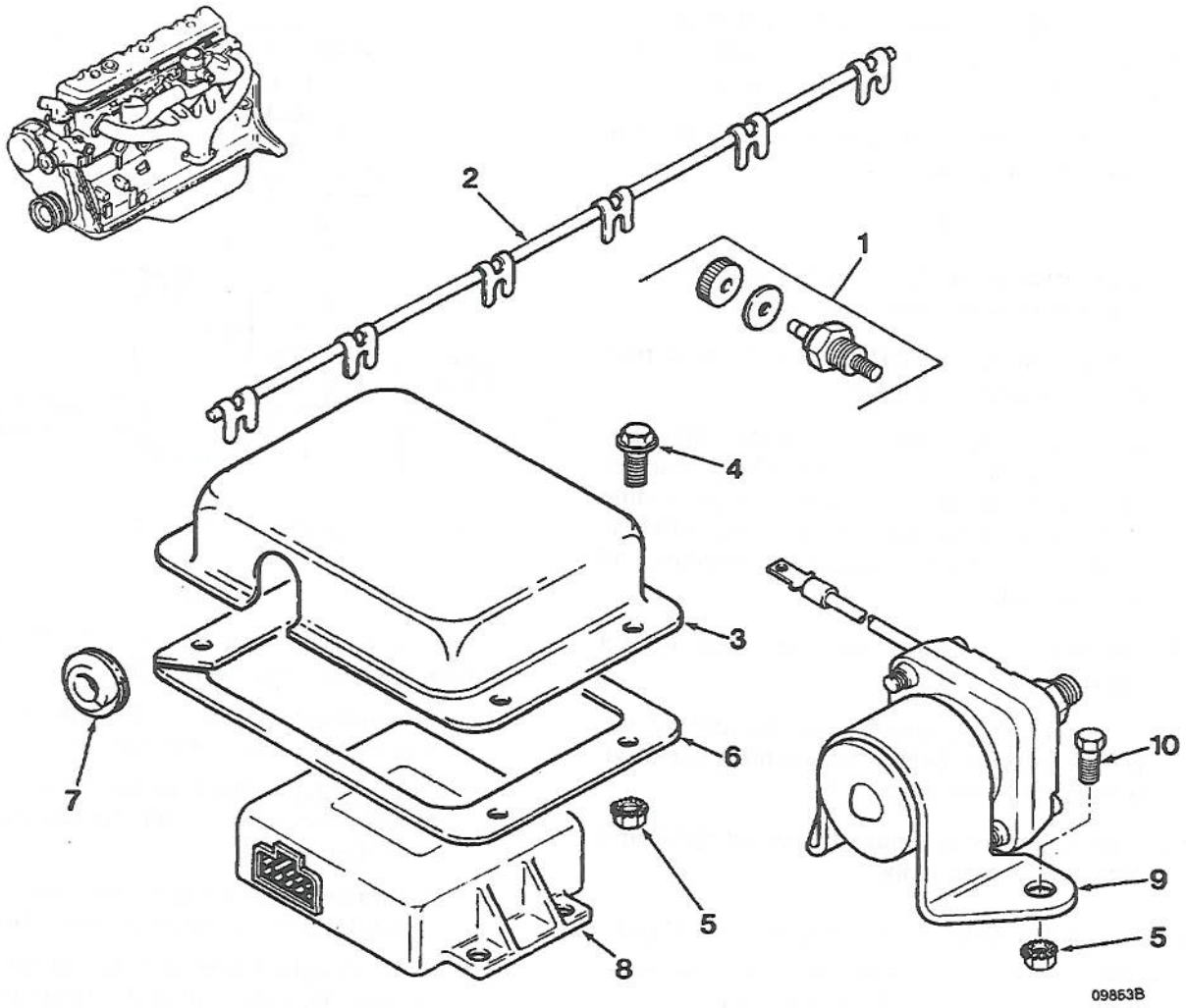


1. Glow Plug
2. Cable Assembly
3. Control Splash Cover
4. Capscrews
5. Hex Nuts and Washers
6. Splash Cover Gasket
7. Beveled Grommet
8. Glow Plug Controller
9. Glow Relay
10. Capscrew

Figure 5-50. Diesel Preheating Group

b. Cleaning and inspection. Refer to paragraphs 5-4.3 and 5-4.4 for cleaning and inspection procedures. In addition, perform the following steps:

(1) Visually inspect cable assembly (2) and glow plugs (1) for damage.

NOTE

Close observation of ohmmeter is required for the following low resistance specification.

(2) Connect ohmmeter leads to body of glow plug (1) and electrical terminal.

(3) Glow plug resistance should be the value prescribed in table 6-1. A low reading indicates glow plug insulation is faulty. A high reading indicates an open heat coil. If either of these conditions exists, glow plug (1) is defective and must be replaced.

(4) Visually inspect glow relay assembly (9) for damage.

(5) Connect lamps, variable resistor and 12 vdc power source to glow relay assembly (9) terminals as shown in figure 5-51.

(6) Vary resistance at terminal 2 according to table 5-5 and observe lamps.

Table 5-5. Glow Relay Assembly Lamp Test Chart

Resistance KU	Lamp On Time (Seconds)	
	Lamp A	Lamp B
11.5	9.5 to 12.5	13 to 16
5.6	5.9 to 8.5	13 to 16
2.5	3 to 5	13 to 16
1.2	1.4 to 3	13 to 16
1.2	1.4 to 3	13 to 16
0.61	0.6 to 1.8	13 to 16

(7) If time intervals are not as specified, glow relay assembly (9) is defective.

(8) Visually inspect glow plug controller (8) for damage.

(9) Connect positive side of 12 vdc power source to center wire of relay glow plug controller (8).

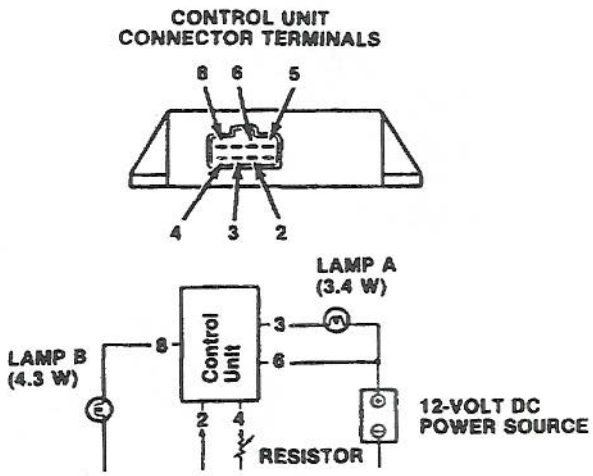


Figure 5-51. Control Unit Test Connectors

NOTE

Relay coil should energize and audible click should be heard as contacts close.

(10) Ground negative side of 12 vdc power source to case of glow plug controller (8).

(11) To verify that contacts are closed, connect ohmmeter between two outer terminals of glow plug controller (8).

(12) If ohmmeter does not show continuity, glow plug controller (8) is defective and must be replaced.

c. Repair and replacement. Replace all worn or damaged parts, including all parts found defective in inspection procedure above.

d. Assembly and installation. Assembly is accomplished during installation. Install diesel preheating group as follows:

(1) Install glow plugs (1) in cylinder head.

(2) Install electrical leads from cable assembly (2) to glow plugs (1).

(3) Install glow plug controller (8) on right front inner fender panel or inside under dash, using hex nuts and washers (5).

(4) Position the splash cover gasket (6) over the glow plug controller (8).

(5) Slide the beveled grommet (7) over the wiring connector, and connect the wiring connector to the glow plug controller (8).

(6) Position beveled grommet (7) in groove of control splash cover (3).

(7) Position control splash cover (3) over glow plug controller (8), and install control splash cover (3) and splash cover gasket (6) using capscrews (4) and hex nuts and washers (5).

(8) Install glow relay assembly (9) on right front inner fender panel using capscrews (10) and hex nuts and washers (5).

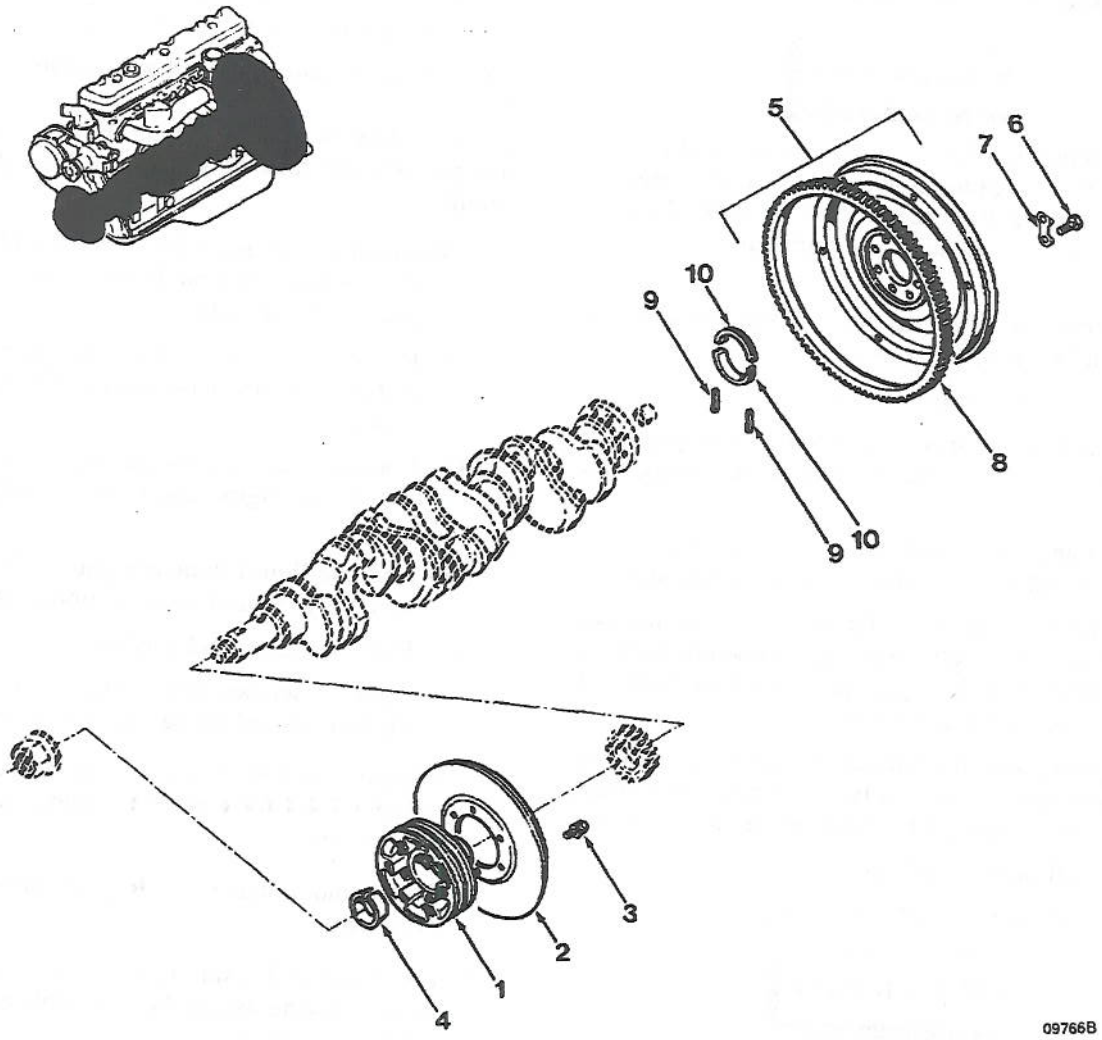
(9) Connect wiring harness to glow relay assembly (9).

