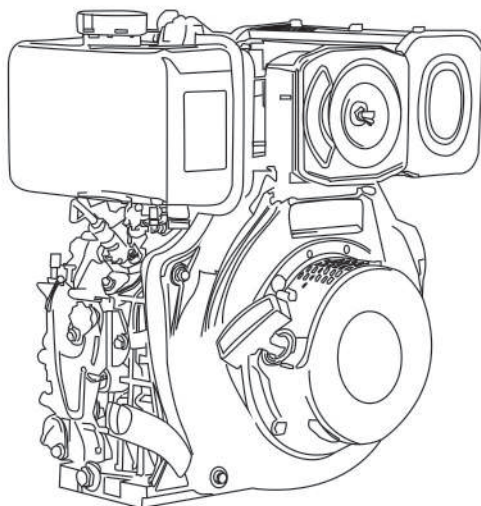


**IMPORTANT-Please make certain that persons who are to use this equipment thoroughly read and understand this user's manual prior to operation**

# **DIESEL ENGINE**

## **USE'S MANUAL**



## PREFACE

The following manual is only a guide to assist you and is not a complete or comprehensive manual of all aspects of maintaining and repairing your engine. The engine you have purchased is a complex piece of machinery. We recommend that that you consult with a dealer if you have doubts or concerns as to your experience or ability to properly maintain or repair your engine. You will save time and the inconvenience of having to go back to the store if you choose to write or call us concerning missing parts, service questions, operating advice, and/or assembly questions.

### Engine Features and Highlights

- Direct fuel injected intake system
- Recoil-type manual starter and or optional electric starter system
- Force air convection cooling system
- Composite steel fan cover for minimum noise levels

Our four stroke diesel engines are air cooled with a direct fuel injected intake system. They offer maximum efficiency through the minimal conservation of energy and materials. These diesel engines are compact and lightweight. They are easily maintained and portable making it convenient to move. They are widely used as a source of mechanical power for industrial, agricultural, and machinery equipment. Some applications include irrigation equipment, diesel powered pressure sprayers, grass-cutting machines, and soil-sampling machines. Other applications include vibration rammers, shock rammers, marine engines, lightweight transport vehicles, portable compressors, and lightweight portable generators.

This operating manual will explain how to operate and maintain your series of engines. Please read it before running the engine for correct operation

To ensure long engine life please follow the operating requirements listed in this manual.

If you have any questions or suggestions about this manual, please contact your local dealer or us. Consumers should notice that this manual might differ slightly from the actual product as more improvements are made to our products.

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## SAFETY PRECAUTIONS

**Please be sure to follow each instruction carefully**

### EXHAUST PRECAUTIONS

- Never inhale the exhaust gases, it contains carbon monoxide, a colorless, odorless and extremely dangerous gas which can cause unconsciousness or death
- Never operate the engine indoors or in a poorly ventilated area, such as a tunnel or cave, etc.
- Exercise extreme care when operating the engine near people or animals. Keep the exhaust pipe free of external objects.



### REFUELING PRECAUTIONS

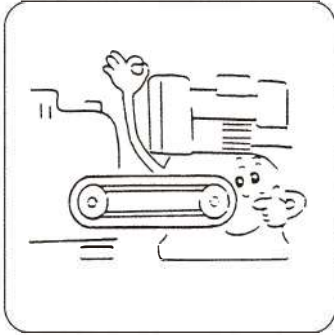
- Be sure to stop the engine before refueling.
- Do not overfill the fuel tank.
- If fuel is spilled, wipe it away carefully and wait until the fuel has dried before starting the engine again.
- When changing oil, make sure that the fuel cap is tightly secured to prevent fuel leakage.



### FIRE PREVENTION

- Never operate the engine while smoking or near an open flame.
- Never use the engine around dry brush, twigs, cloth-rags, or other flammable materials.
- Keep the engine at least 3 feet(1 meter) away from buildings or other structures.
- Keep the engine away from flammables and other hazardous materials.





## PROTECTIVE COVER

- Always place the protective covers over the rotating parts. If rotating parts such as the driving pulley, belts, and shafts are exposed, serious injuries can be caused. To prevent injury, please equip all rotating parts with protective covers.
- Be careful of hot parts. The muffler and other engine parts can become very hot while the engine is running or after the engine has been run. Always operate the engine in a safe area and keep children away from running engines.

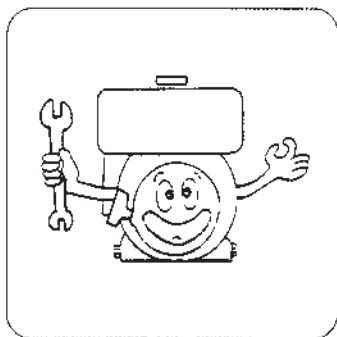
## SURROUNDINGS

- Operate the engine on a table or level surface free of small rocks and loose gravel.
- Operate the engine on a level surface. If the engine is tilted, fuel may spill from the gas tank.

NOTE: Operating the engine at a steep incline may cause the engine to seize up due to improper lubrication even when the oil level is a maximum.

- Be careful of fuel spillage when transporting the engine. Always tighten the fuel cap and close the fuel strainer cock before moving the engine around.
- Never move the engine while it is in operation.
- If the engine will be transported over a long distance, drain all the fuel from the fuel tank to prevent fuel leakage.





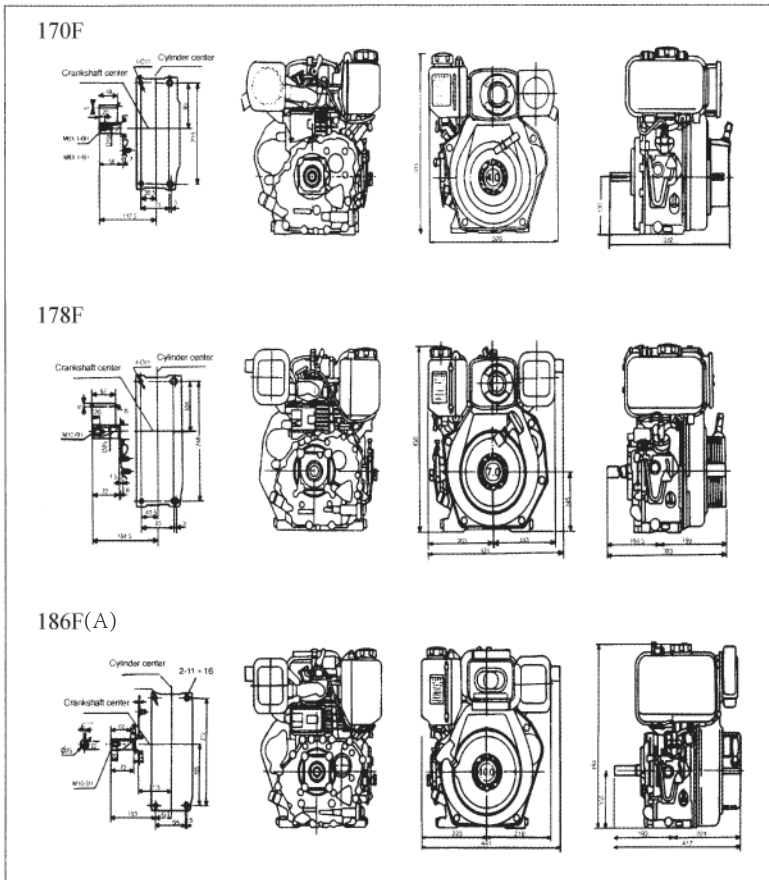
### PRE-OPERATION CHECKS

- Carefully check fuel pipes and fuel joints for fuel leakage. Leaked fuel creates a dangerous situation.
- Verify that all the nuts and bolts of the engine are tight. A loose nut or bolts may cause serious engine failure and could lead to serious injuries.
- Always check the engine oil and refill it if necessary.
- Always check the fuel level and refill it if necessary. Never overfill the fuel tank.
- Avoid wearing dangling or long clothes such as loose aprons, towels, and waist belts, as these items may be caught in a rotating part of the engine.

## 1-1 Specifications and technical data

Model No.	300 Diesel	420 Diesel	460 Diesel	480 Diesel	500 Diesel
Diesel Engine Type	Singel-cylinder , vertical、 4-stroke、 air-cooled、 direct injection				
Bore*Stroke(mm)	78*62	86*72	88*75	90*75	92*75
Displacement(cc)	296	418	456	477	498
Rated speed (rpm)	3000 3600	3000 3600	3000 3600	3000 3600	3000 3600
Rate power/Hp	5.0 6.0	8.0 9.0	9.0 10.0	10.0 11.0	14.0 15.0
Piston running speed(m/s)	5.5 6.6	7.2 8.64	7.5 9	7.5 9	7.5 9
Fueltank capacity(L)	3.5	5.5	5.5	5.5	5.5
Lube oil capacity ( L )	0.75	1.65	1.65	1.1	1.1
Rotation direction	Clockwise from flywheel end				
Cooling Type	Air-cooled				
Lubricating system	Pressure splashed				
Net Weight (kg)	28	52	52	52	52
Gross Weight ( kg)	30	54	54	54	54
Overall dimension ( mm)	420*380*470	500*475*555	500*475*555	500*475*555	500*475*555

## 1-2 Overall engine dimensions



### Installation Conditions

- (1) There must be a tight stationary foundation for the diesel engine to avoid vibrations or movement when the engine is running. For prolonged engine life, consider using some type of motor mount.
- (2) Make sure that the centering position of the output shaft is properly aligned.
- (3) Verify that the dimensions of the hole on the belt wheel and keyway shaft match or correspond with each other. Also make sure that the bolt of the engine shaft is tightened to the proper torque specifications.



(4) When the engine is matched with other belt driven machines, the total desired belt distance traveled by the driven wheel must equal the total distance traveled by the driver wheel. If this is not properly calculated and matched, the desired speed on the driven wheel will be incorrect. A formula used to calculate the necessary diameters of the various wheels is provided below.

The diameter of driving wheel (belt wheel) can be calculated as follows:

$\frac{\text{Diameter of engine driving wheel (engine pulley)}}{\text{Diesel speed(engine speed)}} = \frac{\text{Diameter of driven machine} \times \text{speed of drive machine}}{\text{Diesel speed(engine speed)}}$
--

(5) Make sure that the belt has a correct tension to it.

