

**ENGINE SERVICE  
(Kubota 743)**

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**KUBOTA  
(743)**



## TROUBLESHOOTING

### Chart

The following troubleshooting chart is provided for 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
Engine will not turn over with the starter.	1, 2, 3, 4, 5, 6
Engine will not start or is difficult to start.	7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19
Engine misses, runs irregularly or stops.	20, 21, 22, 23, 24
Engine overheats.	25, 26, 27, 28
Too much engine vibration.	29, 30

### KEY TO CORRECT THE CAUSE

1. Battery has lost its charge.
2. Loose battery connections.
3. Loose starter connections.
4. Damaged starter switch.
5. Broken starter switch.
6. Damaged starter solenoid.
7. Wrong starting procedure.
8. No fuel in tank.
9. Air cleaner is dirty.
10. Fuel vent in cap has restriction.
11. Fuel line has air leak, dirt or water.
12. Damaged fuel lift pump.
13. Hydraulic/Hydrostatic load on engine.
14. Damage to fuel injection system.
15. Crankcase oil is thick.
16. Check glow plugs.
17. Check pre-heat solenoid.
18. Check the fuel shutoff button.
19. Delivery valve nuts not tightened.
20. Fuel injection set wrong.
21. Dirty fuel, or fuel filter restricted.
22. Poor compression.
23. Wrong fuel (use diesel only).
24. Water in the fuel.
25. Engine is overloaded.
26. Dirty engine oil.
27. Exhaust system has restriction.
28. Injection timing is wrong.
29. Loose engine mounts.
30. Worn rubber mounts.

## FUEL FILTER

### Replacing The Fuel Filter

The fuel filter is on the right hand side of the engine on the main frame. Replace the fuel filter every 250 hours of loader operation.

To replace the fuel filter element:

Clean the filter areas.

Shut off the fuel at the fuel tank.

Remove the bolt from the top of the filter housing (Item 1) **[A]**.

Remove the element and the rubber seal from the housing.

Install a new rubber seal on the housing and put a small amount of oil on the rubber seal.

Install the new filter element in the container and install on the filter head. Hand tighten only.

Open the fuel shutoff valve at the tank until the fuel filter container is full.

Tighten the bolt to prevent leakage.

### Removing Air From The Fuel System

After replacing of the fuel filter element or when the fuel tank has run out of fuel, the air must be removed from the fuel system before starting the engine.

Open the rear door. The engine must be cool.

Open the vent plug (Item 2) **[A]**.

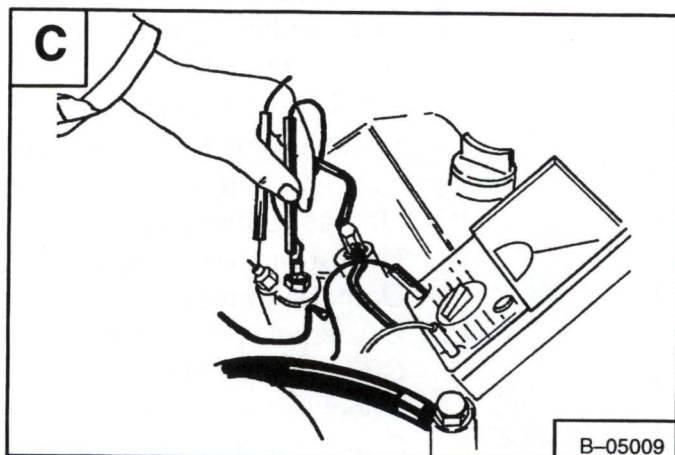
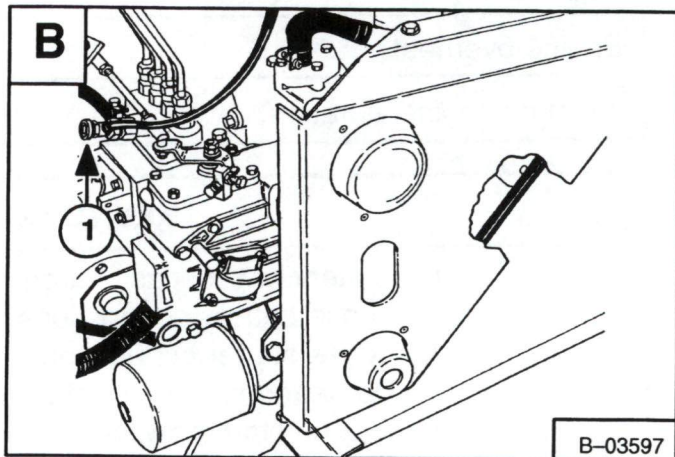
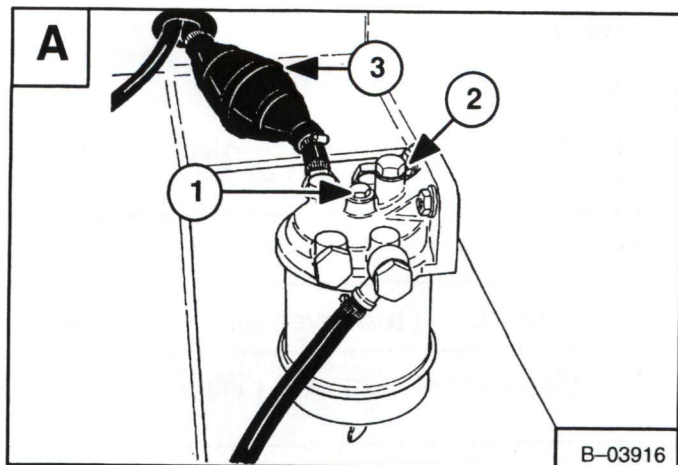
Operate the hand pump (Item 3) **[A]** until fuel flows from the vent plug (Item 2) **[A]** with no air bubbles.

Tighten the vent plug.

Operate the hand pump until it feels solid.

Move the throttle control to minimum RPM. Loosen the valve (Item 1) **[B]**.

Start the engine. When the engine runs smoothly, close the valve (Item 1) **[B]**.



## GLOW PLUG

### Checking

Disconnect the glow plug cables and leads.

Remove the glow plug from the cylinder head.

Connect a circuit tester, one terminal to each end of the glow plug **[C]**.

The reading must be approximately 1.5 ohms. If the resistance is zero ohms the glow plug has a short circuit. If the resistance is infinite the coil of the glow plug is broken.

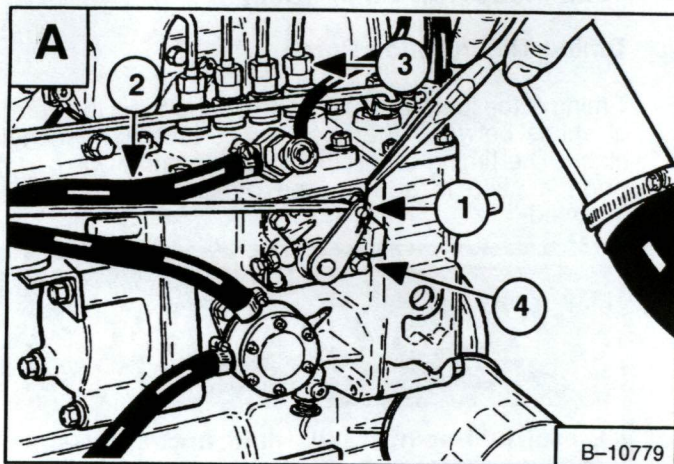
## FUEL INJECTION PUMP

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

### IMPORTANT

Do not attempt to maintain or adjust unless you are trained and have the correct equipment.

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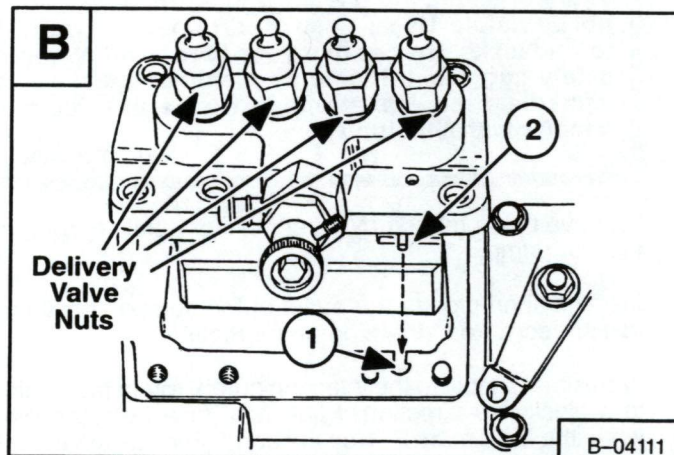
### Removal and Installation

Clean the area around the injection pump. Disconnect the fuel shut-off linkage (Item 1) [A].

Disconnect the fuel inlet hoses (Item 2) [A].

Disconnect the high pressure tubelines (Item 3) [A].

**Installation:** Tighten the delivery valve nuts to 29–36 ft.-lbs. (39–48 Nm) torque.



### IMPORTANT

Do not bend the high pressure fuel injection tubes when removing or installing them.

I-2029-0289

Remove the side cover (Item 4) [A].

Remove the four mounting nuts.

**Installation:** Tighten the nuts to 17–20 ft.-lbs. (23–27 Nm) torque.

Put the pin in the control rack in alignment with the slot in the engine block (Item 1) [B]. Remove the injection pump.

**NOTE:** Make sure the same number of shims are installed under the injection pump. The shims are used for engine timing.

**Installation:** When the injection pump is installed, make sure the pin (Item 2) [B] on the control rack is correctly installed on the fork lever. If the slot is not installed correctly, the engine will run over maximum speed and serious damage can result.

## FUEL INJECTION PUMP (Cont'd)

### Timing The Injection Pump

Timing of the fuel system is done by changing the number of shims between the injection pump and the engine block. The timing of the fuel injection pump will be later when a shim is added, and earlier when a shim is removed.

# WARNING

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

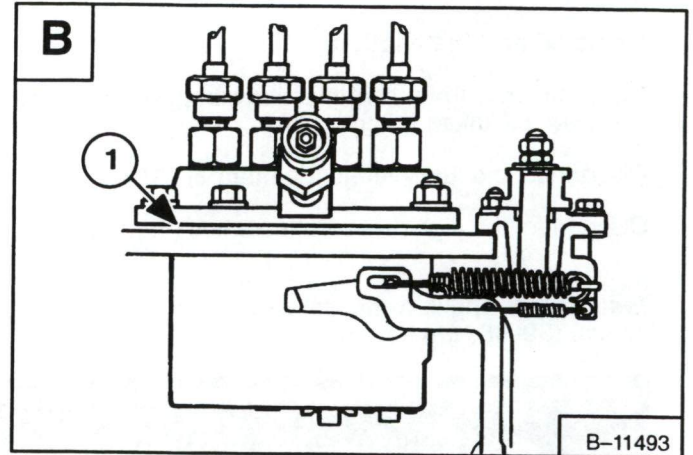
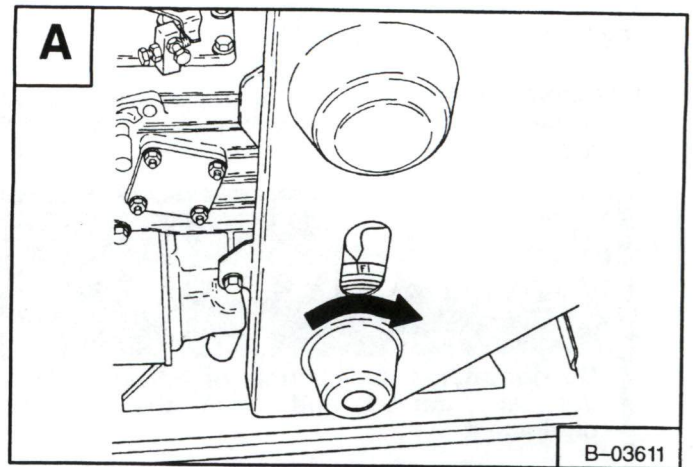
W-2072-0496

Remove the number 1 cylinder injector tubeline from the injector pump.

Install a short pipe to the outlet of the number 1 cylinder injector port. Point the pipe up (vertical).

With a fuel supply to the injection pump, rotate the engine in a clockwise direction. Fuel must flow from the pipe when the fixed mark F-1 on the crankshaft pulley and the point comes into alignment [A].

The correct timing for the engine is 25 degrees B.T.D.C. (#1 cylinder). Add or subtract shims (Item 1) [B] as needed to adjust the delivery time of the fuel. Each shim will change the timing 1.5 degrees.



## FUEL INJECTION PUMP (Cont'd)

### Checking The Injection Pump

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

MEL1237 – Adapter Fuel Line  
MEL1173-1 – Pressure Gauge

To check the discharge pressure at the fuel injection pump, use the following procedure:

Disconnect a high pressure fuel line (Item 1) [A] at the pump. Loosen the other end of the same high pressure line so it can be turned away from the fitting.

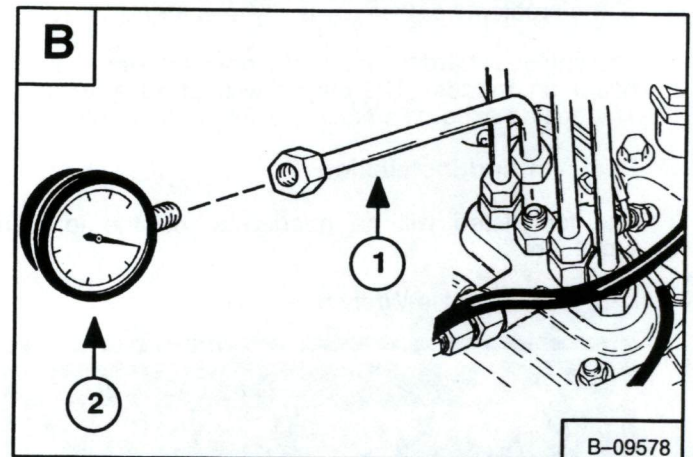
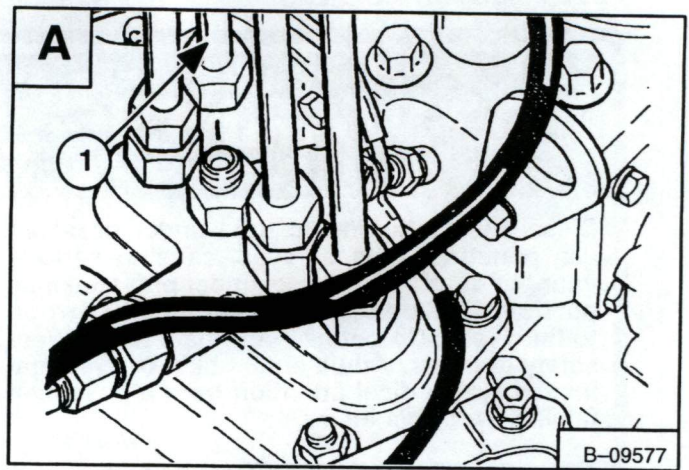
Connect the adapter fuel line (Item 1) [B] to the fitting.

Connect the pressure gauge (Item 2) [B].

Rotate the engine, with the starter, until the pressure raises. Then turn the engine by hand until the pressure gauge reads 1400 PSI (9653 kPa).

Align F1 on crankshaft pulley.

The injection pump must hold the 1400 PSI (9653 kPa) for at least 5 seconds. If not, replace or repair the injection pump.



# ⚠ WARNING

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

W-2072-0496

Some 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

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

MEL1181 – Nozzle Wrench

# IMPORTANT

Do not bend the high pressure fuel injection tubes when removing or installing them.

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Disconnect the high pressure fuel lines at the fuel injector [A].

Disconnect the high pressure fuel lines at the injection pump [B].

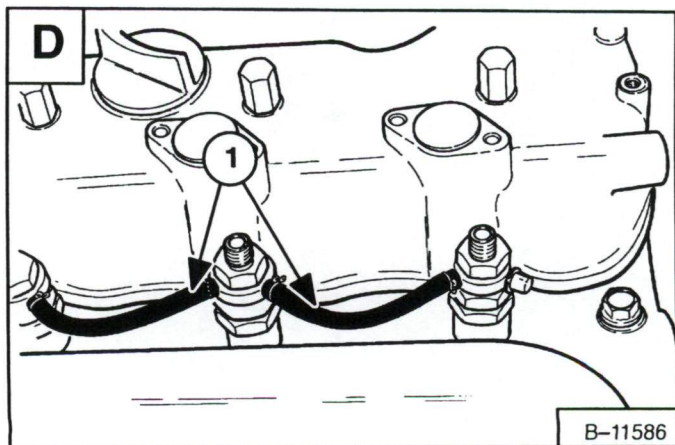
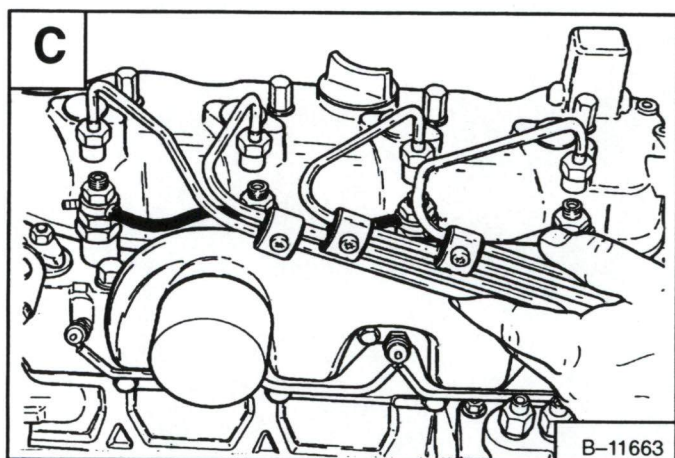
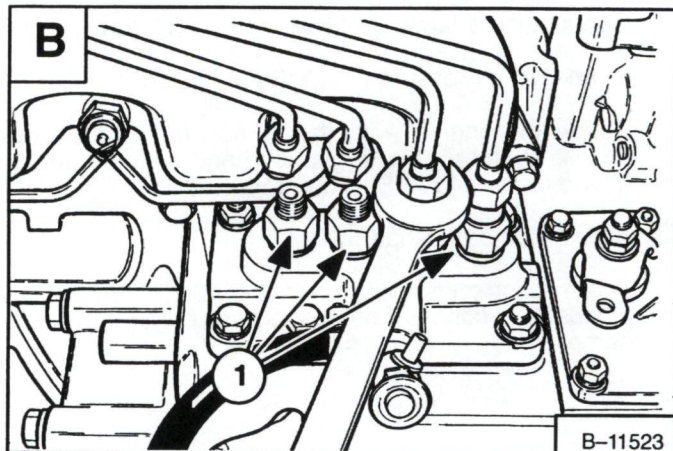
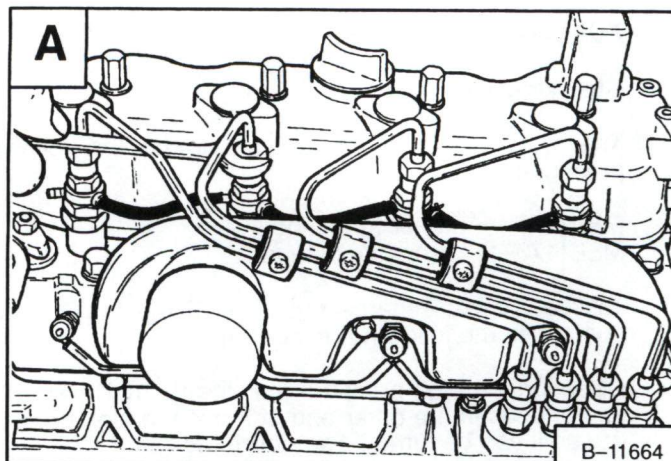
Remove the high pressure lines [C].

Disconnect the low pressure hoses (Item 1) [D] at the injectors.

Use the special tool and remove the fuel injector from the cylinder head.

**Installation:** Tighten the delivery valve nuts (Item 1) [B] to 29–36 ft.-lbs. (39–49 Nm) torque.

Tighten the nozzle holder to 22–36 ft.-lbs. (30–29 Nm) in the cylinder head.





## FUEL INJECTOR NOZZLES (Cont'd)

### Checking the Nozzles

You can adjust the release pressure of the injector by adding or removing spacers (Item 1) [A] at the top of the nozzle spring (Item 2) [A].

Each 0.0039 inch (0,01 mm) spacer will change the release pressure about 142 PSI (979 kPa). The release pressure must be 1920–2133 PSI (13238–14707 kPa).

Connect the injector nozzle to the tester with the nozzle down.

Use tools MEL10018 & MEL10019.

Operate the hand lever at a slow rate and not the opening pressure.

If the pressure is not correct, disassemble the injector nozzle and add or remove spacers.

Assemble the injector nozzle and check the pressure again.

When you assemble the injector nozzle, tighten the nozzle body (Item 3) [A] to 43–58 ft.-lbs. (59–79 Nm) torque.

