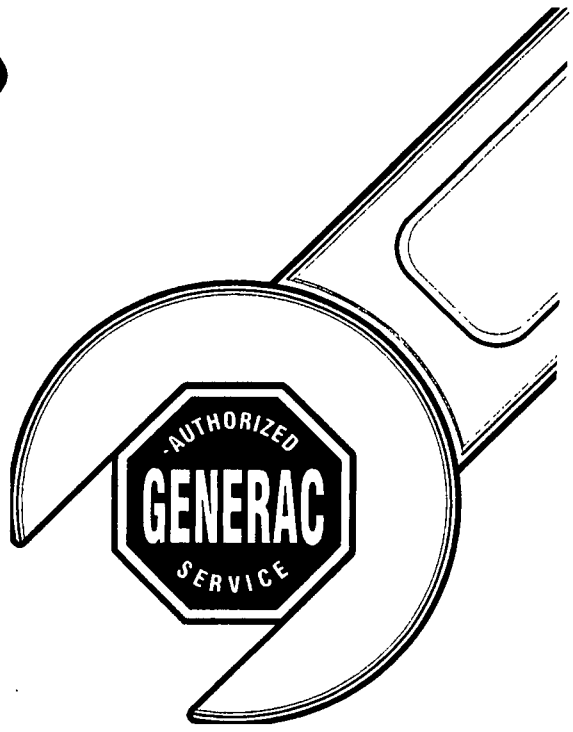
P/N A3024

GENERAC
One-Stop Service



2.4 DIESEL

REPAIR MANUAL

P.O. BOX 8 WAUKESHA WI. 53187

PHONE: (414) 544-4811 / FAX: (414) 544-0179

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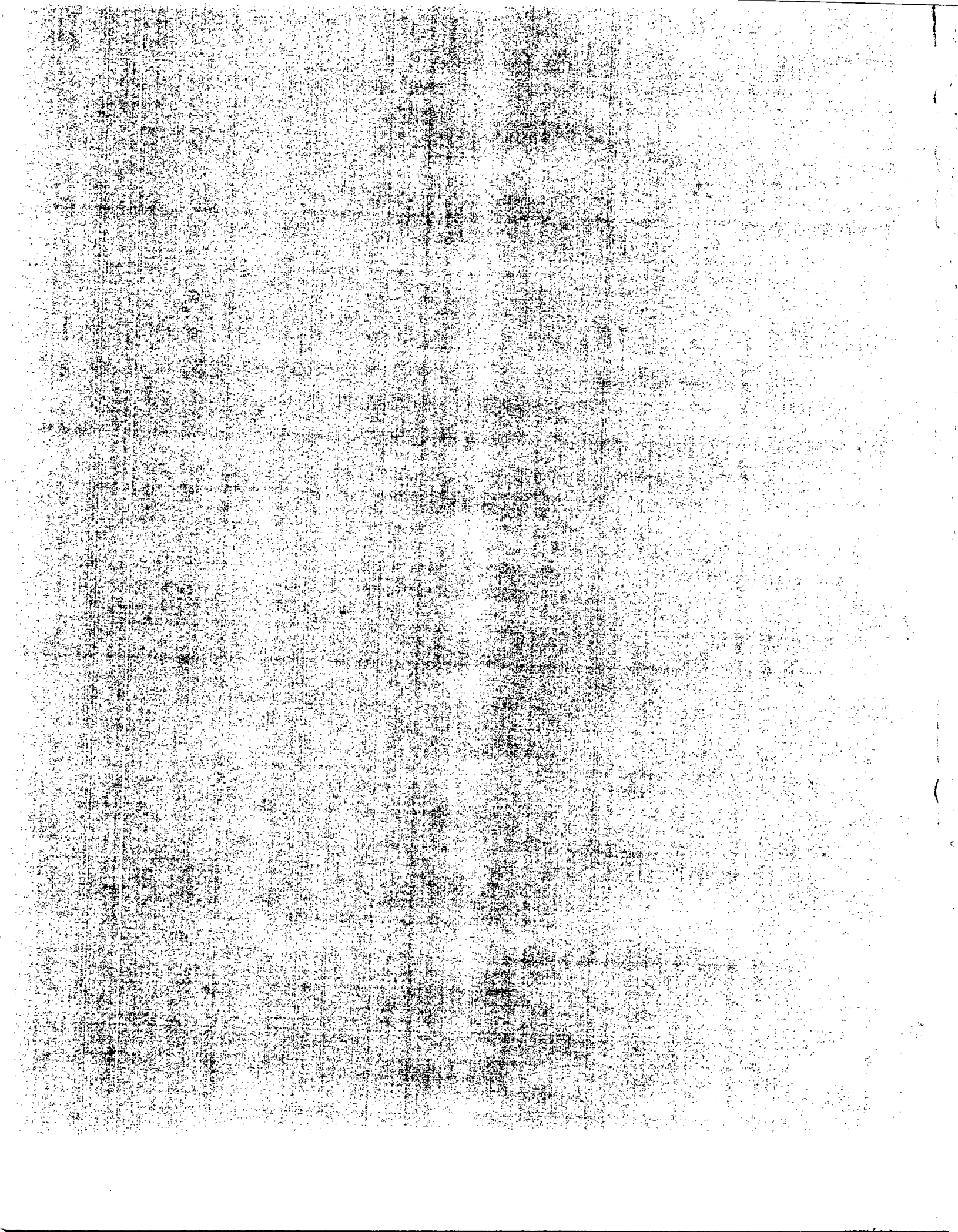

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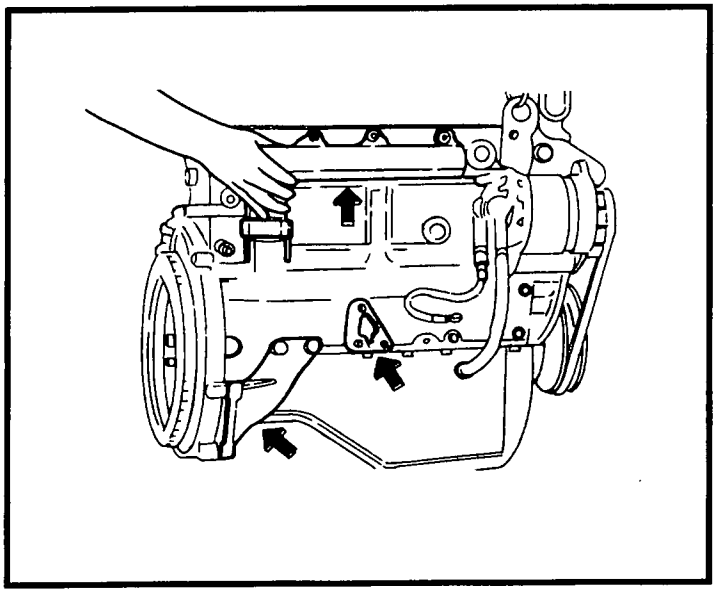
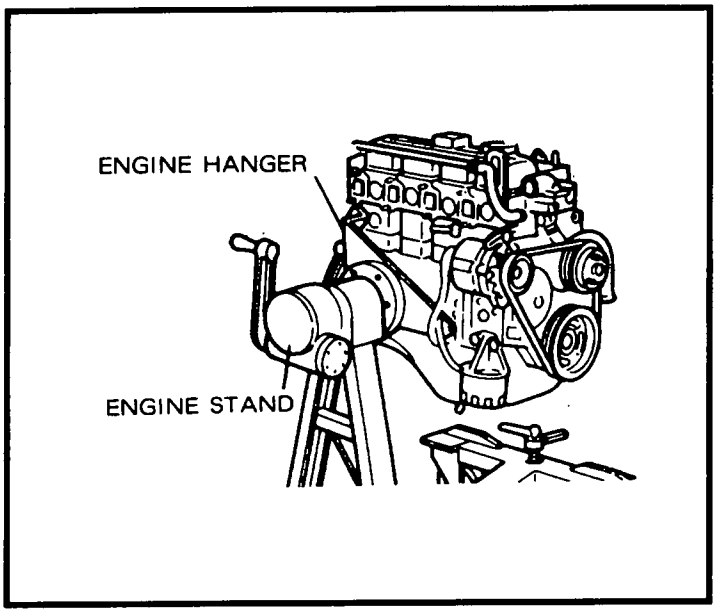
CHAPTER 1. ENGINE DISASSEMBLY



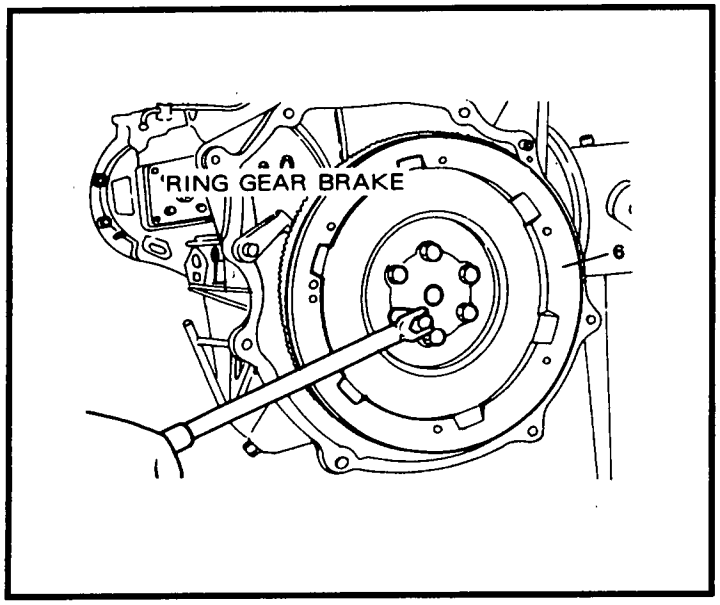
Engine Disassembly

Installation of engine on engine hanger.

1. Before installing the engine stand, remove the exhaust manifold, gusset plates and engine mounting brackets.

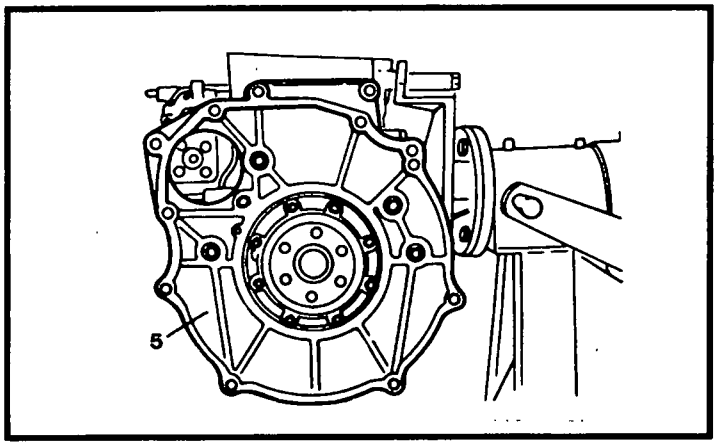


2. Install the engine hanger to the engine.
3. Install the hanger to the engine stand.

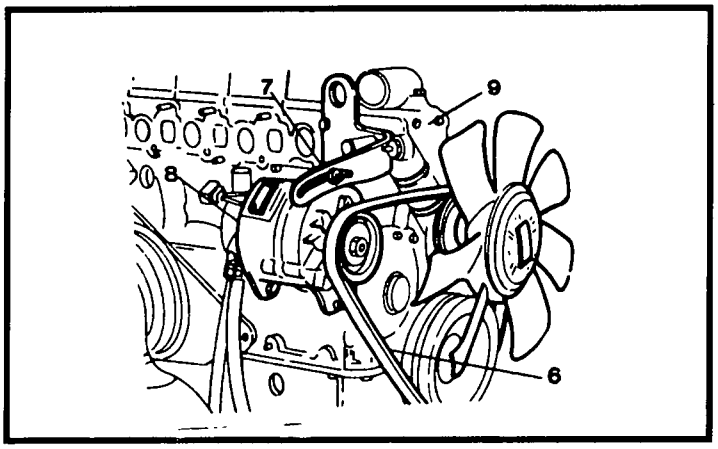


4. Use a flywheel holding device.

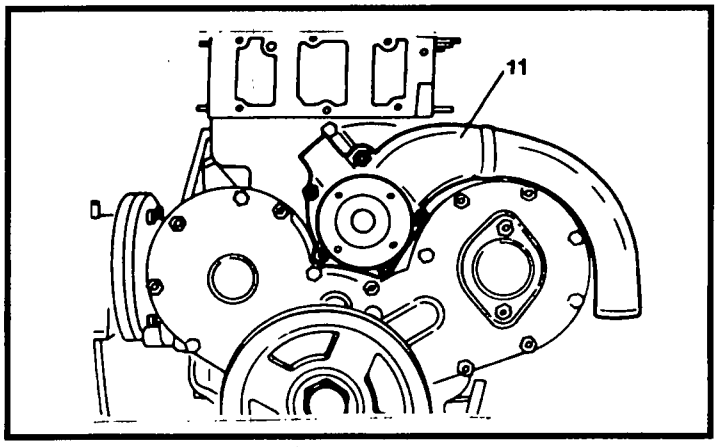
NOTE: *Loosen the crankshaft pulley bolt before removing the flywheel.*



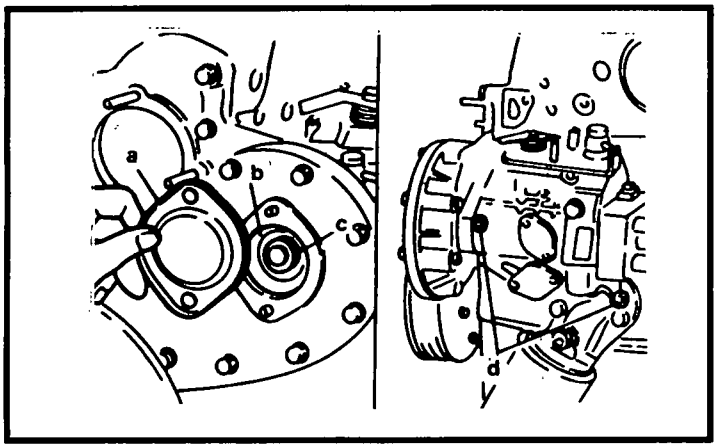
5. End plate.



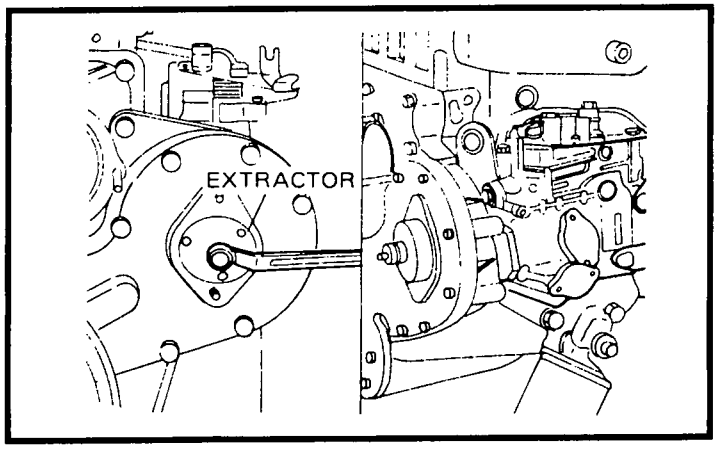
6. Cooling fan, pulley and "V" belt.
7. Alternator and bracket.
8. Alternator strap.
9. Thermostat casing assembly.
10. Oil level gauge.



11. Water pump assembly.

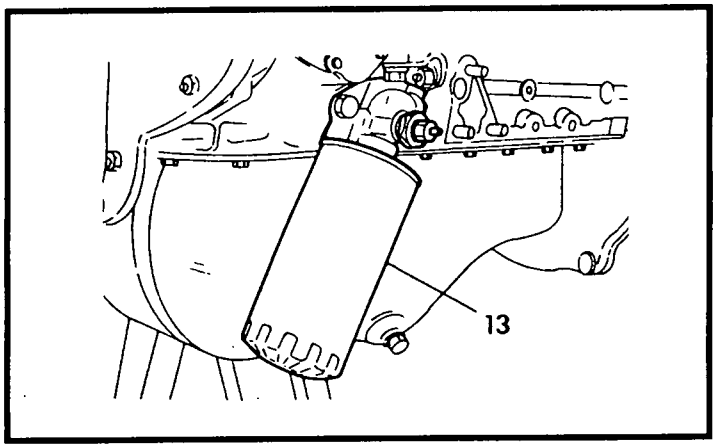


12. Fuel injection pump.
    a. Cover.
    b. Injection pump drive gear.
    c. Lock plate.
    d. Injection pump attaching nuts and bolt.

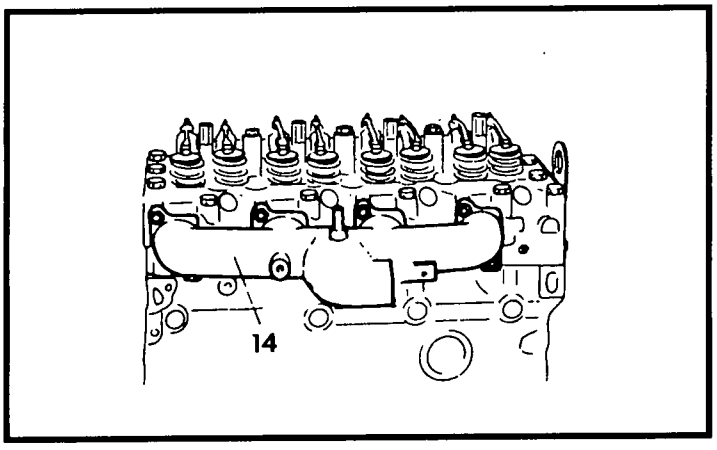


e. Fuel injection pump.

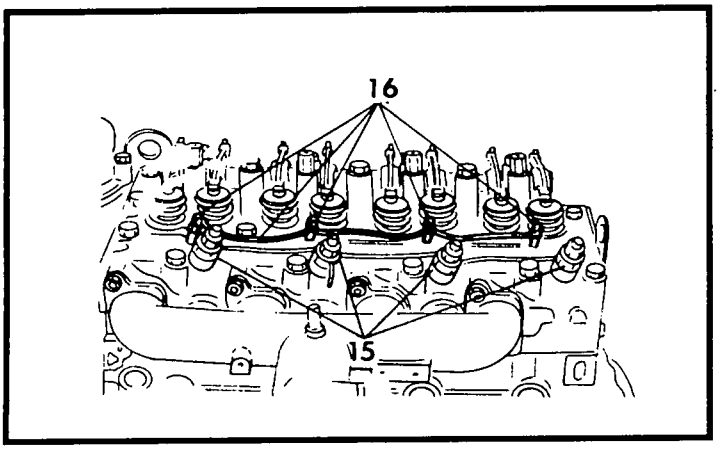
NOTE: *Apply identification marks on the fuel injection pump flange and timing gear case for reinstallation.*



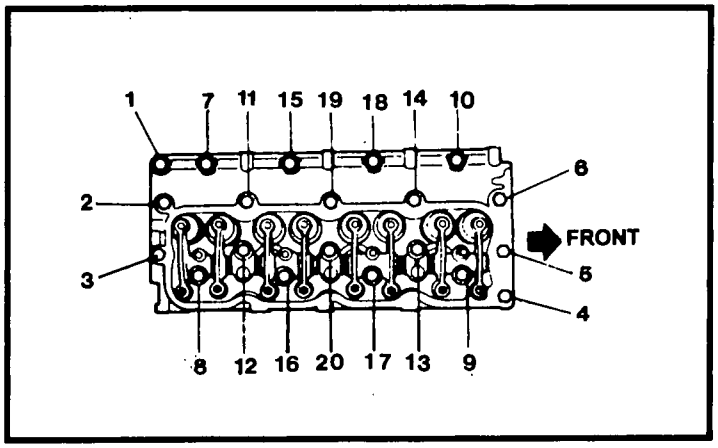
13. Oil filter.



14. Intake manifold.



15. Fuel injection nozzles.
    a. Fuel leak pipe attaching bolts.
    b. Fuel leak pipe.
    c. Fuel injection nozzles.
16. Glow plugs and connector.

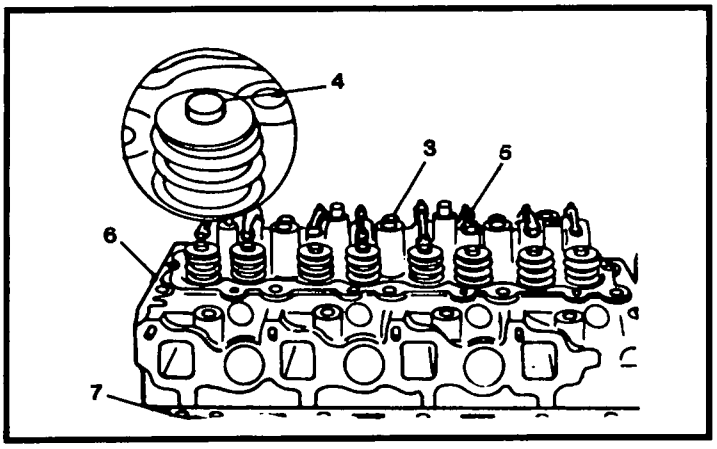


Engine Disassembly

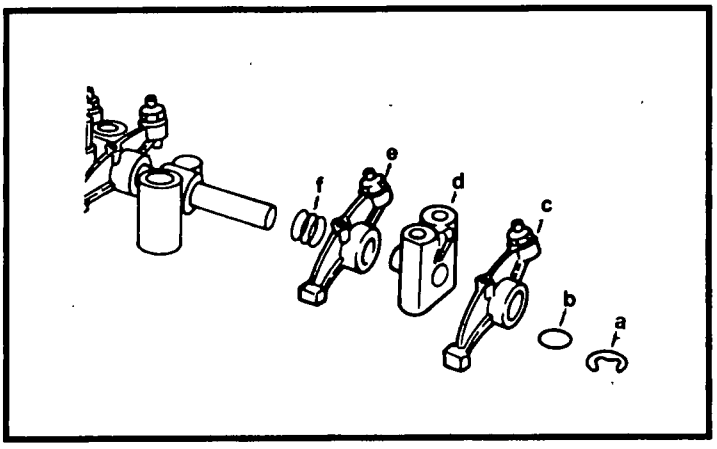
Disassemble in the following order:

1. Cylinder head cover.
2. Cylinder head bolts.

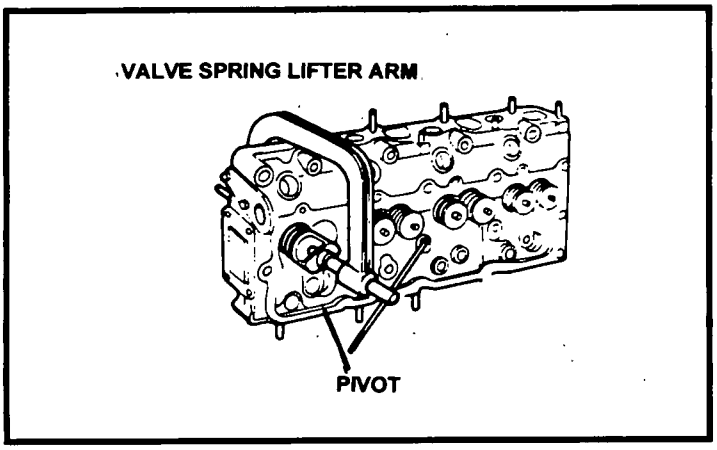
NOTE: *Remove the bolts in the order shown in Figure*



3. Rocker arm assembly.
4. Valve caps.
5. Push rods.
6. Cylinder head.
7. Cylinder head gasket.

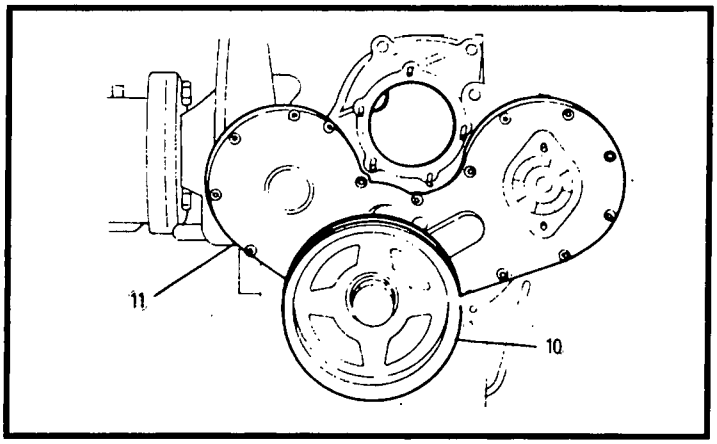


8. Rocker arm assembly.
   a. Stop ring.
   b. Wave washer
   c. Rocker arm
   d. Rocker bracket
   e. Rocker arm
   f. Spring

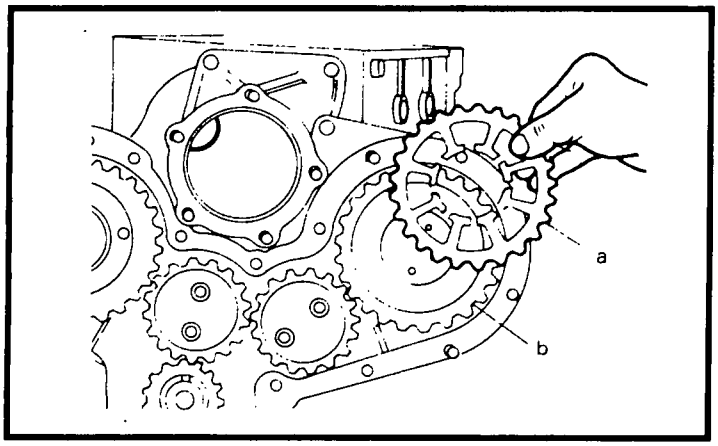


9. Intake and exhaust valves.

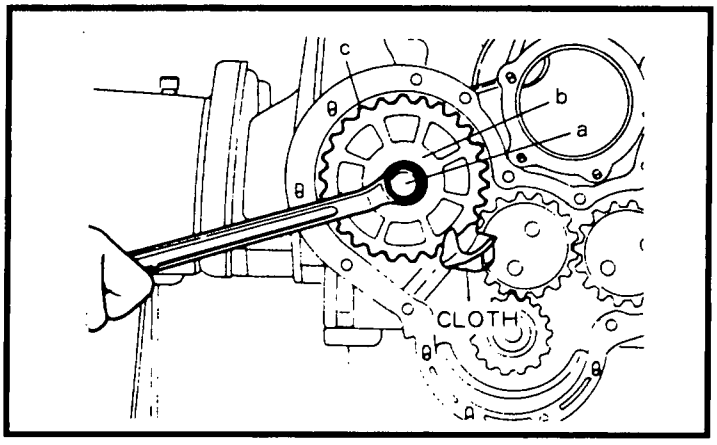
NOTE: *After removing the valve assemblies, arrange them in the order of removal, so that they may be refitted in their original position.*



10. Crankshaft pulley.
11. Timing gear cover.



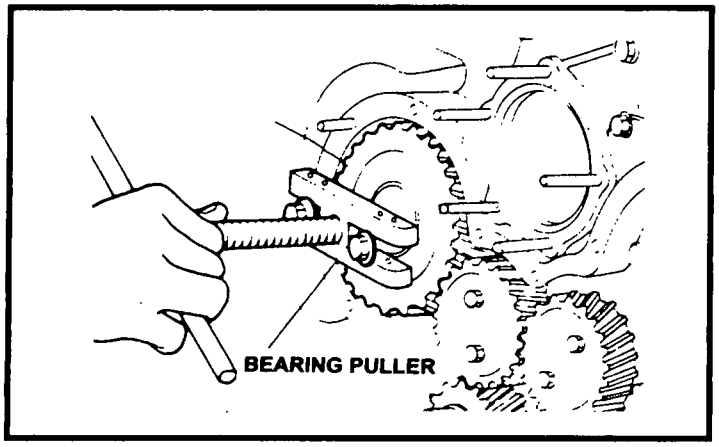
12. Injection pump drive gear.
    a. Friction gear.
    b. Drive gear.



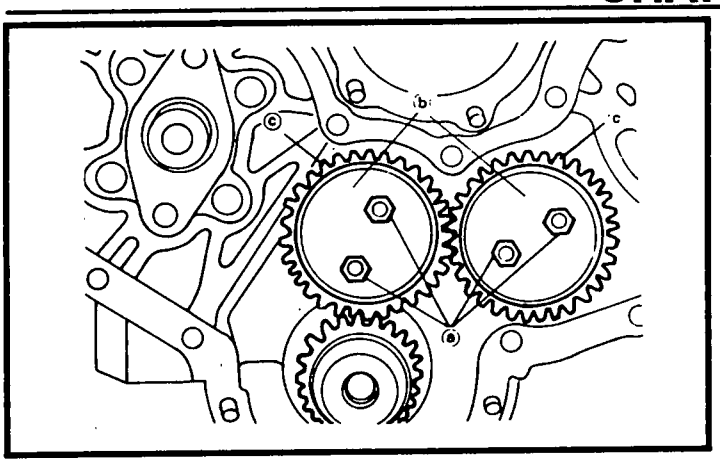
13. Camshaft gear
    a. Lock bolt

NOTE: *Bite a cloth between the camshaft gear and the idler gear, remove the lock bolt.*

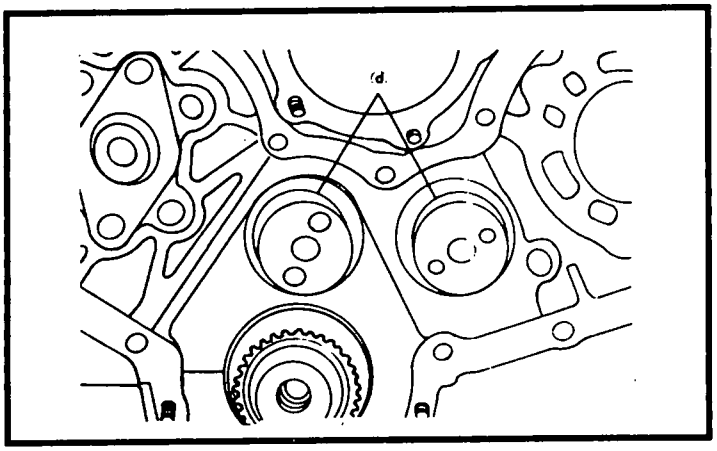
    b. Lock plate.
    c. Friction gear.
    d. Camshaft gear.



NOTE: *Use a commercially available gear puller to remove the camshaft drive gear from the camshaft.*

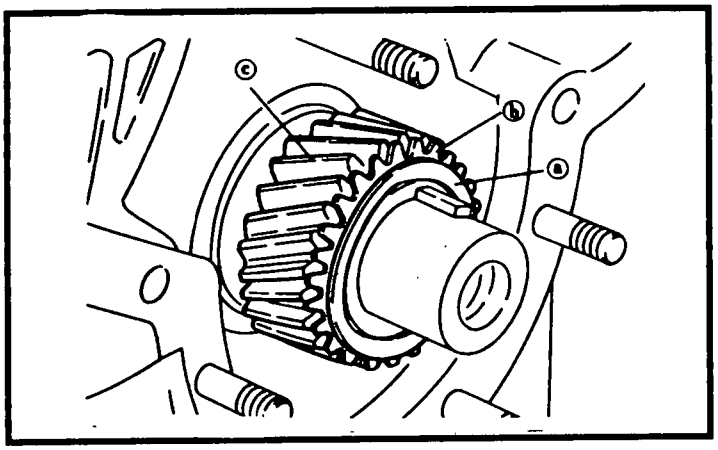


14. Idle gears.
    a. Attaching nuts
    b. Thrust plates.
    c. Idle gears.

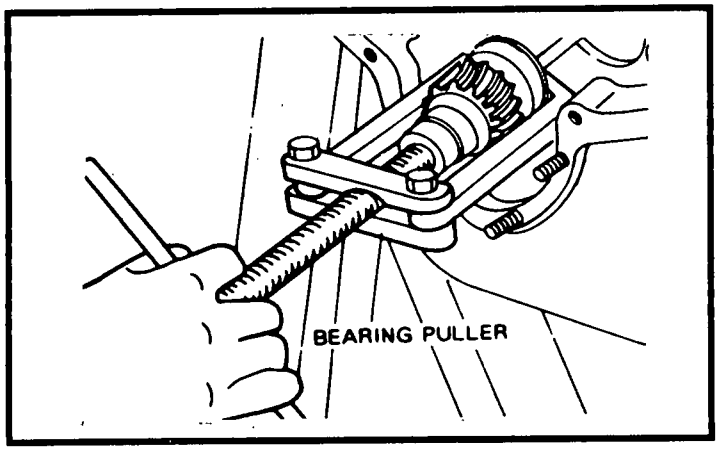


d. Idle gear spindles.

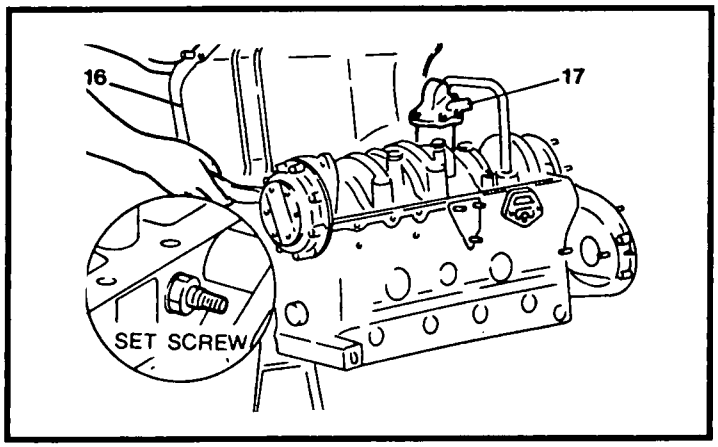
NOTE: *Keep the spindle and idle gear so that both parts are not confused.*



15. Crankshaft gear.
    a. Wave washer.
    b. Friction gear.
    c. Crankshaft gear.

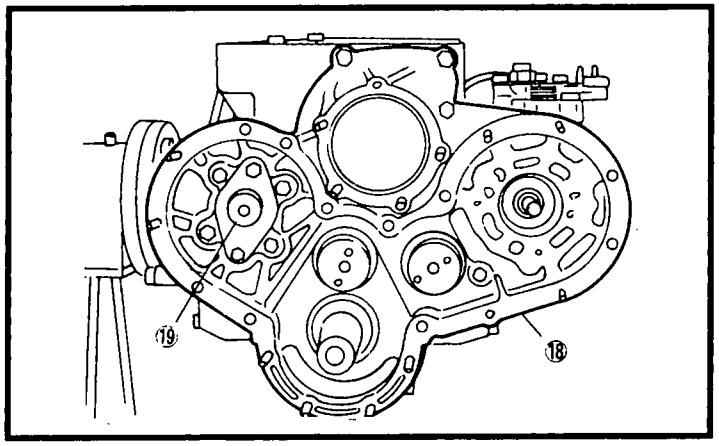


NOTE: *Use a commercially available gear puller for the removal of the crankshaft gear.*



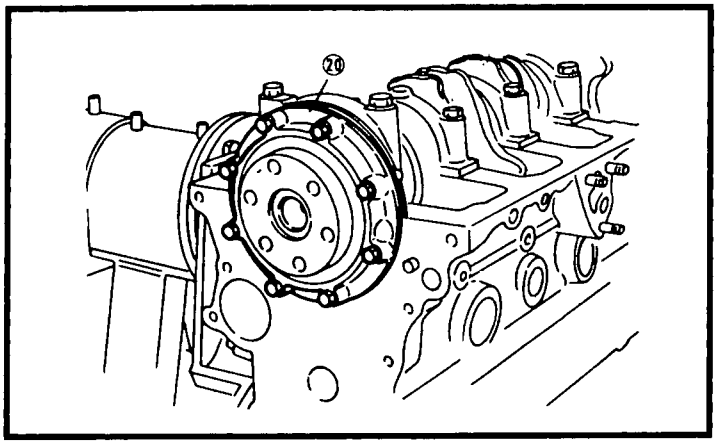
16. Oil pan.
17. Oil pump assembly.

