P/N 99342

ONE-STOP

GENERAC

2.2 DIESEL

SERVICE REPAIR MANUAL

P.O. BOX 8 WAUKESHA WI. 53187

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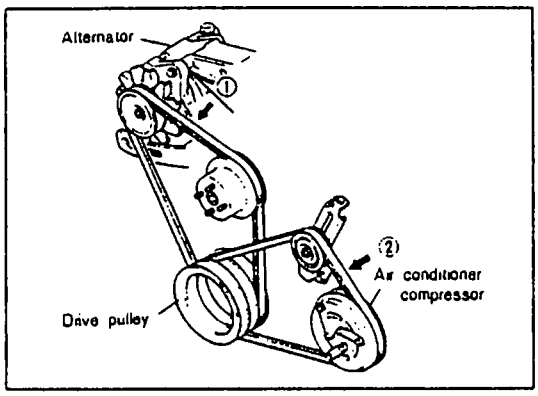
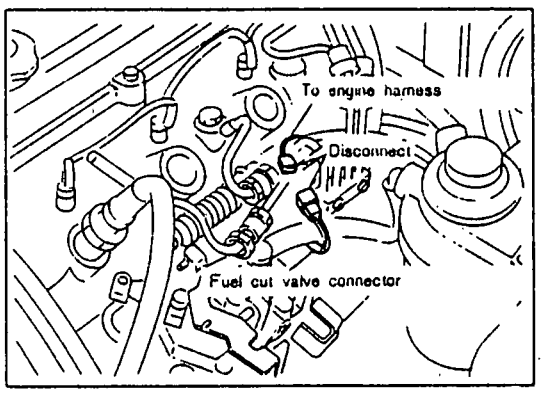
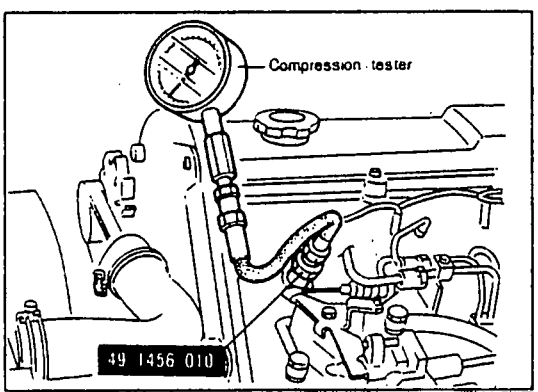
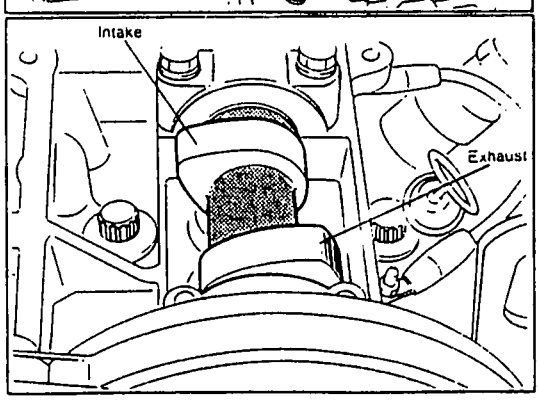
ENGINE SPECIFICATIONS

ENGINE MODEL	R2
TYPE	Diesel, 4 cycle
NUMBER OF CYLINDERS	4 cylinders, in line
COMBUSTION CHAMBER	Swirl flow type
VALVE SYSTEM	Direct drive, OHC
DISPLACEMENT C.C. (C.I.)	2184 (133.2)
BORE AND STROKE mm (in)	86.0 X 94.0 (3.39 X 3.70)
COMPRESSION RATIO	22.7 : 1
COMPRESSION PRESSURE kg/cm^2 (lb/in^2)-rpm	30 (427) - 200
VALVE TIMING: intake open	BTDC 13°
VALVE TIMING: intake closed	ABDC 39°
VALVE TIMING: exhaust open	BBDC 60°
VALVE TIMING: exhaust closed	ATDC 8°
VALVE CLEARANCE (cold eng. int.)	0.25 (0.098) mm (in.)
VALVE CLEARANCE (cold eng. exh.)	0.35 (0.138) mm (in.)
IDLING SPEED (rpm)	725 (+/-) 25
INJECTION ORDER	1-3-4-2









INSPECTION AND ADJUSTMENT

CHECKING DRIVE BELT

To check the belt tension, apply moderate pressure (10 kg, 22 lb) midway between the pulleys. Check the deflection, and adjust it if necessary.

Caution
If the drive belt becomes worn, cracked, or frayed, it should be replaced.

Drive belt	Deflection	
	New	Used
1 Alternator	11 ~ 12 mm (0.44 ~ 0.47 in)	12 ~ 14 mm (0.47 ~ 0.55 in)
2 Air conditioner compressor	4 ~ 5 mm (0.16 ~ 0.20 in)	5 ~ 6 mm (0.20 ~ 0.24 in)

CHECKING COMPRESSION

1. Warm up the engine thoroughly.
2. Stop the engine.
3. Remove all the fuel injection pipes, nozzles, washers and corrugate washers.
4. Disconnect the fuel cut valve connector.

Caution
If this is not done, fuel will be injected from the injection pump while cranking.

5. Connect a suitable cap to the fuel return pipe on the injection pump.

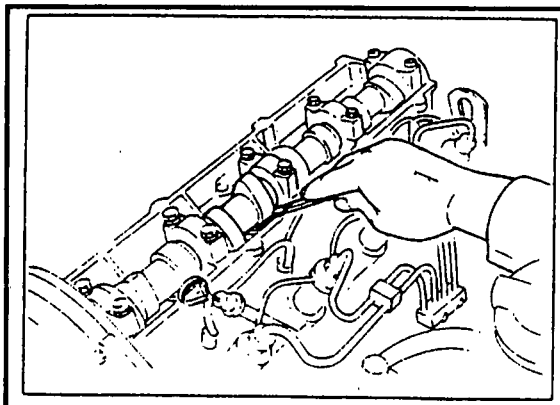
6. Install the **compression gauge adapter** (49 1456 010) to the injection nozzle hole.
7. Connect a compression gauge to the compression gauge adapter.
8. Crank the engine.
9. Check whether the gauge reading is above the limit.

Compression pressure	kg/cm² (lb/in²)-rpm
Standard	30 (426) — 200
Limit	27 (384) — 200

ADJUSTMENT OF VALVE CLEARANCE

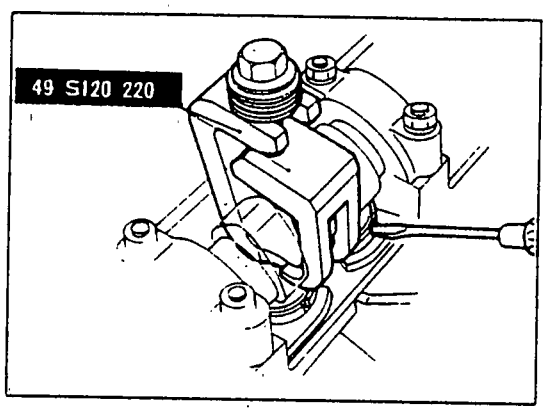
1. Remove the cylinder head cover.
2. Set the No. 1 cylinder to compression TDC.

Note
Turn the crankshaft so that the intake and exhaust cam lobes face upward.

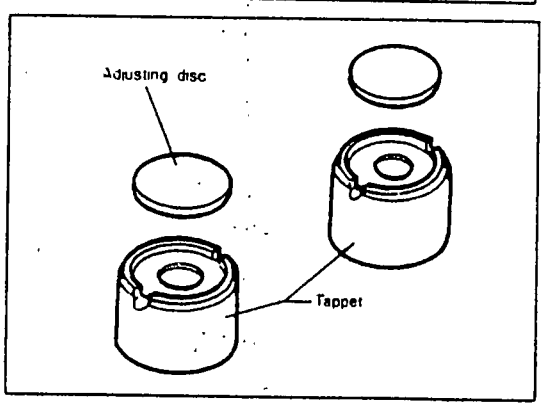


3. Measure the valve clearance of No. 1 cylinder by using a thickness gauge.

Standard valve clearances (engine cold condition):
Intake:
0.20 ~ 0.30 mm (0.008 ~ 0.012 in)
Exhaust:
0.30 ~ 0.40 mm (0.012 ~ 0.016 in)

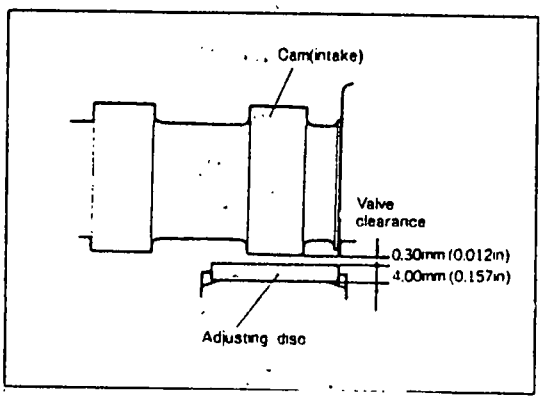


Adjust the valve clearances by following the procedures below if they are not within the standard.
4. Face the intake cam straight upward.
5. Move the tappet so that its notch is at the manifold side, so that access to the adjusting disc is easy.
6. Using the **tappet holder** (49 S120 220), press the tappet down to the position where the adjusting disc becomes accessible.
7. Using a small screw driver or similar tool, take out the adjusting disc.



8. Select an appropriate disc depending on the valve clearance measured. Install it and check the clearance again.

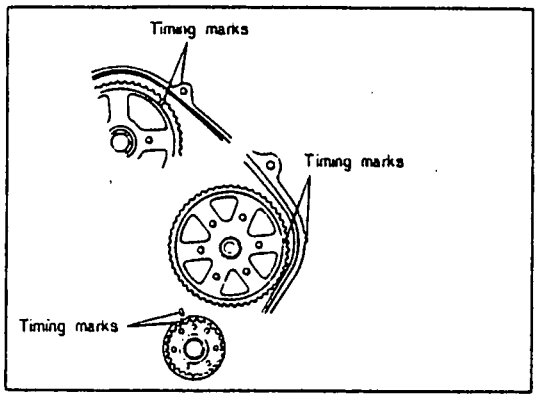
Example (Intake valve):
Thickness of original adjusting disc + (measured clearance − standard clearance) = **thickness of new adjusting disc.**
4.00 + (0.30 − 0.25) = 4.05 mm
0.157 + (0.012 − 0.010) = 0.159 in



Note
The number marked on the disc indicates its thickness
Example: 3825 means 3.825 mm (0.1056 in).
Adjusting discs are available in 25 different thicknesses within the 3.40 ~ 4.60 mm (0.1339 ~ 0.1811 in) range, at intervals of 0.050 mm (0.002 in).

9. Measure and adjust cylinder 2 to 4 in the same way.

TIMING BELT REPLACEMENT

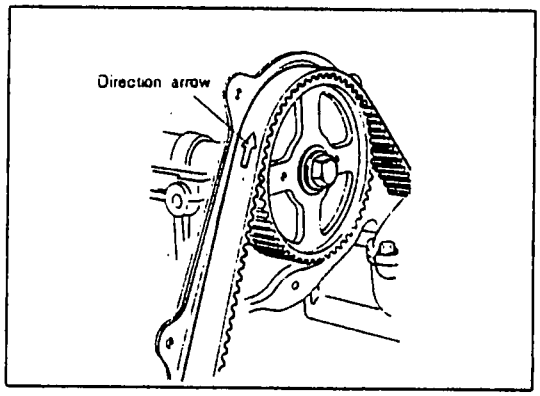


Timing belt

1. Before removing the timing belt and timing belt tensioner, aline each timing mark.

Caution

a) After removing the timing belt, don't rotate the crankshaft pulley and camshaft pulley to prevent damaging the valves.

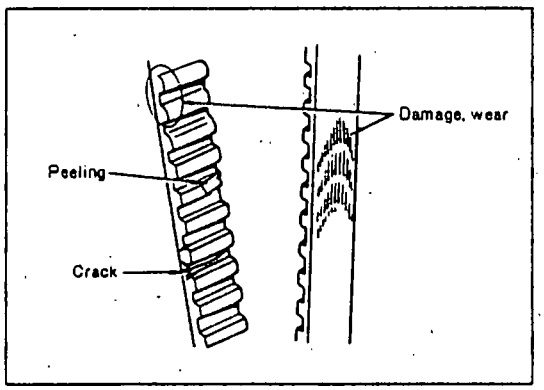


b) If reusing the timing belt, draw a direction arrow on the timing belt to replace it in the same direction.

Inspection

Timing belt

1. Replace the belt if there is any oil, grease, or moisture on it.
2. Check for damage, wear, peeling, cracks, or hardening.
   Replace if necessary.



Cautions

a) Never forcefully twist the timing belt, turn it inside out, or bend it.

b) Be very careful not to allow oil, grease, or moisture to get on the timing belt.

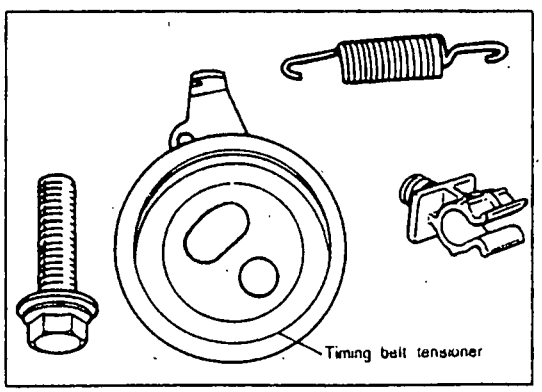
Timing belt tensioner

1. Check the rotation of the timing belt pulley, and check for play or abnormal noise. Replace if necessary.

Cautions

a) Do not clean the timing belt tensioner with cleaning fluides.

b) If it is dirty, use a rag to wipe it clean, so as to avoid scratching it.



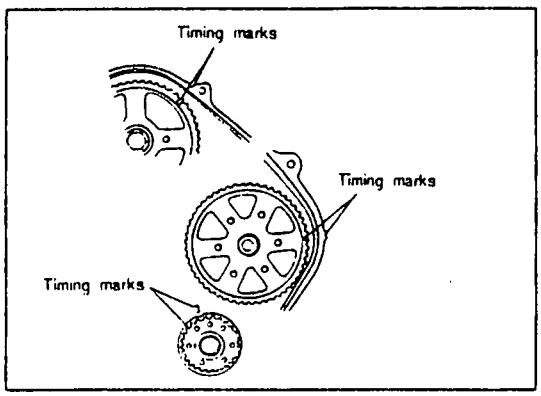
Timing belt pulley, camshaft pulley and injection pump pulley

1. Check the pulley teeth for damage, wear, deformation, etc.
   Replace if necessary.

Caution

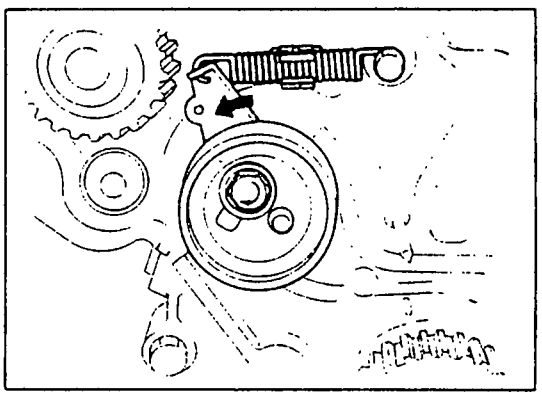
Do not wash the pulley. If it is dirty, use a rag to wipe it clean, so as to avoid it being contaminated by oil etc.

TIMING BELT REPLACEMENT

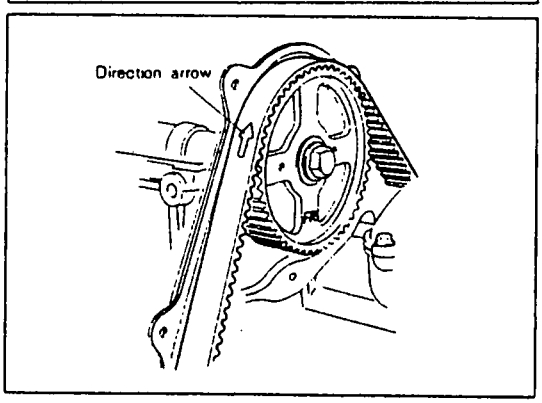


Installation

1. Check to be sure that the timing marks of camshaft pulley, timing belt pulley and crankshaft pulley match to each timing mark.

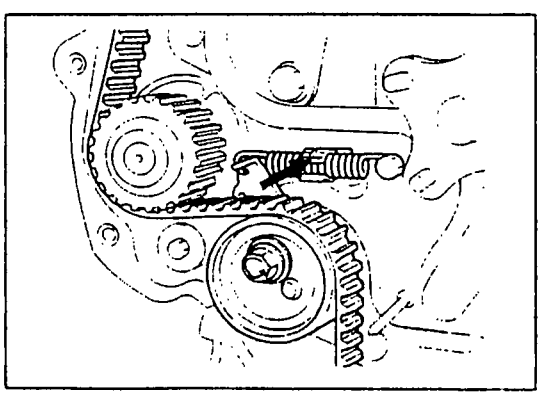


2. Install the timing belt tensioner, lock bolt and spring in fully loosened position, and then push timing belt tensioner left as far as it will go and the temporarily tighten it.



3. Install the timing belt.

Caution
The timing belt must always be reinstalled in the same direction of previous rotation for continued durability.

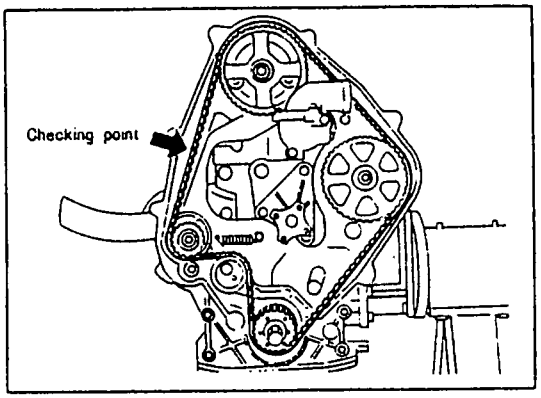


4. Release the timing belt tensioner lock bolt to allow spring pressure to bear on the timing belt.
5. Turn the crankshaft twice in the direction of rotation (clockwise) to equalize tension on the timing belt.

Caution:
Do not turn in reverse direction.

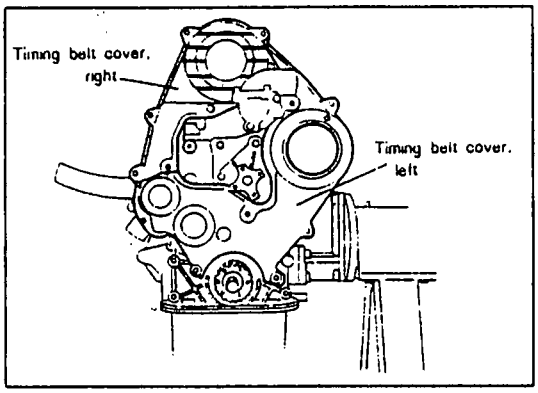
6. Tighten the timing belt tensioner lock bolt.

Tensioner lock bolt tightening torque:
3.2 ~ 4.7 m-kg (23 ~ 34 ft-lb)



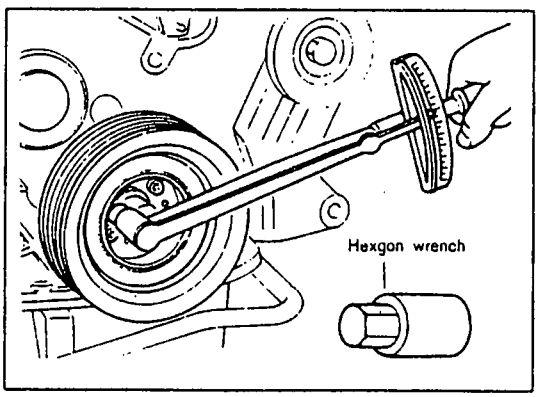
7. Re-check the timing marks on the crankshaft, injection pump and camshaft pulley, and check the timging belt deflection when pressed with a force of 10 kg (22 lb).

Standard deflection: (under cold engine condition)
10.8 ~ 12.9 mm (0.43 ~ 0.51 in)



8. Install the timing belt cover left with rubber seal.
9. Install the timing belt cover right with rubber seal.

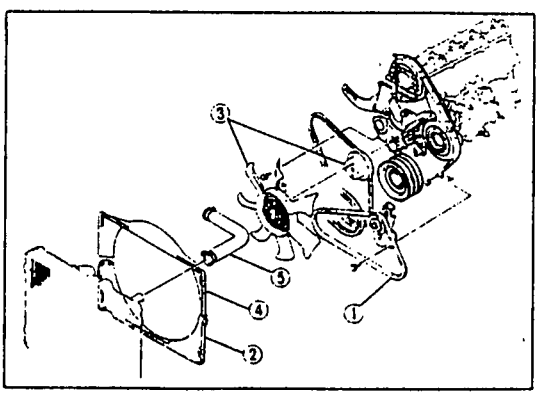
Timing belt covers tightening torque:
0.7 ~ 1.0 m-kg (5 ~ 7 ft-lb)



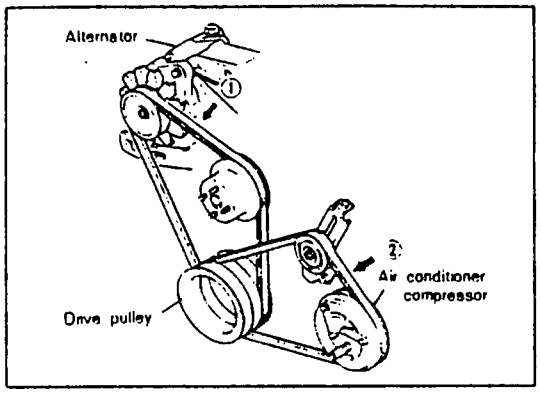
10. Install the crankshaft pulley and torsional dumper to the timing belt pulley with the semi circular (wood-ruff) key, then tighten it to the specified torque.

Crankshaft pulley tightening torque:
2.3 ~ 3.3 m-kg (17 ~ 24ft-lb)

Caution
Aline the torsional dumper to the knock pin on the timing belt pulley, when installing.



11. Install the following parts.
    (1) Air conditioner drive belt, tensioner and bracket
    (2) Cooling fan cover, lower
    (3) Cooling fan pulley and cooling fan.
    (4) Cooling fan cover, upper
    (5) Radiator hose upper.



12. Install the air conditioner drive belt and air conditioner compressor drive belt (if equipped).
13. Adjust each drive belt tension.
    To check the belt tension, apply moderate pressure (10 kg, 22lb) midway between the pulleys. Check the deflection, and adjust it if necessary.

    Caution
    If the drive belt becomes worn, cracked, or frayed, it should be replaced.

Drive belt	Deflection	
	New	Used
1 Alternator	11 ~ 12 mm (0.44 ~ 0.47 in)	12 ~ 14 mm (0.47 ~ 0.55 in)
2 Air conditioner compressor	4 ~ 5 mm (0.16 ~ 0.20 in)	5 ~ 6 mm (0.20 ~ 0.24 in)

14. Fill the radiator with coolant.
15. Install the Parking brake member and seat.
    Adjust the Parking brake lever stroke. (See page 1B–11)

CYLINDER HEAD

Removal

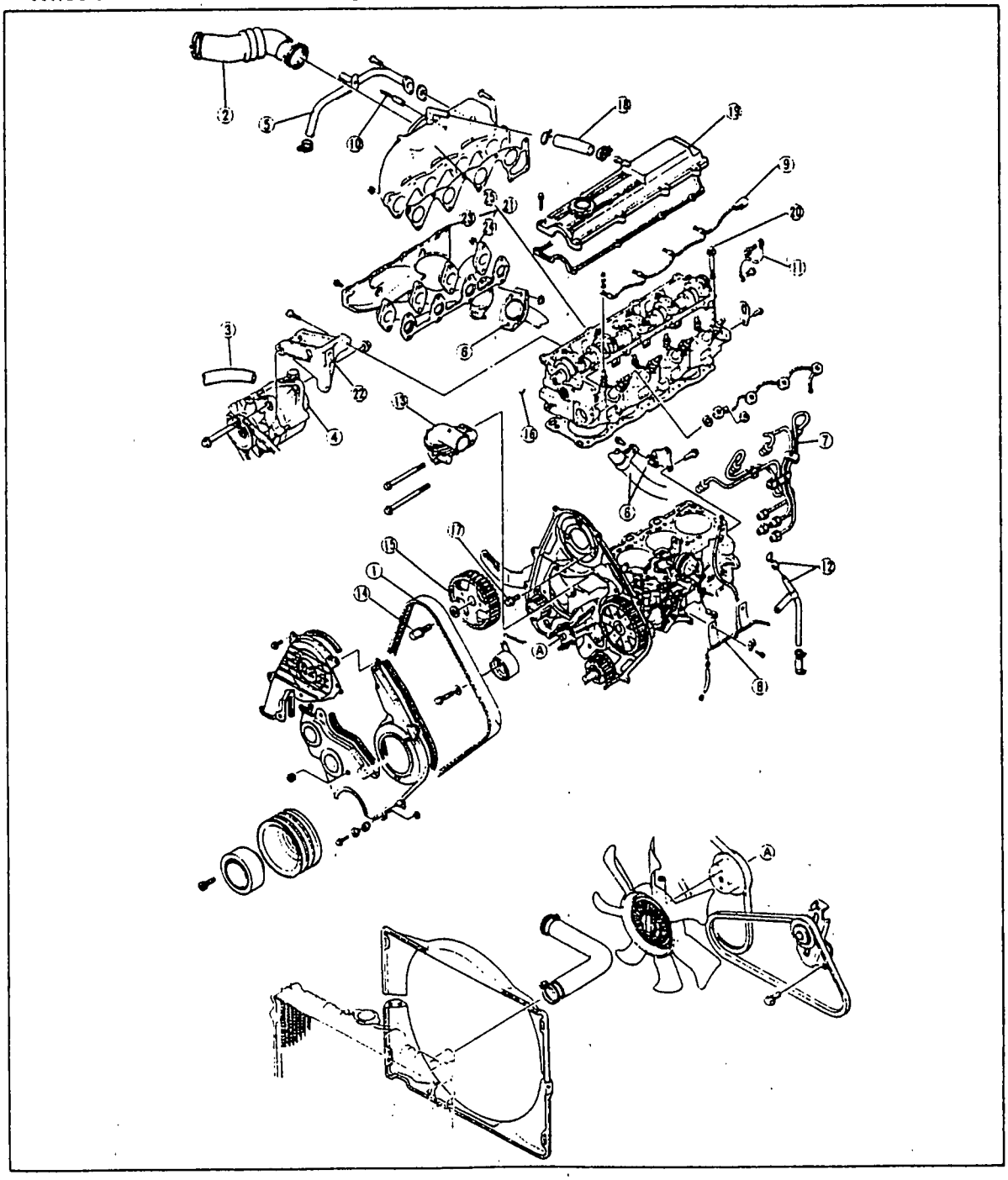
Remove the seat and parking brake frame, then disconnect the battery negative cable from the battery. (See page 18–11)

Drain engine coolant into a suitable container.

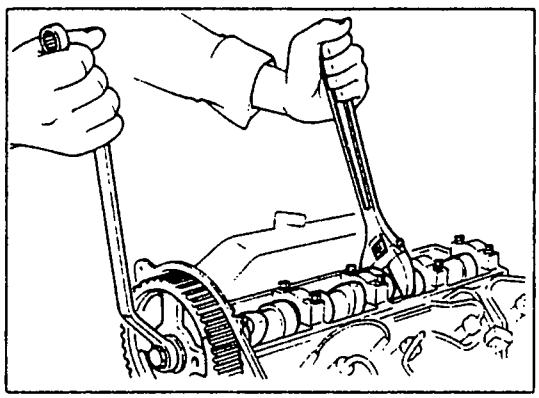
Then remove each part in the rumbered sequence as shown in the figure.

Caution

Wheels must be blocked during maintenance.

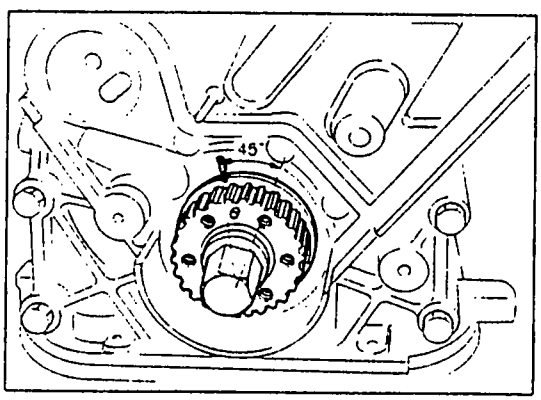


1. Timing belt (refer to page 18–12)
   (Turn the crankshaft 45°)
2. Air intake hose
3. Vacuum hose
4. Alternator
5. Oil cooler water pipe
6. Exhaust pipe and bracket
7. Injection pipes
8. Fuel return pipe
9. Glow plug connector
10. Thermo unit gauge connector
11. Engine ground wire
12. Oil level gauge and pipe
13. Thermostat assembly
14. Camshaft pulley lock bolt
15. Camshaft pulley
16. Semi circular (woodruff) key
17. Seal plate attaching bolts (2)
18. Breather hose
19. Cylinder head cover
20. Cylinder head bolts
21. Cylinder head with intake and exhaust manifold
22. Alternator bracket
23. Hot air duct
24. Exhaust manifold
25. Intake manifold



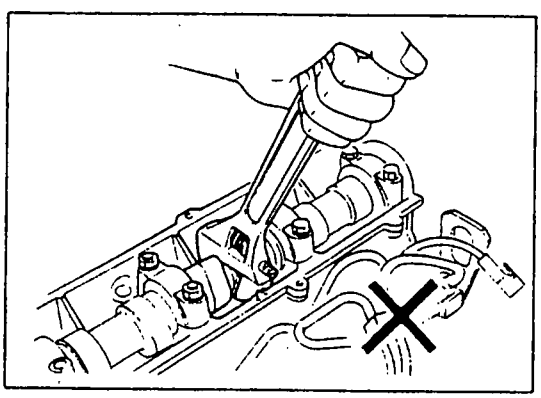
Camshaft pulley

1. Hold the camshaft with the wrench (29 mm, 1.14 in) and loosen the camshaft pulley lock bolt.

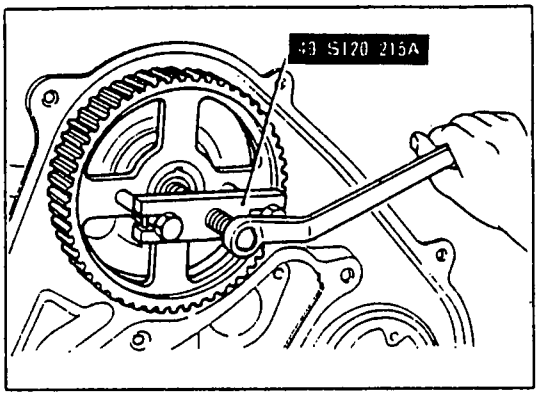


Cautions

a) Before removing the camshaft pulley, turn the crankshaft 45° clockwise, to prevent damage to the valve.



b) Don't damage the cylinder head edge with the wrench.

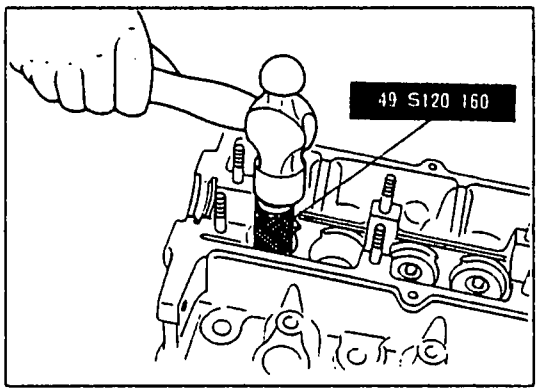


2. Separate the camshaft pulley from the camshaft, using the **pulley puller** (49 S120 215A).

Caution:
Do not hit the camshaft pulley with a hammer.

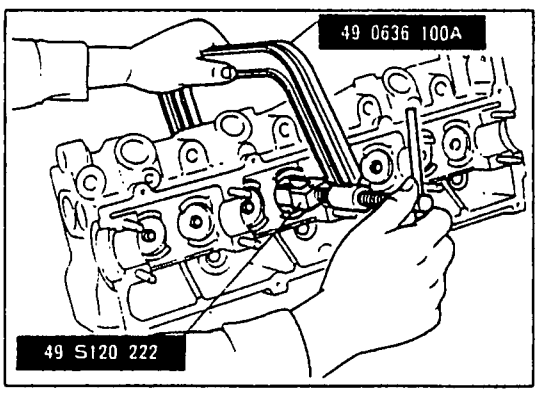
Disassembly
Refer to page 18–36.

Inspection
Refer to page 18–41.

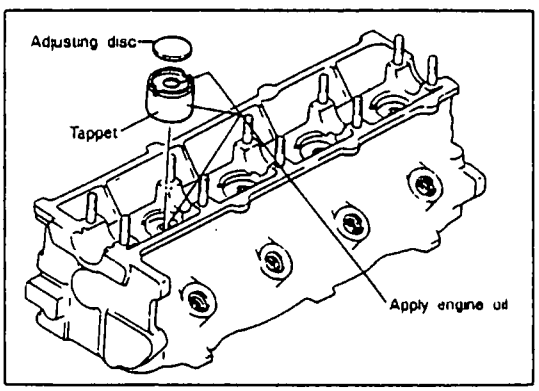


Assembly
1. Install the valve seals.
   (1) Apply engine oil to the valve guides.
   (2) Using the **valve seal pusher** (49 S120 160), Install the valve seals.

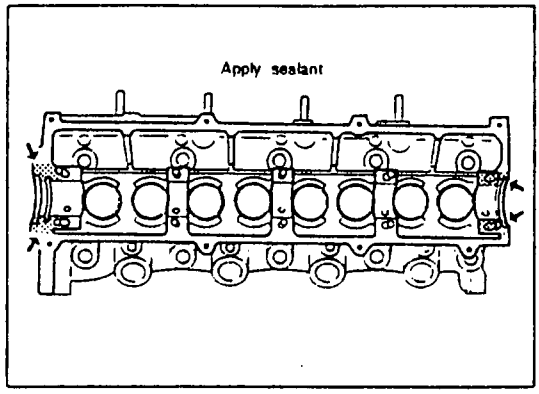
Caution
Be sure to use the special tool for installation. If it is not installed correctly, the oil might work down.



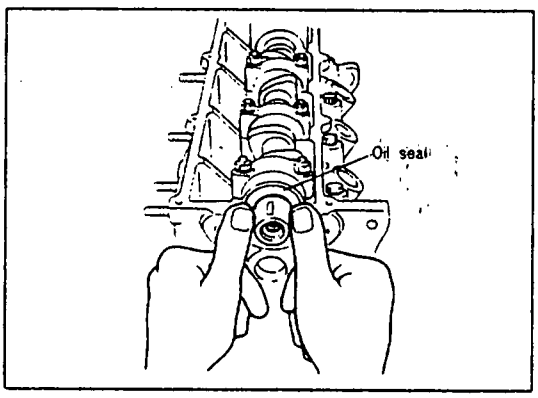
2. Install the valves on to the cylinder head.
   (1) Install the valve spring seat, lower.
   (2) Insent the valve after applying grease (use a molybdenum disulphide grease) to the valve stem.
   (3) Install the valve spring and valve spring seat, upper.
   (4) Using the **valve spring lifter** (49 0636 100A) and **pivot** (49 S120 222), Press the valve spring. And then install the spring retainer securely.



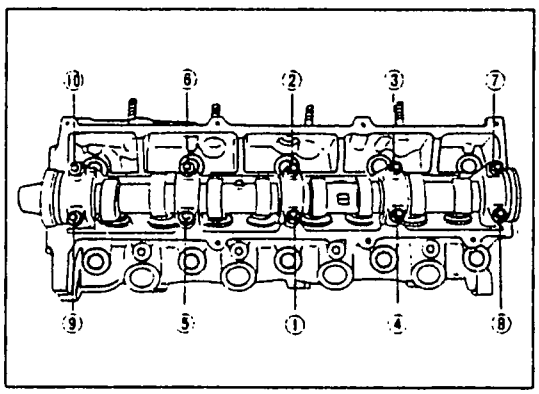
3. Install the tappets and adjusting discs
   (1) Install the tappet to the tappet hole, after appling engine oil to the tappets.
   (2) Install the adjusting discs.



4. Install the camshaft as follows:
   (1) Apply a coat of engine oil to the camshaft and the cylinder head journal.
   (2) Apply a coat of sealant to the places shown in the figure.
   (3) Set the camshaft and camshaft cap in position, and loosely tighten the cap nuts.



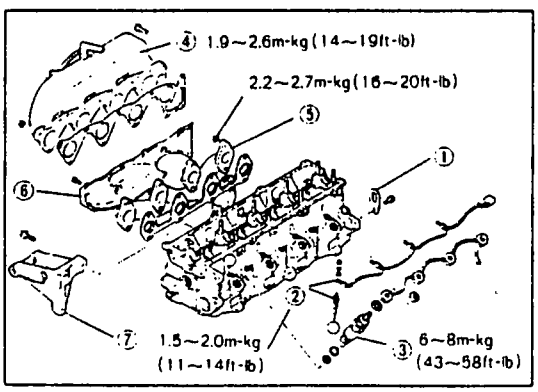
   (4) Insert the oil seal onto the camshaft after applying a coating of engine oil to the lip.
   (5) Insert the seal cap in position after applying a coating of sealant to the seal cap.



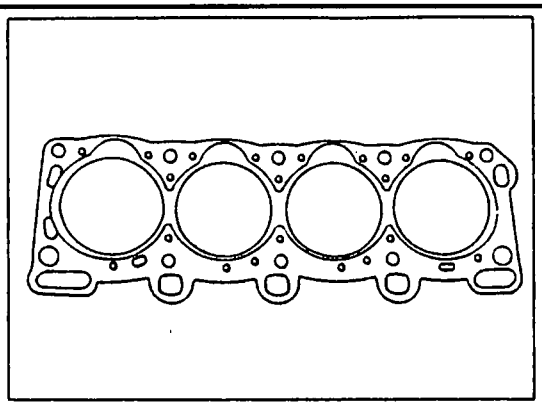
   (6) Tighten the camshaft cap nuts to the specified torque.

Camshaft cap tightening torque:
2.0 - 2.7 m-kg (15 ~ 22 ft-ib)

Caution
Tighten the left and right camshaft cap nuts alternately, as shown in the figure, two or three times each.



5. Install the following parts to the cylinder head
   (1) Engine hanger
   (2) Glow plugs and connector
   (3) Injection nozzles
   (4) Intake manifold
   (5) Exhaust manifold
   (6) Hot air duct
   (7) Alternator bracket

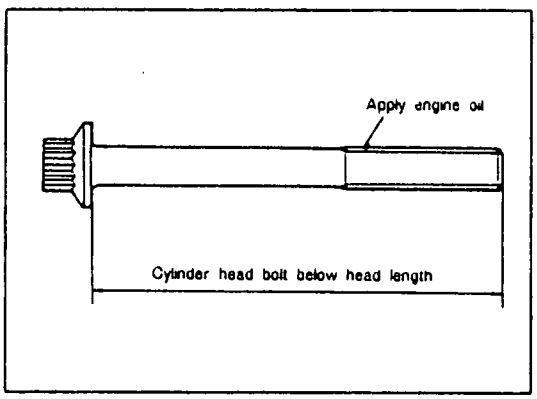


Installation

1. With a rag thoroughly remove all dirt and grease from the top of the cylinder block.
2. Place the cylinder head gasket in position.

Caution
Use a new cylinder head gasket.

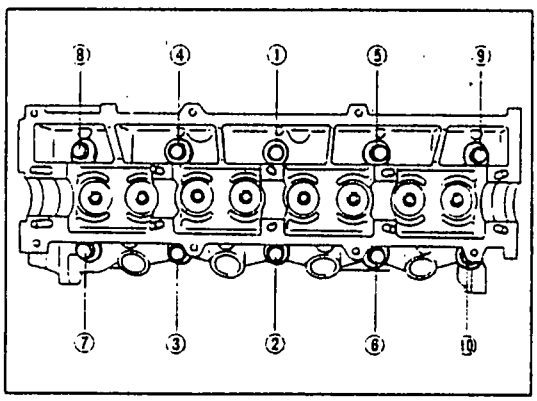
3. Remove any dirt and grease from the bottom surface of the cylinder head.
4. Place the cylinder head in position.



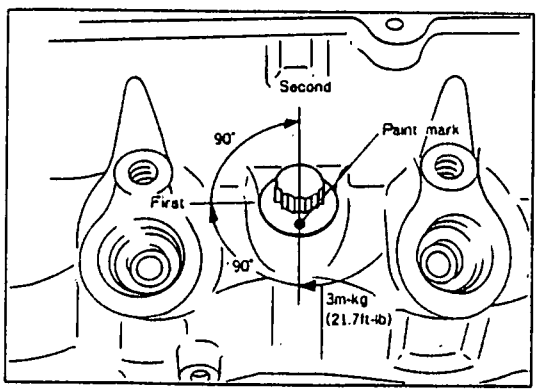
5. Measure the length of the cylinder head bolt below the head. If the measured value is within the limit, apply a coating of engine oil to the threaded part and install.

Length of cylinder head bolt below head
Standard length:
112.7 ~ 113.3 mm(4.437 ~ 4.460 in)
Limit: 114.5 mm (4.508 in)

Caution
If the length of the bolt below the head exceeds the limit, it must be replaced with a new one.

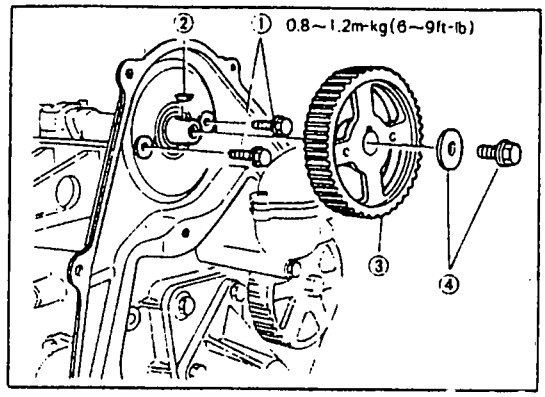


6. Tighten the cylinder head bolts to a tightening torque of **3 m-kg (21.7 ft-lb)**, tightening them in the order shown in the figure.



7. Make paint marks on the bolt heads, as shown in the figure.
8. With the paint marks as a reference point, turn the cylinder head bolts **another 90 ° (90° ~ 105 °)** in the tightening direction, turning them in the order shown in the figure.
9. Then tighten them **once again 90° (90° ~ 105°)** more in the tightening order shown in the figure.

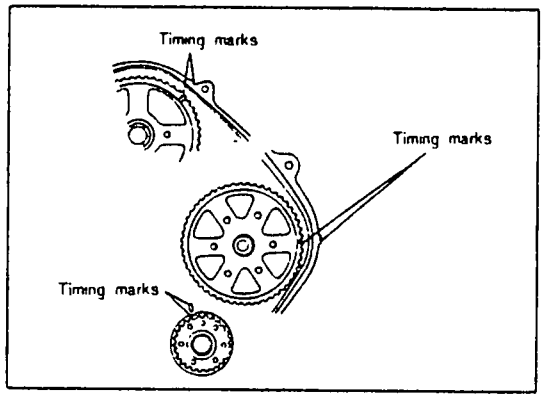
Caution
Be absolutely sure that the bolts are tightend in the order shown in the figure.



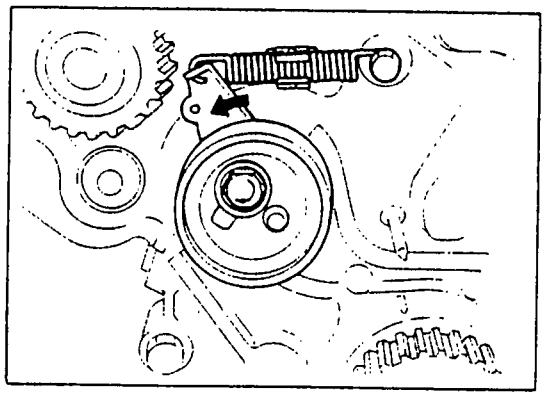
10. Install the following parts to the camshaft as shown in the figure.
    (1) Seal plate attaching bolts (2).
    (2) Semi circular (woodruff) key
    (3) Camshaft pulley
    (4) Camshaft pulley lock bolt

    Camshaft pulley tightening torque:
    5.6 ~ 6.6 m-kg (41 ~ 48 ft-lb)

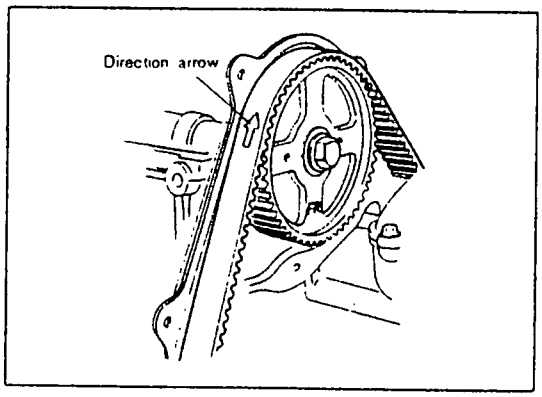
    Note
    Hold the camshaft with a wrench (29 mm, 1.4 in), then tighten the camshaft pulley lock bolt.



11. Align the timing mark of the camshaft pulley with the timing mark on the seal plate.
12. Return the timing belt pulley so that the timing mark of the timing belt pulley alignes with the knock pin.
13. Turn the injection pump pulley until timing marks align, then affix it by using two affixing bolts (35 ~ 40 mm).

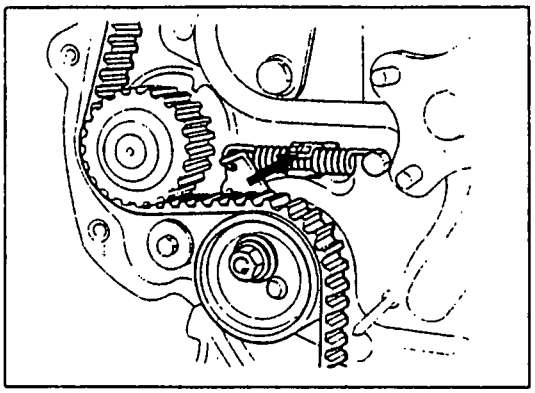


14. Install the timing belt tensioner and spring in fully loosened position.
    Position the tensioner all the way to the water pump side, and then tighten the lock nut temporarily.



15. Install the timing belt.

    Caution
    The front timing belt must always be reinstalled in the same direction of rotation for continued durability.