5-5.1.24 *Crankshaft Pulley and Flywheel Group*. Refer to figure 5-52, and perform the following steps to overhaul the crankshaft pulley and flywheel group.

a. Removal and disassembly. Disassembly is accomplished during removal. Remove and disassemble crankshaft pulley and flywheel as follows:

(1) Lock crankshaft and remove crankshaft nut.

(2) Remove cone bushing (4) from crankshaft pulley (1).



1. Crankshaft Pulley
2. Crankshaft Damper
3. Screw W/Washer
4. Cone Bushing
5. Flywheel Assembly
6. Hex Head Screw
7. Lockplate
8. Ring Gear
9. Oil Seal
10. Oil Seal

Figure 5-52. Crankshaft Pulley and Flywheel Group

(3) Remove woodruff key.

(4) Remove crankshaft pulley (1).

(5) Remove screws and washers (3) and crankshaft damper (2).

(6) Remove timing gear case according to procedure given in paragraph 5-5.1.18.

(7) Measure lateral runout of clutch disc contacting surface of flywheel, and record for future reference.

(8) Flatten fingers of lockplates (7) and remove capscrews (6) and lockplates (7).

WARNING

When removing flywheel capscrews, hold flywheel tightly against crankshaft by hand to prevent it slipping off the crankshaft. Serious injury to personnel or damage to equipment may occur.

(9) Remove flywheel assembly (5) and remove ring gear (8) from flywheel.

(10) Remove oil seals (9) and (10).

b. Cleaning and inspection. Refer to paragraphs 5-4.3 and 5-4.4 for general cleaning and inspection procedures.

c. Repair and replacement. Replace worn or damaged parts. In addition, perform the following step:

(1) If lateral runout of clutch disc contacting surface of flywheel (measured during removal) was greater than the figure prescribed by table 6-1, regrind or replace flywheel.

d. Assembly and installation. Installation is accomplished during assembly. Assemble and install crankshaft and flywheel assemblies as follows:

(1) Install oil seals (9) and (10).

(2) Install ring gear (8) on flywheel.

WARNING

When installing hex head flywheel capscrews, hold flywheel firmly by hand to prevent it from slipping off the end of the crankshaft. The flywheel is not dowelled to the crankshaft. Serious injury to personnel or damage to equipment may occur.

(3) Install flywheel assembly (5) by inserting hex head flywheel capscrews (6) through lockplates (7). Tighten screws to torque prescribed by table 6-2.

(4) Bend fingers of lockplates (7) over heads of capscrews (6).

(5) Install timing gear case according to procedure given in paragraph 5-5.1.17.

(6) Install crankshaft damper (2) on crankshaft pulley (1) using screws and washers (3).

(7) Insert woodruff key in crankshaft and lock crankshaft.

(8) Install crankshaft pulley (1) and crankshaft damper (2).

(9) Install cone bushing (4). Align opening in cone bushing (4) with woodruff key.

(10) Install crankshaft nut on crankshaft.

5-5.1.25 *Engine Oil Pan Group*. Refer to figure 5-53, and perform the following steps to the engine oil pan group.

a. Removal and disassembly. Disassembly is accomplished during removal. Remove and disassemble engine oil pan as follows:

(1) Remove drain plug (5), drain plug washer (6) and drain oil from oil pan (1) into suitable container.

(2) Loosen connector which attaches guide assembly (9) to engine and remove guide assembly (9).

(3) Remove liquid indicator gauge (7) from guide assembly (9) and remove rubber ring (8).

(4) Remove screw and washer (3).

(5) Remove screws and washers (2), and remove oil pan (1) and oil pan gasket (4) from engine.

b. Cleaning and inspection. Refer to paragraphs 5-4.3 and 5-4.4 for general cleaning and inspection procedures.

c. Repair and replacement. Replace all worn or damaged parts.

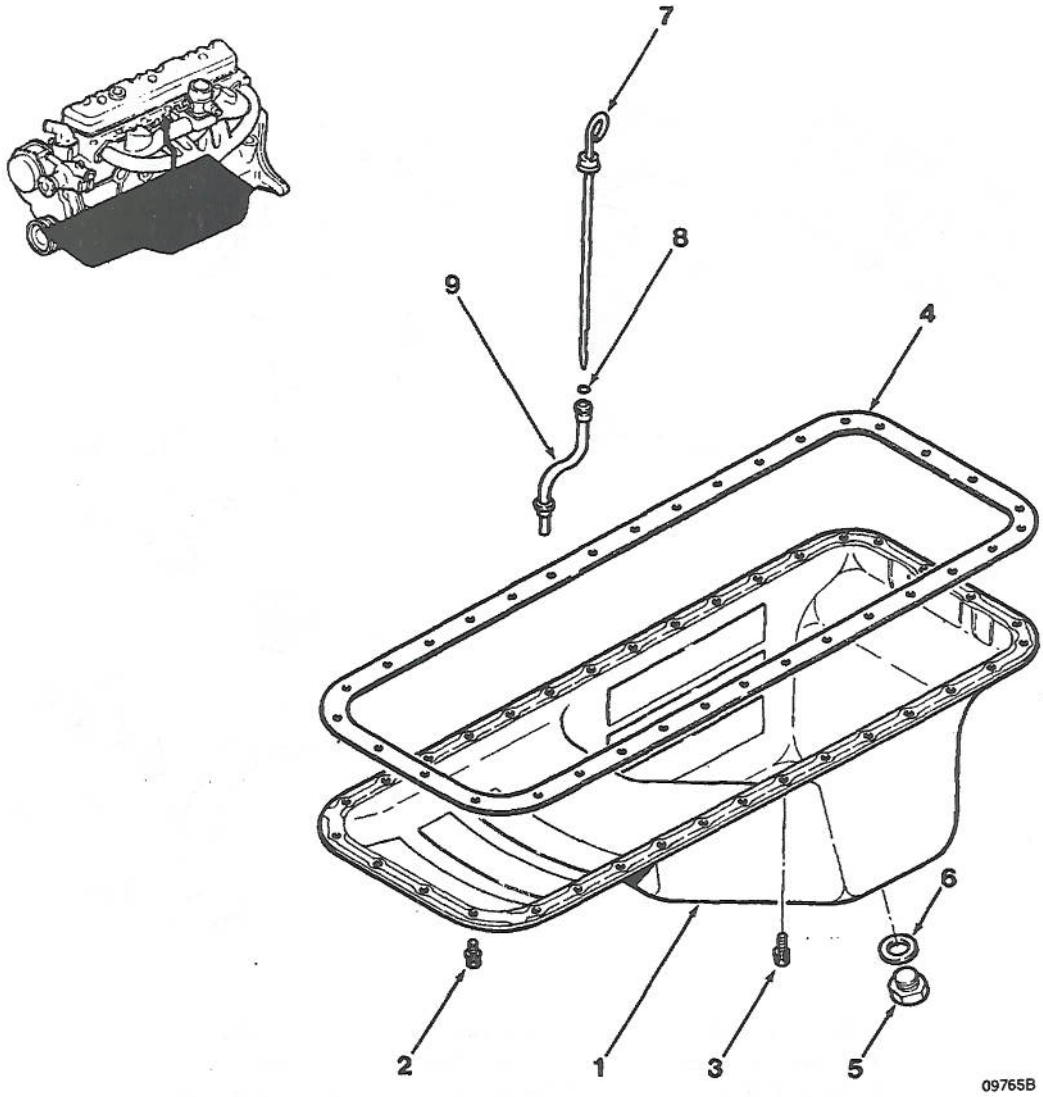
d. Assembly and installation. Installation is accomplished during assembly. Assemble and install the oil pan as follows:

(1) Install guide assembly (9) on engine. Tighten connector.

(2) Install rubber ring (8) in guide assembly (9).

(3) Insert liquid indicator gauge (7) into guide assembly (8).

(4) Position oil pan (1) and gasket (4) on engine, and install using screws and washers (2). Tighten bolts to torque prescribed by table 6-2.



