2. In the ***float position*** the hydraulic cylinder (with implement attached) should move freely in and out when the implement moves over uneven ground. An example would be using a Greensaver over an uneven green, the cylinder should float in and out to insure that the rear wheels always make good contact with the ground.

		Gallons Per Minute @ PSI										
PSI		0	250	500	750	1000	1250	1500	1750	2000	2250	2300
Pump test (Gal./min.)												
Circuit test												
Cylinder Circuit	Raise											
	Lower											
Motor Circuit	Run											

		Gallons Per Minute @ PSI										
PSI		0	250	500	750	1000	1250	1500	1750	2000	2250	2300
Pump test (Gal./min.)												
Circuit test												
Cylinder Circuit	Raise											
	Lower											
Motor Circuit	Run											

These are some extra forms used for recording readings used while testing the hydraulic system.

HYDRAULIC DIAGRAM FOR TURF–TRUCKSTER 9110 AND LATER

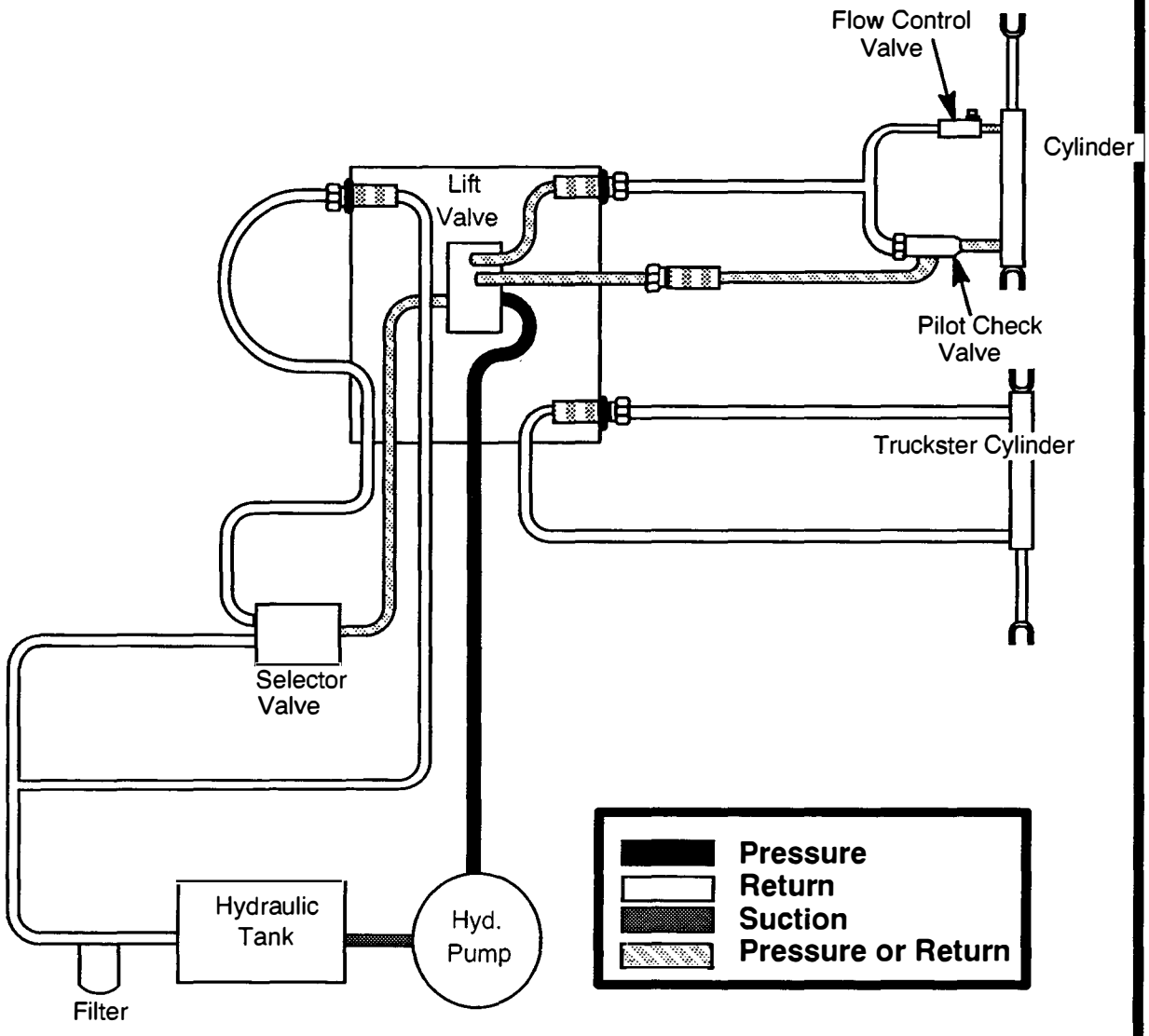


GA–60 OPERATION

Specifications:

Pump — 3.46 GPM at 2000 psi — Relief set at 2300 psi
Filter — 25 micron full flow — 25 psi bypass in base
Truck cylinder — 2" bore — 10" stroke
Lift valve — pressure relief set at 1800 psi
Capacity — 3 1/2 quarts (3.34 L)

HYDRAULIC DIAGRAM FOR TURF–TRUCKSTER 9110 AND LATER

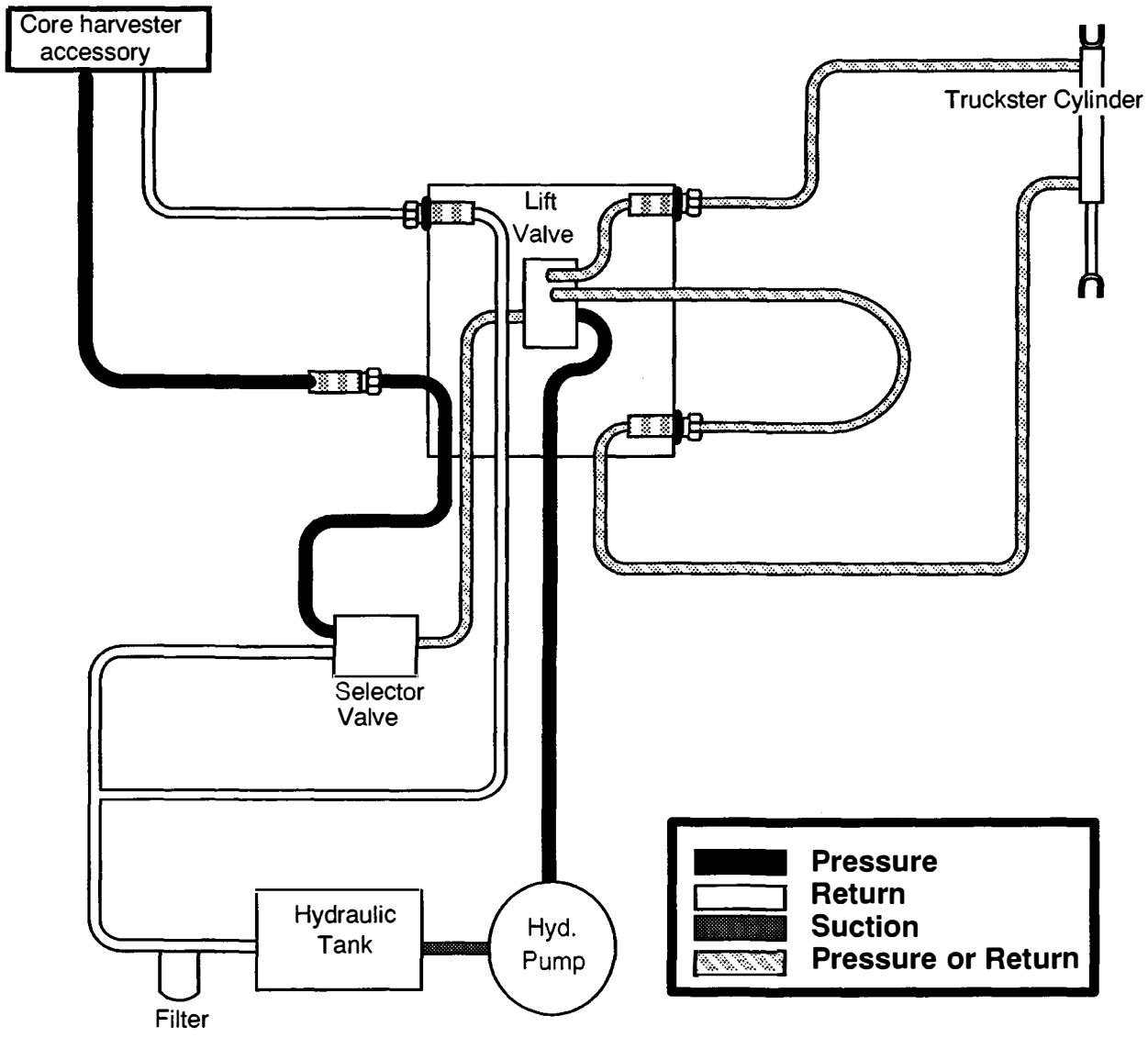


Fifth Wheel Dump Box operation

Specifications:

Pump — 3.46 GPM at 2000 psi — Relief set at 2300 psi
Filter — 25 micron full flow — 25 psi bypass in base
Truck cylinder — 2" bore — 10" stroke
Lift valve — pressure relief set at 1800 psi
Capacity — 3 1/2 quarts (3.34 L)

HYDRAULIC DIAGRAM FOR TURF–TRUCKSTER 9110 AND LATER

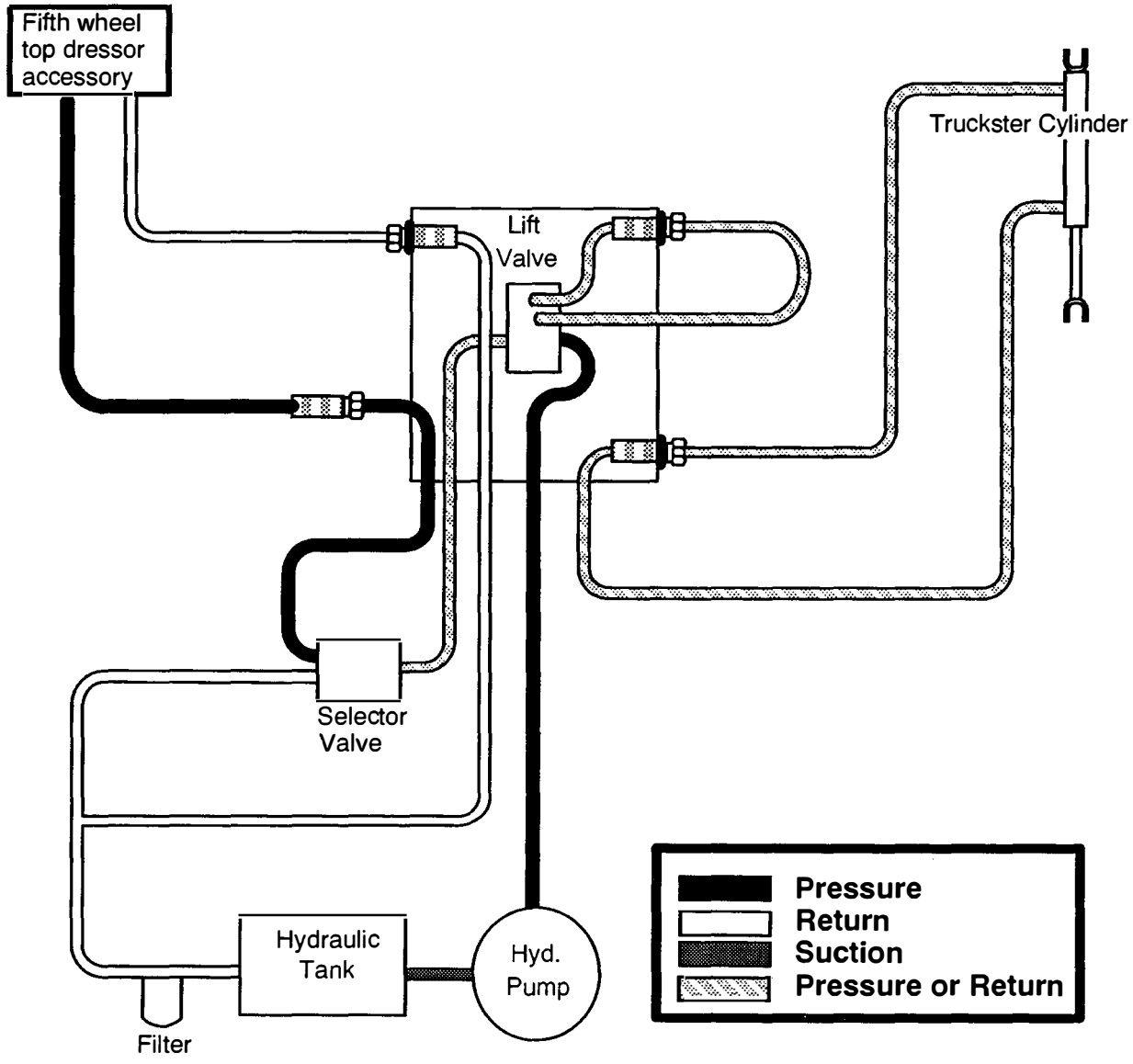


Core Harvester

Specifications:

Pump — 3.46 GPM at 2000 psi — Relief set at 2300 psi
Filter — 25 micron full flow — 25 psi bypass in base
Truck cylinder — 2" bore — 10" stroke
Lift valve — pressure relief set at 1800 psi
Capacity — 3 1/2 quarts (3.34 L)

HYDRAULIC DIAGRAM FOR TURF–TRUCKSTER 9110 AND LATER

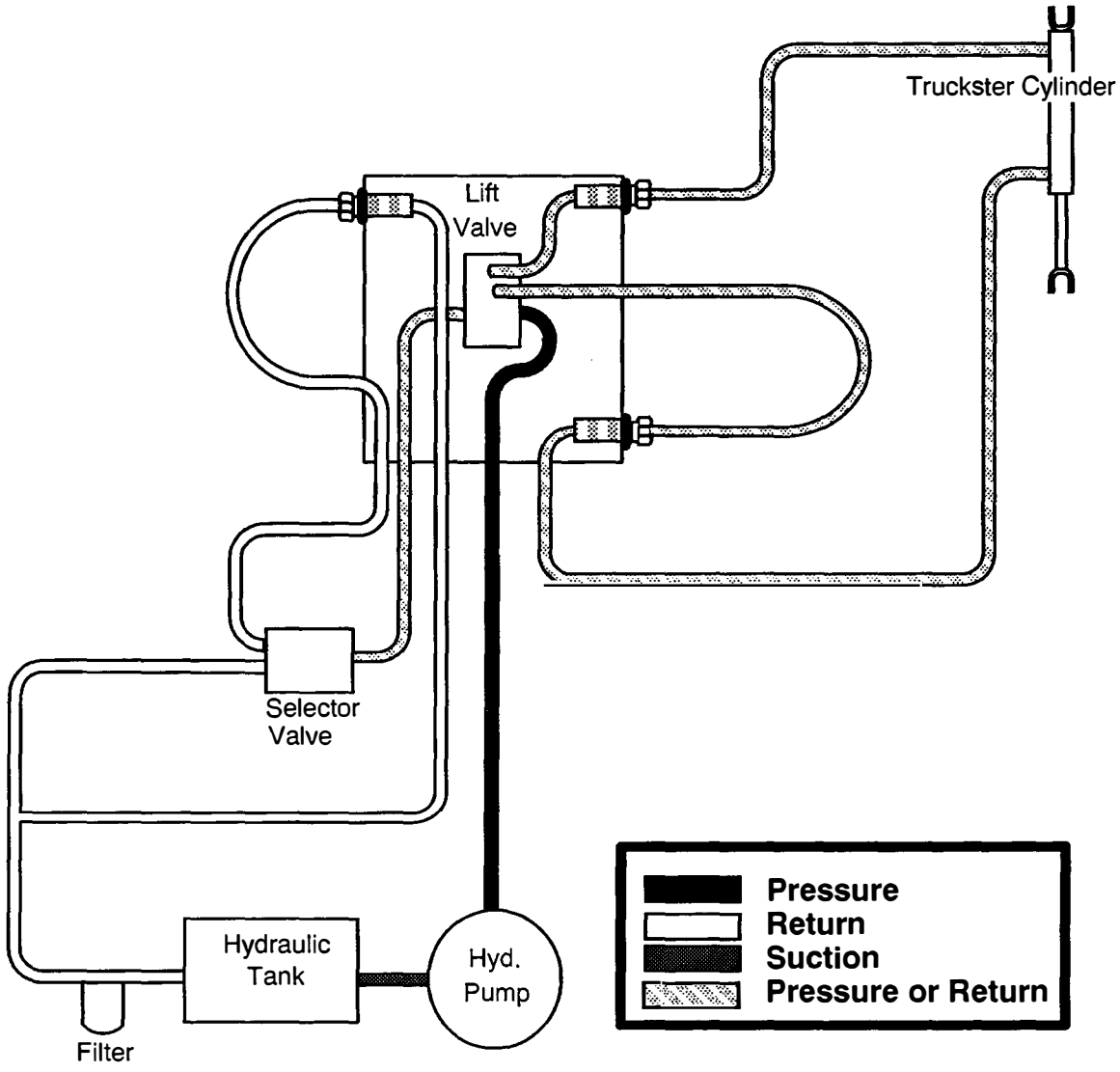


FIFTH WHEEL TOP DRESSOR

Specifications:

Pump — 3.46 GPM at 2000 psi — Relief set at 2300 psi
Filter — 25 micron full flow — 25 psi bypass in base
Truck cylinder — 2" bore — 10" stroke
Lift valve — pressure relief set at 1800 psi
Capacity — 3 1/2 quarts (3.34 L)

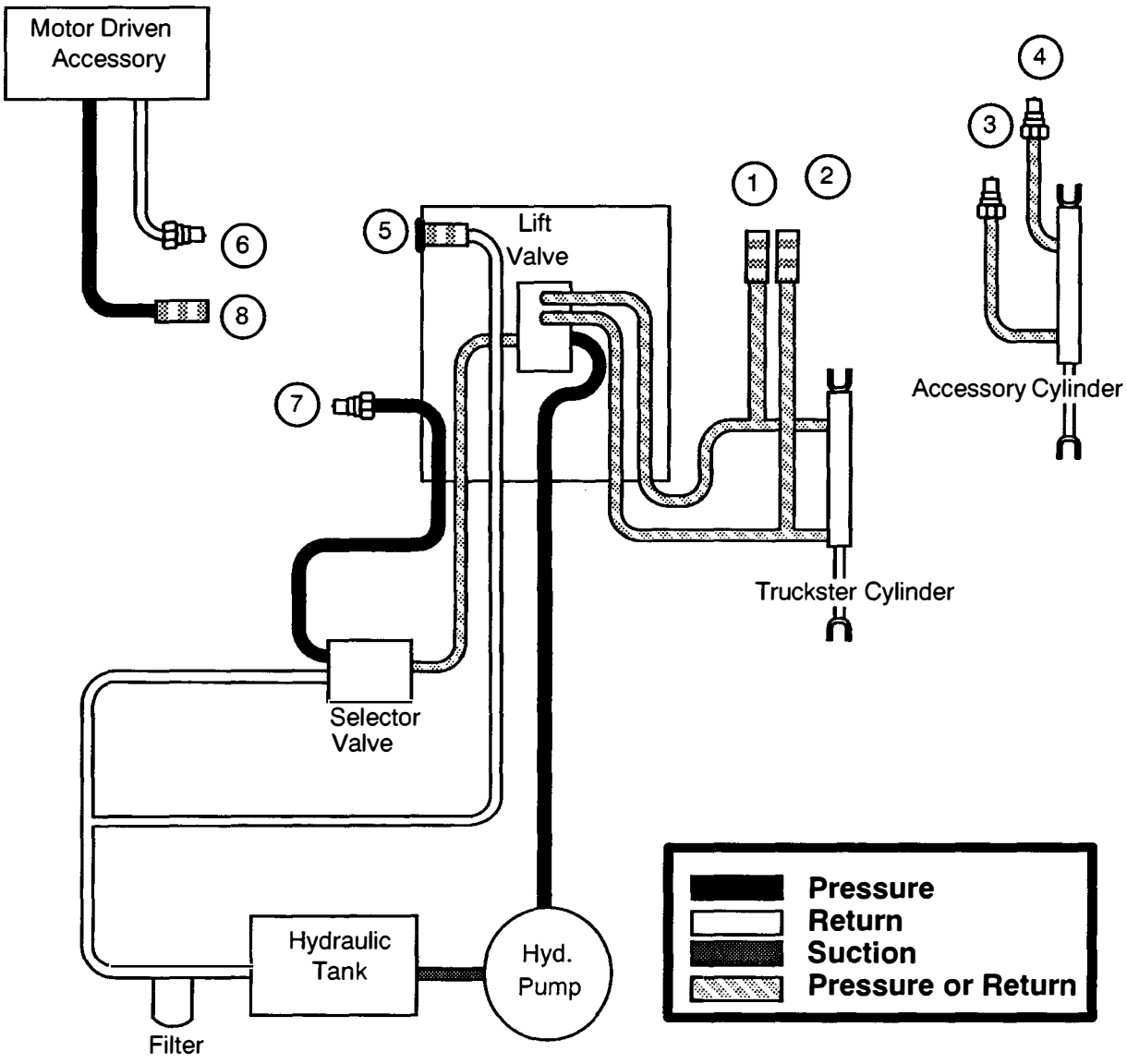
HYDRAULIC DIAGRAM FOR TURF–TRUCKSTER 9110 AND LATER



Truckster operation only (Dump Box)

Specifications:

Pump — 3.46 GPM at 2000 psi — Relief set at 2300 psi
Filter — 25 micron full flow — 25 psi bypass in base
Truck cylinder — 2" bore — 10" stroke
Lift valve — pressure relief set at 1800 psi
Capacity — 3 1/2 quarts (3.34 L)



Specifications:

Pump — 3.46 GPM at 2000 psi — Relief set at 2300 psi
Filter — 25 micron full flow — 25 psi bypass in base
Truck cylinder — 2" bore — 10" storke
Lift vavle — pressure relief set at 1800 psi
Capacity — 3 1/2 quarts (3.34 L)

For Motor Driven Accessory and Truckster Dump Box Operation:

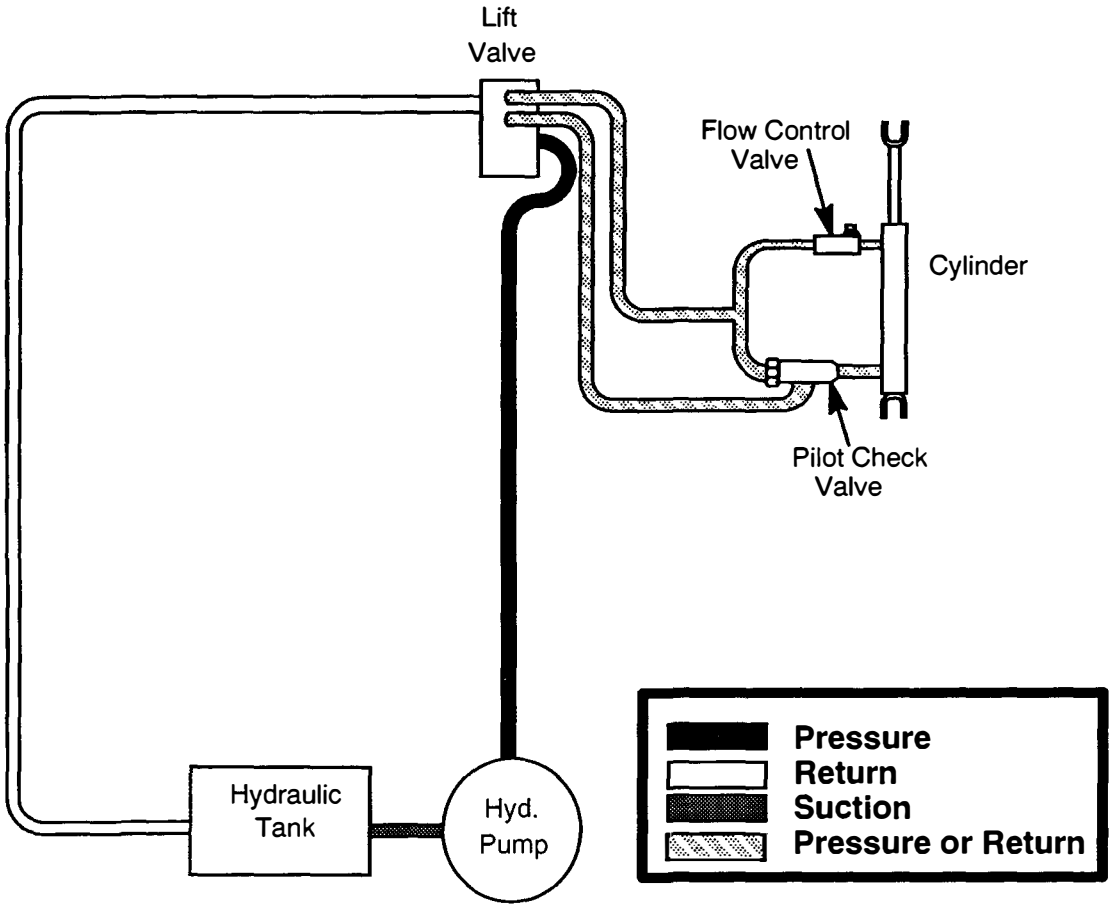
- Plug 5–6, 7–8
- Disregard 1, 2, 3, 4

For Accessory Cylinder Operation

- Plug 1–2, 3–4, 5–7
- Disregard 6–8

HYDRAULIC DIAGRAM FOR TURF–TRUCKSTER 9010

HYDRAULIC DIAGRAM FOR REFUSE HAULSTER 9110 AND LATER



Specifications:

Pump — 3.46 GPM at 2000 psi — Relief set at 2300 psi
Truck cylinder — 2" bore — 10" storke
Lift vavle — pressure relief set at 1800 psi
Capacity — 3 1/2 quarts (3.34 L)

To adjust hydraulic cylinder for proper operation:

With the engine running at 3500 rpm (with the box empty) the box should raise and lower in 11 seconds.
Adjust the flow control valve to increase or decrease the raise and lower cycle.
If the box will lower with the engine not running replace pilot check vavle.