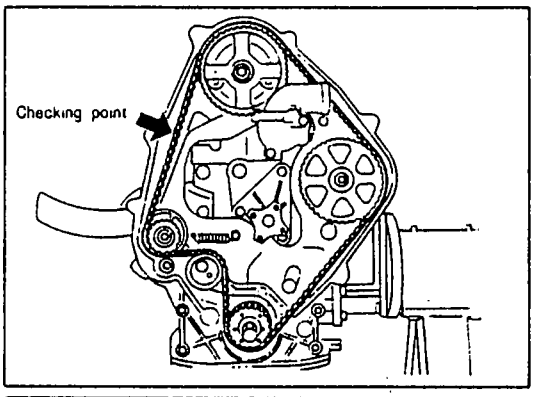


16. Release the timing belt tensioner lock bolt to allow spring pressure on the belt.
17. Turn the crankshaft twice in the direction of rotation (clockwise) to equalize tension on the belt.

Caution
Do not turn in reverse direction.

18. Tighten the tensioner lock bolt.

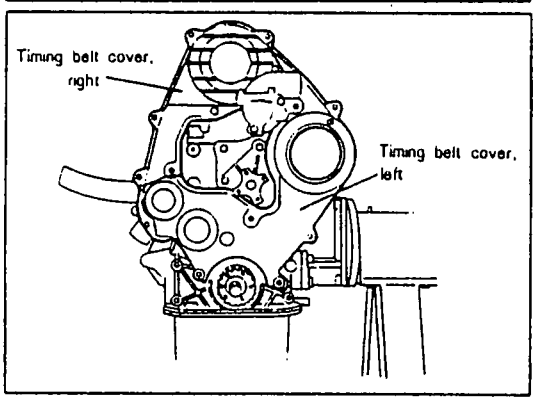
Tensioner lock bolt tightening torque:
3.2 ~ 4.7 m-kg (23 ~ 34 ft-lb)



19. Recheck the timing marks on each pulley.
20. Check the timing belt deflection, when pressed with a force of 10 kg (22 lb).

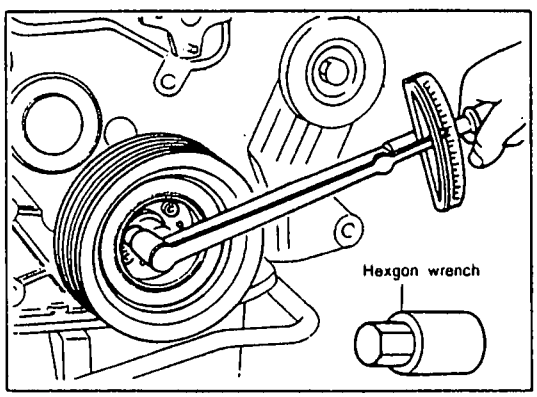
Standard deflection (under cold engine condition):
10.8 ~ 12.9 mm (0.425 ~ 0.508 in)

Caution
If the deflection isn't within specification, repeat the procedure from 11.



21. Install the timing belt cover, left and timing belt cover, right.

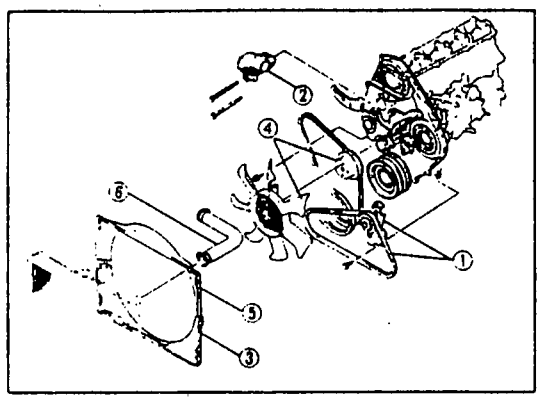
Timing belt cover tightening torque:
0.7 ~ 1.0 m-kg (5 ~ 7 ft-lb)



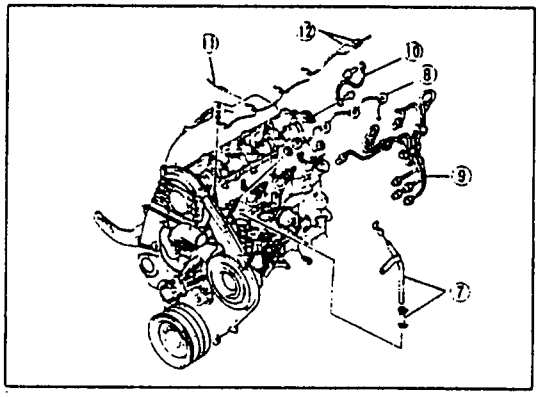
22. Install the crankshaft pulley and torsional dumper to the timing belt pulley with the semi circular (woodruff) key, then tighten the hexgon bolts (6mm) to specified torque.

Crankshaft pulley tightening torque:
2.3 ~ 3.3 m-kg (17 ~ 24 ft-lb)

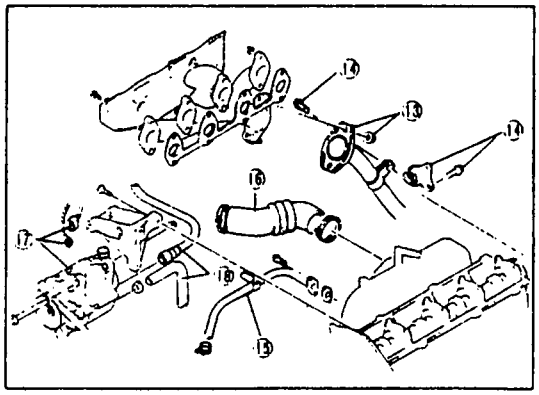
Caution
Aline the torsional dumper to the knock pin on the timing belt pulley, when installing.



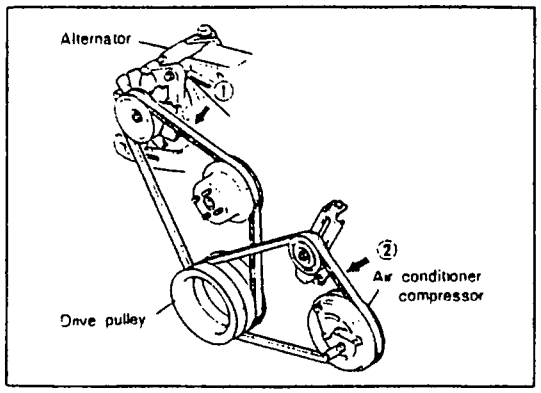
23. Install the following parts
    (1) Air conditioner drive belt, tensioner and bracket.
    (2) Thermostat assembly
    (3) Cooling fan cover, lower
    (4) Cooling fan and pulley
    (5) Cooling fan cover, upper
    (6) Radiator hose, upper



    (7) Oil level gauge and pipe
    (8) Leak pipe
    (9) Injection pipes
    (10) Engine ground
    (11) Thermo unit gauge connector
    (12) Glow plug connector



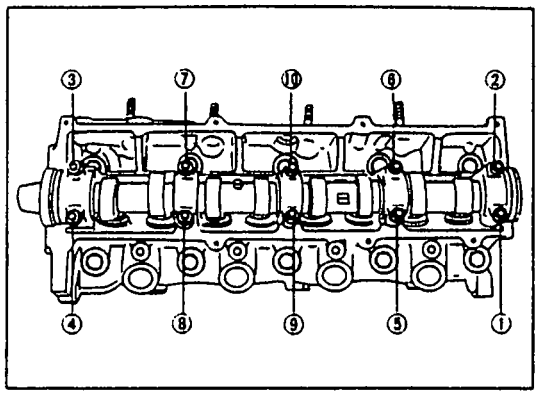
    (13) Exhaust pipe
    (14) Exhaust pipe bracket
    (15) Oil cooler water pipe
    (16) Air intake hose
    (17) Alternator
    (18) Vacuum pump o.. hoses



24. Install the drive belts and adjust deflections.
    To check the belt tension, apply moderate pressure (10 kg, 22 lb) midway between the pulleys. Check the deflection, and tighten if necessary.

Drive belt	Deflection	
	New	Used
1 Alternator	11 ~ 12 mm (0.44 ~ 0.47 in)	12 ~ 14 mm (0.47 ~ 0.55 in)
2 Air conditioner compressor	4 ~ 5 mm (0.16 ~ 0.20 in)	5 ~ 6 mm (0.20 ~ 0.24 in)

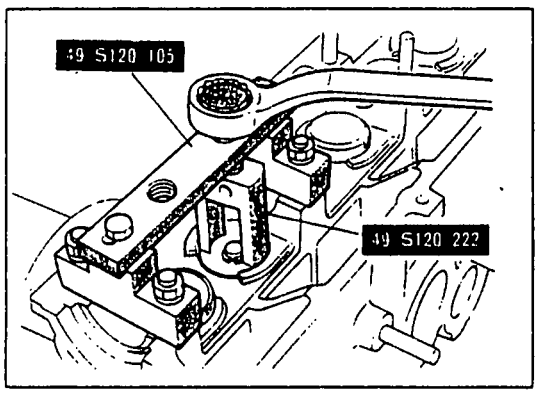
CYLINDER HEAD VALVE SEALS



VALVE SEALS

Replacement

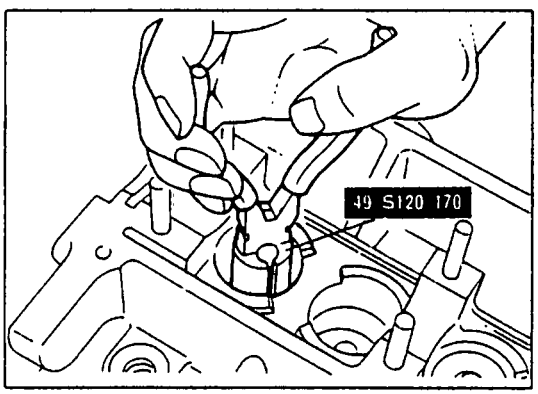
1. Remove the cylinder head cover.
2. Referring to the Timing Belt section of ON-VEHICLE MAINTENANCE, remove the camshaft pulley.
3. Remove the camshaft cap. (The nuts should be gradually loosened, in the order shown in the figure.)
4. Remove the camshaft and oil seal.



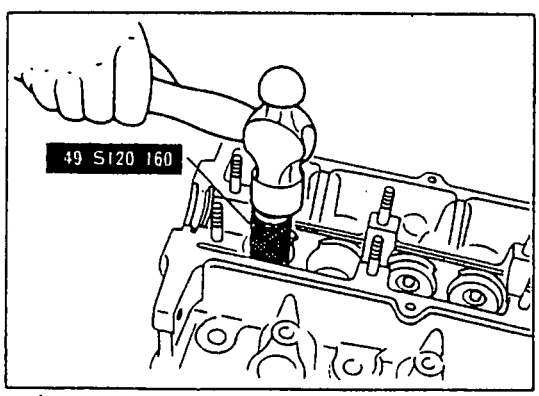
5. Remove the valve seals as follows:
   (1) Remove the tappets and adjusting discs.
   (2) Move the piston of the valve seal to be replaced to approximately top dead center.
   (3) As shown in the figure, remove the spring retainers and the valve spring by using the **valve spring compressor** and **pivot** (49 S120 105 and 49 S120 222).

Caution

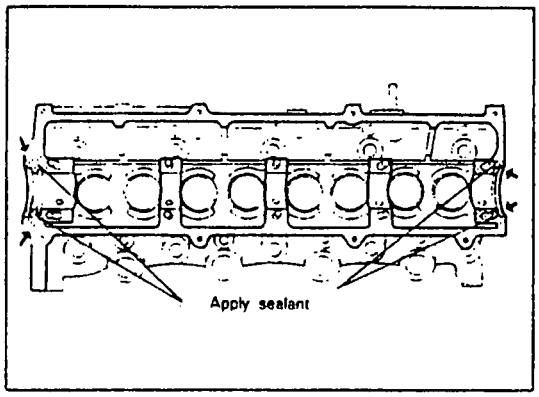
Plug the oil return hole with a rag in order to prevent the spring retainers from falling into the oil pan.

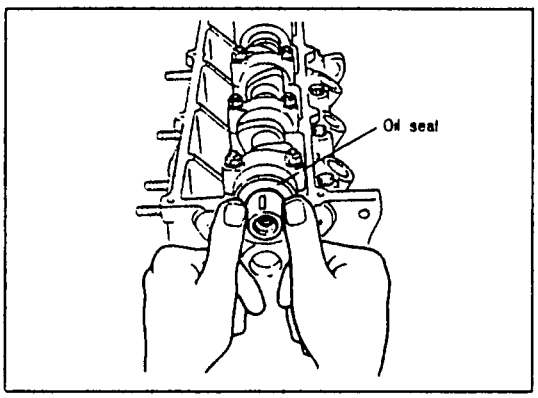


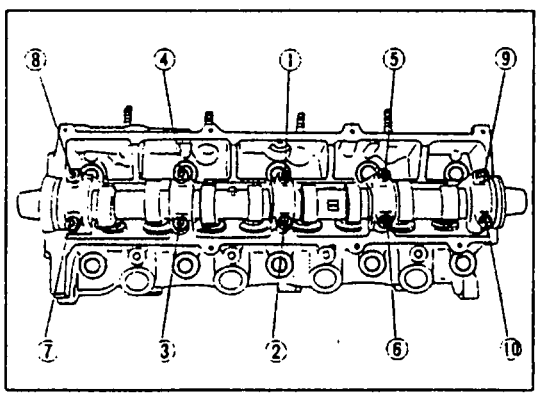
   (4) After removing the spring seat, lower , use the **valve seal remover** (49 S120 170) and remove by working it to the left and right.



6. Install the valve seal as follows:
   (1) Apply a coat of engine oil to the inside surface of the new valve seal.
   (2) Install the valve seal by using the **valve seal pusher** (49 S120 160).
   (3) Install the spring seats, valve springs and spring retainers by using the **valve spring compressor** and **pivot** (49 S120 105 and 49 S120 222).







7. Move the No.1 piston to the top dead center, and then rotate the crankshaft approximately 45 °.

Caution
If not done, the valves may be damaged by the pistons when tightening the camshaft cap nuts.

8. Install the tappets and adjusting discs after first applying a coating of engine oil.
9. Install the camshaft as follows:
   (1) Apply a coat of engine oil to the camshaft and the journal.
   (2) Apply a coat of sealant to the seal cap, then install it.
   (3) Set the camshaft and camshaft cap in position, and loosely tighten the cap nuts.

Note
Set the camshaft so that the key groove faces directly upward.

   (4) Insert the oil seal after first applying a coating of engine oil to the lip.

   (5) Tighten the camshaft cap nuts to the specified torque.

Camshaft cap tightening torque:
2.0 ~ 2.7 m-kg (15 ~ 20 ft-lb)

Caution
Tighten the left and right camshaft cap nuts alternately, as shown in the figure, two or three times each.

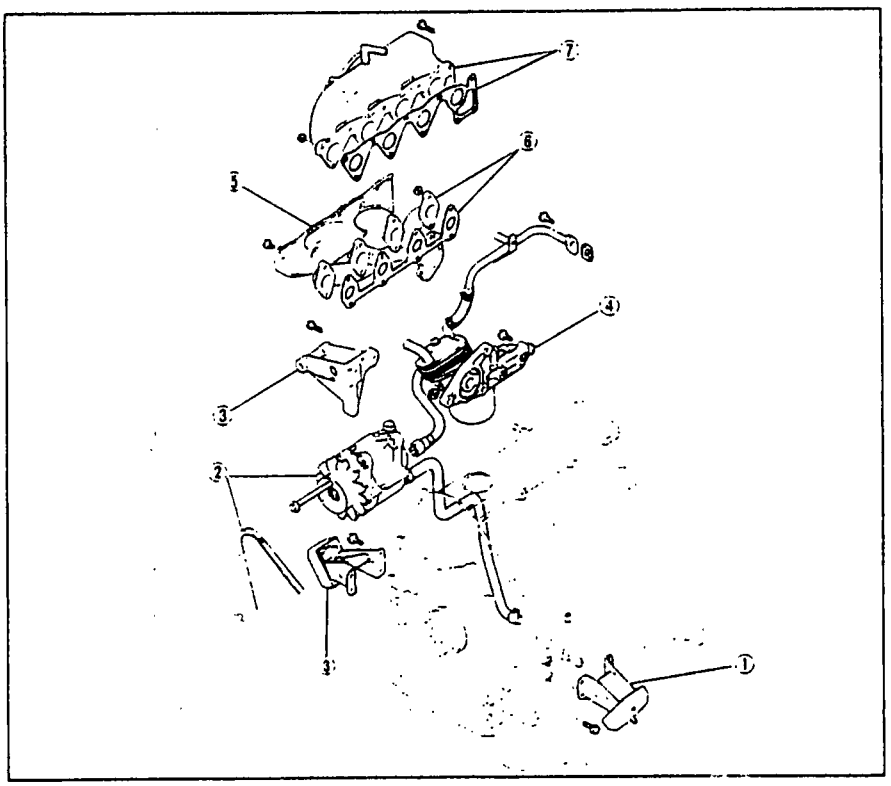
10. Referring to the Timing Belt section of ON-VEHICLE MAINTENANCE, install the camshaft pulley, and the timing belt.
11. Make the adjustment of the valve clearances, and then install the cylinder head cover.

DISASSEMBLY OF ENGINE

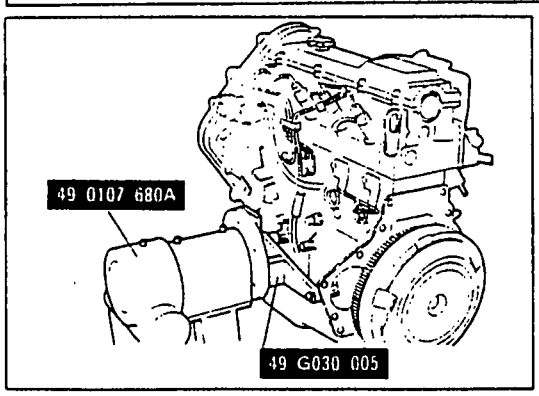
Disassembly Notes

1. Each part when removed should be carefully inspected, for deformation, damage and other problems.
2. All disassembled parts should be carefully arranged for reassembly.
   Be sure to separate or otherwise identify the parts to be replaced from those that will be reused.
3. If the disassembly procedure is complex, requiring many parts are to be disassembled, all parts should be disassembled in a way that will not affect their performance or external appearance so that correct reassembly can be performed efficiently.
4. After disconnecting the transmission from the engine, disassemble the engine.
5. Remove each part in the numbered sequence shown in the figure. Important points on the disassembly are shown after the structural view.

Disassembly of Engine Auxiliary Parts



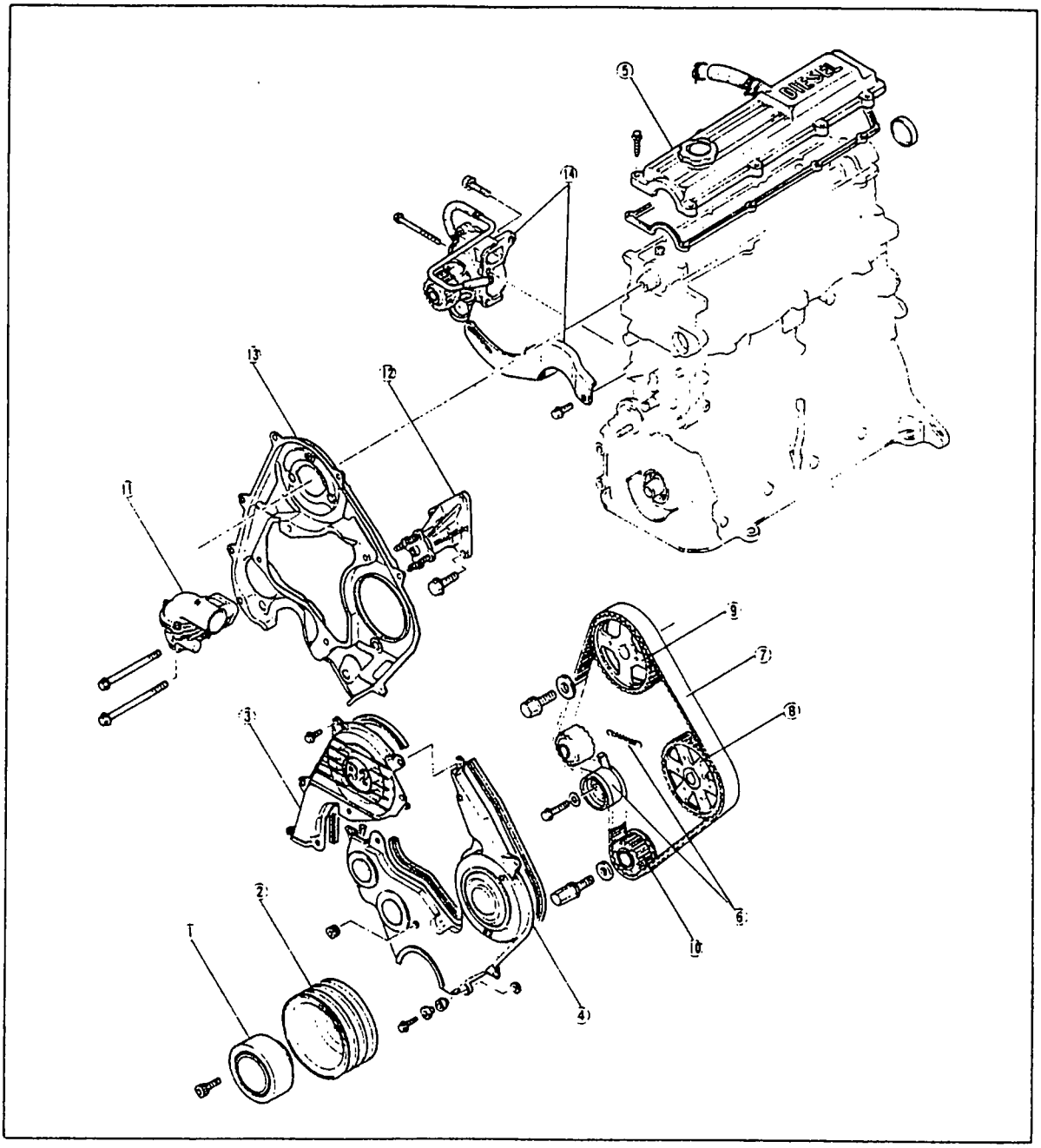
1. Engine mount, left and right
2. Alternator and drive belt
3. Alternator bracket
4. Oil cooler and oil filter assembly
5. Hot air duct
6. Exhaust manifold and gasket
7. Intake manifold and gasket



Engine stand and engine hunger

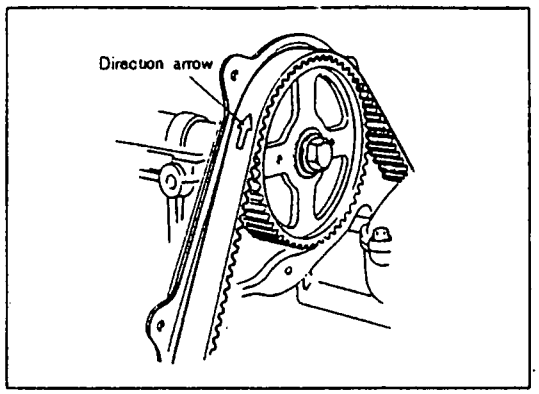
After removing the engine mount (left and right) install the engine onto the **engine hanger** (49 G030 005) attached to the **engine stand** (49 0107 680A).

Disassembly Related to Timing Mechanism.



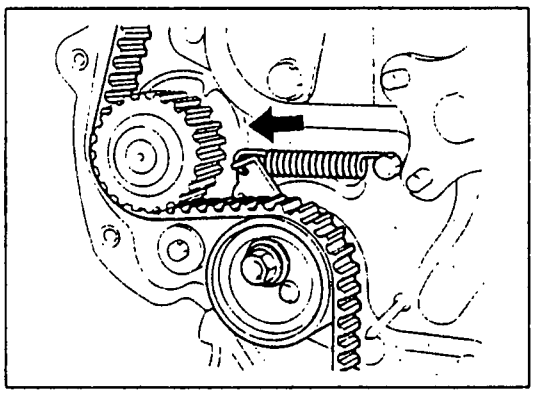
JEG01B-081

1. Torsional dumper
2. Crankshaft pulley
3. Timing belt cover, right
4. Timing belt cover, left
5. Cylinder head cover
6. Timing belt tensioner and spring
7. Timing belt
8. Injection pump pulley
9. Camshaft pulley
10. Timing belt pulley
11. Thermostat assembly with bypass pipe
12. Cooling fan bracket
13. Seal plate
14. Water pump with alternator strap

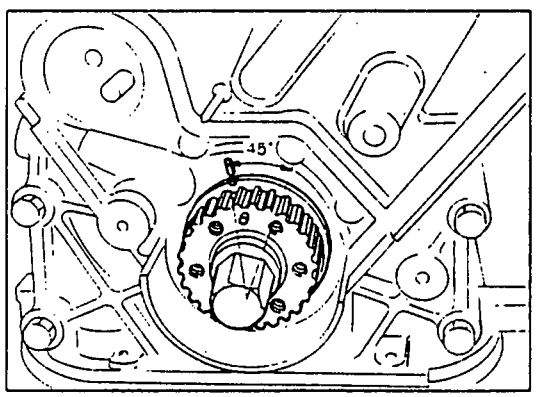


Timing belt

1. Draw a direction arrow in direction of engine revolution on the timing belt, if the timing belt is to be reused.

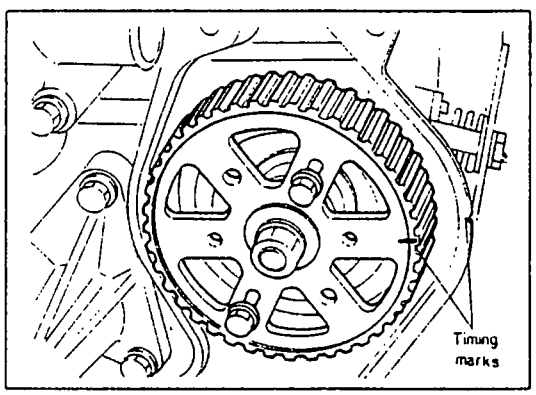


2. Loosen the timing belt tensioner lock bolt, push it left as far as it will go, then temporarily tighten the timing tensioner lock bolt.



3. Turn the crankshaft about 45° from the timing mark which is marked on the oil pump housing.

Note
This prevents the pistons and valves from contacting one another.

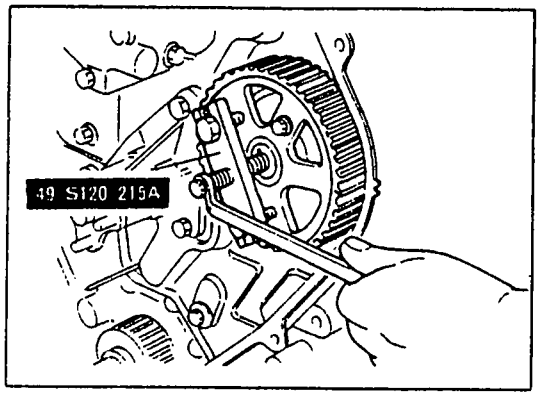


Injection pump pulley

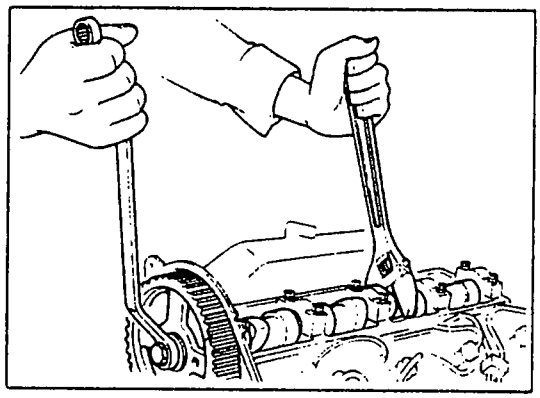
1. Put two bolts of M8 × 1.25 × 35 ~ 40 mm size into the arms of the injection pump pulley and affix them in the thread hole of the injection pump bracket.

Note
This is to prevent the injection pulley from turning while loosening the injection pulley lock bolt.

2. Loosen the injection pump pulley lock bolt.

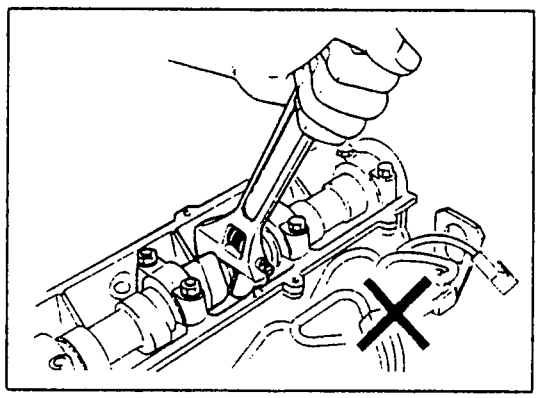


3. Using the **pulley puller** (49 S120 215A), Separate the injection pump pulley from the injection pump shaft.



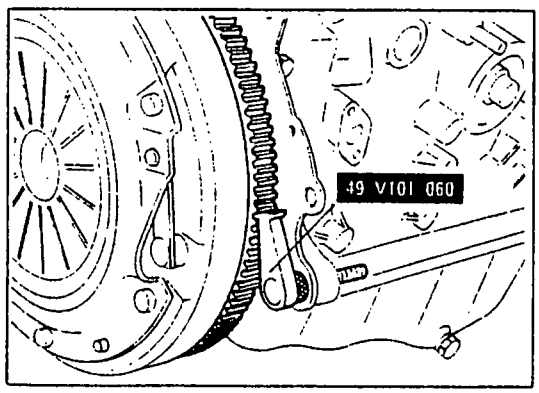
Camshaft pulley

1. Hold the camshaft with a wrench (29 mm, 1.1 in) and loosen the camshaft pulley lock bolt.



Caution
Don't damage the edge of the cylinder head with the wrench.
If damaged, engine oil may leak.

2. Separate the camshaft pulley from the camshaft by refering the procedure of the injection pump pulley described above.

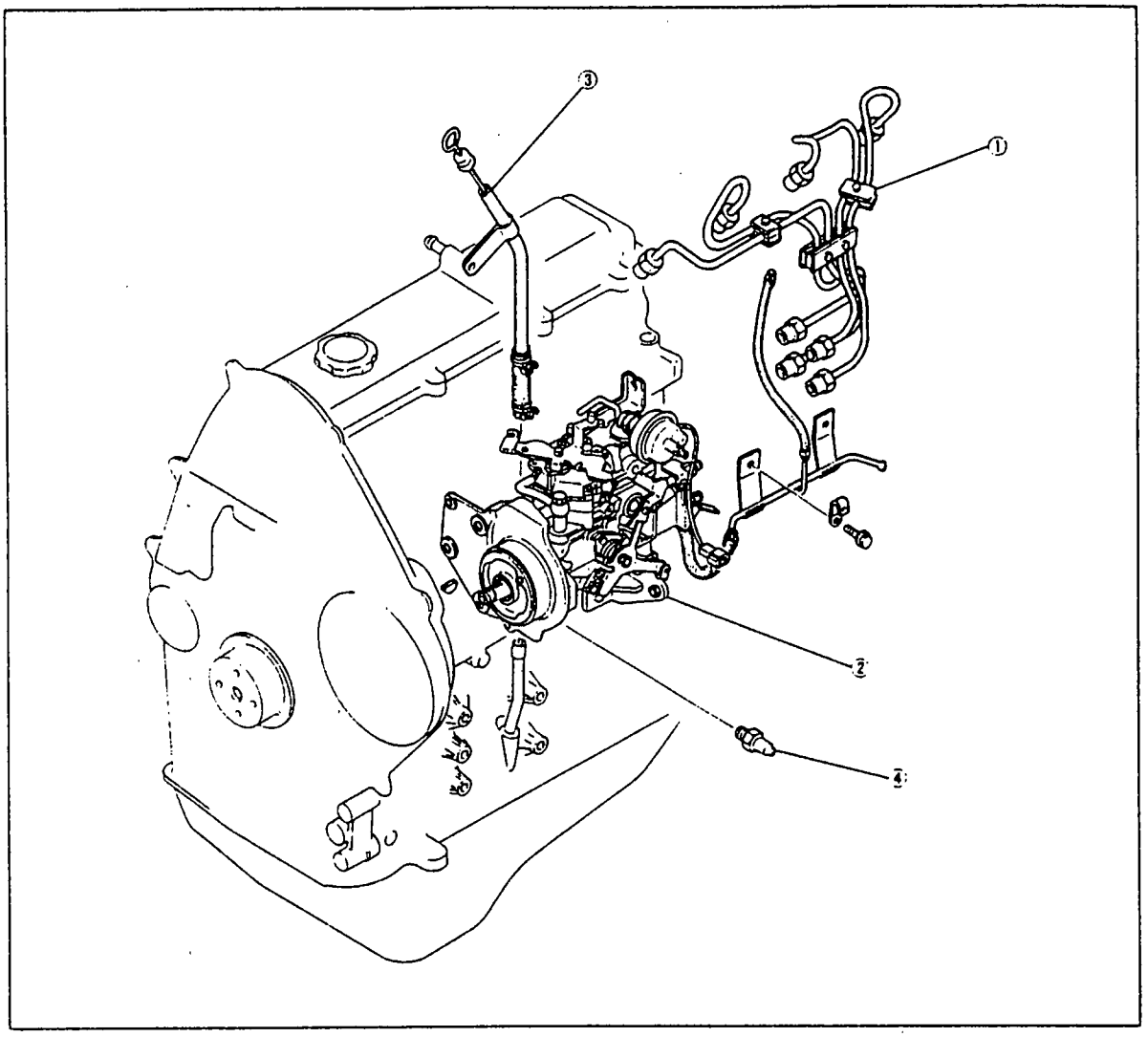


Timing belt pulley

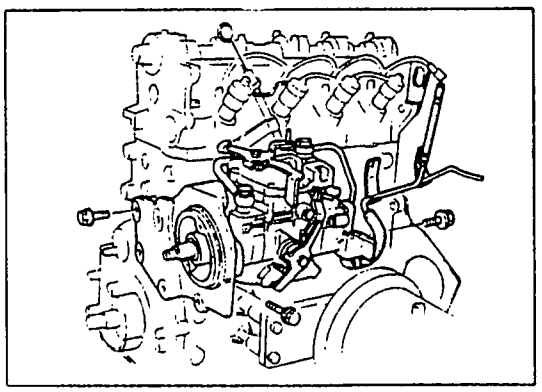
1. Remove the timing belt pulley.

Caution
Set the ring gear brake (49 V101 060) securely, before loosening the lock bolt.

Disassembly Related to Injection Pump



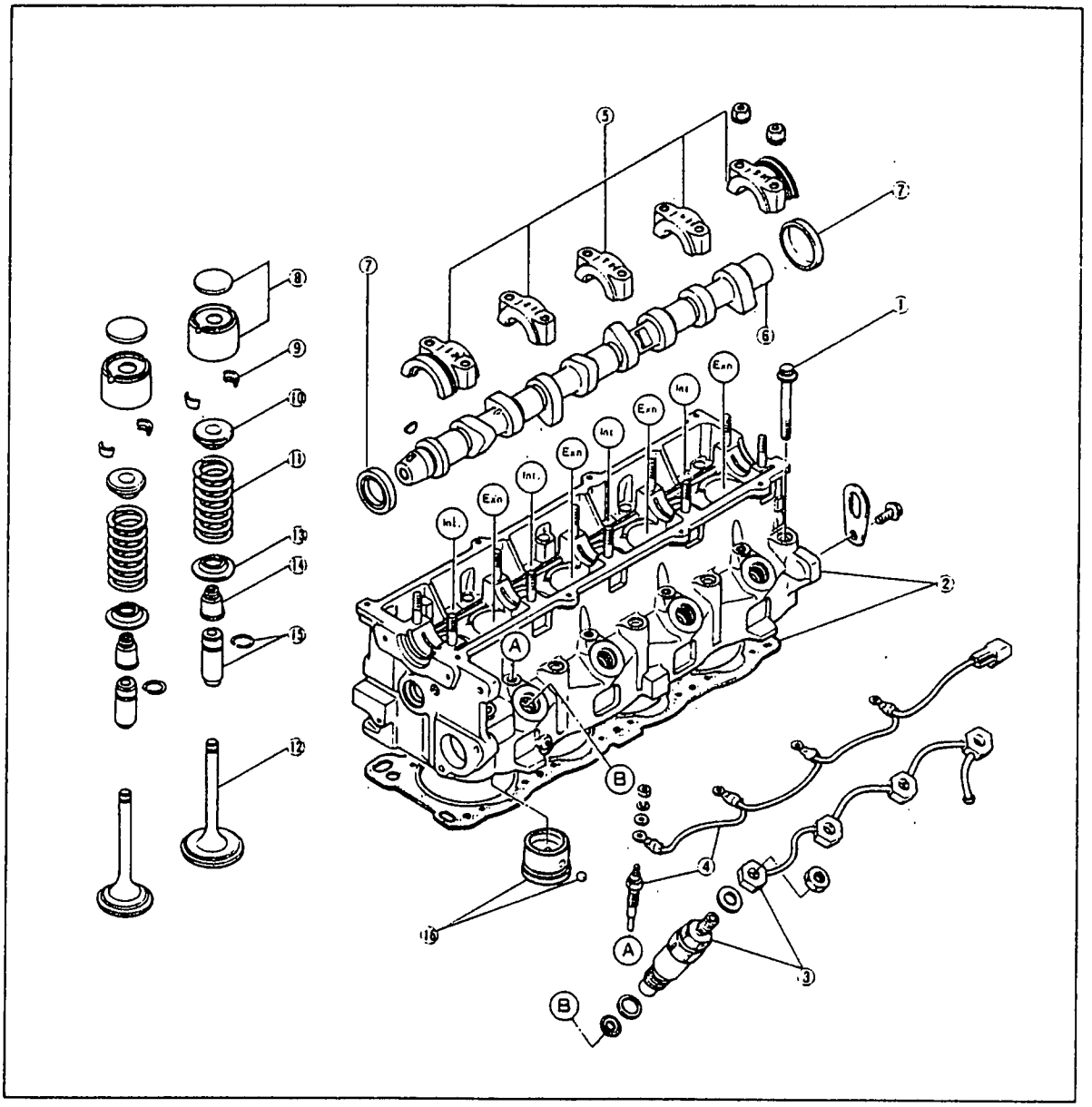
1. Injection pipes
2. Injection pump with injection pump brackets and fuel feed pipe
3. Oil level gauge and pipe
4. Oil pressure switch



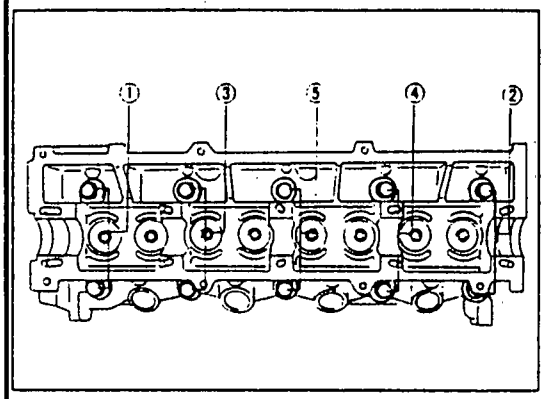
Injection pump

1. Remove the injection pump with its brackets and fuel feed pipe for easy reassembly.

Disassembly Related to Cylinder Head

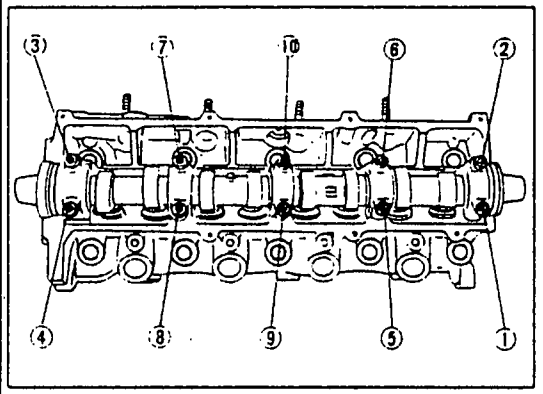


1. Cylinder head bolts
2. Cylinder head assembly and gasket
3. Injection nozzles and leak pipe
4. Glow plug connector and glow plugs
5. Camshaft caps
6. Camshaft
7. Camshaft oil seal and seal cap
8. Tappet and adjusting disc
9. Spring retainers
10. Spring seat, upper
11. Valve spring
12. Valve
13. Spring seat, lower
14. Valve seal
15. Valve guide and clip
16. Combustion chamber insert and ball



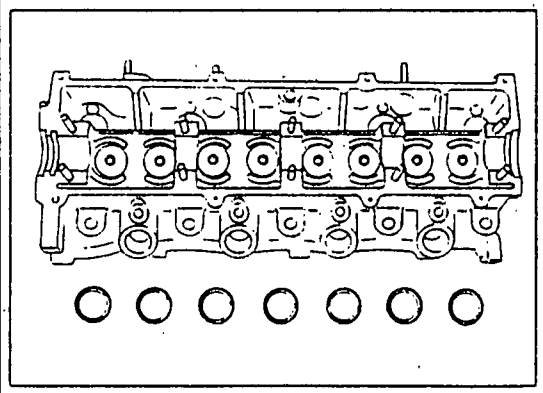
Cylinder head bolt

1. Loosen the cylinder head bolts in the numbered order shown in the figure. Loosen a little at a time, in order.
2. Remove the cylinder head by tapping the cylinder head with a plastic hammer.



Camshaft cap

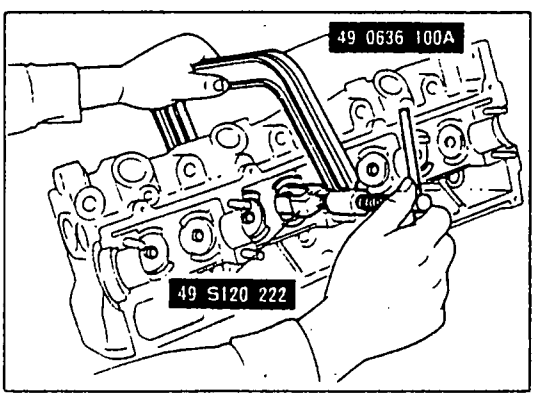
1. Loosen the camshaft cap nuts in the numbered order shown in the figure.
   Loosen a little at a time, in order.



Adjusting disc and tappet

1. Remove the adjusting discs and tappets with a set.

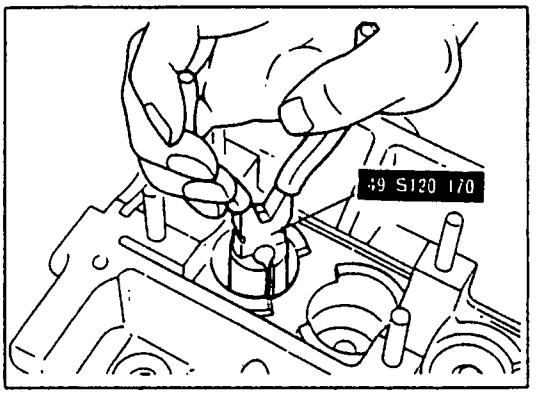
Caution
All adjusting discs and tappets should be disassembled in a way so that correct reassembly can be performed efficiently.



Valve spring

1. Remove the valves, spring seats and spring retainers from the cylinder head by using the **valve spring lifter** (49 0636 100A) and **pivot** (49 S120 222).

Note
Disassemble the valve guide after completion of checking and corrections.
The procedure is described on page 1B–45.

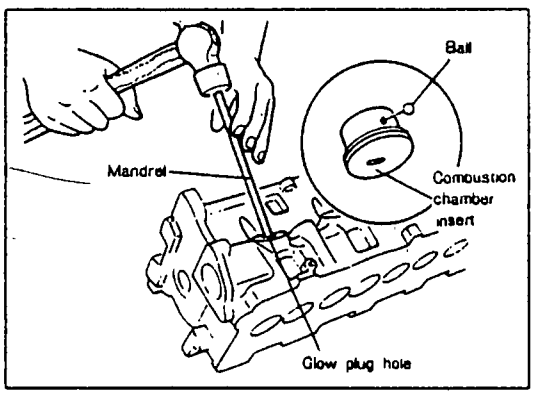


Valve seal

1. After removing the spring seats (lower), remove the valve seals by using the **valve seal remover** (49 S120 170) to grasp and work them out.

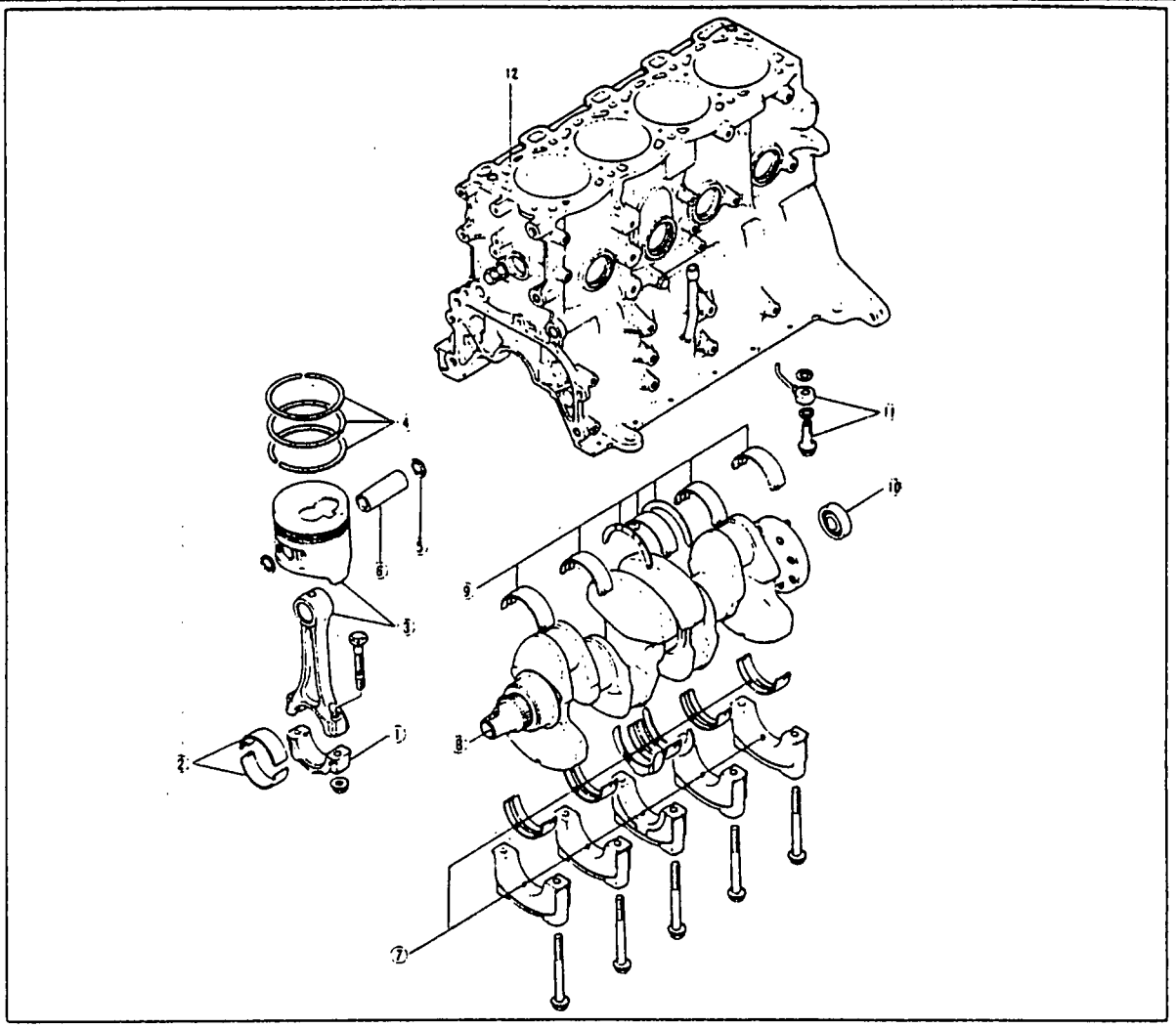
Note

The valve seal remover (49 S120 170) cannot grasp the valve seals unless the spring seats (lower) have been removed.

