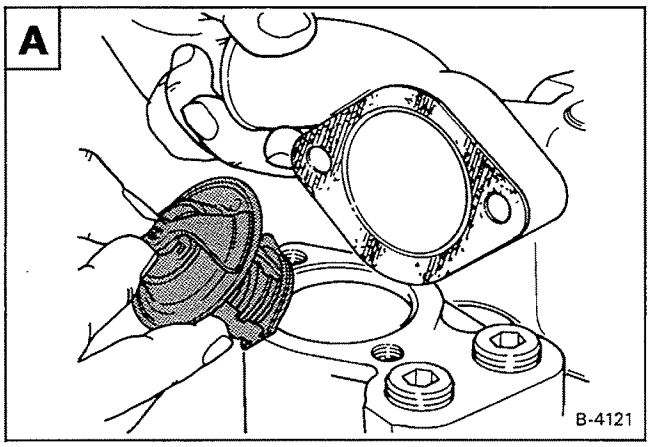
THERMOSTAT

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.

7 ENGINE SERVICE

TROUBLESHOOTING

The following troubleshooting chart is provided as an assistane 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, 11, 12, 13, 14, 15, 16, 17, 19, 27, 28, 29
Difficult to start.	5, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 25, 27, 28, 29
No power from engine.	8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 20, 21, 22, 23, 27, 28, 29
Engine is mis-firing.	8, 9, 11, 12, 13, 15, 16, 17, 21, 22, 24, 25, 26, 28
Too much fuel consumption.	10, 12, 13, 15, 16, 17, 19, 20, 21, 23, 24, 25, 27, 28, 29
Black exhaust.	10, 12, 13, 15, 16, 17, 19, 20, 21, 23, 24, 25, 27, 28, 29
Blue/white exhaust.	4, 10, 15, 16, 17, 21, 23, 27, 29, 30, 50
Low oil pressure.	4, 31, 32, 33, 34, 35, 37, 39, 52
Engine knocking.	13, 15, 16, 19, 22, 24, 25, 27, 29, 31, 40, 41, 53
Engine running rough.	7, 8, 9, 10, 11, 12, 13, 17, 18, 22, 24, 25, 26, 29, 40, 53
Vibration.	12, 13, 17, 21, 22, 25, 26, 29, 40, 42, 43
High oil pressure.	4, 33, 36
Overheating.	10, 12, 13, 15, 16, 20, 21, 40, 44, 45, 46, 47, 51
Too much crankcase pressure.	22, 27, 29, 30, 40, 49
Poor compression.	10, 16, 21, 24, 25, 27, 28, 29, 30, 41, 53
Start and stop.	9, 10, 11

KEY TO CORRECT THE CAUSE

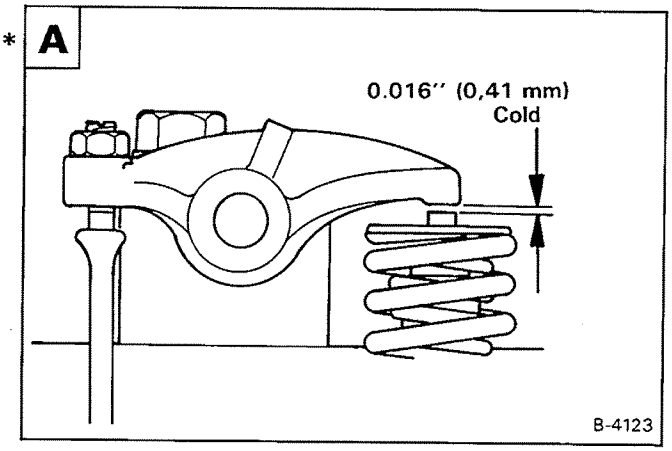
1. Battery capacity low.
2. Bad electrical connections.
3. Faulty starter motor.
4. Incorrect grade of oil.
5. Low cranking speed.
6. Fuel tank empty.
7. Faulty stop control operation.
8. Plugged fuel line.
9. Plugged fuel filter.
10. Restriction in the air cleaner.
11. Air in fuel system.
12. Faulty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

VALVE CLEARANCE

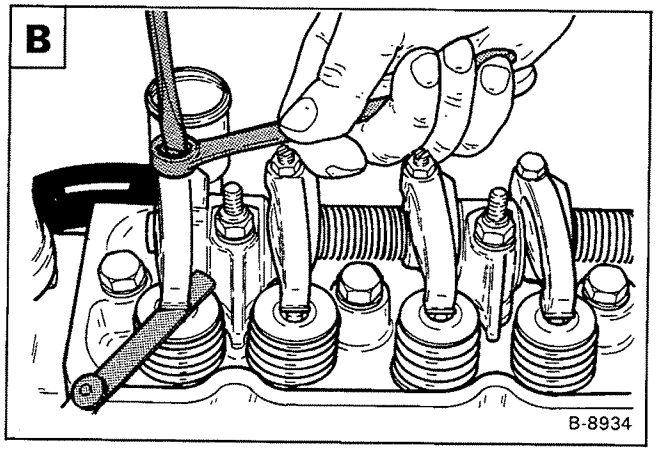
Adjustment

Make the valve clearance adjustment with engine stopped and cold.

The correct clearance is 0.016" (0,41 mm) with the engine cold [A].

* 

Put the correct size feeler gauge between the rocker arm and the valve stem. Turn the adjustment bolt until the clearance is correct [B].



Use the following sequence to set the valve clearance:

	Front						Rear	
Cylinder No.	**1**		**2**		**3**		**4**	
Valve arrangement	I	E	I	E	I	E	I	E
Piston in No. 1 cylinder is at TDC on compression stroke	O	O	O			O		
Piston in No. 4 cylinder is at TDC on compression stroke				O	O		O	O

ENGINE COMPRESSION

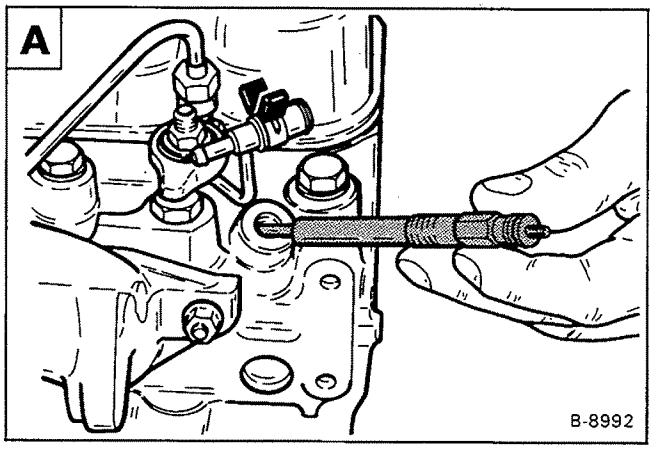
Checking

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

MEL-10630-1 — Engine Compression Kit
MEL-1268 — Compression Gauge Test Adapter

The engine must be at operating temperature.

Remove the glow plugs (See Page 7C—14 for the correct procedure) [A].



Install the correct compression adapter into the cylinder head.

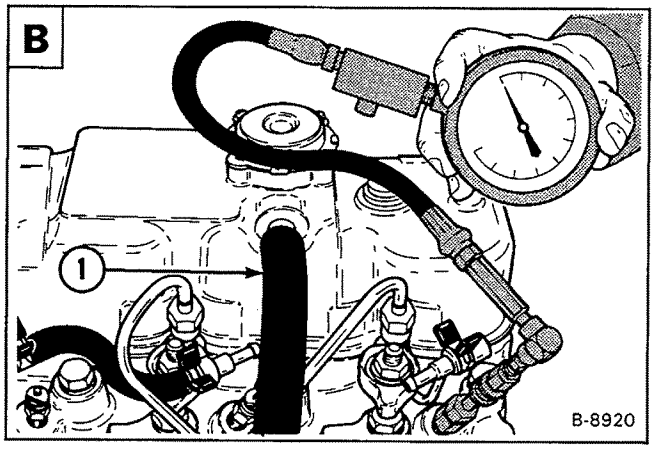
Connect the compression gauge [B].

The engine must be turning at about 175 RPM.

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

The engine has an open crankcase ventilation system.

The ventilation hose comes from the valve cover tube (Item 1) and passes down the side of the engine block [B].

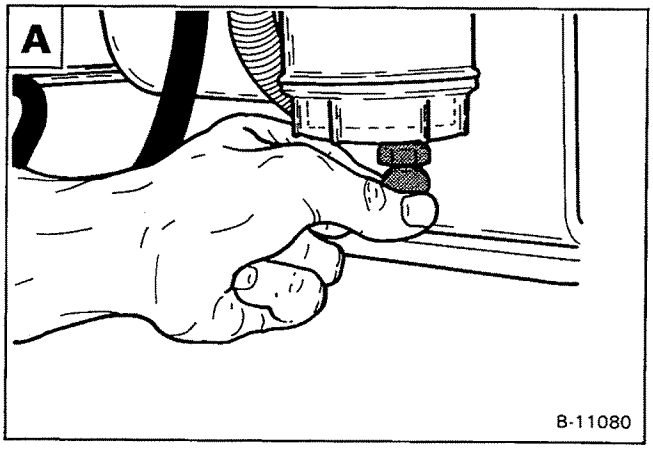


FUEL FILTER

Water Trap

See the Service Schedule (Page 1—1) for the service interval to remove the water from the filter.

Push up on the spring loaded poppet at the bottom of the fuel filter [A], until all the water is removed from the filter.

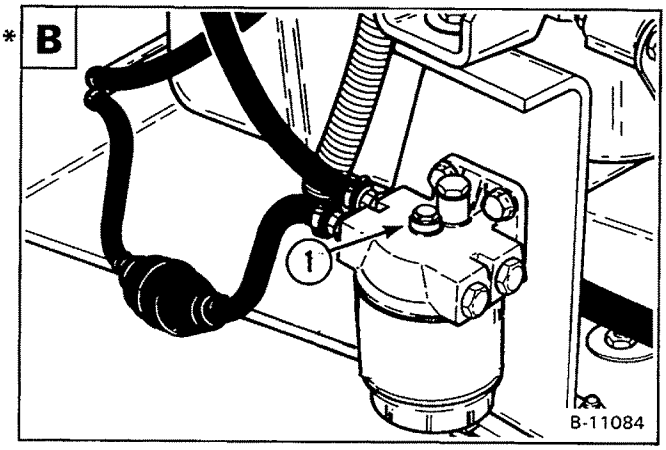


Fuel Filter Element

See the Service Schedule (Page 1—1) for the service interval to replace the element.

Clean the area around the filter element.

Loosen the bolt (Item 1) [B].

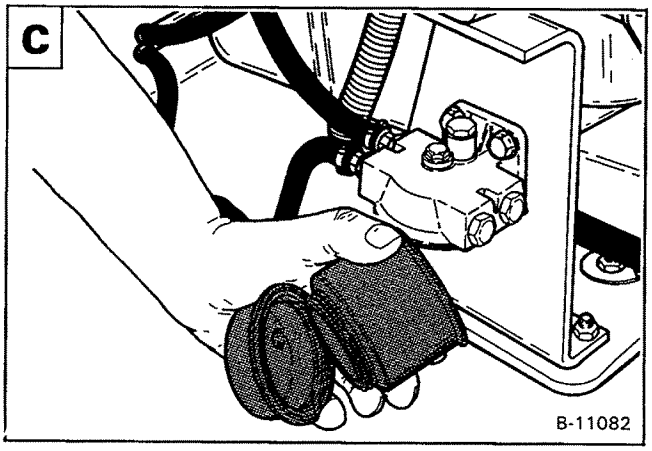


Remove the water trap and filter element [C].

Put oil on the seal of the new filter element.

Install the filter element, water trap and tighten the nut.

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

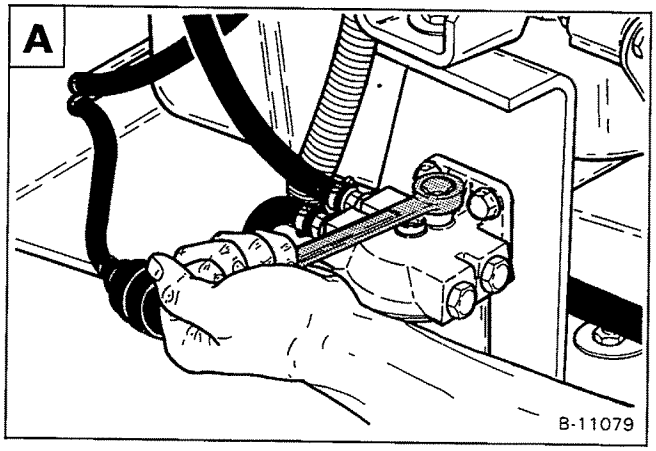


REMOVING AIR FROM FUEL SYSTEM

Procedure

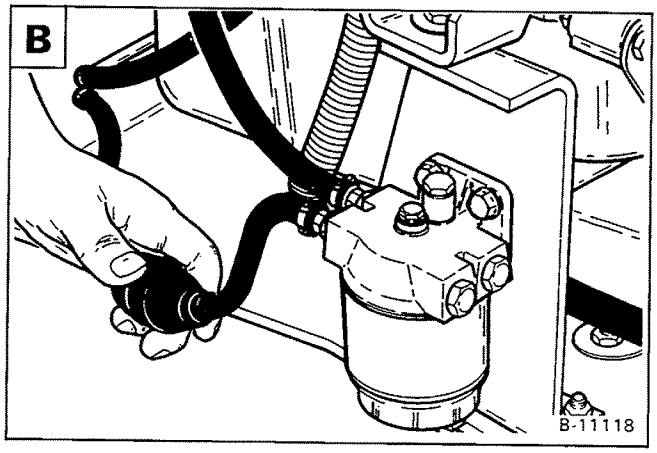
After replacing the fuel filter element or when the fuel tank has run out of fuel, the air must be removed from the fuel system to start the engine.

Loosen the plug at the top of the filter housing [A].



Operate the priming bulb until fuel flows from the plug with no air bubbles showing [B].

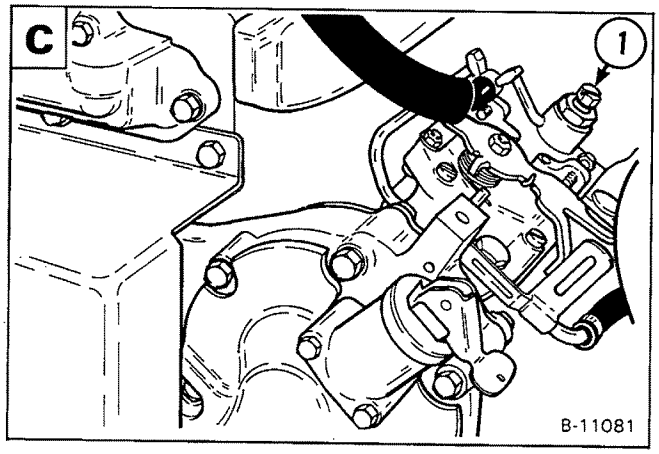
Close the plug at the top of the filter housing.



Loosen the plug at the fuel injection pump (Item 1) [C].

Operate the priming bulb until fuel flows from the plug with no air bubbles showing [B].

Tighten the plug at the fuel injection pump.



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

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

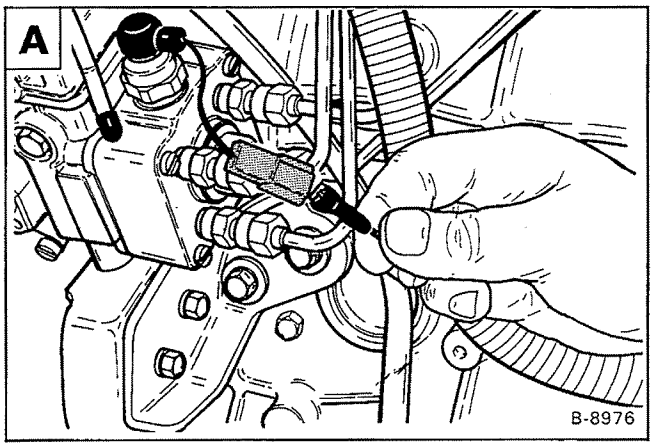
I-2028-0284

Removal and Installation

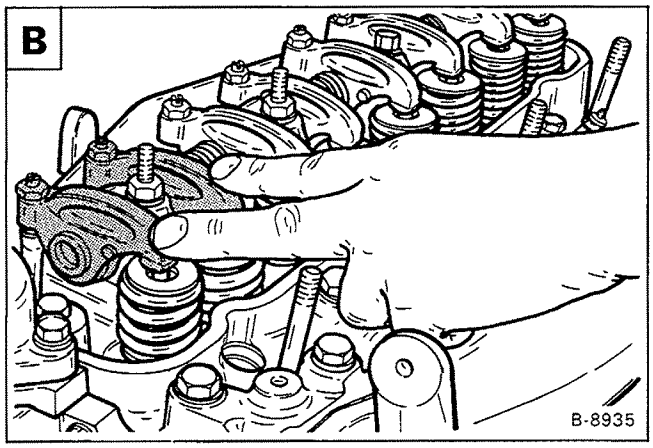
Disconnect the throttle linkage.

Disconnect the shut-off wire [A].

Remove the valve cover.

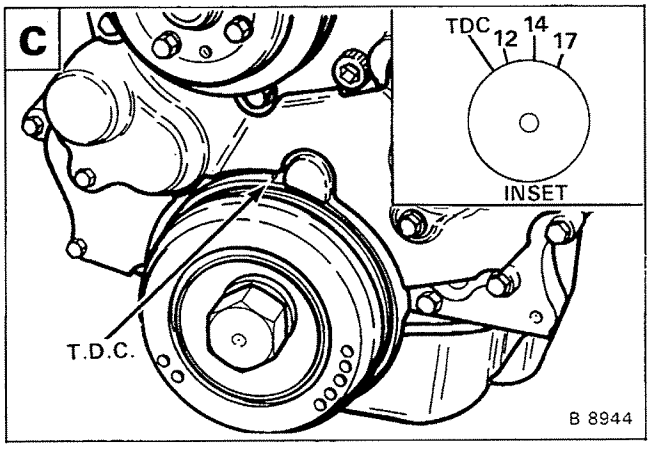


Rotate the engine until No. 1 piston is at TDC. Both valves at No. 1 cylinder are not moving and have clearance [B].

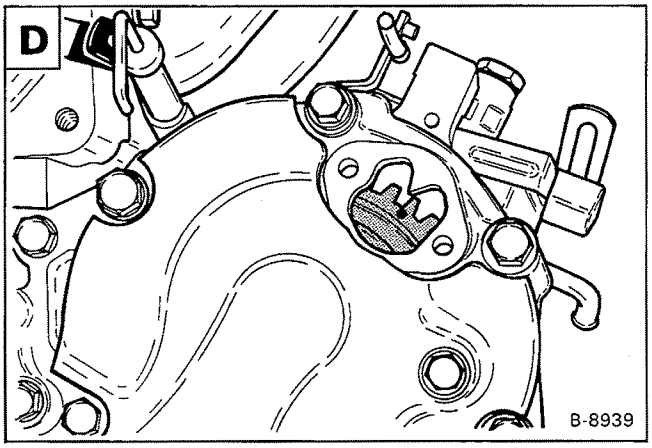


* The 4th mark on the front pulley is at TDC [C].

Remove the oil fill pipe at the timing case cover.



* Make alignment of the mark on the injection pump gear with the pointer in the window [D].



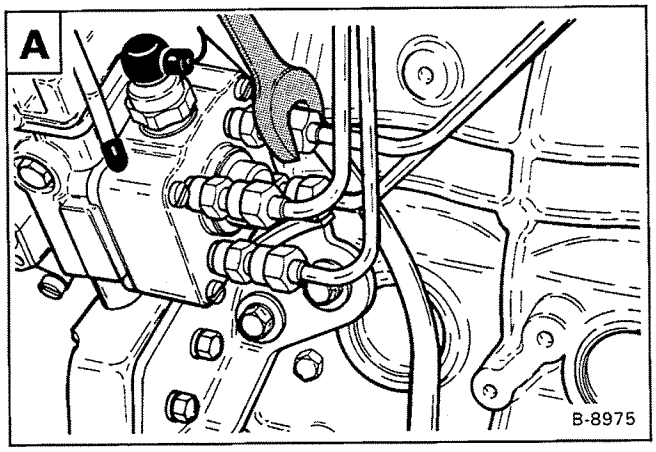
* Revised Feb. 94

IMPORTANT

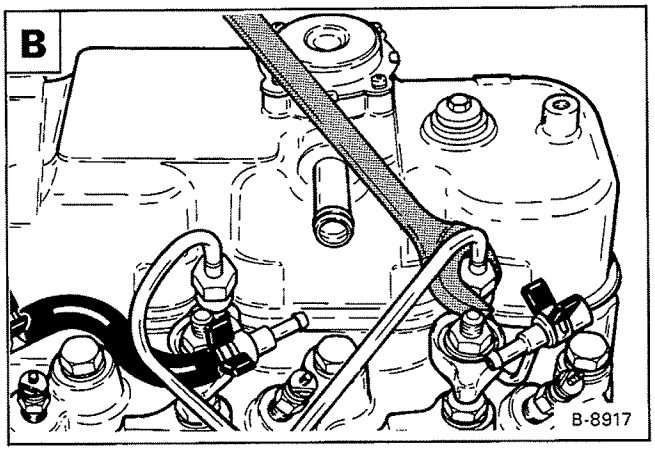
Do not bend the tubelines when removing or installing them on the injection pump or the injectors.

I-2029-0284

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

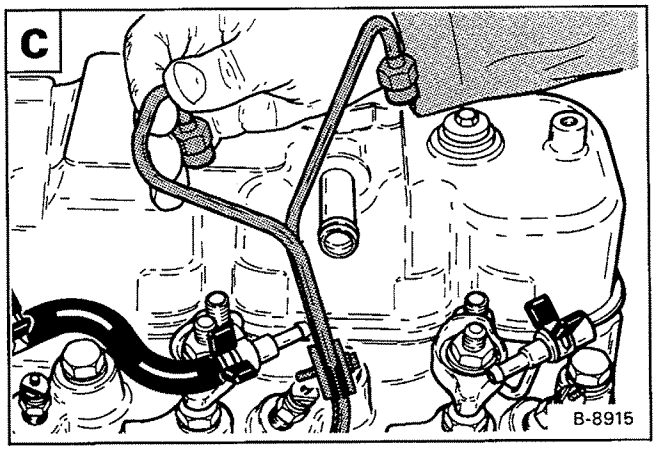


Disconnect the fuel lines at the injectors [B].

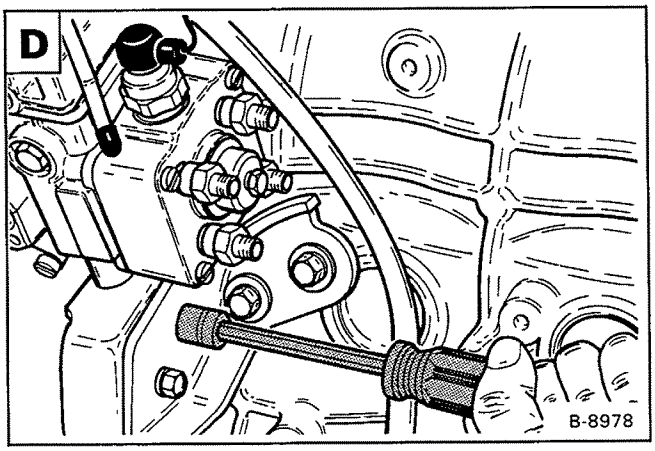


Installation: Tighten the fittings on the high pressure fuel lines to 14-29 ft.-lbs. (19-39 Nm) torque.

Remove the high pressure fuel lines from the engine [C].



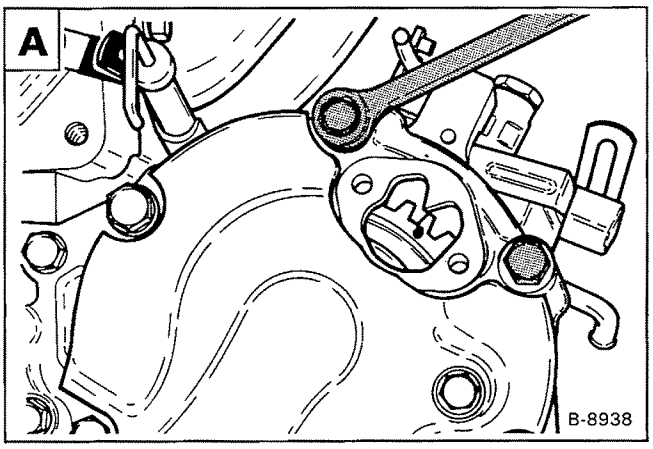
Remove the bolts at the rear of the injection pump and remove the bracket [D].



FUEL INJECTION PUMP (Cont'd)

Remove the bolts at the front of the timing case cover [A].

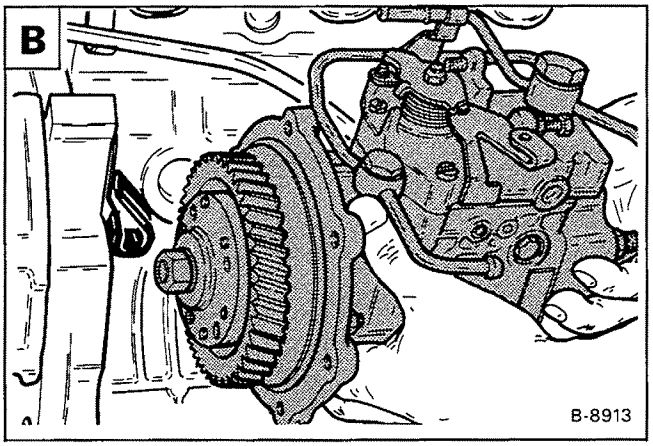
Installation: Tighten bolts & nuts to 10-17 ft.-lbs. (14-23 Nm) torque.



Remove the fuel injection pump [B].

Installation: After the injection pump is installed the air must be removed from the fuel system (See Page 7C—5).

Also the injection pump timing must be set (See Page 7C—9).



ENGINE TIMING TO INJECTION PUMP

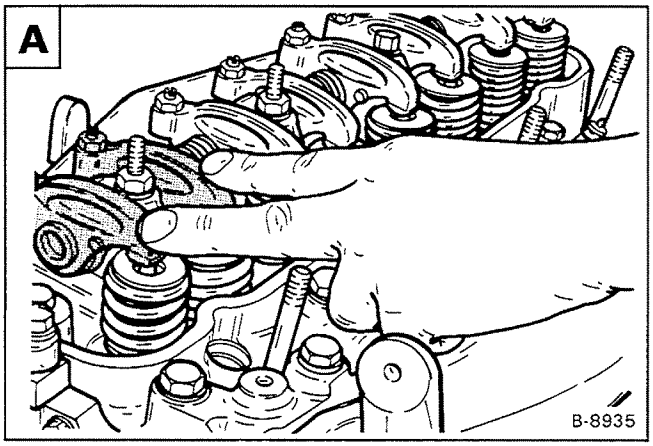
Procedure

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

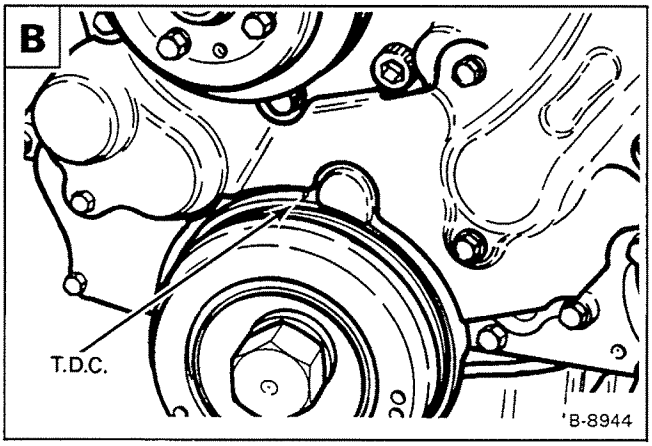
MEL-1201 — Timing Tool

Remove the valve cover.

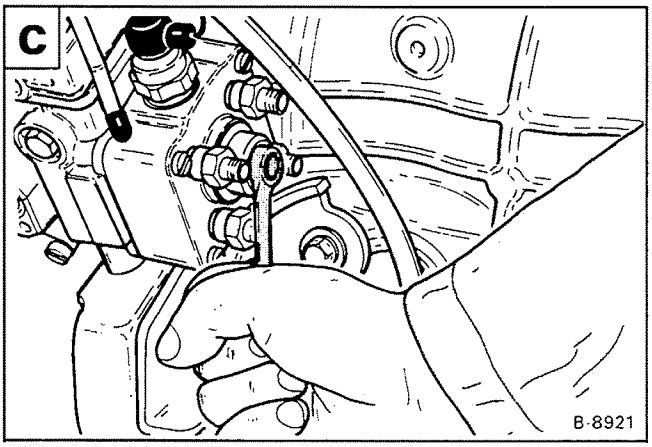
Rotate the engine until No. 1 piston is at TDC. Both valves at No. 1 cylinder are not moving and have clearance [A].



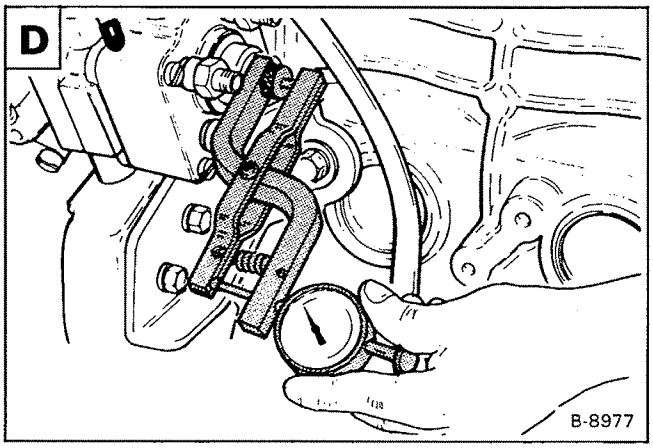
The mark on the front pulley is at TDC [B].



Remove the plug at the rear of the injection pump [C].

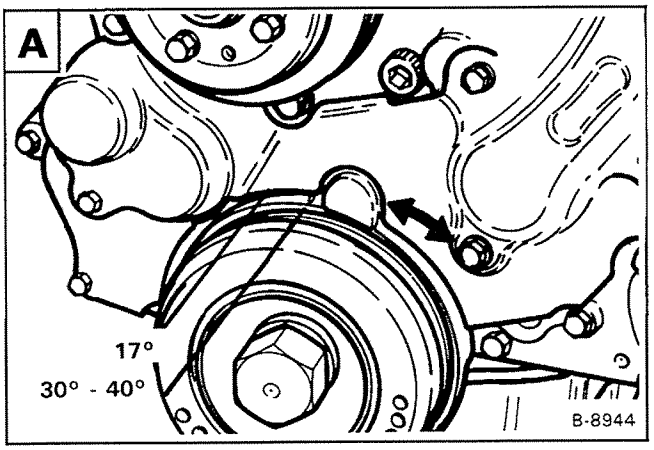


Install timing tool and dial indicator [D].



ENGINE TIMING TO INJECTION PUMP (Cont'd)

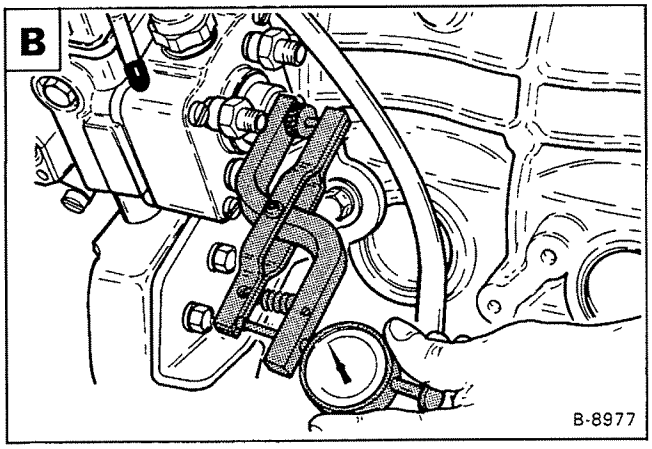
Rotate the engine counterclockwise so the front pulley mark goes 30° to 40° before TDC [A].



Set the dial indicator to zero [B].

