

**MITSUBISHI DIESEL ENGINE**

**SERVICE MANUAL**

**MODEL K2AS  
K2B  
K2C  
KE70  
KE75**

'85-10

STM0140

*vetros*



**MITSUBISHI**  
**HEAVY INDUSTRIES, LTD.**



## **FOREWORD**

This Service Manual, prepared for the benefit of service mechanics, describes the structure and service procedures of the Mitsubishi vertical 2-cylinder diesel engines.

To ensure proper, effective and fast service and enable the engine to provide top performance over an extended period of time, you are urged to read this manual carefully.

Please note that the contents are subject to change due to design change for improvement and other reasons.



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## 0. General

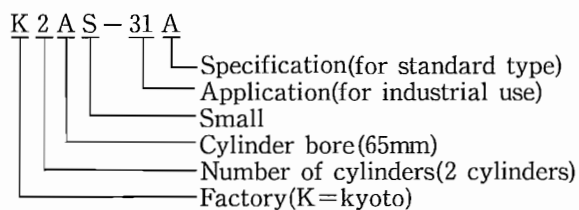
### 0.1 Engine Model and Serial Number

#### (1) Model Type Number and Use

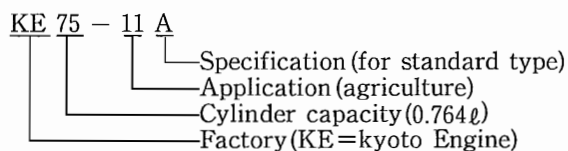
Model	Type Number	Use	Model	Type Number	Use
K2AS	-31DG	Generator and welder	KE70	-11BE	Tractor
	-61A	Standard for export		-11BF	"
	-61WM	Marine		-11GE	"
K2B	-31A	Standard type for industrial use		-11LH	"
	-31DG	Generator		-11SF	"
	-31DW	Welder		-13A	"
	-31SW	"	KE75	-11GE	Tractor
	-32SW	"		-11SF	"
	-51M	Marine		-12HK	"
-61A	Standard type for export	-12HL		"	
K2C	-31CW	Welder		-31A	Standard type for industrial use
	-31N	Power shovel		-31NA	Off-road 8-wheel vehicle
	-61A	Standard type for export	-31SW	Welder	
	-61EM	Marine	-61A	Standard type for export	
	-61SA	For export	-61EM	Marine	
	-61SS	Boat	-61SA	For export	
	-61WM	Marine	-61SS	Boat	
			-61WH	Hoe truck	

#### (2) Model & Type Number System

Example 1: Model k2

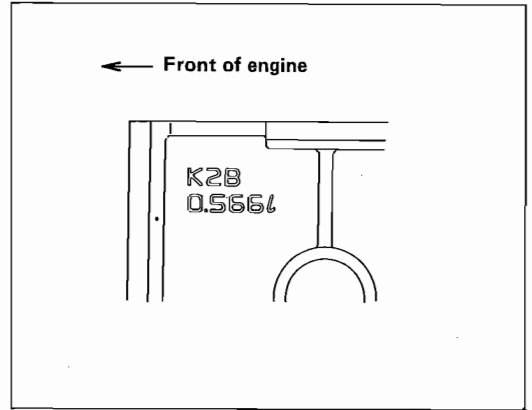


Example 2: Model KE 75



**(3) Location of Engine Model Indication**

The engine model is embossed on the front left side of the crankcase.



**Engine Model**

**(4) Location of Engine Number Stamp**

The engine number stamp position is as follows.

◎K2AS = left rear upper side of crankcase

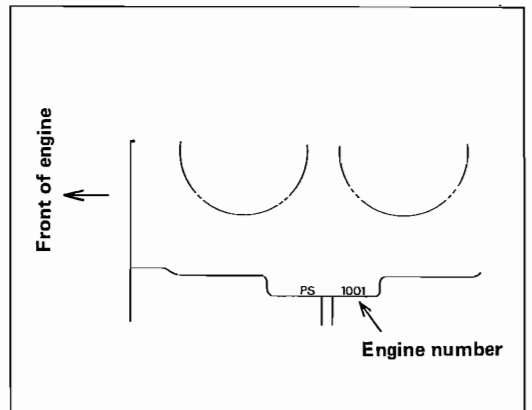
◎K2B&C = left center upper side of crankcase

◎KE70&75 = left front upper side of crankcase

**(5) Stamping of Engine Number**

The engine number is stamped as follows for every model.

Engine number	1001~
---------------	-------

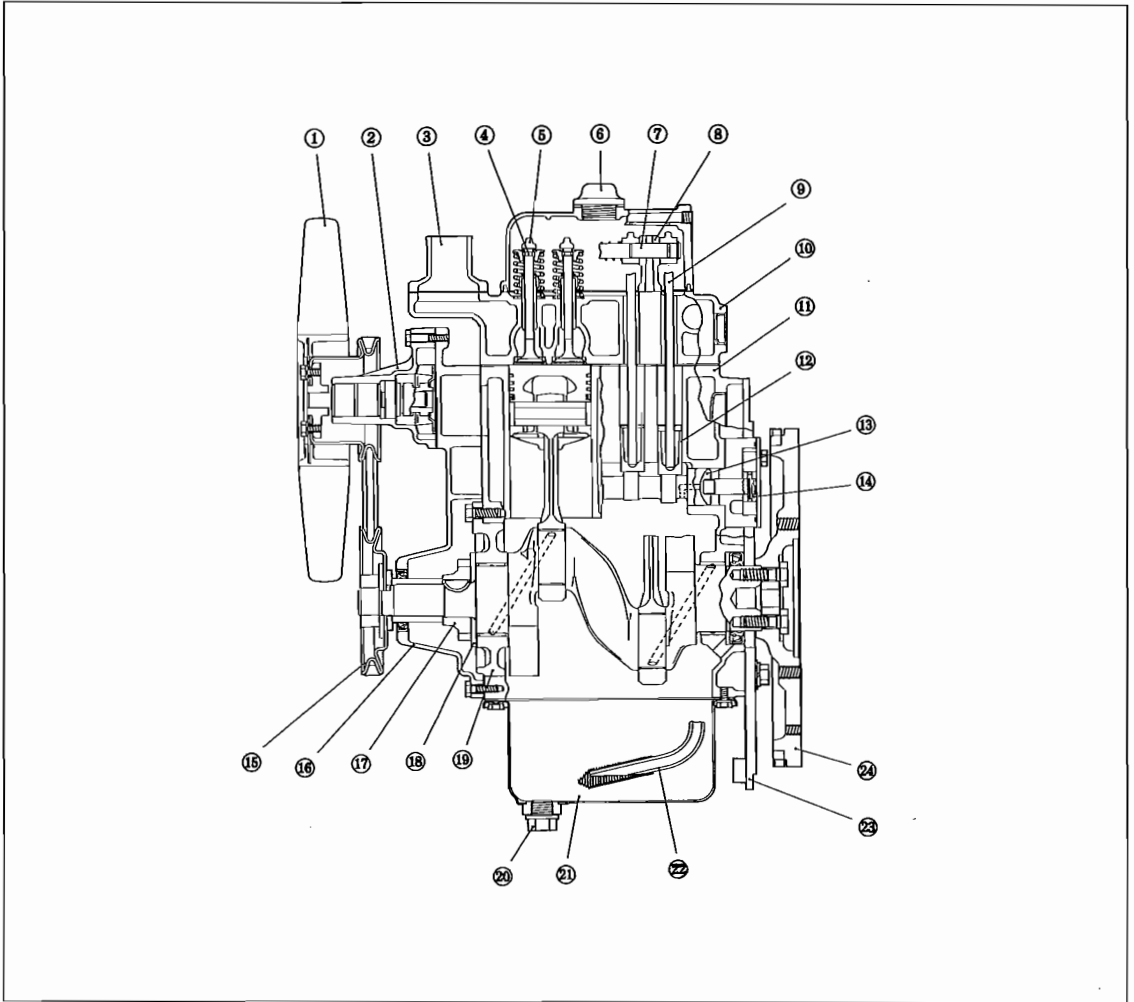


**Engine Number**



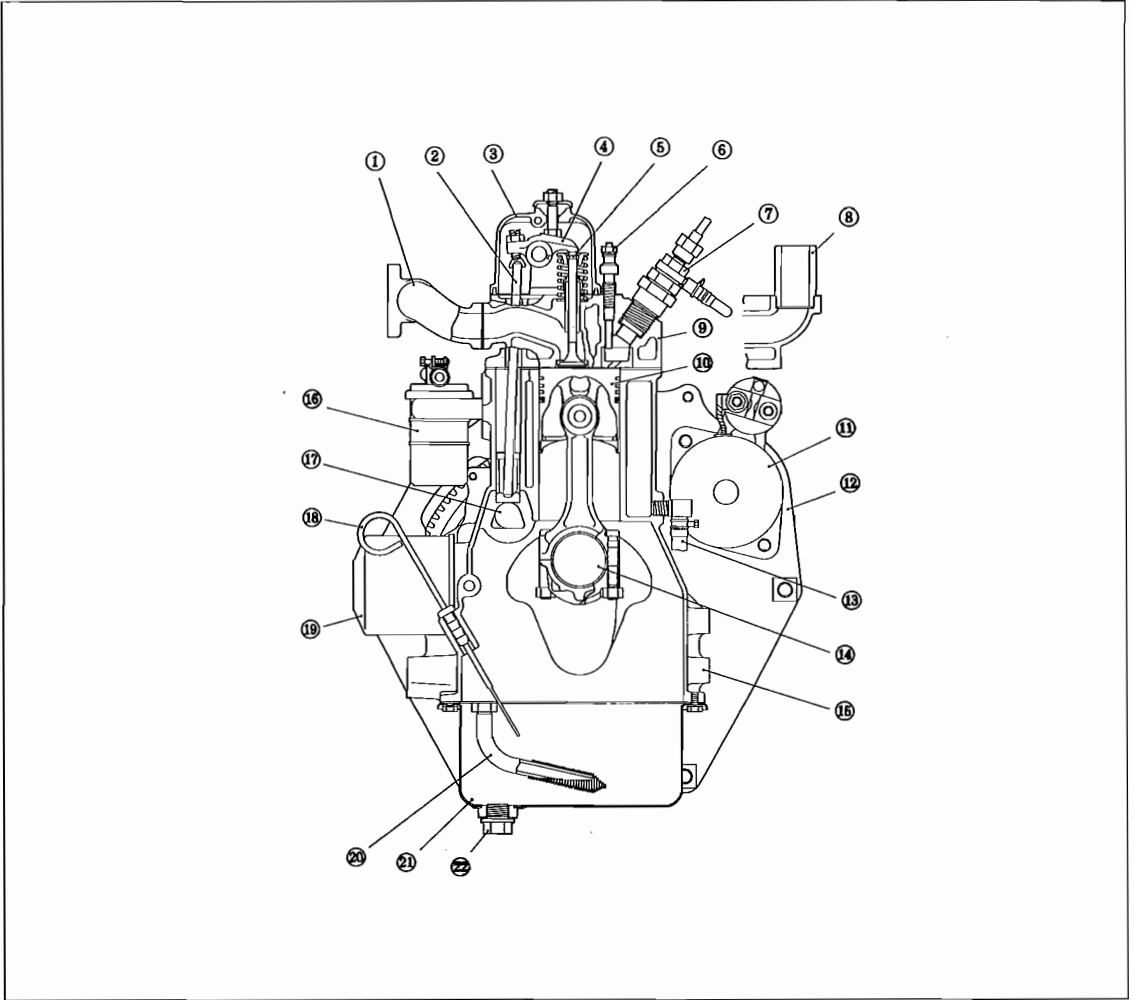
## 0. 2 Sectional Views

### (1) Cross Section of K2AS



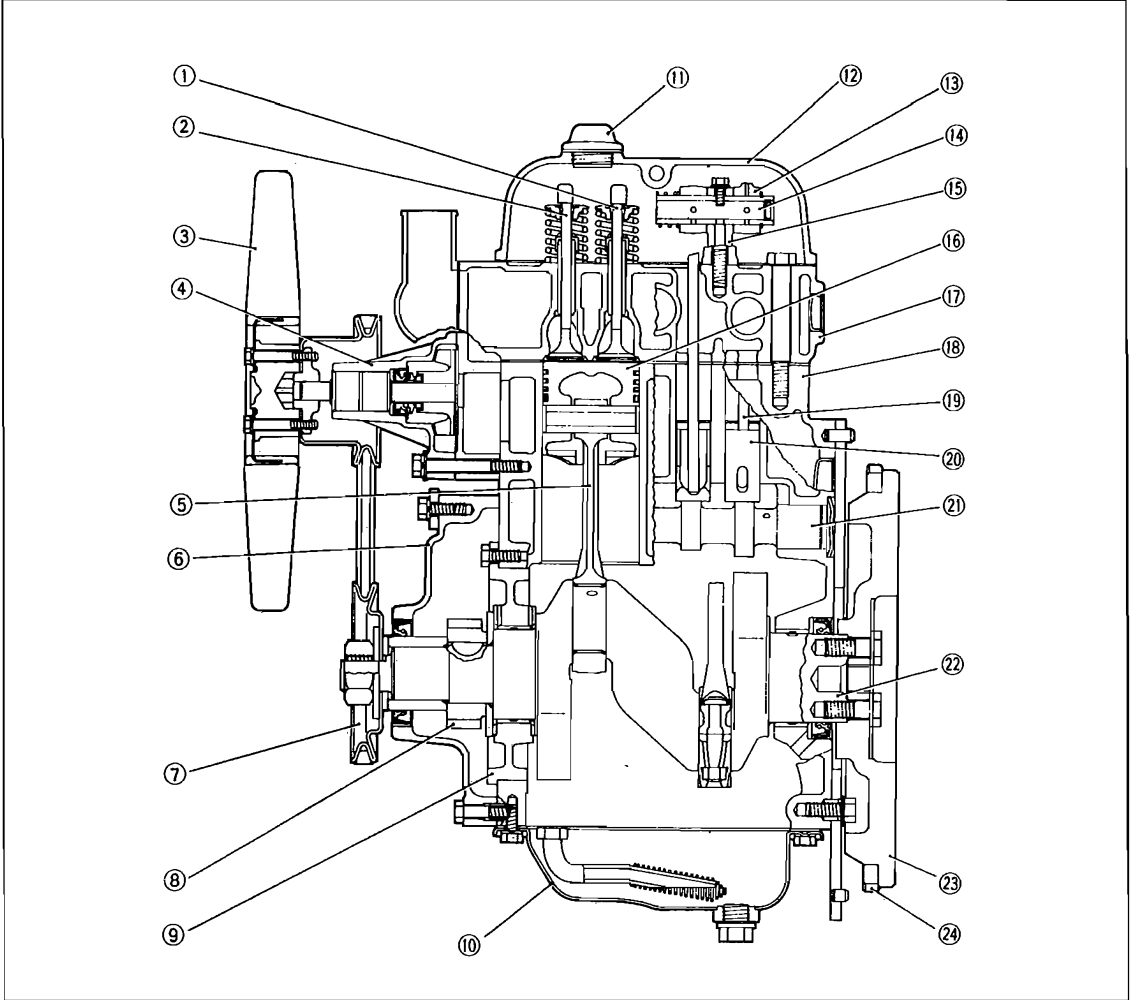
1. Cooling fan 2. Water pump 3. Water outlet fitting 4. Exhaust valve 5. Rocker arm 6. Oil filler cap  
7. Rocker shaft 8. Rocker shaft stay 9. Push rod 10. Cylinder head 11. Crankcase 12. Tappet 13. Camshaft  
14. Oil pump 15. Crankshaft pulley 16. Gear case 17. Crankshaft gear 18. Stopper plate 19. Bearing housing  
20. Oil drain plug 21. Oil pan 22. Oil screen 23. Rear plate 24. Flywheel

**(2) Profile of K2AS**



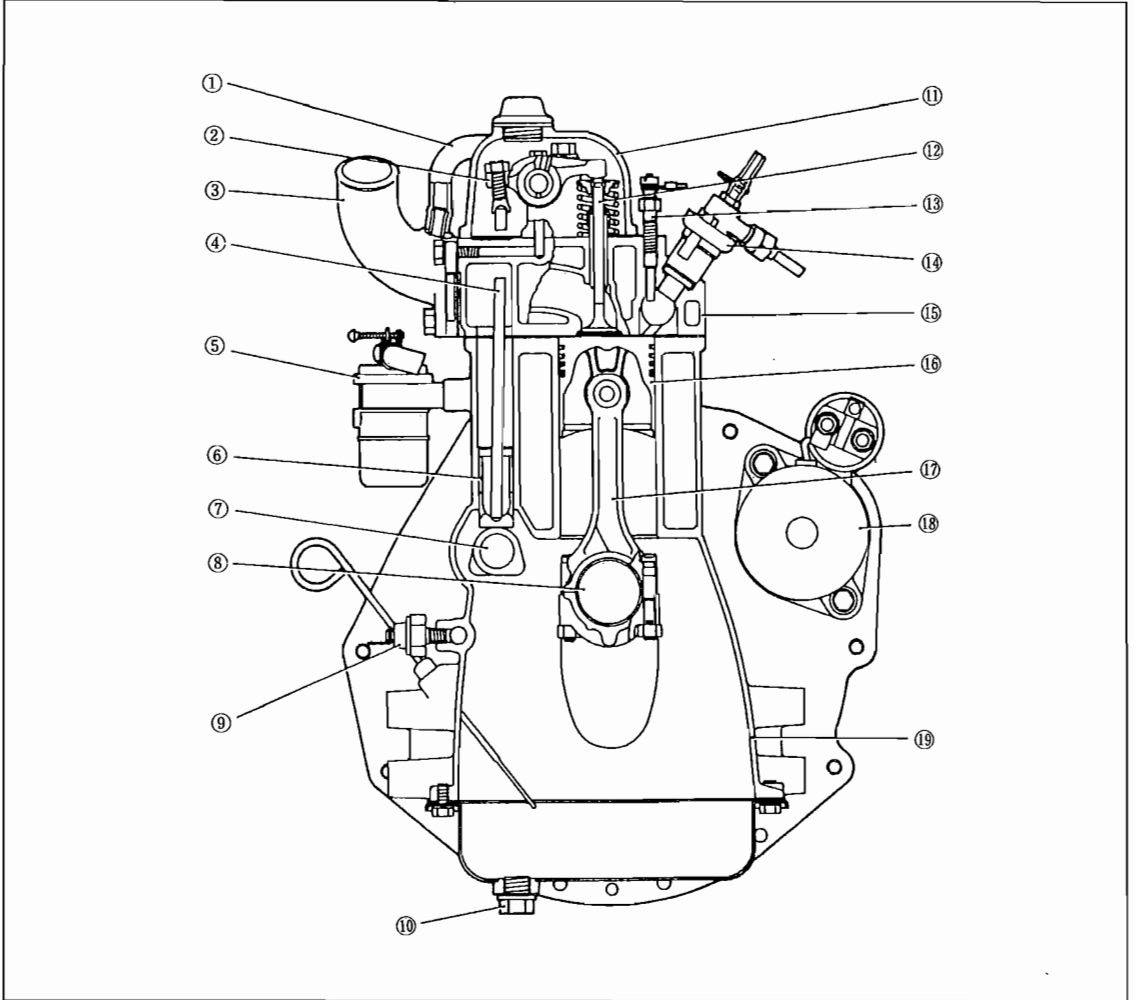
1. Exhaust manifold 2. Push rod 3. Rocker cover 4. Rocker arm 5. Exhaust valve 6. Glow plug 7. Nozzle holder 8. Intake pipe 9. Cylinder head 10. Piston 11. Starter 12. Rear plate 13. Water drain pipe 14. Crankshaft 15. Crankcase 16. Fuel filter 17. Camshaft 18. Oil level gauge 19. Oil filter 20. Oil screen 21. Oil pan 22. Oil drain plug

**(3) Cross Section of K2B & C**



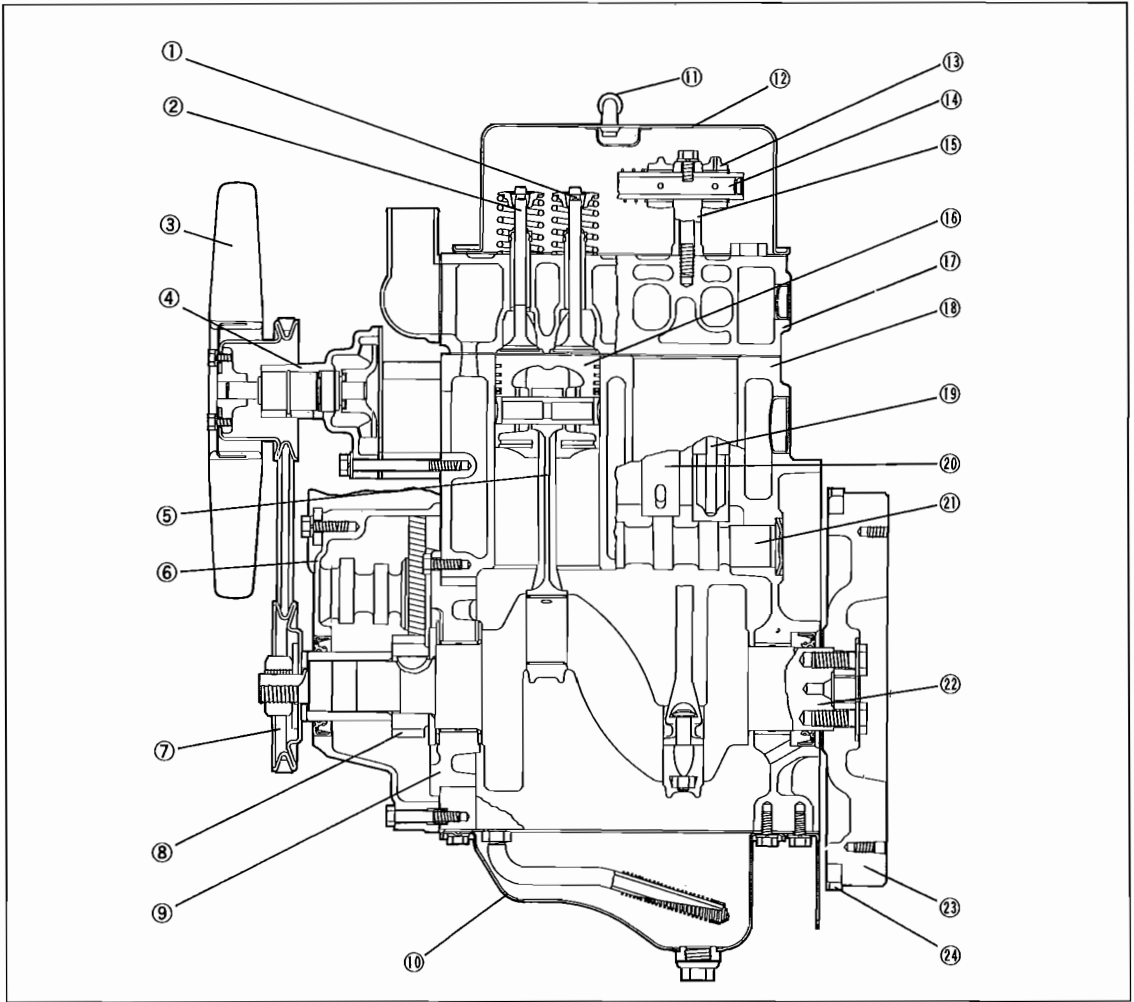
1. Intake valve 2. Exhaust valve 3. Cooling fan 4. Water pump 5. Connecting rod 6. Gear case 7. Crankshaft pulley 8. Crankshaft gear 9. Bearing housing 10. Oil pan 11. Oil filler cap 12. Rocker cover 13. Rocker arm 14. Rocker shaft 15. Rocker stay 16. Piston 17. Cylinder head 18. Crankcase 19. Push rod 20. Tappet 21. Camshaft 22. Crankshaft 23. Flywheel 24. Ring gear

**(4) Profile of K2B & C**



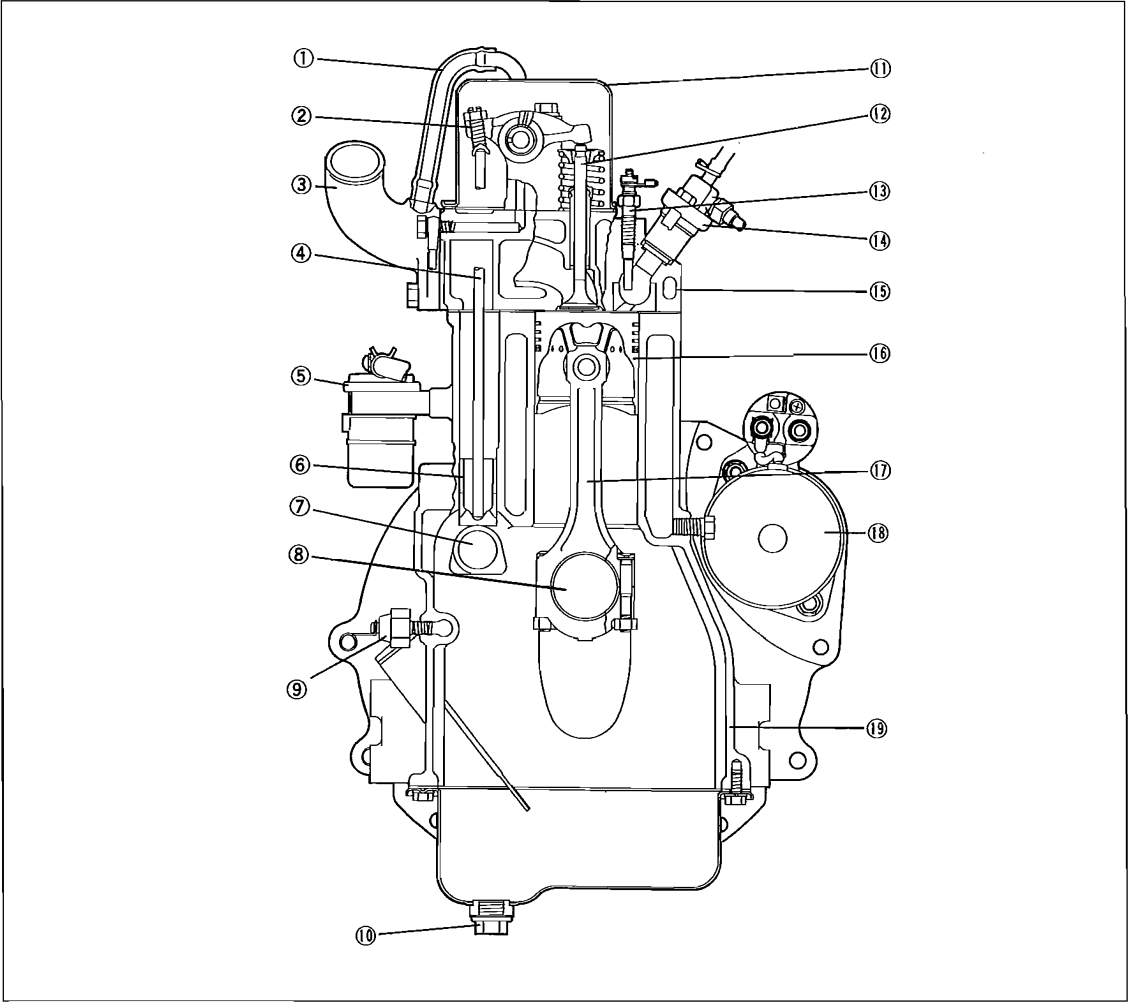
- 1. Breather hose
- 2. Rocker arm
- 3. Intake pipe
- 4. Push rod
- 5. Fuel filter
- 6. Tappet
- 7. Camshaft
- 8. Crankshaft
- 9. Oil pressure gauge
- 10. Drain plug
- 11. Rocker cover
- 12. Exhaust valve
- 13. Glow plug
- 14. Nozzle
- 15. Cylinder head
- 16. Piston
- 17. Connecting rod
- 18. Starter
- 19. Crankcase

(5) Cross section of KE70



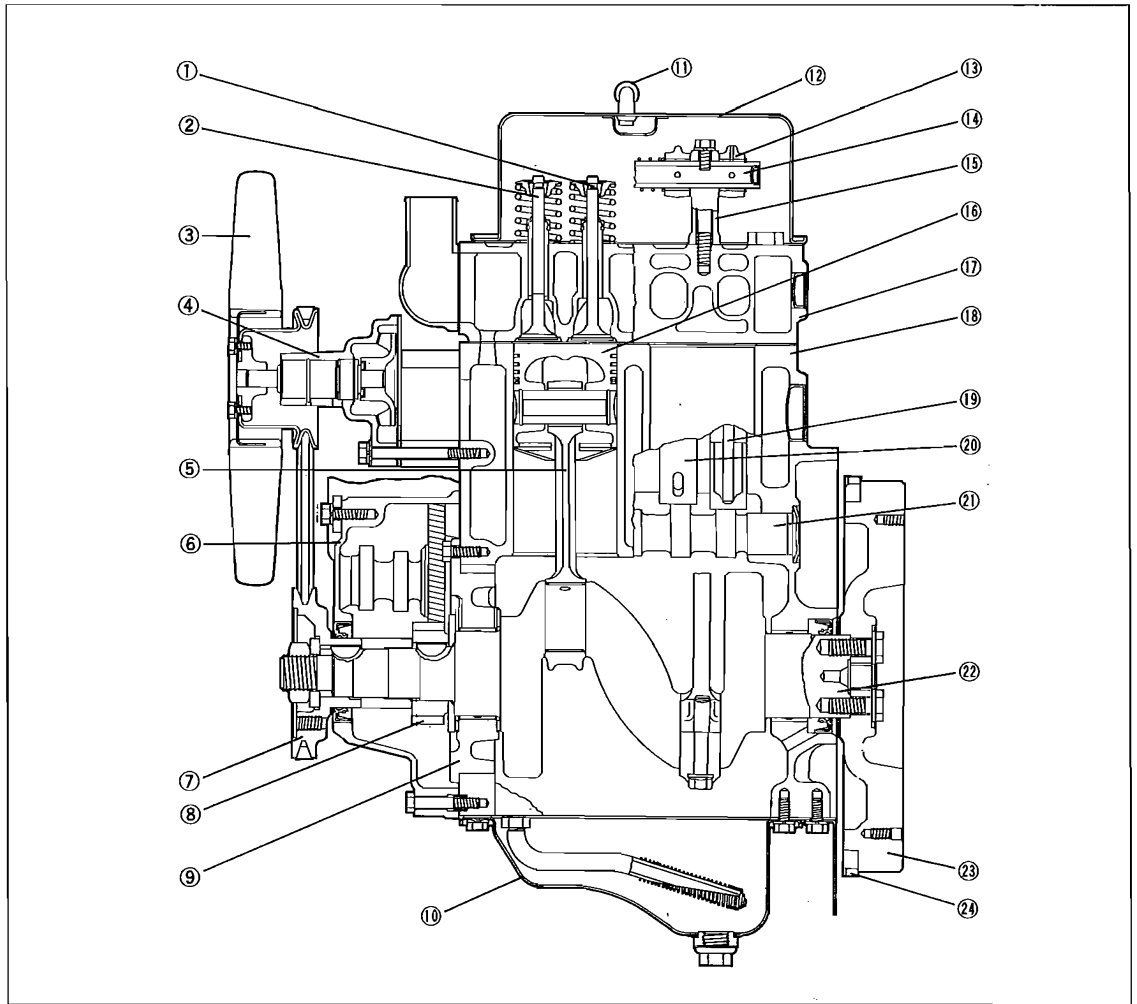
1. Intake valve 2. Exhaust valve 3. Cooling fan 4. Water pump 5. Connecting rod 6. Gear case 7. Crankshaft pulley 8. Crankshaft gear 9. Bearing housing 10. Oil pan 11. Air breather pipe 12. Rocker cover 13. Rocker arm 14. Rocker shaft 15. Rocker stay 16. Piston 17. Cylinder head 18. Crankcase 19. Push rod 20. Tappet 21. Camshaft 22. Crankshaft 23. Flywheel 24. Ring gear

**(6) Profile of KE70**



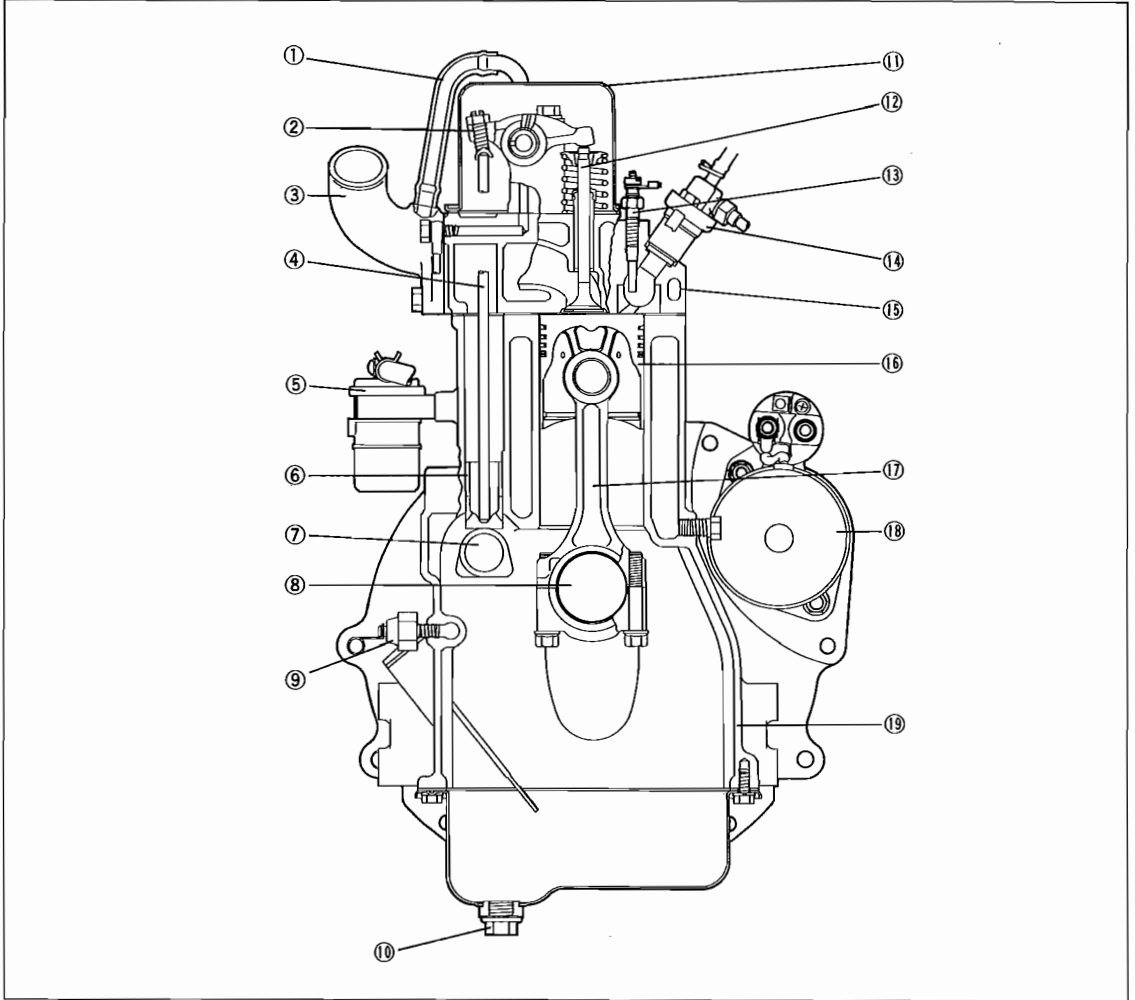
1. Breather hose 2. Rocker arm 3. Intake pipe 4. Push rod 5. Fuel filter 6. Tappet 7. Camshaft  
8. Crankshaft 9. Oil pressure gauge 10. Drain plug 11. Rocker cover 12. Exhaust valve 13. Glow plug  
14. Nozzle 15. Cylinder head 16. Piston 17. Connecting rod 18. Starter 19. Crankcase