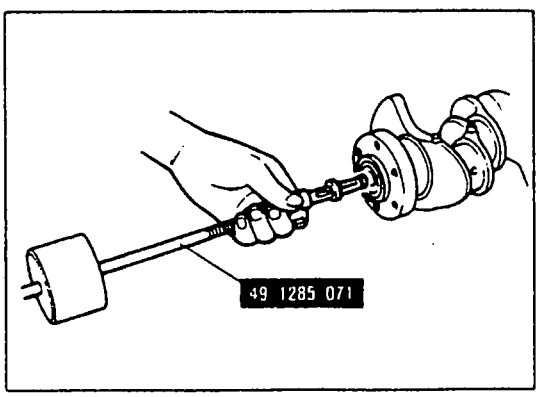


Combustion chamber insert

1. Remove the combustion chamber inserts from the bottom surface of the cylinder head by using a suitable mandrel.



1. Connecting rod bearing caps
2. Connecting rod bearings
3. Connecting rods and pistons
4. Piston rings
5. Snap rings
6. Piston pins
7. Main bearing caps, main bearings and thrust bearings
8. Cranksnat
9. Main bearings and thrust bearings
10. Pilot bearing
11. Oil jets
12. Cylinder block

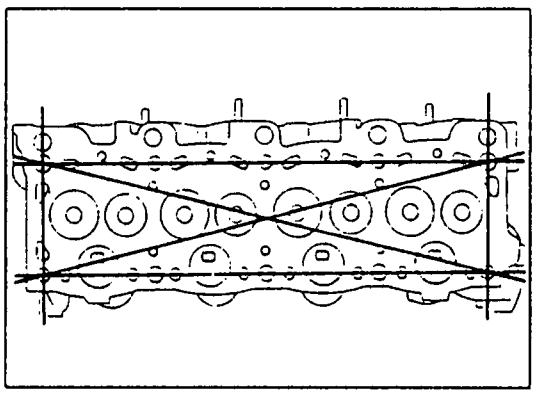


Pilot bearing

1. Using the **needle bearing puller** (49 1285 071), remove the pilot bearing from the crankshaft end.

Maintenance Notes

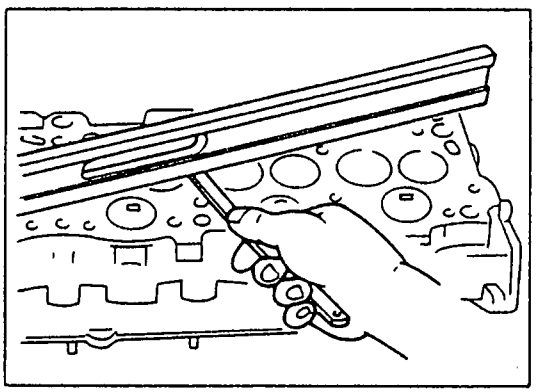
1. Before inspection, clean each part, taking care to remove any gasket fragments, dirt, oil or grease, carbon, moisture residue, or other foreign materials.
2. Be careful not to damage the joints or sliding parts of aluminum alloy components such as cylinder head, pistons.
3. Inspection and repair must be done in the order specified.



Cylinder head

1. Inspection and repair of cylinder head
   (1) Inspect for water leakage, fuel leakage, damage, and cracks. If a problem is found, replace the part.
   (2) Measure cylinder head for distortion in the six directions shown in the figure.

Distortion limit: 0.10 mm (0.004 in)

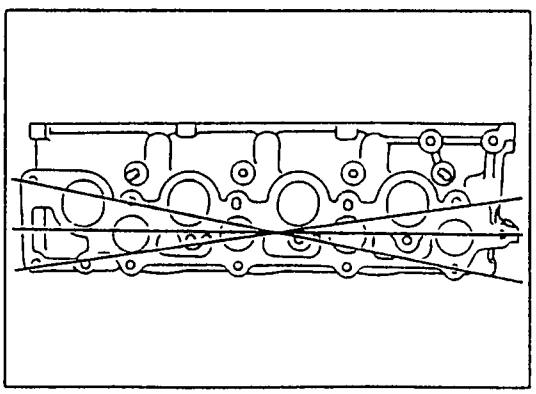


(3) If cylinder head distortion exceeds the limit, replace the cylinder head.

Cautions

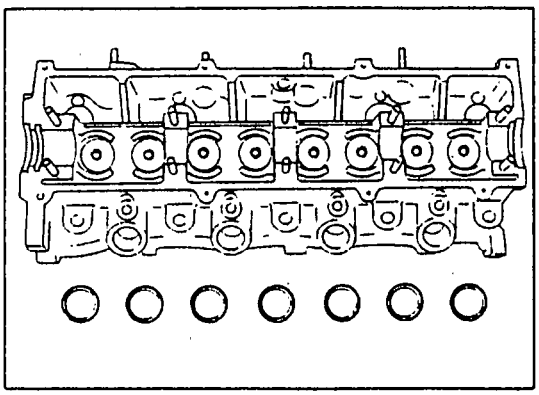
a) Do not attempt to repair a cylinder head by milling or grinding.

b) Handle the cylinder head carefully, taking special care not to damage its lower surface.

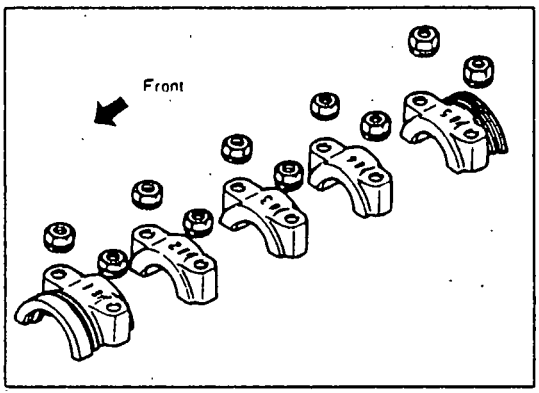


(4) Measure the manifold contact surface distortion.
If the distortion exceeds the limit, grind the surface, or replace the cylinder head.

Distortion limit: 0.20 mm (0.008 in)



(5) Measure the oil clearance of the camshaft.
(a) Remove the tappet and adjusting disc from the cylinder head, and separate them by cylinder.

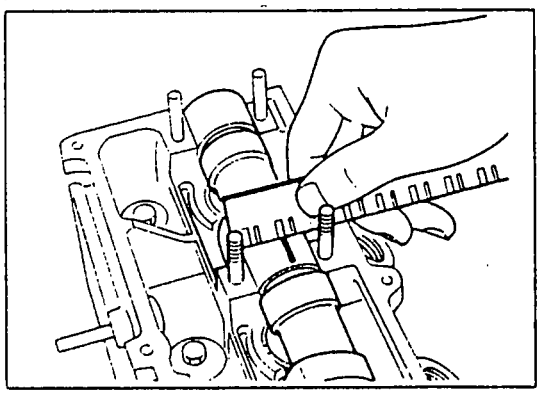


(b) Clean away oil or dirt from the camshaft or cylinder head journal.
(c) Set a platinum gauge on the camshaft journal (in the axial direction of the journal).
(d) Set the camshaft cap, and tighten to the specified torque.

Camshaft cap tightening torque:
2.0 ~ 2.7 m-kg (15 ~ 20 ft-lb)

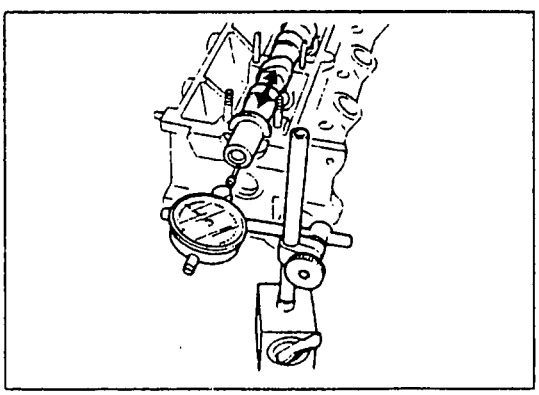
Cautions
a) When installing the camshaft cap, note the correct order and arrow marks.
b) When tightening the camshaft cap nut, do so evenly and in the order shown in the Engine assembly section.

(e) Remove the camshaft cap and measure the oil clearance.



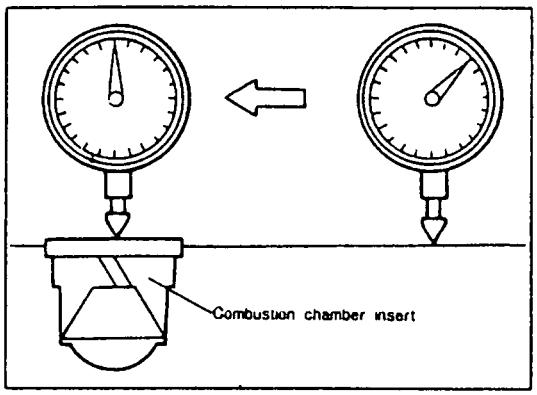
Standard oil clearance:
0.025 ~ 0.066 mm (0.0098 ~ 0.0260 in)
Limit: 0.1 mm (0.0039 in)

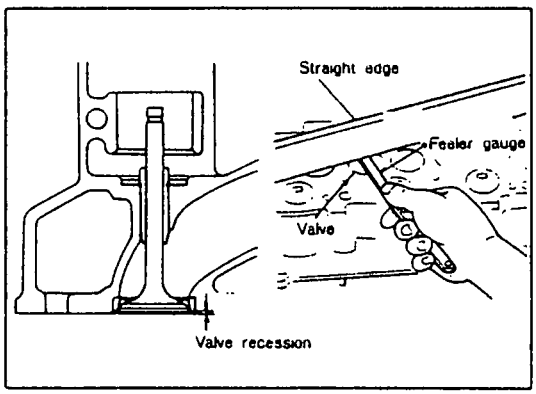
(f) If the oil clearance exceeds the limit, replace the cylinder head or camshaft with a new one.

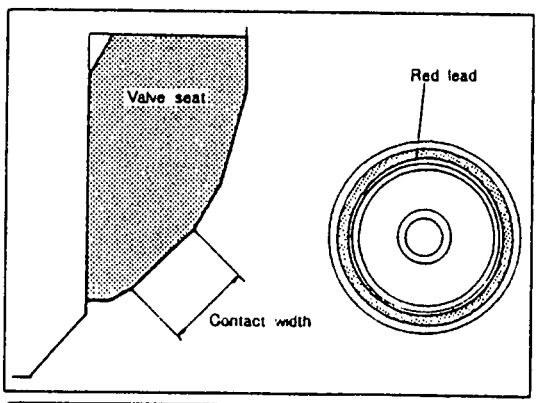


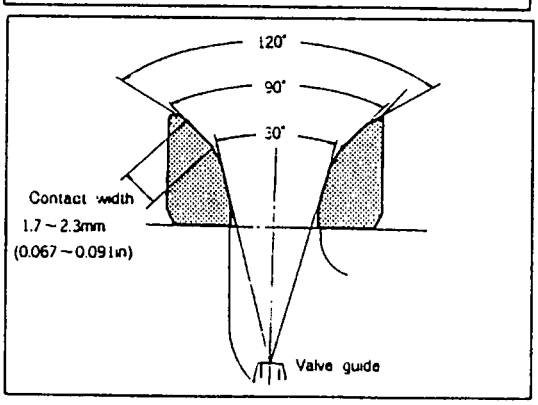
(6) Measure the end play of the camshaft.
If the end play exceeds the limit, replace the camshaft or the cylinder head.

Standard camshaft end play:
0.02 ~ 0.15 mm (0.00079 ~ 0.00591in)
Limit: 0.2 mm (0.0079 in)









(7) Measure the amount that the combustion chamber insert has receded.
   (a) Clean the lower side so that the surface of the combustion chamber insert won't be scarred.
   (b) Measure by using a dial gauge.

Limits:
receded amount: 0.04 mm (0.0016 in)
projection amount: 0.05 mm (0.0024 in)

   (c) If either limit is exceeded, replace the insert or the cylinder head.

2. Checking and repair of valve seats
   (1) Use a thickness gauge, as shown in the figure, to measure the receded amount from the cylinder head surface.
   If the receded amount is **1.55 ~ 2.55 mm (0.061 ~ 0.100 in)**, use an equivalent washer at the valve spring seat. If the receded amount is **2.55 mm (0.100 in)** or more, replace the cylinder head.

Standard amount of valve recession:
Intake and exhaust:
0.75 ~ 1.05 mm (0.030 ~ 0.041 in)

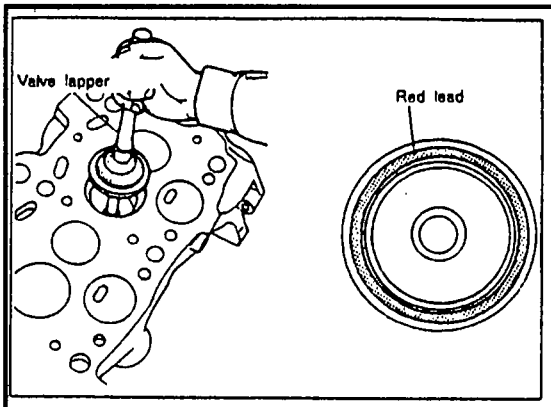
   (2) Check the surface which contacts the valve face for roughness or damage. If necessary, use a valve seat cutter or valve seat grinder to repair to the specified shape.

Notes
a) To check the contact width, apply a thin coating of red lead to the valve seat, and press the valve against the valve seat. Be sure not to turn the valve when doing so.

b) When grinding the valve seat, use a 15°, 45° or 60° valve seat cutter or valve seat grinder to grind away the roughness and/or scars (to the minimum limit) of the seat surface, always checking the contact width and contact position while grinding.

Standard valve seat contact width:
1.7 ~ 2.3 mm (0.067 ~ 0.091 in)

   (3) Seat the valve.
   To seat the valve, apply a thin coating of engine oil mixed with a small amount of compound to the seat surface, and then lightly tap while turning the valve.

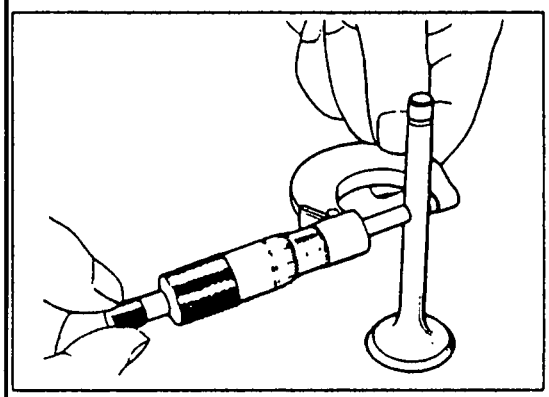


Cautions

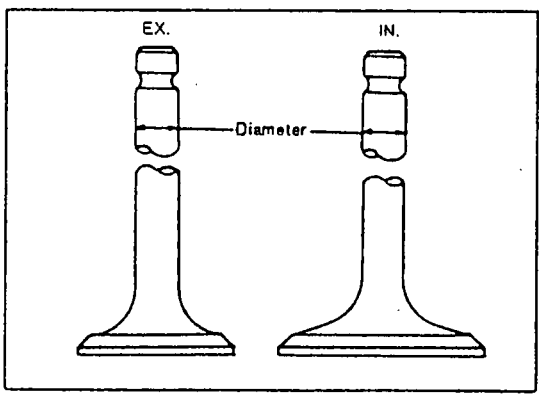
a) When seating the valve, be careful not to let compound adhere to the valve stem.

b) The valve contact position in relation to the valve seat must be at the center of the circumference, and the contact width must be the standard value.

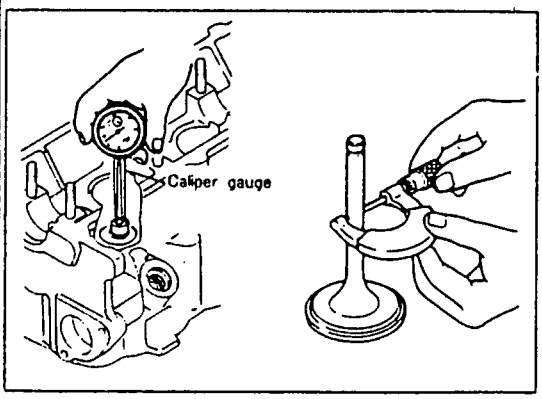
c) Check to be sure that the amount of valve recession is within the specification.



3. Inspection and repair of valves
   (1) Inspect each valve and replace any that show valve stem wear, damage, bending, or dents.
   (2) Inspect each valve for roughness or damage on its faces. If the problem is slight, repair the valve with valve refacer.

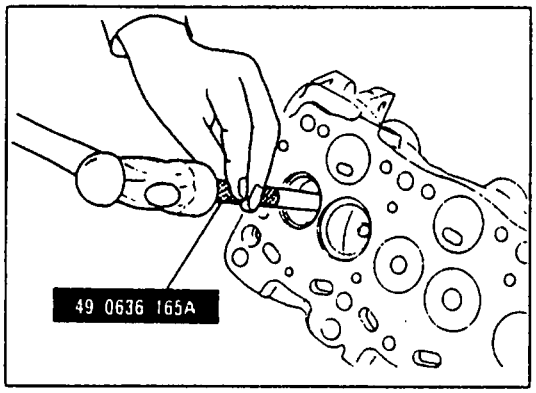


Standard valve stem diameter:
Intake:
7.970 ~ 7.985 mm (0.3138 ~ 0.3144 in)
Exhaust:
7.965 ~ 7.980 mm (0.3136 ~ 0.3142 in)

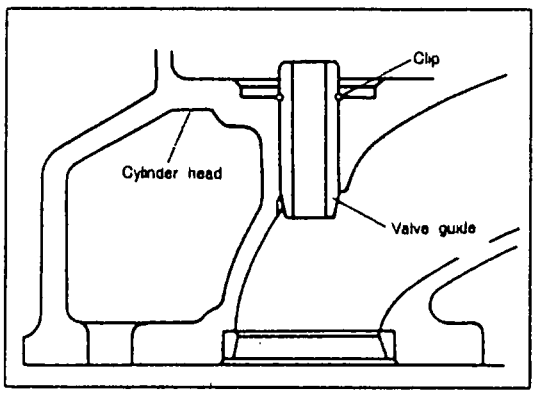


4. Inspection and repair of valve guides
   (1) Measure the difference between the inner diameter of each valve guide and the diameter of the corresponding stem. Replace the valve guide if the gap exceeds the limit.

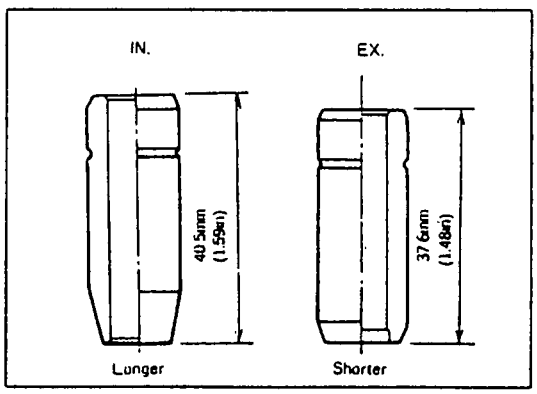
Gap limit: 0.10 mm (0.004 in)



5. Replacement of valve guide
   (1) Removal
   Tap the valve guide to the side opposite the combustion chamber using the **valve guide remover** (49 0636 165A).



(2) Installation
Fit the clip onto the valve guide. Use the **valve guide installer** (49 0552 165) to tap the valve guide in from the side opposite the combustion chamber until the clip barely contacts the cylinder head.



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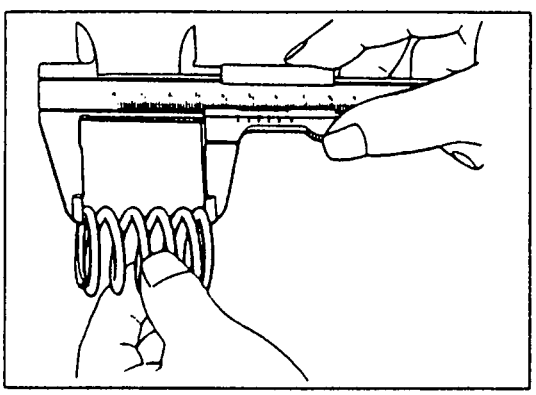
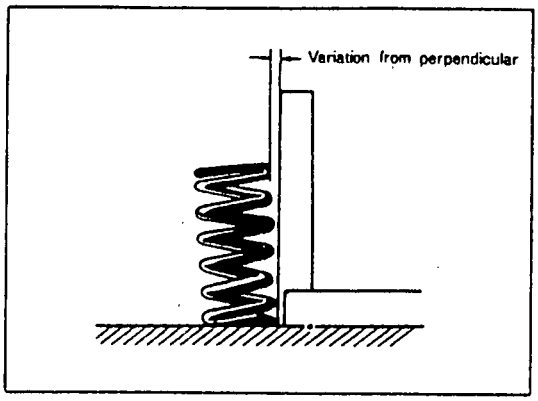
Cautions
a) When the valve guide is replaced, check the gap between the valve and valve guide once again.
b) The valve seal should be installed after inspection and repair of the valve seat.
c) Don't misassemble the valve guides because intake and exhaust valve guides have a different seat.
Intake valve guide ..... longer
Exhaust valve guide ..... shorter

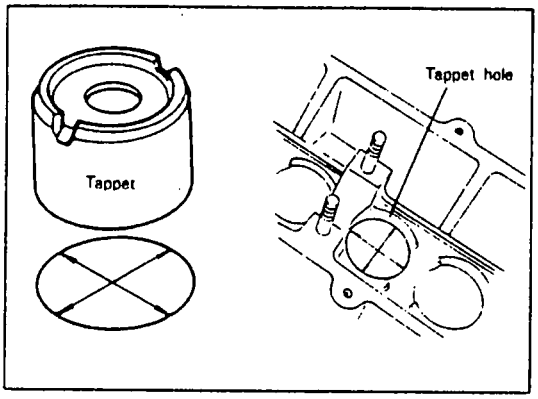


6. Inspection of valve spring
   (1) Inspect each valve spring for cracks or other damage. Replace it if necessary.
   (2) Check each spring for free length and angle limit. Replace it if necessary.

Free length limit: 44.8 mm (1.764 in)

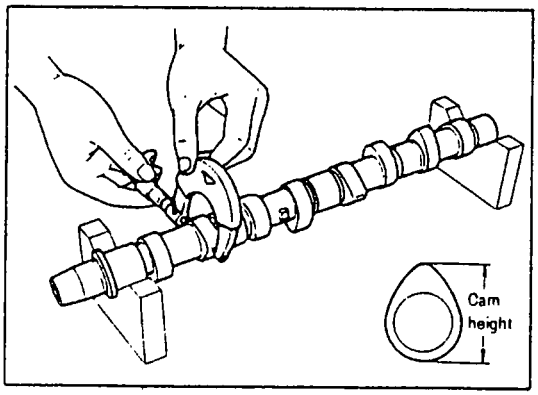


Angle limit: 1.58 mm (0.062 in)



7. Checking the tappet and adjusting disc
   (1) Measure the outer diameter of the tappet; replace it if the limit is exceeded.
   (2) Measure the inner diameter of the tappet hole in the cylinder head, calculate the difference (clearance) between it and the outer diameter of the tappet; if this clearance is the limit value or more, replace the tappet or the cylinder head.

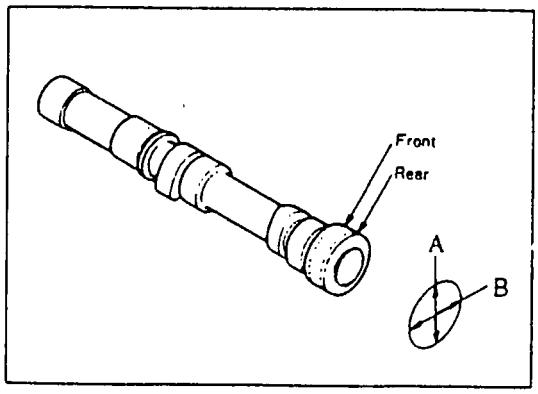
Standard tappet outer diameter:
34.96 ~ 34.98 mm (1.3763 ~ 1.3771 in)
Standard tappet hole:
34.99 ~ 35.02 mm (1.3776 ~ 1.3787 in)
Standard clearance:
0.02 ~ 0.06 mm (0.0008 ~ 0.0024 in)
Clearance limit: 0.10 mm (0.0040 in)



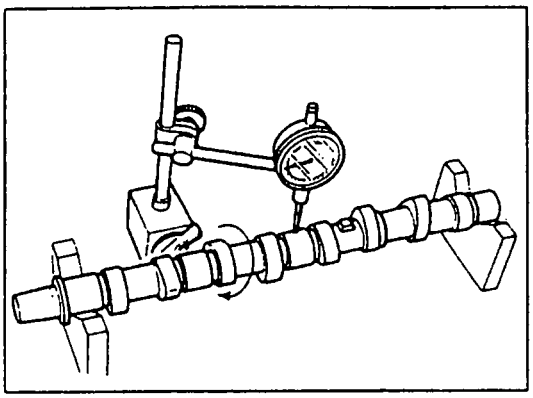
Camshaft
1. Check the camshaft for wear or damage. Replace if necessary.

Standard cam height:
Intake: 44.31 mm (1.744 in)
Exhaust: 45.30 mm (1.783 in)
Cam height limit:
Intake: 43.90 mm (1.728 in)
Exhaust: 44.90 mm (1.768 in)

2. Measure wear of the journal at the four places shown in the figure in directions A and B, front and rear. Replace the camshaft if necessary.



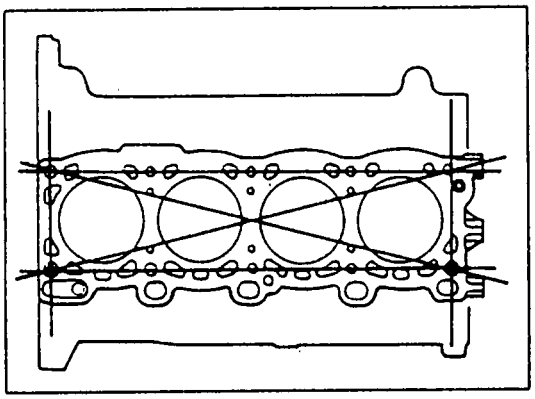
Journal elliptical limit: 0.05 mm (0.002 in)
Standard journal diameters:
31.96 ~ 31.98 mm (1.258~1.259 in)
Journal diameter limit: 31.86 mm (1.254 in)



3. Check the camshaft deflection.

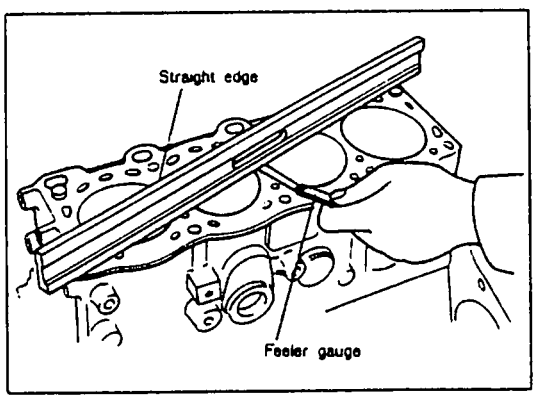
Camshaft deflection limit:
0.10 mm (0.0040 in)

Note
Install the front and rear journals on a V-block to make the measurement.



Cylinder block
1. Cylinder block inspection and repair
   (1) Check each cylinder for dampness, damage, and cracks. Replace if necessary.
   (2) Measure the distortion (degree of flatness) of the top surface of the cylinder block in the six directions shown in the figure.

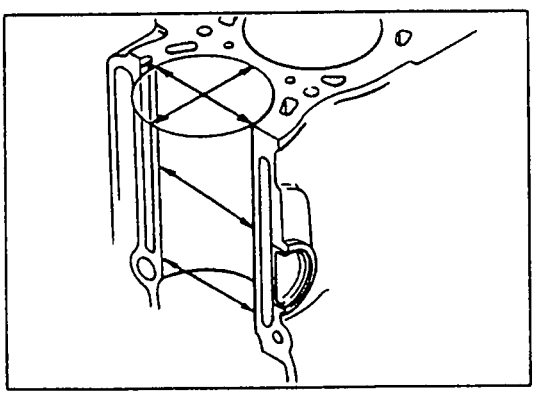
Distortion limit: 0.10 mm (0.0040 in)



(3) If the distortion exceeds the limit, replace the cylinder block.

Caution
Don't grind the surface of the cylinder block. If grinded, the valves will hit the pistons.

(4) Check the cylinder wall for scoring or signs of seizure. If a problem exists, reboring or replacement is necessary.

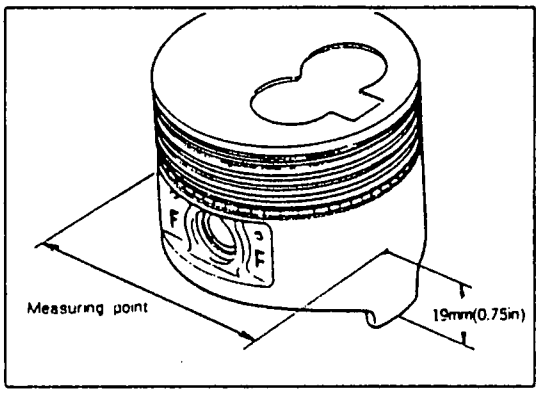


(5) If the upper part of the cylinder wall shows uneven wear, use a ridge reamer to repair.
(6) Measure the cylinder diameter at the six places shown in the figure. Check the amount of wear.
The amount of wear is the difference between the maximum and minimum diameters. If the amount of wear exceeds the limit, the cylinder must be rebored.

Standard cylinder bore: 86.00 mm (3.39 in)
Cylinder bore wear limit: 86.17 mm (3.92 in)
Difference between cylinder bores:
0.022 mm (0.0009 in)

Caution
The boring size should be based on the size of an oversize piston.

Over-size pistons: 0.25 mm (0.010 in)
0.50 mm (0.020 in)

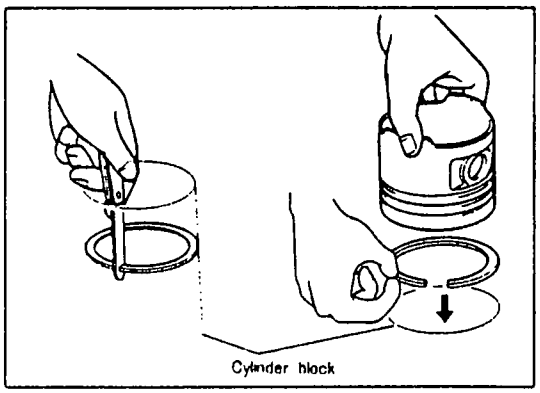


Pistons and piston rings

1. Inspect the piston outer circumferences of all pistons for seizure or scoring. Replace if necessary.
2. Measure the outer diameter of each piston, and be sure the clearance between the piston and cylinder is correct.

Piston standard outer diameter
85.95 ~ 85.98 mm (3.384 ~ 3.385 in)
Piston and cylinder clearance limit:
0.15 (0.006 in)

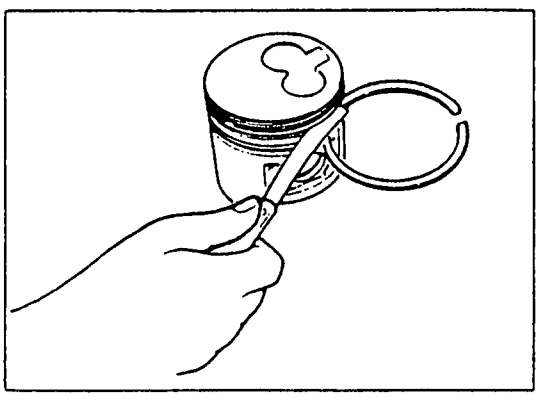
Cautions
a) Measure the piston outer diameter in the thrust direction, 19 mm (0.75 in) above the bottom of piston.
b) If the piston is replaced, replace the piston ring also.



Oversize Piston Rings
0.25 mm (0.010 in), 0.50 in (0.020 in)

3. Inspect the piston rings for damage, abnormal wear, or breakage. Replace if necessary.
4. Insert the piston ring into the cylinder by hand, and push it in by using the piston.
5. Measure the ring opening clearance.

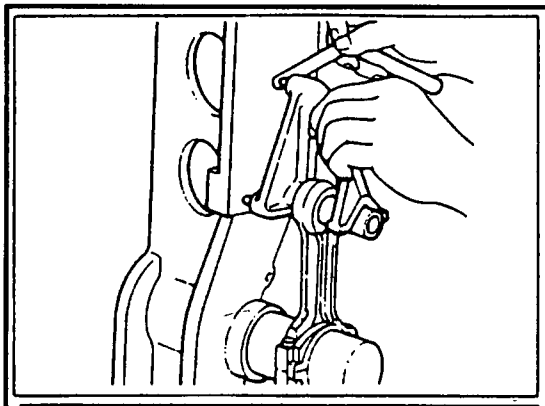
Opening clearance limit: 1.0 mm (0.039 in)

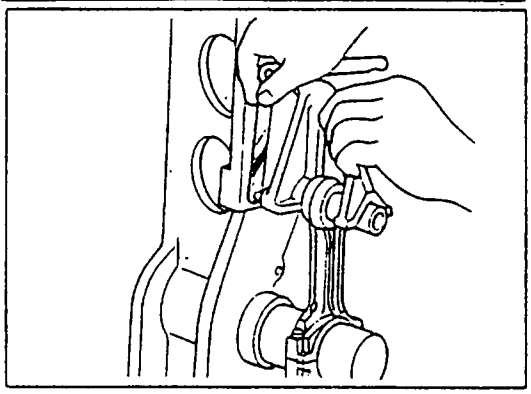


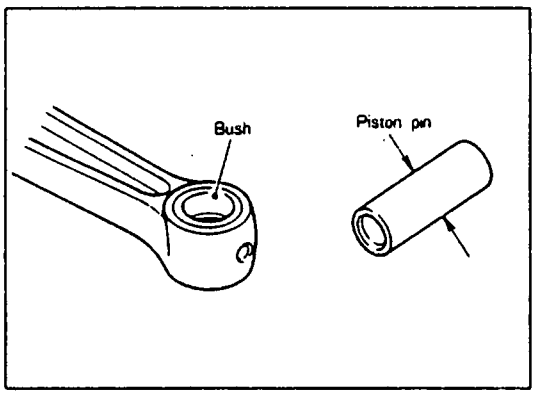
6. Measure the clearance of the piston ring and ring groove.

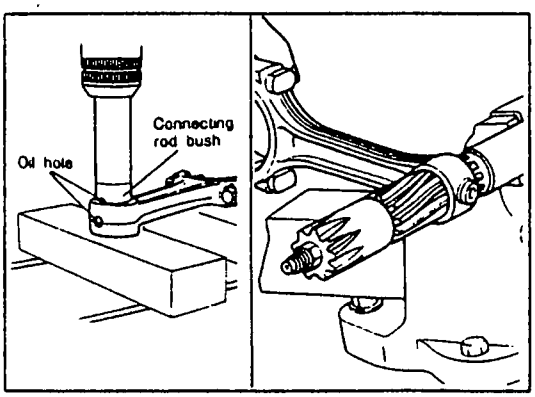
Clearance limit: 0.2 mm (0.008 in)

Caution
Measure the clearance around the entire circumference of the ring groove.









Connecting rods

1. Check each connecting rod for bending or torsion.

Connecting rod bending limit:
0.16 mm (0.006 in) per 100 mm (3.94 in)

Connecting rod torsion limit:
0.16 mm (0.006 in) per 100 mm (3.94 in)

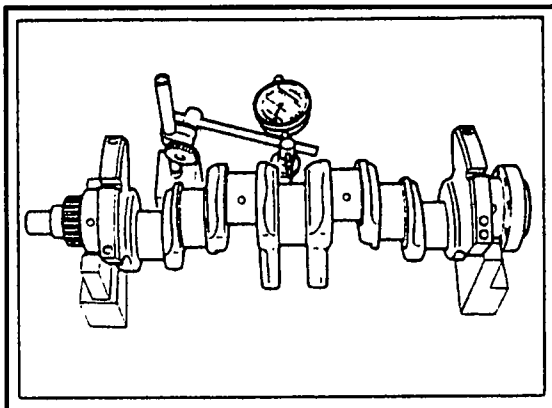
2. Connecting rod bushing inspection and repair.
   (1) Measure the clearance between the outer diameter of the piston pin and the inner diameter of the bushing.
   If the clearance exceeds the limit, replace the connecting rod bushing.

Standard connecting rod bushing inner diameter:
25.01 ~ 25.03 mm (0.9846 ~ 0.9854 in)
Clearance limit: 0.05 mm (0.002 in)

(2) Replacement of the connecting rod bushing
Use a press and a suitable pipe (diameter = 27 ~ 27.5 mm, 1.06 ~ 1.88 in).

Cautions
a) Before assembling, apply a coating of clean engine oil to the connecting rod bushing and connecting rod.
b) Align the oil hole of the connecting rod bushing and the connecting rod.

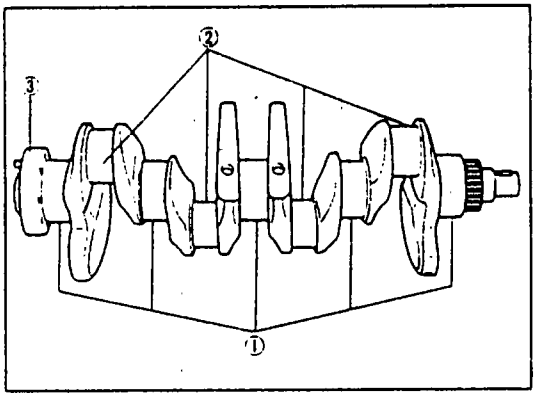
(3) After pressing it in, correct the bushing inner diameter, so that the clearance will come within the standard value, by using a spiral expansion reamer.



Crankshaft

1. Check around the journals and pins for damage, scoring, and oil hole clogging.
2. Check the crankshaft deflection and each diameter. Replace if necessary.

Deflection limit: 0.05 mm (0.002 in)



Standard journal diameters:
(1) Main journal diameter:
59.94 ~ 59.96 mm (2.360 ~ 2.361 in)
(2) Crankshaft pin diameter:
50.94 ~ 50.96 mm (2.006 ~ 2.007 in)
(3) Rear housing oil seal sliding surface:
89.95 ~ 90.00 mm (3.541 ~ 3.543 in)

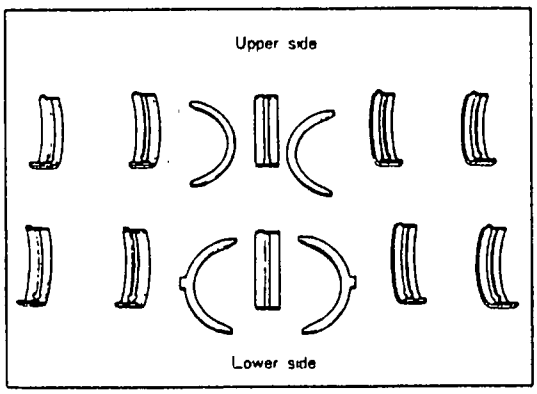
Journal wear limit: 0.05 mm (0.0020 in)

If the wear exceeds the limit, replace or grind the crankshaft to agree with the undersize bearing.

Journal grinding limit: 0.75 mm (0.0295 in)
Undersize bearings:
0.25 mm (0.010 in), 0.50 (0.020 in), 0.75 mm (0.0295 in)

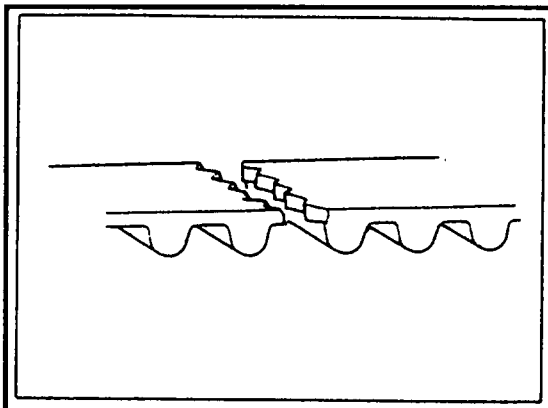
Caution
When grinding the journal or pin, pay attention to each Fillet R dimension.

Fillet R dimension:
2.6 ~ 3.0 mm (0.102 ~ 0.118 in)



Main and connecting rod bearings.

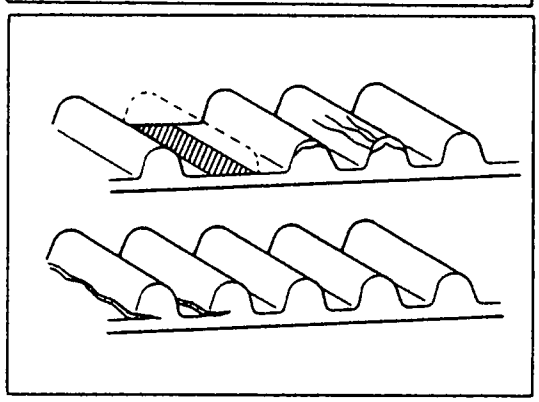
1. Check the main and connecting rod bearings
   (1) Check the bearing inside surfaces for streaking, flaking, pin holes, etc.; replace all bearings as a set if there is a problem.



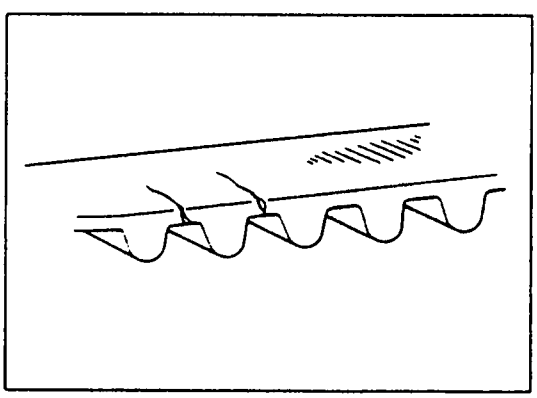
Timing belt

If there are problems, as shown in the figures, check the following points and replace the timing belt if necessary.

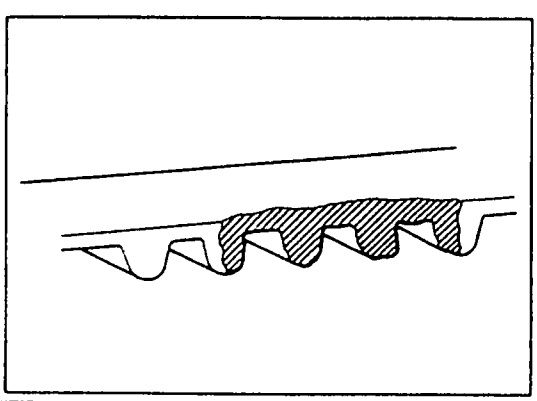
1. Premature severance
   (1) Check for proper installation.
   (2). Check timing belt cover gaskets for damage and installation.



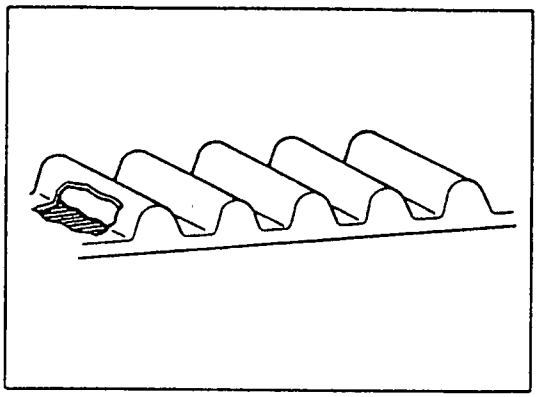
2. If the belt teeth are cracked or damaged, replace the timing belt.



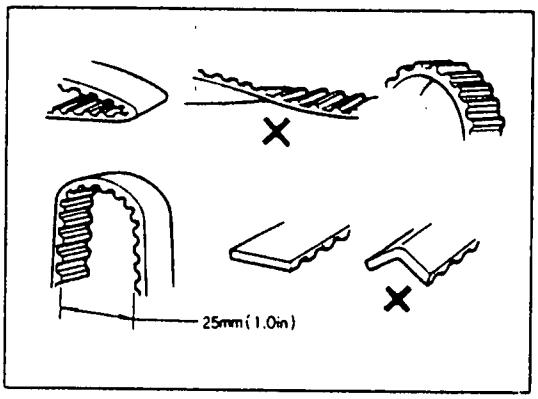
3. If there is noticable wear or cracks on the belt face, replace the timing belt.



4. If there is wear or damage on only one side of the belt, replace the timing belt.



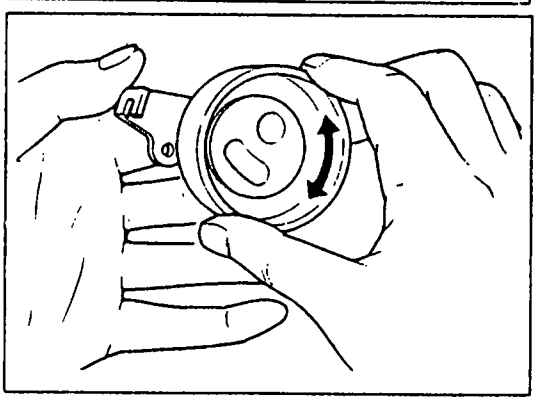
5. If there is noticeable wear on the belt teeth, replace the timing belt.



Cautions

a) Never forcefully twist the timing belt. Don't turn it inside out or bend it.

b) Be careful not to allow oil, grease, or moisture on the belt.



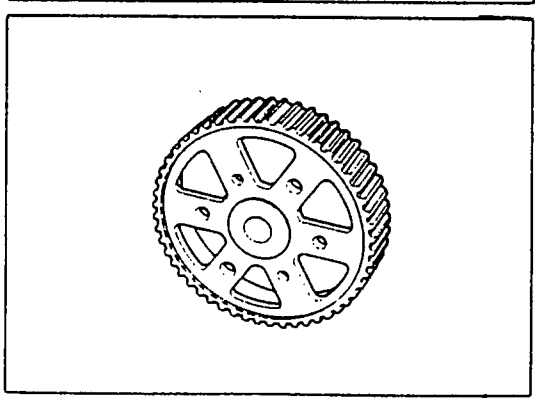
Timing belt tensioner

1. Check the rotation of the pulley, and check for play or abnormal noise. Replace if necessary.

Cautions

a) Do not clean the tensioner with cleaning fluids.

b) If it is dirty, use a rag to wipe it clean, so as to avoid scratching it.



