bobcat

ENGINE SERVICE (200 Series)

Continued on Next Page

7B ENGINE SERVICE - PERKINS (200 Series)

TROUBLESHOOTING

The following troubleshooting chart is provided as an assistance in locating and correcting problems which are most common. Many of the recommended procedures must be done by authorized Bobcat Service Personnel only.

PROBLEM	CAUSE
Slow cranking speed.	1, 2, 3, 4
Engine will not start.	2, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 30, 31, 32
Difficult to start.	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 28, 30, 31, 32
No power from engine.	8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 23, 24, 25, 26, 30, 31, 32
Engine is mis-firing.	8, 9, 10, 12, 13, 14, 16, 18, 19, 20, 24, 25, 27, 28, 29, 31
Too much fuel consumption.	11, 13, 14, 18, 19, 20, 22, 23, 24, 26, 27, 28, 30, 31, 32
Black exhaust.	11, 13, 14, 16, 18, 19, 20, 22, 23, 24, 26, 27, 28, 30, 31, 32
Blue/white exhaust.	4, 11, 18, 19, 20, 24, 26, 30, 32, 33, 53
Low oil pressure.	4, 34, 35, 36, 37, 38, 40, 42, 55
Engine knocking.	9, 14, 16, 18, 19, 22, 25, 27, 28, 30, 32, 34, 43, 44, 56
Engine running rough.	7, 8, 9, 10, 11, 12, 13, 14, 16, 20, 21, 25, 27, 28, 29, 32, 43, 56
Vibration.	13, 14, 20, 24, 25, 28, 29, 32, 43, 45, 46
High oil pressure.	4, 36, 39
Overheating.	11, 13, 14, 16, 18, 19, 23, 24, 43, 47, 48, 49, 50, 54
Too much crankcase pressure.	25, 30, 32, 33, 43, 52
Poor compression.	11, 19, 24, 27, 28, 30, 31, 32, 33, 44, 56
Start and stop.	10, 11, 12

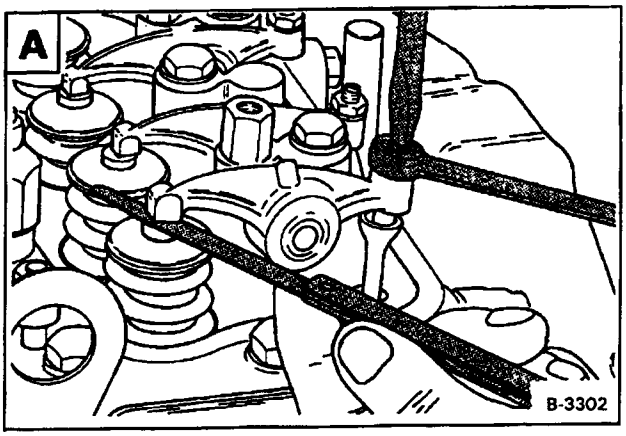
KEY TO CORRECT THE CAUSE	
1. Battery capacity low.	29. Incorrect high pressure fuel pipes.
2. Bad electrical connections.	30. Worn cylinder bores.
3. Faulty starter motor.	31. Worn valves and seats.
4. Incorrect grade of oil.	32. Broken, worn or sticking piston rings.
5. Low cranking speed.	33. Worn valve stems or guides.
6. Fuel tank empty.	34. Worn or damaged bearings.
7. Faulty stop control operation.	35. Not enough oil in the oil pan.
8. Plugged fuel line.	36. Switch is defective.
9. Faulty fuel lift pump.	37. Oil pump worn.
10. Plugged fuel filter.	38. Pressure relief valve is sticking open.
11. Restriction in the air cleaner.	39. Pressure relief valve is sticking closed.
12. Air in fuel system.	40. Broken relief valve spring.
13. Faulty fuel injection pump.	41. Faulty suction pipe.
14. Faulty fuel injectors.	42. Plugged oil filter.
15. Incorrect use of ether start unit.	43. Piston seizure.
16. Faulty ether start unit.	44. Incorrect piston height.
17. Broken fuel injection pump drive.	45. Faulty engine mounting.
18. Incorrect fuel injection pump timing.	46. Incorrect alignment of flywheel.
19. Incorrect valve timing.	47. Faulty thermostat.
20. Poor compression.	48. Restriction in the water jacket.
21. Plugged fuel tank vent.	49. Loose alternator belt.
22. Incorrect type or grade of fuel.	50. Plugged radiator.
23. Exhaust pipe restriction.	51. Faulty water pump.
24. Cylinder head gasket leaking.	52. Plugged breather pipe.
25. Overheating.	53. Damaged valve stem oil deflectors.
26. Cold running.	54. Coolant level to low.
27. Incorrect tappet adjustment.	55. Plugged oil pump pipe strainer.
28. Sticking valves.	56. Broken valve spring.

VALVE CLEARANCE

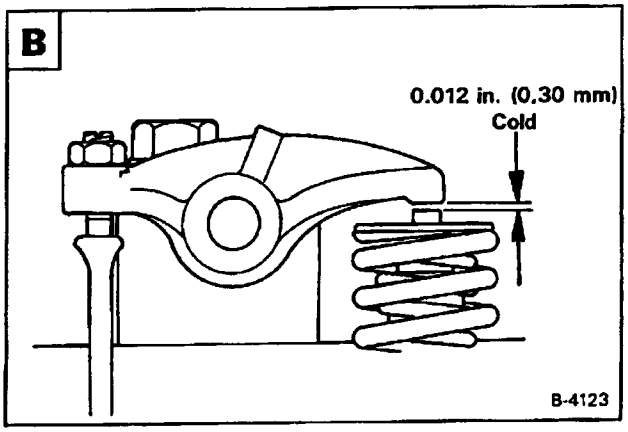
Adjustment

Make the valve clearance adjustment with engine stopped and cold.

Put the correct size feeler gauge between the rocker arm and the valve stem and turn the adjusting bolt until the clearance is correct [A].



The correct clearance is 0.012" (0,30 mm) with the engine cold [B].



Use the following sequence to set the valves:

a. With the rocker arms rocking at No. 4 , set clearance at No. 1 valves.

b. With the rocker arms rocking at No. 2, set clearance at No. 3 valves.

c. With the rocker arms rocking at No. 1, set clearance at No. 4 valves.

d. With the rocker arms rocking at No. 3, set clearance at No. 2 valves.

ENGINE COMPRESSION

Checking

The tool listed will be needed to do the following procedure:

MEL-10630 — Engine Compression Kit

The engine must be at operating temperature.

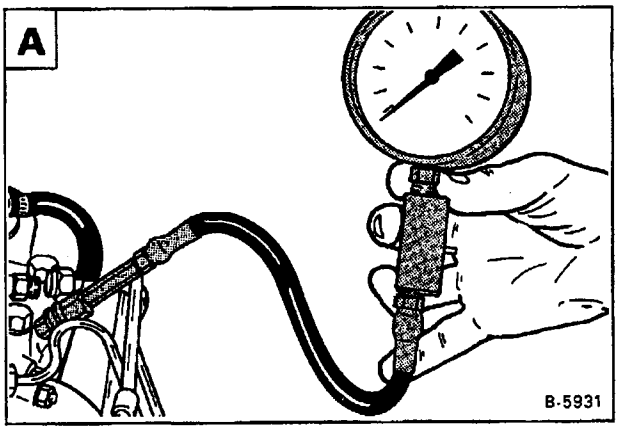
Remove the fuel injectors (See Page 7B—11).

Install the correct compression adapter into the engine.

Connect the compression gauge [A].

The engine must be turning at about 300 RPM.

The compression must be between 300 - 500 PSI (2069 - 3448 kPa), with no more than 50 PSI (345 kPa) difference between cylinders.



FUEL FILTER (S/N 13315 & Below)

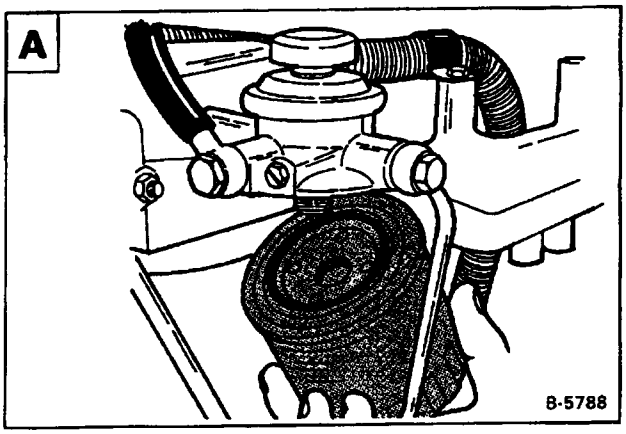
Removal and Installation

See the Service Schedule (Page 1—1) for the correct service sequence when replacing the fuel filter.

Clean the area around the fuel filter. Remove the fuel filter [A] using a filter wrench.

Lubricate the seal before installation.

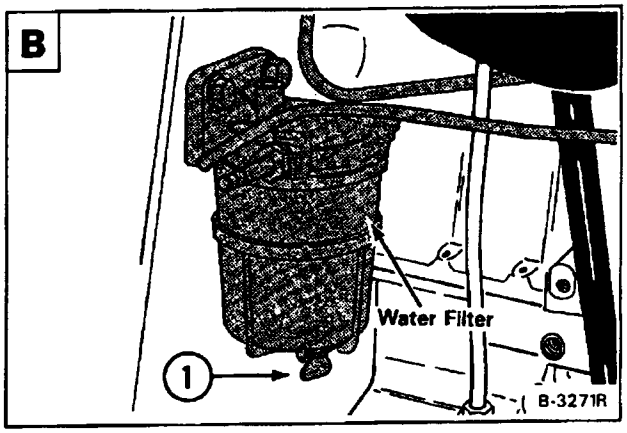
Remove the air from the fuel system (See Page 7B—5).



Water Trap

The water trap is located between the fuel tank and the fuel filter. See the Service Schedule (Page 1—1) for the correct service sequence when cleaning the water trap.

To clean the water trap: Loosen the thumb screw (Item 1) at the bottom of the filter and drain the water from the filter [B]. Tighten the thumb screw when all the water is removed.



FUEL FILTER (S/N 13316 & Above)

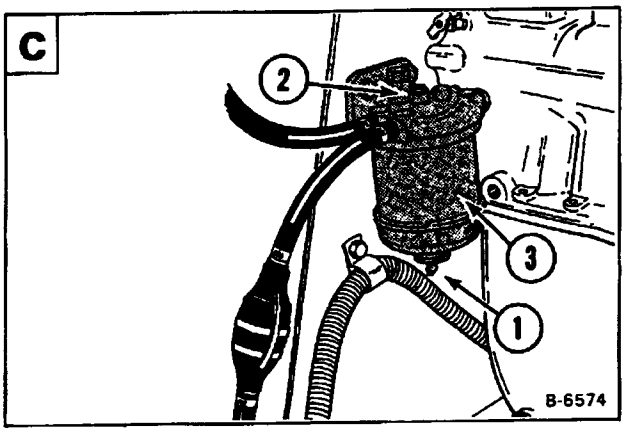
Removal and Installation

Clean the area around the fuel filter. Close the shut-off valve at the fuel tank. Remove the thumb screw (Item 1) to drain the fuel from the filter [C].

Remove the bolt (Item 2) at the top of the filter, while holding the nut below the filter bowl. Remove the filter element (Item 3) and bowl [C].

Lubricate the seal before installing the fuel filter element.

Remove the air from the fuel system (See Page 7B—6).



Water Trap

Loosen the thumb screw (Item 1) and drain the bowl until the water is removed [C].

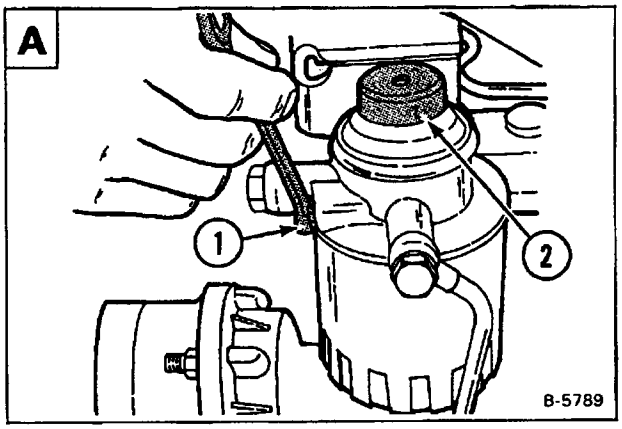
REMOVING AIR FROM THE FUEL SYSTEM (S/N 13315 & Below)

Procedure

Loosen the vent plug (Item 1) [A].

Operate the priming pump (Item 2) until the fuel, which flows from the vent, shows no air bubbles.

Holding the priming pump down, tighten the vent plug (Item 1) [A].



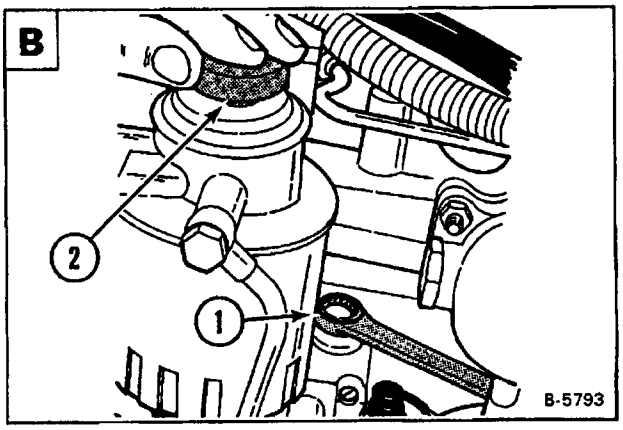
Loosen the tubeline connection (Item 1) at the fuel injection pump [B].

Operate the priming pump (Item 2) until the fuel which flows from the tubeline connection shows no air bubbles [B].

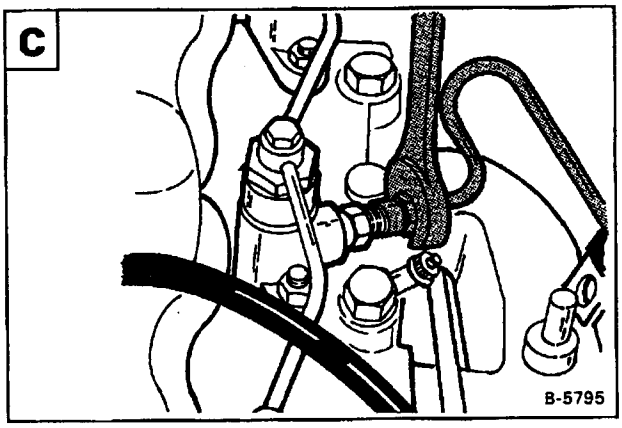
Holding the priming pump down, tighten the tubeline connection.

Loosen the fittings at the fuel injector high pressure lines.

Move the throttle to half open position. Turn the engine with the starter until fuel shows at the fittings.



Tighten the fittings at the high pressure lines to 15 ft.-lbs. (20 Nm) torque [C].



REMOVING AIR FROM THE FUEL SYSTEM (S/N 13316 & Above)

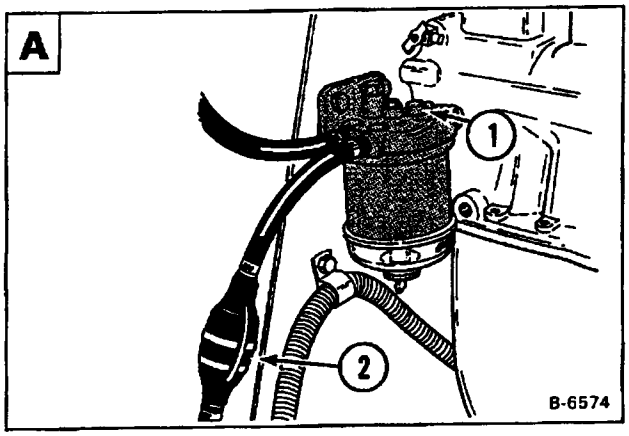
Procedure

Open the vent plug (Item 1) [A].

Operate the hand pump (Item 2) until the fuel flows from the vent plug with no air bubbles [A].

Tighten the vent plug.

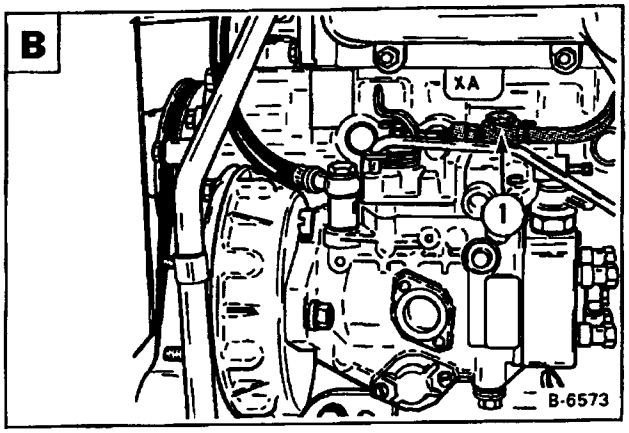
Operate the hand pump (Item 2) until it feels solid [A].



Loosen the tubeline connection (Item 1) [B].

Operate the hand pump until the fuel flows from the tubeline connection with no air bubbles.

Start the engine. When the engine runs smoothly, tighten the tubeline connection [B].



FUEL INJECTION PUMP

The injection pump contains parts which have very close tolerances and its operation has a direct effect on the performance of the engine.

IMPORTANT

If you do not have the correct equipment and trained personnel, adjustment or maintenance must not be done.

I-2028-0284

Removal and Installation

The tool listed will be needed to do the following procedure:

MEL-1200 — Puller

Disconnect the throttle control linkage (Item 1) from the injection pump [A].

Disconnect the wire at the fuel shut-off solenoid [B].

Disconnect the high pressure fuel lines at the injection pump.

IMPORTANT

Do not bend the tubelines when removing or installing them on the injector pump or on the injectors.

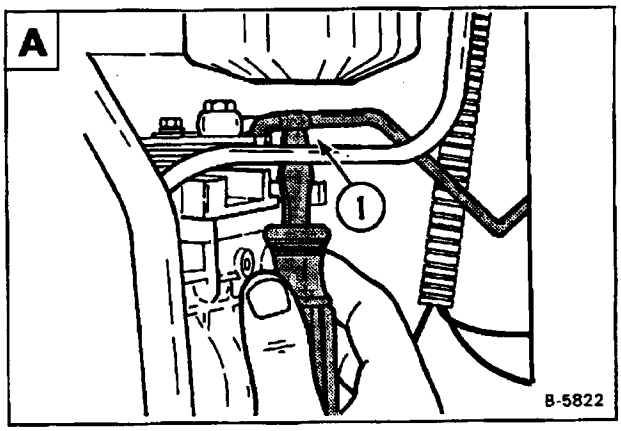
I-2029-0284

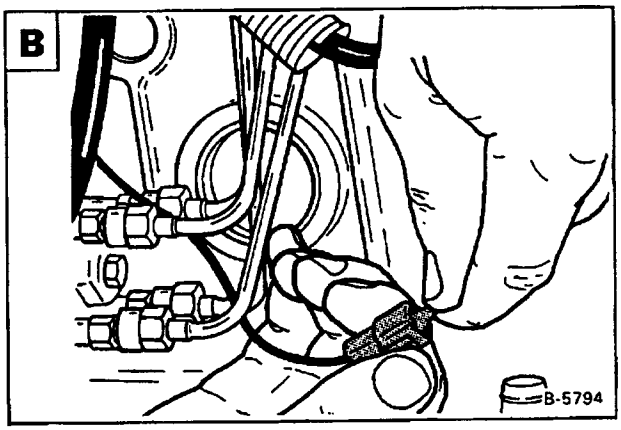
Remove the pump support bracket at the bottom of the pump [C].

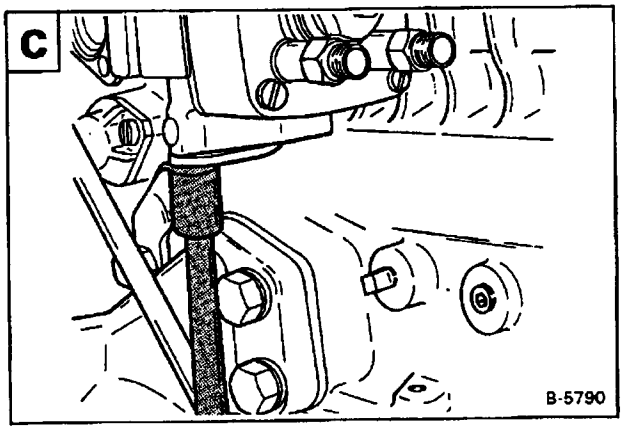
Remove the valve cover. Turn the engine crankshaft until both valves at No. 4 cylinder are moving.

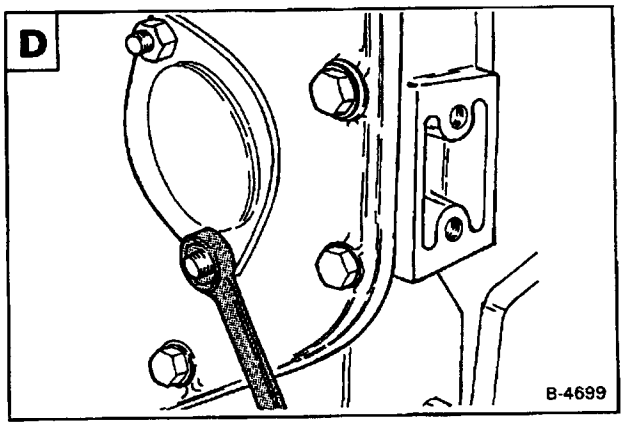
NOTE: Make sure the valves on No. 4 cylinder are both open. This will put the key for the injection pump at the top so that the key will not fall into the timing case when the pump is removed.

Remove the cover from the timing case cover [D].







