AIRMAN

SG

INSTRUCTION MANUAL

ENGINE GENERATOR

SDG220S-3A6

[DUAL VOLTAGE TYPE]

Please be sure to read this manual before using this machine.

HOKUETSU INDUSTRIES CO., LTD.

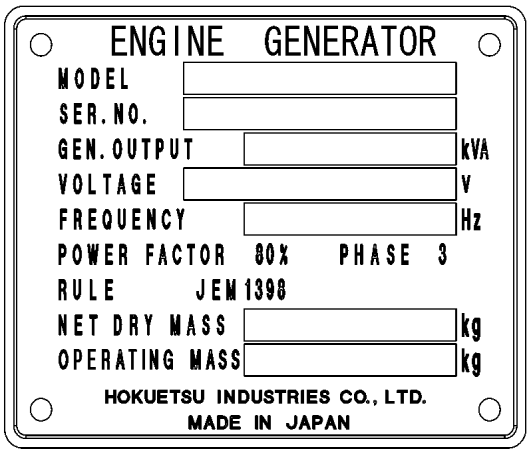
Preface

Thank you for having selected our “AIRMAN” product.

- This manual explains about the proper operation and daily inspection and maintenance of this machine.
- In order to use a machine safely, people with sufficient knowledge and sufficient technology need to deal with it.
- Before operating the unit, read the manual carefully, fully understand its operation and maintenance requirement. Maintain “SAFETY OPERATION AND PROPER MAINTENANCE OF THE UNIT”.

Be sure to follow safety warnings and cautions given in the manual. Unsafe operation could cause serious injury or death.

- For details of handling, maintenance and safety of the engine, see the Engine Operation Manual.
- Keep the manual available at all times for the operator or safety supervisor.
- If the manual is lost or damaged, place an order with your dealer for another copy.
- Be sure that the manual is included with the unit when it is handed over to another user.
- There may be some inconsistency in detail between the manual and the actual machine due to improvements of the machine. Ask your dealer if you have any questions or problems.
- If you have any questions about the unit, please inform us the model and serial number. A plate stamped with the model and serial number is attached to side of the unit.



A040491

- Each illustrated figure (Fig.) has a number (for instance, A040491) at the right bottom. This number is not a part number, but it is used only for our reference number.

Table of Contents

1.Safety

This manual explains and illustrates general requirements for safety and cautions for safety.

Please read these safety requirements carefully and fully understand the contents before starting the machine.

For your better recognition, according to the degree of potential danger harmful to a human body, safety messages are classified into three hierarchical categories, namely, ⚠ DANGER, ⚠ WARNING, and ⚠ CAUTION with a caution symbol ⚠ — attached to each message.

When one of these messages is found, please take preventive measures for safety to carry out "SAFETY OPERATION AND PROPER MAINTENANCE OF THE UNIT ".

⚠ DANGER	**DANGER** indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.
⚠ WARNING	**WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	**CAUTION** indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.
IMPORTANT	**IMPORTANT** indicates important caution messages for the performance or durability of the unit, which has no concern to injury or accident of or to a human body.

Follow warnings mentioned in this manual. This instruction manual does not describe all safety items. We, therefore, advise you to pay special attention to all items (even though they may not be described in the manual) for your safety.

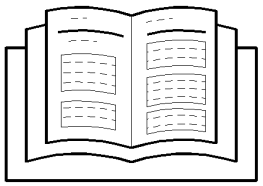
1.Safety

1.1 Caution before Operation

WARNING

Follow the safety instructions

- Read each instruction plate which is displayed in the manual or on the machine carefully, understand its content and follow the indications thereof.
- Keep the Safety Warning labels clean. When they are damaged or missing, apply new ones.
- Do not modify the machine without prior approval. The safety may be compromised, functions may be deteriorated, or machine life may be shortened.
- Never use the machine for the other purposes than power supply. Otherwise, serious accidents may occur.



TR0086

WARNING

Ventilation

- Exhaust gas from the engine is poisonous, and could cause casualties when it is inhaled.
  Avoid using the machine in an insufficiently ventilated building or a tunnel.

PC002

WARNING

Handling battery

- Keep flames away from battery.
  Battery may generate hydrogen gas and may explode.
- Battery electrolyte is dilute sulfuric acid.
  In case of mishandling, it could cause skin burning.
- Wear protective gloves and safety glasses when handling a battery.
- Dispose of battery, observing local regulations.

D004

TR0093

1.Safety

⚠ WARNING

Safety outfit

- When handling machine, do not wear;
- loose clothes
- clothes with unbuttoned sleeves
- hanging tie or scarf
- dangling jewelry
- Such outfit could be caught in the machine or dragged in the rotating portion of the machine, and could cause a serious injury.

TR0084

⚠ WARNING

Maintain both physical and mental health

- Do not operate the machine when you are tired or drunk or under the influence of drugs. Otherwise, a hasty conclusion or careless handling may cause unexpected injury or accident. Manage your physical and mental health and be cautious in handling the machine.

⚠ CAUTION

Protection equipments

- Please wear protection implements, such as a helmet, protection glasses, earplugs, safety shoes, a glove, and a protection-against-dust mask, according to the contents of work for safety.

TR0085

⚠ CAUTION

Safety fittings

- Have first-aid boxes and fire-extinguishers near the unit ready for emergency situations such as injuries and a fire.
- It is advisable to have a list of phone numbers of doctors, ambulance and the fire department available in case of emergency.

TR0096

⚠ CAUTION

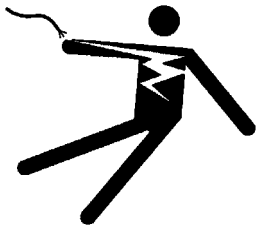
Safety around the machine

- Such things as unnecessary equipment and tools, cables, hoods, canvas sheets and pieces of wood which are a hindrance to the job, have to be cleared and removed. This is because operators and personnel nearby may stumble on them and may be injured.

1.2 Caution during Operation

⚠ WARNING — ***Never touch the output terminals and interior of control board***

- Never touch the output terminals during operation.
- Notice that the voltage of several hundreds volt is applied to the output terminal.
- When removing or connecting a connecting cable for changing load, be sure to switch OFF the circuit breaker, remove the starter key from the starter switch, then carry out a work. The operator must keep the key during operation.
  Neglecting the cautions mentioned above, and a third party starting the machine during operation may cause serious accidents such as electric shock.



H990208

⚠ WARNING — ***Hands off from rotating parts and belts***

- Keep hands off from the rotating portion or belts while running. It could cause serious injuries if hands should be caught in.

TR0304

⚠ CAUTION — ***Do not remove radiator cap during operation***

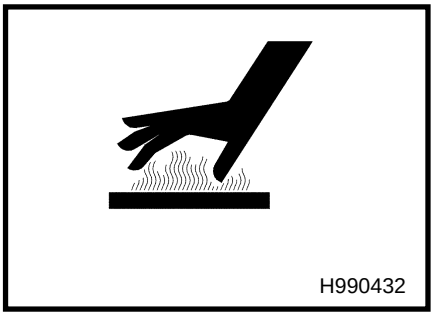
- Do not, under any circumstance, open the radiator cap while running or immediately after stopping operation. Otherwise high temperature steam jets out and this could cause scalding.

H990432

⚠ CAUTION

Do not touch hot parts

- Never work nearby hot portions of the machine while it is running.
- Do not touch hot portions of the machine while inspecting the machine when running.
- Such parts as engine, exhaust manifold, exhaust pipe, muffler, and radiator are especially hot, so never touch those parts, because it could cause scalding.
- Coolant water and engine oil are also very hot and dangerous to touch. Avoid checking or refilling them while the unit is running.



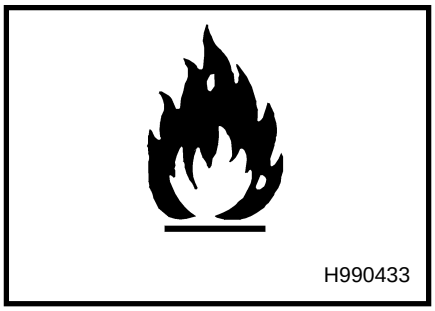
H990432

⚠ CAUTION

Fire prevention

- Do not, under any circumstance, bring lit cigarettes or matches near such oils as diesel fuel oil, and engine oil, etc.
  They are extremely flammable and dangerous, so be careful when handling.
- Refilling oils should be done in an outdoor well-ventilated place.
- Refuel after stopping the engine, and never leave the fuel nearby the machine. Do not spill. It may cause a fire. When it is spilt, wipe it up completely.
- **Do not fill fuel oil up to the cap level. When fuel tank is filled up to the cap level, fuel oil will be overfilled due to volume expansion caused by rise of ambient temperature. Further, fuel will be possibly spilled from fuel tank due to vibration caused during movement and/or transportation of machine.**
- Such parts as muffler and exhaust pipe can be extremely hot. Remove twigs, dried leaves, dried grass and waste paper, etc. from the exhaust outlet of the muffler.
- Keep a fire extinguisher available by the machine in case of unexpected fire.

D004



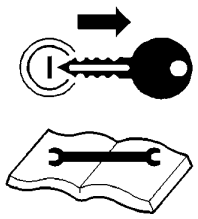
H990433

1.3 Caution during Inspection and Maintenance

WARNING

Hang a "Now Checking and under Maintenance" tag

- Before starting inspection, switch off the circuit breaker of this machine, remove the starter key from the starter switch, and then hang a "Now Checking and under Maintenance" tag where it can be easily seen. The checker must keep the key during checking and maintenance.
- Remove the negative (–) side cable from the battery.
  If the above procedure is neglected, and another person starts operating the machine during check or maintenance, it could cause serious injury.



SY001

WARNING

Adjusting tension of belt

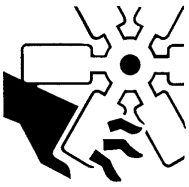
- Be sure to stop the engine and remove the starter key whenever the tension of the belt is to be adjusted.
- If the machine is running, it might catch the operator's hand into the belts, and this could cause a serious injury.

TR0304

WARNING

Hands off from cooling fan

- Be sure to stop the engine and remove the starter key whenever the tension of the belt is to be adjusted.
- If the machine is running, it might catch the operator's hand into the belts, and this could cause a serious injury.



W009

WARNING

Cleaning by air-blow

- When cleaning dust accumulated in such devices as the air-filter, etc., by blowing compressed air, wear safety glasses, etc. to protect your eyes.

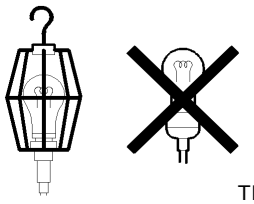
W003

1.Safety

CAUTION

Lighting apparatus

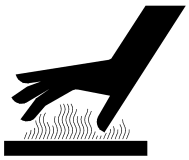
- It is recommended to use a lamp with safety guard fitted where the site is dark. Operating the machine gropingly or by relying on one's intuition could cause unexpected accidents. Any lamps without safety guard are not recommended since they can be broken and they could ignite flammables such as fuel, etc.


TR0206

CAUTION

Opening coolant water drain valve

- Be sure to stop the engine, and let the coolant water sufficiently cool down before draining it.
- If the drain valve is opened before the coolant water is cooled enough, hot water could jet out, and it could cause scalding.


H990432

CAUTION

Refilling or draining of engine oil

- After stopping the engine, wait 10 to 20 minutes until the engine oil cools off. Then check the level of the engine oil, or refill or drain the oil.
- The engine oil is very hot during operation and just after it stops. Be careful because the hot oil also pressurized blows off and it can cause burning.


H990432

CAUTION

Caution of the cleaning

- When washing the machine, cover the control panel, generator and its electric parts to prevent them from being exposed to splashing water and avoid possible decrease in electrical insulation or other troubles to the machine.
- Dust, sand and dirt accumulated inside control panel could cause malfunction or trouble of the instruments. Clean them by blowing compressed air.

CAUTION

Treatment of organic wastes

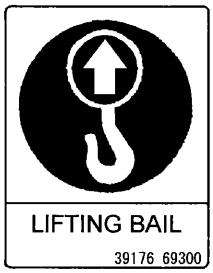
- Waste liquid from the machine contains harmful material. Do not discharge it onto the ground or into the river, lake or sea. Such material will pollute the environment.
- Be sure to use a container to hold the waste liquid from the machine.
- Be sure to follow the designated regulations when disposing of oil, fuel, coolant (antifreeze), filter, battery or other harmful materials.


A100285

1.4 Safety Warning Labels

Following labels are attached to the machine.
Keep them clean at all times. If they are damaged or missing, immediately place an order with your nearest dealer for replacement. Part numbers are indicated on the lower right corner of the label.
Adhere a new one to the original location.

1



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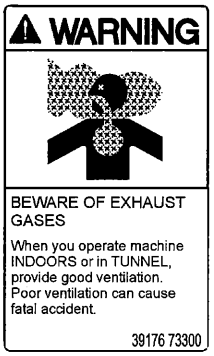

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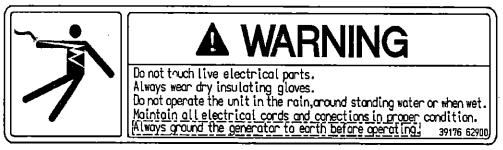

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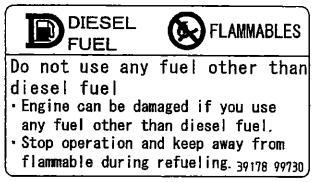

6

39176 30700

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8

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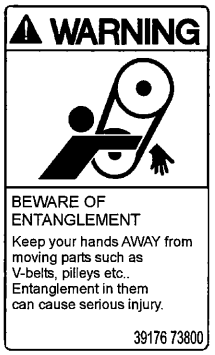
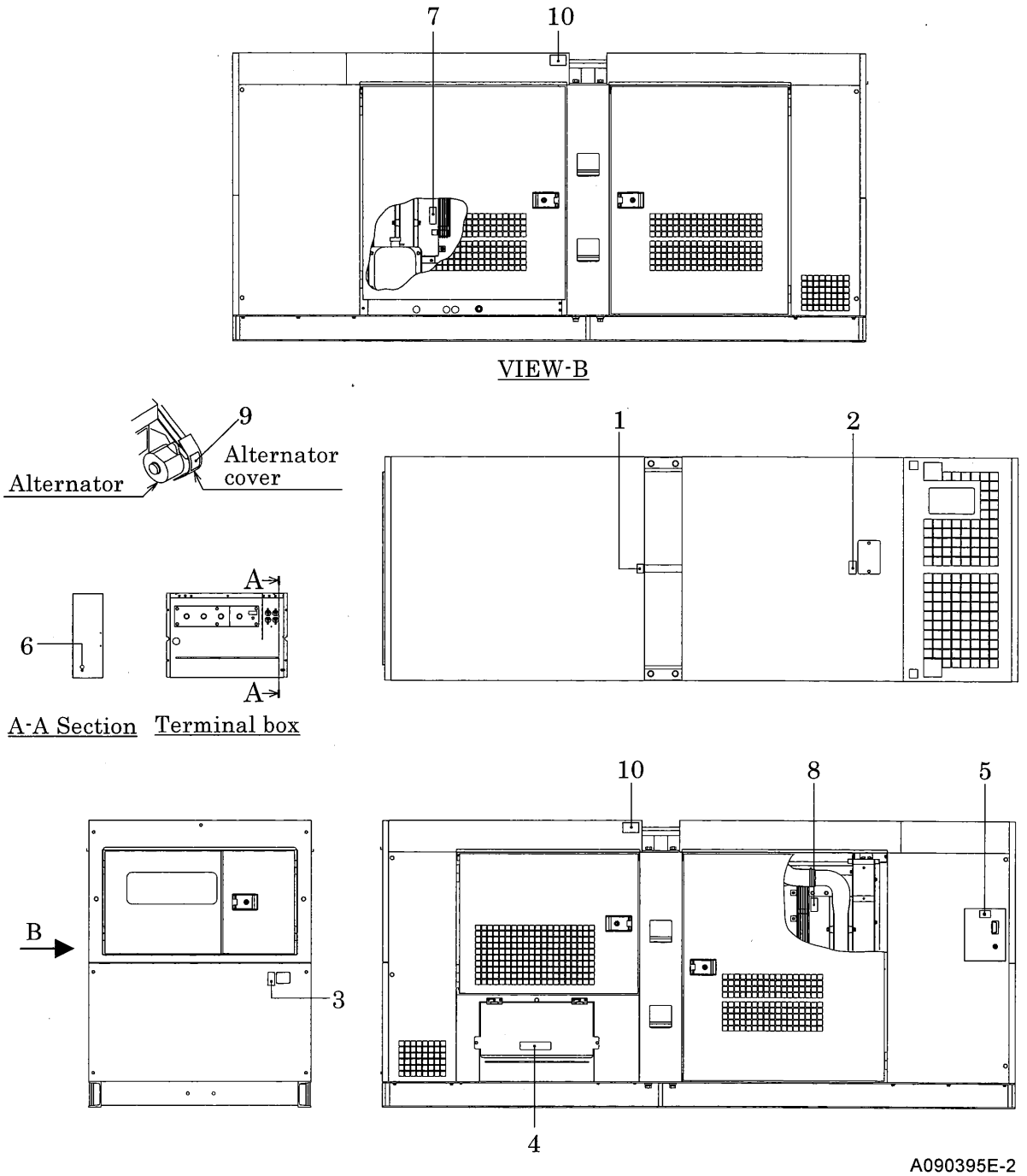


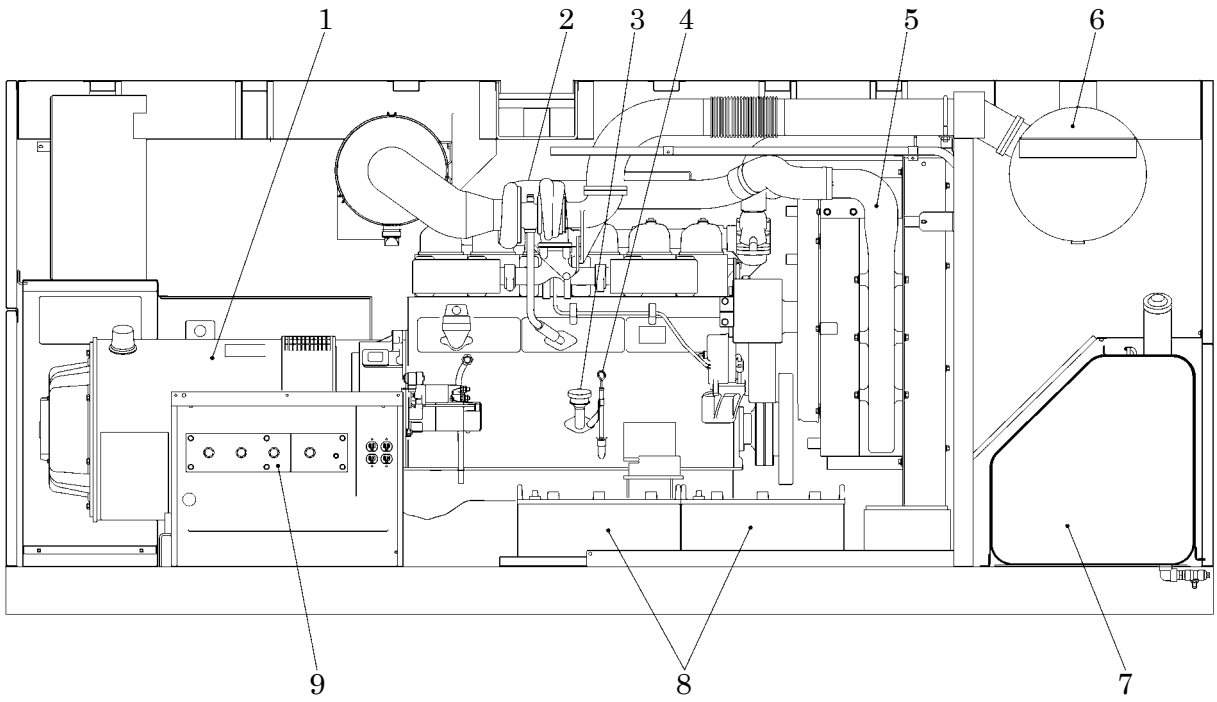
10

● The pasting position of safe warning label is as follows.



