9030 BIDIRECTIONALTM TRACTOR
SERVICE MANUAL
CONTENTS

This service manual refers to serial number breaks at various times throughout the text. It is important to understand the order in which 9030 Bidirectional tractors were built.
The following chart shows how 9030 tractors were built in the following ranges based on year of production:

SERIAL NUMBER RANGE YEAR OF PRODUCTION
0470100 - 0479999 1991
0487501 - 0489999 1992
0932000 - 0939999 1993
0200000 - AND ABOVE 1994 AND ON

An example of correctly identifying a unit follows:
The text reads "units built after *SIN* 0200234 ..... " The tractor being repaired is *SIN* 0487698.
0487698 is a tractor built **before** *SIN* 0200234 and will not *have* the component or feature described in the text.

SECTION 1
ENGINE SYSTEMS

CONTENTS

SECTION 1
ENGINE SYSTEMS
DIESEL ENGINE

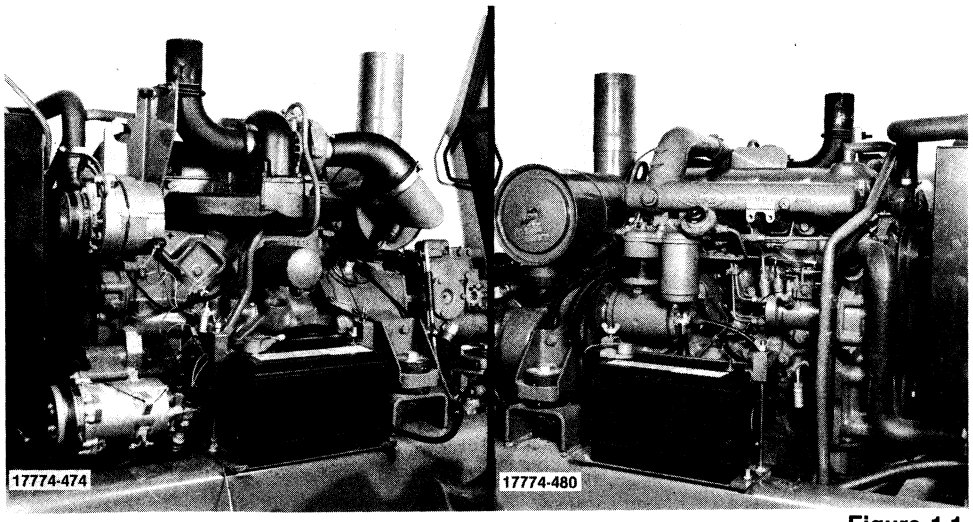


Figure 1-1

Four Cylinder Engine — Left Side
SHIELDS REMOVED FOR CLARITY

Four Cylinder Engine — Right Side
SHIELDS REMOVED FOR CLARITY

DESCRIPTION AND OPERATION

This section describes the overhaul and repair of the 4-cylinder direct injection diesel engine.

NOTE: The engine used in the 9030 tractor is of special manufacture. A "BSD" engine is NOT to be used in a 9030. See S/B 4/92-G12 for further information on engine differences between a 9030 and a BSD engine.

The engine, Figure 1-1, features a cross flow cylinder head with the inlet and exhaust manifolds on opposite sides of the head. The combustion chamber is formed in the crown of the piston which has two compression and one oil control ring all located above the piston pin.

The cylinder head assembly incorporates the valves, valve springs, and the spring retainers. Valve guides are an integral part of the cylinder head with replaceable valve seats pressed into the valve ports. Valve guides are not replaceable.

Cylinder Head Assembly

The cylinder head assembly incorporates the valves, valve springs, and rotators. The valve rocker arm shaft assembly is bolted to the cylinder block, through the head. The intake and exhaust manifolds are bolted to the head, the intake on the right side, and the exhaust on the left. The water outlet connection and thermostat are attached to the front of the cylinder head.

Valve guides are integral with the cylinder head, and valves with oversize stems are available for service. Special replaceable cast alloy valve seats are pressed into each valve port, and exhaust valves are fitted with positive valve rotators. The valves use umbrella-type seals.

Valve lash is maintained by self-locking adjusting screws. The cam shaft runs in four replaceable bearings, and is driven by the camshaft idler gear in mesh with the camshaft and crankshaft gears. Camshaft thrust is controlled by a plate secured to the block and located between the camshaft gear and the front journal of the camshaft.

The cylinder head bolts are evenly spaced in a six-point pattern around each cylinder. Diesel engine injectors are mounted outside the rocker cover.

The engine cylinder head is designed with the entire face of the cylinder head flat. The combustion chambers are recessed into the piston crowns.

Crankshaft Assembly

The crankshaft is supported in the cylinder block by five main bearings and the crankshaft end thrust is controlled by a thrust bearing located on the center main bearing.

A crankshaft driven dynamic balancer counteracts out-of-balance forces and thereby reduces engine vibration. The balancer housing is bolted to the bottom of the cylinder block and contains two meshing gears which are driven and timed from a gear on the crankshaft.

Front and rear crankshaft oil sealing is effected by a one piece, single lip type seal.

The piston is connected to the crankshaft by a heavy I-beam connecting rod with a tapered top end. The crankshaft end of the connecting rod has an insert-type copper lead or aluminum tin alloy bearing. The piston end of the connecting rod has a replaceable bronze bushing. The piston pin is a free-floating steel pin held in place in the piston by two snap rings.

Pistons

Pistons are an aluminum alloy with combustion chambers recessed into the piston crowns. Each piston has two compression rings and one oil control ring, all of which are located above the piston pin.

Connecting Rods

The piston connecting rods have replaceable bronze piston pin bushings. A centrally drilled hole facilitates both pressure lubrication of the piston pin bushing and cooling of the piston crown. Full-floating piston pins are retained by two snap rings in each piston.

Manifolds

The aluminum intake and cast iron exhaust manifolds are on opposite sides of the cylinder head for better heat distribution in the head, and less heat transfer to the intake manifold. All tractors are fitted with vertical exhaust systems.

The intake manifolds are connected through tubing to the air cleaner. The turbocharger crossover tube is provided with a tapped hole for installation of an ether cold starting aid kit.

Cylinder Block Assembly

The cylinder block is a cast iron alloy with heavy webbing and deep cylinder skirts. The block features full length water jackets for cooling the cylinders, which are bored integral with the block. Cylinders are in-line and vertical, and numbered from 1 to 4, front to rear.

The oil pan is attached to the bottom of the cylinder block and is the sump for the lubrication system. The engine front cover is attached to the front engine adapter plate forming a cover for the timing gears.

The crankshaft gear is keyed and press fitted on the front of the crankshaft (later engines do not use a key). The crankshaft gear drives the idler gear, which is attached to the front of the cylinder block. The idler gear drives the camshaft gear and the injection pump drive gear.

The camshaft gear is attached to the front of the camshaft by a key, bolt, lock washer, and flat washer. This ensures the gear maintains correct position on the camshaft.