Timing belt pulley, camshaft pulley and injection pump pulley.

1. Inspect the each pulley teeth for wear, deformation or other damage.
   Replace the pulley if necessary.

Caution

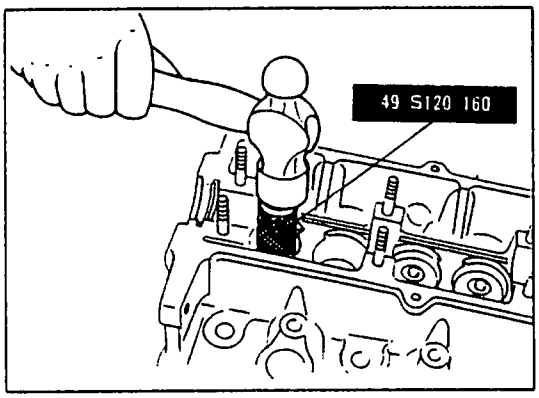
Do not clean the pulley. If it is dirty, use a rag to wipe it clean, so as to avoid it being contaminated by oil, etc.

Timing belt covers (left, right)

1. Inspect each timing belt cover for deformation or cracks. Replace if necessary.
2. Inspect the gasket for deformation, cracks, or hardening.
   Replace if necessary.

Assembly notes

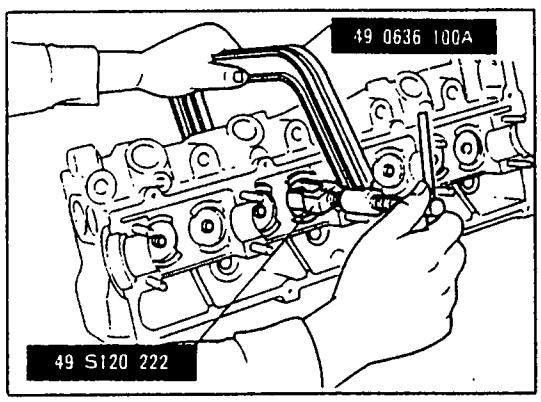
1. Be sure all parts are clean before reassembly.
2. Apply new engine oil to all sliding and turning parts.
3. Do not reuse gaskets or oil seals.
4. During reassembly, inspect all critical clearances, end plays, oil clearances and bends.
5. Tighten all bolts of critical parts to the specified torques.
6. Replace plain bearings if they are peeling, burned, or otherwise damaged.



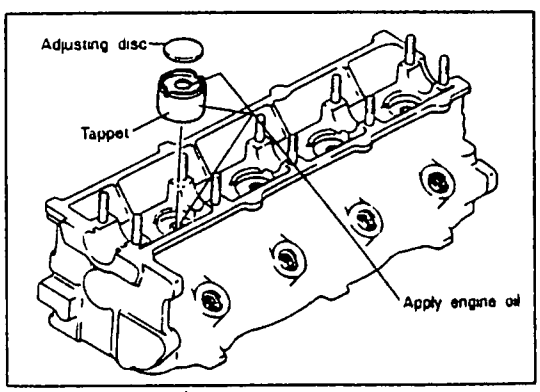
Cylinder head

1. Install the valve seals.
   (1) Apply a engine oil to the valve guides.
   (2) Using the **valve seal pusher** (49 S120 160), Install the valve seals.

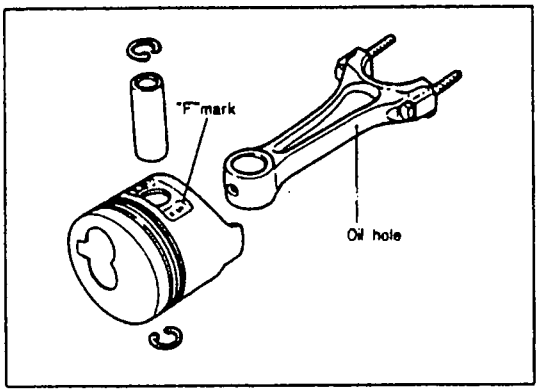
Caution
Be sure to use the special tool for installation. If it is not installed correctly, the oil might work down.



2. Install the valves on to the cylinder head.
   (1) Install the spring seat, lower.
   (2) Insert the valve after applying the molybdenum disulphide de grease to the valve stem.
   (3) Install the valve spring and spring seat, upper.
   (4) Using the **valve spring lifter** (49 0636 100A) and **pivot** (49 S120 222), press the valve spring. And then install the spring retainer securely.

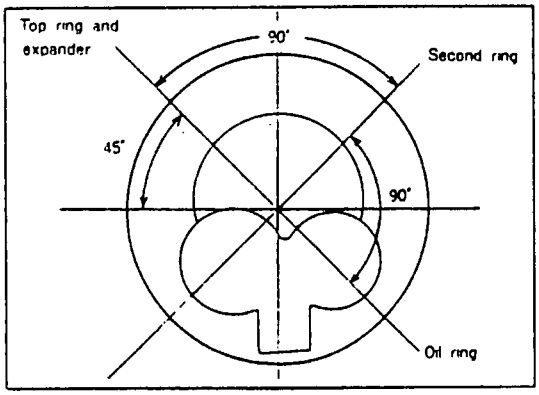


3. Install the tappets and adjusting discs.
   (1) Install the tappet in the tappet hole, after appling engine oil to the tappets.
   (2) Install the adjusting discs.



Piston and connecting rod

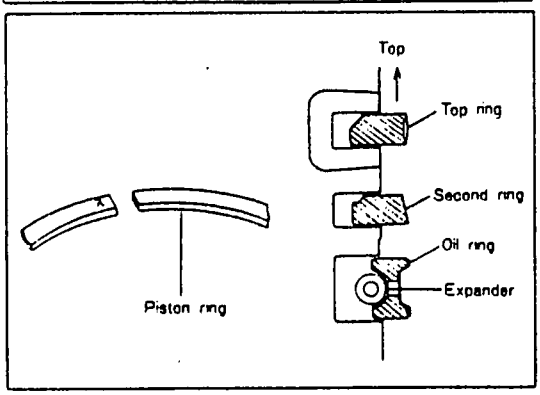
1. Assemble the piston and connecting rod.
   (1) Align the oil hole in the large end of the connecting rod with the "F" mark on the piston.
   (2) Apply a coat of engine oil to the small end of the connecting rod and all around the piston.
   (3) Insert a snap ring into one of the piston pin holes in the piston.
   (4) Connect the piston and connecting rod by the piston pin, and lock the snap ring so it won't come out. (When doing so, the piston should be heated to 50~75°C.)
2. Assembly of the piston rings.
   (1) Assemble the piston ring to the piston by using a piston ring inserting tool (commercially available.)
   The order of assembly is: oil ring expander, oil ring, second ring, top ring.
   (2) Align the piston ring matching places, as shown in the figure.



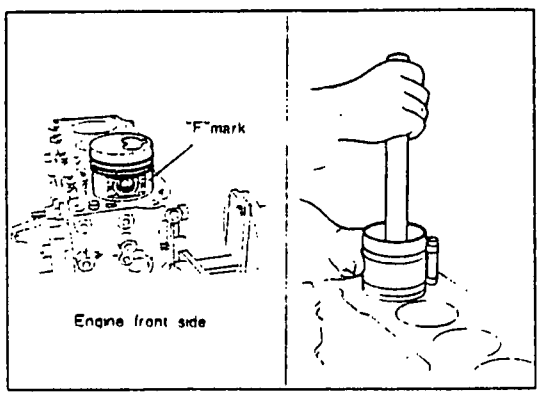
Cautions

a) Apply a liberal coat of engine oil during installation.

b) The rings must be mounted so the "R" or "RN" marks face upward.



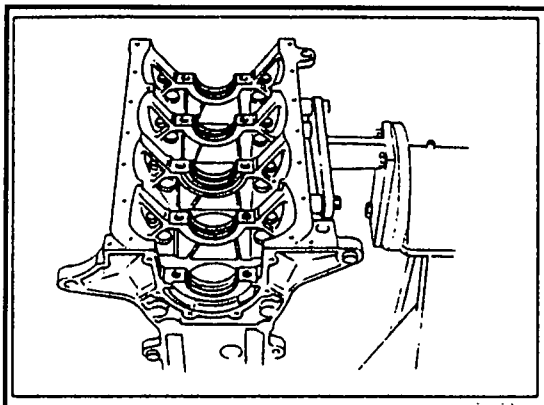
3. Install the piston and connecting rod.
   (1) Fit the connecting rod bearing to the connecting rod, and apply a coating of engine oil.
   (2) After cleaning the inner surface of the cylinder, apply a coating of engine oil.
   (3) Insert each piston and connecting rod into the cylinder block using a piston insertion tool (commercially available).

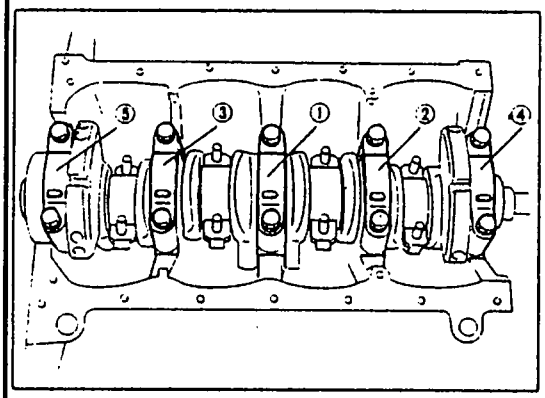


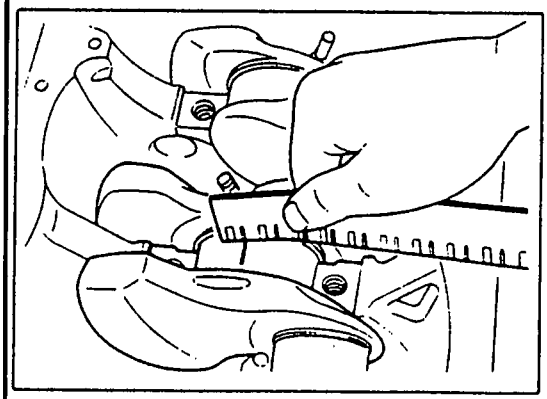
Cautions

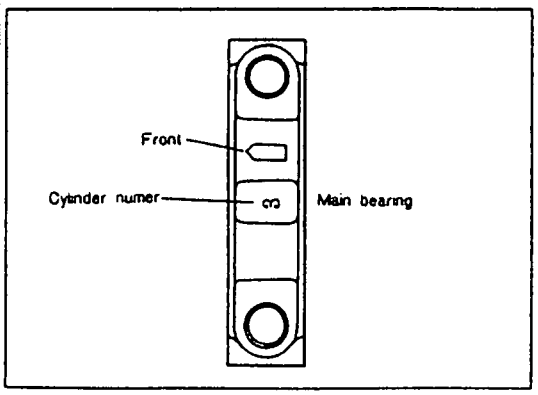
a) The pistons must be inserted so that the "F" marks face the front of the cylinder block.

b) Apply a liberal coating of engine oil to the cylinder walls, piston circumference, and rings.









Crankshaft assembly

1. Install the oil jets to the cylinder block.

   Oil jet tightening torque:
   1.2 ~ 1.8 m-kg (9 ~ 13 ft-lb)

2. Install the crankshaft.
   (1) Install the main bearings.

   Cautions
   a) No oil, dirt, etc. should be on the back surface of the bearings.
   b) Because width of the center main bearings are wider than those of the others, there isn't interchangeability between the center main bearings and others.

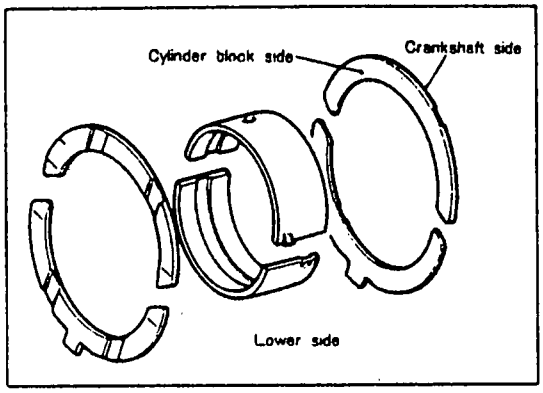
   (2) Check the oil clearance of the crankshaft and main bearings with a plasti-gauge.
   (a) Remove any foreign material from the journal or bearing.
   (b) Position the Plasti-gauge on top of the journal (in the journal axial direction).
   (c) Set the main bearing cap in position, and tighten it to the specified torque, and in the order shown in the figure.

   Main bearing cap tightening torque:
   8.4 ~ 9.0 m-kg (61 ~ 65 ft-lb)
   (d) Remove the main bearing cap, and measure the oil clearance.

Standard oil clearance:
0.031 ~ 0.049 mm (0.0012 ~ 0.0019 in)
Oil clearance limit: 0.08 mm (0.0031 in)

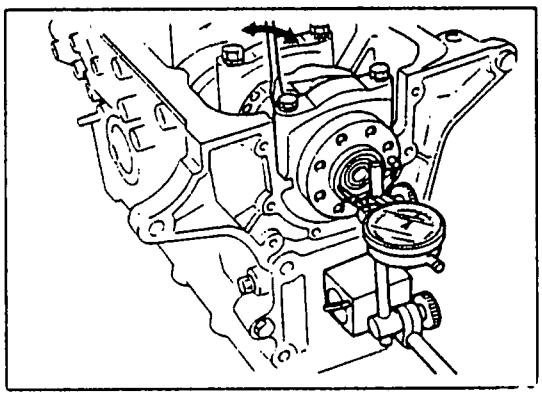
   (e) If the oil clearance exceeds the limit, replace the main bearings with new ones. And measure the oil clearance again.
   (f) In case the oil clearance exceeds the limit even if the main bearings are replaced, repair the crankshaft by grinding, and use undersize bearings.

Cautions
a) Position the Plasti-gauge horizontally on the crankshaft, away from the oil hole.
b) Do not rotate the crankshaft when measuring the oil clearance.
c) Install the main bearing cap according to the cap No. and ◊ mark.



(3) After checking and correcting the oil clearance, apply a coating of engine oil to the main bearing and main journal, and then install the crankshaft.
(4) Apply a coat of engine oil to the thrust bearing, and install to the center part of the main journal.

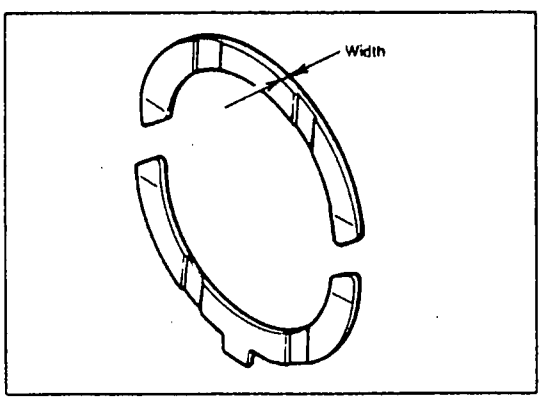
Caution
Install the thrust bearing so that the inner surface of the oil groove faces toward the cylinder block side.



(5) With the main bearing cap in the set condition, manually push the crankshaft toward the front, and then, with it pulled toward the rear, tighten the bolt to the specified torque.
Main bearing cap tightening torque:
8.4 ~ 9.0 m-kg (61 ~ 65 ft-lb)

(6) Measure the end play of the crankshaft, and confirm that it is within the standard range. At this time, check to be sure that the crankshaft can be lightly turned.

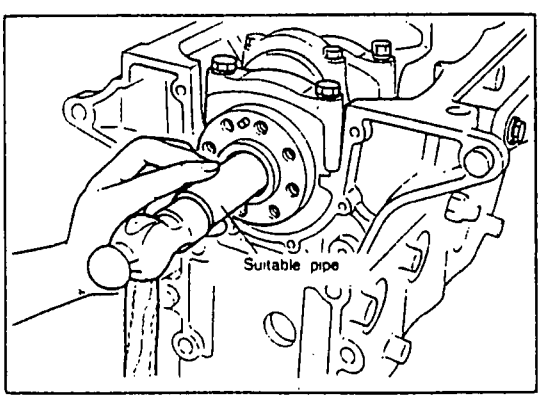
Standard crankshaft end play:
0.04 ~ 0.28 mm (0.0016~0.0111 in)
End play limit: 0.3 mm (0.0118 in)



(7) If the end play is not within the standard range, select another thrust bearing.

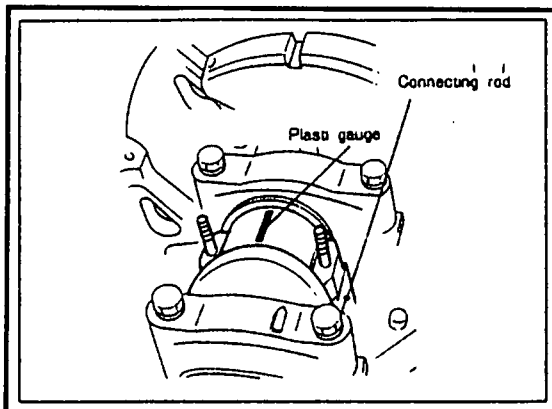
Undersize thrust bearing width:
2.18 ~ 2.23 mm (0.0858 ~ 0.0878 in)
Standard thrust bearing width:
2.00 ~ 2.05 mm (0.0787 ~ 0.0807 in)

Caution
First replace the rear thrust bearings, if still not within limit, replace the front thrust bearings also.



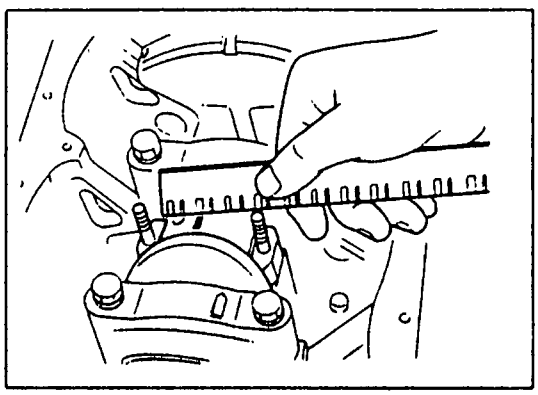
3. Use piece of pipe to tap the pilot Pilot bearing onto the crankshaft.

Cautions
a) Apply a coating of engine oil to the outer circumference of the Pilot bearing and the crankshaft.
b) Set a piece of pipe against the outer race of the bearing, and tap evenly.
c) After installation, apply grease to the bearing.

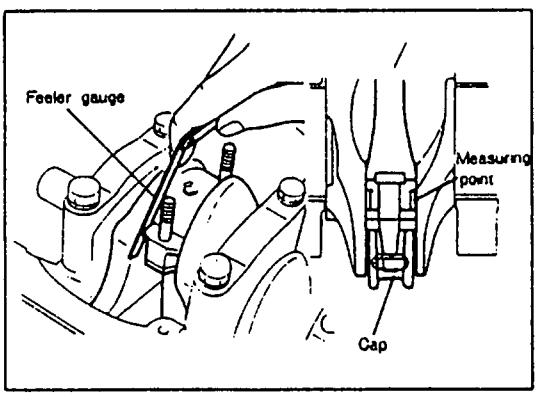


4. Install each connecting rod cap as follows:
   (1) Measure and adjust the connecting rod bearing and crankshaft pin journal oil clearance by the same procedure used to measure and adjust the crankshaft and main bearing oil clearance.

Connecting rod cap tightening torque:
7.0 ~ 7.5 m-kg (51 ~ 54 ft-lb)



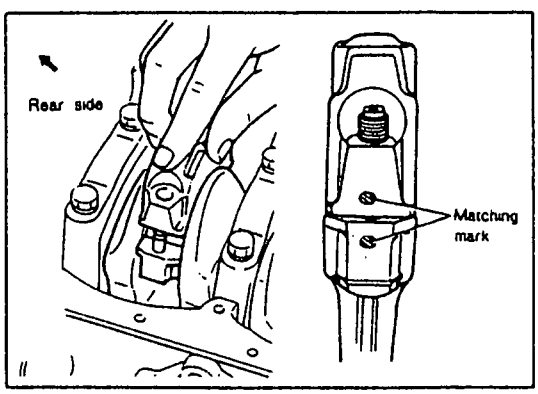
Standard oil clearance:
0.03 ~ 0.06 mm (0.0012 ~ 0.0024 in)
Oil clearance limit: 0.08 mm (0.0031 in)
Undersize connecting rod bearings:
0.25 mm (0.010 in), 0.50 mm (0.020 in), 0.75 mm (0.030 in)



(2) Check the end play of the connecting rod.

Standard connecting rod end play:
0.11 ~ 0.26 mm (0.0043 ~ 0.0102 in)
End play limit: 0.35 mm (0.014 in)

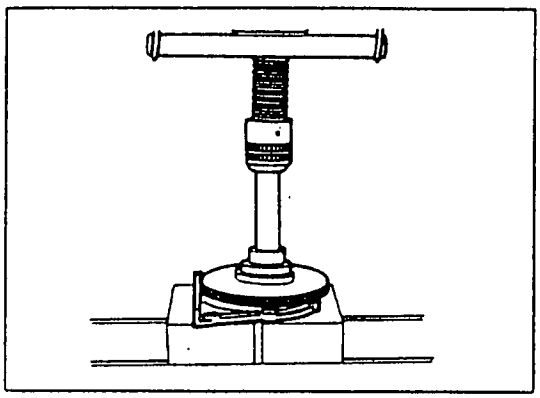
Caution
Measure the connecting rod end play before installing the connecting rod cap.



(3) Install the connecting rod bearing cap, and tighten to the specified torque.
When doing so, apply a coating of engine oil to the bolt threaded parts, nuts and bearing surfaces.

Connecting rod bearing cap tightening torque:
7.0 ~ 7.5 m-kg (51 ~ 54 ft-lb)

Cautions
a) When installing the connecting rod cap, do so after aligning the cap and connecting rod matching marks.
b) Before installation, be absolutely sure to apply a coating of engine oil to the bearing.

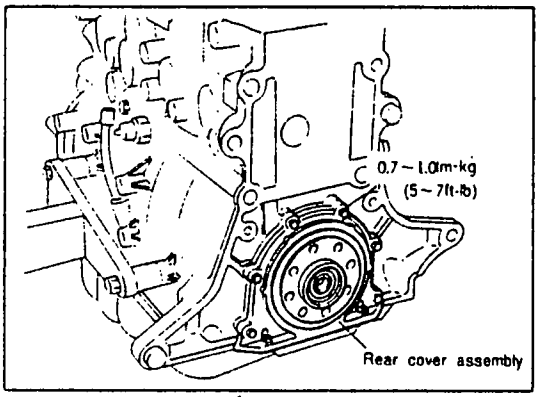


Rear cover assembly

1. Apply engine oil to the rear cover and the oil seal.

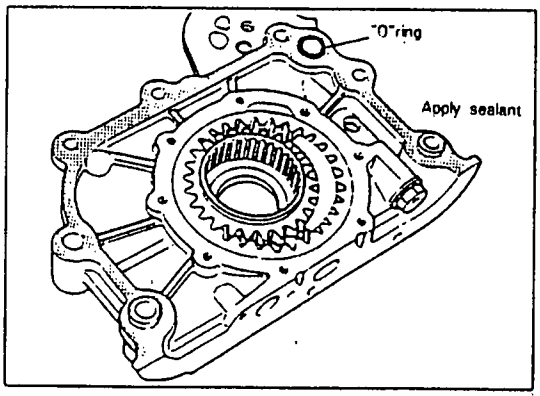
Caution
Remember that when the engine oil is applied to the cover and seal, it must also be applied to the oil seal lip.

2. Press the oil seal into the rear cover.



3. Install the rear cover assembly through the gasket.

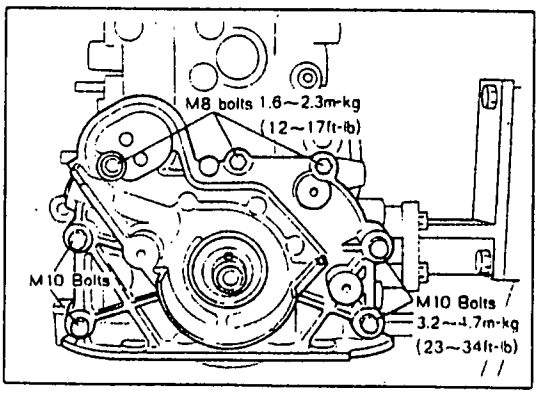
Rear cover assembly tightening torque:
0.7 ~ 1.0 m-kg (5 ~ 7 ft-lb)



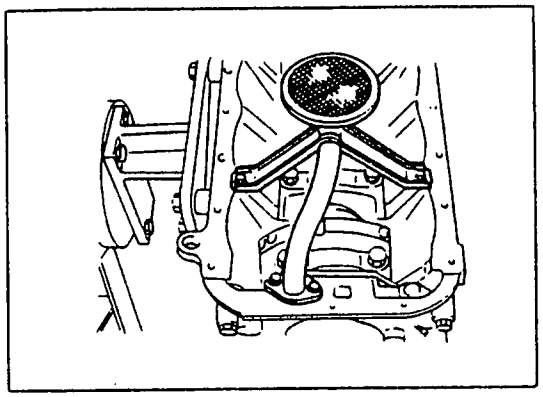
Oil pump assembly

1. Install an O-ring applied with grease (lithium base, NLGI No. 2) onto the oil pump assembly.
2. Install the oil pump assembly after applying sealant (1016 77 739).

Oil pump assembly tightening torque:
M8 (Smaller) bolts:
1.6 ~ 2.3 m-kg (12 ~ 17 ft-lb)
M10 (Bigger) bolts:
3.2 ~ 4.7 m-kg (23 ~ 34 ft-lb)



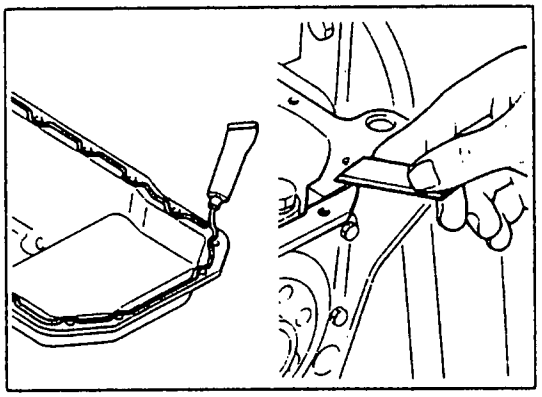
Cautions
a) Do not let sealant get into the oil hole.
b) Apply engine oil to oil seal lip.
c) Before applying the sealant, use a rag to thoroughly clean away any dirt or grease from the contact surfaces of the cylinder block and oil pump assembly.
d) Apply the sealant continuously without any interruption around the bead as shown in the figure.
e) After installation, clean away any sealant which oozes out.



Oil strainer and oil pan

1. Install the oil strainer on the oil pump body and cylinder block and tighten it to the specified torque.

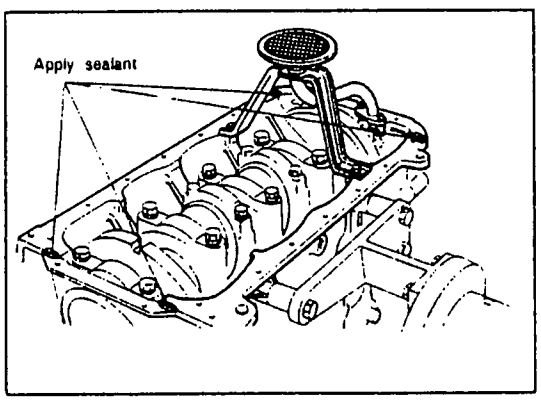
   Oil strainer tightening torque:
   0.7 ~ 1.0 m-kg (5 ~ 7 ft-lb)



2. Cut away the part of the gasket which projects out from the rear cover assembly to the oil pan.

   Caution
   Do not scratch the rear cover assembly.

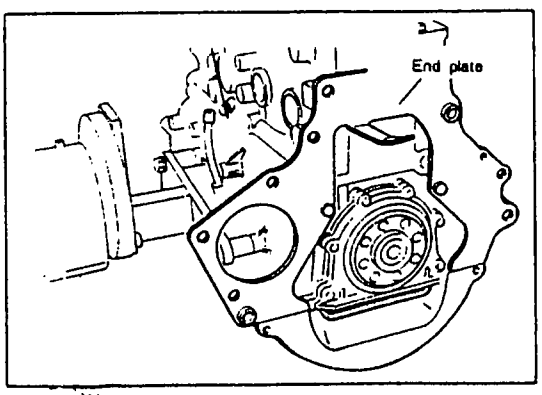
3. This method must be used to install the oil pan.
   (1) Apply sealant to where the oil pan and cylinder block meet. It should be put on continuously (thickness 2 ~ 4 mm, 0.08 ~ 0.16 in), rimming the surface inside the bolt holes, and the end should overlap.



   Cautions
   a) Before application, remove with a rag any dirt or grease from the contact surfaces.
   b) Apply sealant only to the cylinder block or the oil pan, not to both.
   c) After the sealant is a applied, the pan must be secured within 30 minutes.

   (2) If a gasket is used, apply sealant to the shaded areas. Then install the gasket and the oil pan, tightening to the specified torque.

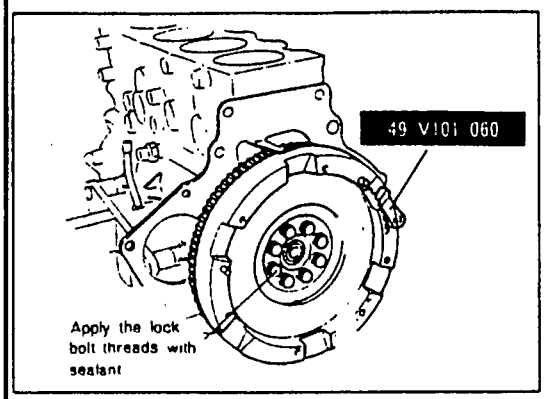
   Oil pan tightening torque:
   0.7 ~ 1.0 m-kg (5 ~ 7 ft-lb)



End plate, flywheel and clutch cover

1. Install the end plate.

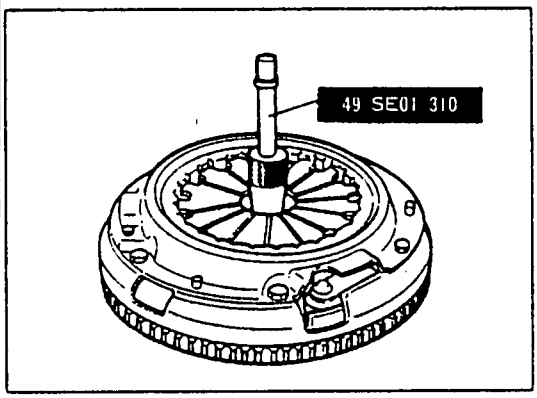
   End plate tightening torque:
   1.6 ~ 2.3 m-kg (12 ~ 17 ft-lb)



2. Install the flywheel assembly, using the **ring gear brake** (49 V101 060).

Tightening torque:
18 ~ 19 m-kg (130 ~ 137 ft-lb)

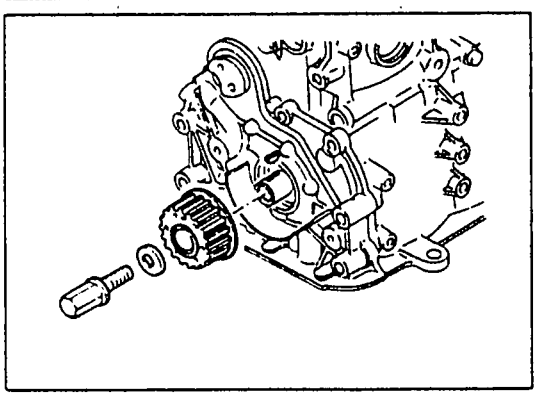
Cautions
a) Sealant (part No.8530 77 743) must be applied to the lock bolt to prevent oil leakage from the lock bolts.
b) After installation, do not remove the ring gear brake.



3. Install the clutch disc and clutch cover using the **clutch disc center tool** (49 SE01 310).

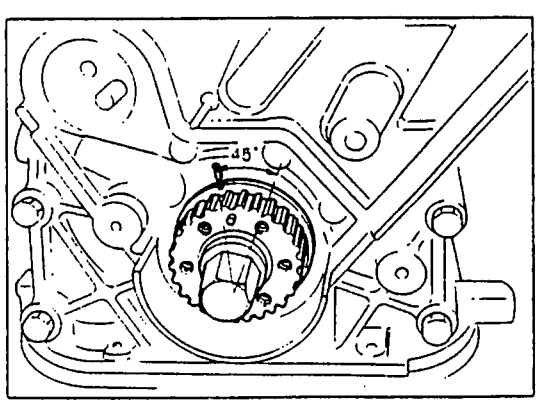
Clutch cover tightening torque:
2.2 ~ 3.3 m-kg (16 ~ 24 ft-lb)

Cautions
a) Remember to insert the spring washer.
b) Be careful to follow the clutch disc installation directions exactly. (See Section 6.)



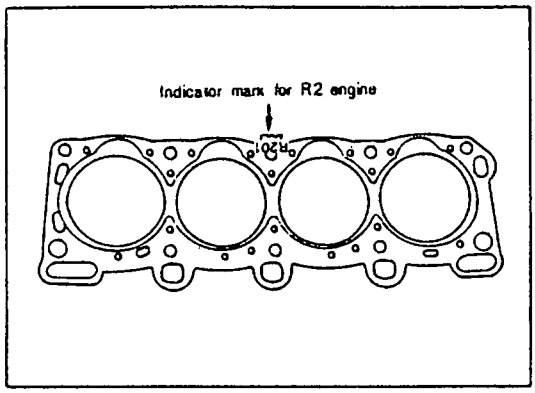
Timing belt pulley
1. Install the timing belt pulley with the semicircular (Woodruff) key and tighten it to specified torque.

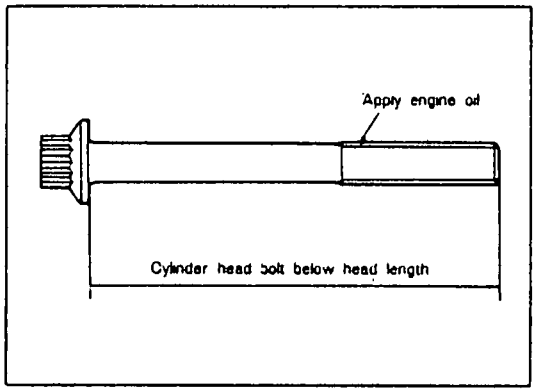
Timing belt pulley bolt tightening torque:
16 ~ 17 m-kg (116 ~ 123 ft-lb)

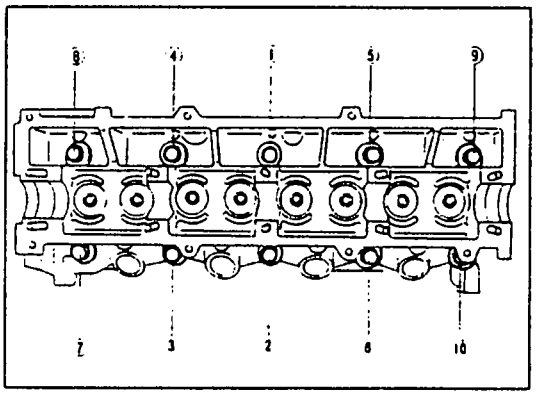


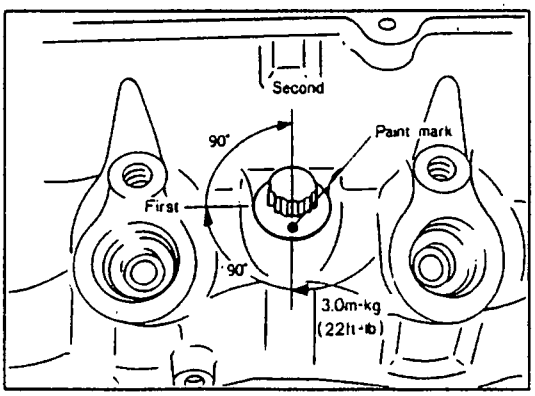
2. Release the ring gear brake, turn the flywheel, move the No. 1 piston to the top position, and then turn it approximately 45° in the forward direction.

Caution
This is to prevent damage to the piston and valve when the cylinder head is installed.









Cylinder head

1. Install the cylinder head.
   (1) With a rag thoroughly remove all dirt and grease from the top of the cylinder block.
   (2) Place the cylinder head gasket in position.

Caution
Use a new cylinder head gasket.

   (3) Remove any dirt or grease from the bottom surface of the cylinder head.
   (4) Place the cylinder head in position.

   (5) Measure the length of the cylinder head bolt below the head. If the measured value is within the limit, apply a coating of engine oil to the threaded part and install.

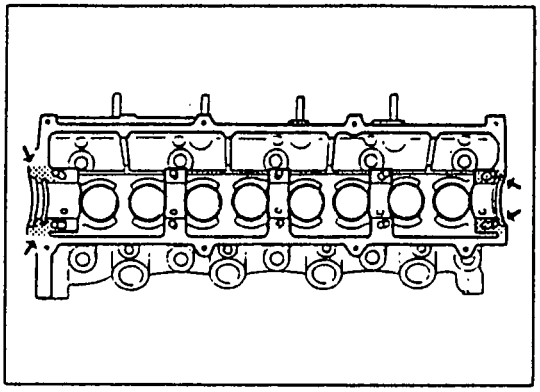
Length of cylinder head bolt below head
Standard length
112.7 ~ 113.3 mm (4.437 ~ 4.460 in)
Limit 114.5 mm (4.508 in)

Caution
If the length of the bolt below the head exceeds the limit, it must be replaced with a new one.

   (6) Tighten the cylinder head bolts to a tightening torque of **3.0 m-kg (22 ft-lb)** in the order shown in the figure.

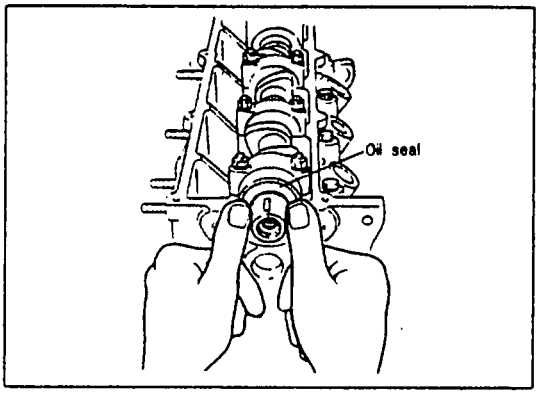
   (7) Make paint marks on the bolt heads, as shown in the figure.
   (8) With the paint marks as a reference point, turn the cylinder head bolts **another 90° (90° ~ 105°)** in the tightening direction, turning them in the order shown in the figure.
   (9) Then tighten them **once again 90° (90° ~ 105°)** more in the tightening order shown in the figure.

Caution
Be absolutely sure to tighten all bolts in the order shown in the figure.



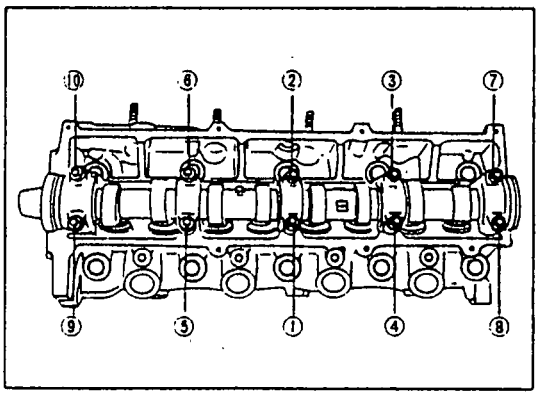
2. Install the camshaft.
   (1) Apply a coat of engine oil to the camshaft and journal part of the cylinder head.
   (2) Set the seal cap, and then apply sealant (1016 77 739) to the places shown in the figure.
   (3) Set the camshaft and camshaft cap, and then loosely tighten the camshaft cap bolt.

Note
Set the camshaft so that the key groove faces directly upward.

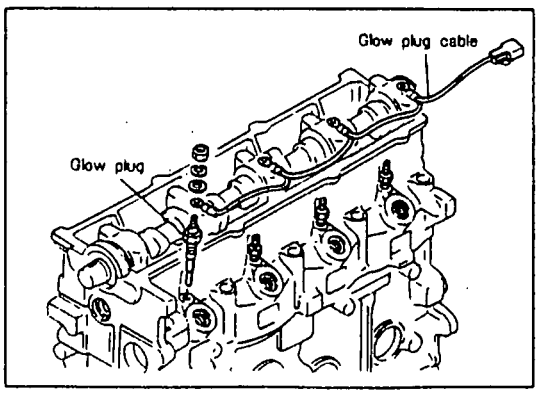


   (4) Apply a coat of engine oil to the lip part of the camshaft oil seal, and then insert it.
   (5) Tighten the camshaft cap nut to the specified torque. (Refer to page 1B–42 for measurement of the oil clearance.)

Camshaft cap tightening torque
2.0 ~ 2.7 m-kg (15 ~ 20 ft-lb)

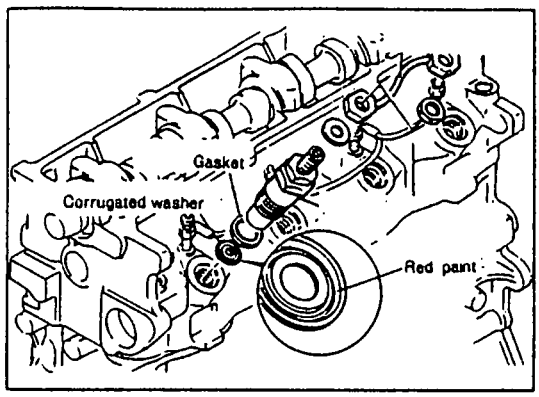


Cautions
a) When tightening the camshaft cap nut, do so evenly, and in the order shown in the figure.
b) The adjustment of the valve clearance should be made only after the camshaft pulley, injection pump pulley and timing belt have been installed.



3. Install the glow plugs and injection nozzles.
   (1) Install the glow plugs and glow plug connector.

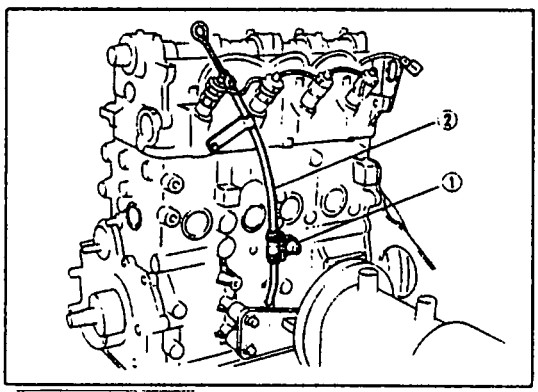
Glow plug tightening torque:
1.5 ~ 2.0 m-kg (11 ~ 15 ft-lb)



(2) Install the corrugated washers, copper gaskets and injection nozzles and leak pipe as shown in the figure.

Cautions
a) Be sure that the corrugated washer is in the directional position shown in the figure.
b) The corrugated washer and copper gasket must be replaced with new ones each time the injection nozzle is removed.

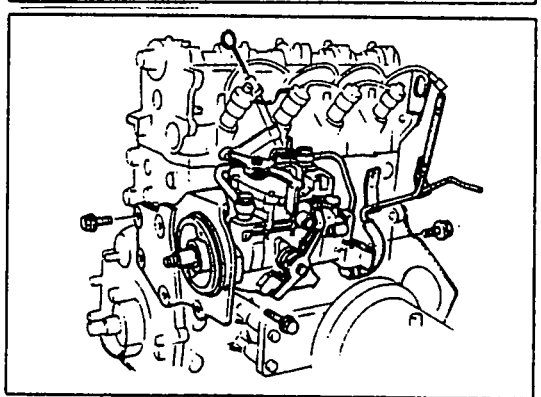
Injection nozzle tightening torque
6.0 ~ 7.0 m-kg (43 ~ 51 ft-lb)



Oil pressure switch and oil level gauge
1. Install the oil pressure switch.

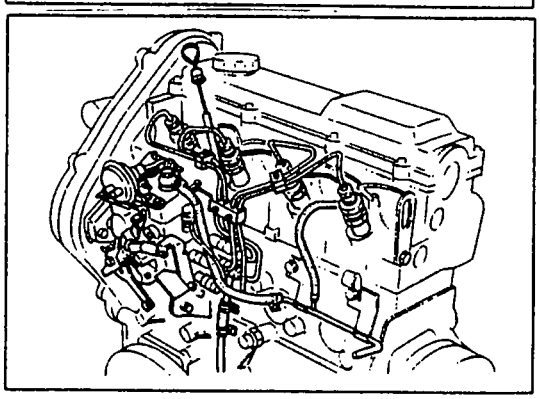
Oil pressure switch tightening torque:
1.2 ~ 1.8 m-kg (9 ~ 13 ft-lb)

2. Install the oil level gauge.



Injection pump
1. Install the injection pump with the fuel feed pipe and injection pump bracket.

Note
In case the injection pump bracket and the injection pump are separated, injection timing adjustment is necessary after installing the timing belt.

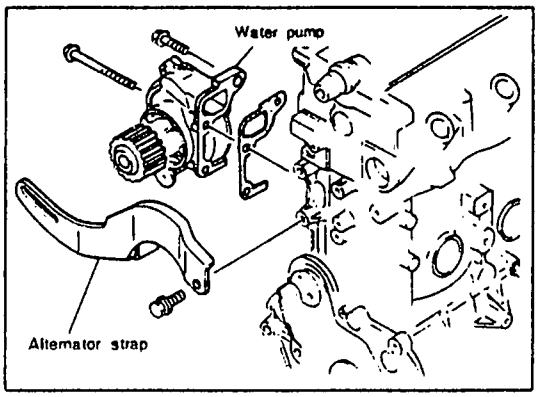


Injection pipe
1. Install the fuel injection pipes.

Fuel injection pipe tightening torque:
1.8 ~ 2.3 m-kg (13 ~ 17 ft-lb)

Caution
Check to be sure that no dirt or other foreign material has adhered to the pipe coupling.

2. Tighten the clip channels.

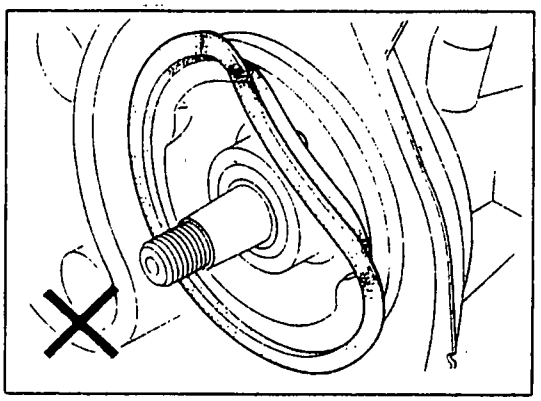


Water pump

1. Install the water pump through the gasket and alternator strap, and tighten it to specified torque.

Water pump tightening torque
3.2 ~ 4.7 m-kg (23 ~ 34 ft-lb)

Caution
Before installation, remove any dirt from the contact surface. Use a new gasket.