**NOTE: Do not over tighten, or slow action of the valve will occur.**

Check for inside leakage. Operate the hand lever until the pressure is almost enough to open the injector valve. Record the pressure.

Release the hand lever. Check the pressure decrease for 10 seconds.

If the pressure decrease is more than 740 PSI (5102 kPa) in 10 seconds, the nozzle is damaged.

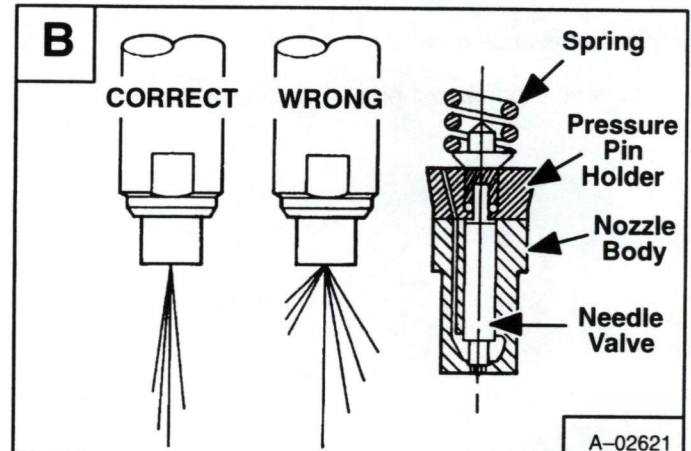
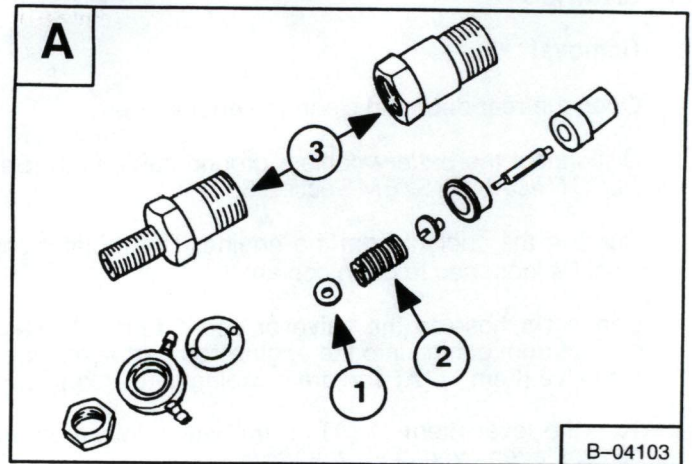
Check that the spray pattern is correct [B].

The spray pattern is not correct if any of the following occur:

Fuel comes out of the side of the nozzle.

Drops of fuel are present at the nozzle.

The nozzle does not have an even flow coming from the nozzle.



## IMPORTANT

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

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## ! WARNING

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

W-2072-0496

## ENGINE

### Removal

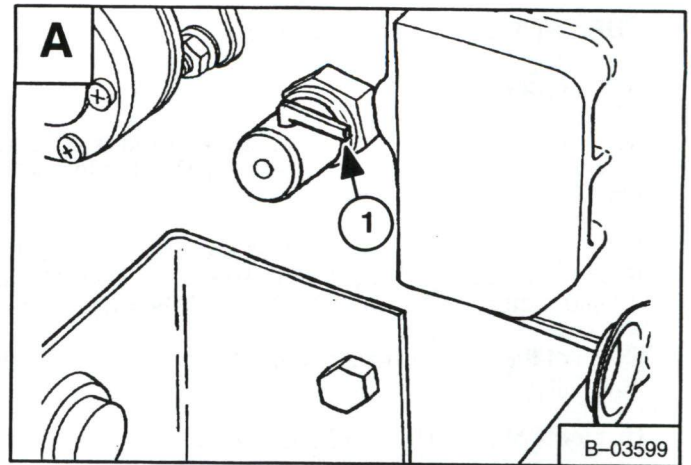
Open the rear door and clean the engine area.

Disconnect the battery cables, ground cable first. (See *ELECTRICAL SYSTEM* Section 6.)

Remove the coolant from the engine. The radiator cap must be loosened to drain coolant.

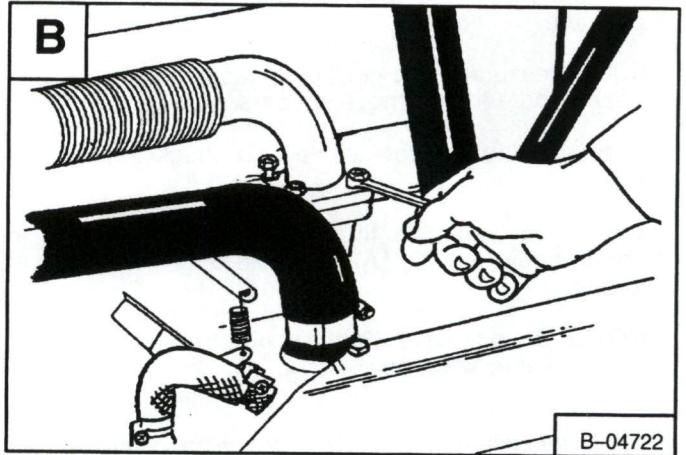
Connect a hose to the valve or use a funnel to keep coolant from getting into the engine compartment. Open the valve (Item 1) [A] and drain coolant into a container.

Turn the lever (Item 1) [A] on the valve. When all the coolant is removed close the valve.

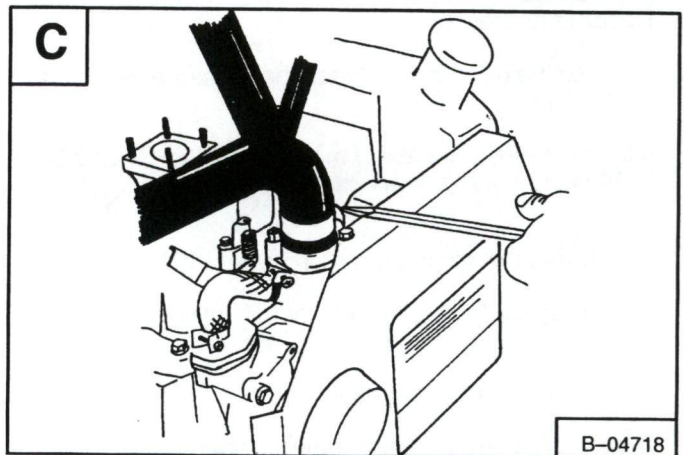


Close the shutoff valve.

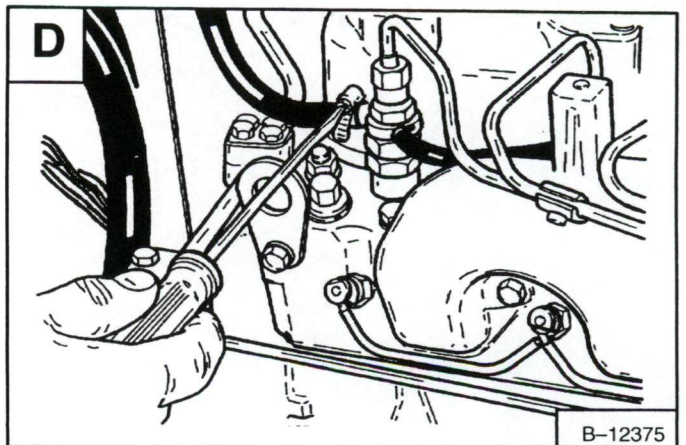
Remove the exhaust pipe from the manifold [B].



Remove the radiator hoses [C].



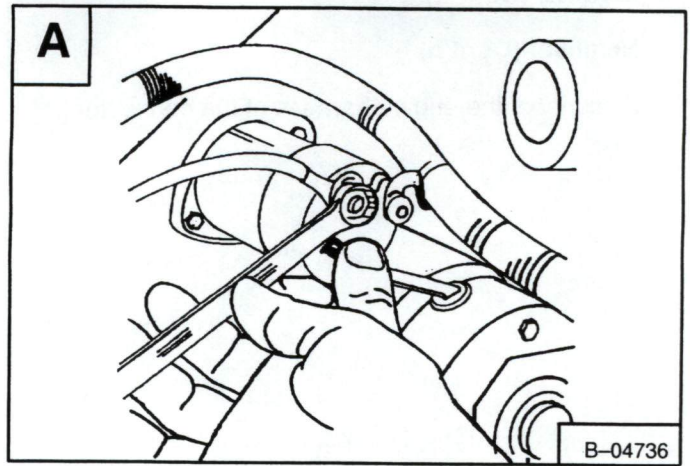
Remove the fuel return hose [D].



**ENGINE (Cont'd)**

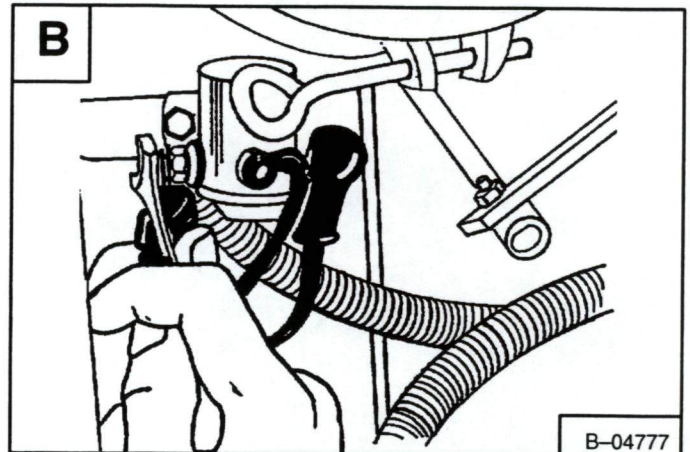
**Removal (Cont'd)**

Remove the hot wire from the starter [A].



Remove the electrical wire from the solenoid [B].

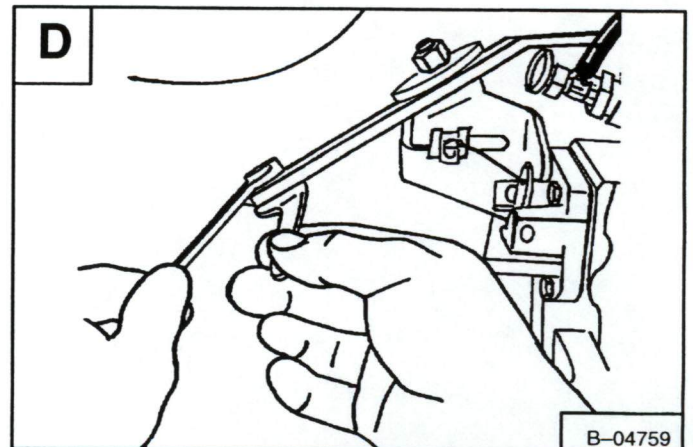
Remove the fuel inlet line at the fuel filter.



Remove the air cleaner hose [C].



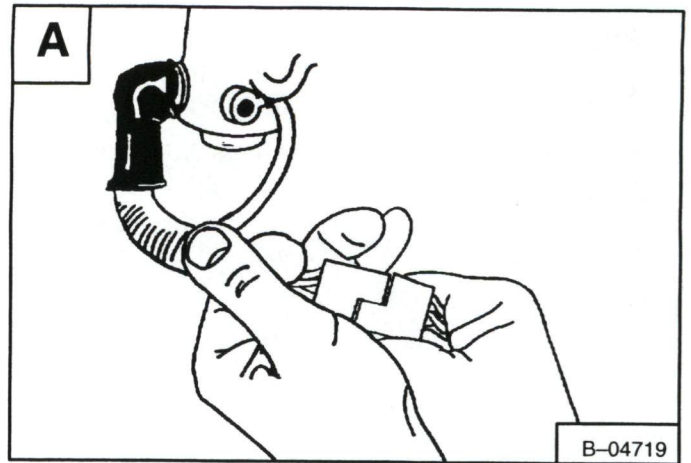
Remove the throttle linkage [D].



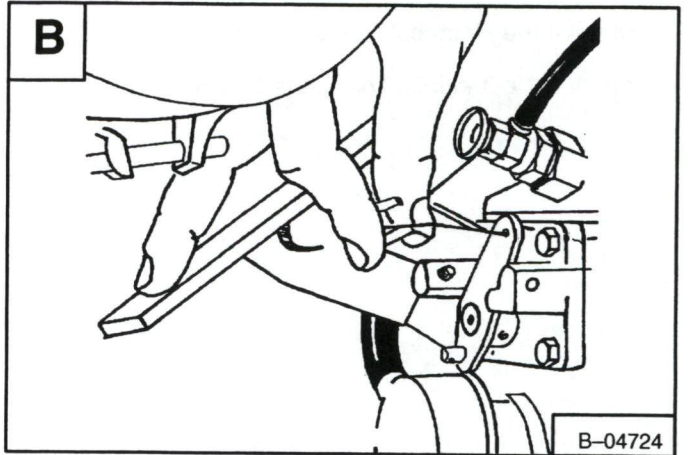
**ENGINE (Cont'd)**

**Removal (Cont'd)**

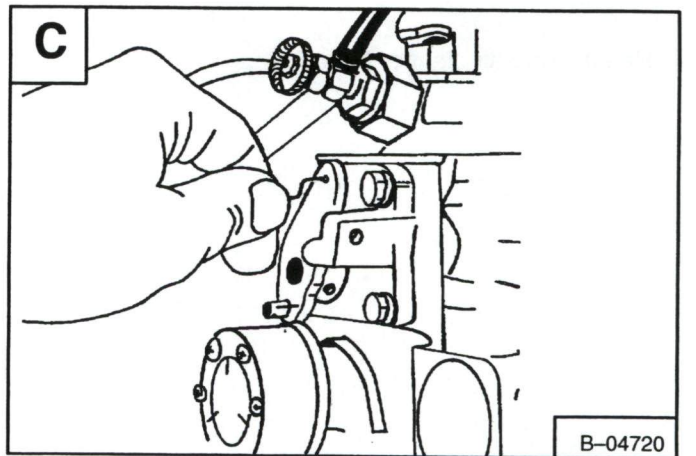
Disconnect the engine harness at the connector [A].



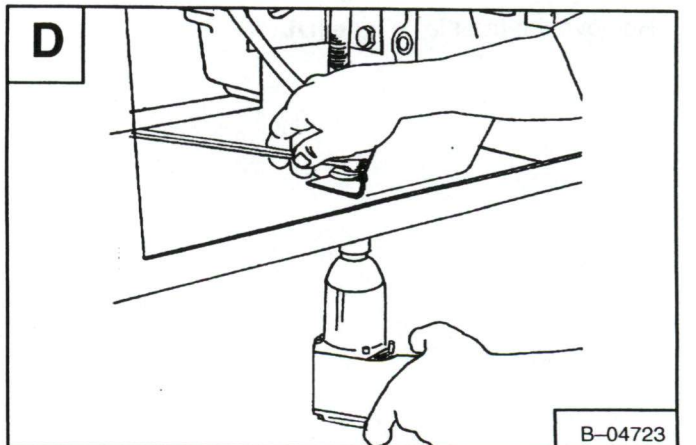
Remove the spring clamp from the fuel shutoff cable [B].



Remove the cable from the speed control arm [C].



Remove the engine mounting bolts [D].



## ENGINE (Cont'd)

### Installation

Raise the operator cab.

Put the engine in the loader.

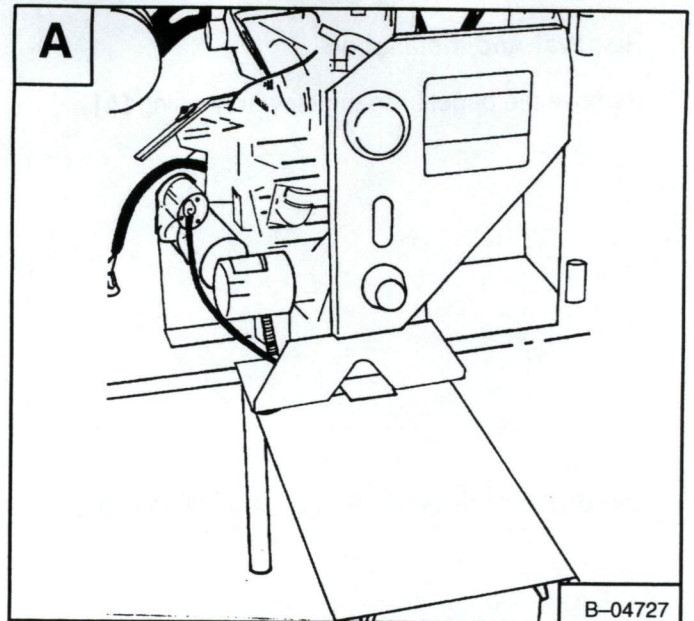
Have a second person in the pump area. Align the coupler on the engine flywheel to the splined shaft on the hydrostatic motor by turning the engine with the tool listed.

MEL1234 – Crankshaft Nut Socket

**NOTE: Belt shield must be removed.**

Install the engine mount bolts and tighten to 65–70 ft.-lbs. (88–95 Nm) torque.

Install all other parts removed.



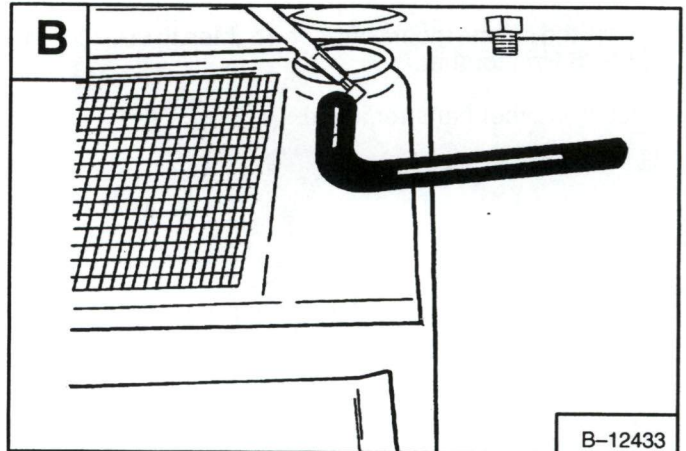
## RADIATOR AND OIL COOLER

### Removal And Installation

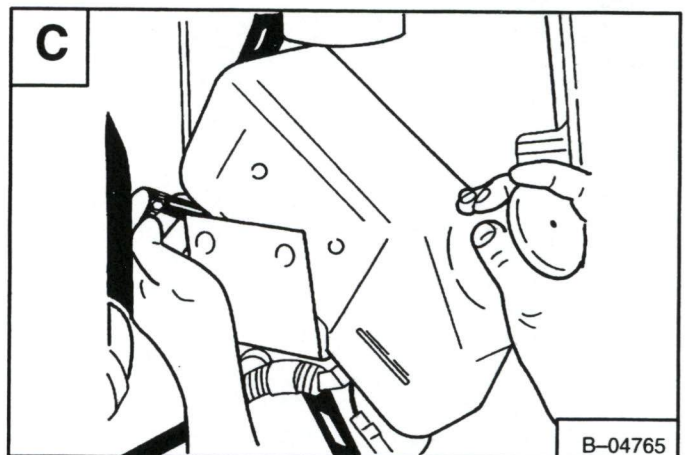
Remove the panel from the blower housing [A].



Loosen the hose clamp on the overflow hose [B].

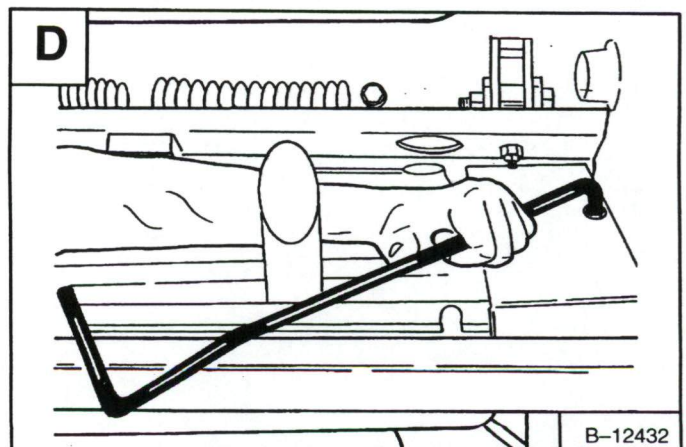


Drain the coolant tank and loosen the clamp on the overflow hose by the recovery tank and remove the tank [C].



Remove the overflow hose [D].

