



Shop Manual

4D55



Pub. No. TWDE8605

4D55

ENGINE

Shop Manual

FOREWORD

This shop manual contains the specifications, construction, operation, and the adjustment as well as service procedures of the diesel engine (Model 4D55 installed on the Mitsubishi CANTER). It will prove invaluable to service mechanics engaged in servicing of the Mitsubishi diesel engines.

Please make the most of this shop manual to perform correct servicing and wasteless operations.

Note that some of the contents of this manual are subject to change without notice to incorporate possible future improvements.

For more details, consult your local Mitsubishi dealers and distributors.

July 1986

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The preceding page contains a "Table of Contents" which lists the group number and group title. The group number is also located at the left or right top of each page.

GROUP CONTENTS

The first page in each group has an index to the subjects included in that group.

PAGE NUMBERS

All page numbers consist of two sets of digits separated by a dash. The digits preceding the dash identify the number of the group. The digits following the dash represent the consecutive page number within the group. The page numbers can be found on the lower left or right of each page.

TEXT

The text describes removal (or disassembly), inspection and installation (or reassembly). The procedures for removal (or disassembly), however, are omitted and the key points and points to note described.

ILLUSTRATIONS

The first illustration in each section shows the component parts. For parts that have to be tightened to specific torque values, however, the torque values are shown for the sake of convenience.

GENERAL

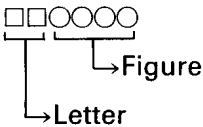
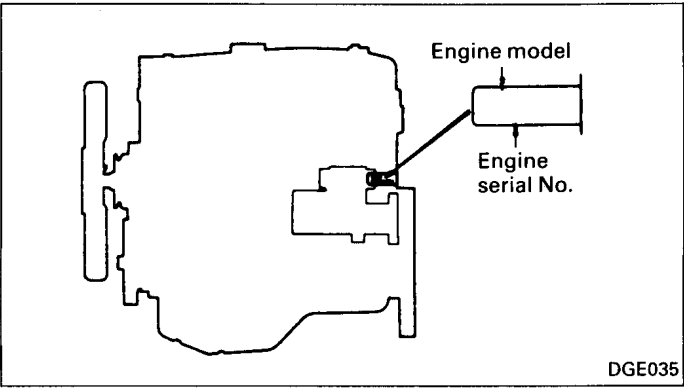
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1. ENGINE-TRANSMISSION MODEL TABLE

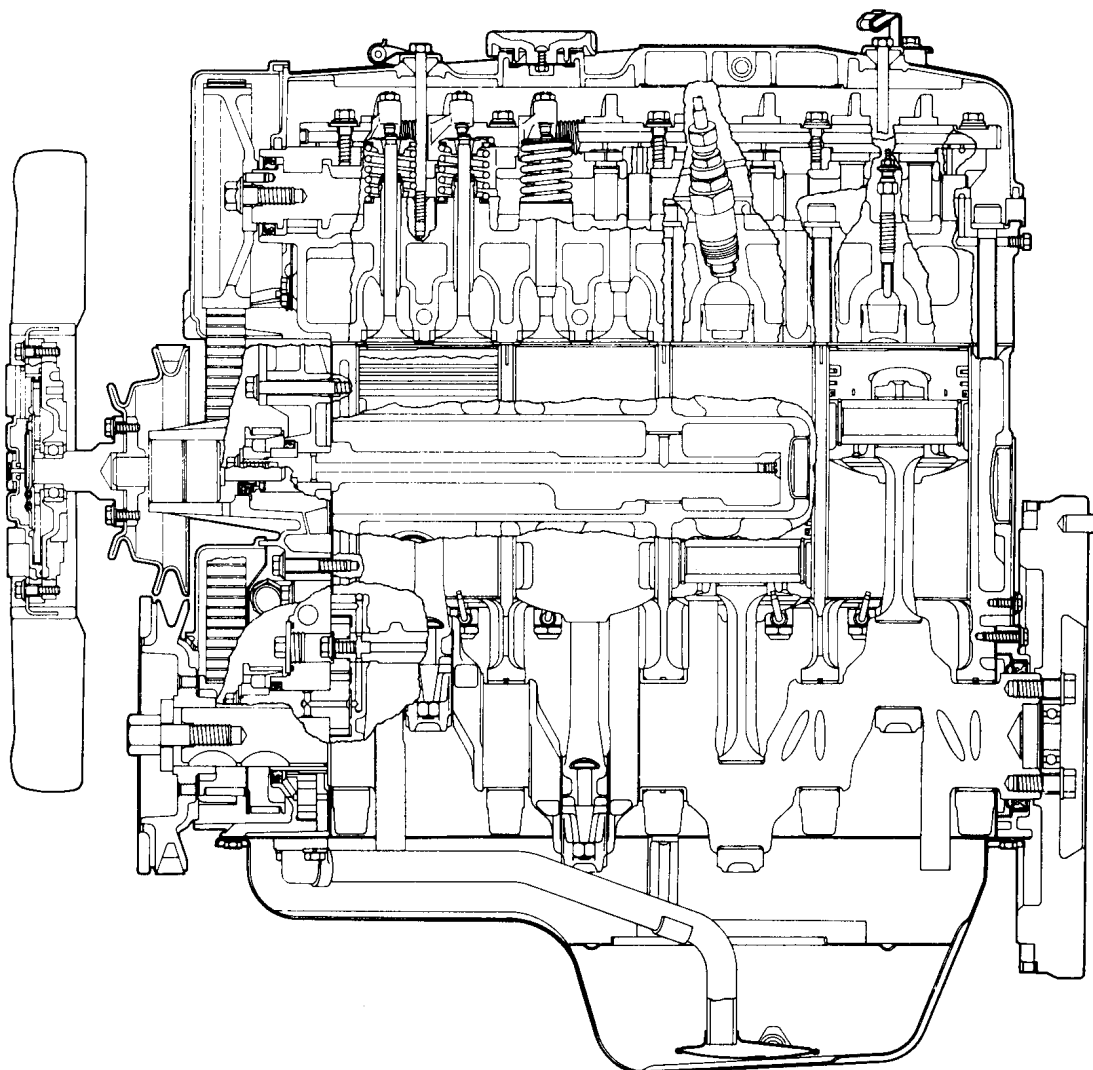
Engine – Transmission	Transmission	Vehicle model	Remarks
4D55 – 0 – 90U	M1S5	FB433	EUROPE

2. ENGINE MODEL AND SERIAL NUMBER LOCATION

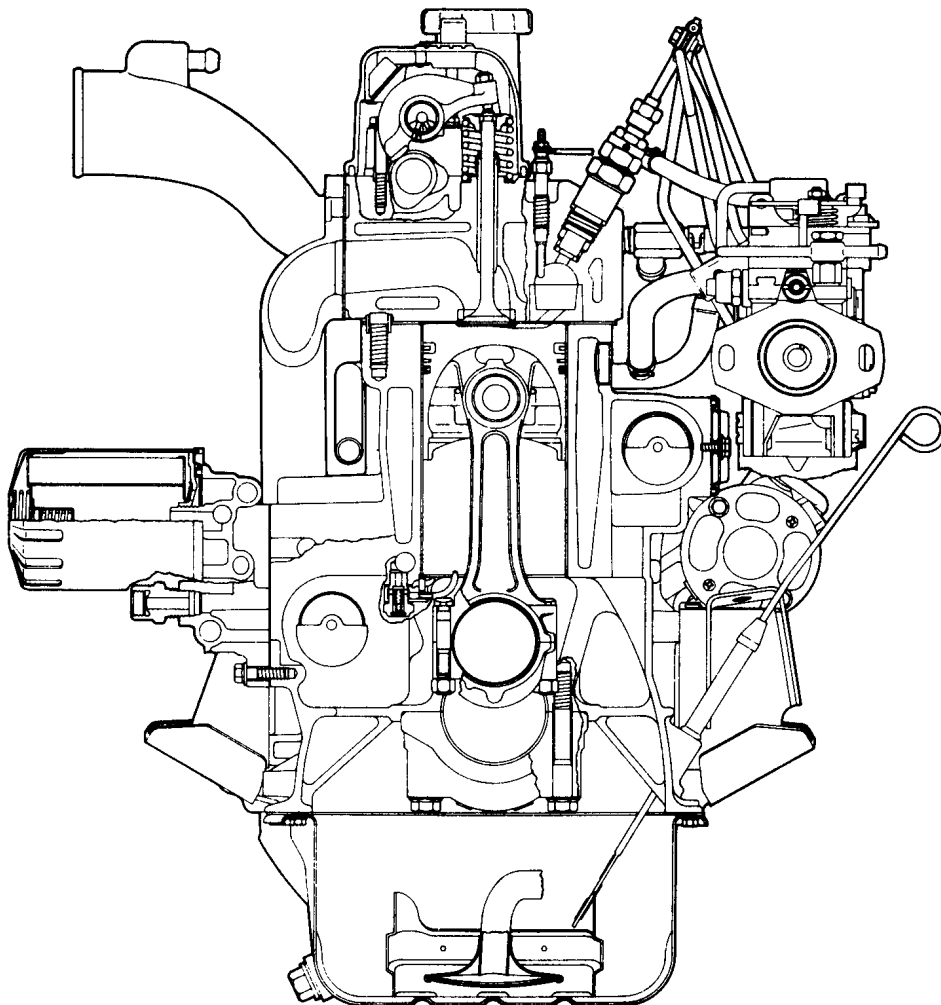


Example: AA0101 to AA9999

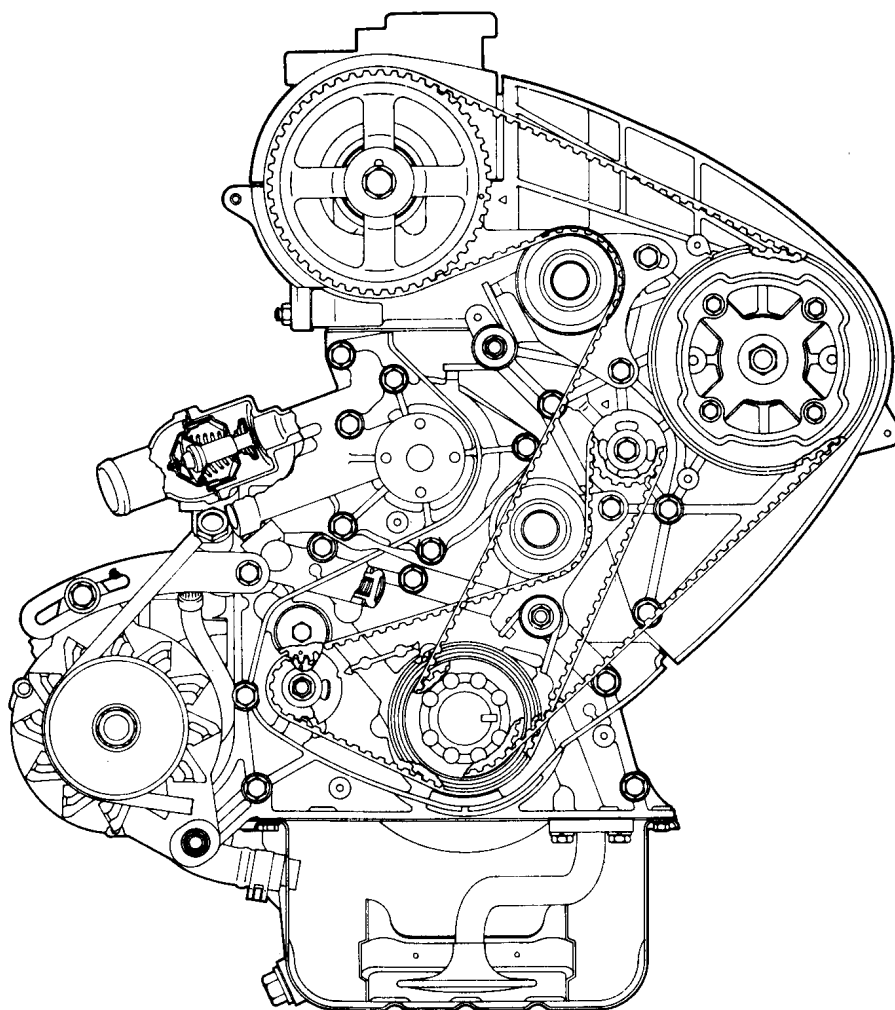
↓
AB0001
⋮
AY9999
↓
BA0001

3. ENGINE SECTION**Longitudinal Section of Engine**

DGE002

Cross Section of Engine

DGE003

Timing Belt Train

DGE004

4. MAJOR SPECIFICATIONS

Description	Specifications	Remarks
Type	4 cycle, diesel engine	
No. of cylinders, arrangement	4-in line, longitudinal	
Type of combustion chamber	Swirl chamber	
Valve mechanism	Overhead valve, single overhead camshaft (SOHC), belt drive	
Cylinder liner type	Dry type	
Bore x stroke	91.1 x 90.0 mm	
Total displacement	2.346 lit.	
Compression ratio	21.0	
Compression pressure	2 256 kPa (23 kg/cm ²) or more	
	– 250 rpm	
Valve timing		
Intake valve		
Opens/Closes	BTDC 20°/ABDC 48°	
Exhaust valve		
Opens/Closes	BBDC 54°/ATDC 22°	
Valve clearance (hot)		
Intake valve	0.25 mm	
Exhaust valve	0.25 mm	
Idling speed	750 ± 50 rpm	
Blow-by gas recirculation system	Sealed type	
Lubrication system	Pressure-feed type	
Oil pump type	Gear type	
Oil filter type	Full flow filtration, filter paper type	
Engine oil quantity	6.5 lit. (including 0.6 lit. oil filter and 0.4 lit. oil cooler)	
Fuel feed pump type	Vane type	
Fuel injection pump type	Distribution type	
Injection timing	ATDC 5°	
Nozzle holder type	Screw type	
Nozzle type	Throttle type	
Injection pressure	11 768 kPa (120 kg/cm ²)	
Cooling system	Water cooling system	
Glow plug type	Sheathed type	
Starting motor type	Reduction drive	
Alternater type	AC type with vacuum motor	

5. STANDARD PARTS TIGHTENING TORQUE**Tightening Torque of Bolt or Nut with Spring Washer**

Classification Torque Thread size mm (dia. x pitch)	Head mark 4		Head mark 7		Head mark 10	
	Nm	kgm	Nm	kgm	Nm	kgm
5 x 0.8	–	–	4 – 5	0.4 – 0.6	–	–
6 x 1.0	–	–	8 – 9	0.8 – 1	10 – 12	1 – 1.3
8 x 1.25	10 – 12	1 – 1.3	15 – 21	1.5 – 2.2	25 – 34	2.5 – 3.5
10 x 1.25	18 – 24	1.8 – 2.5	30 – 41	3 – 4.2	49 – 68	5 – 7
12 x 1.25	30 – 41	3 – 4.2	54 – 73	5.5 – 7.5	94 – 117	9.5 – 12
14 x 1.5	49 – 68	5 – 7	79 – 107	8 – 11	157 – 186	16 – 19

Tightening Torque of Flange Bolt or Nut

Classification Torque Thread size mm (dia. x pitch)	Head mark 4		Head mark 7	
	Nm	kgm	Nm	kgm
5 x 0.8	–	–	5 – 6	0.5 – 0.7
6 x 1.0	–	–	8 – 11	1 – 1.2
8 x 1.25	12 – 14	1.2 – 1.5	20 – 26	2 – 2.7
10 x 1.25	27 – 33	2.7 – 3.4	43 – 53	4.3 – 5.5
12 x 1.25	47 – 58	4.8 – 6	79 – 98	8 – 10

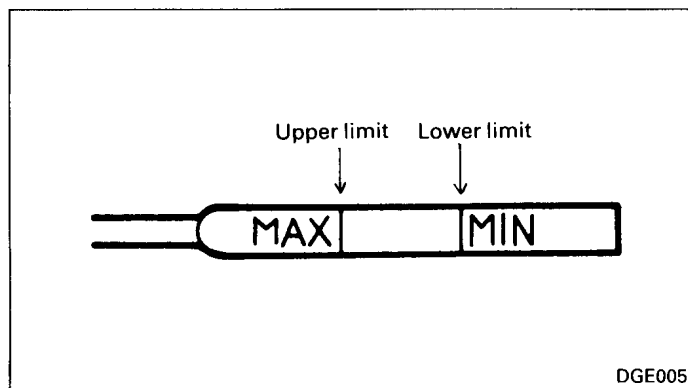
Tightening Torque of Taper Thread

Classification Torque Thread size	Aluminium alloy		Cast iron or steel	
	Nm	kgm	Nm	kgm
NPTF 1/16	5 – 7	0.5 – 0.8	8 – 11	0.8 – 1.2
PT 1/8	8 – 11	0.8 – 1.2	15 – 21	1.5 – 2.2
PT 1/4, NPTF 1/4	20 – 29	2 – 3	35 – 44	3.5 – 4.5
PT 3/8	40 – 53	4 – 5.5	54 – 73	5.5 – 7.5
PT 1/2	69 – 98	7 – 10	118 – 156	12 – 16

6. MAINTENANCE

6.1 ENGINE OIL AND OIL FILTER

Checking Engine Oil Level and Replenishing Engine Oil



1. Position the vehicle on a flat level.
2. Check the engine oil level with an oil level gauge. If the oil level is found to have fallen to the lower limit as indicated by the MIN mark, replenish 1 liter of engine oil.

Caution:

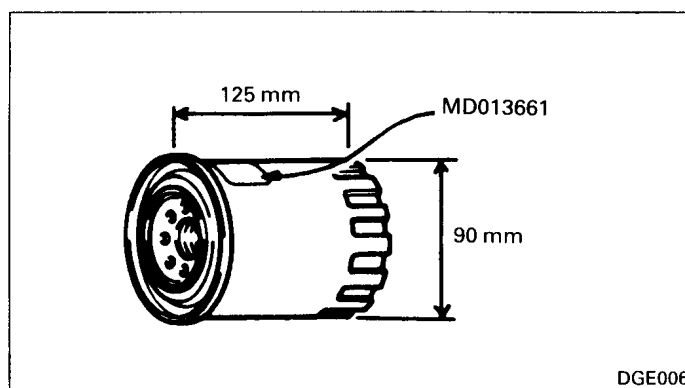
- Check the oil level approximately one minute after replenishment
- For replenishment, use the same type of engine oil as one currently used.
- In the case of a vehicle that has been out of service for a prolonged period, run the engine for several minutes and then stop for some time before attempting to check the oil level.
- If the oil cooler and hose have been removed or replaced, check the oil level with the engine fully warmed up or at a coolant temperature of 80 to 90°C.

Engine Oil

Be sure to use engine oil equivalent or superior to the specified grade, and of the viscosity suitable for the atmospheric temperature as shown at the right.

API classification	Temperature	Viscosity (SAE)
Class CC or higher	0 to 40°C	30
	Above -10°C	20W – 40
	Above -15°C	15W – 40
	-20 to 40°C	10W – 30
	Below 10°C	5W – 30

Oil Filter



Use the oil filter of the size shown in figure. Do not use the oil filter for other models.

Replacing Engine Oil

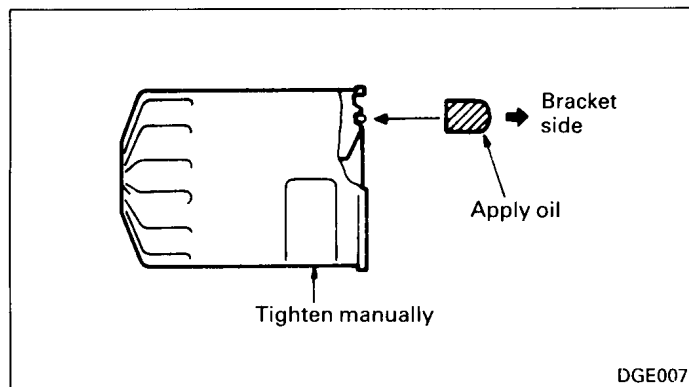
After warming up the engine, remove the drain plug from the oil pan to drain off the old oil.

Then, tighten the drain plug and pour new engine oil through the oil filler.

- Drain plug tightening torque:
59 to 78 Nm (6 to 8 kgm)
- Oil quantity:
Approximately 6.5 lit. (including 0.6 lit. in oil filter and 0.4 lit. in oil cooler).

Caution:

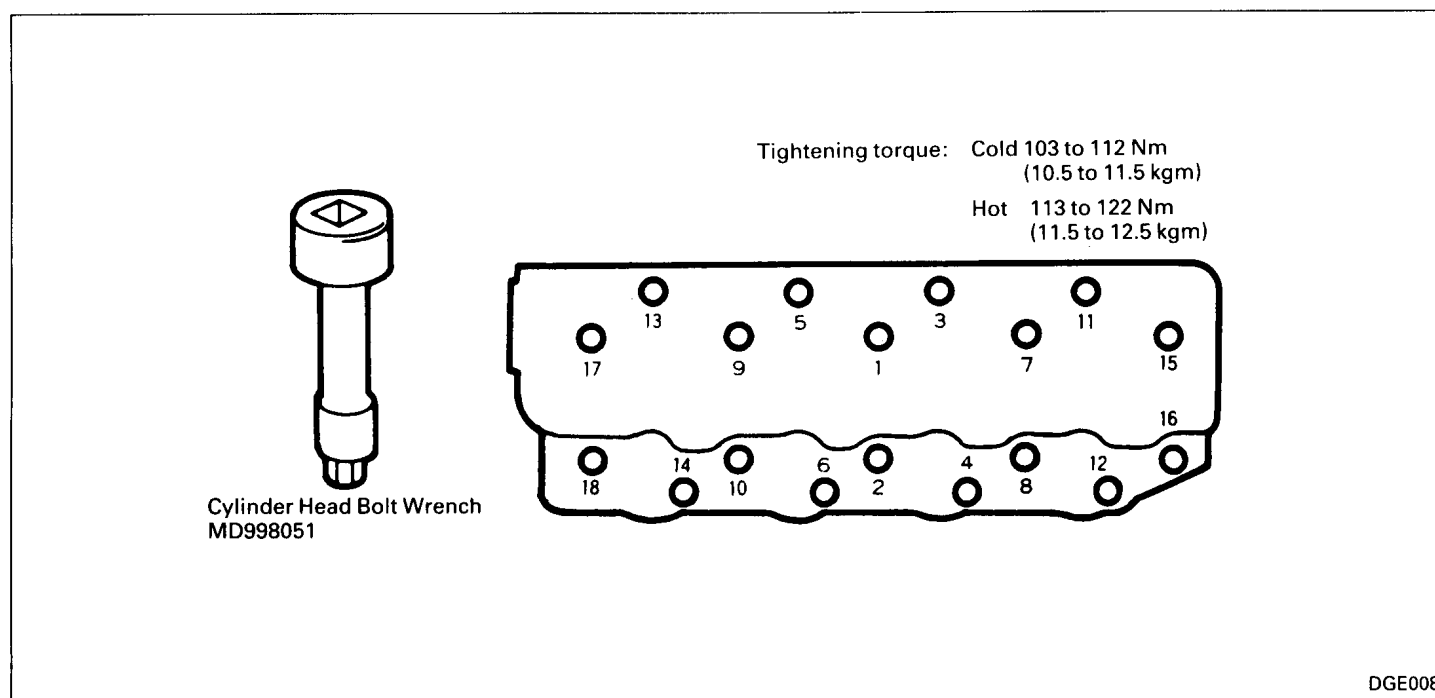
- When draining the engine oil, most of the oil in the oil cooler (including pipe) and the oil filter remain undrained. When filling oil, therefore, make allowance for that quantity.
- If the oil cooler and hose have been removed or replaced, check the oil level with the engine fully warmed up or at a coolant temperature of 80 to 90°C.

Replacing Oil Filter

1. Use filter wrench or the like to remove the oil filter.
2. When installing the oil filter, clean the filter mounting surface of the filter bracket and lightly apply engine oil to the filter O-ring. Finger tighten the oil filter. [Tightening torque: 11 to 12 Nm (1.1 to 1.3 kgm)]

Caution:

- **Protect O-ring against twist and bending.**
3. Run the engine for several minutes to check for engine oil leaks.
 4. After stopping the engine, check the oil level and replenish as necessary.

6.2 ADDITIONAL TIGHTENING OF HEAD BOLTS

When giving additional tightening to the cylinder head bolts, back off the bolts slightly and then tighten to the specified torque. The tightening sequence of the bolts is as shown in illustration.

6.3 VALVE CLEARANCE ADJUSTMENT

Nut
12 to 17 Nm
(1.2 to 1.8 kgm)

Valve whose clearance is adjustable when the piston in No. 1 cylinder is at top dead center on compression stroke

Valve whose clearance is adjustable when the piston in No. 4 cylinder is at top dead center on compression stroke

Valve clearance

	When hot	When cold (ref.)
In.	0.25 mm	0.15 mm
Ex.	0.25 mm	0.15 mm

DGE032

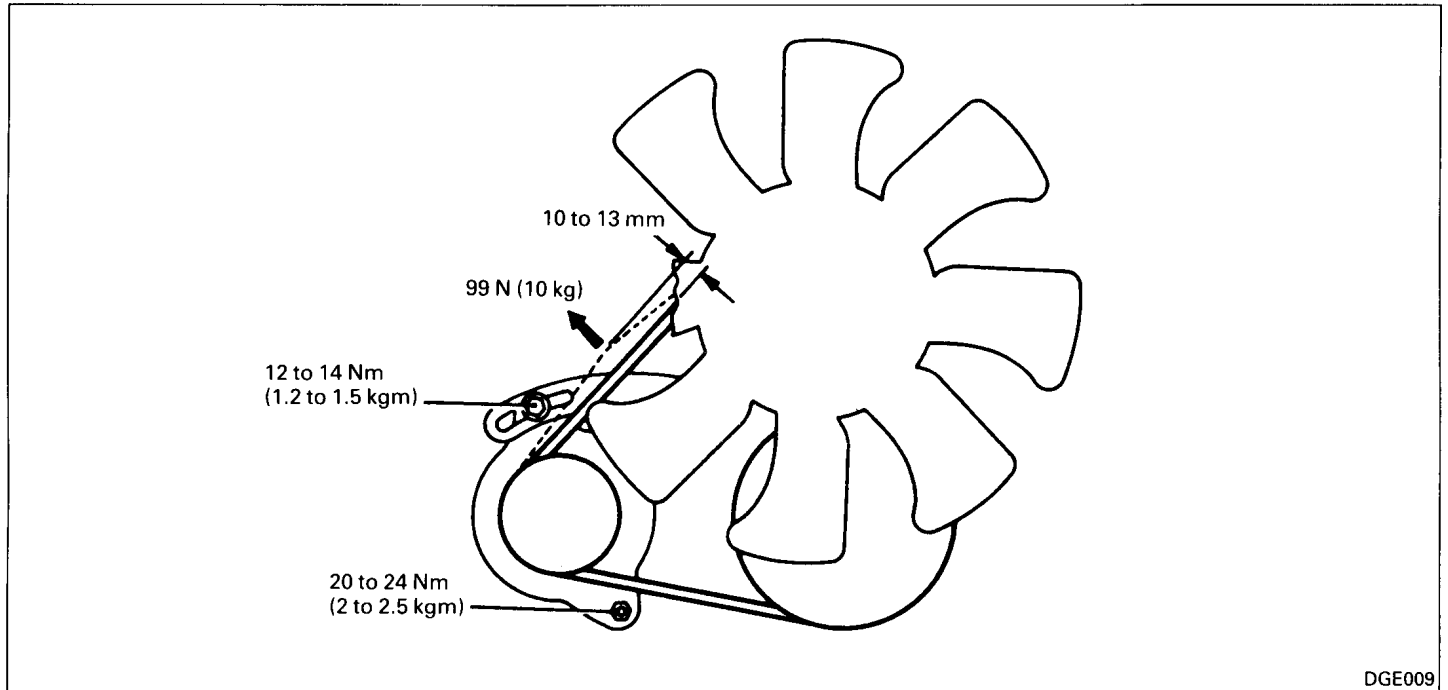
Caution

- **The valve clearance adjustment shall be preceded by additional tightening of the cylinder head bolts.**

1. Warm up the engine until the coolant is heated to 80 to 90°C.
2. Loosen the rocker arm nut and turn the adjust screw to measure and adjust the valve clearance with a thickness gauge.
3. Tighten the nut while holding the adjust screw to prevent it from turning.

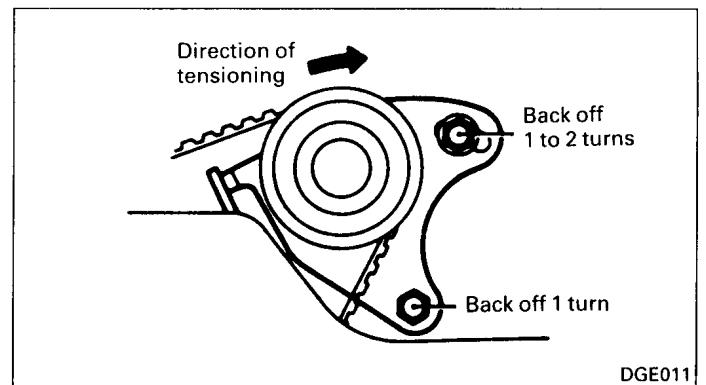
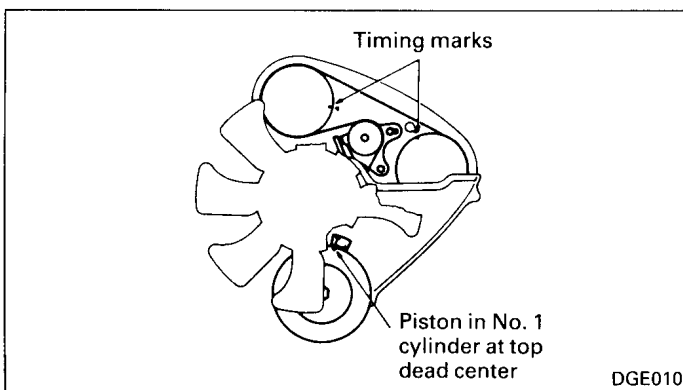
The valves shown in illustration can have their clearance adjusted when the piston in No. 1 cylinder is at the top dead center on compression stroke or the piston in No. 4 cylinder at the top dead center on compression stroke.

6.4 ADJUSTING FAN BELT TENSION



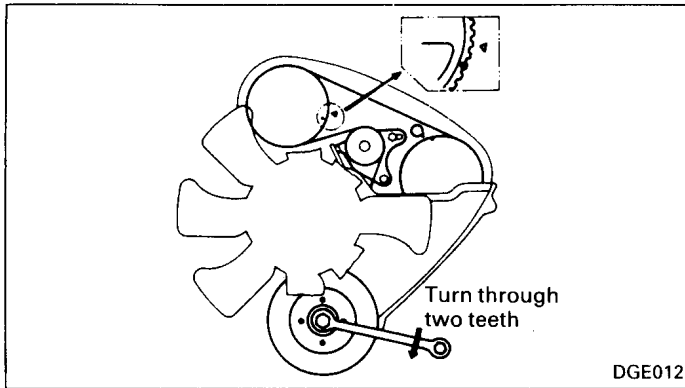
Adjust the position of the alternator so that the belt deflects 10 to 13 mm when it is pulled in the direction normal to the belt with a force of approximately 99 N (10 kg) at a point halfway between the water pump pulley and the alternator pulley.

6.5 ADJUSTING TIMING BELT TENSION

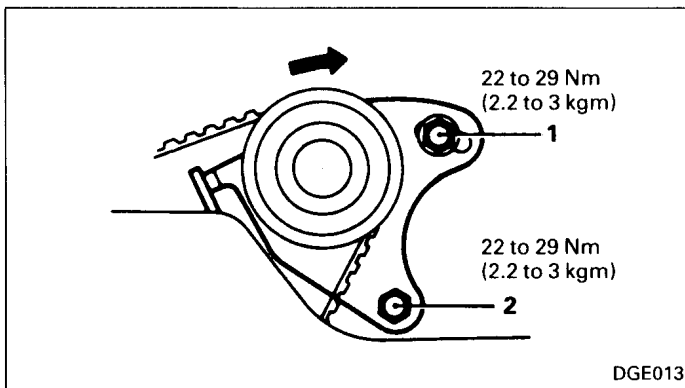


1. Remove the timing belt upper cover and bring the piston in No. 1 cylinder to the top dead center on the compression stroke. Check that the timing marks of the chain and sprockets are aligned. (If not, see "Timing Belt".)

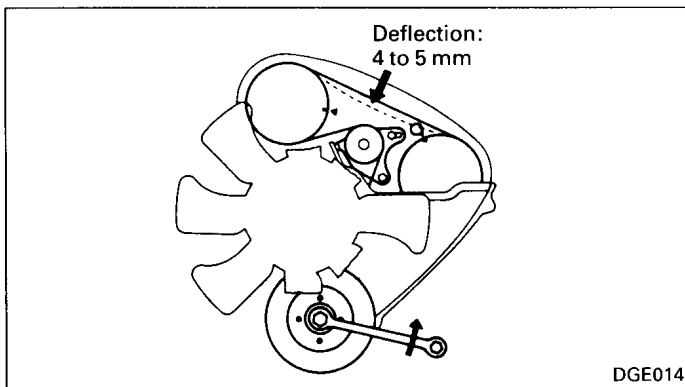
2. Loosen the timing belt tensioner mounting bolts. This causes the tensioner spring to work for automatic tensioning of the timing belt.



3. Turn the crankshaft in the normal direction through two teeth of the camshaft sprocket and hold in this position. Be sure to turn smoothly by the specified amount as this operation is necessary to give a fixed tension to the tension side of the belt.

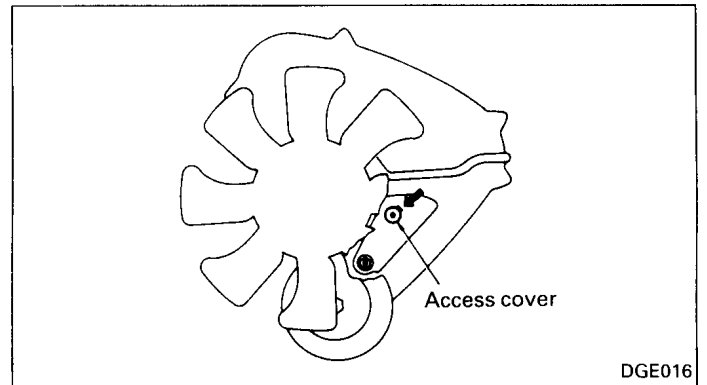


4. Tighten the two tensioner mounting bolts. In order to prevent free rotation of the tensioner bracket, first tighten the bolt (on oblong hole side) and then tighten the other bolt.

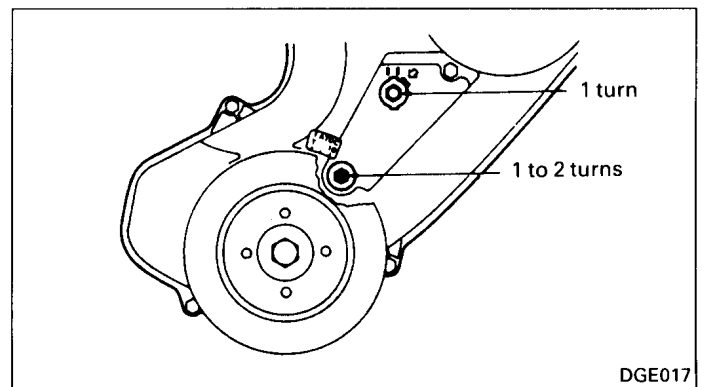


5. Turn the crankshaft in reverse direction until the timing marks are aligned. Then, check the belt tension by pushing down the belt with a forefinger at a point halfway between the cam sprocket and the injection pump sprocket.

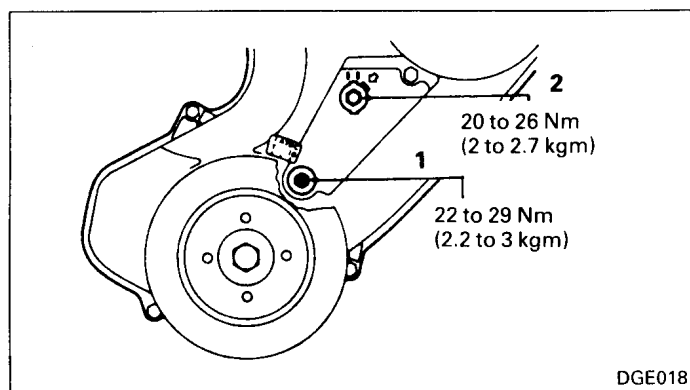
6.6 ADJUSTING TENSION OF TIMING BELT "B" (SILENT SHAFT DRIVE BELT)



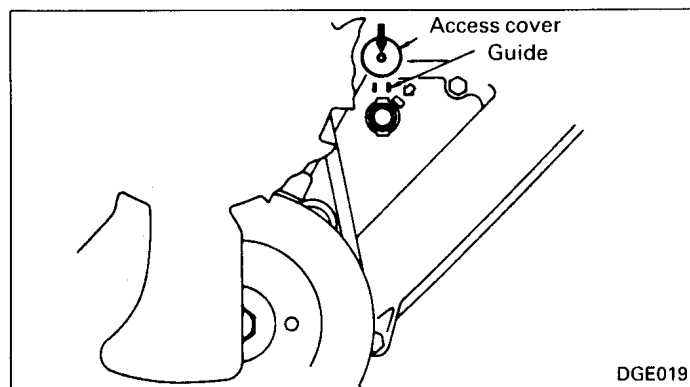
1. Turn the crankshaft to bring the piston in No. 1 cylinder to the top dead center on the compression stroke, and remove the access cover. Inserting a screwdriver tip through the position indicated by the arrow and prying up the cover will facilitate its removal.



2. Loosen the tensioner mounting bolts and nuts. This will result in proper tensioning of the belt "B".



3. Tighten the tensioner mounting nuts and bolts. In order to prevent rotation of the tensioner bracket, be sure to tighten the nut (lower side) first.



4. Mount the access cover, sliding down along the two embossed lines of the front lower cover.

6.7 BLEEDING FUEL SYSTEM

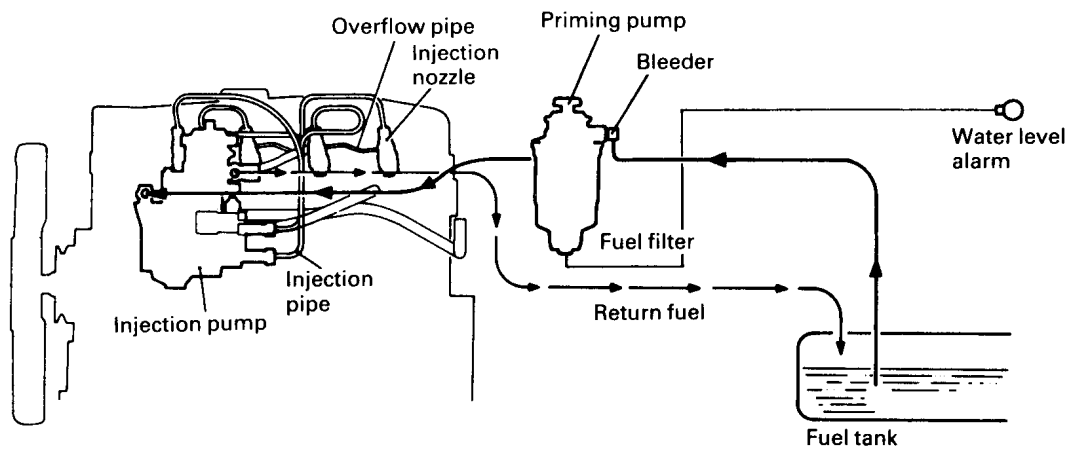
Whenever the fuel piping is disconnected or the fuel filter is replaced, bleed the fuel system in the following procedure:

1. Cover the bleeder plug at the fuel filter top with a cloth.
2. Loosen the bleeder plug.
3. Operate the priming pump until bubble-free flowing is seen.
4. Firmly tighten the bleeder plug and wipe the spilled fuel with a cloth.

Caution:

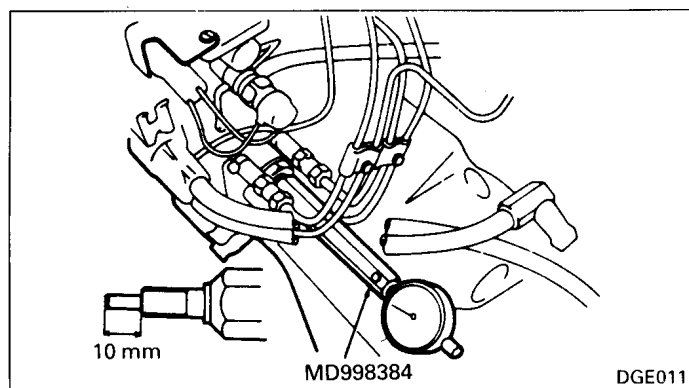
- **Be sure to completely remove the spilled fuel.
If the fuel is left unremoved, it could get fire.**

5. Operate the priming pump until it becomes hard to operate.



DGE020

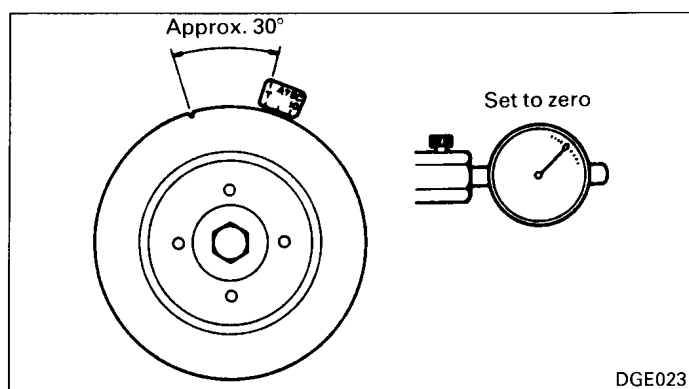
6.8 ADJUSTING INJECTION TIMING



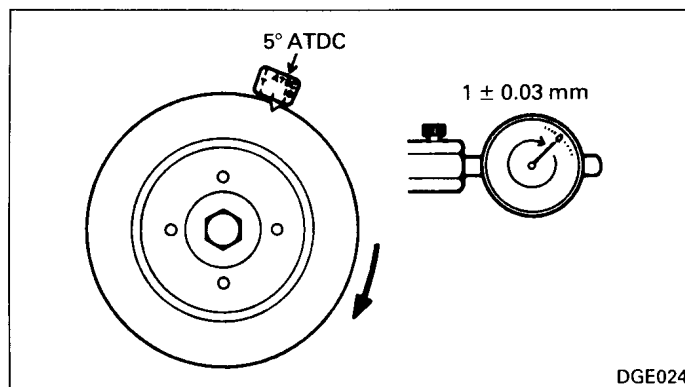
1. Remove the plug from the rear of the injection pump and attach the prestroke measuring adapter (MD998384) and a dial indicator.

Caution

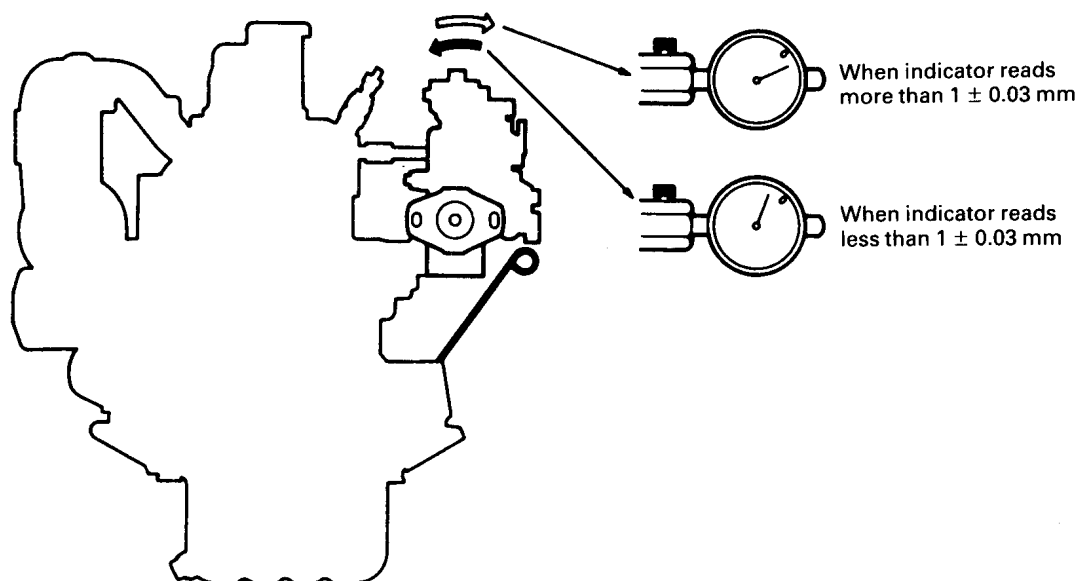
- Before installation of adapter, make sure that the push rod is protruding by 10 mm.
- Protrusion of push rod can be adjusted with an inner nut.



2. Turn the crank pulley to such a position that the notch on the pulley is at approximately 30° before the top dead center on the compression stroke of the piston in No. 1 cylinder. Then, set the dial indicator to zero. Slightly turn the crank pulley clockwise and counterclockwise to make sure that the dial indicator pointer does not deviate from the zero position. If it does, readjust the pulley position so that the notch on the pulley is at 30° before the top dead center.

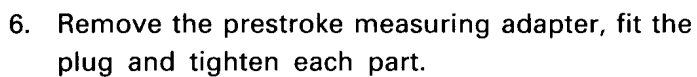


3. Turn the crankshaft in the normal direction to bring the notch to 5° ATDC, and check that the dial indicator reads 1 ± 0.03 mm.

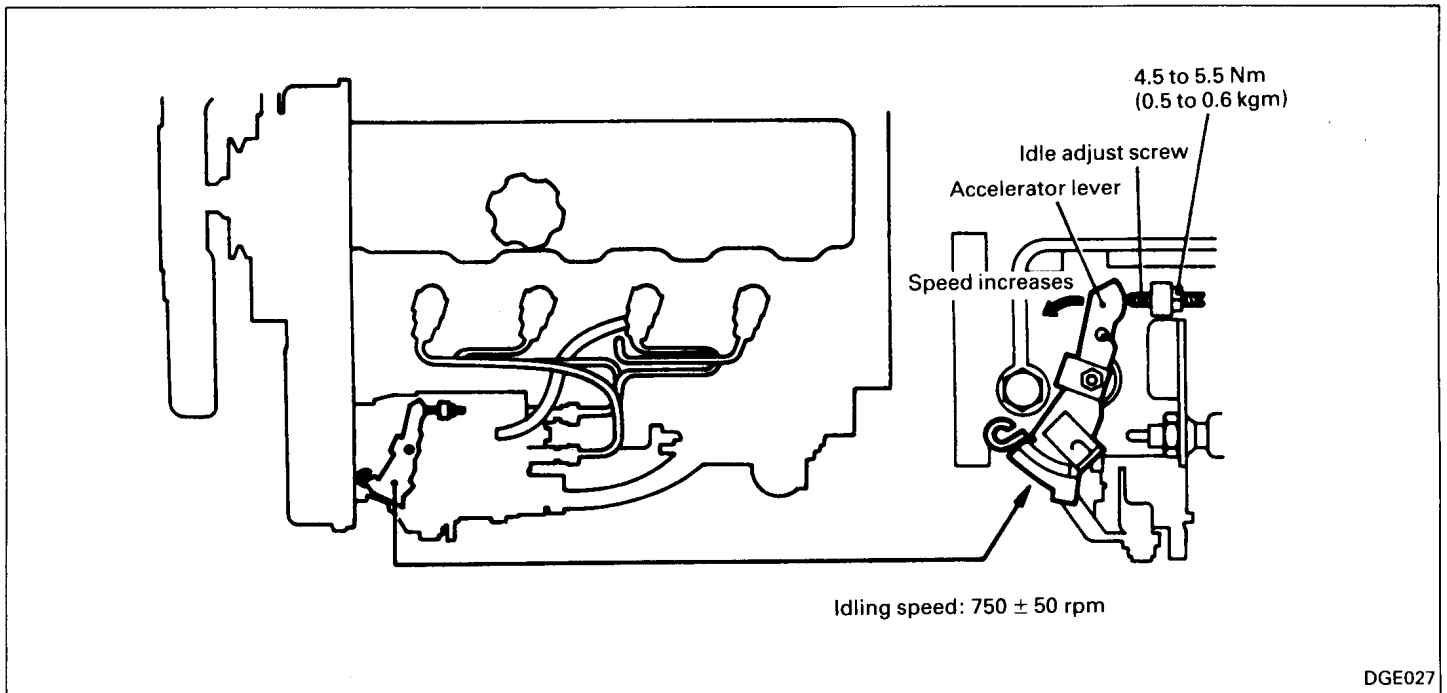


DGE025

4. If the dial indicator does not indicate the specified value, tilt the injection pump body to the right or left until the dial indicator reads 1 ± 0.03 mm. Then, provisionally tighten the bolts securing the injection pump.
5. Repeat Steps 2. thru 4. to check that the adjustment has been made correctly.



6.9 ADJUSTING IDLING SPEED



Check the following before attempting to adjust the idling.

1. The engine has been warmed up sufficiently to heat the coolant to 80 to 90°C.
2. The valve clearance has been adjusted correctly. Adjust as necessary.
3. The injection timing is as specified (5° ATDC).
4. The fast idle is released.
5. The injection nozzle operates normally.

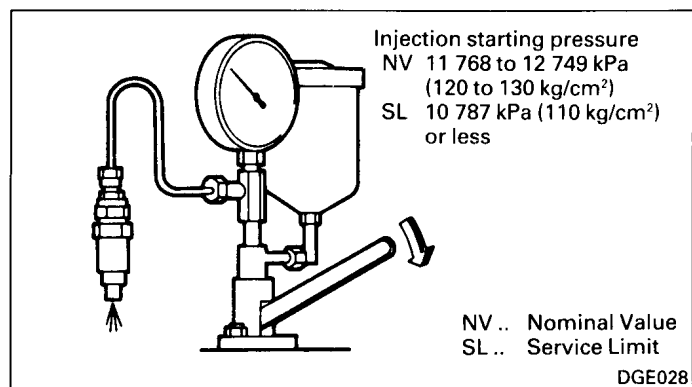
Adjust the idling as follows.

1. Loosen the lock nut of the idle adjust screw and turn the screw clockwise or counterclockwise to obtain an idling speed of 750 ± 50 rpm. After adjustment, tighten the lock nut.

Caution:

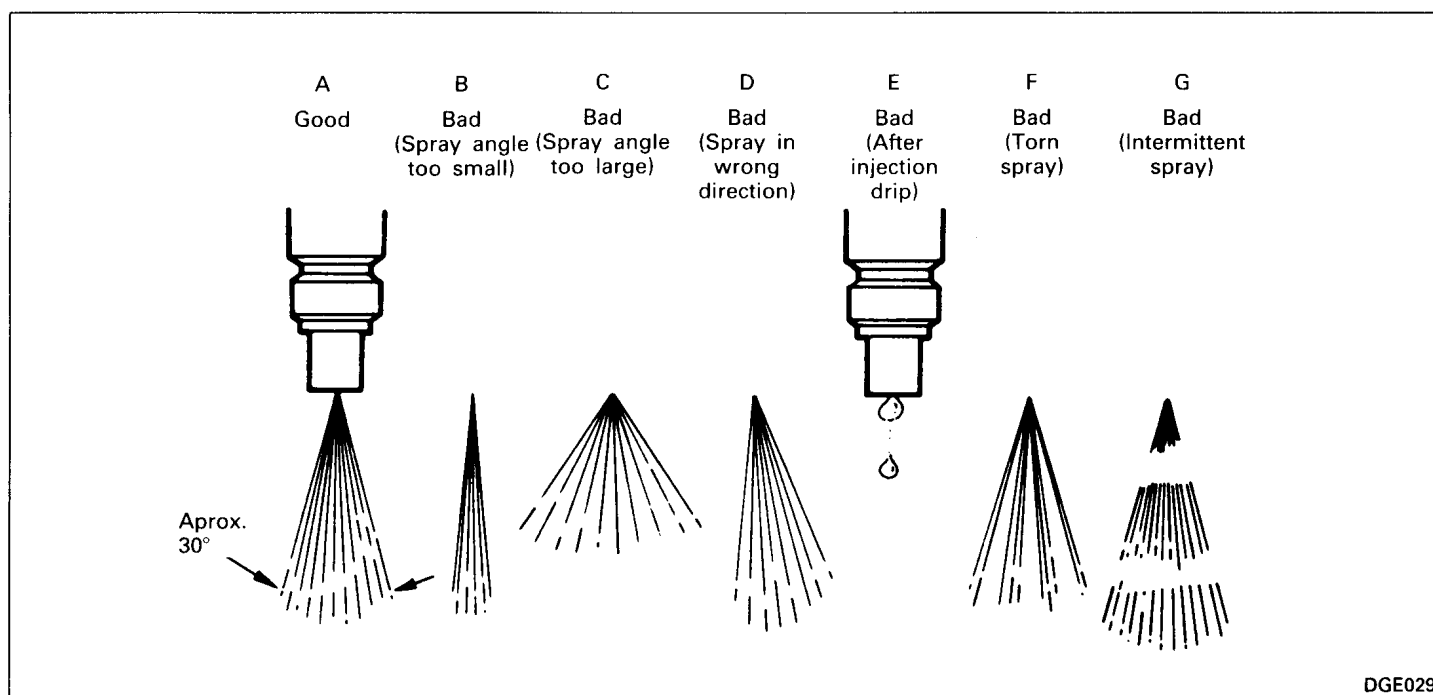
- **Do not disturb other screws.**

6.10 CHECKING NOZZLE



Check the nozzles for the following items and correct or replace defective nozzle.

Checking Spray Condition



1. Operate the tester handle at a rate of approximately one stroke/min.

- Vibrating condition of needle valve

When the tester handle is stroked, the nozzle should inject, producing characteristic intermittent noises (Schnarre), and the vibration of the needle valve should be felt at the tester handle.

- Spraying condition

The spray pattern A shown in above figure is normal, all other patterns being abnormal. Sometimes, the fuel may be injected in a straight stream of coarse particles, leaving fuel oil in the orifice after injection. This phenomenon occurs only during the check and does not mean abnormal nozzle function.

2. Operate the tester handle at a rate of approximately 4 to 6 strokes/second.
 - A normal spray pattern obtained should be a circular cone with a vertical angle of approx. 30° and made of uniform and fine mist. Patterns other than pattern A represent abnormal conditions.

