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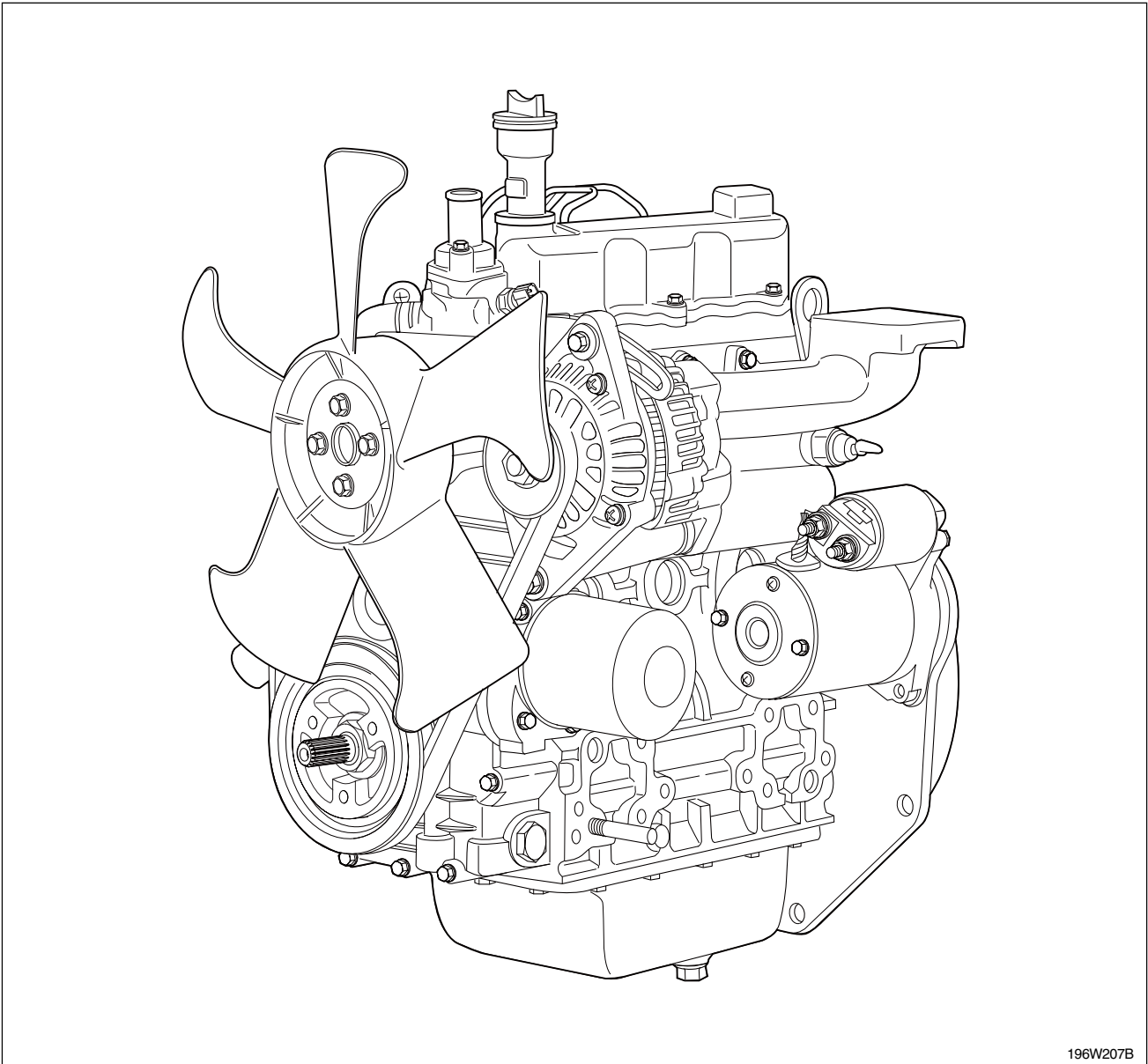
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1. ENGINE IDENTIFICATION

1.1 GENERAL FEATURES



196W207B

The 3C100A is a vertical, water-cooled, 4-cycle diesel engine. They are incorporated with DAEDONG's leading technologies. They feature greater power, lower fuel consumption, and little vibration and quiet operation due to the DAEDONG's circular combustion chamber, well-known Bosch K type injection pump and well-balanced designs.

1.2 ENGINE EPA DECAL

This aluminum decal is riveted on the engine cylinder head cover. This provides the information such as model number, displacement, rated output, valve clearance, injection timing, etc.

This decal represents that this engine is in compliance with the U.S.EPA and California (CARB) exhaust emission regulation.

1.3 BAR CODE FOR ENGINE NUMBER

The bar code for the DAEDONG engine number is located on the intake manifold.

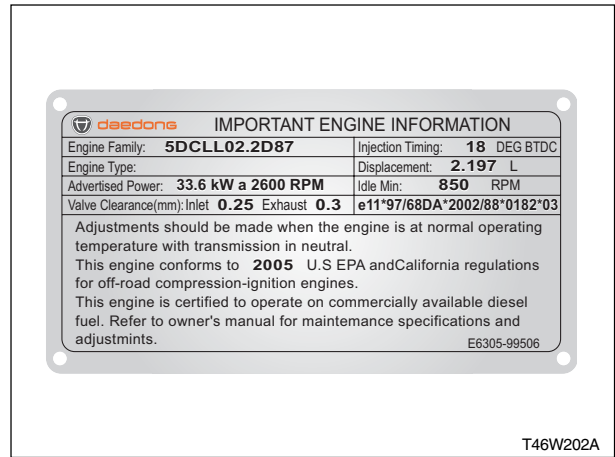
1.4 ENGINE NUMBER ASSIGNMENT STANDARD

The engine number is also stamped near the fuel injection pump on the cylinder block, in case the bar code is not available due to damage.

+ IMPORTANT

- *The engine number is necessary information that is requested on the warranty registration form. This number should be on the form as well as the tractor serial number and the amount of time used.*

For example, FD4000001 means that this engine is the first manufactured unit, 3B183 LXM, in 2006.



T46W202A

F D 4 0 0 0 0 1

Serial number

Engine model

3B183LXM	D40
3B183LXH	D41
4A200LXM	D22
4A200LXH	D23
4A220LXM	D24
4A220LXH	D25
4B243LXM	D38
4B243LXH	D39

Year of manufacturing

...	...
8	1998
9	1999
0	2000
1	2001
2	2002
3	2003
D	2004
E	2005
F	2006
G	2007
...	...

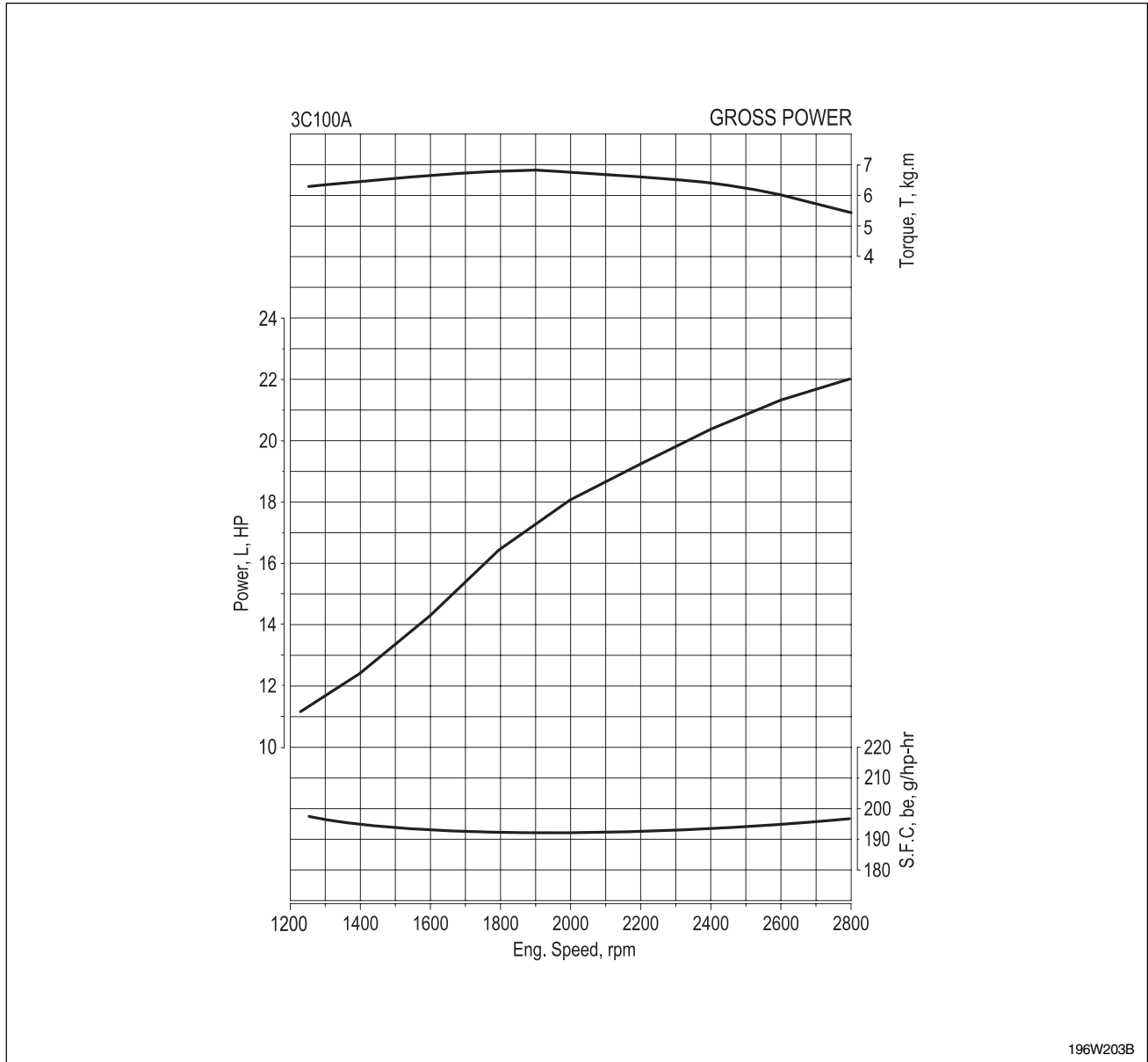
2. SPECIFICATIONS

2.1 GENERAL SPECIFICATIONS

Item	Factory Specification
Model	3C100A
Type	Vertical, water-cooled 4 cycle diesel engine
Number of cylinders	3
Bore stroke	75 X 76 mm
Total displacement	1007 cm ³ , 61.45 cu.in.
Engine gross power	22 HP (16.2 kW) / 2,800 rpm.
Maximum idle speed	3,000 rpm
Minimum idle speed	1,000 rpm
Maximum torque	63.7 Nm, 6.5 kgf-m, 47 lbs-ft/1,900 rpm
Combustion chamber	Spherical type, swirl chamber
Fuel injection pump	Bosch type K mini pump
Plunger bore	5 mm, 0.197 in.
Governor	Centrifugal ball mechanical governor
Injection type	Indirect injection with pre combination chamber
Injection timing	18° before top dead center
Injection pressure	14.2 MPa, 145 kgf/cm ² , 2,062 psi
Compression ratio	21.5 : 1
Lubricating system	Forced lubrication by rotor-type pump
Lubricating oil filter	Full flow paper filter (cartridge type)
Oil relief pressure	4.5 ~ 5.4 kgf/cm ² (64 ~ 76 psi)
Lubricating oil capacity	3.2 ℓ (0.84 U.S.gal.)
Engine oil specification	SAE 15W-40, CD or high or of API grade
Cooling system	Pressurized radiator, forced circulation (with pump)
Coolant capacity	4.6 ℓ (1.21 U.S.gal.)
Antifreeze	Ethylene glycol 50% with anti corrosive agent
Starting system	Electric starting with start motor
Battery	12 V, 80AH, Equivalent (CCA, 630AH)
Starting support device	By glow plug in combustion chamber
Dynamo for charging	12 V, 240 W
Fuel	Diesel fuel No.2-D (ASTM D975)
Weight (Dry)	98 kg, 216 lbs.
Injection order	1 - 2 - 3
Direction of rotation	Counterclockwise (wiewed from flywheel side)

- The engine gross output is measured with the cooling fan removed.
- The cylinder number for ignition sequence is given from the cylinder on the engine cooling fan side.
- If the coolant level drops due to its evaporation, add only water. If the coolant level drops due to the leakage, add coolant mixed with anti-freeze.
- The freezing point of the coolant mixture is -37°C (-34°F) in a normal condition.
- When replacing the coolant with a different type of coolant, flush the cooling system thoroughly beforehand.

2.2 PERFORMANCE CURVE



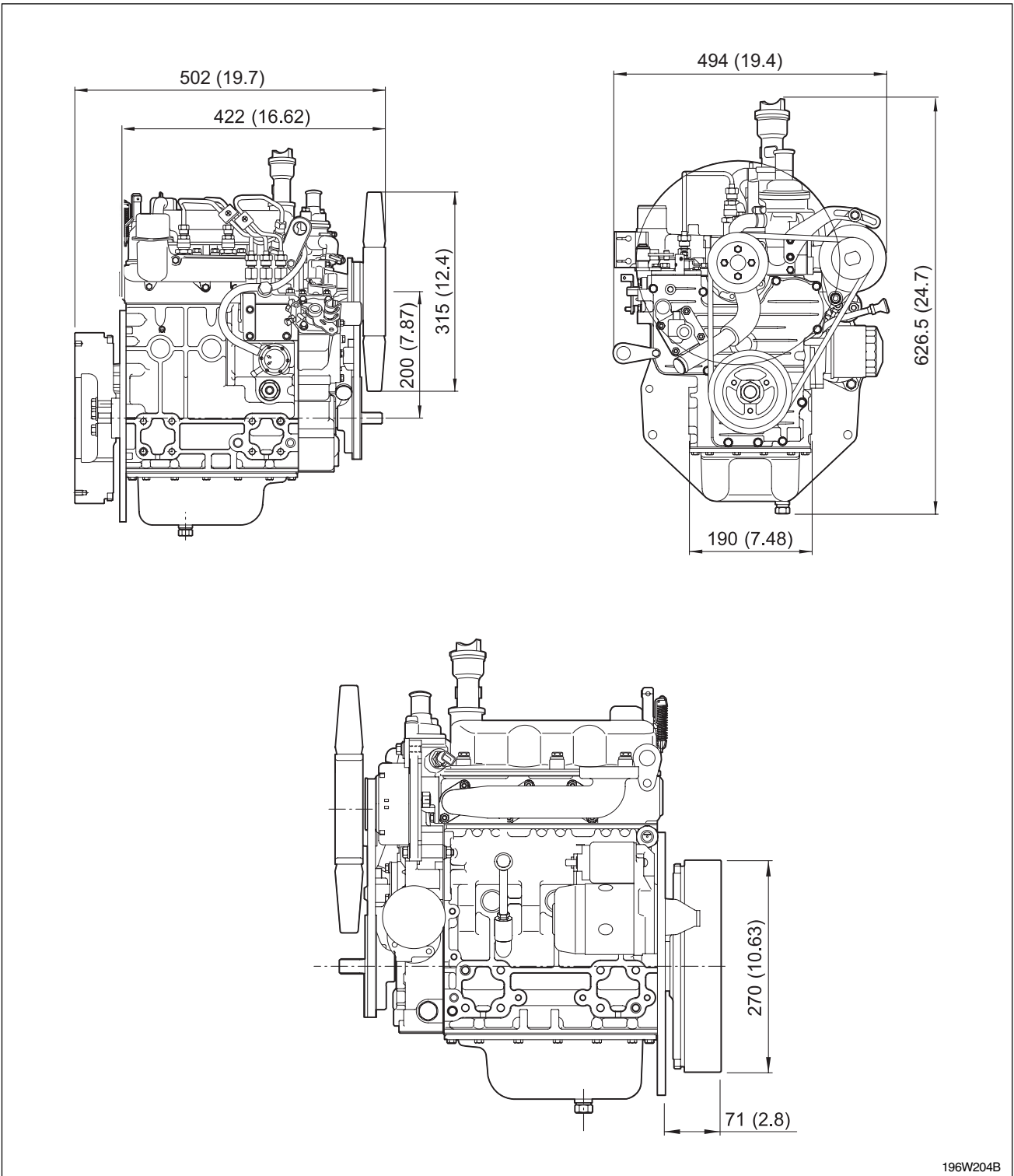
196W203B

NOTE:

- Performance curve, obtained in accordance with SAE J 1995.
- SFC (Specific Fuel Consumption)
 According to the curve,
 197g/Hp-hr at 2,800 rpm
 → $197\text{g/Hp-hr} \times 22\text{ HP} = 4,334\text{ kg/hr}$
 → $4,334\text{ kg/hr} \div 0.81\text{ kg/l} = 5.35\text{ l/hr}$
 ★ 1 l of diesel fuel is 0.81 kg

2.3 DIMENSIONS

mm (in.)



GENERAL

ENGINE

CLUTCH

TRANSMISSION

HST

REAR AXLE

BARKE

FRONT AXLE

STEERING

HYDRAULIC

ELECTRIC

INDEX

2.4 SERVICE SPECIFICATIONS

2.4.1 CYLINDER HEAD

Item	Reference Value	Allowable Limit
Distortion of cylinder head surface length.	0.05 mm (0.0020 in.) / 100 mm (4 in.) of cylinder head surface length.	-
Thickness of gasket	When tightened 1.15 ~ 1.25 mm (0.045 ~ 0.049 in.)	-
Top clearance	0.7 ~ 0.9 mm (0.0275 ~ 0.0354 in.)	-
Tightness of head bolts	58.8 ~ 63.7 Nm 6.0 ~ 6.5 kgf-m (43.4 ~ 47.0 lb-ft)	-

2.4.2 VALVES

Item	Reference Value	Allowable Limit
Valve seat width	2.1 mm 0.083 in.	-
Valve seat angle (intake, exhaust)	1.047, 0.785 rad. 60°, 45°	-
O.D. of valve stems (intake, exhaust)	6.960 ~ 6.975 mm 0.2740 ~ 0.2746 in.	-
I.D. of valve guides (intake, exhaust)	7.010 ~ 7.025 mm 0.2759 ~ 0.2765 in.	-
Clearance between valve stems and guides	0.035 ~ 0.065 mm 0.0014 ~ 0.0026 in.	0.1 mm 0.004 in.
Valve recessing	-0.05 ~ +0.15 mm -0.002 ~ +0.006 in.	1.3 mm 0.051 in.
Valve clearance (intake, exhaust) cold	0.15 mm 0.006 in	-

2.4.3 VALVE SPRINGS

Item	Reference Value	Allowable Limit
Free length	35.1 ~ 35.6 mm 1.382 ~ 1.402 in.	34.8 mm 1.37 in.
Fitted length	30.99 mm 1.2201 in.	-
Load to compress to fitted length	74 N / 31 mm 7.5 kgf / 31 mm, 16.5 lbs / 1.22 in.	63 N / 31 mm 6.4 kgf / 31 mm, 14.1 lbs / 1.22 in.
Squareness	1.3 mm 0.051 in.	-

2.4.4 VALVE ROCKER ARMS

Item	Reference Value	Allowable Limit
O.D. of rocker arm shafts	12.955 ~ 12.980 mm 0.5100 ~ 0.5110 in.	-
I.D. of rocker arm bushings	13.000 ~ 13.025 mm 0.5118 ~ 0.5128 in.	-
Clearance between rocker arm shafts and bushings	0.02 ~ 0.07 mm 0.0008 ~ 0.0027 in.	0.12 mm 0.0047 in.
Adjustment of compression release	0.750 ~ 1.125 mm 0.0295 ~ 0.0443 in.	-

2.4.5 CAMSHAFT

Item	Reference Value	Allowable Limit	
O.D. of camshaft bearing journal	32.934 ~ 32.950 mm 1.2966 ~ 1.2972 in.	-	
I.D. of camshaft bearing	33.000 ~ 33.025 mm 1.2992 ~ 1.3002 in.	-	
Clearance between camshaft bearing journals and bearings	0.050 ~ 0.091 mm 0.0020 ~ 0.0036 in.	0.15 mm 0.0020 in.	
Alignment of camshaft	-	0.05 mm 0.0020 in.	
Cam height	Intake	26.75 mm 1.0530 in.	26.83 mm 1.0563 in.
	Exhaust	26.88 mm 1.0583 in.	26.88 mm 1.0583 in.
Gear backlash	0.042 ~ 0.115 mm 0.0017 ~ 0.0045 in.	0.2 mm 0.0079 in.	

2.4.6 PISTON RINGS

Item	Reference Value	Allowable Limit	
Ring gap	Top ring	0.15 ~ 0.30 mm 0.0059 ~ 0.0118 in.	1.25 mm 0.0492 in.
	2nd ring	0.30 ~ 0.45 mm 0.0118 ~ 0.0177 in.	1.25 mm 0.0492 in.
	Oil ring	0.20 ~ 0.35 mm 0.0079 ~ 0.0138 in.	1.25 mm 0.0492 in.
Side clearance of ring in groove	Top ring	-	-
	2nd ring	0.04 ~ 0.08 mm 0.0016 ~ 0.0031 in.	-
	Oil ring	0.02 ~ 0.06 mm 0.0008 ~ 0.0024 in.	-

2.4.7 PISTONS

Item	Reference Value	Allowable Limit
I.D. of piston bosses	20.000 ~ 20.013 mm 0.7874 ~ 0.7879 in.	20.03 mm 0.7885 in.
O.D. of piston pin	20.002 ~ 20.011 mm 0.7875 ~ 0.7878 in.	-
I.D. of connecting rod small end bushings (fitted)	20.025 ~ 20.040 mm 0.7884 ~ 0.7890 in.	-
Clearance between piston pin and small end bushings	0.014 ~ 0.038 mm 0.0006 ~ 0.0015 in.	0.15 mm 0.0059 in.
Connecting rod alignment	0.02 mm 0.0008 in.	0.05 mm 0.0020 in.

2.4.8 CRANKSHAFT

Item	Reference Value	Allowable Limit
Crankshaft alignment	0.02 mm 0.0008 in.	0.08 mm 0.0031 in.
O.D. of crankshaft journals	47.934 ~ 47.950 mm 1.8872 ~ 1.8878 in.	-
I.D. of crankshaft bearing 1	48.068 ~ 48.138 mm 1.8924 ~ 1.8952 in.	-
I.D. of crankshaft bearing 2	47.980 ~ 48.006 mm 1.8890 ~ 1.8900 in.	-
Clearance between crankshaft journals and bearing 1	0.118 ~ 0.204 mm 0.0046 ~ 0.0080 in.	0.20 mm 0.0079 in.
Clearance between crankshaft journals and bearing 2	0.030 ~ 0.072 mm 0.0012 ~ 0.0028 in.	0.20 mm 0.0079 in.
O.D. of crankpins	39.959 ~ 39.975 mm 1.5732 ~ 1.5738 in.	-
I.D. of crankpin bearings	39.994 ~ 40.020 mm 1.5746 ~ 1.5756 in.	-
Clearance between crankpins and bearings	0.035 ~ 0.061 mm 0.0014 ~ 0.0024 in.	0.20 mm 0.0079 in.
End play of crankshaft	0.15 ~ 0.31 mm 0.0059 ~ 0.0122 in.	0.5 mm 0.0197 in.

2.4.9 FUEL INJECTION NOZZLES

Item	Reference Value	Allowable Limit
Opening pressure	14.2 ~ 15.2 MPa 145 ~ 155 kgf/cm ² , 2,062 ~ 2,204 psi.	-
Fuel tightness of nozzle valve seat	Dry nozzle at 12.7 MPa 130 kgf/cm ² , 1,848.6 psi.	-

2.4.10 INJECTION PUMP

Item	Reference Value	Allowable Limit
Tightness of plunger	More than 60 seconds; initial pressure from 34.32 ~ 39.23 MPa 350 ~ 400 kgf/cm ² , 4,978 ~ 5,689 psi.	30 seconds
Tightness of delivery valve	More than 10 seconds; initial pressure from 20.59 ~ 21.57 MPa 210 ~ 220 kgf/cm ² , 2,987 ~ 3,129 psi	5 seconds
Injection timing	22° Before Top Dead Center	-

2.4.11 OIL PUMP

Item	Reference Value	Allowable Limit
Oil pressure	At rated speed 245 ~ 441 kPa 2.5 ~ 4.5 kgf/cm ² , 36 ~ 64 psi.	245 kPa 2.5 kgf/cm ² , 36 psi
	At idle speed More than 49 kPa 0.5 kgf/cm ² , 7.11 psi.	-
Rotor type	Rotor lobe clearance 0.11 ~ 0.15 mm 0.0043 ~ 0.0059 in.	0.20 mm 0.0079 in.
	Radial clearance between outer rotor and pump body 0.07 ~ 0.15 mm 0.0028 ~ 0.0059 in.	0.25 mm 0.0098 in.
End clearance between rotor and cover	0.08 ~ 0.13 mm 0.0031 ~ 0.0051 in.	0.2 mm 0.0079 in.

2.4.12 RADIATOR

Item	Reference Value	Allowable Limit
Opening pressure of cap	88.3 kPa 0.9 kgf/cm ² , 12.8 psi.	-
Test pressure	88.3 kPa 0.9 kgf/cm ² , 12.8 psi.	-

2.4.13 THERMOSTAT

Item	Reference Value	Allowable Limit
Opening temperature cap	Beginning 80.5°C ~ 83.5°C 176.9°F ~ 182.3°F	-
	Full-open 95°C 203°F	-
Distance of lift	8 mm 0.3150 in.	-

2.4.14 FANBELT

Item	Reference Value	Allowable Limit
Belt sag under load of 78.5 N (8 kgf, 17.6 lbs.)	8 mm (0.32 in.)	-

2.4.15 TIGHTENING TORQUE

Indicate the bolts with ■ mark and manually tighten first.

Item	Nm	kgf-m	lb-ft
Head bolt, nut	58.8 ~ 63.7	6.0 ~ 6.5	43.4 ~ 47.0
■ Bearing case bolt 1	29.4 ~ 34.3	3.0 ~ 3.5	21.7 ~ 25.3
■ Bearing case bolt 2	29.4 ~ 34.3	3.0 ~ 3.5	21.7 ~ 25.3
■ Flywheel bolt	53.9 ~ 58.8	5.5 ~ 6.0	39.7 ~ 43.4
■ Connecting rod bolt	26.5 ~ 30.4	2.7 ~ 3.1	19.5 ~ 22.4
Rocker arm bracket sink bolt	23.5 ~ 27.5	2.4 ~ 2.8	17.4 ~ 20.3
Idle gear shaft bolt	7.8 ~ 9.8	0.8 ~ 1.0	5.7 ~ 7.2
Glow plug (no lubrication)	19.6 ~ 24.5	2.0 ~ 2.5	14.4 ~ 18.1
Waste oil plug	32.4 ~ 37.3	3.3 ~ 3.8	23.9 ~ 27.5
Nozzle holder	49.0 ~ 68.6	5.0 ~ 7.0	36.1 ~ 50.5
Overflow pipe nut	29.4 ~ 34.3	3.0 ~ 3.5	21.7 ~ 25.3
Oil switch	Bis	1.4 ~ 1.9	0.14 ~ 0.20
	Taper screw	14.7 ~ 19.6	1.5 ~ 2.0
Fuel supply limit cap nut	27.5 ~ 34.3	2.8 ~ 3.5	20.3 ~ 25.3
Idle limit fixing nut	13.7 ~ 15.7	1.4 ~ 1.6	10.1 ~ 11.5
Injection pipe nut	24.5 ~ 34.3	2.5 ~ 3.5	18.0 ~ 25.3
Crankshaft nut	137.2 ~ 156.9	14 ~ 16	101.2 ~ 115.7

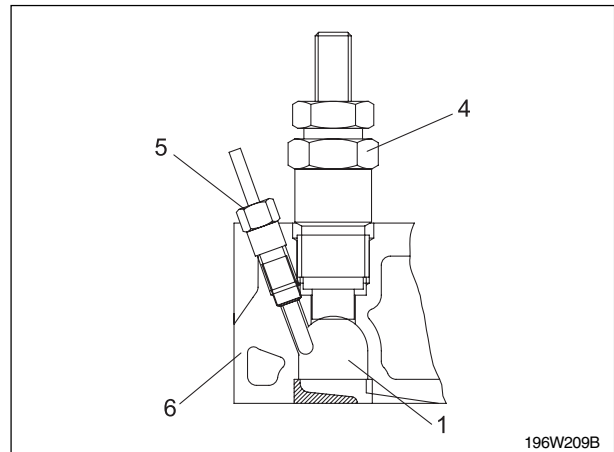
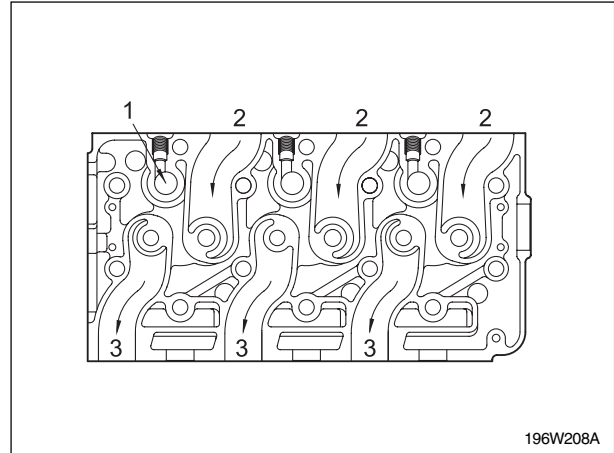
3. OPERATING PRINCIPLE

3.1 BODY AND POWER TRAIN

3.1.1 CYLINDER HEAD

The cylinder head has openings on both sides that allow cross-flow type inlet/exhaust ports to the engine. Because the inlet/exhaust ports overlap and are smaller than other ports, the suction air can be protected from being heated and expanded by exhaust air. The cool, high mass suction air has a high large effectiveness and raises the power of the engine. Deformation of the cylinder head by heat exhaust air is reduced because inlet ports are arranged alternately. The combustion chamber is of DAEDONG's select circular combustion chamber type. Suction air is combustion and reduces fuel consumption. Throttle type injection nozzles and rapid heating enclosed glow plugs are installed in the combustion.

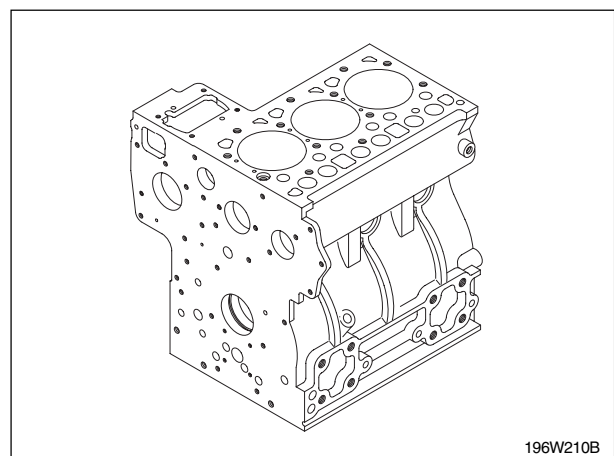
This glow plug assures easier engine starts even at a temperature of -15°C (5°F).



- | | |
|------------------------|---------------------|
| (1) Combustion chamber | (4) Nozzle assembly |
| (2) Inlet port | (5) Glow plug |
| (3) Exhaust port | (6) Cylinder head |

3.1.2 CYLINDER BLOCK

The engine features a high resilience tunnel-type cylinder block. Pressure-fitted cylinders allow effective cooling, less distortion, higher wear-resistance qualities and each cylinder having its own chamber helps to minimize noise.



3.1.3 CRANKSHAFT

The crankshaft drives the pistons and connecting rods, and transfers its reciprocating movement to a circular camshaft. Six counterweights are integrated into one unit to minimize bearing wear and lubricating oil temperature rise.

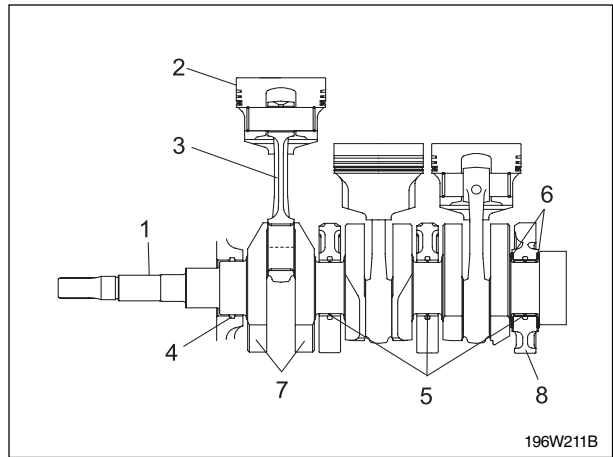
Seal sliding sections are induction-hardened to raise wear resistance quality.

Crankshaft journals are supported by the main bearing cases in which bearings are used.

Crankshaft bearing 1 at the front end is a wind type bushing.

Thrust bearing 1, 2 of split type are mounted on both sides of the main bearing case at the flywheel side.

Crankshaft bearing and thrust bearings are plated with special raised alloy wear resistance.



- (1) Crankshaft
- (2) Piston
- (3) Connecting rod
- (4) Crankshaft bearing 1
- (5) Crankshaft bearing 2
- (6) Thrust bearing
- (7) Counterweight
- (8) Main bearing case

3.1.4 PISTON AND PISTON RINGS

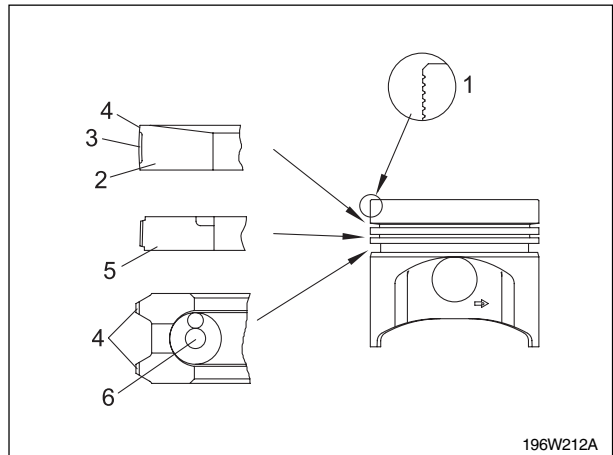
Piston circumference has special elliptic shape in consideration of expansion due to heat. The piston head is flat formed and ribbed to reduce distortion and to help heat radiation.

