HINSHI—H10—005

YANMAR

SERVICE MANUAL

DIESEL GENERATOR

MODEL YDG series

YDG 2700E (EE)
YDG 3700E (EE)
YDG 5500E (EE)
YDG 6600TE

YANMAR DIESEL ENGINE CO.,LTD.

Publication No. HINSHI-H10-005

History of Correction				Page No.	1
Manual Name:		Yanmar Service Manual for Diesel Generator			
Engine Model:		Model YDG series			
Number of correction	Date of correction	Cause for correction	Outline of correction	Corrected item number	Corrected by:
1st	Apr. 2001	The EPA and ARB-OR certified engine installing gen.	For U.S.A. and Canada, YDG2700EE-6EH YDG3700EE-6EI YDG5500EE-6EI installing EPA and ARB-OR certified engine added.	• Corrected pages: -i-, 2-1, 6-17, 11-7, 11-9, 11-13, 11-19 11-23 and cover pages, • Added pages: -ix-, -x-, -xi-, -xii-, 3-26-2, 3-26-3, 3-41, 3-42, 11-24-2, 11-24-3 and History of correction	Quality Assurance Dept.

FOREWORD

This manual explains the service procedure for Yanmar air-cooled diesel generator model YDG series.

Please use this manual for correct, quick, safe servicing of the diesel generator sets.

For the engine servicing, refer to the Industrial Diesel Engine Model L-A Series Service Manual (Pub. No. 0000A0A5012-9108 or A0A50012T9018) or Model: L48EE · L70EE · L100EE Service Manual (Pub. No. M9961-H11310) for the EPA and ARB-OR certified engines.

Please be advised that the contents of this manual may be different from actual generator set because of any later modifications of parts or specifications for improving the generator quality.

CONTENTS

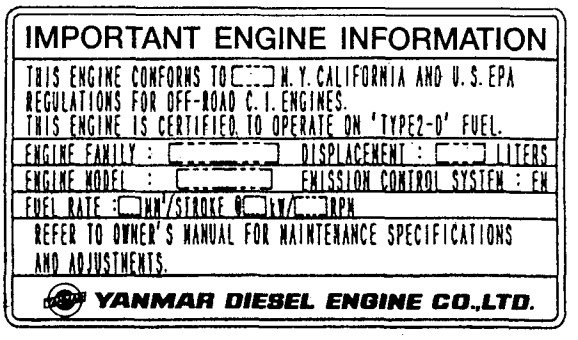
Both EPA and ARB-OR CERTIFIED ENGINE

The engines installing on the YDG air cooled diesel generator series (YDG2700EE, YDG3700EE, YDG5500EE for U.S.A. and Canade) meet the low emission standards set by EPA and ARB-OR and have the following emission control label affixed on the certified engines.

1. Engine identification

With the regulations on engine emission worldwide, it has become necessary to identify engines in a manner to determine which regulations they comply with, hence

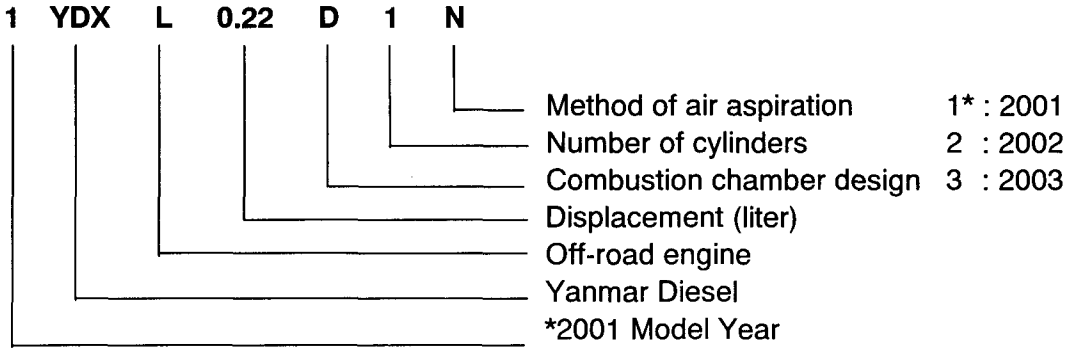
a) Emission control label as shown below which will contain:



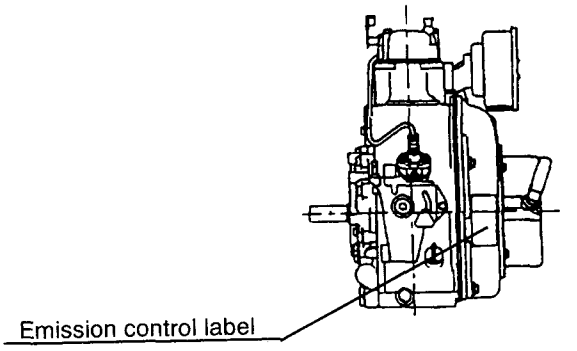
* Emission Control is accomplished through Engine Modification (EM-Design)

• Engine family name as assigned by EPA and ARB-OR identifying engine family group

1 YDXL 0.22D1N and this identifies



b) Label location:



Exhaust Gas Regulations

- This engine conforms to the EPA exhaust gas regulations for a low emission engine.

Exhaust emission	—	EPA Standard (Tier 1) (Max.)	Condition
		Constant speed (3600 rpm) (Under 8 kW)*	
NOx + NMHC	g/kWh	10.5	· EPA recommended fuel is used.
CO		8.0	
PM		1.0	

* Gross power

< Condition to Insure Compliance with EPA and ARB-OR Emission Standards >

- Fuel oil and lubricating oil
  (1) Fuel: The diesel fuel oil [ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.)]
  (2) Lube oil: API grade, class CC, SAE 10W-30.

- Do not remove the seals restricting injection quantity and engine speed.

● The EPA Regulations

The EPA regulations for non-road engines.
[Engines which will be used in the North American (U.S.A. and Canada) market]

1. Requirements on engine installation condition

The followings are required from the point of view of engine installation in order to comply with the EPA regulations. Unless otherwise satisfying these, engines exhaust gas emission will not be within the regulated value of the EPA Regulations for Non-road Engines.

1-1) Maximum exhaust gas restriction shall be
3.628 kPa (370 mmAq) or less for L48EE-DEGY6 (YDG2700EE-6EH)
3.727 kPa (380 mmAq) or less for L70EE-DEGY6 (YDG3700EE-6EI)
4.315 kPa (440 mmAq) or less for L100EE-DEGY6 (YDG5500EE-6EI)

1-2) Maximum air intake restriction shall be
0.686 kPa (70 mmAq) or less for L48EE-DEGY6 (YDG2700EE-6EH)
1.373 kPa (140 mmAq) or less for L70EE-DEGY6 (YDG3700EE-6EI)
1.471 kPa (150 mmAq) or less for L100EE-DEGY6 (YDG5500EE-6EI)

2. Emissions-related parts

The EPA regulates specific emissions-related parts are warranted for the period in the following table. However, ultimate purchasers are obligated to use and maintain the engine correctly.

Power Range kW (Gross power)	Warranty Period
Range < 19	1,500 hours or 2 years

*Actual hours or years of operation whichever occurs first is applied.

The specific emissions-related parts are 1) Fuel injection nozzle 2) Fuel injection pump

3. Maintenance schedule

To maintain optimum engine performance and compliance with the EPA Regulations Non-road Engines, it is necessary that the maintenance schedule be adhered to.

Regular scheduled maintenance is a major key to engine service life and emissions regulations compliance. It is of utmost importance that scheduled maintenance, requirements are performed on a timely basis.

● The ARB Off-Road Compression-Ignition Engine Regulations (ARB-OR)

The California Air Resources Board regulations for the off-road engines.

(Engines which will be used in the California State)

The exhaust emission regulation for the CI engines rated under 25 hp started on August 1, 1995 as the CARB-ULGE (California Air Resources Board – Utility Lawn & Garden Engines). And it has terminated on December 31, 1999. After that the SORE (Small Off-Road Engines) regulations was applied for the CI engines rated under 25 hp.

Further, the ARB-OR regulations harmonized with EPA regulations has been considered by the authority. And it has been issued and enacted on December 28, 2000 as new regulations.

1. Safety

1.1 Warning Symbols

- Most accidents are caused by negligence of basic safety rules and precautions.
  Avoiding possible cause is important for accident prevention. Be sure to read this manual carefully for full understanding of safety precautions and appropriate service/inspection procedures before starting actual repair or service jobs. Repair or service jobs without sufficient knowledge may lead to unexpected accidents.

- It is not possible to cover all possible accidents in repair or service in the manual.
  It is, therefore, necessary to pay sufficient attention to safety in various jobs not indicated with the following warning symbols and notice signs. Especially for the safety in conducting various jobs not covered herein, receive instructions from a knowledgeable leader.

- The warning symbols used in this manual and their meanings are as follows:

⚠ DANGER	**DANGER- Indicates an imminently hazardous job which, if not conducted correctly, will result in death or serious injury.**
⚠ CAUTION	**CAUTION- Indicates a potentially hazardous job which, if not conducted correctly, may result in minor or moderate injury.**

- The notice sign used in this manual and its meaning are as follows:

[NOTICE]	**NOTICE- Indicates an important point in service operation which, if not observed, the product performance and quality may be guaranteed.**

1.2 Safety Precautions

Always observe the following instructions for safe repair and maintenance jobs:

1.2.1 Service Shop (Location)

⚠ DANGER

Well-ventilated location

- Select a well-ventilated location for conducting generator operation, parts welding or polishing the paint with sandpaper.
  [Non-observance]
  Very dangerous for human health since inhalation of poisonous gas or dust is possible.

⚠ CAUTION

Sufficiently wide, flat location

- The floor of the service shop (area) for inspection and service shall be sufficiently wide and flat without any hole.
  [Non-observance]
  Dangerous since unexpected accidents such as a violent fall may occur.

⚠ CAUTION

Cleaned location arranged in good order

- The floor surface shall be free from dust, dirt or oil without any flammable substance or parts on it.
  [Non-observance]
  Unexpected accidents may arise.

⚠ CAUTION

Brightly and safely illuminated location

- The working area shall be illuminated in a safe manner with sufficient brightness. When operating in a dark place involving poor visibility, use a safe, portable flashlight. The bulb shall be covered with wire cage.
  [Non-observance]
  Accidental breaking of the bulb may cause ignition of leaking oil.

⚠ CAUTION

Location with fire-extinguishing equipment

- Always work in the neighborhood of a first aid kit and fire extinguisher in preparation for an accidental fire.

1.2.2 Working Wear

⚠ CAUTION

Wear for safe operation

- Wear protective items such as a cap, safety shoes and working wear matching the job to be done. Especially select a working wear fitting your body.

[Non-observance]
Critical accidents such as trapping in a machine may arise.

1.2.3 Tools to Be Used

⚠ CAUTION

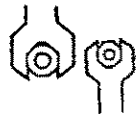
Proper supporting and lifting

- Never operate when the product is supported with blocks or wooden pieces or only with a jack. Always use a crane with sufficient allowance in limit load or with rigid jack(s) for lifting and supporting the product.

[Non-observance]
Severe accidents may arise.

⚠ CAUTION

Use of appropriate tools



- Use appropriate tolls for individual jobs. Use a correct-size tool when loosening or tightening a nut or bolt.

[Non-observance]
A sever injury or damage to a machine or part may arise.

1.2.4 Parts and Lubricants

[NOTICE]

Always use genuine items.

[Non-observance]
Shortening of the machine life or unexpected accidents may arise.

1.2.5 Bolt Tightening Torque

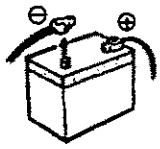
⚠ CAUTION

Always tighten to the torque specified in the manual, if any.

[Non-observance]
Loosening or falling will arise to damage the machine or parts or cause injuries.

1.2.6 Electrical Equipment

⚠ CAUTION



Harness short circuit

- Disconnect the battery negative terminal before starting maintenance operation.

  [Non-observance]

  A fire may be started by short circuit of the harness.

⚠ CAUTION

Battery charging

- Select a well ventilated location without any possible fire source when charging the battery. Never bring a fire source near the battery because flammable gas is generated during charging.

  [Non-observance]

  Generated flammable gas may be exploded.

⚠ DANGER

Battery electrolyte

- Do not let the electrolyte come into contact with your skin, eyes and clothes. Wash the electrolyte thoroughly off with water when it comes into contact with your body. If it enters your eye, immediately go to a doctor for treatment.

  [Non-observance]

  A burnt hole in your wear, blinding or scalding may occur.

1.2.7 Product Handling

⚠ CAUTION

Fuel filling

- When filling fuel, cool the engine sufficiently, keep off from a fire source, and do not spill it. Do not allow any lit cigarette or match flame approach the filling location.
  [Non-observance]
  A fire or explosion may arise.

⚠ CAUTION

Pay attention to hot parts.

- Do not touch the engine body or muffler cover during engine operation or immediately after stopping it.
  [Non-observance]
  Scalding may occur.

⚠ CAUTION

Pay attention to the rotating part.

- Do not let a wear or tool approach the rotating part during operation.
  [Non-observance]
  An injury may be caused by unexpected entrapping.

⚠ DANGER

Carefully avoid shock hazard.

- Do not let the generator be wetted or operate the generator with a wetted hand.
  [Non-observance]
  An electrical shock may be caused by a leaking current.

⚠ CAUTION

Precaution for operation

- Do not let any flammable substance like waste paper or oil approach the engine or generator during operation.
  [Non-observance]
  A fire may start.

⚠ DANGER

Precaution at starting

- Unload all connected work equipment (switch off) before starting the engine.
  [Non-observance]
  Accidents may occur due to sudden unexpected operation of the connected equipment.

[NOTICE]

Avoidance of commercial power supply connection

- Never connect to the commercial power supply.
  [Non-observance]
  The generator may be damaged.

1.2.8 Waste Disposal

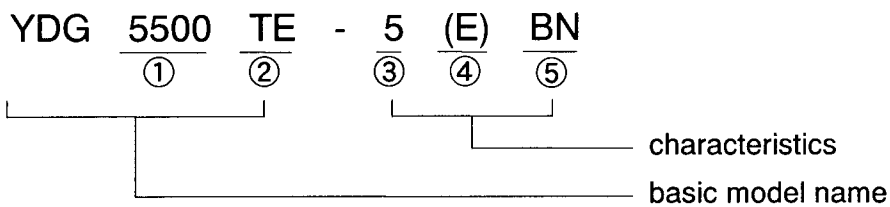
⚠ CAUTION

- Do not discharge waste oil from the machine into a sewer or river.
- Put waste oil into an appropriate container once before disposal.
- When disposing oil, grease, fuel, filter element, battery and other harmful substances, be sure to observe the applicable law and regulations.

2. Name of Generator Set

2.1 How to Read the Model Name

The model name and main specifications of the YDG series are as follows:



basic model name	①	Rated output	output at 60 Hz (W)	
	②	phase and Exh. gas emission regulations	E: Single-phase TE: Triple-phase EE: Single-phase, EPA and ARB-OR certified engine installing	
characteristics	③	Frequency	5: 50 Hz 6: 60 Hz	
	④	Starting system	E: Electric starting (No symbol: Manual starting)	
	⑤	Destination	Asia	B: Southeast Asia and Philippines C: Taiwan F: Australia
			(Saudi Arabia)	CS: Saudi Arabia
			Europe	BG: Germany, Holland and Italy BN: Norway
			America	H, I: U.S.A. and Canada

3. Outline of Generator Set

3.1 Specifications

3.1.1 Southeast Asia and Philippines

Model			Unit	YDG2700E-5B	YDG3700E-5B	YDG5500E-5B
Generator	Type		–	Revolving-field type AC generator (with brush)		
	Excitation		–	Self-excited		
	Voltage regulation		–	Automatic voltage regulator (AVR)		
	Frequency		Hz	50		
	Speed		rpm	3000		
	Rated output	AC	kVA	2.0	3.0	4.2
		DC	V-A	12-8.3		
	Rated voltage		V	220		
	Rated current		A	9.1	13.6	19.1
	Power factor		–	1.0		
	Phase		–	Single-phase		
	No. of poles		–	2		
	Type of insulation		–	E-class		
	Bearing system			Ball bearing (Grease-enclosed)		
	Output terminal	AC	–	250V / 15A, receptacle × 2		
		DC		Terminal × 1		
	Breaker	AC	–	10A (NFB)	15A (NFB)	20A (NFB)
		DC		12A (Thermal breaker)		
	Voltmeter		–	AC 300 V		
	Emergency stop system		–	Engine stop device by low level oil sensor		
	Alarm lamp		–	–		
Engine	Engine model		–	L48AE-DGY5B	L70AE-DGY5B	L100AE-DGY5B
	Type		–	Vertical, air-cooled, 4-cycle diesel engine		
	Output	Continuous rating	kW (PS) /rpm	2.8 (3.8) / 3000	4.0 (5.5) / 3000	5.6 (7.7) / 3000
		Maximum				
	Cylinder bore × Stroke		mm	70 × 55	78 × 62	86 × 70
	Displacement		liter	0.211	0.296	0.406
	Cooling system		–	Forced air-cooling		
	Lubrication system		–	Forced lubrication		
	Recommended fuel oil		–	Diesel fuel (UK, BS 2869 A1 or Equivalent)		
	Fuel tank capacity Full/Effective		liter	7.2 / 7.0	13.0 / 12.5	
	Recommended lub. oil		–	API grade CC, SAE 10W-30		
	Lub. oil capacity Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60
	Starting system		–	Recoil starter		
	Stopping system		–	Fuel oil shut-off		
	Governing system		–	All speeds by centrifugal weight		
	Air cleaner		–	Wet paper element		
	Exhaust silencer		–	Expansion type		Expansion sound absorption type
	Charging system		–	–		
Battery	Model		–	–		
	Capacity		V-AH	–		
Gen. Set	Dimension	L	mm	590	650	720
		W		416	496	480
		H		500	530	578
	Dry weight		kg	55	68	95