Note: If the belt is too tight, the engine bearings will wear at a high rate leading to engine failure. If the belt is too loose, the belt will slip at high speeds and high loads causing high pitch whistling noises.

### 1-2.1 Allowed clearance between belt wheel and engine

The belt pulley wheel should be as close to the engine as possible. The values of L are tabulated in table 1-1.

Model		170F	178F	186F(A)
Item				
Belt	Type	A	B	C
	Qty.	2	2	2
Min. diameter of pulley		68	97	135
L		≤ 3.15in (80mm)	≤ 2.76in (70mm)	

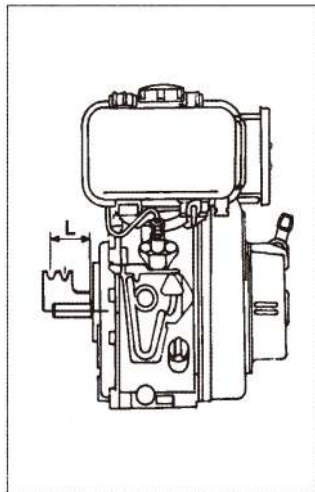


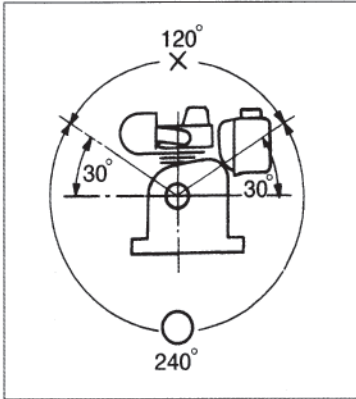
Table 1-1





**1-2.2 Crankshaft driving angles must be less than 120°, see Fig 1-1**

The tilt must be kept within the allowed value shown in Fig 1-2

Fig. 1-1 Allowed driving angles.

Fig. 1-2 Allowed tilt angles.



Output Shaft Tilt		
Allowed Tilt (continuous running)	$\leq 20^\circ$	
Engine Tilt		
Allowed Tilt (continuous running)	$\leq 20^\circ$	

**1-2.3 Please contact our dealers about electric circuits involved with this engine.**

We recommend the use of accumulators rated at 20 hours shown in table 1-2.

Table 1-2.

Model	Units:(amp-hours)
170F	18~24
178F	24~36
186F(A)	36~45

### 1-3 Diesel Engine shaft specifications

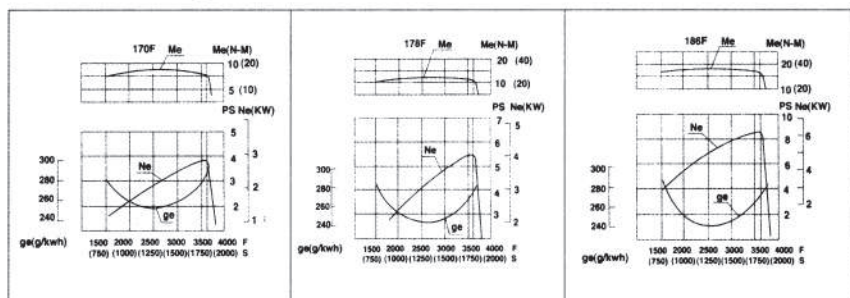
unit:mm

MODEL	Keyway shaft	Thread shaft	Taper shaft
170F	<p>170FA-5/16" -24NF-6H 170FB-M8 x 1-24NF-6H</p>		
178F	<p>178FA-7/16" -20UNF-6H 178FB-M10 x 1.25-20UNF-6H</p>		
186F(A)	<p>186FA-7/16" -20UNF-6H 186FB-M10 x 1.25-20UNF-6H</p>		

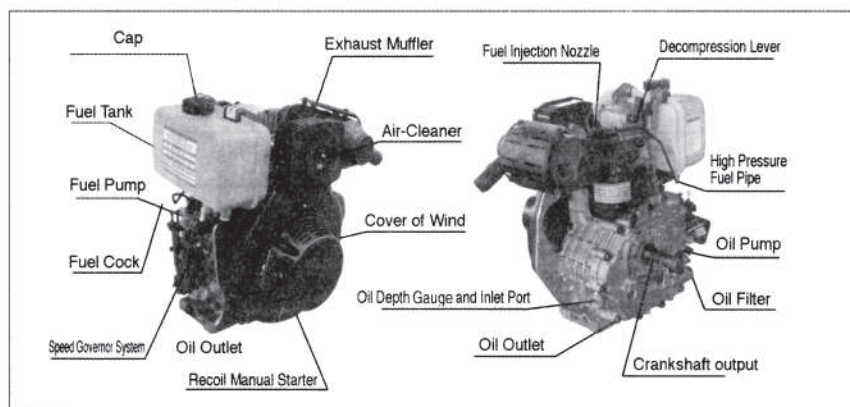
## Sizes of PTO flanges

PTO Flanges		
170F	178F	186F(A)

## Diesel characteristic graph



## 1-4 Names of Diesel Engine Parts



### 1-5 Valve timing, initial angle of fuel delivery and valve clearances.

Table 1-3

Units:Degrees

ITEM \ MODEL	PHASE		
	170F	178F	186F(A)
Intake valve open	BTDC18° 30'	BTDC18°	BTDC13°
Intake valve close	ATDC45° 30'	ATDC46°	ATDC52°
Exhaust valve open	BBDC55° 30'	BBDC52°	BBDC57°
Exhaust valve close	ABDC8° 30'	ABDC12°	ABDC8.5°

### 1-5.2 Initial angle of fuel delivery

Table 1-4

Units:Degrees

170F	178F	186F	186F(A)
21° ± 1°		22° ± 1°	23° ± 1°

### 1-5.3 Valve clearance

Table 1-5

unit:mm

Description \ Model	170F	178F	186F(A)
Intake valve	0.10~0.15(Cold state)		
Exhaust valve	0.10~0.15(Cold state)		

### 1-6 Temperature ranges for exhaust and injection pressure specifications

Description \ Model	170F	178F	186F(A)
Exhaust temperature(°C)	≤ 480		
Machine oil temperature(°C)	≤ 95		
Smoke(Bosch)	≤ 4		
Pressure of injection MPa(kgf/cm <sup>2</sup> )	19.6 ± 0.49(200 ± 5)		

## 1-7 Torque specifications for various engine nuts and bolts

Table 1-7. Torque specifications in English units

Unit:ft-lbs

Description	Model			Note
	170F	178F	186F(A)	
Connecting rod nut	18.44~22.13		29.50~33.19	Retighten up after test period
Cylinder head nut	25.81~29.50	30.98~31.72	40.57~44.25	
Flywheel nut	73.76~88.51		88.51~103.26	
Nozzle retainer nut	7.38~8.85			
Tighten bolt of rocker support	18.44~22.13			
Standard M8 bolt	14.75~22.13			
Standard M6 bolt	11.06~14.75			

Table 1-8. Torque specifications in SI units

Unit:N · m

Description	Model			Note
	170F	178F	186F(A)	
Connecting rod nut	25~30		40~45	Retighten up after test period
Cylinder head nut	35~40	42~43	55~60	
Flywheel nut	100~120		120~140	
Nozzle retainer nut	10~12			
Tighten bolt of rocker support	25~30			
Standard M8 bolt	20~30			
Standard M6 bolt	15~20			

## CHAPTER 2 DIESEL ENGINE OPERATION

### 2-1 Please pay close attention for safe operation of the diesel engine.


1. The fuel used must be filtered by silk fabric or settled for 24 hours before it is used in the engine. Never add oil to the crankcase when the engine is running.
2. Keep flammable and combustible goods away from engine while engine is running.  
The engine should be placed in a simple ventilated place.
3. Do not touch the muffler when the engine is running or just after it has stopped.
4. The diesel engine should be operated at its rated power and rated speed. If abnormal operating conditions are detected, stop the engine immediately to check and fix the problem.
5. A new engine must be properly broken in. For the first 20 hours, run the engine at low speed and low loads. Do not allow engine to run at high speeds and high loads during the break in period.

### 2-2 Fuel Choices

Choice of fuel:  
Only use light diesel fuel for diesel engine. (No.0 in Summer No.-10 or No.-20 in winter. ) Do not allow dust or water in the fuel and fuel tank.

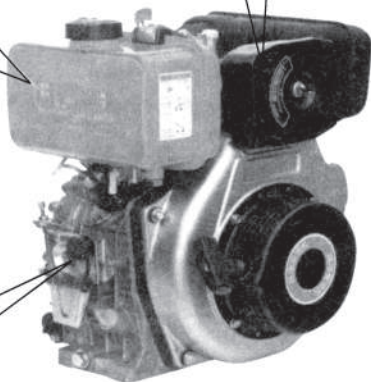
Model	170F	178F	186F(A)
Capacity Liter	1.9	2.7	4.7
British Gal	(0.42)	(0.59)	(1.03)

Caution: Do not let fuel level be higher than Red Mark

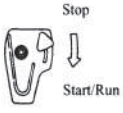


cap  
Red mark

Core of air filter:  
Do not wash the core of air filter, because this part is dry type. When power of engine is not good or the color of exhaust is abnormal, change the core. Do not operate the engine without the core of filter.



Stop  
Start/Run



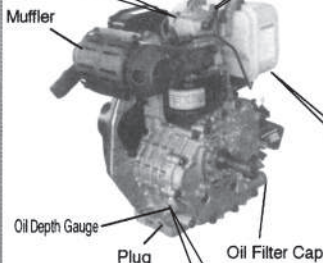
#### Oiling pulg:

In winter, if it is difficult to start the engine, pull the plug out and fill 2cc of lube oil into the hole and then put the plug back in place. Make sure the plug is tight, if not, the engine can absorb dust into the combustion chamber and damage itself.

#### Compression release lever:

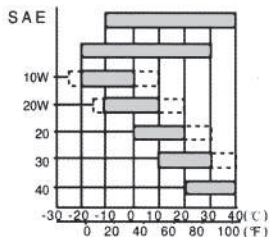
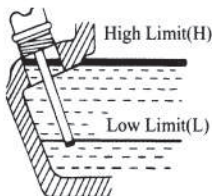
Push the lever down to start the engine

The factory has replaced the engine fuel and engine oil once already. To check the fuel pipeline, make sure the fuel line is completely drained. If there is air in the pipeline, drain it out. To do this, loosen the nut between the injection pump and fuel pipe, then drain out the air until there are no bubbles left in fuel line.



