

COMPRESSION PRESSURE

Compression pressure may be checked to establish relative condition of engine before proceeding with engine disassembly. Engine should be run briefly to ensure there is a normal fill of oil on rings and cylinder before checking pressure. Remove injector and install Deutz special adapter 100 080 with pressure gage. Cranking speed must be at least 150 rpm. Compression pressure should be 1900-2100 kPa (275-305 psi).

VALVE ADJUSTMENT

Valve clearance should be adjusted with engine cold. Recommended clearance is 0.15 mm (0.006 inch) for intake and 0.20 mm (0.008 inch) for exhaust.

To adjust clearance, remove rocker cover and rotate crankshaft until piston is at TDC on compression stroke. Loosen rocker arm adjusting screw locknut. Turn adjusting screw as required until appropriate size feeler gage can be inserted between valve and rocker arm with a slight drag. Tighten locknut and recheck clearance.

On hand-start engines, a decompression device is fitted to cylinder head to partially open the intake valve during engine starting. With intake valve closed and decompression device in disengaged position, measure clearance between stop pin of rocker arm and decompressor cam with a feeler gage. Clearance should be 0.7 mm (0.027 inch). If necessary, adjust stop pin to obtain desired clearance. To check decompressor operation, measure distance from rocker arm to top of rocker arm housing with decompressor engaged and disengaged. The difference between the two readings is distance valve is being opened which should be 0.4-0.6 mm (0.016-0.023 inch).

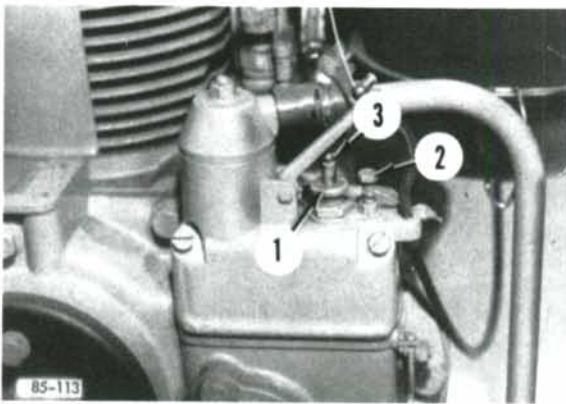


Fig. D1-3—Idle speed is adjusted using screw (1) and maximum speed is adjusted using screw (2). Be sure governor rod (3) moves freely.

temperature and an accurate tachometer used when adjusting engine speed setting. The engine speed settings depend on the engine application. Recommended engine speed should be stamped on the engine nameplate.

Low idle speed is normally 800-1000 rpm. Idle speed is adjusted using adjusting screw (1—Fig. D1-3). Note that some engines are not equipped with a low idle adjusting screw.

Maximum speed is adjusted using adjusting screw (2). Maximum rated speed must not exceed 3600 rpm on F1L 208 D engine or 3000 rpm on F1L 210 D engine. Be sure to install a new seal wire on maximum speed screw to secure adjustment.

INJECTION PUMP TIMING. To check injection pump static timing, first turn crankshaft in normal direction until piston is on compression stroke. Disconnect fuel inlet pipe and injector high pressure pipe from injection pump. Connect a nozzle tester pump to fuel inlet of injection pump and attach a drip tube to high pressure outlet of pump. Move speed control lever to full-speed position. Do not actuate excess fuel starting button. Actuate tester pump and note that fuel should flow from drip tube. Slowly rotate crankshaft until fuel flow from injection pump outlet just stops. AT this point beginning of injection occurs, and timing marks on crankshaft pulley and front cover should be aligned as shown in Fig. D1-4.

Injection timing is adjusted by changing thickness of pump mounting shims. Reducing shim thickness will advance timing and increasing shim thickness will retard timing.

Connecting rod:	
F1L 208 D.....	35 N·m (26 ft.-lbs.)
F1L 210 D.....	45 N·m (33 ft.-lbs.)
Cylinder head:	
F1L 208 D.....	40 N·m (30 ft.-lbs.)
F1L 210 D.....	55 N·m (40 ft.-lbs.)
Crankshaft pulley.....	40 N·m (30 ft.-lbs.)
Flywheel:	
F1L 208 D.....	160 N·m (118 ft.-lbs.)
F1L 210 D.....	180 N·m (133 ft.-lbs.)
Front cover.....	23 N·m (17 ft.-lbs.)
Injection pump.....	23 N·m (17 ft.-lbs.)
Injector.....	35 N·m (26 ft.-lbs.)
Main bearing flange.....	35 N·m (26 ft.-lbs.)
Oil sump.....	23 N·m (17 ft.-lbs.)
Rocker arm bracket.....	30 N·m (22 ft.-lbs.)
Rocker cover.....	23 N·m (17 ft.-lbs.)

REPAIRS

TIGHTENING TORQUES

Refer to the following table for special tightening torques. Metric fasteners are used throughout the engine.

Fig. D1-4—At beginning of injection, timing marks should be aligned as shown.