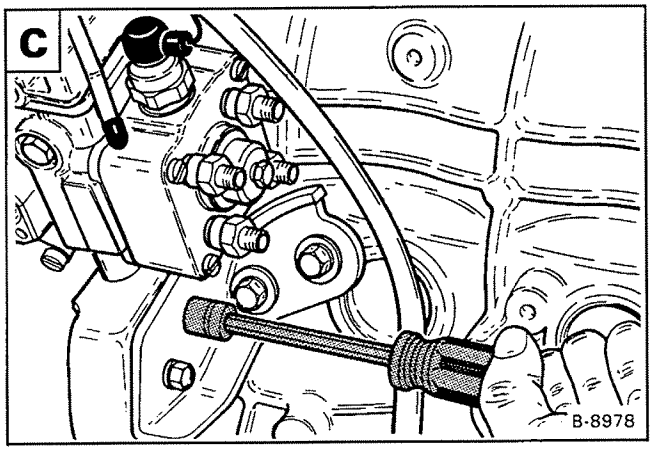
Rotate the engine back to 17° BTDC mark on the front pulley [A].

The dial indicator must read approximately 0.020'' (0,50 mm) [B].

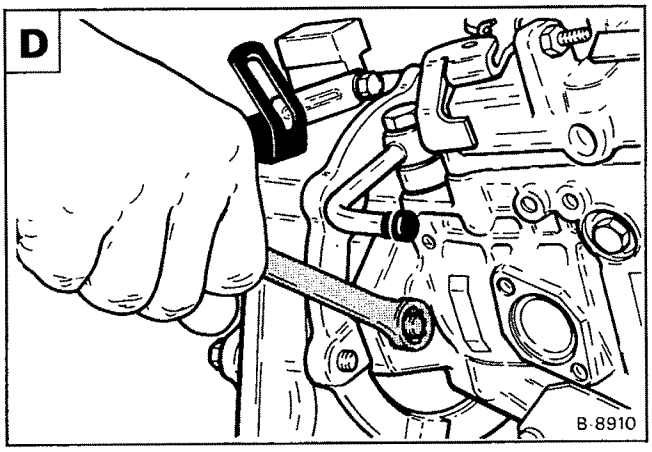


If not, loosen the bolts at the bracket [C] and at the injection pump flange [D].

Move the injection pump to obtain the 0.020-0.022'' (0,50-0,59 mm) reading at the dial indicator with the front pulley marks at the 17° BTDC.



Repeat the procedure until the timing is correct.



⚠ WARNING

Diesel fuel or hydraulic fluid under pressure can penetrate 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 your bare hand. Wear safety goggles. If fluid enters skin or eyes, get immediate medical attention.

W-2074-1285

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

IMPORTANT

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

I-2029-0284

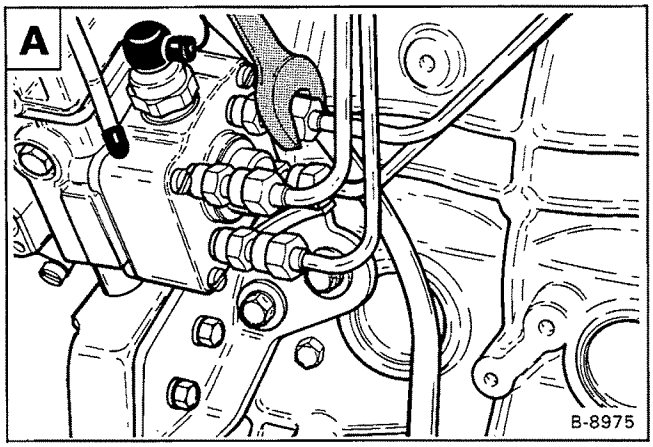
Disconnect the high pressure fuel lines at the fuel injection pump [A].

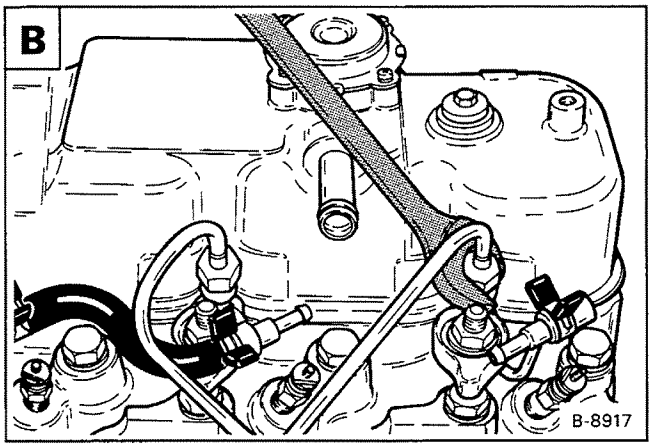
Installation: Tighten the fittings on the high pressure fuel lines to 14-29 ft.-lbs. (19-39 Nm) torque.

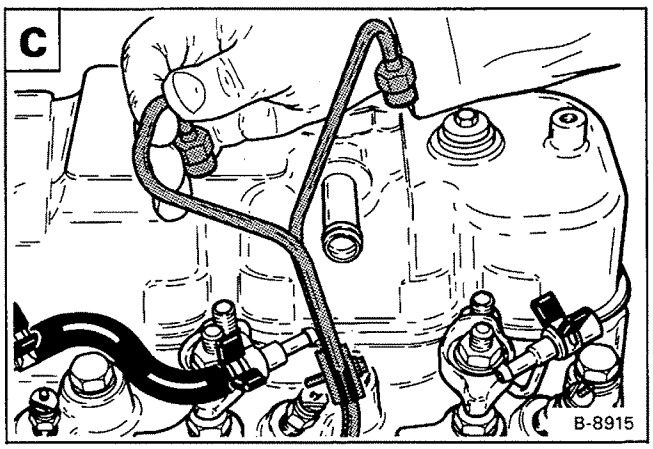
Disconnect the fuel lines at the fuel injectors [B].

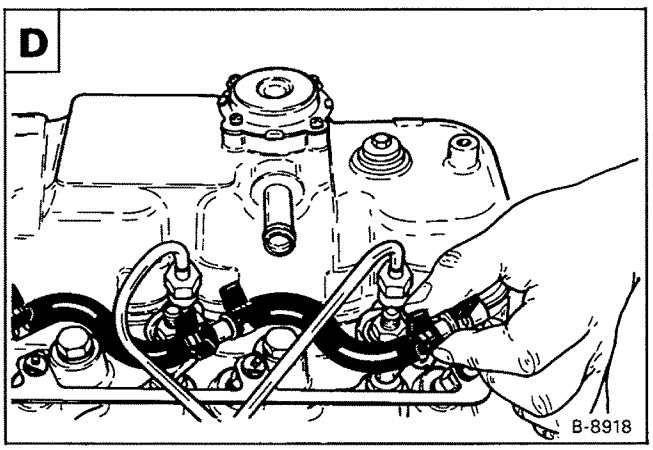
Remove the high pressure fuel lines from the engine [C].

Remove the low pressure hoses from the fuel injector nozzles [D].





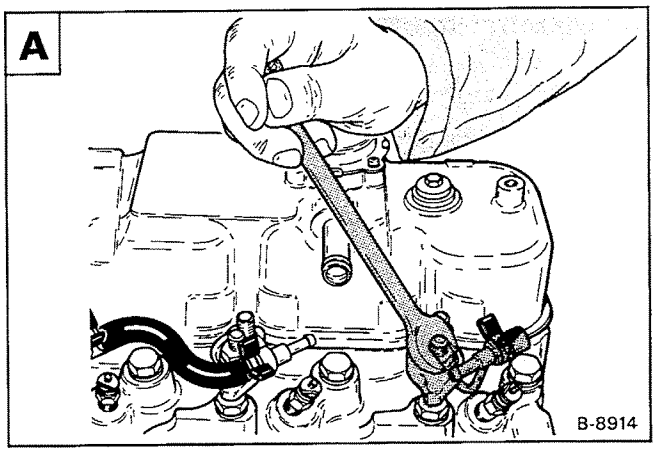




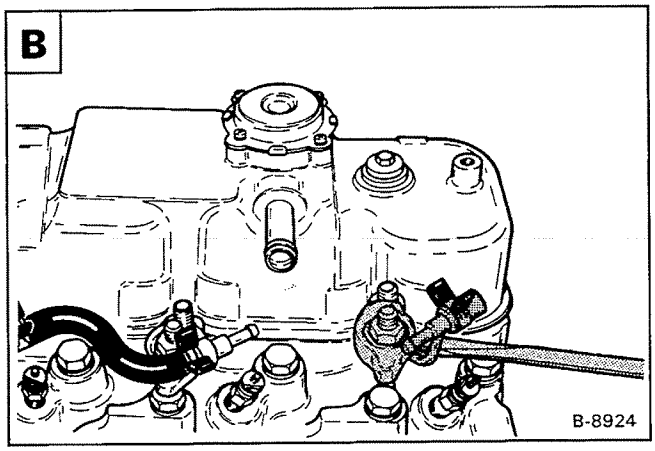
FUEL INJECTOR NOZZLES (Cont'd)

Remove the nut at the fuel injector holddown clamp [A].

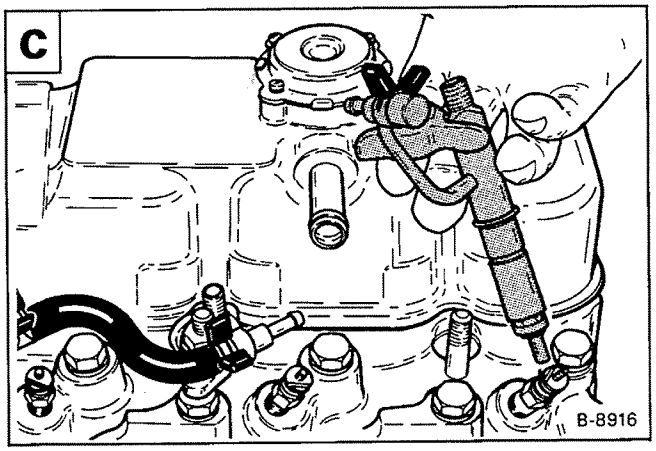
Installation: Tighten the nuts to 23-32 ft.-lbs. (31-43 Nm) torque.



Use a screwdriver and pry the injector from the cylinder head [B].



Remove the injector nozzle from the head [C].



Checking

IMPORTANT

DO NOT disassemble or test the injector nozzle unless you have the correct service and testing equipment.

I-2027-0284

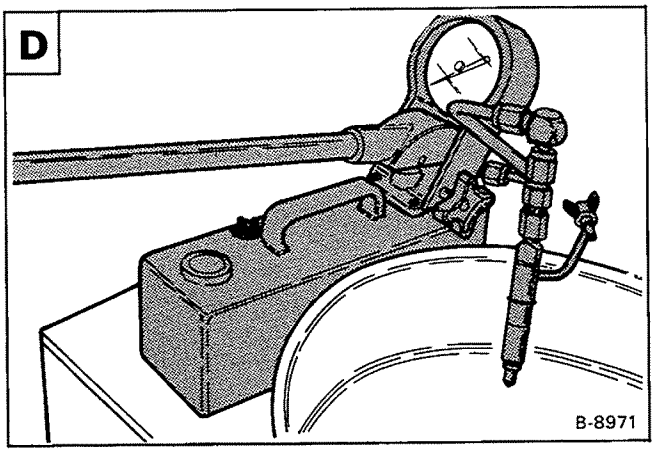
The tools listed will be needed to do the following procedure:

OEM-1064 — Injection Nozzle Tester
OEM-1065 — Accessory Set

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

Operate the test pump until the nozzle valve opens:

Injection Pressure: 2630 PSI (18134 kPa)



FUEL INJECTOR NOZZLES (Cont'd)

If the pressure is not correct, do the following:

Disassemble the injector nozzle and clean.

Replace the shim (Item 6) [A].

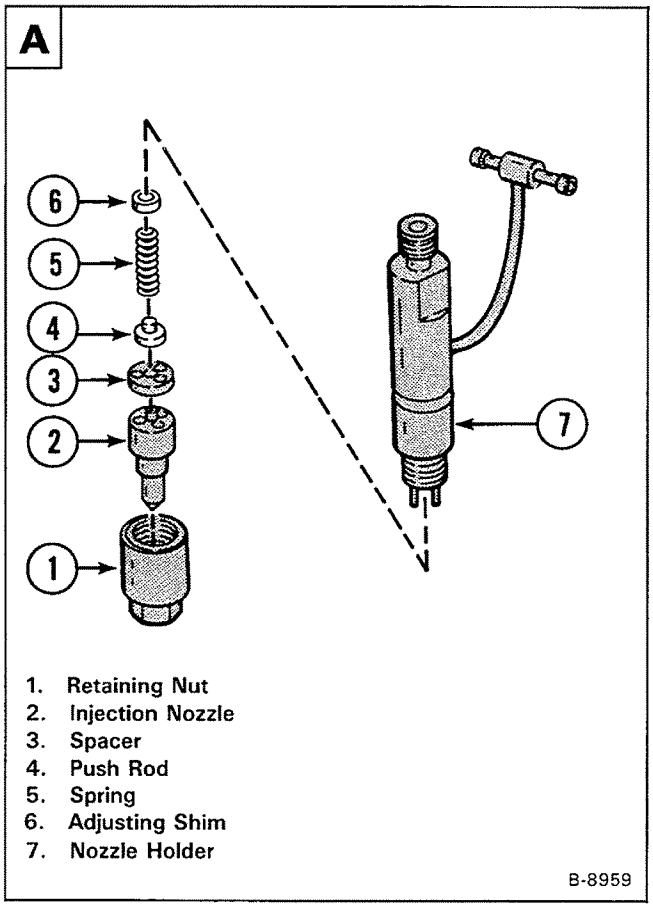
Check the pressure again.

⚠ WARNING

Do not disassemble or 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. If fuel enters skin or eyes, get immediate medical attention. Failure to obey warnings can cause injury or death.

W-2075-0284

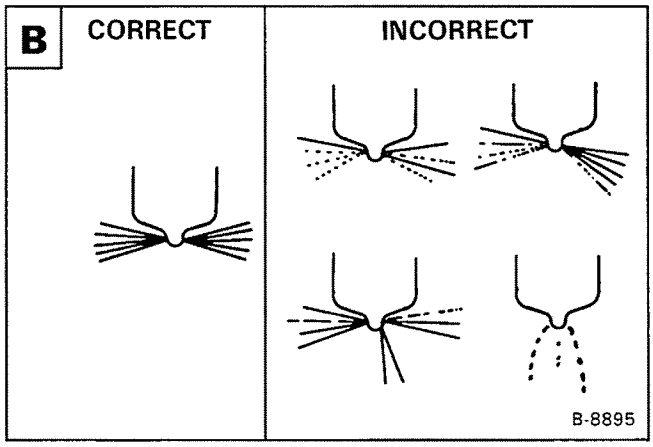
Assembly: Tighten the retaining nut (Item 1) to 29-32 ft.-lbs. (39-43 Nm) torque [A].



Checking nozzles spray pattern [B].

Does not come out the side of the nozzle. Does not have drops coming from the nozzle. Does not have a solid stream coming from nozzle.

Any of the above conditions show a defect or dirty injector nozzle. Clean or replace any injector nozzle that does not operate correctly.

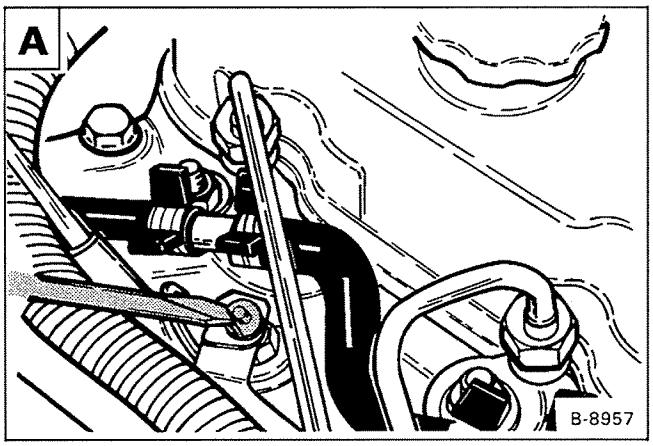


GLOW PLUGS

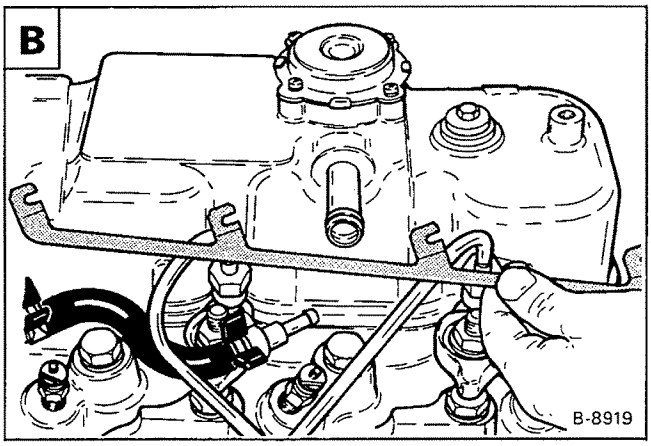
Removal and Installation

Disconnect the negative (—) cable at the battery.

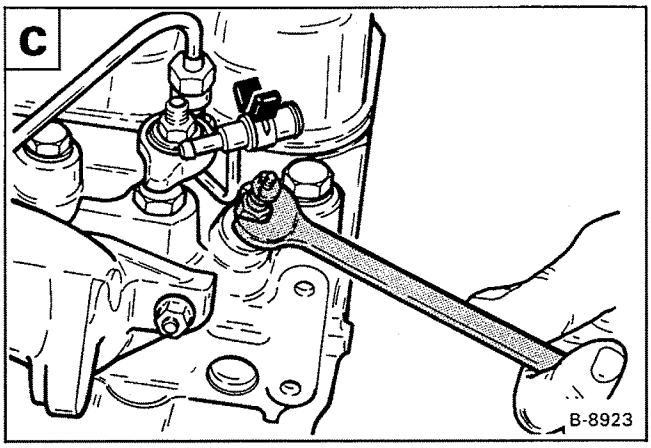
Remove the electrical bar holddown nuts at the glow plugs [A].



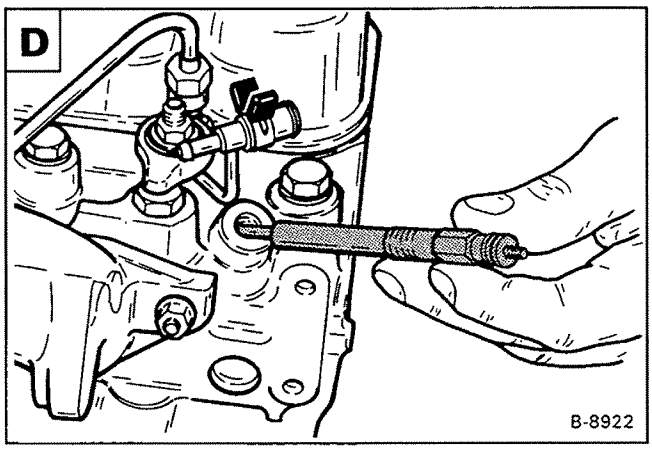
Remove the electrical connector bar [B].



Loosen the glow plug [C].



Remove the glow plug from the cylinder head [D].



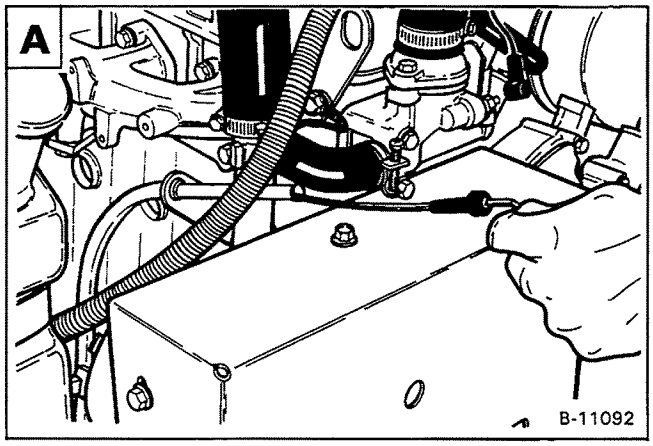
ENGINE OIL AND FILTER

Removal and Installation

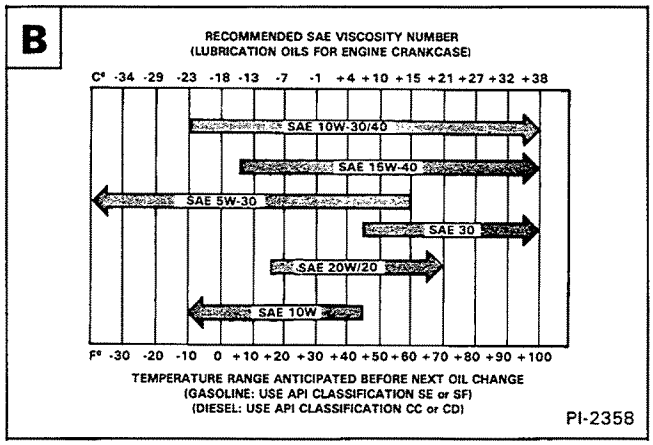
See the Service Schedule (Page 1—1) for the correct service interval.

Check the oil level every day [A].

Add the correct oil as needed.



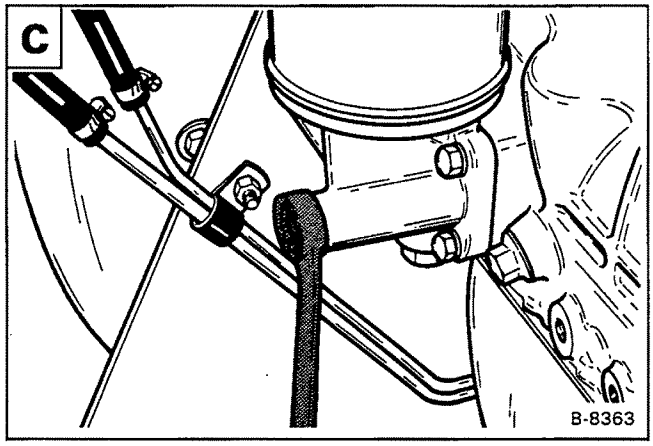
Use recommended engine oil [B].



Run the engine until warm. Stop the engine.

Turn the plug at the oil filter housing out about 3 to 5 turns to drain the oil in the filter element into the oil pan [C].

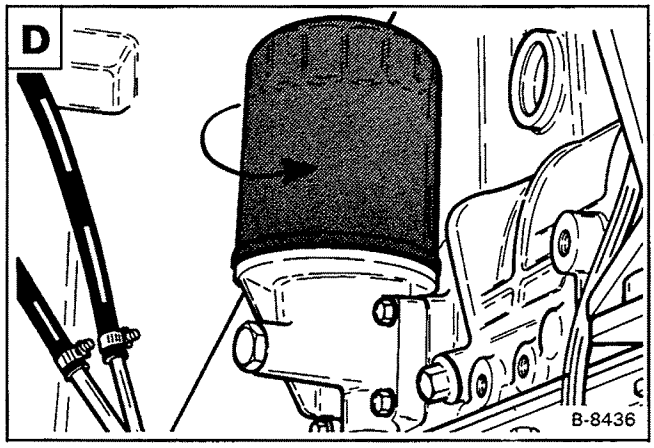
NOTE: This plug must be tightened after oil is removed from the filter element, because if it is not, there will be no engine oil pressure and engine damage will result.



⚠ WARNING

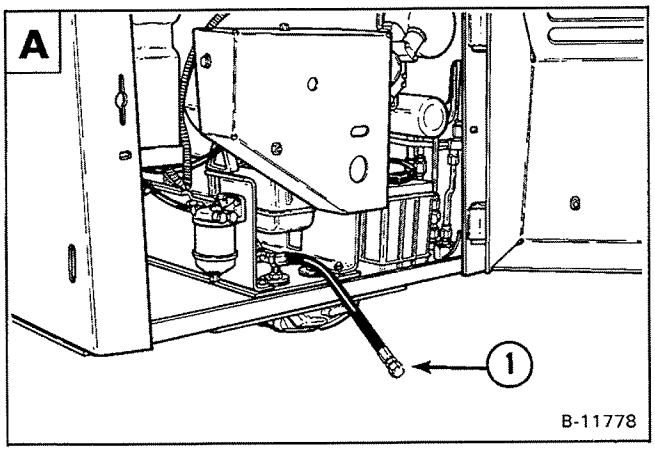
Engines can have hot parts. Wear protective clothing when removing oil filter to avoid burns.

W-2108-0986



Remove the filter element [D].

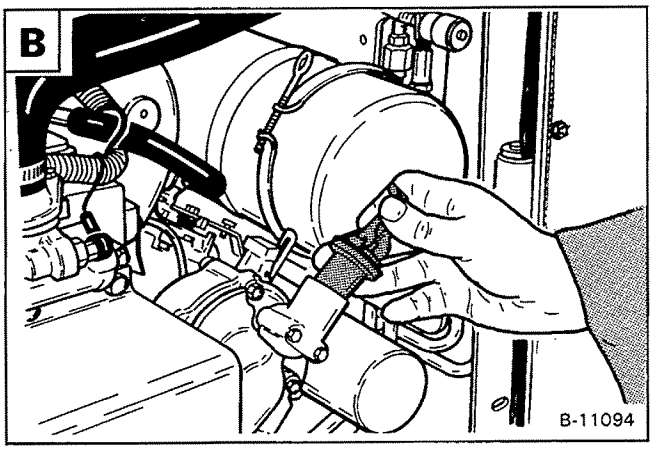
Clean the filter housing surface. Put clean oil on the gasket of the new filter. Install the filter element and hand tighten only.

* 

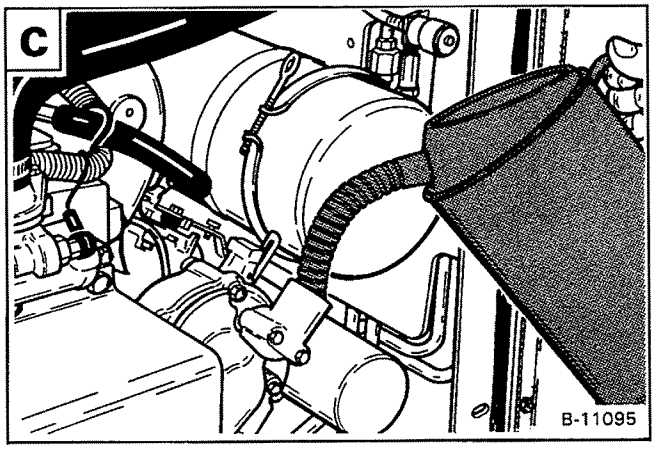
Remove the cap (Item 1) at the end of the hose [A].

Drain the oil into a container.

Install the cap on the end of the hose and tighten [A].



Remove the filler cap [B].



Fill to capacity [C] (See Specification, Section 8C—2).

Start the engine and let it run for about 5 minutes. Check for leaks at the filter.

Stop the engine. Check the oil level.

Add oil until the level is at the "FULL" mark on the dipstick. Install the filter cap [B].

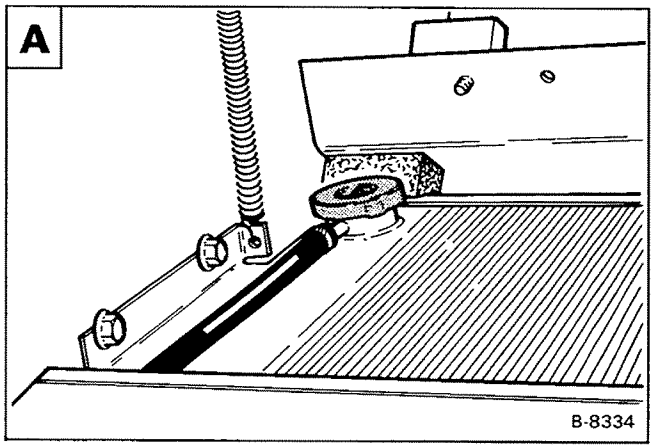
NOTE: Do Not overfill the crankcase.

ENGINE

Removal and Installation

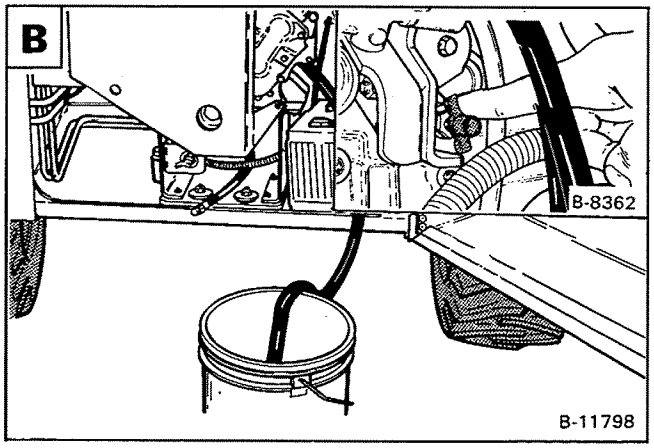
Remove the battery (See Page 6—2 for the correct procedure).

Lift the rear grill and remove the radiator cap [A].

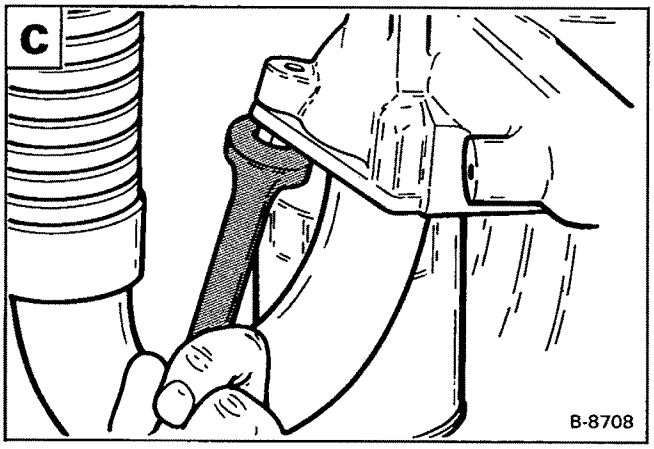


Open the valve at the side of the engine block and drain the coolant [B]. *

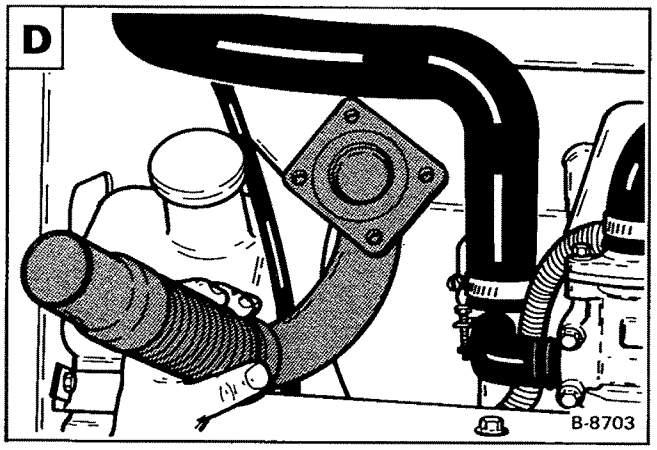
Disconnect the throttle linkage at the fuel injection pump.



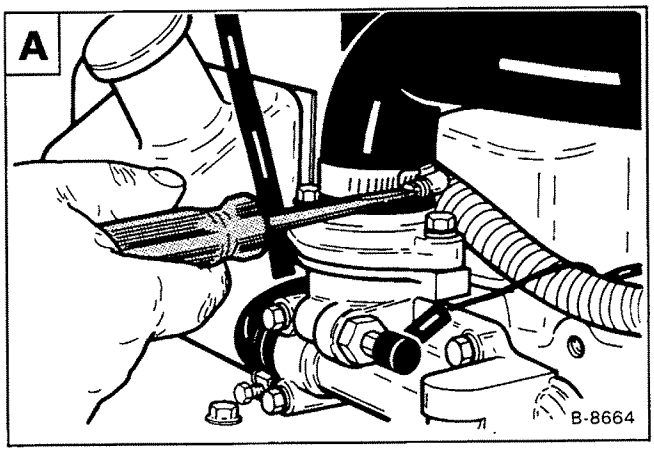
Remove the four bolts at the exhaust manifold [C].