All the timing gears are timed to each other via an identification mark to insure proper gear position in relation to each other.

Lubrication System

Lubrication of the engine is maintained by a gerotor type oil pump mounted at the base of the engine block. The oil pump is driven from the camshaft and draws oil from the engine sump through a wire mesh screen.

A spring loaded relief valve in the pump body limits the pressure in the system by directing excess oil back to the intake side of the pump.

Oil passes from the pump to an external, throw-away, spin-on type filter incorporating a relief valve which permits oil to be bypassed if filter blockage occurs, and so ensures engine lubrication at all times.

Oil flows from the filter to the main oil gallery which runs the length of the cylinder block and intersects the camshaft follower chambers.

The main gallery also supplies oil to the crankshaft main bearings and to the connecting rod journals via drillings in the crankshaft. Drilled passages from each main bearing direct oil to the camshaft bearings.

The idler gear bushing is pressure lubricated through a drilled passage from the front main bearing. The gear has small oil passages machined on both sides which allow the oil to escape.

The timing gears are lubricated by oil from the cam follower chamber and the pressure lubricated idler gear bushing.

The dynamic balancer is lubricated through a drilled passage from the cylinder block intermediate thrust bearing web to the balancer housing. Oil flows through the balancer housing to the drilled balancer gear shafts and onto the bushings in the balancer gears.

Cylinder walls, piston, and piston pins are splash lubricated by the connecting rods and rotating crankshaft.

The connecting rods have a centrally drilled hole which facilitates both pressure lubrication of the piston pin bushing and cooling of the piston crown.

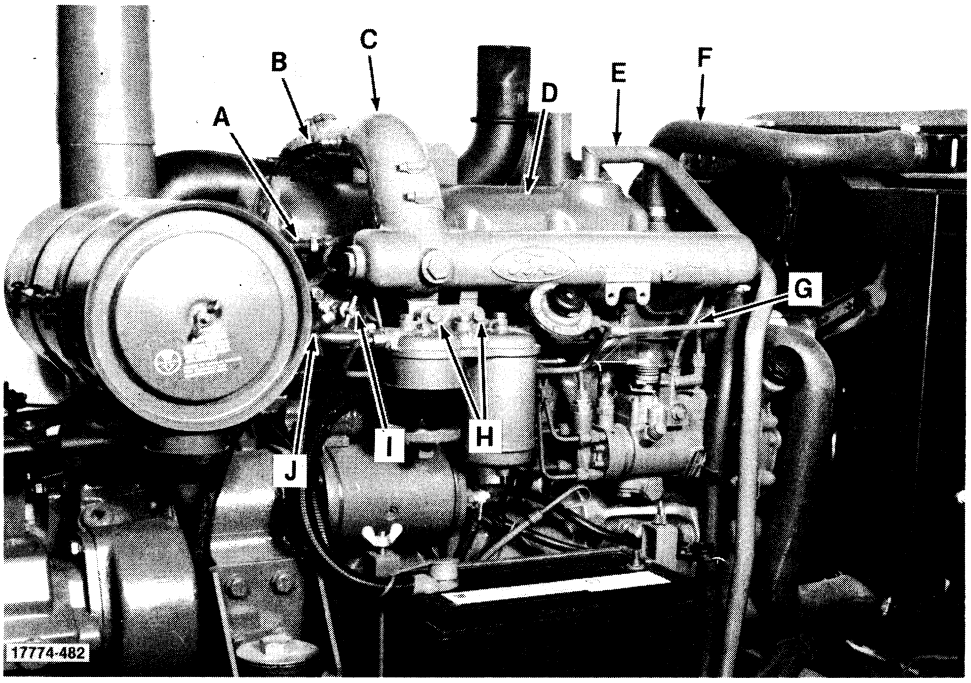
An intermittent flow of oil is directed to the valve rocker arm shaft assembly via a drilled passage in the cylinder block located vertically above No. 1 camshaft bearing. This drilling aligns with a corresponding hole in the cylinder head.

As the camshaft turns, holes in the camshaft and camshaft bearing align and a regulated stream of oil is directed to the cylinder head and on up the rocker arm shaft support bolt to the rocker shaft.

The oil flows from the shaft through drilled holes in each rocker arm bushing to lubricate both ends of the arms. Excess oil flows down the push rods and assists in lubricating the cam followers before draining back into the sump through cored openings in the block.

A water-to-oil type oil cooler, located in the base of the radiator, is connected into the lubrication system main oil gallery and cools a portion of the circulating oil. A restrictor at the oil outlet limits the flow to the cooler and maintains internal lubrication at low engine speeds. Return oil from the cooler is fed back to the engine sump via a pipe tapped into the skirt of the cylinder block.

SECTION 1A
CYLINDER HEAD



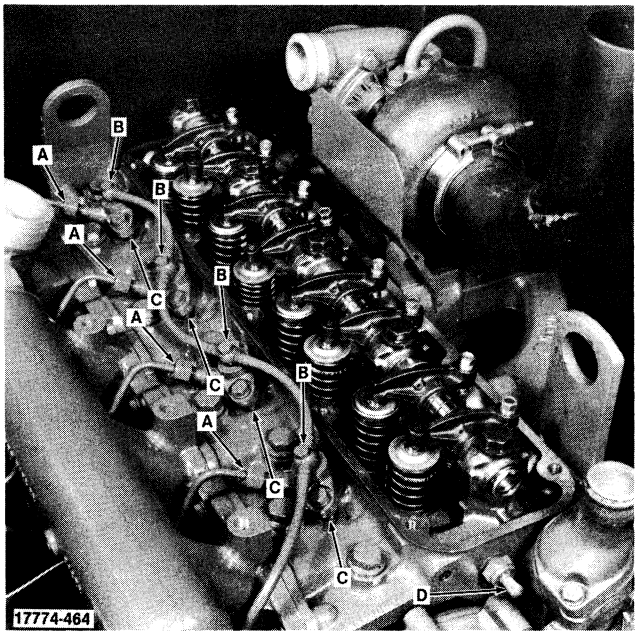
Engine — Right Side **Figure 1A-1**

A	Leak-off line - rear	E	Crankcase breather tube	I	Heater inlet valve
B	Cold start tube	F	Upper radiator hose	J	Heater inlet hose
C	Turbo transfer tube	G	Leak-off line - front		
D	Rocker cover	H	Bolts		

CYLINDER HEAD — REMOVAL

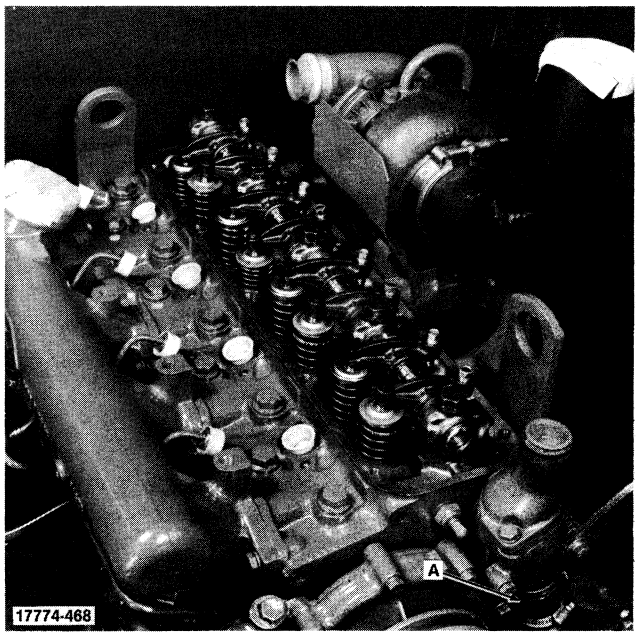
NOTE: The cylinder head can be removed with the engine installed in the tractor. If only the valves are to be adjusted, follow Steps 4 through 7 and then see "Cylinder Head - Installation" in this section.

