ISSUE EMD-ES0805

Robin Engines

Air-cooled, 4-cycle Diesel Engine

Model

DY23-2/27-2

SERVICE MANUAL

INDEX

CONTENTS

1. SPECIFICATIONS

Model	DY23-2D	DY23-2B	DY27-2D	DY27-2B
Type	Air-Cooled, 4-cycle, Overhead Valve, Single vertical cylinder, Diesel engine			
Bore × Stroke	70 × 60 mm (2.76 × 2.36 in.)		75 × 60 mm (2.95 × 2.36 in.)	
Piston Displacement	230 cc (14.04 cu.in.)		265 cc (16.11 cu.in.)	
Compression Ratio	21			
Output HP/rpm DIN6270NB (KW•min^{-1})	4.8/3600 (3.5/3600)	4.8/1800 (3.5/1800)	5.5/3600 (4.0/3600)	5.5/1800 (4.0/1800)
Output HP/rpm DIN6270NA (KW•min^{-1})	4.2/3600 (3.1/3600)	4.2/1800 (3.1/1800)	5.0/3600 (3.7/3600)	5.0/1800 (3.7/1800)
Torque kg-m/rpm DIN6270NB (ft.lbs/rpm)	1.07/2200 (7.7/2200)	2.14/1100 (15.4/1100)	1.23/2400 (8.9/2400)	2.46/1200 (17.8/1200)
Rotation	Counterclockwise as viewd from PTO shaft side			
Cooling	Forced air cooling			
Lubrication	Forced oil lubrication			
Lubricant	Diesel engine oil, service rank CC or CD			
Oil Pump	Trochoid gear pump			
Fuel Injection Pump	ZEXEL PFRIMD55 / 2NP1			
Injection Nozzle	ZEXEL DLLA150PN052			
Fuel	Automotive diesel fuel			
Fuel Feed	Gravity type			
Fuel Tank Capacity	3.2 liters (0.84 U.S.gal.)			
Combustion System	Direct injection type			
Governor System	Centrifugal flyweight type			
Lighting Capacity	–	12V-39W/3000 12V-43W/3600	–	12V-39W/3000 12V-43W/3600
Starting System	Recoil starter (Electric starter as option)			
Dry Weight	29 kg (63.9 lbs.)	29.5 kg (65.0 lbs.)	29.5 kg (65.0 lbs.)	30 kg (66.1 lbs.)
Dimension L × W × H	329 x 357 x 402 mm (12.95 x 14.06 x 15.82 in.)		339 x 357 x 402 mm (13.35 x 14.06 x 15.82 in.)	

Specifications are subject to change without notice.

2. PERFORMANCE

2-1 MAXIMUM OUTPUT

The maximum output of an engine is the output power of the engine operating with its throttle valve fully open after it has been broken in properly.
Therefore, a brand-new engine or an engine which has not been broken in properly may not produce the maximum output.

2-2 CONTINUOUS RATED OUTPUT

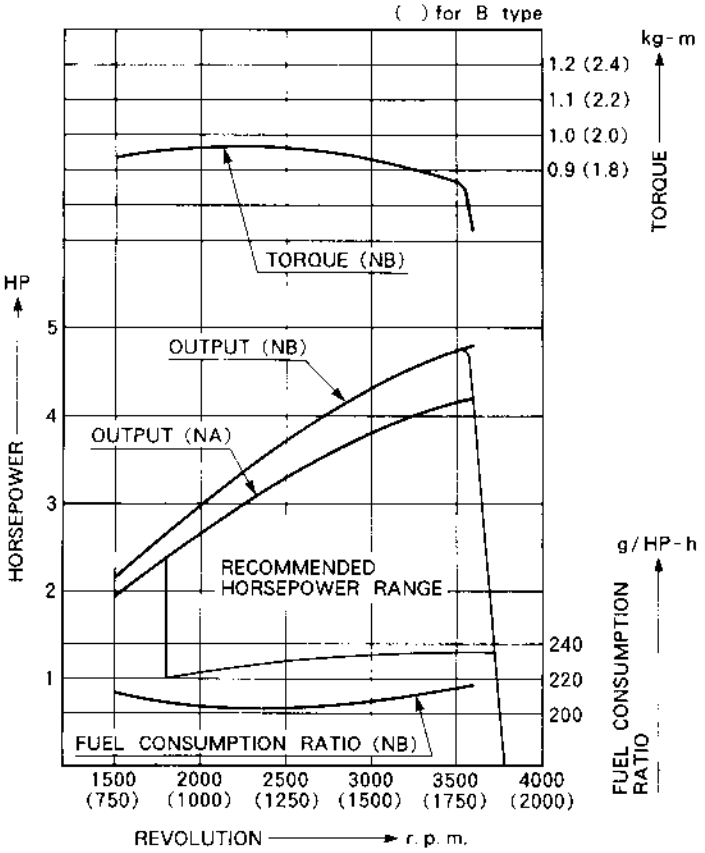
The continuous rated output of an engine is the output power of the engine running at the rated engine speed controlled by its governor system.
The operation of the engine at the continuous rated output is most favorable from the view point of engine life and fuel economy.
It is recommended, therefore, that the equipment driven by the engine to be designed to require the engine power less than its continuous rated output.

2-3 MAXIMUM TORQUE

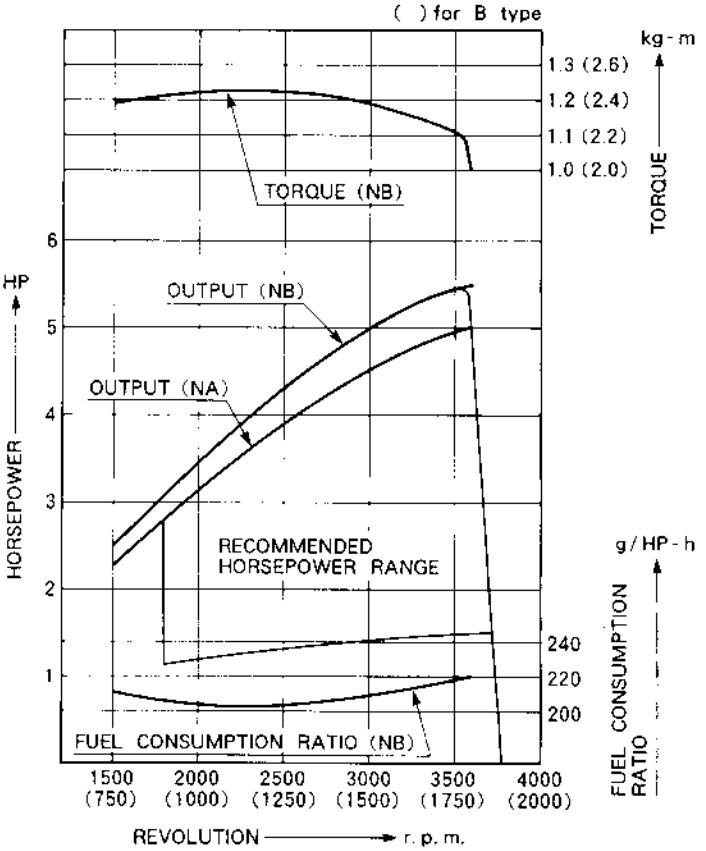
The maximum torque indicates the torque at the output shaft when the engine is producing the maximum output.

2-4 PERFORMANCE CURVES

MODEL DY23-2



MODEL DY27-2



3. FEATURES

3-1 ECONOMICAL RUNNING

The direct injection system using the newly developed micro fuel injection pump assures superior combustion efficiency and minimized fuel consumption.

3-2 EXTREMELY QUIET OPERATION

- The precisely synchronized fuel injection and refined combustion chamber allow lower combustion pressure which results in reduced combustion noise.
- Blower housing and cylinder baffle are made from "DUMPING SHEET", a special material for insulating noise and vibration.
- Larger super silent muffler and double element air cleaner reduce the exhaust and intake noise.

3-3 EASY STARTING

- Light pull recoil starter and centrifugal automatic decompressor allow effortless starting similar to a gasoline engine.
- An auxiliary fuel inlet is provided for easy starting in cold weather.
- An air check valve for easy air bleeding from the fuel line.

3-4 LESS VIBRATION

- In addition to the reduced weight of reciprocating parts, a balancer shaft has been adopted for extremely smooth running with less vibration.
- The automatic decompressor prevents shaky vibration at stopping.

3-5 HIGH PERFORMANCE

Die-cast cylinder head generates a stable swirl of air-fuel mixture which results in the high output power and an exceptional fuel economy.
Its flat torque characteristic provides tenacious running from slow speed to high speed.

3-6 SUPERB RELIABILITY

The advanced Robin technology, such as well proven crankcase design, tension bolt system for joining cylinder and cylinder head, and forced lubrication system, for longer service life under the toughest operating conditions.

3-7 SMALL AND LIGHTWEIGHT

The newly developed micro fuel injection pump and crankcase structure originated in the gasoline engine have minimized the size and weight of the engine.

3-8 WIDE RANGE OF APPLICATIONS

Robin's new air-cooled diesel engine series assures maximum adaptability to any application.

- Direct output type (D type) and reduction type (B type) are available.
- Selection of P.T.O. shafts for various applications.
- Variable muffler exhaust direction.
- Recoil starter and optional electric starter.
- Strong power from small and lightweight body.
- Lower noise and less vibration.

4. GENERAL DESCRIPTION OF ENGINE CONSTRUCTION

4-1 CYLINDER AND CRANKCASE

The cylinder and crankcase are single piece aluminum die casting. The cylinder liner, made of special cast iron, is built into the alminum casting.
The crankcase is separable on the output shaft side, where the main bearing cover is attached to it. (See Fig. 1.)

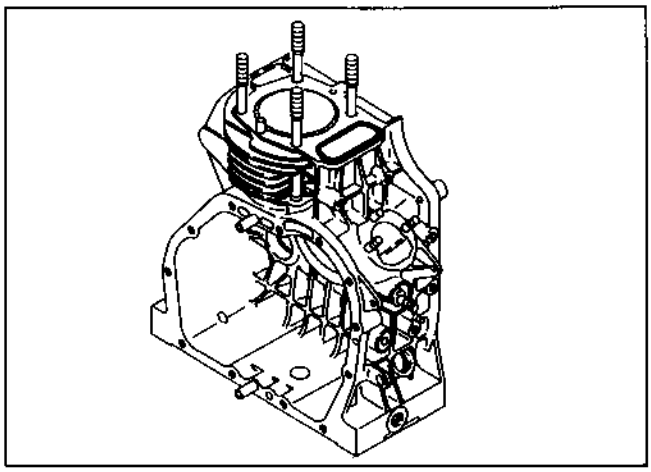


FIG. 1

4-2 MAIN BEARING COVER

The main bearing cover made of aluminum die casting is built onto the output shaft side of the crankcase so that the inside of the engine can readily be checked by simply removing the cover. It is provided with a flange and boss for directly mounting machines, such as generators and pumps.
Two oil gauges also serving as oil filler caps can be mounted.
(See Fig. 2)

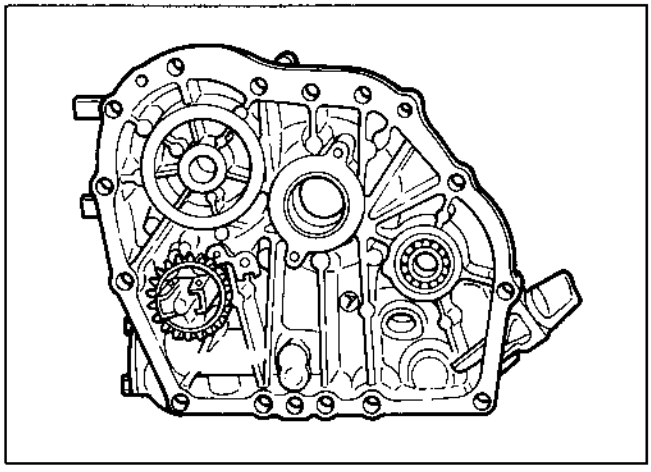


FIG. 2

4-3 CRANKSHAFT

Crankshaft is made from forged carbon steel and its crankpin and journal are induction-hardened.
Crankshaft is supported by a ball bearing at flywheel side and a kelmet bearing at P.T.O. side.
A passage for lubricating oil is provided through the journal and crankpin to lubricate the large end bearing of connecting rod.
The crank gear is pressure-fitted on the P.T.O. side of the crankshaft.
A balancer gear is also pressure-fitted for the engines with optional balancer.
(See Fig. 3.)

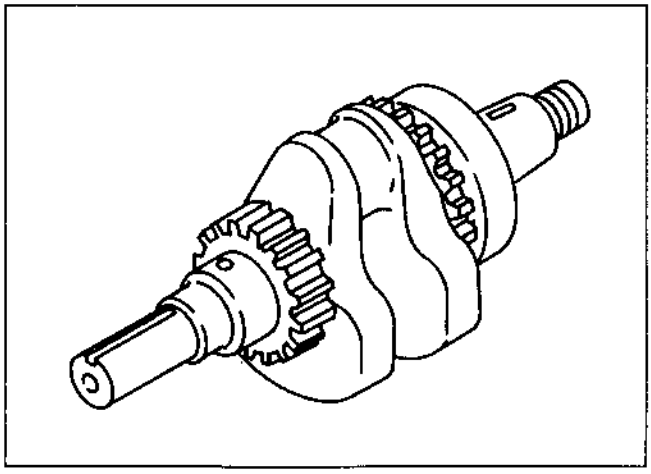


FIG. 3

4-4 CONNECTING ROD

Connecting rod is made from forged aluminum alloy which withstands high combustion pressure and tension under heavy load and high speed operation. Kelmet bearings are provided as large end bearing, while the material of connecting rod itself serves as small end bearing. (See Fig. 4.)

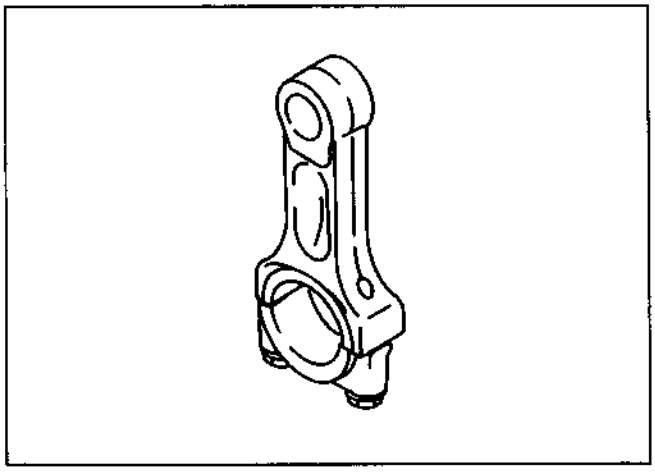


FIG. 4

4-5 PISTON

Piston is made from aluminum alloy casting, and it has three grooves for piston rings.
On the piston top, a combustion chamber is arranged where the injected fuel mixes with air and ignites.
The piston profile is so designed as to minimize piston noise. (See Fig. 5.)

4-6 PISTON RINGS

Piston rings are made from special cast iron. The profile of top ring is barrel face, and that of second ring is taper with under cut. The oil ring is the combination of cutter rings and an expander which is excellent in gas sealing and reducing oil consumption. (See Fig. 5.)

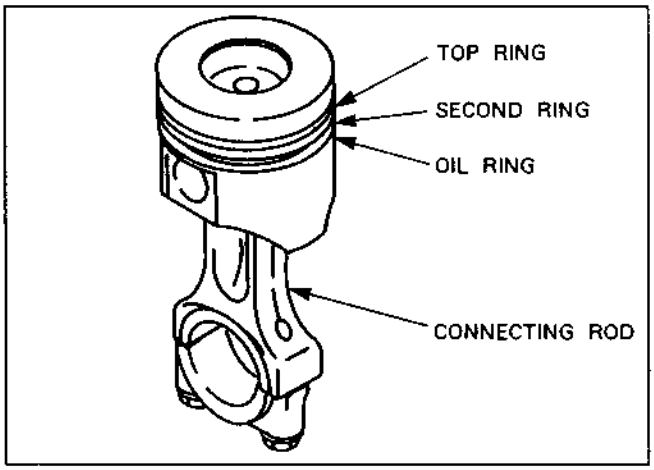


FIG. 5

4-7 CYLINDER HEAD

Cylinder head is the most important part of the diesel engine. It is made from one-piece aluminum alloy die cast, in which intake and exhaust ports, rocker arm room, and cooling fins are molded in the most ideal structure for the highest strength and the highest cooling efficiency.
High quality heat resistant valve seats are pressure-fitted considering high resistance to abration and corrosion at high temperature. (See Fig. 6.)

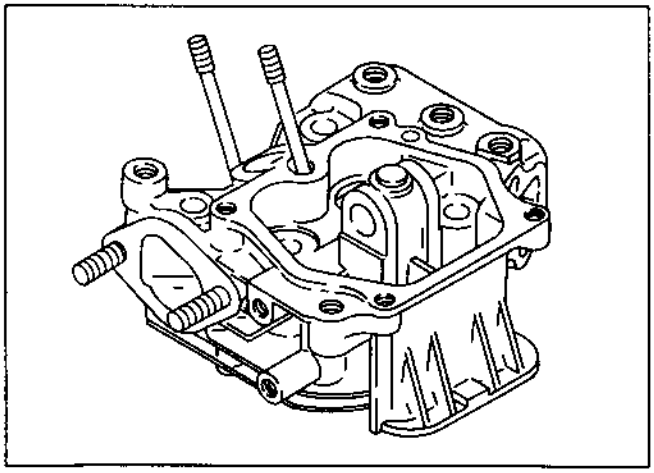


FIG. 6

4-8 CAMSHAFT

Camshaft for "D" type engine is made from special cast iron integrated with cam gear. Camshaft for "B" type engine works as PTO shaft and is made from forged carbon steel and the cam gear is pressure-fitted. Camshaft has three cams, one for intake, one for exhaust, and one for injection pump. A release lever for centrifugal decompressor is assembled to the camshaft. (See Fig. 7.)

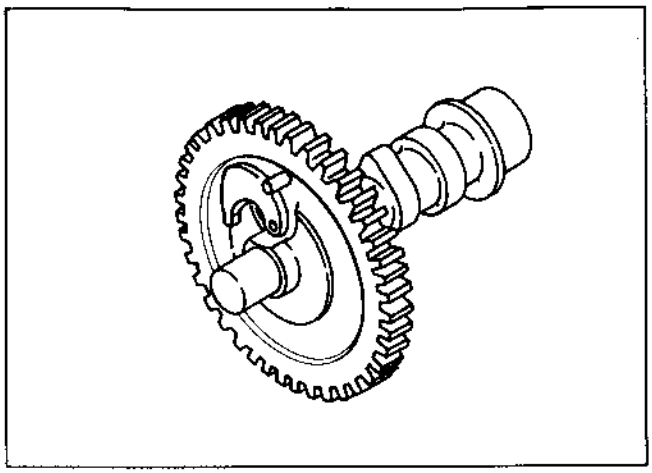


FIG. 7

4-9 TAPPET

Tappets are made from sintered steel. They are precisely finished by grinding after sintering. (See Fig. 8.)

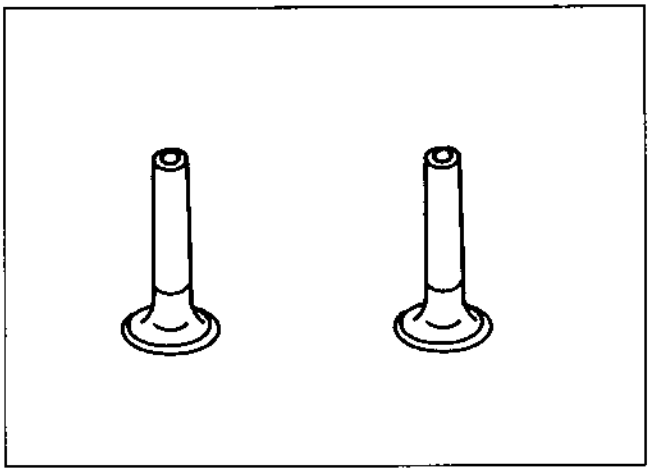


FIG. 8

4-10 VALVE

Valves are made from forged heat resistant alloy.
Stellite is fused to the head of exhaust valve for added durability. (See Fig. 9.)

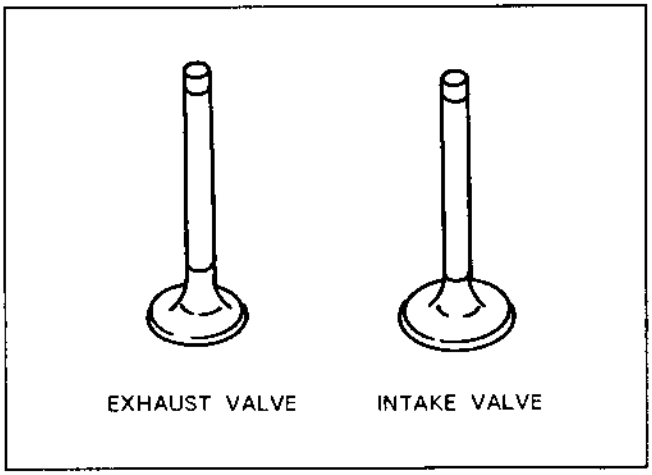


FIG. 9

4-11 ROCKER ARM

Rocker arms are made from forged steel and are wholly sintered.
A screw for adjusting valve clearance is provided at the end of rocker arm.
Rocker arms are lubricated by the oil mist contained in the breathing air from crankcase. (See Fig. 10.)

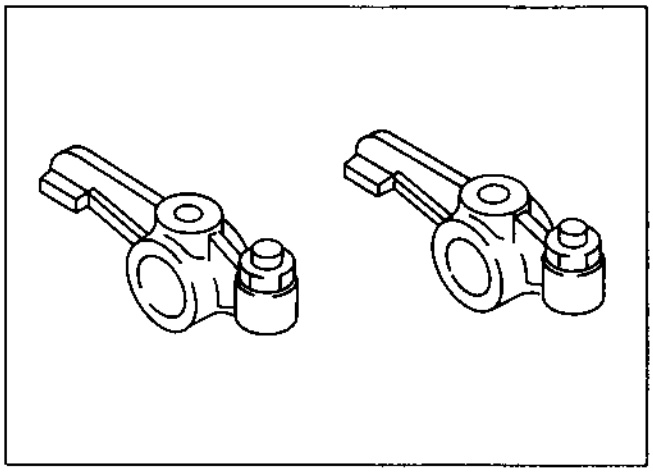


FIG. 10

4-12 ROCKER COVER

Rocker cover is made from steel sheet.
A breather plate is installed in the rocker cover to breath air into intake port. (See Fig. 11.)

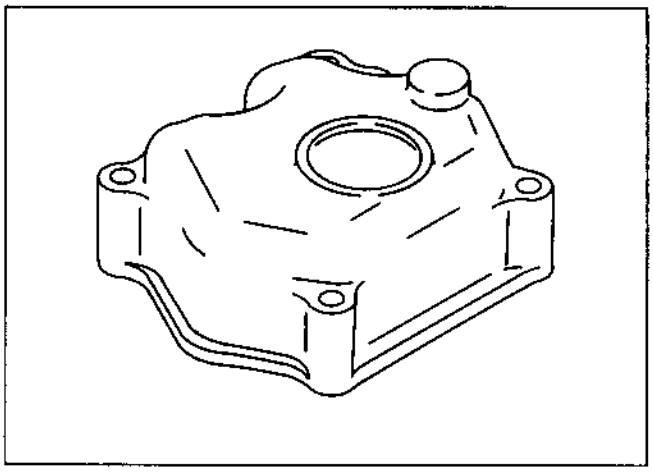


FIG. 11

4-13 AUTOMATIC DECOMPRESSION SYSTEM

Automatic decompression system is composed of a release lever and a flyweight assembled to the comshaft.
Below the predetermined speed, the release lever lifts the exhaust tappet slightly to release compression. (See Fig. 12.)

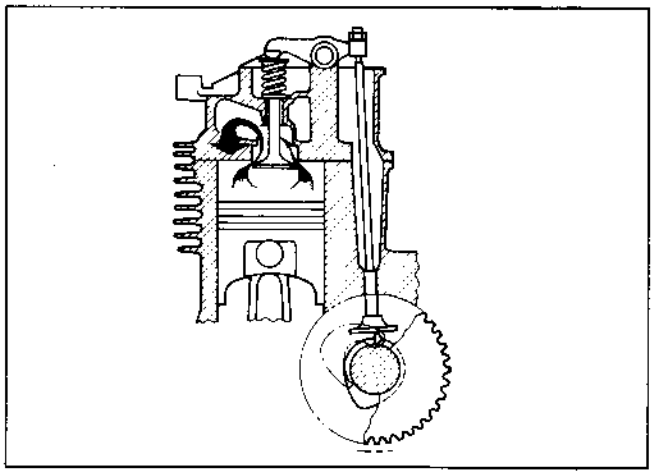


FIG. 12

4-14 GOVERNOR SYSTEM

The governor is a centrifugal flyweight type which permits constant operation at the selected speed against load variations by controlling the quantity of fuel injected. Governor system is driven by the governor gear engaged with cam gear.
(See Fig. 13.)
Refer to section **6-4** for details.

