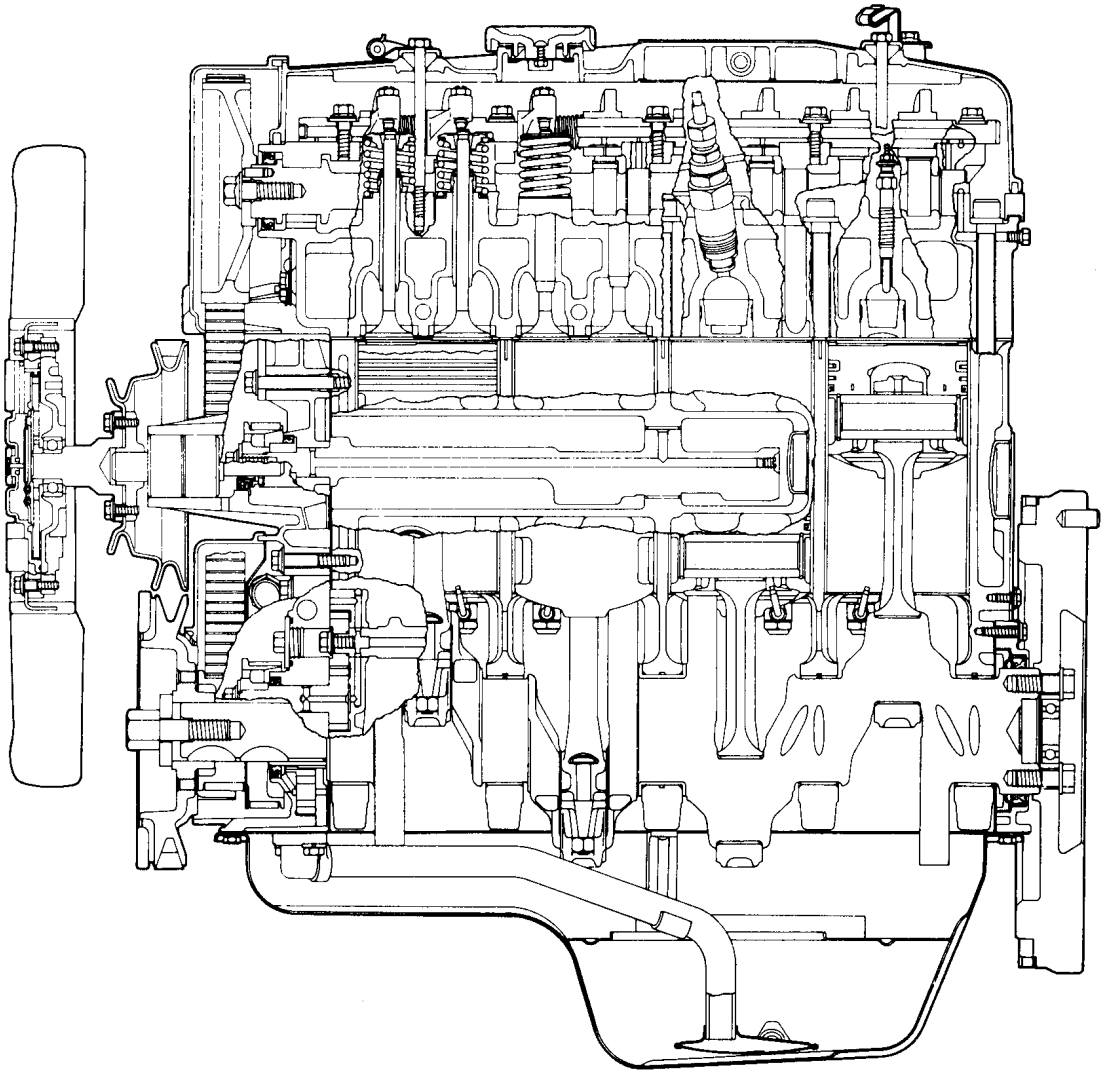
3. ENGINE SECTION

Longitudinal Section of Engine



DGE002

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

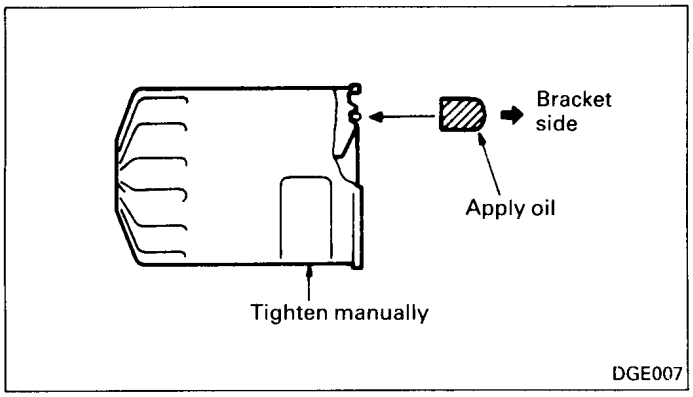
Tightening Torque of Flange Bolt or Nut

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

Replacing Oil Filter



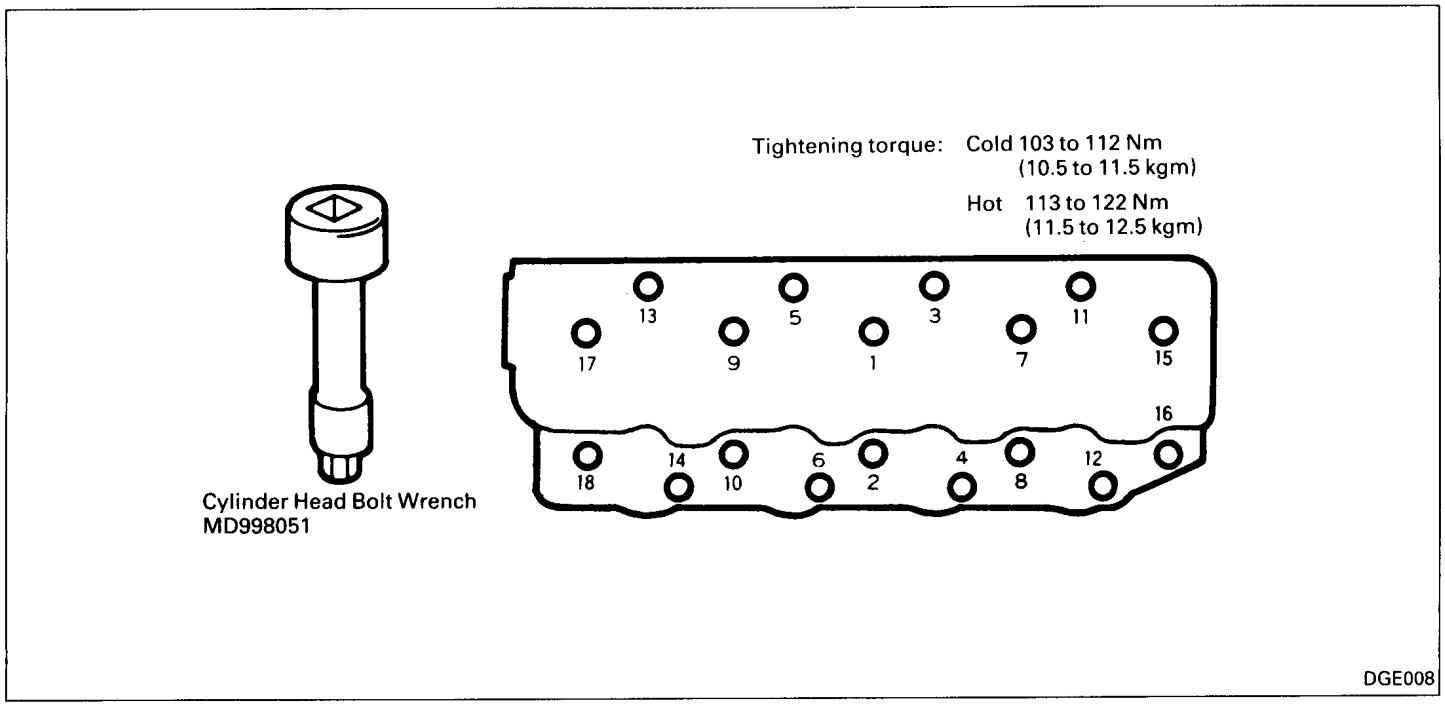
1. Use filter wrench or the like to remove the oil filter.