Pistons are made of special aluminum alloy of low thermal expansion and high temperature resistance. The key stone type top ring is well fitted to the wall and plated with hard chrome.

Second ring type is effective in preventing oil rising.

The oil ring is effective because it is closely fitted to the cylinder wall by a coil so oil can be scraped from the upper and lower ends of its sliding cylinder walls.

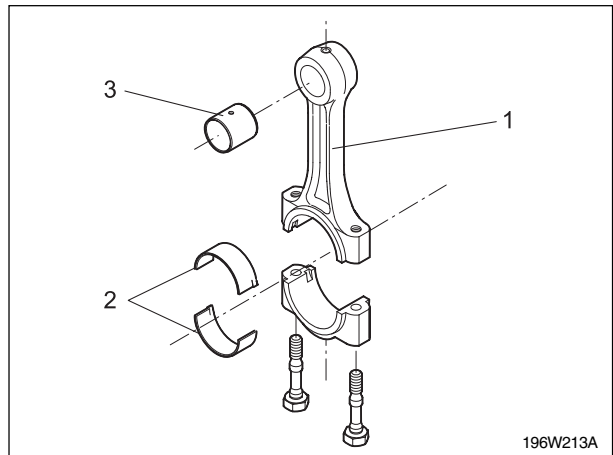
A portion of the scraped oil is forced inside the piston through escape holes of the rings and pistons. The oil ring is plated with hard chrome to raise the wear resistance quality.



- (1) Rib
- (2) Top ring
- (3) Surface
- (4) Hard chrome
- (5) 2nd ring
- (6) Coil expander ring

3.1.5 CONNECTING RODS

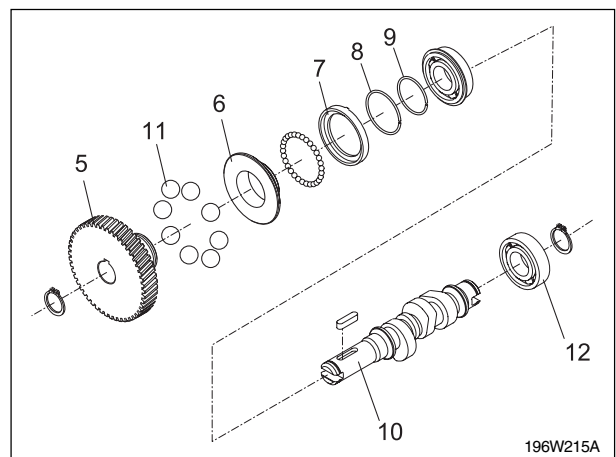
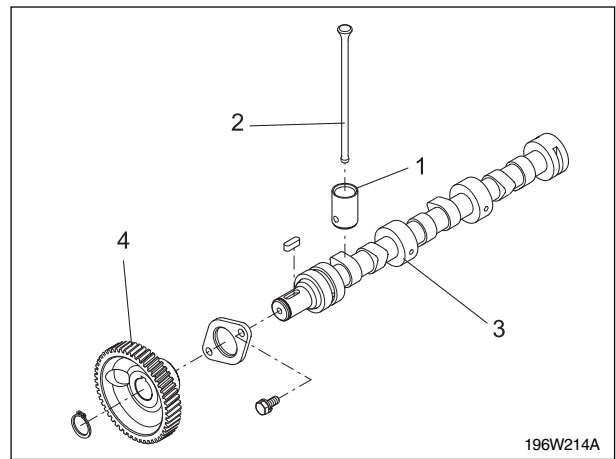
The connecting rod is used to connect the piston with the crankshaft. The big end of this rod has crankpin bearings (split type) and the small end has a bushing (solid type).



- (1) Connecting rod
- (2) Crankpin bearing
- (3) Bushing

3.1.6 CAMSHAFT AND FUEL CAMSHAFT

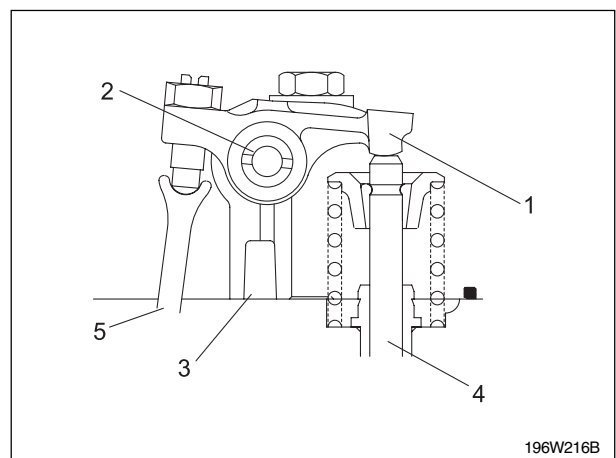
The camshaft is made of special cast iron; the journal and cam sections are chromed to resist wear. The journal sections are force-lubricated. The fuel camshaft controls the reciprocating movement of the injection pump, and is also equipped with a ball to control the governor. Fuel camshaft is made of carbon steel and cam sections are covered and tempered to provide greater wear resistance.



- (1) Tappet
- (2) Push rod
- (3) Camshaft
- (4) Camshaft gear
- (5) Injection pump gear
- (6) Governor sleeve
- (7) Governor ball case
- (8) Cir-clip
- (9) Cir-clip
- (10) Fuel camshaft
- (11) Ball
- (12) Ball bearing

3.1.7 ROCKER ARM ASSEMBLY

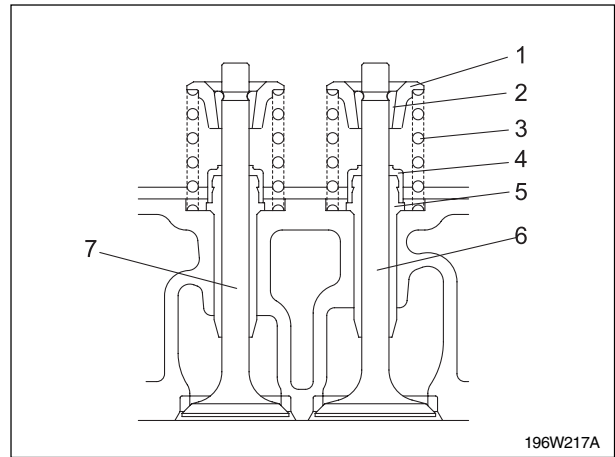
The rocker arm assembly includes the rocker arms, arm brackets and arm shafts and converts the movement of the push rods to open/close of the inlet and exhaust valves. Valve controlled timing must be adjusted with screws on the rocker arms. Lubrication oil is pressurized through arm bearings and the entire system is lubricated.



- (1) Rocker arm
- (2) Rocker arm shaft
- (3) Rocker arm bracket
- (4) Valve
- (5) Push rod

3.1.8 INLET AND EXHAUST VALVES

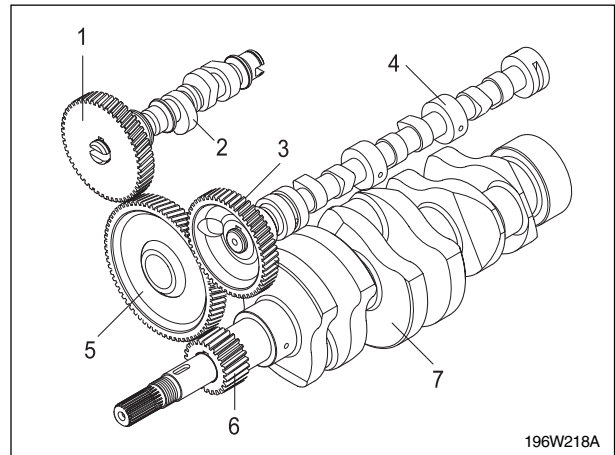
The inlet and exhaust valves and their guides are different from each other. Other parts, such as valve springs, spring retainers, valve spring collets, valve stem seals, and valves all contact or sliding parts, which are covered and tempered to resist wear.



- (1) Valve spring retainer
- (2) Valve spring collets
- (3) Valve spring
- (4) Valve stem seal
- (5) Valve guide
- (6) Inlet valve
- (7) Exhaust valve

3.1.9 TIMING GEARS

The crankshaft drives the oil pump and the idle gear engages the fuel camshaft and camshaft. The timings for opening and closing the valve are extremely important to achieve effective air intake and sufficient gas exhaust. The appropriate timing can be obtained when assembling by aligning the mark on the crankshaft gear either with (6) the one on the idle gear or (5), the idle gear with camshaft gear (3), idle gear (5) or with injection pump gear (1).

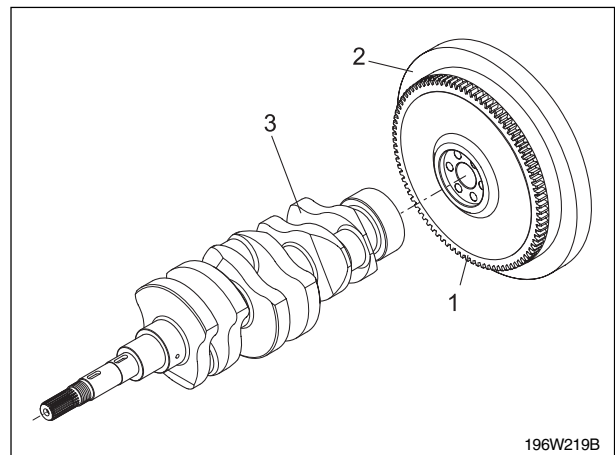


- (1) Injection pump gear
- (2) Fuel camshaft
- (3) Camshaft gear
- (4) Camshaft
- (5) Idle gear
- (6) Crankshaft gear
- (7) Crankshaft

3.1.10 FLYWHEEL

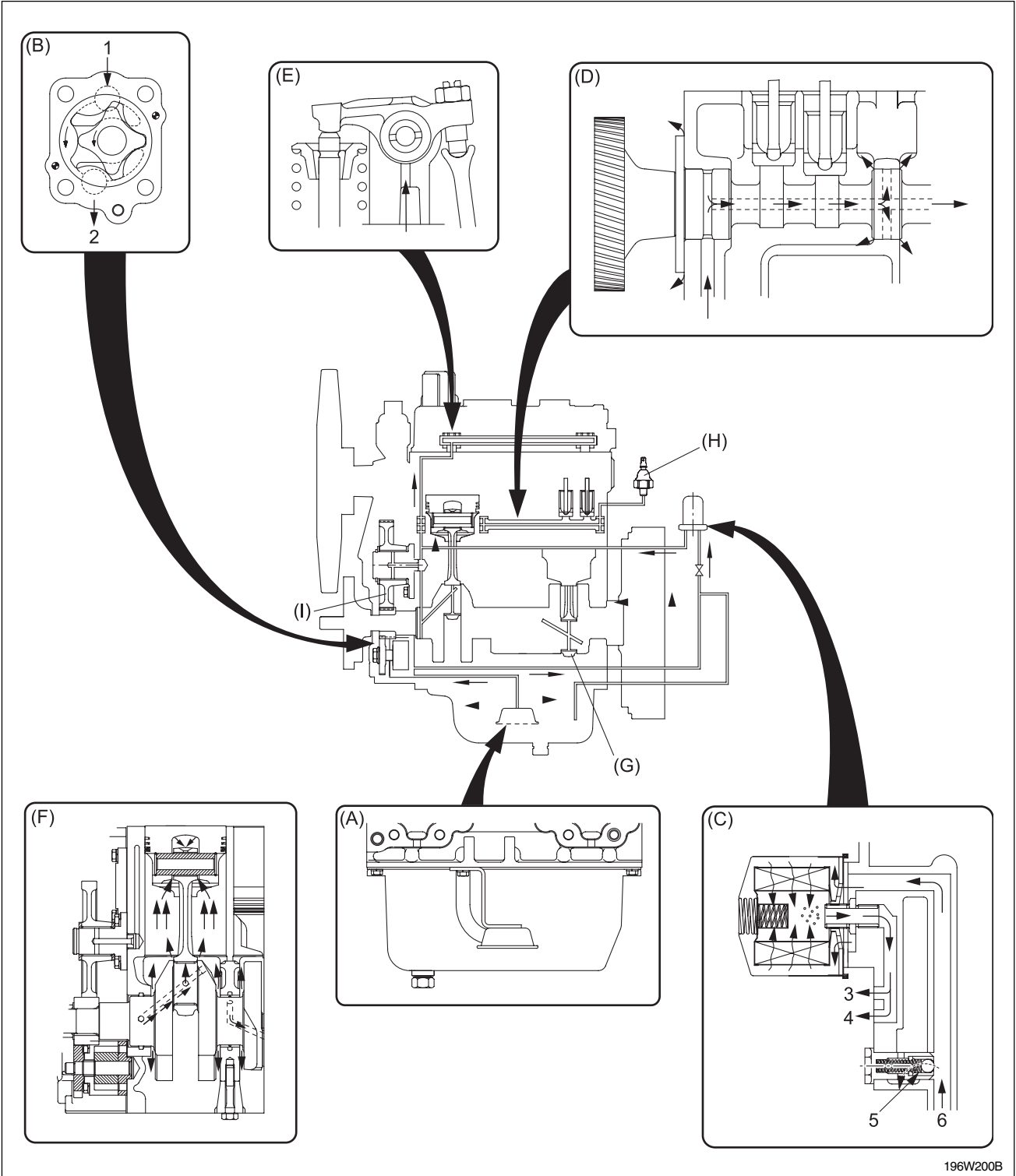
The flywheel is installed on the rear end of the crankshaft and keeps the flywheel turning at a constant speed. While the crankshaft tends to speed up during the power stroke it slows down during other strokes. The flywheel has a ring gear (1), which meshes with the drive pinion of the starter. The flywheel has marks "TC" and "FI" on its outer rim. The mark TC shows the piston's top dead center and the mark FI shows the fuel injection timing, when they are aligned with the mark of window on the clutch housing.

- Injection sequence
Three cylinders: 1 → 2 → 3



- (1) Ring gear
- (2) Flywheel
- (3) Crankshaft

3.2 LUBRICATION SYSTEM



196W200B

- A. Oil filter 1
- B. Oil pump
 - 1. Inlet hole
 - 2. Outlet hole

- C. Oil filter cartridge and relief valve
 - 3. To rocker arm shaft and camshaft
 - 4. To crankshaft
 - 5. Relief valve
 - 6. From pump

- D. Camshaft
- E. Rocker arm rocker arm shaft
- F. Piston
- G. Crankpin bearing
- H. Oil switch
- I. Idle gear

GENERAL

ENGINE

CLUTCH

TRANSMISSION

HST

REAR AXLE

BARKE

FRONT AXLE

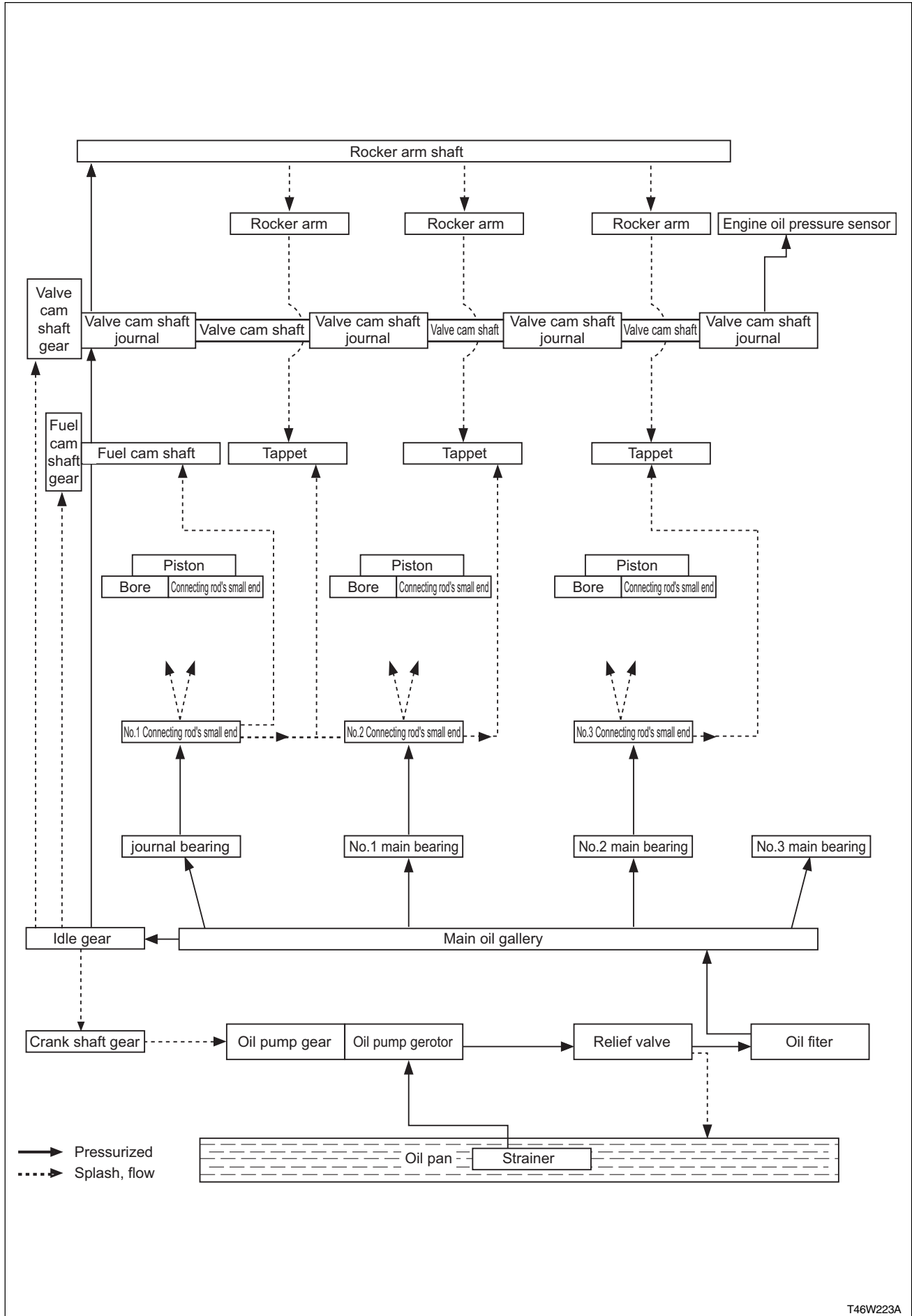
STEERING

HYDRAULIC

ELECTRIC

INDEX

3.2.1 ENGINE OIL FLOW



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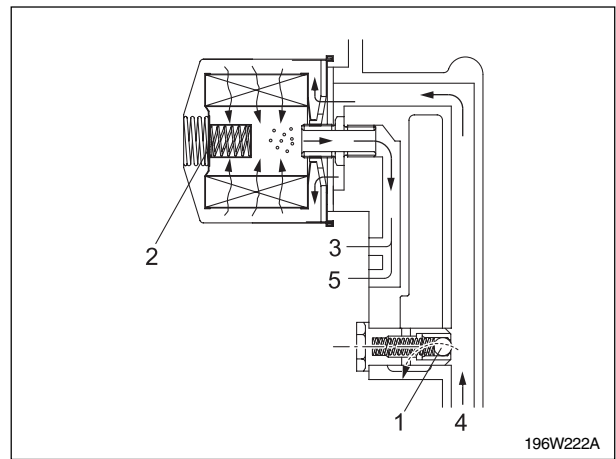
- GENERAL
- ENGINE
- CLUTCH
- TRANSMISSION
- HST
- REAR AXLE
- BARKE
- FRONT AXLE
- STEERING
- HYDRAULIC
- ELECTRIC
- INDEX

3.2.2 RELIEF VALVE

The relief valve prevents damage to the lubrication system due to high oil pressure. Control range of the relief valve is 196 to 441 Kpa (2.0 to 4.5 kgh/cm², 28 to 64 psi).

3.2.3 BY-PASS VALVE

Oil filter cartridge has a by-pass valve inside, to prevent the lack of lubrication oil in the engine, If the oil filter element is clogged the by-pass valve opens and lets the oil pass to each part of the engine without passing through the filter.



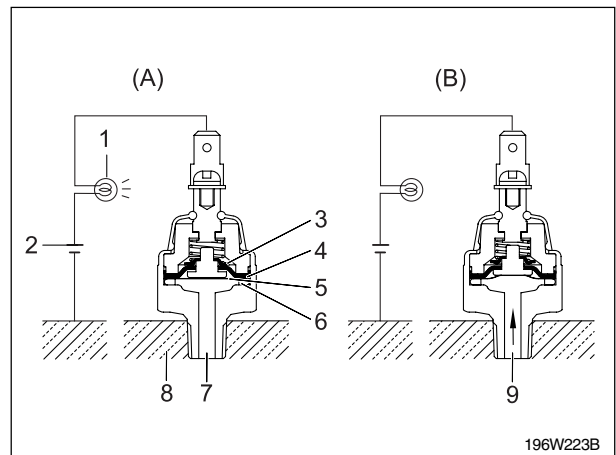
- (1) Relief valve
- (2) By-pass valve
- (3) To rocker arm shaft and camshaft
- (4) From pump
- (5) To crankshaft

3.2.4 OIL PRESSURE SWITCH

The oil pressure switch is installed on the cylinder block and leads to the oil passage of the lubricating oil.

When the oil pressure falls below the specified value, the contacts of the oil pressure switch closes to turn on the warning lamp (1).

- (A) At lower oil pressure
(49 kPa (0.5 kgf/cm², 7 psi) or less)
- (B) At proper oil pressure



- (1) Warning lamp
- (2) Battery
- (3) Rubber gasket
- (4) Contact rivet
- (5) Contact
- (6) Oil passage
- (7) Cylinder block
- (8) Oil

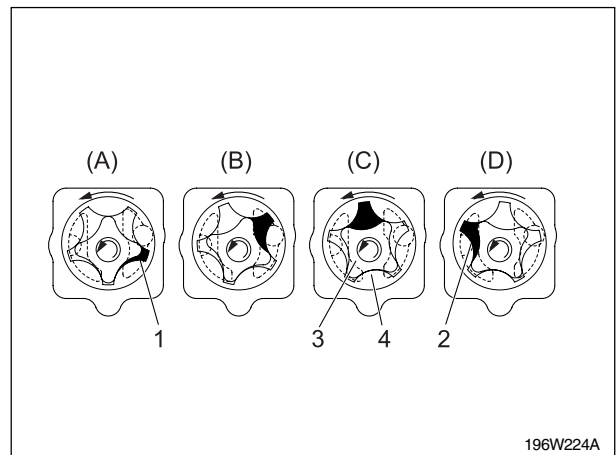
3.2.5 OIL PUMP

The oil pump is a gear pump, whose rotors have trochoid lobes. The inner rotor (3) has 4 lobes and the outer rotor (4) has 5 lobes, and they are eccentrically engaged with each other. The inner rotor, which is driven by the crankshaft in the same direction, rotates the outer rotor in the same direction, varying the space between the lobes.

While the rotors rotate from (A) to (B), the space leading to the inlet port increases, which causes the oil to flow through the inlet port.

When the rotors rotate to (C), the port to which the space leads is changed from inlet to outlet.

At (D), the space decreases and sucked oil is discharged from the outlet port.



- (1) Inlet
- (2) Outlet
- (3) Inner rotor
- (4) Out rotor

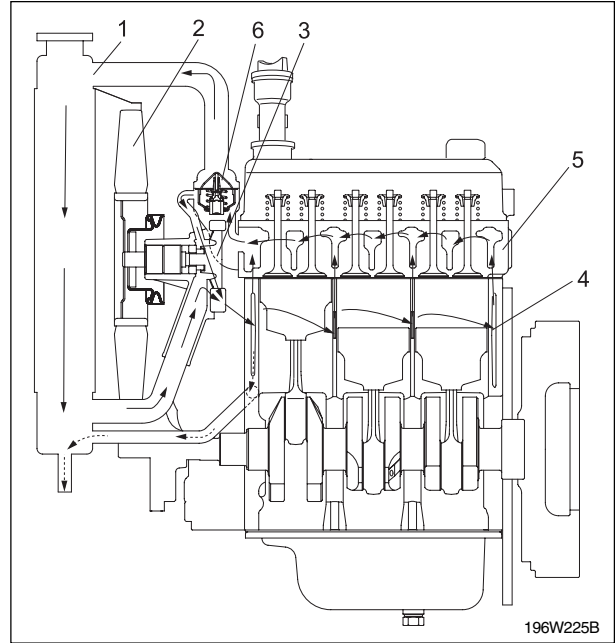
3.3 COOLING SYSTEM

The cooling system consists of a radiator, centrifugal water pump, suction fan and thermostat.

The water is cooled through the radiator core, and the fan set behind the radiator pulls cooling air through the core to improve cooling.

The pump sucks the cooled water, forces it into the cylinder block and draw out the hot water. Then the cooling is repeated. Furthermore, to control temperature of water, a thermostat is provided on the way. When the thermostat opens, the water moves directly to radiator, but when it closes, the water moves toward the water pump through the by-pass between thermostat and water pump.

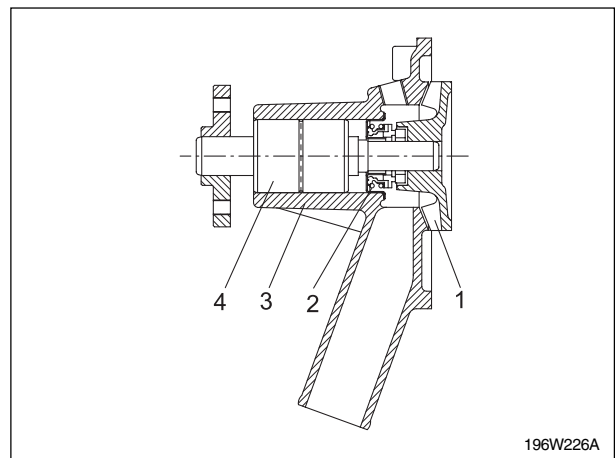
The opening temperature of thermostat is about 83°C (180°F).



- (1) Radiator
- (2) Suction fan
- (3) Water pump
- (4) Cylinder block
- (5) Cylinder head
- (6) Thermostat

3.3.1 WATER PUMP

35 ℓ/min. (7.7 Imp.gals/min, 9.2 U.S gals/min) of water is forced into the crankcase and cylinder head to cool them. The impeller, of backward type, is bent as far as possible from the center, in the opposite direction to rotation; the bearing unit prevents cooling water from entering by a special mechanical seal.



- (1) Water pump impeller
- (2) Mechanical seal
- (3) Water pump body
- (4) Bearing unit

3.3.2 THERMOSTAT

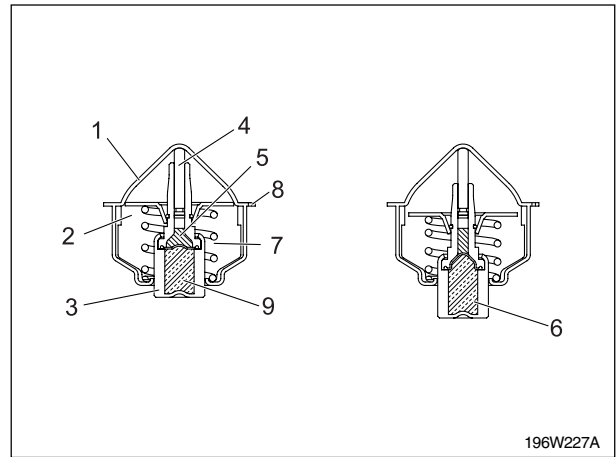
The thermostat is wax pellet type, which controls the flow of the cooling water to the radiator to keep the proper temperature. The case has a seat (1) and the pellet has a valve (2). The spindle attached to the case is inserted into the synthetic rubber in the pellet. The pellet is charged with wax.

(A) At low temperature (lower than 71°C (160°F))

The valve (2) is seated by the spring (7) and the cooling water circulates in the engine through the water return pipe but does not engine the radiator.

(B) At high temperature (higher then 71°C (160°F))

As the water temperature rises, the wax in the pellet (3) melts expands, repelling the spindle. The pellet lowers and the valve (2) opens to send the cooling water to the radiator.

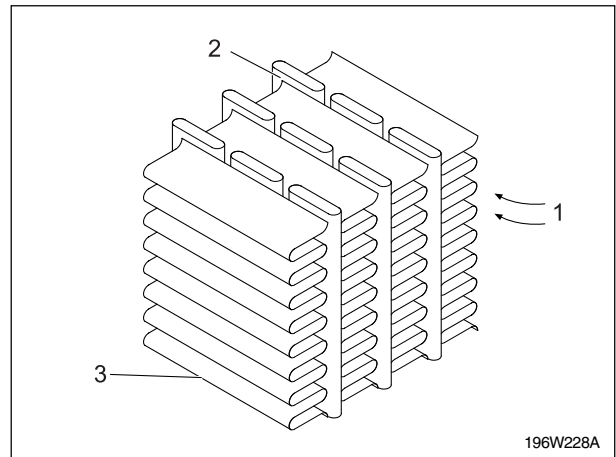


- (1) Seat
- (2) Valve
- (3) Pellet
- (4) Spindle
- (5) Synthetic rubber
- (6) Wax (solid)
- (7) Spring
- (8) Leak hole
- (9) Wax (liquid)

3.3.3 RADIATOR

The radiator core consists of water carrying tubes (2) with fins (3) at a right angle to it.

The air flowing through between the tube wall and the fin cools the water in the radiator.



- (1) Cooling air
- (2) Tube
- (3) Fin

3.3.4 RADIATOR CAP

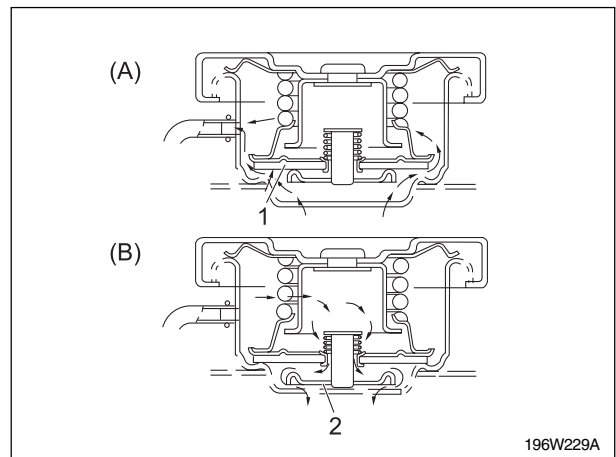
The pressure type cap is installed on the radiator, which prevents the pressure difference between the inside and the outside of the radiator from deforming the radiator.

(A) At high pressure (higher than 88 kPa (0.9 kgf/cm², 13 psi))

When the water temperature rises and the pressure in the radiator increase above the specified pressure, the pressure valve (1) opens to reduce the internal pressure.

(B) At low pressure

When the water temperature falls and a vacuum is formed in the radiator, the vacuum valve (2) opens to allow the air to enter the radiator.

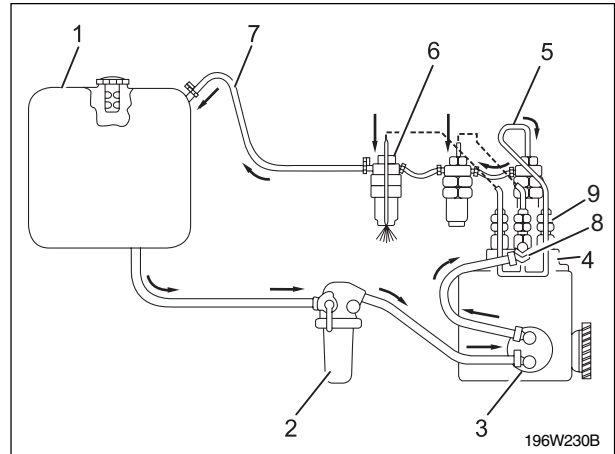


- (1) Pressure valve
- (2) Vacuum valve

3.4 FUEL SYSTEM

3.4.1 FLOW OF FUEL

The fuel is feed from the fuel tank (1) through the fuel filter (2) to the injection pump (4) by the fuel feed pump (3). The injection pump force-feeds the fuel through the injection nozzles (6), which inject the fuel into the cylinders for combustion. Any excessive fuel from the injection pump to the injection nozzles is collected in the fuel overflow pipes (7) and returns to the fuel tank.

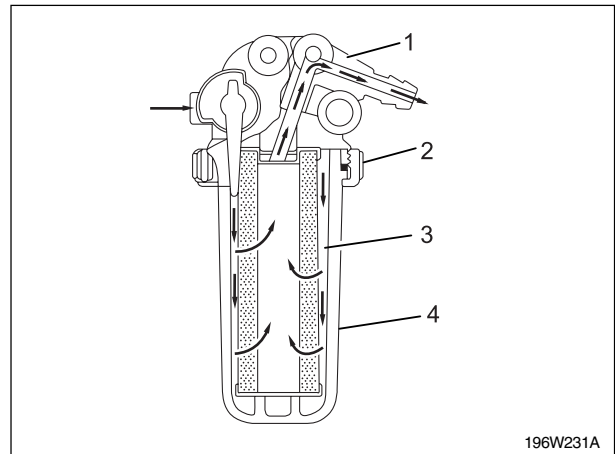


- (1) Fuel tank
- (2) Fuel filter
- (3) Fuel feed pump
- (4) Injection pump
- (5) Injection pipe
- (6) Injection nozzle
- (7) Fuel overflow pipe
- (8) Air bleed bolt
- (9) Nozzle holder nut

3.4.2 FUEL FILTER

A fuel filter is used to prevent dirty fuel from reaching the injection pump and injection nozzles. The filter element will require occasional replacement to maintain an adequate flow. This flow will vary according to the cleanliness of available fuel and the care used in storage.

The fuel filter between the tank and pump to eliminate foreign matter and protect injection pump and nozzles filters fuel pumped by the fuel pump from the fuel tank. When fuel enters the filter, it passes through the filter element's circumference toward the center for filtering. The maximum filtrated granular size of this element is 48 μm (0.048 mm, 0.0019 in.) and general size is from 10 to 20 μm (0.01 to 0.02 mm, 0.0004 to 0.0008 in.).



- (1) Cock body
- (2) Retainer ring
- (3) Element
- (4) Filter cup

3.4.3 AIR BLEED BOLT

1. Check the fuel level in the fuel tank and fill the tank with fuel if necessary.
2. Check the fuel level in the fuel filter is 2/3 or higher. If not, loosen the air bleed bolt (8) and crank the engine to bleed the system.
3. When air stops bleeding, tighten the air bleed bolt and crank the engine.
4. If the engine still fails to start, loosen the nozzle holder nut (9) or injection nozzle nut (6) and crank the engine to bleed the system.
5. Tighten the loosened nut and start the engine.

