(5) Open gauge valve on pressure tester and operate pump to check pressure at which nozzle opens. Nozzle should open at pressure specified in table 6-1.

(6) Wipe nozzle tip dry and operate pump at 500 psi below opening pressure. Nozzle should not leak. Slight wetting is normal after about 10 seconds.

(7) Operate pump and inspect overflow valve connection. If excessive fuel leaks or if fuel surges when pump is cycled, replace nozzle and holder assembly (19).

e. Assembly and installation. Assembly is accomplished during installation. Install the injector nozzle and tubes as follows:

(1) Install gasket (20) on each of nozzle and holder assemblies (19).

(2) Use special tool #99724Z5000 to install hex nuts (12), gaskets (18) and nozzle and holder assemblies (19) on spill tube (11).

(3) Install injection tubes (5), (6), (7), (8), (9) and (10) with tube supports (2), (3) and (4) and three machine screws (1).

(4) Install fuel hose (13) from connector (17) to spill tube (11). Tighten hose clamps (14).

(5) Install valve (15), gaskets (16) and connector (17) on fuel filter.

5-5.1.16 *Oil Cooler and Filter Group*. Refer to figure 5-41, and perform the following steps to overhaul the oil cooler and filter group.

a. Removal. Remove oil cooler and filter group as follows:

(1) Remove screws and washers (27) and (28).

(2) Remove screws and washers (35) and (36), retainers (37), oil cooler assembly (25), cover gasket (33) and oil cooler pipe (34).

(3) Separate oil cooler pipe (34) and oil cooler assembly (25).

(4) Remove screw and washer (2), capscrew (3), lockwasher (4), bracket assembly (15), gasket (5) and filter assembly (1).

b. Disassembly. Disassemble oil cooler and filter group as follows:

(1) Remove screws and washers (26), (29), and (30) and clip (31).

(2) Remove hex nuts (44), lockwashers (45) and gaskets (46), and separate oil cooler element (47), oil cooler (32) and oil cooler housing (43).

(3) Remove screws and washers (39), connector (38) and gasket (40).

(4) Remove connector bolt (41) and gaskets (42).

(5) Loosen center bolt (7) and remove case (6) and element kit (8) from bracket (24).

(6) Remove preformed packing (12), oil filter element (11), inner bolt seal (10), outer bolt seal (9), spring retainer (14) and spring set (13).

(7) Remove plug valves (16), plug gaskets (17), valve springs (18) and valves (19).

(8) Remove plug valve (20), plug gasket (21), valve spring (22) and valve (23).

c. Cleaning and inspection. Refer to paragraphs 5-4.3 and 5-4.4 for general cleaning and inspection procedures. In addition, block one opening of the oil cooler element (47) with a suitable plug and immerse element (47) in water.

CAUTION

Do not use compressed air at a pressure higher than 140 psi or damage to oil cooler element may result.

(1) Apply compressed air to unplugged opening of oil cooler. If air bubbles appear, element (47) must be replaced.

(2) Check oil to see if it is dirty. If dirty, oil filter element (11) must be replaced.

(3) Check case (6) for cracks or other damage. If damaged, it must be replaced.

(4) Check seatings of valves (19) and (23). If valve seats or balls are scratched or if valve action isn't smooth, defective parts must be replaced.

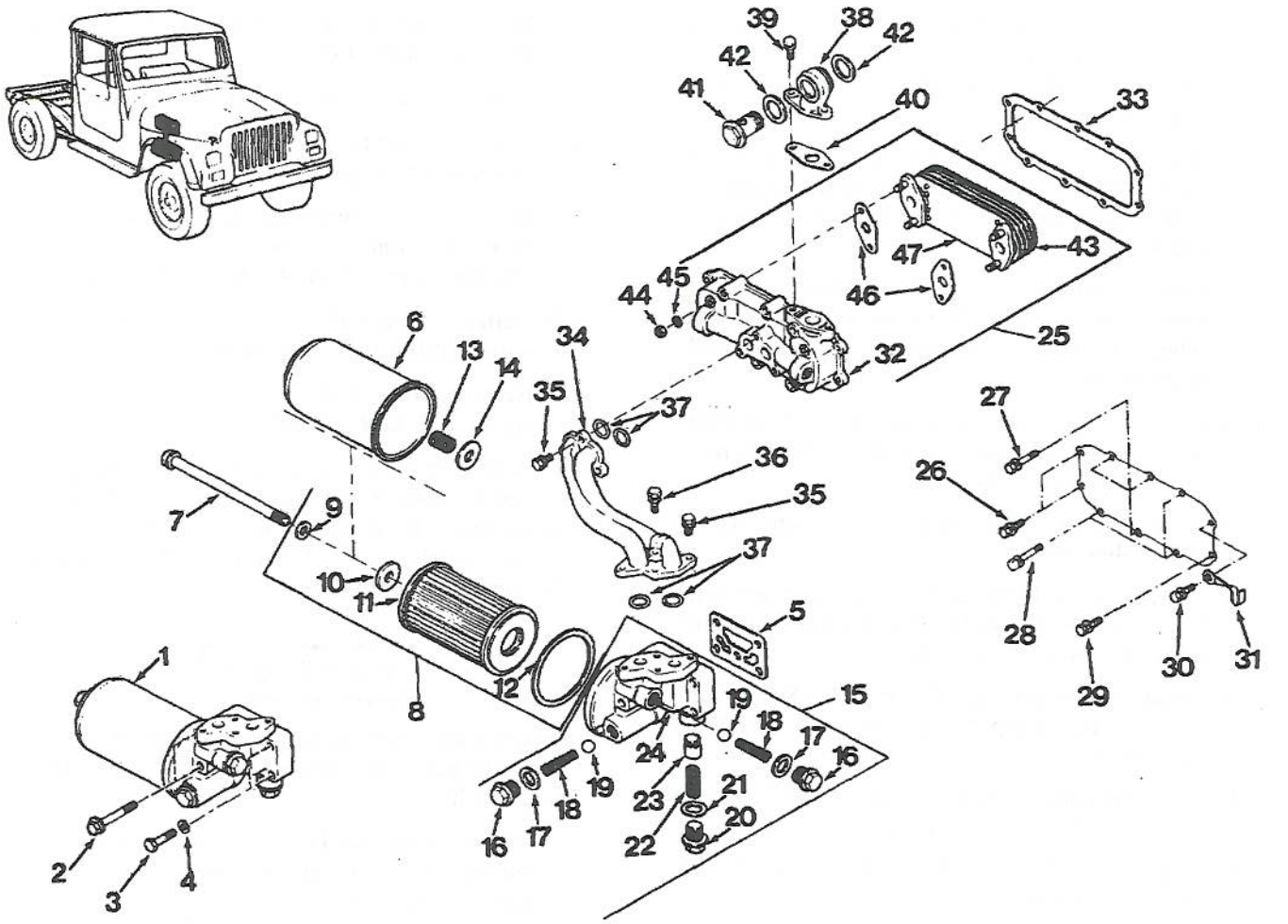
d. Repair and replacement. Replace all worn or damaged parts and those found defective during cleaning and inspection. In addition, perform the following steps:

(1) Replace preformed packing (12) and gaskets (17) and (21), regardless of condition.

(2) If oil filter time interval has elapsed, replace oil filter element (11). If oil is found to be dirty during cleaning and inspection, replace element (11) regardless of condition.

e. Assembly. Assemble oil cooler and filter group as follows:

(1) Install valve (23), valve spring (22), plug gasket (21) and plug valve (20) in bracket (24).



1. Filter Assembly
2. Screw and Washer
3. Capscrew
4. Lockwasher
5. Gasket
6. Case
7. Center Bolt
8. Element Kit
9. Outer Bolt Seal
10. Inner Bolt Seal
11. Oil Filter Element
12. Preformed Packing
13. Spring Set
14. Spring Retainer
15. Bracket Assembly
16. Plug Valve
17. Plug Gasket
18. Valve Spring
19. Valve
20. Plug Valve
21. Plug Gasket
22. Valve Spring
23. Valve
24. Bracket
25. Oil Cooler Assembly
26. Screw and Washer
27. Screw and Washer
28. Screw and Washer
29. Screw and Washer
30. Screw and Washer
31. Clip
32. Oil Cooler
33. Cover Gasket
34. Oil Cooler Pipe
35. Screw and Washer
36. Screw and Washer
37. Retainer
38. Connector
39. Screw and Washer
40. Gasket
41. Bolt
42. Gasket
43. Housing
44. Hex Nut
45. Lockwasher
46. Gasket
47. Element

Figure 5-41. Oil Cooler and Filter Group

(2) Install valves (19), valve springs (18), plug gaskets (17) and plug valves (16).

(3) Install center bolt (7) in case (6).

(4) Install spring set (13), spring retainer (14), outer bolt seal (9), inner bolt seal (10), oil filter element (11) and preformed packing (12) on center bolt (7) inside case (6).

(5) Install filter assembly (1) on bracket (24) and tighten center bolt to torque specified by table 6-2.

(6) Install connector bolt (41) and gasket (42) in connector (38).

(7) Install gasket (40) and connector (38) on oil cooler housing (43) using screw and washer (39).