HYDRAULIC DIAGRAM FOR REFUSE VEHICLES

TROUBLE SHOOTING

Symptom	Probable Cause	Solution	Comments
System Inoperative	• No oil in system	Fill to full mark. Check for leaks	
	• Oil low in reservoir	Fill to full mark. Check for leaks	
	• Oil of wrong viscosity	Refer to specifications	
	• Filter dirty or plugged	Drain oil, replace filters	
	• Restriction in system	Clean lines, orifices	
	• Air leaks in suction line	Repair or replace lines	
	• Dirt in pump	Clean and repair	
	• Badly worn pump	Repair or replace	
	• Badly worn components	Examine and text system	
	• Oil leak in pressure lines	Tighten fittings, replace lines	
	• Operating system under excessive load	Check for load limits	
	• Slipping or broken pump drive	Replace, align, and adjust	
	• Pump not operating	Check, repair, and/or replace	
System Operates Erratically	• Air in system	Examine suction side for leaks	
	• Cold oil	Allow oil to warm	
	• Components sticking or binding	Check for dirt deposits, bent or worn parts	
	• Pump damaged	Determine cause of damage	
	• Restriction in filter or suction	Clean or replace lines; check filter	
System Operates Slowly	• Cold oil	Warm up before operating	
	• Oil viscosity too heavy	Use recommended oil	
	• Insufficient engine speed	Adjust speed accordingly	
	• Low oil supply	Fill to full mark. Check for leaks	
	• Air in system	Check suction side of system	
	• Badly worn pump	Repair or replace	
	• Restriction in suction line or filter	Clean line. Replace filter.	
	• Badly worn components	Test and examine components	
	• Oil leak in pressure lines	Tighten fittings	
	• Pump belt slipping	Adjust belt to proper tension	
	• Pressure relief to low	Replace pump	
Overheating of oil	• Holding valve in power position too long	Return lever to neutral	
	• Using incorrect oil	Use recommended oil	
	• Low oil level	Fill to full mark. Check for leaks	
	• Dirty oil	Drain and refill with clean oil	
	• Engine running too fast	Reset governor to specifications	
	• Internal oil leakage	Text and examine components	
	• Restriction in suction line	Clean line.	
	• Dented, plugged, or under-sized oil lines	Replace or clean	

TROUBLE SHOOTING

Symptom	Probable Cause	Solution	Comments
Overheating of oil; Continued	•Control valve stuck open	Clean and repair valve	
Foaming of Oil in System	•Low oil level •Water in oil •Wrong kind of oil being used •Air leak in suction side •Kink in oil line •Worn seal around pump shaft	Fill to full mark. Check for leaks Drain and replace oil Use recommended oil Tighten fittings Replace, or reroute lines Replace seal. Check for mis-alignment	
Pump Makes Noise	•Low oil level •Oil viscosity too high •Pump speed too fast •Suction line plugged or pinched •Dirt in pump •Reservoir air vent plugged •Air in oil •Worn or scored pump bearings or shafts •Inlet screen plugged •Broken, sticking, or damaged parts •Pressure relief to low	Fill to full mark. Check for leaks Change to recommended oil Reset governor to specifications Clean or replace line Clean, and inspect pump Clean breather cap Tighten suction. Check for leaks Repair or replace pump Clean screen Test, and repair defective parts Replace pump	
Load Drops with control valve in neutral position	•Leaking or broken oil lines •Oil leaking past cylinder packing, or O-rings •Oil leaking past control valve •Control lever not centering when released	Tighten or replace lines Repair or replace cylinder Repair or replace valve Check and adjust linkage	
Control valve sticks	•Misalignment of linkage •Valve mounting bolts too tight •Valve broken or scored internally	Adjust and lubricate linkages Loosen bolts and torque Repair or replace valve	
Control valve leaks	•Worn or damaged seals •Broken valve parts	Repair or replace valve Check mounting hardware	
Cylinder leaks	•Damaged cylinder barrel •Loose parts •Piston rod damaged	Replace cylinder Tighten all hardware Replace cylinder	

SECTION 10 CLUTCH

General Information

This is a dry, single disc, diaphragm automotive type clutch. The outer diameter is 6.7 inches. It is operated by a foot pedal through linkage to the throw out bearing to disengage the clutch.

Repair

Removal (vehicles without auxiliary transmission)

SAFETY WARNING

- **Support the vehicle with approved jack stands. Do not rely on mechanical or hydraulic jacks.**

1. Remove drive shaft yoke from differential.
2. Disconnect clutch safety switch spring from clutch arm.
3. Remove transmission linkage and clutch linkage.
4. Remove clutch housing and remove clutch.
5. If the throw out bearing actuator fork needs replacing, drive out the roll pins and install new actuator.
6. Remove the clutch pressure plate from the engine flywheel. Six screws.

Removal (vehicles with auxiliary transmission)

SAFETY WARNING

- **Support the vehicle with approved jack stands. Do not rely on mechanical or hydraulic jacks.**

1. Raise rear wheels.
2. Remove front shackle bolts.
3. Disconnect clutch safety switch spring from clutch arm.
5. Remove clutch housing and remove clutch.
6. Lower differential; the drive shaft will separate.
7. If the throw out bearing actuator fork needs replacing, drive out the roll pins and install new actuator.
8. Remove the clutch pressure plate from the engine flywheel.

NOTE

- The actuator has one side machined and hardened. This side must be installed toward the engine. Note position of notch. See Figure 1.
- When assembling the clutch lever and the actuator the clutch lever arm must be point up. See Figure 1.

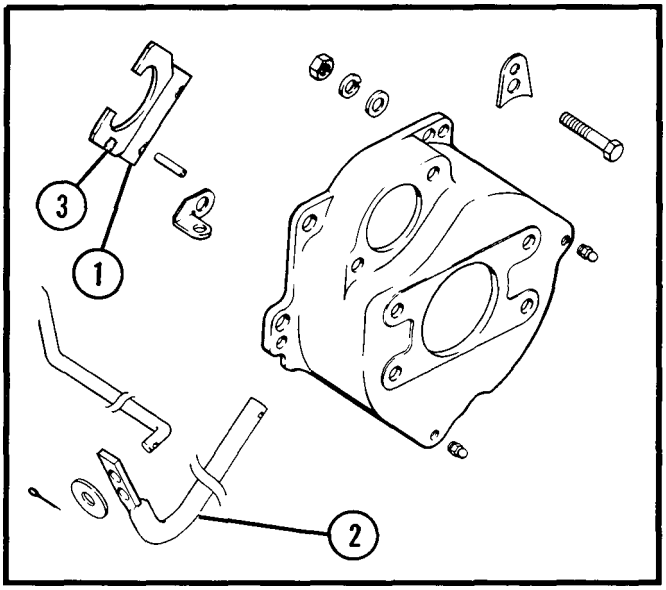


Figure 1.
1. Actuator 3. Notch
2. Clutch Lever

Inspection

1. Check the clutch pressure plate and the clutch disc contact surface of the flywheel for wear.
2. Check the clutch cover spring levers for wear or damage. See Figure 2.

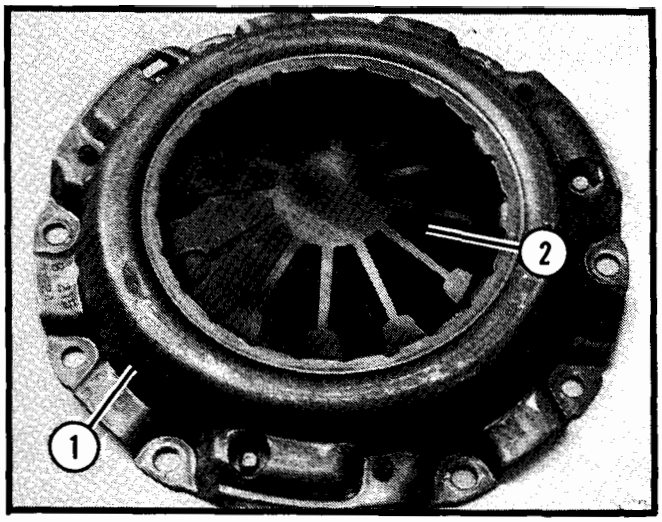


Figure 2.
1. Clutch Pressure Plate
2. Pressure Plate Spring Levers

3. Check the clutch disc for wear. See Figure 3.
   Rivet depth: 0.12 in. (0.3 mm) minimum

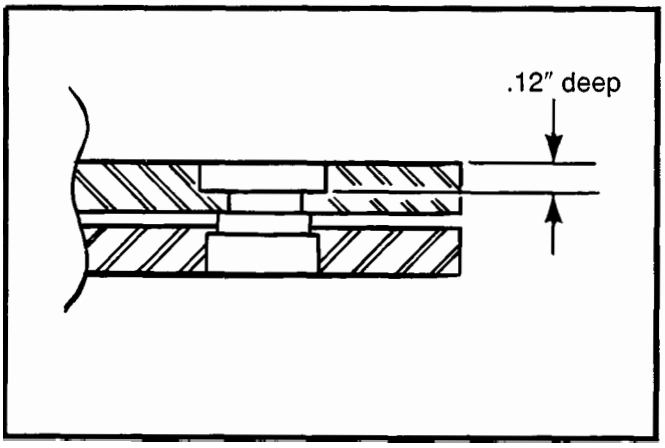


Figure 3.
1. Rivet Depth on Clutch Disc

4. Check the pressure plate lever tips for variation in height with a thickness gauge.
   Allowable limit: .027 in. (0.7 mm) maximum

5. Replace all worn or damaged parts.

Assembly

1. Apply a thin film of lubricant Mobile H. P. #9010025 to the surface of the pilot bushing and the splines of the clutch disc.

NOTE

- Using more than a thin film could cause clutch slippage.

2. Install the clutch disc and pressure plate using alignment tool. See Figure 4.
   Torque: 5 to 7 ft. lbs (7 to 9 N·m)

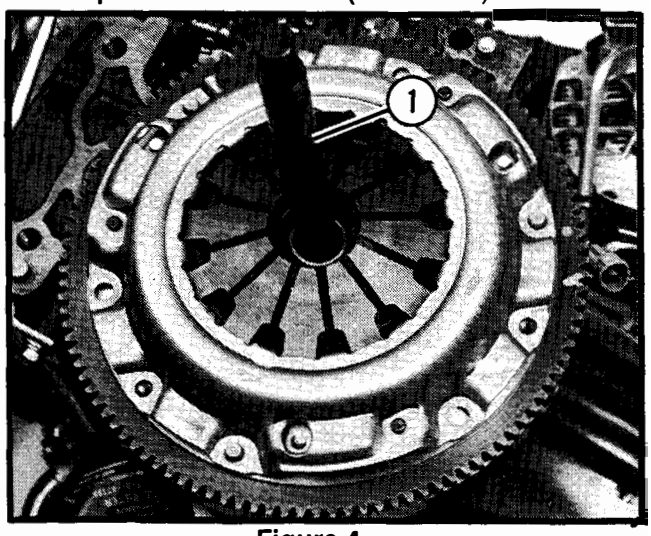


Figure 4.
1. Clutch Alignment Tool

NOTE

- Be certain to tighten the bolts evenly, starting with those bolts near the locating pins.

3. If the clutch lever was removed, install the clutch lever noting the direction of the actuator and the clutch lever arm. See Figure 1.

4. Install the clutch housing.

5. Install transmission and linkage.

6. Connect clutch safety switch spring to clutch arm.

Vehicles without auxiliary transmission

7. Connect drive shaft yoke to differential

Vehicles with auxiliary transmission

8. Align drive shaft male and female shafts and raise differential.

9. Install front shackle bolts and lower vehicle.

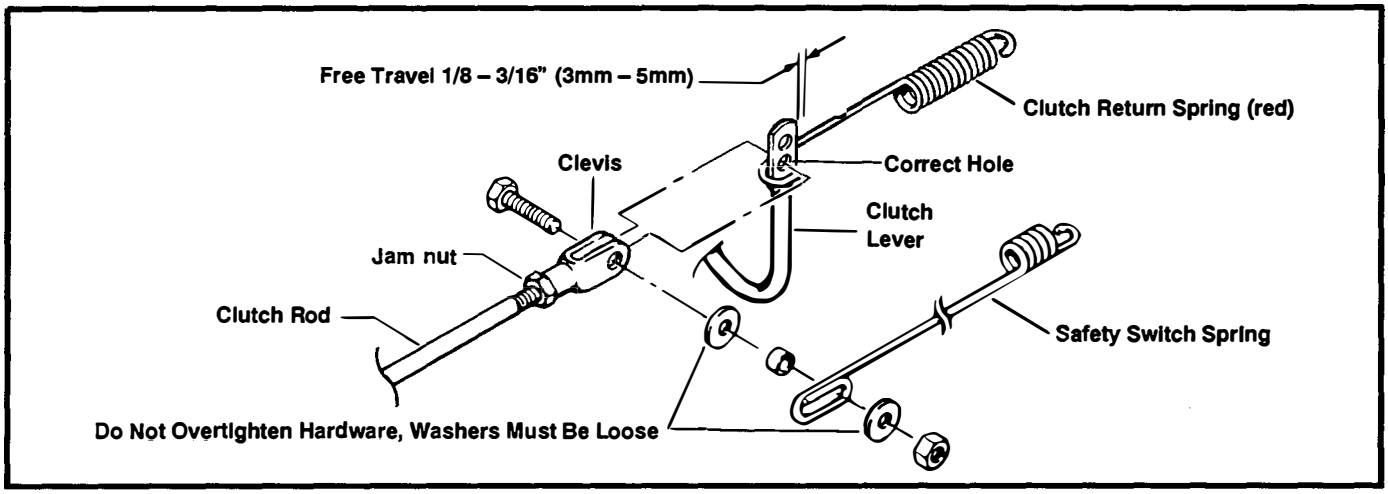


Figure 5.

Clutch Adjustment

To check clutch for proper free travel:

- Disconnect the "RED" clutch return spring from the clutch lever.
- Move clutch lever by hand, lever should have 1/16 to 1/8" (1.5 to 3 mm) free travel, measured at the end of the clutch lever. See Figure 5.
- If proper free travel is present, reconnect the red clutch spring.
- If proper free travel is not present, adjust as follows:

1. Disconnect the clevis on the clutch rod from the clutch lever. (Red clutch spring is still disconnected) See Figure 5.

2. Pull the clutch rod rearward.

3. With the clutch lever forward, adjust the clevis so that the lower hole in the clutch lever aligns with the holes in the clevis. Now lengthen the clutch pedal linkage by backing the clevis out three full turns. (One full turn of the clevis lengthens the linkage by approximately 1/16"). Tighten the clevis jam nut.

4. Reconnect the clevis to the clutch lever (including the safety switch spring). CAUTION: Do not overtighten clevis hardware, washers should be loose. Recheck free travel of lever. Reconnect the red clutch spring. Tighten the clevis jam nut. See Figure 5.

Clutch Interlock Switch

The vehicle is equipped with a clutch starting interlock switch. Depress the clutch pedal to disengage the clutch and activate the interlock switch. If the vehicle engine will start without depressing the clutch pedal:

- Do not operate the vehicle.
- Have the clutch interlock switch repaired immediately.

⚠ SAFETY WARNING

- **Failure to act as instructed can result in sudden unexpected vehicle movement or attached accessory operation when vehicle engine is started. Operator or bystanders may be hurt.**

Clutch Interlock Switch Adjustment

The clutch safety switch must be adjusted so the engine WILL NOT START until the clutch is disengaged.

1. Correct adjustment is accomplished by moving the switch mounting bracket on the safety switch slide bracket until the spring is pulled tight. (Not pulling on the switch activating plunger.) See Figure 6.

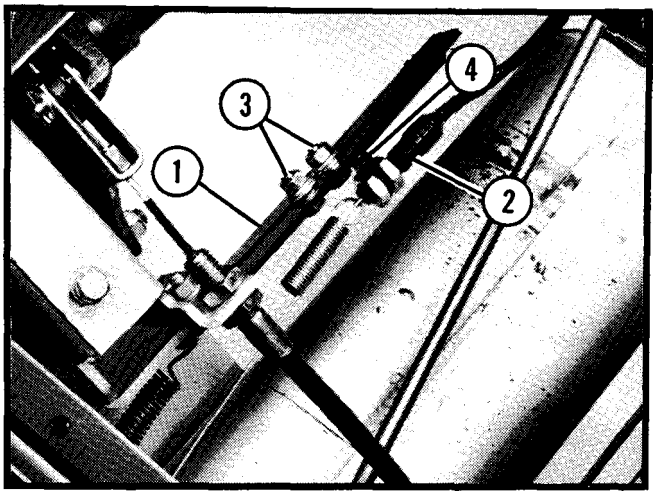


Figure 6.
1. Safety Switch Slide Bracket
2. Clutch Safety Switch
3. Locking Nuts
4. Switch Mounting Bracket

2. Additional adjustment can be made by moving the two locking nuts on the switch threaded shaft. See Figure 6.

Trouble-shooting

Clutch Slips

1. Insufficient pedal travel, linkage adjustment needed.
2. Worn clutch lining.
3. Clutch lining contaminated.

Clutch Will Not Release

1. Clutch facing adhered to clutch plate by ice, chemicals, etc.
2. Too much pedal free-travel.

Clutch Chatters

1. Warped clutch disc.
2. Broken or damaged clutch lining.
3. Broken or loose engine and/or transmission mounts.
4. Actuator worn or bent.
5. Clutch lining contaminated.

SECTION 11 TRANSMISSION

Disassembly

1. Drain lubricant from transmission and clean case with solvent.
2. Remove Power Take-off or side cover.
3. Remove the control levers.
4. Remove front and rear bearing retainers. See Figure 1.

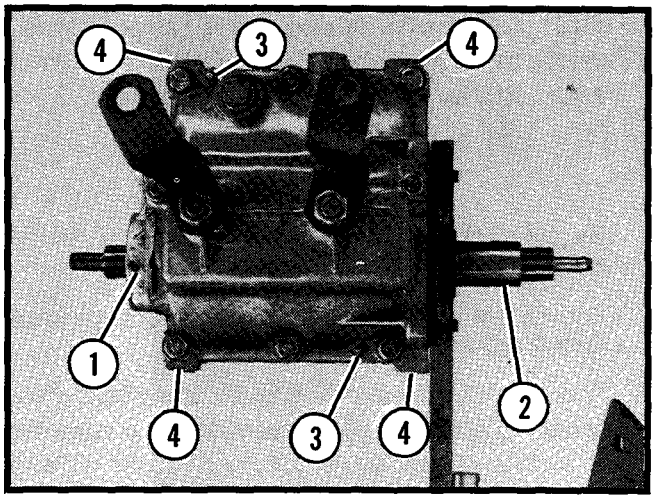


Figure 1.
1. Rear Bearing Retainer
2. Front Bearing Retainer
3. Tapered Locating Pins
4. Separating Tabs (4)

5. Remove both taper locating pins from transmission case. See Figure 1.
6. Remove the six retaining screws and nuts. Remove the two retaining nuts located on the left side of the transmission (shifter lever side).
7. Separate the two transmission halves.

NOTE

- DO NOT insert any tool between case halves. Use a hammer on the separating tabs located on the left half of the transmission. See Figure 1.

Inspection of Parts

1. Check interlock sleeve for correct clearance in all four gear positions, (low, second, high, and reverse. **DO NOT check in neutral**). See Figure 2.
   Clearance must be:
   .005 in. (0.13 mm) maximum

NOTE

- This check must be done before shift levers are removed from the transmission.
- If a clearance of more than .005 in (0.13 mm) is found the transmission may get into two gears at once.
- Sizes of NEW interlock sleeves and markings:

Part No.	Mark	Size
815139		1.259"
815140	"A"	1.255
815141	"B"	1.251
815142	"C"	1.247
815143	"D"	1.243
822238	"E"	1.263
822239	"F"	1.267

These interlocks are to be used as required to provide .005 in. (0.13 mm), maximum clearance between end of interlock sleeve and shift lever when one is in neutral and the other in gear.

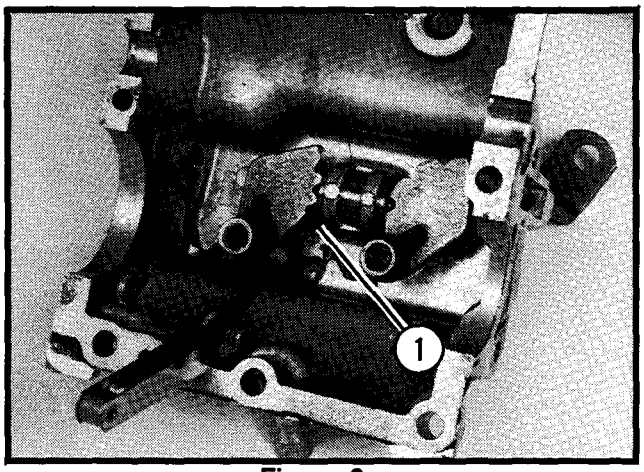


Figure 2.
1. Interlock Clearance .005 in (0.13 mm)

2. If the clearance is .005 (0.13 mm) or less proceed with step 4.
3. Using a straight punch, drive out the shifter lever retaining spirol pins.
4. Remove the shifter levers, interlock sleeve, balls, spring and spacer. See Figure 3.

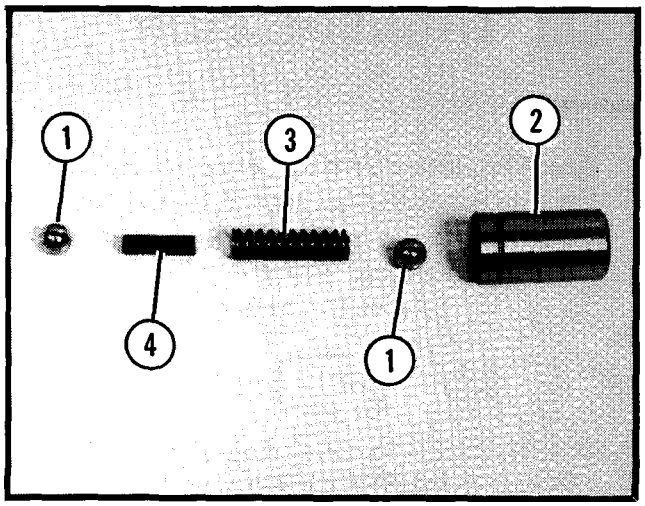


Figure 3.
1. Interlock ball **3. Spring**
2. Interlock Sleeve **4. Spacer**

5. Inspect the case for wear. If the shifter shaft bushings are worn excessively both halves of the case must be replaced.
   If the interlock sleeve is worn, it may be measured and a different size used to adjust for a maximum clearance of .005 in. (0.13mm).
   The shift lever wear surface is hardened. If the wear is on the shift levers, they must be replaced.

Shift lever and Interlock Sleeve Replacement

1. Install the second-high shift lever into the transmission case.

NOTE

- DO NOT install the "O" ring onto the shift lever before installing into the case. This will be done AFTER the interlock and both shift levers are assembled.

2. Install the interlock sleeve, balls, spring and spacer, and position transmission half as illustrated in Figure 4.

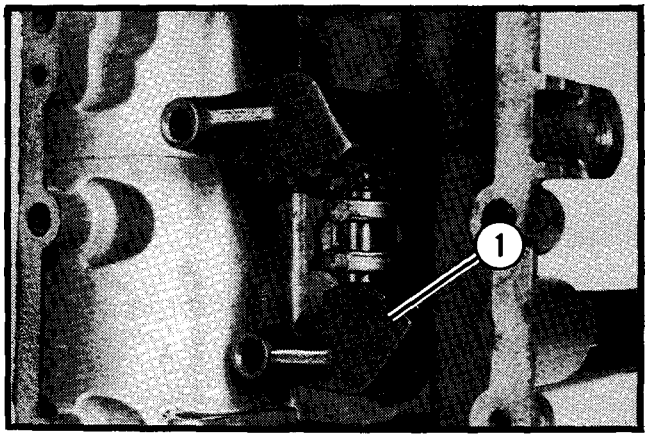


Figure 4.
1. Second-high Shift lever

3. Insert the low-reverse shift lever into the housing, but before pushing it all the way in, insert a thick, .018" (0.46 mm) or thicker, feeler gauge between the top ball and the shifter lever. Push the ball down as the shift lever is installed into the case.

NOTE

- Engine oil on all parts will ease the assembly of the shift levers and interlock sleeve.
- Both shift levers must be kept in the neutral position during this assembly procedure.

4. After the interlock and shift levers are properly assembled, push the shift levers into the case far enough to assemble new "O" rings into the "O" ring groove in each shaft. **This should be done one at a time.**

5. Push each shift lever back to align the roll pin groove in the shaft with the roll pin hole in the transmission case.

6. Install the spirol pins with slots toward the top of the case.

NOTE

- Coat each spirol pin with 3M #EC847 before installation.

7. Recheck the clearance between the interlock sleeve and the shift levers to ensure, the clearance is less than .005 in (0.13 mm) , when one lever is in neutral and one in gear.

8. Use 3M #EC847 to seal the roll pin holes. This will prevent leaks at the roll pin holes.

Disassembly of Main Shaft and Cluster Gear

1. Remove the main drive gear from the transmission case.
2. Remove the cluster gear from the transmission case.
3. Remove the reverse idler gear from the transmission case.
4. Separate main drive gear from the main shaft assembly.
5. Inspect the bearings of the main drive gear. Replace if necessary.
6. Remove clutch sleeve and the three shifter plates.
7. Remove the retaining ring that holds the second and high hub to the main shaft.
8. Remove the second and high hub, synchronizer ring, second gear, and low and reverse gear from the main shaft.
9. Inspect the ball bearing on the end of the main shaft. Replace if necessary.

Gears

Wash all gears in cleaning solvent. Inspect for worn or chipped teeth. It is advisable to slide each gear onto a new shaft so that the exact amount of wear may be determined.

Bearings

To wash a bearing, submerge it in cleaning solvent that is free of dirt. rotate the bearings to wash away any oil and dirt. Dry the bearings thoroughly. Bearings must be handled with care. Wrap them in a clean cloth or paper until they are needed. Carefully examine each bearing for cracked races, worn or scored balls. Replace if necessary.