3.4.4 FUEL FEED PUMP

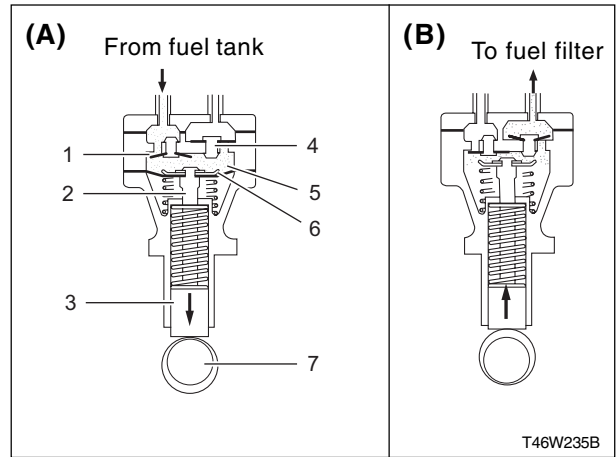
The diaphragm (6) is linked to the tappet (3) with the push rod (2). The tappet is reciprocated by the eccentric cam on the fuel camshaft (7).

A. INTAKE STROKE

When the diaphragm is pulled down by the spring, it builds a vacuum in the chamber (5) causing the exhaust valve (4) to close and the atmospheric pressure in the fuel tank to force the fuel into the chamber, opening the intake valve (1).

B. SCAVENGING STROKE

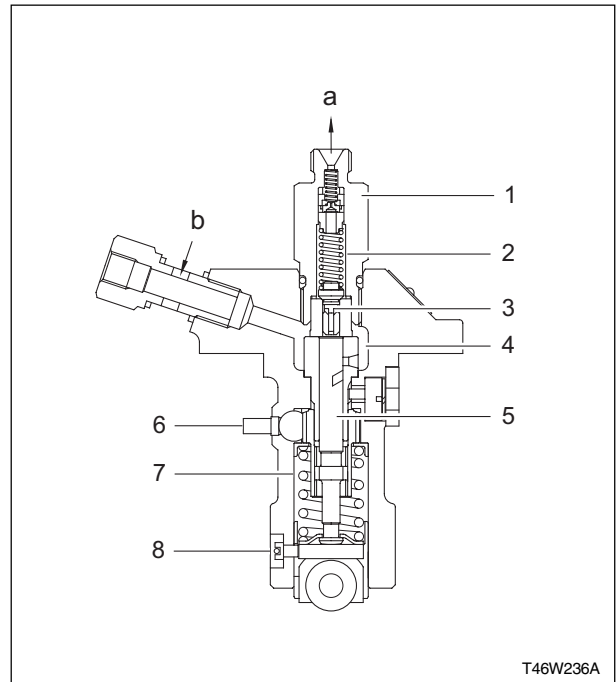
When the diaphragm is pushed up by the cam, the pressure in the chamber causes the intake valve to close and forces out the fuel, opening the exhaust valve.



- (1) Intake valve
- (2) Push rod
- (3) Tappet
- (4) Exhaust valve
- (5) Chamber
- (6) Diaphragm
- (7) Fuel camshaft

3.4.5 FUEL INJECTION PUMP

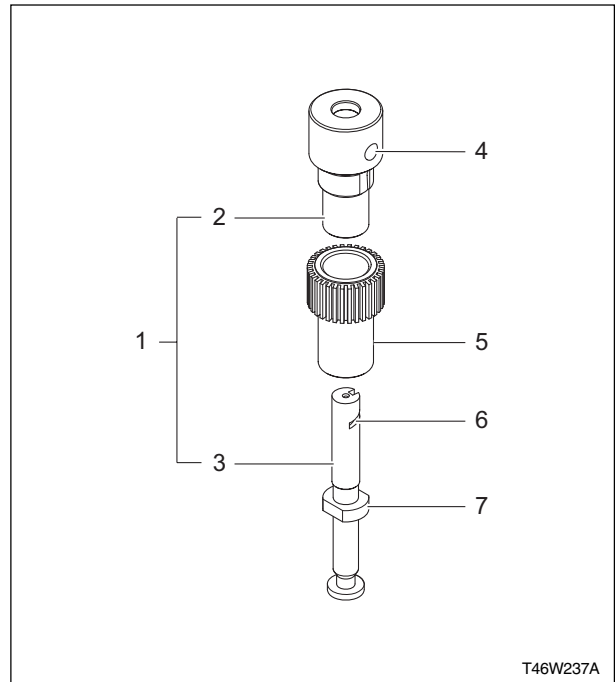
This fuel injection pump is Bosch K type fuel injection pump. It features a compact and light weight design.



- (a) To injection nozzle
- (b) From fuel filter
- (1) Delivery valve holder
- (2) Delivery valve spring
- (3) Delivery valve
- (4) Cylinder
- (5) Plunger
- (6) Control rack
- (7) Plunger spring
- (8) Tappet

A. PUMP ELEMENT

The pump element (1) consists of a plunger (3) and cylinder (2) which their sliding surfaces are finely machined to maintain the fuel tightness. The plunger (3) is installed in the control sleeve (5) and the sleeve is engaged with the control rack that rotates the plunger in the cylinder to control the amount of fuel delivered.



- (1) Pump element
- (2) Cylinder
- (3) Plunger
- (4) Feed hole
- (5) Control sleeve
- (6) Control groove
- (7) Sliding surface

B. OPERATION OF PUMP ELEMENT

a. Before delivery

As the plunger (2) lowers, fuel is drawn into the delivery chamber (1) through the feed hole (4) from the fuel chamber (5).

b. Beginning of delivery

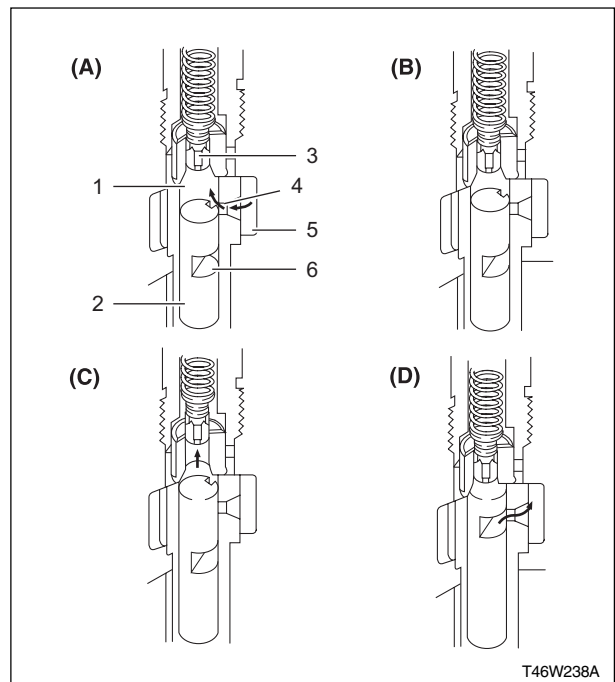
When the plunger is pushed up by the cam and the head of the plunger closes the feed hole (4), the pressure in the delivery chamber (1) rises to push the delivery valve (3) open.

c. Delivery

While the plunger (2) is rising, delivery of fuel continues.

d. End of delivery

When the plunger rises further and the control groove (6) on its periphery meets the feed hole, the injection stops because the pressure in the delivery chamber (1) is reduced to the opening pressure.

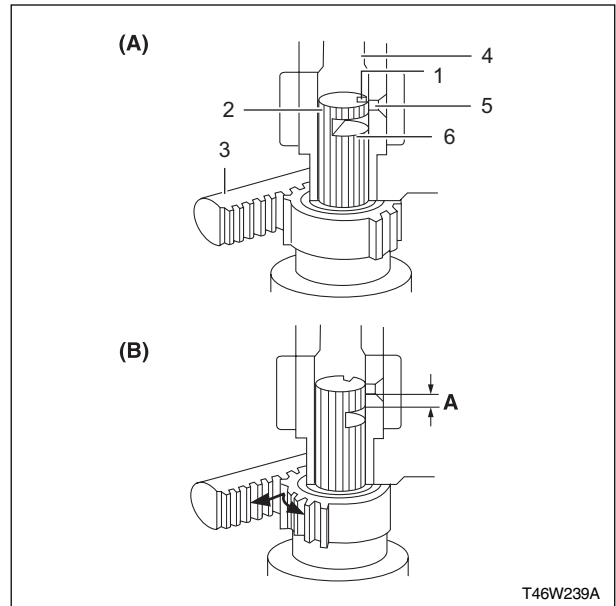


- (1) Delivery chamber
- (2) Plunger
- (3) Delivery valve
- (4) Feed hole
- (5) Fuel chamber
- (6) Control

C. AMOUNT OF FUEL DELIVERY

a. No fuel delivery

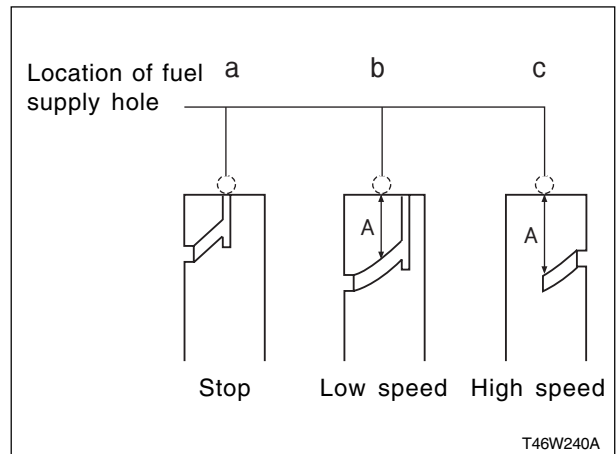
When the control rack (3) is at the engine stop position, the lengthwise slot (1) on the plunger (2) aligns with the feed hole (5). The pressure in the delivery chamber (4) does not build up and no fuel is forced to the injection nozzle since the delivery chamber (4) is opened to the feed hole during the entire stroke of the plunger.



- (1) Slot
- (2) Plunger
- (3) Control rack
- (4) Delivery chamber
- (5) Feed hole
- (6) Control groove

b. Fuel delivery

The plunger is rotated by the control rack and the feed hole is not aligned with the lengthwise slot. When the plunger is pushed up, the feed hole is closed by the plunger. The pressure in the delivery chamber builds up and forces the fuel to the injection nozzle until the control groove (6) meets the feed hole. The amount of the fuel to be forced into the nozzle corresponds to distance A. In the above figure, the amount of injected fuel in (c) is larger than the amount of injected fuel in (b).

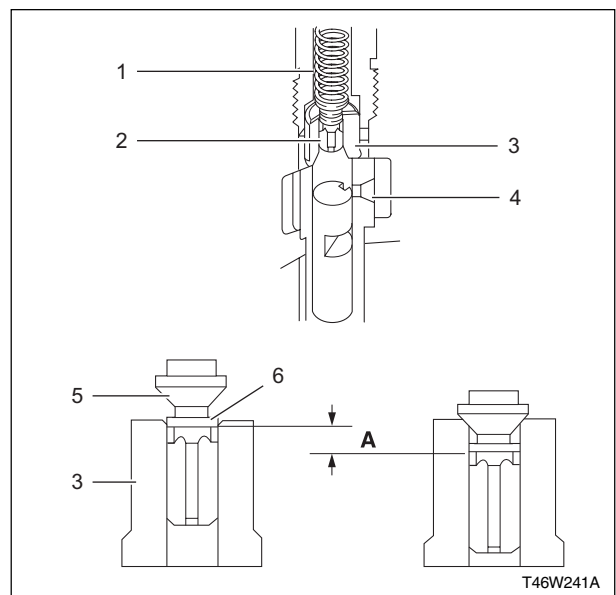


D. DELIVERY VALVE

The delivery valve (2) prevents the fuel in the injection pipe from flowing back into the delivery chamber and the fuel in the injection nozzle from dribbling after injection.

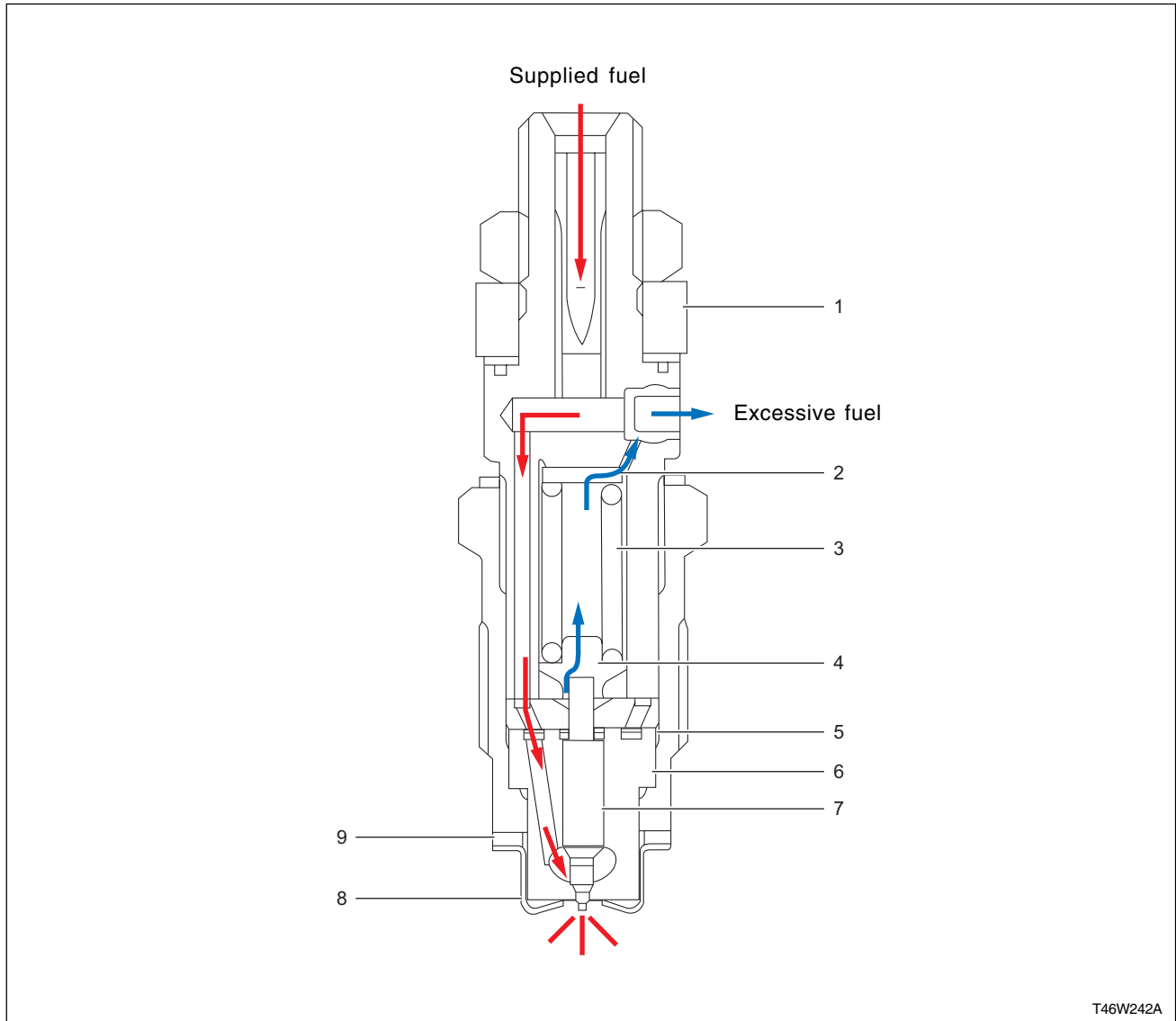
The relief plunger (6) sucks the fuel back from the injection pipe to prevent the leakage dribbling and unnecessary subsequent injection after the major injection.

The stroke of A corresponds to the amount of fuel sucked back (35 mm³).



- (1) Valve spring
- (2) Delivery valve
- (3) Valve seal
- (4) Fuel chamber
- (5) Valve face
- (6) Relief plunger

E. INJECTION NOZZLE



T46W242A

- | | | |
|----------------------------|-----------------|------------------|
| (1) Nozzle holder assembly | (4) Push rod | (7) Needle valve |
| (2) Adjusting washer | (5) Lock nut | (8) Heat seal |
| (3) Nozzle spring | (6) Nozzle body | (9) Packing |

This injection nozzle is throttle type nozzle. It features the low fuel consumption and works well with DAEDONG combustion chamber. The nozzle valve opening pressure is about 14.7 MPa (150 kgf/cm², 2134 psi). When the pressure overcomes the counterforce of nozzle valve spring (3), the pressure pushes up the needle valve (7) constantly and then the proper amount of fuel is injected into the swirling air inside the combustion chamber for combustion.

The opening pressure can be adjusted by adding or reducing the washer (2). A washer of 0.1 mm corresponds to 980 kPa (10 kgf/cm², 142 psi) change in opening pressure. The heat seal (8) is adopted to improve the durability and reliability of the nozzle.

GENERAL

ENGINE

CLUTCH

TRANSMISSION

HST

REAR AXLE

BARKE

FRONT AXLE

STEERING

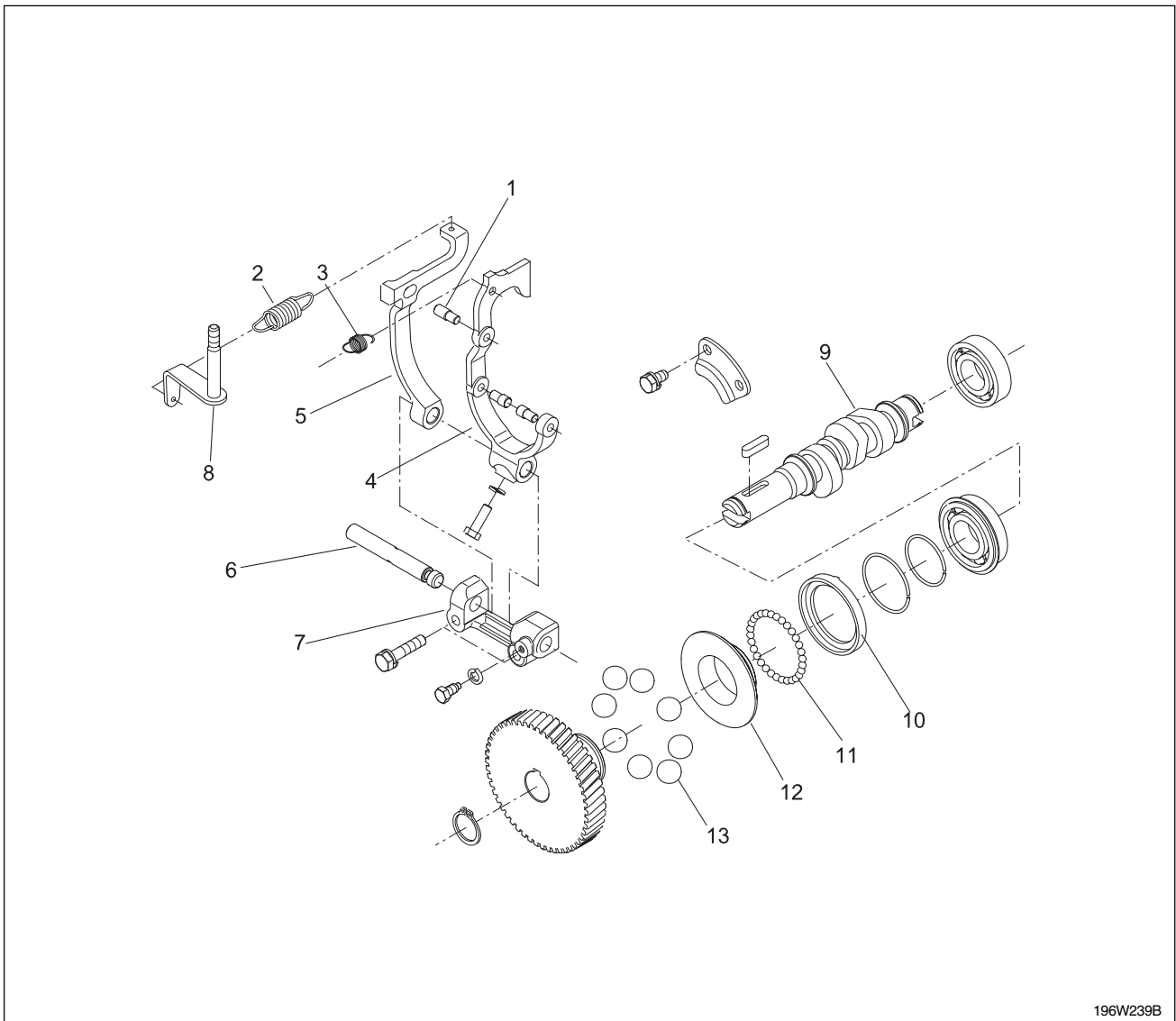
HYDRAULIC

ELECTRIC

INDEX

3.5 GOVERNOR SYSTEM

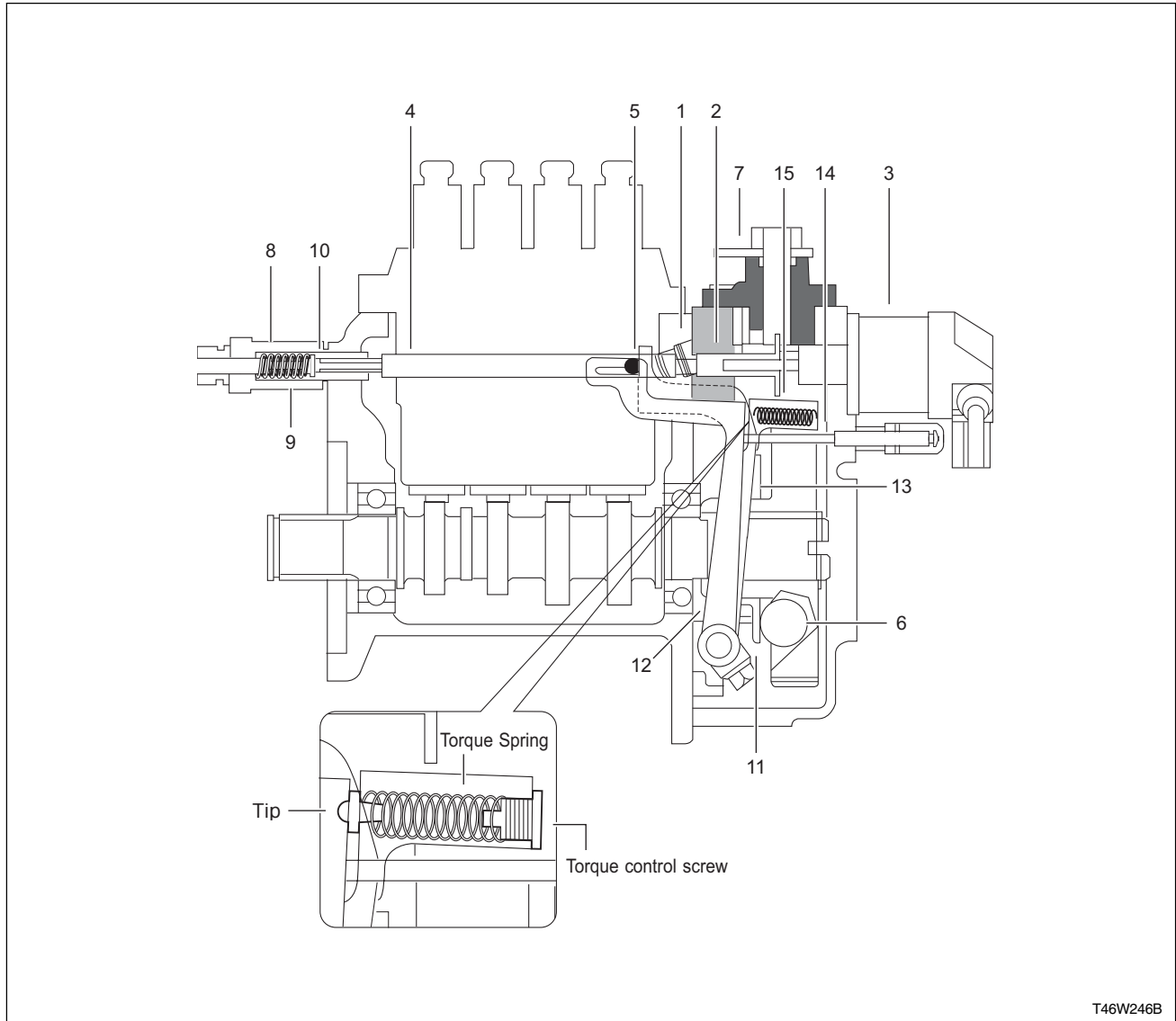
3.5.1 DISASSEMBLED VIEW



- | | | |
|-----------------------|-----------------------------|----------------------|
| (1) Start spring | (6) Fork lever shaft | (11) Steel ball |
| (2) Governor spring 1 | (7) Fork lever holder | (12) Governor sleeve |
| (3) Governor spring 2 | (8) Governor lever | (13) Steel ball |
| (4) Fork lever 1 | (9) Fuel injection camshaft | (14) Fork lever pin |
| (5) Fork lever 2 | (10) Governor ball case | |

The governor keeps the engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load. The engine employs an all-speed governor, which controls centrifugal force of the steel ball (13) weight, produced by rotation of the fuel camshaft (9), and tension of the governor spring 1 (2) and 2 (3) are balanced.

3.5.2 BASIC PRINCIPLE OF GOVERNOR SYSTEM



T46W246B

- | | | |
|--------------------------|--------------------|----------------------|
| (1) Governor spring 1, 2 | (6) Steel ball | (11) Governor sleeve |
| (2) Solenoid guide | (7) Governor lever | (12) Fork lever 2 |
| (3) Stop solenoid | (8) Idle spring | (13) Fork lever 1 |
| (4) Pump rack | (9) Start spring | (14) Fuel limit bolt |
| (5) Rack pin | (10) Idle shaft | (15) Torque spring |

As shown in the above figure, the steel ball (6) in the fuel camshaft gear is supported by the governor sleeve (11) to prevent from coming out. The sleeve pushes the fork lever 1 (13) to transfer the power to the fuel injection pump pin (5).

GENERAL
ENGINE
CLUTCH
TRANSMISSION
HST
REAR AXLE
BARKE
FRONT AXLE
STEERING
HYDRAULIC
ELECTRIC
INDEX

3.5.3 OPERATION OF GOVERNOR

A. WHEN STOPPED

The fuel is blocked since the solenoid (3) pushes the speed control rack (4) to the left.

B. WHEN TURNING THE KEY SWITCH ON

When the electromagnet in the stop solenoid operates and the pin is retracted, the speed rack (4) of the fuel injection pump is pushed to the right by the start spring (9) and the start shaft (10) to supply the sufficient amount of fuel to start the engine.

C. WHEN STARTING THE ENGINE AND RUNNING THE ENGINE AT LOW IDLE SPEED

When the engine is started, the steel ball (6) pushes the sleeve (11) to the left as the centrifugal force of the steel ball increases. Therefore, the governor fork lever 1 (13) pushes the speed rack (4) of the pump to the left to reduce the amount of fuel supplied.

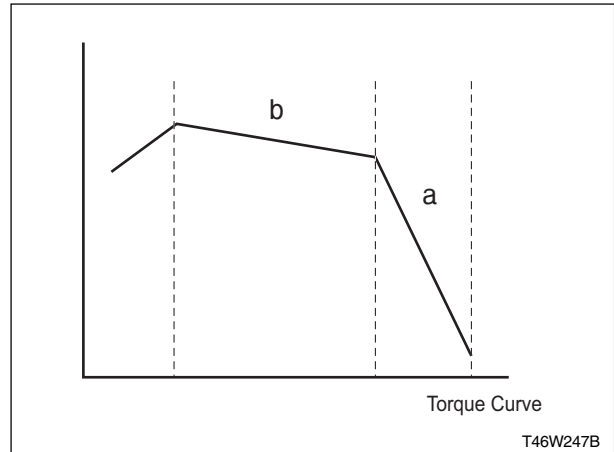
As the speed rack is stopped by the idle spring (8), it keeps the balance with the centrifugal force of the steel ball so that at least minimum amount of fuel is delivered for stable engine running at idle speed.

D. ACCELERATION AND DECELERATION

When depressing the accelerator pedal, the governor spring (1) pulls the fork lever 2 (12) to the right and then pushes the fork lever 1 (13) to the right. The fork lever (13) is stopped by the sleeve (11).

When the centrifugal force of the steel ball (6) that is proportional to the engine speed is balanced with the tension of the governor spring (1) that is determined by the driver, the stable speed is maintained.

E. LOAD INCREASE AT HIGH SPEED



When a load is applied to the engine running at a high speed, the centrifugal force of steel ball (6) decreases as the engine speed drops. Also, the fork lever 2 (12) is pulled to the right by the governor spring until it contacts the fuel limit bolt (14). Until then, the amount of injected fuel per one stroke of the injector plunger and the torque increase.

This range (a) is between the max. speed point with no load and the max. power point of the torque curve.

When the fork lever 2 is blocked by the fuel limit bolt (14) and does not move any more and the load is increased, the centrifugal force of steel ball drops further and the torque spring (15) compressed between the fork lever 1 and 2 is loosened. Then, the fork lever 2 moves to the right until the torque spring is free, and the amount of fuel supplied and the torque increase simultaneously.

This range (b) is between the max. power and the max. torque point in the torque curve.



IMPORTANT

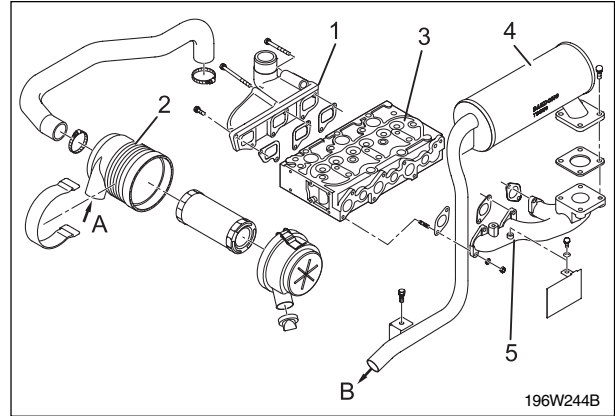
- **The fuel limit bolt (14), idle spring (9) and max. rpm setting bolt are set at factory. Unauthorized adjustment of such components can negatively effect the performance of the engine. Therefore, never adjust them without permission from DAEDONG. Such action violates the EPA regulation and also can void the warranty.**

F. WHEN STOPPED

When the key switch is moved to the "OFF" position, the stop solenoid power is cut off to release the electromagnet. Therefore, the stop pin comes off by the return force of the spring and pushes the solenoid guide (2) and fuel injection pump rack to the stop position to stop the engine.

3.6 INTAKE AND EXHAUST SYSTEM

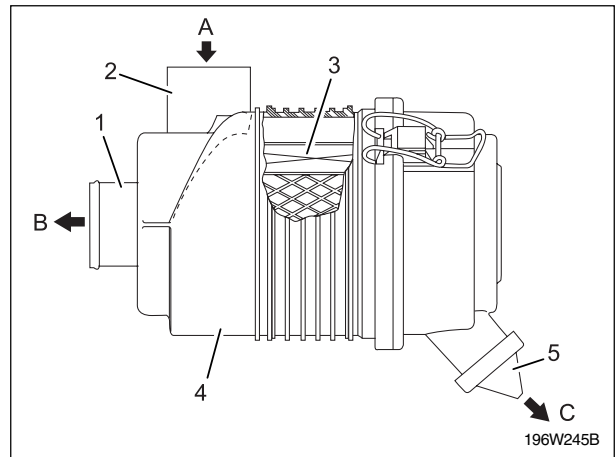
3.6.1 FLOW OF INTAKE AIR AND EXHAUST GAS



- (A) Inlet air
- (B) Exhaust gas
- (1) Inlet manifold
- (2) Air cleaner
- (3) Cylinder head
- (4) Muffler
- (5) Exhaust manifold

3.6.2 AIR CLEANER

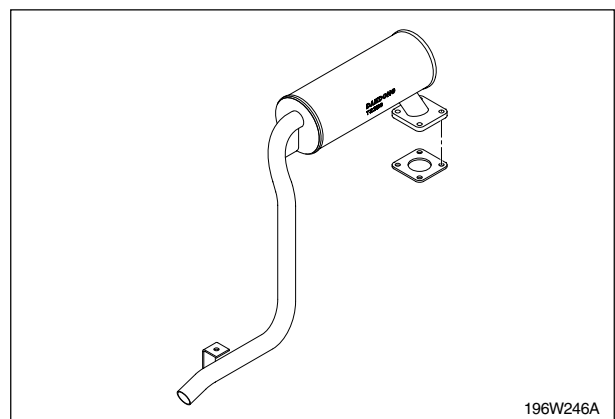
The air cleaner is dry-cyclone type and easy to maintain. The air from the inlet port (2) circulated along the fin (3) and around the air cleaner element (4) and the heavier dust is carried to the evacuator (6), where the dusts exhaust port. The fine dust in the air is filtered with the air cleaner element (4), and the filtered air flows to the outlet port (1).



- (A) Inlet air
- (B) To inlet manifold
- (C) Heavier dust
- (1) Outlet port
- (2) Inlet port
- (3) Air cleaner element
- (4) Body
- (5) Evacuator

3.6.3 MUFFLER

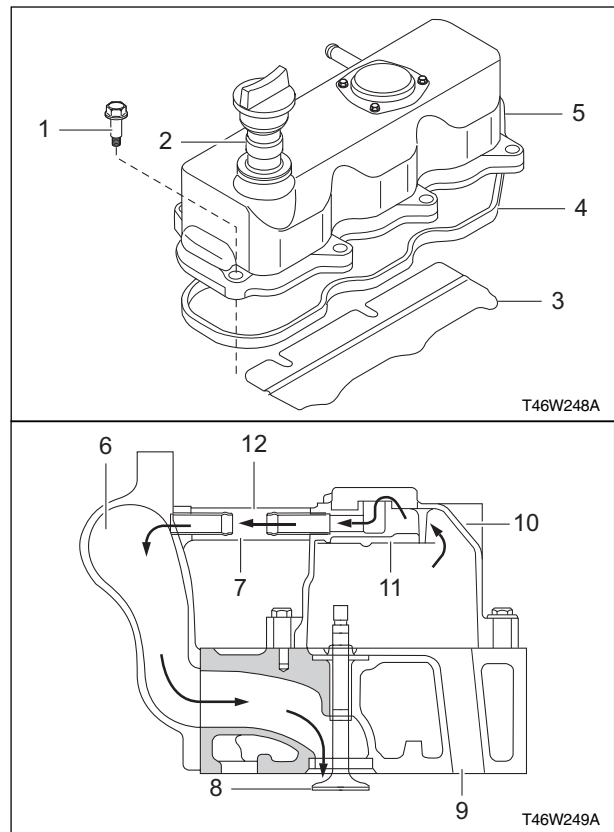
The exhaust noises are absorbed and dumped, while the gas pass through a series of holes on the inner tube and fiberglass wool of muffler.