1. Disconnect the batteries. See "Battery - Removal" Section 3, Electrical, in this manual.
2. Remove the muffler.
3. Drain the radiator and cylinder block. See "Radiator - Removal" in this section.
4. Remove the side panels and hood.
5. Remove the cold start tube, B, Figure 1A-1, and the turbocharger crossover tube, C.
6. Remove the crankcase breather tube, E.
7. Remove the rocker cover, D, and gasket.
8. Close the heater inlet valve, I. Remove and cap the heater inlet line, J.
9. Remove and cap the injector leak-off line. Front, G, and rear, A.
10. Remove and cap the upper radiator hose, F.
11. Remove two bolts, H, securing the fuel filters to the intake manifold.



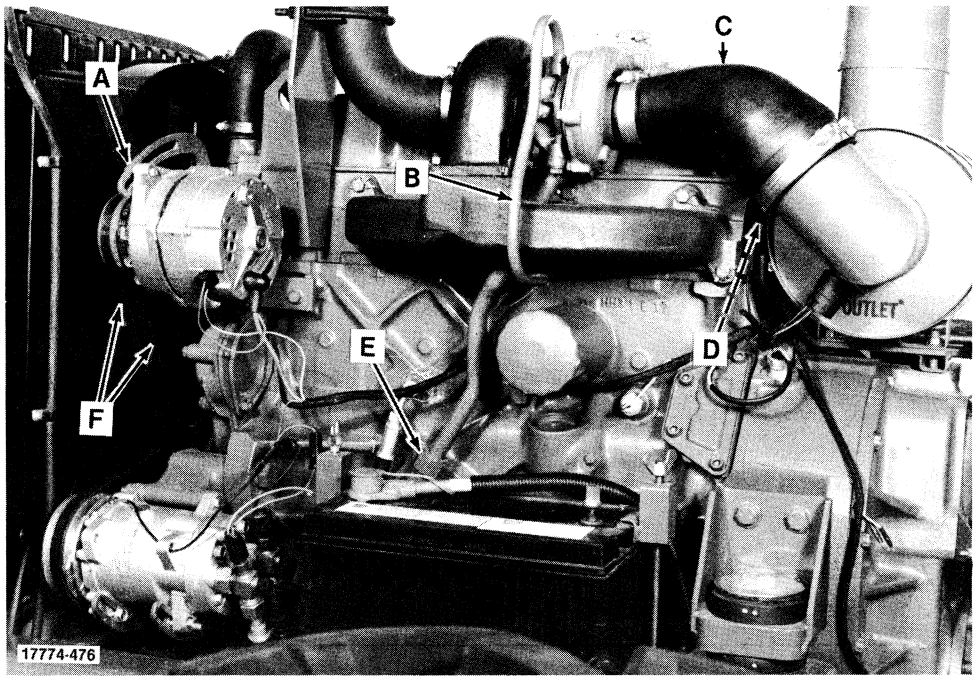
Top of Engine **Figure 1A-2**

A Fuel injector lines
B Leak-off line banjo bolts
C Fuel injectors
D Coolant temperature sender



Thermostat Bypass Hose **Figure 1A-3**

A Thermostat bypass hose



Engine Left Side **Figure 1A-4**

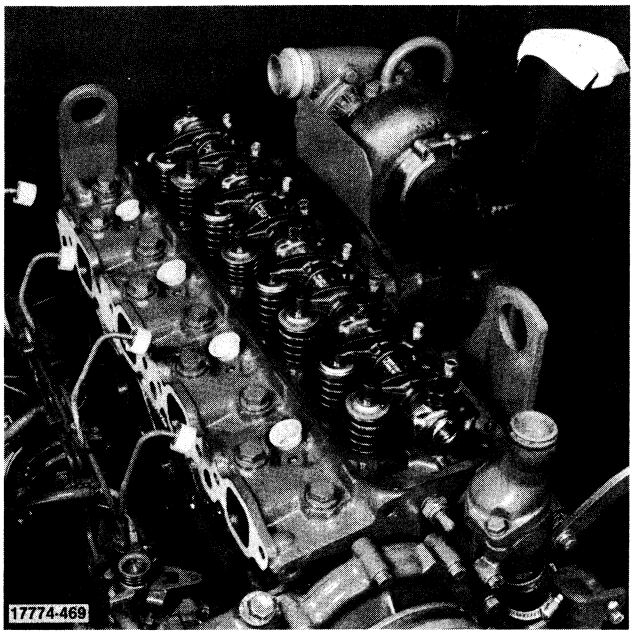
A Alternator adjustment bolt
B Turbocharger oil pressure line
C Turbocharger air inlet hose
D Thermo-Guard™
E Turbocharger oil return tube
F Alternator belts

12. Remove and cap the fuel injector lines, A, Figure 1A-2. Remove the fuel injector leak-off lines, B. Remove and cap the fuel injectors, C.

13. Remove the electrical lead from the coolant temperature sender, D.

14. Loosen the clamp on the thermostat bypass hose, A, Figure 1A-3.

15. Remove the alternator adjustment bolt, A, Figure 1A-4, drive belts, F, and adjustment arm. Let the alternator rotate down as far as possible.



Inlet Manifold Removed Figure 1A-5

Exhaust Manifold Removed Figure 1A-6

16. Disconnect the turbocharger oil pressure line, B. Disconnect the turbocharger return oil line, E.

17. Remove the turbocharger air inlet hose, C.

18. Disconnect the Thermo-Guard™ electrical lead, D.

19. Loosen the rocker shaft retaining bolts, which also serve as cylinder head bolts, evenly and alternately. Remove the rocker shaft assembly.

NOTE: Leave the bolts in the rocker shaft supports during removal as they retain the supports on the shaft.

NOTE: At this point if the head gasket only is being replaced, proceed with Steps 22 through 24. If the valves are to be removed, proceed with the complete cylinder head removal procedure.