NOTE

- When using compressed air to dry the ball bearings, do not allow the bearings to spin freely in the race.

Transmission Case Inspection

1. Examine the surfaces of the bearing recesses in the transmission case for wear or scoring which would indicate that the bearings have been revolving in their housings. Examine the case for cracks or other damage. If wear, scoring, cracks or other damage is evident both case halves must be replaced.
   Using a lacquer thinner or other suitable solvent, remove old cement from mating surfaces of both transmission halves.

NOTE

- Never use a scraper or any tool that will mar the mating surfaces or cause leaks after the transmission is assembled.

Synchronizer Ring Inspection

1. Check clearance between bronze synchronizer ring and high gear. Check clearance between bronze synchronizer ring and second gear. See Figure 5.
   Minimum clearance: .005 in (0.13 mm)

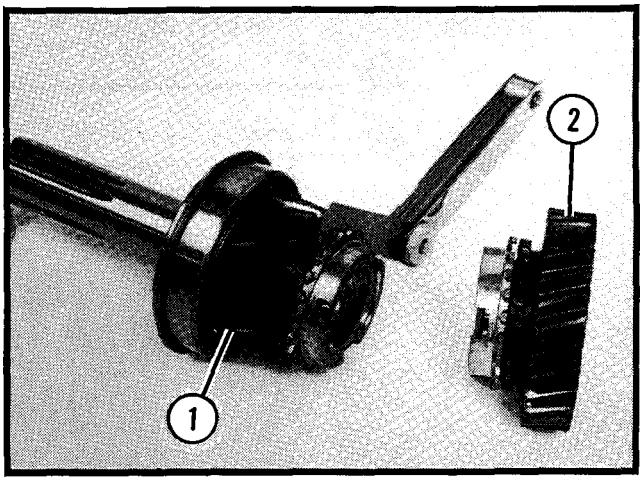


Figure 5.
1. High Gear
2. Second Gear

2. Although the transmission will function properly as long as there is clearance, it is advisable to replace the synchronizer rings if the clearance is .005 in (0.13 mm) or less.

Reverse Idler Gear Assembly

1. Assemble the reverse idler gear, shaft, and thrust washer as shown in Figure 6. **Note direction of idler gear. Note direction of shaft, notch for the locking plate must be to the rear of the transmission case.**

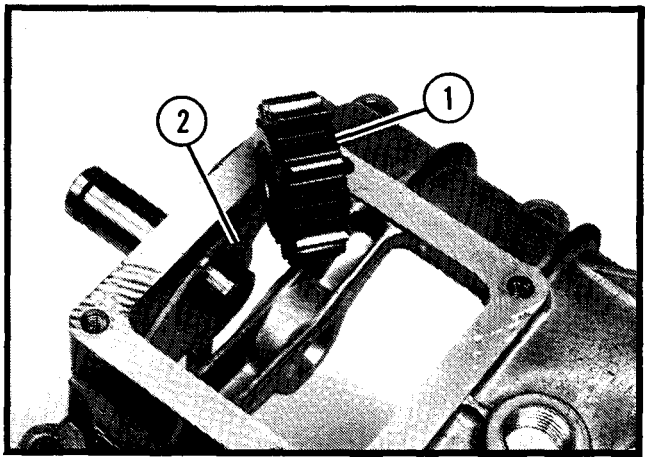


Figure 6.
1. Reverse Idler Gear
2. Thrust Washer

2. Select one of the following thrust washers to give .005 to .017 in. (0.13 to 0.43 mm) clearance between the gear and the transmission case. See Figure 7.

815150	**.024 in (0.61 mm)**
815154	**.036 in (0.91 mm)**
816503	**.048 in (1.22 mm)**

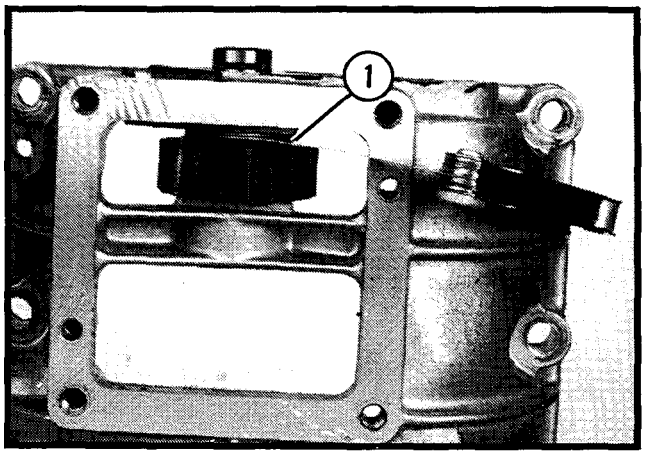


Figure 7.
1. .005 to .017 in (0.13 to 0.43 mm) Clearance

3. The thrust washer is keyed to the case by a tab. A notch in the case is provided to accept this tab.

Cluster Gear Assembly

1. If the bushings or bearings (9120 models and later) are worn and need to be replaced they must be pressed into position flush with the end of the cluster gear. The oil hole in the bushing installed in the rear of the cluster gear must be aligned with the hole in the rear of the cluster gear.

2. After new bushings are installed they must be re-sized with a reamer to:
   .752 to .754 in (19.10 to 19.15 mm)

3. Insert the countershaft into the cluster gear assembly **(slot in the end of the shaft is next to low and reverse gear)**. Check for thrust clearance of .005 to .017 in (0.13 to 0.43 mm). This must be done in the right half of the transmission case.

4. A thrust washer must be used on each end of the cluster gear. Select thrust washers listed below to satisfy clearance and location of the cluster gear shown in Figure 9. The thrust washer is keyed to the case by a protruding tab. Tabs on the thrust washers must be positioned as shown in Figure 8.

815150	**.024 in (0.61 mm)**
815154	**.036 in (0.91 mm)**
816503	**.048 in (1.22 mm)**

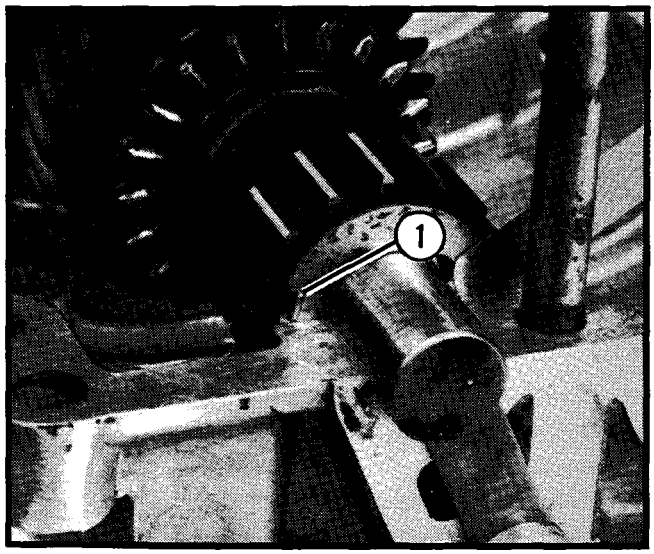


Figure 8.
1. Tabs

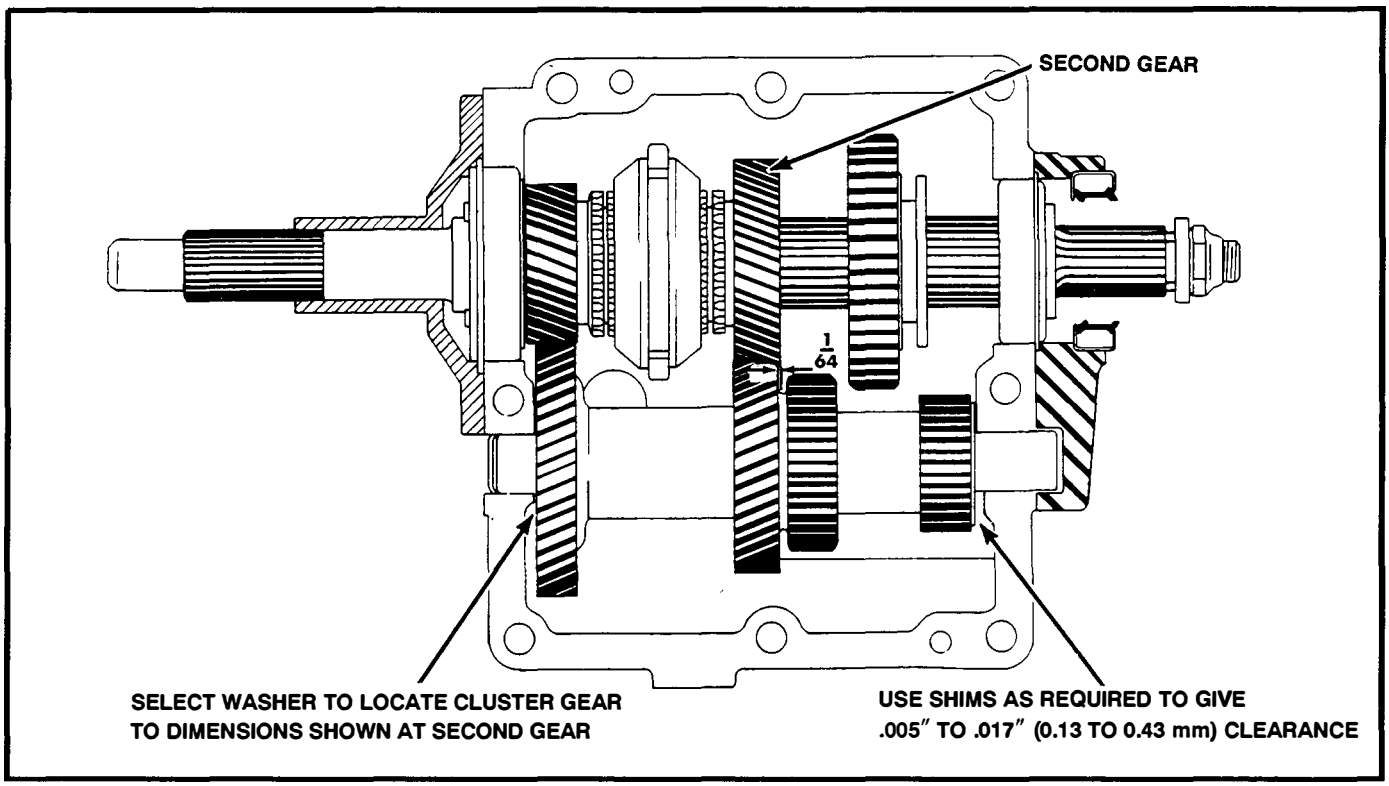


Figure 9.

Shifter Hub And Sleeve Assembly

The shifter hub and sleeve assembly consists of the following:

- Second and high clutch hub
- Second and high clutch sleeve
- Shifting plates
- Springs
- Hub

1. Install springs in the hub as shown in Figure 10. To ensure proper tension on shift plates the spring ends must be placed as shown.

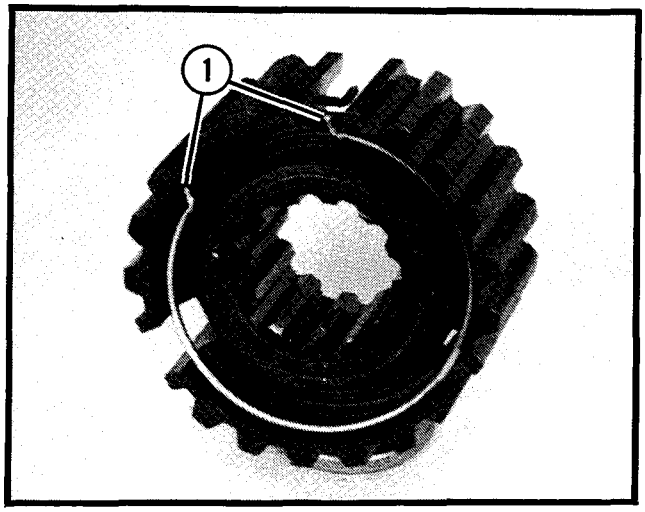


Figure 10.
1. Spring Ends

Second Gear Assembly

1. **9120 and later:**
   If the needle bearing is worn it must be replaced. Install new needle bearing flush to 1/16" recessed with the face of the gear.

2. **9110 and earlier:**
   Remove the old bushing and press the new into the gear. It must be flush to 1/16" (1.6 mm) recessed with the rear face of the gear.

3. After installing the bushing it must be re-sized to:
   .812 to .814 in. (20.63 to 20.68 mm)

Main Shaft Assembly

1. Assemble the low and reverse gear,second gear, and synchronizer ring onto the main shaft. See Figure 11.

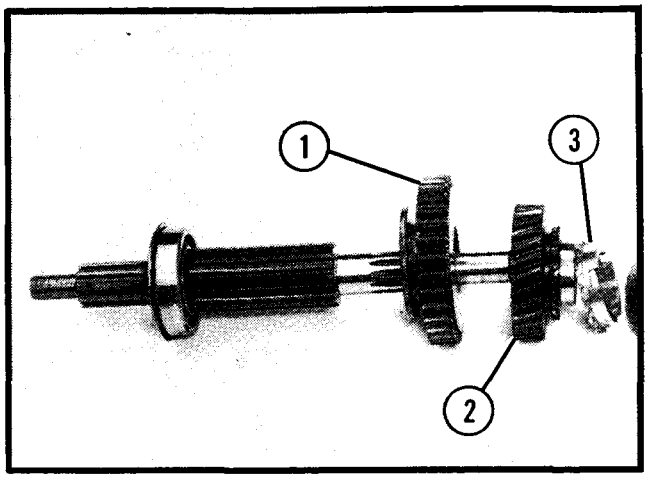


Figure 11.
1. Low and Reverse Gear
2. Second Gear
3. Synchronizer Ring

2. Install the shifter hub and sleeve assembly onto the main shaft.

NOTE

- Ensure that the hub goes onto the shaft in the proper direction or the main drive gear assembly will not fit completely onto the main shaft. (The taper on the inside of the hub shaft must go onto the main shaft first.) See Figure 12.

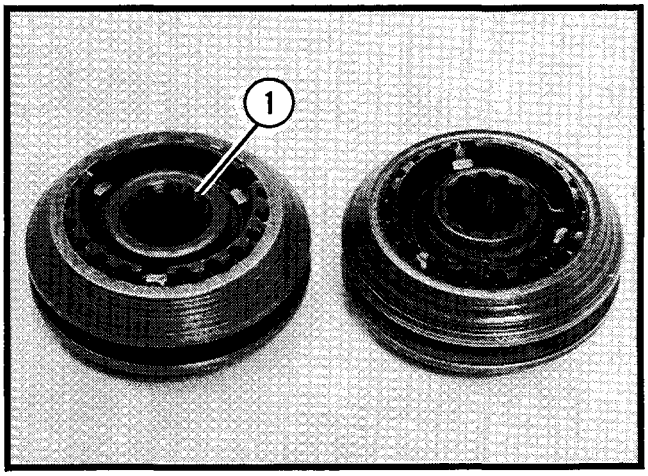


Figure 12.
1. Tapered Splines

3. Install retaining ring.

4. Install synchronizer ring onto main drive gear.

5. Assemble main drive gear onto main shaft and install into the right half of the transmission case.

6. Place the shifter forks onto the gears. See Figure 13. Place assembly grease on the shifter forks to help position them while assembling the second half of the transmission.

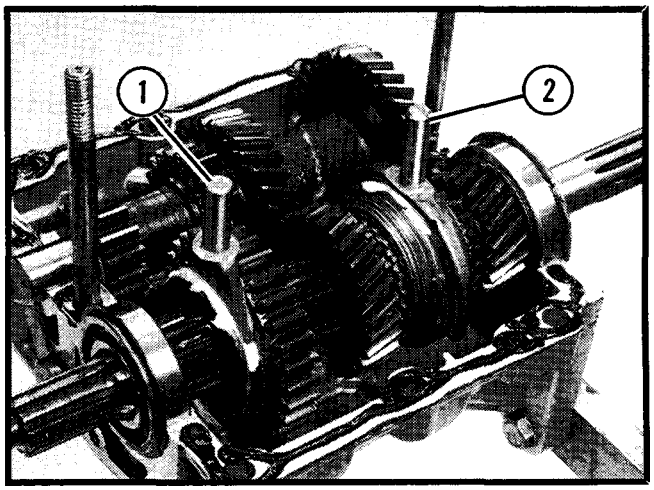


Figure 13.
1. Low & Reverse Shifter Fork
2. Second & High Shifter Fork

7. Place a 1/8 " (3mm) bead of Loctite 515 sealer on one half of the transmission. After the sealer has been applied assemble the two transmission halves. See Figure 14.

8. Insert the two retaining nuts located near the shift levers. Tighten until they lightly compress the lock-washer.

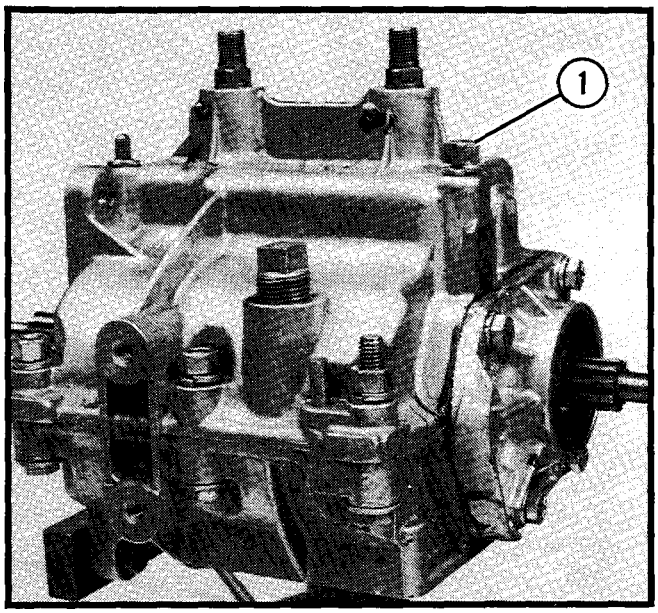


Figure 14.
1. Retaining Nut (2)

9. To align the transmission case halves drive in the two tapered locating pins.

10. Install the remaining retaining screws and nuts. Snug up all screws and nuts using a criss-cross pattern starting with the screws next to the locating pins. Use the same criss-cross pattern and tighten all hardware to the following torque specifications.
Torque:

3/8" Screws	**20 to 25 ft. lbs. (27 to 34 Nm)**
3/8" Stud	**17 to 23 ft. lbs. (23 to 31 Nm)**
5/16" Stud	**10 to 15 ft. lbs (14 to 20 Nm)**

11. After the halves are fastened together, remove the excess sealer from the front and rear machined surfaces. These are gasket surfaces and must be free of sealer.

12. Install countershaft and reverse idler shaft lock-plate. The lock-plate must be centered. See Figure 15.

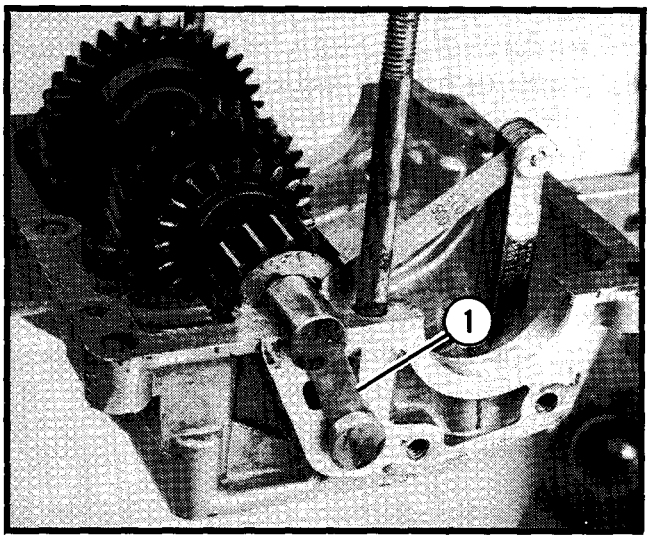


Figure 15.
1. Lock-plate

13. Coat expansion plug OD with sealer 3M #EC847. Install in front countershaft hole and set. Rear of countershaft must rest against a flat solid surface so that when the expansion plug is being set countershaft will not move.

14. Apply a light coat of Permatex #3 on both sides of the rear bearing gasket. Coat the front and rear bearing retainer screws with Permatex #3. Install front and rear bearing retainers.
Torque:
10 to 15 ft. lbs. (14 to 20 N·m)

15. Place a small amount of grease on the lips of the rear seal. Install the spacer washer onto the out-put shaft of the transmission. Install the drive-shaft carefully so that the oil seal is not injured.

Pre-installation Checks

NOTE

- These checks are to be made before the power take-off or side cover is installed.

1. With the transmission in neutral, the low and reverse sliding gear must be centered between the low gear on the cluster and the reverse idler gear.

2. With the transmission in neutral, the main shaft and main drive gear shaft must turn freely.

3. Shift into gear (reverse, low, second and high).

4. When in gear, the transmission must drive through without binding. Check to make certain the transmission cannot be shifted into two gears at the same time by attempting to move one control lever when the other control lever is shifted into gear.

5. Check operation of transmission form neutral to low and neutral to reverse without the main drive gear shaft turning for smooth operation and no binding of the linkage. The amount of torque to shift the linkage must not exceed 25 in. lbs. (3 Nm) on the nut attaching the low and reverse control lever.

PTO or Cover Plate Assembly

1. Coat the threads of one mounting screw with 3M #EC847. This screw is to be installed in the upper right mounting hole.

2. Coat both sides of the gasket with 3M #EC847 sealer.

3. Install the power take-off unit or side cover.
   Torque:
   10 to 15 ft. lbs. (14 to 20 N·m)

NOTE

- When the power take-off assembly is used in conjunction with this transmission, use .003 to .005 in. (0.08 to 0.13 mm) thick paper gasket. When the side cover is used, use .063 in (1.59 mm) thick cork gasket.

Trouble Shooting

Leaks Oil

1. Oil level too high
2. Oil too thin
3. Low grade oil–oil foams excessively
4. Leakage at rear oil seal because of wear or loose bearing
5. Drain and/or filler plug damaged or loose
6. Crack in transmission case
7. Shifter lever "O" rings damaged or worn or installed in wrong groove
8. Power take-off or opening cover loose or gasket damaged
9. Power take-off case or opening cover retaining screw (upper front) will leak if improperly sealed or has not been sealed
10. Leak between case halves due to improper sealer or marred mating surfaces or unmatched case halves
11. Oil return passage in front bearing retainer clogged
12. Front or rear bearing retainer loose or gasket damaged
13. Expansion plugs in front of transmission damaged or improperly installed
14. Insufficient amount of sealer on spirol pins

Slips Out of Low or Reverse

1. Shifter linkage travel incomplete due to excessive wear or need of adjustment
2. Interlock spring is weak or broken
3. Interlock ball broke, worn or stuck
4. Notches on shifter lever worn
5. Shifter fork worn
6. Shifter lever retaining pin broken
7. Worn low and reverse sliding gear

Slips Out of Second Only

1. Second speed gears worn
2. Synchronizer ring teeth that engage second gear are worn

Gears Clash When Shifted

1. Mis-alignment between transmission and clutch housing
2. Dragging clutch
3. Synchronizer rings worn or damaged
4. Second and high hub loose on main shaft due to wear
5. Lubricant too heavy
6. Shifter plates worn or broken or not properly installed
7. Synchronizer springs broken
8. Oil level too low

Slips Out of Second or High

1. Shifter linkage travel incomplete due to excessive wear or need of adjustment
2. End play in main shaft and main gear assembly due to loose front and/or rear bearing retainers or worn bearing housing "case"
3. Clutch teeth of main drive gear and /or the second speed gear worn
4. Splines on second and high hubs worn
5. Main shaft spines worn
6. Main drive gear and/or main shaft bearings worn
7. Snap ring that holds clutch sleeve in place broken
8. Shifter fork worn
9. Interlock spring weak or broke. Interlock ball worn or broken. Notches on shifter lever worn.
10. "Clutch plate" pilot bearing worn
11. Shifter lever retaining pin broken
12. Bent main shaft

Power Take-Off Assembly

Disassembly

1. Drain oil from transmission and remove power take-off assembly from the transmission.
2. Remove expansion plug from front of assembly.
3. Remove the retaining ring from PTO housing that retains the bearing.
4. Remove retaining ring from PTO shaft.
5. Remove PTO shaft, gear and shifter fork from case.
6. Remove shifter arm from shifter lever.
7. The shifter lever, shifter lever shim, interlock button and interlock spring may now be removed from the case.
8. Remove PTO "O" ring.

PTO Case

1. Wash the case with solvent and inspect for cracks, marred or uneven mating surfaces. If any cracks, marred of uneven surfaces are found the PTO case must be replaced.
2. Check bearing and replace if necessary.
3. Measure the inside diameter of the rear PTO shaft bushing.
   Allowable limits:
   .9394 to .9374 (23.86 to 23.80 mm)
4. If worn, it must be removed with a press and a new bushing installed. After pressing new bushing into place it must be reamed :
   Allowable limits:
   .9394 to .9374 (23.86 to 23.80 mm)

Assembly of PTO

Regardless of appearance, all gaskets, and oil seals must be replaced.

1. Install spring and button into PTO case.
2. Assemble shim and "O" ring onto shifter lever. Apply assembly oil to the "O" ring and shaft. Install shifter lever into PTO case.
3. Install shim onto shifter lever shaft. Install PTO shifter arm onto shifter lever. Secure with lock washer and nut.
   Torque **50± 2 ft. lbs. (68± 2 Nm)**
4. Check shifter lever end play.
   Allowable limits:
   .005 to .030 in (0.13 to 0.76 mm)
   If necessary add another shim on the shifter shaft between the PTO case and the PTO shifter arm.
5. Lubricate shifter fork shaft. Install shifter fork onto shifter arm.
6. Install new PTO shaft seal. Lubricate the seal lips.
7. Place PTO sliding gear into PTO case. Ensure that shifter fork slides into the grove on the sliding gear.

NOTE

- The groove of the PTO sliding gear must face the front of the case.