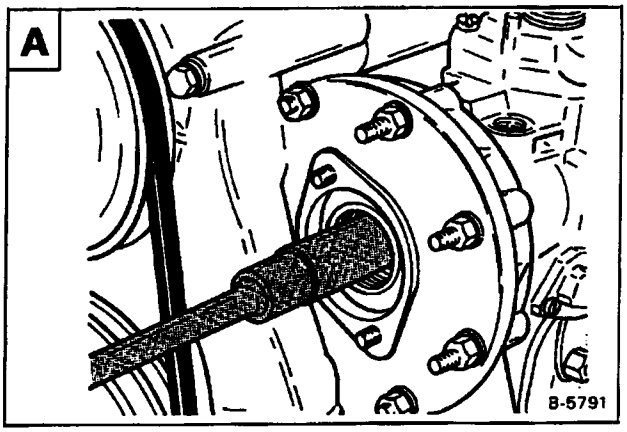


FUEL INJECTION PUMP (Cont'd)

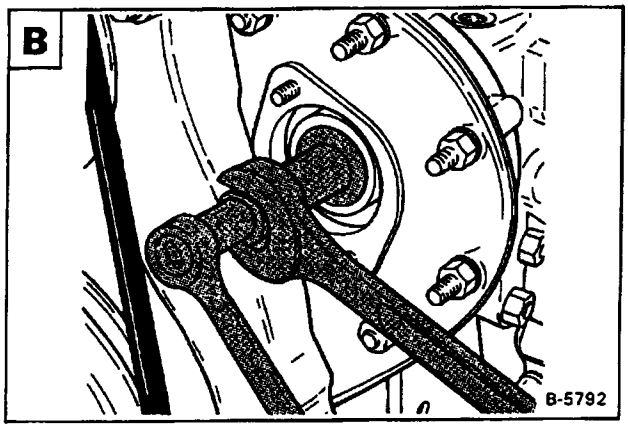
Remove the gear nut and spring washer [A].

Installation: Tighten the nut to 50 ft.-lbs. (69 Nm) torque.

Remove the nuts at the pump mounting flange.



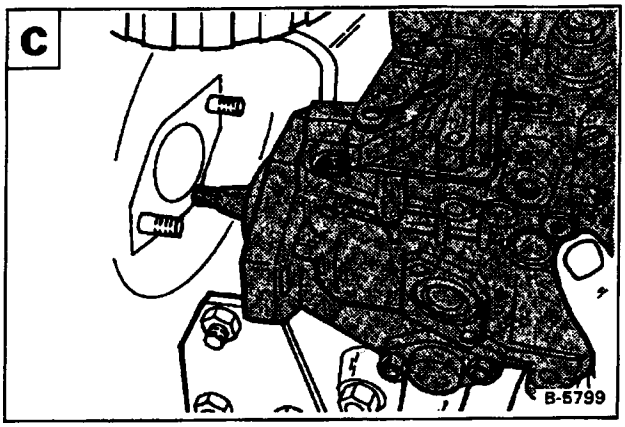
With the injection pump supported, loosen the pump gear using the special tool [B].



Remove the injection pump from the engine [C].

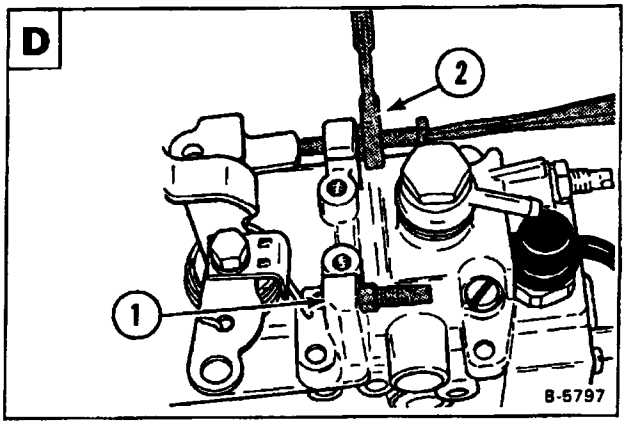
NOTE: Make sure that the key does not drop off the shaft and into the timing gears.

Installation: Make sure the key enters the keyway of the gear. Align the timing marks and tighten the nuts at the mounting flange.



Maximum Speed Setting

The maximum speed screw (Item 1) is set by the manufacturer [D]. Any adjustment must be done by an experienced fuel injection technician. The idle speed screw (Item 2) can be adjusted to give the engine idle RPM of 500 - 600 RPM at normal operating temperature [D].



TIMING THE FUEL INJECTION PUMP

Procedure

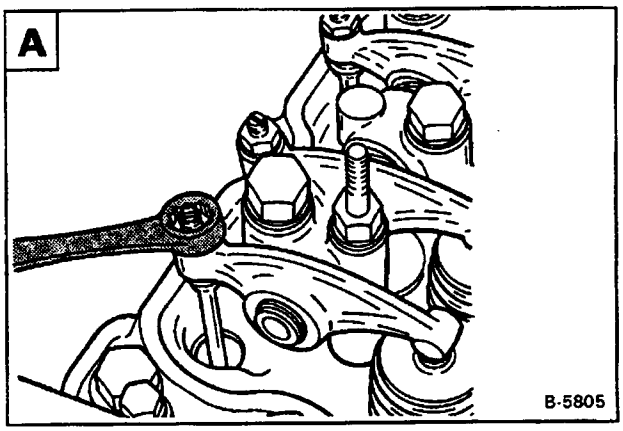
The tool listed will be needed to do the following procedure:

MEL-1201 — Timing Tool

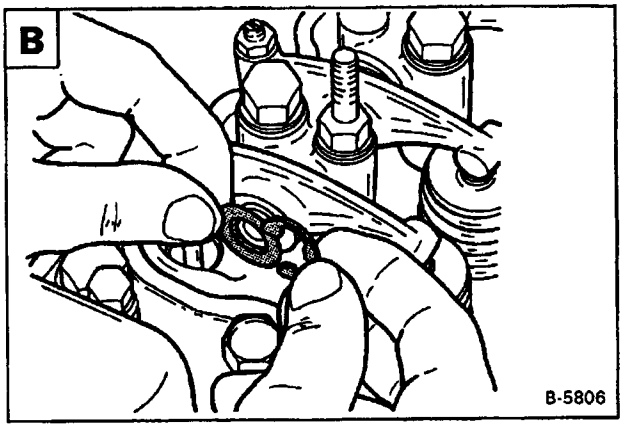
Remove the valve cover.

Turn the engine crankshaft until No. 1 piston is at TDC on the compression stroke. Both valves at No. 4 cylinder are moving.

Loosen the adjustment bolt at the rocker arm intake valve [A].

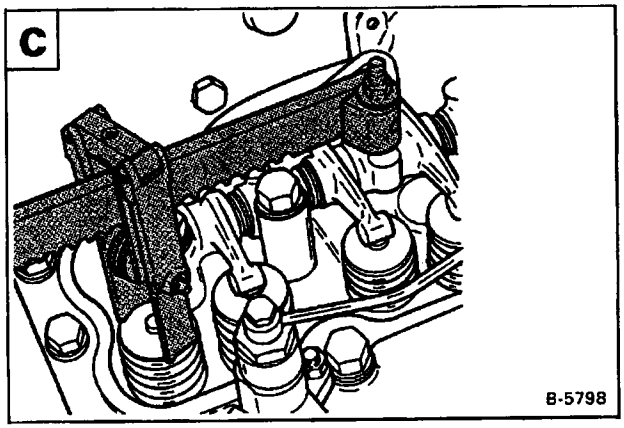


Remove the snap ring at the end of the rocker arm shaft and remove the rocker arm [B].



Remove the valve spring [C].

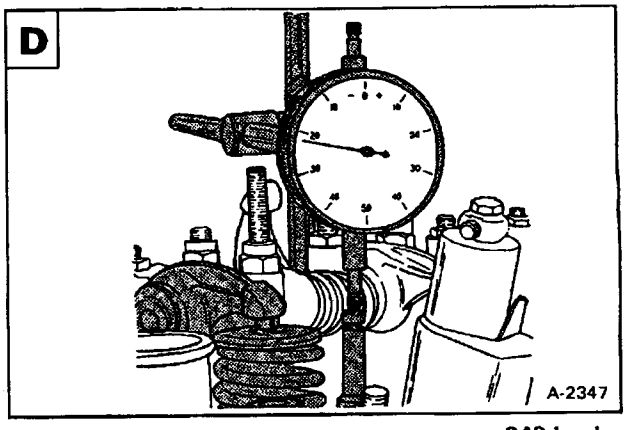
Put the valve head on the top of the piston crown.



Install a dial indicator on the top of the valve stem [D].

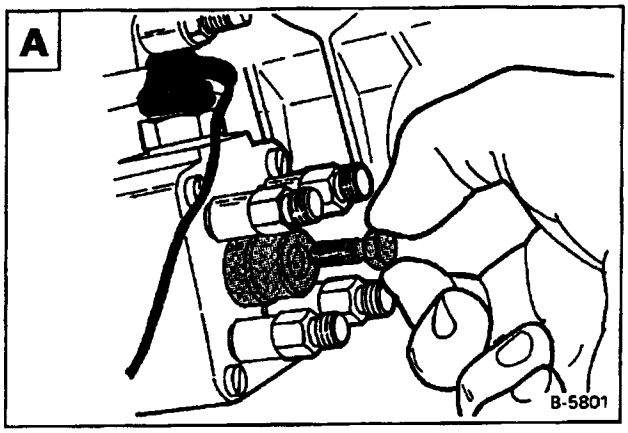
Turn the engine crankshaft backward and forward a small amount to find TDC (maximum piston height) and zero the dial indicator.

Remove the high pressure fuel lines from the injection pump.

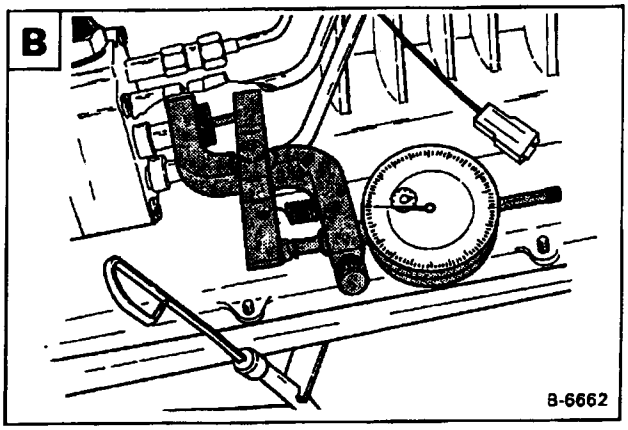


TIMING THE FUEL INJECTION PUMP (Cont'd)

Remove the plug and washer at the rear of the injection pump [A].



Install the timing tool and dial indicator so the plunger of the timing tool is against the pump plunger and dial indicator reads approximately 0.08" (2,0 mm) [B].



Slowly turn the engine crankshaft counterclockwise until the plunger of the timing tool reaches its maximum travel (minimum plunger lift) and set the dial indicator to zero.

Turn the crankshaft clockwise until No. 1 piston is at TDC and the dial indicator at the intake valve reads zero.

Check the reading on the timing tool. If it reads 0.0386 - 0.0402" (0,98 - 1,02 mm) plunger lift, the injection pump timing is correct.

If the timing is not correct, do the following procedure:

a. Disconnect the low pressure fuel line.

b. Loosen the flange nuts and support bracket bolt.

c. If the dial indicator reads more than 0.0402" (1,02 mm), turn the pump counterclockwise (viewed from the rear) until 0.0394" (1,0 mm) plunger movement is indicated. Tighten the nuts and bolt.

d. If the dial indicator reads less than 0.0386 " (0,98 mm), turn the pump clockwise (viewed from the rear) past the 0.0394" (1,0 mm) and counterclockwise to 0.0394" (1,0 mm). Tighten the nuts and bolt.

Turn the crankshaft a small amount in each direction and back to TDC. Check the timing again.

FUEL INJECTOR NOZZLES

⚠ WARNING

Diesel fuel or hydraulic fluid under pressure can penetrate the skin or eyes causing serious injury. Fluid leaks under pressure may not be visible. Use a piece of cardboard or wood to find leaks. Do not use bare hand. Wear safety goggles. If fluid enters skin or eyes, get immediate medical attention.

W-2074-1285

Problems caused by faulty injector nozzles:

The engine is hard to start or will not start.

Rough engine operation and idle.

The engine will not have full power.

The engine exhaust smoke is black, white or blue.

Removal and Installation

Remove the high pressure fuel lines (Item 1) [A].

IMPORTANT

Do not bend the tubelines when removing or installing them on the injector pump or on the injectors.

I-2029-0284

Remove the fuel return line (Item 2) [A].

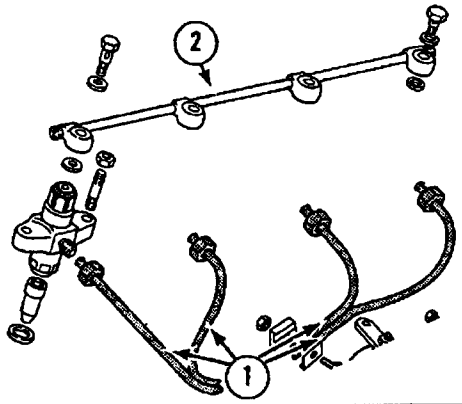
Remove the nuts from the mounting flange [B].

Installation: Tighten the nuts to 12 ft.-lbs. (16 Nm) torque [C].

Remove the fuel injector nozzles from the cylinder head.

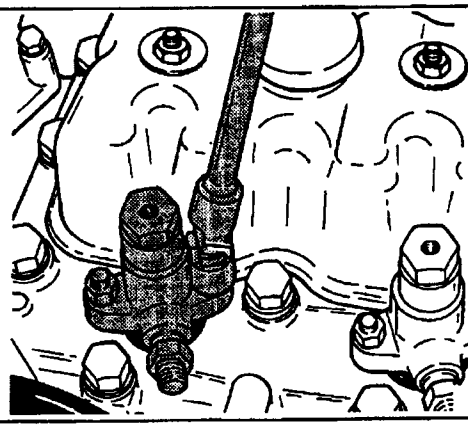
Installation: Always replace the copper washer (Item 1) with a new copper washer when installing the fuel injector nozzle [D].

A



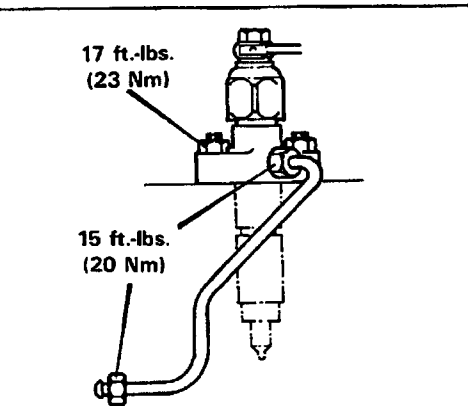
C-2635

B



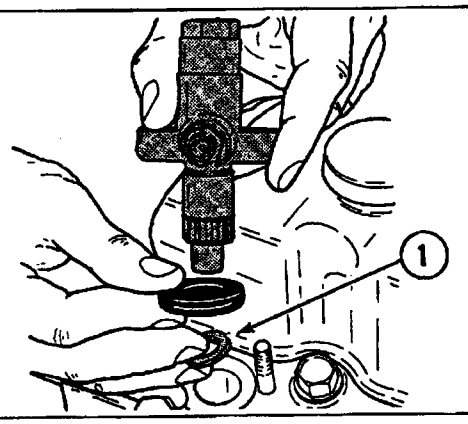
B-5803

C



A-2668

D



A-2846

FUEL INJECTOR NOZZLES (Cont'd)

Checking

IMPORTANT

Do not disassemble or test the fuel injector nozzles unless you have the correct service and testing tools.

I-2027-0284

The tools listed will be needed to do the following procedure:
MEL-10018 — Injector Nozzle Tester
MEL-10019 — Accessory Set

Connect the nozzle to a test pump in a down position [A].

Operate the test pump until the nozzle valve opens:

NOZZLE PRESSURE - 1920 PSI (13238 kPa)

If the pressure is not correct, replace or clean the nozzle.

Check for inside leakage:

Operate the test pump to almost opening pressure. Record the pressure and check the pressure decrease for six seconds. The nozzle has a defect if the pressure decrease is more than 740 PSI (5163 kPa).

⚠ WARNING

Do not test fuel injector nozzles unless you have correct service and testing tools. Keep away from fuel coming from the nozzles. Wear safety goggles. Fuel under pressure can penetrate skin or eyes causing serious injury. If fuel enters skin or eyes, get immediate medical attention.

W-2075-1285

Checking nozzle spray pattern [B]:

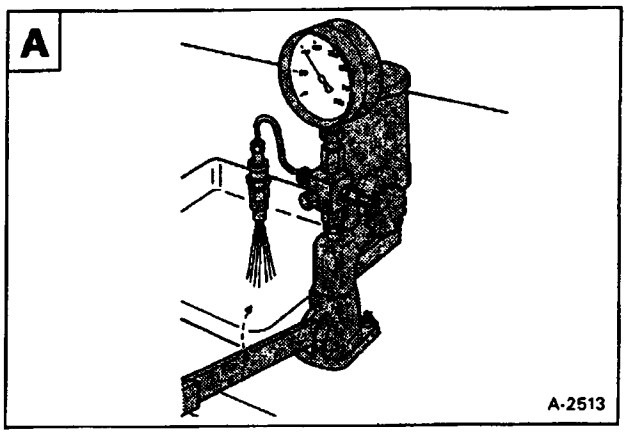
Does not come out the side of nozzle.

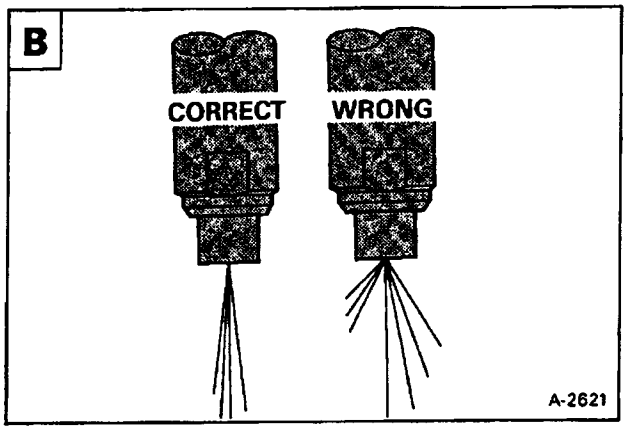
Does not have drops coming from nozzle.

Does not have a solid stream coming from the nozzle.

Any of the above conditions show a defect or dirty injector nozzle.

Clean or replace any nozzle that does not operate correctly.





GLOW PLUGS

Checking

IMPORTANT

The bar that connects the four glow plugs together is energized when the glow plugs are in use. Keep all pipes, clips and other metal objects away from the bar.

Check the glow plug continuity, use the following procedure:

Remove the bar from the glow plugs.

Connect a 12V/6W test lamp to the positive (+) battery terminal. Make sure the test lamp works.

Connect the test lamp to the top of each glow plug, if test lamp is illuminated the glow plug is good.

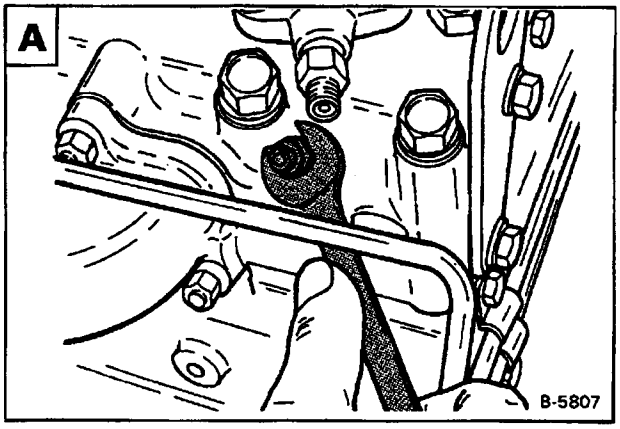
If the test lamp does not illuminate, remove the glow plug [A][B].

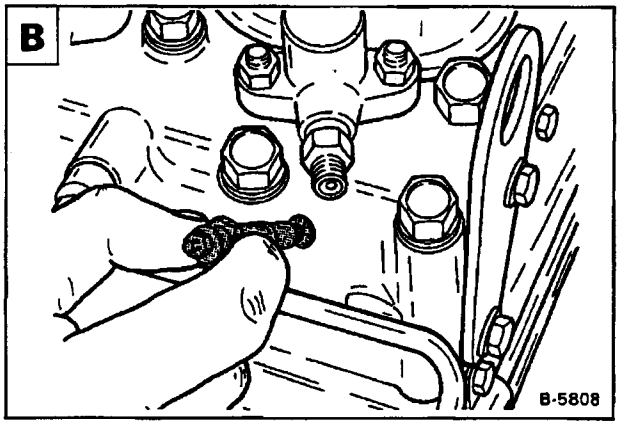
Installation: Tighten the glow plug to 11 ft.-lbs. (15 Nm) torque.

Check the electrical supply to the glow plugs, use the following procedure:

Connect a 12V/6W test lamp at the glow plug farthest from the supply connection. Connect the other end of the test lamp to ground (-).

Turn the ignition switch to the "HEAT" position, the test lamp must illuminate. If the test lamp does not illuminate, check the switch and electrical connections.





ENGINE

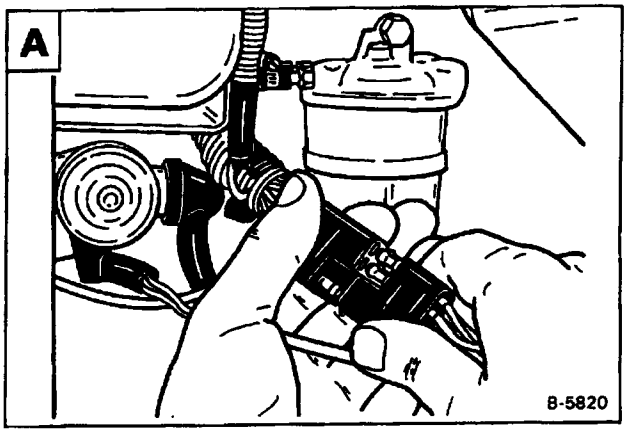
Removal and Installation

Lift and block the loader (See Page 1—2 for the correct procedure).

Raise the operator cab (See Page 1—7 for the correct procedure).

Remove the batteries from the loader (See Page 6—2 for the correct procedure).