(8) Install oil cooler element (47), oil cooler (32) and gaskets (46) in oil cooler housing (43).

(9) Install hex nuts (44), lockwashers (45), screws and washers (26), (29) and (30), and clip (31). Tighten screws (26), (29) and (30) to torque specified in table 6-2.

f. Installation. Install oil cooler and filter group as follows:

(1) Install bracket assembly (15), filter assembly (1) and gasket (5) using screw and washer (2), capscrew (3) and lockwasher (4).

(2) Install oil cooler assembly (25) and cover gasket (33) using screws and washers (27) and (28). Tighten screws (27) and (28) to torque specified by table 6-2.

(3) Install oil cooler pipe (34) and retainers (37), using screws and washers (35) and (36).

5-5.1.17 *Engine Front Cover Group*. Refer to figure 5-42, and perform the following steps to overhaul the engine front cover group.

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

(1) Remove screws and washers (8), spring washer (10), screws and washers (9) and timing gear cover (7) with cover gasket (11).

(2) Refer to paragraph 5-5.1.20 and remove timing assembly.

(3) Lock crankshaft pulley and remove crankshaft pulley nut.

(4) Remove cone bushing from crankshaft pulley and remove crankshaft pulley.

CAUTION

Do not scratch or nick the sealing edge of the oil seal.

(5) Remove screws and washers (3), (2), (4) and (5); and remove timing gear case (1) and gasket (15).

(6) Remove oil seal (6) from timing gear case (1).

(7) Remove screws and washers (13), cover (12) and gasket (14).

(8) Remove screws and washers (17), plate assembly (16) and front plate gasket (19).

(9) Remove injector pump bolt (18).

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. In addition, perform the following step:

(1) Measure plate assembly (16) warp. If measurement exceeds figure prescribed by table 6-1, replace plate assembly (16).

d. Assembly and installation. Assemble and install engine front end cover as follows:

(1) Install injector pump bolt (18) and tighten.

(2) Install front plate gasket (19) and plate assembly (16) using screw and washers (17). Tighten screws to torque specified by table 6-2.

(3) Install cover (12) and gasket (14) on timing gear case (1) using screws and washers (13).

(4) Install oil seal (6) on timing gear case (1).

(5) Install gasket (15) and timing gear case (1) using screws and washers (3), (2), (4), and (5). Tighten screws (3), (2), (4), and (5) to torque prescribed by table 6-2.

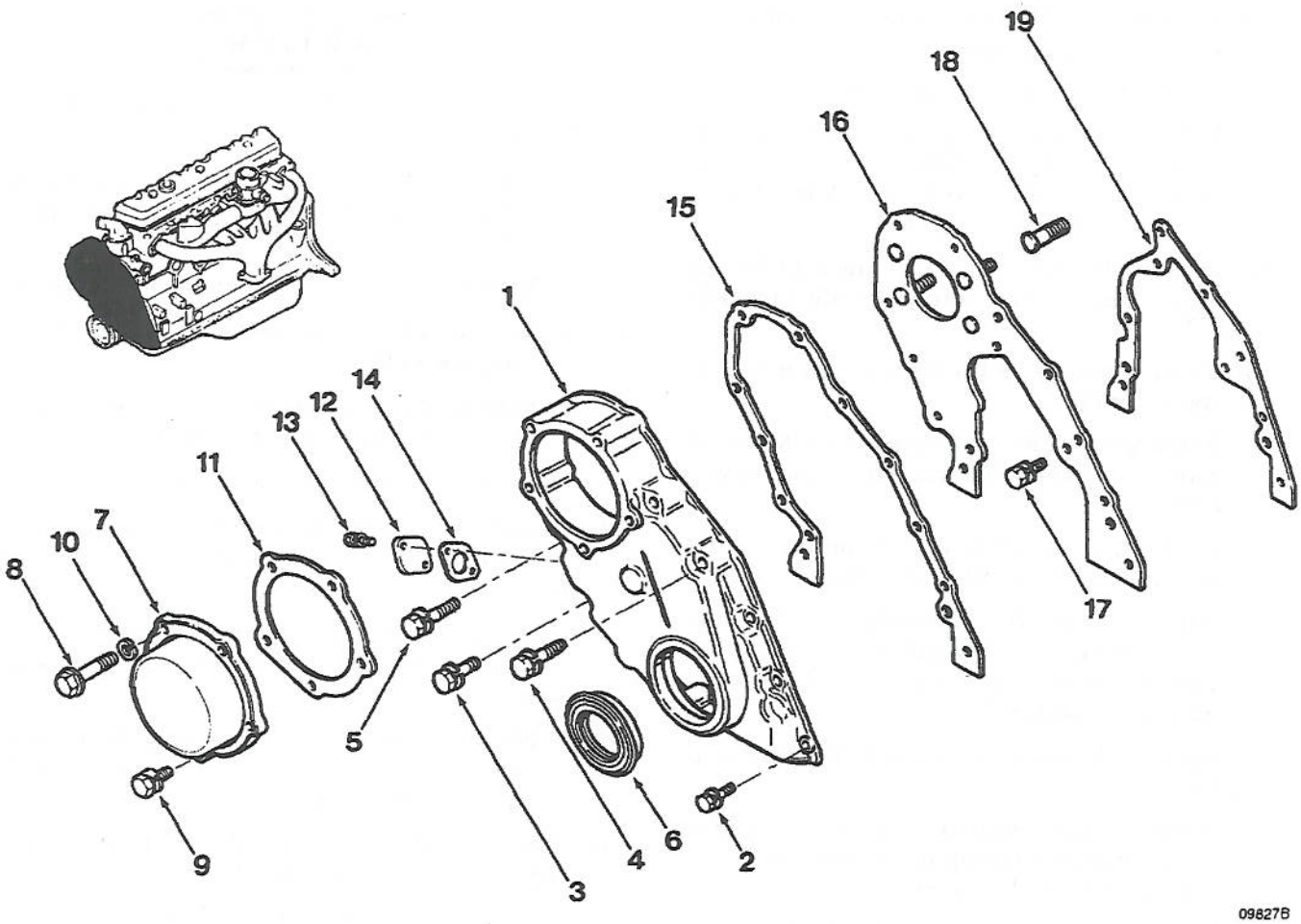
(6) Install cone bushing on crankshaft pulley.

(7) Install crankshaft pulley nut and tighten to torque prescribed by table 6-2.

(8) Unlock crankshaft.

(9) Install timing assembly according to procedures given in paragraph 5-5.1.20.

(10) Install cover gasket (11) and timing gear cover (7) using screw and washer (8), spring washer (10) and screw and washer (9).



1. Timer Gear Case
2. Screw W/Washer
3. Screw W/Washer
4. Screw W/Washer
5. Screw W/Washer
6. Oil Seal
7. Timing Gear Cover
8. Screw W/Washer
9. Screw W/Washer
10. Spring Washer
11. Cover Gasket
12. Cover
13. Screw W/Washer
14. Gasket
15. Gasket
16. Plate Assembly
17. Screw W/Washer
18. Injector Pump Bolt
19. Front Plate Gasket

Figure 5-42. Engine Front Cover Group

5-5.1.18. *Governor Assembly Installation.* Refer to figure 5-43, and perform the following steps to overhaul the governor assembly.

a. Removal and disassembly. Disassembly is accomplished during removal. Remove the governor assembly as follows:

(1) Remove nonmetallic hose (8) and nonmetallic hose (9) with hose clips (11) from governor tube (5).