Checking Oil Tightness of Nozzle

Operate the nozzle tester to maintain the nozzle inside pressure at 9 807 to 10 787 kPa (100 to 110 kg/cm²) as indicated by the pressure gauge, and check for fuel leaks from the nozzle tip.

6.11 CHECKING COMPRESSION PRESSURE

Prior to checking the compression pressure, ensure that:

1. The engine oil, air cleaner, starting motor and batteries are all in normal condition.
2. The engine is warmed up [coolant temperature: 80 to 90°C].

Check the compression pressure as follows.

1. Loosen the injection pipe nut on the nozzle side and remove the pipe from the nozzle holder.

Caution:

- **Keep the nozzle capped to prevent entry of foreign matter.**
2. Remove the glow plugs from all cylinders and attach the compression gauge adapter and the compression gauge to the cylinder under test.
 3. Turn on the starting motor to start the engine and read the compression gauge after its pointer has stabilized.

Description	Nominal value
Engine speed	250 rpm
Compression pressure	2 256 kPa (23 kg/cm ²) or more
Pressure difference among cylinders	294 kPa (3 kg/cm ²) or less

Caution:

- **When checking the pressure, remember that the fuel will gush out from the injection pipe.**
4. After measurement, remove the compression gauge and the compression gauge adapter and attach the glow plugs and the injection pipe.

Part to be tightened	Torque
Injection pipe nut	23 to 36 Nm (2.3 to 3.7 kgm)
Pipe clamp nut	8 to 9 Nm (0.8 to 1.0 kgm)
Glow plug	15 to 19 Nm (1.5 to 2.0 kgm)

ENGINE

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1. SPECIFICATIONS

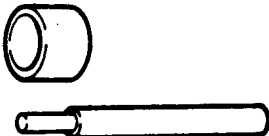
Description	Specifications	Remarks
Cylinder head		
Material	Aluminum alloy	
Combustion chamber type	Swirl chamber	
Combustion chamber jet		
Material	Heat resisting steel (press-fit in cylinder head)	
Inlet and exhaust port type	Turn flow type	
Camshaft		
Material	Cast iron (with cam face specially treated)	
Arrangement – drive	OHC – cogged type belt	
Rocker arm		
Material	Aluminum alloy, with tip	
Identification mark		
In.	I	
Ex.	E	
Valve seat		
Material	Heat resisting steel (press-fit in cylinder head)	
Valve		
Face angle	45°	
Identification mark		
In.	N	
Ex.	N	
Valve spring		
Type	Non-uniform pitch, single	
Identification color	Orange	
Cylinder head gasket	Steel asbestos	
Cylinder head bolt	Special steel, 18 pcs.	
Cylinder block		
Cylinder bore	91.1 mm	
Cylinder liner	Dry type	
Water jacket	Full Siamese type	
Crankshaft		
Material	Special alloy	
Surface treatment	Full surface, specially treated	
Identification (by surface color)	Full surface, gray	
Journal dia. x pin dia. x distance between journal and pin centers	66 x 53 x 45 mm	
Crankshaft pulley	With damper	
Drive plate	Ring gear welded	

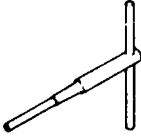
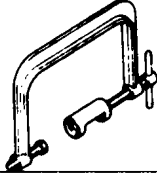
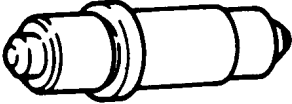
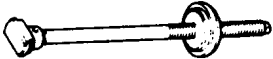
Description	Specifications	Remarks
Piston		
Type	Autothermic type	
Coupling to connecting rod	Full floating type	
Cooling	Oil jet cooling	
Piston ring		
No. 1	Barrel type, chrome face	
No. 2	Taper type, chrome face	
Oil	Bevel cutter type, chrome face, with coil expander	
Silent shaft		
Right	Counterclockwise rotation by idler gear (opposite to crankshaft rotation)	
Left	Clockwise rotation	
Timing belt		
Type	Cogged type	
Driven units	Camshaft and fuel injection pump	
Loose belt alarm	Timing belt switch	
Timing belt "B"		
Type	Cogged type	
Driven units	Right and left silent shafts	
Oil pump		
Type	Geared type (internal gear in mesh)	
Drive	Directly coupled to crankshaft	

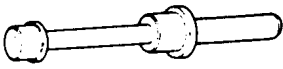
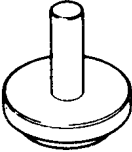
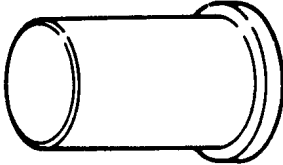
2. TORQUE

Item	Nm	Torque kgm
Cylinder head bolts – Cold engine	103 – 112	10.5 – 11.5
Cylinder head bolts – Hot engine	113 – 122	11.5 – 12.5
Camshaft bearing cap bolts	19 – 20	1.9 – 2.1
Camshaft sprocket bolt	64 – 73	6.5 – 7.5
Rocker arm shaft bolts	35 – 39	3.5 – 4
Rocker cover bolts	5 – 7	0.5 – 0.7
Intake and exhaust manifold nuts or bolts	15 – 19	1.5 – 2
Rocker arm adjusting nuts	12 – 17	1.2 – 1.8
Main bearing cap bolts	74 – 83	7.5 – 8.5
Connecting rod cap nuts	45 – 47	4.5 – 4.8
Crankshaft pulley bolts	167 – 186	17 – 19
Silent shaft sprocket bolt	34 – 39	3.4 – 4
Timing belt tensioner nut	22 – 29	2.2 – 3
Front case bolts	12 – 14	1.2 – 1.5
Silent shaft chamber cover bolts	4 – 5	0.4 – 0.6
Drive plate bolts	128 – 137	13 – 14
Engine support bracket bolts	40 – 49	4 – 5
Oil pressure switch or gauge unit	8 – 11	0.8 – 1.2
Oil pan bolt	6 – 7	0.6 – 0.8
Oil pan drain plug	59 – 78	6 – 8
Oil filter	11 – 12	1.1 – 1.3
Oil relief valve plug	30 – 45	3 – 4.5
Water temperature gauge unit	30 – 39	3 – 4
Clutch wheel	128 – 137	13 – 14
Fluid coupling to drive plate bolt	49 – 57	5 – 5.9

3. SPECIAL TOOLS

Tool name	Part No.	Shape	Use
Cylinder Head Bolt Wrench	MD998051		Loosening and tightening cylinder head bolts
Camshaft Oil Seal Installer	MD998381		Driving in camshaft oil seal
Valve Guide Installer	MD998115		Removing and installing valve guide

Tool name	Part No.	Shape	Use
Valve Stem Seal Installer	MD998377		Driving in valve stem seal
Valve Seat Cutter Pilot	MD998148		Correcting valve seat
Valve Seat Cutter 45°	MD998158		Correcting valve seat
Valve Seat Cutter 65°	MD998165		
Valve Seat Cutter 30°	MD998175		
Valve Spring Compressor	MD998303 (Commercially available tool acceptable)		Compressing valve spring
Connecting Rod Small End Bushing Replacement Tool	MD998386		Replacing connecting rod small end bushing
Silent Shaft Drive Gear Oil Seal Guide	MD998385		Mounting silent shaft drive gear oil seal
Silent Shaft Bearing Puller	MD998251		Removing silent shaft rear bearing

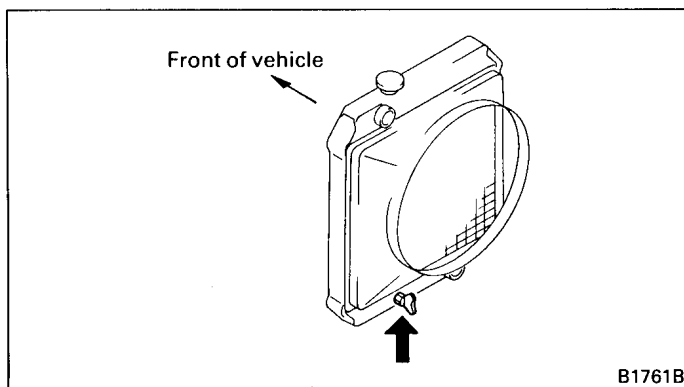
Tool name	Part No.	Shape	Use
Silent Shaft Bearing Installer	MD998250		Driving in silent shaft rear bearing
Bearing Installer Stopper	MD998380		
Crankshaft Rear Oil Seal Installer	MD998376		Driving in crankshaft rear seal
Crankshaft Front Oil Seal Guide	MD998382		Driving in crankshaft front seal
Crankshaft Front Oil Seal Installer	MD998383		

4. ENGINE REMOVAL AND INSTALLATION

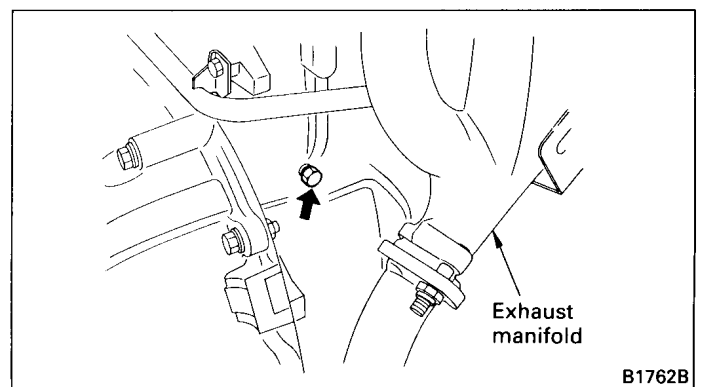
4.1 PREPARATION BEFORE REMOVAL

1. Apply chocks to the rear wheels.
2. Disconnect the negative (ground) cable from the battery.
3. Drain off the coolant.

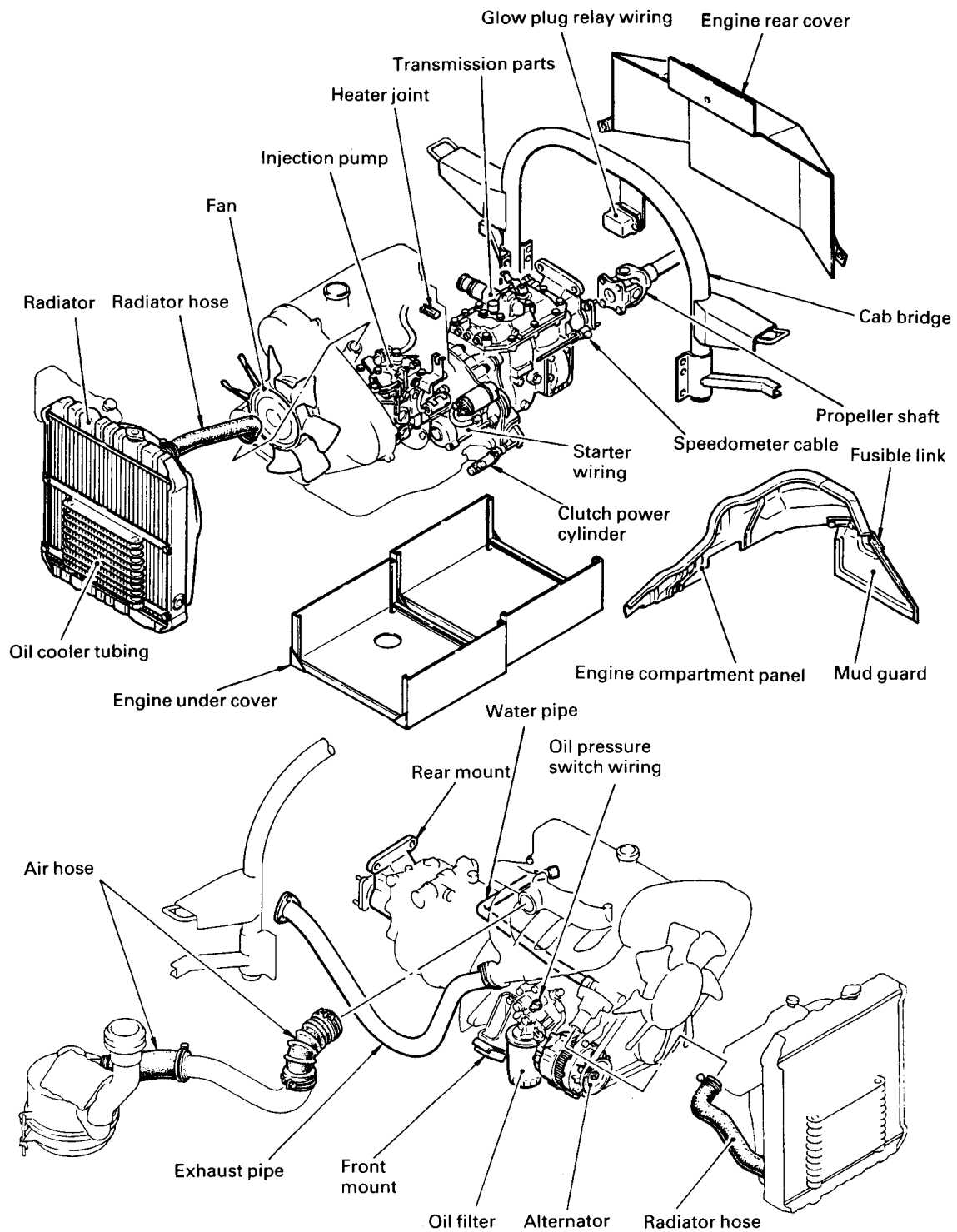
Radiator Drain Cock



Crankcase Drain Plug



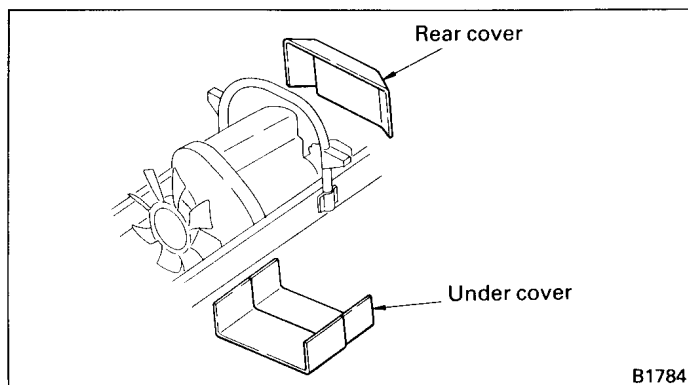
4.2 MAJOR PARTS FOR REMOVAL



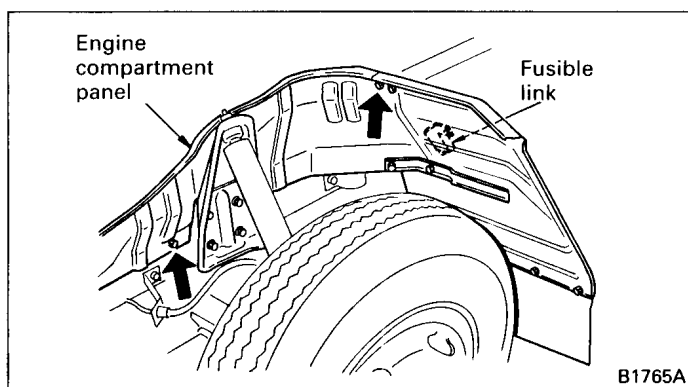
B1783A

4.3 REMOVAL OF EACH PART

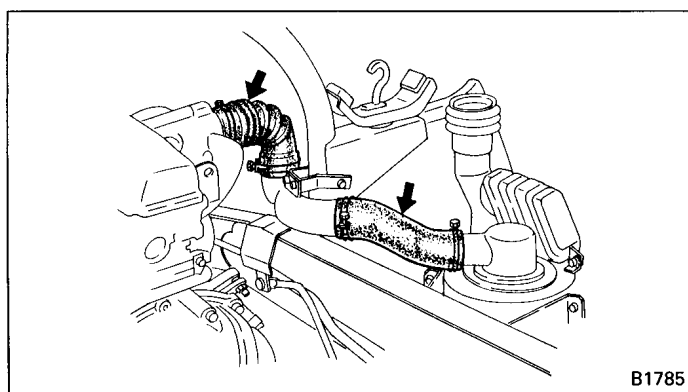
Engine Rear Cover and Under Cover



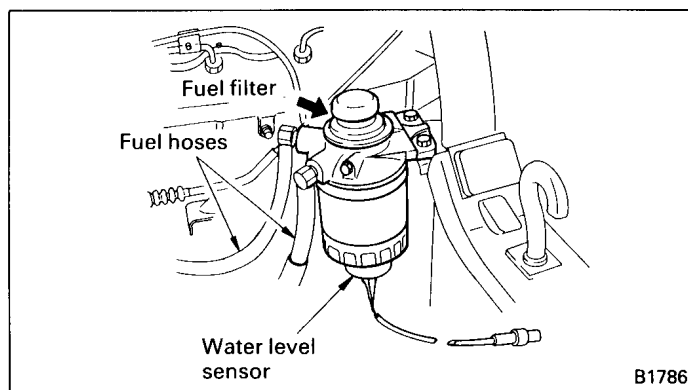
Engine Compartment Panel



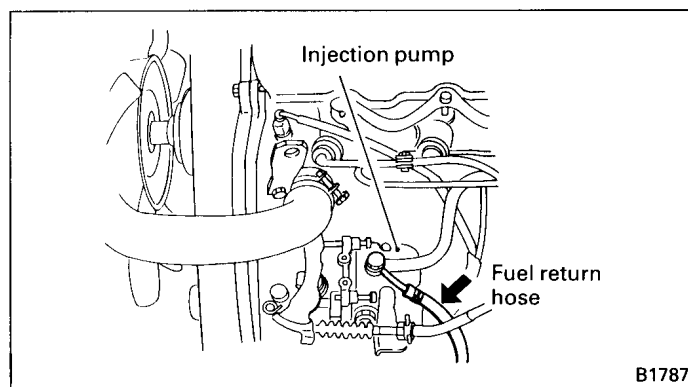
Air Intake Hose



Fuel Filter

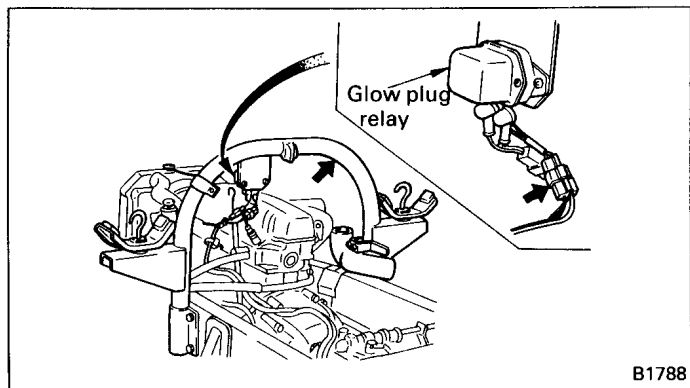


Fuel Hose

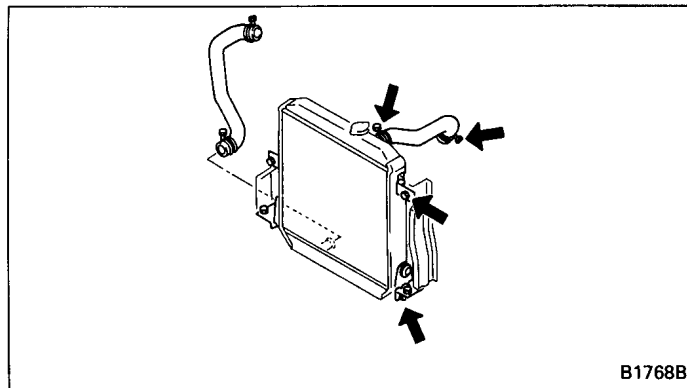


After removal of the hose, hold its end at a higher level than the fuel tank to prevent the fuel from flowing out of the hose.

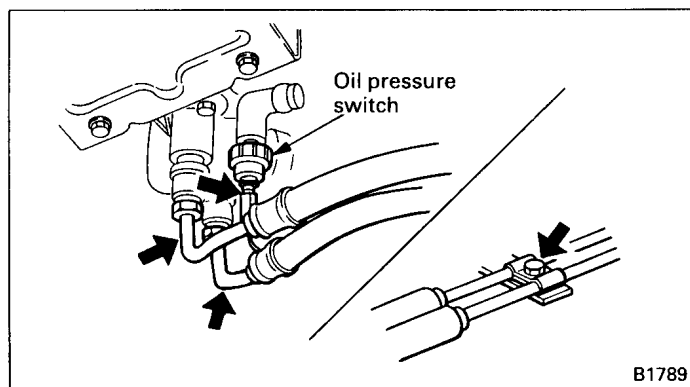
Cab Bridge and Glow Plug Relay Wiring



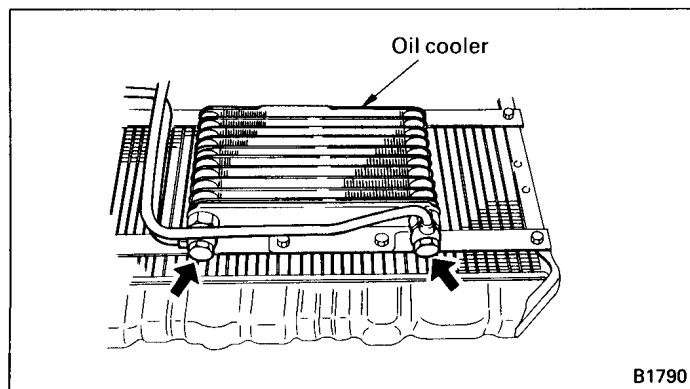
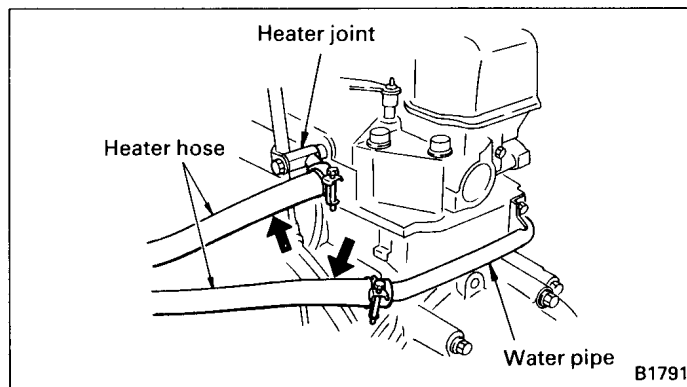
Radiator and Radiator Hose



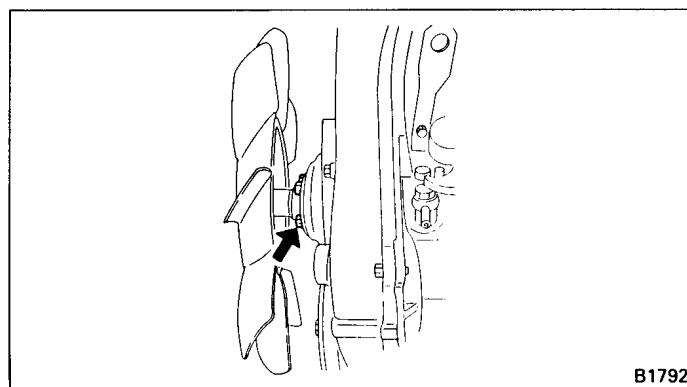
Oil Cooler Piping and Oil Pressure Switch Wiring



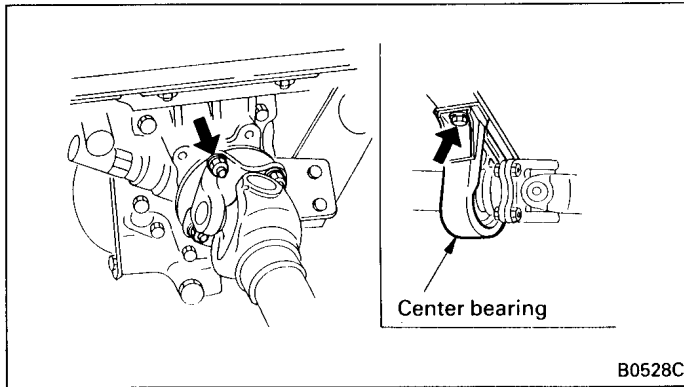
Heater Hose (Engine with Heater)



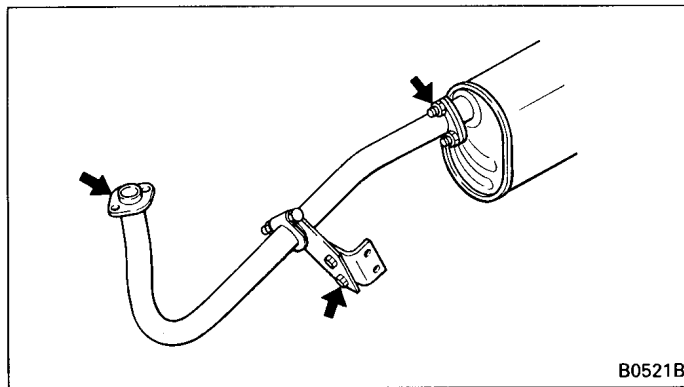
Cooling Fan



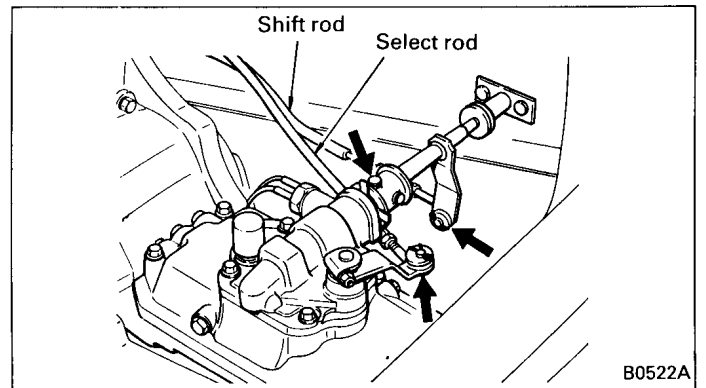
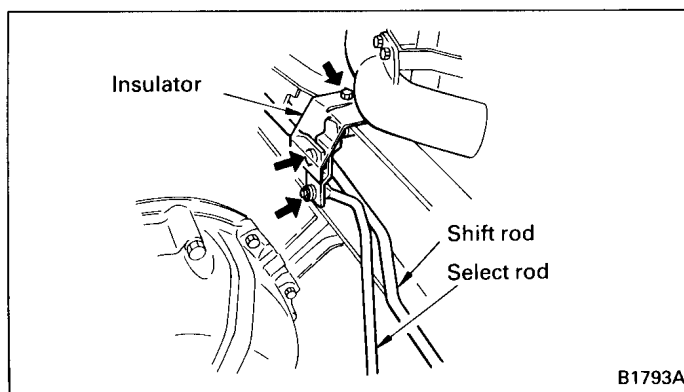
Propeller Shaft



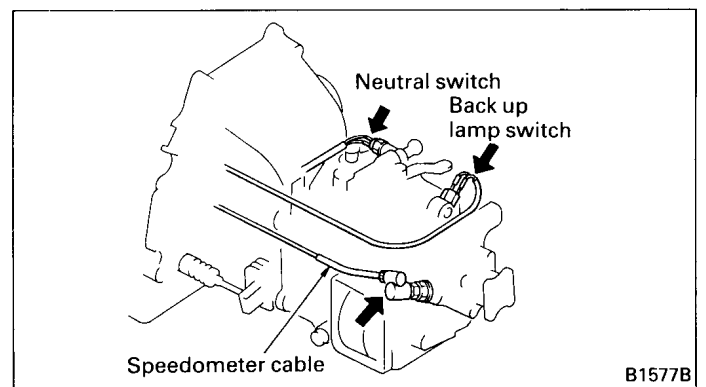
Exhaust Pipe



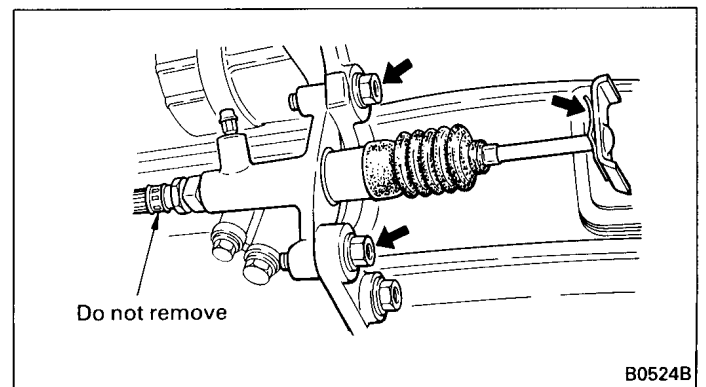
Transmission Control



Transmission Wiring

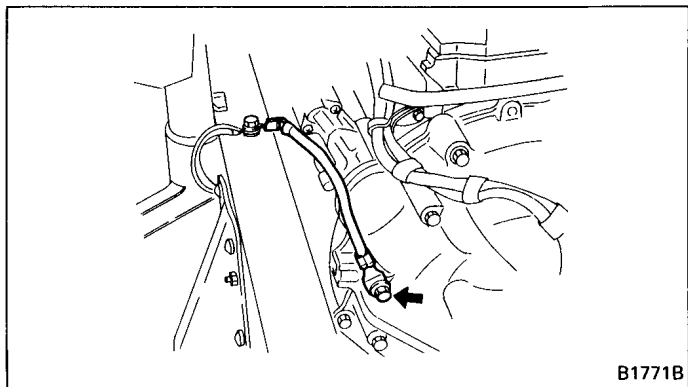


Clutch Power Cylinder

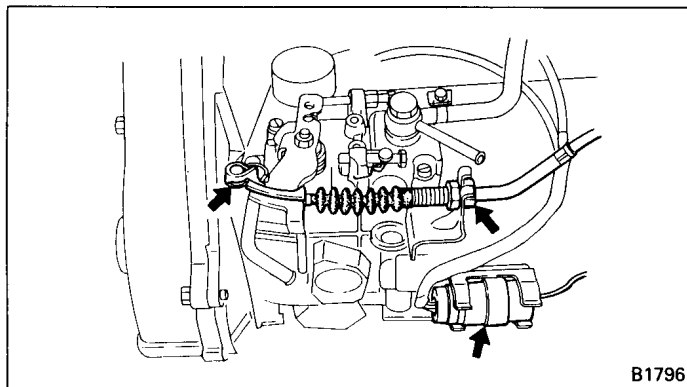


After removal of the ground secure it with a rope or the like.

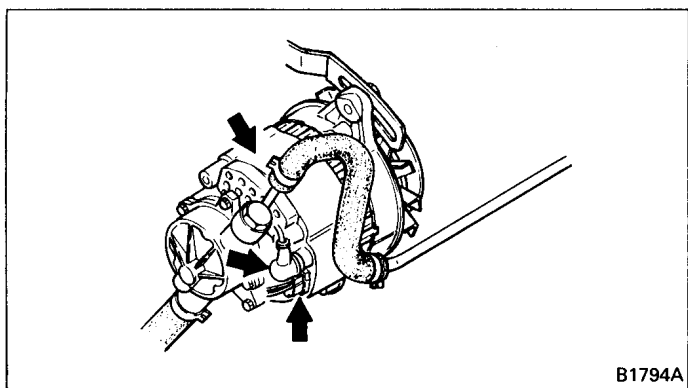
Engine Ground



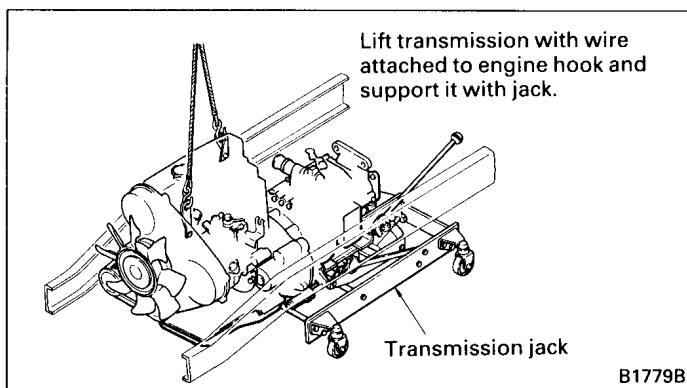
Accelerator Control Cable and Chassis Wiring



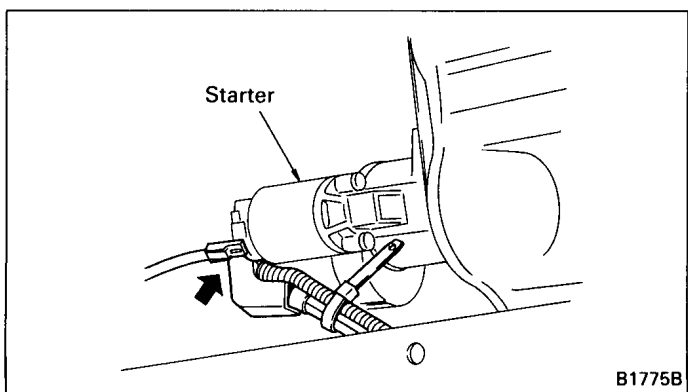
Alternator



Supporting of Transmission

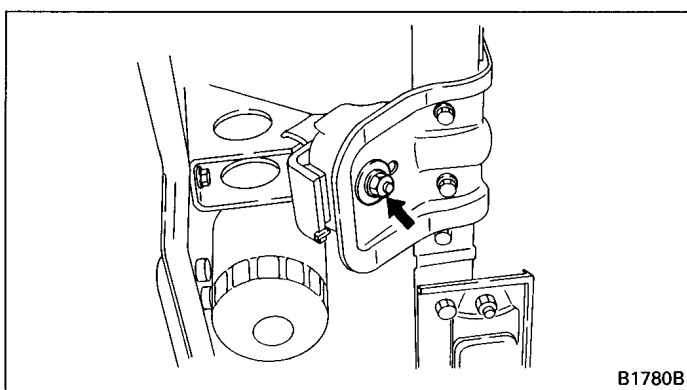


Starter Wiring

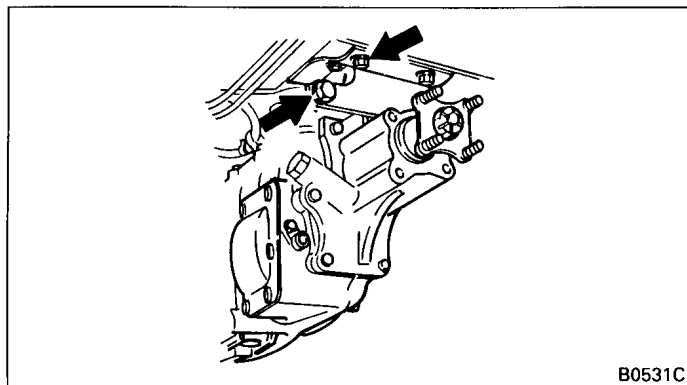


Use engine lifting wire adjustable in length so that the lifting angle may be adjusted for smooth operation.

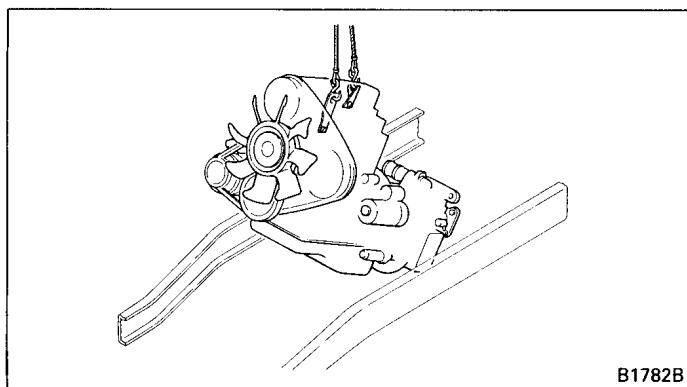
Front Engine Mount



Rear Engine Mount



Lifting of Engine



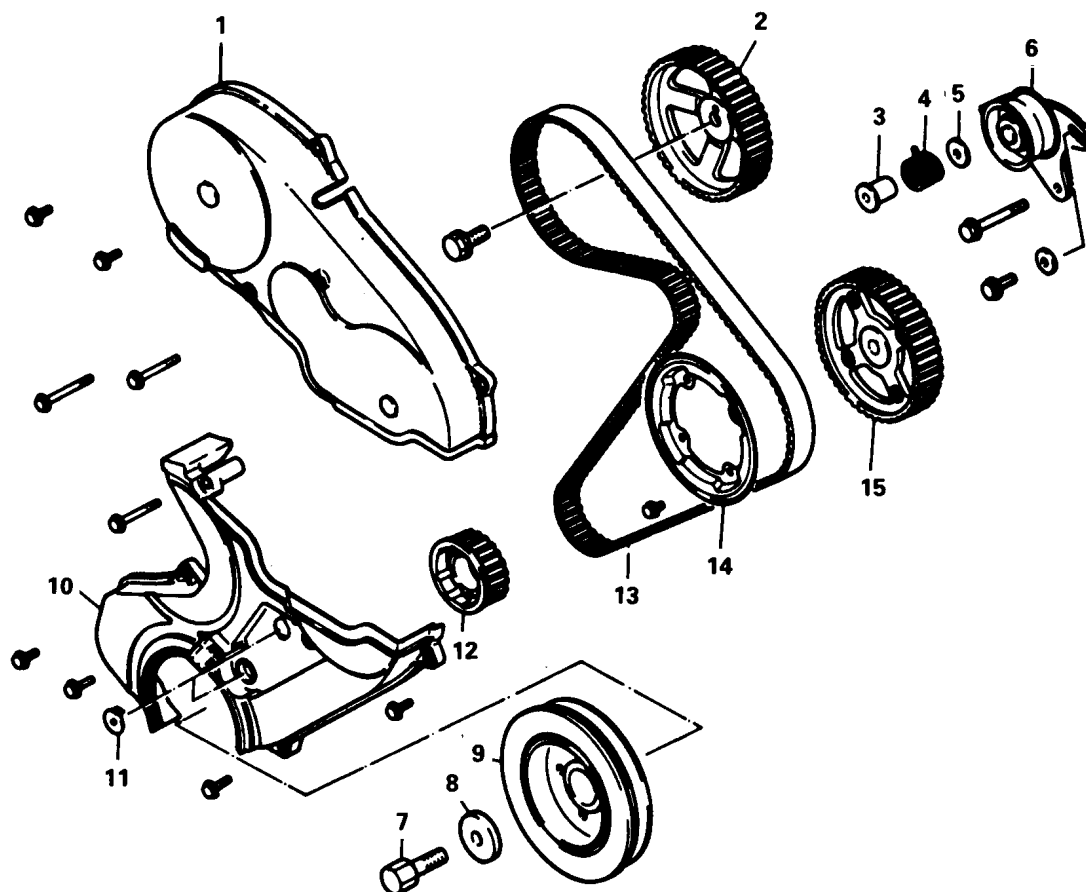
Lift the engine with care not to hit the rear body, cab, etc.

Get the transmission out of the front end of rear body, while the engine lifting angle is finely adjusted. Then, using care not to hit the cab, frame, etc., move the engine sidewise and lower it.

4.4 INSTALLATION

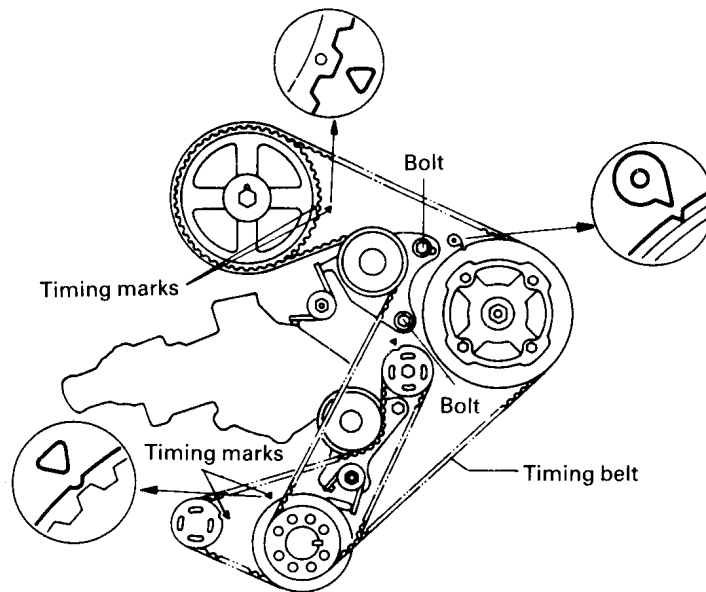
To install the engine, reverse the removal procedure.

5. TIMING BELT



- | | |
|---------------------------|----------------------------|
| 1 Timing belt upper cover | 9 Crankshaft pulley |
| 2 Camshaft sprocket | 10 Timing belt lower cover |
| 3 Tensioner spacer | 11 Access cover |
| 4 Tensioner spring | 12 Crankshaft sprocket |
| 5 Washer | 13 Timing belt |
| 6 Timing belt tensioner | 14 Flange |
| 7 Bolt | 15 Injection pump sprocket |
| 8 Special washer | |

5.1 REMOVAL



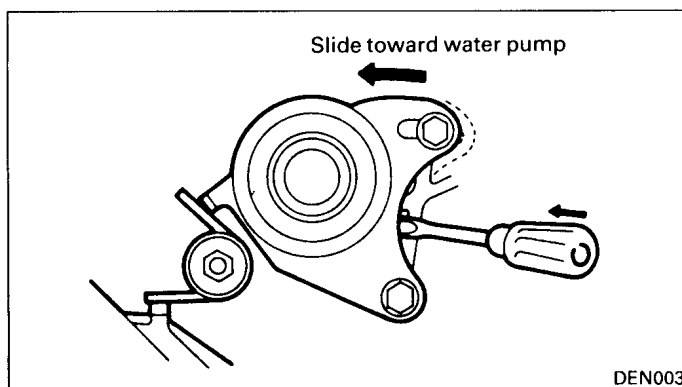
DEN002

1. Remove the cooling fan, water pump, crankshaft pulley and timing belt cover.
2. Turn the crankshaft to bring the piston in No. 1 cylinder to the top dead center on the compression stroke.
The piston in No. 1 cylinder is at the top dead center on the compression stroke when all timing marks at the three places are aligned as shown in illustration.
3. Using chalk or the like, put an arrow on the back of the timing belt, indicating the direction of drive.

5. Remove the timing belt.
6. Loosen the bolt securing the camshaft sprocket and remove the camshaft sprocket.
7. Loosen the nut securing the injection pump sprocket and using a small puller (available commercially) remove the sprocket.
8. Remove the tensioner and tensioner spring.

Caution:

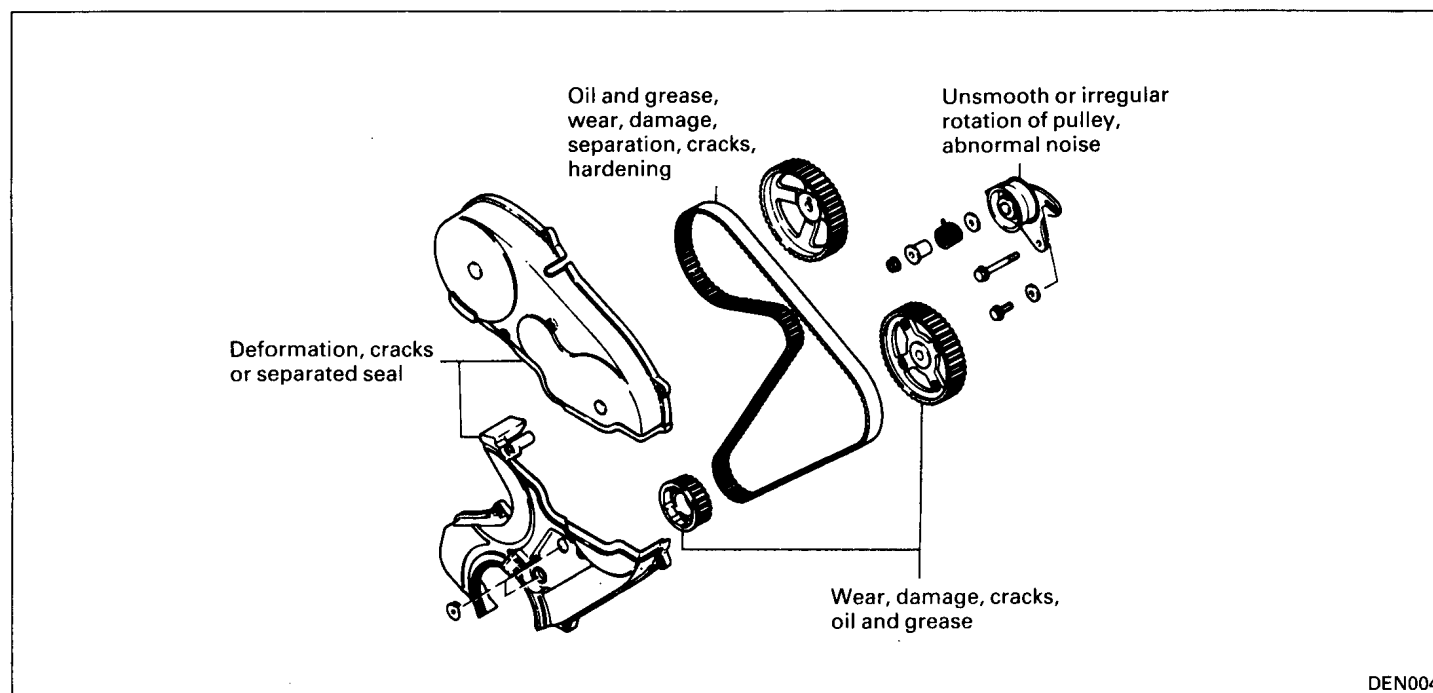
- **Keep the removed parts free from oil and grease.**
- **Do not use detergent to clean the timing belt, sprockets and tensioner. Wipe clean with rag if found dirty. Replace if excessively contaminated by dirt, oil or grease.**



DEN003

4. Slightly loosen the two bolts securing the tensioner. Then, slide the tensioner toward the water pump and tighten the bolts temporarily to secure the tensioner in place.

5.2 INSPECTION

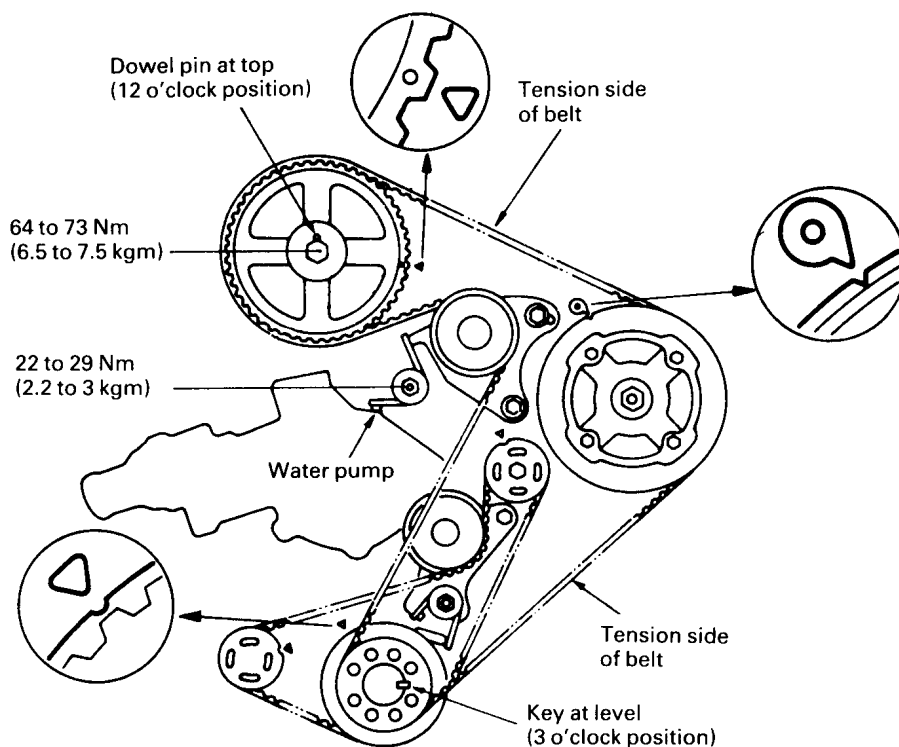


Replace defective parts.

Caution:

- If trace of oil is found on the parts, check the front case oil seals.

5.3 INSTALLATION

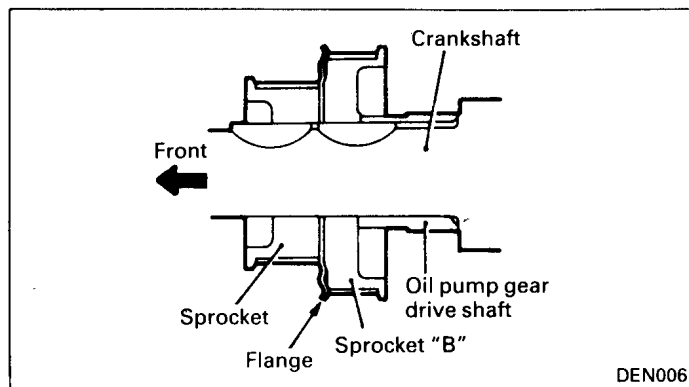


NOTE:

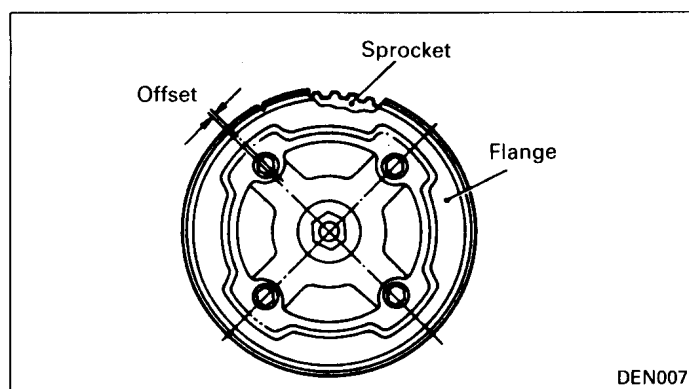
The figure shows the timing belt position when the piston in No. 1 cylinder is at the top dead center on the compression stroke.

DEN005

When installing the timing belt "B", pay attention to the following.



1. Mount the crankshaft sprocket to the crankshaft noting the direction of the sprocket as well as the flange.
2. Mount the camshaft sprocket and tighten the flange bolts to specified torque.
3. Mount the injection pump sprocket and tighten the nut to specified torque.



4. Mount the flange to the injection pump sprocket.
5. Mount the tensioner, tensioner spring and tensioner spacer. Shift the tensioner toward the water pump as far as it goes and secure in place temporarily. (See page 11-15.)
6. Correctly align the timing marks of the three sprockets.
7. Engage the timing belt first with the crankshaft sprocket, then with the injection pump sprocket, tensioner and the camshaft sprocket in the order of mention.

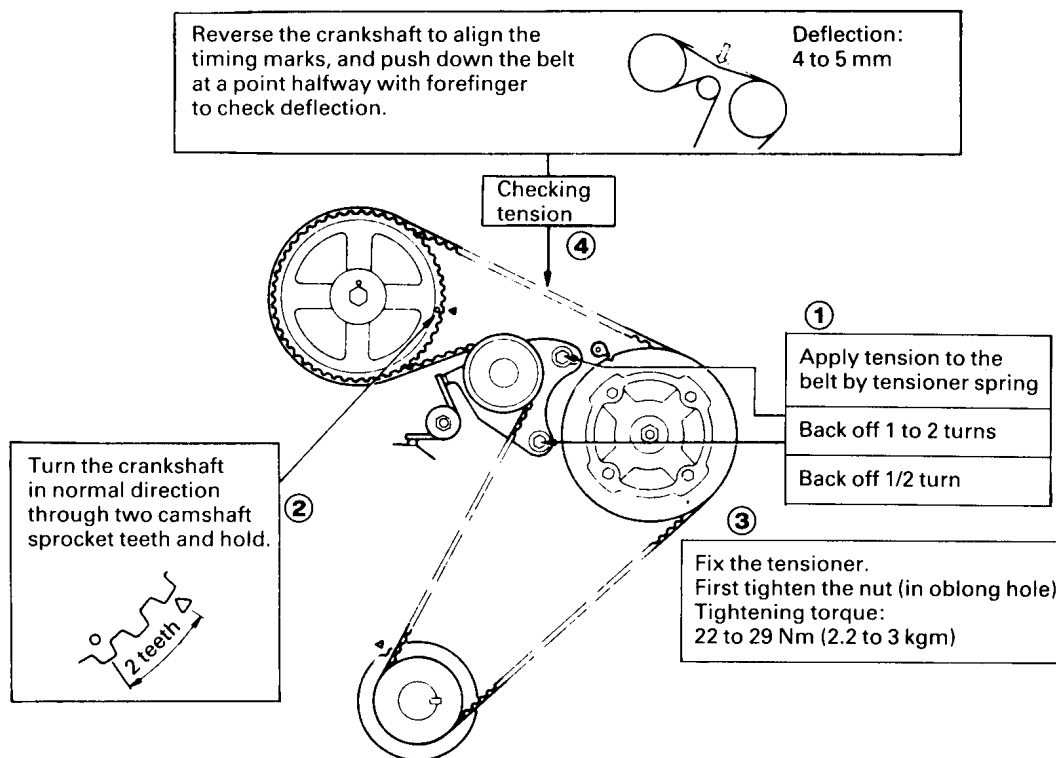
Caution:

- With the tension side kept taut, engage the belt with each sprocket.
- When aligning the timing marks, the injection pump sprocket tends to rotate itself. Therefore, engage the belt, holding the sprocket to prevent rotation.
- When refitting the belt, note the arrow put on its back during disassembly to indicate the direction of drive.

8. Adjust the belt tension.
9. Mount the timing belt covers.
10. Mount the crankshaft pulley, washer and bolt and torque the bolt to 167 to 186 Nm (17 to 19 kgm).

5.4 ADJUSTING TIMING BELT TENSION

Adjust the belt tension as follows (carry out the steps in numerical order).