3.6.4 PCV VALVE

A. PCV (POSITIVE CRANKCASES VENTILATION)

The PCV system is a system that prevents air pollution by returning the blow-by gas to the intake manifold through the bleeding pipe of the cylinder head cover for recirculation of the gas. (However, the turbo charged engine has the open crankcase type that discharges the blow-by gas to the air.)



- | | |
|-------------------------|-------------------------------|
| (1) Head cover bolt | (7) Bleeding pipe |
| (2) Oil filler flange | (8) Intake valve |
| (3) Oil baffle plate | (9) Cylinder head |
| (4) Head cover gasket | (10) Cylinder head cover |
| (5) Cylinder head cover | (11) Oil baffle plate |
| (6) Intake manifold | (12) Bleeding pipe connection |

GENERAL

ENGINE

CLUTCH

TRANSMISSION

HST

REAR AXLE

BARKE

FRONT AXLE

STEERING

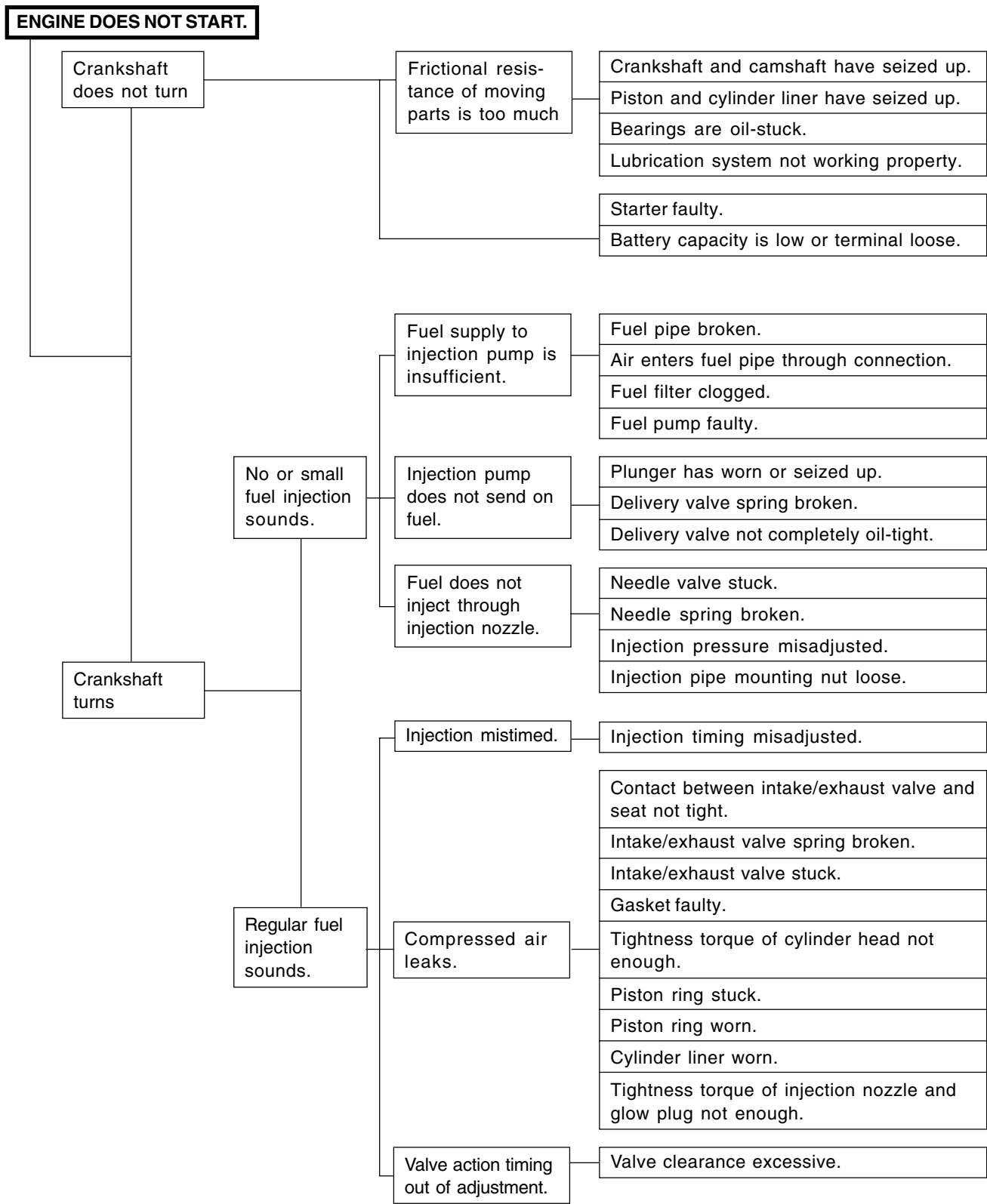
HYDRAULIC

ELECTRIC

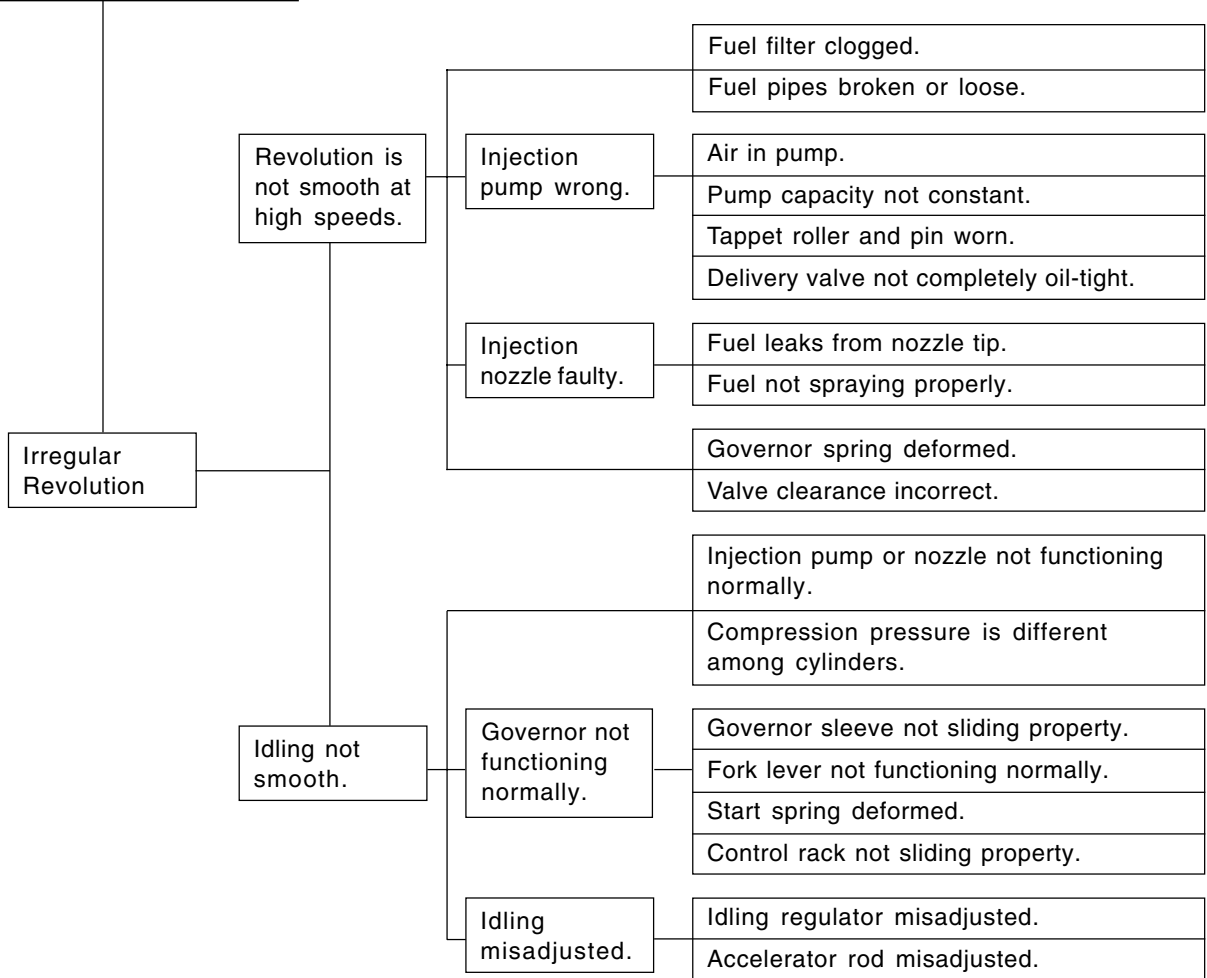
INDEX

4. TROUBLESHOOTING

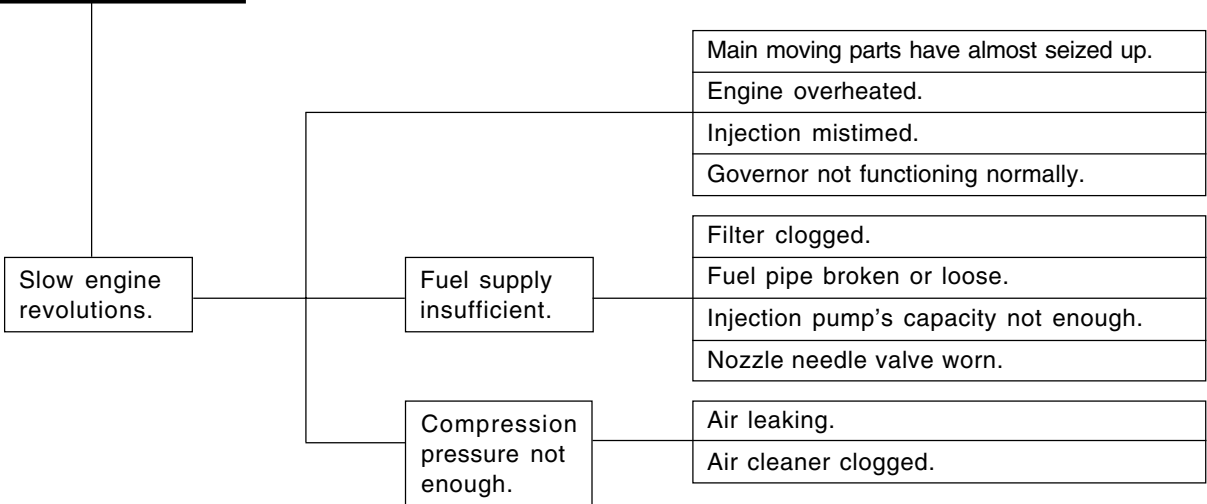
- GENERAL
- ENGINE**
- CLUTCH
- TRANSMISSION
- HST
- REAR AXLE
- BARKE
- FRONT AXLE
- STEERING
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- INDEX



Engine does not turn normally.



Engine output insufficient.



GENERAL

ENGINE

CLUTCH

TRANSMISSION

HST

REAR AXLE

BARKE

FRONT AXLE

STEERING

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Color of exhaust fumes not normal.

White or blue smoke.

Lubricant rises through piston gap.

- Piston ring stuck.
- Piston ring worn.
- Excessive gap between cylinder liner and piston.
- Too much oil.
- Injection delayed.
- Compression pressure insufficient.

Black or dark gray smoke.

Injection mistimed.

- Injection too early.
- Injection delayed.

Fuel pump's injecting capacity varies.

- Plunger does not return completely because spring is stuck or broken.
- Plunger worn.

Nozzle does not inject fuel properly.

- Needle valve stuck.
- Nozzle spring broken.
- Too much carbon sticks to nozzle tip.
- Injection pressure too low.

- Compressed air leaks.
- Not enough air.

Excessive lubricant consumption.

- Excessive gap between piston and liner.
- Piston ring stuck.
- Piston ring worn.
- Excessive gap between intake/exhaust valve and valve stem.
- Valve stem seal broken.
- Oil leaks from defective seals.

Lubricant increasing.

Fuel mixed with oil.

- Injection pump plunger leaking.
- Fuel pump leaking.

Water mixed with oil.

- Head gasket seal faulty.
- Crankcase cracked.

Gear oil mixed with oil.

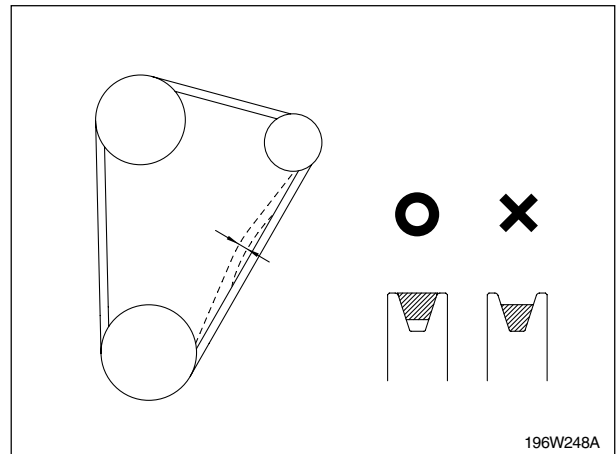
- Hydraulic pump's oil seal broken.

5. MEASUREMENT AND ADJUSTMENT

5.1 FAN BELT

1. Measure the deflection, depressing the belt half-way between the fan drive pulley and the alternator pulley at 78.5 N (8 kgf, 17.6 lbs) of force.
2. If the deflection is not between the factory specifications, loosen the bolts and nuts, and relocate the alternator to adjust.
3. Replace the belt if damaged or worn

Item	Factory spec.
Belt tension (deflection)	8 mm(0.32 in.) at 78.5 N (8 kgf, 17.6 lbs) of force



5.2 COMPRESSION PRESSURE

1. Run the engine until warm.
2. Stop the engine and remove the air cleaner, the muffler and all nozzle holders.
3. Set a compression tester to the adaptor installed in the nozzle holder hole and fixed with the locating screw.
4. Pull the stop lever to cut the fuel and run the engine with the starter at 200 to 300 rpm for 5 to 10 seconds. Measure the maximum pressure while running, several times.
 - For the test, use a fully charged battery and the specified valve clearance.
 - If the pressure does not reach the allowable limit, apply a small amount of oil to the cylinder wall through the nozzle holder hole and measure the pressure again.

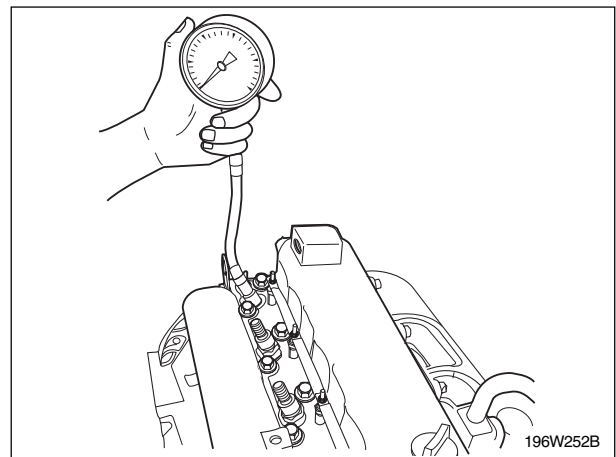
► JUDGMENT

- If the pressure raises after applying oil, check the cylinder wall and piston rings.
- If the pressure still low, check the top clearance, valve clearance and cylinder head.
- If the compression differs more than 10% among the cylinders, trace the cause of pressure variation and take corrective measures.

Item	Factory spec.	Allowable limit
Compression pressure	2.8 ~ 3.2 Mpa 29 ~ 33 kgf/cm ² 412 ~ 269 psi.	2.32 Mpa 23.7 kgf/cm ² 337 psi.
Difference between two cylinders	-	10 %

NOTE:

- Check the compression pressure with the specified valve clearance for proper air intake.

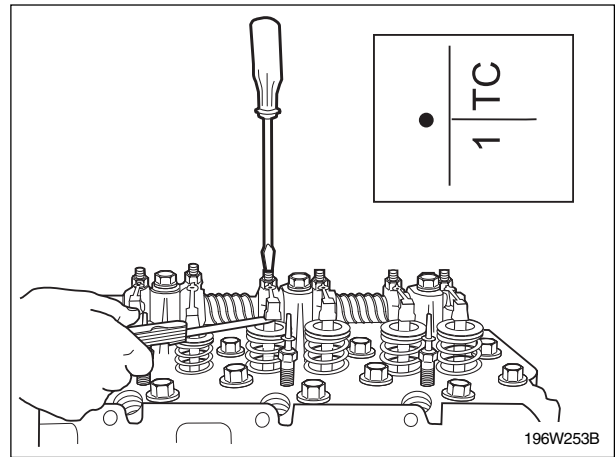


5.3 VALVE CLEARANCE

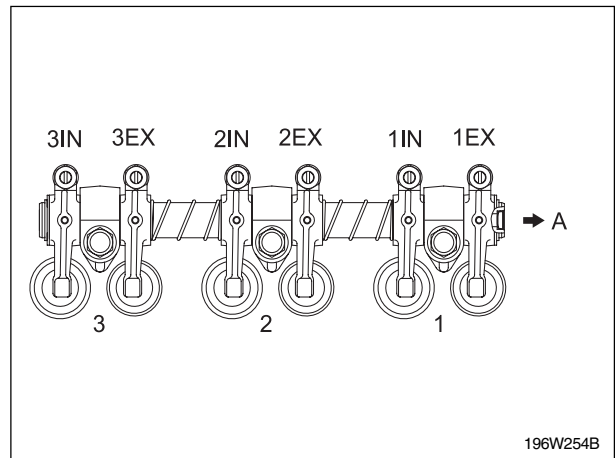
1. Remove the cylinder head cover and the timing window cover on the flywheel housing and all glow plugs.
2. Turn the flywheel and align the 1TC to mark with the timing mark of window on the flywheel housing to position the 1st cylinder valves at the top dead center during compression.
3. Measure the clearance at the valves marked with ○ in the table below with a feeler gauge.
4. If the clearance is not within the factory specifications, turn the adjusting screw to adjust.
5. Turn the flywheel just one turn to position the 1st cylinder valves at the top dead center during overlap.
6. Measure the clearance at the valves marked with ● in the table below with a feeler gauge.
7. If the clearance is not within the factory specifications, adjust.

Item	Factory spec.
Valve clearance	0.15 mm 0.006 in.

Cylinder No.	1	2	3
Valve	IN. EX.	IN. EX.	IN. EX.
Checking	○ ○	● ○	○ ●



(A) Gear case

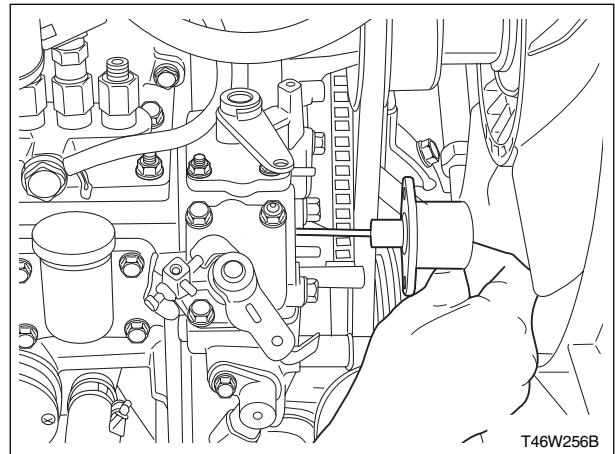


5.4 INJECTION TIMING MEASUREMENT AND ADJUSTMENT

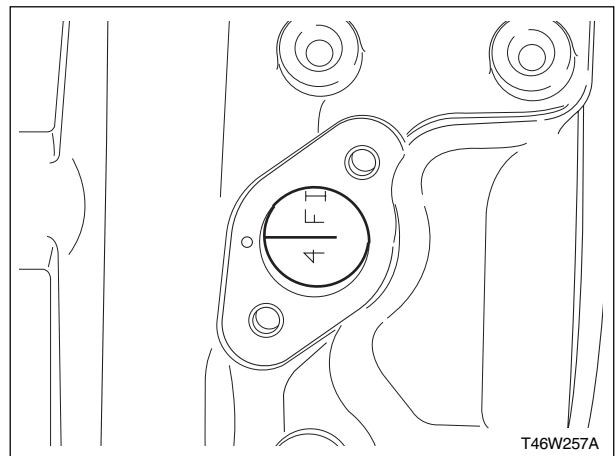
NOTE:

- Perform the work with the engine installed in the tractor.

1. Remove the engine stop solenoid.



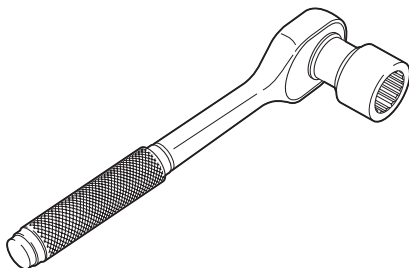
2. Remove the timing check window cover of the clutch housing.
3. Turn the flywheel to find "1, 4 FI" mark for 4-cylinder engine or 1 FI mark for 3-cylinder engine on the flywheel.
4. When the mark is found, turn the crankshaft counterclockwise approx. 30° (when looking at the front of the engine).
- "1, 4 FI" means the injection timing of the No. 1 or 4 cylinders.



- When turning the crankshaft, use a socket for turning the crankshaft.

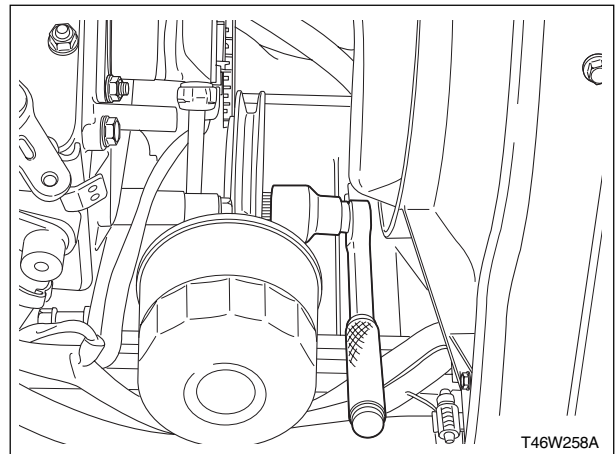
NOTE:

- How to use the crankshaft turning socket

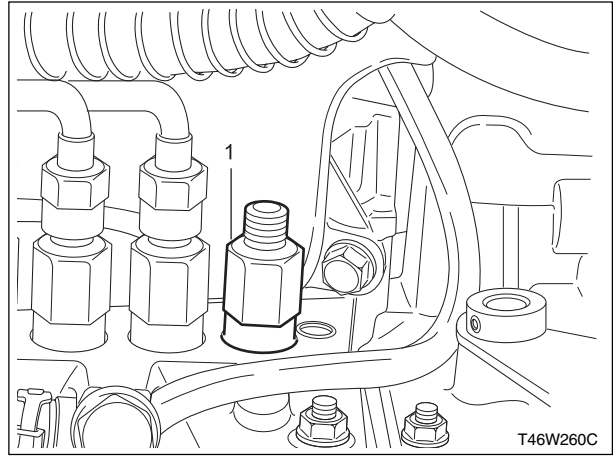


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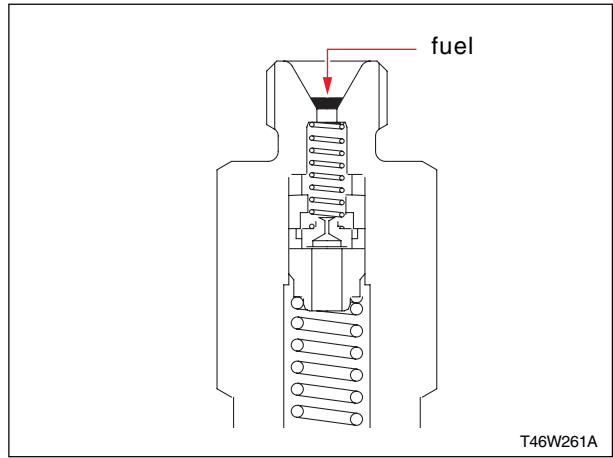
You can use DAEDONG special tool kit (part No.: G0611-B0010) for spline socket.



4. Remove the No. 1 high pressure pipe.
5. Unscrew the nozzle holder (1) slightly and tighten it when it is filled with fuel.



6. Remove the fuel in the nozzle holder with clean cloth and leave only small amount of fuel.
7. Observe the fuel of the nozzle holder while turning the crankshaft clockwise (when looking at the front of the engine) slowly.
8. When the amount of the fuel in the nozzle holder increases abruptly, that moment is the injection timing.
 - If the fuel increases too much, it means that the injection timing is passed already. Repeat the above process to identify the moment when the amount of fuel starts to increase.
 - If the fuel does not increase, it means that it is the exhaust cycle. Therefore, turn the crankshaft 360° to find the compression cycle and repeat the above procedures.

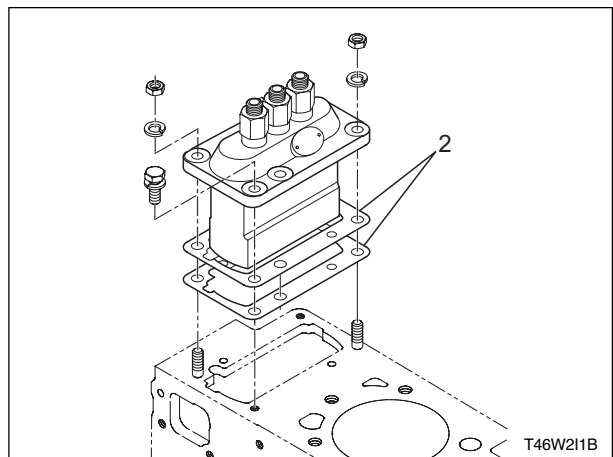


9. Mark the measured injection timing on the flywheel through the timing window and measure the distance between the "1, 4 FI" or "1 FI" and the mark you made.

10. To advance the injection timing, reduce the amount of shims. To delay the injection timing, increase the amount of shims(2).

Model	Injection timing	Diameter of flywheel	Flywheel circumference for 1°	Amount of shims to adjust 1°
CK22	BTDC 22°	270 mm (10.6 in.)	2.35 mm (0.093 in.)	0.1 mm (0.004 in.)
CK22H	BTDC 18°	270 mm (10.6 in.)	2.35 mm (0.093 in.)	0.1 mm (0.004 in.)

- BTDC: Before top dead center



5.5 ENGINE OIL PRESSURE

1. Remove the oil pressure switch and install adaptors and pressure tester.
2. Start the engine and run it until it is warmed up, and measure the oil pressure both at idling and rated speed.
3. If the oil pressure is less than the allowable limit, check the amount of oil, oil filter, oil pump relief valve, oil passages and oil clearances.

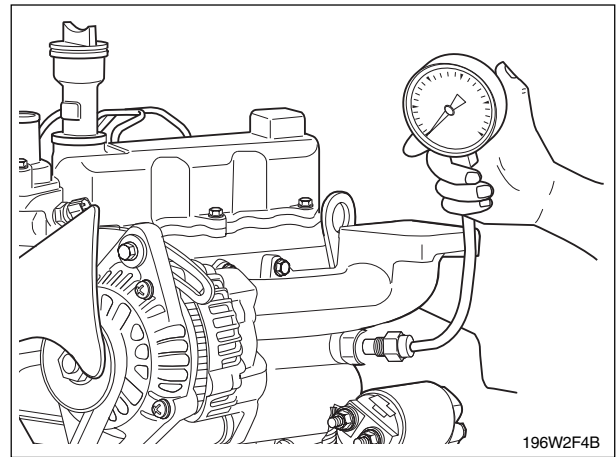
(When reassembling)

- Supply the specified amount of recommended oil.
- The oil filter must not be clogged or broken.

Item		Factory spec.	Allowable limit
Engine oil pressure	At idle speed	More than 49 kPa 0.5 kgf/cm ² 7.11 psi.	-
	At rated speed	245 ~ 441 kPa 2.5 ~ 4.5 kgf/cm ² 36 ~ 64 psi.	245 kPa 2.5 kgf/cm ² 36 psi.

(Reference)

Item	Tightening torque
Oil pressure switch	14.7 ~ 19.6 Nm 1.5 ~ 2.0 kgf-m 10.8 ~ 14.5 lb-ft



GENERAL

ENGINE

CLUTCH

TRANSMISSION

HST

REAR AXLE

BARKE

FRONT AXLE

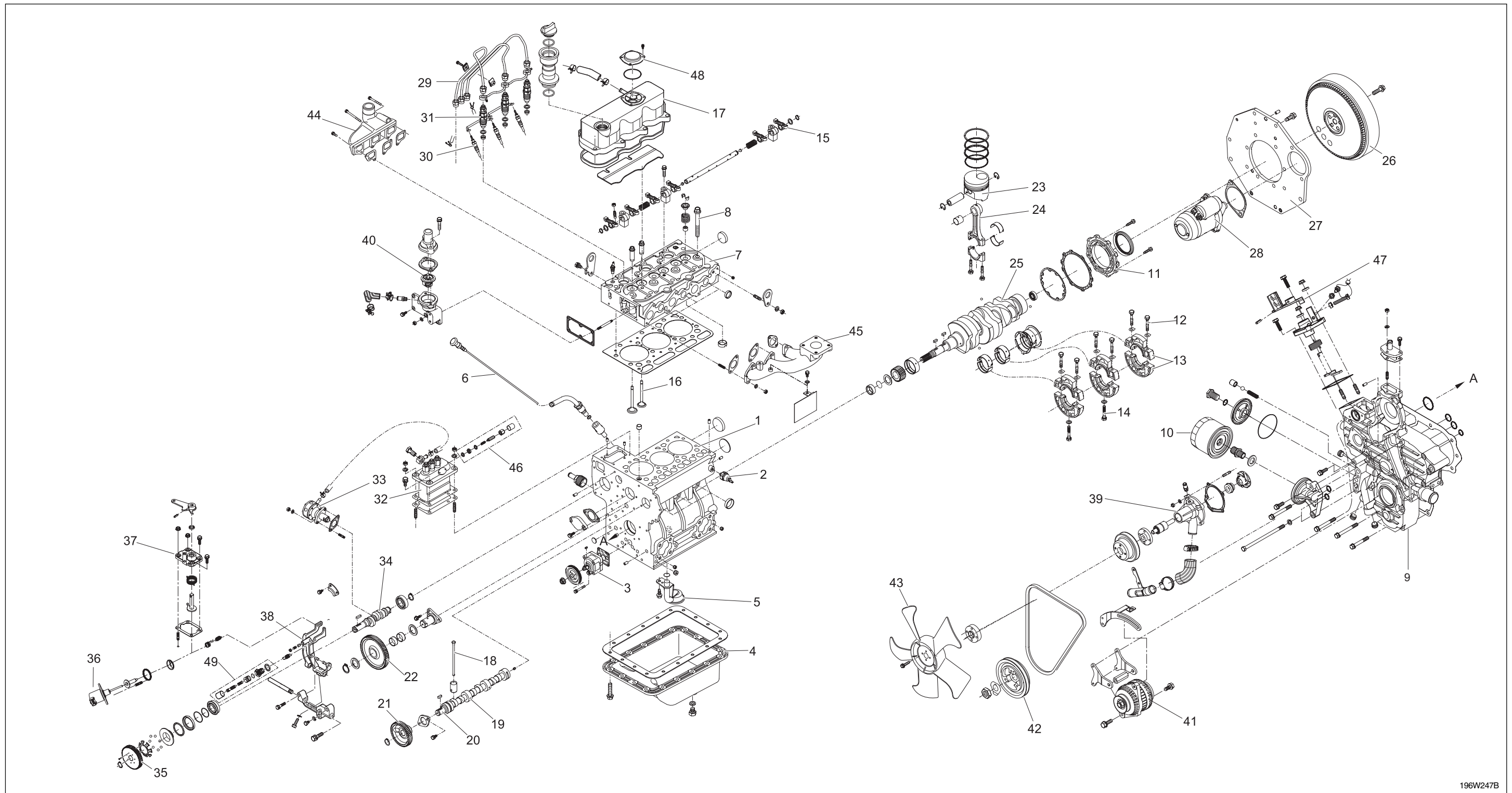
STEERING

HYDRAULIC

ELECTRIC

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6. EXPLODED VIEW (CK22/CK22H)



196W247B

- | | | | | | | | | |
|-------------------------|-----------------------------|---------------------------|--------------------|---------------------|--------------------------|----------------------------|-----------------------|-------------------------|
| (1) Cylinder Block | (7) Cylinder Head | (12) Bearing Case Bolt 1 | (18) Push Rod | (24) Connecting Rod | (30) Glow Plug | (36) Engine Stop Solenoid | (41) Alternator | (46) Idle Limit System |
| (2) Oil Pressure Switch | (8) Head Bolt | (13) Mainbearing Case | (19) Tappet | (25) Crankshaft | (31) Nozzle | (37) Manual Stop Lever | (42) Fan Drive Pulley | (47) Speed Control |
| (3) Oil Pump | (9) Gearcase | (14) Bearing Case Bolt 2 | (20) Camshaft | (26) Flywheel | (32) Fuel Injection Pump | (38) Fork Lever (Governor) | (43) Cooling Fan | (48) PCV V/v |
| (4) Oil Pan | (10) Oil Filter | (15) Rocker Arm | (21) Camshaft Gear | (27) Rear End Plate | (33) Fuel Feed Pump | (39) Water Pump | (44) Inlet Manifold | (49) Fuel Control Limit |
| (5) Oil Strainer | (11) Mainbearing Case Cover | (16) Inlet, Exhaust Valve | (22) Idle Gear | (28) Starter | (34) Fuel Camshaft | (40) Thermostat | (45) Exhaust Manifold | |
| (6) Dipstick | | (17) Cylinder Head Cover | (23) Piston | (29) Injection Pipe | (35) Fuel Camshaft Gear | | | |

7. SERVICING

7.1 REMOVAL AND REASSEMBLE

7.1.1 ENGINE ASSEMBLY

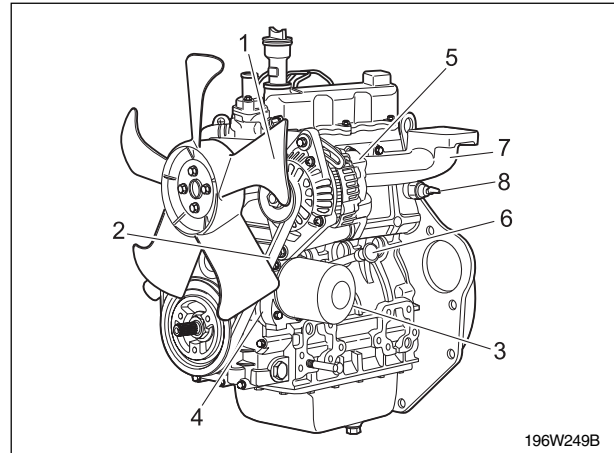
Drain the oil and the water, if disassemble the engine body.