1. Oil Pan Assembly
2. Screw W/Washer
3. Screw W/Washer
4. Oil Pan Gasket
5. Drain Plug
6. Drain Plug Washer
7. Liquid Indicator Gauge
8. Rubber Ring
9. Guide Assembly

Figure 5-53. Engine Oil Pan Group

(5) Install screw and washer (3) and tighten to torque specified in table 6-2.

(6) Install drain plug (5) and drain plug washer (6). Tighten to torque prescribed in table 6-2.

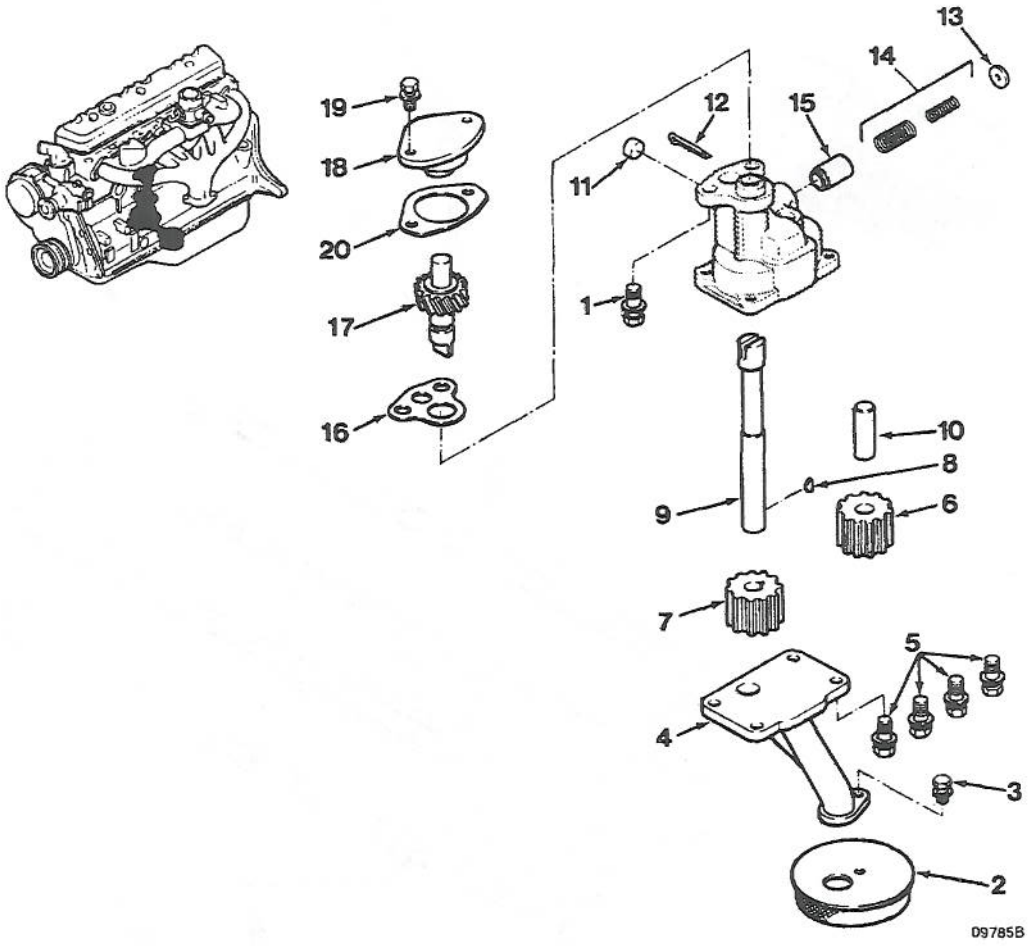
(7) Refill engine with oil.

5-5.1.26 *Oil Pump Group*. Refer to figure 5-54, and perform the following steps to overhaul the oil pump group.

a. Removal. Remove oil pump as follows:

(1) Remove screws and washers (19).

(2) Remove spindle support (18), support gasket (20) and spindle assembly (17).



1. Screw W/Washer
2. Strainer Assembly
3. Screw W/Washer
4. Cover
5. Screw W/Washer
6. Driven Gear
7. Drive Gear
8. Woodruff Key
9. Drive Shaft
10. Driven Gear
11. Blind Plug
12. Cotter Pin
13. Flat Washer
14. Spring Set
15. Valve
16. Oil Pump Gasket
17. Spindle Assembly
18. Spindle Support
19. Screw W/Washer
20. Support Gasket

Figure 5-54. Oil Pump Group

NOTE

For the following steps, engine must be turned on right side.

(3) Remove screws and washers (1).

(4) Remove oil pump and oil pump gasket (16).

b. Disassembly. Disassemble oil pump as follows:

(1) Remove screws and washers (5) and cover (4).

(2) Remove strainer assembly (2) from cover (4).

(3) Using a straight edge and feeler gauge, measure clearance between ends of gears (6) and (7) and cover (4) as shown in figure 5-55. Record measurements for future reference.

(4) Measure clearance between tips of gear teeth and gear case at several points around drive gear (7) and driven gear (6). Record for future reference.

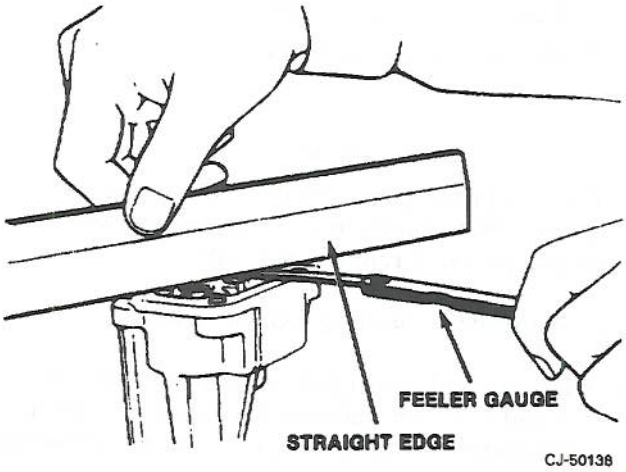


Figure 5-55. Oil Pump Cover-to-Gear Measurement

(5) Crush length of soft solder between pump drive gear (7) and driven gear (6). Measure width of solder to measure gear backlash. Record measurement for future reference.

(6) Remove drive gear (7) from shaft.

(7) Remove driven gear (6) from shaft.

(8) Force driven gear shaft (10) from oil pump.

WARNING

When relief valve is disassembled, removing cotter pin allows springs to expand with considerable force. Always keep valve facing downward and release slowly to avoid injury.

(9) With valve facing downward, remove cotter pin (12), flat washer (13), spring set (14) and valve (15).

(10) Remove blind plug (11).

c. Cleaning and inspection. Refer to paragraphs 5-4.3 and 5-4.4 for general cleaning and inspection procedures. In addition, perform the following steps:

NOTE

For the next three steps, refer to the measurements taken during disassembly.

(1) If clearance between end of gears (6) and (7) and cover (4) exceeds figure specified in table 6-1, both gears (6) and (7) must be replaced.

(2) If clearance between gear teeth tips and case exceeds figure specified in table 6-1, both gears (6) and (7) must be replaced.

(3) If pump gear backlash exceeds figure specified in table 6-1, both gears (6) and (7) must be replaced.

CAUTION

If any part is replaced due to chipped teeth, replace mating part as it may have invisible fractures.

(4) Inspect interior of pump case, surface of cover (4) and gears (6) and (7). If damaged, they must be replaced.

(5) Measure diameters of shafts (9) and (10). Compare measurements to figures specified in table 6-1. If wear exceeds these figures, shafts (9) and (10) must be replaced.

(6) Measure clearances between drive shaft (9) and its bore in pump body. If clearance exceeds figure specified in table 6-1, replace drive shaft (9) or body.

d. Repair and replacement. Replace all worn or damaged parts.

e. Assembly. Assemble oil pump as follows:

(1) Coat all friction surfaces with engine oil.

(2) Install valve (15), spring set (14), flat washer (13) and cotter pin (12).

(3) Install blind plug (11).

(4) Install driven gear shaft (10).

(5) Install both gears (6) and (7) with beveled sides toward pump body.

(6) Recheck clearances.

(7) Turn drive shaft (9) by hand to check for smooth rotation.

(8) Install strainer (2) using screw and washer (3). Tighten to torque specified in table 6-2.

(9) Install cover (4) using four screws and washers (5). Tighten to torque specified in table 6-2.

f. Installation. Install oil pump as follows:

(1) Position oil pump and oil pump gasket (16) on engine. Install using screws and washers (1) tightened to torque specified in table 6-2.

(2) Position spindle assembly (17), support gasket (20) and spindle support (18) on engine. Install using screws and washers (19).

5-5.1.27 *Piston, Connecting Rod and Crankshaft Group.* Refer to figure 5-56, and perform the following steps to overhaul the piston, connecting rod and crankshaft group.

a. Removal and disassembly. Disassembly is accomplished during removal. Remove and disassemble piston, connecting rod and crankshaft group as follows:

(1) Refer to paragraph 5-5.1.21 and remove cylinder head.

(2) Remove crankshaft nut (8).

(3) Remove timing gear case.

(4) Turn engine on side.

NOTE

Mark bearings for reinstallation with proper components. Do not exchange upper and lower shell metals.

(5) Measure end play at large end of each connecting rod. Record for future reference.

(6) From bottom of engine, remove connecting rod hex nuts (4), lower connecting rod caps and lower bearings (7).

(7) Remove carbon from top of pistons and ridge from top of cylinder bores prior to piston removal.

(8) Remove pistons, connecting rods, bushings (6), connecting rod capscrews (5) and upper bearings (7).

(9) Remove main bearing cap bolts, main bearing caps lower bearings (10) and lower thrust washers (12).

NOTE

Upper bearings and upper thrust washers may be removed when crankshaft is removed according to paragraph 5-5.1.24.

(10) Remove upper bearings (10) and upper thrust washers (11).

(11) Remove crankshaft pulley and flywheel assembly according to the procedures given in paragraph 5-5.1.24.

