SUBARU

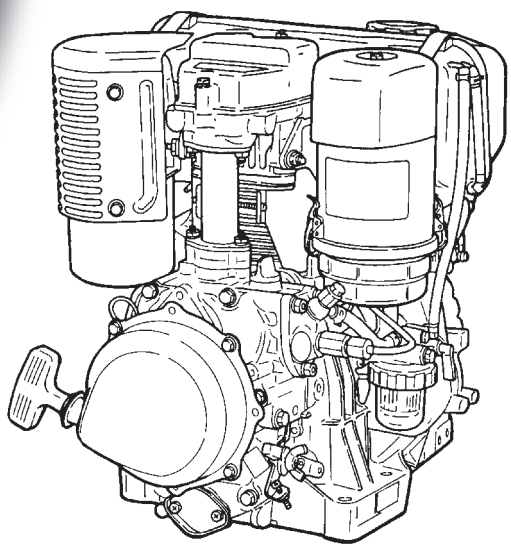
DY30
DY35
DY41
DY42

SUBARU

FUJI HEAVY INDUSTRIES LTD.,
TOKYO JAPAN

Air-cooled, 4-cycle

Diesel Engine



【Revised】

SERVICE MANUAL

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1. SPECIFICATIONS

Model		DY30					
		DY30D	DY30DS	DY30B	DY30BS		
Type		Air-cooled, 4-stroke, Single cylinder, Horizontal P.T.O. shaft, OHV Diesel Engine					
Bore x Stroke		76 x 66 mm (2.99 x 2.60 in.)					
Piston Displacement		299 cm^3 (18.25 cu.in.)					
Compression Ratio		21					
Output	Continuous	4.0kW (5.5 HP) / 3600 r.p.m. 3.7kW (5.0 HP) / 3000 r.p.m.		4.0kW (5.5 HP) / 1750 r.p.m. 3.7kW (5.0 HP) / 1450 r.p.m.			
	Maximum	4.8kW (6.5 HP) / 3600 r.p.m. 4.4kW (6.0 HP) / 3000 r.p.m.		4.8kW (6.5 HP) / 1750 r.p.m. 4.4kW (6.0 HP) / 1450 r.p.m.			
Maximum Torque		15.2 N·m (1.55 kgf·m) / 2400 / r.p.m.		31.6 N·m (3.22 kgf·m) / 1160 / r.p.m.			
Rotation		Counter-Clockwise as viewed from P.T.O. shaft side					
Cooling System		Forced air cooling					
Lubrication		Forced oil lubrication type					
Lubricant		Diesel Engine Lubricating Oil ; API classification "Grade CC or higher"					
Oil Pump		Trochoid gear type					
Injection Pump		ZEXEL PFRIKD55 (Bosch type)					
Injection Nozzle		ZEXEL DLLA150PN000					
Fuel		Automotive Diesel Fuel					
Fuel Consumption		230 g/HP·h (5.5 HP/3600 r.p.m.) · 200 g/HP·h (5.0 HP/3000 r.p.m.) 310 g/kW·h (4.0kW/3600 r.p.m.) · 270 g/kW·h (4.4 kW/3000 r.p.m.)		230 g/HP·h (5.5 HP/1750 r.p.m.) · 200 g/HP·h (5.0 HP/1450 r.p.m.) 310 g/kW·h (4.0 kW/1750 r.p.m.) · 270 g/kW·h (3.7 kW/1450 r.p.m.)			
Fuel Feed		Gravity type					
Fuel Tank Capacity		Approx. 4.5 liters (1.19 U.S. gal.)					
Labricating Oil Capacity		Approx. 1.0 liters (0.26 U.S. gal.)					
Combustion System		Direct injection type					
Speed Governor		Centrifugal flyweight type					
Lighting Capacity		–	–	12V-29W / 3000 12V-31W / 3600	–	–	12V-29W / 1500 12V-31W / 1750
Starting System		Hand cranking	Recoil starter	Electric starter & Recoil starter	Hand cranking	Recoil starter	Electric starter & Recoil starter
Dry Weight	without Balancer	38 kg (83.8 lbs.)	37 kg (81.6 lbs.)	45 kg (99.2 lbs.)	44 kg (97 lbs.)	43 kg (94.8 lbs.)	51 kg (112.4 lbs.)
	with Balancer	39.2 kg (86.4 lbs.)	38.2 kg (84.2 lbs.)	46.2 kg (101.9 lbs.)	45.2 kg (99.6 lbs.)	44.2 kg (97.4 lbs.)	52.2 kg (115.1 lbs.)
Dimensions	Lenght	386 mm (15.2 in.)	436 mm (17.2 in.)	436 mm (17.2 in.)	447 mm (17.6 in.)	497 mm (1 9.6 in.)	497 mm (1 9.6 in.)
	Width	370 mm (14.6 in.)	370 mm (14.6 in.)	404 mm (15.9 in.)	402 mm (15.8 in.)	370 mm (14.6 in.)	404 mm (1 5.9 in.)
	Height	450 mm (17.7 in.)	450 mm (17.7 in.)	450 mm (17.7 in.)	450 mm (17.7 in.)	450 mm (17.7 in.)	450 mm (17.7 in.)

Specifications are subject to change without notice.

Model			DY35					
			DY35D	DY35DS	DY35B	DY35BS		
Type			Air-cooled, 4-stroke, Single cylinder, Horizontal P.T.O. shaft, OHV Diesel Engine					
Borex Stroke			82 x 66 mm (3.23 x 2.60 in.)					
Piston Displacement			348 cm^3 (21.25 cu.in.)					
Compression Ratio			21					
Output	Continuous		4.8kW (6.5 HP) / 3600 r.p.m. 4.4kW (6.0 HP) / 3000 r.p.m.		4.8kW (6.5 HP) / 1750 r.p.m. 4.4kW (6.0 HP) / 1450 r.p.m.			
	Maximum		5.5kW (7.5 HP) / 3600 r.p.m. 5.2kW (7.0 HP) / 3000 r.p.m.		5.5kW (7.5 HP) / 1750 r.p.m. 5.2kW (7.0 HP) / 1450 r.p.m.			
Maximum Torque			17.2 N·m (1.75 kgf·m) / 2400 / r.p.m.		34.3 N·m (3.5 kgf·m) / 1160 / r.p.m.			
Rotation			Counter-Clockwise as viewed from P.T.O. shaft side					
Cooling System			Forced air cooling					
Lubrication			Forced oil lubrication type					
Lubricant			Diesel Engine Lubricating Oil ; API classification "Grade CC or higher"					
Oil Pump			Trochoid gear type					
Injection Pump			ZEXEL PFRIKD55 (Bosch type)					
Injection Nozzle			ZEXEL DLLA150PN000					
Fuel			Automotive Diesel Fuel					
Fuel Consumption			230 g/HP·h (6.5 HP/3600 r.p.m.) · 200 g/HP·h (6.0 HP/3000 r.p.m.) 310 g/kW·h (4.8kW/3600 r.p.m.) · 270 g/kW·h (4.4 kW/3000 r.p.m.)		230 g/HP·h (6.5 HP/1750 r.p.m.) · 200 g/HP·h (6.0 HP/1450 r.p.m.) 310 g/kW·h (4.8 kW/1750 r.p.m.) · 270 g/kW·h (4.4 kW/1450 r.p.m.)			
Fuel Feed			Gravity type					
Fuel Tank Capacity			Approx. 4.5 liters (1.19 U.S. gal.)					
Labricating Oil Capacity			Approx. 1.0 liters (0.26 U.S. gal.)					
Combustion System			Direct injection type					
Speed Governor			Centrifugal flyweight type					
Lighting Capacity			–	–	12V-29W / 3000 12V-31W / 3600	–	–	12V-29W / 1500 12V-31W / 1750
Starting System			Hand cranking	Recoil starter	Electric starter & Recoil starter	Hand cranking	Recoil starter	Electric starter & Recoil starter
Dry Weight	without Balancer		38 kg (83.8 lbs.)	37 kg (81.6 lbs.)	45 kg (99.2 lbs.)	44 kg (97 lbs.)	43 kg (94.8 lbs.)	51 kg (112.4 lbs.)
	with Balancer		39.2 kg (86.4 lbs.)	38.2 kg (84.2 lbs.)	46.2 kg (101.9 lbs.)	45.2 kg (99.6 lbs.)	44.2 kg (97.4 lbs.)	52.2 kg (115.1 lbs.)
Dimensions		Lenght	386 mm (15.2 in.)	436 mm (17.2 in.)	436 mm (17.2 in.)	447 mm (17.6 in.)	497 mm (1 9.6 in.)	497 mm (1 9.6 in.)
		Width	370 mm (14.6 in.)	370 mm (14.6 in.)	404 mm (15.9 in.)	402 mm (15.8 in.)	370 mm (14.6 in.)	404 mm (1 5.9 in.)
		Height	450 mm (17.7 in.)	450 mm (17.7 in.)	450 mm (17.7 in.)	450 mm (17.7 in.)	450 mm (17.7 in.)	450 mm (17.7 in.)

Specifications are subject to change without notice.

Model			DY41					
			DY41D	DY41DS	DY41B	DY41BS		
Type			Air-cooled, 4-stroke, Single cylinder, Horizontal P.T.O. shaft, OHV Diesel Engine					
Borex Stroke			82 x 78 mm (3.23 x 3.07 in.)					
Piston Displacement			412 cm^3 (25.14 cu.in.)					
Compression Ratio			21					
Output	Continuous		5.5kW (7.5 HP) / 3600 r.p.m. 5.2kW (7.0 HP) / 3000 r.p.m.		5.5kW (7.5 HP) / 1750 r.p.m. 5.2kW (7.0 HP) / 1450 r.p.m.			
	Maximum		6.3kW (8.5 HP) / 3600 r.p.m. 5.9kW (8.0 HP) / 3000 r.p.m.		6.3kW (8.5 HP) / 1750 r.p.m. 5.9kW (8.0 HP) / 1450 r.p.m.			
Maximum Torque			19.7 N·m (2.01 kgf·m) / 2400 / r.p.m.		40.9 N·m (4.17 kgf·m) / 1160 / r.p.m.			
Rotation			Counter-Clockwise as viewed from P.T.O. shaft side					
Cooling System			Forced air cooling					
Lubrication			Forced oil lubrication type					
Lubricant			Diesel Engine Lubricating Oil ; API classification "Grade CC or higher"					
Oil Pump			Trochoid gear type					
Injection Pump			ZEXEL PFRIKD55 (Bosch type)					
Injection Nozzle			ZEXEL DLLA150PN000					
Fuel			Automotive Diesel Fuel					
Fuel Consumption			230 g/HP·h (7.5 HP/3600 r.p.m.) · 200 g/HP·h (7.0 HP/3000 r.p.m.) 310 g/kW·h (5.5 kW/3600 r.p.m.) · 270 g/kW·h (5.2 kW/3000 r.p.m.)		220 g/HP·h (7.5 HP/1750 r.p.m.) · 200 g/HP·h (7.0 HP/1450 r.p.m.) 300 g/kW·h (5.5 kW/1750 r.p.m.) · 270 g/kW·h (5.2 kW/1450 r.p.m.)			
Fuel Feed			Gravity type					
Fuel Tank Capacity			Approx. 4.5 liters (1.19 U.S. gal.)					
Labricating Oil Capacity			Approx. 1.1 liters (0.29 U.S. gal.)					
Combustion System			Direct injection type					
Speed Governor			Centrifugal flyweight type					
Lighting Capacity			–	–	12V-29W / 3000 12V-31W / 3600	–	–	12V-29W / 1500 12V-31W / 1750
Starting System			Hand cranking	Recoil starter	Electric starter & Recoil starter	Hand cranking	Recoil starter	Electric starter & Recoil starter
Dry Weight	without Balancer		47 kg (103.6 lbs.)	46 kg (101.4 lbs.)	53 kg (116.8 lbs.)	51 kg (112.4 lbs.)	50 kg (110.2 lbs.)	57 kg (125.7 lbs.)
	with Balancer		48.2 kg (106.3 lbs.)	47.2 kg (104.1 lbs.)	54.2 kg (119.5 lbs.)	52.2 kg (115.1 lbs.)	51.2 kg (112.9 lbs.)	58.2 kg (128.3 lbs.)
Dimensions		Lenght	386 mm (15.2 in.)	436 mm (17.2 in.)	436 mm (17.2 in.)	447 mm (17.6 in.)	497 mm (19.6 in.)	497 mm (19.6 in.)
		Width	370 mm (14.6 in.)	370 mm (14.6 in.)	404 mm (15.9 in.)	402 mm (15.8 in.)	370 mm (14.6 in.)	404 mm (15.9 in.)
		Height	478 mm (18.8 in.)	478 mm (18.8 in.)	478 mm (18.8 in.)	478 mm (18.8 in.)	478 mm (18.8 in.)	478 mm (18.8 in.)

Specifications are subject to change without notice.

Model			DY42			
			DY42D	DY42DS	DY42B	DY42BS
Type			Air-cooled, 4-stroke, Single cylinder, Horizontal P.T.O. shaft, OHV Diesel Engine			
Borex Stroke			82 x 78 mm (3.23 x 3.07 in.)			
Piston Displacement			412 cm^3 (25.14 cu.in.)			
Compression Ratio			21			
Output	Continuous		6.3kW (8.5 HP) / 3600 r.p.m. 5.7kW (7.6 HP) / 3000 r.p.m.		6.3kW (8.5 HP) / 1750 r.p.m. 5.7kW (7.6 HP) / 1450 r.p.m.	
	Maximum		7.0kW (9.4 HP) / 3600 r.p.m. 6.5kW (8.7 HP) / 3000 r.p.m.		7.0kW (9.4 HP) / 1750 r.p.m. 6.5kW (8.7 HP) / 1450 r.p.m.	
Maximum Torque			21.8 N·m (2.22 kgf·m) / 2400 / r.p.m.		45.3 N·m (4.61 kgf·m) / 1160 / r.p.m.	
Rotation			Counter-Clockwise as viewed from P.T.O.shaft side			
Cooling'System			Forced air cooling			
Lubrication			Forced oil lubrication type			
Lubricant			Diesel Engine Lubricating Oil ; API classification "Grade CC or higher"			
Oil Pump			Trochoid gear type			
Injection Pump			ZEXEL PFRIKX60 (Bosch type)			
Injection Nozzle			ZEXEL DLLA150PN000			
Fuel			Automotive Diesel Fuel			
Fuel Consumption			230 g/HP·h (7.5 HP/3600 r.p.m.) · 200 g/HP·h (7.0 HP/3000 r.p.m.) 310 g/kW·h (5.5 kW/3600 r.p.m.) · 270 g/kW·h (5.1 kW/3000 r.p.m.)		230 g/HP·h (7.5 HP/1750 r.p.m.) · 200 g/HP·h (7.0 HP/1450 r.p.m.) 310 g/kW·h (5.5 kW/1750 r.p.m.) · 270 g/kW·h (5.1 kW/1450 r.p.m.)	
Fuel Feed			Gravity type			
Fuel Tank Capacity			Approx. 4.5 liters (1.19 U.S. gal.)			
Labricating Oil Capacity			Approx. 1.1 liters (0.29 U.S. gal.)			
Combustion System			Direct injection type			
Speed Governor			Centrifugal flyweight type			
Lighting Capacity			–	12V-29W / 3000 r.p.m. 12V-31W / 3000 r.p.m.	–	12V-29W / 1450 r.p.m. 12V-31W / 1750 r.p.m.
Starting System			Recoil starter	Electric starter	Recoil starter	Electric starter
Dry Weight	without Balancer		47 kg (103.6 lbs.)	54 kg (119.0 lbs.)	51 kg (112.4 lbs.)	58 kg(127.9 lbs.)
	with Balancer		48.2 kg (106.3 lbs.)	55.2 kg (121.7 lbs.)	52.2 kg (115.1 lbs.)	59.2 kg (130.6 lbs.)
Dimensions		Lenght	436 mm (17.2 in.)	436 mm (17.2 in.)	497 mm (19.6 in.)	447 mm (17.5 in.)
		Width	370 mm (14.6 in.)	408 mm (16.1 in.)	394 mm (15.5 in.)	408 mm (16.1 in.)
		Height	478 mm (18.8 in.)	478 mm (18.8 in.)	478 mm (18.8 in.)	478 mm (18.8 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 lever 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 described in this manual.

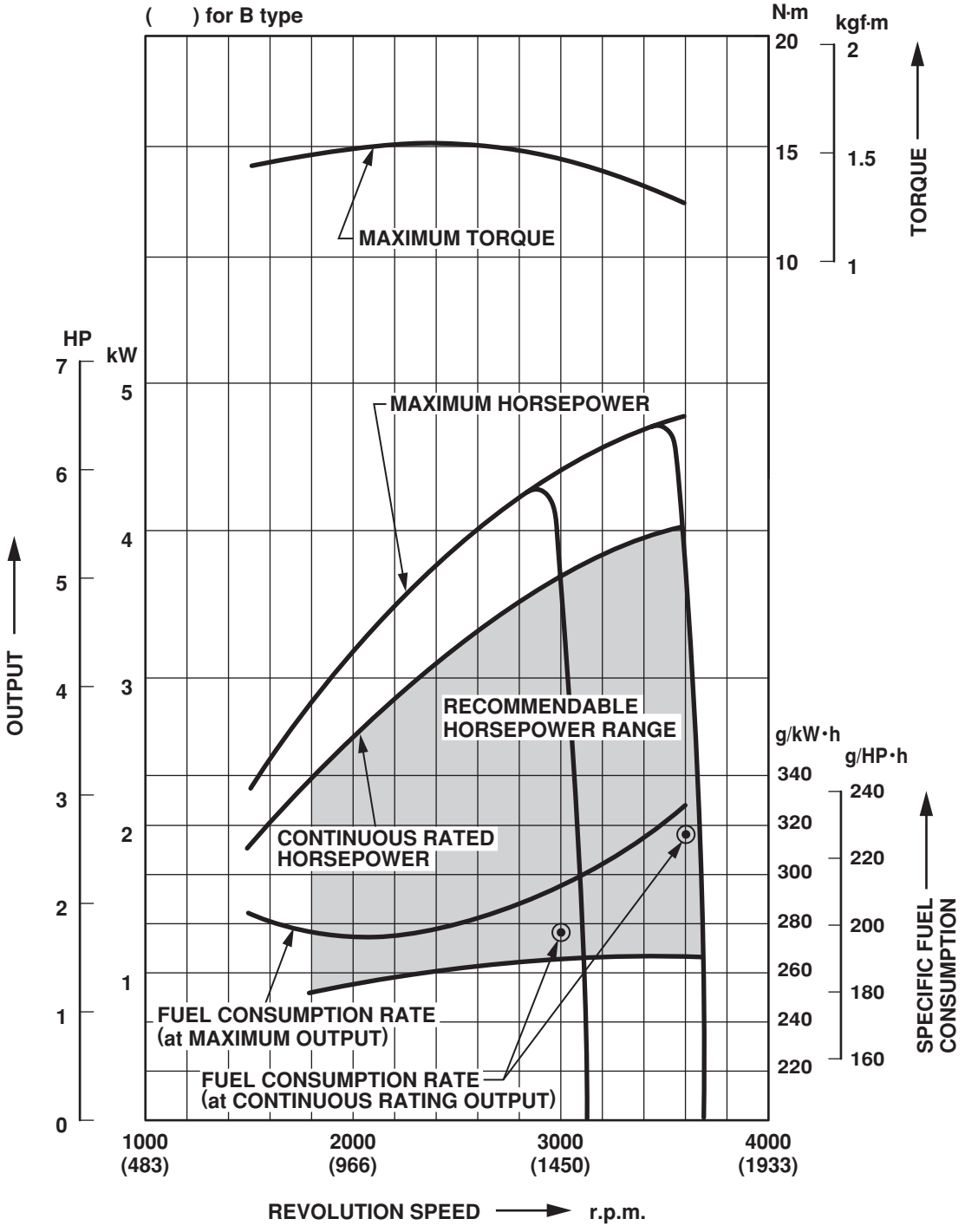
2-2 CONTINUOUS RATED OUTPUT

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 engine life and fuel economy point of view. 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.

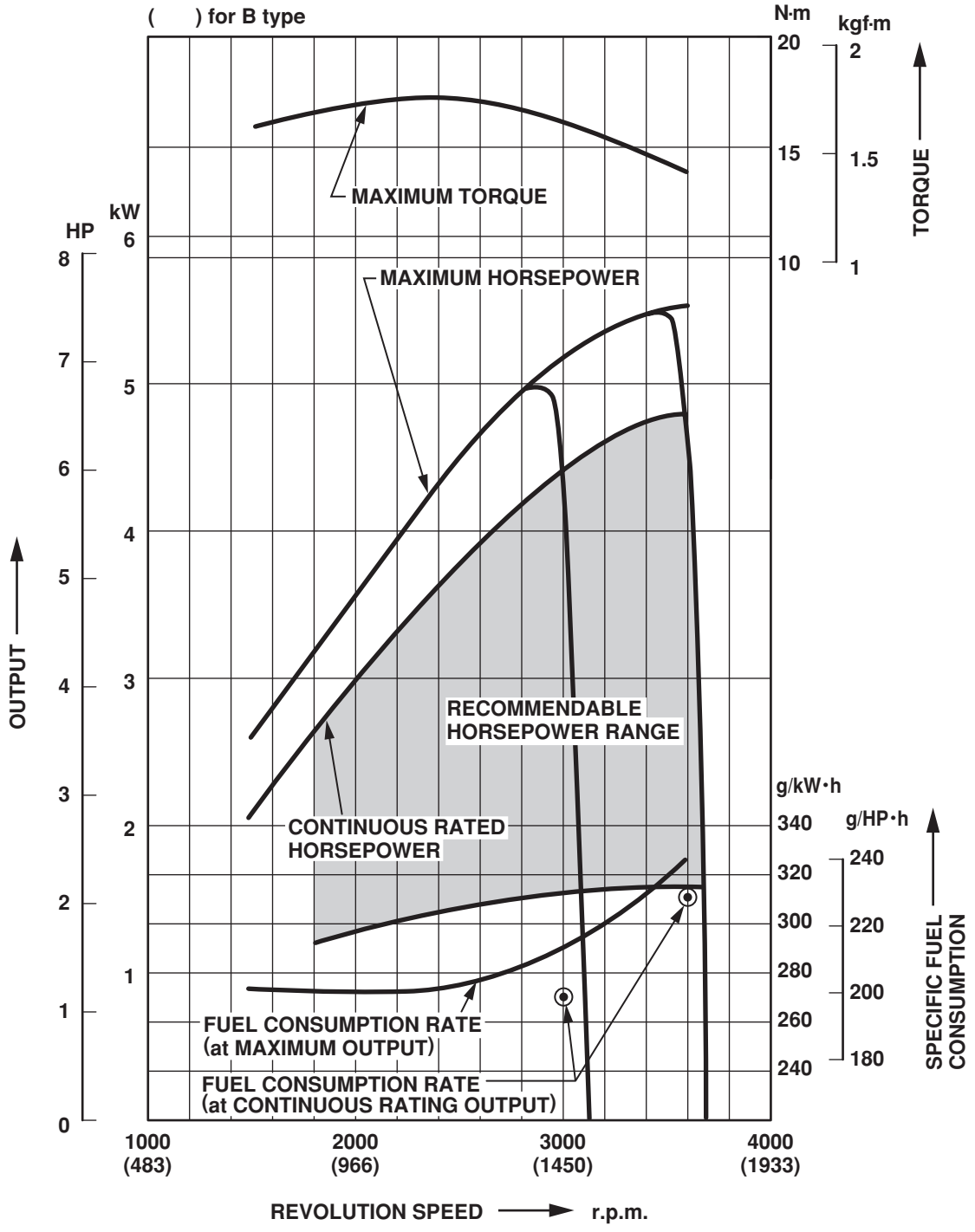
2-3 MAXIMUM TORQUE

Maximum torque is a maximum rotational force that an engine can produce in the speed range.

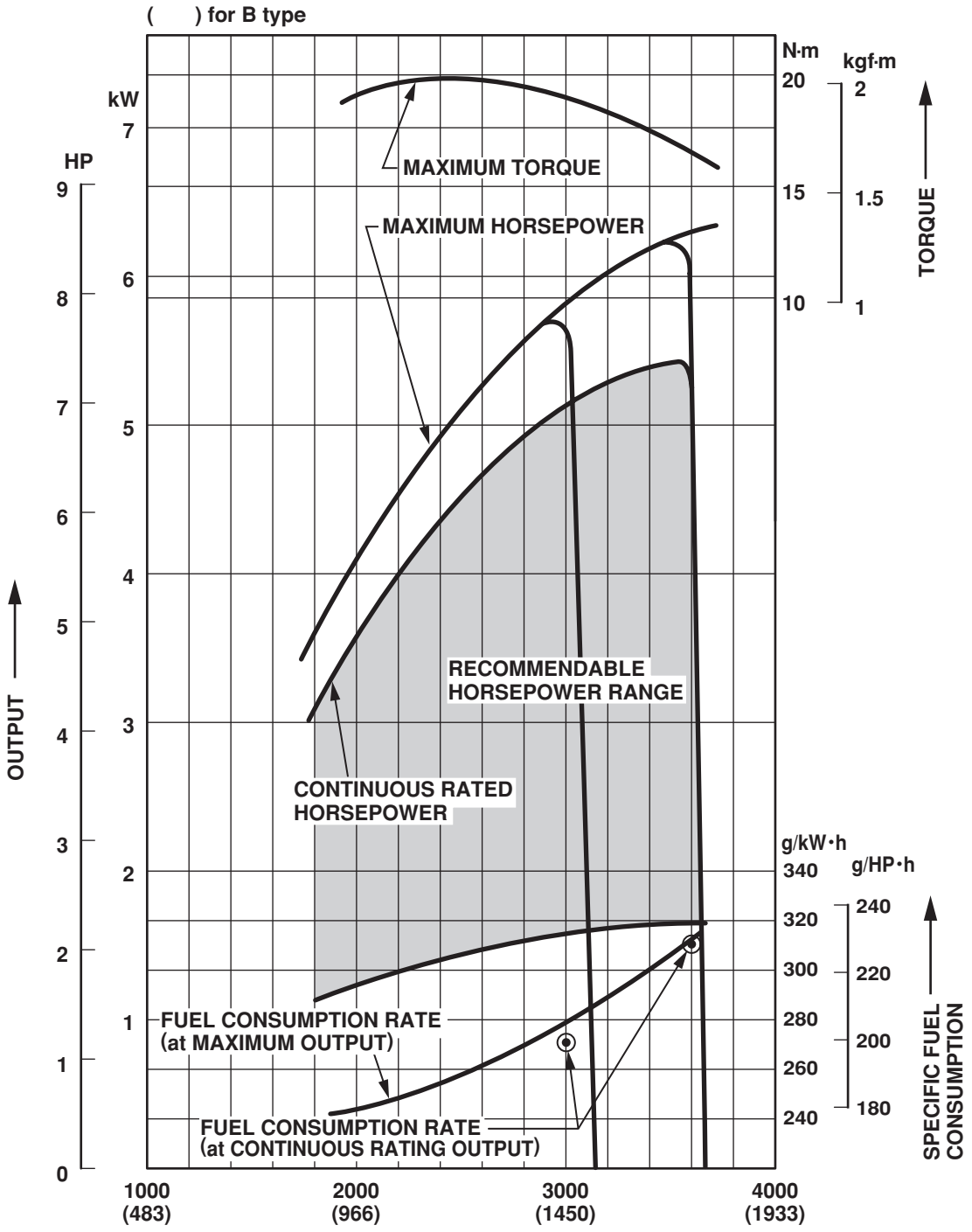
● **DY30D,B**


( ) for B type
N·m
kgf·m
20
2
15
1.5
10
1
TORQUE
MAXIMUM TORQUE
HP
kW
7
5
6
4
5
3
4
2
3
1
2
0
1
MAXIMUM HORSEPOWER
OUTPUT
RECOMMENDABLE
HORSEPOWER RANGE
CONTINUOUS RATED
HORSEPOWER
g/kW·h
g/HP·h
340
240
320
220
300
200
280
180
260
240
220
160
SPECIFIC FUEL
CONSUMPTION
FUEL CONSUMPTION RATE
(at MAXIMUM OUTPUT)
FUEL CONSUMPTION RATE
(at CONTINUOUS RATING OUTPUT)
1000
(483)
2000
(966)
3000
(1450)
4000
(1933)
REVOLUTION SPEED
r.p.m.

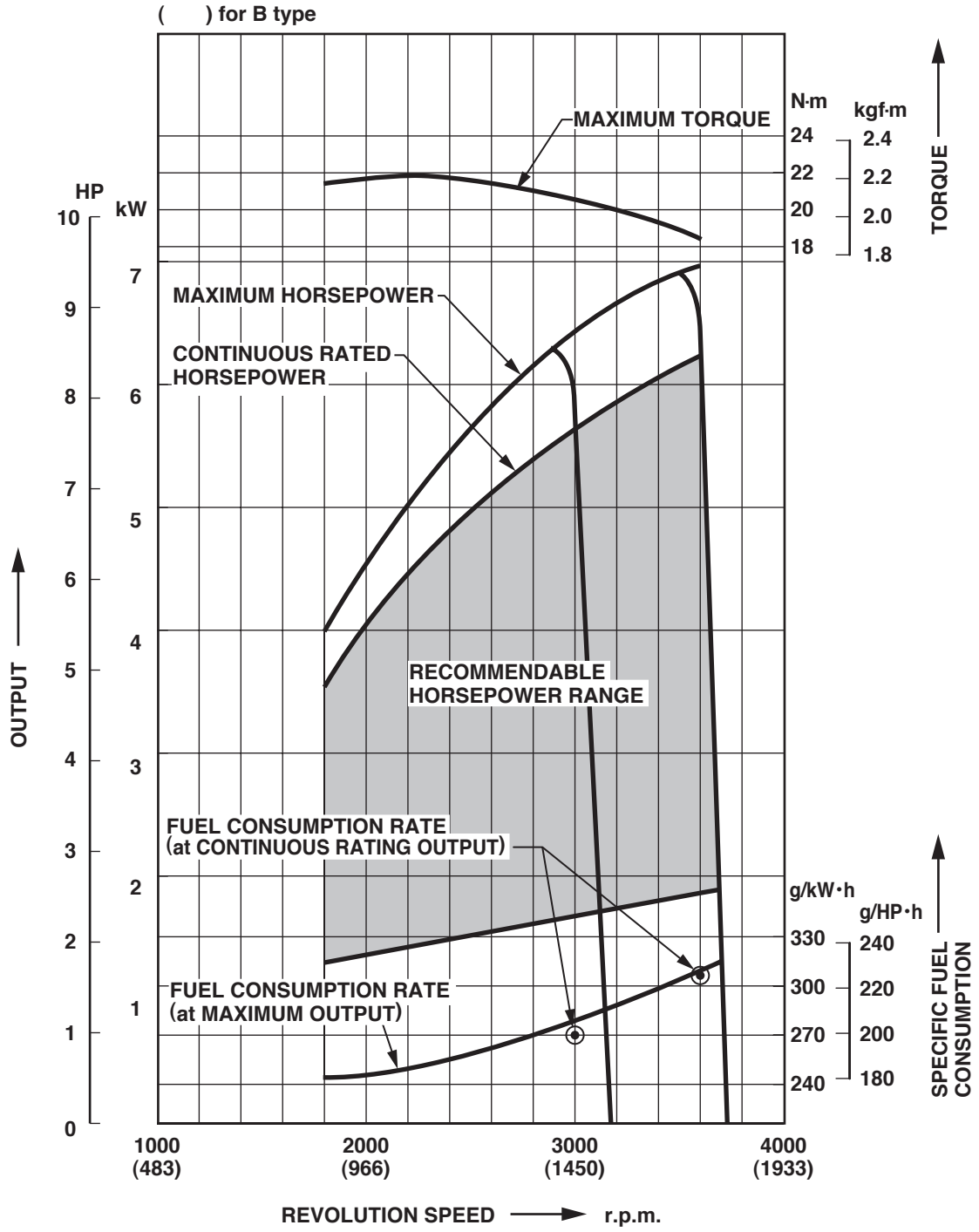
● **DY35D,B**


( ) for B type
N·m
kgf·m
20
2
15
1.5
10
1
TORQUE
MAXIMUM TORQUE
HP
kW
8
6
7
5
6
4
5
3
4
2
3
1
2
1
0
OUTPUT
MAXIMUM HORSEPOWER
RECOMMENDABLE
HORSEPOWER RANGE
CONTINUOUS RATED
HORSEPOWER
g/kW·h
g/HP·h
340
240
320
220
300
200
280
180
260
240
SPECIFIC FUEL
CONSUMPTION
FUEL CONSUMPTION RATE
(at MAXIMUM OUTPUT)
FUEL CONSUMPTION RATE
(at CONTINUOUS RATING OUTPUT)
1000
(483)
2000
(966)
3000
(1450)
4000
(1933)
REVOLUTION SPEED
r.p.m.

● **DY41D,B**


( ) for B type
N·m
kgf·m
kW
HP
MAXIMUM TORQUE
MAXIMUM HORSEPOWER
TORQUE
RECOMMENDABLE
HORSEPOWER RANGE
CONTINUOUS RATED
HORSEPOWER
OUTPUT
g/kW·h
g/HP·h
FUEL CONSUMPTION RATE
(at MAXIMUM OUTPUT)
FUEL CONSUMPTION RATE
(at CONTINUOUS RATING OUTPUT)
SPECIFIC FUEL
CONSUMPTION
1000
(483)
2000
(966)
3000
(1450)
4000
(1933)

● **DY42D,B**


( ) for B type
MAXIMUM TORQUE
N·m
kgf·m
24
22
20
18
2.4
2.2
2.0
1.8
TORQUE
HP
kW
10
9
8
7
6
5
4
3
2
1
0
7
6
5
4
3
2
1
MAXIMUM HORSEPOWER
CONTINUOUS RATED HORSEPOWER
RECOMMENDABLE HORSEPOWER RANGE
OUTPUT
FUEL CONSUMPTION RATE (at CONTINUOUS RATING OUTPUT)
FUEL CONSUMPTION RATE (at MAXIMUM OUTPUT)
g/kW·h
g/HP·h
330
300
270
240
240
220
200
180
SPECIFIC FUEL CONSUMPTION
1000 (483)
2000 (966)
3000 (1450)
4000 (1933)
REVOLUTION SPEED
r.p.m.

3. FEATURES

3-1 ECONOMICAL RUNNING

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

3-2 EXTREMELY QUIET OPERATION

- Precisely synchronized fuel injection and refined combustion chamber allow lower combustion pressure which results in lowered combustion noise.
- Blower housing and cylinder baffle are made from "SOUND ATTENUATING SHEET", a special material for insulating noise and vibration.
- Lager super silent muffler and double element air cleaner reduce the exhaust the 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 technology, such as proven crankcase design, tension bolt system for joining cylinder and cylinder head, and forced librication system, for longer service life under toughest operating conditions.

3-7 SMALL AND LIGHTWEIGHT

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

3-8 WIDE RANGE OF APPLICATION

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 COMPONENTS

DY series engine is a Forced Air Cooled, 4-Stroke, Single Cylinder, Overhead Valve Diesel Engine. The combustion system is a direct injection type.

4-1 CRANKCASE

The crankcase is made of a one-piece aluminum alloy die casting. On the side of pump, bearing is press-fitted; and on the fan side cast iron bearing housing is arranged, and it supports the crankshaft by a ball bearing press-fitted to the shaft. Also, on the fan side, blower housing of aluminum die casting is fitted. This blower housing has a faucet joint and it enables direct coupling with a machine.

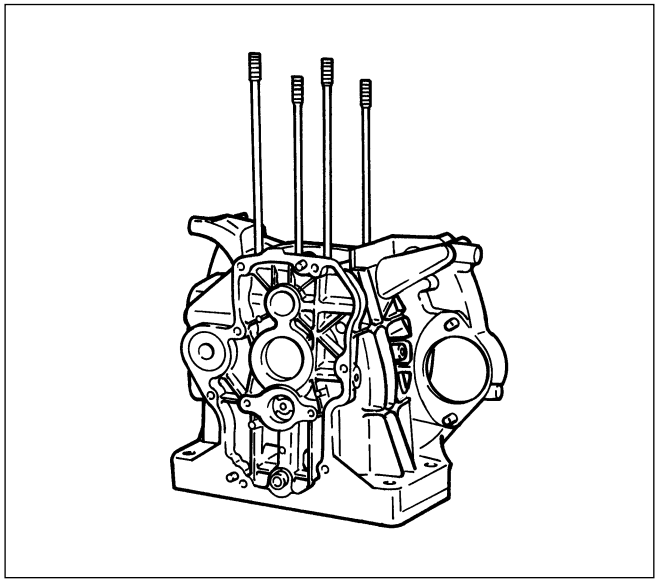


Fig. 4-1

4-2 CRANKSHAFT

The crankshaft is made of a forged chrome and molybdic steel piece with the crank pins and the journals ground to high precision after induction hardening. It is fitted to the flywheel on the fan side, and connection of the drive shaft to it is also possible. In the center of the pins and the journals,holes for forced lubrication are drilled through.