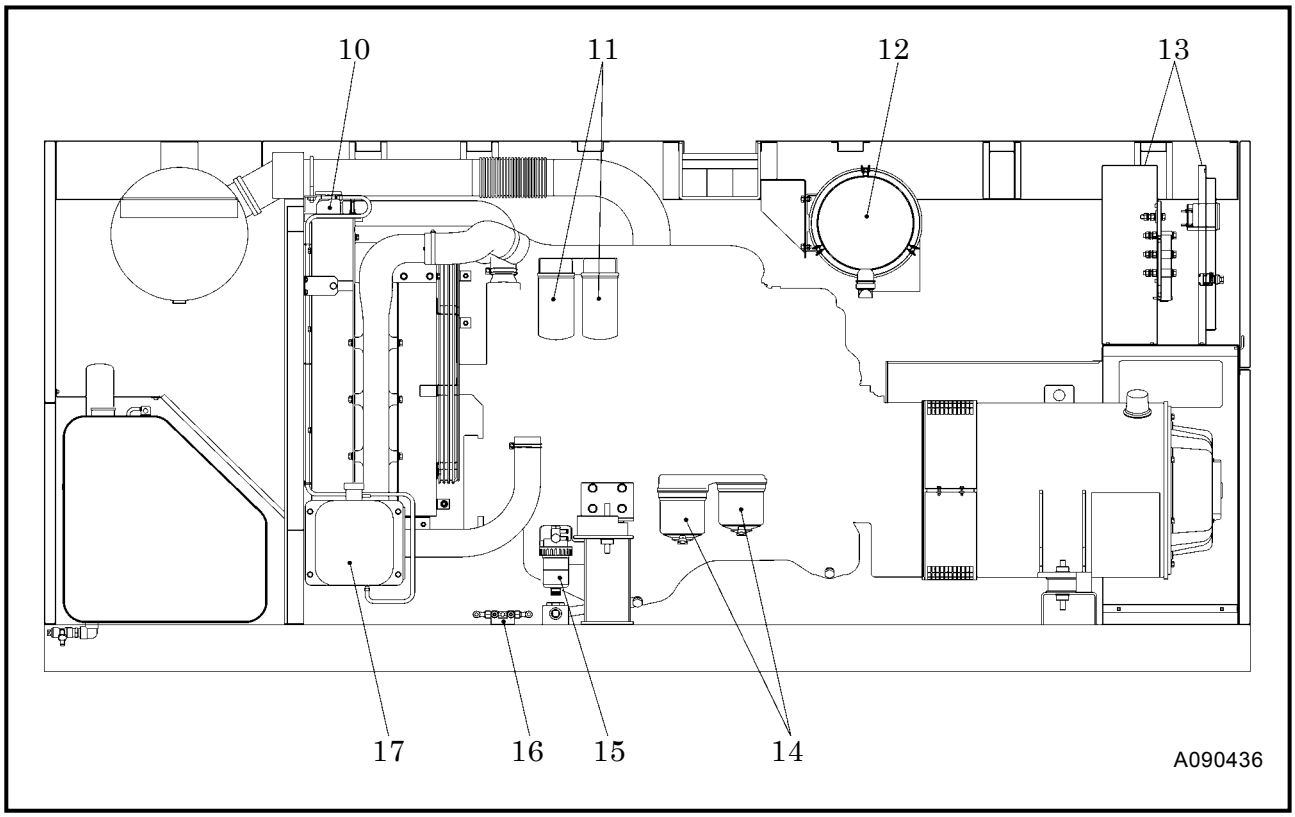
2. Part Names

2.1 Internal Components



No.	Description	Function
1	Generator main unit	Device for generating AC power.
2	Engine	For driving the generator main unit.
3	Engine oil filler port	For supplying and replenishing engine oil to engine.
4	Engine oil level gauge	Scale for measuring engine oil level.
5	Intercooler	For cooling the air compressed by engine supercharger.
6	Exhaust muffler	Equipment which muffles an engine exhaust sound.
7	Fuel tank	Fuel oil container.
8	Battery	For electrically starting engine.
9	Output terminals	Outlet port for AC power.

2. Part Names



No.	Description	Function
10	Radiator	Device for engine cooling water.
11	Fuel filter	Filtering device for filtering dust mixed in fuel oil.
12	Air filter	Filtering device for filtering dust floating in intake air.
13	Control panel	Panel fitted with various meters and controllers.
14	Engine oil filter	For filtering engine oil.
15	Sedimentor	For separating water mixed in fuel oil.
16	Fuel pipe change-over system	For fuel supply from outside set fuel tank.
17	Reserve tank	For feeding cooling water.

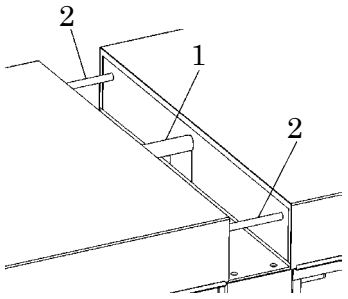
3. Installation

3.1 Transporting Unit

WARNING

Transportation

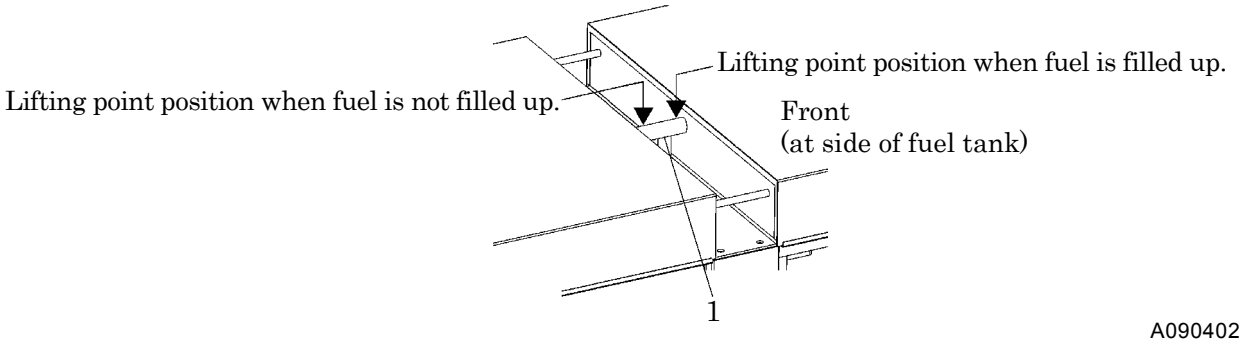
- Use the lifting bail "1" at the center of bonnet for hoisting up and down the machine.
  Since the rope hook is not strong enough to be used for hoisting, never use it to prevent falling accident.
- When transporting the machine, be sure to put it on the truck bed and use the rope hooks "2" to secure it with rope.
- Do not hoist up the machine while it is running.
  Otherwise, a fatal trouble or serious accident may occur.



A090401

3.1.1 Lifting

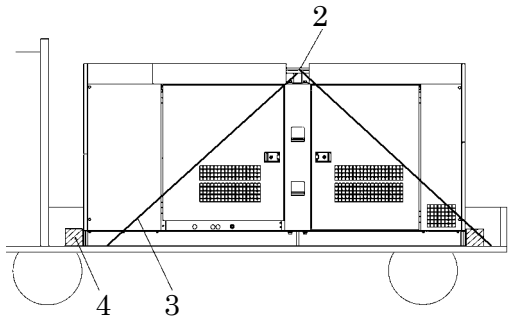
- Use the lifting bail "1" fitted on center of bonnet.
- Adjust the lifting point position, according to the fuel volume filled.
- Select an appropriate crane or truck by referring to the mass and dimensions mentioned in "Specifications".
- Only a qualified crane operator is allowed to operate a crane.



A090402

3.1.2 Securing a machine on truck bed when transporting

- When moving or transporting a machine from site, place it on truck bed and fasten it by ropes "3" at two hooks "2" on both right and left sides and 4 points on the common frame.



A090400

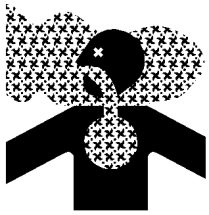
3. Installation

3.2 Conditions of Unit Installation

WARNING

Ventilation

- Exhaust gas from the engine is poisonous, and it could cause casualties when it is inhaled.
  Avoid using the machine in an insufficiently ventilated building or a tunnel. When the machine is unavoidably used in such insufficiently ventilated place, ventilation devices and ventilation pipe should be provided for better ventilation.

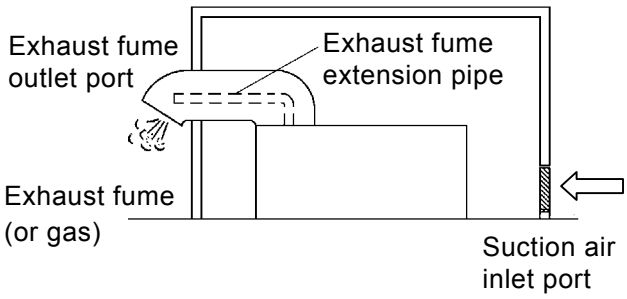


PC002

WARNING

In case that the unit is installed indoors

- In case that the unit is installed indoors for operation, suction air port and exhaust fume outlet port should be provided for better air ventilation.
- Make sure to secure enough space in front of air suction port and also to secure it after exhaust fume outlet port so that the engine may not get overheated.
- Exhaust fume pipe extension should be provided to send exhaust fume out of the installation place.



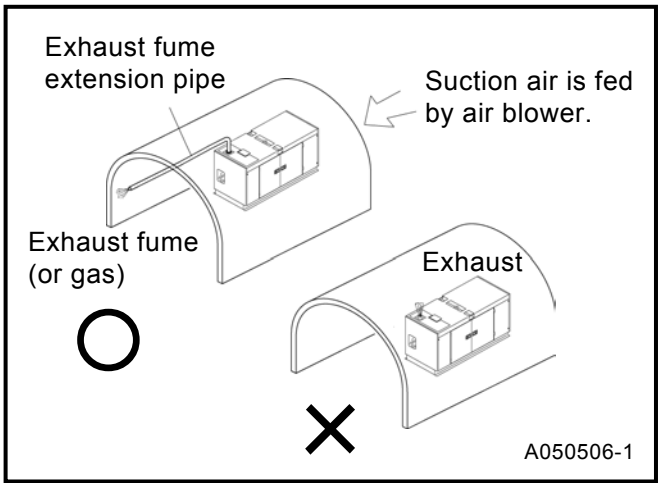
A090641

- Outlet port of radiator cooling air should be equipped outdoors with a duct or the like provided so that cooling air can be exhausted outdoors.
  (Engine blowby gas is exhausted together with cooling air through a duct.)

WARNING

Installing the unit st such poorly-ventilated place

- In case that the unit is installed inside any tunnel, make sure to provide fresh air and ventilate it.
- In this case, make sure to extend the exhaust fume pipe outdoors, and also make sure to prevent any leak from any connection pipes.



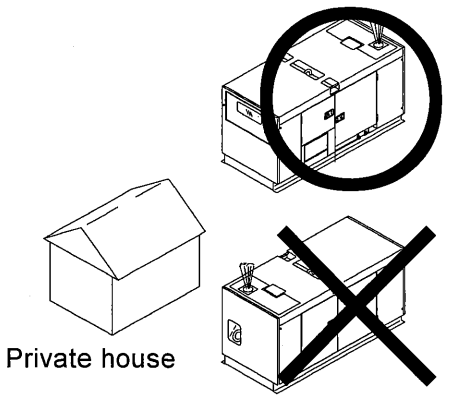
A050506-1

3. Installation

⚠ WARNING

- Never locate the unit with the exhaust muffler facing any private house:
- As the exhaust fume (gas) from the engine is poisonous, never direct it to any other persons passing by.

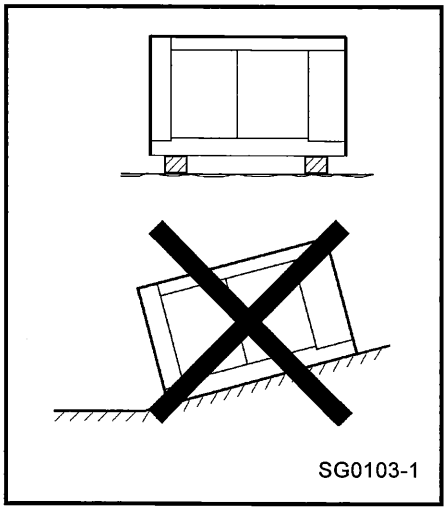
How to locate the unit



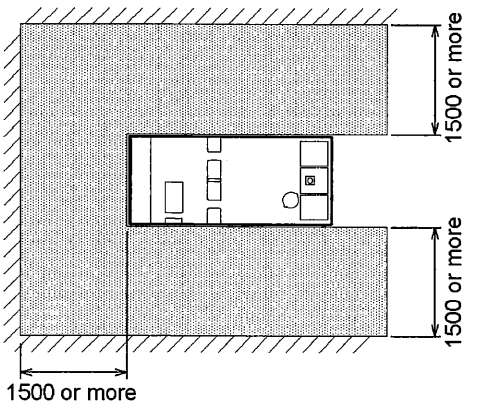
⚠ WARNING

Installation

- The machine has to be installed on dry, firm, and level area.
- The machine should be installed within 5° degree inclination.
- Avoid installing the machine in a place such as a damp place or a place where puddles are apt to be formed after rain. Such installation could cause electric shock.
- When installing the machine at the sea shore or on a ship, make sure that the machine should not be exposed directly to sea water.
- When installing the machine at a sandy place, make sure that exhaust from the generator or radiator does not blow the sand up in the air, or into the machine.
- In case that the unit has to be installed inevitably on any rough and uneven ground; it is necessary to insert square wooden bars under the unit for levelling it.



- The machine should be operated in following conditions:
- Ambient temperature ..... -15℃ to +40℃
- Humidity ..... Less than 85%
- Altitude ..... Lower than 500m above sea level
- If more than two machines are placed parallel in operation, keep enough distance so that exhaust air from one machine does not effect the other one.
- Keep enough space around the machine for inspection and maintenance access.

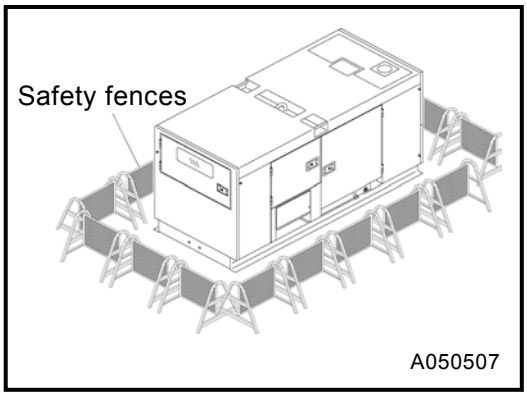


3. Installation

⚠ CAUTION

Preparation of safety fences

- In order to prevent from entering the jobsite or touching the equipment any other persons than the persons engaged in the job, please prepare for safety fences around the unit:



3. Installation

3.3 Leakage Protection Device and Grounding Method

⚠ WARNING — ***Caution on Grounding***

- Make sure to perform grounding connection of the external body of load. If such grounding connection is neglected or fails, it can cause electric shock to human body by leaked current, leading to serious accident as death.
- Grounding terminal for residual current relay and grounding terminal of the package of the machine can be connected to both independent grounding base and to common grounding base.
- This ground fault circuit interrupter does not function to protect such electric shock accident caused between these two wires (cables).

3.3.1 Leakage protection device

- This machine is equipped with a leakage relay which detects leakage caused by a defective insulation of working load to prevent an accident such as an electric shock by shutting down the circuit. However, for additional safety, install ground fault circuit interrupter (GFCI) for each load equipment close to the load equipment. The sensitivity current of the leakage relay is 30 mA.

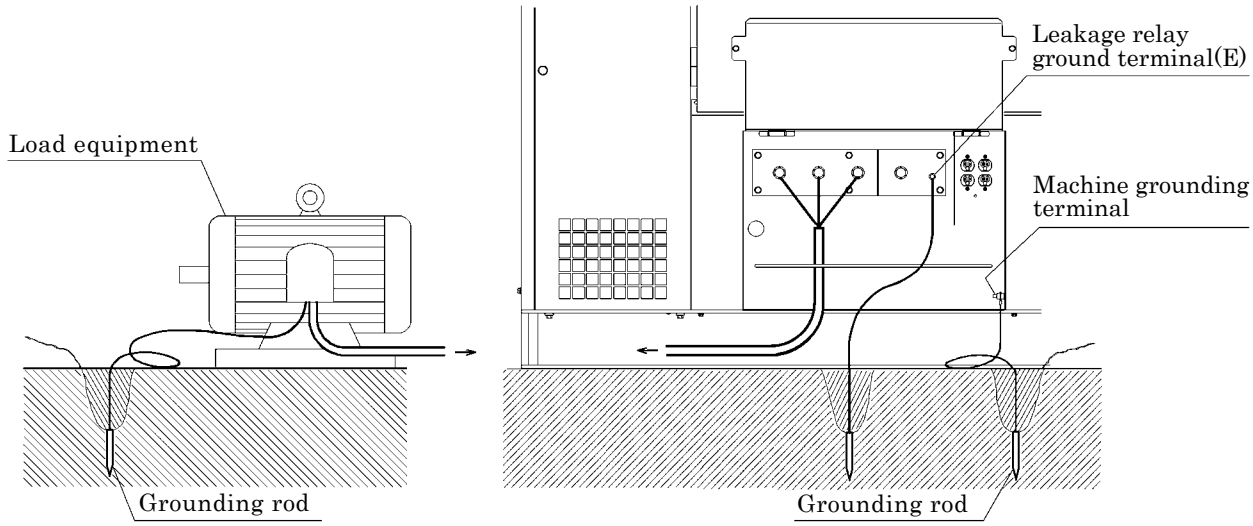
3.3.2 Grounding method

<Procedure>

- Connect a lead wire fitted with a ground rod to the leakage relay grounding terminal (E) of the three-phase output terminal board.

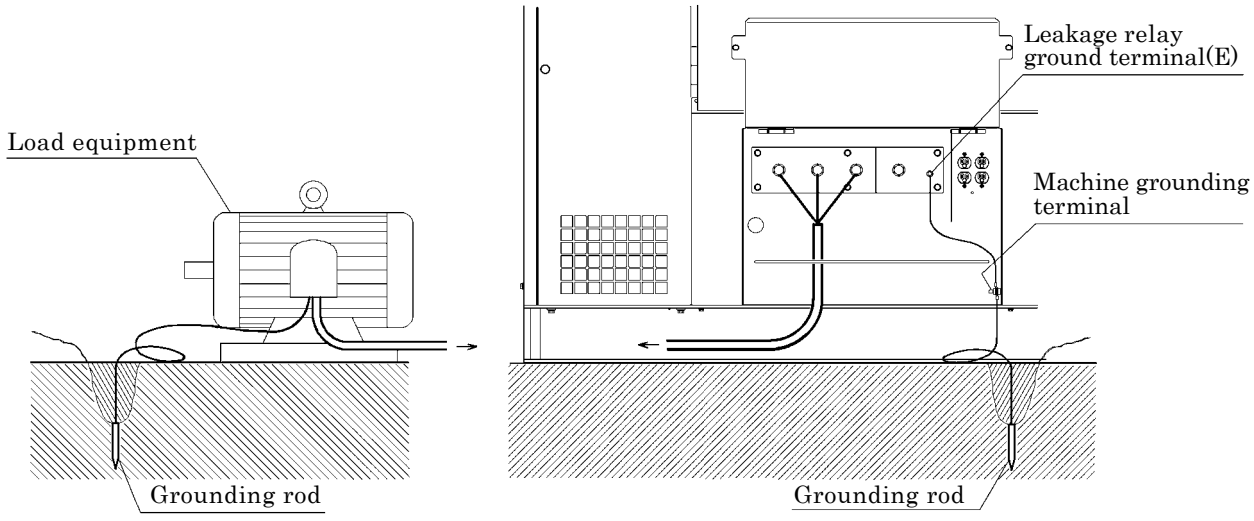
① Connect the generator machine ground terminal of the package to ground.
② Be sure to ground the package of the load equipment as well.
③ These grounding must be carried out in accordance with local regulations.