Disconnect the engine wiring harness [A].

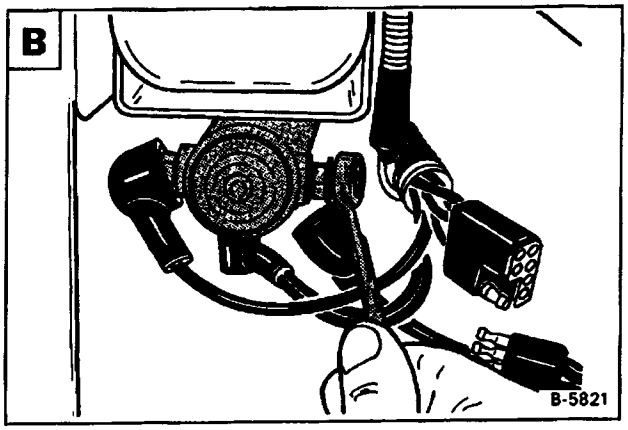


Disconnect the wires at the two solenoids [B].

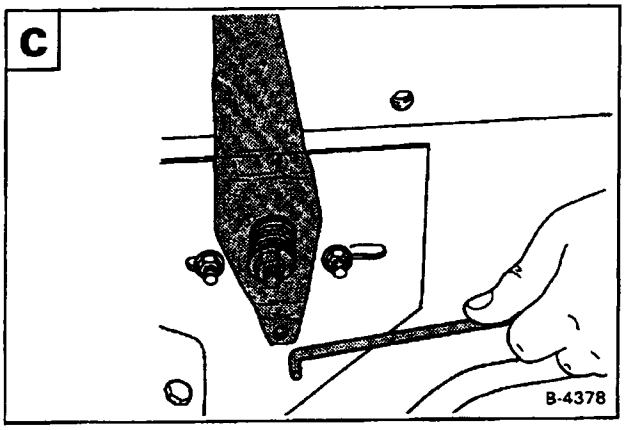
NOTE: Mark the wires for correct installation.

Disconnect the ground wire at the left side of the engine.

Disconnect the air cleaner hose at the intake manifold.



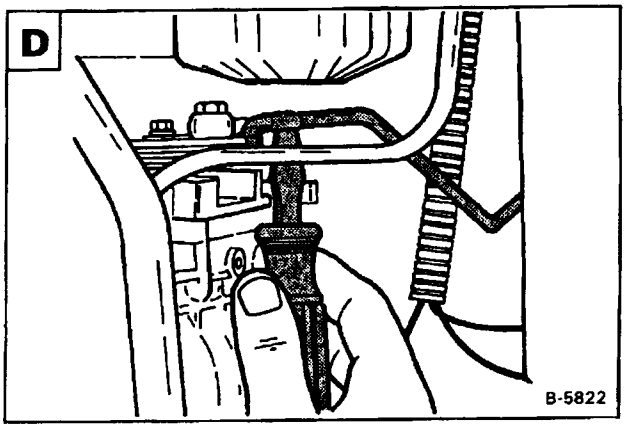
Disconnect the throttle linkage at the throttle lever [C].



Disconnect the throttle linkage at the fuel injection pump [D].

Remove the bolt and nut at the cross lever and remove the throttle linkage assembly.

Remove the rear grill.



ENGINE (Cont'd)

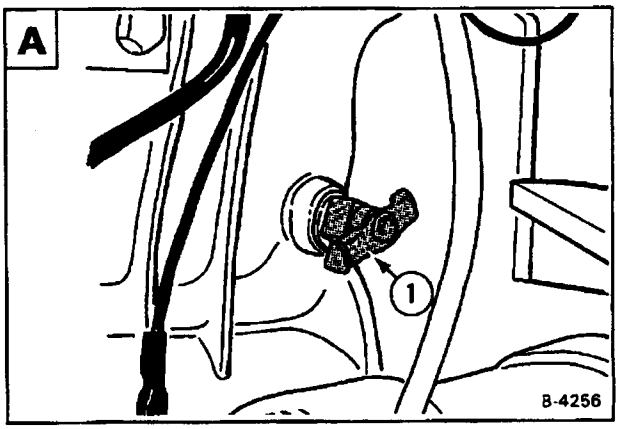
Remove the radiator cap.

Open the coolant drain at the engine block (Item 1) [A]. Put a hose over the end of the coolant drain and drain into a container.

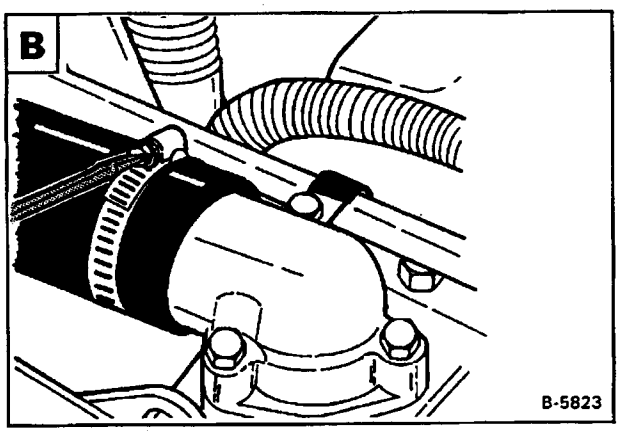
Turn the fuel shut-off valve to the "OFF" position at the fuel tank.

Disconnect the fuel line at the fuel filter.

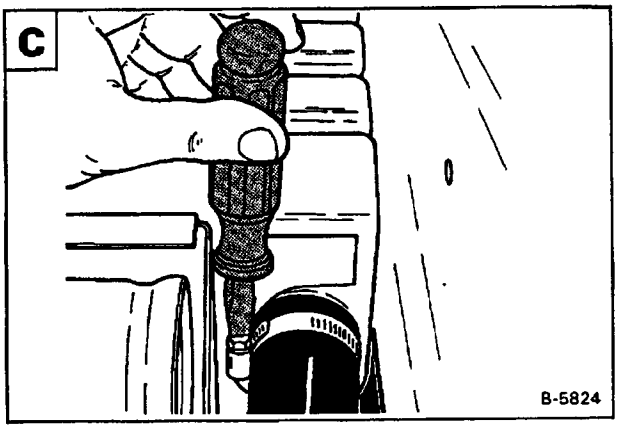
Disconnect the fuel return lines at the fuel injectors.

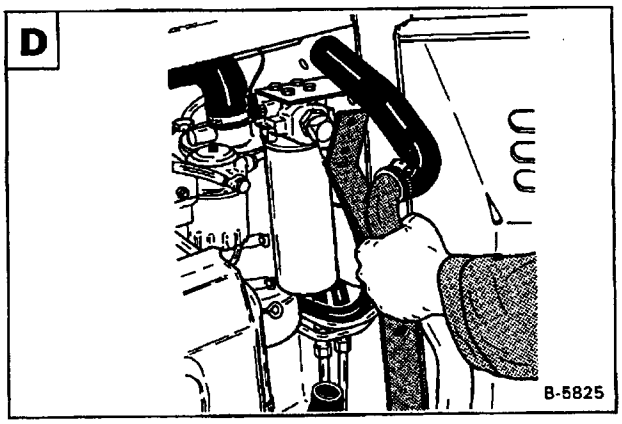


Disconnect the radiator hoses at the engine and radiator [B][C].



Remove the coolant pipe and radiator hose [D].

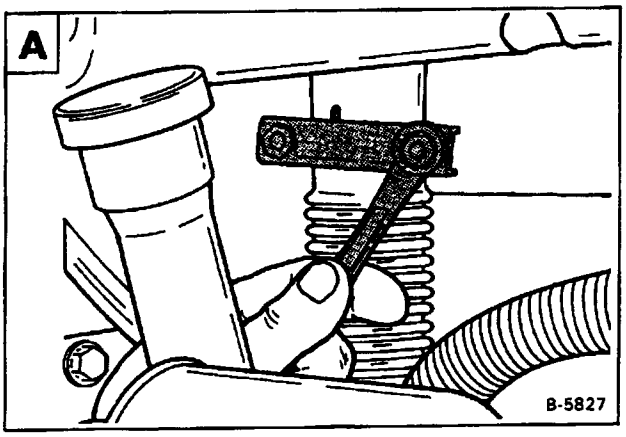




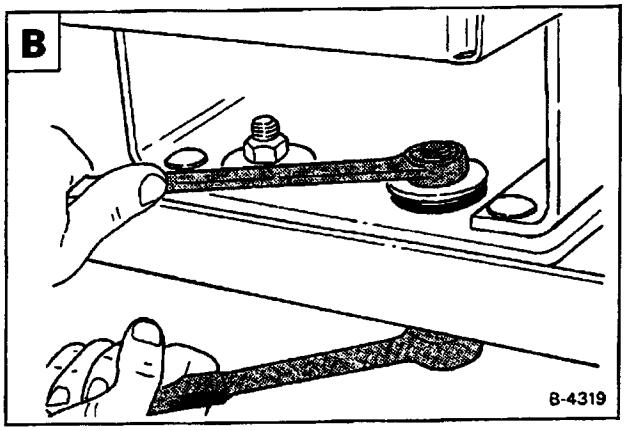
ENGINE (Cont'd)

Disconnect the exhaust pipe at the exhaust manifold.

Disconnect the exhaust pipe at the muffler [A].



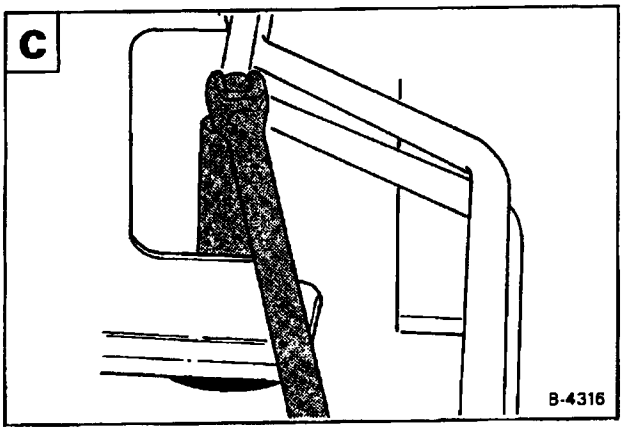
Remove the rear engine mounting bolts, washers and nuts [B].



Remove the front engine mounting bolts, washers and nuts [C].

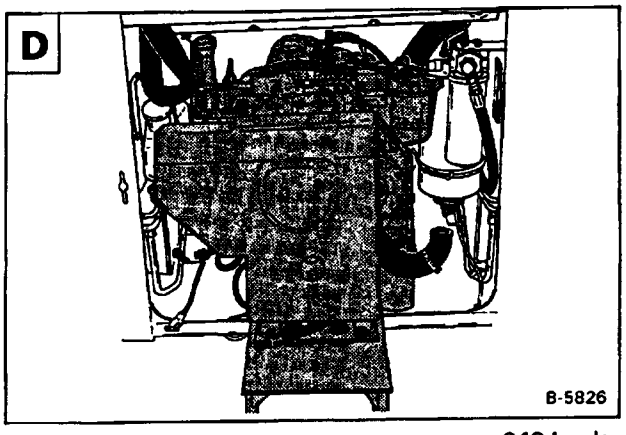
Installation: Add liquid ahesive (LOCTITE) to the bolt threads and tighten to 125 - 140 ft.-lbs. (169 - 190 Nm) torque.

Lift the rear of the engine over the edge of the loader frame.



Slide the engine out of the loader [D].

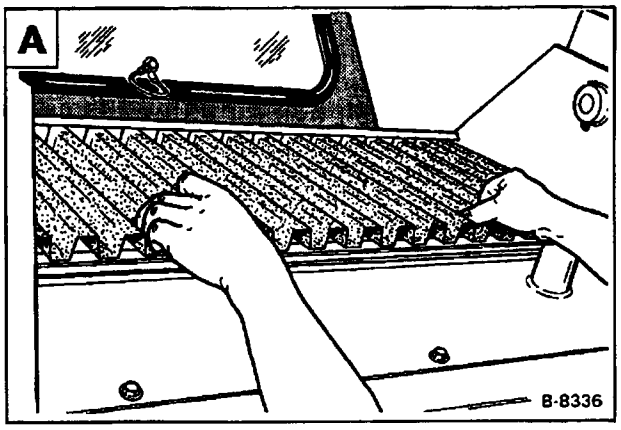
Installation: Move the engine into the loader until the universal joint is in the blower housing. Have a second person reach behind the blower housing (at the hydrostatic pump) and guide the universal joint unto the splines of the hydrostatic pump shaft, while the engine is moved toward the front of the loader.



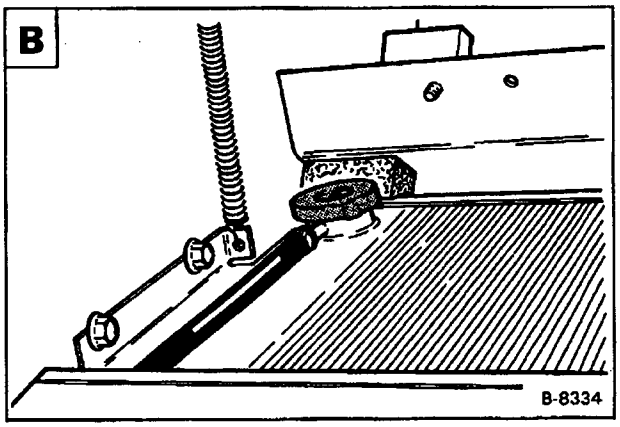
RADIATOR

Removal and Installation

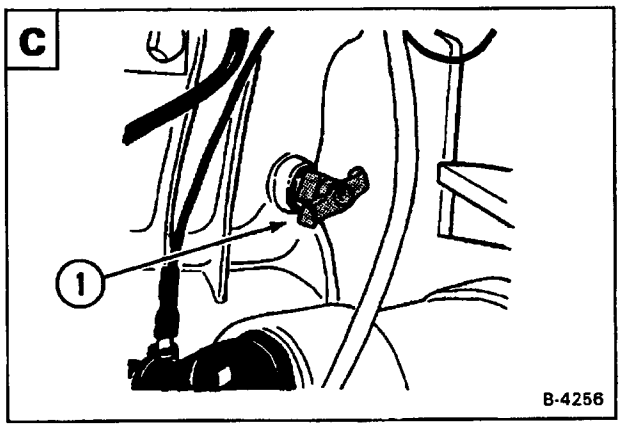
Remove the rear grill [A].



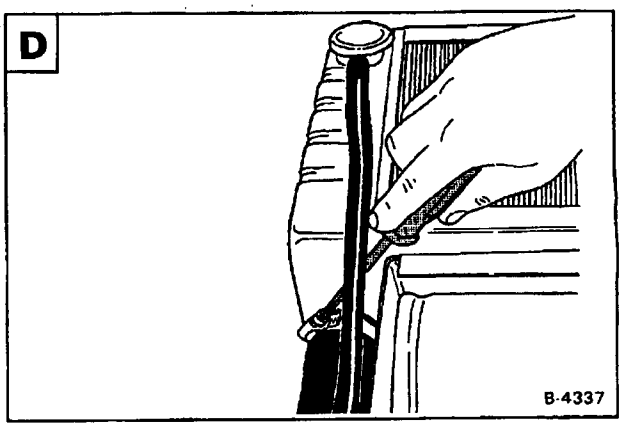
Remove the radiator cap [B].



Open the coolant drain (Item 1) at the side of the engine block and drain the coolant into a container [C].

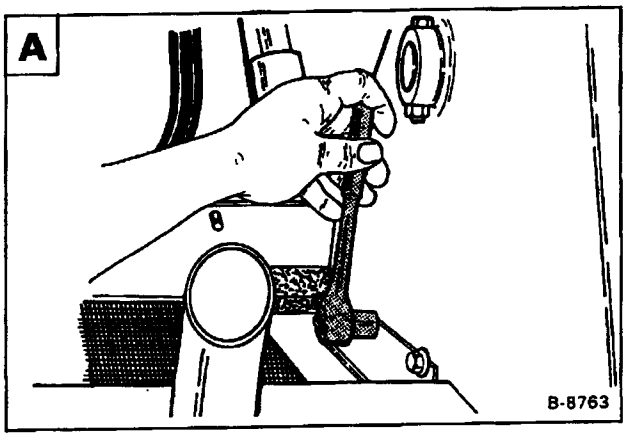


Disconnect both radiator hoses at the radiator [D].



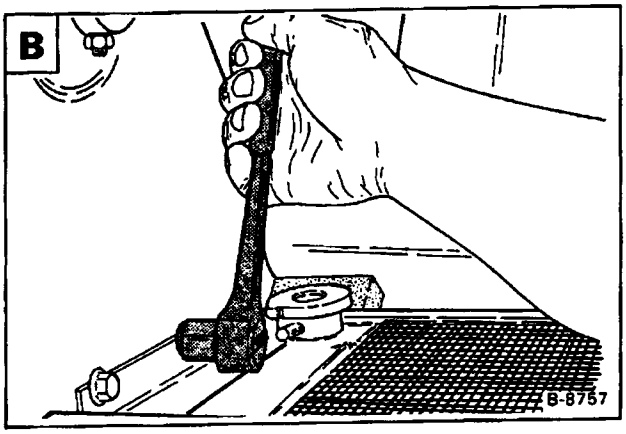
RADIATOR (Cont'd)

Remove the radiator holddown bracket at the right side of the frame [A].

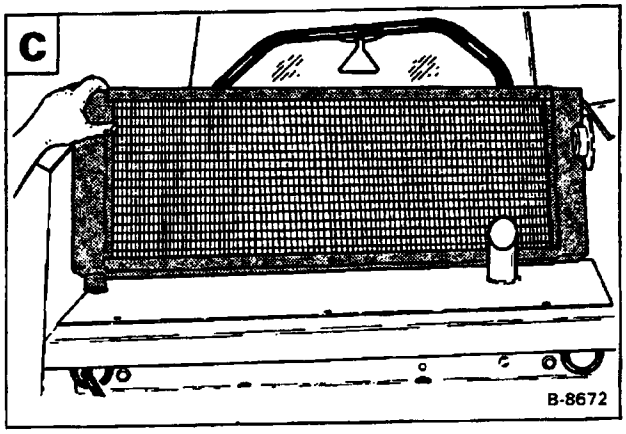


Remove the holddown bracket at the left side of the loader frame [B].

Remove the bolts under the radiator.



Lift the radiator up and remove it from the loader [C].



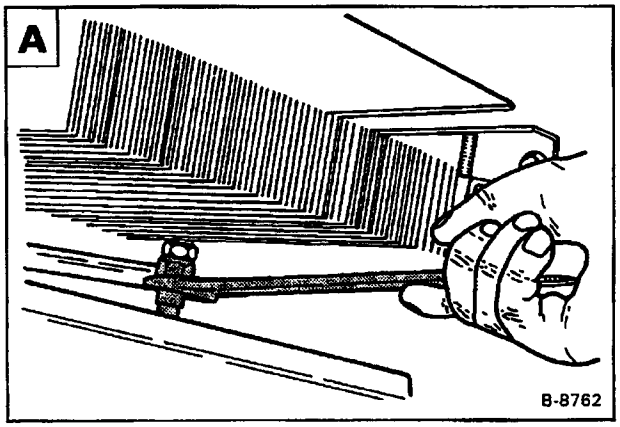
OIL COOLER

Removal and Installation

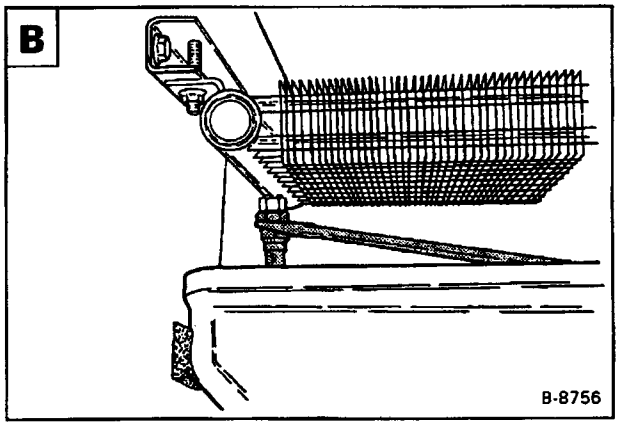
Remove the panels above the engine on the blower housing.

Remove the radiator (See Page 7B—17).

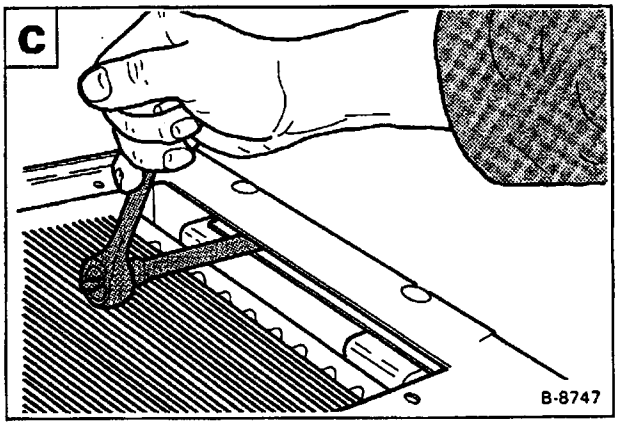
Disconnect the tubeline at the right side of the oil cooler [A].



Disconnect the tubeline at the left side of the oil cooler [B].

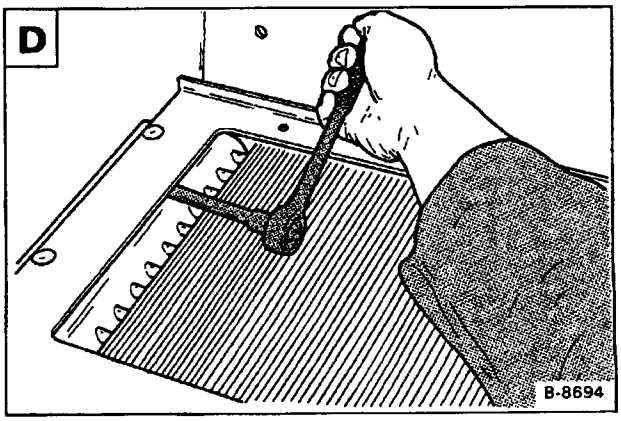


Remove the bolts at the right side bracket for the oil cooler [C].