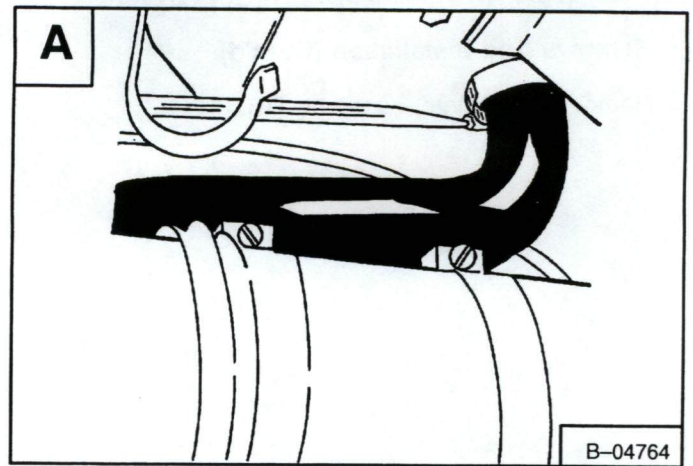
Remove the muffler exhaust pipe.



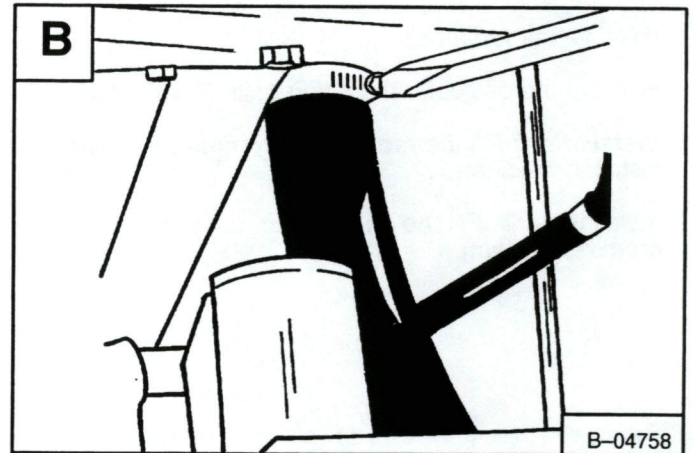
## RADIATOR AND OIL COOLER (Cont'd)

### Removal And Installation (Cont'd)

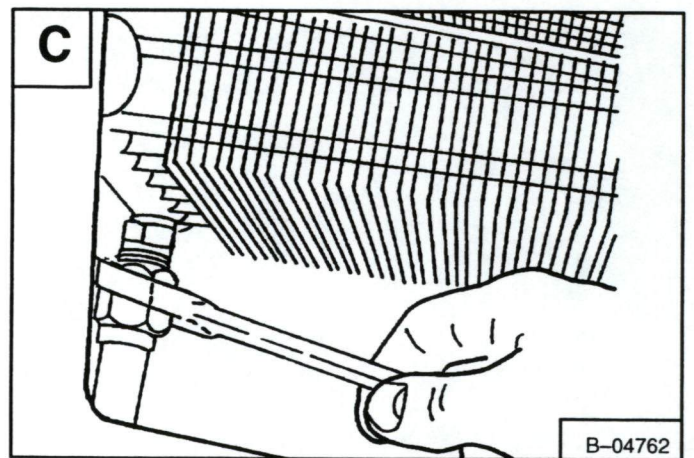
Drain the coolant and remove the inlet radiator hose [A].



Remove the outlet radiator hose [B].

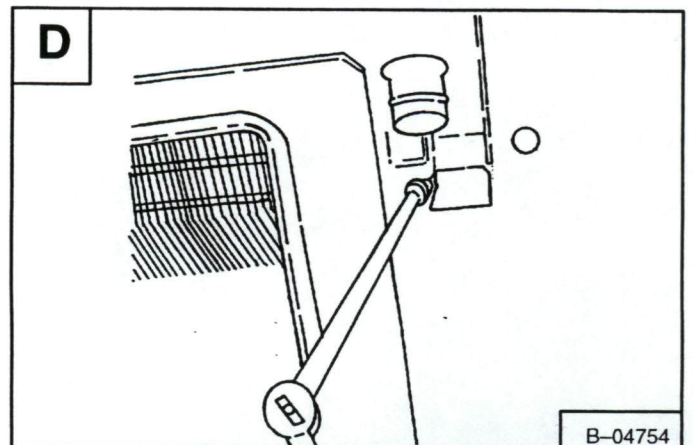


Remove both the inlet and the outlet tubelines from the oil cooler [C].



Remove the mounting bolts for the radiator assembly [D].

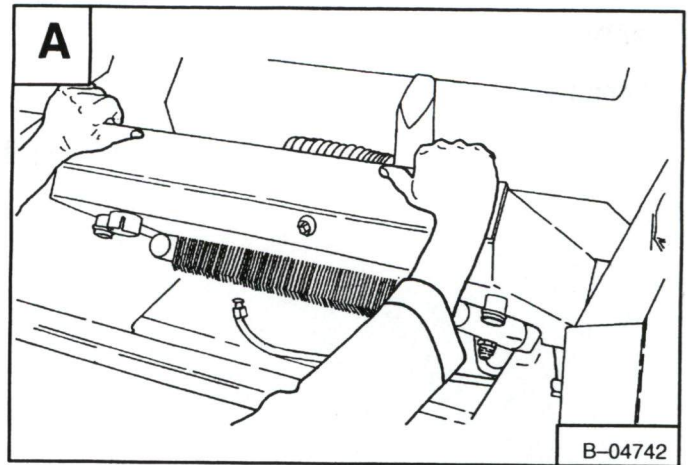
**Installation:** Tighten the bolts to 180–200 in-lbs. (21–23 Nm) torque.



## RADIATOR AND OIL COOLER (Cont'd)

### Removal And Installation (Cont'd)

Remove the radiator assembly [A].



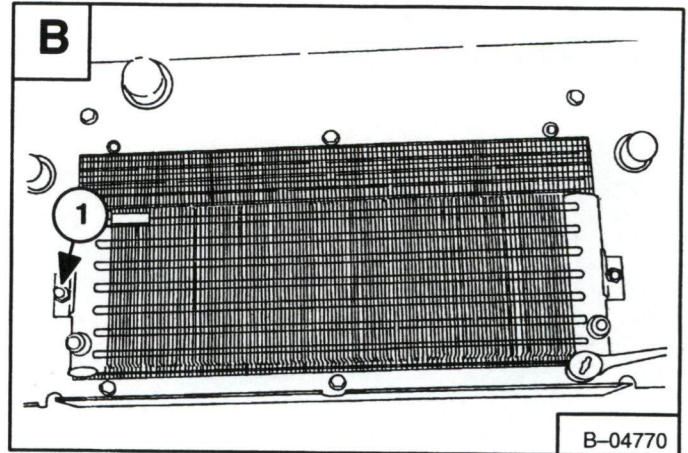
Remove the radiator mounting bolts [B].

Remove the radiator.

Remove the oil cooler mounting bolts (Item 1) [B].

**Installation:** Fill the radiator with premixed coolant and install the radiator.

Install the grill. Fill the coolant recover tank 1/3 full with premixed coolant.





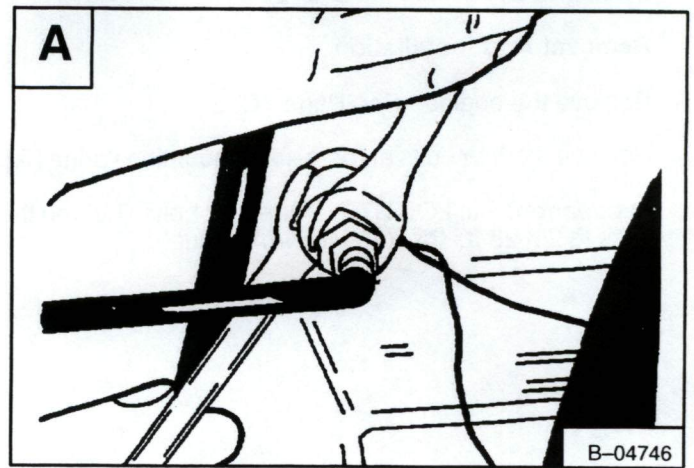
## BLOWER HOUSING

### Removal And Installation

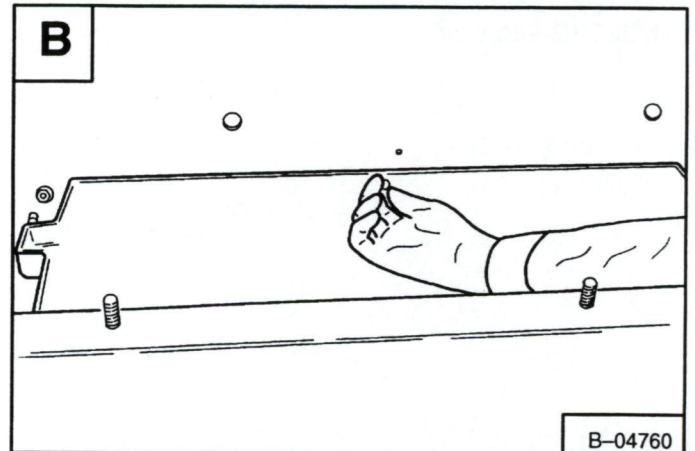
Remove the engine. (See Page 7C-8.)

Remove the radiator, oil cooler assembly. (See Page 7C-12.)

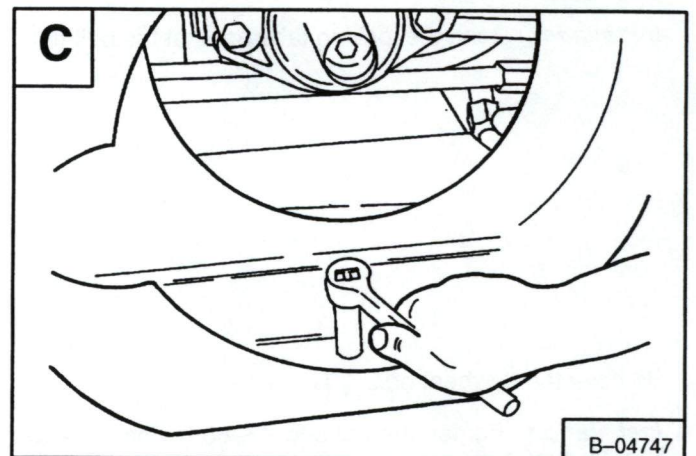
Disconnect the fuel lines from the fuel filter [A].



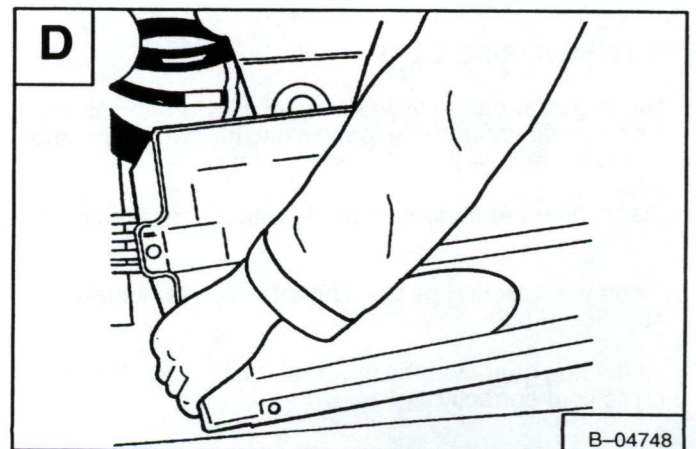
Remove the center nut from the blower housing [B].



Remove the bottom bolt from the blower housing [C].



Remove the blower housing [D].



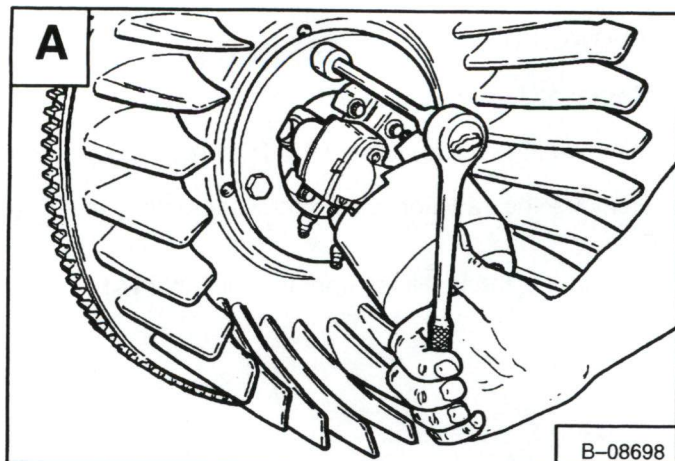
## ENGINE FLYWHEEL AND U-JOINT

### Removal And Installation

Remove the engine. (See Page 7C-8.)

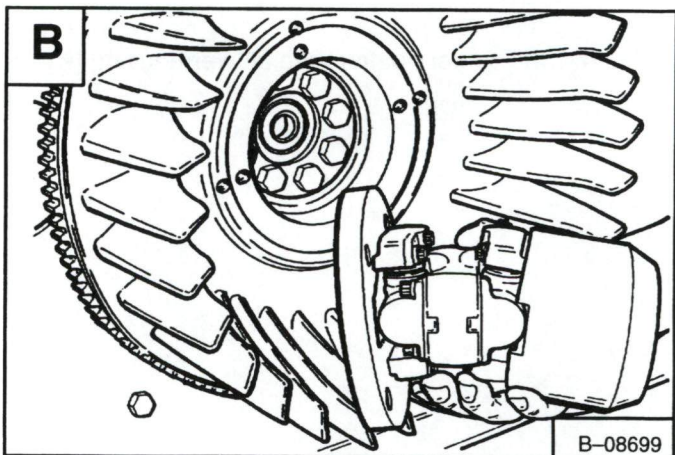
Remove the four bolts at the u-joint mounting flange [A].

**Installation:** Put LOCTITE on the four bolts. Tighten the bolts to 25–28 ft.-lbs. (43–48 Nm) torque.



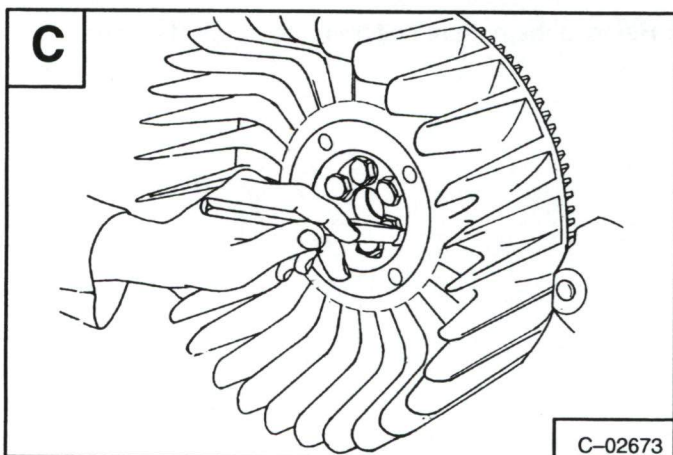
Remove the u-joint from the flywheel [B].

MEL1187 – Socket



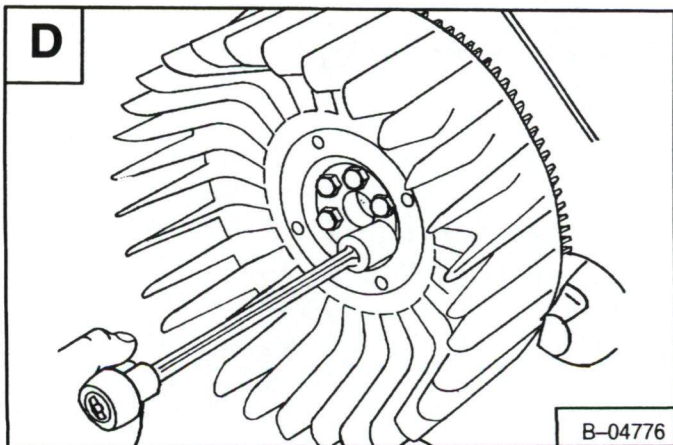
Bend the locking tabs away from the bolt flats [C].

**Installation:** Bend the locking tabs against the bolt flats.



Remove the flywheel bolts [D].

**Installation:** Tighten the bolts to 72–80 ft.-lbs. (98–108 Nm) torque.



### 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 a smooth fit.

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

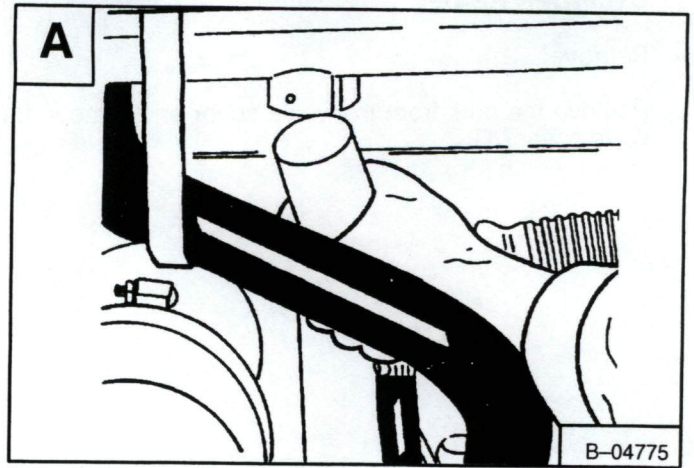
Fit the ring gear over the flywheel. Make sure the gear is on its seat correctly.

## MUFFLER

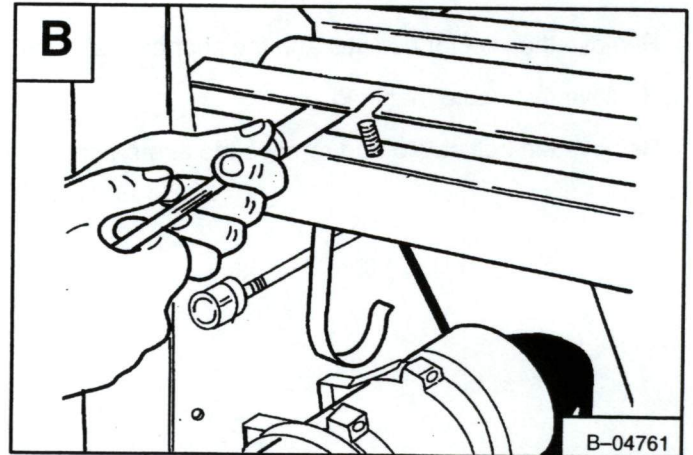
### Removal And Installation

Remove the rear grill.

Remove the exhaust pipe from the muffler [A].



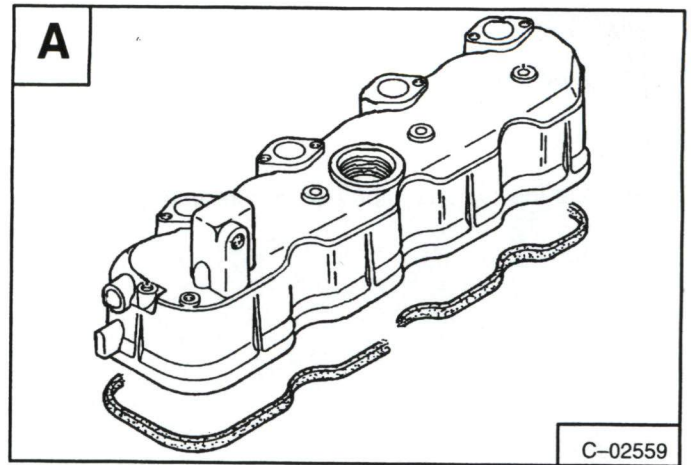
Remove the bolts holding the muffler [B].



## CYLINDER HEAD

### Removal

Remove the nuts from the valve cover and remove the valve cover [A].

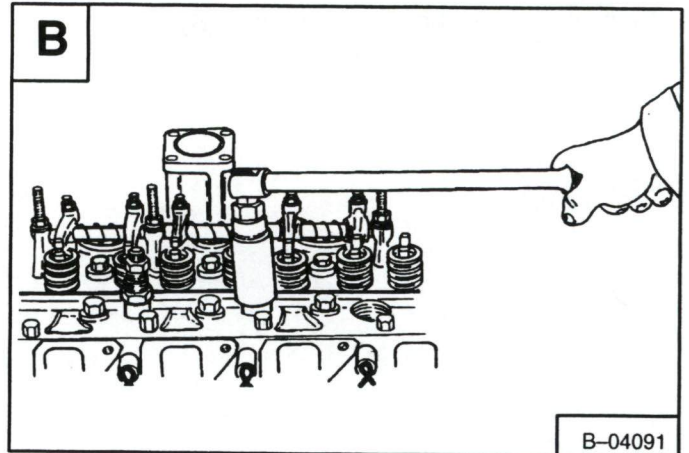


Disconnect the injector tubelines.

Remove the injector nozzles and the copper gasket [B].

Remove the intake manifold.

Remove the belt shield and remove the alternator.

