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WORKSHOP MANUAL **DIESEL GENERATOR**

GL SERIES

The Kubota logo is written in a bold, stylized font. The letters are thick and have a slightly irregular, hand-drawn appearance. The 'K' is particularly large and prominent.

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TO THE READER

This Workshop Manual has been prepared to provide service personnel with information on the mechanism, service and maintenance of KUBOTA Generator GL Series. It is divided into two parts, "Mechanism" and "Disassembling and Servicing".

■ Mechanism

Information on the construction and function are included on this section of Engine and Generator. This information should be understood before proceeding with troubleshooting, disassembling and servicing.

■ Disassembling and Servicing

The heading "General" includes general precautions, check and maintenance, and special tools. For each Engine and Generator section, there are troubleshooting, servicing specification lists, checking and adjusting, disassembling and assembling, and servicing which cover procedures, precautions, factory specifications and allowable limits.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. The right is reserved to make changes in all information at any time without notice.

Due to covering many models of this manual, illustration or picture being used, have not been specified as one model.

March '88



SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on decals on the generator itself to warn of the possibility of personal injury. Read these instructions carefully. It is essential that you read the instructions and safety regulations before you attempt to repair or use this unit.



DANGER : Immediate hazards which **WILL** result in severe personal injury or death.



WARNING : Hazards or unsafe practices which **COULD** result in severe personal injury or death.



CAUTION : Hazards or unsafe practices which **COULD** result in minor personal injury.



IMPORTANT : Indicates that equipment or property damage could result if instructions are not followed.



NOTE : Gives helpful information.

SAFETY SERVICING AND REPAIRING

- (1) Before working on the generator :
 - Stop the engine, and remove the key.
 - Allow the engine to cool before proceeding.
 - Place the generator on a firm and level surface.
 - Disconnect the battery's ground cable.
 - Clean the work area and generator.
- (2) Do not work on the generator while under the influence of alcohol, medication, or other substances or while fatigued.
- (3) Do not wear a necktie, scarf, necklace, loose or bulky clothing when you work near machine tools or moving parts.
- (4) Use tools appropriate to the work. Makeshift tools, parts, and procedures will not make good repairs.
- (5) When servicing is performed together by two or more persons, take care to perform all work safely.
- (6) If the engine must be running to do some work, make sure the area is well ventilated. Never run the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.

- (7) Do not touch the rotating or hot parts and high voltage wires while the engine is running.
- (8) Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.
- (9) To avoid sparks from an accidental short circuit, always disconnect the battery's ground cable first and connect it last.
- (10) Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, clothing and cause blindness if splashed into eyes. Keep electrolyte away from eyes, hands and clothing. If you spill electrolyte on yourself, flush with water, and get medical attention immediately.
- (11) Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.
- (12) Never remove the radiator cap while the engine is running, or immediately after stopping. Otherwise, hot water will spout out from radiator. Wait for more than ten minutes to cool the radiator, before removing the cap.
- (13) Escaping fuel fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel lines. Tighten all connections before applying pressure.
- (14) Do not start the engine by shorting across starter terminals.
- (15) Unauthorized modifications to the generator may impair the function and /or safety and affect generator life.
- (16) Do not alter or remove any part of generator safety system.
- (17) Do not swing while lifting.
- (18) Never use the hook when the bonnet is removed or when any bolts are loose to lift up at transportation.

SAFETY OPERATION

[BEFORE OPERATION]

- (1) Read the "OPERATOR'S MANUAL" carefully. Be thoroughly familiar with the controls and the proper use of the equipment.
- (2) Do not operate the generator while under the influence of alcohol, medication, or other substances or while fatigued.
- (3) Keep all shields and safety devices in place. If a shield, safety device or decal is missing, defective or damaged, repair or replace it before operating.
- (4) Make certain all power cables and wiring are in good condition. Bare wire or frayed insulation can cause dangerous electrical shock and injury.
- (5) Be sure to ground the generator before operating .
- (6) Fuel is very flammable. Handle fuel carefully.
 - Use a properly and approved safety container.
 - Refuel the generator outdoors.
 - Shut off engine and allow it to cool before refueling.
 - Do not refuel the generator while smoking or when near open flame or sparks.
 - Do not overflow fuel while filling fuel tank.
 - Install the fuel tank cap securely, and clean up any spilled fuel before starting the engine.

[OPERATION]

- (1) Do not use the generator in damp or wet conditions.
- (2) Refrain from touching the generator with wet hands. You may get an electric shock.
- (3) Do not run the engine in a closed area without adequate ventilation.
- (4) Keep inflammables away from the exhaust outlet.

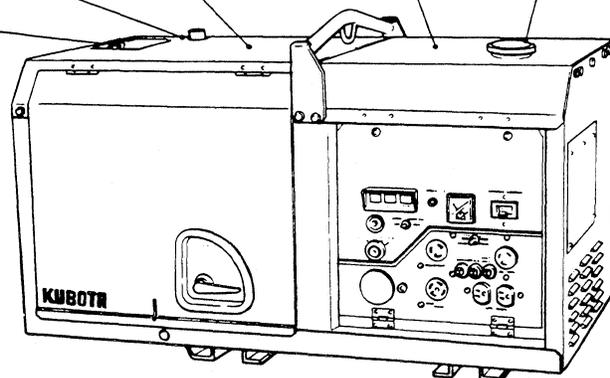
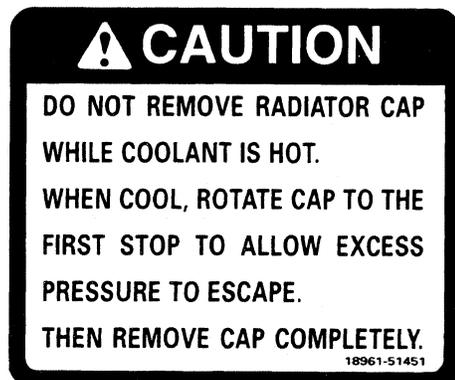
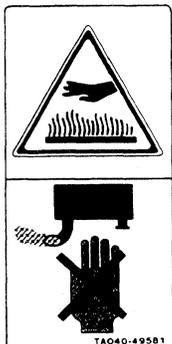
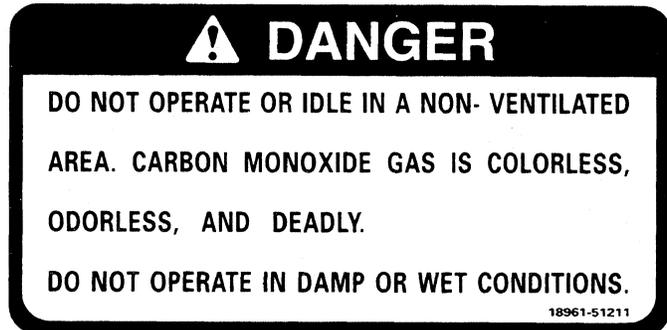
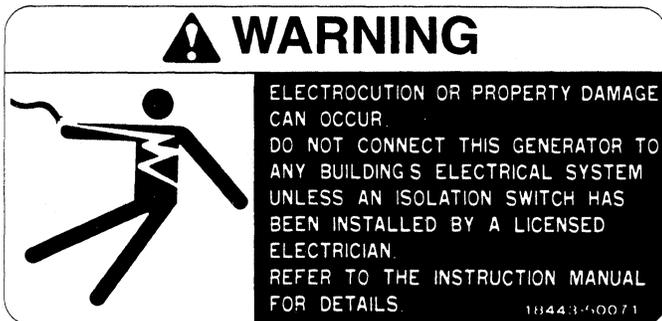
- (5) Never allow children or inadequately trained persons to operate the generator. Keep everyone, especially children and pets, away from the area of operation.
- (6) Never touch the electrical system during operation.
- (7) Do not tilt or move the generator while it is running.
- (8) Be sure to use wire of sufficient capacity. If you hook up many electrical appliances, do not take power off only one terminal, but distribute the load over the other terminals.
- (9) Do not run other generators in parallel.
- (10) If the generator should start to vibrate abnormally, stop the engine and check immediately for the cause. Vibration is generally a warning of trouble.