**(7) Cross Section of KE75**



1. Intake valve 2. Exhaust valve 3. Cooling fan 4. Water pump 5. Connecting rod 6. Gear case 7. Crankshaft pulley 8. Crankshaft gear 9. Bearing housing 10. Oil pan 11. Air breather pipe 12. Rocker cover 13. Rocker arm 14. Rocker shaft 15. Rocker stay 16. Piston 17. Cylinder head 18. Crankcase 19. Push rod 20. Tappet 21. Camshaft 22. Crankshaft 23. Flywheel 24. Ring gear

**(8) Profile of KE75**



- 1. Breather hose
- 2. Rocker arm
- 3. Intake pipe
- 4. Push rod
- 5. Fuel filter
- 6. Tappet
- 7. Camshaft
- 8. Crankshaft
- 9. Oil pressure gauge
- 10. Drain plug
- 11. Rocker cover
- 12. Exhaust valve
- 13. Glow plug
- 14. Nozzle
- 15. Cylinder head
- 16. Piston
- 17. Connecting rod
- 18. Starter
- 19. Crankcase



### 0.3 Specifications

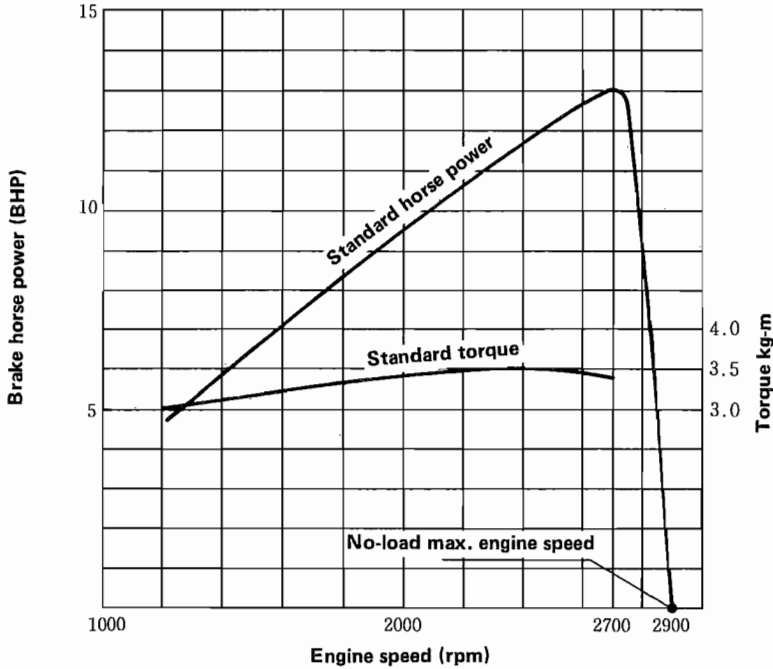
Item \ Model	K2AS	K2B	K2C	KE70	KE75
Type	Vertical,overhead valve type,water-cooled 4-cycle diesel engine				
Combustion chamber	Swirl chamber				
Number of cylinders	2				
Bore × storke :mm	65×68	68×78	70×78	73×80	78×80
Total displacement :cc	451	566	600	669	764
Compression ratio	25	23		20	
Ignition order	1-2				
Engine performance	See Performance Curves.				
Outside dimension of agricultural standard type(length×width×height) :mm	393×342×519	426×446×548		475×474×624	
Dry weight (agricultural standard type) :kg	80	82	84	100	105
Fuel	Diesel fuel oil				
Fuel injection pump	Bosch M type				
Governor	Centrifugal flyweight type				
Nozzle	Throttle type				
Fule injection pressure:kg/cm <sup>2</sup>	160	120			
Lubrication	Forced Lubrication				
Oil pump	Trochoid type				
Oil filter	Pre-element type				
Lubricating oil capacity :ℓ (including oil fillter 0.3 ℓ)	2.8(upper limit) ~1.8(lower limit)			2.9(upper limit) ~1.9(lower limit)	
Cooling method	Forced water circulation				
Water pump	Centrifugal type				
Coolant capacity (engine proper only) :ℓ	1.6	2.1			
Starter moter (V-kW)	Solenoid shift type (12-0.9, 1.1, 1.2 or 1.6)				
Altenator (V-A)	AC type (12-14, 15, 35 or 50)				
Glow plug	Sheath type				

## 0. 4 Performance Curves

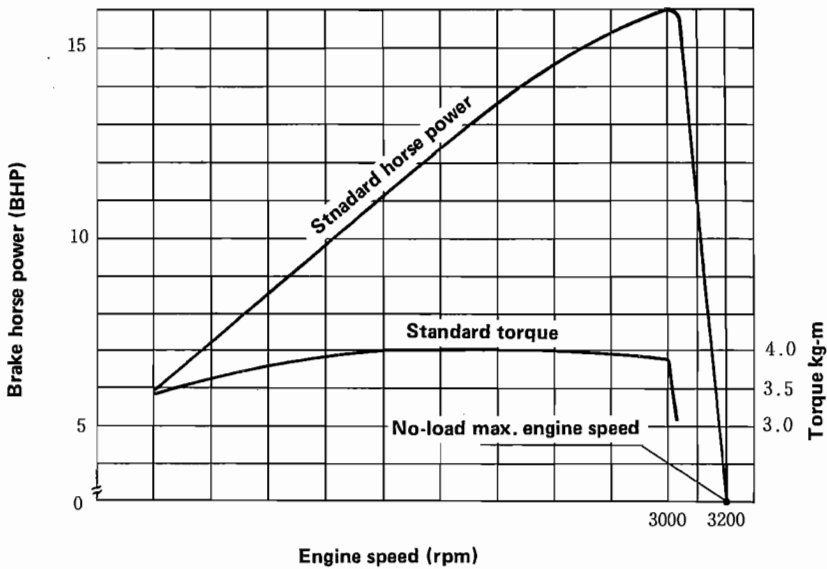
These performance curves show the values under standard conditions (atmosphere 760mmHg, temperature 20°C and humidity 65%).

### 0. 4. 1 AGRICULTURAL

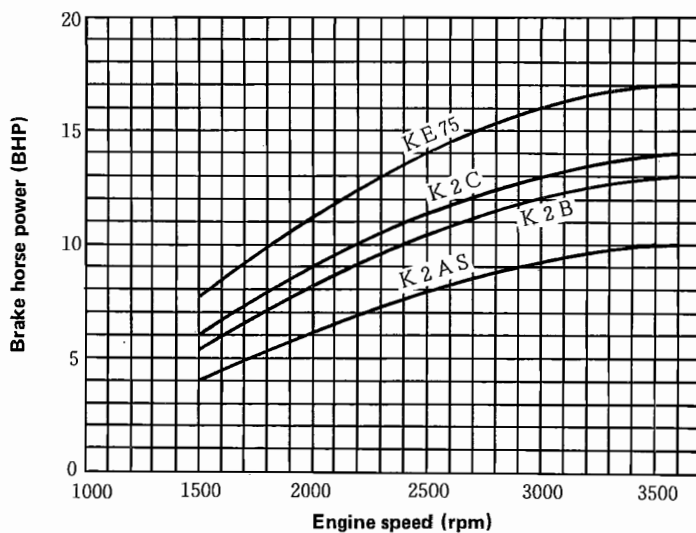
#### (1) KE70 for Tractor and Combine



#### (2) KE75 for Tractor and Combine



## 0. 4. 2 INDUSTRIAL



By application	r.p.m	K2AS	K2B	K2C	KE75
Overload power output rating(PS)	1500	4.0	5.3	6.3	7.6
	1800	5.3	7.0	7.8	9.8
	2000	6.0	8.2	8.8	11
	2400	7.5	10.0	10.7	13.5
	2700	8.5	11.2	12	15
	3000	9.2	12.0	13	16
	3600	10.0	13.0	14.0	17.0
Rated horsepower for constuction equipment(PS)	1500	3.8	5.0	6	7.3
	1800	5.0	6.5	7.5	9.3
	2000	5.7	7.7	8.5	10.5
	2400	7.1	9.5	10	12.5
	2700	8.1	10.5	11.2	14
	3000	8.7	11.0	12.2	15
	3600	9.5	12.0	13.0	16.0
Continuous cruising power for general purpose(PS)	1500	3.6	4.7	5.7	6.8
	1800	4.8	6.3	7	8.8
	2000	5.4	7.3	8	10
	2400	6.8	9.0	9.5	12
	2700	7.7	10.0	10.5	13.2
	3000	8.3	10.5	11.5	14
	3600	9.0	11.0	12.0	14.5

## 0. 5 Troubleshooting

Common engine troubles are shown below together with possible causes and remedies.

### 0. 5. 1 HARD STARTING

Symptom and possible cause	Remedy
<b>(1) Low cranking speed</b> (a) Engine oil viscosity too high (b) Discharged battery (c) Aged battery (d) Improper connection of battery terminals (e) Starter failure (f) Defective main drive clutch	Use lower viscosity oil. Recharge battery. Use new battery. Clean terminals and correct cables. Repair or replace starter. Check clutch for disengagement.
<b>(2) Defective injection system</b> (a) Air trapped in fuel passage (b) Clogged fuel filter (c) Low injection pressure (d) Inadequate nozzle spray (e) Insufficient fuel supply from injection pump. (f) Improper fuel (g) Injection timing too early	Bleed air from fuel system. Clean or replace filter. Adjust injection pressure. Clean or replace nozzle. Overhaul or replace injection pump. Use JIS No. 2 fuel (JIS No. 3 in cold weather) Adjust injection timing.
<b>(3) Engine body troubles</b> (a) Improper compression 1) Incorrect valve clearance 2) Inadequate contact of valve seat 3) Seizure of valve stem 4) Breakage of valve spring 5) Compression leakage from cylinder head gasket 6) Piston ring seized 7) Worn piston ring and cylinder (b) Burnt glow plug (c) Faulty glow plug operation (d) Incorrect position of governor lever (e) Governor spring out of position	Adjust valve clearance. Lap valve. Replace valve or valve guide. Replace valve spring. Replace gasket. Replace piston and piston ring. Overhaul engine. Replace glow plug. Correct lead wire connection. Set lever to starting position. Correct spring.

### 0. 5. 2 LOW OUTPUT

Symptom and possible cause	Remedy
<b>(1) Low compression</b> <b>(2) Improper adjustment of injection system</b> (a) Improper injection timing (b) Insufficient injection (c) Low injection pressure	See "Improper compression" in (3) (a), 0.5.1. Adjust injection timing. Overhaul or replace injection pump. Check injection nozzle and adjust pressure.
<b>(3) Insufficient fuel</b> (a) Air mixed in fuel system (b) Clogged filter (c) Contaminated fuel tank	Check and retighten connector. Clean or replace filter. Clean tank.
<b>(4) Insufficient intake air</b> (a) Clogged air cleaner	Clean air cleaner and replace element.
<b>(5) Overheating</b> (a) Insufficient coolant (b) Loose V-belt (c) Clogged or leaking radiator	Add coolant. Adjust or replace V-belt. Clean or replace radiator.

- (d) Inadequate injection timing
- (e) Insufficient engine oil

Correct injection timing.  
Replenish engine oil.

### 0. 5. 3 EXCESSIVE OIL CONSUMPTION

Symptom and possible cause	Remedy
<b>(1) Oil leakage</b> (a) Defective oil seals (b) Broken gear case gasket (c) Gear case mounting bolts loosened (d) Loosened drain plug (e) Loosened oil pipe connector (f) Broken rocker cover gasket (g) Rocker cover mounting bolts loosened	Replace oil seals. Replace gasket. Retighten bolts. Retighten plug. Retighten connector. Replace gasket. Retighten mounting bolts.
<b>(2) Oil up</b> (a) Incorrect piston ring position (b) Displaced or twisted connecting rod (c) Worn piston ring (d) Worn piston or cylinder.	Correct piston ring position. Replace connecting rod. Replace piston ring. Replace piston or rebore cylinder.
<b>(3) Oil down</b> (a) Defective stem seal (b) Worn valve and valve guide	Replace stem seal. Replace valve and valve guide.

### 0. 5. 4 ABNORMAL SOUND OR NOISE

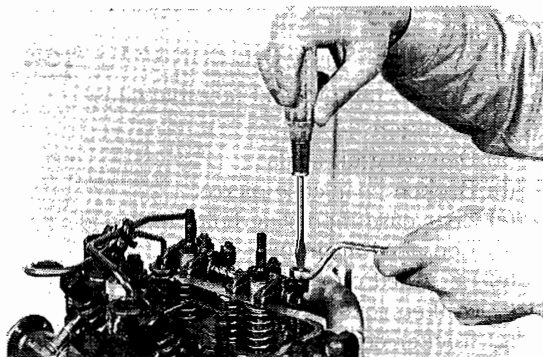
Symptom and possible cause	Remedy
<b>(1) Crankshaft and main bearing</b> (a) Badly worn bearing (b) Badly worn crankshaft (c) Melted bearing	Replace bearing and grind crankshaft. Grind crankshaft to undersize. Replace bearing and check oil system.
<b>(2) Connecting rod and connecting rod bearing</b> (a) Wear of bearing on big end of connecting rod (b) Worn crankpin (c) Bent connecting rod	Replace bearing and grind crankshaft. Grind crankshaft. Correct or replace connecting rod.
<b>(3) Piston, piston pin and piston ring</b> (a) Worn cylinder (b) Worn piston pin (c) Piston seized (d) Worn or broken piston ring	Rebore cylinder to oversize and replace piston. Replace piston pin. Replace piston. Replace piston ring.
<b>(4) Valve mechanism, etc.</b> (a) Worn camshaft (b) Excessive valve clearance (c) Worn timing gear (d) Worn fan pulley bearing	Replace camshaft. Adjust valve clearance. Replace timing gear. Replace bearing.

## 0. 6 Adjustments

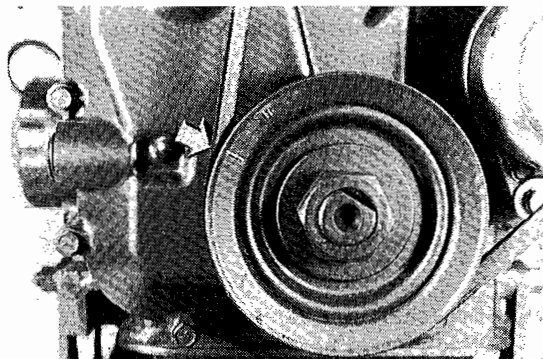
### 0. 6. 1 ADJUSTMENT OF VALVE CLEAR-ANCE

- (1) Remove the rocker cover and loosen the rocker arm nut. Check the valve clearance with a feeler gauge and, if necessary, adjust it with the adjusting screw.
- (2) Adjust the intake and exhaust valves on No. 1 cylinder side first at TDC on compression stroke of No. 1 cylinder. Then, adjust on No. 2 cylinder side at TDC on compression stroke of No. 2 cylinder.
- (3) Each cylinder piston is at TDC on compression stroke when the timing mark on the gear case is in alignment with that on the crankshaft pulley.
- (4) After adjustment, keep the adjusting screw from turning and tighten the rocker arm nut securely.

**Note:** Retighten the cylinder head bolts before valve clearance is adjusted.



Adjustment of Valve Clearance



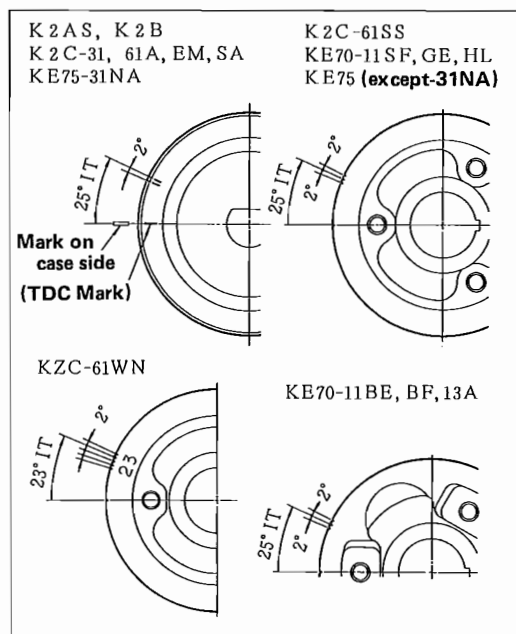
Alignment of Timing Mark

Description		Standard
Valve clearance (both intake and exhaust)	K 2	0.25mm
	KE	0.35mm
Cylinder head bolt tightening torque	K 2	12~13kgm
	KE70, KE75	13~14kgm (old:bolt only)
		14~15kgm (new:bolt w/washer)

### 0. 6. 2 ADJUSTMENT OF FUEL INJECTION TIMING

- (1) Incorrect fuel injection timing will deteriorate the startability and performance of the engine. Therefore, adjust the injection timing in the following procedure.

Remove the No. 1 delivery valve holder and take out the delivery valve and spring, and then install the delivery valve holder only. Turn the crankshaft, and the moment when the fuel coming out of the discharge opening of the holder stops is the injection time. If the injection timing differs with the engine specification, it should be adjusted to the specified timing (align the injection timing (IT) mark on the crankshaft pulley with the mark on the gear case).



Confirmation of Injection Timing

(2) If the specified injection timing cannot be achieved, increase or decrease the thickness of the injection pump shims.

If the shim thickness is changed 0.1 mm, the injection timing will vary about 1°. If the above adjustment cannot be done, use the following method without removing the delivery valve and spring.

Remove the injection pipe No. 1 on the nozzle holder side.

Then, slowly turn the crankshaft pulley nut with a wrench, and the moment when the fuel at the pipe end swells is the injection timing, and in this case, the injection timing appears about 1° later than the normal injection timing.

Model	Injection time (at smoke set)
K 2 C—31, 61	23° B T D C
K 2 A S—61WM K 2 B—31, 61 K 2 C—31CW K E 70—All types K E 75—"	25° B T D C
K 2 A S—31DG —61A	27° B T D C

### 0. 6. 3 ADJUSTMENT OF MAXIMUM IDLING SPEED

Using the high speed setting bolt, set to the maximum idling speed specified below and lock the setting bolt.

Model		Maximum idling speed (rpm)	Reted horsepower (PS/rpm)	
K2AS	31DG	3750 <sup>+30</sup> <sub>-10</sub>	8.5/3600	
	61A,WM	3150 <sup>+30</sup> <sub>-10</sub>	9.2/3000	
K2B	31A,DW,SW,61A	3150 <sup>+30</sup> <sub>-10</sub>	12/3000	
	51M	3100 <sup>+30</sup> <sub>-10</sub>	11.5 or more /3000	
	32SW	3430 <sup>+30</sup> <sub>-10</sub>	12/3300	
	31DG	3750 <sup>+30</sup> <sub>-10</sub>	12.5/3600	
K2C	31H	2700 <sup>+30</sup> <sub>-10</sub>	11/2500	
	61A,EM,SA,SS,WM	3150 <sup>+30</sup> <sub>-10</sub>	13/3000	
	31CW	3750 <sup>+30</sup> <sub>-10</sub>	14/3600	
KE70	11,13	2850 <sup>+30</sup> <sub>-10</sub>	13/2700	
KE75	11	2850 <sup>+30</sup> <sub>-10</sub>	15/2700	
	12	3150 <sup>+30</sup> <sub>-10</sub>	16/3000	
	31A,SW	3150 <sup>+30</sup> <sub>-10</sub>	16/3000	
	31NA	2850 <sup>+30</sup> <sub>-10</sub>	15/2700	
	61A,EA,SA,61SS		3150 <sup>+30</sup> <sub>-10</sub>	16/3000
				16.7/3000
	61WH	2950 <sup>+30</sup> <sub>-10</sub>	15/2800	

# 1. Engine Proper

## 1.1 Cylinder Head Construction and Service

### 1. 1. 1 CONSTRUCTION OF CYLINDER HEAD

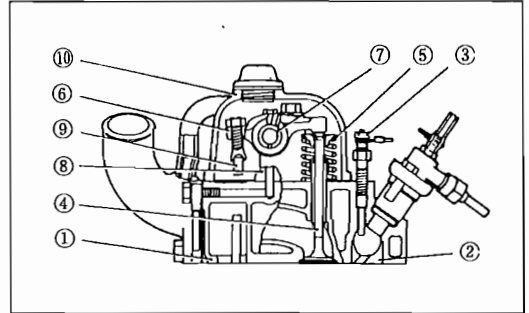
#### (1) Cylinder Head

The cylinder head made of cast iron has high rigidity and excellent cooling effect.

The valve system is of an overhead valve type and the intake and exhaust ports for K2AS are located separately on the left and right sides of the head (cross-flow type), and for other models, they are collected on the right side of the head.

The swirl chambers and the glow plugs are provided on the left side of the head.

Some models are provided with the valve seat rings.



1. Cylinder head 2. Swirl chamber 3. Glow plug  
4. Exhaust valve 5. Valve spring 6. Rocker arm  
7. Rocker shaft 8. Rocker stay 9. Push rod 10. Rocker cover

Cross Section of Cylinder Head

Model	Type with valve seat rings
K2AS	All types
K2B	-31DG, 32SW
K2C	-31CW

#### (2) Cylinder Head Gasket

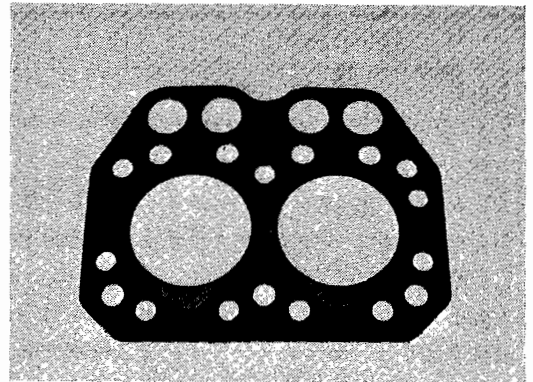
The cylinder head gasket is made highly airtight and durable with stainless steel grommets used on the cylinder bore portion. Since sealant has been applied to both sides except the cylinder bore periphery to prevent water and oil leakage, no sealant is required when assembling.

The type name is stamped on the cylinder head side.

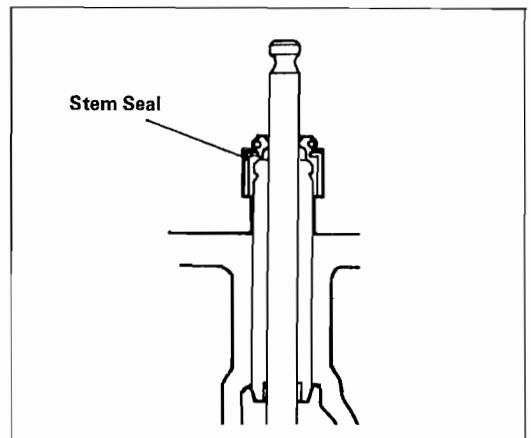
#### (3) Valve and Valve Spring

The intake valve has a large-diameter head to provide a great intake efficiency. All valves are made of heat-resistant steel and the exhaust valve has special heat-resistant steel welded to the head to withstand higher temperature.

The upper part of the valve guide is provided with the valve stem seal to prevent oil-down.



Cylinder Head Gasket



Valve Stem Seal



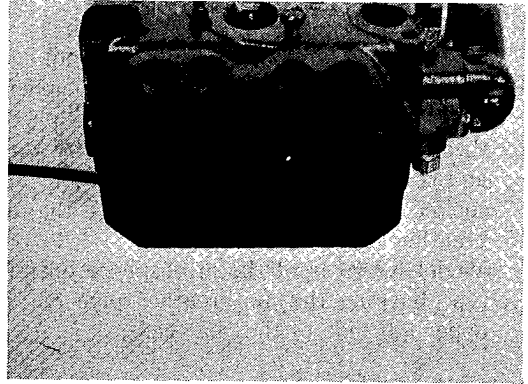
The valve springs are made of highly rigid material.

The spring, spring retainer and retainer lock are common parts for both intake and exhaust valves.

**(4) Valve Spring seat**

The models for continuous high speed use are provided with the spring seats on the cylinder head side to ensure high performance and durability.

Model	Type with spring seats
K2B	31DG, 32SW
K2C	31CW



**Combustion Chamber**

**(5) Combustion Chamber**

The combustion chamber is of the swirl chamber type.

The swirl chamber is made of heat-resistant steel and press-fit.

Since the swirl chamber is processed in combination after being press-fit into the head, it cannot be disassembled.

**(6) Rocker Arm and Rocker Shaft**

The rocker arms are made of special cast iron for K2 models and forging for KE models.

The rocker shaft for K2AS is made of bar steel and the perimeter is cemented. The rocker shaft for other models is made hollow to form a passage for lubricating oil and the rocker arm contact portions are induction-hardened.

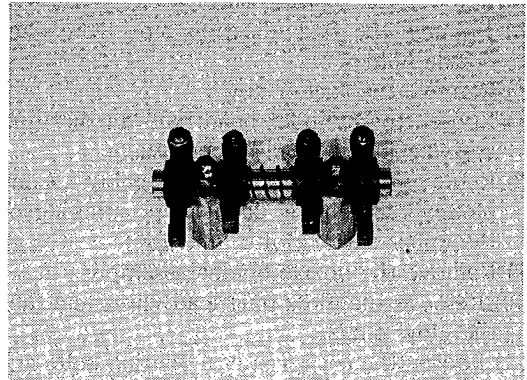
The oil supply to rocker portion of K2AS is made through the oil hole in the rocker cover.

**(7) Rocker Cover**

The rocker cover for K2 models is made of die cast aluminum.

On the top of rocker cover for K2AS a passage for supplying oil to the rocker system is provided.

The rocker cover for KE models is made of sheet metal.



**Rocker Arms and Rocker Shaft**

## (8) Blowby Gas Reduction System (Except K2AS)

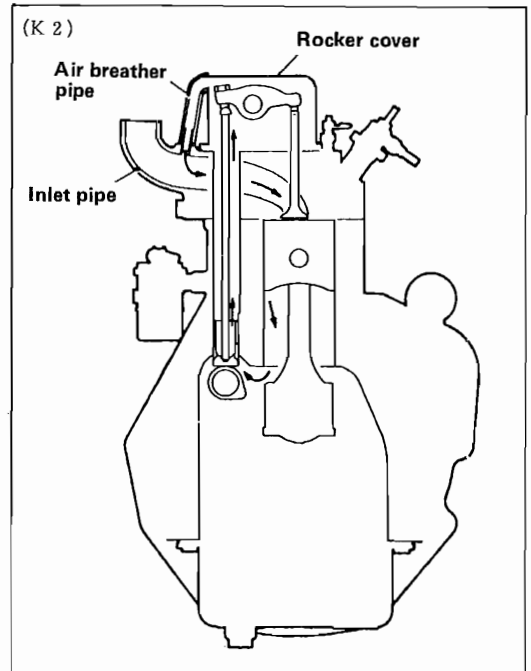
The blowby gas reduction system is to prevent the blowby gas in the crankcase from being discharged into the atmosphere. The blowby gas in the crankcase passes through the tappet holes and push rod holes and is introduced into the rocker cover and sucked into the intake pipe via the air breather pipe and again burnt. Model K2AS is of the atmosphere opening type having the air breather pipe on the upper left side of the gear case.

### 1. 1. 2 CYLINDER HEAD SERVICE

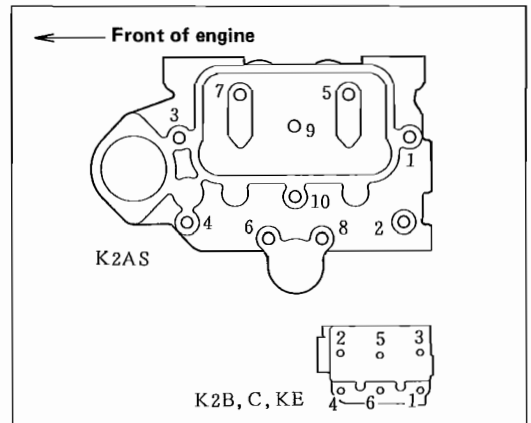
#### 1. Disassembling

- (1) Remove the air breather pipe (except K2AS).
- (2) Remove the intake pipe (except K2AS) and exhaust manifold.
- (3) Remove the oil pipe from the cylinder head.
- (4) Remove the fuel return pipe.
- (5) Remove the fuel injection pipe from each nozzle holder.
- (6) Remove the rocker cover.
- (7) Loosen the cylinder head bolts in the illustrated sequence and remove them.
- (8) Remove the cylinder head assembly. Completely remove the gasket, etc. sticking on the upper surface of crankcase.
- (9) Remove the nozzle holder assembly.
- (10) Remove the glow plug lead wires and then the glow plugs.
- (11) Loosen the rocker stay mounting bolts and remove the rocker shaft assembly.
- (12) Using a valve lifter, compress the valve spring and remove the retainer, spring and valve.

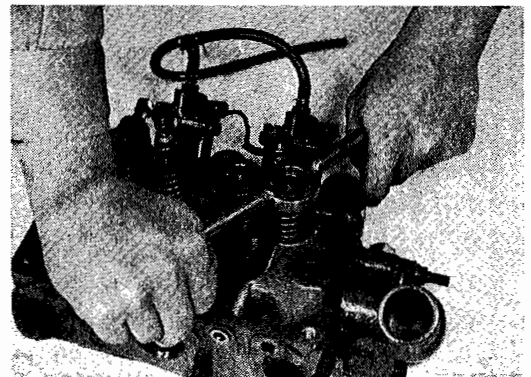
Place the removed valves and other parts in order for each cylinder.



Blowby Gas Reduction Equipment



Loosening Sequence of Cylinder Head Bolts

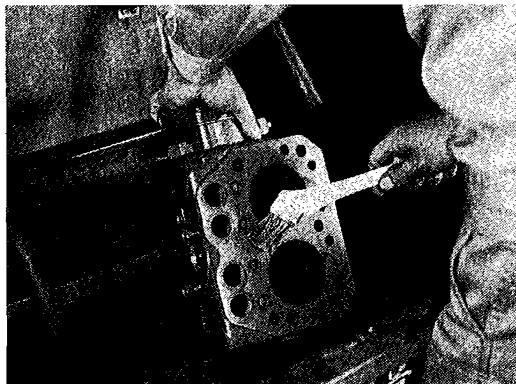


Removal of Valve Spring

## 2. Inspection

### Caution

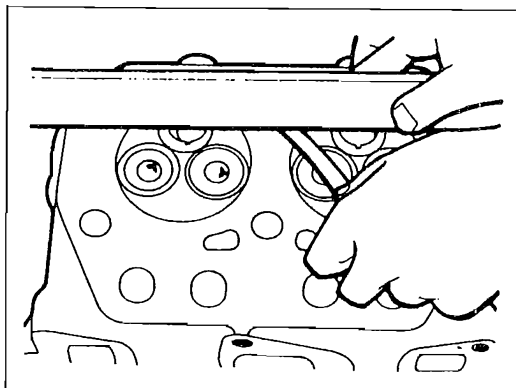
1. Check the cylinder head for water leakage and damage before cleaning.
2. Before inspection and repair, thoroughly clean all parts to remove oil, deposit, carbon and dust.
3. Blow oil holes with compressed air to remove dust and dirt and make sure that they are not clogged.



Cleaning of Cylinder Head

### (1) Cylinder Head

- (a) Before cleaning the cylinder head, check it for any crack, damage or water leakage.
- (b) Make sure that the oil passage is not clogged.
- (c) Distortion on lower surface of cylinder head.  
Using a straight edge and a thickness gauge, check the distortion as illustrated.



Checking of Distortion on Cylinder Head Lower Surface

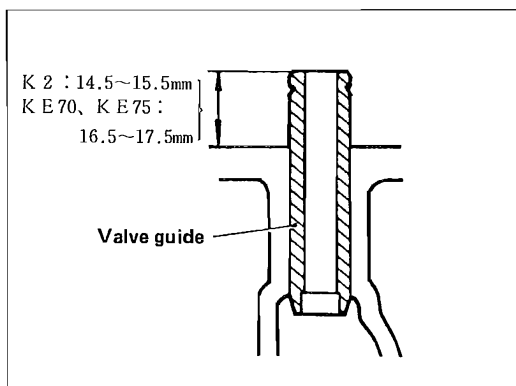
### (2) Valve Guide

- (a) Check the clearance between the valve stem and the valve guide, and if service limit is exceeded, replace the valve guide and valve.

If the valve is replaced for the reason of worn valve stem, also replace the valve guide which should be worn.

- (b) To remove the valve guide, press it upward from the lower side of the cylinder head.

To install a new guide, press-fit from the upper side of the cylinder head to the illustrated size. After press-fitting the valve guide, check the clearance between it and the valve stem, and if the clearance is smaller than the standard value, correct it with a reamer.



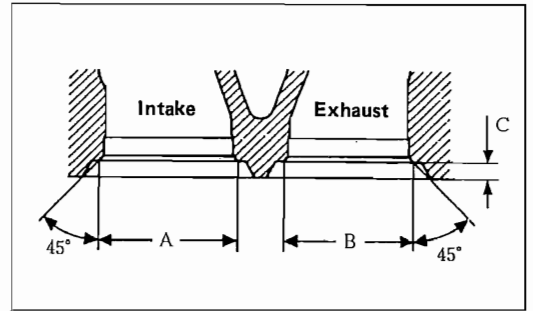
Press-Fitting of Valve Guide

**(3) Valve Seat**

- (a) Check the valve seat for damage and improper contact, and if defective, correct as illustrated. After correction, lap the valve seat to fit it with the valve.
- (b) If the valve seat sinkage exceeds the service limit, replace the cylinder head. To check the valve seat sinkage, measure the installation length of the valve spring.

**Caution**

The valve seat should be corrected after the wear of the valve guide is checked, and if necessary, after the guide is replaced.

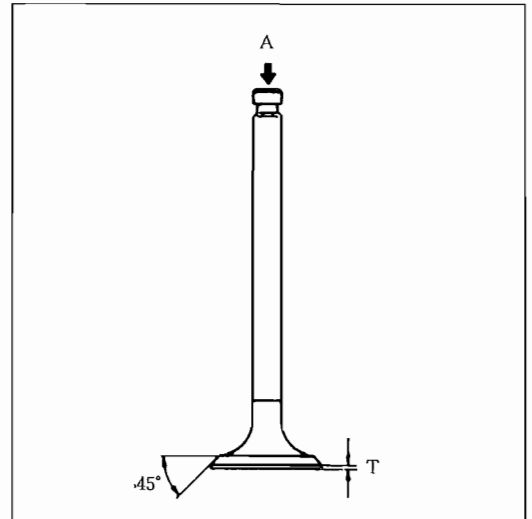


**Correction of Valve Seat**

Model	Length Amm	Bmm	Cmm
K2AS	23.7	21.7	2.5
K2B, C	26.2	24.2	2.9
KE70, 75	29.0	27.0	3.4

**(4) Valve**

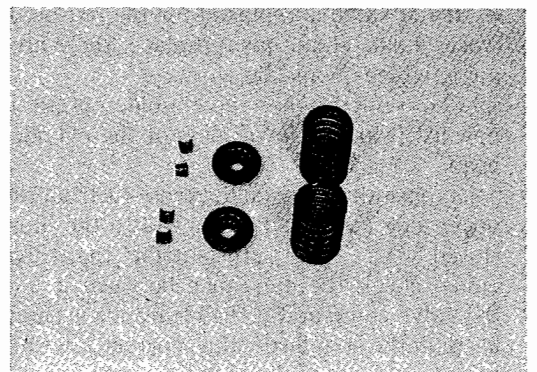
- (a) Check the valve head (seat surface) and stem for excessive wear, damage and distortion, and if necessary, correct or replace the valve.
- (b) If the valve head thickness (T) exceeds the service limit, replace the valve.
- (c) Check the valve stem top A (surface in contact with the roker arm), and if it is worn or dented, correct or replace.