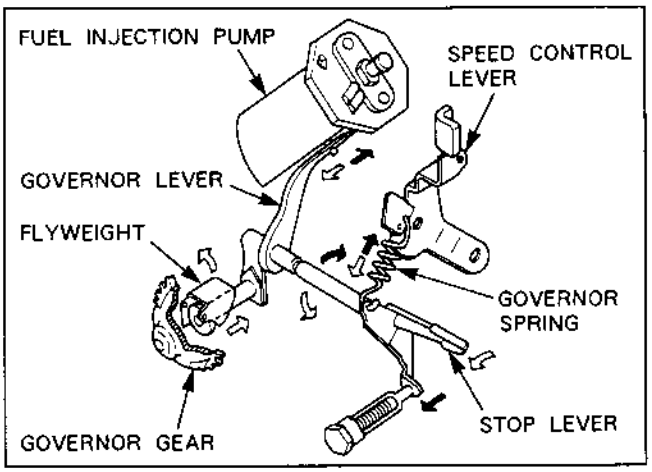


FIG. 13

4-15 LUBRICATION SYSTEM

Lubricant is forcibly supplied by the trochoid pump to the crank journal and crankpin. Other rotating parts and moving parts are lubricated by the splash of oil.
Lubricant (engine oil) is wholly filtered by the oil filter installed on the main bearing cover.
The trochoid pump is driven by the governor gear.

4-16 COOLING SYSTEM

Cooling air is forced by the flywheel fan to blow through the cooling fins of cylinder and cylinder head guided by the blower housing and the cylinder baffle.

4-17 FUEL INJECTION PUMP

Fuel injection pump is BOSCH type and is driven by the camshaft.
The fuel from the tank is pressurized by the injection pump and is supplied to the injection nozzle through the high pressure pipe. (See Fig. 14.)

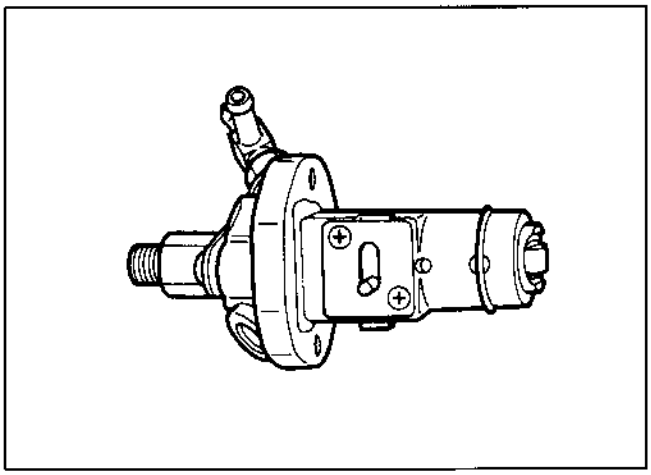


FIG. 14

4-18 FUEL INJECTION NOZZLE

Fuel is injected in the combustion chamber as fine mist through the four small ports of fuel injection nozzle. (See Fig. 15.)

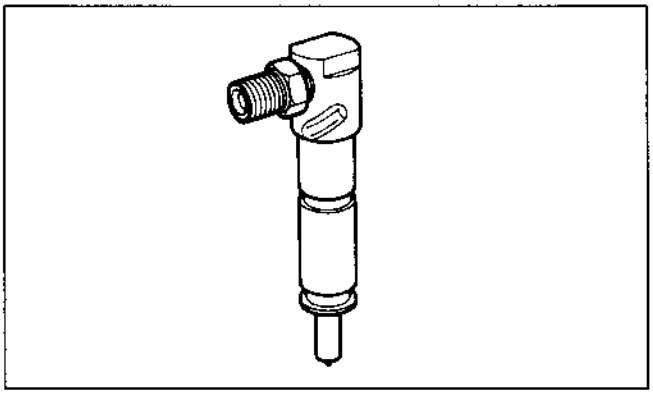


FIG. 15

4-19 AIR CLEANER

Air cleaner is dry type double element system.
Primary element is polyurethane foam and the secondary element is paper.
The air cleaner cover is made from high strength plastic and its air inlet is specially designed to reduce intake noise. (See Fig. 16.)

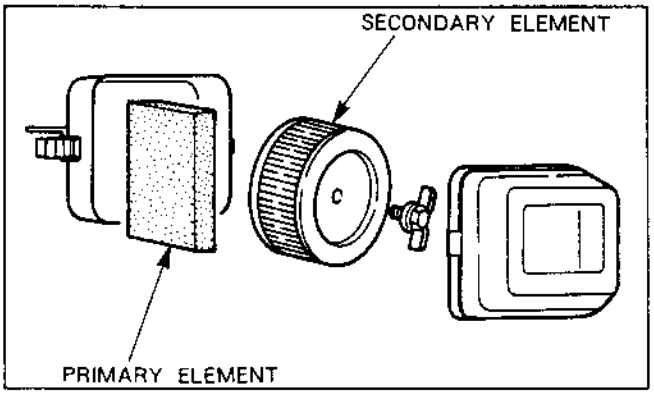


FIG. 16

4-20 FUEL FILTER

Fuel filter is a paper element disposable type. Its has a automatic air bleeding outlet on the top and a water drain on the bottom. (See Fig. 17.)

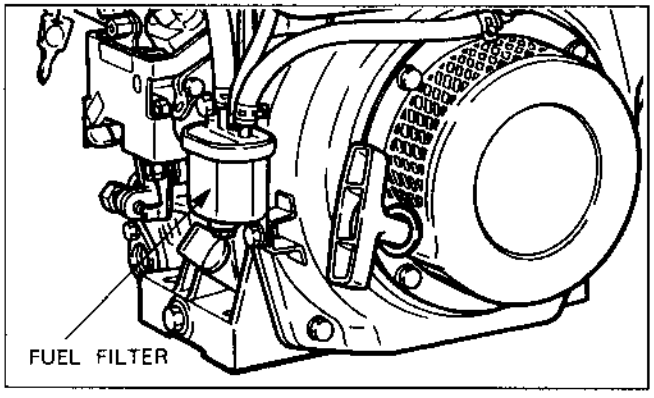


FIG. 17

4-21 COMBUSTION SYSTEM

For lower fuel consumption and easy starting of the engine, the direct injection system is adopted in the combustion chamber.

4-21-1 FORMING OF COMBUSTION GAS AND COMBUSTION

(1) SWIRL (Inspiring swirl)

In order to promote mixing injected fuel and air under the direct injection system, swirl flow is utilized for good combustion. Swirl is spiral flow of air generated in the cylinder during inspiring stroke, and it decreases during compressing stroke but it still remains and promotes mixing of fuel and air toward ignition timing.

Spiral flow of air (swirl) is generated by the shape of intake port, which is called helical port or spiral port.

Tail end of intake port, i. e. upper part of intake valve seat, is made in the spiral form ; and while the inspired air is passing through this part, swirl is generated around the intake valve.

Thus, intake port plays an important role in generating swirl. (See Fig. 19.)

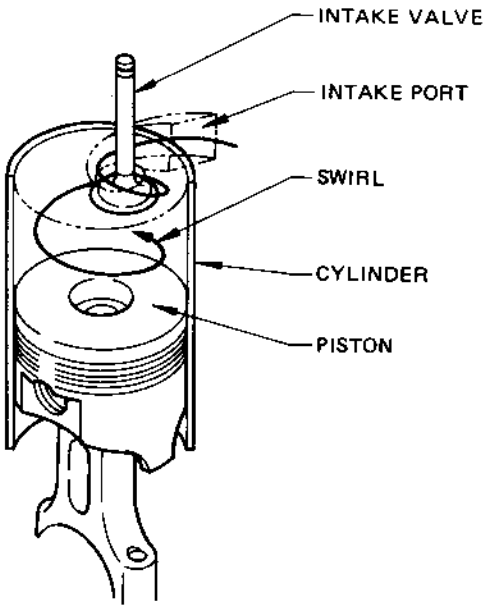


FIG. 19

(2) SQUISH (Squished air flow)

In the piston, combustion chamber (dish type combustion chamber) is formed. When the piston comes up to TDC (top dead center), air in the gaps is squished in the combustion chamber and air flow is generated, which is called "squish." (See Fig. 20.)

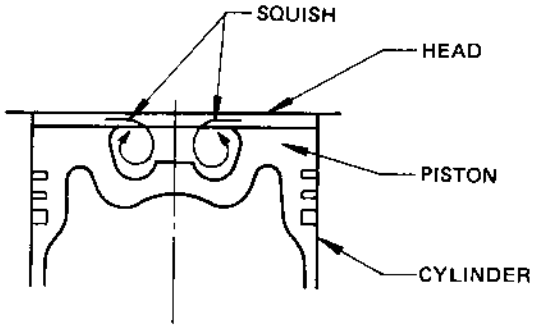


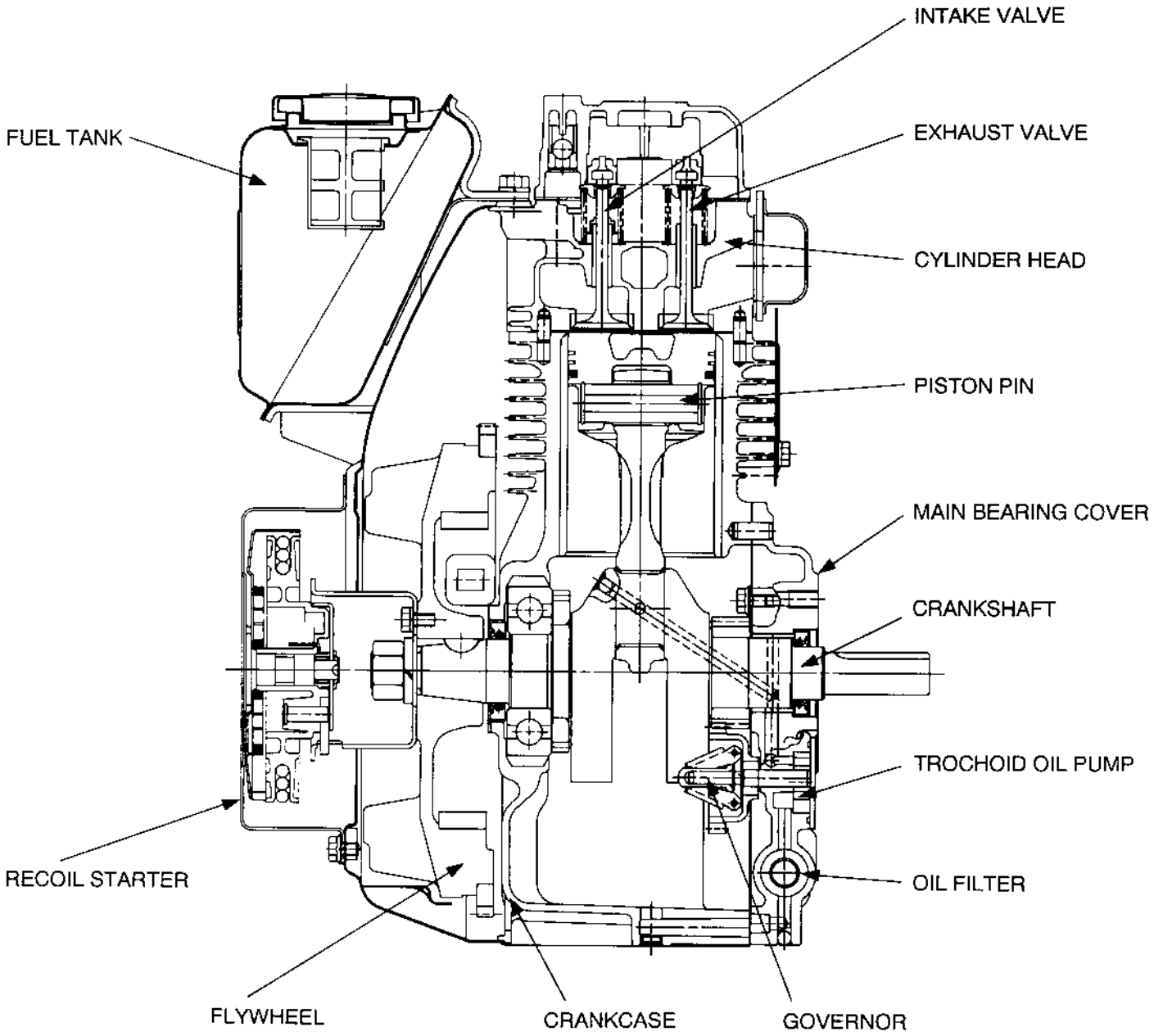
FIG. 20

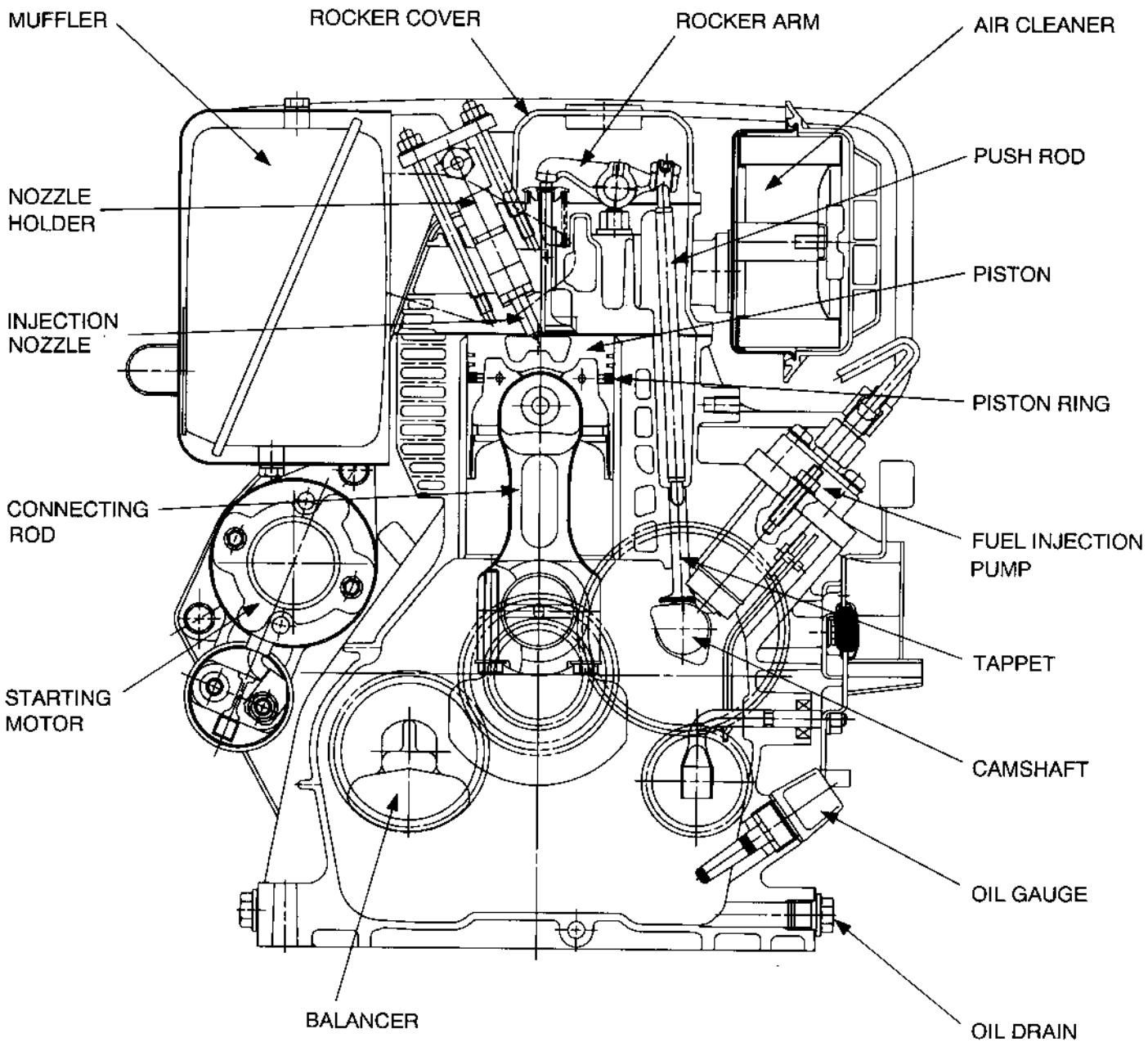
(3) FORMING OF COMBUSTION GAS AND COMBUSTION

For igniting quickly the fuel injected from the nozzle, it is essential to atomize very fine fuel particles for distributing evenly in the combustion chamber.

For this purpose, fuel should be injected through hole type nozzle by very high pressure, i. e.195 kg/c㎡. The fuel, thus injected, is mixed with air by the flow of swirl and squish while piston is coming up. Accompanying crimb of the piston, combustion gas compressed further and finally it automatically begins igniting and while piston is going down,"squish" functions and promotes combustion.

4- 22 SECTIONAL VIEW OF ENGINE




MUFFLER
ROCKER COVER
ROCKER ARM
AIR CLEANER
PUSH ROD
NOZZLE HOLDER
PISTON
INJECTION NOZZLE
PISTON RING
CONNECTING ROD
FUEL INJECTION PUMP
TAPPET
STARTING MOTOR
CAMSHAFT
OIL GAUGE
BALANCER
OIL DRAIN

5. DISASSEMBLY AND REASSEMBLY

5-1 PREPARATIONS AND SUGGESTIONS

(1) When disassembling the engine, memorize well the locations of individual parts so that they can be reassembled correctly. If you are uncertain of identifying some parts, it is suggested that tags to be attached to them.

(2) Have boxes ready to keep disassembled parts by group.

(3) To prevent missing and misplacing, temporarily assemble as much as possible each group or set of disassembled small parts such as bolts and nuts,etc.

(4) Carefully handle disassembled parts, and clean them with washing oil.

(5) Use the correct tools in the correct way.

5-2 SPECIAL TOOLS

Tool No.	Tool	Use
209-95001-07	Flywheel puller with bolt	For pulling off the flywheel
228-95003-07	Piston ring compressor	For placing piston ring

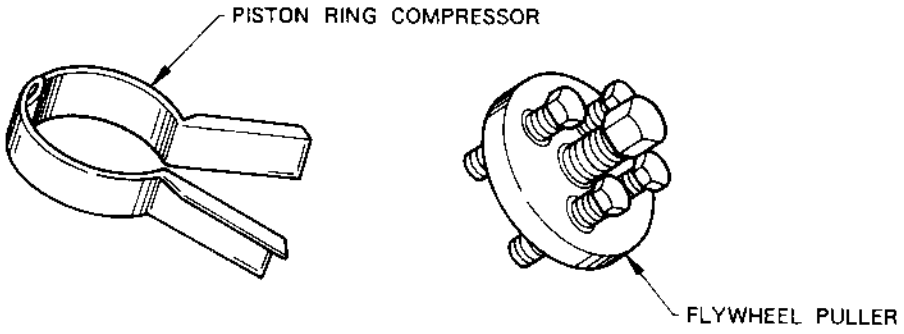


FIG. 21

5-3 DISASSEMBLY PROCEDURES

Step	Part to remove	Proocedures	Remarks	Tool
1	Engine oil	(1) Remove drain plug and discharge oil from crakcase. Drain plugs are located on both sides of the crankcase. (2) To discharge oil quickly, remove oil gauge.	Be careful not to lose the gasket.	14 mm spanner
2	Fuel	(1) Remove drain plug from fuel filter and discharge fuel from fuel tank.	Be careful not to lose the gasket.	10 mm spanner
3	Injection pipe	(1) Loosen the two joint nuts at the both ends of injection pipe to remove it.	Be careful to keep the inside of the pipe, injection pump and the nozzle free of dust.	12 mm spanner

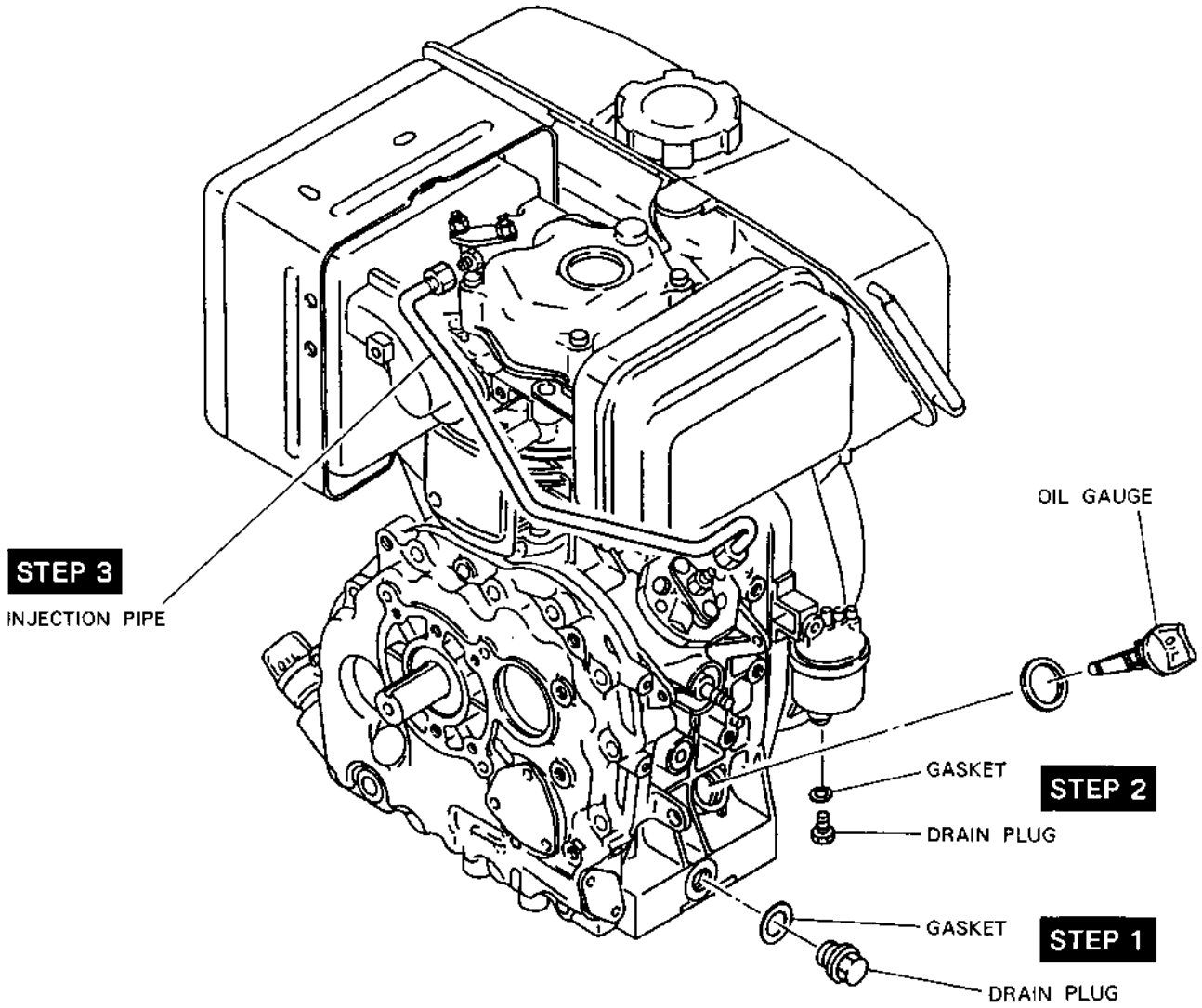


FIG. 22

Step	Part to remove	Procedures	Remarks	Tool
4	Air cleaner	(1) Remove cleaner cover from the cleaner body. (2) Loosen the wing bolt to remove element. (3) Remove cleaner body from intake manifold. 6 ϕ × 12 mm flange bolt·····2pcs.	Be careful not to lose the washer and the packing for wing bolt.	10 mm box wrench 12 mm box wrench

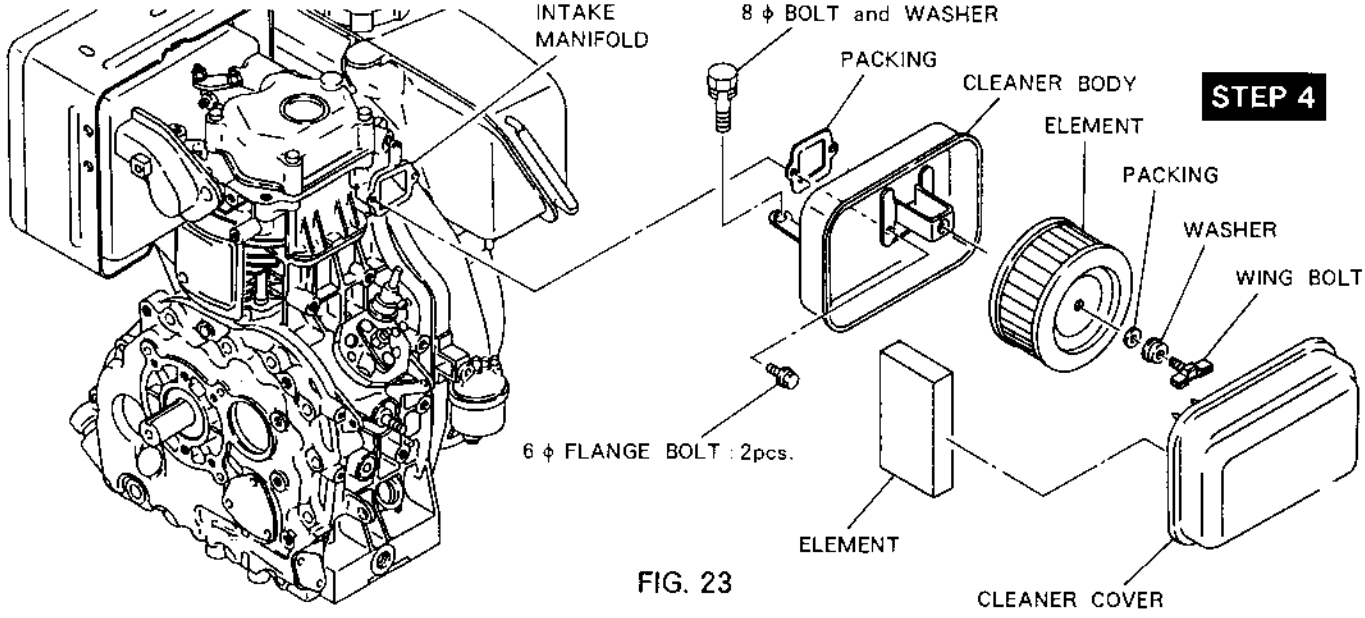


FIG. 23

Step	Part to remove	Procedures	Remarks	Tool
5	Recoil starter	(1) Remove recoil starter from blower housing. 6 ϕ × 10 mm flange bolt·····4pcs.		10 mm spanner