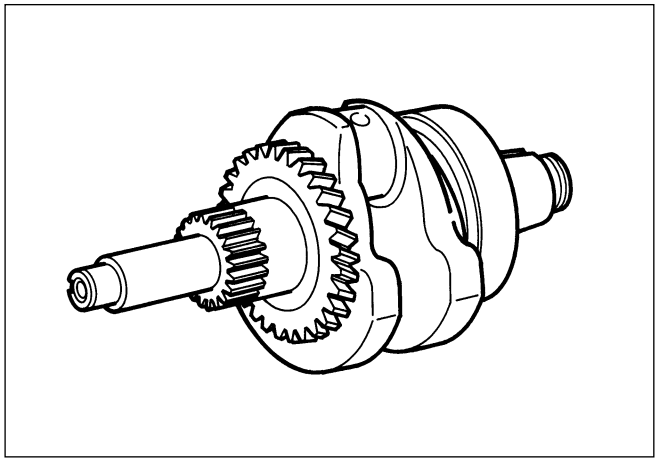


Fig. 4-2

4-3 CONNECTING ROD and PISTON

4-3-1 CONNECTING ROD

The connecting rod is made of forged pieces of aluminum alloy (DY41/42 : forged steel) designed with sufficient strength to withstand buckling and tensile forces inflicted on it under high-load operating conditions. At the small end a bushing is forcefitted to withstand the pressure resultant from pitching during high-speed operation. At the larger end thin kelmet is fitted for increaing durability.

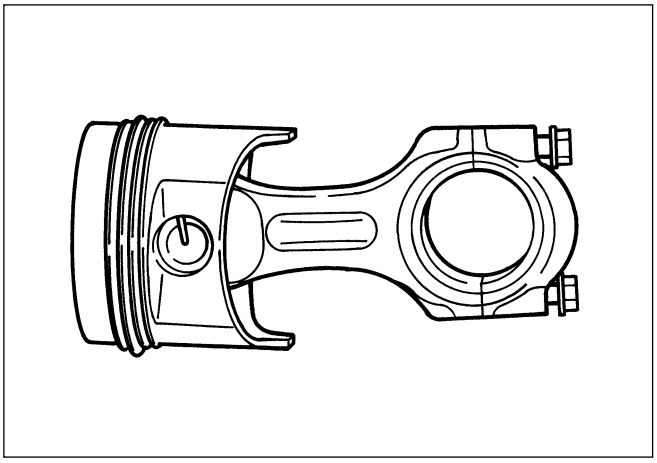


Fig. 4-3

4-3-2 PISTON

Piston is made of case aluminum alloy, and it has two compression rings and an oil ring. Combustion chamber arranged at the piston head, where combustion gas is made up by mixing atomized fuel and air, and ignites.

4-4 CYLINDER and CYLINDER HEAD

4-4-1 CYLINDER

Cylinder is made of aluminum alloy die casting, in which special cast iron liner is cast, and is provided with many fins designed for effective cooling.

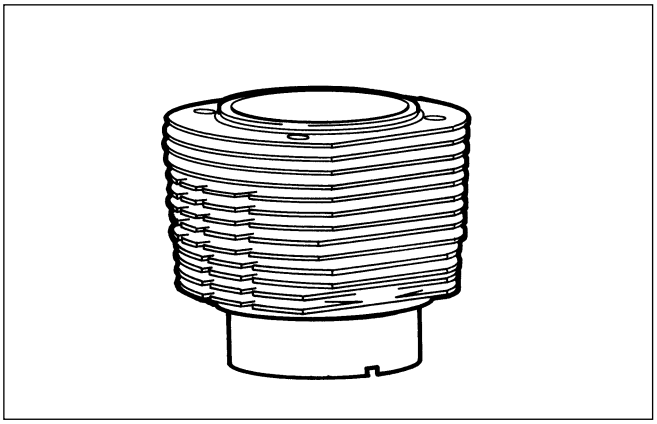


Fig. 4-4-1

4-4-2 CYLINDER HEAD

The most important part of the diesel engine is cylinder head. It is a one-piece aluminum alloy die casting, in which intake and exhaust ports, and rocker chamber are cast in the most ideal structure for the highest strength and the highest cooling efficiency. The valve seats are fine quality heat resistance type and are pressure-fitted considering high resistance to abrasion and corrosion at high temperature.

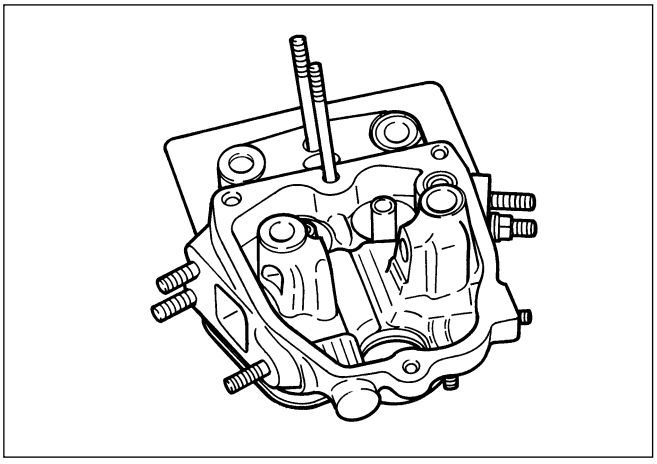


Fig. 4-4-2

4-5 GEAR CASE COVER

Gear case cover is made of a aluminum alloy die-casting and is fitted on the opposite side of the flywheel. This cover embraces the injection pump, timing gear, speed control lever and supports the camshaft. To the gear case cover the tappet guide is fitted and then the tappets are assembled.

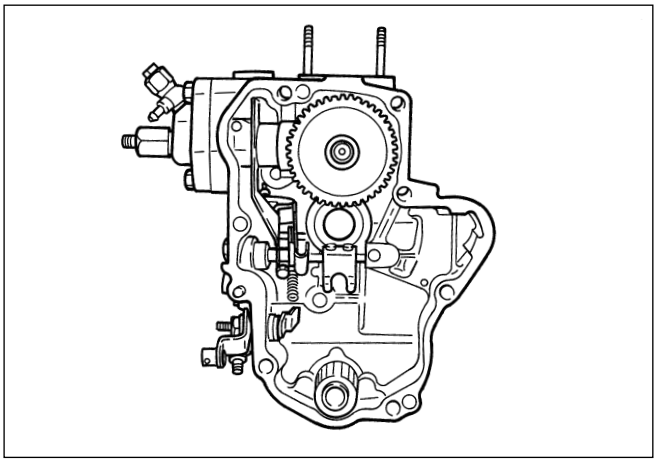


Fig. 4-5

4-6 CAMSHAFT

The camshaft is made of forged chrome steel wholly sintered and then ground. It carries three cams, viz. one intake cam, one exhaust cam, and one fuel injection pump cam, and the shaft is supported by a ball bearing pres-fitted in the gear case cover and by the gear case. The camshaft is assembled inside the gear case cover. To the shaft the release lever and a pin are fitted. The lever is used when starting engine by recoil starter.

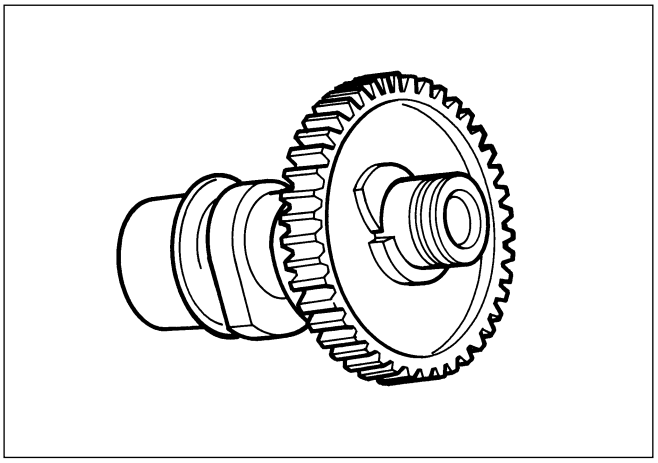


Fig. 4-6

4-7 TAPPET and TAPPET GUIDE

4-7-1 TAPPET

Tappet is made of forged steel and wholly sintered, grounded, and then taftride finished. The camshaft has oil holes for lubricating tappets.

4-7-2 TAPPET GUIDE

Tappet guide is made of a aluminum alloy die-cast. It determines tappet positions and is fitted to the gear case cover. In the crankcase there is a blow-by gas passage, Where the gas goes through up till rocker chamber via push rod sleeve.

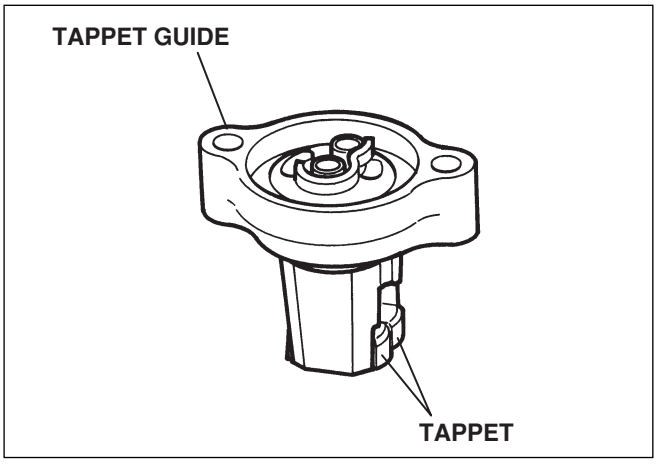


Fig. 4-7

4-8 VALVE

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

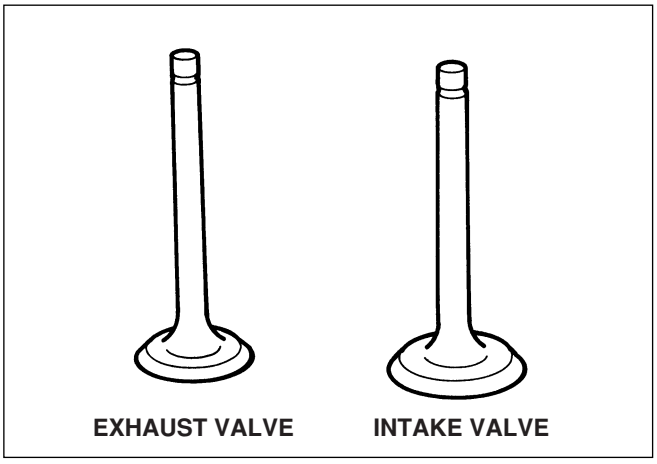


Fig. 4-8

4-9 ROCKER ARM

Rocker arm is made of forged steel and is wholly sintered and then grounded, and it is supported by the rocker shaft. At the one end it has valve clearance adjusting screw. With this screw valve clearance is adjusted to the specified number and is fixed by lock nut. Lubrication of the rocker arm is carried out by the oil splash contained in the blow-by gas from the crankcase.

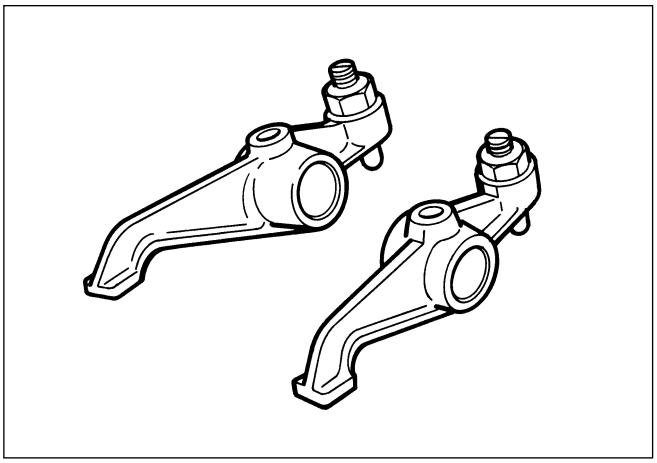


Fig. 4-9

4-10 ROCKER COVER

Rocker cover is made of aluminum alloy die-cast and is fitted to the cylinder head. It covers the rocker chamber. Rocker cover has a breather; and the air breathed is brought to the intake port.

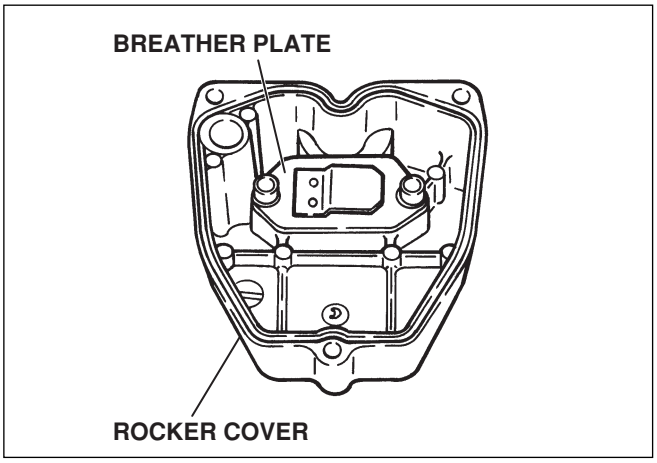


Fig. 4-10

4-11 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 intake tappet slightly to release compression.

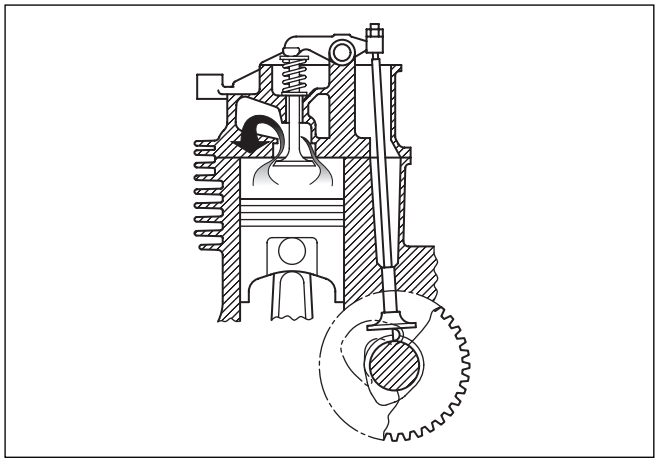


Fig. 4-11

4-12 GOVERNOR SYSTEM

The governor is a centrifugal flyweight type and is installed on the governor gear. Through the lever it adjusts the rack of fuel injection pump and keeps constant operation at the selected speed against load variations.

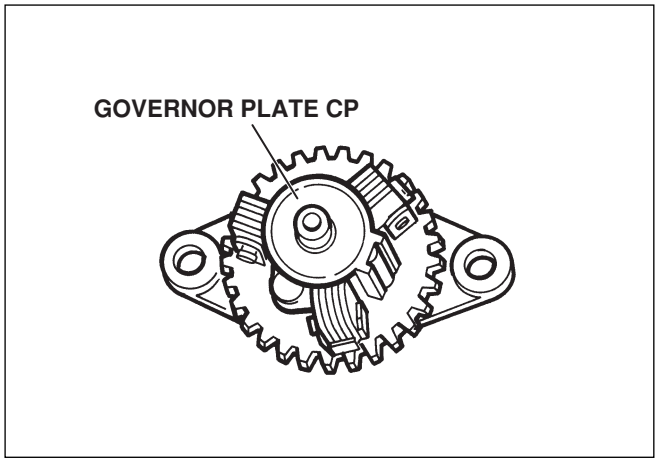


Fig. 4-12

4-13 LUBRICATION SYSTEM

Lubrication is wholly filtered and pressurized lubrication system by trochoid type oil pump. From the main gallery in the crankcase the pressurized oil runs through the crank journals and crank pins, and from the larger part of the rod the oil is supplied in the form of splash to the parts necessary to be lubricated, while part of the oil also runs through the bearings of camshaft to lubricate both intake and exhaust cams, and tappets. This system includes the governor gears and it is installed in the crankcase

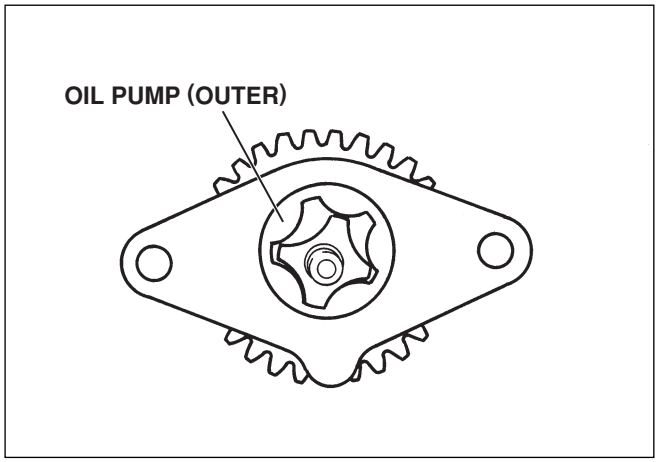


Fig. 4-13

4-14 COOLING SYSTEM

The cooling fan and the flywheel are a single piece casting and it is fitted to the top end of the crankshaft. Cooling air produced by this fan blows through blower housing and cylinder baffle, and cools cylinder and cylinder head.

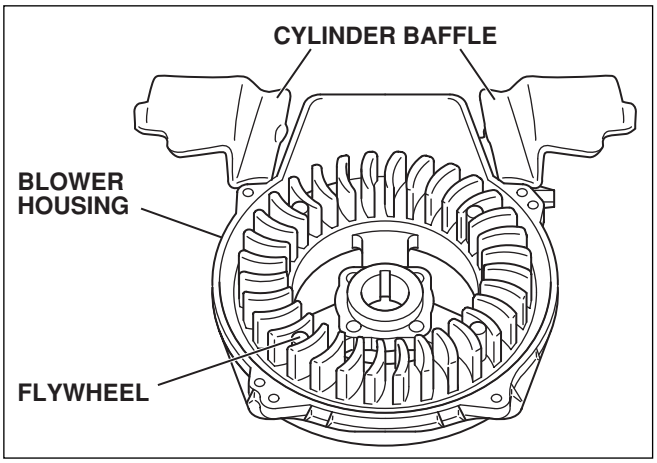


Fig. 4-14

4-15 FUEL INJECTION PUMP

The plunger of the fuel injection pump is operated by the injection pump cam, and the fuel from the tank is pressurized in the pump and supplied to the nozzle via the high pressure pipe.

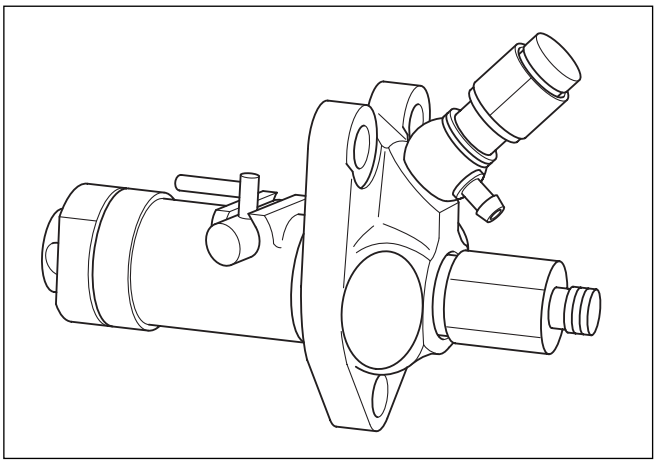


Fig. 4-15

4-16 FUEL INJECTION NOZZLE

Into the combustion chamber the nozzle injects the pressurized fuel supplied from the pump through the high pressure pipe.

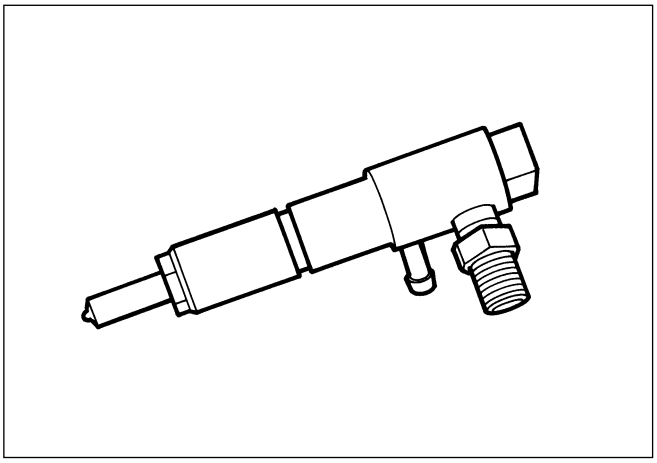


Fig. 4-16

4-17 COMBUSTION SYSTEM

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

4-17-1 FORMING of COMBUSTION GAS and COMBUSTION

1) SWIRL (Inspiring swirl)

In order to promote mixing injected fuel and air unaer 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.

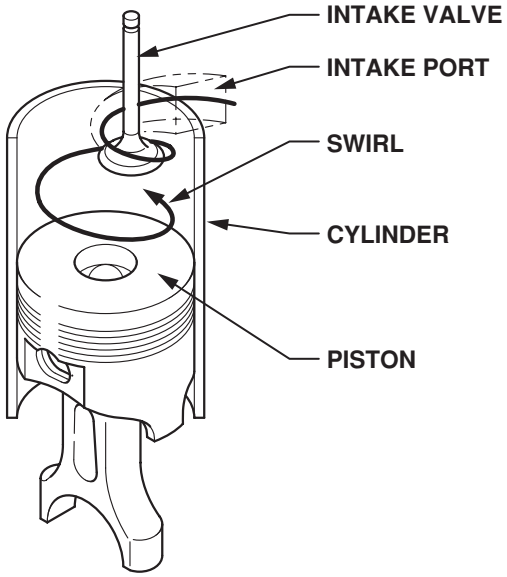


Fig. 4-17

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.".

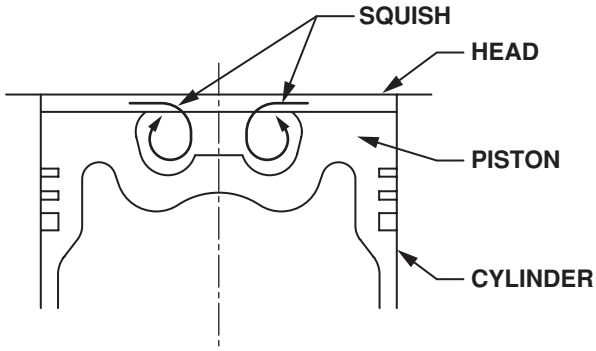
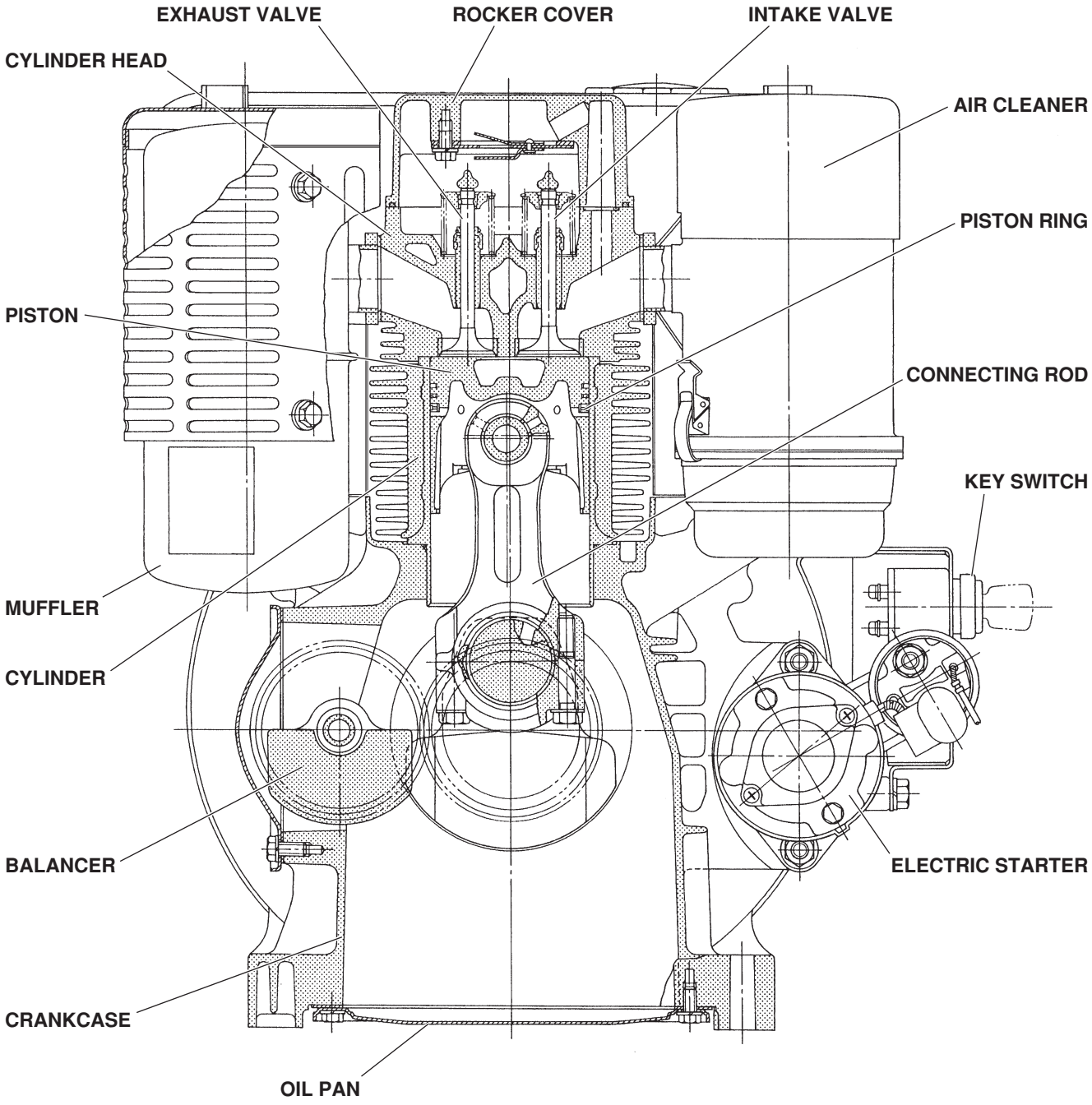


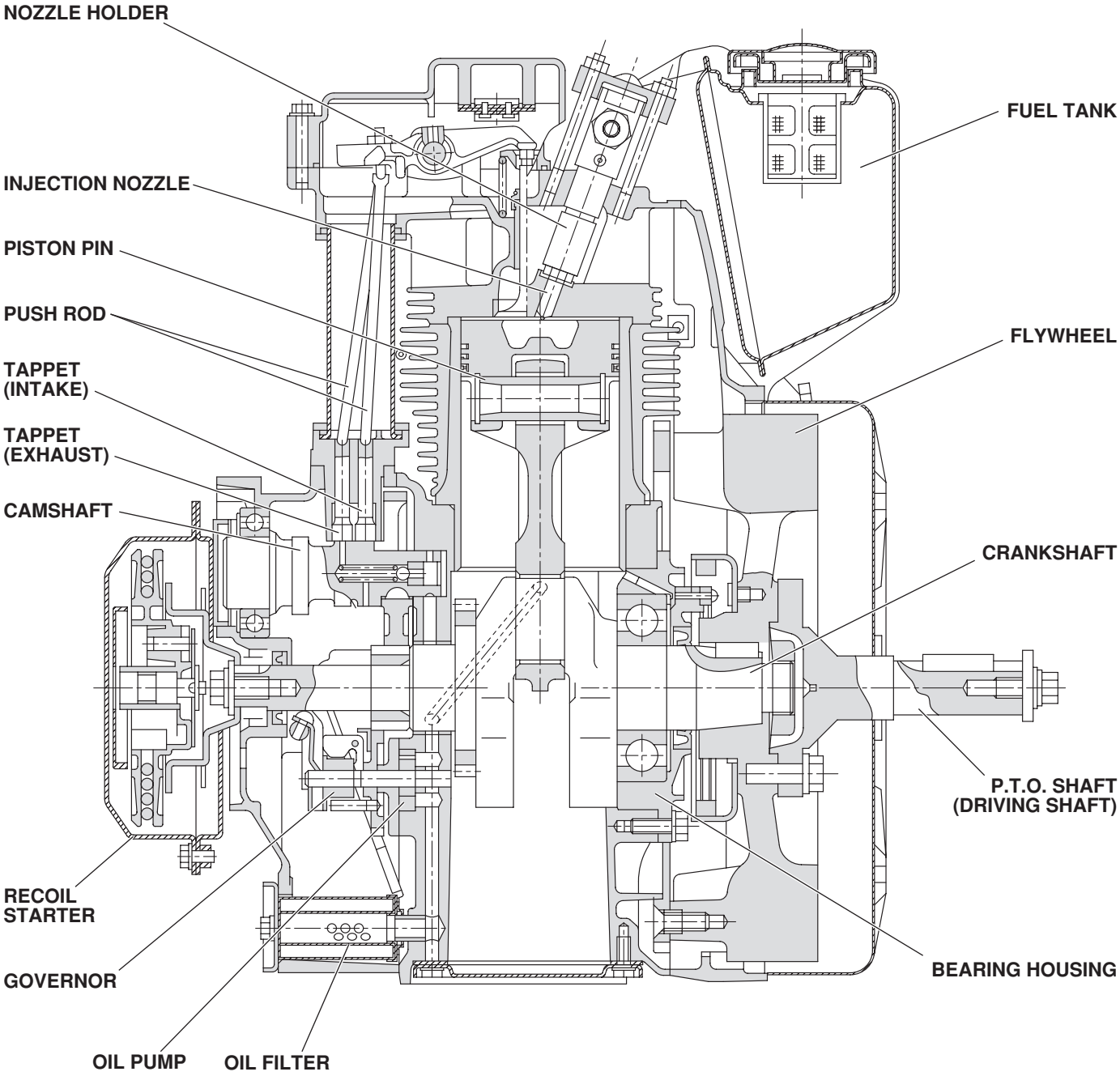
Fig. 4-18

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. 19.5MPa (195kg/cm^2) . 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.

4-18 SECTIONAL VIEW of ENGINE




NOZZLE HOLDER
INJECTION NOZZLE
PISTON PIN
PUSH ROD
TAPPET (INTAKE)
TAPPET (EXHAUST)
CAMSHAFT
RECOIL STARTER
GOVERNOR
OIL PUMP
OIL FILTER
FUEL TANK
FLYWHEEL
CRANKSHAFT
P.T.O. SHAFT (DRIVING SHAFT)
BEARING HOUSING

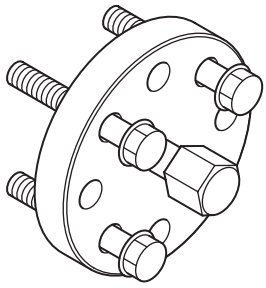
5. DISASSEMBLY AND REASSEMBLY

5-1 PREPARATIONS and SUGGESTIONS

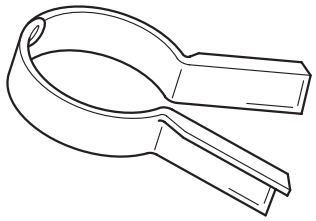
1) When disassembling the engine, memorize well the locations of individual parts so that they can be reassembled correctly. If you are uncertain in identifying some parts, it is suggested that tags to be attached to them.
2) Have boxes ready to keep disassembled parts by group.
3) To prevent missing 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 Name	Use
228-95001-17	Flywheel puller (with bolt)	For pulling off the flywheel
228-95003-07	Piston ring compresser	For placing piston ring



FLYWHEEL PULLER



PISTON RING COMPRESSER

Fig. 5-1

5-3 DISASSEMBLY PROCEDURES

Step	Parts to remove	Remarks and procedures	Fasteners
1	Oil drain	(1) Remove oil drain plug and drain oil. Drain plug are located under the gear case cover. (Remove oil filter.) Be sure not to miss the O-ring. The drain plug serves as an oil filter too. (2) To discharge oil quickly, remove oil gauge.	M6 × 13 : 2pcs.

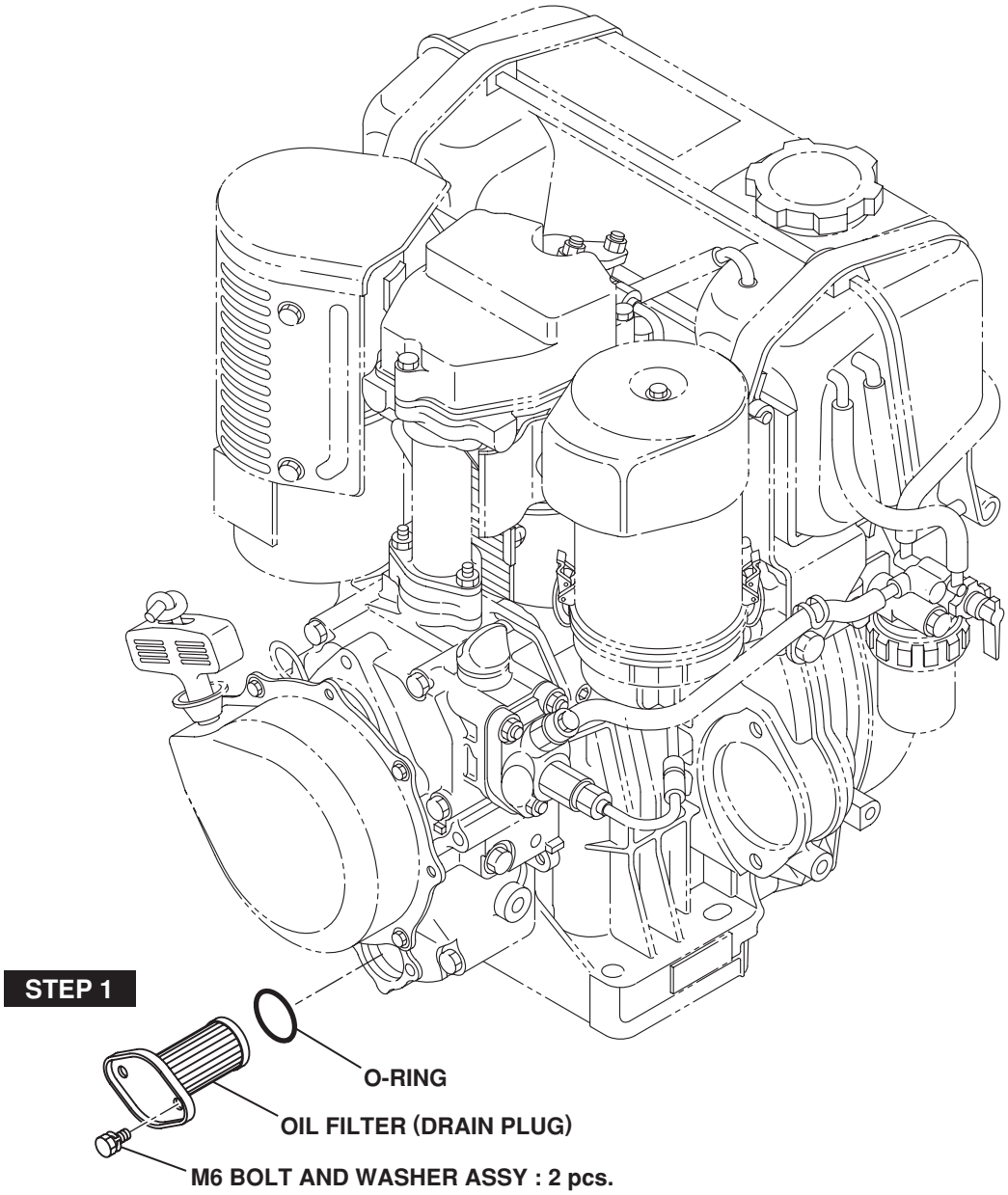


Fig. 5-2

Step	Parts to remove	Remarks and procedures	Fasteners
2	Fuel tank	(1) Close fuel valve. (2) Disconnect fuel pipe between fuel filter and fuel injection pump. (3) Disconnect fuel return pipe. (4) Remove tank band. * Wipe off spilt fuel thoroughly.	M6 x 45 : 2pcs.
3	Muffler cover and Muffler	Be careful not to lose muffler gasket.	M6 x 8 : 4pcs. M8 nut : 2pcs.
4	Injection pipe	Loosen two joint nuts at the both ends of injection pipe to remove it. (17mm wrench) * Be careful to keep the inside of the pipe, injection pump and the nozzle free of dust.	