(12) Remove woodruff key (13) and crankshaft gear (14).

(13) Measure end play at large end of each connecting rod. Record for future reference.

(14) Measure crankshaft end play. Record measurement for future reference.

(15) Remove crankshaft and bushing (9).

(16) Remove ring sets (3) from pistons.

(17) Remove retaining rings (1) and piston pins (2).

NOTE

Because piston pin is fitted tightly into piston at ambient temperatures, it may be necessary to heat piston to remove piston pin.

(18) Separate connecting rod and piston.

b. Cleaning and inspection. Refer to paragraphs 5-4.3 and 5-4.4 for general cleaning and inspection procedures. In addition, perform the following steps:

(1) Check periphery of piston for chipping and check ring grooves for wear. If parts are chipped or worn, they must be replaced.

(2) Measure piston diameter as shown in figure 5-57 and calculate clearance with cylinder liner. Measurement location is 1.988 inches down from piston top, perpendicular to piston pin hole.

(3) Install ring sets (3) on pistons and measure clearance at five points around rings (3). See figure 5-58. If clearances exceed figures prescribed by table 6-1, install new rings (3) and recheck clearances. If new rings (3) still exceed figures given in table 6-1, pistons must be replaced.

(4) Insert ring (3) in cylinder and push down with piston to make sure ring (3) is squarely in cylinder bore. See figure 5-59. In standard size cylinder, gap should not exceed figure specified by table 6-1. If gap exceeds this figure, ring (3) must be replaced.

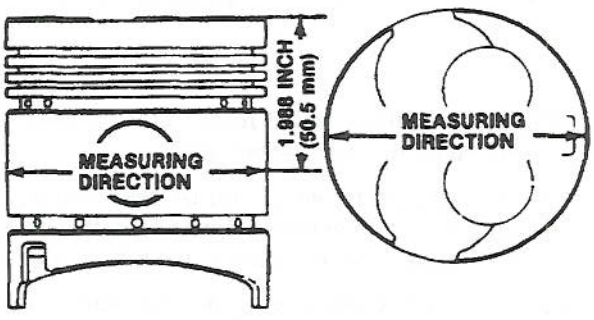


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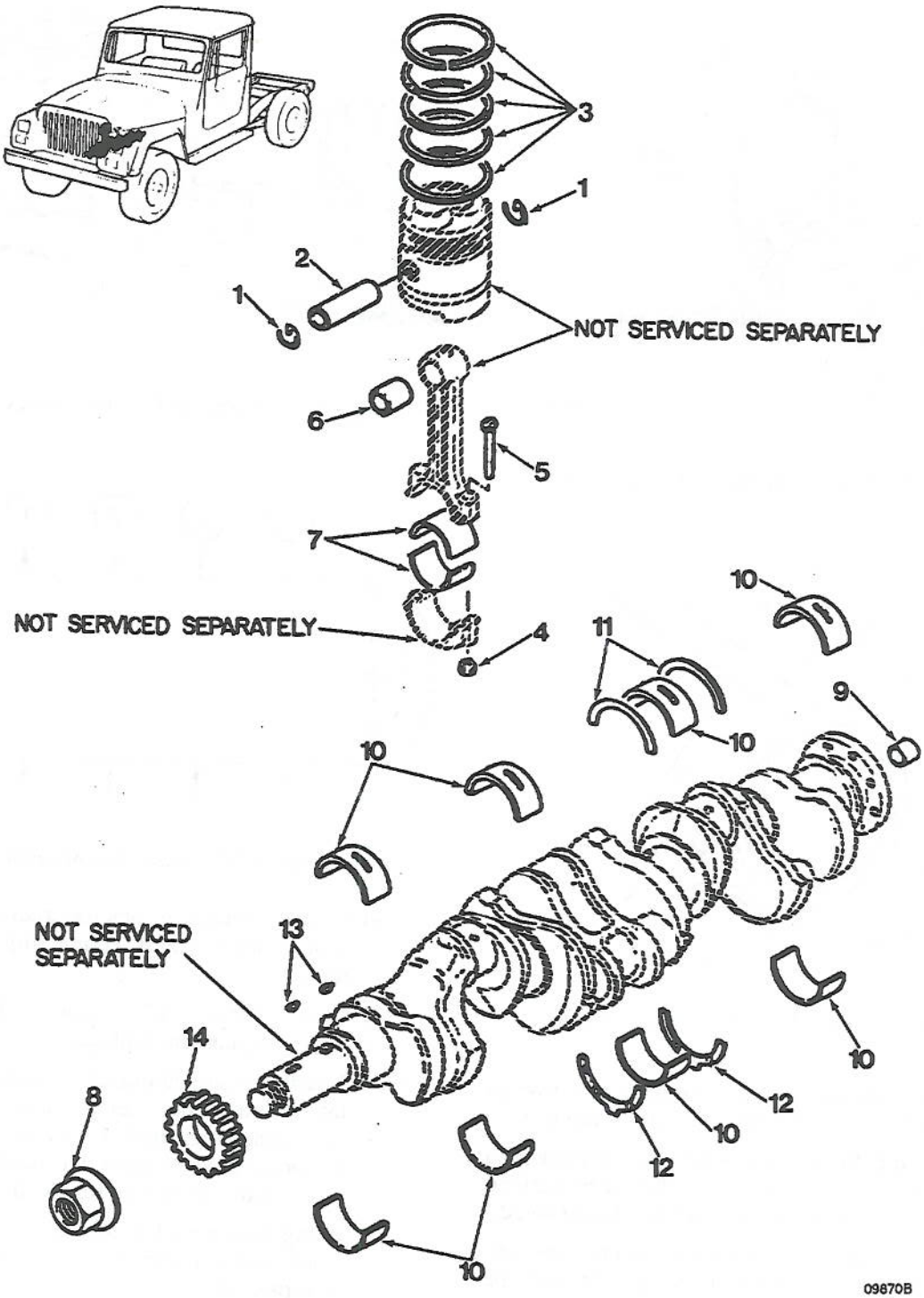
Figure 5-56. Piston Measurement



1. Retaining Ring
2. Piston Pin
3. Ring Set
4. Connecting Rod Hex Nut
5. Connecting Rod Capscrew
6. Bushing
7. Bearing
8. Crankshaft Nut
9. Bushing
10. Bearing
11. Upper Thrust Washer
12. Lower Thrust Washer
13. Woodruff Key
14. Crankshaft Gear

Figure 5-57. Piston, Connecting Rod and Crankshaft Group

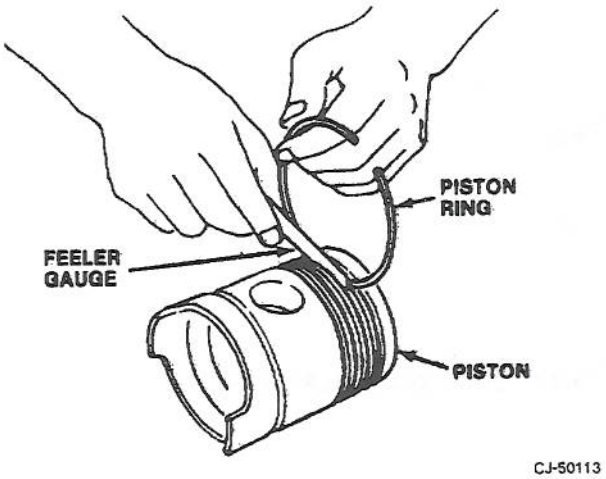


Figure 5-58. Ring Clearance Measurement

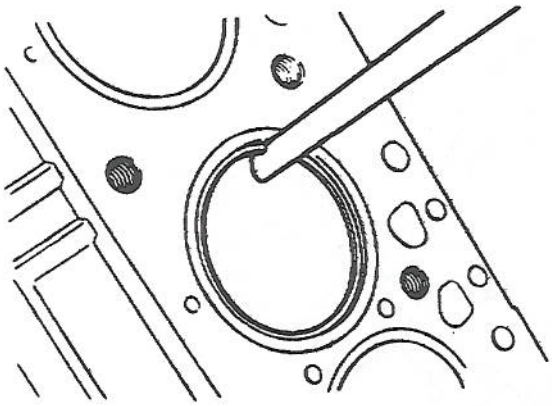


Figure 5-59. Ring End Gap Measurement

(5) Measure piston pin bore diameter as shown in figure 5-60, and record for future reference.

(6) If the end play of the connecting rod measured during removal exceeds the figure prescribed in table 6-1, connecting rod must be replaced.

(7) Check piston pin (2) for severe wear or scratches. If worn or scratched, piston pin (2) must be replaced.

(8) Measure diameter of piston pin (2) as shown in figure 5-61, and calculate clearance between piston pin (2) and piston pin bore (as measured earlier). If clearance exceeds figure prescribed in table 6-1, piston pin (2) and/or piston must be replaced.

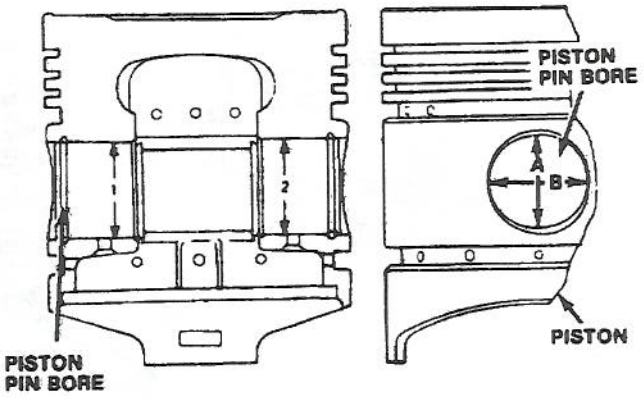


Figure 5-60. Piston Pin Bore Measurement

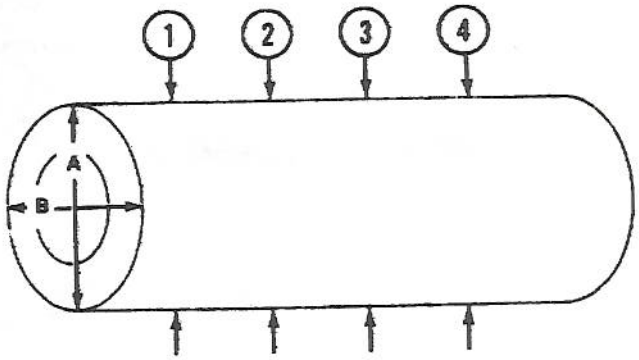


Figure 5-61. Piston Pin Measurement

(9) Check connecting rods for cracks or scoring. If scratched or scored, connecting rods must be replaced.