8. Lubricate PTO shaft. Install the PTO shaft through the seal end of the case and through the sliding gear. Ensure that the oil seal is not damaged.
9. Install bearing onto PTO shaft and secure with bearing retaining ring. Install bearing retaining ring into PTO case.
10. Coat expansion plug OD with 3M #EC847 sealer before expanding plug into PTO case.

Installing PTO Assembly to Transmission

NOTE

- If, during inspection, foreign matter or metal particles were found in case, the transmission also must be flushed and checked for foreign matter
- The clearance or mesh between the PTO gear and the reverse idler gear of the transmission is critical, therefore, the gasket must be .003 to .005 in (0.08 to 0.13 mm) thick.

1. Coat the gasket surfaces of the PTO assembly and transmission with 3M #EC847 sealer.
2. Install the PTO assembly to the transmission.
3. Use Permatex No. 3 on threads of the upper front mounting screw ONLY.
   Torque:
   10 to 15 ft. lbs (1.2 to 1.6 Nm)

Auxiliary Transmission

Overhaul Procedure

1. Drain the auxiliary transmission oil.

NOTE

- The auxiliary transmission may be controlled by cable or by shift linkage.

2. Remove shift rod or shift cable from transmission lever.

3. Remove detent lock nut, adjusting screw, spring and positioning button.

4. Remove the transmission cover.

SAFETY WARNING

Support the vehicle on approved jack-stands, to prevent it from falling and causing injury. DO NOT rely on hydraulic or mechanical jacks to support the vehicle while working on it.

5. Raise the rear wheels off the ground and support the rear of the vehicle frame with jack-stands.

6. Raise the differential to release load from the springs.

7. Remove spring mounting bolts from the front shackle.

8. Lower differential until the rear half of the drive-shaft slides out of the front half of the drive-shaft.

NOTE

- Some force must be applied to the differential or rear shackles rotated to separate drive-shaft.

9. Remove the four screws holding the bearing retainer to the front of the auxiliary transmission. Remove the bearing retainer, drive gear, and drive shaft as one assembly.

10. Remove the main shaft retaining nut and pull the main shaft and shift collar from the differential worm shaft. See Figure 16.

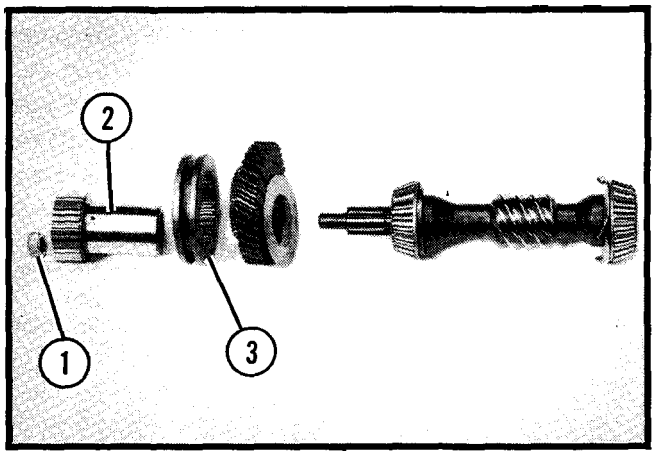


Figure 16.
1. Retaining Nut
2. Main Shaft
3. Shift Collar

NOTE

- Be sure the shims are removed from the worm shaft.

11. Remove the auxiliary transmission case from the differential.

12. Remove the expansion plugs covering both ends of the jack shaft.

13. Drive out the roll pin retaining the jack shaft in the case and drive the jack shaft from the case.

14. Inspect all parts carefully and replace any that show wear or damage. Never attempt to re-use old gaskets or seals.

Reassemble

1. Install the cluster gear. Install one shim between cluster gear and front of case, and install necessary shims between cluster gear and the rear of the case to provide .005 to .032 in., (.0127 to 0.812 mm) end play. Coat expansion plugs with 3M #EC847 sealer before expanding plug.

2. If the auxiliary transmission case was removed it must be installed onto the differential. Be sure the pinion flange gasket is in position.
Torque:
20 to 25 ft. lbs. (24 to 34 N·m)

3. Install sufficient shims over the worm shaft, behind the driven gear to allow .010 to .020 (0.25 to 0.51 mm) clearance between the driven gear and the brass thrust washer when the worm shaft nut has been securely tightened. This can best be accomplished by installing approximately .070 in (1.78 mm) shims. Tighten the worm nut securely and measure the distance between the gear and brass thrust washer; then removing sufficient shims to acquire the proper clearance. See Figure 17.

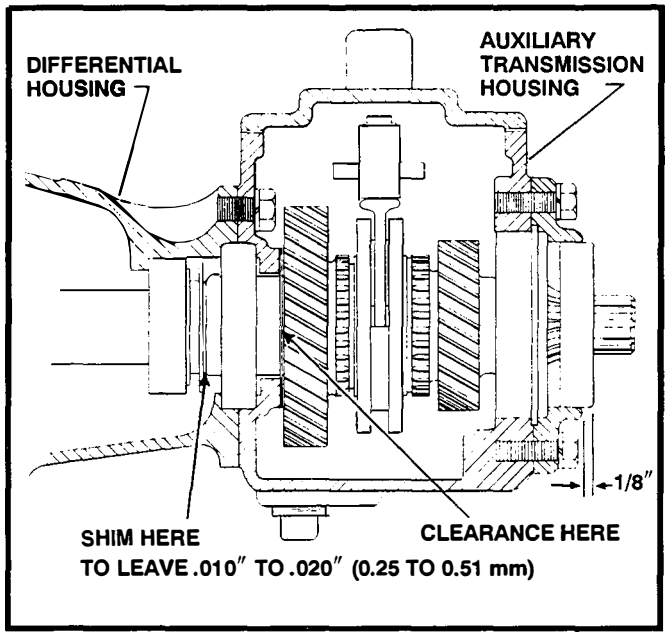


Figure 17.

NOTE

- This will eliminate the necessity of several installation and removing operations to acquire the desired clearance. Install shifter collar on main shaft prior to final installation as this collar cannot be installed after the worm nut has been torqued.
  Torque:
  20 to 25 ft. lbs. (27 to 34 N·m)

4. Install new oil seal in retainer. See Figure 17.

5. Install the drive gear and bearing retainer. Be sure the new gasket is in position.
   Torque
   16 ft. lbs. (21 N·m)

6. Install the transmission cover, new gasket, and ratio tag. Be sure the shifter is seated in the shifter collar groove.
   Torque:
   8± 2 ft lbs. (11 N·m)

7. Install the shifter positioning button, spring and adjusting screws. Tighten adjusting screw to provide sufficient spring tension to hold transmission in gear.

8. Install the drive shaft by raising the differential and align the two drive shaft halves.

9. Install shackle bolts in front shackles. Tighten shackle bolts.

10. Connect shift rod or cable to the transmission.

11. Install 22 oz. (0.7 L) NEW lubricant:
    SAE 80W above 32° F (0°C)
    SAE 20W below 32° F (0°C)

SECTION 12 DIFFERENTIAL

Special tools needed for this section:

809315 Knock-off
880026 Worm Bearing Cup Driver
Bearing Cup Puller
Bearing Cone Puller

General Information

Servicing this differential is a major service operation and should be performed by an authorized Cushman dealer who has the necessary equipment and information.

To keep your differential performing at it's peak, you should:

1. **Drain after the first 100 hours of service and refill with EP80–90**
2. Re-pack axle bearings annually, (minimum).
3. Check lubricant level frequently.
4. **Do not** tow vehicle faster than 5 mph.

Removal

SAFETY WARNING

Support the vehicle with approved jack stands. Do not rely on mechanical or hydraulic jacks.

1. Raise the vehicle and remove the rear wheels.

2. Remove the cotter pin, axle nut and washer. Install a knockoff part number 809315. Hit the knockoff with a sharp blow with a heave hammer to loosen the hub from the axle. See Figure 1.

NOTE

- Be sure the knockoff is tight against the end of the axle, to prevent damage to the threads.

- Slight pressure behind the brake drum will aid in loosening the hub from the axle.

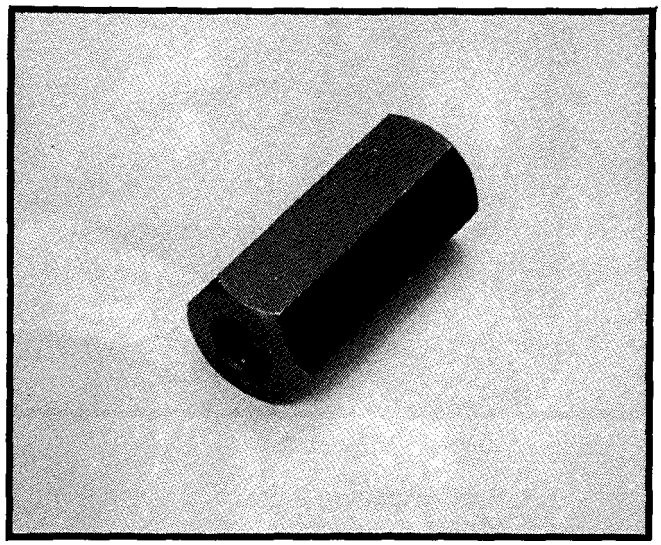


Figure 1.
Tool 809315

3. Drain the differential oil. Do not reuse oil.

4. Remove both rear shock absorbers.

5. Disconnect brake hose at the tee on the rear axle.

SAFETY WARNING

Do not bend or kink brake lines. Kinked brake lines will cause restrictions, leaks and possible premature failure of the brake system.

6. Support the differential to take the load from the springs and remove the spring shackle bolts.

Differential Disassembly

1. Remove the leaf springs from the differential. Note position of hardware for reassembly.

2. Disconnect brake return spring. Remove seal retainers and brake backing plates. Keep shims in their respective positions for reassembly, noting which side of the differential they go on. See Figure 2.

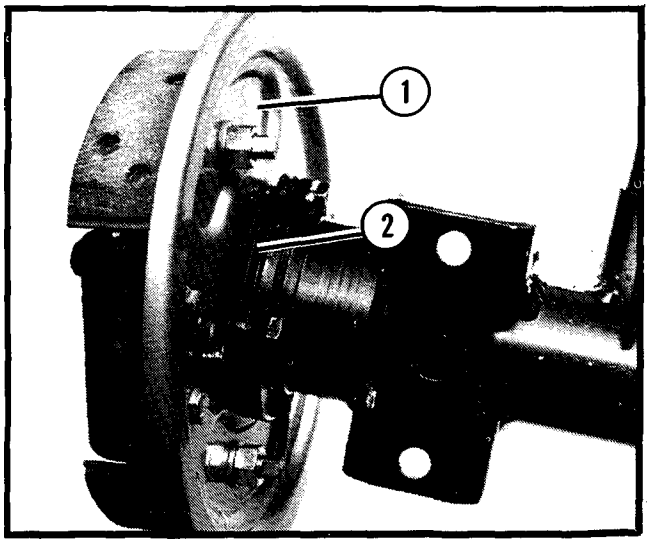


Figure 2.

1. Brake Backing Plate
2. Shims

3. Remove the axles. This will also remove the bearing cups and cones, and the backing ring. (A slide hammer puller may be needed.) Inspect for wear and cracks on the axle splines and the wheel bearings. Replace all worn or bad parts.

4. Remove and discard the inner wheel bearing seals from both housing halves.

5. Remove the six nuts and screws that hold the axle housing halves together, and separate the housing halves by tapping with a mallet to break the seal.

NOTE

- Do no use a sharp object between the housing halves as it will cause a leak.

6. Remove the carrier gear assembly from the housing.

Worm Removal and Inspection

1. Remove the four screws holding the worm bearing retainer, shims and gasket, from the housing assembly.

2. Remove the worm. See Figure 3.

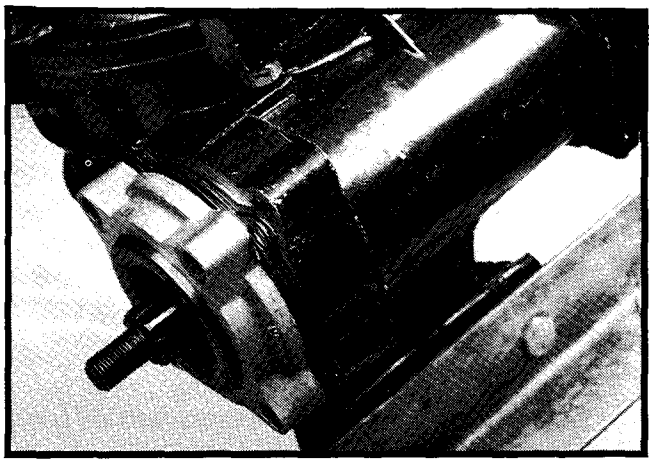


Figure 3.
Drive Worm Removal

3. Clean and visually inspect the worm and bearings for excessive wear or damage.
4. Check the bearing cups inside the differential housing. Remove and discard bearings and cups if necessary. If a cup or cone must be replaced, replace its corresponding (mating) cone or cup. The expansion plug must be removed from the end of the differential housing before the bearing cup can be driven out.

Housing Inspection

1. Thoroughly clean all parts and inspect for wear and damage. Replace all worn or damaged parts.

2. If the carrier bearing cups need to be replaced, or if a new or rebuilt carrier assembly will be installed the shims located behind the bearing cups will be damaged when the bearing cups are removed. Measure each shim and write down its thickness, noting which side of the differential it was taken from. It will be necessary to replace them with new parts during assembly. Figure 4.

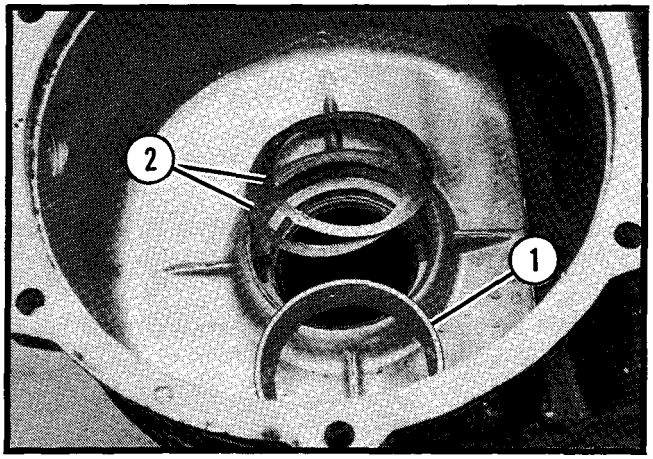


Figure 4.

1. Roller Bearing Cup
2. Shims

Carrier Disassembly and Inspection

1. Permanently mark (punch, stamp, etc.) the carrier housing to indicate the assembled position of the four planet gears. They MUST be reinstalled in the same configuration. Figure 5.

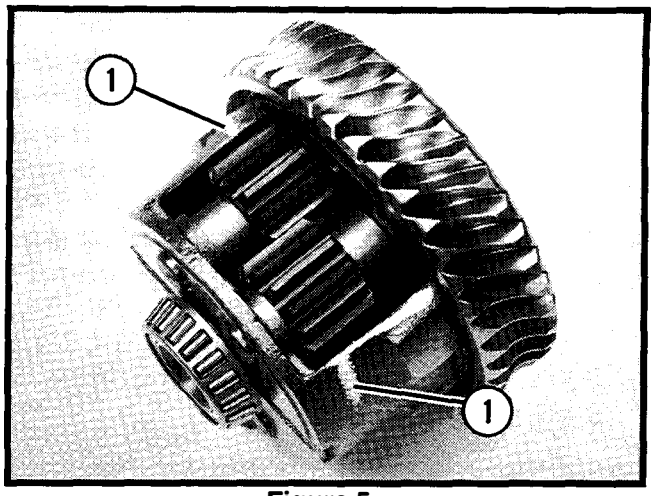


Figure 5.
1. Markings For Planet Gears

2. Remove the special screws and locking plates securing the worm gear.

NOTE

- The gear retaining screws are specially machined to provide locking tension once installed. Do not substitute standard hardware. Figure 6.

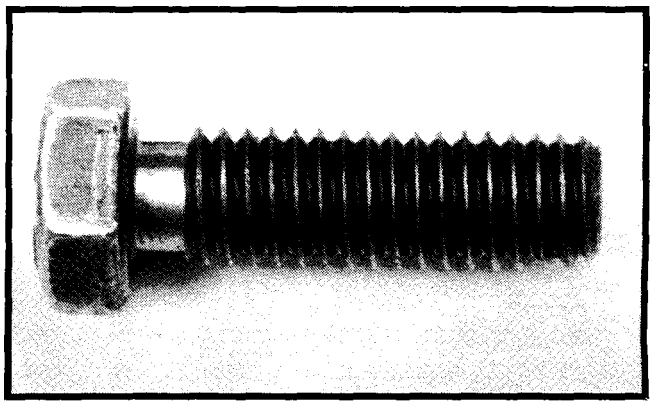


Figure 6.
Gear Retaining Screw (Special)

3. Remove the retainer screws, retainer plates, and locking plates. Remove the planet gears, spacers and shafts. Remove the two axle gears and the spacer.

4. Clean all items thoroughly and inspect for wear.

5. Lay a metal straightedge across the top of the planet gear shaft bosses, and use a feeler gauge to check for wear at the axle bosses, (Two places.)
Allowable limit: .010 in. (0.254 mm)
Excess wear indicates the need for a new carrier, axle gears and end-play spacer.

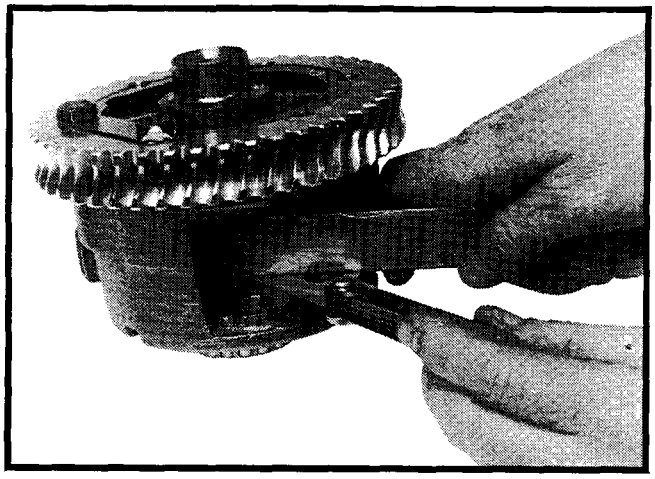


Figure 7.
Measuring Shaft Boss Wear

6. Inspect the worm gear and carrier for excessive wear or damage. Replace if necessary.

Worm Gear Replacement

NOTE

- A carrier may be fitted with a replacement worm gear only once, since it is necessary to drill and tap new mounting holes. If more than one set of worm gear mounting holes exists in the carrier assembly, discard and replace the entire carrier assembly.

1. Remove the worm gear by sawing through as far as possible with a hacksaw and then splitting the gear with a chisel

2. Inspect the gear mounting surface for nicks, burrs, etc., and smooth if necessary.

3. Heat the bronze worm gear in an oven or hot oil (do not use an open flame) for three-quarters of an hour at 300° F.

4. With the differential carrier housing in an upright position, set the heated worm gear onto the differential carrier housing with the chamfered side of the gear down. Numbers stamped on the gear should show. See Figure 8. Ascertain that the worm gear is seated square and even against the carrier flange. Clamp into place and allow to air cool.

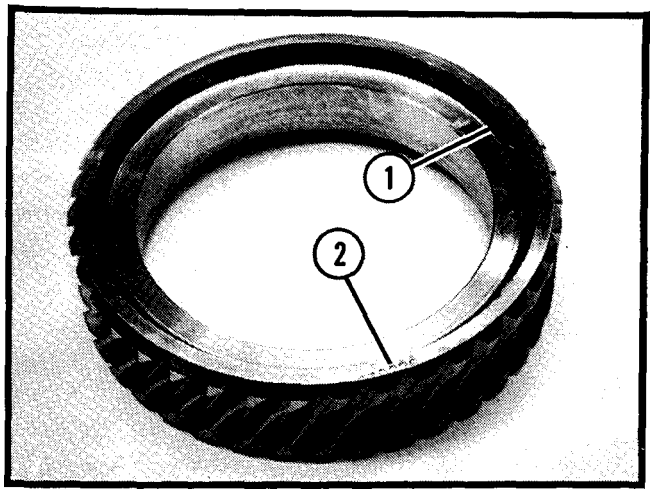


Figure 8.

1. Chamfered Side
2. Stamped Numbers

NOTE

- Do not press the worm gear into place. If it does not drop on, it has not been heated sufficiently, or there is a burr or other obstruction on the gear or housing.

5. Center punch six marks on the line that divides the worm gear from the carrier housing. See Figure 9. for location of center punch marks.

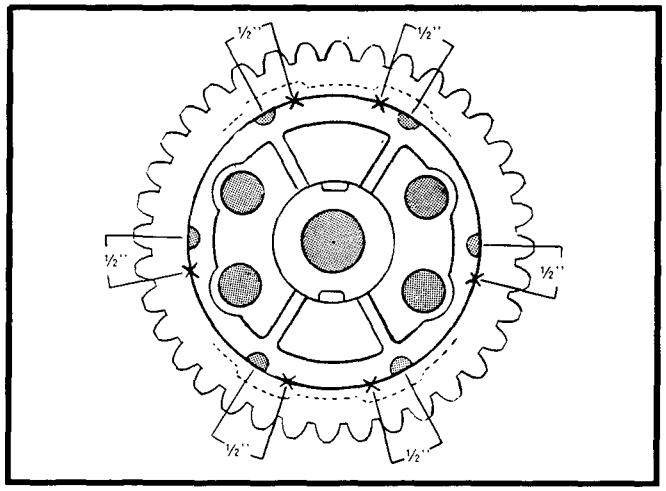


Figure 9.

1. New Hole Locations

6. Rigidly attach differential carrier housing to the base plate of a drill press. It is very important that the flat of the worm gear is perpendicular to the chuck shaft of the drill press.

NOTE

- Exact alignment of the drill and gear surface is critical for proper results. DO NOT attempt this operation with a hand held drill. It is critical that the threads be half in the bronze gear and half in the carrier case.

7. The holes that are to be drilled into the differential carrier and worm gear should be 5/16" in diameter and 1 3/4" deep. After each hole is drilled and before differential carrier is moved to the next hole, remove the 5/16" bit from the drill press chuck and install in its place a 3/8 – UNC tap. Tap the hole 1 1/2" deep that has just been drilled. This will insure a perfectly straight hole. WHEN TAPPING, TURN THE PRESS CHUCK OR TAP BY HAND; DO NOT USE POWER. See Figure 10. Repeat this procedure until all holes are drilled and tapped.

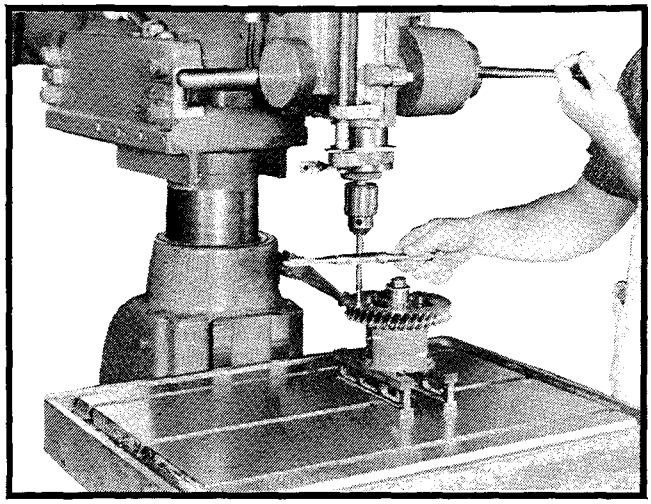


Figure 10.

1. Tapping Carrier

8. Thoroughly wash the differential carrier housing and worm gear in a clean solvent.

9. Place the spacer between the axle gears and install them. Install the planet gears and shafts, making sure the planet gears are in proper position, according to the marks made during disassembly. Install new shaft retainer locks and existing plates.

10. Clean the two 5/16" screws that hold the planet shaft retainers and treat with Locktite® Sealent, Grade D. Install with lock plates.

Torque: 20 to 25 ft. lbs. (27 to 34 N·m)

11. Bend the locks against the heads of the retaining screws.

12. Place the three lock plates in position, each covering two holes, and install the special screws into the differential carrier housing and worm gear.

Torque: 38 to 45 ft. lbs. (52 to 60 N·m)

NOTE

- The gear retaining screws are specially machined to provide locking tension once installed. Do not substitute standard hardware. Figure 6.

- It will be necessary to modify one of the lock plates due to the fact that the distance between two of the retaining screws is now different than originally. See Figure 11.

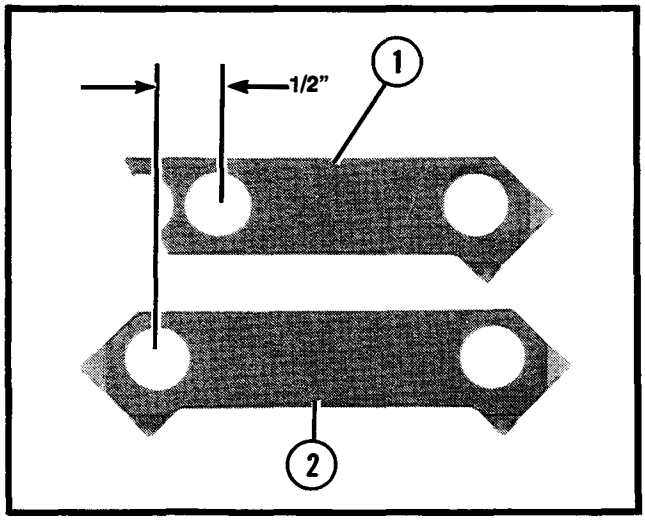


Figure 11.

1. Modified locking plate
2. Original locking plate

13. Bend the corners of the lock plates against flats and over top of the screw heads.

14. One of the special retaining screws will need approximately two threads ground from it to provide clearance for a planet gear.

Worm Installation

1. Clean the bearing cones in a cleaning solvent (when using air pressure to dry the bearing cones, do not allow the bearing to spin freely on the cone). Inspect cones and cups for any damage or blue marks indicating overheating and softening of the bearing.