#### Oil Lubricant Inlet:

Place the engine on level ground and fill the lubricant into the inlet. When checking the oil level, gently place the dipstick into the oil. Do not turn the oil scale.



■ Suggested Value  
 □ Allowed Limit Value

Be sure to use oil GRADE CC or CD  
 A.P.I Diesel Engine Service.

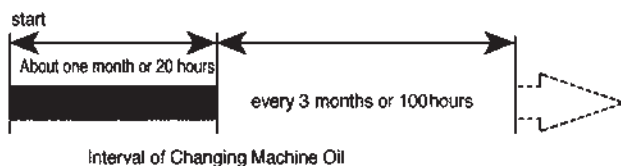
Model	170F	178F	186F(A)
Capacity			
Litre (British Gal)	0.75 (0.16)	1.1 (0.24)	1.65 (0.36)



If your engine is still relatively new, follow the break in procedure. The life of the engine will shorten if it is overloaded during its break in period. For the first 20 hours, the engine must be started and stopped according to the test run method.

Avoid overloading the engine.

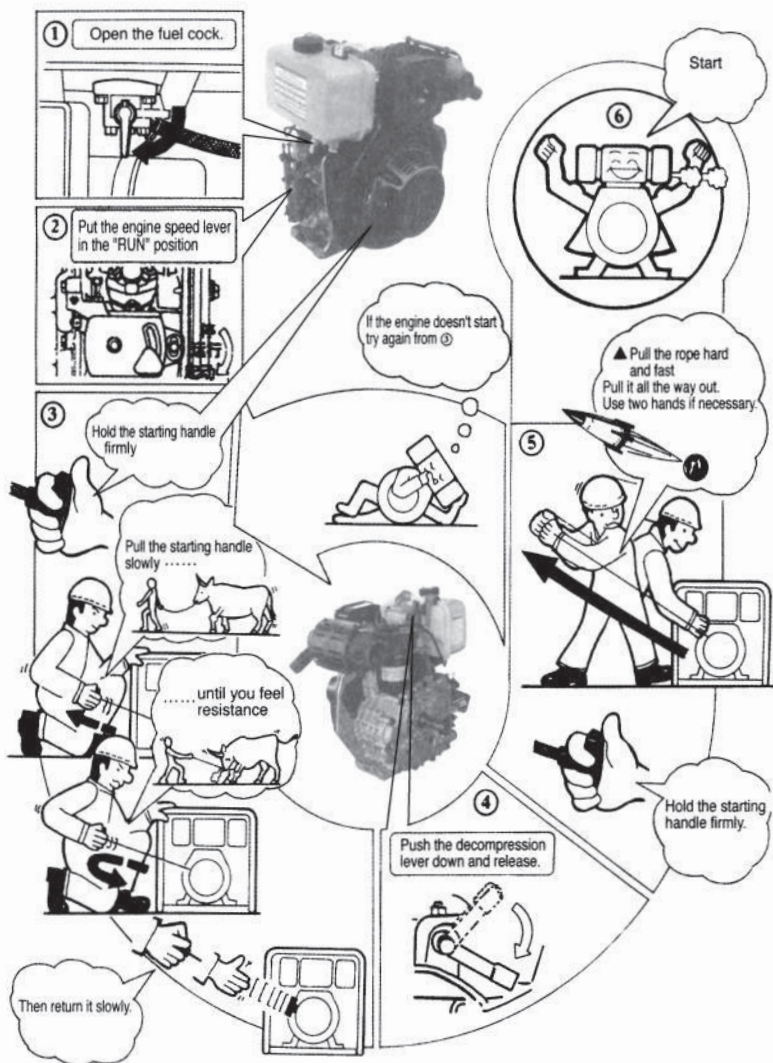
Change the engine oil regularly. Below a table for the interval of oil changes will be provided.

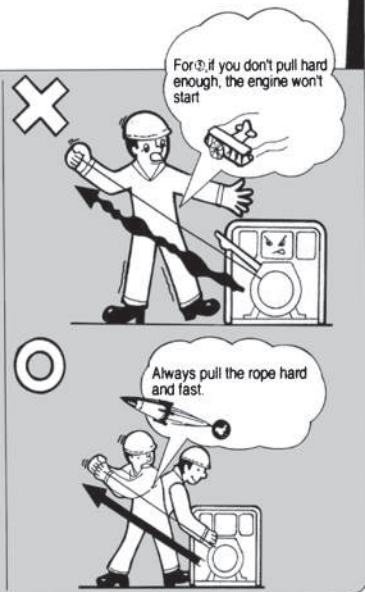


## 2-3 Starting of the Diesel Engine

### 2-3.1 Recoil starting

NOTE: When the engine is running, do not pull the recoil handle, otherwise the engine may be damaged.



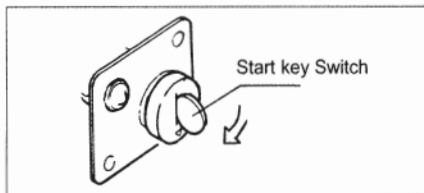


### 2-3.2 Diesel engine with electric starter system

#### (1) starting

The preparation of the diesel engine for the electric starting system is the same as the manual recoil type.

- a. Open the fuel cock.
- b. Set the speed governor lever to the start position.
- c. Turn the start switch clockwise to the "Start" position.



- d. If the engine is started, immediately remove your hand away from the key switch.
- e. If the engine does not start after 10 seconds, wait for a while (about 15 seconds) before trying to start the engine again.

If you run the starter motor too long, the voltage of the accumulator will drop and the motor may be damaged. Keep the key switch in the "ON" position

#### (2) Battery

Always check the liquid level of the battery every month, if the level is lower than the low limit mark, refill the battery with distilled water till you reach the upper limit mark.

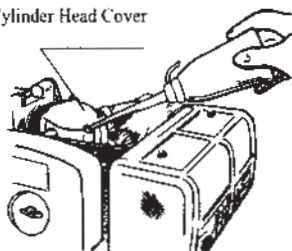
If the liquid level in the battery is too low, the electric starter will not function to its best potential. Always keep the level of the liquid in the battery between the upper and lower limits. If there is too much liquid, the liquid will splash onto other nearby parts thereby ruining the battery.

### 2-3.3 Cold starting

If the engine is difficult to start in winter, take off the rubber seal plug and put 2cc of machine oil into the hole.

Notice: Engines supplied to the torrid zone will not contain the rubber plug. A solid plug is provided instead.

Cylinder Head Cover

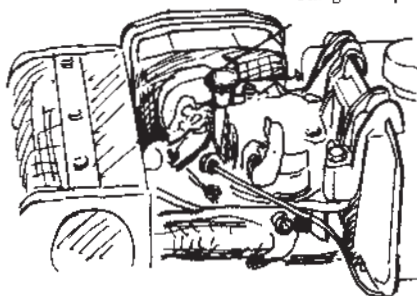


**Warning:**

Never use flammable liquids as fuel, such as gasoline etc. Also, never take away the air cleaner for easy starting of the engine, doing so may cause explosions from the intake gases.

Never take the oil plug unless your planning on filling the oil. If the plug is not in place, rain, dust, and other impurities may be sucked into the engine causing serious damage to the engine parts.

Oiling screw plug



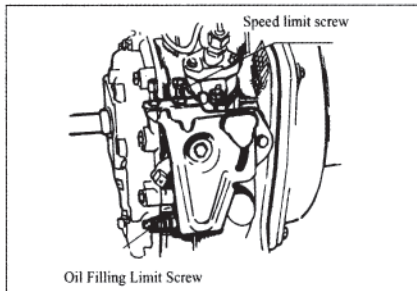
## 2-4 Running and Stopping of the Diesel Engine

### 2-4.1 Running the Diesel engine

(1) Preheat the engine for three minutes at no load.

(2) Set the speed governor lever to the desired speed.

Use the speed governor lever to control the speed of engine. Never loosen or readjust the speed limiting screw and the oil filling limit screw.



### 2-4.2 Checks on the engine while the engine is running.

(1) Check to see whether there are abnormal noises such as vibration.

(2) Check to make sure there is good combustion. (Extremely high speeds are not recommended for the engine, as that will decrease engine life.)

(3) Check to see the color of the exhaust gases to see if it is too white or too black.

(4) If any of these conditions are detected, stop the engine immediately and contact your nearest dealer for repair information.

### 2-4.3 Stopping the engine

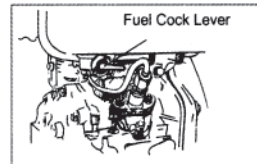
(1) First, bring down the speed of the engine by using the speed governor. Let it run for 3 minutes at no load before stopping it.

(2) Then stop the engine.

Sudden stops to the engine will cause abnormal temperature increases in the block of the engine.

Decrease the load gradually when stopping the engine. Also, never stop the engine with decompression lever.

(3) Set the fuel cock at "S" (stop position)



(4) If the engine comes with an electric starter, turn the starting switch to the "Off" position.

(5) Pull the recoil handle slowly until pressure is felt by your hand, this means the piston is on the compression stroke; where the intake and exhaust valves are closed and then let the handle recoil back into the engine. This natural position will prevent rust from occurring when the engine is being stored for long periods of time.

Note: Only perform step 5 when the engine is off. Doing so otherwise will damage the engine.

## CHAPTER3 TECHNICAL MAINTENANCE OF DIESEL ENGINE

### 3-1 Daily checks and maintenance

Check the oil level of the engine to see whether it is between the upper and lower limits.

Check to see whether there any oil leaks within the engine.

Keep the engine clean by cleaning up the dirt and other greasy deposits on the engine.

### 3-2 Regularly checks and maintenance

Regular checks and maintaining are very important for normal operation and engine life.

The following table indicates what is necessary to be performed at specific time intervals.

The marks signify that a special tool or technique is needed for maintenance. Please contact your local dealer for special maintenance.