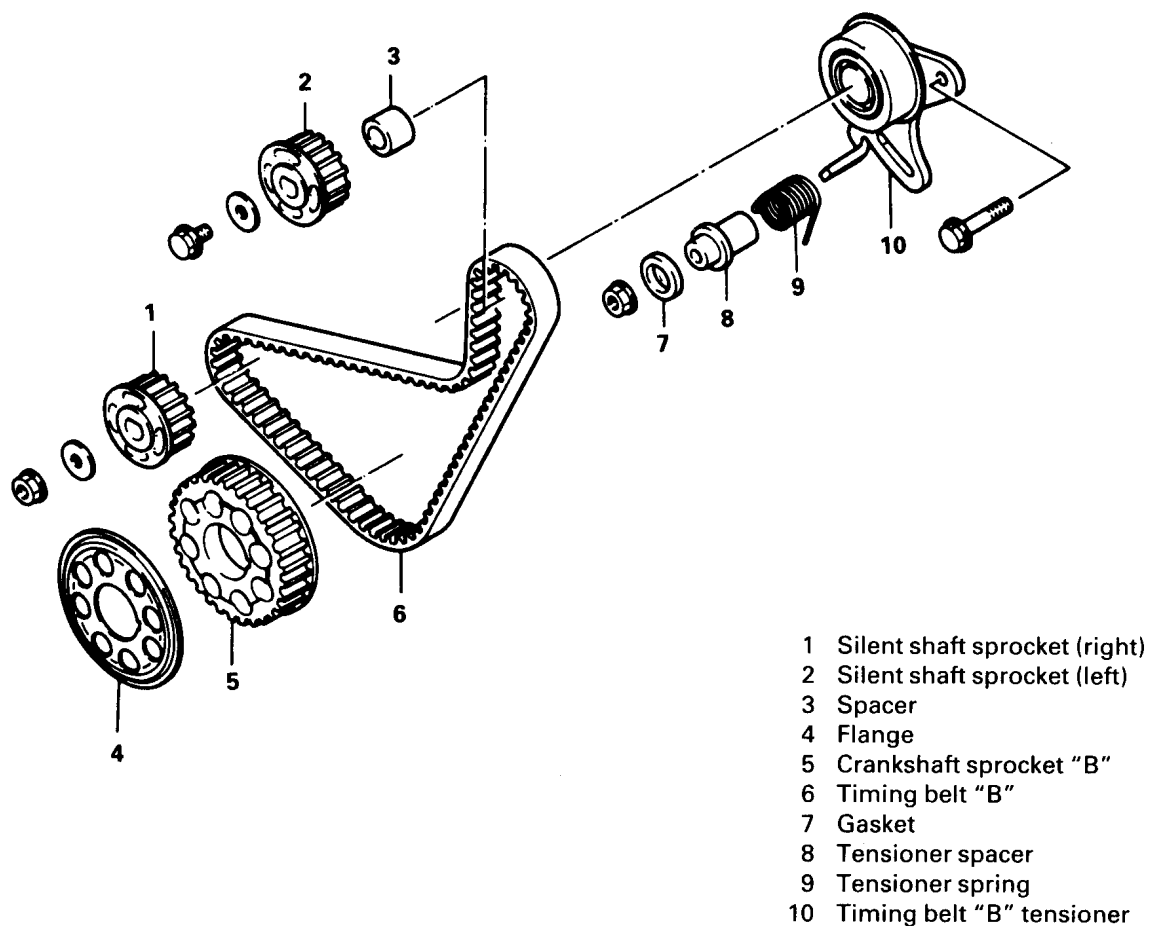


DEN008

Caution:

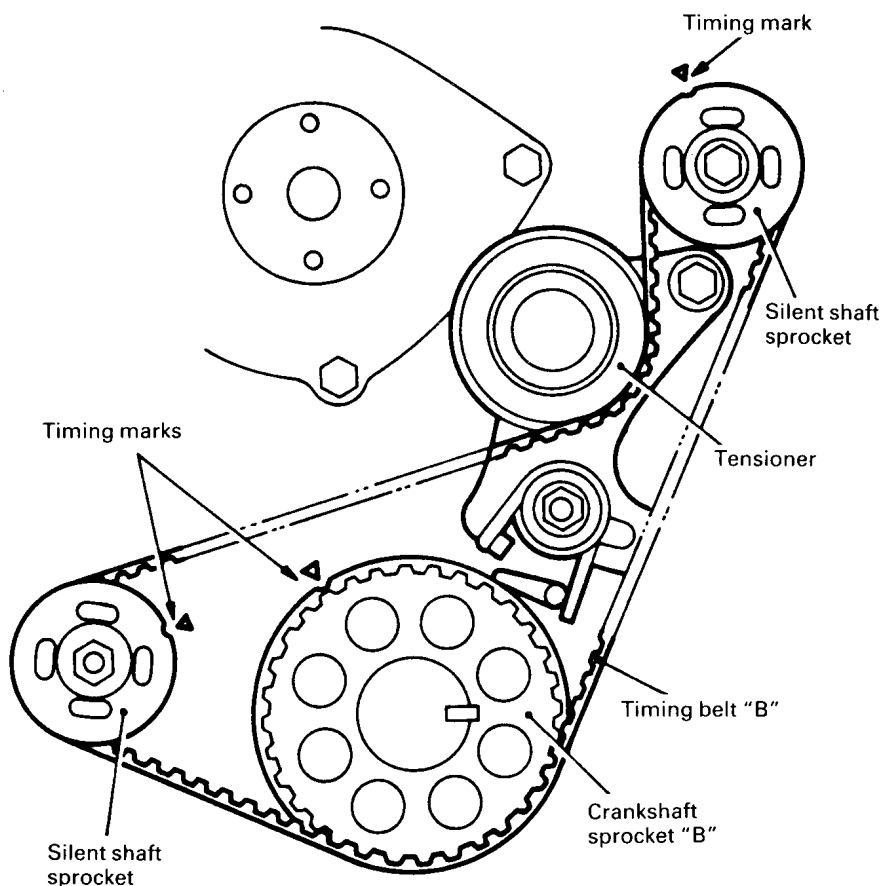
- **Crankshaft rotation ② is necessary to give specified tension to the tension side of the belt.**
Turn the crankshaft through exactly two camshaft sprocket teeth.
- **Do not turn the crankshaft in the reverse direction.**
- **During adjustment, do not touch the belt.**

6. TIMING BELT “B”



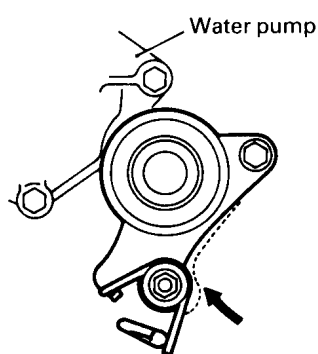
DEN009

6.1 REMOVAL

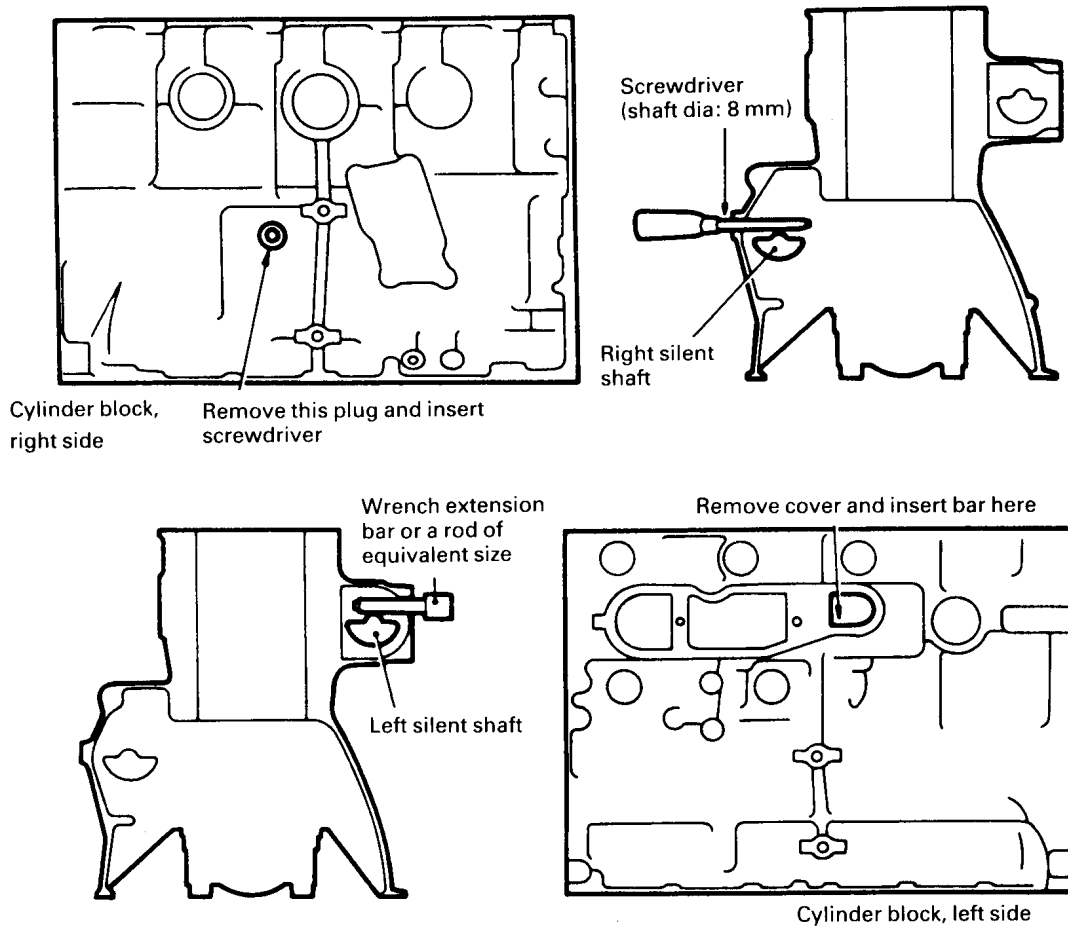


DEN010

1. Remove the timing belt. (See the preceding section.)
2. Using chalk or the like, put an arrow on the back of the timing belt “B” to indicate the direction of drive.
3. Slightly loosen the bolts and nuts securing the tensioner. Then, slide the tensioner toward the water pump and tighten the nuts to secure the tensioner in place temporarily.
4. Remove the timing belt “B”.
5. Remove the crankshaft sprocket “B”.



DEN011



DEN012

DEN013

6. Remove the two silent shaft sprockets. When loosening the sprocket nut and bolt, hold the silent shaft as shown in illustration to prevent the shaft from turning with them.

Caution:

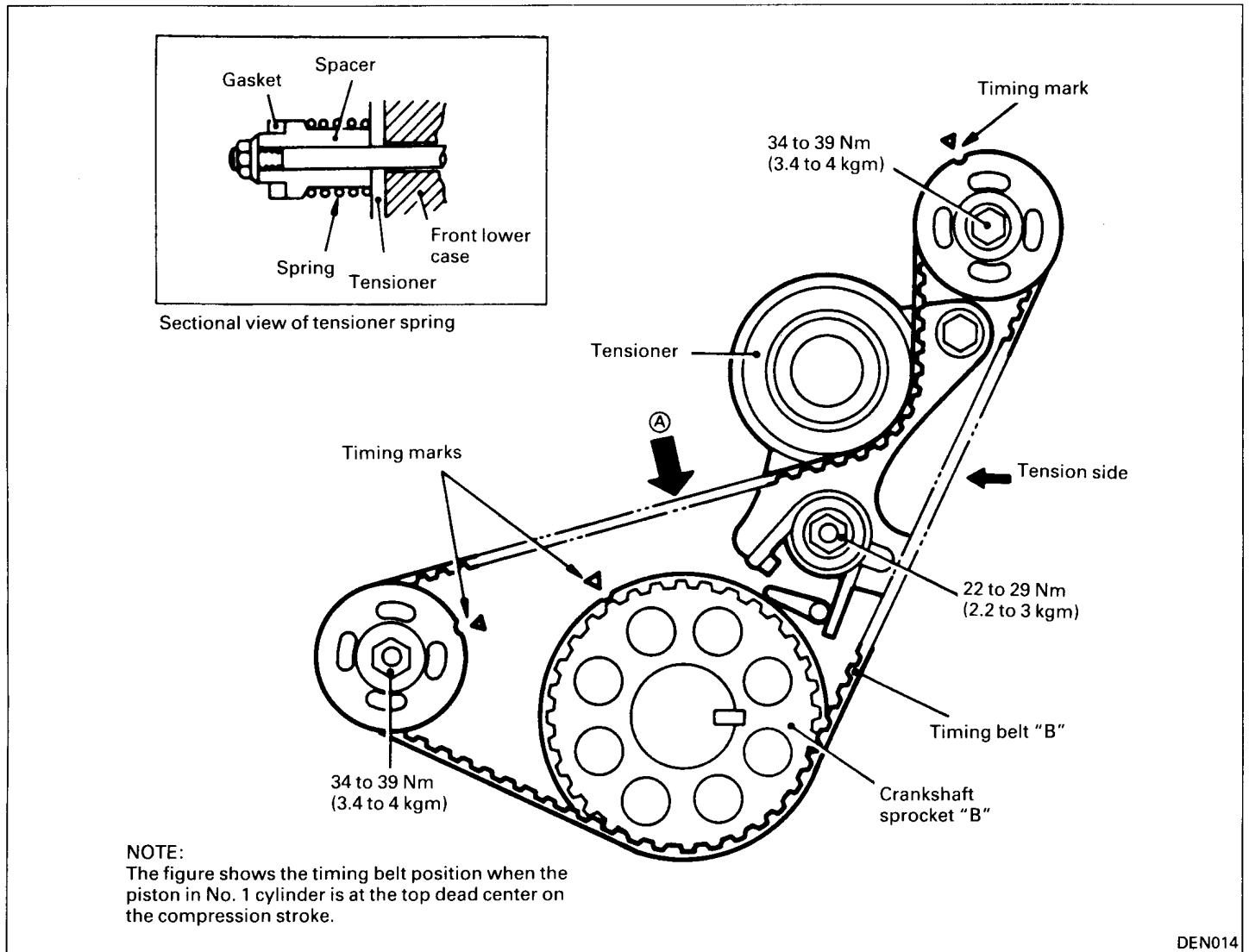
- **Keep the removed parts free from oil and grease.**
- **Do not use detergent to clean the timing belt “B”, sprocket and tensioner. Wipe clean with rag it found dirty. Replace if excessively contaminated with dirt, grease or oil.**

6.2 INSPECTION

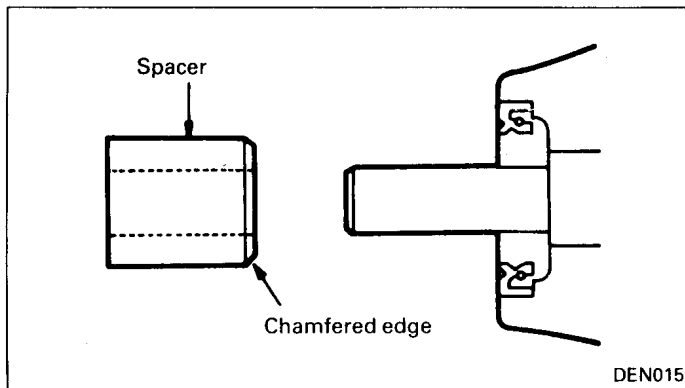
See the preceding section. Inspection of “Timing Belt”.

6.3 INSTALLATION

When installing the timing belt “B”, pay attention to the following.



1. Mount the crankshaft sprocket "B" to the crankshaft, noting the direction of the sprocket "B". (See page 11-18.)



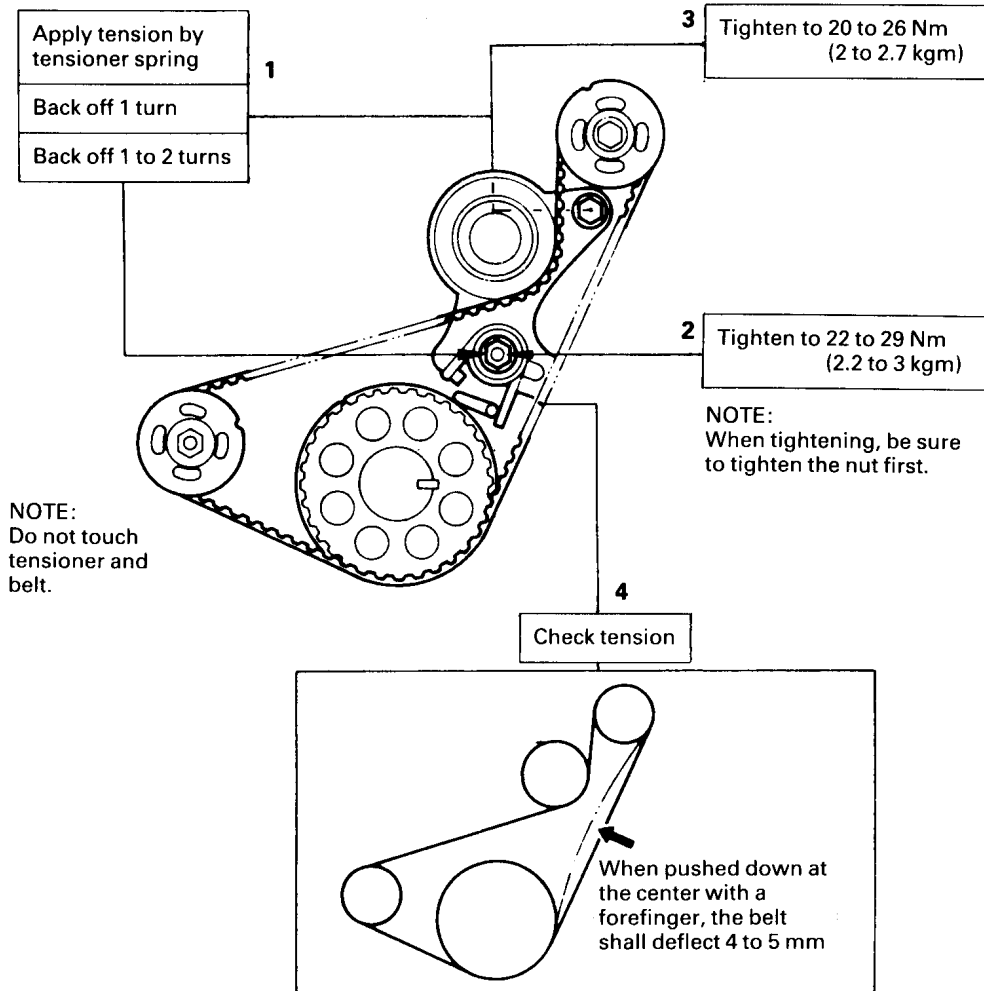
2. Mount the spacer to the left silent shaft, with its chamfered end toward the oil seal. Note that mounting the spacer in opposite direction will result in damaged oil seal.
3. Mount the two silent shaft sprockets and tighten the nuts and bolts to specified torque while holding the silent shafts to prevent from turning with them. (See page 11-22.)
4. Mount the tensioner, tensioner spring and spacer. Shift the tensioner toward the water pump as far as it goes and secure it in place temporarily. (See page 11-21.) Be sure to install the gasket. (See page 11-23.)
5. Align the timing marks of sprockets. (See page 11-23.)
6. With the tension side kept taut, engage the timing belt “B” with the sprockets.

Caution:

- **When reusing the belt, install it noting the arrow put on its back during dis-assembly to show the direction of drive.**
7. With the slack side of the timing belt “B” pushed down with a finger (at a point indicated by an arrow Ⓐ in illustration on page 11-23) to keep the tension side tight, check that all of the timing marks are properly aligned.
 8. Adjust the tension of the timing belt “B”.

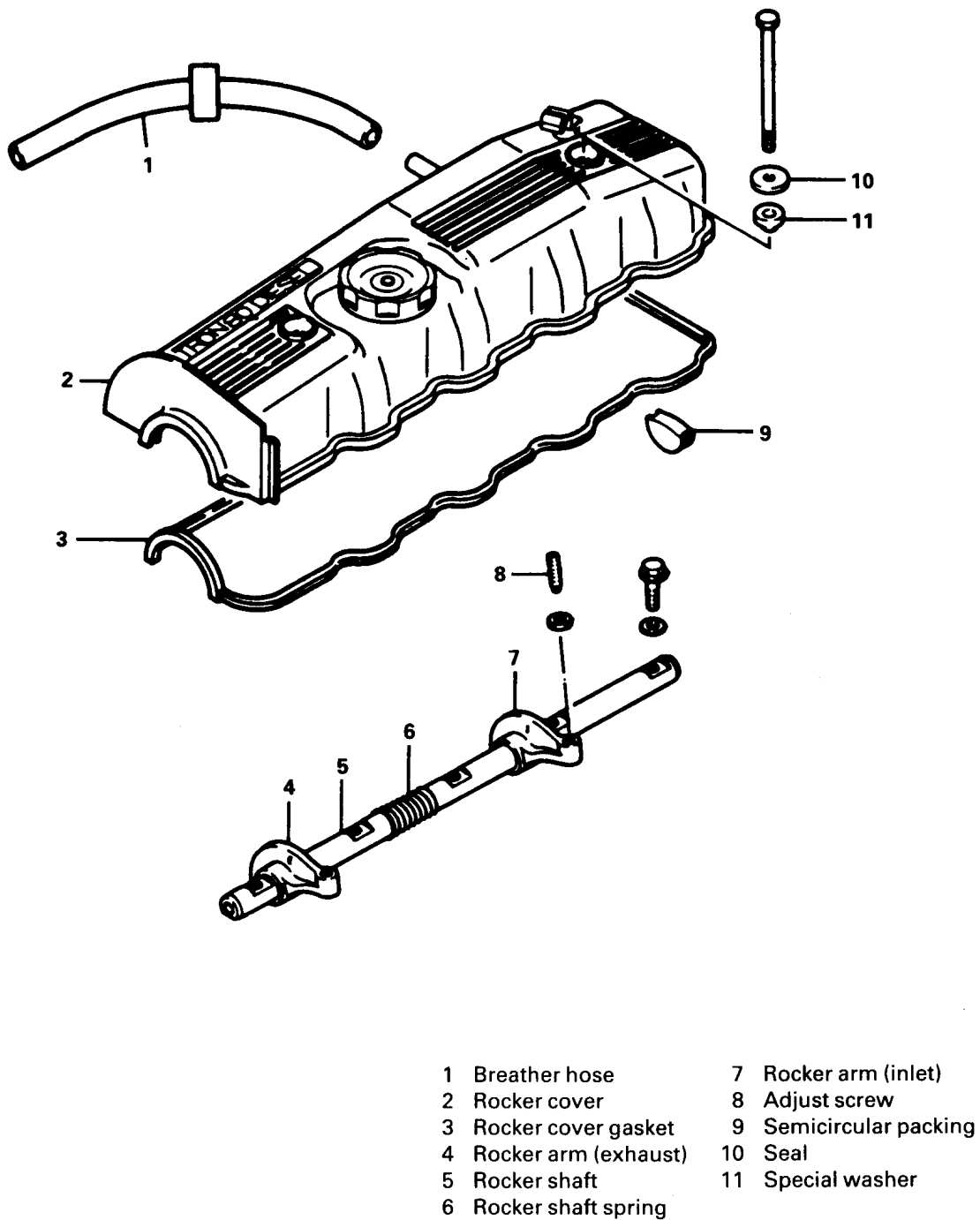
6.4 ADJUSTING TIMING BELT “B” TENSION

Adjust the belt tension paying attention to the following.



DEN016

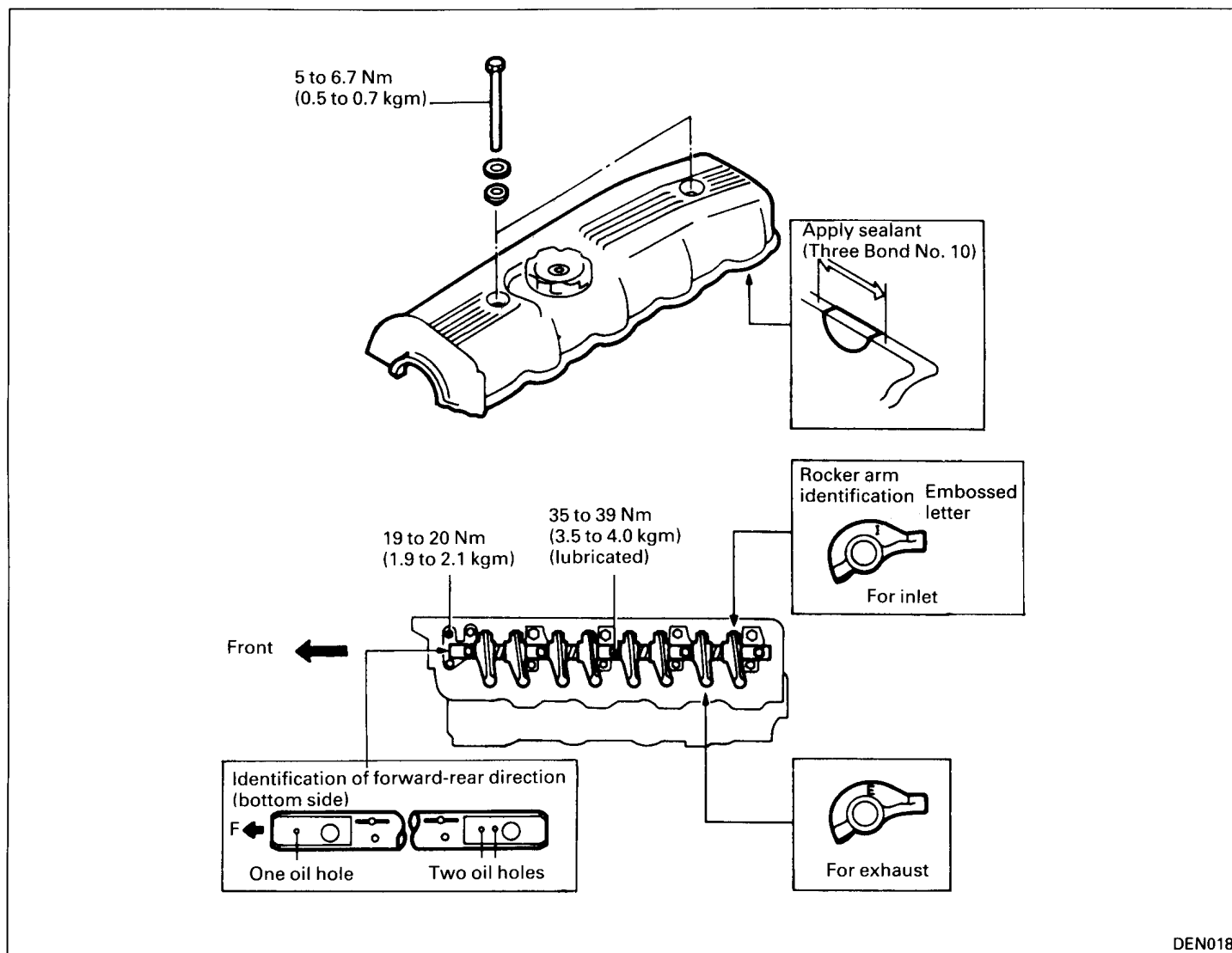
7. ROCKER ARM AND ROCKER SHAFT



DEN017

7.1 REMOVAL AND INSTALLATION

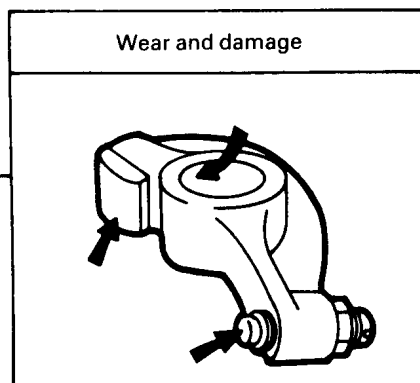
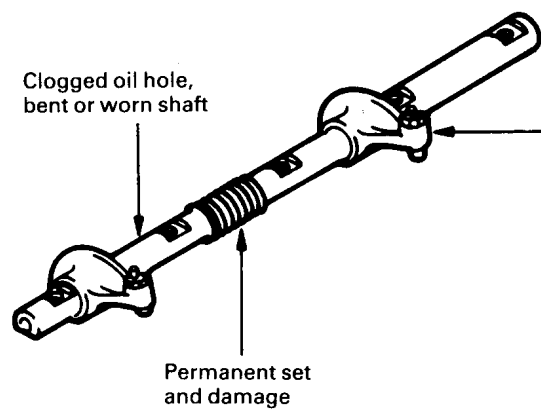
When removing or installing, pay attention to the following.



1. Turn the crankshaft to bring the piston in No. 1 cylinder to the top dead center on the compression stroke. This reduces the cam lift to minimum and facilitates installation.
2. After installation, adjust the valve clearance.

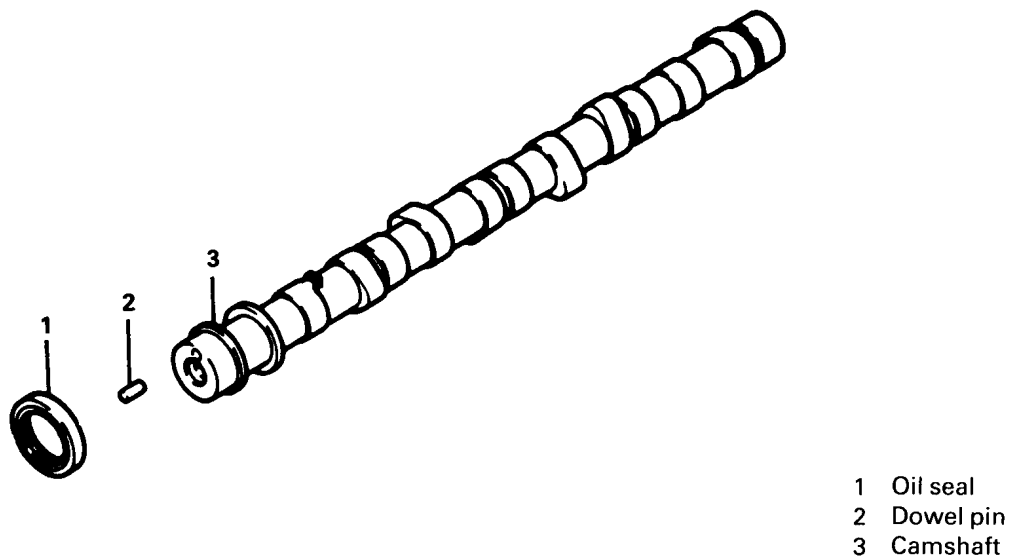
7.2 INSPECTION

Replace defective parts.



DEN019

8. CAMSHAFT



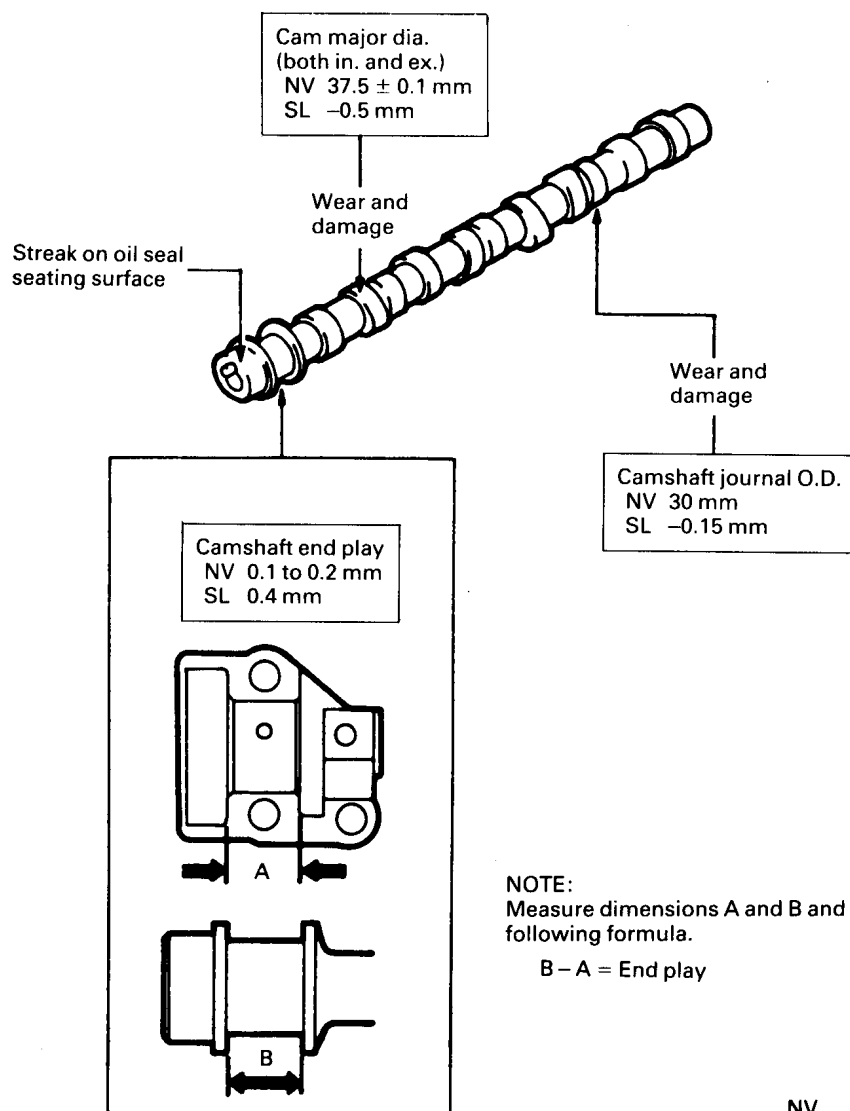
DEN020

8.1 REMOVAL

1. Turn the crankshaft to bring the piston in No. 1 cylinder to the top dead center on the compression stroke. (The piston in cylinder is at the top dead center on the compression stroke when the dowel pin is at the topmost.)
2. Remove the timing belt upper cover. With the timing belt as installed, remove the camshaft sprocket, and place on the timing belt lower cover.
3. Remove the rocker shaft assembly.
4. Remove the camshaft bearing cap and take out the camshaft.

8.2 INSPECTION

Check the camshaft and replace it defective.



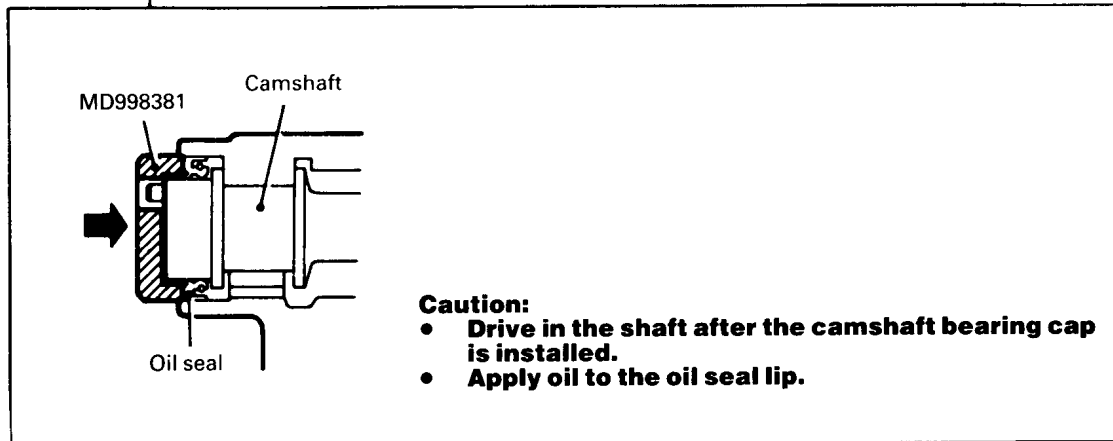
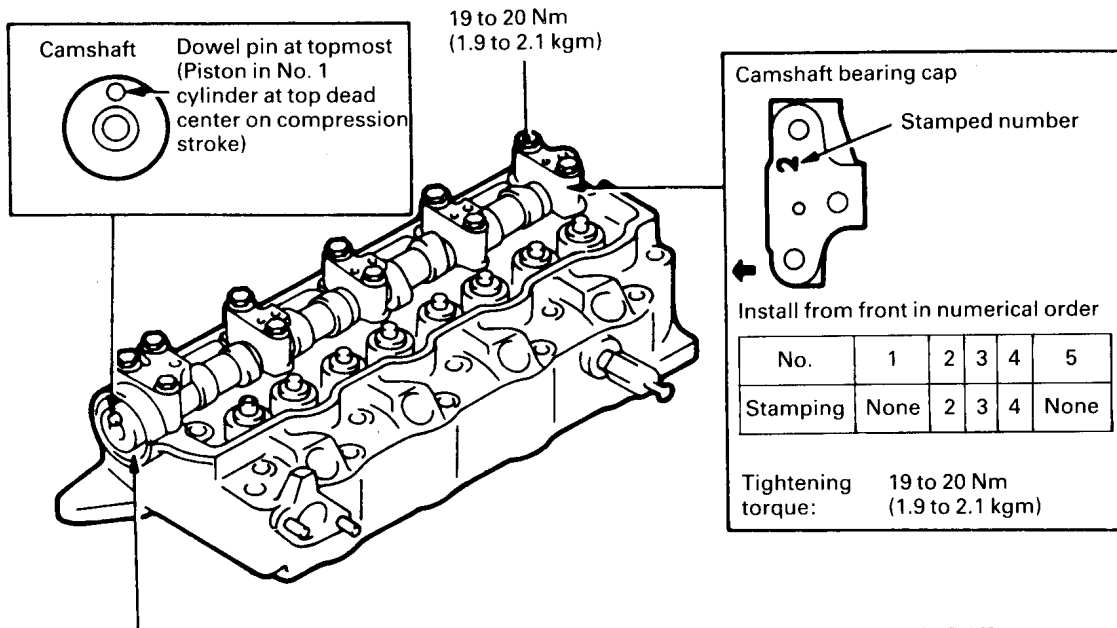
NOTE:
Measure dimensions A and B and calculate end play by the following formula.

$$B - A = \text{End play}$$

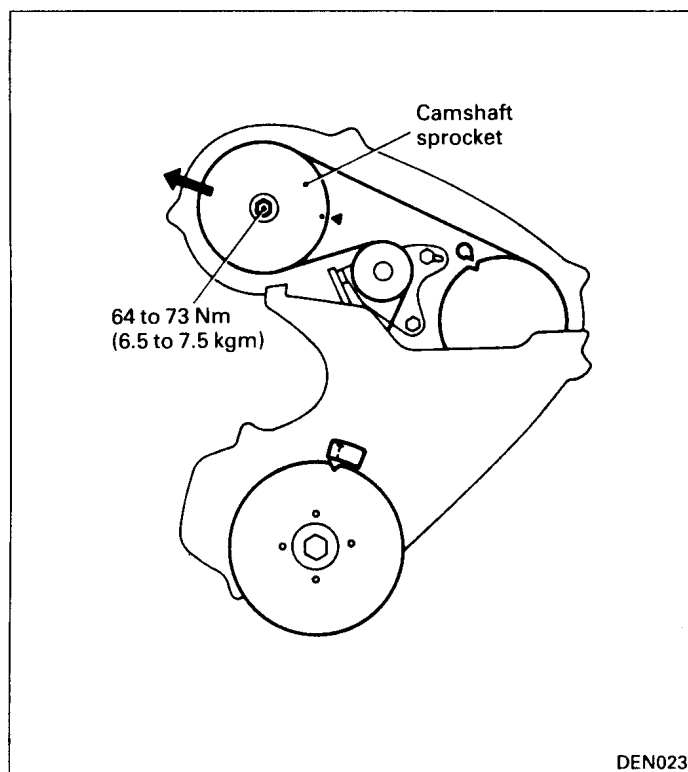
NV .. Nominal Value
SL .. Service Limit

8.3 INSTALLATION

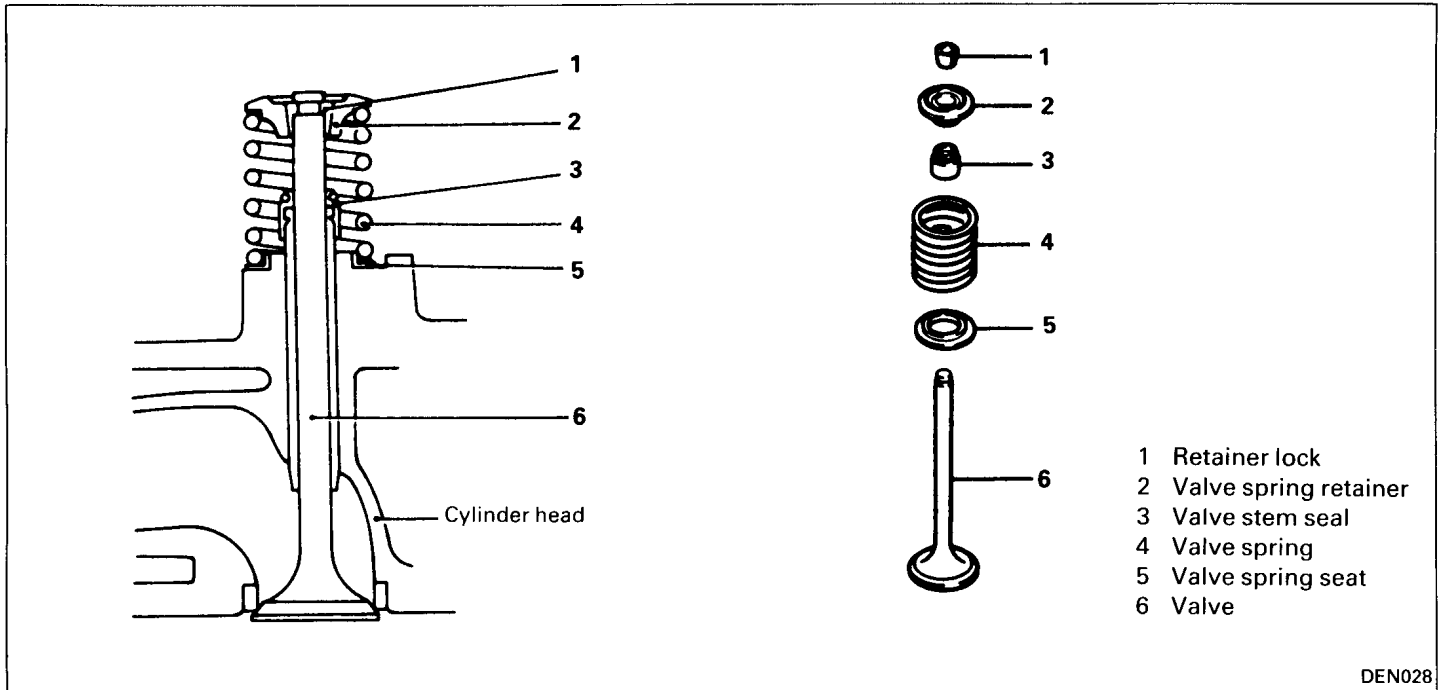
Install the camshaft paying attention to the following.



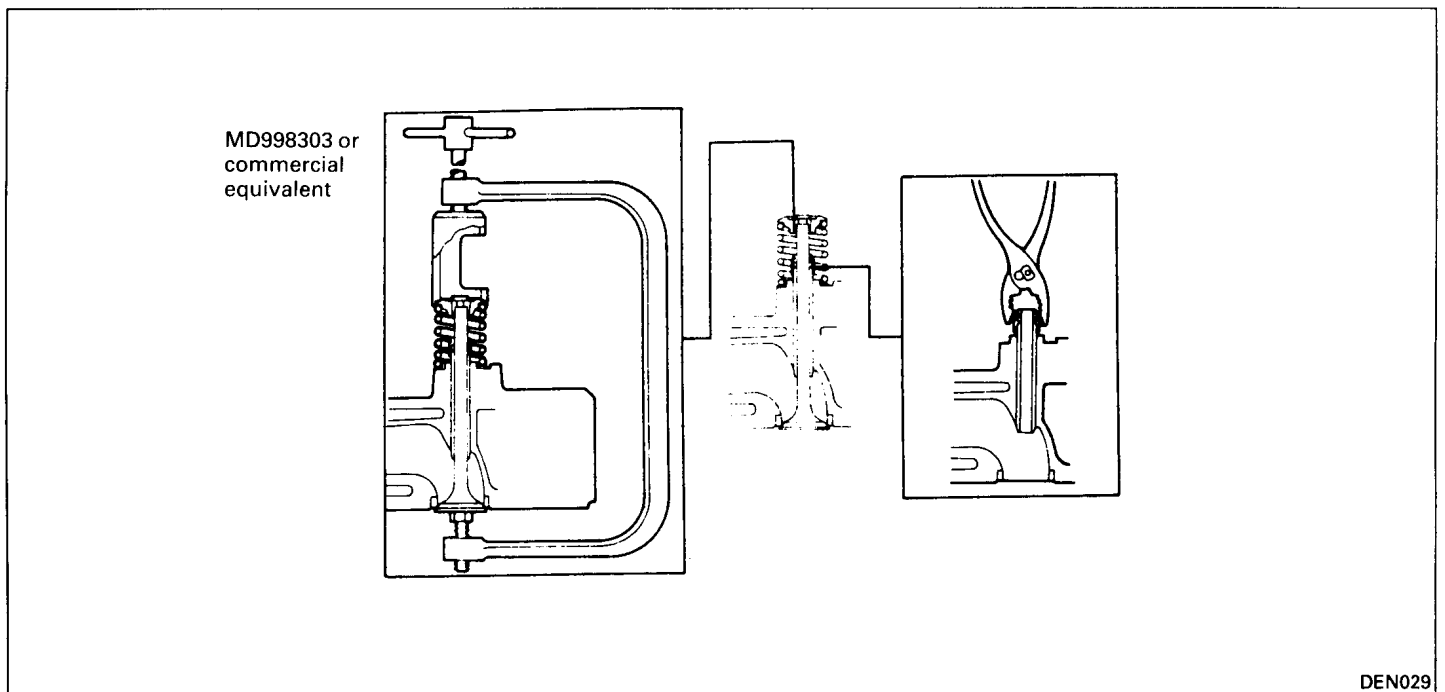
1. Install the rocker shaft assembly.
2. Make sure that the timing marks on the crank pulley and the pump sprocket are aligned.
Then, install the camshaft sprocket while pulling it firmly in the direction of the arrow.

**Caution:**

- **The injection pump sprocket tends to rotate causing misalignment of timing marks. Be sure to check alignment of the timing marks after the installation.**
- **After installation, check the belt tension and readjust as necessary.**
- **Check the valve clearance and adjust as necessary.**

9. VALVE AND VALVE SPRING**9.1 REMOVAL**

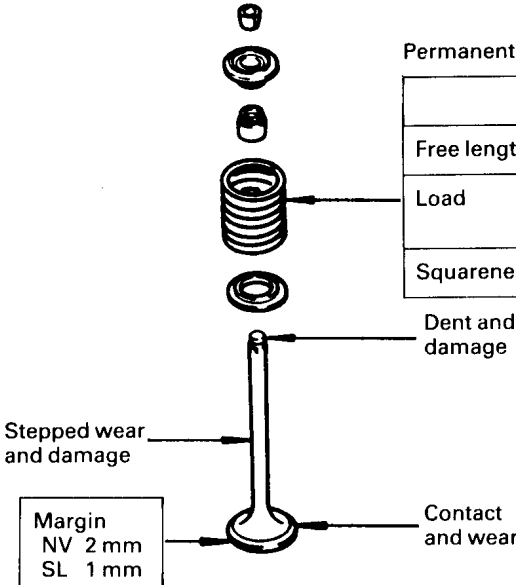
1. Remove the cylinder head assembly.



2. Remove the parts as illustrated above and store them separately for each cylinder.

9.2 INSPECTION AND CORRECTION

Check and correct or replace parts if defective.

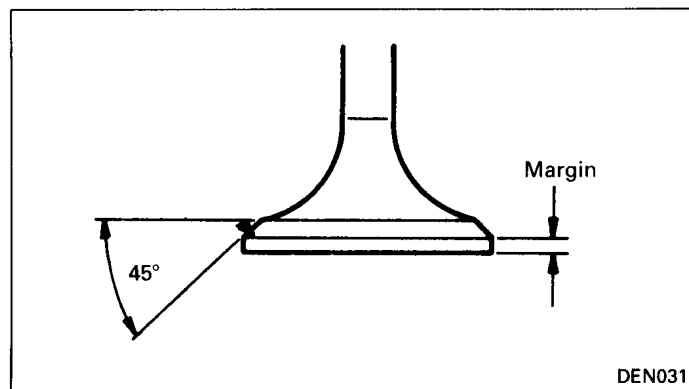


	NV	SL
Free length	49.1 mm	-1 mm
Load	270.7 N (27.6 kg)/ 40.4 mm	—
Squareness	1°30' max.	3°

NV .. Nominal Value
SL .. Service Limit

DEN030

Correcting Valve Face



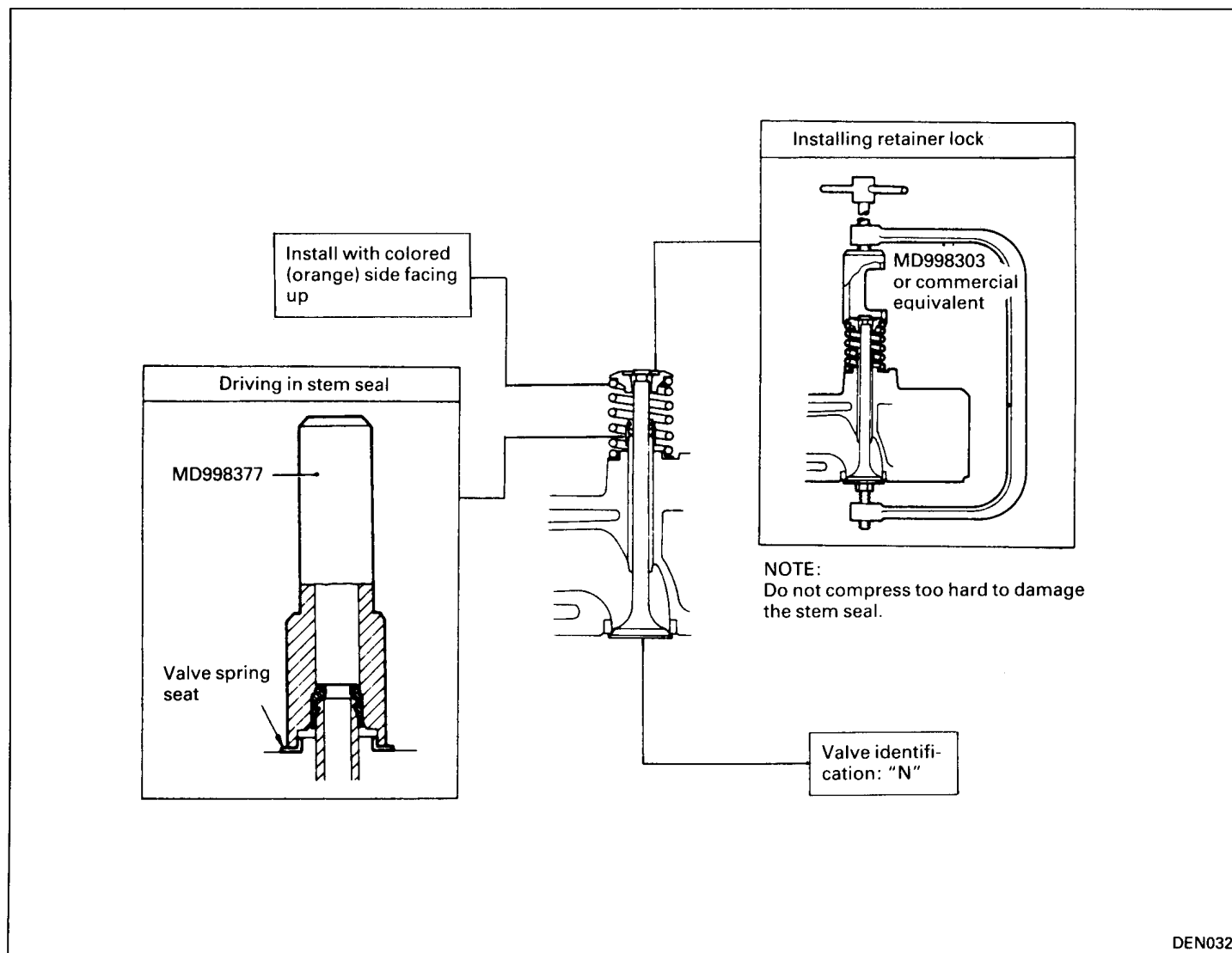
Correct worn valve face with a valve refacer. If the margin after correction is not within the service limit, replace the valve.

Correcting Valve Stem End

Correct worn or dented stem end to the minimum necessary degree using a valve refacer, oilstone or other tool.

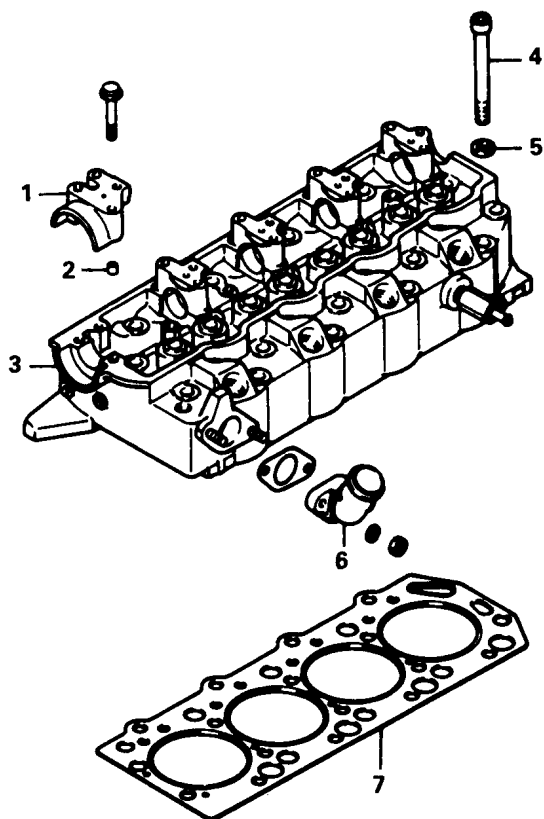
9.3 INSTALLATION

1. In the installation, pay attention to the following.

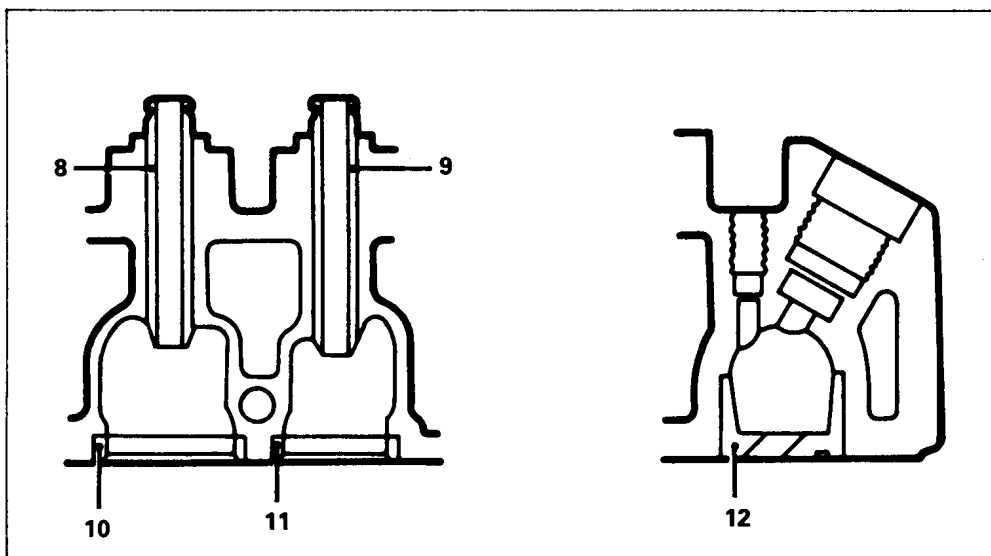


2. Install the cylinder head assembly.
3. Adjust the valve clearance.

10. CYLINDER HEAD



- 1 Camshaft bearing cap
- 2 Bushing knock
- 3 Cylinder head
- 4 Cylinder head bolt
- 5 Washer
- 6 Water outlet fitting
- 7 Cylinder head gasket
- 8 Valve guide (In.)
- 9 Valve guide (Ex.)
- 10 Seat ring (In.)
- 11 Seat ring (Ex.)
- 12 Combustion chamber jet



10.1 REMOVAL

1. Remove the injection pipe assembly. When loosening, the injection pipe nut, hold the nozzle holder and the delivery valve holder with a spanner to prevent them from turning with the nut.