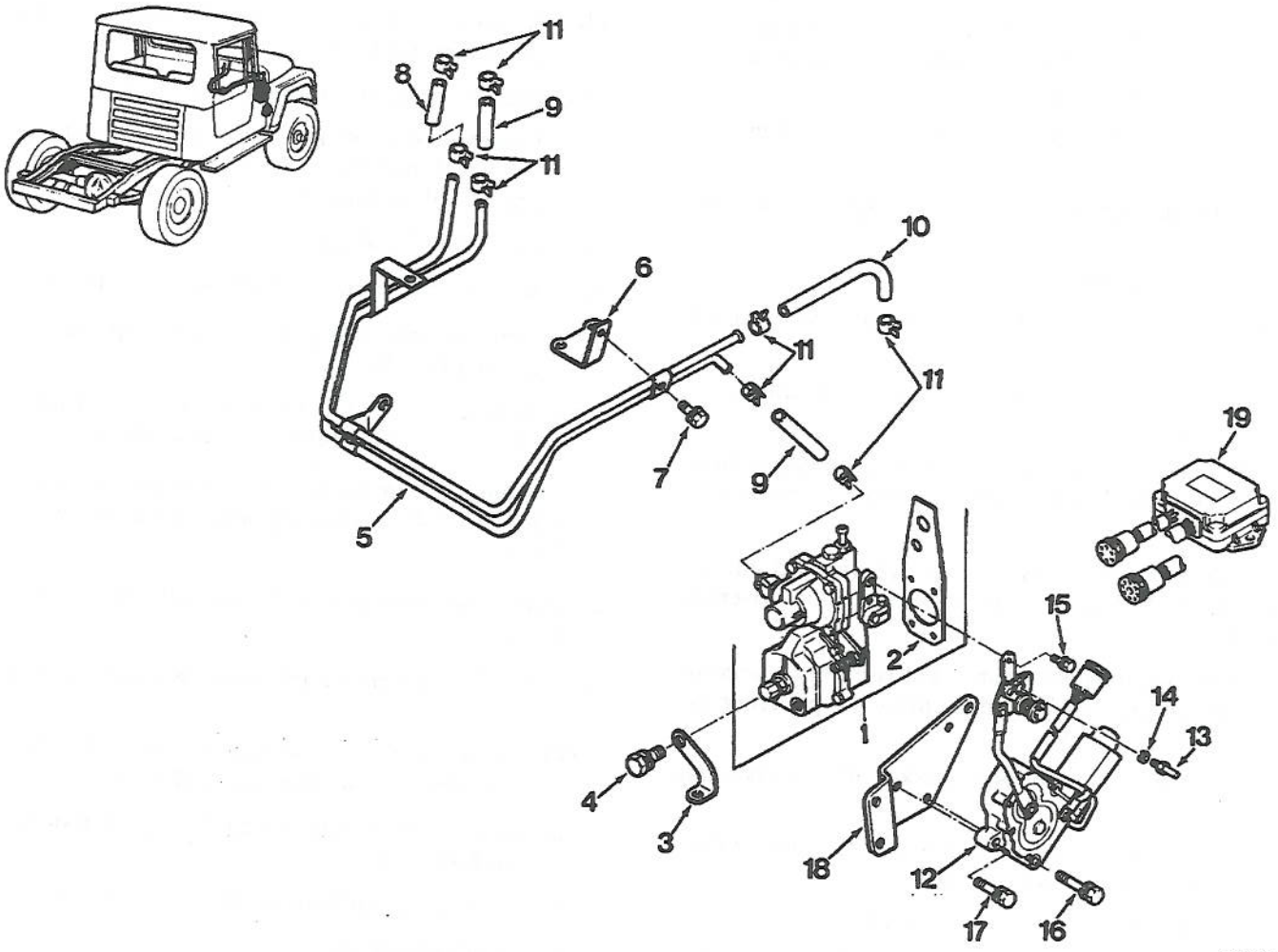
(2) Remove nonmetallic hose (9) and nonmetallic hose (10) with hose clips (11).

(3) Remove screw with washer (7) and tube bracket (6).

(4) Remove governor tube (5).

(5) Remove injection pump controller relay assembly (19).

(6) Remove controller bolt (13) and spring washer (14).



1. Governor Assembly
2. Gasket
3. Support
4. Screw W/Washer
5. Governor Tube
6. Bracket
7. Screw W/Washer
8. Hose
9. Hose
10. Hose
11. Hose Clip
12. Controller
13. Controller Bolt
14. Spring Washer
15. Screw W/Washer
16. Screw W/Washer
17. Screw W/Washer
18. Bracket
19. Relay Assembly

Figure 5-43. Governor Assembly Installation

(7) Remove screw and washers (15),(16) and (17), injection pump controller (12) and controller bracket(18).

(8) Remove screw and washer (4) and injection pump support (3).

(9) Remove governor assembly (1) and gasket (2).

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

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

f. Assembly and installation. Assembly is accomplished during installation. Install the governor assembly as follows;

(1) Install gasket (2) and governor assembly (1).

(2) Install injection pump support (3) and screw with washer (4).

(3) Install controller bracket (18) and injection pump controller (12), using screw and washers (15), (16) and (17).

(4) Install spring washer (14) and controller bolt (13).

(5) Install injection pump controller relay assembly (19).

(6) Install governor tube (5).

(7) Install tube bracket (6) and screw with washer (7).

(8) Install nonmetallic hose (9), nonmetallic hose (10) and hose clips (11).

(9) Install nonmetallic hose (8), nonmetallic hose clips (9) and hose clips (11) on governor tube (5).

5-5.1.19. *Governor Assembly*. Refer to figure 5-44, and perform the following steps to overhaul the governor assembly.

a. Removal and disassembly. Disassembly is accomplished during removal. Remove the governor assembly as follows:

(1) Remove cap nut (45), gasket (46) and hex nut (47).

(2) Remove screws (22), pin (23), capscrews (48) and push rod washer (50).

(3) Remove cover (25) and gasket (49).

(4) Remove screw (53), spring seat (54), spring (55) and shim (56).

(5) Remove spring seat (57), retaining ring (58), sleeve (59), nut (60) and spring washer (61).

(6) Remove flyweight assembly (62), housing capsule (19), nut (20), woodruff key (69) and impeller (68).

(7) Remove plug (29), nut (30) and capsule (31).

(8) Remove eye bolt (32), gaskets (33), and hose joint (34).

(9) Remove capscrews (27) and cover (26).

(10) Remove shim (35), governor spring (36) and stopper (37).

(11) Remove hex nut (43), spring washer (42), diaphragm screw (41), diaphragm washer (40), split pin (3) and diaphragm (38).

(12) Remove plugs (1) and gaskets (2).

(13) Remove capscrews (64), adapter (65) and hose joint (66).

(14) Remove split pin (3), washer (4), washer (5) and preformed packing (6).

(15) Remove governor housing shaft (17).

(16) Remove woodruff key (16), lever (67), spring (15), bushing (14), washer (4), washer (5) and preformed packing (6).

(17) Remove oil seal (18).

(18) Remove capscrews (63) and governor housing.

(19) Remove fork (24), push rod (52), spring (51) and washer (50).

(20) Remove screw (13), lever (9), bolt (11), washer (12), lever (10), spring (8) and bushing (7).

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

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

d. Assembly. Assemble governor assembly as follows:

(1) Install bushing (7), spring (8), lever (10), bolt (11), lever (9), washer (12) and screw (13).

(2) Install washer (50), spring (51), push rod (52) and fork (24).

(3) Install governor housing and capscrews (63).

(4) Install oil seal (18).

(5) Install preformed packing (6), washer (5), washer (4), bushing (14), spring (15), lever (67) and woodruff key (16).

(6) Install governor housing shaft (17).

(7) Install preformed packing (6), washer (5), washer (4) and split pin (3).

(8) Install hose joint (66), adapter (65) and capscrews (64).

(9) Install gaskets (2) and plugs (1).

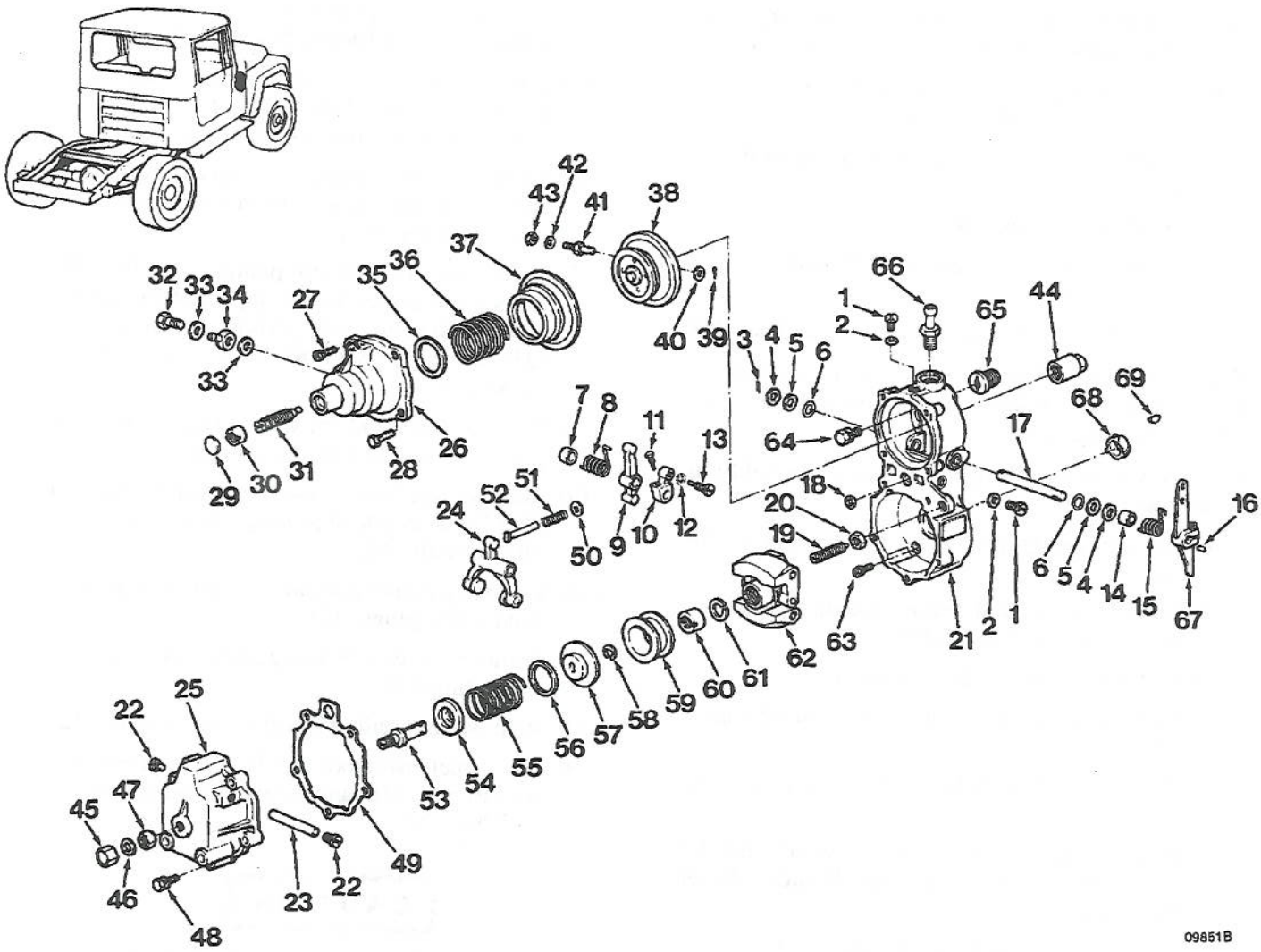
(10) Install diaphragm (38), split pin (3), diaphragm washer (40), diaphragm screw (41), spring washer (42) and hex nut (43).