2. Install the two bearing cones and oil slinger onto the worm shaft.

3. Press the bearing cone on using a bearing cone driver and an arbor press, press on the outer bearing first. Fit oil slinger to the other end of the worm shaft and press the inner bearing down tight against the convex side of the oil slinger. See Figure 12.

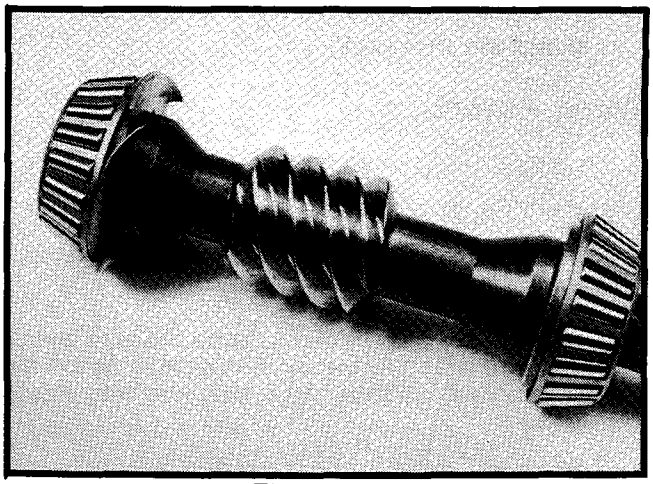


Figure 12.
Bearing Installation

4. To replace the worm shaft bearing cup, first drive out the 2 3/8" diameter expansion plug located at the rear of the axle housing. The cup that is pressed into the rear of the axle housing may now be removed, using a brass drift and hammer. The same method can be applied to remove the cup from the worm bearing retainer.

5. Before either cup is replaced, it is imperative that all mating surfaces be checked for burrs, nicks and mars that would interfere with the proper seating of the cup.

6. The worm bearing cups are installed by using the worm bearing cup driver, part No. 880026 , as shown in Figure 13.

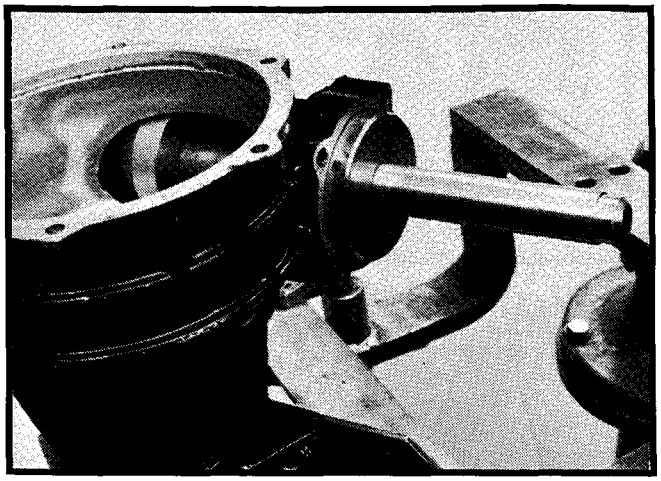


Figure 13.
Bearing Cup Installation

7. Install worm shaft assembly (oil slinger end first) into axle housing half.

8. Insert the worm bearing retainer, over worm shaft, into housing opening, using shim pack and two or more gaskets (with minimum of one gasket on each side of the shim pack).

Worm Preload

NOTE

- Do not lubricate bearings until preload and endplay adjustments have been made.
- The endplay and preload must be checked and determined with only the worm assembly in the axle housing half. (Worm shaft must turn with you fingers.)
- The 3/8 – 16 threaded retaining screw must be drawn up **equally** and tightened to **20 to 25 ft. lbs (27 to 34 N·m)** torque. Turn the worm assembly slowly while tightening the screws to prevent locking the bearings.
- The worm shaft assembly must be shimmed to obtain **zero end play** to a **preload of 5 in. lbs (0.4 N·m)** torque. (Start with original shim thickness.)
  End play must be checked with a dial indicator. See Figure 14.
  Preload must be checked by attaching an in. lb. torque wrench to the end of the worm shaft, using the wrench to determine the preload. See Figure 15.

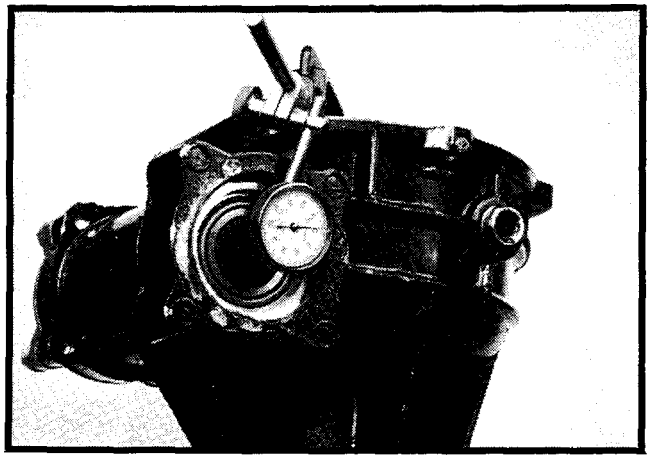


Figure 14.
End Play Check

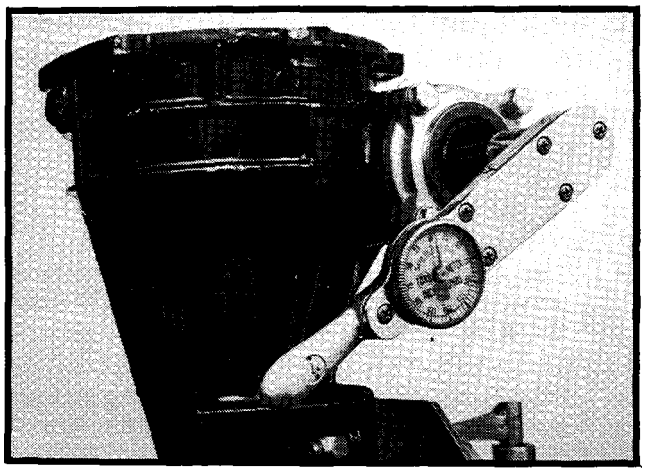


Figure 15.
Preload Check

9. Coat expansion plug OD with 3M #EC847 (part number 112008) sealer before setting plug into differential housing.

Carrier Installation

NOTE

- If differential housing is replaced (one or both halves). You must:
  1. Remove the carrier bearing cups from the old housing.
  2. Measure the shims behind the bearing cup.
  3. Install the same amount of shims in the new differential housing with a new bearing cup.

1. Lubricate the bearings and planet gears of the differential carrier with SAE 30 oil. Install the carrier into the differential case.

2. Apply 3M #EC847 to the small housing half and fit housing halves together.

NOTE

- The use of improper sealer may result in build-up which affects shim settings.

3. Install screws and self locking nuts. Under the head of one of the screws, install the metal tag that designates the proper gear ratio. See Figure 16.
   Torque: 16 to 20 ft. lbs. (22 to 27 N·m)

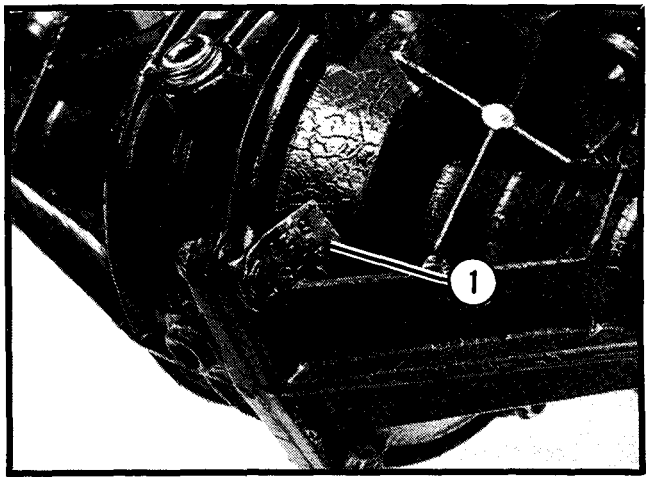


Figure 16.

1. Gear Ratio Name Plate

Axle Installation

1. Lubricate and install new inner oil seals to a depth of 3/4". See Figure 17.

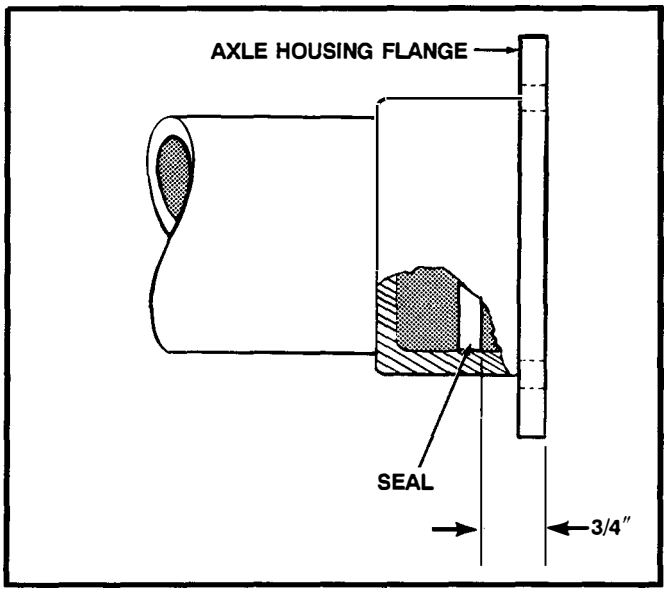


Figure 17.

Correct Inner Oil Seal Position

NOTE

- Correct depth of installation is critical. If the seal is incorrectly located, it will not contact the sleeve on the axle.

2. Install new bearing cones onto an axle and pack with wheel bearing grease, then install the axle in differential housing.

NOTE

- Lubricate bearing surface near splines on axle shaft.

3. Install bearing cup over the axle bearing. Ensure that the bearing cup seats properly into the axle housing.

4. Replace the existing shims (if damaged). Install the bearing gasket.

5. Install new seal into the seal retainer.

6. Install the brake backing plate and seal retainer onto axle housing. Reconnect the brake return spring.
   Torque: 16 to 20 ft. lbs (22 to 27 N·m)

7. Repeat steps 1 thru 6 for the other axle.

8. Seat both axles by tapping the end of the axle sharply with a soft hammer.

Axle End Play Adjustment

NOTE

- It is critical that both rear wheels be off the ground and the axles be seated into the carrier gears before the axle end play is checked.

1. Use a dial indicator to check axle end play. The end play must be a minimum of .001 in (0.025 mm) each side. The maximum of both axles must not exceed .010 in (0.25 mm).
2. Adjust shims behind the brake backing plate to obtain proper endplay.

3. Install the brake hub. Install special washer, key and castle nut.
   Torque: 70 to 90 ft. lbs. (95 to 140 N·m)

4. Align the castle nut with the hole in the axle and install a new cotter pin. If needed tighten the castle more to align the hole. **DO NOT LOOSEN THE CASTLE NUT TO ALIGN THE HOLE.**

Installation of Differential

1. Install the springs to the differential.
   Torque: 70± 2 ft. lbs. (95± 2 N·m)

2. Support the differential and raise into place under the vehicle. Align the drive shaft and install the spring shackle bolts.
   Torque: 70± 2 ft. lbs. (95± 2 N·m)

3. Install the shock absorbers.

4. Fill the differential with proper lubricant to the level plug.
   Specification: EP80-90 gear oil
   12 oz. (0.4 L)

5. Install the wheels.
   Torque: 70 to 90 ft. lbs. (95 to 140 N·m)

TROUBLE SHOOTING

Noise Under Power

1. Worm shaft bearing bad or adjusted too tight
2. Low oil level

Noise When Vehicle is Coasting

1. Worm shaft bearing adjusted too loose
2. Low oil level

Worm Shaft Seal Leaking

1. High oil level in differential

Will Not Differentiate

1. Axle shaft froze in carrier housing
2. Planet gears installed improperly

Worm Gear Worn Off

1. Towing vehicle too fast. **Do not tow faster than 5 mph**
2. Differential out of oil

Axles Break

1. Loading vehicle beyond design limits

SECTION 13 STEERING

Special tools required in this section:

- Inch pound torque wrench
- Foot pound torque wrench
- Knockoff Part no. 809316

THREE WHEEL STEERING SERVICE

Disassembly of Steering Gear

1. Disconnect horn wire.

2. Remove the top idler bolt nut, knurled washer and the upper steering gear housing retaining screws. The top of the housing, with steering wheel attached, may now be lifted off. See Figure 1.

SAFETY WARNING

- **There is a special bearing washer inside the upper steering gear housing, and below the idler gear cluster. If these are worn or damaged they must be replaced with genuine Cushman parts or parts with equivalent characteristics. Failure to do so may result in product malfunction and possible injury to the operator and/or bystanders.**

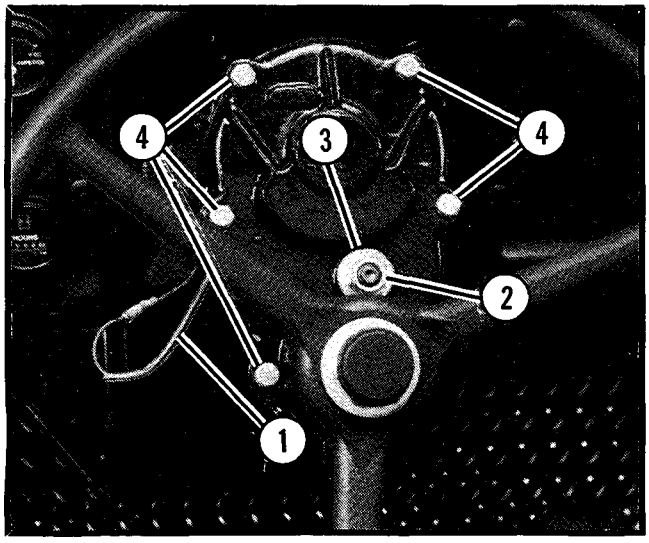


Figure 1.
1. Horn Wire
2. Idler Nut
3. Knurled Washer
4. Gearcase Retaining Screws

3. Remove the driven steering gear retaining nut. The gear may be removed by the use of special tool part number 809316. See Figure 2.

NOTE

- The knockoff must bottom out against the end of the fork, not on the driven gear itself. Hit the knockoff a sharp blow with a hammer while applying pressure as shown.

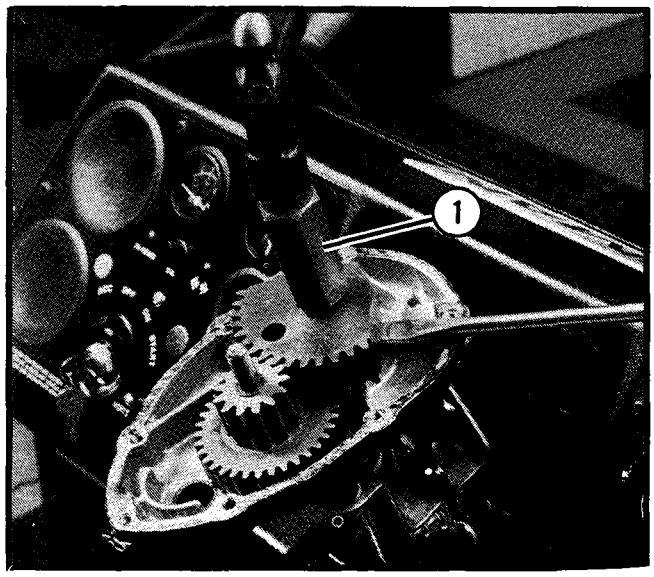


Figure 2.
1. Tool part number 809316

4. Remove the idler bolt nut, knurled washer, cluster gear, special washer and idler bolt from the lower case.

5. Remove lower case from brackets. Do not remove brackets from fork tube.

6. Clean and inspect all gears and for wear or damage. If gears are worn or damaged, replace with new parts. Also inspect the pinion shaft bearing, and cases for wear.

7. Check fork bearings for smooth operation by moving front fork from stop to stop. If bearings seem rough see Front Fork Section for proper maintenance and adjustment procedures.

Reassemble

1. Install lower case onto brackets and secure with hardware. Apply Loctite 515 or equivalent (sealer) to screw threads.

2. Place a liberal amount of Mobil HP grease in the recess of the idler adjusting bolt. Install (special) washer into lower housing.

3. Place idler adjusting bolt into lower housing. Install knurled washer. Secure with nut, finger tight.

4. Place the cluster gear over the idler adjusting bolt.

5. Determine the correct keyway in the driven gear and install gear. See Figure 3.

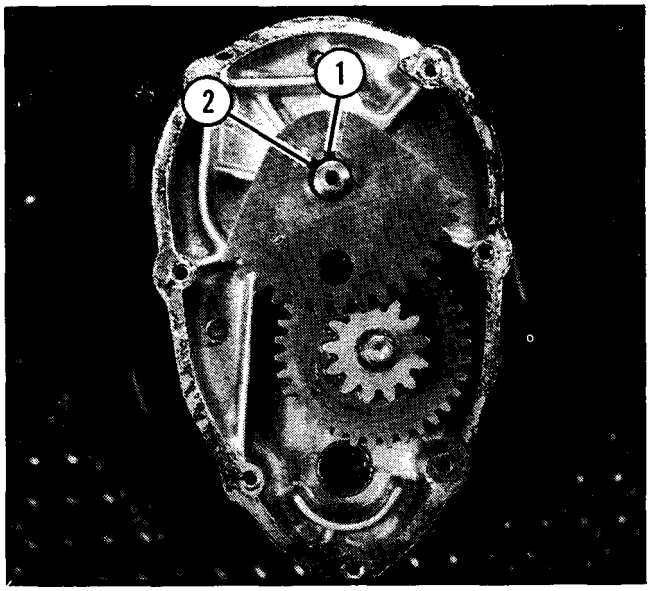


Figure 3.
1. Single passenger vehicle
2. Two passenger vehicle

6. Apply Loctite 271 to fork threads. Install special nut and tighten to 40 to 50 lbs. ft. (54 to 70 N·m). See Figure 4.

NOTE

- The threads on the fork must be CLEAN before applying the loctite 271 to the threads.

7. Apply a liberal amount of lithium–base grease to the gear teeth, and all bearing or mating surfaces.

8. If brackets mounting lower case to the fork tube have been loosened, or removed you will need to adjust gear alignment.

9. Adjust alignment of the gear by moving the lower housing. Adjust brackets mounting the lower housing to the fork tube to obtain a minimum clearance of 1/16 inch between the bottom of the driven gear and the top of the idler gear. See Figure 4.

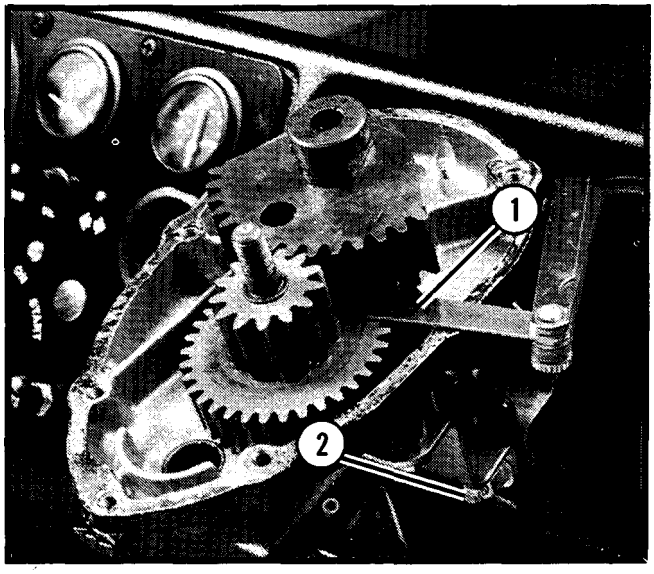


Figure 4.
1. Clearance (1/16 inch).
2. Bracket screws

10. Tighten the lower housing mounting and support bracket screws to 20 to 25 lbs. ft. (27 to 34 N·m) torque. Recheck for 1/16 inch clearance.

11. Place the special washer over the idler bolt. Place the top housing on the the bottom housing and install 1/4–20 screws. Tighten to 3 – 4 lbs. ft. (4 to 5 N·m).

12. Place knurled washer on the idler adjustment bolt. Tighten nut finger tight.

13. If the steering wheel was removed it must be secured to the steering shaft. The correct torque is 40 lbs. ft. (54 N·m).

SAFETY WARNING

- **Failure to tighten the steering nut to the torque specified may allow the steering wheel to become disengaged from the shaft with resulting loss of steering control.**

14. Rotate front fork from side to side to check gear alignment.

15. Reconnect horn wire to main harness, and apply caulking sealer to seal the hole where the wire enters the lower steering gear housing. (This will prevent seepage of oil onto vehicle occupants.)

Steering Backlash Adjustment (3 – Wheel)

1. Loosen the upper and lower idler adjustment bolt nuts.

2. The weight of the vehicle must be on the wheels.

3. Snug the lower and upper idler adjusting nuts simultaneously while holding slight pressure on the steering wheel in a counterclockwise direction. See Figure 5. Care **MUST** be exercised to avoid cocking the idler bolt.

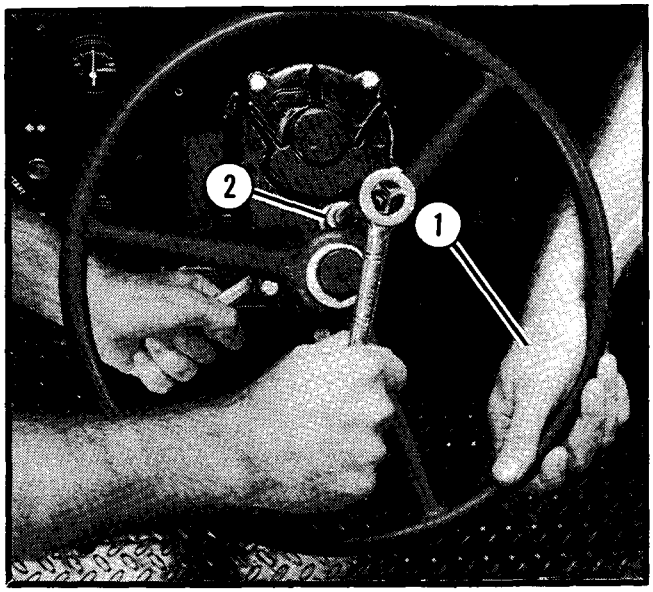


Figure 5.
1. Pressure counterclockwise
2. Idler Adjustment Bolt Nut

4. Tighten idler bolt nuts 40 to 50 lbs. ft. (54 to 70 N·m) torque.

5. Check backlash for a maximum of 1/4" (6mm) travel at the steering wheel rim with the front wheel straight forward.

6. Check steering gear for free movement. A slight amount of roughness in the steering gear is permitted after the front fork has rotated 15° either direction. It is better to have a slight amount of roughness than the maximum permitted backlash. If it is necessary to readjust the idler bolt, the knurled washers must be rotated to prevent the serrations from falling into the same marks.

FRONT FORK

1. **DISASSEMBLY**
Raise vehicle high enough to provide room for the fork to be removed from bottom of vehicle.

SAFETY WARNING

- **When it is necessary to raise the vehicle for any repair or service, use jackstands to provide adequate support. Do not rely on hydraulic or mechanical jacks.**

2. Disassemble the steering gear assembly (see three wheel steering gear service this section).

3. Remove front wheel assembly and related parts.

4. Remove top jam nut on fork.

5. Remove second jam nut securing fork in frame and carefully lower fork assembly.

NOTE

- Care must be used in removing the fork. There are loose ball bearings in the bottom and top end of fork tube in the frame. Refer to Figure 6. for proper stack-up of parts. Part numbers and number required will vary from model to model.

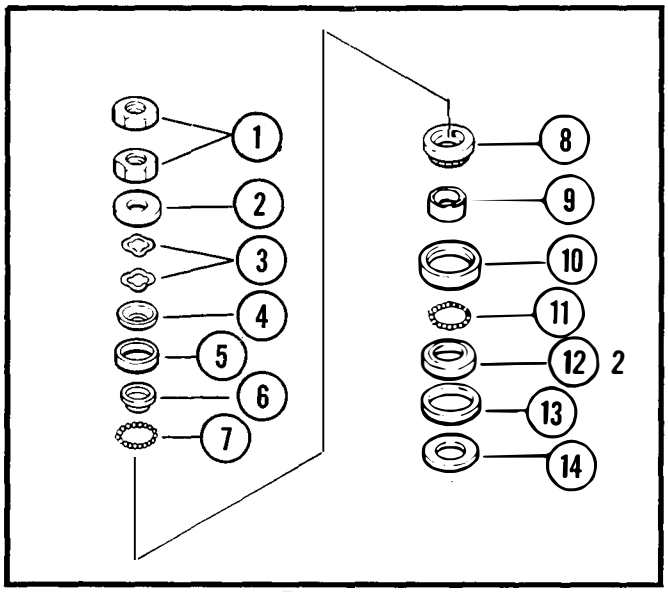


Figure 6.

1. Jam Nut
2. Dust Seal Cover
3. Wave Washer
4. Washer
5. Dust Seal
6. Upper Bearing Cone
7. 3/16 Ball
8. Upper Bearing Cup
9. Upper Fork Bushing
10. Lower Bearing Cup
11. 1/4 Ball
12. Lower Bearing Cone
13. Felt Dust Shield
14. Large Washer

6. Clean and inspect all parts for wear and damage. If parts are worn or damaged, replace with new parts.

1. **REASSEMBLE**
   Place 1/4 ball bearings in lower bearing cone. Apply a liberal amount of wheel bearing grease. Place felt dust shield around bearings to hold them in place. See figure 7.

2. Place 3/16 ball bearings in upper bearing cup. Apply liberal amount of wheel bearing grease. Place dust shield around bearings to hold them in place. See Figure 7.