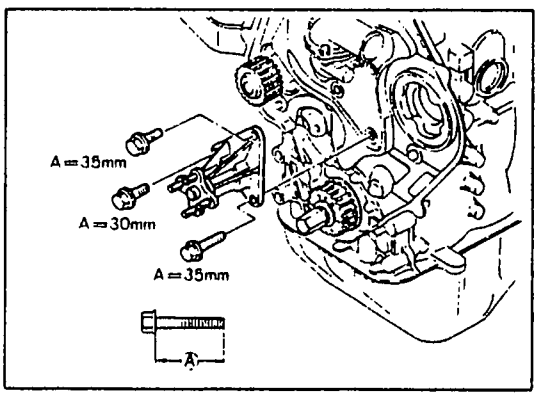


Seal plate

1. Install the seal plate.

Seal plate tightening torque:
0.8 ~ 1.2 m-kg (6 ~ 9 m-kg)

Caution
Check to be sure that the seal plate sealing rubbers are installed in position.

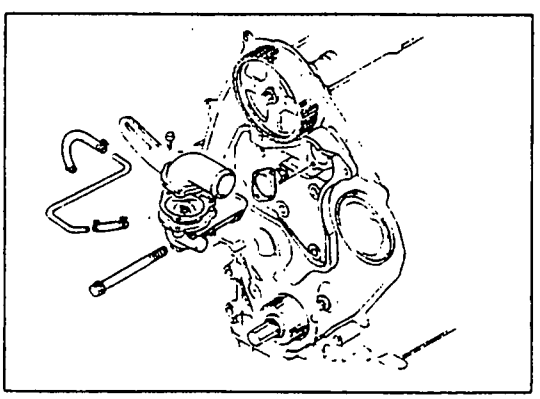


Cooling fan bracket and thermostat assembly

1. Install the cooling fan bracket.

Cooling fan bracket tightening torque:
3.2 ~ 4.7 m-kg (23 ~ 34 ft-lb)

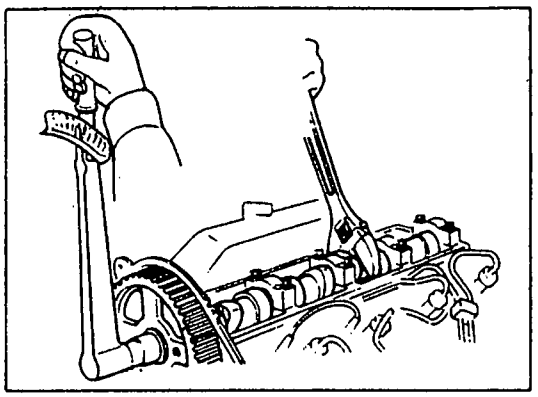
Note
Because there are two lengths of cooling fan bracket bolts, don't misassemble.



2. Install the thermostat assembly through the new gasket.

Thermostat assembly tightening torque:
1.6 ~ 2.3 m-kg (12 ~17 ft-lb)

3. Connect the bypass hose to the thermostat assembly.



Camshaft pulley

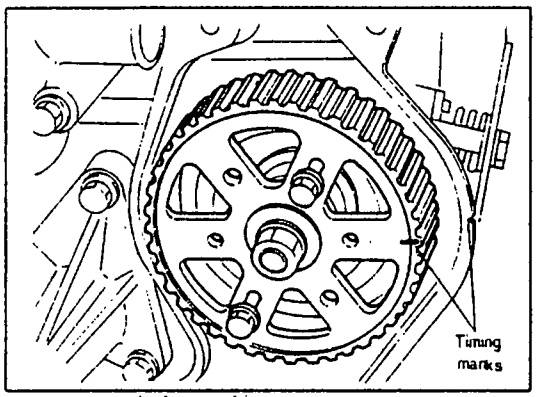
1. Connect the camshaft pulley onto the camshaft with the semi circular (woodruff) key.
2. Hold the camshaft with a wrench (29 mm, 1.14 in), then tighten the camshaft pulley lock bolt to the specified torque.

Camshaft pulley tightening torque:
5.6 ~ 6.6 m-kg (41 ~ 48 ft-lb)

Cautions

a) Check to be sure that the mark on the camshaft pulley aligns with the mark on the seal plate.

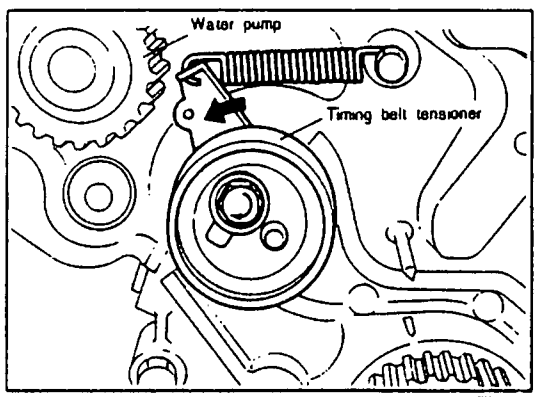
b) Don't damage the cylinder head edge with the wrench.



Injection pump pulley

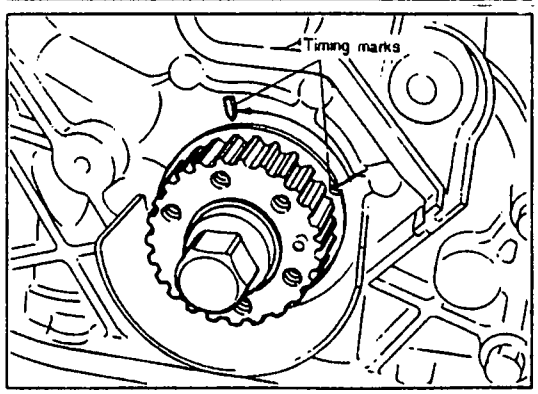
1. Install the injection pump pulley with the semi circular (woodruff) key to the injection pump shaft.
2. Rotate the injection pump pulley until the timing mark on the injection pump pulley aligns with the timing mark on the seal plate.
3. Affix the injection pump pulley to the injection pump bracket using the two bolts (35 ~ 40 mm), and tighten it to specified torque.

Injection pump pulley tightening torque:
6.0 ~ 7.0 m-kg (43 ~ 52 ft-lb)



Timing belt tensioner and spring

1. Install the timing belt tensioner and spring in a fully loosened position.
2. Position the timing belt tensioner all the way to the water pump side, and then tighten the lock nut temporarily.

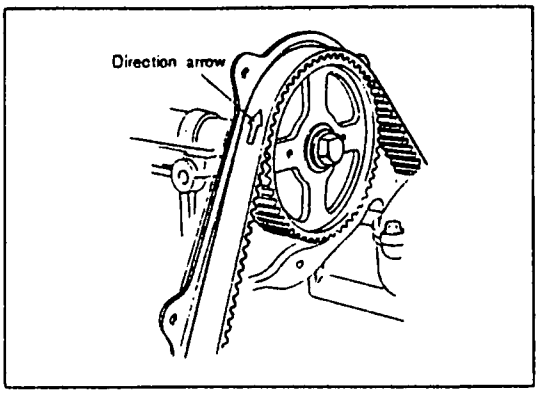


Timing belt

1. Return the crankshaft about 45° to the timing mark which is marked on the oil pump housing.

Caution

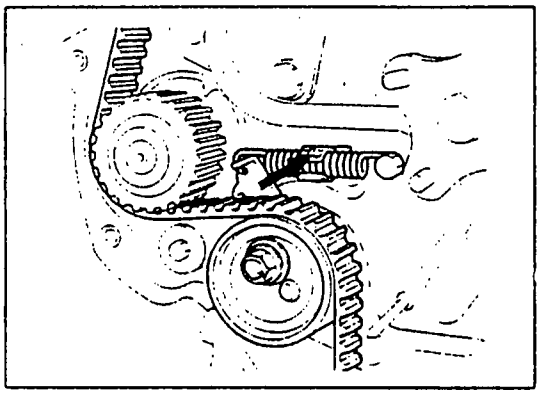
Check to be sure that the matching marks of the camshaft pulley and the injection pump pulley align to the each matching mark on the seal plate.



2. Install the timing belt.

Caution
The timing belt must always be reinstalled in the same direction of rotation for continued durability.

3. Remove the two affixing bolts from the injection pump pulley.

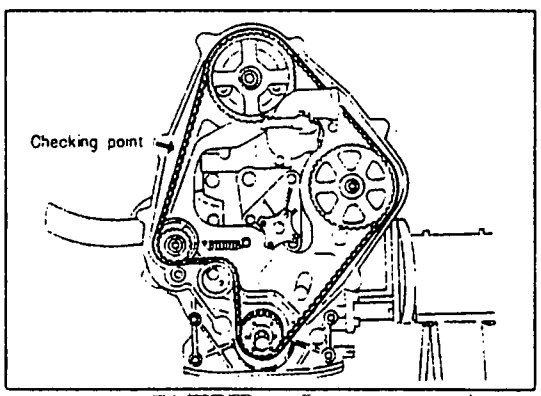


4. Loosen the tensioner lock bolt so that tension is applied to the timing belt by the tensioner spring.
5. Turn the crankshaft twice in the direction of rotation (clockwise) to equalize tension on the timing belt.

Caution
Don't rotate in reverse direction.

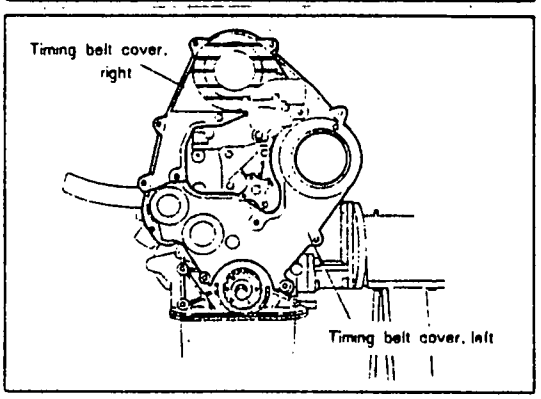
6. Tighten the timing belt tensioner lock bolt.

Timing belt tensioner tightening torque:
3.2 ~ 4.7 m-kg (23 ~ 34 ft-lb)



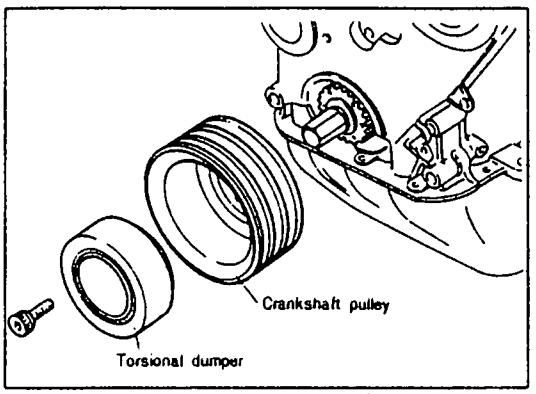
7. Recheck the timing marks on the crankshaft, camshaft pulley and injection pump pulley.
8. Check the timing belt tension.

Standard timing belt deflection:
10.8 ~ 12.9 mm (0.43 ~ 0.51 in)/10kg (22lb)



9. Install the left and right timing belt covers.

Timing belt cover tightening torque:
0.7 ~ 1.0 m-kg (5 ~ 7 ft-lb)

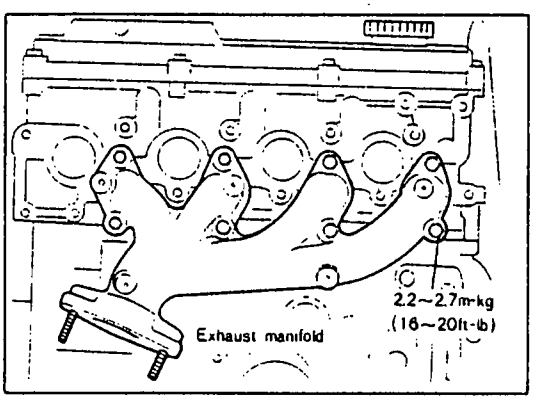


Crankshaft pulley and torsional dumper

1. Install the crankshaft pulley and the torsional dumper with the semi circular (woodruff) key.

Crankshaft pulley tightening torque:
2.3 ~ 3.3 m-kg (17 ~ 24 ft-lb)

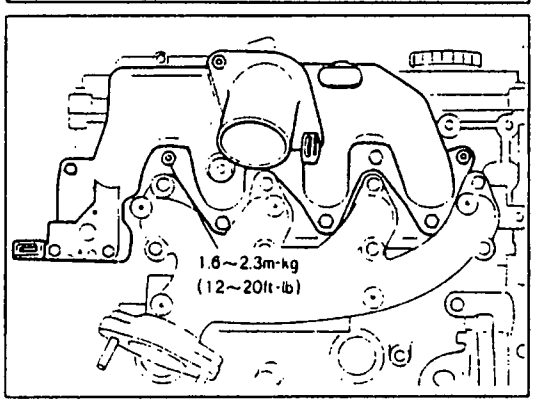
Note
Align the torsional dumper with the knock pin on the timing belt pulley.



Exhaust and intake manifold

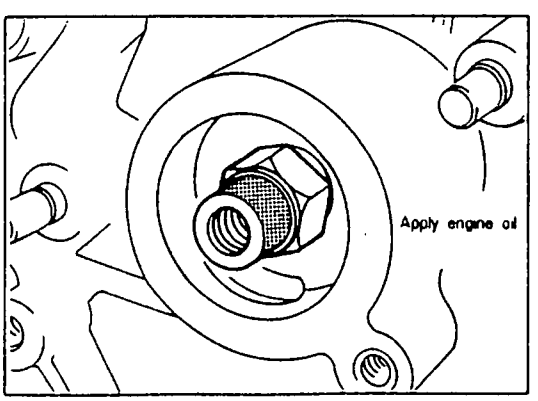
1. Place the exhaust manifold gasket in position.
2. Install the exhaust manifold, tighten it to the specified torque.

Exhaust manifold tightening torque:
2.2 ~ 2.7 m-kg (16 ~ 20 ft-lb)



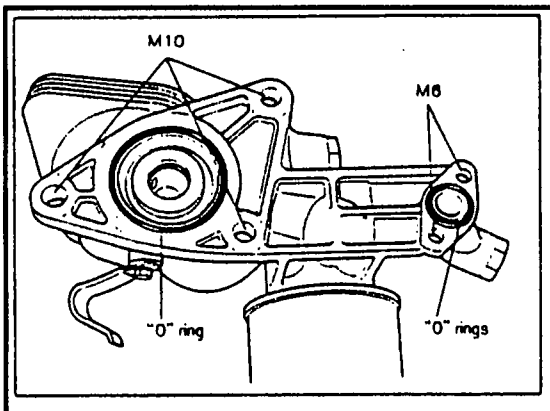
3. Install the intake manifold and gasket, and tighten it to the specified torque, then install the hot air duct to the exhaust manifold.

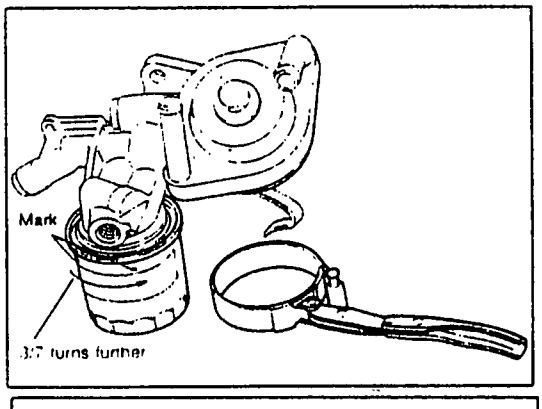
Intake manifold tightening torque:
1.6 ~ 2.7 m-kg (12 ~ 20 ft-lb)

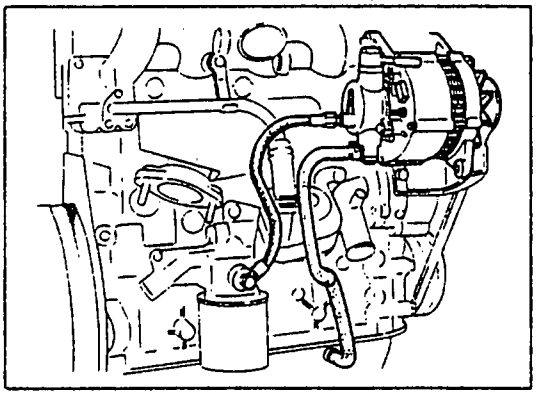


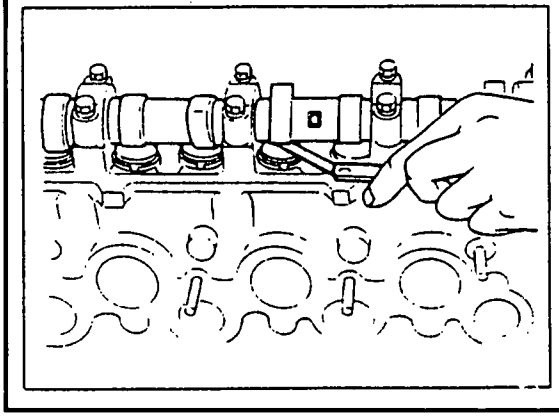
Oil cooler and oil filter assembly

1. Apply a coating of engine oil to the shaded area in the figure.









2. Install three new "O" rings, and apply a coating of engine oil to them.
3. Install the oil cooler assembly, and tighten it to the specified torque.

Oil cooler assembly tightening torque:
M10 (Bigger):
3.2 ~ 4.7 m-kg (23 ~ 34 ft-lb)
M6 (Smaller):
0.7 ~ 1.0 m-kg (5 ~ 7 ft-lb)

4. Install the water hose with a new gasket.

Water hose tightening torque:
Bracket: 1.9 ~ 2.6 m-kg (14 ~ 19 ft-lb)
Flange: 0.8 ~ 1.1 m-kg (5.8 ~ 8.0 ft-lb)

5. Install the oil filter.

Caution
When the oil filter is installed apply a coating of engine oil to the filter's O-ring.
After completely tightening the oil filter with one hand, then use a wrench to tighten it 3/7 of a turn further.
The wrench used to further tighten the filter in the step above must be a band-type wrench which will not damage the filter.

Alternator

1. Install the alternator bracket, and tighten it to the specified torque.

Alternator bracket tightening torque:
3.2 ~ 4.7 m-kg (23 ~ 34 ft-lb)

2. Install the alternator and drive belt.

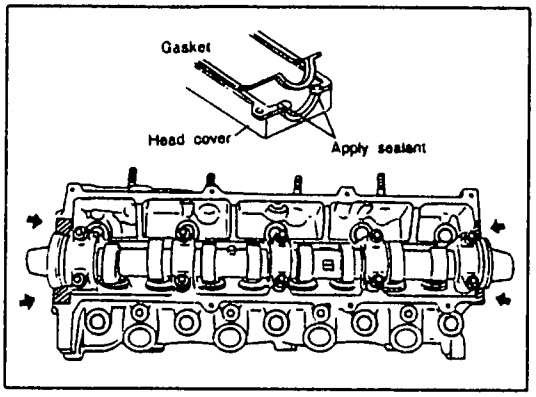
Standard alternator drive belt deflection:
New 11 ~ 12 mm (0.44 ~ 0.47 in)/10 kg (22lb)
Used 12 ~ 14 mm (0.47 ~ 0.55 in)/10kg (22lb)

3. Connect the vacuum pump oil hoses.

Vacuum pump oil hose tightening torque:
1.2 ~ 1.8 m-kg (9 ~ 13 ft-lb)

Valve clearance adjustment

1. Measure the valve clearance and adjust it, if necessary.
(Refer to page 1B-9)

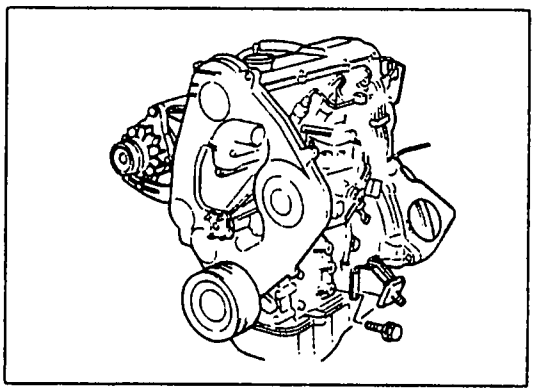


Cylinder head cover

1. Apply sealant to the shaded area.
2. Install the cylinder head cover, and tighten it to the specified torque.

   Cylinder head cover tightening torque:
   0.7 ~ 1.0 m-kg (5 ~ 7 ft-lb)

3. Install the PCV hose.
4. Remove the engine from the **engine hanger** (49 G030 005).

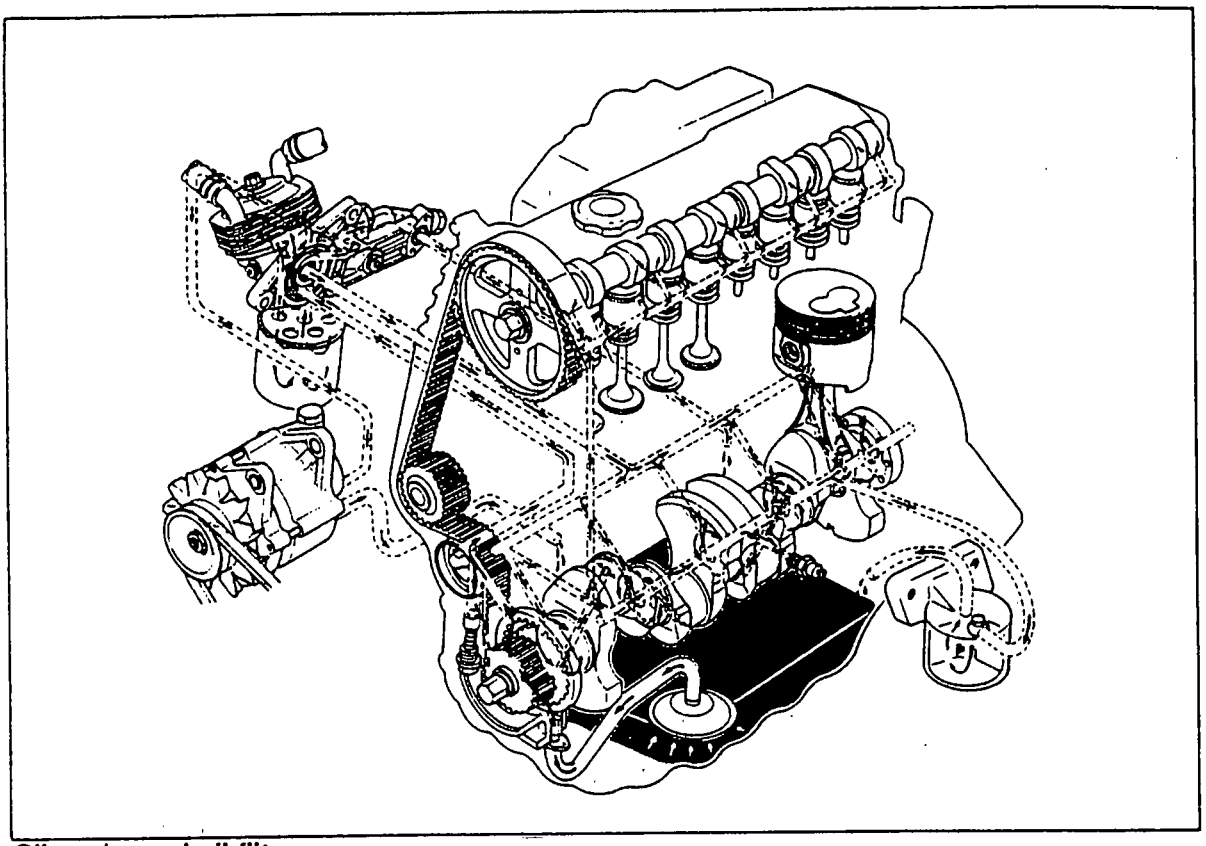


Engine mount

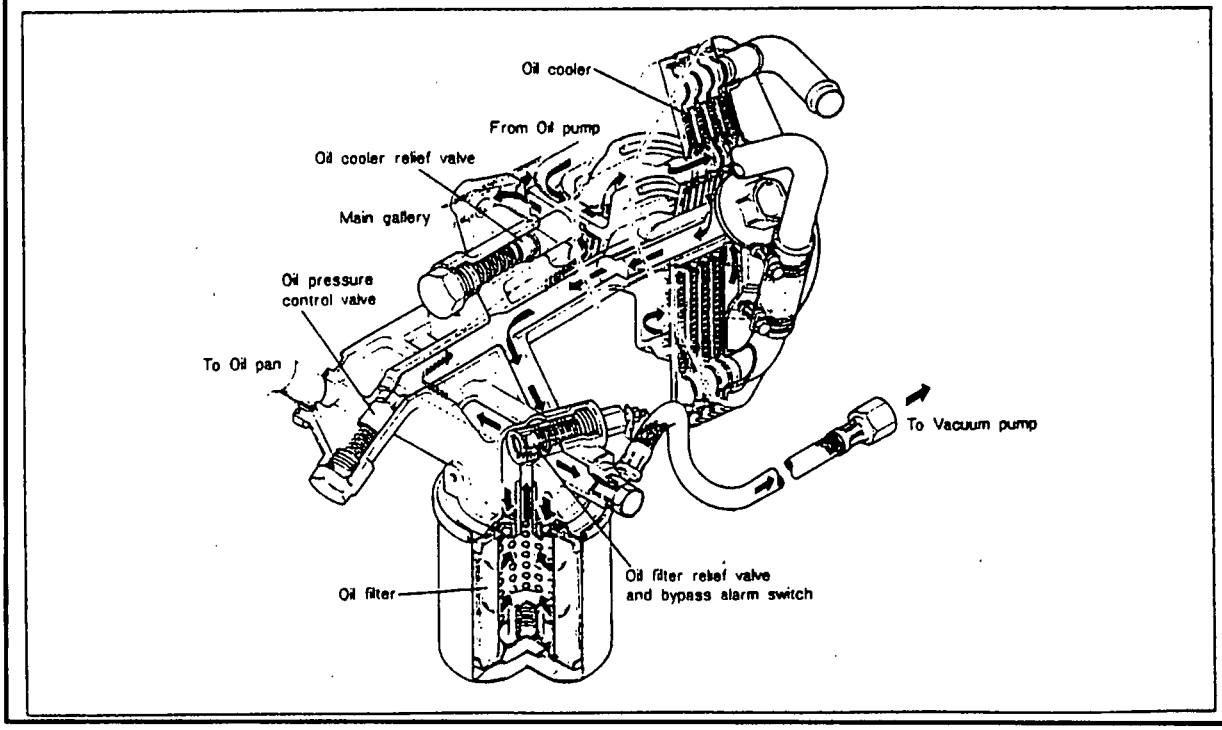
1. Install the engine mount and tighten it to specified torque.

   Engine mount tightening torque:
   3.2 ~ 4.7 m-kg (23 ~ 34 ft-lb)

Diesel Engine



Oil cooler and oil filter



LUBRICATION SYSTEM

LUBRICATING SYSTEM	FORCE FED TYPE
OIL PUMP TYPE	CRECENT INNER GEAR TYPE
OIL PRESSURE CONT. VALVE OPENING PRESSURE	8.0 kg/cm^2 (114 lb/in.^{2})
OIL FILTER TYPE	FULL FLOW TYPE, PAPER FILTER
OIL FILTER RELIEF VALVE OPENING PRESSURE	1.0 kg/cm^2 (14 lb/in.^{2})
OIL BYPASS FILTER TYPE	FULL FLOW TYPE, PAPER FILTER
OIL COOLER TYPE	WATER COOLED TYPE
OIL PRESSURE CONTROL VALVE OPENING PRESSURE	4.5 kg/cm^2 (64 lb/in.^{2})
OIL FILTER RELIEF VALVE OPENING PRESSURE	DIFFERENT PRESSURE 1.0 kg/cm^2 (14 lb/in.^{2})
OIL COOLER RELIEF VALVE OPENING PRESSURE	DIFFERENT PRESSURE 2.0 kg/cm^2 (28 lb/in.^{2})
BYPASS ALARM SWITCH ACTIVATION PRESSURE	DIFFERENT PRESSURE 0.3 kg/cm^2 (4.3 lb/in.^{2})
OIL WARNING LAMP ACTIVATION PRESSURE	0.3 kg/cm^2 (4.3 lb/in.^{2})
TOTAL OIL CAPACITY OIL PAN CAPACITY OIL FILTER CAPACITY OIL BYPASS FILTER CAPACITY	6.4 LITERS (6.76 U.S. QUARTS 5.0 LITERS (5.28 U.S. QUARTS) 0.4 LITERS (0.42 U.S. QUARTS) 0.4 LITERS (0.42 U.S. QUARTS)
ENGINE OIL	API SERVICE CC AND CD

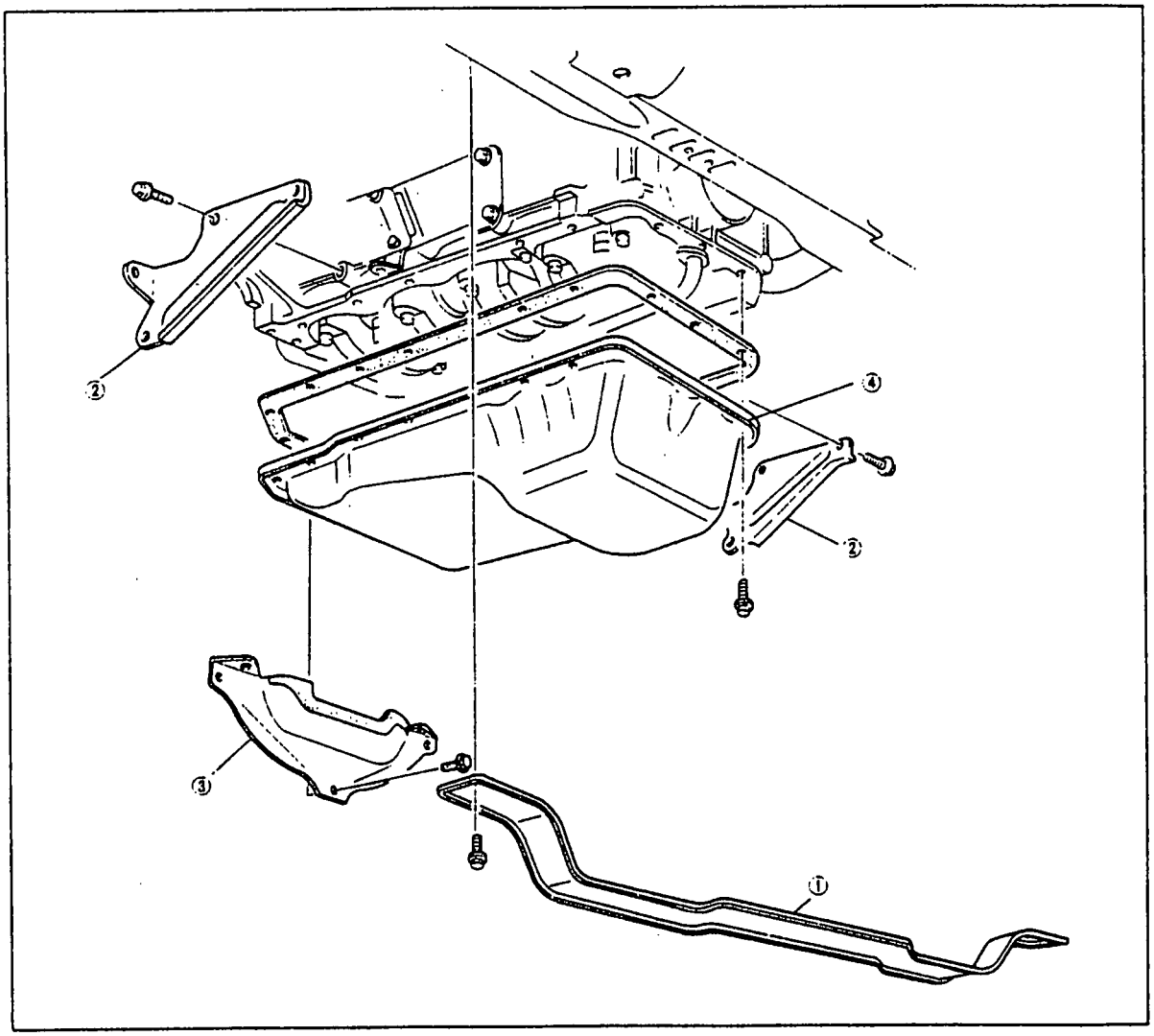
OIL PAN

REMOVAL AND INSTALLATION

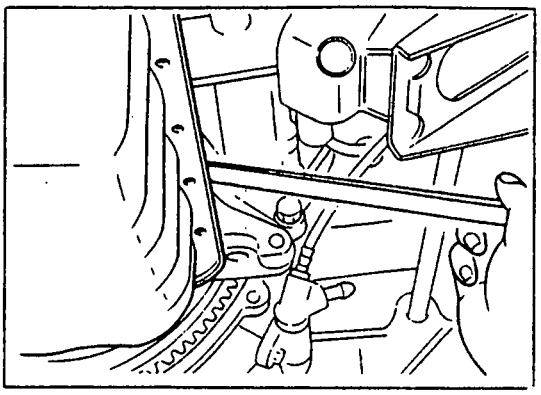
Jack up the vehicle and use safety stands to support it. Disconnect the battery negative cable(s). After draining the engine oil, remove the parts in the numbered order shown in the figure. Installation order is the reverse order of removal.

Note

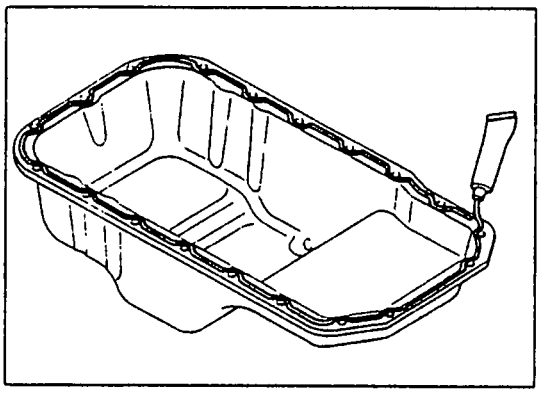
The figure below shows the gasoline-powered vehicle.



1. Under cover
2. Gusset plates
3. Dust cover
4. Oil pan

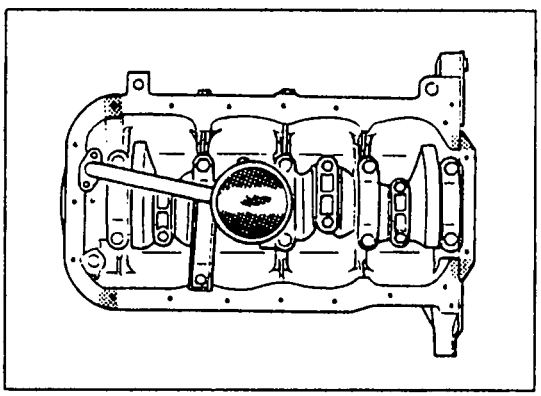


Oil pan
Insert a flat-tipped scraper between the oil pan and the cylinder block to separate them and remove the oil pan.

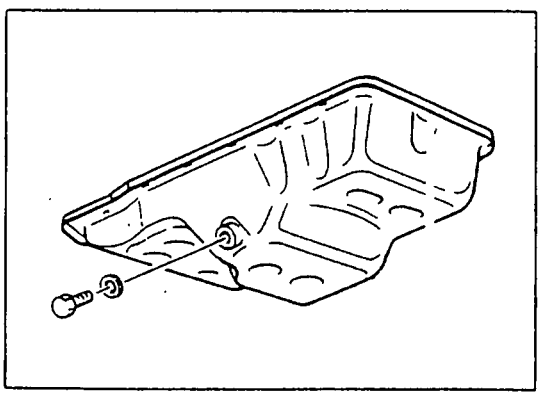


After cleaning the surfaces where the oil pan and the cylinder block meet, apply sealant (8527 77 739, or equivalent) to the oil pan, as shown in the figure, and then install the oil pan.

Note
Tighten the oil pan bolts within 30 minutes after application of the sealant.



If a gasket is used, apply sealant (8527 77 739, or equivalent) to the places indicated by the arrows in the figure after first cleaning the surface where the oil pan meets the cylinder block.

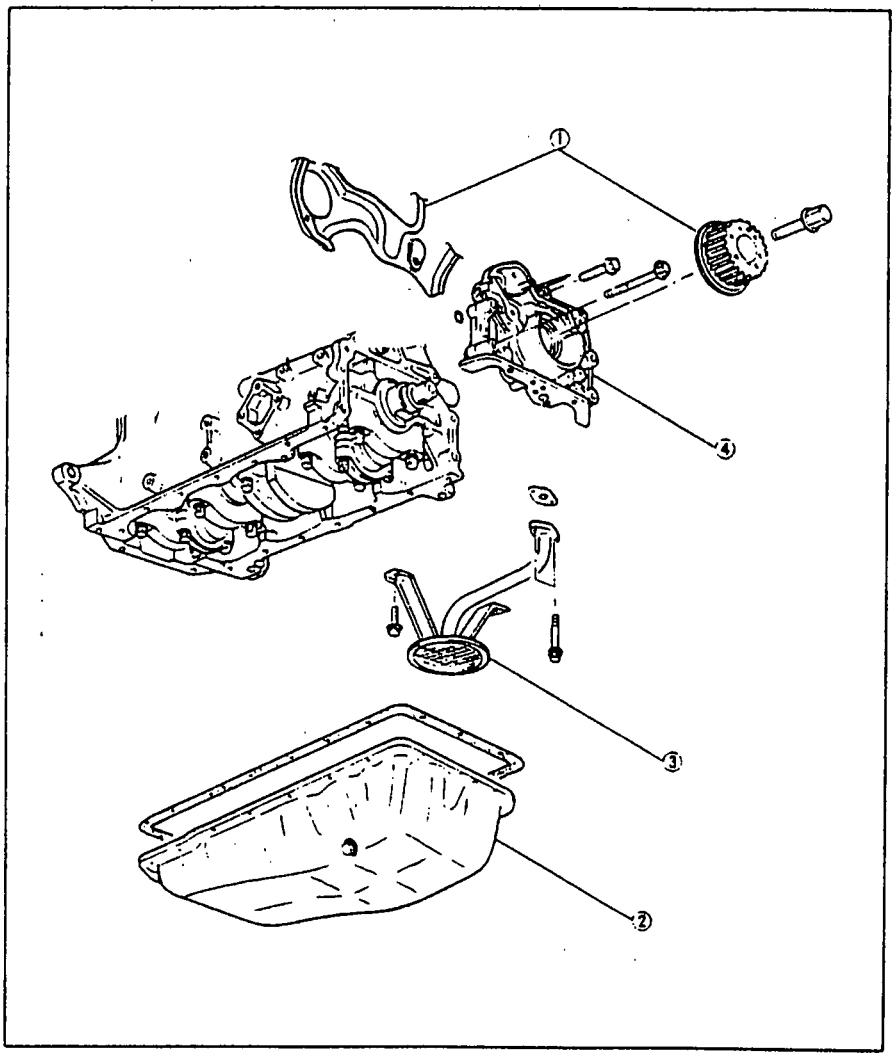


INSPECTION
Check the following points. Repair or replace if necessary.
1. Cracks, deformation, damage (at bolt locations)
2. Damaged drain plug threads

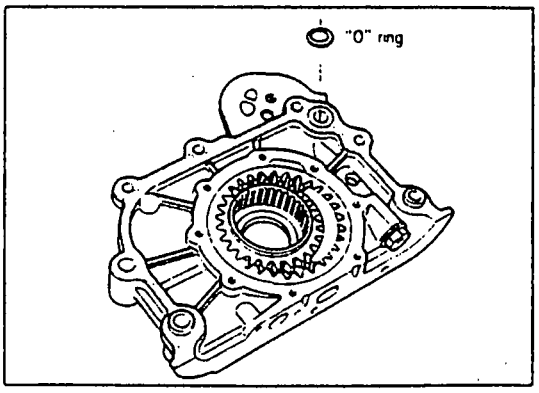
OIL PUMP

REMOVAL AND INSTALLATION

Jack up the vehicle and support it with safety stands. Disconnect the battery negative cable. After draining the engine oil, remove the parts in the numbered order shown in the figure. Installation is the reverse order of removal.



1. [Gasoline engine]
   Timing belt pulley
   (Refer to Section 1A)
   [Diesel engine]
   Timing belt pulley
   Camshaft pulley
   Injection pump pulley
   Seal plate
   (Refer to Section 1B)
2. Oil pan
   (Refer to page 2–9)
3. Oil strainer
4. Oil pump



Oil pump

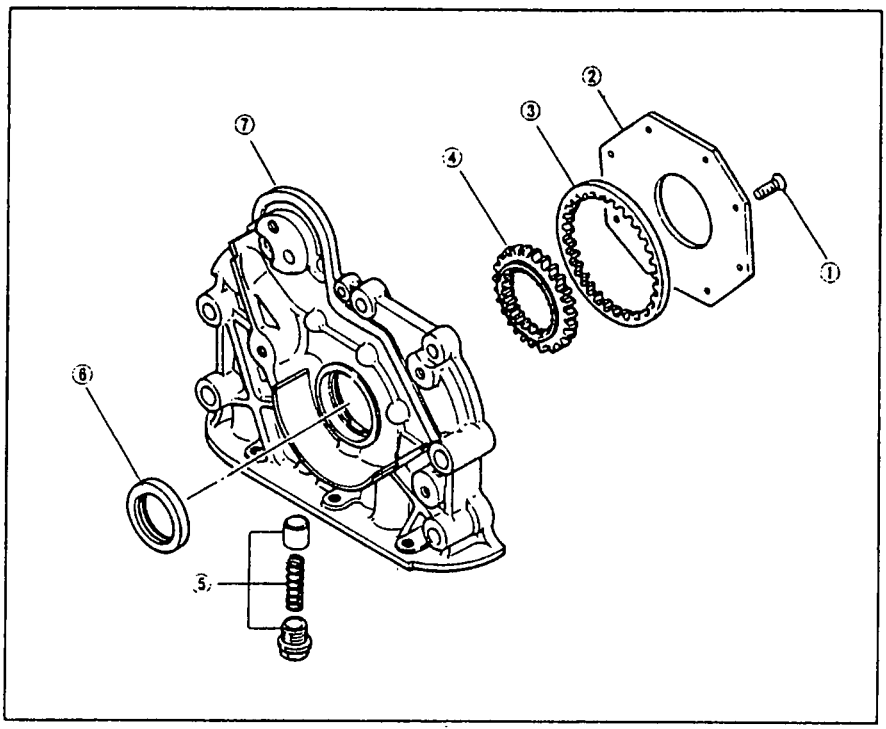
1. Apply a thin coating of grease to the O-ring, and attach it at the position shown in the figure.
2. Apply a coat of sealant (1016 77 739, or equivalent) to the oil pump installation surface shown in the figure.

   Note
   Be careful not to let sealant get into the oil hole.

3. Coat the oil seal lip with engine oil, and then install the seal, taking care not to damage the lip.

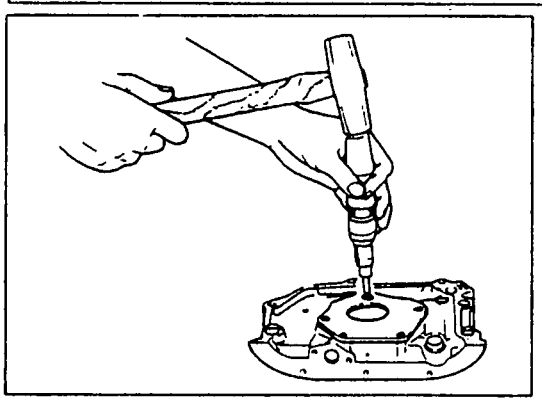
DISASSEMBLY AND ASSEMBLY

Disassemble the oil pump in the numbered order shown in the figure. Assembly is the reverse order of disassembly.



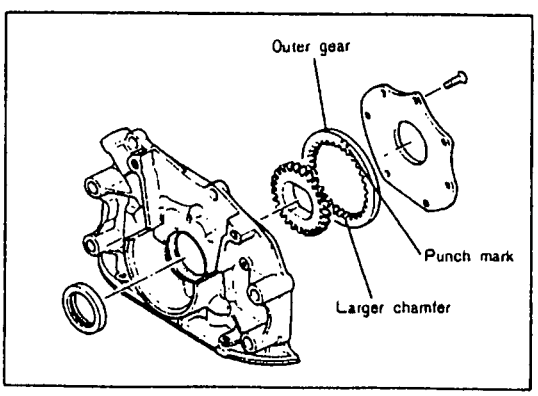
1. Screws
2. Oil pump cover
3. Outer gear
4. Inner gear
5. Oil pressure control valve assembly
6. Oil seal
7. Oil pump body

Note
The figure on the left snows the diesel engine oil pump.



Screws

Loosen the screws by a impact driver or like tool so that the oil pump body is not damaged..

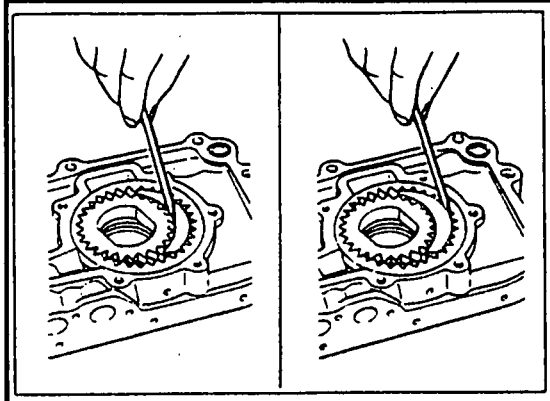


Punch mark on the outer gear

(Gasoline engine)
Install the outer gear with the mark indicated by the punch holes facing toward the **oil pump body.**
(Diesel engine)
Install the outer gear with the mark indicated by the punch holes facing toward the **oil pump cover.**

Note
The figure on the left shows the gasoline engine oil pump.

OIL PUMP

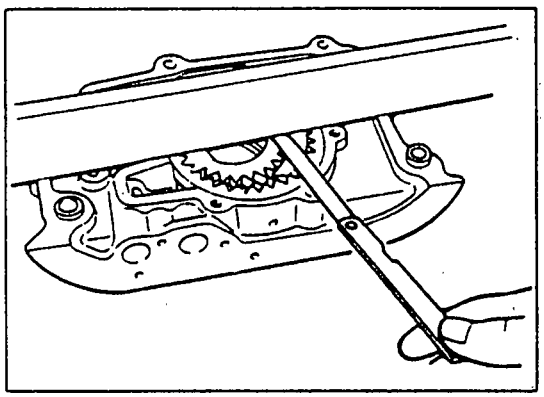


INSPECTION

Check the following points. Repair or replace if necessary.