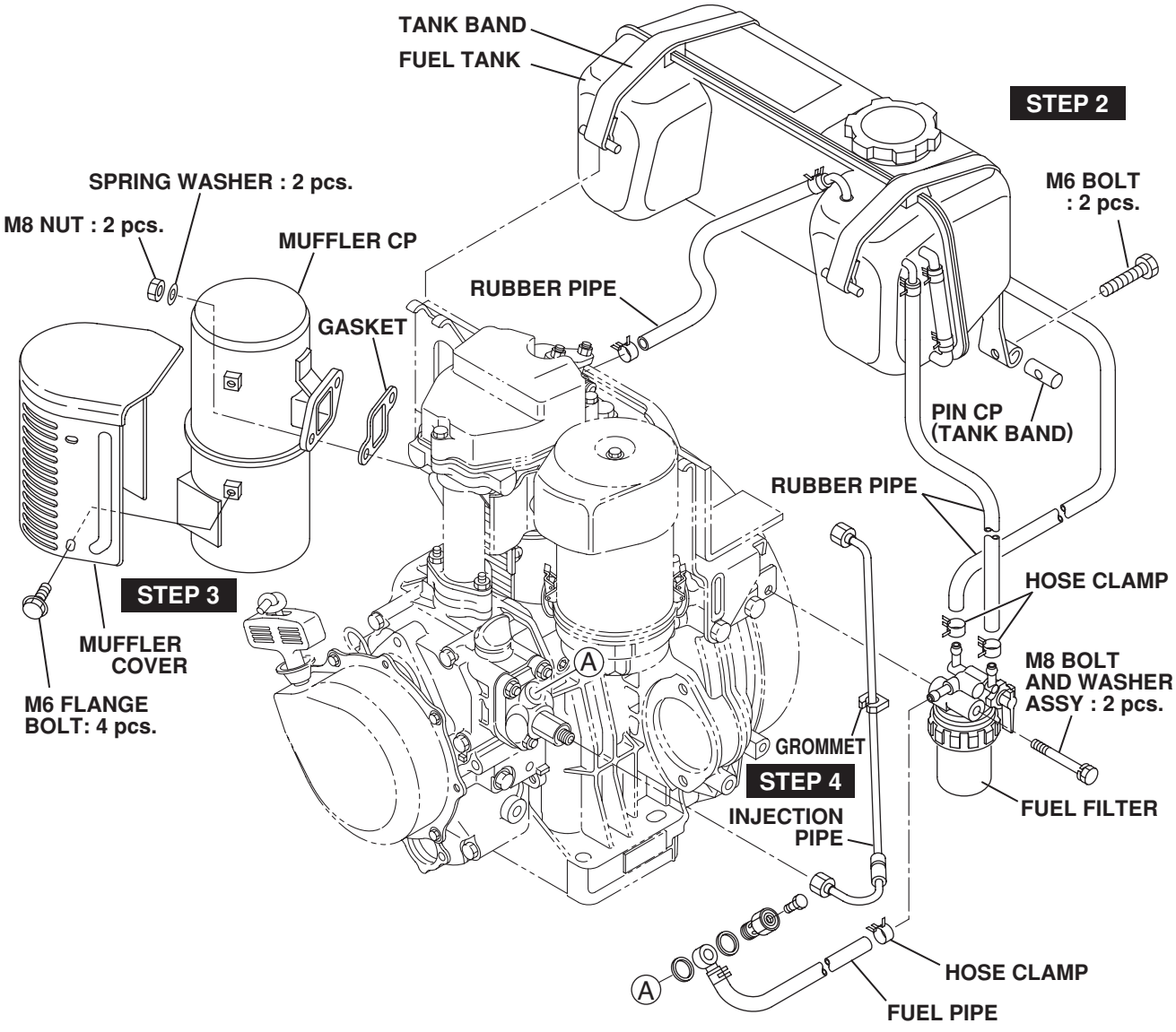


Fig. 5-3

Step	Parts to remove	Remarks and procedures	Fasteners
5	Air cleaner	Remove air cleaner from cylinder head. Be careful not to lose cleaner gasket.	M8 nut : 2pcs.
6	Tank bracket	Remove tank bracket from crankcase.	M8 X 20 : 2pcs. M6 nut : 1pce. (Tank bracket 1 only)

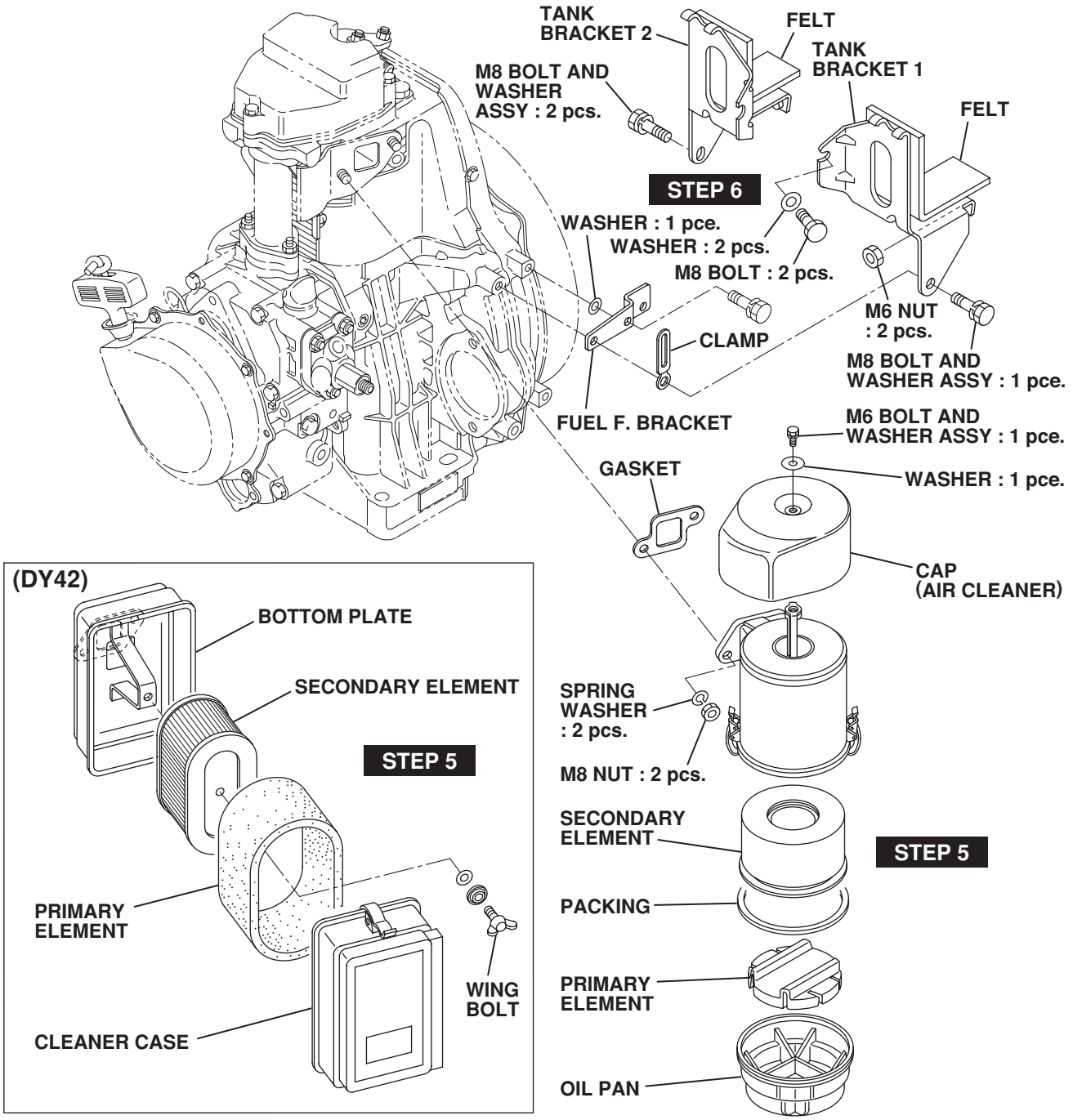


Fig. 5-4

Step	Parts to remove	Remarks and procedures	Fasteners
7	Recoil starter	Dismantle recoil starter from recoil cover.	M6 : 4pcs.
8	Starting pulley	Remove starting pulley from crankshaft Adop stopper bar into the opening of starting pully.	M10 X 20 : 1pce.
9	Recoil cover and key	Remove recoil cover and key.	M8 X 20 : 3pcs.

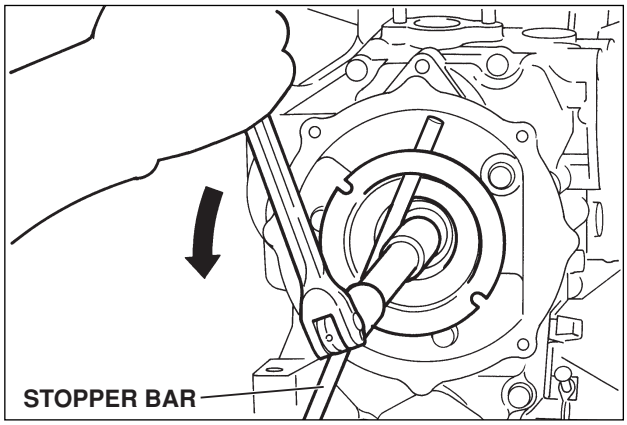


Fig. 5-6

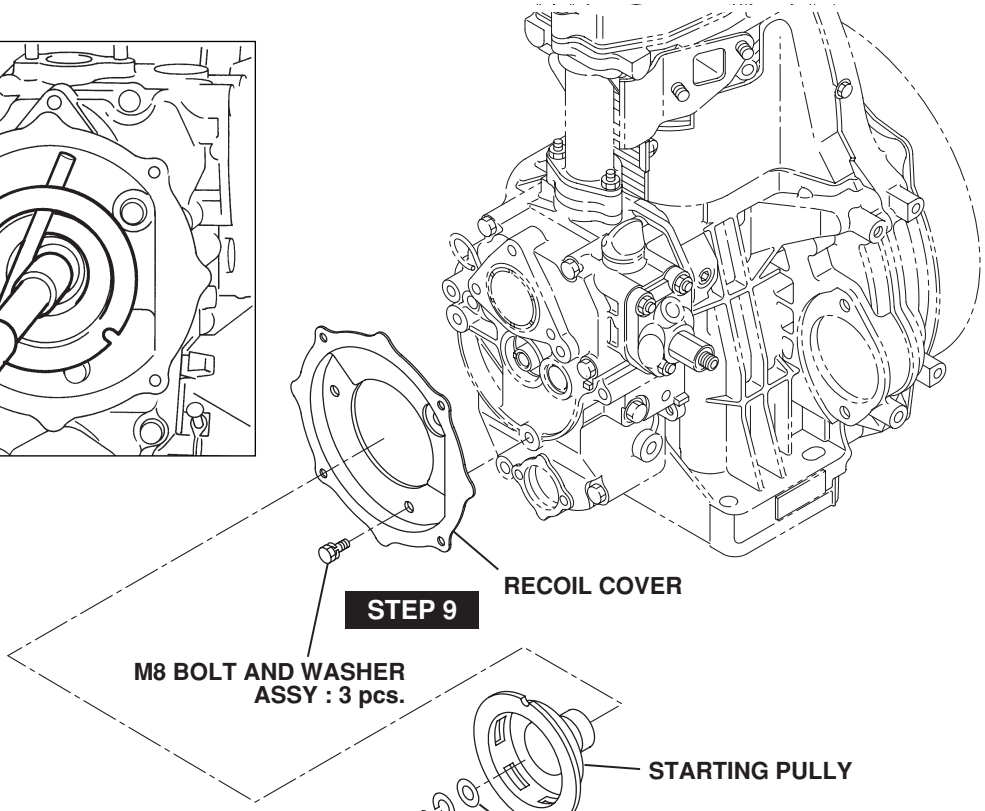


Fig. 5-5

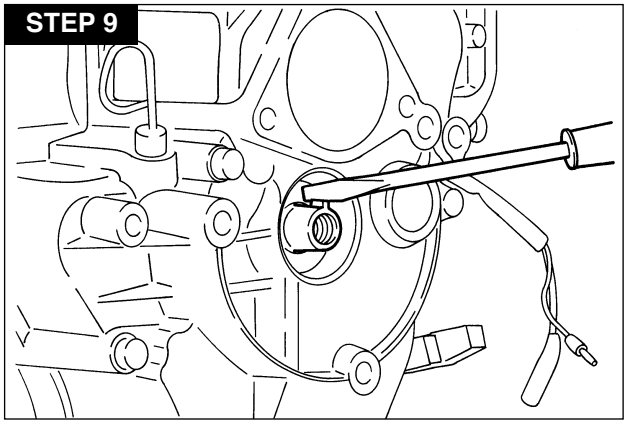


Fig. 5-7

Step	Parts to remove	Remarks and procedures	Fasteners
10	Flywheel	(1) Remove flywheel cover from crankcase. (2) Remove driving shaft. (3) Raise up lock washer, loosen lock nut useing box wrench. (See Fig.5-9-1.) Use flywheel puller as illustrated below. (See Fig. 5-9-2.)	M8 X 16 bolt and washer : 4pcs. M10 : 4pcs. M10 X 22 : 1pce. Lock nut : 1pce.

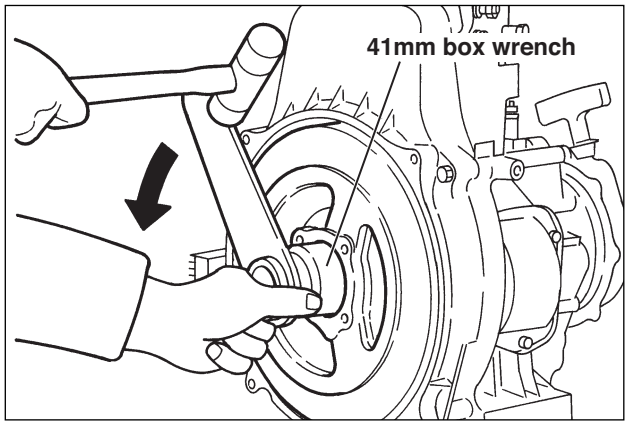


Fig. 5-9-1

Fig. 5-9-2

Fig. 5-8

Step	Parts to remove	Remarks and procedures	Fasteners
11	Blower housing	Remove blower housing from crankcase.	M8 X 40 bolt and washer : 2pcs. M8 X 55 bolt and washer : 2pcs.
12	Cylinder baffle	Remove cylinder baffle from cylinder. Be sure not to miss 5mm nut.	M6 : 2pcs. (DY41/42 : 4pcs.) M5 screw (pan head) 1 pce. M5 nut : lpce.

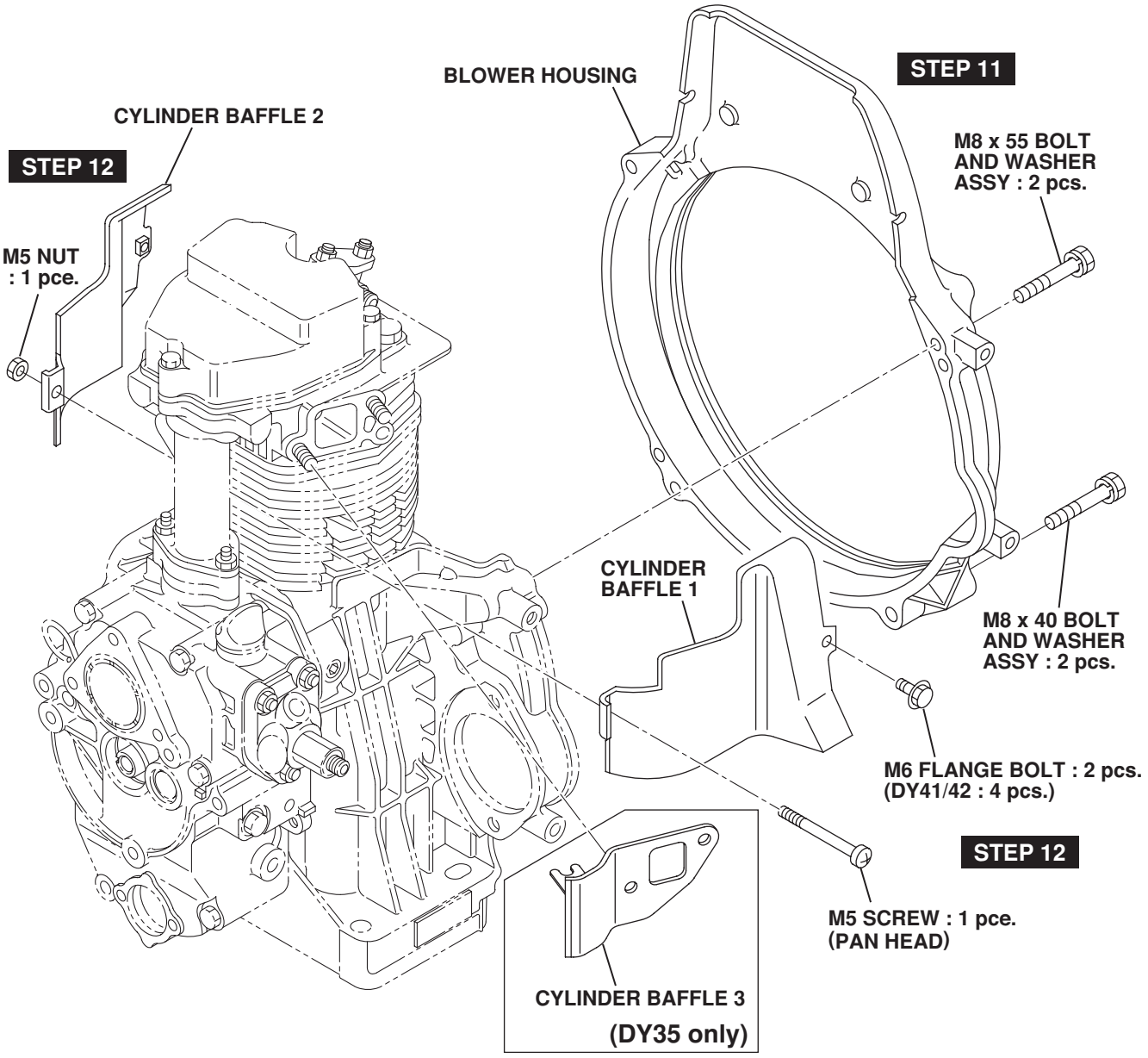


Fig. 5-10

Step	Parts to remove	Remarks and procedures	Fasteners
13	Rocker cover	(1) Remove rocker cover from cylinder head. (2) Remove breather plate from rocker cover.	M6 x 40 bolt and washer : 3pcs. M6 x 13 bolt and washer : 2pcs.
14	Fuel injection nozzle	(1) Remove nozzle, bracket. (2) Remove fuel injection nozzle from cylinder head. Be careful not to lose gasket at the bottom end of nozzle.	M6 flange nut : 2pcs.

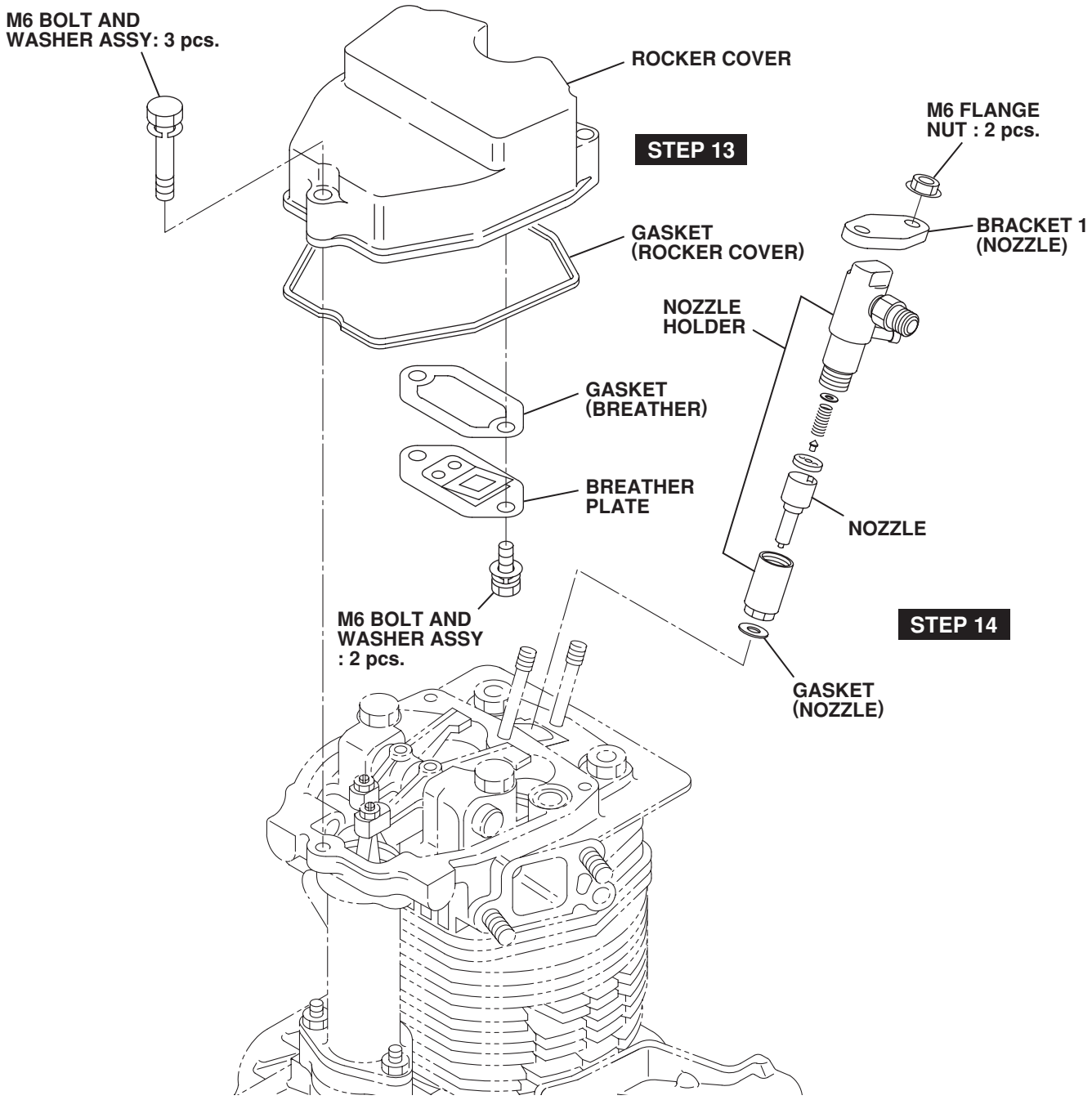


Fig. 5-11

Step	Parts to remove	Remarks and procedures	Fasteners
15	Rocker arm	(1) Loosen adjusting screw on the rocker arm. (2) Loosen cylinder head nuts. (3) Push rocker shaft out from cylinder head to remove rocker arms.(See Fig. 5-13.) Make rocker arms and push rods distinguishable of intake side and exhaust side.	M6 nut : 2pcs. M10 flange nut : 4pcs.
16	Cylinder head	(1) Just loosen nut which is fastening push rod sleeve on the side of cylinder head. (2) Pull out push rod. (3) Remove flange nut and cylinder head from cylinder.	M6 nut : 2pcs. M10 flange nut : 4pcs.

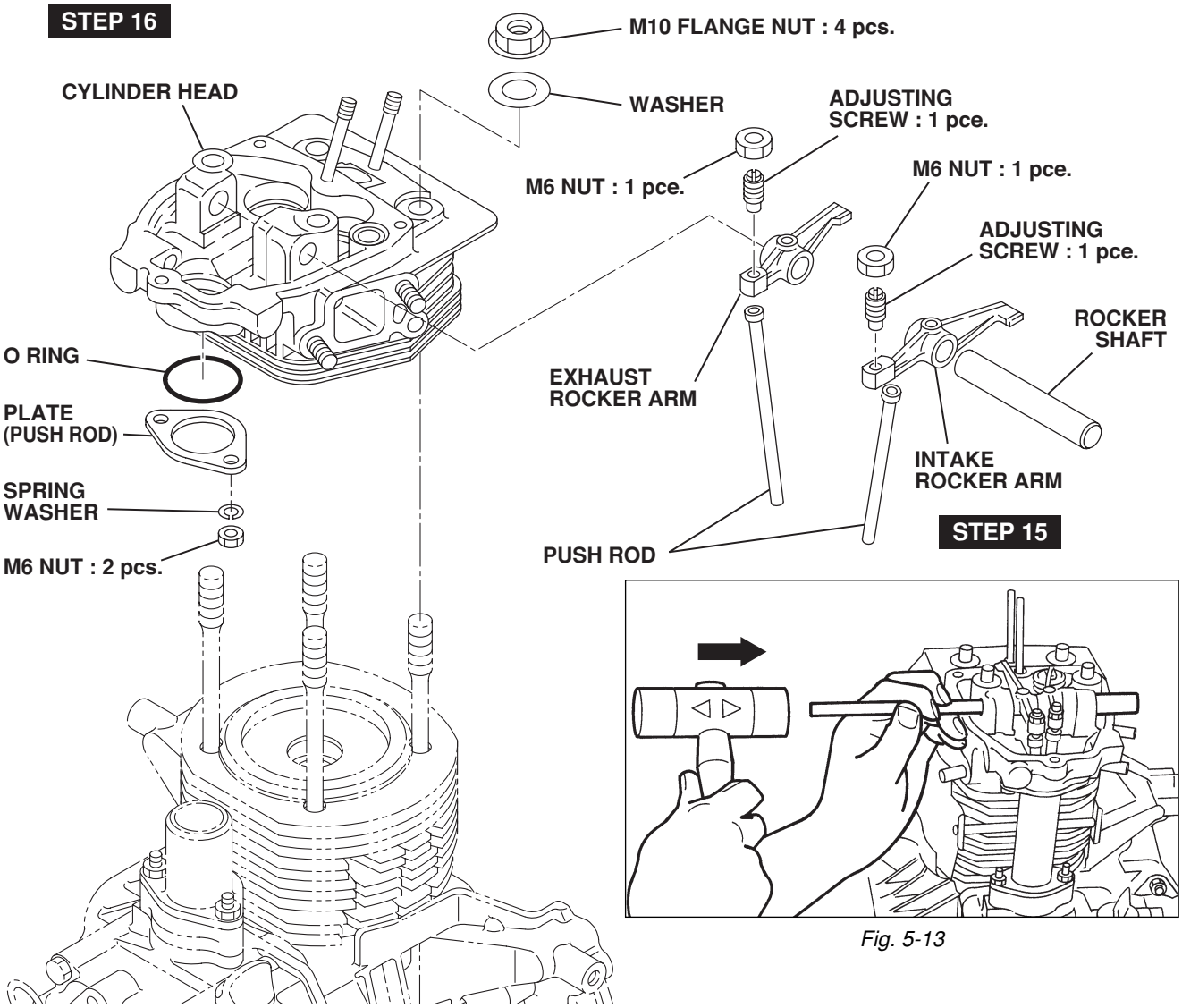


Fig. 5-12

Fig. 5-13

Step	Parts to remove	Remarks and procedures	Fasteners
17	Cylinder	Remove cylinder from crankcase. Under cylinder, there are O-ring and spacer. (See Fig. 5-15.)	
18	Push rod sleeve	Remove push rod sleeve from gear case cover.	M6 nut : 2pcs.
19	Tappet guide and Tappet	Remove tappet guide from gear case cover. A holder is necessary for not lef fall tappet. (See Fig. 5-16.)	

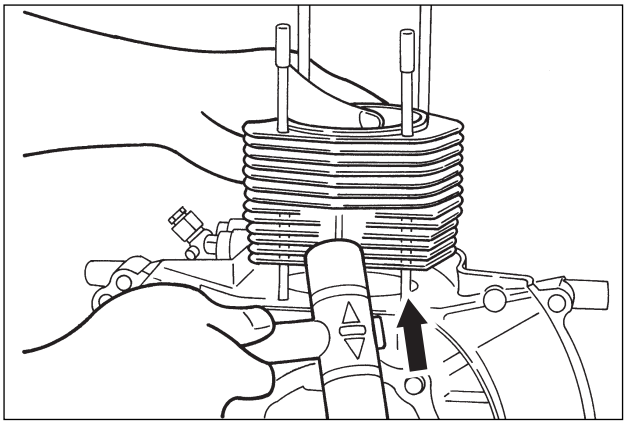


Fig. 5-15

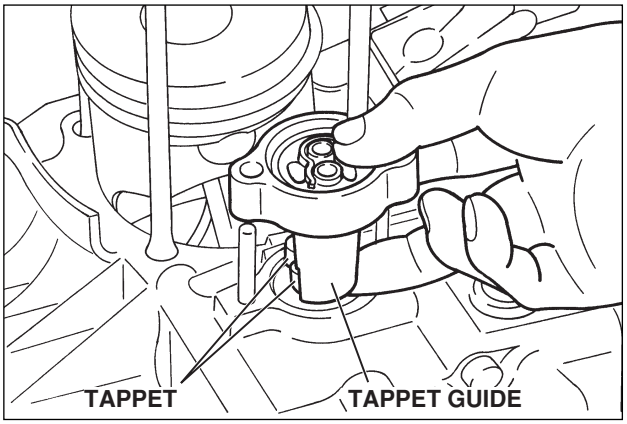


Fig. 5-16

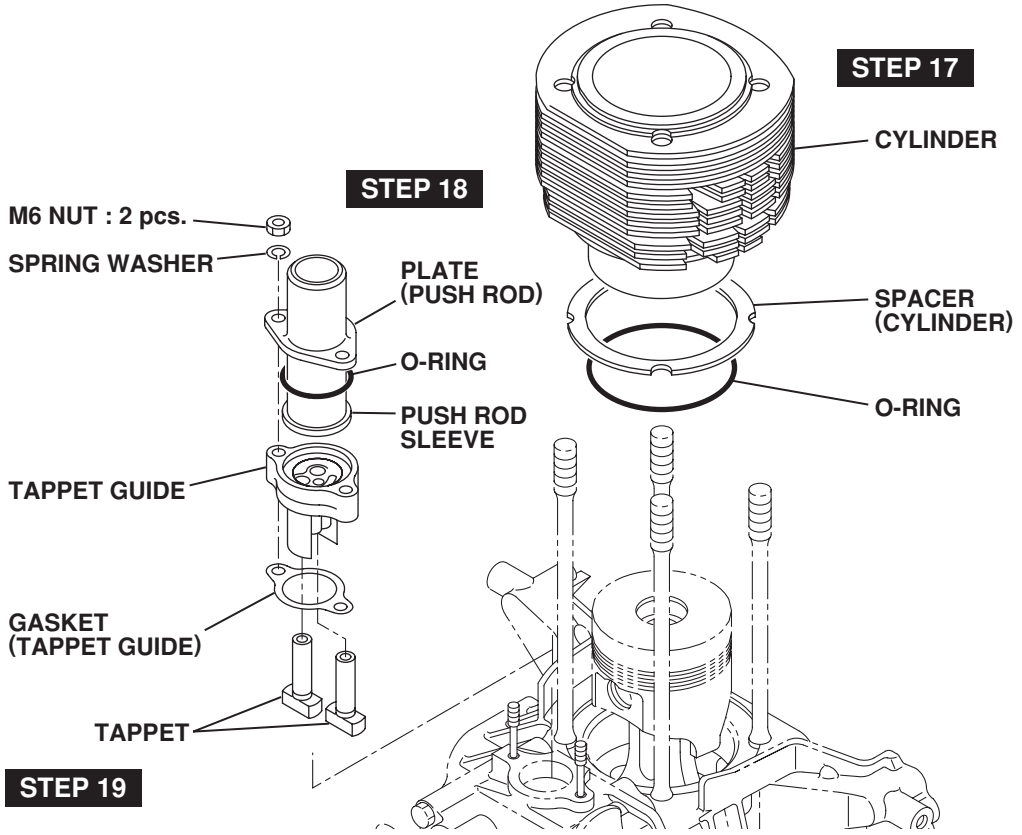


Fig. 5-14

Step	Parts to remove	Remarks and procedures	Fasteners
20	Fuel injection pump	(1) Remove oil filler cap. (2) Place control rack at the center. Or the pump can not be removed. The control rack may be shifted by moving governor lever. (See Fig. 5-18.) (3) Remove fuel injection pump from gear case cover.	M8 nut : 3pcs.

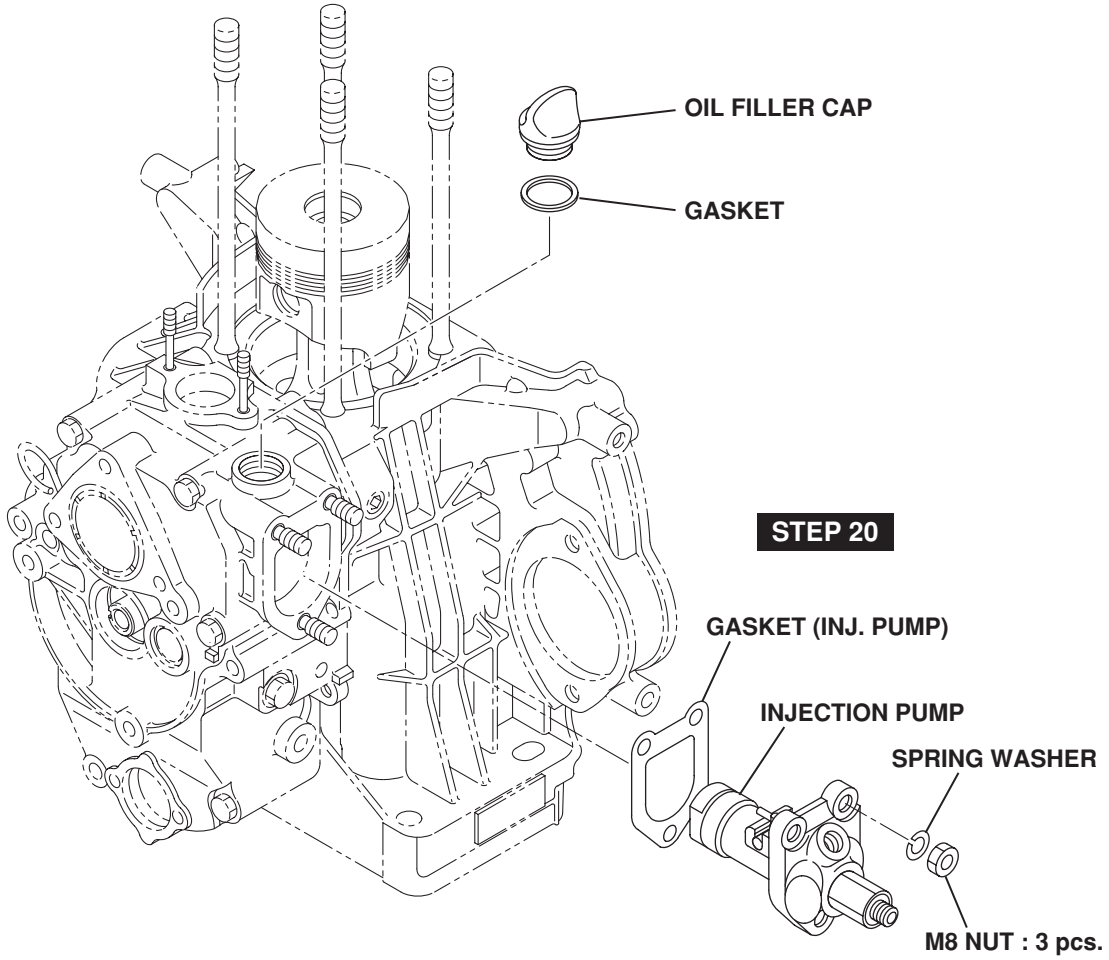


Fig. 5-17

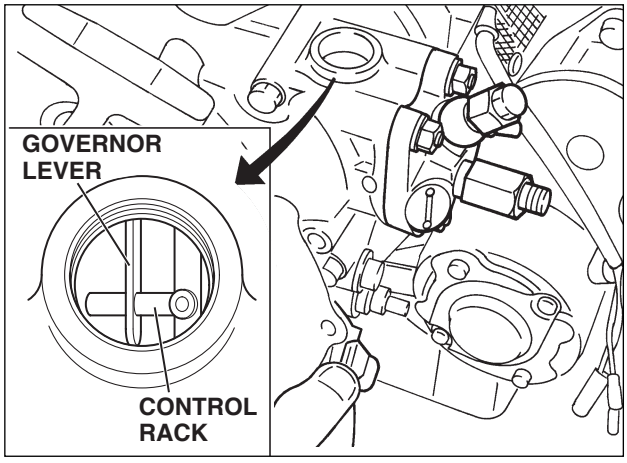


Fig. 5-18

Step	Parts to remove	Remarks and procedures	Fasteners
21	Gear case cover	Remove gear case cover from crankcase. (See Fig. 5-20-1.)	M8 × 65 bolt and washer : 3pcs. (DY41/42 : 4pcs.) M8 × 85 bolt and washer : 4pcs.
22	Camshaft	Pull out camshaft. (See Fig. 5-20-2.) There is a spacer between camshaft and gear case.	