NOTE: *Remove the oil pump assembly after loosening the oil pump set screw.*

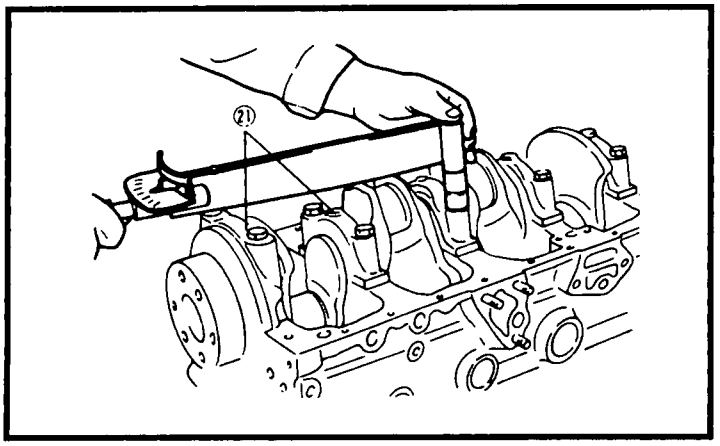


18. Timing gear case.
19. Camshaft.

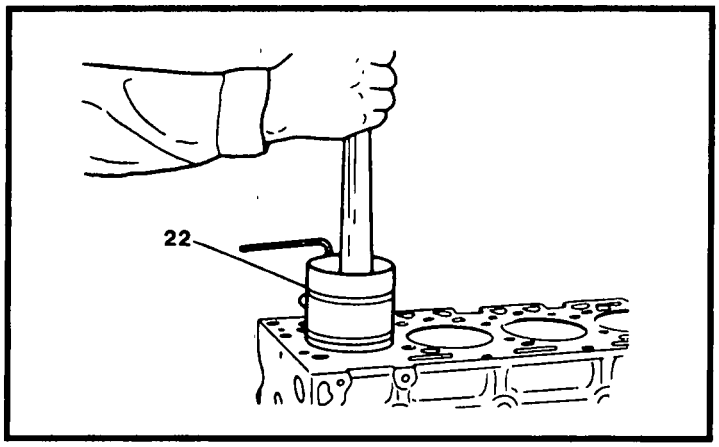
NOTE: *Turn the engine upside down for removing the camshaft easily.*



20. Rear oil seal assembly.

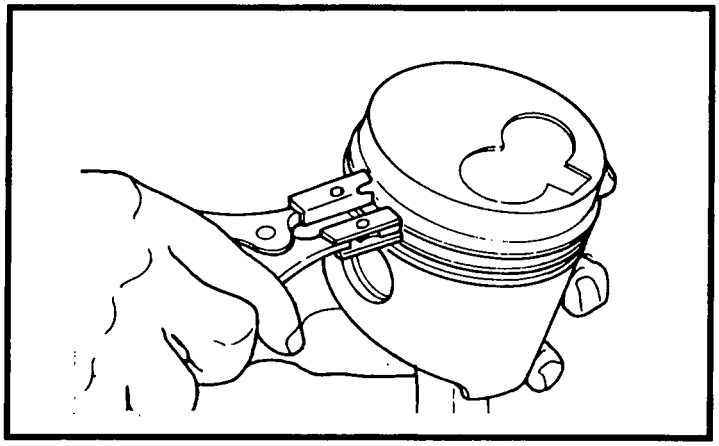


21. Connecting rod caps.

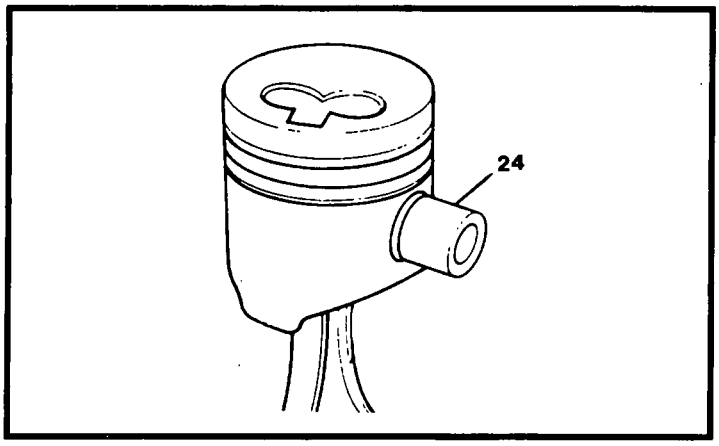


22. Piston and connecting rod assemblies.

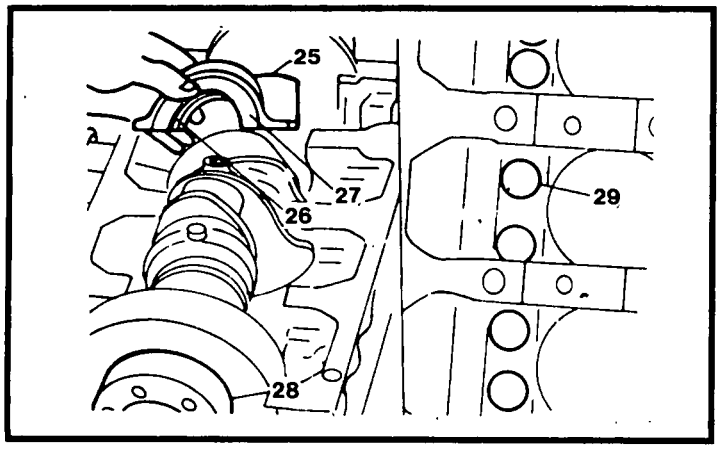
NOTE: *After removing the piston rings, arrange them at every cylinder.*



23. Remove piston rings with a commercially available piston ring pliers.



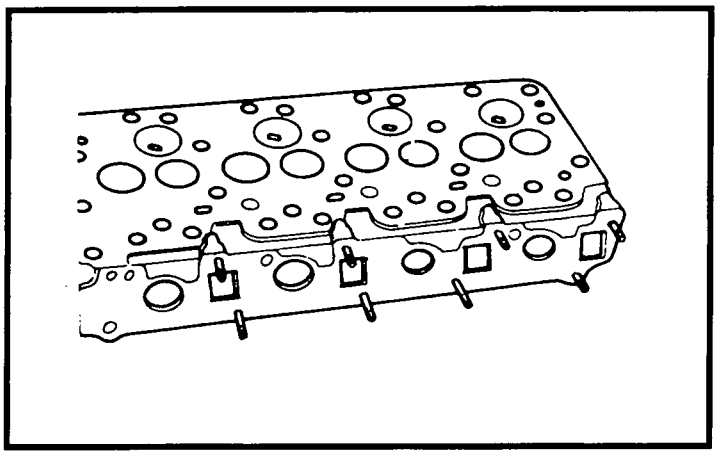
24. Piston pin.



25. Main bearing caps.
26. Main bearings.
27. Thrust bearings.
28. Crankshaft.
29. Tappets.

NOTE:

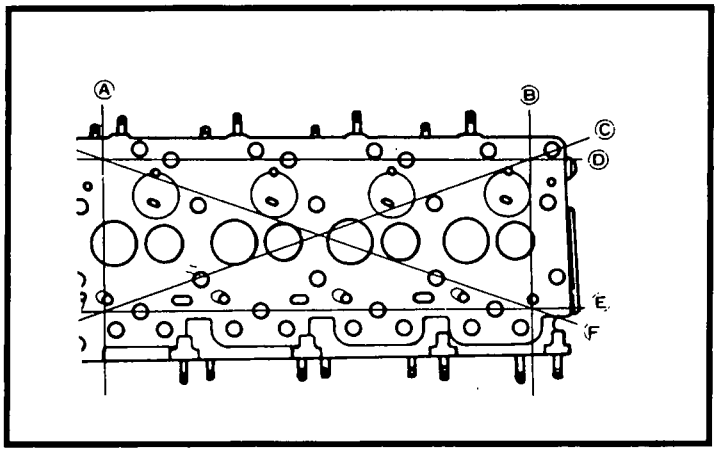
- *Tap bearing caps with a plastic hammer to aid in removal.*
- *Number and arrange bearing caps at every cylinder.*
- *After removing thrust bearings, arrange them so they may be installed in their original order.*



Inspection and Adjustment

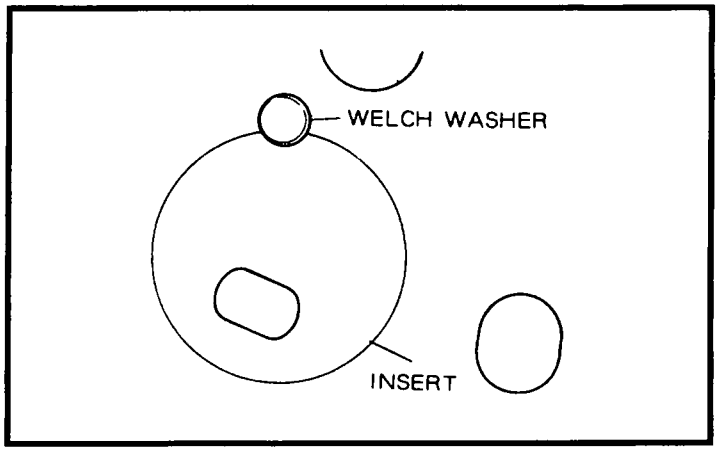
Checking Cylinder Head

1. Check the cylinder head for damage or cracks. If either are noticeable, repair or replace the cylinder head.

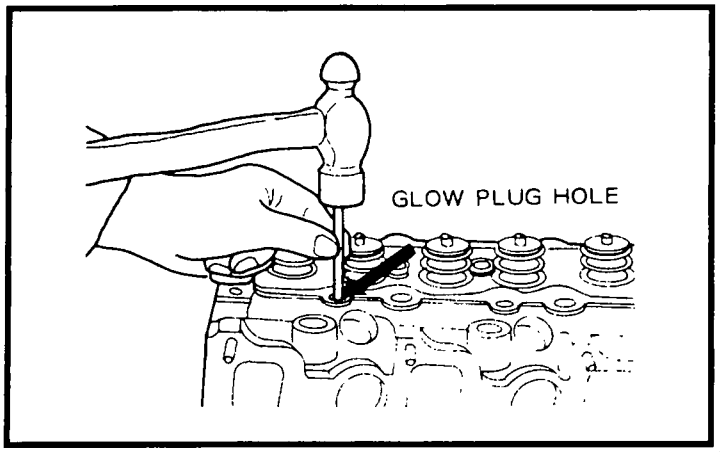


2. Check the cylinder head for distortion. If it exceeds the limit, replace the cylinder head.

A, B: 0.10mm (0.004in.)
C, D, E, F: 0.25mm (0.10 in.)

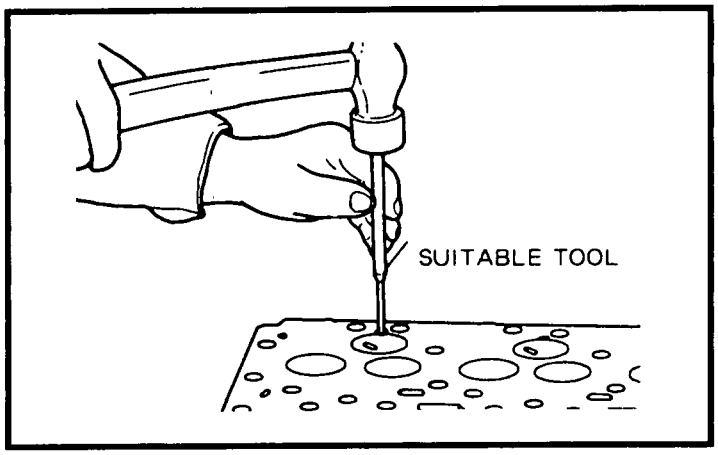


3. Check the insert for damage or cracks. If damaged, replace.

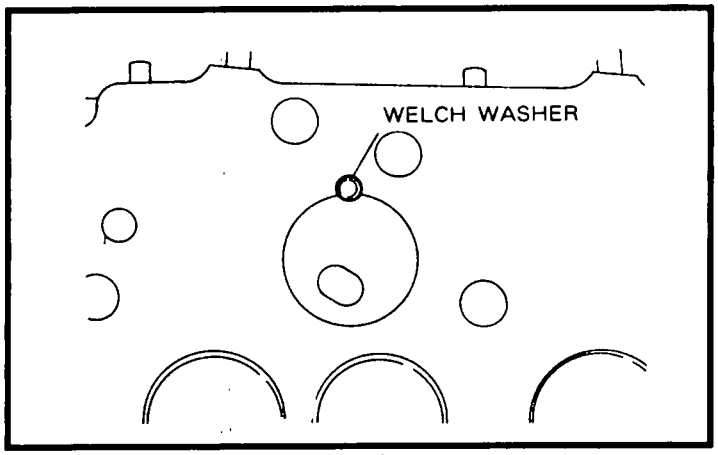


Replacing Combustion Chamber Insert.

1. To remove the insert, strike the insert with a suitable mandrel.

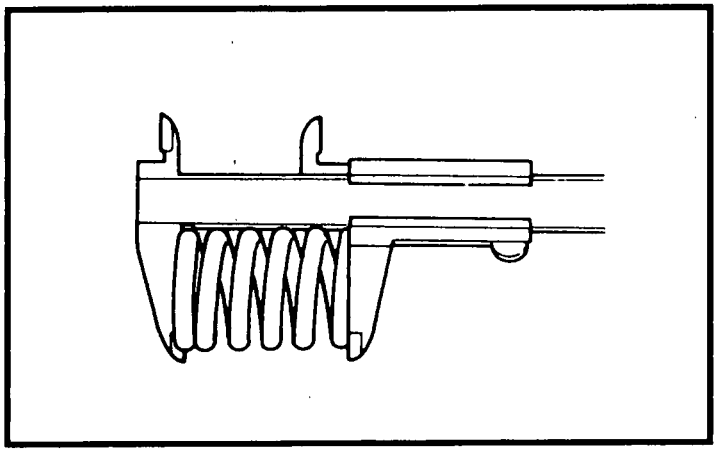


2. To install the insert, at first locate a new insert on the cylinder head. Next fit a welch washer in a recess on the cylinder head. Then expand the welch washer with a suitable tool.



NOTE: *Always replace the welch washer with a new one when replacing an insert.*

NOTE: *After installation of the welch washer, ensure that the insert is properly secured.*

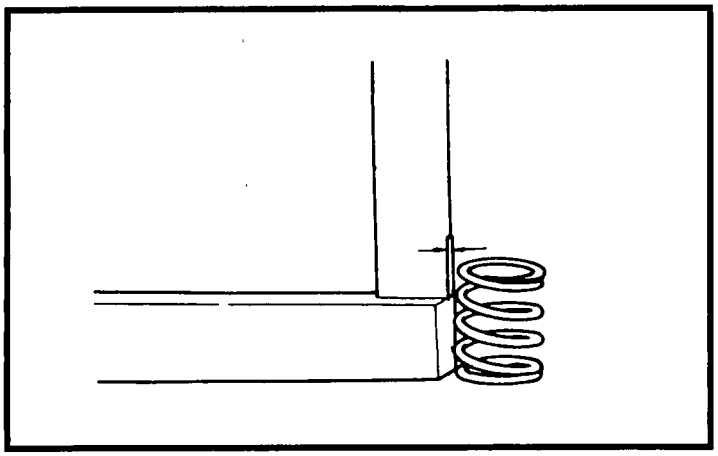


Checking Valve Spring

1. Check the spring for corrosion or damage. If it is severe, replace with a new one.
2. Check the spring length and replace the spring if the free length is less than the following dimension.

Free length limit:

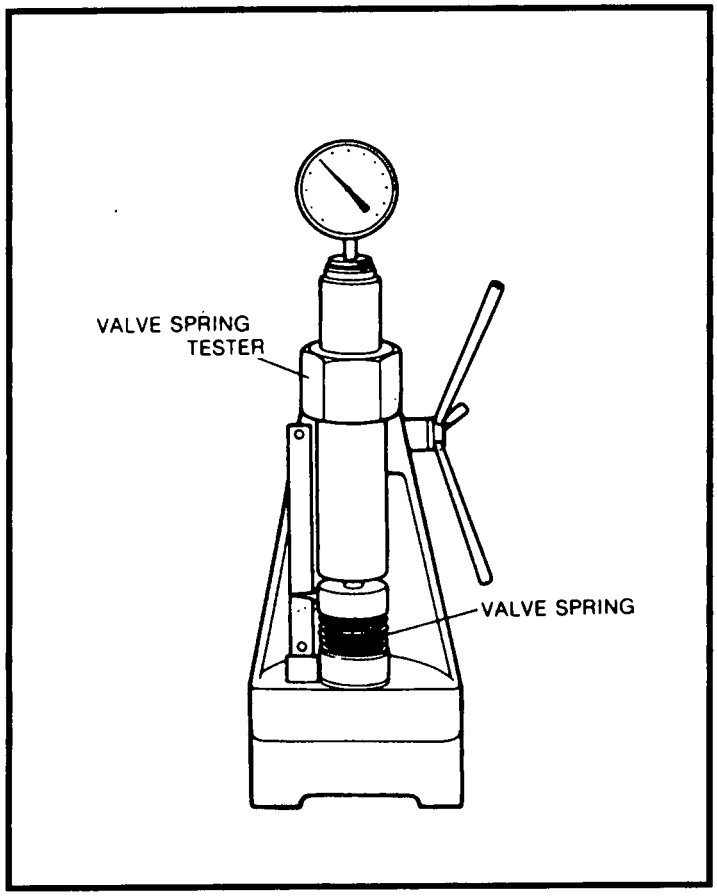
Inner spring: 42.0 mm (1.654 in)
Outer spring: 43.6 mm (1.717 in)



3. Check the squareness of the valve spring with a steel square. If it exceeds the limit, replace it with a new one.

Squareness limit:

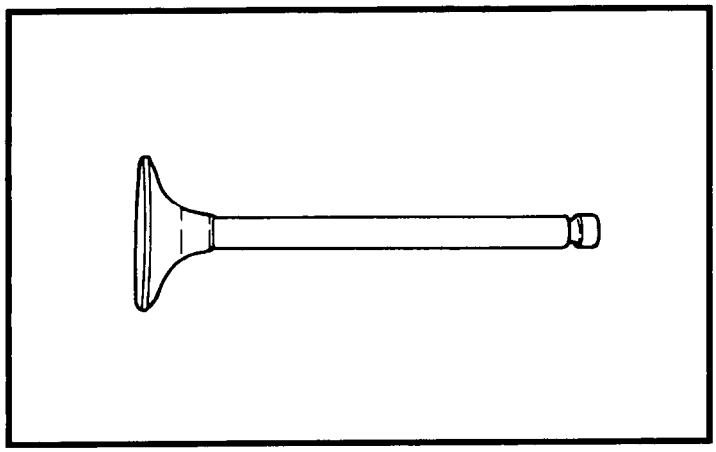
Inner spring: 1.25 mm (0.049 in)
Outer spring: 1.37 mm (0.054 in)



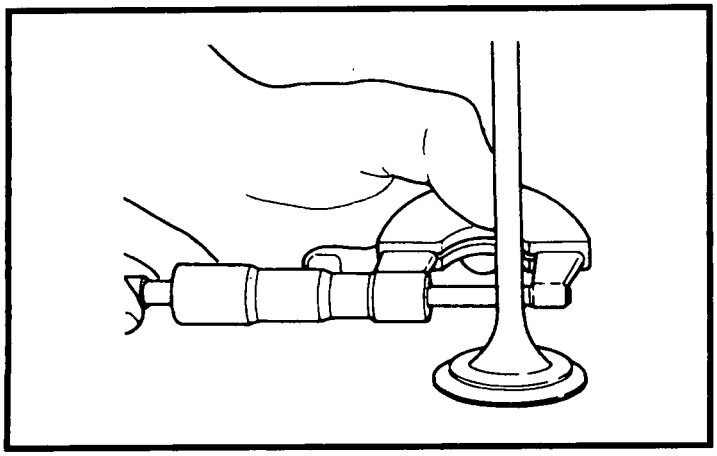
4. Check the fitting tension of the valve spring as follows:
   a) Install the valve spring on a valve spring tester.
   b) Measure the spring tension at the speci fied fitting length. If it is not within the specifi cation, the spring must be replaced.

NOTE: *Measure the spring tension after compressing the spring several times.*

Fitting tension limit:
Fitting Length:
Inner: 37.8 mm (1.488 in)
Outer: 40.3 mm (1.587 in)
Fitting tension limit:
Inner: 10.3 kg (22.7 lb)
Outer: 14.5 kg (32.0 lb)

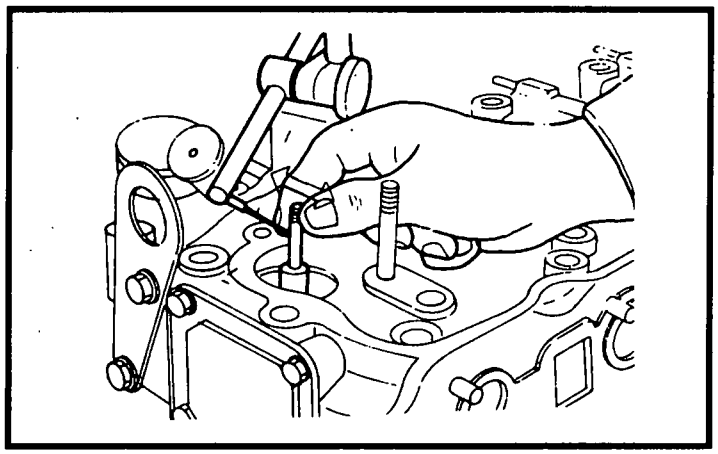


Checking Valve
1. Check all valves for bends, cracks or excessive burning and replace them if any of these conditions are found.



2. Check the valve stem diameter with the micrometer at the top, middle and bottom of the stem. If the wear exceeds limit, replace the valve.

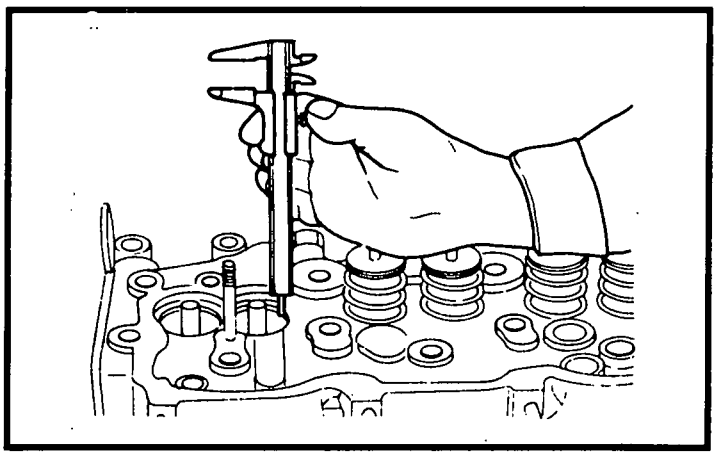
Valve stem diameter limit:
Intake valve: 7.880 mm (0.3102 in)
Exhaust valve: 7.867 mm (0.3097 in)



Checking Valve Guide

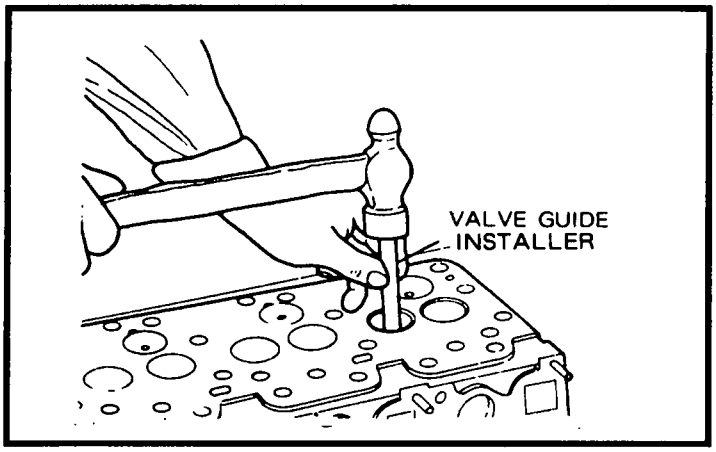
1. Check the clearance between the valve stem and guide with a mounted dial indicator by moving the valve stem back and forth.
If the clearance exceeds the limit, replace the valve and guide.

Clearance limit: 0.127 mm (0.0050 in)



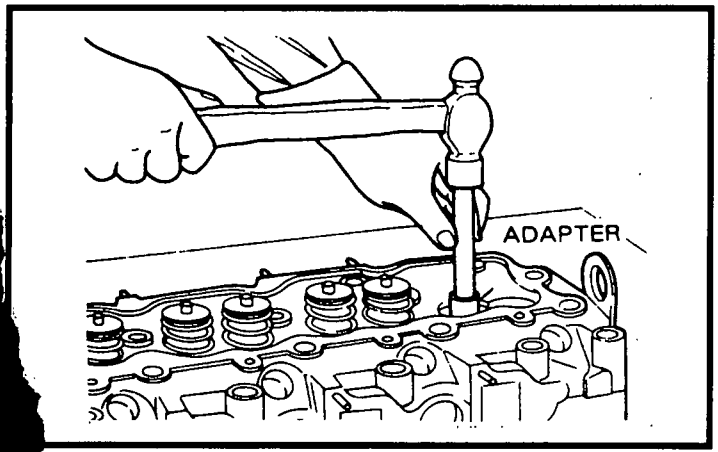
2. Check the protruding length of the valve guide. If it is not within specification, correct it.

Protruding length: 16.5 mm (0.65 in)



Replacing Valve Guide

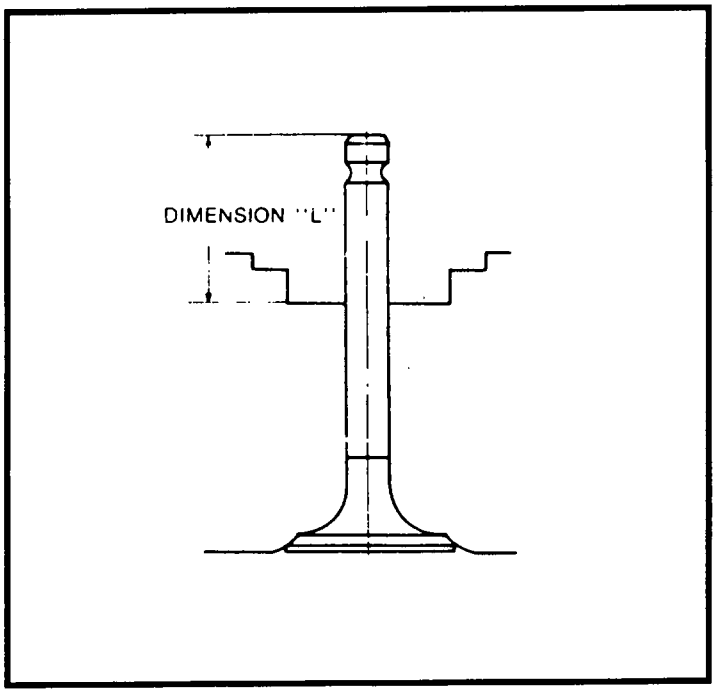
1. To remove the valve guide, press out the guide with a commercially available valve guide installer.



2. To install the valve guide, press fit a new guide into the cylinder headwith a commercially available valve guide installer and adapter, until the adapter comes in contact with the cylinder head.

NOTE: *When installing be careful to press in each new guide squarely and check to see if the valve moves smoothly.*

NOTE: *After installing the valve guide, assure the protruding length of the valve guide.*



Checking Valve Seat

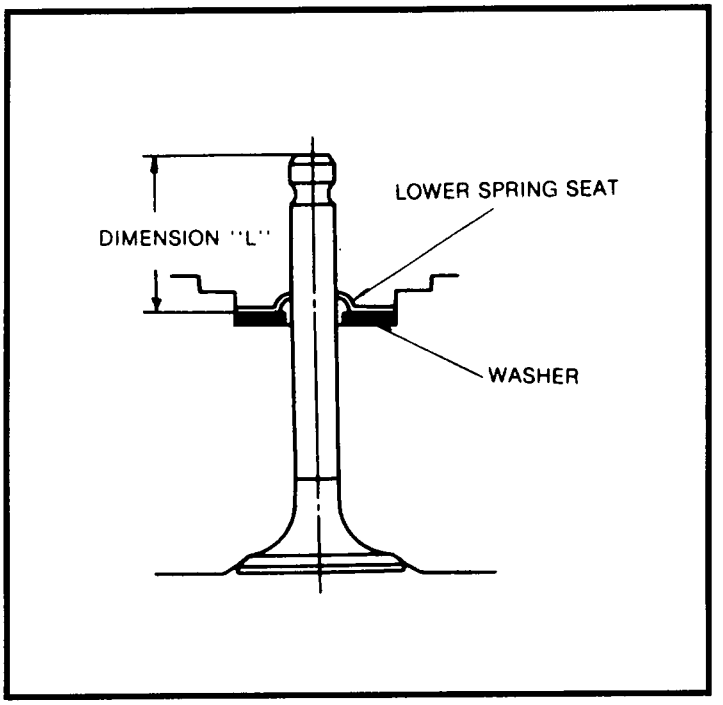
1. Check the protruding length of the valve stem (Dimension "L"), if it exceeds the specification, correct as follows.

Dimension "L" (standard): 48.0 mm (1.890 in)

When Dimension "L" becomes large **(0~0.5 mm)** from the standard:

It is possible to use both of the valves and cylinder head.

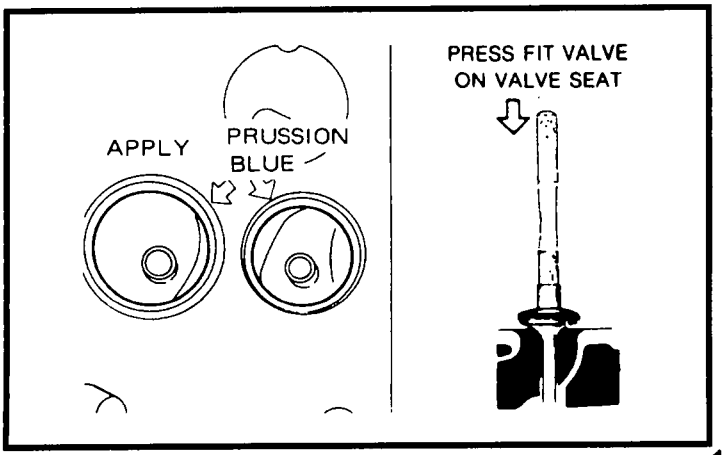
When Dimension "L" becomes large **(0.5~1.5mm)** from the standard: Adjust Dimension "L" to the standard by adding some washers (inner diameter 12.8 mm, outer diameter 39 mm) between the lower spring seat and cylinder head.



When dimension "L" becomes large **(more than 1.5 mm)** from the standard.

Install the valve with a new one, recheck dimension "L".

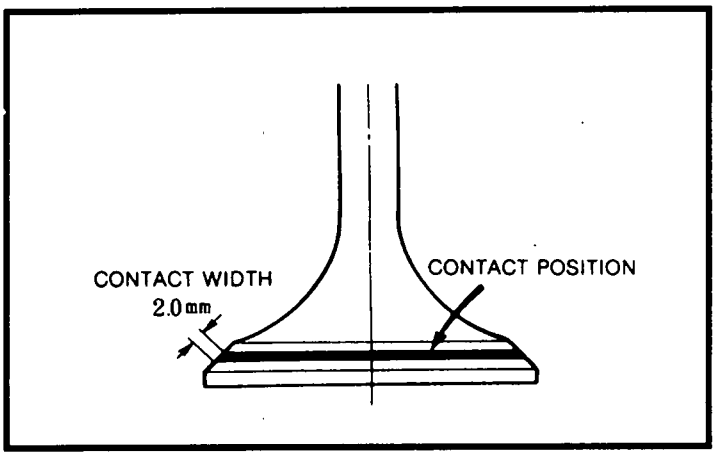
1) When the dimension "L" becomes large **(~0.5 mm)** from standard, replace the valve.
2) When dimension "L" becomes large **(0.5~1.5 mm)** from standard, replace the valve and adjust dimension "L" to the standard by adding washers between the lower spring seat and cylinder head.
3) When dimension "L" becomes large (more than 1.5 mm) from standard, replace both the valve and cylinder head.



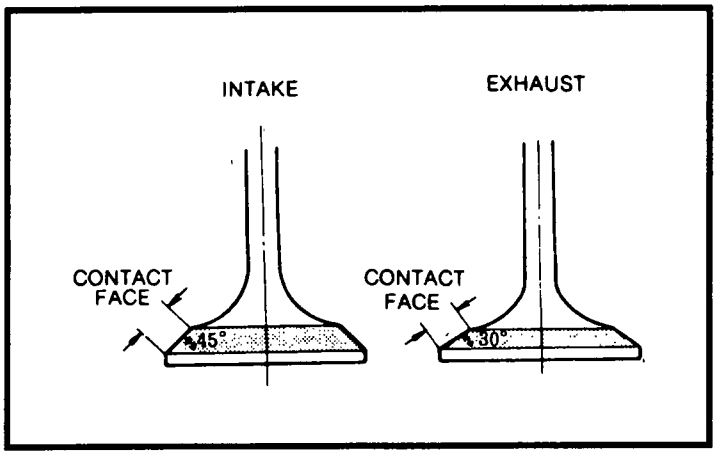
2. Check for contact between valve and valve seat as follows:

1) Apply a thin coat of Prussian Blue (or Red lead) on the valve seat contact face.
2) Insert the valve into the valve guide and press fit the valve on the valve seat.

NOTE: *Do not rotate the valve.*

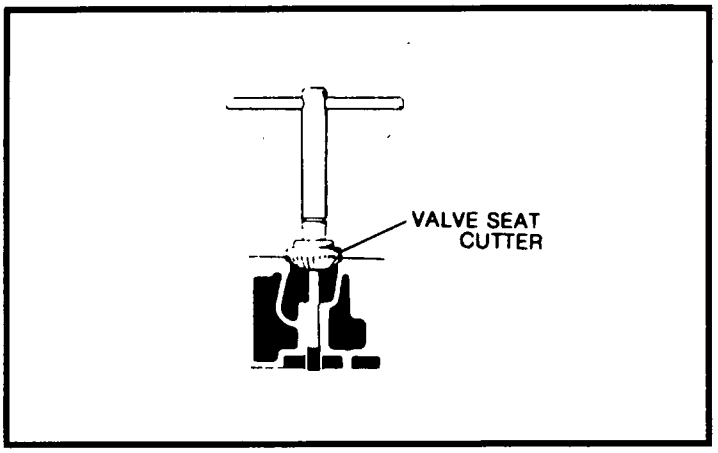


3) Check if the valve seat contact face con tacts the center position of the valve con tact face. If the contact position is not center, repair the valve and valve seat.



Refacing Valve and Valve Seat
Reface in the following order:
1. Raface the valve with the proper valve grinding equipment to the specified angle.

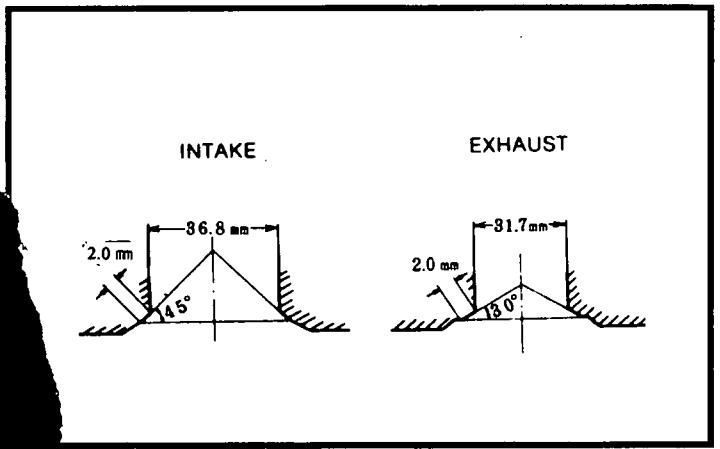
Valve face angle:
Intake valve: 45°
Exhaust valve: 30°



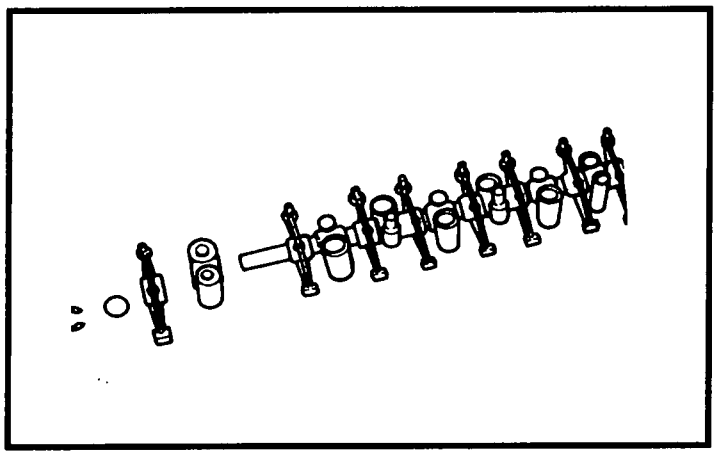
2. Reface the valve seat with the proper valve seat equipment while checking the contact between the valve and valve seat.