Caution:

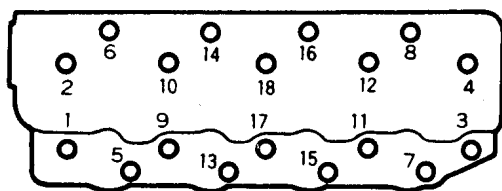
- **After the injection pipe is removed, put a cap on the nozzle holder and the delivery valve holder to prevent ingress of dust and foreign matter.**

2. Remove the timing belt upper cover.
3. Loosen the camshaft sprocket bolt to such an extent that it can be further loosened with fingers.
4. Bring the piston in No. 1 cylinder to the top dead center on the compression stroke. Align the timing mark on the camshaft sprocket with that made on the upper case. (See page 11-17.)
5. Manually remove the camshaft sprocket bolt.
6. With the timing belt engaged, remove the sprocket from the camshaft and place the assembly on the timing belt lower cover.

Caution:

- **Do not turn the crankshaft once the sprocket is removed.**
 - **Keep the timing belt taut.**
7. Remove the rocker cover, rocker arm shaft assembly and camshaft.

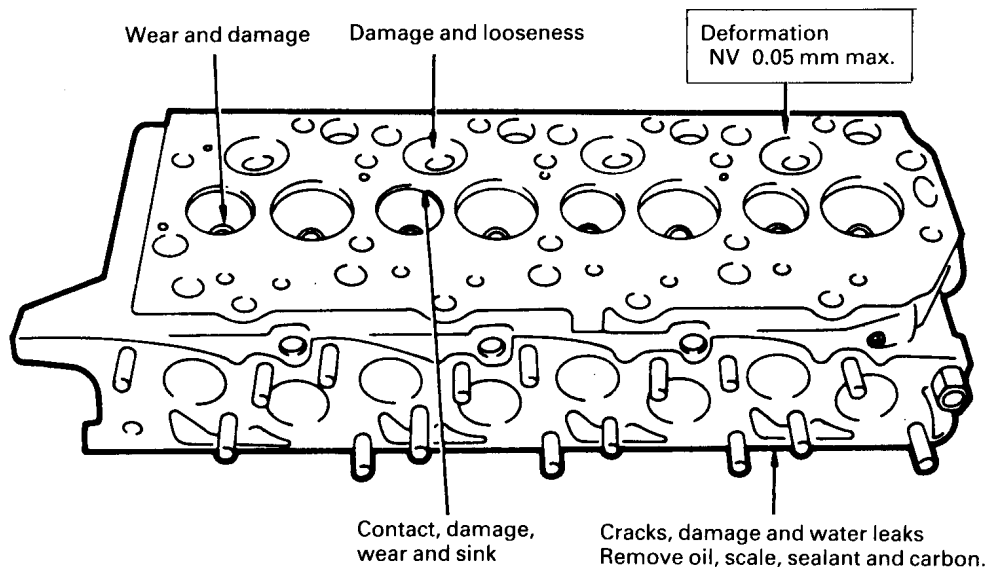
8. Using the special tool Cylinder Head Bolt Wrench (MD998051), loosen 18 cylinder head bolts and remove them. Loosen the bolts in the sequence shown in illustration and in two to three steps.
9. Remove the cylinder head.
10. Remove the cylinder head gasket. Clean the cylinder head and cylinder block gasket surfaces.



DEN034

10.2 INSPECTION AND CORRECTION

Check the cylinder head and correct or replace if defective.



NV .. Nominal Value

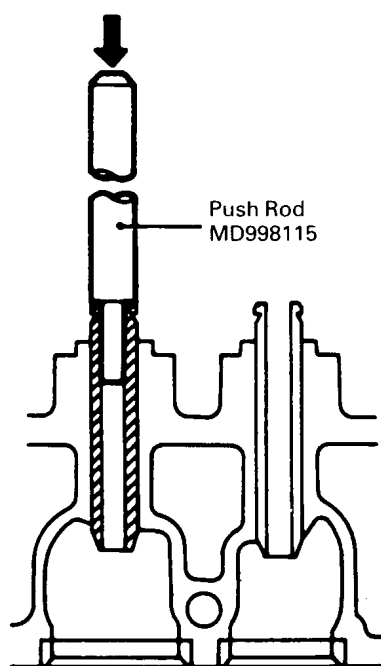
DEN035

10.3 REPLACING VALVE GUIDE

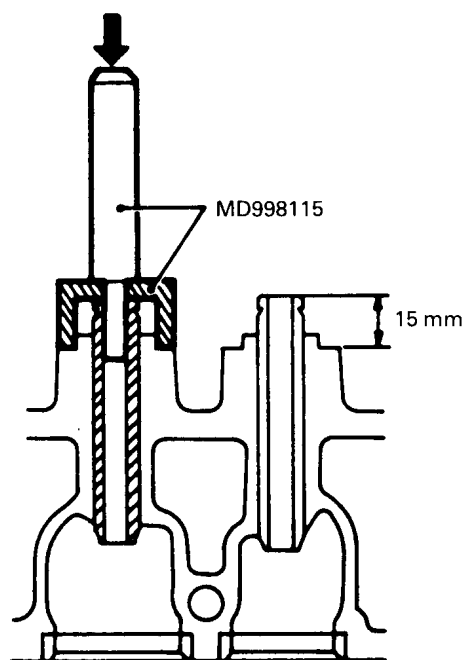
Replace defective valve guide with O.S. part.

Valve guide service size

Size	Symbol	Cylinder head bore
0.05 mm O.S.	5	13.050 to 13.068 mm
0.25 mm O.S.	25	13.250 to 13.268 mm
0.50 mm O.S.	50	13.500 to 13.518 mm



Removal

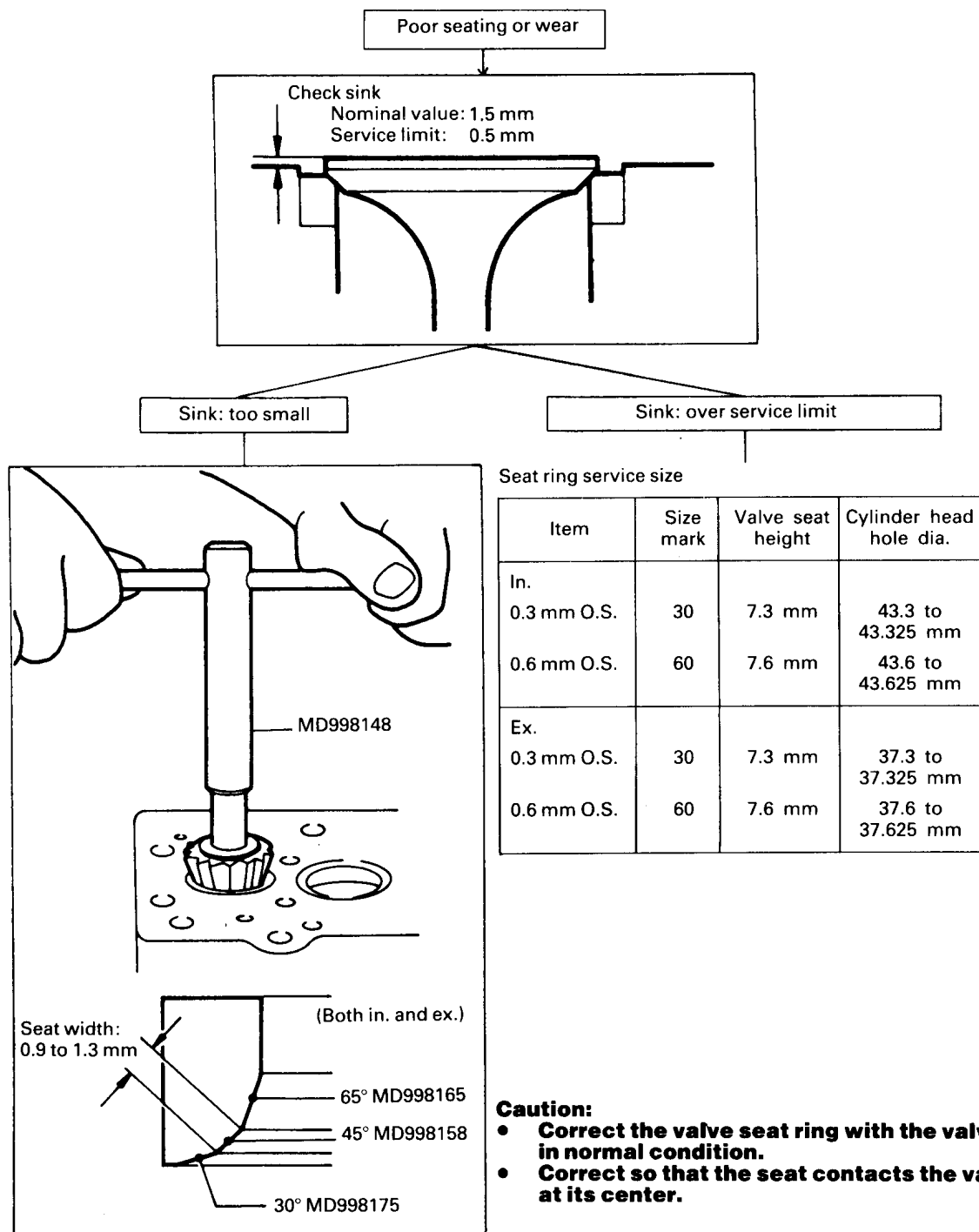


Installation

DEN036

10.4 CORRECTING VALVE SEAT RING

Correct or replace defective valve seat ring.

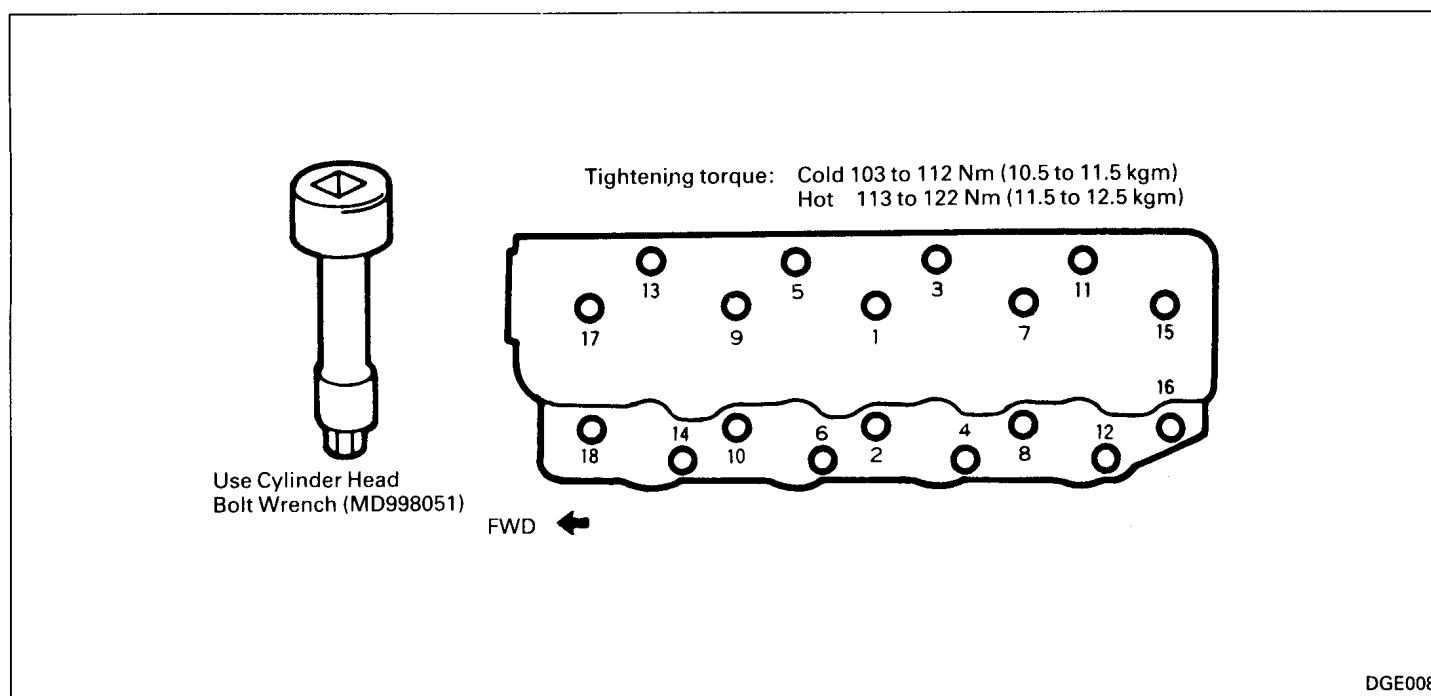


DEN037

10.5 INSTALLATION

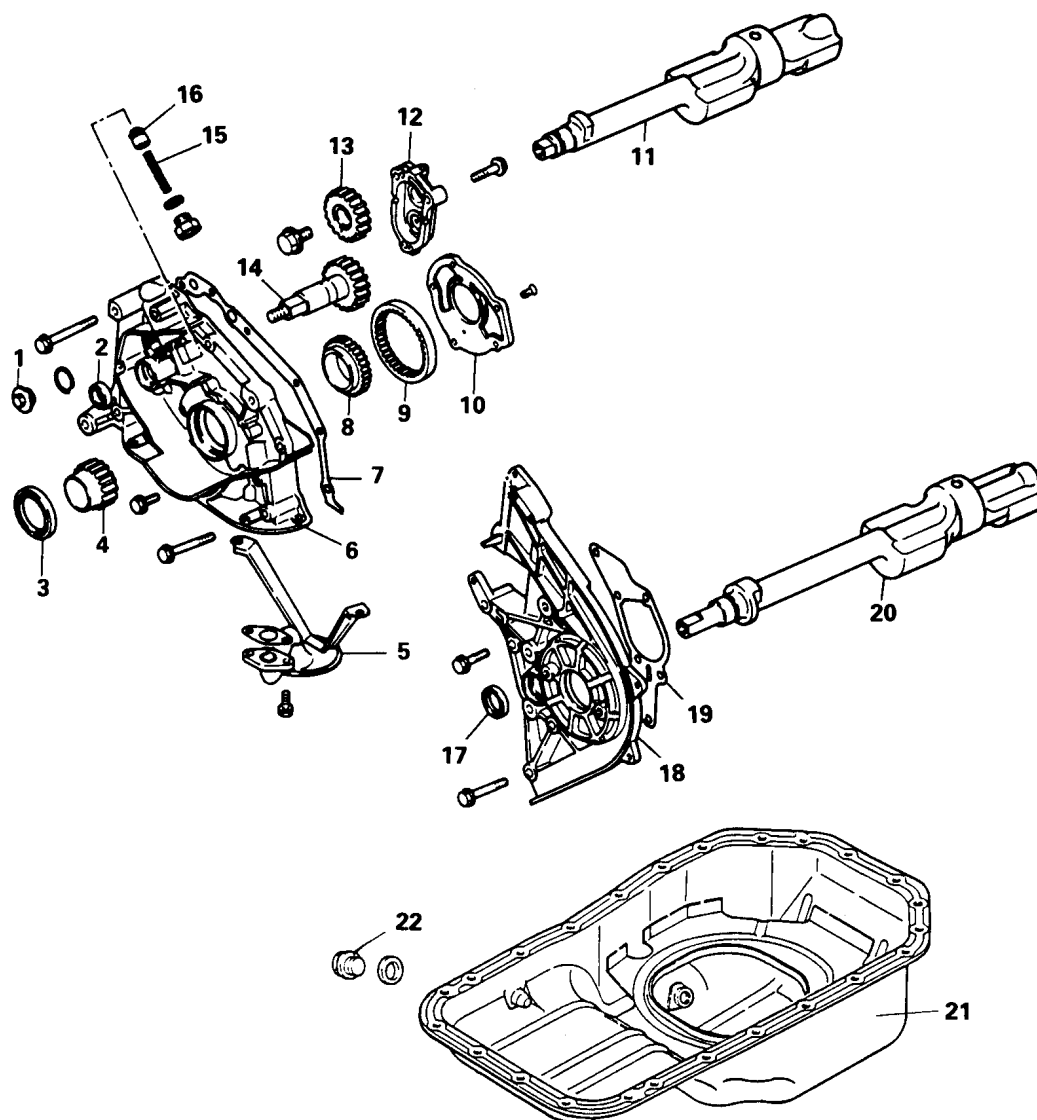
Install the cylinder head in reverse order of the removal, paying attention to the following.

1. Use a new cylinder gasket. Do not apply sealant.
2. Tighten the cylinder head bolts in the sequence shown and in two to three steps. Finally, tighten to specified torque.



3. Loosen the pipe clamp before installing the injection pipe assembly. Tighten the nuts on both ends of the pipe to 21 to 34 Nm (2.3 to 3.7 kgm). When tightening the nuts, hold the nozzle holder and the delivery valve holder to prevent them from turning with them. Also take care to prevent ingress of foreign matter in the fuel passage.
4. After installing the camshaft sprocket, make sure that the timing marks of the sprockets are aligned.

11. FRONT CASE, SILENT SHAFT AND OIL PUMP



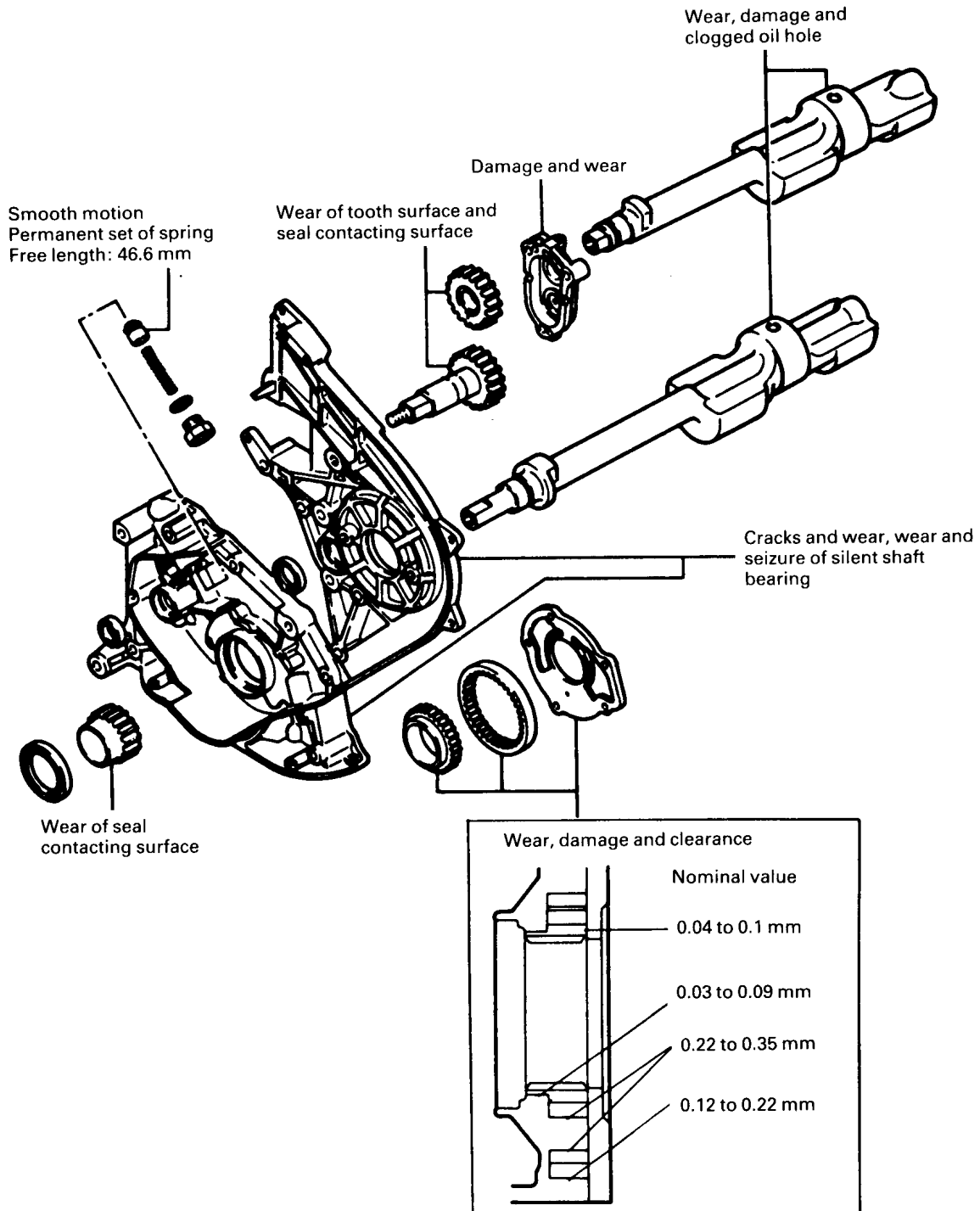
- | | | |
|-----------------------------|-----------------------------|----------------------------|
| 1 Plug cap | 9 Oil pump outer gear | 16 Relief valve |
| 2 Oil seal | 10 Oil pump cover | 17 Oil seal |
| 3 Front oil seal | 11 Right silent shaft | 18 Front upper case |
| 4 Oil pump gear drive shaft | 12 Silent shaft gear cover | 19 Front upper case gasket |
| 5 Oil screen | 13 Silent shaft driven gear | 20 Left silent shaft |
| 6 Front lower case | 14 Silent shaft drive gear | 21 Oil pan |
| 7 Front lower case gasket | 15 Relief valve spring | 22 Oil drain plug |
| 8 Oil pump inner gear | | |

11.1 REMOVAL

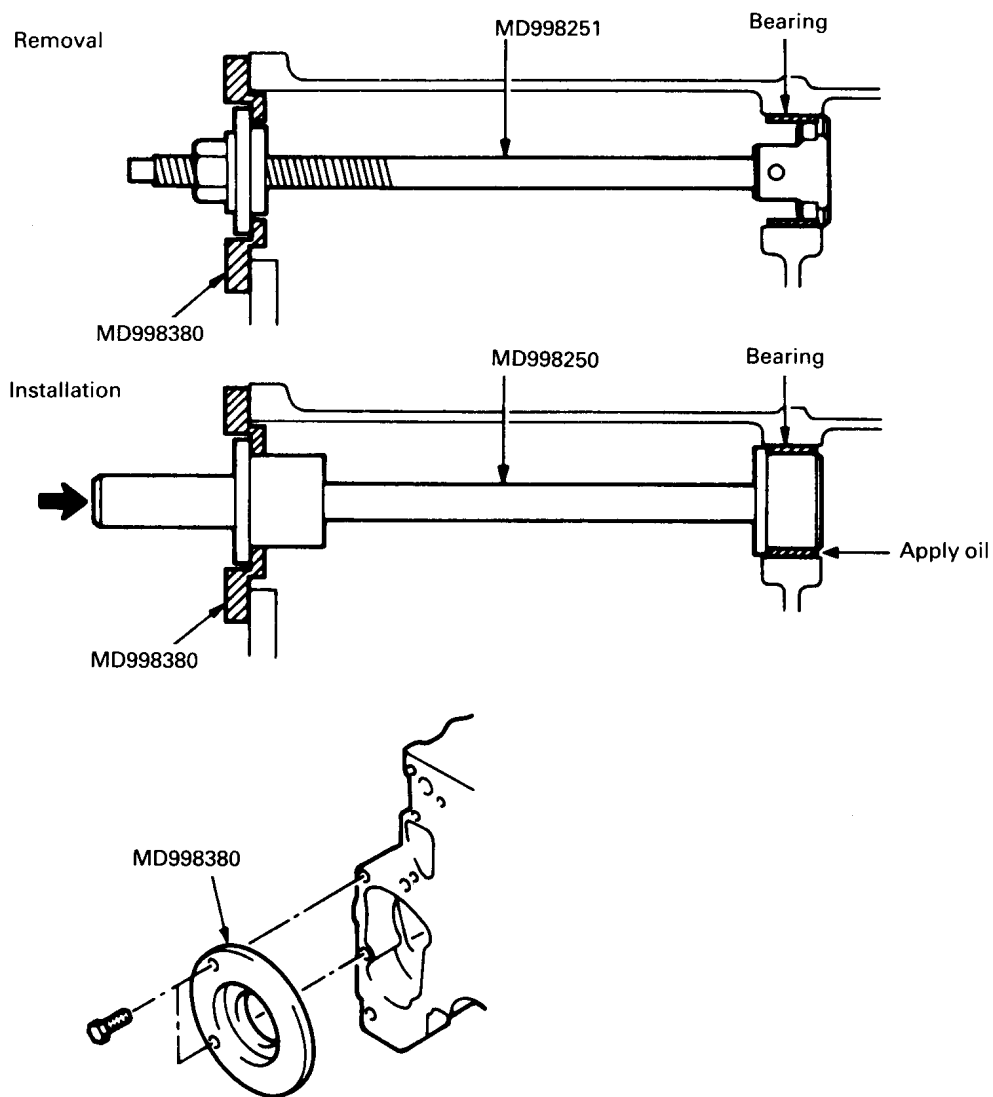
1. Remove the oil pan.
2. Remove the oil screen.
3. Remove the spacer from the forward end of the left silent shaft.
4. Remove the front upper case.
5. Remove the left silent shaft.
6. Remove the plug cap from the top of the right silent shaft drive gear.
7. Slightly loosen the flange bolt at the forward end of the right silent shaft. When loosening the bolt, remove the plug on the right side of the cylinder block and insert a screwdriver to prevent rotation. (See page 11-22.)
8. Remove the front lower case and the silent shaft as an assembly.
9. Remove the left silent shaft from the front lower case.
10. Remove the oil pump cover from the front lower case.
11. Remove the oil pump outer gear and inner gear. Put mating mark on the outer gear to insure correct reassembly.
12. Remove the silent shaft drive gear cover and then remove the drive gear and driven gear.

11.2 INSPECTION

Check and replace if defective.



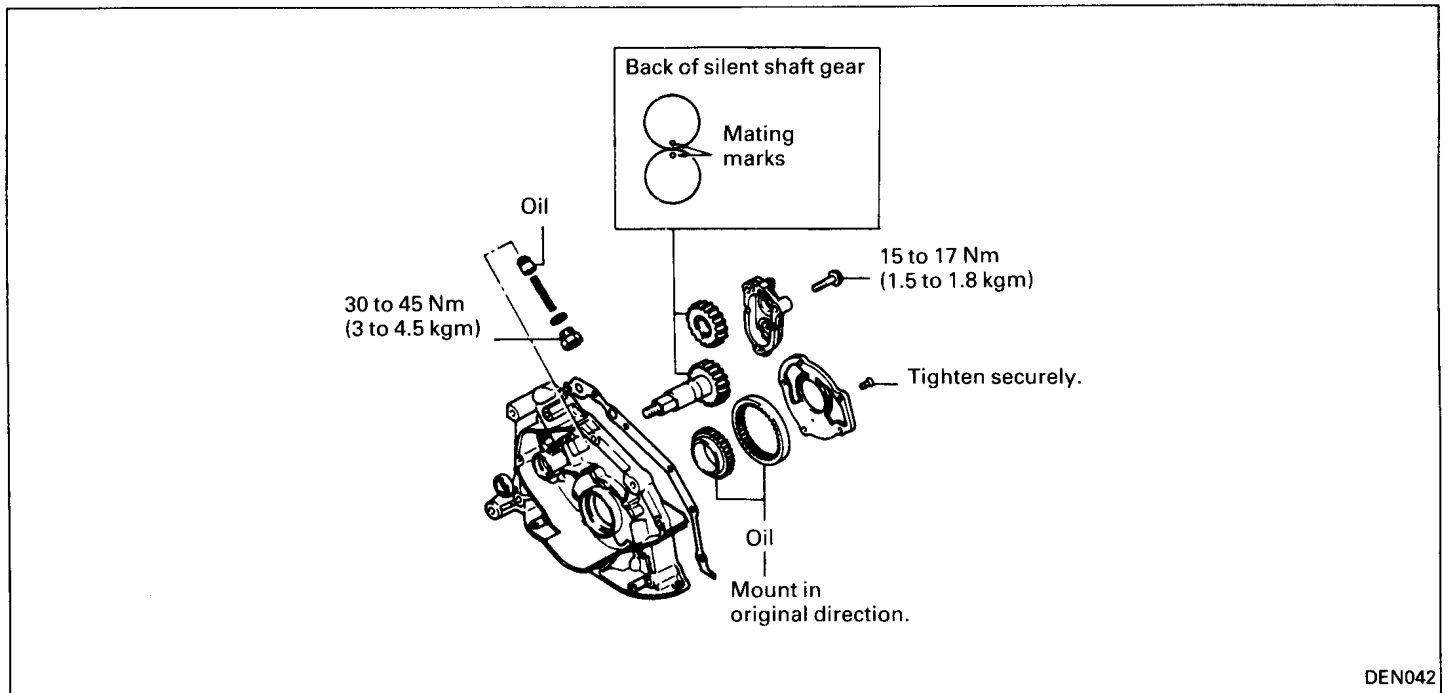
DEN040

11.3 REPLACING SILENT SHAFT BEARING

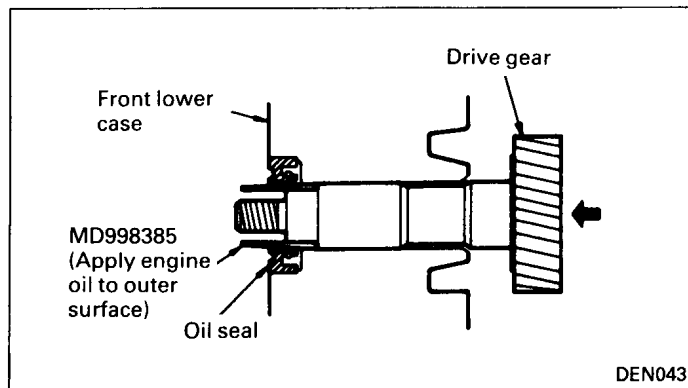
NOTE:
Use the Bearing Installer Stopper (MD998380) only when removing/installing the right side bushing.

DEN041

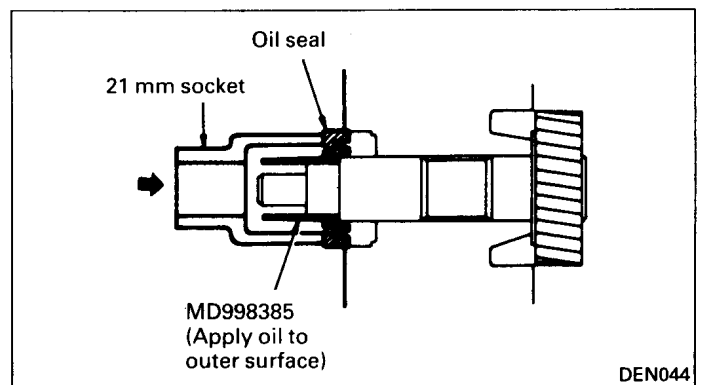
11.4 ASSEMBLING FRONT LOWER CASE



When installing the oil pump drive gear and the oil seal, pay attention to the following.

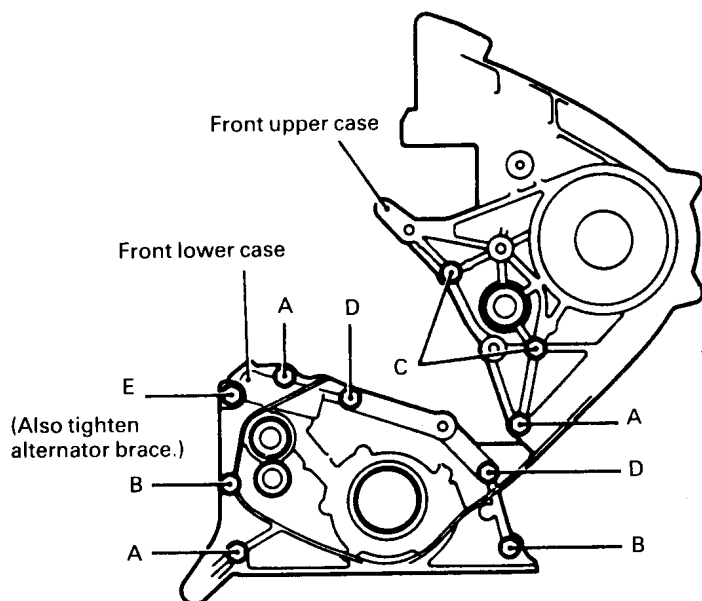


1. When installing the drive gear shaft after pressfitting of gear oil seal in the front lower case, fit the special tool Oil Seal Guide (MD998385) over the drive gear shaft before the gear is inserted.



2. When pressing in the oil seal after installation of drive gear shaft, similarly fit the special tool Oil Seal Guide (MD998385) over the drive gear shaft to prevent the oil seal from being caught by the stepped section of the shaft.

11.5 INSTALLATION

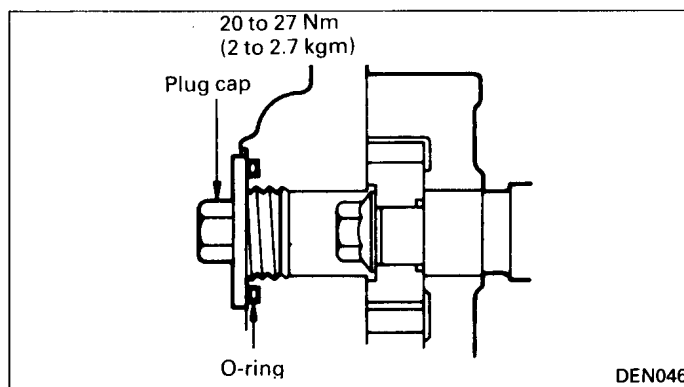


Symbol	Bolt body length
A	55 mm
B	65 mm
C	35 mm
D	25 mm
E	75 mm

Torque: 12 to 14 Nm
(1.2 to 1.5 kgm)

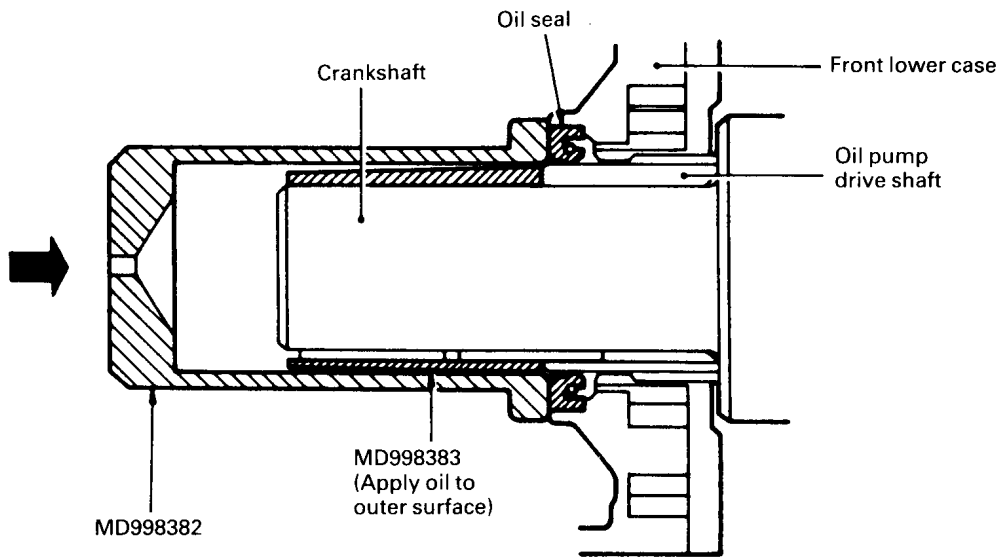
DEN045

1. Install the right silent shaft to the front lower case assembly and tighten the flange bolt temporarily. Apply oil to the silent shaft journal.
2. Install a new front lower case gasket to the cylinder block. Then, install the front lower case while inserting the right silent shaft in the cylinder block. Tighten the 7 flange bolts to specified torque.



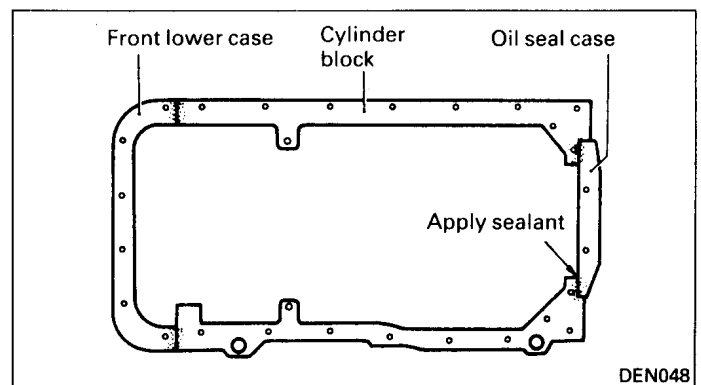
DEN046

3. Tighten the bolt at the forward end of the right silent shaft to 20 to 27 Nm (2 to 2.7 kgm). When tightening the bolt, hold the silent shaft to prevent its rotation.
4. Fit O-ring in the groove of the case and install the plug cap.



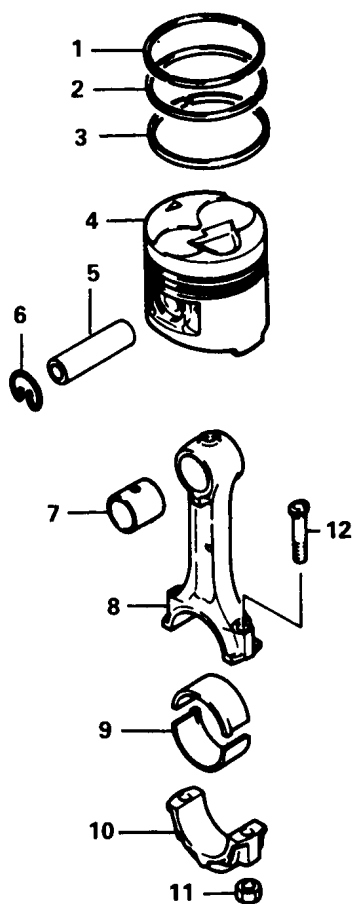
DEN047

5. Using the special tool Oil Seal Installer (MD998382) and Guide (MD998383), install the crankshaft front oil seal.
Insert the oil pump drive shaft before installing the front oil seal.
When installing the front lower case assembly with a press-fit front oil seal, install the Oil Seal Guide (MD998383) to the crankshaft in advance.
6. Apply oil to the left silent shaft journal and place the shaft in the cylinder block.
7. Install a new front upper case gasket to the cylinder block and install the front upper case. Tighten the three flange bolts to specified torque. (See page 11-47.)
8. Press the silent shaft oil seal into the front upper case, until the oil seal end is flush with the case end.
9. Apply oil to the spacer outer surface and insert it with the chamfered end facing the oil seal.



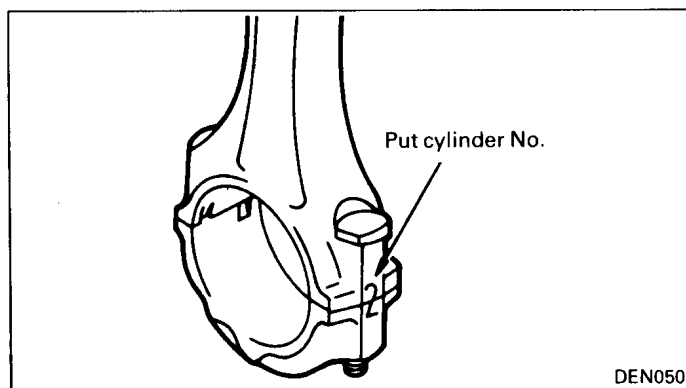
DEN048

10. Apply sealant to the lower surface (surface on which the oil pan is to be mounted) in areas indicated in illustration.
11. Install a new oil pan gasket and oil pan, and tighten the bolts to 6 to 7.5 Nm (0.6 to 0.8 kgm).

12. PISTON AND CONNECTING ROD

- 1 Piston ring No. 1
- 2 Piston ring No. 2
- 3 Oil ring
- 4 Piston
- 5 Piston pin
- 6 Snap ring
- 7 Bushing
- 8 Connecting rod
- 9 Connecting rod bearing
- 10 Connecting rod cap
- 11 Connecting rod nut
- 12 Connecting rod bolt

DEN049

12.1 REMOVAL

DEN050

1. Put cylinder No. on the side of the connecting rod big end for reference in reassembly.

2. Remove the connecting rod cap and lift out the connecting rod and piston assembly from the cylinder, taking sufficient care to prevent the connecting rod from contacting the cylinder and the crank pin.

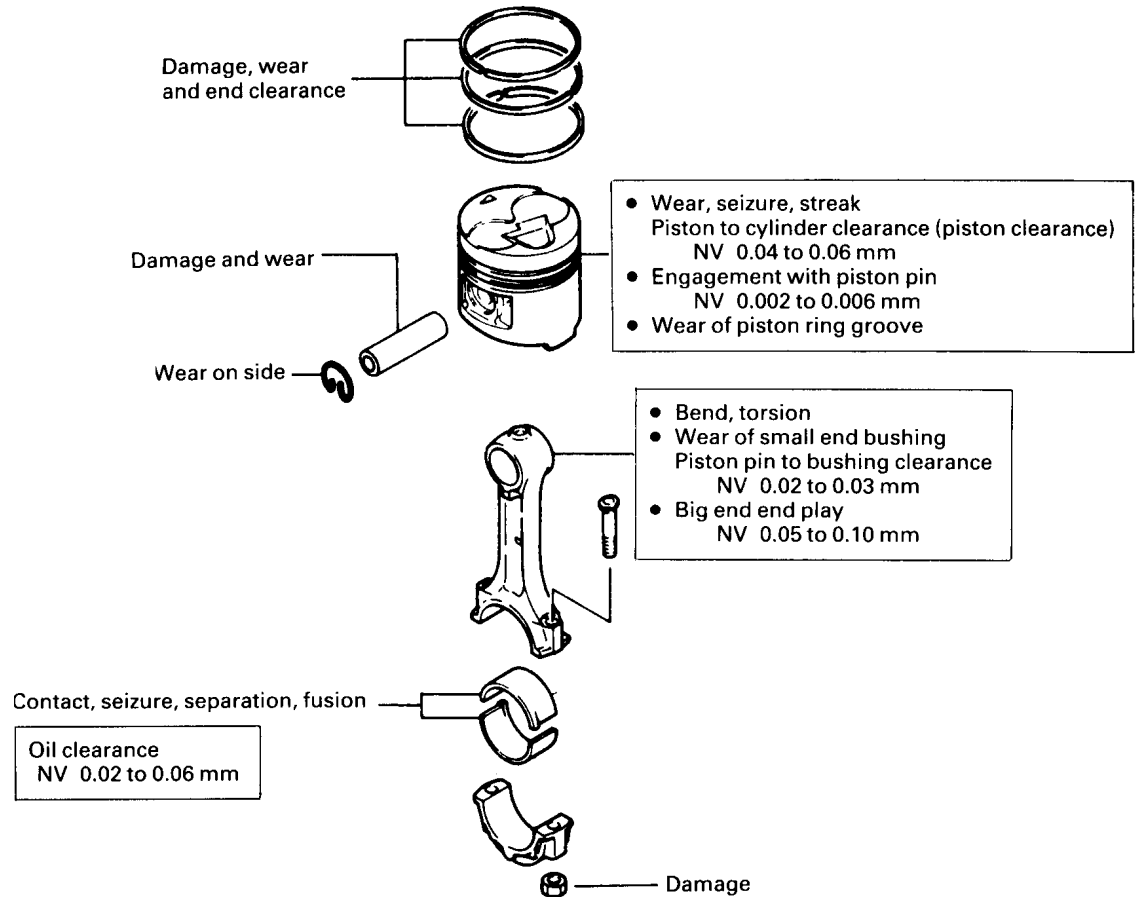
Store the removed connecting rod and piston assembly together with the connecting rod cap and bearing, separately for each cylinder.

Caution:

- **Do not allow the connecting rod to come in contact with the oil jet.**
- **Oil jet in improper direction will result in sharp reduction of the piston cooling effect.**

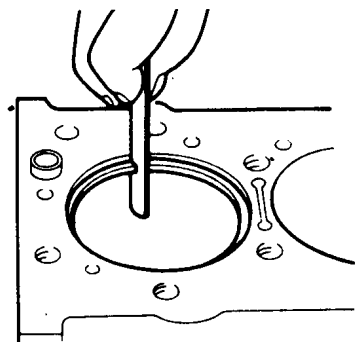
12.2 INSPECTION

Correct or replace if defective.



NV .. Nominal Value

DEN051

Checking Piston Ring End Clearance

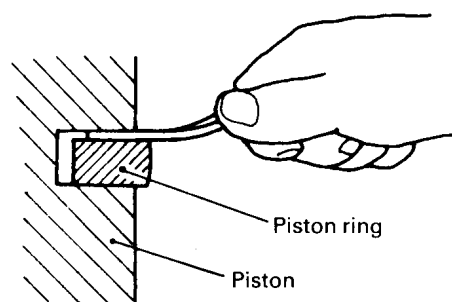
Description	Nominal value	Service limit
No. 1	0.25 to 0.40 mm	1.0 mm
No. 2	0.25 to 0.40 mm	1.0 mm
Oil ring	0.25 to 0.45 mm	1.0 mm

DEN052

Place a piston ring in the cylinder bore and set it square by pushing it down with the piston. Then, measure the end clearance using a thickness gauge. Replace the piston ring if the end clearance exceeds the service limit.

Caution:

- If the ring only is replaced without reboring the cylinder bore, measure the end clearance with the ring placed at the lower part of the cylinder where wear is minimum.
- When the ring is replaced, use ring of the same size as the piston.
- Rings are available in the service size of STD and oversize (0.25, 0.50, 0.75 and 1.00 mm).

Checking Ring Grooves

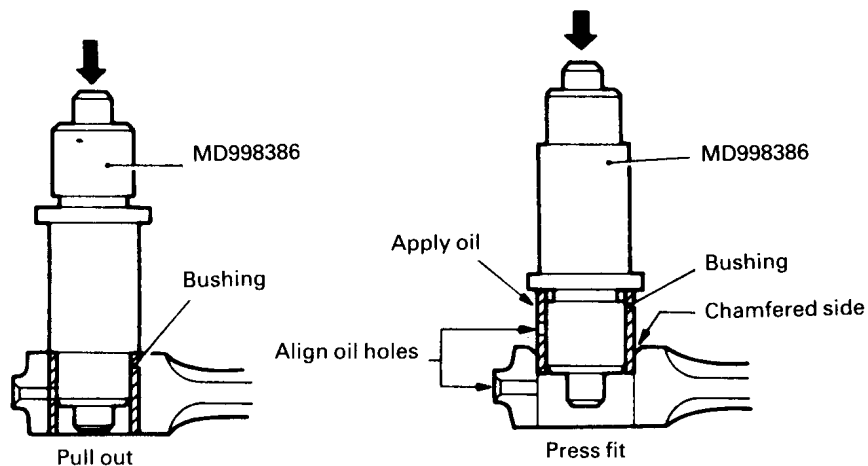
Description	Nominal value	Service limit
Oil ring	0.02 to 0.07 mm	0.15 mm

DEN053

Measure the piston ring groove to ring clearance (side clearance). If the clearance exceeds the service limit, use a new ring and measure the clearance again. If the clearance still exceeds the service limit, replace both the piston and ring.

12.3 REPLACING CONNECTING ROD SMALL END BUSHING

Replace the connecting rod small end bushing as follows.

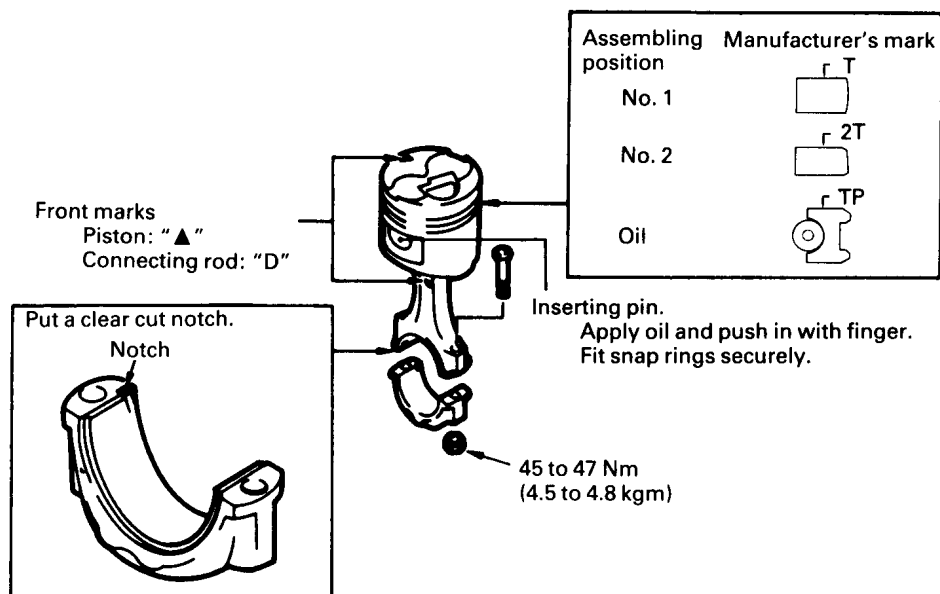


After press-fitting the bushing, ream or hone the bushing I.D. to fit the size of the piston pin to be used.

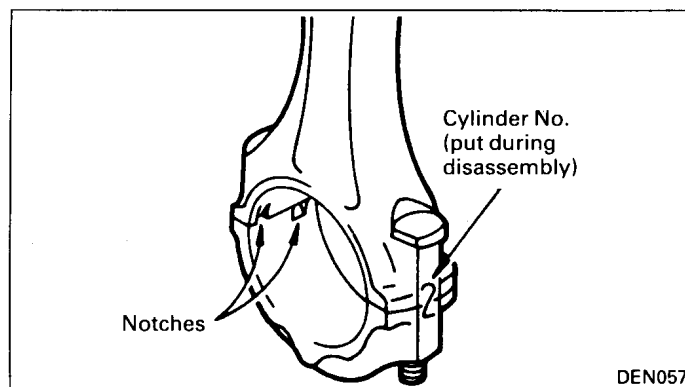
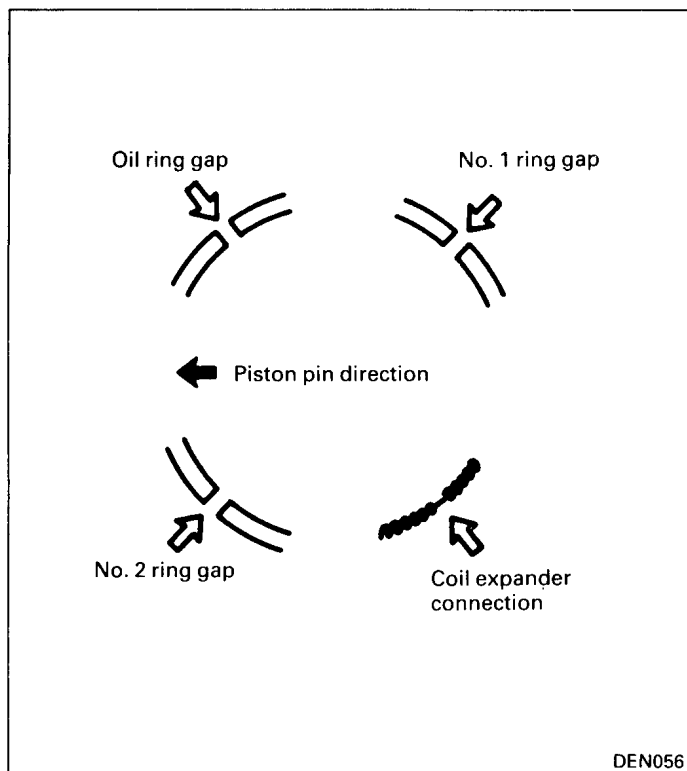
DEN054

12.4 INSTALLATION

1. In the installation, pay attention to the following.



DEN055



2. Position the piston ring gaps as shown in illustration and apply oil to the piston, rings and cylinder wall.
3. Holding the ring securely with a piston ring band, insert the piston and connecting rod assembly into the cylinder from the top. Do not give a hard blow to the piston crown. Otherwise, the ring could be broken. Make sure that the piston and connecting rod front marks face toward the front of the engine.