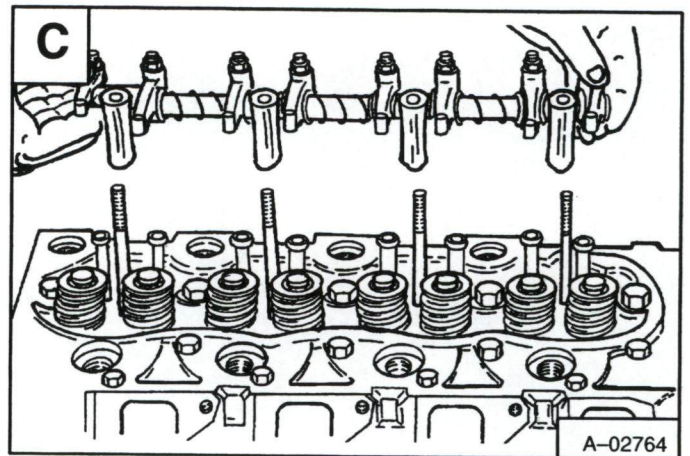


Remove the rocker arm [C].

Remove the push rods.

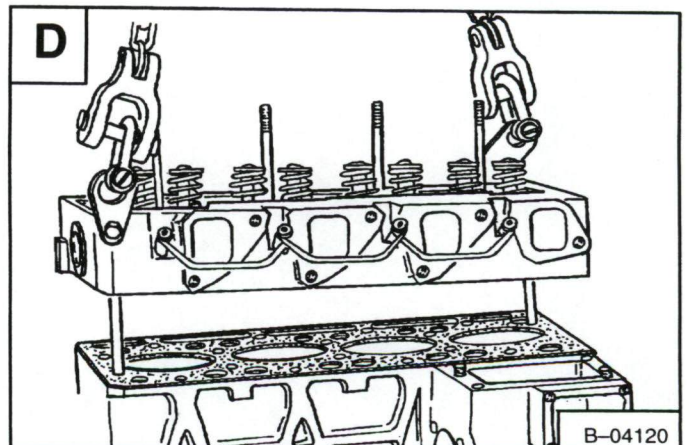
Remove the water return pipe.

Remove the cylinder head bolts.



Remove the cylinder head [D].

Remove the cylinder head gasket and the O-rings.



## CYLINDER HEAD (Cont'd)

### Disassembly

**NOTE:** There may be a shim under the head gasket. Use the shim over again or replace it with the same size shim.

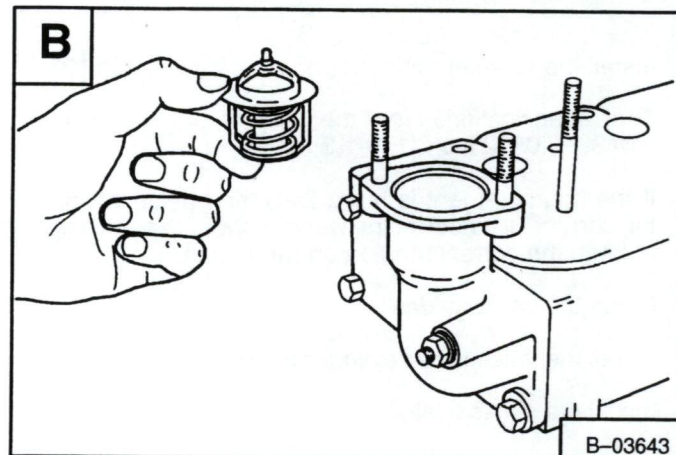
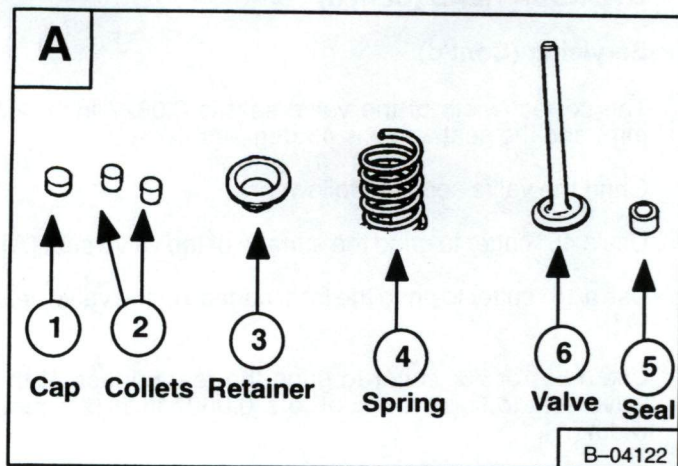
Remove the valve cap (Item 1) [A] and the valve spring collet (Item 2) [A].

Remove the valve spring retainer (Item 3) [A].

Remove the spring (Item 4) [A].

Remove the seal (Item 5) [A] and the valve (Item 6) [A].

Remove the thermostat [B].



### Servicing

Use the tool listed for the following procedure:

MEL1098 – Valve Lapper

Clean the surface of the cylinder head.

Put a straight edge (Item 1) [C] on the cylinder head.

**NOTE:** Do not put the straight edge across the combustion chamber.

Put a feeler gauge (Item 2) [C] between the straight edge and the surface of the cylinder head.

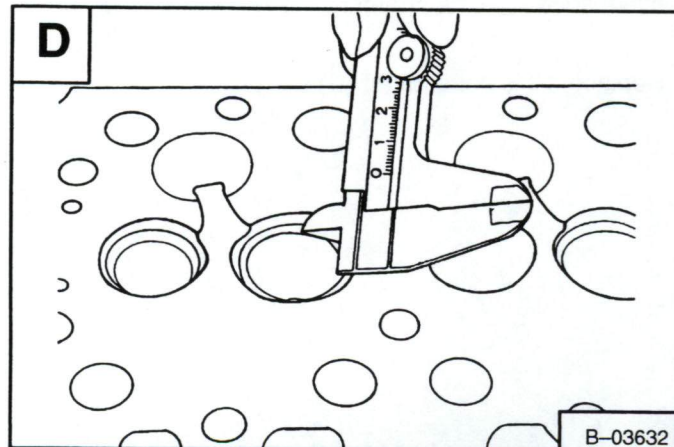
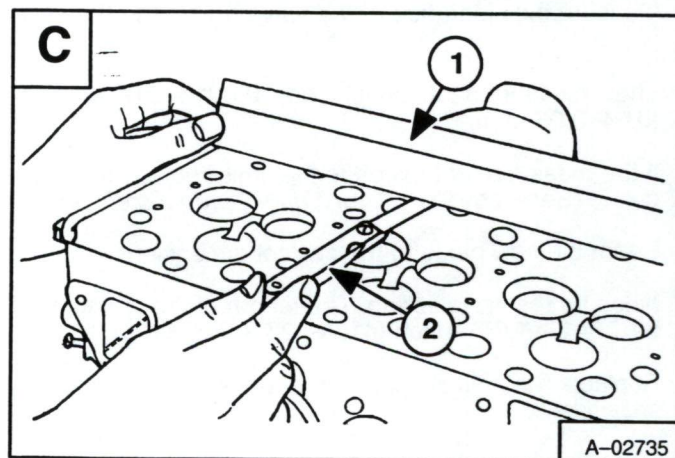
The maximum distortion of the cylinder head surface is  $\pm 0.002$  inch ( $\pm 0.005$  mm).

If the measurement is more than the specifications, the cylinder head must be planed.

**NOTE:** Place a soft brass rod through the injector hole and tap the combustion chamber out before planing the head. Plane the same amount from the bottom side of the combustion chamber before installing it back in the head.

Clean the valve surface.

Measure the width of the valve seat [D].



## CYLINDER HEAD (Cont'd)

### Servicing (Cont'd)

The correct width of the valve seat is 0.0827 inch (2,1 mm) and the seat angle is 45 degrees.

Grind the valve seats as follows:

Use a 45° cutter to grind the surface of the valve seat [A].

Use a 15° cutter to grind the front surface of the valve seat [A].

Use a 65° or 75° cutter to grind the rear surface of the valve seat to finish the seat to a 0.0827 inch (2,1 mm) width [A].

Grind the valve surface to a 45° angle.

Install the valve in the seat and check the depth [B].

The specifications for the depth of the valve is 0.0433–0.0512 inch (1,1–1,3 mm).

If the measurement is more than the specification, add the correct thickness of the washer under the valve spring to keep the correct tension on the spring.

Clean the valve guide.

Install the valve in the cylinder head.

Install the dial indicator.

Measure the clearance of the valve guide and the valve [C].

The measurement must be 0.0016–0.0023 inch (0,04–0,06 mm).

If the measurement exceeds the limit, replace the valve guide. (See Page 7C–21 for *Valve Guide Installation*.)

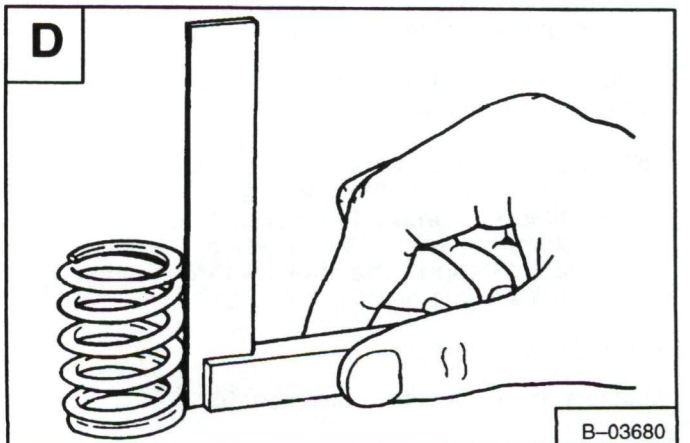
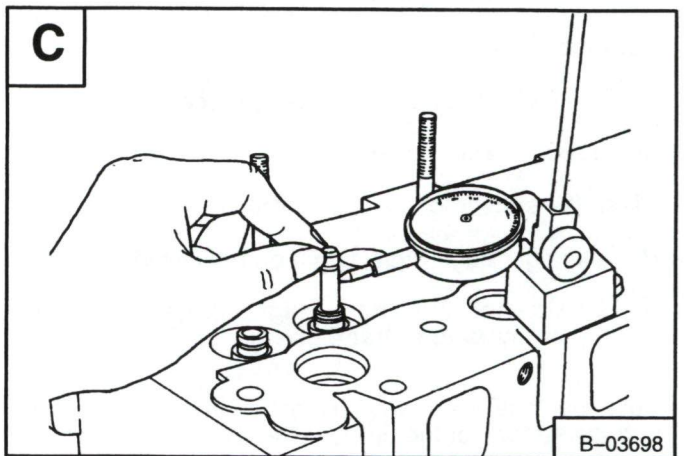
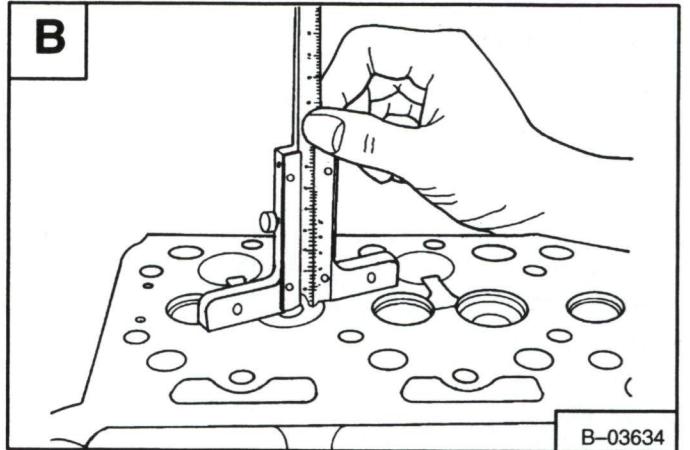
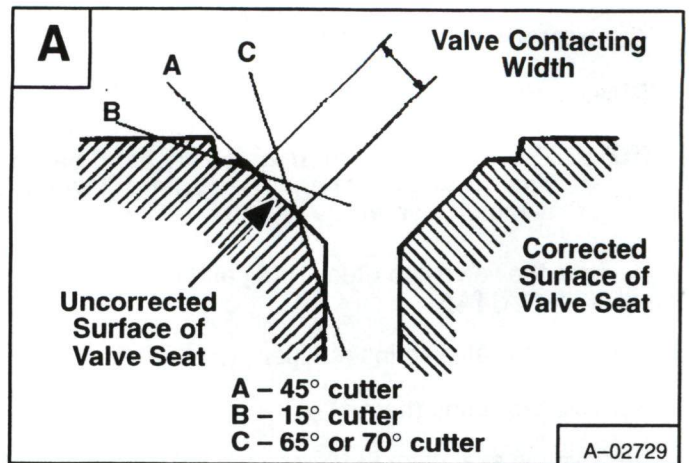
Ream the new guide to the correct dimensions.

Measure the valve spring. The length of the spring must be 1.6417–1.6614 inch (41,7–42,2 mm).

Replace the valve spring if it does not meet these specifications.

Check the valve spring with a combination square to make sure it stands straight [D].

Replace it if is not straight [D].



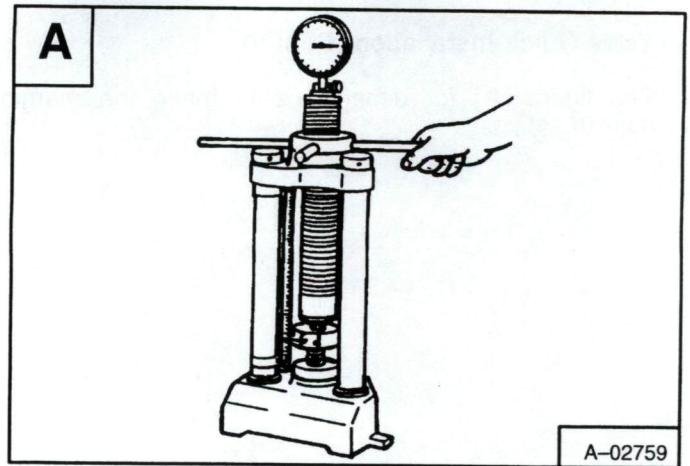
## CYLINDER HEAD (Cont'd)

### Servicing (Cont'd)

Put the valve spring in a tester [A].

Push down on the spring 1.3839 inch (35,15 mm). The compression load must be 22.5–26.5 lbs. (100–118 N).

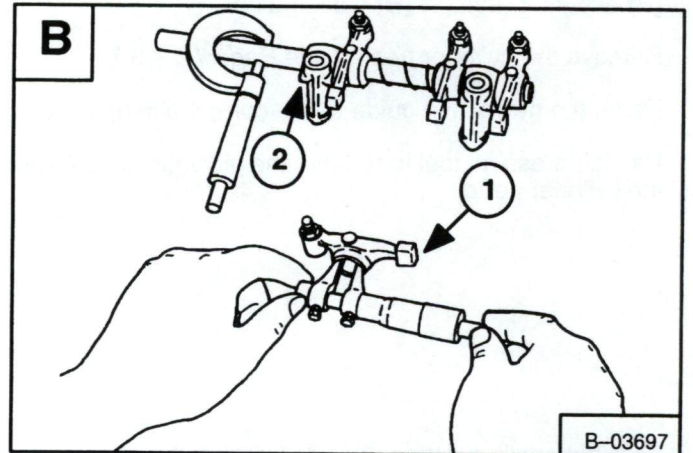
Replace the valve spring if it does not meet these specifications.



Measure the inside diameter of the rocker arm bushing (Item 1) [B] and the shaft diameter (Item 2) [B].

The inside of the rocker bushing is 0.5513–0.5529 inch (14,0–14,04 mm).

If the measurements are not within the specifications replace the needed parts.

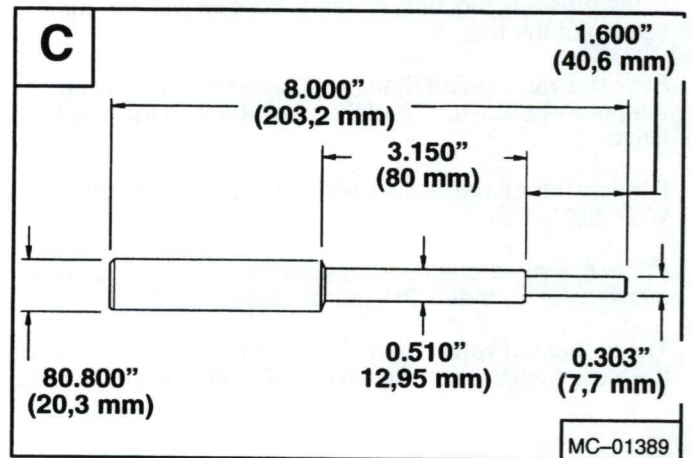


### Valve Guide Installation

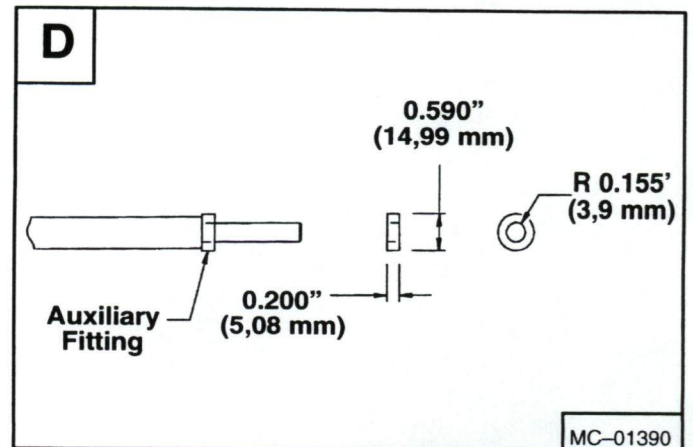
Use the tools listed to replace the valve guides:

Press-fit tool  
Auxiliary fitting  
Margin adjustment jig

See figure [C] for dimensions to make the press-fit tool.



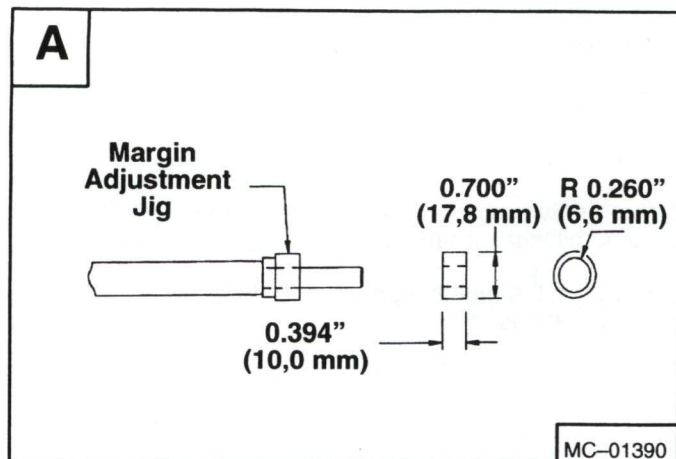
See figure [D] for dimensions to make the auxiliary fitting.



## CYLINDER HEAD (Cont'd)

### Valve Guide Installation (Cont'd)

See figure [A] for dimensions to make the margin adjustment jig.

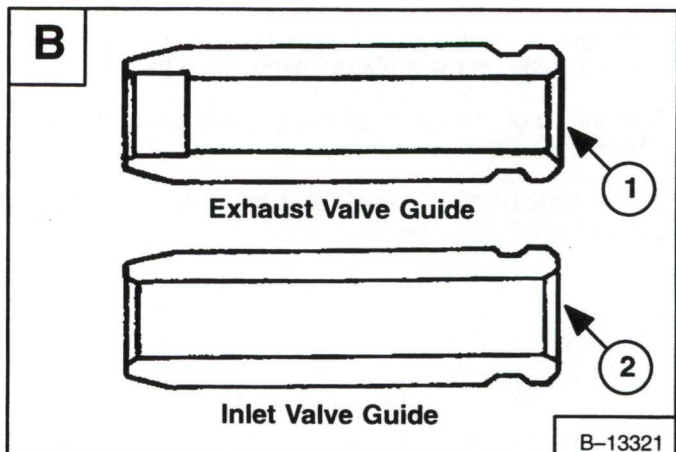


Use the following procedure to replace exhaust (Item 1) [B] and inlet (Item 2) [B] valve guides.

Remove the cylinder head. (See Page 7C-18.)

Ream the new valve guide to the correct dimensions.

Use the press-fit tool to remove the old valve guide from the cylinder head.



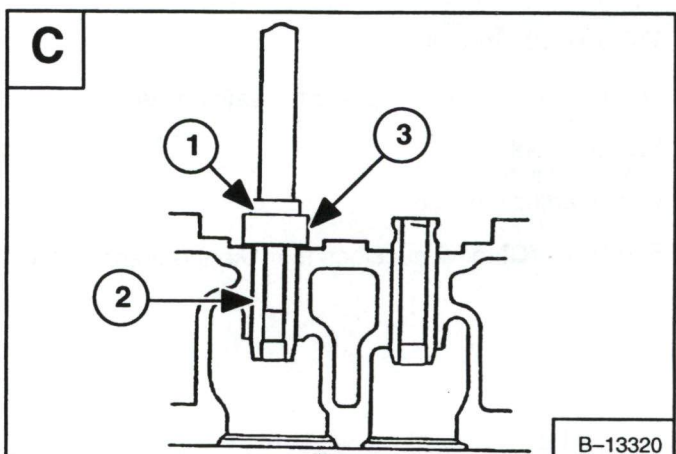
Slide the auxiliary fitting (Item 1) [C] over the narrow end of the press-fit tool until it makes contact with the middle section of the tool.