CYLINDER HEAD AND VALVE SYSTEM

To remove cylinder head, first remove fuel tank (if equipped), air cleaner and exhaust pipe. Remove injector pipe and injector. Remove rocker cover, rocker arm bracket and push rods. Remove stud nuts and lift off cylinder head. Remove valves from cylinder head and inspect all parts for wear or other damage. Cylinder head is equipped with renewable valve seat inserts and valve guides. Refer to Fig. D1-5.

Valve face and seat angles are 45° for intake and exhaust. Renew valve if head margin is less than 0.7 mm (0.027 inch). Refer to the following table for valve and valve guide dimensions.

F1L 208 D

Intake:

Valve stem OD.	6.953-6.975 mm (0.2737-0.2746 inch)
Valve guide ID.	7.00-7.015 mm (0.2756-0.2762 inch)
Clearance-desired.	0.025-0.062 mm (0.0010-0.0024 inch)
Wear limit.	0.12 mm (0.005 inch)

Exhaust:

Valve stem OD.	6.938-6.960 mm (0.2732-0.2740 inch)
Valve guide ID.	7.00-7.015 mm (0.2756-0.2762 inch)
Clearance-desired.	0.040-0.077 mm (0.0016-0.0030 inch)
Wear limit.	0.15 mm (0.006 inch)

F1L 210 D

Intake:

Valve stem OD.	7.953-7.975 mm (0.3131-0.3140 inch)
Valve guide ID.	8.00-8.015 mm (0.3150-0.3155 inch)
Clearance-desired.	0.025-0.062 mm (0.0010-0.0024 inch)
Wear limit.	0.12 mm (0.005 inch)

Exhaust:

Valve stem OD.	7.938-7.960 mm (0.3125-0.3134 inch)
Valve guide ID.	8.00-8.015 mm (0.3150-0.3155 inch)
Clearance-desired.	0.040-0.077 mm (0.0016-0.0030 inch)
Wear limit.	0.15 mm (0.006 inch)

Valve guides should have an interference fit in cylinder head bores of 0.027-0.055 mm (0.001-0.002 inch). Guides with 0.02 mm (0.0008 inch) oversize outside diameter are available for F1L 210 D engines. Use suitable tools to remove and install valve guides.

Cylinder head should first be heated to 240°-260°C (465°-500°F). Press new guides in until snap ring contacts cylinder head surface. Be sure guides are installed with chamfered end facing outward. After installation, guide bore must be reamed to provide recommended clearance for valve stem.

NOTE: When renewing valve guides and valve seat inserts, both operations should be performed together so cylinder head is heated only once.

When renewing valve seat inserts, suitable tools must be used to avoid damage to cylinder head. Grind valve seats to obtain recommended valve seating width of 0.8-1.0 mm (0.031-0.039 inch). Maximum allowable seat width is 1.5 mm (0.059 inch).

Install valves and measure distance top of valve head is recessed below surface of cylinder head. Distance should be 0.8-1.0 mm (0.031-0.039 inch) with a maximum limit of 2.0 mm (0.079 inch). If recession is excessive, renew valve seat. If recession is less than specified, grind valve seat as necessary.

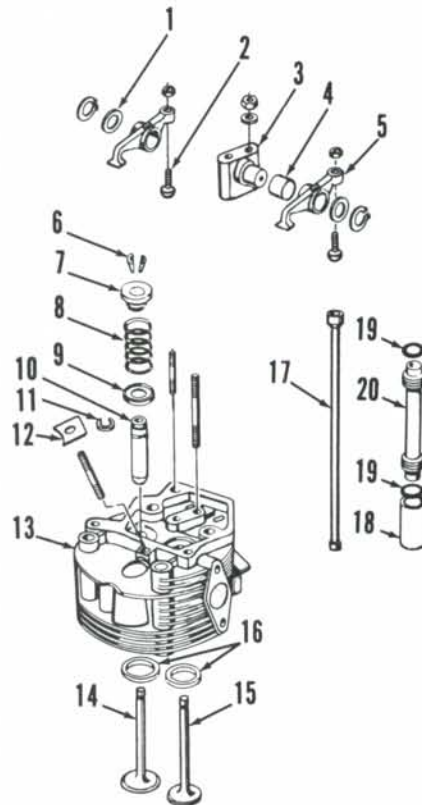


Fig. D1-5—Exploded view of cylinder head and valve system

- | | |
|-----------------------|-----------------------------|
| 1. Washer | 11. Snap ring |
| 2. Adjusting screw | 12. Injector retainer plate |
| 3. Rocker arm bracket | 13. Cylinder head |
| 4. Bushing | 14. Intake valve |
| 5. Rocker arm | 15. Exhaust valve |
| 6. Valve keepers | 16. Valve seat inserts |
| 7. Spring retainer | 17. Push rod |
| 8. Valve spring | 18. Cam follower |
| 9. Spring seat | 19. Gasket |
| 10. Valve guide | 20. Push rod tube |

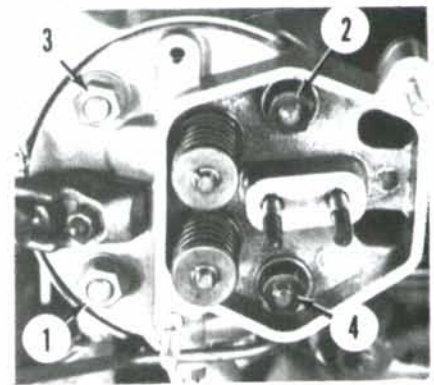


Fig. D1-6—Tighten cylinder head stud nuts in steps following sequence shown.