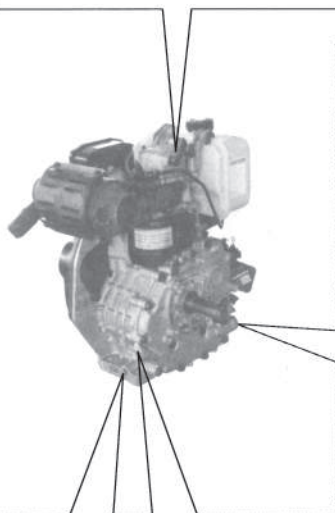
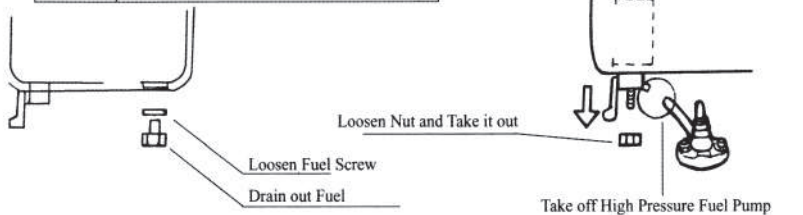
Item \ Time	Daily	After 20 hours or 1 month	100 Hours or Every 3 month	500 Hours Every 6 month	1000 Hours or Every year
Check and tighten the nut and screw	○				
Check and fill machine oil	○				
Change machine oil		○ (First time)	○ (Second time and later)		
Clean and change oil filter				○	● (Change)
Check oil-leakage	○				
Change the core of air filter		Cycle of check and main-tenance will be shortened at dusty place.		○	
Clean fuel tank	Every month				
Clean or change fuel filter				○ (Clean)	○ (Change)
Check nozzle				●	
Check injection pump				●	
Check pipeline of fuel				○ (Change if necessary)	
Adjust valve clearance of inlet and exhaust		● (First time)		●	
Grind valve holder of inlet and exhaust					●
Change piston ring					●
Check accumulator liquid	each month				
Clean the core of air filter		○ (Clean) every month or 50 hours			

### Clean and change fuel filter

The fuel filter must be kept clean day-to-day to guarantee max output of the engine

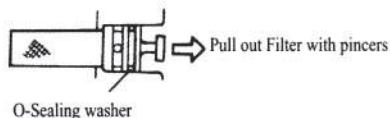
Take the filter out of fuel tank and clean it.

Clean	Every six months or 500-hours
Change	Every year or 1000 hours



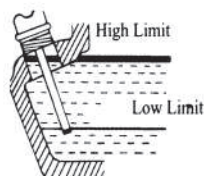
### Change Lube oil filter

Clean	250 Hours
Change	500 Hours or when maintaining



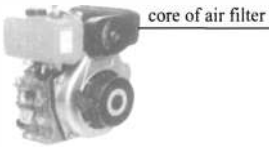
	170 <sup>F</sup>	178 <sup>F</sup>	186 <sup>F</sup> (A)
Capacity(Liter)	0.75	1.10	1.65

Change	Operating period
First	First month or after 20 hours
Second and Later	Every 30 months or 1000 hours





## Change the core of air filter



Change	Every 6 months or 500 hours(earlier if necessary)
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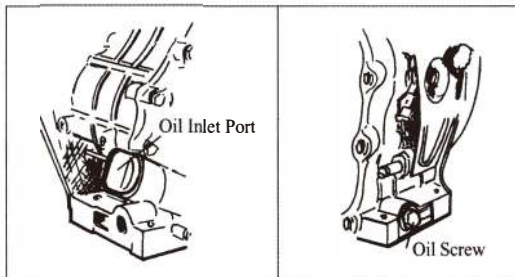
Do not use detergent to clean filter core. Use a soft brush instead.
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The core of the air filter may become dirty from various impurities. If this occurs, the performance of the engine will decrease because the amount of air entering the combustion chamber is incorrect. Also, because the amount of air is incorrect, the amount of fuel entering also becomes incorrect leading to an overall incorrect air/fuel mixture. This will lead to poor performance of the diesel engine. Always keep the air filter and air filter core clean.

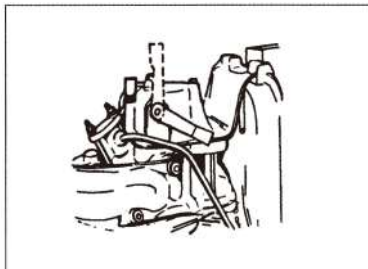
### 3-3 Storing the engine for long periods of time.

Please follow the instructions below if you plan on storing the engine for long periods of time.

- (1) Run the engine for three minutes to burn out the excess fuel in the chamber.
- (2) Quickly drain away the engine oil lubricant before the engine becomes cool and refill it with new oil. The figure below shows where the oil plugs are.



- (3) Take the rubber plug off the cover of the rocker shaft and put about 2cc of lubricant into it and put the plug back in place. The figure below shows where to access the plug.



- (4) For recoil starting engines, push the decompression lever down and pull the recoil starter two or three times. This pushes all the excess intake mixture out of the combustion chamber.
- (5) For engines that come with an electric starter, hold down the decompression lever and turn the start key switch to the start position. Let the engine rotate for about two to three seconds. Once again, this pushes all the excess intake mixture out of the combustion chamber.
- (6) Now pull the decompression lever up and pull on the recoil starter slowly until you feel resistance. The resistance point occurs on the compression stroke where the intake and exhaust valves are closed. It is also the point that will prevent moisture from entering the chamber to cause rust.
- (7) Finally, clean excess oils from the engine and put the engine in a nice dry place.

## CHAPTER 4 PART LISTINGS

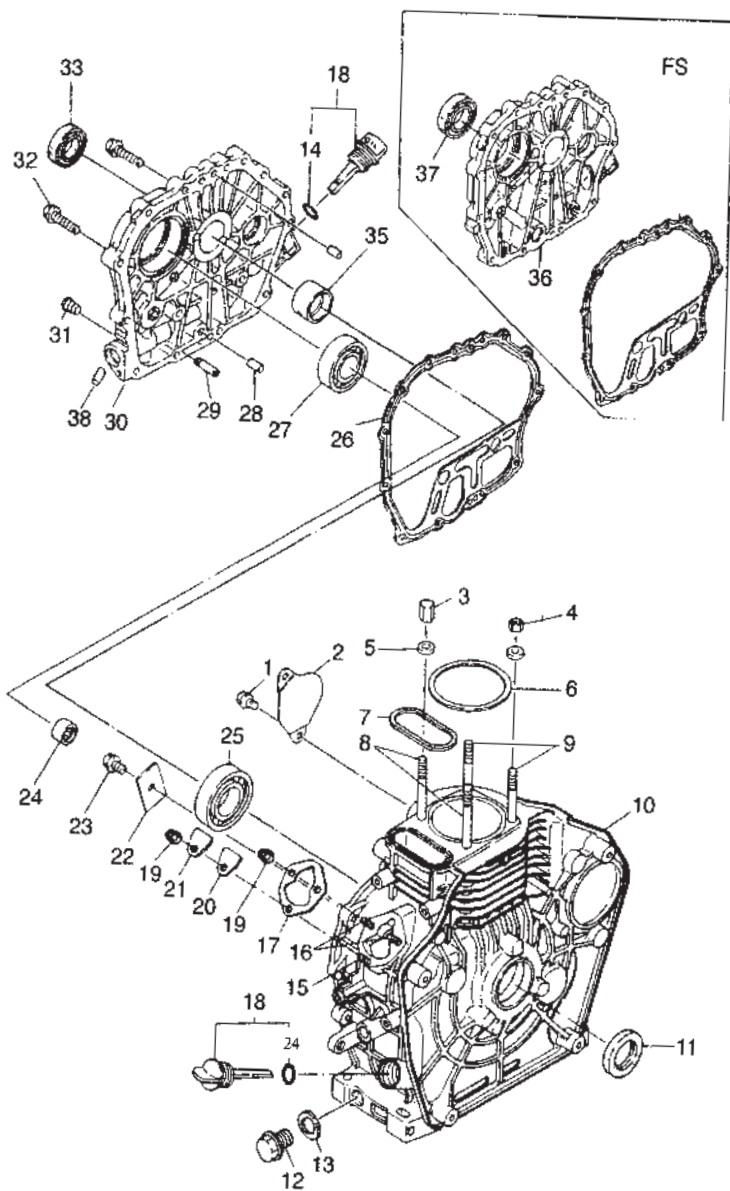
### 4-1 Engine Block

NO.	Code	Name of part	Unit	Qty each set
1	1710626	M10×20 Flange face bolt	Piece	2
2	17138	Starter motor hole cover	Piece	1
3	70-1704901	Cylinder head nuts(long)	Piece	2
	78-1704902		Piece	2
	86-1704903		Piece	2
	92-1704904		Piece	2
4	70-1705001	Cylinder head nuts(short)	Piece	2
	78-1705002		Piece	2
	86-1705003		Piece	2
	92-1705004		Piece	2
5	70-1704801	Cylinder head nuts gasket	Piece	4
	78-1704802		Piece	4
	86-1704803		Piece	4
	92-1704804		Piece	4
6	70-1719501	Cylinder head gasket	Piece	1
	73-1719502		Piece	1
	78-1719503		Piece	1
	86-1719504		Piece	1
	88-1719505		Piece	1
	90-1719506		Piece	1
7	70-17182	Oval ring gasket	Piece	1
	78-17183		Piece	1
	86-17184		Piece	1
8	70-1700201	Cylinder head bolts(long)	Piece	2
	78-1700202		Piece	2
	86-1700203		Piece	2
	92-1700204		Piece	2
9	70-1700301	Cylinder head bolts(short)	Piece	2
	78-1700302		Piece	2
	86-1700303		Piece	2
	92-1700304		Piece	2
10	70-1700107	Engine block	Piece	1
	73-1700108		Piece	1
	78-1700103		Piece	1
	86-1700110		Piece	1
	88-1700111		Piece	1
	90-1700112		Piece	1
11	70/78-1711702	Rear oil seal 30×45×8	Piece	1
	86-1711704	Rear oil seal 30×50×8	Piece	1
12	17121	Oil drain plug	Piece	1
13	17120	Oil drain plug gasket	Piece	1
14	1711324	O ring for oil dipstick	Piece	2
15	17123	Fuel pump fastening bolt(short)	Piece	1
16	17122	Fuel pump fastening bolt(long)	Piece	2