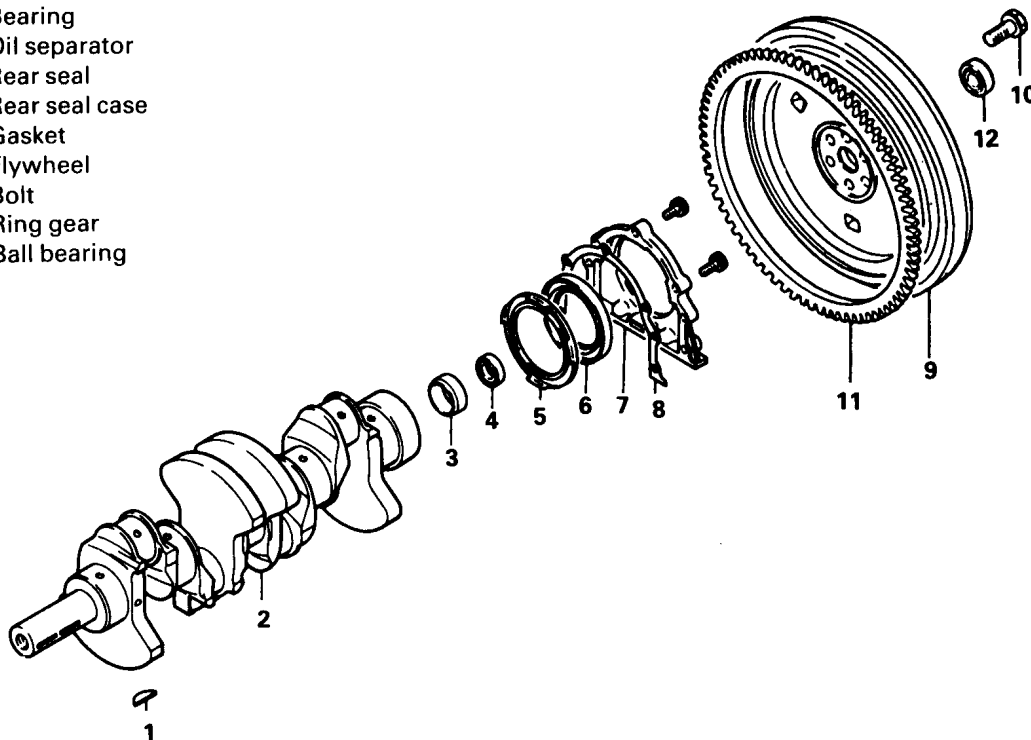
Caution:

- **Never allow the connecting rod to come in contact with the oil jet.**
- **After assembling the piston and connecting rod, visually check that the oil jet faces toward the reverse side of the piston crown.**

4. Apply engine oil to the bearing surface of the connecting rod cap and assemble referring to the mating marks put during disassembly. In the case of a new connecting rod without mating marks, assemble with the bearing stopper notches on the same side as shown in illustration.

13. CRANKSHAFT AND FLYWHEEL

- 1 Key
- 2 Crankshaft
- 3 Crankshaft bushing
- 4 Bearing
- 5 Oil separator
- 6 Rear seal
- 7 Rear seal case
- 8 Gasket
- 9 Flywheel
- 10 Bolt
- 11 Ring gear
- 12 Ball bearing



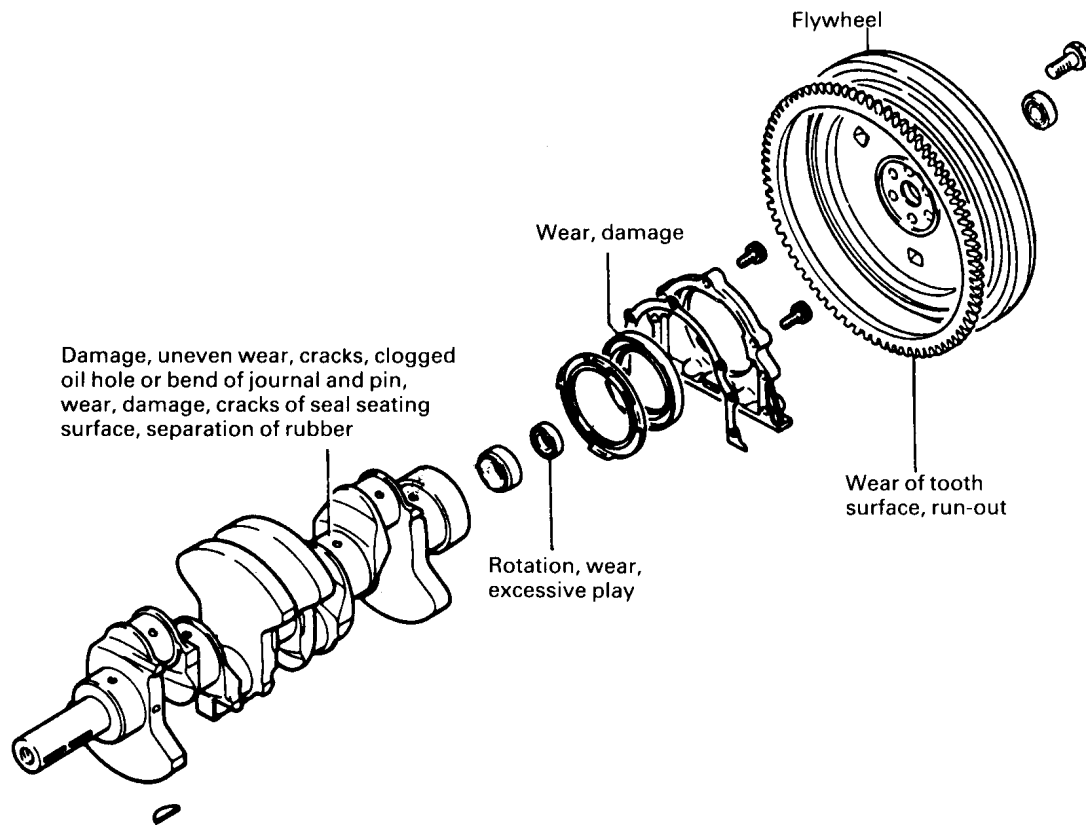
DEN058

13.1 REMOVAL

1. Remove the six bolts securing the drive plate and remove the drive plate.
2. Remove the rear oil seal case assembly.
3. Remove the main bearing caps. Store the main bearing separately for each bearing cap No.
4. Remove the crankshaft.

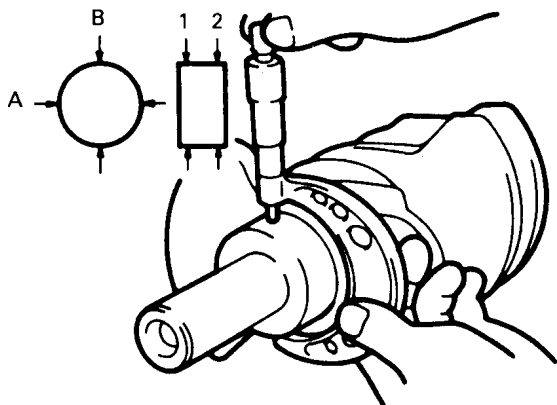
13.2 INSPECTION

Correct or replace if defective.



DEN059

Checking Crankshaft Wear



Journal O.D. and pin O.D.

Description	Nominal value
Journal O.D.	66 mm
Pin O.D.	53 mm

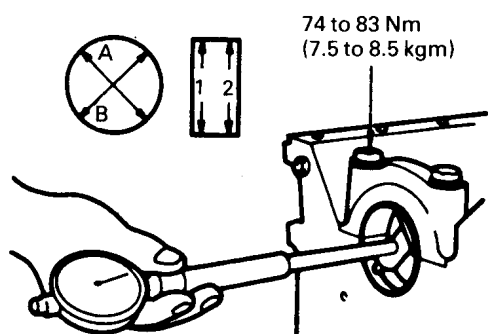
Undersize finish dimensions

	Journal O.D.	Pin O.D.
0.25 mm U.S.	$65.75 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix} \text{ mm}$	$52.75 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix} \text{ mm}$
0.50 mm U.S.	$65.50 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix} \text{ mm}$	$52.50 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix} \text{ mm}$
0.75 mm U.S.	$65.25 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix} \text{ mm}$	$52.25 \begin{smallmatrix} 0 \\ -0.03 \end{smallmatrix} \text{ mm}$

DEN060

Measure the journal and pin dimensions in directions A and B at front and rear (1 and 2) positions. If worn excessively, grind to an undersize. If the service limit is exceeded, replace the crankshaft.

Checking Crankshaft Oil Clearance



Description	Nominal value
Main bearing	0.021 to 0.046 mm
Connecting rod bearing	0.019 to 0.056 mm

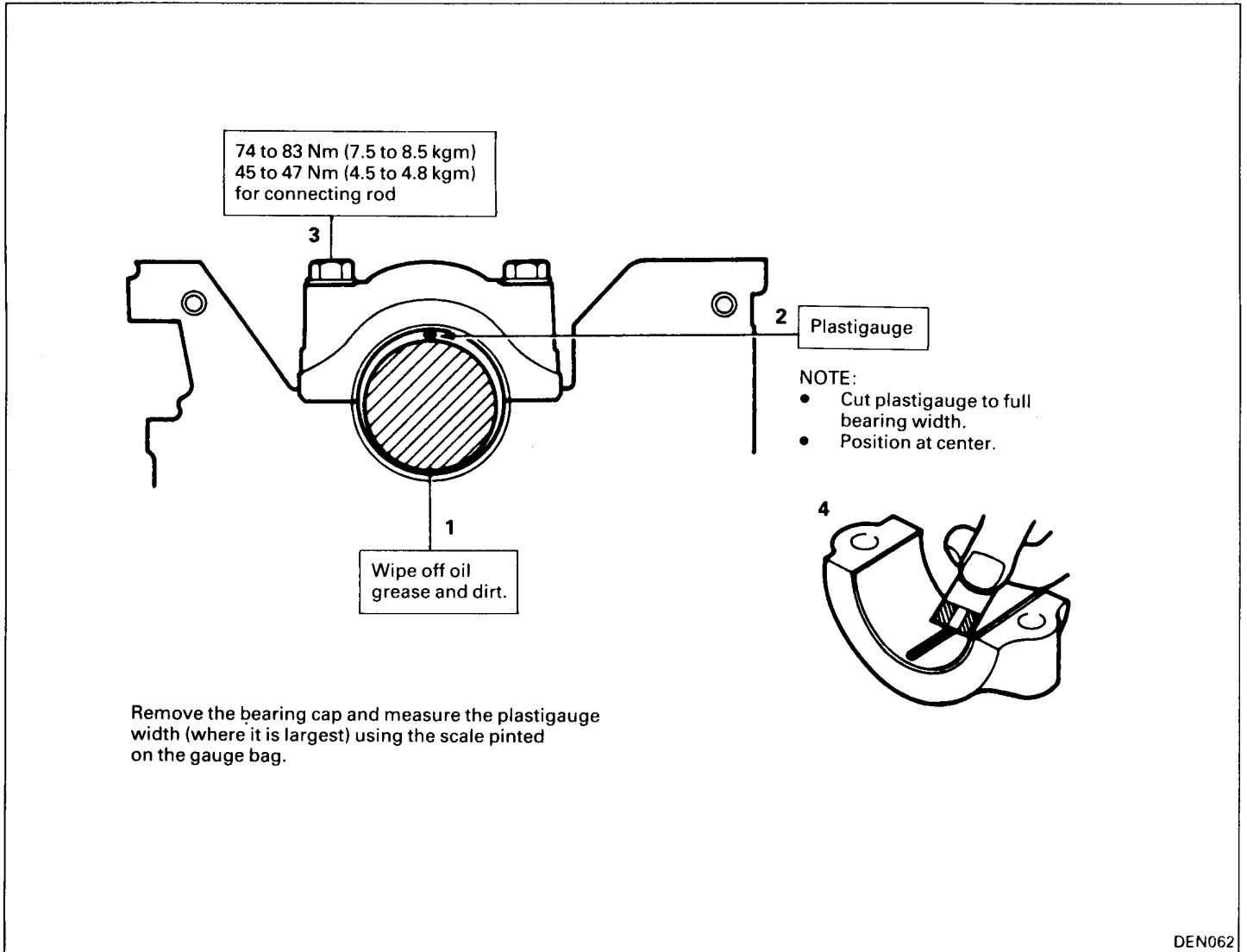
DEN061

Determine the clearance from the difference between the O.D. of journal as well as pin O.D. and the I.D. of each bearing as assembled to the crankshaft. Measure the bearing I.D. in directions A and B at front and rear (1 and 2) positions as shown in illustration.

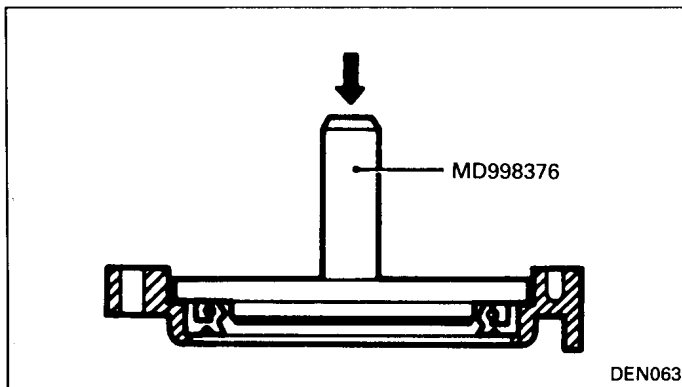
If the use of a new bearing still results in an oil clearance larger than the standard value, grind the crankshaft to an undersize and use a bearing of corresponding undersize.

(Reference)

Checking oil clearance with a plastigauge



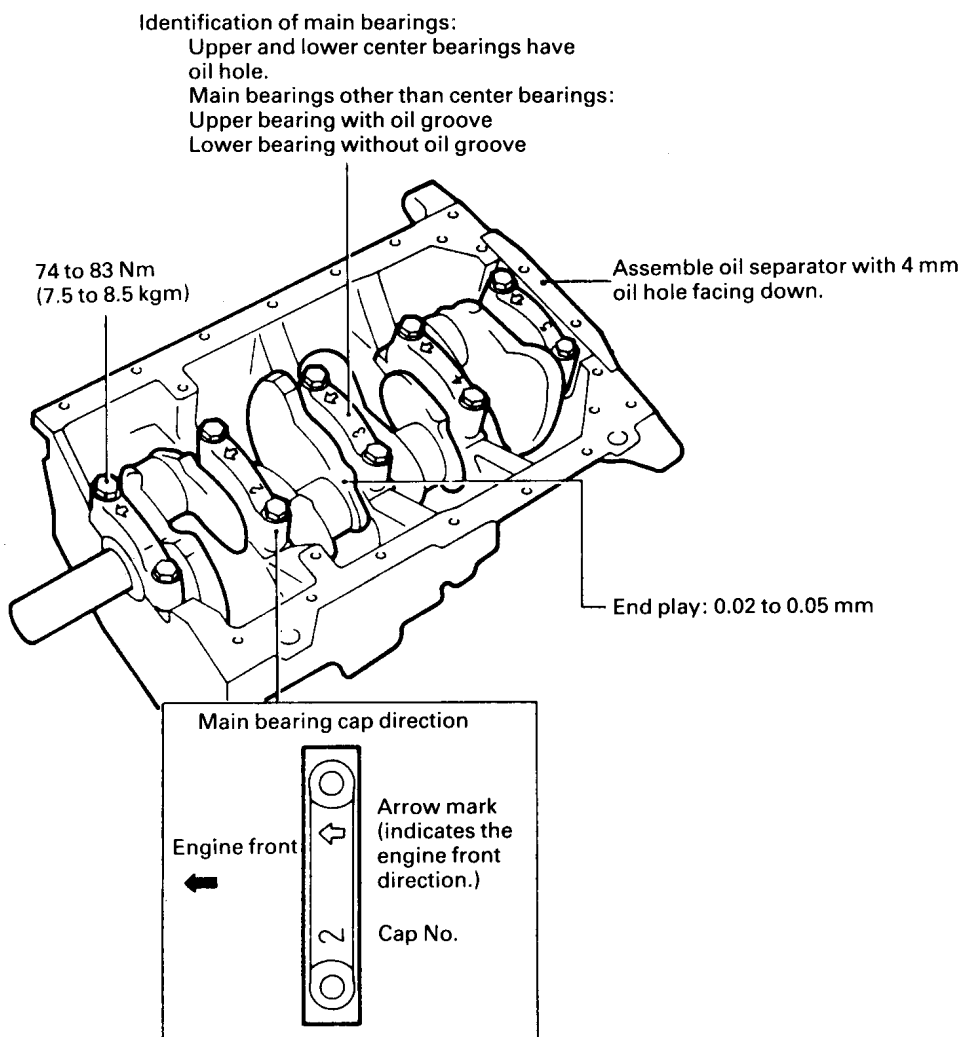
13.3 REPLACING CRANKSHAFT REAR OIL SEAL



1. Remove the oil seal using a screwdriver.
2. Drive in a new oil seal using the special tool Oil Seal Installer (MD998376).

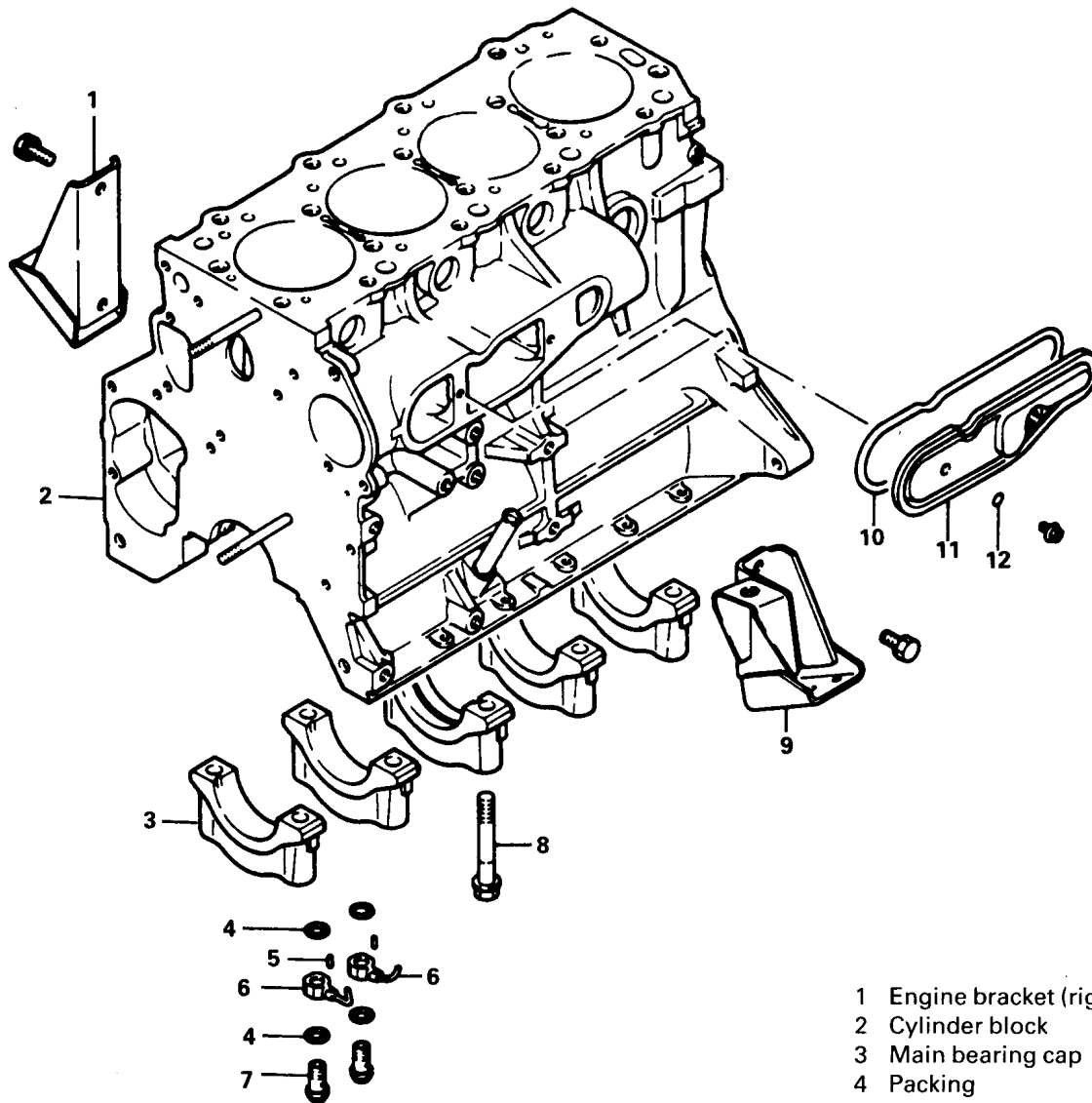
13.4 INSTALLATION

When installing, pay attention to the following.



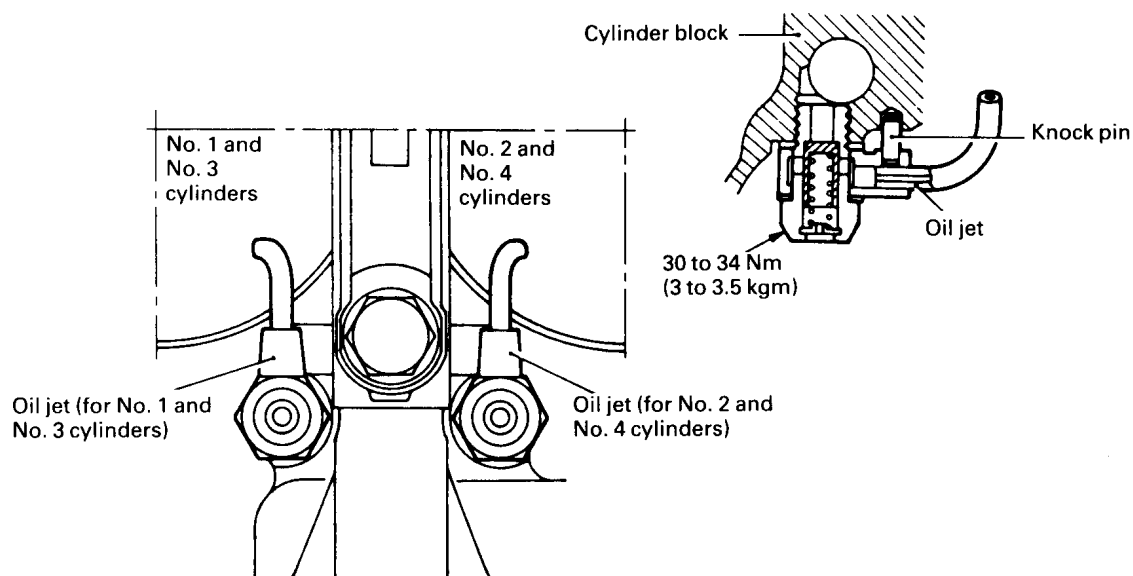
DEN064

14. CYLINDER BLOCK



- 1 Engine bracket (right)
- 2 Cylinder block
- 3 Main bearing cap
- 4 Packing
- 5 Knock
- 6 Oil jet
- 7 Check valve
- 8 Cap bolt
- 9 Engine bracket (left)
- 10 Packing
- 11 Cover
- 12 O-ring

DEN065

14.1 DISASSEMBLY AND ASSEMBLY

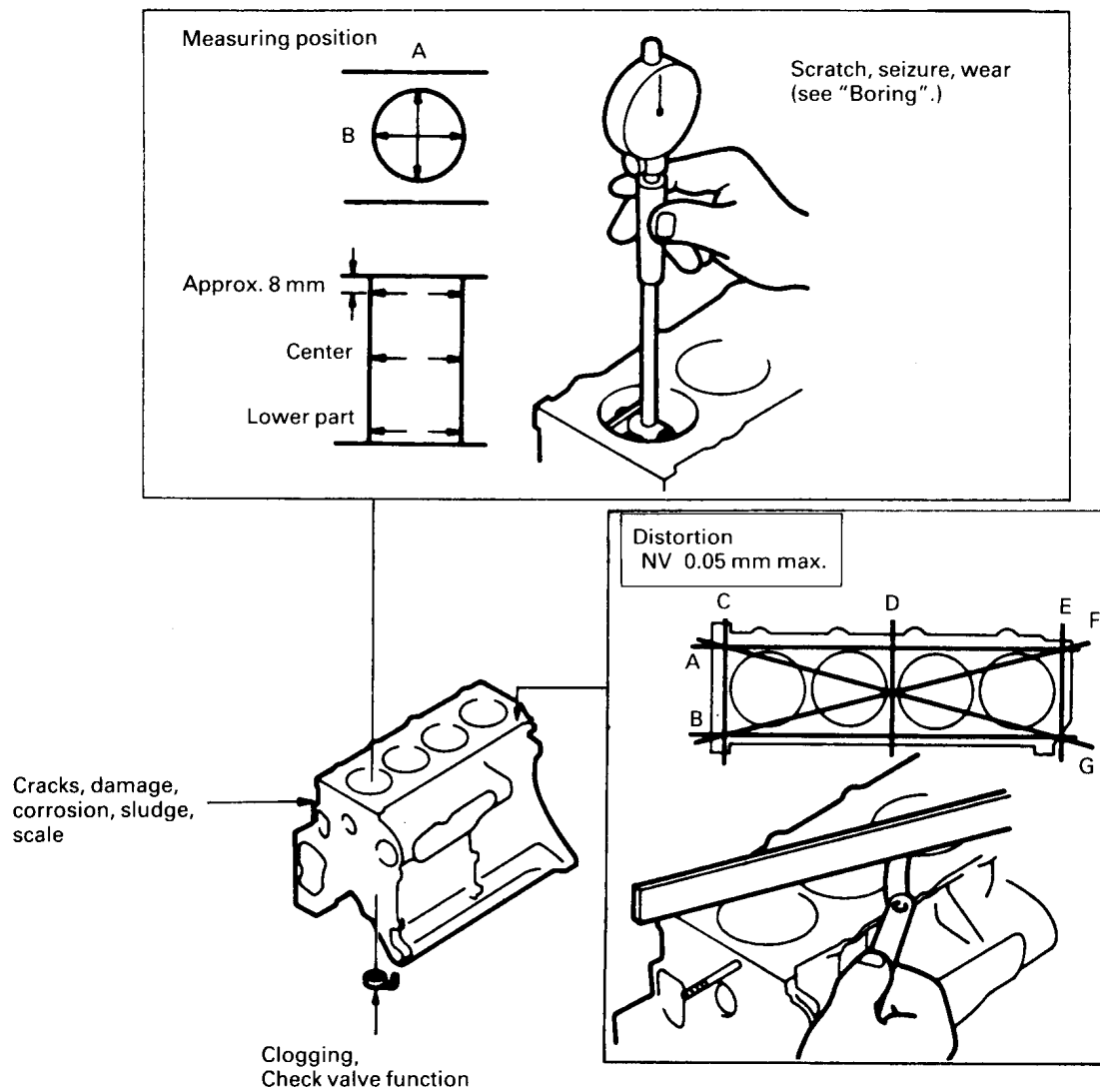
DEN066

When assembling or disassembling, pay attention to the following.

1. The journal cap has been worked with the cylinder block. Handle with care not to damage it. Do not intermix the journal caps.
2. There are two types of oil jets, i.e. one for No. 1 and No. 3 cylinders and the other for No 2 and No. 4 cylinders. Install in correct direction as illustrated above.

14.2 INSPECTION

Correct or replace if defective.



NV .. Nominal Value

DEN067

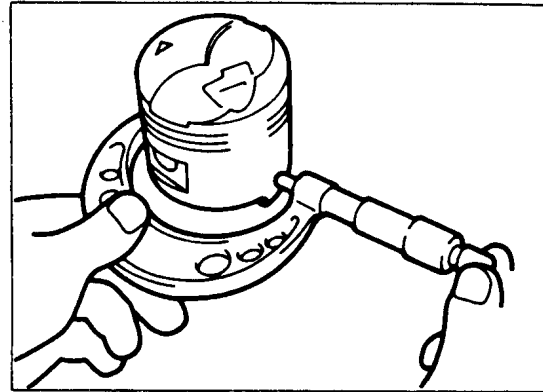
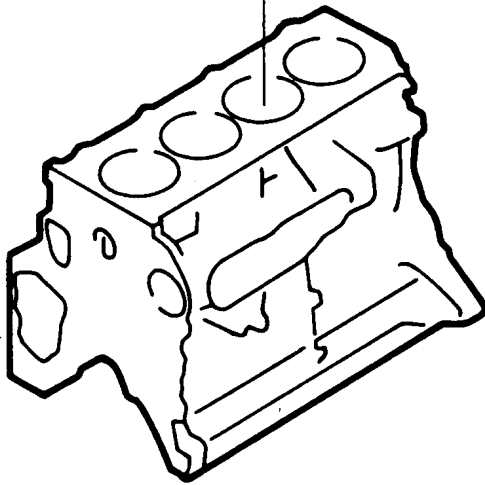
14.3 BORING CYLINDER

To bore the cylinder, proceed as follows.

Piston service size

Size	Size symbol
STD	None
0.25 mm O.S.	0.25
0.50 mm O.S.	0.50
0.75 mm O.S.	0.75
1.00 mm O.S.	1.00

1 Selecting O.S. piston



2 Measuring piston O.D.

3 Boring finish dimensions
 Piston O.D. + clearance – honing allowance:
 0.02 mm
 Clearance (piston to cylinder clearance)
 Nominal value: 0.04 to 0.06 mm

4 Boring, honing

NOTE:

When boring the cylinders, finish all of four cylinders to the same oversize. Do not bore only one cylinder to an oversize.

15. TROUBLESHOOTING

Problem	Probable cause	Remedy
Low compression	Blow cylinder head gasket	Install new head gasket.
	Worn or broken piston rings	Horn cylinder bores and install new rings.
	Warped or pitted valves	Install new valves.
	Excessive run-out of valve seats on valve faces	Reconditioning valve seats and valves.
Noisy valves	Incorrect valve clearance	Adjust to specifications.
	Worn valve guides	Install new valves and/or new valve guides with O.S.
	Excessive run-out of valve seats on valve faces	Reconditioning valve seats and valves.
Connecting rod noise	Insufficient oil supply	Check engine oil level.
	Low oil pressure	Check engine oil level, inspect oil relief valve and spring.
	Thin or diluted oil	Change oil to correct viscosity.
	Excessive bearing clearance	Measure bearings for correct clearance.
	Connecting rod journals out-of-round	Replace crankshaft or regrind journals.
	Misaligned connecting rods	Replace bent connecting rods.
Main bearing noise	Insufficient oil supply	Check engine oil level.
	Low oil pressure	Check engine oil level. Inspect oil relief valve and spring.
	Thin or diluted oil	Change oil to correct viscosity.
	Excessive bearing clearance	Measure bearings for correct clearances.
	Excessive end play	Check No. 3 main bearing for wear on flanges.
	Crankshaft journal out-of-round worn	Replace crankshaft or regrind journals.
	Loose flywheel or torque converter	Tighten to correct torque.

Problem	Probable cause	Remedy
Oil consumption	Worn, scuffed, or broken rings	Hone cylinder bores and install new rings.
	Carbon in oil ring slot	Install new rings.
	Rings fitted too tight in grooves	Remove the rings. Check grooves. If groove is not proper width, replace piston.
	Worn valve guides	Install new valves and/or new valve guides with O.S.
	Faulty valve stem seals	Install new valve stem seals.
Oil pressure drop	Low oil level	Check engine oil level.
	Faulty oil pressure switch	Install new switch.
	Clogged oil filter	Install new oil filter.
	Worn parts in oil pump	Replace worn parts or pump.
	Thin or diluted oil	Change oil to correct viscosity.
	Excessive bearing clearance	Measure bearings for correct clearance.
	Oil relief valve stuck	Remove valve and inspect, clean, and reinstall.
	Oil pump cover bent or cracked	Install new oil pump.

LUBRICATION

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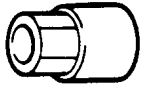
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2. SPECIAL TOOLS	2	3.3 CHECKING COOLER BYPASS	
3. OIL FILTER AND BRACKET	3	VALVE	5
3.1 REMOVAL AND			
INSTALLATION	4		

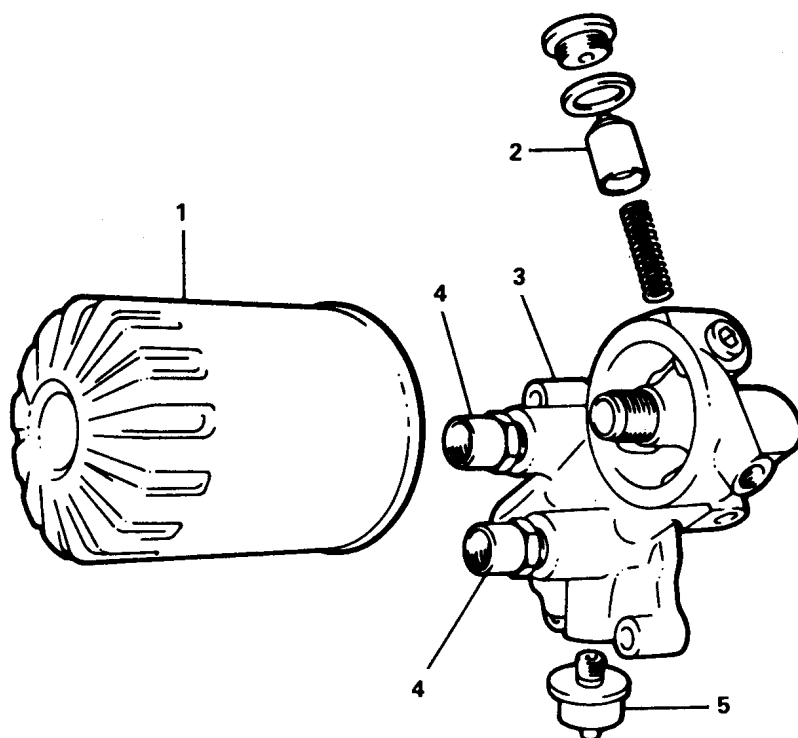
1. SPECIFICATIONS

Description	Specifications	Remarks
Lubrication and filtration system	Pressure feed, full flow filtration system	
Quantity of oil	6.5 lit. (including 0.6 lit. in oil filter and 0.4 lit. in oil cooler)	
Oil pump		
Type	Geared (internal gear) type, built in front lower case	
Drive	Directly coupled to crankshaft	
Relief valve opening pressure	539 $\pm$ 49 kPa (5.5 $\pm$ 0.5 kg/cm ²)	
Oil jet valve opening pressure	196 kPa (2 kg/cm ²)	
Oil pressure switch operating pressure	28 kPa (0.3 kg/cm ²) max.	
Oil filter	Filter paper type, cartridge filter	
Oil filter bracket		
Relief valve opening pressure	147 $\pm$ 20 kPa (1.5 $\pm$ 0.2 kg/cm ²)	
Bypass valve opening pressure	Oil cooler circuit opens at oil temperature of 80°C or higher	

The oil pump is built in the engine front lower case and therefore is described in "Group 11 ENGINE".

2. SPECIAL TOOLS

Tool name	Part No.	Shape	Use
Oil Pressure Switch Wrench	MD998054		Removing and installing oil pressure switch

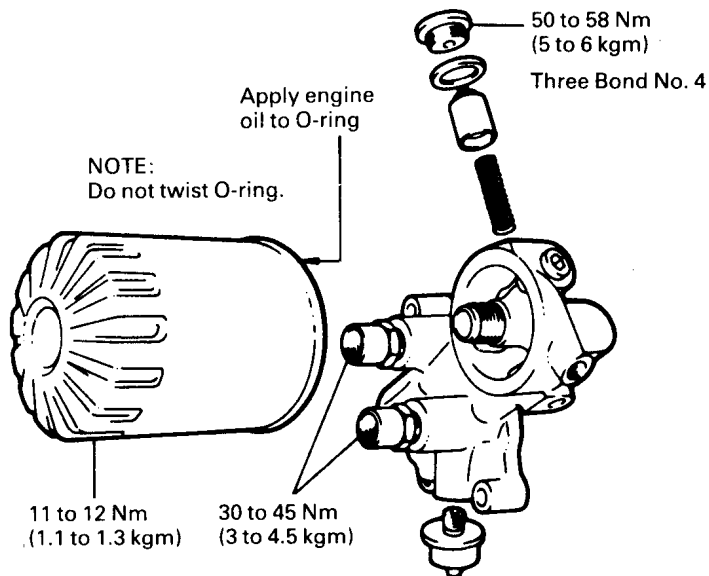
3. OIL FILTER AND BRACKET

- 1 Oil filter
- 2 Oil cooler bypass valve
- 3 Oil filter bracket
- 4 Joint (cooler)
- 5 Oil pressure switch

DLU001

3.1 REMOVAL AND INSTALLATION

When removing or installing, pay attention to the following.

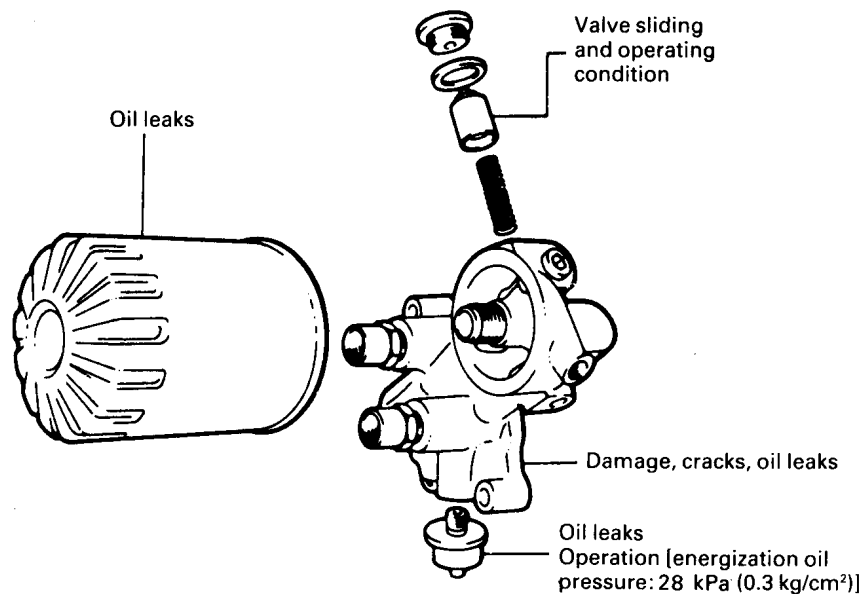


NOTE:
After assembly, run engine to check for oil leaks.

DLU003

3.2 INSPECTION

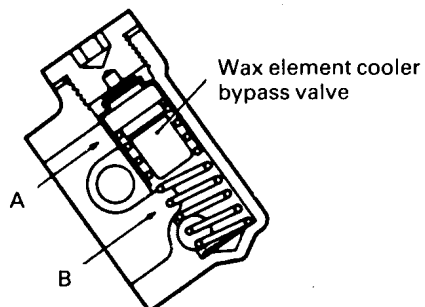
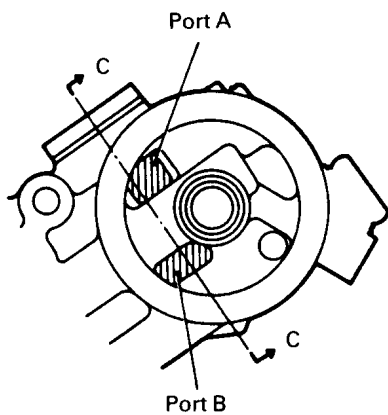
Check the following and replace if defective.



DLU003

3.3 CHECKING COOLER BYPASS VALVE

Check as described below and replace if defective.



Section C-C

Check ports A and B while heating in oil.

80°C or lower: Port A closes
Port B opens

100°C or higher: Port A opens
Port B closes

DLU004

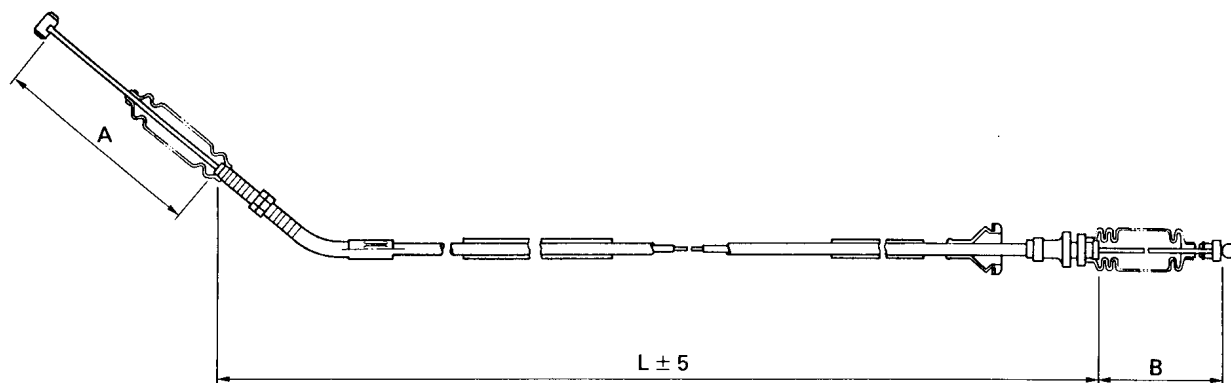
FUEL AND ENGINE CONTROL

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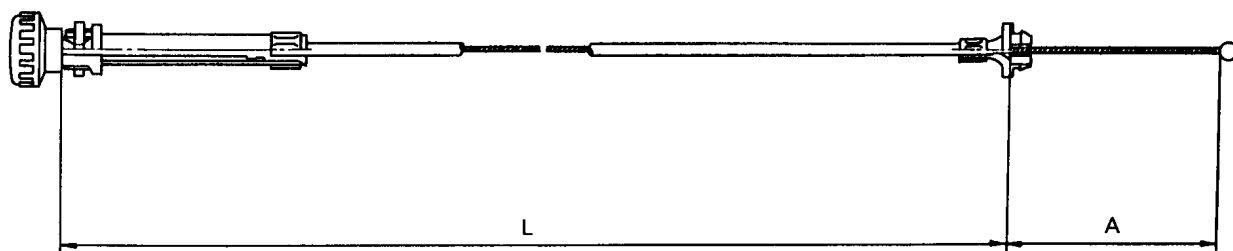
1. SPECIFICATIONS**1.1 GENERAL SPECIFICATIONS**

Description	Specifications	Remarks
Fuel injection pump		
Injection pump		
Type	Distribution type (Diesel Kiki)	
Turning direction	Clockwise as viewed from drive side	
Injection sequence	1 – 3 – 4 – 2	
Injection timing	5° ATDC (when pluger lift 1 mm)	
Cam lift	2.2 mm	
Plunger diameter	10 mm	
Delivery valve opening pressure	2 108 kPa (21.5 kg/cm ²)	
Governor type	Centrifugal type	
Timer type	Hydraulic	
Feed pump type	Vane type	
Control equipment		
Fuel cut solenoid	Rated voltage: 12V; Resistance: 8Ω	
Injection nozzle		
Type	Screw type	
Nozzle		
Type	Throttle type	
Injection orifice (Number – diameter)	1 – 1.02 mm	
Injection pressure	11 768 kPa (120 kg/cm ²)	
Engine control system	Pedal-operated cable type, incorporating electric engine stop mechanism interlocked with starter switch	
	Throttle button type	
Throttle knob stroke	25 or more	

1.2 CABLE SPECIFICATIONS**Accelerator Control Cable**

$L \pm 5$	$(A + B) \pm 3$
3 060	179

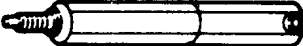
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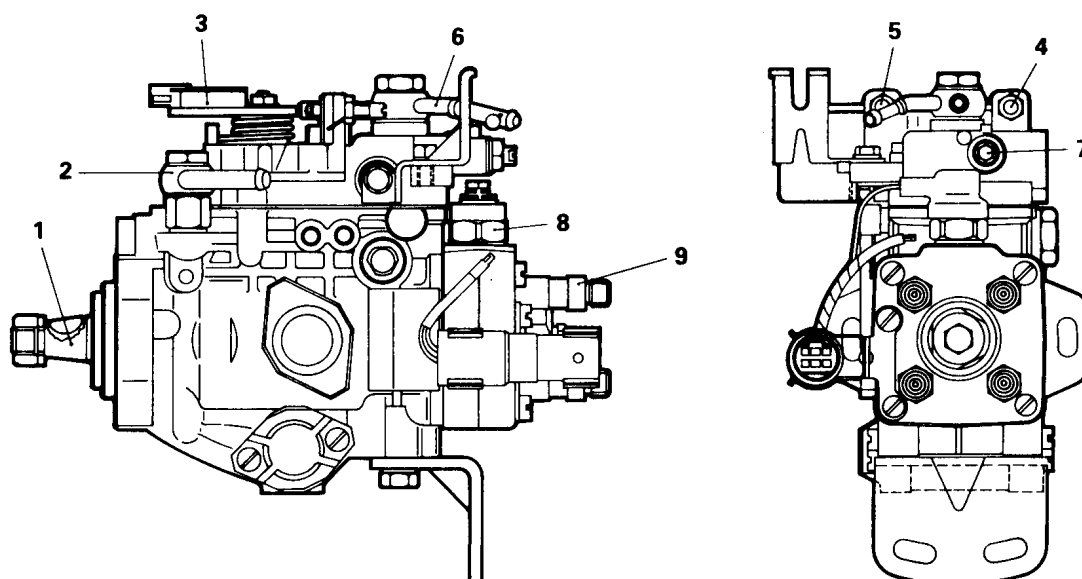
Throttle Cable

$L \pm 5$	$A +3$ 0
430	90

B0673A

2. SPECIAL TOOLS

Tool name	Part No.	Shape	Use
Nozzle Holder Socket Wrench	MD998387		Removing or installing nozzle holder assembly
Prestroke Measuring Adaptor	MD998384		Adjusting injection timing

3. FUEL INJECTION PUMP

- 1 Drive shaft
- 2 Fuel inlet
- 3 Accelerator lever
- 4 Idle adjust screw
- 5 Maximum speed adjust screw
- 6 Fuel return
- 7 Full load adjusting screw
- 8 Fuel cut solenoid
- 9 Delivery valve holder

DFU002

3.1 INSPECTION ON VEHICLE

If found defective, replace the injection pump as assembly.

NOTE:

Limit the injection pump adjustment to the idle adjustment

Description	Check procedure	Criteria
Idling run	Measure rpm	750 ± 50 rpm (See "Adjusting Idling".)
Color of exhaust gas	Give fast acceleration under no load and check color of exhaust gas. (Measure smoke value.)	Voluminous black smoke is unacceptable. (Smoke ref. value: within 50%.)
Timer	Operate accelerator lever to maintain an engine speed of approx. 1 500 rpm. In this condition, manually operate accelerator switch knob to see how engine speed changes.	Engine noise changes.
Fuel cut solenoid	Turn on and off ignition switch.	Actuating sound (click) is heard.

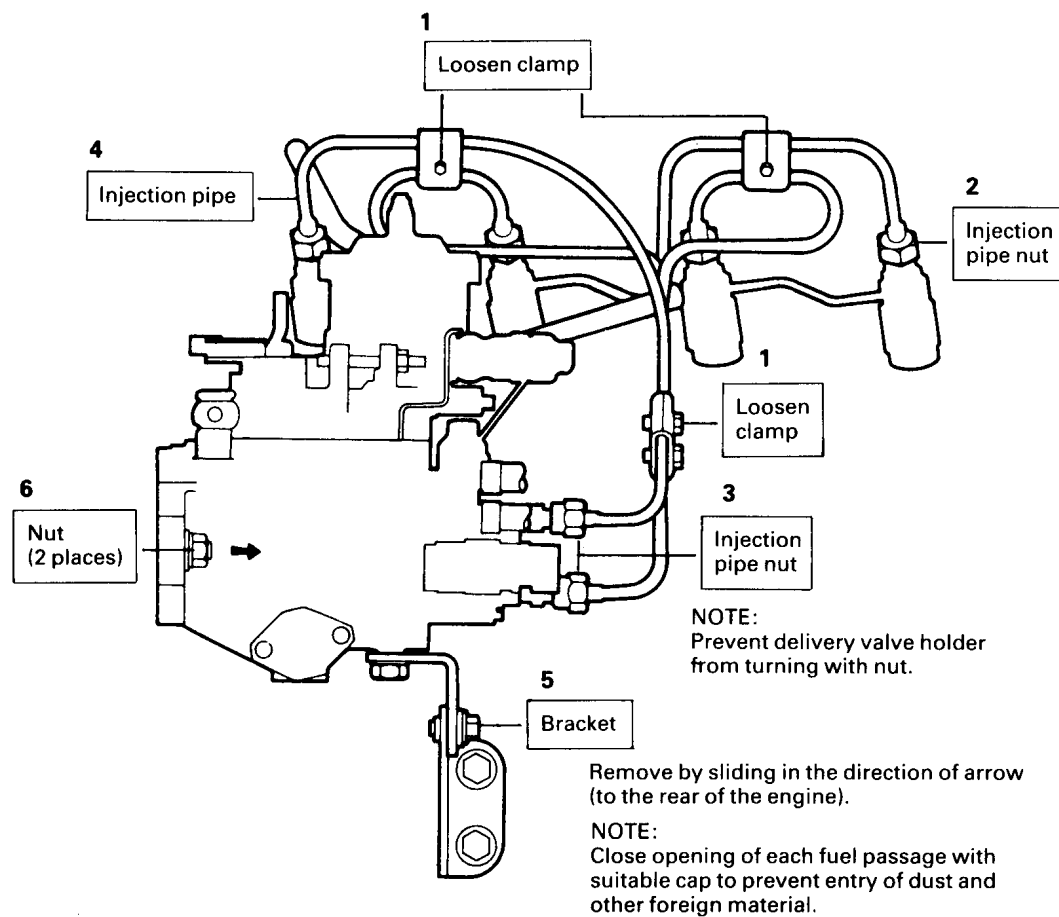
3.2 REMOVAL

1. Remove the timing belt upper cover.
2. Remove the nut and washer securing the injection pump sprocket. Take care not to drop the nut and washer in the lower cover.
3. Turn the crankshaft to bring the piston in No. 1 cylinder to the top dead center on the compression stroke.
4. Using a puller (commercially available), disengage the sprocket from the taper section of the drive shaft. Do not remove the sprocket but accommodate it in the timing belt lower cover with the belt engaged.

Caution:

- **Protect the timing belt against undue stress (torsion, bending, etc.).**
- **After the removal, do not turn the crankshaft.**

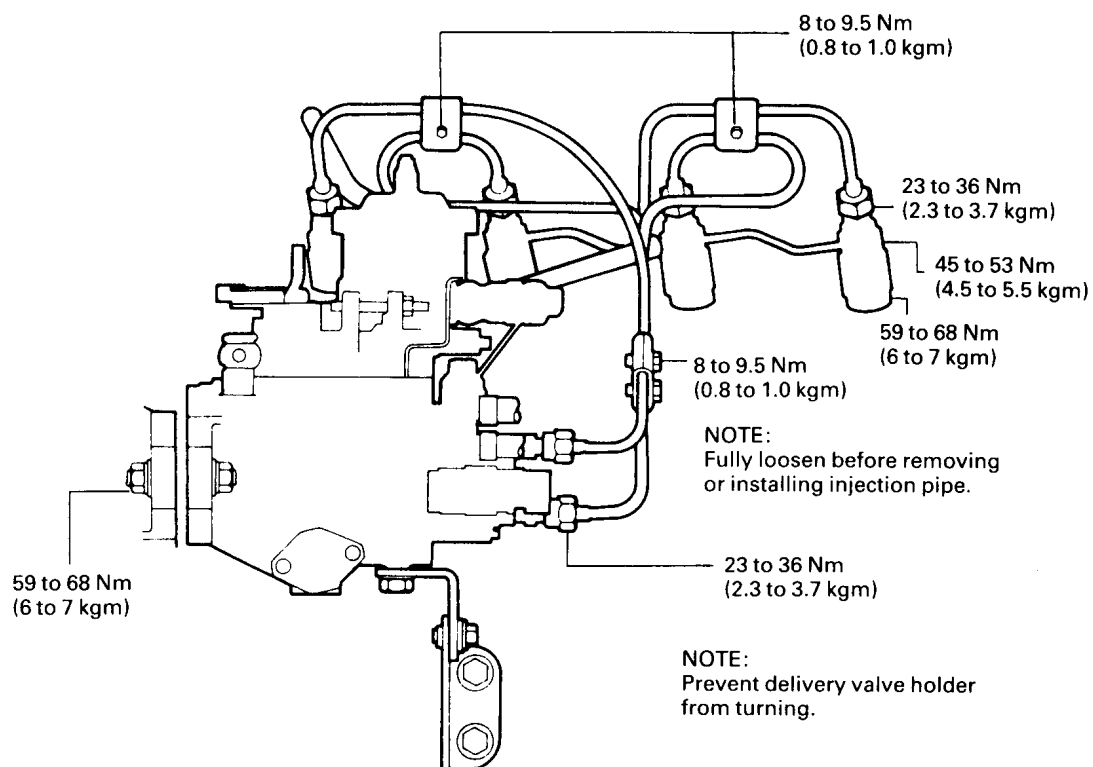
5. To remove, proceed as follows (in numerical order).



DFU003

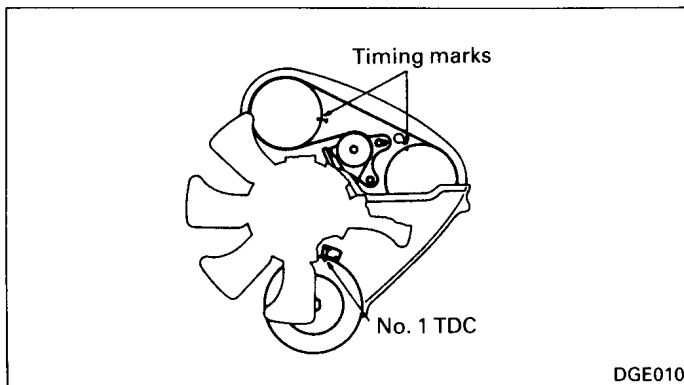
3.3 INSTALLATION

Install in reverse order of the removal, paying attention to the following.



DFU004

Installing Injection Pump Sprocket



1. Make sure that the timing marks on the camshaft sprocket and the crankshaft pulley are aligned. (Piston in No. 1 cylinder at the top dead center on the compression stroke.)
2. With the injection pump sprocket (carrying the belt) lifted up, install the injection pump inserting the injection pump drive shaft in the sprocket taper hole.