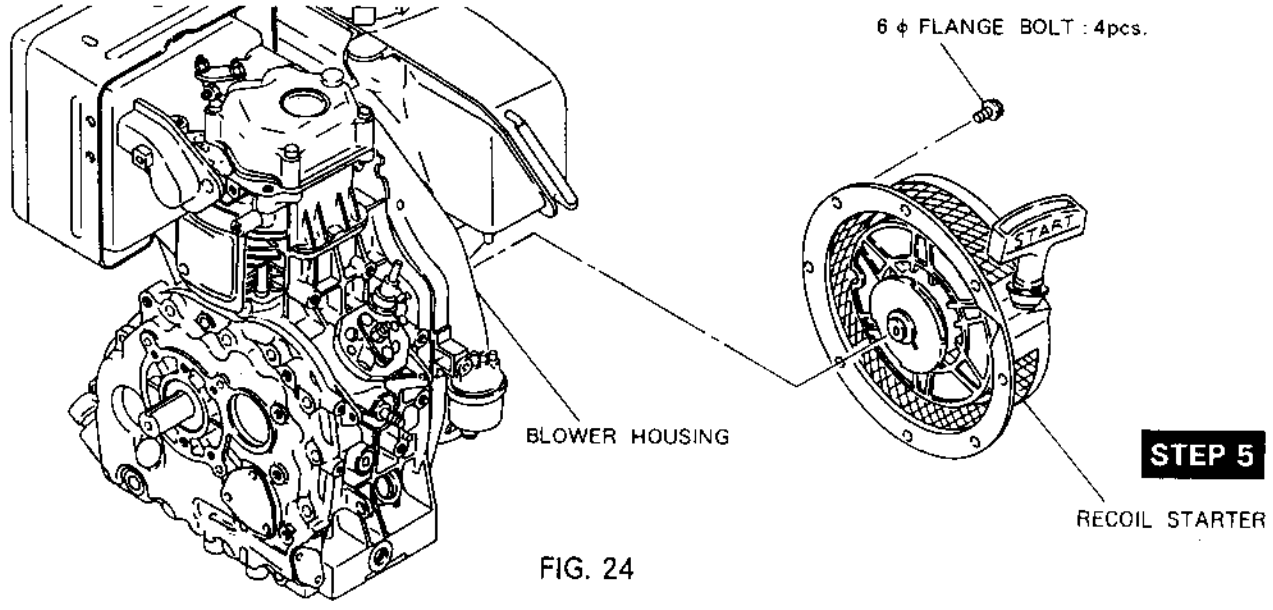


FIG. 24

Step	Part to remove	Procedures	Remarks	Tool
6	Fuel tank	(1) Disconnect fuel pipe from fuel tank. (2) Disconnect fuel return pipe. (3) Disconnect rubber pipe from the check valve. (4) Remove the fuel tank. 8 ϕ × 20 mm bolt • • • • • • • • • 1 pce. 8 ϕ × 30 mm bolt • • • • • • • • • 2 pcs.		10 mm spanner
7	Muffler	(1) Remove the muffler cover from muffler. 6 ϕ × 10 mm bolt • • • • • • • • • 4 pcs. (2) Remove the muffler. 8 ϕ nut • • • • • • • • • • • • • • • • • 2 pcs. 8 ϕ spring washer • • • • • • • • • 2 pcs.	Be careful not to lose the gasket.	12 mm box wrench

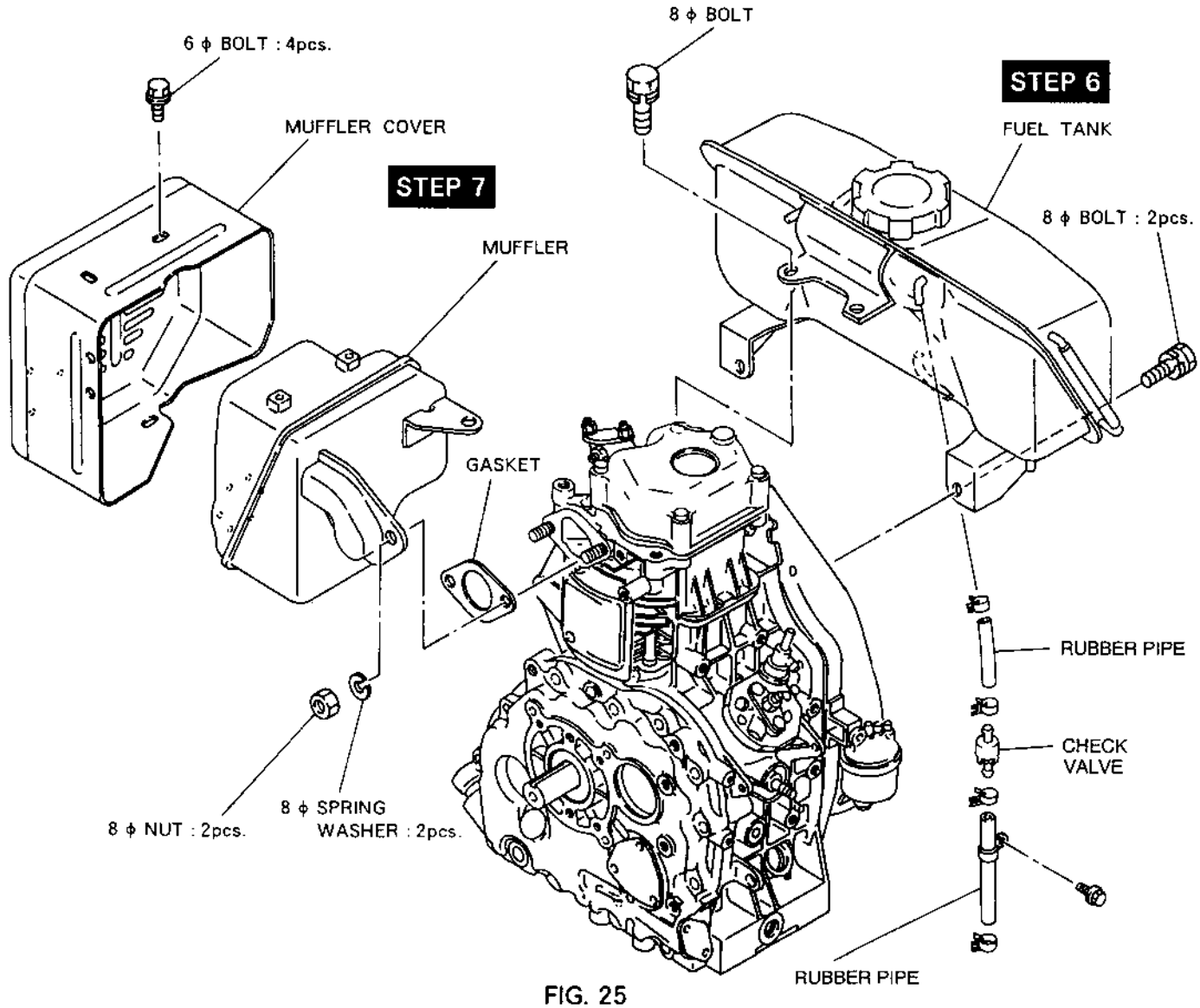


FIG. 25

Step	Part to remove	Procedures	Remarks	Tool
8	Starting motor	(1) Remove the wire harness from the starting motor. (2) Remove the starting motor from crankcase. 8 ϕ × 30 mm bolt·····2pcs.	Reattach the terminal nut to the motor to keep it from missing.	10mm spanner 12mm spanner
9	Fuel filter	(1) Remove the fuel filter from the blower housing. 6 ϕ × 20 mm flange bolt·····2pcs.	Wipe off spilt fuel thoroughly.	10 mm box wrench
10	Blower housing	(1) Remove the blower housing from crankcase. 8 ϕ × 20 mm bolt and washer ·····2pcs.		12 mm box wrench

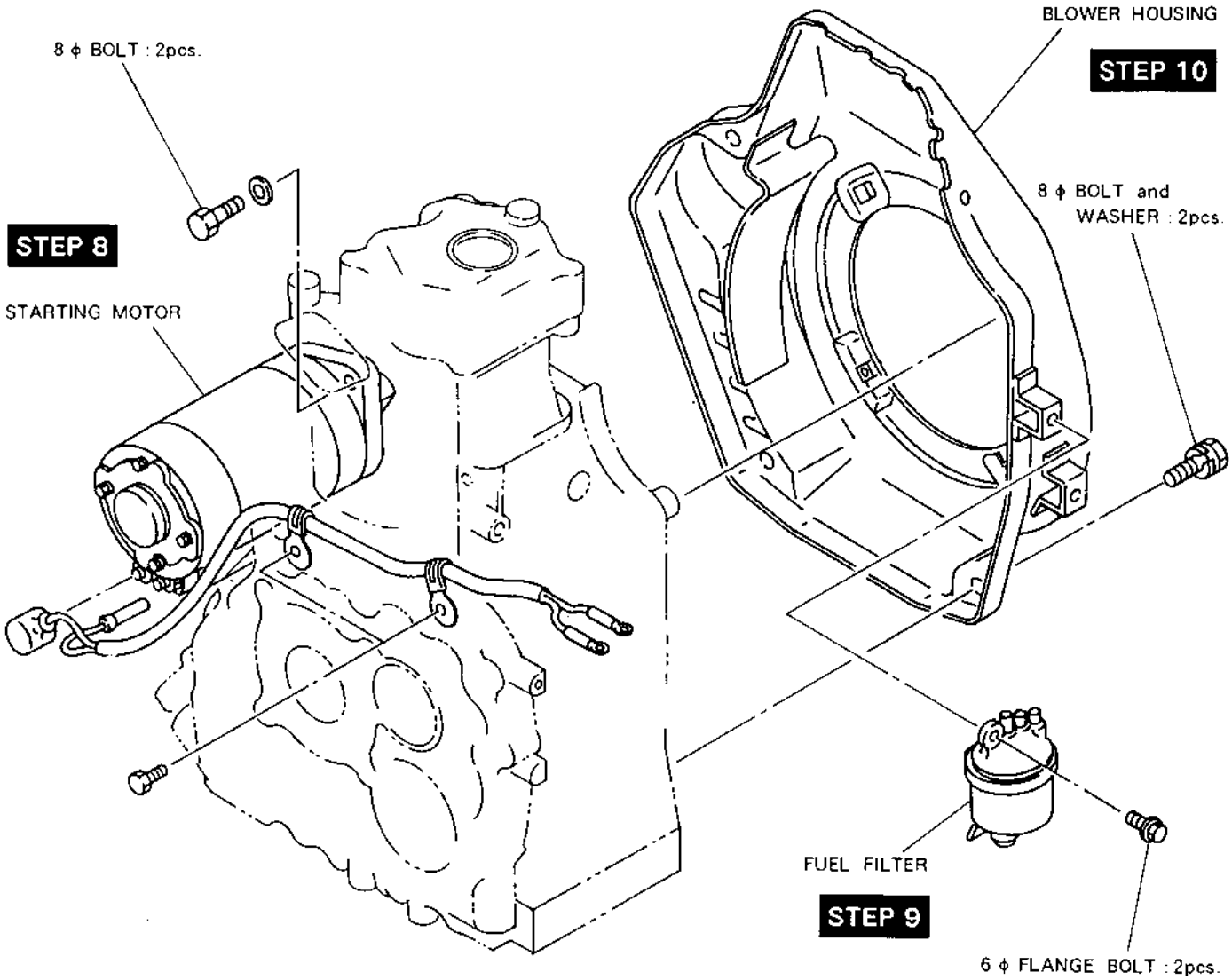


FIG. 26

Step	Part to remove	Procedures	Remarks	Tool
11	Flywheel	(1) Remove the starting pulley. 6 ϕ × 12mm bolt ·····3pcs. (2) Remove the flywheel nut. (See Fig. 27.) (3) Set the flywheel puller to the flywheel. (See Fig. 28.) Turn the center bolt clockwise to pull out the flywheel. (4) Remove the key from crankshaft.	Flywheel can easily be removed by striking with a hammer the head of the center bolt of flywheel puller. Be careful not to lose the key.	10 mm box wrench 24 mm socket wrench

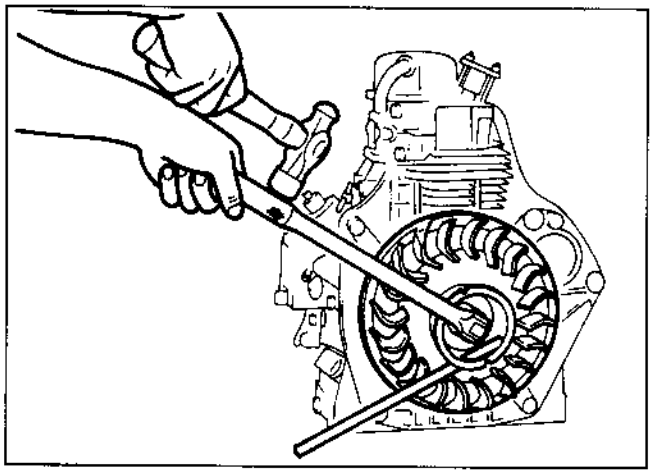


FIG. 27

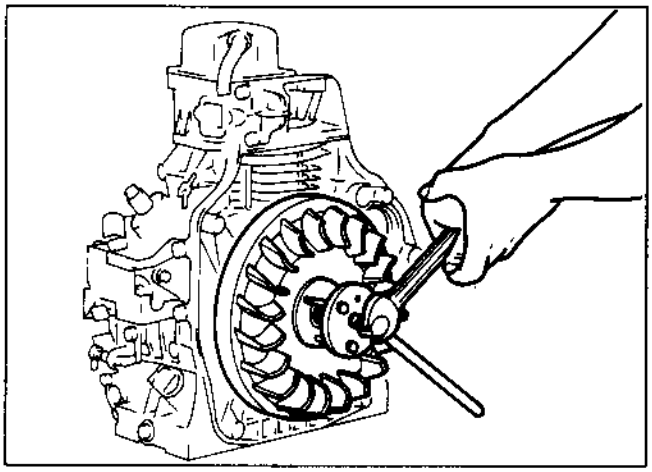


FIG. 28

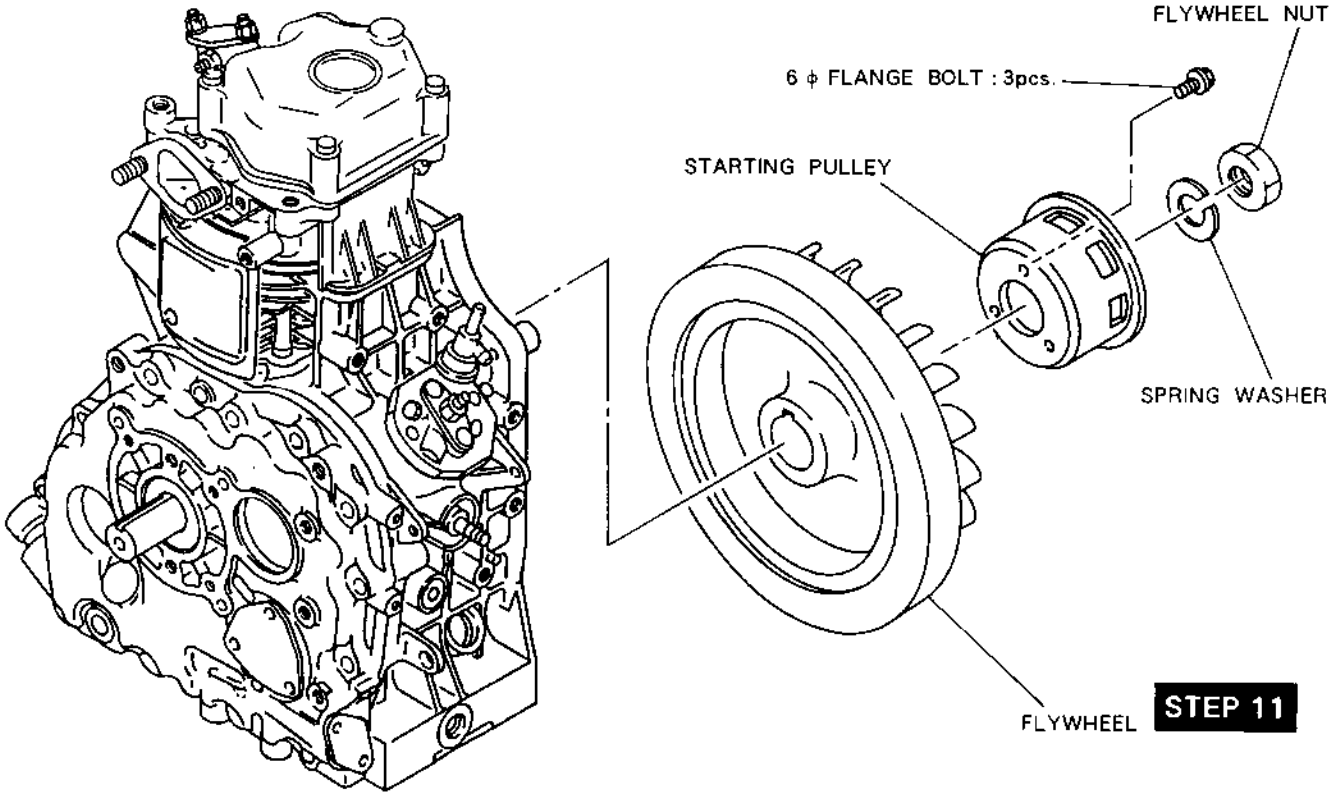


FIG. 29

Step	Part to remove	Procedures	Remarks	Tool
12	Cylinder baffle	(1) Remove the cylinder baffle from cylinder. 6 ϕ × 10 mm flange bolt·····1pce.		
13	Rocker cover	(1) Remove the rocker cover from cylinder head. 6 ϕ × 40 mm flange bolt·····4pcs.		10 mm box wrench
14	Fuel injection nozzle	(1) Remove the bracket, nozzle. 6 ϕ nut·····2pcs. (2) Remove the fuel injection nozzle from cylinder head.	Be careful not to lose the gasket at the bottom end of the nozzle.	

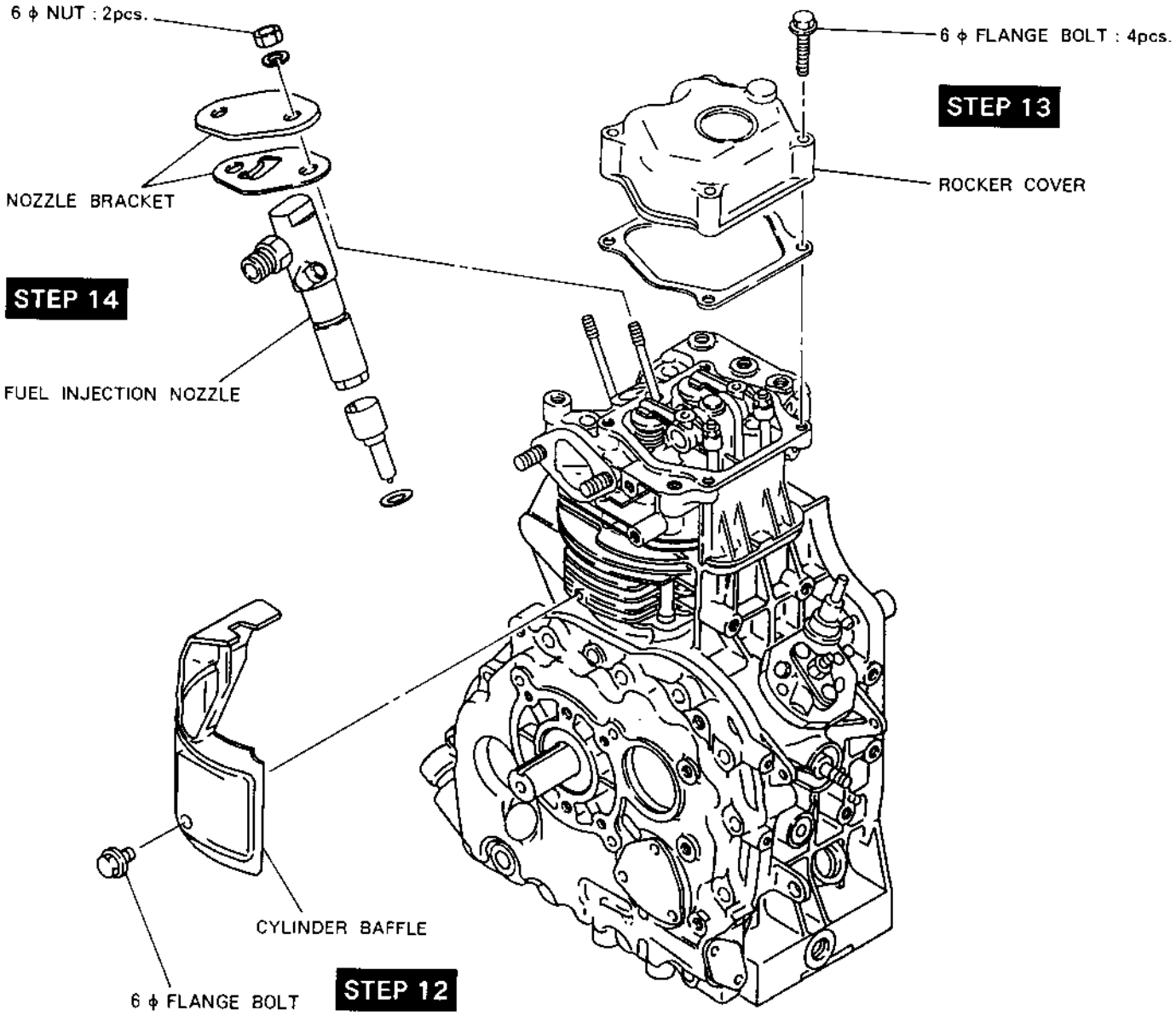


FIG. 30

Step	Part to remove	Procedures	Remarks	Tool
15	Rocker arm	(1) Loosen the adjusting bolts on the rocker arms. (2) Push the rocker shaft out from the cylinder head to remove the rocker arms. (3) Remove the push rods.	Make the rocker arms and push rods distinguishable of intake side and exhaust side.	10 mm spanner screw driver
16	Cylinder head	(1) Remove the cylinder head from cylinder. 8 ϕ flange nut·····4pcs.	Be careful of the spacer.	12 mm socket wrench

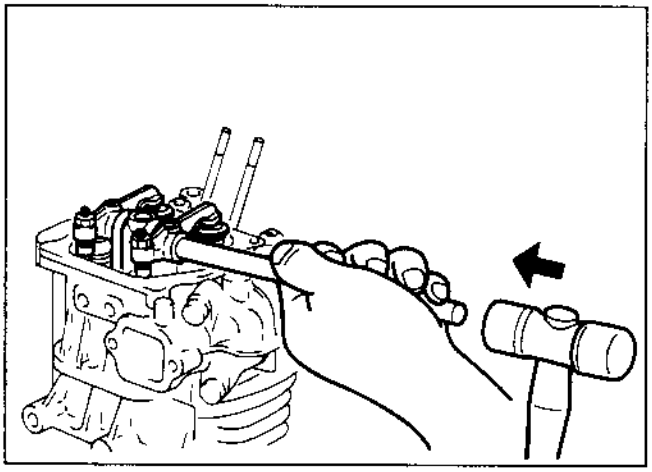


FIG. 31

FIG. 32

Step	Part to remove	Procedures	Remarks	Tool
17	Fuel injection pump	(1) Remove the fuel injection pump from crankcase. 6 ϕ nut·····2pcs.	Be careful of the position of the control rack.	10 mm socket wrench
18	Main bearing cover	(1) Remove the bolts joining the main bearing cover and crankcase. 8 ϕ × 35 mm bolt····· 11pcs. 8 ϕ × 40 mm bolt·····1pce. (2) Lightly tapping with a plastic hammer, remove the main bearing cover from the crankcase. (See Fig. 33.)	Be careful not to damage the oil seal.	12 mm box wrench plastic hammer

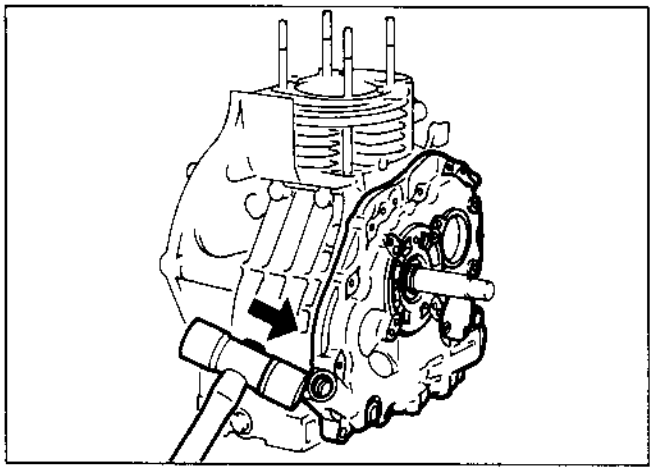


FIG. 33

FIG. 34

Step	Part to remove	Procedures	Remarks	Tool
19	Camshaft	(1) Remove the camshaft from the crankcase. (See Fig. 35.)	(1) To prevent the tappet from falling and getting damages, put the crankcase injection pump side down.	
		(2) Remove the tappets from the crankcase.	(2) Put marks on the tappets to distinguish intake tappet from exhaust.	
20	Balancer (Optional part)	(1) Remove the balancer from the crankcase.	Be careful of the spacer on the balancer shaft.	