(11) Install stopper (37), governor spring (36) and shim (35).

(12) Install cover (26) and capscrews (27).

(13) Install joint (34), gaskets (33) and eye bolt (32).

(14) Install capsule (31), nut (30) and plug (29).



1. Plug
2. Gasket
3. Pin
4. Washer
5. Washer
6. Preformed Packing
7. Bushing
8. Spring
9. Lever
10. Lever
11. Bolt
12. Spring Washer
13. Screw
14. Bushing
15. Shaft Spring
16. Woodruff Key
17. Shaft
18. Oil Seal
19. Screw Capsule
20. Nut
21. Housing Governor
22. Capscrew
23. Screw Capsule
24. Fork
25. Cover
26. Cover
27. Capscrew
28. Capscrew
29. Plug
30. Nut
31. Screw Capsule
32. Bolt
33. Gasket
34. Joint
35. Shim
36. Spring
37. Stopper
38. Cover
39. Pin
40. Washer
41. Screw
42. Washer
43. Hex Nut
44. Cap
45. Nut
46. Gasket
47. Hex Nut
48. Capscrew
49. Gasket
50. Washer
51. Spring
52. Pushrod
53. Flyweight Screw
54. Seat
55. Spring
56. Shim
57. Seat
58. Retaining Ring
59. Sleeve
60. Nut
61. Washer
62. Flyweight Assembly
63. Capscrew
64. Capscrew
65. Adapter
66. Joint
67. Lever
68. Impeller
69. Woodruff Key

Figure 5-44. Governor Assembly

(15) Install impeller (68), woodruff key (69), nut (20), capsule (19) and flyweight assembly (62).

(16) Install spring washer (61), nut (60), sleeve (59), retaining ring (58) and spring seat (57).

(17) Install shim (56), spring (55), spring seat (54) and screw (53).

(18) Install gasket (49) and cover (25).

(19) Install washer (50), capscrews (48), pin (23) and screws (22).

(20) Install hex nut (47), gasket (46) and cap nut (45).

5-5.1.20. *Injection Pump Assembly*. Refer to figure 5-45, and perform the following steps to overhaul the injection pump assembly.

a. Removal. Remove injection pump assembly as follows:

(1) Refer to paragraph 5-5.1.1 and remove air filter.

(2) Loosen capnuts and remove nozzle pipe assemblies and nozzle spill tube.

(3) Remove nozzle holder assemblies.

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

(5) Remove oil line between injector pump and engine block.

(6) Remove diesel pump control bracket and "E" clip to governor control arm. Remove diesel pump control.

(7) Remove injection pump assembly (1).

NOTE

Do not disassemble the injection pump unless steps 1-5 in paragraph c., Cleaning and Inspection, indicate overhaul is necessary.

b. Disassembly. If steps 1-5 of paragraph c., Cleaning and Inspection, indicate overhaul is necessary, disassemble the injection pump as follows.

(1) Place special wrench #J-57916-432 in hole in timer assembly (47) to prevent turning of camshaft (45), and use socket wrench #J57914-010 with L-type handle to remove timer assembly nut (58), spring washer (59) and injection pump gasket (60) from timer assembly (47).

(2) Lock camshaft (45) with special wrench #J57916-432 and screw projected portion of extractor tool #J-57926-511 into threaded hole at center of flyweight holder (57). Remove flyweight (56) and flyweight holder (57).

(3) Loosen hex nut (48) and remove springs (54), shims (55), flange (53), washer (52), shim (51), washer (50), lockplate (49) and nut (48).

(4) Mount injection pump assembly (1) in a vise and remove hex head capscrew (3), gasket (4) and pump cover (5).

(5) Turn camshaft (45) to lift plunger assembly (35) to top dead center. Insert tappet holder tool #J-57931-210 between tappet bolt (24) and hex nut (23) of each tappet (18). Disconnect cam and tappet (18).

(6) Remove hex head capscrews (62) from drive gear (61). Remove drive gear (61).

(9) Remove hex head capscrews (30) from cover (39). Press on side of bearing cover (39) to work off camshaft (45).

(10) Lay pump housing on side and remove recessed-head screw plugs (17).

(11) Remove screws (43) and gaskets (44) from center bushing (42).

(12) Remove camshaft (45) with center bushing (42).

(13) Use tappet insert tool #J-57921-012 to hold tappet assembly (18) and remove tappet holder tool #J-57921-210.

CAUTION

Perform procedure with care. Lay out parts on bench in proper order. Place serviceable plungers in proper plunger barrels and immerse in solvent.

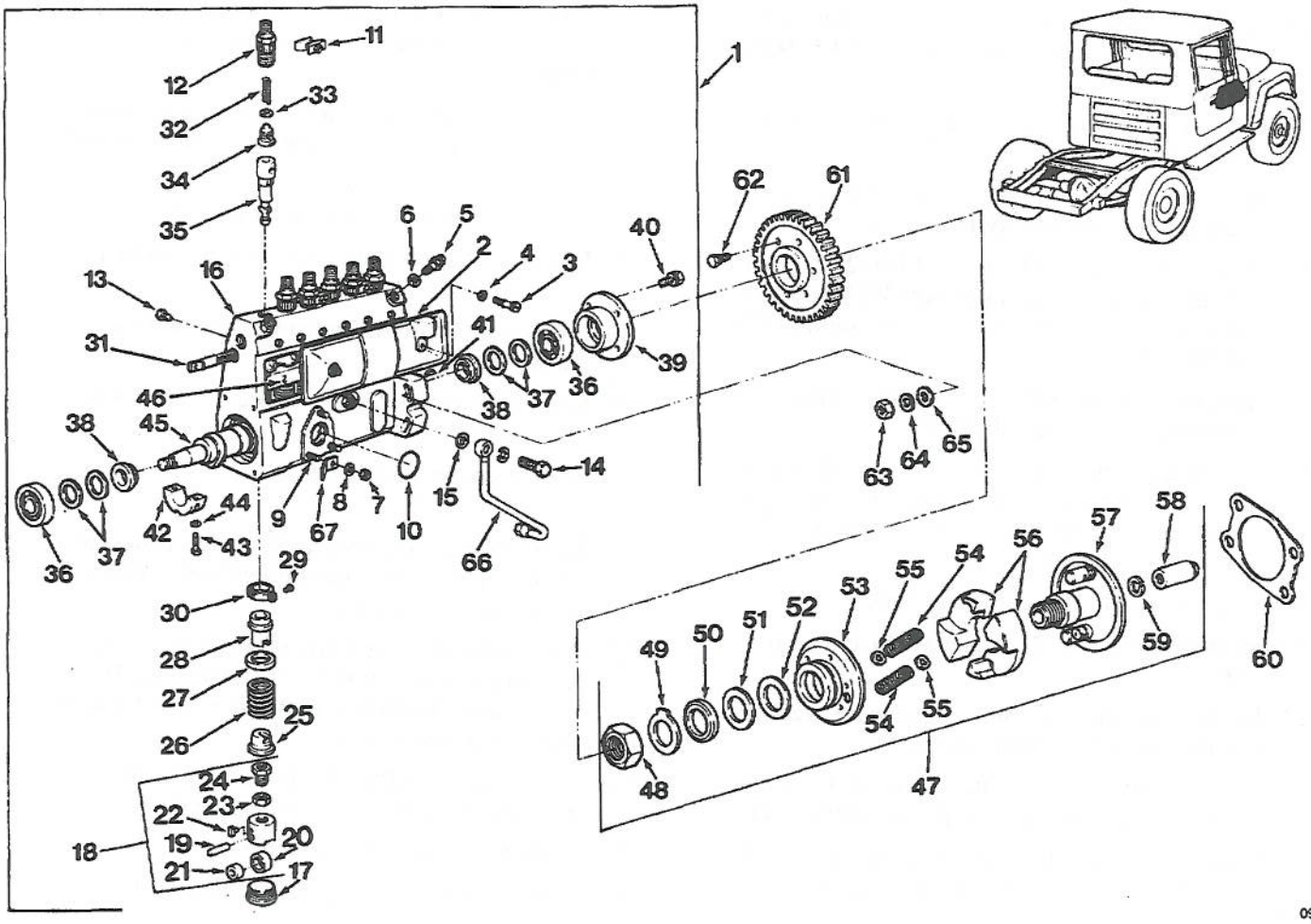
(14) Loosen tappet insert tool #J-57921-012, and withdraw tappet into camshaft chamber. Remove tappet assembly (18) with tappet clamp #J-57931-612.