1. Remove the muffler and exhaust manifold (7).
2. Remove the oil pressure switch (8).
3. Pull out the dipstick (6).
4. Remove the alternator (5) and the belt (2).
5. Loosen the oil filter cartridge (3) with the filter wrench and remove it and the flange (4).

(When reassembling)

- Apply liquid gasket (Three bond 1215 or equivalent) on the thread of the oil pressure switch.
- Apply liquid gasket to the both sides of the hour meter gasket.
- Apply oil to the O-ring and tighten the oil filter cartridge not with wrench but by hands
- Adjust the fan belt tension. (See Fan Belt)

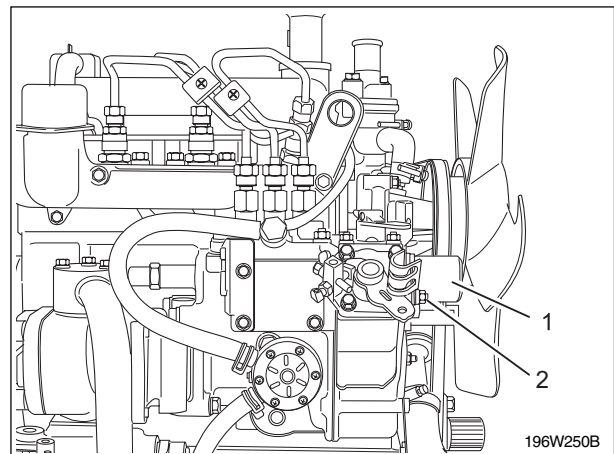
Item	Tightening torque
Oil pressure switch	14.7 ~ 19.6 Nm
	1.5 ~ 2.0 kgf-m
	10.8 ~ 14.4 lb-ft



- | | |
|--------------------------|-------------------------|
| (1) Cooling fan | (5) Alternator |
| (2) Fan belt | (6) Dipstick |
| (3) Oil filter cartridge | (7) Exhaust manifold |
| (4) Filter flange | (8) Oil pressure switch |

7.1.2 ENGINE STOP SOLENOID

1. Disconnect the wire connector of solenoid (1).
2. Remove the nut (2).
3. Remove the stop solenoid (1).



- | |
|--------------------------|
| (1) Engine stop solenoid |
| (2) Nut |

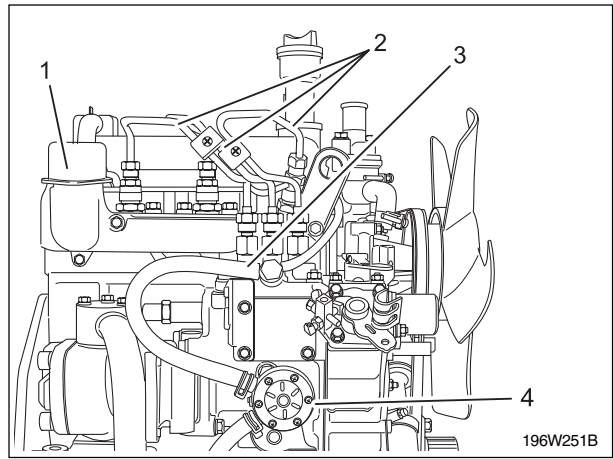
7.1.3 INTAKE MANIFOLD AND FUEL HOSES

1. Disconnect the fuel hose (3).
2. Loosen the injection pipe fittings with two wrenches and remove the injection pipes (2).
3. Remove the inlet manifold (1) and the fuel feed pump (4).

⊕ IMPORTANT

- *Tighten or loosen injection pipe fittings using the one-hand two-wrench squeeze method.*
- *Cap the nozzle inlet to prevent entrance of foreign materials.*

Item	Tightening torque
Injection pipe nut 19 mm (0.75 in.) across flats	14.7 ~ 24.5 Nm 1.5 ~ 2.5 kgf-m 10.8 ~ 18.1 lb-ft



(1) Intake manifold (3) Fuel hose
(2) Injection pipe (4) Fuel feed pump

7.1.4 INJECTION NOZZLE

⚠ ATTENTION

- *When reassembling, replace all the O-rings and gaskets by new ones.*

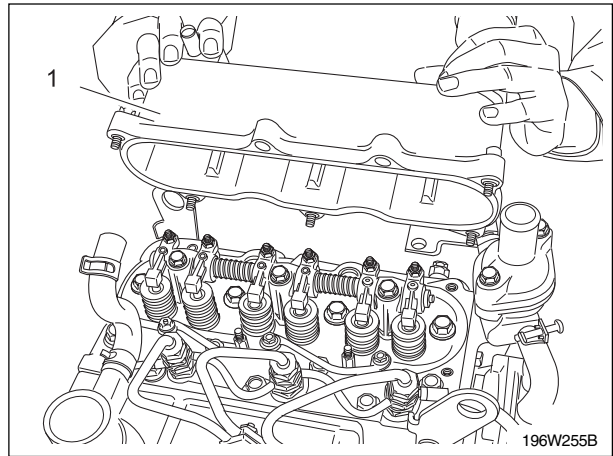
A. REMOVING HEAD COVER

1. Remove the head cover bolts.
2. Remove the head cover.

(Note for reassembling)

- Check to see if the cover gasket is not defective.
- To prevent valve stem seizure, apply enough engine oil to the valve guide and valve stem.

Item	Tightening torque
Nut x 2, Bolt x 5 (10 mm)	48.1 ~ 55.8 Nm 4.9 ~ 5.7 kgf-m 35.5 ~ 41.2 lb-ft



(1) Head cover

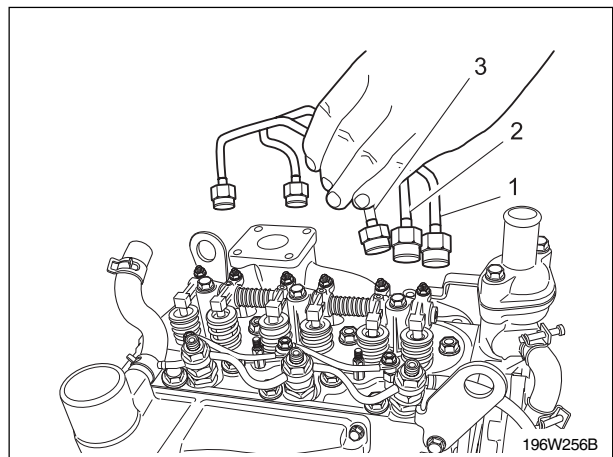
B. REMOVING INJECTION PIPES 1, 2 AND 3

1. Loosen the screws on the pipe clamps.
2. Detach the injection pipes in the order of 1, 2 and 3.

(Note for reassembling)

- Send compressed air, into the pipes to blow out dust. Then reassemble the pipes in the reverse order.

Item	Tightening torque
Injection pipe nuts	24.5 ~ 34.3 Nm 2.5 ~ 3.5 kgf-m 18.1 ~ 25.3 lb-ft



(1) Injection pipe 1 (3) Injection pipe 3
(2) Injection pipe 2

- Pipe clamp
- Feed pipe (17 mm)
- Injection pipe

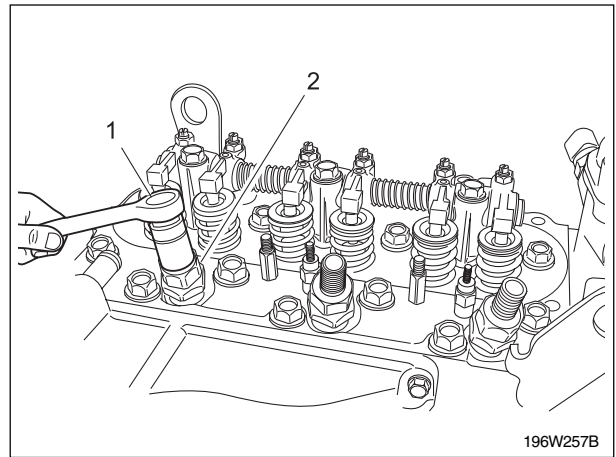
C. REMOVING NOZZLE HOLDER ASSEMBLIES

1. Remove the pipe clips holding the fuel overflow pipes, and detach the pipes.
2. Detach the nozzle holders using a 27 mm (1.0630 in.) nozzle holder socket wrench, after loosening the lock nuts.
3. Detach the copper gaskets on the seats on which the nozzles are to be installed.

(Note for reassembling)

- Return the nozzle holders after confirming that there are no metallic particles or foreign matter on the surface on which the nozzles are to be installed.

Item	Tightening torque
Nozzle holder ass'y	49.0 ~ 68.6 Nm 5.0 ~ 7.0 kgf-m 36.1 ~ 50.6 lb-ft



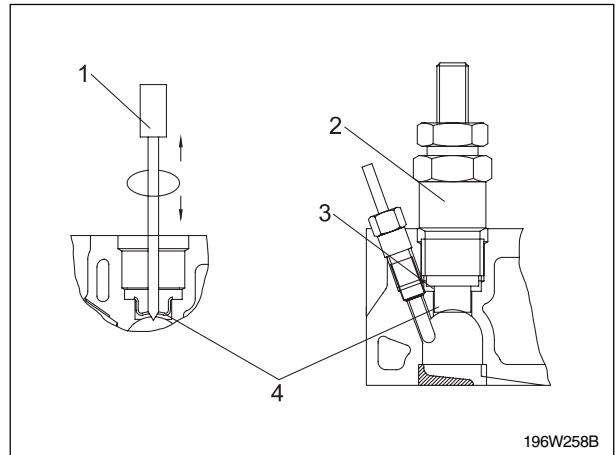
- (1) Nozzle holder socket wrench
- (2) Lock nut

D. HEAT SEAL ROMOVAL PROCEDURE

1. Drive screw driver lightly into the heat seal hole.
2. Turn screw driver three or four times each way.
3. While turning the screw driver, slowly pull the heat seal put together with the injection nozzle gasket. If the heat seal drops, repeat the above procedure.
4. Heat seal and injection nozzle gasket must be changed when the injection nozzle is removed for cleaning or for service.

NOTE:

- Use a plus screw driver that has a diameter which is bigger than the geat seal hole 1/4 in (approx. 6 mm)



- (1) Plus screw driver
- (2) Nozzle
- (3) Injection nozzle gasket
- (4) Heat seal

E. NOZZLE HOLDER

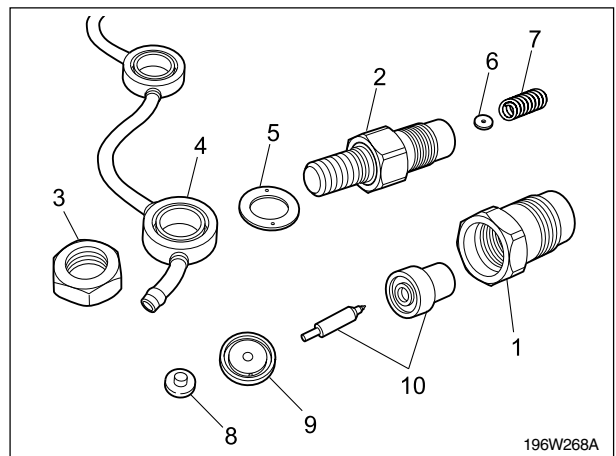
► DISASSEMBLING NOZZLE HOLDER

1. Secure the retaining nut with a vise.
2. Remove the nut, the over flow pipe Ass'y and the plain washer.
3. Remove the nozzle holder body and take out parts inside.

(Note for reassembling)

- When disassembling and reassembling the nozzle piece dip it in clean fuel.
- Install the push rod, noting its direction(upside down).
- Do not tighten it too much, or the needle valve will not slide easily and the injection performance will be decreased.

Item	Tightening torque
Retaining nut	29.4 ~ 49.0 Nm 3 ~ 5 kgf-m 21.7 ~ 36.1 lb-ft



- (1) Retaining nut
- (2) Nozzle holder body
- (3) Nut
- (4) Over flow pipe ass'y
- (5) Gasket
- (6) Adjusting washer
- (7) Nozzle spring
- (8) Push rod
- (9) Distance piece
- (10) Nozzle piece

7.1.5 ROCKER ARM AND PUSH-RODS

A. ROCKER ARM ASSEMBLY

- Loosen the nuts in several steps and the specified sequence shown in the figure and remove them.
 - To loosen (3) to (1).
 - To tighten (1) to (3).
- Remove the rocker arm and shaft assembly.

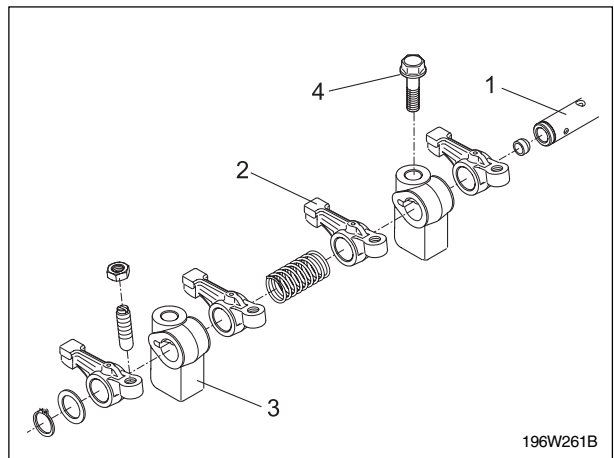
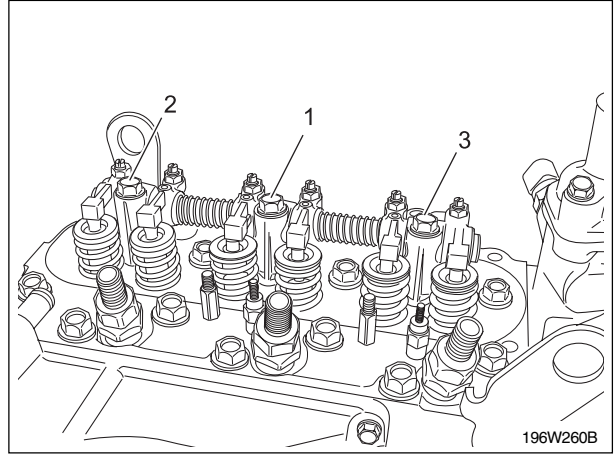
(When reassembling)

- Rest the end of push rod at the indent of tappet and install the rocker arm assembly.
- Tighten the bolts in several steps and the specified sequence shown in the figure to the specified torque.
- Adjust the valve clearance after assembling the rocker arm assembly.

+ IMPORTANT

- When assembling the rocker arm assembly, locate groove of rocker arm shaft on stud bolt.

Item	Tightening torque
Rocker arm shaft on stud bolt	16.7 ~ 20.6 Nm 1.7 ~ 2.1 kgf-m 12.3 ~ 15.2 lb-ft



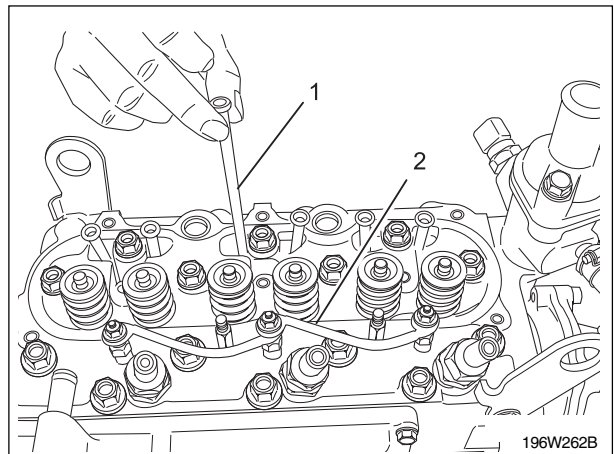
(1) Rocker arm shaft (3) Rocker arm bracket
(2) Rocker arm (4) Bolt

B. REMOVING PUSH-RODS

- Remove the six push-rods.

(Note for reassembling)

- Before inserting the push rods into the tappets, check to see if their ends are properly engaged with the grooves. If a push rod is roughly inserted, it may hit the shoulder of the tappet and be damaged.



(1) Push-rod (2) Glow plug cable

7.1.6 CYLINDER HEADS AND VALVES

A. REMOVING CYLINDER HEADS AND GASKET.

1. Remove the fourteen cylinder head set bolts and two nuts.
 - To loosen (14) to (1)
 - To tighten (1) to (14)
2. Lift up the cylinder head to detach.
3. Remove the cylinder head gasket.

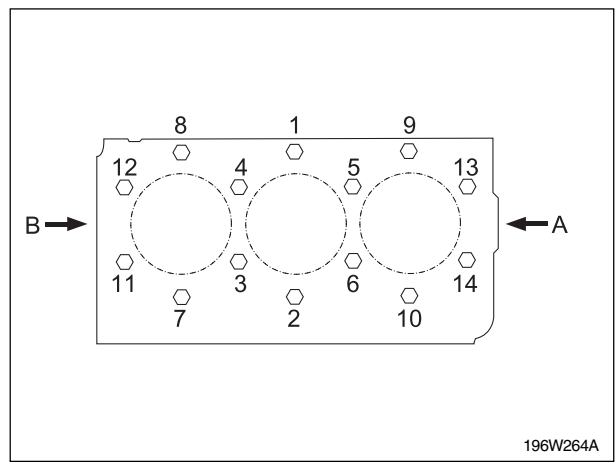
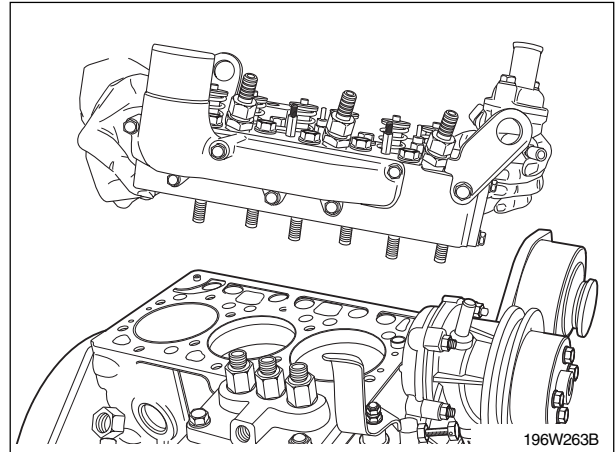
(Note for reassembling)

- Tighten the bolts and nuts after applying sufficient oil.
- Tighten the bolts and nuts in diagonal sequence starting from the center. Tighten them uniformly, or the head may deform in the long run.
- Before installing the gasket, check to see there is no foreign matter on the cylinder head and the cylinder.

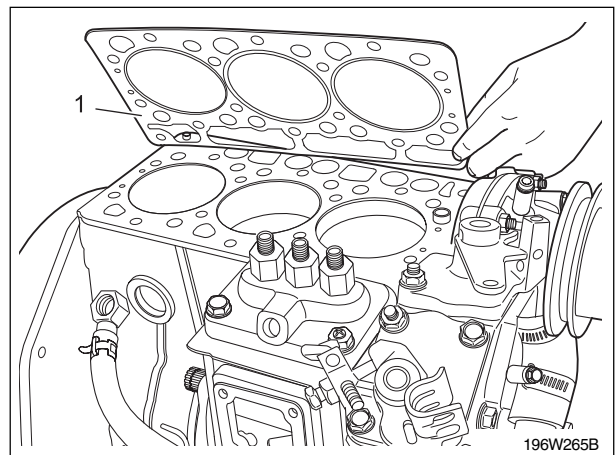
+ IMPORTANT

- *When overhauling the engine, replace the gasket with a new one without confusing its front and back. Retighten the cylinder head after running the engine for 30 minutes.*
- *Tighten the cylinder head bolts and nuts to:*

Item	Tightening torque
Cylinder head bolts	58.8 ~ 63.7 Nm
	6.0 ~ 6.5 kgf-m
	43.4 ~ 47.0 lb-ft



(A) Gear case side (B) Flywheel side



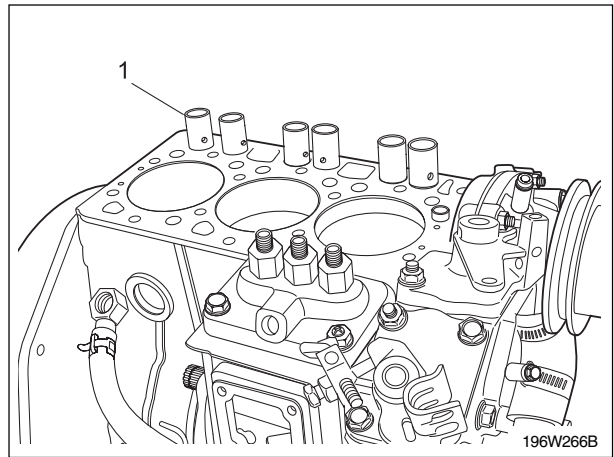
(1) Cylinder head gasket

B. REMOVING TAPPETS

1. Remove the six tappets from the crankcase.

(Note for reassembling)

- Visually check the contact between tappets and cams for proper rotation. If a defect is found, replace tappets.
- Before installing the tappets, apply a thin coat of oil around them.



(1) Tappets

C. VALVES

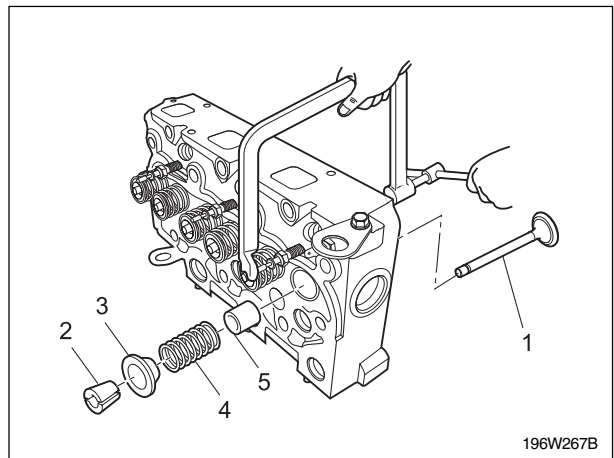
1. Compress the valve spring with a valve spring replacer and remove the collet (2).
2. Remove the valve spring retainer (3), valve spring (4), valve stem seal (5) and the valve (1).

⊕ IMPORTANT

- **Do not interchange valves and valve parts. Mark the cylinder number on the valve and the parts to prevent interchanging.**

(When reassembling)

- Apply oil to the stem of valve and install in the cylinder head.
- Lubricate the valve and the parts after reassembling.



(1) Valve (4) Valve spring
 (2) Collet (5) Valve stem seal
 (3) Retainer

7.1.7 FUEL FEED PUMP AND INJECTION PUMP

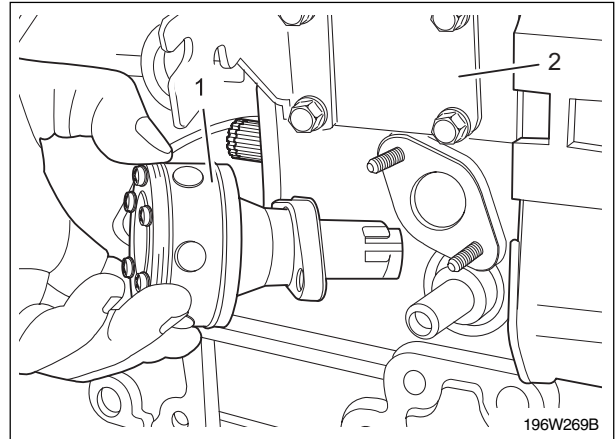
A. FUEL FEED PUMP

► REMOVING FUEL FEED PUMP

1. Remove the two fuel feed pump mounting nuts.
2. Detach the fuel feed pump.
3. Remove the injection pump cover(2).

(Note for assembling)

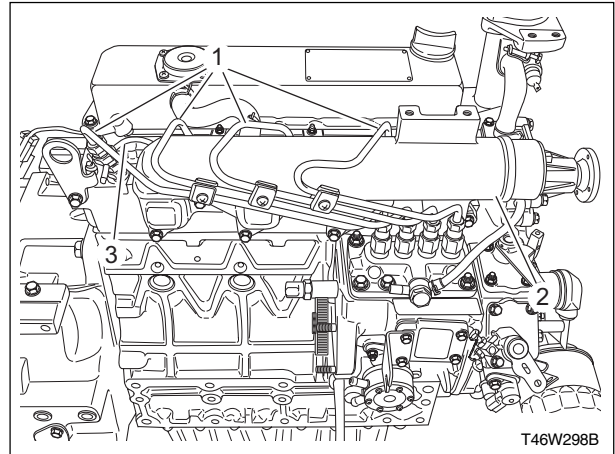
- Be careful the install the fuel feed pump in the right direction.
- Install the fuel feed pump gasket after applying non-drying adhesive to it.



(1) Fuel feed pump assembly (2) Cover

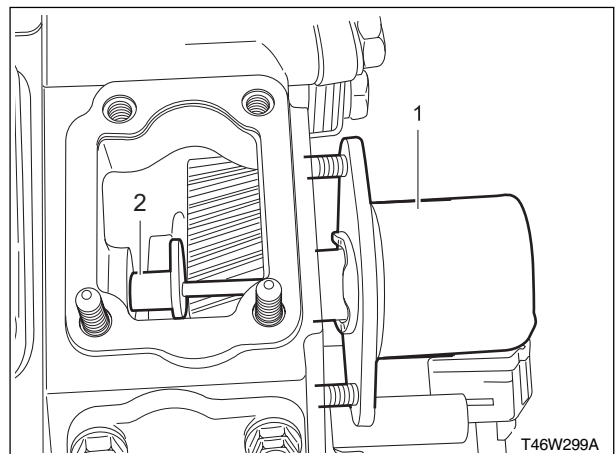
B. INJECTION PUMP

1. Remove the injection pipes (1) and the intake manifold (2).
2. Remove the overflow pipe (3).



(1) Injection pipes
(2) Intake manifold
(3) Overflow pipe

3. Remove the stop solenoid (1) with guide (2).



(1) Stop solenoid
(2) Stop solenoid guide

GENERAL

ENGINE

CLUTCH

TRANSMISSION

HST

REAR AXLE

BARKE

FRONT AXLE

STEERING

HYDRAULIC

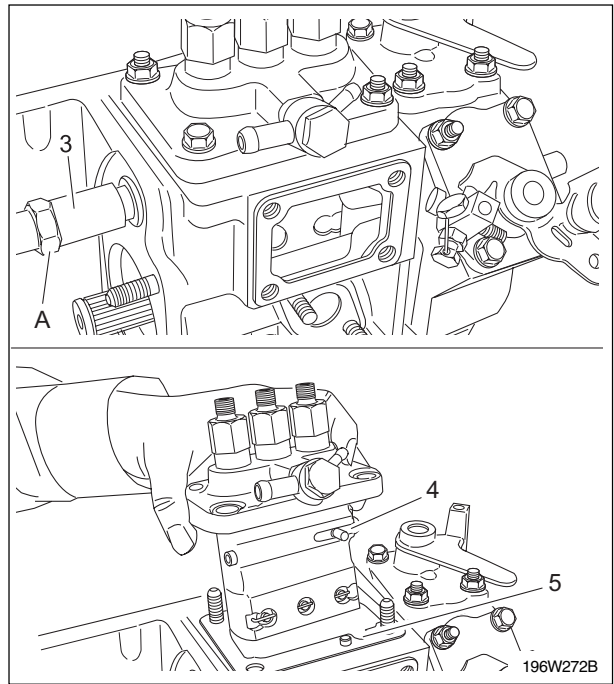
ELECTRIC

INDEX

4. Remove the idle limit system (3).
5. Remove the injection pump mounting bolts and nuts (A).
6. Align the control rack pin (4) with the slot (5) on the cylinder and remove the injection pump.
7. The injection pump should not be disassembled.

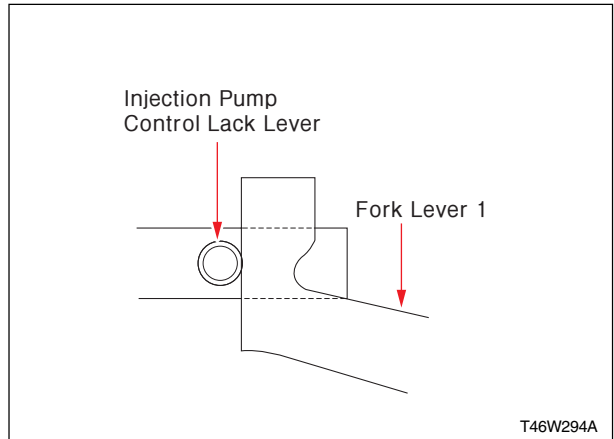
(Note for reassembling)

- Install the injection pump by aligning the control rack with the indicated position.
- Addition or reduction of one shim (0.1 mm) delays or advances the injection timing by 0.017 rad. (1°).



⊕ IMPORTANT

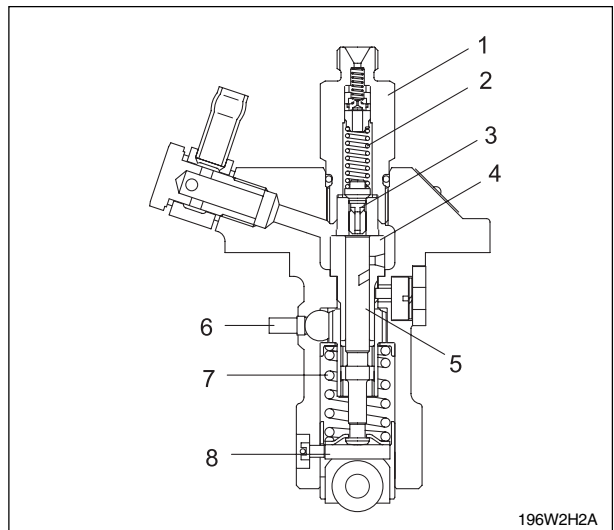
- *Make sure that the lever of the pump control rack is on the outer side from the fork lever 1 when installing the pump. Otherwise, the engine can be damaged by over speed or cannot be started.*



C. INJECTION PUMP

⊕ IMPORTANT

- *If replacing the pump element, the amount of fuel injection should be adjusted on specified bench.*



- | | |
|---------------------------|--------------------|
| (1) Pump body | (5) Delivery valve |
| (2) Control rack | (6) Tappet roller |
| (3) Delivery valve holder | (7) Cylinder |
| (4) Delivery valve spring | (8) Plunger |

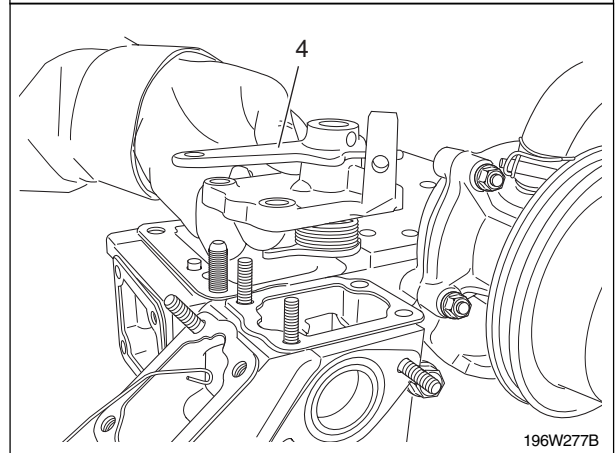
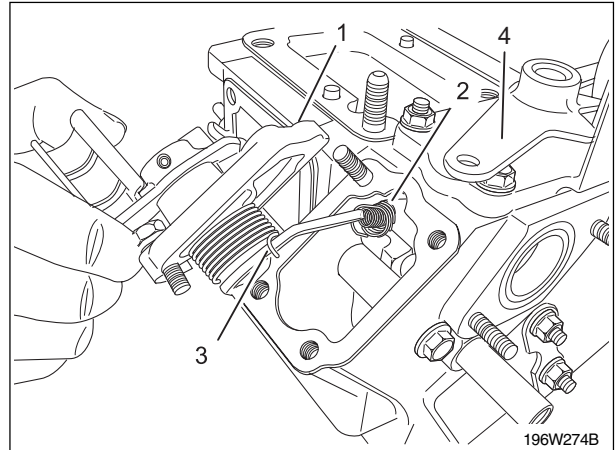
7.1.8 CRANK CASE

A. DETACH THE GOVERNOR SPRING

1. Detach the governor spring 1, 2 and speed control plate from governor lever.
2. Remove the manual stop lever plate (4).

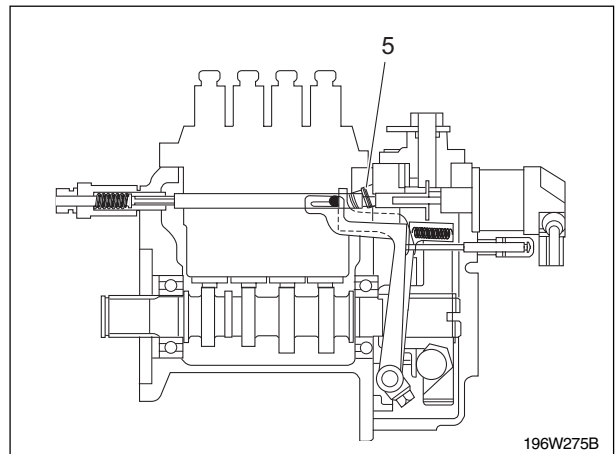
(Note for reassembling)

- Be careful not to drop the governor spring 1, 2 in the gear case.
- Fix the governor spring 1, 2 to the fork lever and pull the spring, hook on the governor lever.