(10) Check bearings (10). If worn or damaged, bearings (10) must be replaced.

(11) Measure inside diameter of bushing (6). Calculate clearance between bushing (6) and pin (2) (as measured earlier). If clearance exceeds figure prescribed by table 6-1, bushing (6) and/or piston pin (2) must be replaced.

(12) Using flaw detector, inspect crankshaft (1) for cracks and scratches. If cracked, crankshaft must be replaced.

(13) Measure main journals at two locations, as shown in figure 5-62.

(14) If out-of-round (difference between measurements A and B in figure 5-62) or taper exceeds figure prescribed by table 6-1, journal will have to be reground to a standard bearing undersize.

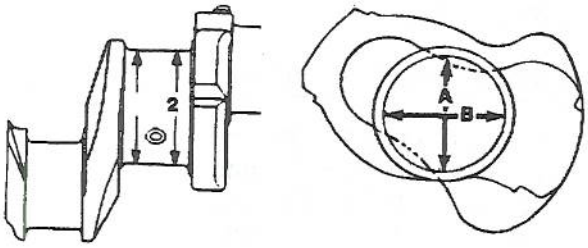


Figure 5-62. Main Bearing Journal Measurement

(15) Measure clearance between bearing and journal. If measurement exceeds figure prescribed by table 6-1, journal must be reground.

(16) Measure connecting rod diameter at two locations, as shown in figure 5-63.

(17) If circularity (difference between measurements A and B in figure 5-63) exceeds figure prescribed by table 6-1, connecting rod journal must be reground to a standard bearing undersize.

(18) Measure clearance between connecting rod journal and bearings. If measurement exceeds figure specified by table 6-1, journal must be reground.

(19) Support crankshaft (1) horizontally and measure bend as shown in figure 5-64. One-half of indicated deflection is crankshaft bend.

(20) If bend exceeds figure prescribed by table 6-1, crankshaft must be straightened to bring bend to within figure prescribed by table 6-1.

c. Repair and replacement. Replace all worn or damaged parts. In addition, perform the following steps:

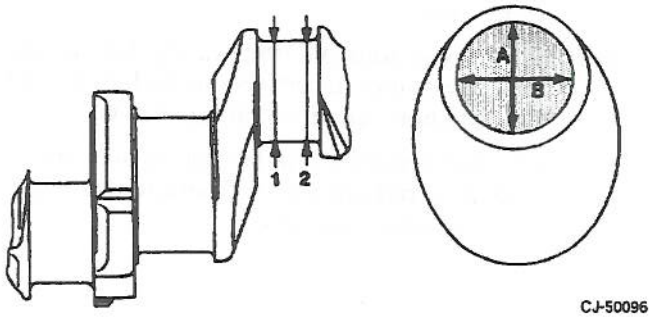


Figure 5-63. Connecting Rod Journal Measurement

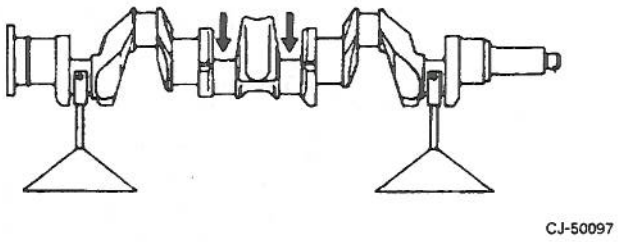


Figure 5-64. Crankshaft Bend Measurement

NOTE

During overhaul always replace piston ring set.

(1) If crankshaft is scratched, grind to remove scratches, if there is sufficient metal to regrind.

(2) If it is necessary to regrind main bearing journals, grind to obtain a journal-to-bearing clearance between figures prescribed by table 6-1. Refer to table 5-6.

(3) If it is necessary to regrind connecting rod journals, grind to obtain a journal-to-bearing clearance between figures prescribed by table 6-1. Refer to table 5-6.

NOTE

In grinding main journals and connecting rod journals, make sure dimension R in figure 5-65 is as prescribed by table 6-1. At the same time, make sure that the surface width does not increase.

(4) If crankshaft end play recorded during disassembly was more than figure prescribed by table 6-1, install thrust washers to bring end play below figure prescribed by table 6-1. Refer to table 5-7 for thrust washer sizes.

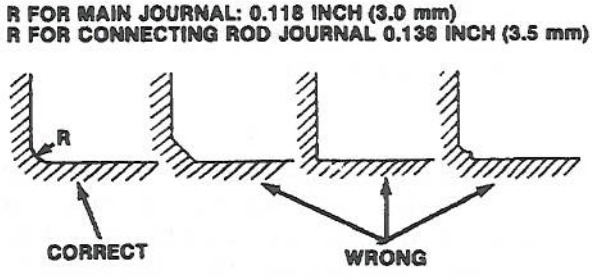


Figure 5-65. Proper Radius Dimension

Table 5-6. Bearing and Journal Regrind Chart

Main Bearing Undersize	Main Bearing Journal Reground To
0.25 mm (0.0098 in.)	2.7818-2.7823 in. (70.657-70.670 mm)
0.50 mm (0.0197 in.)	2.7719-2.7724 in. (70.407-70.420 mm)
0.75 mm (0.0295 in.)	2.7621-2.7626 in. (70.157-70.170 mm)
1.00 mm (0.0394 in.)	2.7522-2.7528 in. (69.907-60.920 mm)
Con. Rod Bearing Undersize	**Con. Rod Journal Reground To**
0.25 mm (0.0098 in.)	2.0733-2.0739 in. (52.663-52.676 mm)
0.50 mm (0.0197 in.)	2.0634-2.0640 in. (52.413-52.426 mm)
0.75 mm (0.0295 in.)	2.0537-2.0542 in. (52.163-52.176 mm)
1.00 mm (0.0394 in.)	2.0438-2.0433 in. (51.913-51.926 mm)

Table 5-7. Crankshaft Thrust Washer Chart

Type	Inch	mm
A	0.092	2.325
B	0.093	2.350
C	0.094	2.375
0.20 mm Oversize	0.099	2.525
0.40 mm Oversize	0.107	2.725

d. Assembly and installation. Assemble and install piston, connecting rod and crankshaft group as follows:

(1) Install crankshaft and bushing (9).

(2) Assemble matching bearings (10), thrust washers (11) and (12) and connecting rods and caps on crankshaft. Tighten bearing cap bolts to torque specified in table 6-2.

(3) Measure inside diameter of bearings (10), and calculate clearance between bearings (10) and connecting rod journals. If clearance exceeds figure specified by table 6-1, bearings (10) must be replaced as a set.

NOTE

The removed bearings must be measured to determine the correct size for replacement. If the specified clearances cannot be attained using replacement bearings, the crankshaft journals must be ground undersize according to procedures given in paragraph 5-5.1.24. If journals are already at maximum underside, the crankshaft must be replaced.

(4) Insert bushings (6) into connecting rods.

(5) Heat pistons in hot oil bath to 140°F.

(6) Insert piston pins (2) through pistons and connecting rods.

NOTE

Make certain that identifying numbers on pistons and connecting rods are on the same side of the assembly.

(7) Install retaining rings (1) in piston pins (2).

(8) Install ring sets (3) on pistons using markings as shown in figure 5-66.

NOTE

Install top ring (3) so end gap is in direct line with piston pin. Install remaining rings (3) so gaps are 180° to each other.

(9) Insert connecting rod capscrews (5) into connecting rods.

(10) Lubricate pistons and ring sets (3). Using a ring compressor tool, insert pistons and connecting rods into bore, as shown in figure 5-67.

(11) Slip short lengths of rubber tubing over ends of connecting rod capscrews (5) and guide rod ends over crankshaft journals.