Note:
- **Reface the valve seat making sure the valve seat contacts the center position of the valve.**

Valve seat angle:
Intake: 45°
Exhaust: 30°
Valve seat width:
Intake: 2.0mm (0.079 in)
Exhaust: 2.0mm (0.079 in)

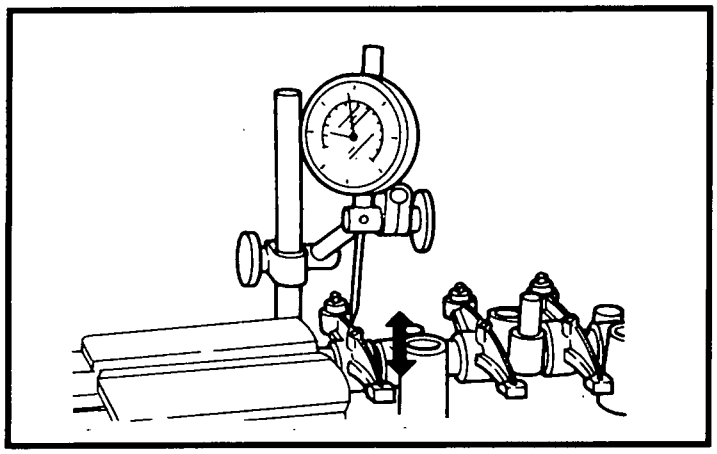


3. Reface the valve and valve seat with a compound.
4. Measure the dimension "L".
5. Adjust the dimension "L" ot the standard by adding some washers between the lower spring seat and cylinder head.



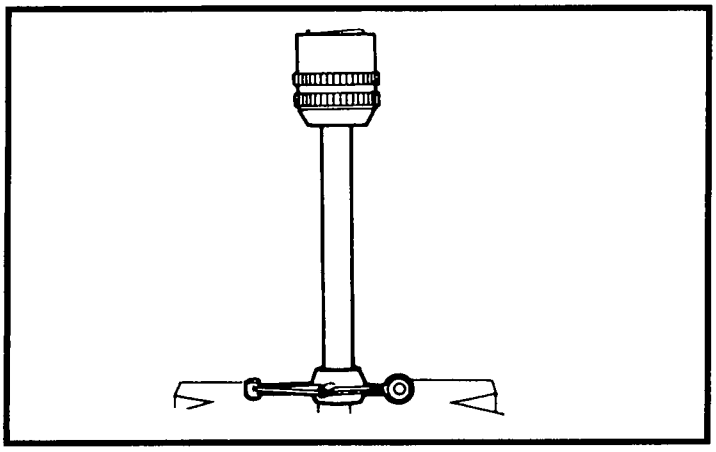
Checking Rocker Arm and Shaft

1. Check the rocker arm assembly for damage or cracks. If it is cracked or damaged, replace with a new one.
2. Check if the oil passages of the rocker arm and shaft are open. If any clogs are found, remove them.



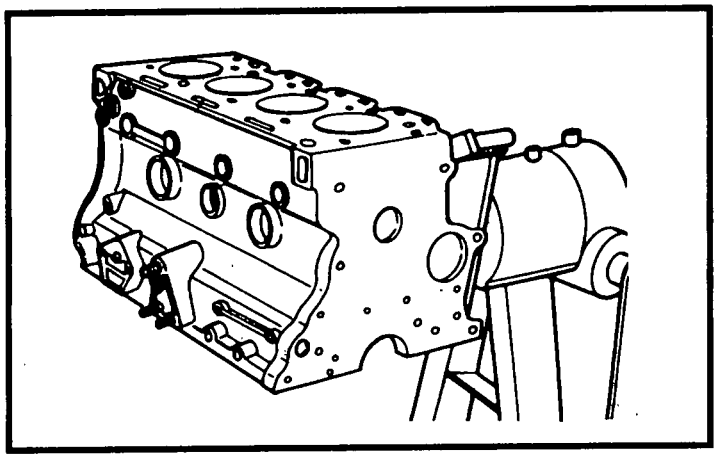
3. Check the clearance between the rocker arm bore and shaft. If it exceeds the limit, replace the rocker arm bushing and shaft.

Clearance between rocker arm and shaft:
Standard: 0.016~0.061 mm (0.0006~0.0024 in)
Limit: 0.07 mm (0.0028 in)



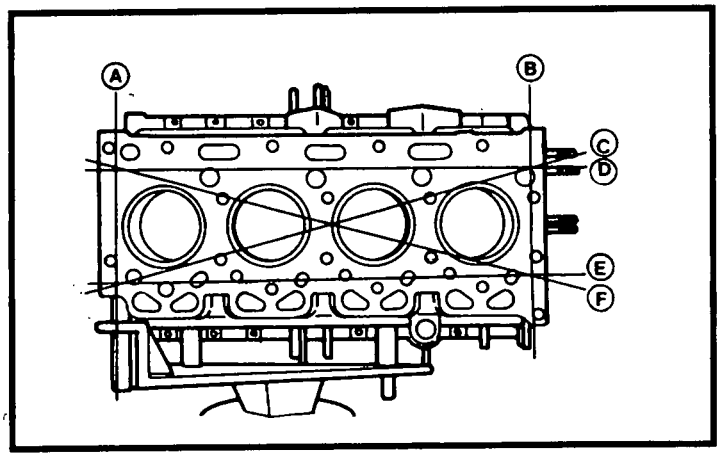
Replacing Rocker Arm Bushing

1. To remove the rocker arm bushing, press out the old bushing with a suitable mandrel.
2. To install the rocker arm bushing, press fit a new bushing, align the oil holes of the bushing and rocker arm.
3. Finish the bushing with a spiral expansion reamer or a pin hole grinder to assure correct fit.



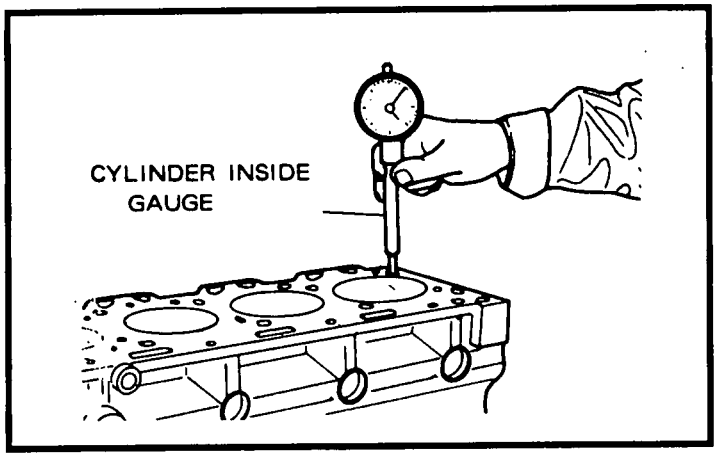
Checking Cylinder Block

1. Check the cylinder block for damage or cracks. If damaged , repair or replace cylinder block.
2. Check if the oil passages and coolant passages of the cylinder block are open. If any clogs are found, remove them with com pressed air, or oil passage cleaning brush.



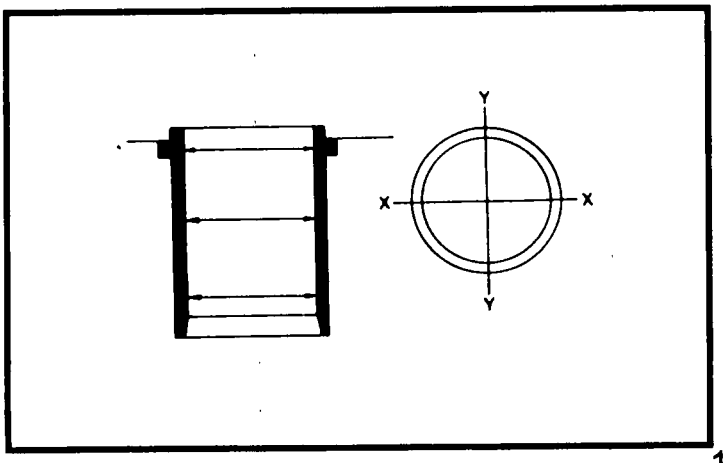
3. Check the cylinder block for distortion. If it exceeds limit, repair or replace the cylinder block.

Max permissable distortion:
A, B: 0.10 mm (0.004 in)
C, D, E, F: 0.25 MM (0.010 in)



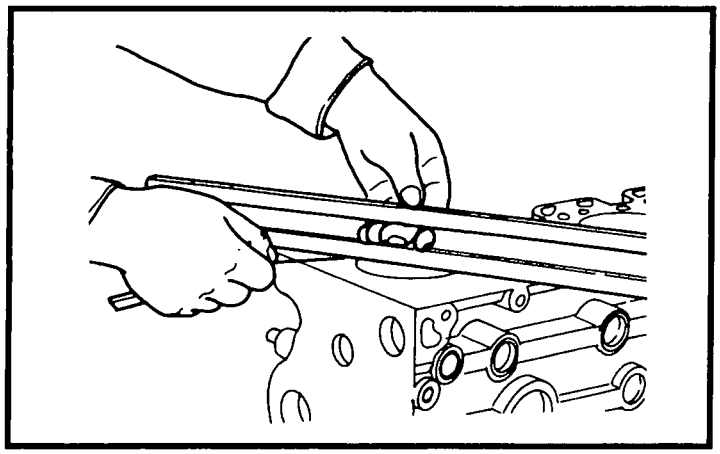
Checking Cylinder Liner

1. Check the cylinder loner bores for streching and waveness. If it is severe, replace the cylinder liner.
2. Check the cylinder liner for wear with a cylinder inside gauge. If it exceeds the limit, replace the cylinder liner.



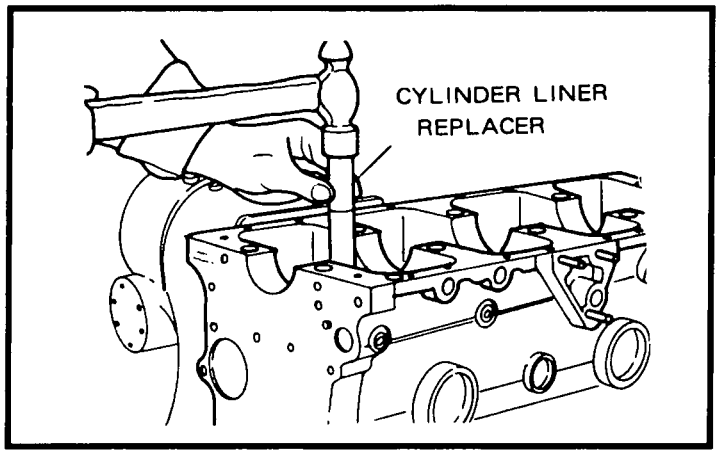
NOTE: *This measurement should be taken in the X-X direction and the Y-Y direction at each of the three sections, upper, middle and lower, of one cylinder.*

Cylinder liner bore:
Standard: 880925~88.950 mm
(3.5010~3.5020 in)
Wear limit: 0.20 mm (0.0079 in)



3. Check the protruding height of the liner with a straight edge and a feeler gauge. If it exceeds the specified value, re-press fit the liner.

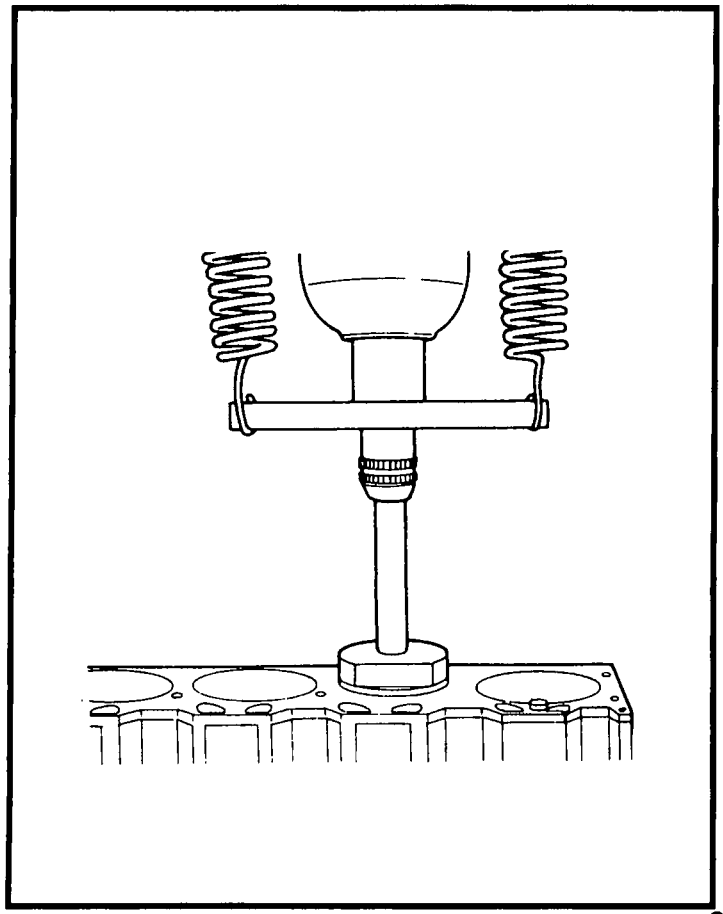
Protruding height:
0.659~0.790 mm (0.0259~0.0311 in)



Replacing Cylinder Liner

a. Removal

1. Press out the old cylinder liner with a commercially available liner tool.
2. Check the cylinder block bore for any scratch es. If any scratches are found, remove the scratches with a oil soaked fine emery paper.

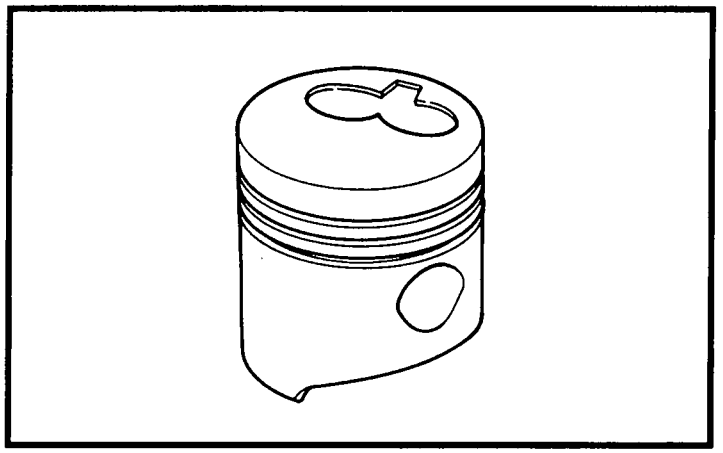


b. Installation

1. Apply engine oil to the cylinder block bore and the outer surface of the new liner and set the liner on the cylinder block.
2. Press fit the new cylinder liner taking extreme care not to distort the new liner.

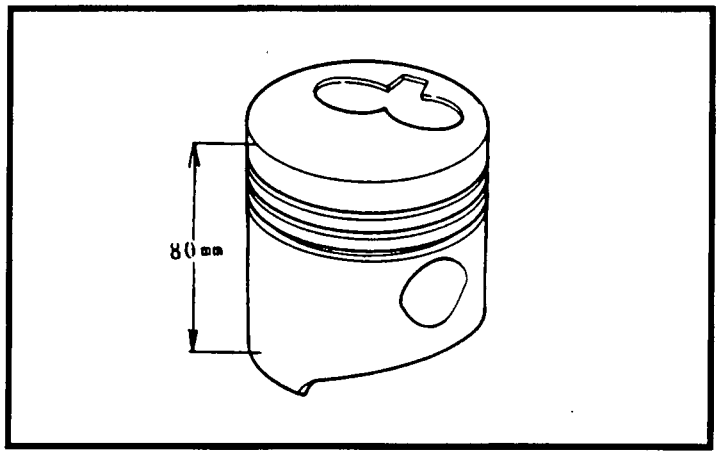
NOTE: *When inserting the liner into the cylinder block, press fit it within the limits of 1.0~3.0 ton. If the pressing force exceeds the limits, find the problem and exclude it.*

After installing the liner, check the protruding height of the liner.



Checking Piston

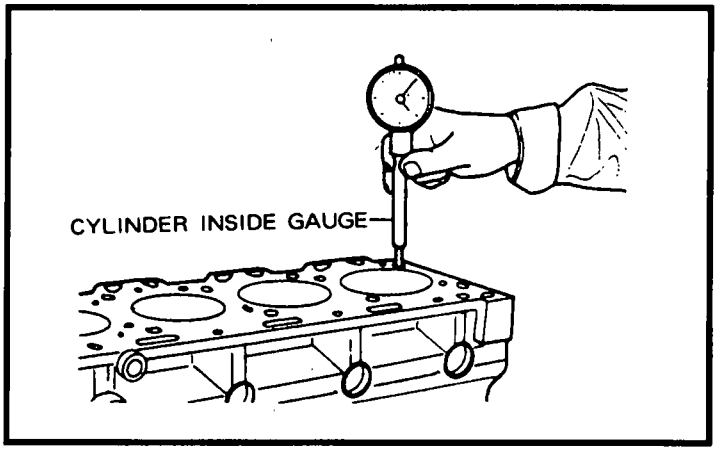
1. Check the piston carefully, replace it if it is severely scored, scratched or burned.

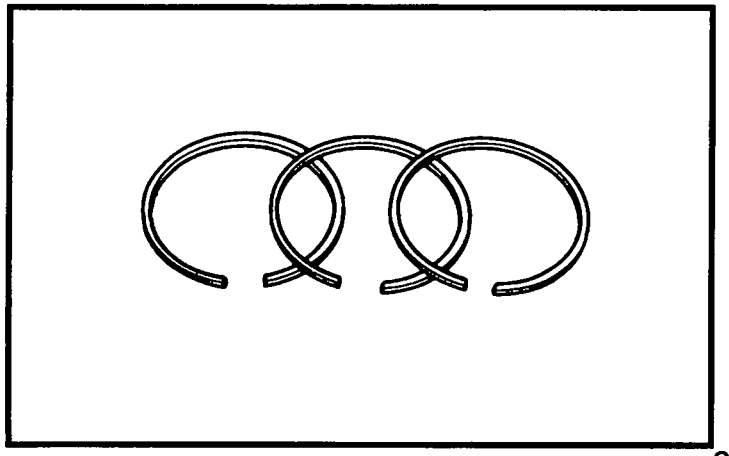


2. Check the clearance between the piston and cylinder liner bore. If wear is excessive, the piston and liner must be replaced.

NOTE: *Measure the piston diameter at 90° (perpendicular) to the pin bore axis and 80 mm (3.15 in) below the piston top.*

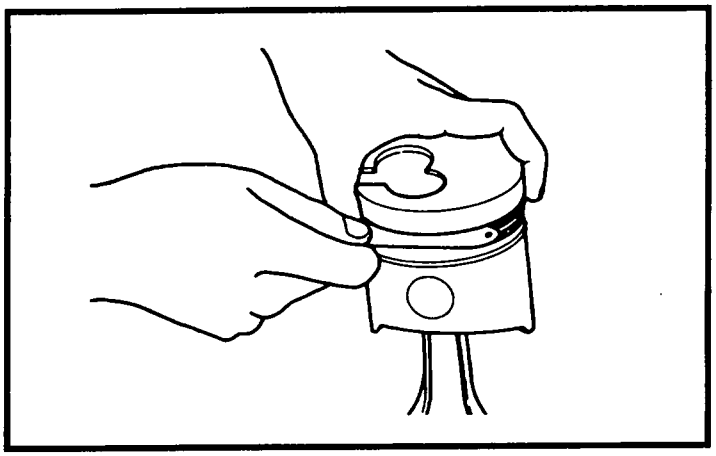
Piston clearance:
0.044~0.070 mm (0.0017~0.0028 in)





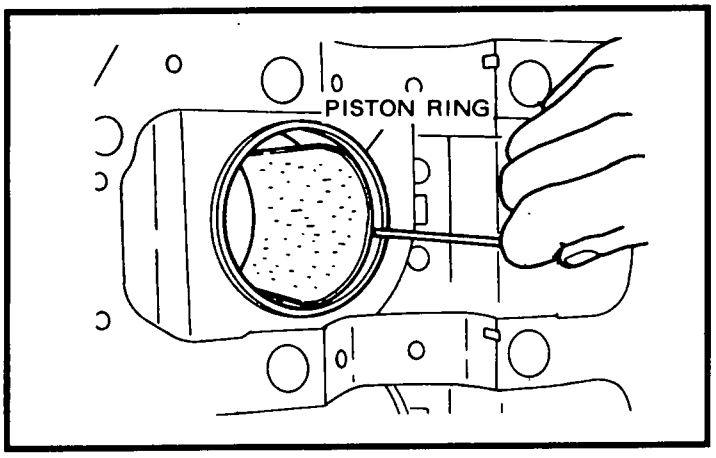
Checking Piston Ring

1. Check the piston ring for snapping, burning or wear. If it is severe, replace the ring.



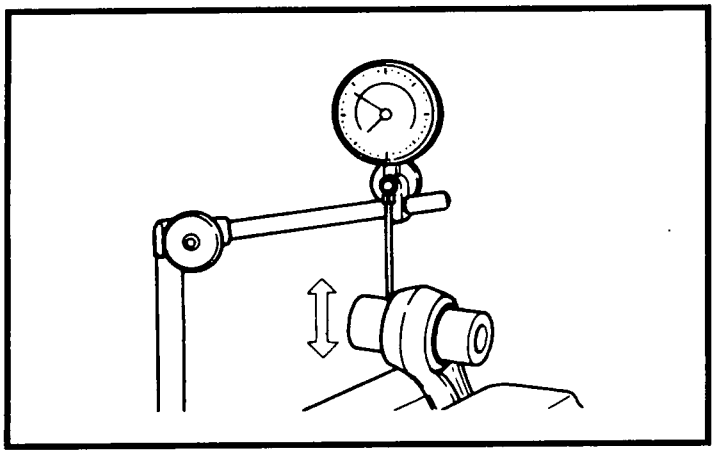
2. Check the side clearance of the piston rings at several places. If they exceed the limit, replace the piston rings or piston.

Side clearance limit: 0.30 mm (0.0118 in)



3. Check the piston ring end gap as follows:
   1) Place the piston ring in the cylinder liner bore below the ring travel by using a piston head to push the ring in squarely.
   2) Measure the piston ring end gap. If it exceedsthe limit, replace the piston ring.

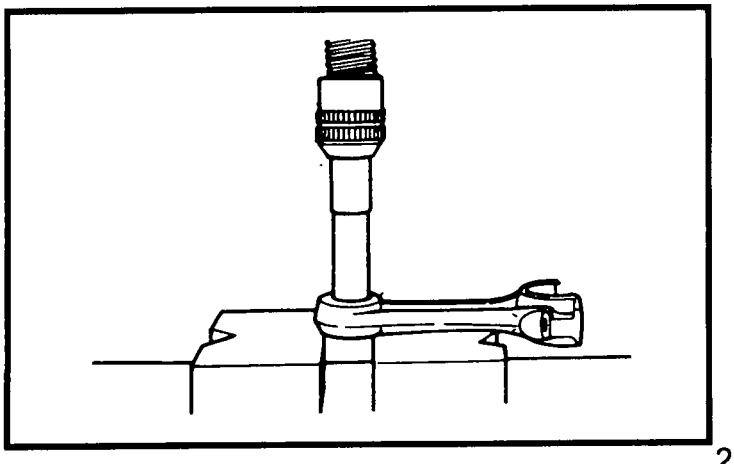
End gap limit: 1.5 mm (0.0591 in)



Checking Piston Pin and Connecting Rod Bushing

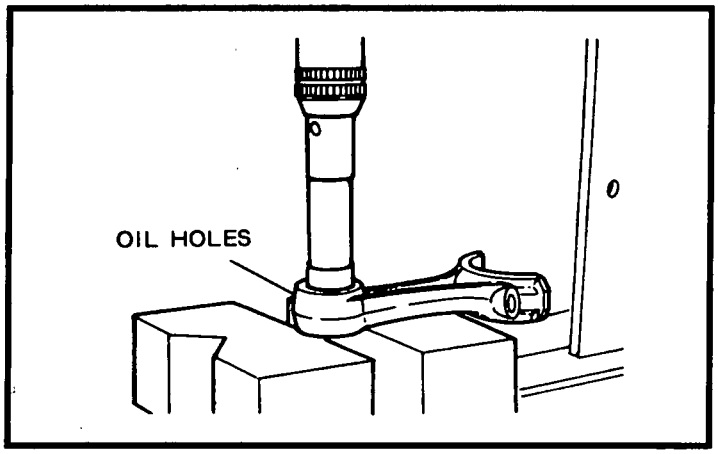
1. Check the clearancebetween the piston pin and connecting rod bushing shown in Figure. If it exceeds the limit, replace the piston pin and bushing.

Clearance between piston pin and bushing:
Standard: 0.014!0.041 mm
(0.0006~0.0016 in)
Limit: 0.05 mm (0.0020 in)

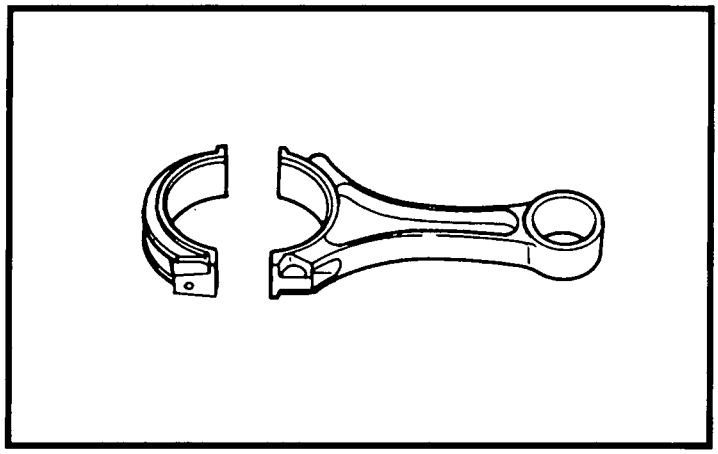


Replacing Connecting Rod Bushing

1. To remove remove the connecting rod bushing, press out the old bushing with a suitable mandrel.

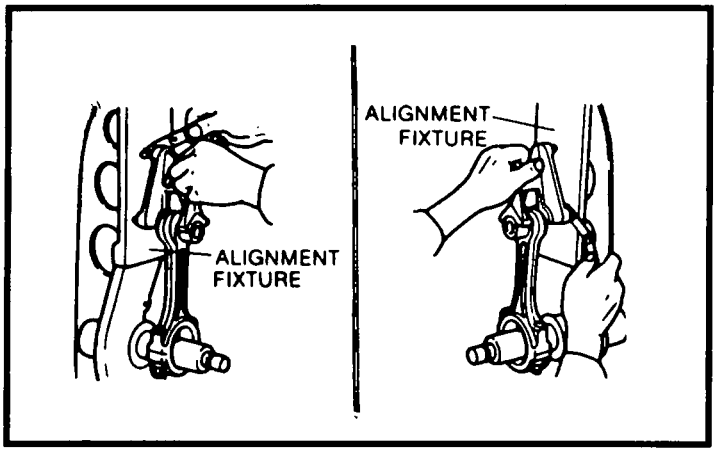


2. To install the connecting rod bushing, press fit a new bushing aligning the oil holes of the bushing and connecting rod.
3. Finish the bushing with a spiral expansion reamer or a pin hole grinder to assure the correct fit.



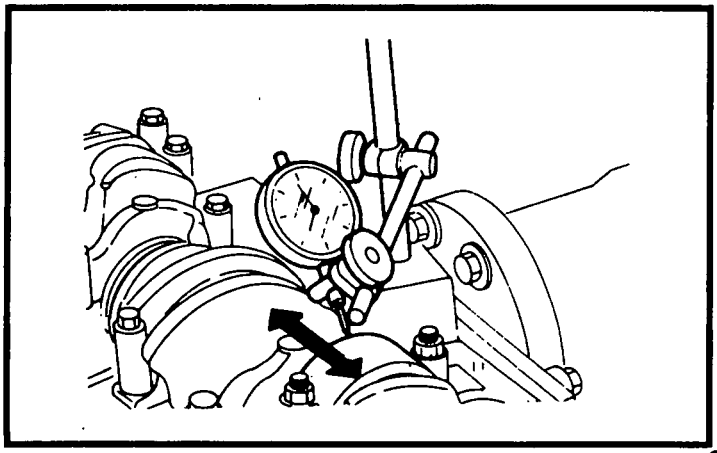
Checking Connecting Rod

1. Check the side of the connecting rod small end and large end for cracks or damage. If there is any damage, replace the connecting rod.



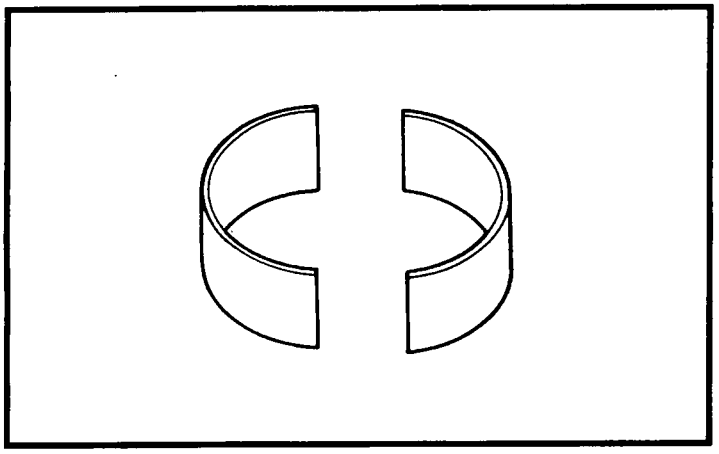
2. Check the connecting rod for bends or twists with a suitable alignment fixture. If realignment is necessary, correct by using a press and applying a gradual pressure to the end of the rod or replace the connecting rod.

Permissible deflection:
0.05 mm per 100 mm
(0.0020 in per 4 in)



3. Check the connecting rod end play with a dial indicator or a feeler gauge as shown in the Figure. If it exceeds limit, replace the connecting rod or crankshaft.

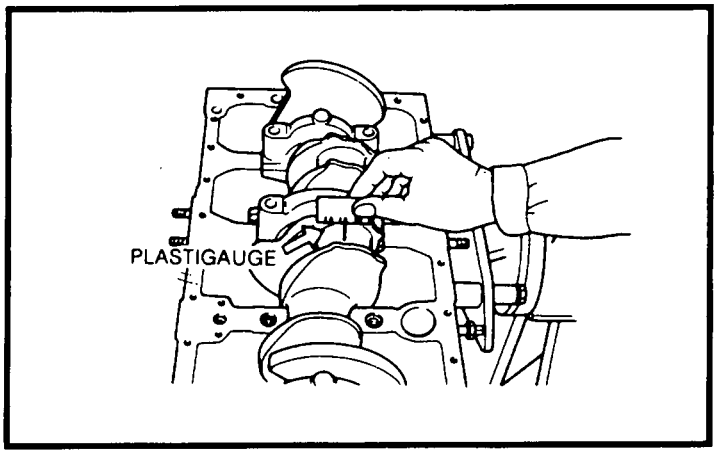
End play limit:
0.4 mm (0.0157 in)



Checking Connecting Rod Bearing

1. Check the connecting rod bearing carefully and replace if worn scratched or flaked.

NOTE: *It is recommended to replace bearings any time the engine is rebuilt.*



2. Check the connecting rod bearing clearance with a "Plastigauge". If it exceeds the limit, correct the crankpin with a suitable grinder and use it with a suitable undersize bearing.

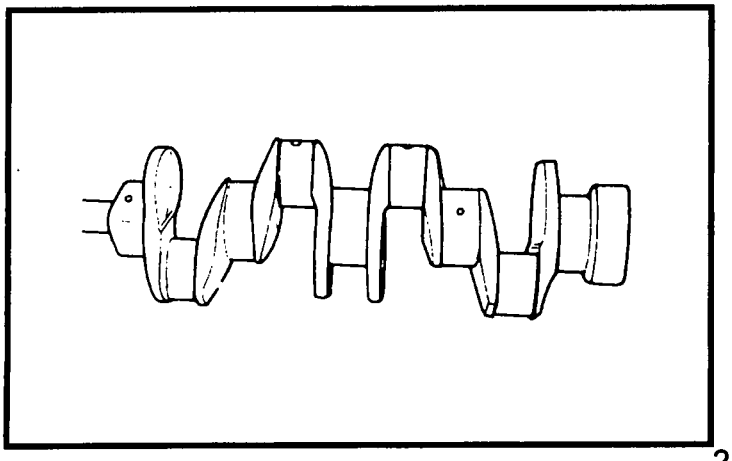
NOTE: *Tighten the connecting rod cap bolts to the specified torque.*

Cap tightening torque (14 mm):
6.9~7.5 m-kg (50~54 ft-lb)

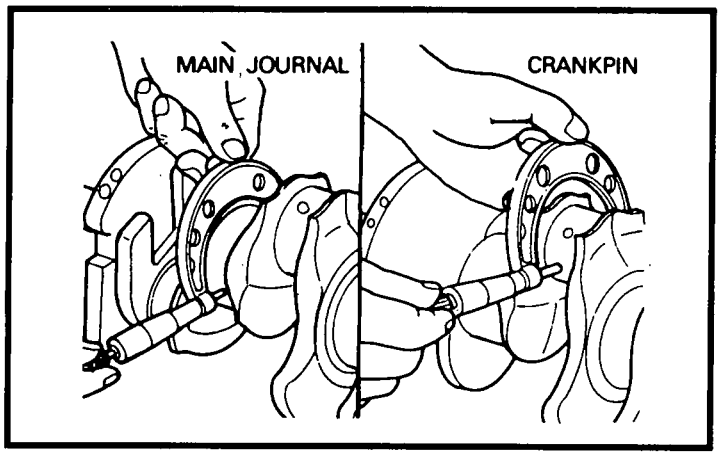
Bearing clearance:
Standard: 0.036~0.076 mm
(0.0014~0.0030 in)
Limit: 0.10 mm (0.0039 in)

Checking Crankshaft

1. Check the crankshaft for damage or cracks. If it is severe, replace the crankshaft.
2. Check if the oil passages of the crankshaft are open. If any clogs are found, remove them with compressed air or a oil passage brush.

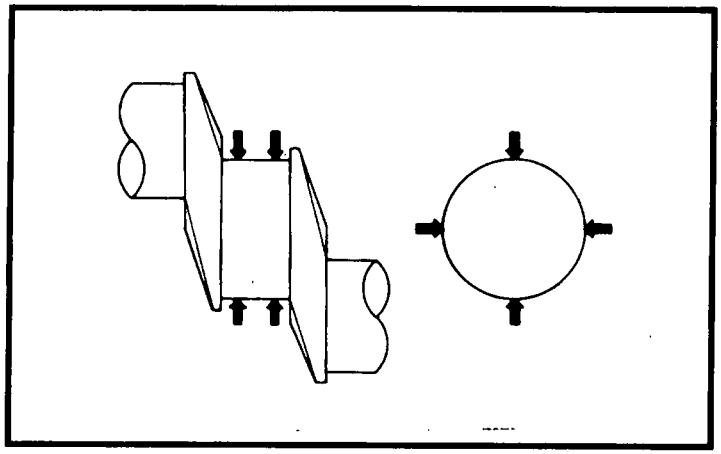


Undersize bearing:
0.254 mm (0.010 in)
0.508 mm (0.20 in)
0.762 mm (0.030 in)



3. Check the crankshaft for wear. If it exceeds the limit, correct the crankshaft via a crankshaft grinder, and utilize a compatable under size bearing.

NOTE: *Measure the diameter of each of the crankpin and main journal at two points (the front and rear portions) at 90° to the crankshaft axis, as shown in the Figure.*



Diameter:

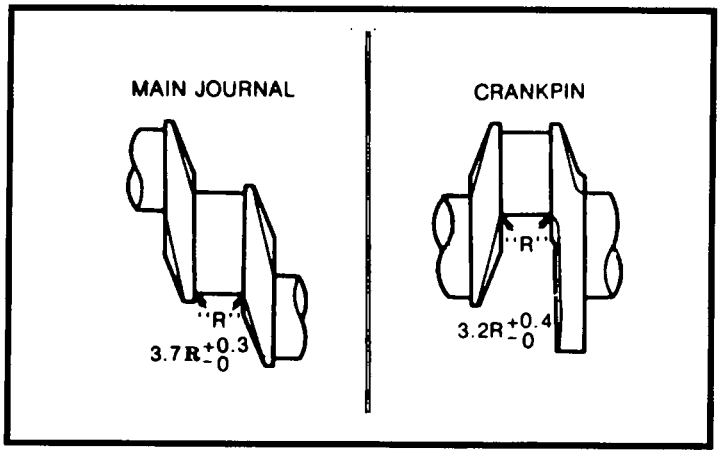
Main journal: 64.987~65.000 mm (2.5585~2.5591 in)

Crankpin: 52.987~53.000 mm (2.0861~2.0866 in)

Wear limit:

Main journal: 0.05 mm (0.0020 in)

Crankpin: 0.05 mm (0.0020 in)



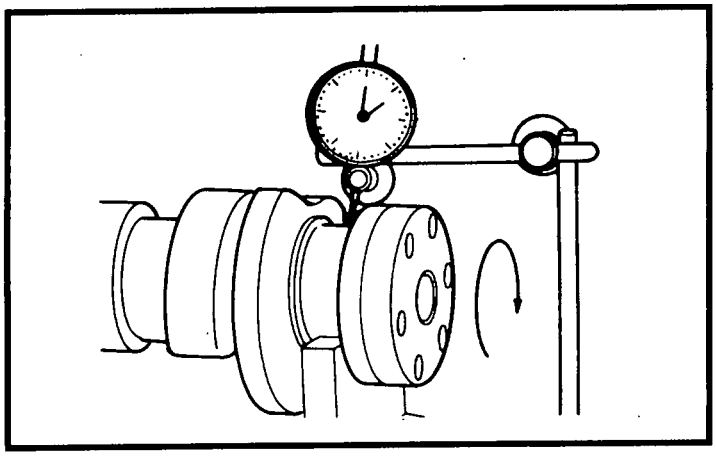
When correcting the crankshaft, take care on the following points.