Check valve springs for distortion, sign of overheating and other damage. Spring free length should be 44.1-44.5 mm (1.736 inches) for F1L 208 D engine and minimum allowable length is 42 mm (1.653 inches). On F1L 210 D engine, spring free length should be 51.3-51.7 mm (2.020-2.035 inches) and minimum allowable length is 49 mm (1.929 inches).

To reinstall cylinder head, reverse the removal procedure. Be sure push rod cover tubes are properly seated. Tighten cylinder head stud nuts in steps following sequence shown in Fig. D1-6. Final tightening torque is 40 N·m (30 ft.-lbs.) for F1L 208 D or 55 N·m (40 ft.-lbs.) for F1L 210 D.

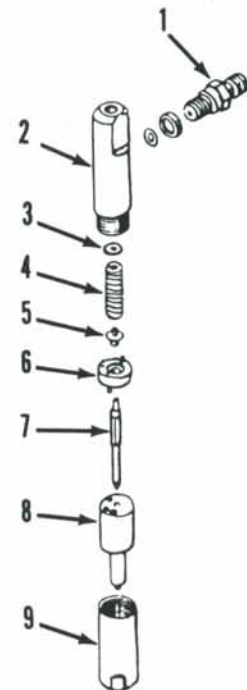


Fig. D1-7—Exploded view of injector assembly.

- | | |
|------------------------|------------------|
| 1. High pressure inlet | 6. Spacer |
| 2. Injector body | 7. Nozzle needle |
| 3. Shim | 8. Nozzle body |
| 4. Spring | 9. Nozzle nut |
| 5. Spring seat | |

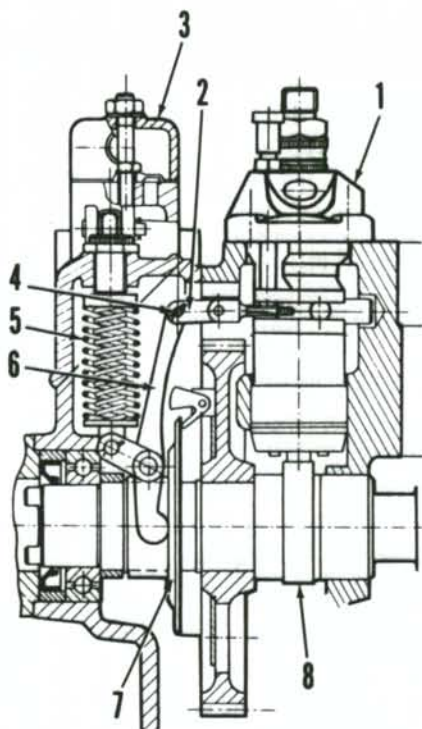


Fig. D1-8—Cross-sectional view of injection pump and governor assembly.

- | | |
|-------------------|---------------------|
| 1. Injection pump | 5. Governor springs |
| 2. Fork | 6. Governor lever |
| 3. Governor cover | 7. Governor plate |
| 4. Pin | 8. Camshaft |

INJECTOR

R&R AND OVERHAUL. Before removing injector, thoroughly clean injector and surrounding area. Immediately plug all openings as fuel lines are disconnected. Be sure to remove seal washer from cylinder head bore after injector is removed.

Be sure to renew copper seal washer when reinstalling injector. Tighten injector clamp nut to 35 N·m (26 ft.-lbs.).

To disassemble injector, secure body (2—Fig. D1-7) in a vise. Remove nozzle nut (9), then withdraw nozzle valve, spacer, spring and shims.

Clean exterior surfaces with a brass wire brush. It may be necessary to soak parts in an approved carbon solvent to loosen hard carbon deposits. Rinse parts in clean diesel fuel after cleaning with solvent. Be sure nozzle needle (7) moves smoothly in nozzle body (8). When needle is pulled about halfway out of body and then released, it should slide down to its seat from its own weight. If needle sticks, reclean or renew nozzle valve assembly.

When reassembling injector, all parts should be wet with diesel fuel. Check injector operation as outlined in TESTING paragraph.

TESTING. A complete job of testing

and adjusting injector requires use of special test equipment. Injector should be checked for opening pressure, seat leakage and spray pattern.

WARNING: Fuel emerges from injector with sufficient force to penetrate the skin. When testing injector, keep yourself clear of nozzle spray.

Connect injector to test pump, then operate tester lever several quick strokes to purge air from the injector and to make sure nozzle valve is not stuck. Then operate tester lever slowly while observing tester gage. Nozzle opening pressure should be 19000-22000 kPa (2755-3190 psi). Opening pressure is adjusted by increasing or decreasing thickness of shims (3—Fig. D1-7).