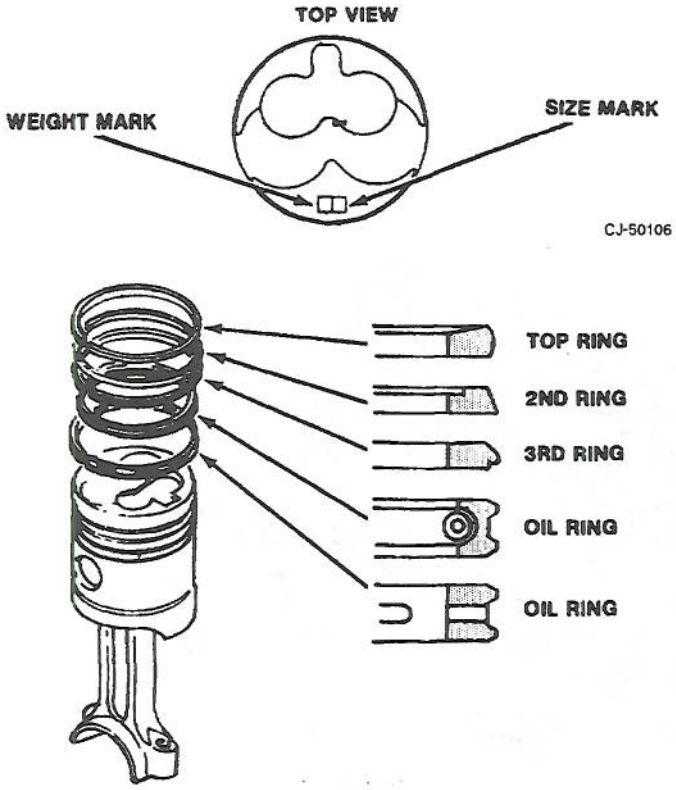


Figure 5-66. Piston and Ring Markings

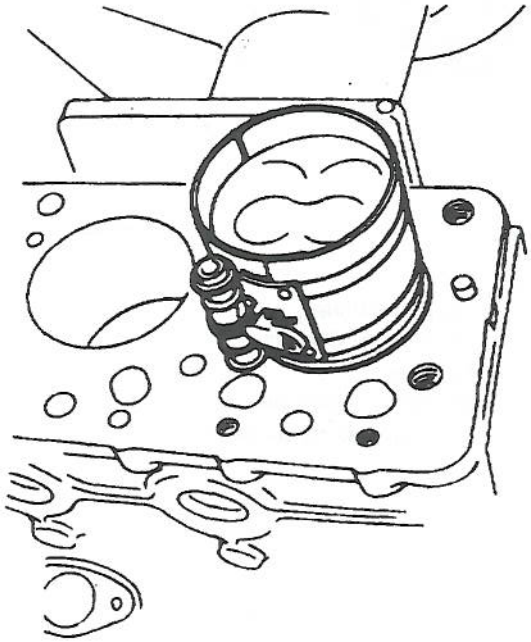


Figure 5-67. Piston and Connecting Rod Installation

NOTE

Check number stamped onto side of connecting rod to make sure pistons are in proper cylinders. Numbered side must face exhaust manifold side of block. Casting numbers on connecting rods must face front of block on numbers 1, 3 and 5 cylinders and must face rear on numbers 2, 4 and 6 cylinders.

(12) Match numbers on connecting rods and connecting rod caps. Coat bearings (7) with engine oil. Remove rubber sleeves from connecting rod capscrews (5) and install bearings (7) and connecting rod caps. Install connecting rod hex nuts (4) and tighten to torque prescribed in table 6-2.

(13) Recheck rod side clearance.

(14) Position each piston dead center and measure top clearance at front and rear of piston. If clearance is not between figures specified by table 6-1, disassemble each piston and check all parts.

(15) Insert woodruff key (13) into key slot on crankshaft and install crankshaft gear (14). Rotate crankshaft until marks on crankshaft and camshaft coincide.

(16) Check backlash. If backlash is not between figures prescribed by table 6-1, adjust backlash.

(17) Install crankshaft pulley assembly according to procedures given in paragraph 5-5.1.24.

(18) Install timing gear case according to procedure given in paragraph 5-5.1.17.

(19) Install crankshaft nut (8) and tighten it to torque prescribed by table 6-2.

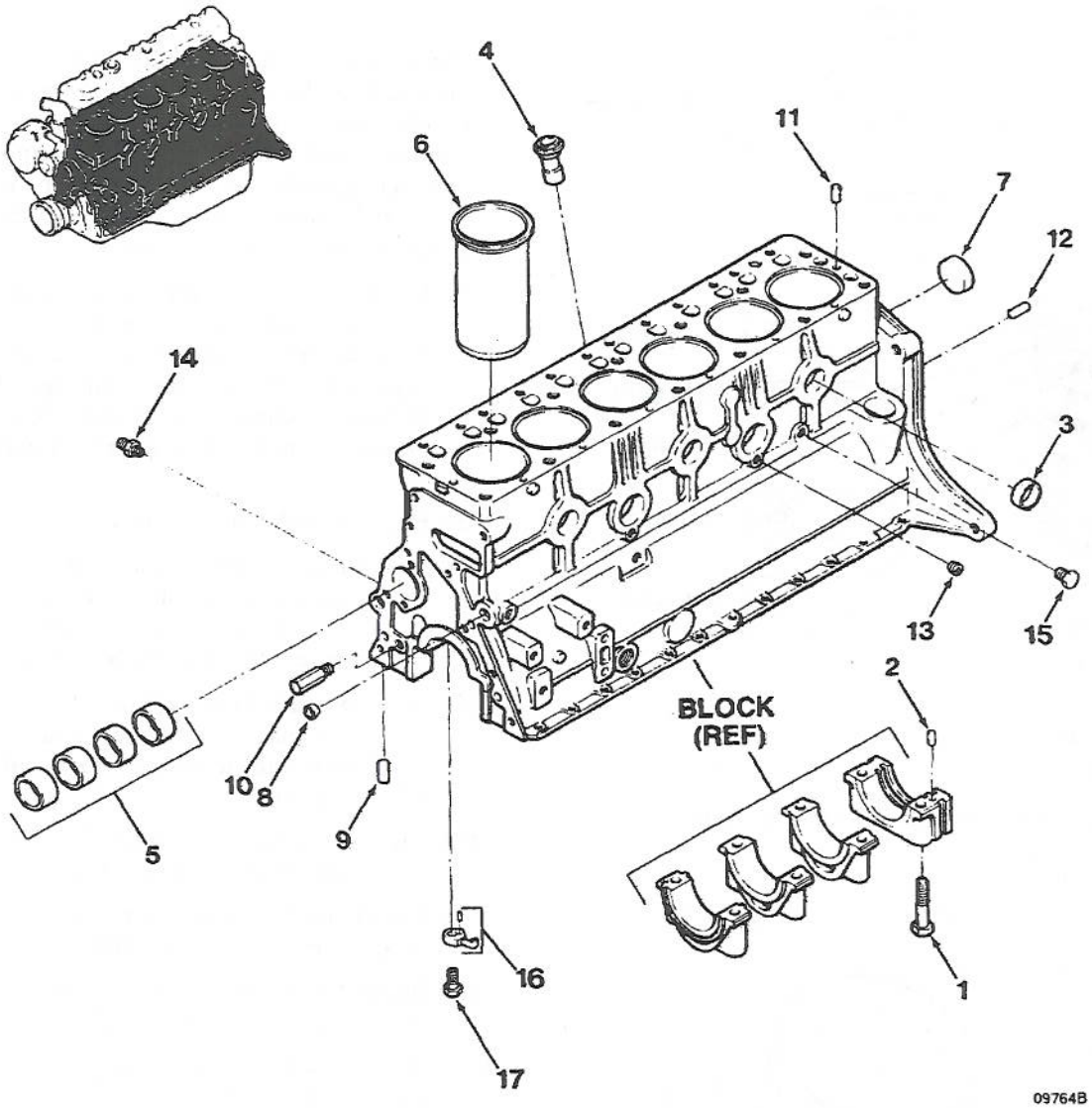
(20) Install cylinder head according to procedure given in paragraph 5-5.1.21.

5-5.1.28 *Engine Block Group*. Refer to figure 5-68, and perform the following steps to overhaul the engine block group.

a. Removal. Disassembly of the engine block group must be preceded by removing the following assemblies:

(1) Refer to paragraph 5-5.1.21 and remove cylinder head.

(2) Refer to paragraph 5-5.1.7 and remove starter motor.



1. Capscrews
2. Straight Pin
3. Welch Plugs
4. Oil Pump Bushing
5. Cam Bushing Set
6. Cylinder Lines
7. Welch Plug
8. Welch Plug
9. Blind Plug
10. Oil Jet
11. Straight Pins
12. Dowels
13. Screw Plugs
14. Straight Connector
15. Plug
16. Oil Jet Assemblies
17. Capscrew Assemblies

Figure 5-68. Engine Block Group

(3) Refer to paragraph 5-5.1.8 and remove alternator and vacuum pump.

(4) Refer to paragraph 5-5.1.11 and remove water pump and fan.

(5) Refer to paragraph 5-5.1.14 and remove fuel pump and fuel filter.

(6) Refer to paragraph 5-5.1.13 and remove fuel lines.

(7) Refer to paragraph 5-5.1.16 and remove oil cooler and filter.

(8) Refer to paragraph 5-5.1.17 and remove engine front cover.

(9) Refer to paragraph 5-5.1.18 and remove governor assembly installation.

(10) Refer to paragraph 5-5.1.20 and remove injection pump assembly.

(11) Refer to paragraph 5-5.1.22 and remove camshaft and valve train.

(12) Refer to paragraph 5-5.1.23 and remove diesel preheating group.

(13) Refer to paragraph 5-5.1.24 and remove crankshaft and flywheel.

(14) Refer to paragraph 5-5.1.25 and remove engine oil pan.

(15) Refer to paragraph 5-5.1.26 and remove oil pump.

(16) Refer to paragraph 5-5.1.27 and remove pistons, rods, crank and main bearings.

(17) Refer to paragraph 5-5.2 and remove transmission from engine.

b. Disassembly. Disassemble the engine block group as follows:

NOTE

Do not remove the cylinder lines unless inspection of them indicates they need repair or replacement.

(1) Use puller tool #99600Z7000 to remove cylinder lines (6) from cylinder block.

(2) Remove bearing cap capscrews (1) and straight pin (2) with bearing caps.

NOTE

Removal of cam bushings is not required unless they do not meet measurement limits specified in paragraph c, Cleaning and Inspection. The welch plug located in the rear of the block assembly will be removed by using the rear cam bushing.

(3) Remove cam bushing set (5), if required, by driving out bushings, one at a time, from front of cylinder block. Knock out welch plug (7) with rear bushing.

NOTE

Do not remove welch plugs from sides of engine block unless required for cleaning entire engine block.

(4) Remove welch plugs (3) from sides of block assembly and welch plug (8) from front of cylinder block.

(5) Remove oil pump bushing (4).

(6) Remove capscrew assemblies (17) and oil jet assemblies (16) from underside of cylinder block.

(7) Remove blind plug (9) from underside of cylinder block.

(8) Remove oil jet (10) from front of cylinder block.

(9) Remove straight pins (11) and cylinder dowels (12) from cylinder block.