2. When installing the oil filter, clean the filter mounting surface of the filter bracket and lightly apply engine oil to the filter O-ring.
   Finger tighten the oil filter. [Tightening torque: 11 to 12 Nm (1.1 to 1.3 kgm)]

Caution:

- **Protect O-ring against twist and bending.**

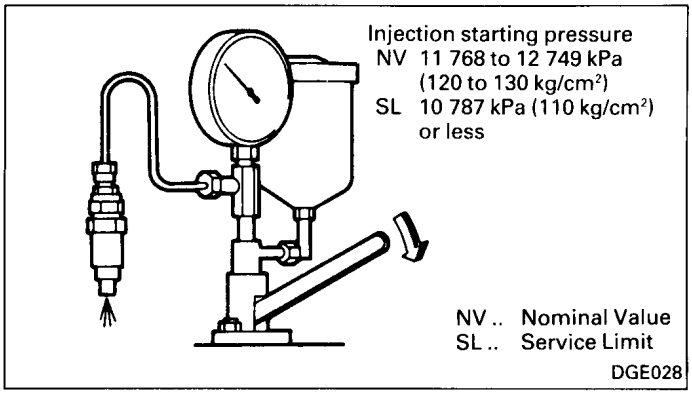
3. Run the engine for several minutes to check for engine oil leaks.
4. After stopping the engine, check the oil level and replenish as necessary.