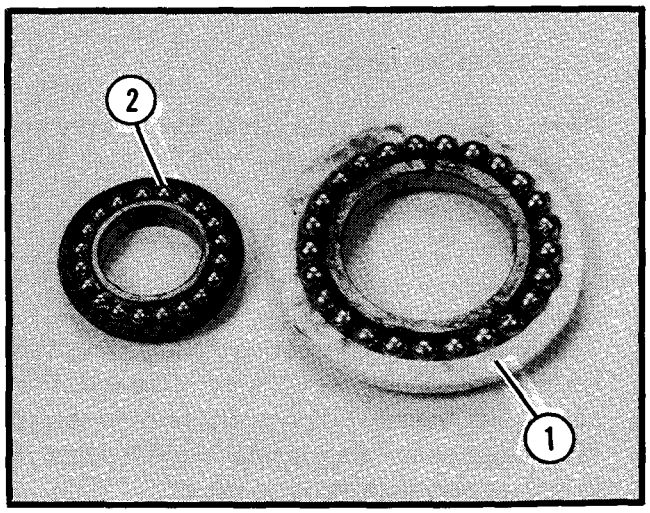


Figure 7.
1. Bottom ball, cone, and dust seal
2. Top ball, cone, and dust seal

3. Place large washer onto fork. See Figure 6. for proper location of parts.

4. Place bearing cone with 1/4 inch balls, cup and dust seal in place onto fork. Install fork into frame.

5. Install upper fork bushing with bearing cup 3/16 inch balls, cone, dust seal, and install washer, two wave washers, dust seal, and cover. See figure 6 for proper location of parts.

6. Secure parts in place by installing the lower jam nut to fork threads, snug nuts enough to hold fork assembly into frame tube securely.

7. Install front wheel assembly.

Fork Bearing Adjustment

1. Raise the front of the vehicle off the floor.

SAFETY WARNING

- **When it is necessary to raise the vehicle for any repair or service, use jackstands to provide adequate support. Do not rely on hydraulic or mechanical jacks.**

NOTE

- The complete steering gear must be removed to adjust fork pivot bearings. Refer to the steering gear overhaul section of this manual for proper parts position, assembly sequence and torque specifications during assembly.

2. Tighten the jam nut to 15 lbs. ft. (20 N·m) torque. Hold this nut to keep it from turning and tighten the locking nut to 91 lbs. ft (120 N·m) minimum, 109 lbs. ft. (150 N·m) maximum torque. See Figure 8.

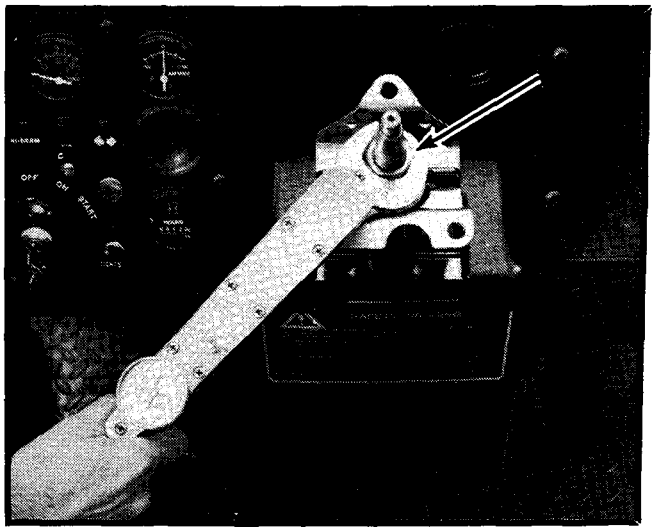


Figure 8.
1. Jam nut

NOTE

- The adjustment shown will depress the wave washers and provide the proper preload on the bearings. The fork must turn freely side to side.

3. Lubricate fork tube grease fitting. See Figure 9.

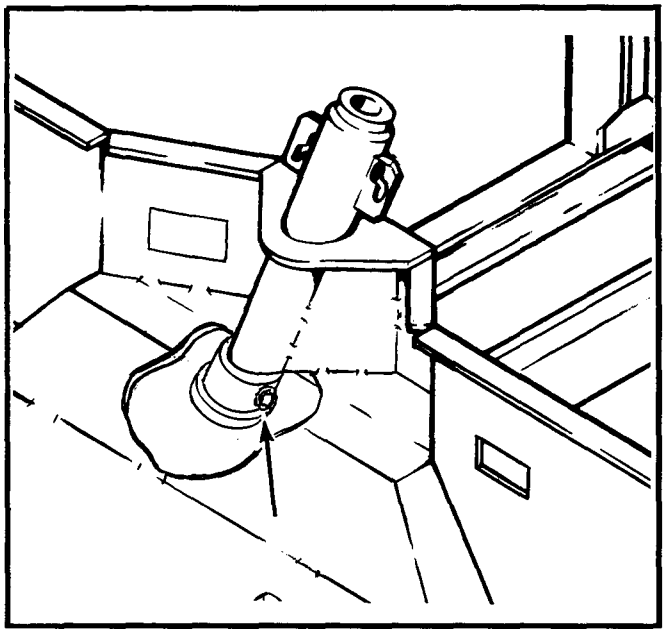


Figure 9.
1. Fork tube grease fitting

FRONT WHEEL BEARINGS (3–WHEEL)

1. The front wheel is mounted on taper roller bearings. The bearings must be checked periodically for proper operation and adjustment, the bearings must be cleaned and relubricated periodically.

2. Raise the front of the vehicle off the floor.

SAFETY WARNING

- **When it is necessary to raise the vehicle for any repair or service, use jackstands to provide adequate support. Do not rely on hydraulic or mechanical jacks.**

3. Remove the front wheel and hub assembly by removing the axle nut, lock washer and turning the axle lock to let the axle assembly slide from the fork sidearm assembly. See Figure 10.

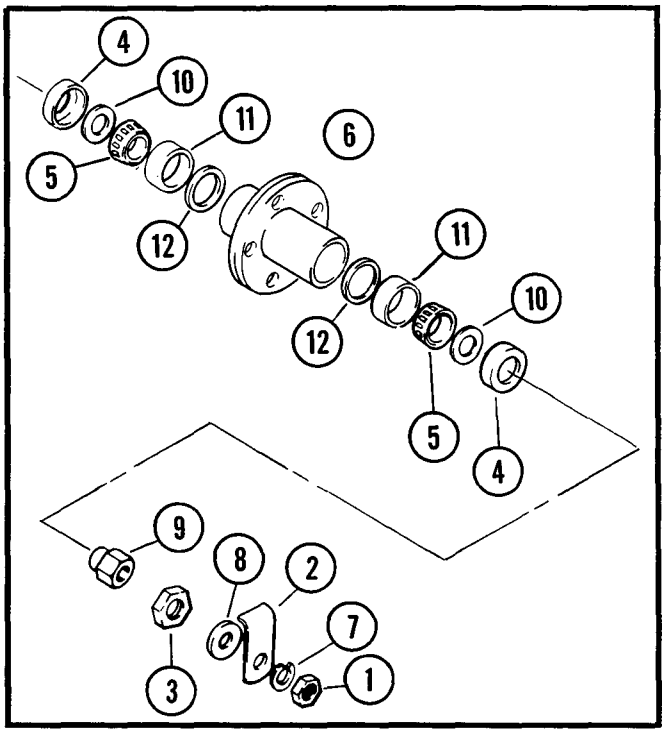


Figure 10.

1. Axle Nut	**7. Lock Washer**
2. Axle Lock	**8. Special Washer**
3. Jam Nut	**9. Bearing Adjusting Nut**
4. Grease Seals	**10. Oil Slinger**
5. Bearing Cone	**11. Bearing Cup**
6. Hub	**12. Bearing Backing Ring**

4. Remove special washer, jam nut and bearing adjusting nut.

5. Remove grease seals, oil slinger, and bearings.

6. Clean and inspect all parts for wear and damage. If there is any sign of wear, replace with new parts.

7. If the roller bearing cup was removed replace with new parts. Be sure backing ring is installed first.

8. Pack bearings with wheel bearing grease.

9. Install bearings and new grease seals into wheel hub.

NOTE

- Do not reuse grease seals after they have been removed. Replace with new parts to prevent damage to bearings and other components.

10. Install hub onto axle. Tighten the bearing adjustment nut 7 to 13 lbs. ft. (10 to 17 N·m) torque while rotating the hub by hand. Back off nut 1/6 turn. This will allow the hub to rotate freely without drag. A slight amount of end play is allowed. See Figure 11.

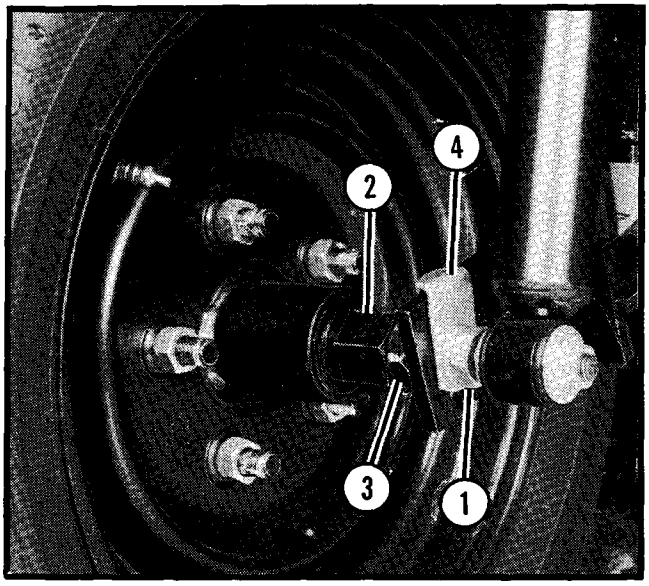


Figure 11.
1. **Axle lock nut**
2. **Bearing adjusting nut**
3. **Bearing jam nut**
4. **Axle lock**

11. Tighten bearing jam nut. See Figure 11.

FRONT WHEEL INSTALLATION

Without Front Brake

1. Reinstall the entire wheel, hub and axle assembly. Make sure all parts are properly positioned. See Figure 12.

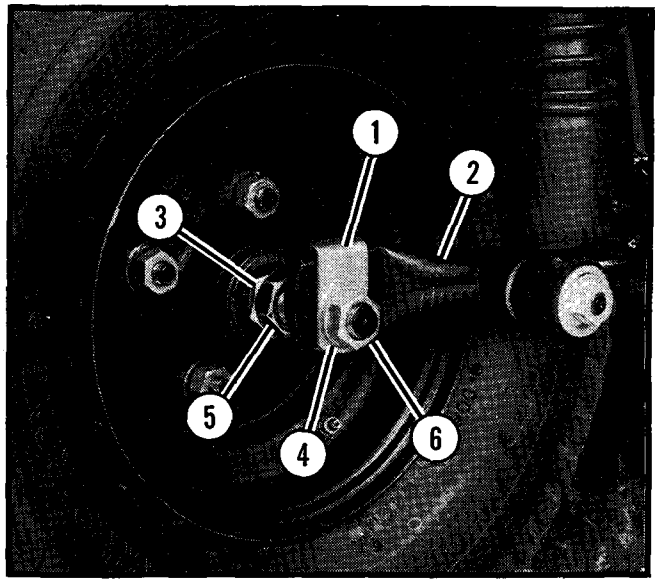


Figure 12.
1. **Axle Lock**
2. **Fork Arm**
3. **Adjusting Nut**
4. **Lock Washer**
5. **Lock Nut**
6. **Axle Nut**

2. Lower the vehicle to the floor so the weight of the vehicle is on the front wheel. Tighten the axle nuts 70–100 lbs. ft. (95–100 N·m) torque.

NOTE

- On a vehicle without front brakes, install the wheel and hub assembly with the bearing adjusting nuts and valve stem on the right side.

- The large flat washers located on the ends of the axle must be positioned on the inside of the sidearm assembly.

SAFETY WARNING

- **When reinstalling the front wheel and axle assembly to the fork side arm, the front axle lock must be positioned over the side arm (as shown Figure 12.) and the axle nuts tightened. Failure to follow the procedure may cause erratic steering and/ or loss of control of the vehicle.**

With Front Brake

1. Reinstall the entire wheel, hub, brake and axle assembly. Make sure all parts are properly positioned. See Figure 13.

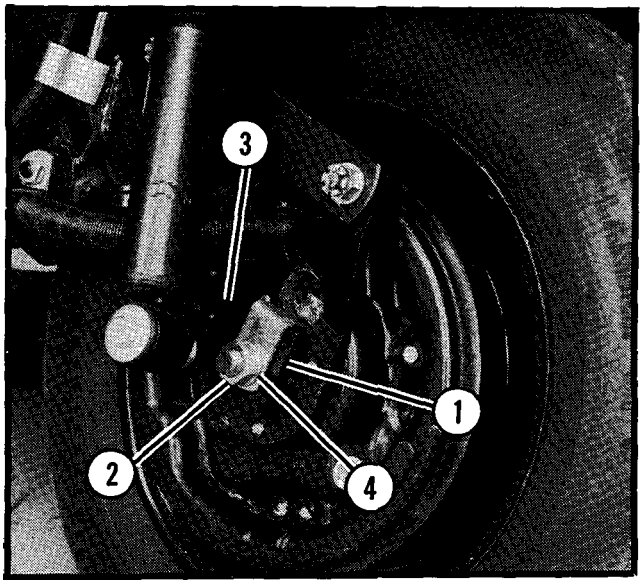


Figure 13.
1. Flat Washer 3. Sidearm
2. Axle Nut 4. Lock Washer

2. Lower the vehicle to the floor so the weight of the vehicle is on the front wheel. Tighten the axle nuts 70 – 100 lbs. ft. (95 to 100N·m) torque.

3. If the brake lines were removed, reattach the brake lines and bleed brake system. See Section 13.

NOTE

- On a vehicle with front brakes, install the wheel and hub assembly with the bearing adjusting nuts and valve stem on the left side.
  The large flat washers located on the ends of the axle must be positioned on the inside of the sidearm assembly.

SAFETY WARNING

- **When reinstalling the front wheel and axle assembly to the fork side arm, the front axle lock must be positioned over the side arm. Failure to follow this procedure may cause erratic steering and/or loss of control of the vehicle.**

- **Make sure the backing plate stop is secured over the stop pin when reinstalling the backing plate. This will prevent the backing plate from turning, which could result in brake hose damage and complete brake failure.**

FOUR WHEEL STEERING SERVICE

NOTE

- Tie rods have left and right hand threads. The left hand threads are identified by red jam nuts. The tie rods do not need to be removed from the bellcrank or king pin arms when making adjustments.

FRONT WHEEL BEARINGS (4 WHEEL)

1. Raise front of the vehicle.

SAFETY WARNING

- **When it is necessary to raise the vehicle for any repair or service, use jackstands to provide adequate support. Do not rely on hydraulic or mechanical jacks.**

2. Remove the dust cover and the cotter pin from the front spindle assembly.
3. Remove the castle nut. Pull the hub assembly off.
4. Remove the grease seal. Remove bearings and clean parts.
5. Inspect bearings and bearing cups for wear and damage. If there is any sign of wear, replace with new parts.
6. If the bearing cup is removed replace with new parts.
7. Pack bearings with wheel bearing grease.

NOTE

- Do not reuse the grease seals after they have been removed. Replace with new parts to prevent damage to bearings and other components.

8. Assemble bearings, lubricate seal, and hub. Mount on axle with proper hardware. See Figure 14.

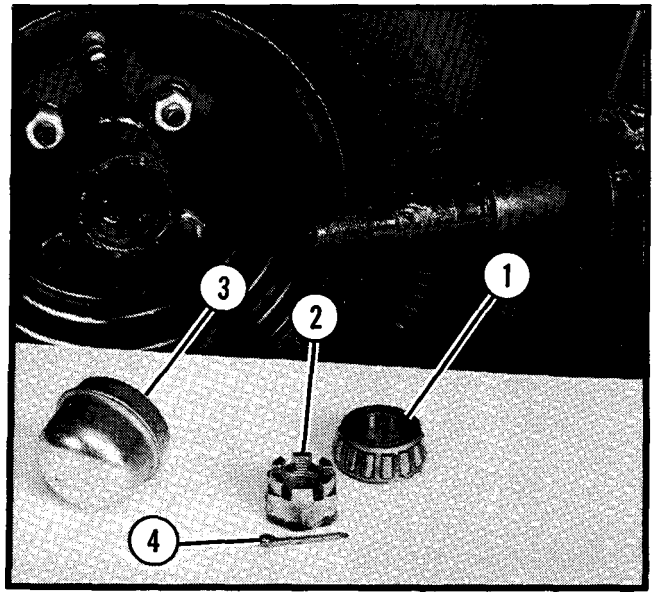


Figure 14.
1. Cone & roller bearing
2. Castle Nut
3. Cover
4. Cotter Pin

9. Tighten castle nut 7 to 13 lbs. ft. (10 to 18 N·m) torque, while rotating hub by hand.
10. Back off nut to align castle nut with hole in axle and insert new cotter pin.
11. This adjustment will allow the wheel to turn freely without drag. A slight amount of end play is allowed.

Toe In Adjustment

1. Before attempting adjustment , check for worn spindle bushings, worn arm bushings or worn tie rod ends. Wear at any of these points will make an accurate toe in adjustment impossible.

2. Find the center of travel in the steering gear. (When the vehicle will travel in a straight line forward.) With the steering gear in this position, the bellcrank should be pointing straight forward. Adjustment is made by loosening the jam nut on the drag link and rotating the drag link until the bellcrank points forward.

3. Tightening torque for the drag link jam nut is 50 ± 2 lbs. ft. (65 to 70 N·m). After adjustment and parts are properly torqued, be sure tie rod nuts are secured keyed with new cotter pins if they have been removed.

SAFETY WARNING

- **Failure to tighten the jam nuts to the torque specified may allow the tie rod ends to become disengaged from the drag link resulting in loss of control of the vehicle.**

4. Measure the distance between the brake backing plates at both the rear and front of the plates. If these two measurements are the same, the front end will have zero toe–in. See Figure 15.

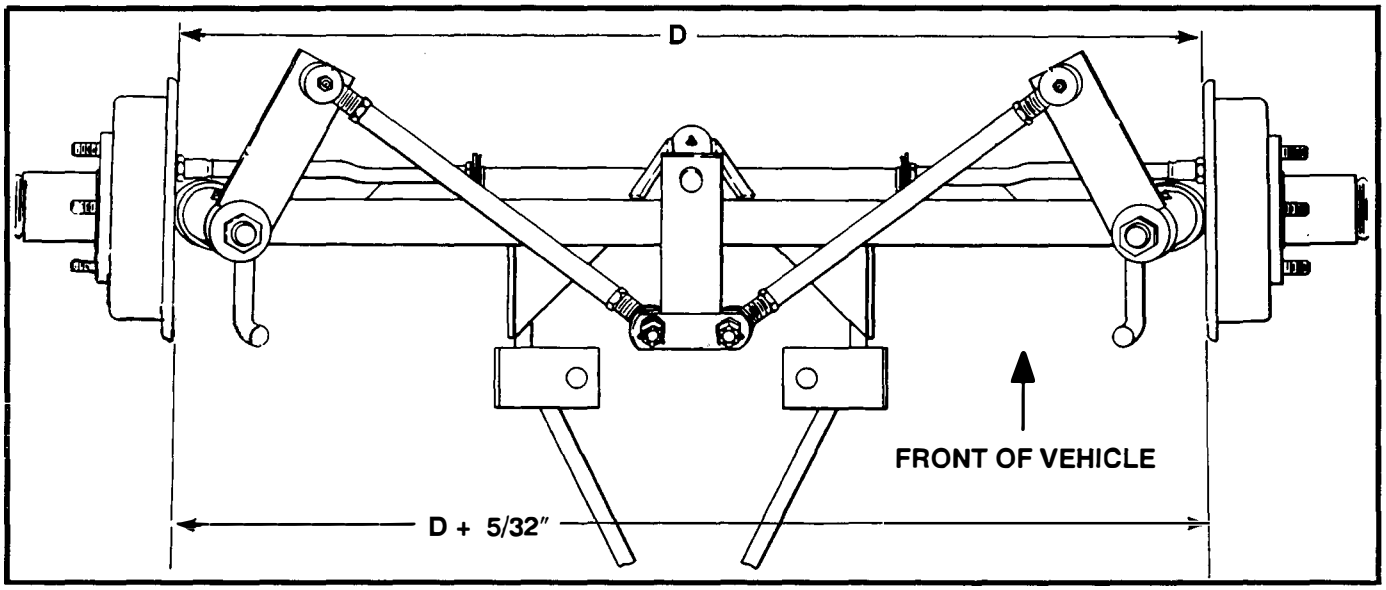


Figure 15.

5. Adjust the tie rods as necessary to obtain a distance of 5/32" (3.97 mm) less at the front of the brake backing plate than at the rear. This adjustment sets the front end at one degree toe-in. The toe-in must never exceed one degree. See Figure 15.

6. Adjustment is made by loosening the jam nuts on the tie rods and turning the rod until proper adjustment is obtained.

SAFETY WARNING

- **Tie rods must be adjusted evenly to prevent the tie rod end from becoming disengaged in tie rod.**

7. Torque for the tie rod jam nuts is 50 ± 2 lbs. ft. (65 to 70 N·m). After adjustment and proper torque applied, be sure tie rod end nuts are secured with new cotter pins if they were removed.

SAFETY WARNING

- **Failure to tighten the jam nut to the torque specified may allow the tie rod ends to become disengaged from the tie rod resulting in loss of control of the vehicle.**

Steering Stop Adjustment

1. Toe in must be set prior to steering stop adjustment.

2. The steering arms on the king pin tubes make contact with stops on the top of the axle on full right and left turns.

3. After contact with the steering stops the steering wheel should travel 1/2 to 3/4 turn at the rim before the internal stop in the gear stops the wheel from turning, in either a full left hand or right hand turn.

4. Tie rod ends may be loosened and tie rods adjusted to obtain this specification.

SAFETY WARNING

- **Tie rods must be adjusted evenly to prevent the tie rod end from becoming disengaged in tie rod.**

5. Tighten the tie rod jam nut to 50 ± lbs. ft. (65 to 70 N·m) torque. After adjustment and proper torque applied, be sure the tie rod end nuts are secured with new cotter pins if they were removed.

SAFETY WARNING

- **Failure to tighten the jam nut to the torque specified may allow the tie rod ends or the drag link ends to become disengaged resulting in loss of control of the vehicle.**

Centering Front Axle Under Vehicle

1. For the vehicle to track straight the front end must be properly centered under the vehicle.

2. The distance from one tie rod end on the radius rod to the other tie rod end is 23". Loosen the tie rod jam nuts and turn radius rod to obtain this adjustment. See Figure 16.

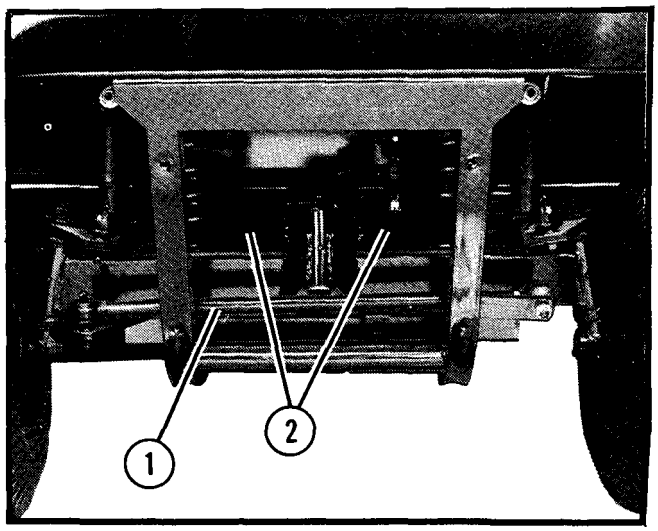


Figure 17.
1. Radius rod
2. Tie rod ends

3. Tighten the tie rod jam nut to 50 ± lbs. ft. (65 to 70 N·m). After adjustment and proper torque applied, be sure the tie rod end nuts are secured with new cotter pins if they have been removed.

SAFETY WARNING

- **Failure to tighten the jam nut to the torque specified may allow the tie rod ends to become disengaged from the radius rod resulting in loss of control of the vehicle.**

Setting Steering Gear Backlash (4 – WHEEL)

1. Loosen the worm bearing adjuster until all endplay has been removed, then loosen 1/4 turn. See Figure 18.

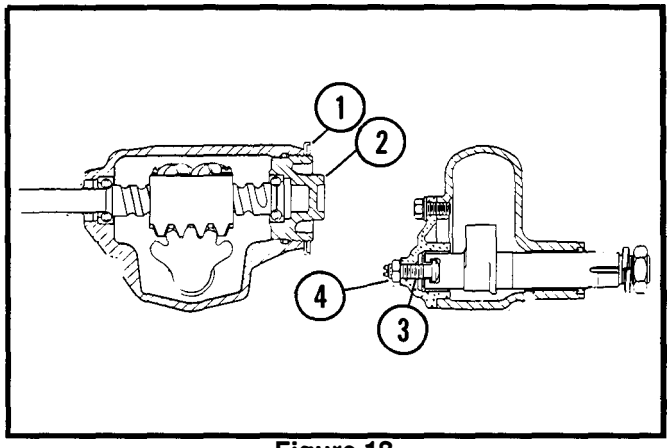


Figure 18.
1. Worm bearing adjuster locknut
2. Worm bearing adjuster
3. Backlash adjuster
4. Backlash lock nut

2. Carefully turn the steering wheel all the way to the right, then turn it back about 1/2 turn.

3. Tighten the worm bearing adjuster until the thrust bearing preload, (5–8 in. lbs.) is obtained. Tighten the adjuster lock nut to 85 lbs. ft. (115 N·m) torque.

4. Turn the steering wheel from one stop to the other, count the number of turns. Turn the wheel back exactly half that number of turns, to the center position

5. Turn the backlash, (sector shaft) adjuster screw clockwise to remove all lash between the ball nut or worm gear and the sector teeth. The steering shaft must still turn freely, without binding. Tighten the lock nut to 25 lbs. ft. (34 N·m) torque.

SECTION 14 BRAKES

Special **tools required in this section:**

Foot pound torque wrench
Inch pound torque wrench
Knock off Part no. 809315
Common Brake Tools

SAFETY WARNING

- **To AVOID LOSS OF BRAKES, adjust or repair brakes if the brake pedal travels closer than one inch to the vehicle floorboard.**

OPERATION AND FUNCTION

Cushman vehicles use an automotive–type brake system. Service procedures are much the same as on most automobiles. All brakes are serviced with shoe and lining assemblies only.