20. Remove the retaining bolts and lock washers and remove the inlet manifold from the cylinder head, Figure 1A-5.

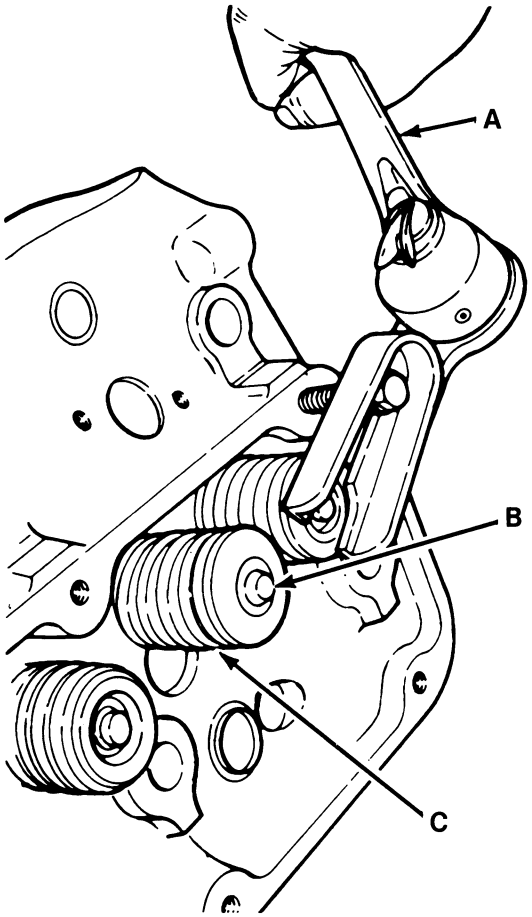
21. Straighten the lock tabs on the attaching bolts, remove the bolts. Remove the exhaust manifold and turbocharger as an assembly, Figure 1A-6.

22. Remove the push rods and place in a numbered rack.

23. Remove the remaining cylinder head bolts and washers working inwards from the ends toward the center of the head.

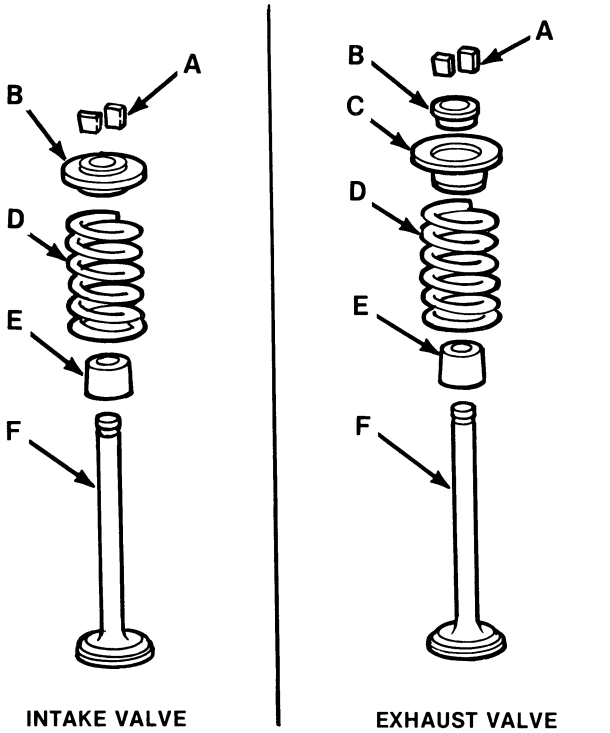
24. Attach a suitable lifting device to the cylinder head lifting brackets. Lift the cylinder head assembly from the tractor. If necessary, use the pads provided to pry the cylinder head from the block. Take care not to damage the block or head.

25. Remove the retaining bolts and the thermostat housing from the cylinder head.



Valve Removal **Figure 1A-7**

A Valve spring compressor
B Retainer locks
C Spring



INTAKE VALVE EXHAUST VALVE

Valve Components **Figure 1A-8**

A Retainer locks
B Retainer
C Rotator (exhaust valve only)
D Spring
E Seal
F Valve

CYLINDER HEAD — DISASSEMBLY

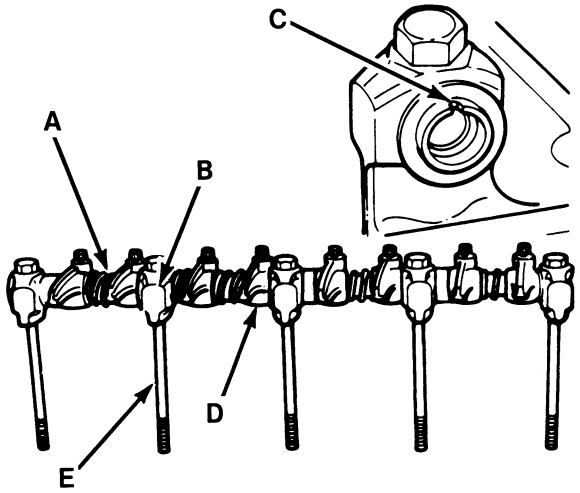
1. Clean the head of all gasket material and remove the carbon from around the valve heads.

2. Using a valve spring compressor, A, Figure 1A-7, remove the retainer locks, B, spring retainers/rotators, springs, and seals from each valve. See Figure 1A-8 for valve assembly layout.

Rocker Arms and Shaft — Disassembly Refer to Figure 1A-9

1. Remove the bolts that attach the rocker arm shaft to the cylinder head.

2. Remove rocker arms, D, rocker arm shaft supports, B, and springs, A, from the shaft.

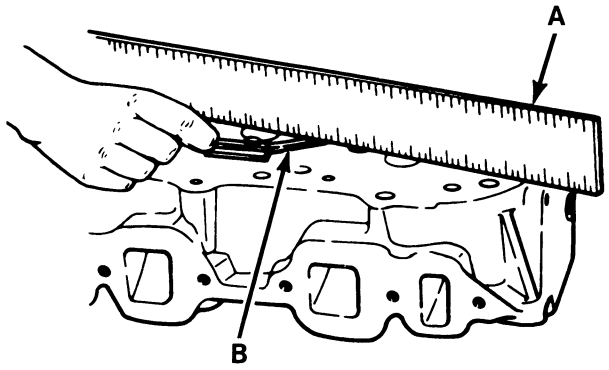


Rocker Shaft Components **Figure 1A-9**

A Spring
B Rocker arm shaft support
C Notch
D Rocker arm
E Retaining bolts

Assembly

1. Coat the rocker arm shaft with engine oil prior to assembly. Lubricate the valve pads on all rocker arms.



Measuring Cylinder Head Flatness **Figure 1A-10**
A Straight edge
B Feeler gauge

2. The rocker shaft has an identification groove at one end of the shaft. Position the mark upwards and use this end as the front of the shaft. The oil holes and grooves in the shaft should be facing down.