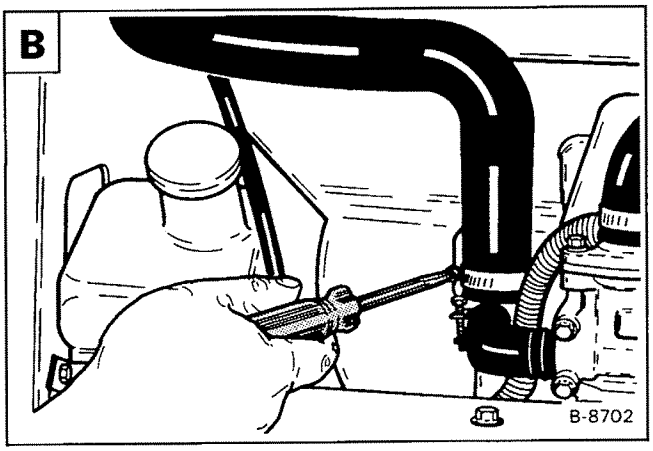
Remove the exhaust pipe [D].



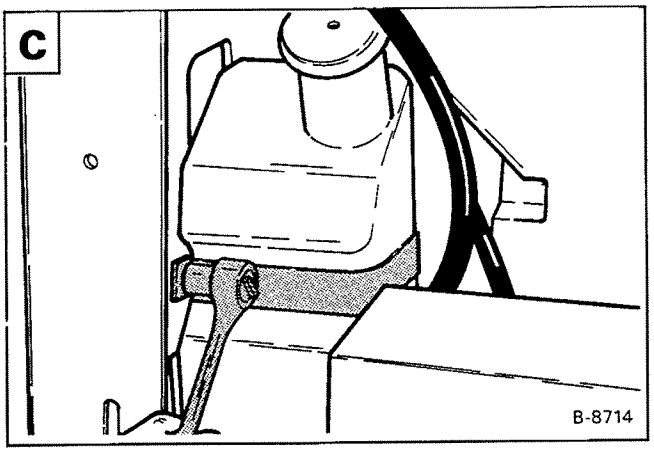
Disconnect the radiator hose [A].



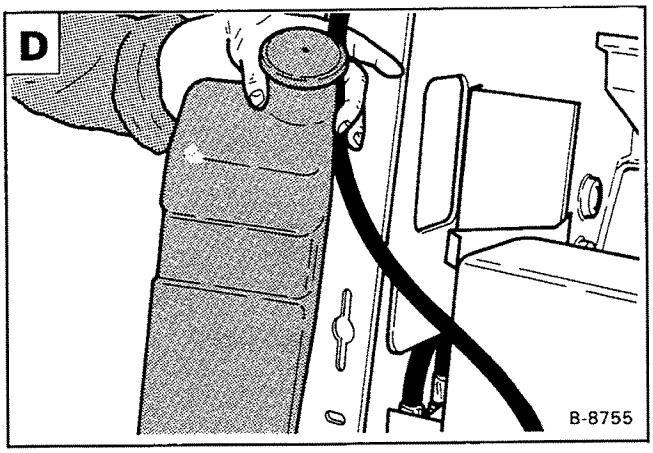
Disconnect the radiator hose [B].



Remove the holddown band for the coolant recovery tank [C].



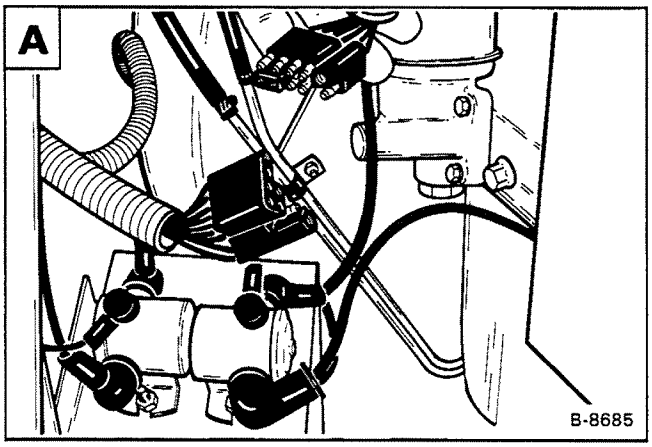
Remove the coolant recovery tank [D].



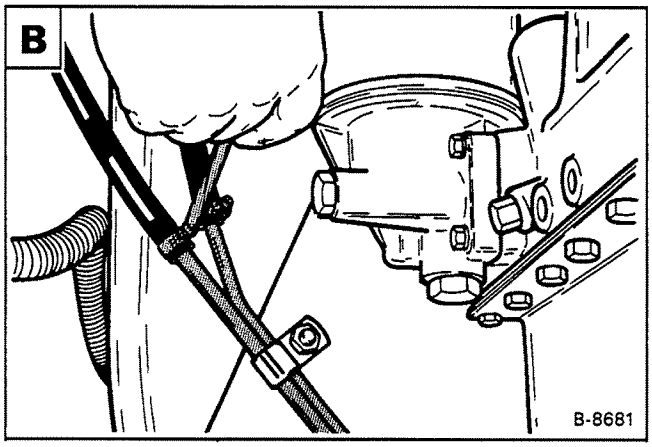
ENGINE (Cont'd)

Disconnect the wire harness connectors [A].

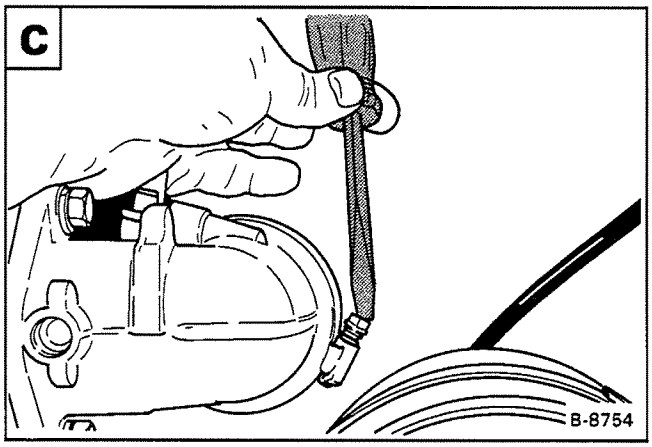
Disconnect the wires from the solenoid [A].



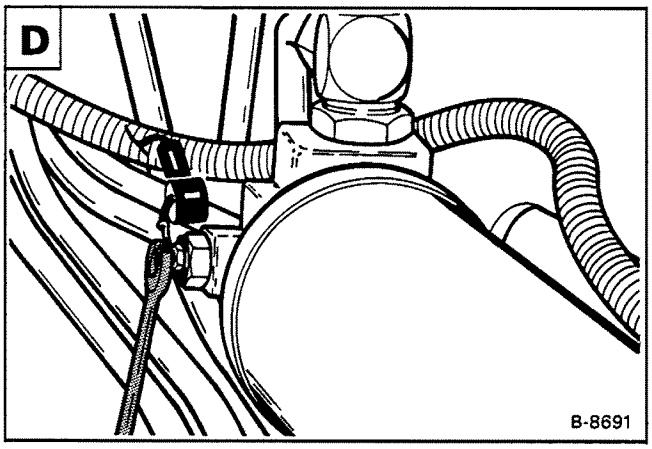
Disconnect the inlet and return fuel hoses [B].



Disconnect the air cleaner hose at the intake manifold [C].

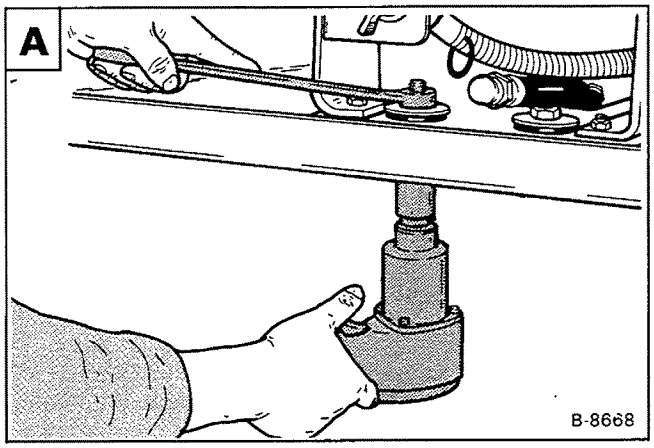


Disconnect the wire at the hydrostatic filter sending switch [D].

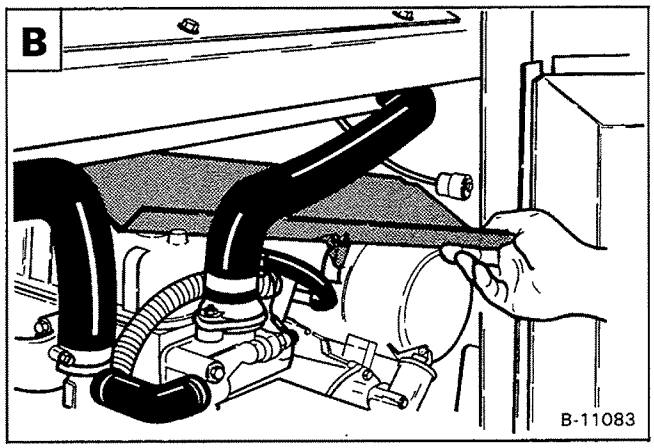


ENGINE (Cont'd)

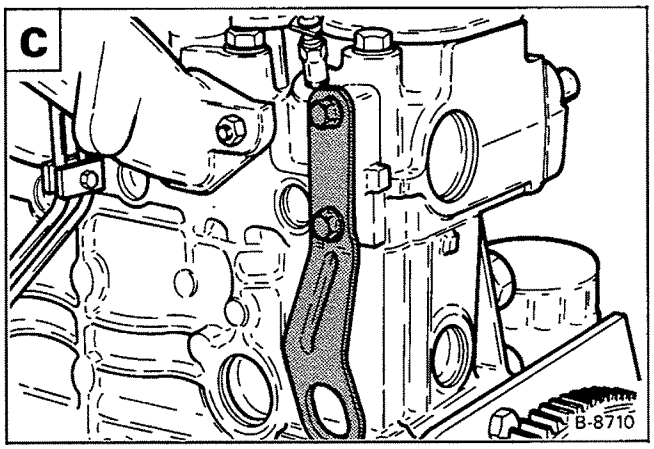
Remove the four engine mounting bolts and nuts [A].



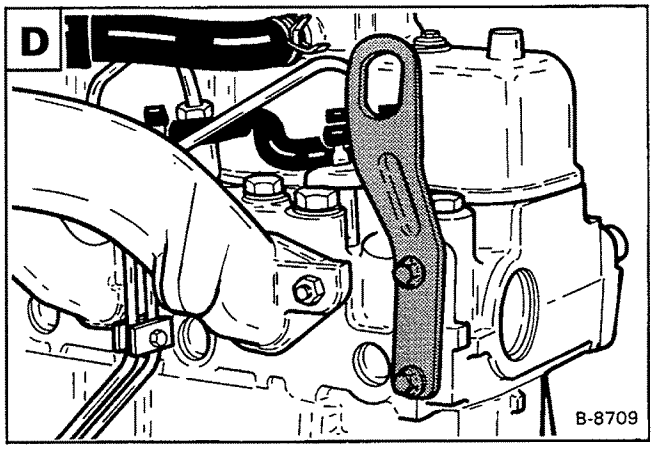
Remove the panels over the oil cooler [B].



The lift hook at the rear of the engine is in a down position [C].



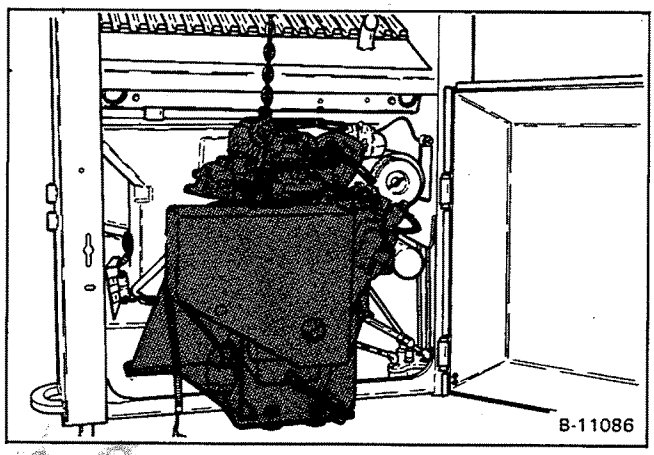
Remove the lift hook and put it in the up position for removal of the engine [D].



ENGINE (Cont'd)

Hook the chain hoist into the front lift hook [A].

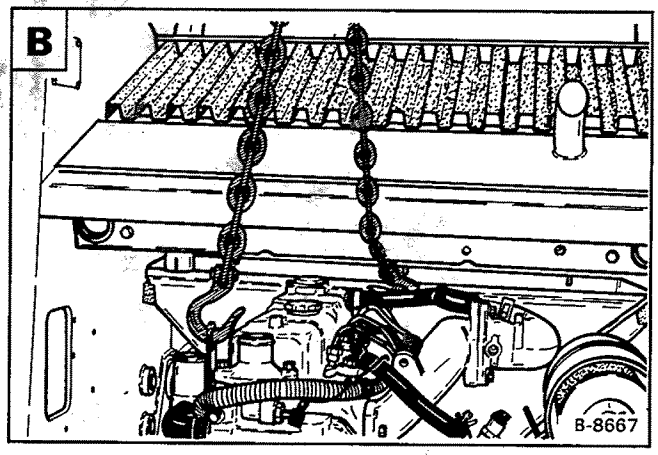
Lift the engine just enough to make clearance at the rear edge of the frame.



Slide the engine out of the frame until the chain hoist can be hooked into the rear lift hooks [B].

Remove the engine from the loader.

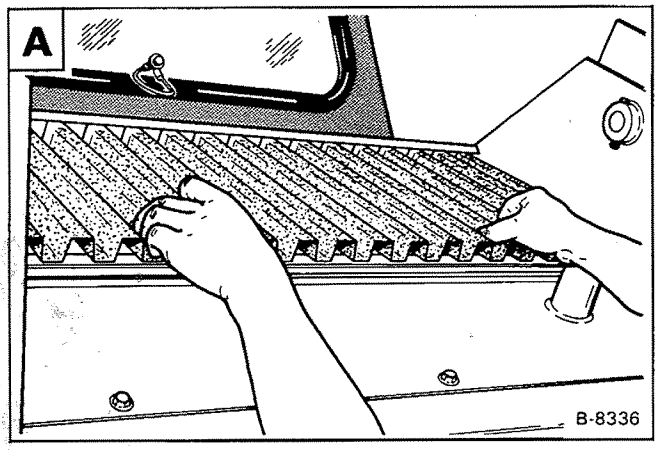
Installation: Make sure to make alignment of the U-joint to the spline on the hydrostatic pump shaft when installing the engine in the Feller Buncher.



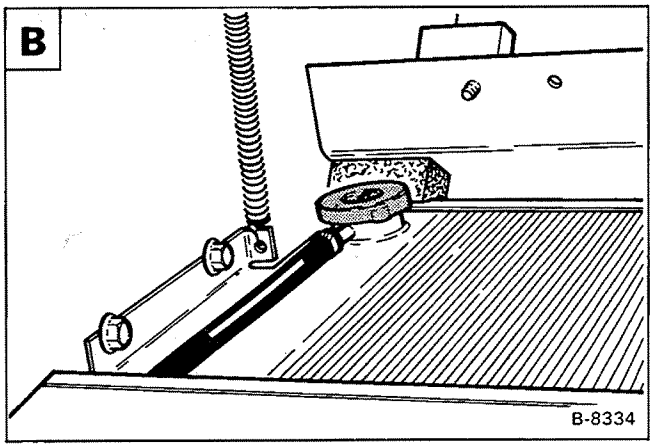
RADIATOR

Removal and Installation

Remove the rear grill [A].

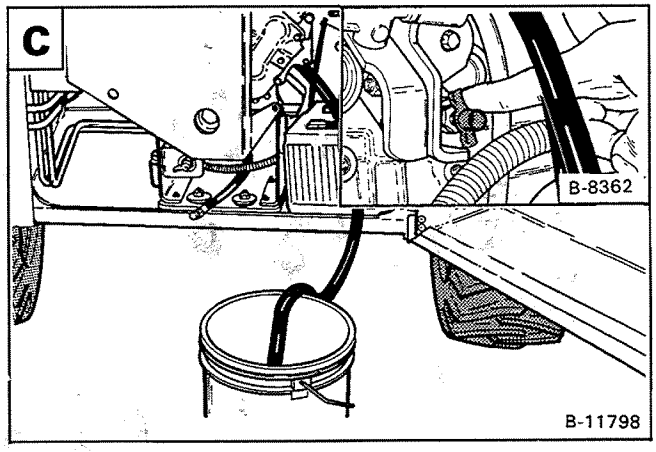


Remove the radiator cap [B].

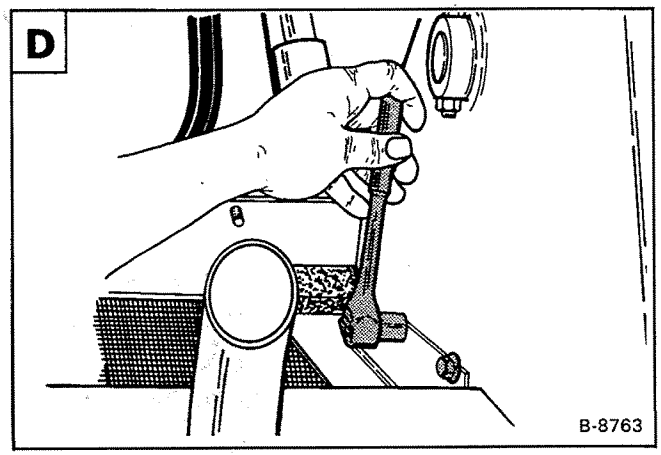


Open the valve at the side of the engine block and drain the coolant [C].

Disconnect both radiator hoses at the radiator.



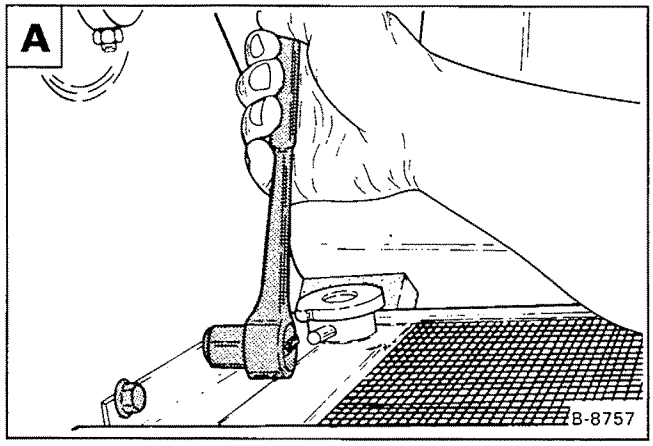
Remove the radiator holddown bracket at the right side of the frame [D].



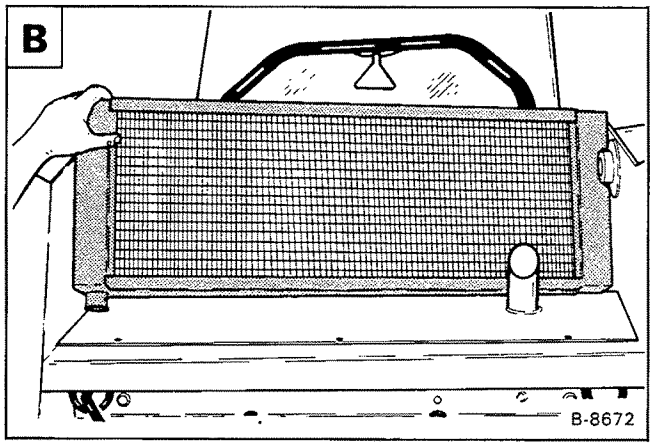
RADIATOR (Cont'd)

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

Remove the bolts under the radiator.



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



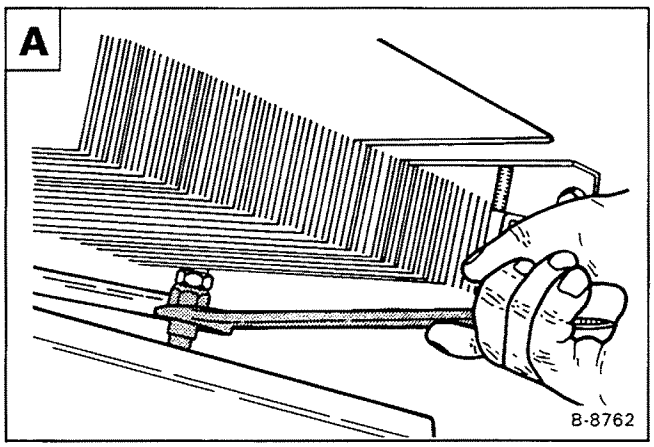
OIL COOLER

Removal and Installation

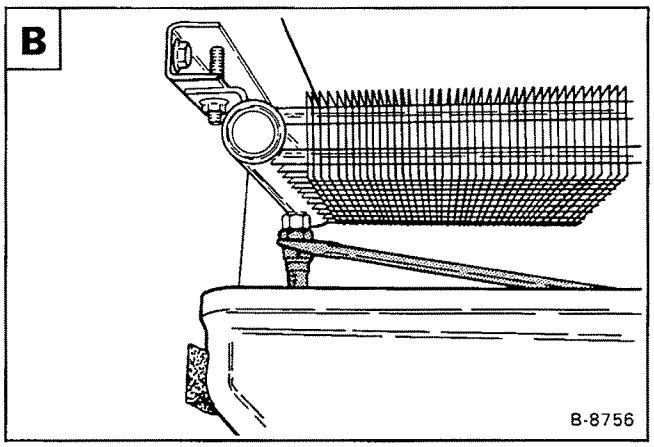
Remove the panels above the engine on the blower housing.

Remove the radiator (See Page 7C—22).

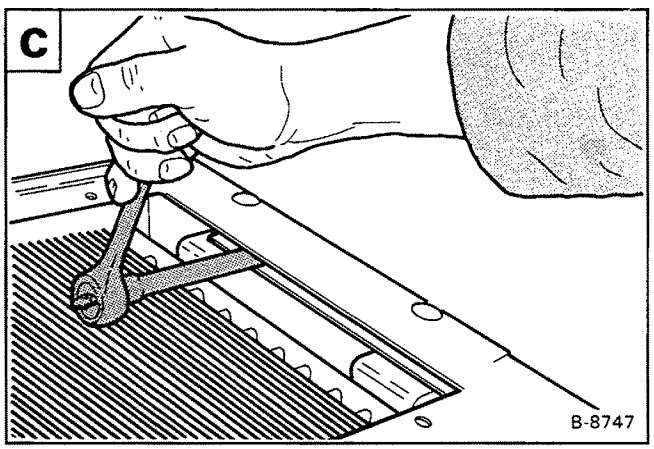
Disconnect the tubeline at the right side of the oil cooler [A].



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

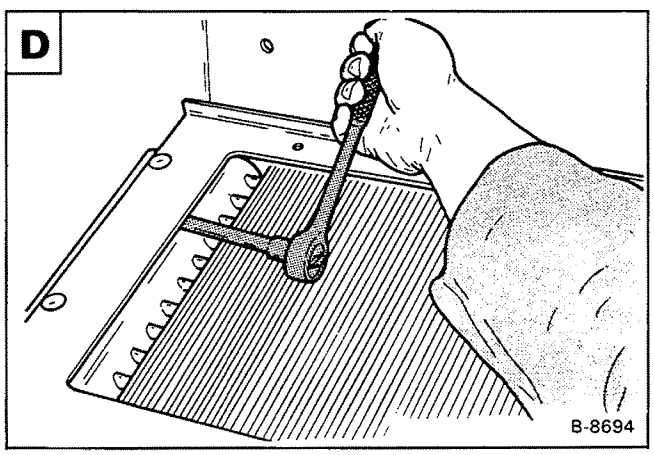


Remove the bolts at the right side oil cooler bracket [C].



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

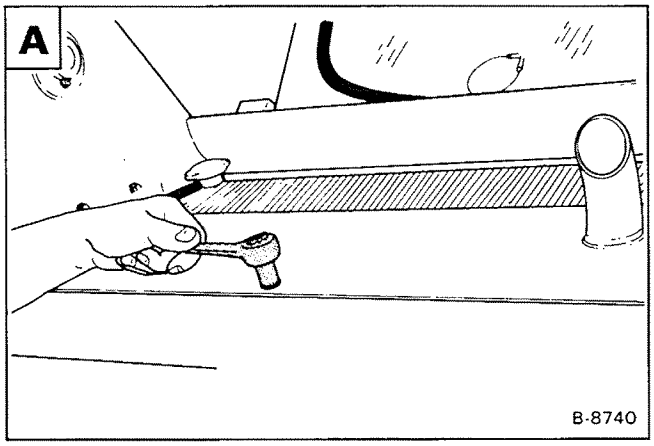
Remove the oil cooler from the mounting frame.



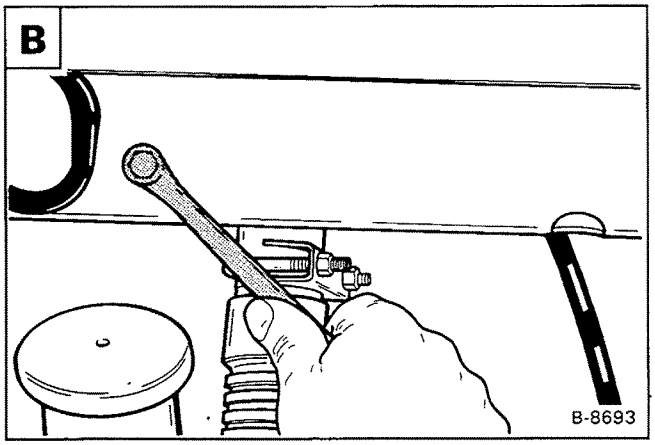
ENGINE MUFFLER

Removal and Installation

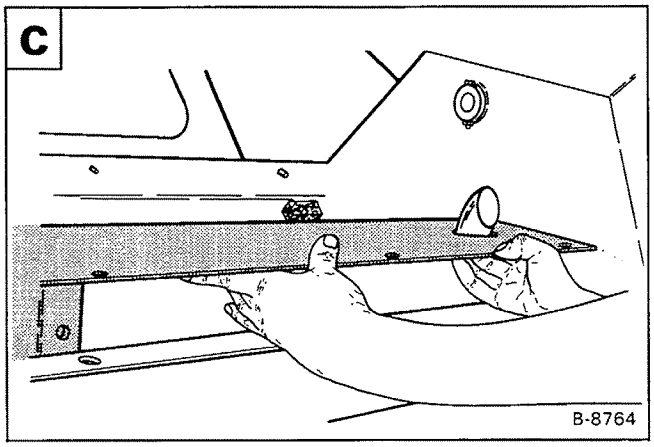
Remove the bolts from the plate which covers the muffler [A].



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



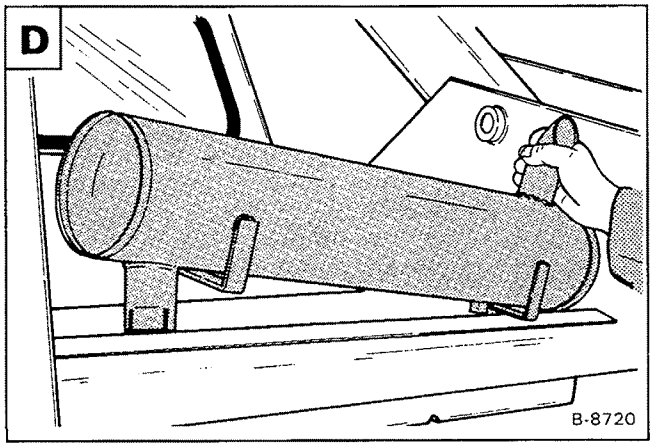
Remove the shield from the muffler [C].



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].

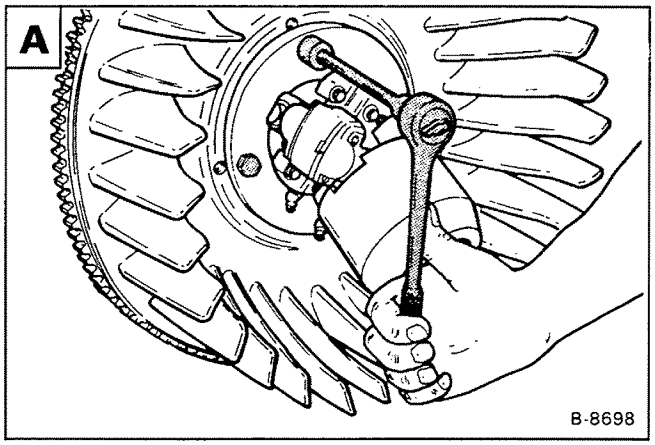


ENGINE FLYWHEEL & U-JOINT

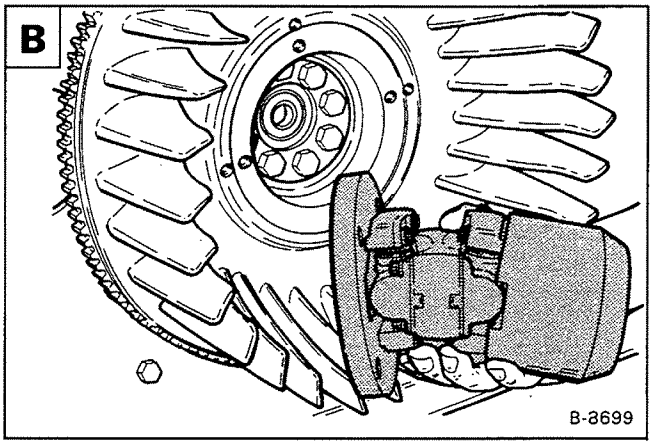
Removal and Installation

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

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

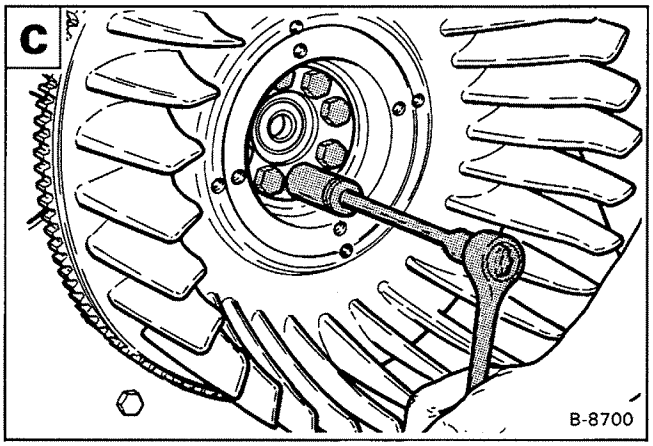


Remove the u-joint from the flywheel [B].



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.

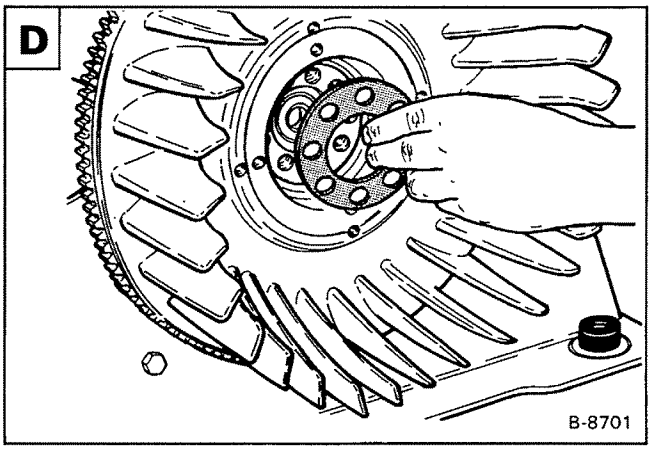
Flywheel Ring Gear

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 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.