1) When correcting the crankshaft, finish the place of "R" as shown in the Figure.

2) The crankshaft processing diameters are as shown in the table below. **U.S. = undersize**

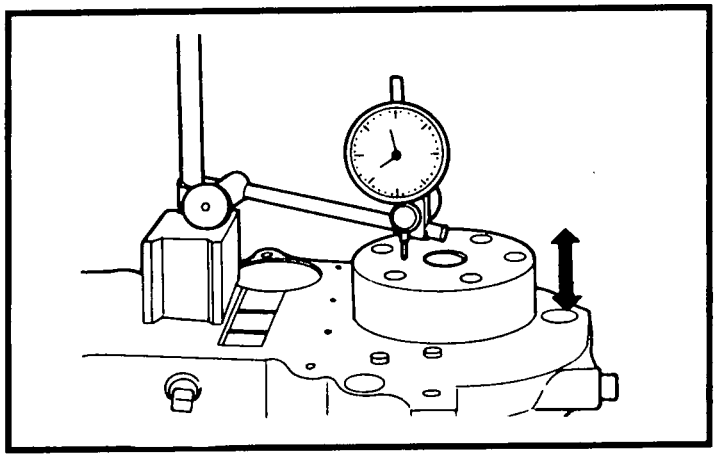
Processing diameter (Main journal) Bearing size
U.S. 0.254: 64.733~64.746 mm (2.5485~2.5491 in)
U.S. 0.508: 64.479~64.492 mm (2.5385~2.5391 in)
U.S. 0.762: 64.225~64.238 mm (2.5285~2.5291 in)

Processing diameter (Crankpin) Bearing size
U.S. 0.254: 52.733~52.746 mm (2.0761~2.0766 in)
U.S. 0.508: 52.479~52.492 mm (2.0661~2.0666 in)
U.S. 0.762: 52.225~52.538 mm (2.0561~2.0566 in)



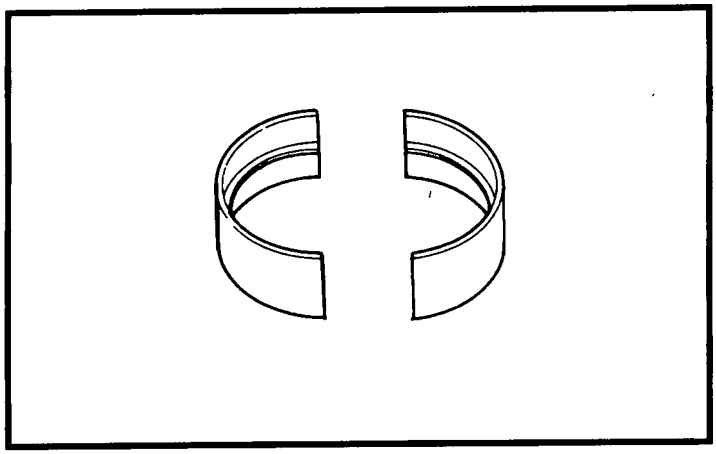
4. Check the crankshaft alignment. If it exceeds the limit, replace it with a new one.

Maximum allowable run-out:
0.5 mm (0.020 in)



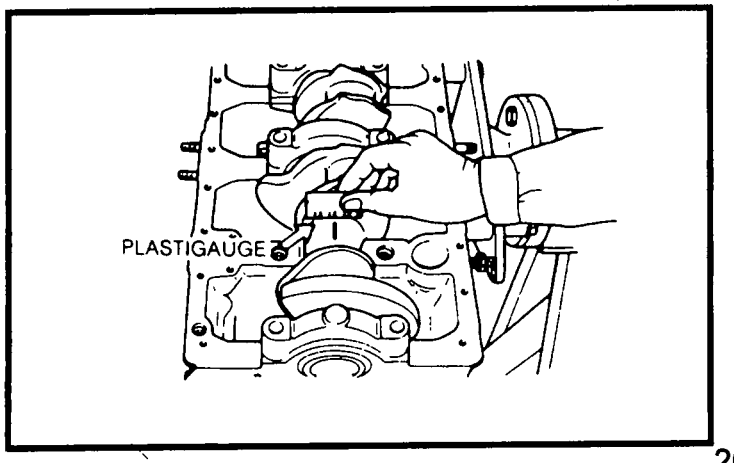
5. Check the crankshaft end play with a dial indicator or a feeler gauge as shown in the Figure. If it exceeds the limit, replace the thrust bearing with an oversized thrust bearing of **0.178 mm (0.007 in).**

End play limit: 0.40 mm (0.0157 in)



Check Main Bearing

1. Check the main bearing carefully and replace if it is worn, scored or flaked.



2. Check the main bearing clearance with a "Plastigauge". If it exceeds the limit, correct the main journal with a crankshaft grinder and install a suitable undersize bearing.

NOTE: *Tighten the mein bearing cap bolts to the specified torque.*

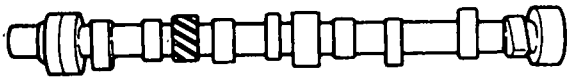
Cap tightening torque (¾"):
11.0~11.7 m-kg (80~85 ft-lb)

Bearing clearance:

Standard: 0.040~0.091 mm (0.0016~0.0036 in)

Limit: 0.12 mm (0.0047 in)

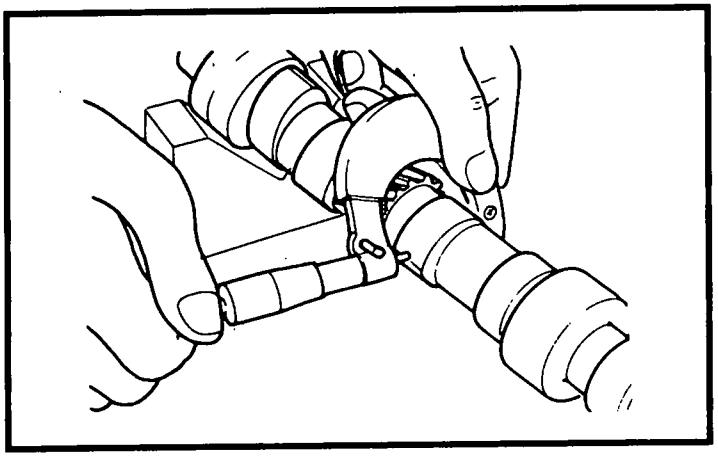
Undersize bearing:
0.254 mm (0.010 in)
0.508 mm (0.020 in)
0.762 mm (0.030 in)



Checking Camshaft

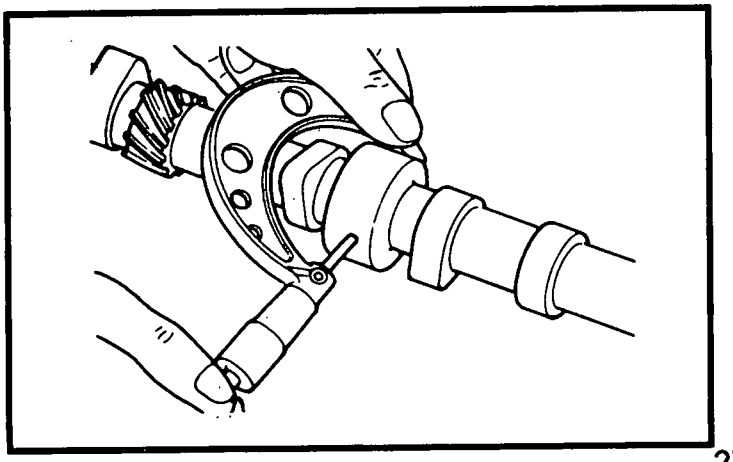
1. Check the camshaft for damage or cracks, also check the cut gear on the camshaft for excessive wear.

NOTE: *If there are ANY signs of significant wear, replace the camshaft.*



2. Check the cam height and replace the camshaft if wear exceeds limit.

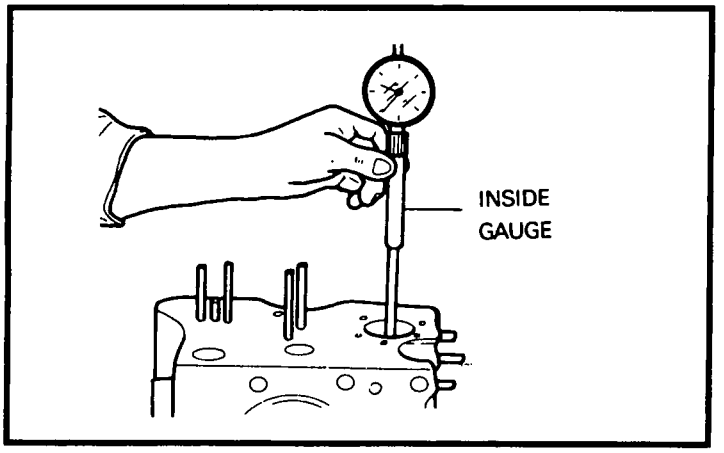
Cam height limit:
42.485 mm (1.6728 in)



3. Check the camshaft journal for wear. If it exceeds limit, replace the camshaft.

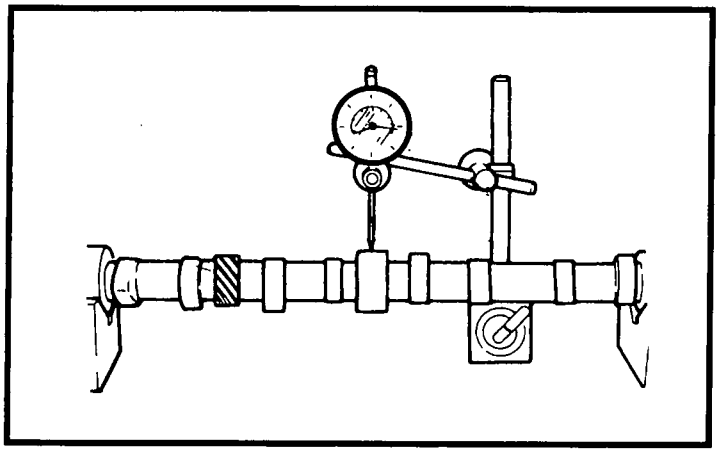
Journal diameter:
No. 1: 51.910~51.940 mm (2.0437~2.0449 in)
No. 2: 51.660~51.690 mm (2.0339~2.0350 in)
No. 3: 51.160~51.190 mm (2.0142~2.0154 in)

Wear limit:
No. 1: 0.008 mm (0.0003 in)
No. 2: 0.008 mm (0.0003 in)
No. 3: 0.008 mm (0.0003 in)



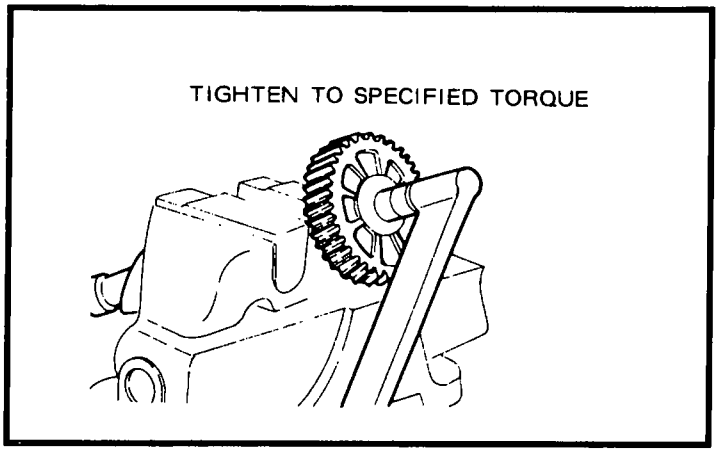
4. Check the clearance between the camshaft journal and camshaft support bore as follows:
   1) Measure the camshaft journal diameter and camshaft support bore.
   2) Calculate the clearance and replace the camshaft or cylinder block if the clearance exceeds the limit.

Clearance limit: 0.145 mm (0.0057 in)



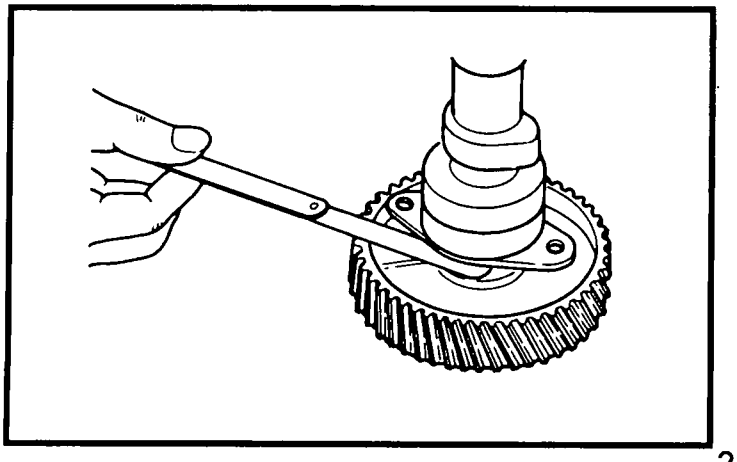
5. Check the camshaft alignment. If it exceeds the limit, replace it with a new one.

Maximum allowable run-out:
0.08 mm (0.0031 in)



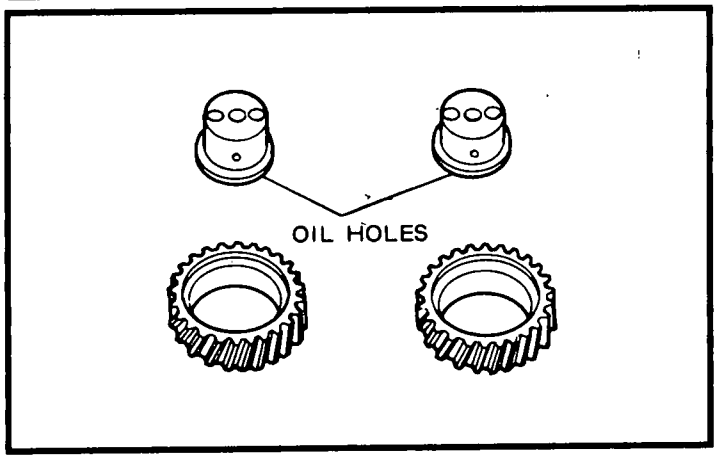
6. Check the camshaft end play as follows:
   1) Install the thrust plate, camshaft gear, friction gear, lock plate and camshaft gear lock bolt on the camshaft.
   2) Tighten the lockbolt to the specified torque.

Tightening torque (19 mm):
6.2~ 7.0 m-kg (45~51 ft-lb)



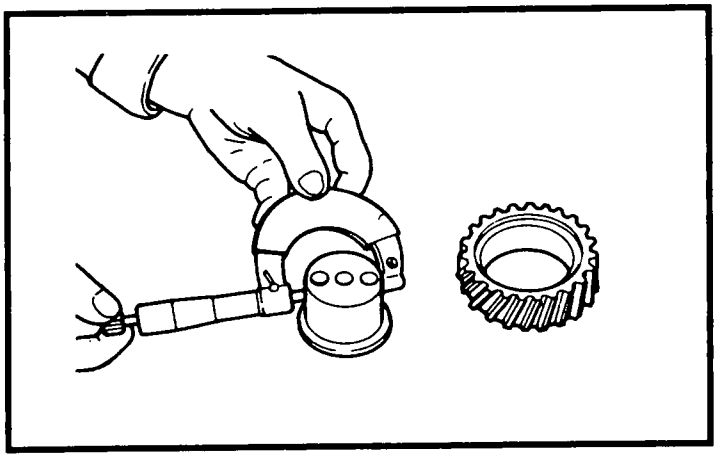
3) Measure the clearance bertween the thrust plate and camshaft. If it exceeds the limit, replace the thrust plate.

End play limit: 0.30 mm (0.0118 in)



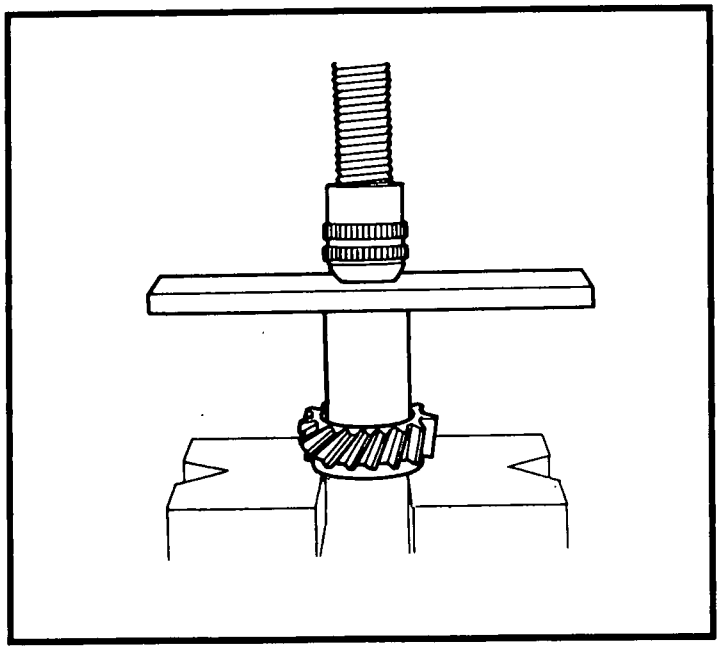
Checking Idle Gear Bushing and Spindle

1. Check the bushing and spindle for chipped, worn or broken teeth and replace it if it's severe.
2. Check if the oil passages of the spindle are open. If any clogs are found, remove them.



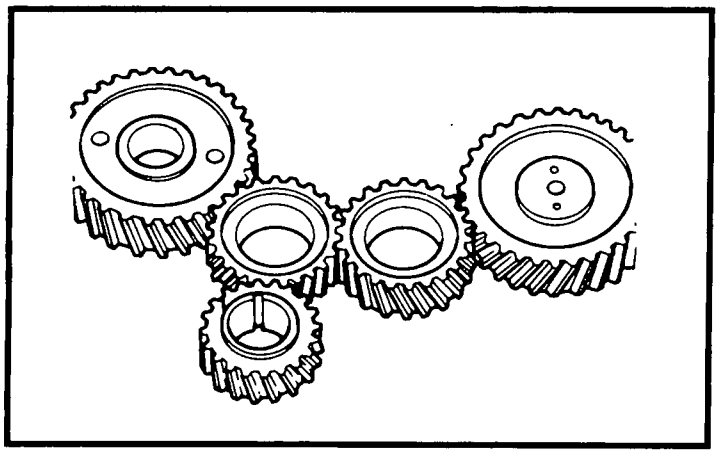
3. Check the clearance between the bushing and spindle by measuring the bushing bore and spindle diameter.

Clearance between bushing and spindle:
Standard:
0.034~0.084 mm (0.0013~0.0034 in)
Limit:
0.15 mm (0.0059 in)



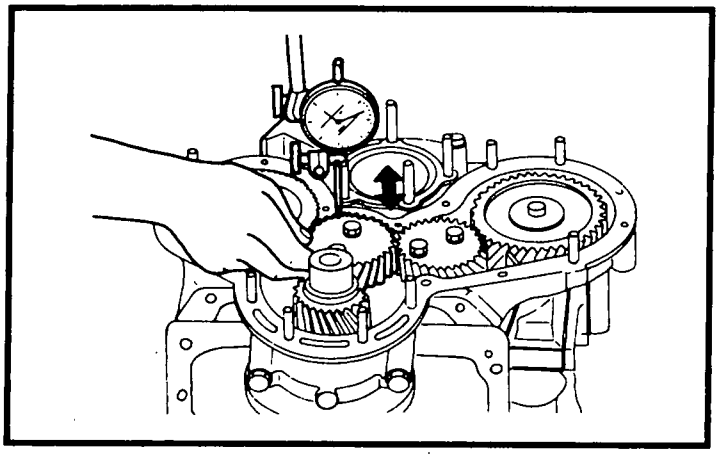
Replacing Idle Gear Bushing

1. To remove the idle gear bushing, press out the old bushing with a suitable mandrel.
2. To install the idle gear bushing, press fit a new bushing with a suitable mandrel.
3. Finish the bushing with a spiral expansion reamer or a pin hole grinder to assure the correct fit.



Checking Gear

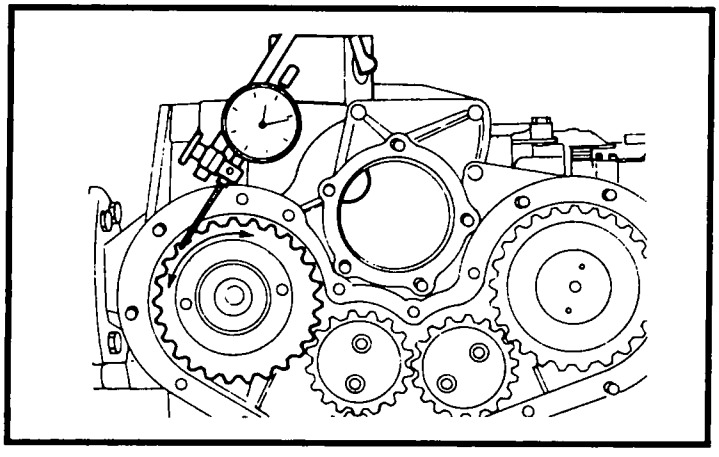
1. Check the gears (idle gears, injection pump drive gear, crankshaft gear, camshaft gear) for cracks or damage. If the damage is severe, replace as required.



2. Check the idle gear end play with a dial indicator as shown in the Figure. If it exceeded the specified value, replace the thrust plate or idle gear.

NOTE: *Measure the end play after tightening the idle gear attaching nuts to the specified value.*

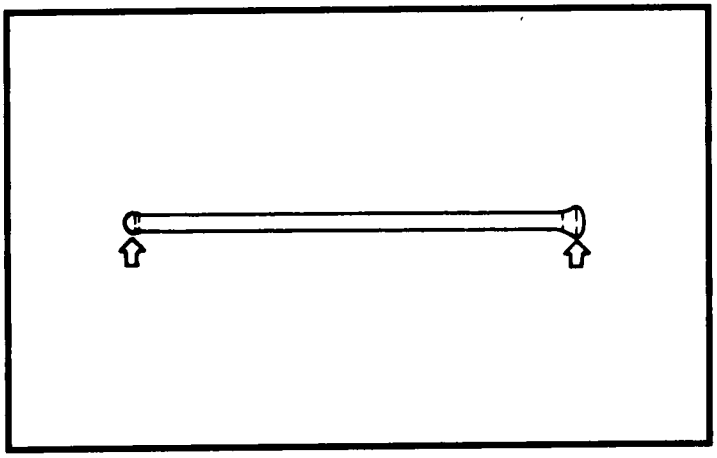
Thrust plate tightening torque (½")
2.3~3.2 m-kg (17~23 ft-lb)



End play standard:
0.20~0.30 mm (0.0079~0.0118 in)

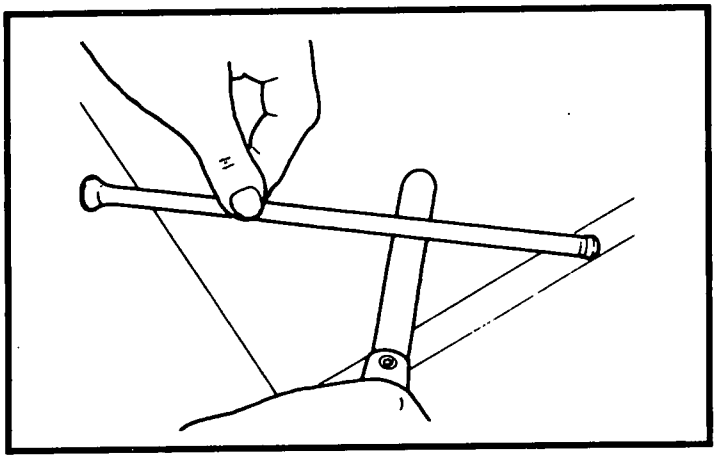
3. Check the backlash after assuring that the idle gear end play and the clearance between the idle gear bushing and spindle are within standard.

Backlash limit: 0.30 mm (0.0118 in)



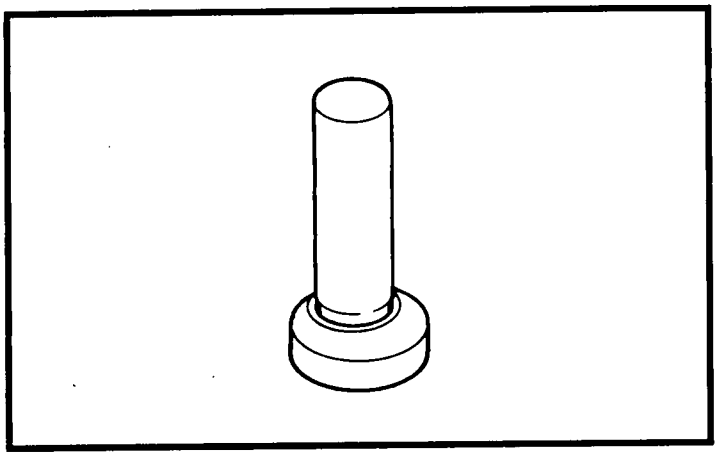
Checking Push Rod

1. Check the push rod ends for damage. If ANY damage is found, replace the push rod.



2. Check the push rod for bends with the corner of a surface plate. If it exceeds limit, replace it with a new one.

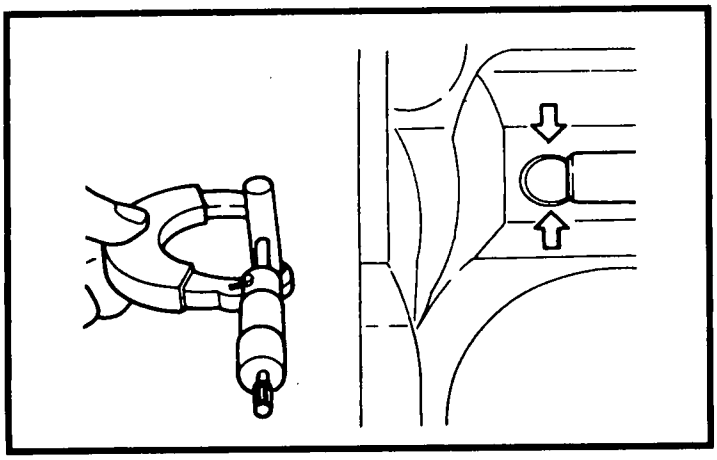
   Bending limit: 0.19 mm (0.0075 in)



Checking Tappet

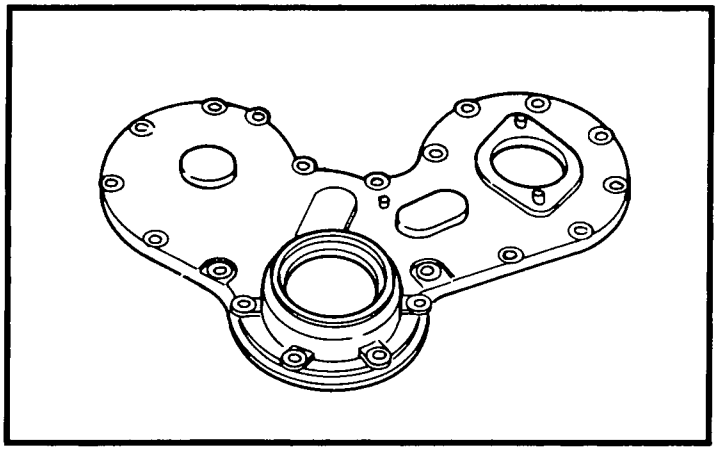
1. Check the tappet for cracks or damage. If any such damage is detected, replace the tappet.
2. Check the contact surface of the tappet with the cam for wear. If it is abnormal, replace the tappet.

NOTE: *Number each tappet to keep it with the correct tappet bore for reassembly.*



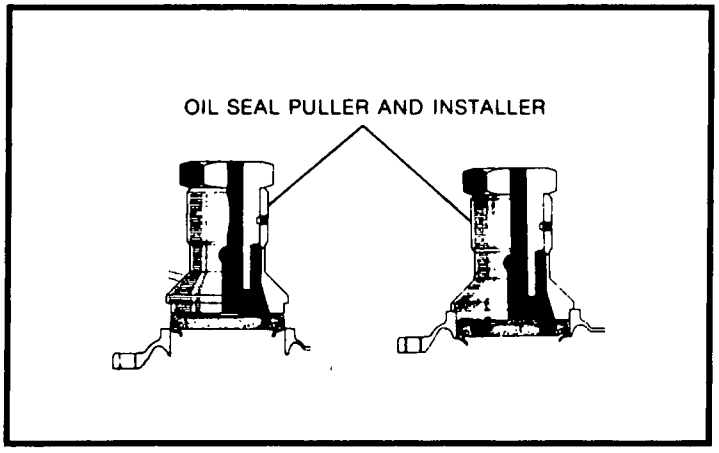
3. Check the clearance between the tappet and tappet guide. If it exceeds the limit, replace the tappet or the cylinder block.

   Clearance limit: 0.10 mm (0.0039 in)



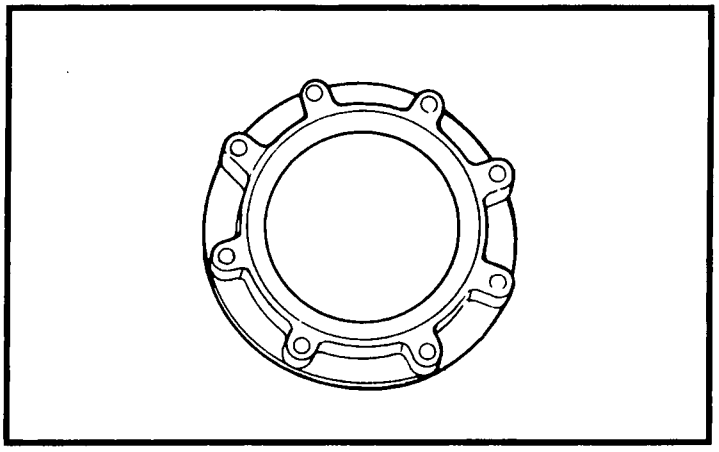
Checking Timing Gear Cover Oil Seal

1. Check the lip of the oil seal for wear and damage. Replace as required.



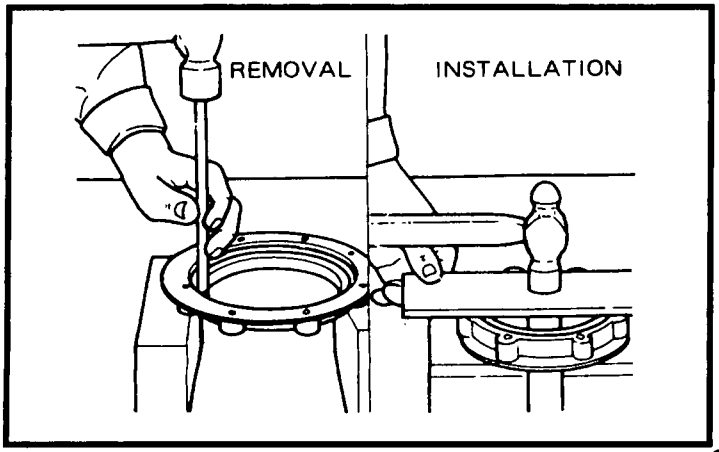
Replacing Timing Gear Cover Oil Seal

1. To remove the timing gear cover oil seal, press out the old seal with a commercially available oil seal puller / installation tool.
2. To install the timing gear cover oil seal, apply engine oil onto the outside of the new seal and press fit the seal with the seal puller / installation tool mentioned above.



Checking Rear Oil Seal

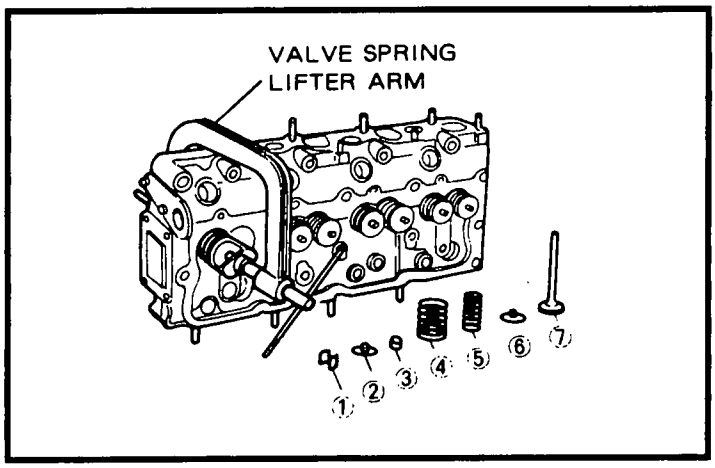
1. Check the lip of the oil seal for wear and damage. Replace as required.



Replacing Rear Oil Seal

1. To remove the rear oil seal, strike out the old seal with a suitable mandrel.
2. To install the rear oil seal, apply engine oil onto the outside of a new seal and press fit the seal in the rear oil seal cap equally.

NOTE: *If the crankshaft is worn, the oil seal must be fitted on the oil seal cap with it's fitting position moved by approx. 3 mm so that the seal does not touch the worn portion of the crankshaft.*



1. Valve cotter.
2. Spring seat (upper).
3. Oil deflector.
4. Valve spring (outer).
5. Valve spring (inner).
6. Spring seat (lower).
7. Valve.

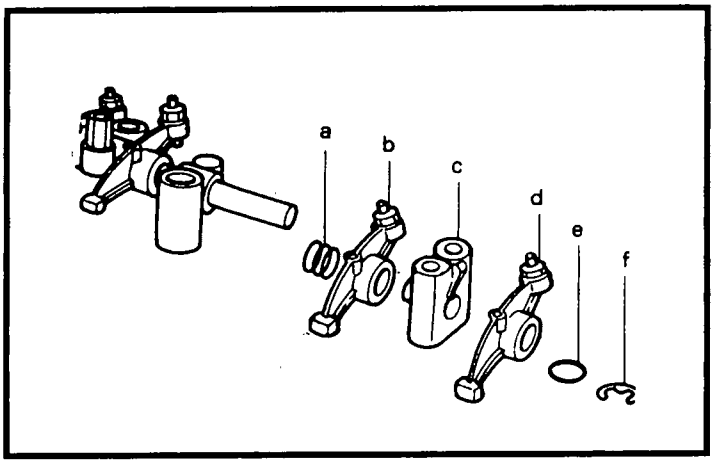
ENGINE ASSEMBLY

Assembling Engine

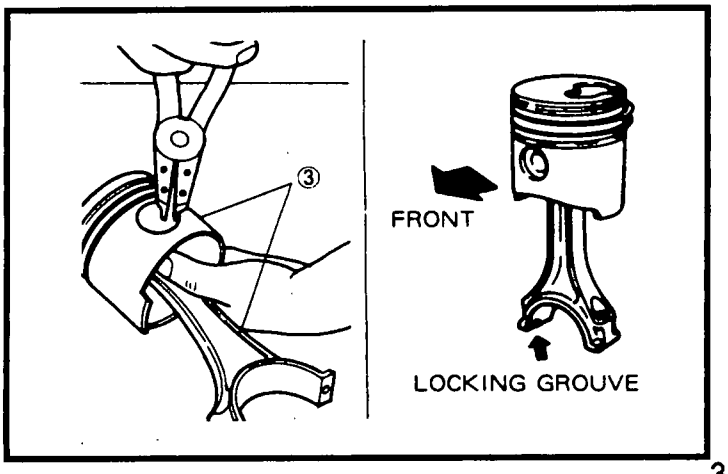
Assemble in the following order:

1. Intake and exhaust valves.
   Use a commercially available valve spring compressor.

NOTE: *Apply engine oil to the sliding section of the valve stem. Insert the oil deflector on the intake side.*

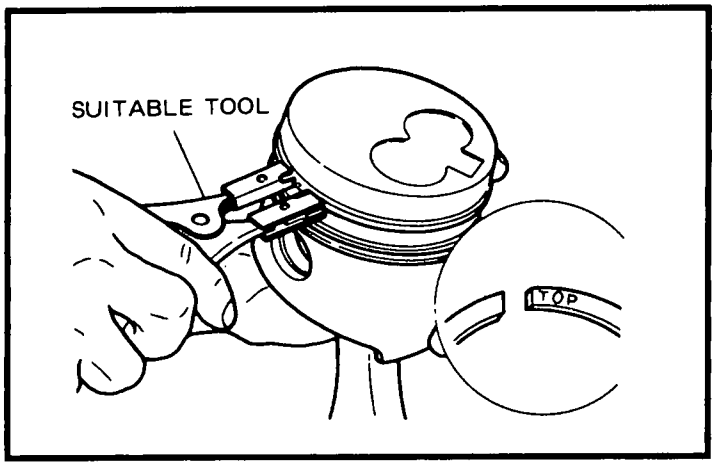


2. Rocker arm assembly.
   a. Spring
   b. Rocker arm
   c. Rocker bracket
   d. Rocker arm
   e. Wave washer
   f. Stop ring



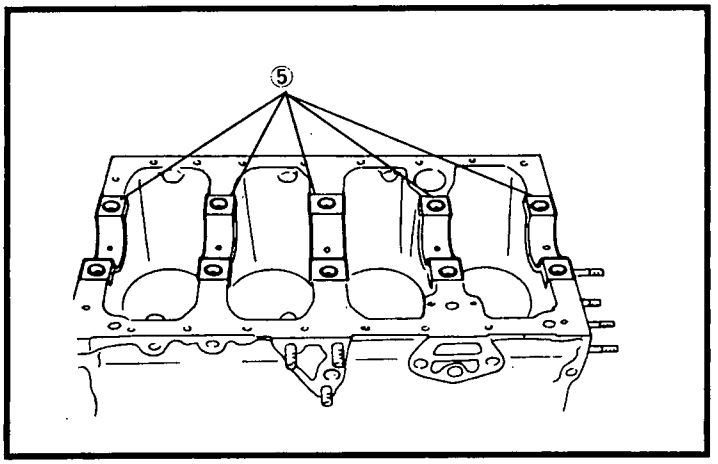
3. Piston and connecting rod.
   a. Piston pin
   b. Snap ring

NOTE: *Assure that the connecting rodlocking groove faces the piston front as shown in the Figure.*



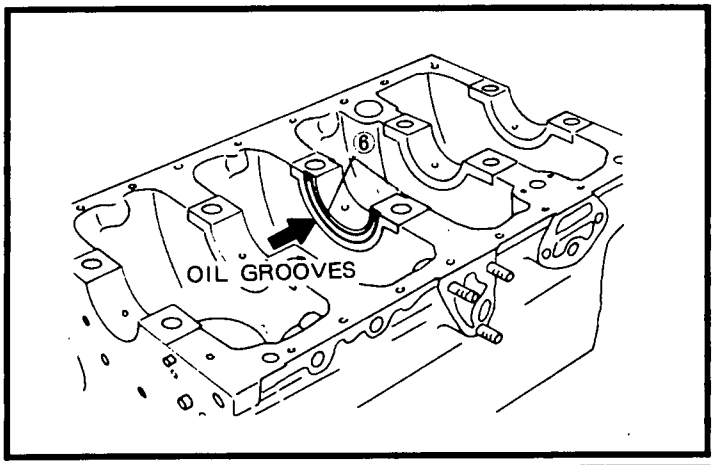
4. Piston rings. Use a commercially available ring expander.