NO.	Code	Name of part	Unit	Qty each set
17	1719605	Fuel injector gasket	Piece	1
18	70-1702001	Oil dipstick	Piece	2
	78/86-1702002		Piece	2
19	1710103	M6 Hex flange nut	Piece	3
20	17159	Sealing plate gasket	Piece	1
21	17158	Sealing plate	Piece	1
22	17195	Thrust plate	Piece	1
23	1710713	M8×12 Flange face bolt	Piece	1
24	1710010	Needle bearing HK1512	Piece	1
25	70-1710006	Ball bearing 6306	Piece	1
	78-1710007	Ball bearing 6307	Piece	1
	86-1710008	Ball bearing 6308	Piece	1
26	70-1704601	Crankcase cover gasket	Piece	1
	73-1704602		Piece	1
	78-1704603		Piece	1
	86-1704604		Piece	1
27	70-1710002	Bearing 6025	Piece	1
	78-1710003	Bearing 6026	Piece	1
	86-1710004	Bearing 6027	Piece	1
28	1711111	Ø8×12 Retaining pin	Piece	2
29	78/86-17080	Oil duct	Piece	1
30	70-1701901	Crankcase cover	Piece	1
	73-1701903		Piece	1
	78-1701902		Piece	1
	86-1701904		Piece	1
31	17133	Hexagonal socket head plug	Piece	1
32	70-1710083	Flange face bolt M8×33.5	Piece	1
	70-1711062	Flange face bolt M6×25	Piece	14
	78-1710083	Flange face bolt M8×33.5	Piece	15
	86-1710083	Flange face bolt M8×33.5	Piece	16
33	70-1711701	Front oil seal 25×42×10	Piece	1
	78-1711703	Front oil seal 30×45×10	Piece	1
	86-1711705	Front oil seal 35×50×10	Piece	1
34	70-1701801	Main bushing	Piece	1
	78-1701802		Piece	1
	86-1701803		Piece	1
35	78-1701804	Front side Main bushing	Piece	1
	86-1701805		Piece	1
36	78-1701903	Front side crankcase cover	Piece	1
	86-1701904		Piece	1
37	78-1711703	Front side oil seal 30×45×10	Piece	1
	86-1711704	Front side oil seal 35×50×10	Piece	1
38	70-1711602	Aluminum plug diameter 8×8	Piece	2
	78/86-1711602		Piece	3

Note: If purchasing the engine cylinder block, the included parts are numbers 1,2,8,9,10,12,13,14,15,16,18 and 24. The parts of the crankcase cover include numbers 14,18,27,28,29,30,31,35 and 38.

Fig 4-1. Exploded view of engine block assembly



## 4-2 Cylinder head Assembly

*Table 4-2. Part listing for cylinder head assembly. Please refer to Fig 4-2*

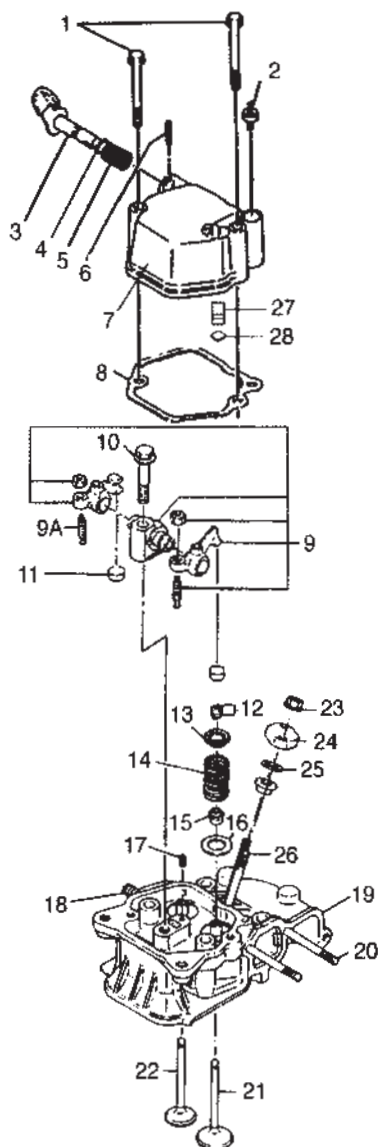
No.	Code	Name of part	Unit	Qty each set
1	70/78-1710755	M6×55 Flange face bolt	Piece	2
	86-1710730	M6×70 Flange face bolt	Piece	2
	86FA-1710730		Piece	3
2	17142	Onling hole plug	Piece	1
3	17139	Decompression shaft	Piece	1
4	1711310	O ring 10×1.9	Piece	1
5	17140	Decompression shaft spring	Piece	1
6	1711103	Ø3×16 Retaining pin	Piece	1
7	70/78-1706601	Cylinder head cover	Piece	1
	86-1706602		Piece	1
	86FA-1706603		Piece	1
	92-1706604		Piece	1
8	70/78-171701	Cylinder head cover gasket	Piece	1
	86-171702		Piece	1
	86FA-171703		Piece	1
	92-171704		Piece	1
9	70/78-1716801	Rocker arm	Piece	1
	86-1716802		Piece	1
	86FA-1716803		Piece	1
9A	17165	Valve cleanance adjusting screw	Piece	2
10	70/78-1710745	Rocker arm shaft fastening bolt	Piece	1
	86-1710747		Piece	2
	86FA-1710748		Piece	1
11	70-1705201	Adjusting valve spacer	Piece	2
	78-1705202		Piece	2
	86-1705203		Piece	2
12	70-1702701	Valve clip	Piece	4
	78-1702702		Piece	4
	86-1702703		Piece	4
13	70-1702801	Valve spring seat	Piece	2
	78-1702802		Piece	2
	86-1702803		Piece	2
14	70-1702901	Valve spring	Piece	2
	78-1702902		Piece	2
	86-1702903		Piece	2
15	70-1702011	Valve guide oil seal	Piece	2
	78-1702012		Piece	2
	86-1702013		Piece	2
16	70/78-1713601	Valve spring washer	Piece	2
	86-1713602		Piece	2
17	1711104	Ø4×8 Retaining pin	Piece	1
18	86-1710920	Double ended stud M8×20	Piece	2
	92-1710921	Double ended stud M10×25	Piece	2

No.	Code	Name of part	Unit	Qty each set
19	70-1702401	Cylinder head	Piece	1
	73-1702402		Piece	1
	78-1702403		Piece	1
	86-1702404		Piece	1
	86FA-1702405		Piece	1
	90-1702406		Piece	1
	92-1702407		Piece	1
20	70/78-1710955	Double ended stud M6×55	Piece	2
	86-1710956	Double ended stud M6×55	Piece	2
21	70-1702501	Intake valve	Piece	1
	73-1702502		Piece	1
	78-1702503		Piece	1
	86-1702504		Piece	1
	90-1702505		Piece	1
	92-1702506		Piece	1
22	70-1702601	Exhaust valve	Piece	1
	73-1702602		Piece	1
	78-1702603		Piece	1
	86-1702604		Piece	1
	90-1702605		Piece	1
	92-1702606		Piece	1
23	1710103	M6 Hex flange nut	Piece	2
24	1717302	Fuel injector pressure plate	Piece	1
25	1724502	Fuel injector gasket	Piece	1
26	86-1712201	M6×50 Injector studs	Piece	2
	86FA-1712202	M6×55 Injector studs	Piece	2
	90-1712203	M6×46 Injector studs	Piece	2
27	17141	Breather assembly	Piece	1
28	1711312	O ring 12*1.9	Piece	1

**Note:** The parts of the cylinder head cover include are numbers 2, 3, 4, 5, 6, 7, 27, 28 and 29. The parts of the rocker arm include 9 and 9a.

The parts of cylinder head include 12, 13, 14, 15, 16, 17, 18, 19, 20, 22 and 26.

Fig 4-2. Exploded view of cylinder head





### 4-3 Piston connecting rod and crankshaft balancing mechanism

Table 4-3. Please refer to Fig 4-3 for a complete illustration of the parts.

No.	Code	Name of part	Unit	Qty each set
1	70-1701401	Piston rings	Piece	1
	73-1701402		Piece	1
	78-1701403		Piece	1
	86-1701404		Piece	1
	88-1701405		Piece	1
	90-1701406		Piece	1
	92-1701407		Piece	1
2	70-1701601	Retainer clip of piston pin Dia Ø19	Piece	2
	78-1701602	Retainer clip of piston pin Dia Ø21	Piece	2
	86-1701603	Retainer clip of piston pin Dia Ø23	Piece	2
3	70-1701201	Piston	Piece	1
	73-1701202		Piece	1
	78-1701203		Piece	1
	78FS-1701204		Piece	1
	86-1701205		Piece	1
	86FA-1701206		Piece	1
	88-1701207		Piece	1
	90-1701208		Piece	1
	92-1701209		Piece	1
	86FS-1701210		Piece	1
4	70-1701701	Piston pin	Piece	1
	73-1701702		Piece	1
	78-1701703		Piece	1
	86-1701704		Piece	1
	88-1701705		Piece	1
	92-1701706		Piece	1
5	70-1701301	Connecting rod	Piece	1
	73-1701302		Piece	1
	78-1701303		Piece	1
	86-1701304		Piece	1
	88-1701305		Piece	1
	92-1701306		Piece	1
6	70-1701501	Connecting rod journal bearing	Piece	1
	78-1701502		Piece	1
	86-1701503		Piece	1
	92-1701504		Piece	1
7	70/78-1710005	Bearing 6202	Piece	2
	86-1710002	Bearing 6203	Piece	2
8	70-1706501	Balancing shaft	Piece	1
	78-1706502		Piece	1
	86-1706503		Piece	1
9	1710507	Key 5×7	Piece	2
10	70-1707701	Balancing shaft timing gear	Piece	1
	78-1707702		Piece	1
	86-1707703		Piece	1
11		Bolt 7/16-20UNF-2B	Piece	1
12	70-1700801	Crankshaft timing gear	Piece	1
	78-1700802		Piece	1
	86-1700803		Piece	1
13	70/78-1710510	Key 5×12	Piece	2
	86-1710510	Key 5×12	Piece	1