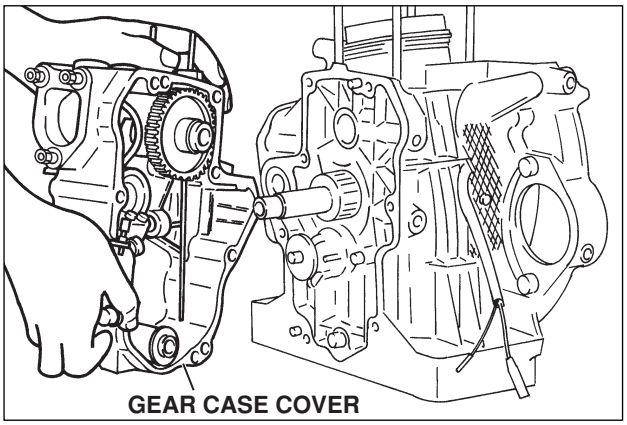


Fig. 5-20-1

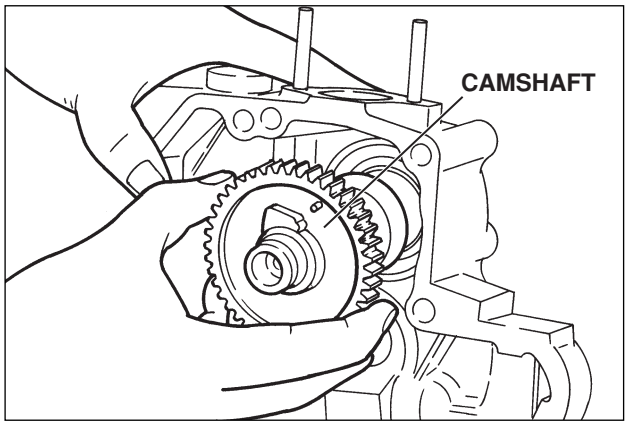


Fig. 5-20-2

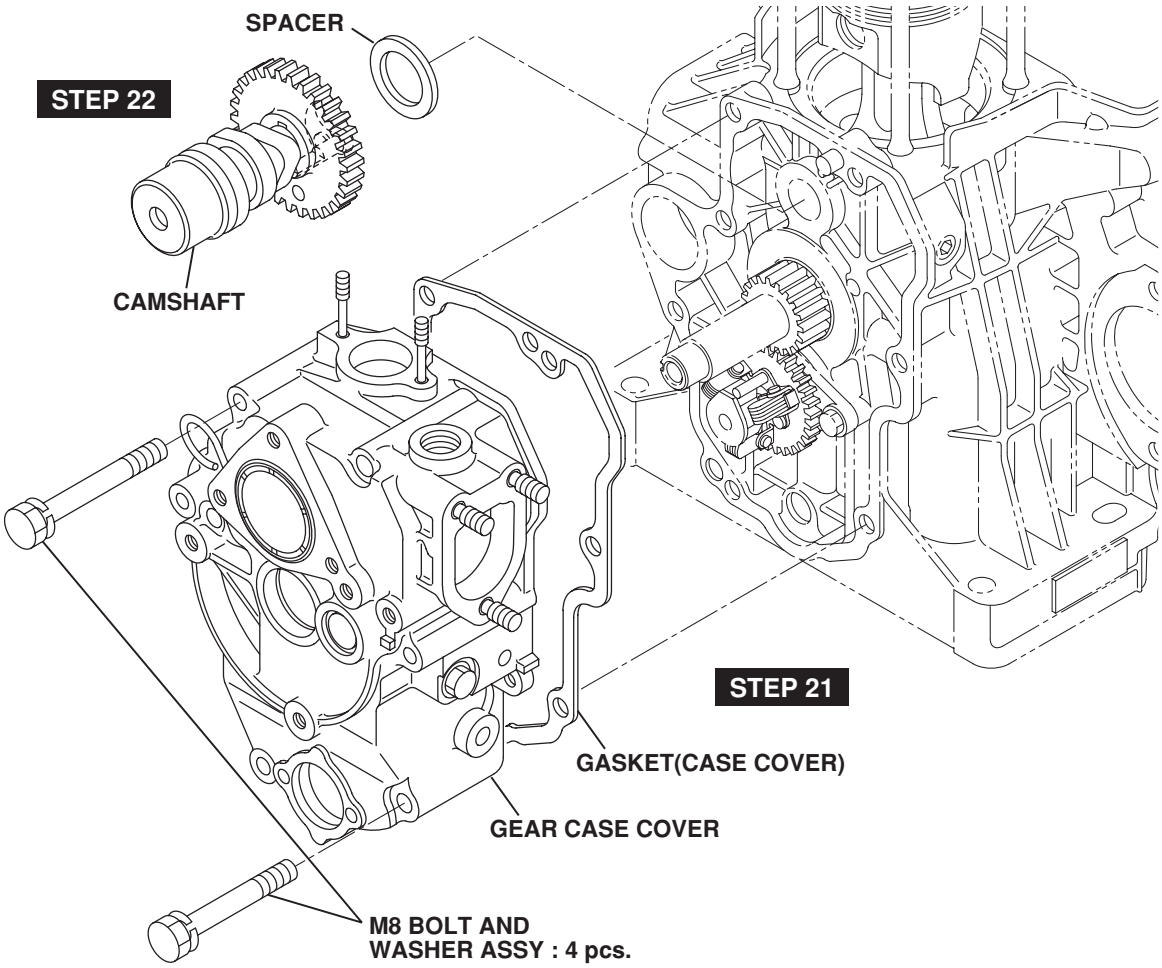


Fig. 5-19

Step	Parts to remove	Remarks and procedures	Fasteners
23	Piston pin and Piston	(1) Remove clip and push out piston pin. (See Fig. 5-22-1 and 5-22-2.) (2) Remove piston from connecting rod. Watch the direction of clip, also pay attention to the direction of the piston.	
24	Governor plate and oil pump	Remove governor plate and oil pump in from of one piece from crankcase.	M6 bolt and washer : 2pcs.

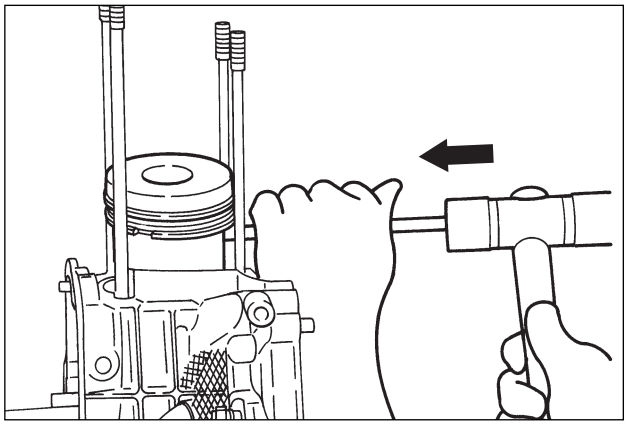


Fig. 5-22-1

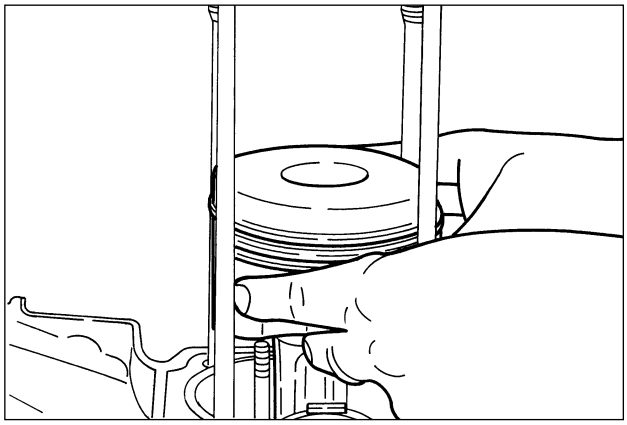


Fig. 5-22-2

Fig. 5-21

Step	Parts to remove	Remarks and procedures	Fasteners
25	Oil pan	Remove oil pan from crankcase.	M6 × 13 bolt and washer : 8pcs.
26	Connecting rod	Remove connecting rod from crankshaft. (See Fig. 5-24.) No lock washer. Be careful of direction of rod. (Fan mark is on the side of the flywheel.) Be careful of the setting mark of the cap.	

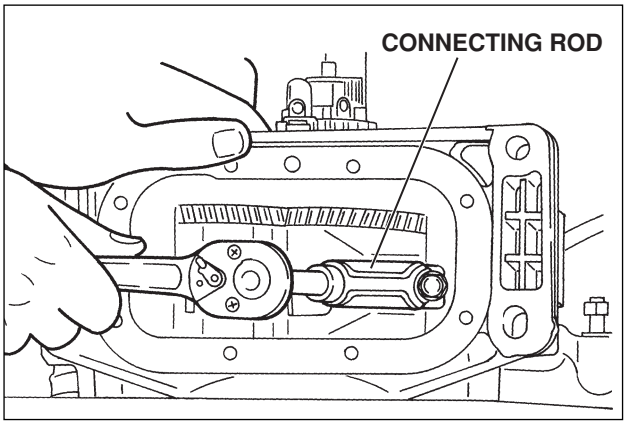


Fig. 5-24

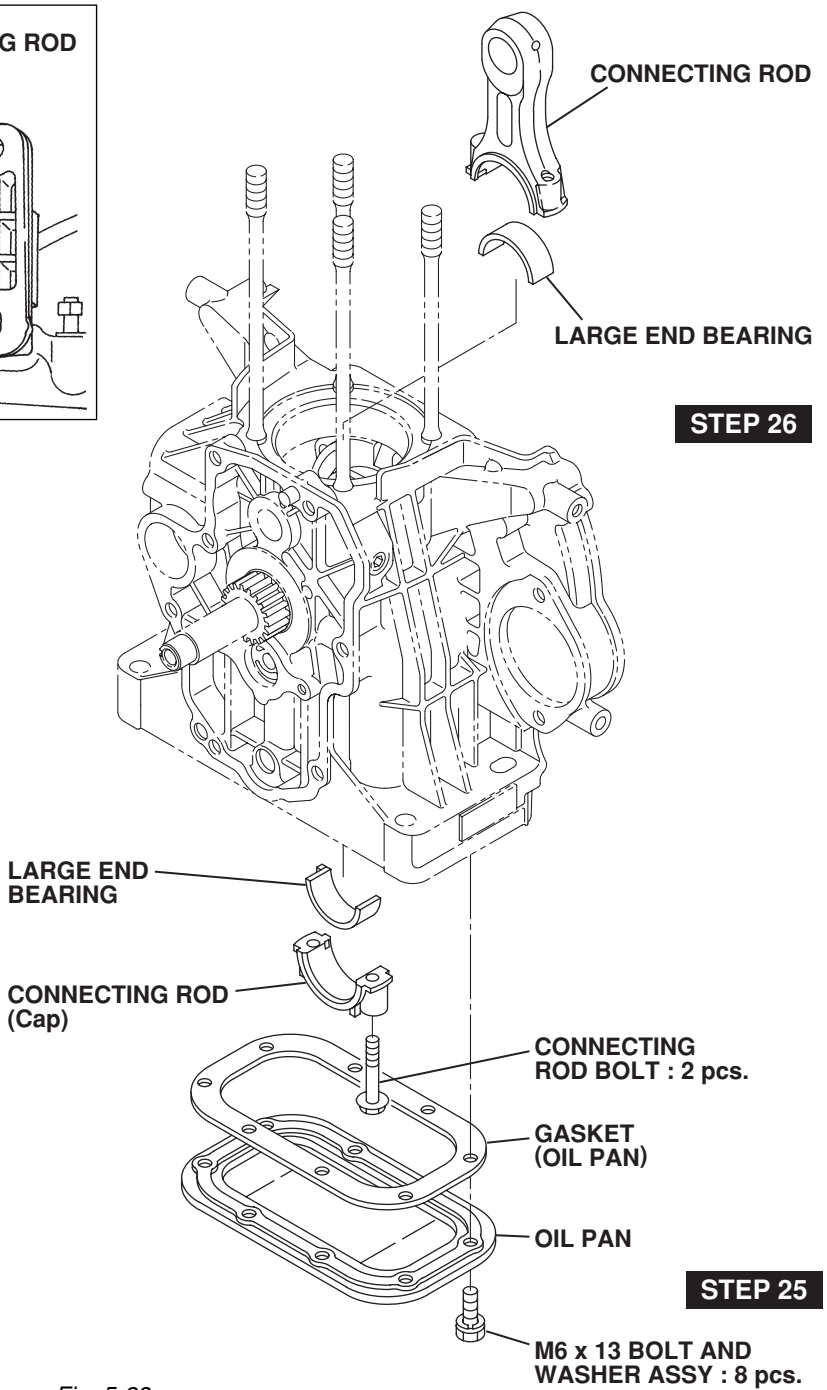


Fig. 5-23

Step	Parts to remove	Remarks and procedures	Fasteners
27	Bearing housing and Crankshaft	(1) From crankshaft remove key on the side of fan. (See Fig. 5-26.) (2) Remove bolt fastening bearing housing. Be careful of copper shim and O-ring between bearing housing and case. Also be careful of hole for oil. (3) Pull crankshaft together with bearing housing. (Gently tap side of crank gear with plastic hammer.) (See Fig. 5-27. and 5-28.) After pulling out crankshaft from case, remove housing. The bearing remains on crankshaft.	M8 × 20 bolt and washer : 6pcs. (DY41/42 : 7pcs.)

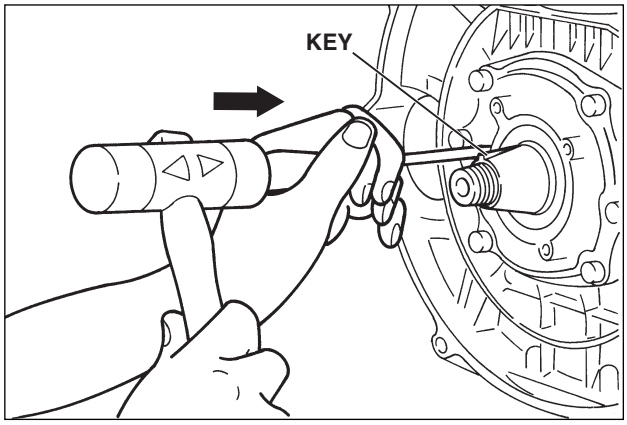


Fig. 5-26

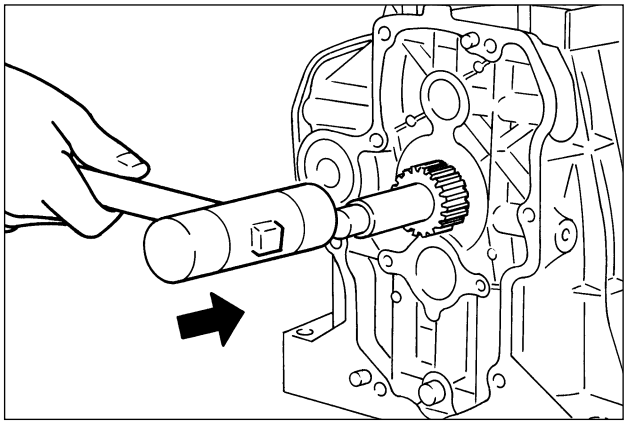


Fig. 5-27

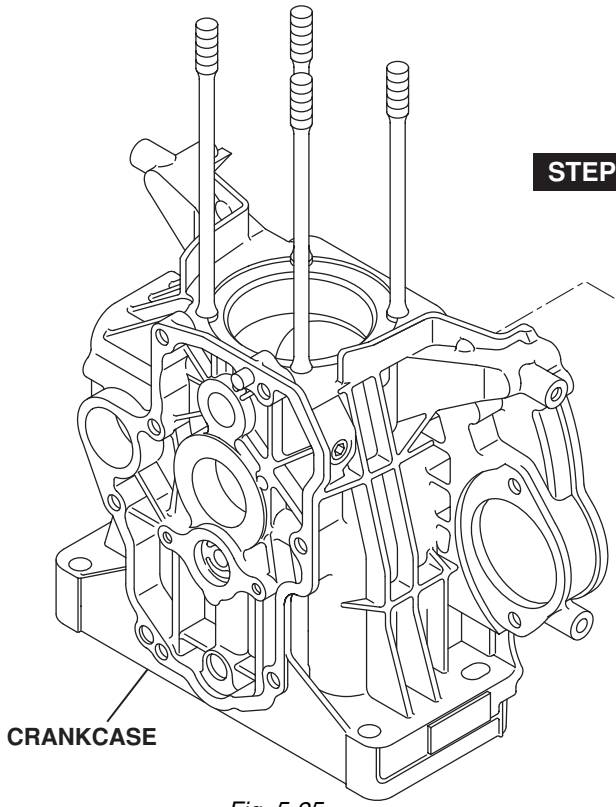
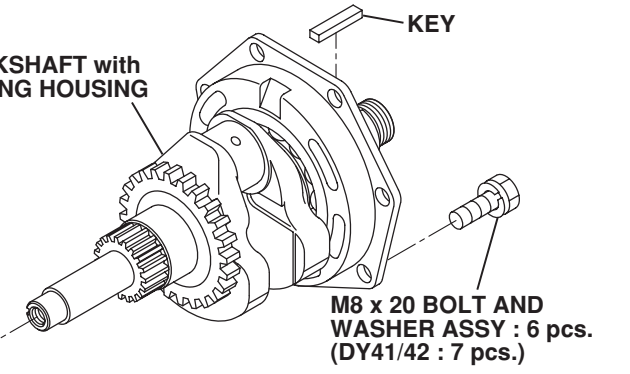


Fig. 5-25

STEP 27



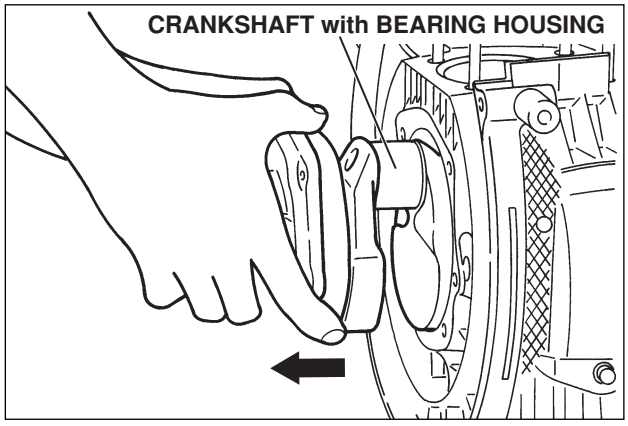


Fig. 5-28

Step	Parts to remove	Remarks and procedures	Fasteners
28	Balancer shaft Balancer gear	(1) Remove balancer cover (2) Remove snap ring. (See Fig. 5-30.) (3) Slide out balancer shaft so that balancer gear may be removed. (See Fig. 5-31.)	M6 bolt and washer : 3pcs.

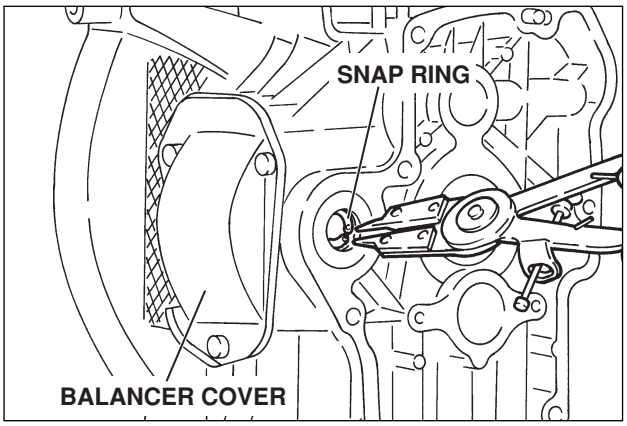


Fig. 5-30

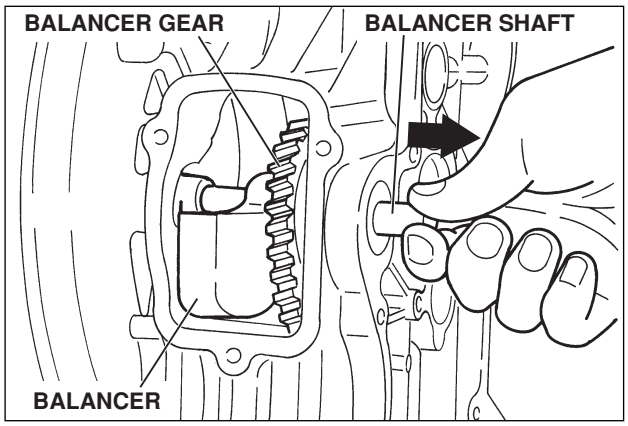


Fig. 5-31

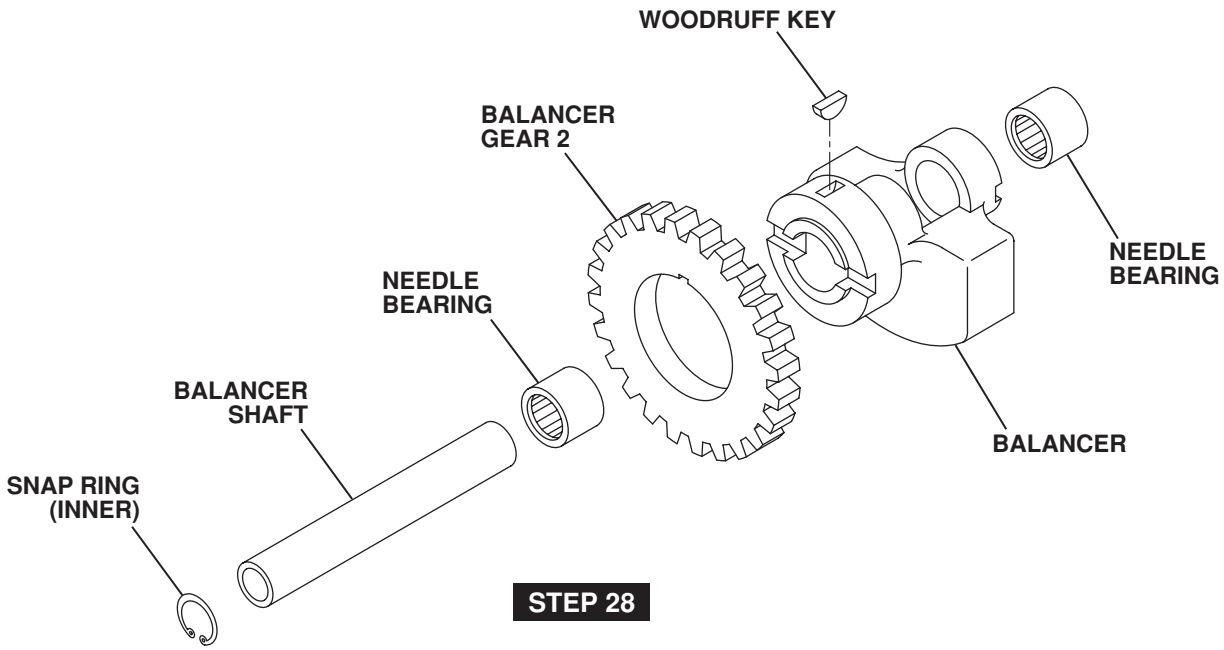


Fig. 5-29

Step	Parts to remove	Remarks and procedures	Fasteners
29	Intake and exhaust valves	(1) Press valve springs and remove retainer locks from valve stems. (See Fig. 5-33.) (2) Remove valves from cylinder head. Put marks on the valves, valve springs and spring retainers to distinguish them for intake side from exhaust side.	

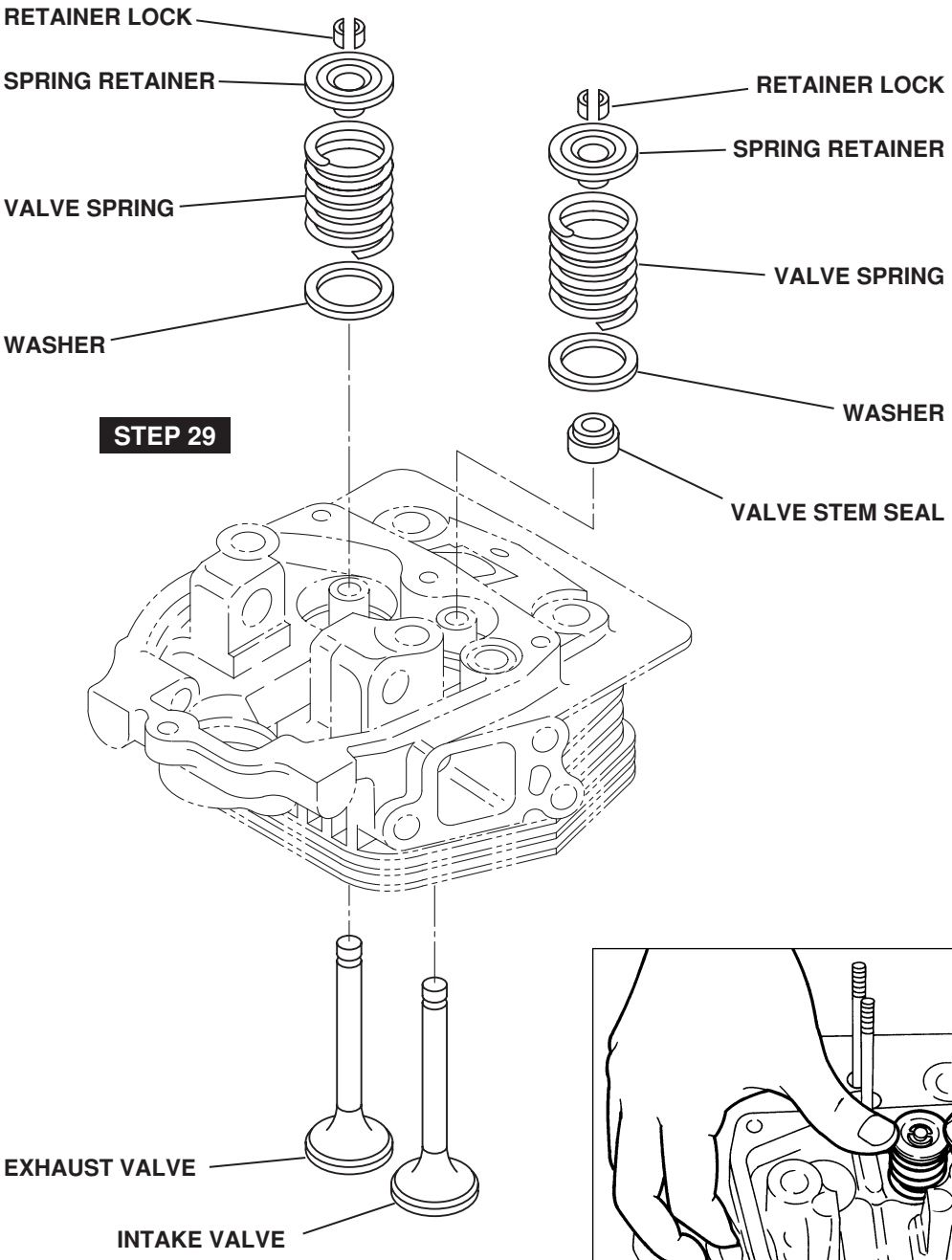


Fig. 5-32

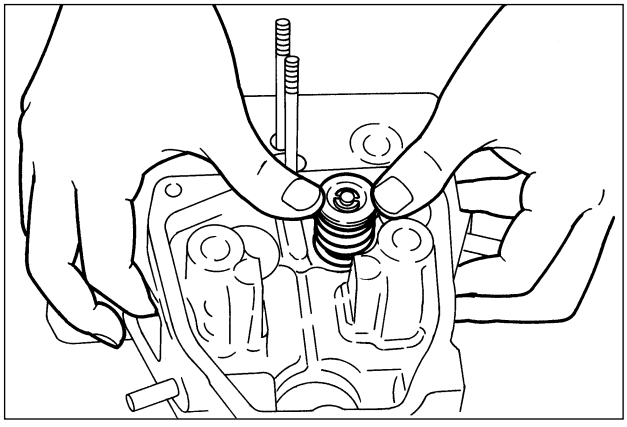


Fig. 5-33

5-4 REASSEMBLY PROCEDURES

● PRECAUTIONS FOR REASSEMBLING

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

1) BALANCER

a) Insert the balancer.
b) Insert the balancer shaft.
c) Assemble the snap ring.

2) CRANKSHAFT

Insert the crankshaft into the crankcase.
For the engine with the balancer, fit the balancer first to the crankcase.

CAUTION

Be careful not to damage bearing metal.
When fitting, check the mating mark.

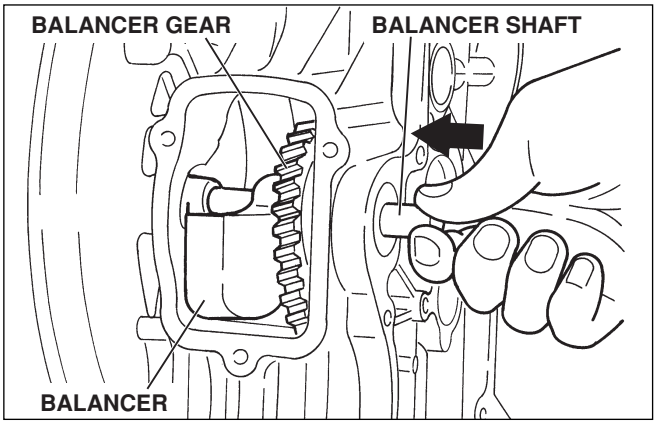


Fig. 5-34-1

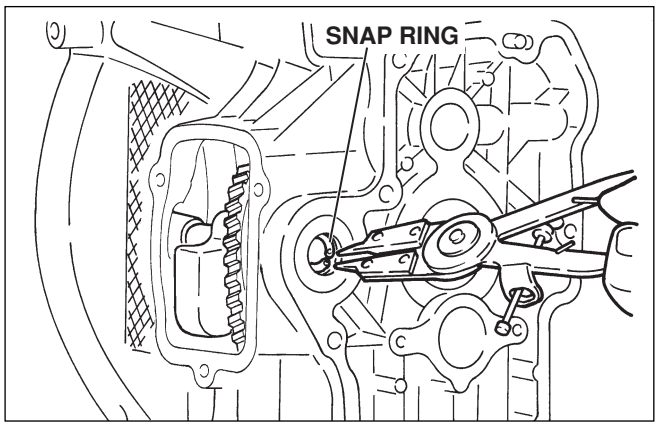


Fig. 5-34-2

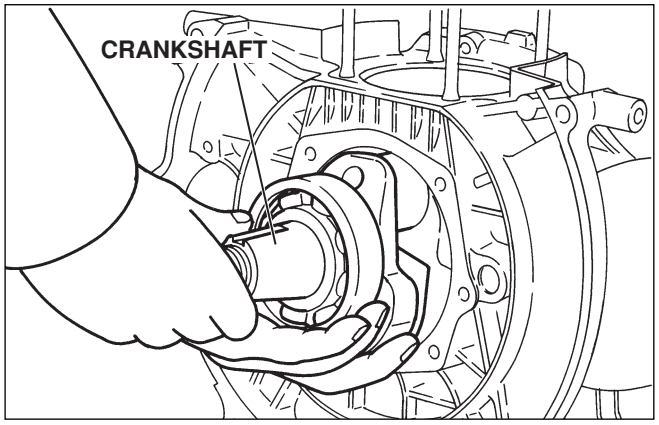


Fig. 5-34-3

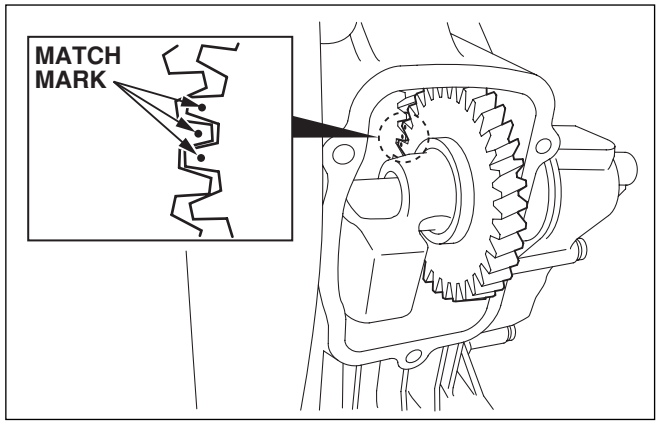


Fig. 5-34-4

3) BEARING HOUSING

Assemble the bearing housing.

[NOTE]

Apply oil or grease inside the housing oil seal. Set the bearing housing so that its oil hole may face upward.

CAUTION

Be sure to put O-ring on.

Cupper shim ; GASKET (Bearing Housing)	DY30/35	228-15004-03	T = 0.1
		228-15005-03	T = 0.2
		228-15006-03	T = 0.3
	DY41/42	231-15004-03	T = 0.1
		231-15005-03	T = 0.2
		231-15006-03	T = 0.3

※Select 1 piece only Unit : mm

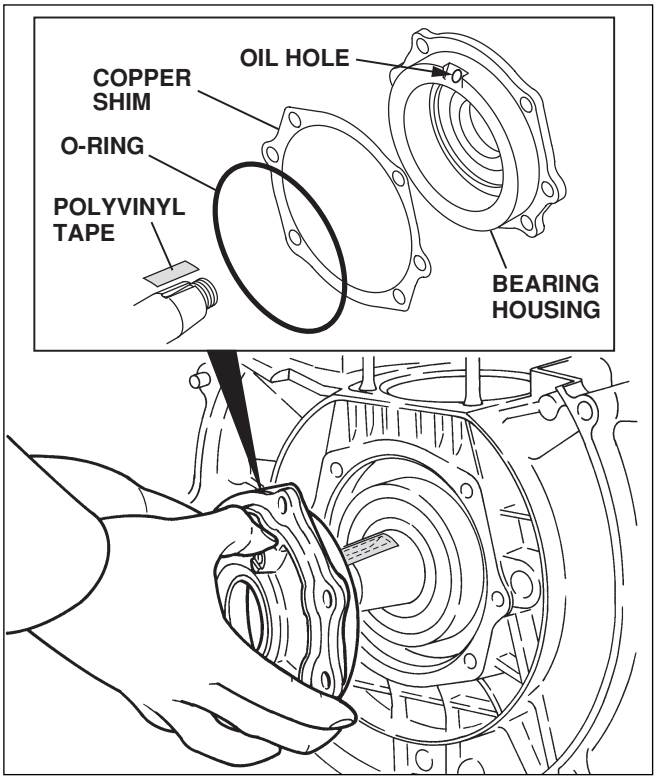


Fig. 5-35-1

[NOTE]

Temporality fix bearing housing with the copper shim ; Gasket (Bearing Housing) adjust the side clearance of the crankshaft.

Crankshaft side clearance
0.1 - 0.2 mm (0.0039-0.0079 in.)

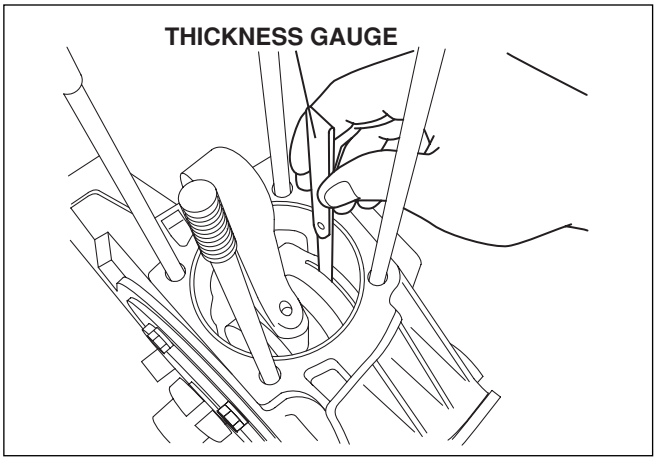


Fig. 5-35-2

M8 X 20 mm bolt and washer ···· 6 pcs.
(DY41/42 : 7 pcs.)

Tightening torque
20.0-23.0 N·m (200-230 kgf·cm) (14.5-16.7 ft·lb)

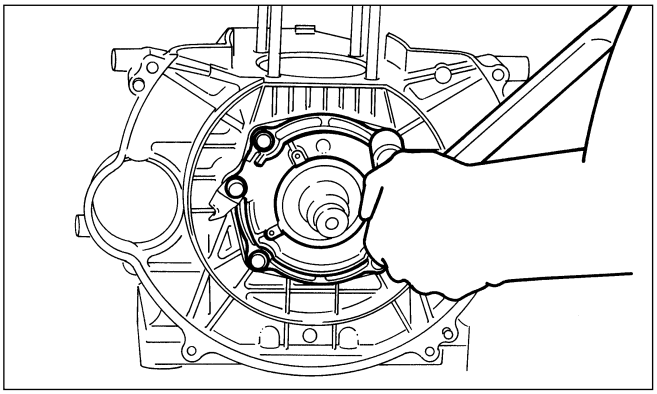


Fig. 5-36

4) CONNECTING ROD

Assemble the connecting rod.

CAUTION

Pay attention to the direction of the rod.
(FAN mark is to be set on the side of the flywheel.)

[NOTES]

1. Check the match mark on the cap.
2. The lock washer is not used when fastening the bolt.

Tightening torque	
DY30/35	**DY41/42**
25.0-27.0 N·m (250-270 kgf·cm) (18.1-19.5 ft·lb)	39.0-45.0 N·m (390-450 kgf·cm) (28.8-33.2 ft·lb)

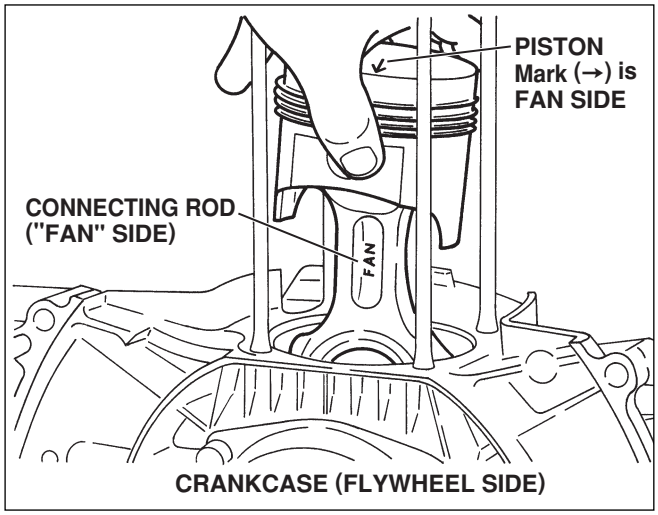


Fig. 5-37

5) OIL PAN

Assemble the oil pan.

M6 X 13mm bolt and washer ···· 8 pcs.

[NOTE]

Use new gasket.

6) PISTON

Assemble the piston.

[NOTES]

1. Mark(→) in the upper part of the piston is to be faced to the fan side.
2. Piston rings are not assembled.
3. Shape of the piston pin is "Φ"(clip).

TOP RING
SECOND RING
OIL RING

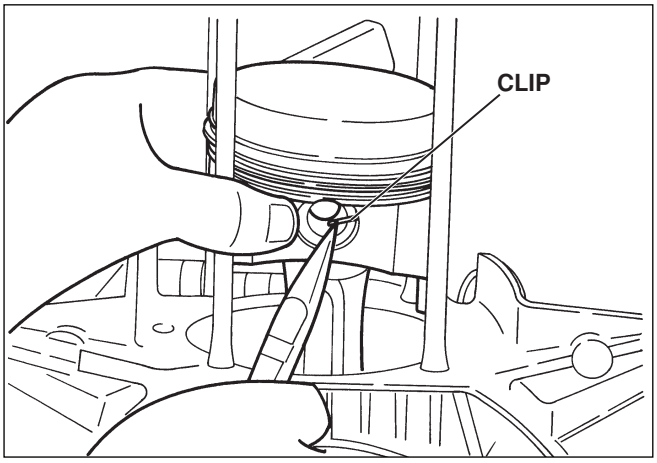


Fig. 5-38-1

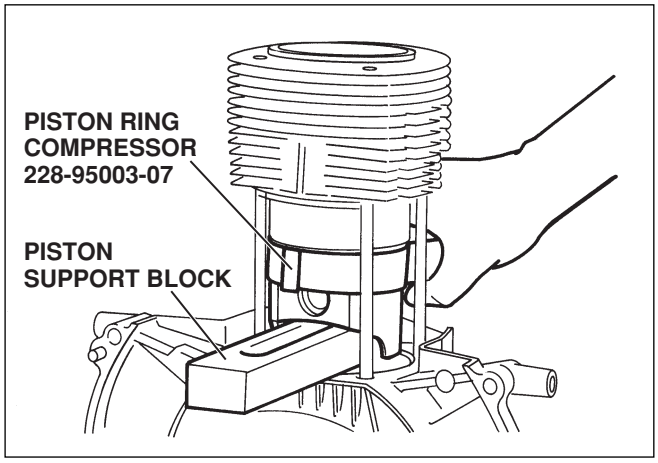


Fig. 5-38-2

7) CYLINDER

Assemble the cylinder.