NOTE: *Install the piston ring with the inscription facing upward. Be very careful not to expand the rings too far as they will break.*



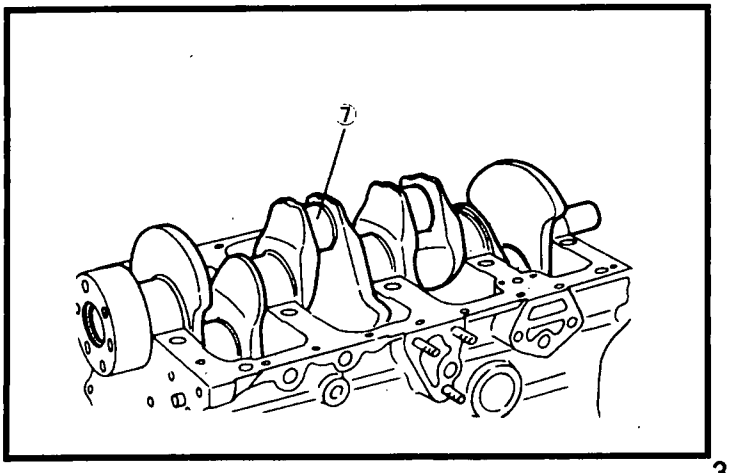
5. Main bearings

- Install the main bearings in their proper position.
- Apply engine oil onto the surface of the main bearing.
- Do not apply oil onto the back side of the bearing.

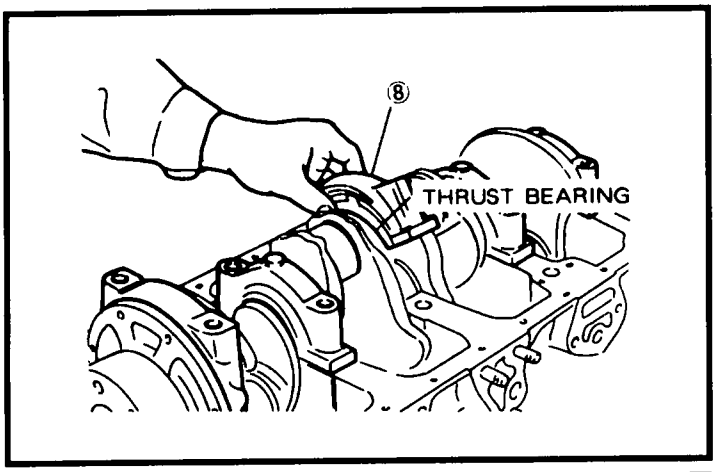


6. Thrust bearings

- Fit the thrust bearings with the oil groove side facing outward.

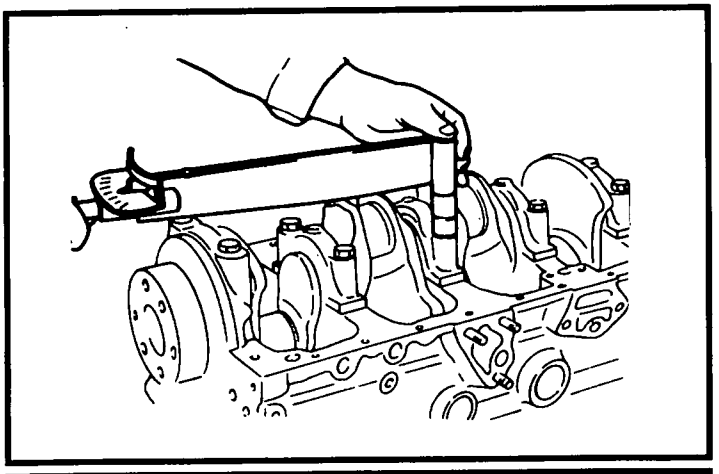


7. Crankshaft



8. Main bearing caps

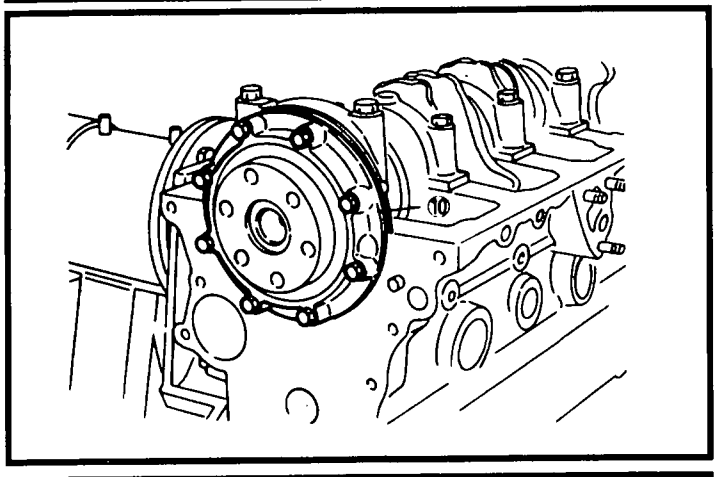
- Fit the thrust bearing (with flange) with the oil groove side facing upward.
- The arrow on the top of the cap should face forward.



9. Cap bolts

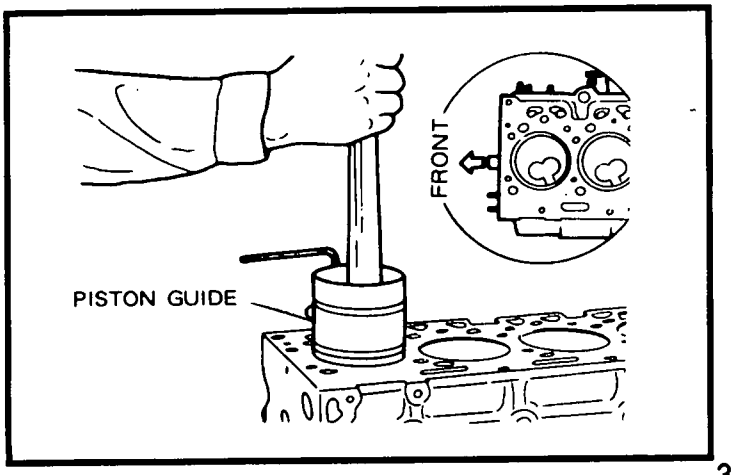
- Make sure that the crankshaft rotates smoothly after installing.

Tightening torque (¾"):
11.0~11.7 m-kg (80~85 ft-lb)



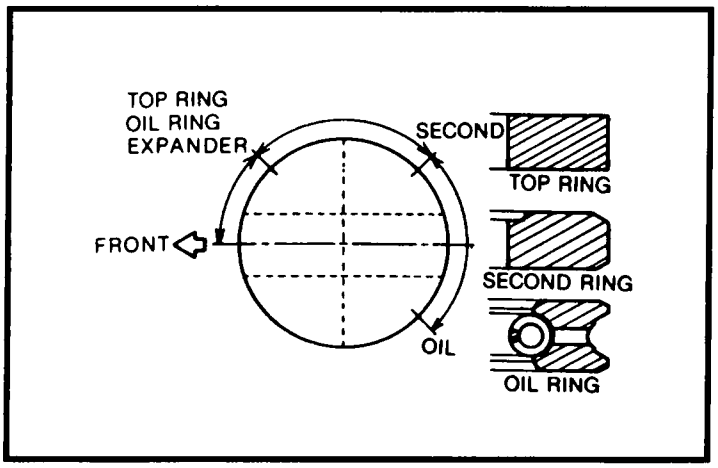
10. Rear oil seal assembly

- Apply engine oil onto the lip of the seal.
- Fix a gasket between the oil seal assembly and cylinder block.

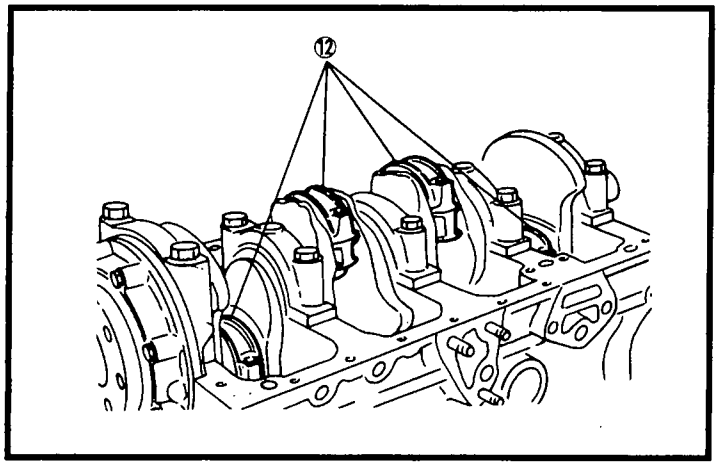


11. Piston and connecting rod assemblies. Use a commercially available ring compressor and a plastic mallet to install the piston assemblies.

- Install the piston and connecting rod assembly in the piston as shown in the Figure.
- Apply engine oil onto the sliding face of the piston and cylinder block.

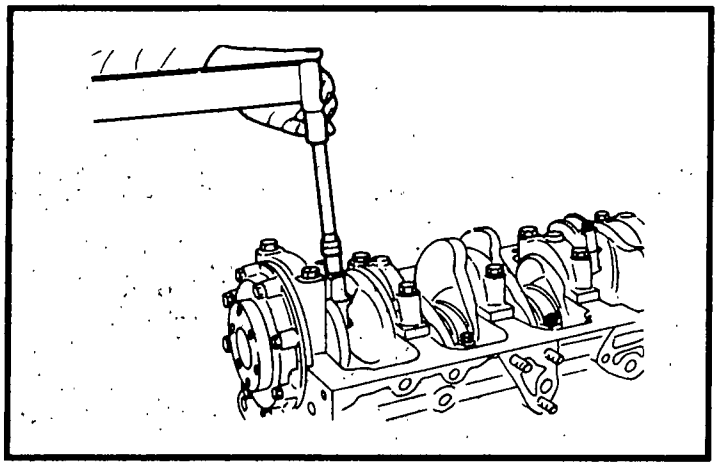


- Place the piston rings at approx. 90° apart as shown in the Figure.
- Place the top and second rings in the opposite direction of the pre-combustion chamber.



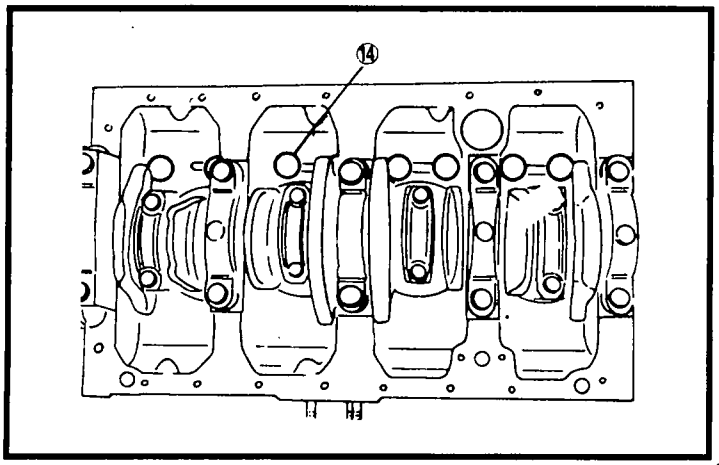
12. Connecting rod caps bolts

- Apply engine oil onto the surface of the connecting rod bearing. DO NOT oil the back side of the bearing.
- Match the identification numbers.



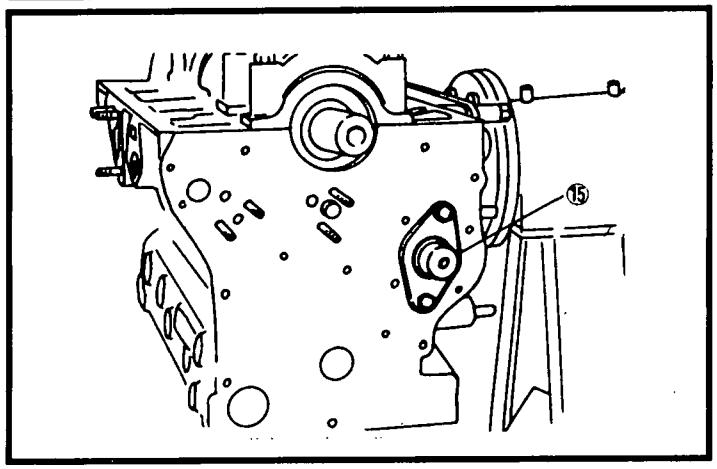
13. Connecting rod cap bolts.

Tightening torque (14 mm):
6.9~7.5 m-kg (50~54 ft-lb)



14. Tappets

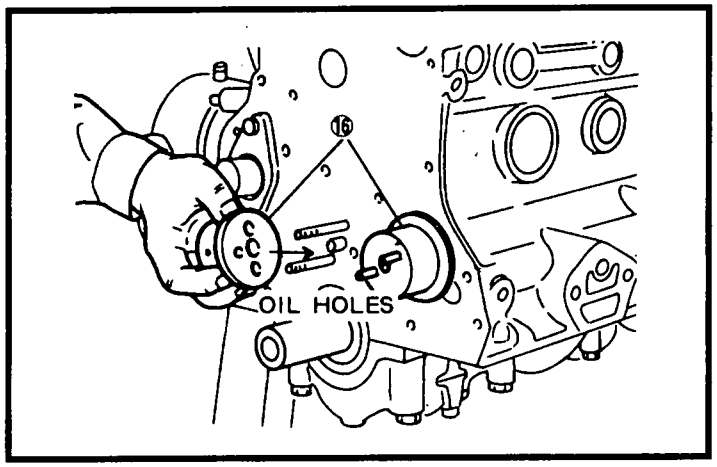
- Apply engine oil onto the sliding face of the tappet.



15. Camshaft

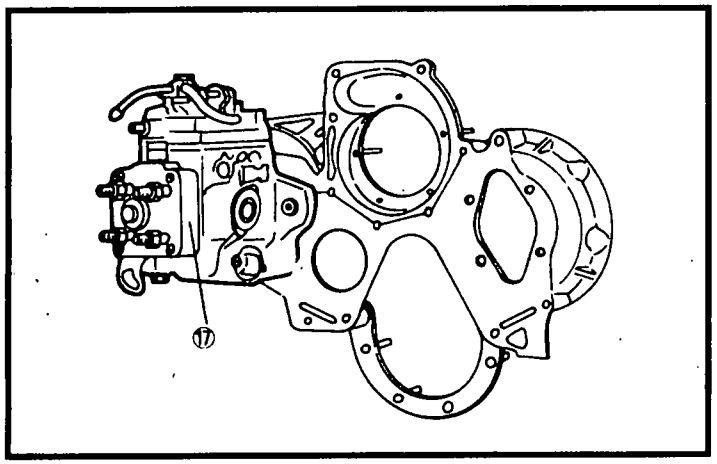
- Apply engine oil onto the camshaft journal.

Tightening torque (½"):
1.6~2.4 m-kg (12~17 ft-lb)



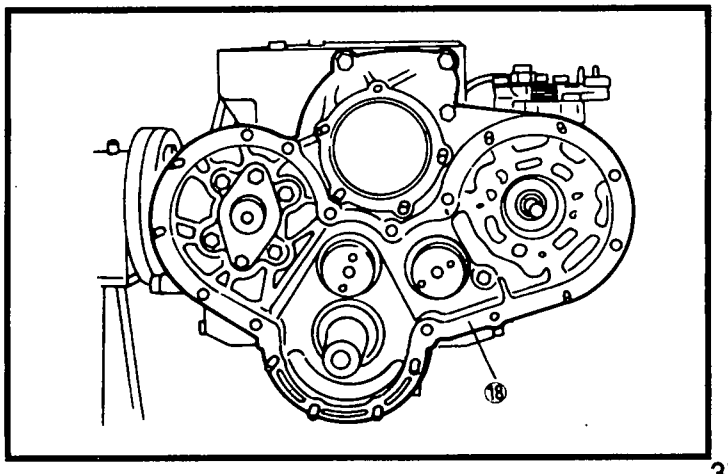
16. Idle gear spindles

- Align the oil holes.



17. Fuel injection pump

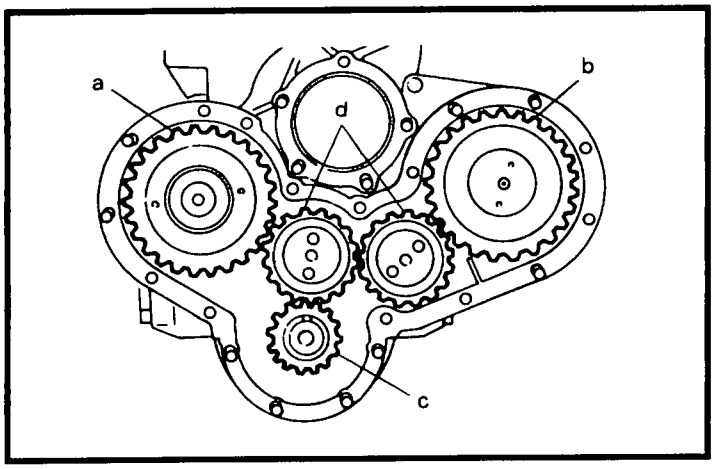
- After installing the injection pump to the timing gear case, it is easier to install them onto the engine.
- Install the injection pump aligning the identification marks.



18. Timing gear case

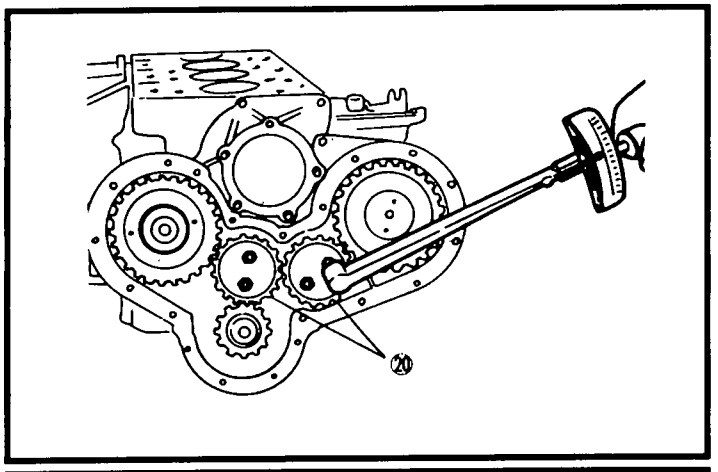
- Align the end face of the timing gear case and cylinder block.
- Cut off the excessive gasket.

Tightening Torque (½ in):
1.6~2.4m-kg (12~17 ft-lb)



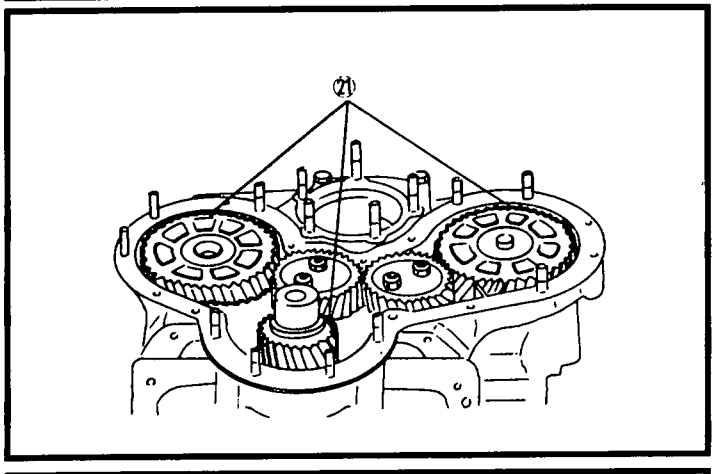
19. Gears
    a. Camshaft gear
    b. Injection pump drive gear.
    c. Crankshaft gear.
    d. Idle gears

- Align the timing gear marks of every gear.

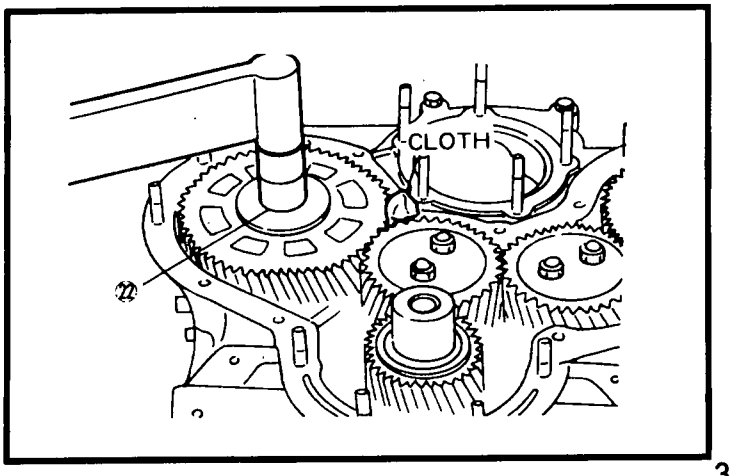


20. Idle gear thrust plates and attaching nuts.

    Tightening torque (½ in):
    2.3~3.2 m-kg (17~23 ft-lb)



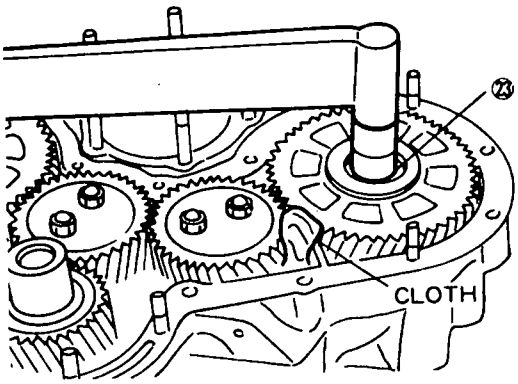
21. Friction gears



22. Camshaft gear lock bolt

- Bite a clean cloth between the camshaft gear and idle gear.

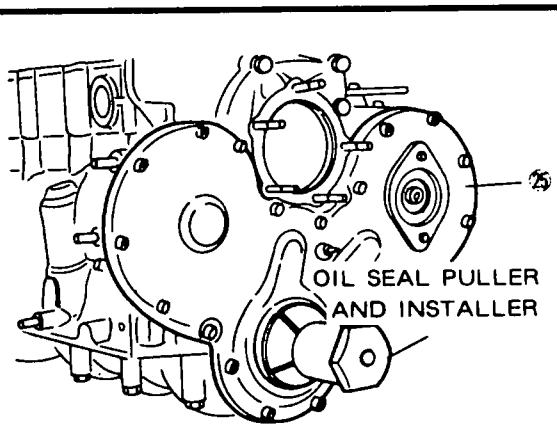
    Tightening torque (19mm):
    6.2~7.0 m-kg (45~51 ft-lb)



23. Injection pump drive gear lock nut.

- Bite a clean cloth between the injection pump drive gear and idler gear.

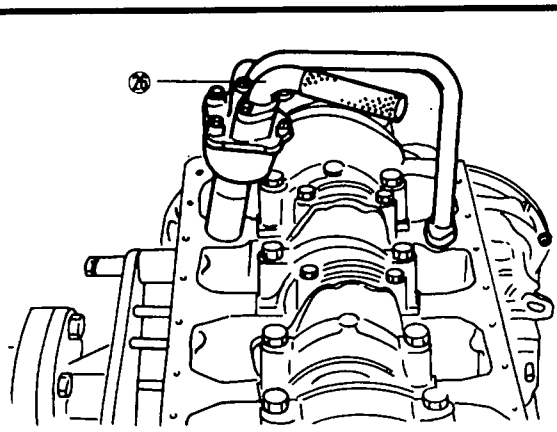
  Tightening torque (19 mm):
  4.0~7.0 m-kg (29~51 ft-lb)



24. Oil deflector
25. Timing gear cover

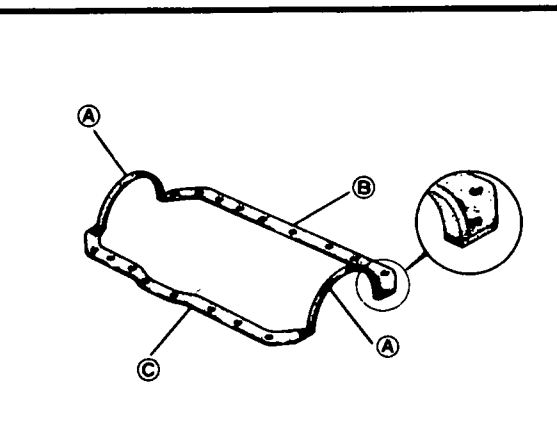
NOTE: *Use an Oil seal puller and installer to remove and install seals.*

Tightening torque (½ in):
1.6~2.4 m-kg (12~17 ft-lb)



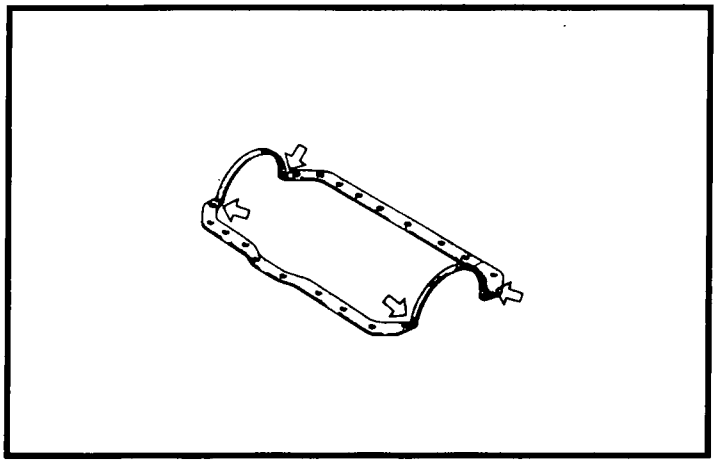
26. Oil pump assembly

- Make sure that the oil pump drive gear and driven gear mesh.



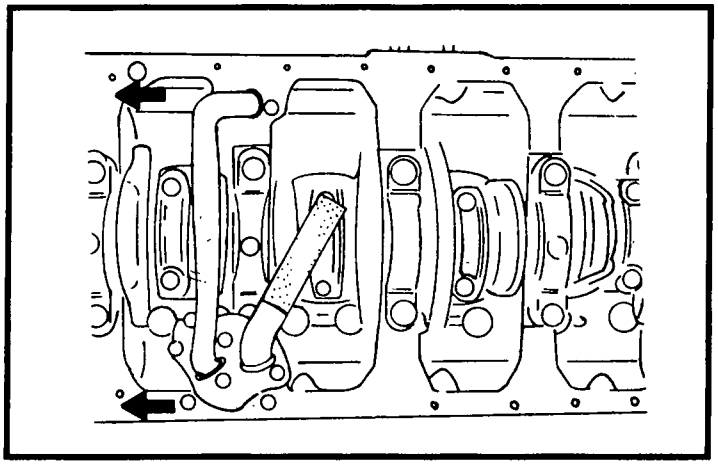
27. Oil pan gaskets

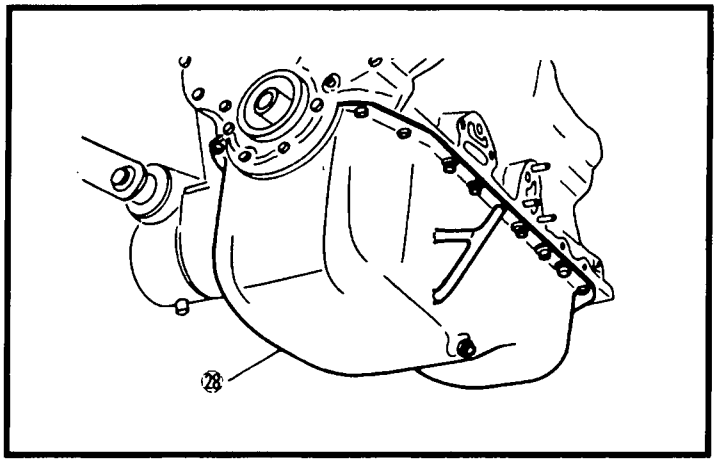
- Place the end of the gasket (A) on the gasket (B) and (C).



Applying gasket sealer:

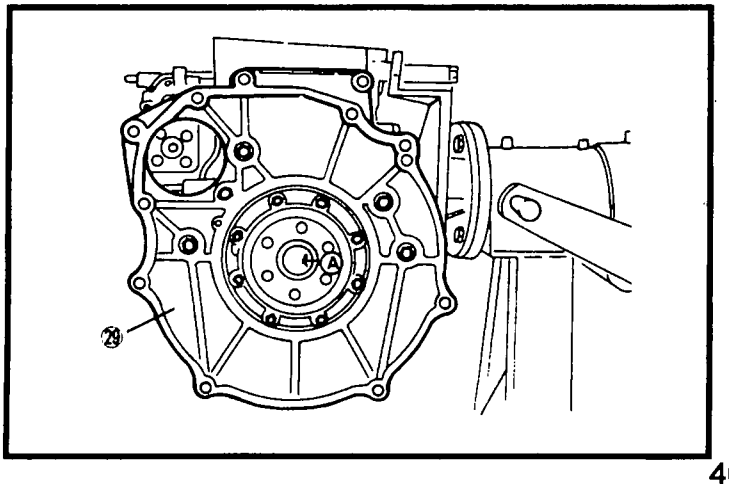
- Apply gasket paste on the contact points of the gaskets and on the contact points of the timing gear case and the cylinder block.





28. Oil pan

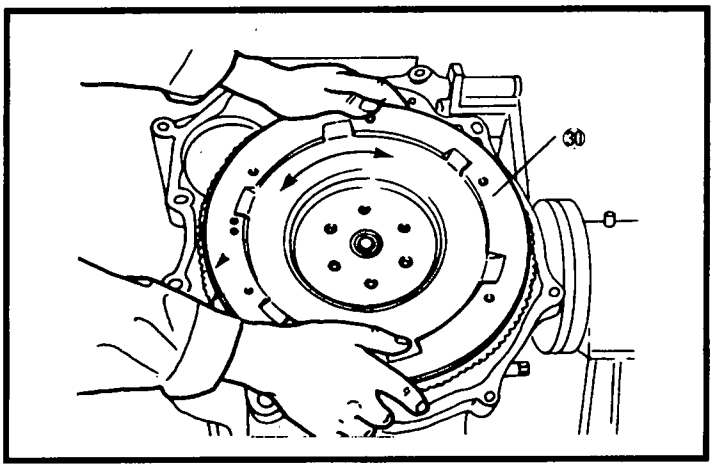
Tightening torque (½ in):
0.7~1.2 m-kg (5~9 ft-lb)



29. End plate

- Apply lithium grease on the center (A) of the crankshaft as shown in the figure.

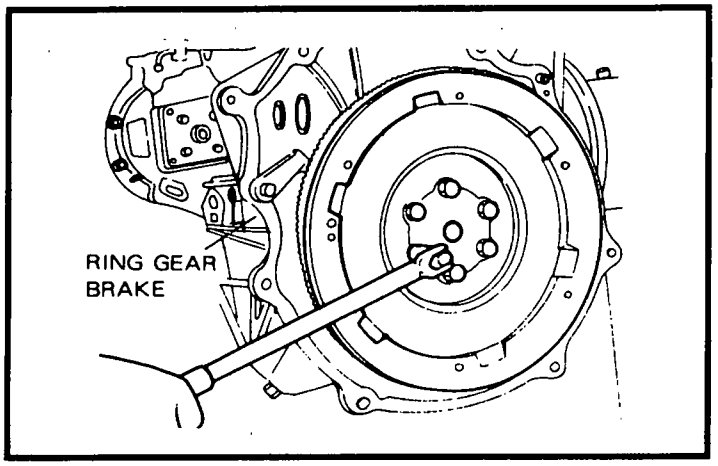
Tightening torque (14 mm):
3.3~4.8 m-kg (24~35 ft-lb)

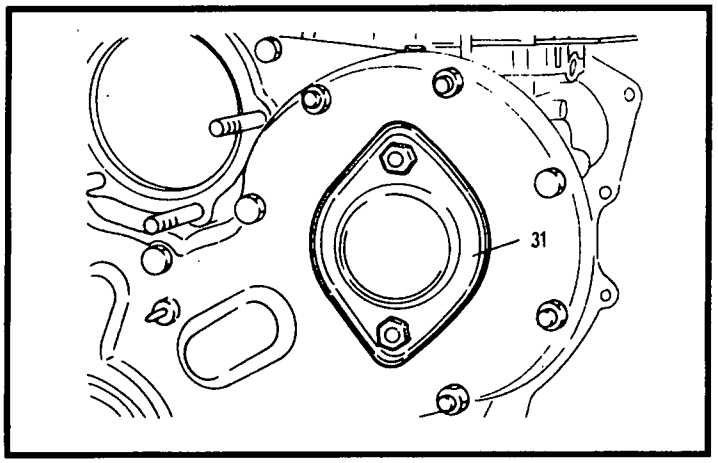


30. Flywheel

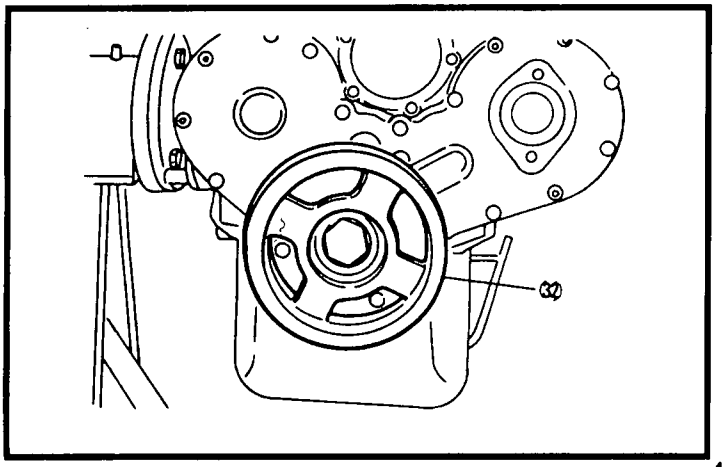
- Install the flywheel onto the end of the crank shaft making sure that it seats flat.
- Rotate the flywheel and tighten the attaching bolts in the position aligning the bolt holes so that the bolt holes align in one position.