[TRANSPORTATION]

- (1) Do not swing while lifting.
- (2) Never use the hook when the bonnet is removed or when any bolts are loose.

SAFETY DECALS

- The following safety decals are installed on the generator.
If a decal becomes damaged, illegible or is not on the generator, replace it. The decal part number is listed in the parts list.



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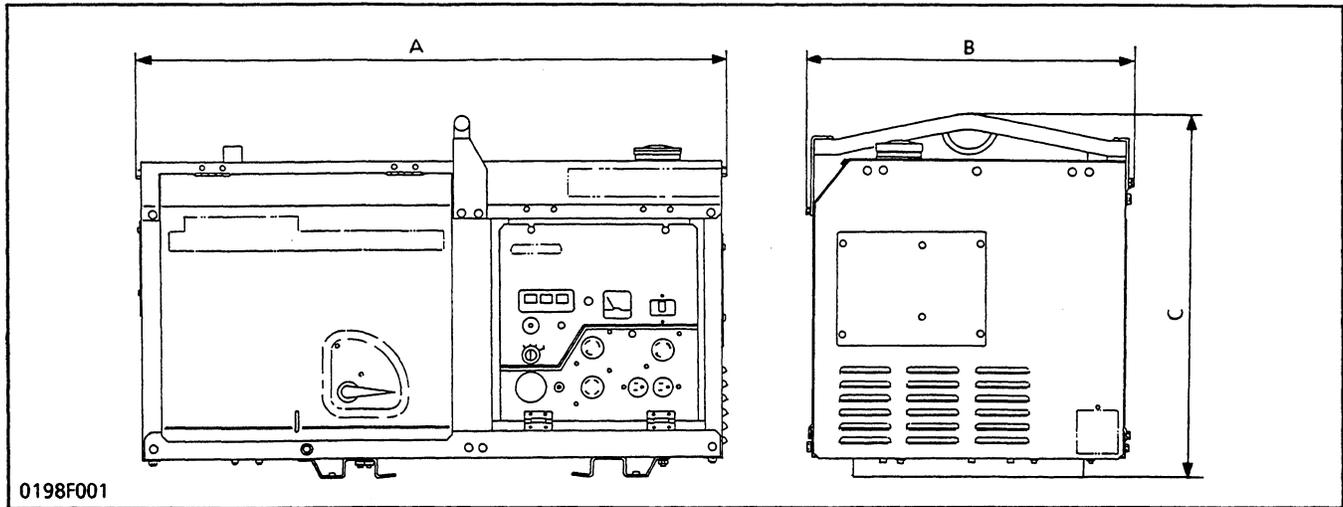
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SPECIFICATIONS

MODEL		GL4500-S	GL5500-S	GL6500-S	
GENERATOR	Type	Rotating Field Single-Phase AC Generator			
	Frequency	Hz	60		
	Maximum Output	kW	4.5	5.5	6.5
	Rated Output	kW	4	5	6
	Rated Voltage	V	120/240 Dual Voltage		
	Rated Current	A	33.3/16.7	41.7/20.9	50/25
	Phase		Single		
	No. of Poles		2		
	Power Factor	%	100		
	Generator Rotation Speed		3600 rpm		
	Generator Driving System		V-Belt		
	MODEL		ZB400-GL-S	ZB500-GL-S	ZB600-GL-S
ENGINE	Type	4-cycle, 2 cylinder water-cooled diesel engine			
	Bore x Stroke	mm (in.)	64 x 62.2 (2.52 x 2.45)	68 x 70 (2.68 x 2.76)	72 x 70 (2.83 x 2.76)
	Displacement	cm ³ (cu.in.)	400 (24.41)	508 (31.00)	570 (34.78)
	Rated Output	HP	8	10	12
	Revolution	rpm	3000	3000	3000
	Fuel Tank Capacity	ℓ (U.S. gals.)	11.5 (3.0)	19.0 (5.0)	19.0 (5.0)
	Cooling System		Radiator Cooling System		
	Starting System		Battery Assisted Electric Starter		
	Dry Weight	kg (lbs)	175 (385)	230 (506)	235 (517)
	Battery		36B20R(S)	46B24R(S)	46B24R(S)
Capacity 20 HR	V-AH	12V-35AH	12V-45AH	12V-45AH	
AC Receptacle		3	4		
Voltage Regulator		A.V.R.			

MODEL		GL3500	GL4500	GL5500	
GENERATOR	Type	Rotating Field Single-Phase AC Generator			
	Frequency	Hz	60		
	Maximum Output	kW	3.5	4.5	5.5
	Rated Output	kW	3	4	5
	Rated Voltage	V	120/240 Dual Voltage		
	Rated Current	A	25/12.5	33.3/16.7	41.7/20.9
	Phase		Single		
	No. of Poles		4		
	Power Factor	%	100		
	Generator Rotation Speed		1800 rpm		
Generator Driving System		V-Belt			
MODEL		ZB400-GL	ZB500-GL	ZB600-GL	
ENGINE	Type	4-cycle, 2 cylinder water-cooled diesel engine			
	Bore x Stroke	mm (in.)	64 x 62.2 (2.52 x 2.45)	68 x 70 (2.68 x 2.76)	72 x 70 (2.83 x 2.76)
	Displacement	cm ³ (cu.in.)	400 (24.41)	508 (31.00)	570 (34.78)
	Rated Output	HP	6	8	10
	Revolution	rpm	2600	2600	2600
	Fuel Tank Capacity	ℓ (U.S. gals.)	11.5 (3.0)	19.0 (5.0)	19.0 (5.0)
	Cooling System		Radiator Cooling System		
	Starting System		Battery Assisted Electric Starter		
	Dry Weight	kg (lbs)	180 (390)	235 (517)	240 (528)
	Battery		36B20R(S)	46B24R(S)	46B24R(S)
Capacity 20 HR	V-AH	12V-35AH	12V-45AH	12V-45AH	
AC Receptacle		3	4		
Voltage Regulator		A.V.R.			