To check nozzle for leakage, operate tester lever slowly to maintain pressure at about 2750 kPa (400 psi) below opening pressure and observe nozzle tip for leakage. If a drop forms on nozzle tip within a 10 second period, nozzle valve is not seating and must be overhauled or renewed. A slight wetness at tip is allowable if a drop does not form.

Operate tester lever several quick strokes (about one stroke per second) and check spray pattern. Spray should be uniform, well atomized and form a cone shape. Nozzle should produce a buzzing sound when operating properly.

INJECTION PUMP

A CIPA injection pump is used on all engines. It is recommended that injection pump be tested and serviced only by a shop qualified in diesel fuel injection repair.

To remove injection pump, remove fuel lines from pump and immediately plug all openings. Remove governor housing cover and lift out governor inner and outer springs (5—Fig. D1-8). Disconnect governor arm (6) from fork (2), then screw fork out and move pump control rack to center position. Remove

pump retaining nuts and lift out pump. Retain pump mounting shims for use in reassembly.

To reinstall injection pump, proceed as follows: If original pump shim pack is not available or if a new pump is being installed, place mounting gasket on crankcase and measure distance from surface of gasket to base circle of pump cam. Compare measurement with dimension scribed on pump body and assemble shim pack to obtain the required dimension. The distance with gasket and shims in place cannot be smaller than 82.6 mm (3.252 inches). Install pump and tighten nuts to 23 N·m (17 ft.-lbs.). Turn in fork (2—Fig. D1-9) and connect governor arm (6). Press governor plate (7) forward and check governor lever play (P) at pin (4). Adjust fork in or out to provide 0.2-0.4 mm (0.008-0.016 inch) free play at pin. Reinstall springs and governor cover. Bleed air from fuel system and check injection pump static timing. Check engine speed settings and adjust if necessary.

TIMING GEARS AND FRONT COVER

To remove engine front cover, remove governor cover (3—Fig. D1-8) and lift out governor springs (5). Disconnect governor lever (6) from fork (2). Remove governor pivot shaft and lift out governor lever. Remove front pulley. Remove camshaft cover and balance weight cover with shims. Remove front cover mounting screws, then use a suitable puller to withdraw cover with bearings. Heat cover before tapping out bearings.

Inspect gears for excessive wear and other damage. To remove balance weight and bearing, use a suitable slide hammer puller to remove balancer assembly (2—Fig. D1-10) from crankcase. Remove crankshaft gear retaining ring, then use a suitable puller to pull gear (3) off crankshaft. Refer to

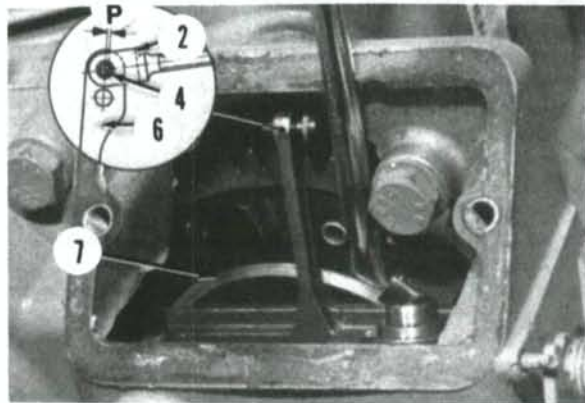


Fig. D1-9—When reconnecting governor linkage, adjust yoke (2) to provide 0.2-0.4 mm (0.008-0.016 inch) end play (P) at governor lever pin (4).

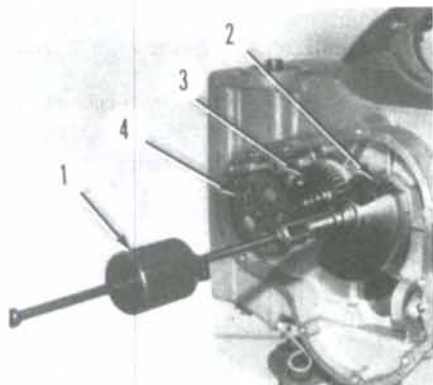


Fig. D1-10—Use a slide hammer puller to remove balance weight assembly.

1. Slide hammer puller
2. Balance weight assy.
3. Crankshaft gear
4. Oil pump gear

CAMSHAFT section for removal of camshaft gear. Remove oil pump gear (4) retaining nut and withdraw gear.

To reinstall gears, proceed as follows: Heat crankshaft gear to about 150°C (300°F) before reinstalling. Heat bearings before installing onto balance weight shaft and camshaft. Make certain timing marks (Fig. D1-11) on crankshaft gear (1), balance weight gear (2) and camshaft gear (3) are aligned as shown. Install oil pump drive gear (1—Fig. D1-12) and check for specified backlash of 0.10-0.15 mm (0.004-0.006 inch) between crankshaft gear and oil pump gear. To adjust backlash, loosen pump mounting cap screws and rotate pump housing in crankcase as necessary. Tighten pump mounting screws to 10 N·m (8 ft.-lbs.). Tighten oil pump drive gear nut to 23 N·m (17 ft.-lbs.).