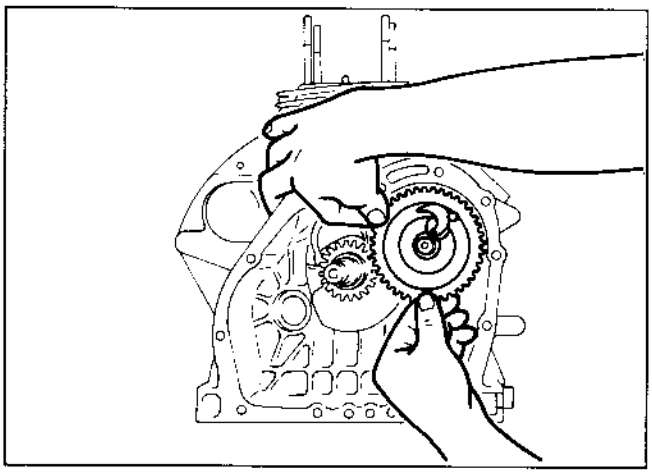


FIG. 35

FIG. 36

Step	Part to remove	Procedures	Remarks	Tool
21	Connecting rod	(1) Scrape off the carbon deposit from the piston top and cylinder. (2) Remove the connecting rod bolts and the large end cap. (3) Turn the crankshaft to the top dead center. Then, push the connecting rod up and pull the piston and connecting rod out from the cylinder.		10 mm box wrench
22	Piston and piston pin	(1) Remove the two clips from the piston at the both ends of piston pin. (2) Push the piston pin out from the piston. Remove the piston from the connecting rod. (3) Remove the piston rings from the piston by spreading their open ends.	Be careful not to give damages to the piston and connecting rod. Be careful not to break the rings by spreading too much or twisting them.	

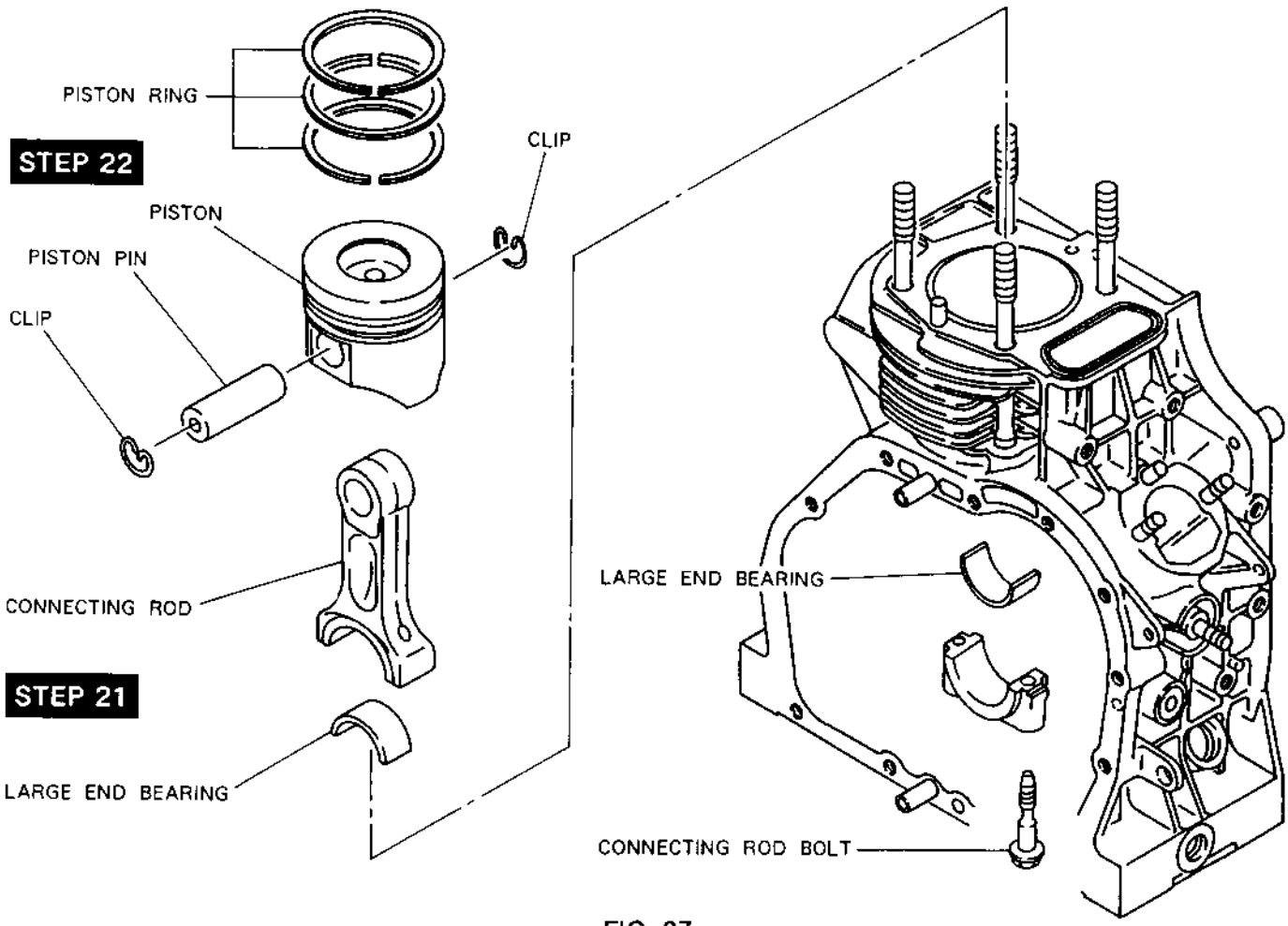


FIG. 37

Step	Part to remove	Procedures	Remarks	Tool
23	Crankshaft	(1) Lightly tap the crankshaft end at the flywheel side using a plastic hammer to remove it from the crankshaft. (See Fig. 38.)	The ball bearing comes off with the crankshaft.	

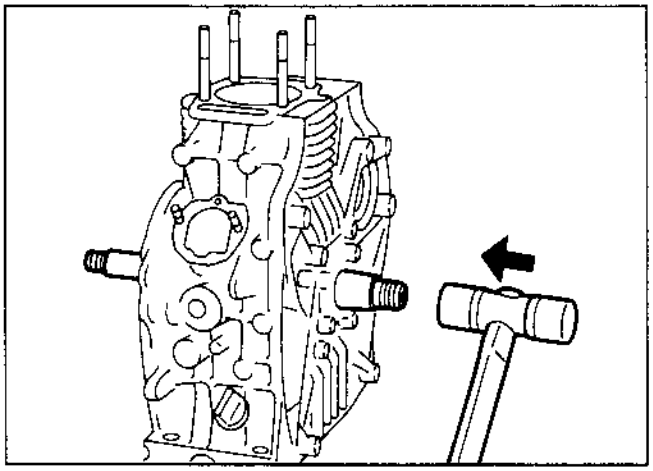


FIG. 38

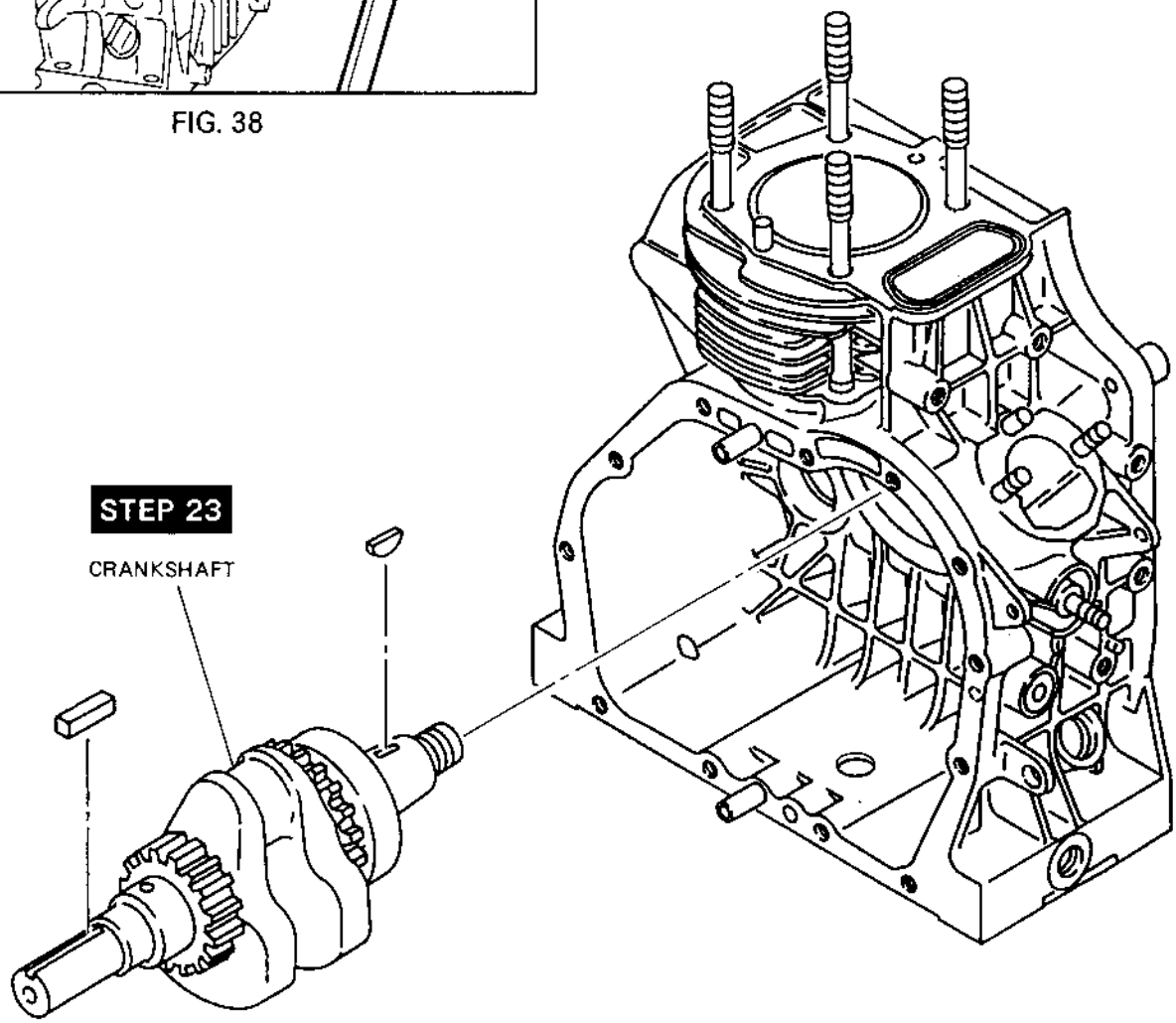


FIG. 39

Step	Part to remove	Procedures	Remarks	Tool
24	Intake and exhaust valve	(1) Press the valve springs and remove the retainer locks from the valve stems. (See Fig. 40.) (2) Remove the valves from the cylinder head.	Put marks on the valves, valve springs and spring retainers to distinguish them for intake side from exhaust side.	pliers
25	Oil filter	(1) Remove the oil filter from the main bearing cover. 6 ϕ × 12mm flange bolt……2pcs.	Be careful not to lose the o-ring.	10 mm spanner

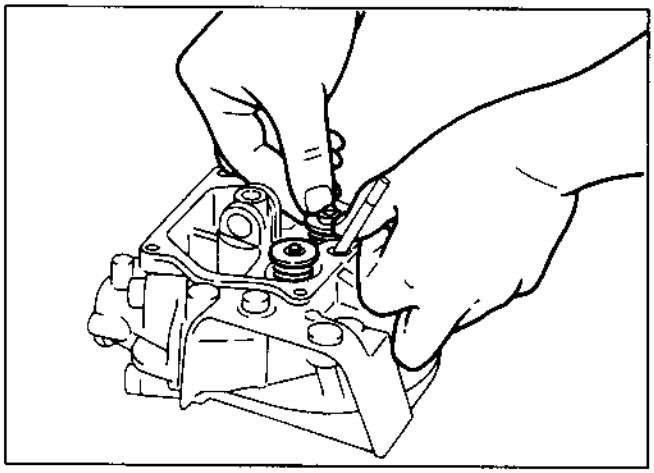


FIG. 40

FIG. 41

5-4 REASSEMBLY PROCEDURES

● PRECAUTIONS FOR REASSEMBLING

(1) Clean parts thoroughly before reassembly.
Pay most attention to cleanliness of piston, cylinder, crankshaft, connecting rod and bearings.
(2) Scrape off all carbon deposits from cylinder head, piston top and piston ring grooves.
(3) Check lips of oil seals. Replace oil seal if a lip is damaged.
Apply oil to lips before reassembly.
(4) Replace all gaskets with new ones.
(5) Replace keys, pins, bolts, nuts, etc., if necessary.
(6) Torque bolts and nuts to specification refering to the "Table of tightening torque".
(7) Apply oil to rotating and sliding portions.
(8) Check and adjust clearances and end plays where specified in this manual.

5-4-1 CRANKSHAFT

(1) Fit the oil seal guide onto the end of the crankshaft, and insert the crankshaft into the crankcase.

NOTE

In case that the oil seal guide is unavailable, be careful not to damage the oil seal lip.

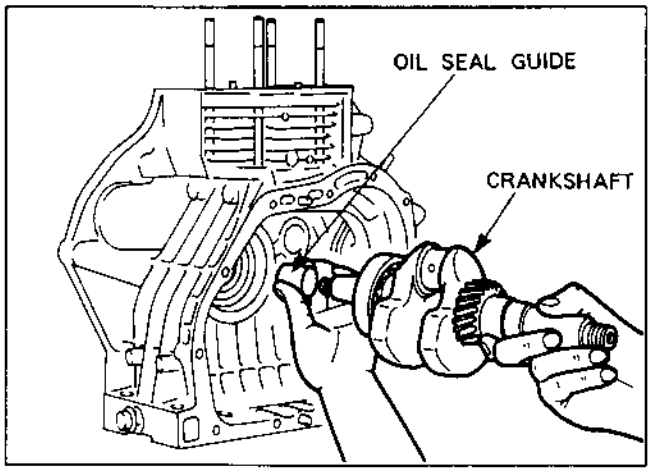


FIG. 42

5-4-2 PISTON AND PISTON RING

(1) If the piston ring expander is unavailable, install the piston rings by placing the open ends over the top land of the piston and spreading the ring ends only far enough to slip them into the correct ring grooves.

NOTES

1. Pay attention not to break the piston ring by twisting.
2. Install the oil ring first followed by the second ring and then top ring.
3. Second ring have "N" marks stamped on the ring ends. These "N" marks have to face upward when installed on the piston.

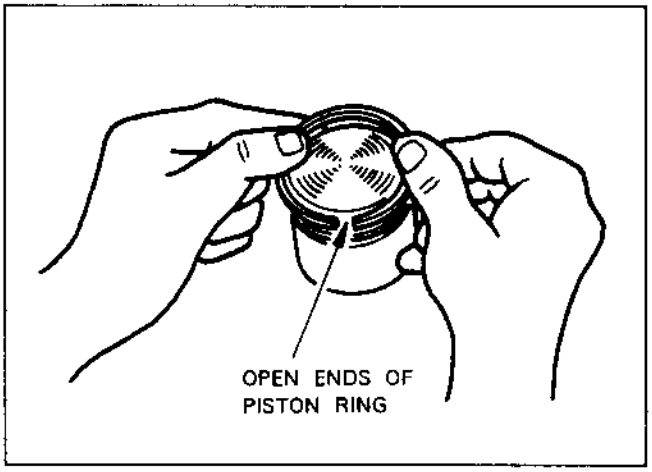


FIG. 43

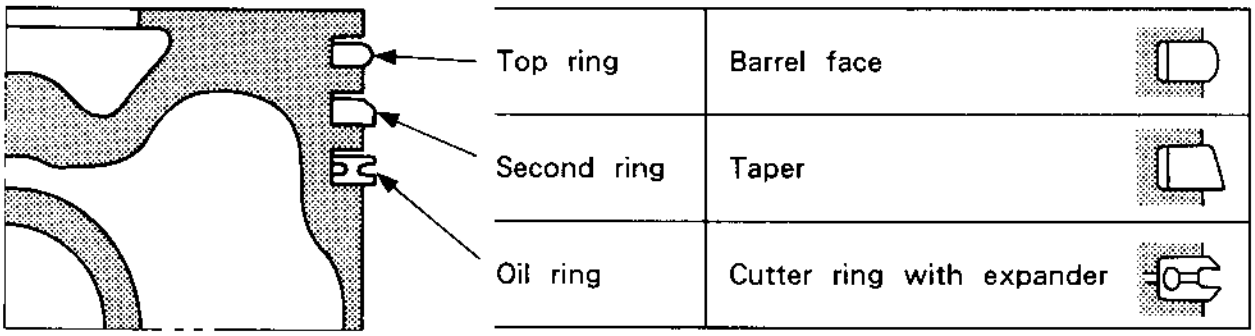


FIG. 44

(2) Assemble the piston and connecting rod with the piston pin.

NOTES

1. Set the "D" or "B" mark stamped on piston top to the "FAN" mark side of the connecting rod.
2. Apply enough oil to the small end of the connecting rod.
3. Be sure to set the clips on both ends of the piston pin.

(3) Install the piston and connecting rod assembly into the cylinder.
Use the piston ring compressor to hold the piston rings.
The "FAN" mark of the connecting rod have to face flywheel side when assembled. (See Fig. 45.)

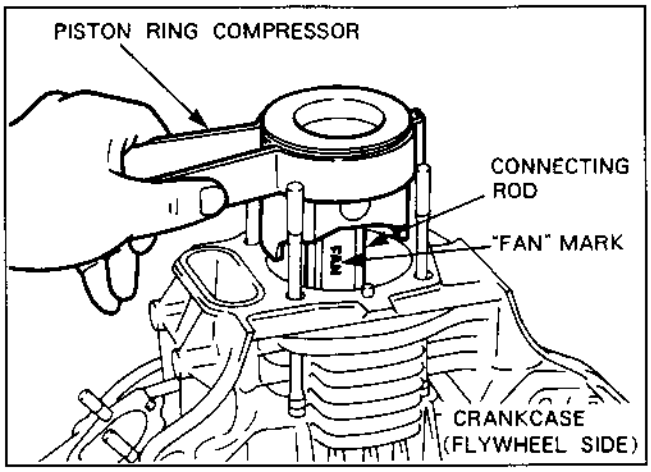


FIG. 45

NOTES

1. **Apply enough oil to the piston rings, connecting rod bearings and cylinder bore before assembly.**
2. **Set the open end of the piston rings 90 degrees apart from one another before assembly.**

5-4-3 CONNECTING ROD

(1) Turn the crankshaft to the bottom dead center, lightly hammer the piston head until the connecting rod contacts the crankpin, and assemble.

(2) When reassembling the large end cap, match the alignment mark on the rod.

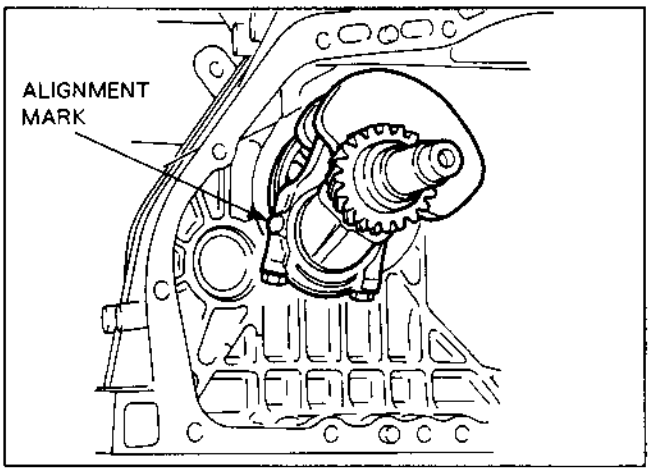


FIG. 46

NOTES

1. **No lock washer is used for the connecting rod bolts.**
2. **Tighten the rod bolts securely by the specified tightening torque.**
   Tightening torque : 180~200 Kg-cm

5-4-4 BALANCER (Optional part)

Install the balancer to the crankcase. Align the matching marks of the balancer gear and crank gear as shown in Fig. 47.

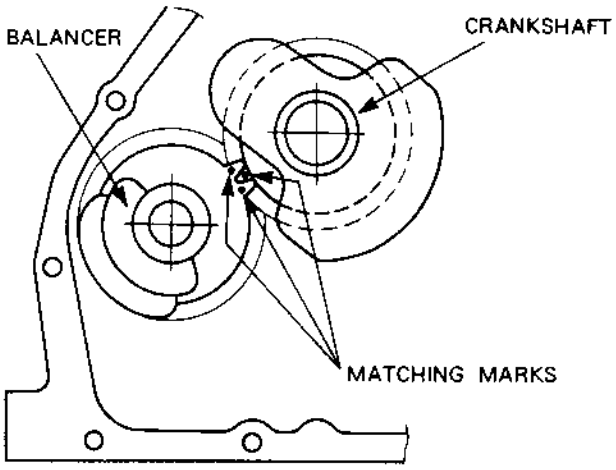


FIG. 47

5-4-5 TAPPET AND CAMSHAFT

(1) Insert the tappets into the tappet holes of the crankcase.

NOTE

Be sure to assemble the intake tappet to intake side and exhaust tappet to exhaust side.

(2) Install the camshaft into the crankcase matching the timing marks on the crank gear and cam gear. (See Fig. 48.)

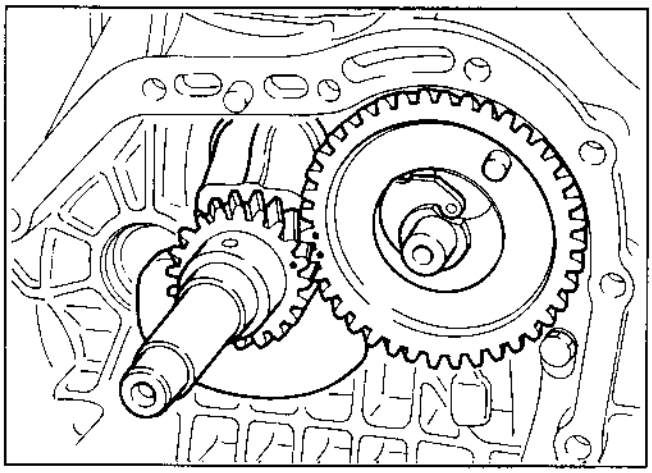


FIG. 48

5-4-6 MAIN BEARING COVER AND GOVERNOR GEAR

(1) Installation of governor gear shaft set.

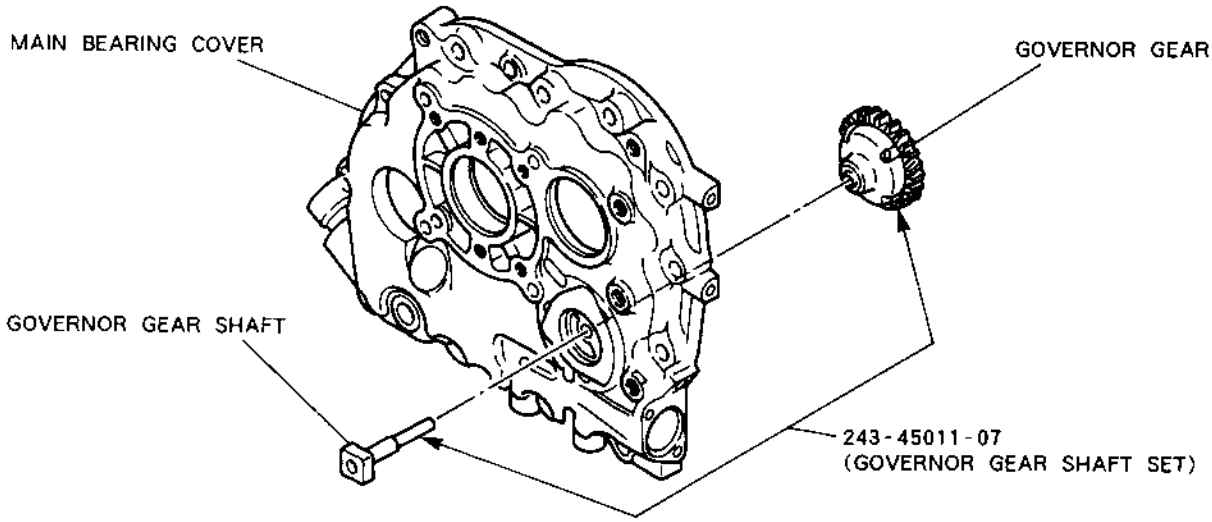


FIG. 49

a) Insert GOVERNOR GEAR SHAFT to the main bearing cover.
b) Put GOVERNOR GEAR on the governor gear shaft.
c) Press the iron sleeve of governor gear using a pressing machine to fit on the governor gear shaft. (See Fig. 50.)
Be sure to make a clearance of 1 mm (0.04 in) between governor gear and mounting boss of main bearing cover. (See Fig. 51.)