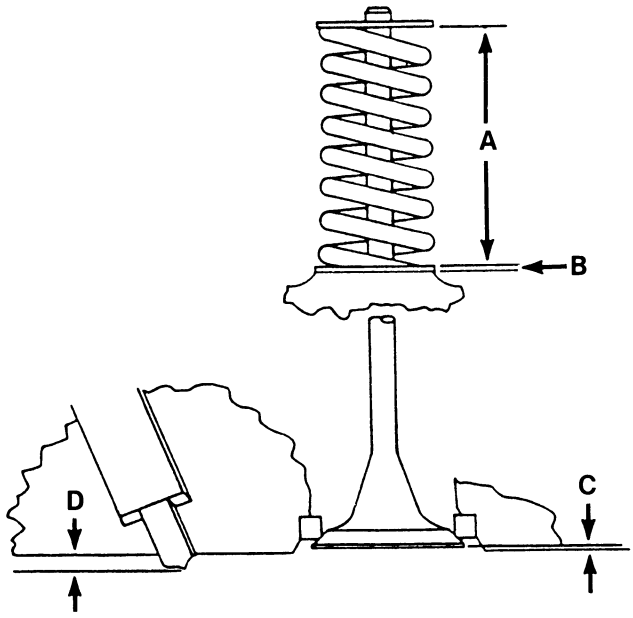
3. Start assembly from the rear of the shaft by first positioning a rocker arm support with the notch, C, on the support to the rear of the shaft.

CYLINDER HEAD — INSPECTION

Scrape all gasket surfaces clean. Wash the cylinder head in a suitable solvent and thoroughly dry with a lint free cloth or compressed air.

Inspect the cylinder head for cracks, nicks, or burrs and, if necessary, remove nicks and burrs from the gasket surfaces using a suitable abrasive. Be sure all traces of abrasive material are removed after repair.

With a straight edge, A, Figure 1A-10, and feeler gauge, B, check the flatness of the cylinder head. Specifications for flatness are 0.006″ (0.15 mm) maximum overall, or 0.003″ (0.08 mm) in any 6.0″ (153.00 mm). Also, the change in flatness must be gradual - not more than 0.001″ (0.025 mm) per 1″ (25.4 mm) of head length.



Valve Recession **Figure 1A-11**
A Installed spring height
B Shim (as required)
C Valve recession
D Injector protrusion

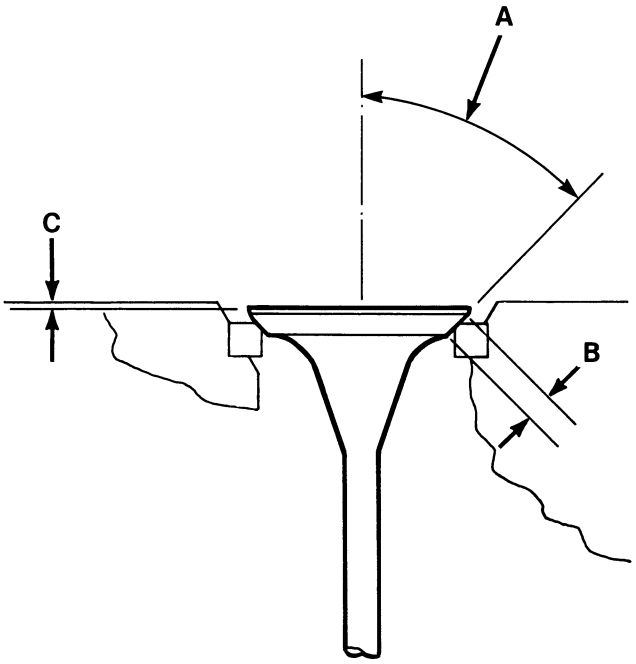
NOTE: If the face of the cylinder head does not meet the flatness specification it may be milled, provided that valve recession is at least 0.059 to 0.084 in. (1.50 to 2.13 mm), see Figure 1A-11. Injector nozzle protrusion must be 0.093 to 0.125 in. (2.4 to 3.2 mm). Maximum material removal from the cylinder head cannot exceed 0.020 in. (0.508 mm). Surface finish of the milled head must be between 60 and 150 micro inches.

Check to make sure that the milled head thickness, measured from the face of the head to the head bolt pad, is not less than 3.96″ (100.58 mm).

The valve spring must stand within 1/16″ of vertical, on both ends, on a flat surface.

If the valve seats must be reground to adjust recession, installed valve spring height may be greater than specified [1.71 to 1.77 in. (43.4 to 45.0 mm)] and should be adjusted with shim(s) (part #C5NE6A526A), as shown in Figure 1A-11.

After resurfacing a cylinder head, be sure the head bolts will not bottom in the cylinder block. Temporarily install the head without the head gasket. Install the head bolts until they are snug and check with a 0.010″ feeler gauge to ensure that there is no gap between the head of the bolt and the surface of the cylinder head.



Valve Seat Dimensions **Figure 1A-12**

A Valve seat angle: 45°00′ - 45°30′ Exhaust 30°00′ 30°30′ inlet

B Valve seat width: Inlet 0.080-0.102 in. (2.032-2.590 mm) Exhaust 0.084-0.106 in. (2.133-2.692 mm)

C Valve head recession: Intake- 0.059-0.084 in. (1.5-2.3 mm) Exhaust - 0.059-0.084 in. (1.5-2.3 mm)

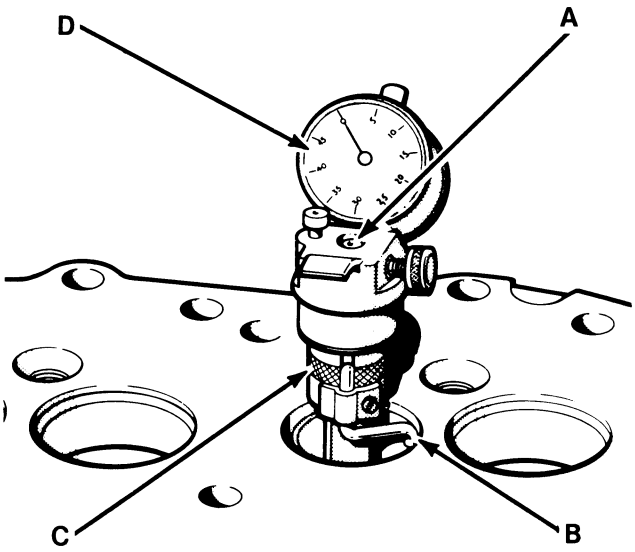
Valve Seats

1. Examine the valve seat inserts and reface if pitted, but renew if loose or damaged. If necessary, install an oversize insert by machining the seat counterbore in the cylinder head. See "Specifications" in this section. The insert must be chilled in dry-ice prior to installation.

   NOTE: Valve seat inserts of 0.010 in. (0.25 mm) and 0.020 in. (0.5 mm) oversize on diameter are sometimes installed in cylinder heads in production. Heads fitted with oversize inserts are stamped $^{SO10}_{OS}$ or $^{SO20}_{OS}$ on the exhaust manifold side in line with the valve seat concerned.

2. When replacing exhaust valve seat inserts be sure the replacement inserts are of the correct type as the size and material specification varies for the different engine types.