Tightening torque: (3/4 in):
13.1~19.0 m-kg (95~137 ft-lb)





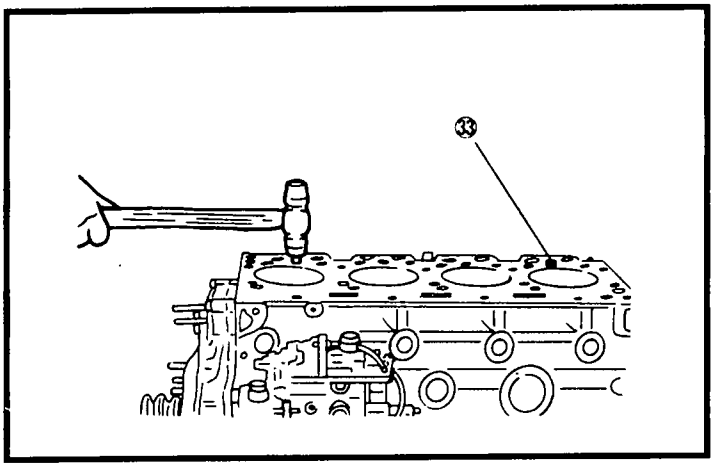
31. Injection pump drive gear cover.



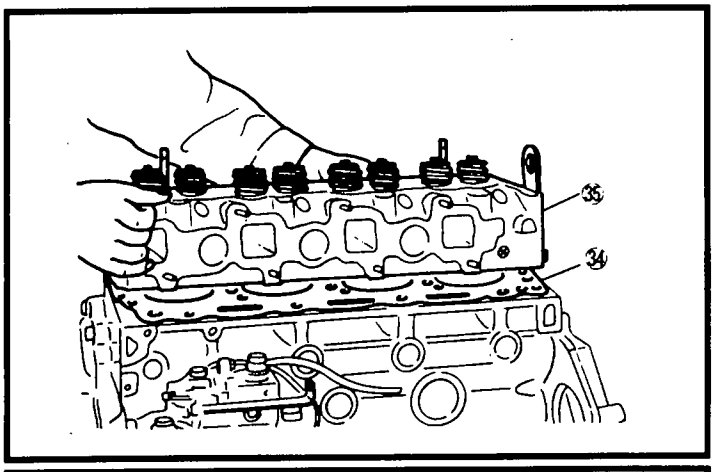
32. Crankshaft pulley.

- Apply engine oil onto the lip of the oil seal.

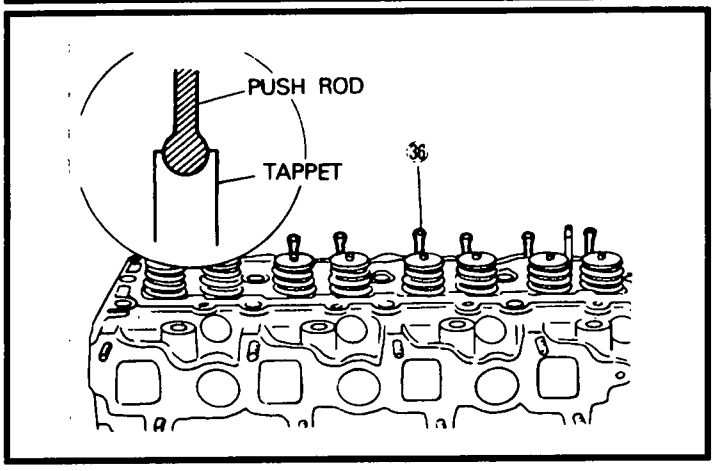
Tightening torque (38 mm):
20~25 m-kg (145-181 ft-lb)



33. Tubular pins.

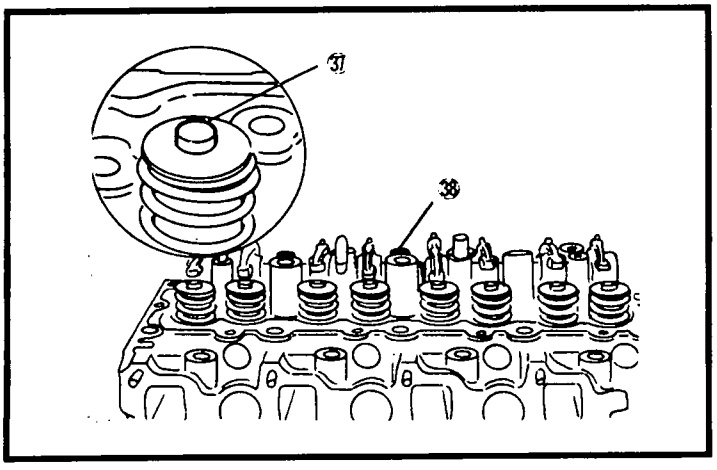


34. Cylinder head gasket.
35. Cylinder head.



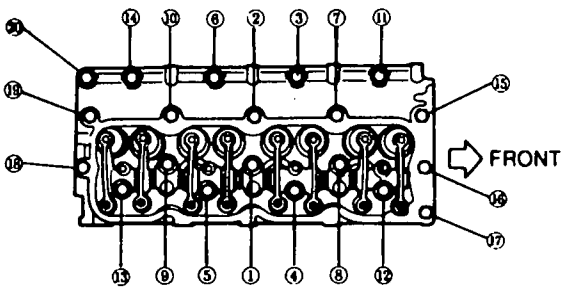
36. Push rods.

- Make sure that the push rod inserts in the pit on the tappet.



37. Valve caps.
38. Rocker arm assembly.

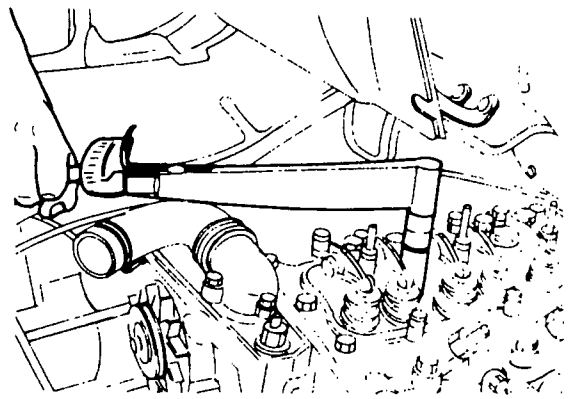
- Make sure that the valve cap is installed properly on the valve stem.

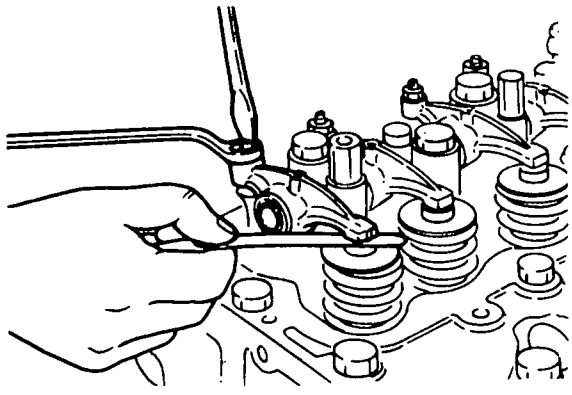


39. Cylinder Head Bolts

- Tighten the cylinder head bolts in the order shown in the figure.
- After tightening the cylinder head bolts, make sure that the rocker arms move smoothly.

Tightening torque (3/4 in):
11.0~11.7 m-kg (80~85 ft-lb)

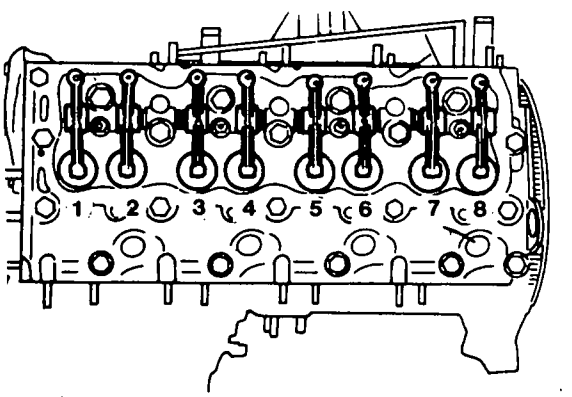




40. Adjusting valve clearance.

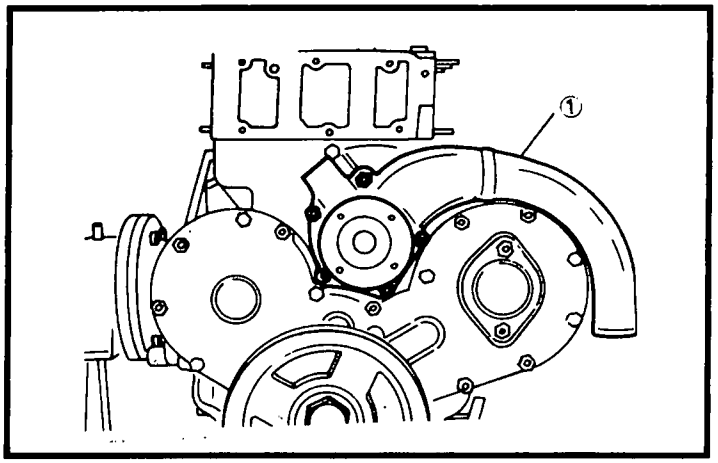
- Whenever the engine is overhauled, warm up the engine and re-adjust the valve clearance after tightening the cylinder head bolts to specified torque.

Valve clearance:
Intake: 0.3 mm (0.012 in)
Exhaust: 0.3 mm (0.012 in)



Service point:

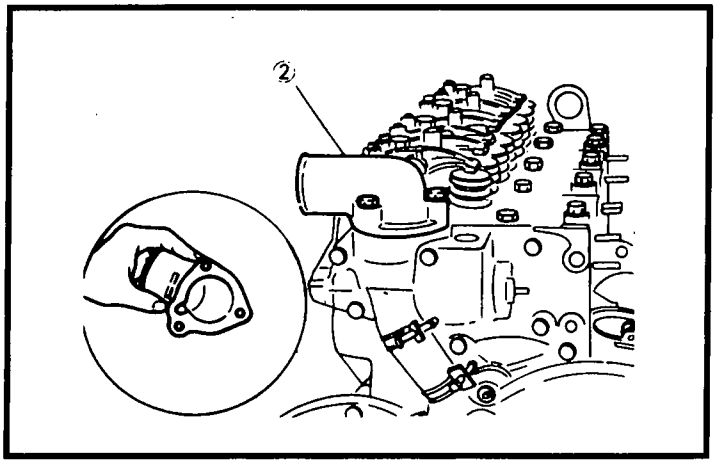
- **Adjust the No. 1, 2, 3, and 6 valves when the No. 1 piston is coming up on compres sion stroke.**
  Next, when the No. 4 piston is coming up on compression stroke, adjust the No. 4, 5, 7, and 8 valves.



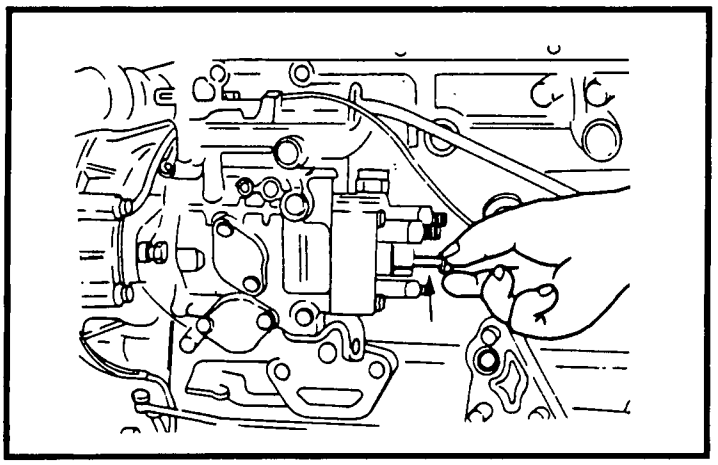
Installing Engine Equipment Parts

Install in the following order:
1. Water pump assembly.

Tightening torque (½ in):
1.6~2.4 m-kg (12~17 ft-lb)

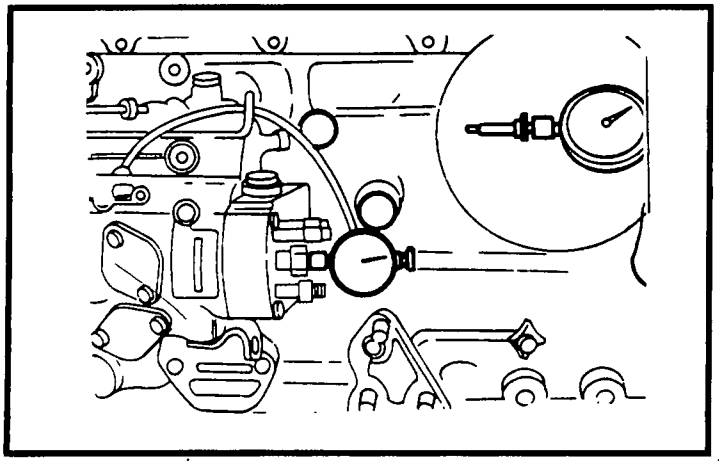


2. Thermostat casing assembly.

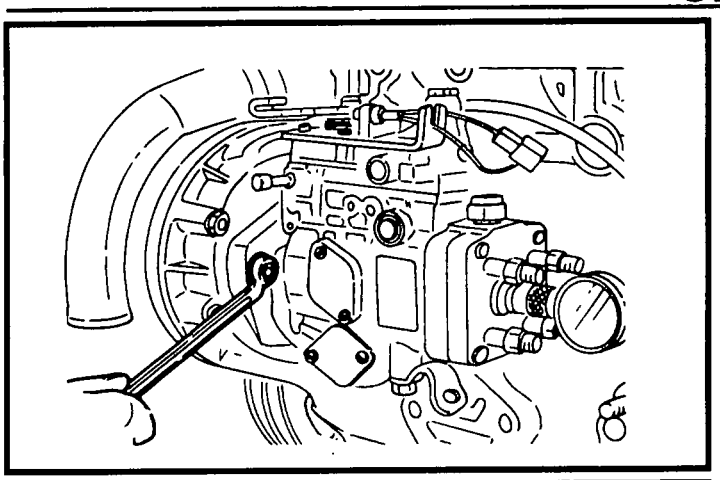


3. Adjusting injection timing.

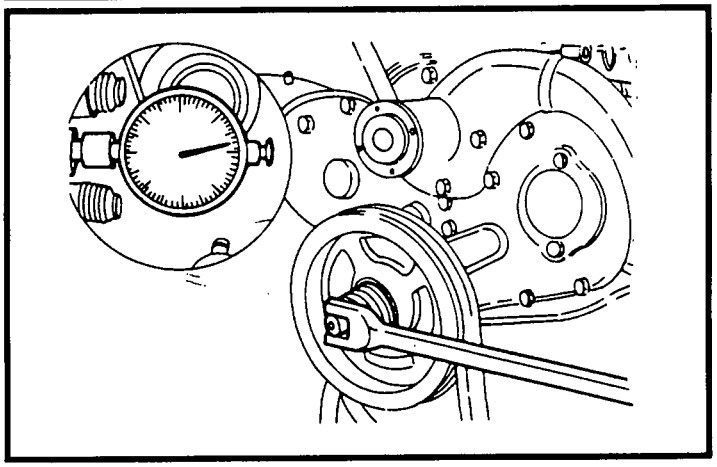
a). Remove the injection pump distributer head plug bolt.



b). Install a commercially available dial indica tor onto the injection pump so that the rod end comes in contact with the plunger.



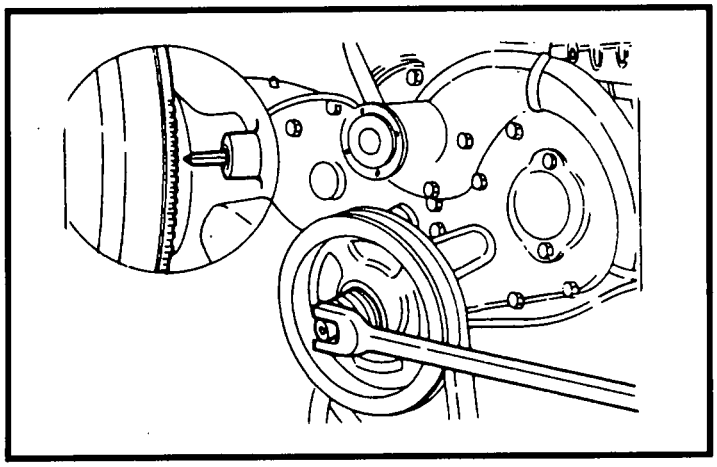
c.) Loosen the injection pump attaching nuts.



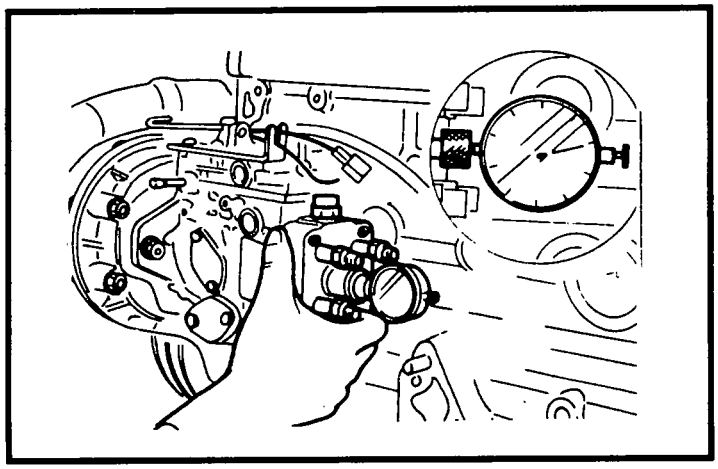
d). Turn the crankshaft to set the indicatorpin at **30° BTDC.**

e). Set the dial indicator pointer at 0 by mov ing the outer ring.

NOTE: *When setting the dial inndicator, confirm that the dial indicator pointer does not deviate from the scale mark of 0 by slightly turning the crankshaft to the right and left.*

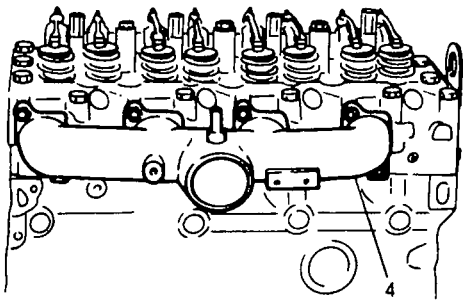


f). Turn the injection pump in the direction of the engine rotation to set the indicator pin at **0° TDC.**



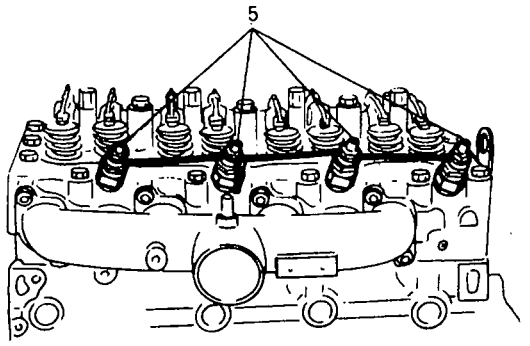
g). Turn the injection pump in the reverse direction of engine rotation and then turn the injection pump in the direction of engine rotation so that the dial indicator pointer indicates the scale mark of **1 mm (0.039 in).**

h). Tighten the injection pump attaching nuts.



4. Intake manifold

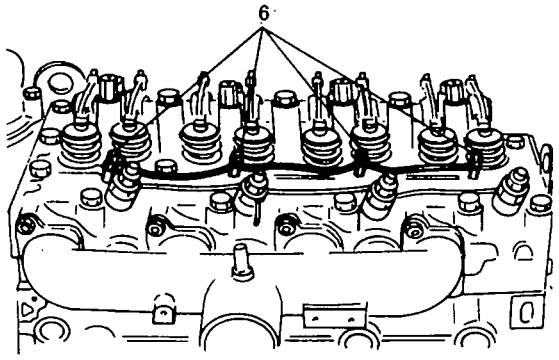
Tightening torque (½ in):
1.6~2.4 m-kg (12~17 ft-lb)



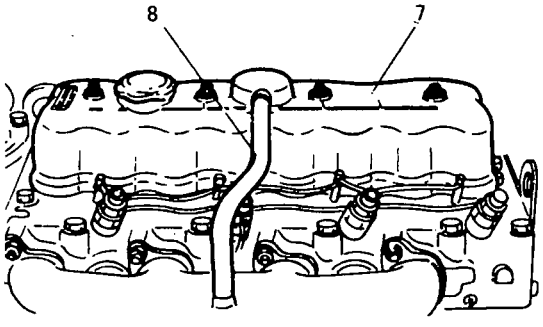
5. Fuel injection nozzles and leak pipe

NOTE: *The copper wahers should not be reused.*

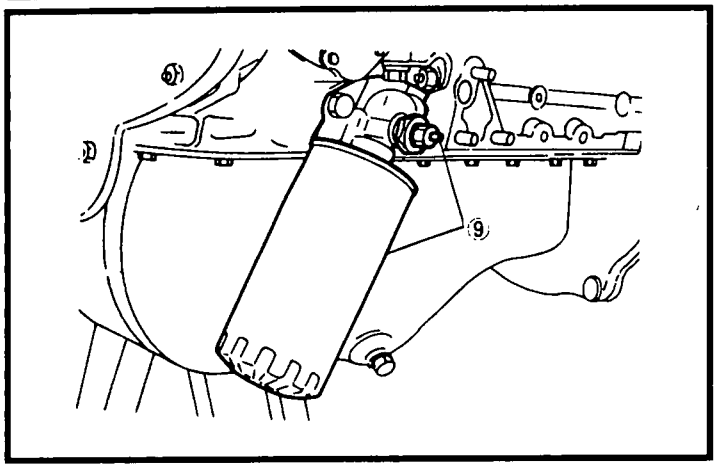
Nozzle tightening torque (27 mm):
8.0 ~10.0 m-kg (58~72 ft-lb)



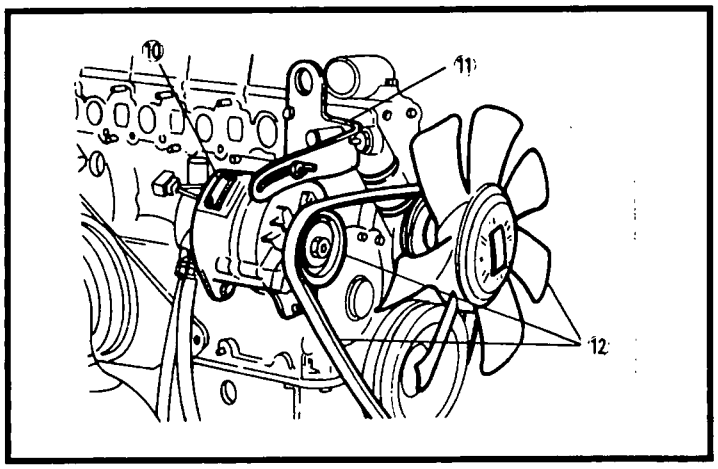
6. Glow plugs and connector



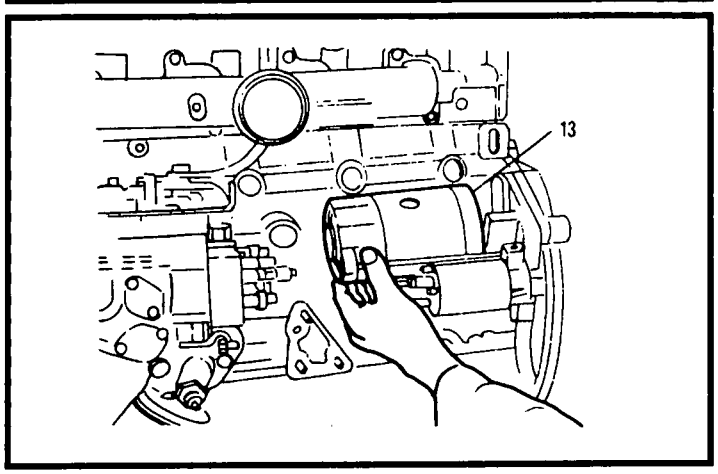
7. Cylinder head cover.
8. Bleeder hose



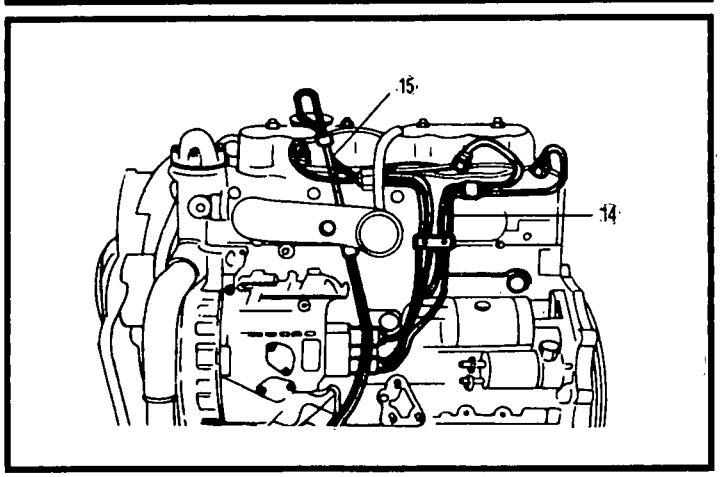
9. Oil filter and oil pressure switch



10. Alternator and bracket
11. Alternator strap
12. Cooling fan, pulley and "V" belt



13. Starting motor

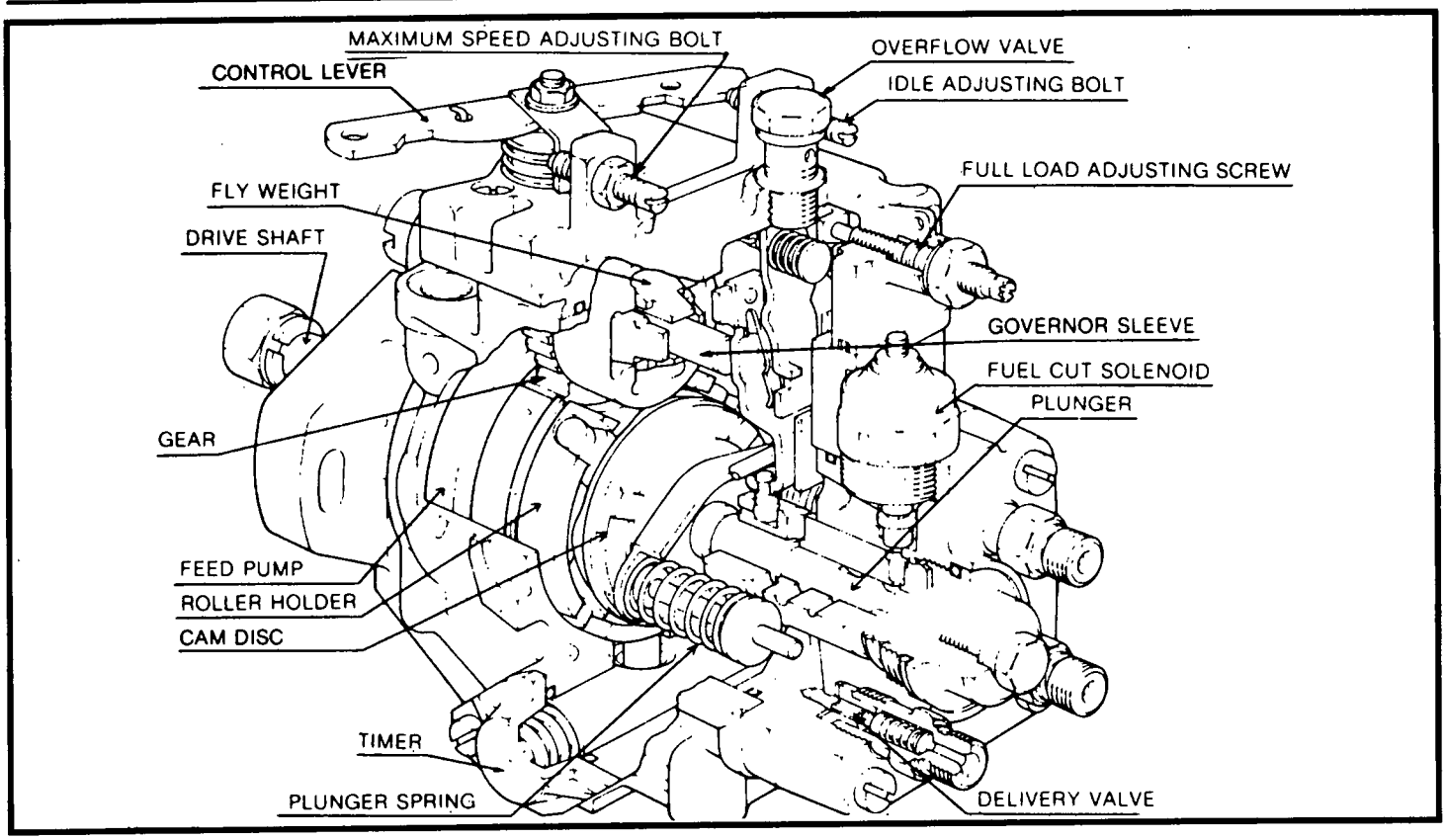


14. Fuel injection pipes
15. Oil level gauge

CHAPTER 4. INJECTION PUMP

POINTS

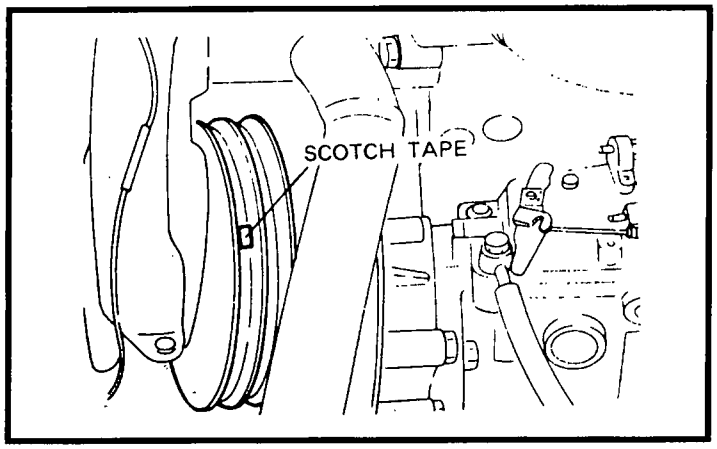
- The injection pump is Diesel Kiki's Bosch-VE-distributer type which is compact, light and of simple design that provides high performance.
- By turning off the engine switch key, the supply of fuel into the combustion chamber is cut off to stop engine dieseling.
- When the engine is to run is reverse, the fuel injection pressure does not develop and therefore the fuel is not injected and the engine never runs in reverse.
- When excess water has collected in the fuel filter, the buzzer sounds to indicate that the water should be drained.
- The fuel filter incorporates a hand priming pump for air bleeding and fuel suction in the fuel sys tem.

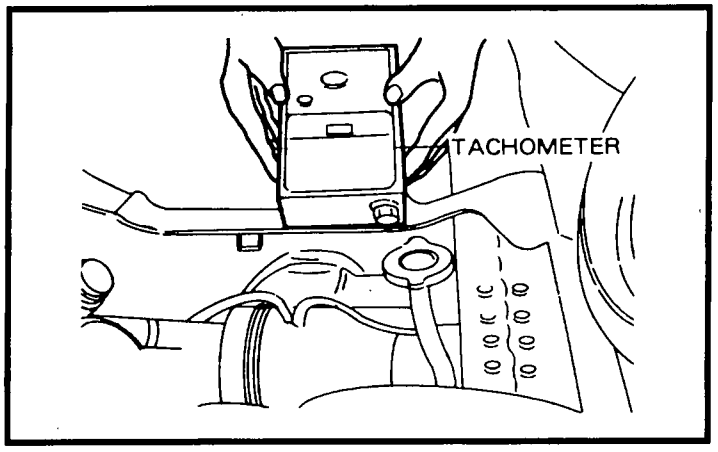


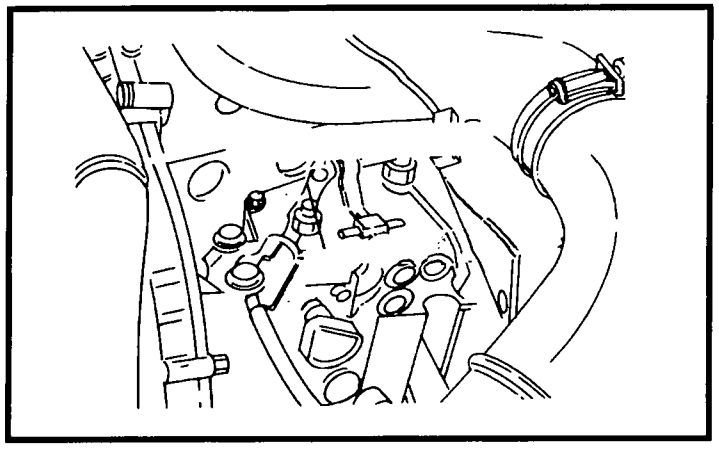
ITEM	SF
Type	Bosch-VE-Pump
Injection timing	1.5° ATDC
Plunger diameter (mm)	9 mm
Cam lifter	22 mm
Injection pressure	135 kg/cm^2
Driving type	Gear

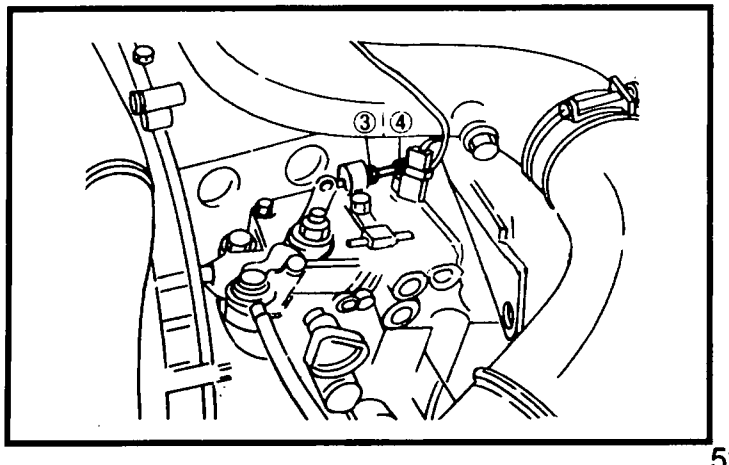
Item	Pump Speed (R.P.M.)	Injection Amount (mm^3 / 1,000 stroke)	Chamber Pressure (kg / cm^2)	Timer Stroke (mm)
Start	100	more than 55	-	-
Idling	325	5.5~9.5	-	-
Full Load	500	35~39	-	-
Full Load	1,200	42.5~44.5	4.2~4.8	3.6~4.0
Full Load	2,000	35.8~39.2	6.4~7.0	7.8~8.6
Full Load	2,400	12~18	-	-

CHAPTER 4. INJECTION PUMP









INJECTION PUMP

Checking and Adjusting Injection Pump on Generator

A. Checking Idle Speed

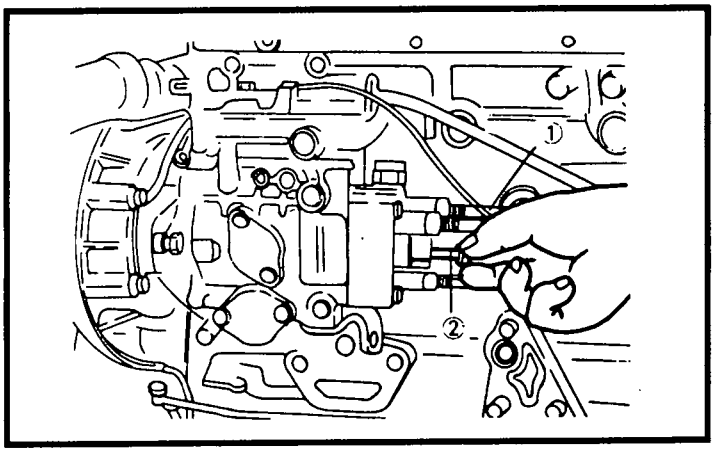
1. Warm the engine to operating temperature.
2. Remove any specs on the crankshaft pulley with a waste cloth and place a piece of scotch tapeon the pulley to facilitate use of a photo electric type tachometer.
3. Start the engine and let idle.
4. Project the light of the tachometer onto the scotch tape to confirm the engine r.p.m.
5. Adjust according if the engine r.p.m. is not within the specified value.

Idle speed: 650 ± 25 r.p.m.

B. Adjusting Idle Speed

Loosen the lock nut nut (3) of the idle adjusting bolt and adjust by turning the idle adjusting bolt (4).