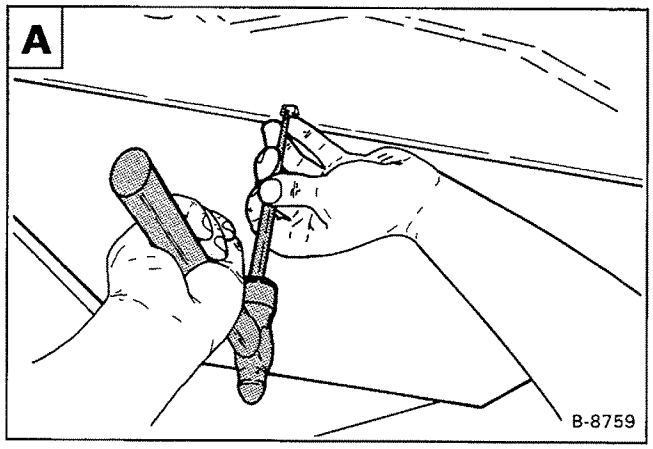


ENGINE BLOWER HOUSING

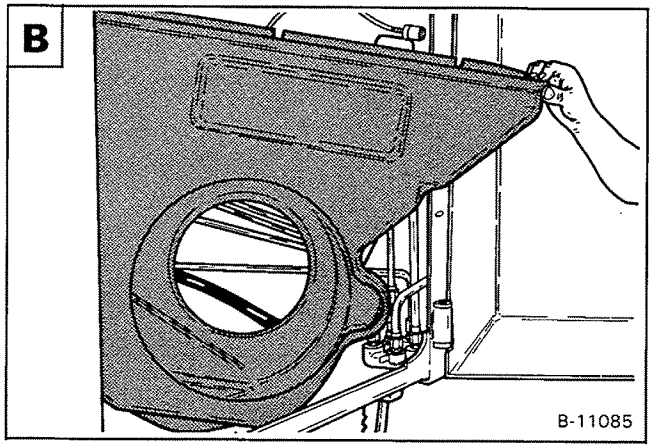
Removal and Installation

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

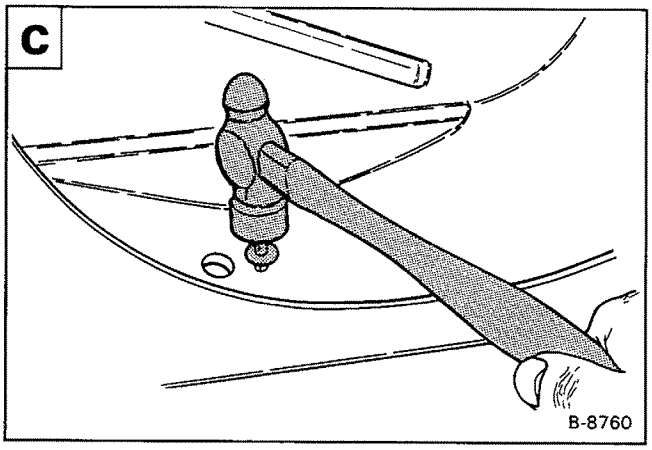
Remove the bolts along the top edge of the blower housing.



Remove the blower housing from the loader [B].



After the blower housing is installed, install the rivet in the bottom of the blower housing and hit it with a hammer [C].



ENGINE MOUNTS

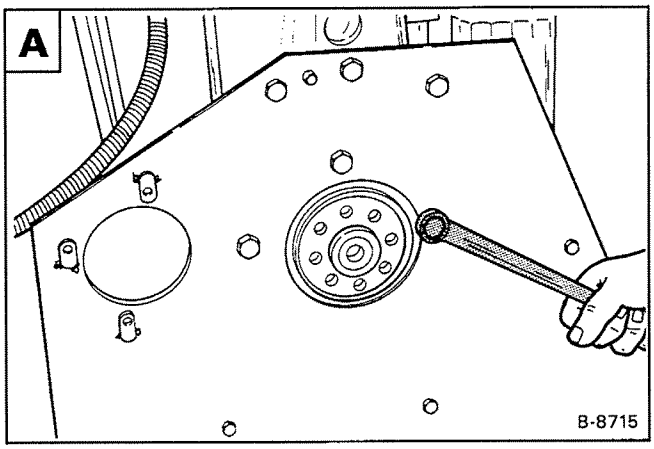
Removal and Installation

Lift the engine with a chain hoist.

Remove the flywheel (See Page 7C—26).

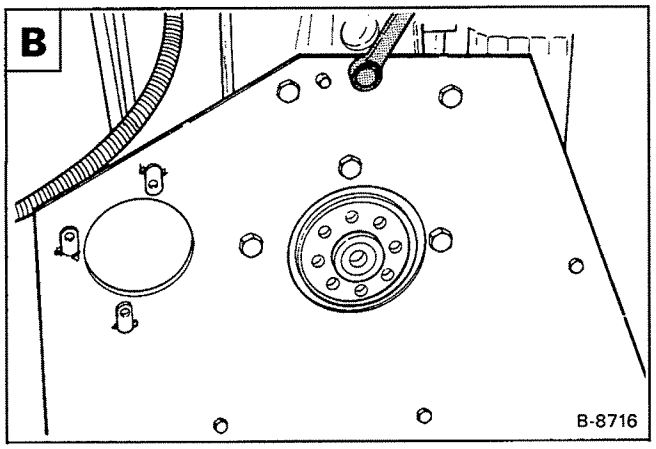
Remove the bolts around the crankshaft flange [A].

Installation: Tighten the bolts to 56-62 ft.-lbs. (75-85 Nm) torque.



Remove the bolts around the engine block [B].

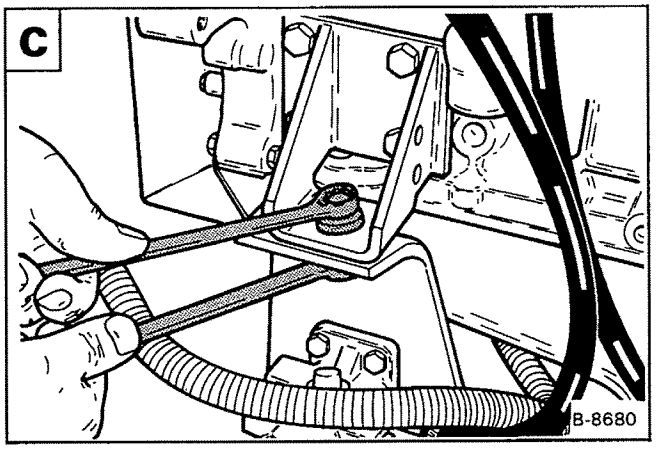
Installation: Tighten the bolts to 31-35 ft.-lbs. (43-47 Nm) torque.



Remove the bolts at the crankshaft pulley end of the engine [C].

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

Lift the engine from the mounts.



CYLINDER HEAD

Removal and Installation

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

MEL-1267 – Cylinder Head Bolt Wrench

Clean all the debris from the cylinder head and engine.

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

Remove the fuel injectors and fuel tubelines (See Page 7C – 11 for the correct procedure).

Remove the valve cover nuts in the correct sequence [A].

Installation: Tighten the nuts to 6-13 ft.-lbs. (8-17 Nm) torque in the correct sequence [A].

Remove the rocker arm assembly bolts in the correct sequence [B].

Installation: Tighten the bolts in the correct sequence to 36-43 ft.-lbs. (49-58 Nm) torque.

Remove the cylinder head bolts in the correct sequence [C].

Installation: Lubricate the bolts and tighten them in two steps as listed, in the correct numerical sequence [D].

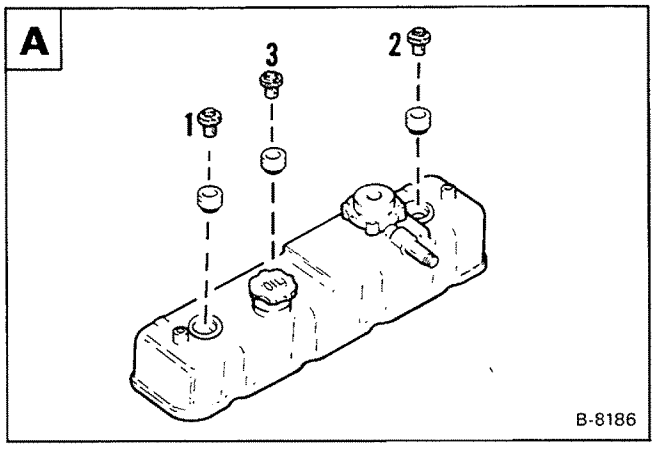
	Step 1	Step 2
New Bolts	29 ft.-lbs. (39 Nm)	59-67 ft.-lbs. (80-91 Nm)
Used Bolts	62 ft.-lbs. (83 Nm)	72-80 ft.-lbs. (97-108 Nm)

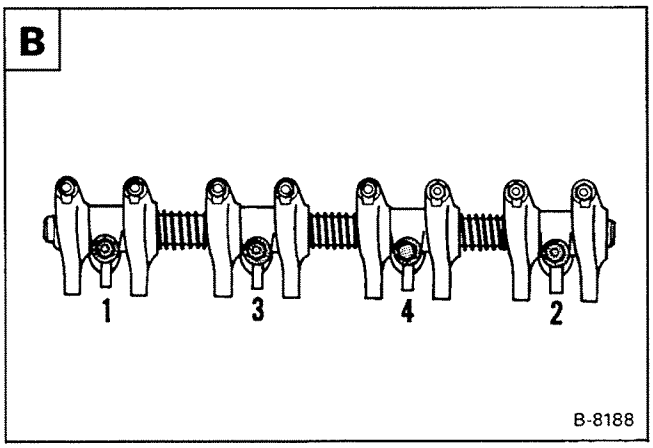
NOTE: When removing the head, do not use a sharp tool between the head and the engine block. Always put the cylinder head on a flat surface, such as wood, to prevent damage to the machined surface.

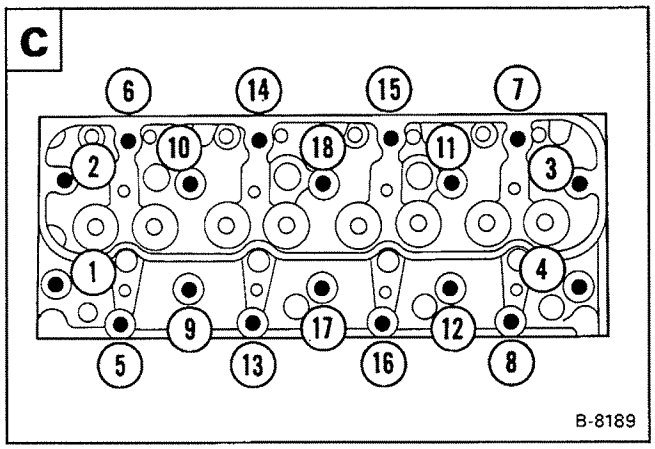
Remove the head from the engine.

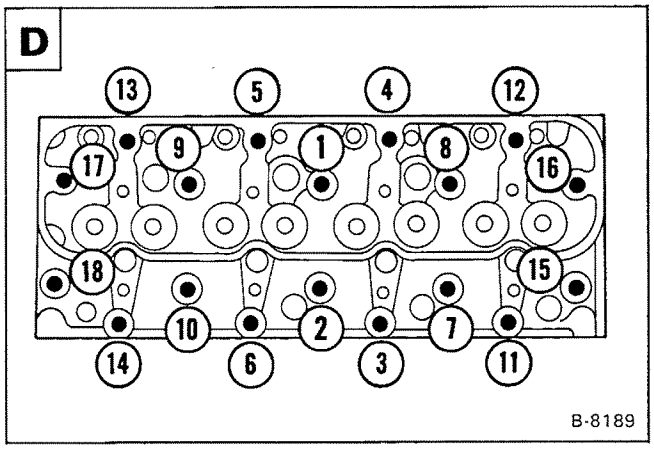
See Page 7C – 31 for removing and reconditioning the valves.

After the cylinder head is installed, adjust the valve clearance (See Page 7C – 2 for the correct procedure).





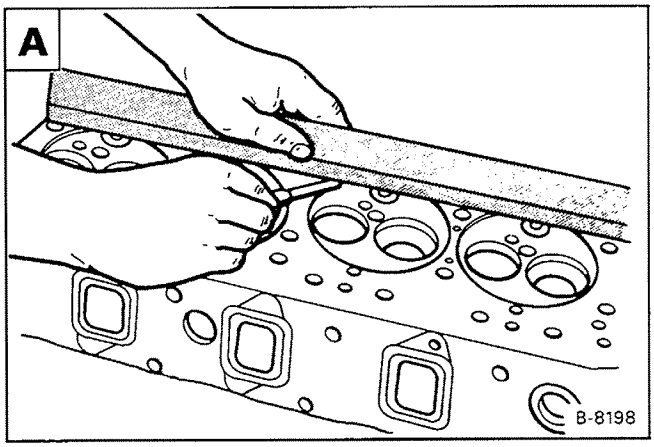




CYLINDER HEAD (Cont'd)

Cylinder Head Surface Alignment

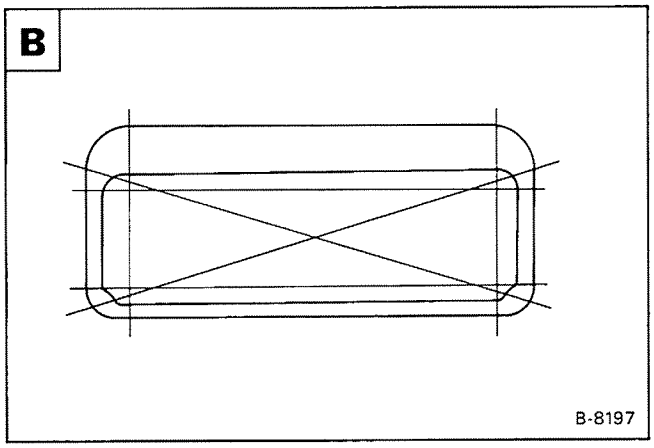
Check the surface of the head with the straight edge [A].



Check the head at six different directions [B].

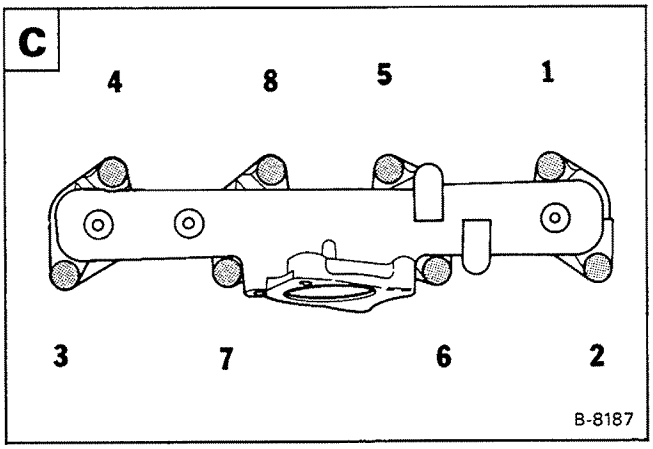
The standard distrotion is 0.002" (0,05 mm) and the maximum limit is 0.008" (0,20 mm).

When the head distrotion exceeds the maximum limit, regrind the head with a maximum limit of 0.012" (0,30 mm).



Exhaust Manifold

If the exhaust manifold has been removed, use the correct torque sequence and tighten the bolts to 10-17 ft.-lbs. (14-23 Nm) torque [C].



VALVES

Removal and Installation

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

MEL-1266 — Valve Stem Seal Installer

Mark the valves and parts so they are returned to their original position when assembling.

Remove the valve spring locks [A], using a spring compressor [B].

Remove the valve springs, spring seats, oil seal and valve [A].

Before reassembly, check the valves, valve seats and guides.

Installation: Make sure the head is clean.

Put oil on the valve guides and valve stems.

Put each valve in the correct location.

Install the valve springs, spring seats and oil seals [A].

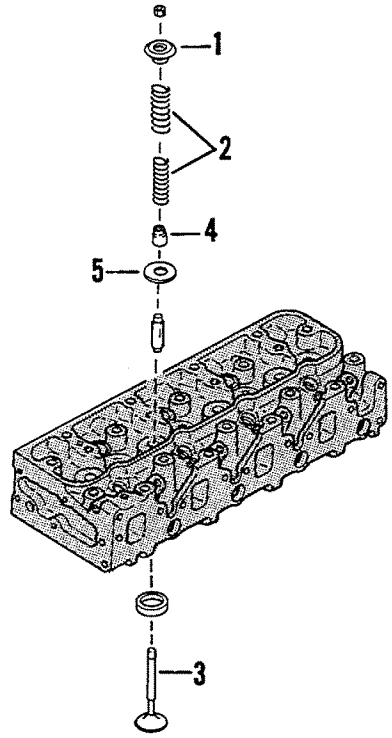
NOTE: Install the valve springs with their closed pitched (painted side) end toward the cylinder head.

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

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

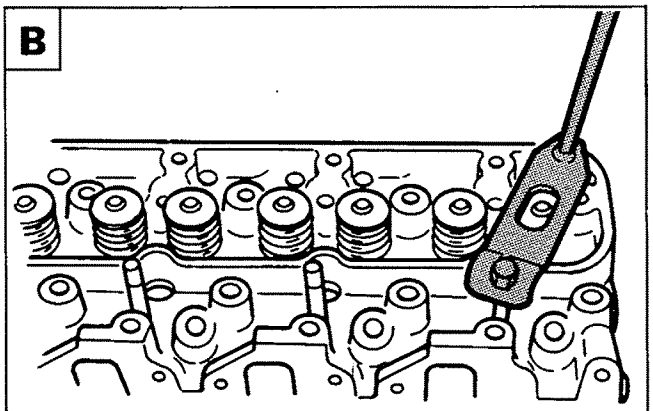
A

1. Spring Seat
2. Springs
3. Valve
4. Oil Seal
5. Spring Seat



B-8192

B



B-8193

Reconditioning the Valve and Valve Seats

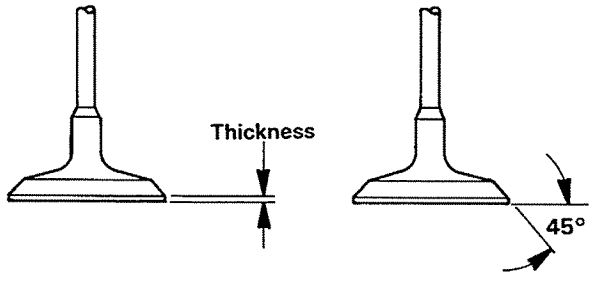
Use the correct equipment to grind the valve and valve seats.

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

The valve head thickness is as listed [C]:

Standard — 0.071" (1,8 mm)
Limit — 0.059" (1,5 mm)

C



B-8202

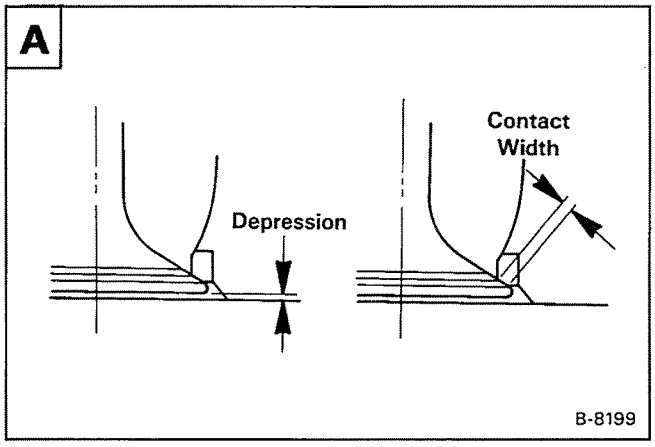
VALVES (Cont'd)

Check the valve head depth in the cylinder head after grinding the valves and seat. The correct specifications are as follows [A]:

Intake -	Standard	0.029" (0,73 mm)
	Limit	0.05" (1,28 mm)
Exhaust -	Standard	0.028" (0,70 mm)
	Limit	0.047" (1,20 mm)

Check the valve seat contact width [A]:

Intake -	Standard	0.067" (1,70 mm)
	Limit	0.087" (2,20 mm)
Exhaust -	Standard	0.079" (2,0 m)
	Limit	0.098" (2,5 mm)

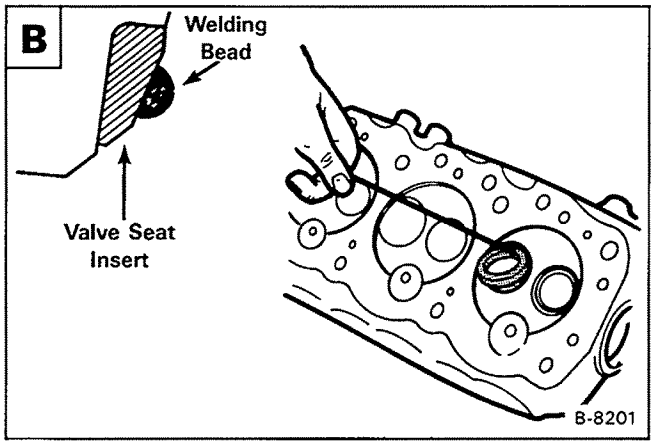


Valve Seat Insert

To remove the valve seat insert, put a bead of weld around the inner face of the insert and allow to cool a few minutes, then pry them out [B].

Press the new valve seat insert into the bore using a hydraulic press.

After installation, grind the insert to the correct angle and check the depth of the valve.



Valve Guides

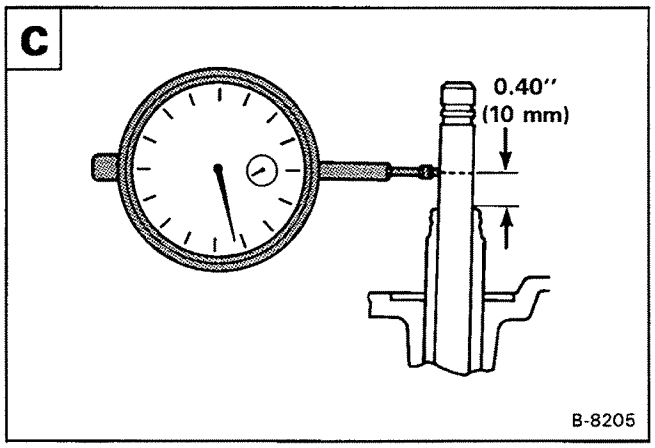
The tools listed will be needed to do the following procedure:

MEL-1259 — Valve Guide Remover

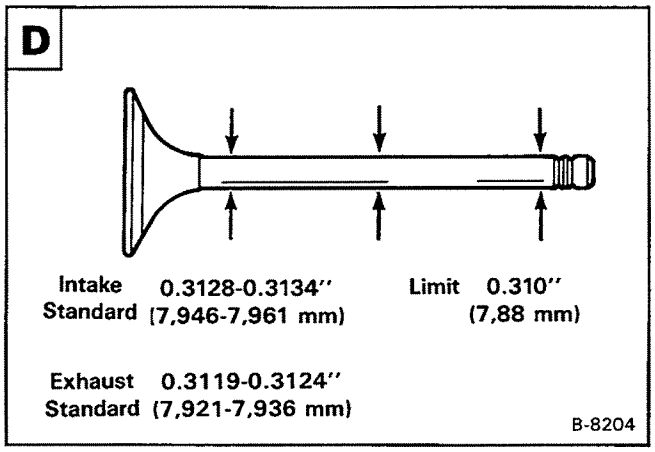
Check the valve guides for wear with a dial indicator [C].

If the movement is more than the listed specifications, replace the guide.

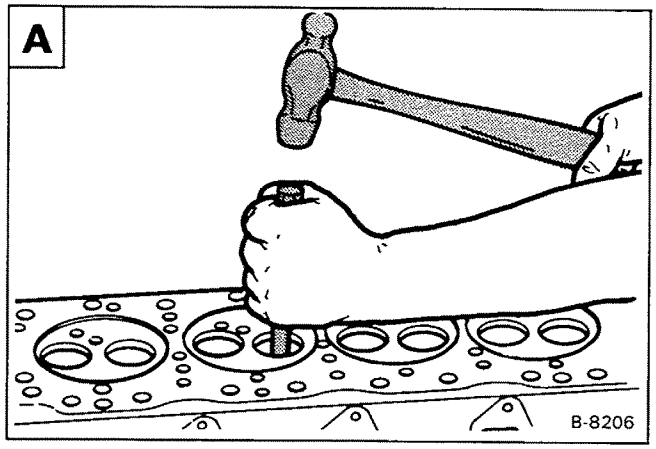
Intake -	Standard	0.0015-0.0027" (0,039-0,068 mm)
	Limit	0.008" (0,2 mm)
Exhaust -	Standard	0.0025-0.0038" (0,064-0,96 mm)
	Limit	0.010" (0,25 mm)



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

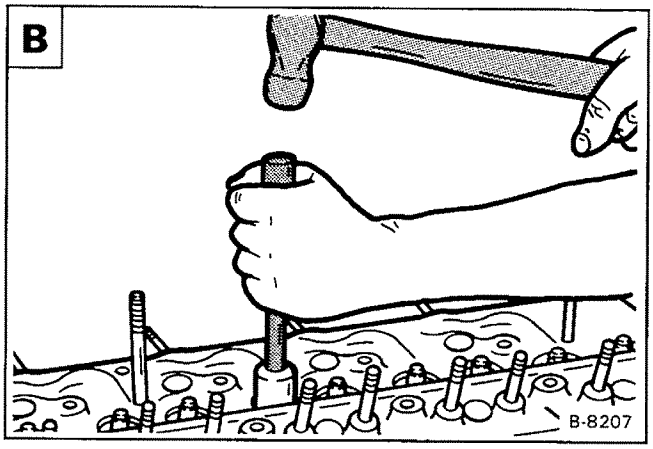


Remove the guide [A].



Install the new guide [B].

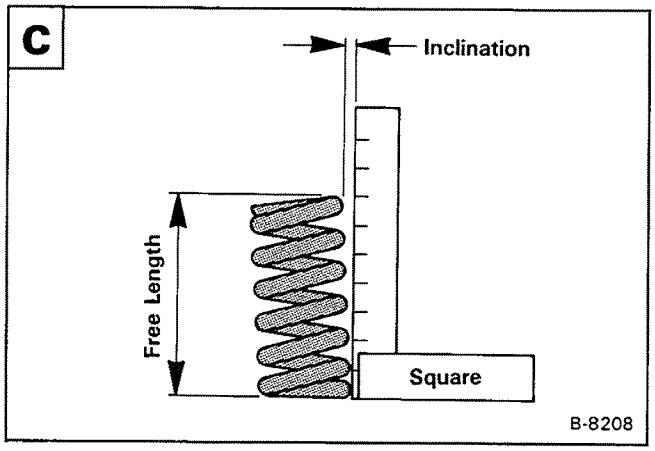
The height of the valve guide top edge to the cylinder is 0.51" (13 mm).



Valve Springs

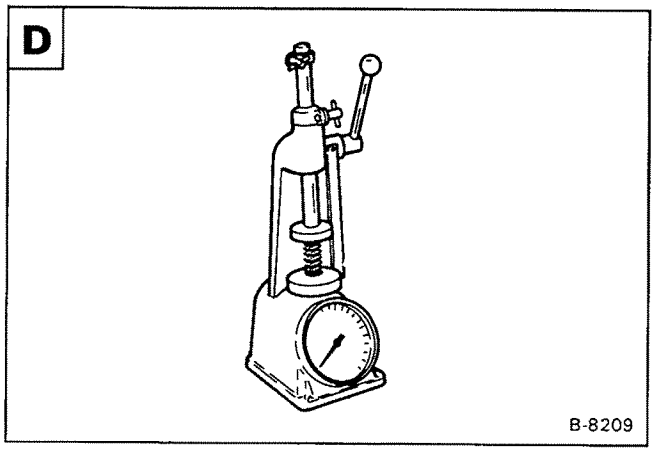
Check the free length and inclination [C].

		Std.	Limit
Free Length	Inner	1.783" (45,3 mm)	1.748" (44,4 mm)
	Outer	1.957" (49,7 mm)	1.898" (48,2 mm)
Inclination	Inner	- - -	0.118" (3,0 mm)
	Outer	- - -	0.126" (3,2 mm)



Check the valve spring tension [D].

	Set Length	Std.	Limit
Inner	1.46" (37 mm)	13 lbs. (5,9 kg)	11 lbs. (5,02 kg)
Outer	1.54" (39,0 mm)	46 lbs. (20,9 kg)	40 lbs. (18,1 kg)



ROCKER ARMS

Disassembly and Assembly

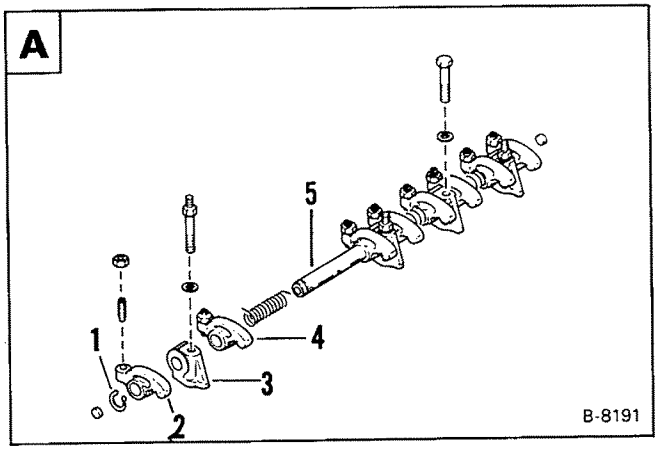
Mark the rocker arms and support brackets for correct assembly.

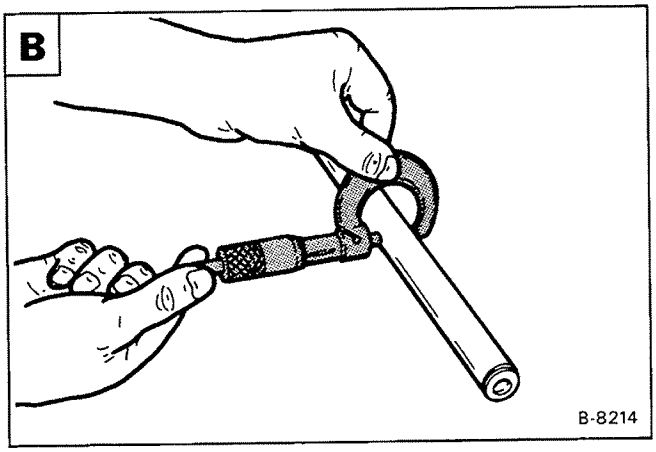
Remove the snap ring (Item 1) from each end of the shaft (Item 5) [A].

Remove the rocker arms (Items 2 & 4) and support brackets (Item 3) [A].

Assembly: The support bracket with the oil hole is toward the front of the engine.

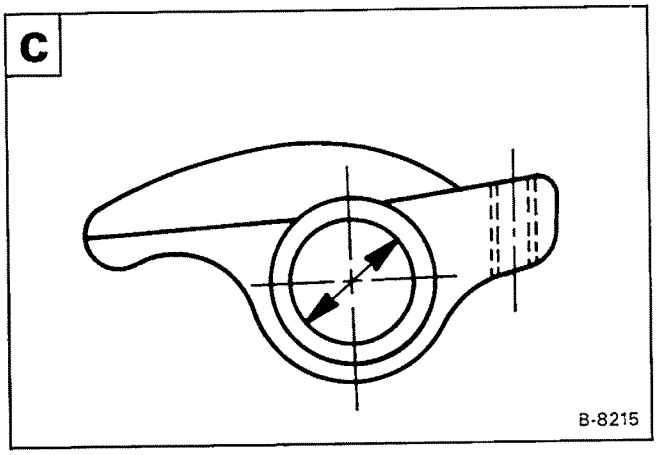
Inspect all the parts for wear or damage.





Standard — 0.7478-0.7486" (18,98-19 mm)
Limit — 0.7427" (18,85 mm)

Check the rocker arm [C].



Rocker arm diameter.

Standard — 0.7489-0.7497" (19,01-19,03 mm)
Limit — 0.7505" (19,05 mm)

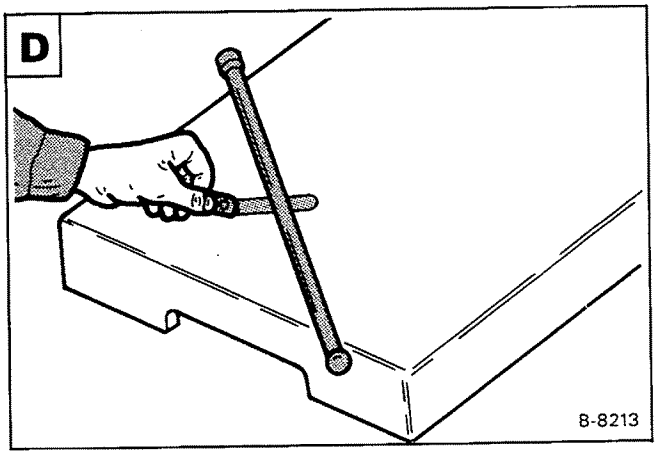
Clearance between rocker arm and shaft.

Standard - 0.0003-0.002" (0,01-0,05 mm)
Limit - 0.0078" (0,2 mm)

Replace the parts as needed.

Push Rods

Check the push rods for run-out [D].