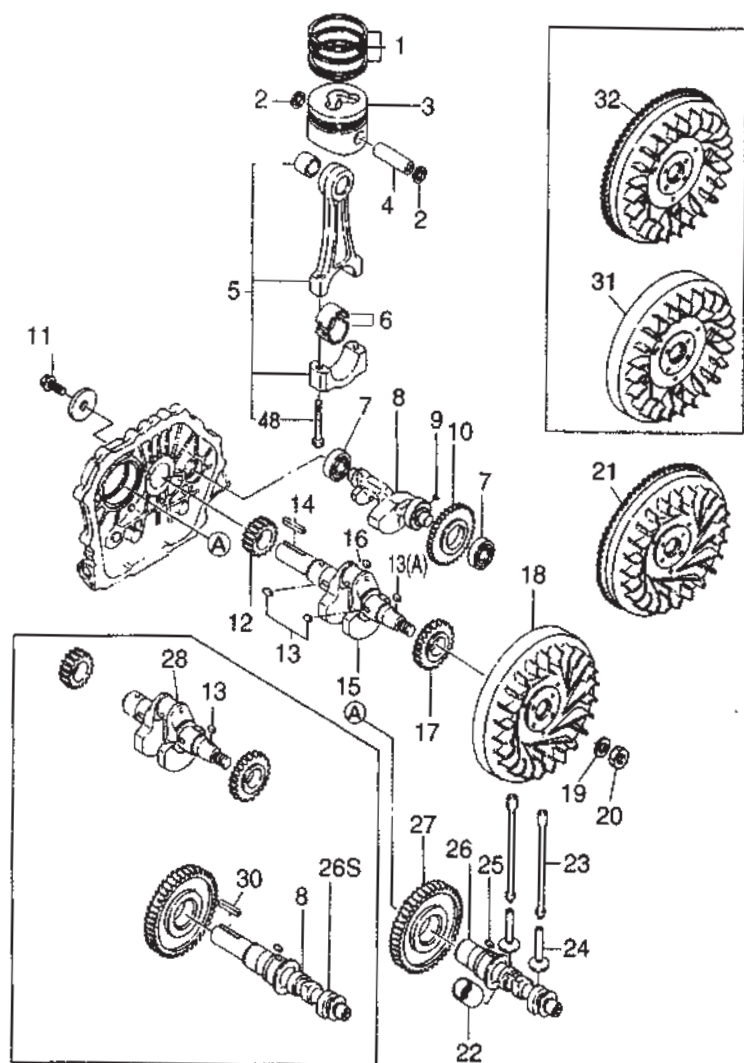
No.	Code	Name of part	Unit	Qty each set
13A	86-1710512	Key 5×14	Piece	1
14	70-1710530	Key 5×30	Piece	1
	86-1710531	Key 6×40	Piece	1
15	70-1700601	Crankshaft	Piece	1
	73-1700602		Piece	1
	78-1700603		Piece	1
	86-1700604		Piece	1
	86FA-1700605		Piece	1
	88-1700606		Piece	1
16	92-1700607	Ø6.35 Steel ball	Piece	1
	1711601		Piece	1
17	70-1707801	Balancing shaft driving gear	Piece	1
	78-1707802		Piece	1
	86-1707803		Piece	1
18	70-1704401	Flywheel	Piece	1
	70-1704402		Piece	1
	70-1704403		Piece	1
	70-1704404		Piece	1
19	70/78-1715601	Flywheel nut gasket	Piece	1
	86-1715602		Piece	1
20	70/78-1715501	Flywheel nut	Piece	1
	86-1715502		Piece	1
21	70-1704501	Flywheel ring gear(for electric starter)	Piece	1
	78-1704502		Piece	1
	86-1704503		Piece	1
22	1704706	Tappet body	Piece	1
23	70-1705101	Push rod	Piece	2
	78-1705102		Piece	2
	86-1705103		Piece	2
	92-1705104		Piece	2
24	70-1715701	Tappet	Piece	2
	78-1715702		Piece	2
	86-1715703		Piece	2
25	70/86-1710512	Key 5×14	Piece	1
	78-1710504	Key 4×12	Piece	1
26	70-1701001	Camshaft	Piece	1
	78-1701002		Piece	1
	86-1701003		Piece	1
26S	78FS-1701004	Front side camshaft	Piece	1
	86-1701005		Piece	1
27	70-1701101	Camshaft timing gear	Piece	1
	78-1701102		Piece	1
	86-1701103		Piece	1
28	78-1700702	FS camshaft	Piece	1
	86-1700703		Piece	1
30	1710545	Key 8×40 camshaft key	Piece	1
31	78FS-1704405	FS flywheel	Piece	1
	86FS-1704406		Piece	1
32	78FS-1704504	FS flywheel ring gear	Piece	1
	86FS-1704505		Piece	1

Note: The included parts with the piston connecting rod are numbers 1, 2, 3, 4, 5 and 6.

The included parts with the balancing shaft are numbers 8, 9 and 10.

The included parts with the crankshaft are numbers 9, 12, 13, 15 and 17.

Fig 4-3. Exploded view of Piston / Crank Assembly



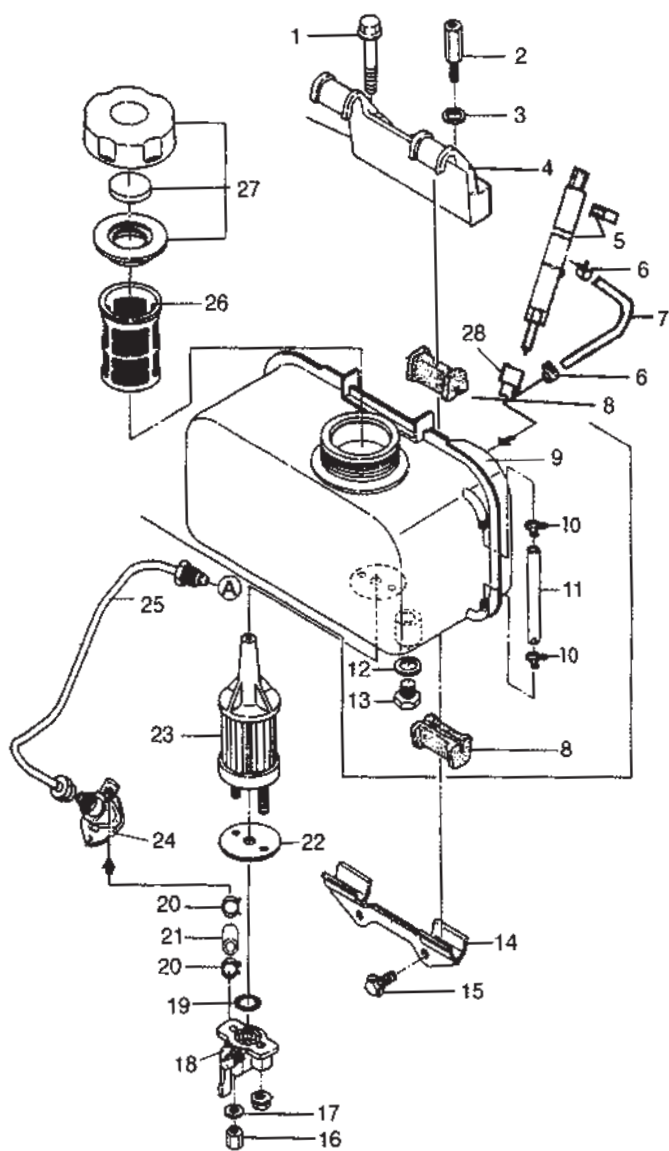
#### 4-4 Fuel System Parts

*Table 4-4. Fuel system parts; please refer to Fig 4-4 a complete illustration*

No.	Code	Name of part	Unit	Qty each set
1	1710745	M8×45 Flange face bolt	Piece	1
2	17185	Upper fuel tank bracket fastener	Piece	1
3	1710208	Flat washer Ø8	Piece	1
4	70-1705801	Upper fuel tank bracket	Piece	1
	78-1705802		Piece	1
	86-1705803		Piece	1
5	70/78-1705301	Injector	Piece	1
	86-1705302		Piece	1
	86FA-1705303		Piece	1
	88-1705304		Piece	1
	92-1705305		Piece	1
6	17212	Hose clamp	Piece	2
7	17192	Fuel pipe	Piece	1
8	17184	Rubber fuel tank mount	Piece	4
9	70-1704201	Fuel tank	Piece	1
	78-1704202		Piece	1
	86-1704203		Piece	1
10	17212	Fuel pipe connectors	Piece	2
11	17147	Fuel pipe	Piece	1
12	17151	Fuel drain gasket Ø12	Piece	1
13	17152	Fuel drain plug	Piece	1
14	17183	Lower fuel tank bracket	Piece	1
15	1710708	M6×14 Flange face bolt	Piece	2
16	1710103	M6 Hex flange nut	Piece	2
17	1710206	Ø6 Flat washer	Piece	1
18	17150	Fuel tank cock assembly	Piece	1
19	17154	Fuel tank switch pad	Piece	1
20	1719403	Fuel pipe clamp	Piece	2
21	17189	Fuel pipe	Piece	1
22	17148	Fuel filter gasket	Piece	1
23	70-1704301	Fuel filter assembly	Piece	1
	78-1704302		Piece	1
	86-1704303		Piece	1
24	70/78-1704702	Fuel injection pump	Piece	1
	86-1704703		Piece	1
	88-1704704		Piece	1
	92-1704705		Piece	1
25	70-1705601	High pressure fuel pipe	Piece	1
	78-1705602		Piece	1
	86-1705603		Piece	1
	86FA-1705604		Piece	1
	88-1705605		Piece	1
	92-1705606		Piece	1
26	17146	Fuel cap filter	Piece	1
27	17153	Fuel cap assembly	Piece	1
28	86-1705306	heatproof lagging	Piece	1
	86FA-1705307		Piece	1

Note: The fuel tank assembly comes with numbers 9, 10, 11, 12, 13, 16, 17, 18, 19, 22, 23, 26 and 27.