**Valve Checking**

**(5) Valve Spring**

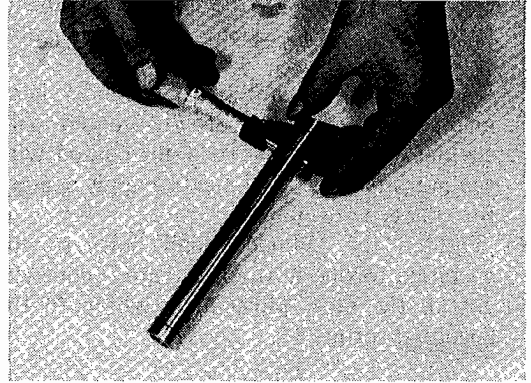
- (a) Check the valve spring for cracks and damage.
- (b) Check for free height and load of the spring. Replace the spring if excessively deteriorated.
- (c) Check for squareness of the spring, and if tilted excessively, replace it.



**Valve Springs**

### (6) Rocker Arm and Rocker Shaft

- (a) If the rocker arm surface in contact with the valve is excessively worn or damaged, replace the rocker arm. Check the adjusting screw, and if the surface in contact with the push rod is excessively worn or damaged, replace the adjusting screw.
- (b) Measure the rocker arm bush ID and rocker shaft OD (rocker arm mounting portion), and if the clearance is excessive, replace the rocker arm assembly.



Measuring of Rocker Shaft OD

### 3. Reassembling and Adjustment

#### Caution

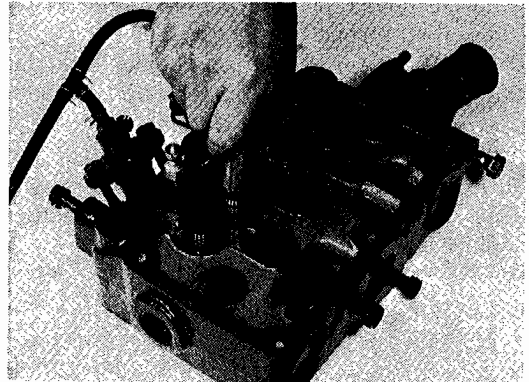
1. Thoroughly clean the parts to be assembled.
2. When the sliding or rotating parts are assembled, apply oil to them.

- (1) Accurately fit the valve stem seal in the valve guide.

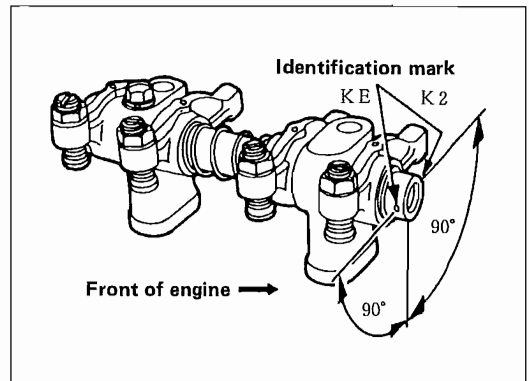
#### Caution

The valve stem seal is not reusable.

- (2) Apply engine oil to the valve stem and insert it into the valve guide. Then, with the red side of the retainer spring to the retainer side, install the retainer, compress with a valve lifter, and install the retainer lock.
- (3) Install the rocker arm, rocker shaft, rocker stay, etc. as illustrated. Pay attention to the installation direction of the rocker shaft. The identification mark on the front end of the shaft should face right, as viewed from the front, for K2 and left for KE (no direction for K2AS). Apply engine oil to the bore of the rocker arm bush.

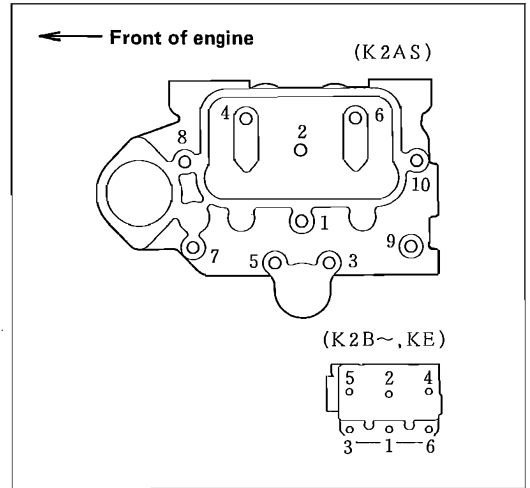


Installation of Valve Stem Seal



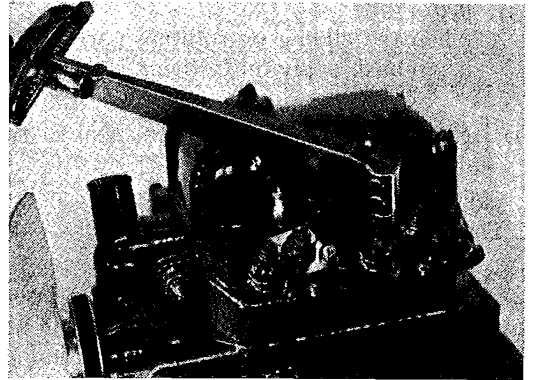
Assembly of Rocker Arm Shaft

- (4) Install the rocker arm and shaft assembly on the upper surface of the cylinder head and tighten the bolts. Then, install the valve springs.
- (5) Do not apply sealant to the cylinder head gasket because it is already coated with sealant. Grafoil gasket is not coated with sealant but there is no need to apply sealant for this type of gasket.
- (6) Tighten the cylinder head bolts to the specified torque in the illustrated sequence.
- (7) Install the glow plugs and tighten to the specified torque.



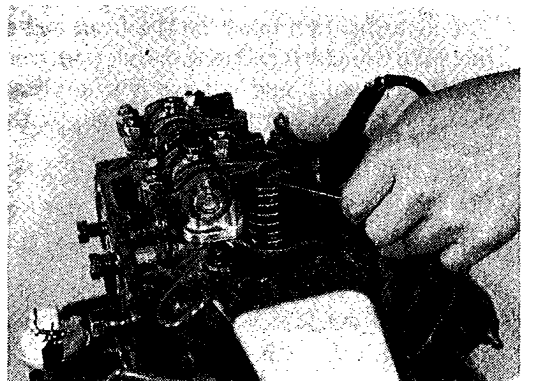
**Tightening Sequence of Cylinder Head Bolts**

- (8) Fit in the nozzle holder gasket. Install the nozzle holder assembly and tighten to the specified torque.  
For K2AS, turn the nozzle holder retaining nut. For other models, tighten two bolts evenly to the specified torque.
- (9) Install the glow plug lead wires.
- (10) Replace the old gaskets and packings with new ones, and apply sealant to the specified places.



**Tightening of Nozzle Holder**

- (11) Adjustment of Valve Clearance  
At TDC on compression stroke of each cylinder piston, adjust the clearance between each valve stem and rocker arm using the feeler gauge.



**Adjustment of Valve Clearance**

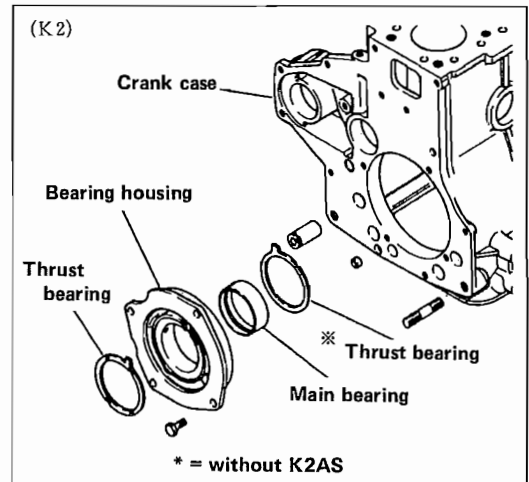
## 1. 2 Crankcase Construction and Service

### 1. 2. 1 CONSTRUCTION OF CRANKCASE

#### (1) Crankcase

The crankcase is made of alloy cast iron and of the full jacket type with monolithic-molded cylinders.

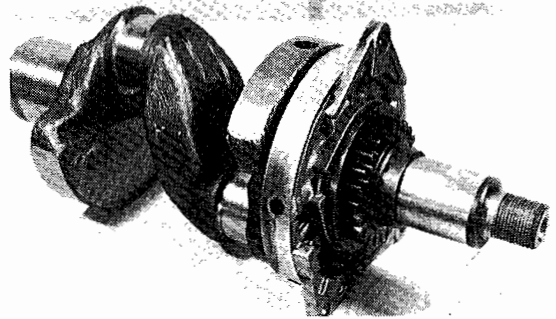
The main bearings are made of special copper alloy with bush type backing and are flash-plated. The crankshaft thrust is received by the thrust bearing installed on the front bearing section except for K2AS in which the thrust load is directly received by the plate of the crankshaft.



Crankcase and Bearing

#### (2) Crankshaft

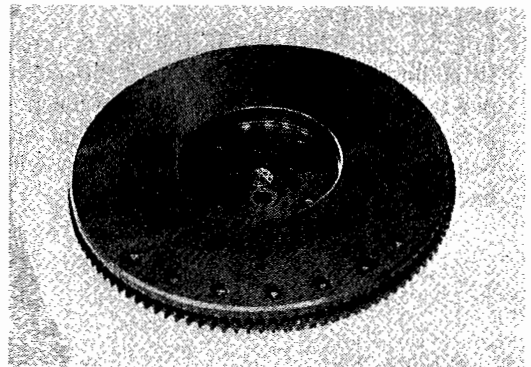
The crankshaft is precision-forging of high carbon steel, and its pins and journals are induction-hardened to increase wear resistance, and the balancer is monolithic-molded.



Crankshaft

#### (3) Flywheel and Ring Gear

The flywheel features high inertia efficiency and minimum torque fluctuation. The ring gear is shrink-fitted to the flywheel. Its tips are induction-hardened to increase wear resistance.



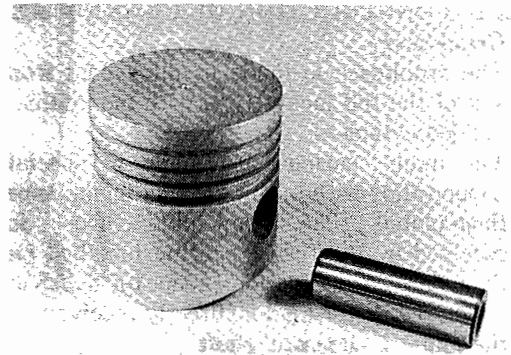
Flywheel

#### (4) Piston, Piston Pin and Piston Rings

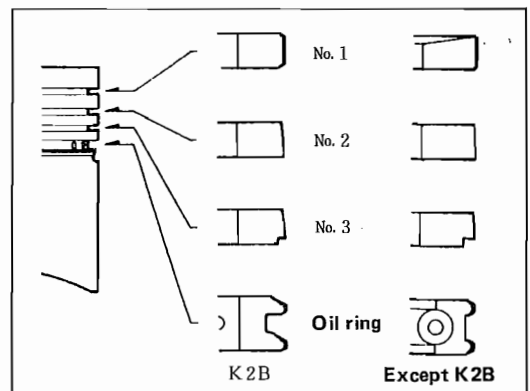
The piston is made of special light alloy and tapered (smaller toward the top) with elliptic cross section so that the optimum contact with the cylinder bore can be obtained.

The piston pin is a hollow pin made of special alloy steel and is cemented entirely. The piston pin is press-fitted and fixed in the connecting rod, except for KE75 which adopts a full-float type, where the piston pin is fitted to the piston with snap rings.

There are 4 piston rings—3 compression rings and one oil ring. The No. 1 ring and oil ring are hard chrome-plated on the surface which comes into contact with the cylinder. Except for K2B, the No. 1 ring is of the semi-keystone type and the oil ring is provided with a coil expander.



Piston and Piston Pin

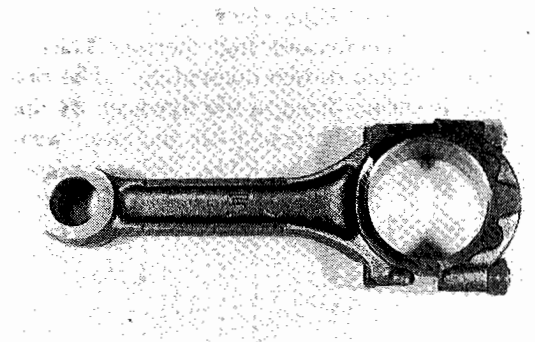


Piston Rings

#### (5) Connecting Rod

The connecting rod is high carbon steel forging, and the rod has I-shaped cross section and the big end is horizontally split to increase rigidity.

For K2 and KE70 the piston pin is press-fitted into the small end. For KE75 its piston pin is loose (clearance-fit) and the bush is press-fitted in the rod side. The big end bearing is made of copper special alloy with backmetal and is flash-plated.

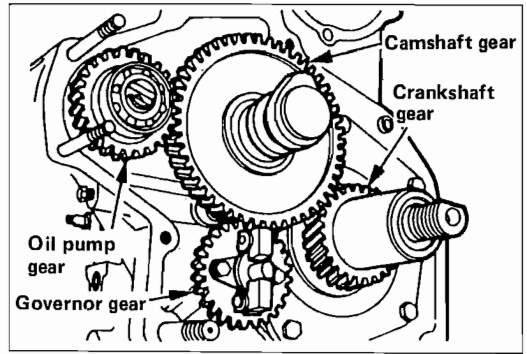


Connecting Rod



**(6) Timing Gears**

The timing gears are spur gears for K2AS and bevel gears for other models. The crankshaft gear drives the camshaft gear, which drives the governor gear and high pressure oil pump gear. (No oil pump gear is used for K2AS).



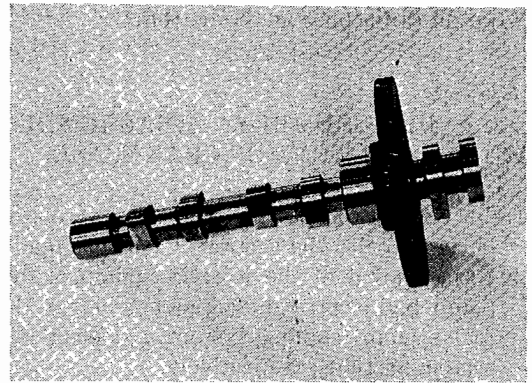
**Arrangement of Timing Gears**

**(7) Camshaft**

The camshaft is high carbon steel forging and is integrated with the cams for fuel injection pump and the cam surface and journal are induction-hardened. On the rear end of the camshaft for K2AS, a groove is provided to drive the oil pump.

The camshaft is supported by the machined holes in the crankcase. The front journal is provided with an oil hole to supply oil intermittently to the cylinder head and rocker arm parts.

The camshaft thrust is received by the front side of the crankcase and the plane provided in the timing gear case.

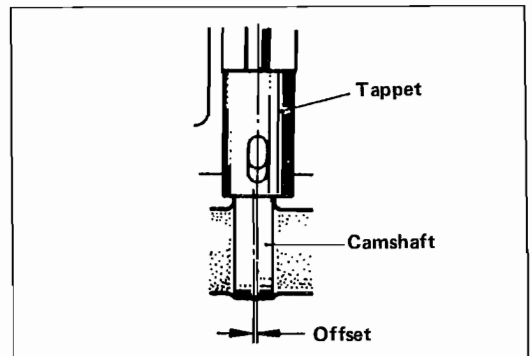


**Camshaft**

**(8) Tappet and Push Rod**

The tappet is tubular, and its bottom and the push-rod receiving part are specially surface-treated. The tappet is offset from the cam center to prevent uneven wear of tappet bottom.

The push rod is made of bar steel and both ends are specially hardened.

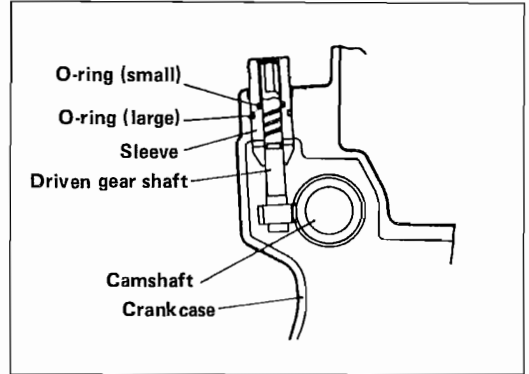


**Offset of Tappet and Camshaft**

**(9) Speedometer Driven Gear (Special Specification)**

For special KE70 and 75 models, a speedometer driven gear unit of passenger car type which can withstand high speed is installed in the center on the right side of the crankcase. The gear is driven by the camshaft.

Model	Type with gear unit
KE70	-11BE, BF, 13A
KE75	-11SF



**Speedometer Driven Gear**

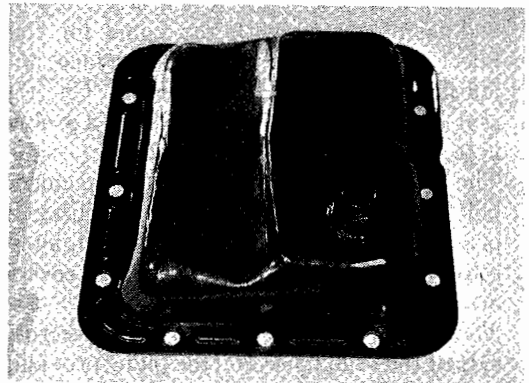
**(10) Oil Pan**

The oil pan is made of sheet metal and has an oil drain plug at the bottom.

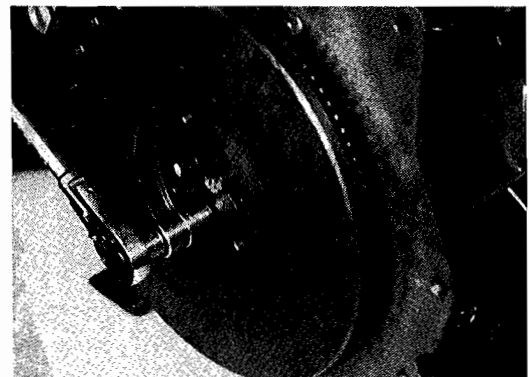
**1. 2. 2 DISASSEMBLY, REASSEMBLY AND ADJUSTMENT OF CRANKCASE**

**1. Disassembly**

- (1) For removal of the cylinder head and related parts, refer to the section "Cylinder Head".
- (2) For removal of the injection pump, water pump, and electrical equipment, refer to the fuel system, cooling system and electrical system sections, respectively.
- (3) For removal of the oil filter and oil pump (except for K2AS), refer to the section of lubricating system.
- (4) Remove the push rods and pull out the tappets from the upper side of the crankcase.
- (5) Remove the oil pan gasket.
- (6) Remove the flywheel.
- (7) Remove the rear plate.
- (8) For K2AS remove the oil pump at the rear end of the camshaft.
- (9) Loosen the crankshaft pulley nut. Remove the pulley and washer.
- (10) Remove the gear case and gasket.
- (11) Remove the oil pump gear (except for K2AS).
- (12) Remove the governor weight assembly and then the governor gear.

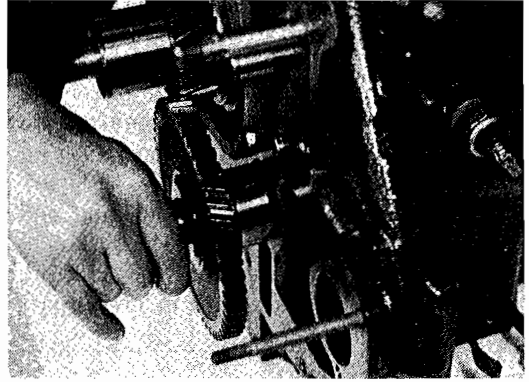


**Oil Pan**

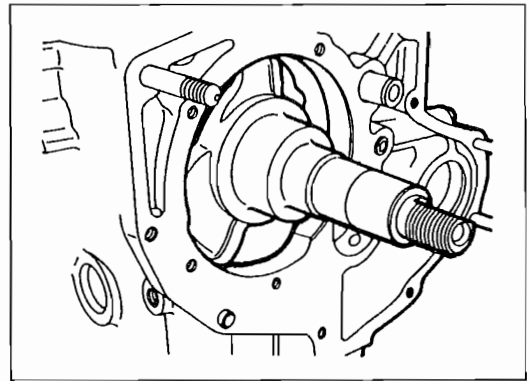


**Removal of Flywheel**

- (13) Remove the camshaft and gear from the crankcase. For KE70 and 75, however, remove the seedometer driven gear unit before pulling out the camshaft.
- (14) Remove the sleeve, crankshaft gear, plate and thrust washer (not provided for K2AS).
- (15) Remove the connecting rod cap and pull out the piston and connecting rod assembly from the upper side of the crankcase. Keep the rod cap and bearing for each cylinder so that there will be no mixing.
- (16) Remove the bearing housing from the crankcase.
- (17) For KE70 and 75, align the crankshaft counterweight with the notch in the crankcase hole and then pull out the crankshaft. In such case, take care not to damage the main bearings.



**Removal of Camshaft**

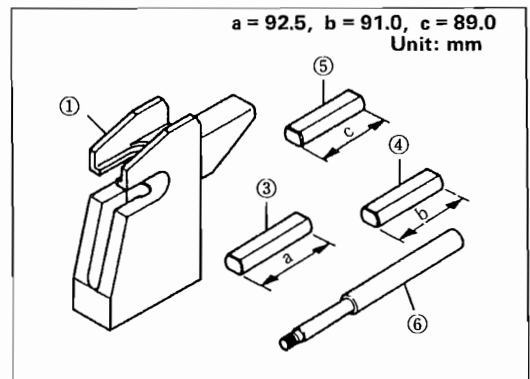


**Removal of Crankshaft**

- (18) Disassembly of piston and connecting rod
  - (a) Except for KE75, to disassemble the piston and connecting rod, use the special piston pin setting tool and proceed as follows.
    - 1) Set the piston and connecting rod assembly on the tool body as illustrated, insert the tool push rod into the piston pin hole, push with a press and remove the piston pin. No tool guide is used for removing the pin.

**Caution:Correction of tool**

In case it is difficult to set the K2AS' s piston rod assembly on the old tool, make correction by grinding the upper end on the rod receiving side of the tool (not on the piston set side).



1. Body 3. Guide (D) :for K2AS 4. Guide (E) : for K2B 5. Guide (F) : for KE70 6. Push rod  
**Piston Pin Setting Tool**

### Caution

1. To remove the piston pin except for KE75, be sure to use the press. Never hit the piston pin. If excessive pulling force is required because the piston pin is stuck hard, replace the assembly. Do not apply a load of more than 3,000 kg on the pin setting tool.
2. When the piston and connecting rod assembly is set on the tool body, make sure that the small end of the connecting rod rests properly on the receiving part of the tool body.

- 2) To disassemble the piston and connecting rod for KE75, immerse them in the oil of about 80°C for 3 to 5 minutes after removing the snap rings on both ends of the piston pin, and then remove the pin.

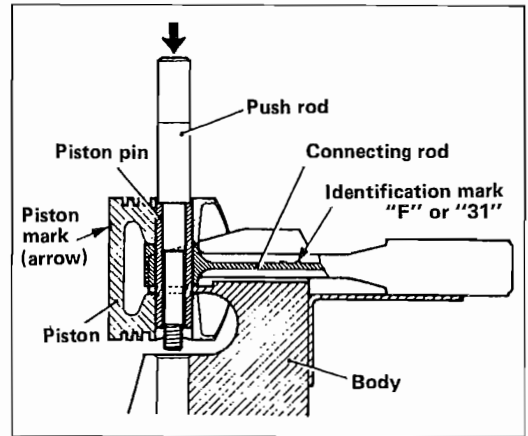
## 2. Inspection

### Caution

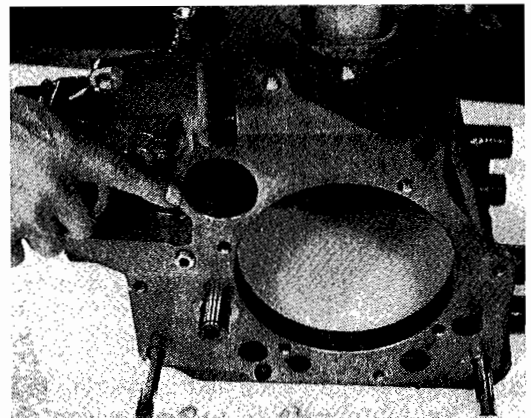
1. Before cleaning the crankcase, check for water or oil leakage and damage.
2. Before inspection and repair, clean the parts and remove dust, oil, carbon and deposit.
3. Blow the oil holes with compressed air to remove foreign matter and make sure that there is no clogging.

### (1) Crankcase

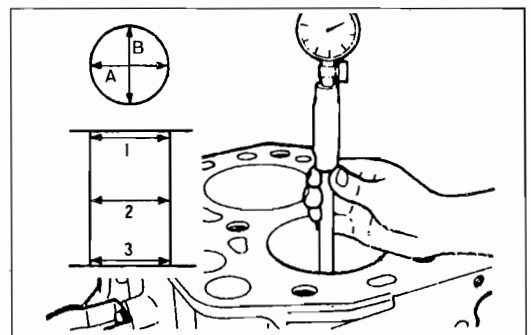
- (a) Check the crankcase for cracks and damage. If any problem is found, replace the crankcase.
- (b) Check the water jacket for scale and corrosion. If any, correct.
- (c) Using a cylinder gauge, measure the cylinder bore in A and B directions at three different positions in height, and if necessary, rebore to oversize or replace.
- (d) If the cylinder bore is not so worn and only the piston rings are to be replaced, check the upper part of the cylinder bore for stepped wear, and if any, remove it by honing.



Removal of Piston Pin



Cleaning and Inspection of Crankcase



Measurement of Cylinder Bore

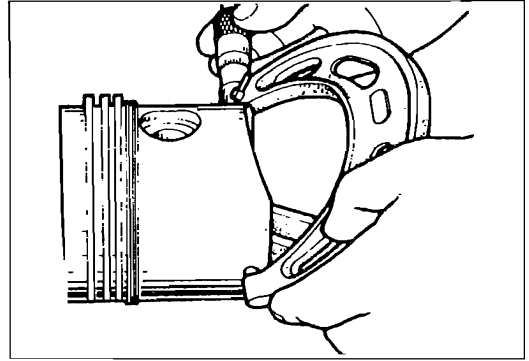
## (2) Piston, Piston Pin and Piston Rings

- (a) Check the piston for seizure, scratches and wear, and if defective, replace.
- (b) Measure the piston OD, and if excessively worn, replace.

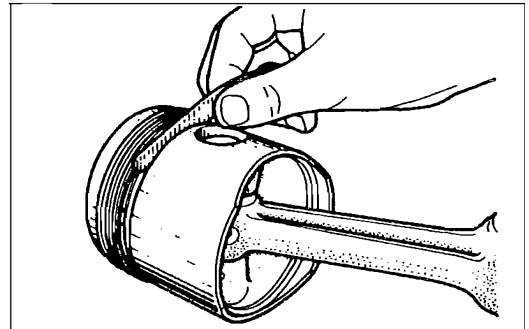
If the piston to cylinder clearance is excessively large, machine the cylinder bore to oversize and replace the piston. Measure the piston OD in the direction at right angle to piston pin hole (thrust direction) at the lower part of the skirt.

- (c) When an oversize piston is used, finish the cylinder bore to oversize. Firstly, measure the outside diameter of the oversized piston to be used (diameter in the thrust direction at the lower end of the piston skirt) and then rebore and hone the cylinder so that the clearance between cylinder bore and piston will be the specified value.
- (d) Measure the side clearance between each piston ring and its groove, and if necessary, replace the ring. If the clearance is too large with the new ring, also replace the piston.

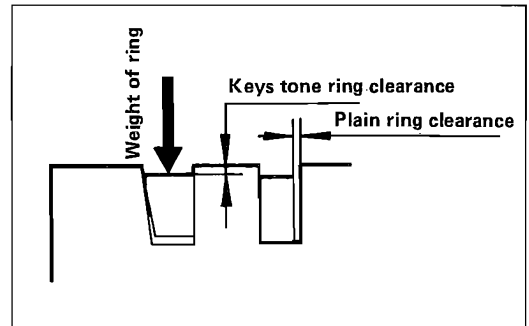
As to the No. 1 semi-keystone type ring (except for K2B), measure the amount of sinkage from the sliding surface of the piston when it fits into the groove with its own weight (see illustration).



Measurement of Piston O. D.

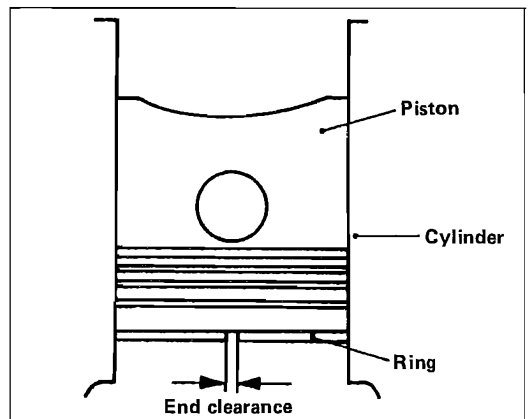


Measurement of Side Clearance



Measurement of Side Clearance

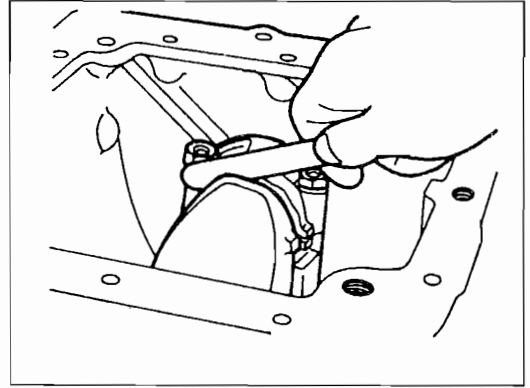
- (e) Measure the gap of each piston ring, and if the gap is too large, replace the ring. To measure the ring gap, push the ring into the least worn part of the cylinder (skirt) with the piston as illustrated and measure the gap with a feeler gauge.
- (f) When the clearance between the piston pin and piston (or the bore of the small end of connecting rod for KE75) is excessive, replace the piston, pin assembly or connecting rod assembly.



Measurement of Ring Gap

### (3) Connecting Rod

- (a) Using a connecting rod aligner, check the connecting rod for bending and distortion, and if necessary, correct or replace it.
- (b) Install the connecting rod on the crankshaft and measure the thrust clearance, and if the clearance is excessive, replace the rod assembly.



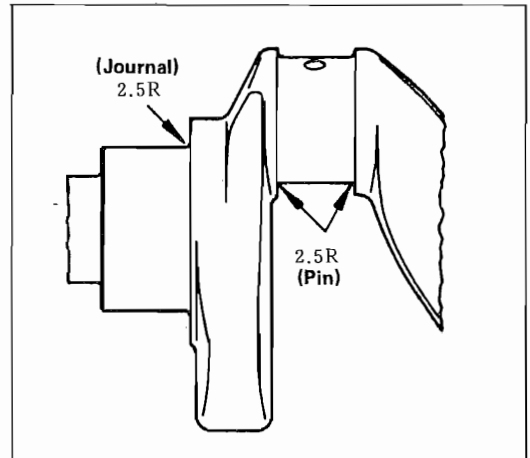
Measurement of Thrust Clearance of Rod

### (4) Crankshaft

- (a) Check the journals and pins for damage and seizure. Measure the outside diameter and if wear is excessive, finish it to undersize and replace the main bearings and connecting rod bearings with equally undersized bearings.

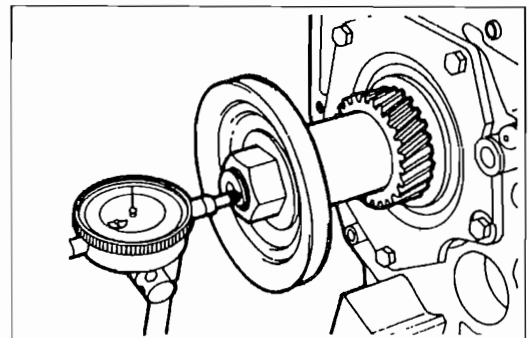
#### Caution

- 1. Do not use the seized crankshaft. Pay attention to the following points.
- 2. Correct the bedding before the crankshaft is polished.  
Pay attention to the fillet R and finish to the illustrated dimensions.
- 3. When the crankshaft journals and pins are machined to undersize, measure the surface hardness and only use Hv550–780.  
The hardness after undersize machining must be more than Hv 450.



Fillet R

- (b) Check the crankshaft end play, and if the specified limit is exceeded, replace the main bearing housing for K2AS or the thrust bearing for other models.  
To check the end play, install the crankshaft and main bearing housing for K2AS (with thrust plate for other models) and also install the gear, sleeve and pulley, and tighten the nut and measure the end play with a dial gauge at the front end of the crankshaft.



Measurement of Crankshaft End Play

**(5) Main Bearing and Connecting Rod Bearing**

(a) Check the bearing surface for flaking, melting, seizure and poor contact, and if defective, replace the bearing.

(b) Install the main bearings and connecting rod bearings in the respective crankcase bearing housings and on the connecting rods and measure the inside diameter of the bearings.

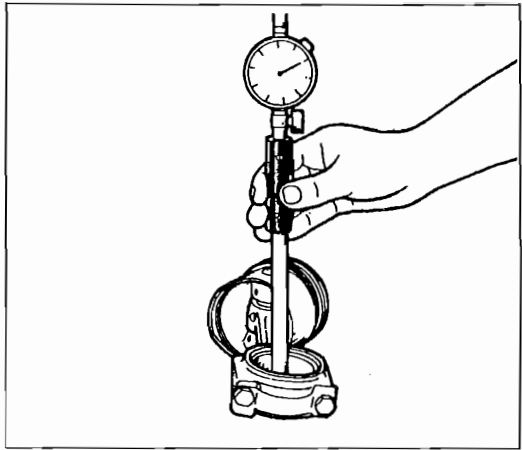
Then, measure the outside diameter of the crankshaft journals and pins and calculate the oil clearance.

If any oil clearance is excessively large, replace the bearing. When the standard oil clearance cannot be obtained even if the bearing is replaced, grind the crankshaft to undersize and install equally undersized bearing.

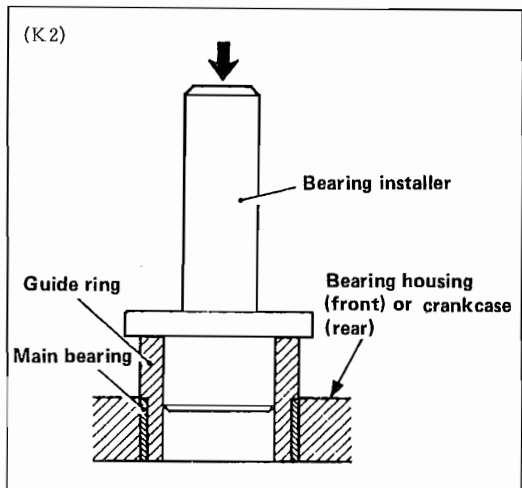
(c) To replace the main bearings, use the special tool; bearing installer. To remove the bearing, either the K2 bearing installer or KE bearing installer can be used.

1) To remove the main bearing, use the combination of the installer body and guide ring as illustrated.

To remove the main bearing from the bearing housing, push it from the front side to the rear side. To remove the main bearing located at the rear of the crankcase, push it from the rear side of the crankcase toward the inside of the crankcase after removing the oil seal.