Independent grounding method



A090403E

Common grounding method



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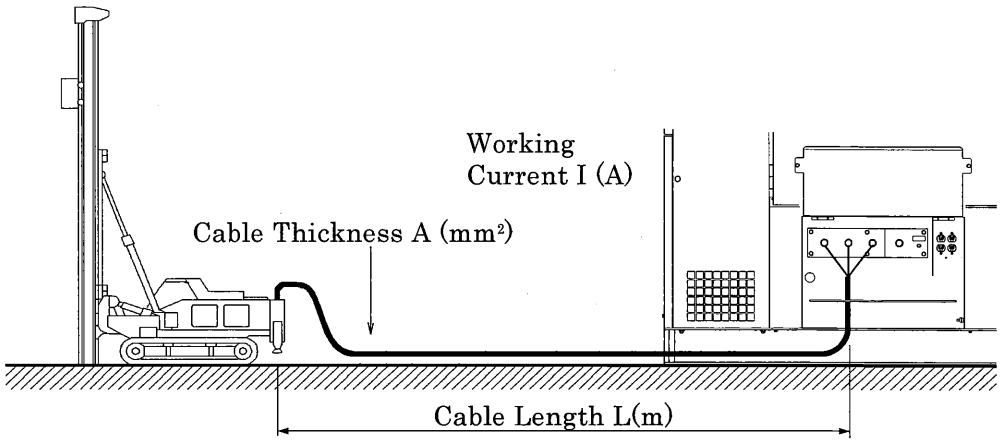
3. Installation

3.4 Selecting Cable

- Select a cable with sufficient diameter by considering the permissible current on the cable and the distance from the machine to the load.
- If the current flowing to the load exceeds the permissible current of the cable, resultant overheating may burn the cable. Similarly, if the cable is too small in thickness to the length, the input voltage to the load will fall to cause the load input power to drop, as a result, the performance of the machine cannot be displayed.



- Simplified three-phase three-wire formula to seek voltage drop or cross-sectional area of the cable from cable length and working current. Select such a cable length and thickness so that the voltage drop will remain less than 5%.

Output system	Voltage drop	Cross-sectional area of the cable	e : Voltage drop(V) e' : Voltage drop between an outside line or one line of each phase, and a neutral line (V) A : Cable thickness (mm²) L : Cable length (m) I : Working current (A)
Single-phase 2-wire Type	$e=\frac{35.6\times L\times I}{1{,}000\times A}$	$A=\frac{35.6\times L\times I}{1{,}000\times e}$	
Three-phase 3-wire Type	$e=\frac{30.8\times L\times I}{1{,}000\times A}$	$A=\frac{30.8\times L\times I}{1{,}000\times e}$	
Single-phase 3-wire Type and Three-phase 4-wire Type	$e'=\frac{17.8\times L\times I}{1{,}000\times A}$	$A=\frac{17.8\times L\times I}{1{,}000\times e'}$	

- The following tables show the relations between the cabtyre cable length and the cable thickness (nominal cross-sectional area) suited to the working current.
(Based on the condition that working voltage is 200 V, with voltage drop of 10 V.)

Single-Conductor Cabtyre Cable — Unit:mm²

Current \ Length	50m	75m	100m	125m	150m	200m
200A	65	60	60	80	100	125
400A	125	125	150	200	200	250
600A	200	200	200	250	150×2	200×2

Three-Conductor Cabtyre Cable — Unit:mm²

Current \ Length	50m	75m	100m	125m	150m	200m
200A	38×2	38×2	38×2	50×2	50×2	60×2
400A	60×2	60×2	60×2	80×2	100×2	125×2
600A	100×2	100×2	100×2	125×2	150×2	200×2

3. Installation

3.5 Selector Valve of Fuel Pipe

⚠ CAUTION

- Always keep watching the fuel feeding conditions while feeding fuel from a separate fuel storage tank separately installed.
- In order to use a separator fuel storage tank, be sure to change the handles of the selector valves to a predetermined position. If you make a mistake in turning the handles, it can burst the fuel pipe and cause overflowing. It could lead to a serious accident.
- If excessive force is loaded to the selection handle, it will not move smoothly and it could cause fuel leakage. Be careful about the handle.

3.5.1 Selector valve

This valve is designed to feed fuel directly to the engine of the unit, not from the tank integrated in the unit, but from a fuel tank installed separately.

3.5.2 Operation method

① Unit is delivered from factory with fuel line piping and selector valves built in as shown in the following Fig.1. When operating a unit, using installed fuel tank, run the machine with the fuel line piping and the handles of selector valves factory-arranged.

② When using a separate storage tank, remove the plug fitted at the connections to the separator tank and make piping as shown in Fig.2. And then turn the handles of the selector valve as shown in Fig.2.

③ When removing the piping connections, make sure to return the handles to the original positions shown in Fig.1 and install the plugs.

3.5.3 Installation of separate storage fuel tank and piping method

① Use oil resistant hoses of inside diameter of 8mm to 10mm.

② Install the fuel tank so that the fuel level of the tank may be kept at the level from zero to 2.5m high from the machine installation level.

③ In order to avoid suction of water and sediment together, install the suction pipe so that the inlet port of suction pipe may be kept at the 15mm to 20mm higher level than the bottom line of the tank. Also install the outlet port of the return pipe inside the tank. (see Fig.2・A)

④ When refilling fuel in the tank, take much care not mix water and sediment.

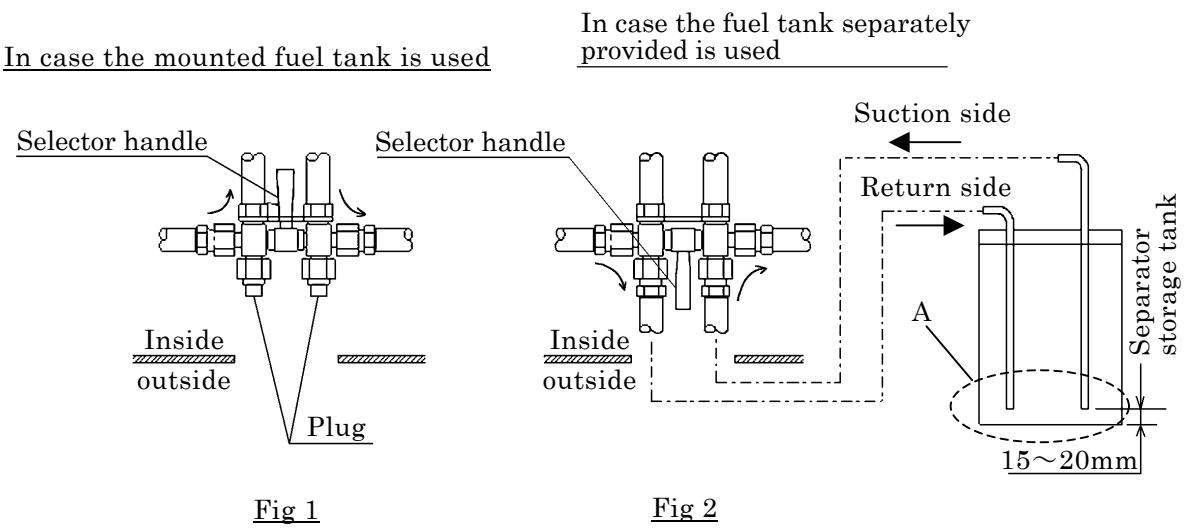


Fig 1 Fig 2

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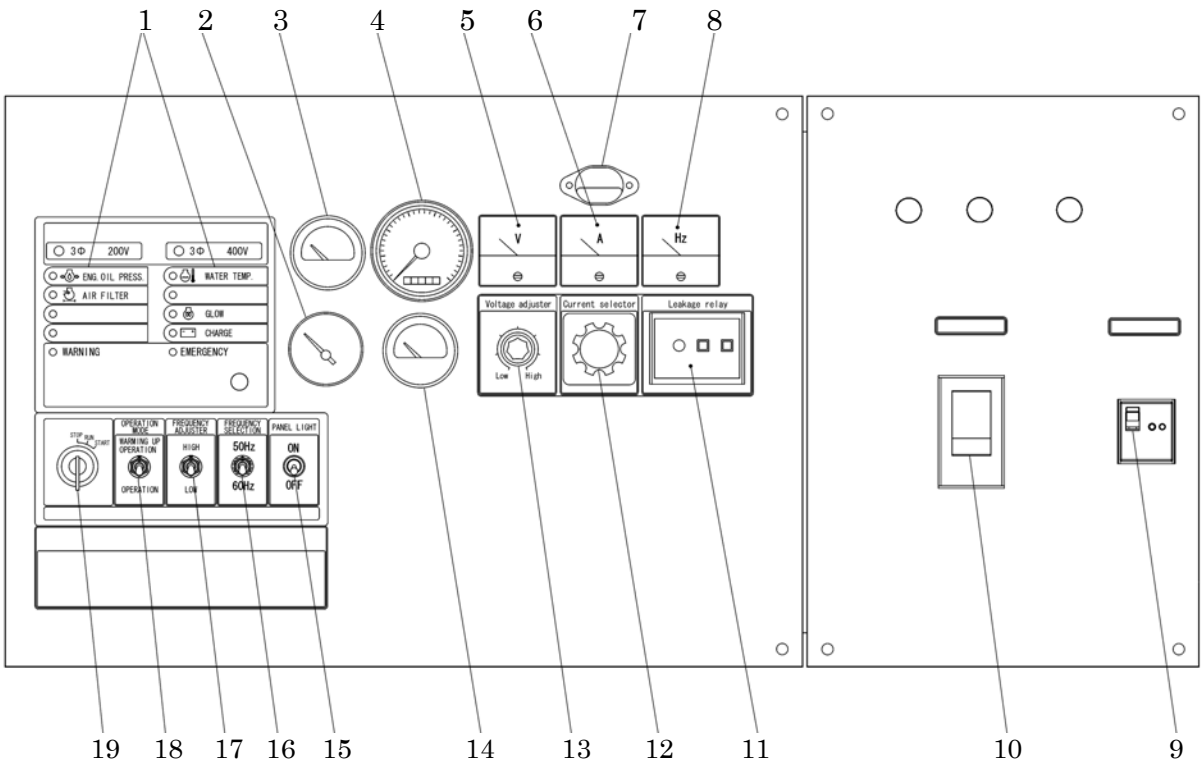
4. Operation

4.1 Instrument panel



1. Monitor lamp (for details, see 4.2.1)
2. Engine water temperature gauge
3. Fuel gauge
4. Tachometer with hourmeter
5. Voltmeter
6. Ammeter
7. Panel light
8. Frequency meter
9. Circuit breaker (dedicated to single phase)
10. Circuit breaker
11. Leakage relay
12. Current selection
13. Voltage adjuster
14. Engine oil pressure gauge
15. Panel light switch
16. Frequency selection switch
17. Frequency adjuster switch
18. Operation mode selection switch
19. Starter switch

4. Operation

4.2 Protection device

⚠ WARNING

- For prevention of troubles during operation, this machine is provided with various protection devices. When the engine stops due to function of the protection devices and circuit breaker trips, get rid of the causes of trouble, referring to the trouble shooting clause and then restart operation.

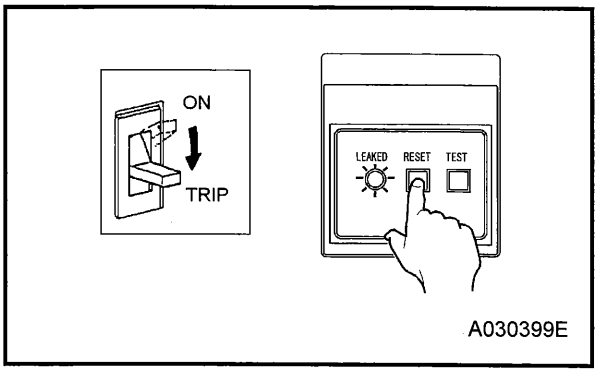
4.2.1 List of protection devices

- This machine is equipped with the following devices in the table. Repair and make necessary treatment in accordance with the item ○.

Item	Engine stops	3 phase or single phase circuit breaker trips.	Lamp display	Monitor lamp	Functions
Engine oil pressure drop	○	—	○		When engine oil pressure drops, it functions. Operating pressure: lower than 78kPa
Engine water temperature rises	○	—	○		In case of abnormal rise of engine water temperature, it functions. temperature reaches 101℃
Over speed	○	—	○	—	When engine rotates excessively, it begins to function. Function rotation: 2,070min^{-1} (69Hz)
Clogging of air filter	—	—	○		When air filter is clogged and it becomes necessary to clean it, it functions.
Leakage current	—	○	○	—	In case of current leakage it functions. Sensing current: 30mA
Discharged battery	—	—	○		It functions in case of faulty battery.
Over current or short circuit	—	○	—	—	In case of overload or short circuit accident, it functions.

4.2.2 Leakage relay

- When residual current flows to machine and load, the residual current indicator lamp goes on to trip the circuit-breaker and circuit breaker (dedicated to single phase).
  <Set value at which it starts to function: 30mA>
- Pressing the reset button of leakage relay, and returning the lever of the circuit-breaker to OFF position once, then it is possible to switch ON the circuit-breaker again. (See 4.2.3)

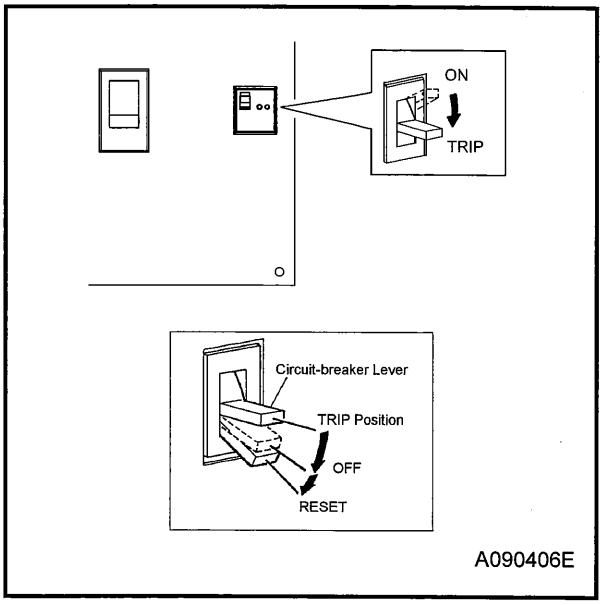


4.2.3 Circuit-breaker and circuit breaker(dedicated to single phase).

- In case overload and short-circuited wire connection should occur, the circuit-breaker trips.
- When this is tripped, stop the unit immediately and reset the circuit breaker after getting rid of the causes of trouble.

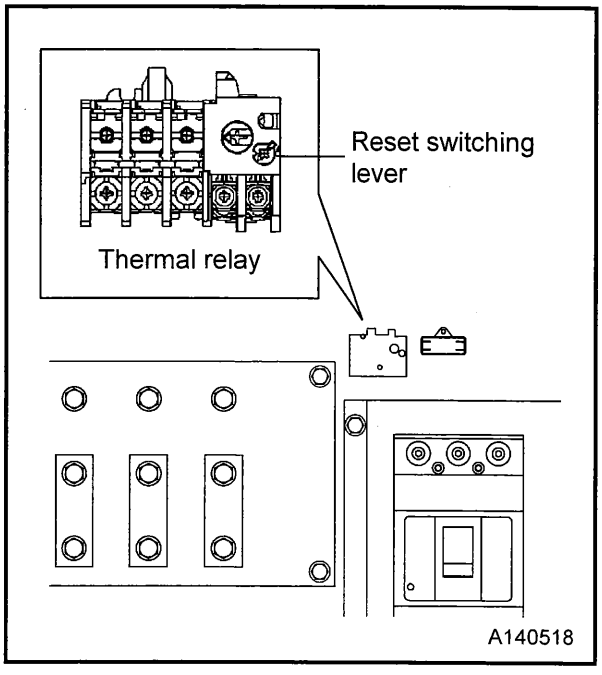
<How to reset>

- In order to reset the lever of circuit-breaker, press hard the lever downward till the lever sounds "click".



4.2.4 Thermal relay

- In case overload or short-circuit should occur to load or load connection cable, this relay functions to trip the circuit-breaker.
- It is not necessary to push the reset button even after the three phase main breaker is tripped since the thermal relay is set automatic return at factory.



4.2.5 Circuit protector (CP) for AVR protection

AVR is equipped with circuit-protector (CP) for protection against over current. Under the following cases, it happens to function.

- In case the machine gets overloaded while engine speed is still lower.
- In case the output voltage of machine is increased higher than the specified voltage.

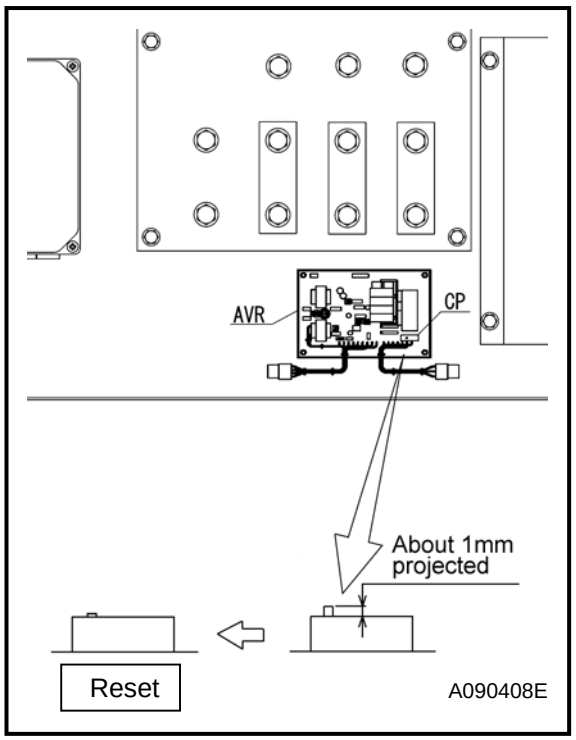
<Symptom>

- When circuit protector functions and load is applied to the machine, such trouble as larger variance of voltage and/or delayed voltage recovery follow.

<How to reset>

- Press the white colored AVR button inside the control panel for resetting the circuit-breaker.

Note: Do not hold the button with such sharply pointed things as a screwdriver, ball point pens etc.

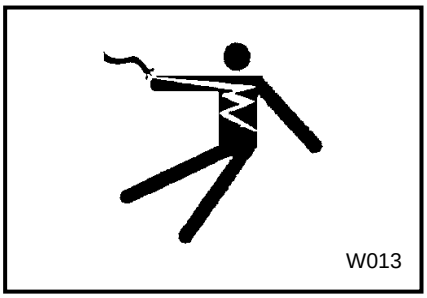


4.3 Check Frequency Selection Switch for AVR

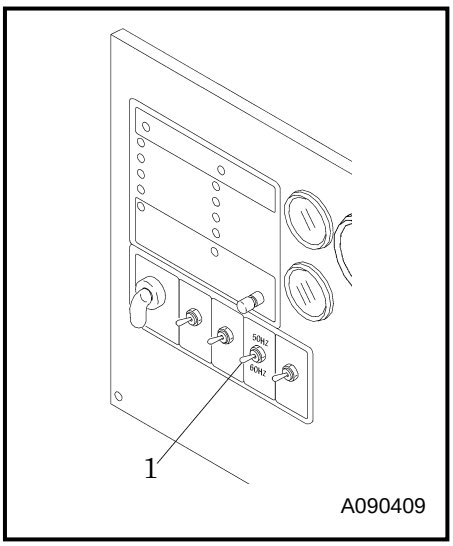
WARNING

Do not leave control box open

- Never touch the interior of control panel during operation. Notice that the voltage of several hundreds volts is applied in the control panel.
- When checking or operating the interior of the control panel for changing AVR frequency, be sure to stop the machine, remove the starter key from the starter switch, then carry out a work. The checker must keep the key during inspection.



- The AVR characteristics should be changed according to the frequency.
- When changing the frequency, set the AVR frequency selection switch "1" in the control panel to the frequency in use.
- If the frequency selection switch "1" is not set to suite the frequency in use, the rated voltage cannot be obtained.



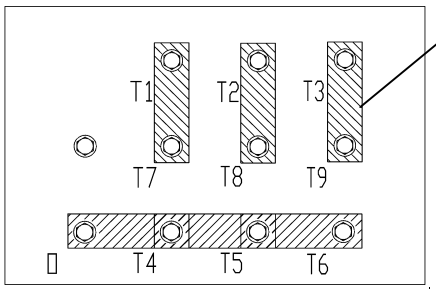
4. Operation

4.4 How To Switch Voltages

WARNING

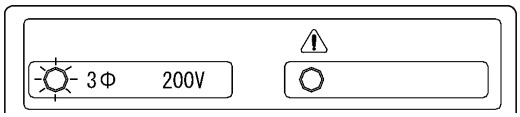
- It is possible to select 3 phase 4 wire 200 volt or 3 phase 4 wire 400 volt.
  But before starting operation, make sure to confirm the voltage set for the machine without fail. If any load is connected to the machine with the wrong voltage set, it can cause damage or burning accident to the load.
- When switching the voltages, make sure to stop the machine.