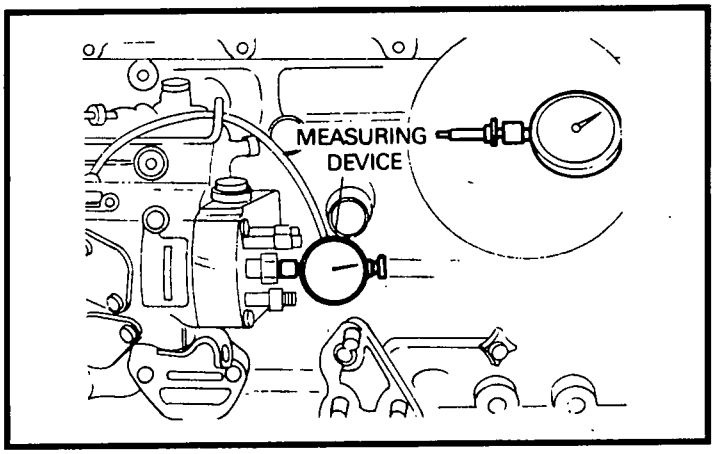
NOTE: *Idle speed will increase when the adjusting bolt is turned to the right and decrease when turned to the left.*



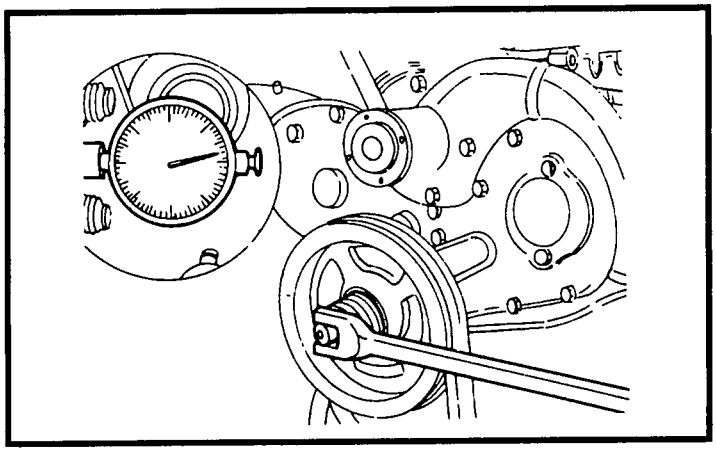
C. Checking Ignition Timing

Check the injection timing so that the injection pump cam lifts 1mm (0.039 in) when the No.1 piston is at top dead center on the com pression stroke.

1. Remove the injection pipes (1) and injection pump distributer head plug bolt (2).

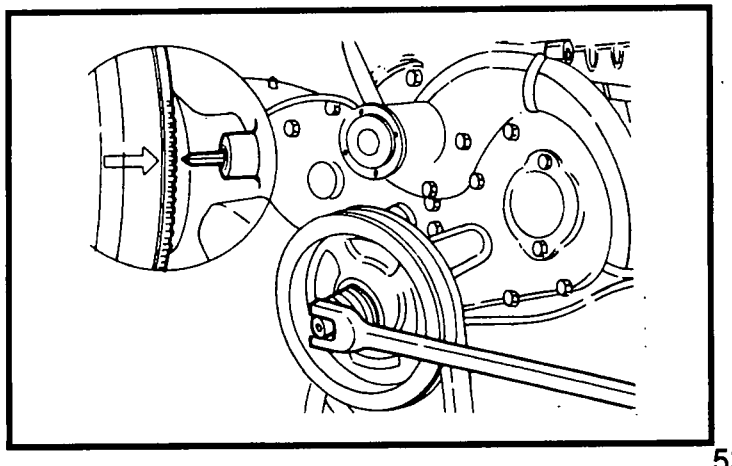


2. Install a commercially available dial indicator onto the fuel injection pump so that the rod end comes in contact with the plunger.

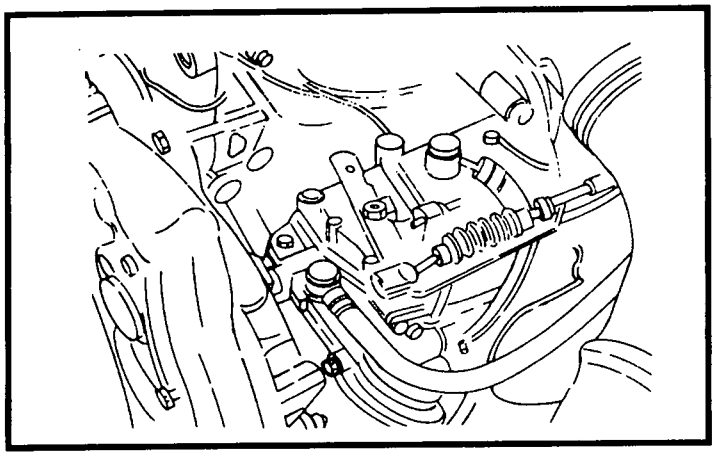


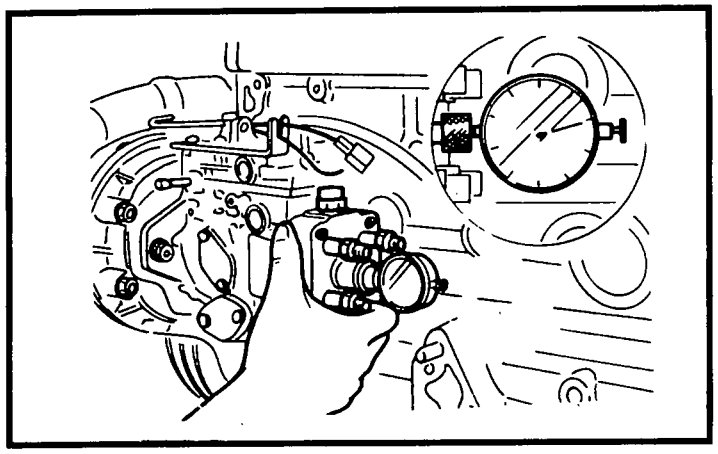
3. Turn the crankshaft to set the indicator pin at **30° BTDC.**
4. Set the dial indicator pointer at 0 by moving the outer ring.

NOTE: *When setting the dial indicator, confirm that the dial indicator pointer does not deviate from the scale mark of 0 by slightly turning the crankshaft to the right and to the left.*



5. Turn the crankshaft in the direction of the engine rotation to set the indicator pin at **0° TDC.**
6. Confirm that the dial indicator pointer indi cates the scale mark of **1 mm (0.039 in).**
7. Make the necessary adjustment if the pointer does not indicate the scale mark of **1 mm (0.039 in).**





D. Adjusting Injection Timing

1. Loosen the injection pump attaching nuts and bolt.
2. Make the adjustment by moving the injection pump.

If the amount of cam lift is too large:
First, turn the injection pump in the reverse direction of the engine rotation so that the dial indicator indicates less than the scale mark of 1 mm (0.039 in). Then turn the injection pump in the direction of the engine rotation so that the dial indicator pointer indicates the scale mark of 1 mm (0.039 in).

NOTE: *The above adjusting procedures are required to minimize the backlash of the gears.*

If the amount of camlift is too small:
Turn the injection pump in the direction of the engine rotation so that the dial indicator pointer indicates the scale mark of 1 mm (0.039 in).
3. After the adjustment, tighten the attaching nuts and bolt and reconfirm that the adjustment has been done properly.

E. Checking Cam Lift

Make this checking the same as Checking Injection Timing.

1. Turn the crankshaft and read the maximum value which the dial indicator pointer indicates.

   Amount of cam lift: 2.2 mm (0.08 in)

2. After the inspection, remove the measuring device and install the injection pipes and injection pump distributer head plug bolt.
3. Evacuate air from the injection pipe on the injection nozzle side.

TROUBLESHOOTING

F. Engine Stopping Mechanism Trouble Shooting

The solenoid does not "open fuel passage" when the engine switch is turned "ON"

↓

Does the fuel cut solenoid operate? — **Yes** → Install the solenoid properly.

↓ **No**

Turn on the engine switch.

↓ **No**

Is the electric current passing through the (A) terminal (WR) of the engine switch? — **No** → Repair open circuit between the engine switch and the battery.

↓ **Yes**

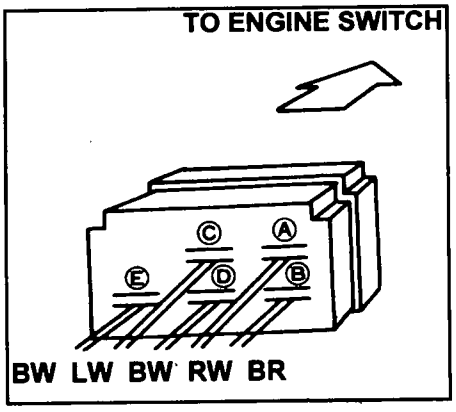
Is the electric current passing through the terminal (BW) of the engine switch? — **No** → Replace the engine switch.

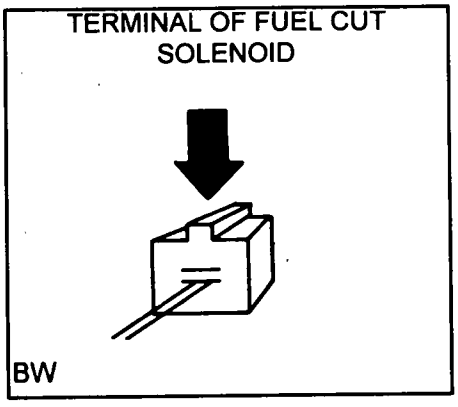
↓ **Yes**

Is the electric current passing through the terminal of the fuel cut solenoid? — **No** → Repair the open circuit between the engine switch and the fuel cut solenoid.

↓ **Yes**

→ Replace the fuel cut solenoid.





The fuel cut solenoid does not "Close the fuel passage" when the engine switch is turned "OFF".

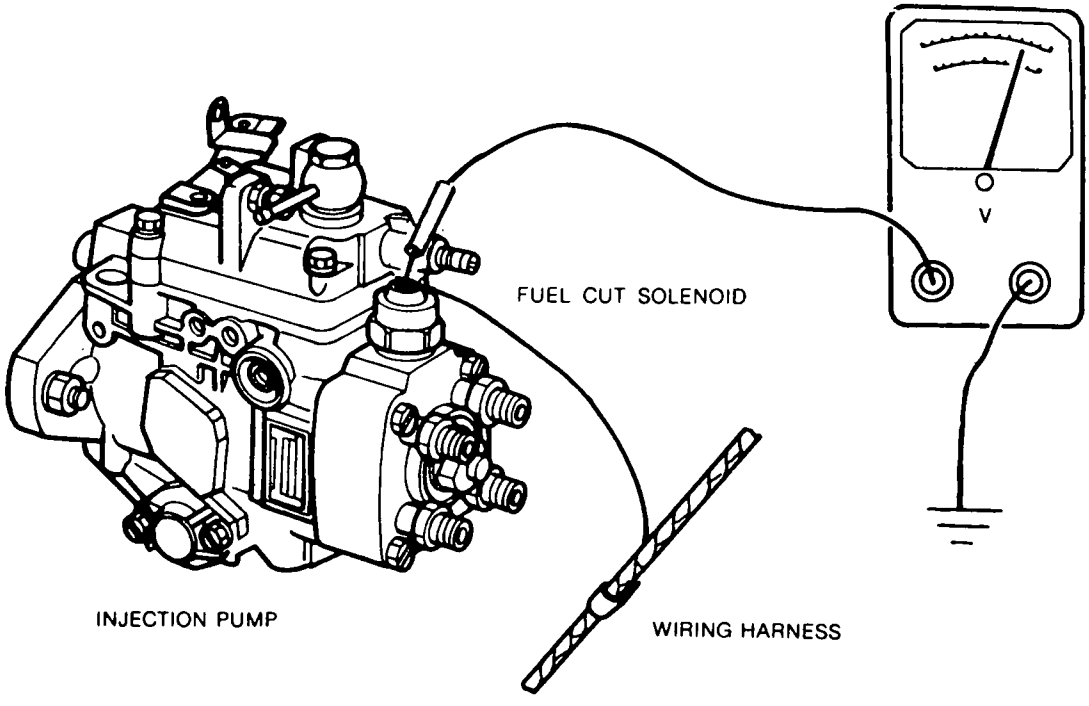
↓

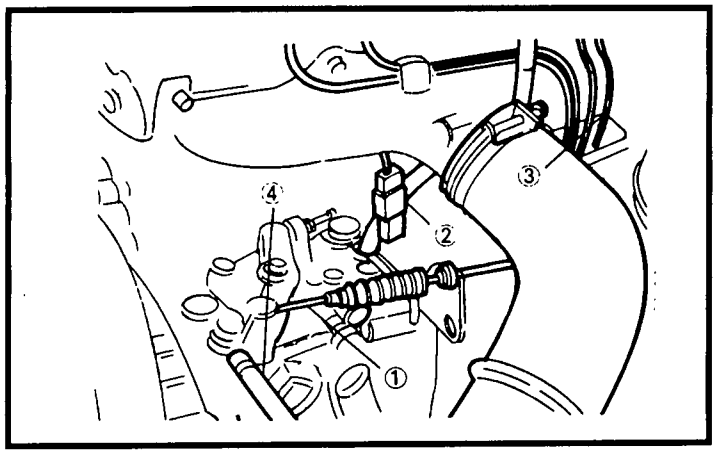
Does the fuel cut solenoid operate?

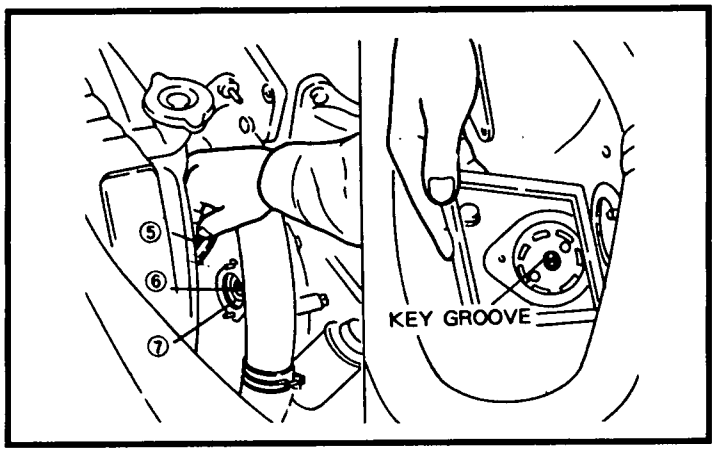
Yes → Install fuel cut solenoid properly.

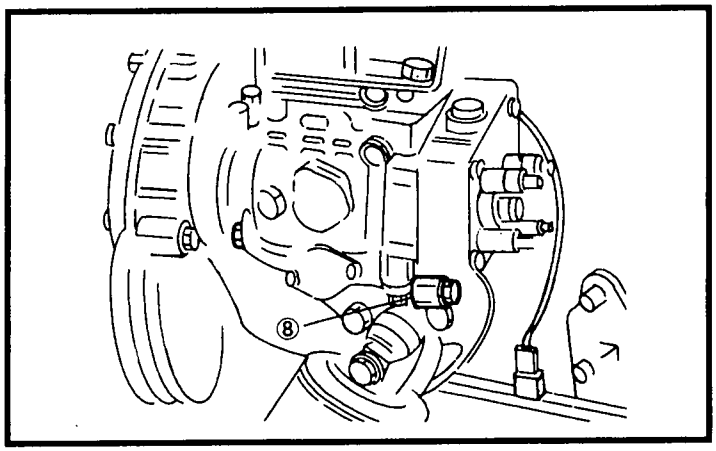
No → Replace the fuel cut solenoid.

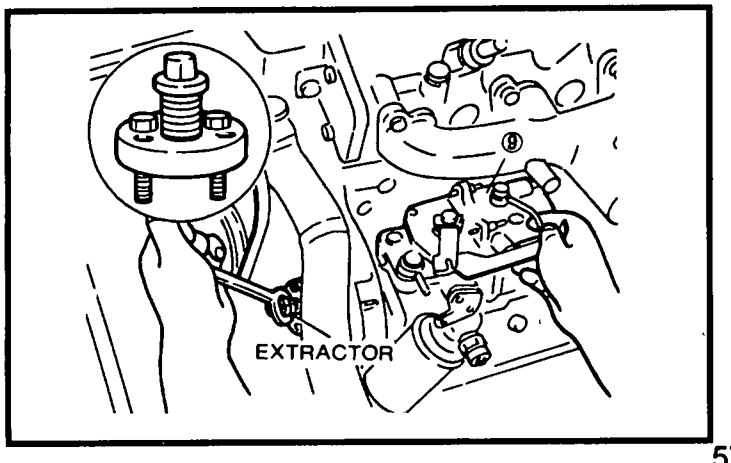
Typical Fuel Injection Pump











Removing Injection Pump
Remove in the following order:

Service point:
Apply identification marks on the injection pump flange and timing gear case for re-installation.

1. Control wire
2. Fuel cut solenoid coupler
3. Fuel injection pipes
4. Fuel hoses
5. Injection pump drive gear cover.
6. Injection pump drive gear lock nut and spring washer.

NOTE: *Care should be taken not to drop the spring washer into the timing gear case. Use a steel wire or similar.*

7. Lock plate

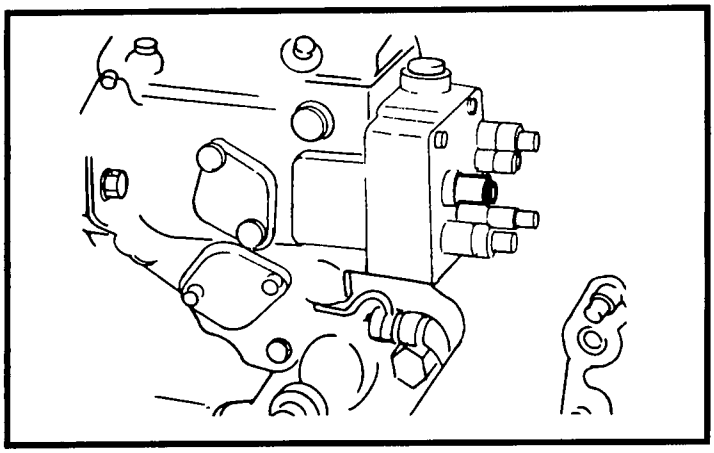
NOTE: *Turn the shaft key groove to the "UP" position. DO NOT drop the injection pump shaft key into the timing gear case.*

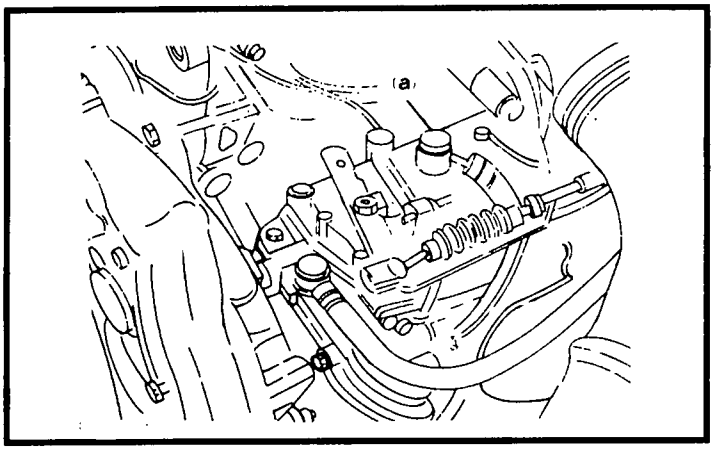
8. Injection pump attaching nuts and bolt.

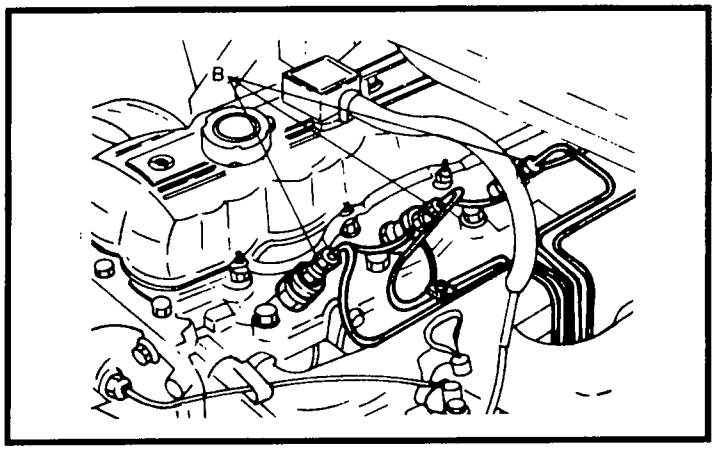
9. Injection pump
Use a commercially available puller to aid in the removal of the injection pump.

NOTE: *When removing the injection pump, use caution as not to drop the key into the timing gear case. This can be assured by sliding the gear case next to and maintaining contact with the gear case side wall.*

CHAPTER 4. AIR EVACUATION







Installing Injection Pump

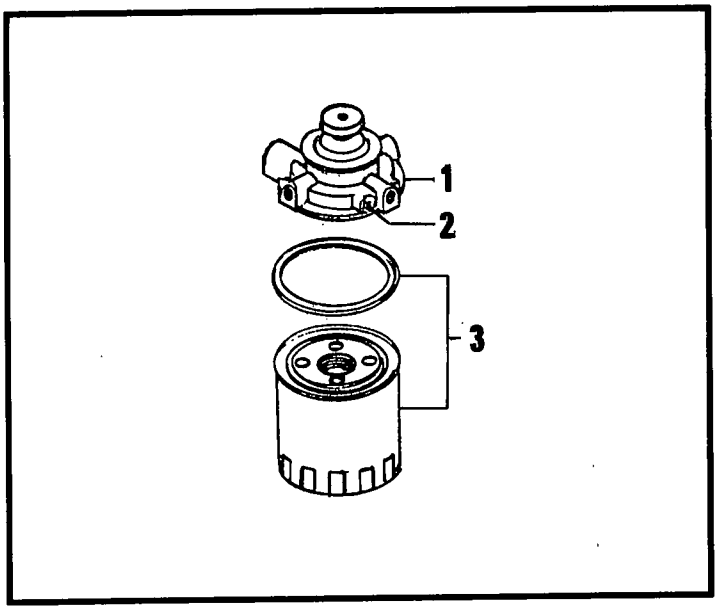
Install pump in the reverse order of removal.

NOTES: *Before installing the key on the drive shaft of the injection pump, lightly tap the key groove of the shaft with a hammer to assure that the key is tightly inserted in the key groove.*
After instastalling the injection pump, evacuate air.

Drive gear tightening torque (19 mm): 4.0~7.0 m-kg (29~51 ft-lb)

AIR EVACUATION

1. Injection pump housing air evacuation: Remove the overflow pipe (A) from the top of the injection pump and operate the priming pump until the fuel flows out.
2. Injection pipe air evacuation: Loosen the flare nut (B) at the injection nozzle side and crank the engine until the fuel flows out.



1. Adaptor
2. Bleeder Screw
3. Filter Cartridge

FUEL FILTER

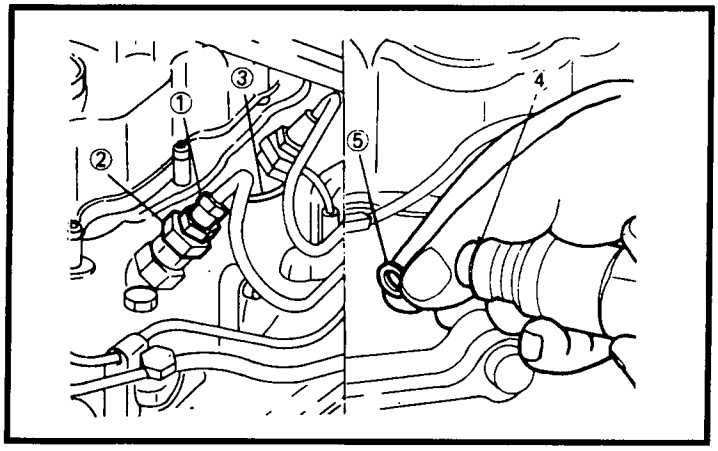
Fuel Filter

The element of the filter is sealed in the container as a unit.
The element should be replaced at intervals following the maintenance schedule.

To replace, proceed as follows:

1. Remove the fuel filter cartridge with the suitable wrench.
2. Apply fuel onto the oil seal on a new filter cartridge.
3. Position the filter and turn clockwise until the gasket surface contacts the sealing surface. Then give the filter an additional 2/3 turn by hand.
4. After replacing the filter element, bleed the filter line.
5. Start the engine and check that joints are not leaking.

CHAPTER 4. INJECTION NOZZLE

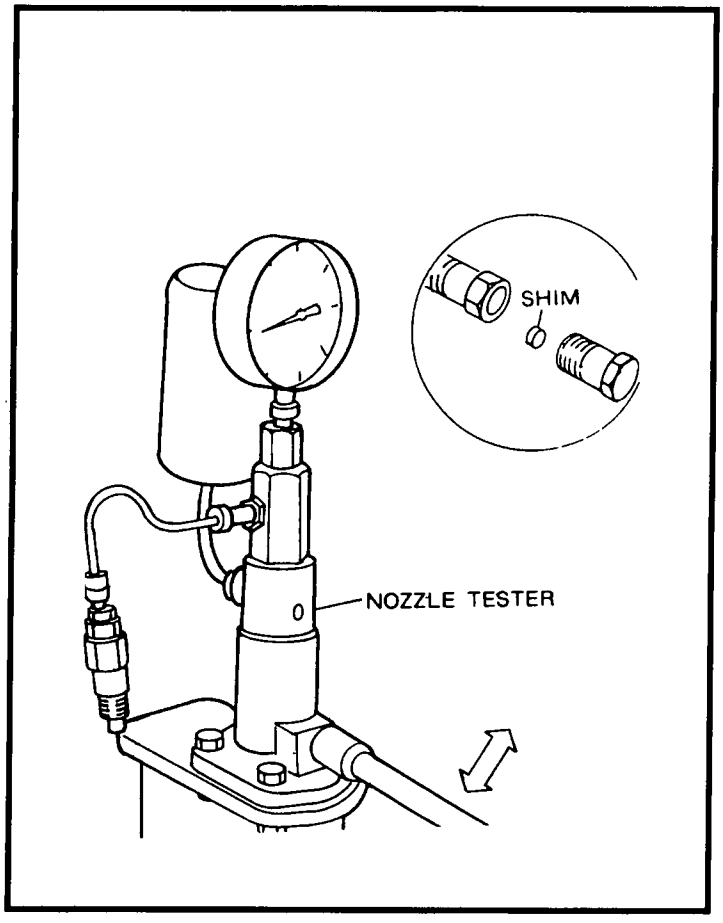


INJECTION NOZZLE

Removing Injection Nozzle

Remove in the following order:

1. Fuel injection pipes
2. Fuel leak pipe attaching nuts
3. Fuel leak pipe
4. Injection nozzles
5. Copper washers



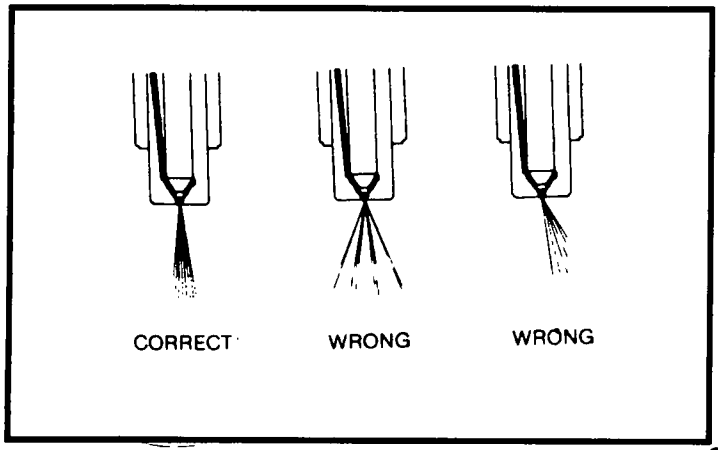
Testing Injection Nozzle

NOTE: *Test the nozzles using light oil at an approzimate temperature of 20° C (68°F).*

A. Checking Injection Starting Pressure

1. Install the nozzle on a nozzle tester and operate the hand lever at any time for air evacuation.
2. Operate the hand lever at 60 strokes / min. and check the injection starting pressure.
   Injection starting pressure:
   135 Kg/cm^2 (1,920 lb/in^2)
3. If the fuel injection starting pressure is not within the specification, adjust it by replacing the shims with suitable ones.

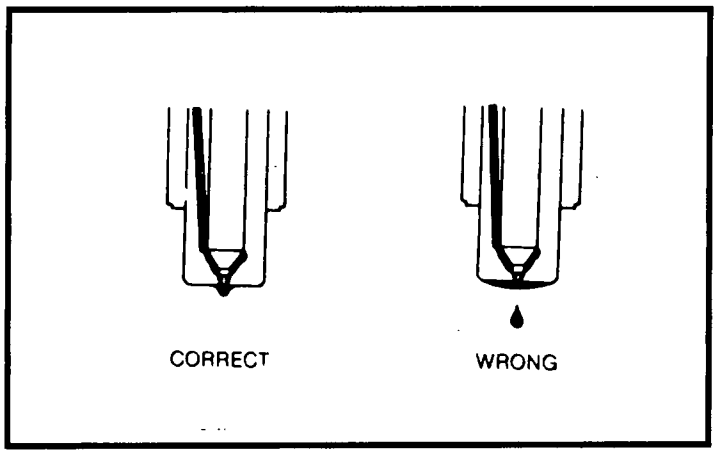
NOTE: *The shims are available in 53 sizes ranging from 0.5 mm to 1.54 mm at 0.02 mm increments. An increment of 0.02 mm causes the starting pressure to rise by approximately 2.4 kg/cm^2 (34 lb/in^2).*



B. Checking Fuel Injection

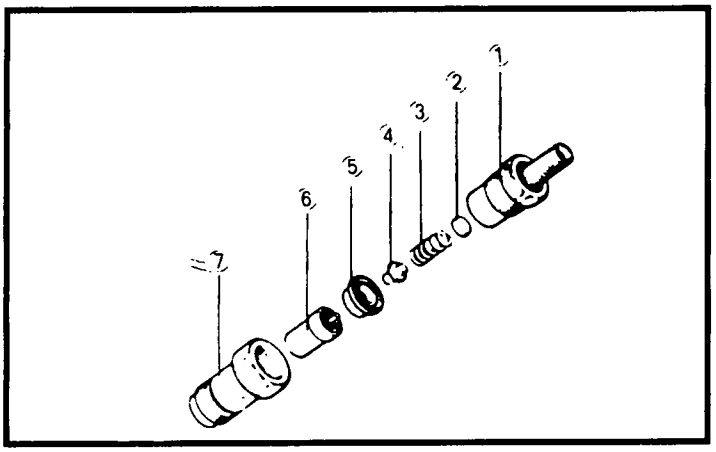
Operate the hand lever quickly and verift that fuel is injected correctly from the nozzle oriface in the direction of the nozzle axis.

Upon checking fuel injection, inspect to confirm that the fuel remains on the nozzle oriface after several injections. A large amount of fuel residual or dripping of fuel are due to mal-cantact between the needle valve and the valve seat. In such cases renew both nozzle valve and nozzle body.



C. Checking Oil Tightness of Needle Valve Seat

Operate the hand lavel to raise the pressure up to **115 kg/cm^2 (1635 lb/in^2)** which is 20 kg/cm^2 (280 lb/in^2) lower than the injection starting pressure. If fuel does not drip from the nozzle oriface under the pressure, oil tightness is satisfactory. Dripping of fuel on the other hand is indicative of damage on the needle valve or the valve body, or mal-contact between both. In that event, both needle valve and valve body must be replaced.



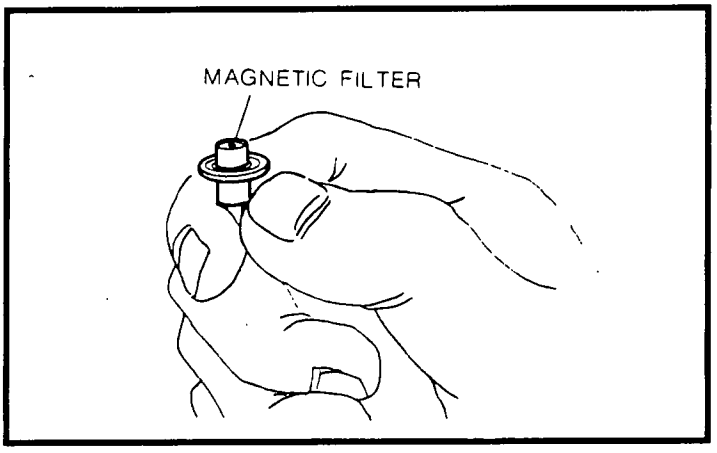
Disassembling Injection Nozzle

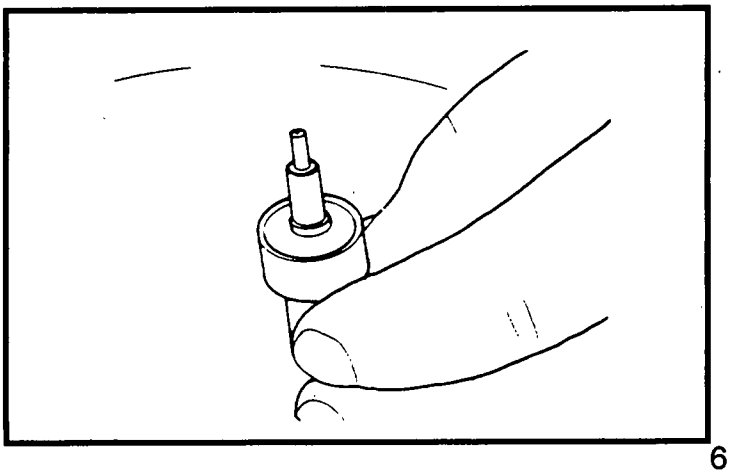
Disassemble in the following order:

1. Nozzle body
2. Adjusting seat
3. Spring
4. Magnetic filter
5. Distance piece
6. Nozzle
7. Nozzle holder

NOTE:

- *Utmost care should be taken in handling the nozzles as they are highly precision.*
- *The nozzle and the needle valve are matched pairs. Do not mix their original combinations. Disassemble and wash each nozzle assembly seperately.*
- *Carbon deposits on the nozzle body must be removed with a piece of hard wood. However, it would be advisable not to clean the surrounding area of the nozzle oriface to avoid possible damage to the oriface.*
- *Iron dust on the magnetic filter top must be removed completely.*

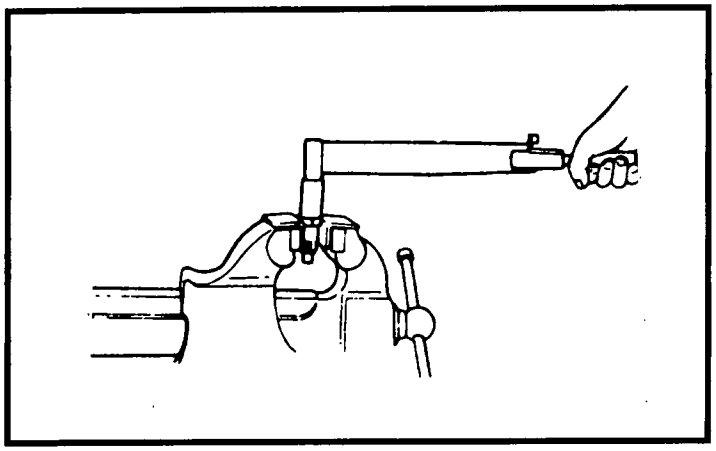




Checking Injection Nozzle

Assure that the needle valve comes down into the valve seat by it's weight when it is pushed in the nozzle body about 18 mm (0.708 in).
If it does not, replace the assembly.
If any defect is found, always replace the needle valve and the nozzle body as a unit.

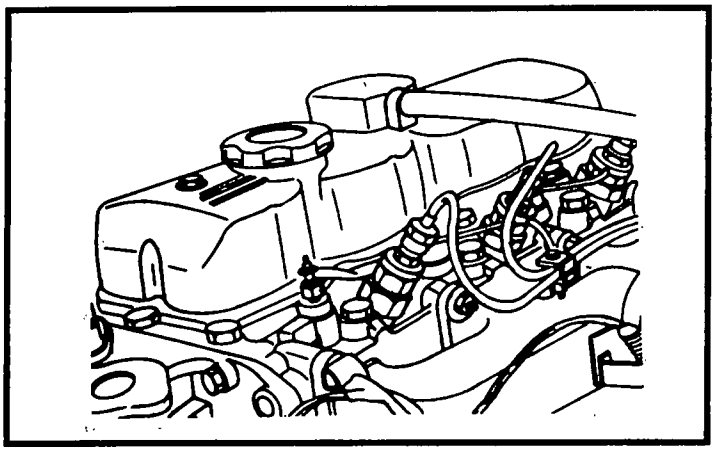
CHAPTER 4. INJECTION NOZZLE



Assembling Injection Nozzle
Assemble in the reverse order of disassembly.