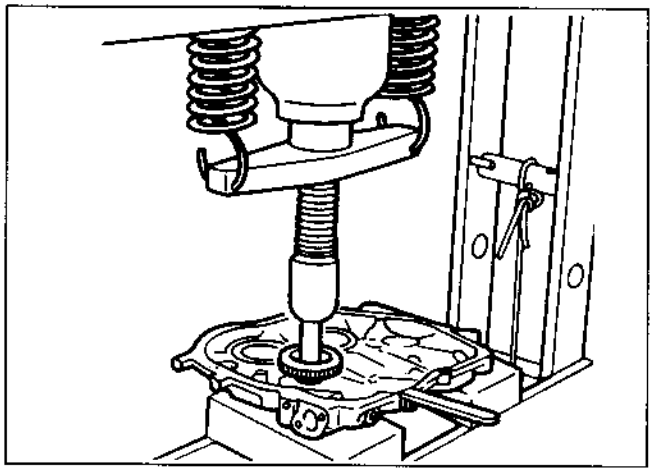


FIG. 50

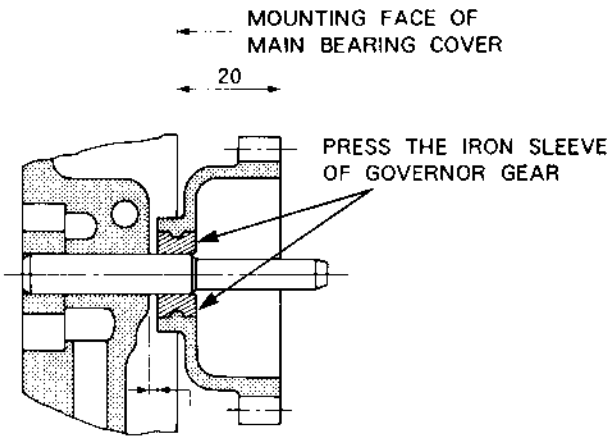


FIG. 51

NOTES

1. **When replacing the governor gear or governor gear shaft, be sure to replace them at the same time.**
2. **Do not press the plastic part of governor gear at assembling.**

(2) Install the main bearing cover to the crankcase.
Adjust the side clearance for the crankshaft, camshaft and balancer shaft to the specified values using the proper spacer and thrust washer.

	CRANKSHAFT	CAMSHAFT		BALANCER SHAFT
		D type	B type	
SIDE CLEARANCE	0.1~0.3 mm	0.05~0.25 mm	0.05~0.3 mm	0.05~0.25 mm
ADJUSTING DEVICE	THRUST WASHER T = 0.1 mm T = 0.2 mm T = 0.3 mm	SPACER T = 0.8 mm T = 1.0 mm	SPACER T = 0.6 mm T = 0.8 mm T = 1.2 mm	SPACER T = 0.8 mm T = 1.0 mm T = 1.2 mm

* Take the thickness of GASKET, BEARING COVER into account as 0.35 mm when calcutating the side clearance.

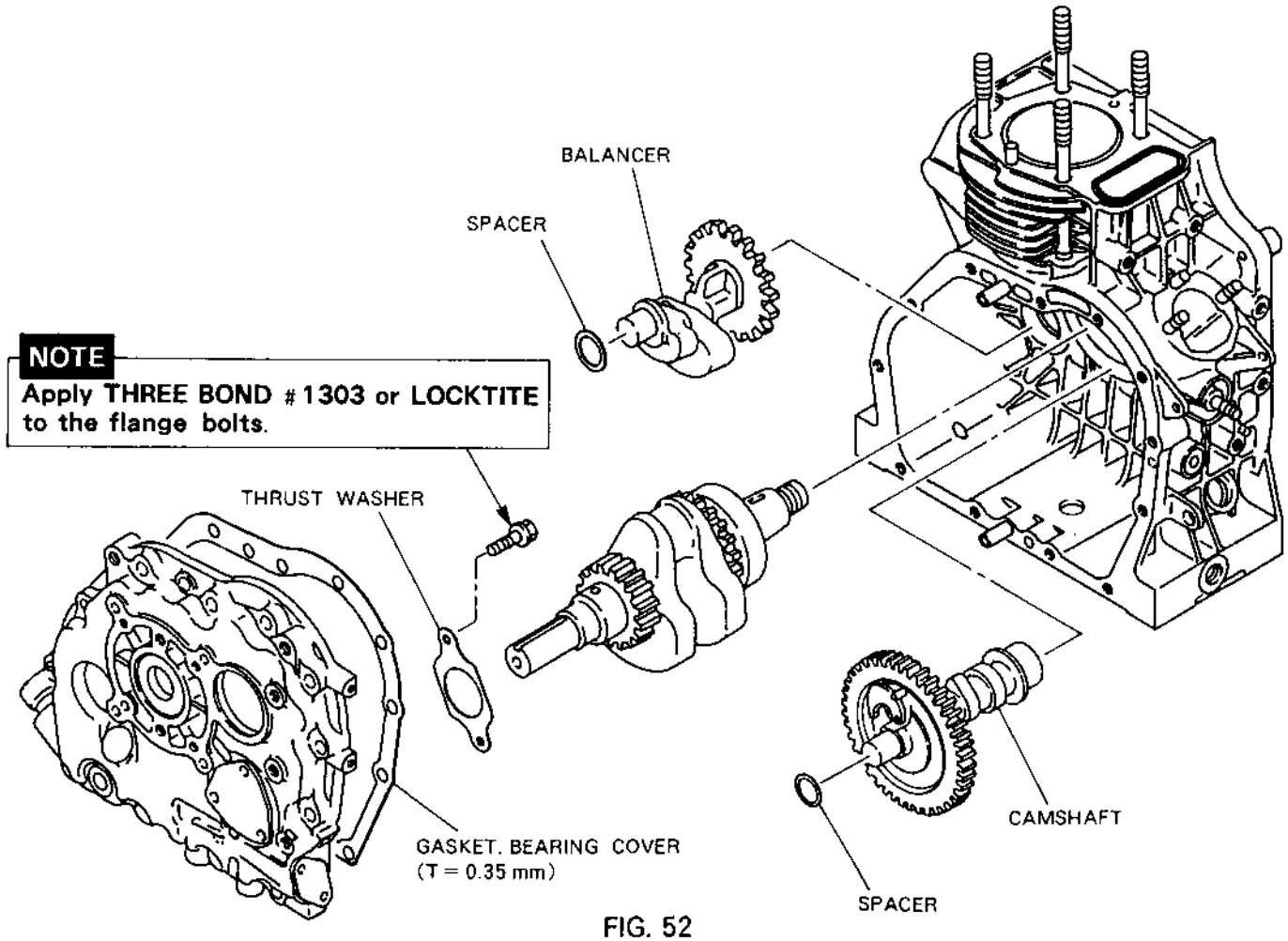


FIG. 52

NOTES

1. **As the governor gear is mounted on the main bearing cover side, install the main bearing cover while checking that it meshes with the teeth of the cam gear. (See Fig. 53.)**
2. **If the replacement of oil seal is necessary, press-fit the new oil seal before installing the main bearing cover.**
3. **Apply oil to the ball bearing and oil seal rip before installing the main bearing cover.**
4. **Be careful not to injure the oil seal rip at reassembly. Use oil seal guide to protect it.**

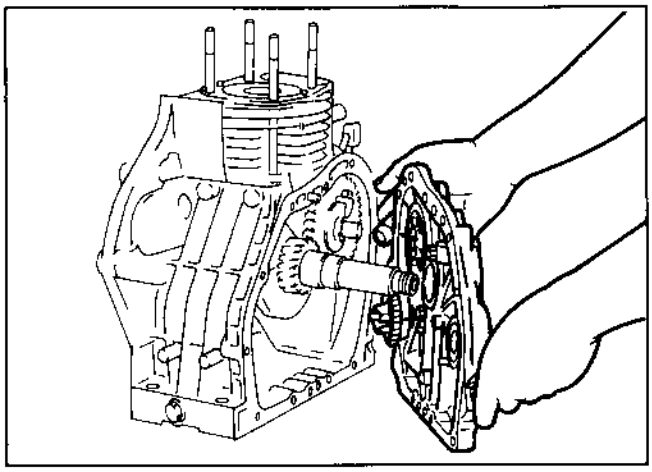


FIG. 53

(3) Tighten the twelve bolts evenly to join the main bearing cover to the crankcase.

8 ϕ × 35 mm bolt and washer assy. ····· 11pcs.

8 ϕ × 40 mm bolt and washer assy. ····· 1pce.

Tightening torque : 170~190 kg-cm

NOTE

Attach the two clamps to the main bearing cover for electric start model.

5-4-7 FLYWHEEL AND STARTING PULLEY

(1) Put the woodruff key (for magneto) in place.

(2) Wipe off oil and grease thoroughly from the tapered portion of the crankshaft and flywheel center hole.

(3) 〈 ELECTRIC START MODEL 〉
Install the charge coil to the crankcase.

(4) Install the flywheel to the crankshaft.
Tighten the flywheel nut with a spring washer.

Tightening torque : 600~650 kg-cm

(5) Attach the starting pulley to the flywheel.

6 ϕ × 12mm bolt and washer assy. ····· 3pcs.

Tightening torque : 70~90 kg-cm

5-4-8 FUEL INJECTION PUMP

(1) Measure the distance between the face of the cam base and the pump mounting face of the crankcase. (See Fig. 54.)
Select the gasket (injection pump) of the proper thickness so as the distance to be adjusted to 66 ± 0.05mm.
The gasket (injection pump) of three different thickness are available.
(T = 0.1 mm, T = 0.2 mm and T = 0.3 mm)

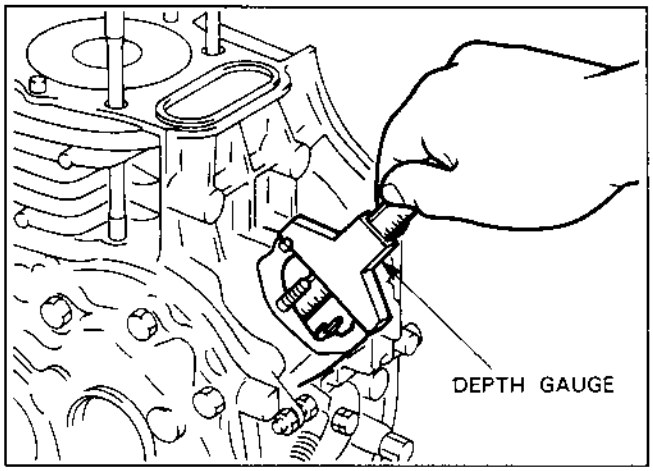


FIG. 54

(2) Apply sealant (THREE BOND 1215) to the both side of the gasket (injection pump).

(3) Install the fuel injection pump to the crankcase checking the control rack of the injection pump to engage with the governor lever correctly. (See Fig. 55.)

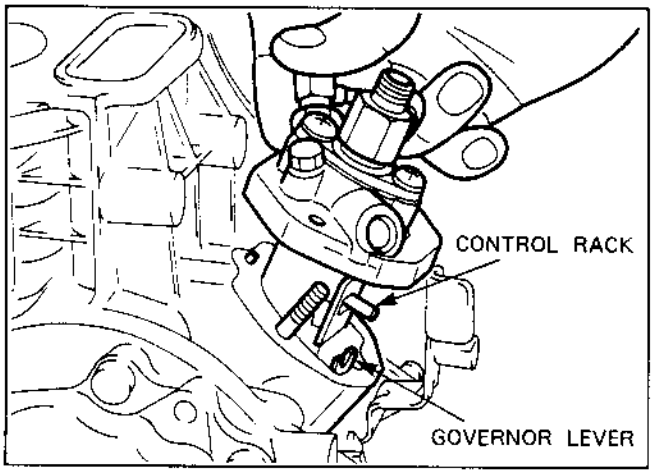


FIG. 55

5-4-9 CYLINDER HEAD

(1) Assemble the intake valve and exhaust valve to the cylinder head.

a) Remove carbon deposits from valves, valve seats, intake and exhaust ports, and valve guides.

b) If the valve face is worn out, replace it with a new one.

c) Check the stem seal in the intake valve guide for a damage.
If the rip of the stem seal is injured, replace it with a new one.

d) Insert the intake valve and the exhaust valve into the valve guide.

e) Assemble the valve springs, spring retainers and the retainer locks.

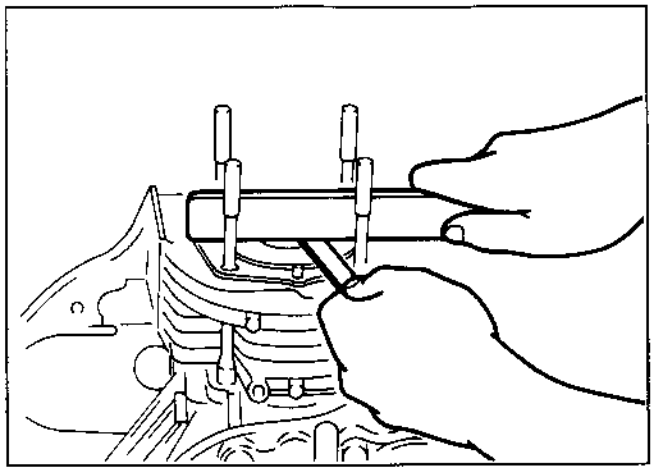


FIG. 56

(2) Check the clearance between the piston top and the cylinder top.
(See Fig. 56.)
Select the proper SPACER (head) so as the clearance to be within 0.6~0.7 mm.
SPACER (head) of two different thickness (T = 0.6 mm and 0.7 mm) are available. (See Fig. 56.)

(3) Put the cylinder head on the cylinder.

(4) Apply sealant (THREE BOND 1215) to the two studs on the rocker shaft side. Apply oil to the other two studs. (See Fig. 57.)

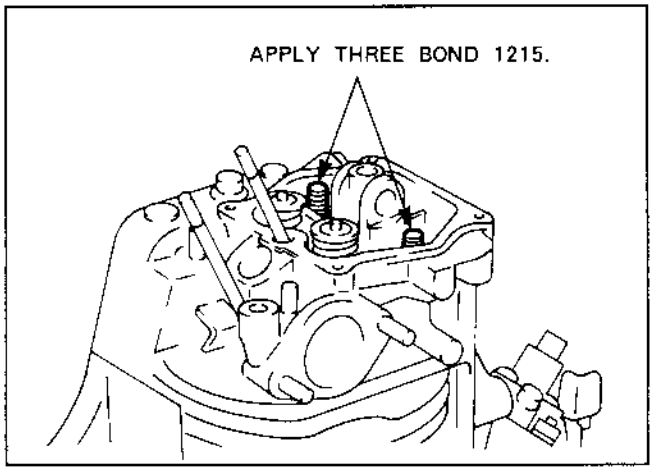


FIG. 57

(5) Tighten the four flange nuts evenly in three steps by the following tightening torque.

1st step ····· 100 kg-cm
2nd step ····· 200 kg-cm
3rd step ····· 300~330 kg-cm

5-4-10 ROCKER ARMS

(1) Insert the push rods into the tappets in the crankcase.

(2) Apply oil to the rocker arms and install them to the cylinder head using the rocker shaft. Attach the snap rings to the both ends of the rocker shaft.

5-4-11 VALVE CLEARANCE ADJUSTMENT

(1) Set the crankshaft to the top dead center by matching the mark "T" of the flywheel with the "TOP" mark of the crankcase.

(2) Loosen the lock nut on the rocker arm and turn the adjusting screw to adjust the clearance between the rocker arm and valve stem end to 0.1 mm. (both intake and exhaust)
Then, tighten the lock nut.

NOTE

Adjust the valve clearance while the engine is cold.

(3) Turn the flywheel by hand and check the valves move smoothly without hitting piston.

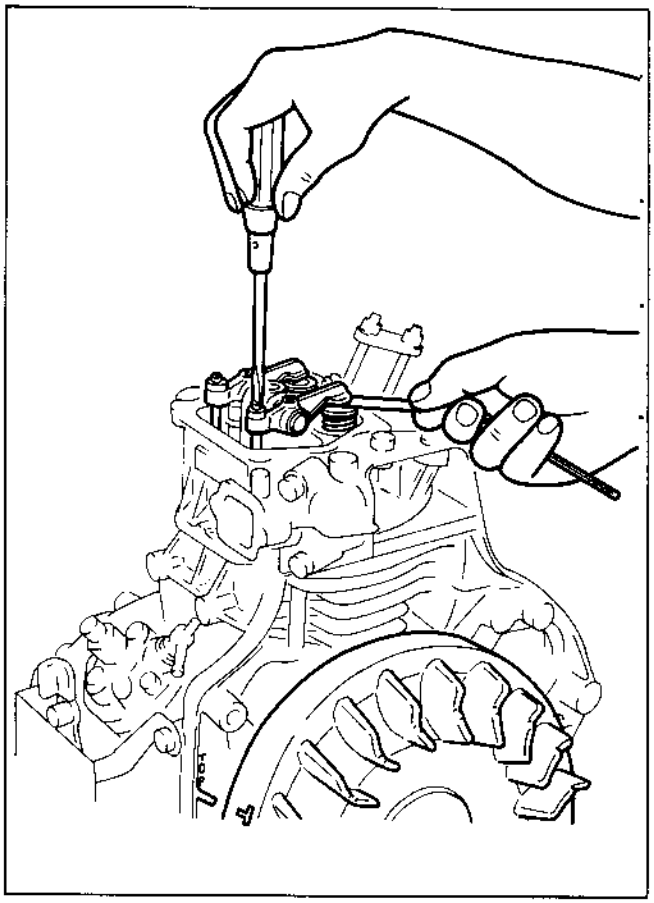


FIG. 58

● INTAKE, EXHAUST VALVE TIMING

The valve clearance shall increase to 0.4 mm while engine is running hot.
In this condition, the valve timing is as follows :

Intake valve opens at 16° before TDC.
Intake valve closes at 54° after BDC.
Exhaust valve opens at 54° before BDC.
Exhaust valve closes at 14° after TDC.

(4) Apply sealant (THREE BOND 1215) to the joining surface of the rocker cover.

(5) Install the rocker cover and the gasket (rocker cover) to the cylinder head.

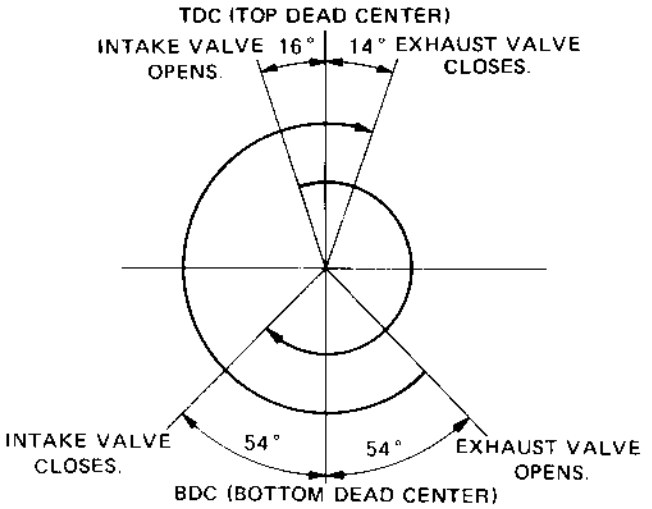


FIG. 59

5-4-12 FUEL INJECTION NOZZLE

(1) Insert the nozzle assembly into the cylinder head attaching the gasket (nozzle) to the nozzle tip.

(2) Attach the fuel return pipe to the injection nozzle.

(3) Attach the BRACKET (nozzle 2) and BRACKET (nozzle 1), and tighten the two nuts with spring washers tentatively.

(4) Attach the fuel injection pipe to the injection nozzle and the injection pump. Tighten the lock nuts tentatively.

(5) Tighten the two nuts on the BRACKET (nozzle 1).
Tightening torque : 50~60 kg-cm

(6) Tighten the lock nuts on both ends of the injection pipe.

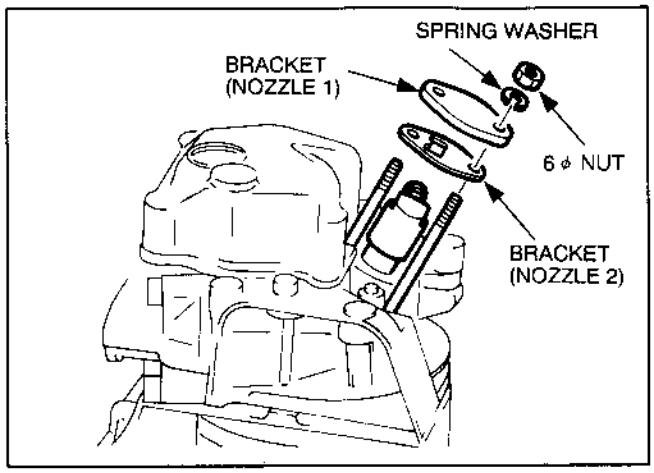


FIG. 60

5-4-13 CYLINDER BAFFLE AND BLOWER HOUSING

(1) Attach the cylinder baffle to the cylinder.

(2) Attach the blower housing to the crankcase.
Tighten the upper two bolts tentatively because these bolts shall be used for mounting fuel tank afterwards.

5-4-14 MUFFLER

(1) Attach the muffler cover to the muffler.

(2) Attach the muffler and the gasket (muffler) to the cylinder head.
Tighten the bolt and nuts tentatively.

5-4-15 FUEL TANK

(1) Attach the fuel pipes to the fuel tank.

(2) Install the fuel tank to the engine.
Tighten the bolts and nuts for joining the blower housing and the muffler to the cylinder head at this step.

5-4-16 FUEL PIPES

(1) Attach the fuel filter to the blower housing.

(2) Attach the fuel pipes between the fuel tank, fuel filter, injection pump and the injection nozzle.
Clamp the each end of rubber pipes using the proper hose clamps.

5-4-17 AIR CLEANER

(1) Attach the cleaner body to the intake manifold.

(2) Attach the elements to the cleaner body.

(3) Attach the cleaner cover to the cleaner body.

5-4-18 RECOIL STARTER

Install the recoil starter to the blower housing.

6 ϕ × 10 mm flange bolt ····· 4 pcs.

CAUTION

Do not use the bolt longer than 10 mm or the flywheel fan may be damaged.

5-4-19 OIL FILTER

(1) Clean the oil filter and check if its mesh is not broken.

(2) Insert the oil filter with the O-ring into the main bearing cover.
Tighten the two flange bolts.

5-4-20 ENGINE OIL

Fill the crankcase with oil to the upper level of the oil gauge.

NOTE

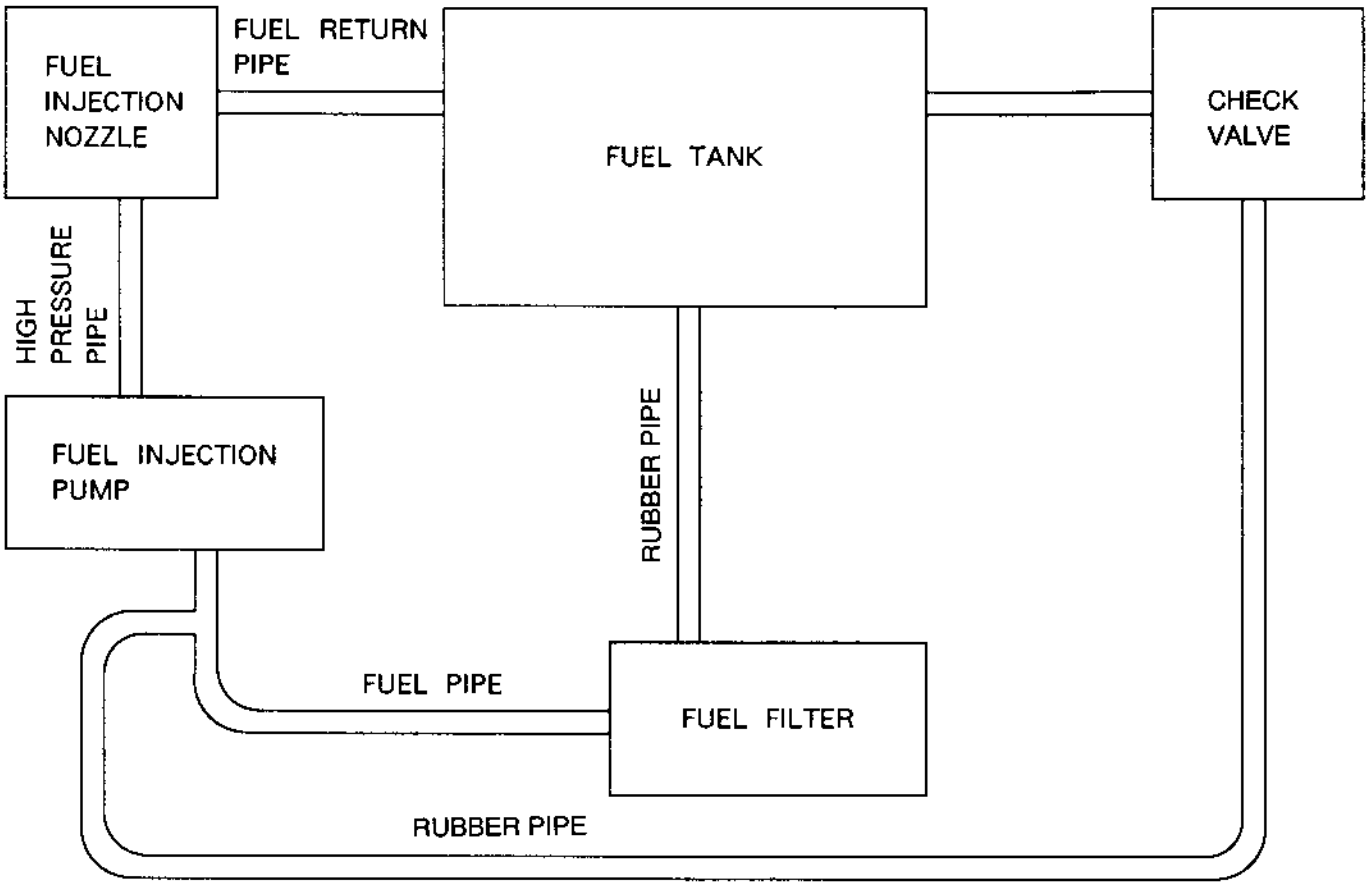
Be sure to use the diesel engine oil of proper grade.
Neve use the gasoline engine oil or the engine may be seriously damaged.