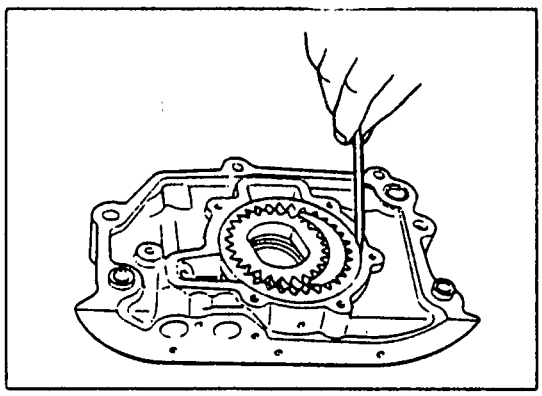
1. Distortion or damage to pump body or cover
2. Worn or damaged plunger
3. Weak or broken plunger spring
4. Measure gear clearances.

Outer gear tooth tip and crescent clearance limit:		0.35 mm (0.013 in)
Inner gear tooth tip and crescent clearance limit:	Gasoline engine	0.40 mm (0.016 in)
	Diesel engine	0.35 mm (0.013 in)



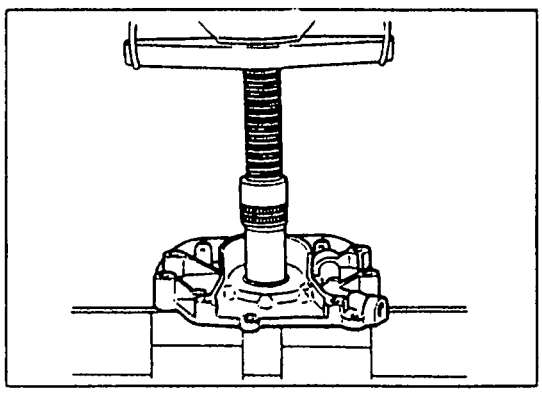
5. Measure the side clearance.

Limit	Gasoline engine	0.10 mm (0.004 in)
	Diesel engine	0.15 mm (0.006 in)



6. Measure the body clearance.

Outer gear to pump body clearance limit	0.20 mm (0.008 in)



Oil seal replacement

1. Removal
   Remove the oil seal by using a screwdriver or similar tool to pry it out.
2. Installation
   Press in the oil seal by using a pipe or round rod with an outer diameter of 45 mm (1.77in).

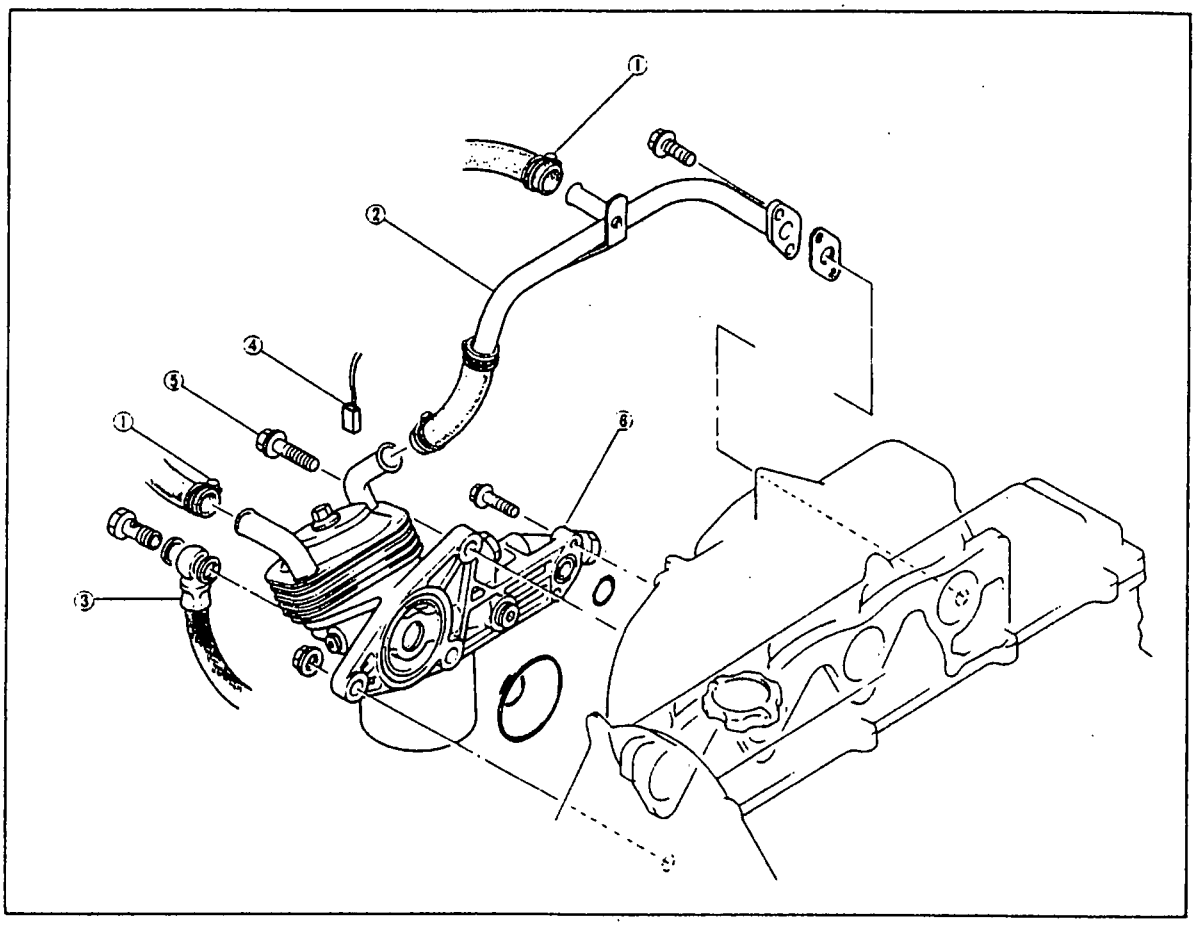
Caution

Press the oil seal in until the front end is aligned with the front end of the pump body.

OIL COOLER (FOR DIESEL ENGINE)

REMOVAL AND INSTALLATION

Disconnect battery negative cable(s). Drain coolant into a suitable container. Remove each part in the numbered sequence shown in the figure. Installation is in reverse order of removal.



1. Coolant hoses
2. Oil cooler pipe
3. Vacuum pump oil hose
4. Bypass alarm switch connector
5. Oil cooler and oil filter assembly attaching bolts and nuts
6. Oil cooler and oil filter assembly

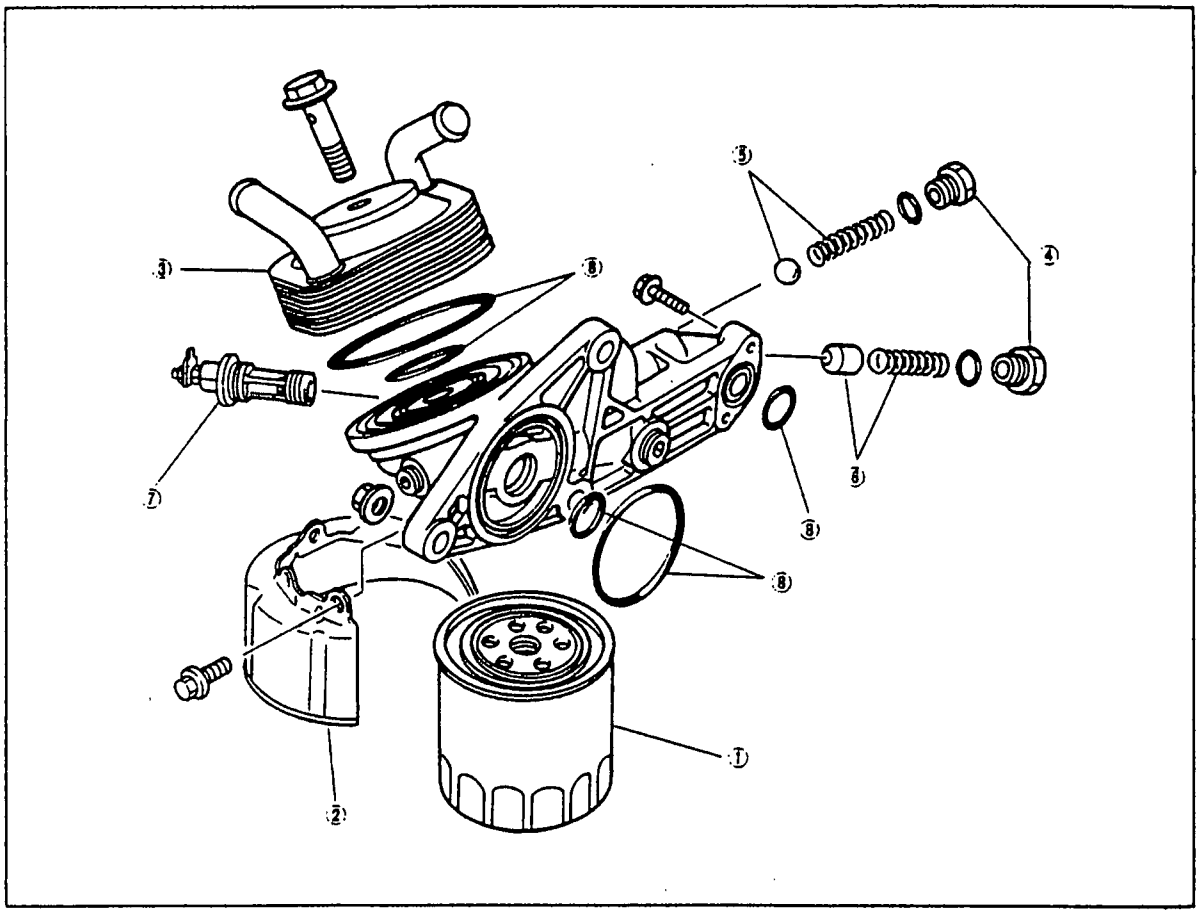
OIL COOLER

DISASSEMBLY AND ASSEMBLY

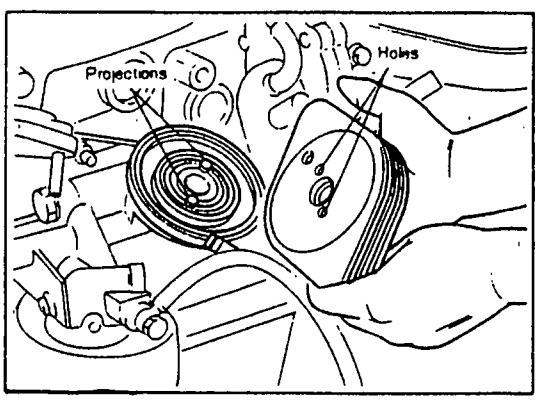
Disassemble each part in the numbered sequence shown in the figure. Assembly is in reverse order of disassembly.

Caution

O-rings must be replaced with new ones, and apply engine oil to the new O-rings.

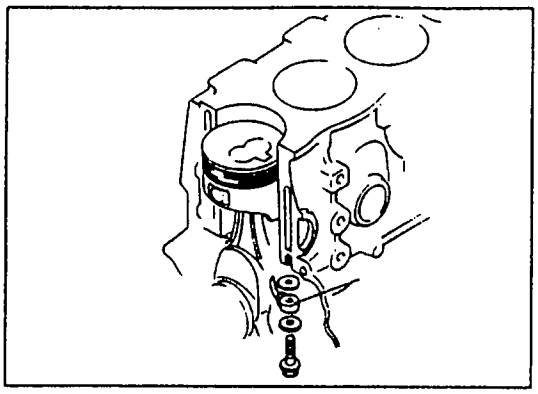


1. Oil filter
2. Oil filter cover
3. Oil cooler
4. Plugs
5. Oil cooler relief valve
6. Oil pressure control valve
7. Oil filter relief valve and bypass alarm switch
8. O-rings



Oil cooler

When installing the oil cooler, align the oil cooler holes and the projections of the oil filter body.

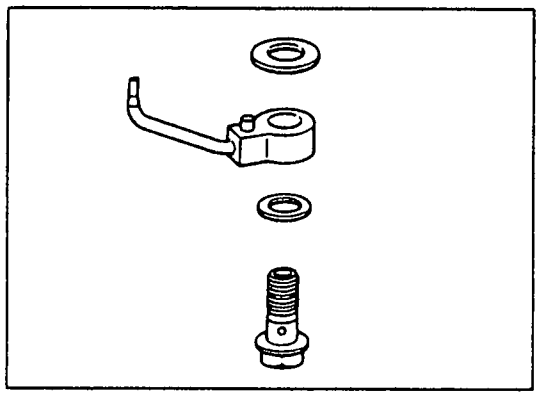


OIL JET (FOR DIESEL ENGINE)

REMOVAL AND INSTALLATION

Remove each part in the following order. Installation is in reverse order of removal.

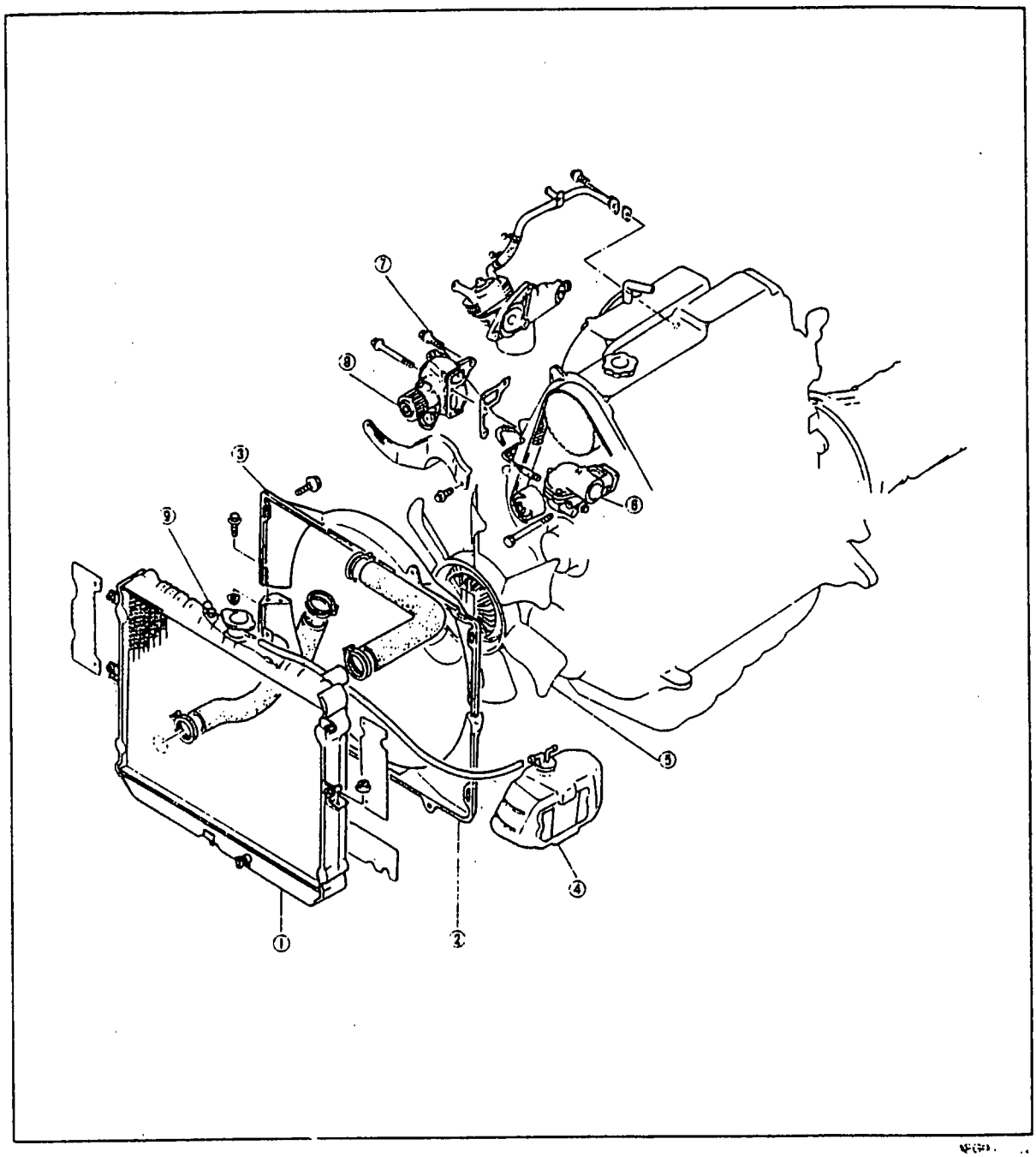
1. Remove the oil pan. (Refer to page 2–9).
2. Remove the oil jet valves.
3. Remove the oil jets.



INSPECTION

1. Make sure that the oil passage is not clogged.
2. Check and ensure that the spring incorporated in the oil jet valve is not stuck or damaged.

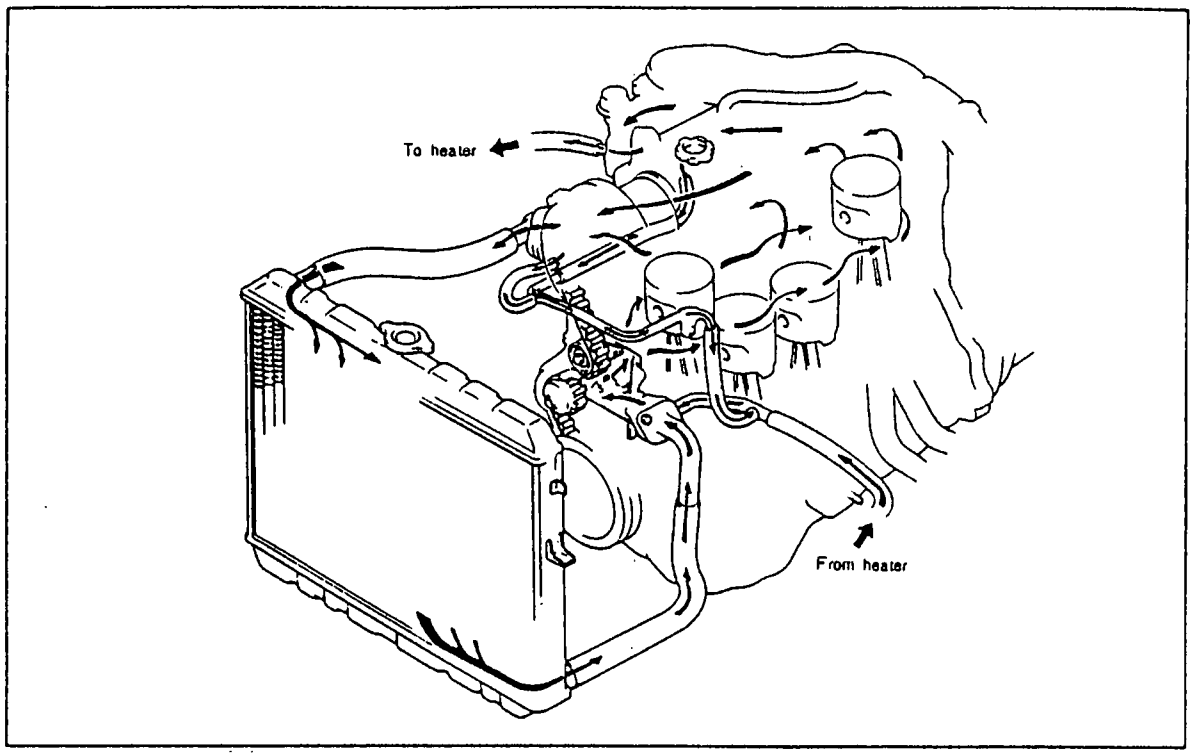
Diesel Engine



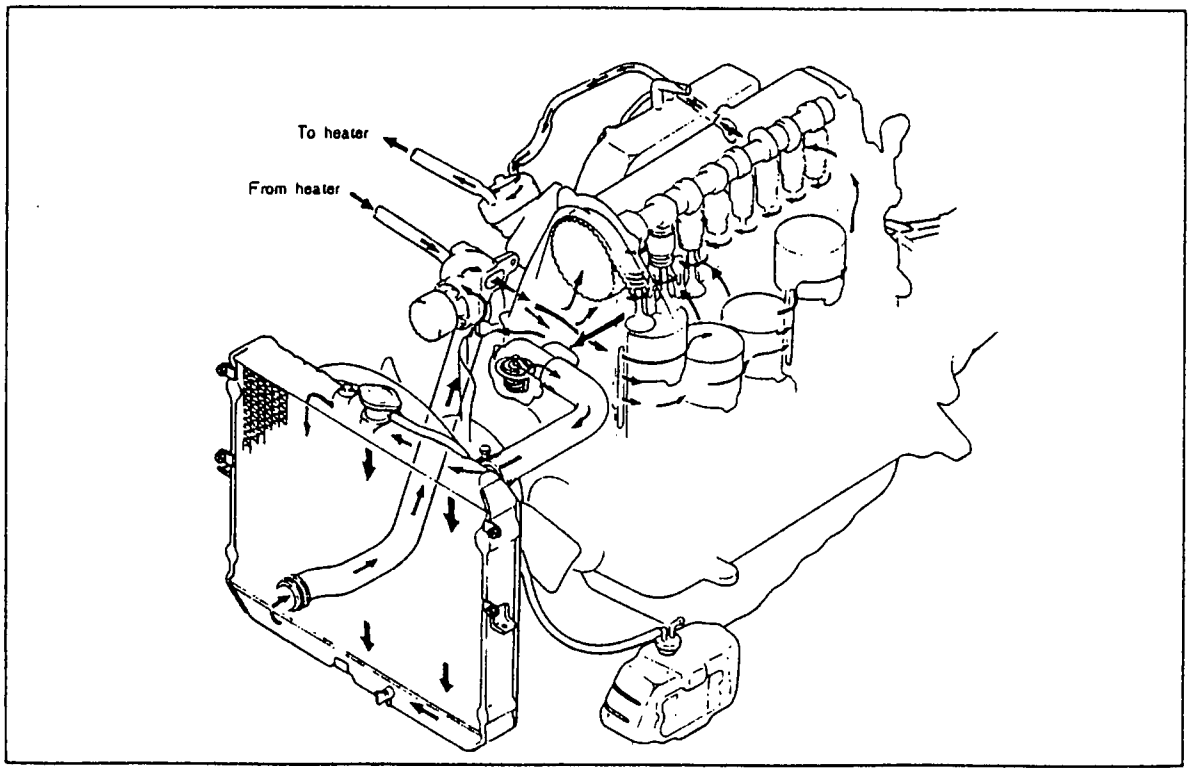
1. Radiator
2. Cooling fan shroud, lower
3. Cooling fan cover, upper
4. Coolant reservoir
5. Cooling fan
6. Thermostat
7. Coolant bypass hose
8. Water pump
9. Coolant level sensor

COOLING SYSTEM FLOWCHART

Gasoline Engine



Diesel Engine

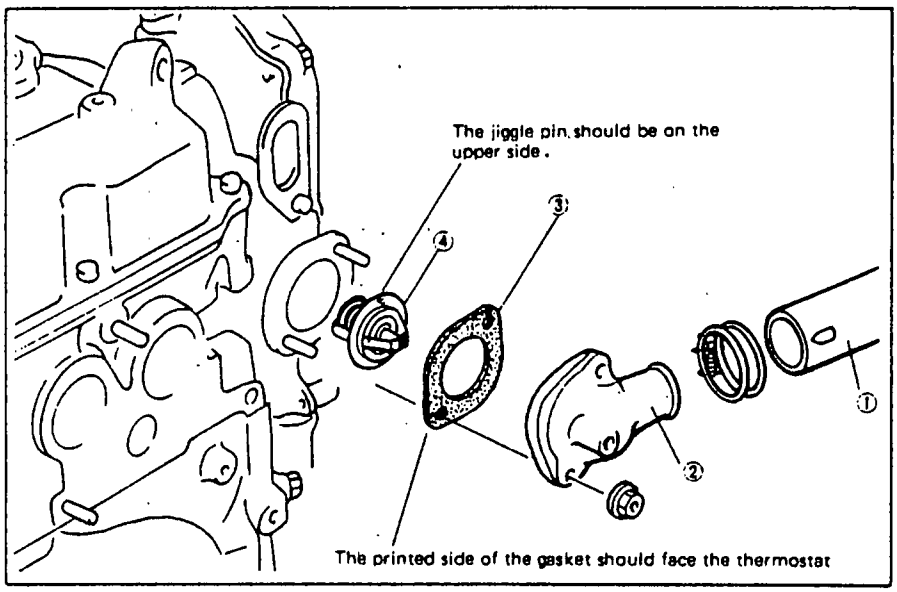


THERMOSTAT R&R

REMOVAL AND INSTALLATION

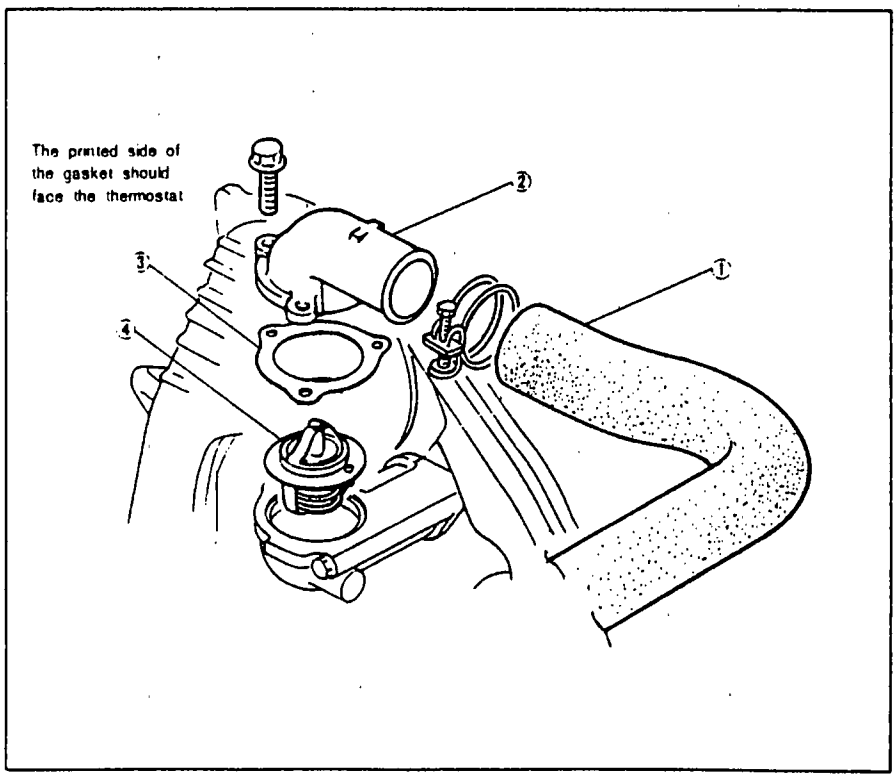
After draining the coolant, remove the parts in the numbered order shown in the figure. Installation is the reverse order of removal.

Gasoline Engine



1. Radiator hose, upper
2. Thermostat cover
3. Gasket
4. Thermostat

Diesel Engine

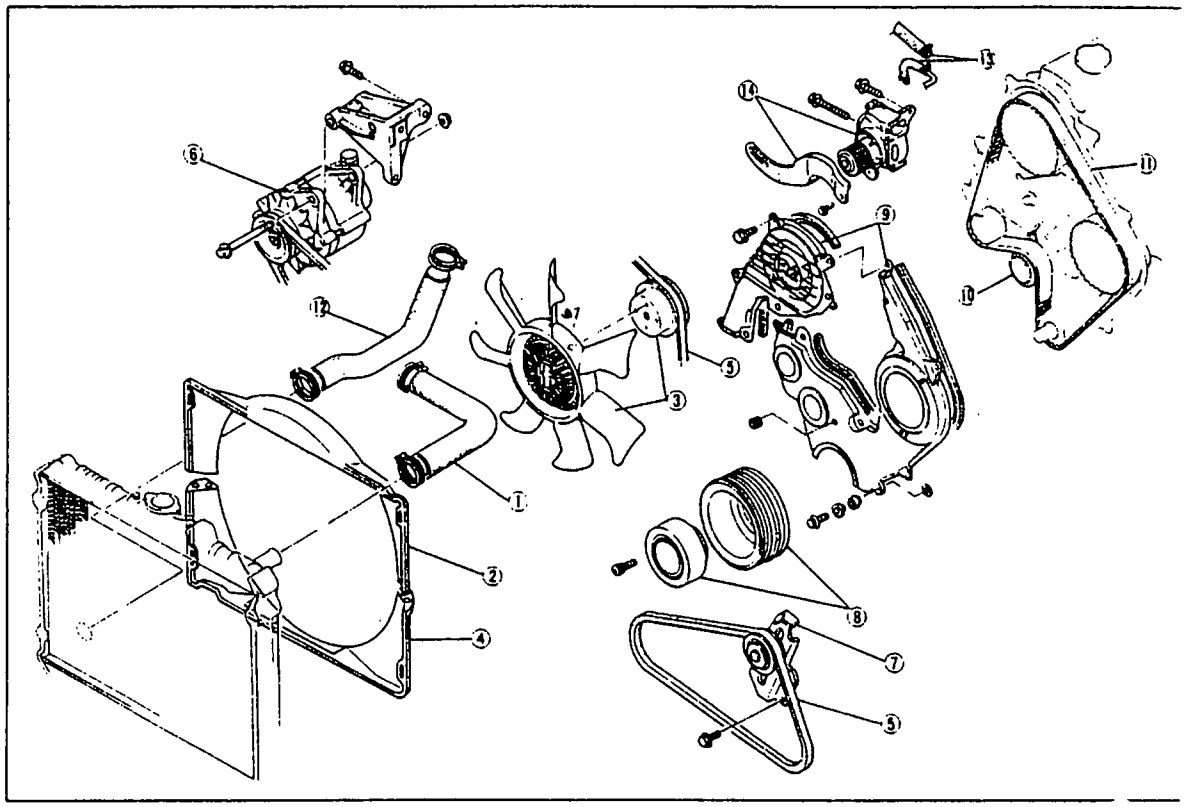


1. Radiator hose, upper
2. Thermostat cover
3. Gasket
4. Thermostat

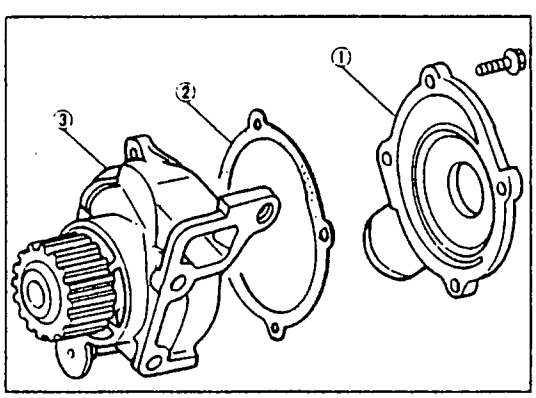
WATER PUMP R&R

REMOVAL AND INSTALLATION

Turn the crankshaft so that the No. 1 cylinder is at top dead center of compression. Referring to Section 1B, remove the seat and parking brake frame.
Drain engine coolant into a suitable container.
Remove each part in the numbered sequence shown in the figure.
Installation is in reverse order of removal.



1. Radiator hose, upper
2. Cooling fan shroud, upper
3. Cooling fan and pulley
4. Cooling fan shroud, lower
5. Alternator and air conditioner compressor drive belts
6. Alternator
7. Air conditioner compressor drive belt tensioner
8. Crankshaft pulley
9. Timing belt cover, upper and lower
10. Timing belt tensioner and spring
11. Timing belt (Refer to Section 1B)
12. Radiator hose, lower
13. Heater and coolant bypass hoses
14. Water pump and alternator strap



DISASSEMBLY AND ASSEMBLY

Disassemble each part in the numbered sequence shown in the figure.
Assembly is in reverse order of disassembly.

1. Water pump cover
2. Gasket
3. Water pump body

Caution
Don't disassemble the water pump body Replace it with an assembly if necessary.

INJECTION PUMP SPECIFICATIONS

NJECTION PUMP MANUFACTURER	DIESEL KIKI CO. LTD
INJECTION PUMP TYPE	VE TYPE
INJECTION TIMING	BTDC 2^{O} AT CAM 1 mm LIFT
INJECTION PUMP CAM LIFT	2.2 mm (0.0866in.)
DIRECTION OF ROTATION	CLOCK-WISE
IDLE SPEED	700-750 RPM
DRIVE TYPE	TIMING BELT
INJECTION NOZZLE TYPE	THROTTLE TYPE
ORIFICE DIAMETER X NUMBER	1.0 mm (0.039 in.) X 1
INJECTION PRESSURE	135 kg/cm^2
SEDIMENTOR	WITH DETECTOR
AIR CLEANER	FILTER, PAPER ELEMENT TYPE
FUEL FILTER	CARTRIDGE TYPE

TROUBLESHOOTING GUIDE

Problem	Probable Cause	Remedy
Hard starting	Clogged fuel filter	Replace
	Air in fuel filter	Air-bleed
	Faulty fuel cut valve	Replace
	Faulty injection timing	Adjust
	Air in injection pump	Air-bleed
	Trouble inside of injection pump	Replace
	Seized needle valve of injection nozzle	Clean or replace
	Fuel dripping from injection nozzle	Replace
	Faulty injection starting pressure	Adjust
	Faulty cold start device	Adjust or replace
Rough idling	Clogged fuel filter	Replace
	Air in fuel filter	Air-bleed
	Faulty fuel cut valve	Replace
	Faulty injection timing	Adjust
	Air in injection pump	Air-bleed
	Trouble inside of injection pump	Replace
	Seized needle valve of injection nozzle	Clean or replace
	Faulty injection starting pressure	Adjust
	Improper mounting to nozzle holder	Disassemble and assemble or replace
	Leakage of gasket	Replace
	Crack of injection pipe	Replace
	Leaking from injection pipe joint	Retighten or replace
	Improper idling speed	Adjust
Engine knocking	Faulty injection timing	Adjust
	Low quality of fuel	Replace
	Faulty injection starting pressure	Adjust
	Seized needle valve of injection nozzle	Clean or replace
	Fuel dripping from injection nozzle	Replace
High fuel consumption	Faulty injection timing	Adjust
	High idling speed	Adjust
	Faulty injection starting pressure	Adjust
	Fuel dripping from injection nozzle	Replace
	Leakage of gasket	Replace
	Leaking from injection pipe joint	Retighten or replace
	Clogged fuel filter	Replace
	Clogged air cleaner	Clean or replace
Poor acceleration	Clogged air cleaner	Clean or replace
	Seized needle valve of injection nozzle	Clean or replace
	Fuel dripping from injection nozzle	Replace
	Faulty fuel cut valve	Replace
	Faulty injection timing	Adjust
	Air in injection pump	Air-bleed
	Trouble inside of pump	Replace
	Crack of injection pipe	Replace
	Leaking from injection pipe joint	Retighten or replace
	Air in fuel filter	Air-bleed
	Clogged fuel filter	Replace
Excessive exhaust smoke	Clogged air cleaner	Clean or replace
	Improper injection timing	Adjust
	Faulty injection nozzle	Adjust or replace

INJECTION PUMP

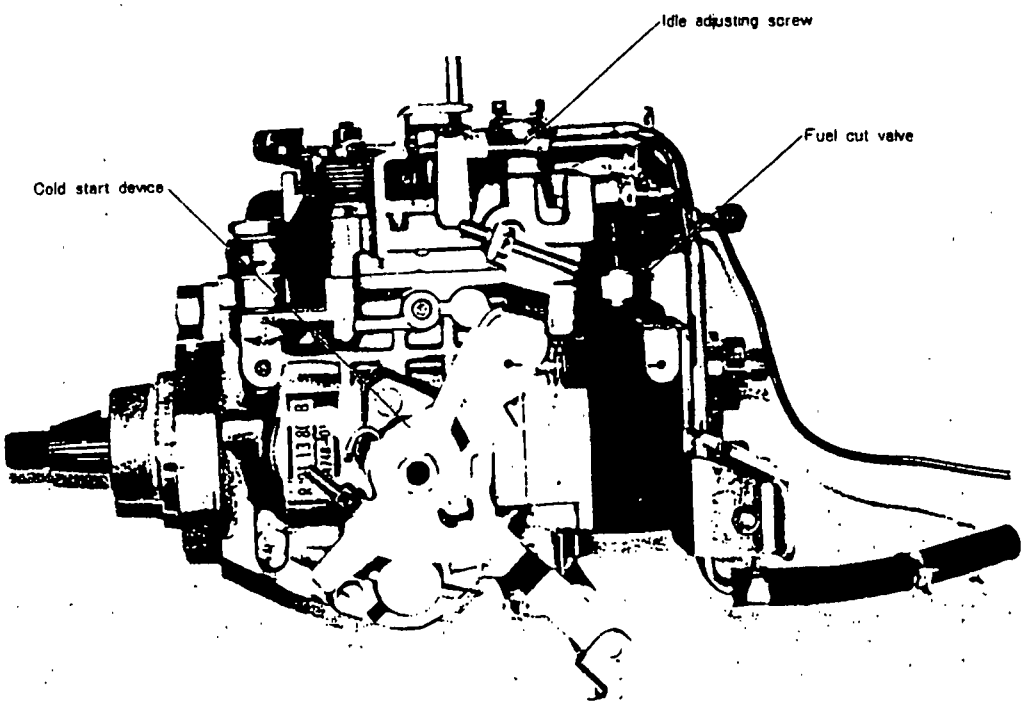
IMPORTANT SERVICE POINT

If the inside of the injection pump is disassembled for maintenance, be sure to properly use the checking device such as the injection pump tester, and carefully inspect each component.

For the disassembling/reassembling, checking and adjusting procedures for the injection pump itself, see the service manual, "Repair Service and Maintenance", prepared by the manufacturer of the injection pump.

Manufacturer of Injection Pump:
Diesel Kiki Co., Ltd.

CONSTRUCTION OF VE INJECTION PUMP



VE-TYPE R201-13-8008 : 104748-0151 For E2200

☆ TEST OIL SAE Standard test oil (SEA 967C)

Fuel injection amount

Item	Pump speed (R.P.M.)	Fuel injection amount (cm^3/stroke)
Start	100	More than 42/1000
Full load	500	30.7 ~ 34.7/1000
	1250	36.0 ~ 40.0/1000
	1500	37.7 ~ 39.7/1000
	2125	32.0 ~ 36.0/1000
	2300	20.1 ~ 26.1/1000
	2400	10.1 ~ 16.1/1000
	2550	Less than 4.0/1000
Idling	350	6.0 ~ 10.0/1000

Chamber pressure and timer stroke

Pump speed (R.P.M.)	Chamber pressure (kg/cm^2)	Timer stroke (mm)
500	2.7 ~ 3.3	———
1250	4.9 ~ 5.5	3.6 ~ 4.2
1500	———	4.6 ~ 5.8
2125	7.3 ~ 7.9	8.2 ~ 9.4
———	———	———

Load sensing timer and overflowing quantity

Item		Fuel injection amount (cm^3/stroke)
Load sensing timer	Start	26.5 ~ 29.5/1000
	End	16.5 ~ 19.5/1000
Overflowing quantity		49.7 ~ 93.7/1000

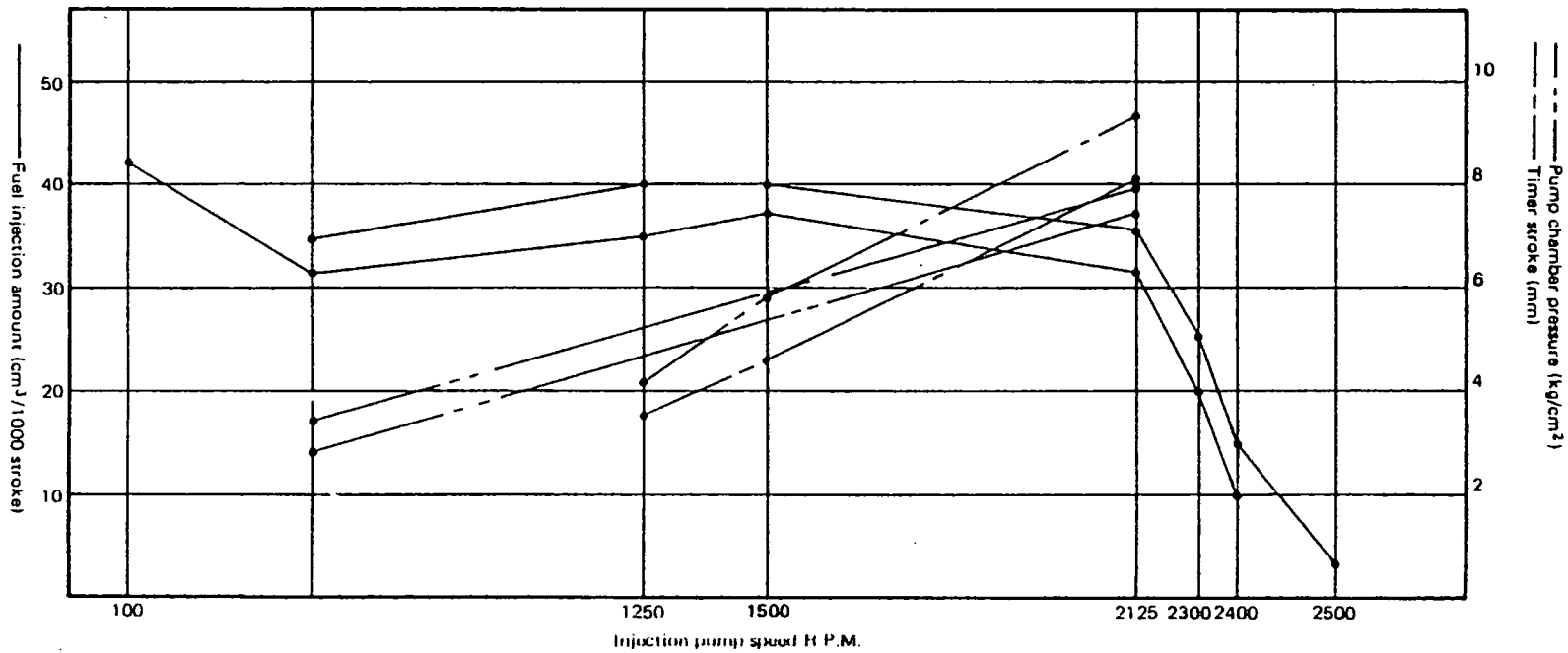
*Checking condition

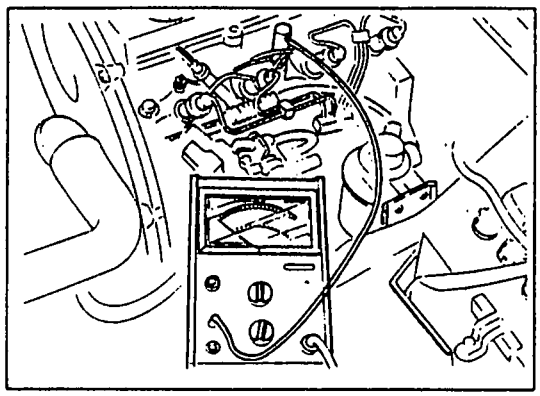
Pump speed: 1250 rpm

Lever: Full load

Measurement

Measuring place	Dimension (mm)
KF	5.7 ~ 5.9
K	3.2 ~ 3.4
MS	1.4 ~ 1.6





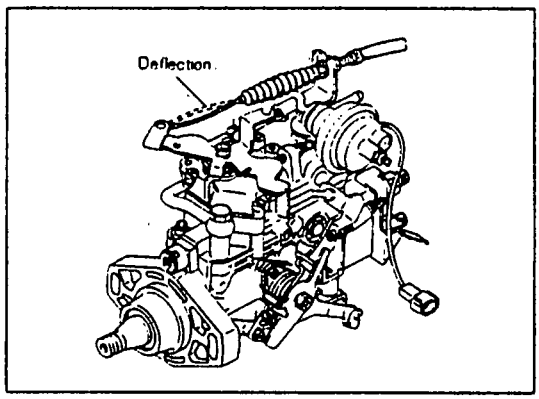
IDLING SPEED

Checking

1. Warm up the engine to normal operating temperature.
2. Attach a tachometer and check the range speed.

Idling speed: 700 ~ 750 rpm

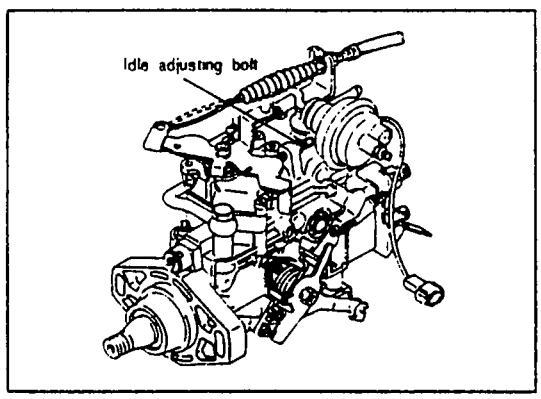
If the idling speed is not within the specified range, adjust the idling speed.



Adjusting

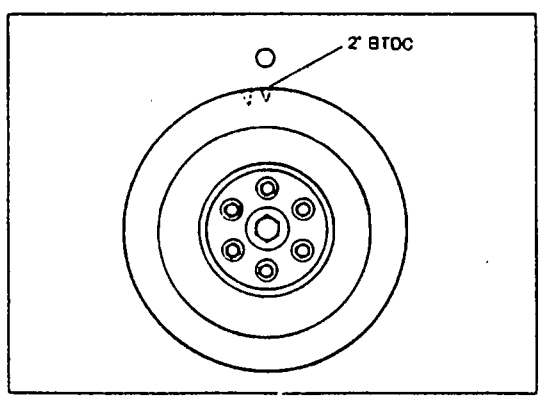
1. Confirm the accelerator cable deflection.
   If the deflection is not within the standard range, adjust it by turning accelerator cable lock nuts.

Standard deflection:
1.0 ~ 3.0 mm (0.04 ~ 0.12 in.)



2. Loosen the lock nut of the idle adjusting bolt and adjust the idling speed by turning the icle adjusting bolt.

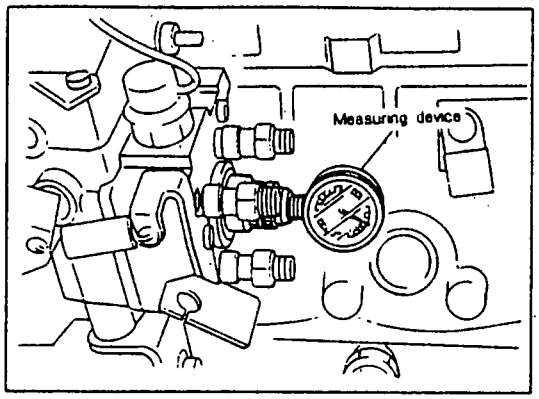
Note
Idle speed will increase when the adjusting bolt is turned clockwise and decrease when turned counter-clockwise.