**Measurement of Connecting Rod Bearing I. D.**



**Removal of Main Bearing**

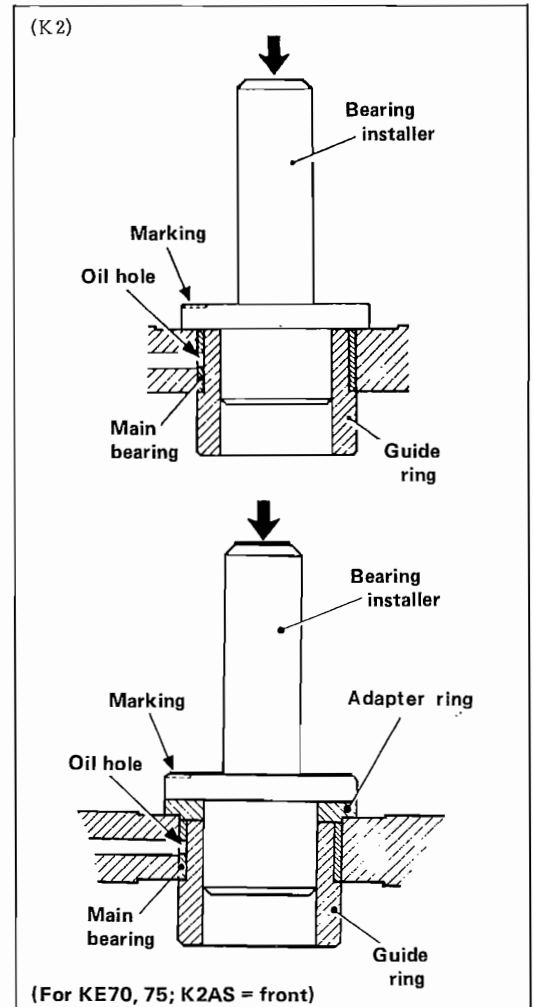
- 2) To press-fit the main bearing, combine the installer body, guide ring and the main bearing as illustrated and press-fit from the same direction as for removal.

Since the press-fitting position of the bearing consists of two types—one flush with the end surface of the hole and the other further pushed in from the end surface of the hole—a suitable tool adapter ring must be selected in accordance with the following table.

Model	Press-fit depth from end surface of main bearing	
	Bearing housing side (front)	Crankcase side (rear)
K2AS	2.5mm	0
K2B,C	0	0
KE70,75	1mm	1mm

#### Caution

1. When a main bearing is press-fitted, the oil hole in the crankcase and that in the bearing must be in alignment. Set the oil hole in the main bearing in alignment with the marker stamped on the collar of the installer body and press-fit it in alignment with the oil hole in the crankcase. After setting, do not turn the tool or bearing. The abutting portion of the main bearing must be positioned at a higher place than the center of the crankshaft.
2. Before press-fitting, apply engine oil to the periphery of the bearing, and be sure to use a press for press-fitting.



Press-Fitting of Main Bearing



**(6) Timing Gears**

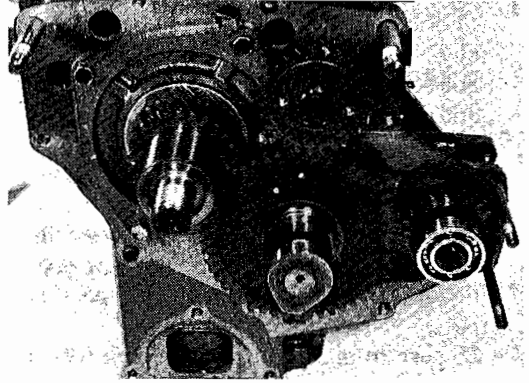
Check each gear for poor contact, wear and damage, and if defective, replace the gear.

**(7) Camshaft**

(a) Measure the clearance between the camshaft journal (both front and rear) and crankcase hole, and if the clearance is excessive, replace the camshaft or crankcase.

(b) If the camshaft surface is damaged or the cam lobe is badly worn beyond the service limit, replace the camshaft.

For K2AS, thoroughly check the oil pump drive groove at the rear end of the camshaft.



**Inspection of Timing Gears**

**(8) Oil Pump Driving Gear (Except for K2AS)**

(a) If the oil pump driving gear and ball bearing are excessively worn or damaged or there is abnormal sound or catching when they are turned, replace them.

**Caution**

When press-fitting the ball bearing onto the gear shaft, be sure to push the inner race so that no load will be imposed on the outer race.



**Inspection of Oil Pump Driving Gear**

**(9) Tappet**

(a) Check the bottom of the tappet (surface in contact with cam) for any crack, flaking and seam, and if defective, replace the tappet.

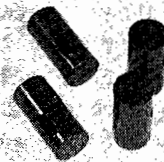
**(10) Push Rod**

(a) If both ends are excessively worn, replace the push rod.

(b) Place the push rod on a surface plate and measure for bending at the center, and if it exceeds the specified limit, correct or replace the rod.

**(11) Speedometer Driven Gear Unit (For special models KE70 and 75)**

Check the driven gear and sleeve for wear and damage and also the O-ring for damage, and if defective, replace.



**3. Inspection of Tappet**

### 3. Reassembly and Adjustment

#### Caution

1. Thoroughly clean the parts to be assembled. Especially carefully clean the oil holes, bearings, lower holes of bearings and inner surface of the cylinders.
2. Apply engine oil to the sliding and rotating parts such as inner wall of cylinders and bearings before assembling.
3. Never reuse the gaskets, packings and oil seals but replace them with new ones.
4. Be sure to apply sealant to the specified parts.
5. Be sure to observe the tightening torque and tightening sequence where specified, and if not specified, use the tightening torque for ordinary screws.
6. Check clearances and end plays while assembling.

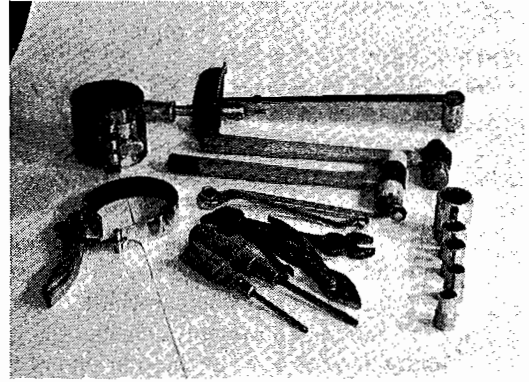
#### (1) Assembling of Piston and Connecting Rod

To combine the piston and connecting rod except for KE75, use the special piston pin setting tools and work in the following procedure.

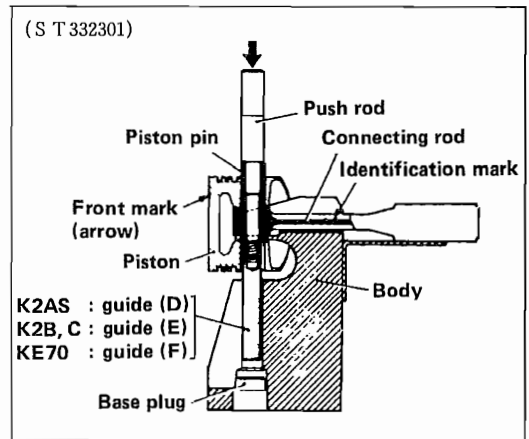
- 1) Insert the piston pin into the tool push rod and completely screw the guide into the push rod. Use the guide D for K2AS, guide E for K2B and guide F for KE70.
- 2) Insert the push rod, piston pin and guide as combined above into the piston pin hole of the piston from the guide side and pass them into the small end hole of the connecting rod. At this time the front mark (arrow) on the top of the piston and the identification mark on the connecting rod must face the same side. Sufficiently apply engine oil to the periphery of the piston pin and the bore of the small end of the connecting rod.

#### Caution : Correction of tool

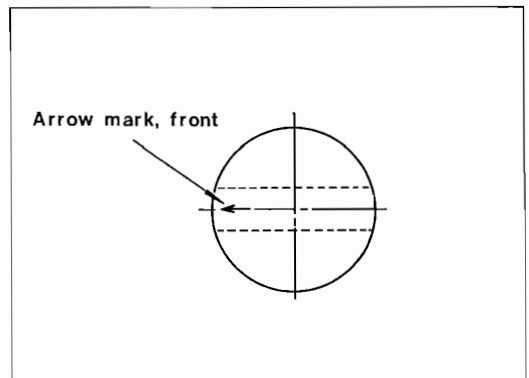
If it is difficult to set the K2AS piston rod assembly in the old type tool, grind the upper end of the receiving side of the tool rod (not the piston set side).



Assembling Tool



Press-fitting of Piston Pin

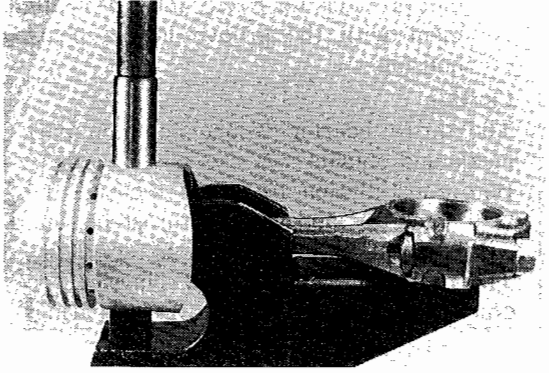


Piston Mark

- 3) Set the piston, connecting rod and tool combined by the preceding paragraph in the tool body. To set, align the notch on the guide with that on the body and turn the guide 90°. After setting, make sure that the small end of the connecting rod is in the receiving part of the body. Also confirm that both the identification mark on the connecting rod and the frontmark (arrow) on the top face of the piston are facing upward.
- 4) Set on a press and press-fit the piston pin. The press-fit load should be 500 to 1500 kg. If more load is needed, replace the connecting rod or piston pin and pin assembly. The piston pin is press-fit in the specified position by means of the guide. After press-fitting, turn the push rod 90° to align the notches of the guide and body with each other and remove the piston and connecting rod assembly from the tool body.

**Caution**

After assembling the piston and connecting rod, make sure that the piston pin is press-fitted equally against the center of the rod. If the pin is abnormally deviated, correct it. In such a case, check the tools.



**Press-fitting of Piston Pin**

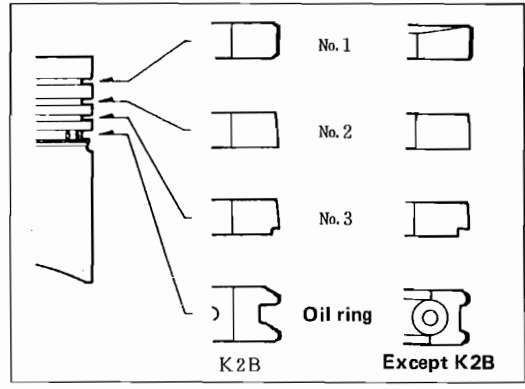
- (b) To assemble the piston and connecting rod for KE75, heat the piston in the oil of 80° C for 3 to 5 minutes and assemble the piston, rod and piston pin and install the snap rings on both ends of the piston pin. The identification mark on the rod and the arrow on the piston must be in the front direction. For the old model whose piston pin hole and the arrow are not in a same direction, the arrow on the piston should be on the combustion chamber side and the rod mark in the front direction.

**(2) Installation of Piston Rings.**

Since the piston rings vary in shape, they must be installed in correct positions and directions as illustrated. The surface on which the manufacturer's mark and size mark are stamped must be on the top face side of the piston.

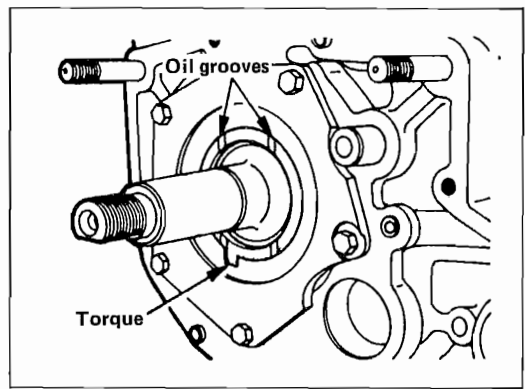
**(3) Installation of Crankshaft**

- (a) Insert the crankshaft into the crankcase. Apply engine oil to the main bearings and journals and take care not to damage the main bearings.
- (b) Install each bearing housing. At this time, the tag on the inside thrust bearing (not provided for K2AS) must be in alignment with the groove in the bearing housing.

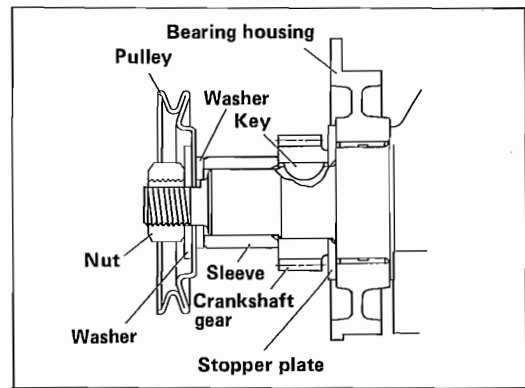


**Installation Position of Piston Rings**

**Caution**  
The thrust bearing is one common part inside and outside. Before installation, be sure to measure the wall thickness and use the thrust bearing within the standard dimension. This will regulate the end play of the crankshaft. (K2AS has no thrust bearing)

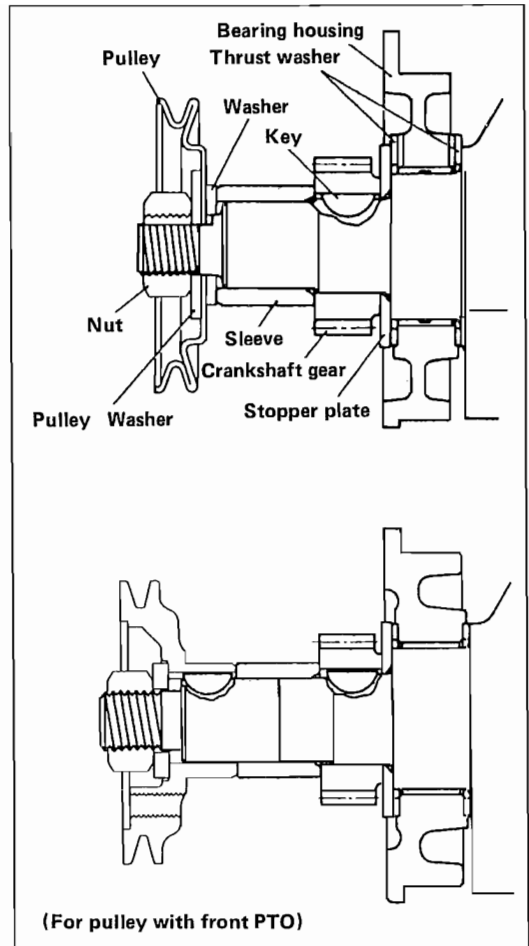


**Installation of Thrust Bearing**



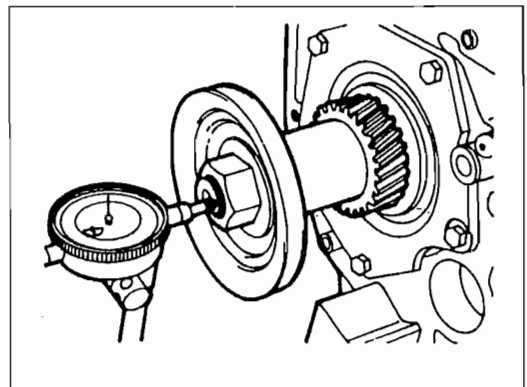
**K2AS Bearing Housig**

(c) Install the outside thrust bearing in alignment with the groove in the bearing housing and install the stopper plate, crankshaft gear and sleeve. The chamfered side of the stopper plate must be on the rear side of the engine, the stepped side of the crankshaft gear on the rear side of the engine and the chamfered side at the peripheral edge of the sleeve on the front side of the engine.



Installation of Gear and Sleeve (Except K2AS)

(d) After temporarily assembling the stopper for sleeve, washer and crankshaft pulley and tightening the nut, check for end play of the crankshaft. If the end play is excessively larger than the specified value, recheck the thrust bearing (except K2AS). For K2AS, check the thrust surface of the bearing housing. Also make sure that the crankshaft gear and sleeve are correctly installed. After checking the end play, loosen the nut and remove the pulley and washer.



Checking of Crankshaft End Play

### (3) Installation of Piston

Insert the piston and connecting rod assembly into the cylinder, install the connecting rod cap and tighten it to specified torque.

For K2 and KE70, insert the bolts from the connecting rod side and tighten the nuts from the cap side. Since KE75 has the tapped holes on the connecting rod side, tighten the bolts from the cap side. When inserting the piston, the piston rings must be clamped securely with the ring band and the front mark (arrow) on the top face of the piston and the identification mark on the connecting rod must face the front side of the engine. For the old type piston of KE75, however, the arrow on the top face of the piston must face the combustion chamber side because the arrow is in the direction at right angle to the pin hole.

For every model the piston rings must be installed in such a way that the gaps of the rings will not be in the thrust direction and piston pin direction and that the gaps of mutually adjacent rings will be as far as possible from each other.

### (4) Installation of Camshaft

Fit the camshaft gear to the camshaft with a key and insert the assembly into the crankcase. At this time, the matchmark on the crankshaft gear must be in alignment with that on the camshaft gear as illustrated.

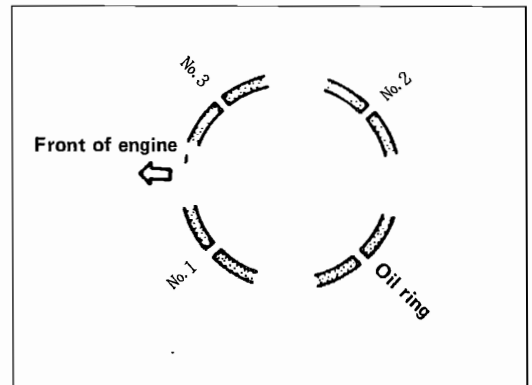
### (5) Installation of Gears

(a) Install the governor gear and lock it with the snap ring. Then, install the governor weight assembly and sliding shaft.

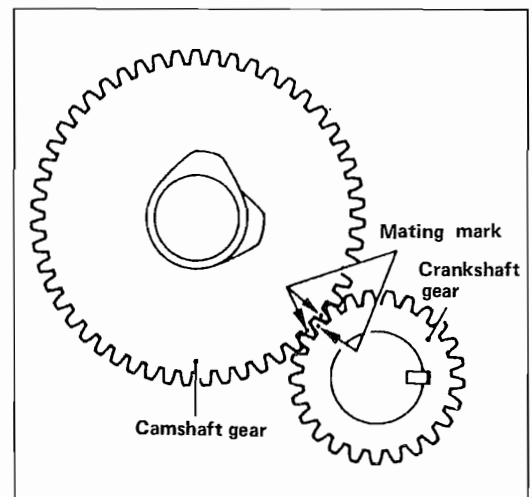
(b) Install the oil pump driving gear (with ball bearing) (not provided for K2AS).

### (6) Installation of Gear Case

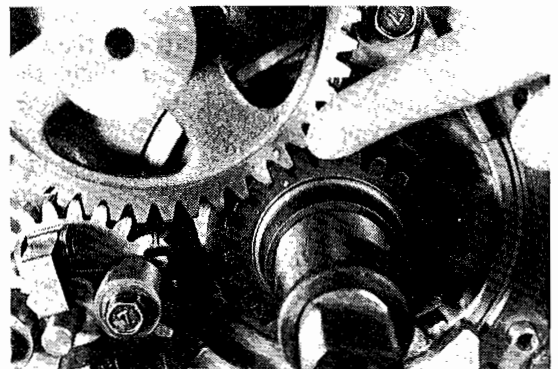
Install the gear case (with governor link assembly). Stick the gasket coated with specified sealant to the gear case.



Piston Ring Gap Positions



Gear Matchmarks



Confirmation of Timing Mark

### (7) Installation of Pulley

Install the crankshaft pulley. Do not forget to install the stopper washer for the crankshaft spacer (only for pulley made of sheet metal) and crankshaft pulley washer (for nut seat).

Model	Flywheel tightening torque
K2AS	6.5–7.0 kg.m
K2B, C KE (current)	13–14 kg.m (bolt without washer, with flange)
K2B, C KE (old)	11.5–12.5 kg.m (bolt with washer)

### (8) Installation of Oil Pump (K2AS) and Flywheel

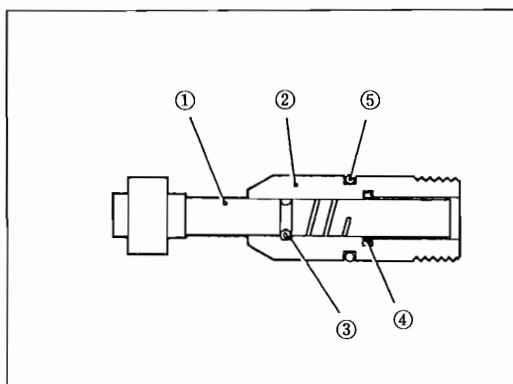
- (a) For K2AS install the oil pump assembly on the rear end of the camshaft. Be sure to install the pump body gasket and the O-ring for the cover.
- (b) Install the rear plate.
- (c) Install the flywheel and tighten the bolts to the specified torque.
- (d) Install the oil pan.

### (9) Installation of Tappets and Driven Gear.

- (a) Insert the tappets.
- (b) Insert the push rods into the tappet hole center.
- (c) If the speedometer driven gear unit is provided, apply the sealant Threebond No. 2 to the periphery of the sleeve and insert the gear into the crankcase and have it engaged with the drive gear on the camshaft. Pay attention to the direction of the groove for the sleeve stopper.

After insertion, fix the gear with the stopper plate. If the driven gear unit is not yet assembled, assemble it in the following way.

- 1) Insert the O-ring correctly into the groove inside the driven gear sleeve.
- 2) Apply Shell Alvania grease #3 to the periphery of the driven gear shaft (especially to the O-ring area) and insert the shaft into the sleeve.



1. Speedometer driven gear 2. Driven gear sleeve  
3. Spring pin, 4. O-ring (small) 5. O-ring (large)

Assembly of Speedometer Driven Unit

- 3) Fix the gear shaft and sleeve with the spring pin.

The spring pin junction must be directed outward in relation to the shaft center and the pin end must not protrude out of the periphery of the sleeve.

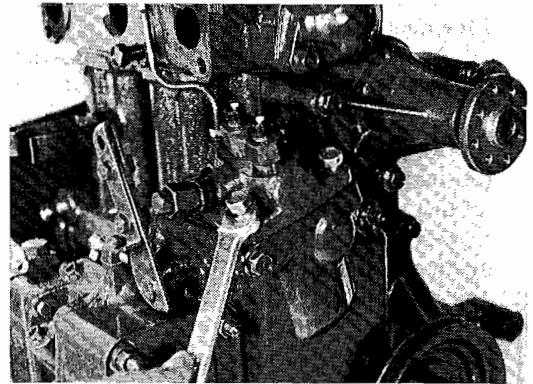
- 4) Fit the O ring into the groove in the outside surface of the sleeve. After assembling, check to see if the gear shaft rotates smoothly.

#### **(10) Installation of Cylinder Head**

Install the cylinder head assembly. (See Assembly of Cylinder Head)

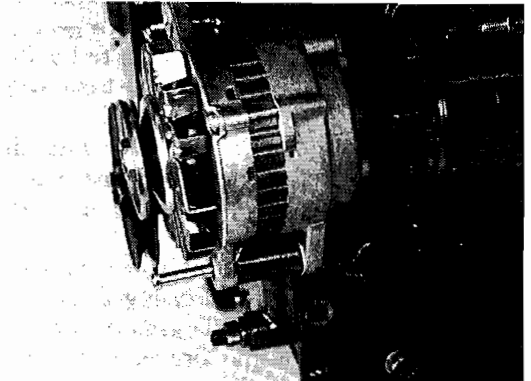
#### **(11) Installation of Accessories**

- (a) Install the injection pump assembly.
- (b) Install the oil pump and oil filter (see Lubrication System).  
If the oil pressure switch is not yet installed, install it after applying sealant to the thread.
- (c) Install the fuel filter and fuel pipe.
- (d) Install the water pump and cooling fan.



**Installation of Fuel Injection Pump**

- (e) Install the fan belt and adjust the tension of the belt. (See Cooling System)
- (f) Install the fan belt and adjust the tension of the belt. (See Cooling System)



**Installation of Alternator**



## 2. Lubrication System

### 2.1 General

The lubrication system uses a trochoid type oil pump and a full-flow filter.

The oil pump is driven through the Oldham's coupling located at the rear end of the camshaft (engine rear) for K2AS or at the rear end of the fuel injection pump camshaft for other models. Oil from the oil pump passes through the check valve which adjusts the pressure. The oil is fully filtered by the cartridge type oil filter, and sent to the engine parts through the oil holes in the cylinder block.

#### 2.1.1 ENGINE OIL

##### (1) Oil to be Used

Use HD engine oil (heavy duty oil Class CC or higher) and change the oil every 100 hours of operation. Do not use poor quality oil. Be sure to carry out the periodic change.

##### (2) Changing of Engine Oil

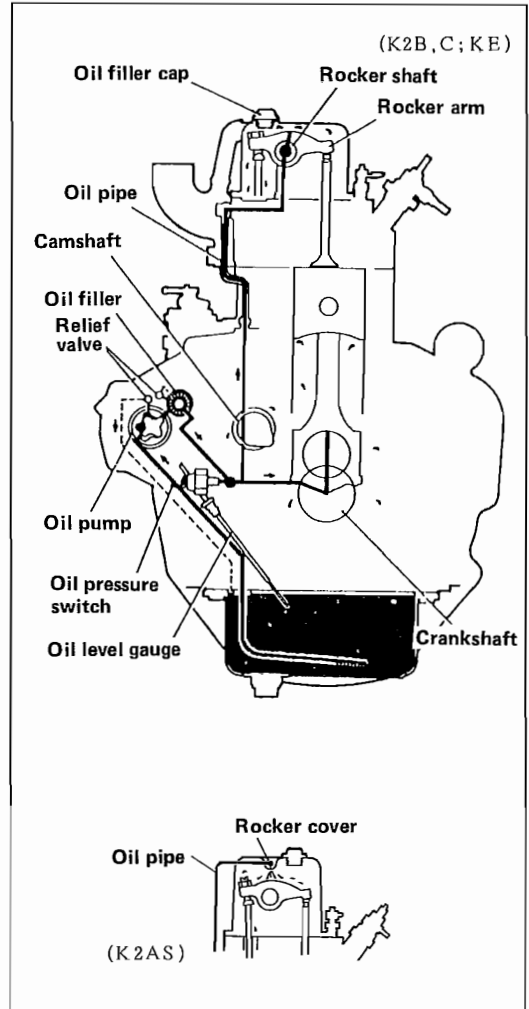
To change the engine oil, warm up the engine and then, remove the drain plug located at the bottom of the oil pan and drain the oil. After tightening the drain plug, remove the filler cap (on the rocker cover for K2 models or oil filter side for KE models) and fill with new oil.

##### (3) Checking and Replenishing of Engine Oil

Replenish the oil so that the oil in the oil pan is near at the upper limit mark of the oil level gauge.

##### Caution

When the oil is replenished, check the oil level again using a level gauge after the elapse of about 1 minute.



Passage of Lubricating Oil

## 2. 2 Oil Filter

### 2. 2. 1 CONSTRUCTION OF OIL FILTER

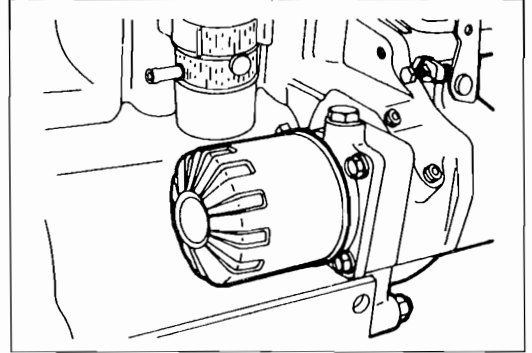
The oil filter is an easy-to-handle cartridge type where the filter element is integrated into the filter body.

If the element is contaminated or clogged and the oil pressure difference at the front and rear of the element exceeds about  $1 \text{ kg/cm}^2$ , the relief valve incorporated in the element is opened and the oil is sent to various parts without passing through the element. Therefore, it is very important to check and replace the oil filter regularly.

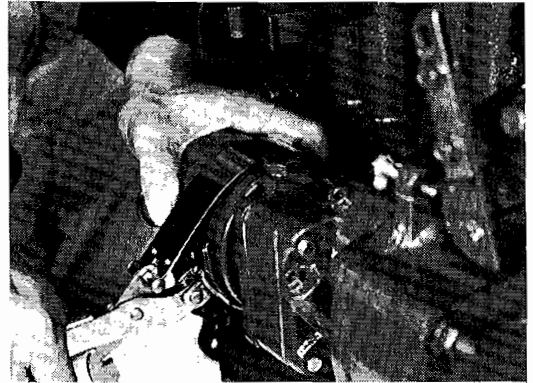
Internal cleaning is not required, and the filter should be replaced with new one every 100 hours of operation.

### 2. 2. 2 DISASSEMBLY AND REASSEMBLY OF OIL FILTER

- (1) If it is difficult to remove the oil filter by hand, use an oil filter remover tool (commercially available).
- (2) When the oil filter is installed, sufficiently tighten it by hand. The tightening torque is  $1.1\text{--}1.3 \text{ kg}$ . Be sure that the O-ring is correctly in the groove and apply engine oil lightly to the O-ring.
- (3) Start the engine and check for any oil leakage.



Oil Filter



Removal of Oil Filter

## 2. 3 Oil Pump

### 2. 3. 1 CONSTRUCTION OF OIL PUMP

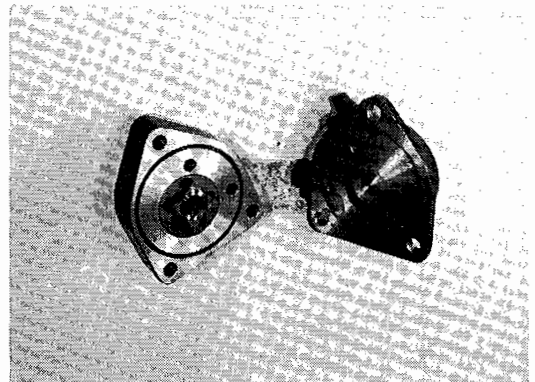
The oil pump is of the trochoid type and is installed at the rear end of the engine (rear end of camshaft) For K2AS.

For other models it is installed on the right and front side of the crankcase. The oil filter for K2AS is installed on the right side of the engine. The oil pump incorporates a relief valve which allows the oil to flow into the oil pan when the delivery pressure becomes  $3.5 \text{ kg/cm}^2$  or more, to prevent the oil pressure from increasing.

### 2. 3. 2 DISASSEMBLY, INSPECTION AND REASSEMBLY OF OIL PUMP

#### 1. Disassembly

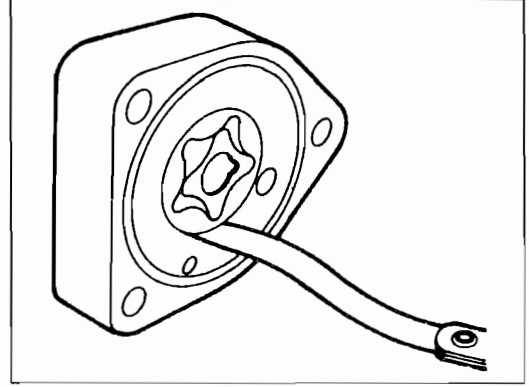
- (1) For K2AS remove the flywheel first and then the oil pump.
- (2) For other models, remove the oil filter first and then the oil pump.



Oil Pump

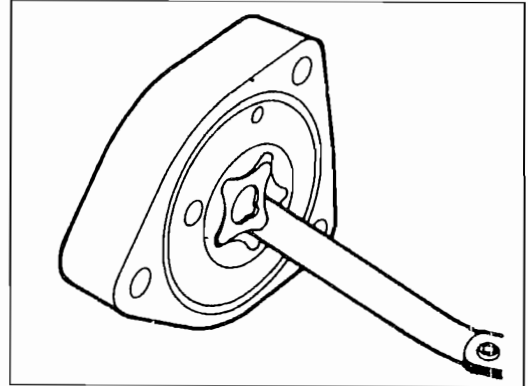
## 2. Inspection

- (1) Check the oil pump rotor shaft for wear and damage.
- (2) Measure the clearance between outer rotor and body with a thickness gauge, and if the clearance is excessive, replace the rotor assembly or body.



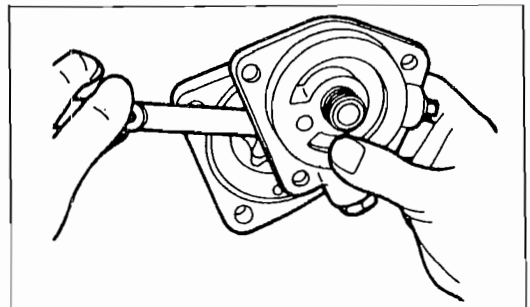
Clearance between Outer Rotor and Body

- (3) Measure the clearance between outer rotor and inner rotor with a thickness gauge, and if the clearance is excessive, replace the rotor assembly.



Clearance between Outer Rotor and Inner Rotor

- (4) To check the clearance between rotor and cover, insert the rotor into the pump body and attach a straight edge, and if the clearance between the straight edge and the rotor is out of standard, replace the rotor assembly or the body.



Clearance between Rotor and Cover

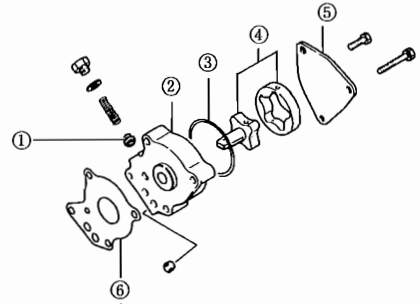
### 3. Reassembly

#### Caution

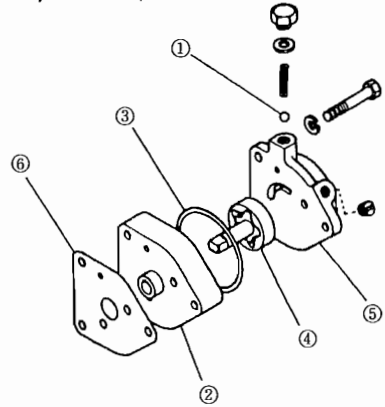
1. Apply engine oil to the rotating parts before assembling.
2. After assembling, make sure that the pump shaft rotates smoothly.
3. Measure the clearance between the outer rotor and the body with a thickness gauge and if the clearance is excessive, replace the rotor assembly or body.

- (1) Install the rotor assembly to the oil pump body.
- (2) Install the pump body to the crankcase so that the projection on the oil pump shaft is engaged in the camshaft groove. Use a new gasket.
- (3) Replace the O-ring with new one, apply oil, fit it in the groove of the pump body and install the cover.

(for K2AS)



(for K2B, C and KE)



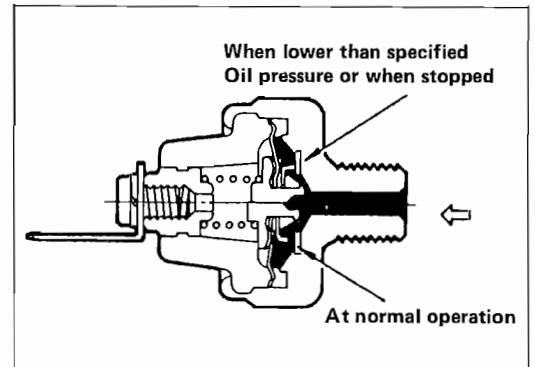
1. Relief valve 2. Body 3. O-ring 4. Rotor assembly 5. Cover 6. Gasket

Oil Pump

### 2. 4 Oil Pressure Switch

#### 2. 4. 1 CONSTRUCTION OF OIL PRESSURE SWITCH

The oil pressure switch is located at the rear of the crankcase, and when the oil pressure in the lubricating system becomes lower than the specified pressure, this switch operates to light a caution lamp. When the lamp lights, stop the engine immediately and investigate the cause and take necessary steps.

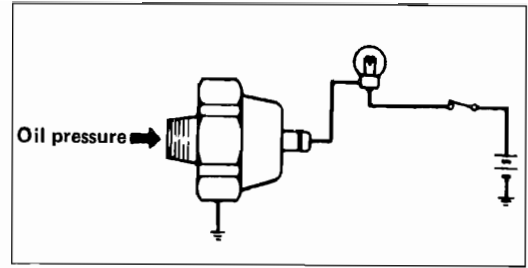


Oil Pressure Switch

## 2. 4. 2 INSPECTION OF OIL PRESSURE SWITCH

Check the oil pressure switch as illustrated, and if out of standard, replace.