DIMENSIONS AND WEIGHT



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unit: mm (in.)

unit: kg (lbs)

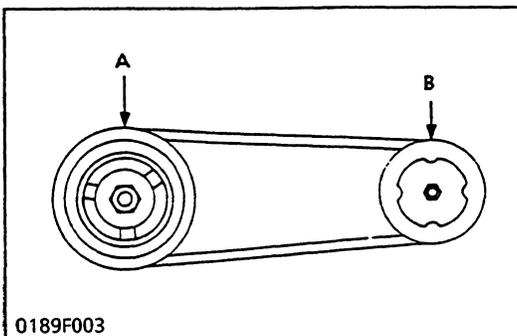
Model	A	B	C	Dry Weight
GL-4500-S	995 (39.17)	550 (21.65)	564 (22.2)	175
				(385)
GL-5500-S	1070 (42.1)	587 (23.1)	646 (25.4)	230
				(506)
GL-6500-S	1070 (42.1)	587 (23.1)	646 (25.4)	235
				(517)
GL-3500	995 (39.17)	550 (21.65)	564 (22.2)	180
				(390)
GL-4500	1070 (42.1)	587 (23.1)	646 (25.4)	235
				(517)
GL-5500	1070 (42.1)	587 (23.1)	646 (25.4)	240
				(528)

Pulley

unit : mm(in.)

CAUTION

- Check and adjust the water pump drive belt and V-belt only when the engine is stopped.



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- (A) Engine Side
- (B) Generator Side

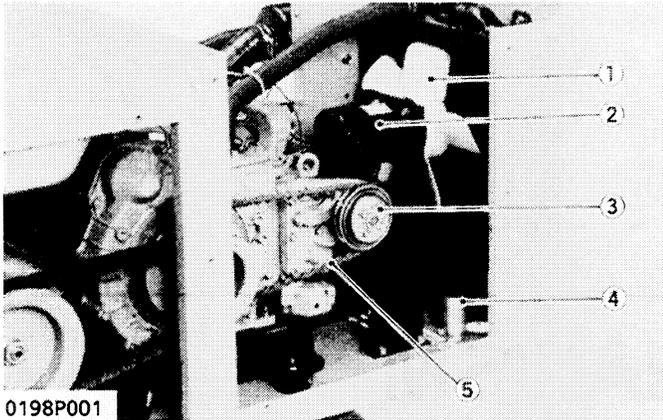
Model	A	B	Belt Length
GL-4500-S	141 (5.55)	118 (4.65)	B35
GL-5500-S	141 (5.55)	118 (4.65)	B37
GL-6500-S	141 (5.55)	118 (4.65)	B37
GL-3500	118 (4.65)	169 (6.65)	B37
GL-4500	118 (4.65)	169 (6.65)	B39
GL-5500	118 (4.65)	169 (6.65)	B39

M. MECHANISM

F FEATURE

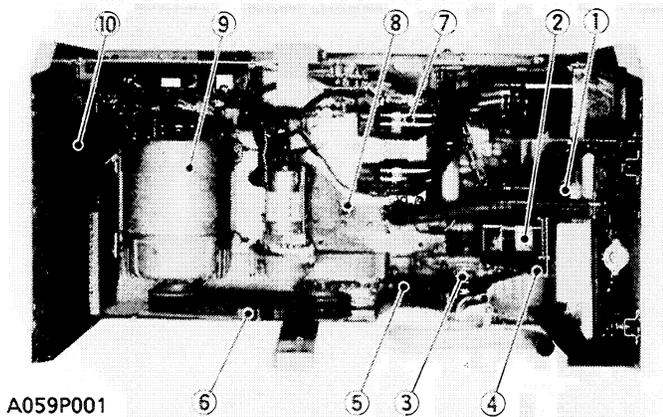
The low-profile, fuel-efficient diesel generator features the world's first construction for better heat balance highly reliable and durable, these models are equipped with a horizontal, water-cooled, 2-cylinder diesel engine mounted at the center and a radiator and a generator placed before and behind the engine.

The fan, driven by a brushless motor, is ingeniously laid out to optimally cool the enclosure and the radiator.



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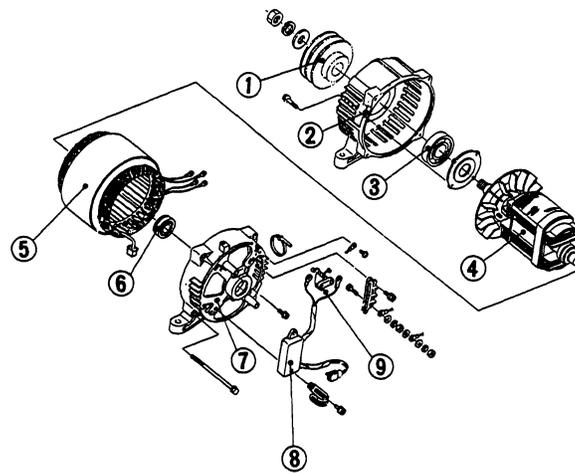
- (1) Cooling Fan
- (2) Brushless Motor
- (3) Water Pump
- (4) Brushless Motor Capacitor
- (5) T-Link Belt
- (6) Generator Drive Belt
- (7) Solenoid Assy
- (8) Thermo Switch
- (9) Generator Assy
- (10) Emergency Unit



A059P001

1 GENERATOR UNITS

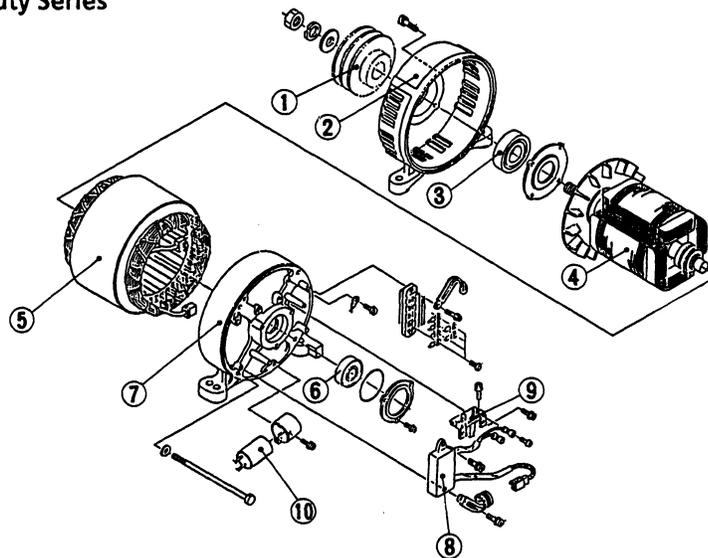
Quiet Type Series



- (1) V-pulley
- (2) Front Bracket
- (3) Bearing
- (4) Rotor Assy
- (5) Stator Assy
- (6) Bearing
- (7) Rear Bracket
- (8) A.V.R.
- (9) Brush Holder
- (10) Capacitor

0198F002

Heavy Duty Series

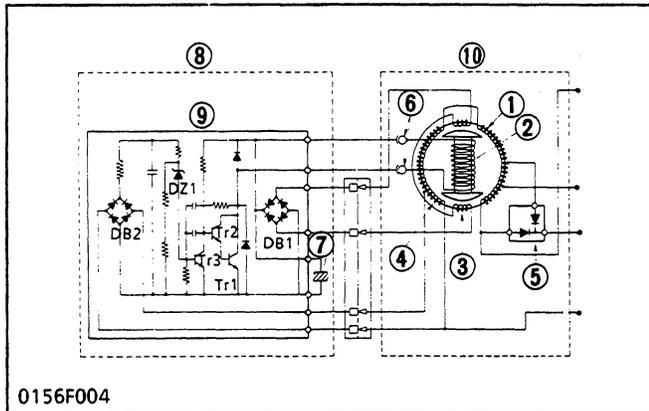


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There are two kinds of Rotor Assy. One is the 2pole type, the other is 4pole. Heavy Duty type is equipped with the 4pole type. Quiet type is equipped with the 2pole type.