- Open the operation panel and connect the short-circuit plate as shown in the following figure. If wrongly connected or loosely connected, it can cause burning to the generator body.
- During operation, never use switch. Because it could cause electric shock and AVR protection device functions to make voltage fluctuation bigger to hinder normal generating operation.
- When protection device works, press white button of AVR to disengage protection device.
- When you start operation, the lamp of your selected voltage goes on. So make sure to check whether the lamp goes on correctly to your selected voltage.



In case of 200/220V

「200V output」
The green lamp lights



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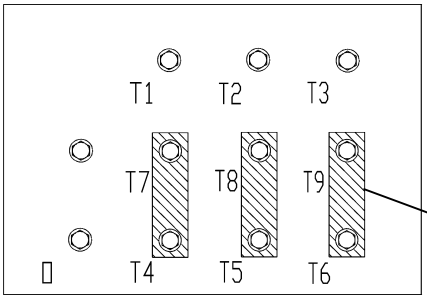
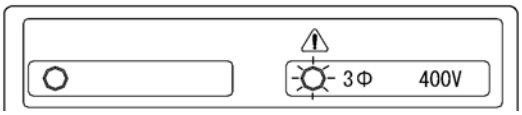


In case of 400/440V

「400V output」
The red lamp lights



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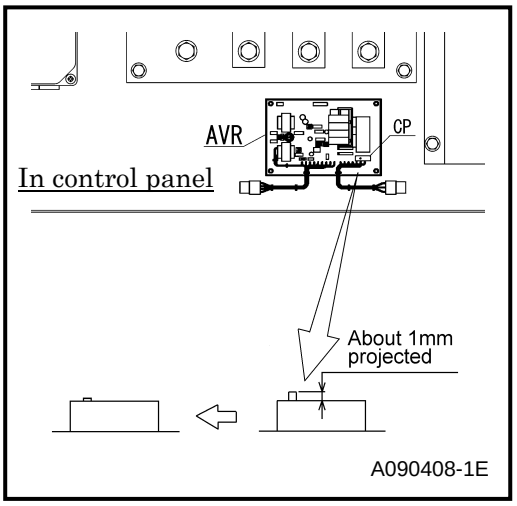
Tighten two plates piled.



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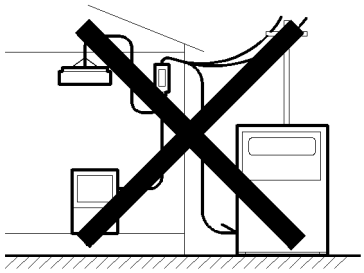
4.5 Connecting Load

WARNING — ***Electric shock and electric leak***

- Make sure not to connect the output terminal of the machine with the commercial power source from electric power company. This is not only prohibited by the regulations, but it may cause an electric shock, machine troubles and even a fire.
- Make sure to ground the machine and the load. It could cause an electric shock when the machine is installed at a damp place or on a steel frame or a steel plate.
- Never touch the output terminals during operation. Notice that the voltage of several hundreds volt is applied to the output terminal.
- When removing or connecting a connecting cable for changing load, be sure to switch OFF the circuit breaker, remove the starter key from the starter switch, then carry out a work. The operator must keep the key during operation.
- For a connecting cable to load, do not use a cable with damaged sheath nor an inappropriate insulation cable to the voltage.
  Secure connections between each cable terminal and input/output terminal. Otherwise, it may be slackened during operation and may cause a fire or an electric shock accident.



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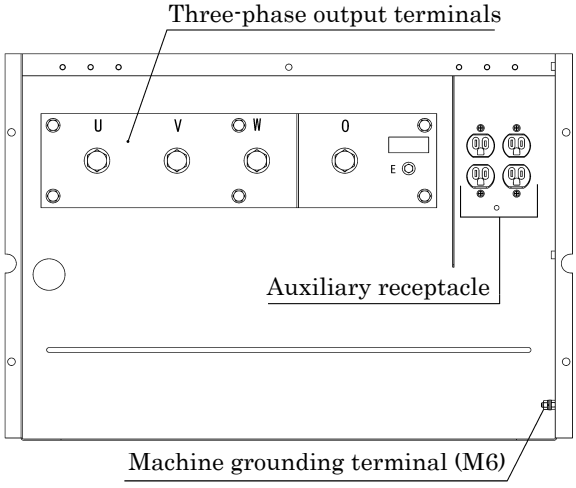
IMPORTANT

- Notice that the terminal O is not a grounding terminal of the generator. Never connect a grounding wire to it. Such connection may cause the generator main unit or the load troubles.
- When using a single-phase load [200/220V or 115/127V], see to it that the loads on the different phases will be evenly balanced. Unbalanced loads may cause the generator main unit burning.

- Select a cable with sufficient diameter by considering the load capacity and the distance from the generator to the load. Use terminals for connection and securely fasten them. (See 3.4)
- After checking phase number and voltage of the load, make sure to connect them correctly.

—Terminal size—

Three-phase output (U・V・W・O) : M16
Leakage relay ground terminal(E) : M6



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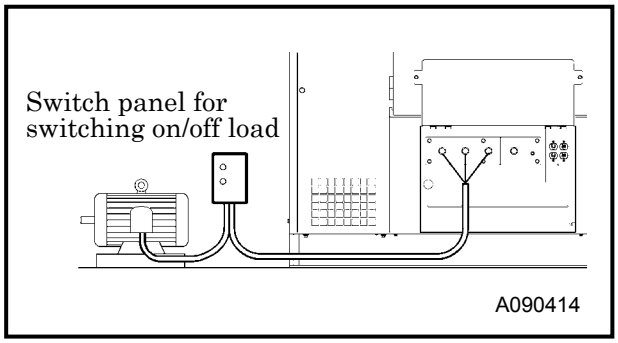
- Install a switch between the output terminal and the load to switch on/off the load. Do not switch the load on/off directly by the circuit-breaker of the machine.
- It could cause damage to the Connect the connecting cable to the load so that the output terminals should not touch each other. circuit-breaker.

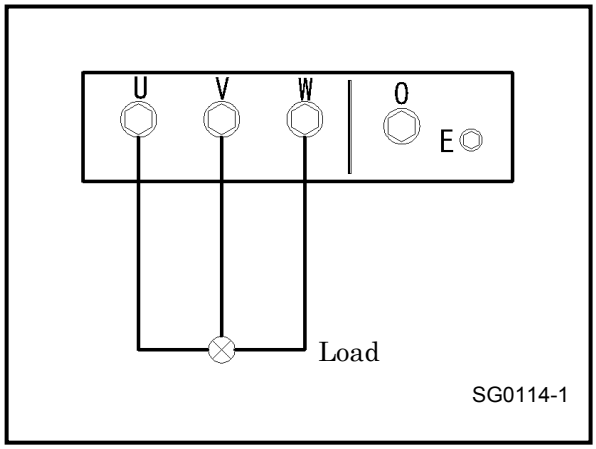


4.5.1 How to connect three phase load

●In case of three-phase load:

Each electric current value of each phase (U.V.W) should not exceed the values in the following table. But please note that the data in the table is based on power factor of 80% (in case of electric motor operated). In case of different power factor, take care not to be overloaded, and reduce load.

Type	Permissible current value
50Hz/200V	577A
60Hz/220V	577A
50Hz/380V	304A
50Hz/400V	289A
60Hz/440V	289A



●In case inverter load:

The inverter capacity (input kVA of inverter) should not exceed the following value (within rated output ÷ 3.0). Also select generator so that the rated output (kVA) of generator so that the rated output (kVA) of generator may be three times of the inverter capacity.

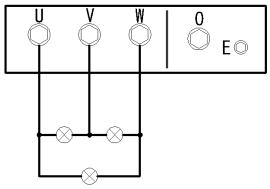
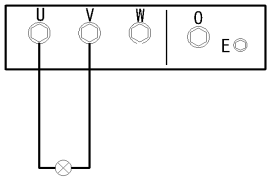
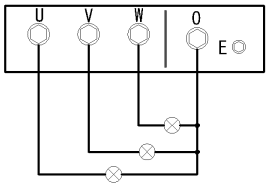
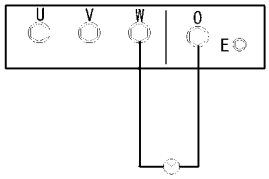
Example: In case of SDG220S,at 50Hz, 200kVA ÷3.0 = 66.7kVA.

50Hz: 66.7kVA (Input kVA of inverter) It is possible to use inverter capacity up to this value.

60Hz: 73.3kVA (Input kVA of inverter) It is possible to use inverter capacity up to this value.

4.5.2 How to connect single phase load

- The method of connection of 3 phase 4 wire single phase load is as follows.
  The allowable current limit shall not exceed the values in the following table.

<table>
<tr><th colspan="3">Conditions of load</th><th>Allowable current limit</th><th>Conditions</th></tr>
<tr><td rowspan="4">3 phase 4 wire type</td><td rowspan="2">In case of using 2 phases</td><td>In case of three phases
  </td><td rowspan="2"><table><tr><th>Type</th><th>Permissible current value</th></tr><tr><td>50Hz/200V</td><td>577A</td></tr><tr><td>60Hz/220V</td><td>577A</td></tr><tr><td>50Hz/280V</td><td>304A</td></tr><tr><td>50Hz/400V</td><td>289A</td></tr><tr><td>60Hz/440V</td><td>289A</td></tr></table></td><td>Allowable current limit up to the rated current.
Adjust the load capacity so that each current value of each phase (U,V,W) may not be more unbalanced than 50%.</td></tr>
<tr><td>In case of using single phase
  </td><td>Allowable current limit up to the rate current.
But voltage change becomes larger due to the unbalance of each phase.</td></tr>
<tr><td rowspan="2">In case of using O phase</td><td>In case of three phases
  </td><td rowspan="2"><table><tr><th>Type</th><th>Permissible current value</th></tr><tr><td>50Hz/115V (200V)</td><td>577A</td></tr><tr><td>60Hz/127V (220V)</td><td>577A</td></tr><tr><td>50Hz/219V (380V)</td><td>304A</td></tr><tr><td>50Hz/231V (400V)</td><td>289A</td></tr><tr><td>60Hz/254V (440V)</td><td>289A</td></tr></table></td><td>Allowable current limit up to the rated current.
Adjust the load capacity, so that each current value of each phase (U,V,W) may not be more unbalanced than 50%.</td></tr>
<tr><td>In case of using single phase
  </td><td>Allowable current limit up to the rated current.
Bur the voltage change becomes larger due to the unbalance of each phase.</td></tr>
</table>

4.5.3 Single phase output (100/110V 50/60Hz)

- In the output terminal portion the auxiliary receptacle are provided.
- When the AC ammeter indicates 200/220V and 400/440V, the single phase output voltage is 100/110V.

Single phase output voltage	100/110V
Auxiliary receptacle	1.5/1.65kVA×4

- When using both single output and three phase output at the same time, the machine shall be used lower than the allowable current limit.
- Four auxiliary receptacles shall be used lower than total 15A×2.

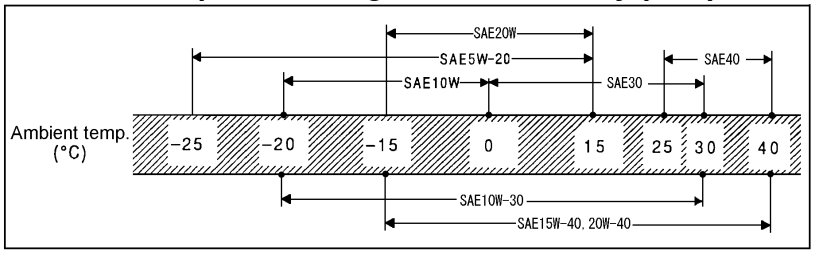
4.6 Engine Oil・Coolant・Fuel

4.6.1 Engine oil

IMPORTANT

- Viscosity of engine oil greatly affects startability, performance, oil consumption of the engine, as well as wear of the moving parts.
- Choose appropriate oil based upon the table below according to the outside air temperature.

Ambient temperature range and oil viscosity (SAE)



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＊When the unit is delivered from factory, it is filled with the engine oil having the following specifications:

Classification	API service classification CD class or higher
Viscosity	SAE10W-30

- When two or more different brands of oil are mixed, its performance can be deteriorated. Do not mix oils.
- When it is expected to be used for a long period at light load (less than 20% load), it is better to replace the oil with suitable oil.
- Follow the designated regulations to dispose of engine oil.

4.6.2 Coolant

IMPORTANT ***Quality of coolant and antifreeze***

- Use soft water of good quality such as tap water for coolant.
- When water with dirt, sand, and/or dust contained, or hard water such as well water (ground water) is used, this will cause deposits inside radiator or on cylinder head, and will cause engine overheat due to poor flow of coolant.
- When the unit is used in a cold region and possible freezing is expected, it is recommended to use LLC (Antifreeze) for the coolant.
- Adjust mixing ratio of LLC with water according to the temperature. **(When the unit is delivered from factory, it is filled with the oil of density 35%.) Use LLC within the range of its mixing ratio between 30 and 60%. (If LLC in the water exceeds more than 60%, it may decrease its antifreezing effect.)**
- Follow the designated regulations to dispose of LLC (Antifreeze).

4.6.3 Fuel

IMPORTANT ***Choose appropriate fuel***

- Be sure to use diesel fuel oil.
  (Using other oil will cause low power output or damage the engine.)

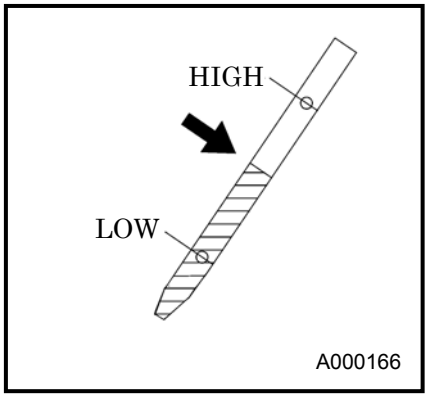
- As for fuel, use diesel fuel oil (having higher than 45 cetane number).
- Use of diesel fuel oil having lower than 45 cetane number will cause inferior function to engine and, what is worse, it will cause serious accident to the engine.

4.7 Check before Starting the Machine

⚠ WARNING — ***Check before starting the unit***

- Be sure to check the machine before operation.
  When any abnormality is found, be sure to repair it before starting the unit.
- Be sure to make daily check before operation. If the unit is operated without prior check and without noticing its abnormality, such operation could cause seizure of components or may even cause fire.

4.7.1 Check engine oil level



- The machine should be on level before checking oil level.
- When you check oil level after you have once started operation, wait 10 to 20 minutes after stopping engine, before checking the oil level.

<Procedures>

① Pull out the engine oil level dipstick, and wipe it with a clean cloth.

② Then, re-insert the dipstick fully and pull it out again. If the gauge shows the oil level between LOW and HIGH limits, it is normal.

③ When the oil level is below its LOW, add engine oil. (See 5.5.1)

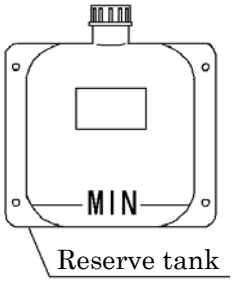
- While checking oil level, check also for contamination. If the oil is found dirty, contaminated, or should be changed according to the periodic inspection list, change the oil.

4.7.2 Check coolant level

⚠ CAUTION — ***Taking off the radiator cap***

- Be sure to stop the machine first and then loosen the radiator cap slowly, after the coolant water is sufficiently cooled and the inner pressure is released.
  If this procedure is neglected, its inner pressure can blow off the cap, and steam jetting out of the radiator could cause scalding.

- Check the coolant level in the reserve tank. If it is lower than the limit, open the cap and replenish the coolant.
  (Level must be kept above LOW mark)
- If little coolant is left in the reserve tank, replenish the tank and radiator also. (See 5.5.16)



4.7.3 Check fuel

- Before starting operation, make sure to check the level of residual fuel so that fuel shortage during operation can be avoided.
- If necessary, drain condensate accumulated at the bottom of the fuel tank.

⚠ WARNING — ***Fire prevention***

- Do not, under any circumstance, bring lit cigarettes and/or matches to the fuel.
- The fuel is extremely flammable and dangerous. Be careful of fire because it is very likely to catch fire.
- Refuel only after stopping the engine, and never leave open fuel can near the machine. Do not spill. It could cause a fire. When it is spilt, wipe it up completely.
- Refilling fuel tank should be done in an outdoor well-ventilated place.
- **Do not fill fuel oil up to the cap level. When fuel tank is filled up to the cap level, fuel oil will be overfilled due to volume expansion caused by rise of ambient temperature. Further, fuel will be possibly spilled from fuel tank due to vibration caused during movement and/or transportation of machine.**

D004

4.7.4 Check sedimentor

Check if the red float "1" in the water sedimentor rises up to the water drain level, then drain water if it is near the drain level "2".

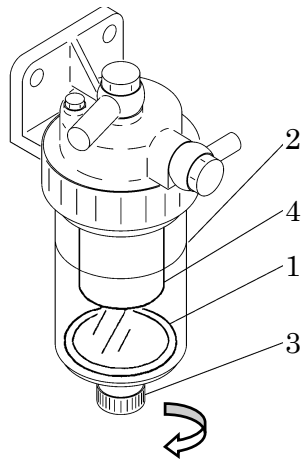
<Procedures>

① Loosen the drain plug "3" to drain the water from the sedimentor.

② After draining the condensate, be sure to fasten the drain plug "3".

③ When any dust or clogging is found in the inside screen "4", take the screen up and wash it in diesel fuel oil or clean it by air blow.

- Drain the condensate in container, and then dispose of condensate according to the designated regulations.



Turning it to left, it will be loosened.

A090461

4.7.5 Check ground of machine package and leakage relay

Make sure that the machine grounding terminal of the machine package, leakage relay grounding terminal, and the package of the load are securely grounded. (See 3.3)

4.7.6 Check belt tension

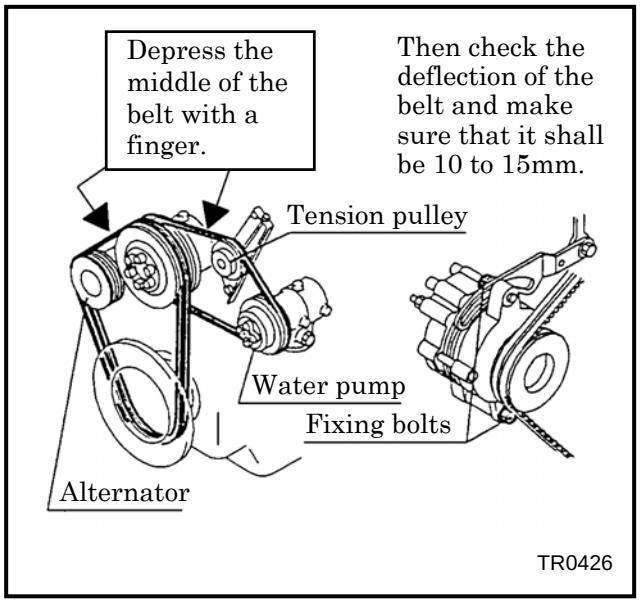
IMPORTANT

- If belt tension too tight, it can cause shaft breakage or shorten the life of a bearing. If too loose, the belt may slip and will cause early breakage or damage to the belt.

1. Check the alternator belt of cooling fan

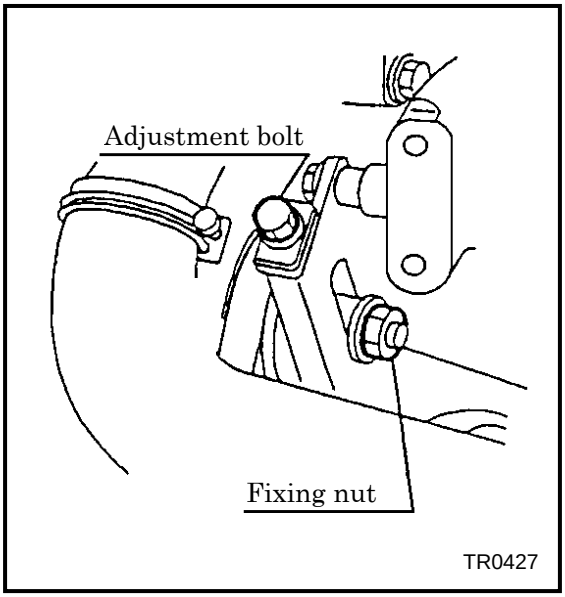
<Procedures>

① Adjust the tension by gradually loosening the fastening bolt of the alternator.
② Visually check if there are any cracks or tears in the belt.
③ Loosen the fastening bolt of the alternator until the play of the belt reaches 10 to 15mm (98N) when pushed by fingers, and adjust it.
④ Be careful not to leave any grease or LLC on a belt while changing it. If any such material is left, wipe it off completely.