	Model			Unit	YDG2700E-5EB	YDG3700E-5EB	YDG5500E-5EB	YDG6600TE-5EB
Generator	Type			–	Revolving-field type AC generator (with brush)			
	Excitation			–	Self-excited			Self-and separately excited
	Voltage regulation			–	Automatic voltage regulator (AVR)			
	Frequency			Hz	50			
	Speed			rpm	3000			
	Rated output		AC	kVA	2.0	3.0	4.2	5.0 [1.7]
			DC	V-A	12-8.3			–
	Rated voltage			V	220			380 [220]
	Rated current			A	9.1	13.6	19.1	7.6 [7.6]
	Power factor			–	1.0			0.8 [1.0]
	Phase			–	Single-phase			Triple phase [Single-phase]
	No. of poles			–	2			
	Type of insulation			–	E-class			
	Bearing system				Ball bearing (Grease-enclosed)			
	Output terminal		AC	–	250V / 15A, receptacle × 2			Terminal × 4 [250V / 15A, receptacle × 1]
			DC		Terminal × 1			–
	Breaker		AC	–	10A (NFB)	15A (NFB)	20A (NFB)	8A NFB
			DC		12A (Thermal breaker)			–
	Voltmeter			–	AC 300 V			AC500V
	Emergency stop system			–	Engine stop device by low level oil sensor			
	Alarm lamp			–	–			
Engine	Engine model			–	L48AE-DEGY5B	L70AE-DEGY5B	L100AE-DEGY5B	L100AE-DEGYT5B
	Type			–	Vertical, Air-cooled, 4-cycle diesel engine			
	Output	Continuous rating		kW (PS) /rpm	2.8 (3.8) / 3000	4.0 (5.5) / 3000	5.6 (7.7) / 3000	
		Maximum						
	Cylinder Bore × Stroke			mm	70 × 55	78 × 62	86 × 70	
	Displacement			liter	0.211	0.296	0.406	
	Cooling system			–	Forced air-cooling			
	Lubrication system			–	Forced lubrication			
	Recommended fuel oil			–	Diesel fuel (UK, BS 2869 A1 or Equivalent)			
	Fuel tank capacity	Full/Effective		liter	7.2 / 7.0	13.0 / 12.5		
	Recommended lub. oil			–	API grade CC, SAE 10W-30			
	Lub. oil capacity	Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60	
	Starting system			–	Starting motor (with recoil starter)		Starting motor	
	Stopping system			–	Fuel oil shut-off			
	Governing system			–	All speeds by centrifugal weight			
	Air cleaner			–	Wet paper element			
	Exhaust silencer			–	Expansion type		Expansion sound absorption type	
	Charging system			–	Flywheel dynamo			
Battery	Model			–	12N18-3	26A19L	38B20L	
	Capacity			V-AH	12-18	12-21	12-28	
Gen. Set	Dimension		L	mm	649	650	720	
			W		416	496	480	
			H		500	530	578	
	Dry weight			kg	64	80	108	

Note : [ ] are for auxiliary power

	Model			Unit	YDG2700E-6B	YDG3700E-6B	YDG5500E-6B
Generator	Type			–	Revolving-field type AC generator (with brush)		
	Excitation			–	Self-excited		
	Voltage regulation			–	Automatic voltage regulator (AVR)		
	Frequency			Hz	60		
	Speed			rpm	3600		
	Rated output		AC	kVA	2.5	3.5	5.0
			DC	V-A	12-8.3		
	Rated voltage			V	220		
	Rated current			A	11.4	15.9	22.7
	Power factor			–	1.0		
	Phase			–	Single-phase		
	No. of poles			–	2		
	Type of insulation			–	E-class		
	Bearing system				Ball bearing (Grease-enclosed)		
	Output terminal		AC	–	250V / 15A, receptacle × 2		
			DC		Terminal × 1		
	Breaker		AC	–	12A (NFB)	16A (NFB)	23A (NFB)
			DC		12A (Thermal breaker)		
	Voltmeter			–	AC 300 V		
	Emergency stop system			–	Engine stop device by low level oil sensor		
	Alarm lamp			–	–		
Engine	Engine model			–	L48AE-DGY6B	L70AE-DGY6B	L100AE-DGY6B
	Type			–	Vertical, air-cooled, 4-cycle diesel engine		
	Output	Continuous rating		kW(PS) /rpm	3.1 (4.2) / 3600	4.4 (6.0) / 3600	6.6 (9.0) / 3600
		Maximum					
	Cylinder bore × Stroke			mm	70 × 55	78 × 62	86 × 70
	Displacement			liter	0.211	0.296	0.406
	Cooling system			–	Forced air-cooling		
	Lubrication system			–	Forced lubrication		
	Recommended fuel oil			–	Diesel fuel (UK, BS 2869 A1 or Equivalent)		
	Fuel tank capacity	Full/Effective		liter	7.2 / 7.0	13.0 / 12.5	
	Recommended lub. oil			–	API grade CC, SAE 10W-30		
	Lub. oil capacity	Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60
	Starting system			–	Recoil starter		
	Stopping system			–	Fuel oil shut-off		
	Governing system			–	All speeds by centrifugal weight		
	Air cleaner			–	Wet paper element		
	Exhaust silencer			–	Expansion type		Expansion sound absorption type
	Charging system			–	–		
Battery	Model			–	–		
	Capacity			V-AH	–		
Gen. Set	Dimension		L	mm	590	650	720
			W		416	496	480
			H		500	530	578
	Dry weight			kg	55	68	95

Model			Unit	YDG2700E-6EB	YDG3700E-6EB	YDG5500E-6EB	YDG6600TE-6EB
Generator	Type		–	Revolving-field type AC generator (with brush)			
	Excitation		–	Self-excited			Self-and separately excited
	Voltage regulation		–	Automatic voltage regulator (AVR)			
	Frequency		Hz	60			
	Speed		rpm	3600			
	Rated output	AC	kVA	2.5	3.5	5.0	6.0 [2.0]
		DC	V-A	12-8.3			–
	Rated voltage		V	220			380 [220]
	Rated current		A	11.4	15.9	22.7	9.1 [9.1]
	Power factor		–	1.0			0.8 [1.0]
	Phase		–	Single-phase			Triple phase [Single-phase]
	No. of poles		–	2			
	Type of insulation		–	E-class			
	Bearing system			Ball bearing (Grease-enclosed)			
	Output terminal	AC	–	250V / 15A, receptacle × 2			Terminal × 4 [250V / 15A, receptacle × 1]
		DC		Terminal × 1			–
	Breaker	AC	–	12A (NFB)	16A (NFB)	23A (NFB)	10A NFB
		DC		12A (Thermal breaker)			–
	Voltmeter		–	AC 300 V			AC500V
	Emergency stop system		–	Engine stop device by low level oil sensor			
	Alarm lamp		–	–			
Engine	Engine model		–	L48AE-DEGY6B	L70AE-DEGY6B	L100AE-DEGY6B	L100AE-DEGYT6B
	Type		–	Vertical, air-cooled, 4-cycle diesel engine			
	Output	Continuous rating	kW (PS) /rpm	3.1 (4.2) / 3600	4.4 (6.0) / 3600	6.6 / (9.0) / 3600	
		Maximum					
	Cylinder Bore × Stroke		mm	70 × 55	78 × 62	86 × 70	
	Displacement		liter	0.211	0.296	0.406	
	Cooling system		–	Forced air-cooling			
	Lubrication system		–	Forced lubrication			
	Recommended fuel oil		–	Diesel fuel (UK, BS 2869 A1 or Equivalent)			
	Fuel tank capacity Full/Effective		liter	7.2 / 7.0	13.0 / 12.5		
	Recommended lub. oil		–	API grade CC, SAE 10W-30			
	Lub. oil capacity Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60	
	Starting system		–	Starting motor (with recoil starter)		Starting motor	
	Stopping system		–	Fuel oil shut-off			
	Governing system		–	All speeds by centrifugal weight			
	Air cleaner		–	Wet paper element			
	Exhaust silencer		–	Expansion type		Expansion sound absorption type	
	Charging system		–	Flywheel dynamo			
Battery	Model		–	12N18-3	26A19L	38B20L	
	Capacity		V-AH	12-18	12-21	12-28	
Gen. Set	Dimension	L	mm	649	650	720	
		W		416	496	480	
		H		500	530	578	
	Dry weight		kg	64	80	108	

Note : [ ] are for auxiliary power

3.1.2 Taiwan

	Model			Unit	YDG2700E-6C	YDG3700E-6C	YDG5500E-6C
Generator	Type			–	Revolving-field type AC generator (with brush)		
	Excitation			–	Self-excited		
	Voltage regulation			–	Automatic voltage regulator (AVR)		
	Frequency			Hz	60		
	Speed			rpm	3600		
	Rated output		AC	kVA	2.5	3.5	5.0
			DC	V-A	12-8.3		
	Rated voltage			V	110 / 220		
	Rated current			A	22.7 / 11.4	31.8 / 15.9	45.5 / 22.7
	Power factor			–	1.0		
	Phase			–	Single-phase		
	No. of poles			–	2		
	Type of insulation			–	E-class		
	Bearing system				Ball bearing (Grease-enclosed)		
	Output terminal		AC	–	125V / 15A, receptacle × 2, 250V / 15A, receptacle × 1,	125V / 15A, receptacle × 3, 250V / 15A, receptacle × 2	
			DC		Terminal × 1		
	Breaker		AC	–	13A (NFB)	17A (NFB)	24A (NFB)
			DC		12A (Thermal breaker)		
	Voltmeter			–	–		
	Emergency stop system			–	Engine stop device by low level oil sensor		
	Alarm lamp			–	–		
Engine	Engine model			–	L48AE-DGY6B	L70AE-DGY6B	L100AE-DGY6B
	Type			–	Vertical, air-cooled, 4-cycle diesel engine		
	Output	Continuous rating		kW(PS) /rpm	3.1 (4.2) / 3600	4.4 (6.0) / 3600	6.6 (9.0) / 3600
		Maximum					
	Cylinder bore × Stroke			mm	70 × 55	78 × 62	86 × 70
	Displacement			liter	0.211	0.296	0.406
	Cooling system			–	Forced air-cooling		
	Lubrication system			–	Forced lubrication		
	Recommended fuel oil			–	Diesel fuel (UK, BS 2869 A1 or Equivalent)		
	Fuel tank capacity	Full/Effective		liter	7.2 / 7.0	13.0 / 12.5	
	Recommended lub. oil			–	API grade CC, SAE 10W-30		
	Lub. oil capacity	Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60
	Starting system			–	Recoil starter		
	Stopping system			–	Fuel oil shut-off		
	Governing system			–	All speeds by centrifugal weight		
	Air cleaner			–	Wet paper element		
	Exhaust silencer			–	Expansion type		Expansion sound absorption type
	Charging system			–	–		
Battery	Model			–	–		
	Capacity			V-AH	–		
Gen. Set	Dimension		L	mm	590	650	720
			W		416	496	480
			H		500	530	578
	Dry weight			kg	55	68	95

Model			Unit	YDG2700E-6EC	YDG3700E-6EC	YDG5500E-6EC
Generator	Type		–	Revolving-field type AC generator (with brush)		
	Excitation		–	Self-excited		
	Voltage regulation		–	Automatic voltage regulator (AVR)		
	Frequency		Hz	60		
	Speed		rpm	3600		
	Rated output	AC	kVA	2.5	3.5	5.0
		DC	V-A	12-8.3		
	Rated voltage		V	110 / 220		
	Rated current		A	22.7 / 11.4	31.8 / 15.9	45.5 / 22.7
	Power factor		–	1.0		
	Phase		–	Single-phase		
	No. of poles		–	2		
	Type of insulation		–	E-class		
	Bearing system			Ball bearing (Grease-enclosed)		
	Output terminal	AC	–	125V / 15A, receptacle × 2, 250V / 15A, receptacle × 1,	125V / 15A, receptacle × 3, 250V / 15A, receptacle × 2	
		DC		Terminal × 1		
	Breaker	AC	–	13A (NFB)	17A (NFB)	24A (NFB)
		DC		12A (Thermal breaker)		
	Voltmeter		–	–		
	Emergency stop system		–	Engine stop device by low level oil sensor		
	Alarm lamp		–	–		
Engine	Engine model		–	L48AE-DEGY6B	L70AE-DEGY6B	L100AE-DEGY6B
	Type		–	Vertical, air-cooled, 4-cycle diesel engine		
	Output	Continuous rating	kW(PS) /rpm	3.1 (4.2) / 3600	4.4 (6.0) / 3600	6.6 (9.0) / 3600
		Maximum				
	Cylinder bore × Stroke		mm	70 × 55	78 × 62	86 × 70
	Displacement		liter	0.211	0.296	0.406
	Cooling system		–	Forced air-cooling		
	Lubrication system		–	Forced lubrication		
	Recommended fuel oil		–	Diesel fuel (UK, BS 2869 A1 or Equivalent)		
	Fuel tank capacity Full/Effective		liter	7.2 / 7.0	13.0 / 12.5	
	Recommended lub. oil		–	API grade CC, SAE 10W-30		
	Lub. oil capacity Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60
	Starting system		–	Starting motor (with recoil starter)		Starting motor
	Stopping system		–	Fuel oil shut-off		
	Governing system		–	All speeds by centrifugal weight		
	Air cleaner		–	Wet paper element		
	Exhaust silencer		–	Expansion type		Expansion sound absorption type
	Charging system		–	Flywheel dynamo		
Battery	Model		–	12N18-3	26A19L	38B20L
	Capacity		V-AH	12-18	12-21	12-28
Gen. Set	Dimension	L	mm	649	650	720
		W		416	496	480
		H		500	530	578
	Dry weight		kg	64	80	108

3.1.3 Australia

Model			Unit	YDG2700E-5F	YDG3700E-5F	YDG5500E-5F
Generator	Type		–	Revolving-field type AC generator (with brush)		
	Excitation		–	Self-excited		
	Voltage regulation		–	Automatic voltage regulator (AVR)		
	Frequency		Hz	50		
	Speed		rpm	3000		
	Rated output	AC	kVA	2.0	3.0	4.2
		DC	V-A	12-8.3		
	Rated voltage		V	240		
	Rated current		A	8.3	12.5	17.5
	Power factor		–	1.0		
	Phase		–	Single-phase		
	No. of poles		–	2		
	Type of insulation		–	E-class		
	Bearing system			Ball bearing (Grease-enclosed)		
	Output terminal	AC	–	250V / 15A, receptacle × 2		
		DC		Terminal × 1		
	Breaker	AC	–	9A (NFB)	13A (NFB)	17.5A (NFB)
		DC		12A (Thermal breaker)		
	Voltmeter		–	AC 300 V		
	Emergency stop system		–	Engine stop device by low level oil sensor		
	Alarm lamp		–	–		
Engine	Engine model		–	L48AE-DGY5B	L70AE-DGY5B	L100AE-DGY5B
	Type		–	Vertical, air-cooled, 4-cycle diesel engine		
	Output	Continuous rating	kW (PS) /rpm	2.8 (3.8) / 3000	4.0 (5.5) / 3000	5.6 (7.7) / 3000
		Maximum				
	Cylinder bore × Stroke		mm	70 × 55	78 × 62	86 × 70
	Displacement		liter	0.211	0.296	0.406
	Cooling system		–	Forced air-cooling		
	Lubrication system		–	Forced lubrication		
	Recommended fuel oil		–	Diesel fuel (UK, BS 2869 A1 or Equivalent)		
	Fuel tank capacity Full/Effective		liter	7.2 / 7.0	13.0 / 12.5	
	Recommended lub. oil		–	API grade CC, SAE 10W-30		
	Lub. oil capacity Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60
	Starting system		–	Recoil starter		
	Stopping system		–	Fuel oil shut-off		
	Governing system		–	All speeds by centrifugal weight		
	Air cleaner		–	Wet paper element		
	Exhaust silencer		–	Expansion type		Expansion sound absorption type
	Charging system		–	–		
Battery	Model		–	–		
	Capacity		V-AH	–		
Gen. Set	Dimension	L	mm	590	650	720
		W		416	496	480
		H		500	530	578
	Dry weight		kg	55	68	95

Model			Unit	YDG2700E-5EF	YDG3700E-5EF	YDG5500E-5EF
Generator	Type		–	Revolving-field type AC generator (with brush)		
	Excitation		–	Self-excited		
	Voltage regulation		–	Automatic voltage regulator (AVR)		
	Frequency		Hz	50		
	Speed		rpm	3000		
	Rated output	AC	kVA	2.0	3.0	4.2
		DC	V-A	12-8.3		
	Rated voltage		V	240		
	Rated current		A	8.3	12.5	17.5
	Power factor		–	1.0		
	Phase		–	Single-phase		
	No. of poles		–	2		
	Type of insulation		–	E-class		
	Bearing system			Ball bearing (Grease-enclosed)		
	Output terminal	AC	–	250V / 15A, receptacle × 2		
		DC		Terminal × 1		
	Breaker	AC	–	9A (NFB)	13A (NFB)	17.5A (NFB)
		DC		12A (Thermal breaker)		
	Voltmeter		–	AC 300 V		
	Emergency stop system		–	Engine stop device by low level oil sensor		
	Alarm lamp		–	–		
Engine	Engine model		–	L48AE-DEGY5B	L70AE-DEGY5B	L100AE-DEGY5B
	Type		–	Vertical, air-cooled, 4-cycle diesel engine		
	Output	Continuous rating	kW (PS) /rpm	2.8 (3.8) / 3000	4.0 (5.5) / 3000	5.6 (7.7) / 3000
		Maximum				
	Cylinder bore × Stroke		mm	70 × 55	78 × 62	86 × 70
	Displacement		liter	0.211	0.296	0.406
	Cooling system		–	Forced air-cooling		
	Lubrication system		–	Forced lubrication		
	Recommended fuel oil		–	Diesel fuel (UK, BS 2869 A1 or Equivalent)		
	Fuel tank capacity Full/Effective		liter	7.2 / 7.0	13.0 / 12.5	
	Recommended lub. oil		–	API grade CC, SAE 10W-30		
	Lub. oil capacity Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60
	Starting system		–	Starting motor (with recoil starter)		Starting motor
	Stopping system		–	Fuel oil shut-off		
	Governing system		–	All speeds by centrifugal weight		
	Air cleaner		–	Wet paper element		
	Exhaust silencer		–	Expansion type		Expansion sound absorption type
	Charging system		–	Flywheel dynamo		
Battery	Model		–	12N18-3	26A19L	38B20L
	Capacity		V-AH	12-18	12-21	12-28
Gen. Set	Dimension	L	mm	649	650	720
		W		416	496	480
		H		500	530	578
	Dry weight		kg	64	80	108