- **Stator assembly**
The main coil and sub coil and battery coil generation are wound in the slots provided on the core. The main coil generates the AC out put and takes AC out put for cooling Fan Motor. The subcoil working as an excitation coil magnetizes the rotor. The battery charge coils give a charge of electricity to a battery.
- **Rotor assembly**
Permanent magnets used for initial excitation are placed at the top of the two or four salient poles. The coils are wound to magnetize the entire core.
- **AVR**
The AVR maintains the AC output voltage at a constant level.

[1] A. V. R.



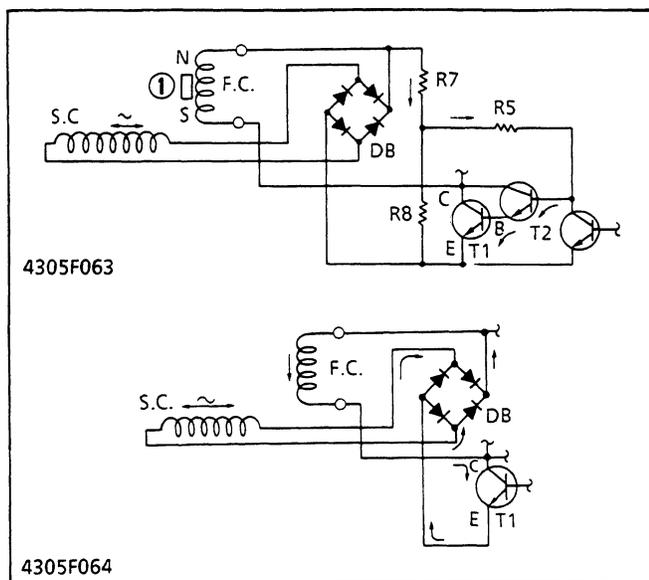
- (1) Main Coil
- (2) Field Coil
- (3) Exciter Coil (Sub Coil)
- (4) Detecting Coil
- (5) Diode for DC
- (6) Slip Ring
- (7) Capacitor
- (8) A.V.R.
- (9) A.V.R. Control Unit
- (10) Generator

The transistor type A.V.R. has a voltage control function which can compensate for variations in the load and rotation speed.

1) A.V.R. bias current path

When the engine starts and the rotor starts rotating, the permanent magnets mounted on the rotor induce an AC voltage of some specified volt across the stator sub coil. The AC voltage is converted into a bias current after full-wave rectification; by the diode bridge DB. The current, as shown in the figure, goes through the bases and emitters of transistors T1 and T2 to cause conduction between the emitter and collector of T1.

To generate a voltage of some specified volt at the stator sub coil without a permanent magnet and with only the residual magnetism of the rotor, an extremely high rpm is required. But with the permanent magnet, generation can be initiated at a low speed. Also the permanent magnets insure a reliable buildup under all conditions.



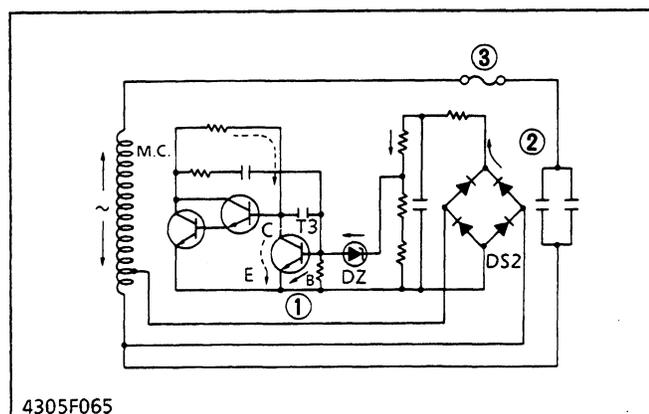
2) Excitation current path from the sub coil to rotor

When the bias current is applied to the A.V.R. and the transistor T1 conducts between C and E, the AC voltage induced at the sub coil is subject to full-wave rectification by the diode bridge (DB) and applied to the rotor field coil (FC).

As the current flows through the field coil (FC), it makes magnetic flux more strong, thus induce an AC voltage at the stator's main coil (MC), which increases as r.p.m. increases.