Front Wheel and Hub Service Three Wheel

Disassemble

1. Raise the vehicle off the floor.

SAFETY WARNING

- **Support the vehicle on approved jackstands, to prevent it from falling and causing injury. DO NOT rely on hydraulic or mechanical jacks to support the vehicle while working on it.**

2. Remove the cotter pins, castle nuts and washers attaching the brake anchor link to the front fork and brake arm. Pull the link straight off the studs, being careful not to lose the brake link bushings located in the holes at each end of the brake anchor link. See Figure 1.

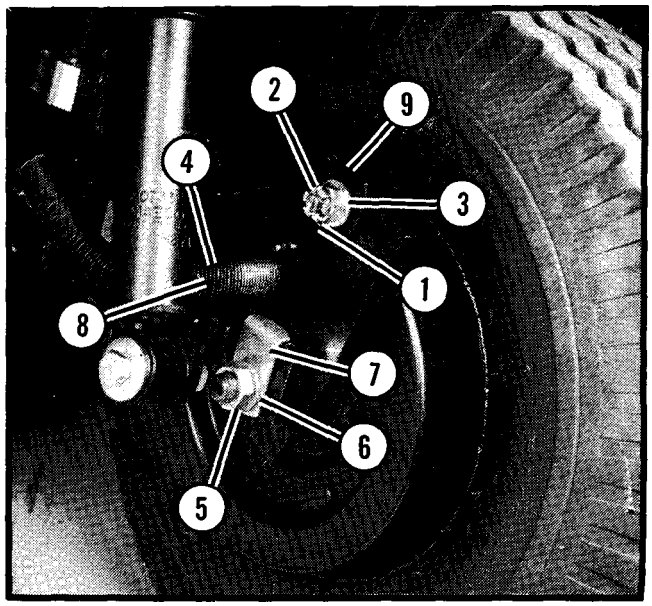


Figure 1.

1. Cotter Pin	**5. Axle nut**
2. Castle Nut	**6. Lock washer**
3. Washer	**7. Axle Lock**
4. Brake Hose	**8. Protector**
9. Brake Anchor Link	

3. Remove the LEFT shock absorber attaching hardware at the lower end of the shock absorber. Note position of all parts.

4. Loosen the axle nuts and lower the entire hub, brake and axle assembly from the front fork. See Figure 1.

NOTE

- Do not disconnect the hydraulic brake line.
- Position and support the brake hose and protector to avoid damage while the wheel, hub and axle are being disassembled and reassembled.

5. Remove all hardware from left end of axle. Note position of all parts.

6. Remove wheel bearing locknut, adjusting nuts and separate the wheel and drum assembly from the brake backing plate and shoe assembly. See Figure 2.

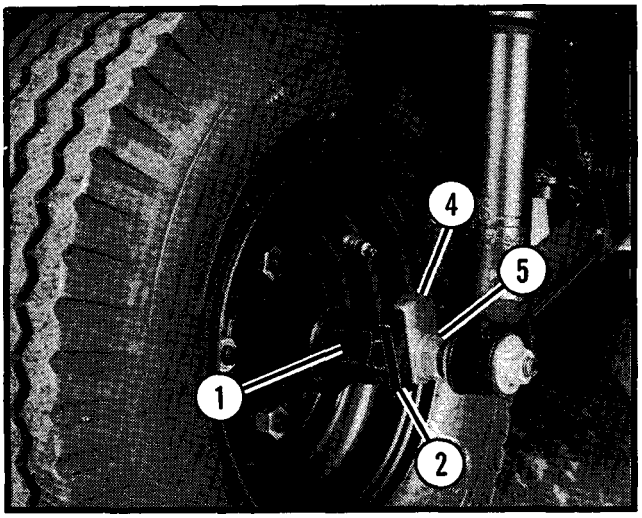


Figure 2.
1. Wheel bearing Adjusting nut
2. Side Arm Assembly
3. Flat Washer (not shown)
4. Axle Lock
5. Axle Nut

NOTE

- The brake adjustment screw may need to be backed off if the brake shoes have worn into the brake drum.

Reassemble

NOTE

- The valve stem must be located on the left side of the vehicle.

1. Install new grease seals, pack the wheel bearings. Install hub and drum assembly onto the brake backing plate assembly.

2. Position the hub, wheel, and brake backing plate assembly into the fork side arms and tighten the axle nuts finger tight. Install brake link into the brake anchor link. Install castle nuts and new cotter keys. See Figure 2.

NOTE

- The large flat washers located on the ends of the axle must be positioned on the inside of the sidearm assembly. See Figure 2.

SAFETY WARNING

- **To PREVENT ERRATIC STEERING and/or LOSS OF CONTROL OF THE VEHICLE, make sure the front axle lock is positioned over the sidearm (as shownFigure 2.) before the axle nuts are tightened.**
- **To PREVENT BRAKE FAILURE, insert the brake link bushings into the brake anchor link and reinstall the link. This will prevent the brake stator and drum assembly from turning, which could result in brake hose damage and complete brake failure.**

3. Replace lower end of left shock absorber with retained hardware.

4. Lower the unit to the floor so the weight of the vehicle is on the front wheel. Tighten the axle nuts to 70 – 100 lbs. ft. (95 – 100 Nm).

5. Raise the front of the vehicle and adjust the wheel bearings. Tighten the adjusting nut until a slight drag is felt and then loosen it until the wheel rolls freely. Hold the adjusting nut and tighten the lock nut against it.

BRAKE SHOE REPLACEMENT 3 – WHEEL, ON ROAD, FRONT (BENDIX BRAKE)

Disassemble

1. Remove the front wheel and hub assembly. See **Front Wheel and Hub Service, Three Wheel.**

2. Remove the return springs from each shoe. Remove the adjusting screw, pivot, and socket from the brake shoes. Remove the brake shoes, and shoe hold down springs. See Figure 3.

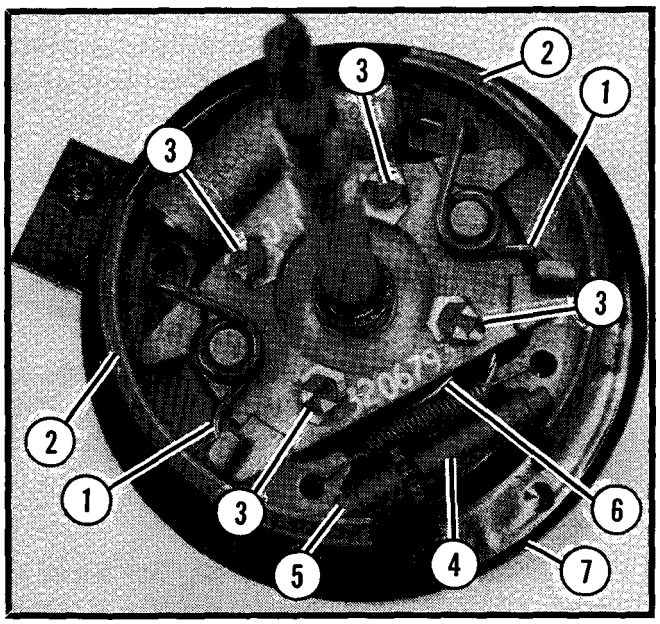


Figure 3.

1. Return Springs
2. Brake Shoes
3. Lock plate
4. Adjusting Screw
5. Socket
6. Spider assembly
7. Backing plate

SAFETY WARNING

- **Do not press the brake pedal while the brake drum is removed.**

3. Clean and inspect the parts for wear and damage. Replace all worn or damaged parts.

4. If the spider assembly is removed from the brake arm assembly, the 5/16 – 18 x 1 1/4 screws mounting the spider assembly to the brake arm assembly must be tightened to 24± 2 lbs. ft. (32± 3 Nm) torque. After tightening, the screws must be turned further, if needed, to achieve approximate head orientation shown Figure 3. After orientation of screws is achieved the lock plate tabs must be bent over top of all four screws.

Reassemble

1. Install the shoe holddown springs, and brake shoes.

2. Install adjusting screw, pivot and socket. Install brake return springs note color. See Figure 3.

3. Install new seals, pack bearings, and install wheel assembly onto vehicle. **See Front Wheel and Hub Service, Three Wheel. (REASSEMBLE).**

Adjustment of Bendix brake

1. Remove the adjuster hole plug from the bottom of the brake backing plate. See Figure 4. Adjust the brake shoes by turning the adjuster star wheel down to move the shoes out. Adjust until a slight drag is felt while turning the wheel, then reinstall the adjuster hole plug.

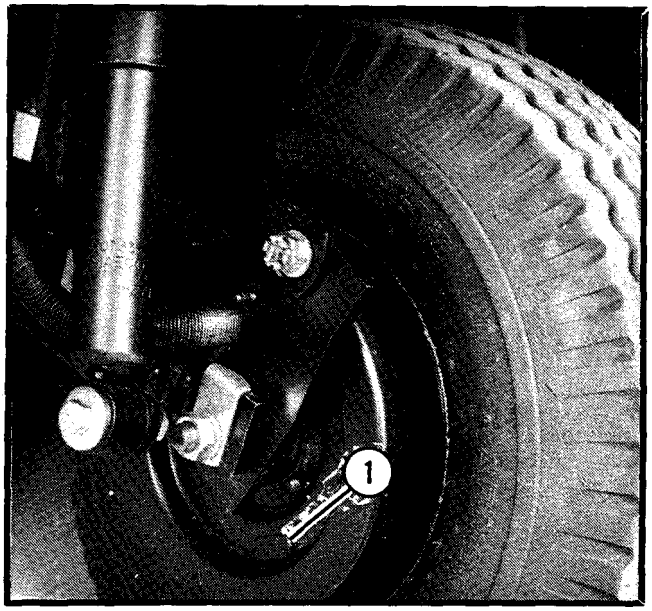


Figure 4.
1. Adjuster hole plug

Brake Shoe Replacement (Cushman Small Brake)

Disassemble

1. Remove the wheel and hub assembly. **See Front Wheel and Hub Service, Three Wheel or Rear Wheel Service or Front Wheel Service, Four Wheel.**

2. The shoes can now be removed from the brake backing plate. Disconnect the return spring from each shoe. Care must be taken not to disturb the hydraulic wheel cylinder. Remove the snap ring securing the shoes to the heel pin. Remove the shoes from the backing plate.

NOTE

- Do not press the brake pedal while the brake is disassembled.
- Examine the wheel cylinder for leaks before reassembly. If repair is needed, follow the procedures under "Wheel Cylinder Service."

3. Clean the brake backing plate, and use emery cloth to remove rust or burrs from the heel pin.

Reassemble

1. Loosen both adjustment pins and the heel pin to facilitate installation of the new shoes, then place the new shoes over the heel pin.

NOTE

- The ends of the shoes that fit over the heel pin are offset and must be installed as shown.The shoes must also fit freely into the guides. See Figure 5.

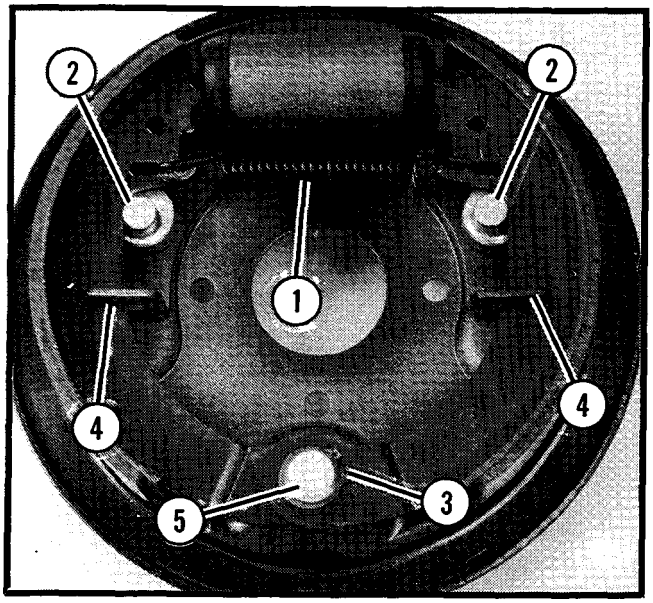


Figure 5.
1. Return Spring 3. Retaining Ring
2. Adjustment pin. 4. Brake Shoe Guides
5. Heel Pin

2. Replace the retaining ring. Make sure the upper ends of the shoes fit properly into the wheel cylinder. Replace the return spring. See Figure 5.

3. Install new seals, pack bearings, and install wheel assembly onto vehicle. **See Front Wheel and Hub Service, Three Wheel or Rear Wheel Service or Front Wheel Service Four Wheel.**

Cushman Brake Adjustment (Small Brake)

1. Raise the vehicle.

SAFETY WARNING

- **Support the vehicle on approved jackstands, to prevent it from falling and causing injury. DO NOT rely on hydraulic or mechanical jacks to support the vehicle while working on it.**

2. Be sure that all brakes are assembled.

3. Loosen the lock nut on the heel pin. See Figure 5. Press the brake pedal firmly to expand and center the shoes in the drum. Tighten the heel pin lock nut while maintaining pedal pressure. Release pressure on the pedal to allow the brake shoes to retract.

4. Loosen the lock nut on each adjusting pin. Adjust each brake shoe individually by placing a wrench on the adjusting pin and turning the wrench up (both sides) until slight resistance is felt while rotating the wheel assembly, then back off slightly. SeeFigure 5. Turn the wheel to be sure the shoes are not dragging.

5. Hold the adjusting pins and tighten the lock nuts. Recheck by turning the wheel assembly to be sure the shoes are not dragging.

Rear Wheel Service

Disassembly

1. Raise the rear of the vehicle.

SAFETY WARNING

- **Support the vehicle on approved jackstands, to prevent it from falling and causing injury. DO NOT rely on hydraulic or mechanical jacks to support the vehicle while working on it.**

2. Remove the cotter pin, axle nut **and washer**. Install a knockoff part number 809315. Hit the knock-off with a sharp blow with a heavy hammer to loosen the hub from the axle. See Figure 6.

NOTE

- Be sure the knockoff is tight against the end of the axle, to prevent damage to the threads.

- Slight pressure behind the brake drum will aid in loosening the hub from the axle.

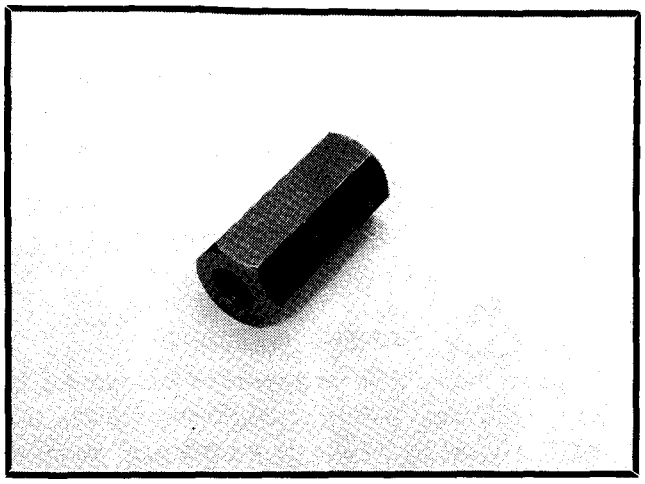


Figure 6.
1. Knock-off Part Number 809315

3. Remove the hub and drum assembly from the axle.

Assemble

1. Replace the hub and drum assembly. Replace flat washer and castle nut, tighten to 70 lbs. ft. (95 N·m). Align castle nut with cotter pin hole by tightening. Install new cotter pin.

2. If the wheel was removed replace and torque lug nuts to 70 – 100 lbs. ft. (95 – 135 Nm).

3. Adjust brakes. **See Cushman Brake Adjustment (Small) or (Large).**

Brake Shoe Replacement (Cushman Brake, Large)

1. Remove the front wheel and hub assembly. **See Front Wheel and Hub Service, Three Wheel or Rear Wheel Service.**

2. Disconnect both return springs from shoe assembly and brake lever. Remove shoe retainers. Remove brake lever and adjuster. Care must be taken not to disturb the hydraulic wheel cylinder.Remove the brake shoes from the backing plate. See Figure 7.

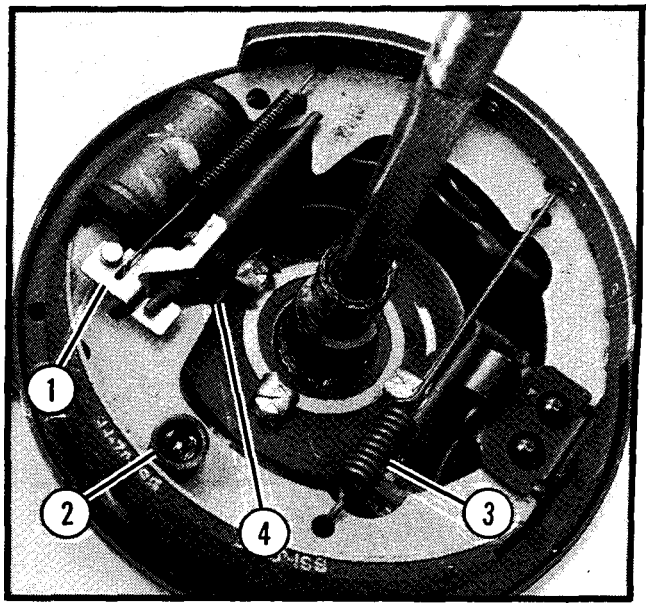


Figure 7.
1. Brake Lever **3. Return Springs**
2. Shoe Retainers **4. Brake Adjuster**

NOTE

- Do not press the brake pedal while the brake is disassembled
- Examine the wheel cylinder for leaks before reassembly. If repair is needed, follow the procedures under "Wheel Cylinder Service."

3. Clean the brake backing plate.

Reassemble

1. Apply a thin layer of high temperature grease to the brake backing plate where the brake shoes make contact (6 places), and brake adjuster. See Figure 8.

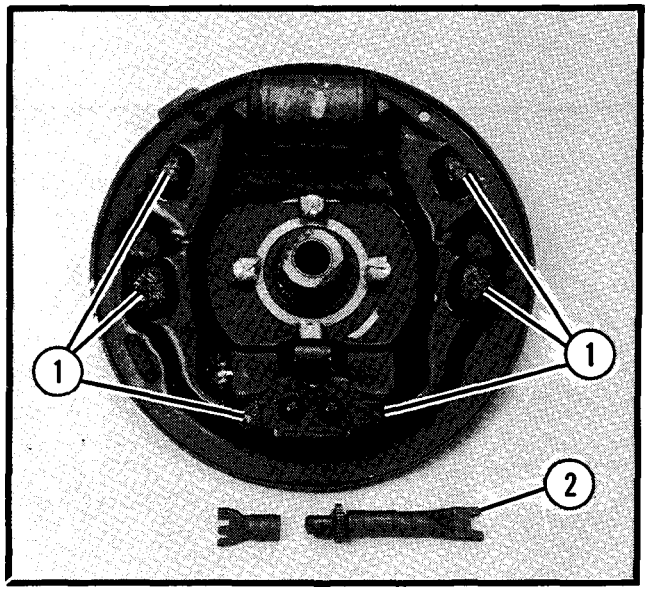


Figure 8.
1. Brake Shoe Contact Pads (6)
2. Brake Adjuster

2. Install brake shoes and brake adjuster. See Figure 9.

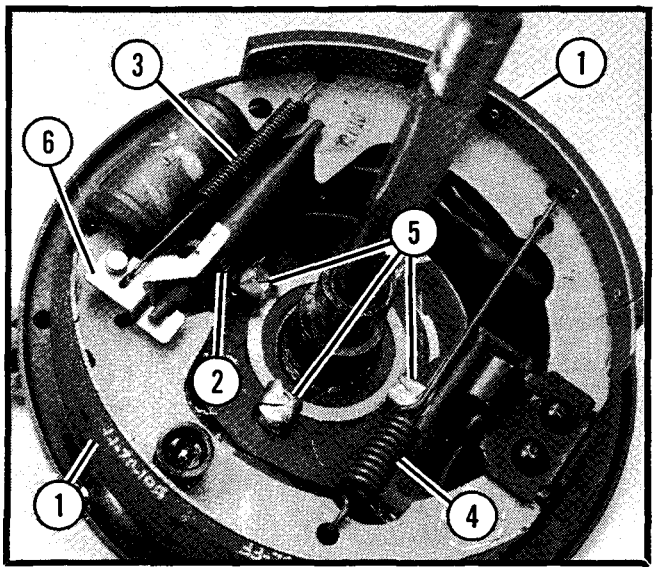


Figure 9.

1. Brake Shoes	**4. Large Retainer Spring**
2. Brake Adjuster	**5. Brake Retainers**
3. Small Retainer Spring	**6. Brake Lever**

3. Install brake retainers, brake lever, and small retainer spring. Install large retainer spring. See Figure 9.

NOTE

- Note position of brake lever, and small retainer spring. See Figure 9.

4. Install new seals, pack bearings, and install wheel assembly onto vehicle. **See Front Wheel and Hub Service, Three Wheel or Rear Wheel Service.**

Adjustment (Cushman Large Brake) Front

NOTE

- This brake is self adjusting and needs adjustment only on initial installation.

1. Raise the vehicle off the ground.

SAFETY WARNING

- **Support the vehicle on approved jackstands, to prevent it from falling and causing injury. DO NOT rely on hydraulic or mechanical jacks to support the vehicle while working on it.**

2. Remove adjusting hole cover. See Figure 10.

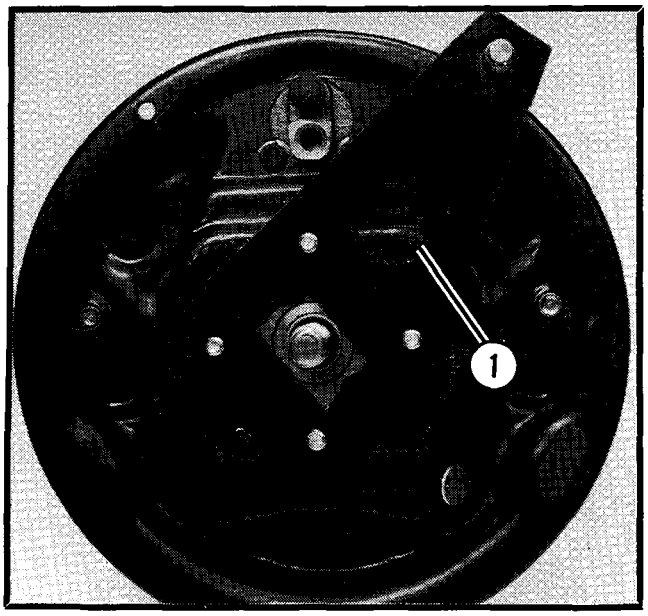


Figure 10.
1. Adjusting Hole Cover

3. Using a flat-bladed screwdriver turn the adjusting wheel up (screwdriver handle down), to adjust brake shoes until a slight drag is felt while turning front wheel assembly.

4. Reinstall the adjuster hole plug.

Adjustment (Cushman Large Brake) Rear

NOTE

- This brake is self adjusting and needs adjustment only on initial installation.

1. Raise the vehicle off the ground.

SAFETY WARNING

- **Support the vehicle on approved jackstands, to prevent it from falling and causing injury. DO NOT rely on hydraulic or mechanical jacks to support the vehicle while working on it.**

2. Remove rear wheel.

3. Turn drum until hole is in approximate position shown. See Figure 11.

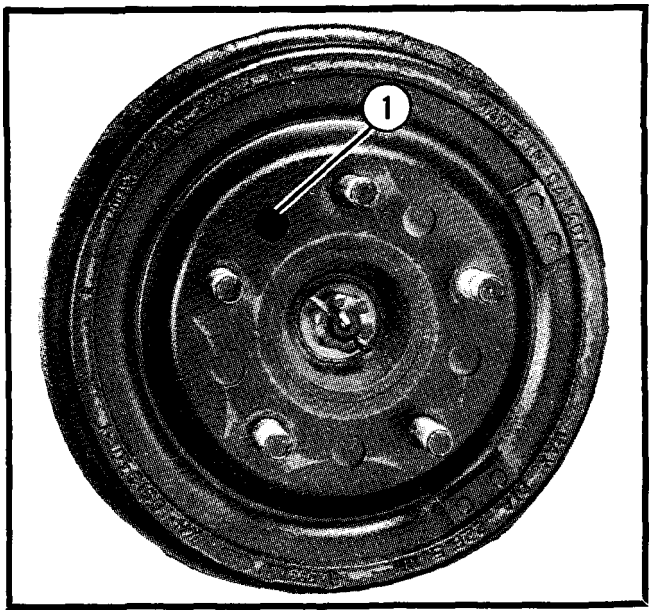


Figure 11.
1. Position Hole Here

4. Using a flat-bladed screwdriver turn the adjusting wheel down (Screwdriver handle up), to adjust brake shoes until a slight drag is felt while turning the rear wheel assembly.

5. Reinstall the rear wheel. Tighten lug nuts to 70 to 100 lbs.-ft. (95 to 140 Nm) torque. Make sure the valve stem is located toward the outside of the vehicle.

Master Cylinder Service

NOTE

- Check the master cylinder and the immediate area for signs of leaking fluid.
- If leakage is found on the end of the cylinder where the brake lines are attached, check for loose or broken lines or a loose brass banjo fitting and repair or replace as necessary.
- If the leakage is found on the opposite end, around the boot, replace or repair the master cylinder
- If the pedal fades while the brakes are being applied and there are no leaks in the lines or at the wheel cylinder. The problem is internal. Replace or rebuild the master cylinder.

SAFETY WARNING

- **To AVOID LOSS OF BRAKES, always examine the internal components of the master cylinder when brake pedal fading has been experienced. Brake failure can be caused by defective internal master cylinder components, even when there has been no loss of fluid.**

Disassemble

1. Remove bottom skid panel.

2. To remove master cylinder from vehicle, remove fitting screw holding brass banjo fitting to master cylinder.

NOTE

- Brake lines need not be removed from brass fitting.