NOTE: *After assembling the nozzle, test it. Tighten the nozzle body on the nozzle holder to the specified torque.*

Nozzle body tightening torque (24 mm):
8.0~10.0 m-kg (58~72 ft-lb)

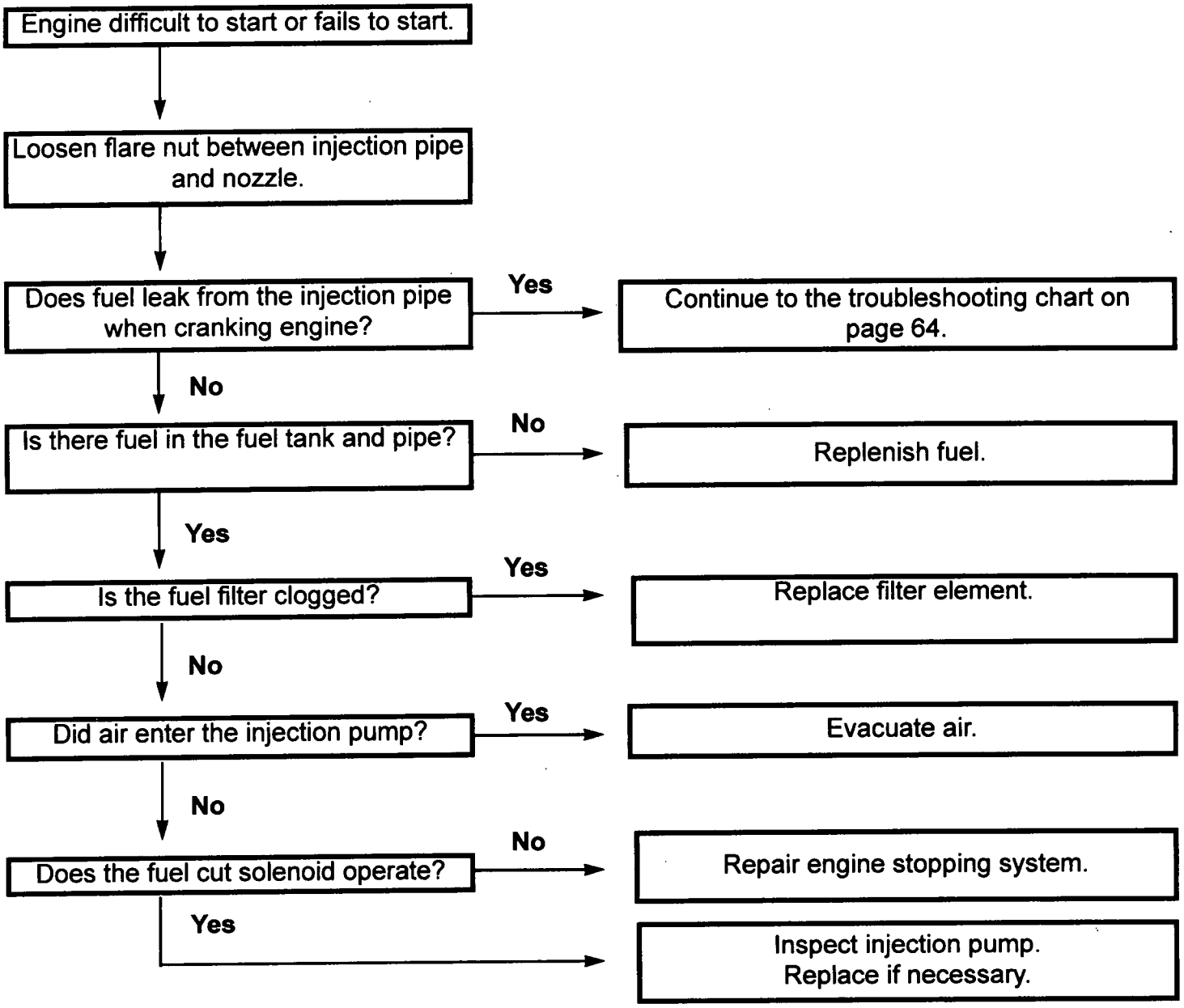


Installing Injection Nozzle
Install in the reverse order of disassembly.

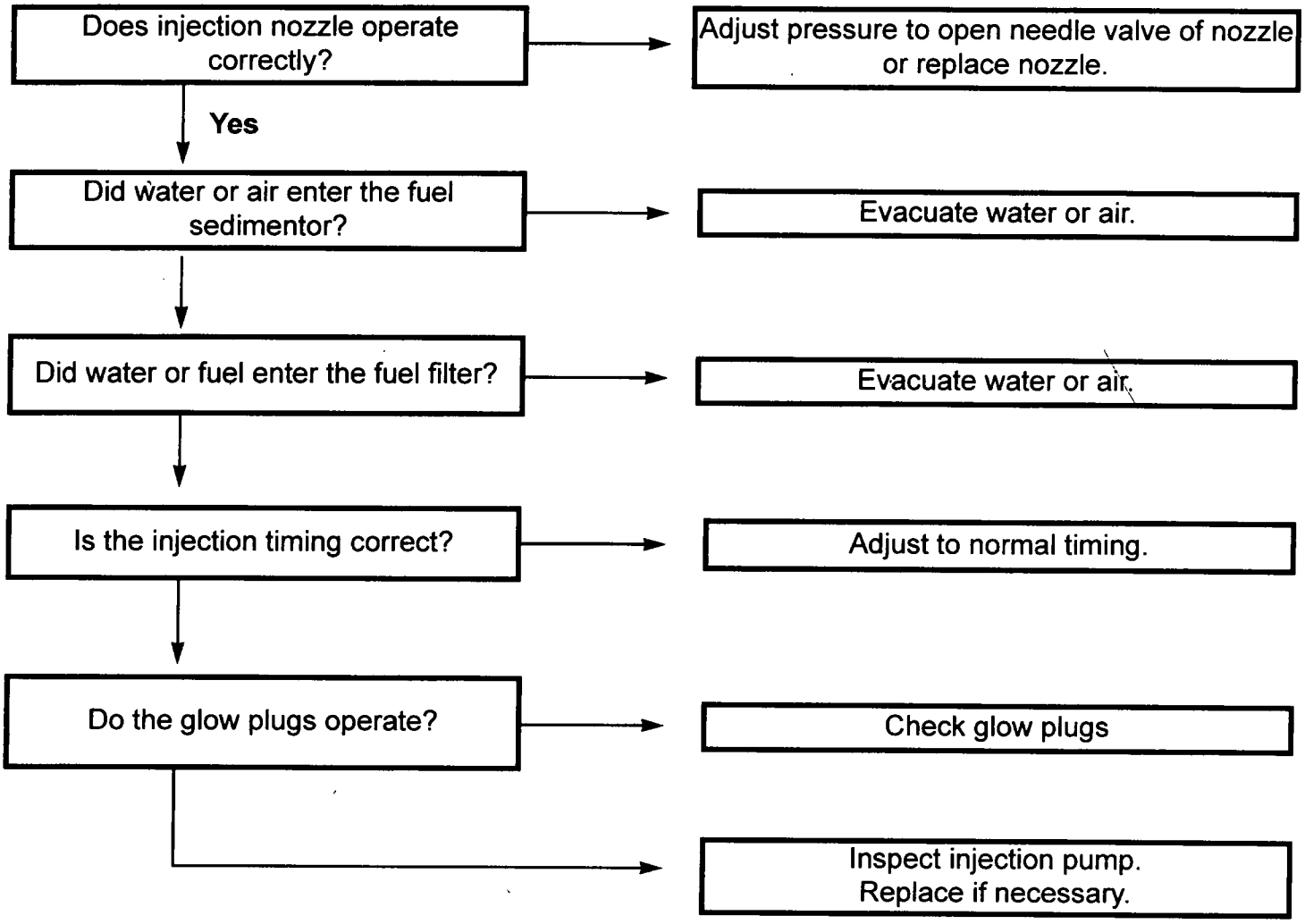
NOTE: *The copper washers should not be reused. Tighten the nozzle on the cylinder head to the specified torque.*

Nozzle tightening torque (27 mm):
6.0~7.0 m-kg (43~51 ft-lb)

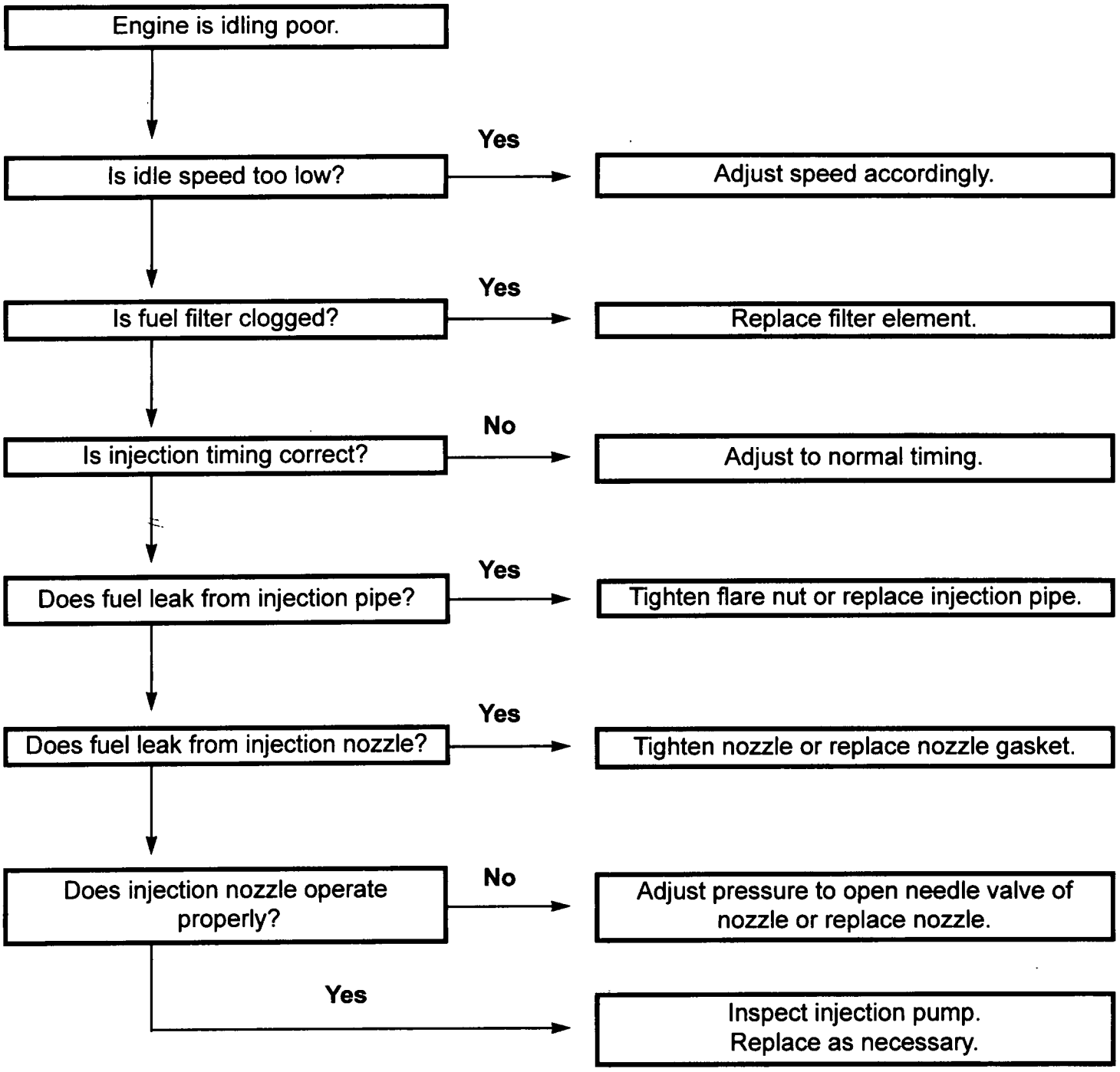
FUEL SYSTEM TROUBLESHOOTING



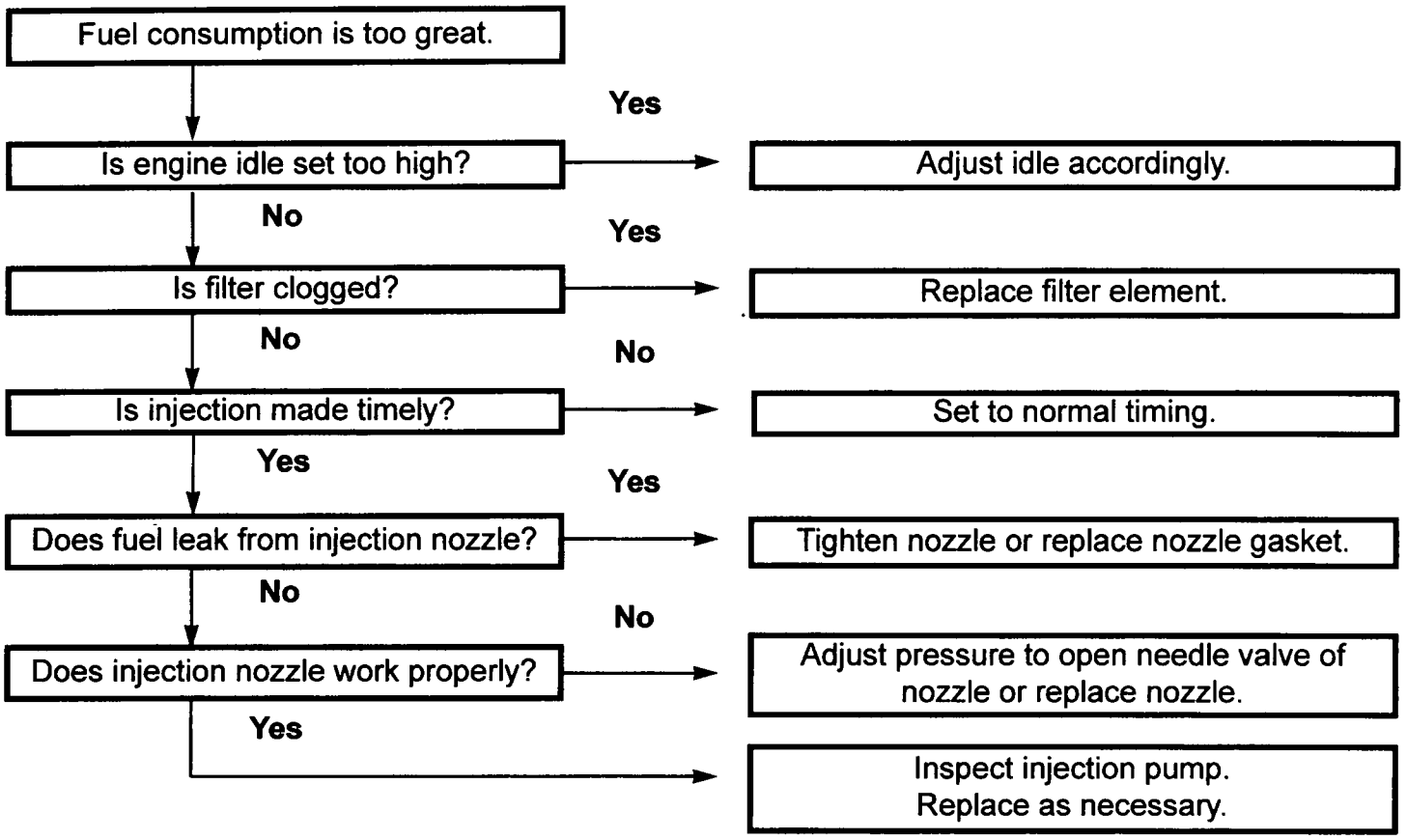
FUEL SYSTEM TROUBLESHOOTING (continued)



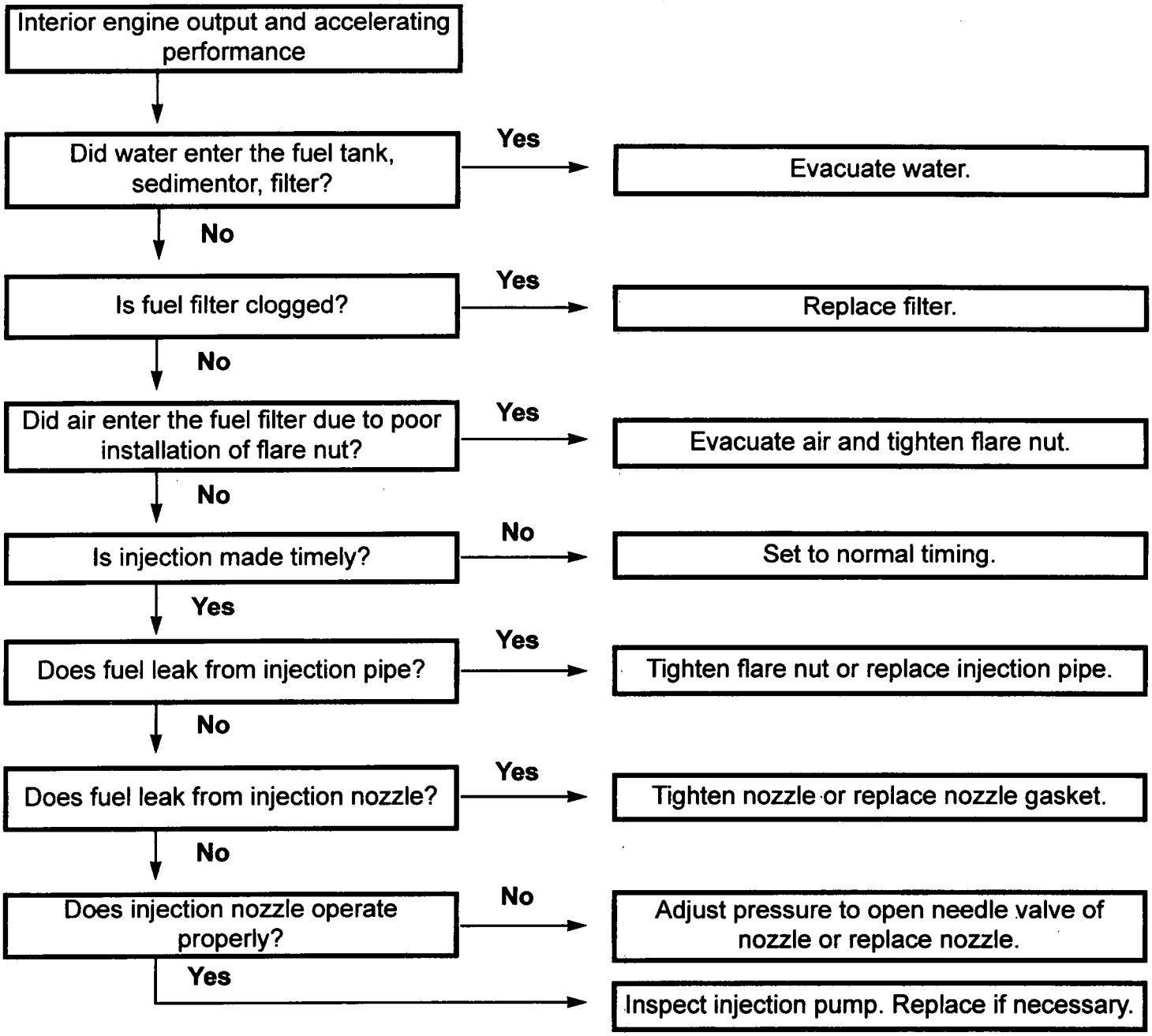
FUEL SYSTEM TROUBLESHOOTING (continued)

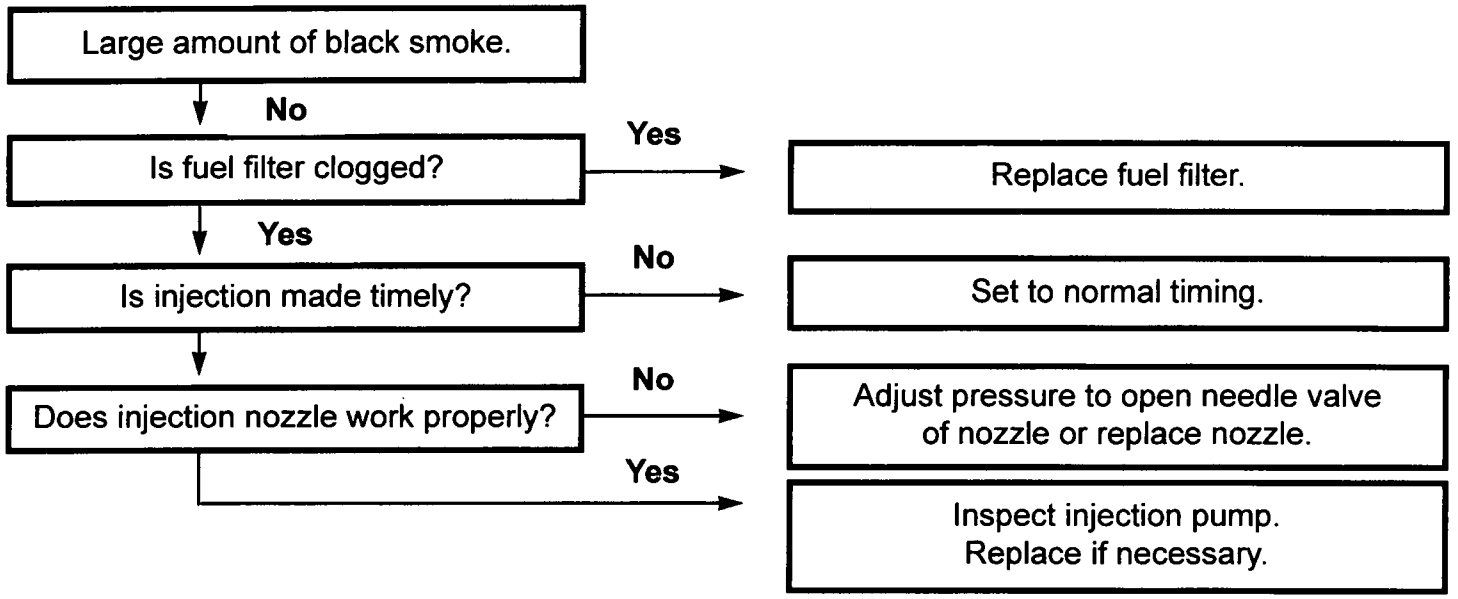


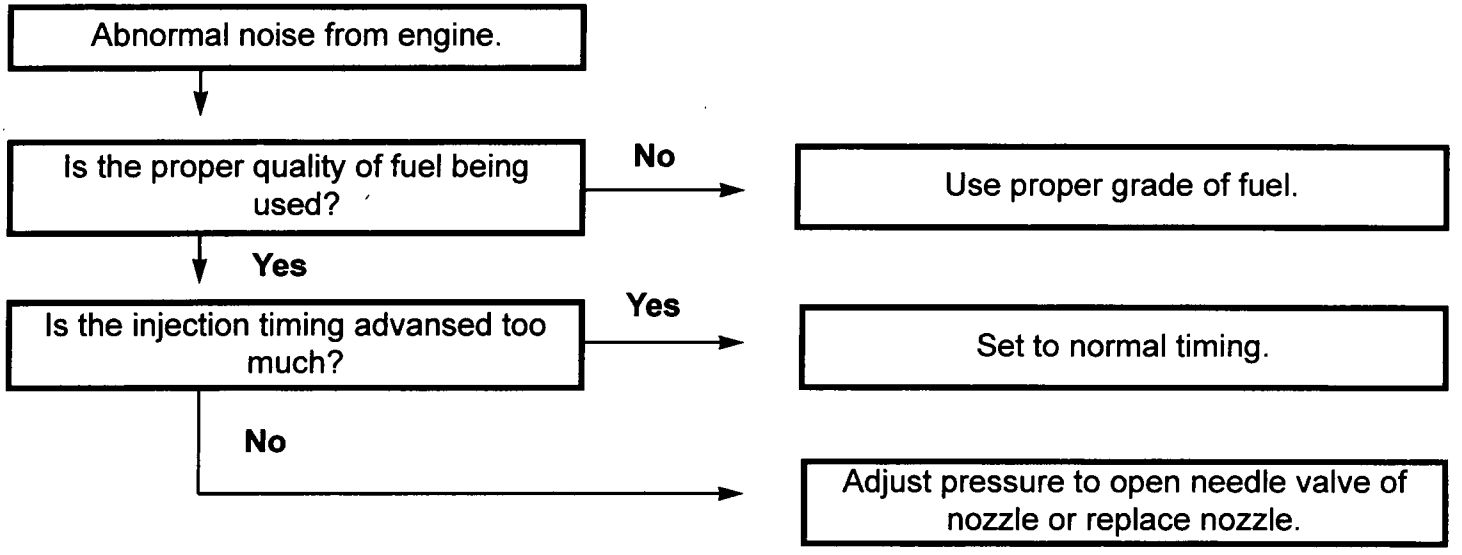
FUEL SYSTEM TROUBLESHOOTING (continued)



FUEL SYSTEM TROUBLESHOOTING (continued)




Large amount of black smoke.
No
Is fuel filter clogged?
Yes
Replace fuel filter.
Yes
Is injection made timely?
No
Set to normal timing.
Does injection nozzle work properly?
No
Adjust pressure to open needle valve of nozzle or replace nozzle.
Yes
Inspect injection pump. Replace if necessary.


Abnormal noise from engine.
Is the proper quality of fuel being used?
No
Use proper grade of fuel.
Yes
Is the injection timing advansed too much?
Yes
Set to normal timing.
No
Adjust pressure to open needle valve of nozzle or replace nozzle.

TECHNICAL DATA

BASIC:	
Bore and Stroke	3.622 x 3.503 in
Total piston displacement	2,367c.c.
Compresion ratio	21.7:1

VALVE TIMING:	
Intake valve	opens 14° BTDC
Intake valve	closes 44° ABDC
Exhaust valve	opens 48° BBDC
Exhaust closes	closes 10° ATDC
Valve clearance warm (Intake)	0.0118 in.
Valve clearance warm (exhaust)	0.0118 in.
Valve seat angle (Intake)	45°
Valve seat angle (Exhaust)	30°
Valve seat width (Intake)	0.0787 in.
Valve seat width (exhaust)	0.0787 in.

VALVE STEM TO GUIDE CLEARANCE:	
Intake (std)	0.0014~0.0045 in.
Intake (limit)	0.005 in.
Exhaust (std)	0.0023~0.0050 in.
Exhaust (limit)	0.005 in.

VALVE GUIDE, VALVE & VALVE SPRING:	
Guide inner diameter	0.3550~0.3559 in.
Guide protrusion from cylinder	0.6496 in.
Valve stem dia. (Intake) discard	0.3102 in.
Valve stem dia. (Exh.) discard	0.3097 in.
Valve head thickness (Int.) std.	0.0669 in
Valve head thickness (Exh.) limit	0.0393 in.
Valve head thickness (Int.) std.	0.0590 in.
Valve head thickness (Exh.) limit	0.03937 in.
Valve head diameter (Intake)	1.5905~1.5984 in
Valve head diameter (Exhaust)	1.4122~1.4224 in
Valve face angle (Intake)	45°
Valve face angle (Exhaust)	30°
Valve spring squareness limit (Inner)	0.0492 in.
Valve spring squareness limit (Outer)	0.0539 in.
Valve spring free length (Inner) std	1.7362 in.
Valve spring free length (Inner) limit	1.6535 in.
Valve spring free length (Outer) std	1.8070 in.
Valve spring free length (Outer) limit	1.7165 in.

ROCKER ARM & SHAFT:	
Bore in rocker arm	0.6258~0.6258 in
Rocker arm shaft diameter	0.6234~0.6244 in
Clearance in rocker arm (std)	0.006~0.0024 in.
Clearance in rocker arm (limit)	0.0027 in.

TAPPET:	
Outer diameter	0.56~0.5609 in.
Tappet bore in cyl. block	0.1688~0.5637 in.
Clearance in cylinder block bore (std)	0.0015~0.0037 in.

CAMSHAFT:	
Camshaft runout	0.003 in.
Camshaft end play (std)	0.0078~0.007 in.
Camshaft end play (limit)	0.0118 in.
Journal diameter No. 1	2.0437~2.0448 in.
Journal diameter No. 2	2.0338~2.0350 in.
Journal diameter No. 3	2.0141~2.0153 in.
Wear limit of journal	0.0003 in.
Camshaft support bore No. 1	2.0472~2.0484 in.
Camshaft support bore No. 2	2.0374~2.0385 in.
Camshaft support bore No. 3	2.0177~2.0188 in.
Journal oil clearance (std)	0.0023~0.0047 in.
Journal oil clearance (limit)	0.0057 in.
Cam height (Intake std.)	1.676 in.
Cam height (Intake limit)	1.672 in.
Cam height (Exhaust std.)	1.676 in.
Cam height (Exhaust limit)	1.672 in.

TIMING GEAR:	
Idle gear end play	0.0078~0.0118 in.
Backlsh between gears (std)	0.0039~0.0066 in.
Backlash between gears (limit)	0.0118 in.
Idle gear bushing inner dia.	1.732~1.733 in.
Idle gear spindle outer dia	1.730~1.731 in.
Spindle and bushing clearance	0.001~0.003 in. (std)
Spindle and bushing clearance	0.0059 in (limit)

CONNECTING ROD & BEARING:	
Small end bore	1.220~1.222 in
Clearance between piston pin and small end bore (std)	0.0005~0.0016 in
(limit)	0.0019 in.
End play (std)	0.0094~0.0141 in.
End play (limit)	0.0157 in.
Oil clearance (std)	0.0015~0.0029 in.
Oil clearance (limit)	0.0039 in.
Available undersize bearing.	0.01, 0.02, 0.03 in.

CRANKSHAFT AND BEARING:	
Crank pin diameter (std)	2.086~2.0866 in.
Crankpin diameter (wear limit)	0.0019 in.
Crankpin dia. (Grinding limit)	2.0561 in.

MAIN JOURNAL DIAMETER:	
Main journal diameter (std)	2.5585~2.5196 in.
Main journal dia. (wear limit)	0.00196 in.
Main journal dia. (grinding limit)	2.5285 in.

MAIN JOURNAL DIAMETER (continued):	
Main journal oil clearance (std)	0.0015~0.0035 in.
Main journal oil clearance (limit)	0.0047 in
Available undersize bearing	0.01, 0.02, 0.03 in.
Thrust washer oversize	0.007 in.
Crankshaft run out limit	0.0019 in.
Crankshaft end play (std)	0.0055~0.0153 in.
Crankshaft end play (limit)	0.0157 in.
CYLINDER BLOCK PISTON AND PIN:	
Limit of distortion of cylinder block	0.0039 in.
Cylinder liner diameter	3.5009~3.5020 in.
Worn liner limit	0.0078 in.
Liner protrusion from cylinder	0.0259~0.0311 in.
Piston diameter	3.4987~3.4997 in.
Clearance between piston and liner	0.0021~0.0031 in.
Ring groove width (top)	0.0957~0.0959 in.
Ring groove width (second)	0.0953~0.0954 in.
Ring groove width (oil)	0.1887~0.1887 in.
Piston ring width (top)	0.0940~0.0194 in.
Piston ring width (second)	0.0938~0.0937 in.
Piston ring width (oil)	0.1875~0.1874 in.
Clearance between ring & groove (top)	0.0019~0.0035 in.
Clearance between ring & groove (2nd)	0.0015~0.0031 in.
Clearance between ring & groove (oil)	0.0011~0.0027 in.
Clearance between ring & groove (limit)	0.0118 in.
Piston ring end gap (top)	0.0157~0.0216 in.
Piston ring end gap (second)	0.0118~0.0157 in.
Piston ring end gap (oil)	0.0137~0.0021 in.
Piston ring end gap (limit)	0.0590 in.
Piston pin diameter	1.1021~0.3149 in.

TECHNICAL DATA

CYLINDER HEAD DISTORTION:

Location A,B:	0.004 in.
Location C,D,E,F	0.10 in.

VALVE SPRING FREE LENGTH:

Inner spring	1.654 in.
Outer spring	1.717 in.

VALVE SPRING SQUARENESS LIMIT:

Inner spring	0.049 in.
Outer spring	0.054 in.

VALVE SPRING INSTALLED HEIGHT AND PRESSURE

Inner spring	1.488 in @ 22.7 lb.
Outer spring	1.587 in. @ 32.0 lb.

VALVE STEM DIAMETER LIMIT:

Intake valve	**0.3102 in.**
Exhaust valve	**0.3097 in.**

VALVE STEM TO GUIDE CLEARANCE:

Intake & Exhaust	0.0050 in.

VALVE GUIDE PROTRUDING LENGTH:

Intake & Exhaust	0.65 in.

VALVE FACE ANGLE:

Intake	45°
Exhaust	30°

VALVE SEAT ANGLE:

Intake	45°
Exhaust	30°

VALVE SEAT WIDTH:

Intake	0.079 in.
Exhuast	0.079 in.

CLEARANCE BETWEEN ROCKER ARM AND SHAFT:

Standard	0.0006~0.0024 in.
Limit	0.0028 in.

CHECKING CYLINDER BLOCK DISTORTION:

A,B	0.004 in.
C,D,E,F	0.010 in.

CYLINDER LINER BORE:

Standard	3.5010~3.5020 in.
Limit	0.0079 in.

PROTRUDING HEIGHT OF CYLINDER LINER:

0.0259~0.0311 in.

PISTON TO CYLINDER BORE CLEARANCE:

0.0017~0.0028 in.

PISTON RING SIDE CLEARANCE:

Limit	0.0118 in.

PISTON RING END GAP LIMIT:

Limit	**0.0951 in.**

CLEARANCE BETWEEN PISTON PIN AND BUSHING:

Standard	0.0006~0.0016 in.
Limit	0.0020 in.

PERMISSIBLE CONNECTING ROD DEFLECTION:

Allowable deflection	0.0020 in. per 4 in.

CONNECTING ROD END PLAY:

End play limit	0.0157 in.

CONNECTING ROD BEARING CLEARANCE:

Standard	0.0014~0.0030 in.
Limit	0.0039 in.

CRANKSHAFT JOURNAL DIAMETERS:

Main journal	2.5585~2.5591 in.
Crankpin	2.0861~2.0866 in.

CRANKSHAFT WEAR LIMIT:

Main journal	0.0020 in.
Crankpin	0.0020 in.

ALLOWABLE CRANKSHAFT RUNOUT:

Maximum run-out	0.020 in.

CRANKSHAFT END PLAY LIMIT:

Limit	0.0157 in.

CRANKSHAFT MAIN BEARING CLEARANCE:

Standard	0.0016~0.0036 in.
Limit	0.0047 in.

CAMSHAFT HEIGHT LIMIT:

Limit	1.6728 in.

CAMSHAFT JOURNAL DIAMETERS:

No. 1	2.0437~2.0449 in.
No. 2	2.0339~2.0350 in.
No. 3	2.0142~2.0154 in.

CAMSHAFT JOURNAL WEAR LIMIT:

No. 1	0.0003 in.
No. 2	0.0003 in.
No. 3	0.0003 in.

CAMSHAFT JOURNAL CLEARANCE LIMIT:

Limit	0.0057 in.

CAMSHAFT ALLOWABLE RUNOUT:

End play limit	0.0118 in.

TECHNICAL DATA (clearances)

CLEARANCE BETWEEN END PLATE AND CAMSHAFT:

End play limit	0.0118 in.

IDLE GEAR BUSHING TO SPINDLE CLEARANCE:

Standard	0.0013~0.0034 in
Limit	0.0059 in.

IDLE GEAR END PLAY STANDARD:

Standard	0.0079~0.0118 in

IDLE GEAR BACKLASH:

Limit	0.0118 in.

CHECKING PUSH RODS FOR BENDING:

Bending limit	0.0075 in.

TAPPET TO TAPPET GUIDE CLEARANCE:

Limit	0.0039 in.

ADJUSTING VALVE CLEARANCE:

Intake	0.012 in.
Exhaust	0.012 in.

V-BELT TENSION

New belt	0.35~0.43 in.
Used belt	0.39~0.47 in.

COMPRESSION PRESSURE

Standard	427 lb/in^2 @ 200 rpm
Limit	384 lb/in^2 @ 200 rpm

ACCELERATOR WIRE PLAY

Permissable play	0.02~0.06 in.

TORQUE SPECIFICATIONS

Connecting Rod Cap Bolts	**50~54 ft/lb**
Main Bearing Cap Bolts	**80~85 ft/lb**
Camshaft Gear Bolt	**45~51 ft/lb**
Idle Gear Plate Bolts	**17~23 ft/lb**
Timing Gear Case Bolts	**12~17 ft/lb**
Camshaft Retainer Bolts	**12~17 ft/lb**
Idle Gear Thrust Plate Bolts	**17~23 ft/lb**
Injection Pump Drive Gear Locknut	**29~51 ft/lb**
Timing Gear Cover	**12~17 ft/lb**
Oil Pan Bolts	**5~9 ft/lb**
End Plate Bolts	**24~35 ft/lb**
Flywheel / Flexplate Bolts	**95~137 ft/lb**
Crankshaft Pulley	**145~181 ft/lb**
Cylinder Head Bolts	**80~85 ft/lb**
Water Pump Bolts	**12~17 ft/lb**
Intake Manifold Bolts	**12~17 ft/lb**
Fuel Injection Nozzles	**58~72 ft/lb**
Injection Pump Drive Gear Torque	**29~51 ft/lb**
Injection Nozzle Body Torque	**58~72 ft/lb**
Injection Nozzle Torque	**43~51 ft/lb**