6.2 ADDITIONAL TIGHTENING OF HEAD BOLTS



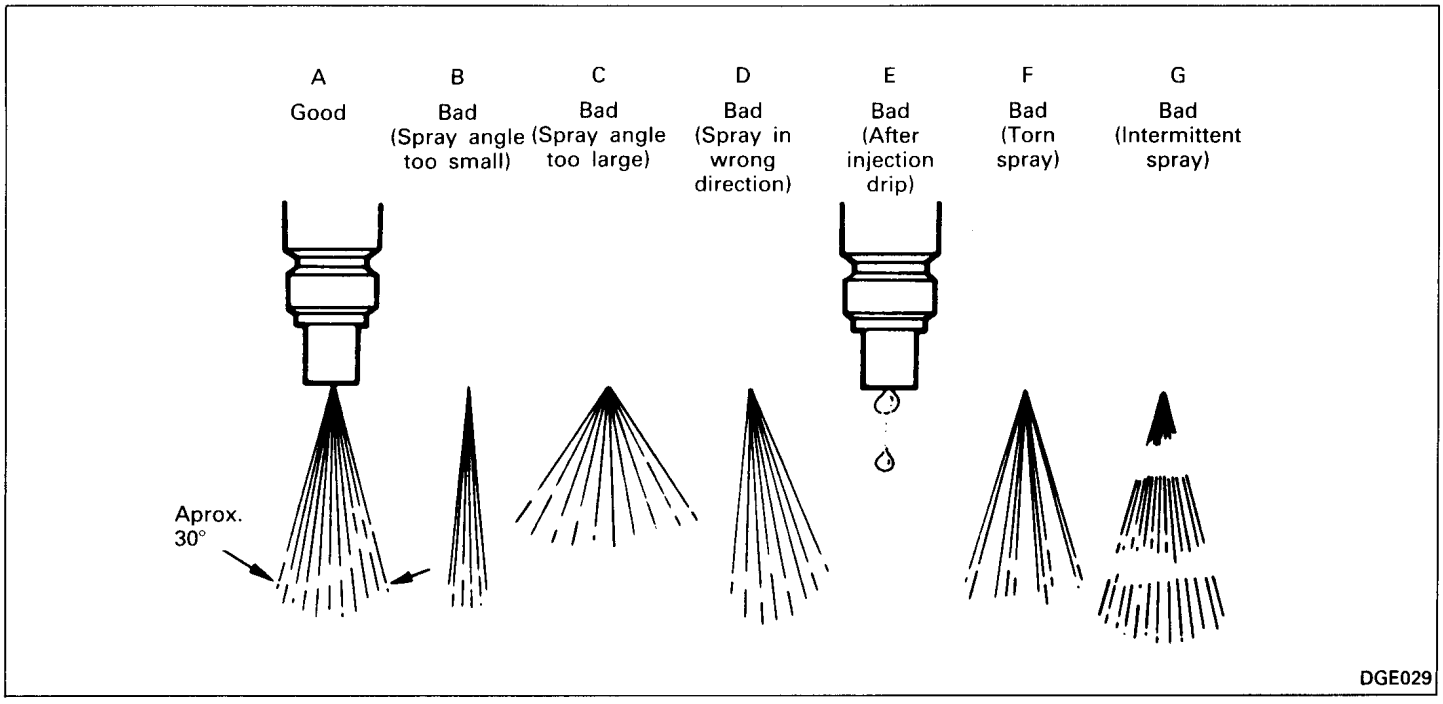
When giving additional tightening to the cylinder head bolts, back off the bolts slightly and then tighten to the specified torque. The tightening sequence of the bolts is as shown in illustration.

6.10 CHECKING NOZZLE



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

Checking Spray Condition

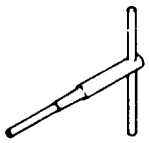
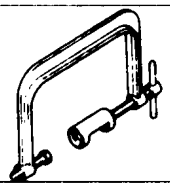
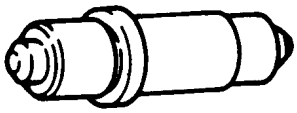
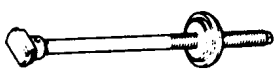


1. Operate the tester handle at a rate of approximately one stroke/min.
   - Vibrating condition of needle valve
     When the tester handle is stroked, the nozzle should inject, producing characteristic intermittent noises (Schnarre), and the vibration of the needle valve should be felt at the tester handle.