3.1.4 Saudi Arabia

Model			Unit	YDG2700E- 6CS	YDG3700E-6CS	YDG5500E-6ECS
Generator	Type		–	Revolving-field type AC generator (with brush)		
	Excitation		–	Self-excited		Self-and separately excited
	Voltage regulation		–	Automatic voltage regulator (AVR)		
	Frequency		Hz	60		
	Speed		rpm	3600		
	Rated output	AC	kVA	2.5	3.5	5.0
		DC	V-A	12-8.3		
	Rated voltage		V	110 / 220		
	Rated current		A	22.7 / 11.4	31.8 / 15.9	45.5 / 22.7
	Power factor		–	1.0		
	Phase		–	Single-phase		
	No. of poles		–	2		
	Type of insulation		–	E-class		
	Bearing system			Ball bearing (Grease-enclosed)		
	Output terminal	AC	–	125V / 15A, receptacle × 2, 250V / 15A, receptacle × 1,	125V / 15A, receptacle × 3, 250V / 15A, receptacle × 2	
		DC		Terminal × 1		
	Breaker	AC	–	13A (NFB)	17A (NFB)	24A (NFB)
		DC		12A (Thermal breaker)		
	Voltmeter		–	–		
	Emergency stop system		–	Engine stop device by low level oil sensor		
	Alarm lamp		–	–		
Engine	Engine model		–	L48AE-DGY6CS	L70AE-DGY6CS	L100AE-DGY6CS
	Type		–	Vertical, air-cooled, 4-cycle diesel engine		
	Output	Continuous rating	kW (PS) /rpm	3.1 (4.2) / 3600	4.4 (6.0) / 3600	6.6 (9.0) / 3600
		Maximum				
	Cylinder bore × Stroke		mm	70 × 55	78 × 62	86 × 70
	Displacement		liter	0.211	0.296	0.406
	Cooling system		–	Forced air-cooling		
	Lubrication system		–	Forced lubrication		
	Recommended fuel oil		–	Diesel fuel (UK, BS 2869 A1 or Equivalent)		
	Fuel tank capacity Full/Effective		liter	7.2 / 7.0	13.0 / 12.5	
	Recommended lub. oil		–	API grade CC, SAE 10W-30		
	Lub. oil capacity Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60
	Starting system		–	Recoil starter		Starting motor
	Stopping system		–	Fuel oil shut-off		
	Governing system		–	All speeds by centrifugal weight		
	Air cleaner		–	Wet paper element		
	Exhaust silencer		–	Expansion type		Expansion sound absorption type
	Charging system		–	–		Flywheel dynamo
Battery	Model		–	–		38B20L
	Capacity		V-AH	–		12-28
Gen. Set	Dimension	L	mm	590	650	720
		W		416	496	499
		H		500	530	634
	Dry weight		kg	55	68	110

3.1.5 Germany, Holland and Italy

Model			Unit	YDG2700E-5BG	YDG3700E-5BG	YDG5500E-5BG
Generator	Type		–	Revolving-field type AC generator (with brush)		
	Excitation		–	Self-excited		
	Voltage regulation		–	Automatic voltage regulator (AVR)		
	Frequency		Hz	50		
	Speed		rpm	3000		
	Rated output	AC	kVA	2.0	3.0	4.2
		DC	V-A	12-8.3		
	Rated voltage		V	230		
	Rated current		A	8.7	13.0	18.3
	Power factor		–	1.0		
	Phase		–	Single-phase		
	No. of poles		–	2		
	Type of insulation		–	E-class		
	Bearing system			Ball bearing (Grease-enclosed)		
	Output terminal	AC	–	250V / 16A, receptacle × 2		
		DC		Terminal × 1		
	Breaker	AC	–	10A (NFB)	15A (NFB)	20A (NFB)
		DC		12A (Thermal breaker)		
	Voltmeter		–	AC 300 V		
	Emergency stop system		–	Engine stop device by low level oil sensor		
	Alarm lamp		–	–		
Engine	Engine model		–	L48AE-DGY5BG	L70AE-DGY5BG	L100AE-DGY5BG
	Type		–	Vertical, air-cooled, 4-cycle diesel engine		
	Output	Continuous rating	kW (PS) /rpm	2.8 (3.8) / 3000	4.0 (5.5) / 3000	5.6 (7.7) / 3000
		Maximum				
	Cylinder bore × Stroke		mm	70 × 55	78 × 62	86 × 70
	Displacement		liter	0.211	0.296	0.406
	Cooling system		–	Forced air-cooling		
	Lubrication system		–	Forced lubrication		
	Recommended fuel oil		–	Diesel fuel (UK, BS 2869 A1 or Equivalent)		
	Fuel tank capacity Full/Effective		liter	7.2 / 7.0	13.0 / 12.5	
	Recommended lub. oil		–	API grade CC, SAE 10W-30		
	Lub. oil capacity Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60
	Starting system		–	Recoil starter		
	Stopping system		–	Fuel oil shut-off		
	Governing system		–	All speeds by centrifugal weight		
	Air cleaner		–	Wet paper element		
	Exhaust silencer		–	Expansion type		Expansion sound absorption type
	Charging system		–	–		
Battery	Model		–	–		
	Capacity		V-AH	–		
Gen. Set	Dimension	L	mm	590	650	720
		W		416	496	480
		H		500	582	578
	Dry weight		kg	55	73	95

	Model			Unit	YDG2700E-5EBG	YDG3700E-5EBG	YDG5500E-5EBG	YDG6600TE-5EBG
Generator	Type			–	Revolving-field type AC generator (with brush)			
	Excitation			–	Self-excited			Self-and separately excited
	Voltage regulation			–	Automatic voltage regulator (AVR)			
	Frequency			Hz	50			
	Speed			rpm	3000			
	Rated output		AC	kVA	2.0	3.0	4.2	5.0 [1.7]
			DC	V-A	12-8.3			–
	Rated voltage			V	230			400 [230]
	Rated current			A	8.7	13.0	18.3	7.2 [7.2]
	Power factor			–	1.0			0.8 [1.0]
	Phase			–	Single-phase			Triple phase [Single-phase]
	No. of poles			–	2			
	Type of insulation			–	E-class			
	Bearing system				Ball bearing (Grease-enclosed)			
	Output terminal		AC	–	250V / 16A, receptacle × 2			AC500V / 16A, receptacle × 1 [AC250V / 16A, receptacle × 2]
			DC		Terminal × 1			–
	Breaker		AC	–	10A (NFB)	15A (NFB)	20A (NFB)	8A (NFB)
			DC		12A (Thermal breaker)			–
	Voltmeter			–	AC 300 V			AC500V
	Emergency stop system			–	Engine stop device by low level oil sensor			
	Alarm lamp			–	–			
Engine	Engine model			–	L48AE-DEGY5BG	L70AE-DEGY5BG	L100AE-DEGY5B	L100AE-DEGYT5B
	Type			–	Vertical, Air-cooled, 4-cycle diesel engine			
	Output	Continuous rating		kW (PS) /rpm	2.8 (3.8) / 3000	4.0 (5.5) / 3000	5.6 (7.7) / 3000	
		Maximum						
	Cylinder Bore × Stroke			mm	70 × 55	78 × 62	86 × 70	
	Displacement			liter	0.211	0.296	0.406	
	Cooling system			–	Forced air-cooling			
	Lubrication system			–	Forced lubrication			
	Recommended fuel oil			–	Diesel fuel (UK, BS 2869 A1 or Equivalent)			
	Fuel tank capacity	Full/Effective		liter	7.2 / 7.0	13.0 / 12.5		
	Recommended lub. oil			–	API grade CC, SAE 10W-30			
	Lub. oil capacity	Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60	
	Starting system			–	Starting motor (with recoil starter)		Starting motor	
	Stopping system			–	Fuel oil shut-off			
	Governing system			–	All speeds by centrifugal weight			
	Air cleaner			–	Wet paper element			
	Exhaust silencer			–	Expansion type		Expansion sound absorption type	
	Charging system			–	Flywheel dynamo			
Battery	Model			–	12N18-3	26A19L	38B20L	
	Capacity			V-AH	12-18	12-21	12-28	
Gen. Set	Dimension		L	mm	649	650	720	
			W		416	496	480	
			H		500	582	578	
	Dry weight			kg	64	85	108	

Note : [ ] are for auxiliary power

3.1.6 Norway

Model			Unit	YDG6600TE-5EBN
Generator	Type		–	Revolving-field type AC generator (with brush)
	Excitation		–	Self- and separately excited
	Voltage regulation		–	Automatic voltage regulator (AVR)
	Frequency		Hz	50
	Speed		rpm	3000
	Rated output	AC	kVA	5.0 [2.8]
		DC	V-A	–
	Rated voltage		V	230 [230]
	Rated current		A	12.5 [12.5]
	Power factor		–	0.8 [1.0]
	Phase		–	Triple phase [Single-phase]
	No. of poles		–	2
	Type of insulation		–	E-class
	Bearing system			Ball bearing (Grease-enclosed)
	Output terminal	AC	–	AC250V / 16A, receptacle × 1 [AC250V / 16A, receptacle × 2]
		DC		–
	Breaker	AC	–	15A (NFG)
		DC		–
	Voltmeter		–	AC 300 V
	Emergency stop system		–	Engine stop device by low level oil sensor
	Alarm lamp		–	–
Engine	Engine model		–	L100AE-DEGYT5B
	Type		–	Vertical, air-cooled, 4-cycle diesel engine
	Output	Continuous rating	kW (PS) /rpm	5.6 (7.7) / 3000
		Maximum		
	Cylinder bore × Stroke		mm	86 × 70
	Displacement		liter	0.406
	Cooling system		–	Forced air-cooling
	Lubrication system		–	Forced lubrication
	Recommended fuel oil		–	Diesel fuel (UK, BS 2869 A1 or Equivalent)
	Fuel tank capacity Full/Effective		liter	13.0 / 12.5
	Recommended lub. oil		–	API grade CC, SAE 10W-30
	Lub. oil capacity Full/Effective		liter	16.5 / 0.60
	Starting system		–	Starting motor
	Stopping system		–	Fuel oil shut-off
	Governing system		–	All speeds by centrifugal weight
	Air cleaner		–	Wet paper element
	Exhaust silencer		–	Expansion sound absorption type
	Charging system		–	Flywheel dynamo
Battery	Model		–	38B20L
	Capacity		V-AH	12-28
Gen. Set	Dimension	L	mm	720
		W		480
		H		578
	Dry weight		kg	108

Note : [ ] are for auxiliary power

3.1.7 U. S. A. and Canada

	Model		Unit	YDG2700E-6EH	YDG3700E-6EI	YDG5500E-6EI
Generator	Type		–	Revolving-field type AC generator (with brush)		
	Excitation		–	Self-excited		
	Voltage regulation		–	Automatic voltage regulator (AVR)		
	Frequency		Hz	60		
	Speed		rpm	3600		
	Rated output	AC	kVA	2.5	3.5	5.0
		DC	V-A	12-8.3		
	Rated voltage		V	120	120 / 240	
	Rated current		A	20.8	29.2 / 14.6	41.7 / 20.8
	Power factor		–	1.0		
	Phase		–	Single-phase		
	No. of poles		–	2		
	Type of insulation		–	E-class		
	Bearing system			Ball bearing (Grease-enclosed)		
	Output terminal	AC	–	125V / 15A, receptacle × 2,	125V / 30A, receptacle (3P Type) × 2, 125V / 250V-20A, receptacle (4P Type) × 1	
		DC		Terminal × 1		
	Breaker	AC	–	21A (NFB)	16A (NFB)	22A (NFB)
		DC		12A (Thermal breaker)		
	Voltmeter		–	AC150V	AC 300 V	
	Emergency stop system		–	Engine stop device by low level oil sensor		
	Alarm lamp		–	–		
Engine	Engine model		–	L48AE-DEGY6B	L70AE-DEGY6B	L100AE-DEGY6B
	Type		–	Vertical, air-cooled, 4-cycle diesel engine		
	Output	Continuous rating	kW (PS) /rpm	3.1 (4.2) / 3600	4.4 (6.0) / 3600	6.6 (9.0) / 3600
		Maximum				
	Cylinder bore × Stroke		mm	70 × 55	78 × 62	86 × 70
	Displacement		liter	0.211	0.296	0.406
	Cooling system		–	Forced air-cooling		
	Lubrication system		–	Forced lubrication		
	Recommended fuel oil		–	Diesel fuel (UK, BS 2869 A1 or Equivalent)		
	Fuel tank capacity Full/Effective		liter	7.2 / 7.0	13.0 / 12.5	
	Recommended lub. oil		–	API grade CC, SAE 10W-30		
	Lub. oil capacity Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60
	Starting system		–	Starting motor		
	Stopping system		–	Fuel oil shut-off		
	Governing system		–	All speeds by centrifugal weight		
	Air cleaner		–	Wet paper element		
	Exhaust silencer		–	Expansion type	Expansion sound absorption type	
	Charging system		–	Flywheel dynamo		
Battery	Model		–	12N18-3	26A19L	38B20L
	Capacity		V-AH	12-18	12-21	12-28
Gen. Set	Dimension	L	mm	649	650	720
		W		416	496	480
		H		500	530	578
	Dry weight		kg	64	80	108

3.2 Performances

3.2.1 Southeast Asia and Philippines

Model			Unit	YDG2700E-5B	YDG3700E-5B	YDG5500E-5B	Remarks
Frequency under load		AC	Hz	50 ± 1			Under rated operation
Voltage under load			V	244 ± 6			
Voltage under no load				MAX 244			After warming-up
Voltage regulation range			%	7			
Waveform distortion			%	25			
Rated current		DC	A	8.3			
Voltage under load			V	11 ± 1			
Voltage under no load				MAX 20			
Frequency regulation	Instantaneous maximum speed difference		%	10			When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6			
	Recovery time		sec	5			
	Stability		Hz	±1			After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20			Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	90	92	93	Measured 1m away from external wall of generator set
Lowest starting temperature			°C	0			
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5			Under rated operation
	Lub. oil temperature		°C	110			
Oil supply interval	Fuel oil		h	6.8	9.5	6.0	Under rated operation
	Lub. oil		h	65	75	70	

Model			Unit	YDG2700E-5EB	YDG3700E-5EB	YDG5500E-5EB	YDG6600TE-5EB	Remarks
Frequency under load		AC	Hz	50 ± 1				Under rated operation
Voltage under load			V	224 ± 6			391 ± 11 [226 ± 6]	
Voltage under no load				MAX 244			MAX 426 [MAX 244]	After warming-up
Voltage regulation range			%	7				
Waveform distortion			%	25			10 [25]	
Rated current		DC	A	8.3			–	
Voltage under load			V	11 ± 1			–	
Voltage under no load				MAX 20			–	
Frequency regulation	Instantaneous maximum speed difference		%	10				When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6				
	Recovery time		sec	5				
	Stability		Hz	±1				After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20				Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	90	92	93		Measured 1m away from external wall of generator set
Lowest starting temperature			°C	-10				
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5				Under rated operation
	Lub. oil temperature		°C	110				
Oil supply interval	Fuel oil		h	6.8	9.5	6.0	5.5	Under rated operation
	Lub. oil		h	65	75	70		

Note: [ ] are for auxiliary power

Model			Unit	YDG2700E-6B	YDG3700E-6B	YDG5500E-6B	Remarks
Frequency under load		AC	Hz	60 ± 1			Under rated operation
Voltage under load			V	244 ± 6			
Voltage under no load				MAX 244			After warming-up
Voltage regulation range			%	7			
Waveform distortion			%	25			
Rated current		DC	A	8.3			
Voltage under load			V	11 ± 1			
Voltage under no load				MAX 20			
Frequency regulation	Instantaneous maximum speed difference		%	10			When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6			
	Recovery time		sec	5			
	Stability		Hz	±1			After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20			Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	91	93	93	Measured 1m away from external wall of generator set
Lowest starting temperature			°C	0			
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5			Under rated operation
	Lub. oil temperature		°C	110			
Oil supply interval	Fuel oil		h	6.5	8.0	6.0	Under rated operation
	Lub. oil		h	58	65	70	

Model		Unit	YDG2700E-6EB	YDG3700E-6EB	YDG5500E-6EB	YDG6600TE-6EB	Remarks
Frequency under load	AC	Hz	60 ± 1				Under rated operation
Voltage under load		V	224 ± 6			391 ± 11 [226 ± 6]	
Voltage under no load			MAX 244			MAX 426 [MAX 244]	After warming-up
Voltage regulation range		%	7				
Waveform distortion		%	25			10 [25]	
Rated current	DC	A	8.3			–	
Voltage under load		V	11 ± 1			–	
Voltage under no load			MAX 20			–	
Frequency regulation	Instantaneous maximum speed difference	%	10				When continuous rated output is abruptly changed to output at no load
	Steady state speed band	%	6				
	Recovery time	sec	5				
	Stability	Hz	±1				After warming-up
Permissible angle of inclination	Continuous	deg	MAX 20				Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)		dB (A)	91	93	93		Measured 1m away from external wall of generator set
Lowest starting temperature		°C	–10				
Lub. Oil characteristics	Specific lub. oil consumption	g/kW-H	1.5				Under rated operation
	Lub. oil temperature	°C	110				
Oil supply interval	Fuel oil	h	6.5	8.0	6.0	4.9	Under rated operation
	Lub. oil	h	58	65	70		