6. GENERAL DESCRIPTION OF FUEL SYSTEM, GOVERNOR SYSTEM, LUBRICATION SYSTEM AND AUTOMATIC DECOMPRESSION

6-1 FUEL

As DY23-2 and DY27-2 are the high speed type diesel engine, be sure to use the fuel of good quality automotive diesel fuel.

● FUEL SYSTEM



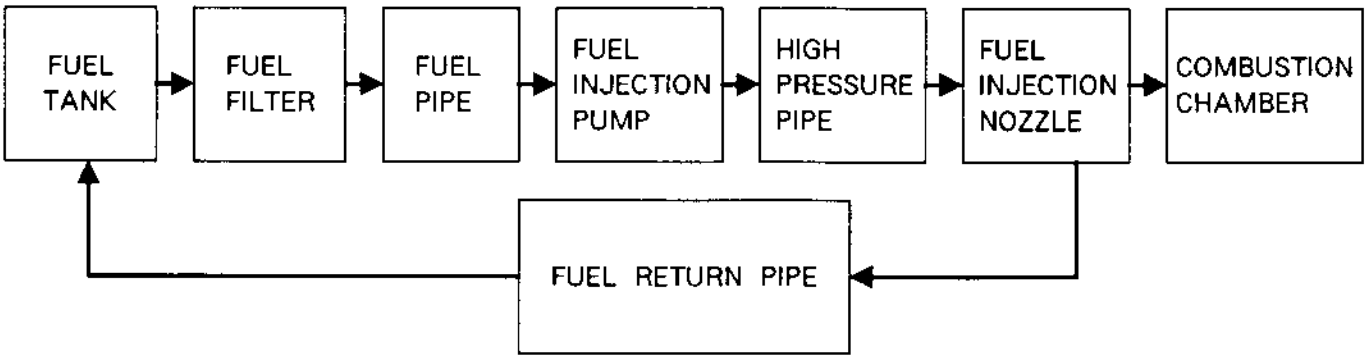


FIG. 61

6-2 FUEL INJECTION PUMP

● FUEL INJECTION PUMP MECHANISM

It is not too much to say that the fuel injection pump is the heart of the diesel engine, and it must be precise enough to satisfy the following functions.

6-2-1 FUNCTION

(1) Injecting fuel, starting with high pressure and ending with low pressure.
(2) Injecting the predetermined amount of fuel accurately at each stroke.
(3) Injecting fuel at specified time within a specified time interval.
(4) Quantity being injected is closely varied by the governor to suit to varying load.
(5) This engine has no automatic advancing device, but in starting (max. delivery), the injection timing is to be delayed.

6-2-2 THEORY OF THE INJECTION PUMP MECHANISM

The plunger of the injection pump is pushed up by the cam of the camshaft, and it is pushed down by the plunger spring. By this up and down motion in a stroke, suction and forced supply of fuel are conducted. (See Fig. 62.)

(1) SUCTION OF FUEL

Through the filter in the fuel tank, fuel is supplied and is in full around the intake port of the plunger barrel. When the top of the cam lobe passed the tappet and cam function ended, plunger spring pushes down the plunger. When the plunger is pushed down passing the fuel intake, fuel is sucked into the barrel, and suction is continued until arrival of the plunger at the bottom of its stroke. This is on the stage of "suction."

(2) FORCED SUPPLY OF FUEL

The camshaft rotates and pushes up the plunger. Forced supply of the fuel is started only when the upper part of the plunger closed the fuel intake in the course of being pushed up by the cam rotation. The fuel in the barrel is pressurized by a very strong force (100 kg/cm² and up), and as a result, the force of the fuel pushes up the delivery valve and the damping valve, and then it injects the fuel into combustion chamber. This is on the stage of "pressurized supply."

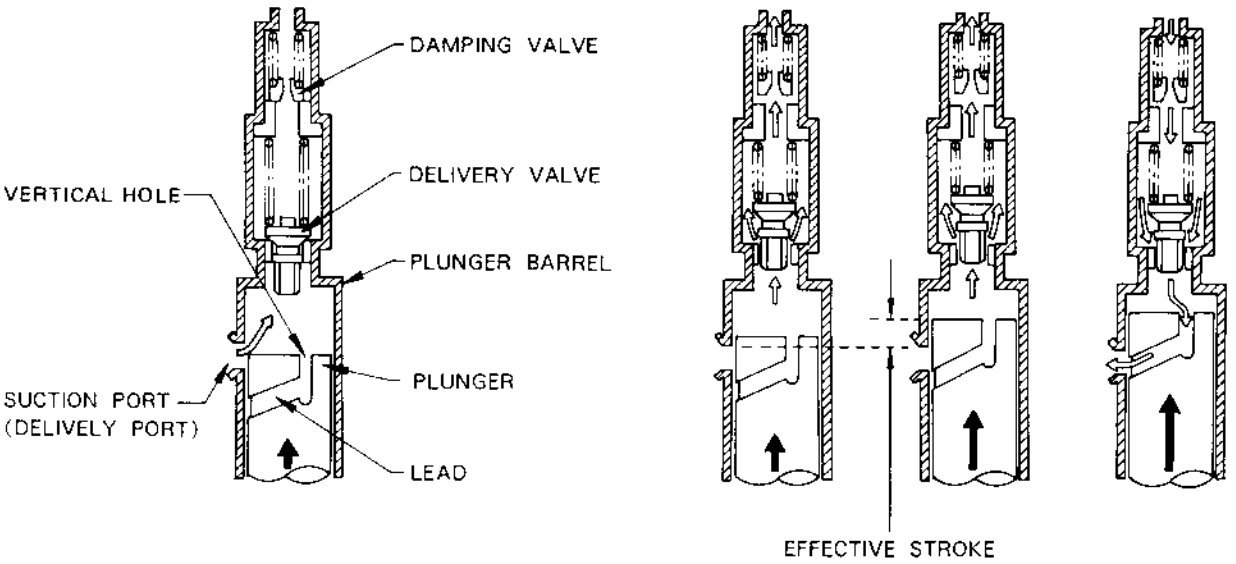


FIG. 62

6-2-3 VARIATION IN QUANTITY OF FUEL TO BE INJECTED

The quantity of fuel injected varies according to the condition of the engine, i. e. high speed or low speed operation and loaded or unloaded operation. (See Figs. 63 and 64.)
The plunger lead is engraved on the surface of plunger in an inclined curve. By rotating the plunger, the distance between the upper part of the plunger and the suction port is varied. (Variation in effective stroke)
Rotation of the plunger is made by the control rack. When this control rack is shifted to left and/or right, the geared pinion rotates, which is connected to the plunger by means of the control sleeve. In other words, the plunger turns as much amount as the rack rotates. Accordingly, the effective stroke varies coincident with the position where the rack is set.

(1) RELATION BETWEEN THE PLUNGER AND THE BARREL

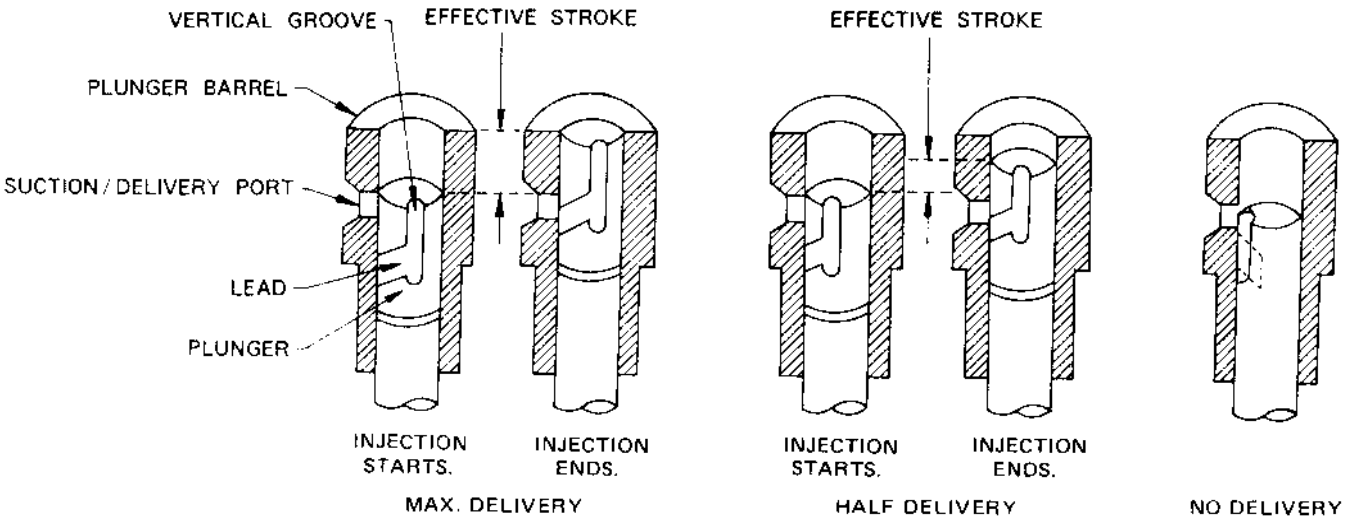


FIG. 63

(2) RELATION BETWEEN THE PLUNGER AND THE RACK

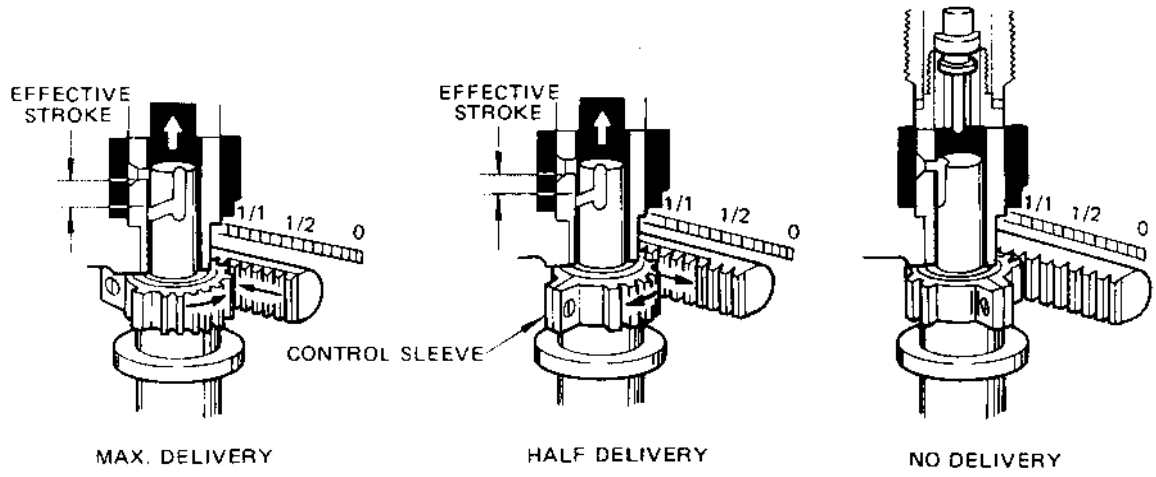


FIG. 64

6-2-4 INJECTION TIMING AND EFFECTIVE STARTING

When the plunger closes suction port of the barrel, forced delivery of fuel starts. But fuel is not injected from the nozzle at once because of contraction of fuel, etc.

Injection timing of this engine is fixed constant (23° before TDC) irrespective of engine rpm. On the other hand, in starting, a proper delay from the timing for high speed running and increased fuel injection is indispensable for effective starting. For this purpose a notch is made at the plunger head, which reserves to delay the injection timing by nearly 8° to facilitate starting. (See Fig. 65.)

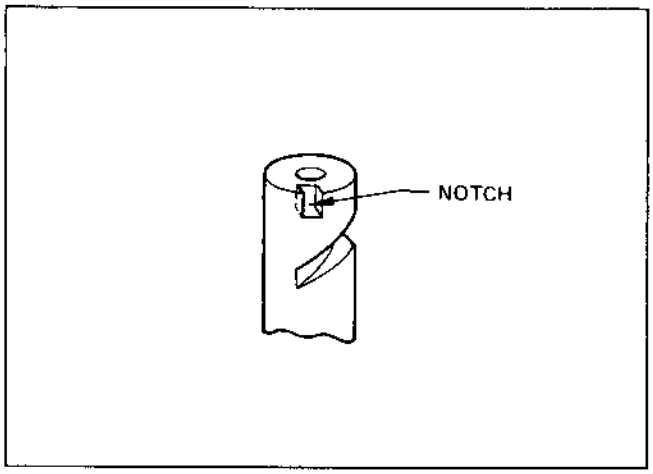


FIG. 65

6-2-5 FUNCTION OF THE DELIVERY VALVE

By the plunger stroke, fuel pressure is raised. And when it becomes higher than the pressure remained in the high pressure pipe, the delivery valve spring is pushed down and the valve opens. As the result, the fuel in the high pressure pipe is delivered forcibly. When the plunger lead meets suction port of the plunger barrel, delivery of fuel ends, and the delivery valve is closed by the spring tension of the valve. At this time, delivery valve prevents reverse flow of the fuel. Also suction back motion around the upper part of the plunger sucks back the fuel in the equal amount of the stroke [A] and decreases remaining pressure in the high pressure pipe. The nozzle jets the fuel clearly off and prevents after dripping. (See Fig. 66.)

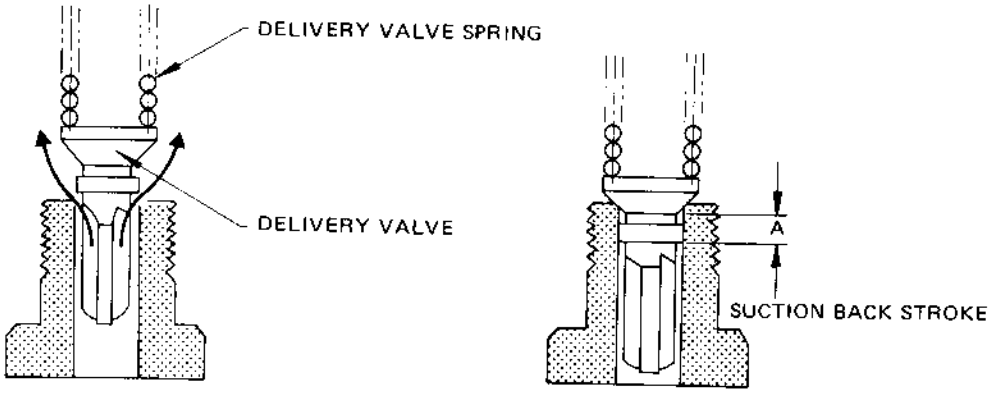


FIG. 66

6-2-6 FUNCTION OF THE DAMPING VALVE

The damping valve is assembled in the end of injection pump and it reaches the seat before arrival of delivery valve at the seat. The small orifice in the valve is the passage of fuel to the chamber in the delivery valve holder. Accordingly, descending velocity of the delivery valve is decreased, which prevents the negative pressure being produced suddenly.
As a result, proper injection is conducted and the engine noise is decreased.
(See Fig. 67.)

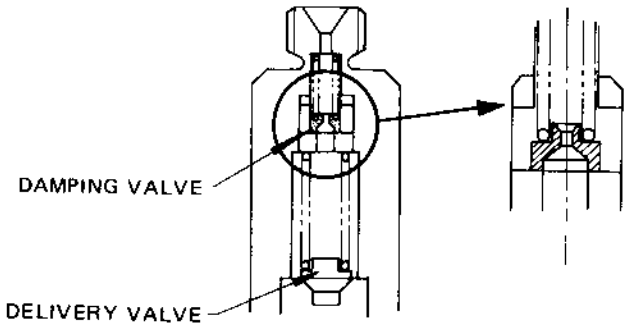


FIG. 67

● FUEL INJECTION PUMP

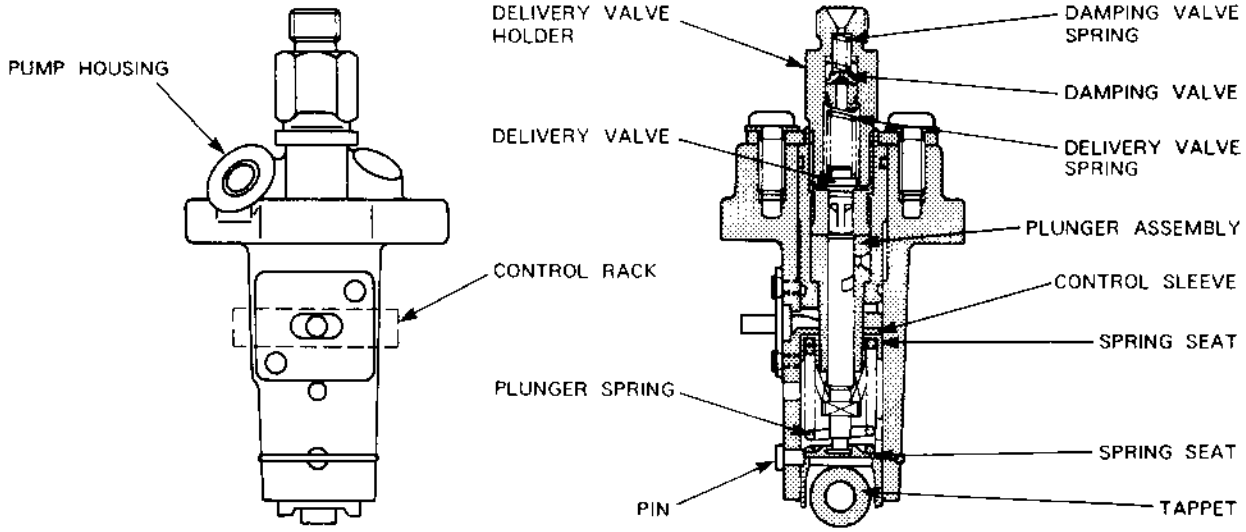


FIG. 68

● SPECIFICATIONS OF FUEL INJECTION PUMP FOR THIS DIESEL ENGINE

Model	PFRIMD55 / 2NP1
Maker	ZEXEL
Plunger diameter	5.5 mm
Lift	6 mm
Lead	Right hand twist
Plunger spring arbitrary	2.21 kg / mm
Delivery valve opening pressure	Approx 15 kg / cm²
Delivery valve spring constant	1.1 kg / mm
Rack stroke	10 mm

6-3 FUEL INJECTION NOZZLE

6-3-1 SPECIFICATIONS

Part Name	NOZZLE ASSEMBLY
Type No.	DLLA150PN52
No. of nozzle hole (Diameter)	4 (0.22 mm)
Valve opening pressure	195 kg/cm²
Spring constant	13.2 kg/mm

6-3-2 FEATURES

Both the injection nozzle and the injection pump are very important parts for producing fuel mist for combustion. There are two types of injection nozzle, one is hole type and the other is pintle type.
The injection nozzle for DY23 and DY27 Diesel engines is developed as a result of joint research and development project by Diesel Kiki and our company, and it is direct combustion system, having the special hole type nozzle.
For producing better air-fuel mixture, it utilizes swirl and squish flows and deliver the fuel mist most effectively, injection pressure is raised up to 195 kg/cm².

6-3-3 STRUCTURE OF THE INJECTION NOZZLE ASSEMBLY

The injection nozzle assembly consists of nozzle holder and nozzle. The nozzle holder fixes the nozzle to the cylinder head and at the same time it plays the role of fuel passage to the nozzle.

The nozzle consists of the nozzle body and needle valve.
When the fuel pressure reaches up to the valve opening pressure, the needle valve is raised up and the fuel is injected through the small holes at the tip of the nozzle body.

- The valve opening pressure is adjustable by changing the adjusting washers.

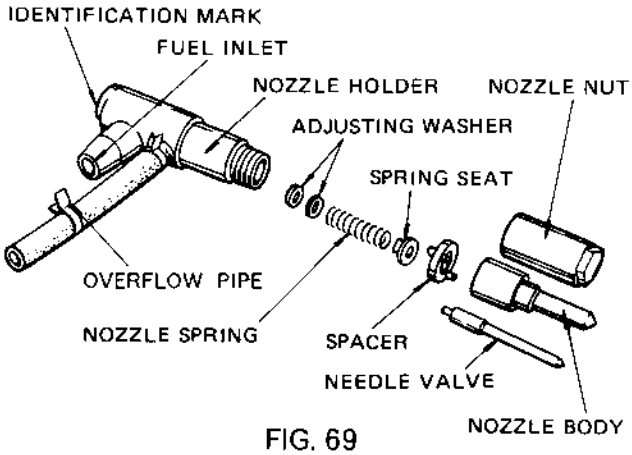


FIG. 69

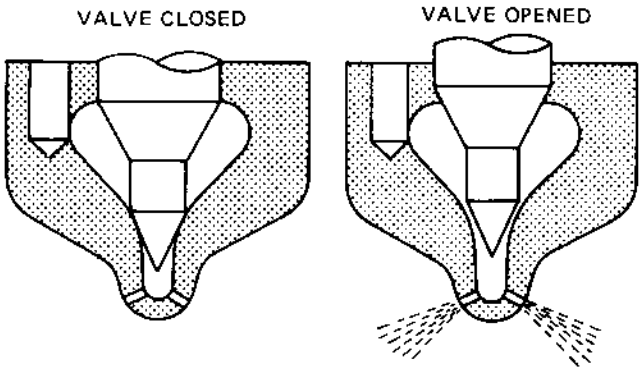


FIG. 70

6-3-4 FUEL PASSAGE

From the plunger pump fuel is sent through the high pressure pipe 1 to the fuel passage 2. Then, at the nozzle body 3, it is pressurized up till 195 kg/cm² and it lifts up the needle valve 4 for 0.18 mm, and is injected into the combustion chamber via the jet hole 5.
An excess fuel which lubricated the inside of the nozzle and nozzle holder returns to the fuel tank via the needle valve→ nozzle spring 6→overflow pipe 7→fuel tank.(See Fig. 71.)

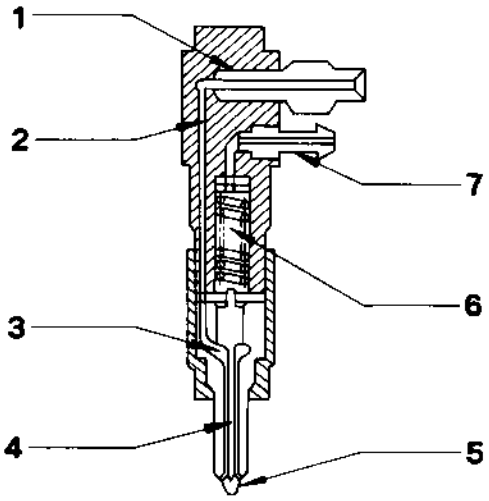


FIG. 71

6-3-5 INSPECTION AND MAINTENANCE

Fuel injecting condition of the nozzle and the valve opening pressure are quite influential to the engine operation, insufficient output, increase of noise and exhaust smoke. Use of improper fuel or contaminated fuel is one of the main causes of the nozzle trouble. Therefore, exert good care for using good fuel. As the nozzle is assembled from very precisely finished parts, utmost care and attention must be paid when inspecting and checking.

(1) INSPECTION

After cleaning nozzle holder outside, inspect in the following steps :

a) Visual inspection
- Whether or not injection hole is damaged, or clogged with carbon.
- Whether or not injection hole is clogged with dust and carbon.

b) Checking by nozzle tester
- Fit the nozzle assy to the nozzle tester.

CAUTION

When removing the nozzle from the engine or fitting it to tester, be sure to keep the nozzle free of dust.

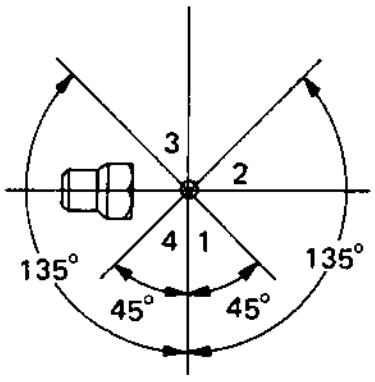


FIG. 72

- Move the lever of the nozzle tester up and down for 2~3 times and suck the air inside the nozzle.

CAUTION

Never bring your face near the injected fuel mist from the nozzle. Also keep away your hands from the mist.

●Gently push down the lever of the nozzle tester and read the pressure gauge just before the fuel being injected. If the figure coincides with the standard value, the nozzle is in a good condition.
●Push further and check whether or not the fuel mist is injected straight.

CAUTION

Good injection is straight forward. Just after injection, check "after dripping."

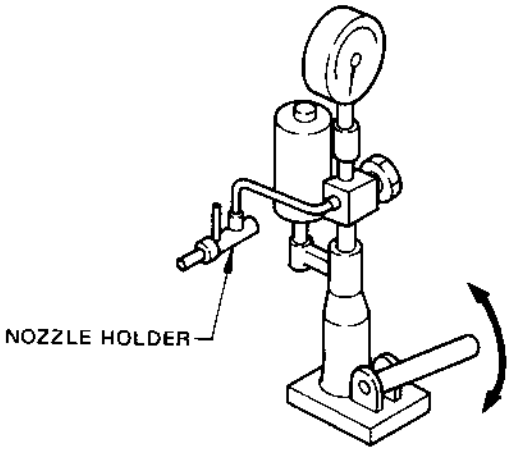


FIG. 73

(2) MAINTENANCE

If the test results are found not good (poor injection and "after dripping"), carefully check and repair in the following procedure :

a) Disassemble the nozzle holder and nozzle, and wash in clean light oil.
When washing, use a wooden chip (for instance, wooden toothpick is serviceable.) for peeling off the carbon adhered to the nozzle.

b) After washing, pull out the needle halfway from the body of nozzle with your fingers and then let it go. And check if the needle sinks by its own dead weight.

c) If it does not sink, replace it in the form of a set.