Remove the bolts at the left side bracket for the oil cooler [D].

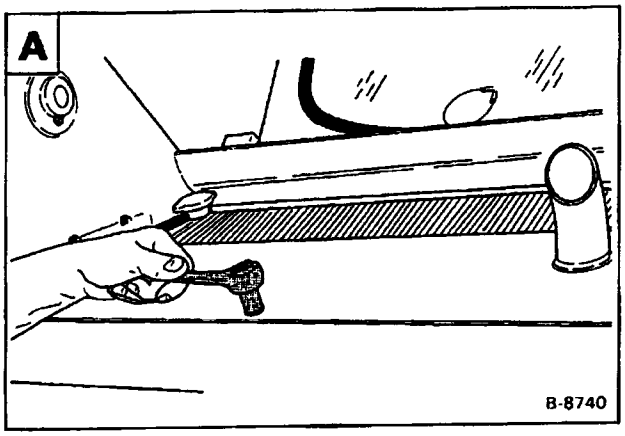
Remove the oil cooler from the mounting frame.



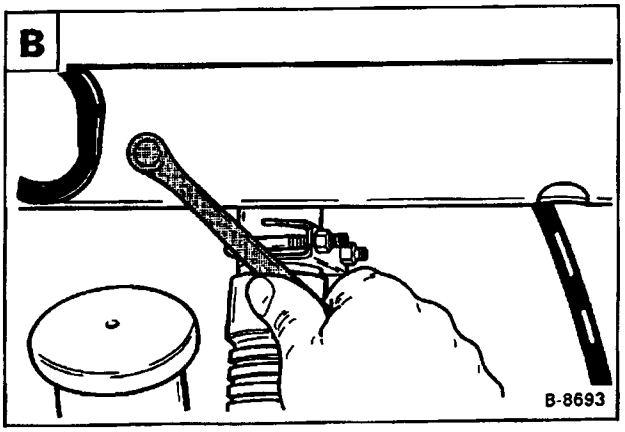
ENGINE MUFFLER

Removal and Installation

Remove the bolts from the plate which covers the muffler [A].



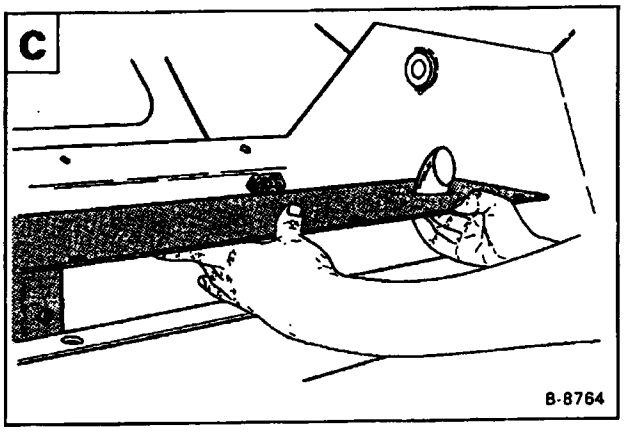
Remove the four bolts inside the engine compartment [B].



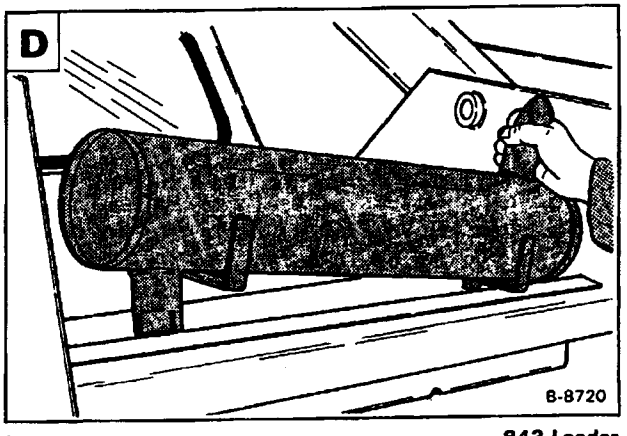
Remove the shield from the muffler [C].

Loosen the clamp at the exhaust pipe.

Remove the bolts which fasten the muffler to the mounting frame.



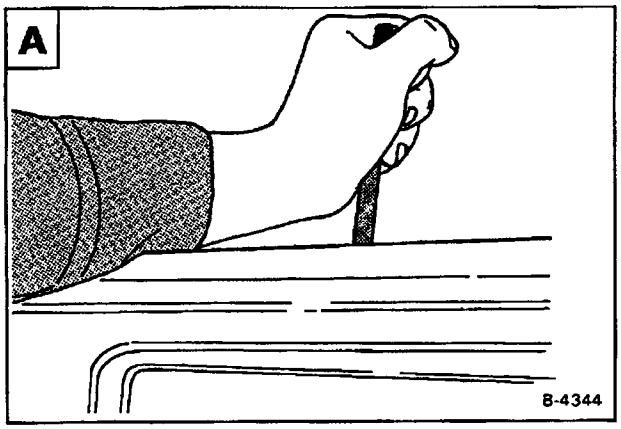
Remove the muffler from the loader [D].



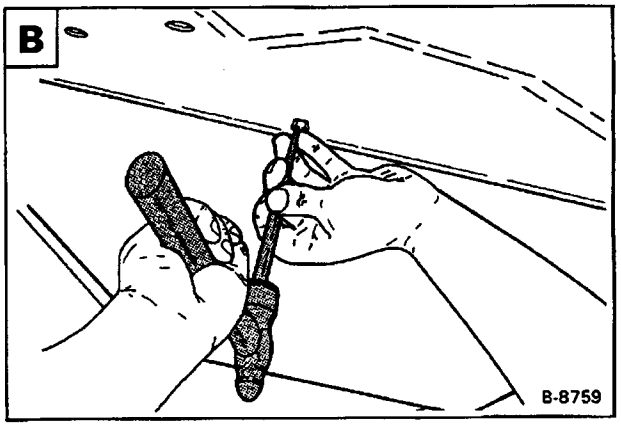
ENGINE BLOWER HOUSING

Removal and Installation

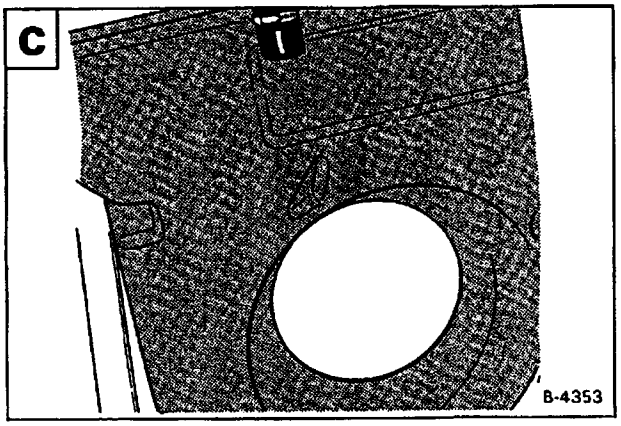
Remove the bolts along the top edge of the blower housing [A].



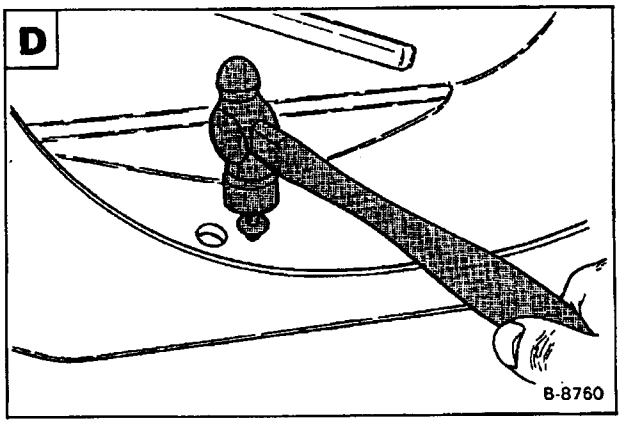
Use a punch and hammer and remove the rivet from the blower housing [B].



Remove the blower housing from the loader [C].



Installation: After the blower housing is installed, install the rivet in the bottom of the blower housing and hit it with a hammer to spread the tabs [D].

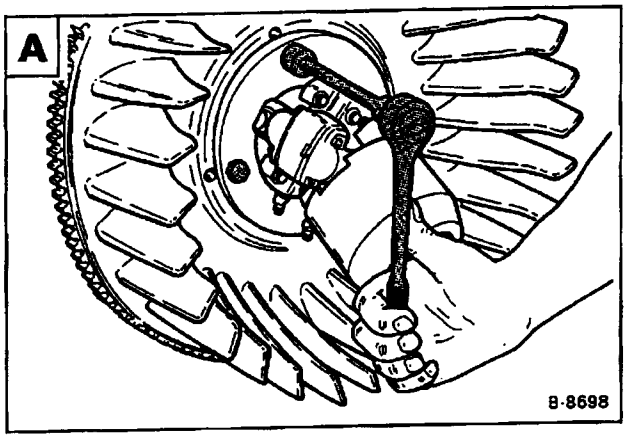


ENGINE FLYWHEEL & U-JOINT

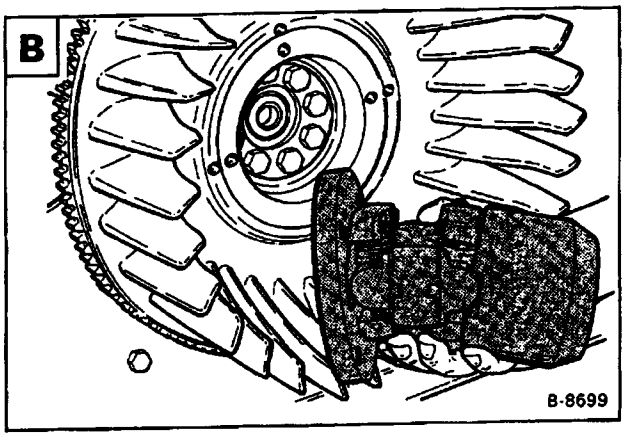
Removal and Installation

Remove the four bolts at the u-joint mount flange [A].

Installation: Tighten the bolts to 25 - 28 ft.-lbs. (34 - 38 Nm) torque.

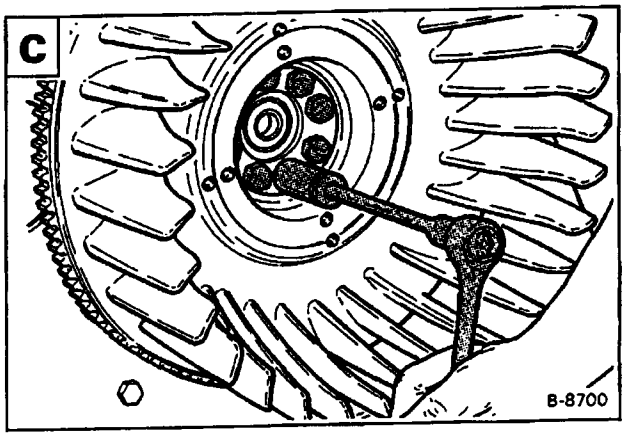


Remove the u-joint from the flywheel [B].



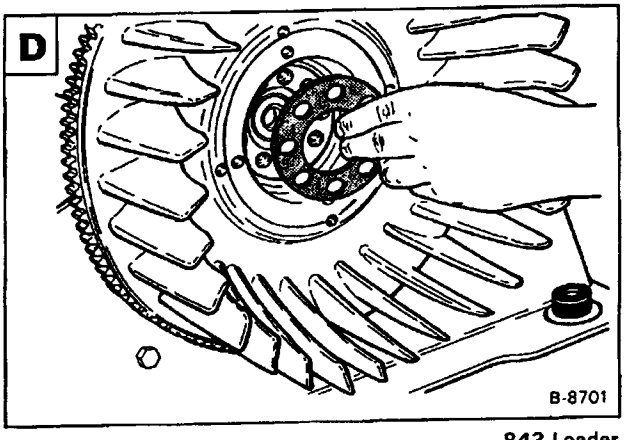
Remove the bolts from the flywheel [C].

Installation: Tighten the bolts to 83 - 90 ft.-lbs. (113 - 122 Nm) torque.



Remove the washer [D].

Remove the flywheel from the crankshaft flange.



Flywheel Ring Gear

The ring gear on the flywheel is an interference fit. Heat the ring gear enough to expand it and hit it with a hammer, evenly, to remove it.

Clean the outer surface of the flywheel to give it a smooth fit.

Clean the new ring gear and heat it to a temperature of 450 - 500° F. (232 - 260° C.).

Fit the ring gear over the flywheel. Make sure the gear is on its seat correctly.

CYLINDER HEAD

Removing the Cylinder Head

Clean all the debris from the engine and cylinder head.

Remove the coolant from the engine and radiator. Remove the radiator hoses.

Remove the fuel injectors and fuel tubelines (See Page 7B—11).

Remove the valve cover.

Remove the nuts from the support brackets for the rocker arms.

Remove the rocker arms. Remove the push rods.

Loosen and remove the cylinder head bolts.

NOTE: When removing the head, do not use a sharp tool between the head and engine block. Always put the cylinder head on a flat surface, such as wood, to prevent damage to the machined surface.

Remove the head from the engine block.

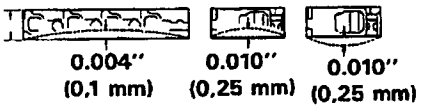
See Page 7B—25 for removing and reconditioning the valves.

Cylinder Head Surface Alignment

Check the surface of the head with a straight edge. The maximum limits for the cylinder head are shown in figure A.

NOTE: DO NOT grind the cylinder head if it is over the maximum limit. Replace with a new cylinder head.

A



DO NOT GRIND CYLINDER HEAD

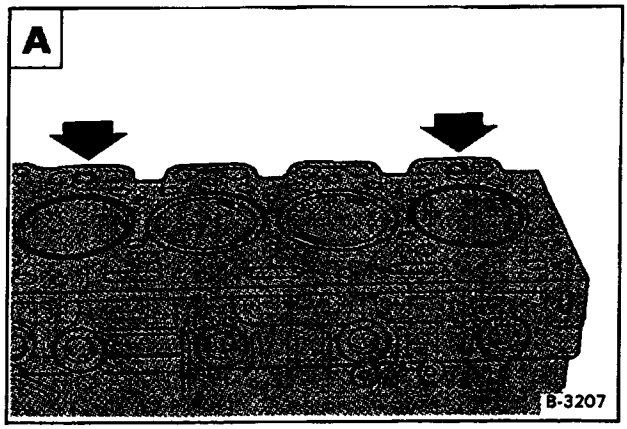
PI-2597

CYLINDER HEAD (Cont'd)

Installing the Cylinder Head

Install a new head gasket. Install it dry, no gasket cement is needed.

When the new head gasket is installed, make sure it is positioned correctly over the dowel pins and the markings "TOP" and "FRONT" are located correctly [A].

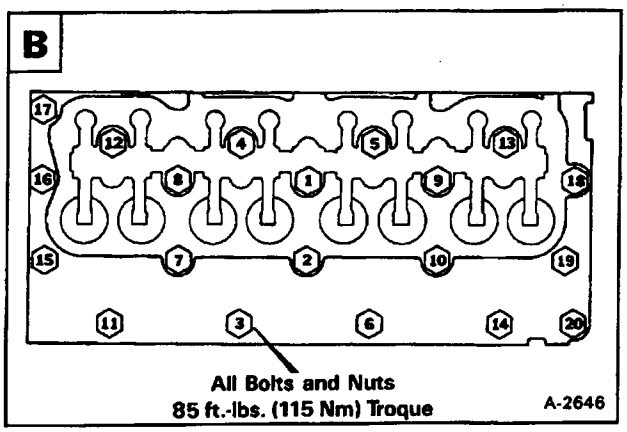


Put oil on the threads of the head bolts. Install the head bolts.

Tighten the bolts in the correct sequence [B]. Do this in a three stop procedure to 85 ft.-lbs. (115 Nm) torque.

EXAMPLE: First tighten all the bolts to 30 ft.-lbs. (41 Nm) torque, then 65 ft.-lbs. (88 Nm) torque and the final torque.

To reduce the risk of early cylinder head gasket failure, after a cylinder head has been fitted, the loader is to be operated under a partial load for about a half an hour. Then re-torque the bolts again. It is not a good practice to just run the engine without a load to bring it to operating temperature.



Install the push rods. Install the rocker arms and support brackets.

Adjust the valve clearance (See Page 7B—2).

Install the valve cover.

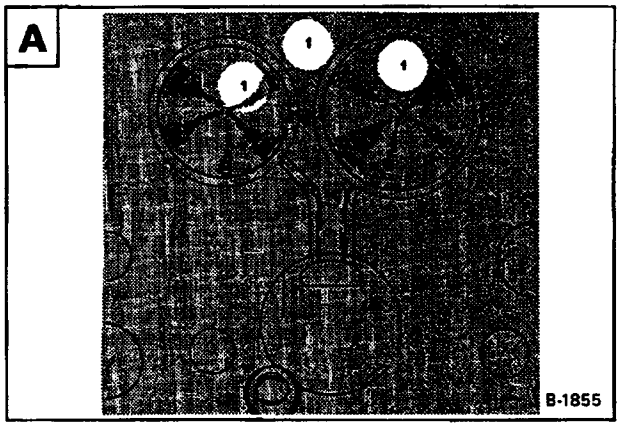
Install the fuel injectors and fuel tubelines.

Add coolant to the engine and radiator.

VALVES

Removing the Valves

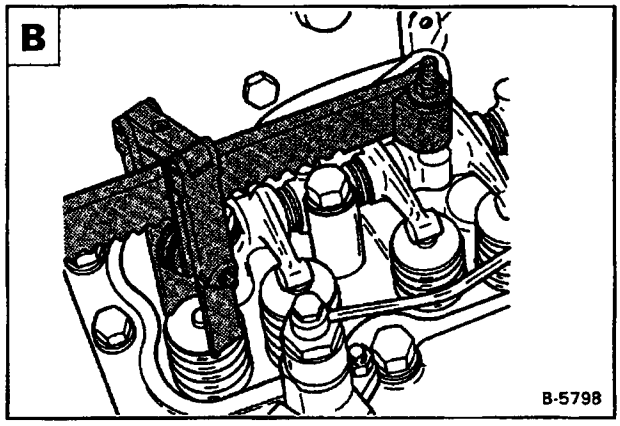
Mark the valves so they are put in the original position on assembly [A].



Use a valve spring compressor and remove the valve spring locks [B].

Remove the valve springs and valve from the cylinder head.

Repeat this procedure for each valve.



Installing the Valves

Make sure the cylinder head is clean.

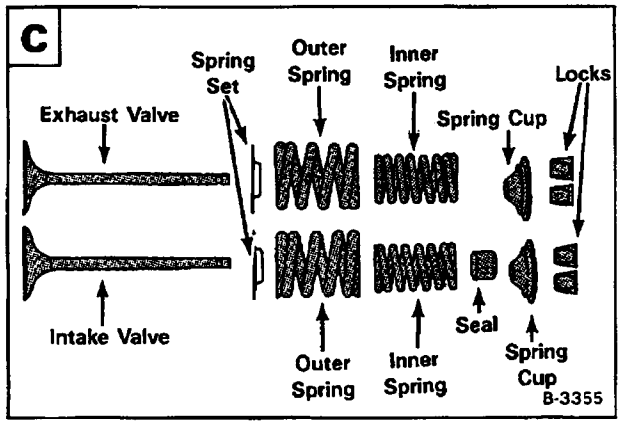
Put oil on the valve guides and valve stems.

Assemble the valve springs and cups [C].

The intake valve is fitted with a rubber seal.

Use a valve spring compressor and install the valve springs and valve stem locks.

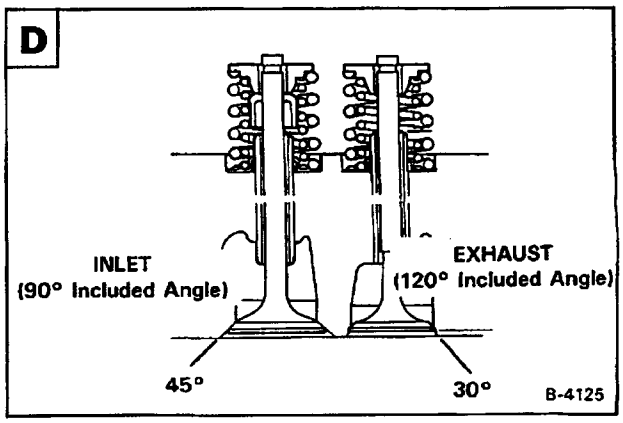
Tap the valve stem with a hammer a small amount to seat the valve stem locks.



Reconditioning the Valves and Valve Seats

Use the correct equipment to grind the valves and valves seats.

The angle of the intake is 45° and exhaust valves is 30° [D].

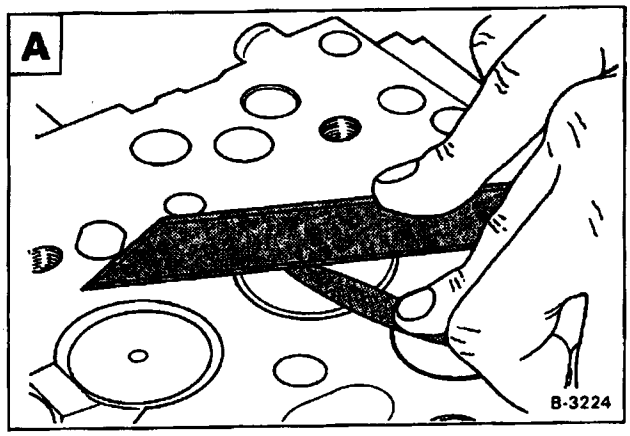


VALVES (Cont'd)

Check the valve head depth in the cylinder head after grinding [A].