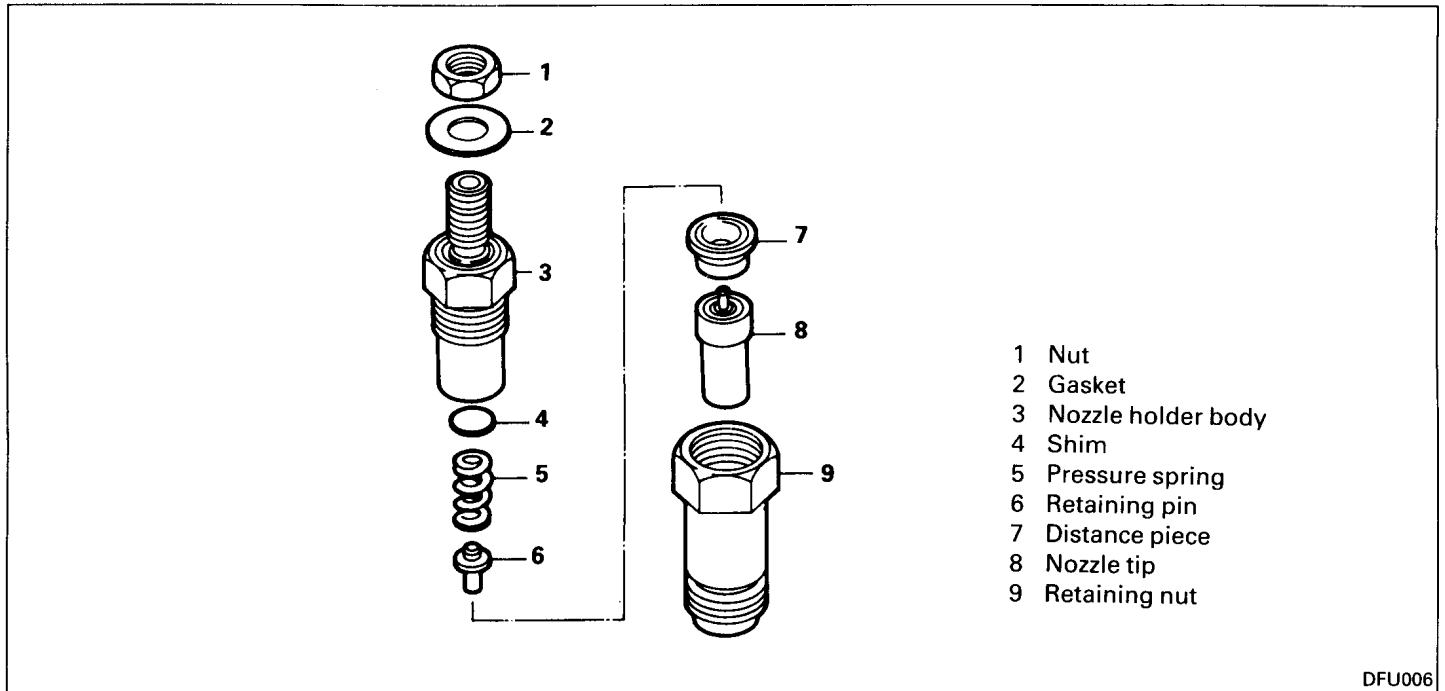
Caution:

- **Make sure that the injection pump drive shaft key is not displaced or dropped.**
3. Tighten temporarily the two nuts and two bolts securing the injection pump.
 4. Tighten the nut securing the sprocket to specified torque.

Adjusting after Installation of Injection Pump

1. Adjust the timing belt tension.
2. Adjust the injection timing.
3. Bleed.

4. INJECTION NOZZLE



4.1 REMOVAL

1. Remove the injection pipe and the fuel return pipe.
2. Remove the injection nozzle and pull out the nozzle tip gasket from the cylinder head.

Caution:

- **Attach a tag indicating No. to the removed injection nozzle.**
- **Put suitable caps to the respective openings to prevent entry of dust, water and other foreign material into the fuel passage and combustion chamber.**

4.2 DISASSEMBLY

If found defective in the inspection, correct or replace defective part.

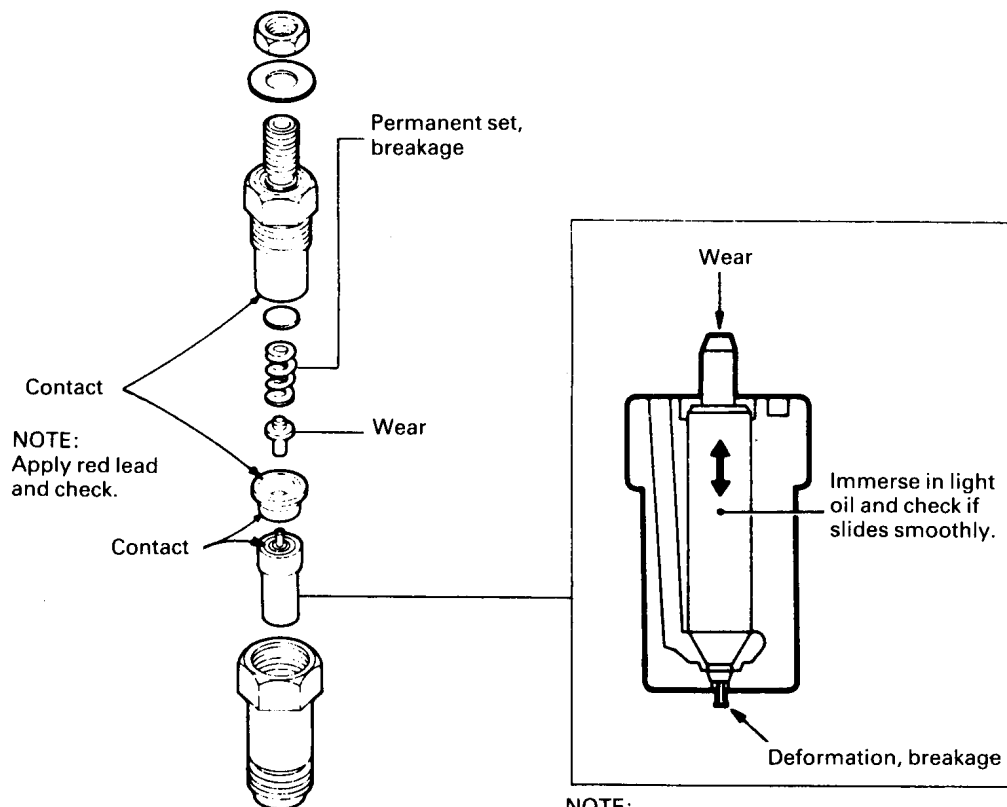
1. Holding the nozzle holder body in a vice or the like, remove the retainer nut with the special tool Nozzle Holder Socket Wrench (MD998387). Do not hold the retaining nut in a vice, etc. as it could result in deformation of the nut.
2. Remove the pressure spring, retaining pin, distance piece and nozzle tip.

Caution:

- **Scrape off carbon deposit with a piece of wood and clean each part with cleaning oil (gasoline). Then, keep the parts immersed in light oil. Take particular care to protect the nozzle tip needle valve against damage.**

4.3 INSPECTION

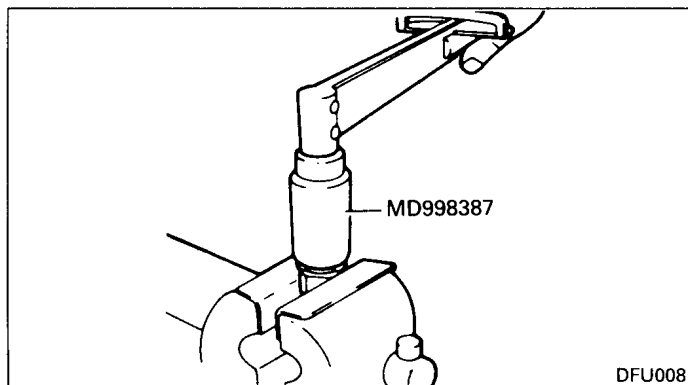
Check and replace if defective.



NOTE:
When using a new nozzle, thoroughly wash it in clean light oil to remove rust preventive oil.

DFU007

4.4 ASSEMBLY



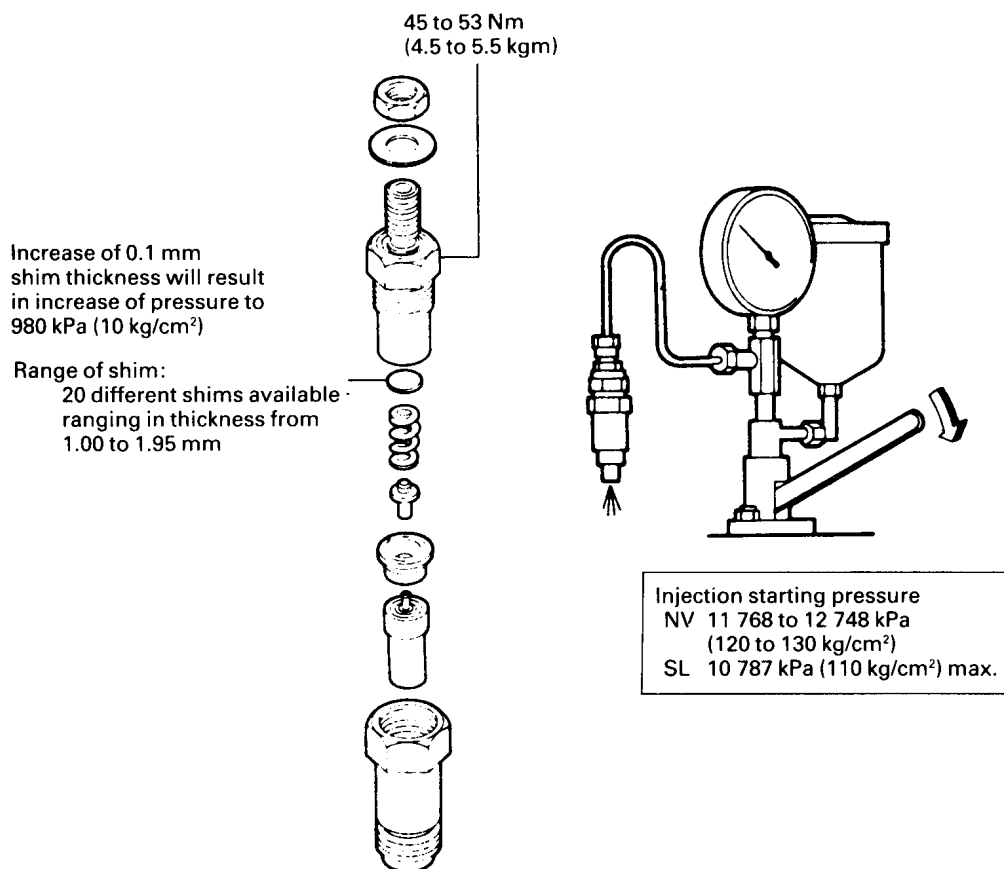
DFU008

1. Insert the nozzle tip into the retaining nut until it is fully seated.
2. Place the distance piece, retaining pin, pressure spring and the shim (removed during disassembly) on the nozzle tip.
3. Finger tighten the nozzle holder body.
4. Hold the nozzle holder in a vice and using the special tool Nozzle Holder Wrench (MD998387), tighten the retaining nut to specified torque.

4.5 ADJUSTMENT

Adjust the injection starting pressure as follows.

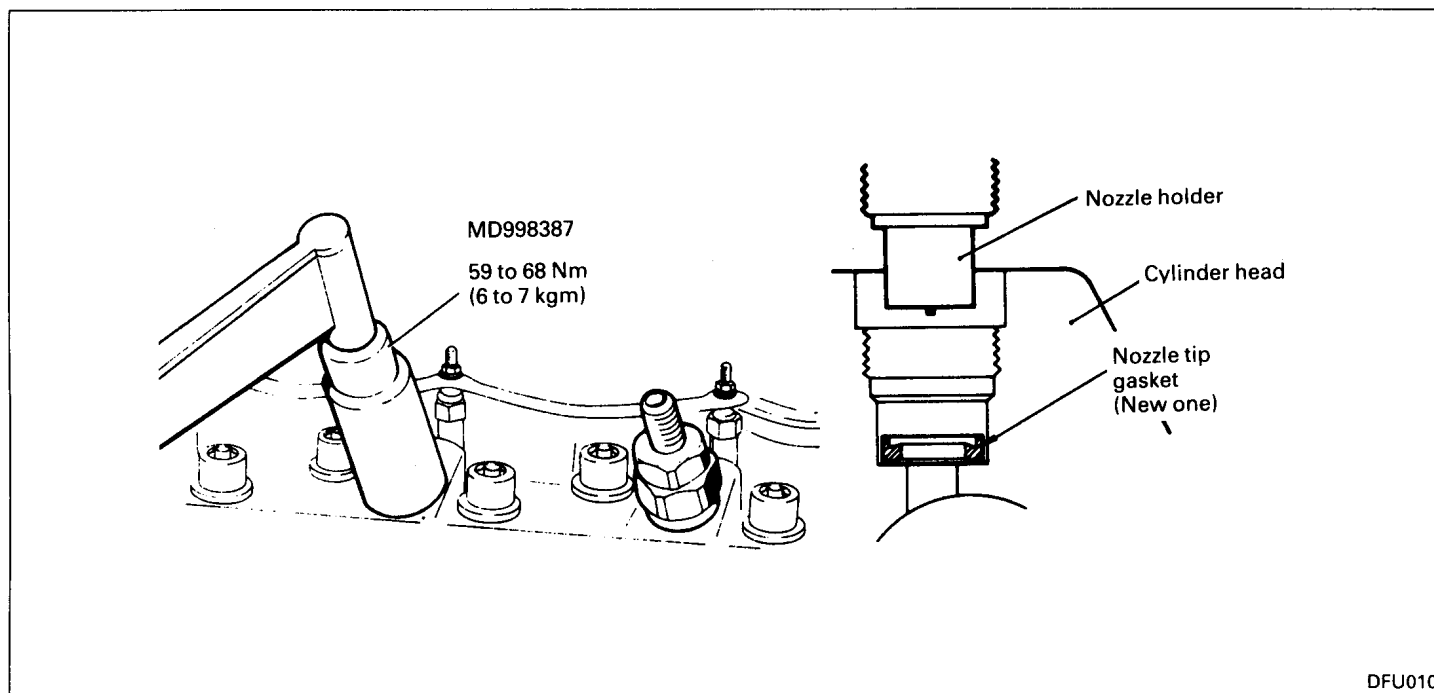
After adjustment, check the spray condition.



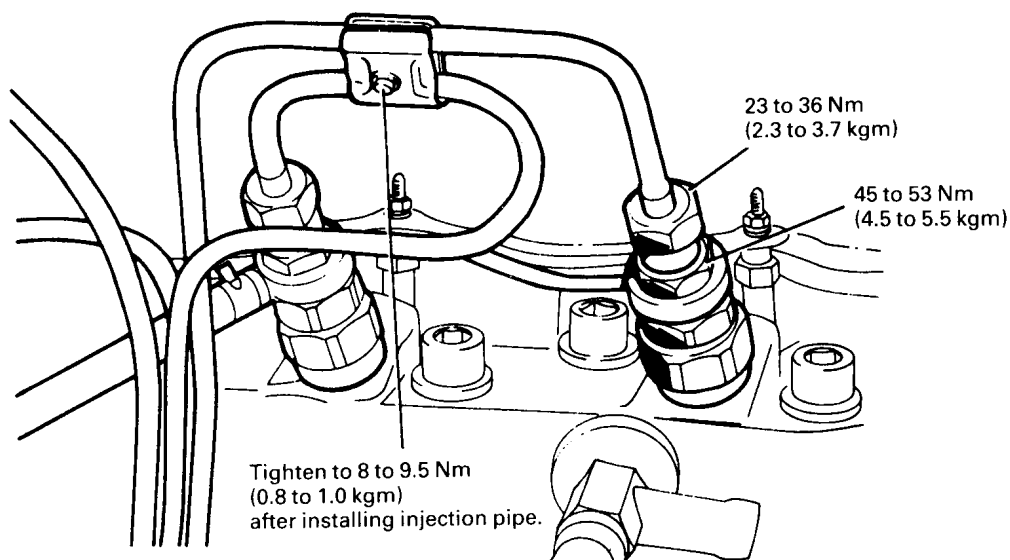
NV .. Nominal Value
SL .. Service Limit

DFU009

4.6 INSTALLATION



1. Clean the nozzle holder mounting area of the cylinder head. Then, fit a new nozzle tip gasket to the nozzle tip and tighten to the cylinder head to specified torque, using the special tool Nozzle Holder Wrench (MD998387).

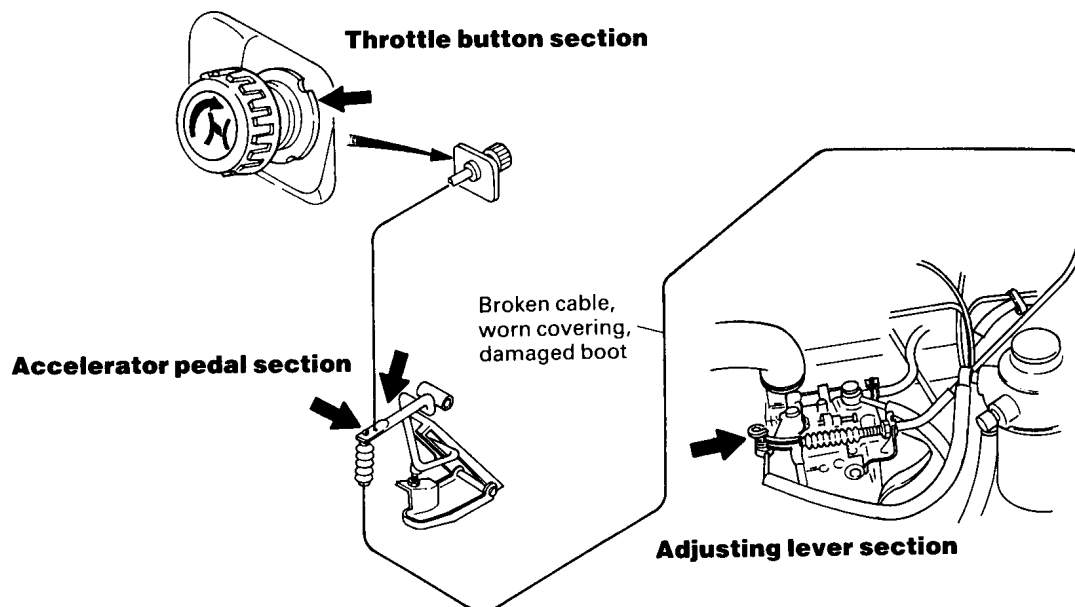


DFU011

2. Install the fuel return pipe and the injection pipe.

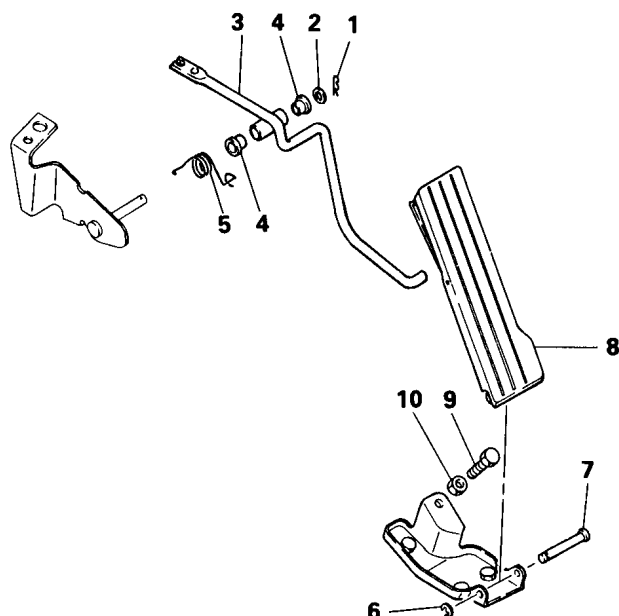
5. ENGINE CONTROL

5.1 REMOVAL AND INSPECTION



B1842A

5.2 DISASSEMBLY

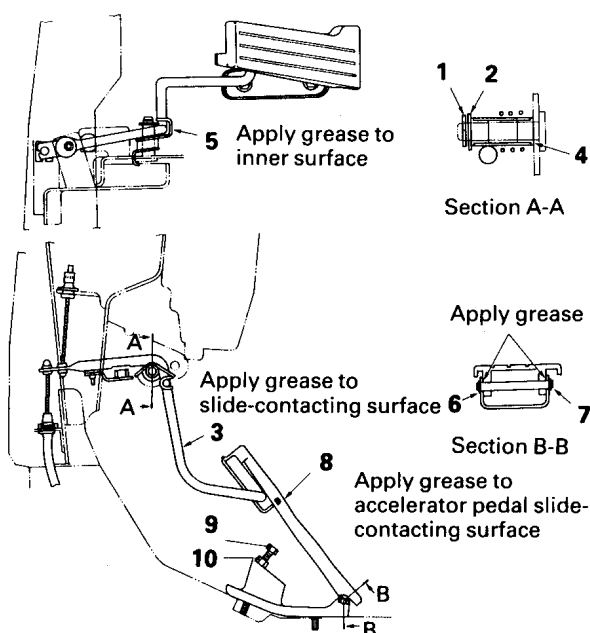


<Disassembly sequence>

- 1 Split pin
- 2 Washer
- 3 Accelerator pedal arm assembly
- 4 Bushing
- 5 Return spring
- 6 Snap ring
- 7 Clevis pin
- 8 Accelerator pedal
- 9 Adjusting bolt
- 10 Lock nut

B0676B

5.3 ASSEMBLY



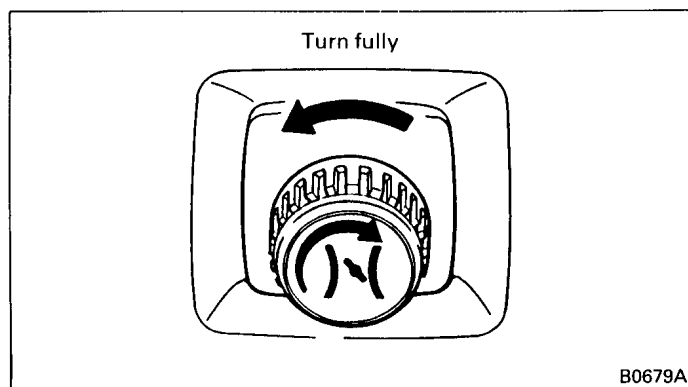
<Assembly sequence>

- | | | | | | | | | |
|---|---|----|---|---|---|---|---|---|
| 5 | → | 3 | → | 2 | → | 1 | | |
| 4 | | | | | | | | |
| 9 | → | 10 | → | 8 | → | 7 | → | 6 |

B1848A

Cable Installation and Adjustment Procedures

1. Throttle Cable

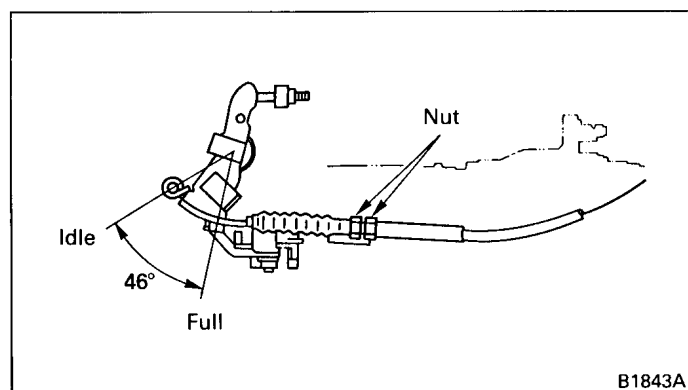


NOTE:

1. Make this adjustment with the cab tilt and tilt handle down.
2. Route each cable so that it may not come in contact with the edge of sheet metal.
3. The routing radius of each cable shall be 150 mm or more.

Turn the throttle button fully in the opposite direction to that of arrow indicated on the button. With the inner cable most protruded, install the accelerator pedal arm or accelerator lever. At that time, make sure that when the engine speed reaches the lowest speed, the inner cable is in the most protruded state.

2. Accelerator Control Cable

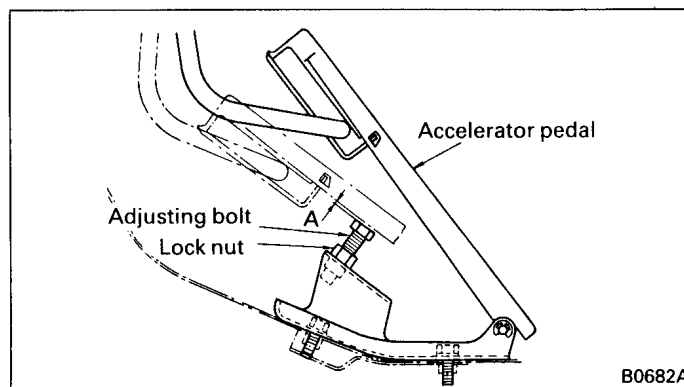


Turn the throttle button in the opposite direction to that of arrow indicated on the button and make sure that the accelerator pedal does not move. Install the accelerator control cable to the adjusting lever and secure the engine side of the cable by tightening the nut.

NOTE:

Do not move the engine side adjusting lever when the accelerator control cable is installed.

3. Accelerator Pedal Stopper



Make adjustment so that when the engine side adjusting lever is in contact with the full stopper, clearance between accelerator pedal and adjusting bolt is equal to dimension A.

Dimension A: 0 to 5

6. TROUBLESHOOTING

6.1 GENERAL INFORMATION

Because the diesel engine's operation and efficiency are highly dependent on cylinder compression, many operating problems that seem to be injection troubles can also be caused by engine mechanical faults. Valves that are badly out of adjustment, valves that are leaking, and a leaking cylinder head gasket are three mechanical faults that can cause poor running, hard starting, or inefficient operation. Worn cylinders or pistons, worn-out or stuck piston rings, and broken pistons can cause similar troubles. Lubricating oil that finds its way past worn piston rings or worn valve stem seals sometimes produces exhaust smoke that is mistaken for the smoke caused by a misadjusted fuel injection system.

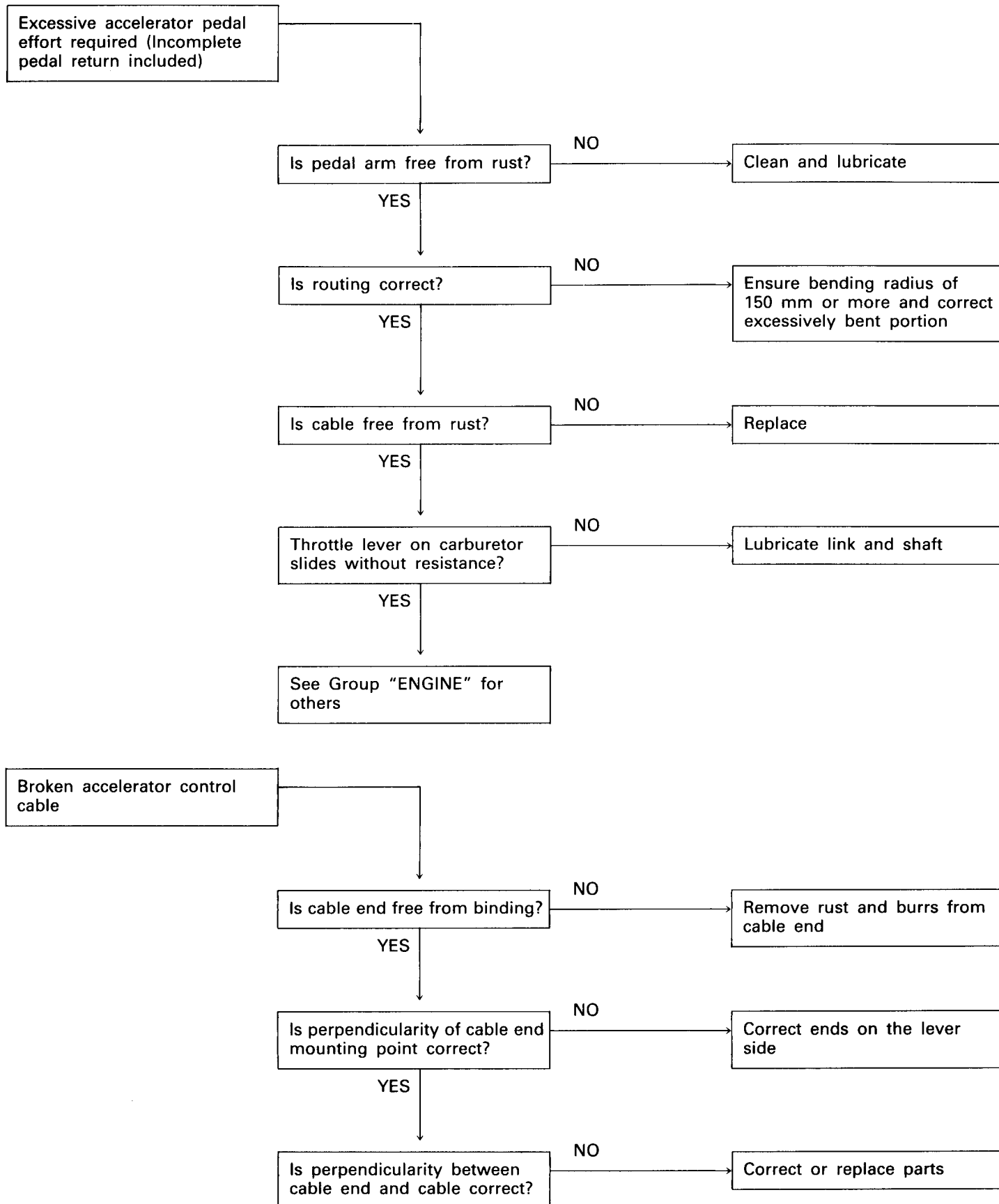
It is therefore wise to make certain routine checks of the fuel injection system when operating problems are encountered, but a compression test is an indispensable part of diesel troubleshooting. Table "Fuel Injection System Troubleshooting" lists five possible problems along with their probable causes and applicable remedies. Check each item in the order that it appears in the table. The numbers in the Remedy column refer to headings in this section of the Manual where the suggested tests and repairs are described.

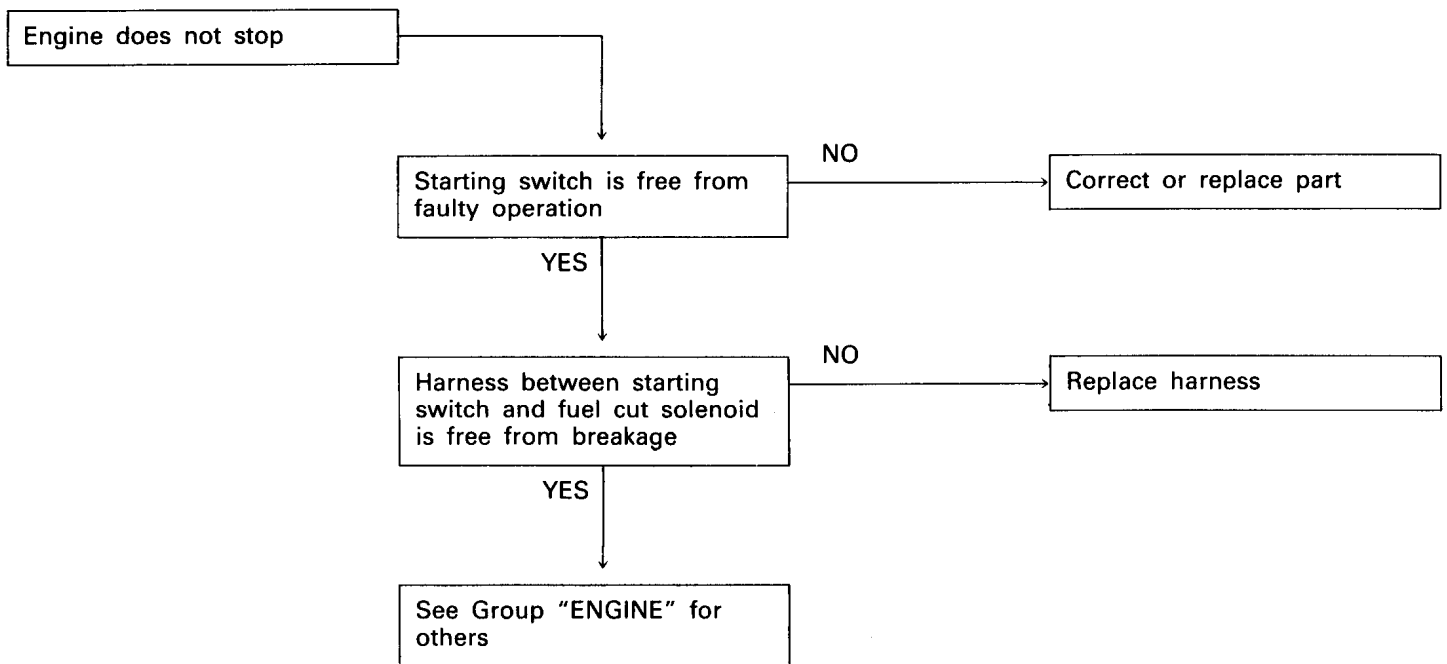
6.2 FUEL INJECTION SYSTEM

Problem	Probable cause	Remedy
1. Engine does not start	a. Cranking speed too low b. No voltage at fuel cut-off solenoid on injection pump c. Fuel cut-off solenoid on injection pump loose or faulty d. No voltage at glow plug bus e. Glow plug faulty f. Air in fuel system g. Injection pump not delivering fuel h. Injection pipes misconnected i. Injection timing incorrect j. Faulty injection nozzles k. Engine mechanical faults, as described earlier under this heading l. Faulty injection pump	a. Repair starting system or charge or replace battery so that engine cranks at a minimum of 150 rpm. b. Check for voltage with test light. If necessary, replace fuse or faulty wires. c. Tighten solenoid. Check that solenoid clicks when key is turned off and on. Replace faulty solenoid. d. If test light shows no voltage at bus with key at "ON" position, test relay and wiring. e. Test and, if necessary, replace glow plug. f. Bleed fuel system. See "Maintenance". g. If no fuel emerges from a loosened injection pipe during cranking, check timing belt and fuel supply from filter. h. Connect pipes in correct location. i. Adjust injection timing. See "Maintenance". j. Check and, if necessary, repair or replace nozzles. See "Injection Nozzles". k. Test compression and, if necessary, repair engine. l. Try to start engine with new pump installed. If necessary, replace pump permanently. See "Fuel Injection Pump" in this group.

Problem	Probable cause	Remedy
2. Idle speed incorrect or idle rough or irregular	a. Idle speed incorrectly adjusted b. Accelerator control binding c. Loose fuel hose between filter and injection pump d. Air in fuel system e. Inadequate fuel supply owing to clogged fuel filter, or fuel return line and injection pipes leaking, dirty, kinked, or squeezed at connections f. Faulty injection nozzles g. Injection timing incorrect h. Engine mechanical faults, as described earlier under this heading i. Faulty injection pump	a. Check and, if necessary, adjust the idle speed. See "Maintenance". b. Check that accelerator lever on pump is not loose, then adjust accelerator cable. See "Chassis Workshop Manual". c. Replace hose or secure with clamps, bleed air from system. See "Maintenance". d. Bleed fuel system. See "Maintenance". e. Inspect and, if necessary, replace lines and hoses or replace fuel filter. f. Check and, if necessary, repair or replace injection nozzles. g. Adjust injection timing. See "Maintenance". h. Test compression and, if necessary, repair engine. i. Try engine at idle with new pump installed. If necessary, replace pump permanently. See "Fuel Injection Pump" in this group.
3. Smoky exhaust (black, blue or white)	a. Engine lugging in too high a gear b. Engine not reaching correct operating temperature c. Maximum rpm incorrect d. Faulty injection nozzles e. Injection timing incorrect f. Restricted exhaust system g. Engine mechanical faults, as described earlier under this heading h. Faulty injection pump	a. Observe correct shift speeds as given in Owner's Handbook. b. Check and, if necessary, replace cooling system thermostat. See "Cooling System". c. Check and, if necessary, replace injection pump. See "Injection Pump". d. Check and, if necessary, repair or replace injection nozzles. e. Adjust injection timing. See "Maintenance". f. Check exhaust system for dents and obstructions. g. Test compression and, if necessary, repair engine. h. Observe exhaust with new pump installed. If necessary, replace pump permanently. See "Fuel Injection Pump" in this group.
4. Poor power output, slow acceleration (speedometer accurate, clutch not slipping)	a. Injection pump accelerator lever loose or not reaching maximum rpm adjusting screw b. Maximum rpm incorrect c. Air cleaner filter dirty	a. Tighten lever, check that accelerator pedal travel is not restricted, then adjust accelerator cable. b. Check and, if necessary, replace injection pump. See "Injection Pump". c. Clean or replace air cleaner filter. See "Intake and Exhaust".

Problem	Probable cause	Remedy
4. Poor power output, slow acceleration (speedometer accurate, clutch not slipping) (continued)	d. Inadequate fuel supply owing to clogged fuel filter, or fuel return line and injection pipes leaking, dirty, kinked, or squeezed at connections e. Air in fuel system f. Ice or solidified wax in fuel lines. (winter time only) g. Faulty injection nozzles h. Injection timing incorrect i. Engine mechanical faults, as described earlier under this heading j. Faulty injection pump	d. Inspect and, if necessary, replace lines and hoses, replace fuel filter. e. Bleed fuel system. See "Maintenance". f. Move car to a warm garage until ice or wax has become liquid, then bleed fuel system. g. Check and, if necessary, repair or replace injection nozzles. h. Adjust injection timing. See "Maintenance" i. Test compression and, if necessary, repair engine. j. Check acceleration and speed with new pump installed. If necessary, replace pump permanently. See "Fuel Injection Pump" in this group.
5. Excessive fuel consumption	a. Air cleaner filter dirty b. Fuel leaks c. Return pipe and hose blocked d. Idle speed too fast or maximum rpm too high e. Faulty injection nozzles f. Injection timing incorrect g. Engine mechanical faults, as described earlier under this heading h. Faulty injection pump	a. Clean or replace air cleaner filter. See "Intake and Exhaust". b. Check and, if necessary, replace or tighten all pipes, hoses and connections. c. Check return line for kinks and dents. Replace faulty lines. If line is clogged, blow it out with compressed air, then bleed fuel system. See "Maintenance". d. Check and, if necessary, adjust idle speed or replace injection pump. See "Maintenance". e. Check and, if necessary, repair or replace injection nozzles. f. Adjust injection timing. See "Maintenance". g. Test compression and, if necessary, repair engine. h. Check fuel consumption with new pump installed. If necessary, replace pump permanently.

6.3 ENGINE CONTROL



COOLING

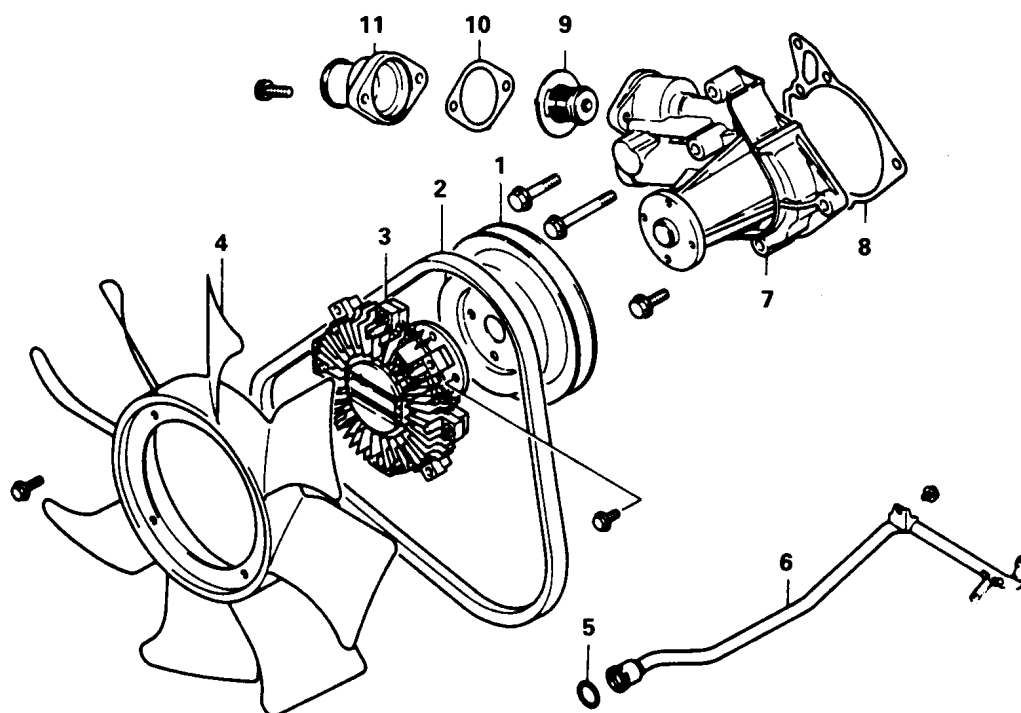
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1. SPECIFICATIONS

Description	Specifications	Remarks
Fan belt		
Type	Low edge multi-ply type B	
Length	1 095 mm	
Cooling fan O.D. x number	410 mm x 8	
Fan clutch type	Thermostatic type	
Water pump type	Centrifugal type with impeller	
Thermostat		
Type	Wax type	
Control system	Inlet control, bypass control	
Valve opening temperature	82°C	
Water temperature gauge unit		
Type	Thermistor, 2 elements	
Element	Water temperature gauge, glow plug control	
Coolant capacity	3.9 lit. in engine only	

2. COMPONENTS

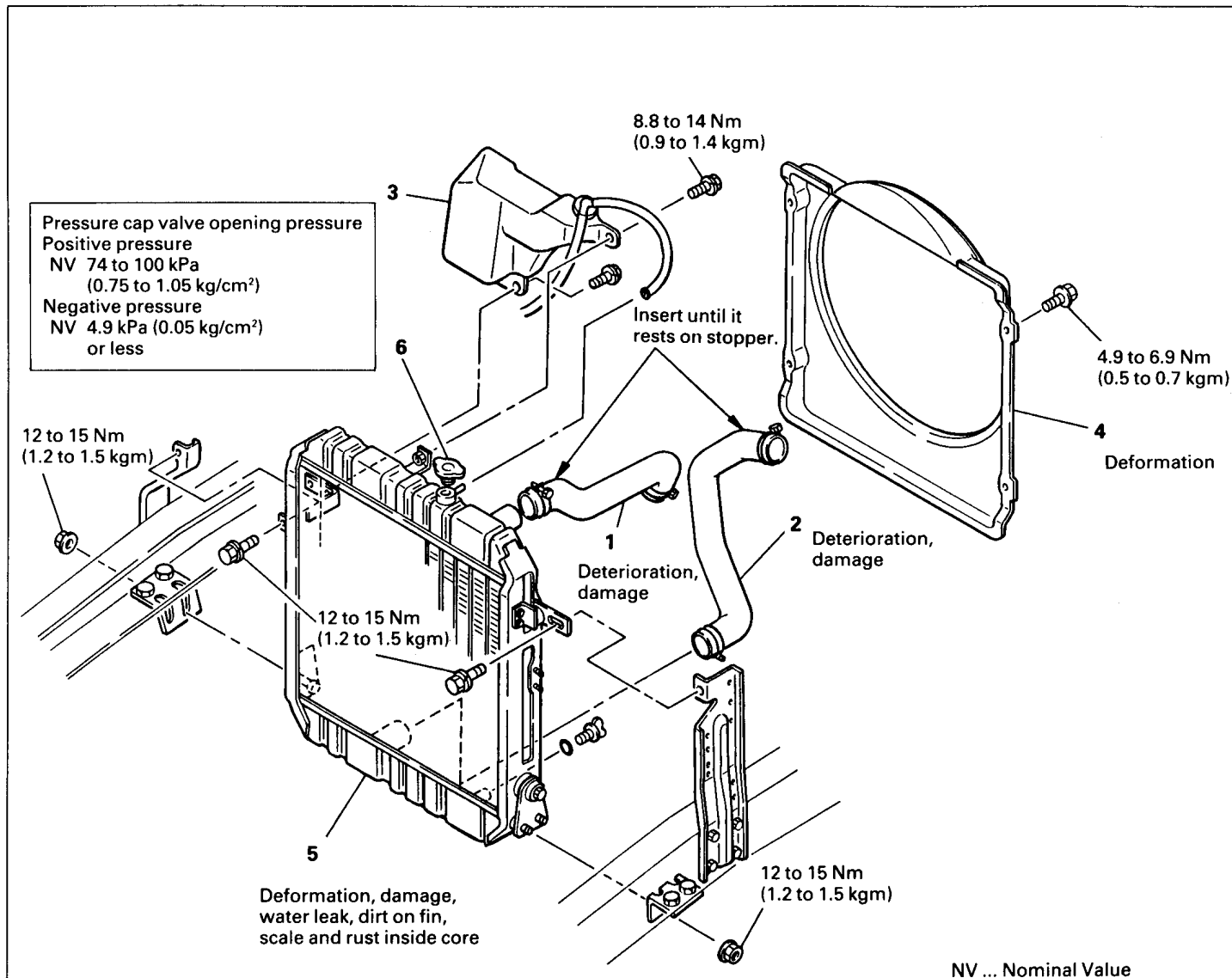


- | | |
|---------------------|------------------------|
| 1 Water pump pulley | 7 Water pump |
| 2 Fan belt | 8 Water pump gasket |
| 3 Fan clutch | 9 Thermostat |
| 4 Cooling fan | 10 Gasket |
| 5 O-ring | 11 Water inlet fitting |
| 6 Water pipe | |

DCO001

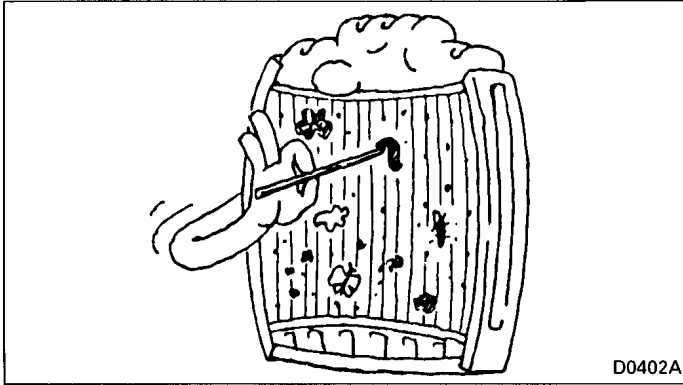
3. RADIATOR

3.1 REMOVAL, INSTALLATION, DISASSEMBLY AND REASSEMBLY

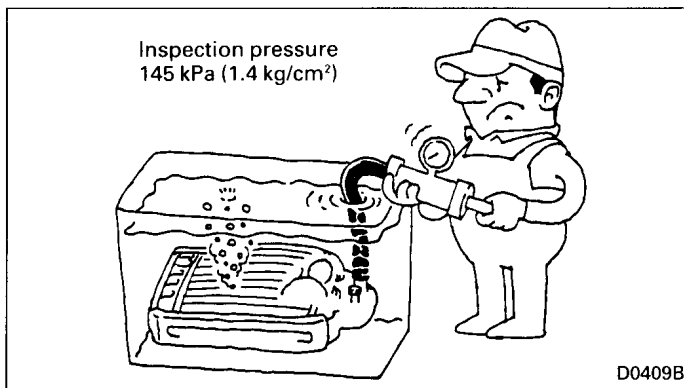


- | | |
|------------------|-------------------|
| 1 Inlet hose | 4 Radiator shroud |
| 2 Outlet hose | 5 Radiator |
| 3 Reservoir tank | 6 Pressure cap |

3.2 INSPECTION



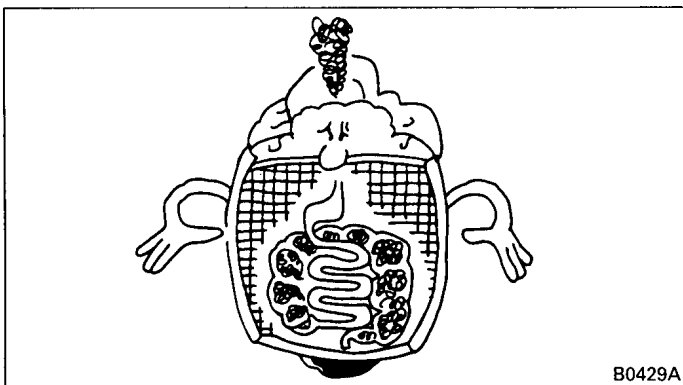
Using a copper wire or similar device, remove dirt, mud, and bugs from the front of radiator core with care to prevent damage to tubings.



Connect a hose to one of the radiator ports, cap the other port, and immerse the radiator into water. Using a radiator cap tester, force the compressed air under the specified inspection pressure from the hose end to check for leaks.

If there is a leak, resolder the point of leakage or replace the radiator.

3.3 CLEANING OF COOLING SYSTEM

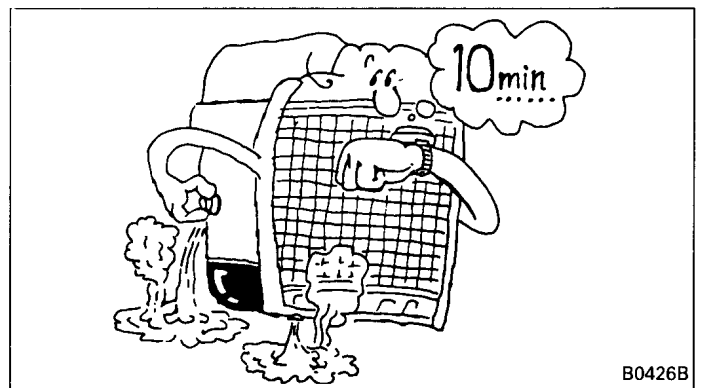


The radiator, if used for a long period, accumulates rust, scale, and mud inside, resulting in overheating of the engine. Clean the cooling system using the following procedures.

NOTE:

1. Use a cleaning solution if the radiator is seriously obstructed or coolant is severely contaminated.
2. When cleaning or flushing the system, keep the coolant temperature at around 90°C, or, the thermostat closes with the coolant temperature below the thermostat valve opening temperature, preventing normal circulation of coolant.

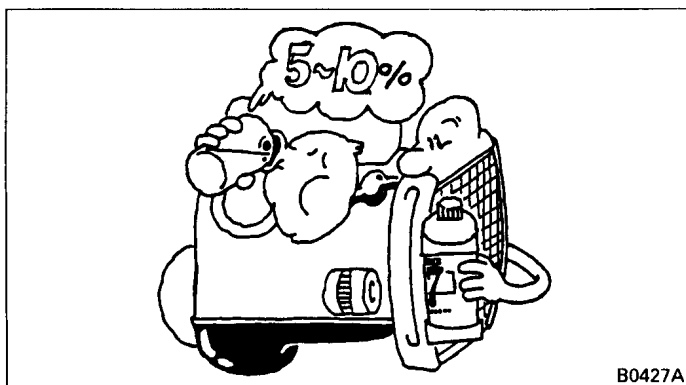
1. Washing with Water (Every two years at coolant change or before and after the use of antifreeze)



Discharge coolant from the radiator, crankcase, and reservoir tank.

After draining the system, fill it with tap water (preferably hot water) and, with the water temperature kept at around 90°C, run the engine at idle for about 10 minutes. Then, discharge water. Continue flushing until the drained water runs clear.

2. Washing with Cleaning Solution (Radipet-7)
(When radiator clogging or coolant contamination are serious)

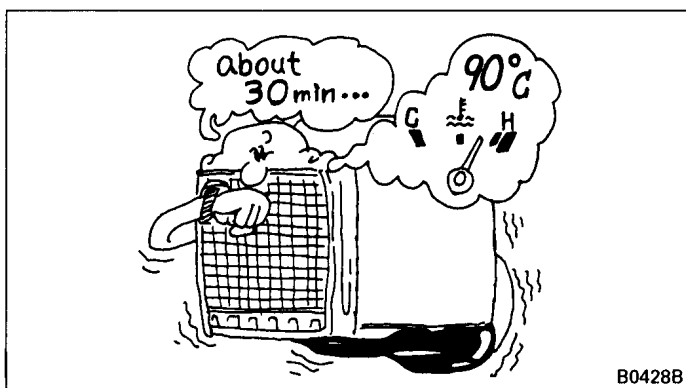


B0427A

Discharge coolant from the radiator, crankcase, and reservoir tank.

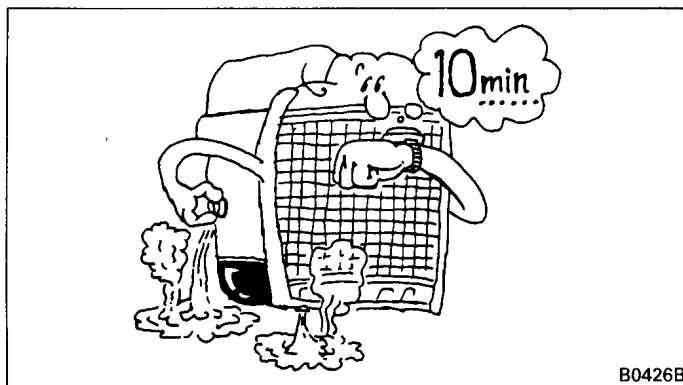
Ready a mixture of Genuine Fuso Radiator Cleaner (Radipet-7: 5 to 10%) and tap water.

Pour the specified amount of mixture into the radiator.



B0428B

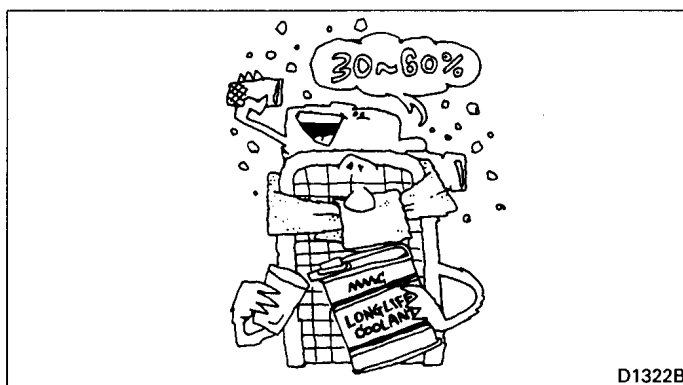
Run the engine to raise the solution temperature to around 90°C. Let the engine run at idle for another 30 minutes, then remove the solution.



B0426B

After discharging the solution, fill the system with tap water (preferably hot water) and, with the water temperature kept at around 90°C, run the engine at idle for about 10 minutes. Then, drain water. Continue flushing until the drained water runs clear.

3. Long Life Coolant



D1322B

Add 30 to 60% (to the total amount of coolant) of "Diaqueen Long Life Coolant" to give protection against freezeup of coolant and corrosion of the system.

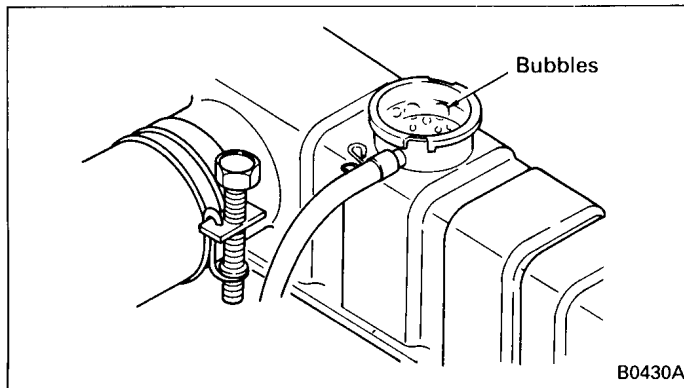
To ensure full antifreeze and antirust effects, change the coolant every two years.