Heat front cover slightly before reinstalling. Tighten mounting screws to 23 N·m (17 ft.-lbs.). Check and adjust balance weight and camshaft end play as follows: Measure distance (A—Fig. D1-13) from surface of front cover to race of ball bearing. Measure distance (B—Fig. D1-15) of bearing retainer with

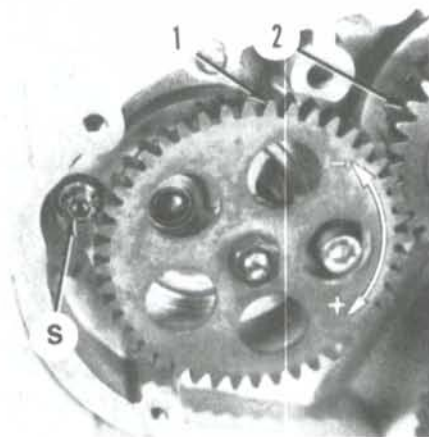


Fig. D1-12—To adjust backlash between oil pump drive gear (1) and crankshaft gear (2), loosen pump mounting screws and rotate pump in crankcase. Note position of small head pump mounting screw (S).

gasket in place as shown. Distance "A" must be 0.15-0.20 mm (0.006-0.008 inch) larger than distance "B". If the distance is too large, install shims between bearing retainer and bearing. If the distance is too small, install thicker gasket between bearing retainer and front cover. Tighten bearing retainer cap screws to 23 N·m (17 ft.-lbs.). Camshaft end play is determined in the same manner by

measuring from surface of front cover to race of bearing (A—Fig. D1-14) and subtracting bearing retainer dimension (B—Fig. D1-15). The difference must be within range of 0.15-0.20 mm (0.006-0.008 inch). Adjustment procedure is the same as that for balance weight shaft. Tighten camshaft cover mounting screws to 23 N·m (17 ft.-lbs.). Complete installation by reversing the removal procedure.

CAMSHAFT

To remove camshaft, first remove cylinder head, push rods, cam follower retainer plate and cam followers. Remove injection pump and engine front cover as previously outlined. Remove camshaft assembly from crankcase.

Inspect camshaft (9—Fig. D1-16) and bearings for excessive wear. Cam height for F1L 208 D engine should be 6.85-6.95 mm (0.2697-0.2736 inch) for intake and exhaust. Cam height for F1L 210 D engine should be 6.55-6.65 mm (0.2579-0.2618 inch). Check governor weights (6), plate (5) and disc (4) for wear and damage and renew if necessary.

To reinstall camshaft, reverse the removal procedure. Be sure to align timing gear marks as shown in Fig. D1-11. Check and adjust camshaft end play as outlined in **TIMING GEARS AND FRONT COVER** section.

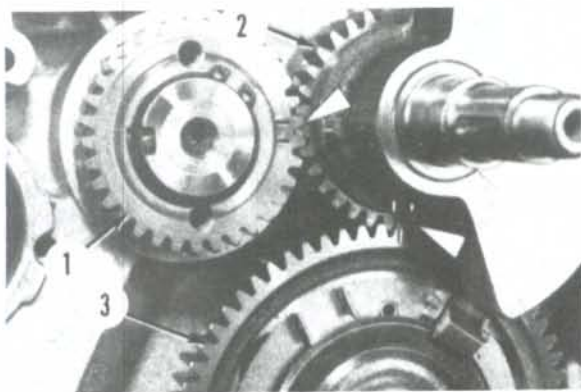


Fig. D1-11—Make certain timing marks are aligned as shown when reassembling engine.

1. Crankshaft gear
2. Balance weight gear
3. Camshaft gear

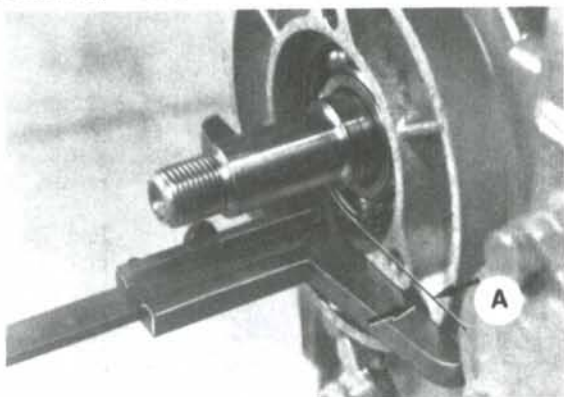


Fig. D1-13—To determine balance weight shaft end play, first measure distance "A" from surface of front cover to race of bearing. Refer to text and Fig. D1-14.

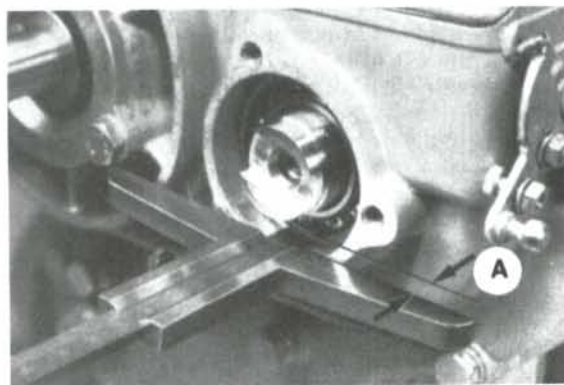


Fig. D1-14—To determine camshaft end play, measure distance "A" from surface of front cover to race of bearing. Refer to text.