(15) Remove plunger assemblies (35) with lower spring seats (25) using plunger insert tool J-57921-412.

(16) Remove plunger springs (26), upper spring seats (27), control sleeves (28), screws (29) and pinions (30).

(17) Place pump housing upright and remove clamp plate (11).

(18) Remove delivery holders (12) and springs (32).



1. Injection Pump Assembly
2. Pump Cover
3. Capscrew
4. Gasket
5. Air Bleed Bolt
6. Gasket
7. Hex Nut
8. Spring Washer
9. Stud
10. Preformed Packing
11. Clamp Plate
12. Delivery Holder
13. Rack Stop Screw
14. Eye Bolt
15. Gasket
16. Housing Assembly
17. Plug
18. Tappet
19. Pin
20. Roller
21. Bushing
22. Guide
23. Hex Nut
24. Tappet Bolt
25. Spring Seat
26. Plunger Spring
27. Spring Seat
28. Control Sleeve
29. Screw
30. Pinion
31. Control Rack
32. Spring
33. Gasket
34. Delivery Valve
35. Plunger Assembly
36. Bearing
37. Shim
38. Ring
39. Cover
40. Capscrew
41. Woodruff Key
42. Center Bushing
43. Screw
44. Gasket
45. Nut
46. Plate
47. Timer Assembly
48. Nut
49. Lockplate
50. Washer
51. Shim
52. Washer
53. Flange
54. Spring
55. Shim
56. Flyweight
57. Flyweight Holder
58. Timer Assembly Nut
59. Spring Washer
60. Injection Pump Gasket
61. Drive Gear
62. Capscrew
63. Hex Nut
64. Spring Washer
65. Plain Washer
66. Oil Tube
67. Clamp

Figure 5-45. Injection Pump Assembly

(19) Remove delivery valves (34) and gaskets (33) using delivery valve extractor tool #J-57920-032.

(20) From below, push plunger assemblies (35) up to remove.

(21) Remove rack stop screw (13) on rear of pump housing. Remove control rack (31).

(22) Using extractor tool #J-57920-032, remove bearing (36) from bearing cover (39) by threading in screw of extractor. Remove shims (37) and ring (38).

(23) Remove bearing (36), shims (37) and ring (38) from other end of camshaft (45).

(24) Remove, in sequence, guide (22), pin (19), bushing (21) and roller (20). Loosen hex nut (23) and remove tappet bolt (24) and hex nut (23) from tappet assembly (18).

(25) Remove air bleed bolt (5) and gasket (6).

(26) Remove eye bolt (14), gaskets (15) and oil tube (23).

(27) Remove O-ring (10), nuts (9), spring washers (8) and clamp (67) from studs (9).

(28) Remove nuts (63), spring washers (64) and washers (65) from injection pump assembly (1).

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

CAUTION

Do not allow cleaning fluid to get into delivery valve and other internal pump parts.

(1) Check pump housing for leaks caused by cracks.

(2) Check for leaks on upper face of pump housing due to faulty delivery valve gaskets.

(3) Check for smooth rotation of injection pump camshaft. Rough operation indicates bearing damage or broken plunger spring.

(4) Remove cover (5) and check interior of pump for presence of water.

NOTE

A small amount of fuel leaking past the clearance between injection pump plungers and plunger barrels is normal for lubricating parts.

(5) Check engine oil color, viscosity and odor to determine if fuel is leaking into the lubrication system. Check for leaks around the feed pump and for clearance between pump housing and plunger barrels.

(6) Check plunger barrel drum for proper contact with plunger barrel seating hole, damage and cracks.

(7) Measure tappet-to-housing clearance.

(8) Inspect cams on camshaft (A) for uneven or excessive wear.

(9) Inspect camshaft (45) threads, taper and oil seal seating surface.

(10) Inspect bearings (36) for wear or discoloration.

(11) Inspect center bushing (42) for wear or damage.

(12) Turn plunger assembly (35) upside down and tilt 60°. Let plunger slide through barrel. Plunger should slide smoothly.

(13) With finger blocking lower part of delivery valve seat, press down on delivery valve (34). If delivery valve (34) falls to seat and does not spring back up, piston is worn.

(14) Inspect tappet, roller (20), bushing (21), pin (19) and guide (22) for wear and damage.

(15) Measure tappet bolt (24) recess.

(16) Inspect control rack for warp and damage.

d. Repair and replacement. Replace all worn or damaged parts. If camshaft (45) end play exceeds specification, adjust as follows:

(1) Remove cover (39), bearing (36) and camshaft (45).

NOTE

Use same thickness of shims on each end of camshaft.

(2) Add or take away shims (37) to bring end play within specifications.

e. Assembly. Assemble injection pump as follows:

(1) Apply thin coat of engine oil to all moving parts.

(2) Apply nondrying liquid gasket material to injection pump housing and cover (39) interface.

(3) Clamp pump housing in universal vise.

(4) Turn plunger assembly (35) escape port toward front of pump housing and install plunger assembly (35) so that groove is aligned with knock pin in housing.

(5) Place gasket (33) on delivery valve (34) with gasket facing part down.

(6) Install delivery valve (34) on top of plunger assembly (35) and, using hammer and extractor tool #J-57920-032, lightly tap into seat.

(7) Set delivery valve springs (32) on delivery valves (34) and install delivery holders (12).

(8) Install clamp plates (11) and clamp delivery holders (12).

(9) Install control rack (31) so that end with hole is toward timer assembly (47). Install rack stop screw (13).

(10) With injection pump (1) on its side, position control rack (31) so that punch marks on both sides are same distance from each end of pump housing.

(11) With pump still on its side, place pinion (30) and screw (29) onto end of control sleeve (28) so that slot in bottom of sleeve faces straight up.

(12) Install spring seat (27) and plunger spring (26) onto plunger assembly (35).

NOTE

Plungers and barrels are precision matched. Make certain to maintain matches on installation.

(13) Insert the plunger insert tool #J-57921-412 into plunger assembly (35) and slowly install the plunger and spring seat (25) into the plunger barrel, with alignment mark toward front cover (2) side of injector pump housing.

(14) Install roller (20), bushing (21), pin (19) and guide (22) into tappet (18).

(15) Using tappet insert tool #J-57921-012, install tappet (18) from bottom of pump housing. Move control rack (31) in or out until L-shaped stem of plunger assembly (35) meets notch in control sleeve (28), then press tappet (18) into position. Insert tappet holder tool #J-57931-210 between tappet bolt (24) and hex nut (23).

(16) Position all tappets (18) and plunger assemblies (35) so that control rack (31) slides smoothly.

(17) Install ring (38), shims (37) and front bearing (36) onto camshaft (45).

(18) Install camshaft (45) with alignment mark toward timer assembly (47).

(19) Apply grease to center bushing (42) and install center bushing (42), gaskets (44) and screws (43).

(20) Install ring (38), shims (37), bearing (36), bearing cover (39) and hex head capscrews (40) on timer side of injection pump housing.

(21) Use dial indicator to measure end play at timer end of camshaft by pushing shaft away from timer.

(22) Install plugs (17) in bottom of injection pump housing.

(23) Install washer (52), shim (51), washer (50), lockplate (49), nut (48), and flange (53) on drive gear (61) with hex head capscrews (62).

(24) Install timer assembly (47), turn camshaft (45) and remove tappet holder tool #J-57921-210.

(25) Using spring balance, measure control rack (31) slide resistance with camshaft stopped. For all positions of camshaft, resistance should be less than 0.331 pound.

(26) Install woodruff key (41) in camshaft (35). Install springs (54), shims (55) and flyweights (56). Align flyweight (56) grooves with woodruff key (41).

(27) Install flyweight holder (57), timer assembly nut (58), spring washer (59) and injection pump gasket (60).

(28) Install gasket (6) and air bleed bolt (5).

(29) Install plain washers (65), spring washers (64) and hex nuts (63) on injection pump assembly (1).

(30) Install clamp (67), spring washers (8), hex nuts (7) and preformed packing (10) on studs (9).

(31) Install oil tube (66), gaskets (15) and eye bolt (14).

(32) Install hex head capscrews (3), gaskets (4) and pump cover (2).

f. Testing. Test the assembled injection pump as follows:

(1) Remove screws (3), gaskets (4) and pump cover (2).

(2) Remove timer assembly (47), hex head capscrews (62) and drive gear (61) from injection pump (1).

(3) Install injection pump (1) to bed of injection pump tester.

(4) Remove drive gear (61) from timer assembly (47) and install test coupling on timer assembly (47).

(5) Install timer assembly (47) on injection pump (1).

(6) Connect test coupling to drive shaft of tester, using coupling disc.

(7) Connect hose from tester to nozzles OSD193.