For use of the Long Life Coolant, see Owner's Handbook.

3.4 GAS LEAK TEST

Air or exhaust gas leaked into the coolant prompts corrosion and rust formation. Perform the following check and, if defects are found, take remedial action.

1. Inspection



Remove the pressure cap from the radiator, and run the engine to raise the coolant temperature up to around 90°C.

If bubbles continue forming in the coolant under the condition, it indicates that air or exhaust gas has leaked into the coolant.

2. Causes

If air is trapped in coolant, check cylinder head bolts, water pump mounting bolts, and hose connections for looseness. Check also hoses for damage.

If the exhaust gas has leaked into coolant, check the cylinder head gasket for damage and the cylinder head for cracks.

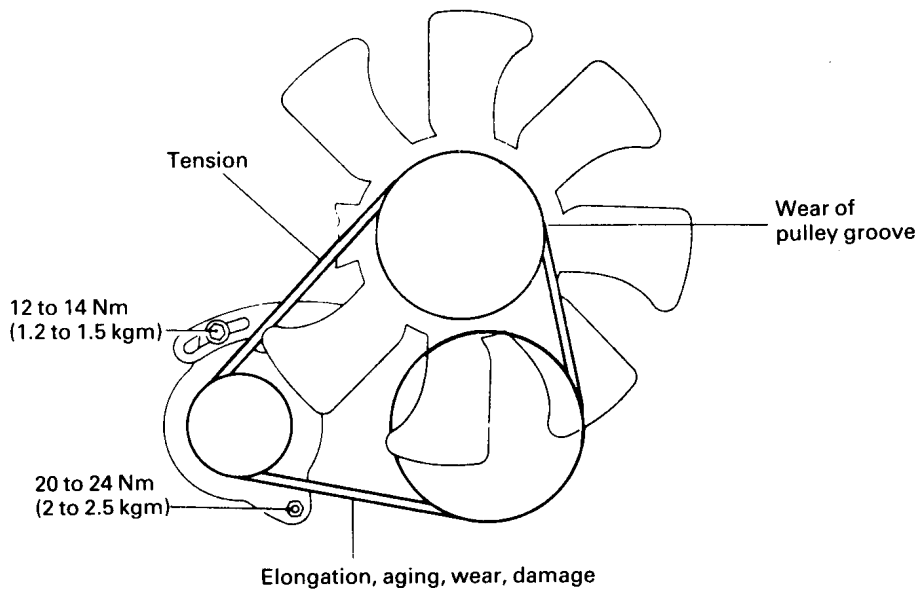
3.5 BLEEDING THE COOLING SYSTEM

1. With the pressure cap removed from the radiator, let the engine run at idle with coolant temperature of about 90°C to bleed the system completely. (In this case, place the heater lever in the maximum-temperature position to allow coolant to circulate through the heating system.)
2. After the system has been bled of air, add coolant to radiator and reservoir tank as required.

4. FAN BELT

4.1 INSPECTION

For fan belt tension, see "Group 00. MAINTENANCE".

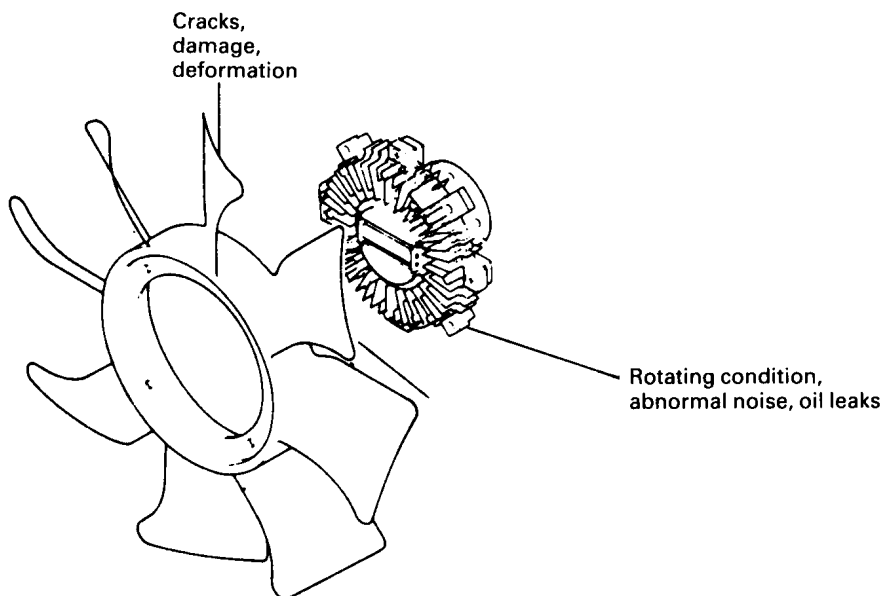


DCO002

5. FAN AND FAN CLUTCH

5.1 INSPECTION

Check and replace if defective.

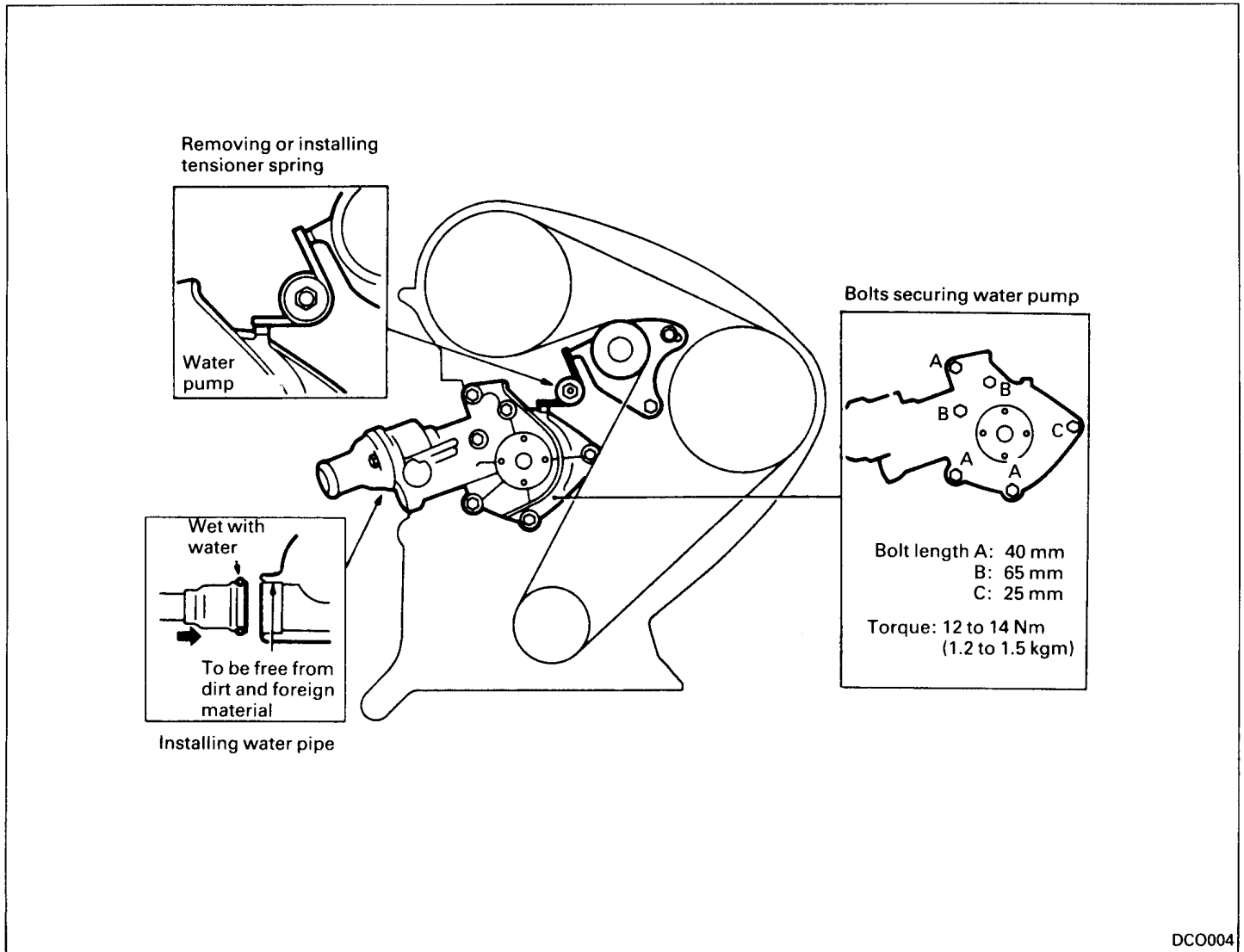


DCO003

6. WATER PUMP

6.1 REMOVAL AND INSTALLATION

1. Remove (install) the water pump pulley, damper pulley and timing belt cover.
2. Pay attention to the following.



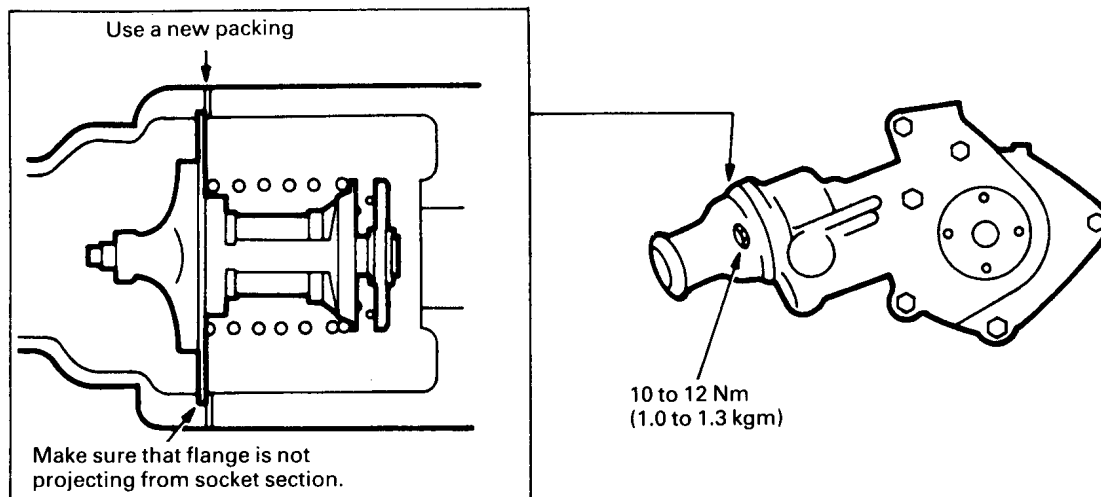
6.2 INSPECTION

Check for water leaks, rotating condition and cracks. If found defective, replace the water pump assembly.

7. THERMOSTAT

7.1 REMOVAL AND INSTALLATION

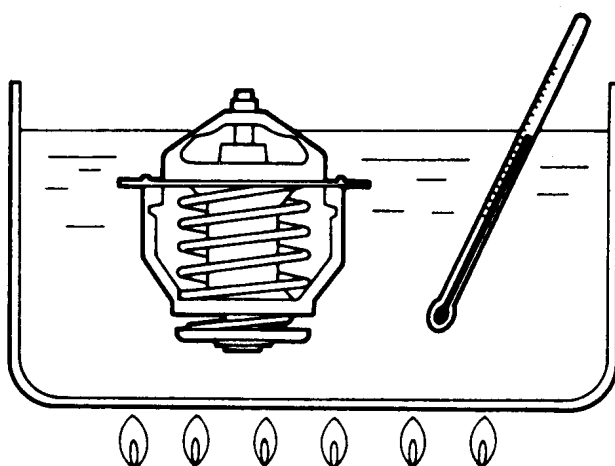
When installing the thermostat, pay attention to the following.



DCO005

7.2 INSPECTION

Check and replace if defective.



Opening temperature: 82°C

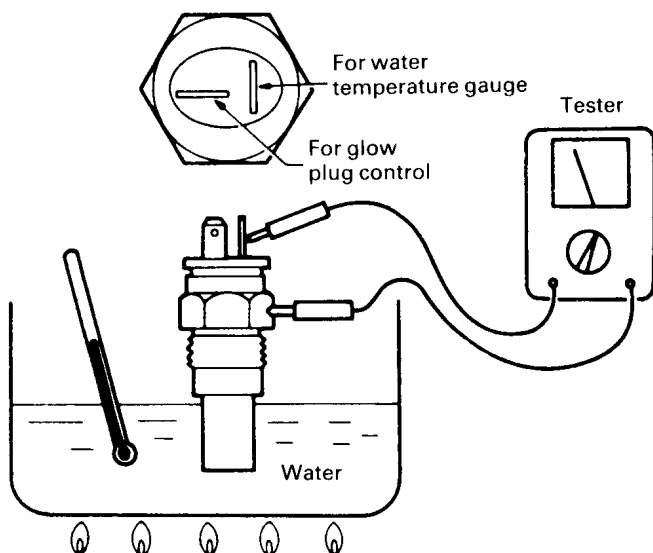
Full open temperature
(when lift is 8 mm): 95°C

DCO006

8. WATER TEMPERATURE GAUGE UNIT

8.1 INSPECTION

Check and replace if defective.

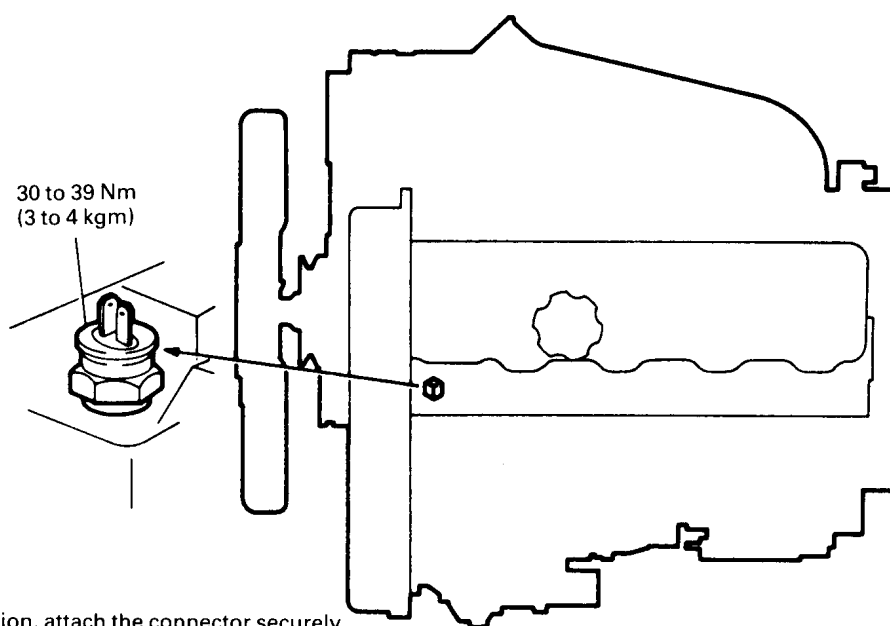


	Temperature	Resistance
For water temperature gauge	80°C	69Ω
	100°C	36Ω
For glow plug control	20°C	3 250Ω
	80°C	300Ω

DCO007

8.2 INSTALLATION

When installing, pay attention to the following.



NOTE:
After installation, attach the connector securely.

DCO008

INTAKE AND EXHAUST

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1. SPECIFICATIONS

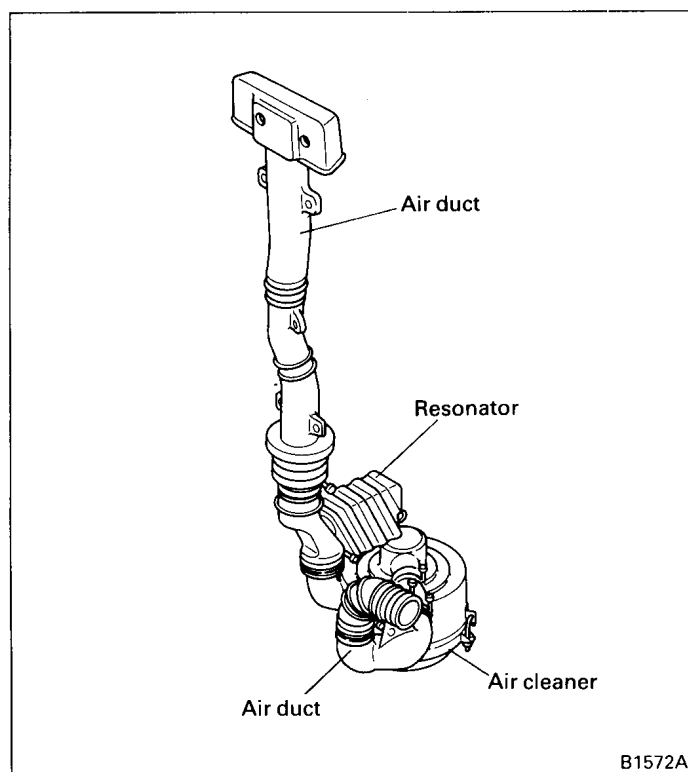
Description	Specifications	Remarks
Air cleaner		
Element type	Paper filter type	

2. TORQUE

Item	Torque	
	Nm	kgm
Air cleaner		
Hook bolt	1.5 – 2.5	0.15 – 0.25
Wing bolt	2 – 2.9	0.2 – 0.3
Intake and exhaust manifold nuts and bolts	15 – 20	1.5 – 2.0

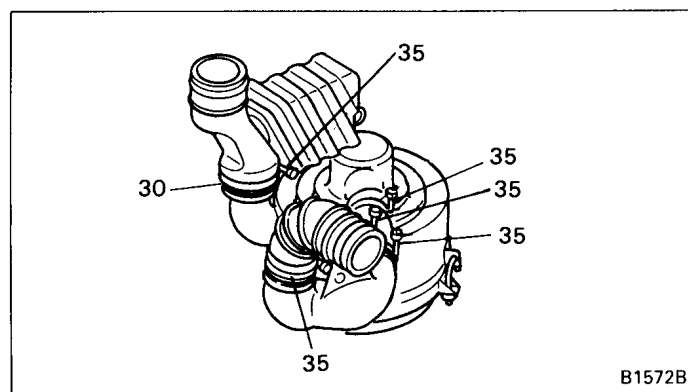
3. INTAKE SYSTEM

3.1 GENERAL

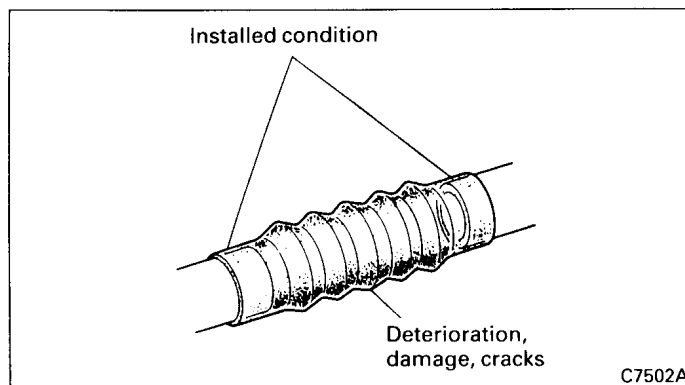


3.2 REMOVAL AND INSTALLATION

Figures in illustration indicate hose overlap.



3.3 INSPECTION

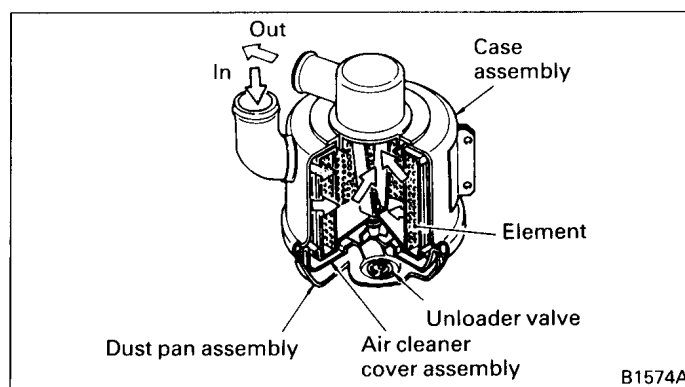


Imperfect sealing of the intake system, resulting in entry of dust and dirt into the engine, can be a cause of greater engine oil consumption. Check air hoses and rubber hoses for damages, collapses, and installed conditions.

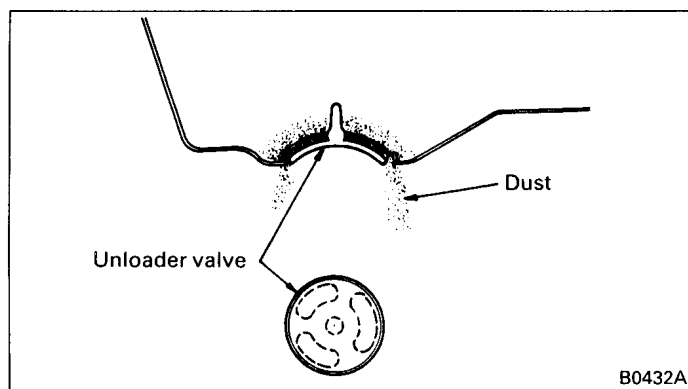
4. AIR CLEANER

4.1 GENERAL

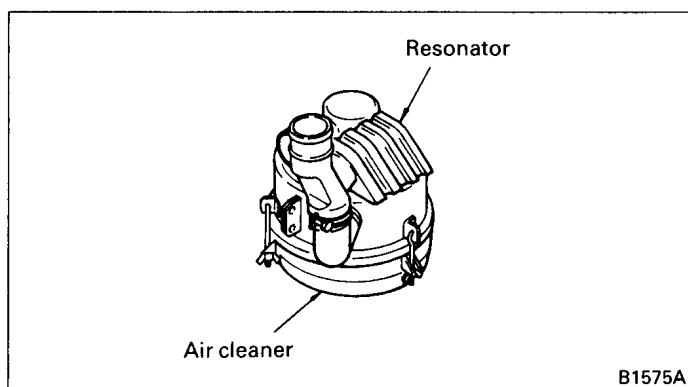
Air Cleaner



Dust and dirt particles are removed from the intake air by the paper filter element so a clean air is drawn into the engine through the center of the air cleaner.

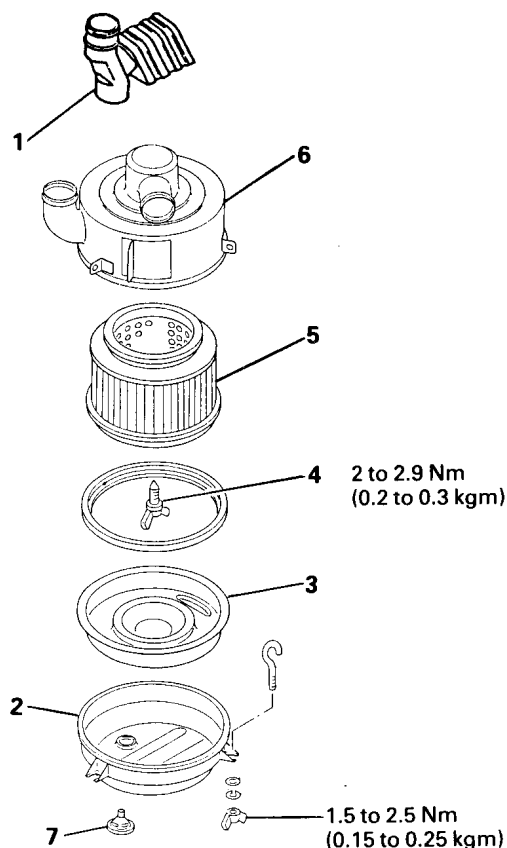
Unloader Valve

Dust, dirt, and water collected in the dust pan of air cleaner are automatically discharged through the unloader valve by vibration caused by vacuum action while the engine is stationary or running at idle.

Resonator

The air cleaner is provided with a resonator that reduces intake noise to a minimum.

4.2 DISASSEMBLY AND REASSEMBLY



<Disassembly sequence>

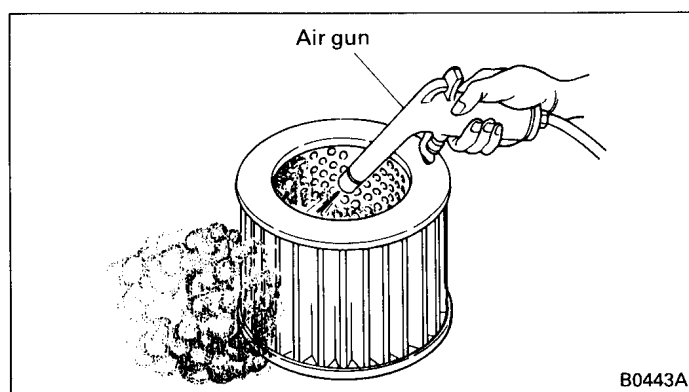
- 1 Resonator
- 2 Dust pan assembly
- 3 Air cleaner cover assembly
- 4 Wing bolt
- 5 Element
- 6 Case assembly
- 7 Unloader valve

To reassemble, reverse the order of disassembly.

B1578A

4.3 INSPECTION AND CLEANING

For periodic cleaning and replacement of the element, see "Owner's Handbook".



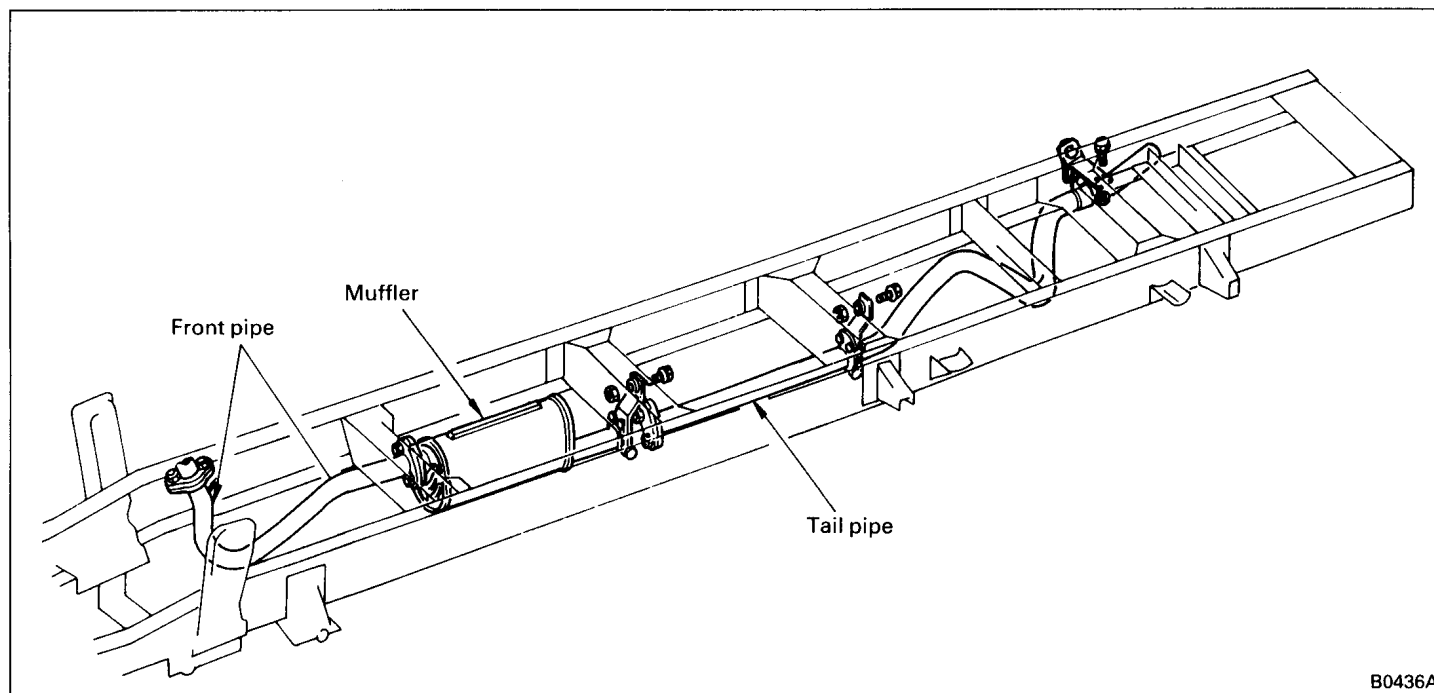
Clean by blowing compressed air from inside, Replace the element if seriously clogged or broken.

NOTE:

Do not hit the element against other object to remove dust. Do not blow air from outside.

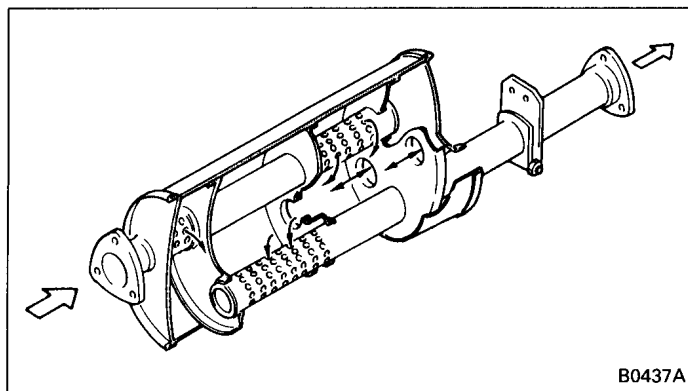
5. EXHAUST SYSTEM

5.1 GENERAL



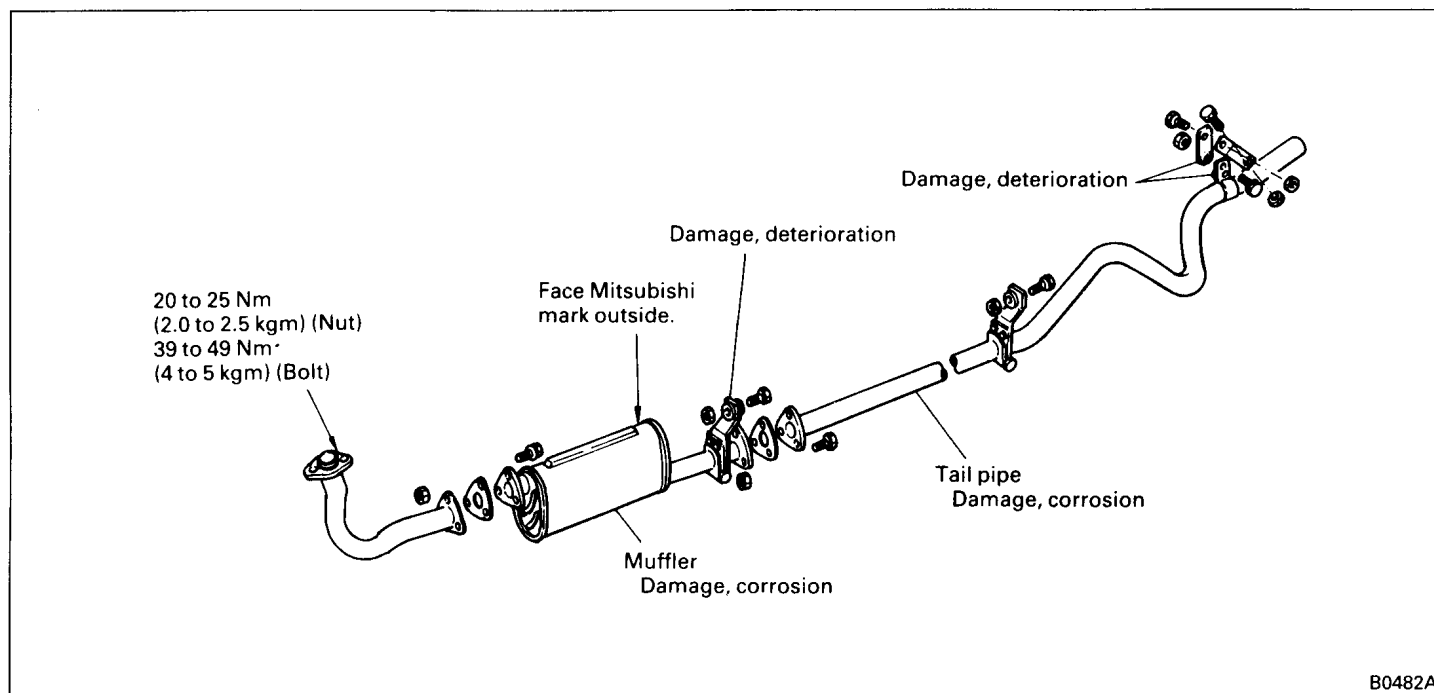
The exhaust system carries the exhaust gases from the engine out into the atmosphere, while dissipating part of the exhaust-gas heat to the outside. The system also includes an exhaust brake unit and muffler.

Muffler



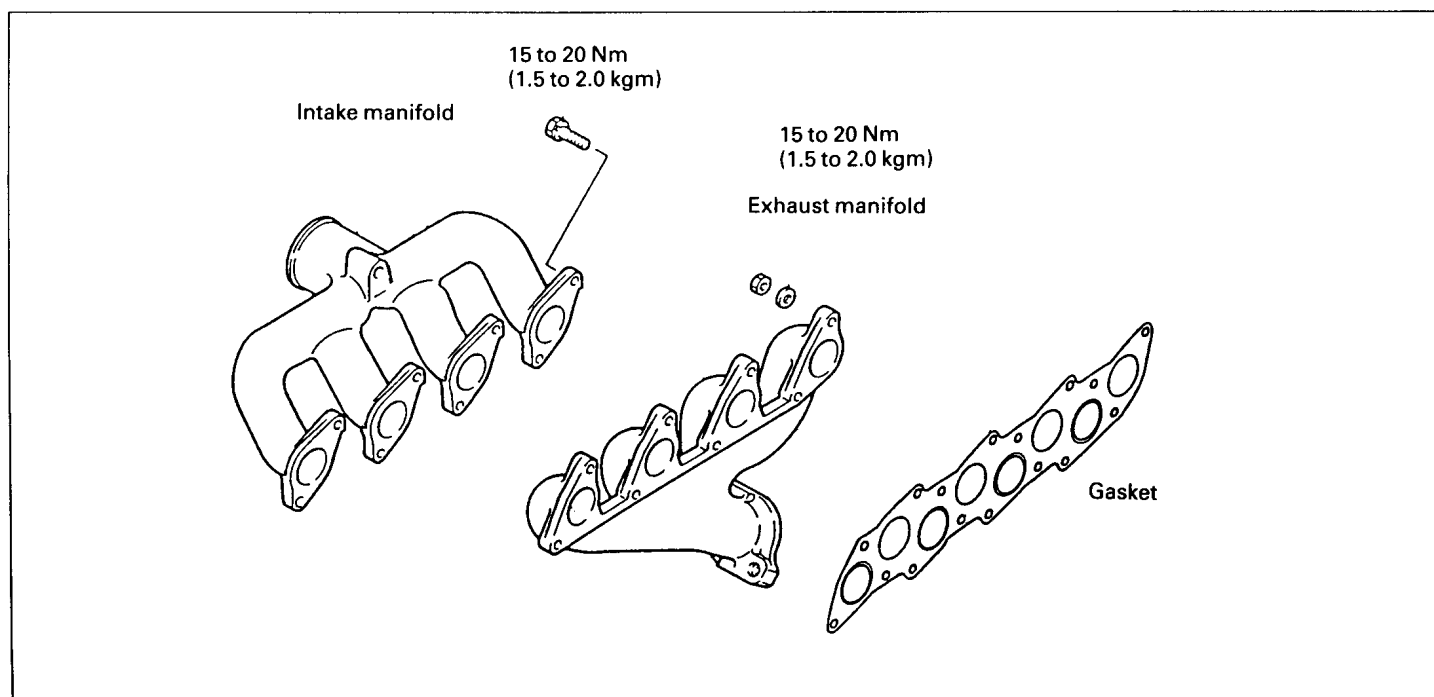
The muffler consists of multiple stages combining the expansion and resonance chambers to absorb heat and noise generated by the high-temperature and high-pressure exhaust gases delivered from the engine.

5.2 REMOVAL AND INSTALLATION



For the details of exhaust brake, see Chassis Shop Manual.

6. INTAKE AND EXHAUST MANIFOLD



6.1 INSPECTION

Intake Manifold

- If cracks or air or water leaks due to excessive distortion of mounting surface are evident, replace.
- Check negative pressure port, water and gas passage for clogging, and correct as necessary.

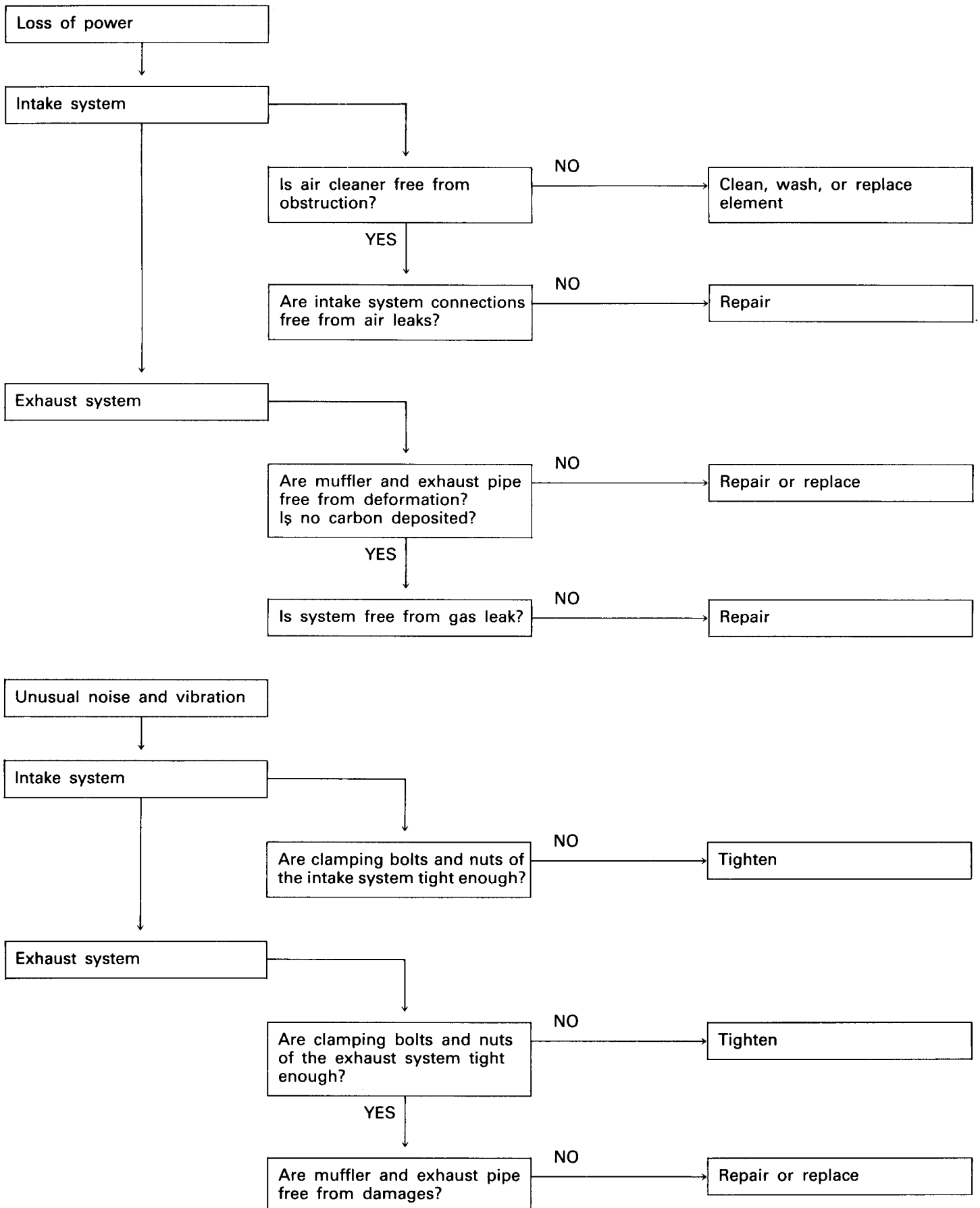
Exhaust Manifold

- If cracks or gas leaks due to excessive distortion of mounting surface are evident, replace.

6.2 INSTALLATION

1. Install new gasket to cylinder head.
2. Install intake manifold and tighten bolts.
3. Install exhaust manifold and tighten nuts.
4. Connect exhaust pipe to exhaust manifold.
5. Install heat protector, heat cowl, etc.
6. Install air cleaner.

7. TROUBLESHOOTING



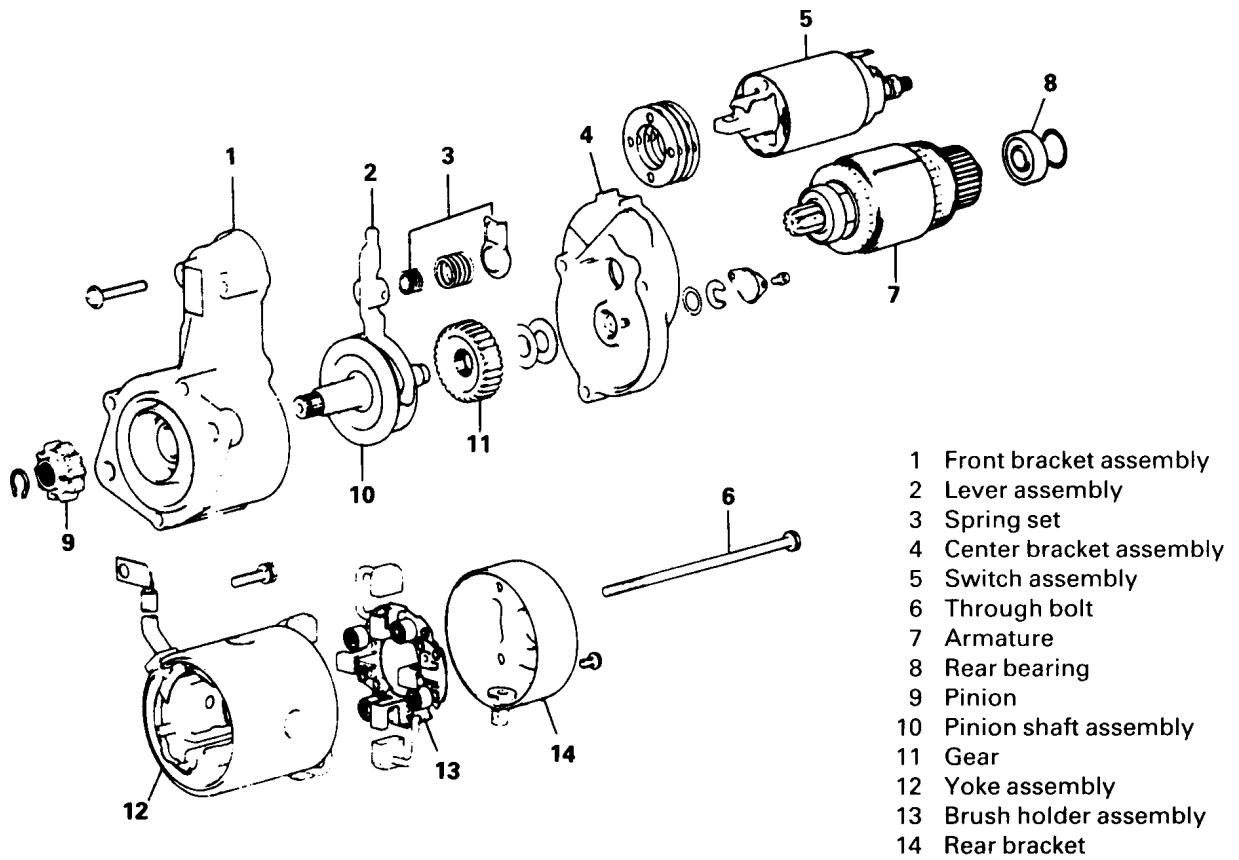
ENGINE ELECTRICAL

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3.6 DISASSEMBLING			
ALTERNATOR	15		

1. SPECIFICATIONS

Description	Specifications	Remarks
Starting motor		
Type	Electromagnetic push-in, reduction drive type	
Part No.	M2T56185	
Output	2 kW	
Turning direction (as viewed from pinion side)	Clockwise	
Number of pinion teeth	12	
No load characteristics		
Terminal voltage	11V	
Current	130A max.	
Speed	4 000 rpm	
Alternator		
Type	AC type with vacuum pump	
Part No.	A5T15784	
Output	12V – 45A	
Regulator type	IC regulator	
No-load regulated voltage	14.4 ± 0.3V (at 20°C)	
Output characteristics		
When cold (20°C)	18A (13.5V, 1 300 rpm) 42A (13.5V, 2 500 rpm)	
When hot	14A (13.5V, 1 300 rpm) 36A (13.5V, 2 500 rpm) 44A (13.5V, 5 000 rpm)	
Capacitor capacity	0.5 µF	
Vacuum pump		
Type	Vane type	
Discharge/rev.	30 cc	
Attainable vacuum	600 mmHg min. (at 3 000 rpm)	
Glow plug		
Type	Sheathed type	
Voltage – Resistance	12.0V – 0.25 Ω	
Energization control	Electronic control	
Control elements (see “Chassis”.)		
	Glow control unit	
	Glow plug relay	

2. STARTING MOTOR

DEL002

2.1 INSPECTION AND ADJUSTMENT

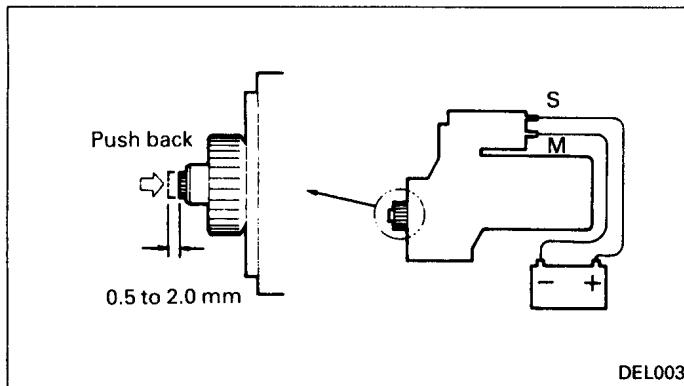
If defective, adjust or disassemble and correct.

Pinion Gap

1. Connect the positive side + of the battery (12V) to the S terminal of the starting motor and the negative side – to the M terminal to cause the pinion to pop out.

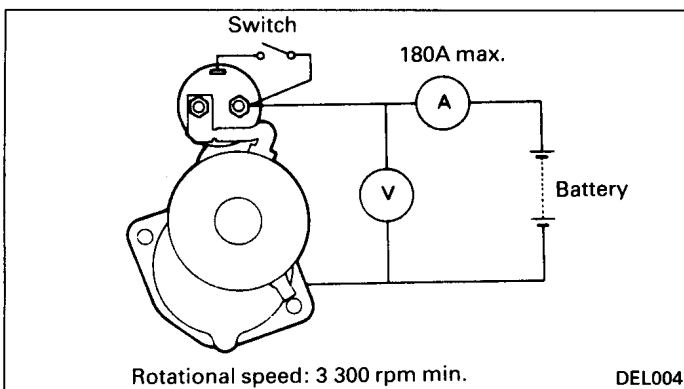
Caution:

- Do not energize over 10 seconds.



2. Lightly push down the popped out pinion with finger to measure the back stroke (shift).
3. If the measured value is not within the range of 0.5 to 2.0 mm, adjust it by increasing the number of switch packings. Increasing the number of packings decreases the pinion gap.

No-load Test

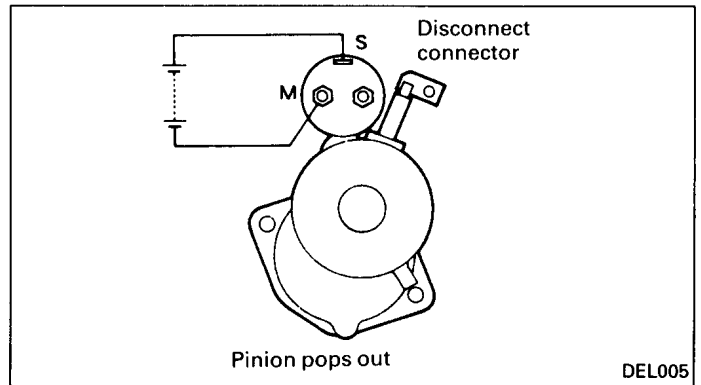


1. Connect an ammeter, a voltmeter and a battery.
2. It is normal if the pinion pops out and the starting motor turns smoothly upon turning on the switch. If the current or motor speed is not within the specified limits, disassemble and check the starting motor and correct as necessary.

Caution:

- Use as thick wire as possible for wiring and tighten sufficiently the terminals.
- When checking rotational noises, note that the noise level is higher than the direct drive motor.
- When detecting rotations at the tip of the pinion, take sufficient care as the pinion will pop out.

Magnetic Switch



Check the following and replace the magnetic switch assembly if defective.

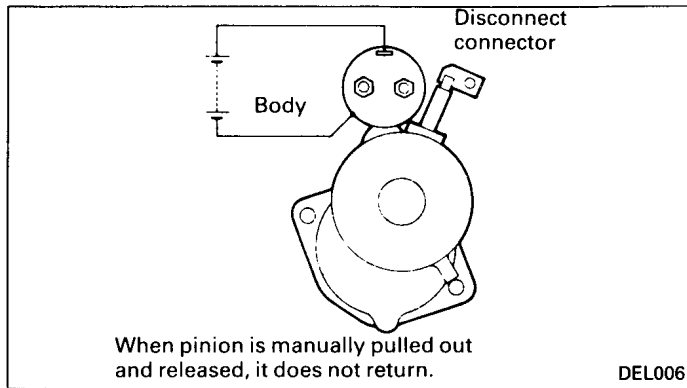
1. Disconnect the M terminal connector.
2. Attraction test

It is normal if the pinion pops out when a battery is connected across the magnetic switch terminals S and M.

Caution:

- Do not energize more than 10 seconds.

3. Holding Test

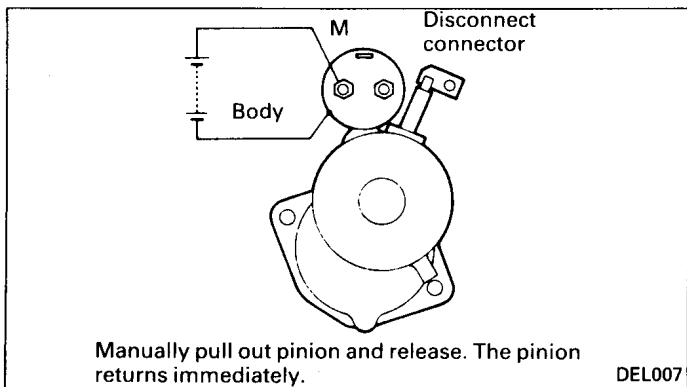


With a battery connected between the magnetic switch S terminal and the body, manually pull out the pinion as far as it goes. It is normal if the pinion does not return when it is released.

Caution:

- **Do not energize more than 10 seconds.**

4. Return Test



With a battery connected between the magnetic switch M terminal and the body, manually pull out the pinion as far as it goes. It is normal if the pinion returns to initial position upon releasing.

Caution:

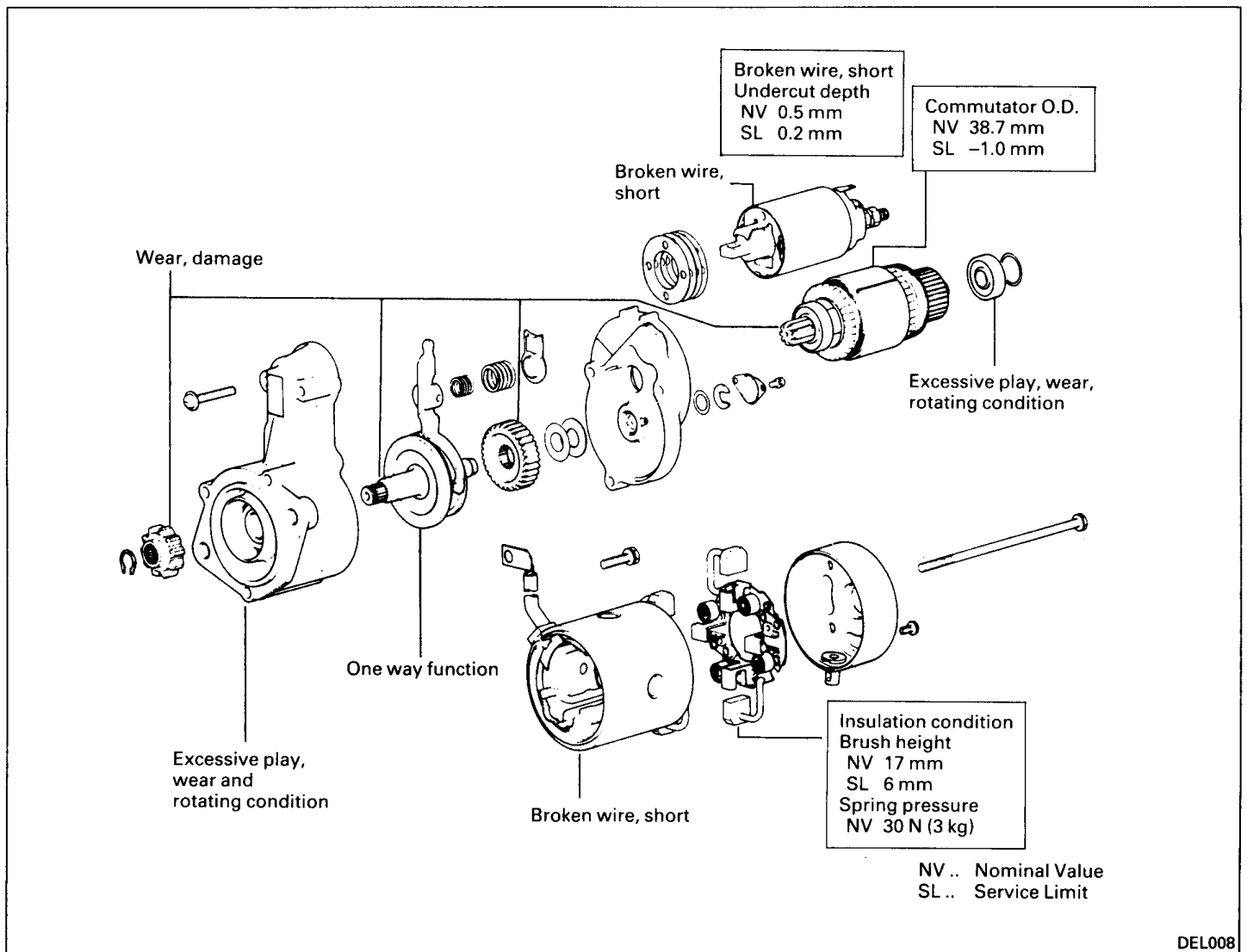
- **Do not energize more than 10 seconds.**

2.2 DISASSEMBLY

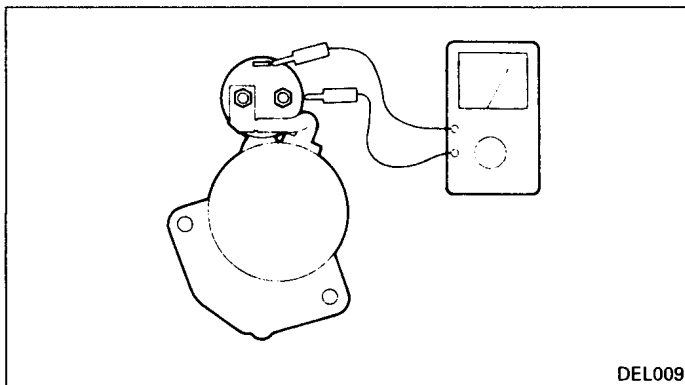
1. Loosen the M terminal nut and disconnect the connector.
2. Remove the two screws securing the magnetic switch and remove the magnetic switch assembly.
3. Remove the two through bolts and remove the two screws securing the brush holder. Then, remove the rear bracket.
4. While lifting two brushes, remove the yoke and brush holder assembly. Then, remove the armature.
5. Remove the cover and remove the snap ring and the washer.
6. Pull out the bolts and remove the center bracket. Several washers for adjusting the pinion shaft end play will come off simultaneously.
7. Remove the reduction gear, lever and lever spring from the front bracket.
8. Remove the snap ring securing the pinion and pull out the pinion and pinion shaft.
9. Using a bearing puller, etc, remove the ball bearings from both ends of the armature. The bearing press-fitted in the front bracket is not replaceable. Therefore, replace the front bracket assembly.