- (1) Speed control plate (3) Governor lever
 (2) Governor spring 1, 2 (4) Manual stop lever

3. Detach governor spring on the side of fork lever if needed.



- (5) Governor springs

GENERAL

ENGINE

CLUTCH

TRANSMISSION

HST

REAR AXLE

BARKE

FRONT AXLE

STEERING

HYDRAULIC

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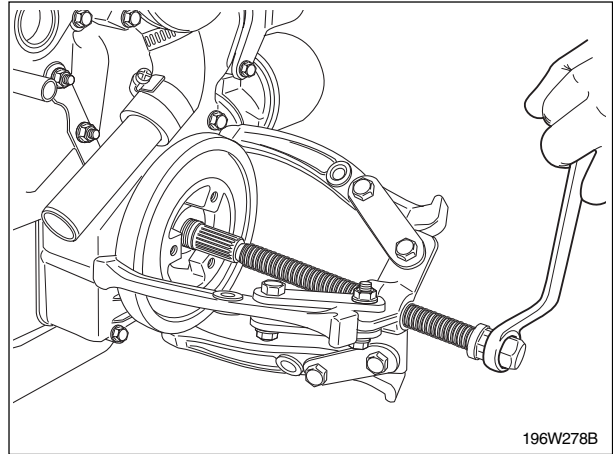
B. REMOVING FAN DRIVE PULLEY

1. Flatten the crankshaft washer.
2. Loosen and remove the crankshaft nut.
3. Draw out the pulley with a puller.

(Note for reassembling)

- Bend the crankshaft washer against one side of the nut.

Item	Tightening torque
Crankshaft nut	137.3 ~ 156.9 Nm 14 ~ 16 kgf-m 101.3 ~ 115.7 lb-ft



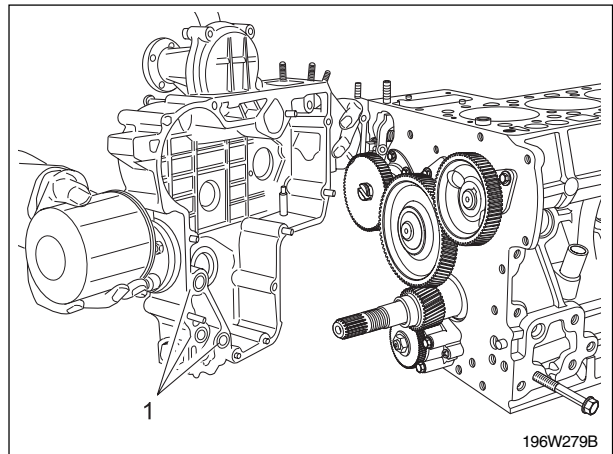
196W278B

C. REMOVING GEAR CASE

1. Remove the gear case cover.
2. Remove the O-ring.

(Note for reassembling)

- Apply a thin coat of engine oil to the oil seal, and install it, noting the lip come off.
- Before installing the gear case gasket, apply a non drying adhesive.
- Tighten the oil filter cartridge by hand.
- Stick the O-ring to the gear case with thin grease to prevent from coming off during reassembling.



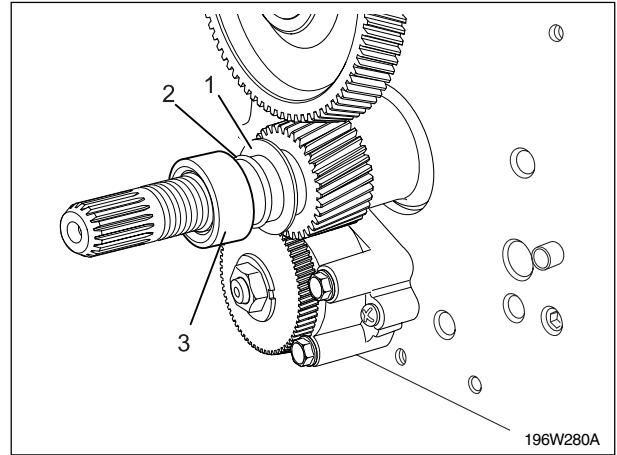
196W279B

(1) O-ring

7.1.9 TIMING GEARS, CAM SHAFTS AND OIL PUMP

A. REMOVING CRANKSHAFT OIL SLINGER

1. Remove the crankshaft collar.
2. Remove the O-ring.
3. Detach the crankshaft oil slinger.



(1) Crankshaft oil slinger (2) O-ring
(3) Crankshaft collar

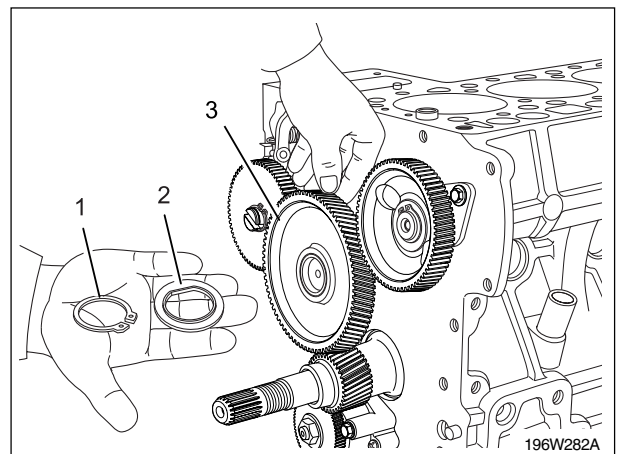
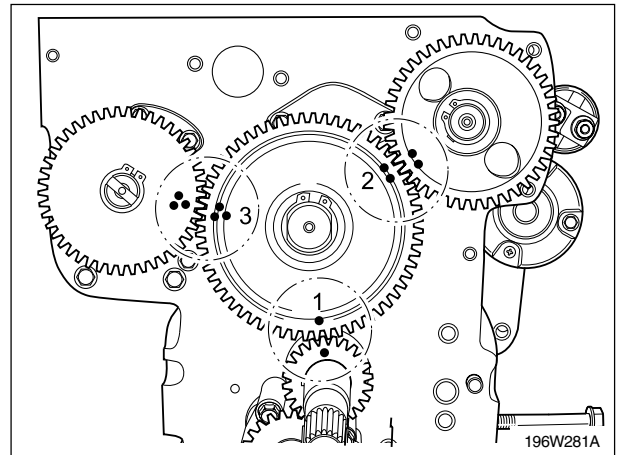
B. REMOVING IDLE GEAR

1. Remove the external circle clip.
2. Detach the idle gear collar 2.
3. Detach the idle gear.
4. Detach the idle gear collar 1.

(Note for reassembling)

- Check to see each gear is aligned with its aligning mark:
 - 1) Idle gear and crank gear
 - 2) Idle gear and camshaft gear
 - 3) Idle gear and injection pump gear

Item	Tightening torque
Idle gear shaft mounting	7.8 ~ 9.8 Nm
bole torque	0.8 ~ 1.0 kgf-m
	5.7 ~ 7.2 lb-ft



(1) External circle clip (2) Gear collar 2
(3) Idle gear

GENERAL

ENGINE

CLUTCH

TRANSMISSION

HST

REAR AXLE

BARKE

FRONT AXLE

STEERING

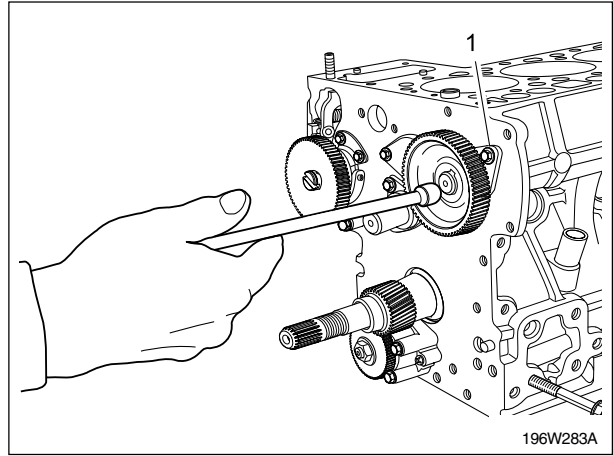
HYDRAULIC

ELECTRIC

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C. REMOVING CAMSHAFT STOPPER

1. Align the round hole on the cam gear with the camshaft stopper mounting bolt position.
2. Remove the camshaft stopper mounting bolt.
3. Detach the camshaft stopper.



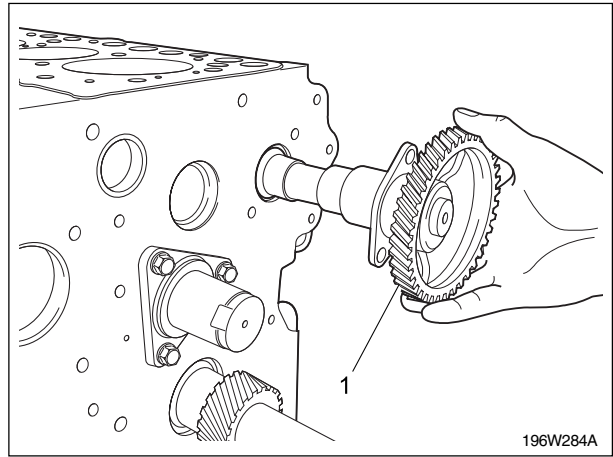
(1) Camshaft stopper

D. REMOVING GEAR AND CAMSHAFT

Draw the camshaft and the cam gear.

(Note for reassembling)

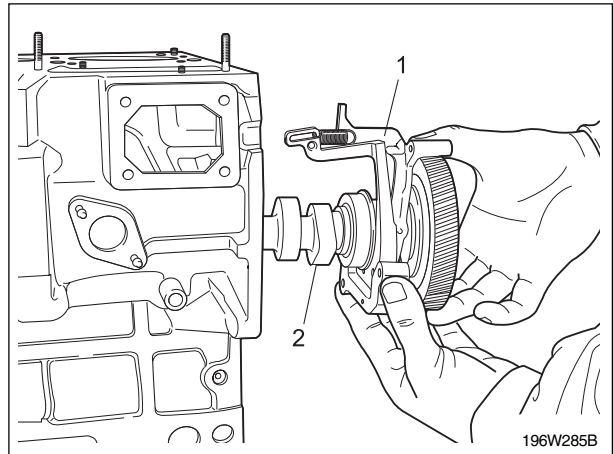
- Apply a thin coat of engine oil to the camshaft before installation.



(1) Camshaft assembly

E. REMOVING FORK LEVER ASSEMBLY AND FUEL INJECTION CAMSHAFT

1. Remove the fuel injection camshaft stopper.
2. Remove the two fork lever holder mounting bolts.
3. Detach the fork lever assembly and fuel camshaft.



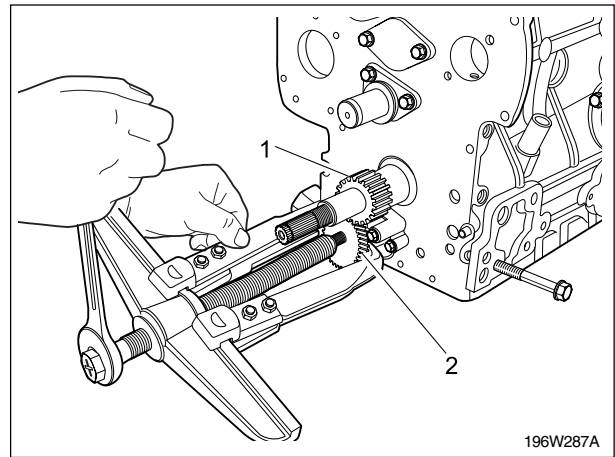
(1) Fork lever assembly
(2) Fuel camshaft assembly

F. REMOVING OIL PUMP DRIVE GEAR

1. Remove the nut from oil pump.
2. Draw out the oil pump drive gear with gear puller.

(Note for reassembling)

- Ensure there is a feather key.



(1) Crank gear

(2) Oil pump drive gear

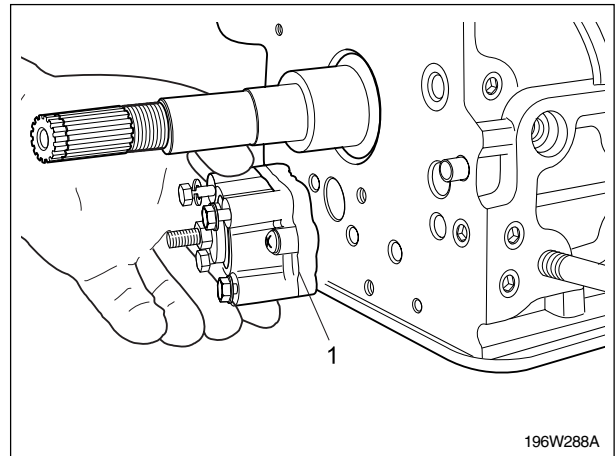
G. REMOVING OIL PUMP

Remove the four oil pump mounting bolts. Detach the oil pump.

(Note for reassembling)

- Remove the gear with crank gear removal tool or pulley removal tool.

Item	Tightening torque
Bolts of oil pump	9.8 ~ 11.8 Nm
	1.0 ~ 1.2 kgf-m
	7.2 ~ 8.7 lb-ft



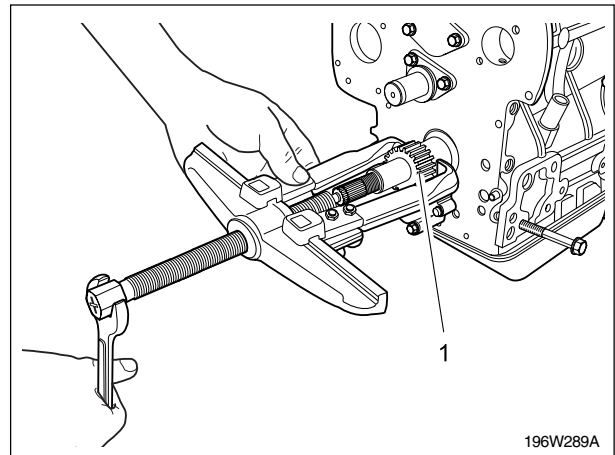
(1) Oil pump assembly

H. REMOVING CRANK GEAR

Remove the gear with crank gear removal tool or pulley removal tool.

(Note for reassembling)

- Check to see that the key is on the crankshaft.
- Heat the crank gear to about 80°C (176°F), and fit on the crankshaft. If there is fear of the shaft being damaged, heat the gear more and fit.



(1) 13T gear (crank gear)

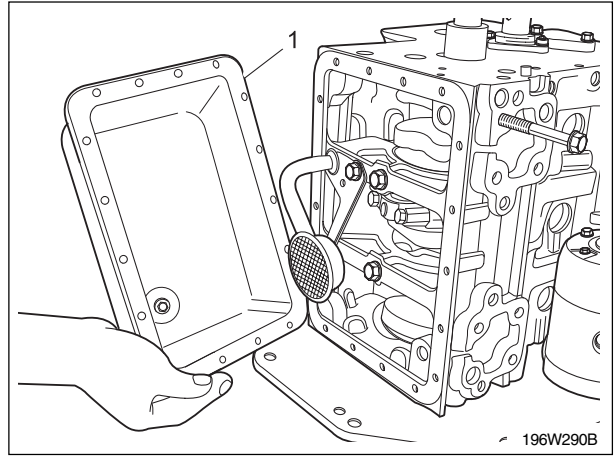
7.1.10 PISTON

A. REMOVING OIL PAN

1. Lay the engine on the engine cradle on its side.
2. Remove the eighteen oil pan mounting bolts.
3. Detach the oil pan by lightly tapping the groove of the pan with a wooden hammer.

(Note for reassembling)

- Wipe off oil on the oil pan mounting surface, apply a non-drying adhesive, and install the oil pan.
- To avoid uneven tightening, tighten mounting bolts in diagonal order from the center.
- Ensure that the drain plug is tight.



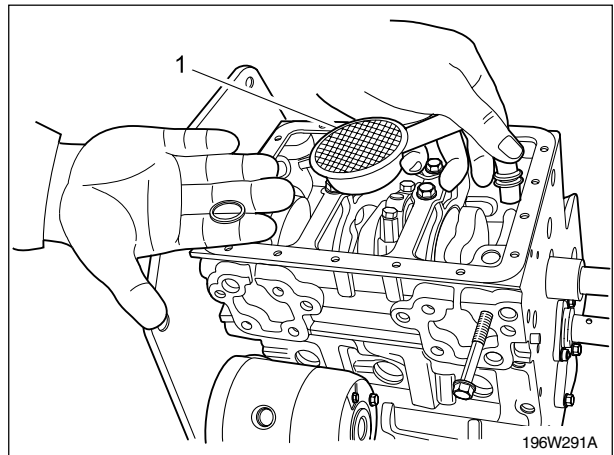
(1) Oil pan

B. REMOVING OIL STRAINER

1. Remove the mounting bolt of oil strainer.
2. Detach oil strainer, being careful of the O-ring.

(Note for reassembling)

- After cleaning the oil strainer, check to see that the strainer mesh is clean, and install it.
- Visually check the O-ring, apply engine oil, and install it.
- After checking to see that the O-ring is securely installed, attach the oil strainer.



(1) Oil strainer

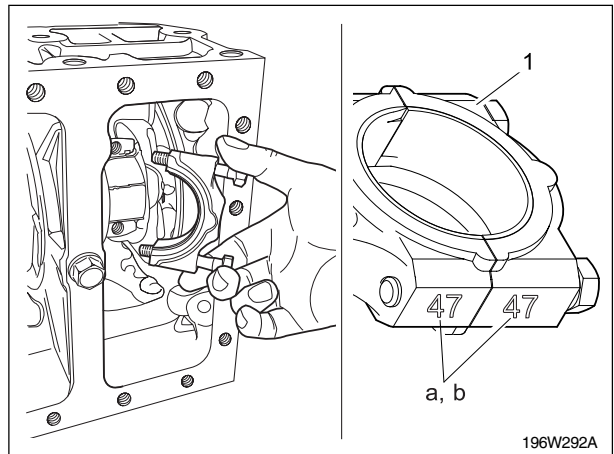
C. REMOVING CONNECTING ROD CAP

1. Remove the connecting rod bolts from connecting rod cap.
2. Detach the connecting rod caps.

+ IMPORTANT

- **Apply engine oil to the connecting rod bolt.**
- **Align the marks with each other.**
- **Face the marks toward the injection pump.**

Item	Tightening torque
Connecting Rod	26 ~ 30 Nm
	2.7 ~ 3.1 kgf-m
	20 ~ 22 lb-ft



(1) Connecting rod cap

(a) Align the marks with each other

(b) Face the marks toward the injection pump

D. REMOVING PISTONS

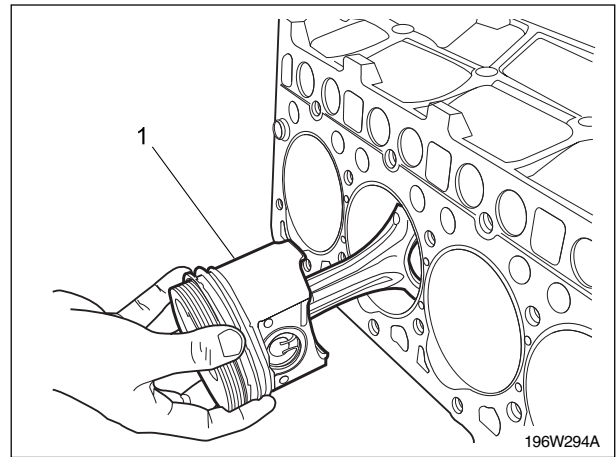
1. Turn the crankshaft and bring the piston to top dead center.
2. Draw out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.
3. Draw out the other two pistons in the same method as above.

(Note for reassembling)

- Before inserting the pistons into the cylinders, apply enough engine oil to the pistons.

**IMPORTANT**

- **Install the piston rings with their end gaps making an angle of 120° (2.09 rad) or 180° (3.14 rad) to each other. (Place the top ring with their gaps on the opposite side of the combustion chamber.)**
- **Attach a ring to the pistons securely with a piston ring compressor, and set them to the cylinder, being careful about the cylinder number and the position of the connecting rod (Connecting rods must be installed with their ends bearing the number toward the fuel injection pump).**
- **Carefully insert the pistons. Otherwise, their chrome plated section may be scratched, causing trouble inside the liner.**
- **Set the gap of top ring toward the opposite direction of combustion chamber.**



(1) Piston

GENERAL

ENGINE

CLUTCH

TRANSMISSION

HST

REAR AXLE

BRAKE

FRONT AXLE

STEERING

HYDRAULIC

ELECTRIC

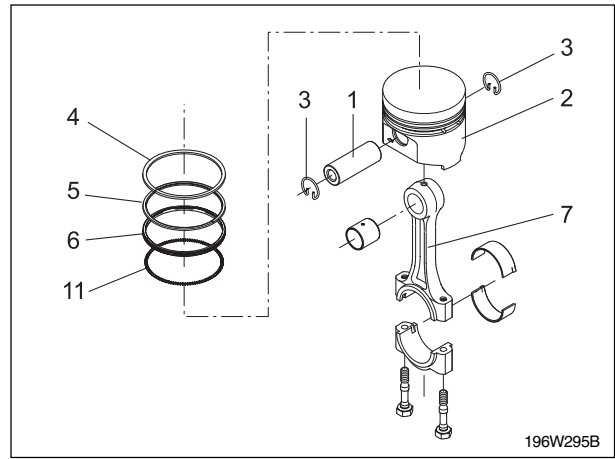
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E. PISTON RING AND PISTON PIN

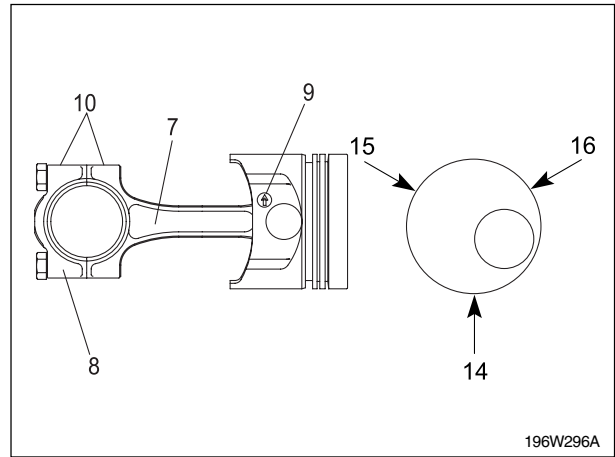
1. Remove the piston rings with a piston ring replacing tool.
2. Remove the piston pin.

(When reassembling)

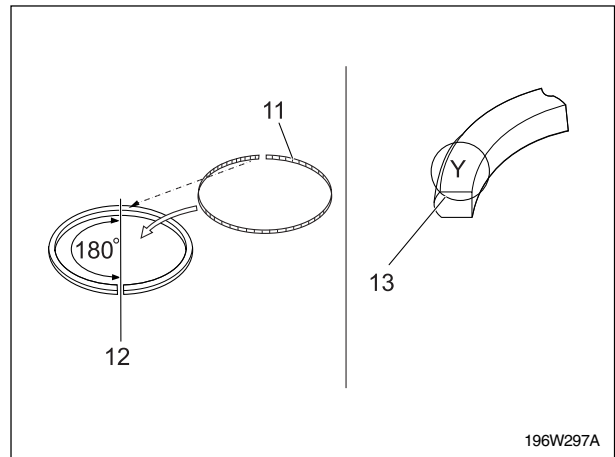
- Clean all the parts before assembling.
- Heat the piston in approx. 80°C (176°F) of oil for 10 ~ 15 minutes, when inserting the piston pin into the piston.
- Install the piston and connecting rod with the mark FW on the piston to the flywheel and the mark on the connecting rod to the injection pump.
- Install the piston rings with their manufacturer's mark to the top of piston.
- Install the top ring with its gap at 90° (1.57 rad) from piston pin to the exhaust port.
- Install the second ring and oil ring with their gap at every 120° (2.09 rad) or 180° (3.14 rad).
- Install the expander in the oil ring with its gap opposite to the gap of oil ring.



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- | | |
|--------------------------|--------------------------|
| (1) Piston pin | (9) Mark |
| (2) Piston | (10) Casting mark |
| (3) Piston pin snap ring | (11) Expander joint |
| (4) Top ring | (12) Oil ring gap |
| (5) Second ring | (13) Manufacturer's mark |
| (6) Oil ring | (14) Top ring |
| (7) Connecting rod | (15) Second ring |
| (8) Connecting rod cap | (16) Oil ring gap |

7.1.11 FLYWHEEL AND MAIN BEARING CASE COVER

A. FLYWHEEL AND REAR PLATE

1. Loosen the flywheel bolt and remove the flywheel.
2. Loosen the bolt and remove the rear plate.

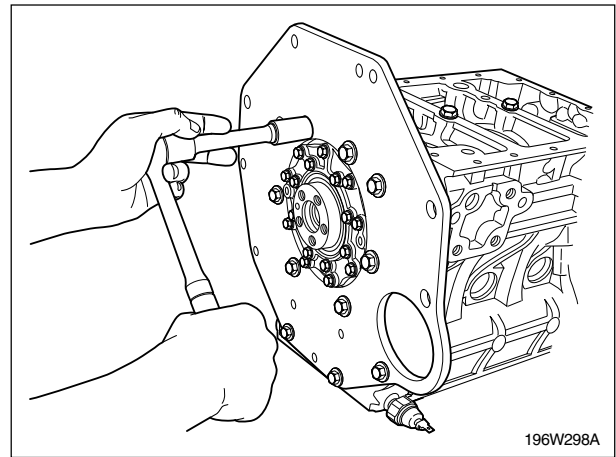
(When reassembling)

- Check the end of crankshaft any uneven wear, lack or crack of teeth.
- Clean the end of crankshaft and the mating surface of the flywheel.
- Apply oil to flywheel screws.
- To ease alignment of the crankshaft and the flywheel, bring the crank of one of the cylinders to TC (top dead center). Make sure of the flywheel TC, align it with the punch mark of the rear and plate, and set the flywheel.
- Tighten the flywheel bolts to in diagonal order.

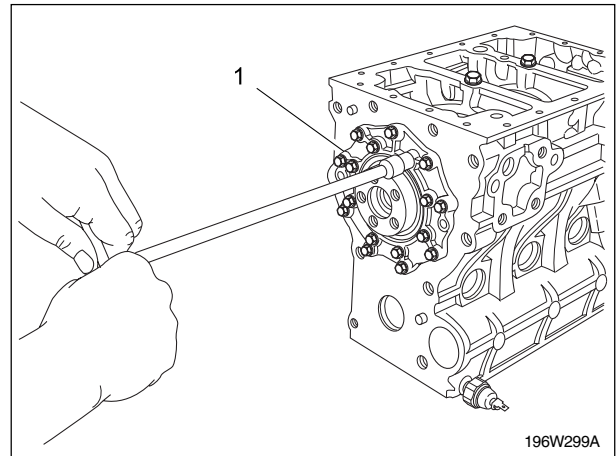
NOTE:

- *Screw longer screws to the flywheel to carry it, if needed.*

Item	Tightening torque
Flywheel screw	54 ~ 59 Nm
	5.5 ~ 6.0 kgf-m
	40 ~ 43 lb-ft



(1) Rear plate



(1) Bearing case cover

B. BEARING CASE COVER

Loosen the screws first inside and next outside, and lift the cover (1) by screwing two screws gradually and evenly, referring to the photo.

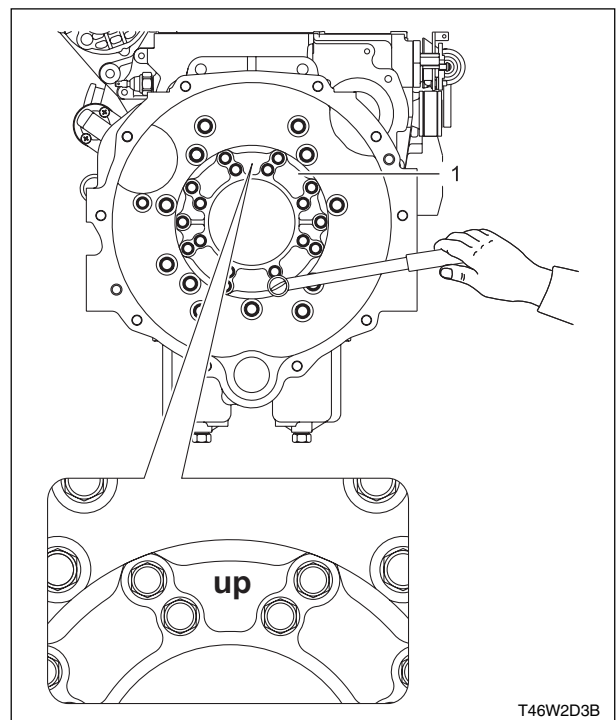
(When reassembling)

- Apply grease to the oil seal lip and take care that it is not rolled when installing.

Item	Tightening torque
Bearing case cover screw	12.7 ~ 15.7 Nm
	1.3 ~ 1.6 kgf-m
	9.8 ~ 11.2 lb-ft

NOTE:

- *When installing the main bearing case cover, the "UP" mark on it should be at the highest position so that its holes are aligned with the holes of the cylinder block.*



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7.1.12 CRANKSHAFT AND JOURNAL BEARING

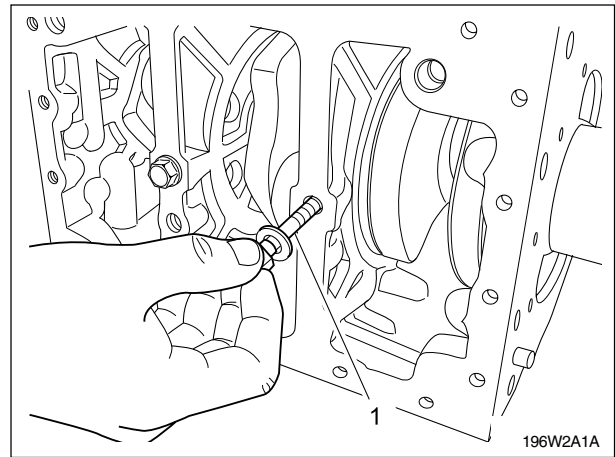
A. REMOVING BEARING CASE BOLT 2

Detach the bearing case bolts.

(Note for reassembling)

- When tightening the main bearing case bolts, align the direction of the holes so that the crankshaft can be easily installed.
- Apply oil to the bearing case screw.

Item	Tightening torque
Main bearing case screw 2	30 ~ 34 Nm 3.0 ~ 3.5 kgf-m 22 ~ 25 lb-ft



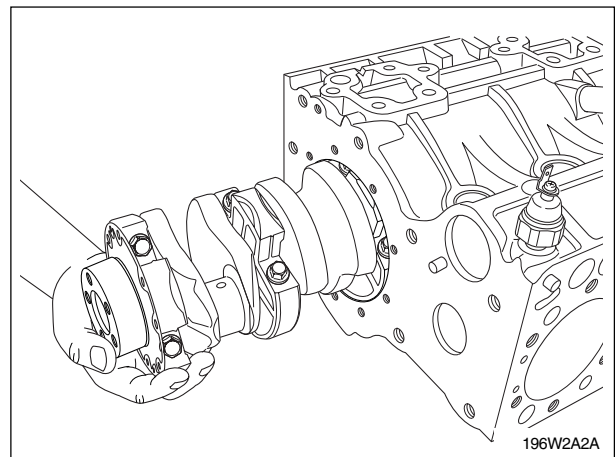
(1) Bearing case bolt 2

B. REMOVING CRANKSHAFT

Pull the crankshaft from the back of the cylinder block by lightly tapping it with a brass hammer.

(Note for reassembling)

- Before installing the crankshaft, clean the oil holes in the crankshaft with compressed air.



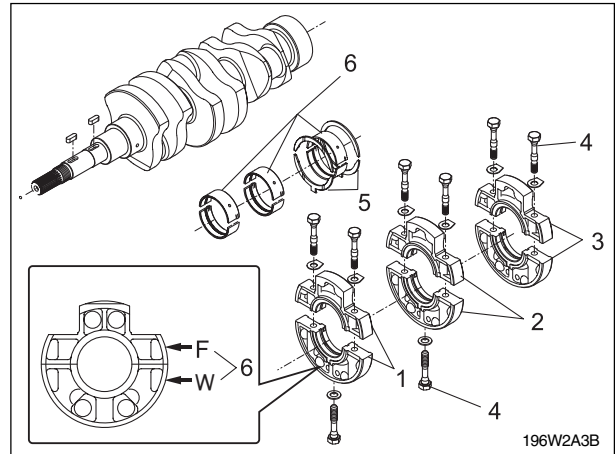
C. REMOVING MAIN BEARING CASE

1. Remove the two mounting bolts for main bearing case assembly 1.
2. Detach the main bearing case, being careful with the side and crankshaft bearing.
3. Detach the other bearing cases 2 and 3 in the same method. Be careful not to mix them up.

(Note for reassembling)

- Clean the oil holes in the main bearing case.
- Install the main bearing case with their side marks toward the flywheel.
- Be sure to install main bearing 1 with its oil groove facing outward.
- Tighten the bearing case bolts 1 to 20 ~ 24 Nm (2.0 ~ 2.4 kfg-m, 15 ~ 17 lb-ft).