(10) Remove screw plugs (3), plug (16) and straight connector (14) from cylinder block.

c. Cleaning and inspection. Refer to paragraphs 5-4.3 and 5-4.4 for general cleaning and inspection procedures. In addition, perform the steps listed below:

(1) Clean all surfaces and oil passages thoroughly.

(2) Inspect engine block for scratches and cracks.

(3) Check top of engine block for warp. If warp exceeds the limit specified in table 6-1, the top surface must be repaired by grinding.

(4) Inspect cylinder liners (6) for chipping. If chipping is present, cylinder liners (6) must be replaced.

(5) Measure bores of cylinder liners (6), as shown in figure 5-69, in direction A and B. Any liner that is worn beyond the limits specified in table 6-1, or with a vertical variation or circularity greater than that specified in the table 6-1, must be replaced.

(6) Measure protrusion of cylinder liner flange as shown in figure 5-70, and compare to values in table 6-1 for minimum, maximum and variation among cylinders. Any liner that is beyond the limits must be replaced.

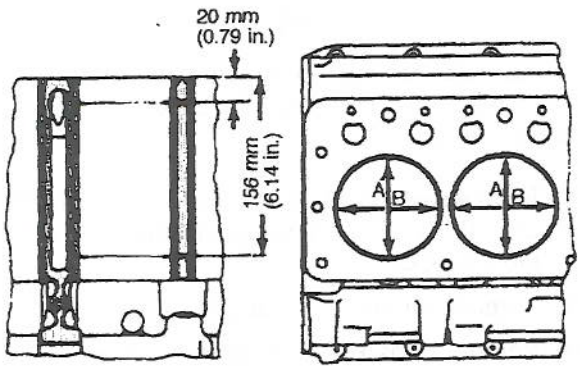


Figure 5-69. Cylinder Liner Measurement

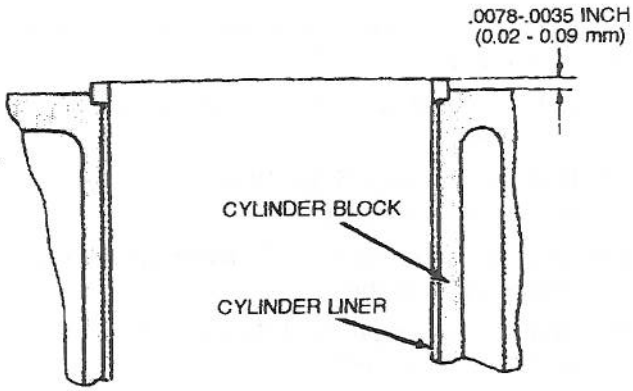


Figure 5-70. Cylinder Liner Protrusion Measurement

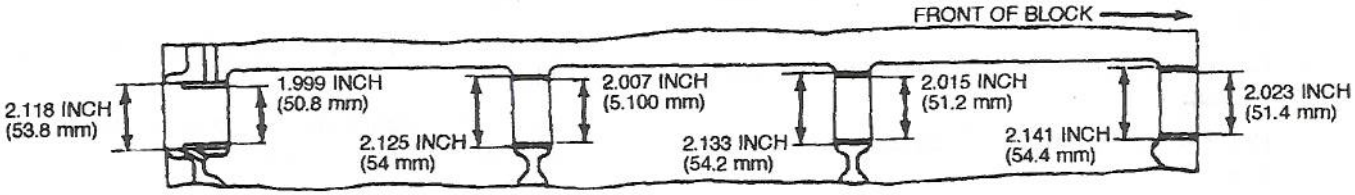


Figure 5-71. Camshaft Bushing Dimensions

NOTE

Diameters will vary from front to rear with the largest diameter on the timing gear side and the smallest toward the rear.

(7) Measure inside dimensions of cam bushing set (5) and the respective camshaft journal diameters as shown in figure 5-71. If clearance is greater than the value in table 6-1, replace the bushing.

WARNING

Compressed air used for cleaning can create airborne particles that may enter the eyes. Pressure shall not exceed 30 psi and wearing of goggles is required.

(8) After washing and inspecting the cylinder block, use compressed air to blow away any traces of dirt from surfaces that contact cylinder head, bolt holes, water passages, etc.

d. Repair and replacement. Replace all worn or damaged parts and make the following repairs as required.

(1) Replace cylinder block if there is severe damage from cracks or scratches.

CAUTION

Do not grind top surface more than specified in table 6-1.

(2) Repair excessive warpage in top of cylinder block by regrinding top surface.

(3) After grinding, check that distance from top surface of block assembly to crankshaft centerline is no lower than minimum wear limit specified in table 6-1.

(4) Replace any chipped cylinder liners (15) or any cylinder liners that are found to be out of limits when measured during inspection.

(5) Replace any camshaft bushing (5) that is out of tolerance when measured during inspection.

e. Assembly. Assemble the engine block group components as follows:

NOTE

Apply engine oil to sliding surfaces of each engine part prior to assembly.

(1) Install straight connector (14), plug (15) and screw plugs (13).

(2) Install cylinder dowels (12) and straight pins (11).

NOTE

When installing oil jet, make sure that the oil jet opening faces the camshaft gear.

(3) Install oil jet (10) in front of cylinder block.

(4) Install blind plug (9) in underside of block assembly (1).

(5) Install oil jet assemblies (16) and capscrew assemblies (17) in underside of cylinder block.

(6) Install oil pump bushing (4).

(7) Apply sealant to edges, and install welch plugs (3) so that lip of welch plugs (3) are toward outside of cylinder block.

NOTE

When installing bushings, align oil holes in bushings with oil holes in block. The number four camshaft bushing has two oil holes. The elongated hole routes oil pressure to the valve rocker shaft, and the other hole aligns with the main oil gallery.

(8) Install the number 2 bushing, then the number 1 bushing of the cam bushing set (5) from the front of the cylinder block. Use tool #J99590Z7000 to drive bushings into place.

(9) Install the number 3 and then the number 4 bushing of the cam bushing set (5) from rear of cylinder block. Use tool #J-99590Z7000 to drive bushings into place.

(10) Apply sealant to welch plugs (7) and (8). Install welch plugs (7) and (8) in cylinder block.

(11) Install bearing caps with bearing cap hex head capscrews (1) and straight pin (2).

NOTE

Cylinder liner protrusions must be within limits specified in table 6-1.

(12) If cylinder liners (6) were removed, coat cylinder liner and bore with engine oil and install cylinder liners (6), using puller tool #J-99600Z7000.

f. Installation. Install the following assemblies.

(1) Refer to paragraph 5-5.2 and install transmission on engine.

(2) Refer to paragraph 5-5.1.27 and install pistons, rods, crank and main bearings.

(3) Refer to paragraph 5-5.1.26 and install oil pump.

(4) Refer to paragraph 5-5.1.25 and install engine oil pan.

(5) Refer to paragraph 5-5.1.24 and install crankshaft and flywheel.

(6) Refer to paragraph 5-5.1.23 and install diesel preheating group.

(7) Refer to paragraph 5-5.1.22 and install camshaft and valve train.

(8) Refer to paragraph 5-5.1.20 and install injection pump assembly.

(9) Refer to paragraph 5-5.1.18 and install governor assembly installation.

(10) Refer to paragraph 5-5.1.17 and install engine front cover.

(11) Refer to paragraph 5-5.1.16 and install oil cooler and filter.

(12) Refer to paragraph 5-5.1.13 and install fuel lines.

(13) Refer to paragraph 5-5.1.14 and install fuel pump and fuel filter.

(14) Refer to paragraph 5-5.1.11 and install water pump and fan.

(15) Refer to paragraph 5-5.1.8 and install alternator and vacuum pump.

(16) Refer to paragraph 5-5.1.7 and remove starter motor.

(17) Refer to paragraph 5-5.1.21 and install cylinder head.

5-5.1.29 *Front Engine Mounts Group*. Refer to figure 5-72, and perform the following steps to overhaul the front engine mounts group.

a. Removal and disassembly. Disassembly is accomplished during removal. Remove front engine mounts group as follows:

(1) Support front of engine wiring jack.

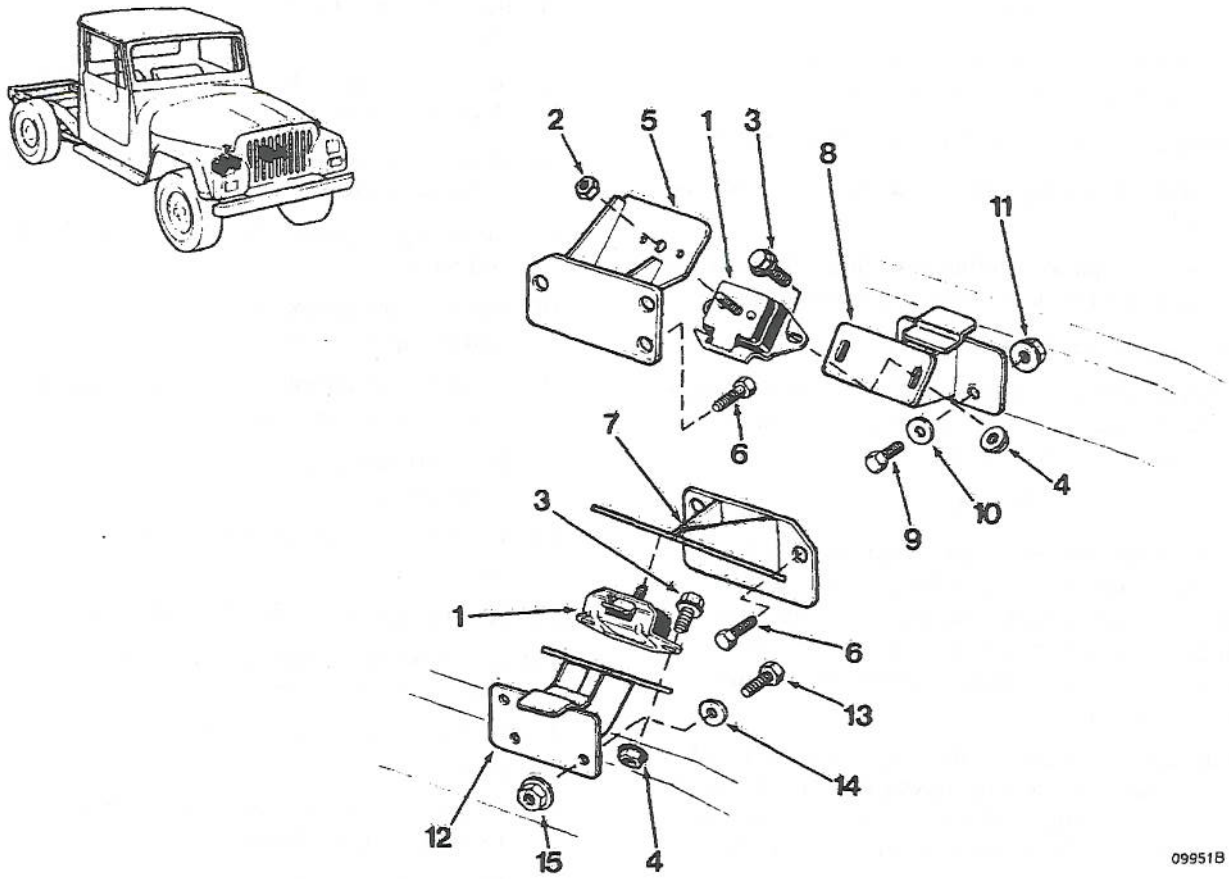
(2) Remove self-locking bolts (3) and hex nuts (4).