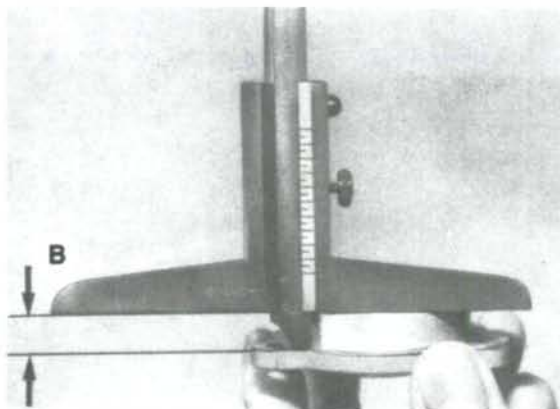


Fig. D1-15—Measure bearing retainer flange distance "B" with gasket in place. Refer to text.

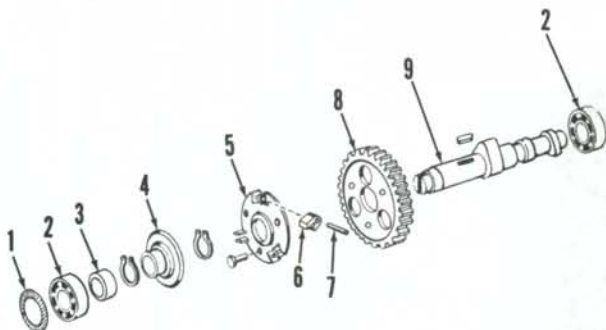


Fig. D1-16—Exploded view of camshaft assembly.

1. Shim
2. Bearings
3. Spacer
4. Governor disc
5. Flyweight plate
6. Flyweight
7. Pivot pin
8. Camshaft gear
9. Camshaft

PISTON, PISTON RING, RINGS AND CYLINDER

To disassemble, remove cylinder head and air shroud. Withdraw cylinder from piston and crankcase. Retain shims used between bottom of cylinder and crankcase for use in reassembly. Remove piston pin retaining rings. Press out piston pin and remove piston from connecting rod.

Cylinder standard bore diameter is 80.00-80.015 mm (3.1496-3.1502 inches) for F1L 208 D and 95.00-95.015 mm

(3.7402-3.7407 inches) for F1L 210 D. Cylinder should be renewed if wear exceeds 0.15 mm (0.006 inch). Piston skirt standard diameter should be 79.805-79.825 mm (3.1419-3.1427 inches) for F1L 208 D and 94.780-94.800 mm (3.7315-3.7322 inches) for F1L 210 D. Pistons and cylinders are available in oversizes of 0.50 mm (0.020 inch) and 1.0 mm (0.040 inch).

With rings installed on piston, measure side clearance between rings and ring grooves using a feeler gage. Compare measurements with the following dimensions and renew if necessary.

Ring Side Clearance

F1L 208 D:

Top ring.....	0.09-0.11 mm
	(0.0035-0.0043 inch)
Maximum.....	0.15 mm
	(0.006 inch)
Second ring.....	0.05-0.07 mm
	(0.0020-0.0027 inch)
Maximum.....	0.15 mm
	(0.006 inch)
Slotted oil ring.....	0.03-0.05 mm
	(0.0012-0.0020 inch)
Maximum.....	0.15 mm
	(0.006 inch)

F1L 210 D:

Top ring.....	0.11-0.13 mm
	(0.0044-0.0051 inch)
Maximum.....	0.20 mm
	(0.008 inch)
Second ring.....	0.07-0.09 mm
	(0.0028-0.0035 inch)
Maximum.....	0.15 mm
	(0.006 inch)
Slotted oil ring.....	0.03-0.05 mm
	(0.0012-0.0020 inch)
Maximum.....	0.15 mm
	(0.006 inch)

Piston ring end gap should be checked using a feeler gage with ring inserted squarely into cylinder bore. On F1L 208 D engine, ring end gap should be 0.25-0.50 mm (0.010-0.020 inch) and maximum allowable gap is 1.0 mm (0.040 inch) for all rings. On F1L 210 D engine, ring end gap should be 0.25-0.55 mm (0.010-0.021 inch) and maximum allowable gap is 1.0 mm (0.040 inch) for all rings.

The piston pin is a transition fit in piston bore. Heating piston to about 80°C (175°F) will make removal and installation easier. Piston pin outer diameter is 27.994-28.000 mm (1.1021-1.1023 inches) and piston bore diameter is 28.000-28.006 mm (1.1023-1.1026 inches).

When reassembling, note that combustion cavity is offset in piston crown.