Correct specification are as follows:

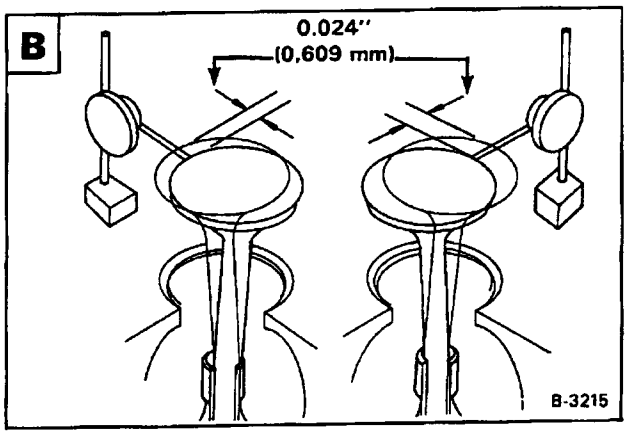
INTAKE & EXHAUST: 0.053" (1,35 mm).



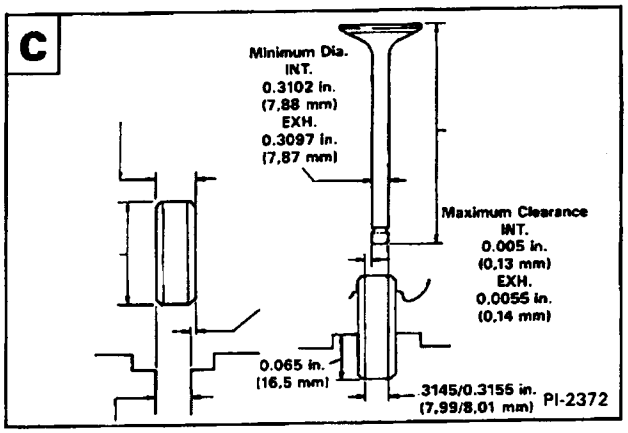
Installing the Valve Guides

Check the valve guides for wear with a dial indicator [B]. If the movement is more than the listed specifications, replace the guide.

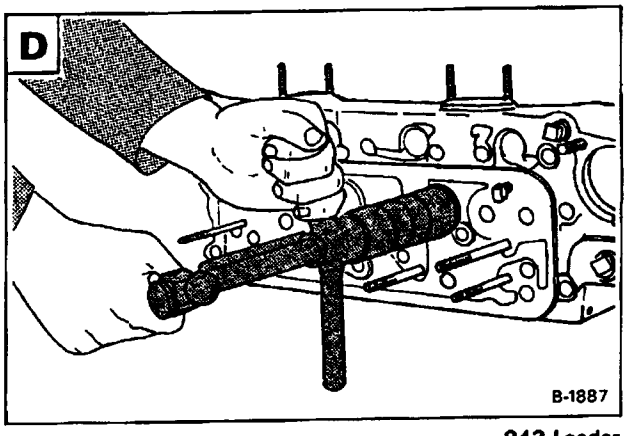
INTAKE & EXHAUST: 0.024" (0,6 mm)



NOTE: **Make sure to check the valve stem for wear before replacing the valve guide [C].**



Remove the guide with a hydraulic press or hand operated tool [D].

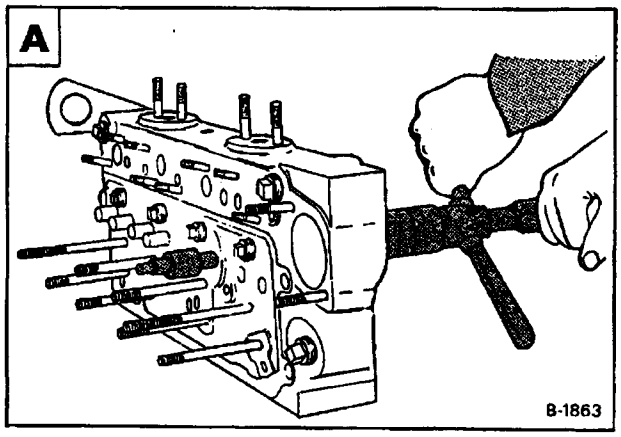


VALVES (Cont'd)

Put oil in the bore and press in the new guide [A].

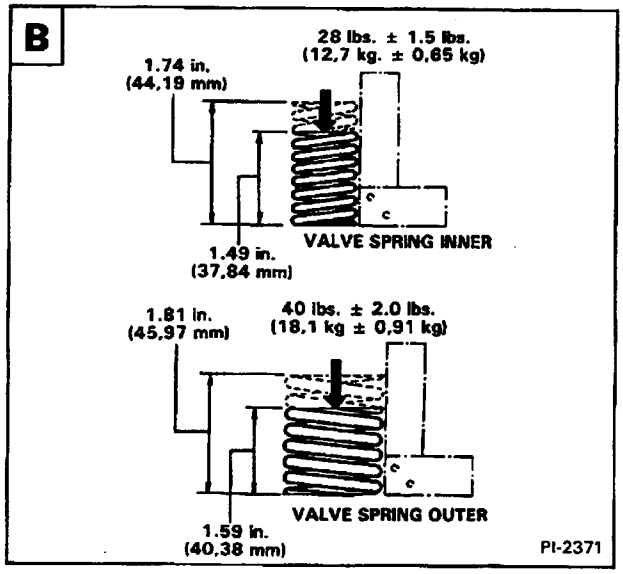
NOTE: Once the guide has started into the bore, do not stop.

Press the guide into the head until 0.065" (16,5 mm) is above the cylinder head.



Checking the Valve Springs

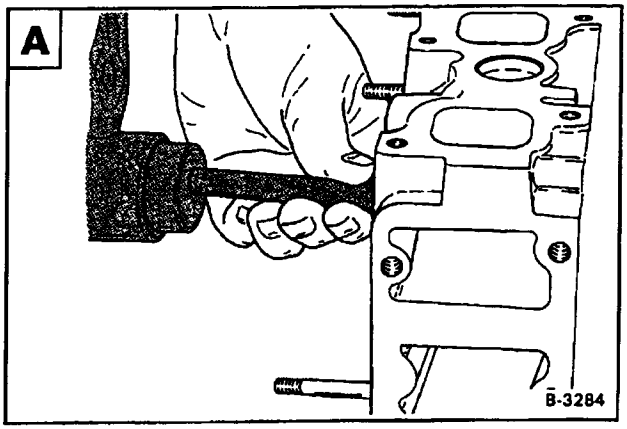
The valve springs for the intake and exhaust valves are the same. Check the spring ends for damage and check the specifications [B].



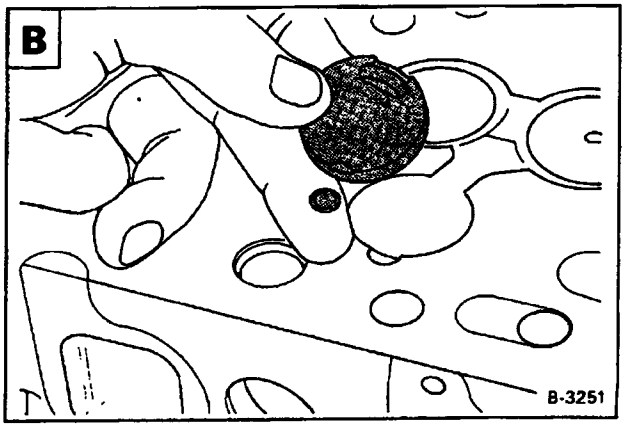
COMBUSTION CHAMBER INSERTS

Removal and Installation

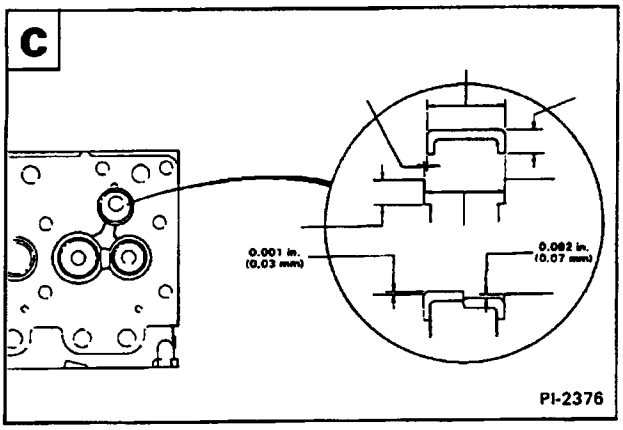
Remove the inserts, using a punch through the injector nozzle bore and hit the punch with a hammer [A].



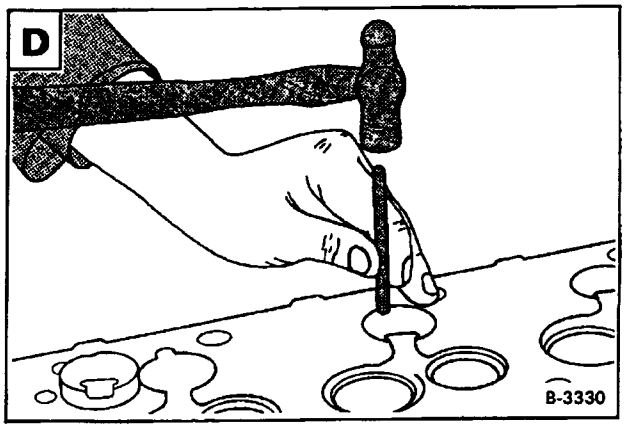
Position the new insert by putting the expansion washer in the correct position [B].



Make sure to check the height of the insert to the cylinder head as shown [C].



Use a hammer and punch to set the expansion washer in position to hold the insert in the cylinder head [D].



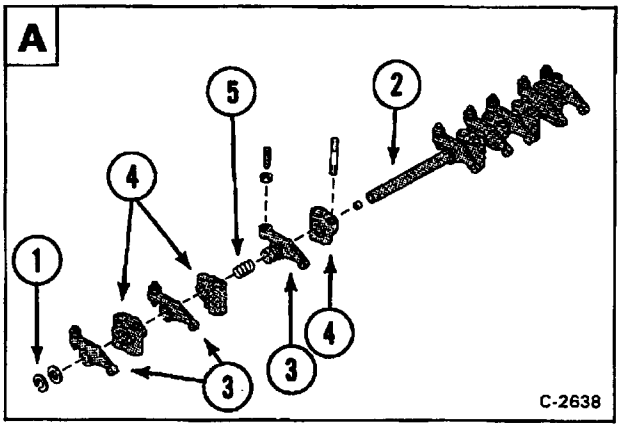
ROCKER ARMS

Disassembly

Mark the rocker arms and support bracket for correct assembly.

Remove the snap rings (Item 1) from each end of the shaft (Item 2) [A].

Remove the rocker arm (Item 3), bracket (Item 4) and spring (Item 5) [A].



Inspect the rocker arm bushings for wear [B].

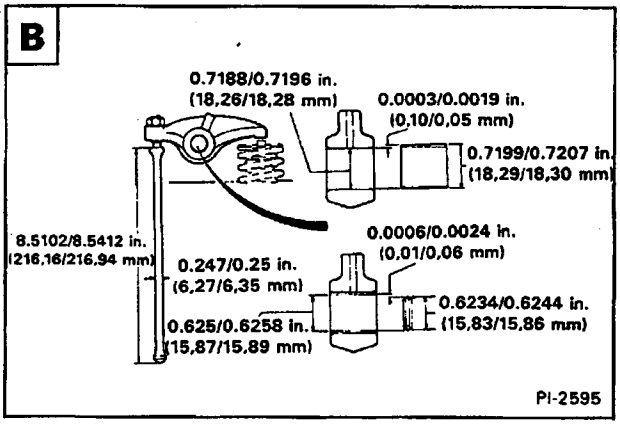
Replace the parts as needed.

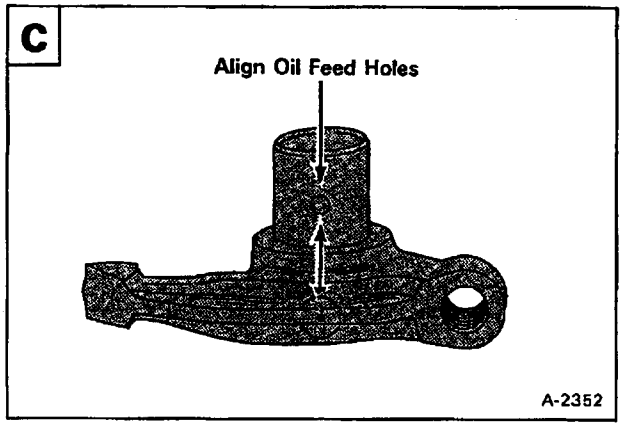
Assembly

When installing a new bushing in the rocker arms, make sure the oil holes are in alignment [C].

Reverse the order of disassembly and make sure that each set of rocker arm pair has the correct off-set.

Put oil on all the parts for protection.





PISTON AND CONNECTING RODS

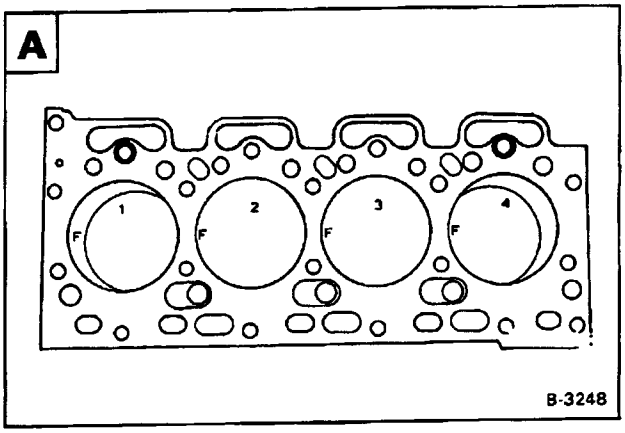
Removal

Remove the cylinder head (See Page 7B—23).

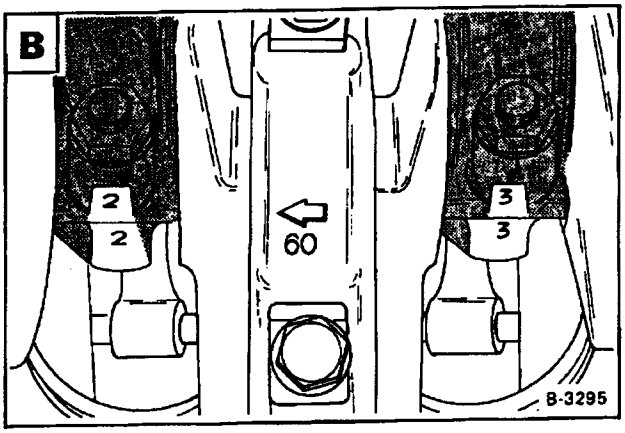
Remove the oil pan and oil pump (See Page 7B—49).

Remove the ridge and carbon deposits at the top of the cylinder bore with a ridge reamer.

Make sure the pistons have identification marks [A].

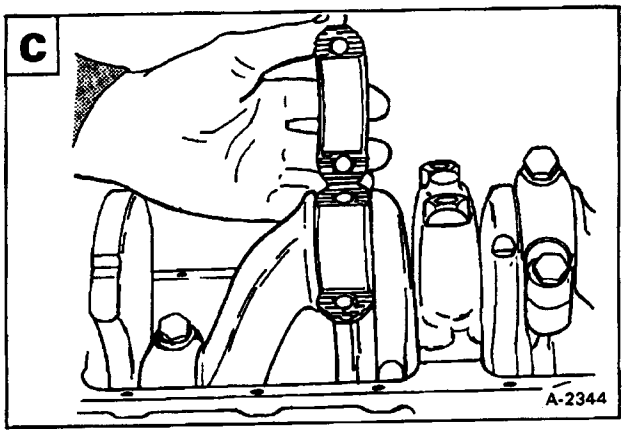


Rotate the crankshaft until a pair of connecting rods are at bottom dead center. Make sure the cab and rod have identification marks [B].



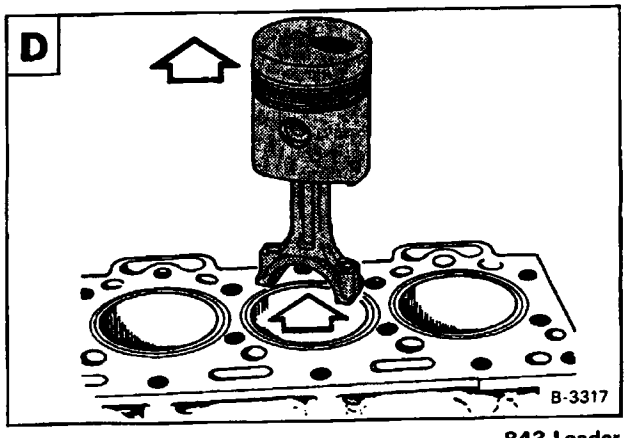
Remove the nuts and remove the bearing cap [C].

NOTE: If the bearings are to be used again, they must be identified so they are returned to their original location.



Using a hammer handle, push the piston and rod assembly out of the block [D].

After the pair has been removed, rotate the engine crankshaft and remove the other pair of pistons.



PISTON AND CONNECTING RODS (Cont'd)

Disassembly

Remove the rings from the pistons.

Remove the piston pin.

NOTE: If the piston pin does not come out easily, do not drive it out. Warm the piston in oil to a temperature of 120°F. (50°C.) and push the pin out.

Inspection

Clean all the parts in clean solvent.

Check the clearance of the new rings in the piston grooves [A].

Check the ring gap in the cylinder bore [B].

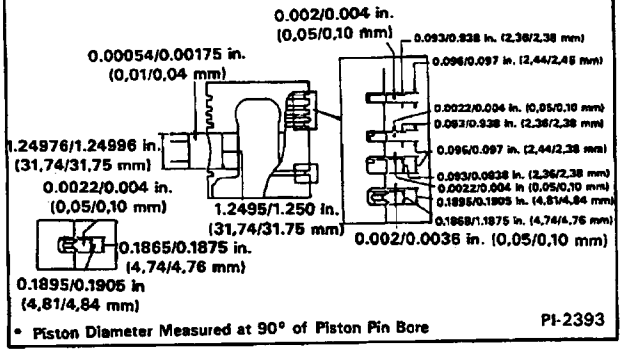
Make sure the specifications are correct [C].

Check the piston and pin bushing [D].

Replace the bushings with a hydraulic press. Remove all metal burrs from the piston bore before installing the new bushings.

Use the correct size reamer to fit the new bushing to the piston pin.

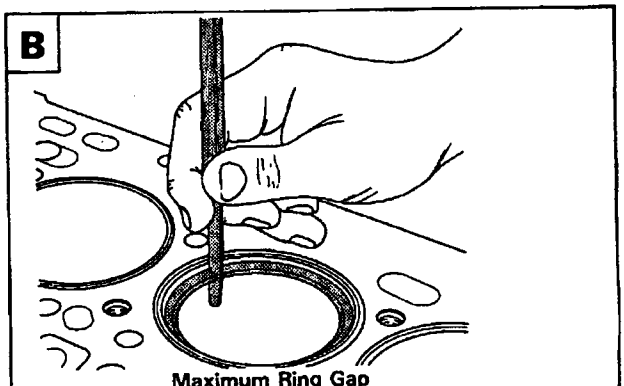
* A



* Piston Diameter Measured at 90° of Piston Pin Bore

PI-2393

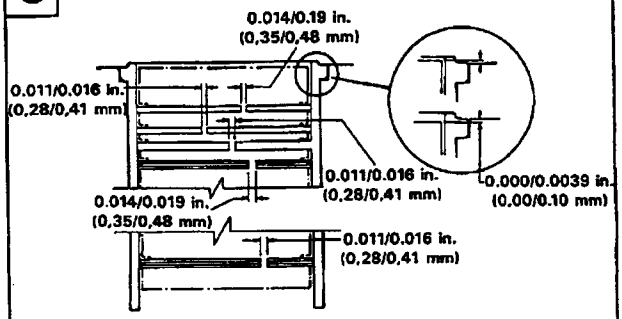
B



Maximum Ring Gap
0.060' (1,5 mm)

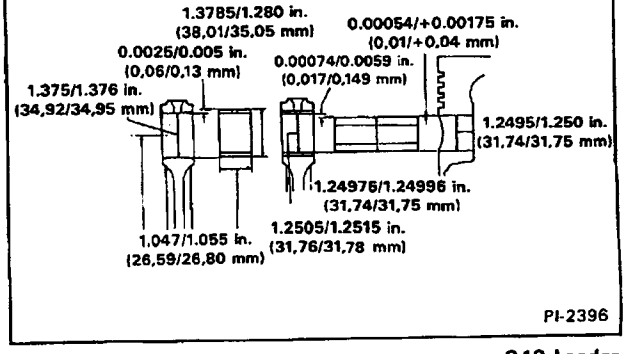
B-3334

* C



PI-2394

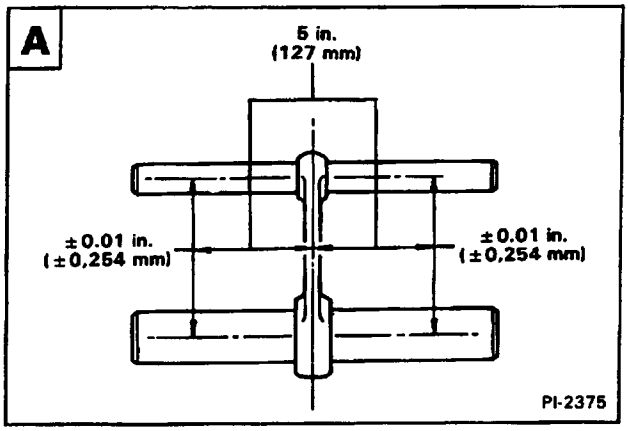
* D



PI-2396

PISTON AND CONNECTING RODS (Cont'd)

Check the connecting rod alignment [A].



Installation

Install the piston pin by putting the piston in clean oil at a temperature of 120° F. (50° C.).

Make sure the identification marks are located correctly at the rod and piston.

Install new snap ring on each side of the piston pin.

Install the piston rings using a expanding tool to prevent the ring from breaking [B].