[NOTES]

1. Insert the piston into the cylinder (piston ring is not Inserted.), and measure the dimensions of the head of piston and upper surface of the cylinder.
2. The concave dimensions of the piston is -0.6–0.7mm from the upper surface of the piston.
3. Adjustment of the concave dimensions is to be made by the shim underneath the cylinder, and available thickness of the shim are 0.1 mm and 0.2 mm.
4. Fit the piston rings on the piston. Punched mark "N" are to be faced up. Open end of each ring must avoid the direction toward the thrust side and it is to be set to the different three directions.
5. Set the cylinder. Be sure to fit rubber O-ring and shim. Notched portion of the cylinder skirt must be set on the side of the gear case cover.

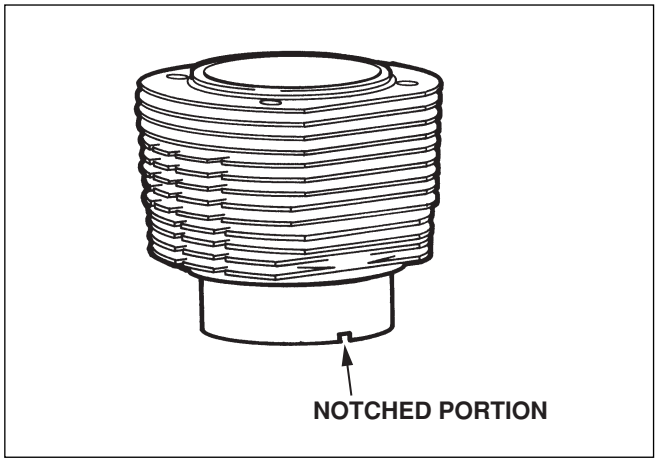


Fig. 5-39-1

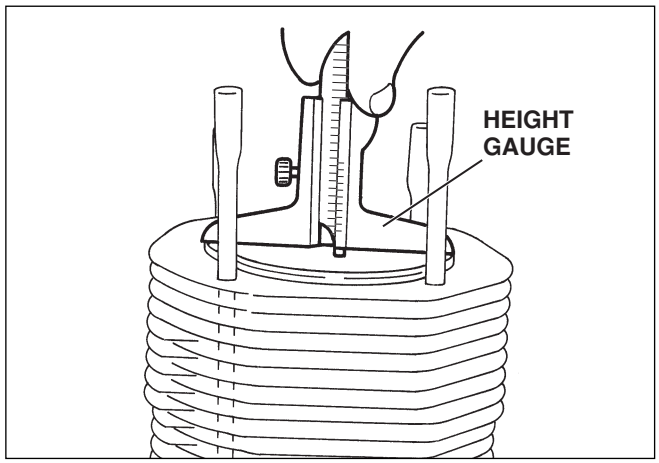


Fig. 5-39-2

8) FLYWHEEL

Install the flywheel.
(Use 41mm box wrench.)

[NOTE]

When putting lock washers on, be sure to bend the tabs securely.

Tightening torque
200.0-220.0 N·m
(2000-2200 kgf·cm)
(145-160 ft·lb)

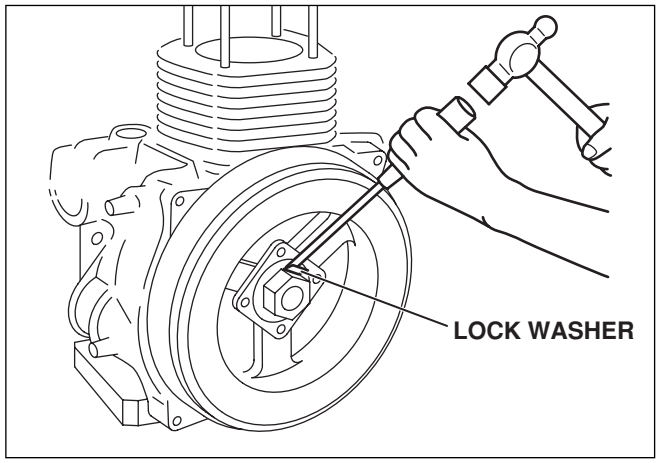


Fig. 5-40

9) CAMSHAFT

Install the camshaft.

[NOTES]

1. Apply oil or grease to the inside of oil seal for the gear case cover.
2. Set the match mark of the camshaft so as to fit to that of the crank gear.
Side clearance is to be adjusted to 0.1- 0.3mm. Three kinds of shim are available, viz. 0.8mm, 1.0mm and 1.2mm. Deem the gasket thickness (the one between crankcase and gear case) to 0.35mm.

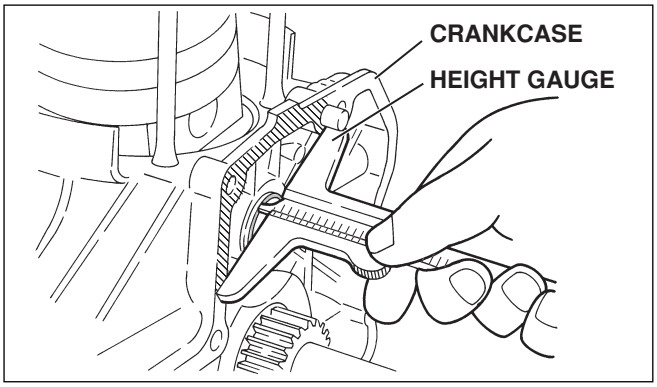


Fig. 5-41

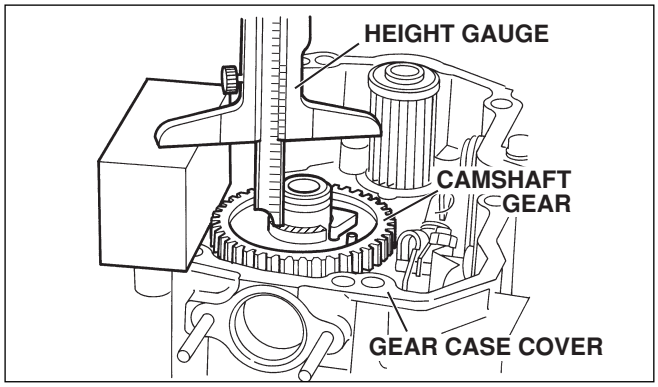


Fig. 5-42

10) OIL PUMP and GOVERNOR

Assemble the oil pump and the governor.

M6 X 20mm bolt and washer ···· 2 pcs.

[NOTES]

1. The hole in the oil pump cover is to face downward.
2. Check if the governor sleeve moves smoothly. Outer surface of the trochoid pump must face the case side.

Tightening torque
8.0-10.0 N·m (80-100 kgf·cm) (5.8-7.2 ft·lb)

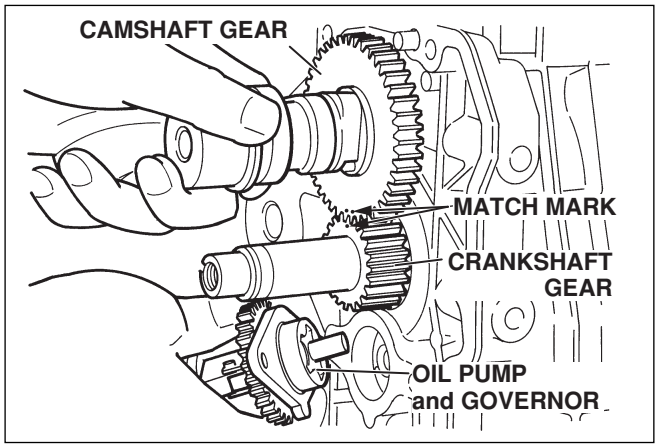


Fig. 5-43a

11) GEAR CASE COVER

Assemble the gear case cover.

M8 X 85mm bolt and washer ···· 4 pcs.

[NOTE]

When the pin is replaced, apply "Three Bond" at the both ends of the pin for cranking. This pin locates at the top of the camshaft. Check if the governor link operates.

M8 X 65mm bolt and washer ···· 3 pcs.
(DY41/42 : 4pcs.)

Tightening torque
20.0-23.0 N·m (200-230 kgf·cm) (14.5-16.7 ft·lb)

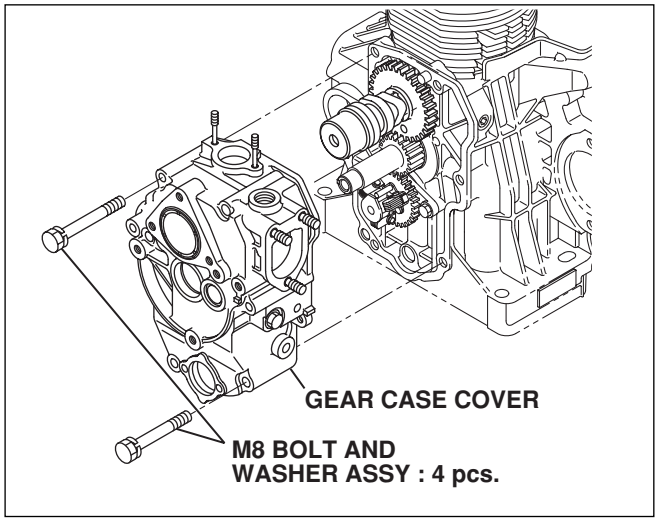


Fig. 5-43b

12) FUEL INJECTION PUMP

Assemble the injection pump.
M8 nut and washer ···· 3 pcs.

[NOTE]

Measure the distance between the face of the cam base and the surface to which the injection pump is to be fitted. And adjust it may become 76 ± 0.05mm, using the shims. Two kinds of the shim are available, viz. 0.1mm, 0.2mm and 0.3mm.

CAUTION

Remove the oil filler cap and check if the control rack surely goes through the govennor lever notch.

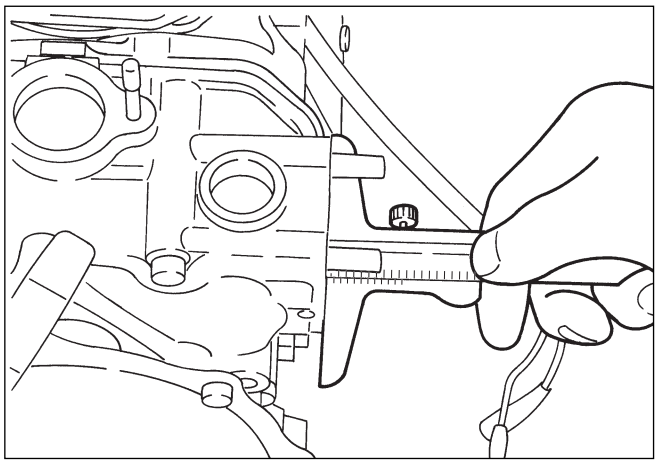


Fig. 5-44

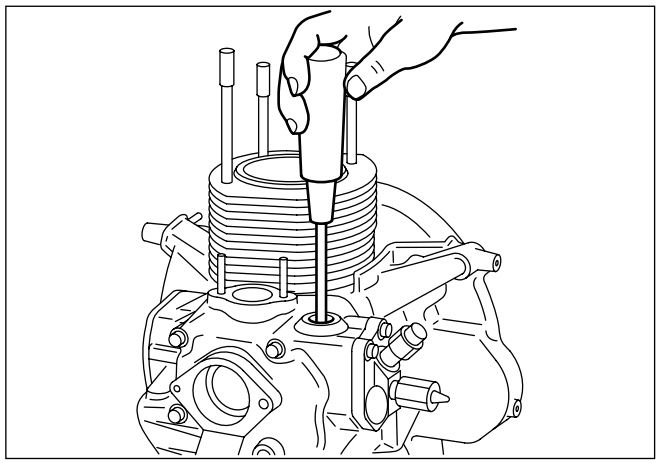


Fig. 5-45

13) TAPPET GUIDE

Assemble the tappet guide.

CAUTION

Be careful not let the tappet fall in the case.

[NOTE]

The roll pin of the tappet guide is to be set at the right side as viewed from the gear case side.

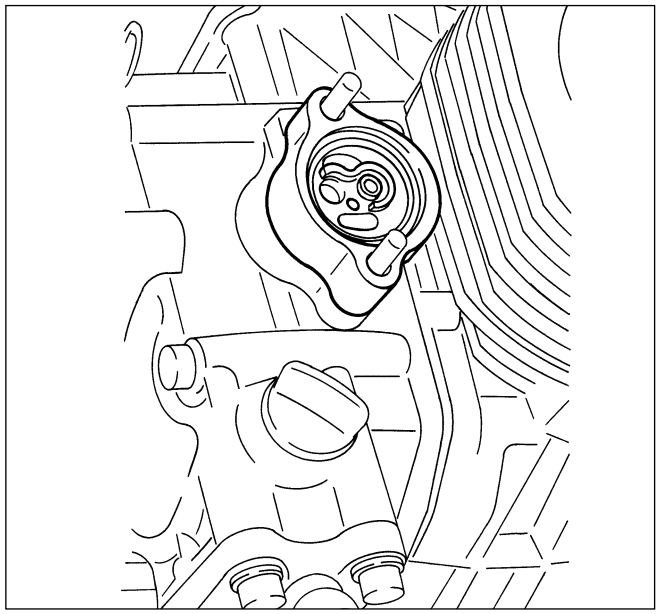


Fig. 5-46

14) PUSH ROD SLEEVE

Temporarily assemble the push rod sleeve.
M6 nut and washer ···· 2 pcs.

[NOTE]

2 pcs. of the plate (push rod sleeve) are to be assembled temporarily.

15) CYLINDER HEAD

Assemble the cylinder head.

M10 flange nut and washer ···· 4 pcs.

[NOTES]

1. Install the intake and exhaust valves. On the intake side there is a stem seal.

2. Insert the push rod.(Intake is on the side of the flywheel) Pay attention to the valve facing, upward or downward, and direction of intake and exhaust. (See Fig. 5-47-2)

3. Install the rocker arm to the cylinder. It is advisable to insert the rocker shaft before clamping the head.

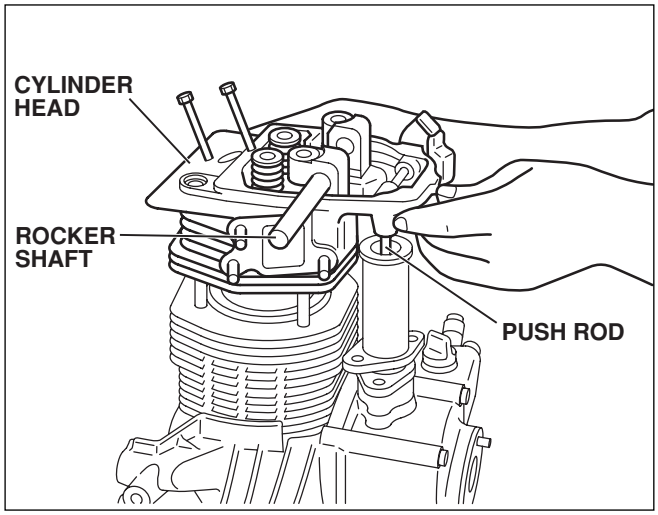


Fig. 5-47-1

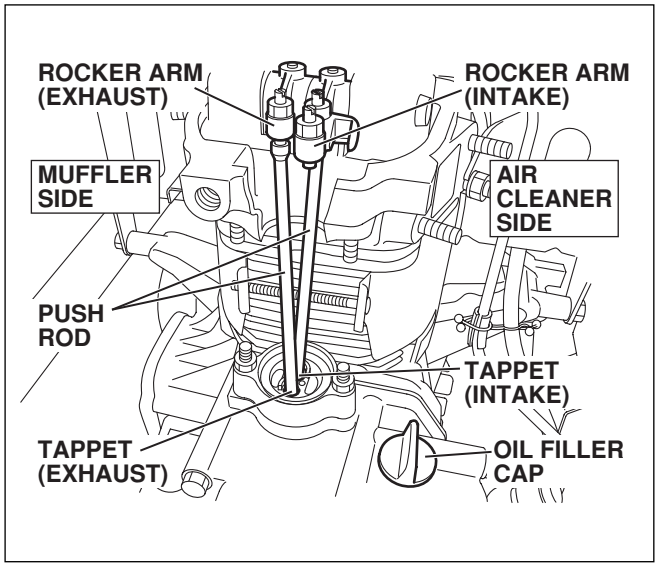


Fig. 5-47-2

[NOTE]

Clamp the head to the cylinder. Apply "Three Bond #1215" to two pieces of the stud bolt (on the side of the rocker shaft) and upper and reverse surfaces of the washer, and then tighten the nuts.

Tightening torque
35.0 N·m
(350 kgf·cm)
(25.4 ft·lb)

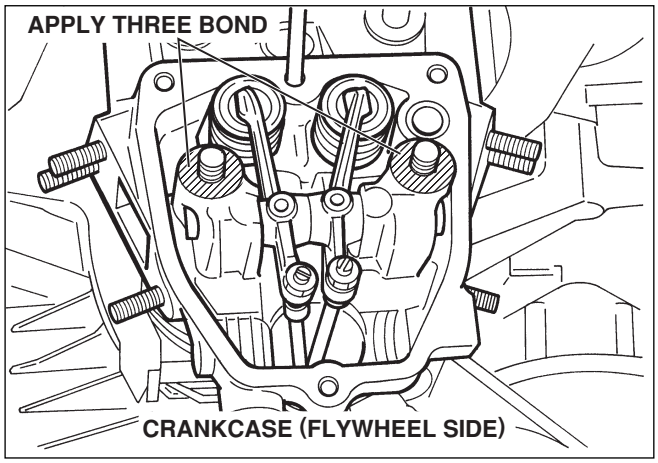


Fig. 5-47-3

Tightening of the nuts is to be done in three rounds, i. e.:

Tightening torque		
1st step	2nd step	3rd round
10.0 N·m	20.0 N·m	30.0-35.0 N·m
100 kgf·cm	200 kgf·cm	300-350 kgf·cm
7.2 ft·lb	14.5 ft·lb	24-25.4 ft·lb

[NOTE]

Fasten tightly the plate (push rod sleeve).

M6 nut · · · · 4pcs.

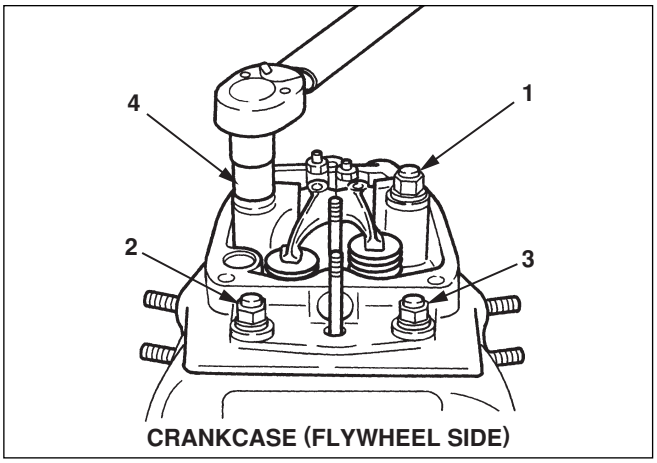


Fig. 5-48

16) VALVE CLEARANCE ADJUSTMENT

Adjust the valve clearance.

Valve clearance (Both intake and exhaust ; cold condition)
0.07 - 0.10 mm (0.0028-0.0039 in.)

Tightening torque
8.0-10.0 N·m (80-100 kgf·cm) (5.8-7.2 ft·lb)

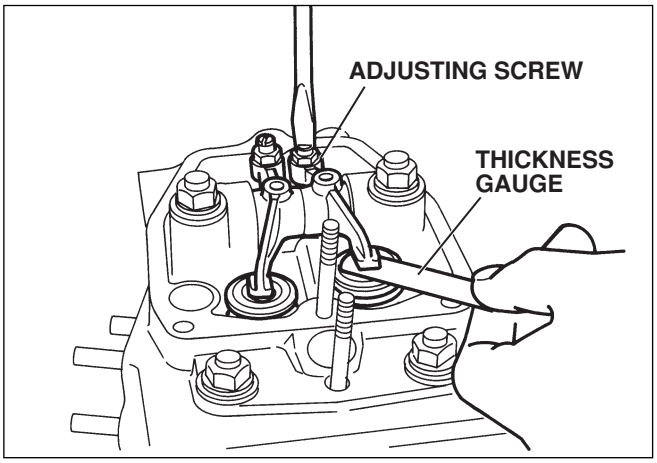


Fig. 5-49-1

[NOTES]

1. Turn the flywheel by hand to the compression at TDC(top dead center). At TDC the camshaft cranking pin stands vertically.

2. Adjust the valve clearance, when the engine is cold.

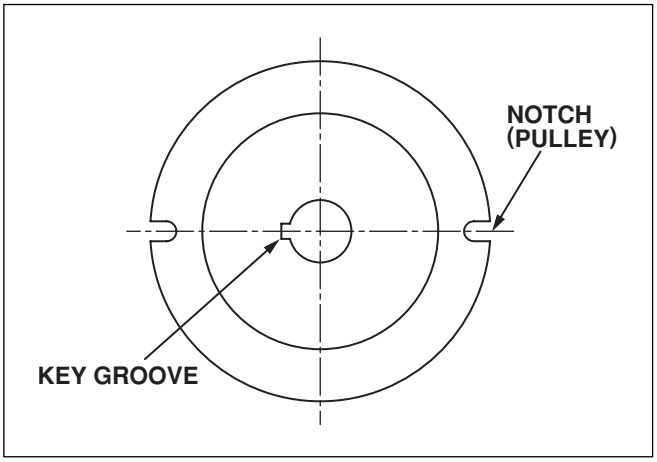


Fig. 5-49-2

INTAKE, EXHAUST VALVE TIMING

When valve clearance is at 0.4mm and the engine is in the warmed up condition ;

- 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.

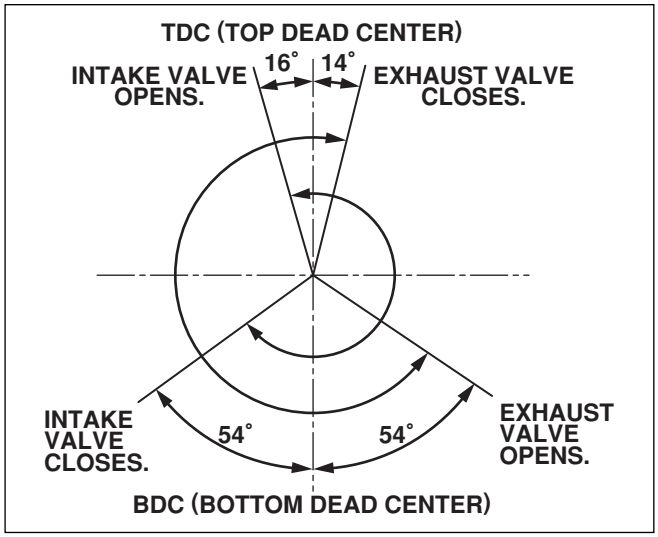


Fig. 5-50

17) DECOMPRESSION CLEARANCE

Adjust the decompression clearance.

[NOTES]

1. The decompression device locates in the rocker arm on the intake valve side.
2. Set the decompression lever at the position of decompression. (Push the lever to the horizontal position.)
3. Clearance is about 0.5mm. Turn the adjust screw until it touches the decompression shaft, and then make another half turn. Threading of this screw is 1.0mm. Turn the flywheel by hand and check a contact between the valve and the piston.

18) ROCKER COVER

Assemble the rocker cover.
M6 X 40mm bolt and washer ···· 3 pcs.

[NOTES]

1. Check if there is an "0" ring for breather hole on the surface of the head (intake breather's side).
2. Check if the gasket for the rocker cover is put correctly in the groove.

19) NOZZLE HOLDER

Install the nozzle holder.
M6 nut and washer ···· 2 pcs.

[NOTE]

Pay attention to the gasket at the top. It is advisable to utilize the driver for easy installation.

Tightening torque
9.0-10.0 N·m
(90-100 kgf·cm)
(6.5-7.2 ft·lb)

20) BLOWER HOUSING

Install the blower housing.
Upper part :
M8 X 55mm bolt and washer ···· 2 pcs.
Lower part :
M8 X 40mm bolt and washer ···· 2 pcs.
(See Fig. 5-51.)

21) DRIVING SHAFT

Install the driving shaft..
M10 X 30mm bolt ···· 4 pcs.
(See Fig. 5-51.)

22) FLYWHEEL COVER

Assemble the flywheel cover.
M8 X 16mm bolt ···· 4 pcs.
(See Fig. 5-51.)

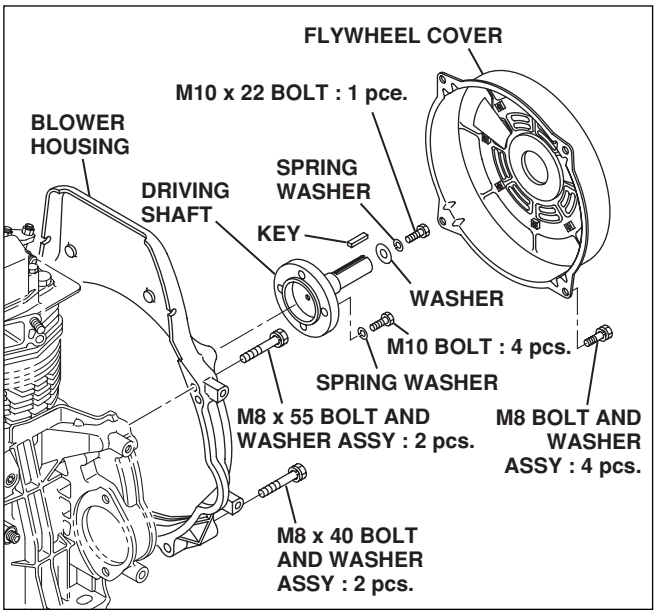


Fig. 5-51

23) CYLINDER BAFFLE

Assemble the cylinder baffle.
M6 X 8mm flange bolt ···· 2 pcs.(DY41/42 : 4pcs.)
M5 X 70mm round head cross recess
bolt and nut 5mm ···· 1 pce. each
(See Fig. 5-52.)

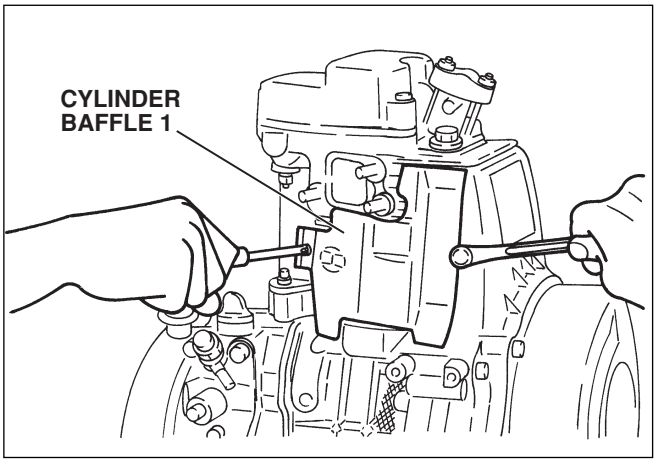


Fig. 5-52

24) TANK BRACKET

(1) Install the tank brackets, left and right.
M8 X 16mm bolt and washer ···· 2 pcs.
M8 nut bolt ···· 2 pcs. each
(See Fig. 5-53.)

(2) Connect the fuel pipe and fuel return pipe securely.
M8 X 18mm banjo bolt ···· 2 pcs.
Aluminum packing ···· 2 pcs.

[NOTE]

Connect the pipe to the nozzle first, and then connect the fuel pipe to the tank.

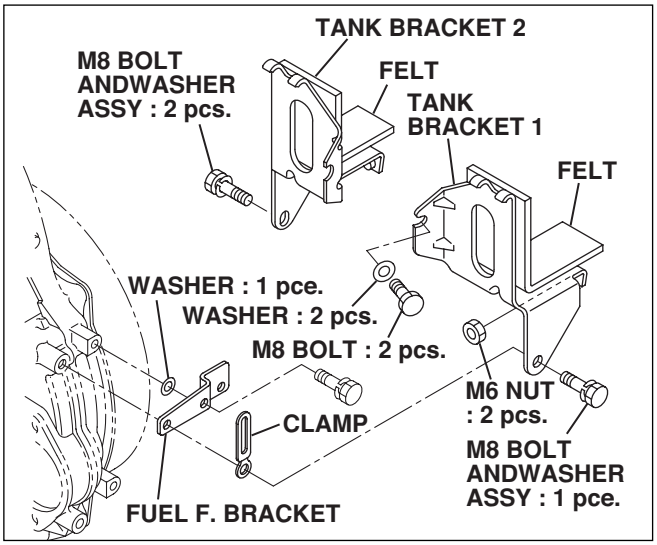


Fig. 5-53

25) AIR CLEANER

Install the air cleaner.

M6 nut and washer····2 pcs.

[NOTE]

Pay attention to the gasket.

26) MUFFLER

Install the muffler and the muffler cover.

Muffler : M8 stainless nut and washer····2 pcs.

Muffler cover : M6 X 8mm flange bolt····4 pcs.

(See Fig. 5-54.)

[NOTE]

Pay attention to the gasket.

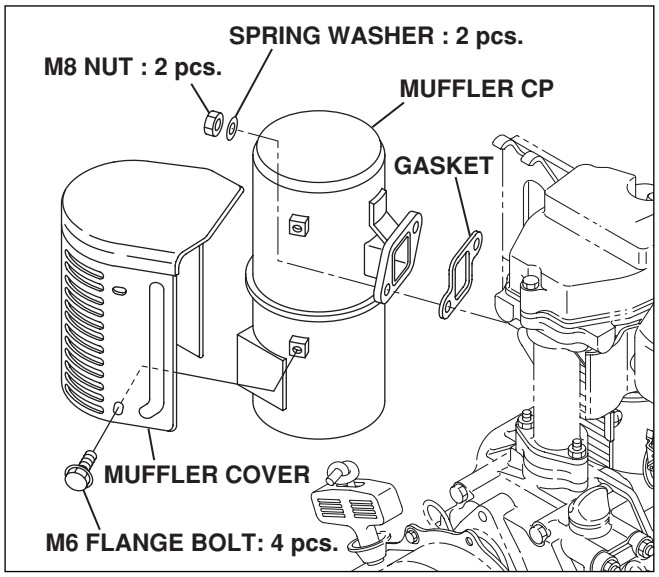


Fig. 5-54

27) FUEL INJECTION PIPE

Connect the fuel injection pipe.(17mm wrench)

It is advisable to remove the cap of the air cleaner and then connect. (See Fig. 5-55.)

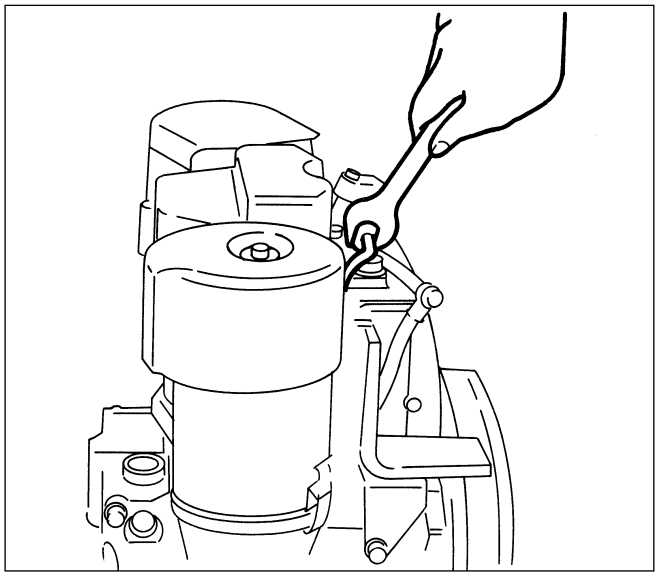


Fig. 5-55

28) FUEL TANK

Mount the fuel tank.

M6 X 45mm round head cross recess screw ···· 2 pcs.

When installing the fuel filter once removed from the tank, fasten the filter by hand and then make 1/4 turn with a spanner.

29) OIL FILTER

Install the oil filter

M6 X 13mm bolt and washer ···· 2 pcs.

The oil filter serves as the oil drain plug too.

Be sure to install O-ring.

30) ENGINE OIL

Supply engine oil.

Upper level ···· 1.0L max.

Lower level ···· 0.6L min.

Also pour oil into the air cleaner, watching oil level. (See Fig. 5-56.)

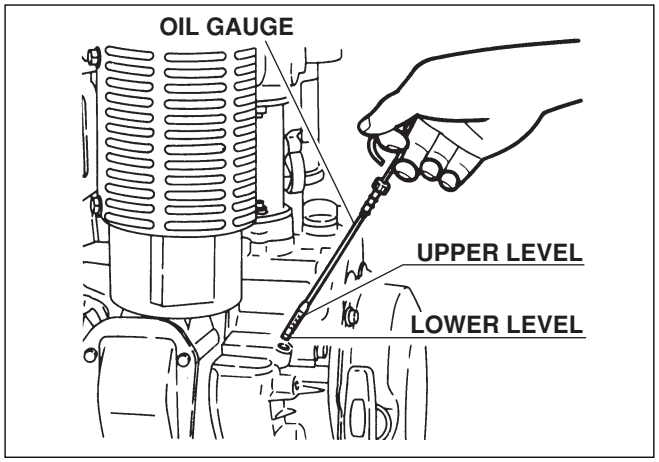


Fig. 5-56

31) DIESEL LIGHT OIL

Supply diesel light oil.

Fuel tank capacity ···· 4.5L

6. FUEL SYSTEM

6-1 OUTLINE

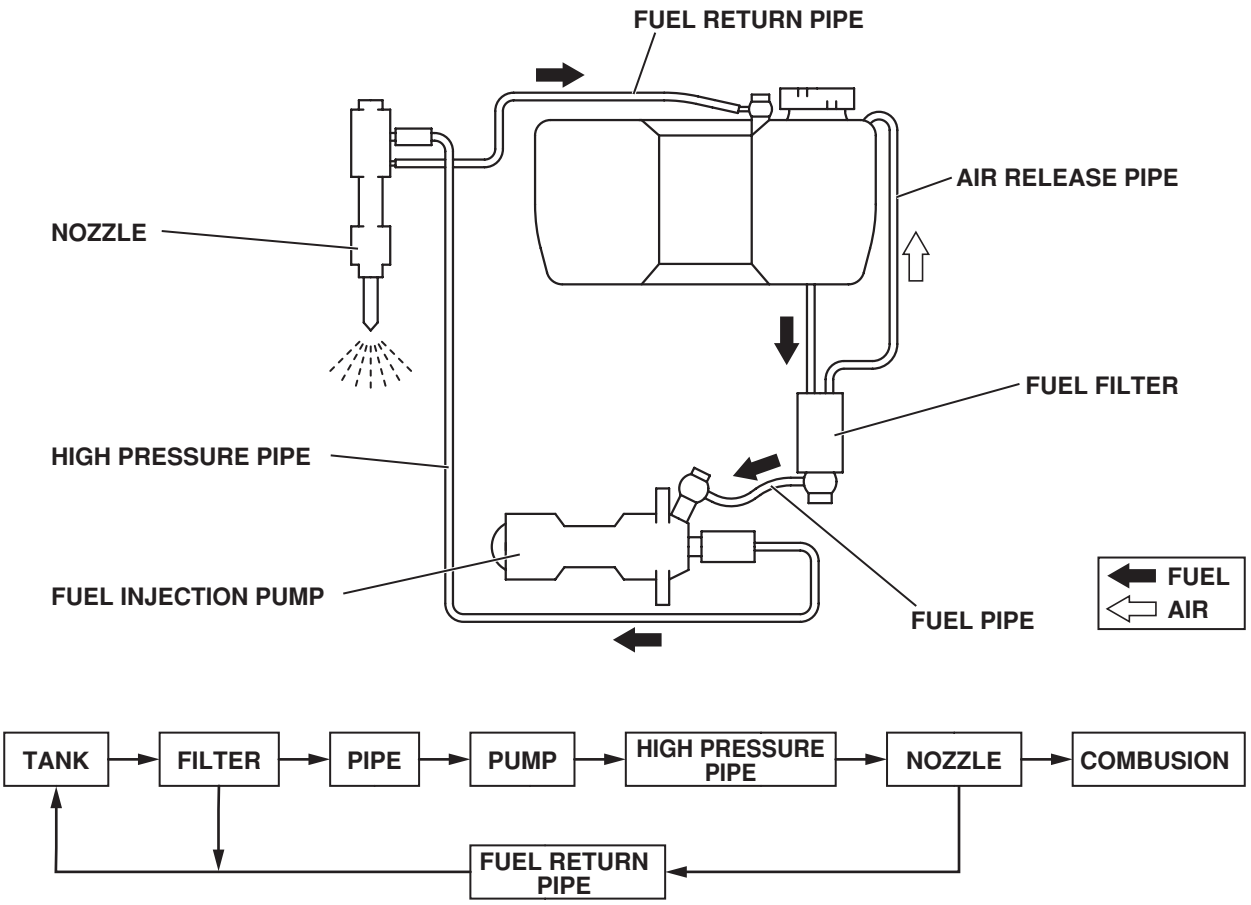


Fig. 6-1

[NOTE]

As DY30, 35, 41 and 42 are the high speed type diesel engine, be sure to use the fuel of good quality automotive diesel fuel.