Limit — 0.012" (0,3 mm)

PISTON AND CONNECTING ROD

Removal

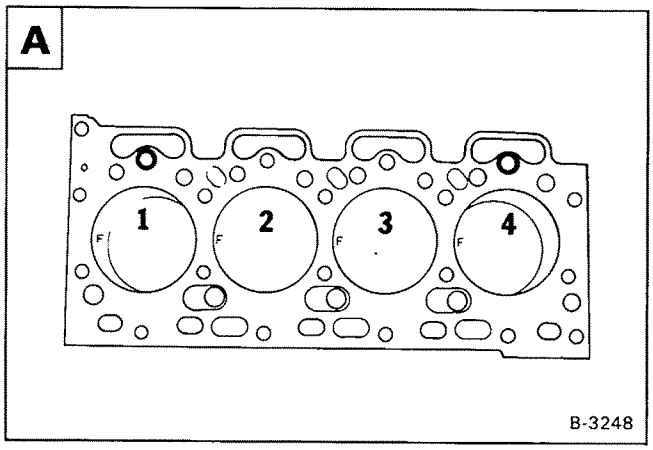
Remove the cylinder head (See Page 7C—29).

Remove the oil pan (See Page 7C—59).

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

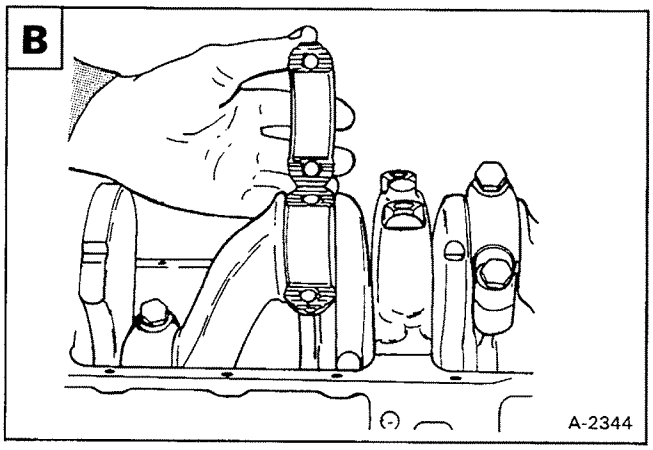
Make sure the pistons have identification marks [A].

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



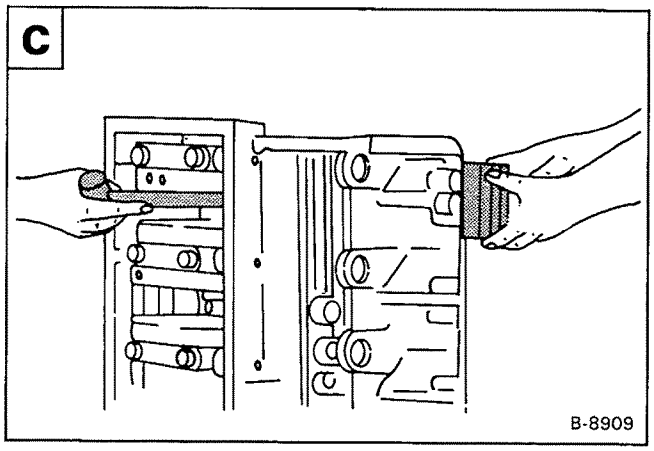
Remove the nuts and remove the bearing caps [B].

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



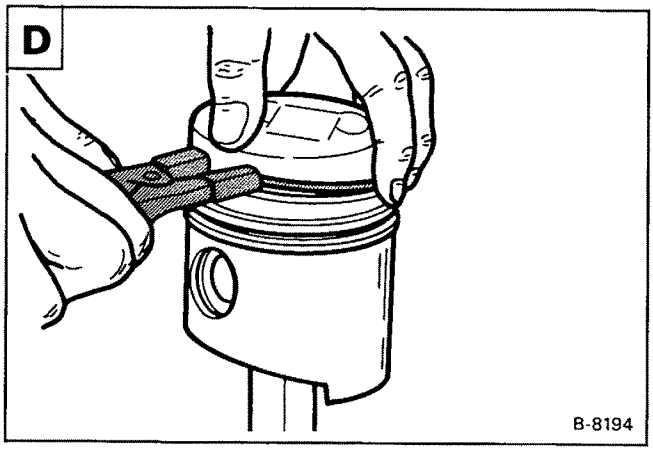
Using a hammer handle, push the piston and rod out of the block [C].

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

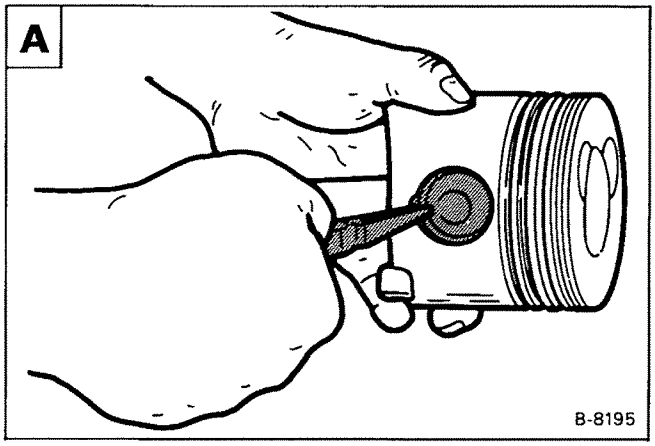


Disassembly

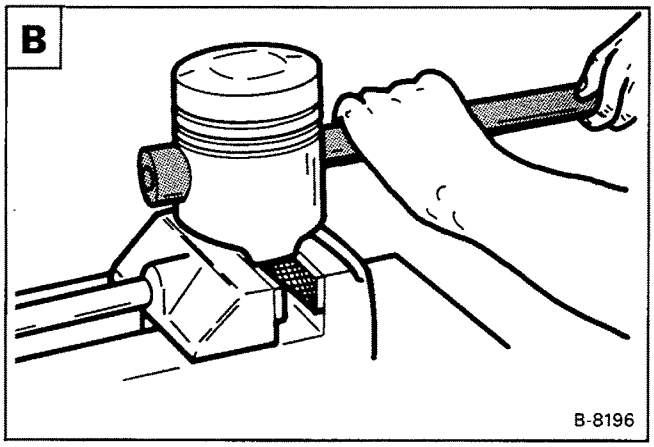
Remove the rings from the pistons [D].



Remove the piston pin snap ring [A].



Drive out the piston pin using a brass rod [B].

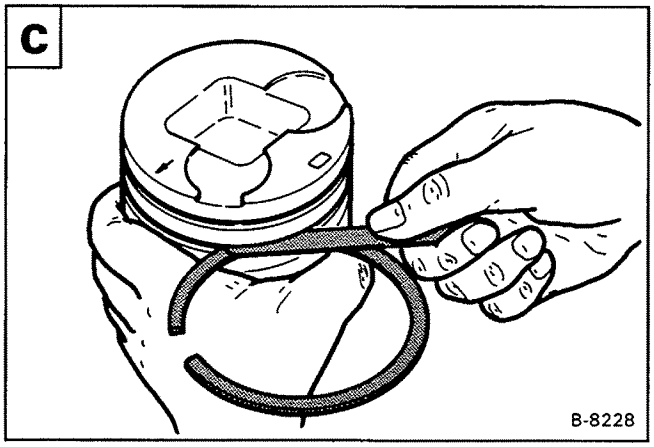


Inspection

Clean all the parts in clean solvent.

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

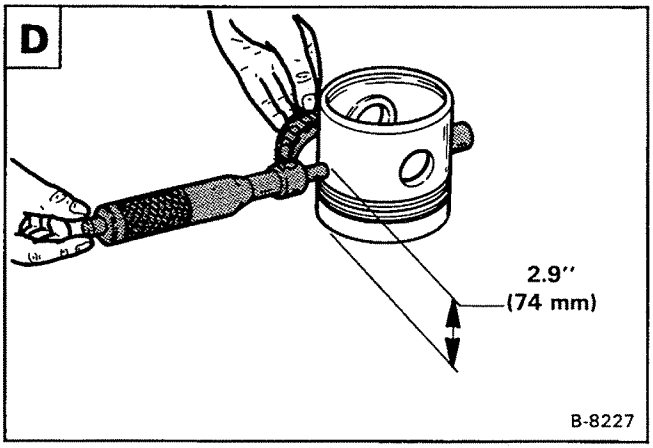
	Standard	Limit
1st Compression	0.0035-0.0049" (0,09-0,125 mm)	0.006" (0,15 mm)
2nd Compression	0.002-0.0033" (0,05-0,085 mm)	0.006" (0,15 mm)
Oil	0.001-0.003" (0,03-0,07 mm)	0.006" (0,15 mm)



Check the piston diameter [D].

Pistons are available in two sizes.

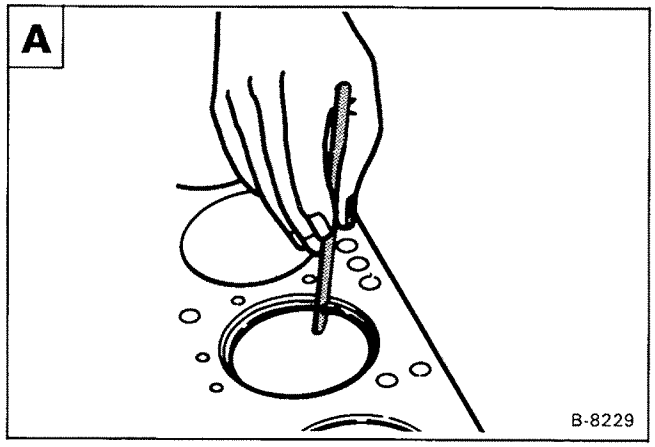
Piston Grade A	3.6608-3.6616" (92,985-93,004 mm)
Piston Grade C	3.6616-3.6624" (93,005-93,024 mm)



PISTON AND CONNECTING ROD (Cont'd)

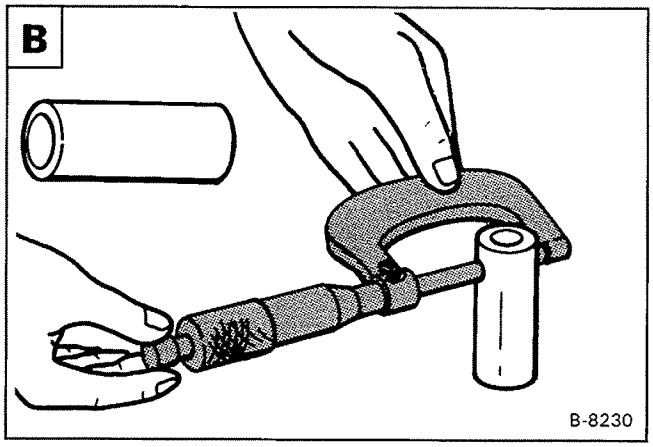
Check the ring gap in the cylinder bore [A].

	Standard	Limit
Compression	0.008-.016" (0,2-0,4 mm)	0.059" (1,5 mm)
Oil	0.004-0.012" (0,1-0,3 mm)	0.059" (1,5 mm)



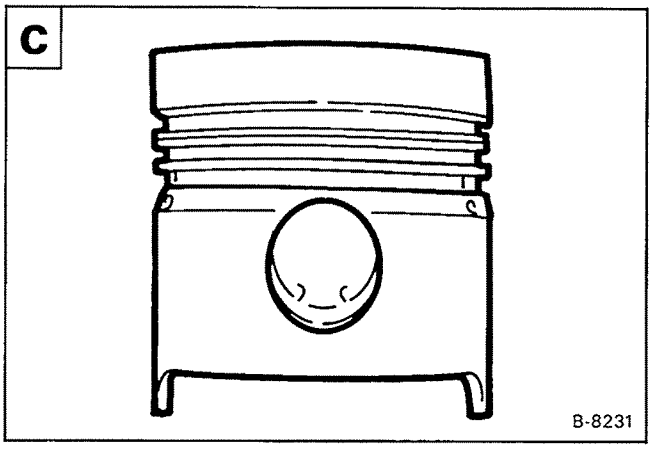
Check the piston pin diameter [B].

Standard —1.220" (31 mm)
Limit — 1.219" (30,97 mm)



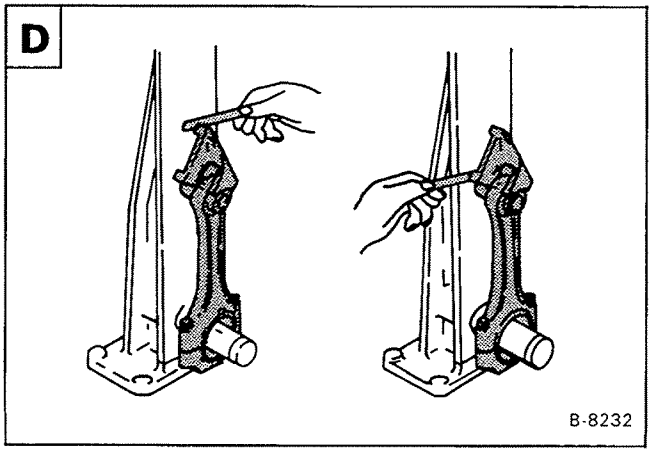
Check the clearance between piston pin and piston pin bore [C]

Clearance — 0.00008-0.0006"
(0,002-0,015 mm)



Check the connecting rod alignment [D].

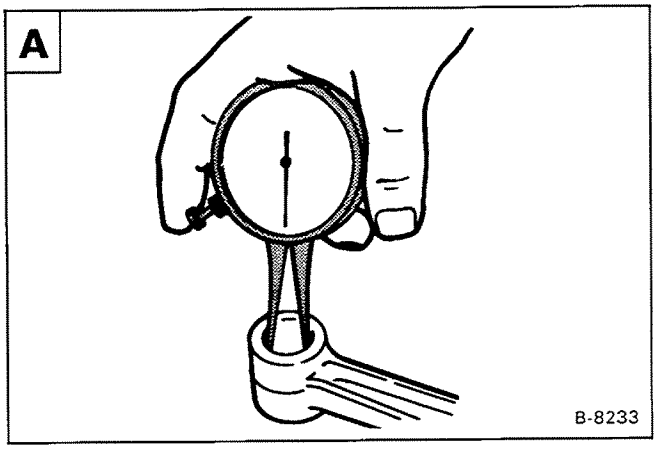
Standard — 0.002" (0,5 mm) or less
Limit — 0.0079" (0,2 mm)



PISTON AND CONNECTING ROD (Cont'd)

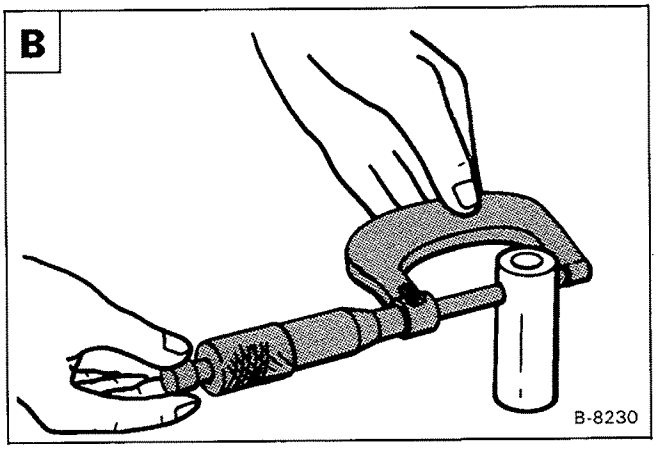
Check the connecting rod small end bushing [A].

Standard — 1.2208-1.2211" (31,008-31,015 mm)

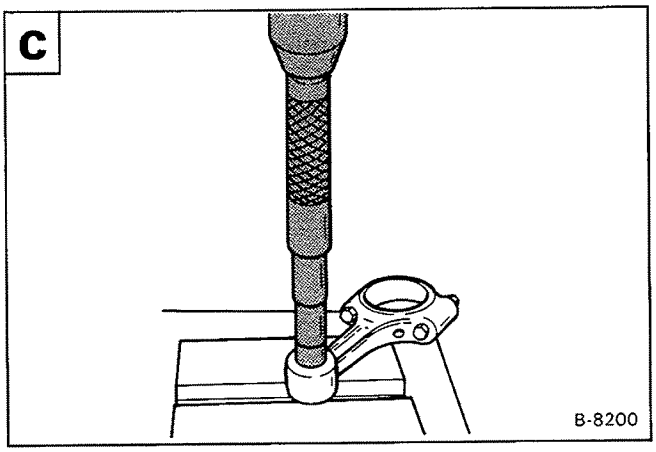


Check the clearance between the piston pin and connecting rod [B].

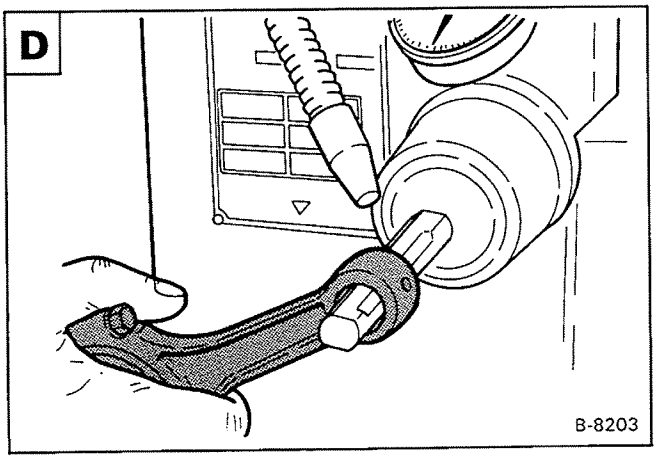
Standard — 0.0003-0.00079" (0,008-0,02 mm)
Limit — 0.0002" (0,5 mm)



Replace the small end bushing if not within specifications using a hydraulic press [C].



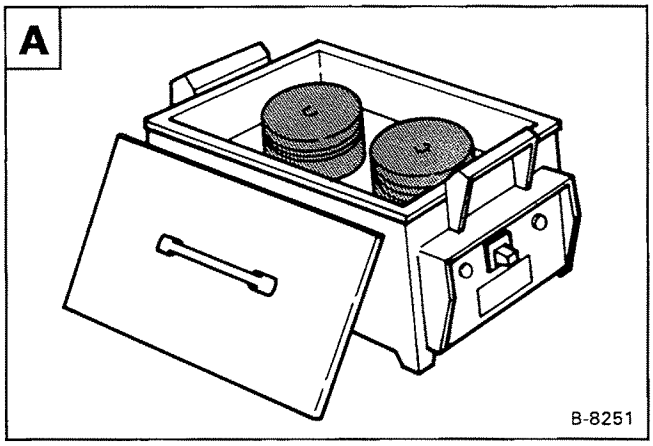
After installation of a new bushing, finish the bushing bore to the correct specifications [D].



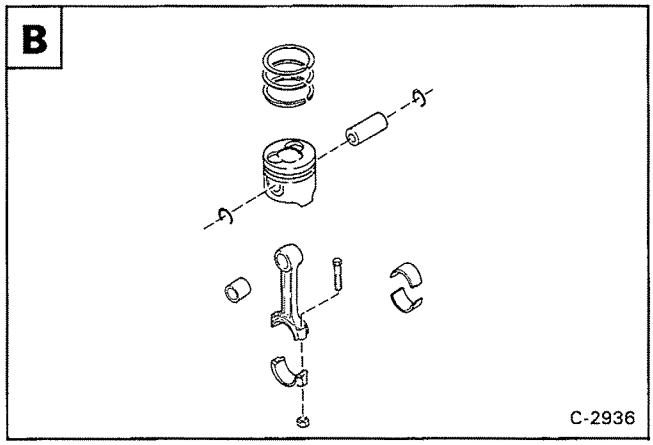
PISTON AND CONNECTING ROD (Cont'd)

Assembly

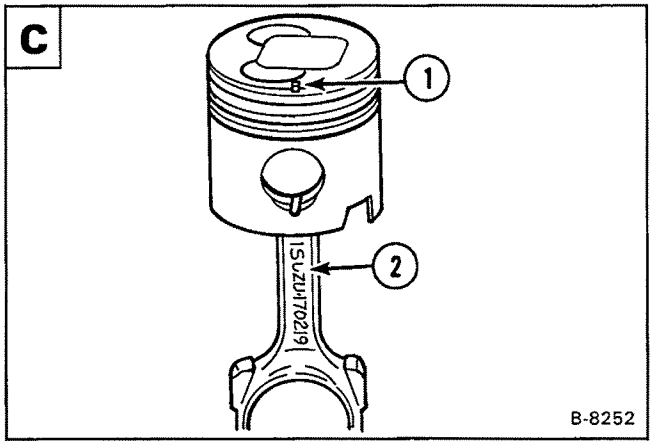
Heat the piston to about 140°F (60°C) [A].



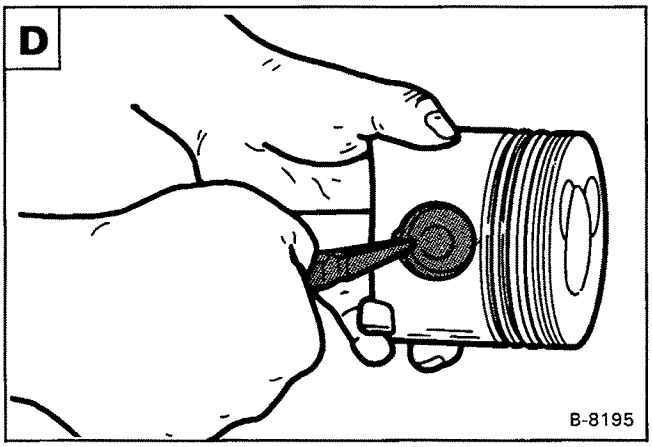
Assemble the piston and connecting rod [B].

* 

Install the piston to the connecting rod. The piston head front mark (Item 1) and the connecting rod "ISUZU" casting mark (Item 2) must be facing the same direction [C].

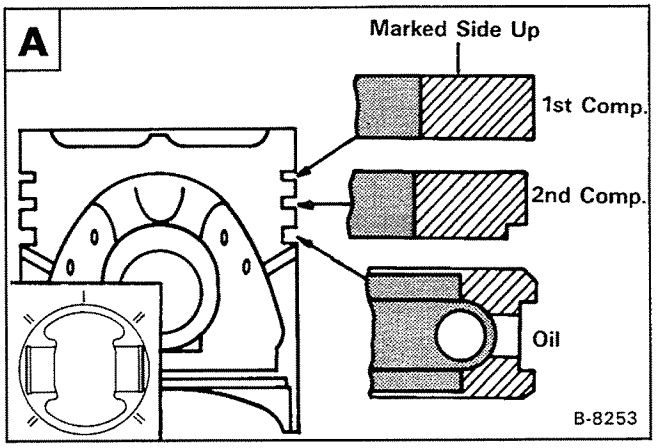
* 

Install the piston pin. Install the snap rings [D].

* 

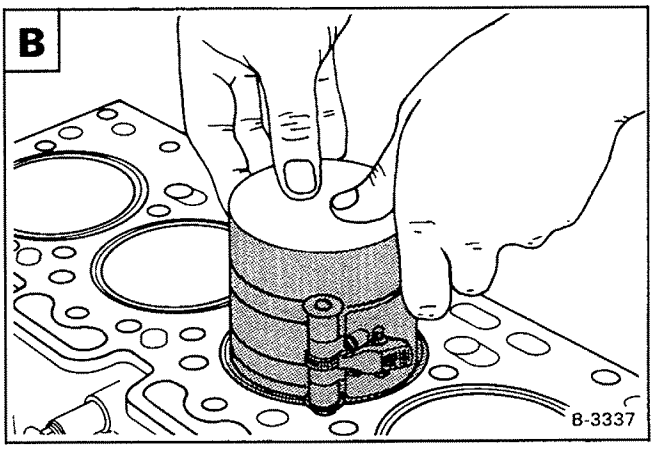
Install the rings on the piston [A].

The face with the mark "NPR" or "TOP" must be turned up for the 1st and 2nd compression rings.

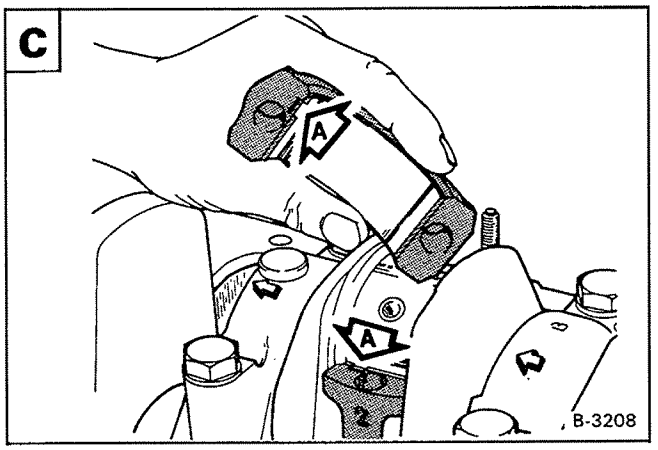
* 

Installation

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

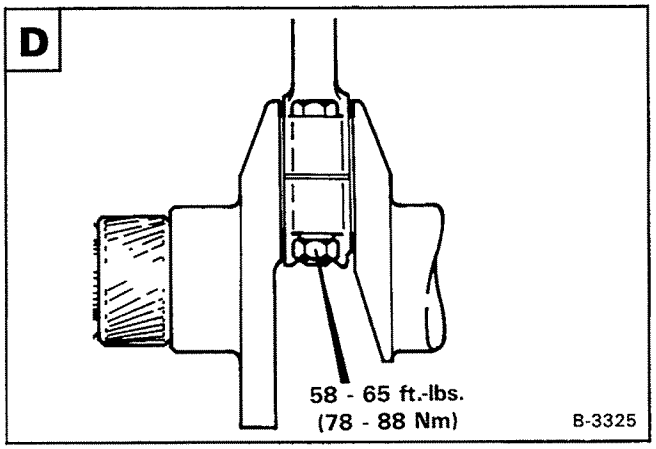
* 

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

* 

Tighten the nuts to 58-65 ft.-lbs. (78-88 Nm) torque [D].

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

* 

CYLINDER LINERS

Checking

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

MEL-1180 — Puller Set
MEL-1261 — Cylinder Liner Remover Ankle

Check the cylinder bore with an inside micrometer. The checks must be made at parrallel and right angles to the center line of the bore [A].

Measuring point is done approximately 0.75" (20 mm) below the top of the cylinder bore.

Standard — 3.6622-3.6638" (93,021-93,060 mm)
Limit — 3.6653" (93,100 mm)

Removal

Remove all the parts from the engine.

Using a cylinder liner tool, remove the cylinder liner from the engine block [B].

There is only one size liner available.

Installation

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

MEL-1262 — Cylinder Liner Installer

Clean the bore and remove any metal burrs.

Clean the grease from the cylinder liner and dry it.

Use dry ice to cool the cylinder liner, so it will install easier and smoothly into the engine block.

Using the correct tool, install the cylinder liner [C].

First apply a load of 1103 lbs. (500 kg) using a hydraulic press.

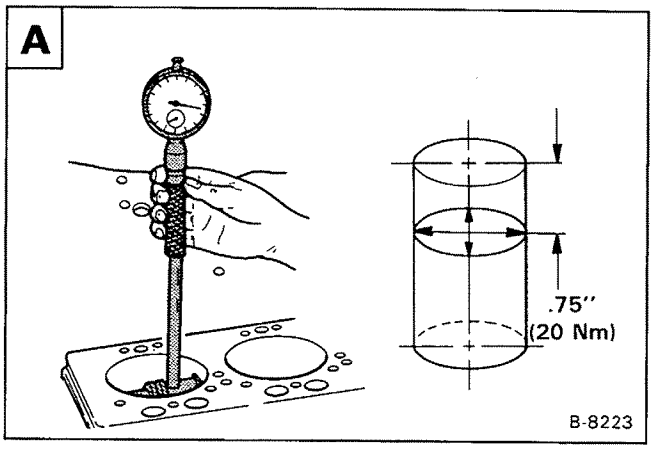
NOTE: Do Not use a hammer to install the cylinder liners.

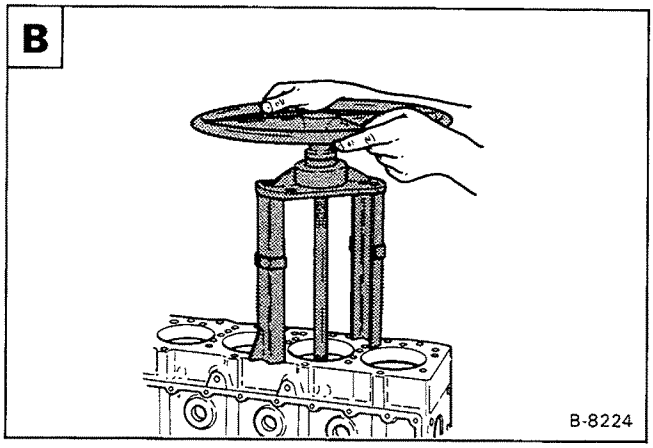
Then, apply a final load of 5513 lbs. (2500 kg). Push the liner in until 0 - 0.0039" (0 - 0,1 mm) of the liner is above the block face [D].

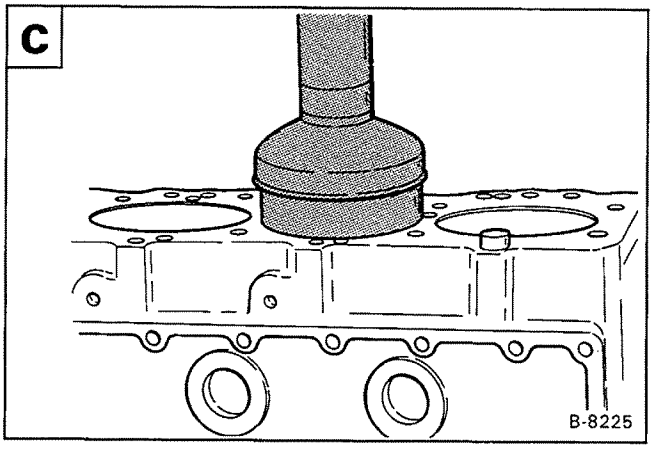
NOTE: Liners are chrome plated and must not be honed after installation.

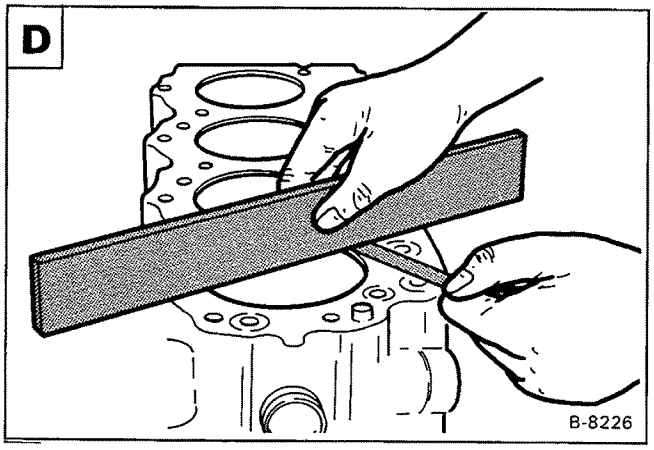
Measure the inside diameter of the liner and select the correct size piston for the liner.

	Minimum Diameter
Piston Grade A	3.6622-3.6630" (93,021-93,040 mm)
Piston Grade C	3.6630-3.6638" (93,041-93,060 mm)







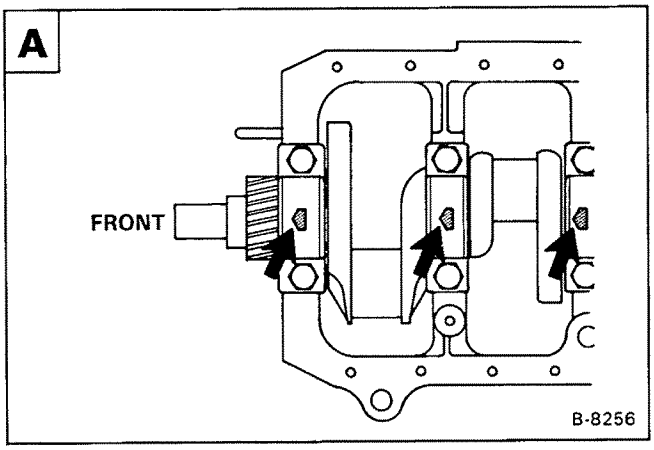


MAIN BEARINGS

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

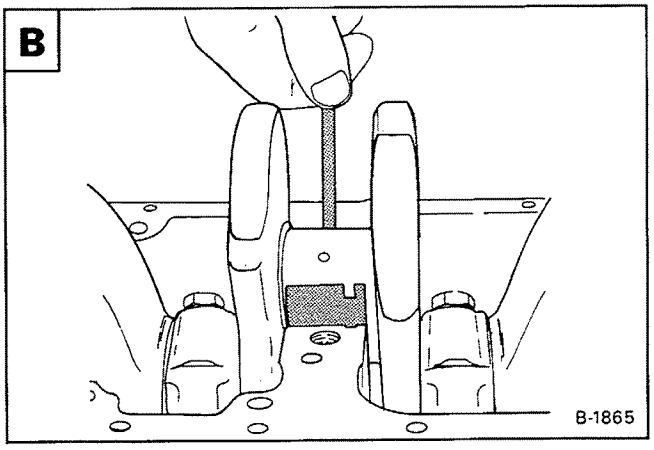
Remove the oil pan (See Page 7C—59).