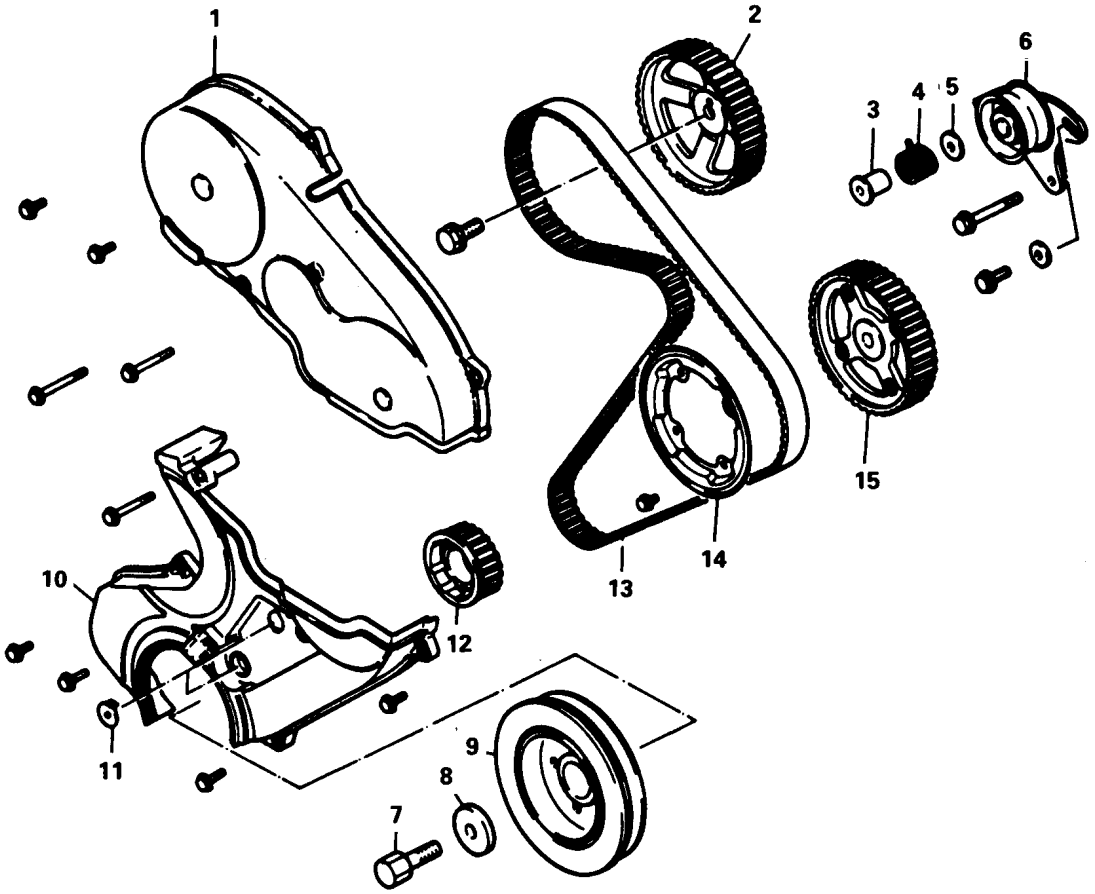
Checking Injection Starting Pressure

1. Mount the nozzle on the nozzle tester and stroke the tester handle to bleed the nozzle.
2. Operate the nozzle tester at a speed of more than 60 cycles/min. and read the pressure gauge. The reading will increase gradually, with the pointer oscillating while the nozzle is injecting. The injection starting pressure is the pressure at which the pointer starts to oscillate.

   - 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 an does not mean abnormal nozzle function.

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		
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

5. TIMING BELT

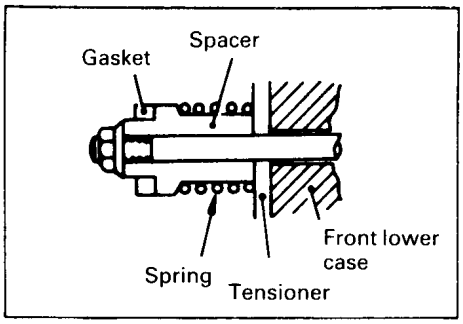


1 Timing belt upper cover
2 Camshaft sprocket
3 Tensioner spacer
4 Tensioner spring
5 Washer
6 Timing belt tensioner
7 Bolt
8 Special washer
9 Crankshaft pulley
10 Timing belt lower cover
11 Access cover
12 Crankshaft sprocket
13 Timing belt
14 Flange
15 Injection pump sprocket

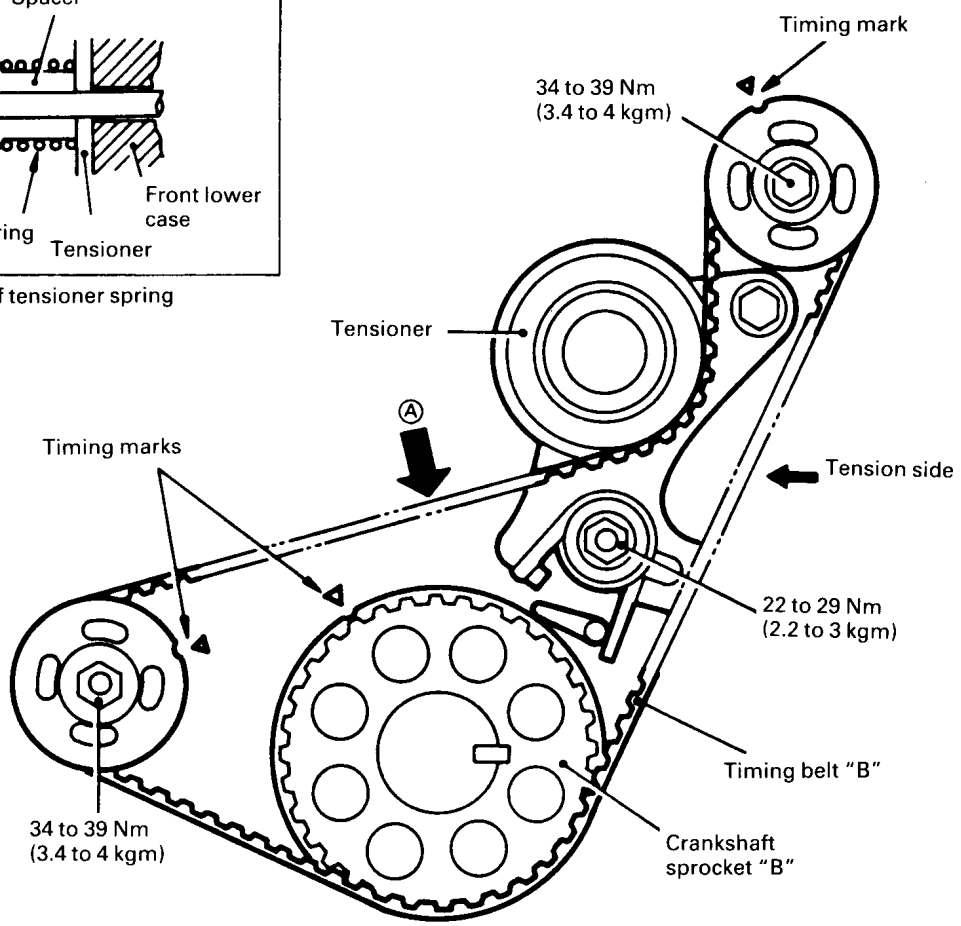
DEN001

6.3 INSTALLATION

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



Sectional view of tensioner spring

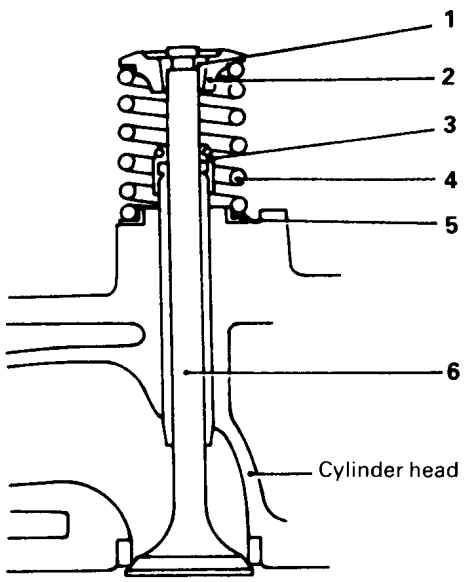


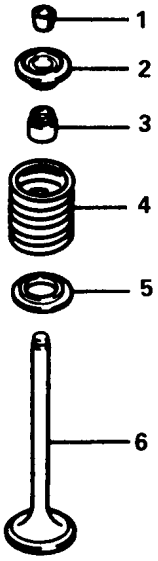
NOTE:
The figure shows the timing belt position when the piston in No. 1 cylinder is at the top dead center on the compression stroke.