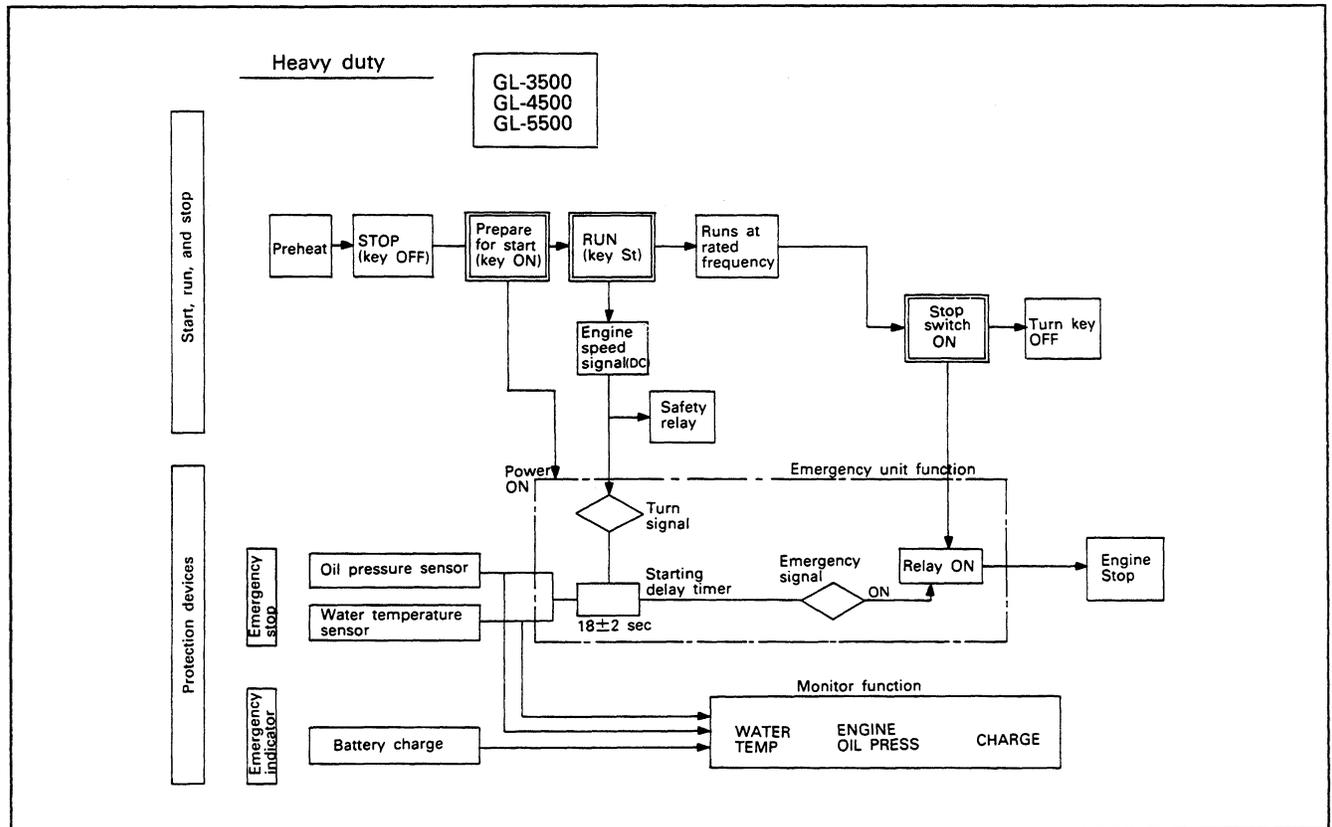
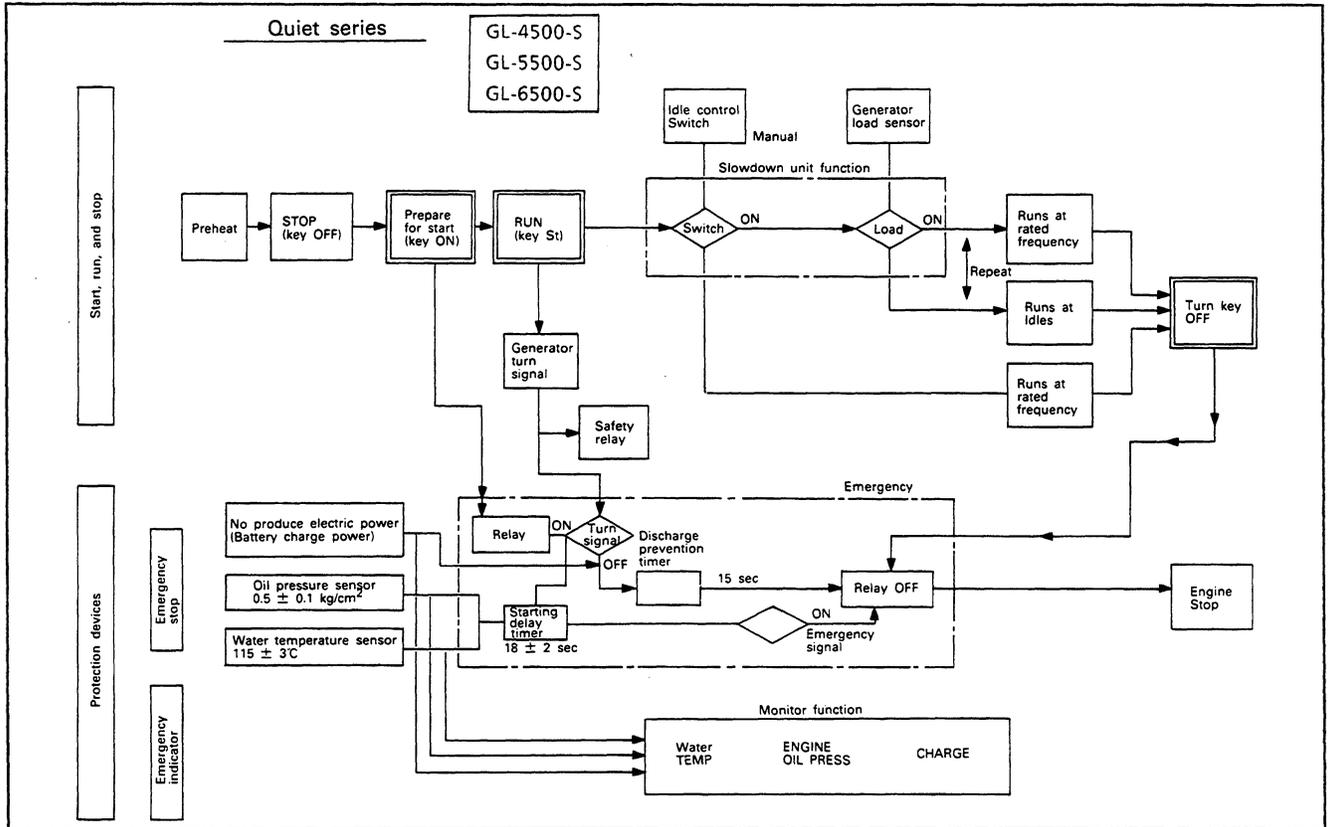
When the voltage generated at the main coil exceeds the rated voltage, the Zener diode (Dz), which has previously been cut off, conducts and the bias current (indicated by the solid line) flows into the base of transistor T3 to establish conduction between the collector and emitter of T3. Thus the bias current of T2 is diverted (toward the direction indicated by the broken line). Then, the bias current of T1 stops and T1 is cut off between its collector and emitter to stop the energizing current from flowing into the field coil through T1.

Without the energizing current, the voltage generated by the main coil would decrease instantly. With the lowered voltage, the detection circuit voltage (applied to the A.V.R.) also lowers to cut off the Zener diode. The bias current of T3 then stops and T2 and T1 again turn on to resume the energizing current flow and the output voltage increases. By repeating the above operation, the rated voltage is held constant.



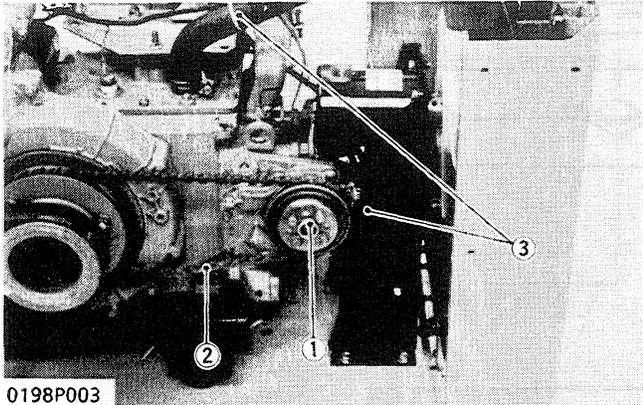
- (1) Detector Circuit
- (2) Plug Socket
- (3) Fuse