3. Check the width of the valve seat inserts and, if necessary, reface by grinding to the dimensions shown in Figure 1A-12.



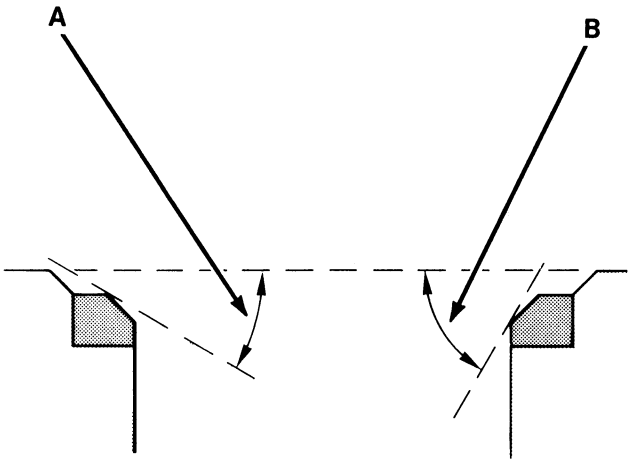
Valve Seat Concentricity **Figure 1A-13**

A Gauge pilot

B Pointer to ride on valve seat face

C Sleeve for rotating pointer

D Dial gauge



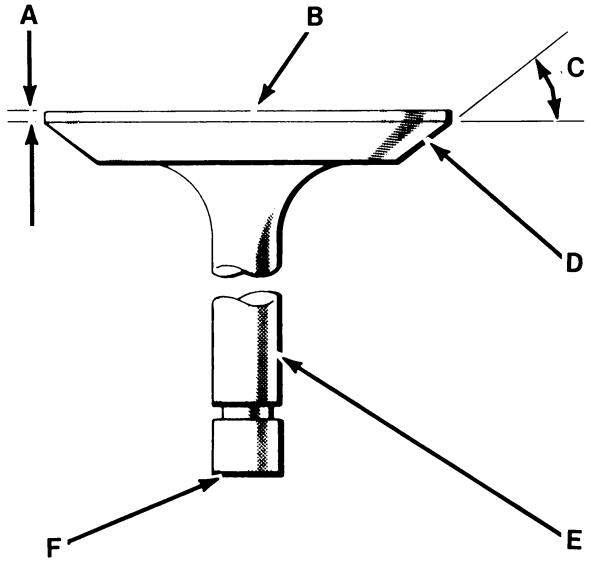
Raising/Lowering Valve Seats **Figure 1A-14**

A Use 30° or 15° grinding wheel for lowering the seat

B Use 60° or 45° grinding wheel for raising the seat

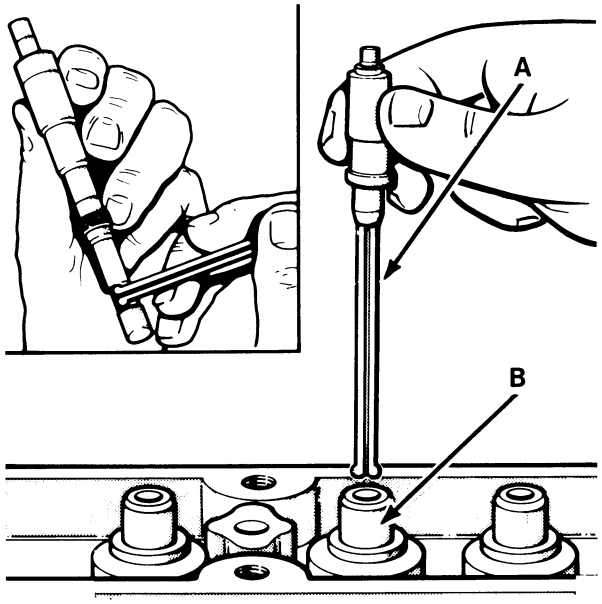
4. Measure the concentricity of the valve seat with a suitable gauge, as shown in Figure 1A-13. If the valve seat runout exceeds the specified figure, reface the seat.

5. Using a seat cutter with the correct angle, refer to Figure 1A-14 and "Specifications" in this section, remove only enough stock from the seat to clean up the pits and grooves, or to correct the seat eccentricity. After refacing, the seat width must be within the specified limit.



Critical valve measurements **Figure 1A-15**

A	Valve head margin	D	Valve face
B	Valve head	E	Valve stem
C	Valve face angle	F	Valve tip



Measuring Valve Guide **Figure 1A-16**

A Ball gauge
B Valve guide

6. If the refaced seat exceeds this width, narrow the seat by removing stock from the top or bottom of the seat. If the seat measures less than this width, widen the seat.

   NOTE: Refacing of the valve seat should always be co-ordinated with refacing of the valve to ensure a compression tight fit.

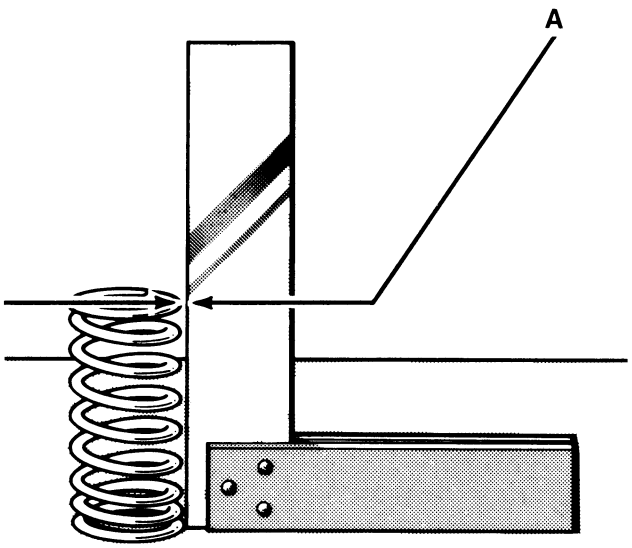
7. Coat the valve seat with Prussian Blue. Position the valve in the head and rotate several times. If the Prussian Blue is transferred to the middle of the valve face, Figure 1A-15, the contact is satisfactory.

8. Lower the valve seat by removing stock from the top of the seat with a 30° grinding wheel, Figure 1A-14. Raise the seat by removing stock from the bottom of the seat with a 60° grinding wheel.

Valve Guides

1. Using a ball gauge, A, Figure 1A-16, and micrometer, measure the valve to guide clearance. Measure the valve stem in several places with a micrometer and compare the measurements to determine the clearance. If the clearance exceeds the specified limits, ream the valve guide to fit the next oversize valve. See "Specifications" in this section.

NOTE: Production cylinder heads may have one or more 0.015 in. (0.38 mm) oversize valve guides and valves installed. Such cylinder heads have 15 or $^{VO15}_{OS}$ stamped on the exhaust manifold side of the head opposite the valve(s) concerned.