2. Check the water pump belt

① After loosening the nut fixing the tension pulley, adjust the belt by moving the pulley with the adjusting bolt.
② While adjusting the belt tension, check it for any crack or wear, and if any fault is found, replace it.
③ Be careful not to leave any grease or LLC on a belt while changing it. If any such material is left, wipe it off completely.



4.7.7 Check leakage relay operation

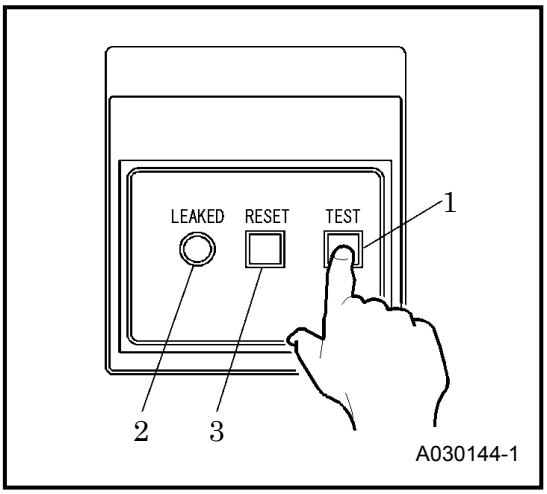
WARNING

- Never attempt to test the leakage relay by way of human body.
- In case the leakage relay has tripped due to leakage, always investigate the cause to remove it.

Regularly check the relay operation for safety.

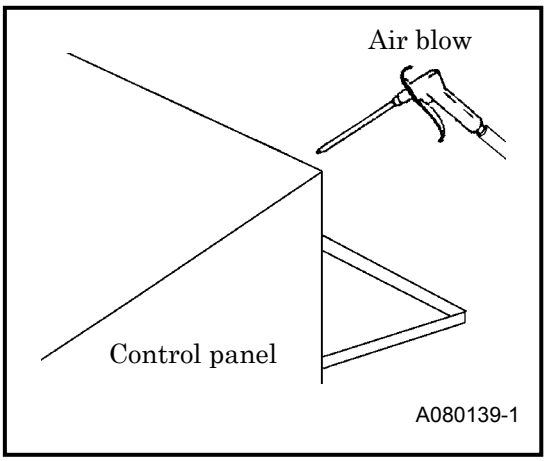
<Procedure>

① Start up the machine. (See 4.8.1)
② Switch“ON”the circuit breaker.
③ Push the leakage relay test button “1” . When the red lamp on the leakage relay and the“LEAKED”lamp “2” on the instrument panel glow, the relay function is normal if the circuit breaker is switched“OFF”.
④ To set the breaker“ON”once again, push the leakage relay reset button “3” and set the breaker lever back to the“OFF”position.



4.7.8 Cleaning the instruments inside control panel

- Before starting operation, open control panel and check each breaker, terminal plate and each controller for any dust, sand and dirt accumulated.
- If the machine is operated with such dust, sand and dirt sticking, it could cause malfunction and trouble of instrumentation. If any, stop the machine, and clean them by blowing compressed air. When doing cleaning job, wear protection glasses.

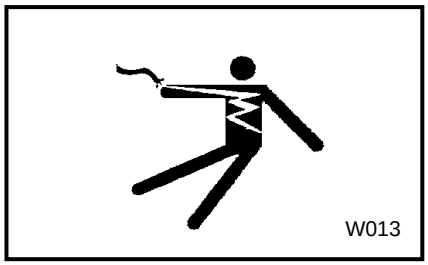


4. Operation

4.8 Operation and Stopping

⚠ WARNING — ***Never touch the interior of output terminals ,control board***

- Keep the output terminal cover shut and locked whenever the machine is running.
  Notice that the voltage of several hundreds volt is applied to the output terminal and control board.
- When opening the door unavoidably, be careful not to touch the rotating parts and hot parts. It could cause scalding and serious injury.
- When removing or connecting a connecting cable for changing load, be sure to switch OFF the circuit breaker, remove the starter key from the starter switch, then carry out a work. The operator must keep the key during operation.
  Neglecting the cautions mentioned above, and a third party starting the machine during operation may cause serious accidents such as electric shock.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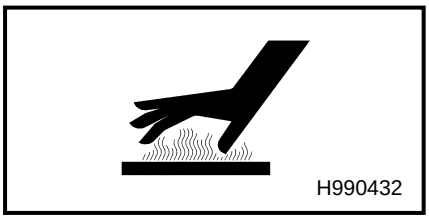
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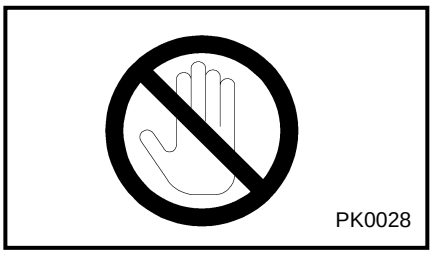
⚠ CAUTION — ***Pay caution to overload and unbalanced load***

- When the breaker functions so often during operation, reduce the load.
- When using single- phase load, check the current of each phase and try to keep the load of each phase constantly average.
- If you continue to operate the generator main unit, ignoring and neglecting these cautions, it could cause burning to the unit and resulting in fire. Furthermore, should continue operation at the lower level than the standard rated frequency, it could cause burns to the generator main unit and also the motor of the load.

⚠ CAUTION — ***Draining during operation prohibited***

- Do not, under any circumstance, open the portions below during operation.
- Coolant drain valve and plug
- Engine oil drain valve and plug


PK0028

IMPORTANT

- After the engine starts up, warm up it under unload for approx. five minutes.
- Warming up after starting up is necessary for smooth operation of the engine. Do not operate the engine at full load immediately after it starts up. This will shorten the equipment life.
- During the warm-up operation, examine the different parts of the equipment for any looseness, leakage of water, oil, fuel, and other irregularities.
- Also, make sure that the alarm lamps are off.
- Be sure to operate the generator at a rated frequency, irrespective of the load capacity.
  If the machine is operated with a frequency lower than the rated frequency, it could cause the generator main unit or to be burned.

4.8.1 Procedure to start the unit

Follow the starting procedure below.

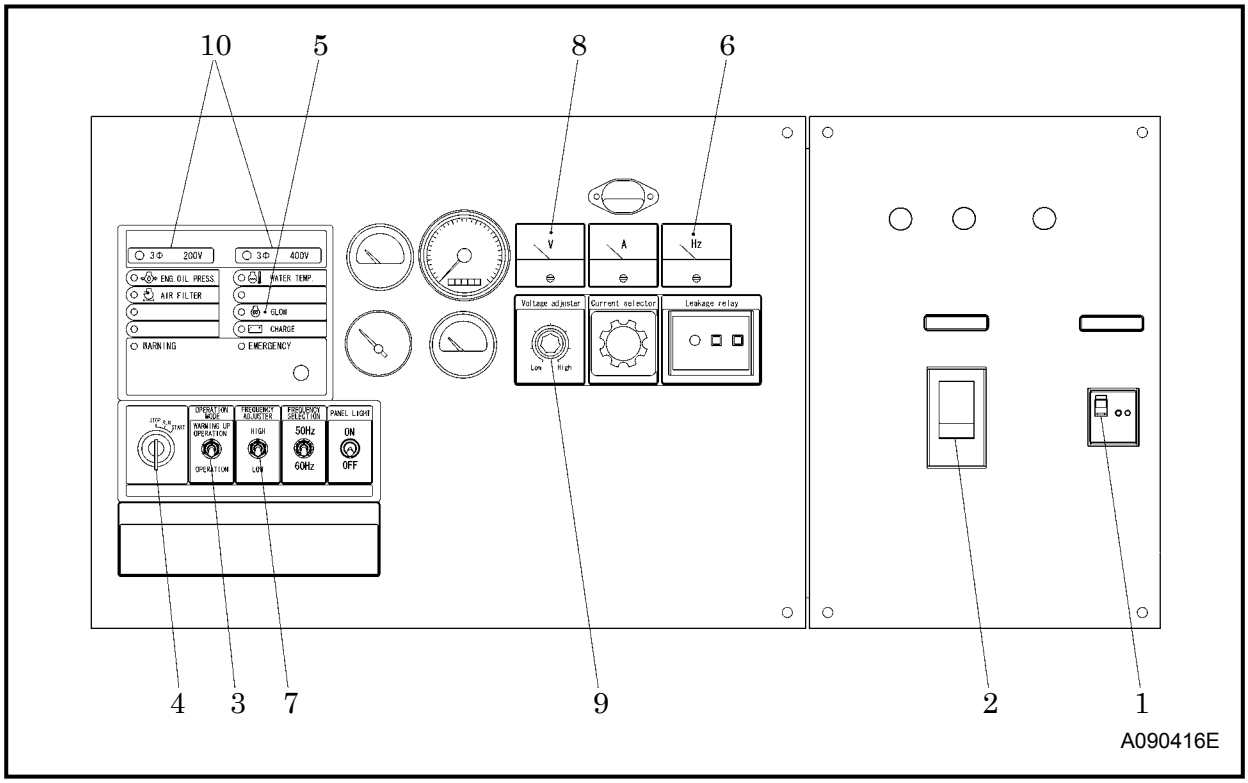
<When engine starts>

① Make sure that both circuit breaker (dedicated to single phase)“1”and circuit breaker“2”are“OFF”. (In cold seasons, place operation mode selector switch “3” to “Warming up”).

② Turn the starter switch “4” to “RUN” position, and the glow lamp “5” goes on. (If water temperature is high, glow lamp “5” will not go on.)

③ Immediately after the glow lamp “5” distinguishes, turn starter switch “4” fully to the right to start engine.

④ Once the engine has started up, leave the engine running to warm up for approximately 5 minutes.



<Confirmation of voltage and frequency>

① After warming up operation, switch operation mode selection switch “3” to “RUN” position.

② After finishing warming up operation, check and confirm frequency meter “6” . If the frequency is wrong, turn frequency adjustment switch “7” . If the frequency at load is adjusted higher than specified speed, turn selector switch to “LOW” and if lower, turn to “HIGH” and adjust it to rated speed (rated frequency). (See 4.8.2)

③ While watching the voltmeter“8”, turn the voltage adjuster“9”knob to set the voltage to the rated. (See 4.8.2)

④ Output display lamp “10” is displayed in accordance with the selected output. 200V output lamp glows in green, and 400V lamp in red.

<Loaded operation>

① Switch circuit breaker (dedicated to single phase) “1”or circuit breaker“2” “ON”, then supply power to the load.

② During operation, check and confirm whether the generator functions properly, according to the table on next page.

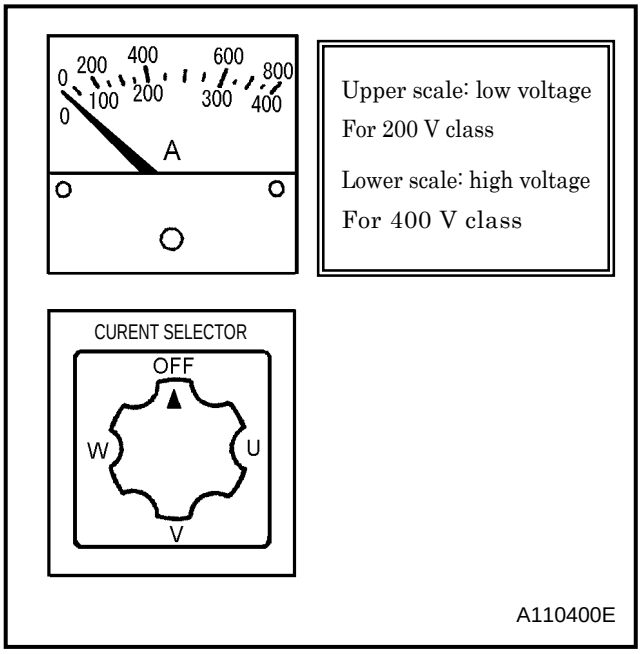
※ Before starting to supply power to the load, make sure that the voltage is in accordance with the load.

4.8.2 Gauge indication while operating

- During normal operation, each indication of instruments is shown in the table below. Refer to the table for daily checks.

		Voltmeter (V)	Frequency meter (Hz)	Ammeter (A)	Monitor lamp						Indicator lamp	
					Engine oil pressure	Water temp.	Charge	Air filter	Engine warning	Engine emergency	Over speed	Leak
Before Starting up	Starter switch (RUN)	0	0	0	● Off	● Off	☼ On	● Off	☼ On	☼ On	● Off	● Off
During operation (Full load)	50Hz	200 /400	50	577 /289	● Off							
	60Hz	220 /440	60	577 /289								
During operation (Unload)	50Hz	200 /400	52.5	0								
	60Hz	220 /440	62.5									

- Be sure to check at times to see if gauges or each component of the unit are properly working, or if there is any air-leak, oil-leak, water-leak or fuel-leak etc.
- The table above gives standard values. They may vary slightly depending on the operating conditions and other factors.
- In single-phase load operation, check the current of U, V, and W phase with the ammeter, by turning the current selection switch.
  When each current is unbalanced, change load connections so that the current of U, V, and W, can be equally balanced. Also make sure that the current of each phase does not exceed the rated one.



4.8.3 Panel light

- The instruments are provided with transmission type illuminators. Switch “ON” the panel light so that they may light on.
- When illumination is not necessary, turn “OFF” the light. (If the machine is always operated with the lamp switched “ON”, the lamp life can be shortened.)

4.8.4 Stopping procedures

<Procedure>

① Set the circuit-breaker on the instrument panel of the machine to "OFF" position.

② After about five minutes' cooling down operation, turn the starter switch to "STOP" position.

4.8.5 Operating procedures when engine fails to start up on first attempt

- When the engine fails to start up even following the start-up procedures, do not keep the starter running, but set the starter switch back to "STOP" and wait about 30 seconds. Then, repeat the start-up procedure once again.
- If the repeated procedure does not allow the engine to run, the following causes are suspected. Therefore, check the following:
- No fuel
- Clogging of fuel filter
- Discharge of battery (Low cranking speed)

4.8.6 Fuel line air bleeding device

If the unit runs out of fuel, bleed the air, according to the following procedures.

<Procedure>

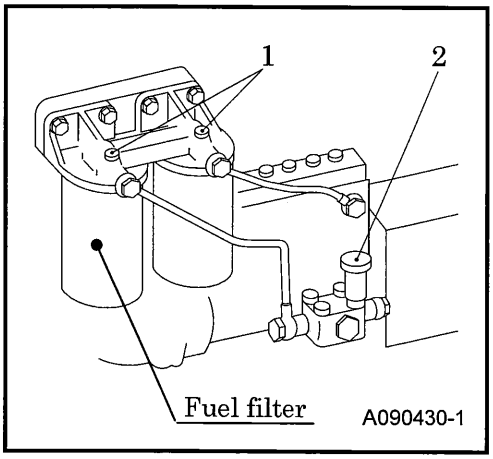
① Loosen air vent plug "1" (2 places).

② Loosen priming pump knob "2" and move the pump up and down to draw off fuel until air ceases to come out of plug "1" (2 places).

③ Tighten up air vent plug "1" (2 places).

④ Push in priming pump knob "2" and tighten it.

- When replacing fuel filter cartridge, see 5.5.8.



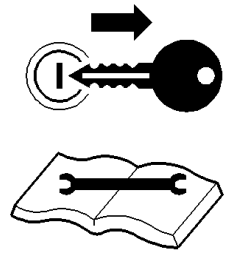
5. Periodic Inspection/Maintenance

5.1 Important Items at Periodic Inspection and Maintenance or after Maintenance

The following table shows the inspection and maintenance intervals under normal operation conditions. When used or operated under hard environmental conditions, it is impossible to warrant the unit even if the above conditions are performed according to the intervals listed in the above table.

WARNING — ***Hang a "Now Checking and under Maintenance" tag***

- Remove the starter key from the starter switch before starting inspection, and hang up a "Now Checking and under Maintenance" tag where it can be easily seen. The checker must keep the key during checking and maintenance.
- Remove the negative (-) side cable from the battery. If the above procedure is neglected, and should another person start operating the machine during check or maintenance, it could cause serious injury.
- Be sure to use appropriate tools for inspection and maintenance work. Inappropriate tools could cause unexpected injury.



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IMPORTANT — ***Precaution for check and maintenance***

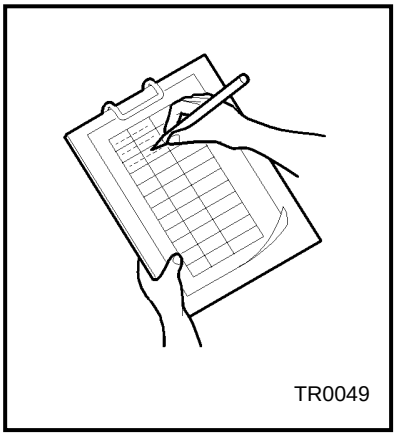
- Be sure to use recommended fuel, oil, grease, or antifreeze.
- Do not disassemble or adjust engine, compressor or part(s) for which inspection or maintenance is not referred to in this manual.
- Use genuine parts for replacement.
- Any breakdown, caused by using unapproved parts or by wrong handling, will be out of the scope of "WARRANTY".
- Do not pour water or steam on electrical components.
- Place a container or a pan underneath the oil port to receiver waste liquid so that such liquid cannot be spilt out on the floor or inside the machine.
- Be sure that no waste liquid is disposed of on the ground. Such waste on the ground, river or lake will cause serious environmental contamination. Be sure to follow the local regulations. If harmful material such as oil, antifreeze solution or filters are disposed of incorrectly, the responsible person should be punished by the authority.
- Observe local regulations when disposing of such toxic materials as oil, fuel, coolant (anti-freeze), filters, and battery etc.

5. Periodic Inspection/Maintenance

5.2 Daily Inspection and Keeping Operation Log

- Be sure to carry out daily inspection every morning before operation. See Chapter 4 "OPERATION" of the manual for the details of inspection.
- Pay attention to and carefully observe the following points during daily operation or inspection and maintenance work. If any trouble or abnormality is found, immediately investigate its cause and make repairs. If the cause is unknown or not traceable, or if the trouble involves a part or component not described in the manual, ask your nearest dealer for information.

(a) Controls and instruments function properly.
(b) Quantity and any leak of water, fuel, and oil or any contamination should be checked.
(c) Appearance, abnormal noise or excessive heat should be checked.
(d) Loose bolt or nut should be checked.
(e) Any damage, wear or shortage of machine components and parts should be checked.
(f) Performance of each part or component should be proper.


TR0049

- Keep the operation log to record constant inspection of each component, so that trouble of the machine can be easily discovered and preventive measures can be taken.
  It is very useful to record information such as frequency, temperature, current, maintenance items and replenishment of lubricant on a daily maintenance log.

5.3 Periodic Replacement of Parts

IMPORTANT — ***Use our genuine elements***

- Air filter is a crucial component for the performance and the life of a unit.
  Use genuine part for replacement.

- Part number changes upon modification. For replacement of parts, make sure whether the part number is correct or applicable.

Part Name	Part Number	Quantity
Element kit for engine oil filter	37438 08200	1
Air filter element	32143 15100	1
Fuel filter	43541 00900	2
Belt (Maine)	MITSUBISHI ME902960	1
Belt (Water pump)	MITSUBISHI ME900742	1
Gasket for fuel feed pump	43531 01600	2

5. Periodic Inspection/Maintenance

5.4 Periodic Inspection List

Such items marked ○ shall be carried out by customers.
For the following items or clauses marked ●, contact us directly or our distributors because they require expert technical knowledge on them.
The following table shows the intervals of inspection and maintenance under normal operation conditions. Inspection and maintenance should be done at either of the hour or the period mentioned in the remarks column, whichever comes earlier.
∗ Refer to engine operation manual for inspection and maintenance of an engine.