Slide the valve guide (Item 2) [C] over the narrow end of the press-fit tool until it makes contact with the auxiliary fitting.

Position the margin adjustment jig (Item 3) [C] above the valve guide hole.

Press the valve guide into the valve guide hole until the auxiliary fitting meets the margin adjustment jig.

The amount of valve guide protrusion will be thickness of the margin adjustment jig which is 0.394 inch (10,0 mm).





## CYLINDER HEAD (Cont'd)

### Assembly

Install the valves.

Put oil in the valve seal and install the seal on the valve.

Install the valve spring and retainer.

Install the spring collet and the valve cap.

Install the thermostat.

**NOTE: If a new cylinder head is installed be sure to install the screw plugs which are shipped with the new cylinder head.**

### Installation

Install a new gasket and O-ring. Install a shim if there was one removed.

Install the cylinder head on the engine block.

Put oil on the bolts and nuts and tighten to the following torque:

Flange Head Bolt ..... 65–68 ft.-lbs. (88–92 Nm)  
Bolt W/Washer ..... 58–61 ft.-lbs. (79–83 Nm)

Use the tightening sequence as shown [A].

Lower the piston which is to be measured for the clearance, between the cylinder head and the piston.

Put a piece of solder in the injector port.

Make sure the solder does not touch the valves [B].

Turn the engine manually.

Remove the solder and measure it. The thickness must be 0.028–0.035 inch (0,7–0,9 mm).

If the measurement is not in the specifications, remove the cylinder head and add the correct shim between the cylinder head the engine block.

Install the cylinder head and tighten the bolts and nut [A].

**NOTE: Be sure to torque the bolts and nuts again after the engine has been operated for 30 minutes.**

Install the push rods.

Install the water return pipe.

Install the rocker arms.

Tighten the rocker arm holding nuts to 15 ft.-lbs. (20 Nm) torque.

Install the alternator, belt and shield.

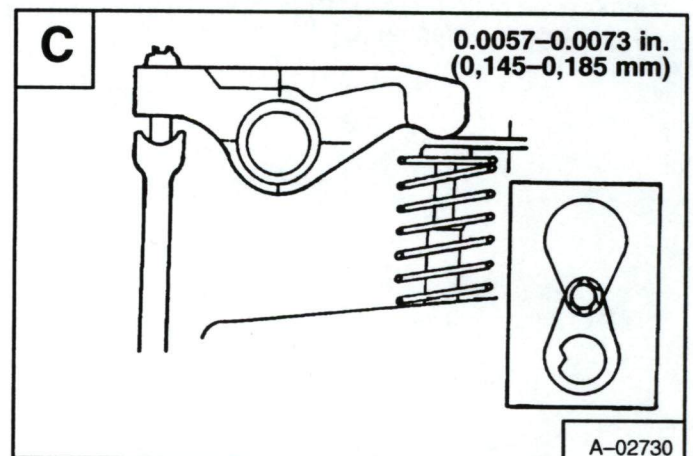
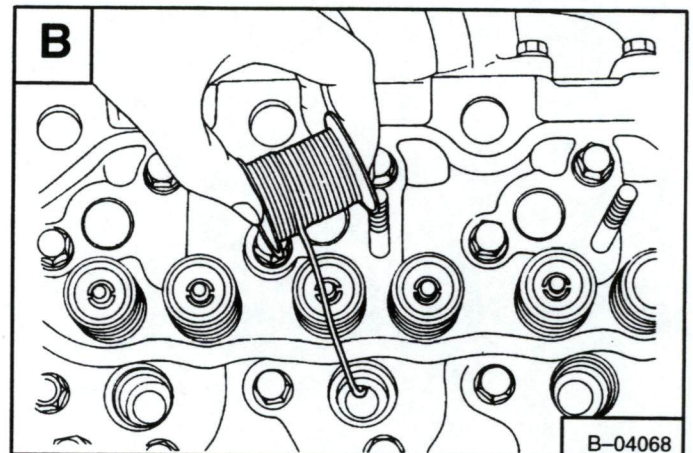
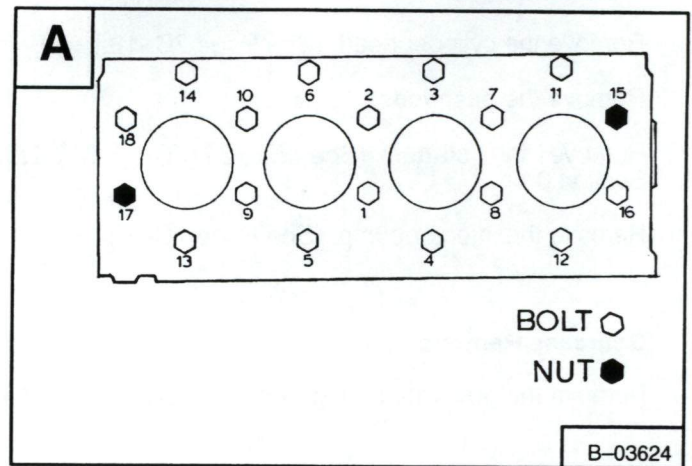
Install the intake manifold.

Install the injector nozzle with a new copper gasket. Tighten to 22–36 ft.-lbs. (30–49 mm) torque.

Install the injector tubelines.

Adjust the valve clearance. Make sure the piston is at T.D.C. when making the adjustment [C].

Install the valve cover.



## ENGINE REPAIR

Remove the cylinder head. (See Page 7C-18.)

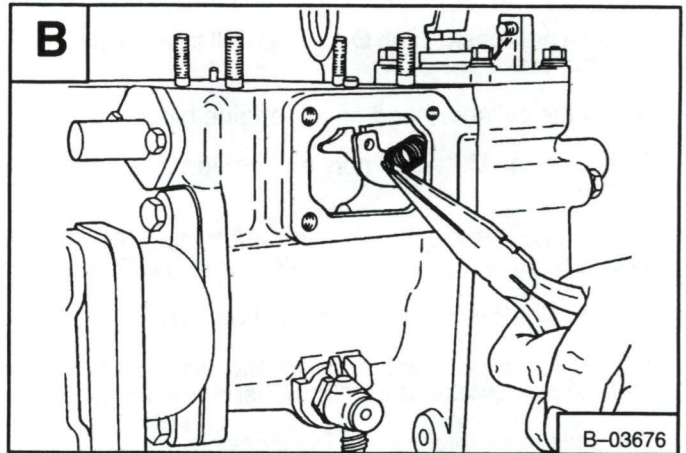
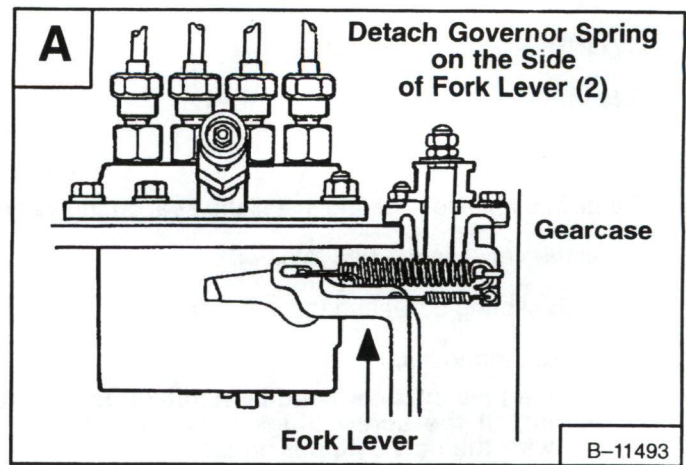
Remove the push rods.

Remove the starter. (See *ELECTRICAL SYSTEM* Section 6.)

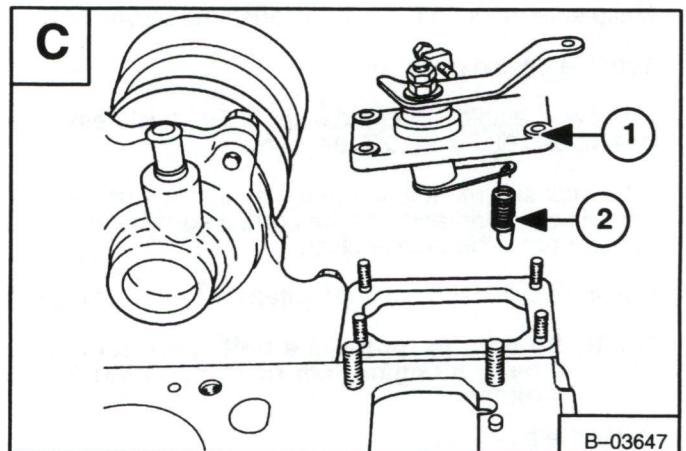
Remove the injector pump. (See Page 7C-3.)

### Gearcase Removal

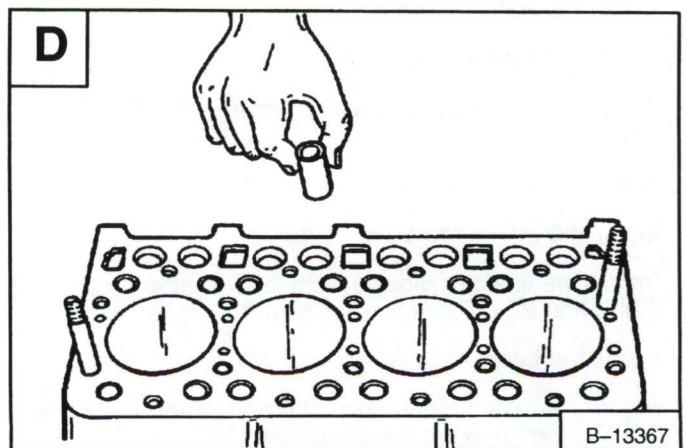
Remove the governor spring from the governor fork [A] & [B].



Remove the plate (Item 1) [C] for speed control and the governor spring (Item 2) [C].



Remove the valve tappets [D].



## ENGINE REPAIR (Cont'd)

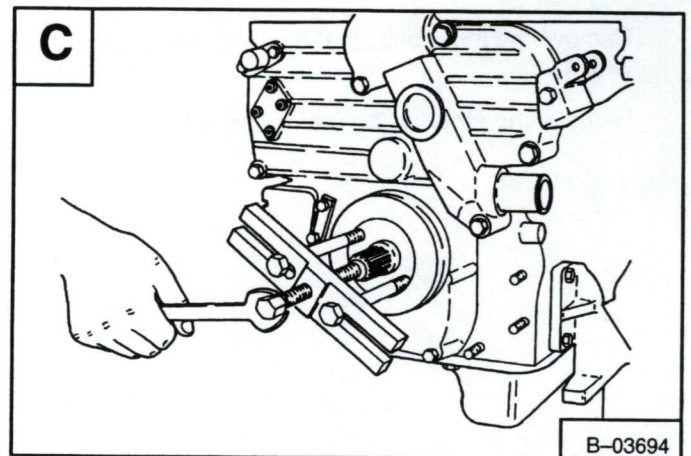
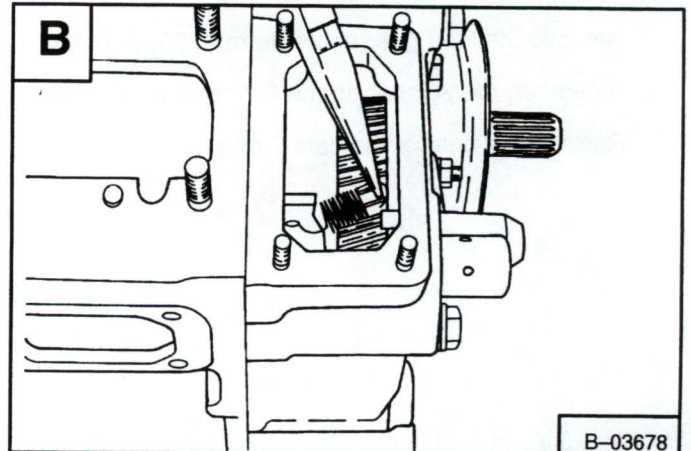
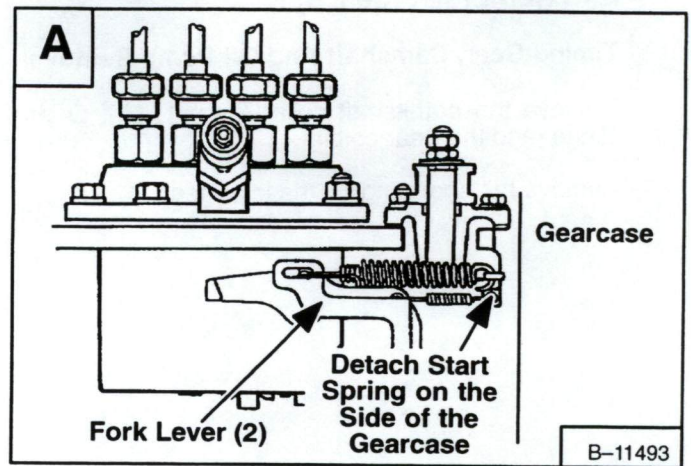
### Gearcase Removal (Cont'd)

Remove the start spring from the gearcase [A] & [B].

Straighten the washer on the crankshaft sheave. Remove the nut and washer.

**Installation:** Tighten the nut to 101–110 ft.-lbs. (137–149 Nm) torque.

After installation, bend the washer on the sheave.



The tool listed will be needed for the following procedure:

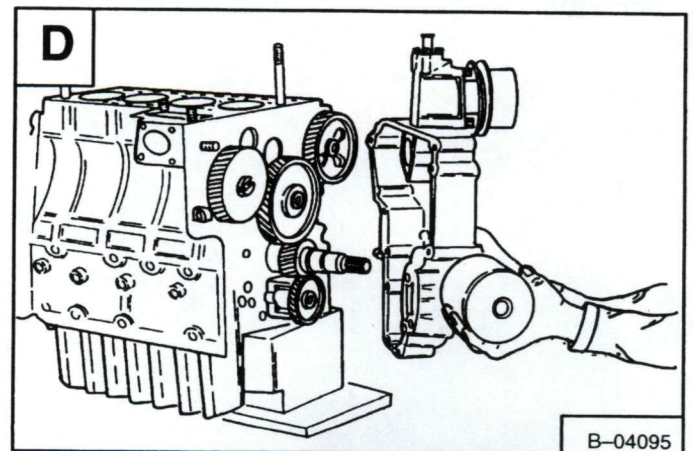
MEL1234 – Crankshaft Nut Socket

Use a puller and remove the engine crankshaft sheave [C].

Remove the key.

Remove the bolts from the gearcase.

Remove the gearcase [D].

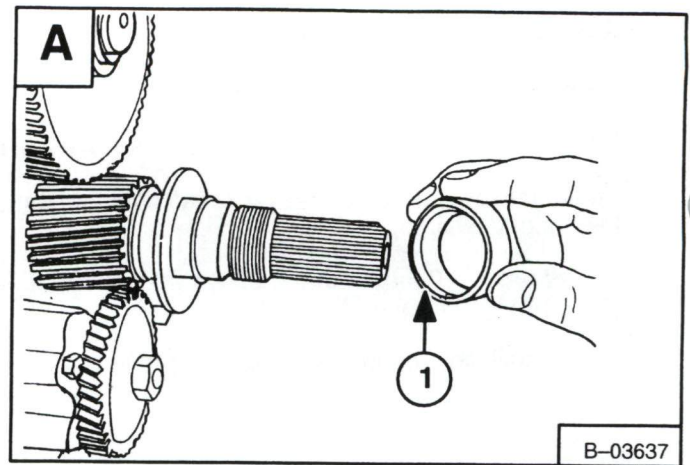


## ENGINE REPAIR (Cont'd)

### Timing Gear, Camshaft And Oil Pump Removal

Remove the crankshaft collar (Item 1) [A], O-ring, oil slinger and the gear collar.

Remove the snap ring on the idler gear.

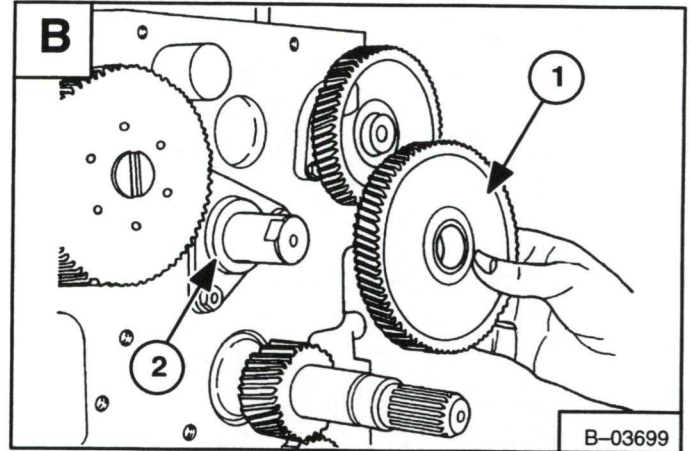


Remove the idler gear (Item 1) [B].

Remove the idler gear collar (Item 2) [B] from the shaft.

Straighten the washer on the bolt for the camshaft stop.

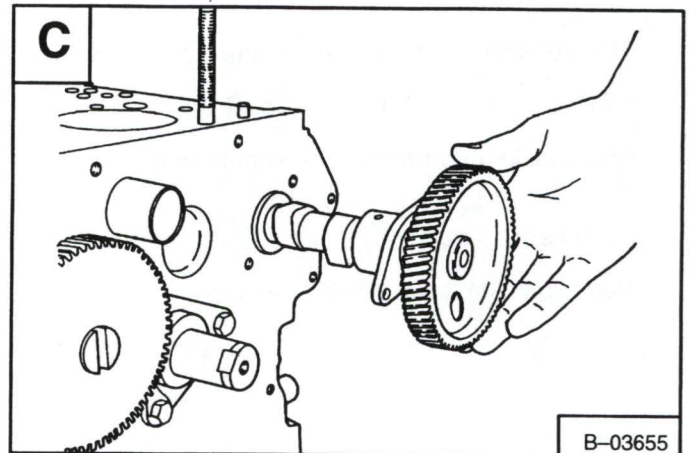
Remove the bolt for the camshaft stop.



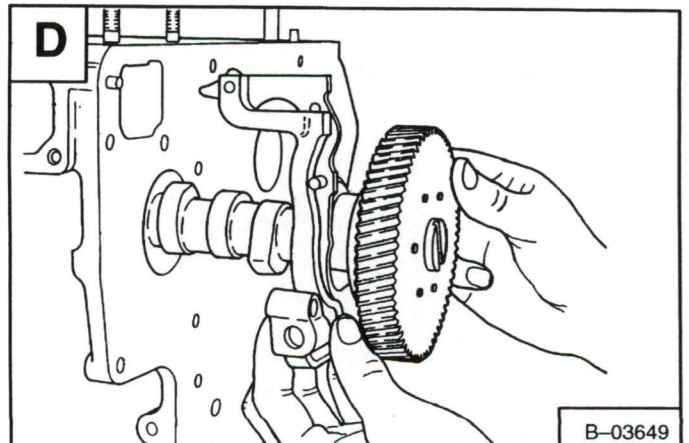
Remove the camshaft [C].

Remove the three bolts that hold the fork lever on the fuel camshaft.

Remove the stop for the fuel camshaft.



Remove the fuel camshaft and the fork lever at the same time [D].



## ENGINE REPAIR (Cont'd)

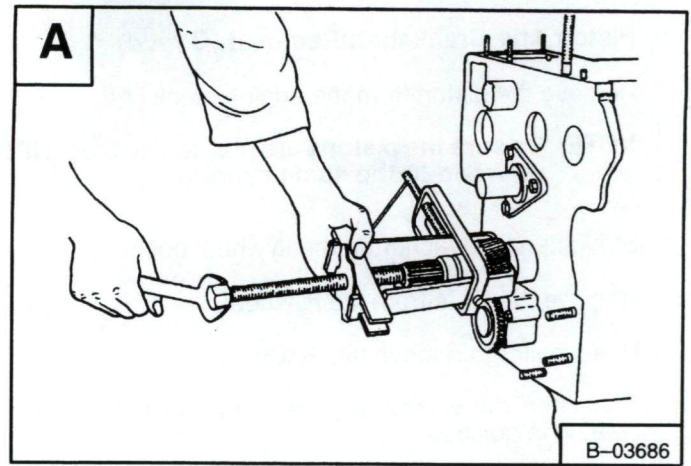
### Timing Gear, Camshaft And Oil Pump Removal (Cont'd)

Remove the crankshaft gear with a puller [A].