(8) Fill tester with JIS No. 2 light oil or Bosch OL6VII test oil at 95° to 113°F.

(9) Install injection pipe (length, 23.6 inches; outside diameter, 0.236 inch; inside diameter, 0.079 inch) on tester.

(10) Set tester nozzle injection pressure at 1422 psi and feed pump oil pressure at 22.8 psi.

(11) Remove control rack cover and install gauge to read control rack (31) movement.

NOTE

Fuel injection starting timing is defined as the instant the plunger barrel fuel intake port is cut off by the top of the plunger. It should be adjusted to a prescribed interval. To determine this interval with a tester, the injection pump tester feeds oil at a pressure of 426.7 to 497.8 psi through the fuel intake. This pressure is sufficient to overcome the force of the fuel injection pump spring (32) and to push the delivery valve up. The injection timing is then measured, based upon the fuel discharged from the test nozzle, and is adjusted to the proper injection timing.

(12) Attach lift gauge to tappet assembly (18) of the first cylinder from drive side.

(13) Lower tappet assembly (18) completely (bottom dead center of camshaft) and set dial gauge to zero.

(14) Bleed air from fuel system.

(15) Loosen ball valve of nozzle holder during test.

(16) Slowly turn pump tester by hand in direction of engine rotation until fuel flows from test nozzle. When fuel suddenly stops flowing, exact position for start of fuel injection has been reached.

(17) At this point, measure tappet assembly (18) lift from bottom dead center. If fuel does not stop flowing when tappet assembly (18) is lifted 0.091 to 0.094 inch, turn tappet bolt (24) to adjust timing.

(18) If fuel does not stop flowing when tappet (18) is lifted beyond 0.094 inch, loosen locknut and turn tappet bolt (24) counterclockwise to raise plunger.

(19) If fuel stops before tappet (18) is lifted to 0.091 inch, turn tappet bolt (24) clockwise to lower plunger.

(20) After adjustment, tighten tappet bolt (24).

(21) With cam at proper setting for cylinder number 1, set angle scale mark on tester flywheel at position for testing (0° or 180°).

(22) Use lever to turn tester flywheel 60° + 30° in direction of engine rotation. Fuel at number 4 cylinder should stop flowing. Adjust if necessary.

(23) Check and adjust fuel injection timing in cylinder firing order as follows:

Injection Order	1	4	2	6	3	5	1
Injection Internal	60°	60°	60°	60°	60°	60°	
Scale Plate Indication	0°	60°	120°	180°	240°	300°	360°

(24) After adjusting injection timing, check clearance between plunger piston pins and plunger barrels.

(25) Position cam at top dead center and lift gauge to contact tappet (18). Set gauge scale to zero.

(26) Lift tappet (18) with suitable tool until plunger contacts end of plunger barrel and tappet top clearance. Adjust if necessary.

g. Installation. Install injection pump assembly as follows:

(1) Install injection pump assembly.

(2) Install diesel pump control. Install "E" clip on governor control and install diesel pump control bracket.

(3) Install oil line between injection pump and engine block.

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

(5) Install nozzle holder assemblies.

(6) Install nozzle spill tube, install nozzle pipe assemblies and tighten capnuts.

(7) Refer to paragraph 5-5.1.1 and install air filter.

5-5.1.21 *Rocker Cover and Cylinder Head Group.* Refer to figure 5-46, and perform the following steps to overhaul the rocker cover and cylinder head group.

a. Removal. Remove rocker cover and cylinder head as follows:

(1) Remove capscrews (2), sealing washers (3) and rocker cover (1).

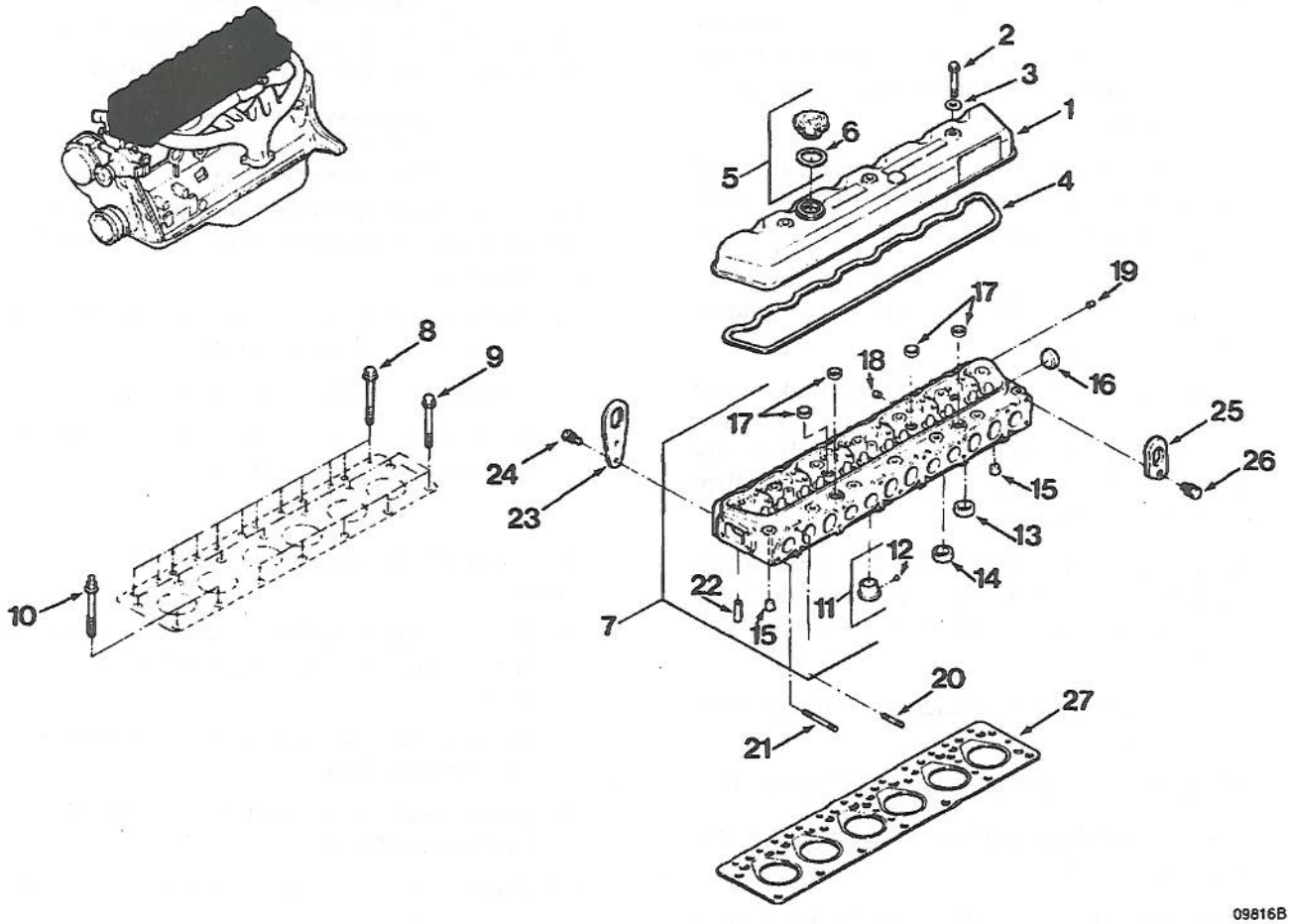
NOTE

Proceed from outside toward center of cylinder head when removing cylinder head screws.

(2) Remove screws (8), screws (9) and studs (10) from cylinder head (7).

(3) Remove cylinder head (7).

b. Disassembly. Disassemble rocker cover and cylinder head as follows:



1. Rocker Cover
2. Capscrew
3. Sealing Washer
4. Gasket
5. Oil Filler Cap Assembly
6. Gasket
7. Cylinder Head
8. Screw
9. Screw
10. Stud
11. Chamber
12. Dowel
13. Valve Seal
14. Valve Seal
15. Taper Plug
16. Welch Plug
17. Welch Plug
18. Blind Plug
19. Blind Plug
20. Stud
21. Stud
22. Pushrod Pipe
23. Slinger
24. Screw and Washer
25. Slinger
26. Screw W/Washer
27. Head Gasket

Figure 5-46. Rocker Cover and Cylinder Head Group

(1) Remove gasket (4), cap assembly (5) and gasket(6).

(2) Insert a 0.118 to 0.196 inch diameter bar into injector nozzle hole, and tap downward lightly to remove chambers (11). Mark chambers (11) by cylinder for proper reinstallation.

(3) Remove dowels (12).

(4) Clean carbon from valve ports.

(5) Insert removal tool #9969Z7000 in exhaust valve seats (13). Center tool over valve seat insert, and tighten lower nut while spreading pawls evenly around bore of insert until pawls are in firm contact with insert.

(6) Slide strip of copper or other soft metal under each leg of tool yoke to protect cylinder head (7), and tighten top nut of tool. Remove seat insert.

(7) Repeat steps 4 and 5 for each of six exhaust valve seats (13).

(8) Insert removal tool #9969Z7001 in intake valve seat (14). Center tool over valve seat insert, and tighten lower nut while spreading pawls evenly around bore of insert until pawls are in firm contact with insert.