Note: [ ] are for auxiliary power

3.2.2 Taiwan

Model			Unit	YDG2700E-6C	YDG3700E-6C	YDG5500E-6C	Remarks
Frequency under load		AC	Hz	60 ± 1			Under rated operation
Voltage under load			V	112 ± 3 / 224 ± 6			
Voltage under no load				MAX 122 / 244			After warming-up
Voltage regulation range			%	7			
Waveform distortion			%	25			
Rated current		DC	A	8.3			
Voltage under load			V	11 ± 1			
Voltage under no load				MAX 20			
Frequency regulation	Instantaneous maximum speed difference		%	10			When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6			
	Recovery time		sec	5			
	Stability		Hz	±1			After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20			Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	91	93	96	Measured 1m away from external wall of generator set
Lowest starting temperature			°C	0			
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5			Under rated operation
	Lub. oil temperature		°C	110			
Oil supply interval	Fuel oil		h	6.5	8.0	6.0	Under rated operation
	Lub. oil		h	58	65	70	

Model			Unit	YDG2700E-6EC	YDG3700E-6EC	YDG5500E-6EC	Remarks
Frequency under load		AC	Hz	60 ± 1			Under rated operation
Voltage under load			V	112 ± 3 / 224 ± 6			
Voltage under no load				MAX 122 / 244			After warming-up
Voltage regulation range			%	7			
Waveform distortion			%	25			
Rated current		DC	A	8.3			
Voltage under load			V	11 ± 1			
Voltage under no load				MAX 20			
Frequency regulation	Instantaneous maximum speed difference		%	10			When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6			
	Recovery time		sec	5			
	Stability		Hz	±1			After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20			Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	91	93	96	Measured 1m away from external wall of generator set
Lowest starting temperature			°C	−10			
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5			Under rated operation
	Lub. oil temperature		°C	110			
Oil supply interval	Fuel oil		h	6.5	8.0	6.0	Under rated operation
	Lub. oil		h	58	65	70	

3.2.3 Australia

Model		Unit	YDG2700E-5F	YDG3700E-5F	YDG5500E-5F	Remarks
Frequency under load	AC	Hz	50 ± 1			Under rated operation
Voltage under load		V	244 ± 6			
Voltage under no load			MAX 264			After warming-up
Voltage regulation range		%	7			
Waveform distortion		%	25			
Rated current	DC	A	8.3			
Voltage under load		V	11 ± 1			
Voltage under no load			MAX 20			
Frequency regulation	Instantaneous maximum speed difference	%	10			When continuous rated output is abruptly changed to output at no load
	Steady state speed band	%	6			
	Recovery time	sec	5			
	Stability	Hz	±1			After warming-up
Permissible angle of inclination	Continuous	deg	MAX 20			Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)		dB (A)	90	92	93	Measured 1m away from external wall of generator set
Lowest starting temperature		°C	0			
Lub. Oil characteristics	Specific lub. oil consumption	g/kW-H	1.5			Under rated operation
	Lub. oil temperature	°C	110			
Oil supply interval	Fuel oil	h	6.8	9.5	6.0	Under rated operation
	Lub. oil	h	65	75	70	

Model			Unit	YDG2700E-5EF	YDG3700E-5EF	YDG5500E-5EF	Remarks
Frequency under load		AC	Hz	50 ± 1			Under rated operation
Voltage under load			V	244 ± 6			
Voltage under no load				MAX 264			After warming-up
Voltage regulation range			%	7			
Waveform distortion			%	25			
Rated current		DC	A	8.3			
Voltage under load			V	11 ± 1			
Voltage under no load				MAX 20			
Frequency regulation	Instantaneous maximum speed difference		%	10			When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6			
	Recovery time		sec	5			
	Stability		Hz	±1			After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20			Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	90	92	93	Measured 1m away from external wall of generator set
Lowest starting temperature			°C	-10			
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5			Under rated operation
	Lub. oil temperature		°C	110			
Oil supply interval	Fuel oil		h	6.8	9.5	6.0	Under rated operation
	Lub. oil		h	65	75	70	

3.2.4 Saudi Arabia

Model			Unit	YDG2700E-6CS	YDG3700E-6CS	YDG5500E-6ECS	Remarks
Frequency under load		AC	Hz	60 ± 1			Under rated operation
Voltage under load			V	112 ± 3 / 224 ± 6			
Voltage under no load				MAX 122/ 244			After warming-up
Voltage regulation range			%	7			
Waveform distortion			%	25			
Rated current		DC	A	8.3			
Voltage under load			V	11 ± 1			
Voltage under no load				MAX 20			
Frequency regulation	Instantaneous maximum speed difference		%	10			When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6			
	Recovery time		sec	5			
	Stability		Hz	±1			After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20			Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	91	93	96	Measured 1m away from external wall of generator set
Lowest starting temperature			°C	0		-10	
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5			Under rated operation
	Lub. oil temperature		°C	110			
Oil supply interval	Fuel oil		h	6.5	8.0	6.0	Under rated operation
	Lub. oil		h	58	65	70	

3.2.5 Germany, Holland and Italy

Model			Unit	YDG2700E-5BG	YDG3700E-5BG	YDG5500E-5BG	Remarks
Frequency under load		AC	Hz	50 ± 1			Under rated operation
Voltage under load			V	234 ± 6			
Voltage under no load				MAX 254			After warming-up
Voltage regulation range			%	7			
Waveform distortion			%	25			
Rated current		DC	A	8.3			
Voltage under load			V	11 ± 1			
Voltage under no load				MAX 20			
Frequency regulation	Instantaneous maximum speed difference		%	10			When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6			
	Recovery time		sec	5			
	Stability		Hz	±1			After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20			Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	91	92	93	Measured 1m away from external wall of generator set
Lowest starting temperature			°C	0			
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5			Under rated operation
	Lub. oil temperature		°C	110			
Oil supply interval	Fuel oil		h	6.8	9.5	6.0	Under rated operation
	Lub. oil		h	65	75	70	

Model			Unit	YDG2700E-5EBG	YDG3700E-5EBG	YDG5500E-5EBG	YDG6600TE-5EBG	Remarks
Frequency under load		AC	Hz	50 ± 1				Under rated operation
Voltage under load			V	234 ± 6			409 ± 11 [236 ± 6]	
Voltage under no load				MAX 254			MAX 440 [MAX 254]	After warming-up
Voltage regulation range			%	7				
Waveform distortion			%	25			10 [25]	
Rated current		DC	A	8.3			–	
Voltage under load			V	11 ± 1			–	
Voltage under no load				MAX 20			–	
Frequency regulation	Instantaneous maximum speed difference		%	10				When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6				
	Recovery time		sec	5				
	Stability		Hz	±1				After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20				Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	91	92	93		Measured 1m away from external wall of generator set
Lowest starting temperature			°C	–10				
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5				Under rated operation
	Lub. oil temperature		°C	110				
Oil supply interval	Fuel oil		h	6.8	9.5	6.0	5.5	Under rated operation
	Lub. oil		h	65	75	70		

Note: [ ] are for auxiliary power

3.2.6 Norway

Model			Unit	YDG6600TE-5EBN	Remarks
Frequency under load		AC	Hz	50 ± 1	Under rated operation
Voltage under load			V	236 ± 6 [236 ± 6]	
Voltage under no load				MAX 254 [MAX 254]	After warming-up
Voltage regulation range			%	7	
Waveform distortion			%	10 [25]	
Rated current		DC	A	–	
Voltage under load			V	–	
Voltage under no load				–	
Frequency regulation	Instantaneous maximum speed difference		%	10	When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6	
	Recovery time		sec	5	
	Stability		Hz	±1	After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20	Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	93	Measured 1m away from external wall of generator set
Lowest starting temperature			°C	–10	
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5	Under rated operation
	Lub. oil temperature		°C	110	
Oil supply interval	Fuel oil		h	5.5	Under rated operation
	Lub. oil		h	70	

Note: [ ] are for auxiliary power

3.2.7 U.S.A. and Canada

Model			Unit	YDG2700E-6EH	YDG3700E-6EI	YDG5500E-6EI	Remarks
Frequency under load		AC	Hz	60 ± 1			Under rated operation
Voltage under load			V	122 ± 3 / 244 ± 6			
Voltage under no load				MAX 132 / 265			After warming-up
Voltage regulation range			%	7			
Waveform distortion			%	25			
Rated current		DC	A	8.3			
Voltage under load			V	11 ± 1			
Voltage under no load				MAX 20			
Frequency regulation	Instantaneous maximum speed difference		%	10			When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6			
	Recovery time		sec	5			
	Stability		Hz	±1			After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20			Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	92	93	93	Measured 1m away from external wall of generator set
Lowest starting temperature			°C	-10			
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-H	1.5			Under rated operation
	Lub. oil temperature		°C	110			
Oil supply interval	Fuel oil		h	6.5	8.0	6.0	Under rated operation
	Lub. oil		h	58	65	70	

(3.1.7) U. S. A. and Canada

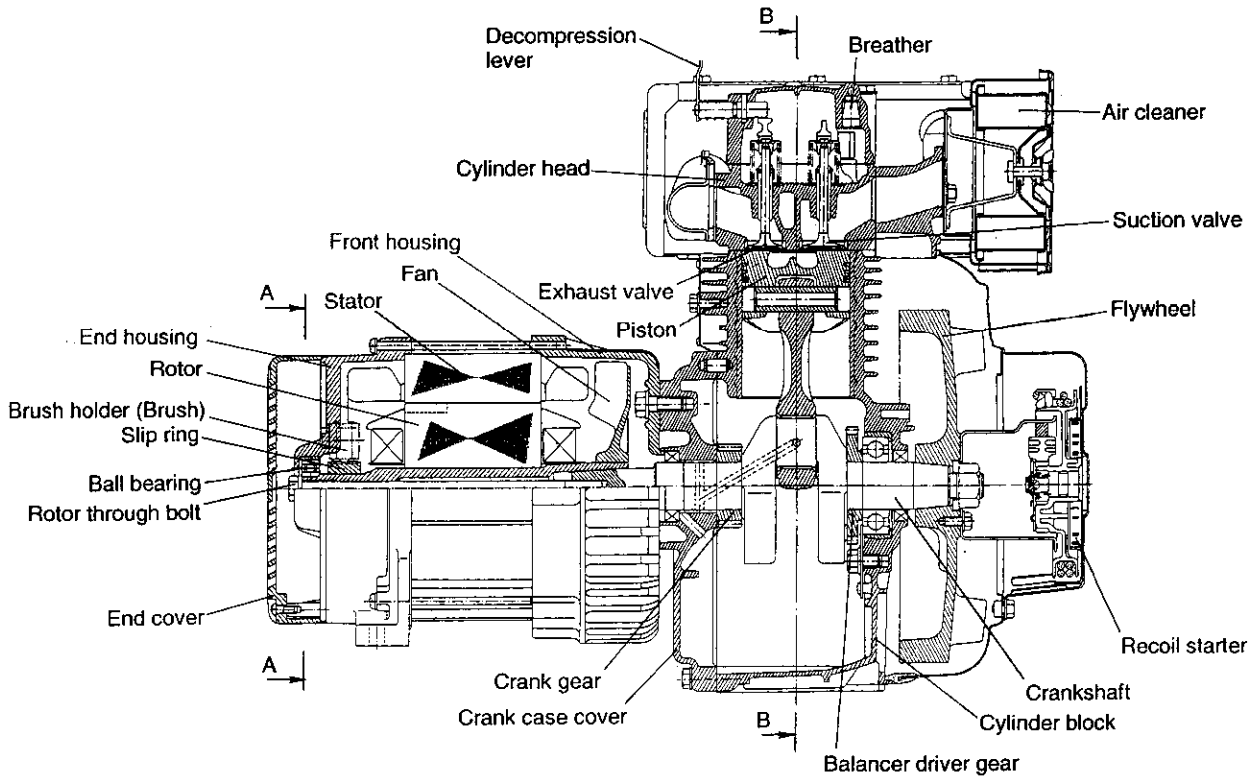
Model			Unit	YDG2700EE-6EH	YDG3700EE-6EI	YDG5500EE-6EI
Generator	Type		–	Revolving-field type AC generator (with brush)		
	Excitation		–	Self-excited		
	Voltage regulation		–	Automatic voltage regulator (AVR)		
	Frequency		Hz	60		
	Speed		rpm	3600		
	Rated output	AC	kVA	2.5	3.5	5.0
		DC	V-A	12-8.3		
	Rated voltage		V	120	120 / 240	
	Rated current		A	20.8	29.2 / 14.6	41.7 / 20.8
	Power factor		–	1.0		
	Phase		–	Single-phase		
	No. of poles		–	2		
	Type of insulation		–	E-class		
	Bearing system			Ball bearing (Grease-enclosed)		
	Output terminal	AC		125V / 20A, receptacle (GFCI)× 1	125V / 30A, receptacle (3P Type) × 1 125 V / 20A, receptacle (GFCI) × 1 125V / 250V-20A, receptacle (4P Type) × 1	
		DC		Terminal × 1		
	Breaker	AC		21A (NFB)	16A (NFB) (twin)	22A (NFB) (twin)
		DC		12A (Thermal breaker)		
	Voltmeter		–	AC120 / (240) V	AC 120/240 V	
	Emergency stop system		–	Engine stop device by low oil press. sensor		
	Alarm lamp		–	–		
Engine	Engine model		–	L48EE-DEGY6	L70EE-DEGY6	L100EE-DEGY6
	Type		–	Vertical, air-cooled, 4-cycle diesel engine		
	Output	Continuous rating	kW (PS) /rpm	3.1 (4.2) / 3600	4.4 (6.0) / 3600	6.6 (9.0) / 3600
		Maximum		3.3 (4.5) / 3600	4.8 (6.5) / 3600	7.1 (9.0) / 3600
	Cylinder bore × Stroke		mm	70 × 57	78 × 64	86 × 72
	Displacement		liter	0.219	0.306	0.418
	Cooling system		–	Forced air-cooling		
	Lubrication system		–	Forced lubrication		
	Recommended fuel oil		–	Diesel fuel [BS 2869 A1 or A2, ISO 8217 DMA (Cetane No. 45 min.)]		
	Fuel tank capacity Full/Effective		liter	7.2 / 7.0	13.0 / 12.5	
	Recommended lub. oil		–	API grade CC, SAE 10W-30		
	Lub. oil capacity Full/Effective		liter	0.80 / 0.25	1.10 / 0.40	1.65 / 0.60
	Starting system		–	Starting motor		
	Stopping system		–	Fuel oil shut-off		
	Governing system		–	All speeds by centrifugal weight		
	Air cleaner		–	Wet paper element		
	Exhaust silencer		–	Expansion type	Expansion sound absorption type	
	Charging system		–	Flywheel dynamo		
Battery	Model		–	12N18-3	26A19L	38B20L
	Capacity		V-Ah	12-18	12-21	12-28
Gen. Set	Dimension	L	mm	649	650	720
		W		416	496	480
		H		500	530	578
	Dry mass		kg	64	80	108

(3.2.7) U.S.A. and Canada

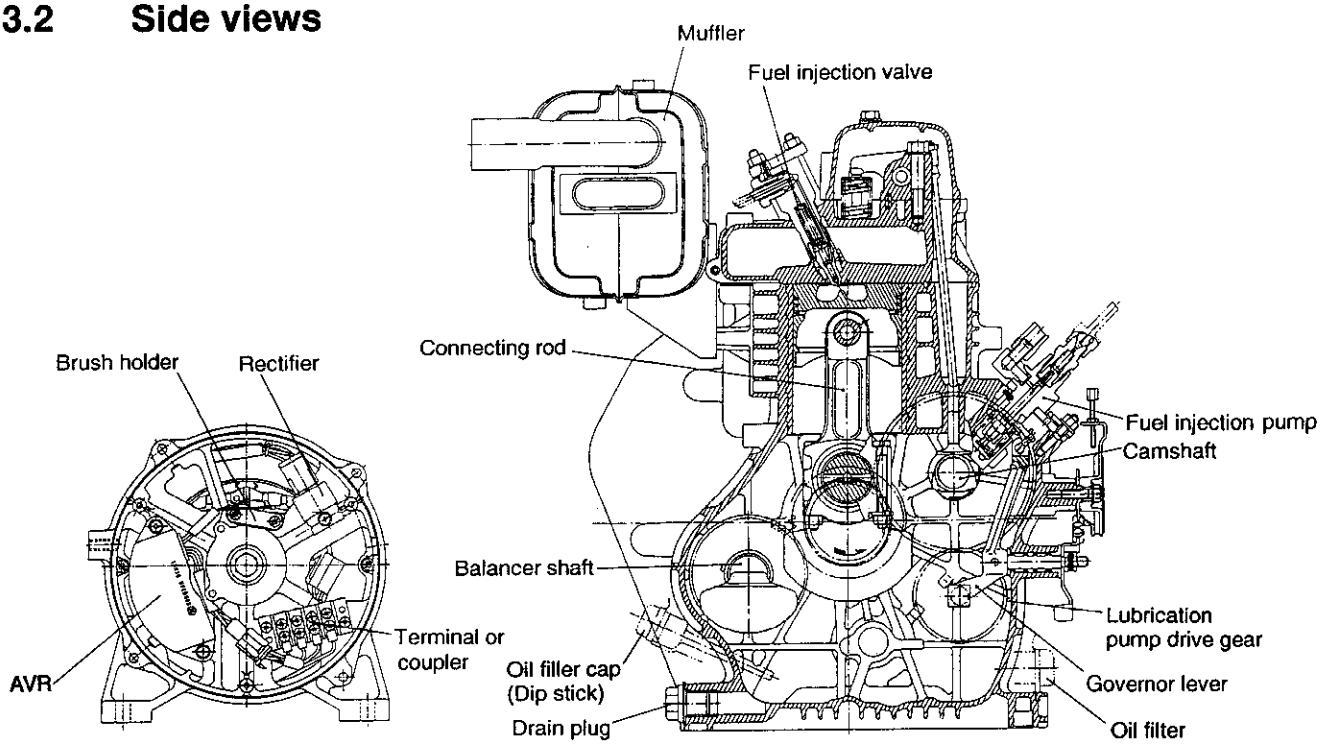
Model			Unit	YDG2700E-6EH	YDG3700E-6EI	YDG5500E-6EI	Remarks
Frequency under load		AC	Hz	60 ± 1			Under rated operation
Voltage under load			V	122 ± 3	122 ± 3 / 244 ± 6		
Voltage under no load				MAX 132	MAX 132 / 265		After warming-up
Voltage regulation range			%	7			
Waveform distortion			%	25			
Rated current		DC	A	8.3			
Voltage under load			V	11 ± 1			
Voltage under no load				MAX 20			
Frequency regulation	Instantaneous maximum speed difference		%	10			When continuous rated output is abruptly changed to output at no load
	Steady state speed band		%	6			
	Recovery time		sec	5			
	Stability		Hz	±1			After warming-up
Permissible angle of inclination	Continuous		deg	MAX 20			Forward/ backward and rightward/ leftward
Noise level (at rated operation) (Average in 4 directions)			dB (A)	92	93	96	Measured 1m away from external wall of generator set
Lowest starting temperature			°C	-10			
Lub. Oil characteristics	Specific lub. oil consumption		g/kW-h	1.5			Under rated operation
	Lub. oil temperature		°C	110			
Oil supply interval	Fuel oil		h	6.5	8.0	6.0	Under rated operation
	Lub. oil		h	58	65	70	