Model	Oil pressure for lighting (kg/cm <sup>2</sup> )
Ordinary models	$0.3 \begin{matrix} 0 \\ -0.15 \end{matrix}$
K2B-31SW,32SW	$0.5 \pm 0.1$
KE70-11HL KE75-12HK,HL	$0.6 \pm 0.1$

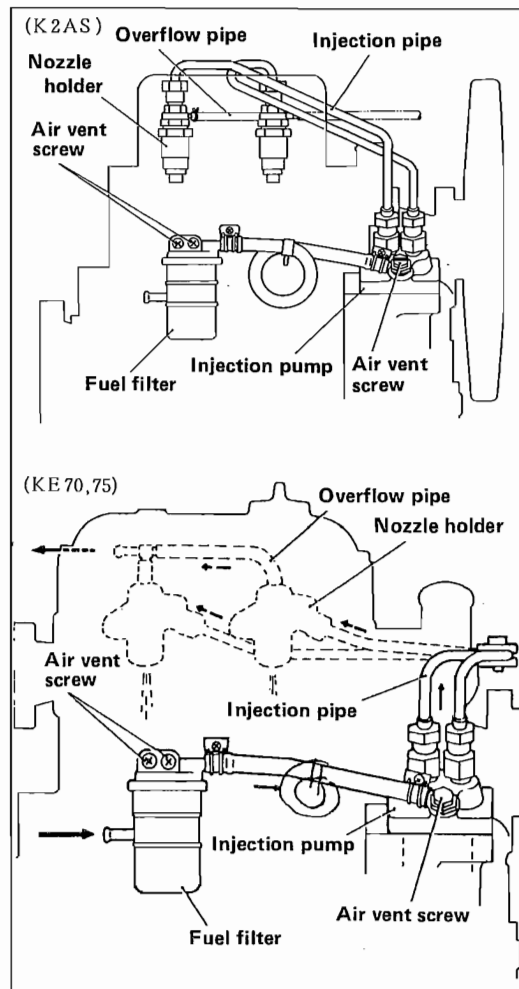


Inspection of Oil Pressure Switch

### 3. Fuel System

#### 3.1 General

Fuel from the fuel tank is sent through the fuel filter to the injection pump and through the plunger and injection pipe to the nozzle through which the fuel is injected into the combustion chamber. Surplus fuel is returned to the tank through the nozzle holder.



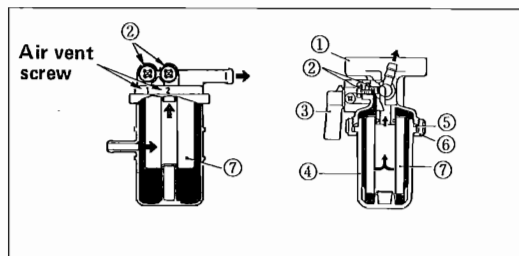
Fuel System

#### 3.2 Fuel Filter

##### 3.2.1 CONSTRUCTION OF FUEL FILTER

The filter is easy-to-handle cartridge type which uses a paper element.

On the filter 2 screws for air vent are provided. On the lower part of these air vent screws, numbers are attached and the air removal must be carried out in the sequence of these numbers. Depending on the engine specifications, other types of filter such as disassembly type and filter-with-cock type are also used.

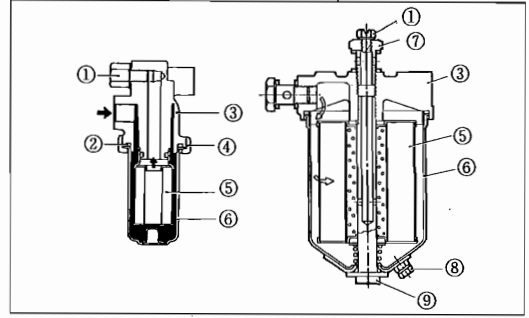


1. Body 2. Air vent screw 3. Cock 4. Cap 5. O-ring  
6. Ring nut 7. Element

Fuel Filter

### 3. 2. 2 INSPECTION OF FUEL FILTER

- (1) Check the cover and body for any crack, deformation and damage, and if defective, replace.
- (2) For the cartridge type filter, replace the filter assembly every 400 hours of operation. If it is excessively contaminated, replace it with new one even before the 400-hour operation.
- (3) Since the filter with cock can be disassembled, take out the filter element every 100 hours of operation and wash it in light oil. The element should be replaced with new one every 400 hours of operation or earlier.



1. Air vent screw 2. O-ring 3. Body 4. Ring nut
5. Element 6. Cap (case) 7. Hollow screw 8. Drain plug 9. Guide

Fuel Filter without Cock

### 3. 3 Fuel Pump

#### 3. 3. 1 CONSTRUCTION OF FUEL PUMP

The electromagnetic type (transistor type) fuel pump uses reciprocating motion of a plunger under the control of the transistorized circuit. The oscillator incorporates the transistor, diodes, resistors, etc.

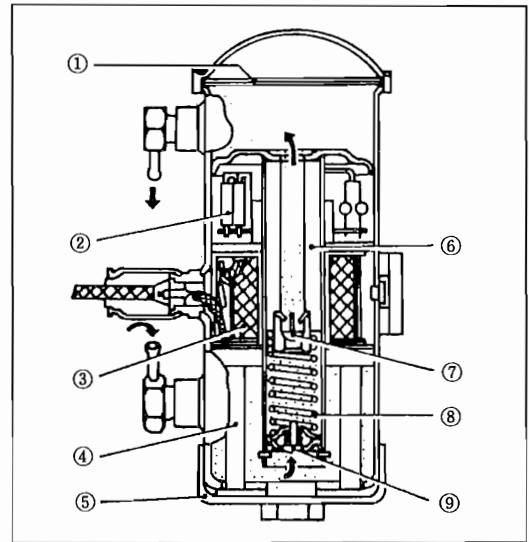
When the transistor is "ON", the solenoid coil is excited and the attracting force acts on the plunger and the plunger is pushed down against the spring force, and the fuel pushes up the delivery valve and is introduced into the plunger.

When the transistor is turned to "OFF", the fuel is pushed out of the outlet by the plunger stroke and the inlet valve is opened and the fuel flows into the chamber under the plunger.

#### 3. 3. 2 DISASSEMBLY AND REASSEMBLY OF PUMP FILTER

##### 1. Disassembly

Since this transistor type fuel pump is totally enclosed, the servicing consists of only cleaning of the cover, filter, and plunger assembly.



1. Diaphragm 2. Oscillator 3. Solenoid coil
4. Filter 5. Filter cover 6. Plunger 7. Delivery valve 8. Spring 9. Inlet valve

Fuel Pump

- (1) Remove the cover ① as illustrated using a 17mm wrench. Once the cover is removed, the cover gasket ②, magnet ③ and filter ④ can be removed from the pump body.

After cleaning the filter with cleaning oil (light oil), remove the dust and cleaning oil with compressed air.

(If the filter is badly contaminated, replace it with new one.)

Check the cover gasket, and if damaged, replace. Thoroughly clean the magnet and cover.

- (2) To remove the plunger, remove the spring retainer ⑥ and plunger tube ⑫ first. Then remove the washer ⑦, O-ring seal ⑧, valve ⑨, plunger spring ⑩ and plunger ⑪ from the tube.

Also clean the above parts in the cleaning oil and remove foreign matter with compressed air.

#### Caution

1. Since the tube ⑫ is very thin in wall thickness, it must be carefully handled so that bore of the tube is not deformed.
2. Also carefully handle the plunger to prevent it from being dented or damaged.

#### 2. Reassembly

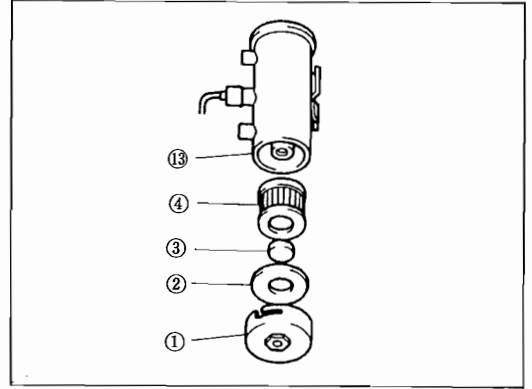
- (1) When assembling, install the plunger, plunger spring, valve, O-ring and washer in that order and finally press these parts with the retainer so that they will not come out.
- (2) Fit in the filter and also fit the magnet and gasket into the cover and install up to the stopper airtight using the 17mm wrench.

### 3. 3. 3 CLEANING AND OPERATION CHECKING OF FUEL PUMP

#### (1) Cleaning of Filter

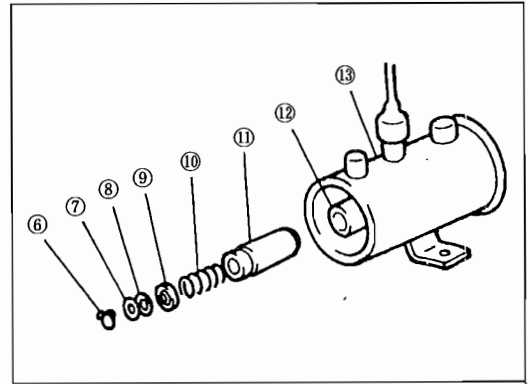
After the initial operation of 50 hours and subsequently every 100 hours of operation, remove the cap at the lower part of the pump body using a spanner in the manner described in the preceding section and clean the filter with fresh light oil.

After cleaning, install it securely to prevent leakage.



1. Cover 2. Cover gasket 3. Magnet 4. filter  
13. Body

#### Removal of Filter



6. Spring retainer 7. Washer 8. O-ring 9. Valve  
10. Plunger spring 11. Plunger 12. Plunger tube  
13. Body

#### Removal of Plunger



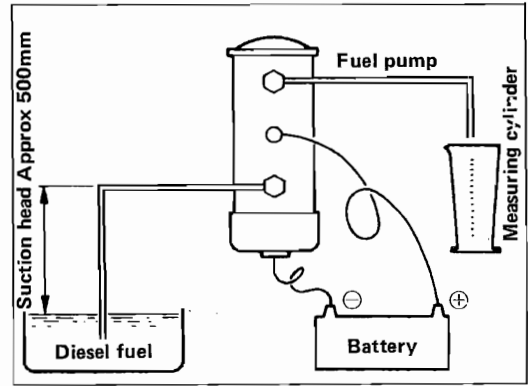
## (2) Operation Checking of Fuel Pump

Turn on the ignition switch and listen to operating sound. If operating sound cannot be heard, connect 12V voltage directly to the pump and listen to sound.

If operating sound cannot still be heard, replace the pump assembly. If you hear operating sound, check the fuse, connection of connector and electrical wiring.

## (3) Checking of Delivery of Pump

Check the delivery as illustrated and check to see if the delivery is at least 200 cc in 15 seconds.



Checking of Delivery

## 3.4 Fuel Injection Pump

### 3.4.1 CONSTRUCTION OF FUEL INJECTION PUMP

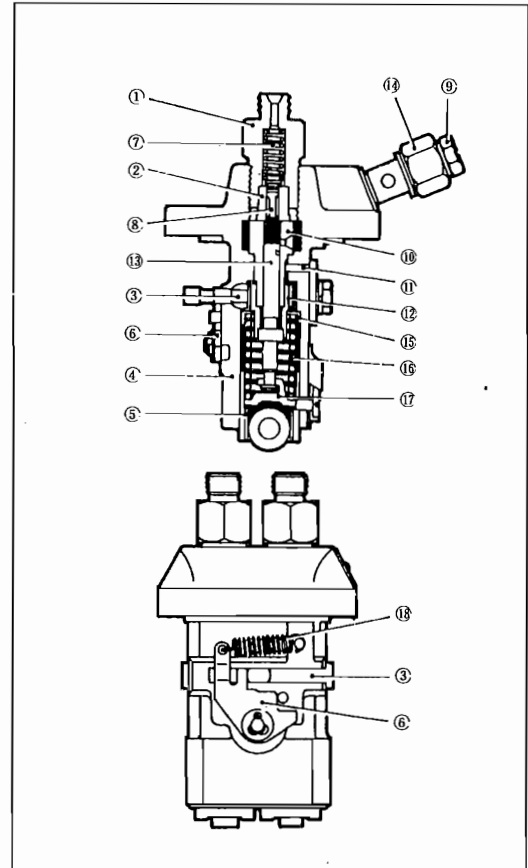
This injection pump built in the cylinder block has 2 cylinders, each of which consists of the pump element (plunger assembly), delivery valve, tappet, smoke set, etc. The pump is located at the front on the right side of the cylinder block and the fuel is sent under pressure when the plunger reciprocates in a certain stroke being pushed up by the pump cam.

#### (1) Fuel Injection Control

The fuel injection rate can be varied by changing the relative position of the plunger lead and barrel. The plunger is moved by the control pinion installed on the plunger barrel.

This pinion is in mesh with the plunger lower collar which transmits the rotation of the pinion directly to the plunger.

As the engine runs, the injection pump camshaft rotates to move the control rack through the centrifugal type governor weight, governor sleeve and lever, and when the control rack slides, this pinion is turned. Rightward movement (STOP → mark side) of the control rack decreases the fuel injection rate and leftward movement increases it.



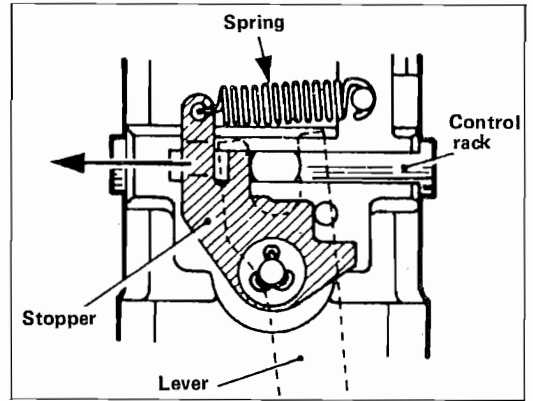
1. Delivery valve holder
2. Delivery valve seat
3. Control rack
4. Pump body
5. Tappet
6. Stopper
7. Delivery valve spring
8. Delivery valve
9. Air vent screw
10. Plunger barrel
11. Lock pin
12. Control pinion
13. Plunger
14. Union bolt
15. Upper seat
16. Spring
17. Lower seat
18. Return spring

Cross Section of Injection Pump

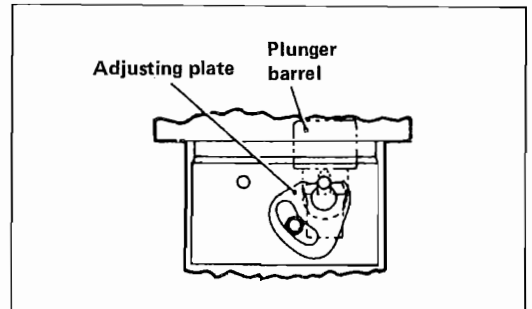
## (2) Smoke Set Unit

The smoke set unit is provided to restrict the maximum fuel injection rate of the injection pump. The stopper is retained by a spring at the illustrated position.

This position is the smoke set position. When the speed control lever is pulled fully toward the maximum speed position, the control rack is moved in the illustrated arrow direction by the governor lever overcoming the spring force of the stopper, thus resulting in excessive injection. The injection rate adjustment between the two cylinders is made by the plunger barrel which is rotated when the adjusting plate with cam mechanism located on the side opposite to the control rack rotates.



Smoke Set Unit



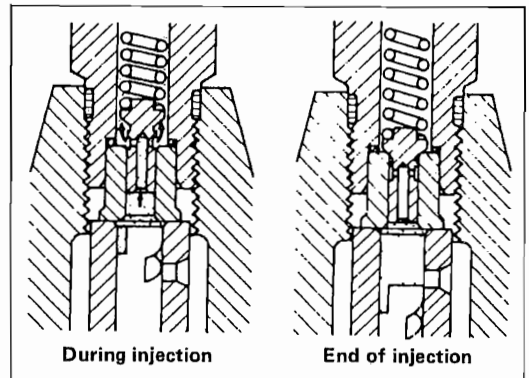
Injection Rate Adjustment between Cylinders

## (3) Delivery Valve

The delivery valve has an important function to prevent "after-drip" from the nozzle at the end of injection, in addition to its main function to deliver the fuel into the injection pipe when the fuel pressure becomes sufficiently high.

At the end of injection when the fuel pressure above the plunger decreases, the piston of the delivery valve closes the delivery valve seat, but at this time the compressed fuel is still remaining in the pipe to cause the after-drip.

To prevent this, the piston of the delivery valve sucks back the fuel in the injection pipe and reduces the pressure in the injection pipe almost to zero before the delivery valve is settled at the seat.



Operation of Delivery Valve

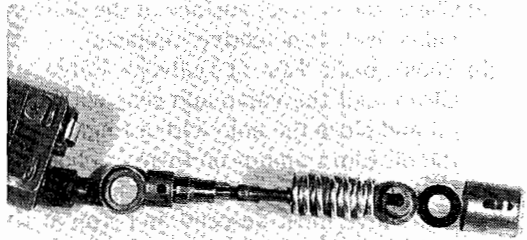
### 3. 4. 2 DISASSEMBLY OF FUEL INJECTION PUMP

- (1) Remove the injection pipe.
- (2) Loosen the injection pump mounting bolts and remove the pump assembly.
- (3) Record the thickness and number of pump adjusting shims for easier adjustment at the time of reassembly.
- (4) Disassemble the pump parts.

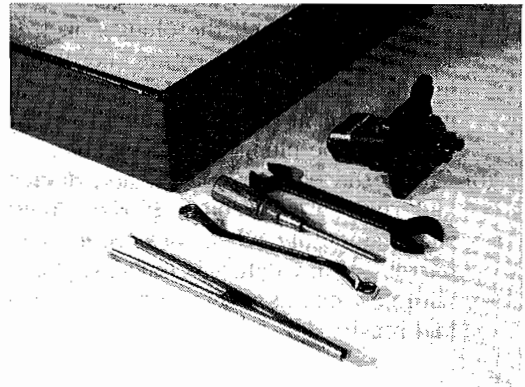
#### Caution

1. Do not attempt to disassemble the fuel injection pump unless it is necessary to do so. Since the adjustment of the injection pump requires a pump tester and skilled hand, disassembly, reassembly and adjustment of the pump should not be performed when such equipment and skill are not available.
2. Before disassembling, cover the fuel inlet and outlet and clean the outside.
3. Put the disassembled parts in a pan filled with clean light oil.
4. Keep the disassembled parts except those to be replaced in order to prevent mixing of them so that they can be reassembled in their original positions.

- (a) Remove the delivery valve holder. Remove the valve spring, valve, and O-ring.
- (b) Remove the gasket and valve seat.
- (c) Extend the lock plate of the tappet guide pin, slightly push in the tappet, pull out the guide pin using pincettes, and remove the tappet.
- (d) Remove the spring and upper seat.
- (e) Remove the pinion.
- (f) Pull out the plunger barrel upward from the pump housing.  
Combine the removed plunger barrel and plunger for each cylinder. (The combination of the plunger and barrel for each cylinder must not be mixed with another combination.)
- (g) Pull out the split pin, remove the washer, return spring and smoke set stopper, and draw out the control rack.



Disassembly of Injection Pump



Pan and Disassembling Tools

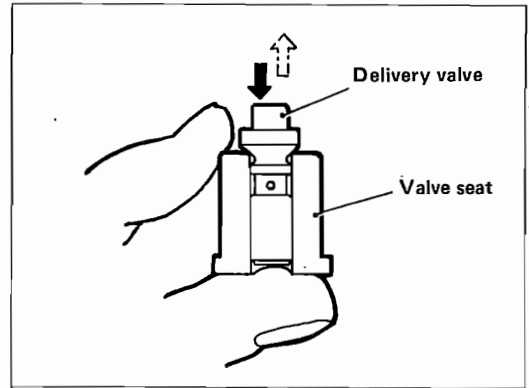


Removal of Tappet

### 3. 4. 3 INSPECTION

#### (1) Delivery Valve Seat

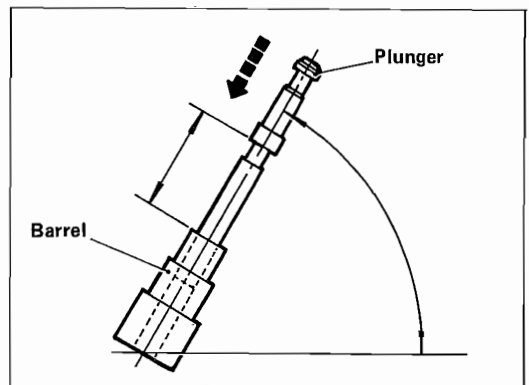
- (a) Check the contact surface of the delivery valve seat, if defective, replace.
- (b) Suck-back Test of Delivery Valve  
Clean well the valve and seat with light oil and close the hole with a finger while the oil film remains on them. Then pull up the valve and leave it on the way. The valve must descend and stop at the relief valve.



Delivery Valve

#### (2) Plunger Barrel

- (a) Sliding Motion Test on Plunger  
After cleaning well the plunger in fresh light oil, pull up and rotate the plunger inclined at 60° and watch the sliding motion. If it drops smoothly without catching, the plunger is acceptable.
- (b) Check the plunger for seizure, damage and rust. Also check if the plunger slides smoothly when inserted into the barrel. If any defect is found, replace it with new one as a set without repairing and reusing it.



Sliding Motion Test on Plunger

#### (3) Control Rack and Pinion

If the rack and pinion have any worn or damaged teeth, replace.

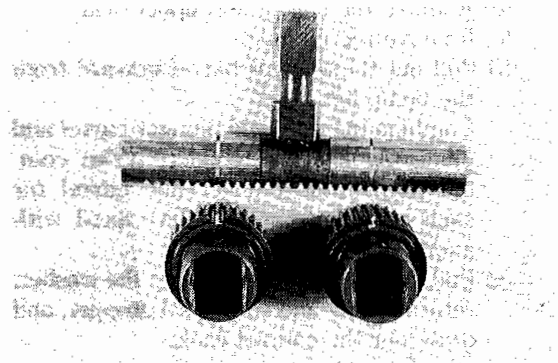
#### (4) Tappet

Check the tappet, roller and shaft for wear and damage, and if defective, replace.

### 3. 4. 4 REASSEMBLY

#### 1. Partial Assembly of Fuel Injection Pump

- (1) Insert the plunger barrel with its slot in alignment with the knock pin in the pump housing.
- (2) Fit the O-ring in the valve holder.
- (3) Fit the spring seat gasket and valve assembly in the holder and install the holder temporarily to the pump housing. Make sure that the O-ring is properly installed.
- (4) Install the control rack.

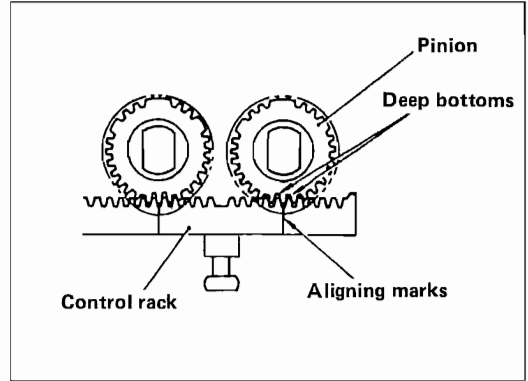


Control Rack and Pinion

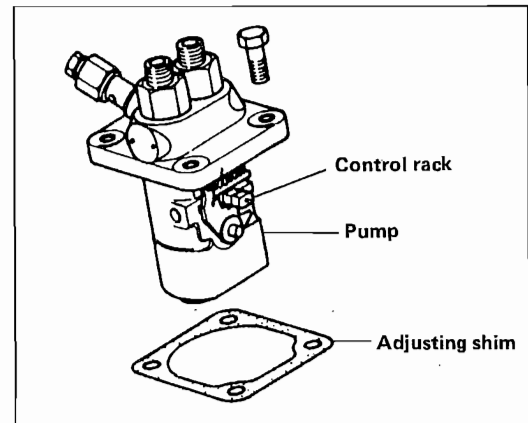
- (5) Install the pinion with the deep-root tooth in alignment with the mark on the rack.
- (6) Install the spring upper seat and spring.
- (7) Combine the plunger and spring lower seat and insert the mark L part of the plunger collar into the control rack.
- (8) Insert the tappet (be careful because shim is included), align the tappet guide hole with the knock hole of the housing, and insert the tappet guide pin. Before inserting the tappet guide pin, attach the lock plate which should be bent to lock after the guide pin is inserted.
- (9) Install the smoke set stopper, return spring and washer and insert the apring pin.
- (10) Tighten the delivery valve holder to the specified torque.

## 2. Installation and Adjustment of Fuel Injection Pump

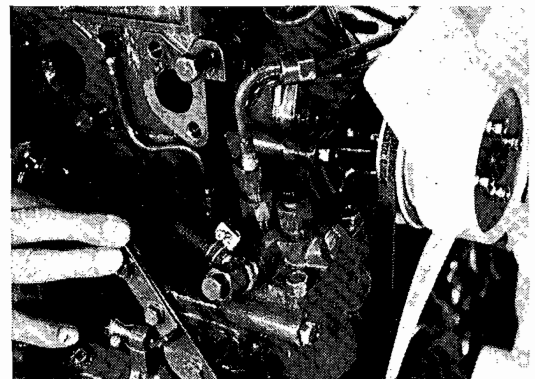
- (1) When installing the pump assembly, select and install the adjusting shims. Be sure to fit the projection on the control rack in the fork at the end of the governor lever. The shim consists of 4 types (thickness), 0.2, 0.3, 0.4 and 0.8 mm.
- (2) Connect the fuel supply hose, loosen the air vent screw on the injection pump and bleed air.
- (3) Check for injection timing. First, remove the delivery valve holder and take out the delivery valve and spring, and then, install only the delivery valve holder. Then, rotate the crankshaft. The injection timing is the moment when the fuel flowing out from the delivery port of the holder stops. If the timing is out of standard, make adjustment by increasing or decreasing the thickness of the adjusting shims. If the shim thickness is changed 0.1mm, the injection timing will change about 1°. If the above work is impossible, checking can be made without removing the valve and spring. In such a case, remove the pipe No. 1 on the nozzle holder side, fit the wrench on the crankshaft pulley nut and gradually rotate it. The injection timing is the moment when the fuel starts coming out of the pipe end and swells and this appears about 1° later than the normal injection timing. The injection timing should be checked when the plunger is in the smoke set position.



Combination of Rack and Pinion



Installation of Injection Pump



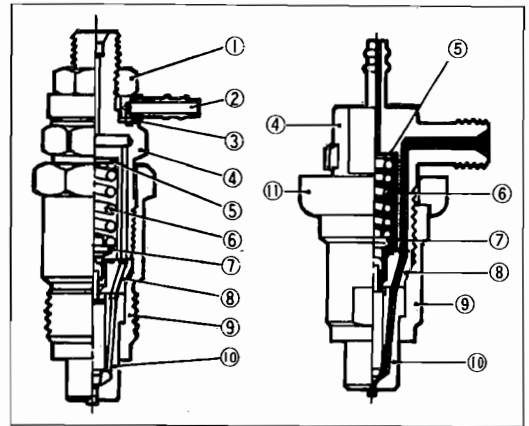
Checking of Injection Timing

### 3. 5 Injection Nozzle

#### 3. 5. 1 CONSTRUCTION OF NOZZLE AND NOZZLE HOLDER

The fuel sent under pressure from the fuel injection pump passes through the passage in the nozzle holder body and is injected into the combustion chamber through the nozzle.

The fuel overflowing from the nozzle passes through the nozzle holder and through the upper nipple and the overflow pipe it is returned to the fuel tank.



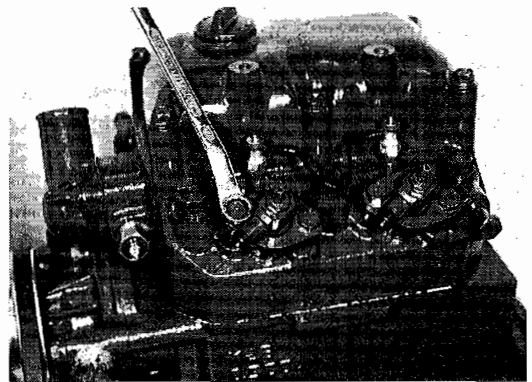
1. Nut 2. Connector 3. Gasket 4. Body 5. Shim washer 6. Spring 7. Pin 8. Distance piece 9. Retaining nut 10. Nozzle 11. Flange  
Cross Section of Nozzle Holder

#### 3. 5. 2 DISASSEMBLY OF NOZZLE HOLDER

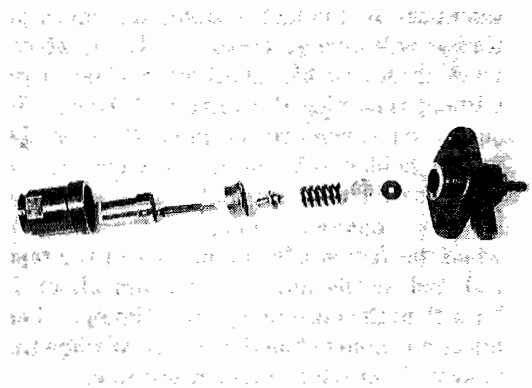
- (1) Remove the overflow pipe from the nipple on the nozzle holder.
- (2) Remove the injection pipe from the nozzle holder.
- (3) Loosen the nozzle holder mounting bolt and remove the nozzle holder from the holder assembly. For K2AS, turn the nozzle holder retaining nut and remove.
- (4) To disassemble the nozzle holder, use the following procedure.
  - (a) Hold the retaining nut in a vise and use the spanner on the nozzle holder body. When holding in the vise, use aluminium or copper plates as a protector.
  - (b) Remove the shim, pressure spring, flange (not provided for K2AS), pressure pin and distance piece. For the old KE70 and 75 precombustion types, remove the upper nipple.
  - (c) Remove the nozzle from the retaining nut. If it is too hard to take out the nozzle, hit it lightly with a wood taking care not to damage the needle valve of the nozzle.

#### 3. 5. 3 INSPECTION

- (1) Check the nozzle for incorrect contact and damage, and if defective, replace the nozzle as an assembly.
- (2) Check the pressure spring for damage.



Removal of Nozzle Holder



Disassembly of Nozzle Holder

### 3. 5. 4 PARTIAL REASSEMBLY OF NOZZLE AND NOZZLE HOLDER

#### Caution

1. Before assembling, thoroughly clean the parts in light oil.  
Do not wipe them with waste cloth.
2. When installing the nozzle holder body and retaining nut, be sure to use the specified tightening torque. Insufficient torque will cause poor compression and excessive torque will make the smooth sliding motion of the nozzle needle difficult, thus affecting the injection performance.

- (1) Install the nozzle assembly, distance piece and pressure pin in the retaining nut.
- (2) Install the shim, spring and flange (not provided for K2AS) in the body and install them to the retaining nut using the specified torque.
- (3) For K2AS, use washers on both sides and tighten the ring connector with the nut.

Description	Tightening torque
Body and retaining nut	6—8 kg·m
Ring connector lock nut (K2AS)	4—5 kg·m

### 3. 5. 5 INJECTION TEST

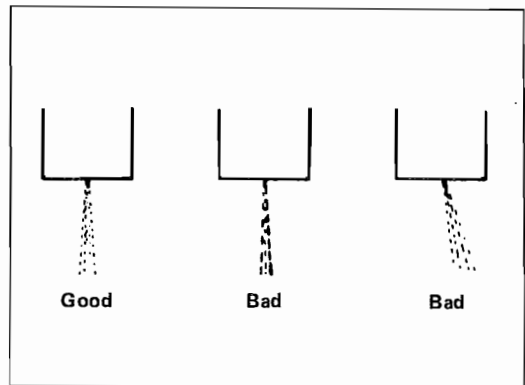
#### (1) Injection Starting Pressure Test

- (a) Measure the injection starting pressure using a nozzle tester, and if it is out of standard, adjust the pressure by increasing or decreasing the adjusting shims.
- (b) If the thickness of the adjusting shims is changed 0.1mm, the pressure will change about 10 kg/cm<sup>2</sup>. To change the shim, fix the retaining nut with a vise and remove the body with a spanner. Tighten the retaining nut to the specified torque when it is reinstalled.

Description		Standard
Injection starting pressure	K2AS	160 <sup>+10</sup> <sub>-0</sub> kg/cm <sup>2</sup>
	Other	120 <sup>+10</sup> <sub>-0</sub> kg/cm <sup>2</sup>

#### (2) Injection Test

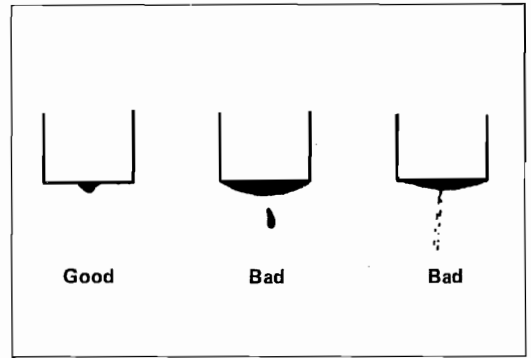
For the chattering test, operate the lever slowly, and if the nozzle sprays sharply and intermittently, the nozzle is considered good. The nozzle should spray fuel straight in its axial direction. If it sprays fuel in a wrong direction or various directions, the nozzle should be considered defective. Also, the injection in the form of big drops indicates a defect.



Chattering test

### (3) After-drip Test

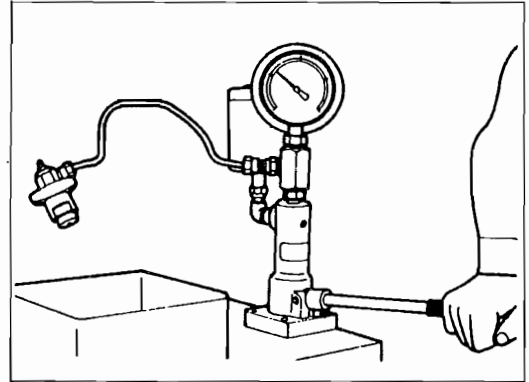
When the injection is stopped in the preceding chattering test, if the fuel is collected at the bottom of the nozzle and drops as droplets, the nozzle should be considered defective and replaced. A small amount of fuel may sometimes remain at the tip of the nozzle but this was caused by the chattering and can be ignored.



After-Drip Test

### (4) Injection Condition

The fuel must be sprayed in fine mist straight in the direction of the nozzle axis when the tester lever is operated quickly (at the rate of 800 strokes per minute).



Injection Nozzle Tester

### 3. 5. 6 INSTALLATION AND ADJUSTMENT OF NOZZLE HOLDER ASSEMBLY

- (1) Install the nozzle holder assembly in the cylinder head.