Fig 4-4. Exploded view of fuel tank parks



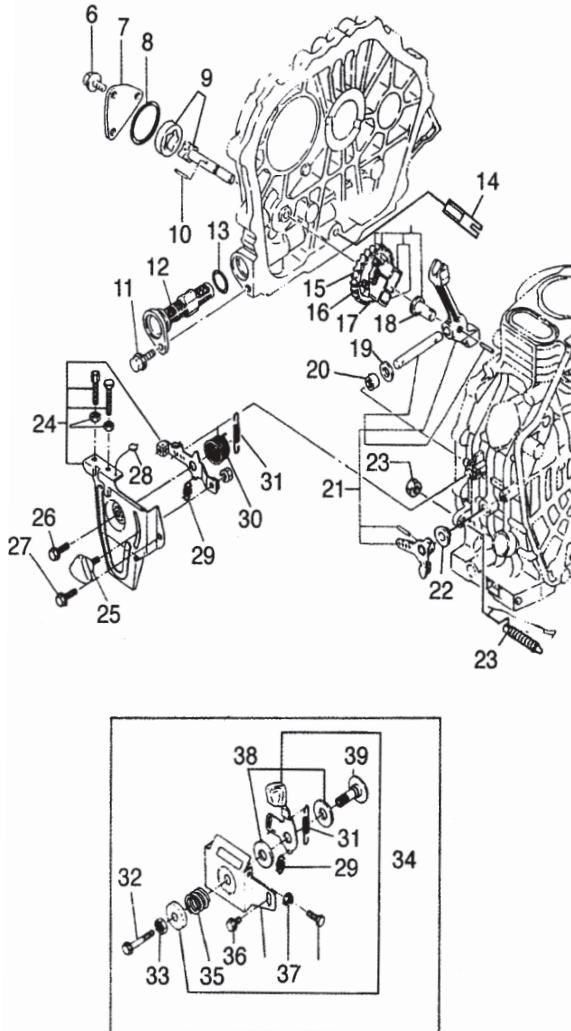
#### 4-5 Oil and speed control system

*Table 4-5. Please refer to Fig 4-5 for a complete illustration.*

No.	Code	Name of part	Unit	Qty each set
6	1710712	M6×12 Flange face bolt	Piece	3
7	17022	Oil pump cover	Piece	1
8	1711334	O ring 34.5×1.8	Piece	1
9	70/78-17135	Oil pump	Piece	1
	86-17136		Piece	1
10	1711103	Ø3×16 Retaining pin	Piece	1
11	70/78/86-1710715	M6×18 Flange face bolt	Piece	1
12	70/78/86-1702103	Oil filter cleaning element	Piece	1
13	1711315	Sealing ring 25×2.4	Piece	1
14	78/86-17080	Oil inlet	Piece	1
15	1702301	Oil pump driving gear	Piece	1
16	17132	Fly block pin	Piece	1
17	17131	Fly block	Piece	2
18	70/78-17233	Governor fork tappet	Piece	1
	86-17234		Piece	1
19	17125	Lever shaft gasket	Piece	1
20	1710009	Needle bearing HKH0810	Piece	2
21	70-1700501	Fork lever assembly	Piece	1
	78-1700502		Piece	1
	86-1700503		Piece	1
22	17124	Ø8 Washer	Piece	1
23	17126	Fuel controller parts	Piece	1
24	17164	Handle bracket	Piece	1
25	17167	Speed-control lever	Piece	1
26	1710708	M6×14 Flange face bolt	Piece	1
27	1710722	M6×22 Flange face bolt	Piece	1
28		Lead seal	Piece	1
29	17162	Return spring 2	Piece	1
30	17161	Return spring 1	Piece	1
31	70-1716001	Speed-control Spring	Piece	1
	78-1716002		Piece	1
	86-1716003		Piece	1
32	1710645	M6×45 Flange face bolt	Piece	1

No.	Code	Name of part	Unit	Qty each set
33	1710111	M10×1.25 Nut	Piece	1
34	1706701	FG Lever	Piece	1
35	1706901	FG governor spring	Piece	1
36	1710714	M6×14 Flange face bolt	Piece	1
37	1710106	M6 Nut	Piece	1
38	1016801	Washer	Piece	2
39	1730720	Shaft handle	Piece	1

Fig 4-5. Lubrication and speed control system





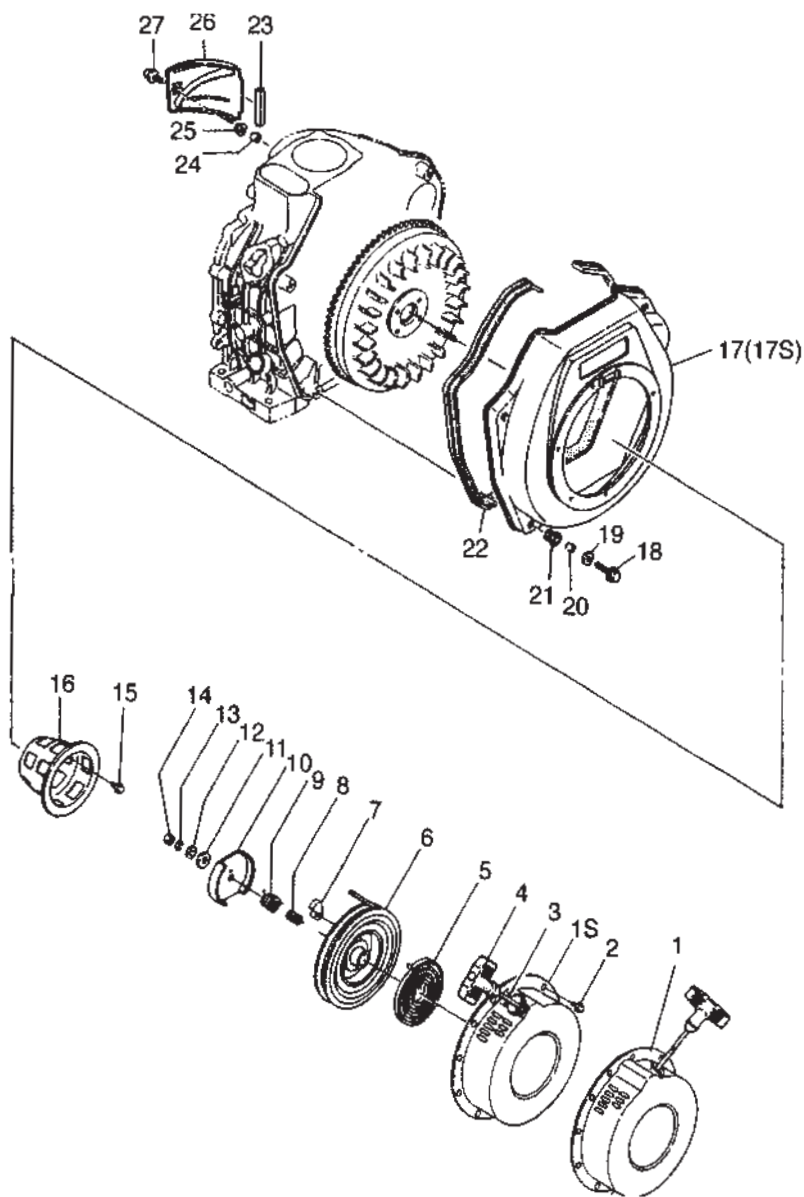
#### 4-6 Cooling and recoil starting system

*Table 4-6. Please refer to Fig 4-6 for illustratin.*

No.	Code	Name of part	Unit	Qty each set
1	70-1703401	Recoil case assembly	Piece	1
	78-1703402		Piece	1
	86-1703404		Piece	1
1S	78-1703405	178FS case assembly	Piece	1
	86-1703406	186FS case assembly	Piece	1
2	1710709	M6×8 Flange face bolt	Piece	4
3	78-1703501	Recoil starter rope	Piece	1
	86-1703502		Piece	1
4	17038	Recoil starter handle	Piece	1
5	70/78-1703301	Flat torsional spring	Piece	1
	86-1703303		Piece	1
6	78-1703201	Recoil reel	Piece	1
	86-1703202		Piece	1
7	1704003	Starting claw	Piece	2
8	17218	Helical spring	Piece	1
9	1721901	Torsional spring	Piece	1
10	1704004	Starting claw plate	Piece	1
11	17039	Friction plate	Piece	1
12	1703903	Friction plate gasket	Piece	1
13	1710306	Ø6 Spring washer	Piece	1
14	1710106	M6 Nut	Piece	1
15	86-1710712	M6×12 Flange face bolt	Piece	4
	88-1710713	M8×12 Flange face bolt	Piece	4
16	78-1705701	Starter	Piece	1
	86-1705702		Piece	1
	88-1705703		Piece	1
17	70-1704101	Recoil starter cover	Piece	1
	78-1704102		Piece	1
	86-1704103		Piece	1
	88-1704104		Piece	1
17S	78-1704105	78FS Recoil starter cover	Piece	1
	86-1704106	86FS Recoil starter cove	Piece	1
18	78-1710622	M6×22 Flange face bolt	Piece	5
	70/86-1710622		Piece	4
19	1710207	Ø6 Increase the washer	Piece	5
20	17145	Collar	Piece	5
21	78-17143	shock absorbing bushing	Piece	5
	70/86-17143		Piece	4
22	17144	Shock pads	Piece	1
23	78/86-17127	Shock isolator	Piece	1
24	17149	Collar	Piece	1

No.	Code	Name of part	Unit	Qty each set
25	78/86-17128	Pad	Piece	1
26	70-1700401	Wind leading plate	Piece	1
	78-1700402		Piece	1
	86-1700403		Piece	1
27	1710715	M6×18 Flange face bolt	Piece	1

Fig. 4-6 Exploded view of cooling and recoil starting system.