DEN014

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

9. VALVE AND VALVE SPRING



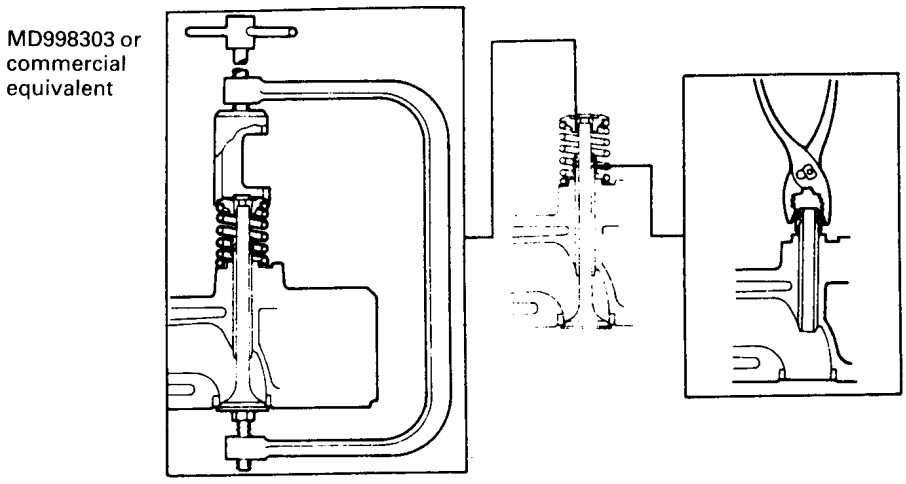


1 Retainer lock
2 Valve spring retainer
3 Valve stem seal
4 Valve spring
5 Valve spring seat
6 Valve

DEN028

9.1 REMOVAL

1. Remove the cylinder head assembly.

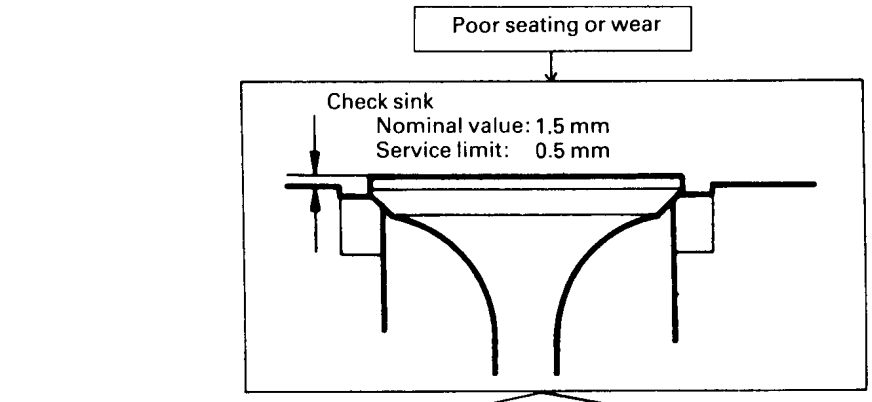


DEN029

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

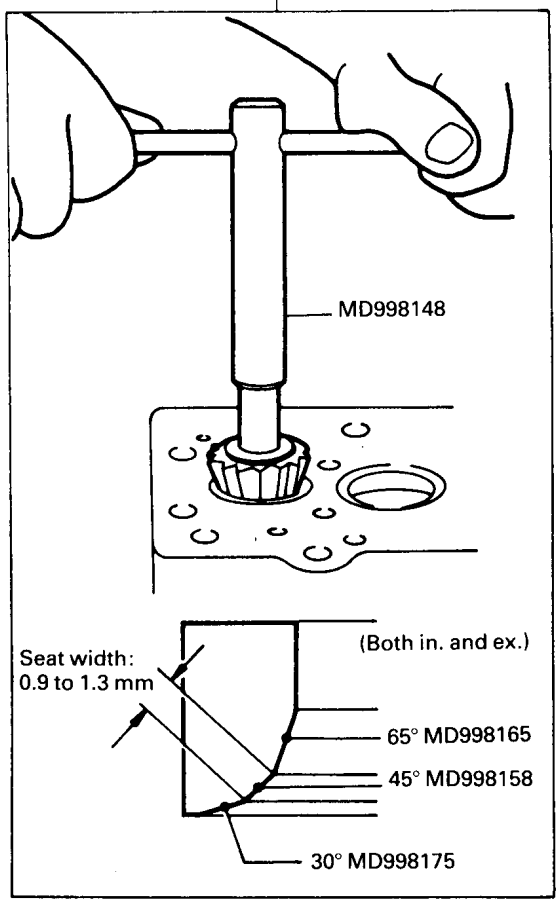
10.4 CORRECTING VALVE SEAT RING

Correct or replace defective valve seat ring.