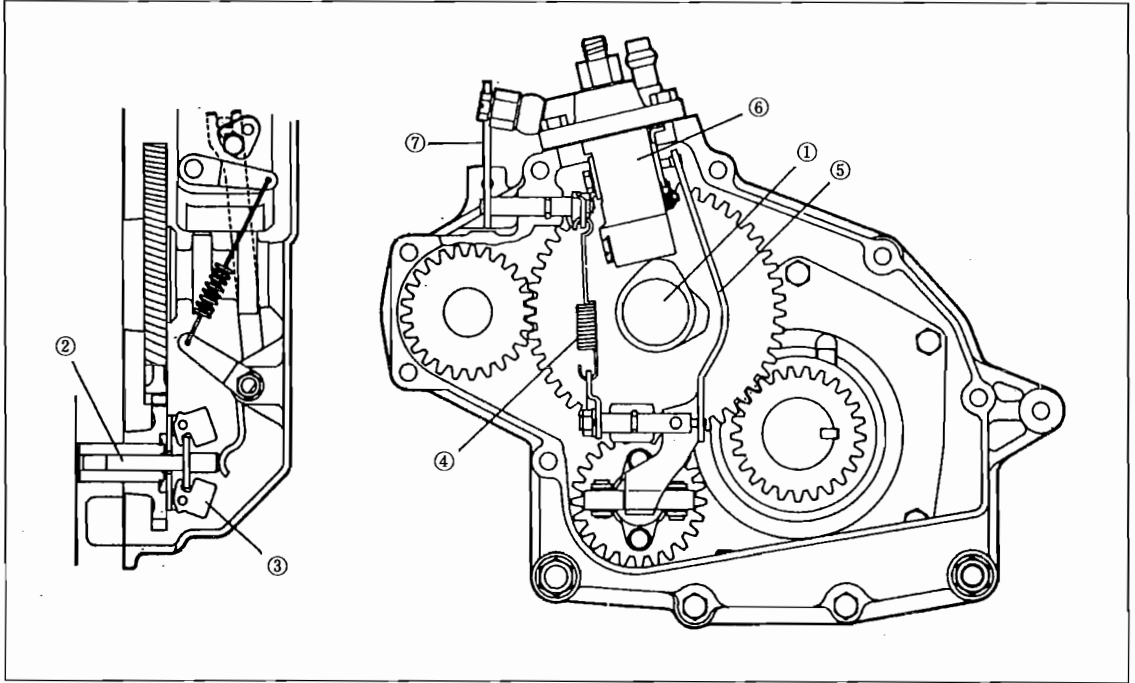
Except for K2AS, the assembly should be temporarily install. After installing the injection pipe, the mounting bolts of the assembly should be retightened equally to the specified torque. Replace the nozzle holder gasket with new one.

Description		Tightening torque
Intallation of nozzle holder to engine	K2AS	5—6kg-m
	Other models	1.5—2.0kg-m



## 4. Governor System

### 4.1 General

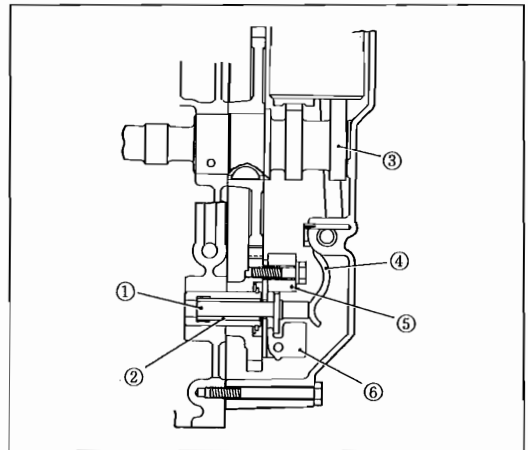


1. Camshaft 2. Sliding shaft 3. Governor weight 4. Governor spring 5. Governor lever 6. Injection pump  
7. Governor lever 8. Sleeve 9. Stopper

### Governor

The governor keeps the engine speed constant by using the balance between the centrifugal force acting on the governor weight and the tension of the governor spring. As the engine speed increases, the governor weight ③ opens forcing the sliding shaft ② forward, and the control rack for the injection pump is moved in the direction to decrease the injection rate by the governor lever ⑤. At the same time, the governor spring ④ is pulled by the governor lever ⑤ and when the spring tension is balanced with the centrifugal force of the governor weight, the speed is kept constant.

If the governor lever ⑦ is pulled toward "high speed", the governor spring ④ is pulled and via the governor lever ⑤ the control rack is moved in the direction to increase the injection rate, and then the speed increases and the centrifugal force of the governor weight increases and when it is balanced with the tension of the governor spring, the engine speed is kept constant.



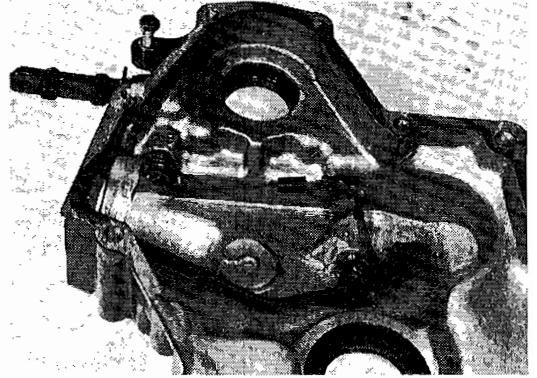
1. Sliding shaft 2. Governor sleeve 3. Camshaft 4. Governor lever 5. Stopper 6. Governor weight

### K2AS Governor

## 4. 2 Governor Lever

### 4. 2. 1 CONSTRUCTION OF GOVERNOR LEVER

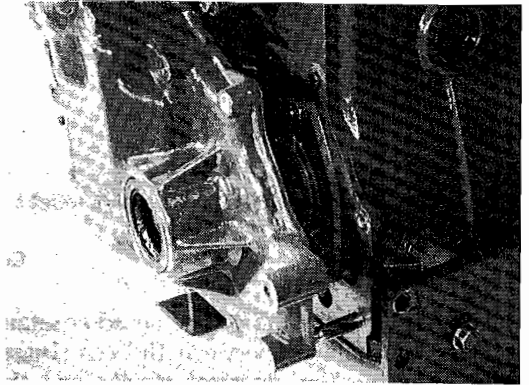
- (1) The governor lever is built in the gear case and the one end is in contact with the injection pump control rack and the other with the governor weight and sliding shaft.
- (2) The lever center is held by the shaft which is engaged with the gear case.
- (3) On the other end of the shaft the governor spring is installed and it is connected with the control lever.



Governor Lever Assembly

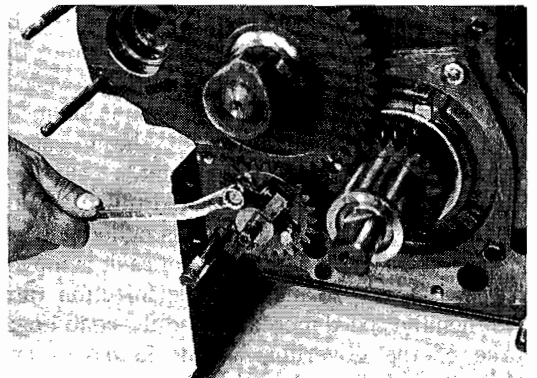
### 4. 2. 2 DISASSEMBLY

- (1) Remove the fan belt.(See Cooling System)
- (2) Remove the crankshaft pulley nut and then the pulley.
- (3) Remove the fuel injection pump. (See Fuel Injection Pump)
- (4) Remove the gear case mounting bolts and remove the gear case.
- (5) Remove the governor spring.
- (6) Remove the nut, washer and spring lever, and take out the speed control lever from the gear case.
- (7) Remove the nut, washer and spring lever, remove the governor lever set bolt, and then remove the governor lever.



Removal of Gear Case

- (8) Remove the governor weight assembly and the sliding shaft from the pump camshaft.



Removal of Governor Weight

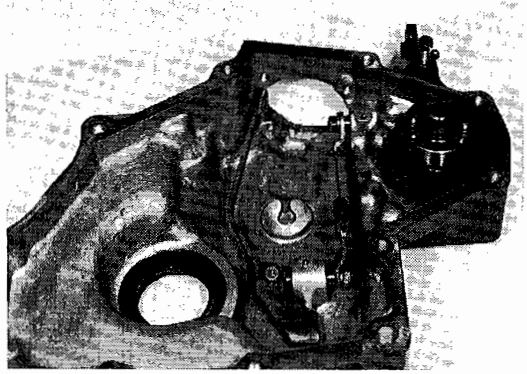
### 4. 2. 3. INSPECTION

#### (1) Governor Lever

Check the connection of the governor lever and the sliding shaft, and if defective, replace.

#### (2) Governor Spring

Check the spring for deterioration and breakage, and if defective, replace it.



Governor Spring

### 4. 3 Governor Weight

#### 4. 3. 1 CONSTRUCTION OF GOVERNOR WEIGHT

(1) The governor weight is installed on the governor gear engaged with the cam gear. For K2AS, the sliding shaft is provided with a detent to improve the governor fluctuation rate.

(2) The governor gear is in mesh with the gear shaft on the crankcase side and locked by the snap ring.

(3) The shaft is hollow and receives the sliding shaft.

#### 4. 3. 2 DISASSEMBLY

(1) Same as for Disassembly of Governor Lever.

#### 4. 3. 3 INSPECTION

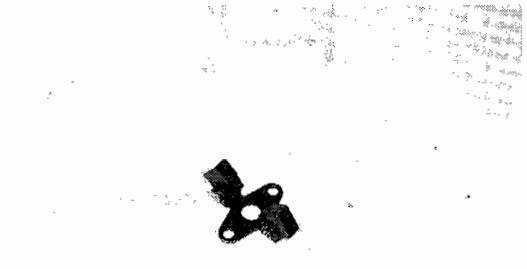
##### (1) Governor Assembly

(a) Check the weight for wear and damage, and if defective, replace it. Pay attention to the caulking.

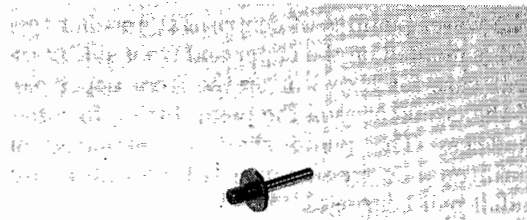
(b) Check the operating part of the sliding shaft for any damage and also check the smooth operation, and if defective, replace.

#### 4. 3. 4 REASSEMBLY

Assembly the governor assembly in the reverse order of disassembly, and after assembling, check the smooth operation.



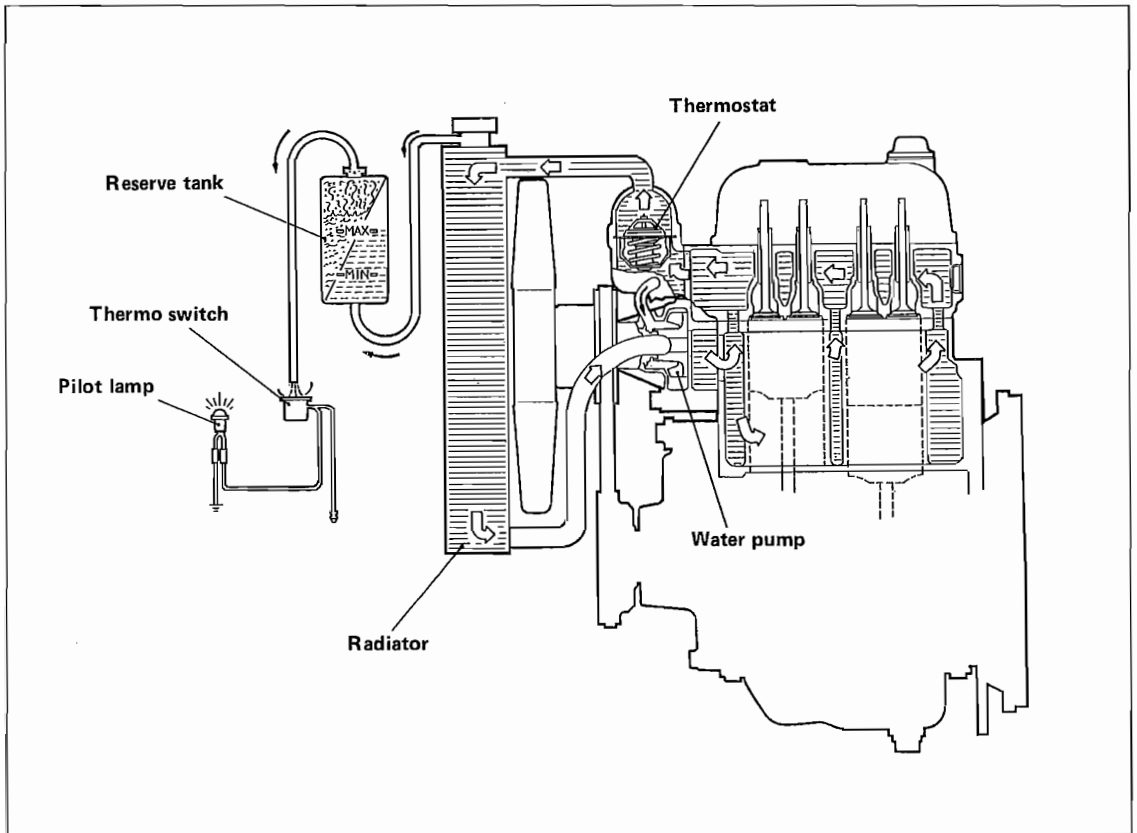
Governor Weight



Sliding Shaft

## 5. Cooling System

### 5.1 General

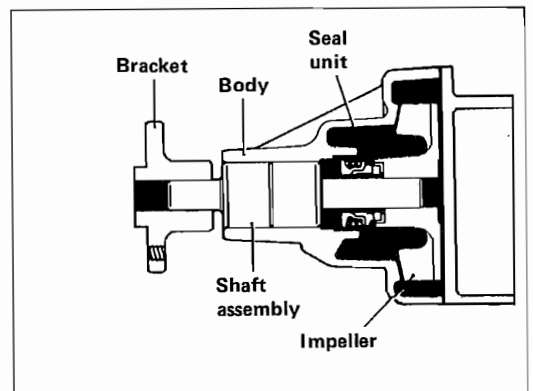


Route of Cooling Water

### 5.2 Water Pump

#### 5.2.1 CONSTRUCTION

The water pump is of centrifugal impeller type and is mounted on the upper and front side of the gear case for K2AS or on the front upper part of the crankcase via the pump fitting for other models. The pump shaft is supported on maintenance-free (grease-filled) double-row radial ball bearings.



Cross Section of Water Pump

### 5. 2. 2 DISASSEMBLY

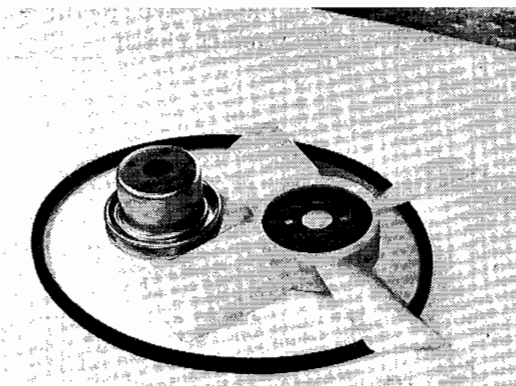
- (1) Drain the cooling water. (The drain plug is located on the right side of the crankcase)
- (2) Remove the water hose.
- (3) Remove the fan belt.
- (4) Remove the cooling fan.
- (5) Remove the water pump assembly.



Water Pump

### 5. 2. 3 INSPECTION

- (1) Check every part for cracks, damage and water leakage, and if defective, replace.
- (2) Check the rotating condition of the impeller and shaft, and if they make noise or rotate irregularly, replace as an assembly.
- (3) Check the fan for crack and damage, and if defective, replace.
- (4) Check the fan belt for elongation and cracks caused by aging, and if defective, replace.



Fan and Fan Belt

### 5. 2. 4 REASSEMBLY

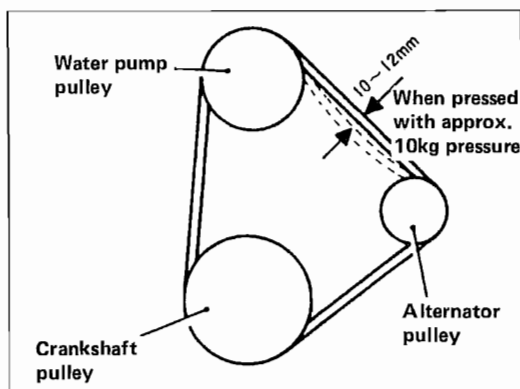
Reassemble the cooling system in the reverse order of disassembly. The fan belt should be adjusted in the following way.

#### (1) adjustment of Fan Belt

Adjust the alternator position so that the belt will deflect 10 to 12mm deep when depressed at the middle point between the alternator pulley and water pump pulley. After adjustment, securely tighten the support bolt and brace bolt.

#### Caution

When the alternator is installed, if there is any clearance between the alternator bracket and the gear case mounting surface, insert shims. If the spacer is provided, install it in its correct position (flush with V-belt).



Adjustment of Fan Belt

### 5.3 Thermoswich

The thermoswitch is provided on the front and left side of the cylinder head. This switch is turned ON and the lamp lights to indicate warning when cooling water temperature rises up to 103°, 108° or 111°C (depending on the specification). Whenever the lamp lights, the cooling system must be checked for water level, etc.

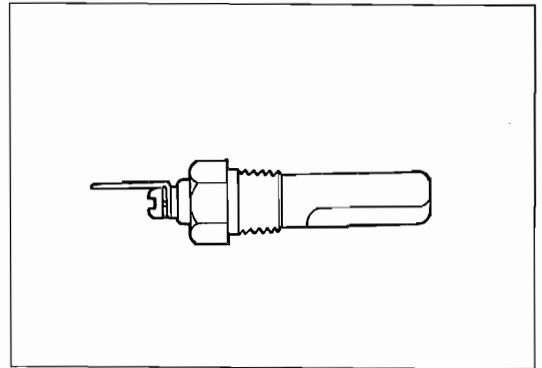
With thermoswich	Operating temperature of thermoswich	
	ON	OFF
K2 (except-61WM) KE70 (except-11BE and BF) KE75 (except-12HK)	111±3°C	higher than 104°C
KE70—11CE and BF	108±3°C	higher than 101°C
KE75—12HK	103±3°C	higher than 96°C

### 5.4 Thermostat(Special Specification)

Wax type thermostat is used. Check the valve cracking temperature of the thermostat, and if defective, replace. If the valve is opened or the outside is damaged, replace.

**Caution**

When the sensor of the wax type thermostat fails, the valve remains closed.



**Thermoswich**

With thermostat	Operating temperature of thermostat	
	Valve opening temperature	Temperature for valve lift 8mm more
K2B—51M K2C—WM KE70—11BE, GE KE75—11GE, 61WH	82±1.5°C	95°C
K2B—61A K2C—61A, EM, SA KE75—61A, EM, SA	76.5±1.5°C	90°C
K2C—61SS	71±1.5°C	85°C

### 5.5 Changing of Cooling Water

If the engine is used for a long time, scale will be accumulated and rusting will occur in the water jacket and radiator, reducing considerably the cooling efficiency. Therefore, carry out flushing(cleaning)of the cooling system once or twice a year.

## 5.6 Antirust and Antifreeze

To protect the cooling system against corrosion and freezing, additives of well-known brand should be used. Also, do not mix the additives with other brand.

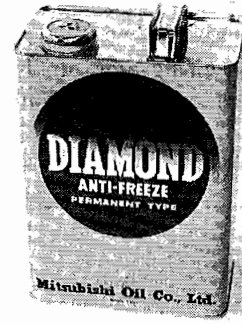
- Recommended antirust(all seasons)

Add 10% of DIA QUEEN Radiator Conditioner or RC-96(Seiwa).

- Recommended antifreeze(for winter)

DIA QUEEN Long Life Coolant(containing antirust)

Antifreeze concentration %	13	23	30	35	45
Freezing temperature °C	-5	-10	-15	-20	-30



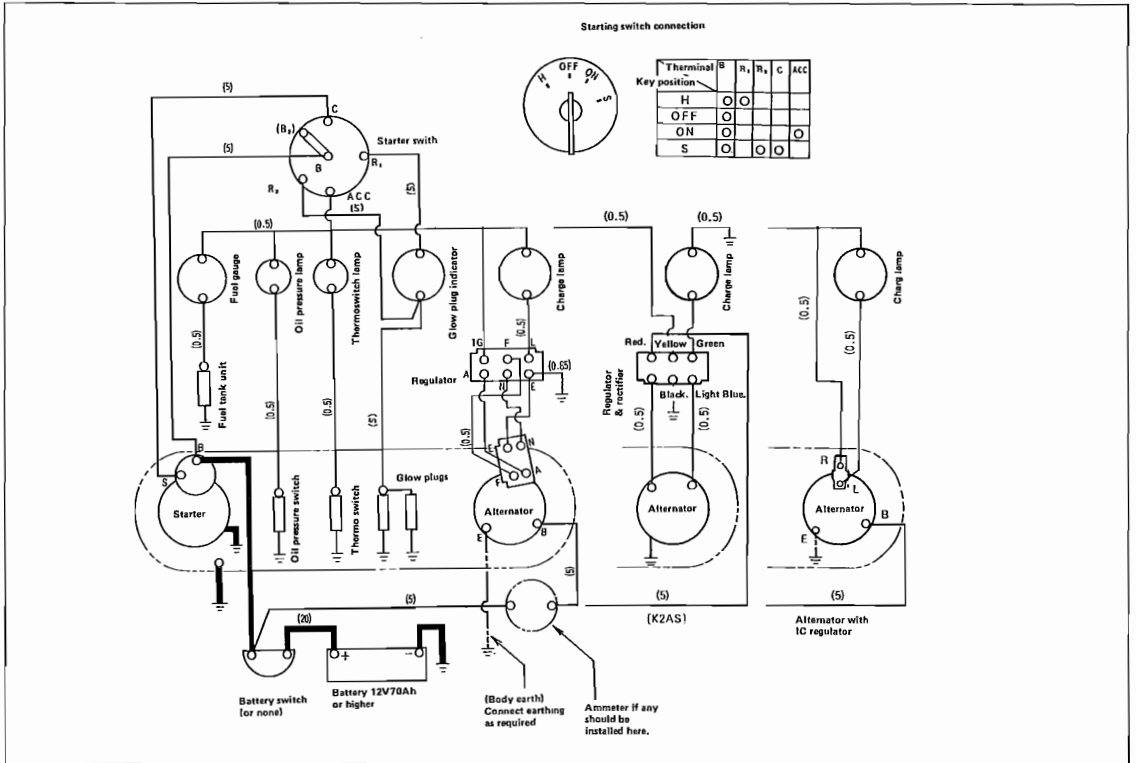
Antifreeze

## 6. Electrical System

### 6.1 General

#### 6.1.1 WRITING DIAGRAM

The following wiring diagram is for the standard specifications, and the numerals in parentheses are "nominal" of JIS C3406(Low-voltage Electrical Wire for Automobile).



#### 6.1.2 OUTLINE OF ELECTRICAL SYSTEM

##### (1) Starting System

Starter and glow plugs

##### (2) Charging System

Alternator and regulator

##### (3) Power Supply(Battery)

It is roughly divided into the following three systems. In the starting system, when the starter switch key is turned to H position, the current runs to the glow plug which becomes red at the tip, and the temperature in the combustion chamber rises and starting becomes easy. The operation of the glow plug can be confirmed by the glow plug indicator.



Then, when the starter switch key is turned to S position, the current runs to the starter, the pinion gear and flywheel ring gear come into engagement, and the engine starts. After starting, when the starter switch key is turned to ON, the pinion gear returns. In the charging system, when the key switch is at ON position, the power generated by the alternator is supplied to the battery via the regulator.

### 6. 1. 3 SPECIFICATIONS OF ELECTRICAL PARTS

Specifications			Types of engine				
Type (Part No.)	Spec	K2AS	K2B	K2C	KE70	KE75	
Starter	M003T32481 (MM319602)	0.9kW-12V	-61A.WM				
	M003T25681 (MM403740)	1.1kW-12V	-31DG	All types	All types except -61WM		
	M002T50381 (MM409410)	1.6kW-12V (Reduction type)			-61WM		
	M004T14674 (MM401600)	1.2kW-12V				All types ←	
Alternator	M40793 (MM403590)	14A-12V	All types except 61WM				
	A001T24770 (MM409651)	35A-12V (w/IC regulator)	61WM		-61SS		
	AR2115Z <sub>2</sub> (MM407671)	15A-12V		All types except -31SW	All types except - 61SS and WM		
	A002T25271 (MM409650)	50A-12V(w/IC regulator)			-61WM		
	021000-2431 (MD011500)	35A-12V			All types	All types except -31SW	
Regulator & rectifier	RS5101 (MM403815)	14V (Regulated voltage)	All types except 61WM				
Regulator	RQB2220D <sub>4</sub> (MD001821)	14.8V		All types except -31SW	All types except - 61SS and WM		
	02600-1763 (K9480910)	14.5V			All types	All types except -31SW	
Glow plug	Y-114T (MM409510)	9.7A-10.5V (Quick heating type)	All types	←	←	-13A	-61WH
	Y-110 (MM401621)	10A-10.5V (Ordinary type)				All types except -13A	All Types except -61WH
Glow plug indicator	HEXZO (MM319500)	20A (Quick heating type)	All types	←	←	-13A	-61WH
	DH-139V-19 (MM401630)	19A (Ordinary type)				All types except -13A	All types except -61WH
Battery (Commercially available)		12V-45Ah over	←	←	←	←	←

Notes:1-Part Nos.and specifications are subject to change.

2-Use a battery with large capacity suitable for engine operational conditions and climate.

## 6. 2 Starter

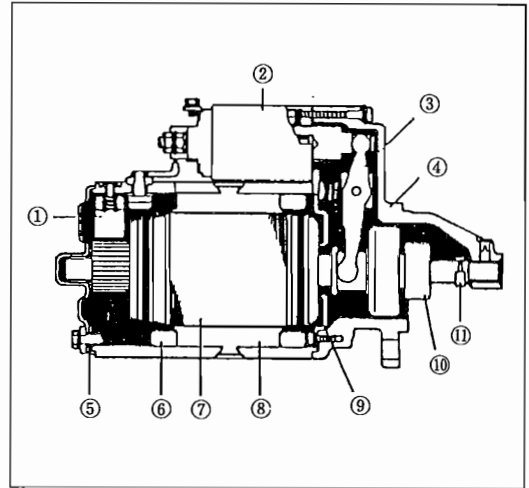
### 6. 2. 1 CONSTRUCTION OF STARTER

The starter roughly consists of the following.

- ① Motor to generate power.
- ② Overrunning clutch to transmit torque and prevent overrunning after the engine is started.
- ③ Switch to move the overrunning clutch via a lever and also serves as a motor load current switch.

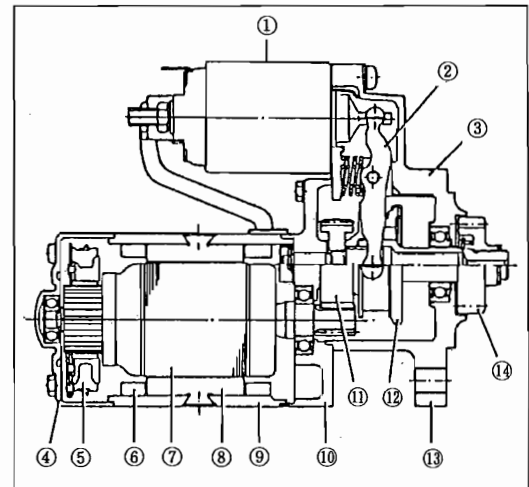
The new speed-reduction type starter is a compact, light-weight, high-speed, internal-reduction starter, and its structural differences from the conventional(single-shaft type)starter are as follows.

- (1) In the conventional starter, the pinion moves on the motor shaft(armature shaft)while the new starter has a pinion shaft, separated from the motor shaft and the pinion moves on the pinion shaft.
- (2) A reduction gear is provided between the motor shaft and the pinion shaft.
- (3) Since the pinion sliding part is not exposed outside the starter, the pinion slides smoothly without being stuck hard with dust and grease.
- (4) For the motor bearings at both ends the ball bearings are used. The lever mechanism, switch and overrunning clutch mechanism and internal circuit are identical to those of the conventional type.
- (5) The starter wiring is as shown below.



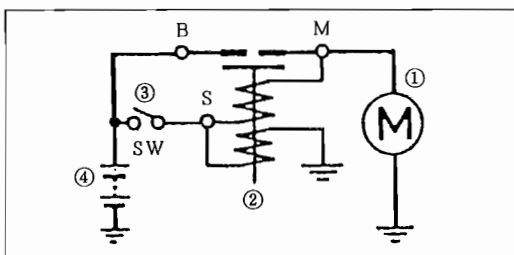
1. Brush 2. Switch 3. Lever 4. Front bracket  
5. Rear bracket 6. Field coil 7. Armature 8. Pole piece 9. Center bracket 10. Overrunning clutch 11. Stopper ring

**Cross Section of Conventional Starter**



1. Magnetic switch 2. Shift lever 3. Front bracket  
4. Rear Bracket 5. Brush 6. Field coil 7. Armature  
8. Pole piece 9. Yoke 10. Center bracket 11. Gear  
12. Clutch 13. Front bracket 14. Pinion gear

**Cross Section of Speed-Reduction Type Starter**

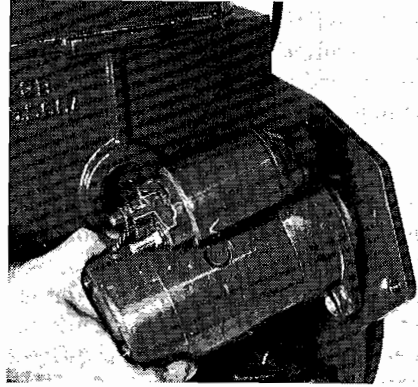


1. Motor 2. Magnetic switch 3. Starter switch 4. Battery

**Wiring of Starter**

**6. 2. 2 REMOVAL**

- (1) Remove the cable from the battery terminal.  
Remove the minus side first.(Plus side first when installed)
- (2) Remove the wires from terminals B and S.
- (3) Remove the mounting nuts and the starter.



**Removal of Starter**

**6. 2. 3 INSPECTION**

**Coution**

Hard engine starting is not necessarily caused by the starter failure. The cause may sometimes exists in other parts such as switch and engine side. Therefore, check the starter circuit without removing the starter, and if no abnormality is found with the circuit, then remove the starter from the engine and test it.

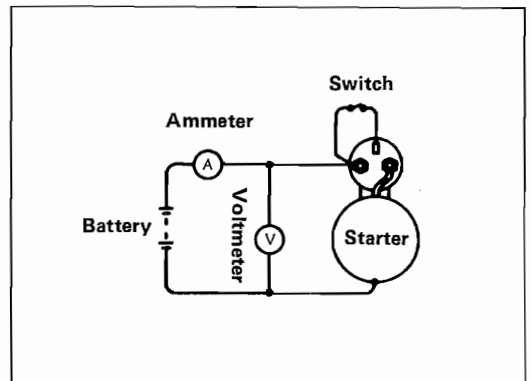
**(1) Inspection of a Starter Circuit**

- (a) Check the charged condition of the battery.
- (b) Check the tightened condition of the battery terminals.
- (c) Check the tightened condition of the starter terminal.
- (d) Check the wiring condition(grounding, disconnection, etc. )
- (e) Check the grounded condition of the starter.

**(2) No-Load Test**

Connect the starter and battery as illustrated and close the switch, and the starter motor will rotate. The starter is considered normal if it runs smoothly at the following values. If any abnormality is found in this test, check in accordance with the following items.

Model	Voltage	Current	Rotating speed
K2AS, K2B K2C (except 61WM)	11.5V	Less than 60A	More than 6500rpm
K2C-61WM	11.5V	Less than 100A	More than 3000rpm
KE70, 75	11V	Less than 62A	More than 4500rpm



**No-Load Test**

### (3) Inspection of Magnetic Switch

If the pinion does not go out, check the magnetic switch in the following procedure.

#### (a) Conduction Test

If there is conduction between terminals S and M and between terminal S and body, it is considered normal. If no resistance is found, it is considered defective and should be replaced.

#### (b) Attraction Test

The pull-in coil is considered normal if the plunger is attracted and the pinion goes out when the battery is connected between the terminals S and M of the magnetic switch.

#### Caution

Do not supply current continuously for more than 10 seconds.

#### (c) Holding Test

With the battery connected between the terminal S of the magnetic switch and the body, manually pull out the pinion to the stopper position. The holding coil is considered normal if the pinion does not return when it is released.

#### Caution

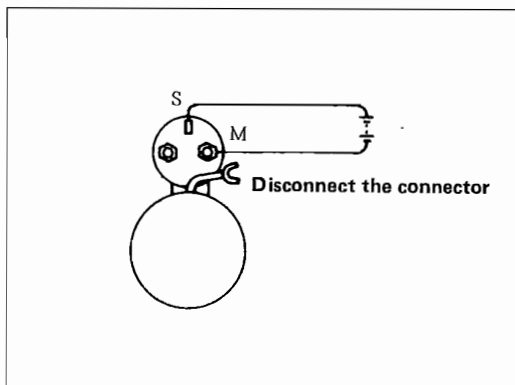
Do not supply current continuously for more than 10 seconds.

#### (d) Return Test

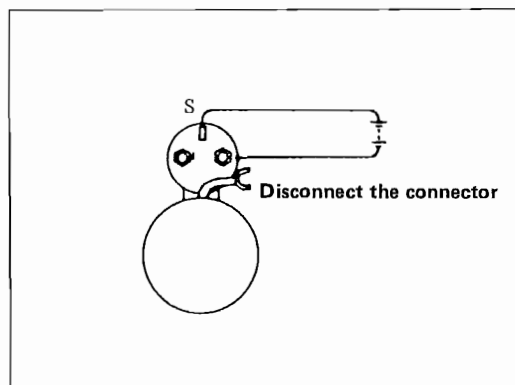
With the battery connected between the terminal S of the magnetic switch and the body, manually pull out the pinion to the stopper position. Both coils are considered normal if the pinion immediately returns when it is released.

#### Caution

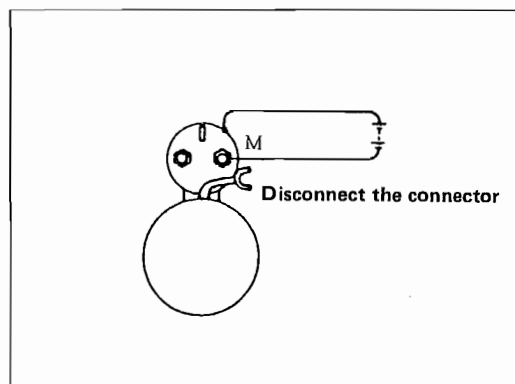
Do not supply current continuously for more than 10 seconds.



Attraction Test



Holding Test



Return Test

#### (4) Inspection of Pinion Gap

If the battery is connected between the terminal S of the magnetic switch and the starter body, the pinion will go out and stop. Then, push back the pinion lightly to the armature side and measure the clearance between the pinion and the stop ring. (The pinion gap measurement should be 0.5–2.0 mm)

The gap adjustment can be made by increasing or decreasing the number of the fiber washers of the magnetic switch mounting surface. The gap is decreased by increasing the number of washers.

#### Caution

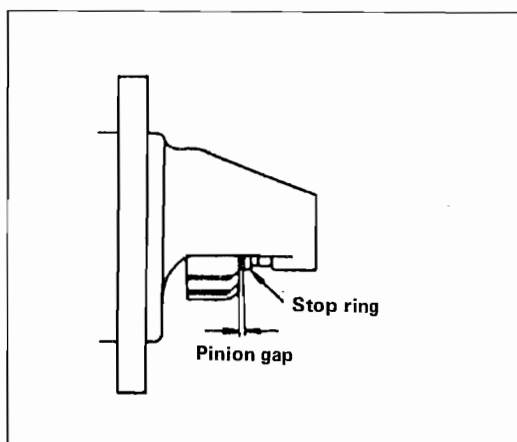
1. In this check, do not supply current for more than 20 seconds to prevent the switch coil from overheating.
2. If the pinion does not go out when checked after reassembling, the shift lever failure, improper installation of plunger spring or magnetic switch failure can be suspected.