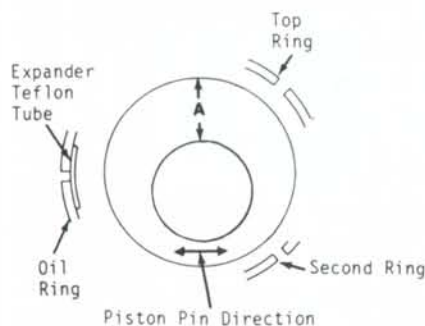
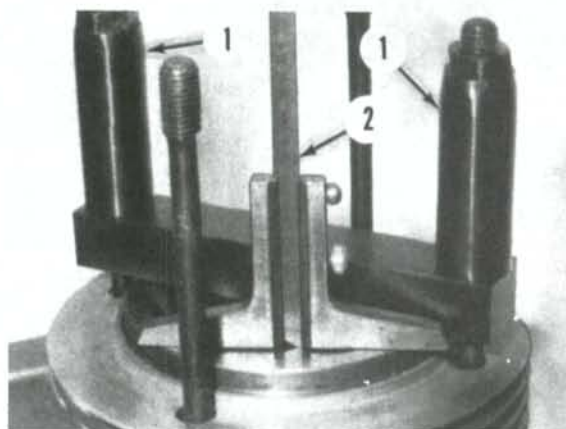


Fig. D1-17—Stagger ring end gaps around piston as shown. Note that combustion cavity in piston crown is offset and wider part of crown (A) should be towards injection pump side of engine.

Fig. D1-18—To check piston crown clearance, secure cylinder using spacers (1) and stud nuts. Measure distance from top of cylinder to piston crown using a depth gage (2).



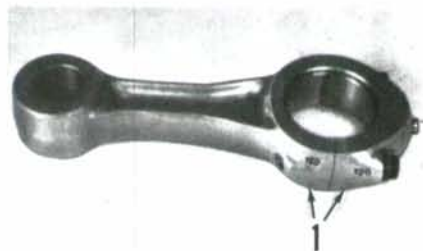


Fig. D1-19—Make certain identification numbers (1) on rod and cap match and are on the same side.

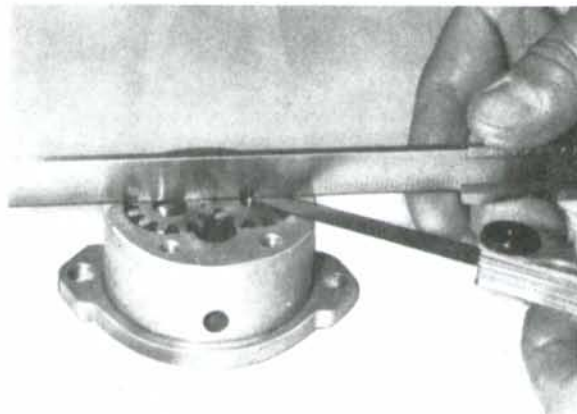
Install piston so wider part of piston crown (A—Fig. D1-17) is towards injection pump side of engine. If connecting rod is removed, make certain side of rod and cap stamped with identification numbers (Fig. D1-19) is opposite from wider side of piston crown. Install rings onto piston making sure second compression ring is installed with side marked "TOP" facing upward and chrome plated ring is installed in top ring groove. Stagger ring end gaps around piston as shown in Fig. D1-17. Position cylinder so side with flattened fins is towards camshaft side of crankcase.

If piston or cylinder was renewed, piston crown clearance should be checked and adjusted as follows: Assemble three shims onto bottom of cylinder, then install cylinder onto piston. Using suitable spacer tubes (1—Fig. D1-18) on cylinder studs, tighten stud nuts securely to clamp cylinder against crankcase. Rotate crankshaft until piston is at top dead center, then measure distance between piston crown and top of cylinder. Recommended distance is 1.0-1.2 mm (0.040-0.047 inch). If measured distance is too large, lift cylinder slightly and cut one of the shims with side cutters. Remove the cut shim and recheck piston crown dimension. When specified dimension is obtained, reinstall cylinder head.

CONNECTING ROD

The connecting rod is equipped with a renewable, precision insert type bearing in the big end. Bearings are available in undersizes of 0.25, 0.50, 0.75 and 1.00 mm (0.010, 0.020, 0.030 and 0.040 inch) as well as standard size. Bearing standard bore diameter is 40.025-40.052 mm (1.5758-1.5768 inches) for F1L 208 D and 51.955-51.994 mm (2.0455-2.0470 inches) for F1L 210 D. Recommended clearance between bearing and crankpin is 0.025-0.068 mm (0.0010-0.0026 inch) for F1L 208 D and 0.010-0.069 mm (0.0004-0.0027 inch) for F1L 210 D. Maximum allowable operating clearance for both engines is 0.12 mm (0.0047 inch).

Fig. D1-20—Use a straight-edge and feeler gage to measure oil pump end clearance.



Inside diameter of small end bore is 28.005-28.015 mm (1.1026-1.1029 inches) for F1L 208 D and outside diameter of piston pin is 27.994-28.000 mm (1.1021-1.1023 inches). Desired clearance of pin in rod bore is 0.005-0.021 mm (0.0002-0.0008 inch) with a wear limit of 0.05 mm (0.0020 inch). Inside diameter of small end bore for F1L 210 D engine is 30.005-30.015 mm (1.1813-1.1817 inches) and outside diameter of piston pin is 29.994-30.000 mm (1.1809-1.1811 inches). Desired clearance of piston pin in rod bore is 0.005-0.021 mm (0.0002-0.0008 inch) with a wear limit of 0.05 mm (0.0020 inch).