6-2 FUEL INJECTION PUMP

6-2-1 SPECIFICATIONS

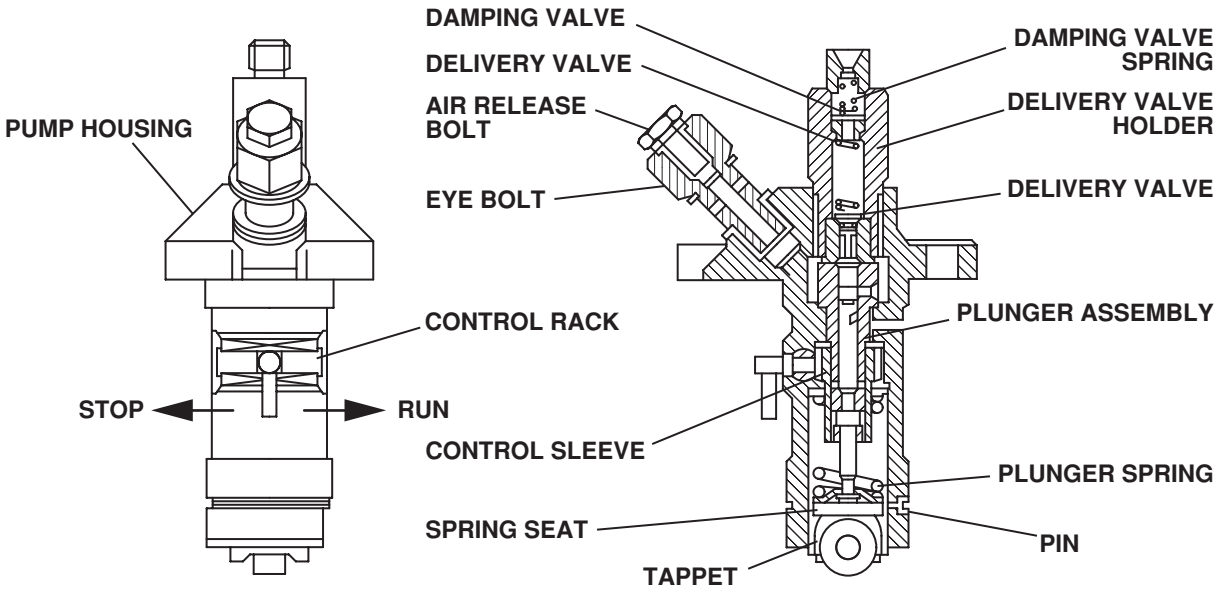


Fig. 6-2a

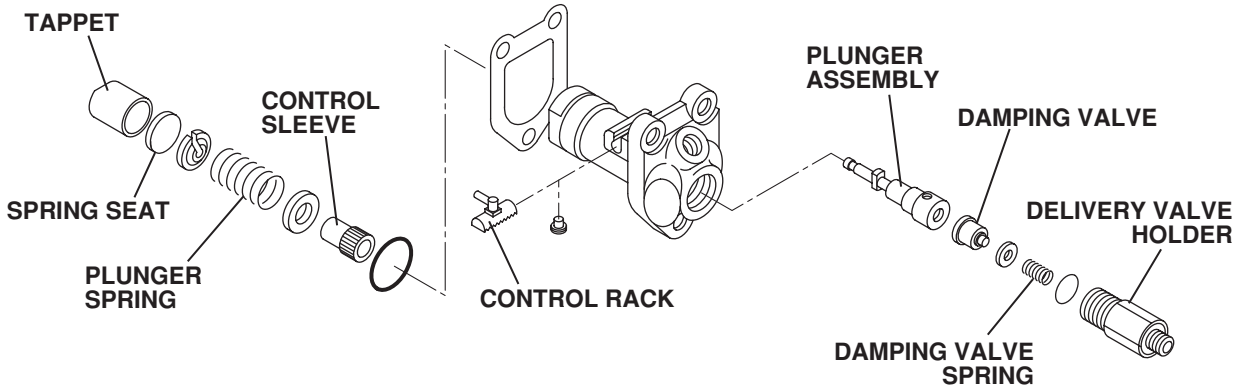


Fig. 6-2b

6-2-2 FUNCTION

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.

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.

6-2-3 THEORY AND 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.

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 (10MPa : 100kg/cm^2 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.”

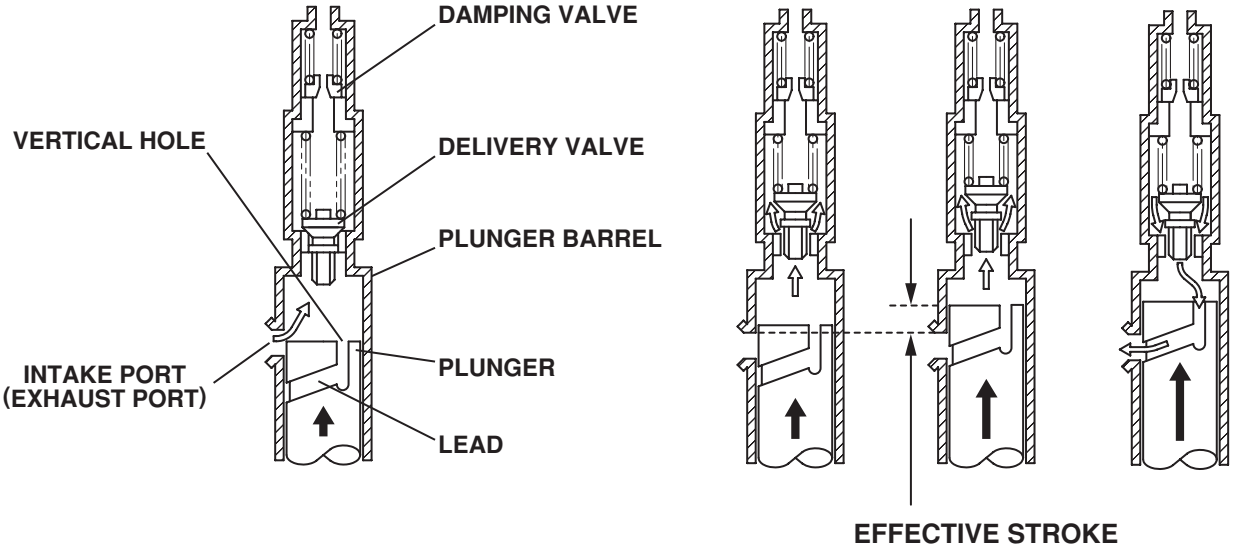


Fig. 6-3

6-2-4 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.

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 PLUNGER AND BARREL

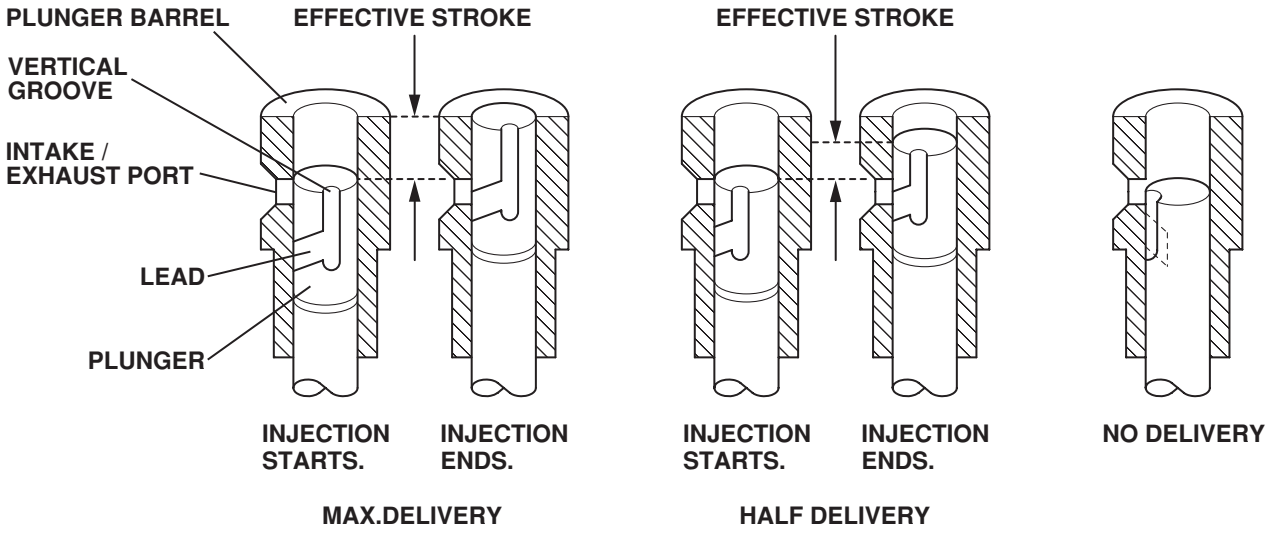


Fig. 6-4

2) RELATION BETWEEN PLUNGER AND RACK

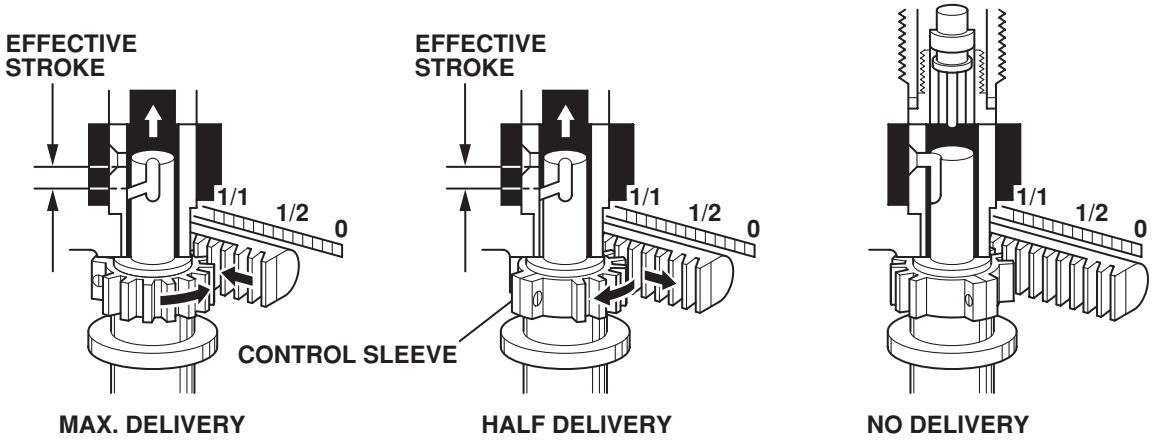


Fig. 6-5

6-2-5 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.

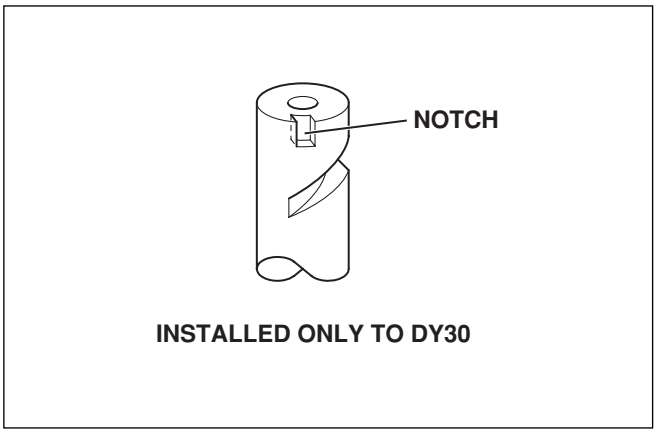


Fig. 6-6

6-2-6 FUNCTION OF 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.

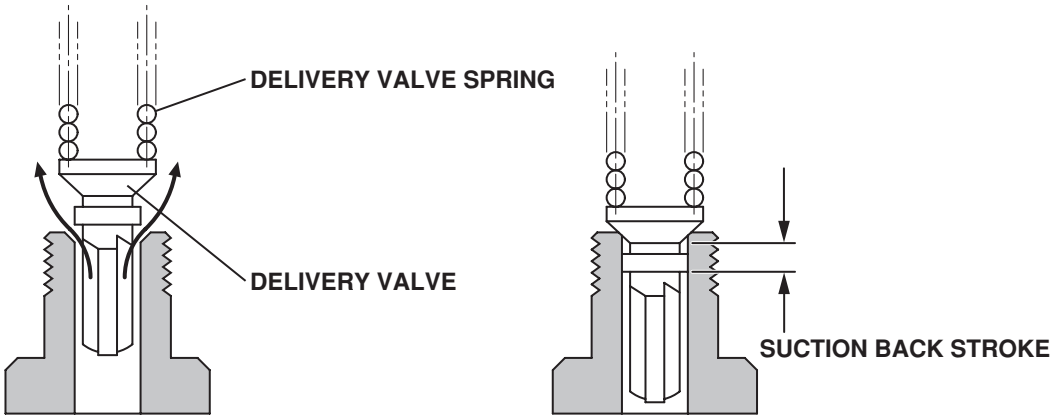


Fig. 6-7

6-2-7 FUNCTION OF 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.

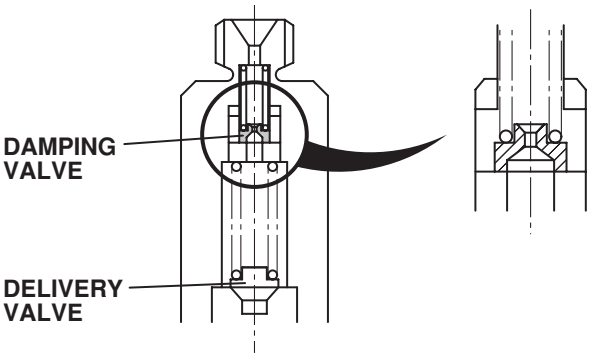


Fig. 6-8

6-3 FUEL INJECTION NOZZLE

6-3-1 SPECIFICATIONS

Part Name	NOZZLE ASSEMBLY
Part No.	228-63201-10
Identification mark	C
No. of nozzle hole (Diameter)	4 (0.22mm)
Valve opening pressure	19.5 MPa (195 kg /cm^2)
Spring constant	21 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 DY30, 35, 41 and 42 Diesel engines is developed as a result of joint research and development project by ZEXEL and our company, and it is direct combustion system, having the special hole type nozzle.

For producing better combustion gas, it utilizes swirl and squish flows and deliver the fuel mist most effectively, injection pressure is raised up to 19.5 MPa (195 kg/cm^2).

6-3-3 STRUCTURE

This consists of the 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.

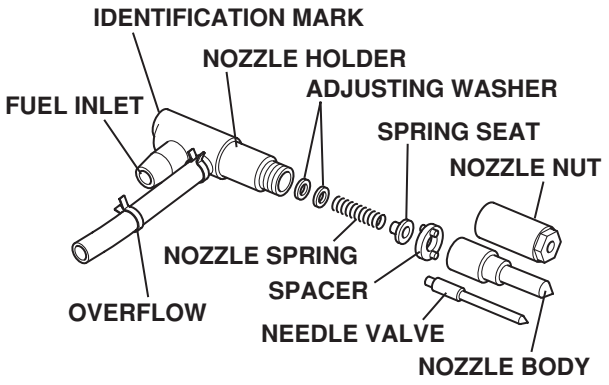


Fig. 6-9

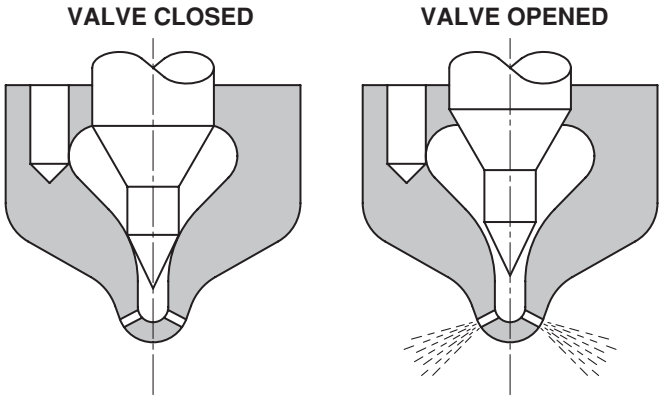


Fig. 6-10

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 19.5 MPa (195 kg/cm^2) and it lifts up the needle valve 4 for 0.18mm, 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. 6-11.)

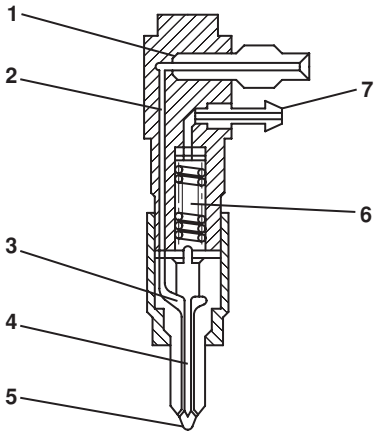


Fig. 6-11

6-3-5 INSPECTION AND MAINTENANCE

Fuel injecting condition of the nozzle and the state of pressure at starting injection are quite influential to the engine malfunction, insufficient output, increase of noise and exhaust smoke. Use of improper fuel or contaminated fuel is one of the main courses 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 below sequence.

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) Inspection by nozzle tester

* Fit the nozzle holder to the nozzle tester.

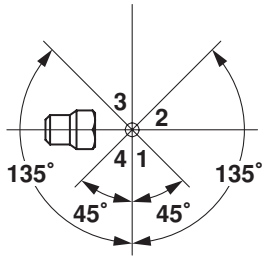


Fig. 6-12

CAUTION

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

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

CAUTION

Never bring your face near the pressurized fog from the nozzle. Also keep away your hands from the fog.

* 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 fog is injected straight.

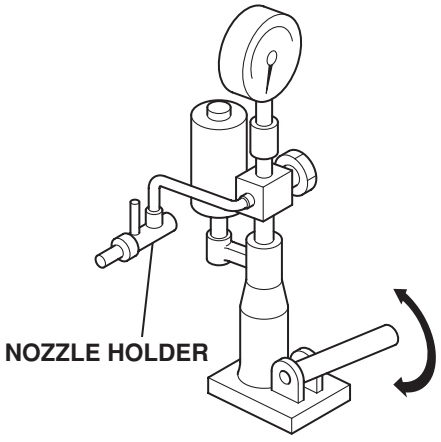


Fig. 6-13

CAUTION

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

2) Maintenance

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

a) Disassemble the nozzle holder and nozzle, and wash in clean light oil. When washing, use a wooden chip (for instance, wooden chopstick 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.

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

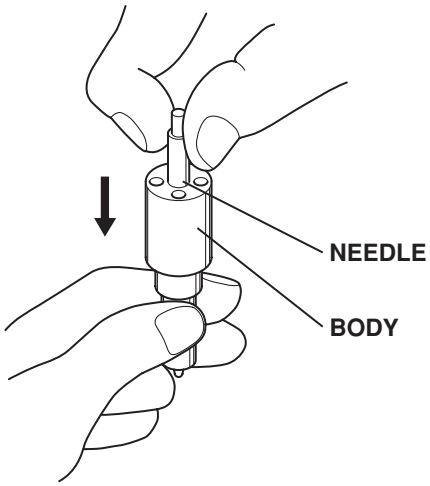


Fig. 6-14

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 torque.

Tightening torque
40.0-50.0 N·m (400-500 kgf·cm) (29-36.3 ft·lb)

h) Recheck with the nozzle tester. If the adjustment of valve opening pressure is necessary, adjust it to 20-21 MPa (200-210 kg/cm^2). The valve opening pressure shall decrease to 19.5 MPa (195 kg/cm^2) after the running in.

7. LUBRICATION SYSTEM

Lubrication is forced lubrication and wholly filtered system by trochoid type oil pump. The oil pump, and the governor are assembled in one piece, which is fitted to the crankcase.

Revolution of the crankshaft is reduced by the reduction gear (1:1.4) of the pump; and from the main gallery oil is forcibly lubricated to the crank journal. That oil will further be supplied to the crankpin, large end of the connecting rod, and then splashed to the piston, small end of the connecting rod, cylinder, etc. Also from the main gallery oil is forcibly supplied to the camshaft bearing and is sent to cam lobe of intake and exhaust valves and lubricated the tappets. In the camshaft oil relief valve is assembled, and it adjusts the oil pressure at 3 kg/cm^2. Lubrication in the rocker chamber is conducted by the splash of oil pushed up by blow-by gas, which lubricates rocker arm, etc.

Furthermore, blow-by gas containing oil will pass through the breather, intake port and the cylinder, where it is finally burnt.

LUBRICATION CHART

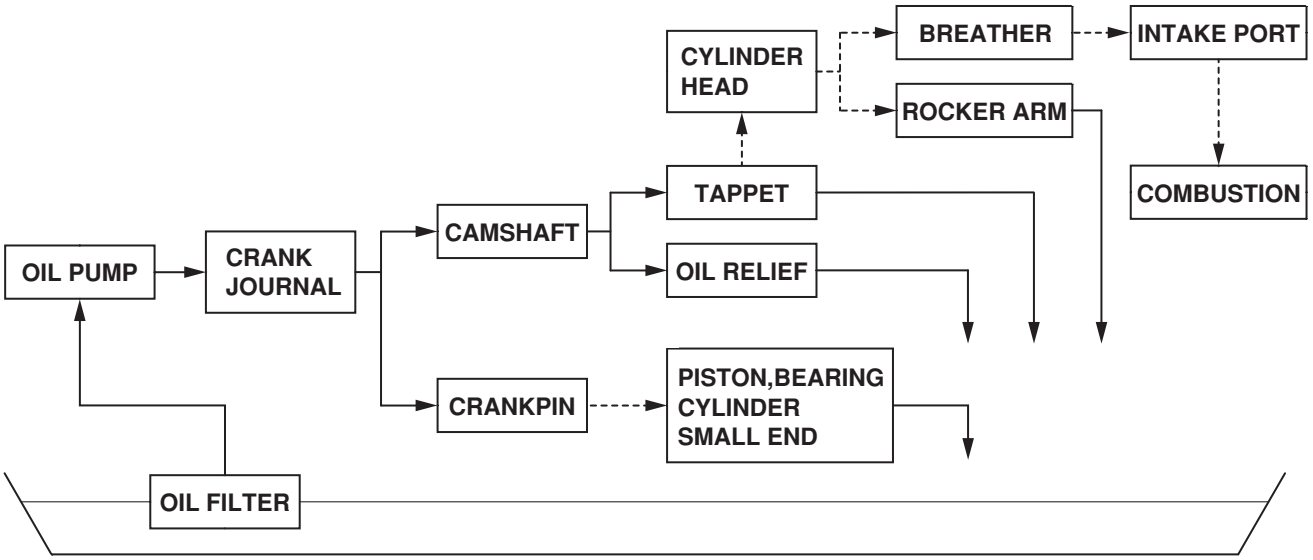


Fig. 7-1

7-1 OIL FILTER

Oil filter is made of double sheets of wire netting, and it is less flow resistance type, and is called full-flow type. As the element is made of wire, it can be washed and used for many times.

7-2 OIL SENSOR (OPTION)

7-2-1 PRINCIPLE OF OPERATION

The pressure switch type oil sensor for diesel engine consists of a pressure switch as a sensor section and a controller section.

The pressure switch detects the drop of oil pressure in the crankcase. When the oil pressure falls down below the predetermined value (30kPa : 0.3kg/cm^2), the pressure switch turns on the generate a signal to the controller sections.

The controller which is powered by the charge coil sets up a delay for a few seconds for detecting signals transmitted during the period.

If more signals than the predetermined number are generated, the controller feeds power to the solenoid which actuates the latch on the control bracket to release the control lever to shut down the engine.

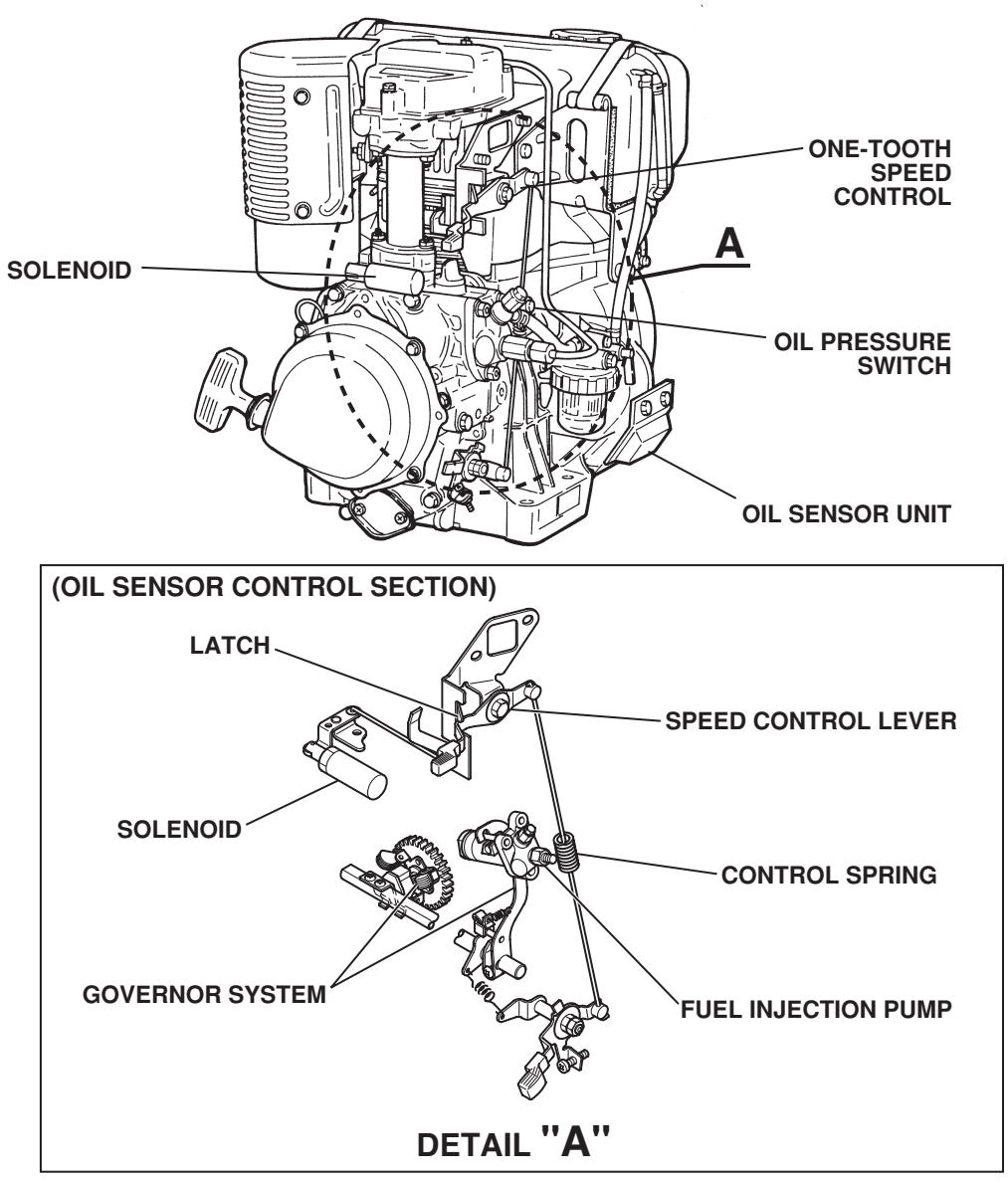


Fig. 7-2

8. GOVERNOR SYSTEM

8-1 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.

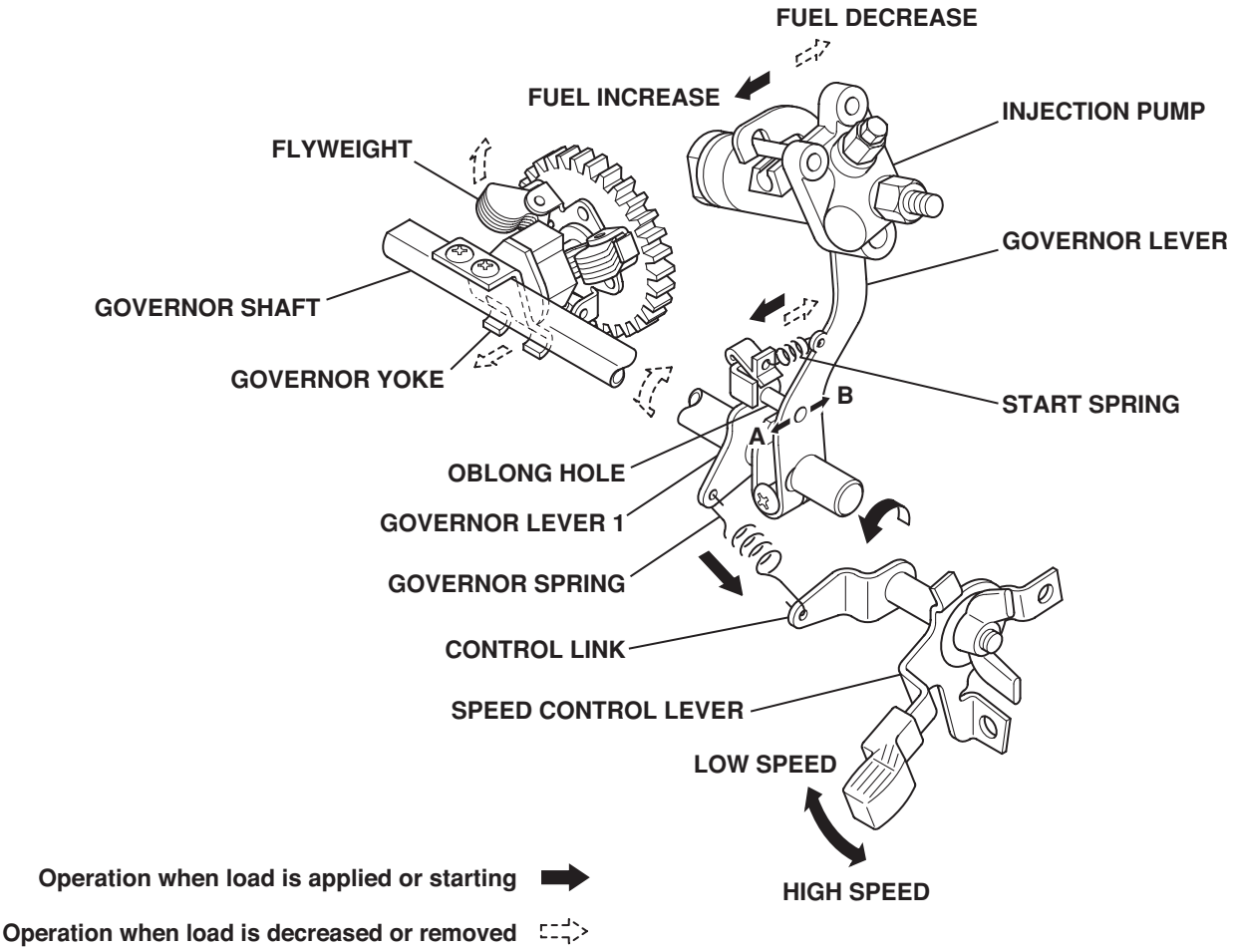


Fig. 8-1

8-2 OPERATION

1. Starting

When the speed control lever is set on the side of high speed, the governor spring is pulled via the control link. The governor levers **1** and **2** are pulled by the tension of the governor spring. The control rack of injection pump is pushed toward "fuel increase." The governor lever **1** has an oblong hole, and the governor lever **2** moves to the extent of this oblong hole by means of the start spring tension.

The control rack of injection pump is pushed toward the maximum of "fuel increase." This movement within the extent of oblong hole is called "revolution playing angle," for which we will explain later.

2. After starting and during operation

When engine starts up, centrifugal force acts on the flyweight and it pushes the governor sleeve.

The governor yoke, governor shaft, and governor lever **2** are assembled in one piece, and accordingly the motion of the governor sleeve pushes the control rack of the injection pump toward "fuel decrease." The governor lever again moves to the extent of the oblong hole. Thereafter, the governor lever **1** and the governor lever **2** move simultaneously and are balanced at the specified revolution.

Suppose that a load is put suddenly on, the fuel supply is as it is at that instance, accordingly the fuel supply is insufficient against the load. As a resut, engine revolution decreases, which means that the centrifugal force on the flyweight decreases. Then the governor lever **2** moves to the position where it balances the tension of the governor spring. The control rack of injection pump is pushed toward "fuel increase" and engine revolution revives.

3. Stopping

The governor plays a role exactly reverse to that of starting. When the speed control lever is set at the position of "Stop," it pushes the control rack of injection pump toward "No Injection" and the engine stops.

8-3 "Revolution Playing Angle"

This mechanism is to supply more fuel than the maximum supply for normal high speed operation.

This mechanism is developed for the purpose of improving starting ability.

Required amount of fuel supply is set by the governor lever **1**. The governor lever **1** has an oblong hole, to which pins of the governor lever **2** is fitted. As the start spring is pulling the governor lever **2**, it moves toward the arrow mark **A**. Then the control rack of the injection pump is pushed to "Maximum supply." The angle the governor lever **2** moves within the extent of oblong hole is called "Revolution Playing Angle."

At the time of starting, the governor does not function as yet and the governor lever **2** functions. However, during operation, the governor functions and accordingly the governor lever **2** moves toward the arrow mark **B** within the extent of oblong hole. The governor levers **1** and **2** incorporate each other and pushes the control rack of the injection pump.

9. AUTOMATIC DECOMPRESSION SYSTEM

Mechanism

(1) Starting

When the ropr is pulled to crank start the engine, the weight is positioned to the inside as indicated in figure 1, and the relationship of the decompressor pin and tappet are as shown in figure 2, with the air pressure valve in the open position. Since there is no pressure, the coil may be cranked with little effort.

When the rotational speed of the decompressor exceeds 300 rpm (crank ratation speed), the weight opens to the position shown in figures 3 and 4, and decompression occurs. To start the engine, one must learn to pull the rope sloely at first, then after the crank has begun turning to put all one's strength into it, and the engine will start easily.

Additionally, when checking engine compression during assembly or repair, loosen the intake rocker cam adjustment screw one turn, then pull the recoil knob and check to see that the fly wheel rotates normally.

(2) During Operation

During operation, the weight is held outward by centrifugal force, the decompression pin is in the intake cam base ring and the mechanism acts a normal valve.