	Maintenance	Daily	Every 50 hours	Every 250hours	Every 500 hours	Every 1,000 hours	Page	Remarks
Generator	Check ground of machine package and leakage relay	○					4-11	
	Check leakage relay operation	○					4-13	
	Check each instrument and monitor lamp	○					4-16	
	Check insulation resistance			○			5-6	Every 2 months
	How to check thermal relay			○			5-7	Every 2 months
	Cleaning instruments in control panel	○					4-13	Cleaning should be done when needed.
Engine	Check sedimentor	○					4-11	
	Check fuel	○					4-11	
	Check engine oil level	○					4-10	
	Check coolant level	○					4-10	
	Check belt tension	○					4-12	In the case of NG, it exchanges.
	Check and clean clogging of air filter element			○			5-7	Perform cleaning when the monitor lamp glows.
	Drain fuel tank			○			5-8	
	Change engine oil		○ (First time)		○		5-4	
	Change engine oil filter		○ (First time)		○		5-5	
	Check battery electrolyte			○			5-5	
	Check specific gravity of battery electrolyte				○		5-5	
	Change fuel filter				○		5-8	
	Clean outside of radiator and inter cooler				○		5-8	Dirt condition cleans.
	Check for crack and leak on the exhaust flexible pipe				○		5-9	Every 4 months
	Change air filter element					○	5-10	
	Clean the strainer provided inside the engine feed pump					○	5-9	
	Change coolant. (LLC)						5-11	Every 2 years
	Check engine valve clearance					●		
	Adjust fuel injection nozzle					●		
	Check fuel injection timing					●		
	Clean inside the fuel tank					●		
Others	Check the terminal portion of electrical circuits and cable connections				○		5-9	Every 4 months
	Check vibration isolator rubbers					○	5-10	Every 1 year
	Check each rubber hose					○	5-10	Every 1 year

Note : The above intervals of inspection and maintenance are respectively based on the operation time of 125 hours of used per month and of 1,500 hours of use per year.

5. Periodic Inspection/Maintenance

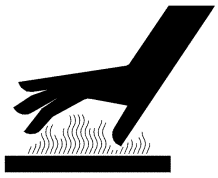
5.5 Maintenance

5.5.1 Change engine oil

[At 50 hours for the first change and every 500 hours thereafter]

⚠ CAUTION — ***Caution in filling or draining engine oil***

- When checking, replenishing, and draining the engine oil, be sure to wait 10 to 20 minutes after engine stops until it cools down.
- Engine oil is very hot and highly pressurized during or just after the operation. Hot oil could blow out and can cause injury.
- Never supply more engine oil than the proper level.
  Too much oil could cause white smoke out of the exhaust, and it can cause damage and accident to engine.



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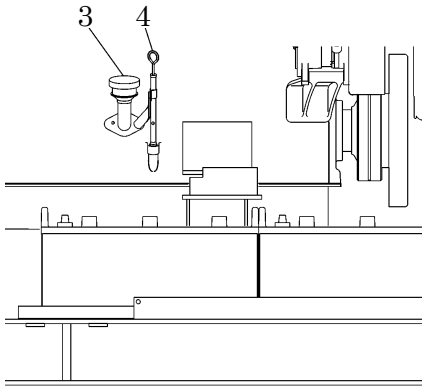
<Procedure>

① Remove the drain plug "1" attached outside the plane, open a drain valve "2" inside the plane, and discharge engine oil drain.

② When the oil is completely drained, close a drain valve "2" after attaching a drain plug "1", remove the cap of an engine oil filler port "3", refill new engine oil.

③ After finishing the oil supply, tighten the cap of oil filter port "3" firmly.

④ Please be sure to check whether engine oil is normal oil supply with an oil level gauge "4" before operating this machine.



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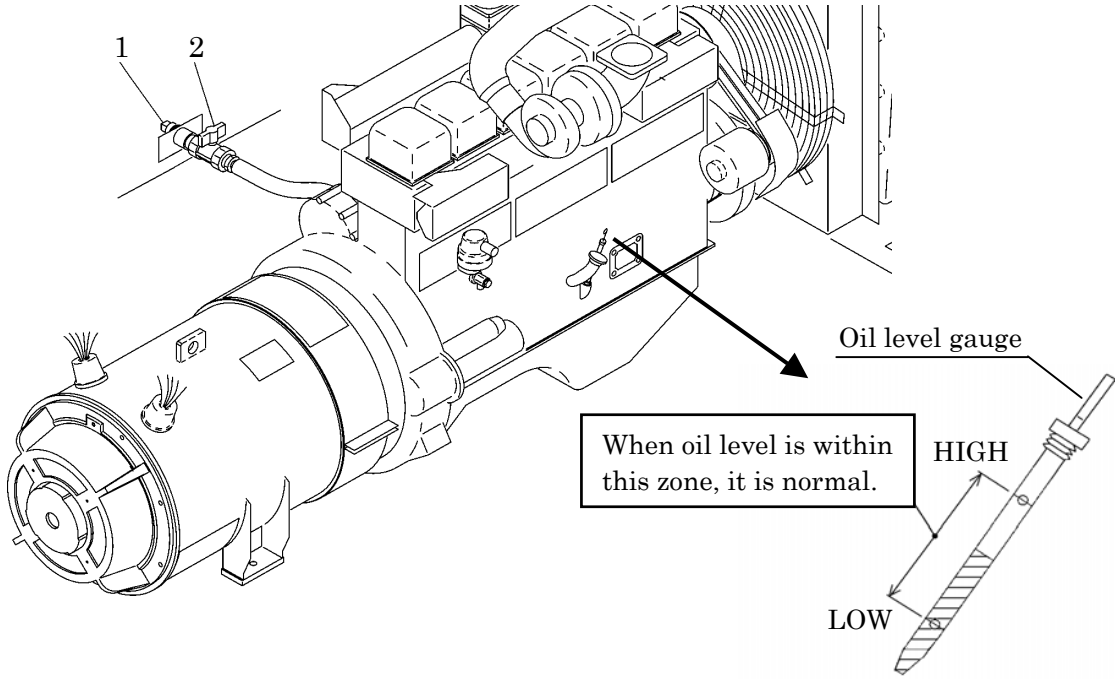

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5.5.2 Change engine oil filter

[At 50 hours for the first change and every 500 hours thereafter]

<Procedure>

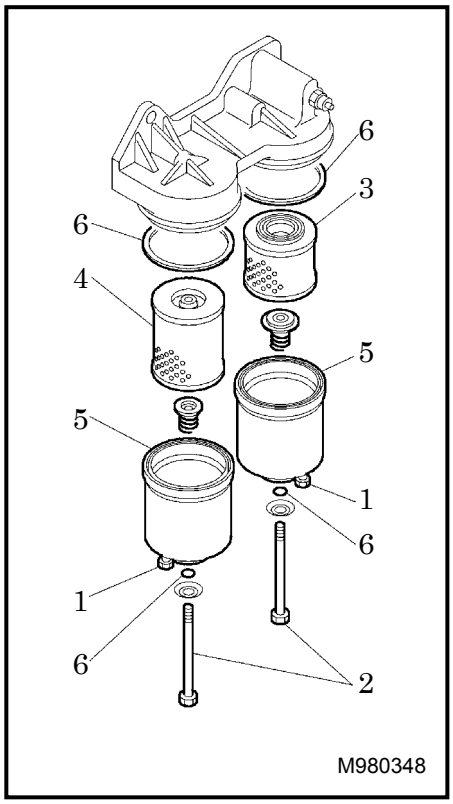
① Drain condensate from the engine oil filter by loosening the drain plug "1".

② Remove the center bolts "2" and then take out element "3" and "4".

③ Wash the element cover "5" in diesel oil.

④ Use the oil filter element kit to replace the elements "3"・"4" and also replace the O-ring "6".

⑤ Put new elements "3" and "4" in the cover and install them by tightening them with the center bolt "2".
(For replacement parts, refer to 5.3)



5.5.3 Check battery electrolyte and specific gravity of battery electrolyte

[Battery electrolyte : every 250 hours]
[Specific gravity of battery electrolyte : every 500 hours]

If there seems to be a problem in starting an engine due to a flat battery, carry out the checks by following the procedures below:

1. Ordinary type battery:

Measure specific gravity of battery electrolyte, and if it shows below 1.24, recharge the battery immediately. (See 6.1)

2. Enclosed type battery:

Check the indicator on top surface of the battery.

If the indicator shows that charge is needed, recharge the battery immediately.

5.5.4 Check insulation resistance

[Every 2 months or every 250 hours]

IMPORTANT

- Insulation resistance should be regularly checked or measured with a 500V insulation resistance meter. If it is reduced to lower than 1MΩ, it could cause an electrical leakage or a fire.
- For recovery or improvement of insulation resistance, wipe and clean dust and dirt around output terminals, circuit breaker, generator body outlet port and receptacle and dry them. Even if it carries out the above disposal, when you do not recover, contact us directly or our distributors.

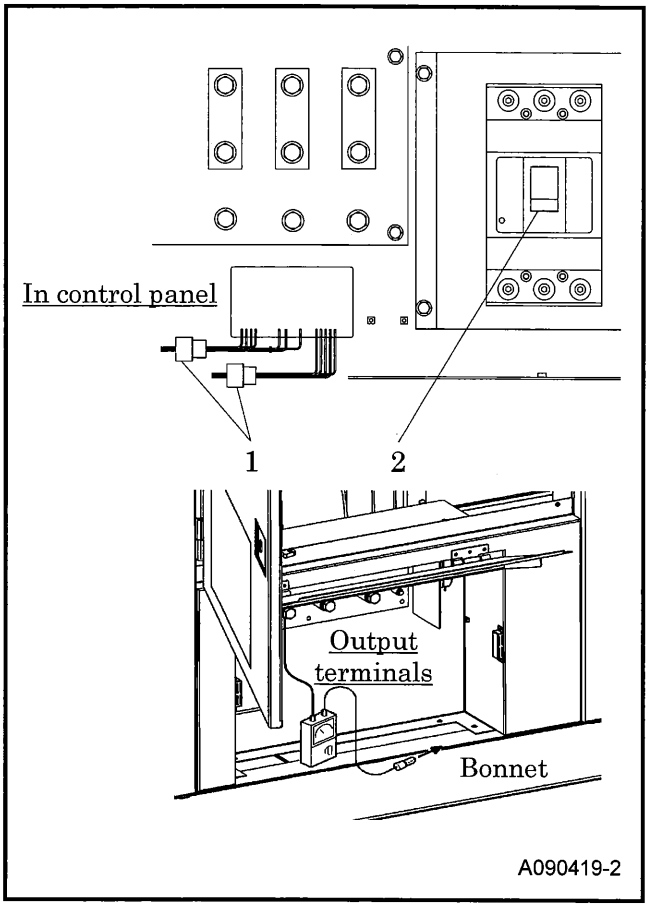
<Procedure>

① Remove the load side cable from the output terminal board.

② Remove the AVR connector "1" inside the machine control panel.

③ Switch ON the circuit breaker"2", measure each insulation resistance between the terminals U. V. W terminal and bonnet.

④ If insulation resistance value measured is found more than 1MΩ, it is good.



5.5.5 How to check thermal relay

[Every 2 months or every 250 hours]

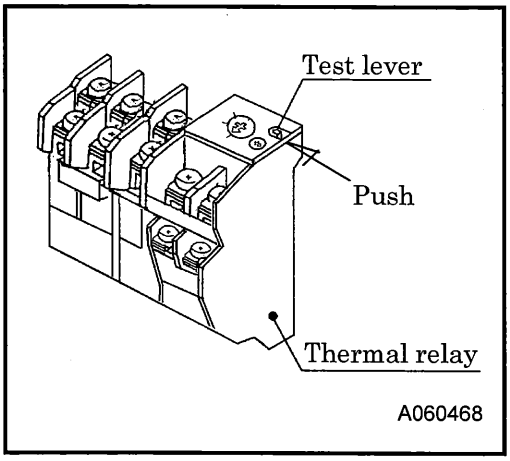
<Procedure>

① Turn the starter switch to "ON" .

② Turn the circuit breaker (dedicated to single phase) and the other breaker to "ON" .

③ Push the test lever of the thermal relay in the "arrow" direction, and then both circuit breakers can "TRIP" .

④ It is possible to return the circuit breakers to "ON" position again by placing the lever of the breakers to "OFF" position again.



5.5.6 Check and clean clogging of air filter element

[Every 250 hours]

IMPORTANT — ***Be sure to properly clean air filter element***

- When an element that is clogged or has holes or cracks is used, dust or foreign material will get in the engine. This causes accelerated wear in each sliding part of the engine. Be sure to make daily check and cleaning so that the life of the engine will not be shortened.

- When the air filter monitor lamp glows, clean the air filter.

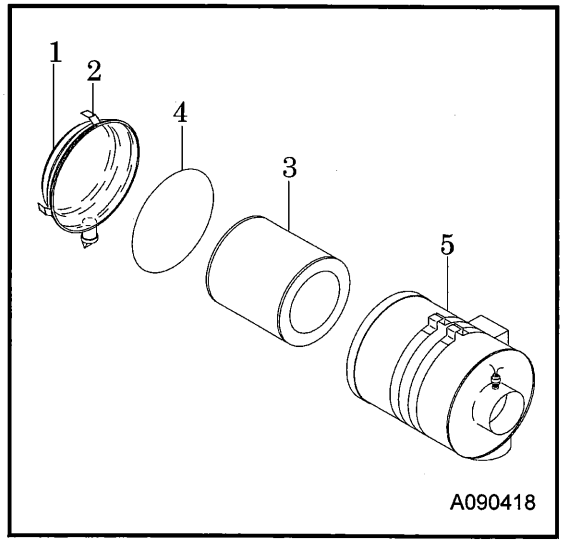
<Procedure>

① After removing the cap "1" by loosening its latch "2" , clean its interior properly.

② Remove the element "3" , and clean it.

③ When cap "1" is installed after it is cleaned, push O-ring "4" surely in case "5" so that it will not be extruded and confirm that the hook of cap fixing latch "2" is surely installed. Then tighten it.

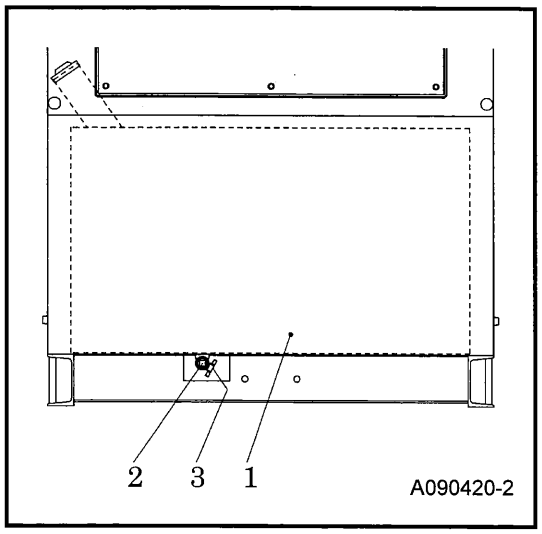
④ If the element is found heavily dusty, replace it with a new one. (For replacement parts, refer to 5.3)



5.5.7 Drain fuel tank

[Every 250 hours]

- To drain fuel tank "1", remove drain plug "2", and open drain valve "3" to drain the condensate accumulated in fuel tank "1".
- After making sure that all condensate is completely drained out, close drain valve "3" firmly and install drain plug "2".
- Drain the condensate in container, and then dispose of condensate according to the designated regulations.



5.5.8 Change fuel filter

[Every 500 hours]

<Procedure>

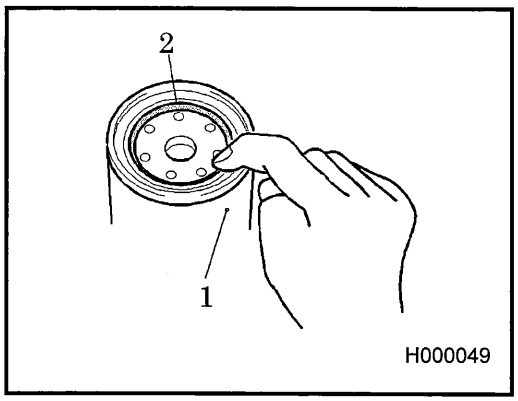
① Take out the cartridge by using a filter wrench.

② After coating fuel on the new cartridge "1" packing "2", screw it in. (For replacement parts, refer to 5.3)

③ After the packing "2" touches the sealing face, tighten another 2/3 turn with a filter wrench.

④ Bleed the air of fuel. (See 4.8.6)

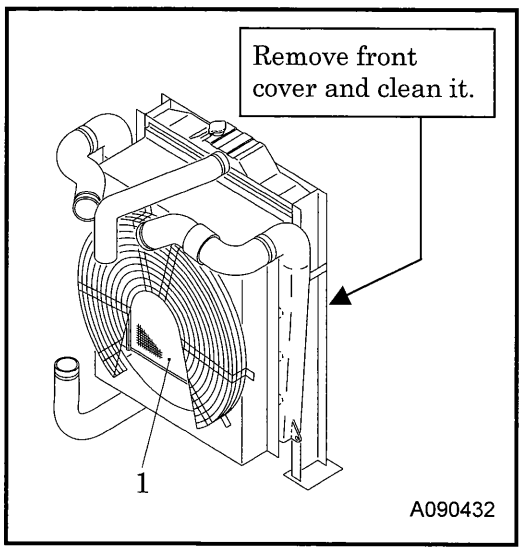
⑤ After installing a fuel filter, check for fuel leakage during operation.



5.5.9 Clean outside of radiator and inter cooler

[Every 500 hours]

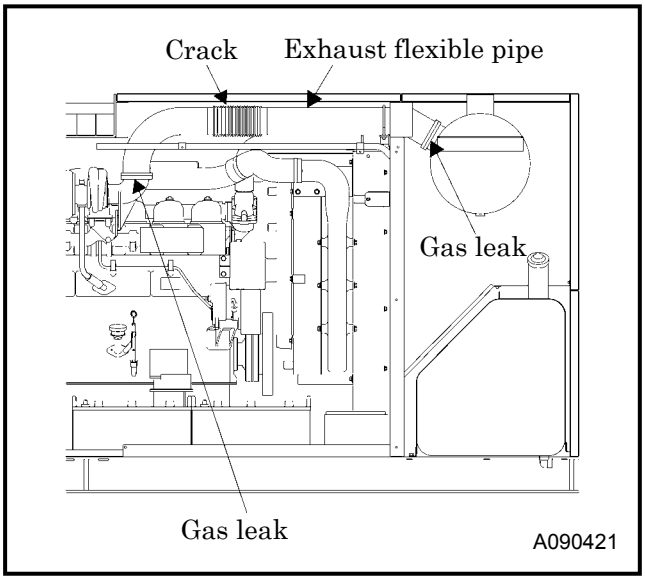
- When the fin tubes "1" of radiator and inter cooler are clogged by dust or other foreign materials, the heat exchange efficiency drops and this will raise coolant temperature. These tubes and fins should be cleaned depending on the state of dirt inside the tubes even before maintenance schedule.
- Do not use high pressure washer for washing to prevent fin tubes "1" from being damaged.
- When the unit is used, installed near seaside and on boat board, clean the radiator using fresh water more times than once a month.



5.5.10 Check for crack and leak on the exhaust flexible pipe

[Every 4 months or every 500 hours]

- Check for any crack and gas leak on the flexible pipe and exhaust between flexible pipe between engine exhaust outlet and the flexible pipe.
- If any leak is found, avoid getting burned by the exhaust gas.



5.5.11 Check the terminal portion of electrical circuits and cable connections

[Every 4 months or every 500 hours]

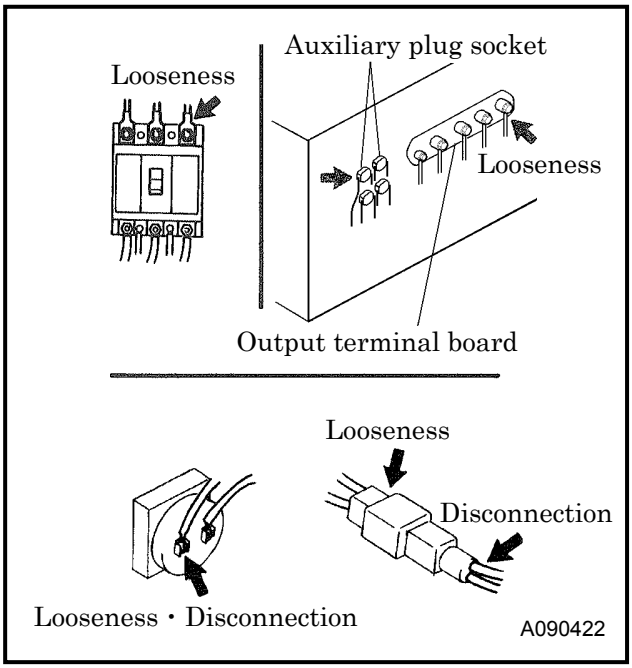
Check for any looseness on the cables and any damages on insulated covers and disconnection, disconnected cables, or short-circuit etc.

[Checking points of electrical circuits on the generator side]

- Terminal connection of three-phase output terminal plate.
- Main circuit of circuit breaker.
- Terminal connection on control box.
- Each terminal connection of each instrument.

[Checking points of electrical circuits on the engine side]

- Portion of connectors to the engine.
- Check for looseness of terminal connections.