Connecting rod side clearance on crankshaft should be 0.20-0.40 mm (0.008-0.016 inch) for all engines. Renew connecting rod if side clearance exceeds 0.60 mm (0.023 inch).

When reinstalling connecting rod, be sure identification numbers (Fig. D1-19) on big end of rod and on cap are on the same side and face away from injection pump side of engine.

NOTE: If connecting rod bearing is renewed, manufacturer recommends renewing connecting rod cap screws.

Tighten connecting rod cap screws to 35 N·m (26 ft.-lbs.) on F1L 208 D engine or 45 N·m (33 ft.-lbs.) on F1L 210 D engine.

CRANKSHAFT AND MAIN BEARINGS

To remove crankshaft, remove cylinder head, oil sump, connecting rod and piston and engine front cover. Remove crankshaft gear and flywheel using suitable pullers. Use two jackscrews in threaded holes of crankshaft rear bearing retainer to pull retainer housing from crankcase. Withdraw crankshaft from crankcase.

Crankpin standard diameter is

39.984-40.000 mm (1.5742-1.5748 inches) for F1L 208 D engine or 51.925-51.945 mm (2.0443-2.0450 inches) for F1L 210 D engine. Journal out-of-round limit is 0.05 mm (0.002 inch). Recommended clearance between connecting rod bearing and crankpin is 0.025-0.068 mm (0.0010-0.0026 inch) for F1L 208 D engine or 0.010-0.069 mm (0.0004-0.0027 inch) for F1L 210 D engine. Maximum allowable clearance for both engines is 0.12 mm (0.0047 inch). Undersize bearings are available.

Main journal standard diameter is 46.995-47.011 mm (1.8502-1.8508 inches) for F1L 208 D engine or 54.993-55.006 mm (2.1651-2.1656 inches) for F1L 210 D engine. Journal out-of-round limit is 0.05 mm (0.002 inch). Standard inside diameter of main bearings is 47.030-47.039 mm (1.8516-1.8519 inches) for F1L 208 D engine or 55.030-55.079 mm (2.1665-2.1684 inches) for F1L 210 D engine. Recommended clearance between main journals and bearings is 0.019-0.084 mm (0.0008-0.0033 inch) for F1L 208 D engine or 0.024-0.086 mm (0.0009-0.0034 inch) for F1L 210 D engine. Maximum allowable main bearing clearance is 0.12 mm (0.0047 inch) for both engines. Undersize bearings are available.

When renewing main bearings, crankcase and bearing retainer should be heated slightly prior to installing new bearings. Press front bearing in until flush with outer surface of crankcase bore and install rear bearing flush with inner surface of retainer housing.

Crankshaft end thrust is taken by thrust washers mounted in crankcase at front and in bearing retainer housing at rear. Recommended end play is 0.15-0.20 mm (0.006-0.008 inch) for both engines. Maximum allowable end play is 0.40 mm (0.016 inch). Standard thickness of thrust washers is 1.95-2.00 mm (0.077-0.079 inch). If end play is excessive, insert a shim behind thrust washers. If end play is less than recom-



Fig. D1-21—Measure clearance between oil pump body and gears with a feeler gage. Refer to text.

mended, assemble thicker mounting gasket for rear bearing retainer.

When reinstalling crankshaft, lubricate bearings and journals with oil prior to assembly. Be sure side of thrust washers with oil grooves is towards crankshaft. Tighten bearing retainer nuts to 35 N·m (26 ft.-lbs.). Be sure timing gear marks are aligned as shown in Fig. D1-11. Complete installation by reversing the removal procedure.

OIL PUMP

To remove oil pump, drain the engine oil and remove oil pan and engine front cover. Remove oil pickup tube. Remove pump mounting screws and withdraw pump assembly from crankcase.

Use a straightedge to check pump rear cover for distortion or wear. Renew cover and pickup assembly if warped or excessively worn. Use a straightedge

and feeler gage to measure gear end clearance (Fig. D1-20). Specified end clearance is 0.07-0.15 mm (0.003-0.006 inch). Renew components as required if end clearance exceeds 0.15 mm (0.006 inch). Use a feeler gage to measure clearance between gears and housing as shown in Fig. D1-21. Specified clearance is 0.03-0.10 mm (0.001-0.004 inch) and maximum allowable clearance is 0.15 mm (0.006 inch). Backlash between pump gears should be 0.06-0.12 mm (0.0023-0.0047 inch) with a wear limit of 0.20 mm (0.008 inch).

To reinstall pump, reverse the removal procedure. Tighten pump cover mounting screws to 8.5 N·m (75 in.-lbs.). Be sure pump mounting screw with smaller head (Fig. D1-12) is installed in outer hole. Rotate pump in crankcase to obtain recommended backlash of 0.10-0.15 mm (0.004-0.006 inch) between pump drive gear and crankshaft gear. Tighten pump mounting screws to 10 N·m (88 in.-lbs.).

Engine oil pressure with oil at 80°C (175°F) and engine running at 3200 rpm should be 300-500 kPa (44-72 psi).