[4] ELECTRONIC CONTROLLER SYSTEM DIAGRAM



2 ENGINE

[1] COOLING SYSTEM



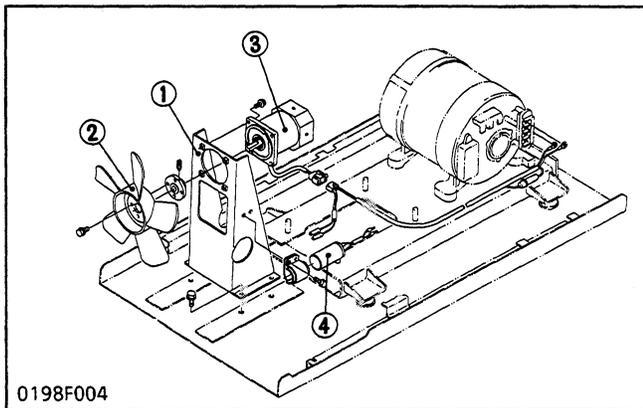
0198P003

- (1) Water Pump
- (2) T-Link Belt
- (3) Water Pipe

The engine cooling system is of forced circulation type with a water pump. The cooling water is sucked up by the water pump from the radiator's lower tank through the water pipe. The water flows round the cylinder head and the water jacket back to the radiator via the water pipe. When the water temperature has gone up above 115° the water temperature sensor is activated to stop the engine for protection against overheating.

NOTE

- For operation below -10°C thermostat kit is required.
Check with your local dealer.



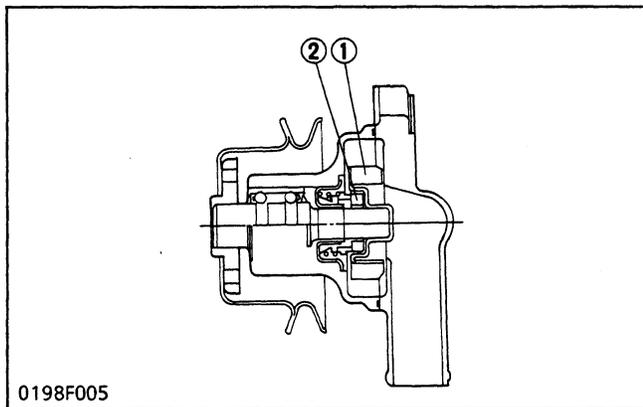
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- (1) Fan Stand
- (2) Cooling Fan
- (3) AC Motor
- (4) Capacitor

1) Fan motor

The cooling fan is driven by a brushless AC induction motor (Single-phase 100V, 90W output), which is highly durable and reliable.

The power for this motor is supplied from the generator terminal.



0198F005

- (1) Pump Impeller
- (2) Mechanical Seal

(2) Water pump

The water pump is driven by the crankshaft with a T-Link Belt. The rotating impeller (1) in the water pump receives cool water from the bottom of the radiator, and feed it into the waterjacket in the cylinder block. The mechanical seal (2) prevents the water from entering the bearing.

B&W INSERT

M-6-1

B&W INSERT

M-5

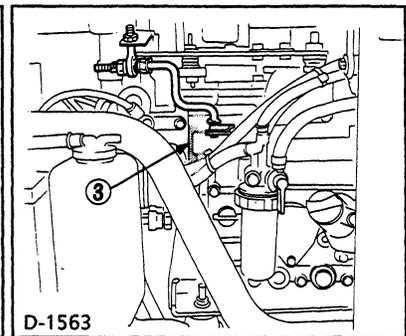
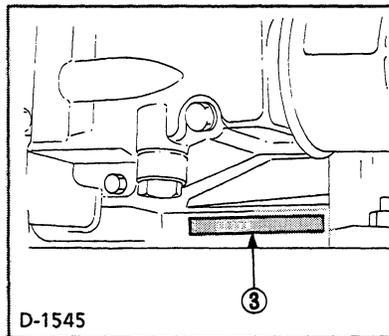
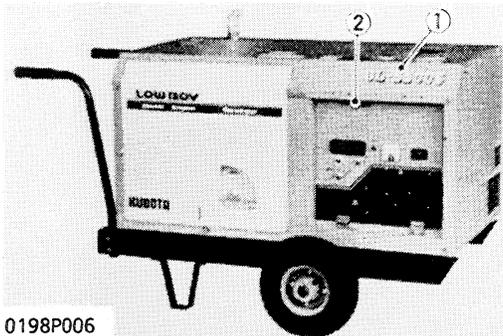
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M-6

S. DISASSEMBLING AND SERVICING



[1] GENERATOR SET IDENTIFICATION



0198P006

D-1545

D-1563

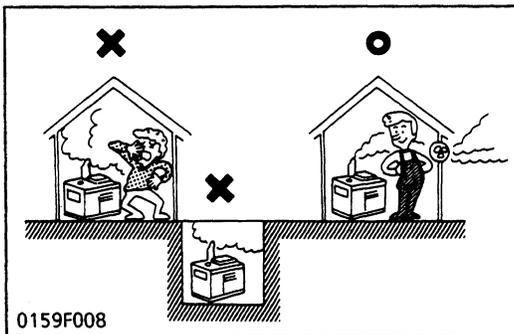
(1) Model Name (2) Serial Number (3) Engine Model and Serial Number

When contacting the manufacture, always specify the serial numbers of both engine and generator model.

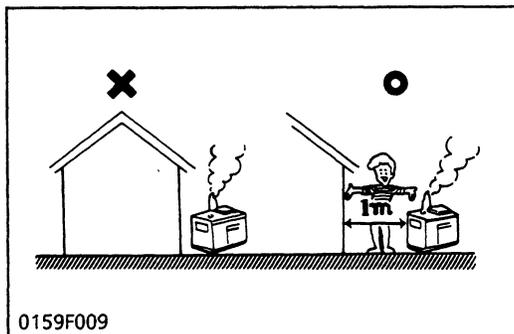
[2] GENERAL SAFETY

Follow the instructions below for extra safety.

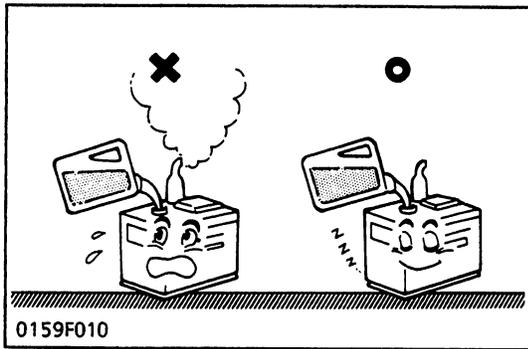
- Before disassembling or servicing electrical wires, always disconnect the ground cable from the battery first.
- Keep away from rotating or hot parts and high voltage cord when the engine is run as its cover removed.



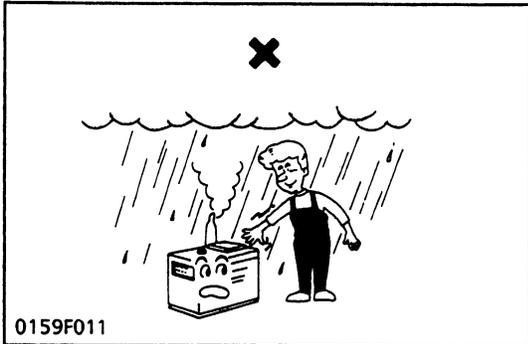
1. Do not operate the generator in a closed area such as inside houses, warehouses, tunnels, wells, ships holds, tanks, etc.