Remove the key.

Straighten the washer on the gear of the oil pump.

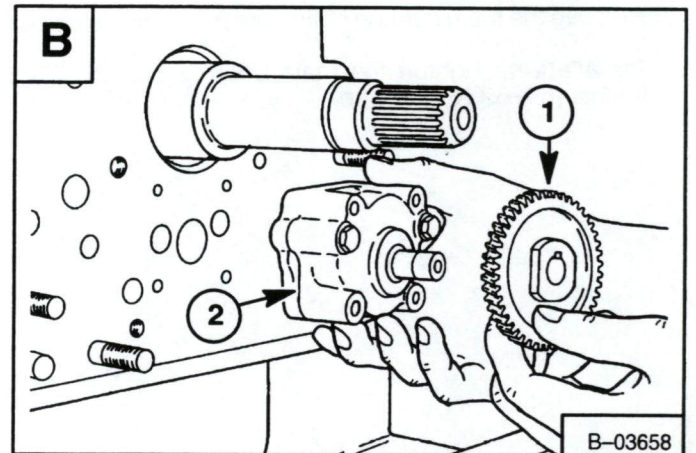
Remove the bolt on the gear of the oil pump.



Remove the gear pump (Item 1) [B].

Remove the oil pump bolt.

Remove the oil pump (Item 2) [B].



### Pistons And Crankshaft Removal

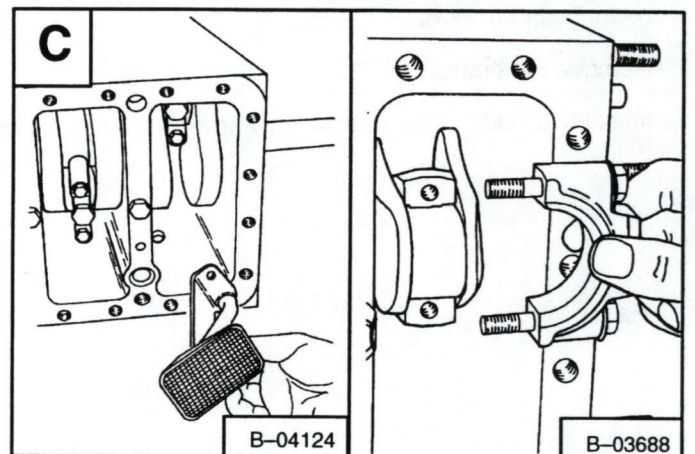
Remove the oil pan.

Remove the screen [C].

**NOTE: Do not damage the O-ring.**

Straighten the washer on the connecting rod bolts.

Remove the connecting rod bolts.



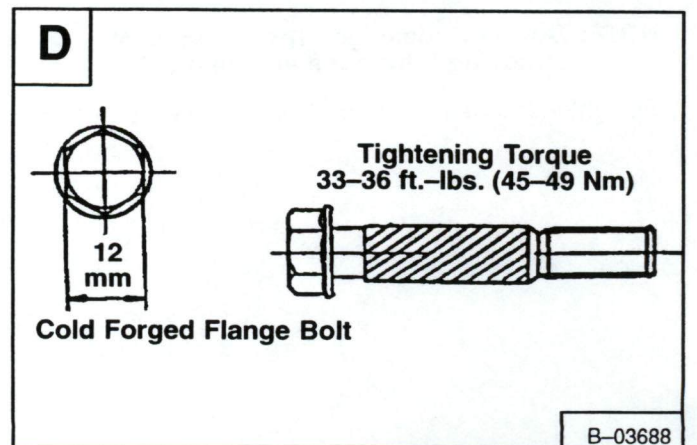
**NOTE: Two types of bolts are used [D]. Install in matched pairs only. Do not mix on same rod.**

Remove the cap and the bearing from the connecting rod [C].

**Installation:** Tighten the rod cap bolts to torque as follows:

Machine Bolt (13 mm size head)  
27–31 ft.-lbs. (37–42 Nm)

Forged Bolt (12 mm size head)  
33–36 ft.-lbs. (45–49 Nm)



## ENGINE REPAIR (Cont'd)

### Piston And Crankshaft Removal (Cont'd)

Remove the piston from the engine block [A].

**NOTE:** Be sure the pistons are marked so they will be returned to the same cylinder.

Straighten the washer on the flywheel bolts.

Remove the bolts from the flywheel.

Use a puller to remove the flywheel.

Straighten the washer on the bolts that hold the main bearing in position.

Remove the main bearing bolts from the engine block [B].

**Installation:** Tighten the main bearing bolts to 47–51 ft.-lbs. (64–69 Nm) torque.

Straighten the washer on the bolts that hold the main bearings in position.

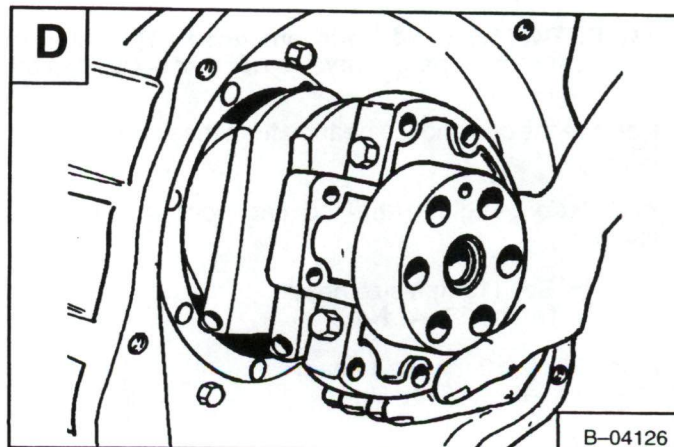
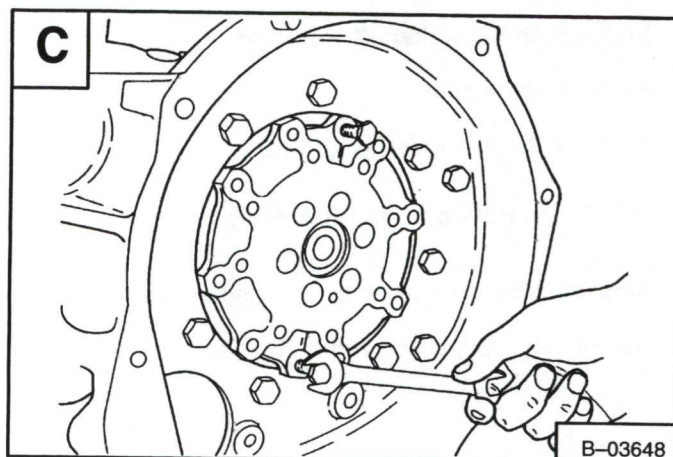
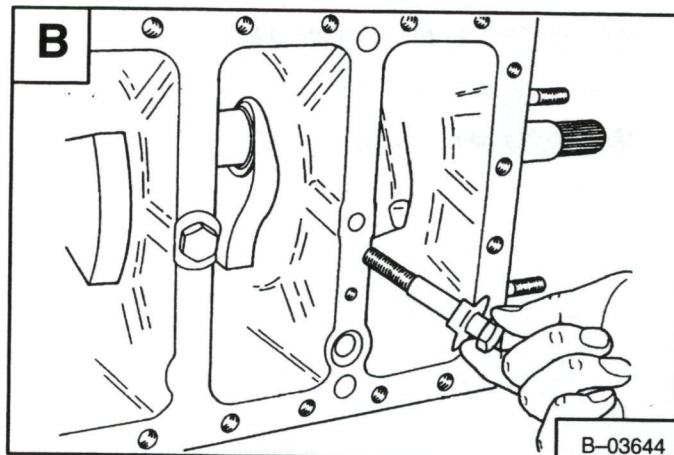
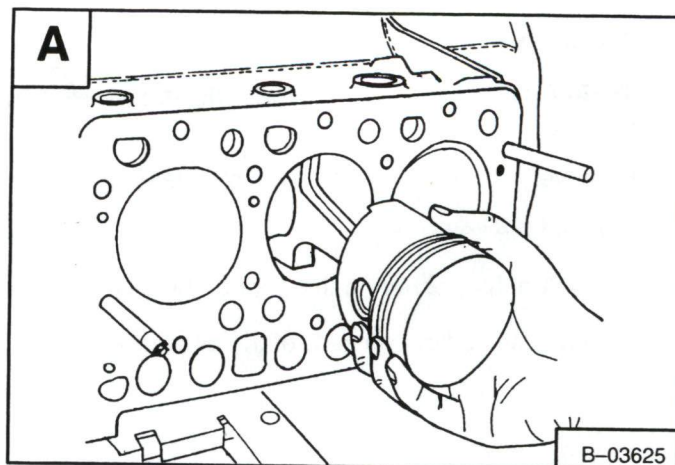
Remove the bolts.

Install two bolts in the rear cover and pull the cover out [C].

Remove the crankshaft from the rear of the engine [D].

**NOTE:** Do not damage the crankshaft when removing it from the engine block.

Straighten the washer on the bolts of the main bearings.



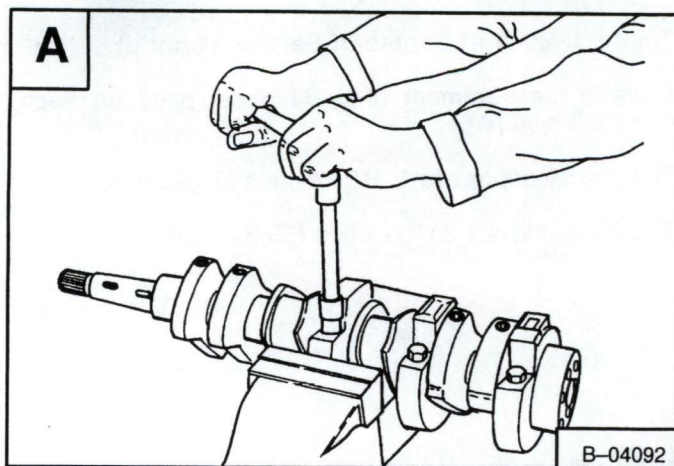
## ENGINE REPAIR (Cont'd)

### Piston And Crankshaft Removal (Cont'd)

Remove the bolts from the bearing cap halves [A].

Remove the halves of the main bearings.

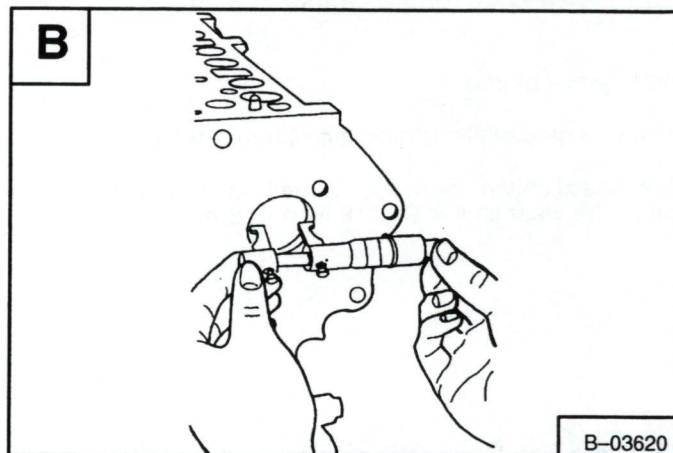
**NOTE:** When installing the bearing cap halves, make sure to position the markings on the bearing caps toward the flywheel. Thrust washers must be installed with oil grooves facing outward.



### Timing Gear And Camshaft Service

Measure the camshaft bearing in the engine block [B].

The specification is 1.5748–1.5758 inches (40–40,03 mm). The wear limit is 0.002–0.0036 (0,05–0,09 mm).



Measure the camshaft journal [C].

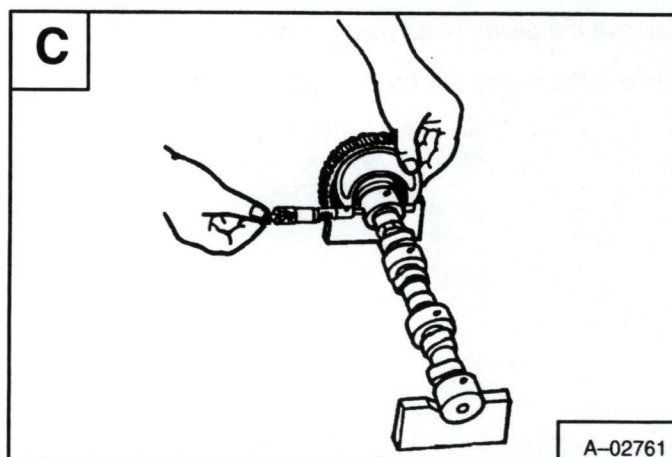
The specification is 1.5722–1.5728 inches (39,934–39,950 mm). The wear limit is 0.002–0.0036 inch (0,05–0,09 mm).

If the measurements are not within the specifications replace the needed parts.

Put the camshaft on V-blocks.

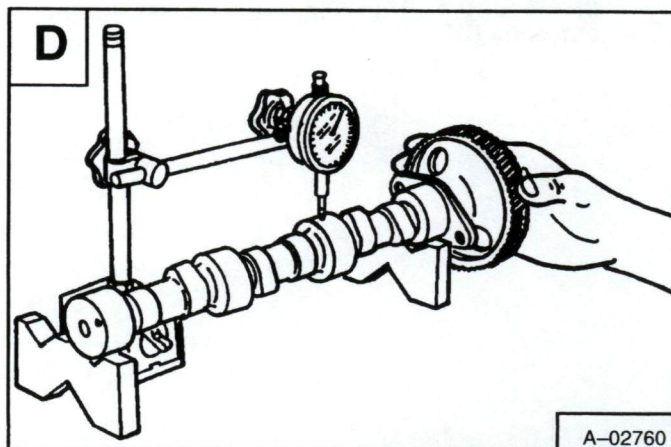
Put a dial indicator on the journals.

Turn the camshaft at a slow rate.



The wear limit is 0.0008 inch (0,02 mm) [D].

If the camshaft measurements are not within the specification replace the needed parts.



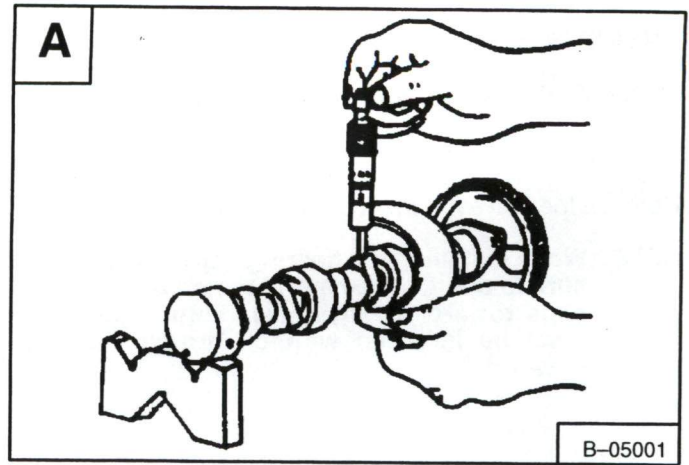
## ENGINE REPAIR (Cont'd)

### Timing Gear And Camshaft Service (Cont'd)

Make a measurement of the highest point on each camshaft lobe [A].

The specifications are 1.3134 inches (33,36 mm).

The wear limit is 1.3115 inches (33,31 mm).

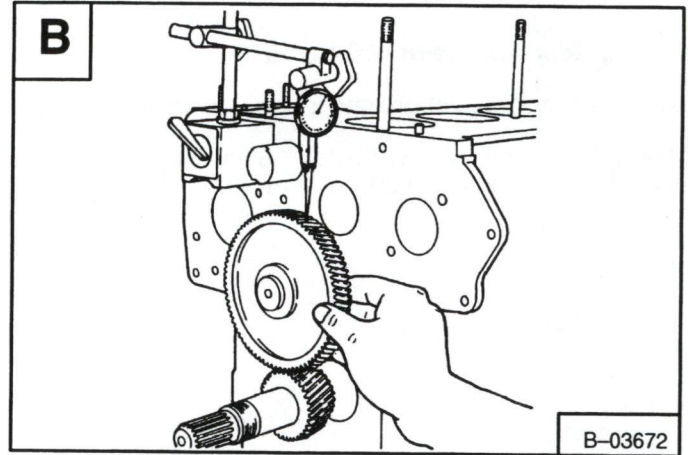


**NOTE:** After the crankshaft is installed, check the clearance for the camshaft gear.

Install a dial gauge.

Hold one gear while turning the other gear [B].

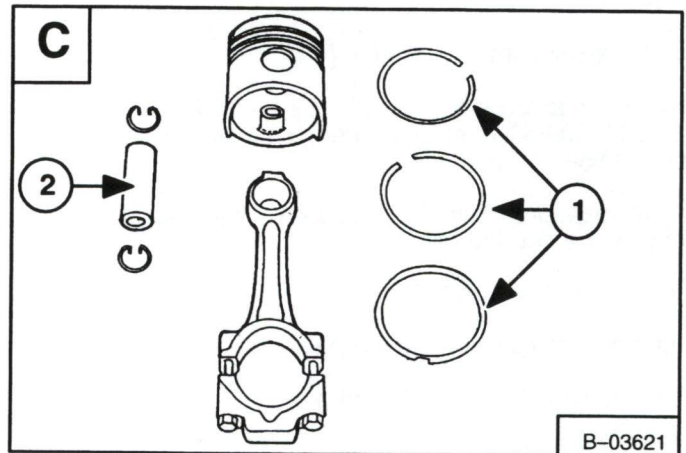
The specification is 0.006–0.0045 inches (0,15–0,11 mm). The wear limit is 0.0118 inch (0,3 mm).



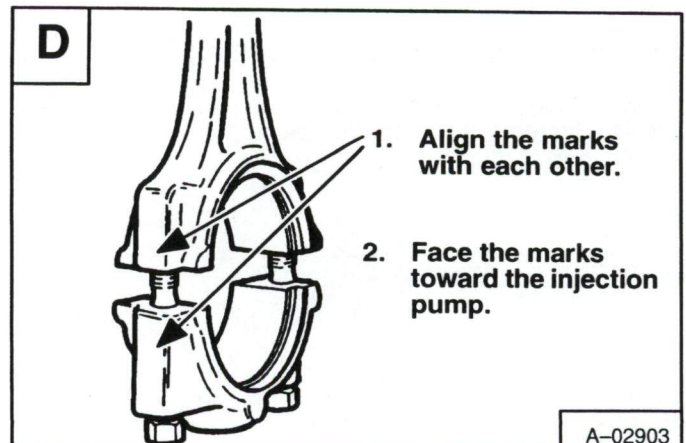
### Servicing The Connecting Rods And Pistons

Remove the piston rings (Item 1) [C].

Remove the piston pin (Item 2) [C].



**NOTE:** Make sure to mark the piston and the connecting rod so they will be assembled correctly [D].



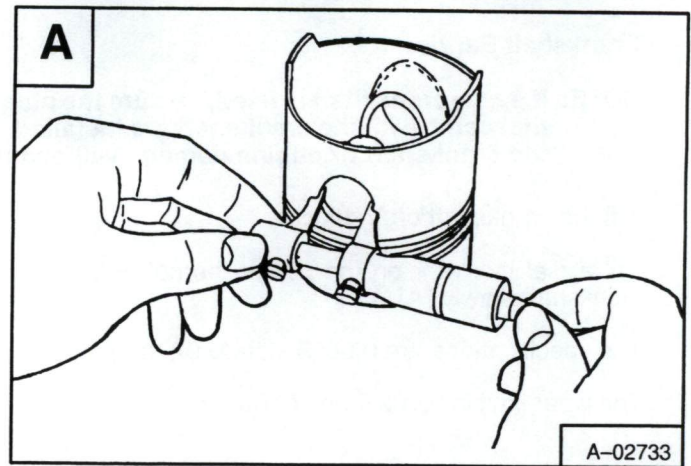


## ENGINE REPAIR (Cont'd)

### Servicing The Connecting Rods And Pistons (Cont'd)

Measure the piston pin hole [A].

The specifications are 0.9055–0.9060 inch (23–23,013 mm). The wear limit is 0.9076 inch (23,053 mm).

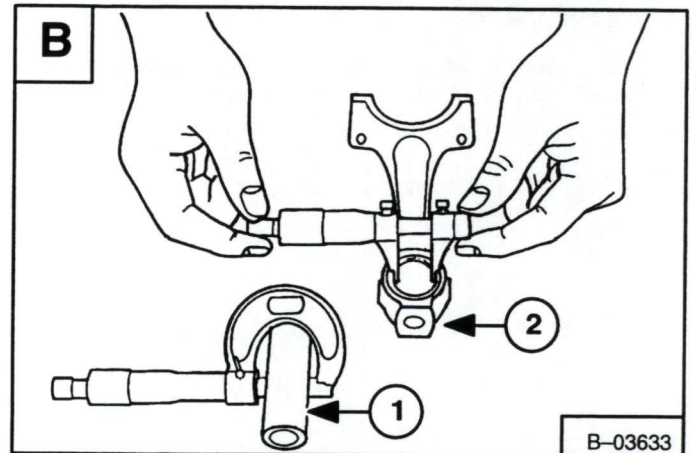


Measure the piston pin (Item 1) [B] and the connecting rod busing (Item 2) [B].