Item	Tightening torque
Bearing case bolts	30 ~ 34 Nm 3.0 ~ 3.5 kgf-m 22 ~ 25 lb-ft



- (1) Main bearing case assembly 1
- (2) Main bearing case assembly 2
- (3) Main bearing case assembly 3
- (4) Bearing case bolt 1
- (5) Thrust bearing
- (6) Alignment mark

7.2 INSPECTION FOR OVERHAUL

7.2.1 CYLINDER HEAD

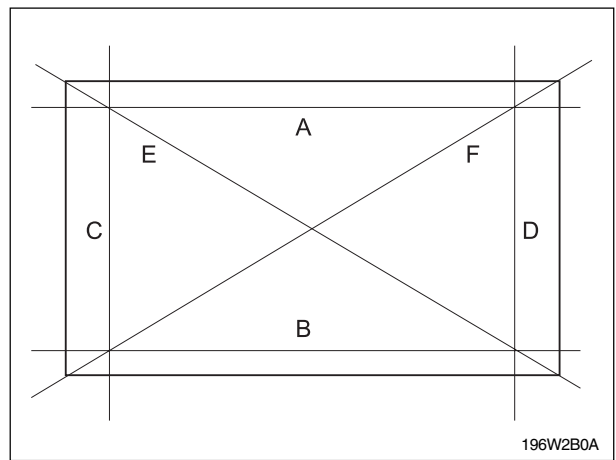
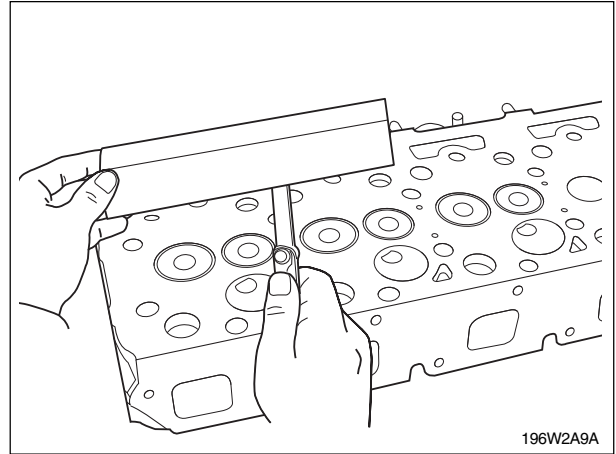
A. CYLINDER HEAD SURFACE FLATNESS

1. Thoroughly clean the cylinder head surface.
2. Place a straightedge on the cylinder head and measure the clearance with a feeler gage as shown in the figure.
3. If the measurement exceeds the allowable limit, replace the cylinder head.

+ IMPORTANT

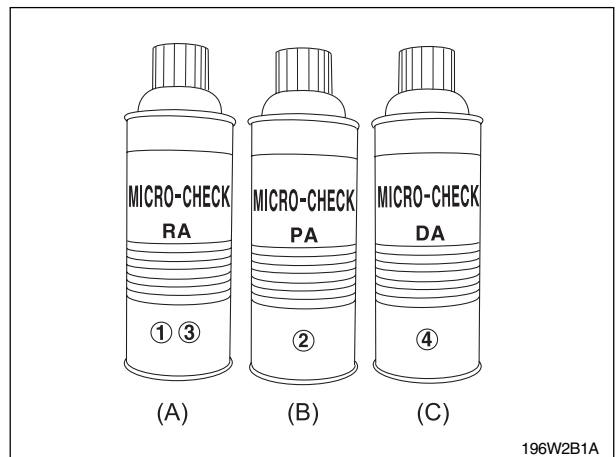
- Do not place the straight edge on the combustion chamber.

Item	Allowable limit
Flatness	0.05 mm 0.0019 in.



B. CYLINDER HEAD SURFACE FLAW

1. Clean the cylinder head surface with the detergent (B).
2. Spray the cylinder head surface with the red permeative liquid (A).
3. Wash away the red permeative liquid on the cylinder head surface with the detergent (B) after ten minutes.
4. Spray the cylinder head surface with the white developer (C).
5. If any flaw is found such as a red mark, replace the cylinder head.



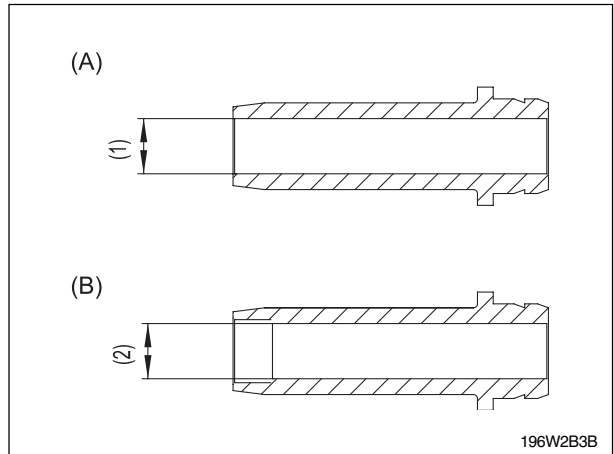
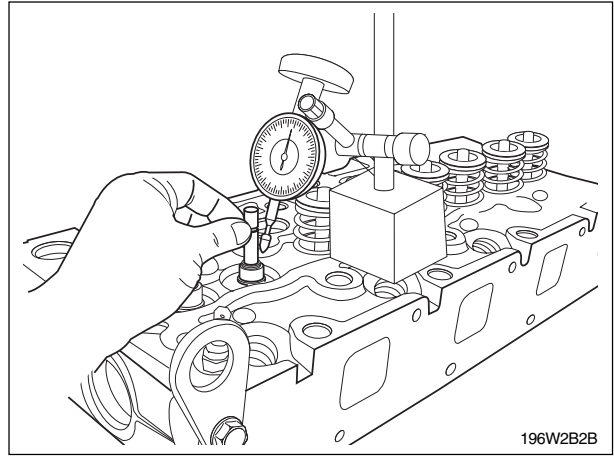
C. VALVE STEM CLEARANCE

1. Remove the carbon from the valve guide.
2. Measure the valve stem O.D. with an outside micrometer.
3. Measure the valve guide I.D. of cylinder head, and calculate the clearance.
4. If the measurement exceeds the allowable limit, replace the valve guide or the valve.

⊕ IMPORTANT

- *When changing the valve guide, be sure to ream as the figure indicates after inserting the valve guide.*

Reference value	0.035 ~ 0.065 mm 0.0014 ~ 0.0026 in.
Allowable limit	0.1 mm 0.004 in.

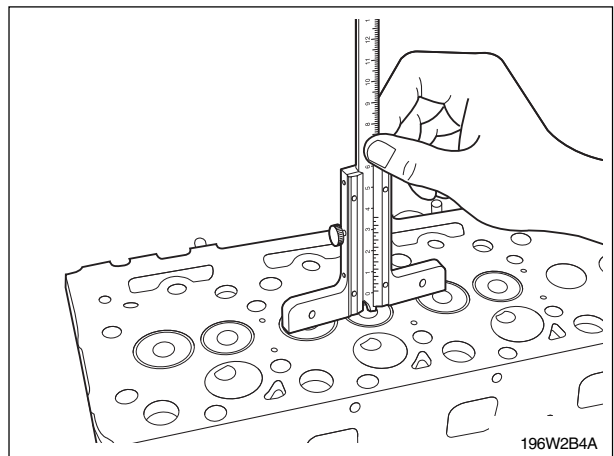


- (A) Finishing size of inlet valve guide
- (B) Finishing size of exhaust valve guide
- (1) 7.010 ~ 7.025 mm 0.2760 ~ 0.2766 in.
- (2) 7.010 ~ 7.025 mm 0.2760 ~ 0.2766 in.

D. VALVE RECESSING

1. Clean the cylinder head, the valve face and the seat.
2. Insert the valve in the guide.
3. Measure the valve recessing with a depth gauge.
4. If the recessing exceeds the allowable limit, replace the valve and check the valve seating.

Item	Factory spec.	Allowable limit
Valve recessing	0.9 ~ 1.1 mm 0.035 ~ 0.043 in.	1.3 mm 0.051 in.

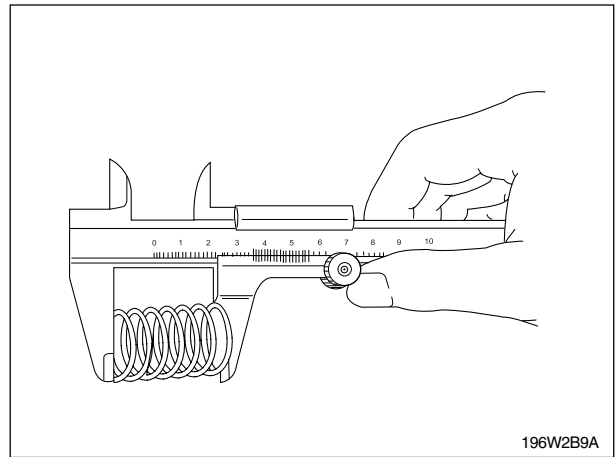


7.2.2 VALVE SPRING

A. CHECKING VALVE SPRING FREE LENGTH

1. Measure the spring with a set of vernier calipers.
2. If the measurement exceeds the allowable limit, replace.

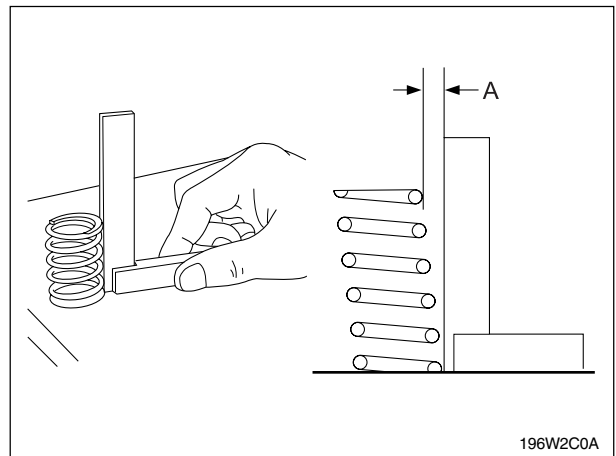
Reference value	35.1 ~ 35.6 mm 1.382 ~ 1.402 in.
Allowable limit	34.8 mm 1.37 in.



B. CHECK VALVE SPRING SQUARENESS

1. Put the spring on a surface plate, place a square on the side of the spring, and check to see if the entire side is in contact with the square.
2. Rotate the spring and measure the maximum A.
- 3 If the measurement exceeds the allowable limit, replace.
 - The flat surface at the end of the spring coil must exceed the full circumference by two-thirds.
 - Check the entire surface of the spring for scratches.

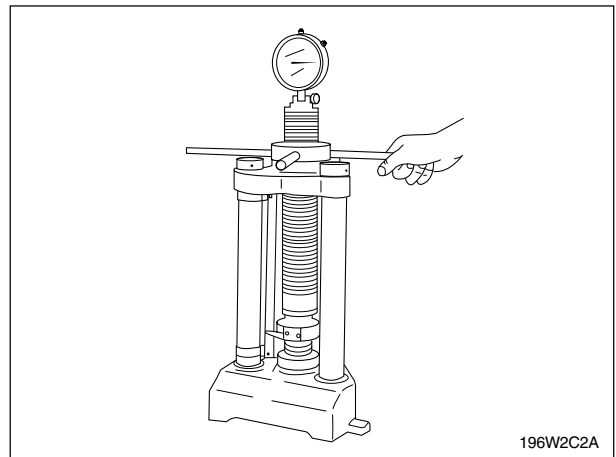
Allowable limit	1.3 mm 0.051 in.
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C. CHECKING VALVE SPRING TENSION

1. Place the spring on a tester and compress it to the same degree that it is actually compressed in the engine. (31 mm, 12 in.)
2. Read the compression load on the gauge.

Reference value	74 N / 31 mm 7.5 kgf / 31 mm 16.5 lbs / 1.22 in.
Allowable limit	63 N / 31 mm 6.4 kgf / 31 mm 14.1 lbs / 1.22 in.

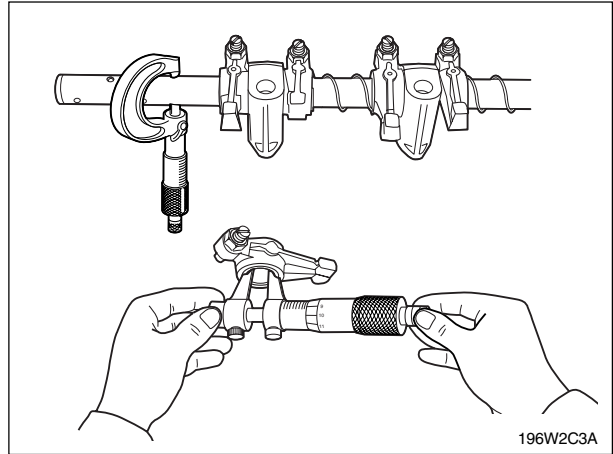


7.2.3 CHECKING OIL CLEARANCE BETWEEN ROCKER ARM SHAFT AND BUSHING

1. Measure the rocker arm I.D.
2. Measure the rocker arm O.D.
3. If the clearance exceeds the allowable limit, replace.

Reference value	0.02 ~ 0.08 mm
	0.0008 ~ 0.0031 in.
Allowable limit	0.12 mm
	0.0047 in.

Rocker arm shaft O.D.	12.955 ~ 12.980 mm
	0.5100 ~ 0.5110 in.
Rocker arm bushing I.D.	13.000 ~ 13.035 mm
	0.5118 ~ 0.5132 in.



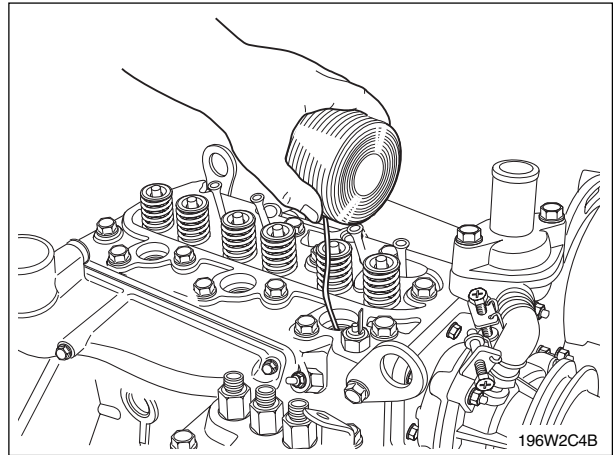
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7.2.4 CHECKING TOP CLEARANCE

1. Remove the nozzle holder.
2. Lower the piston in the cylinder to be measured.
3. Insert a high-quality fuse from the nozzle holder hole. Be careful not to let the fuse touch the valve surface.
4. Rotate the engine with your hand.
5. Take the fuse out carefully.
6. Measure the place where the fuse was crushed with vernier calipers.

Reference value	0.7 ~ 0.9 mm
	0.0275 ~ 0.0354 in.

Thickness of gasket when tightened	1.14 ~ 1.26 mm
	0.045 ~ 0.050 in.



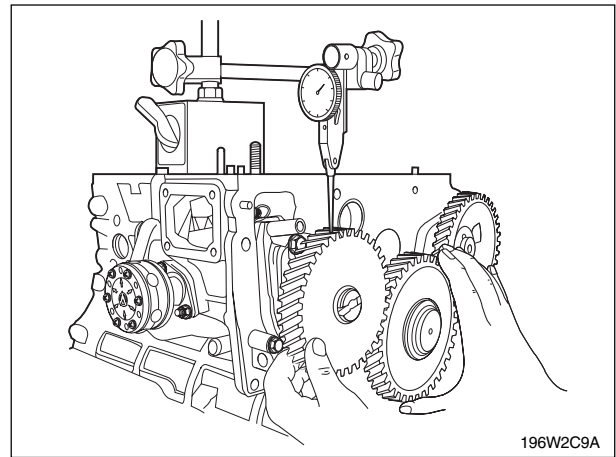
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7.2.5 TIMING GEARS AND CAMSHAFTS

A. TIMING GEAR BACKLASH

1. Set a dial indicator (lever type) with its tip on the gear tooth.
2. Clamp one gear, rotate the other and measure the backlash.
3. If the backlash exceeds the allowable limit, replace.

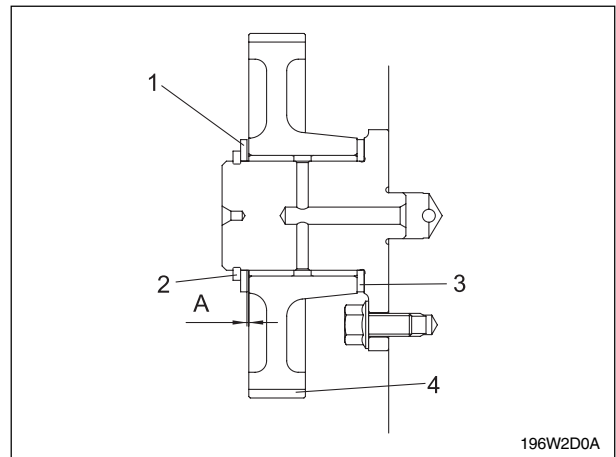
Item	Allowable limit
Reference value	0.042 ~ 0.115 mm 0.0017 ~ 0.0045 in.
Allowable limit	0.2 mm 0.0079 in.



B. IDLE GEAR SIDE CLEARANCE

1. Pull the idle gear collar 2 (1) and push the idle gear (2) to each end.
2. Measure the clearance A between the idle gear and the idle gear collar 2 with a feeler gauge.
3. If the clearance exceeds the allowable limit, replace the idle gear collar 1 (3).

Item	Factory spec.	Allowable limit
Side clearance (A)	0.20 ~ 0.51mm 0.0079 ~ 0.0201 in.	0.9 mm 0.035 in.

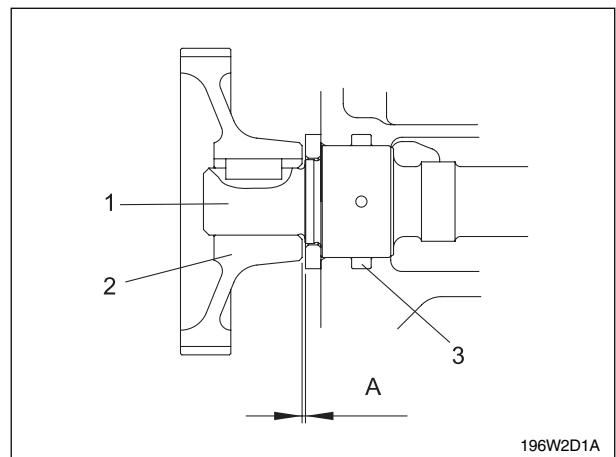


- (1) Idle gear collar 2 (3) Idle gear collar 1
(2) Idle gear snap ring (4) Idle gear

C. CAM GEAR SIDE CLEARANCE

1. Pull the cam gear (2) with the camshaft (1) to its end.
2. Measure the clearance A between the cam gear (2) and the camshaft stopper (3).
3. If the clearance exceeds the allowable limit, replace the camshaft stopper (3).

Item	Factory spec.	Allowable limit
Side clearance (A)	0.07 ~ 0.22 mm 0.028 ~ 0.078 in.	0.3 mm 0.0118 in.

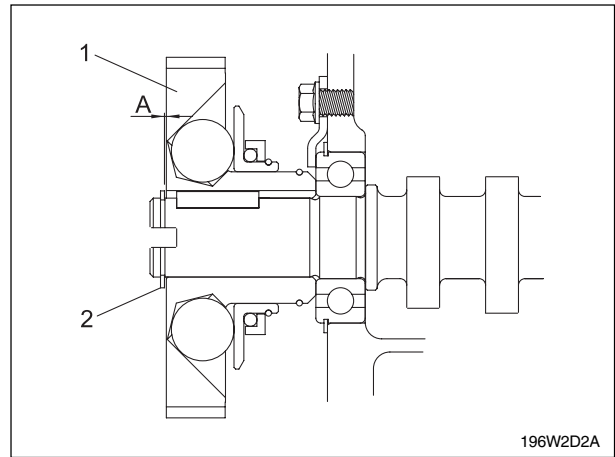


- (1) Camshaft (3) Stopper
(2) Cam gear

D. INJECTION PUMP GEAR SIDE CLEARANCE

1. Pull the fuel camshaft and pull the injection pump gear (1) to each end.
2. Measure the clearance A between the injection pump gear (1) and the snap ring (2) on the fuel camshaft.
3. If the clearance exceeds the allowable limit, check the gear, the bearing and the key.

Item	Factory spec.	Allowable limit
Side clearance (A)	0.15 ~ 0.57 mm 0.0059 ~ 0.0224 in.	0.9 mm 0.035 in.

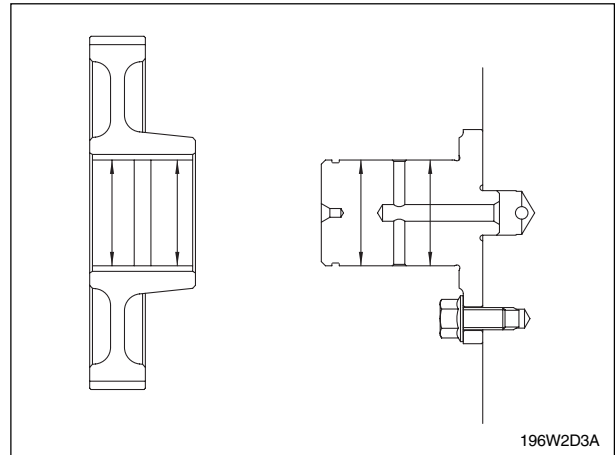


(1) Injection pump gear
(2) Snap ring

E. IDLE GEAR OIL CLEARANCE

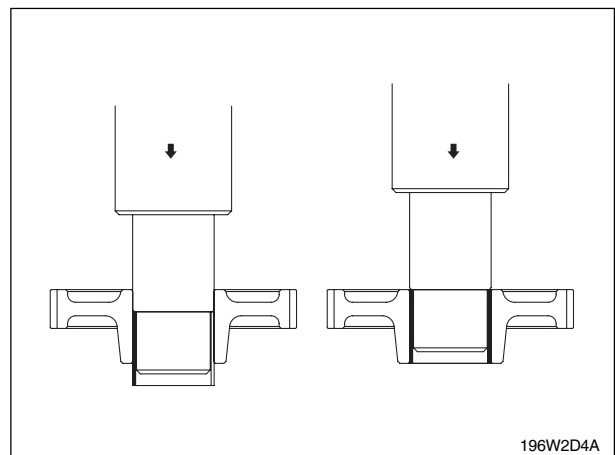
1. Measure the idle gear shaft O.D. with an outside micrometer.
2. Measure the idle gear bushings I.D. with an inside micrometer.
3. If the clearance exceeds the allowable limit, replace the bushing

Item	Factory spec.	Allowable limit
Oil clearance	0.025 ~ 0.066 mm 0.00098 ~ 0.00259 in.	0.1 mm 0.004 in.
Shaft O.D	23.967 ~ 23.98 mm 0.9436 ~ 0.9441 in.	-
Bushing I .D	24.000~ 24.021 mm 0.9449 ~ 0.9457 in.	-



F. REPLACING IDLE GEAR BUSHINGS

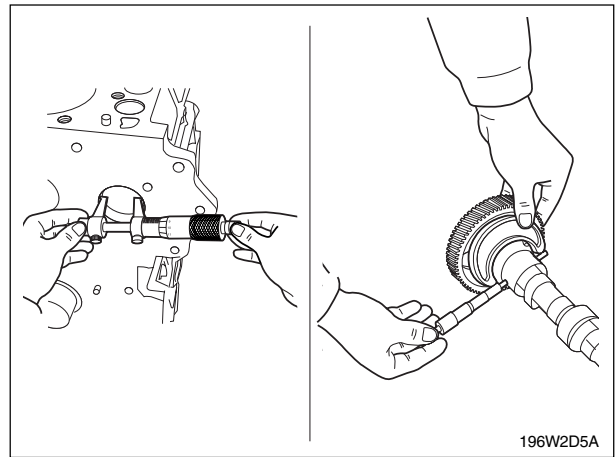
1. Press out the bushings using an idle gear bushing replacing tool.
2. Clean the bushings and the bore, and apply oil to them.
3. Press in the bushing using the replacing tool.



G. CAMSHAFT OIL CLEARANCE

1. Measure the I.D. of the camshaft bore on the crankcase with an inside micrometer.
2. Measure the O.D. of the camshaft journal with an outside micrometer.
3. If the clearance exceeds the allowable limit, replace the shaft.

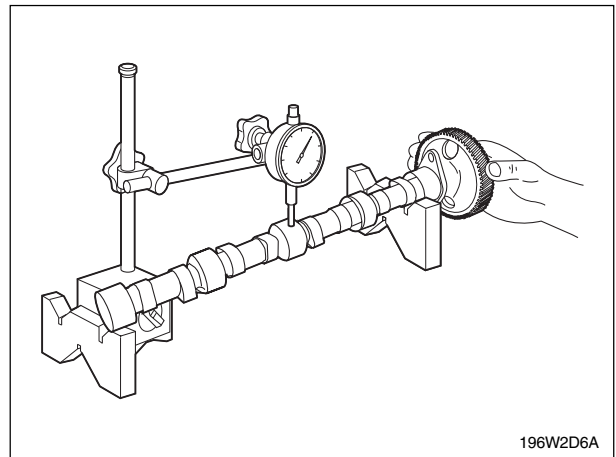
Item	Factory spec.	Allowable limit
Oil clearance	0.050 ~ 0.090 mm 0.0020 ~ 0.0036 in.	0.15 mm 0.0059 in.
Journal O.D.	32.934 ~ 32.950 mm 1.2966 ~ 1.2972 in.	-
Bore I.D	33.000 ~ 33.025 mm 1.2992 ~ 1.3002 in.	-



H. CAMSHAFT ALIGNMENT

1. Support the camshaft with V blocks on the surface plate at both end journals and set a dial indicator with its tip on the intermediate journal.
2. Rotate the camshaft in the V block and get the eccentricity (half of the measurement).
3. If the eccentricity exceeds the allowable limit, replace the camshaft.

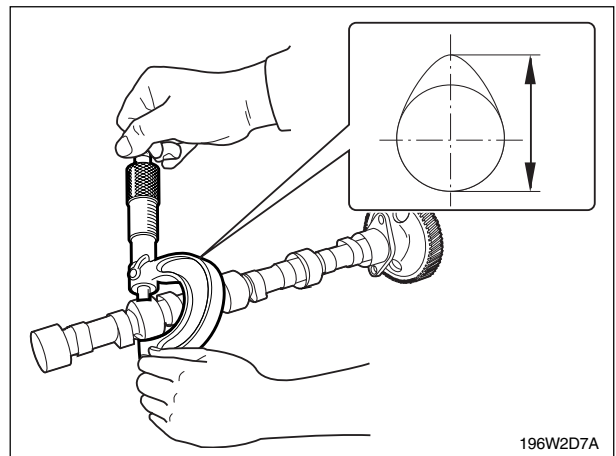
Item	Allowable limit
Eccentricity	0.08 mm 0.0031 in.



I. CAM HEIGHT

1. Measure the height of the camshaft lobes at their largest O.D. with an outside micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft.

Item	Allowable limit
Reference value	26.75 mm 1.0531 in.
Allowable limit	26.83 mm 1.0563 in.

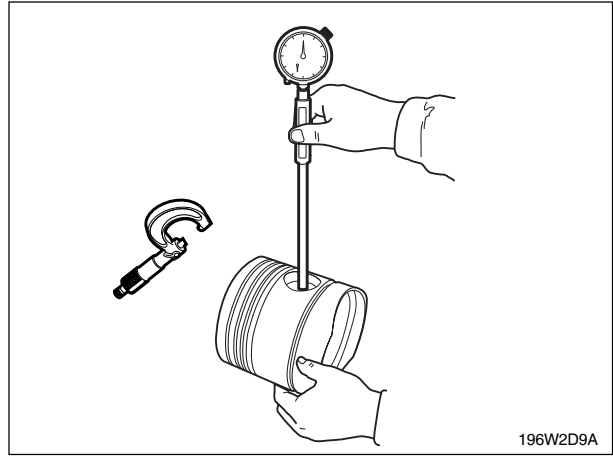


7.2.6 CONNECTING ROD AND PISTON

A. PISTON PIN BORE

1. Measure the I.D. of piston pin bore in piston (lengthwise and widthwise of the piston) with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace the piston.

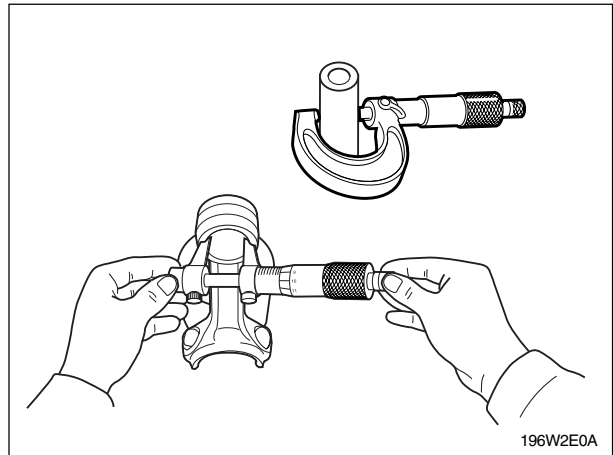
Item	Factory spec.	Allowable limit
Piston pin bore I.D.	20.000 ~ 20.013 mm 0.7874 ~ 0.7879 in.	20.03 mm 0.7886 in.



B. PISTON PIN AND BUSHING CLEARANCE

1. Measure the piston pin O.D. with an outside micrometer.
2. Measure the piston pin busing I.D. with an inside micrometer.
3. Of the clearance exceeds the allowable limit, replace the bushing.
4. If the clearance still exceeds the allowable limit with new bushing, replace the piston pin.

Item	Factory spec.	Allowable limit
Piston pin and bushing clearance	0.014 ~ 0.038 mm 0.00055 ~ 0.00150 in.	0.15 mm 0.0059 in.
Piston pin O.D.	20.002 ~ 20.011 mm 0.7875 ~ 0.7878 in.	-
Bushing I.D.	20.025 ~ 20.040 mm 0.7884 ~ 0.7890 in.	-

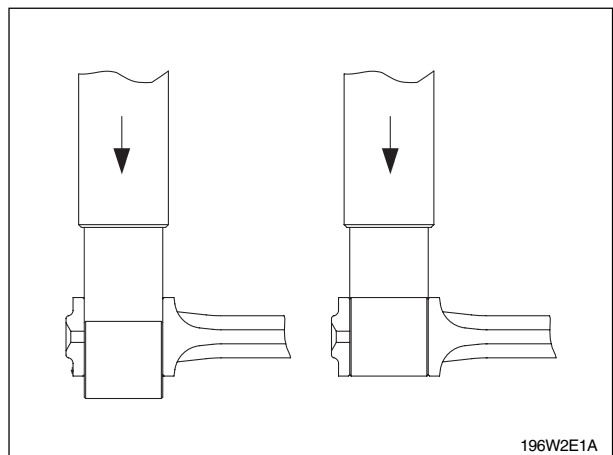


C. REPLACING PISTON PIN BUSHING

1. Press out the bushing, using a piston pin bushing replacing tool.
2. Clean the new bushing and the bore and apply oil to them.
3. Press in the bushing, using the replacing tool.

+ IMPORTANT

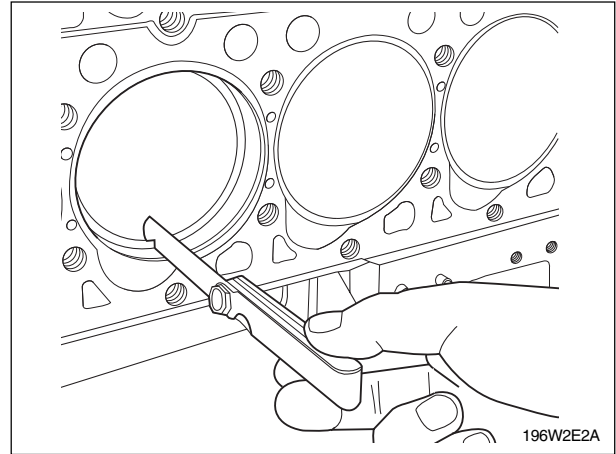
- **Align the oil holes of the connecting rod and the bushing.**



D. PISTON RING GAP

1. Push down the ring into the cylinder to the lower limit of ring travel in the assembled engine with a piston.
2. Measure the ring gap with a feeler gauge.
3. If the gap exceeds the allowable limit, replace the piston ring.

Item		Factory spec.	Allowable limit
Piston ring gap	Top ring	0.15 ~ 0.30 mm	1.25 mm
		0.0059 ~ 0.0118 in.	0.0492 in.
	2nd ring	0.30 ~ 0.45 mm	1.25 mm
		0.0118 ~ 0.0177 in.	0.0492 in.
	Oil ring	0.25 ~ 0.35 mm	1.25 mm
		0.0098 ~ 0.0138 in.	0.0492 in.



+ **IMPORTANT**

- **Measure The piston ring gap at the point of the minimum inside diameter of the cylinder liner.**

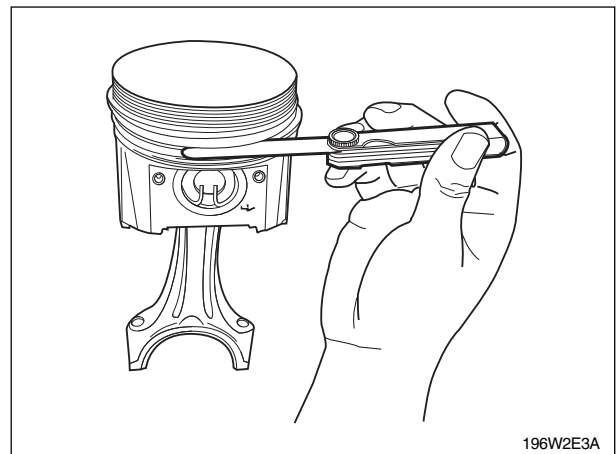
E. PISTON RING CLEARANCE

1. Clean the rings and the ring grooves, and install each ring in its groove.
2. Measure the clearance between the ring and the groove with a feeler gauge.
3. If the clearance exceeds the allowable limit, replace the piston ring.
4. If the clearance still exceeds the allowable limit with new ring, replace the piston.

NOTE:

- *As the top ring is a keystone type, it cannot be measured by this method.*

Item	Reference value
Second ring	0.085 ~ 0.112 mm
	0.0033 ~ 0.0044 in.
Oil ring	0.020 ~ 0.055 mm
	0.0008 ~ 0.0022 in.



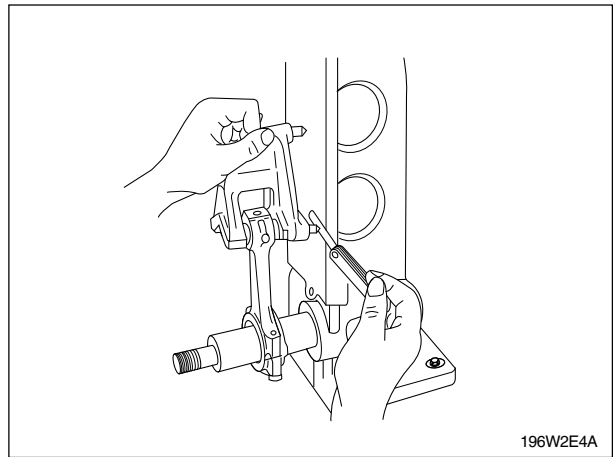
F. CONNECTING ROD ALIGNMENT

1. Remove the connecting rod bearing and install the bearing cap.
2. Install the piston pin in the connecting rod.
3. Install the connecting rod on the connecting rod alignment tool.
4. Put a gauge over the piston pin and move it against the face plate.
5. If the gauge does not fit squarely against the faceplate, measure the space between the pin of the gauge and the faceplate.
6. If the measurement exceeds the allowable limit, replace the connecting rod.