2.3 INSPECTION

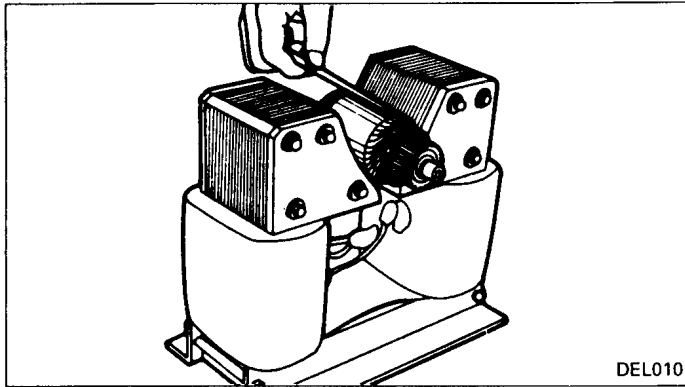
Check the following.



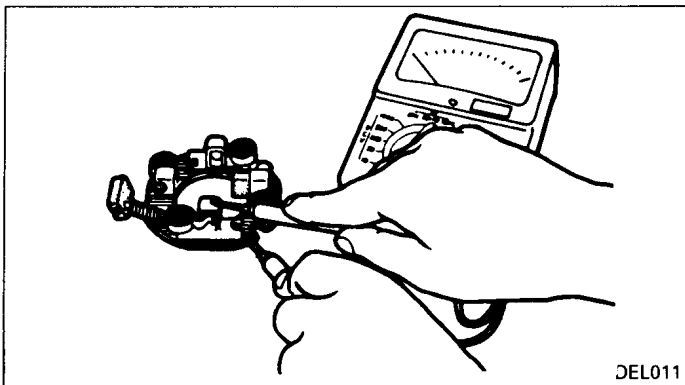
Checking Magnetic Switch



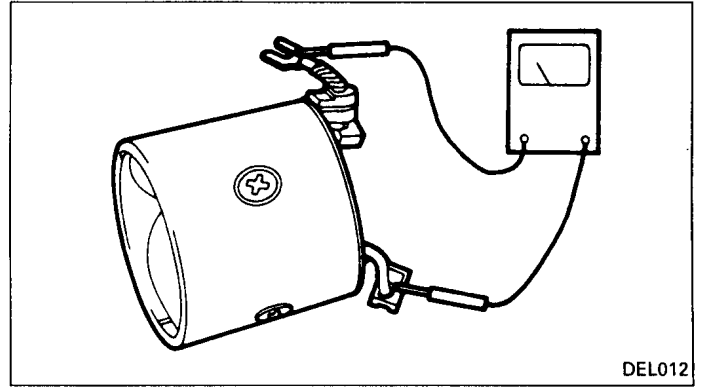
1. There must be continuity between the S and M terminals and between the S terminal and the body. If the resistance is zero (i.e. short circuited), replace the switch.

Checking Armature

1. Using a growler, check the armature coil. Replace if short-circuited. Also check continuity between the commutator and the shaft and replace if there is continuity.
2. Measure the commutator O.D. and undercut depth. Correct or replace if the limits are exceeded. If the commutator outer surface is rough, use fine emery paper to correct it.

Checking Brush Holder

1. Check the brush and replace if worn to the wear limit line (service limit).
2. Check the brush spring tension and replace the brush holder assembly if the spring is defective.
3. Check for continuity between the positive + side brush holder and the brush holder base and replace the holder assembly if there is continuity. Also check for loose brush holder caulking.

Checking Field Coil

1. There must be no continuity between one end (brush) of the coil and the yoke.
2. There must be continuity between both ends (brush) of the coil.
3. The pole piece and the coil shall not be loose.

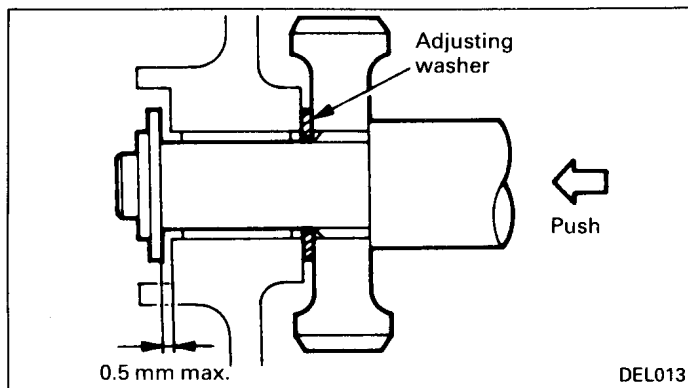
2.4 ASSEMBLY AND ADJUSTMENT

Assemble in reverse order of the disassembly, paying attention to the following.

Adjusting Pinion Shaft End Play

Adjust the end play to 0.5 mm or less by placing adjusting washer(s) between the center bracket and the reduction gear.

1. Assemble the pinion shaft, reduction gear, washer and snap ring to the center bracket.

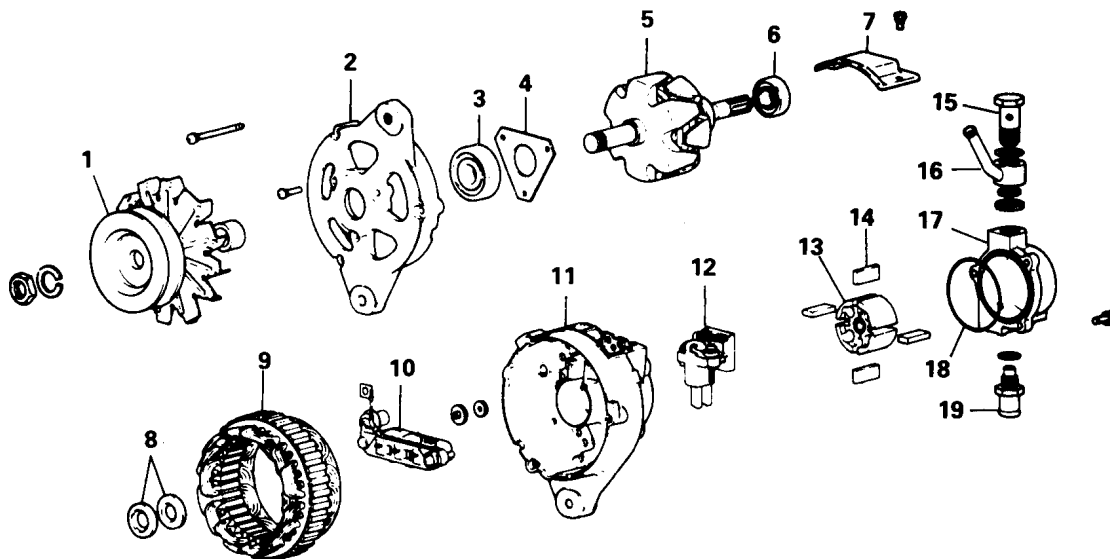


2. Slide the pinion shaft axially to measure the end play. If it exceeds 0.5 mm increase the number of adjusting washers to reduce the end play to 0.5 mm or less.

Lubrication

When the starting motor has been overhauled, apply grease to the following sliding parts, gears and bearings.

- Armature shaft gear and reduction gear
- Bearing
- Pinion shaft washer and snap ring
- Bearing sleeve
- Pinion
- Lever sliding part

3. ALTERNATOR

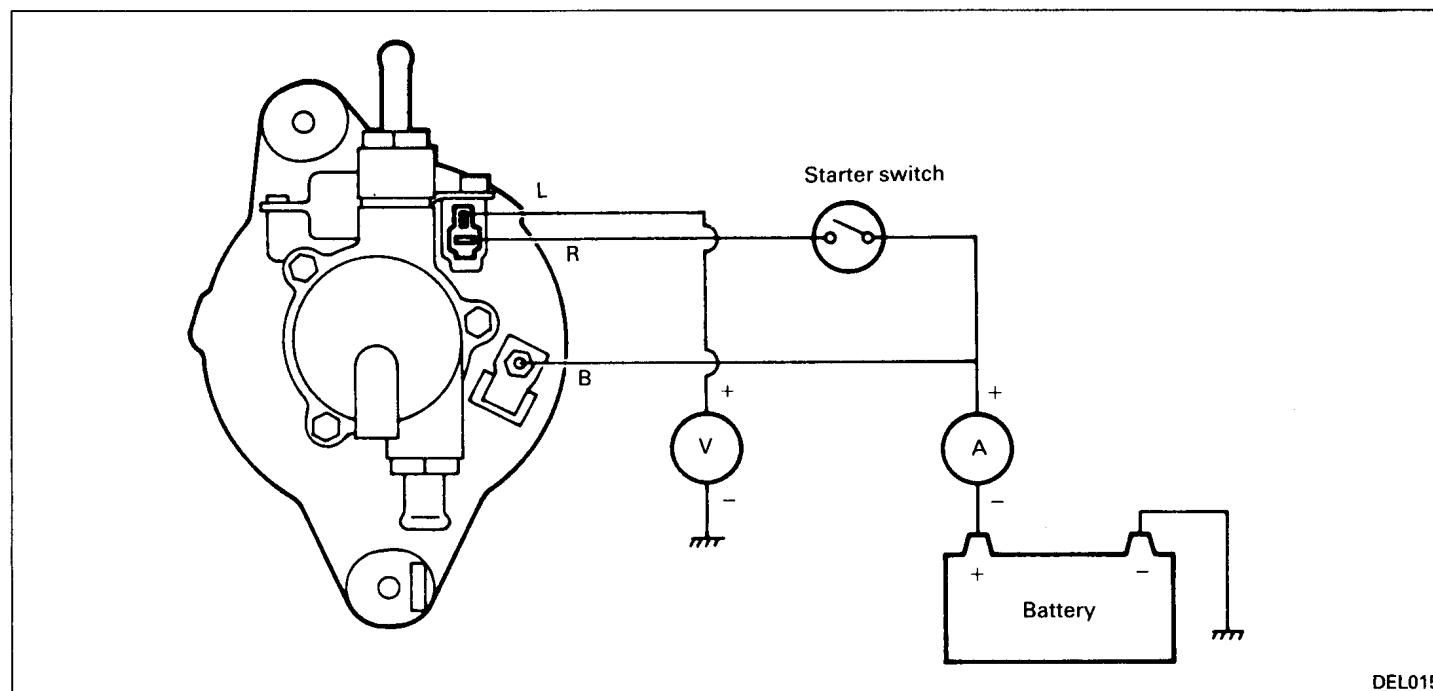
- | | | | |
|--------------------|----------------|-----------------|------------|
| 1 Pulley | 6 Rear bearing | 11 Rear bracket | 16 Nipple |
| 2 Front bracket | 7 Cover | 12 IC regulator | 17 Housing |
| 3 Front bearing | 8 Oil seal | 13 Rotor | 18 O-ring |
| 4 Bearing retainer | 9 Stator | 14 Vane | 19 Joint |
| 5 Rotor | 10 Rectifier | 15 Check valve | |

DEL014

3.1 INSPECTION ON VEHICLE**Precautions on Handling**

Pay attention to the following as mishandling could result in the failure or breakdown of the alternator.

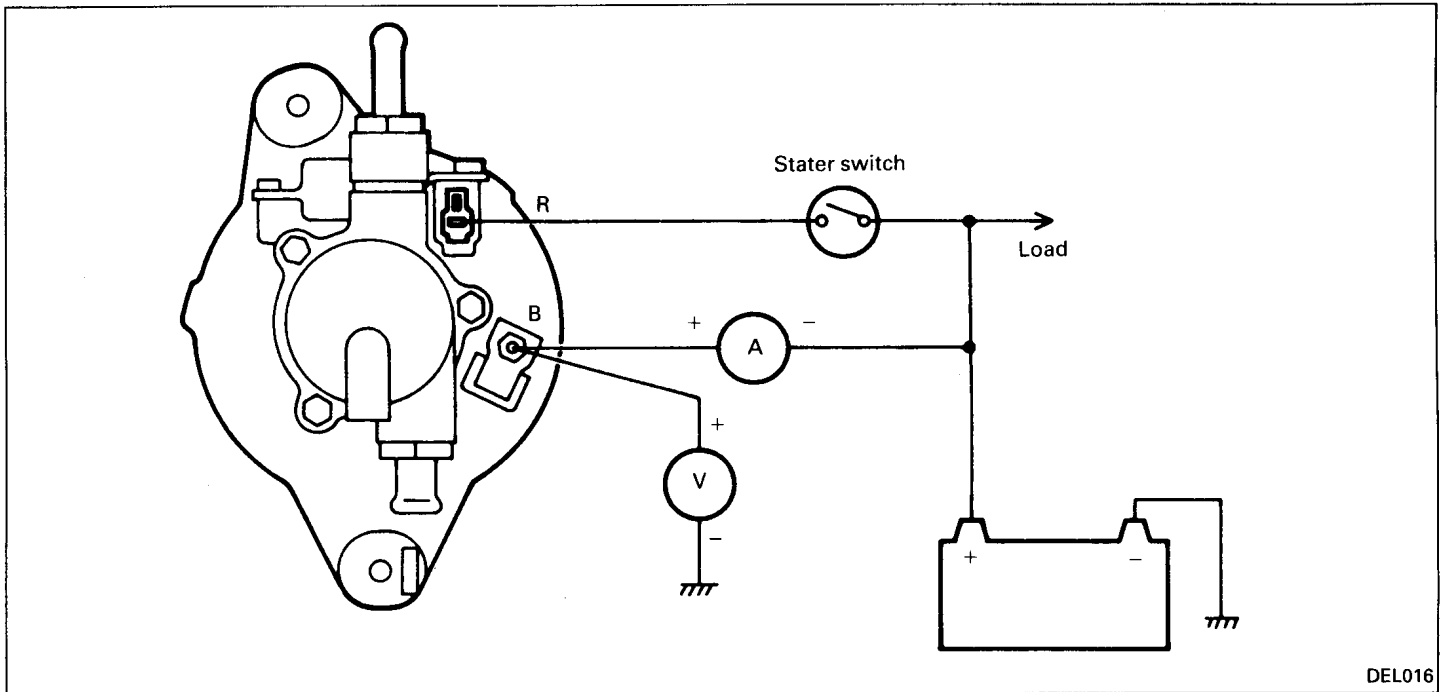
- Do not connect battery in reverse polarity.
- Do not use megger or other high voltage tester.
- Disconnect the battery cable when charging the battery.
- Do not disconnect the lead from the B terminal of alternator while the engine is running.
- Do not ground the B terminal of alternator as it is always applied with the battery voltage.
- Do not short or ground the L terminal.
- When using a steam cleaner, do not apply steam directly to the alternator.

Checking Regulated Voltage

DEL015

1. Disconnect the + terminal of battery and insert an ammeter.
2. Connect a voltmeter between the L terminal and the ground.
3. The voltmeter should read zero when the starter switch is turned off.
The voltmeter should read voltage significantly lower than the battery voltage when the starter switch is turned on (the engine is not started).
4. With the ammeter terminals shorted, start the engine.
5. With the ammeter reading 5A max., the engine running at 2 000 to 3 000 rpm and the indicator lamp switches turned off, read the voltmeter (regulated voltage). Note that the regulated voltage changes with the alternator temperature, decreasing with increasing temperature.

Description	Nominal value
Regulated voltage (at 20°C)	14.4 ± 0.3V

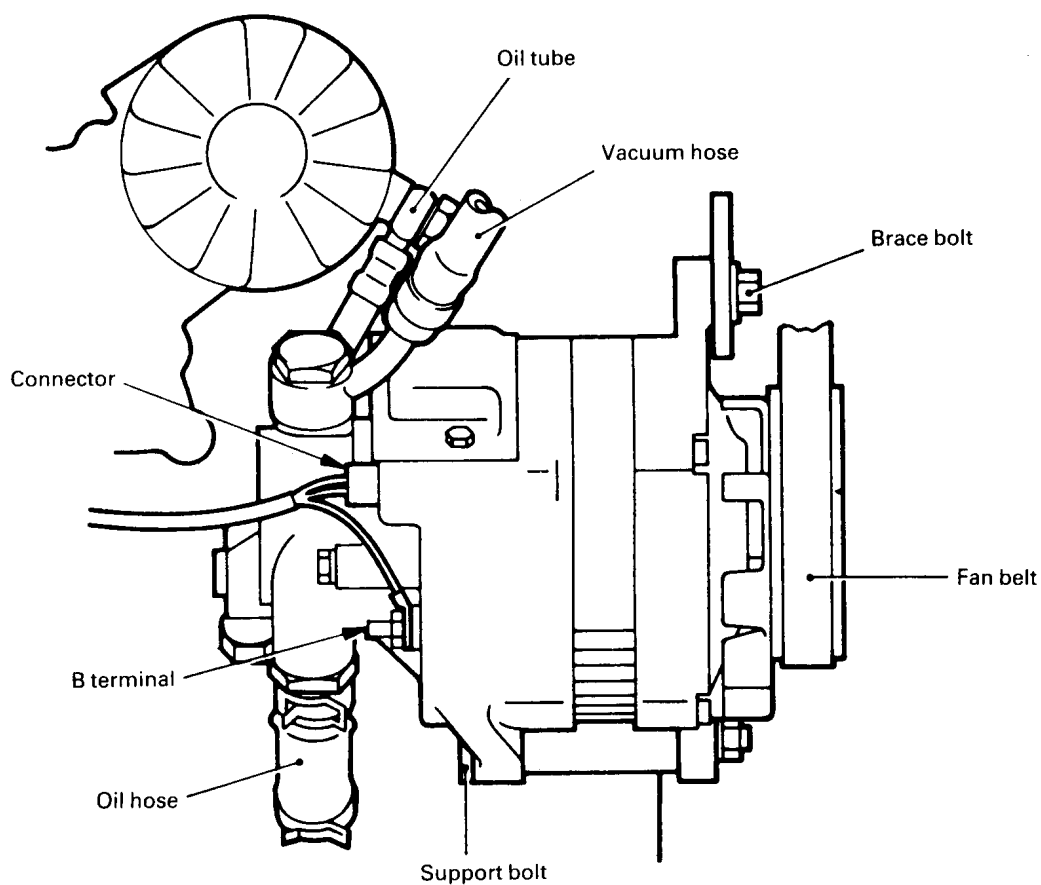
Checking Output

DEL016

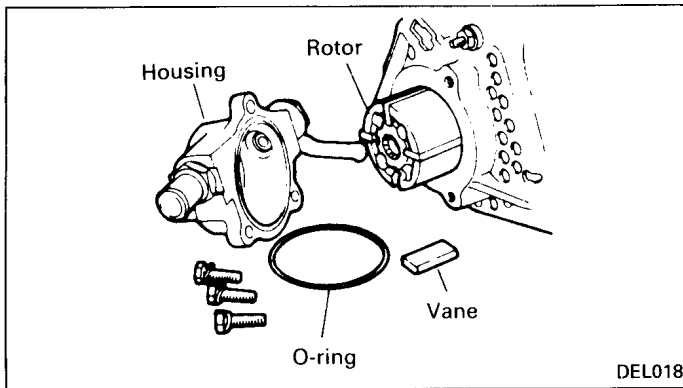
1. Disconnect the battery ground cable.
2. Disconnect the alternator B terminal and insert an ammeter. Connect a voltmeter between the B terminal and the ground.
3. Connect the battery ground cable.
4. Start the engine.
5. Connect all loads including indicator lamps, heater, etc.
6. Increase the engine speed and measure maximum output current obtained when the voltmeter indicates 13.5V and the alternator is at 2 500 rpm. The alternator is normal if the output current reading is over 70% of nominal output.

3.2 REMOVAL

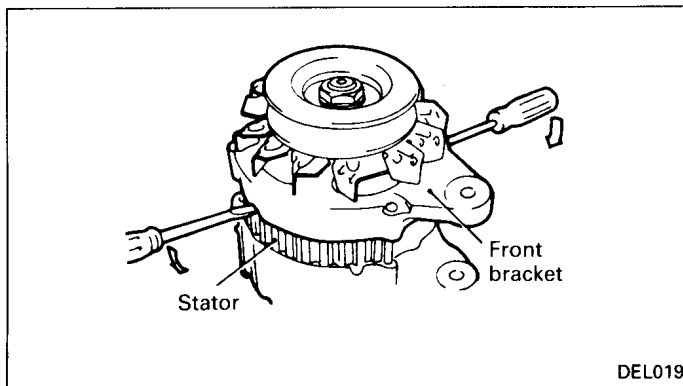
1. Disconnect the battery ground cable.
2. Disconnect the lead from the B terminal on the rear of the alternator.
3. Disconnect the alternator connector.
4. Remove the oil tube, oil hose and vacuum hose.
5. Loosen the alternator brace bolts and support bolts and remove the fan belt with the alternator pressed against the engine.
6. Remove the alternator.



DEL017

3.3 DISASSEMBLING VACUUM PUMP

1. Remove the bolts securing the housing.
2. Remove the housing pulling it back straightly. Remove the vanes.
3. Remove the rotor.
4. Remove the rear bracket cover and remove the IC regulator assembly.

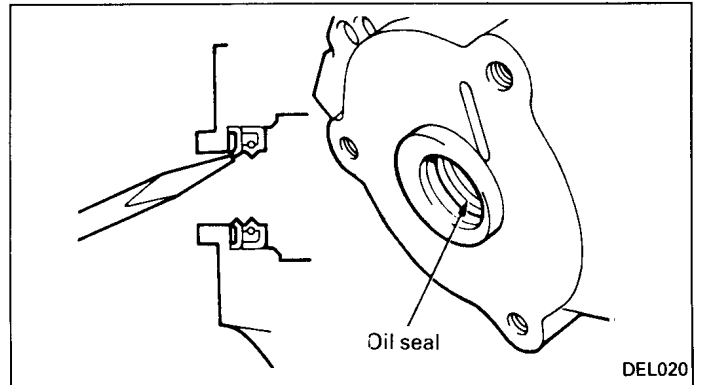


5. Remove the three through bolts securing the alternator and separate the front bracket from the stator, prying with a screwdriver for slotted screw heads inserted between the front bracket and the stator core. If they are not readily separated, tapping the front bracket with a plastic hammer while prying with a screwdriver will facilitate the separation.

Caution:

- **Do not insert the screwdriver too deep. The stator coil could be damaged.**

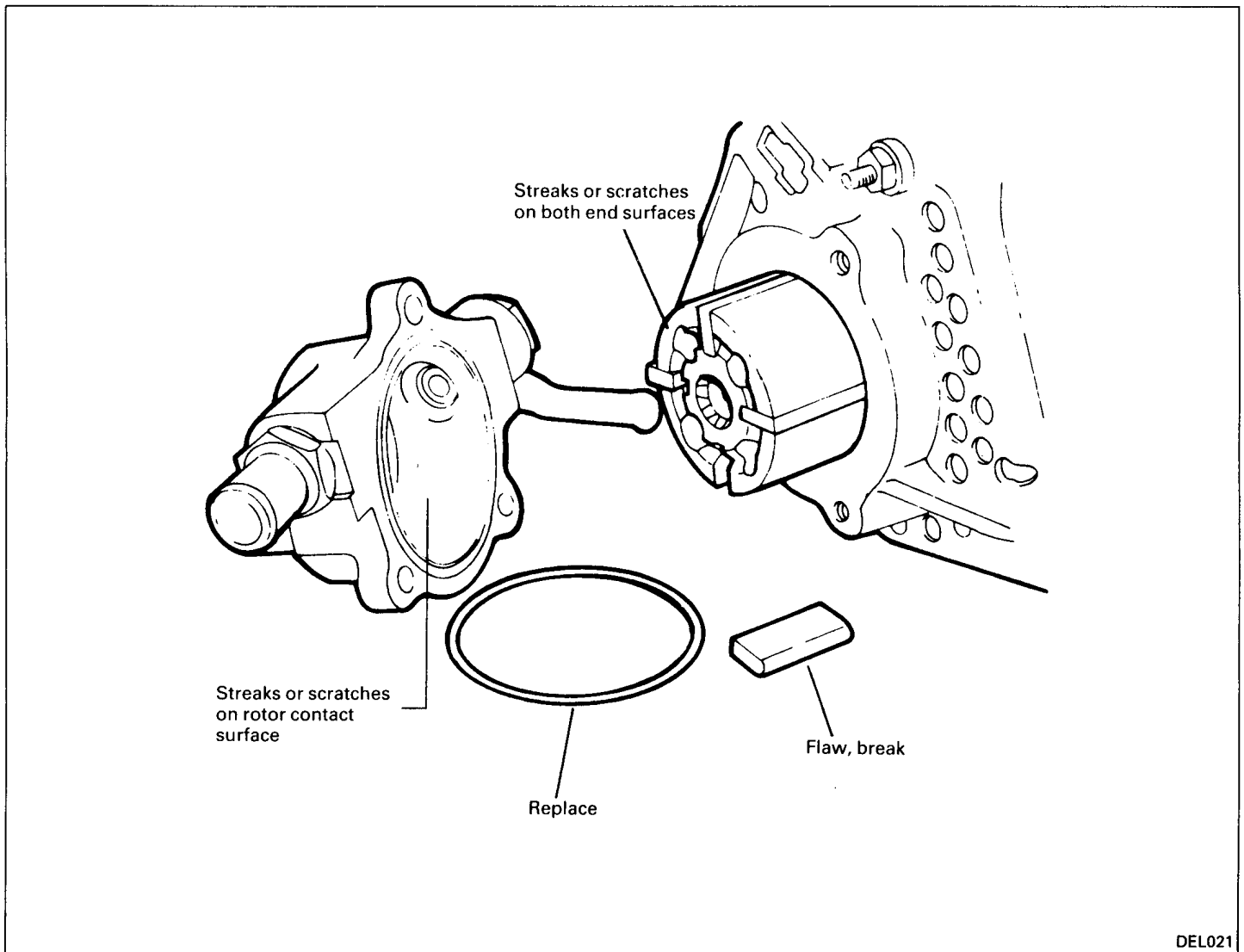
6. Remove the rotor together with the front bracket from the stator core.



7. Remove the oil seal, pushing out with a screwdriver.

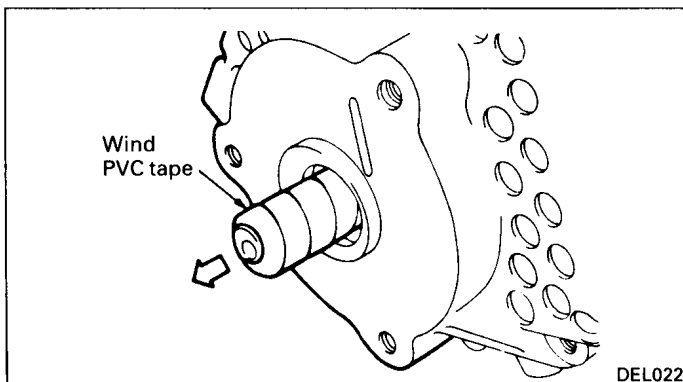
3.4 CHECKING VACUUM PUMP

Check and replace if defective.

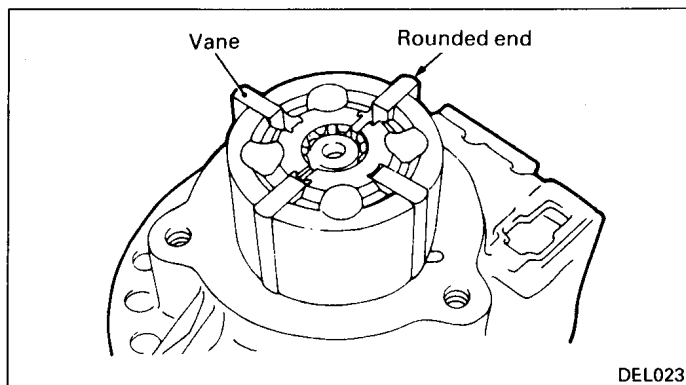


3.5 ASSEMBLING VACUUM PUMP

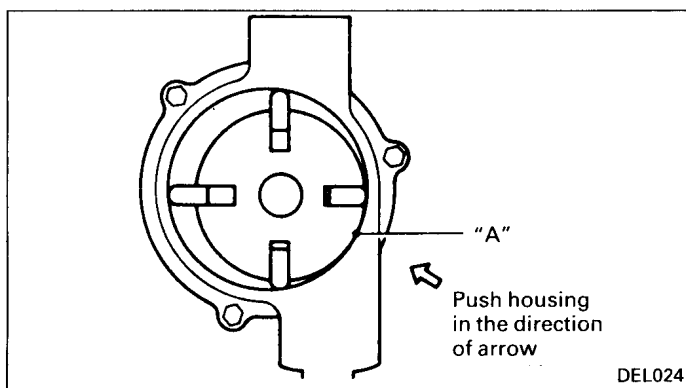
Assemble in reverse order of the disassembly, paying attention to the following.



1. When assembling the rotor to the alternator rear bracket, wind PVC tape or equivalent around the shaft splines to prevent damage of the oil seal and install the rotor slowly.
2. Make sure that the housing and the rotor are free from chips and other foreign material and apply engine oil to the sliding part before assembling.



3. Install the vanes with rounded end facing outward.
4. Apply grease to the O-ring and position it in the housing groove so that it will not be dislodged from the groove when the bolts are tightened.



5. When tightening the housing, push it lightly in the direction of arrow to minimize the clearance at point "A". Tighten the bolts evenly.
6. After assembly, be sure to conduct the performance test to check that the specified values are met.

Description		Nominal value
Attainable vacuum	Vacuum	600 mmHg min.
	rpm	3 000

3.6 DISASSEMBLING ALTERNATOR

1. Remove the vacuum pump.
2. Remove the rear bracket top cover and the voltage regulator assembly.
3. Remove the three through bolts. Then, remove the front bracket and the rotor, prying with a screwdriver (for slotted screw heads) inserted between the stator and the front bracket.

Caution:

- **Do not insert the screwdriver too deep. The stator coil could be damaged.**

4. Hold the rotor in a vice and remove the pulley nut. Then, pull out the pulley, fan and spacer.
5. Remove the rotor assembly from the front bracket.
6. Unsolder the stator coil leads and remove the stator assembly.

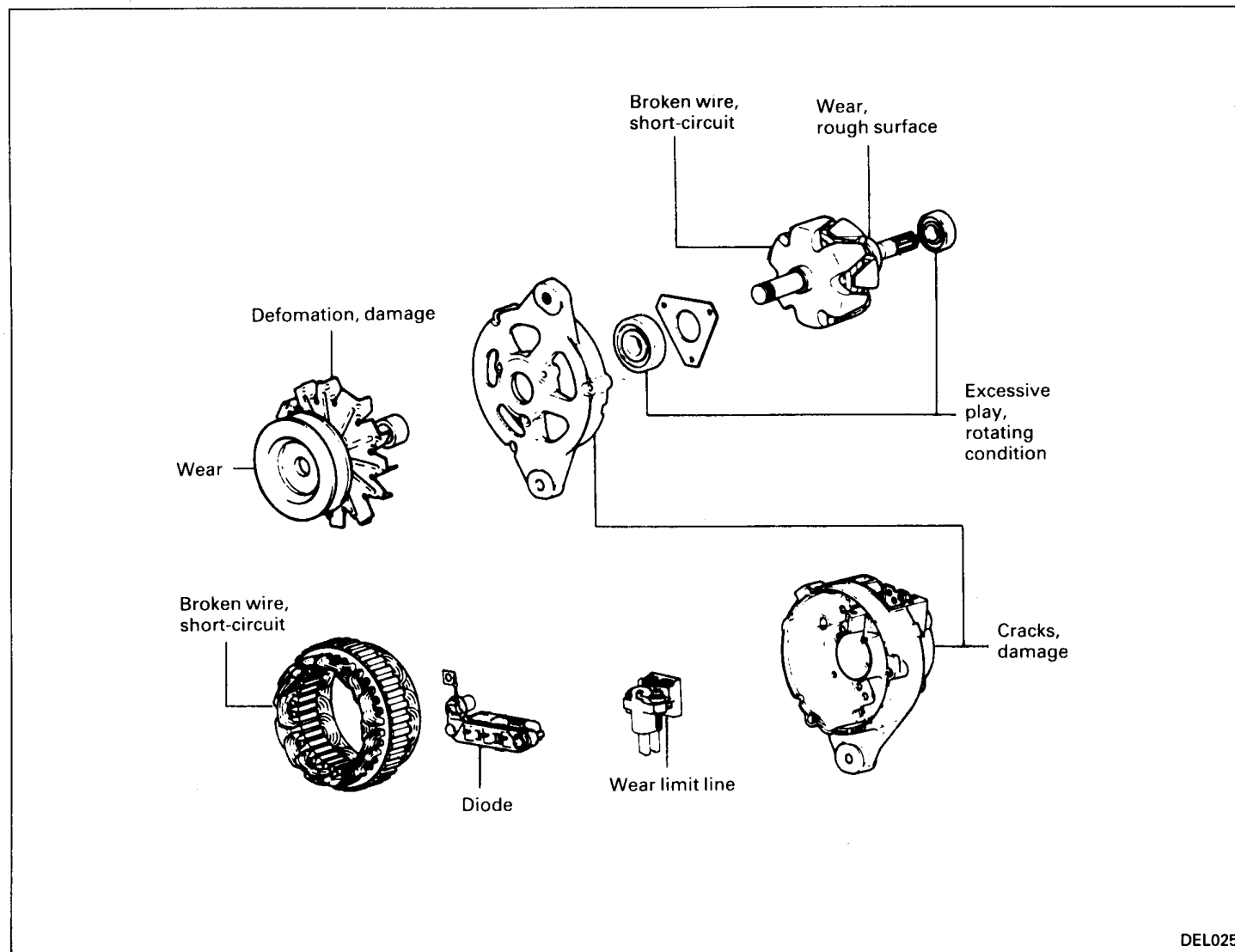
Caution:

- **Unsolder in as short a time as possible. Prolonged heating could result in damage to diode.**

7. Remove the capacitor from the B terminal.
8. Remove the screws securing the rectifier and remove the rectifier.

3.7 CHECKING ALTERNATOR

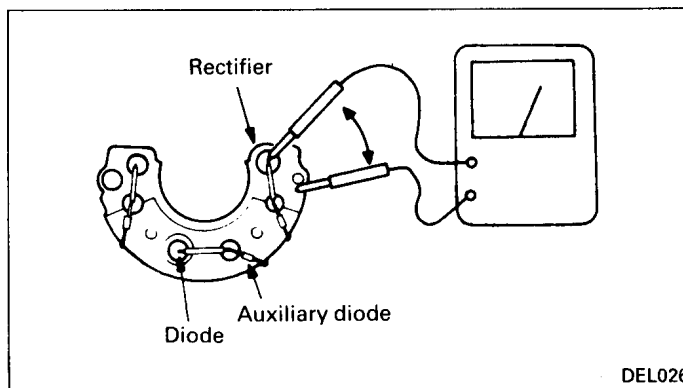
Check and replace if defective.



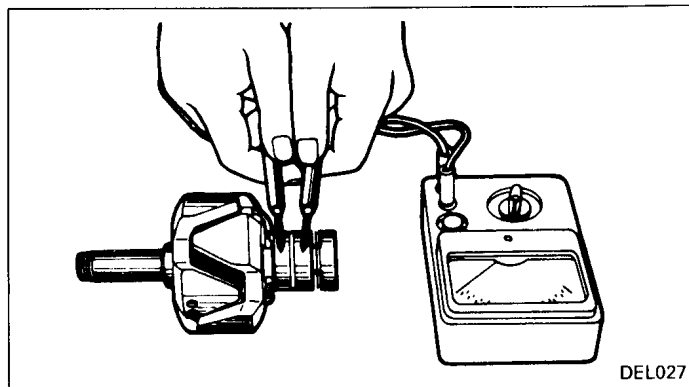
Checking Diodes

Check continuity of the diodes in the rectifier as follows.

1. Using a tester, check continuity between the lead of the diode and the diode case. It is normal if the resistance is large in one direction and small in the other direction.
2. The diode is defective if the same resistance is measured in both directions. In such a case, replace the rectifier assembly.

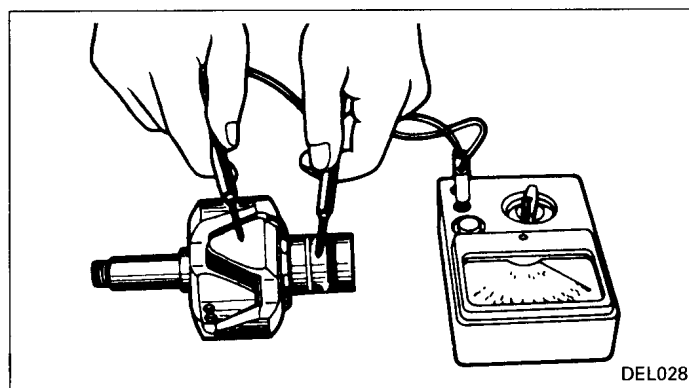


3. Conduct the same check on all diodes (9 in total).

Checking Field Coil

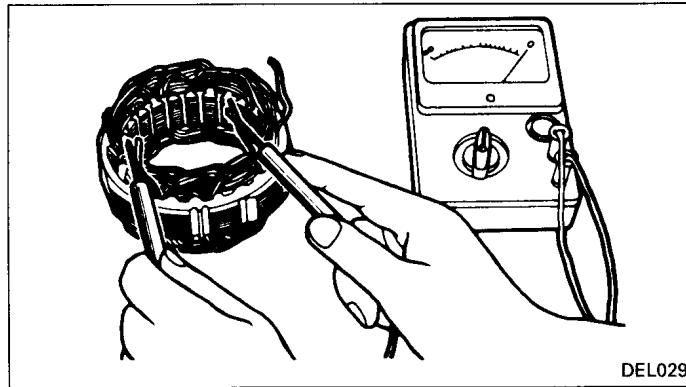
DEL027

1. Check continuity between the slip rings. Absence of continuity means broken wire and requires replacement of the field coil.



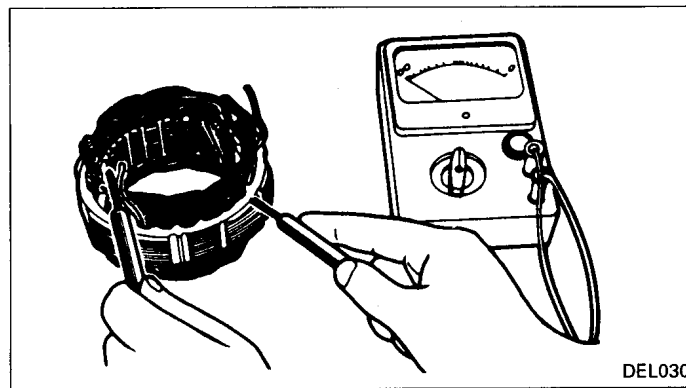
DEL028

2. Check continuity between the slip ring and the shaft (or core). Presence of continuity means grounded field coil and requires its replacement.

Checking Stator Coil

DEL029

1. Check continuity between stator coil leads. Absence of continuity means broken wire of the coil and requires replacement of the coil.



DEL030

2. Check continuity between each lead of the stator coil and the stator core. Presence of continuity means grounded stator coil and requires replacement of the stator coil.

3.8 ASSEMBLING ALTERNATOR

Assemble the alternator in reverse order of the disassembly, paying attention to the following.

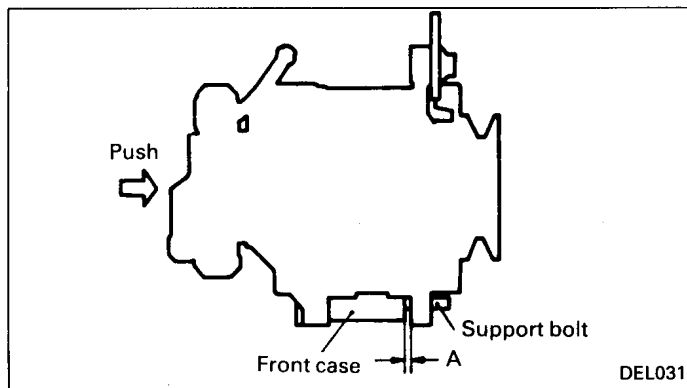
1. When soldering, take appropriate means to prevent transmission of heat from the soldering iron to the diode and complete soldering in as short a time as possible.
2. When inserting the rotor assembly in the rear bracket, take care not to damage the oil seal. (See "Assembling Vacuum Pump".)

3.9 INSTALLATION

Install the alternator in reverse order of the removal, paying attention to the following.

1. With the oil hose connected to the alternator, install the alternator, at the same time, installing the hose over the oil pan side nipple. Clamp the hose clip at the straight section of the nipple.
2. Install the oil tube, taking care to prevent it from contacting the cylinder block and with a radius of curvature large enough.

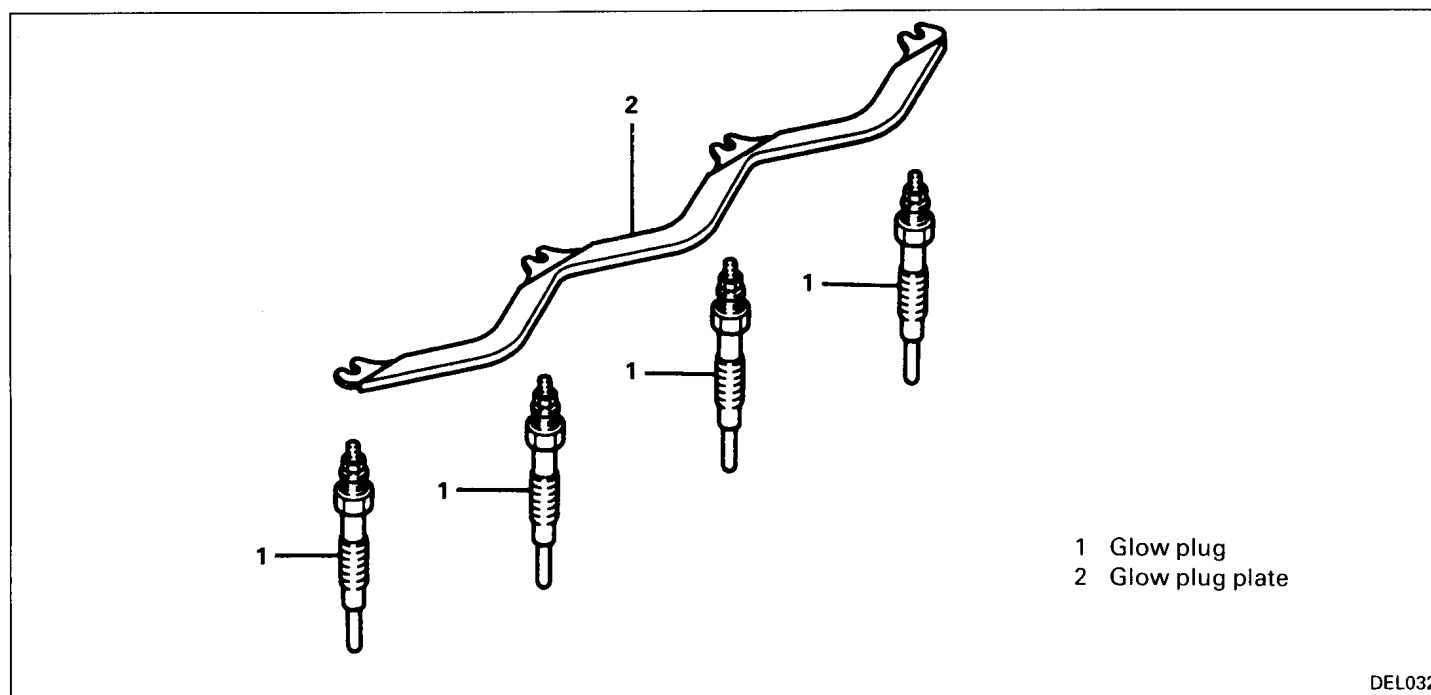
Adjusting Spacer



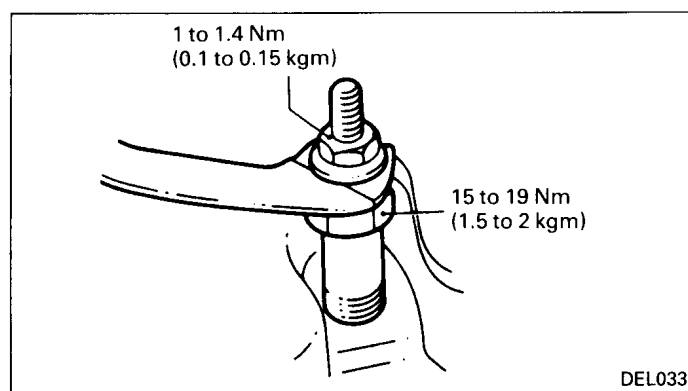
When installing the support bolt, insert spacers as follows.

1. Push in the support bolt to specified position (without nut).
2. With the alternator pushed forward, insert spacer(s) (0.2 mm thick) between the alternator front bracket and the front case to find the number of spacers required. (Use as many spacers as required to keep them in place after releasing them.)
3. Place required number of spacers at position A shown in illustration and assemble the alternator.
4. Adjust the belt tension.

4. GLOW PLUG



4.1 REMOVAL AND INSTALLATION

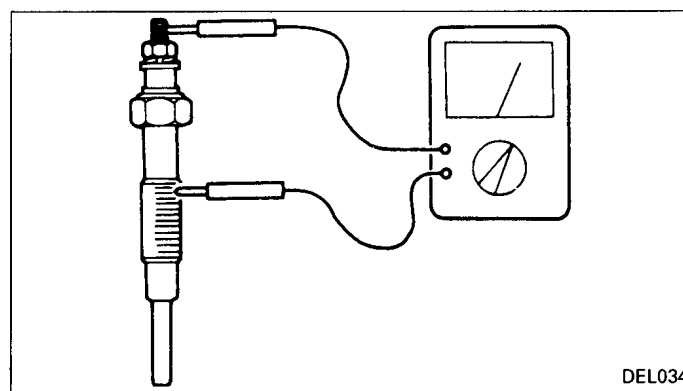


Tighten to the torque indicated in illustration.

Caution:

- **Tighten the glow plug plate correctly. Otherwise, poor continuity could result.**

4.2 INSPECTION



Check continuity between the terminal and the body as shown in illustration. Replace the glow plug if there is no large resistance or no continuity.

Caution:

- **When testing on vehicle, remove the glow plug plate and check each glow plug.**

5. TROUBLESHOOTING**5.1 STARTING SYSTEM**

Problem	Probable cause	Remedy
1. Engine does not crank though starter motor spins	a. Defective starter motor components b. Defective flywheel ring gear	a. Remove starter motor, inspect for broken or worn drive components. b. Inspect ring gear teeth. Replace flywheel if necessary.
2. Engine does not crank	a. Loosely connected or corroded battery cables b. Undercharged battery c. Burnt fusible link in main wire connected to ignition switch d. Loosely connected or broken cables e. Starter motor malfunction	a. Clean and tighten cable connections. b. Check battery. Charge or replace. c. Check fusible link – correct wiring problem. d. Tighten or replace cable. e. Repair or replace as required.
3. Engine cranks slowly	a. Loosely connected or corroded battery cables b. Undercharged battery c. Starter motor malfunction	a. Clean and tighten cable connections. b. Check battery. Charge or replace. c. Repair or replace as required.

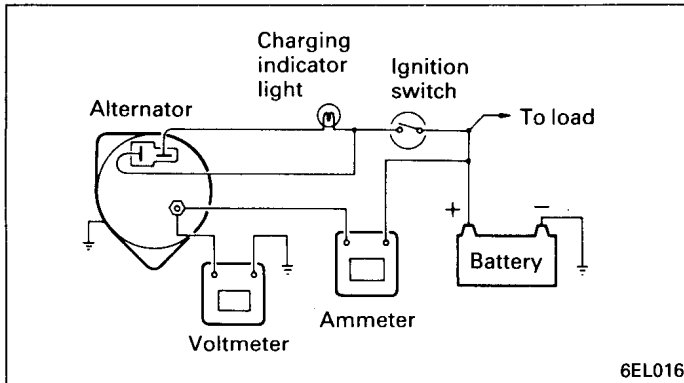
5.2 CHARGING SYSTEM

Problem	Probable cause	Remedy
1. Run-down battery	a. Loosely connected wiring b. Excessive load c. Faulty battery d. Faulty alternator (including voltage regulator)	a. Tighten connections. b. Check accessory. Disconnect unnecessary accessories. c. Check battery. Charge or replace. d. Repair or replace as necessary.
2. Overcharge	a. Faulty voltage regulator b. Damaged battery	a. Replace regulator. b. Check battery and replace as necessary.

5.3 GLOW CONTROL SYSTEM

Problem	Probable cause	Remedy
1. Hard starting at coolant temperature below 30°C	a. Loose connections or wrong wiring b. Faulty coolant temperature sensor c. Faulty glow plug d. Faulty glow plug relay e. Faulty glow control unit	a. Correct wiring and tighten connections. b. Inspect coolant temperature sensor, replace if necessary. c. Inspect glow plug resistance; replace if necessary. d. Inspect relay; replace if necessary. e. Perform engine starting test with new glow control unit connected. If necessary, replace control unit.
2. Engine stall after first explosion or rough idle at coolant temperature below 30°C	a. Loose connections or incorrect wiring harness b. Faulty glow plug c. Open dropping resistor d. Faulty glow plug relay (relay 2 for QGS or S-QGS) e. Faulty glow control unit	a. Correct wiring and tighten connections. b. Inspect glow plug resistance; replace if necessary. c. Inspect resistance and replace resistor if necessary. d. Inspect relay; replace if necessary. e. Perform engine starting test with new glow control unit connected. If necessary, replace control unit.
3. Red or green preheat indication lamp does not light (except for S-QGS)	a. Lamp opened b. Loose connections or broken wiring c. Faulty glow control unit	a. Replace red lamp. b. Replace wiring and tighten connections. c. Perform test with new glow control unit connected. If necessary, replace control unit.
4. Red or green preheat indication lamp does not go out (except for S-QGS)	a. Faulty coolant temperature sensor b. Wiring harness shorted c. Faulty glow control unit	a. Replace sensor. b. Repair or replace wiring harness. c. Replace unit if necessary.

5.4 ALTERNATOR OUTPUT CURRENT TEST



1. Place ignition switch to "OFF".
2. Disconnect battery positive cable.
3. Disconnect the cable from terminal "B" of alternator and connect an ammeter between terminal "B" and the cable.
4. Connect a voltmeter between terminal "B" of alternator and ground.
5. Set the engine tachometer.
6. Connect the battery cable to battery. The voltmeter should indicate the battery voltage.
7. Start the engine.
8. Turn on all electrical loads, accelerate the engine speed to the approx. 1 200 rpm and measure the output current.

Output current: Over 70% of nominal output

If output current is below 70% of nominal value, possible cause is poor brush contact (dirty slip ring), shorted field coil, defective diode, or defective voltage regulator.

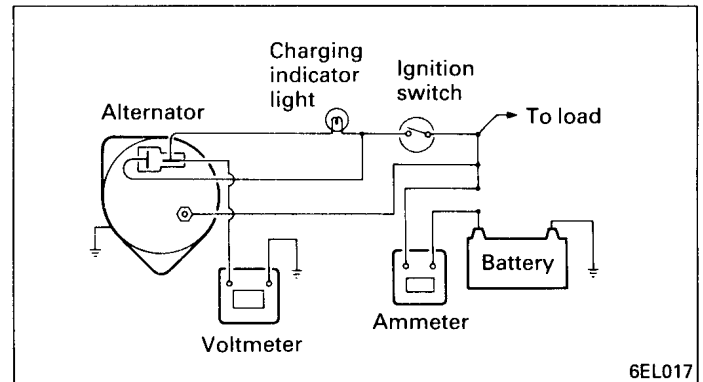
NOTE:

1. After the engine has been started, the ammeter indication will drop as the battery reaches the fully charged condition.

Read the indication at its maximum value while increasing engine speed.

2. If the battery used for test is fully charged, current will not flow and alternator output current measurement is impossible. Measure the output current after the battery has been discharged by cranking engine or connecting additional electrical loads using parallel circuits.

5.5 ALTERNATOR OUTPUT VOLTAGE TEST



1. Turn ignition switch OFF.
2. Disconnect battery positive cable.
3. Connect a voltmeter between terminal "L" of alternator and negative terminal of battery.
4. Set engine tachometer.
5. Connect battery cable to battery.
6. Start engine.
7. Increase engine speed to 2 300 rpm and measure the regulated voltage.

Regulated voltage: $14.4 \pm 0.3 \text{ V}$ at 20°C

If voltmeter indication is less than battery voltage, alternator can be generating no current. Inspect alternator and voltage regulator to locate the cause.