(9) Slide strip of copper or other soft metal under each leg of tool yoke to protect cylinder head (7), and tighten top nut of tool. Remove seat insert.

(10) Repeat steps 4 and 5 for each of six intake valve seats (14).

(11) Remove taper plugs (15) and welch plug (16).

(12) Remove welch plugs (17), blind plugs (18) and blind plugs (19).

(13) Remove studs (20), stud (21) and push rod pipes (22).

(14) Remove slinger (23) and screws and washers (24).

(15) Remove slinger (25) and screw and washer (26).

(16) Remove head gasket (27).

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 step:

(1) Inspect intake valve seats (14), exhaust valve seats (13) and seat recesses for stake burrs or other damage.

d. Repair and replacement. Replace all worn or damaged parts. In addition, perform the following repair procedure:

(1) Remove valve seat stake burrs from intake valve seats (14) and exhaust valve seats (13).

e. Assembly. Assemble rocker cover and cylinder head as follows:

WARNING

Dry ice will cause low temperature burns (-80°). Temperature resistant gloves are required.

CAUTION

Do not apply excessive pressure when installing chambers. Chambers must be even with cylinder head.

(1) Chill chambers (11) in freezing solutions or dry ice for 5 to 10 minutes to shrink them.

(2) Install dowels (12) in chambers (11).

(3) Install chambers (11) by gently tapping into position or by using a press.

NOTE

Work quickly to maintain temperature differential.

(4) Shrink exhaust (13) and intake (14) valve seats in freezing solution or dry ice for 5 to 10 minutes.

(5) Install exhaust valve seats (13) with valve seat tool #99665Z7000.

(6) Install intake valve seats (14) with valve seat tool #99665Z7001.

(7) Stake exhaust valve seats (13) at five spots around seats.

(8) Install head gasket (27) on engine block so that the greater metal side faces up.

(9) Install slinger (25) and screw and washer (26).

(10) Install slinger (23) and screws and washers (24).

(11) Install studs (20), stud (21) and push rod pipes (22).

(12) Install blind plugs (19), blind plugs (18) and welch plugs (17).

(13) Install welch plug (16) and taper plugs (15).

(14) Install gasket (6), cap assembly (5) and gasket (4).

f. Installation. Install rocker cover and cylinder head as follows:

(1) Install cylinder head on gasket with studs (10).

(2) Coat screws (8) and screws (9) with engine oil.

(3) Install screws (8) and screws (9) in the sequence shown in figure 5-47. Tighten to torque values specified in table 6-2.

(4) Install rocker cover (1), sealing washers (3) and capscrews (2).

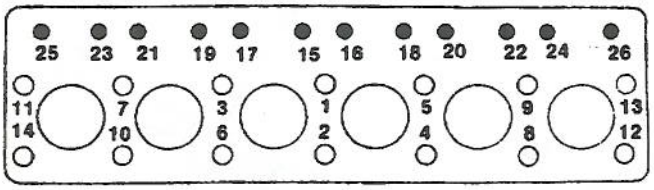


Figure 5-47. Cylinder Head Torque Sequence

5-5.1.22 *Camshaft and Valve Train Group.* Refer to figure 5-48, and perform the following steps to overhaul the camshaft and valve train group.

a. Removal. Remove camshaft and valve train as follows:

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

NOTE

Rocker arm and related parts may be removed as an assembly and disassembled at a later time.

(2) Remove rocker arm assembly.

(3) Remove nuts (26), adjusting screws (27) and push rods (28).

(4) Measure backlash between crankshaft gear and camshaft gear (7). Record value for future reference.

(5) Insert socket wrench through holes in camshaft gear (7) and idler gear (1) and remove two screws with washers (9) from locating plate (8).

(6) Remove camshaft (11) and locating plate (8) from block.

(7) Remove valve lifters (29).

b. Disassembly. Disassemble camshaft and valve train as follows:

NOTE

Before disassembling the camshaft, use feeler gauge to measure clearance between locating plate and camshaft gear.

(1) Clamp camshaft in protected jaws of bench vise.

(2) Remove capscrew (3), washer (5) and spring washer (4).

(3) Remove screws with washers (2), idler gear (1), straight pin (6) and camshaft gear (7).

(4) Remove locating plate (8) and woodruff key (10).

(5) Remove split pins (16), rocker washers (17), outside springs (18) and inside springs (19) from rocker arm assembly.

(6) Remove bolts (13), spring washers (15) and washers (14).

(7) Using split collar tool #99624Z7000, compress valve springs (33) and remove split collars (30).

(8) Remove exhaust valves (34), inlet valves (35), valve springs (33), valve stem seals (32) and retainers (31).

CAUTION

Do not use force to remove rocker brackets. Warm entire assembly to 158°F to free up brackets.

(9) Remove rocker arm A (24), rocker arm B (23), rocker arm C (21), rocker arm D (20), rocker brackets (12), inside springs (22) and inside springs (19).

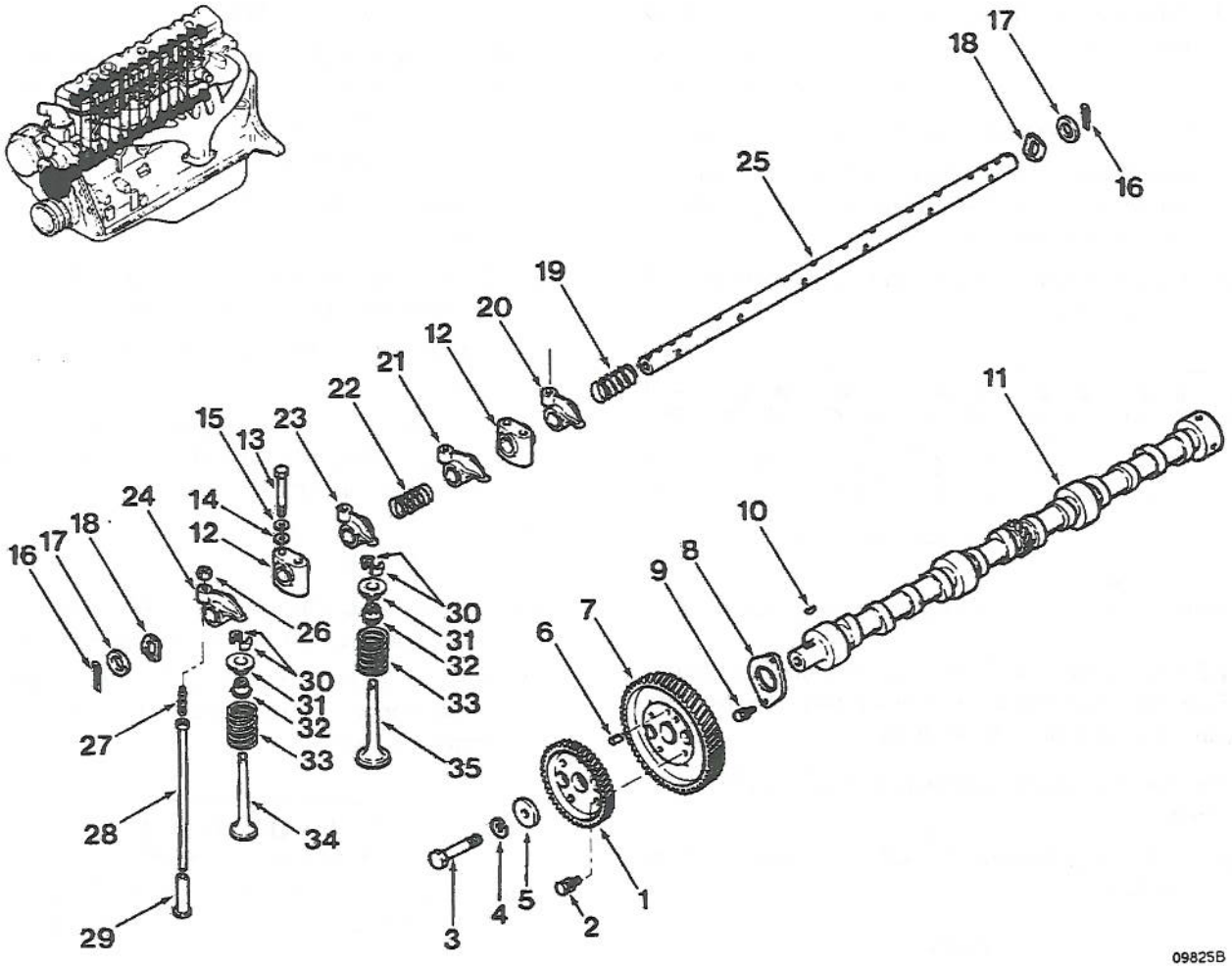
(10) Remove rocker shaft (25).

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:

(1) Inspect contact surfaces of rocker valves (24) through (20) for damage and wear.

(2) Measure inside diameter of rocker valves (24) through (20) and outside diameter of rocker shaft (25). Difference should not exceed figure specified by table 6-1.

(3) Support rocker shaft (25) horizontally and measure bend. One-half dial indicator deflection represents actual bend. Bend should not exceed figure specified by table 6-1.