Reference value	0.02 mm 0.0008 in.
Allowable limit	0.05 mm 0.0020 in.

+ IMPORTANT

- *Because the I.D. of the connecting rod small end bushing is used as the basis for this check, check it is not worn beforehand.*

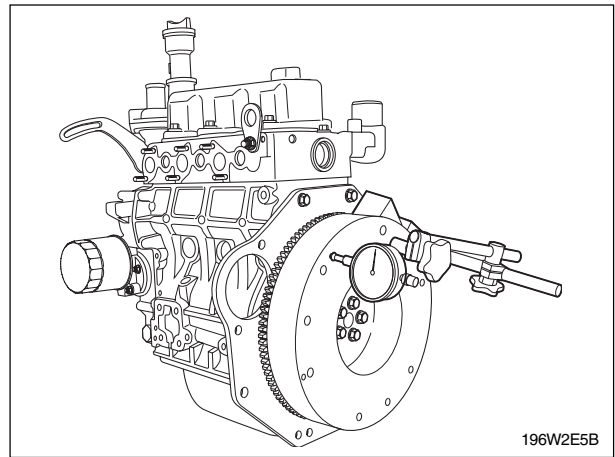


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7.2.7 CRANKSHAFT

A. FLYWHEEL DEFLECTION AND CRANKSHAFT END PLAY

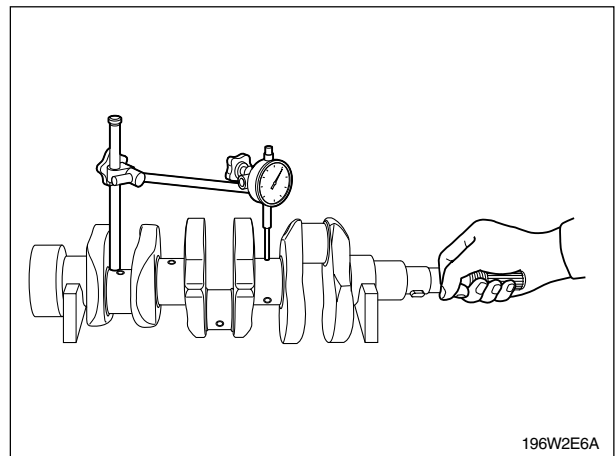
1. Set a dial indicator with its tip on the rear friction face of the flywheel near the edge.
2. Turn the flywheel and measure the deflection or the uneven wear.
3. If the measurement exceeds the allowable limit, remove the flywheel and check the mating faces of the crankshaft and flywheel.
4. If scored or worn excessively, regrind or replace the flywheel.
5. Move the crankshaft with flywheel back and forth to each end and measure the end play.
6. If the play exceeds the allowable limit, replace the side bearing.



Item	Factory spec.	Allowable limit
Deflection	-	0.05 mm 0.0020 in.
End play	0.15 ~ 0.31 mm 0.0059 ~ 0.0122 in.	0.5 mm 0.020 in.

B. CRANKSHAFT ALIGNMENT

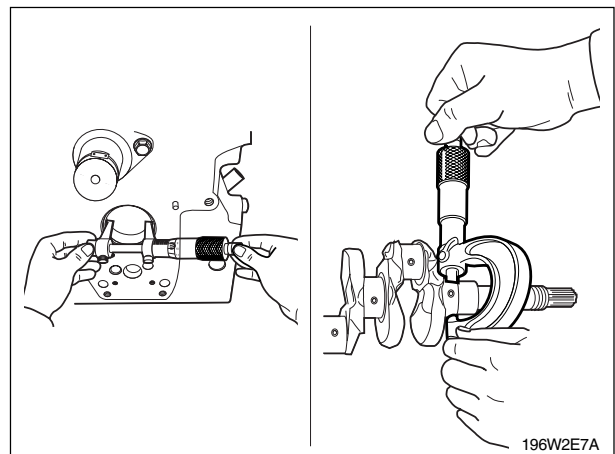
1. Support the crankshaft with V blocks on the surface plate at its front and rear journals and set a dial indicator with its tip on the intermediate journal.
2. Rotate the crankshaft in the V blocks and get the misalignment (half of the measurement)
3. If the misalignment exceeds the allowable limit, replace the crankshaft.



Item	Factory spec.	Allowable limit
Misalignment	0.02 mm 0.0008 in.	0.08 mm 0.0031 in.

C. CRANKSHAFT JOURNAL AND BEARING 1 OIL CLEARANCE

1. Measure the I.D. of the crankshaft bearing 1 with an inside micrometer.
2. Measure the O.D. of the crankshaft journal with an outside micrometer.
3. If the clearance exceeds the allowable limit, replace the bearing replacing to Replacing Crankshaft Bearing 1.

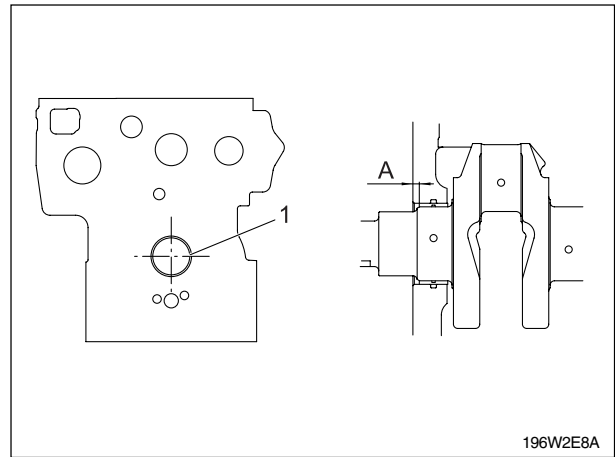


Item	Factory spec.	Allowable limit
Oil clearance	0.034 ~ 0.092 mm 0.0013 ~ 0.0036 in.	0.20 mm 0.0079 in.
Journal O.D.	43.934 ~ 43.950 mm 1.7297 ~ 1.7303 in.	-
Bearing 1 I.D.	43.984 ~ 44.040 mm 1.7317 ~ 1.7339 in.	-

D. REPLACING CRANKSHAFT BEARING 1

1. Press out the bearing 1 with crankshaft replacing tool.
2. Clean a new bearing 1 and bore, and apply engine oil to them.
3. Press fit a new bearing 1 using a inserting tool, taking due care to see that the seam of bearing 1 faces the exhaust manifold side.

Item	Factory spec.
Depressed depth of bush at block	4.2 ~ 4.5 mm 0.165 ~ 0.177 in.



(1) Seam

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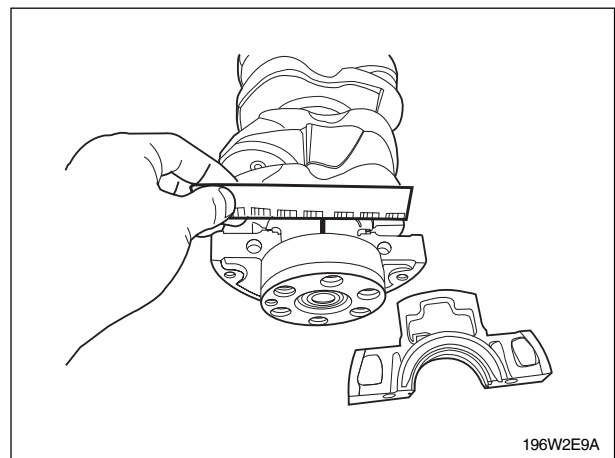
E. CRANKSHAFT JOURNAL AND BEARING 2 OIL CLEARANCE

1. Paste a press gauge with grease on the crankshaft bearing
2. Install the bearing cap and tighten the screws to the specified torque once, and remove the cap again.
3. Detach the bearing case slowly, and measure the depression of the press gauge with a sheet of gauge (paper).
4. If the clearance exceeds the allowable limit, replace the bearing.

Item	Tightening torque
Bearing cap	20 ~ 24 Nm 2.0 ~ 2.4 kgf-m 15 ~ 17 lb-ft

Reference value	0.034 ~ 0.092 mm 0.0013 ~ 0.0036 in.
Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D.	43.934 ~ 43.950 mm 1.7297 ~ 1.7303 in.
Crankshaft bearing 2 I.D.	43.984 ~ 44.026 mm 1.7317 ~ 1.7333 in.



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F. CRANKPIN AND CONNECTING ROD BEARING OIL CLEARANCE

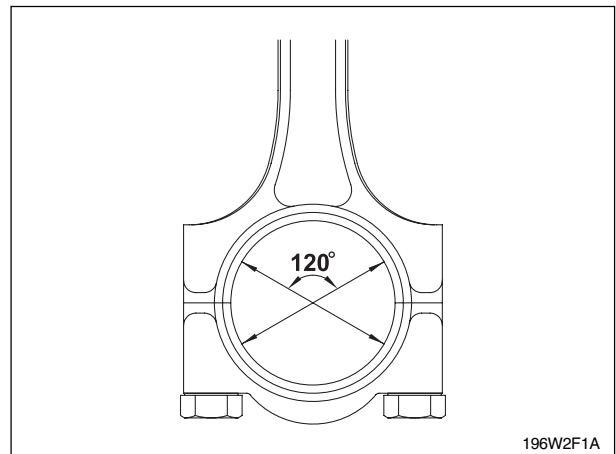
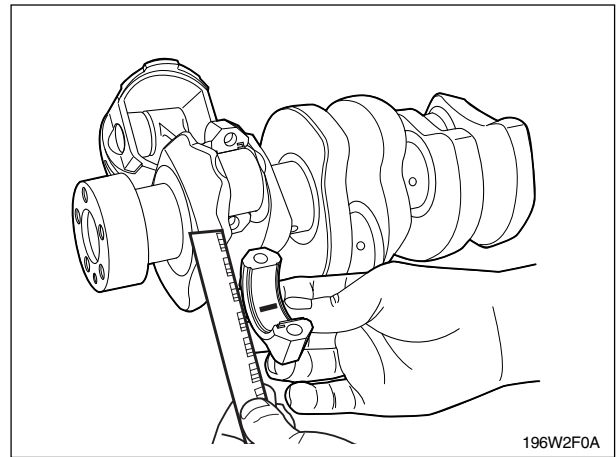
1. Paste a press gauge onto the crank pin bearing with grease.
2. Install the connecting rod cap and tighten the screws to the specified torque once, and remove the cap again.
3. Remove the connecting rod gently, and measure the depression of the press gauge with a sheet of gauge (paper).
4. If the clearance exceeds the allowable limit, replace the bearing.

Item	Tightening torque
Connecting rod cap	26.5 ~ 30.4 Nm 2.7 ~ 3.1 kgf-m 19.52 ~ 22.42 lb-ft

Reference value	0.029 ~ 0.091 mm 0.0011 ~ 0.0036 in.
Allowable limit	0.20 mm 0.0079 in.

(Note for measuring)

- Fasten the crankshaft so that it does not turn.
- Do not insert the press gauge into the crank pin hole.
- Crankpin bearing measuring points are shown below.



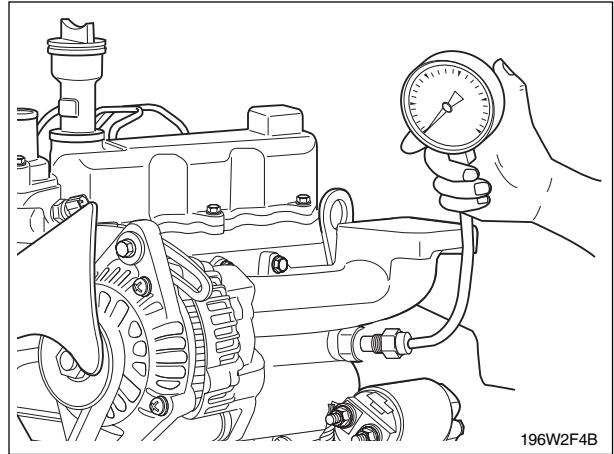
7.2.8 LUBRICATING SYSTEM

A. ENGINE OIL PRESSURE

1. Remove the oil pressure switch and install adaptors and pressure tester.
2. Start the engine and run it until it is warmed up, and measure the oil pressure both at idling and rated speed.
3. If the oil pressure is less than the allowable limit, check the amount of oil, oil filter, oil pump relief valve, oil passages and oil clearances.

(When reassembling)

- Supply the specified amount of recommended oil.
- The oil filter must not be clogged or broken.



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Item		Factory spec.	Allowable limit
Engine oil pressure	At idle speed	More than 49 kPa 0.5 kgf/cm ² 7.11 psi.	-
	At rated speed	245 ~ 441 kPa 2.5 ~ 4.5 kgf/cm ² 36 ~ 64 psi.	245 kPa 2.5 kgf/cm ² 36 psi.

(Reference)

Item	Tightening torque
Oil pressure switch	14.7 ~ 19.6 Nm 1.5 ~ 2.0 kgf-m 10.8 ~ 14.5 lb-ft

B. RELIEF VALVE

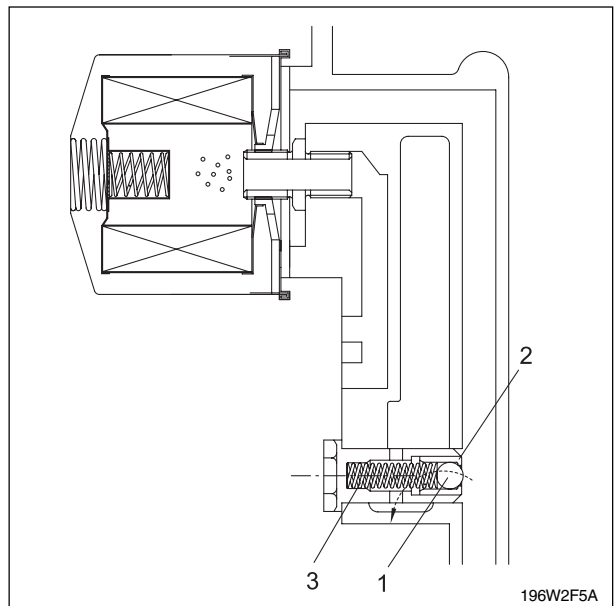
1. Remove the relief valve.
2. Check the relief valve for dirt, and the seat (2) and ball (1) for damage.
3. If damaged, replace.
4. Check the free length of spring (3).
5. If less than the allowable limit, replace.

Item	Factory spec.	Allowable limit
Spring free length	35 mm 1.38 in.	30 mm 1.18 in.

NOTE:

- Install the relief valve cover with the mark ▲ up.

Item	Tightening torque
Relief cover screw	32.4 ~ 36.3 Nm 3.3 ~ 3.7 kgf-m 23.9 ~ 36.8 lb-ft



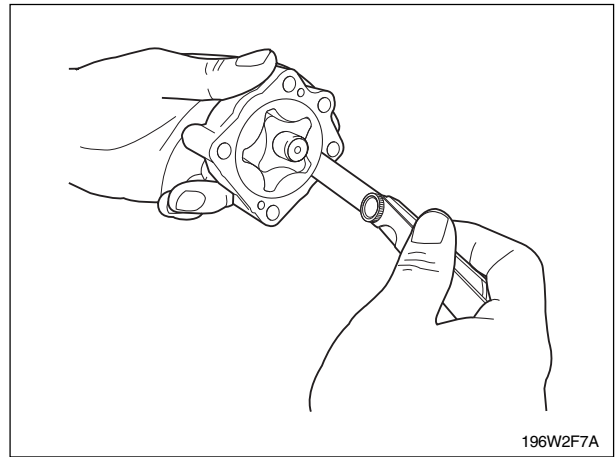
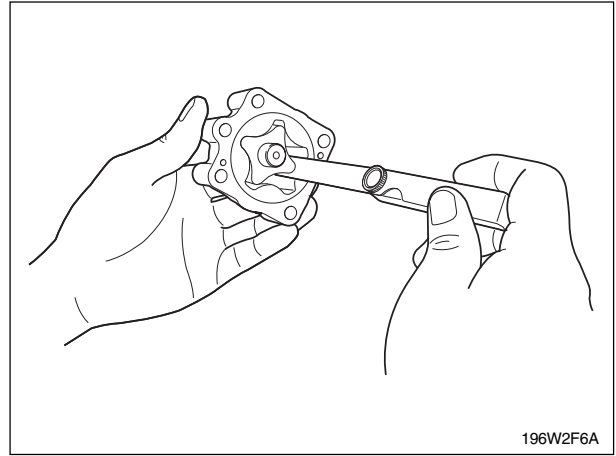
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- (1) Relief valve ball
- (2) Relief valve seat
- (3) Relief valve spring

C. ROTOR AND LOBE CLEARANCE OF OIL PUMP

1. Measure the clearance between the outer and inner rotor with a feeler gauge.
2. Measure the clearance between the outer and the housing with a feeler gauge.
3. If the clearance exceeds the allowable limit, replace the pump.

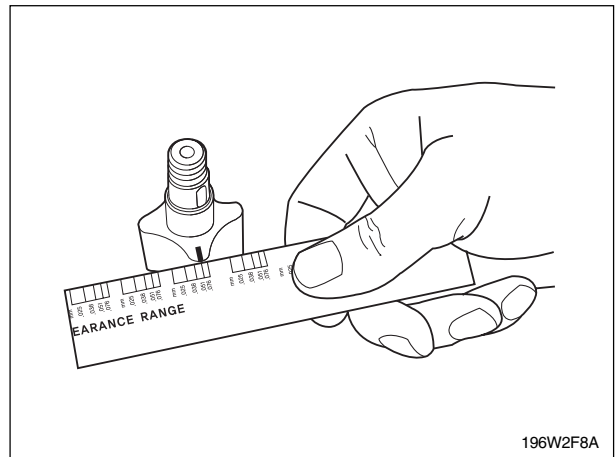
Item	Factory spec.	Allowable limit
Outer and inner rotor clearance	0.11 ~ 0.15 mm 0.0043 ~ 0.0059 in.	0.20 mm 0.0079 in.
Outer rotor and housing clearance	0.07 ~ 0.15 mm 0.0028 ~ 0.0059 in.	0.25 mm 0.0098 in.



D. ROTOR END CLEARANCE OF OIL PUMP

1. Put a strip of Plastic gauge on the rotor and assemble the pump.
2. Disassemble the pump and measure the amount of the flattening with the scale to get the clearance.
3. If the clearance exceeds the allowable limit, replace the pump.

Item	Factory spec.	Allowable limit
End clearance	0.08 ~ 0.13 mm 0.00315 ~ 0.00512 in.	0.20 mm 0.0079 in.



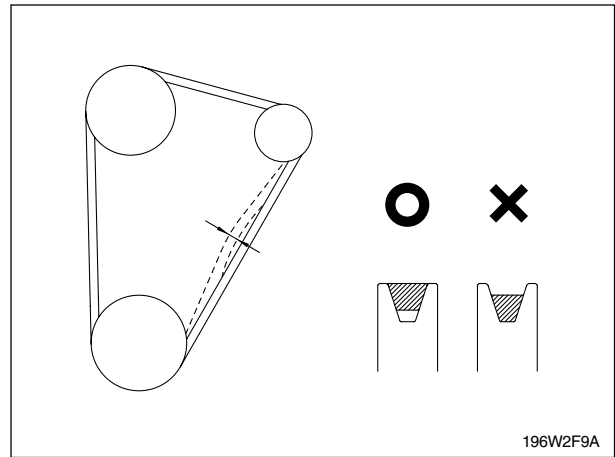
7.2.9 COOLING SYSTEM

A. CHECKING AND ADJUSTING

► Fan Belt

1. Measure the deflection, depressing the belt half-way between the fan drive pulley and the alternator pulley at 78.5 N (8 kgf, 17.6 lbs.) of force.
2. If the deflection is not between the factory specifications, loosen the bolts and nuts, and relocate the alternator to adjust.
3. If the belt is damaged or worn (See figure), replace the belt.

Item	Factory spec.
Belt tension (deflection)	8 mm(0.32 in.) at 78.5 N (8 kgf, 17.6 lbs.) of force

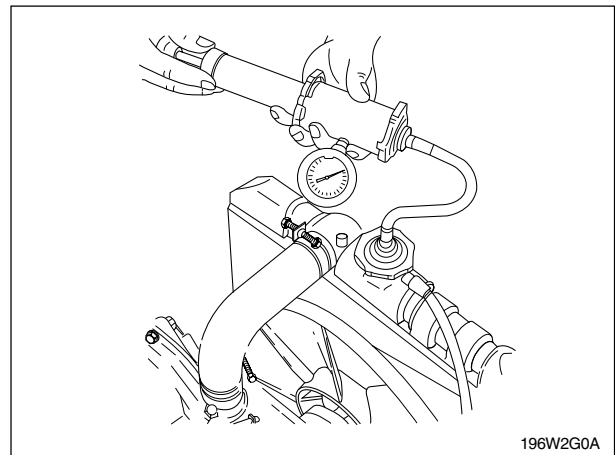


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► Radiator Water Tightness

1. Fill the radiator with water to the specified amount and warm up the engine.
2. Set a radiator tester and raise the water pressure to the specified pressure.
3. Check the radiator for water leaks.
4. For water leak from the pin holes, repair with the radiator cement, and for other leaks, replace the radiator.

Item	Factory spec.
Radiator water tightness	No leaks at 137 kPa (1.4 kgf/cm ² , 20 psi)

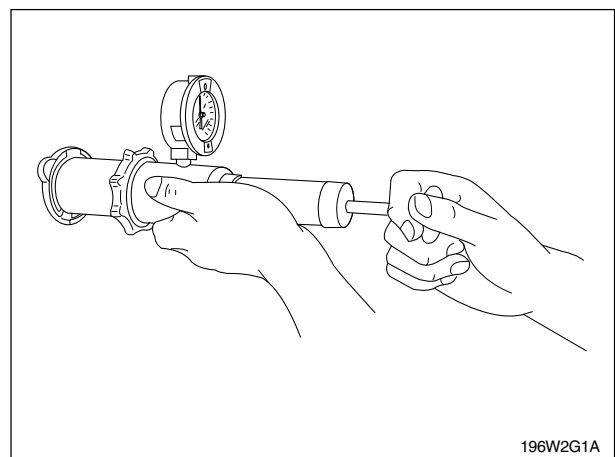


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► Radiator Cap Tightness

1. Set a radiator tester on the radiator cap.
2. Apply 88 kPa (0.9 kgf/cm², 13 psi) of pressure and measure the pressure for 10 seconds.
3. If the pressure falls below 59 kPa (0.6 kgf/cm², psi), replace the radiator cap.

Item	Factory spec.
Radiator cap tightness	More than 10 seconds for pressure fall from 88 ~ 59 kPa (0.9 ~ 0.6 kgf/cm ² , 13 ~ 9 psi).



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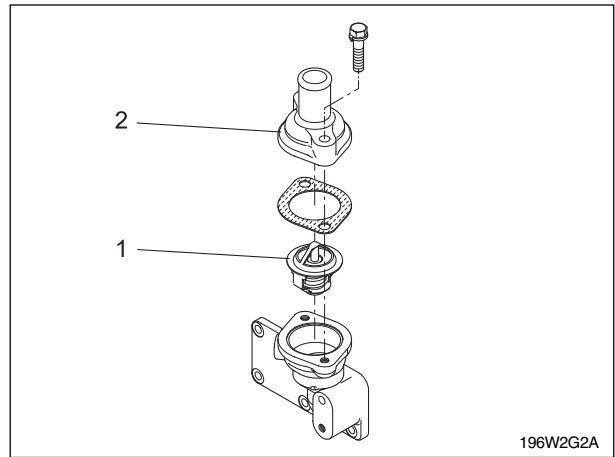
B. DISASSEMBLING AND ASSEMBLING

► **THERMOSTAT**

1. Remove the thermostat cover (2).
2. Take out the thermostat (1).

(When reassembling)

- Apply liquid gasket (Three Bond 1,215 or equivalent) to the gasket.



(1) Thermostat

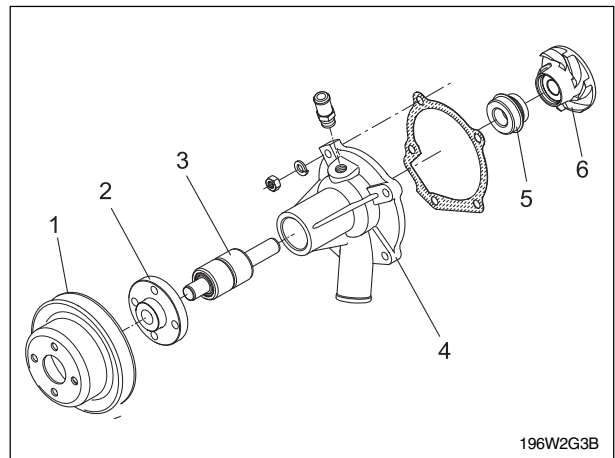
(2) Thermostat Cover

► **WATER PUMP**

1. Remove the fan and fan pulley(1).
2. Remove the water pump body from gear case cover.
3. Remove the water pump flange (2).
4. Remove the impeller and water pump shaft (3).
5. Remove the impeller from the water pump shaft.
6. Remove the mechanical seal (5).

(When reassembling)

- Replace the mechanical seal (5) with new one.
- If changing the water pump, change the whole one.
- If disassembling the water pump, check to see the clearance between the water pump impeller and body.



(1) Fan pulley

(4) Water pump body

(2) Flange

(5) Mechanical seal

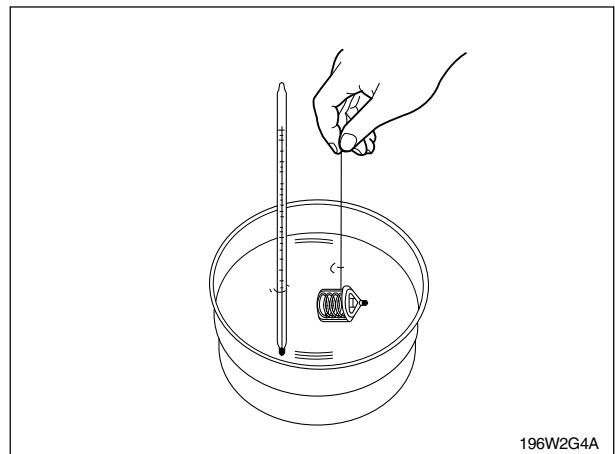
(3) Pump shaft

(6) Impeller

C. THERMOSTAT

1. Suspend the thermostat in the water by a string with its end inserted between the valve and seat.
2. Heating the water gradually, read the temperatures when the valve open and leave the string and when the valve opens approx. 8 mm (0.315 in.)
3. If the measurements are not within the factory specification, replace the thermostat.

Item	Factory spec.
Opening temperature	82 ± 1.5°C (180 ± 3°F) at beginning
	lower than 95°C (203°F) at 8 mm (0.315 in.) of opening.



7.2.10 FUEL SYSTEM

A. DELIVERY VALVES FUEL TIGHTNESS

1. Remove the injection pipes, glow plugs and the inlet manifold, and install the pressure tester.
2. With the speed control lever at the fuel injection position, turn the crankshaft counterclockwise (facing the flywheel) until the pressure build up to the fuel injection pressure.
3. Release the pressure in the delivery chamber by moving down the plunger to bottom dead center (turn the crankshaft clockwise approx. 1.57 rad (90°) from the F1 timing).
4. If the pressure drop for 5 seconds exceeds the allowable limit, replace the delivery valve or pump assembly.
5. If the pressure does not built up, replace the pump element with new one and test again.

Item	Factory spec.	Allowable limit
Fuel injection pressure	21.57 MPa	20.59 MPa
	220 kgf/cm ²	210 kgf/cm ²
	3,129 psi	2,987 psi.
Standards	10 sec	5 sec

CAUTION

- *Never contact with spraying diesel fuel under pressure, which can have sufficient force to penetrate the skin, causing serious personal injury.*
- *Be sure nobody is in the direction of the spray.*

B. FUEL LECTION PRESSURE

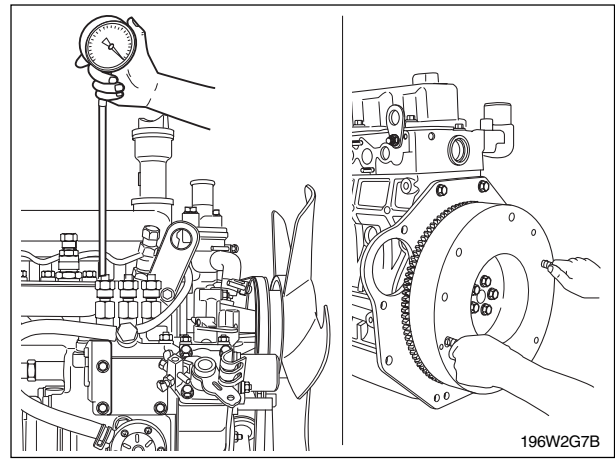
1. Set the injection nozzle to the nozzle tester.
2. Measure the injection pressure.
3. If the measurement is not within the factory specification, adjust with the adjustment washer (1) inside the nozzle holder.

(Reference)

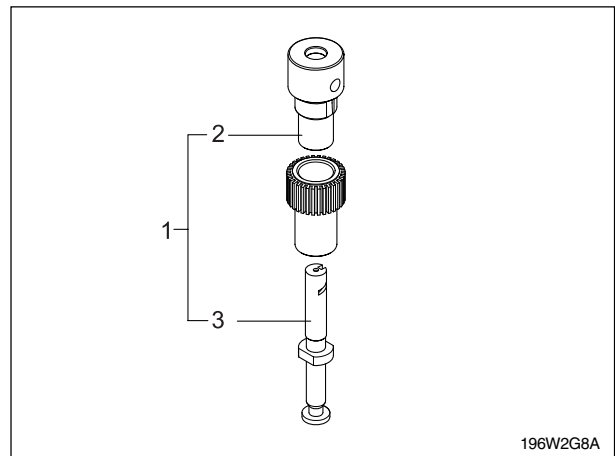
Pressure variation with 0.1 mm (0.004 in.) difference of adjusting washer thickness is approx. 10 kgf/cm².

Fuel injection pressure

Item	Factory spec.
Fuel injection pressure	13.73 ~ 14.71 MPa
	140~ 150 kgf/cm ²
	1,991 ~ 2,133 psi.

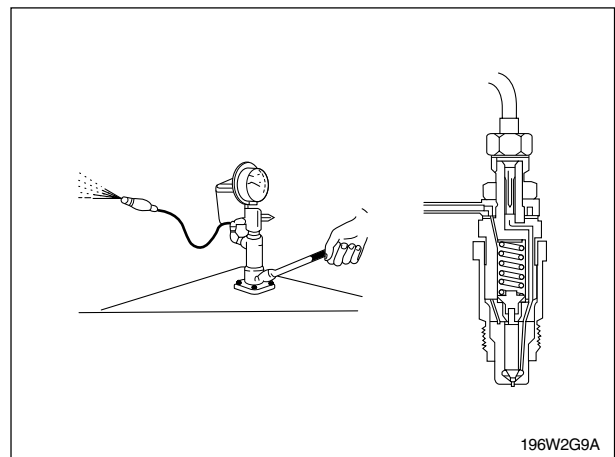


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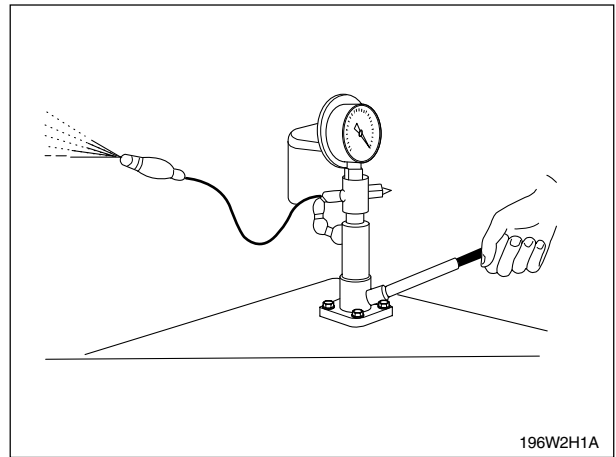
- (1) Pump element
- (2) Cylinder
- (3) Plunger



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C. FUEL TIGHTNESS OF NEEDLE VALVE SEAT TIGHTNESS

1. Set the injection nozzle to the nozzle tester.
2. Apply a pressure 130 kgf/cm² (12.75 MPa, 1,849 psi). After keeping the nozzle under this pressure for 10 seconds. Check to see if fuel leaks from the nozzle.
3. If the should leak, replace the nozzle.



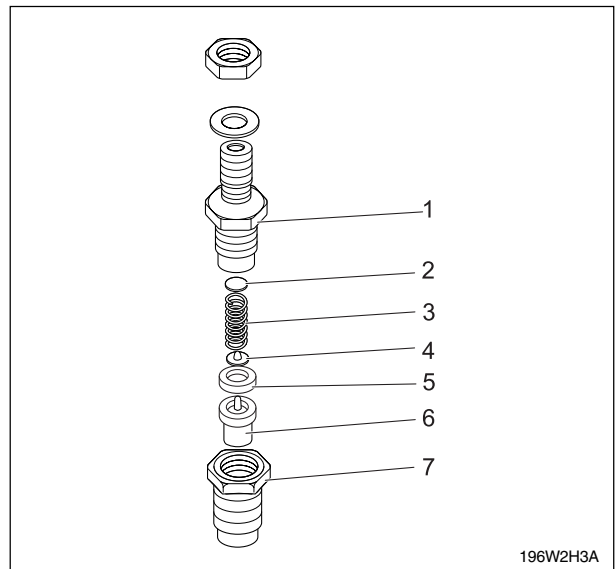
D. INJECTION NOZZLE

Nozzle holder

1. Secure the nozzle retaining nut (7) with a vise.
2. Remove the nozzle holder (1), and take out parts inside.

(When reassembling)

- Assemble the nozzle in clean fuel oil.
- Install the push rod (4), noting its direction.



- | | |
|----------------------|-------------------|
| (1) Nozzle holder | (3) Nozzle spring |
| (2) Adjusting washer | (4) Push rod |

MEMO

Series of horizontal dotted lines for writing.