The clearance specification is 0.0006–0.0026 inch (0,0015–0,07 mm).

The allowable limit is 0.0059 inch (0,149 mm) If the clearance exceeds the allowable limit, replace the part.

**NOTE: When the replacement bushing is installed, be sure to drill the oil hole in the bushing. De-burr the hole after drilling [B].**

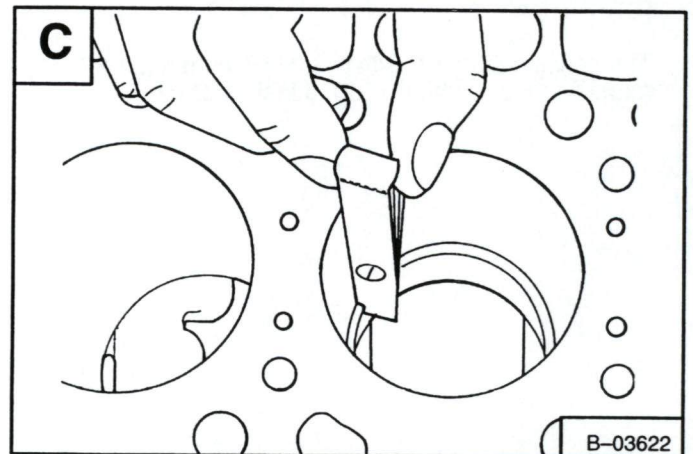


Put the piston ring on the bottom of the cylinder.

Check the clearance of the ring gap [C].

The specification is 0.0018–0.0177 inch (0,046–0,45 mm). The wear limit is 0.0492 inch (1,25 mm).

Install the connecting rod on the tool for checking connecting rod alignment.

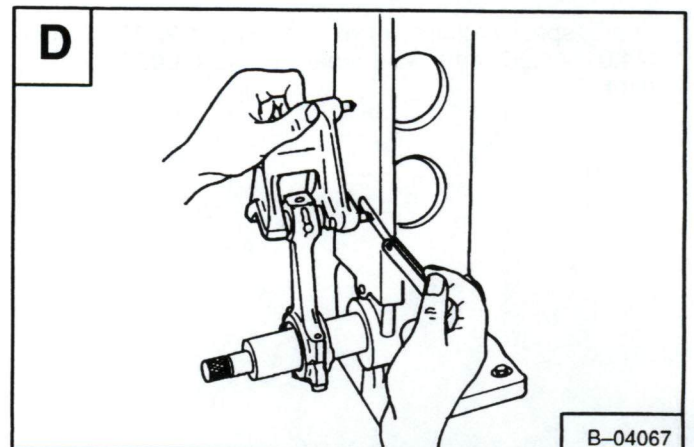


Check the clearance at the piston pin area [D].

The specifications are 0.0008 inch ( 0,02 mm).

The wear limit is 0.0020 inch (0,05 mm).

**NOTE: Be sure the bushing diameter of the connecting rod is within specification.**



## ENGINE REPAIR (Cont'd)

### Crankshaft Service

**NOTE:** If a new crankshaft is used, be sure the plugs that come with the crankshaft are installed in the crankshaft or engine damage will occur.

Put the crankshaft on V-blocks.

Put a dial indicator on the center journal and turn the crankshaft slowly [A].

The specifications are 0.0008 inch (0,02 mm).

The wear limit is 0.0031 inch (0,08 mm).

Check the inside diameter of the crankshaft bearing in the engine block [B].

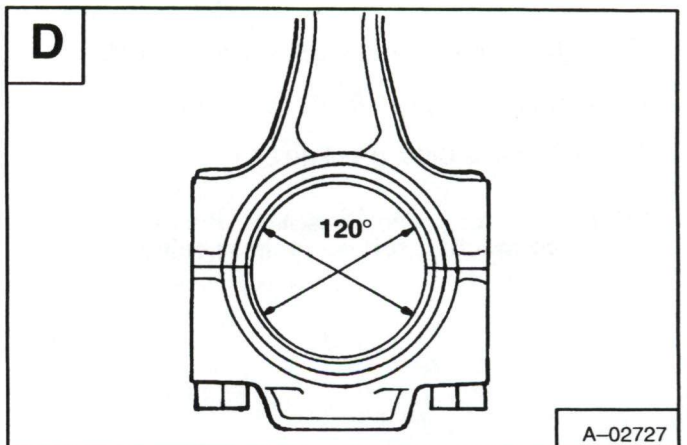
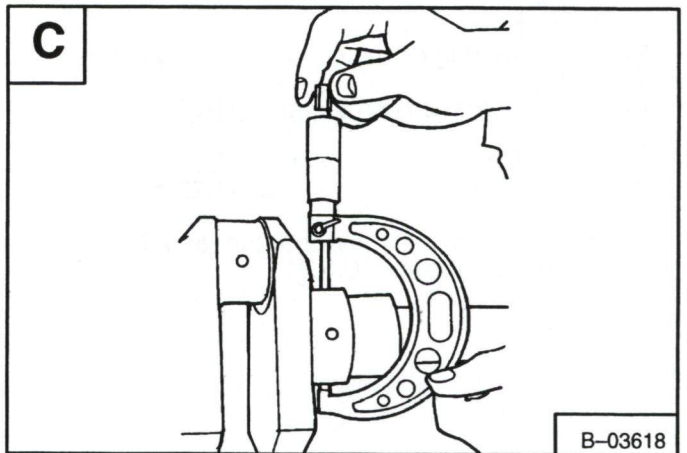
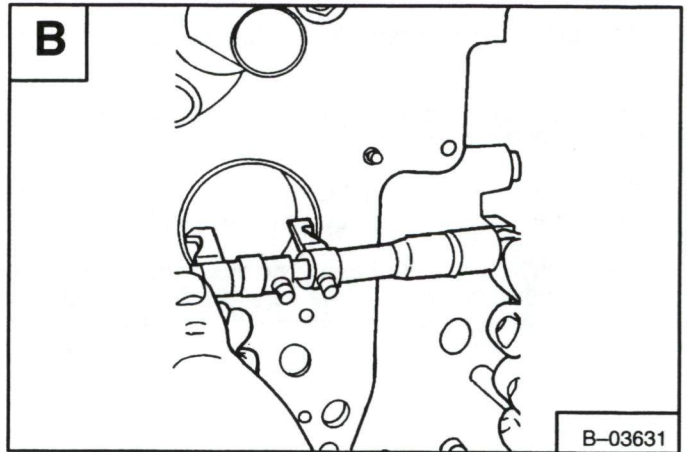
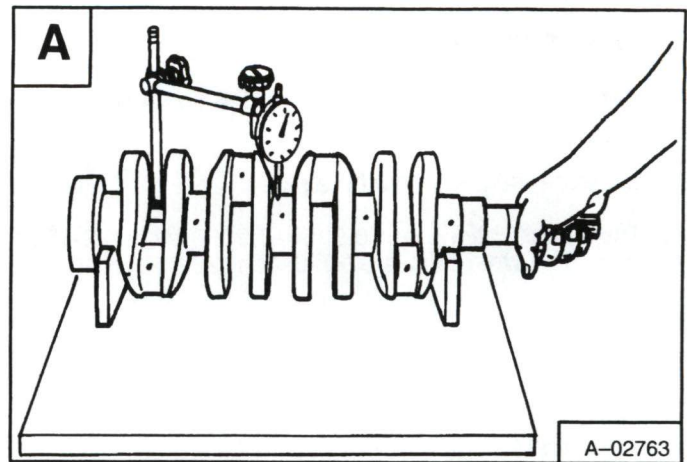
The specification is 2.0465–2.0488 inches (51,98–52,039 mm). The wear limit is 0.0079 inch (0,2 mm).

Check the outside diameter of the #1 crankshaft journal [C].

The specification is 2.0441–2.0449 inches (51,92–51,94 mm). The wear limit is 0.0079 inch (0,2 mm).

Check the connecting rod bearings [D].

The specifications are 1.7327–1.7343 inches (44,01–44,05 mm). The wear limit is 0.0079 inch (0,2 mm).



## ENGINE REPAIR (Cont'd)

### Crankshaft Service (Cont'd)

Check the connecting rod journals [A].

The specifications are 1.7307–1.7313 inches (43,959–43,975 mm). The wear limit is 0.0079 inch (0,2 mm).

If the connecting rod journals are not within specifications grind the journals as follows [B].

- Crankshaft corner radius must be 0.127R inch  $\pm$  .0079 inch (3,5R  $\pm$  0,2 mm).
- The oil hole must be chamfered to 0.0394–0.0591R inch (1,0–1,5R mm).

Install the crankshaft and check the end play [C].

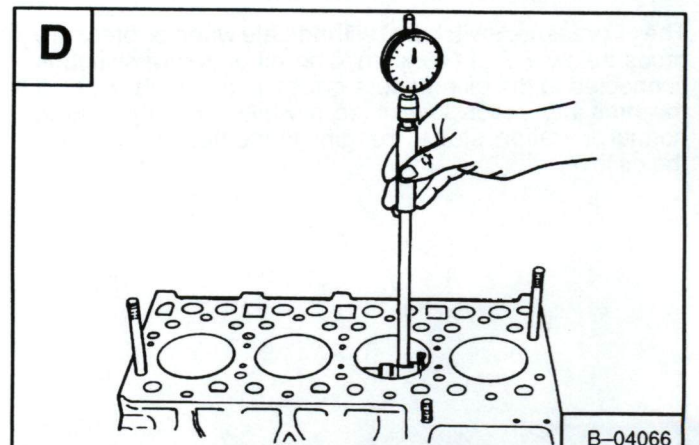
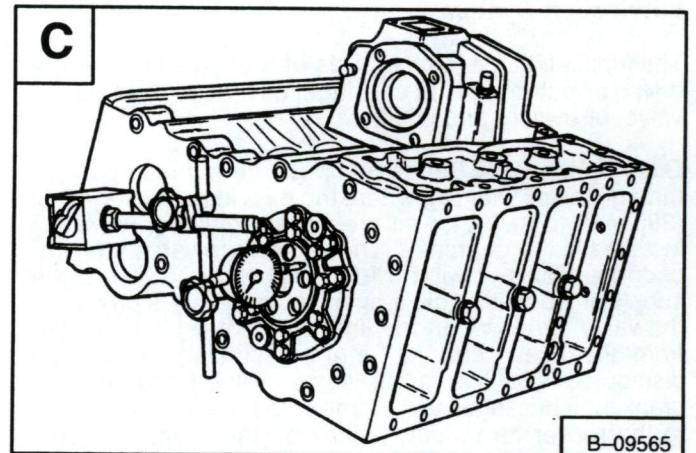
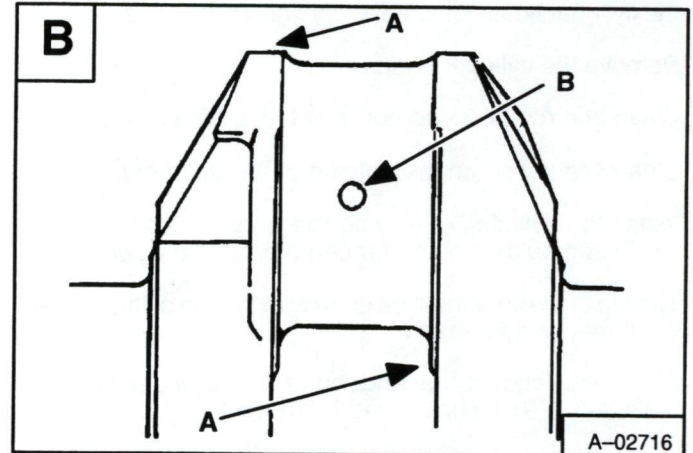
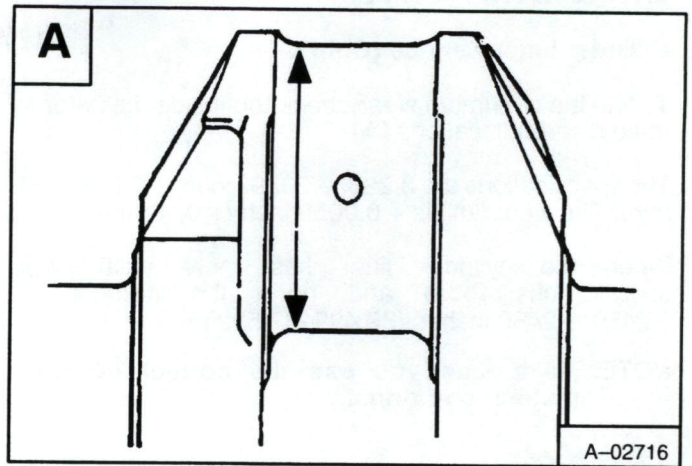
Normal end play is 0.0059–0.0122 inch (0,15–0,31 mm). Replace the thrust bearings on the main bearing if end play exceeds 0.020 inch (0,5 mm).

### Cylinder Liner Service

Check the inside diameter of the cylinder liner [D].

The tools listed will be used for the following procedure:

- MEL1060 – Ridge Reamer
- MEL1180 – Dry Liner Puller



## ENGINE REPAIR (Cont'd)

### Cylinder Liner Service (Cont'd)

To find the maximum wear check the inside diameter in three different locations [A].

The specifications are 3.2283–3.2292 inches (82–82,021 mm). The wear limit is + 0.0059 inch (+ 0,15 mm).

When the cylinder liner has more wear than specifications, bore and hone the cylinder to 3.2480–3.2489 inches (82,499–82,522 mm).

**NOTE: Make sure you use the correct oversize pistons and rings.**

If the cylinder liner is not within the specifications, replace the cylinder liner. These are dry liners.

Remove the cylinder liners.

Clean and rub oil in the bores of the engine block.

Clean and put oil on the outside of the cylinder liners.

Install the cylinder liners into the engine block with the inside and outside diameter chamfered end down.

The top of the liner must be even with the top of the engine block machined surface.

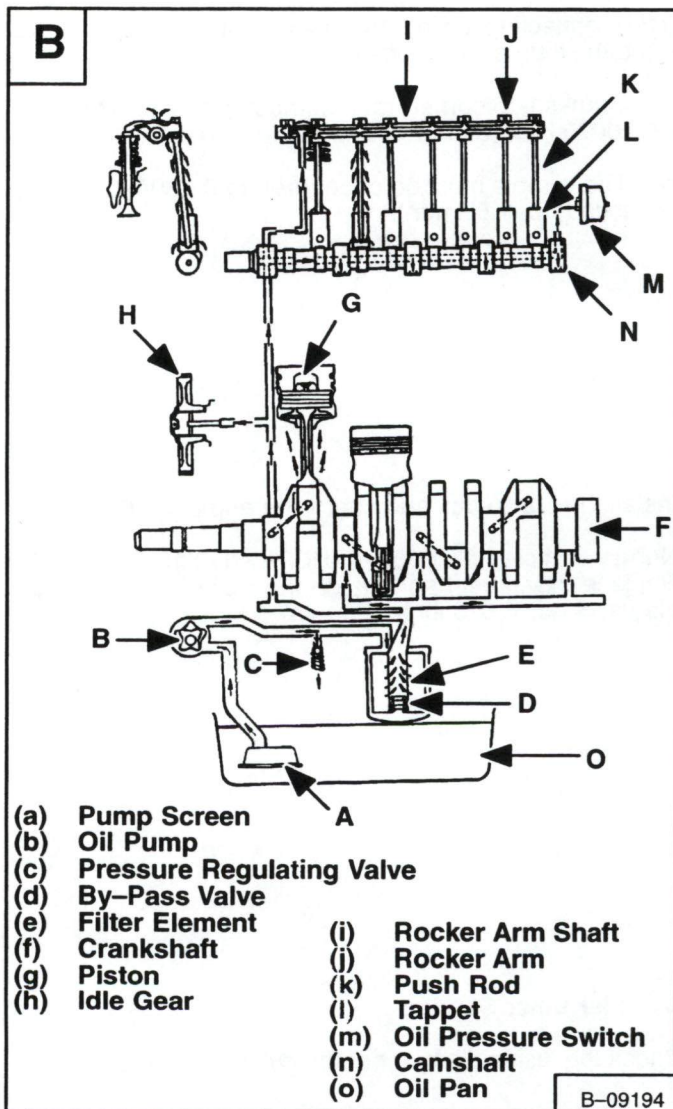
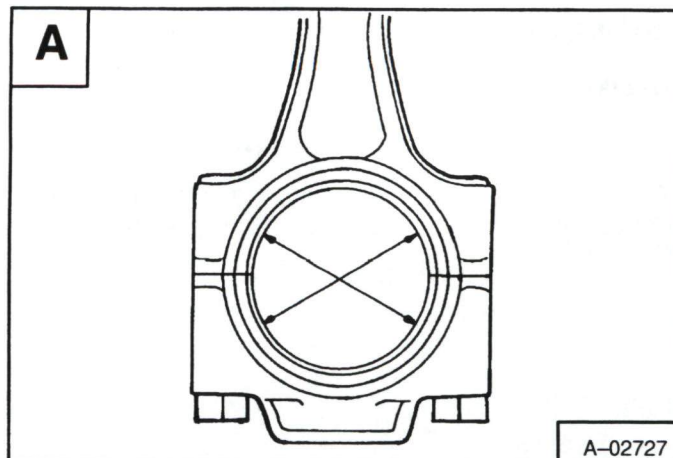
After installation bore and hone the cylinder liner to 3.2283–3.2291 inches (82–82,019 mm).

### Lubrication System

The lubrication system consists of a trochoid rotor-type driven oil pump, oil filter cartridge, oil pressure regulating valve, oil switch, and oil filter [B].

Oil is siphoned by the oil pump (b) from the oil pan (o) through the oil filter (a), where the oil is kept at 41–64 PSI (290–441 kPa) by an oil pressure regulating valve (c) installed in the gearcase. The oil flows towards the filter cartridge where it will be further filtered. To insure the supply of lubricating oil, a by-pass valve (d) is provided, the valve opens when the filter element (e) is restricted, the pressurized oil is then distributed into two areas; some will be fed through crankshaft passages to the crank pin bearing and the rest to the rocker arm shaft (i) through the frame. Oil then returns to the oil pan by gravity.

The oil pressure switch (m) will indicate when oil pressure drops below 7 PSI (48 kPa). The oil pressure switch is connected to the oil pressure gauge in the dash panel. If the pressure reads low or zero while the engine is in normal operation, stop the engine immediately and check the oil level.



## ENGINE REPAIR (Cont'd)

### Oil Pump Service

Check the clearance between the inner and outer rotor [A]

The clearance for the inner rotor is 0.0039–0.0063 inches (0,099–0,160 mm). The wear limit is 0.0079 inch (0,2 mm).

Check the clearance between the outer rotor and the body of the oil pump [B].

The clearance for the outer rotor is 0.0043–0.0075 inches (0,11–0,19 mm).

At full rated engine speed, the normal oil pressure is 42–56 PSI (290–386 kPa) and a minimum of 35 PSI (241 kPa).