3.3 Sectional Views of Engine and Generator Set

3.3.1 Front view



3.3.2 Side views

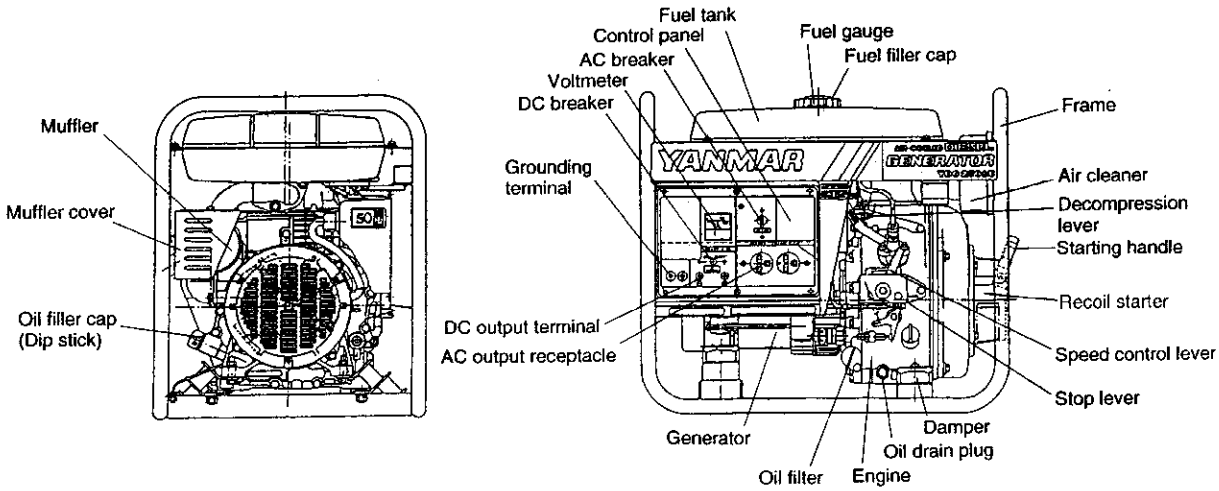


A-A sectional view

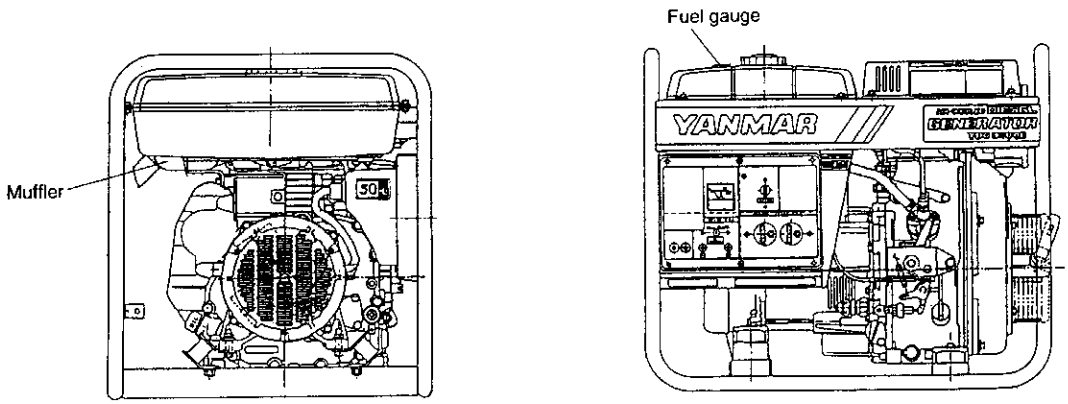
B-B sectional view

3.4 External Views and Components of Generator Set

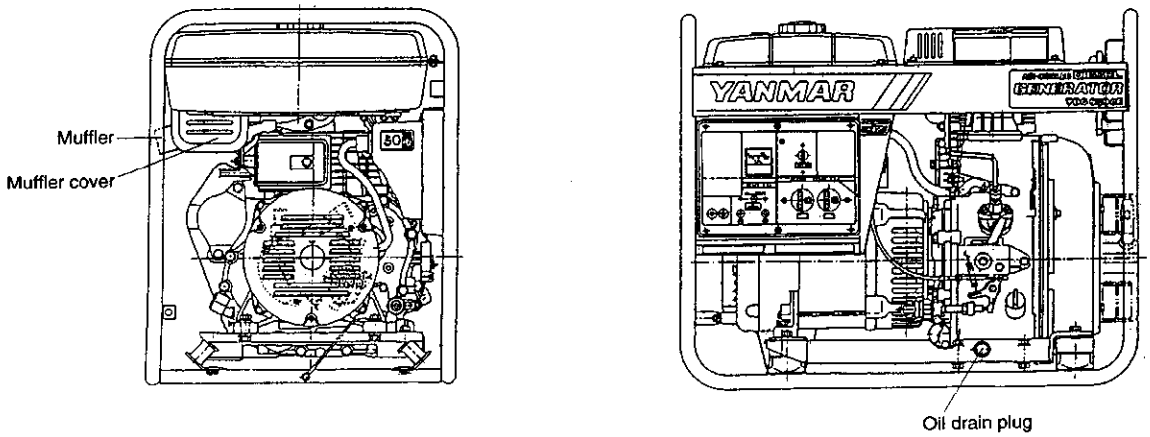
3.4.1 Southeast Asia and Philippines



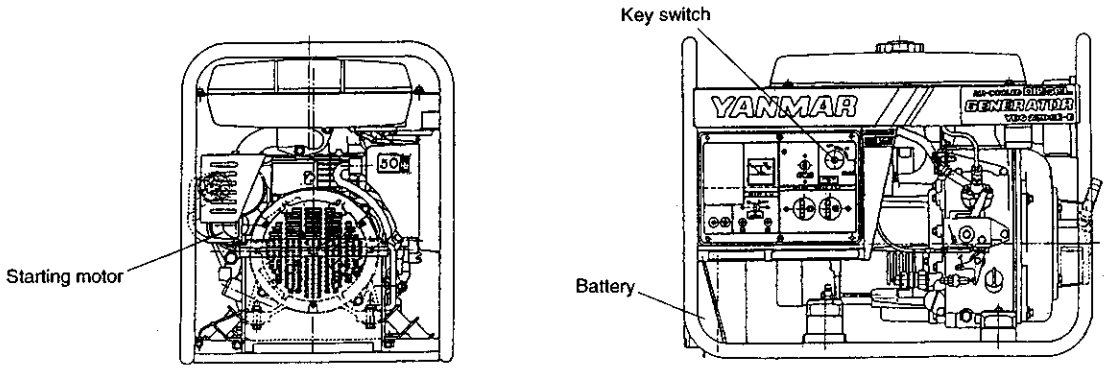
YDG2700E-5B



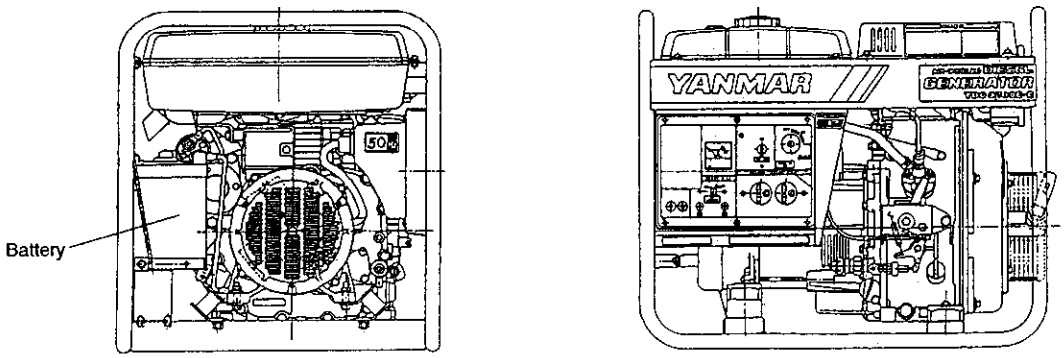
YDG3700E-5B



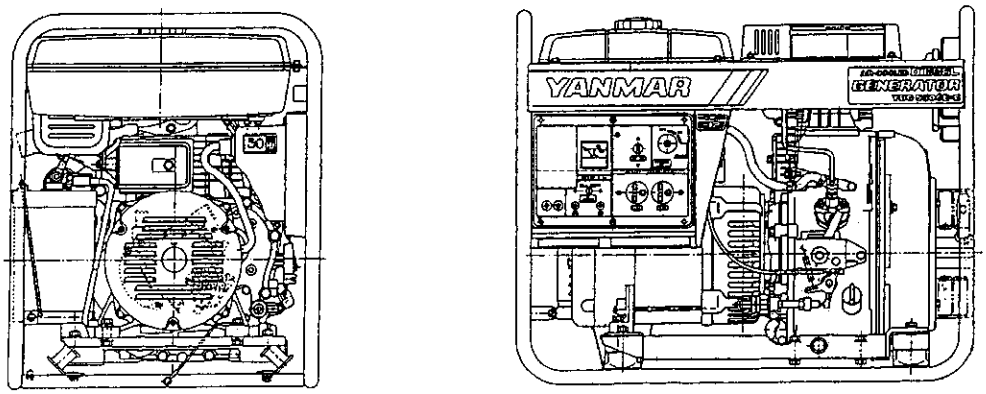
YDG5500E-5B



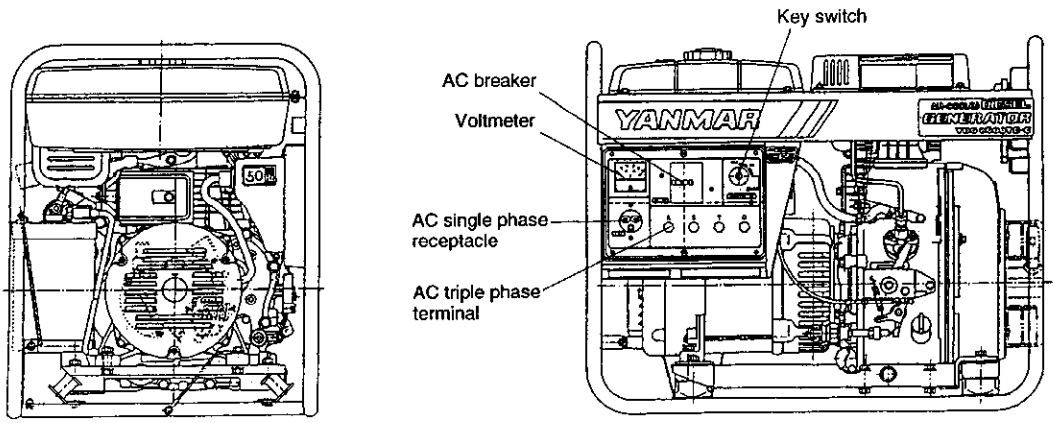
YDG2700E-5EB



YDG3700E-5EB



YDG5500E-5EB



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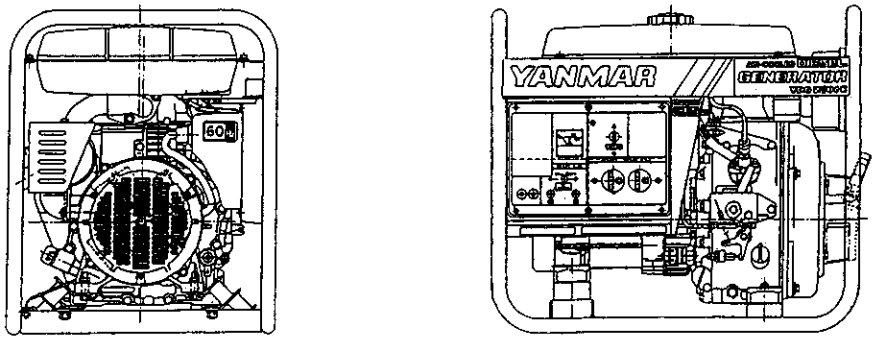

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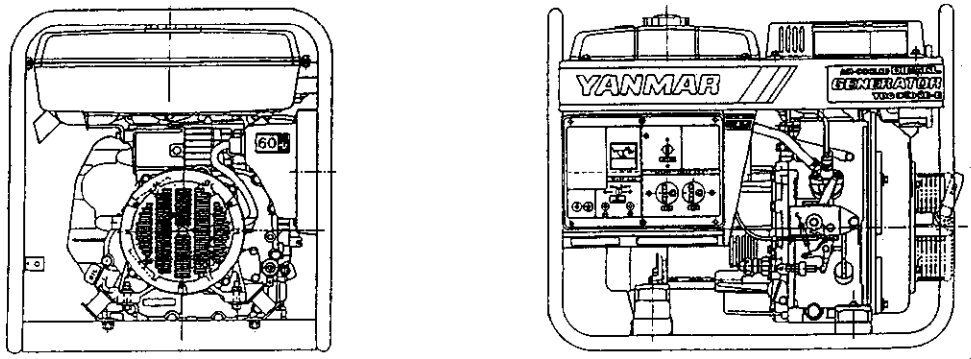

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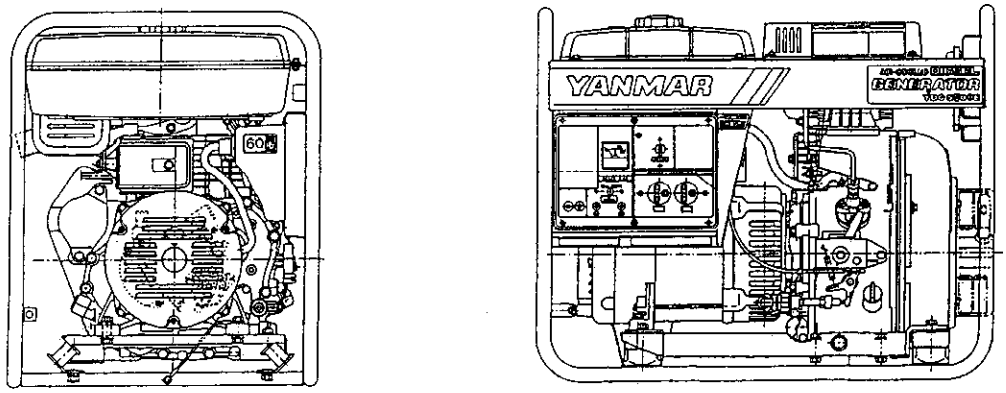

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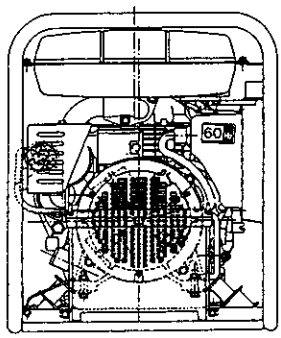
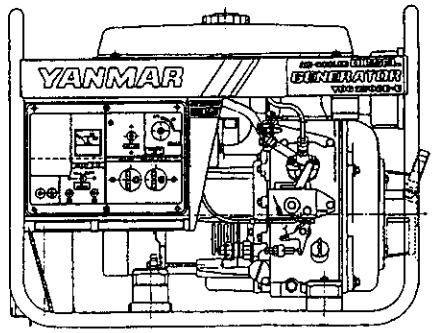

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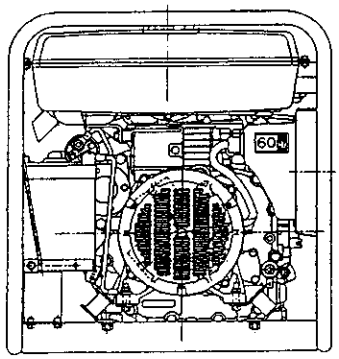
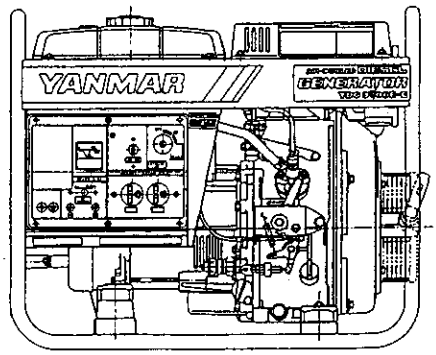

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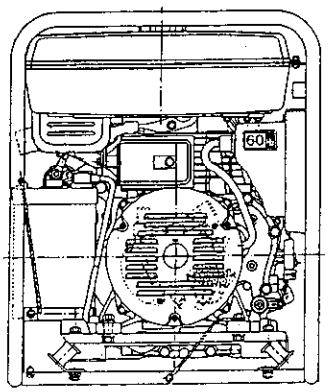
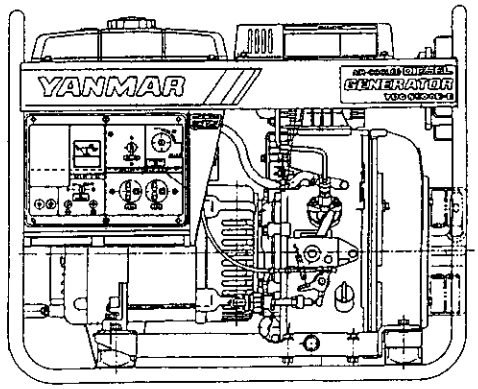