Remove the oil pump (See Page 7C—60).

Remove the bolts from the main bearing caps.

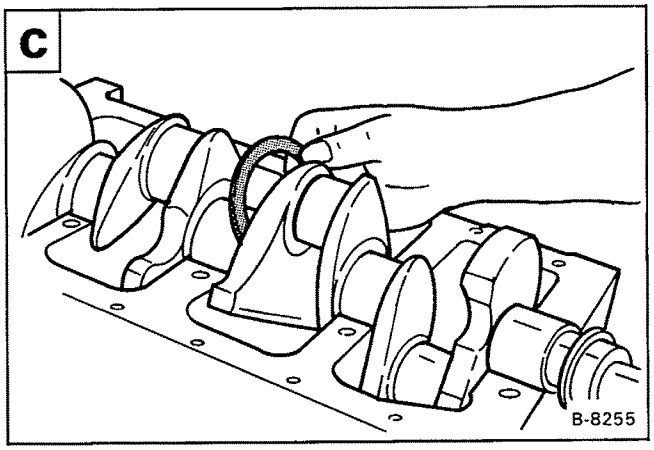
Remove th main bearing cap and remove the bearing from the cap half.

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



On the center main bearing, remove the cap.

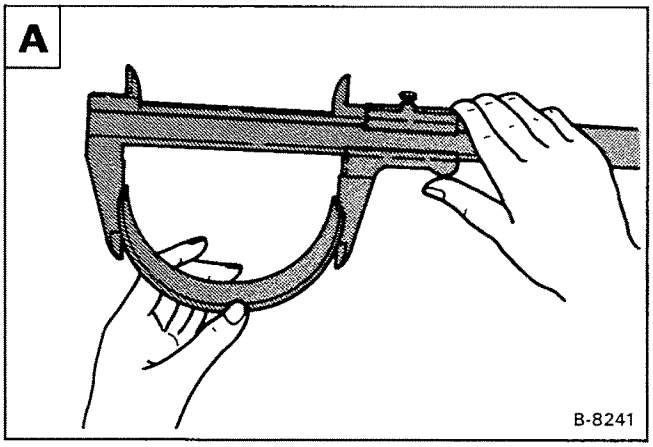
Remove the top half of the bearing and thrust washers by pushing on one side of the bearing and rotating the crankshaft.



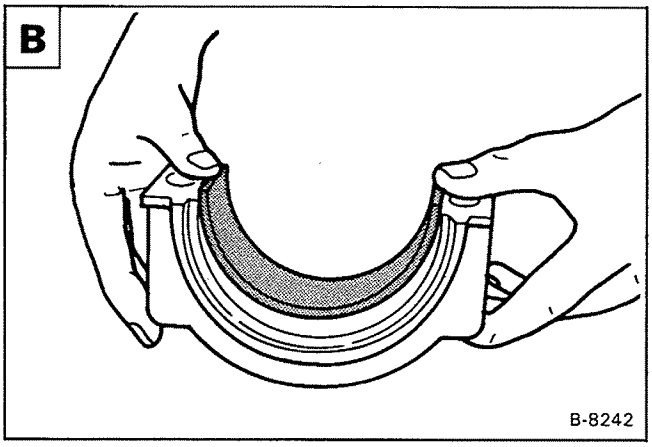
MAIN BEARING (Cont'd)

Check the bearing spread as listed [A].

Limit — 2.93'' (74,5 mm)



Check to see if the bearing has enough tension, so that finger pressure is needed to fit the bearing into the cap [B].



Installation

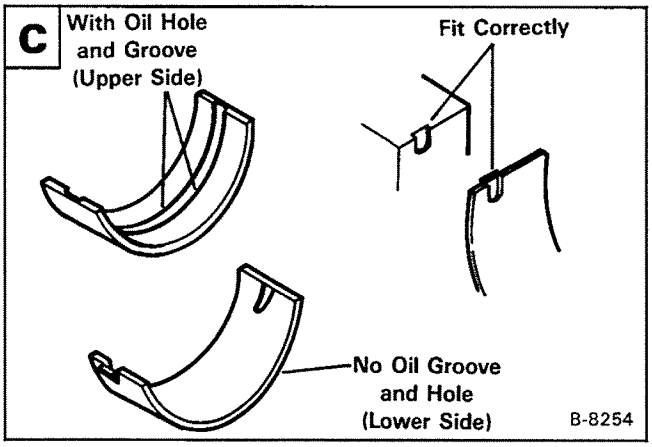
Check the crankshaft journals before installing the main bearings (See Page 7C—45).

Make sure to position the bearing halves in their correct locations [C].

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 bearing cap. Lubricate the bearing and install the cap on the engine block.

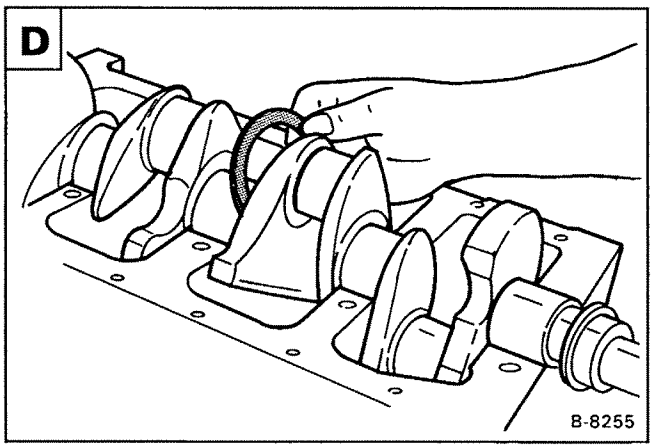
Lubricate the bolts, install them finger tight only.



Install the center main bearing and thrust washers [D].

The thrust washer must be installed so that their oil grooves are turned to the rotating face of the crankshaft.

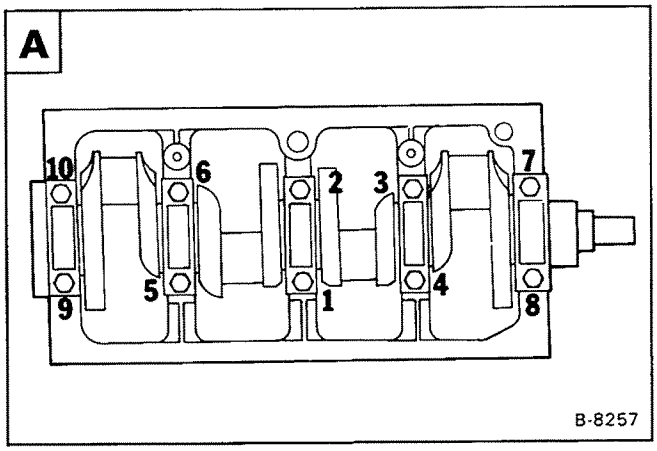
Repeat the procedure until all the main bearings and caps are installed.



MAIN BEARING (Cont'd)

Tighten the crankshaft bearing cap bolts in the correct sequence [A].

Torque — 116-130 ft.-lbs. (157-176 Nm).

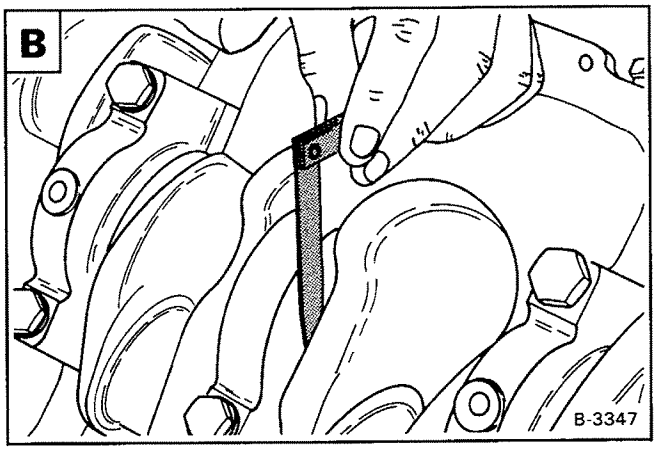


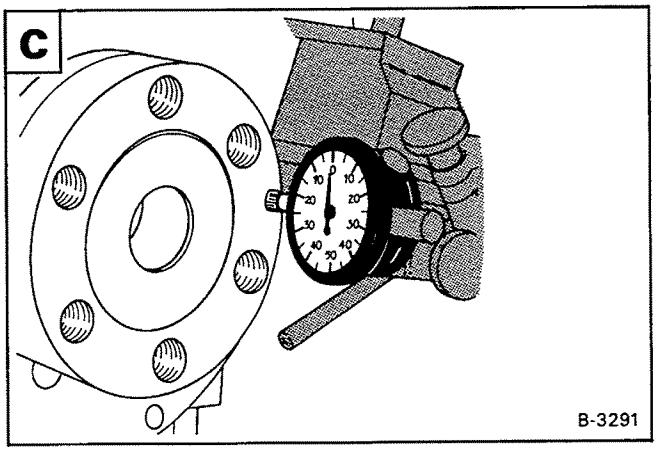
Crankshaft End Play

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

	Std.	Limit
End Play	0.004" (0,1 mm)	0.012" (0,3 mm)

The fitting of oversize thrust washer can be used to correct the end play if it is over the specifications.





CRANKSHAFT

Removal

Remove the oil pan (See Page 7C—59).

Remove the oil pump (See Page 7C—60).

Remove the crankshaft pulley, timing case cover and timing gears (See Page 7C—49).

Remove the flywheel.

Remove the connecting rod cap (See Page 7C—35).

Remove the main bearing cap (See Page 7C—42).

Lift the crankshaft out of the engine block.

Checking Tuffriding (Soft Nitriding) Coating

Clean the crankshaft thoroughly using an organic solvent. Make sure there is no oil or grease in the area to be tested.

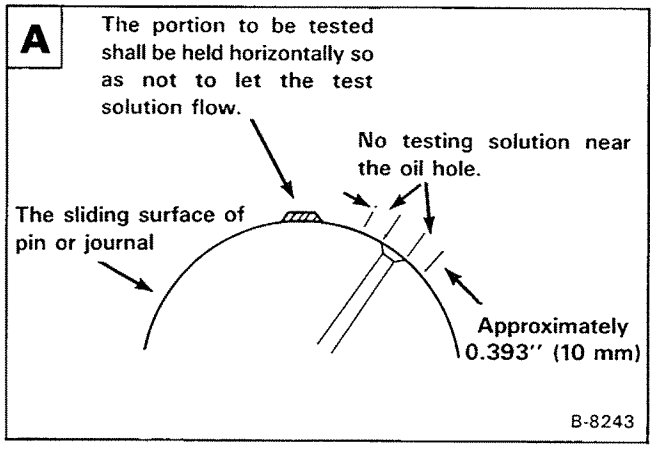
Using a glass rod, put a drop of cupric ammonium chloride 5/10% solution at the test location [A].

If no change takes place after an interval of 30-40 seconds, the crankshaft can be re-used if within specifications.

Replace the crankshaft, if within the 30-40 seconds, the original color of the solution (light blue in color) becomes transparent where the test solution was dropped and will dis-color to a copper color.

Immediatley after the test is completed, wipe off the area with a cloth and thoroughly rinse with water.

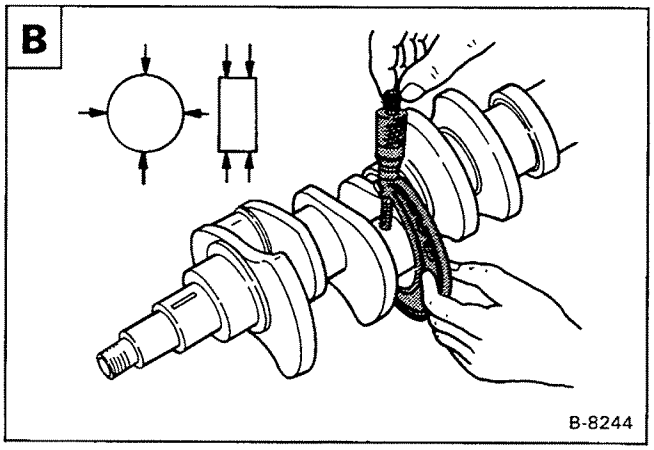
NOTE: Since the crankshaft is tuffride coated it cannot be re-ground.



Checking

Check the crankshaft connecting rod journals [B].

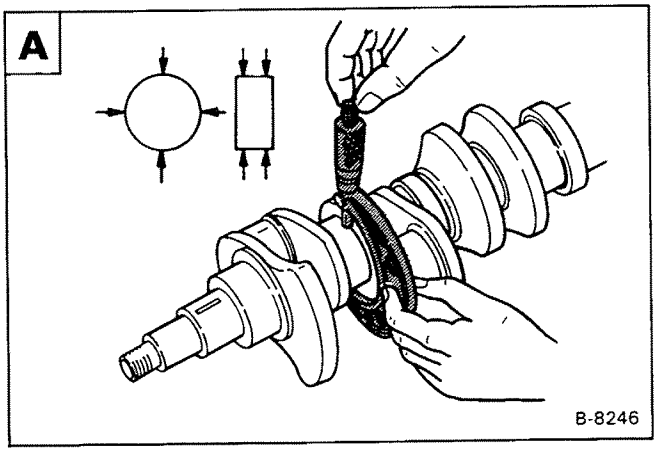
Standard — 2.0833-2.0839" (52,915-52,930 mm)
Limit — 2.0829" (52,906 mm)



CRANKSHAFT (Cont'd)

Check the crankshaft main bearing journals [A].

Standard — 2.7526-2.7532" (69,917-69,932 mm)
Limit — 2.7524" (69,910)



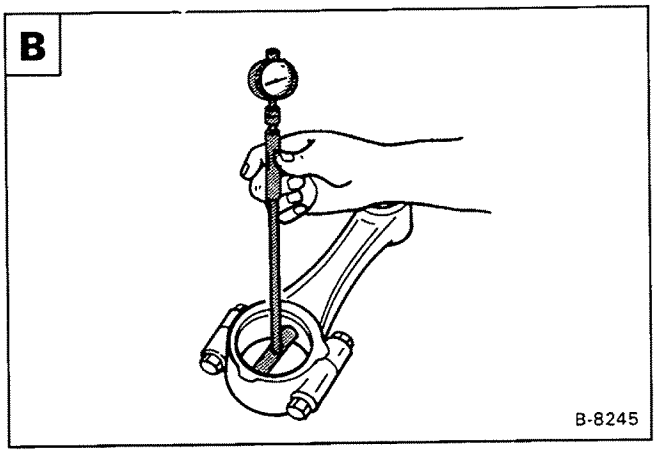
Check the clearance between connecting rod bearing and crankshaft journal [B].

Install the bearing and cap and tighten nuts to 58-65 ft.-lbs. (79-88 Nm) torque. Put oil on the bearing and measure.

Nominal Diameter — 2.09" (53 mm)

Clearance between journal and bearing:

Standard — 0.0011-0.0026" (0,029-0,066 mm)
Limit — 0.004" (0,10 mm)



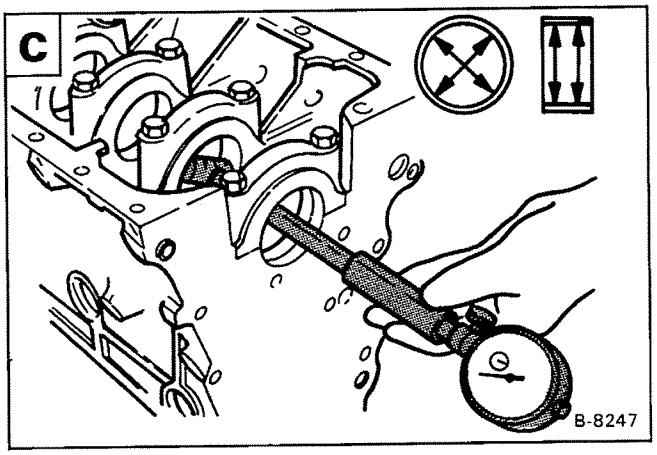
Check the clearance between main bearings and crankshaft journals [C].

Install the main bearing and caps and tighten the bolts to 116-130 ft.-lbs. (157-176 Nm) torque. Put oil on the main bearings and measure:

Nominal Diameter — 2.76" (70 mm)

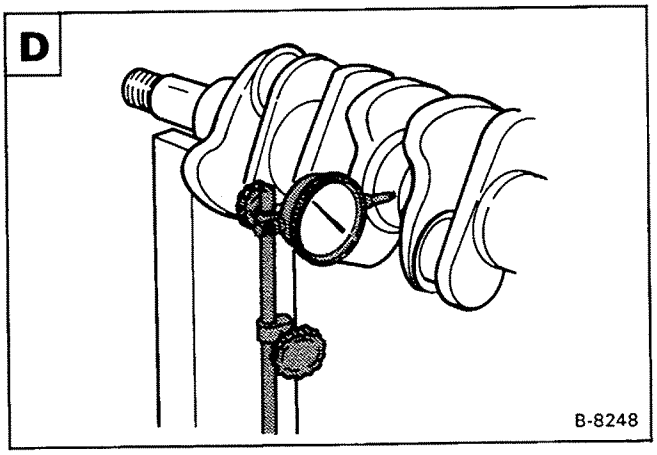
Clearance between the journal and bearing:

Standard — 0.0014-0.0031" (0,035-0,080 mm)
Limit — 0.0043" (0,11 mm)



Check the crankshaft run-out [D].

Standard — 0.0019 (0,05 mm) or less
Limit — 0.003" (0,08 mm)



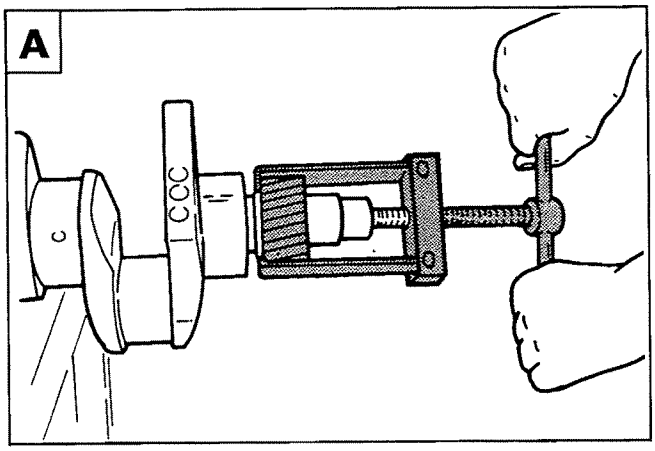
Crankshaft Gear

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

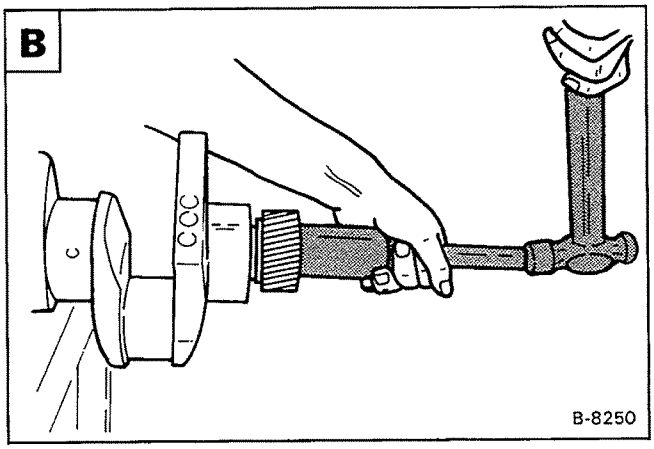
MEL-1263 – Crankshaft Gear Installer
MEL-1264 – Crankshaft Rear Oil Seal

Removal and Installation

Use a puller to remove the gear [A].



Use the correct size driver tool to install the gear [B].



Installation

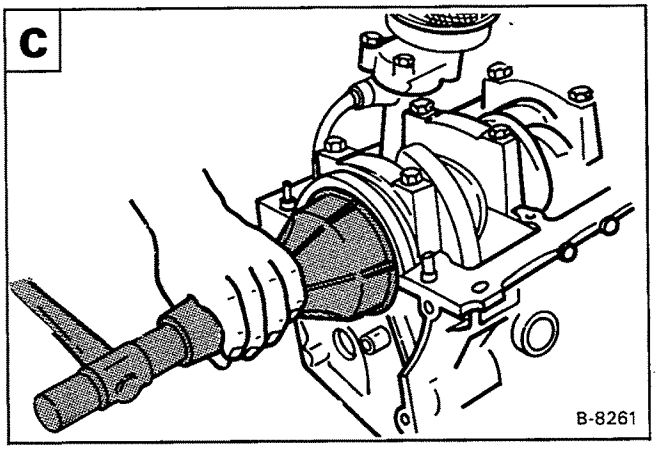
Clean the crankshaft and check that all the oil passages are clean and open.

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

Put the crankshaft carefully in position.

Install the main bearing caps and bolts (See Page 7C–42).

Check the crankshaft so that it rotates freely. Check the end play (See Page 7C–44).



Install a new rear oil seal [C]. Using the correct size driver tool.

Lubricate the connecting rod bearings. Install the bearings and rod caps (See Page 7C–35).

Install the oil pump (See Page 7C–60).

Install the oil pan (See Page 7C–59).

Install the timing gears, timing case cover and new front seal (See Page 7C–49).

Install the flywheel (See Page 7C-26).

TIMING CASE COVER SEAL

Removal and Installation

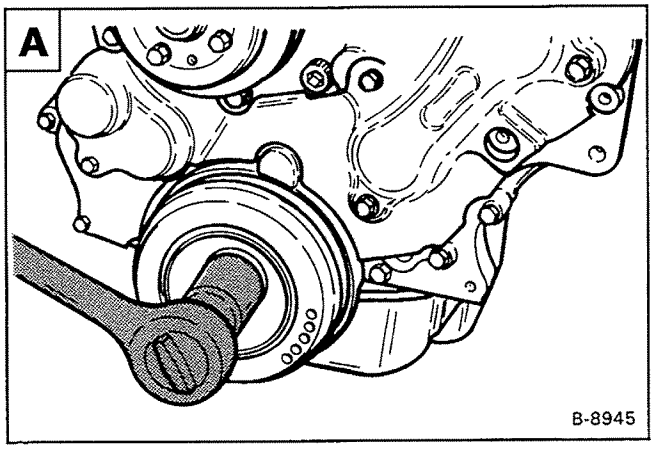
The tools listed will be needed to do the following procedure:

MEL-1265 — Crankshaft Front Oil Seal Installer

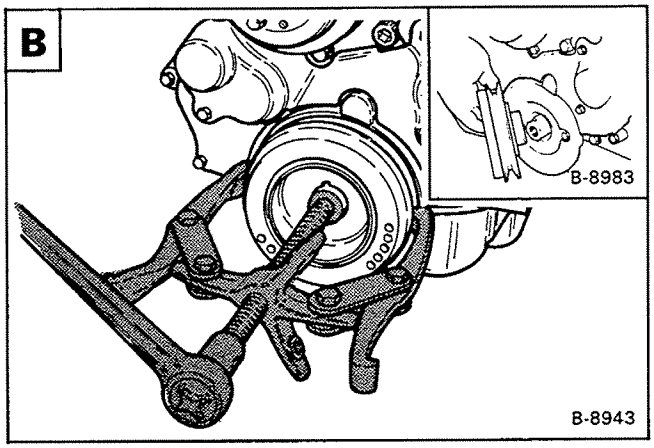
Remove the alternator and belt (See Page 6—8 for the correct procedure).

Remove the bolt at the crankshaft pulley [A].

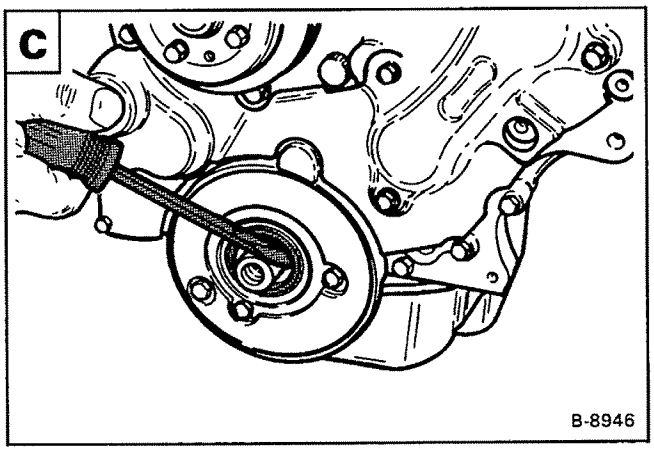
Installation: Tighten the bolt to 123-152 ft.-lbs. (167-206 Nm) torque.



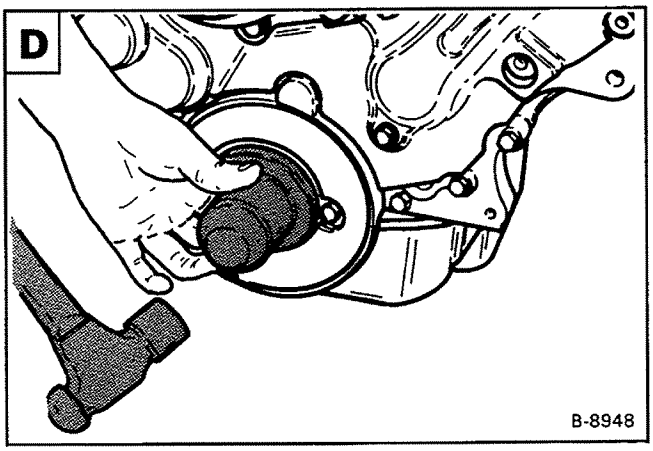
Install a standard puller and remove the crankshaft pulley [B].



Use a screwdriver and pry the front seal out of the timing case cover [C].



Use the seal installation tool and install the new seal [D].



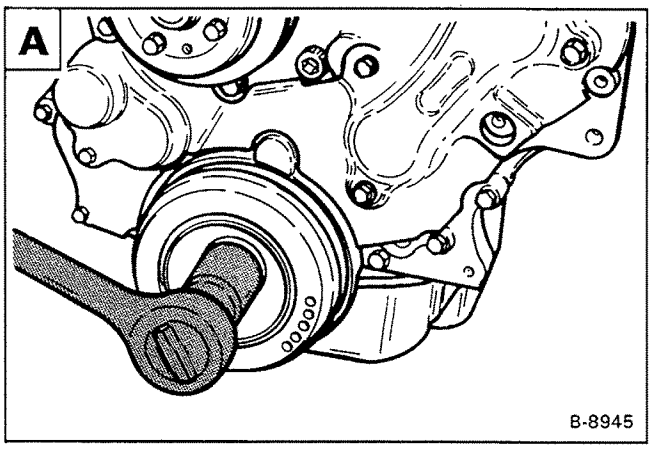
TIMING CASE COVER

Removal and Installation

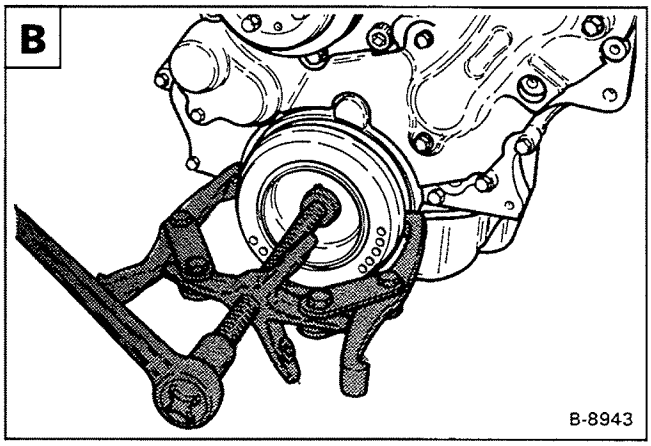
Remove the alternator and belt (See Page 6—6 for the correct procedure).

Remove the bolt at the crankshaft pulley [A].

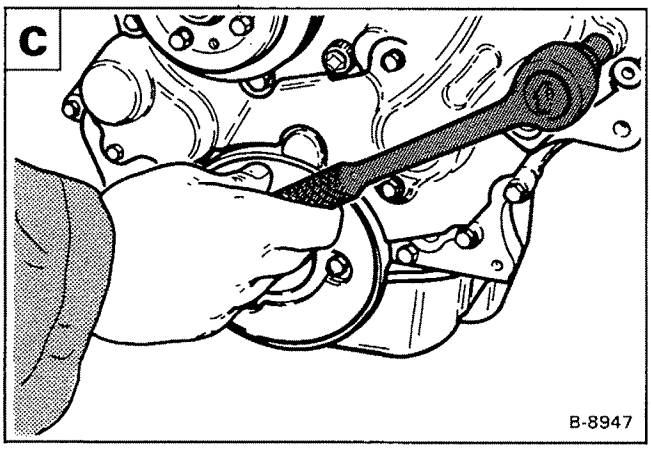
Installation: Tighten the bolt to 123-152 ft.-lbs. (167-206 Nm) torque.



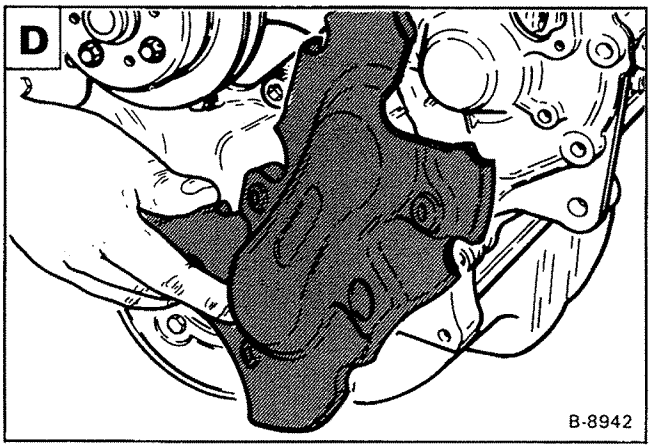
Use a puller to remove the crankshaft pulley [B].



Remove the bolts which fasten the noise dampening shield to the timing case cover [C].



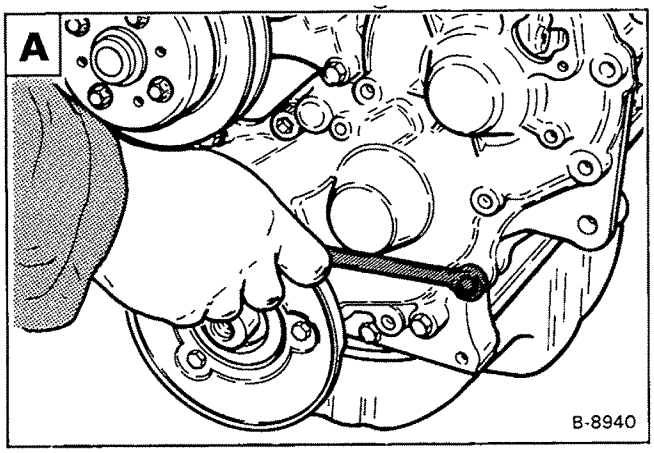
Remove the noise dampening shield [D].



TIMING CASE COVER (Cont'd)

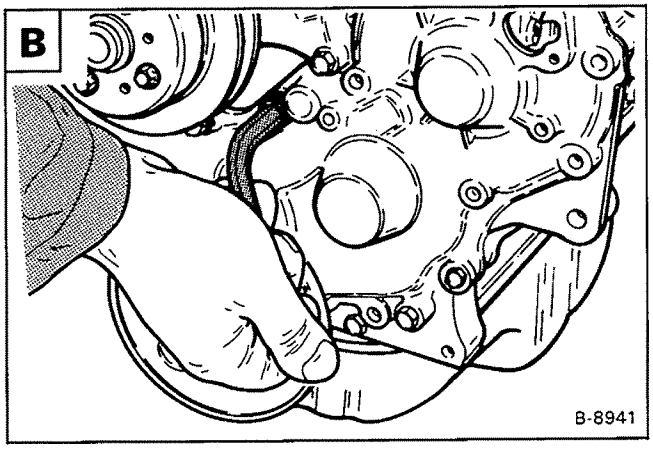
Remove the bolts from the timing case cover [A].