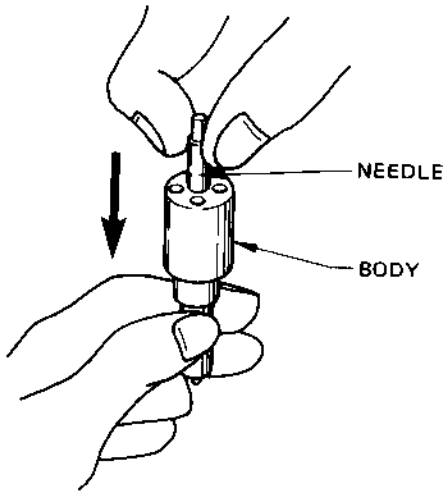


FIG. 74

d) Frinction surfaces of both the needle and nozzle body are ultra precise finish. So, be sure to keep the parts free of dust.

e) If "after dripping" is found, it is poor contact between the needle valve and the seat. In such a case, it is advisable to replace it in the form of a set, needle valve and nozzle body. However, it is possible to coat chrome oxide on the tapered surface of the needle and get a good contact. Wash very carefully after correction.

f) The spacer is an important part to set positions of the nozzle holder and the nozzle body. Pay attention to the position of the pin.

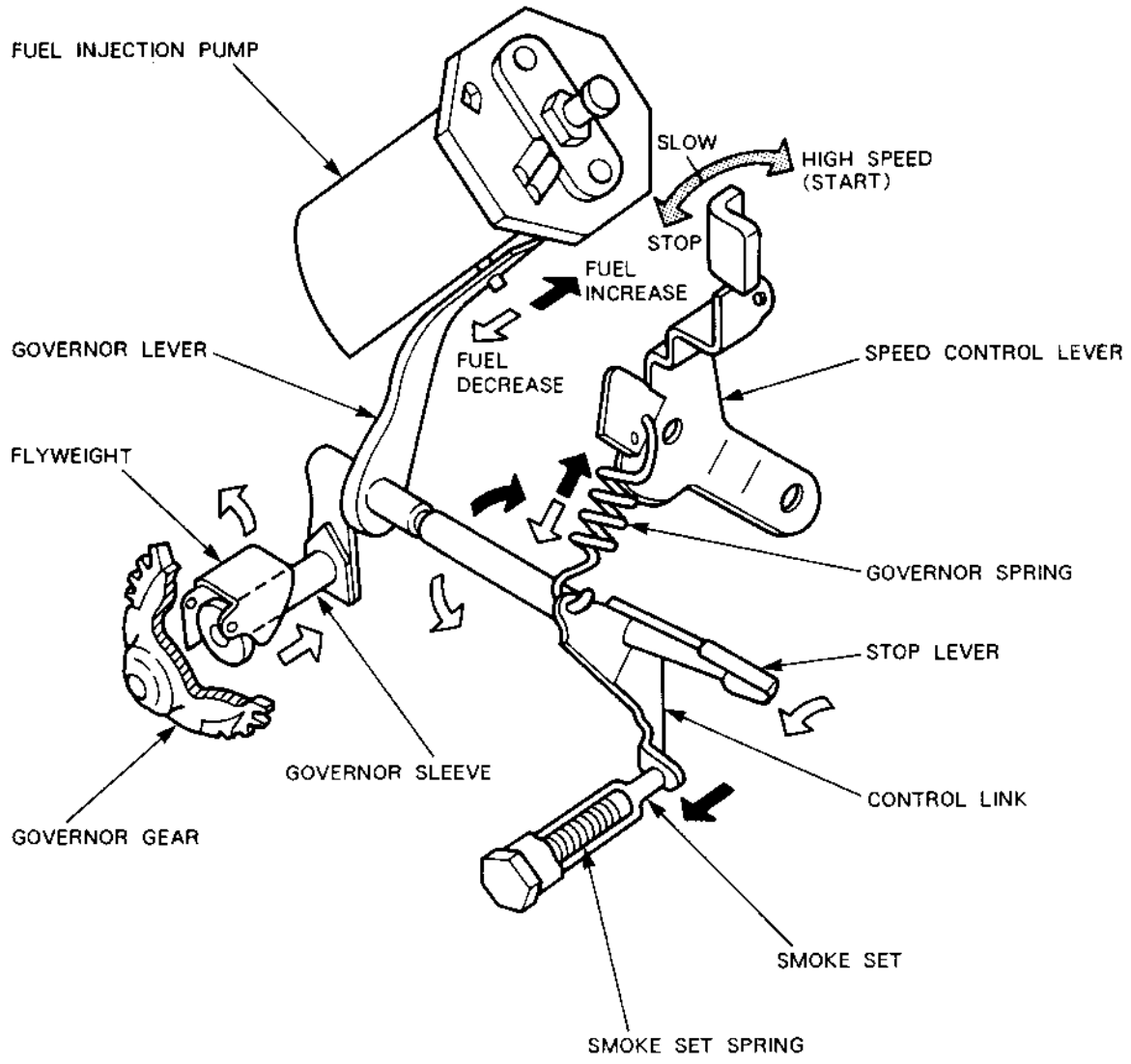
g) When fitting the nozzle body to the nozzle holder, conform to the specified tightening toruqe.
Tightening torque : 300~400 kg-cm

h) Recheck with the nozzle tester. If the adjustment of valve opening pressure is necessary, adjust it to 200~210 kg/c㎡.
The valve opening pressure shall decrease to 195 kg/c㎡ after the running in.

6-4 GOVERNOR MECHANISM AND OPERATION

6-4-1 MECHANISM

The governor is centrifugal flyweight type, which means a flyweight is fitted to the governor gear. The governor sleeve is assembled so that it may slide toward the direction of the axis of the pump shaft, and it is in contact with the flyweight. The governor sleeve gets in touch with the governor yoke, and through the governor lever it makes the control rack of injection pump operate. This mechanism enables to maintain constant operation irrespective of load variation.



Operation when load is applied or starting. ➡
Operation when load is decreased or removed. ⇨

FIG. 75

6-4-2 OPERATION

1. STARTING

When the speed control lever is set to the high speed (start) position, the governor lever is pulled by the governor spring through the control link. The control link compress the smoke set spring at the same time to allow the injection pump to deliver extra fuel for starting.

2. OPERATION UNDER LOAD

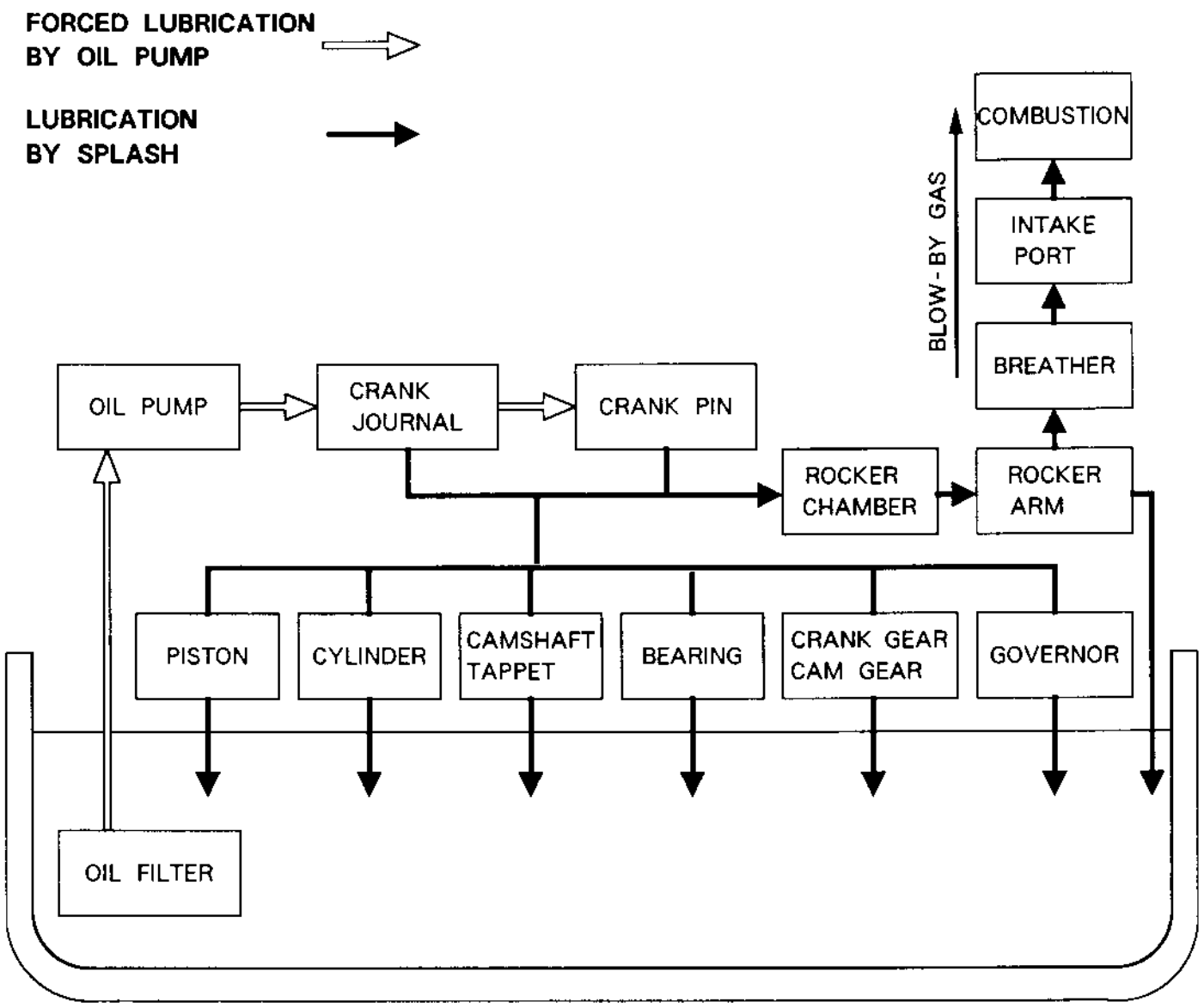
When the engine starts up, the flyweights expand by the centrifugal force pushing the governor sleeve. The governor lever pushed by the governor sleeve moves to push the control rack of the fuel injection pump in the direction of reducing fuel.
Thus, the engine speed rises up to the predetermined level, and maintains this speed where the centrifugal force balances with the tension of the governor spring.
When a load is applied to the engine, the engine reduces its speed for a moment. At this moment, as the centrifugal force at the flyweights is weakened, the governor lever being pulled by the governor spring moves to push the control rack of the fuel injection pump in the direction of increasing fuel. Thus, the engine recovers its speed to the predetermined level. When the load is reduced or removed, the governor system operates exactly in reverse to maintain the engine speed.
When the engine is over-loaded, the control link touches the smoke set. However, the tension of the governor spring is weaker than the combined force of the centrifugal force of the flyweights and the smoke set spring, the governor lever can not move further to increase fuel. Under this condition, the engine speed is reduced and the engine exhausts black smoke.

3. STOPPING

By pushing the stop lever, the governor lever pushes the control rack of the injection pump all the way to "fuel shut off" position to stop the engine.

6-5 LUBRICATION SYSTEM AND OIL PUMP

Forced lubrication system is adopted to DY23 and DY27 engines. The trochoid type oil pump is mounted on the main bearing cover co-axialy with the governor gear and is driven by the cam gear.
The oil in the oil pan is filtered by the oil filter and is forcibly delivered by the oil pump to the crank jounal and then to the crank pin lubricating the main bearing and the large end bearing.
The oil splashes from the crank journal and the crank pin to lubricate cylinder wall, piston, small end, cam shaft and the governor system. The rocker arms, valve system etc. inside of the rocker chamber are lubricated by the oil mist contained in the blow-by gas supplied from crankcase.
The blow-by gas enters into the combustion chamber through the breather valve, and the oil contained in the blow-by gas is finally burnt out.



LUBRICATION SYSTEM

FIG. 76

● OIL FILTER

Oil filter is made of nylon mesh and is reusable after cleaning.

As the oil flows from the inside of the filter to the outside, be sure to clean the inside thoroughly.

Clean the oil filter every time of oil change.

6-6 AUTOMATIC DECOMPRESSION SYSTEM

The decompression system operates to release compression by lifting up the exhaust valve at starting.

The release lever mounted on the camshaft has a flyweight at one end and a crescent cam at the other end. When starting the engine, the crescent cam juts out from the exhaust cam.

The exhaust tappet rides over the crescent cam opening the exhaust valve to release compression.

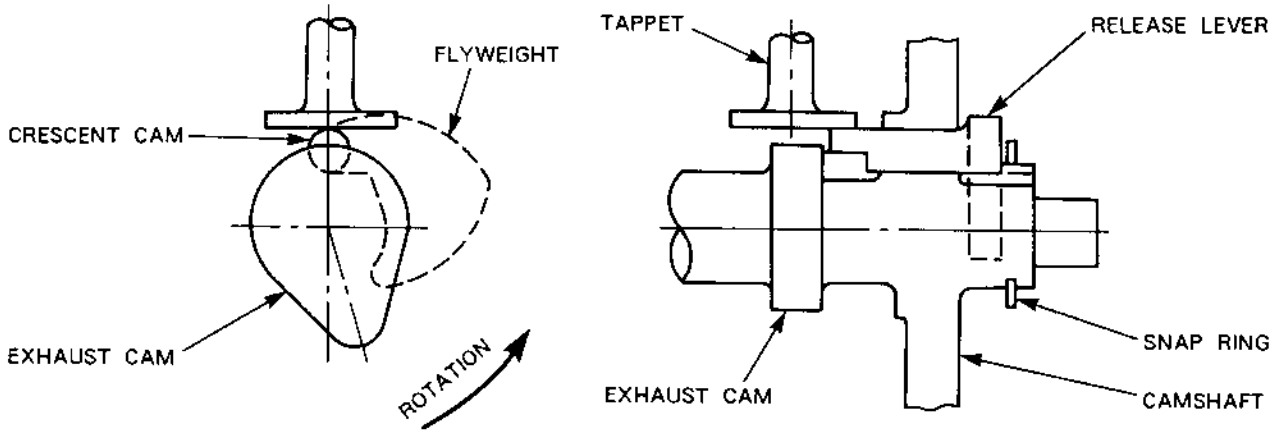


FIG. 77

When the crank speed reaches a certain revolution, the flyweight of the release lever moves outward by the centrifugal force turning the release lever to retract the crescent cam. Thus the exhaust valve closes allowing a sufficient compression for the engine to start up.

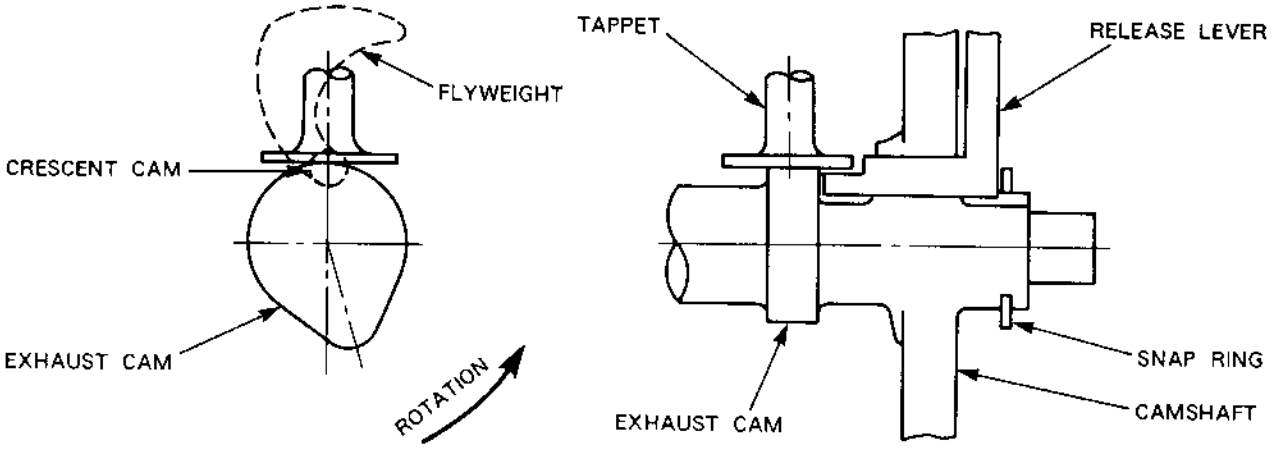


FIG. 78

The components of the decompression system are different by "D" type and "B" type engines, however the principle of operation is the same.

7. STARTING SYSTEM

7-1 RECOIL STARTER

The recoil starter hardly has a trouble in the normal use, however, in case it has a trouble or at the time of lubrication, perform disassembly and reassembly in the following procedures :

Tools to be used : Box spanner (spanner), Cutting pliers (pliers) and Screw driver

NOTE

The following explanation is applicable to the recoil starter for "D" type engines. For "B" type models, reverse the direction of rotation to achieve proper service work.

7-1-1 HOW TO DISASSEMBLE (D Type)

(1) Remove the recoil starter from the engine with a box spanner.

(2) Pull the starting knob and pull out the starter rope for 30 to 40 cm. Firmly press the reel with a thumb as shown in Fig. 79 so that the reel should not make reverse turn at the place where the reel notch comes to the outlet of starter rope. Pull out the starter rope to the inside of recoil starter with a screwdriver.
Then, utilize the reel notch, and rewind it until the rotation stops in the arrowhead direction, braking the reel rotation with a thumb.

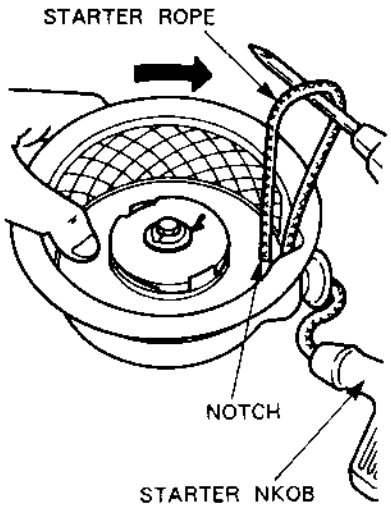


FIG. 79

(3) When removing, take out the parts in the order of the numbering in Fig. 80.

1. "U" type snap ring
2. Thrust washer
3. Friction spring cover
4. Return spring
5. Friction spring
6. Ratchet

Meantime, for removing the "U" type snap ring, nip the shaft with cutting pliers and push it out.

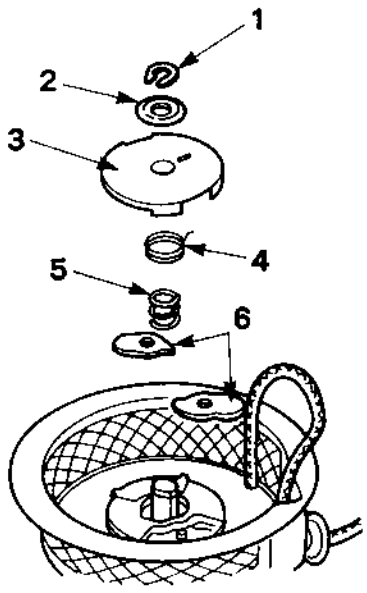


FIG. 80

(4) Take out the reel from starter case as shown in Fig. 81.
In this case, slowly take out it turning the reel lightly toward left and right so that the spring is removed from the reel hook section.
If the reel is suddenly taken out, there is a fear that the spring jumps out in the form as it is hooked, which is very dangerous, so be carefull of it. (If the spring jumped out, house it in the starter case as instructed in Fig. 86.)
Finally, release and take out the starter rope tied to both the reel side and the starting knob side.
Thus, the disassembly work ends.

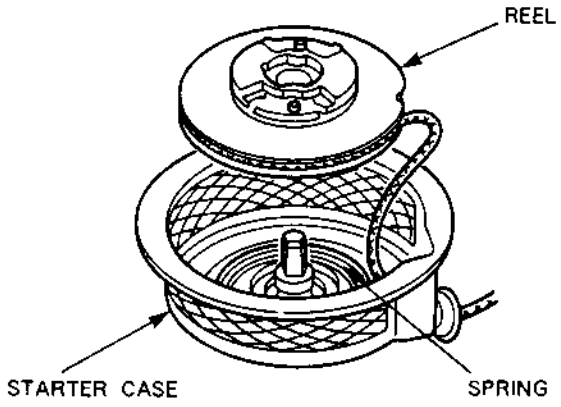


FIG. 81

7-1-2 HOW TO REASSEMBLE (D Type)

(1) First, have the starter rope pass through the starting knob, and tie the rope as shown in Fig. 82 No. 1.
Then, have the opposite side of the rope pass through the starter case and the reel, and tie it as shown in Fig. 82 No. 2. Then surely house the end in the reel. (In the Fig. 82 both the ropes are tied quite lightly, as you see in figures No. 1 and No. 2. Please note this is just for the purpose of easy understanding. Therefore, when actually tying, tie the rope as tightely as possible.

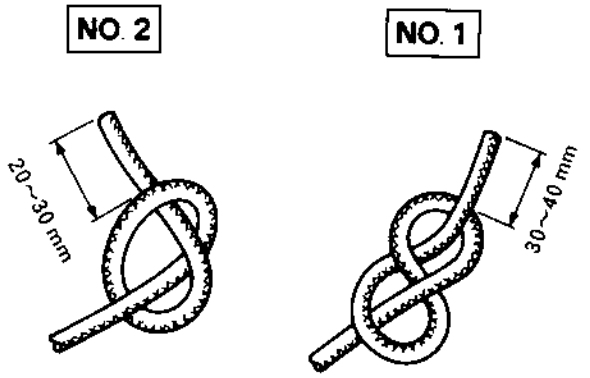


FIG. 82

(2) Confirm that the spring is surely set in the starter case housing section, and have the spring to form so that its inner end will be about 3 mm from the starter shaft and that it hooks surely the reel hook.
Meantime, with the pliers about 10 cm long spring from the inner end can easily be formed.

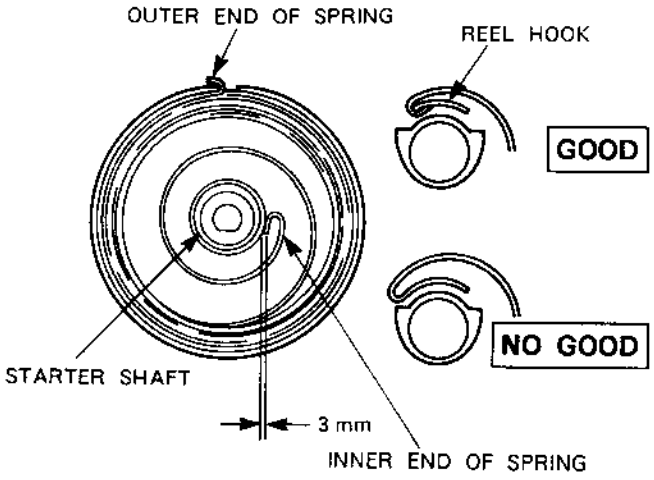


FIG. 83

(3) Before putting the reel in the starter case, wind the starter rope in the arrowhead direction as shown in Fig. 84, and at 2.5 windings take out the rope from the reel notch. Set the reel hook to the inner end of the spring, and put the reel in the starter case. (At this time, confirm that the reel hook is duly set to the spring.)
Then, hold the starter rope as shown in Fig. 84, and turn the reel 4 times in the arrowhead direction. When wound up, firmly press the reel not to allow reverse turn, and pull the starting knob. Then, pull out from the starter case the starter rope utilized for winding, and slowly return the starting knob.

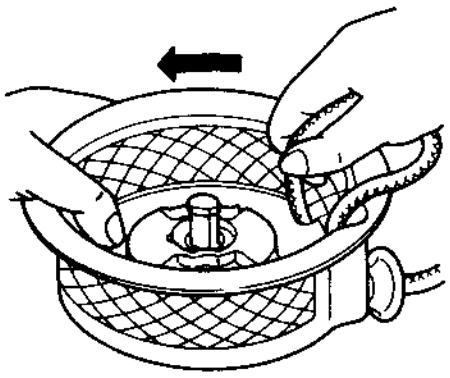


FIG. 84

(4) When reassembling the parts, follow up in the reverse order to Fig. 80. When putting the friction plate in the hole for it, set the return spring a little upward as shown in Fig. 85 so that the friction plate can easily be put in the hole for it.
Next, turn the friction plate in the arrowhead direction till the position where its notch matches with the ratchet. Push firmly the friction plate to the reel side, and put the thrust washer and then clamp it with a "U" type snap ring.
(Use pliers to set the snap ring securely.)

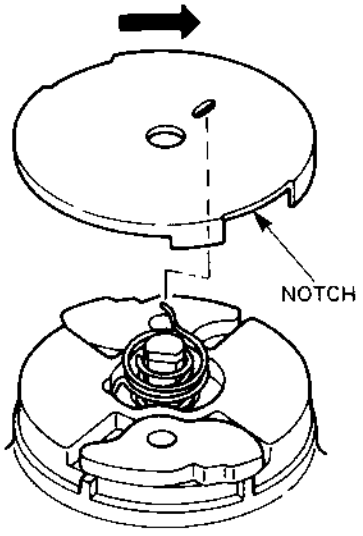


FIG. 85

●This is the end of the disassembly and reassembly procedures.
Test the reassembled recoil starter by the following checking procedures in the next page.

7-1-3 CHECKING PROCEDURES AFTER REASSEMBLY (D Type)

(1) Pull the starting knob 2 or 3 times, and pull out the starter rope a little.

a) If the starting knob is felt heavy to pull or cannot be pulled, check whether all the parts are installed correctly.

b) If the ratchet does not function, check whether the spring is hooked properly.