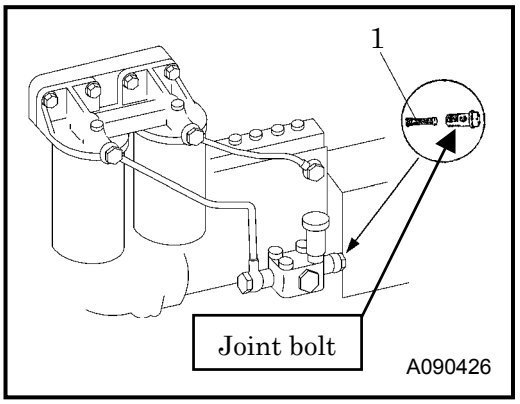


5.5.12 Clean the strainer provided inside the engine feed pump

[Every 1,000 hours]

- Periodically remove the strainer"1"inside the feed pump, and clean it.
- Remove the strainer "1" by loosening the joint bolt and clean it with diesel fuel oil, and also using high air pressure blow. At this time be sure to replace gasket. (For replacement parts, refer to 5.3)

Then after finishing all cleaning jobs, install it again in reverse steps.



5.5.13 Change air filter element

[Every 1,000 hours]

IMPORTANT ***Be sure to properly clean air filter element***

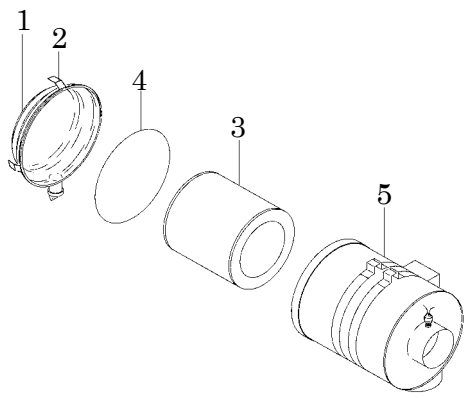
- When an element that is clogged or has holes or cracks is used, dust or foreign material will get in the engine. This causes accelerated wear in each sliding part of the engine. Be sure to make daily check and cleaning so that the life of the engine will not be shortened.

<Procedure>

① After removing the cap "1" by loosening its latch "2", clean its interior properly.

② Remove the element "3" and then replace it with a new one. (For replacement parts, refer to 5.3)

③ When cap "1" is installed after it is changed, push O-ring "4" surely in case "5" so that it will not be extruded and confirm that the hook of cap fixing latch "2" is surely installed. Then tighten it.



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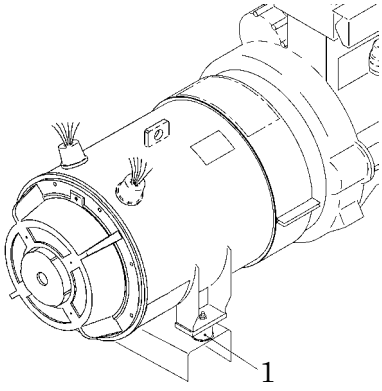
5.5.14 Check vibration isolator rubbers

[Every 1 year or every 1,000 hours]

- The vibration isolation rubber "1" is used for the support of generator and engine. Check the rubber for any damage or deterioration due to oil sticking.



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5.5.15 Check each rubber hose

[Every 1 year or every 1,000 hours]

Check all the rubber hoses for being hardened, crack and fissure.

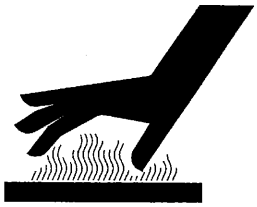
- If any hardening, crack or fissures are found on each hose (air filter, radiator, fuel and drain) replace it by a new one.
- Check each clip fixing the hoses and if any loosened hose is found, retighten it.
- Even before the periodical internal comes, replace it if any hardening, any cracks are found. When replacing it, please contact our branch office or your distributor.

5.5.16 Change coolant

[Every 2 years]

⚠ CAUTION

Upon changing coolant



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- Be sure to stop the machine and loosen the radiator cap slowly, after the coolant water is sufficiently cooled and the inner pressure is released, then take the cap off.
  If the following procedures are neglected, the radiator cap could be blown by the internal pressure or hot moisture air be blown out to cause burning. Therefore, make sure to carry out them without fail.
- LLC (Antifreeze) is a toxic material.
- If it should be swallowed by mistake, it is necessary to see a doctor immediately instead of being sent out enforcedly.
- When a person gets LLC (Antifreeze) in his eyes, wash the eyes with clean running water and make him see a doctor immediately.
- When LLC (Antifreeze) is stored, put it in a container with an indication saying "LLC (Antifreeze) inside" and seal it up, then Keep it in a place away from children.
- Beware of flames.

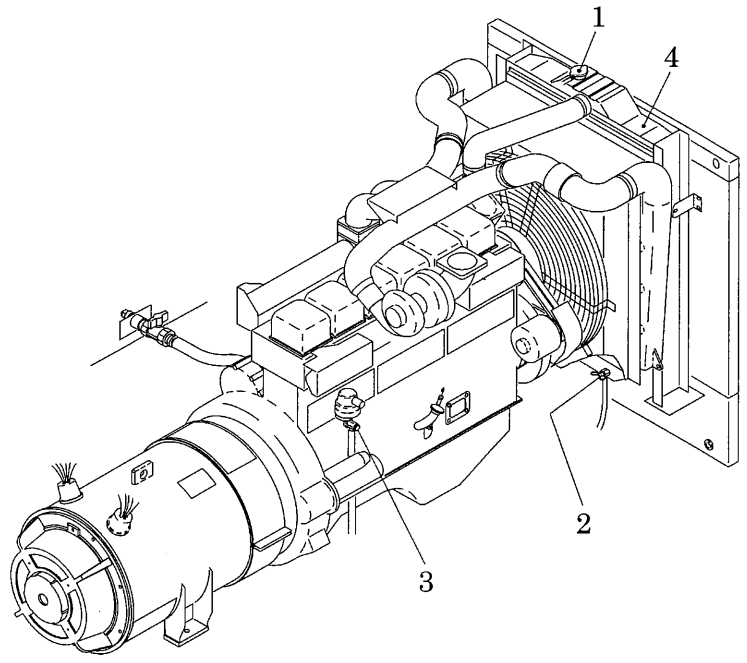
<Procedure>

① To drain coolant, remove the radiator cap "1" , then loosen the drain valve "2" .

② Be sure to also unfasten the drain plug "3" on the engine cylinder block for drainage.

③ When the coolant is completely drained out, close each drain valve "2" and drain plug "3" , and supply new coolant from the filler port of radiator "4" .

④ After changing the coolant, run the engine under unload operation for 2 to 3 minutes, then stop it. Check the coolant level again and replenish it if necessary.



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5. Periodic Inspection/Maintenance

5.6 Periodical Load Operation to be Performed

[Check and inspection upon each occurrence of the following phenomena]

When a diesel engine driven generator is continuously operated with less than 30% load or no load for a long time, carbon will be stuck inside exhaust pipe, exhaust muffler and engine body and also unburned fuel will come out from connected portion of exhaust pipe and outlet port of exhaust muffler. If it is continuously operated under the conditions, the fuel which comes out can ignite and it could cause a fire.

Further, carbon sticking and carbon accumulated could cause power drop of the engine and also it could cause overheating to the engine, resulting a serious damage to the engine. In case that this phenomena occurs, eliminate the carbon accumulated by burning it during the operation with a load burdened until the exhaust gas becomes almost clear.
(For load current, refer to the following table as a standard value.)

⚠ CAUTION

- In case of load operation, increase load factor, checking the conditions of exhaust.
  Carefully perform load operation, watching the surroundings because it could sometimes cause sparks.

Frequency	Hz	50		60	
Rated voltage	V	200	380/400	220	440
Load current	A	460	240/230	460	230

6. Maintenance/Adjustment

6.1 Maintenance of Battery

⚠ DANGER

Handling battery

- Keep flames away from battery.
- Battery may generate hydrogen gas and may explode. Therefore, recharging should be done at a well-ventilated place.
- Do not spark near the battery nor light a match, nor bring lit cigarette and match close to the battery.
- Do not check the battery by short-circuiting the positive and negative terminals with a metallic piece.
- Never operate the machine nor charge the batteries with the battery liquid level being kept lower than the “LOWER” level. Continuing operation at this lower level will cause deterioration of such parts as pole plates etc., and also it may cause explosion as well as reduction of battery life.
  Add distilled water so that the liquid level may reach the middle level between the “UPPER” and “LOWER” level without any delay.
- Do not charge the frozen battery. Otherwise it may explode. If the battery is frozen, warm it up until the battery temperature becomes 16°C to 30°C.
- Battery electrolyte is dilute sulfuric acid.
  In case of mishandling, it could cause skin burning.
- Wear protective gloves and safety glasses when handling a battery.
- When such battery electrolyte contacts your clothes or skin, wash it away with large amount of water immediately.
- If the battery electrolyte gets into your eyes, wash it away immediately with plenty of water and see a doctor at once, because it is feared that eyesight might be lost.
- Dispose of battery, observing local regulations.

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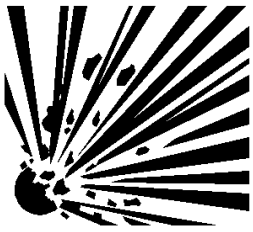

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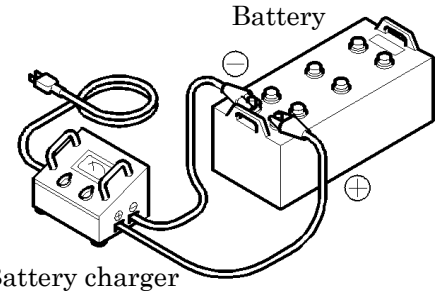
6.1.1 Charge Battery

- Disconnect the cable between battery and the unit, and charge the battery with a 12 V battery charger. Do not charge two batteries at the same time.
- Be sure not to connect (+) and (–) terminals backwards.
- Be sure to read the operation manual of the battery charger to know if it is applicable, before using it.



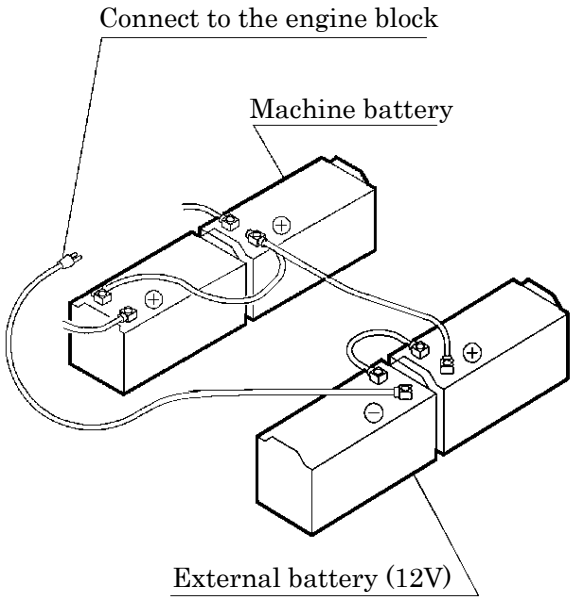
6.1.2 How to use booster cable

CAUTION ***Do not reverse the cable connection***

- When a booster cable has to be used or when cables are connected again after an battery is replaced, be careful not to connect (+) and (–) terminals backwards. Such wrong-connection will cause spark and damage to each component.

<Procedure for using a booster cable>

① Stop the engine.
② Connect one end of the (+) cable to the (+) terminal of the machine battery.
③ Connect the other end of the (+) cable to the (+) terminal of the external battery.
④ Connect one end of the (–) cable to the (–) terminal of the external battery.
⑤ Connect the other end of the (–) cable to the engine block of the machine.
⑥ Start up the engine.
⑦ Disconnect the booster cable by following the procedure back in the reverse order.



6.2 Troubleshooting

- Should any trouble occur during operation, do not leave it. Investigate the cause and take appropriate measures.
- Read the manual carefully and fully understand what to do in case of trouble.
- The better you understand the construction and function of the unit, the faster you can find a problem and solution.
- This chapter describes the state, cause and countermeasures of important troubles in detail:

Symptom	Cause	Counter measures
Starter does not rotate. Low starter revolution speed even when starting.	(1) Battery malfunction	Check Battery→Charge/Change
Starter rotates but engine does not start up.	(1) Fuel filter clogging (2) Faulty of engine control unit (3) Faulty of controller (4) No diesel fuel oil (5) Air mixing in fuel piping	Disassemble, clean, and change Call your nearest dealer Call your nearest dealer Replenish fuel Bleed air
Engine oil pressure drop monitor lamp glows.	(1) Engine oil shortage (2) Engine oil filter clogging (3) Engine oil pump malfunction (4) Oil pressure switch malfunction (5) Loosened or disconnected wiring, or connector	Replenish fuel Change Change Change Check/repair
Coolant temperature rise monitor lamp glows.	(1) Radiator clogging (2) Faulty thermostat (3) Faulty coolant temperature switch (4) Shortage of coolant (5) Slip of belt (6) Looseness, disconnection of wiring or connectors	Clean Change Change Replenish Adjust tension Check/repair
Overspeed trouble lamp blinks.	(1) Trouble of engine governor	Repair
Recharging monitor lamp glows.	(1) Alternator problem (2) Looseness, disconnection of wiring or connector	Check/change Check/repair
The monitor lamp for air filter clogging glows.	(1) Air filter clogging	Clean

Symptom	Cause	Counter measures
Circuit breaker trips.	(1) Overloaded (2) Short-circuit occurred at the load side.	Reduce the load Get rid of cause of short-circuiting.
Even when operated at a rated speed, no voltage or too low voltage generated.	(1) Faulty voltmeter (2) Poor tightening of terminals (3) Broken or short-circuited winding of generator main unit (4) Faulty AVR (5) Faulty silicon rectifier (mounted on generator main unit rotor) (6) Faulty exciter (7) Broken or short-circuited circuit to exciter field winding (8) AVR frequency selection switch is not set to meet the frequency to be operated. (9) CP1 for protection of generator functions.	Check/change Check/repair Check/repair Check/change Check/change Check/repair Check/repair Check/select Reset
Too high voltage generated when set at the rated frequency (50Hz/60Hz), Voltage will not drop even when the voltage regulator controlling knob is turned.	(1) Loosened or disconnected wiring, or connector to AVR (2) Faulty AVR (3) Broken wire or poor contact of AVR variable resistor	Check/repair Check/change Repair or change
Unstable voltage generation	(1) Poor tightening of each terminal (2) Faulty AVR (3) Function circuit protector (CP) for AVR protection	Check/repair Check/change Reset

- Please contact your nearest dealer if you find it difficult to repair by yourselves.
- Please refer to the engine operation manual for troubles concerning the engine.

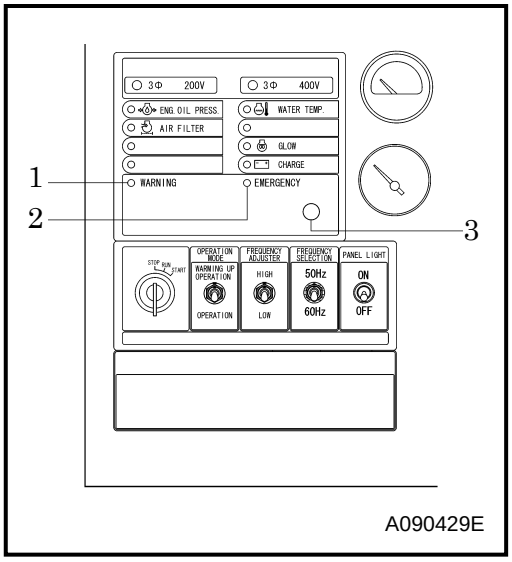
6.2.1 Engine trouble

- This is equipped with controller which memorizes engine troubles. When engine fails, warning lamp "1" or emergency lamp "2" goes on.
  For the details of the troubles, press trouble diagnosis switch"3"and then the trouble conditions are displayed.

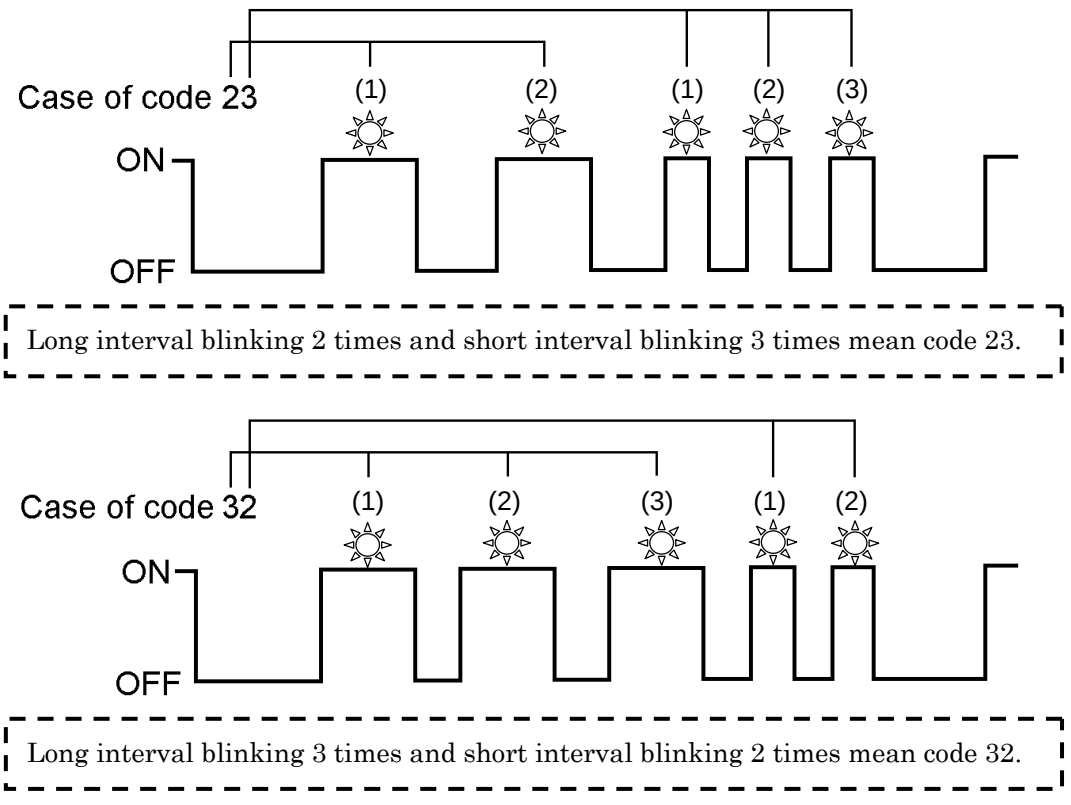
<Procedure>

① Turn starter switch to "RUN" position. When anything abnormal is not found, both warning lamp "1" and emergency lamp "2" goes on. (They go out soon after engine starts.)

② When anything abnormal is found, either of the lamps goes on. So continue pressing trouble diagnosis switch "3". Trouble conditions are displayed in the flashing pattern warning lamp or emergency lamp.



[Examples of reading and confirming diagnostic codes]



Long interval blinking : approx. 1.2 seconds
Short interval blinking : approx. 0.4 seconds

[List of diagnostic codes]

Some examples of diagnostic codes are mentioned in the following table.
Concerning the codes of trouble conditions, they are grouped into decades of the trouble kinds.
For the details and countermeasures, contact our office nearby or distributor because technical knowledge is required.

Code	Items to be detected	Monitor lamp	Details
01	Normal	-	No abnormality
07	Engine overruns	Emergency lamp	Engine excessive rotation
11	Governor servo system	Emergency lamp	Control rack position sensor fails.
14	Timing sensor	Warning lamp	Disconnection/short circuit of harness between ECU and engine speed sensor 2
15	NE sensor	Warning lamp	Disconnection/short circuit of harness between ECU and engine speed sensor 1
14+15	Both revolution sensors	Emergency lamp	Disconnection/short circuit of harness between ECU and engine speed sensor 1,2
16	Accelerator sensor 2	-	Disconnection/short circuit between ECU and accel position sensor 2
17	Electro timer control system	Warning lamp	Timer control valve fails. Engine oil pressure system fails.
19	Atmospheric pressure sensor	-	Atmospheric pressure sensor fails
21	Water temperature sensor	-	Disconnection/short circuit of harness between ECU and water temperature sensor
22	Rack sensor	Emergency lamp	Control rack position sensor fails
23	Timer control valve	Warning lamp	Disconnection/short circuit of harness between ECU and timer control valve
24	Accelerator sensor 1	-	Disconnection/short circuit between ECU and accel position sensor 1
24+16	Accelerator sensor 1, 2 fail At same time	Warning lamp	Disconnection/short circuit of ECU and accel position sensor 1,2 at same time
32	Boost sensor	Warning lamp	Disconnection/short circuit of harness between ECU and boost pressure sensor
33	System error	Emergency lamp	ECU fails
34	Q tone resistance	-	Disconnection/short circuit of harness between ECU and injection adjusting resistance
45	Engine runs reverse	Emergency lamp	Detect RPM with starter switch OFF
78	Heater relay	Warning lamp	Disconnection/short circuit of harness between ECU and heater relay
81	Water temperature rises	Emergency lamp	Overheating. Shortage of coolant
82	Oil pressure drops	Emergency lamp	Shortage of engine oil Engine lubrication system clogged

7. Storage of the Unit

7.1 Preparation for Long-term Storage

When the unit is left unused or not operated longer than half a year (6 months), store it at the dry place where no dust exists after the following treatments have been done to it.