Sink: too small

Sink: over service limit



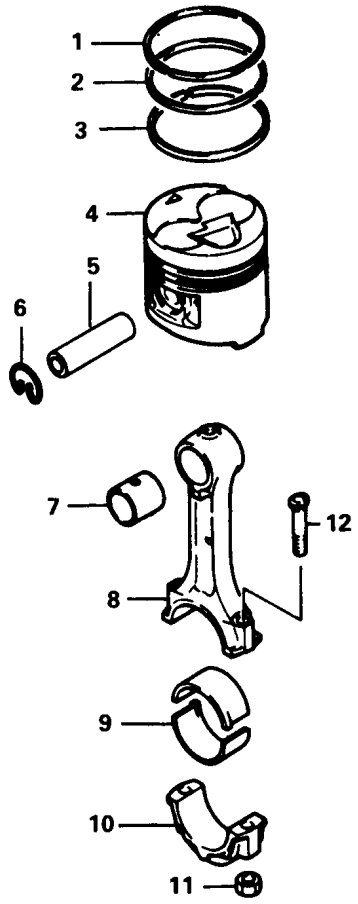
Seat ring service size

Item	Size mark	Valve seat height	Cylinder head hole dia.
In.			
0.3 mm O.S.	30	7.3 mm	43.3 to 43.325 mm
0.6 mm O.S.	60	7.6 mm	43.6 to 43.625 mm
Ex.			
0.3 mm O.S.	30	7.3 mm	37.3 to 37.325 mm
0.6 mm O.S.	60	7.6 mm	37.6 to 37.625 mm

Caution:
- **Correct the valve seat ring with the valve guide in normal condition.**
- **Correct so that the seat contacts the valve face at its center.**

DEN037

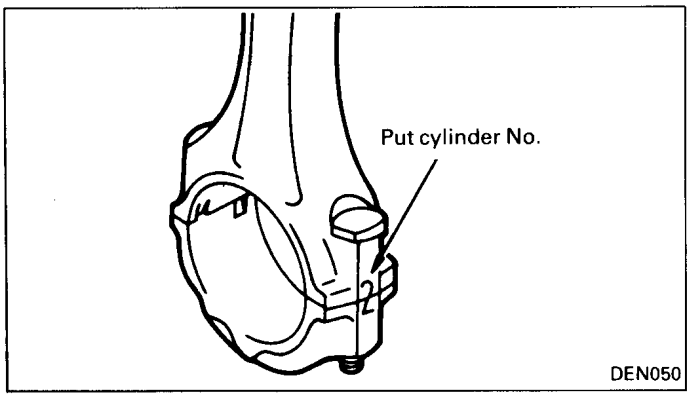
12. PISTON AND CONNECTING ROD



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



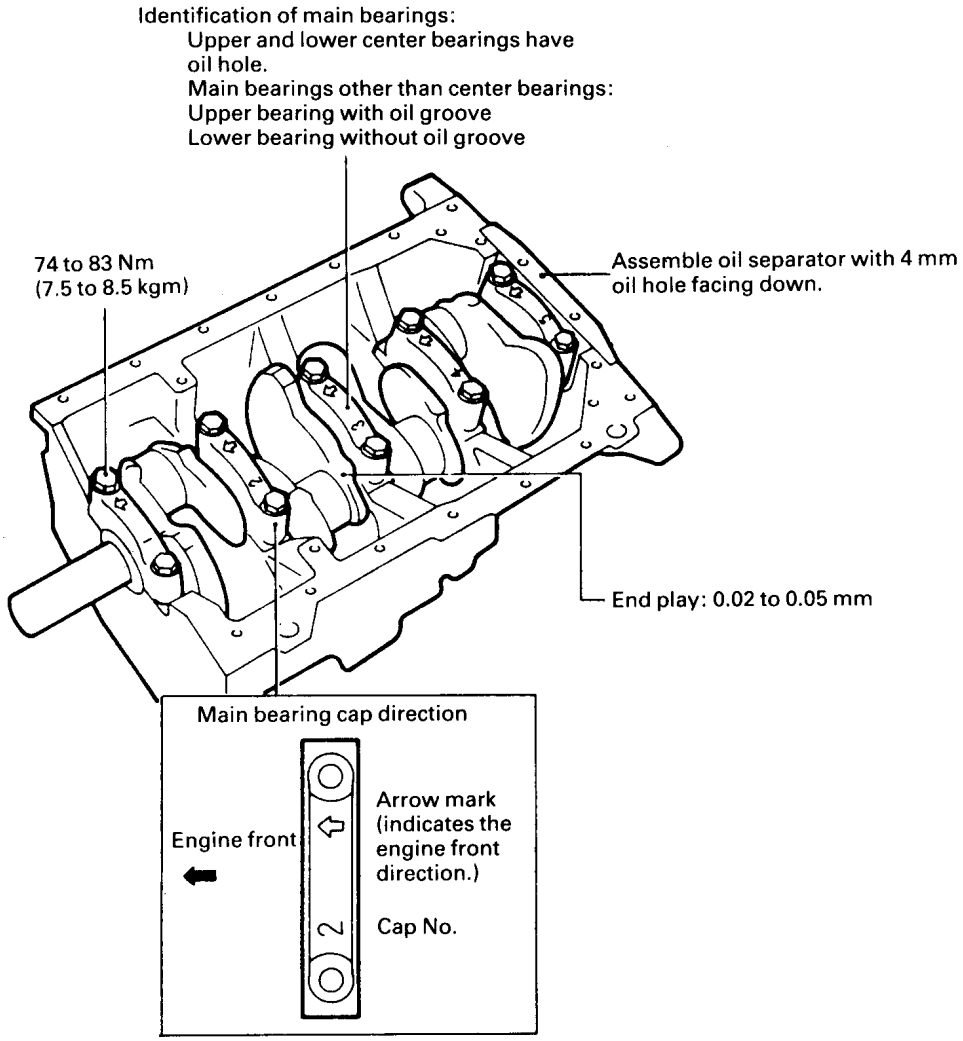
DEN050

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.**

13.4 INSTALLATION

When installing, pay attention to the following.