3. Remove two cylinder mounting screws and remove cylinder by pulling away from master cylinder push rod.

4. Remove the filler cap and gasket and pour the fluid from the reservoir. **(Do not reuse the fluid.)**

5. Remove the boot from the cylinder. See Figure 12.

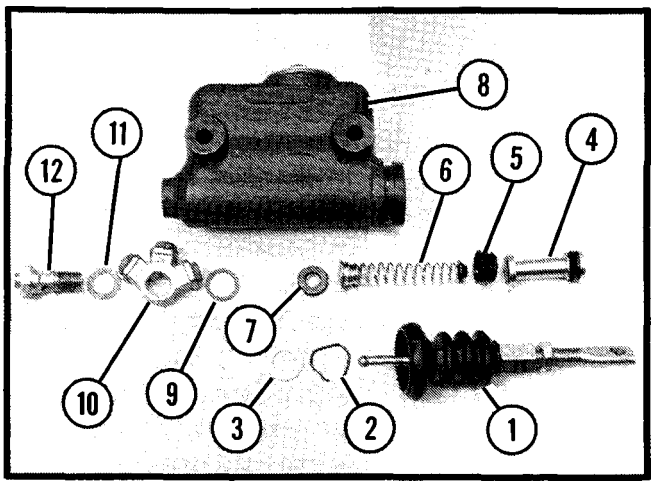


Figure 12.

1. Boot *	**7. Valve Seat ***
2. Lock Ring *	**8. Master Cylinder**
3. Washer *	**9. Washer**
4. Piston*	**10. Banjo Fitting**
5. Primary Cup *	**11. Washer**
6. Spring *	**12. Plug**
13. Bolt	

*** Parts contained in repair kit**

6. Remove the lock ring, washer, piston, primary cup, spring, and valve seat from the master cylinder. See Figure 12.

7. Clean the master cylinder and all parts thoroughly in alcohol. **(Do not use gasoline or kerosene.)**

8. Inspect the walls of the master cylinder barrel for rust or score marks; if necessary, recondition by honing. Hone only enough to clean up the wall.

NOTE

- If honing does not clean up the cylinder walls, replace the master cylinder.

9. Clean cylinder again after honing with alcohol, dry with compressed air.

Assemble

1. Replace all defective parts with new parts. Use all the new parts contained in repair kit. Never reuse old parts if new parts are supplied in the repair kit. Before reassembling, dip all internal parts in brake fluid; then reassemble the cylinder in reverse order of disaassembly. See Figure 12. for proper sequence of parts and parts contained in repair kit.

2. Slip the master cylinder boot over the push rod.

3. Reinstall master cylinder into vehicle.

4. Install the brass banjo fitting to the master cylinder with the bolt. See Figure 12.

5. Fill the cylinder with fluid and bleed the brake system by following the procedure in "Brake Line Bleeding".

Brake Pedal Free Travel

NOTE

Insufficient free travel of the brake pedal may cause the brakes to drag, resulting in poor vehicle performance and premature brake lining wear.

1. To check free travel: Remove the master cylinder filler plug. Press the brake pedal slowly by hand while watching the surface of the fluid for bubbles or slight turbulence, which indicates adequate free travel.

2. If there is no disturbance on the fluid surface, free travel is insufficient and the linkage between the pedal and the master cylinder must be adjusted.

3. To adjust the free travel, loosen the lock nut between the pushrod and the brake rod and turn the pushrod into the brake rod to shorten the length. See Figure 13.

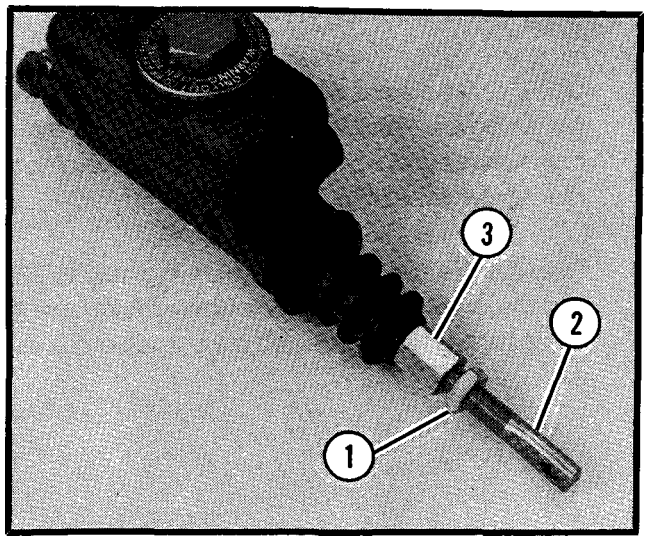


Figure 13.

1. Lock Nut
2. Push Rod
3, Master Cylinder Brake Rod

Wheel Cylinder Repair

Cushman Brakes

1. Remove the hub and drum. **See procedures under Front Wheel and Hub Service, Three wheel or Rear Wheel Service or Front Wheel Service, Four Wheel.**

2. Disconnect the hydraulic brake line from the wheel cylinder.

3. Disconnect the return spring from the two brake shoes and remove the wheel cylinder from the brake backing plate.

4. Remove the boot from each end of the cylinder and push the pistons, rubber cups, and spring out of the cylinder. See Figure 14.

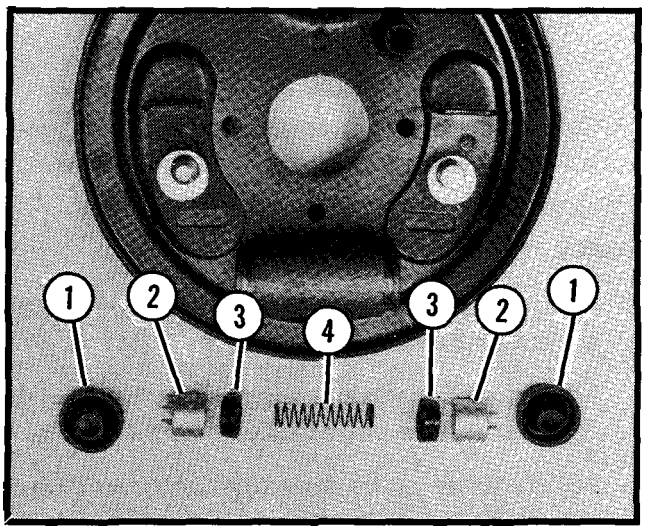


Figure 14.
1. Boot *
2. Wheel Cylinder Piston
3. Rubber Cup *
4. Spring
*** Wheel Cylinder Repair Kit**

5. Clean the wheel cylinder and wheel cylinder parts in alcohol. **(Do not use gasoline or kerosene.)**

6. Inspect the walls of the wheel cylinder barrel for rust or score marks; if necessary, recondition by honing. Hone only enough to clean up the wall.

NOTE

- If honing does not clean up the wheel cylinder walls, replace the wheel cylinder.

7. Clean wheel cylinder again with alchol after honing and dry with compressed air.

8. Dip all internal parts in brake fluid and reassemble the wheel cylinder, making sure to use **all** of the new parts contained in the repair kit.

9. Install the wheel cylinder on the vehicle and reconnect the brake line.

10. Reassemble the brakes and hubs. **See procedures under Front Wheel and Hub Service, Three Wheel or Rear Wheel Service or Front Wheel service, Four Wheel.**

11. Bleed the entire brake system, following the procedure given under "Brake Line Bleeding."

Bleeding Brake Hydraulic System

SAFETY WARNING

- **Should it be necessary to add fluid to maintain the correct level in the master cylinder, use only dot (3) brake fluid. To avoid fluid contamination, clean filler cap before removing. If an unexplained loss of brake fluid occurs, determine the cause to prevent possible loss of brakes.**

The Brake Line Bleeding Sequence is as follows:

- Vehicles with two wheel brakes, bleed the left rear brake first, then the right rear.

- Vehicles with three wheel brakes, bleed left rear first, then right rear, and then the front.

- Vehicles with four wheel brakes, bleed the left rear first, right rear second, right front third, then the left front last.

NOTE

- FOR MODELS WITH HYDRAULIC MICO BRAKE LOCK.
- A bleeder screw is located on the body of the hydraulic parking brake lock. This is the highest point of the hydraulic brake system. *ALWAYS BLEED THIS POINT FIRST WHEN BLEEDING THE HYDRAULIC BRAKE SYSTEM.*

1. Check the fluid level. The master cylinder reservoir should be full or within 3/8 inch (9.5 mm) of the top edge (replace master cylinder cap to avoid splashing). Be sure the master cylinder does not run out of fluid during the brake bleeding operation.

2. Attach small clear tube to the bleeding nipple. This nipple is on the back side of the wheel cylinder and protrudes through a hole in the top of the brake dust shield (do not mistake it for a lubrication fitting). The nipple is threaded and must be turned to the left slightly to allow air trapped in the brake line to escape. Place the free end of the bleeder tube in a container, making sure there is enough brake fluid in the container to seal the end of the tube.

3. Pump brake pedal slowly until fluid coming from the bleeder fitting is clear and free of air bubbles. (By using clear tubing you can see when only brake fluid is passing through the tubing.) When all the air is out of the brake line, tighten the bleeding nipple while holding the brake pedal in the down position. Repeat the above operation for each brake line. After a brake line is bled, refill the master cylinder, making sure it is full before starting the bleeding operation of each brake line.

4. When all brake lines are full of fluid, and are completely free of any air, the next step is to adjust the brake shoes for proper clearance.

PARKING BRAKE

SAFETY WARNING

- **Block the wheels of the vehicle prior to servicing or adjusting the parking brake to prevent unexpected movement of the vehicle.**

NOTE

- When applied the parking brake must keep the vehicle from moving and stall the engine at 2200-2800 RPM in first gear.
- When disengaged the disc assembly must rotate freely in the caliper.

OPERATION

Two types of parking brake controls are used. A foot operated brake system is used in all two passenger vehicles. A hand operated system is used in all one passenger vehicles.

Hydraulic Mico Brake Lock

Some models use a hydraulic micro lock to lock the rear brakes. **To operate the hydraulic parking brake lock, do the following:**

1. Bring the vehicle to a complete stop using the foot brake.
2. Set, engage/apply the mechanical parking brake.
3. Move control lever to full lock as indicated on plate.
4. Apply the service brake pedal firmly.

To release the hydraulic brake lock:

1. Move the control lever to full release as indicated on plate.
2. Release the mechanical parking brake.

SAFETY WARNING

- **The hydraulic mico brake lock is NOT to be used in place of the mechanical parking brake for prolonged or unattended parking. ALWAYS set, engage/apply the mechanical parking brake.**

NOTE

- Release the hydraulic parking brake lock and mechanical parking brake before driving the vehicle.

Adjustments (Hand-Operated Parking Brake)

1. Apply brake firmly and release. (Approximately 35 lbs. pull on handle.)
2. Adjustment is made by turning nut on threaded fitting on end of the cable located near the handle.
3. Adjust so lever can be moved 5 – 10 notches (clicks) with 25 lbs. pull on handle.
4. With lever in "off" position, disk should rotate freely in caliper. When applied the parking brake should stall the engine at (2200 – 2800 RPM) in first gear.

SAFETY WARNING

- **To avoid brake failure, make sure all hardware is tight after adjusting brake.**

Adjustments (Foot-Operated Parking Brake)

1. Apply brake firmly and release. (Approximately 35 lbs. pressure on pedal.)

2. Adjustment is made by turning nut on conduit. See Figure 15.

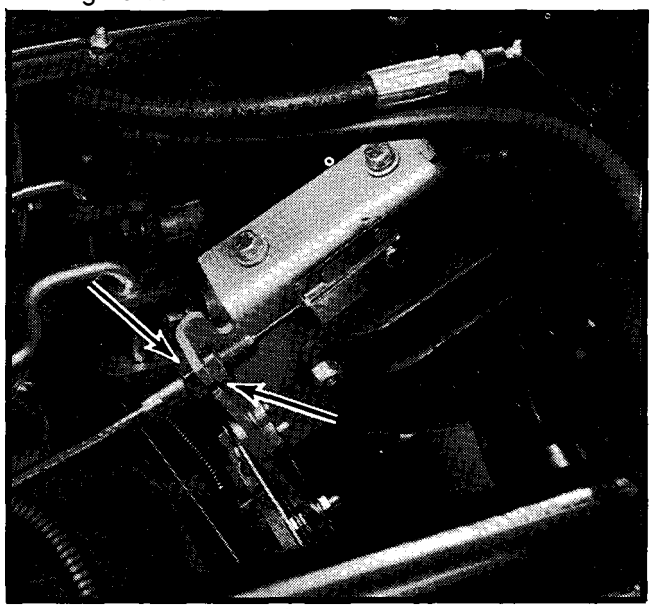


Figure 15.
1. Cable Adjusting Nut

NOTE

- Initial adjustment should be made so that subsequent adjustments can be made at the caliper end.

3. Adjust so foot lever can be moved 2 – 4 notches (clicks) with 35 lbs. force on the pedal
4. With lever in "off" position, pedal should be at or very near rubber bumper on pedal assembly. Disk assembly must rotate freely in caliper.
5. When applied the parking brake should stall the engine at (2200 – 2800 RPM) in first gear.

NOTE

- On vehicles equipped with auxiliary transmission, test in "high" range.

6. Parking brake release and cable stop should be installed with 1/8 inch free travel between end of cable housing and release bracket.

SAFETY WARNING

- **To avoid brake failure, make sure all hardware is tight after adjusting brake.**

TROUBLE SHOOTING

Brake Drag

1. Improper brake shoe adjustment
2. Improper adjustment of master cylinder
3. Brake shoes froze to heel pin
4. Corrosion between parking brake, cable and housing
5. Broken brake lever spring
6. Loose wheel bearings
7. Wheel cylinder stuck

Brakes Grab

1. Leaking wheel cylinder
2. Brake drum scored
3. Grease or oil on lining
4. Air in lines
5. Wheel cylinder stuck
6. Lining loose on shoe

Spongy Brake Pedal

1. Air in hydraulic line
2. Improperly adjusted heel pin

Excessive Pedal Travel

1. Brake shoe adjustment needed
2. Fluid low in master cylinder
3. Faulty or misadjusted master cylinder

SECTION 15 SERVICE SPECIFICATIONS

Cylinder Head

inch (mm)

Item		Service Dimensions and Clearances
Cylinder head gasket surface distortion		.004 (0.10) max.
Cylinder head grinding height (minimum)		3.929 (99.8)
Manifold gasket surface distortion		.004 (0.10) max.
Valve seat	Seat angle	IN 45° – EX 45°
	Valve seat contact surface width Intake and Exhaust	.047 to .063 (1.2 to 1.6)

Valve Guide

inch (mm)

Item	Service Dimensions and Clearances
Guide inner diameter	.2756 to.2774 (7.000 to 7.045)

Valves

inch (mm)

Item		Service Dimensions and Clearances
Seat contact width	IN	.0472 to .0906 (1.2 to 2.3)
	EX	
Valve head margin	IN	.0354 to .0551 (0.9 to 1.4)
	EX	.0433 to .0669 (1.1 to 1.7)
Valve stem diameter	IN	.2732 to 0.2746 (6.940 to 6.975)
	EX	.2730 to .2744 (6.935 to 6.970)
Overall length	IN	4.4228 (112.34)
	EX	4.4346 (112.64)
Stem head recession		.008 (0.2)

Valve spring

inch (mm)

Item	Service Dimensions and Clearances
Free length	1.7441 to 1.8110 (44.3 to 46.0)
Length installed	1.4961 (38.0)
Tension at installed length lb. (kg)	50.7 to 64.8 (23.0 to 29.4)
Squareness	0 to 0.0630 (0 to 1.6)

Valve rocker shaft & rocker arm

inch (mm)

Item	Service Dimensions and Clearances
Rocker arm inner diameter	.6299 to .6313 (16.000 to 16.035)
Valve rocker shaft outer diameter	.6281 to .6294 (15.955 to 15.988)
Shaft to arm oil clearance	.0005 to .0031 (0.012 to 0.8)

Cylinder Block

inch (mm)

Item		Service Dimensions and Clearances
Cylinder block distortion(head gasket surface)		.003 (0.08)
Cylinder block grinding height (minimum)		9.2835 to 9.2953 (235.8 to 236.1)
Cylinder	Bore (Standard)	2.6229 to 2.6232 (66.60 to 66.63)
	Out of roundness or taper	.0012 (0.03)

Piston, Piston pin, Piston ring

inch (mm)

Item			Service Dimensions and Clearances
Piston to cylinder clearance			.0014 to .0022 (0.035 to 0.06)
Piston ring	End gap	Compression No. 1	.010 to .016 (0.25 to 0.41)
		Compression No. 2	.008 to .014 (0.20 to 0.36)
		Oil	.008 to .028 (0.20 to 0.71)
	Side clearance	Compression No. 1	.001 to .003 (0.03 to 0.08)
		Compression No. 2	.001 to .002 (0.03 to 0.05)
Piston outer diameter			2.620 to 2.621 (66.550 to 66.573)
Piston pin outer diameter			.7083 to .7087 (17.991 to 18.000)
Piston pin–to–piston pin bore oil clearance			.0002 to .0004 (0.005 to 0.010)

Connecting rod

inch (mm)

Item	Service Dimensions and Clearances
Rod bend & twist	.002 (0.05)
Pin bore width	.7874 to .7894 (20.00 to 20.05)
Rod width	.7795 to .7815 (19.80 to 19.85)
Rod to crankshaft thrust clearance	.006 to .010 (0.15 to 0.25)
Connecting rod bearing oil clearance	.0008 to .0017 (0.020 to 0.043)

Crankshaft

inch (mm)

Item		Service Dimensions and Clearances
Crankshaft bend(at #3 brg. journal)		.0012 (0.03)
Journal out of round		.008 (0.02)
Main journal diameter		1.8101 to 1.8110 (45.976 to 46.000)
Rod journal diameter	Standard	1.5739 to 1.5748 (39.976 to 40.000)
Main bearing oil clearance		.0008 to .0017 (0.02 to 0.04)
End-play		.001 to .009 (0.03 to 0.23)

Camshaft

inch (mm)

Item		Service Dimensions and Clearances
Camshaft end-play		.002 to .012 (0.05 to 0.31)
Camshaft bend		.0012 (0.03)
Cam lobe height	IN	1.370 to 1.381 (34.80 to 35.08)
	EX	1.368 to 1.378 (34.75 to 35.01)
Camshaft journal diameter	Front	1.6709 to 1.6717 (42.44 to 42.46)
	Center	1.6512 to 1.6520 (41.94 to 41.96)
	Rear	1.1784 to 1.1792 (29.94 to 29.96)
Camshaft Journal Bearing Diameter	Front	1.6732 to 1.6742 (42.500 to 42.525)
	Center	1.6535 to 1.6545 (42.000 to 42.025)
	Rear	1.1811 to 1.1819 (30.000 to 30.021)
Out-of-round Journal		.0016 (0.04)
Journal oil clearance	Front	.0016 to .0034 (0.04 to 0.086)
	Center	
	Rear	.0016 to .0032 (0.04 to 0.081)

Manifolds

inch (mm)

Item	Service Dimensions and Clearances
Intake manifold surface distortion	.004 (0.10)
Exhaust manifold surface distortion	.020 (0.51)

Flywheel

inch (mm)

Item	Service Dimensions and Clearances
Fly–wheel run-out	.004 (0.10)

Timing belt pulley

inch (mm)

Item		Service Dimensions
Pulley outer diameter	Camshaft pulley	4.3531 to 4.3627 (110.57 to 110.813)
	Crankshaft pulley	2.1512 to 2.1575 (54.64 to 54.801)

Machining Information

inch (mm)

Item		Service Dimensions
Cylinder bore (Oversize)	**Standard**	2.6214 to 2.6234 (66.585 to 66.635)
	.0098 (0.25)	2.6313 to 2.6333 (66.835 to 66.885)
	.0197 (0.50)	2.6411 to 2.6431 (67.085 to 67.135)
	.0295 (0.75)	2.651o to 2.6530 (67.335 to 67.385)
	.0394 (1.00)	2.6608 to 2.6628 (67.585 to 67.635)
Main journal (Undersize)	**Standard**	1.8101 to 1.8110 (45.976 to 46.00)
	.0098 (0.25)	1.8005 to 1.8009 (45.732 to 45.742)
Rod journal (Undersize)	**Standard**	1.5739 to 1.5748 (39.976 to 40.000)
	.0098 (0.25)	1.5613 to 1.5646 (39.732 to 39.742)

Piston inch (mm)

	Service Dimensions
Standard	2.6201 to 2.6213 (66.55 to 66.58)
.0098 (.025) O.S.	2.6299 to 2.6311 (66.80 to 66.83)
.0197 (0.50) O.S.	2.6398 to 2.6409 (67.05 to 67.08)
.0295 (0.75) O.S.	2.6496 to 2.6508 (67.30 to 67.33)
.0394 (1.00) O.S.	2.6594 to 2.6606 (67.55 to 67.58)

Fuel pump inch (mm)

Item	Service Dimensions
Push rod overall length	2.2815 to 2.2933 (57.95 to 58.25)
Fuel pump cam lift	.0748 to 0.0827 (1.90 to 2.10)

Oil pump inch (mm)

Item	Service Clearances
End-play	.0014 to .0059 (0.035 to 0.15)
Tip clearance	.0067 to .0138 (0.17 to 0.35)
Drive gear–to–body clearance	.0024 to .0098 (0.06 to 0.25)
Relief valve opening pressure	49.8 to 61.2 psi (3.5 to 4.3 kg/cm2)

Radiator

Item		Specified value
Radiator cap relief pressure	psi (kg/cm^2)	8.5 to 15.0 (0.60 to 1.05)

Thermostat

Item		Specified value
Valve opening temperature	Start to open at	175° to 185°F (82 ± 1.5°C)
	Full opens at	203°F (95°C)

Radiator fan control switch

Item	Specified value
"ON" temperature	205° to 210°F (92 ± 1.5°C)
"OFF" temperature	195°F (87 ± 2°C)

Starter

Item	Specified value
No–load amp draw	Not more than 50Amps at 11Volts

Ignition coil

Item		Specified value
Primary resistance	Ω	1.2 ± 0.12
Secondary resistance	kΩ	26 ± 3.9
External resistance	Ω	1.7 ± 0.17

Distributor

Item	Specified value
Breaker point gap	.018 in (0.45 mm)
Dwell angle	59° to 65°
Condenser capacity μF	0.27 ± 0.027

Resistive wire kΩ

Item		Specified value
Wire resistance	No. 1 wire	60. to 13.2
	No. 2 wire	5.0 to 11.0
	No. 3 wire	4.7 to 10.3
	Coil wire	4.5 to 9.9

TORQUE SPECIFICATIONS
HEX HEAD CAP SCREWS

The torque values shown should be used as a general guideline when specific torque values are not given.

U.S. Standard Hardware

Grade		**Shank Size** (Diameter in inches, fine or coarse thread)													
		1/4	**5/16**	**3/8**	**7/16**	**1/2**	**9/16**	**5/8**	**3/4**	**7/8**	**1**	**1 1/8**			
SAE grade 5 *	lbs. ft.	9	18	31	50	75	110	150	250	378	583	782			
	N·m	12	24	42	68	102	150	203	339	513	790	1060			
SAE grade 8 **	lbs. ft.	13	28	46	75	115	165	225	370	591	893	1410			
	N·m	18	38	62	108	156	224	305	502	801	1211	1912			
Flangelock Screw w/ Flangelock Nut	lbs. ft.		24	40											
	N·m		33	54											

* Grade 5 marking –  Minimum commercial quality (Lower quality not recommended).

** Grade 8 marking – 

Metric Standard Hardware

Grade		**Shank Size** (Diameter in millimeters, fine or coarse thread)												
		M4	**M5**	**M6**	**M7**	**M8**	**M10**	**M12**	**M14**	**M16**	**M18**	**M20**	**M22**	**M24**	**M27**
Grade 8.8*	lbs. ft.	2	4	7	11	18	32	58	94	144	190	260	368	470	707
	N·m	1.5	3	5.2	8.2	13.5	24	43.5	70.5	108	142	195	276	353	530
Grade 10.9**	lbs. ft.	3	6	10	16	25	47	83	133	196	269	366	520	664	996
	N·m	2.2	4.5	7.5	12	18.8	35.2	62.2	100	147	202	275	390	498	747
Grade 12.9 ***	lbs. ft.	3.6	7	11	20	29	58	100	159	235	323	440	628	794	1205
	N·m	2.7	5.2	8.2	15	21.8	43.5	75	119	176	242	330	471	596	904

* Grade 8.8 marking – 

** Grade 10.9 marking – 

*** Grade 12.9 marking – 

TABLE OF TORQUE VALUES

Application	Foot lbs.	Inch lbs	N·m
Engine			
Bearing cap mounting screws	39-48		53-65
Camshaft thrust ring		63-94	7-11
Carburetor		90-136	11-15
Connecting rod cap	17-22		23-30
Clutch	11-16		15-22
Crankshaft pulley	36-43		49-58
Cylinder head	36-43		49-58
Exhaust manifold	11-17		15-23
Fly wheel	29-36		39-49
Fuel pump	11-17		15-23
Intake manifold	11-17		15-23
Oil pan	5-7	60-84	7-10
Oil pick up tube	5-7	60-84	7-10
Oil pump mounting screws	7-11		9.5-15
Oil pump mounting screws (inside)		70-112	8-12
Rear oil seal retainer	11-17		15-23
Rear timing belt cover		63-94	7-11
Timing belt cover		38-57	4-7
Timing belt tension pulley	23-35		31-47
Thermostat housing	11-17		15-23
Valve cover		35-60	4-7
Valve rocker arms	12-18		16-24
Water pump	11-17		15-23
Water pump pulley		38-57	4-7
Transmission			
3/8" screws	20-25		27-34
3/8" stud	17-23		23-31
5/16" stud	10-15		14-20
Front bearing retainer	10-15		14-20
PTO or side cover	10-15		14-20
Rear bearing retainer	10-15		14-20
Auxiliary transmission			
Bearing retainer	16±2		21±2
Cover	8±2		11±2
Driven gear to worm	20-25		27-34
Mounting to differential	20-25		24-34
Differential			
Axle nuts	70-90		95-140
Brake backing plate	16-20		22-27
Housing	16-20		22-27
Leaf springs	70-90		95-140
Planet shaft retainer	20-25		27-34
Spring shackle bolts	70±2		95±2
Worm gear mounting	38-45		52-60
Worm retainer mounting	20-25		27-34

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