Valve Spring Squareness **Figure 1A-17**
A Maximum out-of-squareness 0.06 in. (1.52 mm)

2. Use Kit No. FNH02136 to ream out the valve guide to accept an oversize valve. The kit contains three reamers and pilot combinations as follows:

   - 0.003 in. (0.076 mm) Oversize Reamer and Standard Diameter Pilot.
   - 0.030 in. (0.76 mm) Oversize Reamer and 0.015 in. (0.38 mm) Oversize Pilot.
   - 0.015 in. (0.38 mm) Oversize Reamer and 0.003 in. (0.076 mm) Oversize Pilot.

   When going from a standard valve stem to an oversize, always use the reamers in sequence. After reaming a valve guide, check the valve seating and reface if necessary.

Valve Springs

1. Renew worn or damaged valve springs. Check for squareness and reject if out-of-squareness exceeds 0.060 in. (1.52 mm), Figure 1A-17. Check the free length and loaded length of each valve spring. See "Specifications" in this section. Be sure the valve spring retainer locks are in good condition.

CYLINDER HEAD — INSTALLATION

1. Attach a suitable lifting device to the cylinder head lifting brackets.

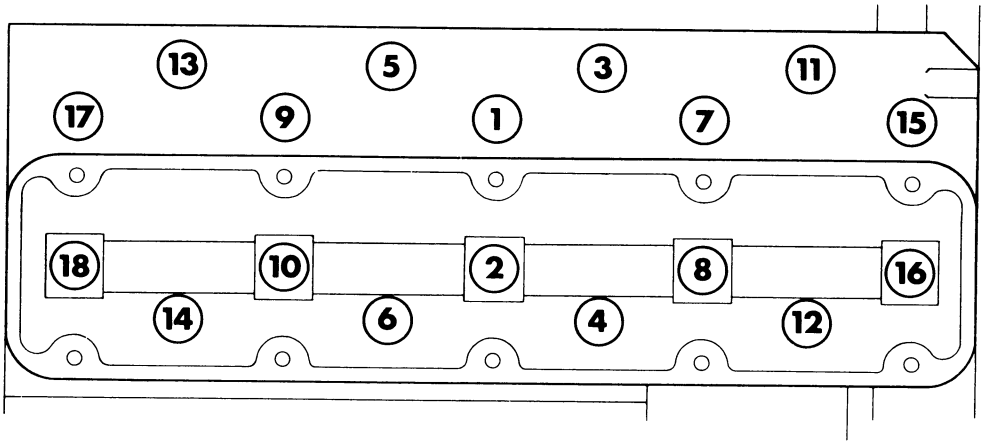
   NOTE: Be sure all traces of gasket material are removed from the head and the block prior to assembly. Failure to do so will cause inadequate sealing between the cylinder head and block. Make sure all cylinder head bolt holes are clean.

2. Place a new head gasket on the cylinder block, then carefully position the cylinder head on the gasket. Two dowels are on top of the cylinder block at opposite corners to aid in positioning the cylinder head and gasket.

3. Lubricate the cylinder head bolt threads with clean engine oil and install them finger-tight.

4. Install the valve push rods with the cupped ends up, in the holes in the cylinder head from which they were removed. Be sure the ball ends of the push rods are seated in the tappet sockets. Fill the cupped ends of the push rods with the specified engine oil.

5. Position the rocker shaft assembly on the cylinder head. Use the long cylinder head bolts with the rocker arm shaft. Make sure that the ball ends of the rocker arm adjusting screws are seated in the cupped ends of the push rods.



Cylinder Head Bolt Tightening Sequence

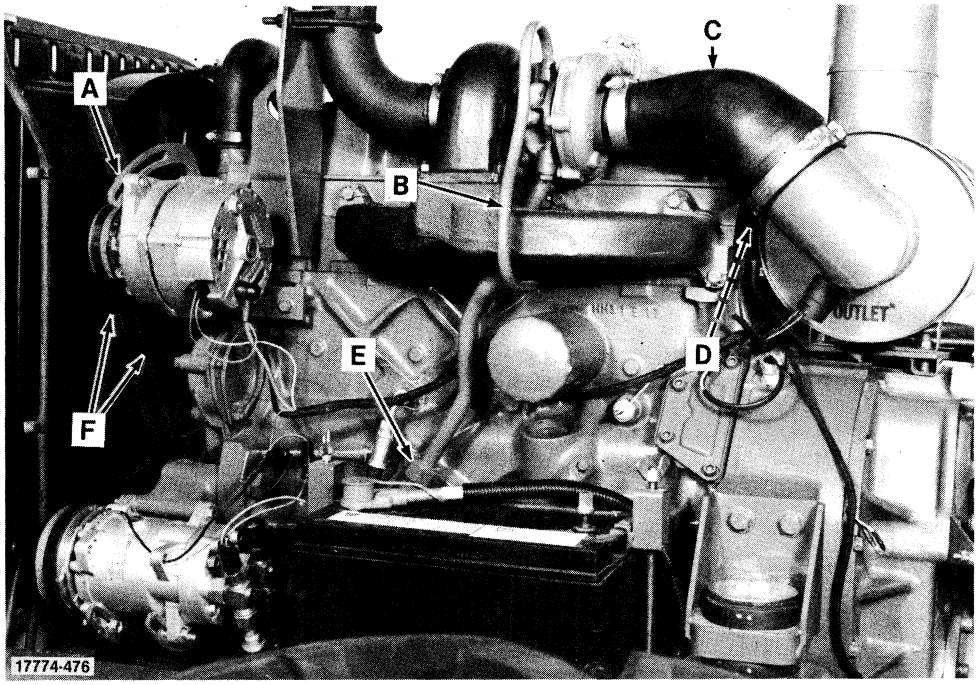
Figure 1A-18

6. Tighten and torque the head bolts in three steps (60, 120, 160 ft. lbs.), in the sequence shown in Figure 1A-18.

7. Set the valve lash. See "Valve Lash Adjustment" in this section.

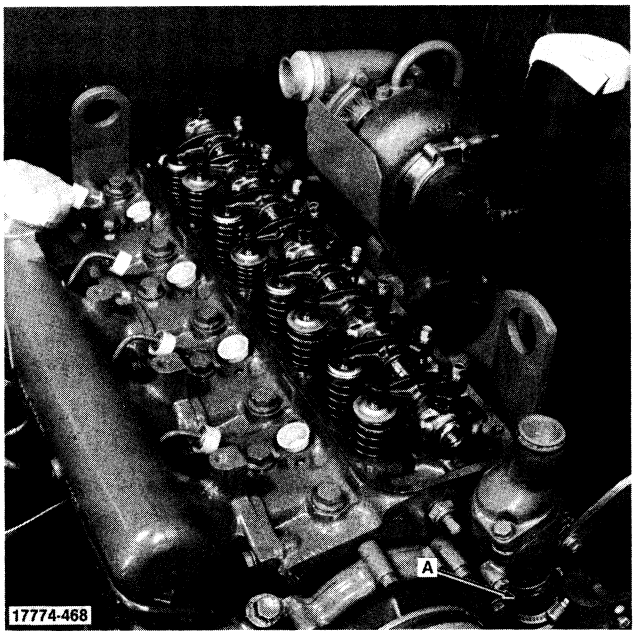
Exhaust Manifold Installation **Figure 1A-19**

8. Position a new exhaust manifold gasket on the cylinder head and install the exhaust manifold and turbocharger assembly, Figure 1A-19. Torque the nuts to 28 lbs.-ft. (38 N·m). Cross torque the nuts in three steps. Bend the locking tabs. Securely tighten the turbocharger oil pressure line, B, Figure 1A-20, and the oil return line, E.