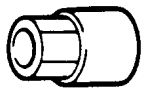
DEN064

1. SPECIFICATIONS

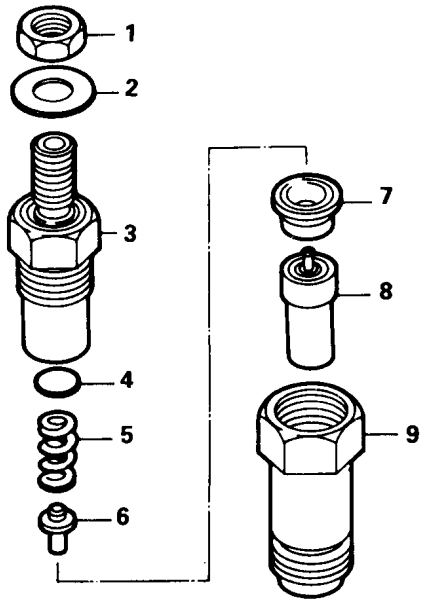
Description	Specifications	Remarks
Lubrication and filtration system	Pressure feed, full flow filtration system	
Quantity of oil	6.5 lit. (including 0.6 lit. in oil filter and 0.4 lit. in oil cooler)	
Oil pump		
Type	Geared (internal gear) type, built in front lower case	
Drive	Directly coupled to crankshaft	
Relief valve opening pressure	539 ± 49 kPa (5.5 ± 0.5 kg/cm²)	
Oil jet valve opening pressure	196 kPa (2 kg/cm²)	
Oil pressure switch operating pressure	28 kPa (0.3 kg/cm²) max.	
Oil filter	Filter paper type, cartridge filter	
Oil filter bracket		
Relief valve opening pressure	147 ± 20 kPa (1.5 ± 0.2 kg/cm²)	
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

4. INJECTION NOZZLE



1 Nut
2 Gasket
3 Nozzle holder body
4 Shim
5 Pressure spring
6 Retaining pin
7 Distance piece
8 Nozzle tip
9 Retaining nut

DFU006

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.

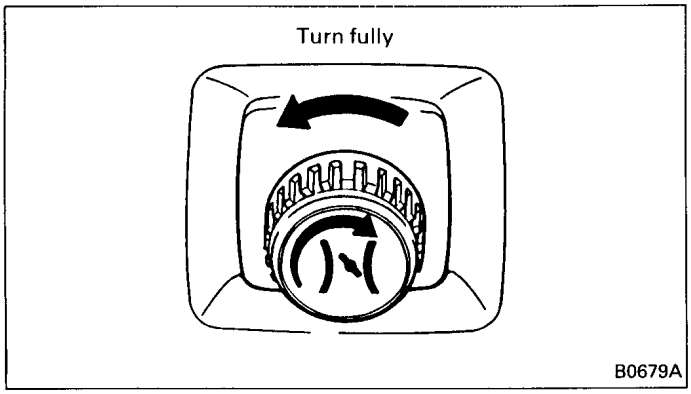
1. Holding the nozzle holder body in a vice or the like, remove the retainer nut with the special tool Nozzle Holder Socket Wrench (MD998387). Do not hold the retaining nut in a vice, etc. as it could result in deformation of the nut.
2. Remove the pressure spring, retaining pin, distance piece and nozzle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

Cable Installation and Adjustment Procedures

1. Throttle Cable

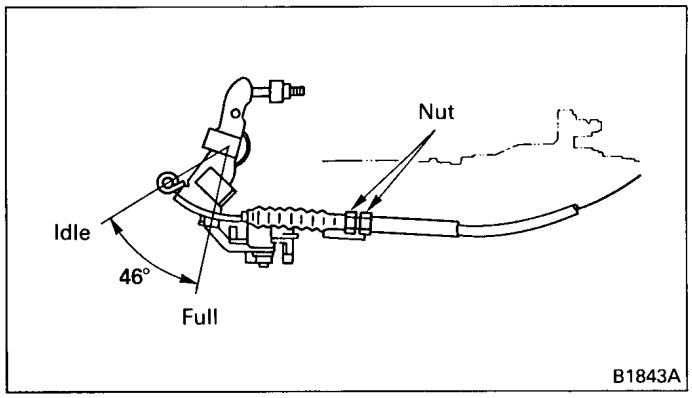


NOTE:

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

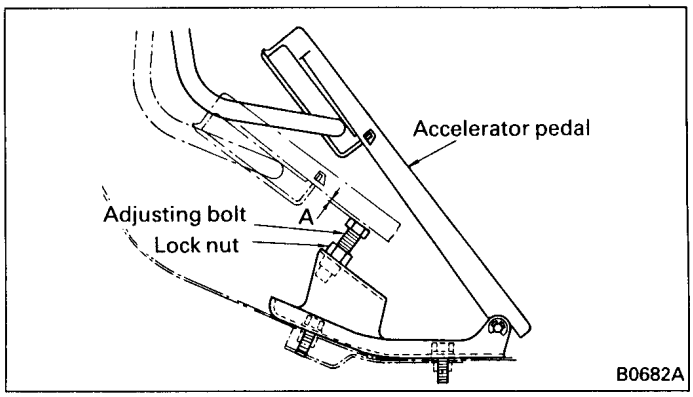


Turn the throttle button in the opposite direction to that of arrow indicated on the button and make sure that the accelerator pedal does not move. Install the accelerator control cable to the adjusting lever and secure the engine side of the cable by tightening the nut.