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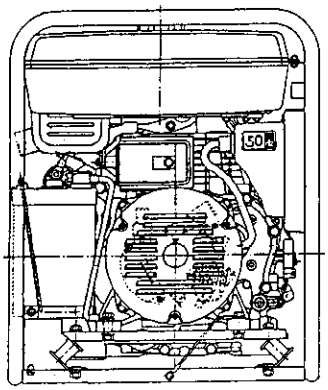
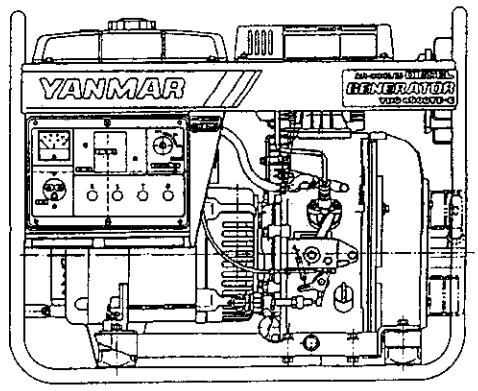

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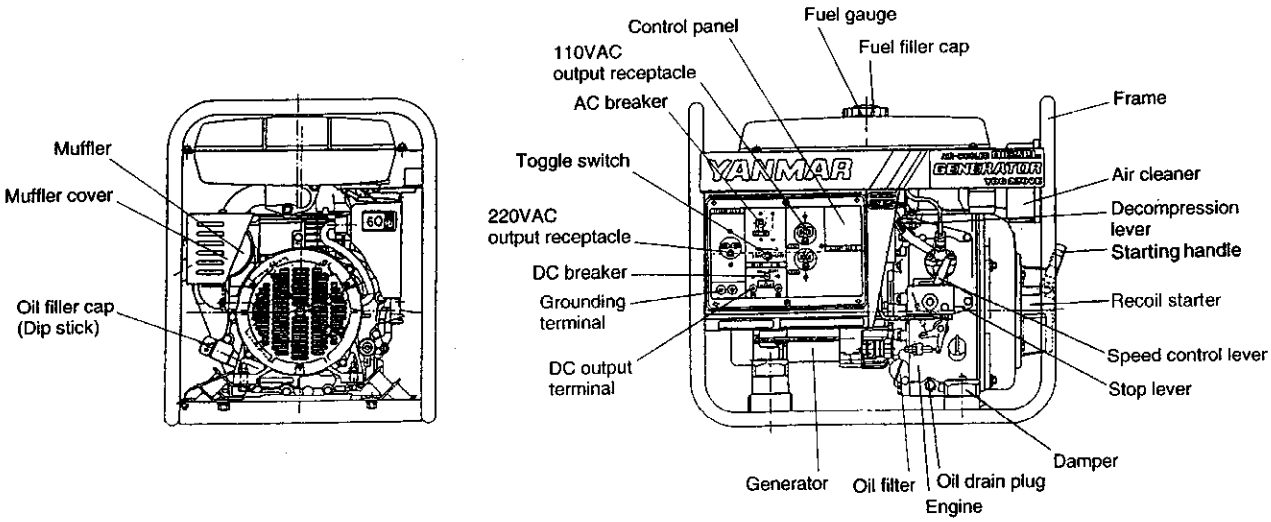

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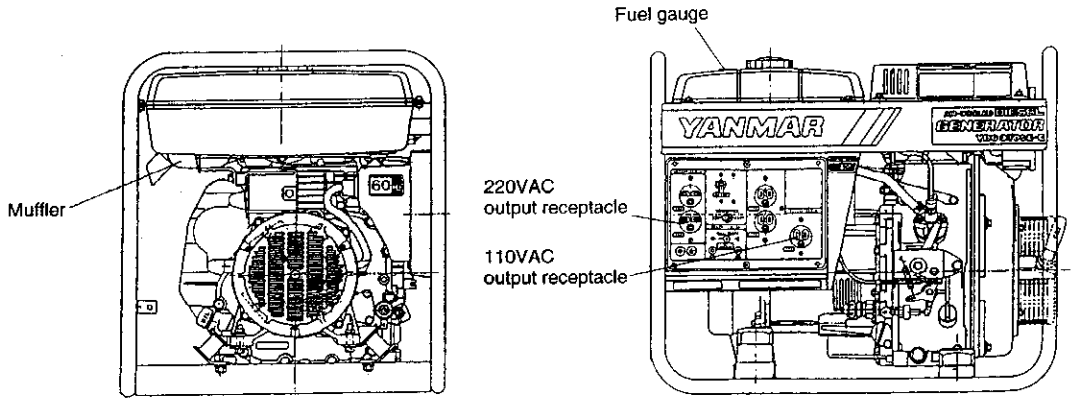

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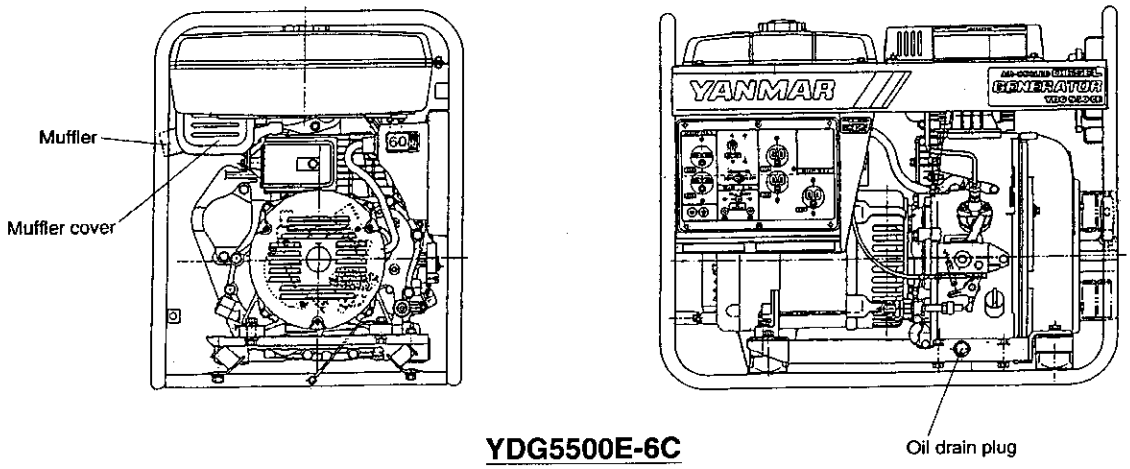

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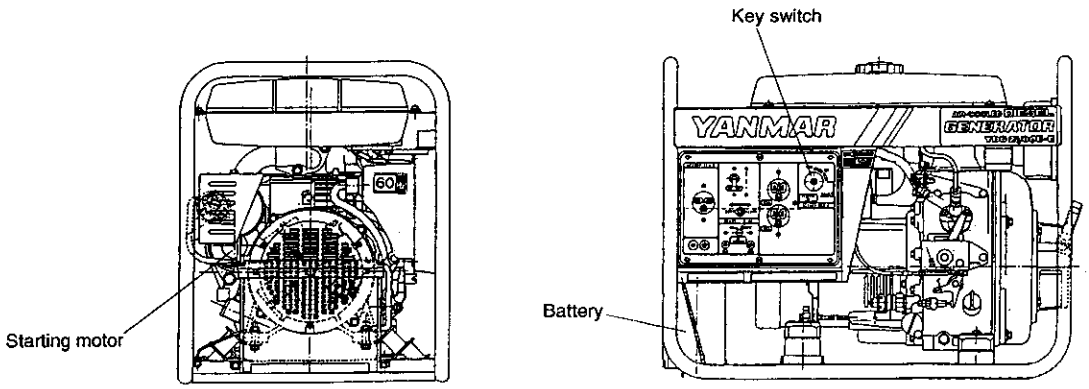

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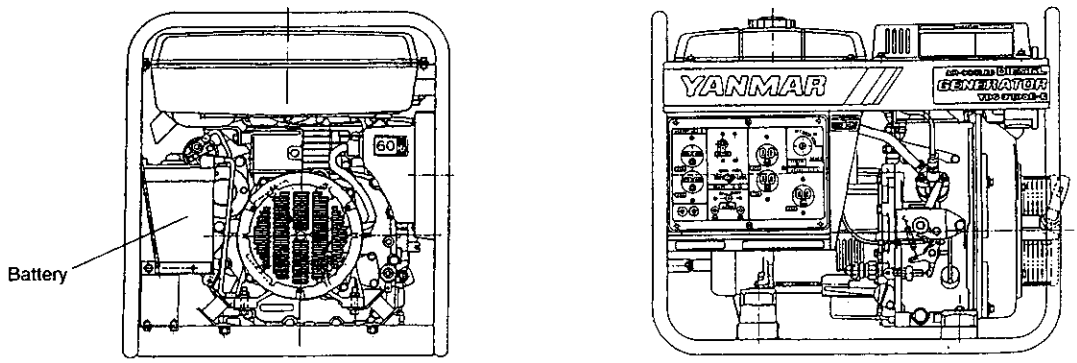

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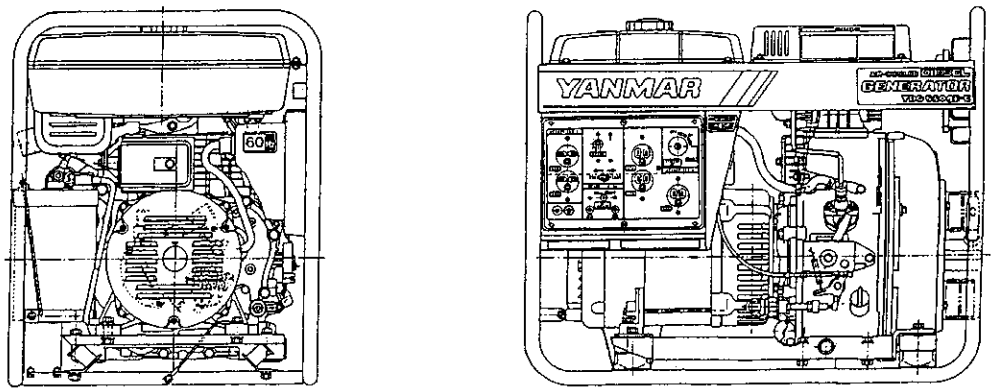

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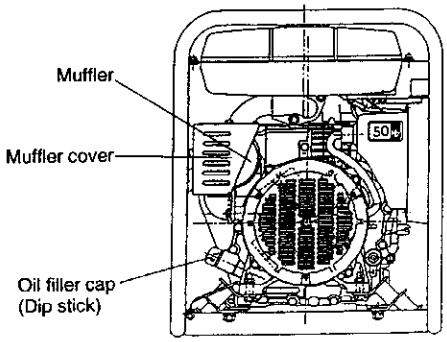
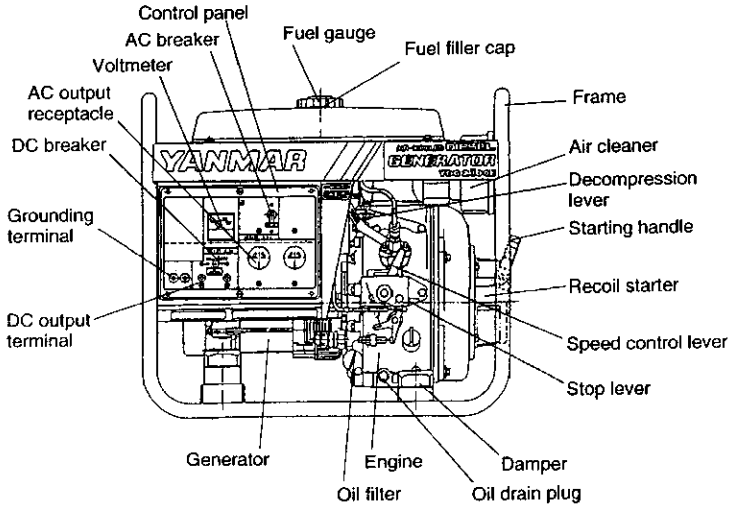
3.4.3 Australia





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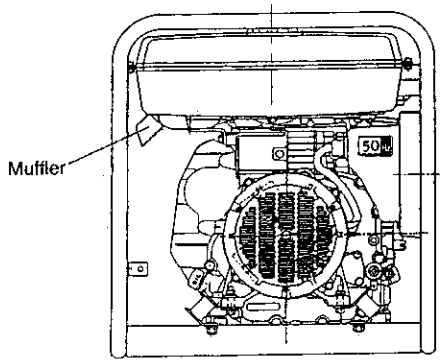

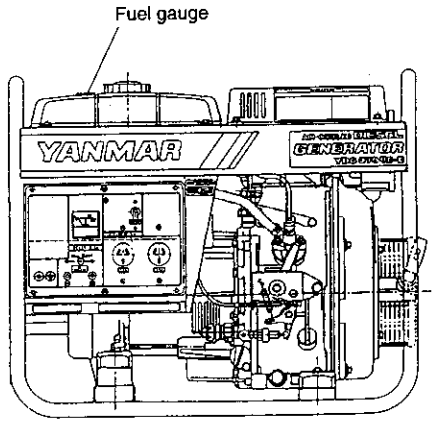

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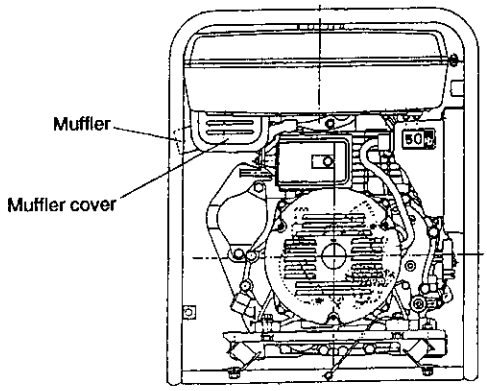

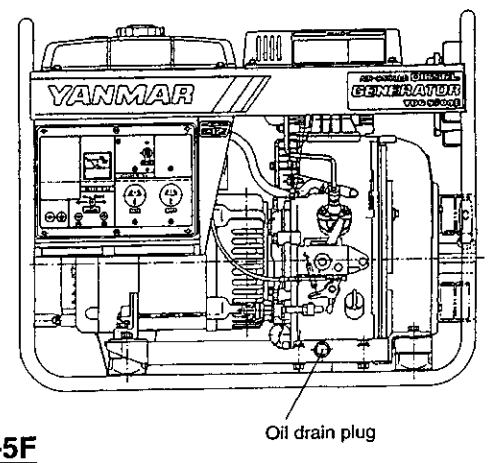

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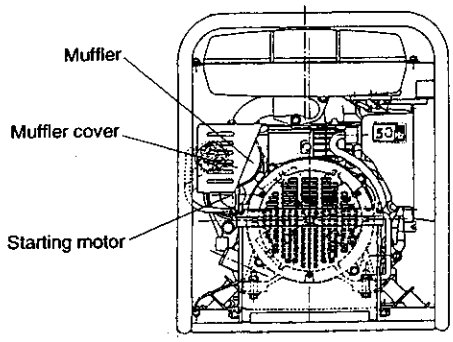

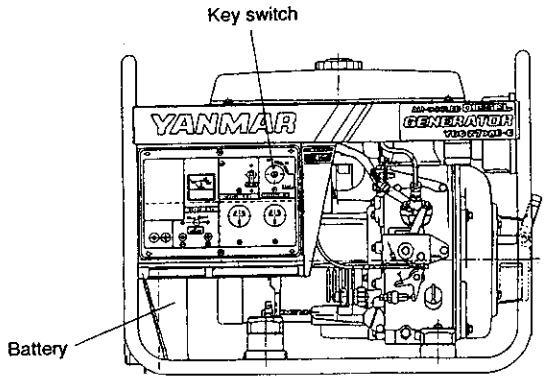

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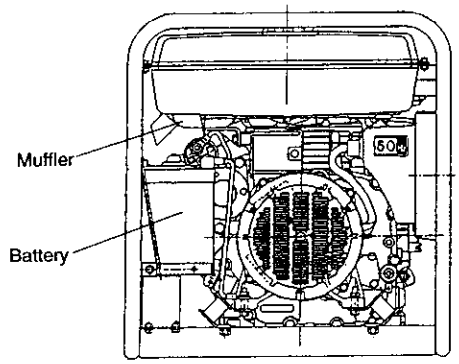

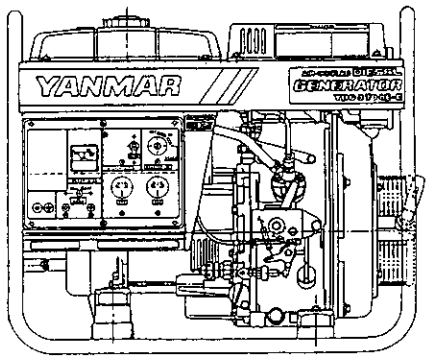

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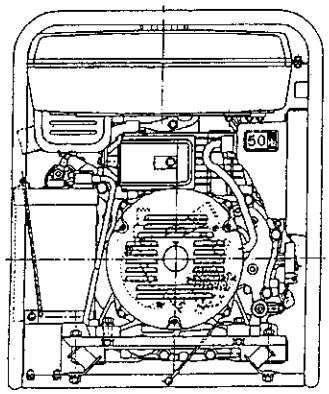