(3) Remove capscrews (9) and (13), lockwashers (10) and (14) and hex nuts (11) and (15). Remove mount assemblies (8) and (12).

(4) Remove locking hex nuts (2) and remove mounting pad (1).

(5) Remove screws and washers (6) and remove mounting brackets (5) and (7).

b. Cleaning and inspection. Refer to paragraphs 5-4.3 and 5-4.4 for general cleaning and inspection procedures.



1. Mounting Pad
2. Locking Hex Nut
3. Self-locking Bolt
4. Hex Nut
5. Mounting Bracket
6. Screw and Washer
7. Mounting Bracket
8. Mount Assembly
9. Capscrew
10. Lockwasher
11. Hex Nut
12. Mount Assembly
13. Capscrew
14. Lockwasher
15. Hex Nut

Figure 5-72. Front Engine Mounts Group

c. Repair and replacement. Replace all worn or damaged parts.

d. Assembly and installation. Assembly is accomplished during installation. Install front engine mounts group as follows:

(1) Install mounting brackets (5) and (7) using screws and washers (6).

(2) Install mounting pads (1) on mounting brackets (5) and (7) using locking hex nuts (2).

(3) Install mount assemblies (8) and (12) using capscrews (9) and (13), lockwashers (10) and (14) and hex nuts (11) and (15).

(4) Fasten mounting pads to mount assemblies (8) and (12) using capscrews (3) and hex nuts (4).

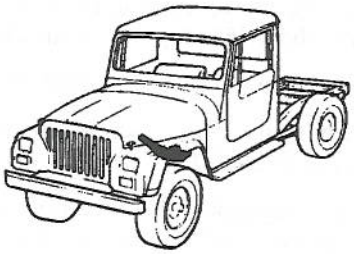
(5) Fasten mounting brackets (5) and (7) to engine using screws and washers (6).

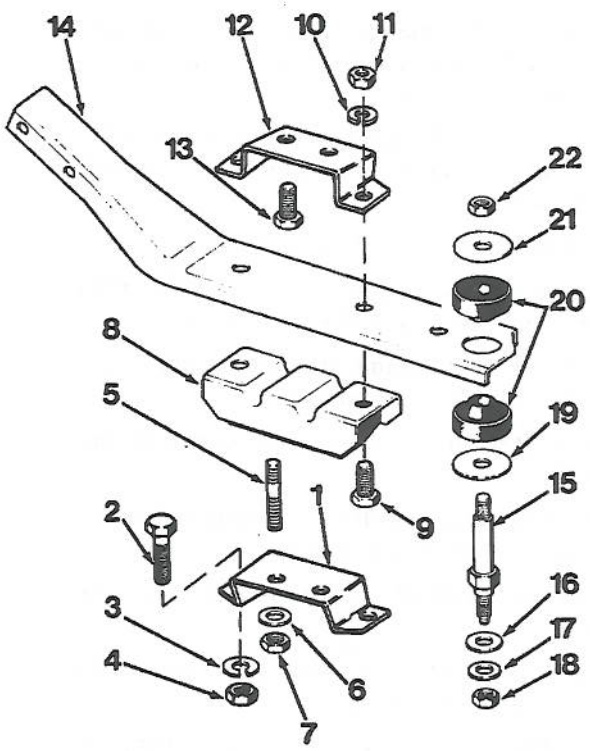
(6) Remove jack from under engine.

5-5.1.30 *Rear Engine Mounts Group*. Refer to figure 5-73, and perform the following steps to overhaul the rear engine mounts group.

a. Removal and disassembly. Disassembly is accomplished during removal. Remove rear engine mounts as follows:

(1) Support transmission with jack.





1. Transmission Support
2. Capscrew
3. Lockwasher
4. Hex Nut
5. Mounting Stud
6. Flat Washer
7. Lock Hex Nut
8. Insulator
9. Capscrew
10. Lockwasher
11. Hex Nut
12. Bracket
13. Capscrew
14. Bracket
15. Stud
16. Washer
17. Washer
18. Lock Hex Nut
19. Flat Washer
20. Upper Mount Insulator
21. Washer
22. Lock Hex Nut

Figure 5-73. Rear Engine Mounts Group

(2) Remove capscrews (13).

(3) Remove lock hex nut (22), flat washer (21) and upper mount insulator (20).

(4) Remove hex nuts (4), lockwashers (3) and capscrews (2).

(5) Remove hardware attaching angled end of bracket (14) to frame and remove bracket (14).

(6) Remove lower mount insulator (20) and flat washer (19).

(7) Remove lock hex nut (18) and flat washers (17) and (16); remove stud (15).

(8) Remove lock hex nut (7), flat washer (6) and transmission support (1).

(9) Remove mounting stud (5) from insulator (8).

(10) Remove hex nut (11), lockwasher (10), capscrew (9), insulator (8) and bracket (12).

b. Cleaning and inspection. Refer to paragraphs 5-4.3 and 5-4.4 for general cleaning and inspection procedures.

c. Repair and replacement. Replace all worn or damaged parts.

d. Assembly and installation. Assembly is accomplished during installation. Install rear engine mounts group as follows:

(1) Install insulator (8) and bracket (12) on bracket (14) using capscrew (9), lockwasher (10) and hex nut (11).

(2) Install mounting stud (5) in insulator (8).

(3) Install transmission support (1) on insulator (8) using flat washer (6) and lock hex nut (7).

(4) Install stud (15) in frame using flat washers (16) and (17) and lock hex nut (18).

(5) Install flat washer (19) and lower mount insulator (20).

(6) Install bracket (14) on frame. Attach angled end on frame using attaching hardware.

(7) Install capscrews (2), lockwashers (3) and hex nuts (4).

(8) Install upper mount insulator (20), flat washer (21) and lock hex nut (22).

(9) Fasten bracket (12) to transmission housing using capscrews (13).

5-5.1.31 *Fuel Tank Assembly Installation.* Refer to figure 5-74 and perform the following steps to repair the fuel tank assembly.

a. Removal and disassembly. Disassembly is accomplished during removal. Remove fuel tank assembly as follows:

(1) Raise back end of vehicle.

WARNING

Do not work under a raised vehicle without using safety jack stand or injury to personnel may occur.

(2) Remove filler cap (11). Remove plug (7) from beneath vehicle and drain fuel tank.

(3) Loosen hose clamp (2) and remove feed line (1) from elbow (6). Tape off feed line (1).

(4) Remove elbow (6) from fuel tank (12).

(5) Loosen hose clamp (4) and remove return line (3) from elbow (5). Tape off return line (3).

(6) Remove elbow (5) from fuel tank (12).

(7) Remove hex nut (18), capscrew (20), lockwasher (19) and loop clip (17).

(8) Refer to paragraph 5-5.1.13 and remove feed line (1) and return line (3) from fuel filter.

(9) Remove machine screws (9) and lockwashers (10) and remove sending unit and gasket (8).

(10) Remove hex nuts (16), lockwashers (15) and flat washers (14). Remove capscrews (13) and flat washers (14).

(11) Remove fuel tank (12) from vehicle.

b. Cleaning and inspection. Refer to paragraphs 5-4.3 and 5-4.4 for general cleaning and inspection procedures.

c. Repair and replacement. Replace all worn or damaged parts.

d. Assembly and installation. Assembly is accomplished during installation. Install fuel tank assembly as follows:

(1) Install fuel tank (12) in vehicle.

(2) Install capscrews (13) and flat washers (14). Install flat washers (14), lockwashers (15) and hex nuts (16).

(3) Install sending unit and gasket (8) using capscrews (9) and lockwashers (10).

(4) Refer to paragraph 5-5.1.13 and connect feed line (1) and return line (3) to fuel filter.

(5) Secure feed line (1) and return line (3) to body using loop clip (17), capscrew (20), lockwasher (19) and hex nut (18).

(6) Install elbow (5) in fuel tank (12).

(7) Install return line (3) on elbow (5) and tighten hose clamp (4).

(8) Install elbow (6) in fuel tank (12).

(9) Install feed line (1) on elbow (6) and tighten hose clamp (2).

(10) Install plug (7) in fuel tank (12) from beneath vehicle.

(11) Fill fuel tank (12) with fuel and install filler cap (11).