- Put the unit in a temporary cabin if it is stored outside. Avoid leaving the unit outside with a sheet cover directly on the paint for a long time, or this will cause rust to the unit.
- Perform the following treatments at least once every three months.

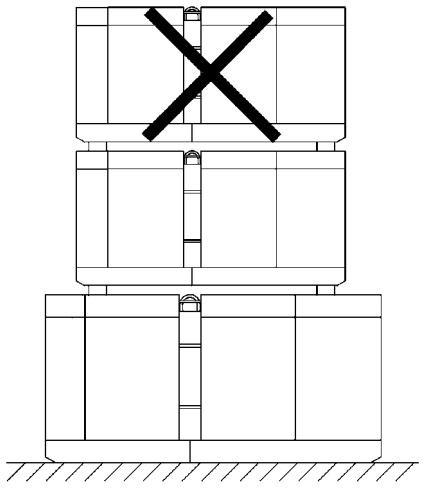
<Procedure>

① Discharge existing lubricant from the engine oil pan. Pour new lubricant in the engine to clean its inside. After running it for a while, drain it again.
② Spread lubricant on each moving part.
③ Completely charge the battery and disconnect grounding wires. Remove the battery from the unit, if possible, and store it in a dry place. (Charge the battery at least once every month.)
④ Discharge coolant and fuel from the unit.
⑤ Seal air-intake port of engine and other openings like the muffler with a vinyl sheet, packing tape, etc., to prevent moisture and dust from getting in the unit.
⑥ Measure the insulation resistance of the generator, and make sure that it is more than 1MΩ. (See 5.5.4)
⑦ Be sure to repair any trouble and maintain the unit so that it will be ready for the next operation.

⚠ WARNING

- When stacking up the machines for storage, only two units stacking is acceptable. The mass of the lower machine should be larger than that of the upper one.
- Select a leveled floor with sufficient strength.
- Before stacking the machines up, check the machine for deformation of bonnet, looseness or missing of bolts, and other parts.
- When stacking them, be sure to securely fix them as shown in the figure so that the balanced weight is applied to each squared lumber for preventing a sideslip or a collapse.
- Never operate the machines with stacking conditions. It is very dangerous.
- Machines stacked could fall down due to sideslip or collaspse when an earthquake occurs. Therefore, safety should be sufficiently considered for surroundings of storage places.

Stacking up box type machines



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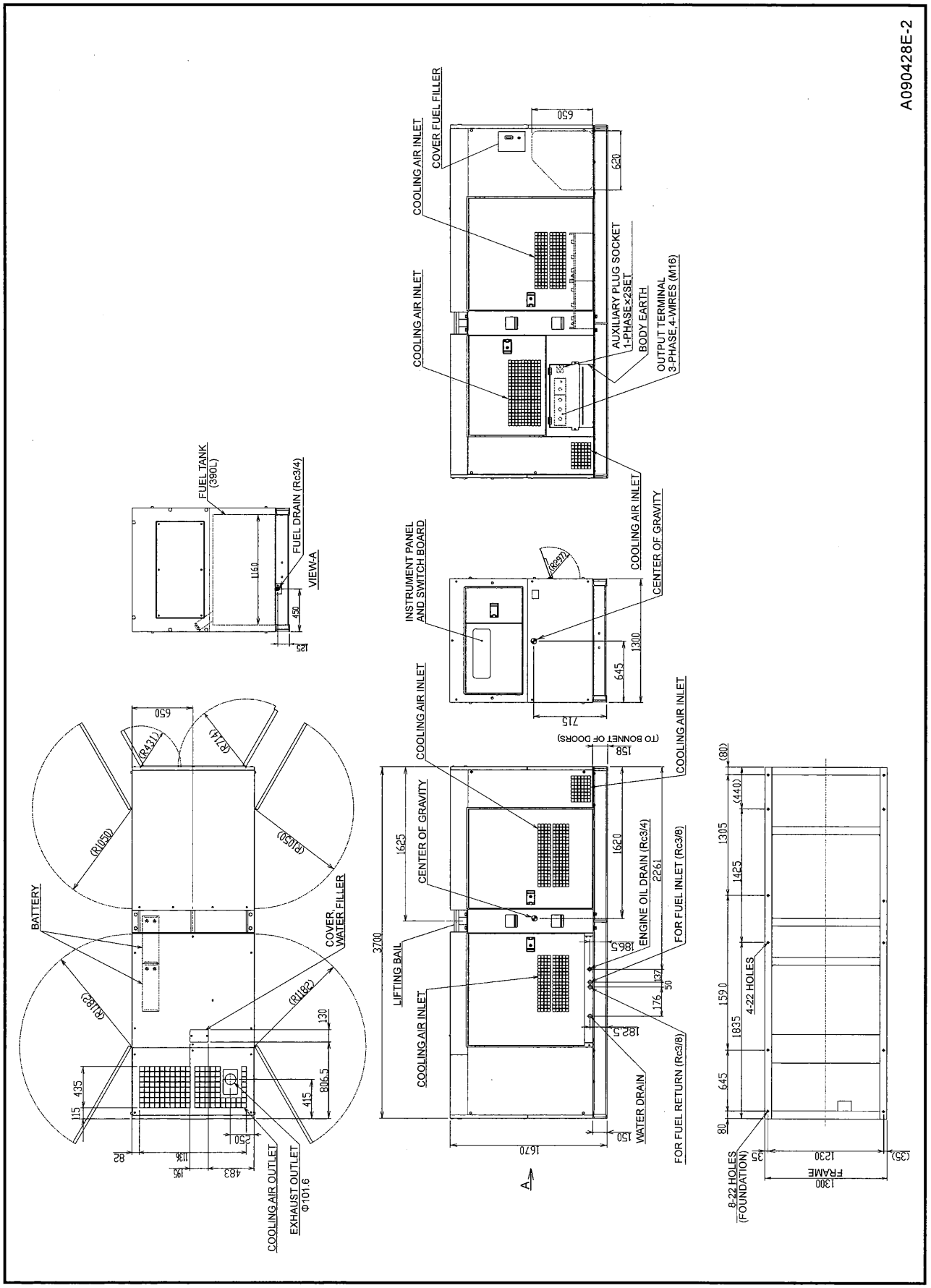
8. Specifications

8.1 Specifications

Model				SDG220S-3A6			
Specifications				Dual Voltage Type			
Generator	Exciting system			Brushless			
	Phase number			Three-phase, four-wire system			
	Power factor		%	80			
	Frequency		Hz	50		60	
	Rated output		kVA	200		220	
	Rated output		kW	160		176	
	Voltage		V	200	380/400	220	440
	Current		A	577	304/289	577	289
	Single phase output	Voltage	V	100		110	
		Outlet	kVA	1.5×2 set (4 shares in total)		1.65×2 set (4 shares in total)	
Engine	Model			MITSUBISHI FUSO TRUCK & BUS CORPORATION 6D24-TLE2B			
	Type			4-cycle, water-cooled, direct injection, turbo charged, air to air intercooled			
	Number of cylinders			6			
	Total displacement		L	11.94			
	Rated output		kW	181		199	
	Revolution per minute		min^{-1}	1,500		1,800	
	Lubricating oil capacity		L	37			
	Coolant capacity (including radiator)		L	39			
	Battery			170F51×2 (24V)			
	Fuel tank capacity		L	390			
Weight・Mass	Overall length		mm	3,700			
	Overall width		mm	1,300			
	Overall height		mm	1,670			
	Net dry mass (weight)		kg	3,240			
	Operating mass (weight)		kg	3,630			

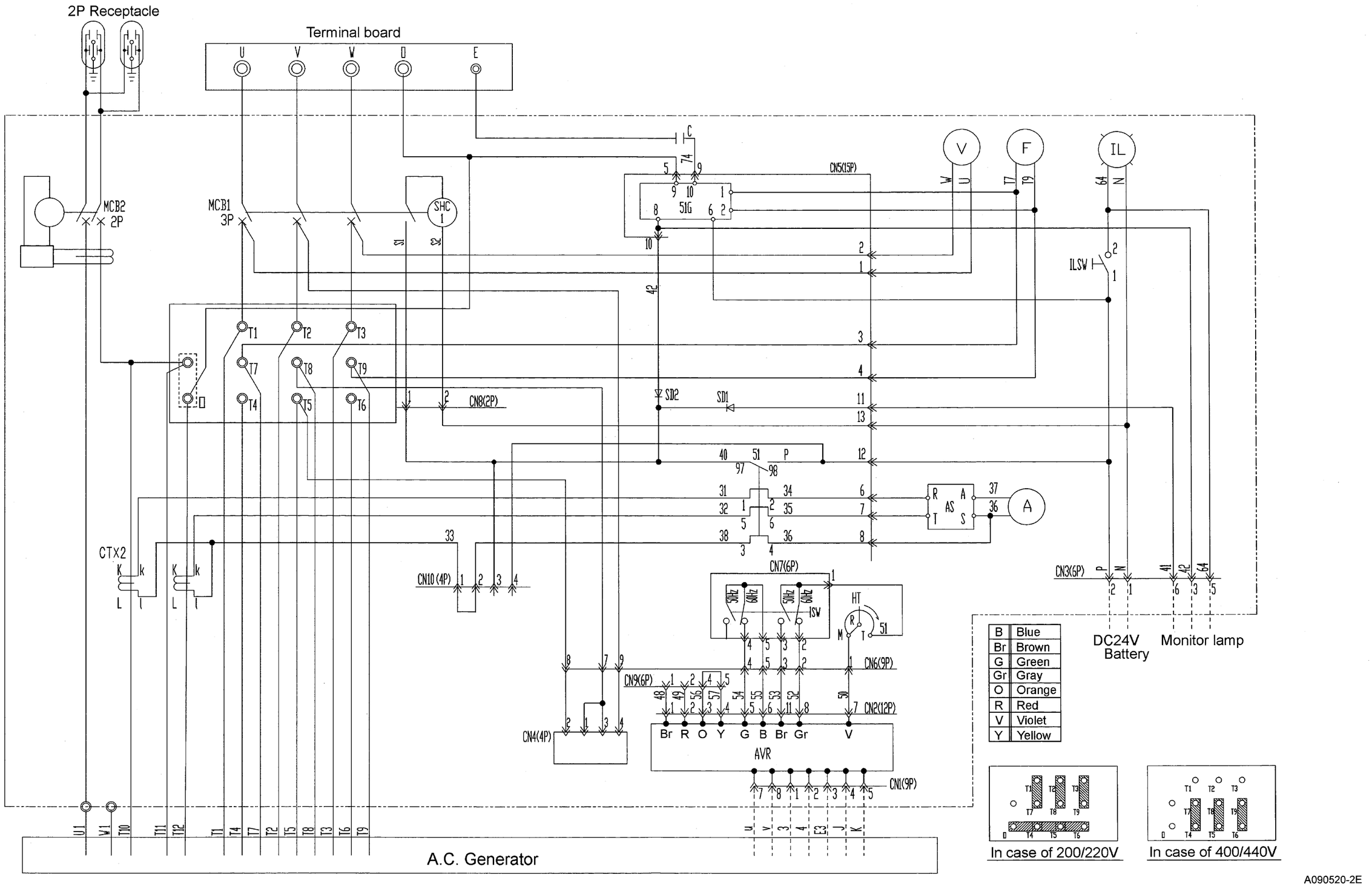
8. Specifications

8.2 Outline drawing



9. Wiring Diagram

9.1 Generator Wiring Diagram



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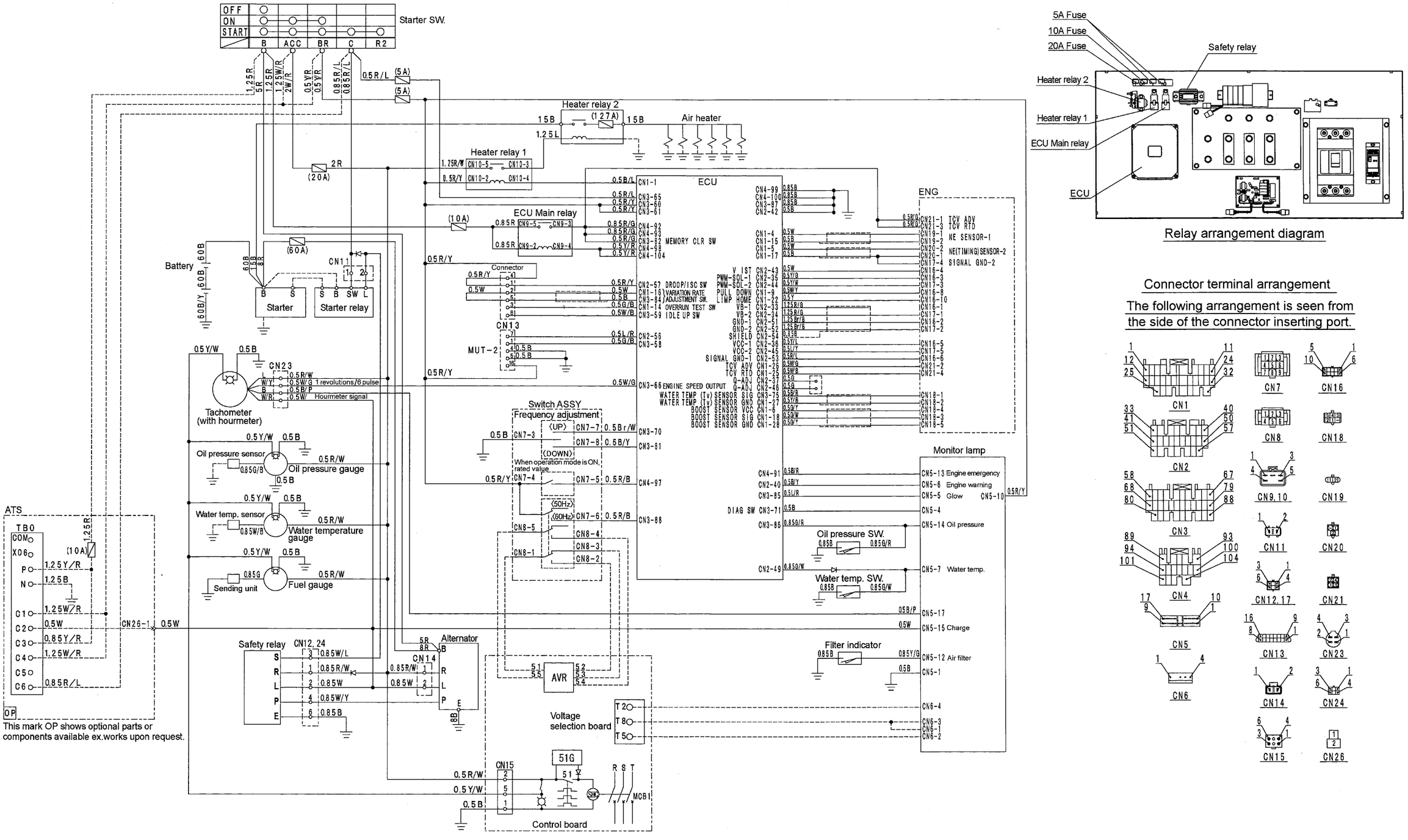
9. Wiring Diagram

9.2 Engine Wiring Diagram



Relay arrangement diagram

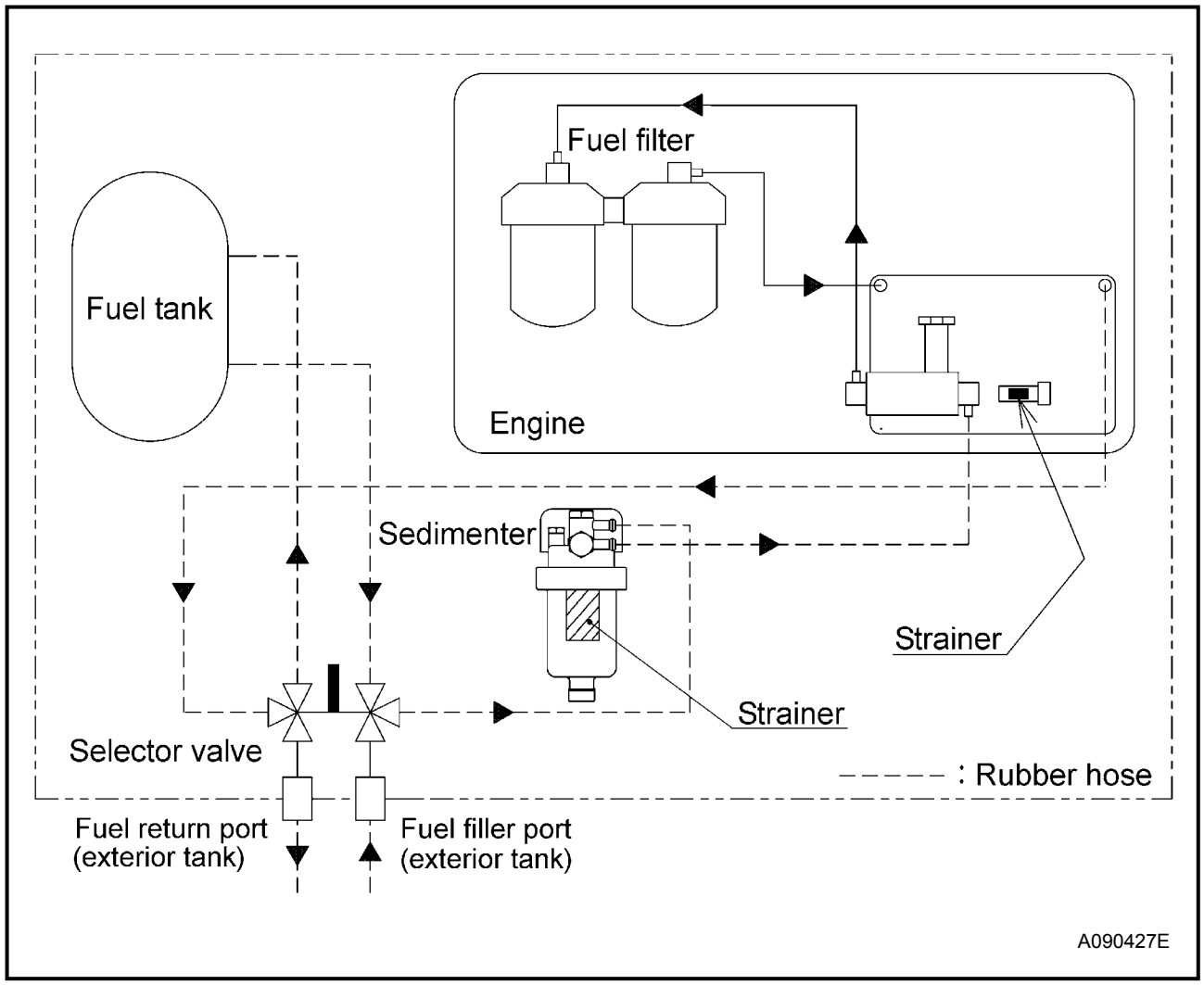
Connector terminal arrangement

The following arrangement is seen from the side of the connector inserting port.

A100151E-2

10. Piping Diagram

10.1 Fuel piping



OPERATION LOG

OPERATION DATE	OPERATION TIME		TOTAL OPERATION HOURS (h)	FREQUENCY (Hz)	OUTPUT VOLTAGE(V)	OUTPUT CURRNT(A)			AMBIENT TEMP.(℃)	COOLANT TEMP.(℃)	ENG. OIL PRESS.(kPa)	ENG.OIL REPLACEMENT HOUR (h)	REMARKS (INSPECTION/PART CHANGE HISTORY ETC.)
	START TIME	STOP TIME				U	V	W					
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