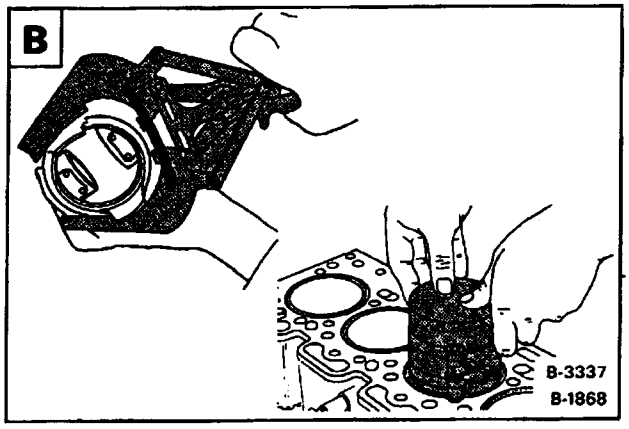
Put oil on the rings so they move freely in the piston grooves.

Position the ring gaps unevenly around the piston.

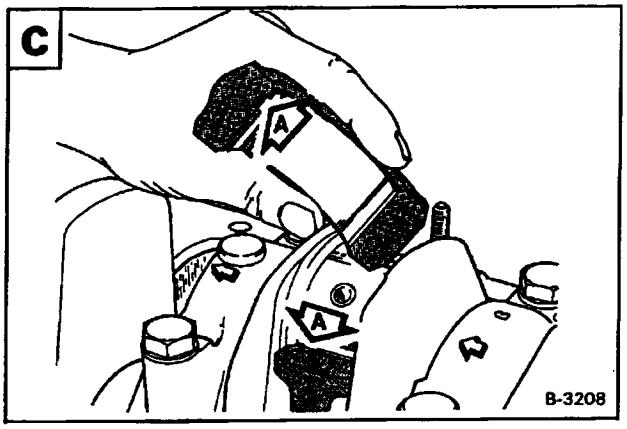
NOTE: Before the pistons are installed, check the cylinder bore.

Rotate the crankshaft until a pair of crank pins are at bottom dead center.

Using a ring compression tool, compress the rings on the piston. Make sure the "F" is to the front of the engine block and install the piston into the block [B].

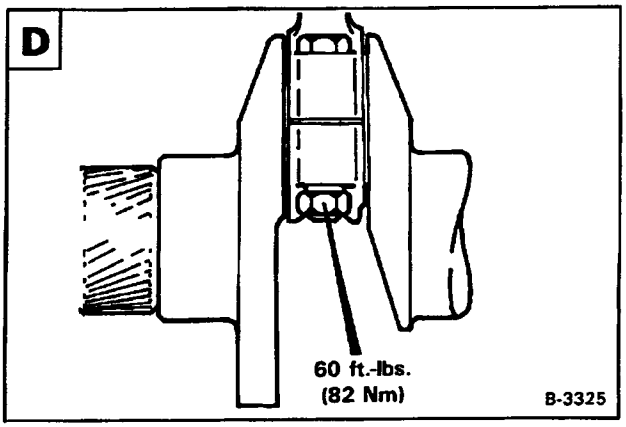


Put oil on the bearings. Install the bearing cap [C].



Tighten the nuts on the connecting rod [D].

Rotate the crankshaft to put the other pair of crank pins at bottom dead center. Repeat the procedure to install the other pair of pistons.



CYLINDER LINERS

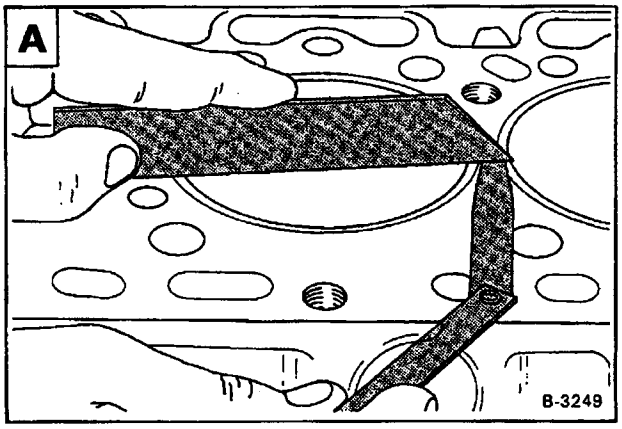
Checking

The cylinder liners are made of cast alloy iron. They are an interference fit in the engine block and are of the dry type.

Boring of these liners to a larger size is not possible. New liners must be installed when the cylinder bores are worn over specifications.

Check the cylinder bore with an inside micrometer. Check the bores in three positions (top, center and bottom). The checks must be made at parallel and right angles to the center line of the bore, giving six dimensions for each bore.

The standard bore of the cylinder liner is 3.501 - 3.502" (88,92 - 88,95 mm). When the bore dimensions is 0.006" (0,15 mm) over standard dimensions the liner must be replaced.



Removal and Installation

Remove all the parts from the engine. Press the cylinder liners out through the top of the engine block.

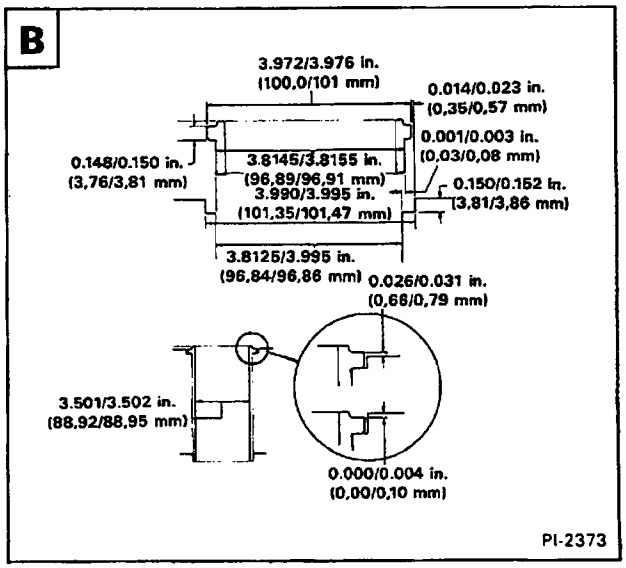
Clean the bore and remove any metal burrs in the block.

Put lubricant on the outside of the liner. Push the liner into the block.

Check the liner height in four position for the correct height [A].

Follow the same procedure for the other cylinder liners.

Hone the cylinder bore to standard dimensions [B].

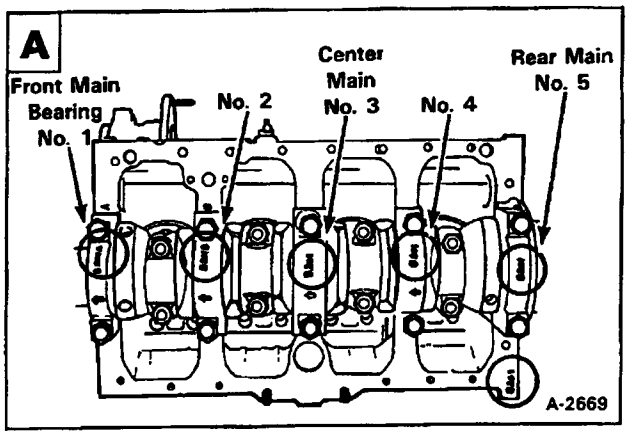
* 

MAIN BEARINGS

The crankshaft has five main bearings. The end play is controlled by a thrust washer on both sides of the center main bearing.

Each main bearing cap has identification mark in relation to the engine block [A].

The position of each cap can not be changed from the original location.



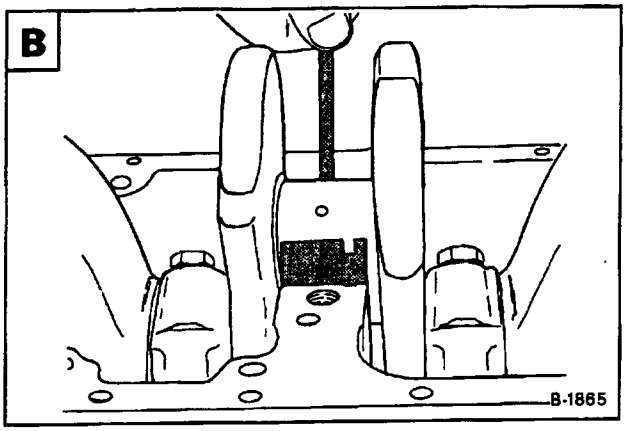
Removal

Remove the oil pan. Remove the oil pump (See Page 7B—49).

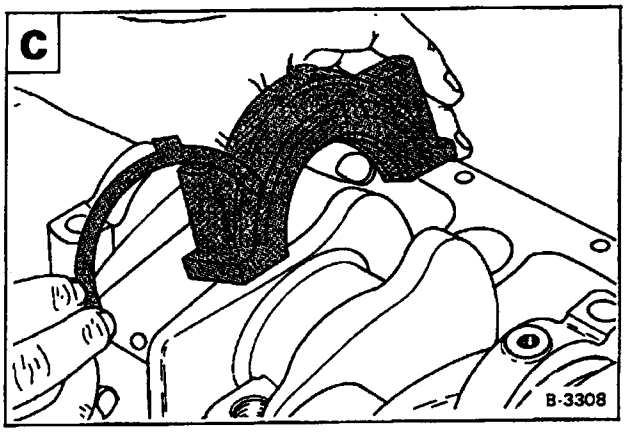
Remove the bolts from the main bearing caps.

Remove the main bearing cap and remove the bearing from the cap half.

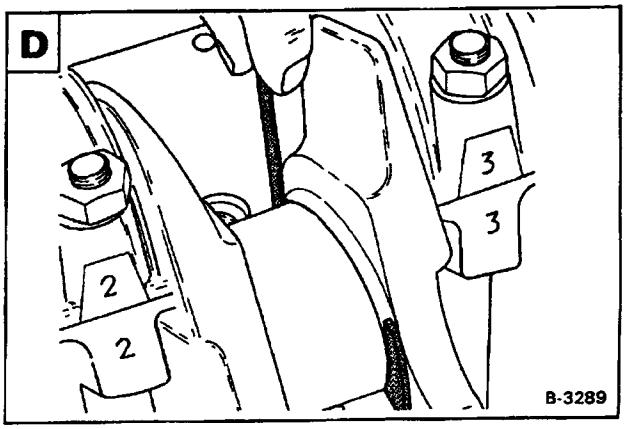
Remove the top half of the bearing by pushing on one side of the bearing and rotating the crankshaft [B].



On the center main bearing, remove the cap and thrust washers from each side of the cap [C].



Remove the top half of the bearing and thrust washer by pushing on one side of the bearing and rotating the crankshaft [D].



MAIN BEARINGS (Cont'd)

Installation

Check the crankshaft journals before installing the main bearings (See Page 7B—36).

Lubricate the new bearings. Install them by putting the end without the tab into the block and rotating the crankshaft until the tab is on its seat.

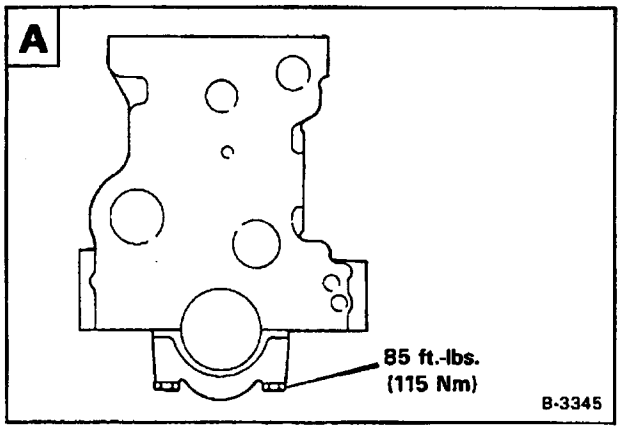
Install the other bearing half in the main bearing cap. Lubricate the bearing and install it on the engine block.

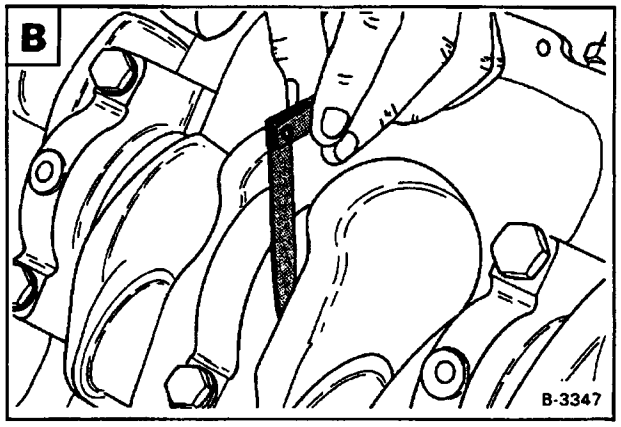
Install the bolts and tighten to position the cap, then loosen them.

Install the center main bearing and thrust washer.

Repeat the procedure until all the main bearings are installed.

Then tighten the bolts to the correct torque [A].

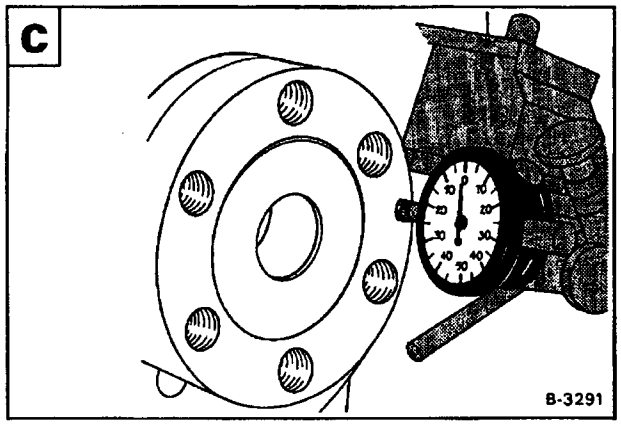




Crankshaft End Play

The end play can be checked by either a feeler gauge [B] or a dial indicator [C].

The maximum end play is 0.014" (0,35 mm). The fitting of oversize thrust washers can be used to correct the end play if it is over specifications.



CRANKSHAFT

Removal

Remove the oil pan. Remove the oil pump (See Page 7B—49).

Remove the crankshaft pulley, timing case cover, timing gears and timing case (See Page 7B—39).

Remove the flywheel (See Page 7B—22).

Remove the rear main seal (See Page 7B—38).

Remove the connecting rod caps (See Page 7B—31).

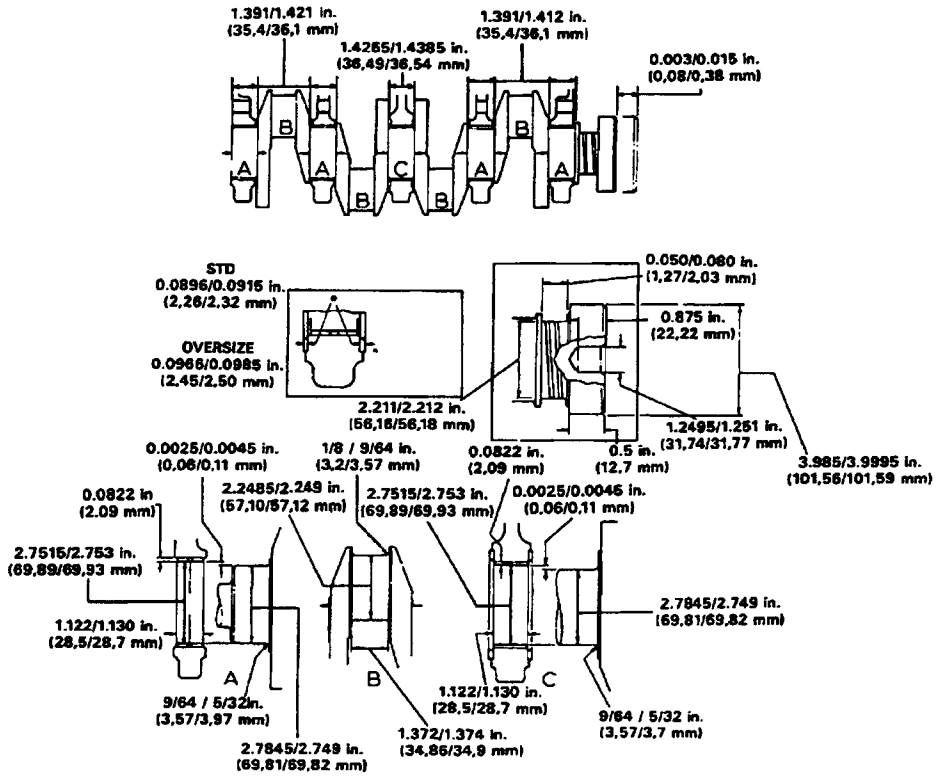
Remove the bolts and main bearing caps (See Page 7B—34).

Lift the crankshaft out of the engine block for inspection.

Checking

Using a micrometer, check the crankshaft for correct dimensions [A].

A



CRANKSHAFT (Cont'd)

NOTE: You can grind the crankshaft to 0.010" (0,25 mm), 0.020" (0,51 mm) and 0.030" (0,76 mm) undersize. (See Page 8B—7 for the correct specifications).

Installation

Clean the crankshaft and check that all the oil passages are clean and open.

Clean the engine block, lubricate and install the upper halves of the main bearings.

NOTE: If you do not install new bearings, always return the old bearings back to their original position.

Put the crankshaft, carefully in position.

Install the main bearing caps (See Page 7B—34).

NOTE: Make sure the lower thrust washer is in its correct location.

Check the crankshaft so that it rotates freely. Check the crankshaft end play (See Page 7B—35).

Install the rear oil seal (See Page 7B—38).

Lubricate the connecting rod bearings. Install the bearings and connecting rod caps (See Page 7B—31).

Install the oil pump.

Install the oil pan.

Install the timing case, timing gears, timing case cover and crankshaft pulley (See Page 7B—39).

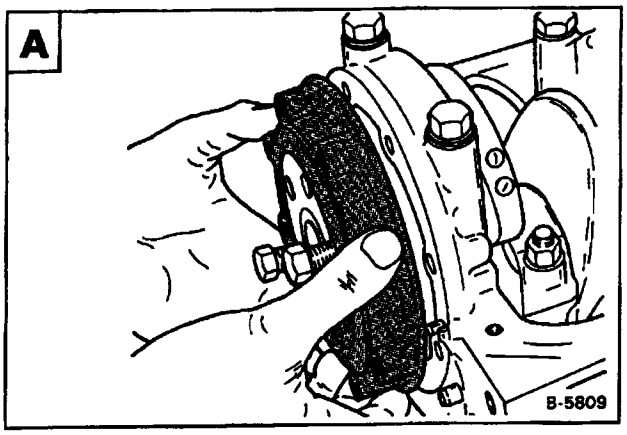
Install the flywheel (See Page 7B—22).

REAR MAIN OIL SEAL

Removal and Installation

The crankshaft is fitted with a lip type rear oil seal and has a mounting flange with an extended width to provide a seat for the seal [A].

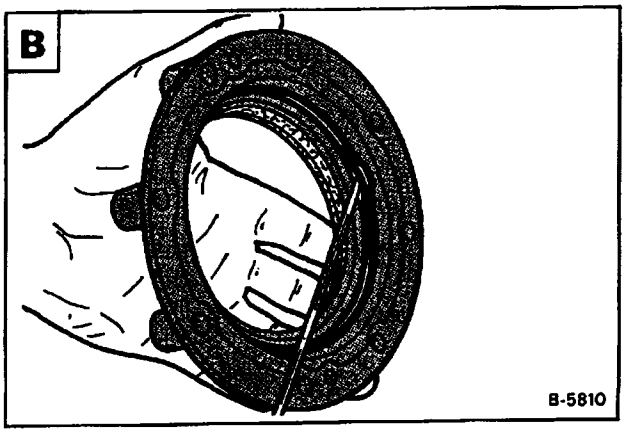
This seal is easily damaged and you must be careful not to damage it. Any visual damage across the lip of the seal will cause leakage.



When installing a new seal, check the crankshaft flange.If it is found to be grooved, the seal must be pressed further into the housing [B]. Lubricate both seal and the housing when installing the seal.

If the three position have been used, the worn sealing area of the crankshaft can be machined to not less than 3.993" (101,4 mm).

The rear main oil seal housing is located at the engine block by two dowels, bolts and washers with a gasket between the housing and the engine block.

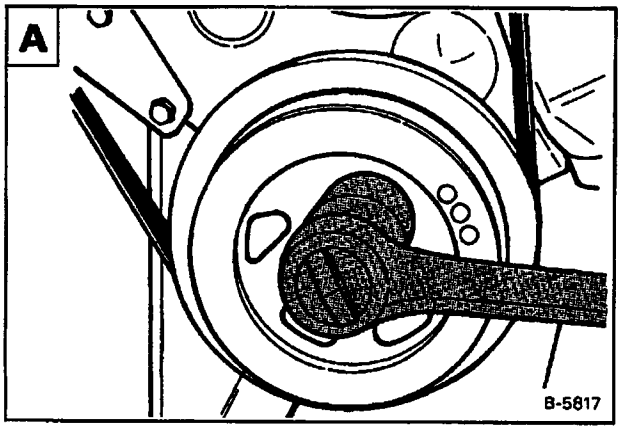


TIMING CASE COVER

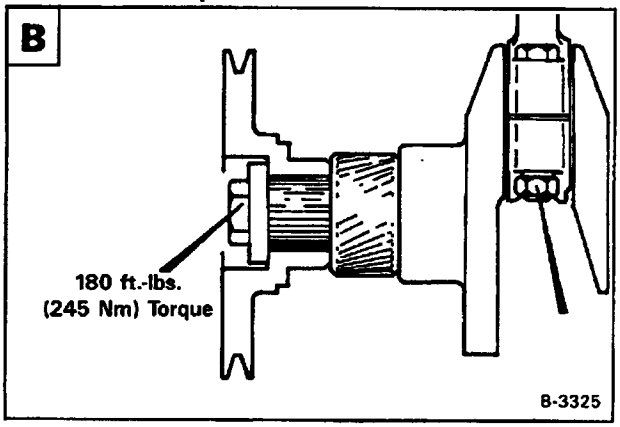
Removal and Installation

Remove the alternator and belt.

Remove the crankshaft pulley bolt [A].