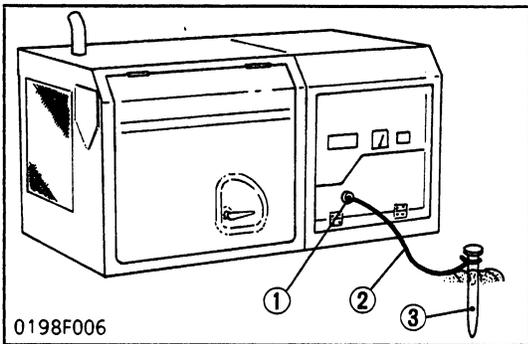
2. Keep inflammables away from the exhaust out let



3. Before refueling, be sure to stop the engine.



4. Refrain from touching the generator with wet hands. You may get an electric shock.



5. Ground the generator as much as possible.

The end user, equipment owner or operator must contact his local, state, county or municipal electric code department to determine the approved generator grounding method to be used in his application or location.

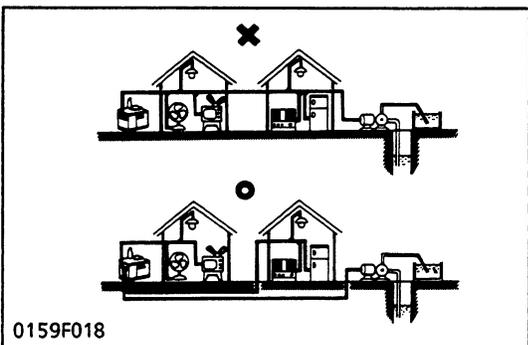
Recommendations in the NEC, NFPA and OSHA regulations must be followed to assure compliance and safe operation. A grounding lug is provided on the Kubota generator frame for earth grounding depending on local, state, national or OSHA requirements.

One possible connection method for construction site use is as follows:

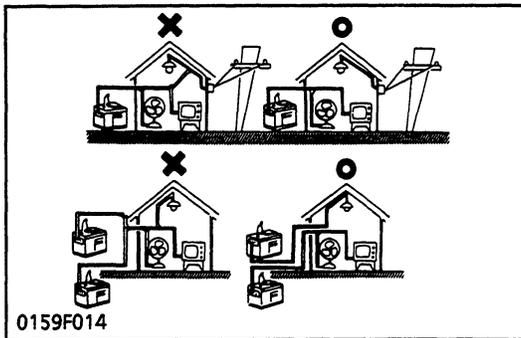
- ① Generator ground terminal
- ② #10 AWG Flexible copper ground connection
- ③ Metal ground rod or building cold water metal pipe system per N.E.C. code

NOTE

- To avoid electric shock, connect a grounding cable to the ground terminal and ground it as shown in the figure. Use a 3 sqmm or larger copper grounding cable whose grounding resistance is below 10 Ω.

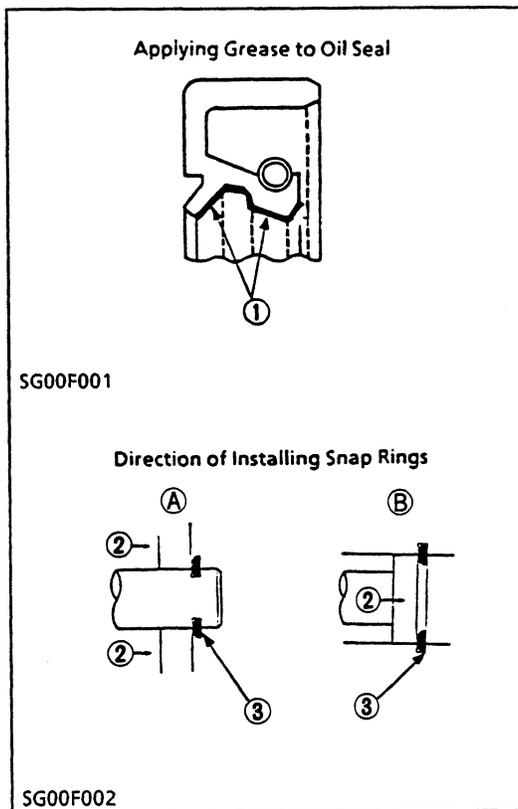


6. Be sure to use wire of sufficient capacity. If you hook up many electrical appliances, don't take power off only one receptacle, but distribute the load over the other receptacle.



7. Do not let the generator and other electric appliances share the same power outlet. If it is unavoidable to let the generator and other electric appliances share the same outlet, be sure to ask a qualified electrician to install a transfer switch to the outlet.
8. Do not run other generators in parallel.

[3] GENERAL PRECAUTION



- During disassembly, carefully arrange removed parts in a clean area to prevent confusion later. Screws and nuts should be installed in their original position to prevent reassembly errors.
- When special tools are required, use KUBOTA genuine special tools. Special tools which are not frequently used should be made according to the drawings provided.
- Before disassembling or servicing electrical wires, always disconnect the ground cable from the battery first.
- Remove oil and dirt from parts before measuring.
- Use only KUBOTA genuine parts for parts replacement to maintain generator sets performance and to assure safety.
- Gaskets and O-rings must be replaced during reassembly.
- Apply grease to new O-rings or oil seals before assembling.
- When reassembling external snap rings or internal snap rings, they must be positioned so that sharp edge faces against the direction from which a force is applied. See the figure left.
- When inserting spring pins, their splits must face the direction from which a force is applied. See the figure left.
- To prevent damage to the hydraulic system, use only specified fluid or equivalent.
- When changing or inspecting, be sure to level and stop the engine.

- (1) Grease
- (2) Force
- (3) Place the Sharp Edge against the direction of Force.

- [A] External Snap Ring
- [B] Internal Snap Ring

[4] FUNDAMENTALS OF ELECTRICAL LOADS

■ OPERATING REQUIREMENTS OF ELECTRICAL LOAD

Power and operating requirements of electrical loads are described below to help users select required generator output for the electrical loads they intend to use or to determine proper loads for a given generator output.

The following factors must be considered for this purpose.

(1) Knowing current

The current necessary for an electrical load is self-evident when it is indicated on the machine or in the machine specifications. An appliance can be used if its current is lower than the rated current of the generator and it cannot be used if its current is higher than the rated current.

(2) Knowing power consumption

Power consumption is also an accurate index for selection. With this method, only power factor should be taken into consideration since the efficiency of the load has been included in the power consumption figure. The power factor varies with loads, however.

$$\text{Input (VA)} = \frac{\text{Power consumption (W)}}{\text{Power factor}}$$

Power factors of typical electrical appliances are:

	Power factor
Single-phase induction motor	0.4 to 0.6
Three-phase induction motor	0.7 to 0.9
Electric tool (commutator motor)	0.5 to 0.9
Fluorescent lamp	0.4 to 0.6
Incandescent lamp and electric heater	1.0
AC welder	0.4 to 0.6

(3) Knowing input from the power factor and efficiency

The capacity of an electrical load is often indicated by power (W) or horsepower (HP) instead of current or power consumption.