### Water Pump Service

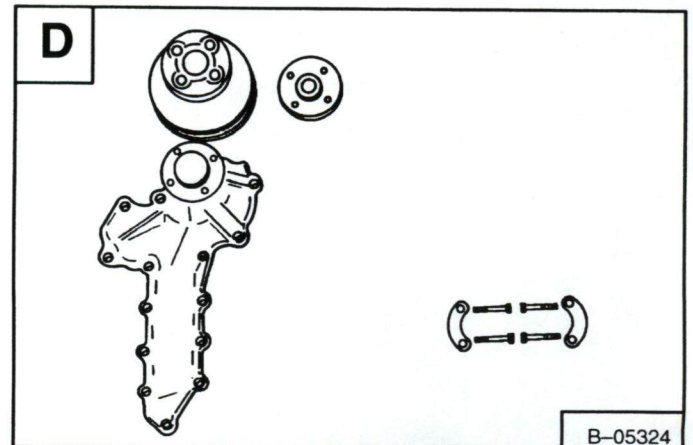
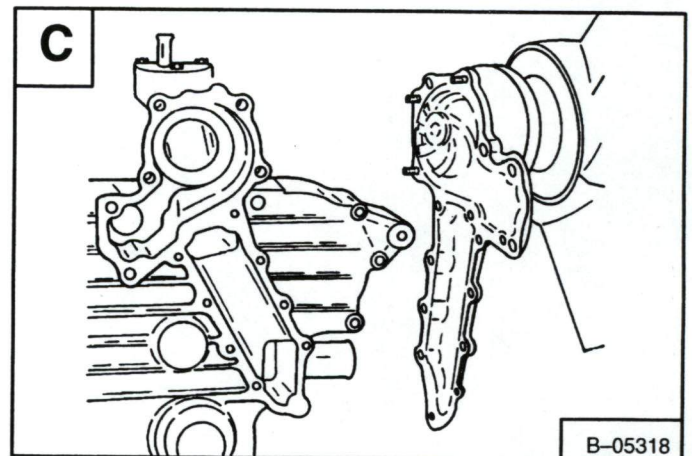
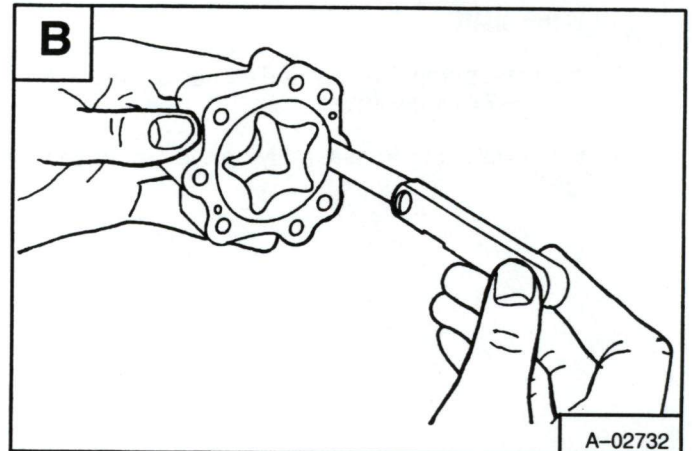
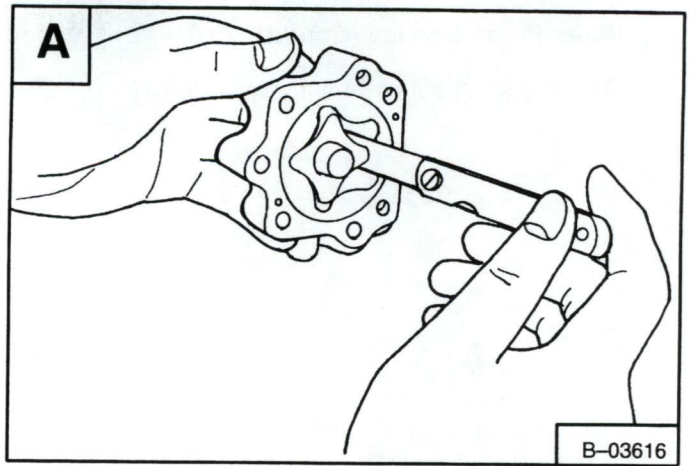
Remove the water pump from the gearcase [C].

Put the water pump in a vise and remove the nut [D].

Remove the pulley using a puller.

Remove the key.

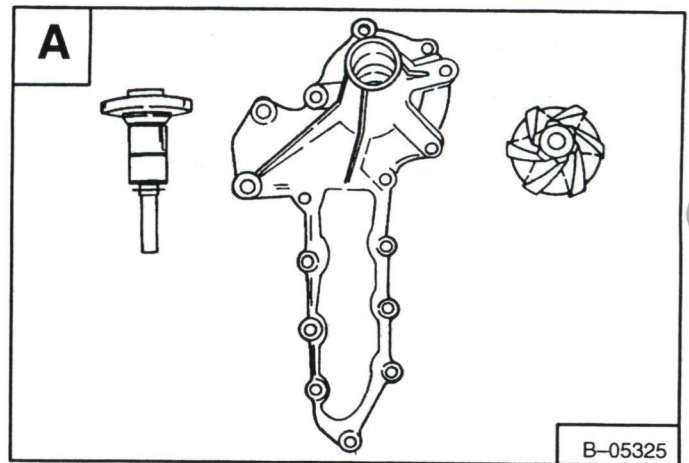
Remove the snap ring.



## ENGINE REPAIR (Cont'd)

### Water Pump Service (Cont'd)

Drive the shaft out of the impeller side [A].

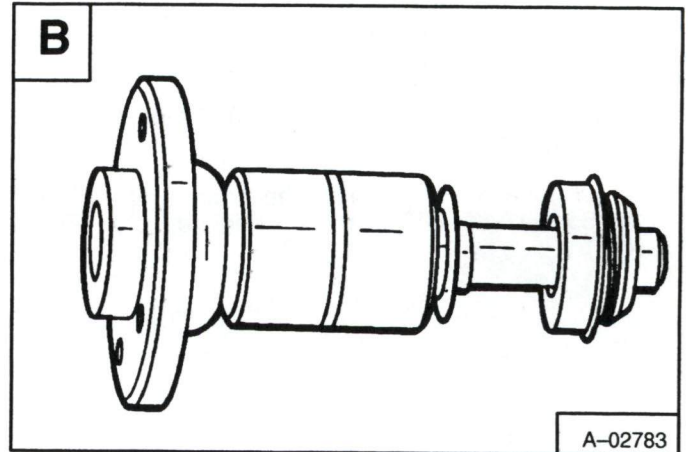


Install the new seal [B].

Install the shaft

Put the water pump in a vise and tighten the nut to 50–57 ft.-lbs. (68–77 Nm) torque.

Install the water pump assembly on the gearcase with a new gasket.



## ENGINE ASSEMBLY

### Crankshaft Installation

Install the main bearing case on the crankshaft journals with marks toward the flywheel end.

Tighten the bolts to 21–25 ft.-lbs. (28–34 Nm) torque.

Install the thrust bearing with the oil grooves to the outside.

Install the crankshaft in the engine block.

Each main bearing is numbered for correct location.

Make sure the oil holes in the main bearings are in alignment with the holes in the engine block [A].

Install the main bearing case bolts and tighten to 47–50 ft.-lbs. (64–68 Nm) torque.

Install new seals into the crankshaft rear cover.

Install the rear cover and tighten the bolts to 13–15 ft.-lbs. (18–20 Nm) torque.

### Installing The Pistons

The tools listed will be needed for the following procedure:

MEL1063 – Ring Compressor

MEL1064 – Piston Ring Expander

Assemble the connecting rod to the piston.

**NOTE: Make sure the marks on the piston and the connecting rod are in the same direction.**

Install the rings on the piston [B].

Position the top ring so the gap is not lined up with the piston pin. Position the other rings so there is a gap every 90°.

Use a ring compressor to install the pistons in the engine block with the marks away from the camshaft.

Align the bearing cap on the connecting rod [C].

Put oil on the bolts, install them in the bearing caps and tighten to 26–30 ft.-lbs. (35–41 Nm) torque.

Install the oil pump tube and screen.

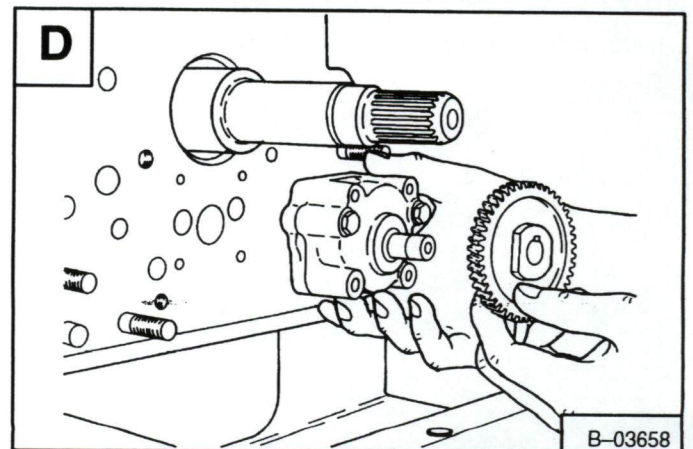
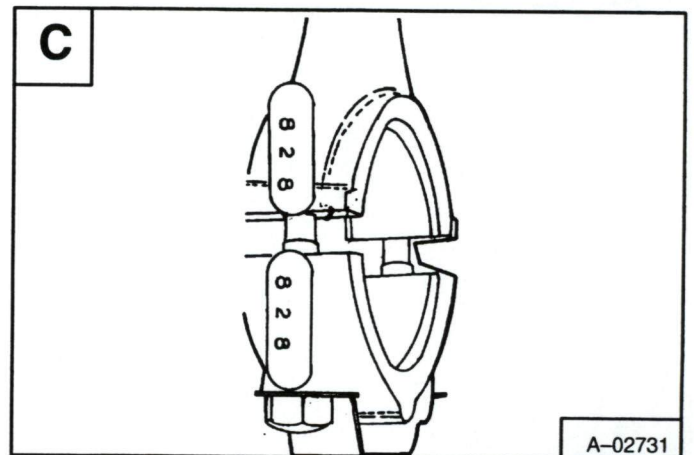
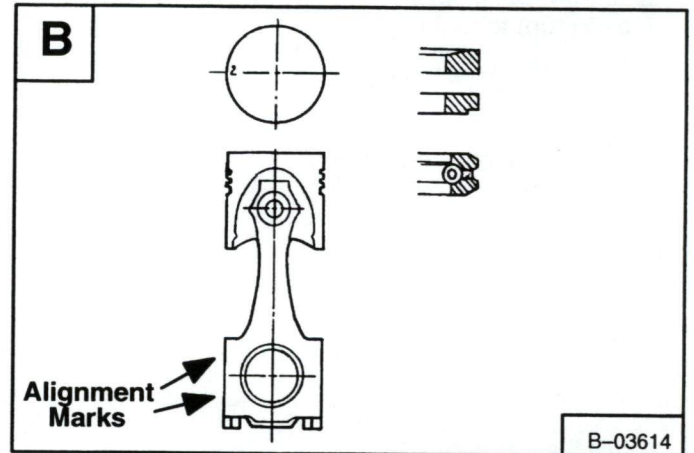
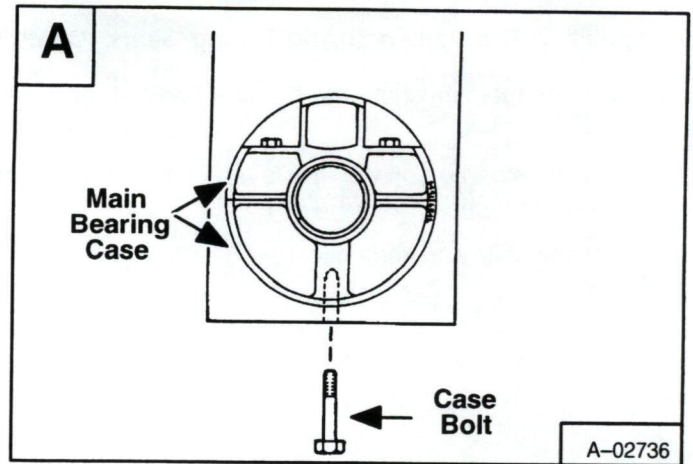
Install a new oil pan gasket and install the oil pan.

### Installing The Camshaft And Timing Gears

Install the oil pump and tighten the bolts to 60–72 in.-lbs. (6,7–8,1 Nm) torque [D].

Install the gear and tighten the nut.

Install the key and the gear on the crankshaft.



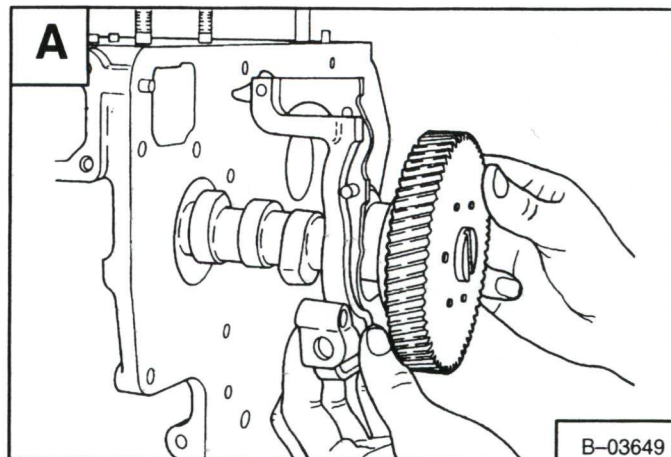
## ENGINE ASSEMBLY (Cont'd)

### Installing The Camshaft And Timing Gears (Cont'd)

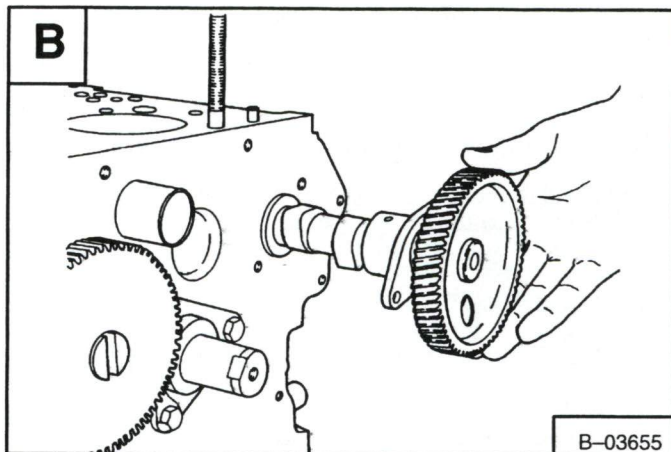
Install the fuel camshaft and the fork lever at the same time [A].

Install the stop bolt on the fork lever. Tighten the bolt to 60–72 in.-lbs. (6,8–8,1 Nm) torque.

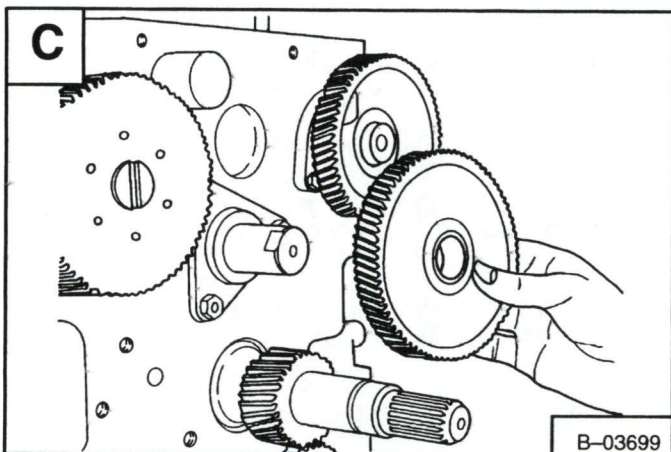
Install the bolts and tighten to 13–15 ft.-lbs. (18–20 Nm) torque.



Install the camshaft and tighten the bolts to 13–15 ft.-lbs. (18–20 Nm) torque [B].

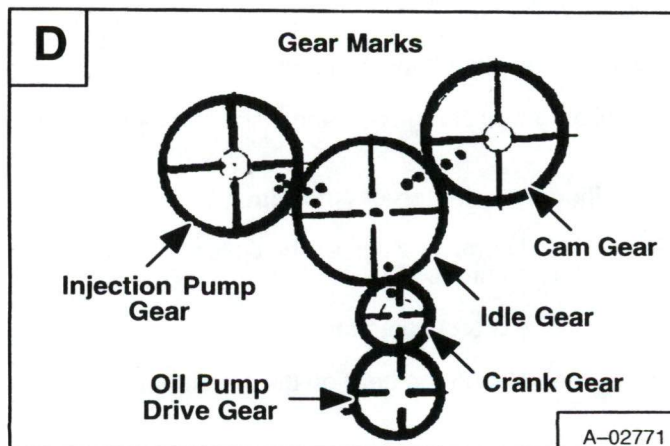


Install the idle gear [C].



Make sure the timing marks are in correct alignment [D].

Install the snap ring on the idler gear shaft.

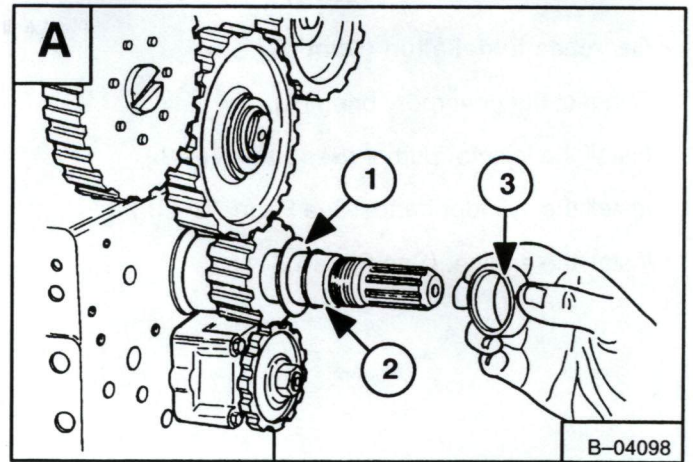




## ENGINE ASSEMBLY (Cont'd)

### Installing The Camshaft And Timing Gears (Cont'd)

Install the oil slinger (Item 1) [A]. Put oil on the O-ring and install the O-ring (Item 2) [A] and the collar (Item 3) [A].



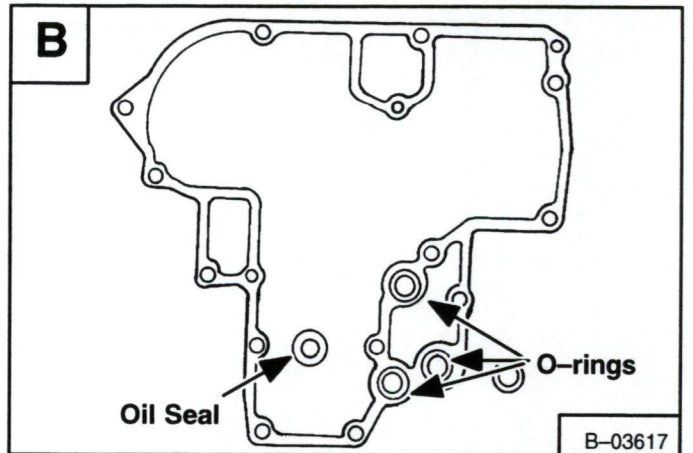
### Gearcase Installation

Install the O-ring and the oil seal in the gearcase cover [B].

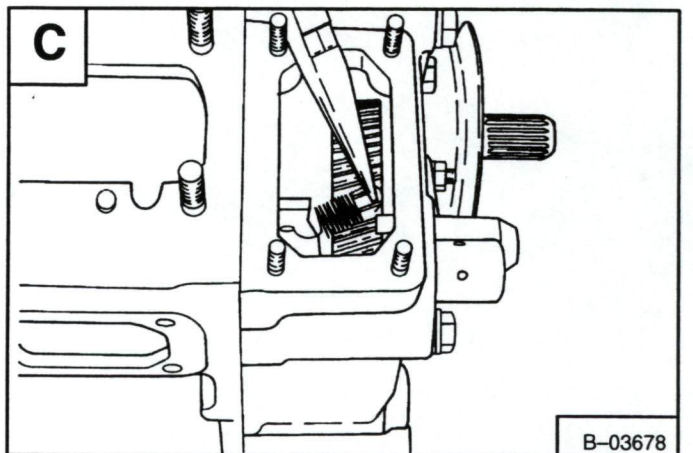
**NOTE: Put oil on the oil seal.**

Install the gearcase cover and bolts. Tighten the bolts to 13–15 ft.-lbs. (18–20 Nm) torque.

Install the crankshaft sheave and tighten the nut to 101–116 ft.-lbs. (137–157 Nm) torque.

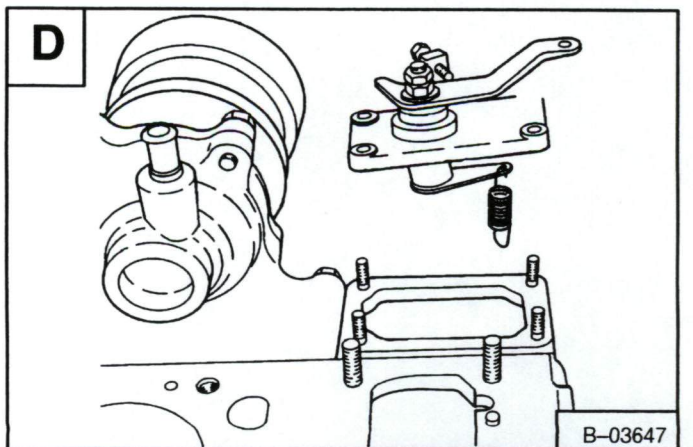


Install the start spring [C].



Install the speed control plate and governor spring [D].

**NOTE: Do not drop the governor spring into the gearcase.**



## ENGINE ASSEMBLY (Cont'd)

### Gearcase Installation (Cont'd)

Connect the governor spring [A].

Install the injector pump. (See Page 7C-3.)

Install the cylinder head. (See Page 7C-23.)

Install the engine. (See Page 7C-11.)