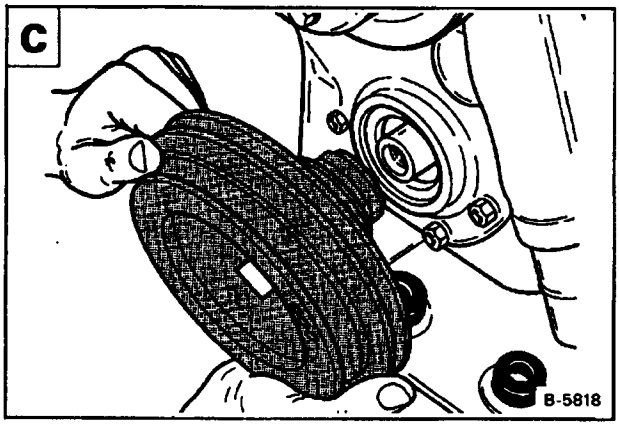


Installation: Tighten the bolt to 180 ft.-lbs. (245 Nm) torque [B].



Remove the pulley from the crankshaft [C].

Remove the bolts and nuts from the cover.



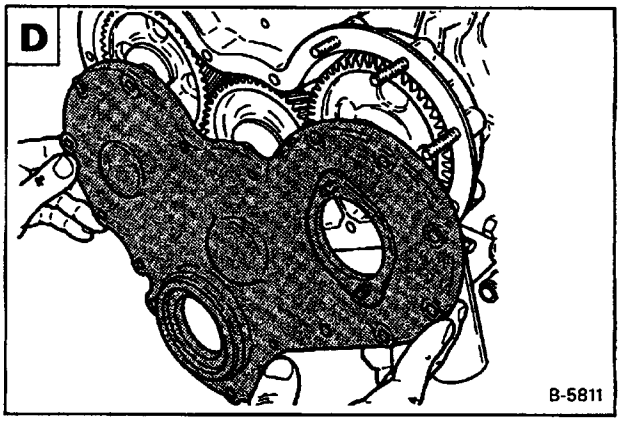
Remove the timing case cover from the engine [D].

Clean the timing case cover and timing case back plate.

Installation: Put a new gasket on the cover. Install the front cover, be careful not to damage the seal.

Install the bolts and finger tighten only. Install the crankshaft pulley to center the front seat on the pulley hub.

Tighten the bolts and nuts. Remove the pulley to tighten the bolts behind the pulley.

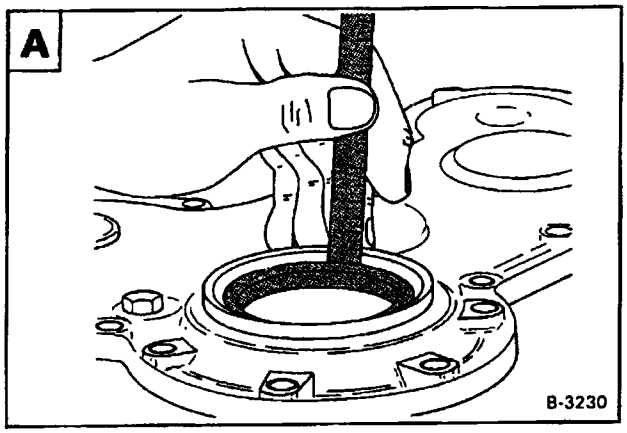


TIMING CASE COVER (Cont'd)

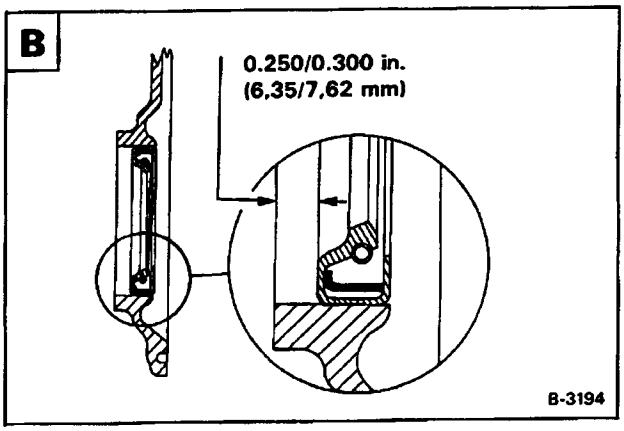
Front Seal

Remove the front seal from the cover by pushing it out through the front.

Press the new seal in from the front until the seal is seated below the front edge of the cover [A].



Make sure it is seated to the correct specifications [B].



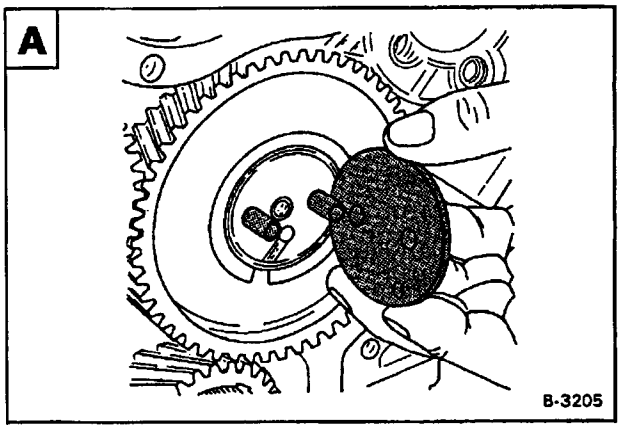
IDLER GEAR AND HUB

Removal

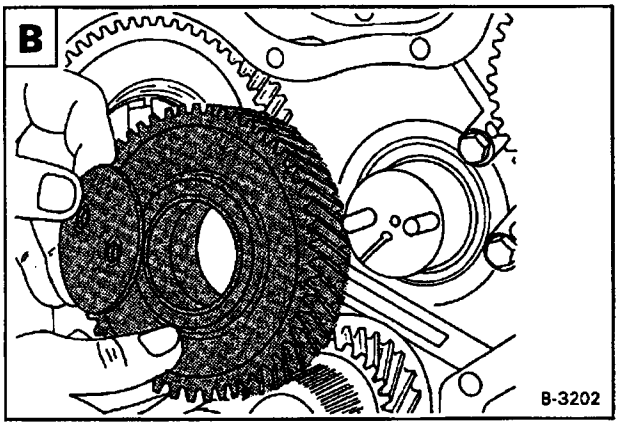
Remove the timing case cover (See Page 7B—39).

Remove the nuts from the idler gear plate.

Remove the retainer plate from the gear [A].

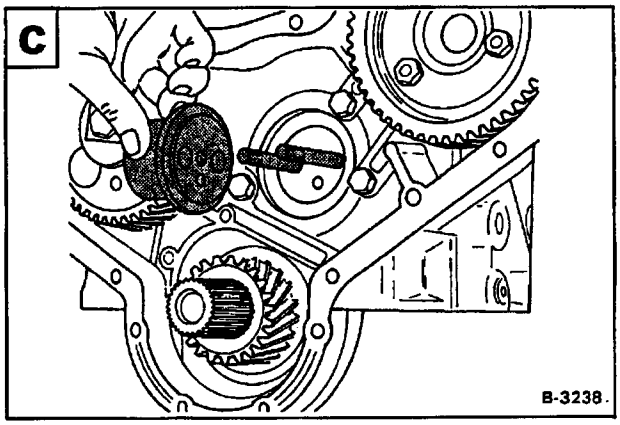


Remove the idler gear [B].

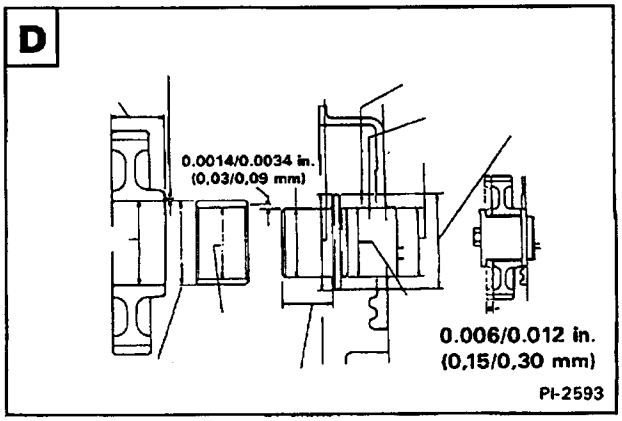


Remove the idler gear hub [C].

The idler gear hub has an interference fit. Use a soft hammer to remove it.



Check the idler gear and hub as the specifications shown [D].



IDLER GEAR AND HUB (Cont'd)

Installation

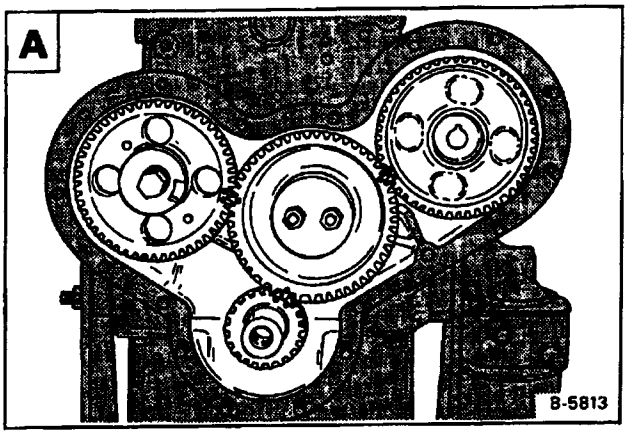
Make sure the oil passages are clean in the engine block and hub.

Install the hub.

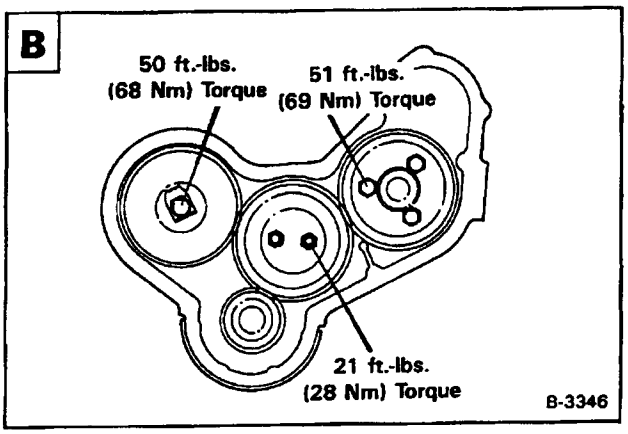
Turn the engine crankshaft until No. 1 piston is at TDC.

Install the idler gear. Make sure the timing marks are in correct alignment [A].

Install the retainer plate.

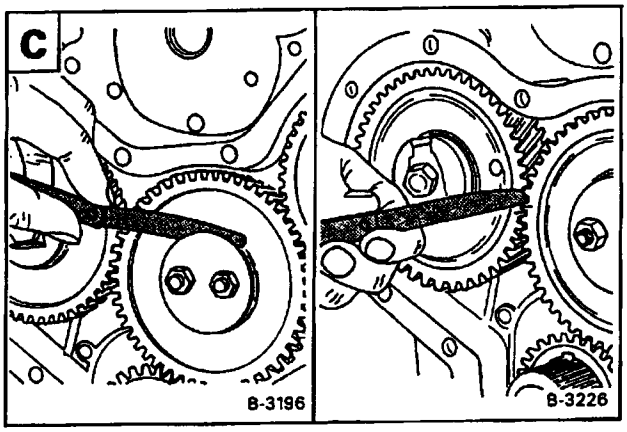


Install the nuts and tighten to the correct torque [B].

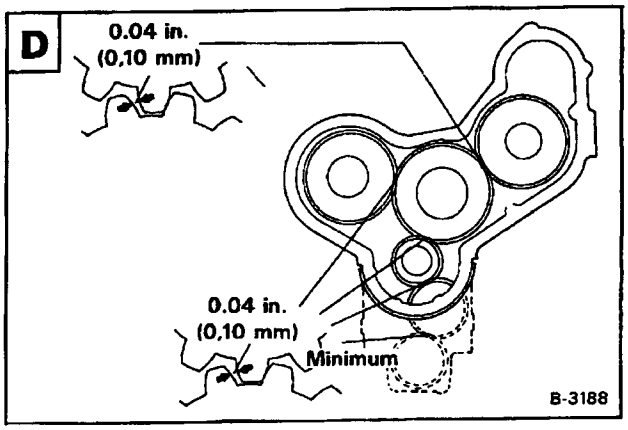


Check the end play for the idler gear [C]. The correct end play is 0.008 - 0.012" (0,20 - 0,030 mm).

Check the clearance at the teeth of the gears [C].



The correct specification is shown in figure [D].



CAMSHAFT GEAR

Removal

The tool listed will be needed to the following procedure:

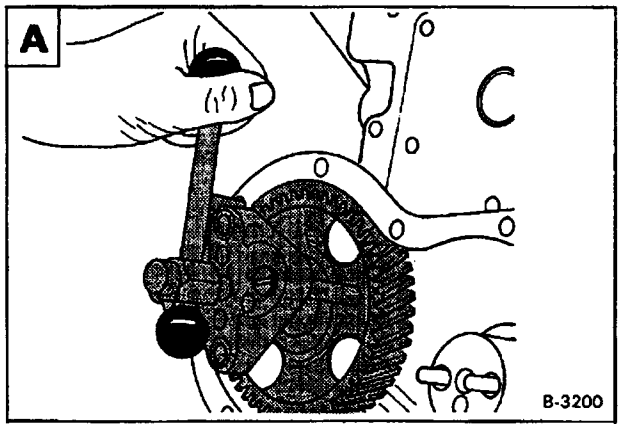
MEL-1054 — Puller

Remove the timing case cover (See Page 7B—39).

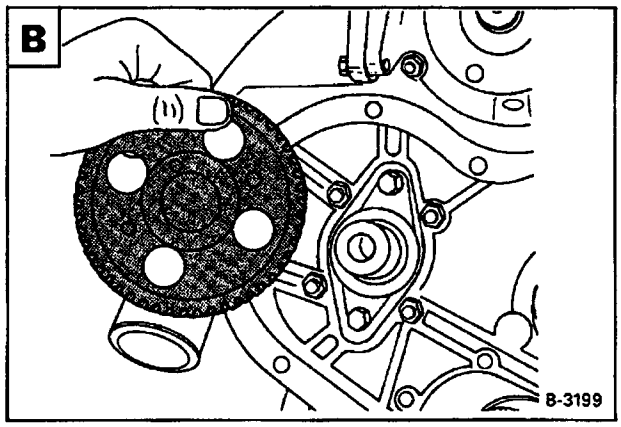
Remove the idler gear (See Page 7B—41).

Remove the bolt and washer from the gear.

Install the puller to remove the camshaft gear [A].



Remove the camshaft gear [B].



Installation

Put the gear over the end of the camshaft.

Install the washer and bolt.

Tighten the bolt to 40 - 50 ft.-lbs. (54 - 68 Nm) torque.

Install the idler gear (See Page 7B—41).

Install the timing case cover (See Page 7B—39).

FUEL INJECTION PUMP DRIVE GEAR

Removal and Installation

The tool listed will be needed to do the following procedure:

MEL-1200 – Puller

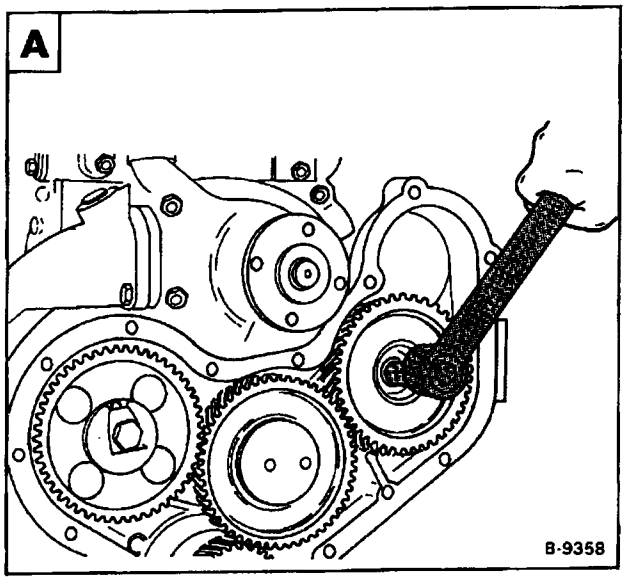
Remove the timing case cover (See Page 7B–39).

Remove the idler gear (See Page 7B–41).

Remove the bolt from the gear [A].

Installation: Tighten the bolt to 50 ft.-lbs. (69 Nm) torque.

Install the puller and remove the gear.



CRANKSHAFT GEAR

Removal

The crankshaft gear is an interference fit on the end of the crankshaft. A key is installed between the gear and the crankshaft.

Use a puller to remove the gear from the crankshaft.

TIMING CASE

Removal and Installation

Remove the timing case cover (See Page 7B—39).

Remove the idler gear (See Page 7B—41).

Remove the camshaft gear (See Page 7B—43).

Remove the fuel injection pump drive gear (See Page 7B—44).

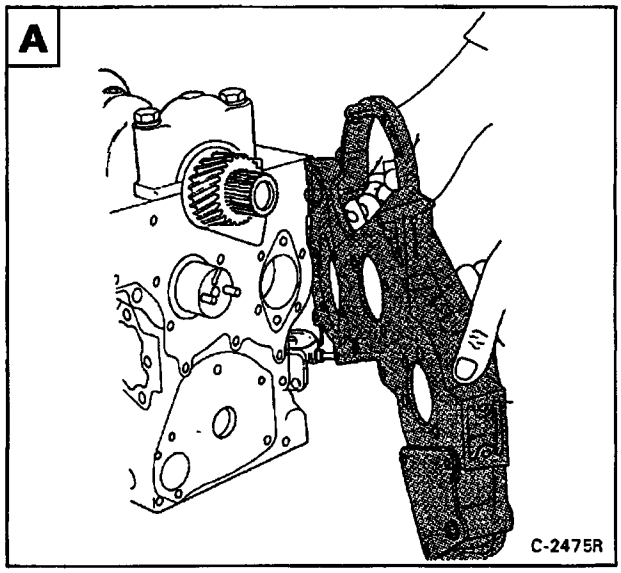
NOTE: The crankshaft gear does not have to be removed.

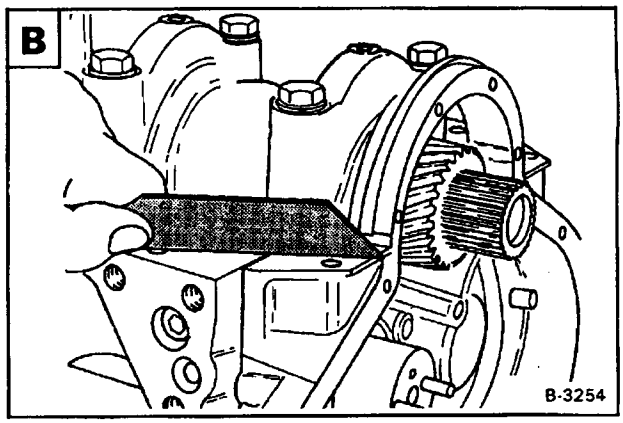
Remove the front bolts at the oil pan.

Remove the bolts and washers from the timing case.

Remove the timing case [A].

Installation: Check that the bottom of the timing case is even with the face of the oil pan attaching surface [B].





CAMSHAFT AND TAPPETS

Removal

Remove the timing case cover (See Page 7B—39).

Remove the idler gear (See Page 7B—41).

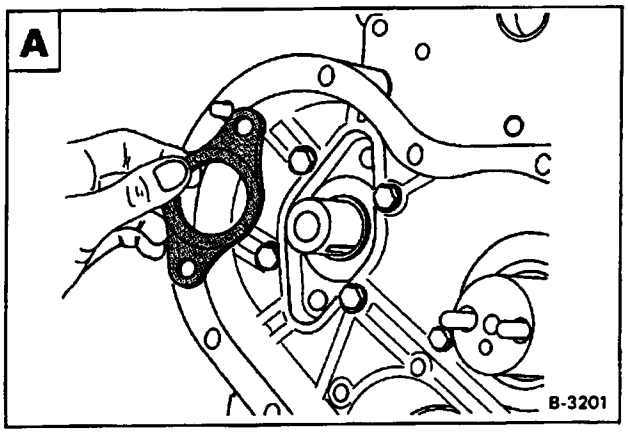
Remove the camshaft gear (See Page 7B—43).

Remove the valve cover.

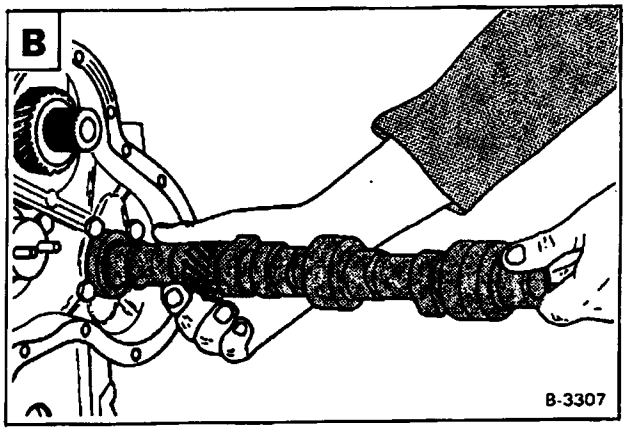
Remove the rocker arm assembly and push rods.

Turn the engine over and remove the oil pan and oil pump (See Page 7B—49).

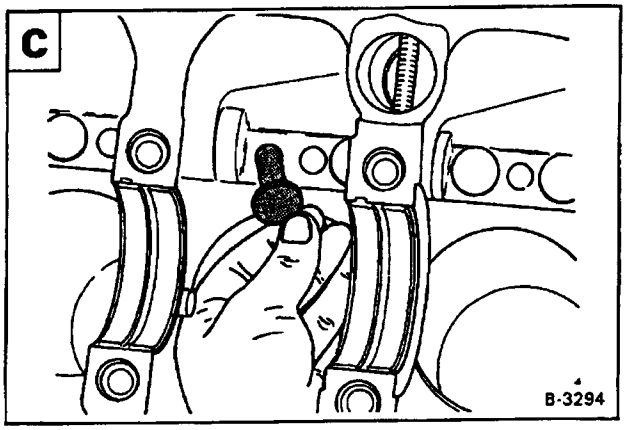
Remove the thrust plate at the camshaft [A].