These indications represent "output", not "input" which means actual power consumption of the load. Input can be calculated from output using the following formulas.

$$1 \text{ Hp} = 746 \text{ (W)} = 0.746 \text{ (kW)}$$

Power factor = 0.8 (usually assumed to be 0.8, although it depends on load as described above)

Efficiency = 85% (assumed to be 85% on the average, although this also depends on load)

$$\frac{\text{Output (kW)}}{\text{Efficiency}} = \text{Input (kW)}$$

$$\frac{\text{Output (HP)} \times 0.746}{\text{Efficiency}} = \text{Input (kW)}$$

$$\frac{\text{Input (kW)}}{\text{Power factor}} = \text{Generator capacity (KVA)}$$

For example, for a motor with an 800-W output

$$\frac{800 \text{ W}}{0.85} = 941.18 \text{ VA (efficiency 85\%)}$$

$$\frac{941.18 \text{ VA}}{0.8} = 1176 \text{ VA (power factor 0.8)}$$

(4) Knowing starting current

Described above (1)~(3) is the current which is consumed during operation. Also important is the current which flows at the start.

This current, although momentarily, is usually much larger than the operating current. Called: Locked rotor current.

Although starting current differs with machine, the required starting current is approximately three times the operating current, when the machine is loaded at the time of starting (e.g., with a submersible pump, it is installed in water). Therefore, for already-loaded machines or split-phase type motors with a large starting current, the current requirement is disadvantageous. Most generators have a capacity to deliver a large instantaneous power (which is different from the rated current indicated) to allow a margin for starting such machines. However, even this has its limits.

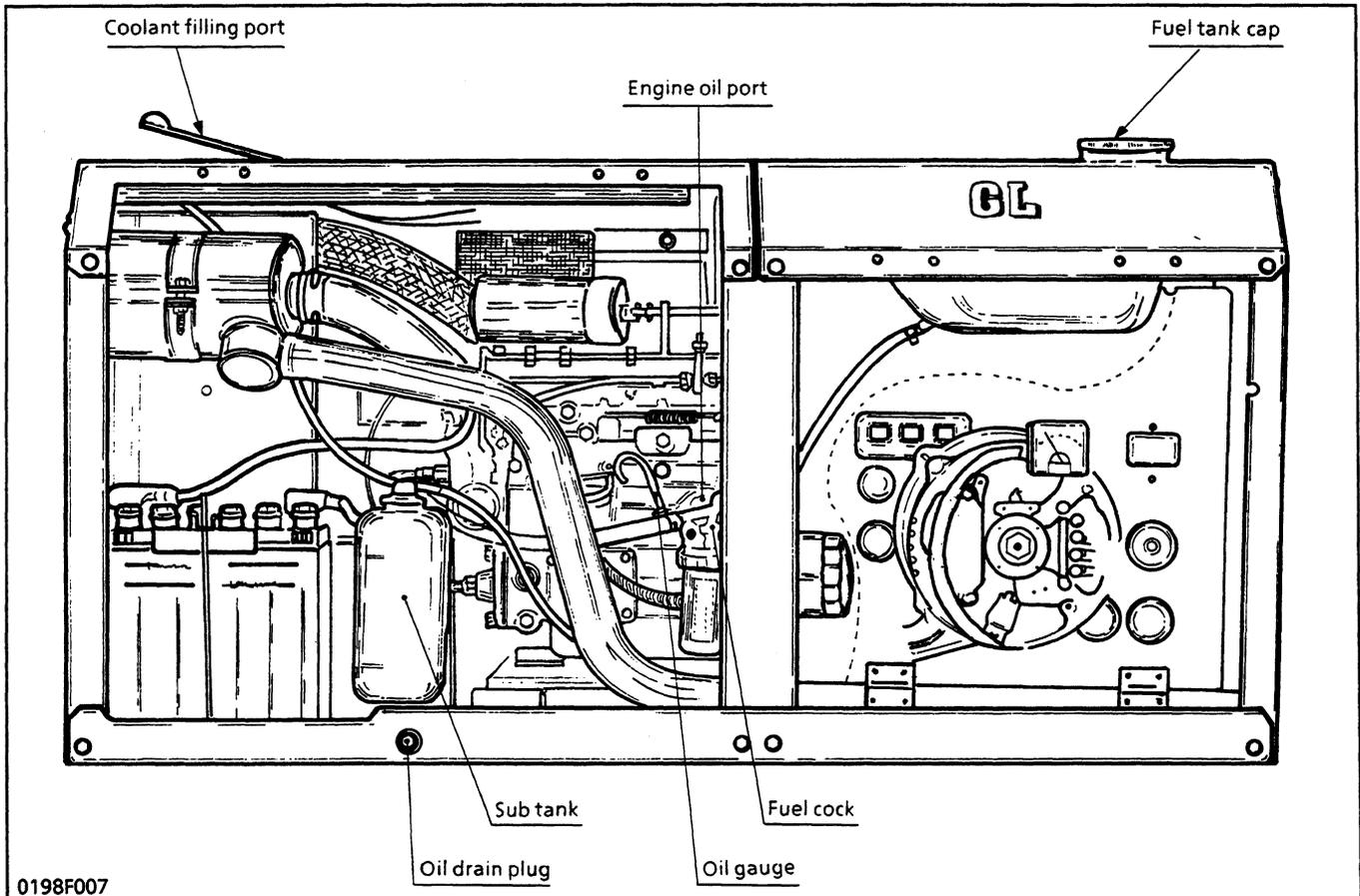
That is the reason why the machines should be started without a load or two or more machines should be started separately.

[5] LUBRICANTS FUEL AND COOLING WATER

⚠ CAUTION

- Do not use ether or starting fluid. Severe engine damage will occur.

Item	Capacity		Grade
Engine Crank Case	GL-3500	2.4 ℓ	API Service CC or CD SAE 30 or 10W-30 Above 80°F (25°C) 20 or 10W-30 32°to 80°F (0 to 25°C) 10 or 10W-30 Below 32°F (0°C)
	GL-4500-S	0.63 U.S.gals.	
	GL-4500	3.0 ℓ	
	GL-5500-S	0.79 U.S.gals.	
Fuel Tank	GL-5500	3.0 ℓ	Diesel Fuel (ASTM D975, No.2-D)
	GL-6500-S	0.79 U.S.gals.	
	GL-3500	11.5 ℓ	
	GL-4500-S	3.00 U.S.gals.	
Cooling Water	GL-4500	19 ℓ	Clean Water (Soft Water) Use Anti freeze [Below 0°C (32°F)]
	GL-5500-S	5.00 U.S.gals.	
	GL-5500	19 ℓ	
	GL-6500-S	5.00 U.S.gals.	
	GL-3500	2.3 ℓ	
	GL-4500-S	0.61 U.S.gals.	
Cooling Water	GL-4500	3.4 ℓ	
	GL-5500-S	0.89 U.S.gals.	
	GL-5500	3.3 ℓ	
	GL-6500-S	0.88 U.S.gals.	



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B&W INSERT

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