#### (5) Inspection of Thrust Gap of Pinion

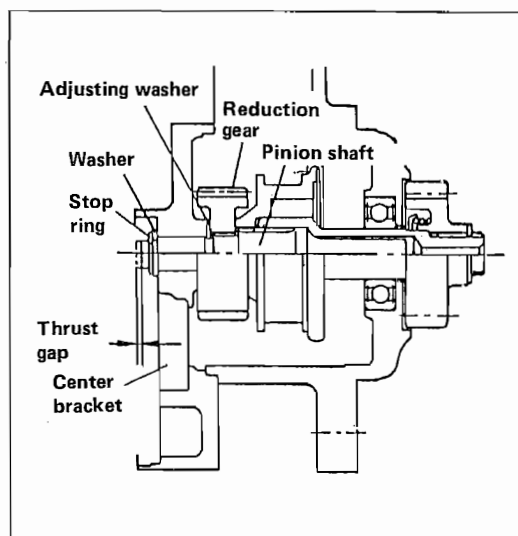
If the thrust gap reduction type of the pinion shaft is used, measure the thrust gap of the pinion shaft. This gap means the amount of play when the pinion shaft is moved in the axial direction. The gap should be adjusted to within 0.5mm by inserting the adjusting washer between the center bracket and reduction gear.

##### (a) When the pinion is removed

After installing the reduction gear on the pinion shaft, insert into the center bracket, and then fix the pinion shaft with the washer and snap ring. Move the pinion shaft in the axial direction and measure the thrust gap. If necessary, adjust using the adjusting shims.



Measurement of Pinion Gap



Inspection of Thrust Gap (Reduction Type)

**(b) When the pinion is not removed**

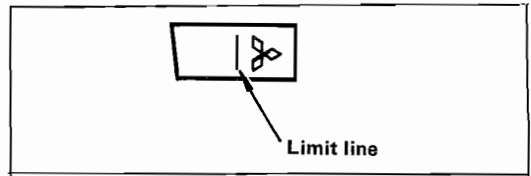
Insert the pinion shaft with reduction gear into the front bracket and tighten the bolts. Move the pinion shaft in the axial direction and measure the thrust gap.

**Caution**

Be sure to remove the lever spring for the measurement in (b).

**(6) Brush and Brush Holder**

- (a) Check the brushes, and if worn beyond the service limit, replace. (See Service Standard.)
- (b) Check for conduction between the plus side brush holder and brush base, and if there is any conduction replace the holder assembly.
- (c) Check for any brush holder caulking.

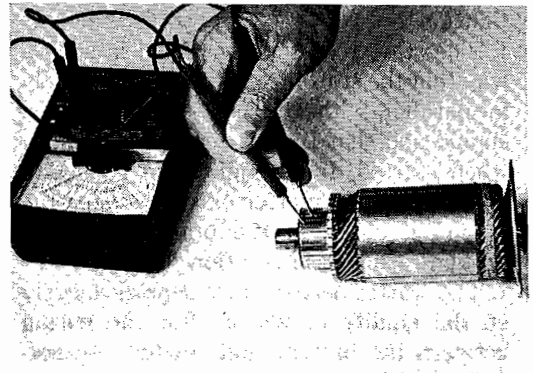


**Wear Limit Line**

	Item	Standard	Use limit
Slip ring	Cutside diameter	$\phi 33 \pm 0.2$	32.2
	Deflection	0-0.03	0.2

**(7) Armature**

- (a) Check the armature coil with a growler tester, and if short-circuited, replace. Also check for conduction between the commutator shafts, and if conduction exists, replace.
- (b) Measure the undercut depth of the commutator, and the limit is exceeded, correct or replace. Also check the contamination on the external surface of the commutator, and if it is dirty or rough, polish with sandpaper No.300 or 400.



**Inspection of Commutator**

### (8) Field Coil

- (a) Check for conduction of the field coil (between brushes), and if there is no conduction which means disconnection, replace the yoke assembly.
- (b) Check for conduction between the connector and yoke, and if there is conduction which means grounded condition, check the insulation and correct. If the correction is impossible, replace the yoke assembly.
- (c) Check the pole for caulking and coil for looseness.

### (9) Overrunning Clutch and Others

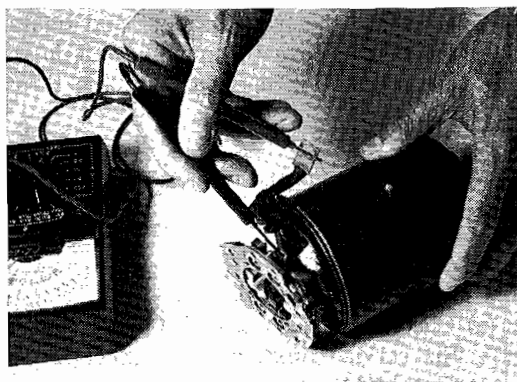
- (a) Check the pinion gear for wear and damage, and if any, replace the pinion.
- (b) Reduction Gear  
Check for wear and damage, and if any, replace.
- (c) Front Bracket  
If the ball bearing or bush is worn, replace the bracket assembly.

### 6. 2. 4 REASSEMBLY

To reassemble, reverse the disassembling order.

#### Caution

1. The starter must be installed in such a way that the starter axis will be completely in parallel with the center axis of the engine and that the starter will not move when started. If the tightening is incomplete or foreign matter exists between the mounting surfaces, the bracket may be broken resulting in rotation failure.
2. The starter performance depends largely on the quality of wiring. For the wiring between the battery and starter, use sufficiently thick conductors and connect them as short as possible and fully tighten each terminal.



Inspection of Field Coil

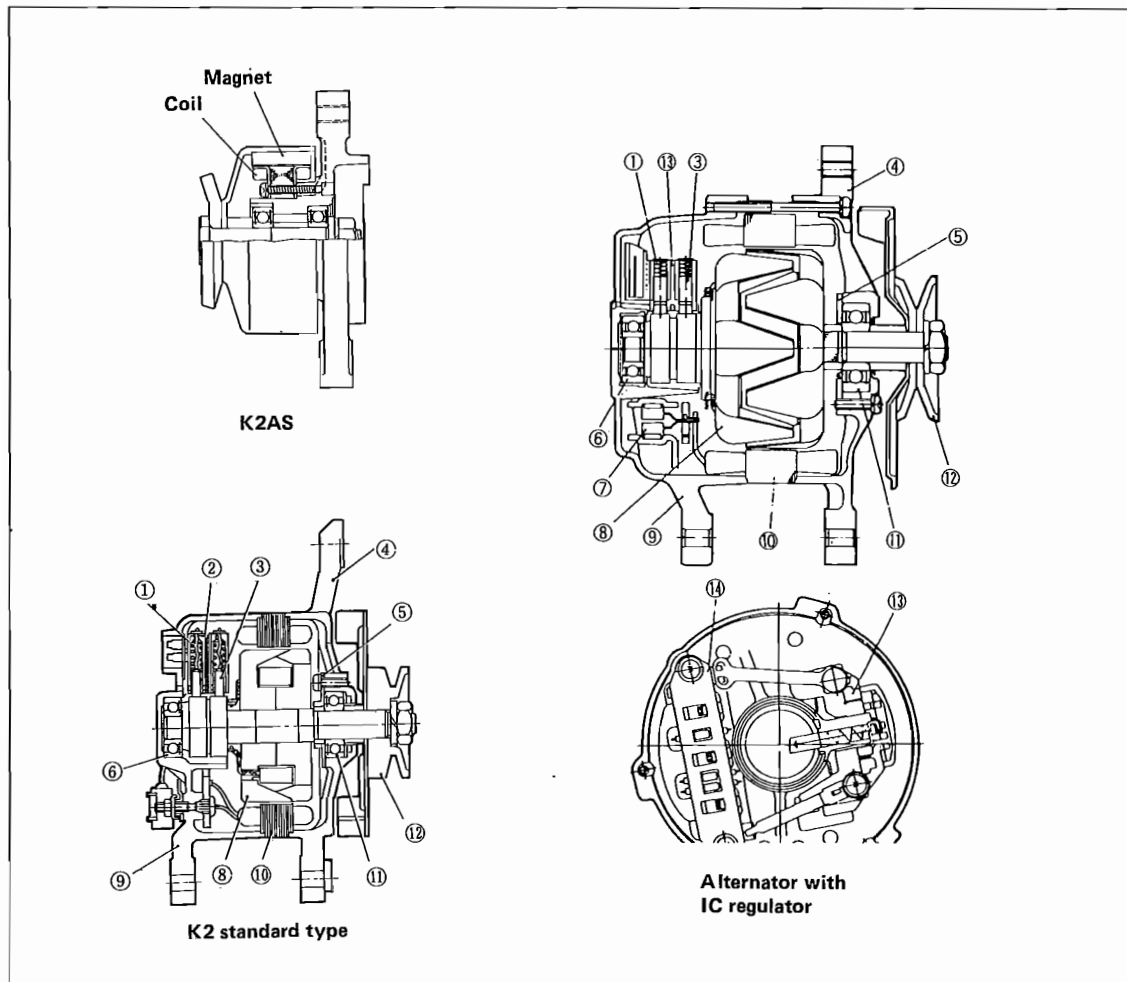


Installation of Starter



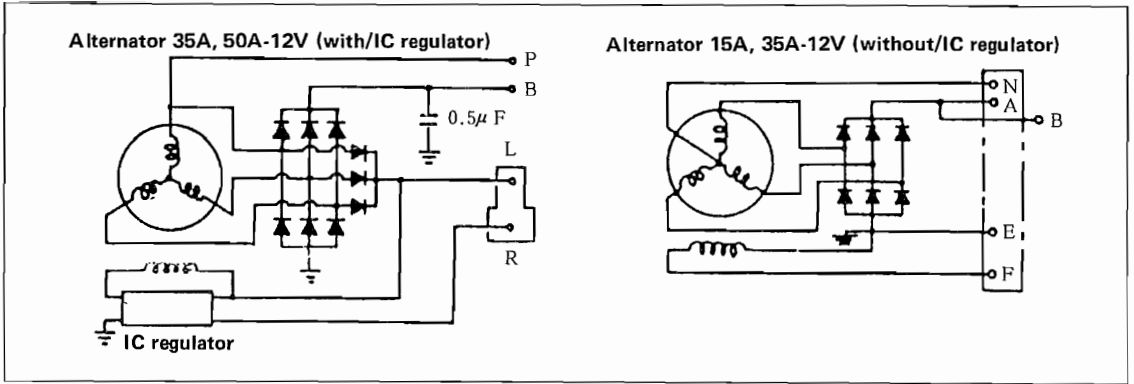
## 6.3 Alternator

### 6.3.1 CONSTRUCTION OF ALTERNATOR



1. Brush spring 2. Brush holder 3. Brush 4. Front bracket 5. Bearing retainer 6. Rear bearing 7. Diode  
8. Rotor 9. Rear bracket 10. Stator 11. Front bearing 12. Pulley 13. IC regulator assembly 14. Rectifier  
assembly

Cross Section of Alternator



Alternator Wiring

The alternator(except K2AS ordinary type)is a three-phase AC generator with diode rectifier and is driven by the crankshaft pulley through the V-belt. The alternator is roughly divided into rotating part and fixed part, and the rotating part consists of the rotor, ball bearings and pulley with fan, and the fixed part consists of the armature, front bracket, rear bracket, fin complete and brushes. Three diodes (+) and three diodes (-) are fixed on the fin complete(heat sink).

In addition to the illustrated type of fin complete, which serves to gather six diodes at one place, the horseshoe-shaped fin complete is also used(for KE70 and 75).

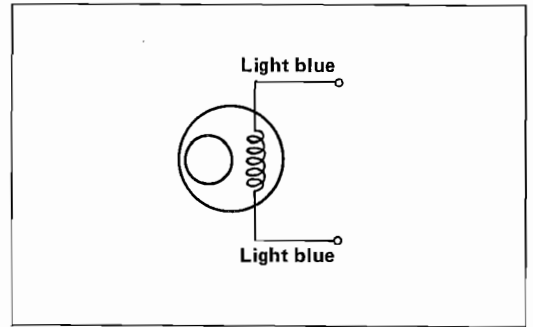
Since the alternator with IC regulator incorporates three sets of diodes(diode trio) to supply three sets of diodes(diode trio) to supply field current, it has two poles(2 terminals of L and R) plus one pole(terminal P) while the ordinary type has 4 poles(4 terminals of A, E, F and N). The terminal P can be used for rotation detection.

K2AS ordinary type uses a compact and light permanent magnet type single-phase AC alternator and the permanent magnet is fixed to the monolithic pulley and case and through the rotation of these the AC current is produced by the stator coil on the body side.

The AC current is rectified by the regulator and rectifier separated from the generator.

### 6. 3. 2 REMOVAL

- (1) Loosen the alternator brace bolts and remove the belt.
- (2) Remove the alternator support bolts.



Permanent Magnet Type Alternator(K2AS)

### 6. 3. 3 INSPECTION

#### Caution

1. Do not use a high-voltage tester such as a megger because the diodes may be damaged.
2. Do not disconnect the (+) or (-) terminal of the battery from the terminal A of the regulator during high-speed running of the engine because the surge voltage will occur to deteriorate the diodes.
3. For the alternator with IC regulator, never make short-circuit between the terminals B and L, because charging current will run to melt the diode trio.
4. Do not start the engine when the lead wire is removed from the terminal B of the alternator, because the voltage coil of the regulator may be damaged.
5. Before charging the battery with a quick charger, be sure to disconnect the battery terminals to prevent damage to the diodes.
6. When a steam cleaner is used, be careful not to splash steam on the electrical equipment.

\*mark means alternator with/IC regulator

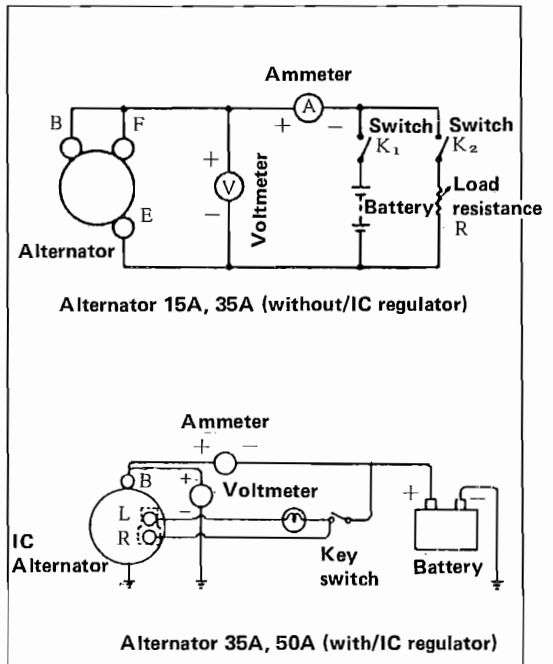
Item		Terminal voltage(V)	Current (A)	Speed (r.p.m)
No-load OUTPUT	15A	14	0	1300 or less
	35A	14	7	
	35A*	13.5	7	
	50A	13.5	24	
Load OUTPUT	15A	14	15 or over	2500 or less
	35A	14	26.5 or over	
	35A*	13.5	30 or over	
	50A	13.5	50 or over	

Standard Value for Output test

#### (1) Output Test

To check the output, remove the alternator from the engine, make connection as illustrated, and drive the alternator with a motor.

First, close the switch K1 to flow the field current from the battery and then, increase the alternator speed gradually until the ammeter registers zero indicating that there is no counter flow of the field coil, and then open the switch K1 for self-excitation. Gradually increase the speed and read the speed when the voltmeter shows the specified voltage for no-load operation. It should be the no-load value (1300 rpm or less) specified in the Service Standard. Then, increase the load resistance R to maximum and when almost no load current flows, close the switches K1 and K2. Keeping the specified terminal voltage constant, increase the speed and read the ammeter indication at the speed of 2500 rpm, and the reading is the value under load.

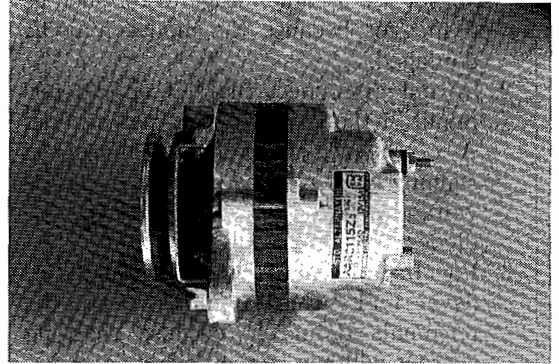


Connection Diagrams for Output Test

In the case of the alternator with IC regulator, make connection as illustrated, and after starting the engine and turning on the lamps, increase the speed to the specified value and confirm that the value listed in the above table is obtained.

**(2) Checking of Diodes**

The diode failure consists of “Open” and “Short”, and the open means no conduction and the short means the state where the current runs also in reverse direction.



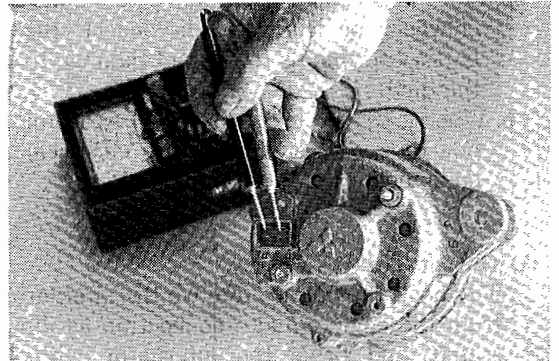
**Alternator Assembly**

**(3) Checking of short-Circuit**

The short-circuit can be found by the conduction between the terminals using a tester without disassembling the alternator. For (+) diode, check for conduction between terminals A and N, and if conduction exists in both directions A to N and N to A, it means short-circuit.

For (-) diode, check for conduction between terminals N and E, and if no conduction exists in both directions, it means all the three diodes are open, but this is a very rare case.

For the alternator with IC regulator, check for conduction between (+) and (-) heat sinks and stator coil lead connection and if conduction exists in both directions in each case, the diodes are short-circuited, and the rectifier assembly must be replaced.



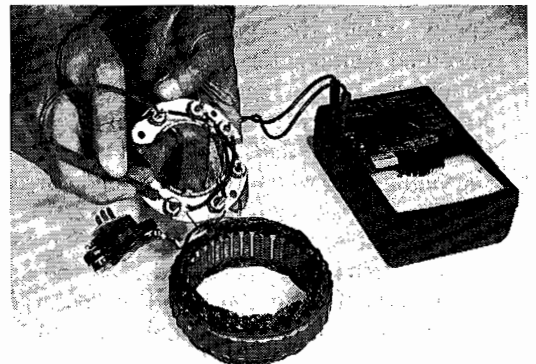
**Checking for Short-Circuit**

**(4) Checking of Open-Circuit**

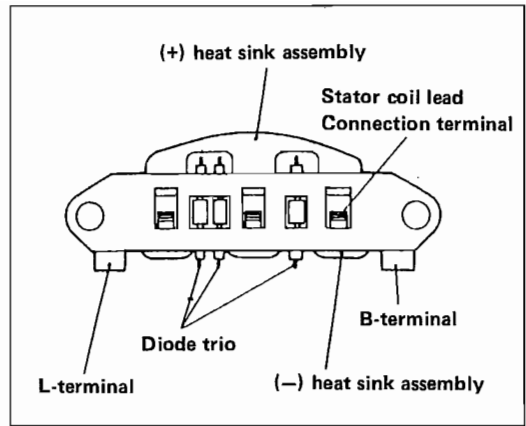
If not short-circuited, open-circuit may be considered. In such a case, remove the diode lead wires and check for conduction of each diode.

**(5) Checking of Diode Trio (w/IC Regulator)**

For a set of three diodes, check for conduction at both ends of each diode, and if there is conduction in both directions or there is no conduction, replace the rectifier assembly.



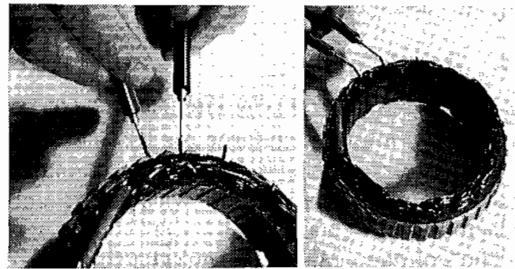
**Checking of Diode**



Checking of Rectifier

**(6) Stator**

Disconnect the stator lead wires and check for conduction between the three leads using a circuit tester. If no conduction exists, it means disconnection. Then, check for conduction between the lead wire and core. If any conduction exists, it means grounding. Replace.



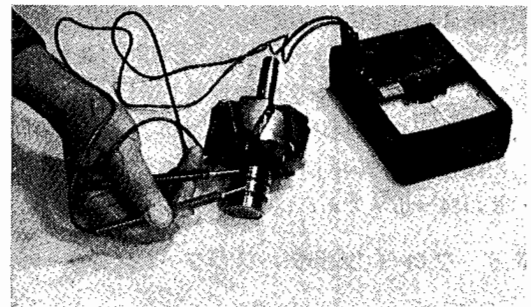
Between core and lead

Between leads

Checking of Stator Coil

**(7) Field Coil (Rotor)**

Check for conduction between the slip rings. If there is no conduction, it means disconnection. Replace. If there is conduction between the slip ring and core, it means short-circuit. Replace.



Checking of Field Coil (Rotor)

**(8) Checking of Brush and Brush Spring**

If the brush is worn to the wear limit line, replace it. Check the spring pressure of the brush and make sure that the brush moves smoothly in the brush holder.

Item	Standard	Service Limit
Length of brush(mm)	18	8

Checking of Brush

**(9) Checking of Slip Ring**

Check the sliding surface of the ring for contamination and roughness and clean or polish with fine sandpaper.

### 6. 3. 4 REASSEMBLY

**Caution**

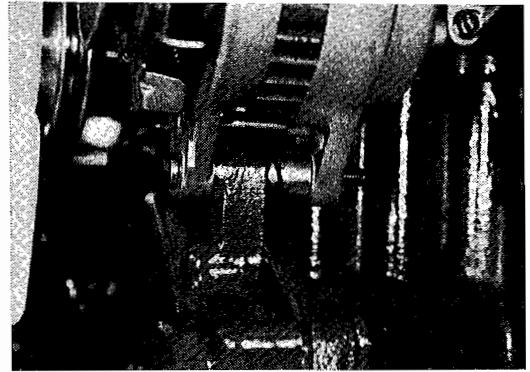
Carefully and correctly connect the alternator, regulator and battery.  
 If the battery polarity is reversed by careless connection, a large current will flow from the battery to the alternator and damage the diodes and wire harness.

- (1) Install the alternator on the left upper part of the gear case. Insert a distance piece between the gear case rear and rear bracket and adjust with shims to eliminate the clearance. Temporarily tighten the bolts.
- (2) After installing the belt and adjusting its tension, tighten the alternator brace and gear case bolts.

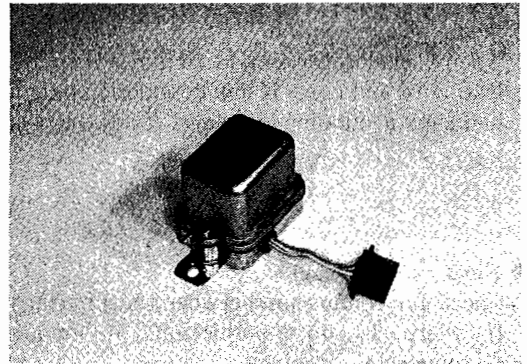
### 6. 4. Regulator

#### 6. 4. 1 CONSTRUCTION OF REGULATOR

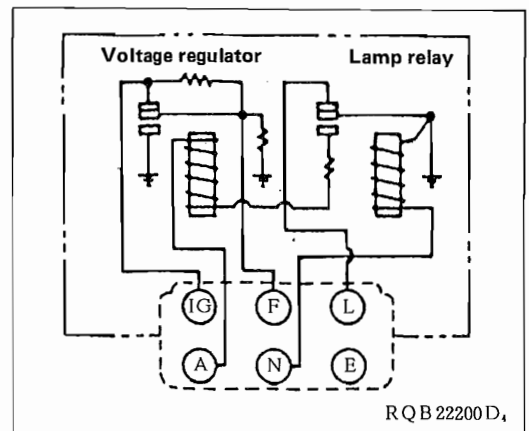
- (1) Construction of Regulator for K2 and KE  
 The regulator consists of voltage regulator and lamp relay and these wirings are collected into a connector.  
 The voltage regulator regulates the power generated by the alternator to charge the battery. The lamp relay is used to turn off the pilot lamp utilizing the neutral point of the alternator.



Installation of Alternator

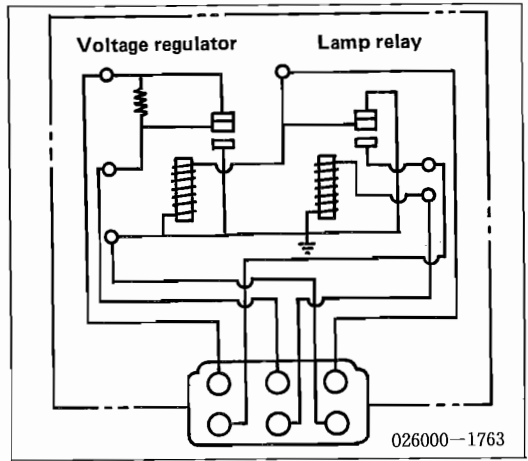


Regulator

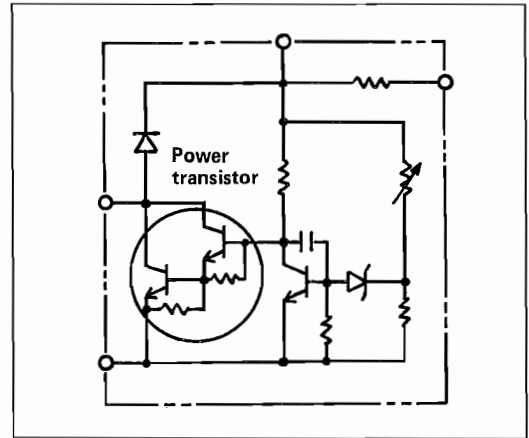


Wiring Diagram of Regulator

Item	Specifications	
	RQB2220D4	026000-1763
Type	Tirril type	←
Element	2 elements	←
Polarity	⊖ earth	←
No-load regulated voltage	14.8±0.3V	14±0.5V
Lamp OFF voltage	0.5-3.0V	0.5-3.5V
Lamp ON voltage	4.2-5.2V	4.0-5.8V
Connector	6 poles	←



Wiring Diagram of Regulator



C: Capacitor Ds: diode Dz: diode(zener)  
 R1, R6, Rv: resistance Tr1: transistor  
 Wiring Diagram of Regulator ('built in alternator')

**(2) Construction of Regulator Rectifier**

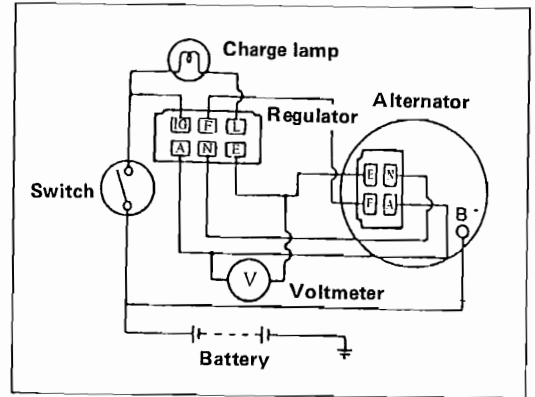
K2AS ordinary type uses a regulator/rectifier type regulator which incorporates diodes and transistor and rectifies the AC current generated by the alternator to charge the battery.

Description	Specification
DC output	12A
Regulated voltage	14.5 ± 5V (at 25°C, 5000rpm, and 8.0 A)

## 6. 4. 2 INSPECTION OF REGULATOR

### Caution

1. The regulator is sealed. If this seal is removed during the warranty period, the regulator is no more covered by the warranty.
2. Do not start the engine with the coupler of the regulator disconnected.
3. Do not connect the capacitor to the terminal (F).
4. The regulator must be installed laterally and upright with the connector lead outlet facing downward.



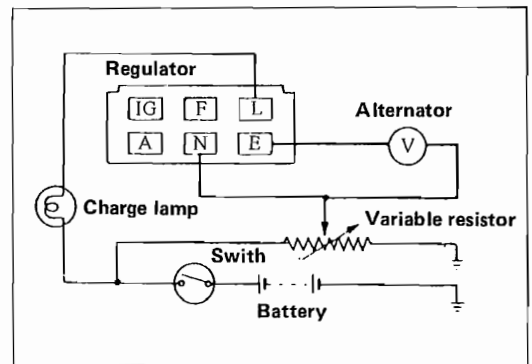
Checking of Regulator

### (1) Checking of No-load Regulating Voltage

- (a) Connect a voltmeter between terminals (A) and (E) of the regulator.
- (b) Start the engine and, while idling, disconnect the lead wire from the terminal (B) of the alternator to run the alternator without load.
- (c) It is normal if the specified value is obtained when the speed of the alternator is increased to 4000 rpm.

### (2) Checking of Pilot Lamp Voltage

- (a) Connect a voltmeter and a variable resistor to the circuit as illustrated.
- (b) Turn on the lamp and gradually increase the voltage and measure the voltage when the lamp goes out.
- (c) Gradually decrease the voltage and measure the voltage when the lamp lights again.



Checking of Pilot Lamp Voltage

### (3) Checking of IC Regulator (built in 35 or 50A alternator)

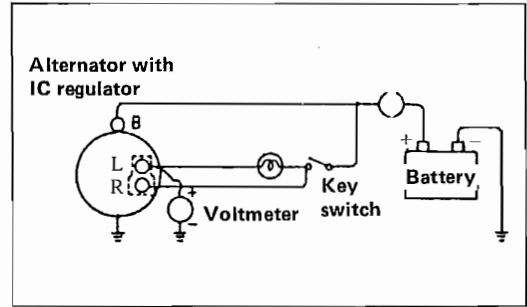
With the alternator mounted on the engine, check the regulator in the following procedure.

- (a) Disconnect the plus terminal of the battery and connect an ammeter (60A class).

Description		Standard
Pilot lamp voltage	Lamp OFF	4.2V-5.2V
	Lamp ON	0.5V-3.0V



- (b) Connect a voltmeter between the L terminal of IC dynamo and the ground. In this case, the voltmeter must indicate "0". If the voltmeter pointer swings, the IC dynamo or wiring may be defective.
- (c) Turn on the key switch one step but do not start the engine. At this time the voltmeter must indicate a value considerably lower than the battery voltage. If the indication is almost the same as the battery voltage, the IC dynamo may be defective.
- (d) With the terminals of the ammeter short-circuited, start the engine. Caution: When starting the engine, be careful not to have the starter current run to the ammeter.
- (e) Immediately increase the engine speed to about 2,000–3,000rpm and read the indication of the ammeter.
- (f) If the indication of the ammeter is less than 5A, read the indication of the voltmeter in that state (2,000–3,000rpm). The voltmeter reading is the regulated voltage.
- (g) If the ammeter reading is more than 5A, continue charging the battery until it becomes less than 5A or replace the battery with a fully-charged one or restrict the charging current by connecting 1/4Ω(25W)resistor in series to the battery.
- (h) Since the IC regulator is of the over-temperature compensation type and the regulated voltage varies with temperature, measure the temperature of the rear bracket(surrounding of regulator)and make the temperature correction of the regulated voltage.

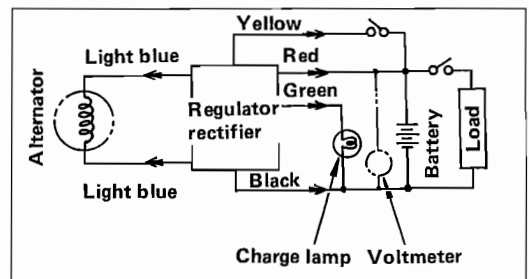


Checking of IC Regulator Voltage

### 6. 4. 3 CHECKING OF REGULATOR WITH RECTIFIER

#### (1) Checking when Servicing

Measure voltage between the battery terminals using a tester. It is normal if about 15.0V is obtained constantly when the alternator speed is more than 5,000rpm without load.



Measurement of Voltage Between Terminals

## (2) Checking of Regulator Alone

To check the regulator itself, check the following lead wires using a tester.

Points to be measured		When normal	Causes for regulator failure when abnormality exists
Tester (+)	Tester (-)		
Red	Light blue 1	Continuity	Disconnection of diode
Red	Light blue 2	Continuity	Disconnection of diode
Light blue 1	Black	Continuity	Disconnection of diode
Light blue 2	Black	Continuity	Disconnection of diode
Light blue 1	Red	No continuity	Diode is short-circuited
Light blue 2	Red	No continuity	Diode is short-circuited
Black	Light blue 1	No continuity	Diode or thyristor is short-circuited
Black	Light blue 2	No continuity	Diode or thyristor is short-circuited

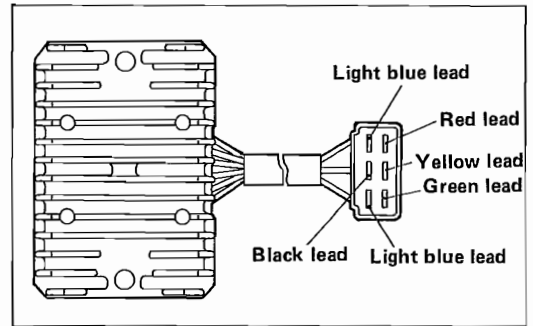
**Note:** Use the tester within the resistance measuring range.

## 6. 4. 4 INSTALLATION

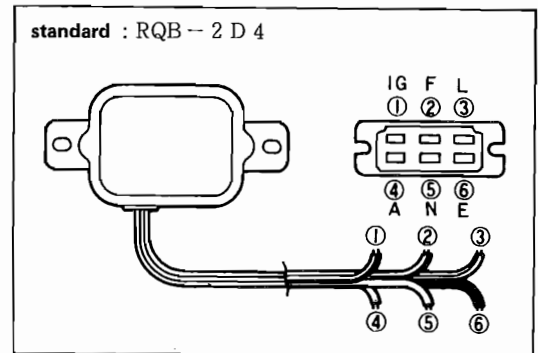
(1) Install the regulator and regulator rectifier in a well-ventilated place because they are weak against heat.

Install the regulator in such a direction that the outlet for the wiring from the main body will face downward.

(2) When the regulator is replaced due to broken connector, correctly connect the wires in accordance with the color codes as illustrated.



Outlet for Coupler wiring



1. Red on white 2. Black on white 3. Green on Yellow 4. White 5. Yellow 6. Black

Color Code for Regulator Wiring

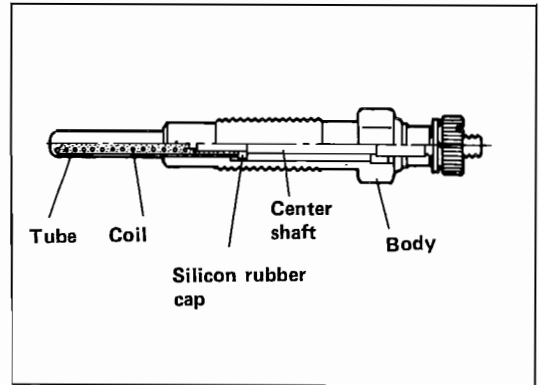
## 6. 5 Glow Plug and Glow Plug Indicator

### 6. 5. 1 CONSTRUCTION

The glow plug has a coil resistor in the end tube and becomes red and hot when energized and the end part becomes very hot, thus increasing the air temperature in the combustion chamber making the starting easier. It is necessary to pay attention to the energizing time because a large current runs to the glow plug. The glow plug indicator is turned with the red and hot state of the glow plug and serves as a pilot when the coil becomes red and hot.

#### Caution

Since there are two types of glow plug, conventional type and quick-heating type, care must be taken in handling them or replacing the parts so that there will be no confusion between them. See the following table.



Glow Plug

Item	Specifications		
Glow plug	Item No.	Y114T	Y100
	Type	Sheath type (quick-heating)	Sheath type (conventional)
	Rated voltage	10.5V	10.5V
	Resistance	0.16Ω	1.05Ω
Glow plug indicator	Item No.	DH-139V-19	JKC. 20
	Type	Red heating type	Red heating type
	Rated current	19A	20A
	Voltage between terminals	1.3-1.7V	0.9-1.1V

Air temperature	Preheating time of glow plug	
	Quick-heating type (w/hexagon nut)	Conventional type (w/round nut)
Higher than +5°C	Abt. 10 seconds	Abt. 20 seconds
+5°C--5°C	Abt. 20 seconds	Abt. 30 seconds
Lower than -5°C	Abt. 30 seconds	Abt. 60 seconds
Limit for continuous preheating	Within 1 minute	Within 2 minutes

## 6. 5. 2 INSPECTION

### (1) Checking of Glow Plug

It is normal if the end part becomes red and hot when the (+) side of the battery is connected to the glow plug terminal and (-) side to the body.