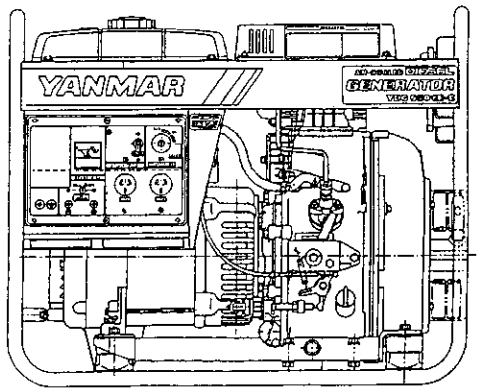

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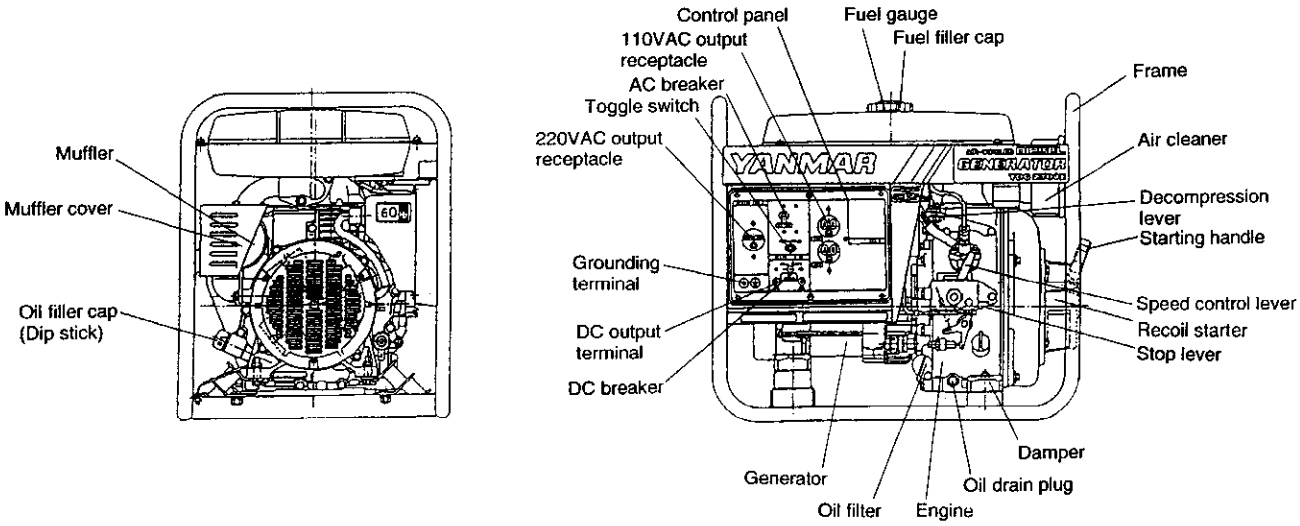
3.4.4 Saudi Arabia



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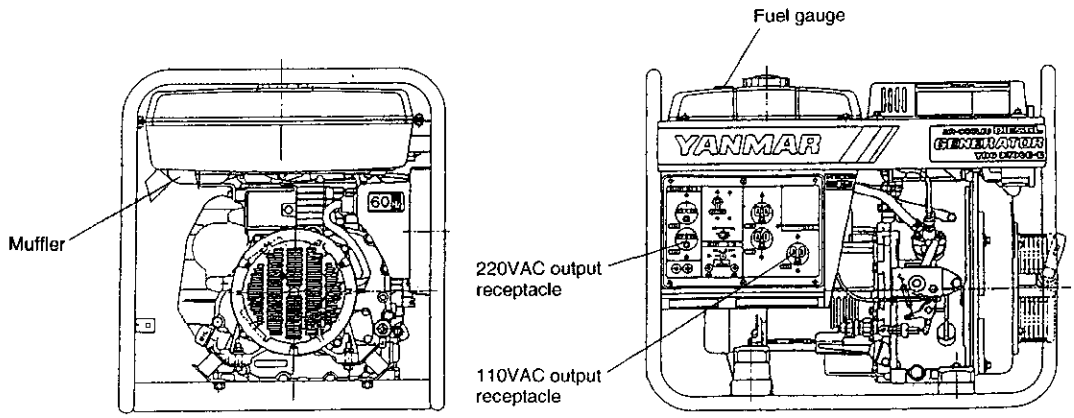

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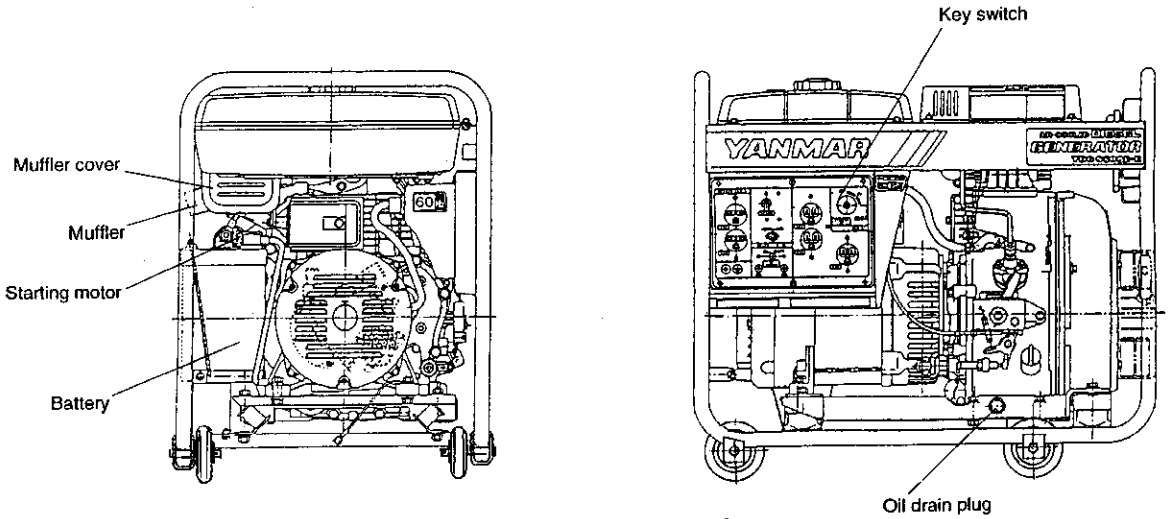

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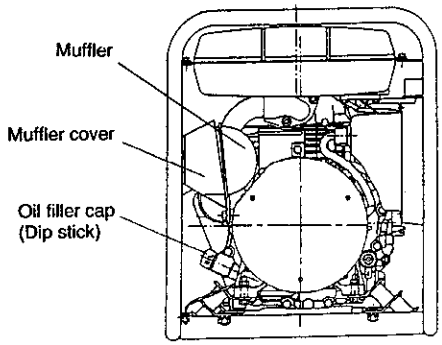

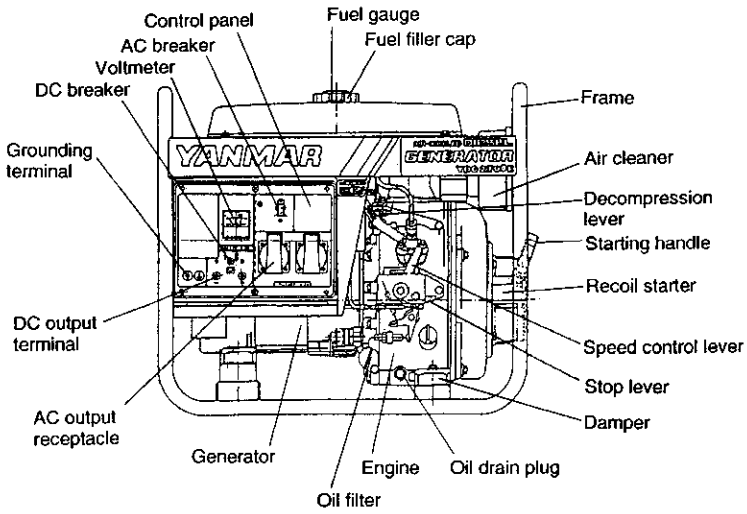

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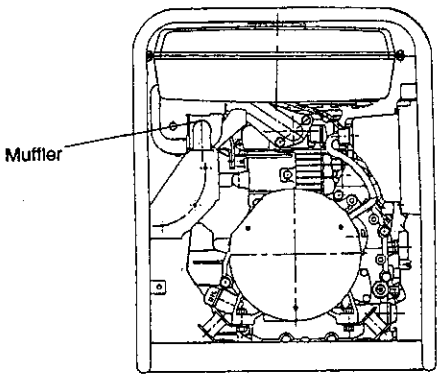

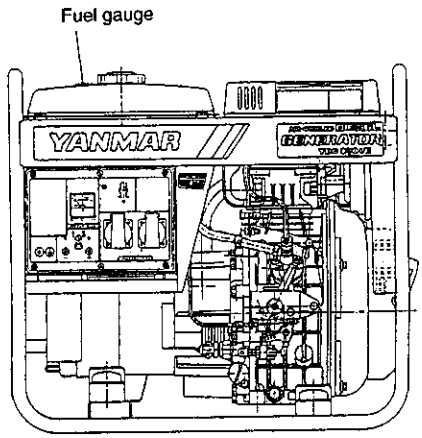

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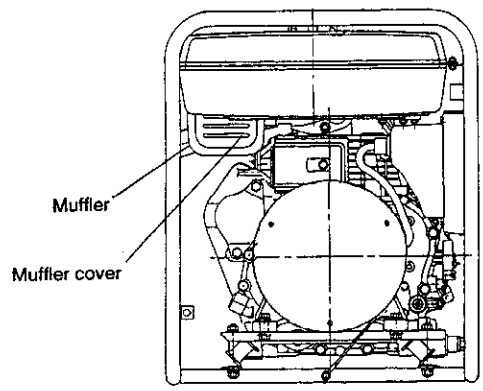

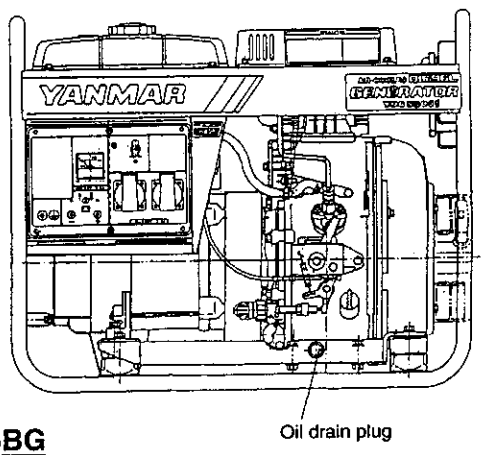

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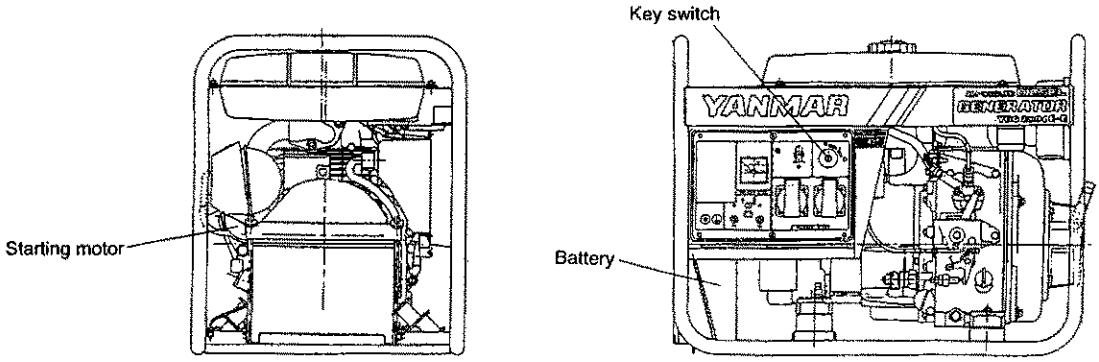

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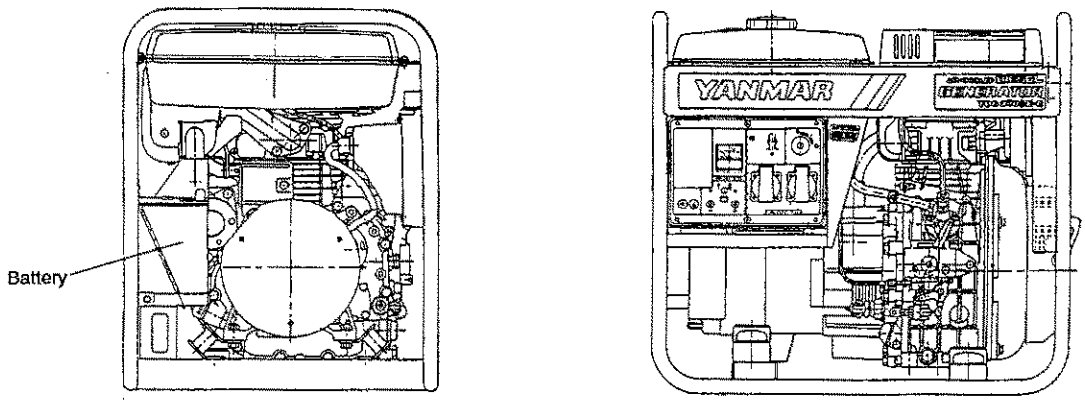

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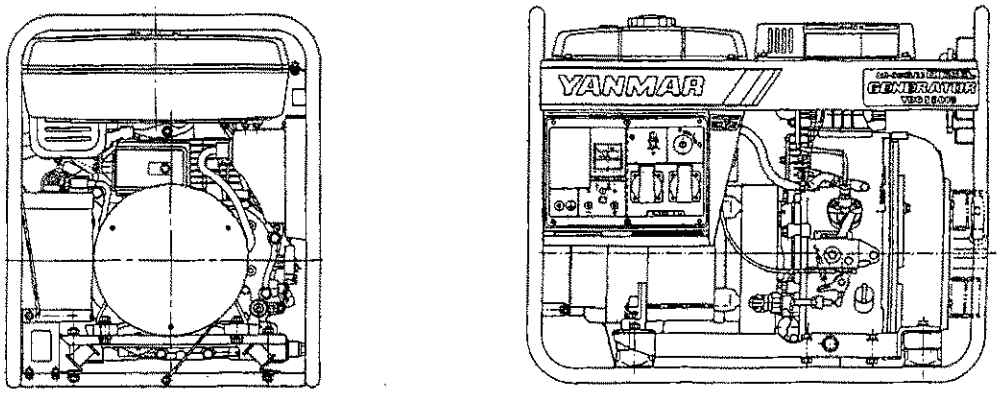

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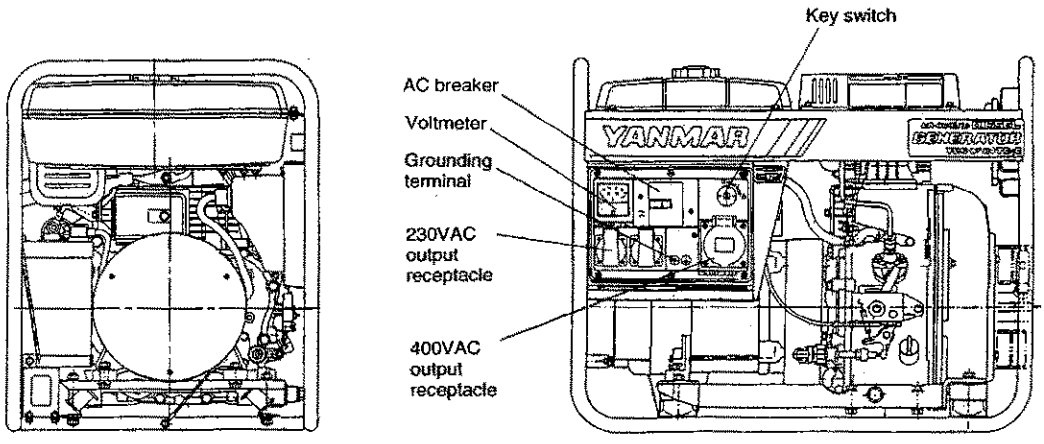

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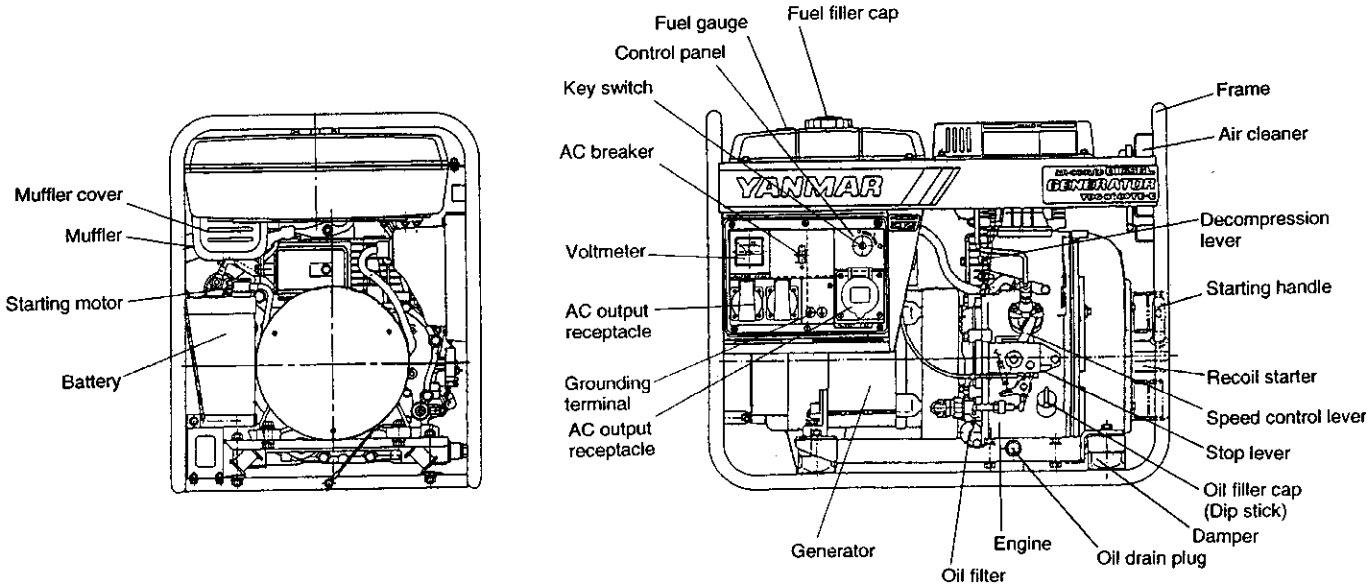
3.4.6 Norway