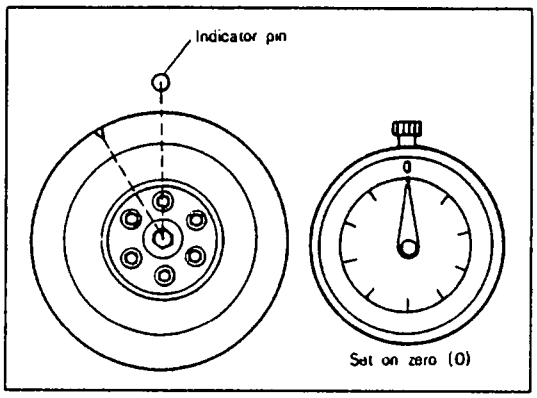
INJECTION TIMING

Checking

1. Align the timing mark (2° BTDC) on the crankshaft pulley with the indicator pin by turning the crankshaft.
2. Disconnect the injection pipes from the injection pump.

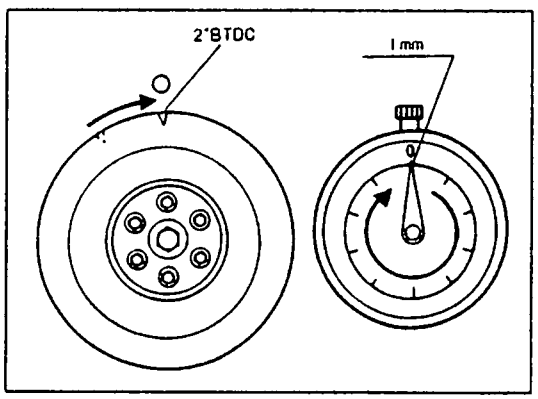


3. Remove the hydraulic head plug on the injection pump.
4. Mount the **measuring device (49 9140 074)** into the plug hole on the hydraulic head so the tip of the dial gauge pointer touches the plunger end of the pump and dial gauge indicates approx. 2.0 mm (0.08 in.).

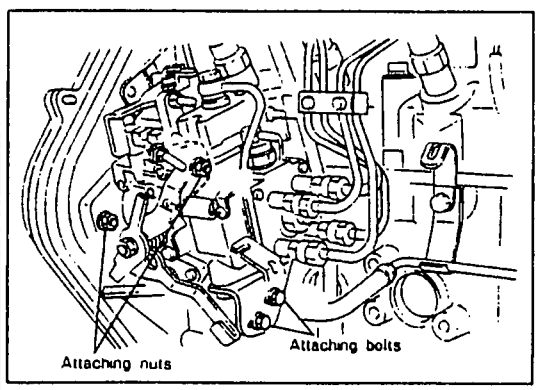


5. Turn the crankshaft pulley slowly counter-clockwise (in reverse direction of engine rotation) until the timing mark on the crankshaft pulley moves from the original position (2° BTDC) to the counter-clockwise side by 30 ~ 50° and make sure the dial indicator pointer stops.
   Set the dial gauge pointer on Zero (0).

   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 left.

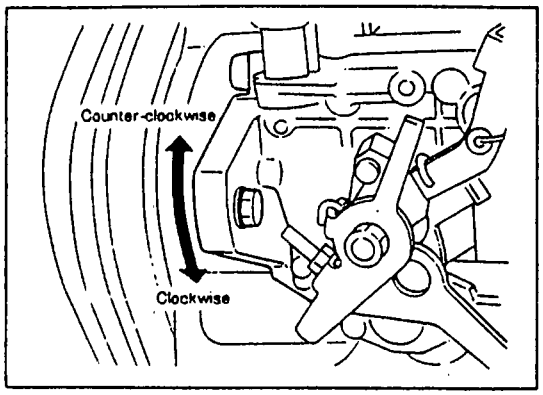


6. Turn the crankshaft pulley clockwise (in direction of engine rotation) to align the timing mark with the indicator pin. If the dial gauge pointer indicates 1 ± 0.02 mm (0.04 ± 0.0008 in.) when the timing mark is aligned with the indicator pin, the injection timing is correctly adjusted.
   If necessary, adjust the injection timing.



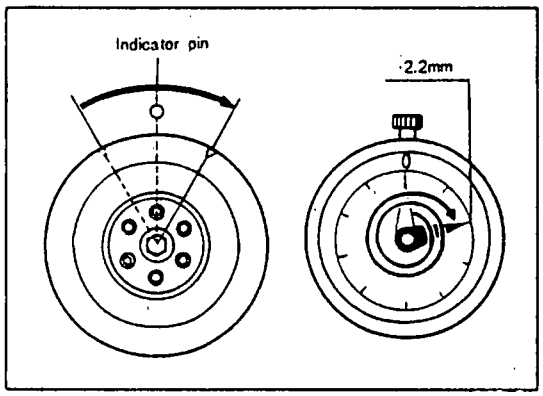
Adjusting

1. Perform the checking procedure.
2. Loosen the injection pump attaching nuts and bolts.



3. Adjust the injection timing by moving the injection pump until the cam lift becomes 1 ± 0.02 mm (0.04 ± 0.0008 in.).

Cam lift	Injection timing	Adjustment
When it is more than 1 ± 0.02 mm	Advanced	Turn the injection pump clockwise (in direction of engine rotation)
When it is less than 1 ± 0.02 mm	Retarded	Turn the injection pump counter-clockwise (in reverse direction of engine rotation)



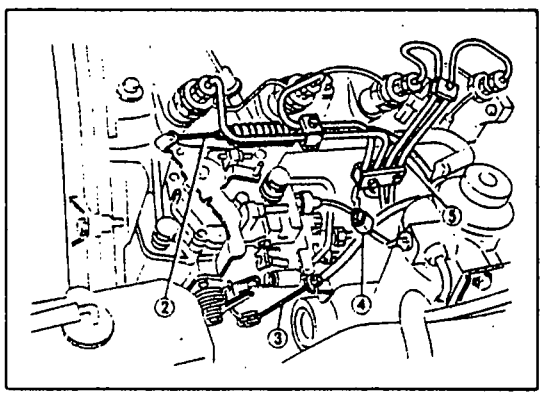
CAM LIFT

Checking

1. Perform the injection timing checking procedure (1 ~ 5).
   (Dial gauge pointer indicates zero (0).)
2. Turn the crankshaft clockwise (in direction of engine rotation) and read the maximum value which the dial indicator pointer indicates.

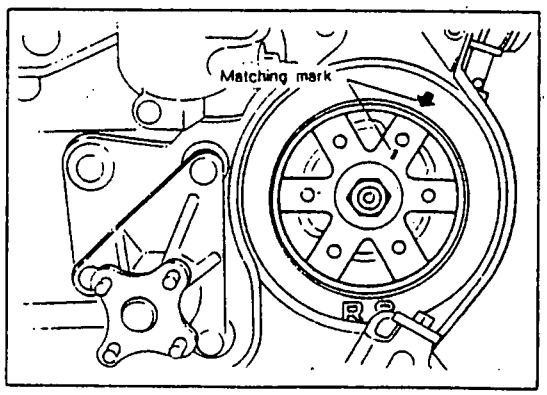
   Cam lift: 2.2 mm (0.08 in.)

3. If the cam lift is less than the specified value there is a problem with the cam disc or roller ass'y.

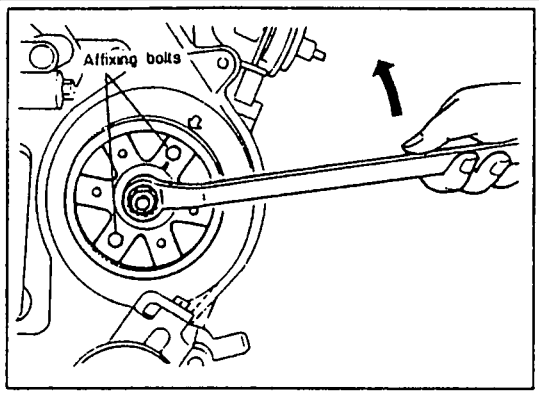


REMOVING

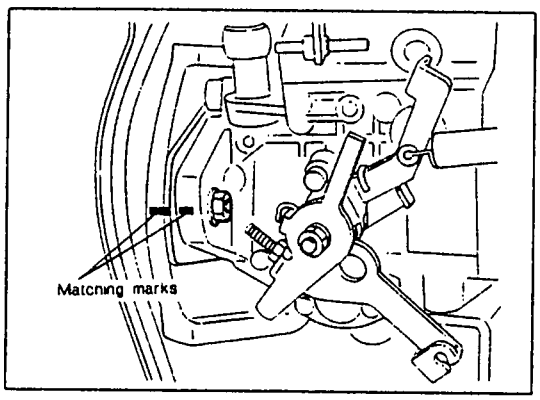
1. Remove the following parts.
   (1) Battery negative cable
   (2) Accelerator control cable
   (3) Cold start device control cable
   (4) Fuel cut valve and pick-up sensor couplers (if so equipped)
   (5) Injection pipes
   (6) Fuel and vacuum hoses



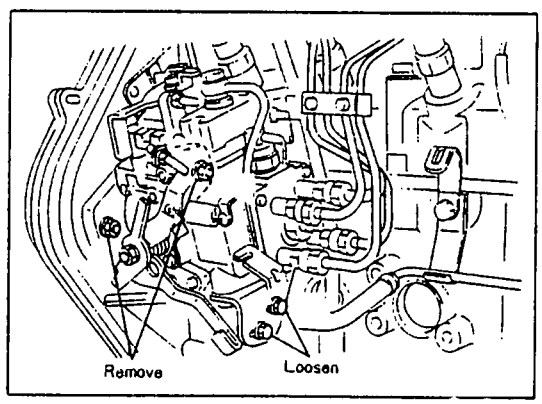
2. Remove the service hole cap of the injection pump pulley.
3. Align the arrow mark on the timing belt cover with the matching mark on the injection pump pulley.



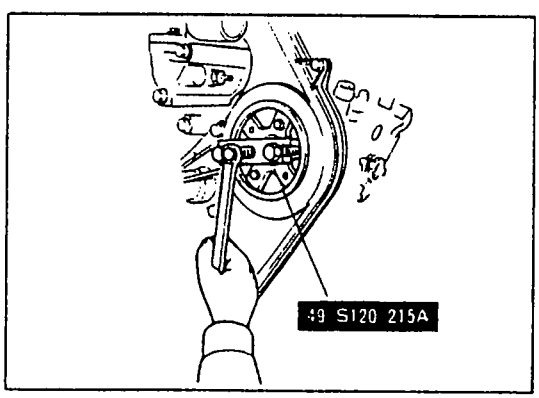
4. Affix the injection pump pulley with two bolts (35 ~ 40 mm).
5. Remove the pulley lock nut and spring washer.



6. Apply the matching marks on the injection pump flange and bracket for reinstallation.



7. Remove the injection pump attaching nuts and loosen the attaching bolts more than three revolutions.

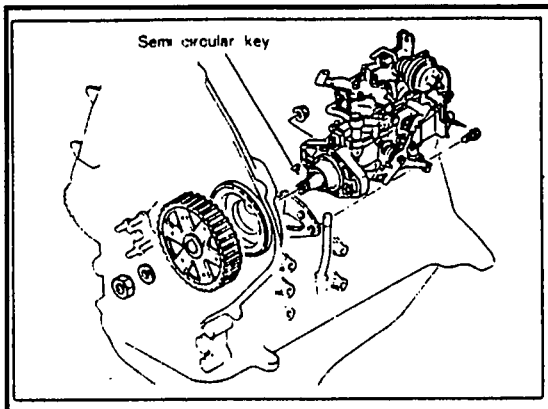


8. After disconnecting the injection pump and pulley by using the **pulley puller (49 S120 215A)**, remove the injection pump.

Cautions

a) Do not remove the two affixing bolts until the injection pump is installed.

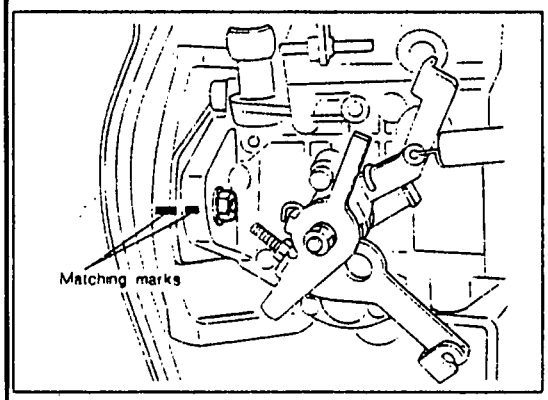
b) Be careful not to drop the semi circular (woodruff) key.



INSTALLING

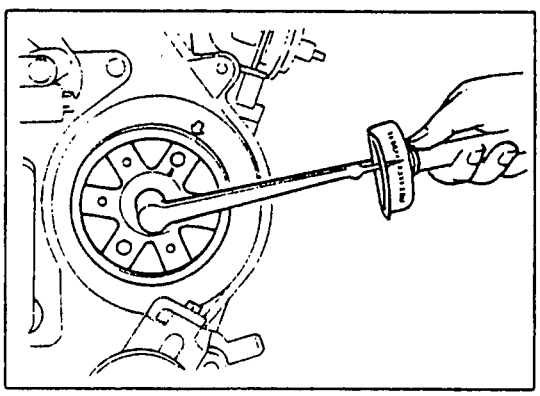
1. Install the semi circular (woodruff) key on the injection pump shaft groove.

Note
Before installing the key on the pump shaft, lightly tap the key groove with hammer to assure the key installation.



2. Install the injection pump and align the matching marks on the injection pump flange and bracket. Then tighten the two attaching bolts and two nuts.

Tightening torque:
Two nuts:
1.6 ~ 2.3 m-kg (11.5 ~ 16.6 ft-lb)
Two bolts:
3.2 ~ 4.7 m-kg (23.0 ~ 33.8 ft-lb)

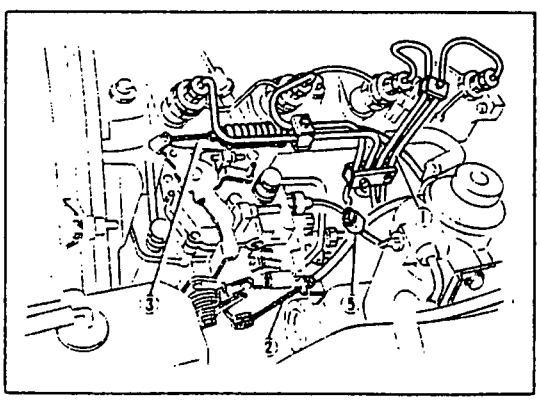


3. Install the spring washer and lock nut and tighten it.

Tightening torque:
7 ~ 8 m-kg (50.6 ~ 57.9 ft-lb)

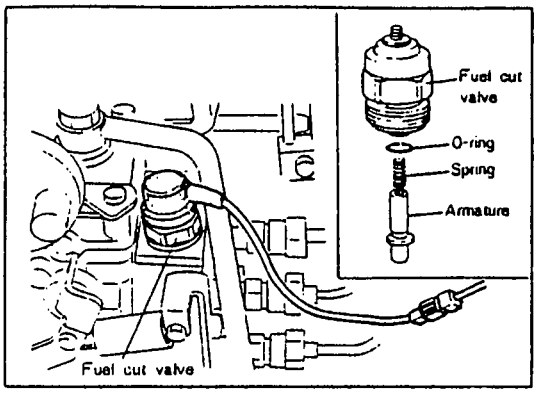
4. Remove the affixing bolts.
5. Install the service hole cap of the injection pump pulley.

Caution
After the installation, check the injection timing. If the injection timing is incorrect, adjust it (shown on page 4B-10).



6. Install the following parts.
   (1) Injection pipes
   (2) Cold start device control cable
   (3) Accelerator control cable
   (4) Fuel and vacuum hoses
   (5) Fuel cut valve and pick-up sensor couplers (if so equipped)
   (6) Battery negative cable

Caution
Bleed air from the injection pump (shown on page 4B-19).

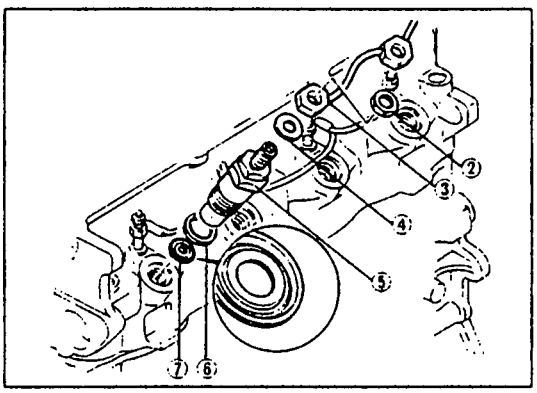


FUEL CUT VALVE

CHECKING

The fuel cut valve is in a normal condition when the engine runs smoothly and is stopped by disconnecting the coupler.
Check the above function. If the engine does not stop by disconnecting the coupler, the fuel cut valve is faulty.

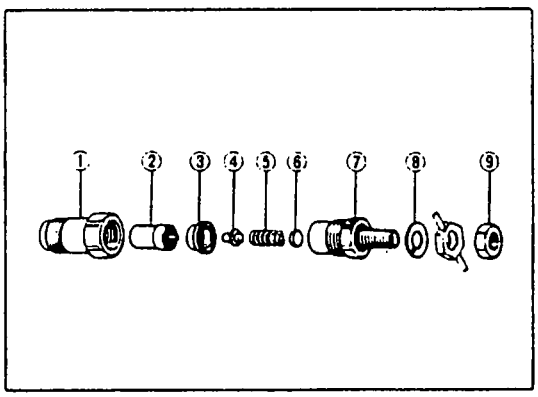
When the fuel cut valve is faulty, replace the parts shown in figure as a complete set.



FUEL INJECTION NOZZLE

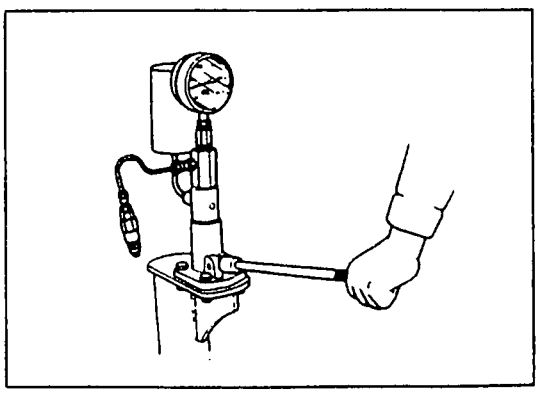
REMOVING

Remove in the following order.
1. Injection pipes
2. Leak pipe lock nut
3. Leak pipe
4. Washer
5. Injection nozzle
6. Gasket
7. Corrugate gasket



COMPONENTS

The injection nozzle consists of the following parts.
1. Retaining ring
2. Nozzle body and needle valve
3. Distance piece
4. Pressure pin
5. Pressure spring
6. Shim
7. Nozzle holder
8. Washer
9. Nut



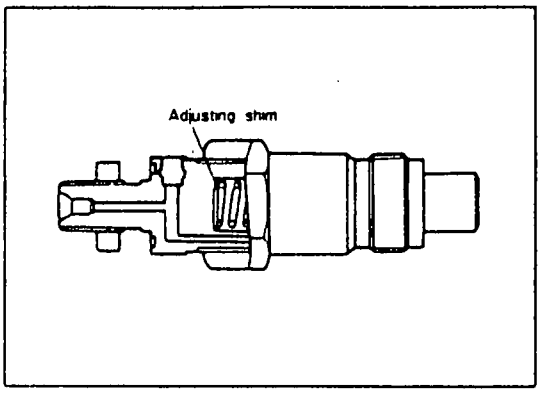
CHECKING

Check the nozzles using diesel fuel at approximate temperature of 20°C (68°F).

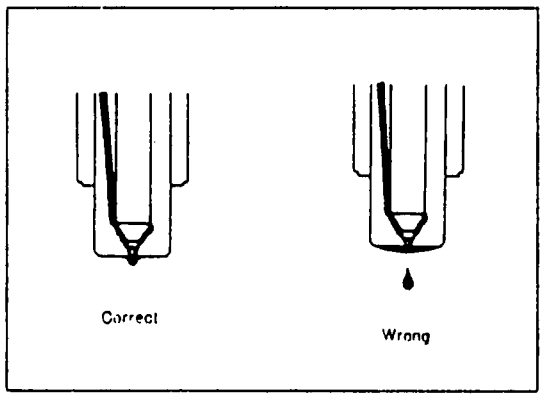
Injection Starting Pressure
1. Set the nozzle on the nozzle tester.
2. Bleed the air by pumping the nozzle tester handle several times.
3. Slowly lower the nozzle tester handle and check the value shown on the pressure gauge when injection is started.

Injection start pressure:
135 kg/cm² (1,919.7 lb/in²)

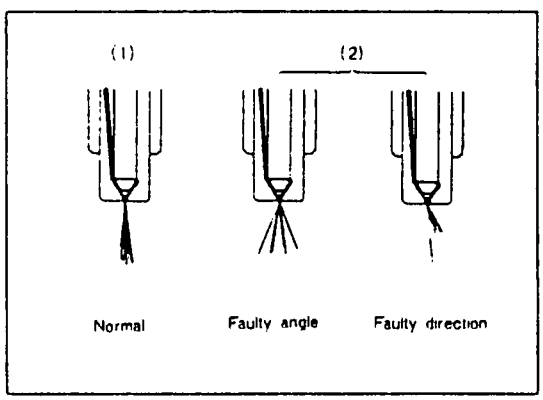
INJECTION NOZZLE



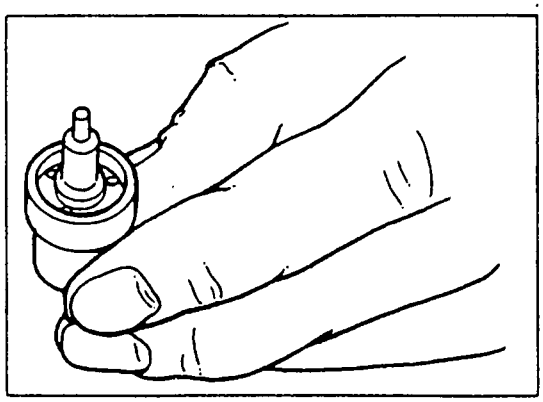
If the injection start pressure is not within the specified range, adjust it.
Adjust the starting pressure with the shim. The shim has 27 different thicknesses for every 0.04 mm (0.0016 in.) from 0.50 mm (0.0197 in.) to 1.54 mm (0.0606 in.).
As 0.04 mm (0.0016 in.) is added, approx. 4.8 kg/cm^2 (16.16 lb/in^2) of injection pressure increases.



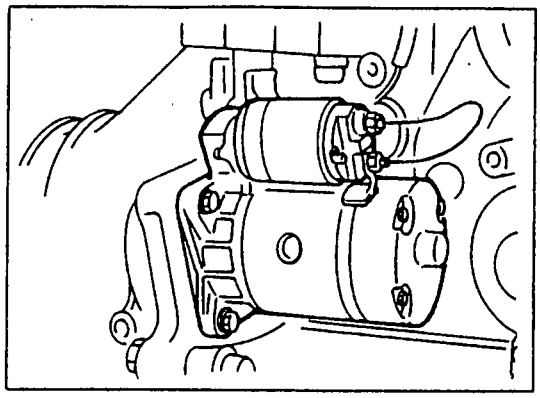
Tightness of Valve Seat
Apply a pressure of 115 kg/cm^2 (1635.3 lb/in^2), and check for fuel leaks from the nozzle injection hole.
If fuel leaks, it is necessary to disassemble, wash and recheck the injection nozzle or replace it.

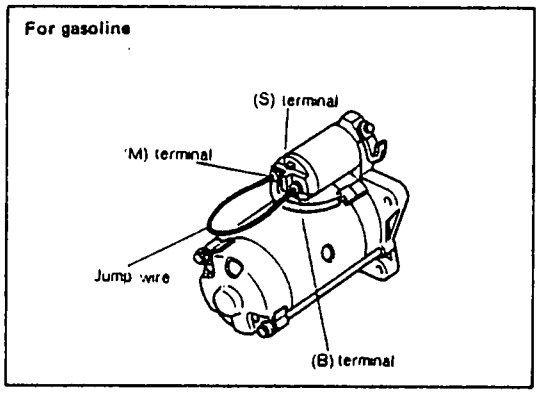


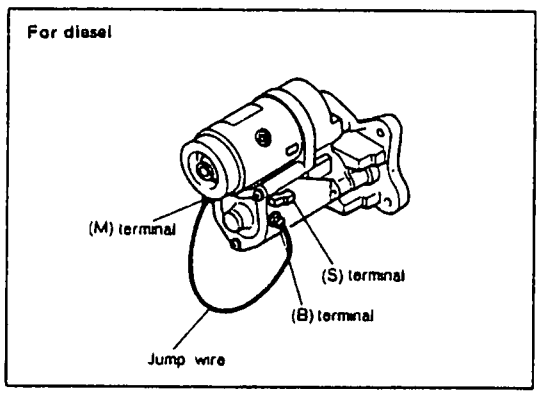
Atomizing Condition (Spray Pattern)
1. Set the injection nozzle on the nozzle tester.
2. Bleed the air by operating the nozzle tester handle several times.
3. Keeping the pressure gauge of the nozzle tester in the non-functioning condition, quickly lower the handle several times (lower the handle as quickly as possible so that a pulsating whisting sound can be heard) and check the atomizing condition.
   (1) Fuel is atomized uniformly and properly.
   (2) The injection angle and direction are normal.
   If the atomizing condition is incorrect, it is necessary to disassemble, wash and recheck the injection nozzle, or to replace it.

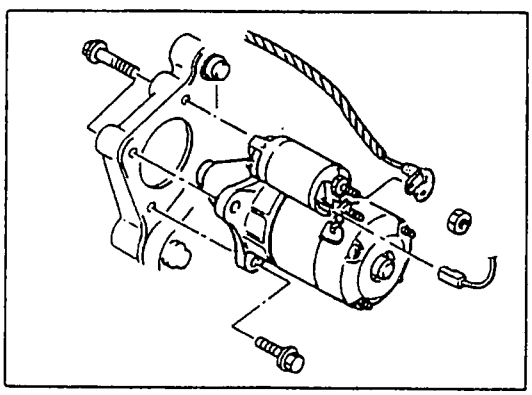


NOZZLE BODY AND NEEDLE VALVE
Checking
1. Check and ensure that the valve seat of the needle valve and other parts are not damaged.
2. Make sure that the nozzle body is not damaged. Hold the nozzle body upright and insert approximately two thirds of the needle valve and see if the needle valve drops to the valve seat by its own weight.









STARTER

ON-VEHICLE INSPECTION

1. Directly connect the Ⓑ and Ⓜ terminals of the starter by using a lead wire.
2. The starter is functioning properly if it turns smoothly, without abnormal noise.
3. If starting is slow, if the starter doesn't turn, or if abnormal noise is heard, remove the starter and check it, but be sure to check the following matters before removing it.
   - A Charging condition of battery
   - B Looseness or corrosion of battery terminal
   - C Condition of wiring
   - D Condition of ignition switch
   - E Locked engine

Warning
Be specially careful, when the starter is operated, the engine may start.

REMOVAL AND INSTALLATION

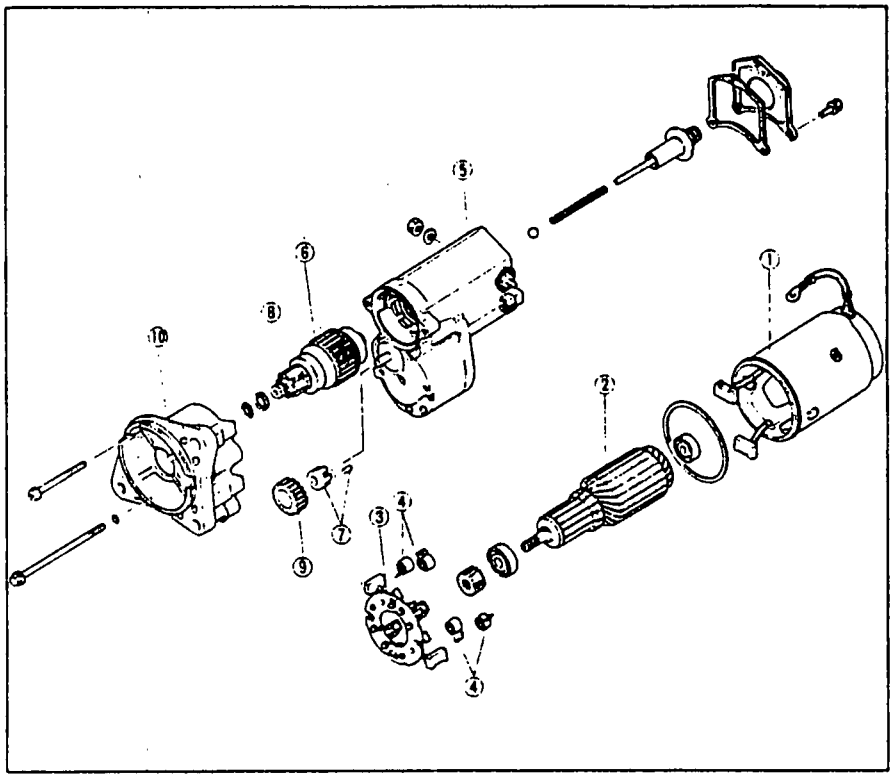
Removal is as follows:

1. Lift the passenger's seat cushion and fasten it with the strap.
2. Disconnect the negative battery cable.
3. Jack up the vehicle, support it on safety stands.
4. Disconnect the wiring from the starter.
5. Remove the starter.

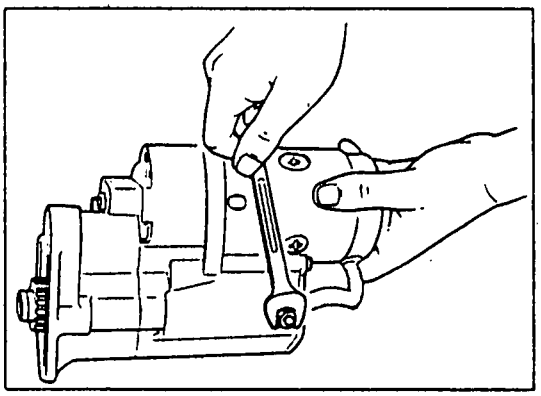
Installation is the reverse order of removal.

STARTER (2.0 kW TYPE)

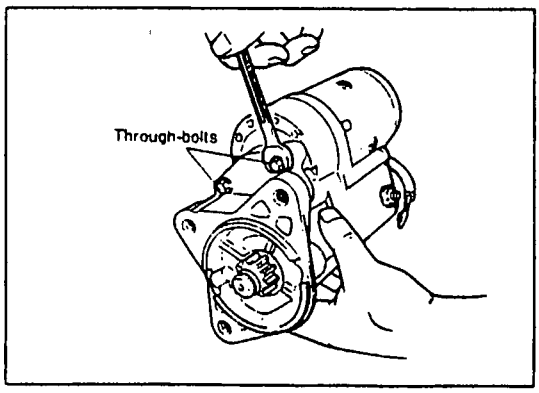
DISASSEMBLY (DIESEL ENGINE 2.0 kW TYPE)



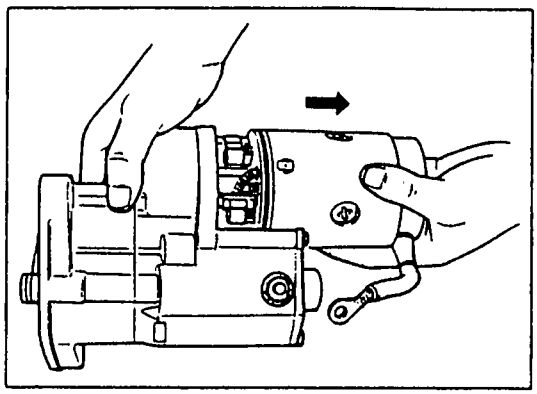
1. Field frame assembly
2. Armature
3. Brush holder
4. Brush spring
5. Magnetic switch assembly
6. Clutch assembly
7. Retainer & Rollers
8. Pinion gear
9. Idler gear
10. Starter housing



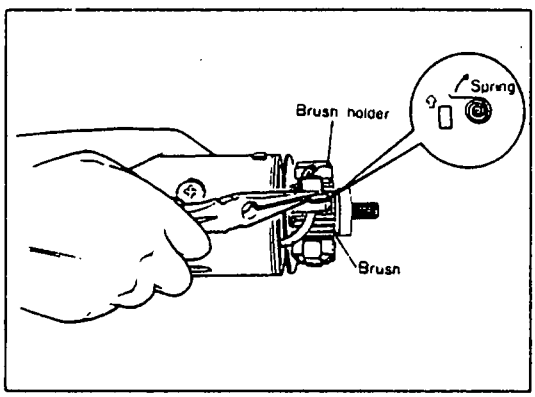
1. Remove the lead wire connected to the magnet switch.



2. Remove the two through-bolts.

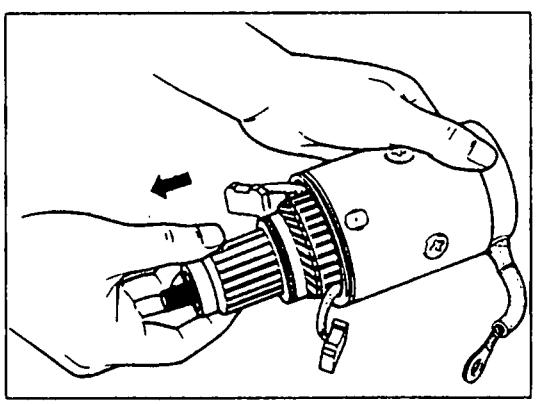


3. Remove the yoke from the magnet switch.



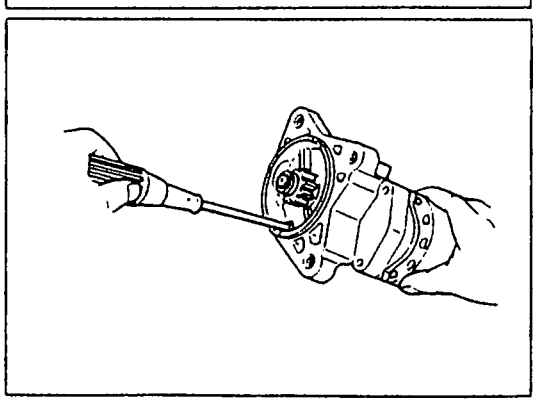
4. Using radio pliers or a similar tool, raise the ⊕ side brush spring and remove the brush.

Caution
Be careful not to scratch the brush or commutator.

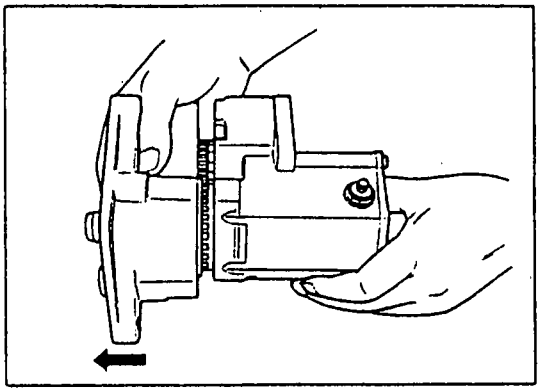


5. Remove the armature from the yoke.

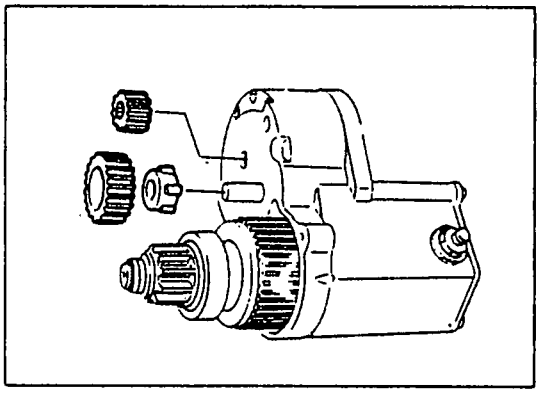
Caution
Be careful not to drop the armature.



6. Remove the two screws which hold the housing and the magnet switch.

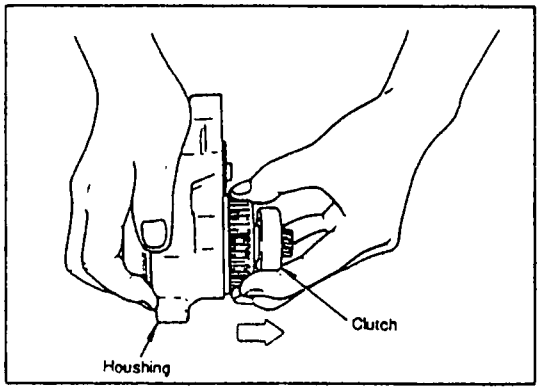


7. Remove the housing from the magnet switch.

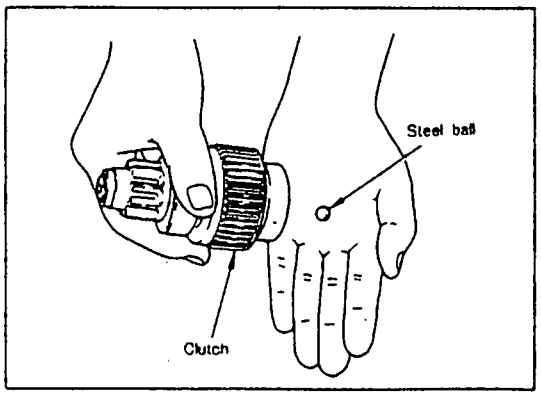


8. Remove the idle gear, retainer and roller.

Caution
Be careful not to lose the roller.

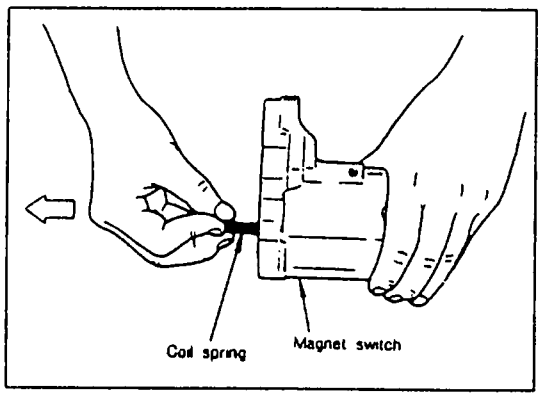


9. Remove the clutch from the housing.

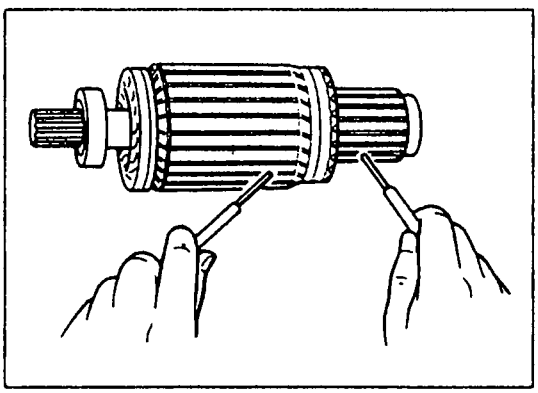


10. Remove the steel ball from the clutch.

Caution
Be careful not to lose the steel ball.



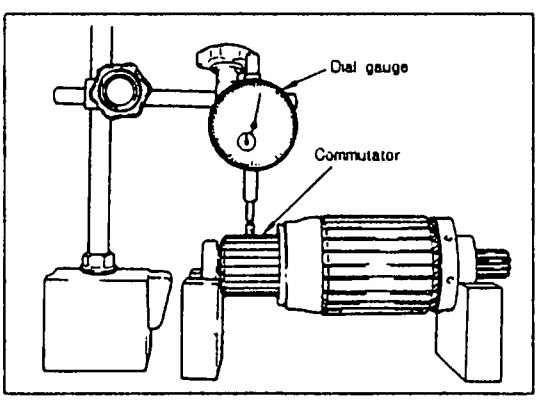
11. Remove the coil spring from the magnet switch.



INSPECTION

Checking the grounding of the armature coil

Check for continuity between the commutator and the core by using a circuit tester. Replace the armature if there is continuity.



Checking the Elliptical Degree of the Commutator

As shown in the figure, use a dial gauge for checking.

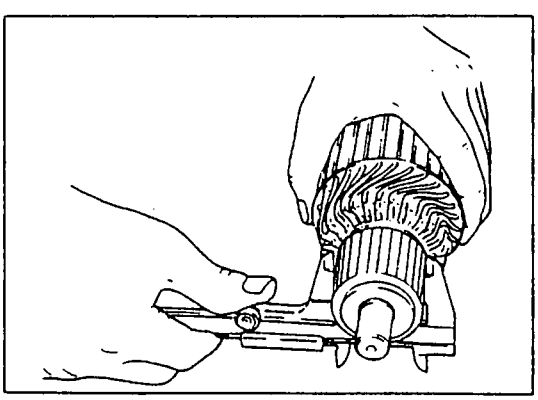
Elliptical degree

If the difference between the maximum diameter and the minimum diameter is **0.4 mm (0.016 in)** or more, adjust so that it is **0.05 mm (0.002 in)** or less.

Caution

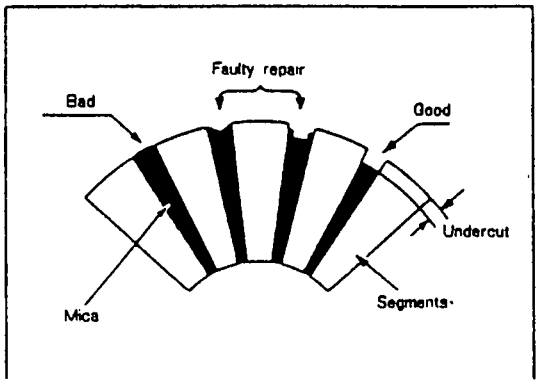
If the elliptical degree is great, also check for bending of the shaft.

Use fine (#300 or higher) sandpaper to polish away roughness of the commutator surface. If it is badly burned, repair by using a lathe.

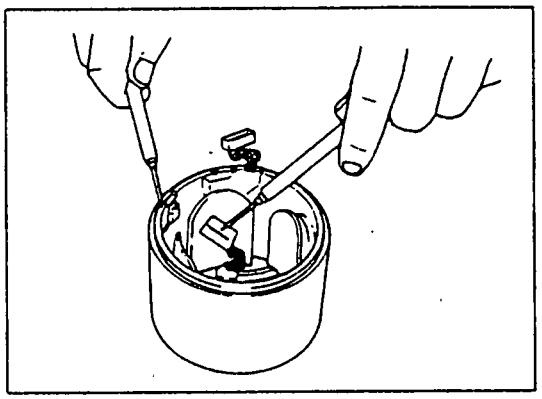


Measure the external diameter of the commutator, and replace the commutator if the measured diameter is **34.5 mm (1.36 in) or more.**

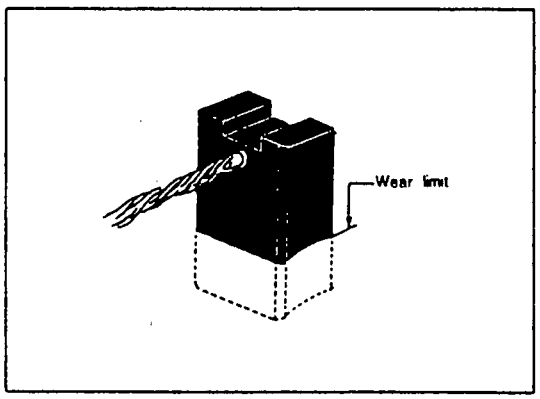
If a lathe is used for repairing, the external diameter limit is **34.0 mm (1.34 in).**



Undercutting the Segments
If the shrinkage of the mold between segments is **0.2 mm (0.008 in) or less,** undercut by **0.5 to 0.8 mm (0.02 ~ 0.03 in).**

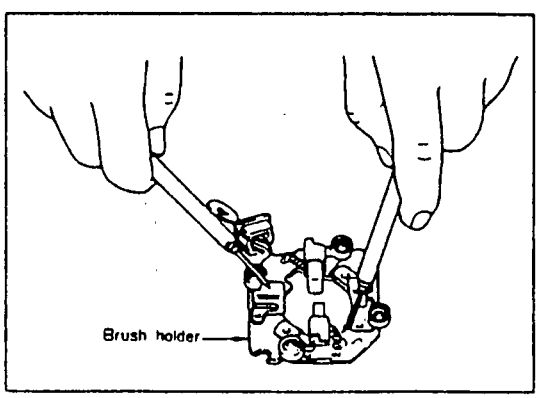


Wiring Damage of the Field Coil
Check for continuity between the connector and brush by using a circuit tester. Replace the yoke assembly if there is no continuity.

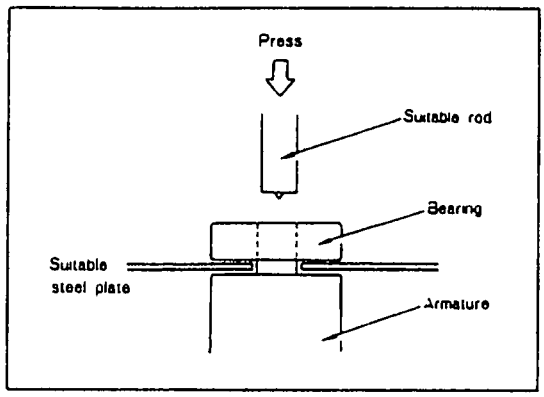


Checking for Brush Wear
If there is brush wear beyond the wear limit, or if the wear is near the limit, replace the brush.

Standard: 14.5 mm (0.57 in)
Wear limit: 10.0 mm (0.39 in)



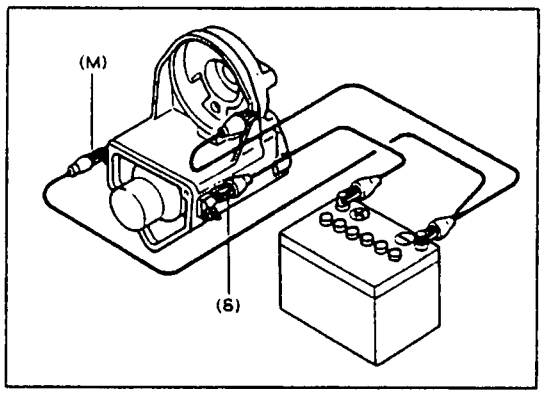
Checking the Brush Holder
Check for continuity between the insulated brush and the plate by using a circuit tester. Repair or replace if there is continuity.
Also check to be sure that the brush slides smoothly inside the brush holder.



Checking and Replacement the Bearing

There should be no apparent roughness or "catching" when the bearing is forcefully rotated by hand, and there should be no abnormal noise when it is rotated at high speed.

Take out the bearing, as shown in the figure, by using the suitable tools.