1. Idler Gear
2. Screw W/Washer
3. Capscrew
4. Spring Washer
5. Plain Washer
6. Straight Pin
7. Camshaft Rear
8. Locating Plate
9. Screw W/Washer
10. Woodruff Key
11. Camshaft
12. Rocker Bracket
13. Capscrew
14. Plain Washer
15. Spring Washer
16. Split Pin
17. Rocker Washer
18. Outside Spring
19. Inside Spring
20. Rocker Valve D
21. Rocker Valve C
22. Inside Spring
23. Rocker Valve B
24. Rocker Valve A
25. Rocker Shaft
26. Hex Nut
27. Adjusting Screw
28. Push Rod
29. Valve Lifter
30. Split Collar
31. Retainer
32. Seal
33. Valve Spring
34. Valve
35. Valve

Figure 5-48. Camshaft and Valve Train Group

(4) Inspect push rods (28) and contact surfaces for wear or damage.

(5) Use a flaw detector or red check to check camshaft for cracks.

(6) Measure camshaft lobe height. Height should exceed figure specified by table 6-1.

(7) Support camshaft (11) horizontally and measure bend. One-half dial indicator deflection represents actual bend. Bend should not exceed figure specified by table 6-1.

(8) Check idler gear (1) and camshaft gear (7) for worn, damaged or broken teeth and for cracked ribs.

(9) Place woodruff key (10) in keyway. Inspect for play.

(10) Measure clearance between rocker shaft (25) and rocker valves (24) through (20).

(11) Measure outside diameters of lifter valve (29) and inside diameter of lifter bores in block.

d. Repair and replacement. Replace all worn or damaged parts. In addition, make the following repairs or replacements:

(1) If camshaft bend exceeds figure specified by table 6-1, straighten camshaft to bring it to within bend range specified by table 6-1.

(2) If backlash between camshaft gears (7 and 1) and crankshaft gears measured during disassembly exceeds figure specified by table 6-1, replace both gears to bring backlash into tolerance range.

(3) If difference between outer diameters of lifter valves (29) and inner diameters of lifter valve bores exceeds figure specified by table 6-1, replace lifter valves (29).

CAUTION

Do not apply heat to straighten shaft.

(4) If rocker shaft (25) bend exceeds figure specified by table 6-1, straighten shaft in press.

(5) If difference between inside diameter of rocker valves (24) through (20) and outside diameter of rocker shaft (25) exceeds figure specified by table 6-1, replace either or both parts.

(6) Remove any burrs from valve seats.

CAUTION

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

(7) Replace idler gear (1) and/or camshaft gear (7) if chipped or broken teeth exist or if ribs are cracked.

e. Assembly. Assemble the camshaft and valve train as follows:

(1) Apply engine oil to the sliding surfaces of each component.

WARNING

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

(2) Use compressed air to blow away any traces of dirt from surfaces that contact the cylinder head and bolt holes.

CAUTION

Do not force rocker shaft brackets onto rocker shaft. If brackets are difficult to install, warm them to 158°F before assembly.

(3) Refer to figure 5-49, and install rocker valves (20), (21), (23), and (24), inside springs (22) and (19) and rocker brackets (12) on rocker shaft (25) in order shown.

(4) Install inside springs (19), outside springs (18) and split pins (16).

(5) Insert push rods (28) into valve lifters (29) with round ends down.

(6) Install push rods (28) into rocker valves (20), (21), (23), and (24) with adjusting screws (27) and hex nuts (26).

(7) Install inlet valves (35) and exhaust valves (34) in proper cylinders.

(8) Install valve springs (33).

(9) Using valve stem seal replacer tool #99674Z7000, install valve stem seals (32) on valves (35) and (34).

(10) Install retainers (31) on valves (35) and (34).

(11) Compress valve springs (33) and install split collars (30) using split collar tool #99624Z7000.

(12) Install rocker shaft assembly and tighten capscrews (13) finger tight.

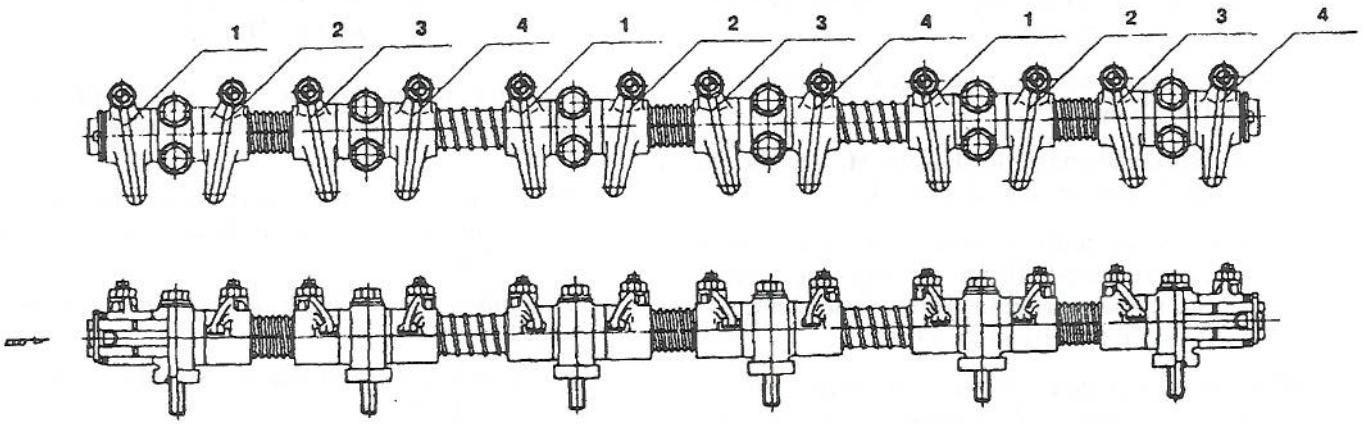


Figure 5-49. Rocker Arm, Assembled

(13) Rotate engine while observing movement of push rod (28) and rocker valves (20), (21), (23), and (24). Correct installation of any push rod (28) that does not properly seat in valve lifters (29).

(14) Starting with inside capscrew, tighten capscrews (13) to torque prescribed by table 6-2 from inside to outside.

(15) Rotate crankshaft until both push rods of number 1 piston have free play. Number 1 piston is at TDC.

(16) Adjust exhaust valve (34) clearance for cylinders 1, 2 and 4 to zero. Adjust inlet valve (35) clearance for cylinders 1, 3 and 5 to zero. Perform steps (18) through (21) for the valves listed in this step.

(17) Loosen hex nut (26) on adjusting screw (27).

(18) Insert feeler gauge between valve stems (35) and (34) and rocker valves (24) through (20) when engine is cold. Measure clearance.

(19) Turn adjusting screw (27) until feeler gauge encounters some resistance when withdrawn.

(20) Hold adjusting screw (27) steady, tighten nut (26) and recheck clearance.

(21) Rotate crankshaft one complete turn to bring piston number 6 to TDC.

(22) With piston number 6 at TDC, adjust inlet valve (12) clearance for cylinders 2, 4 and 6 to zero. Adjust exhaust valve (34) clearance for cylinders 3, 5 and 6 to zero.

(23) Repeat steps (18) through (21) for the valves listed in step (22).

(24) Install locating plate (8) and woodruff key (10) on camshaft (11).

(25) Install straight pin (6), four screws with washers (2) and idler gear (1) on camshaft gear (7).

(26) Install washer (5), spring washer (4) and capscrew (3). Tighten capscrew (3) to torque specified by table 6-2.

f. Installation. Install camshaft and valve train as follows:

(1) Install valve lifters (29).

(2) Install camshaft (11) into engine block.

(3) Install screws with washers (9) through holes in idler gear (6) and camshaft gear (7) into locating plate (8) with a socket. Tighten screws to torque prescribed by table 6-2.

(4) Install rocker arm assembly with washers (14), spring washers (15) and capscrews (13).

5-5.1.23 *Diesel Preheating Group*. Refer to figure 5-50, and perform the following steps to overhaul the diesel preheating group.

NOTE

Disconnect battery before performing maintenance/repair to the electrical system.

a. Removal and disassembly. Disassembly is accomplished during removal. Remove (diesel preheating group as follows:

NOTE

Steps 3, 4 and 6 are not required for vehicles with glow plug controllers located inside under dash assembly.

(1) Remove nuts connecting cable assembly electrical leads.

(2) Remove glow plugs (1) and cable assembly (2) from cylinder head.

(3) Remove hex nuts and washers (5) and capscrews (4); remove control splash cover (3) from right-front inner fender panel.

(4) Remove beveled grommet (7) from control splash cover (3), and slide grommet (7) off wire.

(5) Disconnect glow plug controller (8) wiring connector.

(6) Remove splash cover gasket (6) from control splash cover (3).

(7) Remove hex nuts and washers (5) and capscrews (4) from glow plug controller (8).

(8) Remove glow plug controller (8) from right front inner fender panel or inside under dash assembly.

(9) Disconnect wiring harness from glow plug relay (9).

(10) Remove hex nuts and washers (5) and capscrews (10) from glow relay (9); remove glow relay (9) from right-front fender panel.