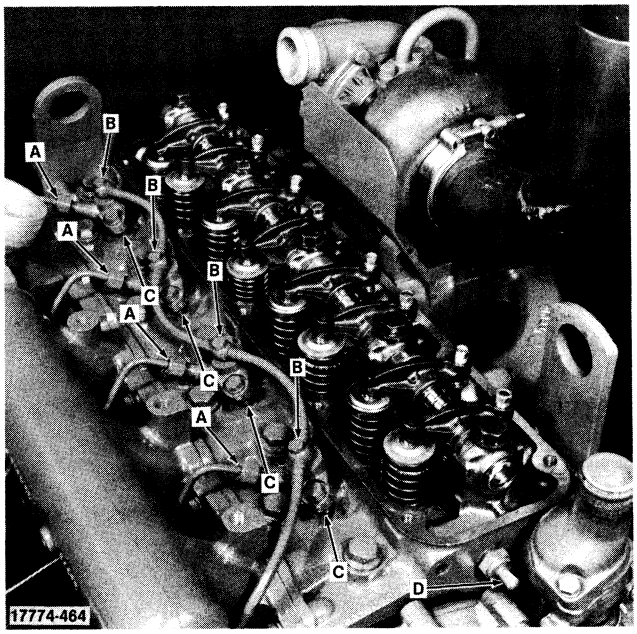
Engine Left Side **Figure 1A-20**

A Alternator adjustment bolt
B Turbocharger oil pressure line
C Turbocharger air inlet hose
D Thermo-Guard™
E Turbocharger oil return tube
F Alternator belts



Thermostat Bypass Hose **Figure 1A-21**

A Thermostat bypass hose



Top of Engine **Figure 1A-22**

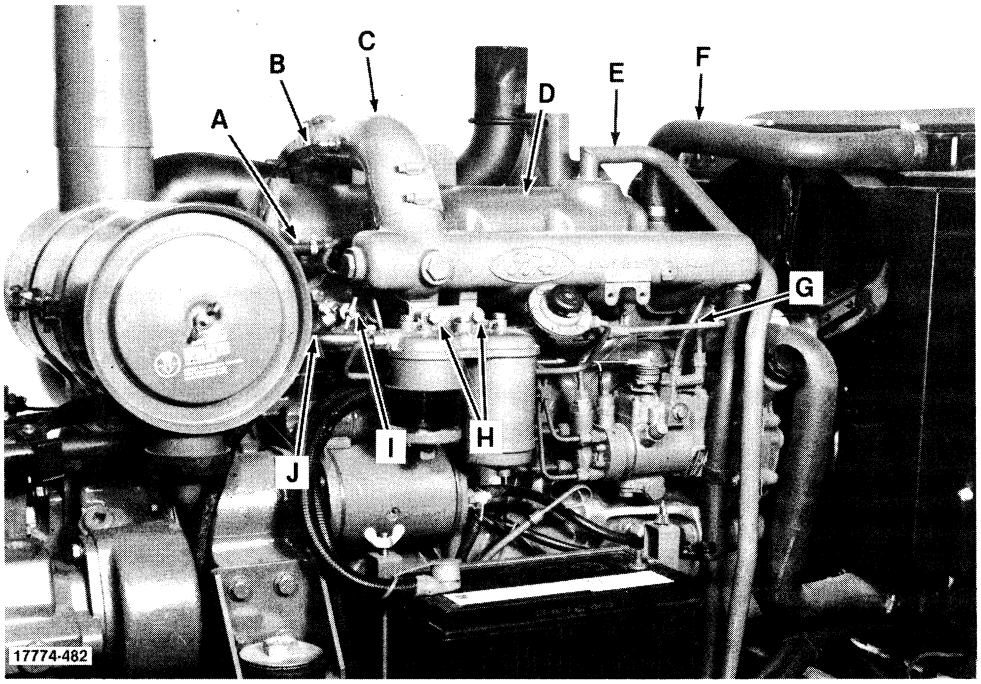
A Fuel injector lines
B Leak-off line banjo bolts
C Fuel injectors
D Coolant temperature sender

9. Position a new intake manifold gasket on the cylinder head and install the intake manifold, Figure 1A-21. Torque the bolts to 26 lbs.-ft. (35 N·m). Cross torque the bolts in two steps. Tighten the thermostat bypass hose clamp, A.

10. Install the fuel injectors, C, Figure 1A-22, with new seals. Install the leak-off line and torque the banjo bolts, B, to 4-5 lbs.-ft. (5.4-6.8 N·m).

11. Attach the fuel injector lines to the injectors and tighten securely.

12. Install the electrical lead, D, Figure 1A-22, to the sender.



Engine — Right Side **Figure 1A-23**

A	Leak-off line - rear	E	Road draft tube	I	Heater inlet valve
B	Cold start tube	F	Upper radiator hose	J	Heater inlet hose
C	Turbo transfer tube	G	Leak-off line - front		
D	Rocker cover	H	Bolts		

13. Position the fuel filters and secure with the two bolts, H, Figure 1A-23.
14. Install the upper radiator hose, F.
15. Install and tighten the front leak-off line, G, and the rear, A.
16. Install the heater inlet line, J, and open the heater valve, I.
17. Install a new gasket and the rocker cover, D. Install the crankcase breather tube, E.
18. Install the turbocharger crossover tube, C. Install the cold start tube, B.
19. Fill the radiator with approved coolant. See "Radiator - Installation" in this section. Connect the batteries.
20. Warm up the engine, cool it down, retorque the head; loosen 1/8 turn, then retorque to 160 lbs.-ft.
21. Install the hood and side panels. Install the muffler.

Valve Adjustment — Cold

NOTE: Valve lash should be checked and adjusted every 600 hours.

Valve adjustment is accomplished using the rocking method. The rocking method is performed by taking one of the cylinders and "rocking" it, while adjusting the valves on another cylinder. Follow this procedure.

1. Piston on exhaust stroke and exhaust valve opened (i.e., valve depressed).
2. Turn crankshaft in the direction of rotation until the exhaust valve comes up and the intake valve begins to open.
3. Move the crankshaft back slightly to the point where neither the exhaust nor the intake valve is opened (i.e., depressed). Both rocker arms will "ROCK", indicating TDC between the intake and exhaust strokes.
4. At this point, another cylinder is at TDC in between the compression stroke and power stroke and is ready to be adjusted.