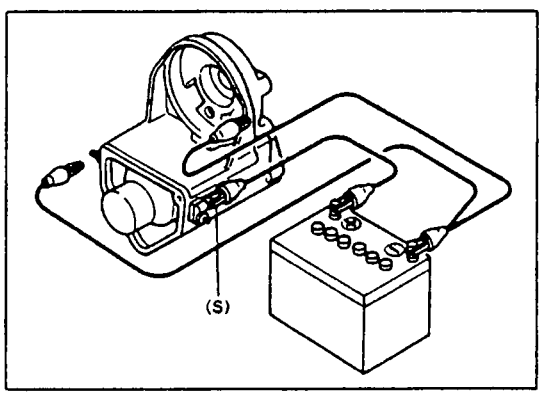


Checking the Magnet Switch

1. Attraction test

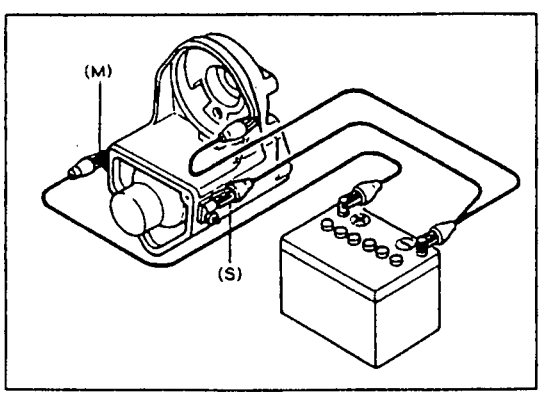
   Make connections from the negative (−) terminal of the battery to the switch body and the M terminal.

   Next, when connecting from the positive (+) terminal of the battery to the S terminal, check to be sure that the pinion projects.



2. Attraction-holding test

   If the pinion is still projecting after the attraction test and the wire is disconnected from the M terminal, the condition is good.

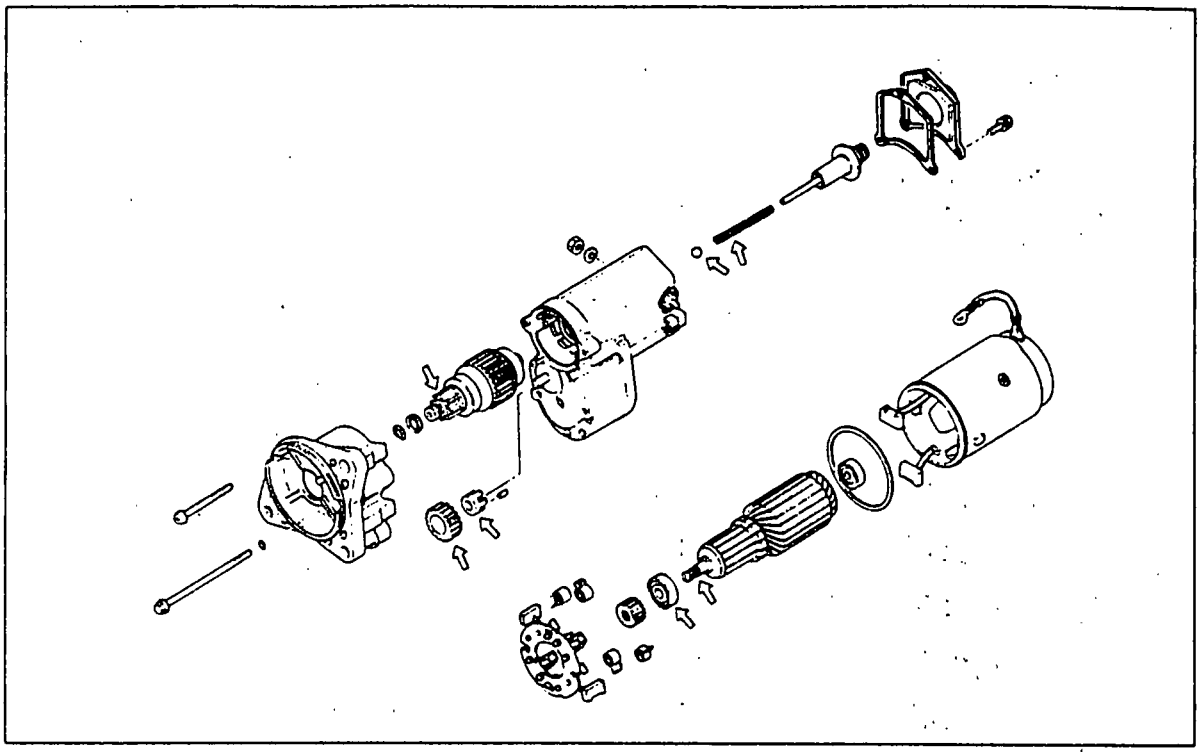


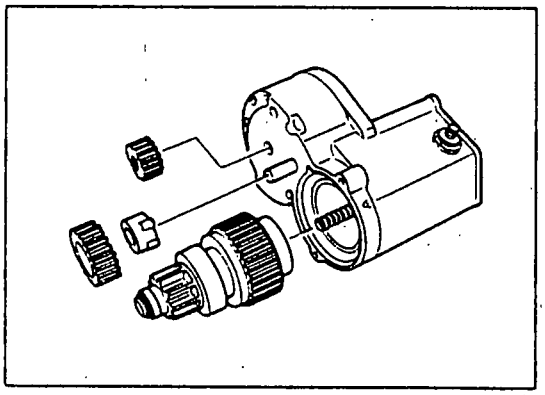
3. Return test

   Make connections from the negative (−) terminal of the battery to the switch body and to the S terminal. Then make a connection from the positive (+) terminal to the M terminal. In this condition, disconnect the wire from the S terminal. The condition is good if the pinion returns immediately.

GREASE LUBRICATION

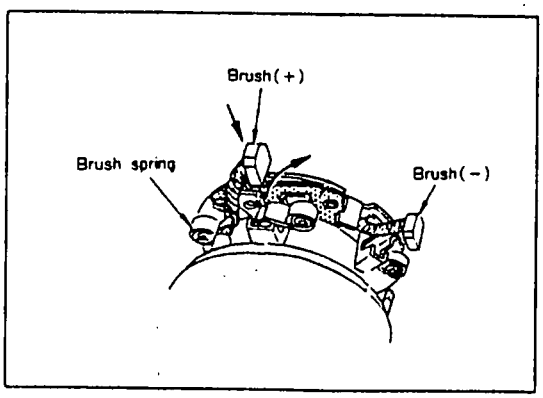
Apply grease (lithium base, N.L.G.I. No. 2) to the places shown in the figure.



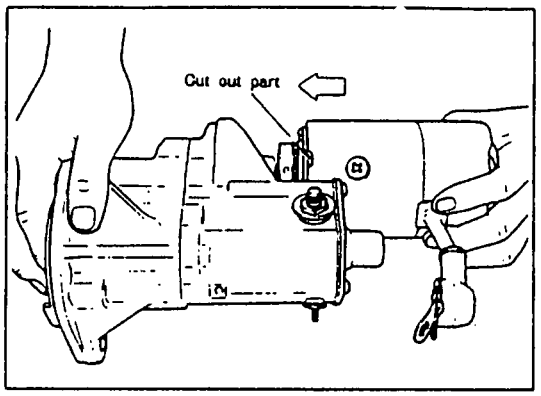


ASSEMBLY (MAIN POINTS)

1. Be careful not to forget to assemble the coil spring and the steel ball of the clutch when the housing and magnet switch are assembled.
   Also be sure not to forget to assemble the retainer and roller to the idle gear.

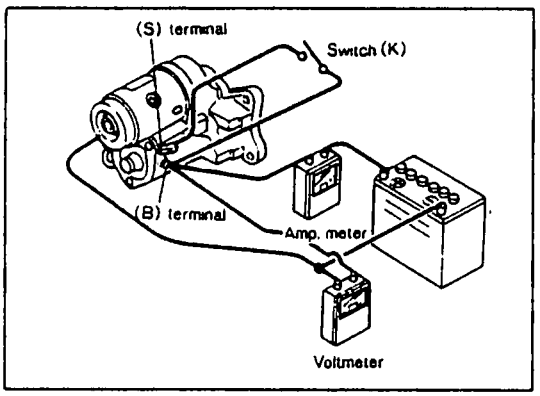


2. As shown in the figure, assemble the brush holder to the yoke, and assemble the two brushes on the yoke side to the brush holder.



4EG05X-065

3. When the yoke is assembled to the magnet switch, align the cut out part with the projection of the magnet switch.



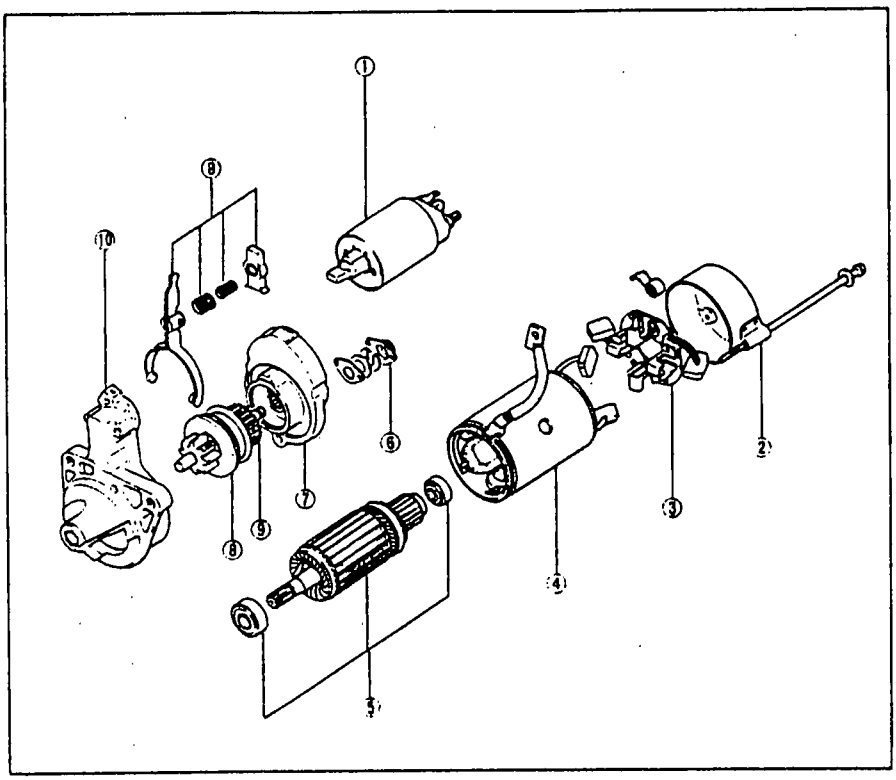
Performance Test (Free Running Test)

When making connections as shown in the figure and closing the switch (K), the starter rotates. If the starter smoothly rotates at the following current and rotating speed when the battery voltage is 12 V, it is normal.

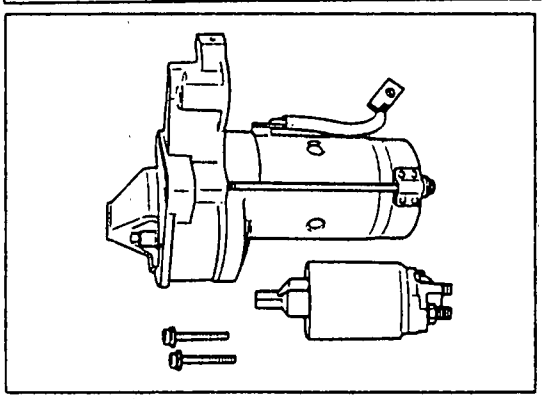
Current: Below 120 A
Voltage: Below 11.5 V
Speed: Over 4000 rpm

STARTER (2.2 kW TYPE)

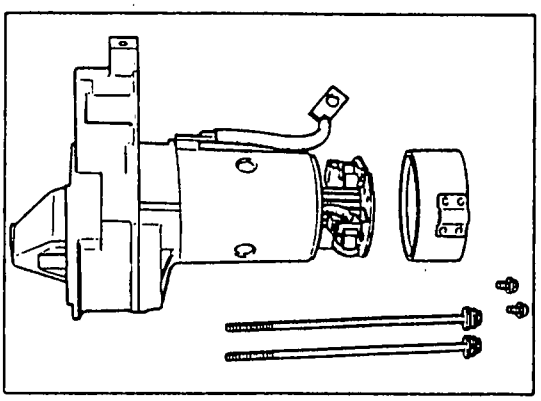
DISASSEMBLY (DIESEL ENGINE 2.2 kW TYPE)



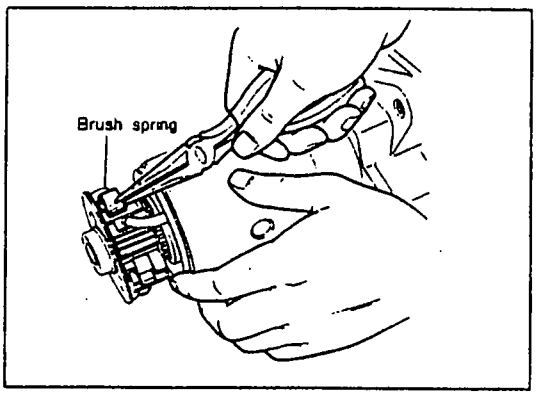
1. Magnetic solenoid
2. Rear housing
3. Brush holder assembly
4. Yoke assembly
5. Armature and bearings
6. Cover
7. Center bracket
8. Drive pinion and Over running clutch assembly
9. Gear
10. Front housing



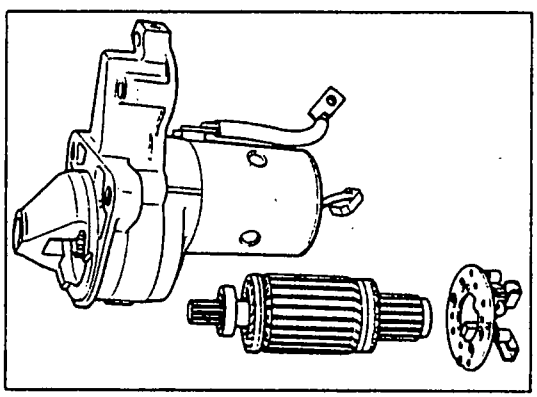
1. Remove the magnetic switch.



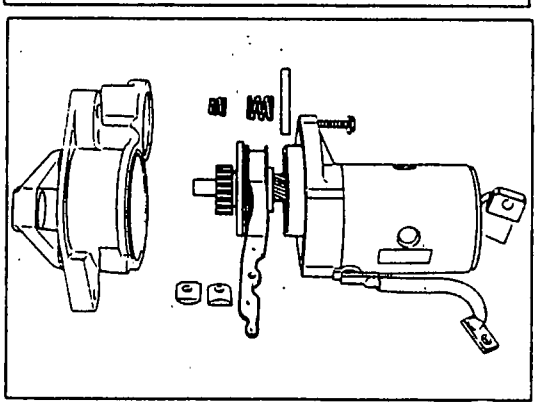
2. Remove the rear housing.



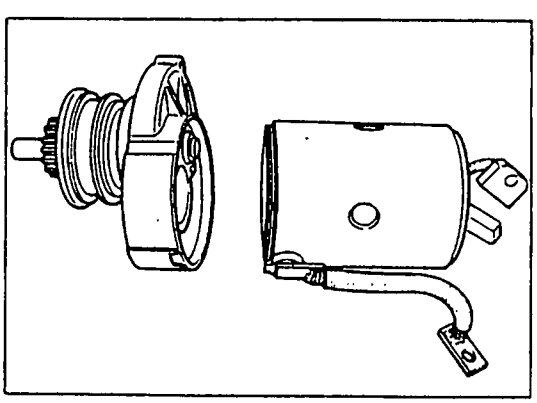
3. Using radio pliers or a similar tool, raise the positive (+) side brush spring, and then remove the brush.



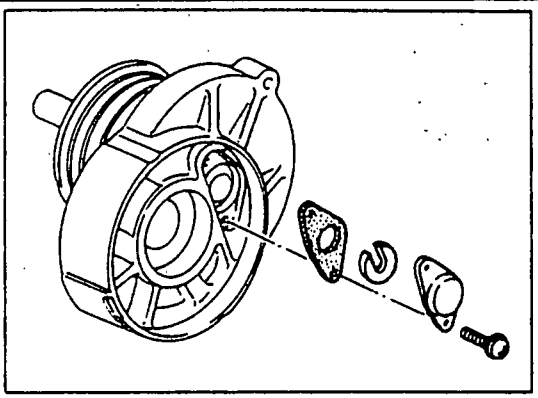
4. Remove the brush holder assembly and the armature.



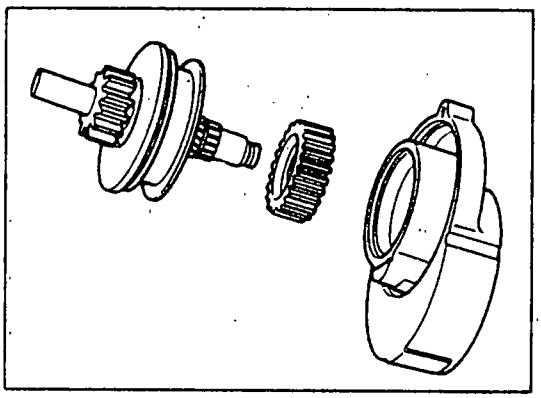
5. Remove the front cover, and then remove the lever and springs (two).



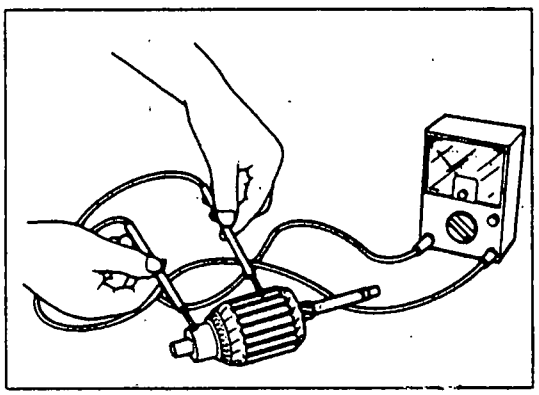
6. Separate the yoke and center bracket.



7. Remove the cover and pull out the snap ring and washer.



8. Remove the pinion, over-running clutch assembly and reduction gear from the center bracket.



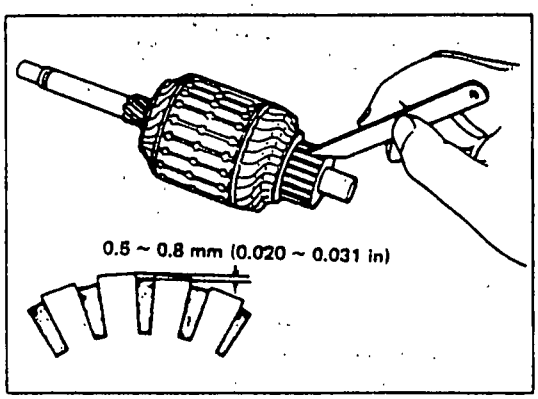
INSPECTION

Check the following components and repair or replace as required.

Armature

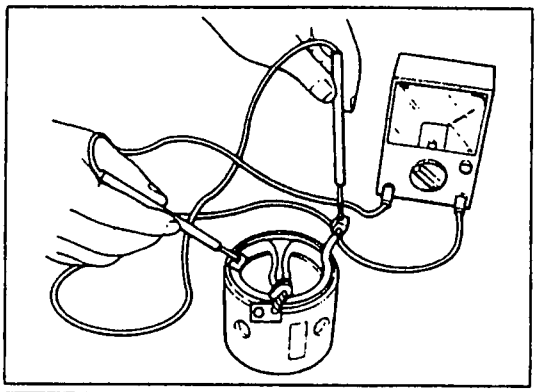
Using a circuit tester, check the continuity between the commutator and shaft (or core).

If continuity is found, it is short-circuited. Replace the armature.



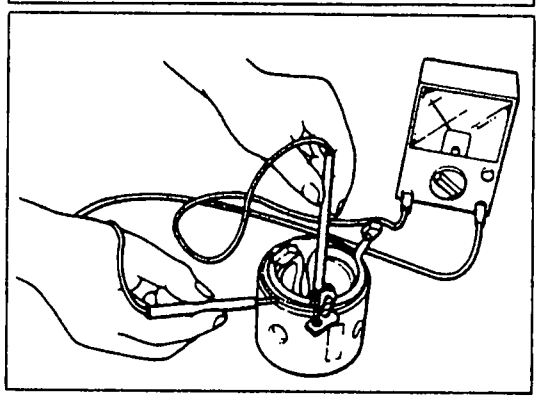
Commutator

1. Rough surface and burnt surface
2. Depth of mica
   Normal depth of mica: **0.5 ~ 0.8 mm (0.020 ~ 0.031 in).**
   Repair (Undercut), if too shallow.

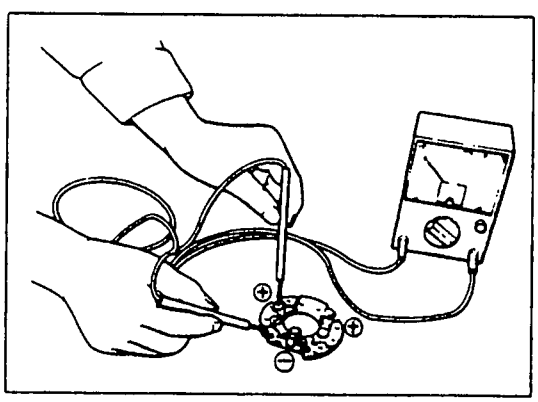


Field Coil

1. Check the continuity between the lead wires (brushes) with a circuit tester.
   No continuity means the coil is broken.
   Replace the yoke assembly.

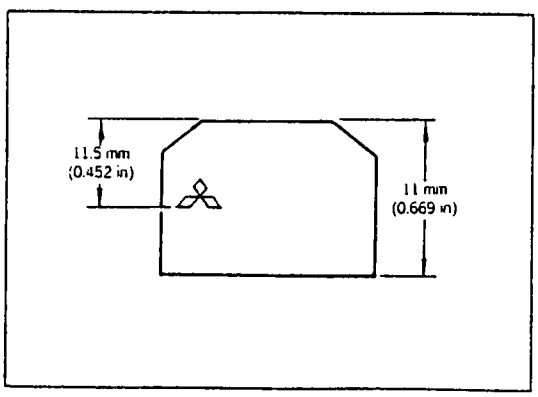


2. Check the continuity between the brush (or connector) and yoke with a circuit tester.
   If continuity is present, it is grounded. Check the insulation condition and replace the yoke assembly, if necessary.



Brush Holder

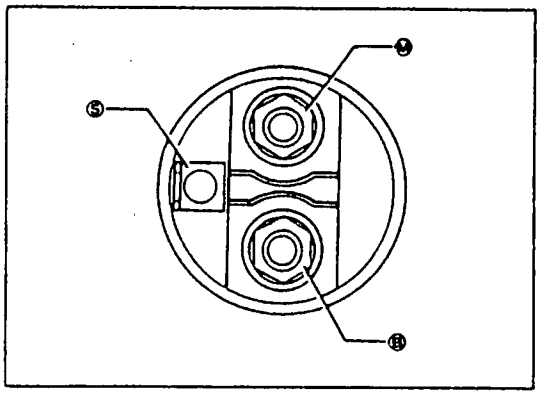
Check the continuity between the positive (+) brush holder and brush holder frame. Use a circuit tester for this inspection.
If continuity is present, replace the brush holder assembly.



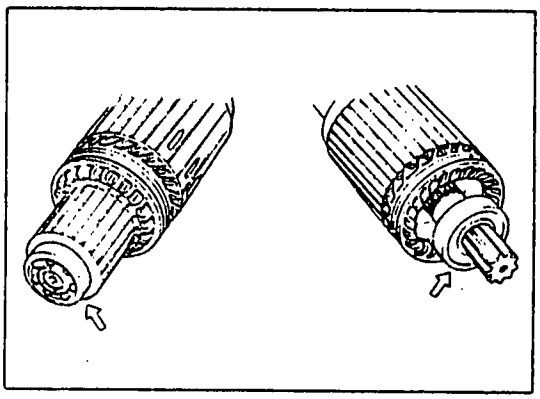
Brush

1. Cleaning of brush
   If dust is adhered onto the brush, clean it.
2. Make sure the brush in the brush holder moves smoothly.
3. Burn or wear (Replace)

Standard length: 17 mm (0.669 in)
Limit: 11.0 (0.433 in)

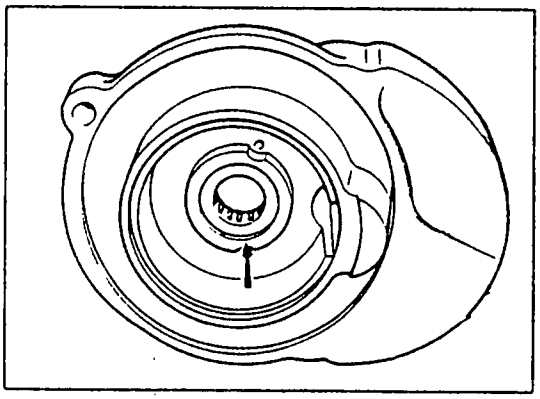


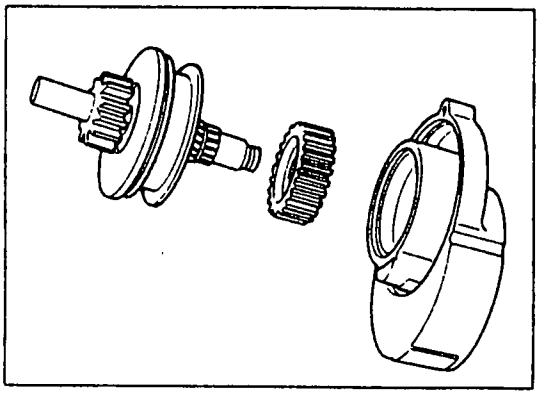
Magnetic Switch
Check continuity between (S) terminal and (M) terminal, and between (S) terminal and ground (body). If there is no continuity, the wire is broken so replace the magnetic switch.



Gear
Wear and damage

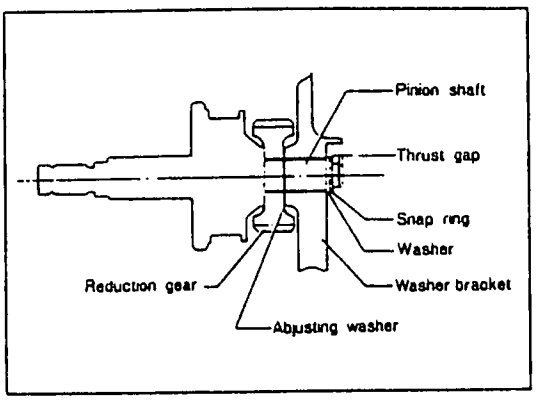
Bearing
Replace the bearing when it is noisy or does not rotate smoothly.





Over-running Clutch
1. Replace the pinion when a worn pinion or damaged pinion are found.
2. If the pinion does not rotate in both directions when rotating the pinion by hand, replace it.

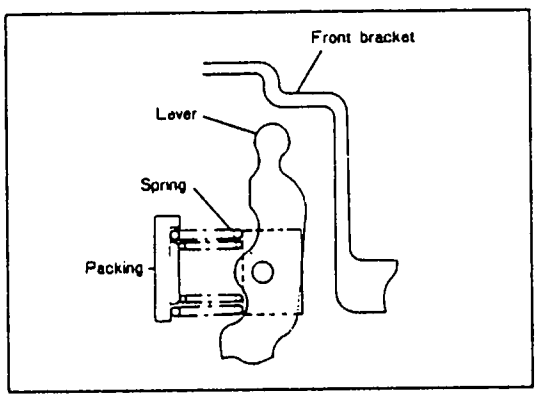
Note
Do not wash the over-running clutch in gas or kerosene, this will destroy the grease packing.



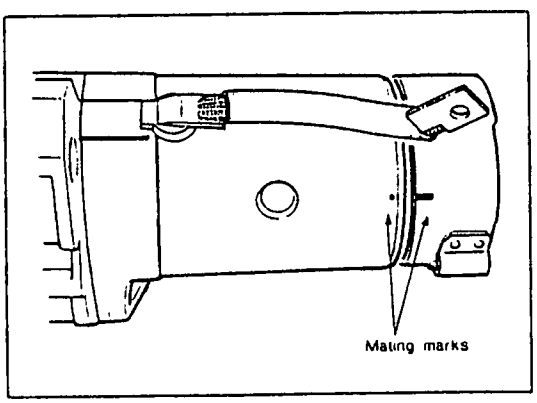
ASSEMBLY

Follow the disassembling procedure in the reverse order and note the following points.

1. Adjusting of thrust gap for pinion shaft
   (Adjusting of free play in axial direction)
   Install the reduction gear in the pinion shaft and insert the pinion shaft in the center bracket. Then, secure the pinion shaft with the snap ring.
   Measure the thrust gap (variation) by moving the pinion shaft axial direction.
   Adjust the gap with the adjusting washer so that it is less than 0.5 mm (0.02 in).



2. Installing lever
   Install the lever as shown in the figure.

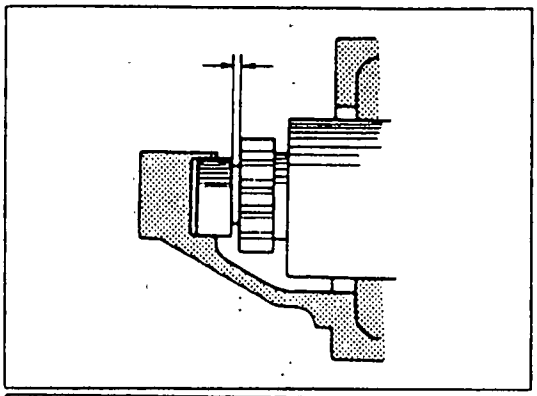


3. Assembly of the rear bracket
   When assembling the rear bracket, first align the mating marks on the yoke and rear bracket.

Greasing

When disassembling or assembling the starter, grease each sliding part, gear and bearing.

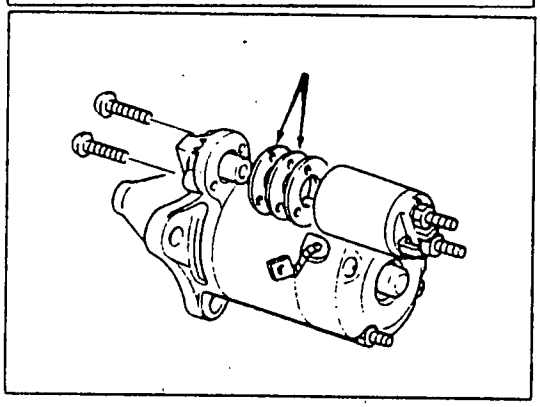
(1) Armature shaft gear
(2) Reduction gear
(3) Ball bearings (both ends of armature)
(4) Bearing box of rear bracket
(5) Snap ring of pinion shaft
(6) Sleeve bearing, pinion, lever sliding part, others



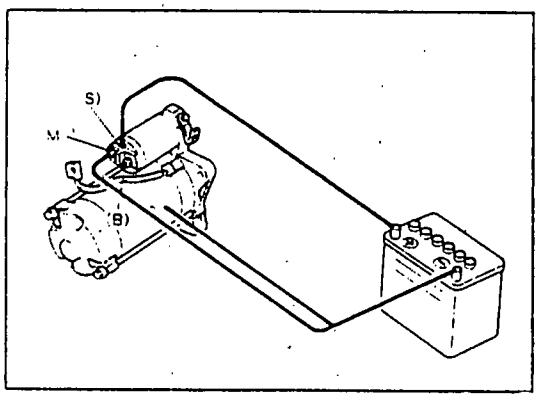
Adjustment of Pinion Gap

1. Disconnect the wiring from terminal M.
2. When the battery is connected between terminal S and the starter body, the pinion will eject outward and then stop. Then measure the clearance (pinion gap) between the pinion and the stopper. Be careful not to supply power continuously for more than 20 seconds.

Pinion gap: 0.5 ~ 2.0 mm (0.20 ~ 0.079 in)



3. If the pinion gap is not within the specified range, make the adjustment by increasing or decreasing the number of washers used between the magnetic switch and the front bracket.
   The gap will become smaller if the number of washers is increased.



CHECKING FUNCTIONS

Magnetic Switch

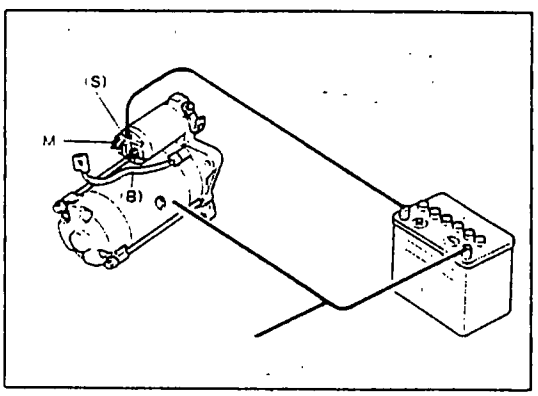
Disconnect the terminal M wiring, and make the following tests.

Pull-in Test

The switch is normal if the pinion ejects outward when the battery is connected as shown in the figure at the left.

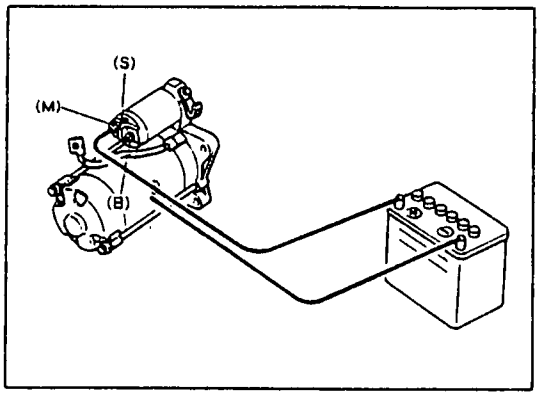
Note

Be careful not to supply power continuously for more than 10 seconds.



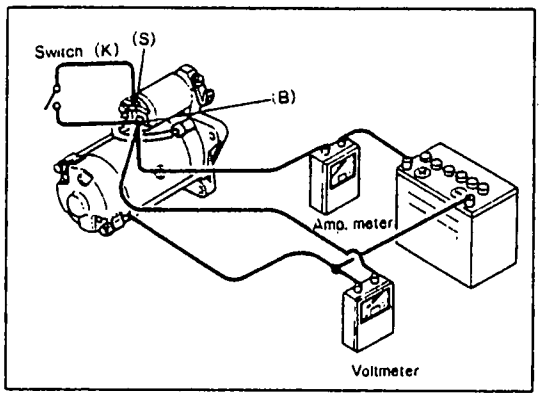
Hold-in Test

After completing the pull-in test, disconnect the wiring to terminal M (with the pinion left ejected). The holding coil is functioning properly if the pinion does not return.



Return Test

1. Connect the battery between terminal M of the magnetic switch and the body, as shown in the figure.
2. Pull out the pinion manually to the pinion stopper position.
3. The pinion should immediately return to its original position when it is released.



Performance Test (Free Running Test)

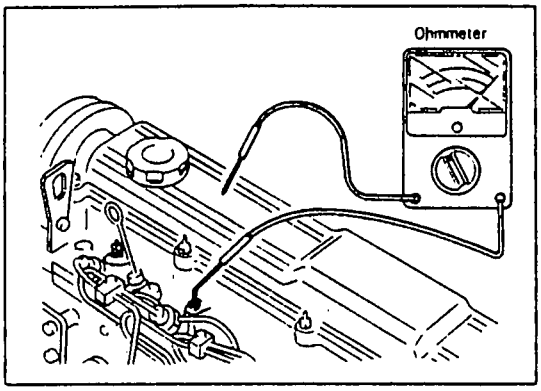
After adjusting the pinion gap, make the performance test.

When making connections as shown in the figure and closing the switch (K), the starter rotates. If the starter motor smoothly rotates at the following current and rotating speed when the battery voltage is 12 V, it is normal.

Note

Since a reduction gear is built-in, the rotating sound under no load is larger than the sound heard under a load.

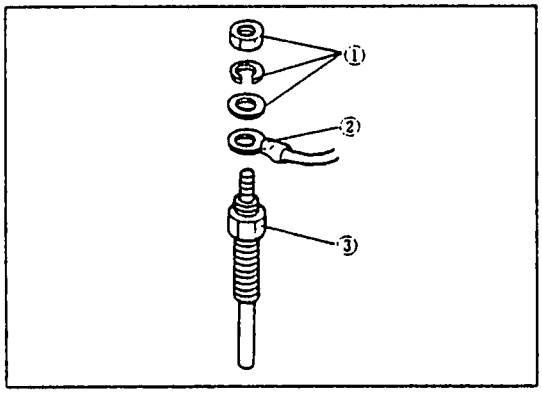
Current: Below 130 A
Voltage: Below 11.0 V
Speed: Over 4,500 rpm



GLOW PLUGS

CHECKING OPEN CIRCUIT OF GLOW PLUGS

Check the continuity between the positive terminal of the glow plug and cylinder head with a circuit tester. If there is no continuity, replace the glow plug.



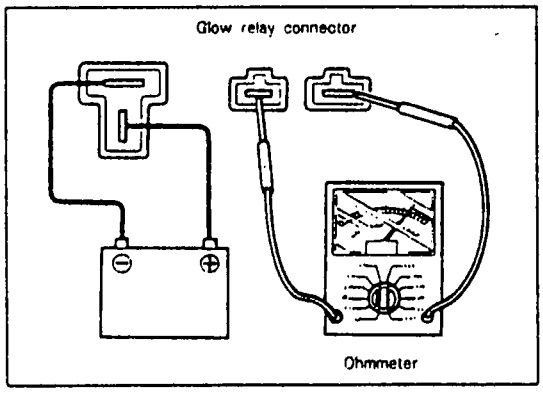
REPLACING GLOW PLUGS

Remove in the following order:

1. Glow plug connector attaching nut and washer. Use a suitable wrench.
2. Glow plug connector
3. Glow plug

Note
Turn the glow plug counterclockwise and remove it.

To install the glow plug, reverse order of removing.



GLOW PLUG RELAY

CHECKING GLOW PLUG RELAY

1. As shown in the figure, connect the battery and an ohmmeter to the relay.
2. If the ohmmeter shows continuity when the battery is connected, and no continuity when the battery is disconnected, the relay is good.
3. Replace the relay if it fails this test.

Item		Engine model	R2
Piston ring end gap mm (in)	Top		0.20 ~ 0.40 (0.0079 ~ 0.0157)
	Second		0.20 ~ 0.40 (0.0079 ~ 0.0157)
	Oil		0.20 ~ 0.40 (0.0079 ~ 0.0157)
	Wear limit		1.0 (0.039)
Piston pin	Diameter	mm (in)	24.994 ~ 25.000 (0.9840 ~ 0.9843)

Tightening torque		m-kg (ft-lb)
Gasoline engine		
Cylinder head bolts	Cold engine	8.2 ~ 8.8 (59 ~ 64)
	Warm engine	9.5 ~ 10.0 (69 ~ 72)
Timing belt cover		0.7 ~ 1.0 (5.1 ~ 7.2)
Cooling fan bearing assembly		3.8 ~ 6.4 (27 ~ 46)
Cylinder head cover		0.3 ~ 0.4 (2.2 ~ 2.9)
Camshaft caps		1.8 ~ 2.7 (13 ~ 20)
Spark plugs		1.5 ~ 2.3 (11 ~ 17)
Camshaft pulley		4.8 ~ 6.6 (35 ~ 48)
Main bearing caps		8.4 ~ 9.0 (61 ~ 65)
Connecting rod caps		5.1 ~ 5.6 (37 ~ 41)
Rear cover assembly		0.8 ~ 1.2 (5.9 ~ 8.7)
End plate		1.9 ~ 3.1 (14 ~ 22)
Oil pump assembly	M8 smaller	1.9 ~ 2.6 (14 ~ 19)
	M10 bigger	3.8 ~ 5.3 (27 ~ 38)
Oil strainer		0.8 ~ 1.2 (5.9 ~ 8.7)
Oil pan		0.7 ~ 1.2 (5.1 ~ 8.7)
Clutch cover		2.2 ~ 3.3 (16 ~ 24)
Water pump		1.9 ~ 2.6 (14 ~ 19)
Rocker arm and shaft assembly		1.8 ~ 2.7 (13 ~ 20)
Front housing		1.9 ~ 2.6 (14 ~ 19)
Crankshaft pulley	For timing belt	15 ~ 16 (108 ~ 116)
	For drive belt	4.8 ~ 6.6 (35 ~ 48)
Tensioner		3.8 ~ 5.3 (27 ~ 38)
Oil pressure switch		1.0 ~ 1.5 (7 ~ 11)
Engine hanger		1.9 ~ 3.1 (14 ~ 19)
Engine mount		3.8 ~ 6.4 (27 ~ 46)
Diesel engine		
Cylinder head bolts		Initial torque 3 m-kg→ Tighten each bolt 90° ~ 95° more
Tensioner		3.2 ~ 4.7 (23 ~ 34)
Timing belt cover		0.7 ~ 1.0 (5 ~ 7)
Crankshaft pulley		2.3 ~ 3.3 (17 ~ 24)
Camshaft caps		2.0 ~ 2.7 (15 ~ 20)
Connecting rod bearing caps		7.0 ~ 7.5 (51 ~ 54)
Rear cover assembly		0.7 ~ 1.0 (5 ~ 7)
Oil pump assembly	M8 smaller	1.6 ~ 2.3 (12 ~ 17)
	M10 bigger	3.2 ~ 4.7 (23 ~ 34)
Oil strainer		0.7 ~ 1.0 (5 ~ 7)
Oil pan		0.7 ~ 1.0 (5 ~ 7)
End plate		1.6 ~ 2.3 (12 ~ 17)
Timing belt pulley		16 ~ 17 (116 ~ 123)
Oil pressure switch		1.2 ~ 1.8 (9 ~ 13)
Water pump		3.2 ~ 4.7 (23 ~ 34)
Camshaft pulley		5.6 ~ 6.6 (41 ~ 48)
Injection pump pulley		6.0 ~ 7.0 (43 ~ 52)

ENGINE SPECIFICATIONS

Item			Engine model: R2
Journal mm (in)	Elliptical limit		0.05 (0.002)
	Diameter	Standard	31.96 ~ 31.98 (1.258 ~ 1.259)
		Limit	31.86 (1.254)
Camshaft deflection limit mm (in)			0.10 (0.0040)
Camshaft end play mm (in)		Standard	0.02 ~ 0.15 (0.00079 ~ 0.0059)
		Limit	0.20 (0.0079)
Oil clearance mm (in)		Standard	0.025 ~ 0.066 (0.0098 ~ 0.0260)
		Limit	0.1 (0.0039)
Standard timing belt deflection mm(in)/10 kg (22 lb)			10.8 ~ 12.9 (0.43 ~ 0.51)
Connecting rod and connecting rod bearing			
Rod bearing limit mm (in)			Less than 0.16 (0.006) per 100 (3.94)
Rod bushing mm (in)	Inner diameter		25.01 ~ 25.03 (0.9846 ~ 0.9854)
	Clearance limit		0.05 (0.002)
Rod end play mm (in)		Standard	0.11 ~ 0.26 (0.0043 ~ 0.0102)
		Limit	0.35 (0.014)
Oil clearance mm (in)		Standard	0.03 ~ 0.06 (0.0012 ~ 0.0024)
		Limit	0.08 (0.0031)
Undersize connecting rod bearing mm (in)			0.02 (0.010), 0.50 (0.020), 0.75 (0.030)
Crankshaft and main bearing			
Crankshaft deflection limit mm (in)			0.05 (0.002)
Crankpin diameter mm (in)		Standard	50.94 ~ 50.96 (2.006 ~ 2.007)
		Limit	0.05 (0.0020)
		Grinding limit	0.75 (0.0295)
Main journal diameter mm (in)		Standard	59.94 ~ 59.96 (2.360 ~ 2.361)
		Limit	0.05 (0.0020)
		Grinding limit	0.75 (0.0295)
Rear housing oil seal sliding surface diameter mm (in)			89.95 ~ 90.00 (3.541 ~ 3.543)
Main journal bearing oil clearance mm (in)		Standard	0.031 ~ 0.049 (0.0012 ~ 0.0019)
		Limit	0.08 (0.0031)
Under size bearings mm (in)			0.25 (0.010), 0.50 (0.020), 0.75 (0.0295)
Crankshaft end play mm (in)		Standard	0.04 ~ 0.28 (0.0016 ~ 0.0111)
		Limit	0.3 (0.0118)
Thrust bearing width mm (in)		Standard	2.18 ~ 2.23 (0.0858 ~ 0.0878)
		Undersize	2.00 ~ 2.05 (0.0787 ~ 0.0807)
Cylinder block, piston and piston ring			
Limit of distortion limit			0.10 (0.0040)
Cylinder bore mm (in)	Standard		86.00 (3.39)
	Limit		86.15 (3.392)
	Difference between bores		0.022 (0.0009)
Piston standard outer diameter mm (in) Diameter measured at 90° to pin bore axis and 19 mm (0.75 in) below the oil ring groove			85.95 ~ 85.98 (3.384 ~ 3.385)
Piston and cylinder clearance limit mm (in)			0.15 (0.006)
Oversize piston rings mm (in)			0.25 (0.010), 0.50 (0.020)
Piston ring opening clearance limit, the ring in the cylinder mm (in)			1.0 (0.039)
Clearance limit, piston and ring groove mm (in)			0.2 (0.008)
Ring groove width mm (in)		Top	2.04 ~ 2.06 (0.0803 ~ 0.811)
		Second	2.03 ~ 2.05 (0.0799 ~ 0.0807)
		Oil	4.02 ~ 4.04 (0.1583 ~ 0.1591)
Piston ring thickness mm (in)		Top	2.04 ~ 2.06 (0.0803 ~ 0.0811)
		Second	2.03 ~ 2.05 (0.0799 ~ 0.0807)
Clearance between piston ring and ring groove mm (in)		Top	0.05 ~ 0.09 (0.0020 ~ 0.0035)
		Second	0.04 ~ 0.08 (0.0016 ~ 0.0031)
		Wear limit	0.20 (0.0079)

ENGINE SPECIFICATIONS

Item		Engine model	R2
Piston ring end gap mm (in)	Top		0.20 ~ 0.40 (0.0079 ~ 0.0157)
	Second		0.20 ~ 0.40 (0.0079 ~ 0.0157)
	Oil		0.20 ~ 0.40 (0.0079 ~ 0.0157)
	Wear limit		1.0 (0.039)
Piston pin	Diameter	mm (in)	24.994 ~ 25.000 (0.9840 ~ 0.9843)

Tightening torque		m-kg (ft-lb)
Gasoline engine		
Cylinder head bolts	Cold engine	8.2 ~ 8.8 (59 ~ 64)
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Rocker arm and shaft assembly		1.8 ~ 2.7 (13 ~ 20)
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Crankshaft pulley	For timing belt	15 ~ 16 (108 ~ 116)
	For drive belt	4.8 ~ 6.6 (35 ~ 48)
Tensioner		3.8 ~ 5.3 (27 ~ 38)
Oil pressure switch		1.0 ~ 1.5 (7 ~ 11)
Engine hanger		1.9 ~ 3.1 (14 ~ 19)
Engine mount		3.8 ~ 6.4 (27 ~ 46)
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Cylinder head bolts		Initial torque 3 m-kg+ Tighten each bolt 90° + 90° more
Tensioner		3.2 ~ 4.7 (23 ~ 34)
Timing belt cover		0.7 ~ 1.0 (5 ~ 7)
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Oil pressure switch		1.2 ~ 1.8 (9 ~ 13)
Water pump		3.2 ~ 4.7 (23 ~ 34)
Camshaft pulley		5.6 ~ 6.6 (41 ~ 48)
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