NOTE:

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

3. Accelerator Pedal Stopper

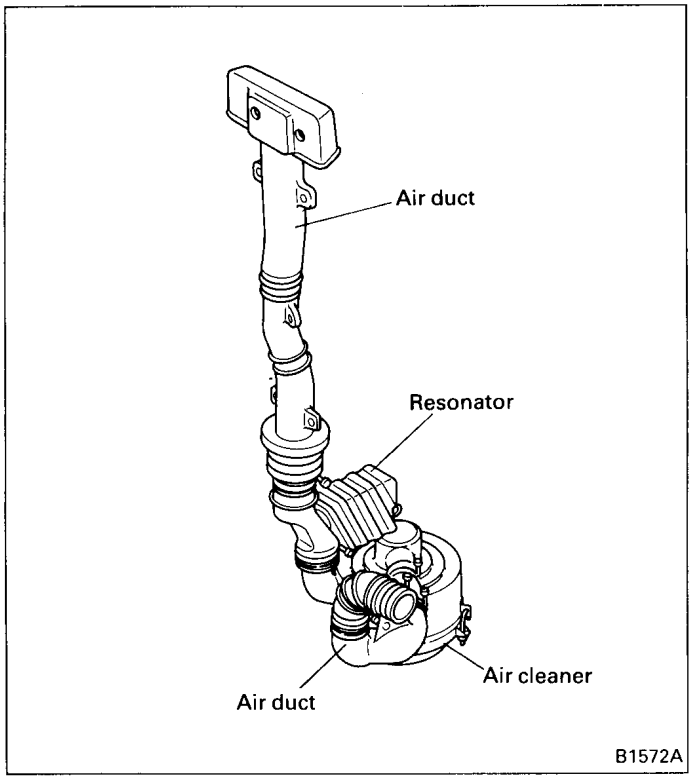


Make adjustment so that when the engine side adjusting lever is in contact with the full stopper, clearance between accelerator pedal and adjusting bolt is equal to dimension A.

Dimension A: 0 to 5

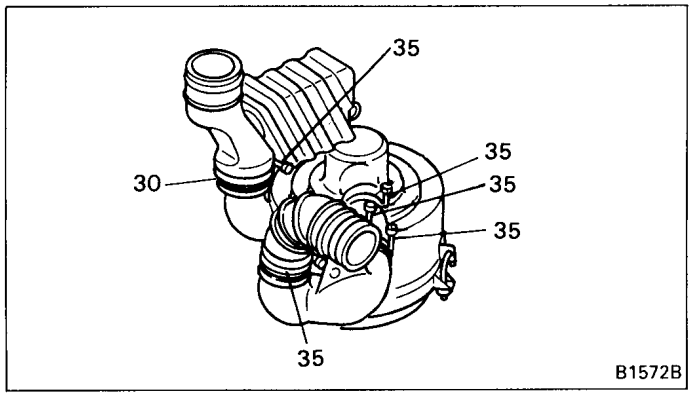
3. INTAKE SYSTEM

3.1 GENERAL

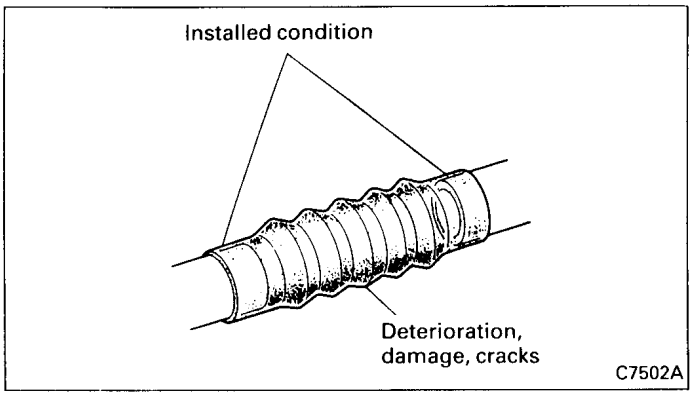


3.2 REMOVAL AND INSTALLATION

Figures in illustration indicate hose overlap.



3.3 INSPECTION

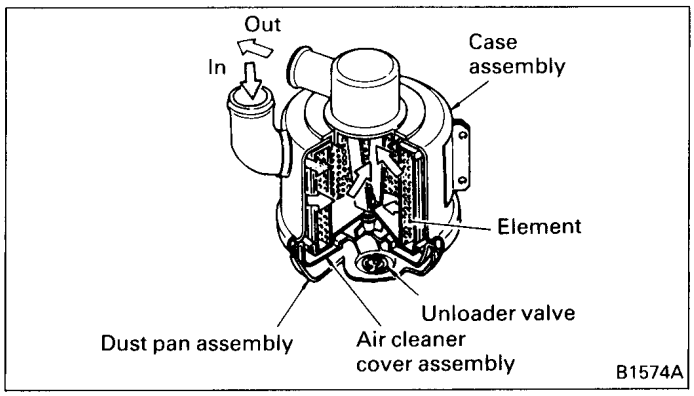


Imperfect sealing of the intake system, resulting in entry of dust and dirt into the engine, can be a cause of greater engine oil consumption. Check air hoses and rubber hoses for damages, collapses, and installed conditions.

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.