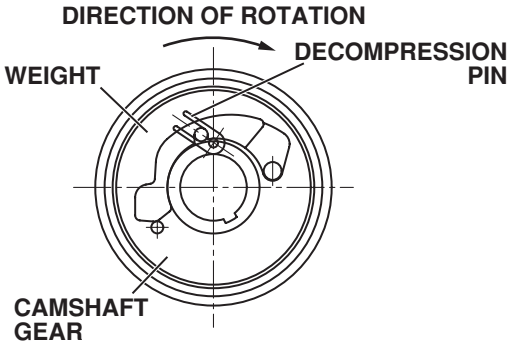


Fig. 9-1

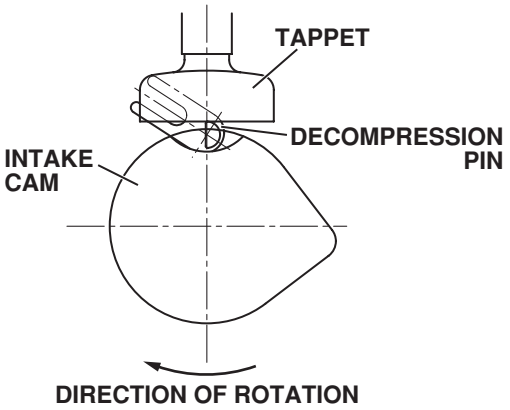


Fig. 9-2

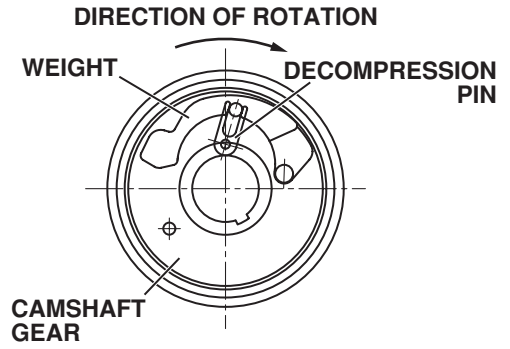


Fig. 9-3

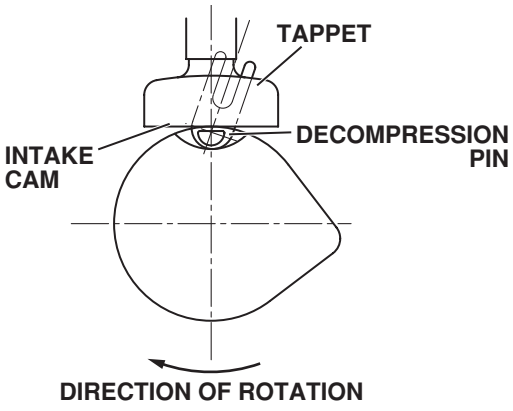


Fig. 9-4

10. REDUCTION GEAR

10-1 CONFIGURATION

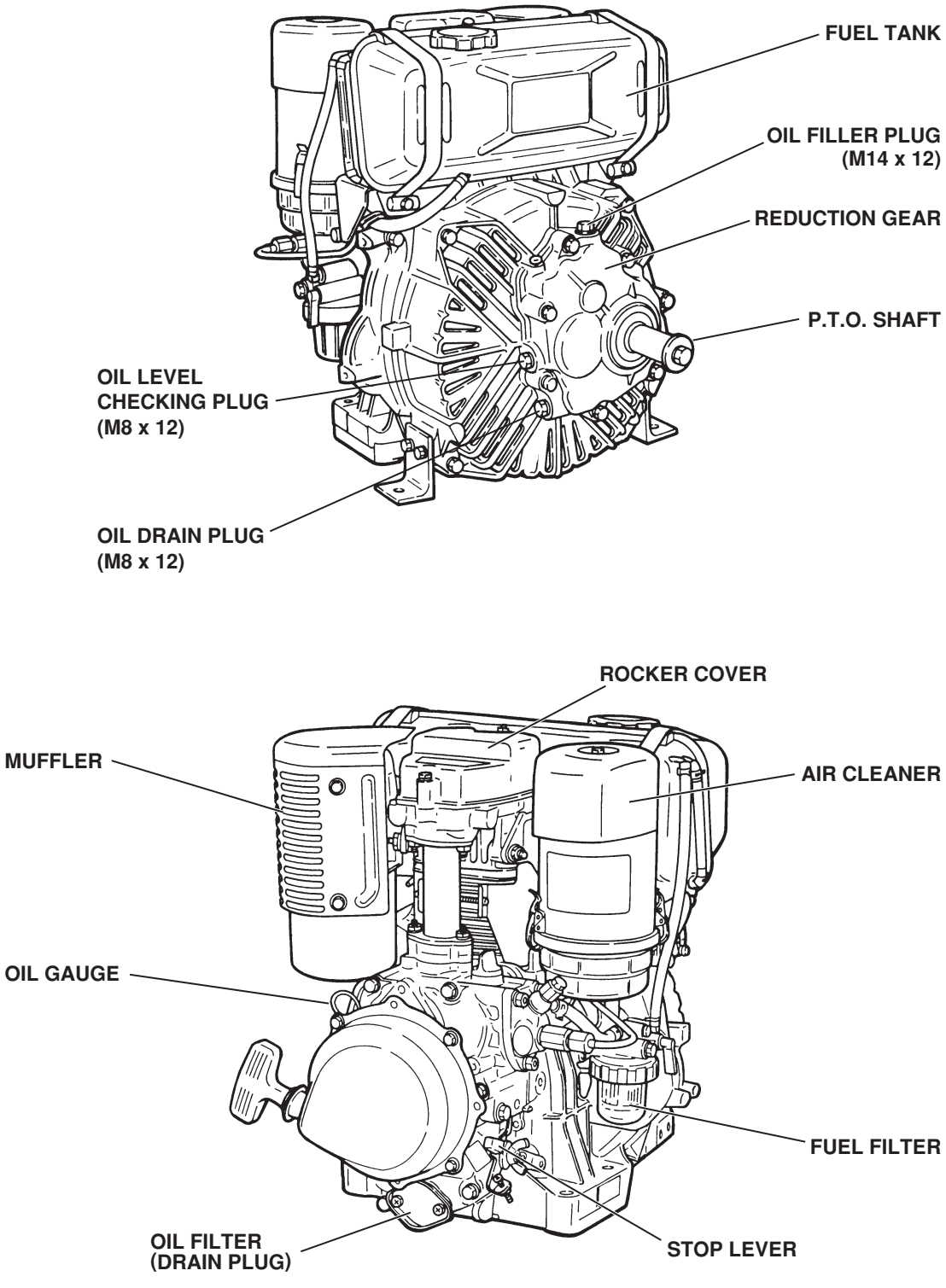


Fig. 10-1

10-2 STRUCTURE

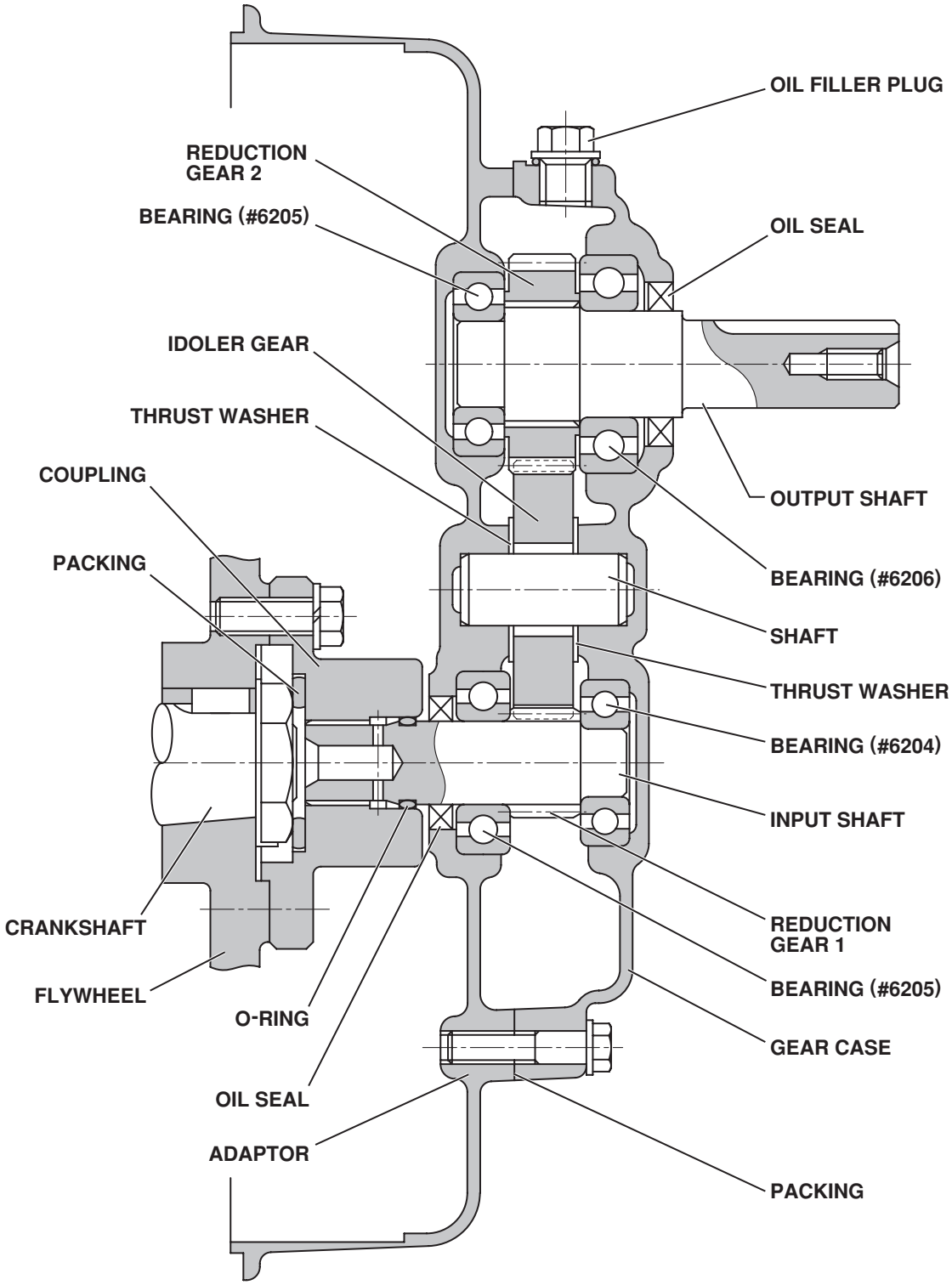


Fig. 10-2

10-2-1 INPUT SHAFT

The input shaft is a wholly carburized product in which chrome-molybudenum steel is used, and the reduction gear 1 and spline are built in it.

10-2-2 OUTPUT SHAFT

The output shaft is made of carbon steel, and the reduction gear 2 is fitted in spline engagement.

10-2-3 IDOLER SHAFT

The idoler shaft is made of chrome-molybudenum steel, and wholly carburized.

10-2-4 REDUCTION GEAR 2 and IDOLER GEAR

The reduction gear 2 and the idoler gear are wholly carburized products, in which chrome-molybudenum steel is used,
and are helical gears with module of 2.

10-2-5 ADAPTOR and GEAR CASE

The adaptor and the gear case are components of a body of the 1/2 reducer, and are made of aluminum alloyed diecast.

10-2-6 COUPLING

The coupling is a component to deliver output from the engine to the 1/2 reducer, and is fitted to the input shaft in spline engagement. The coupling is a wholly carburized product in which molybudenum steel is used.

[NOTE]

Grease is stored in the spline section, and the section is sealed with a packing and an O-ring.

10-3 DISASSEMBLY and REASSEMBLY

10-3-1 DISASSEMBLY

Se-quence	Procedures	Main Item to be disassembled	Remarks	Bolts,etc Used
1	Drain the gear oil.	The oil drain plug is located under the gear case cover.	Replace the gasket with a new one.	M8 bolt
2	Remove the clamping bolt from the adaptor.	M8 bolt ···· 4pcs.		M8 x60 bolt ···· 4 pcs.
3	Remove the 1/2 reducer assembly from the engine.			
4	Remove the clamping bolts from the coupling.	M10 bolt ···· 4 pcs.	Be careful not to lose the packing.	M10 x30 9T bolt ···· 4pcs.
5	Remove the clamping bolts of the gear case.	7 bolts on the gear case urface.	Be careful not to lose the Spring washers.	M8x40 7T bolt ···· 6 pcs. M8x50 7T bolt ···· 1 pce. Spring washer
6	Remove the O-ring of the input shaft.			
7	Wind vinyl tape around the input/output shafts.		Cover whole surface of the shafts to protect the oil seal.	
8	Separate the gear from the adaptor.		Hold the output shaft and strike the adaptor with a wood hammer or a plastic hammer, and then separate the gear case from the adaptor. Don't insert a driver between the mating faces. If inserted, they may be damaged.	
9	Pull out the gear assembly from the case.			
10	Disassemble the input shaft assembly.	Separate the gear from the bearings.	Pull out the bearings by using a gear puller or a press.	
11	Disassemble the P.T.O. shaft assembly.	Separate the gear and the bearings from the P.T.O. shaft.	Pull out the bearings by using a gear puller or a press.	

Table 10-1

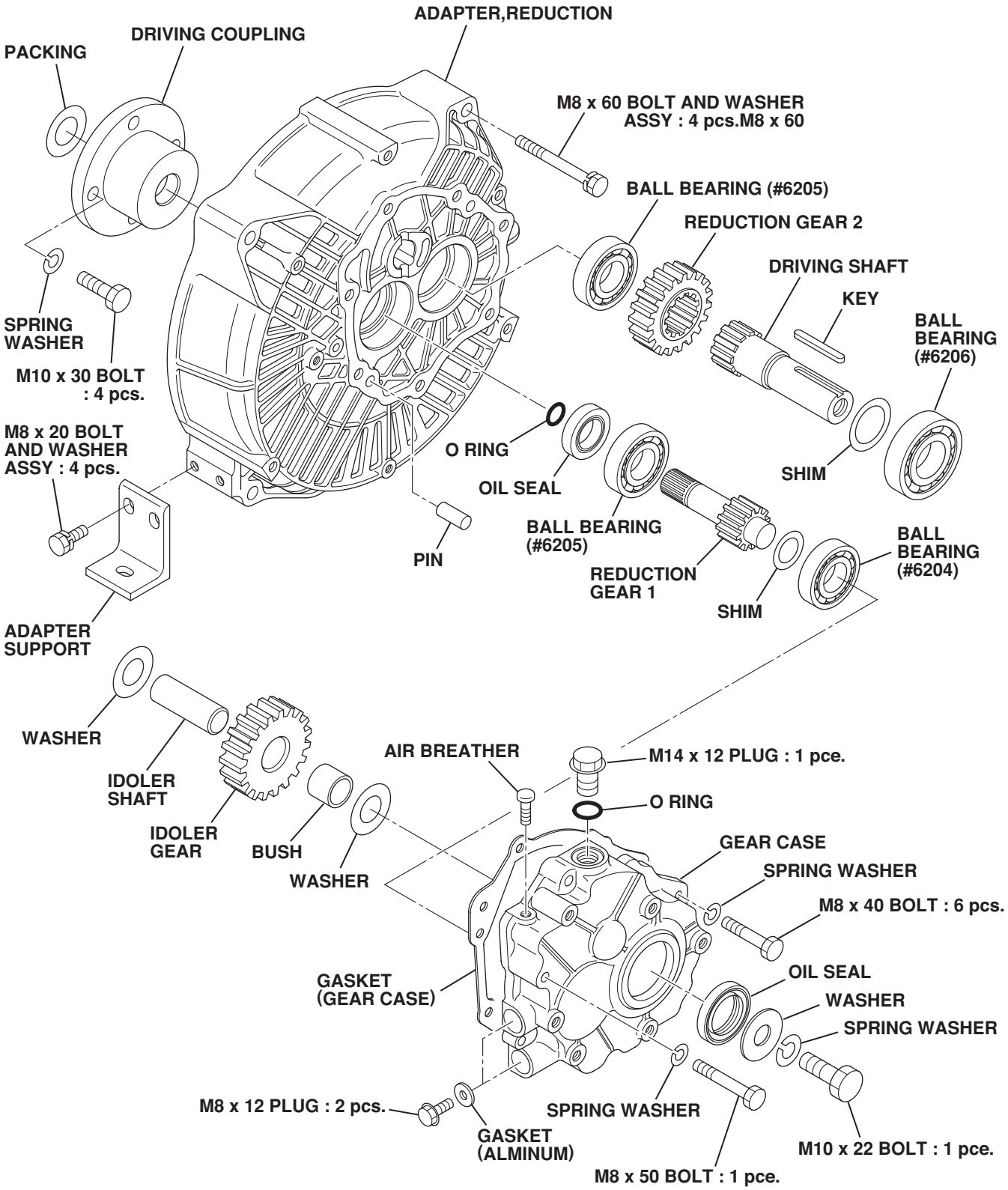

ADAPTER,REDUCTION
DRIVING COUPLING
PACKING
M8 x 60 BOLT AND WASHER ASSY : 4 pcs.M8 x 60
BALL BEARING (#6205)
REDUCTION GEAR 2
DRIVING SHAFT
KEY
BALL BEARING (#6206)
SPRING WASHER
M10 x 30 BOLT : 4 pcs.
M8 x 20 BOLT AND WASHER ASSY : 4 pcs.
O RING
OIL SEAL
BALL BEARING (#6205)
PIN
SHIM
REDUCTION GEAR 1
BALL BEARING (#6204)
SHIM
ADAPTER SUPPORT
WASHER
IDOLER SHAFT
IDOLER GEAR
BUSH
WASHER
AIR BREATHER
M14 x 12 PLUG : 1 pce.
O RING
GEAR CASE
SPRING WASHER
M8 x 40 BOLT : 6 pcs.
GASKET (GEAR CASE)
OIL SEAL
WASHER
SPRING WASHER
M8 x 12 PLUG : 2 pcs.
GASKET (ALMINUM)
SPRING WASHER
M10 x 22 BOLT : 1 pce.
M8 x 50 BOLT : 1 pce.

Fig. 10-3

10-3-2 REASSEMBLY

1. Precautions

a) Every and each part should be thoroughly cleaned. Especially, pay utmost care and attention to cleanliness of the bearing.
b) Carefully check the lip portion of every oil seal. If damaged one is found, replace it with a new one.
c) Replace all the gaskets with new ones.
d) Replace the bolts, if necessary, with new ones.
f) Apply oil to the revolutionary parts and friction surfaces, when reassembling.
g) Check and adjust the clearances of various portions and then reassemble them.
h) When some main portions are assembled in the course of reassembling, turn or move the gadgets by hand, paying attention to the frictional noise and resistance.

2. Reassembly

1) Pressure-fit the bearings into the input shaft so that the bearing (#6205) is set in the spline side and the bearing (#6204) in the edge face side. Then, insert the shim between the bearing (#6205) and the gear so that the clearance between the two bearings after they have been pressure-fitted is from 49mm to 48.9mm. Two types of shim; 0.3mm thick and 0.1mm thick are available. (See Fig. 10-4.)
When installing the spline and the O-rings in the case, wind vinyl tape around their grooves to protect the oil seals. (See Fig. 10-5.)

INPUT SHAFT SHIM ADJUSTING POSITION

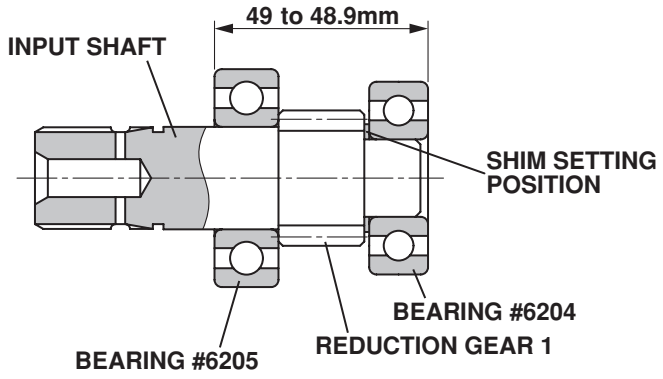


Fig. 10-4

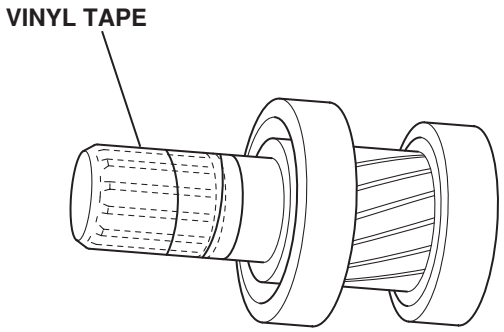


Fig. 10-5

2) Pressure-fit the bearings and install the reduction gear 2 into the output shaft so that the bearing (#6206) is set in the output side, the bearing (#6205) in the edge face side, and the 60 beveling of the reduction gear 2 bore spline is faced to the bearing(#6206).
Then, insert the shim between the bear ing(#6205) and the gear so that the clearances between bearings after they have been pressurefitted is from 52mm to 51.9mm Two types of shim; 0.3mm thick and 0.1mm thick are available.(See Fig. 10-6.)

OUTPUT SHAFT SHIM ADJUSTING POSITION

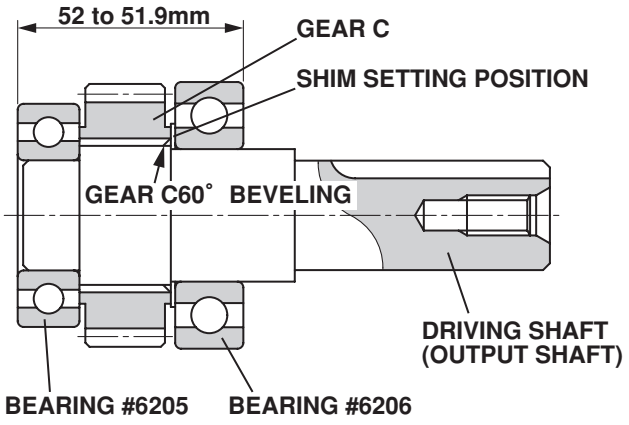


Fig. 10-6

3) Pressure-fit the oil seals into the adaptor and the gear case.
4) Set the idoler shaft with the thrust washer in the adaptor. (See Fig. 10-7.)
5) Set the reduction gear 1 and the idoler shaft in the adaptor, under the condition that their teeth are engaged in each other. (See Fig. 10-8.)
6) Set the thrust washer onto the edge face of the idoler shaft.
7) Set the output shaft assembly in the adaptor.(See Fig. 10-9.)
8) Put the packing on the mating face of the case. (It is not necessary to supply sealing compund to the mating face.)
9) Cover the gear case. (Don't give physical impacts with such tools as a hammer to compulsorily set it.)(See Fig. 10-10.)
10) Clamp the case with six M8-40 7T bolts and M8-50 7T bolt. Never forget to set thrust washers for the bolts.

Tightening torque
20.0-23.0 N·m
(200-230 kgf·cm)
(14.5-16.7 ft·lb)

11) Remove the vinyl tape around the input shaft, and then set the O-ring.

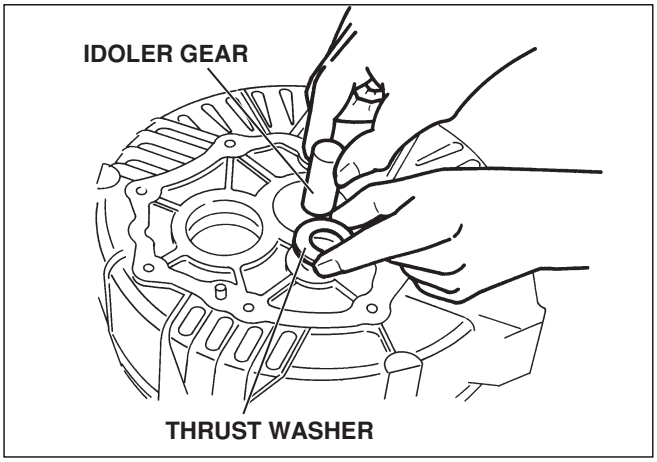


Fig. 10-7

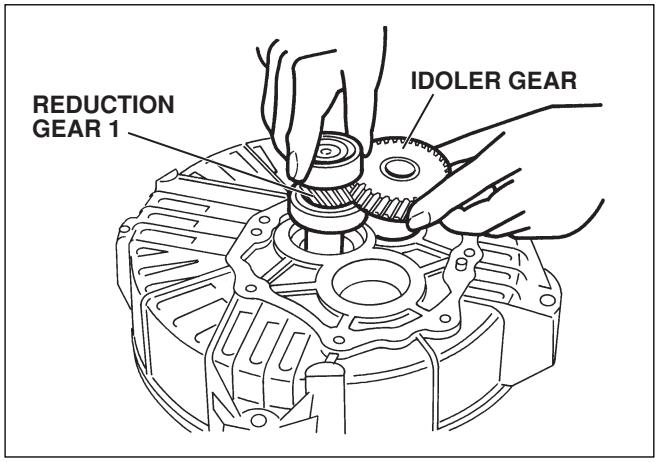


Fig. 10-8

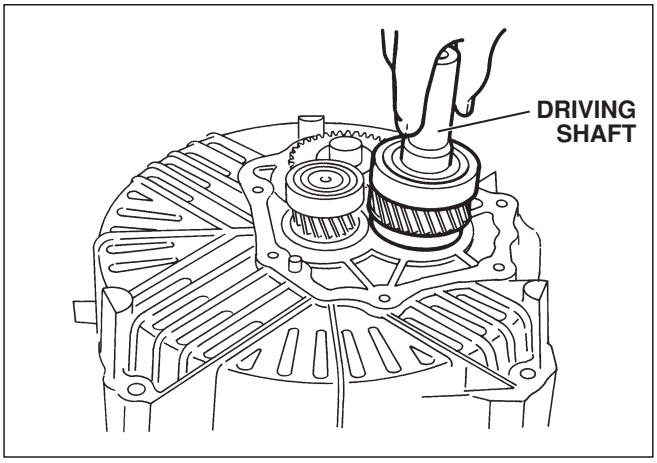


Fig. 10-9

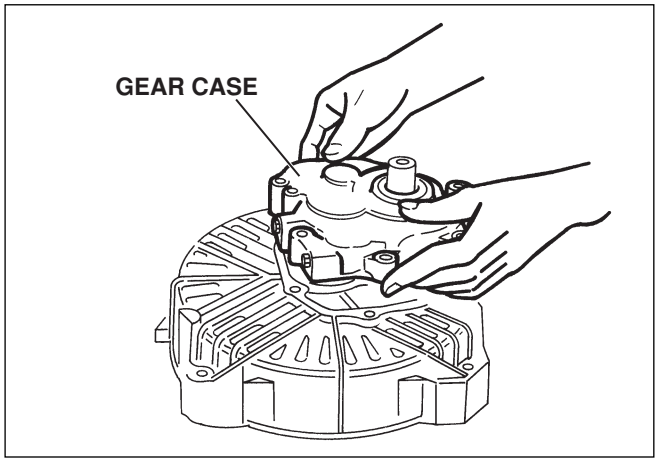


Fig. 10-10

3. Mounting to Engine

1) Supply grease into the grease filler hole (the section shown with inclined lines in the figure) of the input shaft.
2) Set the packing in the coupling, and then clamp it to the engine's flywheel with four 10mm x 30 9T bolts.

Tightening torque
50.0-70.0 N·m
(500-700 kgf·cm)
(36.3-50.8 ft·lb)

3) Apply grease to the coupling and spline gear teeth of the input shaft.
4) Set the 1/2 reducer in the engine under the condition that the spline teeth are engaged, and clamp it with four 8mm x 60 7T bolts.

Tightening torque
20.0-23.0 N·m
(200-230 kgf·cm)
(14.5-16.7 ft·lb)

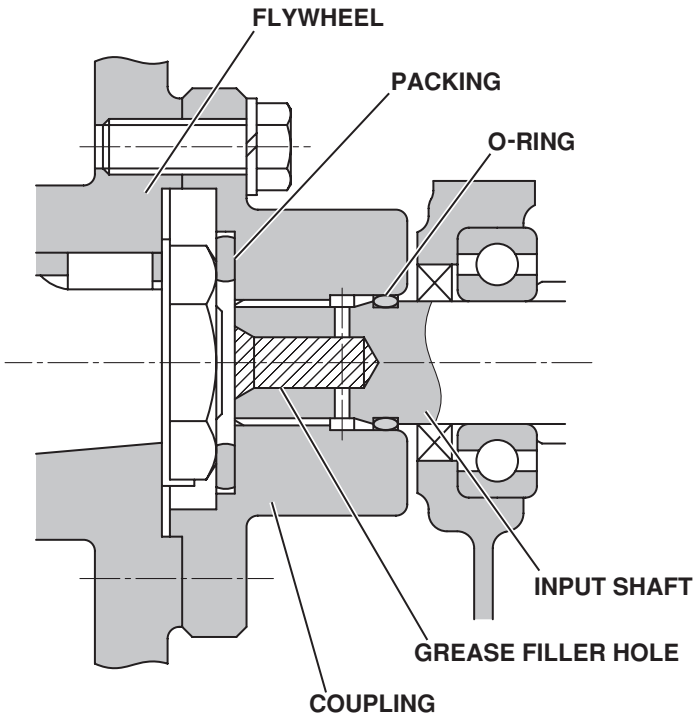


Fig. 10-11

11. STARTING SYSTEM

11-1 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.

11-1-1 DISASSEMBLY (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 40cm. Firmly press the reel with a thumb as shown in Fig. 11-1 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.

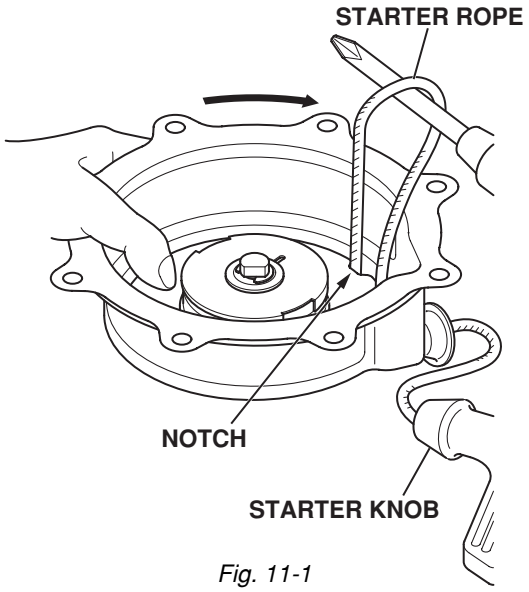


Fig. 11-1

(3) When removing, take out the parts in the order of the numbering in Fig. 11-2.
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.

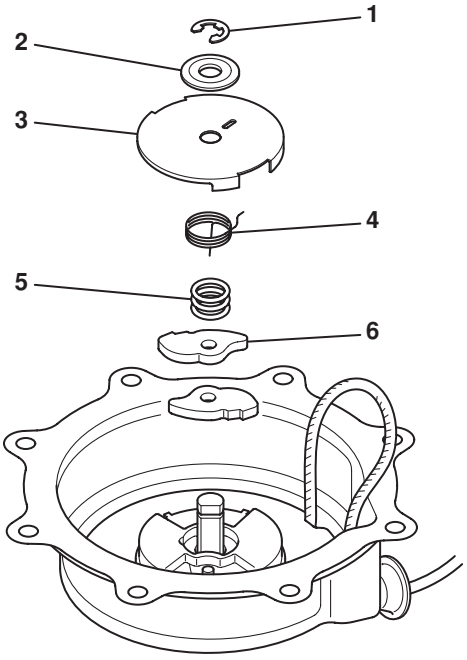


Fig. 11-2

(4) Take out the reel from starter case as shown in Fig. 11-3.
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. 11-8.) Finally, release and take out the starter rope tied to both the reel side and the starting knob side. Thus, the disassembly work ends.

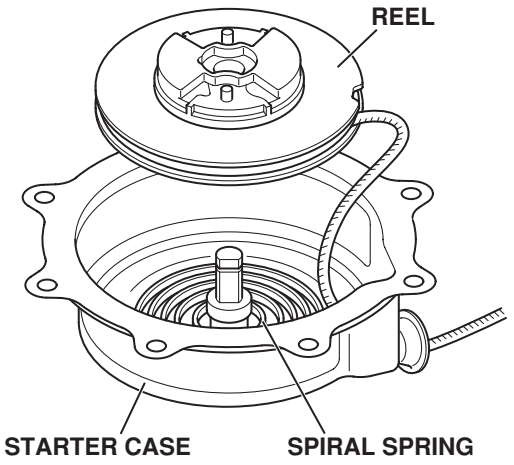


Fig. 11-3

11-1-2 REASSEMBLY (D Type)

(1) First, have the starter rope pass through the starting knob, and tie the rope as shown in Fig. 11-4-1.
Then, have the opposite side of the rope pass through the starter case and the reel, and tie it as shown in Fig. 11-4-2. Then surely house the end in the reel. (In the 11-4-1 and 11-4-2 both the ropes are tied quite lightly, as you see in figures 11-4-1 and 11-4-2. Please note this is just for the purpose of easy understanding. Therefore, when actually tying, tie the rope as tightely as possible.

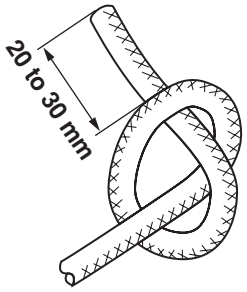


Fig. 11-4-1

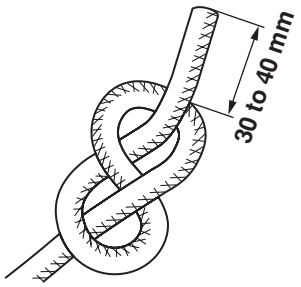


Fig. 11-4-2

(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 3mm from the starter shaft and that it hooks surely the reel hook.
Meantime, with the pliers about 10cm long spring from the inner end can easily be formed.

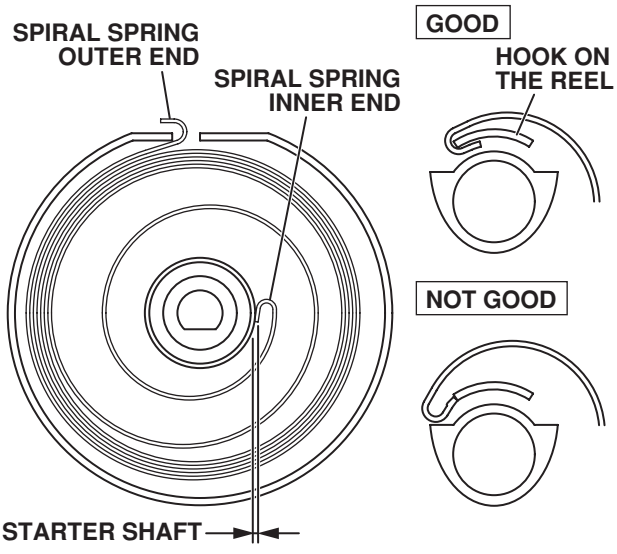


Fig. 11-5

(3) Before putting the reel in the starter case, wind the starter rope in the arrowhead direction as shown in Fig. 11-6, 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. 11-6, 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.

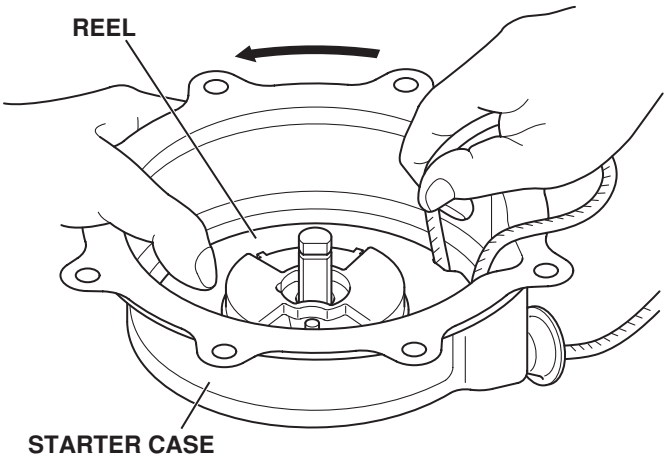


Fig. 11-6

(4) When reassembling the parts, follow up in the reverse order to Fig. 11-2.
When putting the friction plate in the hole for it, set the return spring a little upward as shown in Fig. 11-7 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.)

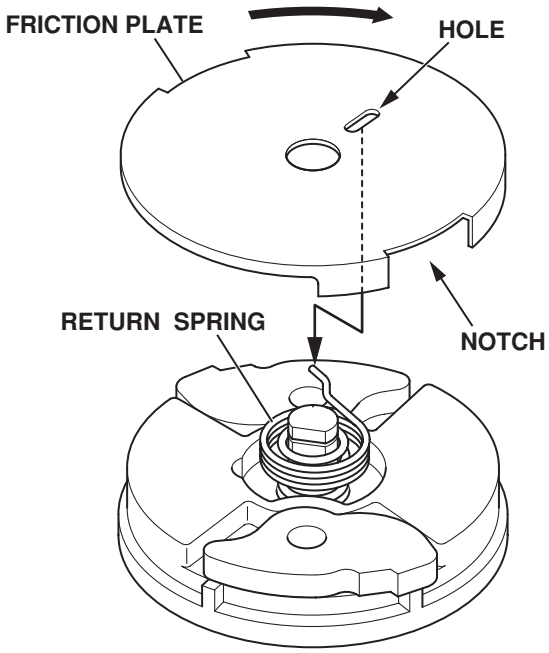


Fig. 11-7

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

11-1-3 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. 9-1.
   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 beginning.

11-1-4 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. 9-8. 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. 9-5 for not to mistake the direction of the spring.

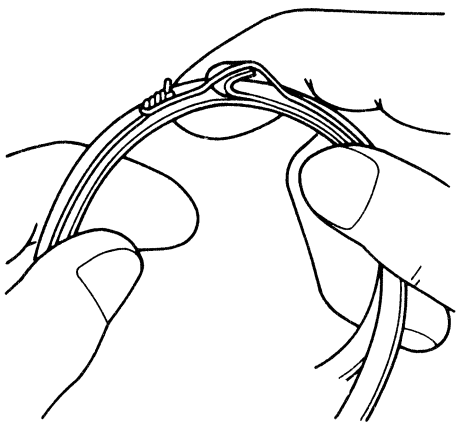


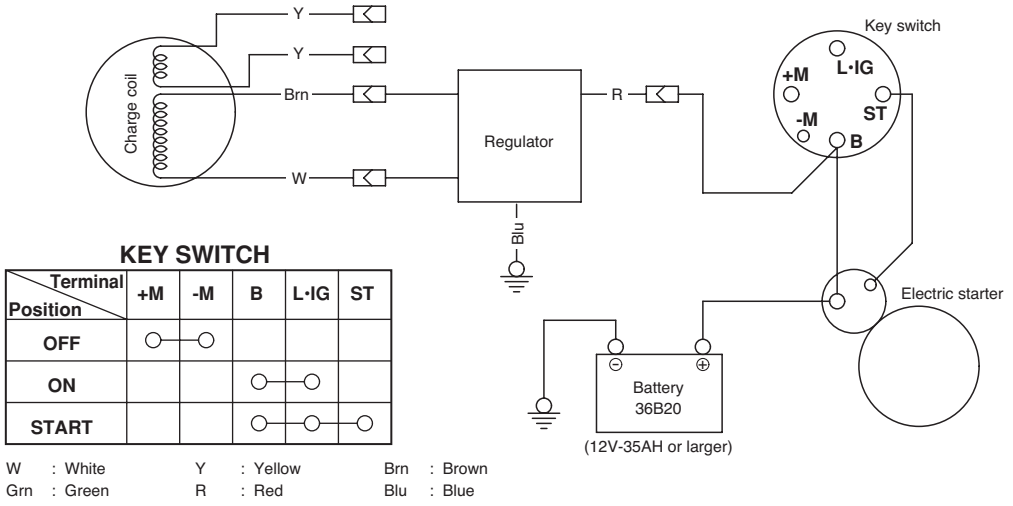
Fig. 11-8

(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.