Installation: Tighten the bolts to 10 ft.-lbs. (14 Nm) torque.

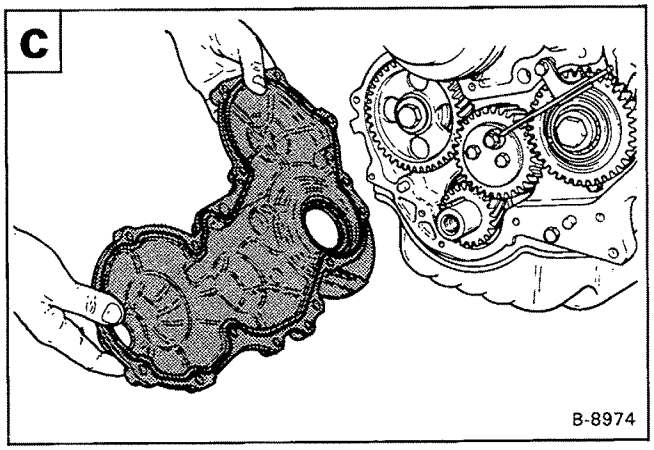


Use a Allen wrench to remove the allen head bolt from the cover [B].

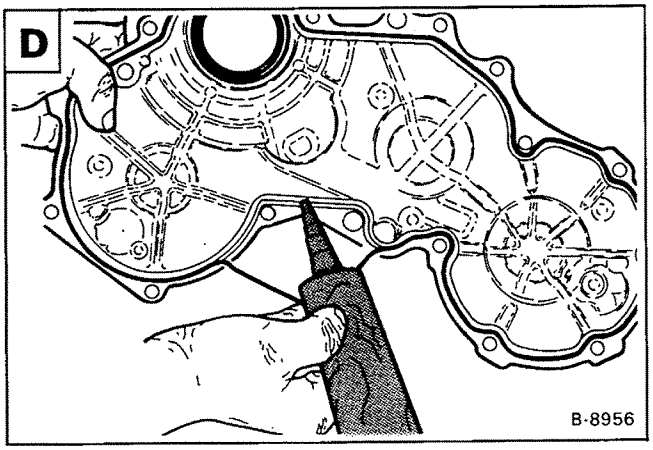
Installation: Tighten the bolt to 11-17 ft.-lbs. (15-23 Nm) torque.



Remove the timing case cover [C].



Installation: Put the O-ring gasket in the groove and hold it in position using Form-A-Gasket so it will not fall out when installing the cover [D].

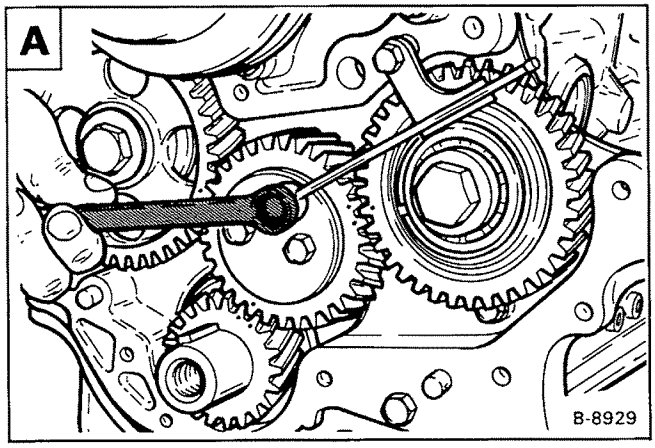


IDLER GEAR AND HUB

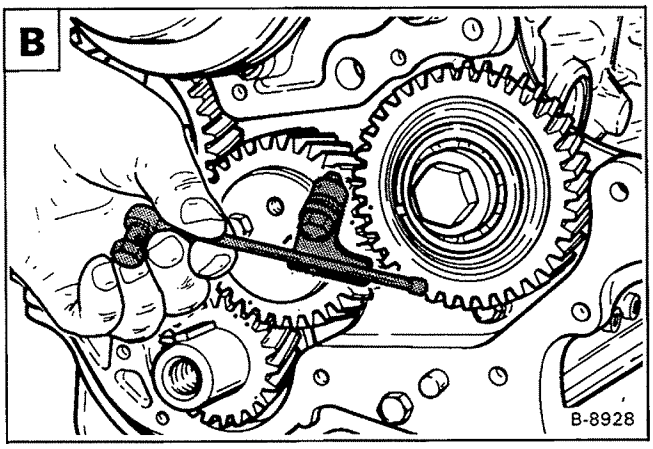
Removal and Installation

Remove the timing case cover (See Page 7C—49).

Remove the bolts at the tube for gear lubrication [A].

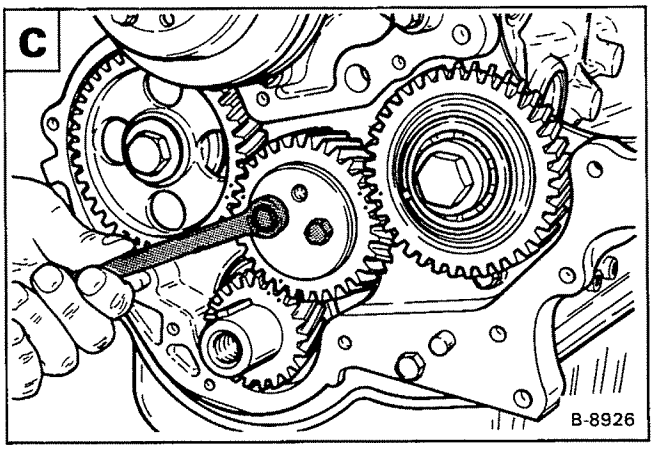


Remove the tube [B].



Remove the bolts at the idler gear [C].

Installation: Tighten the bolts to 10 - 12 ft.-lbs. (14 - 16 Nm) torque.



Remove the idler gear and hub [D].

Checking

Check the idler gear hub:

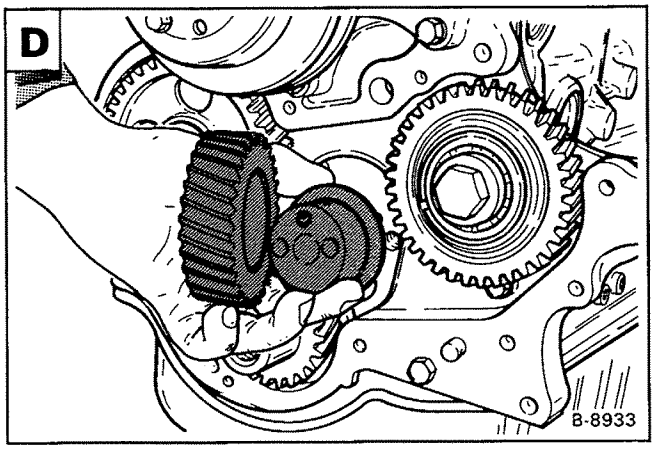
Standard — 1.7695-1.7707" (44,945-44,975 mm)
Limit — 1.7656" (44,845 mm)

Check the clearance between the idler gear and hub:

Limit — 0.0079" (0,2 mm)

Check the end play at the gear and hub:

Standard — 0.003" (0,07 mm)
Limit — 0.008" (0,2 mm)

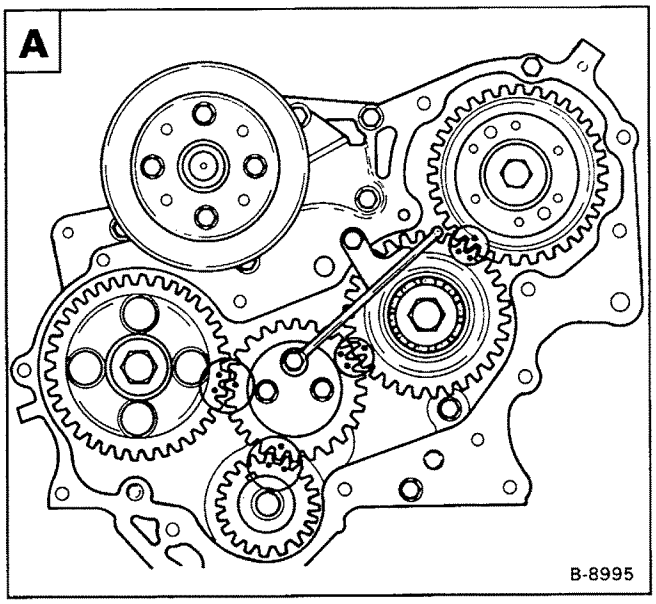


IDLER GEAR AND HUB (Cont'd)

Installation: Install the idler gear on the hub.

Make sure the timing marks are in alignment with the crankshaft, camshaft and fuel injection pump idler gears [A].

Check the backlash between the gears, the correct backlash is 0.003'' (0,178 mm).



FUEL INJECTION PUMP IDLER GEAR

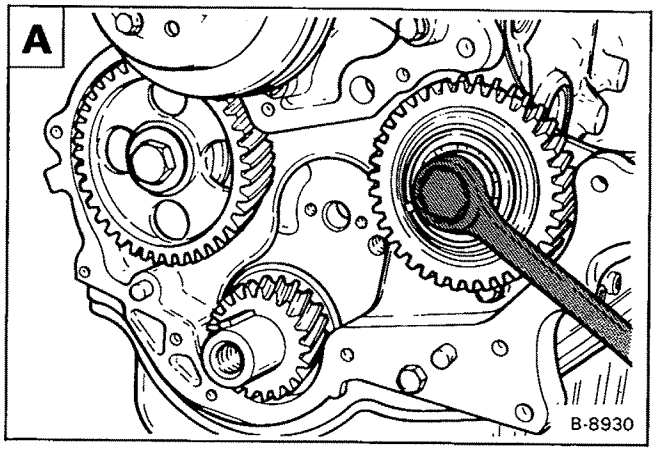
Removal and Installation

Remove the timing case cover (See Page 7C—49).

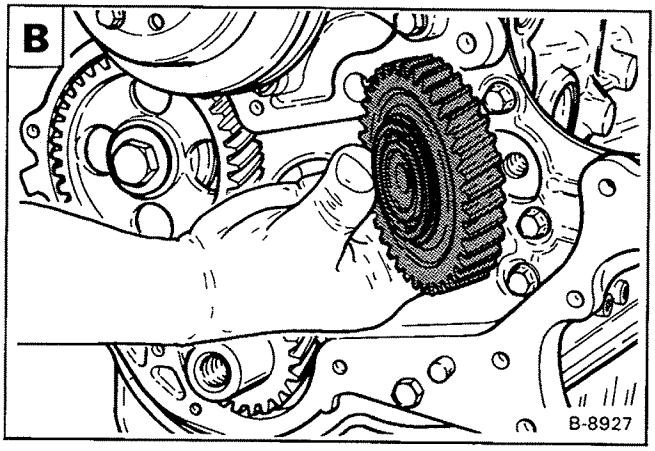
Remove the idler gear (See Page 7C—51).

Remove the bolt at the fuel injection pump idler gear [A].

Installation: Tighten the bolt to 72-87 ft.-lbs. (98-118 Nm) torque.

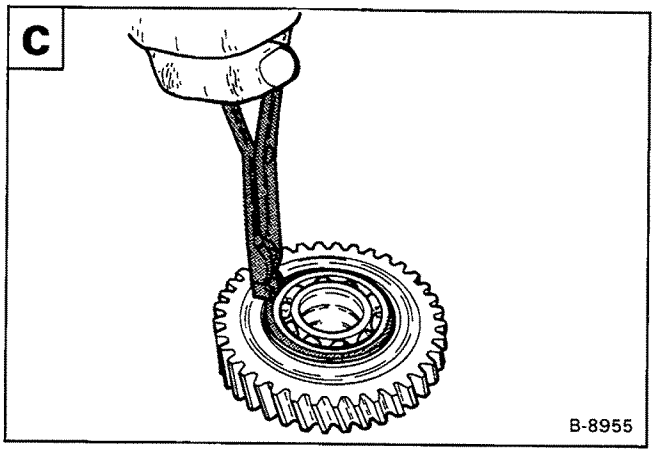


Remove the idler gear and bearing [B].



If the bearing needs replacement, remove the snap ring at the bearing [C].

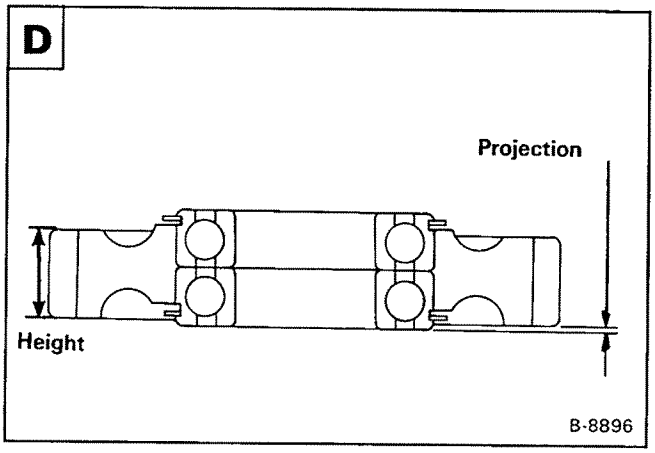
Use a press to remove and install the new bearing.



Bearing Installation

When installing the new bearing, make sure the projection and height is correct [D].

Projection — 0.016-0.024" (0,4-0,6 mm)
Height — 0.933-0.945" (23,7-24 mm)



CAMSHAFT GEAR

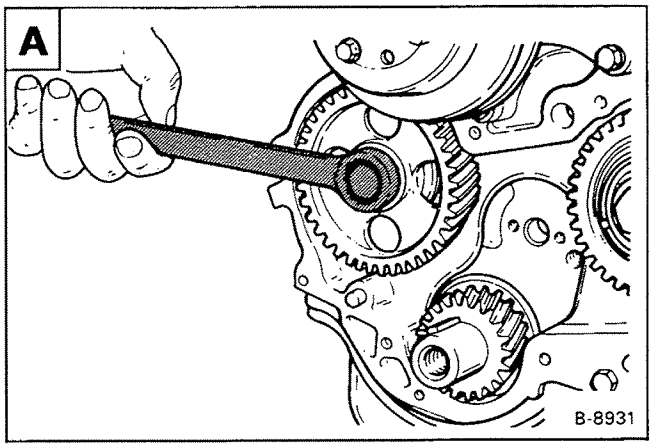
Removal and Installation

Remove the timing case cover (See Page 7C—49).

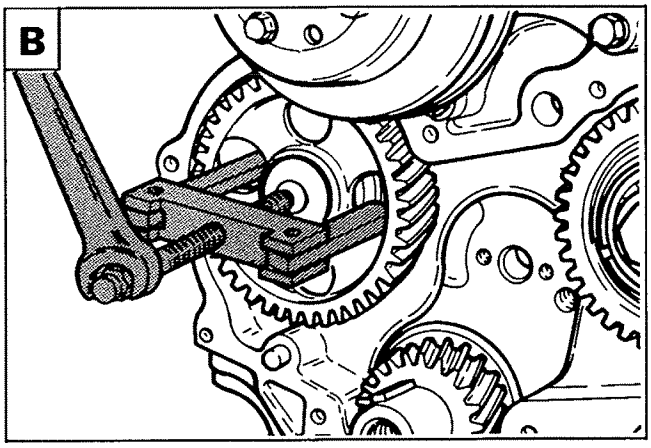
Remove the idler gear (See Page 7C—51).

Remove the bolt at the camshaft gear [A].

Installation: Tighten the bolt to 72-87 ft.-lbs. (98-118 Nm) torque.

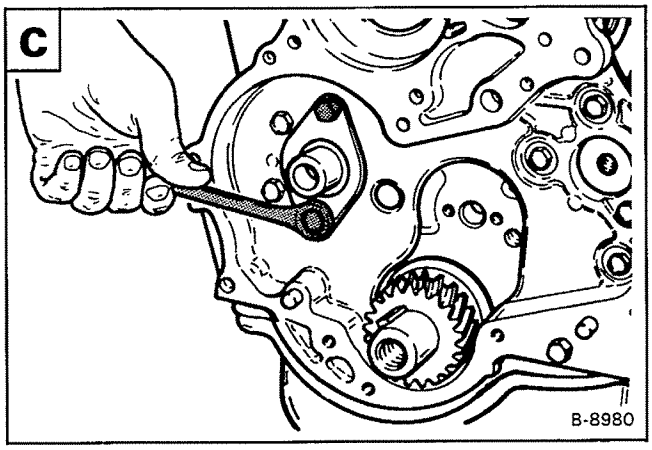


Install the puller and remove the gear [B].



Remove the bolts at the retainer plate [C].

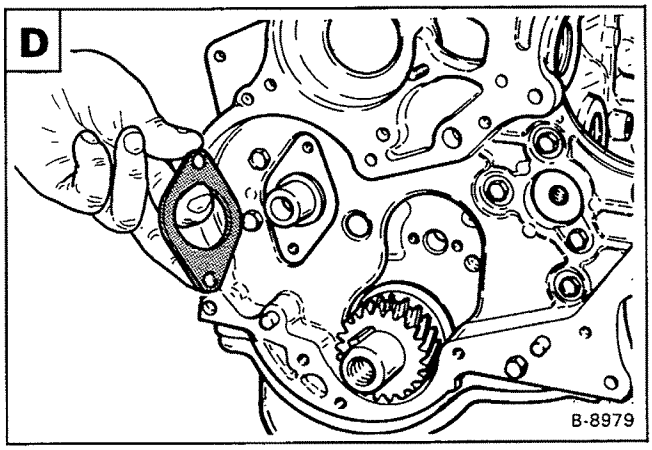
Installation: Tighten the bolts to 11 - 17 ft.-lbs. (15 - 23 Nm) torque.



Remove the retainer plate [D].

Installation: Check the camshaft end play.

Standard — 0.002-0.0045" (0,05-0,114 mm)
Limit — 0.0079 (0,2 mm)



TIMING CASE

Removal and Installation

Remove the timing case cover (See Page 7C—49).

Remove the idler gear (See Page 7C—51).

Remove the fuel injection pump (See Page 7C—6).

Remove the fuel injection pump idler gear (See Page 7C—53).

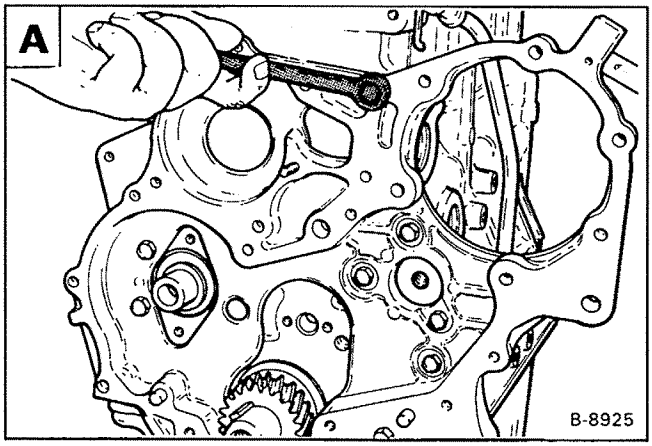
Remove the camshaft gear (See Page 7C—54).

Remove the water pump (See Page 7C—63).

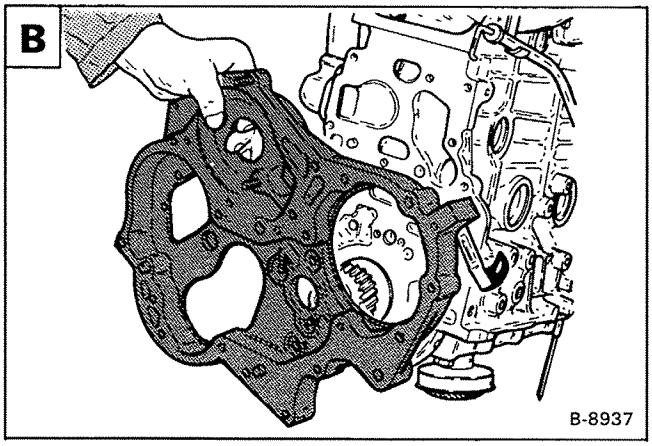
Remove the oil pan (See Page 7C—59).

Remove the bolts at the timing case [A].

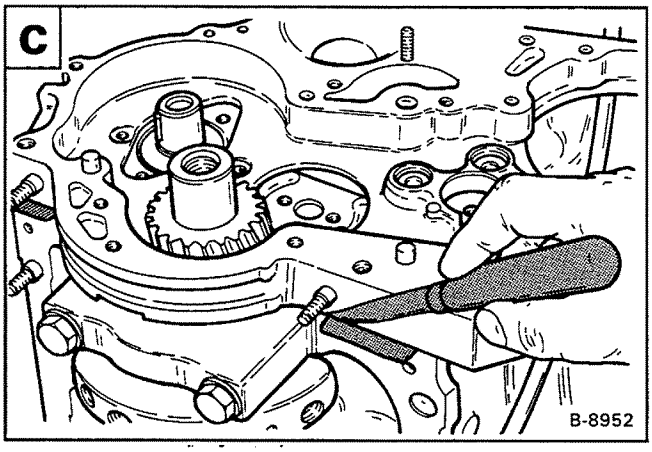
Installation: Tighten the bolts to 11-17 ft.-lbs. (15-23 Nm) torque.



Remove the timing case [B].



Installation: After the timing case cover is installed with the new gasket, cut the excess gasket at the engine block [C].



CAMSHAFT

Removal and Installation

Remove the rocker arm cover, rocker arm assembly and the push rods (See Page 7C—29).

Remove the timing case cover (See Page 7C—49).

Remove the camshaft gear (See Page 7C—54).

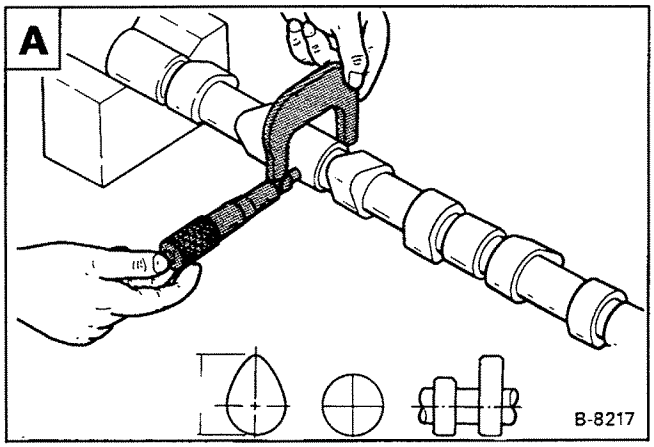
Remove the oil pan and oil pump (See Pages 7C—59 & 7C—60).

Remove the camshaft from the engine.

Checking

Check the camshaft journals [A].

Standard — 1.9662-1.9675" (49,945-49,975 mm)
Limit — 1.9528" (49,60 mm)

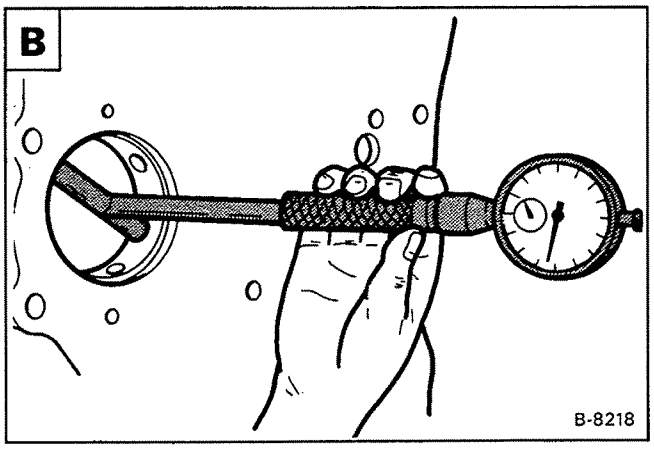


Check the bearing inside diameter [B].

Standard — 1.9685-1.9697" (50,0-50,03 mm)

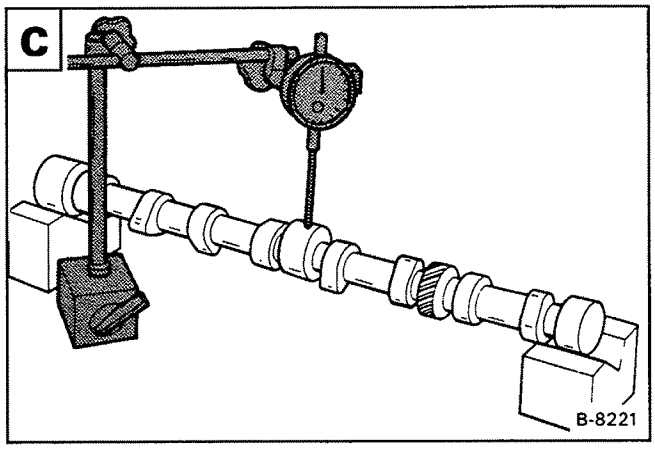
Clearance between camshaft journal and bearing.

Standard — 0.002" (0,05 mm)
Limit — 0.0047" (0,12 mm)



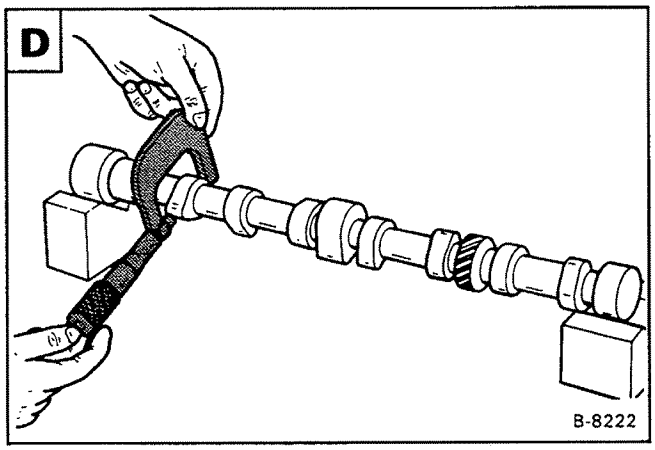
Check camshaft run-out [C].

Limit — 0.0039" (0,1 mm)



Check cam lobe height [D].

Standard — 1.654" (42,02 mm)
Limit — 1.640" (41,65 mm)

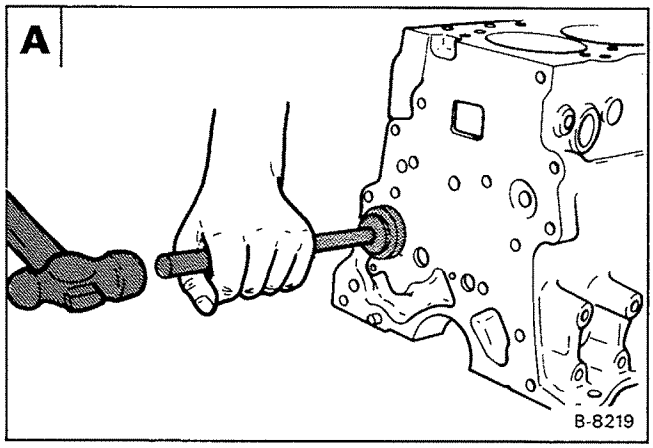


Camshaft Bearings

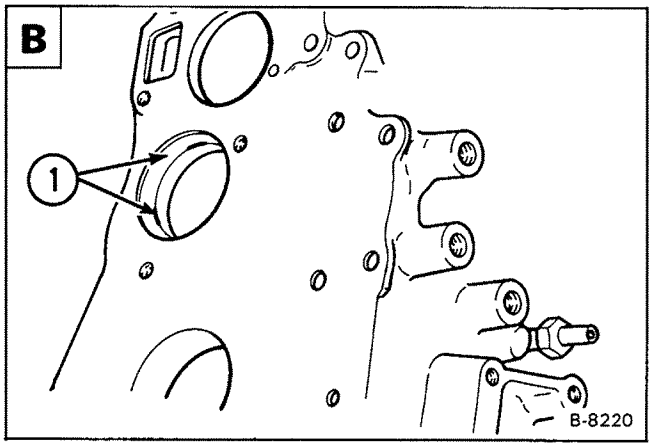
The tools listed will be needed to do the following procedure:

MEL-1260 — Camshaft Bearing Remover/Installer

Use the correct tool to remove the bearings [A].

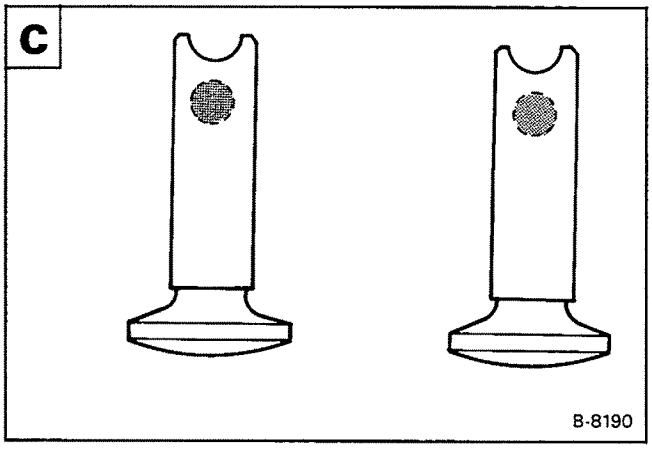


When installing the new bearings, make sure to align the oil hole in the bearing with the hole in the engine block (Item 1) [B].

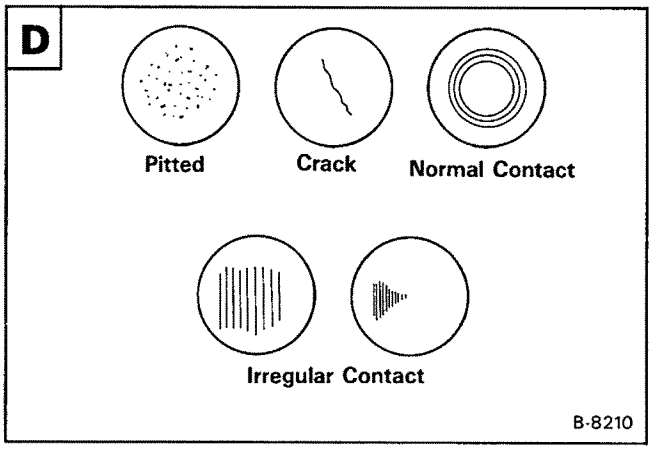


Tappets

Remove the tappets from the engine block. Mark the cylinder number on each tappet after removal [C].



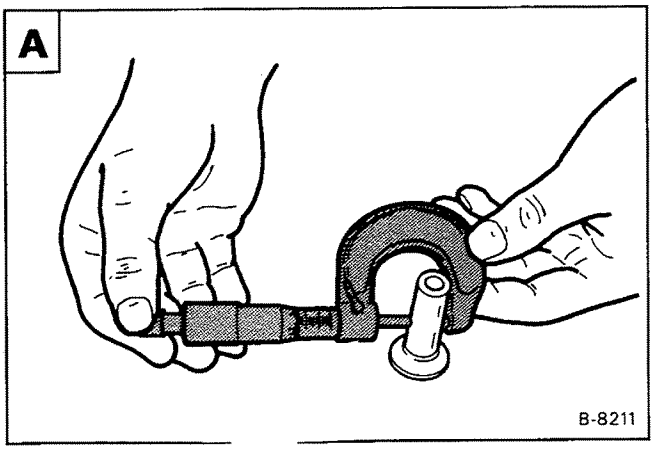
Inspect the tappets for wear, damage or abnormal conditions [D].



CAMSHAFT (Cont'd)

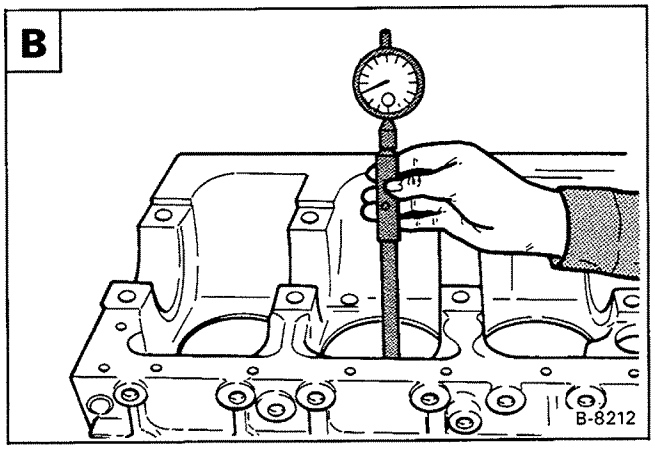
Check the diameter of the tappets [A].