(2) Pull the starting knob, and pull out the starter rope all the way long.

a) If the starter rope remains left in the reel or the starter rope does not return at all, immoderate strain is imposed on the spring. So rewind the starter rope 1 or 2 times as per instruction in Fig.79.

b) If the return power of the starter rope is weak or the starter rope cannot be fully rewind, inject a few drops of mobile oil in the frictional portions. If it does not recover yet, wind the rope 1 or 2 times.
(In this case, refer to the instructions explained in the paragraph a) above and confirm whether or not immoderate strain is imposed on the spring.)

c) If the sound is heard that the spring is falling off, and the starter rope cannot be wound in relay, reassemble once again from the biginning.

7-1-4 USEFUL REMINDERS

(1) IN CASE THE SPRING JUMPS OUT WHEN DISASSEMBLING

With thin wire make a ring smaller than the case for spring, and hook the outer end of spring on the part of the ring as shown in Fig. 86. Store it in the spring housing section of the reel, and carefully remove the ring, pressing the spring with fingers so as not to come out. The ring can easily be removed by squeezing it with the tip of the screwdriver or the like. Refer to Fig.83 for not to mistake the direction of the spring.

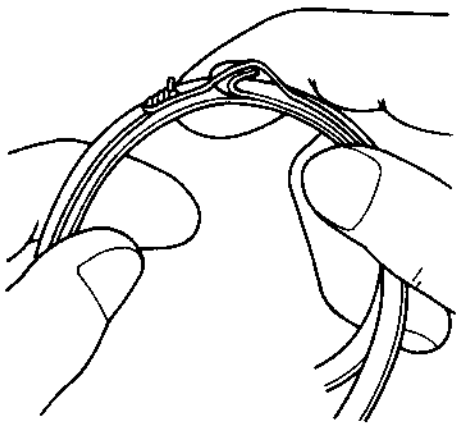


FIG. 86

(2) LUBRICATE RECOIL COMPONENTS

Lubricate the rotating parts, frictional parts and spring with heat resistant grease, or mobile oil at the time of disassembly or at the end of season for use.

7-2 ELECTRIC STARTING MOTOR (OPTIONAL PART)

7-2-1 SPECIFICATIONS

Part Name	Starting Motor
Maker	Nihon Denso K. K.
Voltage	12 V
Output	0.6 kW
Weight	3.0 kg

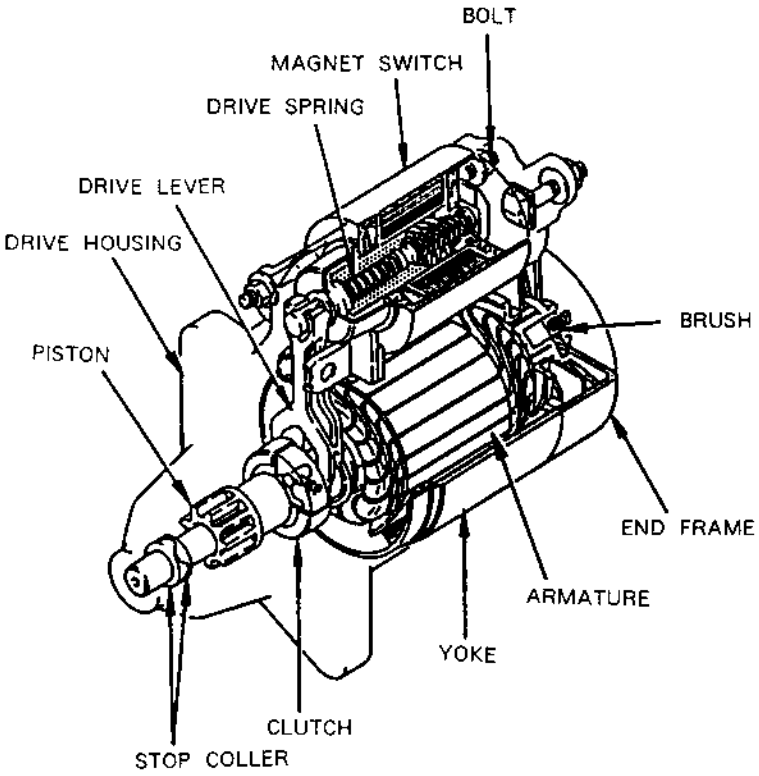


FIG. 87

7-2-2 WIRING DIAGRAM

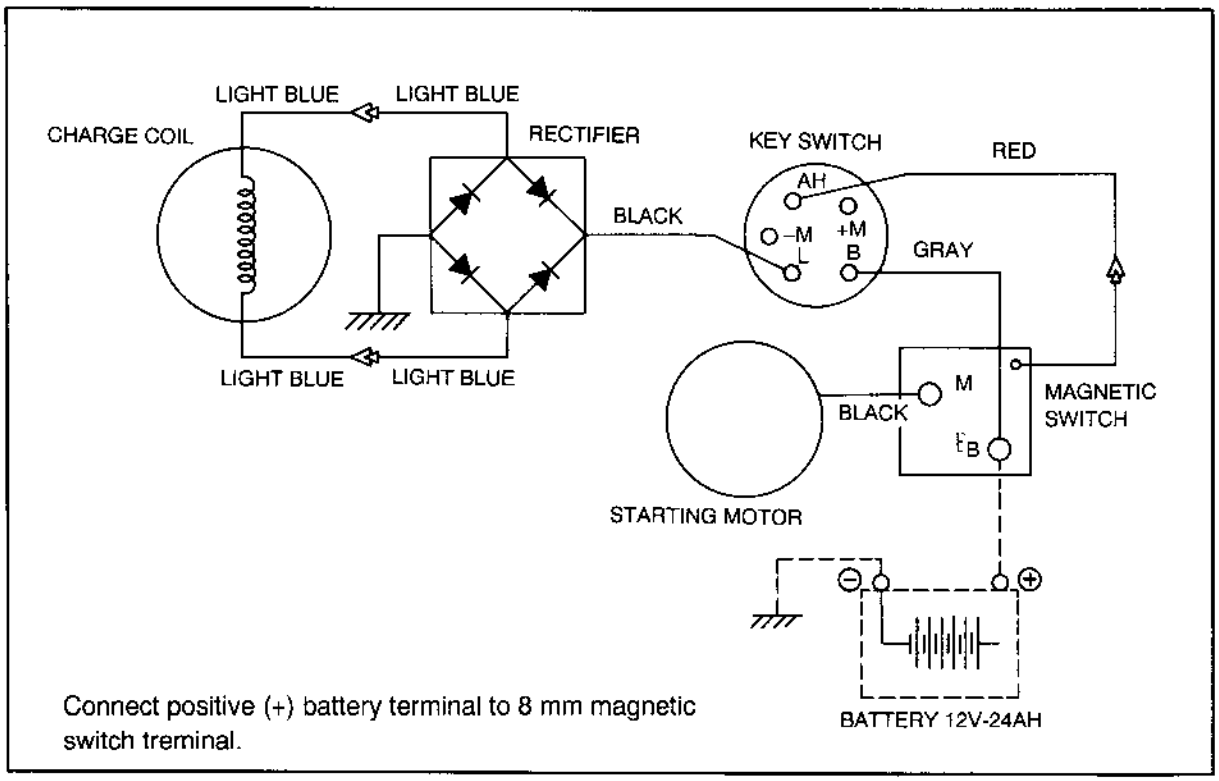


FIG. 88

8. PRECAUTIONS FOR MOUNTING THE ENGINE ON THE EQUIPMENT

The installation of an engine to the equipment effects greatly to the ease of maintenance.

8-1 INSTALLATION

When designing the equipment, pay a sufficient attention to the mounting position, coupling methode with the equipment, base and supports.

8-2 VENTILATION

Engine requires a sufficient amount of clean and fresh air for combustion of fuel and cooling.
If the engine is covered with an enclosure, or the engine is operated in a small room, the engine may overheats unless a sufficient amount of fresh air is supplied from the outside of the engine room.
High surrounding temperature also causes the deterioration of engine oil, increased oil consumption, lower output, and piston seizure resulting in the shorter engine life.
Therefore, it is necessary to provide a duct or a baffle to the engine to prevent recirculation or reflection of hot cooling air.
A prudential attention have to be paid to keep the engine room temperature below 50°C (122° F).

8-3 EXHAUST GAS

Exhaust gas is noxious. Be sure to discharge exhaust gas outdoors when operating the engine indoors or in a poorly ventilated area such as in a cave, tunnel, etc.
If an exhaust pipe extension is used to discharge exhaust gas, be careful of the inner diameter of the pipe to prevent power loss.

Recommendation of exhaust pipe extension :

Less than 3 m long : inner diameter 35 mm.

Less than 5 m long : inner diameter 38 mm.

8-4 FUEL SYSTEM

If the fuel tank is separately mounted on the equipment from the engine, be sure to set the bottom of fuel tank not less than 50 mm higher than the fuel injection pump. If the tank is mounted too low, the fuel may not be supplied properly to the engine. When piping the engine, be careful of heat conduction, pipe size, bends, and leaks from the joints and make the fuel pipe as short as possible to prevent air and vapor from being trapped.

8-5 POWER TRANSMISSION TO DRIVEN MACHINES

8-5-1 BELT DRIVE

Take the following notes into consideration.

(1) V-belts are preferable to flat belts.

(2) The driving shaft of the engine must be parallel to the driven shaft of the equipment.

(3) The driving pulley of the engine must be in line with the driven pulley of the equipment.

(4) Install the driving pulley as close to the engine as possible.

(5) Span the belt horizontally if possible.

(6) Disengage the load at starting the engine.
If the clutch is not adaptable, use a belt tensioner or the like to disengage load.

8-5-2 FLEXIBLE COUPLING

When using a flexible coupling, minimize the runout and misalignment between the engine shaft and the driven shaft.
The allowance are specified by the coupling maker.

9. CHECKS AND CORRECTIONS

After disassembling and cleaning the engine, check and repair, if necessary, according to the correction table. The correction table applies whenever the engines are repaired. It is important for the servicemen to be familiar with the contents of this table. Correct maintenance is recommended by observing the correction standards specified. The meanings of the terms used in the correction table are as follows :

(1) CORRECTION
Repair, adjustment or replacement of any engine parts.

(2) CORRECTION LIMIT
The limit on wear, damage or functional deterioration of engine parts beyond which normal engine performance cannot be expected without repairing such parts.

(3) USE LIMIT
The limit beyond which parts can no longer be used in respect of performance or strength.

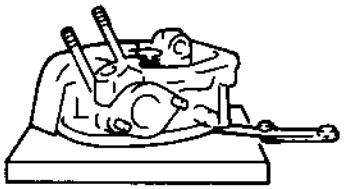
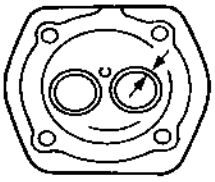
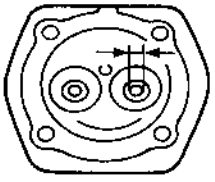
(4) STANDARD DIMENSIONS
The design dimensions of new parts minus tolerance.

(5) CORRECTION TOLERANCE
Tolerance on the dimensions of engine parts refinished or adjusted.

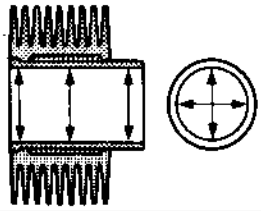
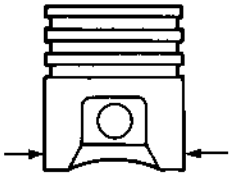
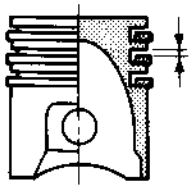
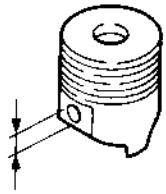
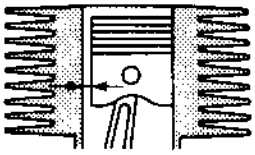
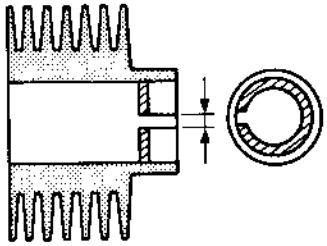
9-1 SERVICE DATA

Engine

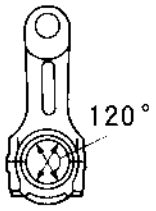
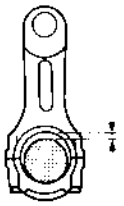
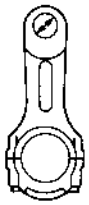
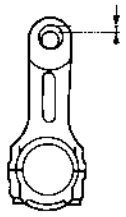
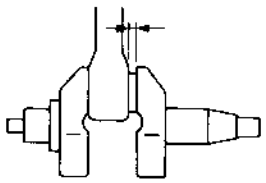
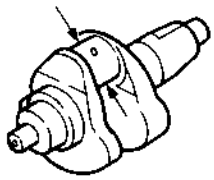
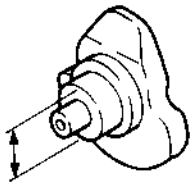
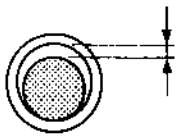
Unit : mm (in)

ITEM		DY23		DY27	
		STD	Limit	STD	Limit
CYLINDER HEAD ● Flatness 			0.05 (0.002)		0.05 (0.002)
● Valve seat contact width 	IN. EX.	1.6 (0.063)	2.2 (0.087)	1.6 (0.063)	2.2 (0.087)
● Valve guide inside dia. 		5.5~5.518 (0.2165~0.2172)	5.65 (0.2224)	5.5~5.518 (0.2165~0.2172)	5.65 (0.2224)

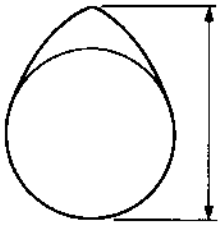
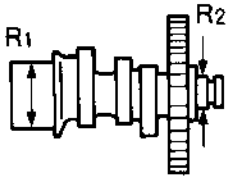
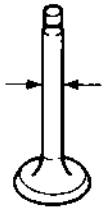
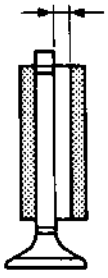
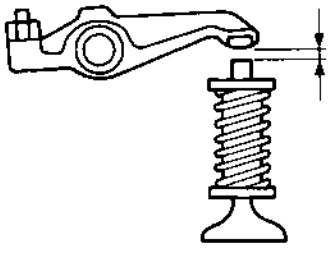
Unit : mm (in)

ITEM		DY23		DY27	
		STD	Limit	STD	Limit
CYLINDER ●Inside dia. 		70.000~70.019 (2.7559~2.7567)	70.25 (2.7657)	75.000~75.019 (2.9528~2.9535)	75.25 (2.9626)
PISTON ●Piston size (At skirt. in thrust direction) 	STD	69.961~69.981 (2.7544~2.7552)	69.871 (2.7508)	74.961~74.981 (2.9512~2.9520)	74.871 (2.9477)
	1st o/s	70.211~70.231 (2.7642~2.7650)	70.121 (2.7607)	75.211~75.231 (2.9611~2.9619)	75.121 (2.9575)
	2nd o/s	70.461~70.481 (2.7741~2.7748)	70.371 (2.7705)	75.461~75.481 (2.9709~2.9717)	75.371 (2.9674)
●Ring groove side clearance 	Top 2nd	0.05~0.09 (0.0020~0.0035)	0.15 (0.0059)	0.05~0.09 (0.0020~0.0035)	0.15 (0.0059)
	Oil	0.015~0.055 (0.0006~0.0022)	0.1 (0.0039)	0.015~0.055 (0.0006~0.0022)	0.1 (0.0039)
●Piston pin hole 		18.001~18.008 (0.7087~0.7090)	18.03 (0.7098)	18.001~18.008 (0.7087~0.7090)	18.03 (0.7098)
●Piston pin outside dia. 		18.000~18.006 (0.7087~0.7089)	17.980 (0.7079)	18.000~18.006 (0.7087~0.7089)	17.980 (0.7079)
●Clearance between piston and cylinder at skirt area. 		0.019~0.058 (0.0007~0.0022)	0.15 (0.0059)	0.019~0.058 (0.0007~0.0022)	0.2 (0.0079)
●Piston ring end gap 	Top 2nd	0.3~0.5 (0.0118~0.0197)	1.0 (0.0394)	0.1~0.3 (0.0039~0.0118)	0.8 (0.0315)
	Oil	0.25~0.45 (0.0098~0.0177)	1.0 (0.0394)	0.25~0.45 (0.0098~0.0177)	1.0 (0.0394)

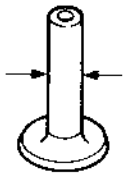
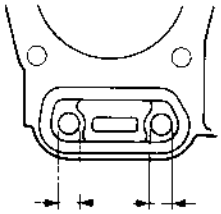
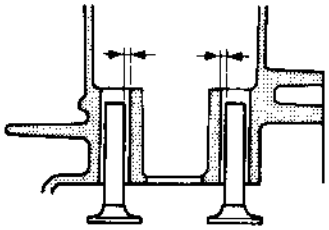
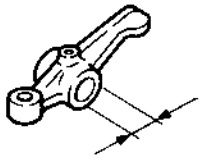
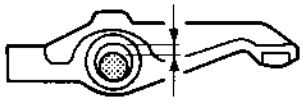
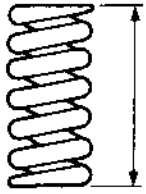
Unit : mm (in)

ITEM	DY23/DY27	
	STD	Limit
CONNECTING ROD ●Big end inside dia. (Metal is fitted) 	33.050~33.090 (1.3012~1.3028)	33.2 (1.3071)
●Clearance between big end and crankpin 	0.023~0.081 (0.0009~0.0032)	0.1 (0.0039)
● Small end inside dia. 	18.013~18.034 (0.7092~0.7100)	18.05 (0.7106)
●Clearance between small end and piston pin 	0.007~0.034 (0.0003~0.0013)	0.08 (0.0031)
● Big end side clearance 	0.10~0.30 (0.0039~0.0118)	0.5 (0.0197)
CRANKSHAFT ● Crankpin outside dia. 	33.011~33.027 (1.2996~1.3003)	32.85 (1.2933)
● Journal dia. 	32.984~33.000 (1.2986~1.2992)	32.85 (1.2933)
●Clealance between journal and main bearing 	0.014~0.086 (0.0006~0.0034)	0.12 (0.0047)

Unit : mm (in)

ITEM		DY23/DY27 STD	DY23/DY27 Limit
CAMSHAFT ● Cam height 	IN. EX. cams	32.13~32.23 (1.2650~1.2689)	31.98 (1.2591)
	Injection pump cam	29.95~30.05 (1.1791~1.1831)	29.85 (1.1752)
●Journal outside dia. "D" type 	Flywheel side R1	24.934~24.947 (0.9817~0.9822)	24.90 (0.9803)
	PTO side R2	14.973~14.984 (0.5895~0.5899)	14.90 (0.5866)
VALVE ● Valve stem outside dia. 	IN.	5.422~5.437 (0.2135~0.2141)	5.35 (0.2106)
	EX.	5.402~5.417 (0.2127~0.2133)	5.35 (0.2106)
●Clearance between valve stem dia. and valve guide 	IN.	0.063~0.096 (0.0025~0.0038)	0.3 (0.0118)
	EX.	0.083~0.116 (0.0033~0.0046)	0.3 (0.0118)
● Valve clearance 	IN./EX. (cold)	0.07~0.1 (0.0028~0.0039)	Adjustable

Unit : mm (in)

ITEM	DY23/DY27	
	STD	Limit
TAPPET ● Stem outside dia. 	7.960~7.975 (0.3134~0.3140)	7.93 (0.3122)
● Guide inside dia. 	8.000~8.015 (0.3150~0.3156)	8.08 (0.318)
● Tappet guide clearance 	0.025~0.055 (0.0010~0.0022)	0.15 (0.0059)
ROCKER ARM ● Rocker shaft outside dia. 	11.937~11.984 (0.4714~0.4718)	11.92 (0.4693)
● Rocker arm hole dia. 	12.000~12.018 (0.4724~0.4731)	12.07 (0.4752)
● Rocker arm shaft clearance 	0.016~0.045 (0.0006~0.0018)	0.15 (0.0059)
VALVE SPRING FREE LENGTH 	32.5 (1.2795)	31.0 (1.2205)

Unit : mm (in)

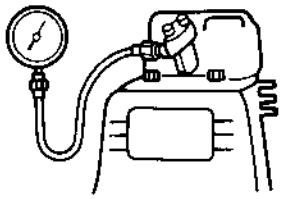
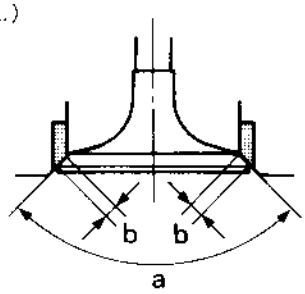
ITEM		DY23/DY27 STD	DY23/DY27 Limit
INJECTION PUMP ● From injection pump flange surface to cam base ● Static injection timing		65.95~66.05 (2.5965~2.6004) 21°~23° BTDC	Adjustable
NOZZLE ● Injection starting pressure ● Nozzle dia./Number of nozzle		195 kg/cm² (2773 lb/in²) 0.22 (0.009) / 4pcs.	
ENGINE COMPRESSION (at 400 r. p. m. by hand) 	DY23	18 kg/cm² (256.0 lb/in²)	13 kg/cm² (184.9 lb/in²)
	DY27	17~17.5 kg/cm² (241.8~248.9 lb/in²)	12 kg/cm² (170.7 lb/in²)
VALVE SEAT ANGLE (IN. EX.) ● Valve cutter angle (a) ● Valve contact width (b) 		a : 90° +30' 0 b : 1.6 mm (0.0630 in)	b : 2.2 mm (0.0866 in)

TABLE OF TIGHTENING TORQUE

Description		Tightening Torque
Bolts for joining main bearing cover		170~190 kg-cm (12.3~13.7 ft • lb)
Nuts for joining cylinder head	DY23	300~330 kg-cm (21.7~23.9 ft • lb)
	DY27	330~350 kg-cm (23.9~25.3 ft • lb)
Bolts for joining connecting rod cap		180~200 kg-cm (13.0~14.5 ft • lb)
Flywheel nut		600~650 kg-cm (43.4~47.0 ft • lb)
Oil drain plug		200~230 kg-cm (14.5~16.6 ft • lb)
Nuts for joining injection nozzle		50~60 kg-cm (3.6~4.3 ft • lb)

10. MAINTENANCE AND STORING

The following maintenance schedule applies to the engines operated correctly under normal conditions.
The indicated maintenance schedule does not necessarily guarantee maintenance-free operations during the intervals.
For example, if the engine is operated in extremely dusty condition, the air cleaner should be cleaned every day instead of every 50 hours.

10-1 DAILY CHECKS AND MAINTENANCE

Checks and maintenance works	Reasons for requiring the maintenance work
Remove dust, dirt, debris, grass and any foreign obstacles from cylinder, cylinder head, carburetor and governor system.	(1) Engine overheats. (2) Engine does not operate properly.
Check fuel leakage. If leakage is found, tighten the loose joint and/or replace leaking part.	Danger of fire.
Check bolts and nuts for looseness. Tighten the loose bolt and/or nut if any.	Engine malfunctions causing damages to the engine and/or the equipment.
Check oil level and fill up as necessary.	Insufficient oil causes engine seizure.

10-2 INITIAL 25 HOURS CHECK AND MAINTENANCE

Checks and maintenance works	Reasons for requiring the maintenance work
Change engine oil.	To remove break-in dregs.

10-3 EVERY 100 HOURS (MONTHLY) CHECKS AND MAINTENANCE

Checks and maintenance works	Reasons for requiring the maintenance work
Change engine oil.	Contaminated oil accelerates wear.
Clean oil filter.	Insufficient oil causes engine failure.
Clean air cleaner.	Clogged air cleaner causes poor engine operation.
Check battery electrolyte level.	Insufficient electrolyte lowers battery performance and shorten battery life.
Discharge water from fuel filter.	Water in the fuel causes poor engine operation, bad starting and corrosion in the injection pump and nozzle.

10-4 EVERY 500 HOURS CHECKS AND MAINTENANCE

Checks and maintenance works	Reasons for requiring the maintenance work
Check and adjust valve clearance.	Improper valve clearance causes poor engine output.
Check and clean injection nozzle.	Poor operation of the engine.
Remove carbon deposit from cylinder head.	Poor operation of the engine.

10-5 EVERY 1000 HOURS (YEARLY) CHECKS AND MAINTENANCE

Checks and maintenance works	Reasons for requiring the maintenance work
Replace piston rings.	Poor performance of the engine.
Replace fuel lines.	To prevent from fuel leaking.
Replace fuel filter.	Poor operation of the engine.
Check valve seats both intake and exhaust. Grind valve seats if necessary.	Poor operation of the engine.

10-6 EVERY 1500 HOURS OVERHAUL

Check and maintenance works	Reasons for requiring the maintenance work
Overhaul the engine.	To recover the engine power and extend engine life.

10-7 PREPARATIONS FOR LONG STORAGE

(1) Perform the above maintenance works 10-1 through 10-4. Also perform 10-5 and 10-6 as necessary.

(2) Drain fuel from the tank.

(3) To protect cylinder bore from rusting, pour a small amount (4~5 cc) of engine oil through the auxiliary fuel inlet into the cylinder and pull the recoil starter slowly 2 to 3 times. (Do not start the engine.)

NOTE

Do not pour too much oil or the oil remaines in the combustion chamber of the piston top.

(4) Pull the recoil starter slowly and stop it at the compression point.

(5) Clean the engine outside with a oily cloth.

(6) Put a cover over the engine and store it in a dry and well ventilated area.