With the glow plug installed in the engine, check if it takes much time to glow up. If so, it is short-circuited and should be checked.

### (2) Checking of Glow Plug Indicator

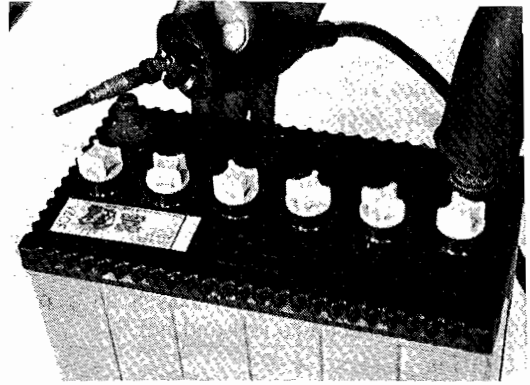
Apply a tester between the glow plug indicator terminals and check for conduction.

Also apply the tester between the terminal and body, and if there is conduction, replace.

## 6. 5. 3 INSTLLATION

Since the glow plug is of the taper shield type, it has no gasket. Be sure to use the specified torque when installing it.

Glow plug tightening torque	1.5-2.0kg.m
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Checking of Glow Plug

## 7. Other Accessories

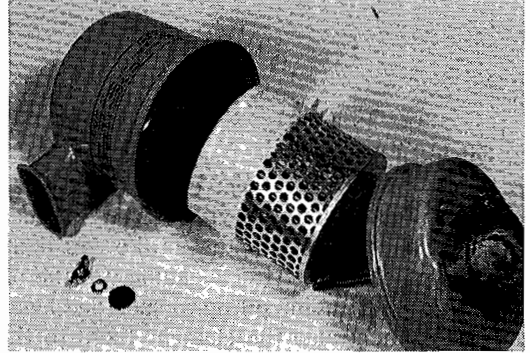
### 7.1 Air Cleaner

#### 7.1.1 CONSTRUCTION

The specifications for the air cleaner differ depending on the application. They are roughly classified as the dry type and wet type. For the dry type the filter paper cyclone type is used and for the wet type the oil bath or oil bath cyclone type is used.

##### (1) Filter Paper Cyclone Type

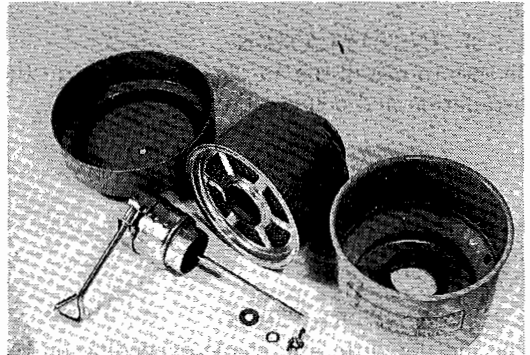
Filter paper element is used and the cyclone fins are provided on the air inlet side above the element.



Filter Paper Type Air Cleaner

##### (2) Oil Bath Type

The oil bath type uses steel wool element and depending on the specifications, ordinary type, cyclone type or other different shape is used.



Oil Bath Type Air Cleaner

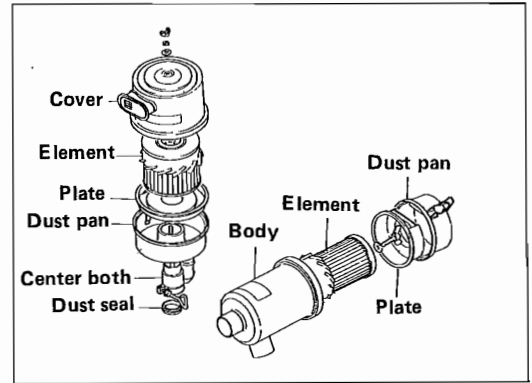
#### 7.1.2 INSPECTION

The air cleaner service mainly consists of cleaning and it is necessary to increase the cleaning frequency depending on the use conditions. That is, in the dusty place the cleaning must be carried out more frequently. The lack of proper service will cause clogging which results not only in the decreased output but also in serious trouble in the engine especially when sandy dust is taken in. Therefore, a proper advice must be given to the user who is not carrying out a proper service.

### (1) Filter Paper Cyclone Type

Remove the air cleaner cover and clean inside the body. To clean the element, blow from inside with compressed air to blow out the dust caught by the element. Also clean the cover and inside the dust pan.

**Note:** If the filter paper element is damaged or seriously contaminated, replace it with new one.



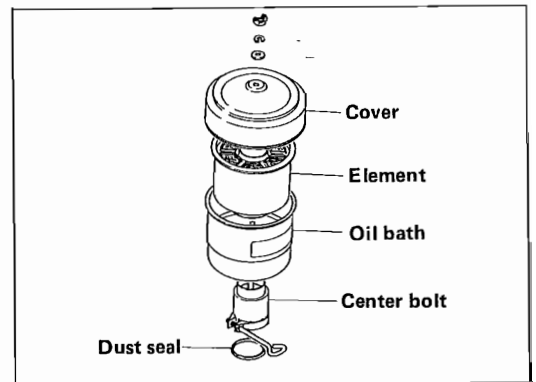
Filter Paper Type Air Cleaner

### (2) Oil Bath Type

Remove the upper cover or case and clean the element and body side with washing oil such as hose cleaner. Remove the intake cap if installed, and clean it. After cleaning, fill the oil bath with fresh engine oil up to specified level. Dry the element(also the element fixed to the case) after cleaning and immerse it in the engine oil once and install it after shaking off the oil.

#### 7. 1. 3 INSTALLATION

Be sure to install the air cleaner airtight at the installation and connection.



Oil Bath Type Air Cleaner

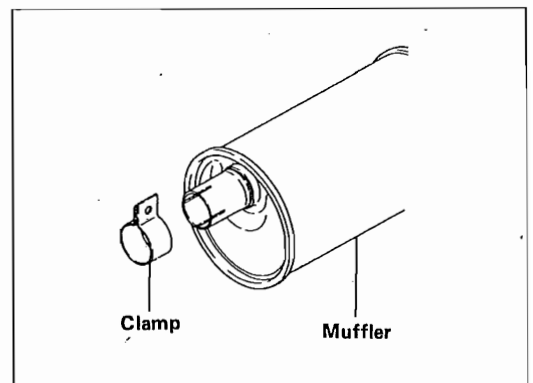
## 7. 2 Muffler

### 7. 2. 1 CONSTRUCTION

The muffler differs in shape depending on the application but basically it has an inner pipe with small holes to reduce the exhaust sound.

### 7. 2. 2 SERVICING OF MUFFLER

If the inner pipe is damaged and not effective, replace the muffler with new one.



Muffler

### 7.3 Safety Covers

Safety covers are required for rotating parts and high temperature parts. Such covers are not provided for the engine itself, but safety measures should be taken in accordance with the working machine side.

#### 1. Covers for Rotating Parts

Covers are provided for the power outlet (if exposed) and fan.

#### 2. High Temperature Parts

Install a safety cover around the muffler in such a way that the heat radiation is not prevented. Check the safety covers for cracked bolt holes and weld cracks, and if defective, correct or replace.

### 7.4 Radiator

#### 7.4.1 CONSTRUCTION

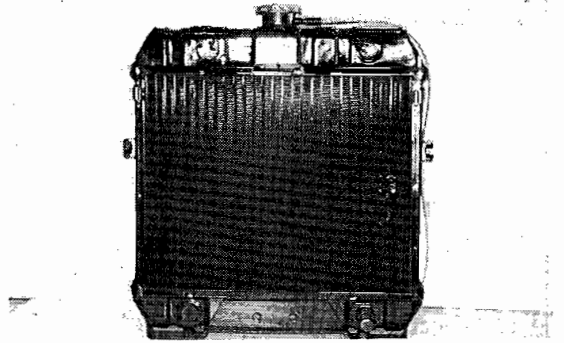
The radiator adopts the vibration-resistant plate fins at the heat radiation part and the water inlet is provided with a pressure cap. The pressure cap raises the boiling point of the cooling water to decrease the consumption of the cooling water and increases the heat radiation of the radiator per unit area.

#### 7.4.2 INSPECTION

- (1) Check the radiator net and fins for clogging with dust and clean.  
Carefully clean using air or fresh water. When washing, be careful not to splash water to the electrical parts.
- (2) Check the pressure cap and the water pipe and hose of the radiator for damage and water leakage.

#### 7.4.3 INSTALLATION

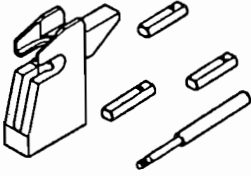
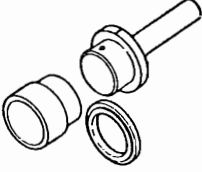

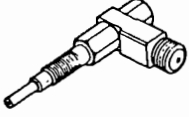
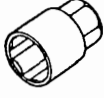
Install the radiator in a vibrationproof manner. If the vibrationproof rubber is provided, take care not to damage the rubber, and install the hoses watertight using clamps.



Radiator

## 8. Maintenance

### 8.1 Special tools

Tool No.	Tool Name	Sketch	Use
ST332301	Piston pin setting tool		Press-fitting and removal of piston pin K2AS = guide D: (92.5 ℓ) K2B, C = guide E: (91 ℓ) KE70 = guide F: (89 ℓ)
ST332320	Crankshaft journal bearing installer		Press-fitting and removal of crankshaft journal bearing (except K2AS)
ST332370			Same as above (for K2AS)
ST332230	Compression gauge adapter (standard type)		Measurement of compression  } Use either one
ST332350	Compression gauge adapter (L type)		
MD998054	Socket wrench (26)		Installation and removal of oil pressure switch

Additionally, commercially available general tools such as various bearing pullers, valve seat cutter, valve guide installer, oil filter wrench, etc. are required.



## 8. 2 Periodic Service Chart

○...Check,adjust or replenish □...Clean ●...Replace △...Drain

Service items		Time to check or adjust							Remarks
		Before operation	After first 50hrs	Every 100 hrs	Every 200 hrs	Every 400 hrs	Every 800 hrs	Long storage	
Engine proper	Looseness,damage and leakage	○							
	Exhaust,noise and vibration	○							
	Retightening of engine parts		○				○		
	Valve clearance		○			○			
	Engine idling		○	○					
	Engine compression pressure						○		
Lubricating system	Engine oil	○	●	●					
	Oil filter		●	●					
Fuel system	Fuel	○						△	
	Fuel tank					□		□	
	Fule filter			□		●			
	Fuel pump		□	□					Filter
	Injection pump						○		Adjustment of fuel injection rate
	Nozzle				○				
Ari intake system	Air cleaner	Filter paper type			□		●		
		Oil bath type	○		□●				Checking and changing of oil
Cooling system	Cooling water	○	●				●	△	Unless antifreeze is used, drain daily in winter
	Tension of fan belt		○		○				
Electrical system	Checking of instruments(pilot lamps)	○							
	Glow plugs					○			
	Starter,alternator and regulator					○	●*		*Abjusement of voltage and current

## 8.3 Judgement on Engine Overhaul Time

### 8.3.1 JUDGEMENT ON TIME FOR OVERHAUL

Generally the time for engine overhaul is judged by the decreased output, decreased compression pressure or increased fuel or oil consumption. The decreased output of the diesel engine, however, may not be directly connected with the engine itself because it is sometimes caused by the damaged nozzle or improper adjustment of the injection pump. Therefore, it is most reasonable to judge by the decrease in compression pressure.

The decrease in compression pressure is caused by many factors. Therefore, it is necessary to determine a cause or causes on basis of the periodic inspection and maintenance data.

If the trouble is caused by worn cylinder, piston ring, etc., the following symptoms will appear.

- ① Decreased output or compression pressure
- ② Increased fuel consumption
- ③ Increased oil consumption
- ④ Hard starting of engine
- ⑤ Increased noise from engine parts

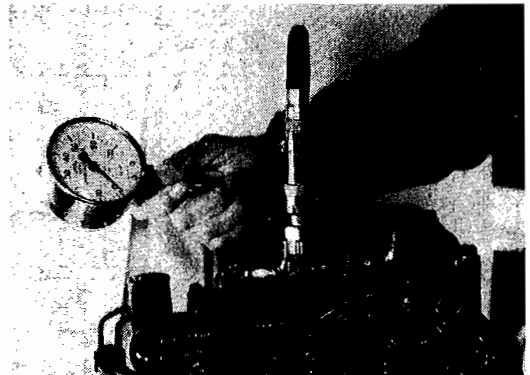
Actually the above symptoms often appear in combination. The troubles in ② and ④ are also caused by excessive fuel injection, improper injection timing or worn plunger or nozzle. Also the quality of the electrical system, i.e. battery, alternator, starter and glow plug gives a considerable effect. Therefore, it is recommendable to judge the optimum engine overhaul time using the decreased compression pressure as a yardstick and also to take into consideration the oil consumption and other factors.

#### (1) Measurement of Compression Pressure

In the diesel engine, the compression pressure is the source for explosive power, and if sufficient compression pressure is not obtained, complete combustion cannot be obtained even if other parts of the engine have no trouble. To judge the overhaul time for the diesel engine on basis of the decreased compression pressure, it is important to measure the compression pressure regularly and know the trend. At the same time the engine speed should be measured because the compression pressure varies with the engine speed.

- Decreased engine output
- Increased fuel consumption
- Increased oil consumption
- Hard starting of engine
- Increased noise

#### Judgement on Overhaul Time



Measurement of Compression

## (2) Measuring Method of Compression Pressure

- (a) Remove the glow plug for the cylinder to be measured.
- (b) Install the adapter for pressure gauge to the threaded hole of the glow plug and connect the pressure gauge.
- (c) Run the starter and when the rotation becomes steady, read the engine rpm and the pressure gauge.

Since the old KE70 and 75 are provided with the gasket shield type glow plug with M12 thread, the pressure gauge adapter with M12 thread and the gasket should be used.

- (d) Measure the compression pressure of other cylinder in the same procedure.

### Caution

It is not a proper way to guess the condition of the other cylinder from the result of measuring one cylinder. Be sure to measure the two cylinders.

## (3) Judgement of Engine Condition by Compression Pressure

- (a) The compression pressure tends to increase a little in a new engine until piston rings and valve seats are broken in, but subsequently it decreases gradually with the progress of wear of these parts.
- (b) When the compression pressure decreases beyond the correction limit, the engine must be overhauled.

## (4) Judgement by Increased Oil Consumption

If the standard oil consumption is 100% (1.0–1.5 cc/PS.h) and when about 150% is exceeded, the engine should be overhauled.

## 8. 3. 2 CAUTION IN DISASSEMBLING AND REASSEMBLING

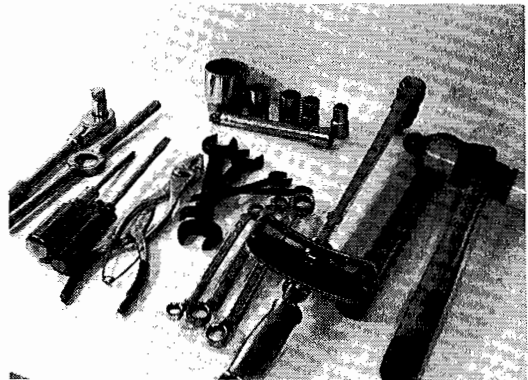
### (1) Cautions in Disassembling

When disassembling the engine, pay attention to the following. Note that the sequence for disassembling and reassembling may vary with engine specifications.

- (a) Before disassembling or cleaning, carefully check for defects which may not be found after disassembling or cleaning.
- (b) Remove water, fuel and oil before disassembling. Also check the extent of contamination of oil.



Compression gauge adapter

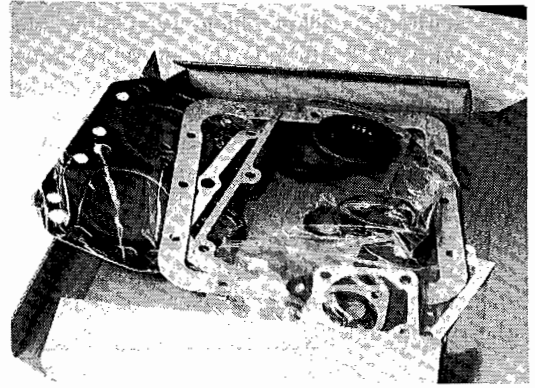


Tools for Disassembling and Reassembling

- (c) Clean or wash the exterior of the engine.
- (d) Do not remove or disassemble the parts, unless it is necessary to do so.
- (e) Use proper tools and follow the specified sequence. Keep disassembled parts in order. Apply oil when required. Take special care to keep the fuel system parts from being contaminated by dust or dirt.

**(2) Cautions in Reassembling**

- (a) Prepare all the parts needed for reassembling.
- (b) Clean or wash the parts and apply where specified.
- (c) Pay attention to all the gaskets, packings and seals and replace them with new ones.
- (d) Use appropriate tools correctly so that there will be no damage to the parts to be installed or press-fitted.
- (e) Be sure to install the parts in correct direction and positions (pay attention to the dowels, matching marks and specified directions). Where tightening torque is not specified, tighten uniformly to the ordinary torque. Apply sealant where specified.
- (f) After completion of reassembly, recheck for any abnormality, prepare for starting the engine, idle the engine sufficiently and carry out a trial run.



**Gasket Kit**

- |  |
|--|
| <ul style="list-style-type: none"> <li>● Preparation of necessary parts</li> <li>● Thorough cleaning or washing of parts</li> <li>● Application of oil or sealant where specified</li> <li>● Checking of installing directions and positions and tightening to specified torque</li> <li>● Trial run after completion of reassembly</li> </ul> |
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**Cautions in Reassembling**

## 8. 4 Service Standard

### 8. 4. 1 ENGINE PROPER

Unit:mm

Description	Standard value	Repair limit	Service limit
<b>Compression pressure</b>	K 2 K E	32kg/cm <sup>2</sup> (at 320 rpm ) 32kg/cm <sup>2</sup> (at 280 rpm )	26kg/cm <sup>2</sup> Abt. 22kg/cm <sup>2</sup> "
<b>Inter-cylinder difference of compression pressure (max.)</b>		2.5kg/cm <sup>2</sup>	
<b>Fuel injection order</b>		1—2	
<b>Injection timing (BTDC on compression stroke)</b>			
: when SS starting			
K 2 A S—61WM		25°±1.5°	
K 2 A S—31, 61A		27°±1.5°	
K 2 B		25°±1.5°	
K 2 C		23°±1.5°	
K E 70, 75		25°±1.5°	
<b>Cylinder Head</b>			
Flatness of bottom surface (distortion)		Within 0.05	0.1
Valve guide I.D. (both intake and exhaust)			
K 2		6.6	
K E 70, 75		8	
Valve seat angle (both intake and exhaust)		45°	
Valve seat width (both intake and exhaust)		1.3~1.8	2.5
Valve seat sinkage			- 1
<b>Valve Clearance (both intake and exhaust)</b>	K 2 K E	0.25 (when engine is cold) 0.35 (when engine is cold)	
<b>Valve</b>			
Head dia. × full length (intake)			
K 2 A S		24.7×92.25	
K 2 B, C		27.2×103	
K E 70, 75		30×116	
Head dia × full length (exhaust)			
K 2 A S		22.7×92.25	
K 2 B, C		25.2×103	
K E 70, 75		28×116	
Stem O.D.	K 2 K E 70, 75	6.6 8	
Stem to guide clearance (intake)			0.10
Stem to guide clearance (exhaust)			0.15
Seat face angle		45°	
Valve head thickness (margin width)			
K 2		1	
K E 70, 75		1.5	
<b>Valve Spring</b>			
Free length	K 2 A S K 2 B, C	44 43	42.5 41.5

Unit:mm

Description	Standard value	Repair limit	Service limit	
Mounting load/height (kg/mm)	K E 70, 75	45.85		
	K 2 A S	10.0±0.5/37.6	-10	
		19.7±1.0/31.4	-10	
	K 2 B, C	14.0±0.7/36 (Old 19.7±1.0/36)	-10	
		29.75±1.5/28 (Old 35.6±1.8/27.9)	-10	
Squareness	K E 70, 75	27.9±1.4/37.3	-10	
		59.4±3.0/28.5	-10	
Valve Spring Seat			3°	
Seat thickness - 31 DG, 32 SW	2 ±0.1	-0.5		
K 2 C - 31 CW				
<b>Rocker Arm</b>				
Rocker arm to shaft clearance	0.05		-0.2	
<b>Crankcase</b>				
Cylinder bore	K 2 A S	65	+0.2	+0.95
	K 2 B	68	+0.2	+0.95
	K 2 C	70	+0.2	+0.95
	K E 70	73	+0.2	+1.2
	K E 75	78	+0.2	+1.2
Cylinder bore oversize finish tolerance	0 ~0.03 for each oversize			
Cylindricity of cylinder bore	Within 0.01			
Camshaft hole diameter				
Front	K 2 A S	32		+0.15
	Others	45		+0.15
Rear	K 2 A S	30		+0.15
	Others	29		+0.15
<b>Piston</b>				
Type	Solid type			
Material	Aluminum alloy			
O.D. (skirt end)	K 2 A S	64.95		
	K 2 B	67.92		
	K 2 C	70.92		
	K E 70	72.91		
	K E 75	77.92		
Piston to cylinder clearance				0.3
Oversize	0.25, 0.50, 0.75, 1.00 (except K 2)			
<b>Piston Pin</b>				
Type	Except K E 75	Semi-floating type		
	K E 75	Full-floating type		
O.D.	Except K E 75	19		
	K E 75	23		
Piston to pin clearance				0.08
Press-fit load with connecting rod				
	Except K E 75	(Press-fit load 500~1500kg)		
Pin to connecting rod clearance				Outside press-fit load
(K E 75 only)				0.1

Unit:mm

Description	Standard value	Repair limit	Service limit
<b>Piston Ring</b>			
Number of rings			
Compression	3 (No.1 chrome-plated, semi-keystone except K 2 B)		
Oil	1 (Chrome-plated, w/expander except K 2 B)		
Ring width			
Compression, except K E70	2.5		
K E70	2		
Oil	4		
Ring side clearance			
Compression	{ K 2 B { Others	0.075~0.12	0.3
No.1		0~0.2	1.5
No.2		0.03~0.08	0.2
No.3		0.03~0.08	0.2
Oil ring		0.03~0.07	0.2
Ring gap clearance		0.2~0.4	1.5
<b>Connecting Rod</b>			
Type	I-shaped beam		
Bend, distortion			Less than 0.15
Big end thrust clearance	1.0~0.35		0.5
<b>Connecting Rod Bearing</b>			
Type	Kelmet metal with backing		
Oil clearance	K 2	0.035~0.050	0.15
	K E70	0.039~0.088	0.15
	K E75	0.035~0.096	0.15
Undersize	0.25, 0.50, 0.75		
<b>Crankshaft</b>			
Type	Complete counterbalance type		
Bend			Less than 0.05
End play	K 2	0.06~0.3	
	K E	0.1~0.35	
Journal O.D.	K 2 A S	54	-0.15 -0.95
Pin O.D.	Except K 2 A S	59	-0.15 -0.95
	K 2	42	-0.15 -0.95
	K E70	45	-0.15 -0.95
	K E75	48	-0.15 -0.95
Undersize finish dimensions			
Journal	U.S. 0.25	(Standard-0.25 <sup>-0.040</sup> <sub>-0.055</sub> )	
	U.S. 0.50	(Standard-0.50 <sup>-0.040</sup> <sub>-0.055</sub> )	
	U.S. 0.75	(Standard-0.75 <sup>-0.040</sup> <sub>-0.055</sub> )	
Pin	U.S. 0.25	(Standard-0.25 <sup>-0.035</sup> <sub>-0.050</sub> )	
	U.S. 0.50	(Standard-0.50 <sup>-0.035</sup> <sub>-0.050</sub> )	
	U.S. 0.75	(Standard-0.75 <sup>-0.035</sup> <sub>-0.050</sub> )	
<b>Main Bearing</b>			
Type	Kelmet metal with backing		
Oil clearance	K 2 A S	0.029~0.090	0.15
	K 2 B, C : K E	0.030~0.115	0.15
Undersize	0.25, 0.50, 0.75		

Unit:mm

Description	Standard value	Repair limit	Service limit
<b>Crankshaft Thrust Bearing</b> (except K 2 A S)			
Type	Special aluminum alloy with backing		
Thickness	2.45~2.50		2.3
<b>Camshaft</b>			
Driving method	Gear		
Journal to cylinder block hole clearance (both front and rear)			0.15
Cam diameter (both intake and exhaust)	K 2	35.76	-1.0
	K E 70, 75	40.76	-1.0
Cam diameter (pump cam)		49	-1.0
<b>Tappet</b>			
Outside diameter	K 2	23	
	K E 70, 75	26	
Tappet to cylinder block hole clearance			0.15
<b>Push Rod</b>			
Bend			Less than 0.3

## 8. 4. 2 LUBRICATING SYSTEM

Unit:mm

Description	Standard value	Repair limit	Service limit
<b>Engine Oil Capacity</b>	K 2 A S } K 2 B, C } KE70, 75 }	2.8 ℓ } 2.5 ℓ } 2.6 ℓ }	(upper limit), (excluding oil filter 0.3 ℓ )
<b>API Service Classification</b>	Class CC or better		
<b>Viscosity</b>	Summer : Higher than 20°C	SAE 30 or 10W-30	
	Spring, autumn : 5 -20°C	SAE 20 or 10W-30	
	Winter : Lower than 5°C	SAE 10W-30	
<b>Oil Pump</b>			
Type	Trochoid type		
Check valve opening pressure	3.5kg/cm <sup>2</sup>		
Outer rotor to body clearance			0.3
Outer rotor to inner rotor clearance			0.25
Rotor to cover clearance			0.25
<b>Oil Pressure Switch</b>			
Oil pressure for lighting			
: ordinary type	0.15~0.3kg/cm <sup>2</sup>		
: K 2 B-31SW, 32SW	0.5±0.1		
: K E 70-11HL	0.6±0.1		
: K E 75-12HK, HL			





### 8. 4. 4 GOVERNOR

Unit:mm

Description	Standard value	Repair limit	Service limit
Type	Centrifugal weight type		
Governor spring			
free length	K 2 A S	68	
	K 2 B, C	88	
	K E	83	
Load (kg/mm)	K 2 A S	4.91/71	
		13.09/76	
	K 2 B, C	5.5/93	
		11.0/98	
	K E	4.4/88	
		8.8/95	

### 8. 4. 5 Cooling System

Unit:mm

Description	Standard value	Repair limit	Service limit
<b>Cooling Fan</b>			
Type			
⊙K 2 A S all types	Pusher (equal pitch 5 blades × $\phi$ 290) (MM 403481)		
⊙K 2 B—31DG, DW			
⊙—31SW, 32SW			
⊙K 2 C—31SW			
⊙K E 75—31SW			
—61WH	Suction (unequal pitch 4 blades × $\phi$ 310) (K 9674400)		
⊙K 2 B—31A, 61A			
⊙K 2 C—61A, SA			
⊙K E 70 all types			
⊙K E 75—11, 12			
—31A, NA	Pusher (equal pitch 5 blades × $\phi$ 310) (MM 403480)		
—61A, SA			
⊙K 2 C—31H			
⊙K 2 B—51M	(Not attached)		
⊙K 2 C—61EM, S S			
—61WM			
⊙K E 75—61EM, S S			
<b>Fan Belt</b>	Type	HM type (width 10.7mm)	
	⊙K 2 AS (except 61WM)	Outer length 721mm	
	⊙K 2 B, C (except 61WM)	Outer length 814mm	
	⊙K 2 C—61WM	Outer length 851mm	
	⊙K E 70, 75	Outer length 870mm	
<b>Water Pump</b>	Type	Centrifugal impeller type	

Description	Standard value	Repair limit	Service limit
<b>Thermoswitch</b>			
111° : K 2 (except 61WM) K E 70 (except 11B E, B F) K E 75(except 12HK) Switch ON/OFF temper- ature	111°±3°C/104°C or higher		
108° : K E 70—11B E, B F Switch ON/OFF temper- ature	108°± 3 °C/101°C or higher		
103° : K E 75—12HK	103°± 3 °C/96°C or higher		
<b>Thermostat</b>			
82° : K 2 B—51M, K 2 C—WM, K E 70—11B E, G E, K E 75—11G E, 61WM Valve cracking temper- ature	82°±1.5°C		
Temperature for valve lift 8 mm or more	95°C		
76.5° : K 2 B—61A, K 2 C—61A, E M, S A K E 75—61A, E M, S A Valve cracking temper- ature	76.5°±1.5°C		
Temperature for valve lift 8 mm or more	90°C		
71°C : K 2 C—61 S S Valve cracking temper- ature	71°±1.5°C		
Temperature for valve lift 8 mm or more	85°C		

8. 4. 6 ELECTRICAL SYSTEM

Unit:mm

Description	Standard value	Repair limit	Service limit
<p><b>Starter</b>                      ◎K 2 A S —61                      Model : M003T 32481                      Type : Solenoid shift type                      Output—voltage                      Rotating direction                      No-load characteristics (20°C)                      Terminal voltage                      Current (when cold)                      Revolution (starter)                      Pinion gap</p>	<p>0.9kW—12V                      Clockwise as viewed from pinion side                      11.5V                      60A or less                      6500 rpm or more                      0.5~2.0</p>		
<p><b>Starter</b>                      ◎K 2 A S —31D G, K 2 B, K                      2 C (except —61WM)                      Model : M003T 25681                      Type : Solenoid shift type                      Output—voltage                      Rotating direction                      No-load characteristics (20°C)                      Terminal voltage                      Current (when cold)                      Revolution (starter)                      Pinion gap</p>	<p>1.1kW—12V                      Clockwise as viewed pinion side                      11.5V                      60A or less                      6500rpm or more                      0.5~2.0</p>		
<p><b>Starter</b>                      ◎For K 2 C—61WM                      Model : M002T 50381                      Type : Solenoid shift type                      (reduction type)                      Output—voltage                      Rotating direction                      No-load characteristics (20°C)                      Terminal voltage                      Current (when cold)                      Revolution (starter)                      Pinion gap                      Thrust gap</p>	<p>1.6kW—12V                      Clockwise as viewed from pinion side                      11.5V                      100A or less                      3000rpm or more                      0.5~2.0                      0.5 max.</p>		
<p><b>Starter</b>                      ◎K E 70, 75                      Model : M004 T 14674                      Type : Solenoid shift type                      Output—voltage                      Rotating direction                      No-load characteristics (20°C)                      Terminal voltage                      Current (when cold)                      Revolution (starter)                      Pinion gap</p>	<p>1.2kW—12V (D C)                      Clockwise as viewed from pinion side                      11V                      62A or less                      4500rpm or more                      0.5~2.0</p>		

Description	Standard value	Repair limit	Service limit
<b>Alternator</b>			
©K 2 A S (except -61WM)			
Model : M40793			
Type : A C type (permanent magnet type)			
Charging performance	5200rpm : 14V/14± $\frac{1}{6}$ A		
Revolution for charging start	Less than 1800 rpm		
Operating speed (alternator)	1600~5600rpm		
<b>Alternator</b>			
©K2B, K2C (except -61SS, WM)			
Model : A R 2115 Z 2			
Output - voltage	15A - 12V		
Rotating direction	Clockwise as viewed from pulley side		
No-load output characteristics (20°C)			
Terminal voltage	14V		
Current (when cold)	0 A		
Speed (alternator)	1300rpm		
Load output characteristics (20°C)			
Terminal voltage	14V		
Current (when cold)	15A or more		
Speed (alternator)	2500rpm		
<b>Alternator</b>			
©K2A S -61WM, K2C -61S S			
K 2 C -61S S			
Model : A 001 T 24770			
Type : AC type(w/IC regulator)			
Output - voltage	35A - 12V		
Rotating direction	Clockwise as viewed from pulley side		
No-load output characteristics (20°C)			
Terminal voltage	13.5V		
Current (when cold)	7 A		
Speed (alternator)	1300rpm		
Load output characteristics (20°C)			
Terminal voltage	13.5V		
Current (when cold)	30A		
Speed (alternator)	2500rpm		
<b>Alternator</b>			
©K 2 C -61WM			
Model : A 002 T 25271			
Type : AC type(w/IC regulator)			
Output - voltage	50A - 12V		
Rotating direction	Clockwise as viewed from pulley side		
No-load output characteristics (20°C)			
Terminal voltage	13.5V		
Current (when cold)	24A		
Speed (alternator)	1300rpm		
Load output characteristics (20°C)			
Terminal voltage	13.5V		
Current (when cold)	50A		
Speed (alternator)	2500rpm		



Description	Standard value	Repair limit	Service limit
<b>Glow Plug Indicator (for quick-heating type)</b> Model : HE × 20 Type : Red-hot type Rated current Terminal voltage <b>Glow Plug Indicator (for conventional type)</b> Model : DH-139V-19 Type : Red-hot type Rated current Terminal voltage	20A 0.9~1.1V  19A 1.3~1.7V		

## 8. 5 Tightening Torque Chart

Parts		Torque (kg·m)
Cylinder head bolt (M 8)	K 2 A S	3.5~4.0
Cylinder head bolt (M 8)	K 2 B A C	12~13
Cylinder head bolt (M 8)	(Old " 7 T" bolt) K E70, 75	13~14
Cylinder head bolt (M 8)	(New bolt w/washer) K E70, 75	14~15
Connecting rod cap nut	K 2, K E70	3.2~3.5
Connecting rod cap bolt	K E75	5.5~6.0
Crankshaft pulley nut		15~20
Flywheel mounting bolt	K 2 A S	6.5~7.0
Flywheel mounting bolt	(Old bolt w/washer) except K 2 A S	11.5~12.5
Flywheel mounting bolt (New bolt w/flange, w/o washer) except	K 2 A S	13~14
Oil filter		1.1~1.3
Oil drain plug		5~6
Injection pump		
Delivery valve holder		4~5
Nozzle holder		
Installation of nozzle holder to engine	K 2 A S	5~6
Nozzle holder mounting bolt	except K 2 A S	1.5~2.0
Nozzle holder and retaining nut		6~8
Nozzle holder and nut for ring (M12)	K 2 A S	4~5
Glow plug		1.5~2.0
Starter B terminal nut (copper stud)		1.0~1.2
Ordinary bolts and nuts		

Screw dia	Head mark		
	4	7	10
M 6	0.3~0.5	0.8~1.0	1.0~1.3
M 8	1.0~1.3	1.5~2.2	2.5~3.5
M10	1.8~2.5	3.0~4.2	5.0~7.0
M12	3.0~4.2	5.5~7.5	9.5~12.0
M14	5.0~7.0	8.0~11.0	16.0~19.0



## 8. 6 Sealant Chart

Parts	Application surface	Sealant	Parts installation place
Taper plug (1/16)	Thread portion	HERMESEAL HI	Crankcase, right (front, rear)
Taper plug (1/8)	Thread portion	HERMESEAL HI	Crankcase, right, oil line
Taper plug (1/2)	Thread portion	HERMESEAL HI	Gear case, right side
Stead (10×20)	Thread portion	HERMESEAL HI	Top of cylinder head exhaust port
Oil pressure switch	Thread portion	HERMESEAL HI	Crankcase, right surface, center
Thermoswitch	Thread portion	HERMESEAL HI	Cylinder head, side face
Bolt (8×50)	Thread portion	HERMESEAL HI	Oil pomp cover
Expansion plug	Periphery of press-fitted portion	HERMESEAL 52 B	Crankcase, read
Gear case gasket	Gear case side	HERMESEAL 52 B	Between crankcase and gear case