Standard — 0.51091-0.51142" (12,977-12,990 mm)
Limit — 0.50984" (12,950 mm)



Clearance between tappet and engine block bore as listed [B].

Standard — 0.0012" (0,03 mm)
Limit — 0.0039" (0,09 mm)



Installation
Lubricate the tappets before installation.

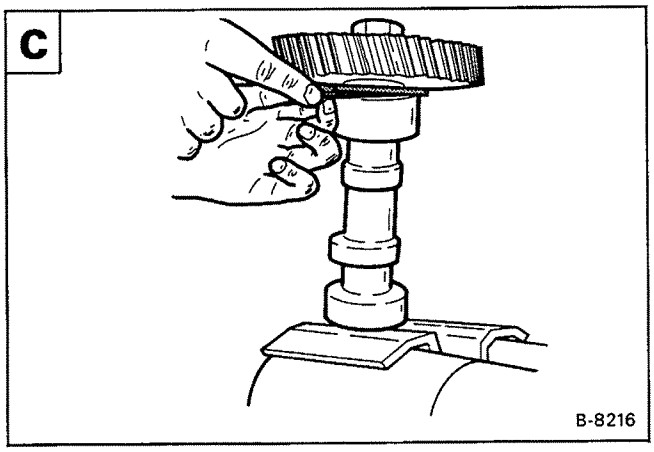
Lubricate the camshaft bearings and journals. Install the camshaft, carefully not to damage the bearings.

Install the camshaft gear (See Page 7C—54).

Check the camshaft end play using a feeler gauge [C].

Standard — 0.0002-0.0045" (0,05-0,114 mm)
Limit — 0.0079" (0,2 mm)

After the rocker arm assembly is installed, make sure to set the valve clearance (See Page 7C—2).



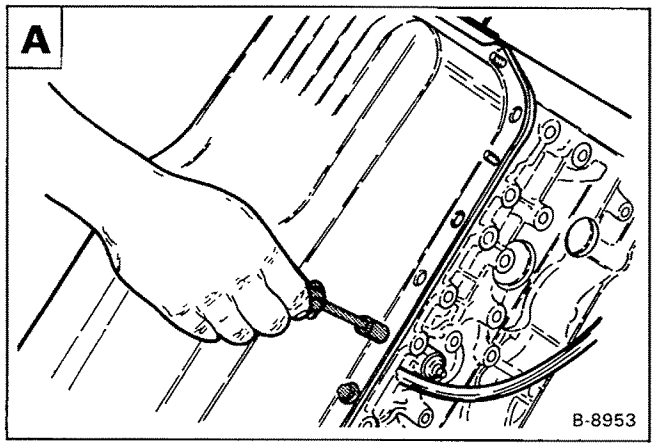
OIL PAN

Removal

Remove the oil drain plug and remove the oil.

Remove the fastening bolts and nuts from the oil pan [A].

Installation: Tighten the bolts and nuts to 13.7-18.6 ft.-lbs. (19-26 Nm) torque.

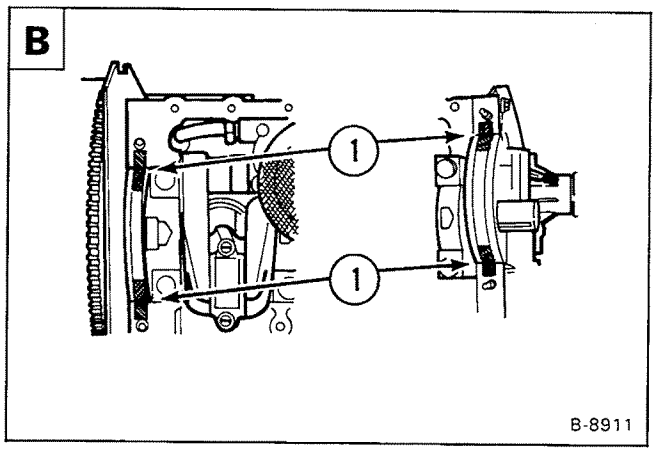


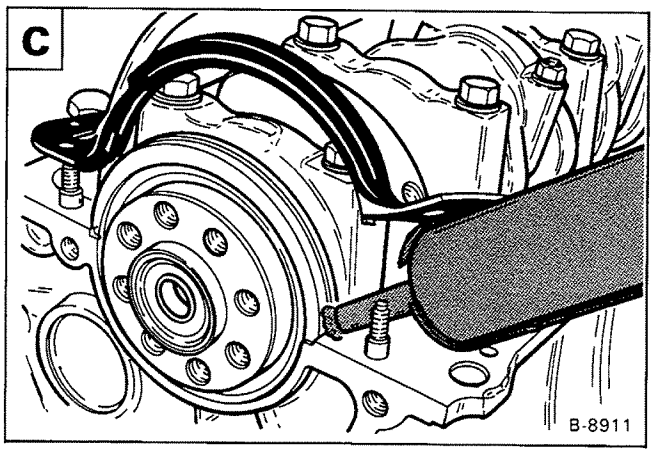
Installation

Clean the surface on the oil pan and engine block.

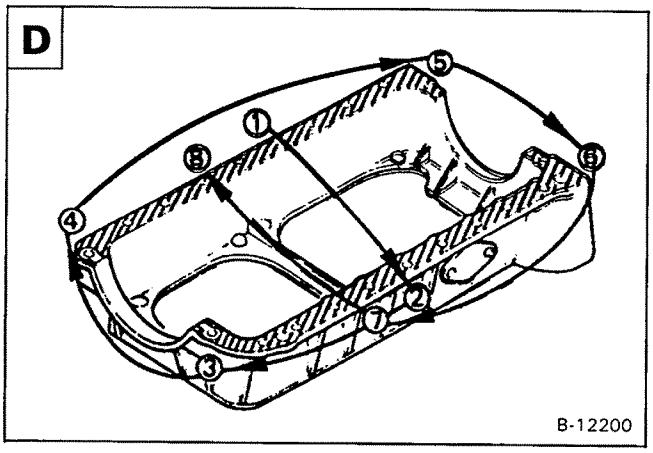
Put Three Bond (TB-1207B) at the front and rear main bearing caps (Item 1) [B], [C].

Put liquid gasket on the oil pan surface area of the engine block.





Install the oil pan. Install and tighten the bolts in the sequence shown [D].



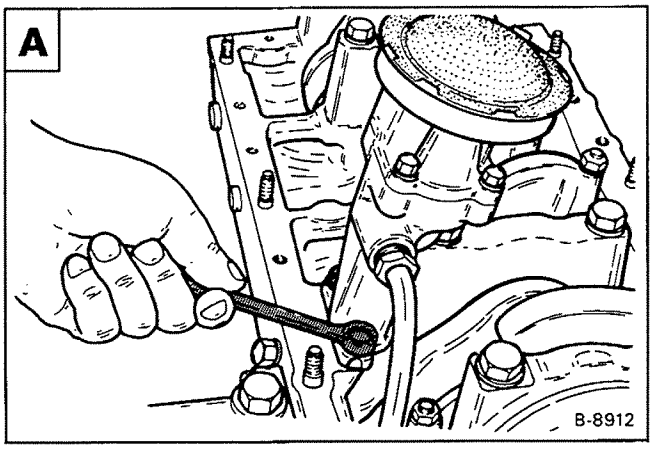
OIL PUMP

Removal and Installation

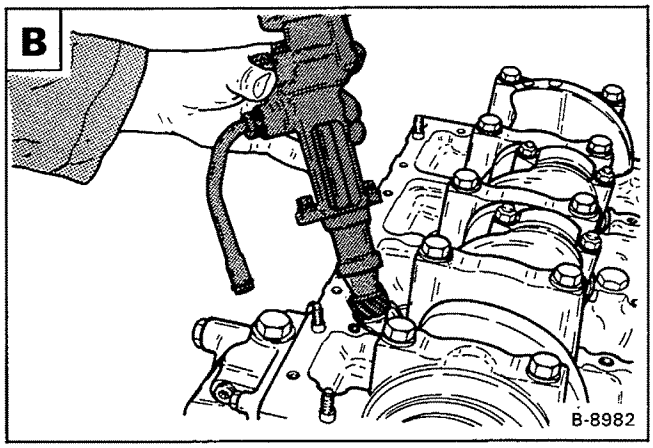
Remove the oil pan (See Page 7C—59).

Remove the bolts at the oil pump [A].

Installation: Tighten the bolts to 10-17 ft.-lbs. (14-23 Nm) torque.

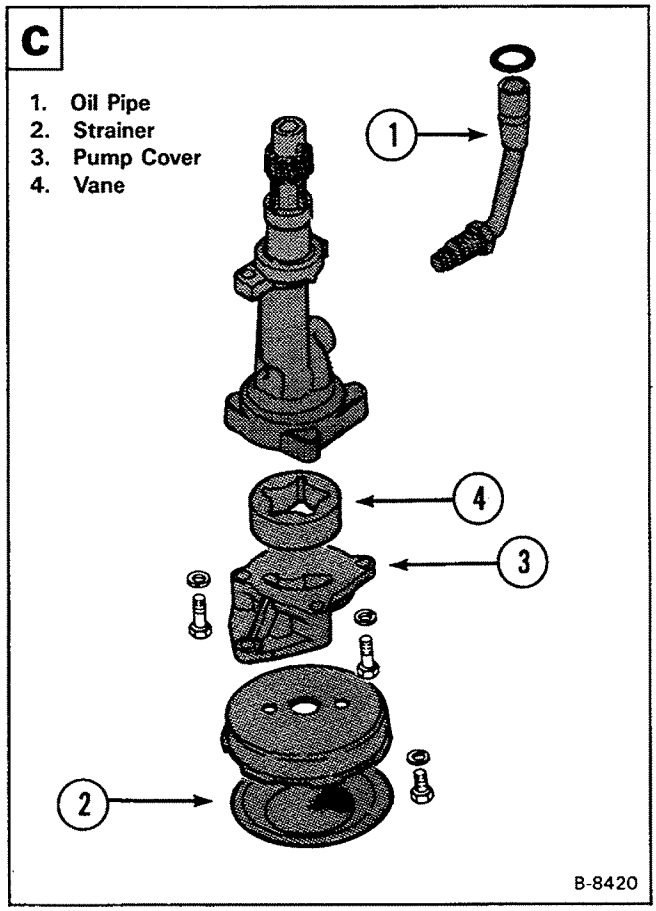


Remove the oil pump assembly from the engine block [B].



Checking

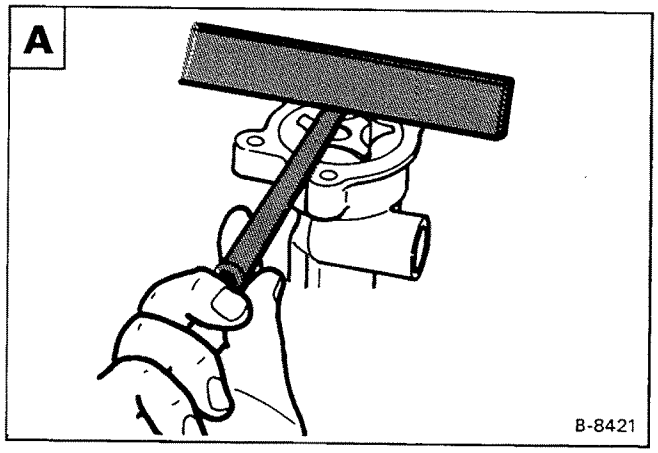
Disassemble the oil pump as illustrated [C].



OIL PUMP (Cont'd)

Check the clearance between vane and body [A].

Standard — 0.0008-0.0028" (0,02-0,07 mm)
Limit — 0.0059" (0,15 mm)



Check the clearance between the rotor and vane [B].

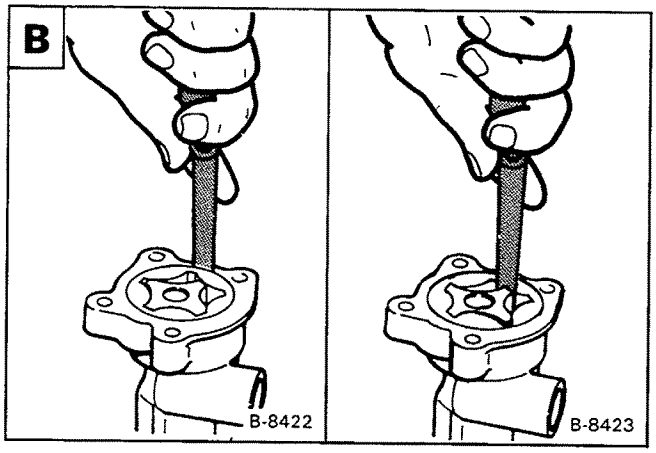
Standard — 0.0055" (0,14 mm) or less

Check the clearance between the vane and pump body [B].

Standard — 0.0079-0.0105" (0,2-0,27 mm)

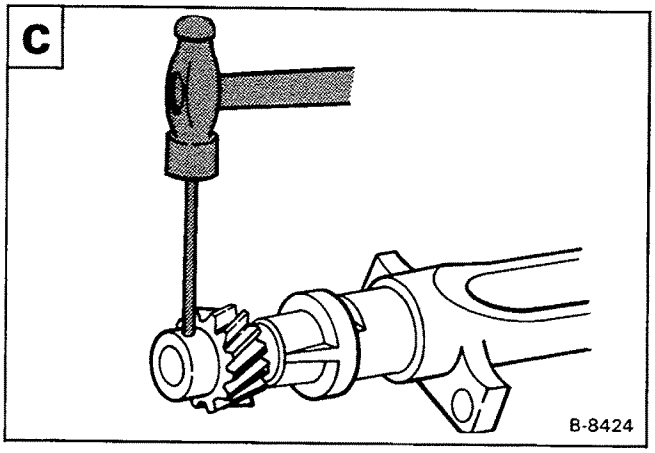
Check clearance between rotor shaft and pump body.

Standard — 0.0016" (0,04 mm)
Limit — 0.0079" (0,2 mm)



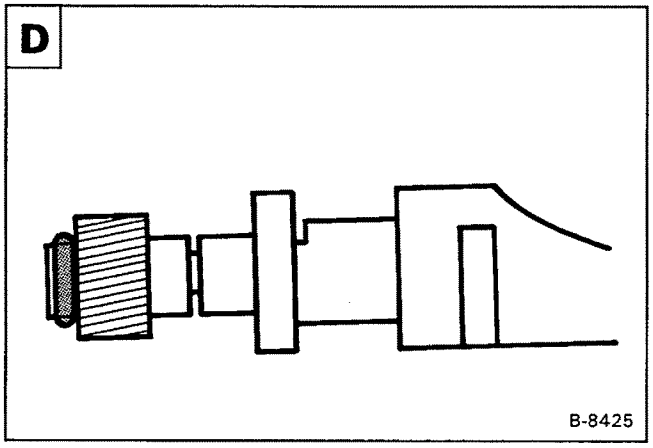
Gear Replacement

File off one end of the roll pin at the gear. Use a punch and hammer and remove the pin [C].



NOTE: It maybe necessary to drill a hole in one side of the gear for service as it does not have a hole on both sides [D].

Installation: Install the gear and new pin. Peen the end of the pin after installation.



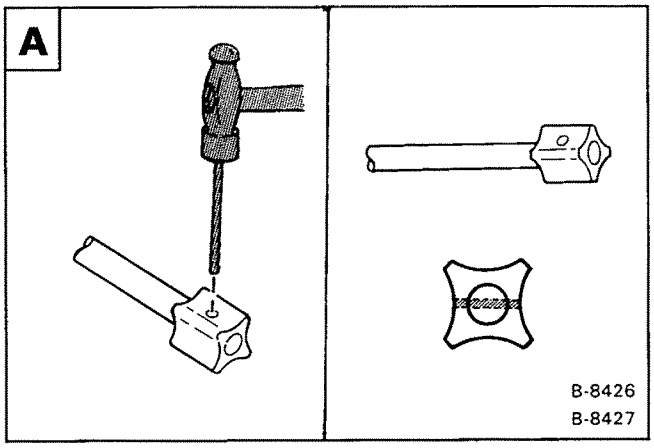
OIL PUMP (Cont'd)

Rotor Replacement

Remove the pin at the rotor using a punch and hammer [A].

Installation: When installing the new pin in the rotor, make sure to check the end of the pin that it does not project from the end of the rotor [A].

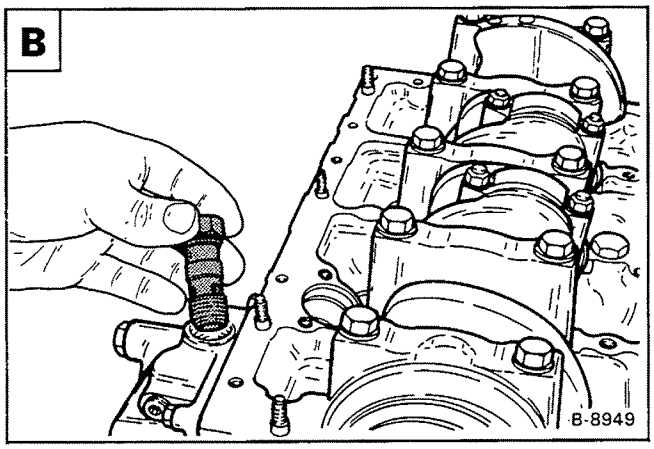
After the oil pump is assembled, put oil into the pump and turn the shaft to prime the pump.



Oil Pump Relief Valve

Remove the relief valve from the oil filter housing [B].

Check the relief valve and clean. Replace as needed.

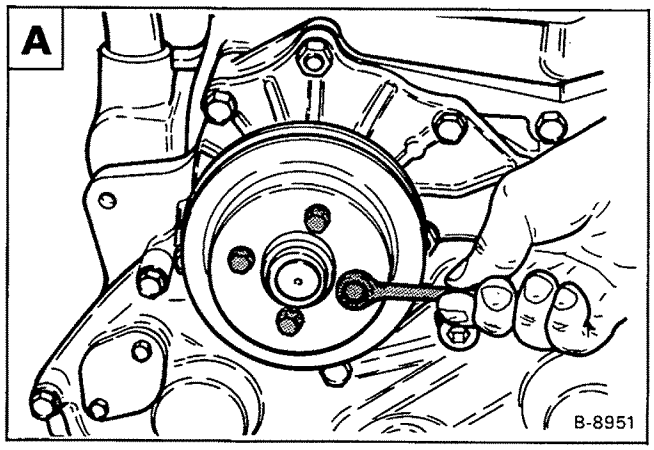


WATER PUMP

Removal and Installation

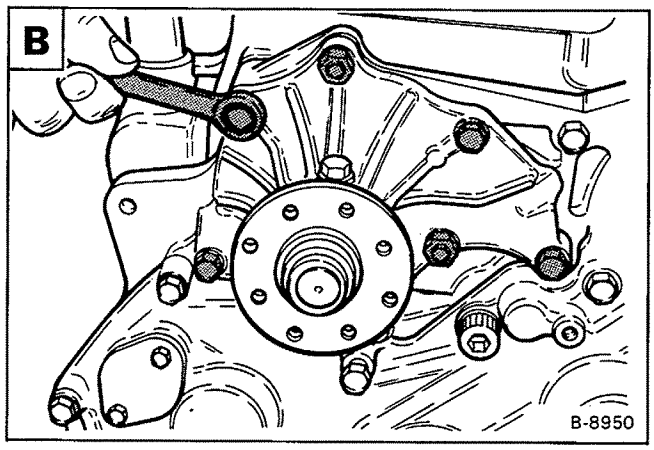
Remove the alternator belt.

Remove the water pump pulley [A].

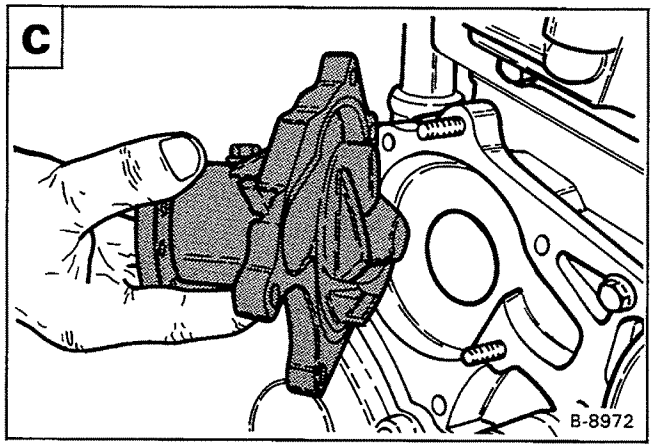


Remove the water pump bolts [B].

Installation: Tighten the bolts to 11-18 ft.-lbs. (15-24 Nm) torque.

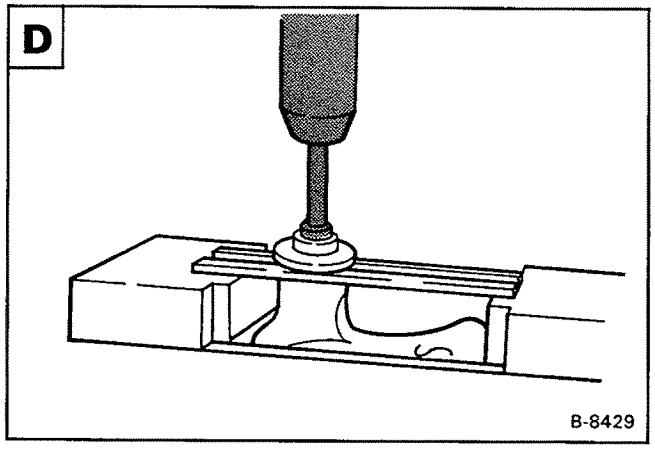


Remove the water pump from the engine block [C].

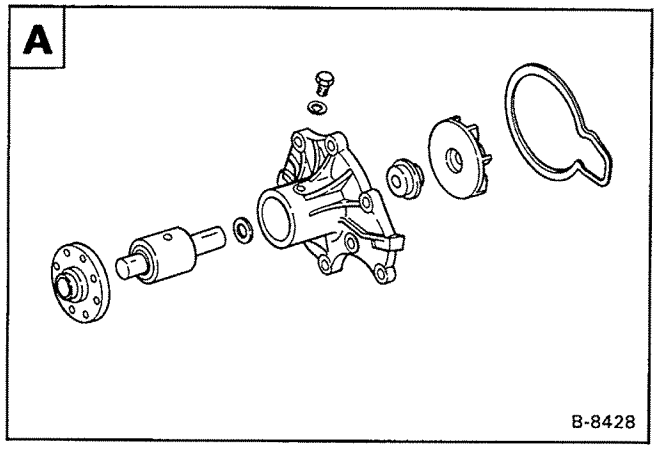


Disassembly

Remove the hub for the pulley using a press [D].

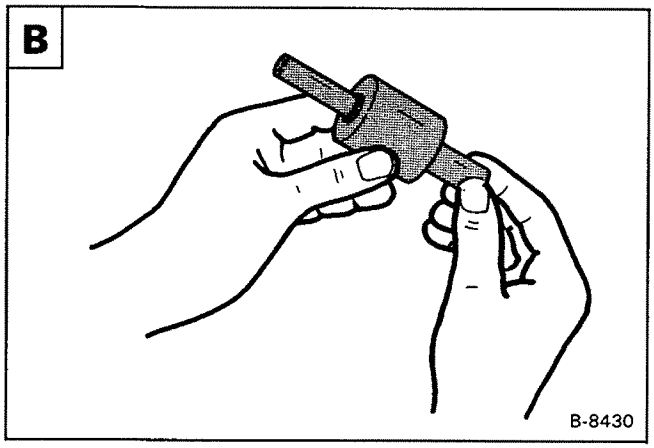


Disassemble the water pump [A].



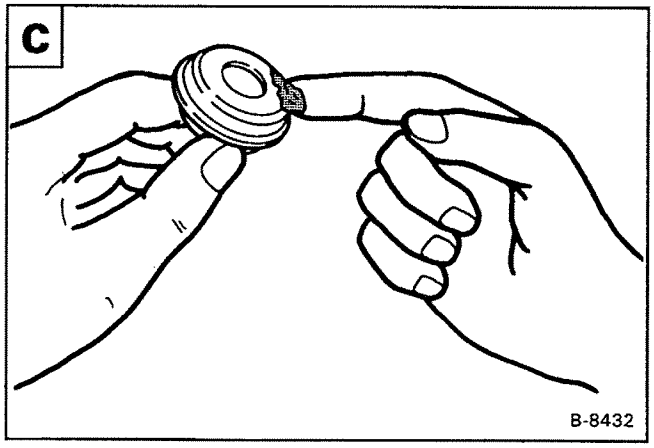
Check the bearing for abnormal noise, binding or wear [B].

Replace the parts as needed.

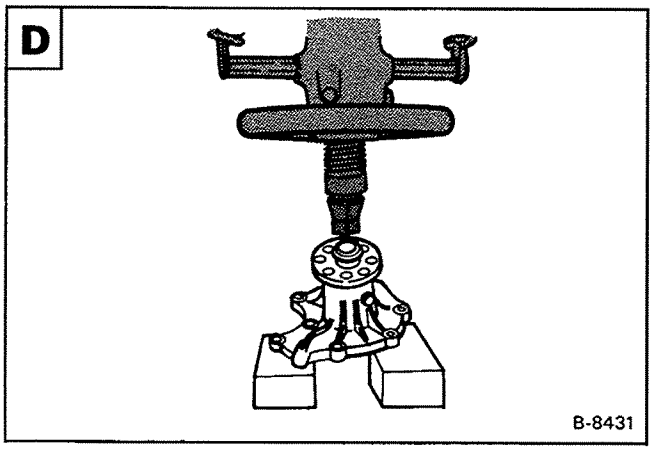


Assembly

Apply a thin coat of liquid gasket cement to the outer surface of the seal unit before assembly [C].



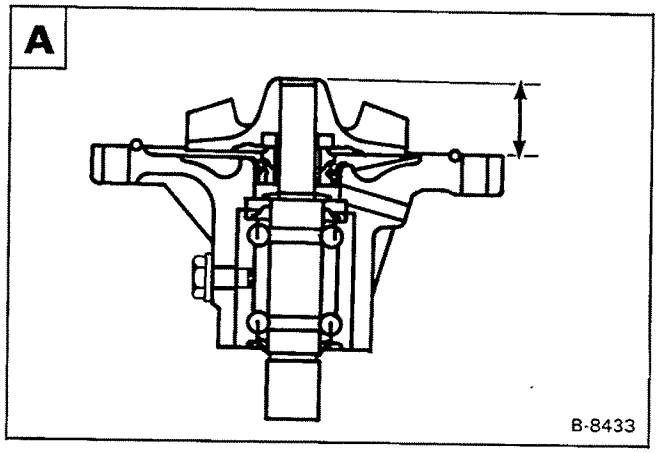
Press the bearing assembly into position by aligning the set screw hole in the bearing with that in the pump body [D].



WATER PUMP (Cont'd)

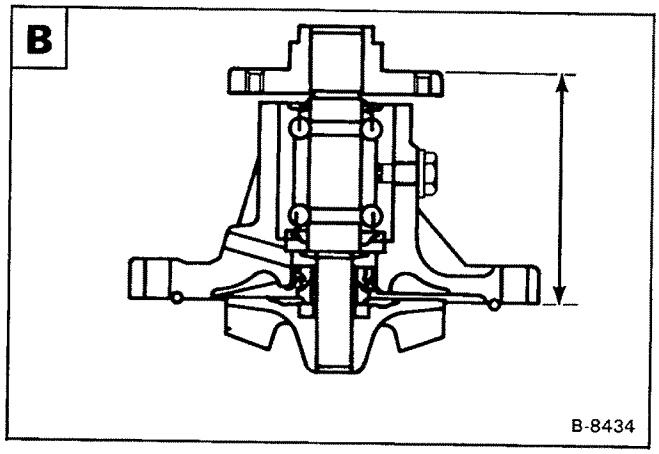
After installation, check that the rear face of the impeller has the correct height [A].

Height — 0.98" (25 mm)



Check the distance between the pulley hub and pump body [B].

Distance — 3.13 ± 0.01" (79,5 ± 0,3 mm).



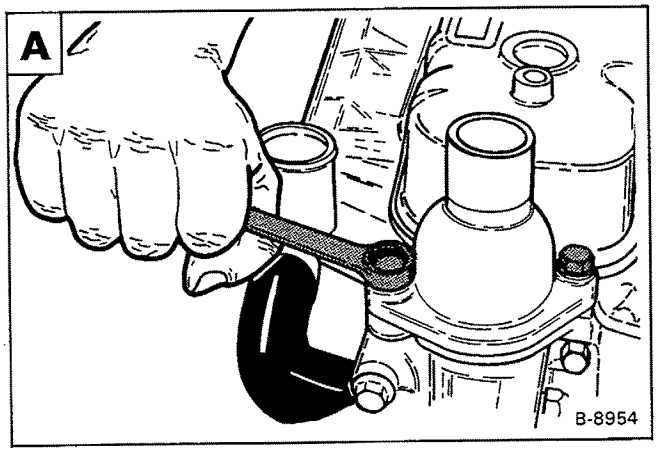
THERMOSTAT

Removal and Installation

Remove the bolts from the thermostat housing [A].

Installation: Tighten the bolts to 10-17 ft.-lbs. (14-23 Nm) torque.

Remove the thermostat.



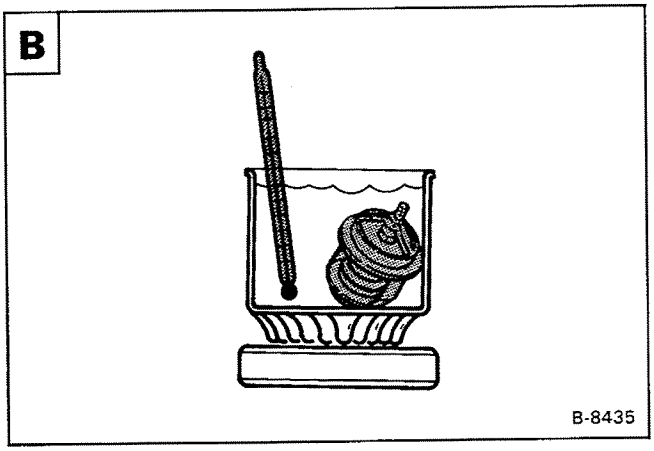
Inspection

Check the thermostat opening temperature [B].

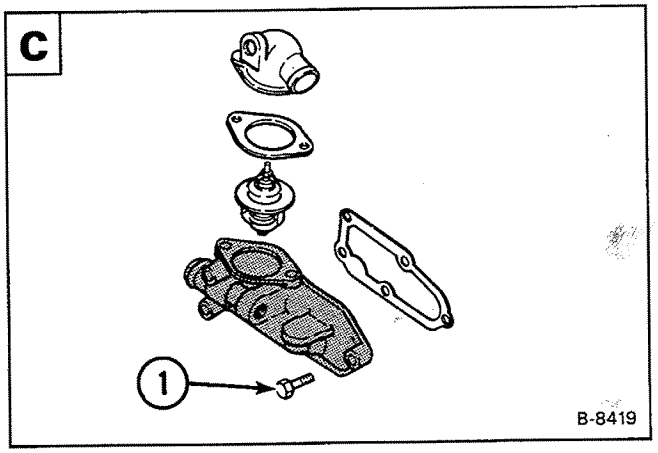
Standard — 176- 183°F (80-84°C)

Check the thermostat valve lift:

Standard — Approximately 0.3" (8 mm) @ 203°F (95°C)



If the thermostat housing assembly is removed, tighten the bolts to 10-17 ft.-lbs. (14-23 Nm) torque (Item 1) [C].



WATER JACKET TUBE

Removal and Installation

Remove the timing case cover (See Page 7C—49).

Remove the idler gear and hub (See Page 7C—51).

Remove the fuel injection pump (See Page 7C—6).

Remove the fuel injection pump idler gear (See Page 7C—53).

Remove the camshaft gear (See Page 7C—54).

Remove the timing case (See Page 7C—55).

Remove the water pump (See Page 7C—63).

Grip the edge of the water jacket tube with a vise grip. Use a screwdriver to pry the jacket from the engine block [A].

Remove the water jacket tube from the engine block [B].