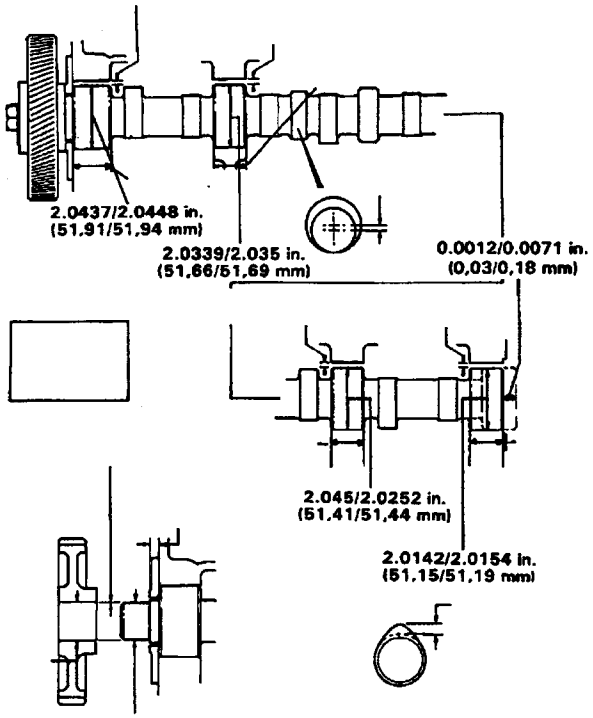
Remove the camshaft from the engine [B].



Remove the tappets from the engine block [C].



A



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Inspection

Check the camshaft and the bearings as the specifications shown [A].

Use the correct tools for removal and installation of the camshaft bearings.

Installation

Lubricate the tappets before installation.

Lubricate the camshaft. Carefully install the camshaft to prevent damage to the bearings.

After rocker arms are installed, make sure to set the valve clearance (See Page 7B—2).

LUBRICATION SYSTEM

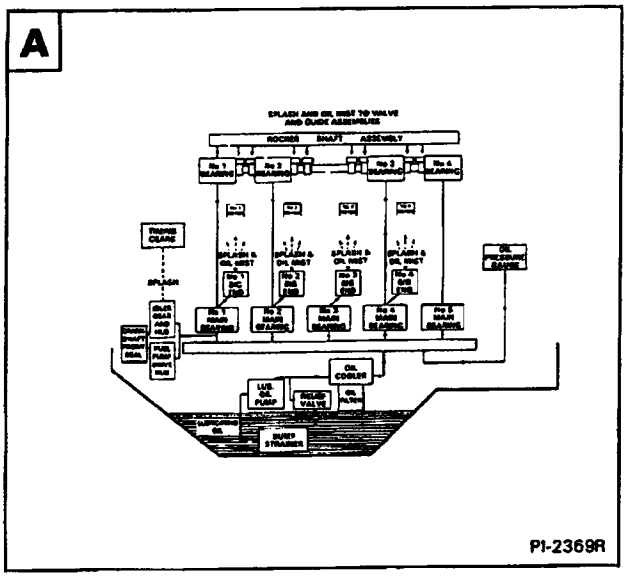
Description

The figure shows the engine oil lubrication system [A].

The lubrication of the engine is done by a full flow oil filter to the main oil gallery from which the oil is put through small holes into the main bearing housings to each of the five main bearings.

Some of the oil is taken off at a hole at the No. 1 main bearing to lubricate the idler gear and the timing gears. Holes in the crankshaft distribute oil to the four connecting rod bearing journals from which oil splash is thrown up to lubricate the cylinder bores and the small ends of the connecting rods.

The four camshaft journals are lubricated directly by oil holes from No. 1, 2, 4 & 5 crankshaft main bearings. The oil pressure is reduced at the No. 1 journal of the camshaft and is used to lubricate the rocker shaft. The oil pump has a pressure relief valve which limits the oil pressure. The oil filter housing has a by-pass valve which prevents the engine from going without lubrication if the filter element becomes plugged.

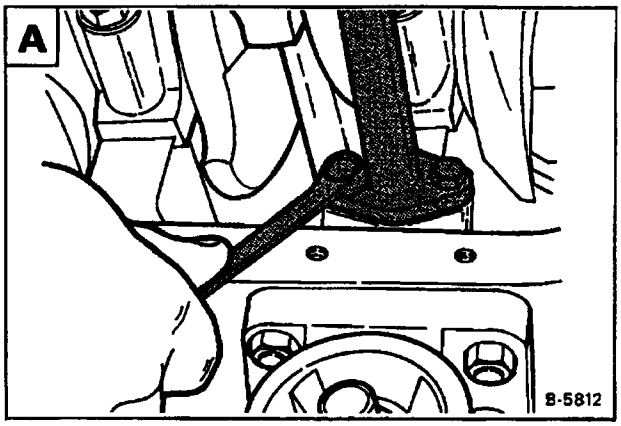


OIL PUMP

Removal and Installation

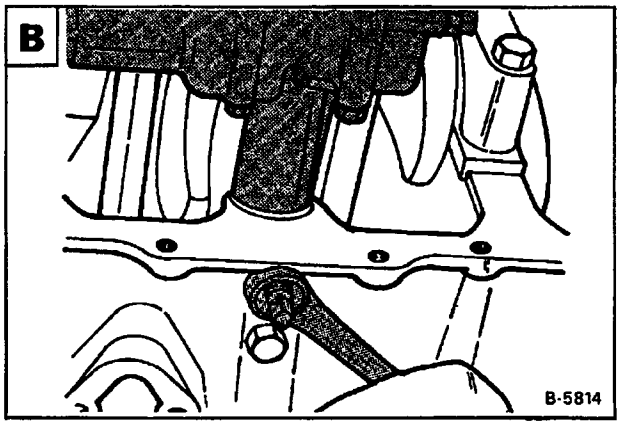
Remove the oil pan.

Remove the bolts which fasten the oil tube to the engine block [A].



Loosen the locknut at the bolt which holds the oil pump in the block [B].

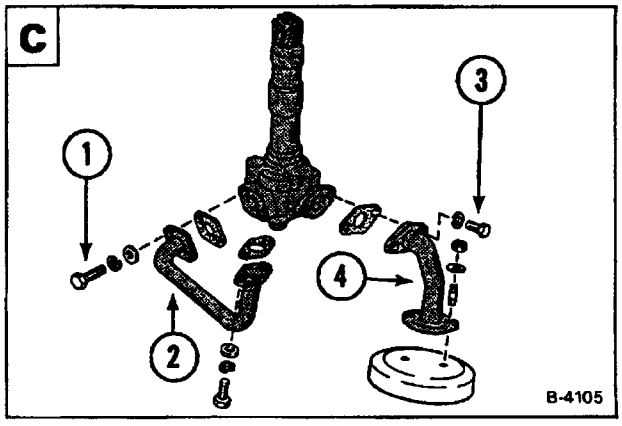
Remove the bolt and remove the oil pump.



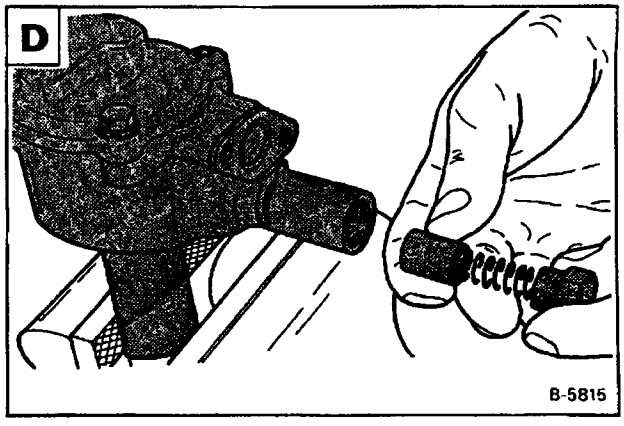
Disassembly and Assembly

Remove the bolts (Item 1) and remove the tube (Item 2) [C].

Remove the bolts (Item 3) and remove the tube (Item 4) with the screen [C].



Remove the relief valve plunger and spring [D].



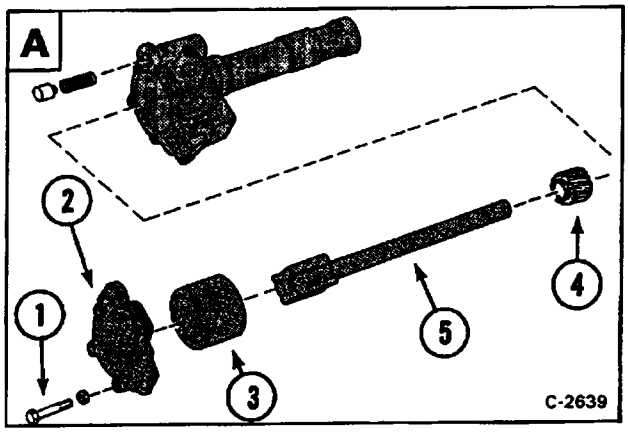
OIL PUMP (Cont'd)

Remove the bolts (Item 1) and remove the end cover (Item 2) [A].

Remove the outer rotor (Item 3) from the housing [A].

Use a puller and remove the gear (Item 4) from the shaft [A].

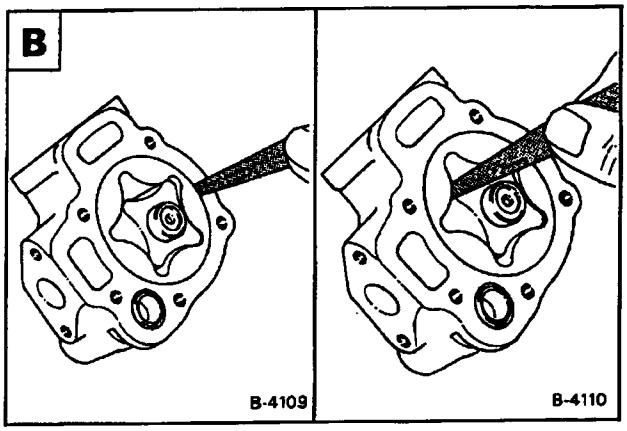
Remove the shaft and inner rotor (Item 5) from the housing [A].



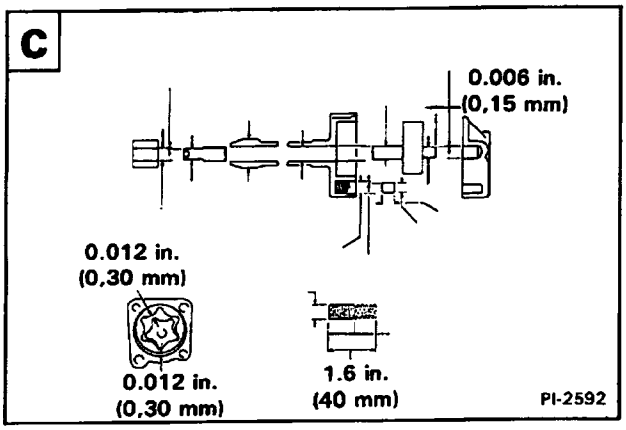
Inspection

Check the clearance between the inner and outer rotor [B].

Check the clearance between the outer rotor and the housing [B].

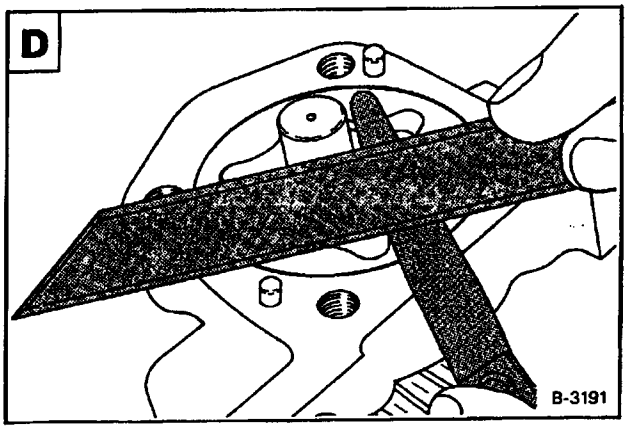


The correct specifications are shown in figure [C].



Check the end play [D].

If any of the clearances are over specifications, the oil pump must be replaced as an assembly.

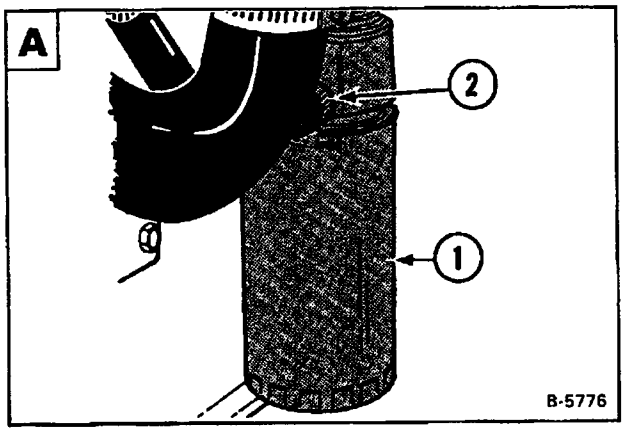


OIL FILTER ADAPTER HOUSING

Removal and Installation

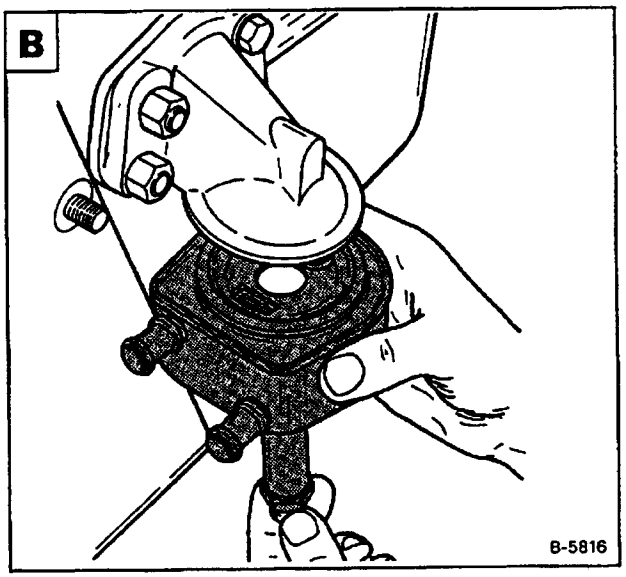
Use a filter wrench and remove the oil filter (Item 1) [A].

Remove the hoses (Item 2) from the adapter housing [A].



Remove the bolt and the adapter housing [B].

Installation: Clean the surface of the adapter housing and install a new O-ring before installation.



WATER PUMP

Removal and Installation

Remove the coolant from the cooling system. Remove the belt shield.

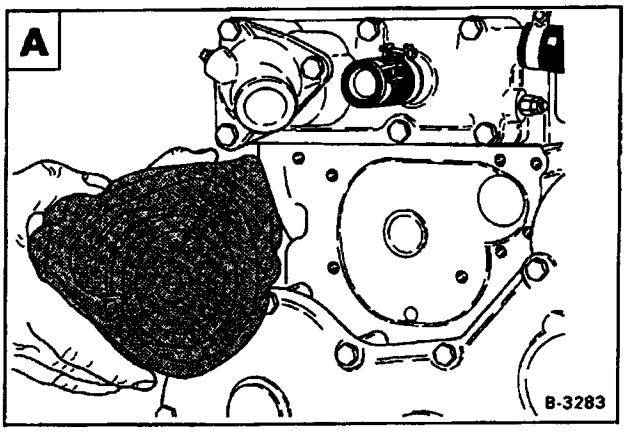
Loosen the alternator adjustment bolt and remove the alternator belt.

Remove the four bolts from the pulley and remove the pulley.

Remove the bolts which fasten the water pump to the engine block.

Remove the water pump [A].

Installation: Clean the block surface. Put gasket cement on the engine block and install a new gasket.



Disassembly

Remove the snap ring (Item 1) [B].

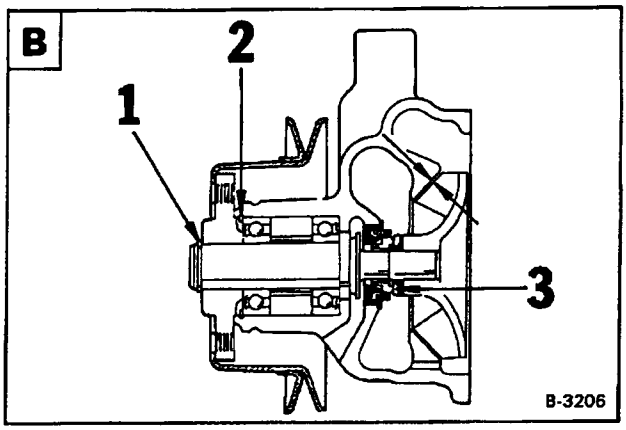
Press the complete assembly out of the impeller end of the housing.

Remove the snap ring (Item 2) [B].

Press the two shaft bearings out through the front of the housing.

Use a puller and remove the impeller from the shaft.

Remove the seal (Item 3) from the shaft [B].

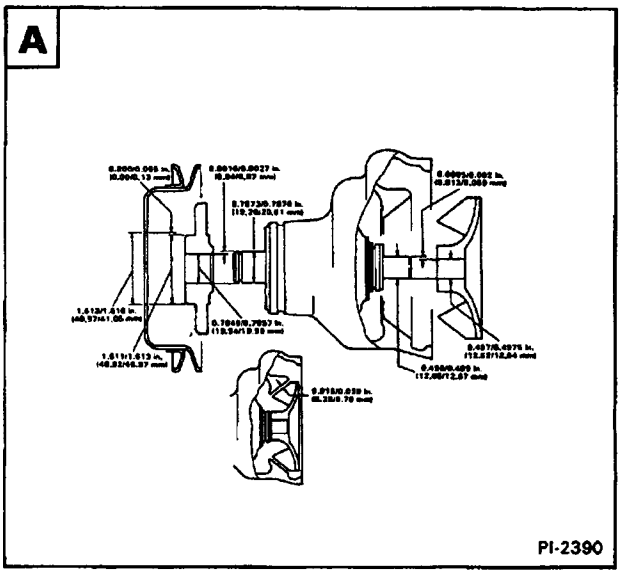


WATER PUMP (Cont'd)

Checking

Check the water pump as listed in the specifications [A].

Replace the seals and worn parts.



Assembly

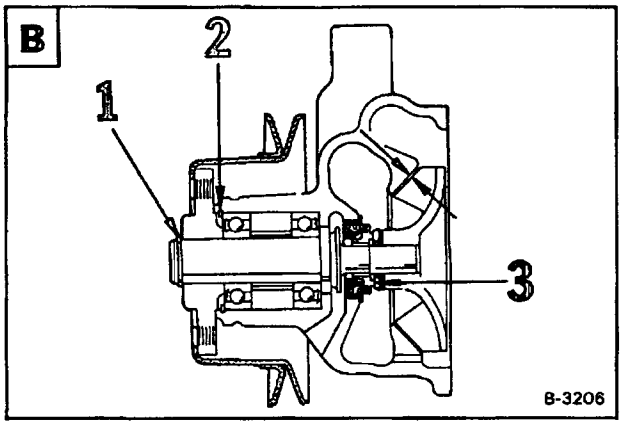
Press the two bearings and spacer (between the bearings) on the shaft.

Put grease on the spacer, about one-half to two-thirds of the area between the bearings. Put grease inside the bearings.

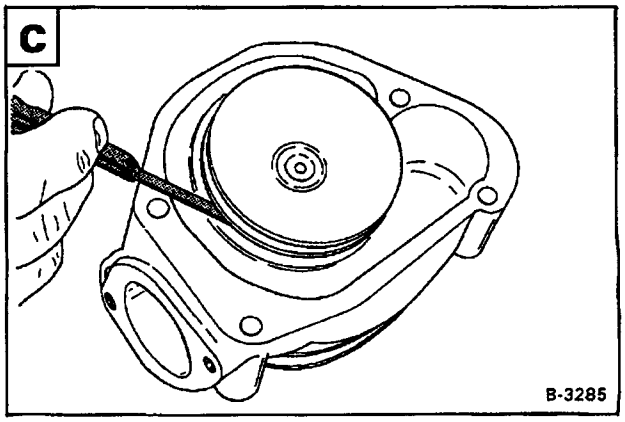
Press the complete assembly in the front of the housing. Locate it in the correct position by installing the snap ring (Item 2) [B].

Put a support under the impeller end of the shaft. Press the hub on the shaft and install the snap ring (Item 1) [B].

Install the seal over the impeller end of the shaft (with carbon surface out). Locate it in position in the flange area of the housing. Install the ceramic counterface seal with ceramic face toward the carbon seal (Item 3) [B].



Press the impeller on the shaft. Check the clearance to make sure there is 0.015 - 0.030" (0,38 - 0,76 mm) between the impeller and the housing [C].



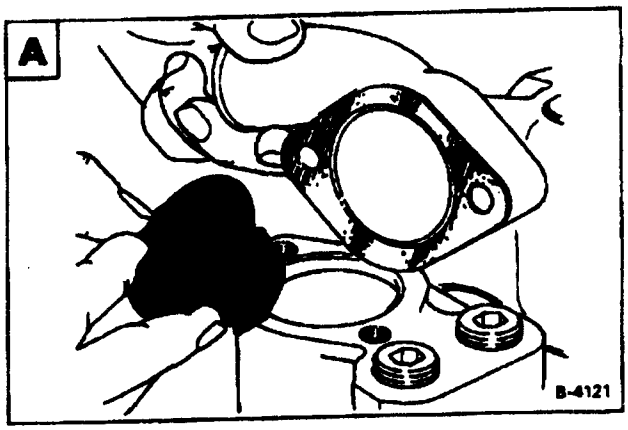
THERMOSTAT

Removal

Remove the coolant from the cooling system.

Remove the hose from the housing of the thermostat.

Remove the bolts, housing and thermostat from the engine block [A].



Testing the Thermostat

Put the thermostat in water and heat the water. The thermostat valve must start to open at 179 - 183° F. (81 - 85° C.) and must be fully open to 0.315" (8 mm) at 185 - 200° F. (88 - 94° C.).

If the thermostat does not open in this range, replace the thermostat.

Installation

Clean the surface of the engine block and housing.

Put gasket cement on the engine block and install a new gasket.

Install the thermostat and the housing on the block and tighten the bolts.

Install the hose and tighten the clamp.

Add pre-mixed coolant of 50% ethylene glycol and 50% water to the cooling system.