11-2 ELECTRIC STARTING MOTOR

11-2-1 WIRING DIAGRAM

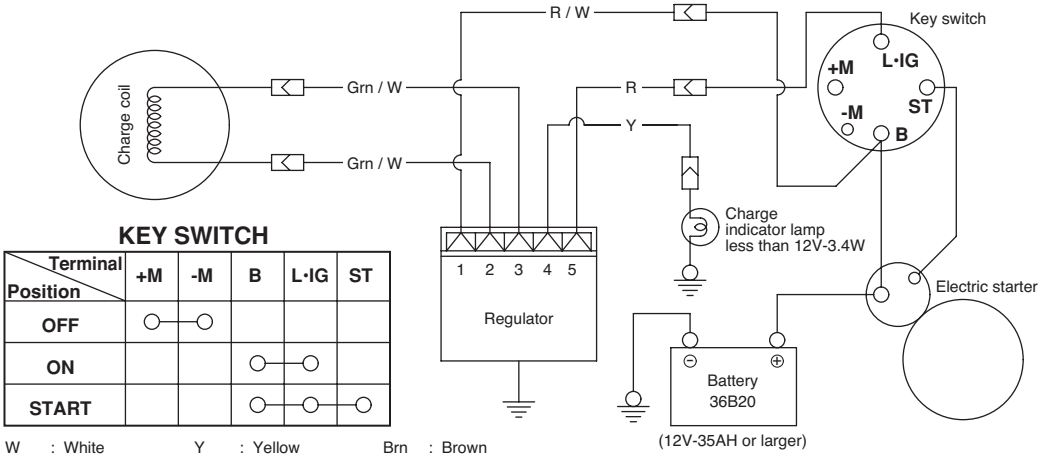


KEY SWITCH

Terminal / Position	+M	-M	B	L·IG	ST
OFF	○	○			
ON			○	○	
START			○	○	○

W : White Y : Yellow Brn : Brown
Grn : Green R : Red Blu : Blue

Fig. 11-9a



KEY SWITCH

Terminal / Position	+M	-M	B	L·IG	ST
OFF	○	○			
ON			○	○	
START			○	○	○

W : White Y : Yellow Brn : Brown
Grn : Green R : Red

Fig. 11-9b

1) Circulation
When starting by the electric starter, (Key is at the position of start.)
Battery (+) → BAT of key → ST of key → Starter → Battery (–)(earth)
Charging, operating (Key is at the position of operation.)
Generator → Rectifier → IG of key → BAT of key → Battery (+)123

11-2-2 LEAD WIRE FOR ELECTRIC STARTER

When mounting the engine, location of the battery may comes into question, but set the lead wire following method:

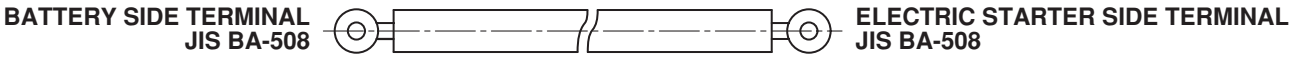


Fig. 11-10

11-2-3 EARTH BAND

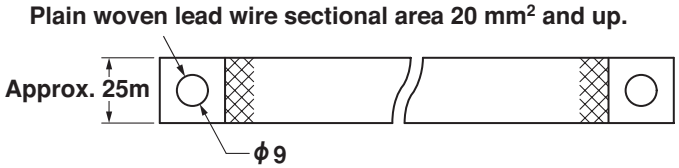


Fig. 11-11

Fasten tightly to the place made of metal and not paint coated. The place must be electrically conducted completely to the crankcase of the engine.

11-2-4 REMARKS

1) All lead wires are classified by coloring, so when connecting, select and connect by color. Meantime, insert the connectors each other up till the roots.
2) The wire from (+) terminal of the battery must be connected to (+) terminal of the electric starter, and the wire from the (–) terminal must be connected to the earth of the engine body.
3) Select the wire from the below Table 11-1, based on the required length of the wire.
4) When the key switch is set apart from the engine body, select the wire from below Table 11-2, based on the required length of the wire between the key switch and the magnetic switch on the side of engine.

Length	Description	Outside dia.
1.5m or shorter	AV15	7.3mm
1.5m - 2.5m	AV20	8.5mm
2.5m - 3m	AV30	10.8mm

Table. 11-1

Length	Description	Outside dia.
1.5m or shorter	AV1.25	1.5mm
1.5m - 3m	AV2	1.9mm
3m - 5m	AV3	1.4mm

Table. 11-2

12. INSTALLATION

Engine life, ease of maintenance and inspection, frequency of checks and repairs, and operating cost all depend on the way in which the engine is installed. Carefully observe the following instructions for installing the engine.

12-1 INSTALLING

When mounting the engine, carefully examine its position, the method of connecting it to a load(machine), the foundation, and the method of supporting the engine.

12-2 ENTILATION

Fresh air is necessary for cooling the engine and burning the fuel.
In cases where the engine is operated under a hood or in a small room, temperature rise in the engine room can cause vapor lock, oil deterioration, increased oil consumption, loss of power, piston seizure, shorter engine life, etc., making it impossible to operate the engine properly. It is necessary, therefore, to provide a duct or baffle to guide cooling air to the engine to prevent recirculation of the hot air used for engine cooling, and temperature rise of the load(machine).
Take steps as necessary to keep the engine room temperature below 60°C even in the hottest period of the year.

12-3 EXHAUST GAS DISCHARGE

Exhaust gas is noxious. When operating the engine indoors, be sure to discharge the exhaust gas outdoors. If a long exhaust pipe is used in such a case, the internal resistance increases causing loss of engine power. Thus pipe inside diameter must in crease in proportion to exhaust pipe length.

Exhaust pipe : Less than 3m long, pipe inside diameter 30mm,
Less than 5m long, pipe inside diameter 38mm.

12-4 FUEL SYSTEM

If the fuel tank is removed from the engine when mounting the engine with a machine, set the fuel tank 50-500mm above the fuel injection pump. If the tank is set too low, the fuel will not be supplied.
When piping 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.

12-5 POWER TRANSMISSION to DRIVE MACHINES

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 load.
3) The driving pulley of the engine must be in line with the driven pulley of the load.
4) Install the engine pulley as close to the engine as possible.
5) If possible, span the belt horizontally.
6) Disengage the load when starting the engine.

If no clutch is used, use a belt tension pulley or the like.

2. Flexible Coupling

When using a flexible coupling, runout and misalignment between the driven shaft and engine shaft must be minimized. Runout and misalignment tolerance are specified by the coupling manufacturer.

13. TROUBLESHOOTING

If the engine shows any sign of malfunction, the cause should be determined immediately and appropriate countermeasures should be taken to prevent the problem from worsening. This section describes certain known problems, their possible causes and appropriate countermeasures. Note, however, that the list of problems presented here is not all. Generally speaking, since there is the possibility of multiple causes for a single problem, please use your experience and common sense when deciding on what action to take.

13-1 ENGINE

Principal Items for proper engine operation

1) Proper fuel-air mixture filled with the cylinder(s).
2) Correct fuel injection timing.
3) Appropriate compression in the cylinder.

Most common phenomenon/causes of engine troubles Starting difficulties

1. Compression System
2. Fuel System
3. Starting System

Poor output and Improper operation

- Engine overheating and black exhaust gas
- Improper engine running
- Low engine speed
- Engine misfire with white exhaust gas
- High fuel consumption (black exhaust gas)
- Excessive wear of rotation parts or sized piston ring(s)
- Sudden engine stop with abnormal noise
- Increased dilute engine oil
- Engine over-running with fuel cut

Starting difficulties

1. Compression system

Phenomenon	Possible causes	Actions
No compression	Intake/exhaust valve stuck open	Adjust rocker arm screw
	Improper adjustment of decompression system	Readjust
Low compression	Incorrect valve seat contact	Repair or replace
	Piston ring(s) wear	Replace
	Cylinder wear	Boring cylinder and replace with oversize piston
	Incorrect mating between cylinder and cylinder head	Repair or replace
	Loosen injection nozzle seat	Retighten nuts uniformly

2. Fuel system

Phenomenon	Possible causes	Actions
No fuel in fuel tank		Refueling
Water, dust or gum in fuel line		Fuel filter cleaning and fuel replacing
No or low fuel flow	Clogged air vent hole of fuel tank	Open the hole
	Fuel line and filter clogged	Cleaning
	Closed fuel filter cock	Open the cock
	Vapor lock of fuel line	Air venting for fuel line
No fuel injection into cylinder	Seized fuel injection pump barrel and plunger	Replace
	Clogged nozzle	Clean or replace
	Seized needle of nozzle	Replace

3. Starting system

Phenomenon	Possible causes	Actions
No pinion gear operation	Starter switch failure	Replace
	Starter magnet switch failure	Adjust the improper contact point
	Battery over discharge	Battery charging
	Improper battery	Replace battery
	Incorrect electric wiring connection	Repair
	Conmitator born out	Repair
	Starter inner wiring shorted or disconnected	Replace
Incorrect pinion gear operation (low speed)	Low battery capacity	Battery charging
	Improper connection at battery terminal	Repair
	Conmitator born out or damaged	Repair
	Starter interior dusted	Disassembling and cleaning
	Starter brush worn	Replace
Improper battery discharged (Quick discharging)	Insufficient battery charging	Full charging
	Improper function of rectifier	Replace
	Battery cell(s) failure	Replace battery
	Generator or generating coil failure	Replace
Low engine speed	Incorrect starting operation	Retry after carefully reading owner's manual
	High viscosity or dusted engine oil	Replace with proper engine oil

Poor output and/or Imposer operation

Phenomenon	Possible causes	Actions
Overheat and black exhaust gas	Cooling fan dusted or damaged	Clean or replace
	Water in fuel filter and/or fuel line	Drain and clean
	Carbon stacked in cylinder, exhaust port etc.	Remove stacked carbon
	Improper smoke setting	Adjust
	Over load	Change to the rated load
	Improper injection timing	Adjust
	Clogged injection nozzle	Clean and/or replace
Improper engine running	Incorrect contact between governor folk and sleeve	Adjust
	Incorrect governor spring force	Replace
	Wear and improper operation of rotation parts, such as flyplate	Repair and/or replace
Low engine speed	Improper valve timing	Adjust tappet clearance
	Clogged exhaust pipe and muffler	Cleaning
	Over load	Change to the rated load
Engine misfire with white exhaust gas at non-load	Fuel injection nozzle clogged	Cleaning and/or replace
	Worn cylinder, piston and piston	Repair or replace
	Seized piston ring	Repair
	Improper fitting of piston ring(s)	Repair
	Incorrect injection timing	Repair
	Incorrect valve timing	Repair
	Loosen injection pump joint	Retighten or replace
High fuel consumption (Black exhaust gas)	Leakage of fuel line	Retighten or replace
	Clogged air cleaner element	Cleaning element
	Improper fuel	Replace
	Over load	Change to the rated load
Excessive wear of rotation parts or Seized piston ring(s)	Improper engine oil	Replace
	No engine oil replacement for long time	Replace at the specified interval
	Damaged air cleaner or No air cleaner replacement for long time	Replace or cleaning
Sudden engine stop with noise	Seized and/or damaged piston	Repair and/or replace
Increased dilute engine oil	Worn injection pump plunger barrel	Replace
Engine over running with fuel cut	Excessive oil level	Adjust oil level
	Incorrect fitting of governor system	Adjust and repair
	Loosen injection pump plug	Repair

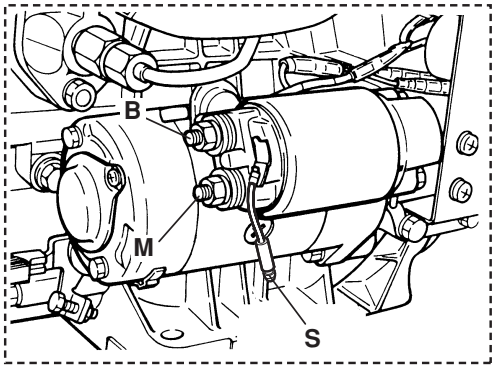
13-2 ELECTRIC STARTER

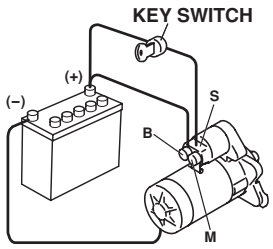
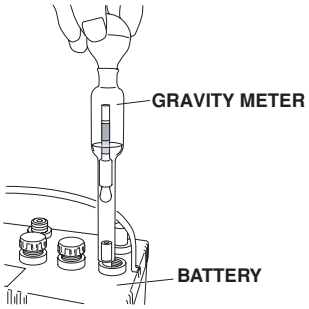
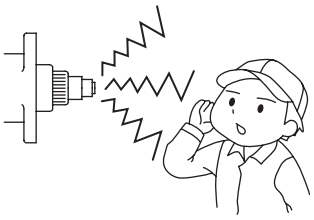
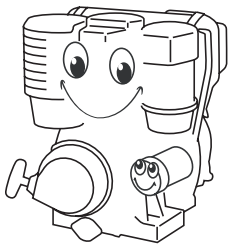
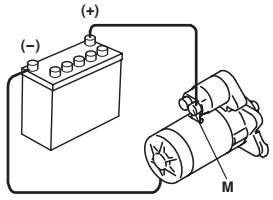
Engine does not start

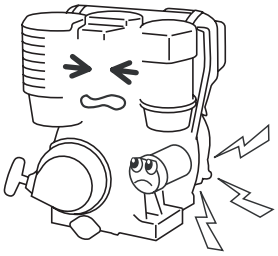
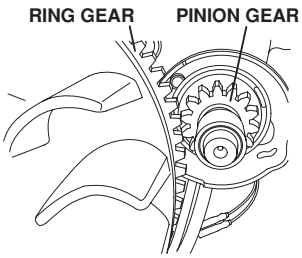
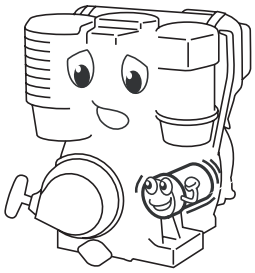
- Does the crank run? — NG → Does the starter run? — NG → Check battery charged state and battery terminal connection or corrosion for any abnormality. — NG → ● Charge or replace the battery. ● Repair connection or corrosion of battery terminals.
- Check battery charged state and battery terminal connection or corrosion for any abnormality. — OK → Operation sound of magnetic switch of starter — NG → ● Key switch ● Connected state ● Check/repair wiring to the starter magnetic switch. ● Repair or replace starter magnetic switch.
- Does the starter run? — OK → Check engagement of pinion and ring gear — NG → ● Check settling of spring and sliding of pinion. ● Replace if pinion/ring gear end face is worn. ● Correction of pinion gap
- Operation sound of magnetic switch of starter — OK → With starter alone, connect the battery (+) terminal and the M terminal of the starter and check if motor runs. — NG → Replace motor (brush holder or armature).
- Does the crank run? — OK → Normal rotation? — NG (Too slow) → Check battery charged state and battery terminal connection or corrosion for any abnormality. — NG → ● Charge or replace the battery. ● Repair connection or corrosion of battery terminals.
- Normal rotation? — OK → Check compression system and fuel system.
- Check battery charged state and battery terminal connection or corrosion for any abnormality. — OK → Check viscosity of engine oil for any abnormality. — NG → Change the engine oil.
- Check viscosity of engine oil for any abnormality. — OK → Replace the starter with a new one and check if it runs. — NG → Check the engine interior.
- Replace the starter with a new one and check if it runs. — OK → Repair or replace the starter.
- Check pinion roller clutch for damage or replace. — OK → Check battery charged state and battery terminal connection or corrosion for any abnormality.
- With starter alone, connect the battery (+) terminal and the M terminal of the starter and check if motor runs. — OK → There is any contact failure of starter magnetic switch. Please replace.

※ When the starter continuously runs
(Immediately remove the (-) terminal of the battery)

Motor does not stop even when the key switch is turned off. → Repair or replace the key switch or starter magnetic switch.



Problem and check item		Description		Remedy
① Starter does not run or only "click" sound is heard.	1. Checking of continuity of wiring	Check S terminal and B terminal for deformation, looseness, rusting, or dust sticking. Carefully check inserting method of the S terminal. If not abnormal, set the key switch to START position while cranking (no combustion of engine) and check if voltage is applied to the S terminal and B terminal of starter motor.		① When no voltage is applied to the S terminal and B terminal, check continuity of the terminals and key switch and repair or replace if necessary. ② If voltage is applied to the S terminal and B terminal, go to "2. Battery checking."
	2. Battery checking	Check battery voltage and specific gravity of battery fluid. **[Voltage]** Normal value : 12.4 to 12.8V Limit (charging required): 12.4V or lower Staring limit : 12V (at 20°C) **[Specific gravity]** Normal value : 1.22 to 1.29 Limit (Charging required) : 1.22 or lower **[Service life]** Variance in specific gravity among cell : 0.04 or more		① Charge or change the battery when voltage is lower than 12.4V or specific gravity is lower than 1.22 (at 20°C). ② If the wiring and battery are normal, remove the starter and go to "3. Checking of pinion operation." * Use battery rated 12V-35AH or larger
	3. Checking of pinion operation	Check if the pinion operates or sound of magnetic switch contactor is heard. If the pinion does not operateor magnetic switch sound is not heard, check continuity of each coil of magnetic switch.		① If the pinion operates or contactor sound is heard, step to "4. Checking of magnetic switch (1)." ② In case of no continuity Replace the magnetic switch. ③ When continuity is OK Step to "4. Checking of magnetic switch (2)."
	4. Checking of magnetic switch	(1) Operate the magnetic switch and check B-M terminals		① In case of no continuity Contact continuity failure. Replace themagnetic switch. ② When continuity is OK Step to "5. Motor checking."
		(2) Check the magnetic switch plunger and bobbin interior for dust sticking or rusting.		① Clean the plunger. If the bobbin interior is contaminated, replace the magnetic switch.
	5. Motor checking	Connect the (+) side of the battery to the M terminal of magnetic switch and check if the motor runs.		① If the motor does not run, check electric circuit inside the motor, field coil, armature, and brush and replace faulty parts.

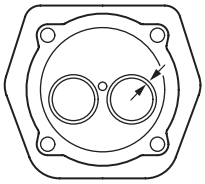
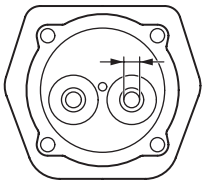
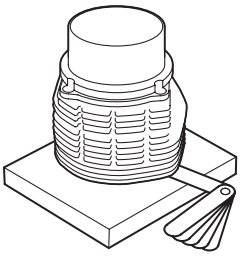
Problem and check item		Description		Remedy
② Starter runs but engine not	Check engaged state of pinion and ring gear.	Motor idles and engine does not run.		① Remove and check the starter. Check or replace the pinion clutch if necessary. ② Check battery charged state and battery terminal connection or corrosion for any abnormality.
		If pinion and ring gear do not engage with each other and abnormal noise is heard between end faces of pinion and ring gear, check the starter pinion and ring gear.		① Remove the starter and check pinion and ring gear end faces. If worn, replace the pinion and ring gear. ② In case of sliding fault of the pinion, correct it. ③ If shift lever or spring is deformed, replace it.
③ Both starter and engine run, but the engine does not start.		Check if the rotation speed is normal or slow. If slow, check the battery and engine oil viscosity.		① When the rotation speed is normal Check the compression system and fuel system. ② When the rotation speed is slow (a) Check the battery. (b) Check the viscosity of engine oil. If not normal, change the oil. (c) If both (a) and (b) are normal Remove and check the starter.

14.SERVICE DATA

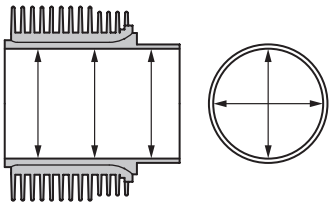
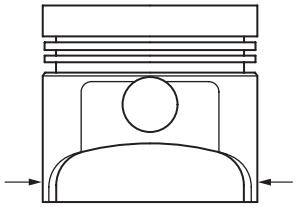
"STD" in the following table is the parts dimension from the brand new engine or the spare parts.
Whereas, "Limit" shows the maximum allowance for the parts to be used on the engine.
If the measurement exceeds beyond the "Limit", the part needs to be replaced and/or repaired.

14-1 STANDARD DIMENSIONS AND SERVICE LIMITS

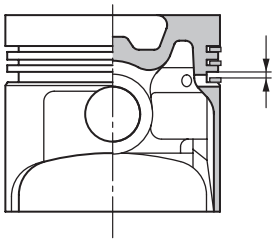
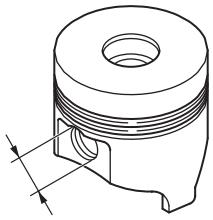
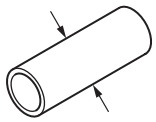
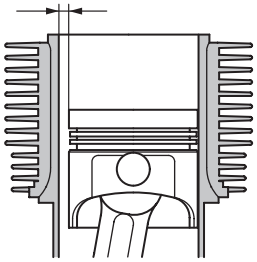
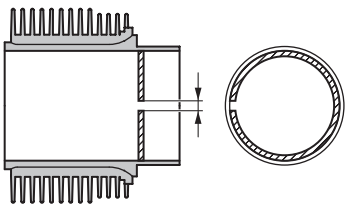
Unit: mm (in)

ITEM		DY30/35/41/42	
		STD	Limit
CYLINDER HEAD ● Valve seat contact width 	IN. EX.	1.40 (0.0551)	2.20 (0.0866)
● Valve guide inside dia. 		7.015 (0.2762)	7.15 (0.2815)
CYLINDER ● Flatness 		0.0	0.025 (0.0010)

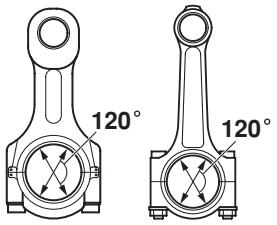
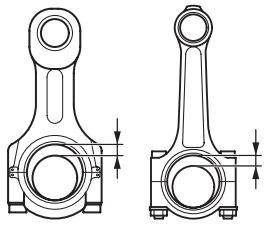
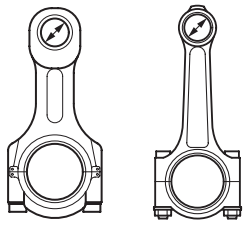
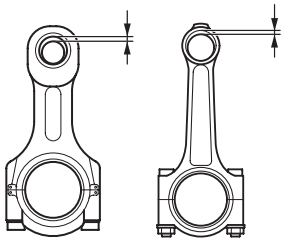
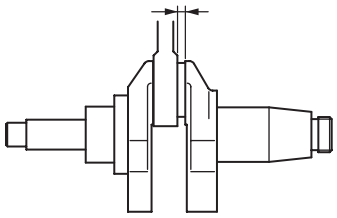
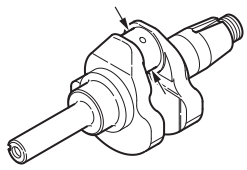
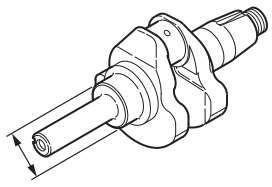
Unit: mm (in)

ITEM		DY30		DY35/41/42	
		STD	Limit	STD	Limit
CYLINDER ● Inside dia. 	STD	76.000 - 76.019 (2.9921 - 2.9929)	To be rebored when the difference between max. and min. of diameter reached to 0.1 (0.004).	82.020 - 82.042 (3.2291 - 3.2300)	To be rebored when the difference between max. and min. of diameter reached to 0.1 (0.004).
	1St reboring	76.250 - 76.269 (3.0020 - 3.0027)	Ditto	82.270 - 82.292 (3.2390 - 3.2398)	Ditto
	2nd reboring	76.500 - 76.519 (3.0118 - 3.0126)	–	82.520 - 82.542 (3.2488 - 3.2497)	–
● Cylindricity after reboring.		0.01 (0.0004)	–	0.01 (0.0004)	–
● Cylindricity after reboring.		0.015 (0.0006)	–	0.015 (0.0006)	–
PISTON ● Piston size (At skirt in thrust direction) 	STD	75.97 - 75.99 (2.9909 - 2.9917)	75.86 (2.9866)	81.92 - 81.94 (3.2252 - 3.2260)	81.84 (3.2220)
	1st o/s	76.19 - 76.21 (2.9996 - 3.0004)	76.11 (2.9965)	82.17 - 82.19 (3.2350 - 3.2358)	82.09 (3.2319)
	2nd o/s	76.44 - 76.46 (3.0094 - 3.0102)	76.36 (3.0063)	82.42 - 82.44 (3.2449 - 3.2457)	82.34 (3.2417)

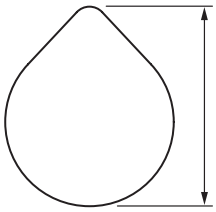
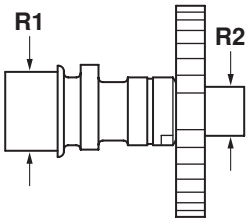
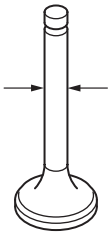
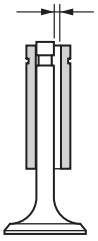
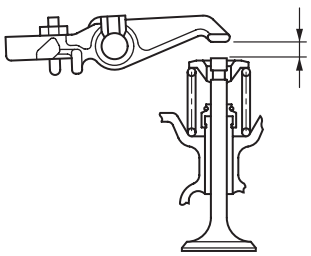
Unit: mm (in)

ITEM		DY30		DY35 / 41 / 42	
		STD	Limit	STD	Limit
● Ring groove side clearance. 	TOP	0.050 - 0.090 (0.0020 - 0.0035)	0.15 (0.0059)	0.050 - 0.090 (0.0020 - 0.0035)	0.15 (0.0059)
	2nd	0.050 - 0.090 (0.0020 - 0.0035)	0.15 (0.0059)	0.050 - 0.090 (0.0020 - 0.0035)	0.15 (0.0059)
	Oil ring	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 		21.001 - 21.008 (0.8268 - 0.8271)	21.030 (0.8280)	DY35 / 41 21.001 - 21.008 (0.8268 - 0.8271)	21.030 (0.8280)
				DY41, 1058686 and after DY42 22.001 - 22.008 (0.8662 - 0.8665)	22.030 (0.8673)
● Piston pin outside dia. 		21.000 - 21.006 (0.8268 - 0.8270)	20.98 (0.8260)	DY35 / 41 21.000 - 21.006 (0.8268 - 0.8270)	20.98 (0.8260)
				DY41, 1058686 and after DY42 22.000 - 22.006 (0.8661 - 0.8664)	21.98 (0.8654)
● Clearance between piston and cylinder at skirt area. 		0.020 - 0.059 (0.0008 - 0.0023)	0.15 (0.0059)	0.080 - 0.122 (0.0031 - 0.0048)	0.2 (0 0079)
● Piston ring end gap 	Top	0.3 - 0.5 (0.0118 - 0.0197)	1.0 (0.0394)	0.15 - 0.35 (0.0059 - 0.0138)	0.8 (0.0315)
	2nd			0.3 - 0.5 (0.0118 - 0.0197)	1.0 (0.0394)
	Oil ring	0.25 - 0.45 (0.0098 - 0.0177)	1.0 (0.0394)	0.1 - 0.3 (0.0039 - 0.0118)	0.8 (0.0315)

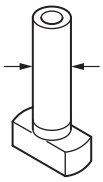
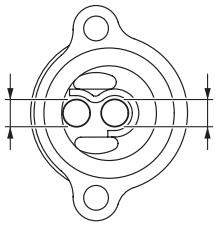
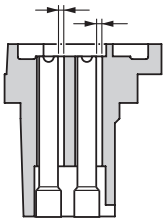
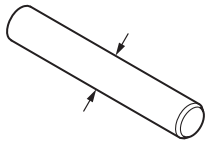
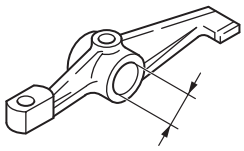
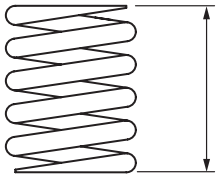
Unit: mm (in)

ITEM	DY30 / 35 / 41 / 42	
	STD	Limit
CONNECTING ROD ● Big end inside dia. (Metal is fitted) 	DY30 / DY35 / DY41 / DY42	
	40.039 - 40.081 (1.5763 - 1.5780)	40.1 (1.58)
	DY41, 1058686 and after / DY42, 1006221 and after	
	40.047 - 40.089 (1.5767 - 1.5783)	40.1 (1.58)
● Clearane between big end and crankpin 	DY30 / DY35 / DY41 / DY42	
	0.010 - 0.068 (0.0004 - 0.0027)	0.1 (0.004)
	DY41, 1058686 and after / DY42, 1006221 and after	
	0.018 - 0.076 (0.0007 - 0.0030)	0.1 (0.004)
● Small end inside dia. 	DY30 / DY35 / DY41	
	21.013 - 21.034 (0.8273 - 0.8281)	21.05 (0.829)
	DY41, 1058686 and after / DY42	
	22.013 - 22.034 (0.8667 - 0.8675)	22.05 (0.868)
● Clearance between small end and piston pin 	0.007 - 0.034 (0.0003 - 0.0013)	0.08 (0.0031)
● Big end side clearance 	0.07 - 0.33 (0.0028 - 0.0130)	0.5 (0.0197)
CRANKSHAFT ● Crankpin outside dia. 	40.013 - 40.029 (1.5753 - 1.5759)	39.85 (1.5689)
● Journal dia. 	41.984 - 41.000 (1.6529 - 1.6142)	42.15 (1.6594)

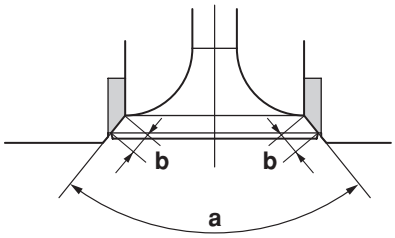
Unit: mm (in)

ITEM		DY30/35/41/42	
		STD	Limit
CAMSHAFT ● Cam height 	IN.EX. CAMS	29.6 - 29.8 (1.165 - 1.173)	29.45 (1.159)
● Journal outside dia. "D" type. 	D1	16.973 - 16.984 (0.6682 - 0.6687)	16.95 (0.6673)
	D2	14.973 - 14.984 (0.5895 - 0.5899)	14.95 (0.5886)
VALVE ● Valve stem outside dia. 	IN.	6.937 - 6.922 (0.2731 - 0.2725)	6.85 (0.2697)
	EX.	6.917 - 6.902 (0.2723 - 0.2717)	6.85 (0.2697)
● Clearance between valve stem dia. and valve guide 	IN.	0.063 - 0.093 (0.0025 - 0.0037)	0.3 (0.012)
	EX.	0.083 - 0.113 (0.0033 - 0.0044)	0.3 (0.012)
● Valve clearance 	IN./EX. (cold)	0.07 - 0.1 (0.0028 - 0.0039)	Adjustable

Unit: mm (in)

ITEM	DY30/35/41/42	
	STD	Limit
TAPPET ● Stem outside dia. 	7.967 - 7.987 (0.3137 - 0.3144)	7.867 (0.3097)
● Guide inside dia. 	8.000 - 8.015 (0.3150 - 0.3156)	8.1 (0.3189)
● Tappet guide clearance 	0.013 - 0.048 (0.0005 - 0.0019)	0.2 (0.0079)
ROCKER ARM ● Rocker shaft outside dia. 	11.966 - 11.984 (0.4711 - 0.4718)	11.92 (0.4693)
● Rocker arm hole dia. 	12.000 - 12.018 (0.4724 - 0.4731)	12.06 (0.4748)
● Rocker arm shaft clearance 	0.016 - 0.052 (0.0006 - 0.0020)	0.15 (0.0059)
VALVE SPRING FREE LENGTH 	36.5 (1.4370)	———

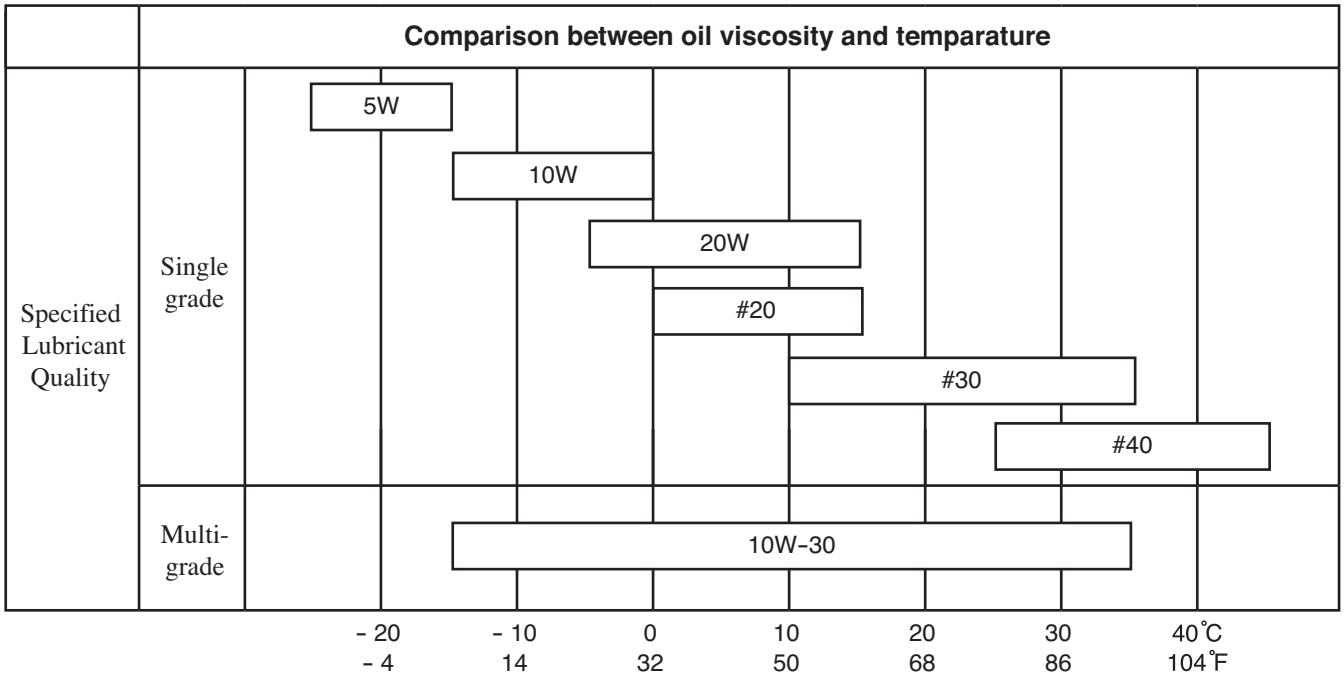
Unit: mm (in)

ITEM	DY30/35/41/42	
	STD	Limit
VALVE SEAT ANGLE(IN. EX.) ● a : Valve cutter angle ● b : Valve contact width 	a 90° b 1.4 (0.06)	——— b 2.2 (0.09)

14-2 TIGHTENING TORQUE

Description		Tightening torque		
		N·m	kgf·cm	ft·lb
Gear case cover		20.0 - 23.0	200 - 230	14.5 -16.7
Blower housing fastening bolt		20.0 - 23.0	200 - 230	14.5 -16.7
Cylinder head fastening nut		30.0 - 35.0	300 - 350	24 - 25.4
Connecting rod cap fastening bolt	**DY30/35**	25.0 - 27.0	250 - 270	18.1 - 19.5
	DY41/42	39.0 - 45.0	390 - 450	28.8 - 33.2
Flywheel fastening nut		200.0 - 220.0	2000 - 2200	145 - 160
Rear bearing fastening bolt		20.0 - 23.0	200 - 230	14.5 - 16.7
Oil pump cover fastening bolt		8.0 - 10.0	80 - 100	5.8 - 7.2
Nozzle bracket fastening nut		9.0 - 10.0	90 - 100	6.5 - 7.2
Rocker arm adjustment nut		8.0 - 10.0	80 - 100	5.8 - 7.2

14-3 OIL GRADE CHART



Use oil classified as CC or higher.
Multi-grade oil tends to increase its consumption at high ambient temperature.

15. MAINTENANCE and STORAGE

The following maintenance jobs apply when the engine is operated correctly under normal conditions.
The indicated maintenance intervals are by no means guarantees for maintenance free operations during these intervals.
For example, if the engine is operated in extremely dusty conditions, the air cleaner should be cleaned every day instead of every 50 hours.

15-1 DAILY MAINTENANCE

Checks and maintenance	Reasons for requiring them
Remove dust from whatever parts which accumulated dust.	To be contaminated with dust when disassembling each and every part.
Check external fuel leakage. If any, retighten or replace.	Not only wasteful but also dangerous.
Check screw tightening. If any loose one is found, re-tighten.	Loose screws and nuts will result in vibration accidents.
Check oil level in crankcase and add up as necessary.	If the engine is operated without sufficient oil, it will fail.

Periodic Maintenance Schedue Table

Maintenance Items	Every 8 hours (Daily)	Every 50 hours (10 days)	Every 100-200 hours (Monthly)	Every 500-600 hours (Semi-annually)	Every 1000 hours (Yeary)	Every 1500 hours
Clean engine and check bolts and nuts	○					
Check and refill engine oil to full level	○					
Change engine oil (*Note 1)		○				
Clean engine oil filter		○				
Clean air cleaner		○				
Clean fuel filter			○			
Replace air cleaner element			○			
Check and adjust valve clearance			○			
Replace engine oil filter (*Note 1)			○			
Check and clean injection nozzle			○			
Remove carbon deposit with cylinder head removed				○		
Replace fuel filter				○		
Check and adjust valve seats				○		
Replace piston rings					○	
Replace fuel lines					○	
Overhaul engine (*Note 2)						○

*NOTE 1 ; Initial oil change should be performed after 25 hours of operation.
Thereafter change oil every 50 hours and replace oil filter every 100 - 200 hours.

Before changing oil, check for a suitable way to dispose of old oil. Do not pour it down into sewage drains, onto garden sol or into open streams.
Your local zoning or environmental regulations will give you more detailed instructions on proper disposal.

*NOTE 2 ; As to the procedures, please refer to the Service Manual or consult with your nearest ROBIN service dealer.

* NOTE 3 ; More frequent oil change, oil filter replacement and air cleaner service or replacement may be necessary depending on operation conditions, such as dusty environment, high ambient temperature, heavy engine loading etc.

15-2 ENGINE STORAGE

1) Perform the above 15-1 maintenance job.
2) Drain fuel from the fuel tank.
3) To prevent rust in the cylinder bore, apply oil through the breather hole on the surface of rocker cover and made cranking for 2-3 times and then fit the rocker cover. Don't apply too much oil as the excess oil will be collected in the combustion chamber of the piston.
4) Turn cranking handle and leave it where the restance is the heaviest.
5) Clean the engine outside with oiled cloth. Put a vinyl or other cover over the engine and store the engine in dry place.

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