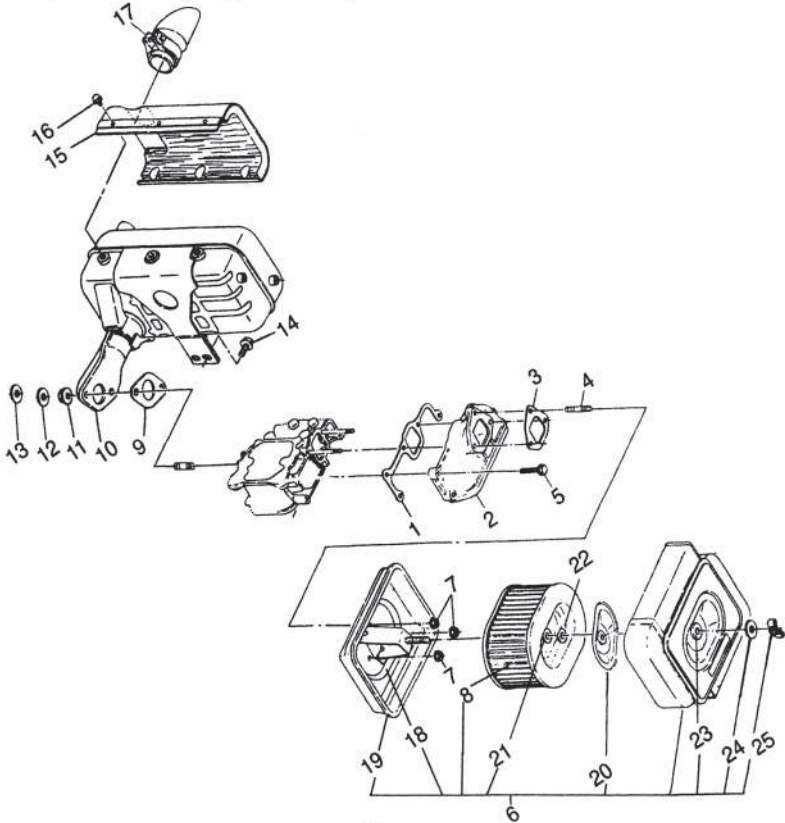
#### 4-7 Air cleaner and silencer system

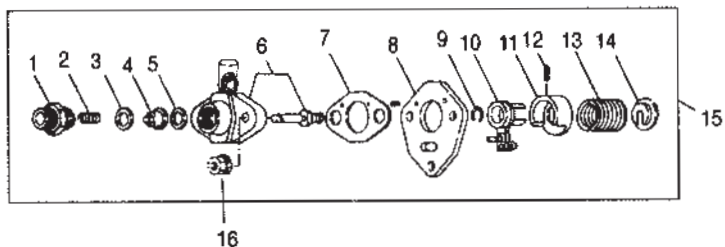
*Table 4-7. Please refer to Fig 4-7 for a complete illustration.*

No	Code	Name of part		Qty each set
1	70-1703101	Intake pipe gasket	Piece	1
	78-1703102		Piece	1
	86-1703103		Piece	1
	92-1703104		Piece	1
2	70-1703001	Intake pipe	Piece	1
	78-1703002		Piece	1
	86-1703003		Piece	1
	92-1703004		Piece	1
3	70/78-17175	Air cleaner gasket	Piece	1
	86-17176		Piece	1
	92-17177		Piece	1
4	70/78-1710755	M6×55 Flange face bolt	Piece	2
	86-1710731	M6×75 Flange face bolt	Piece	2
	86-1710715	M6×18 Flange face bolt	Piece	1
5	1711062	M6×25 Flange face bolt	Piece	3
6	70/78-1717401	Air filter assembly	Piece	1
	86-1717402		Piece	1
	92-1717403		Piece	1
7	1710103	M6 Hex flange nut	Piece	1
8	70/78-1717604	Air filter element	Piece	1
	86-1717605		Piece	1
9	70/78-1718601	Muffler gasket	Piece	1
	86-1718602		Piece	1
	92-1718603		Piece	1
10	70-1705401	Muffler assembly	Piece	1
	78-1705402		Piece	1
	86-1705403		Piece	1
	92-1705404		Piece	1
11	86-1710208	Flat washer Dia Ø8	Piece	2
	92-1710209	Flat washer Dia Ø10	Piece	2
12	86-1710308	Spring washer Dia Ø8	Piece	2
	92-1710309	Spring washer Dia Ø10	Piece	2
13	86-1710108	M8 Nut	Piece	2
	92-1710109	M10 Nut	Piece	2
14	70-1710708	M6×14 Flange face bolt	Piece	1
	78/86-1710757	M8×14 Flange face bolt	Piece	2
15	70-1705501	Muffler screen cover	Piece	1
	78-1705502		Piece	1
	86-1705503		Piece	1
16	1710708	M6×14 Flange face bolt	Piece	1
17	70/78-1705405	Muffler tail pipe	Piece	1
	86-1705406		Piece	1
18	70/78-17179	Inner shock proof sealing ring	Piece	1
	86-17180		Piece	1

No	Code	Name of part		Qty each set
19	70/78-1718001	Bottom case assembly of air cleaner	Piece	1
	86-1718002		Piece	1
20	70/78-17178	Outer shock proof sealing ring	Piece	1
	86-17179		Piece	1
21	70/78-17181	Air filter shock absorber	Piece	1
	86-17182		Piece	1
22	70/78-1710113	Collar	Piece	1
	86-1710114	Collar	Piece	1
23	70/78-17182	Air filter shock absorber	Piece	1
	86-1720106		Piece	1
24	17177	Collar	Piece	1
25	70/78-1710107	M6 Butterfly nut	Piece	1
	86-1710109	M8 Butterfly nut	Piece	1

Fig. 4-7 Exploded view of muffler assembly





1. Delivery holder

2. Delivery spring

3. Delivery gasket

4. Delivery valve

6. Plunger

7. Adjusting gasket

8. Connecting plate of pump body

9. Circlip

10. Control lever Assem

11. Spring seat 1

12. Pin of sleeve

13. Fuel injection pump

14. Fuel injection pump spring

15. Fuel pump assembly

16. Nut M6

## CHAPTER 5 ENGINE TROUBLESHOOTING

### 5-1 Engine is not starting

Possible Cause	Remedy
Weather is cold. Engine oil may have become overly adhesive.	Put engine oil into crankcase after preheated. Put engine oil into the inlet manifold. Disconnect the belts to the engine and run engine under no load conditions until the engine becomes hot. The connect the belts back and start the engine again.
Fuel system may be contaminated with water.	Clean the fuel filter and fuel pipe, and then replace the fuel with new fuel.
The fuel has thickened and does not permit easy flow	Use the correct specific fuel.
There is air in the fuel system	Drain out the air and fuel and tighten the connectors of the fuel pipe.
Very little fuel injected into cylinder or the injected spray is bad.	Check the position of the speed governor handle and clean the fuel injector spray nozzle. Check the fuel pump and change the pump or fuel nozzle if necessary.
Incomplete combustion	The spray nozzle may be bad, or the delivery angle may be incorrect. The gasket of the cylinder head may be leaking and the pressure of compression is not held. Fix each component that is necessary to achieve correct compression and a correct angle of spray.
Fuel delivery is not constant	Fuel level in fuel tank may be to low. Fill the fuel tank until it is full. Or the fuel pipe or fuel filter may be clogged, fix this by replacing them.
Low compression	Replace head gasket or tighten the cylinder head bolts in a diagonal line pattern. If changing the head gasket tighten the cylinder head bolts once again after running the engine.
Piston rings worn leading to low compression	Change the piston rings.
Piston ring gaps may all be set up in a line	Make sure each piston ring gap is off by an angle of 120 degrees from each other.

Possible Cause	Remedy
Piston rings are stuck or broken	Clean the rings and cylinder with diesel fuel and or replace the rings if necessary.
Gas valves are leaking	Grind the gas valves, if the vestige is too deep, please send it to the factory for replacement.
Incorrect valve clearance	Adjust the clearance as specified in the technical specifications chart.
The valve stem is clipped on the guide pipe	Disassemble the gas valve and clean the stem and guide pipe.

### 5-2 Diesel engine lacks power

Possible Cause	Remedy
Fuel system clogged. Clogged fuel line or clogged fuel filter.	Clean fuel filter and fuel pipe. Check the fuel switch, it should be opened fully.
Fuel pump is bad.	Service or change the damaged parts of the fuel pump.
Nozzle not operating correctly or incorrect injection pressure.	Adjust the injection pressure.
Carbon deposits in the spray hole	Clean out the spray hole.
Adhered needle valve	Clean or change needle valve.
Fitting between the needle valve and needle valve body is too loose.	Change the needle valve or needle valve body.
Air filter is dirty	Disassemble the air filter assembly and clean the core and air filter.
Engine may be too slow.	Check the speed of the tachometer. Adjust the high speed limiting screw.

### 5-3 Engine stops automatically

Possible cause	Remedy
No fuel in system.	Add fuel to the fuel tank.
Fuel line is clogged.	Clean out fuel line.
There is air in fuel system	Clean out the system and put new fuel in.
Needle valve of nozzle adhered.	Clean or grind the nozzle if necessary replace the nozzle.
Air filter is clogged.	Clean the air filter.
The load suddenly increases.	Decrease the load.



#### 5-4 Engine exhaust very black

Possible cause	Remedy
Overloaded engine	Decrease the load.If driven machine is not properly fitted with proper engine, change the engine.
Bad fuel injection.	Check the fuel injection pressure and spraying conditions. Correct or replace the nozzle.
Not enough intake air or problems with leaking air.	Clean the air filter and check to see what the cause of the leak is and fix as necessary.

#### 5-5 Engine exhaust very blue

Possible cause	Remedy
Engine oil in the cylinder.	Check the oil level and drain out unnecessary engine oil.
Piston ring worn or piston ring gaps are all aligned to permit oil to travel up into combustion chamber.	Check or change the piston rings and make sure the gaps are not all aligned.
Worn piston or worn cylinder.	Replace as necessary.
Valve and or valve guide worn.	Change the valve or valve guide as necessary.

#### 5-6 Engine exhaust white

Possible cause	Remedy
There is water in the diesel fuel	Clean the fuel tank and diesel filter, replace the diesel fuel.

#### 5-7 Various methods of checking to see if the engine is malfunctioning

Possible cause	Remedy
High and low speed fluctuation.	Check the speed governor system to see if it is loose. Also, check to make sure there is no air in the fuel system.
Abnormal sounds suddenly appear.	Check each rotating part carefully.
Sudden appearance of black smoke from exhaust.	Check the fuel system, especially the injection nozzle.
There are metal knocking sounds in the cylinder.	The fuel delivery angle is too large. Adjust it to the correct specifications.