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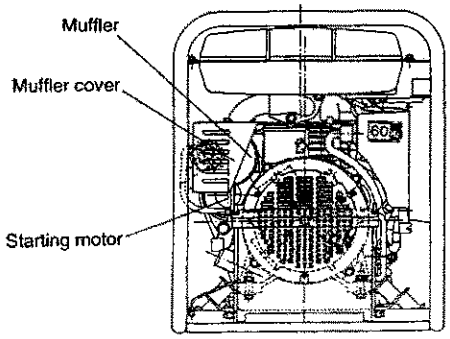
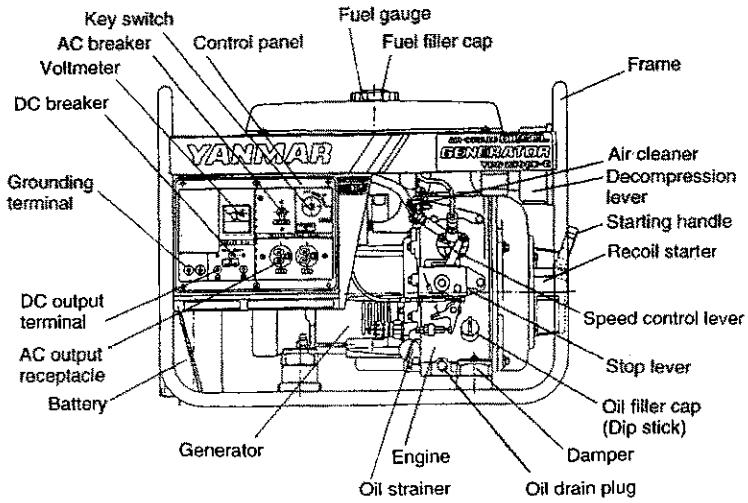
3.4.7 U.S.A. and Canada





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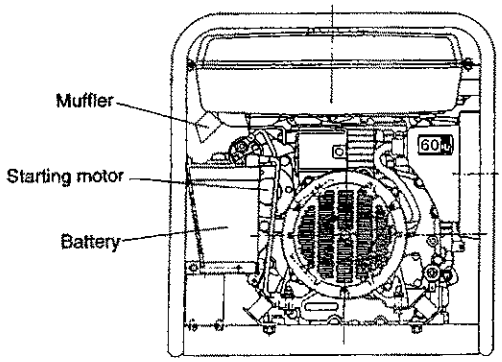

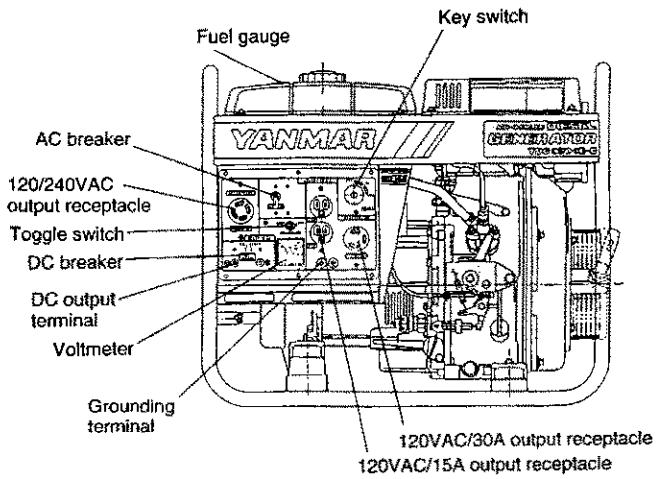

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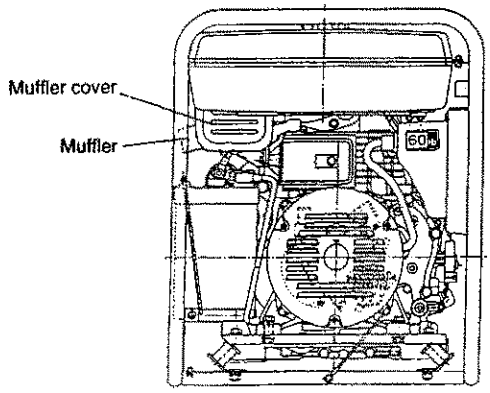

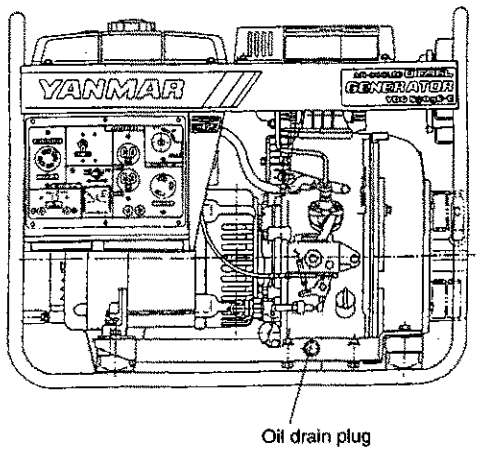

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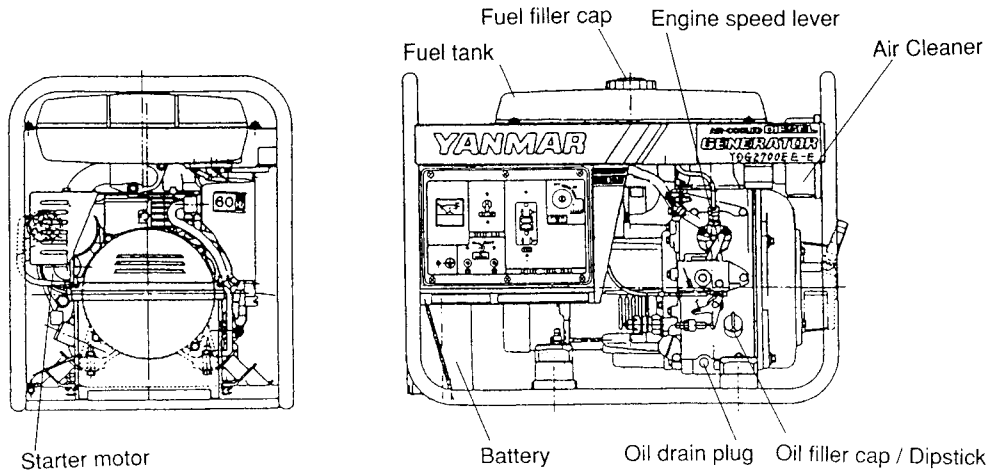

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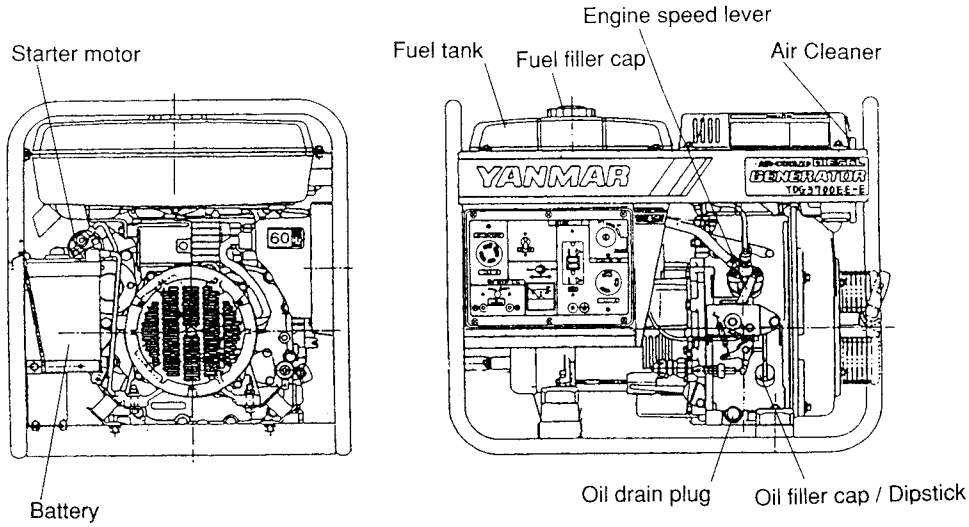

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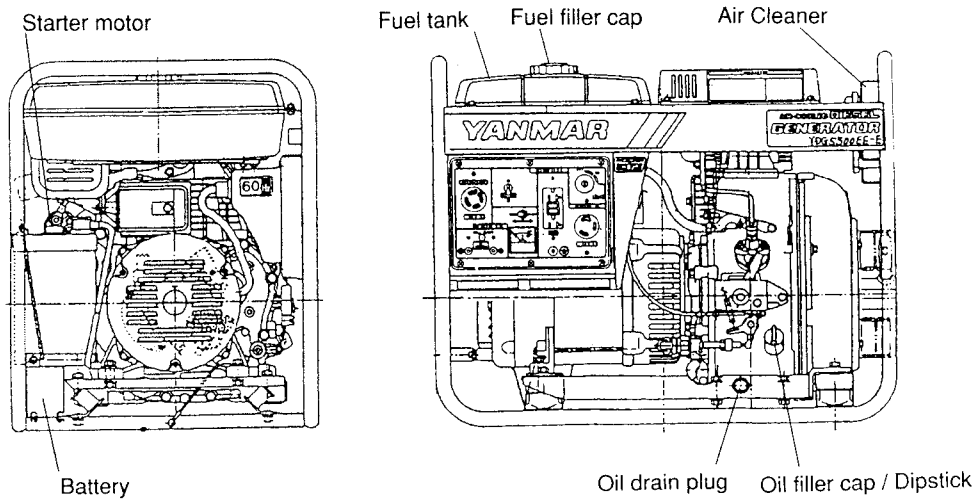

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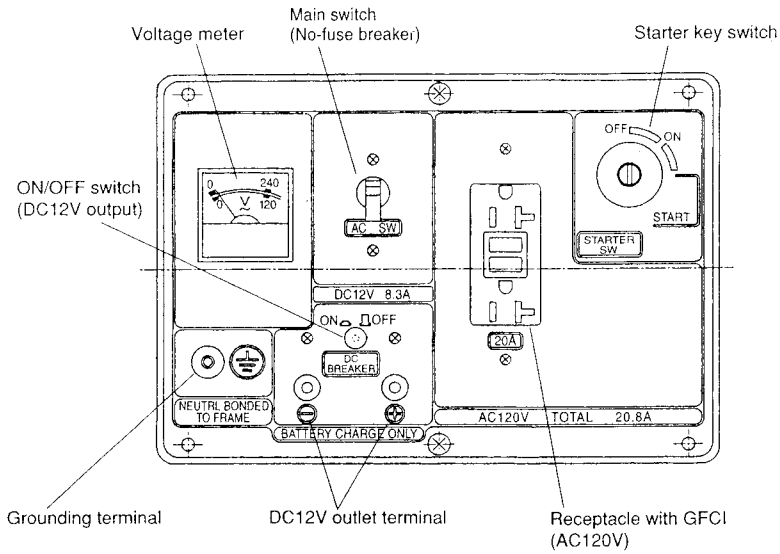
• Control panel



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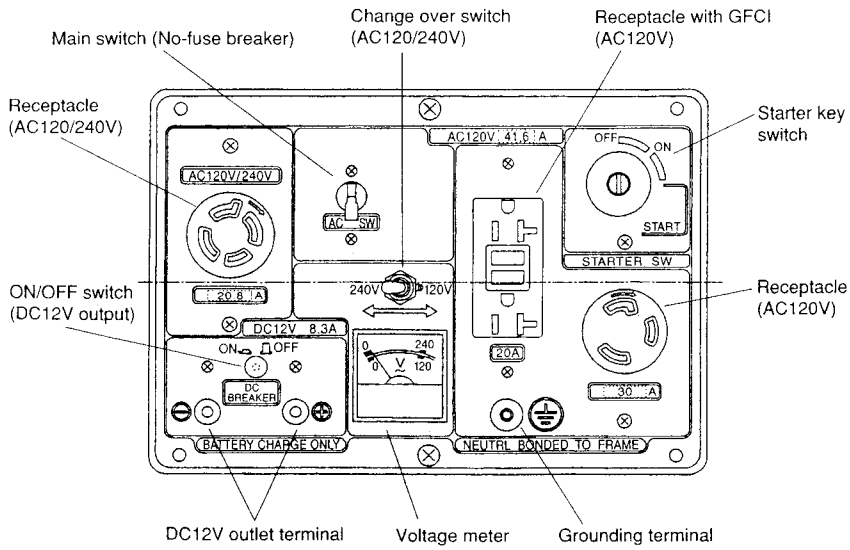


YDG3700EE-6EI / 5500EE-6EI

• Receptacle with GFCI

Please observe the panel and use the grounding terminal on the panel. For your safety, a receptacle in this machine is protected by a GROUND FAULT CIRCUIT INTERRUPTER (GFCI) unit. In the event that the power to this receptacle is lost, and a circuit breaker has not opened, the power can be restored by depressing the RESET button on the GFCI unit. Should the GFCI unit continue to trip, unplug cord connected appliance or any other load from the GROUND FAULT PROTECTED receptacle and check for faulty appliance. Repair the faulty appliance before plugging into the GROUND FAULT PROTECTED receptacle. If the problem persists, contact your nearest Yanmar dealer.

To test, depress the TEST button. The RESET button should extend. If the RESET button does not extend, notify your Yanmar dealer that you have lost GROUND FAULT protection. To restor power, depress the RESET button firmly into the GFCI unit until an audible click is heard. If reset properly, the RESET button is flush with the surface of the TEST button. When the button stays in, the power is ON at all the receptacles protected by the GFCI unit including its own receptacle. For maximum protection against electrical shock, the GFCI unit should be tested monthly.

4. Structure of Generator Set

4.1 Outline of Structure

The generator set consists of four units: frame, control panel, generator and engine. The control panel is mounted on the frame together with the wiring harness. On the other hand, the directly driven generator is fixed on the engine crankcase cover and is mounted on the frame together with the engine.
Models, constructions, capacities, types and quantities of units and their component parts vary with the diesel generator model. For details, see Section 3, Outline of Generator Set and Section 11, Circuit Diagram.

4.2 Frame Unit

The frame unit consists of the main frame made of steel pipes, the sub frame made of angle bars for mounting the generator and engine, and rubber dampers for mounting the sub frame with vibration isolation. (Fig. 4.2)
On top of the main frame are the fuel tank and engine cover. A battery is located on one side of the main frame.

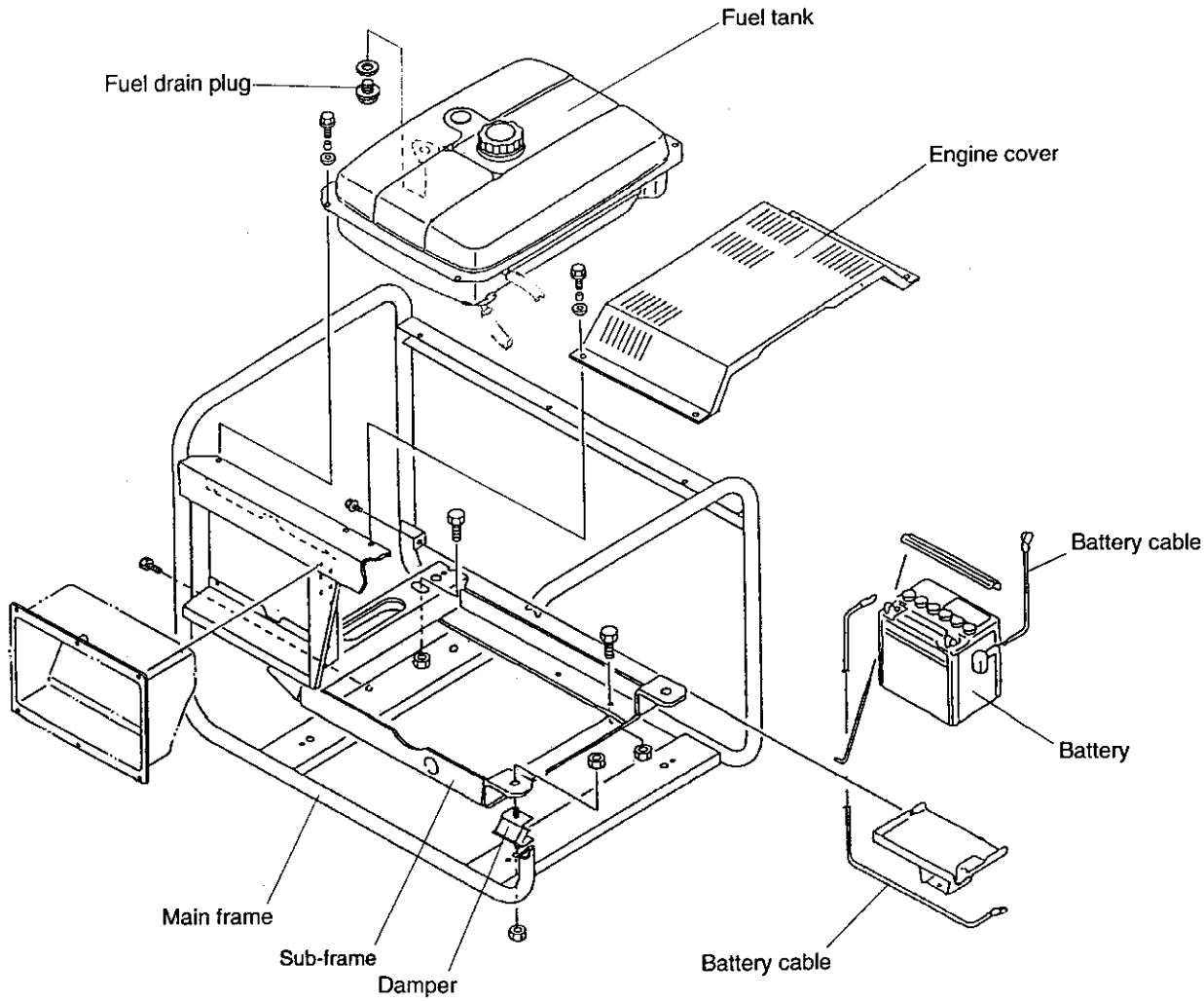


Fig. 4.2 Frame unit

4.3 Control Panel Unit

The control panel unit consists of the control panel, the panel box which covers the rear of the control panel, electrical devices and wiring harness. (Fig. 4.3)
On the control panel are the AC and DC receptacles, terminals, a toggle switch for AC line voltage selection and a voltmeter in addition to an AC breaker with switch function, a DC breaker without switch function, a grounding terminal, a relay for automatically stopping the engine in an emergency, and various other electrical parts.

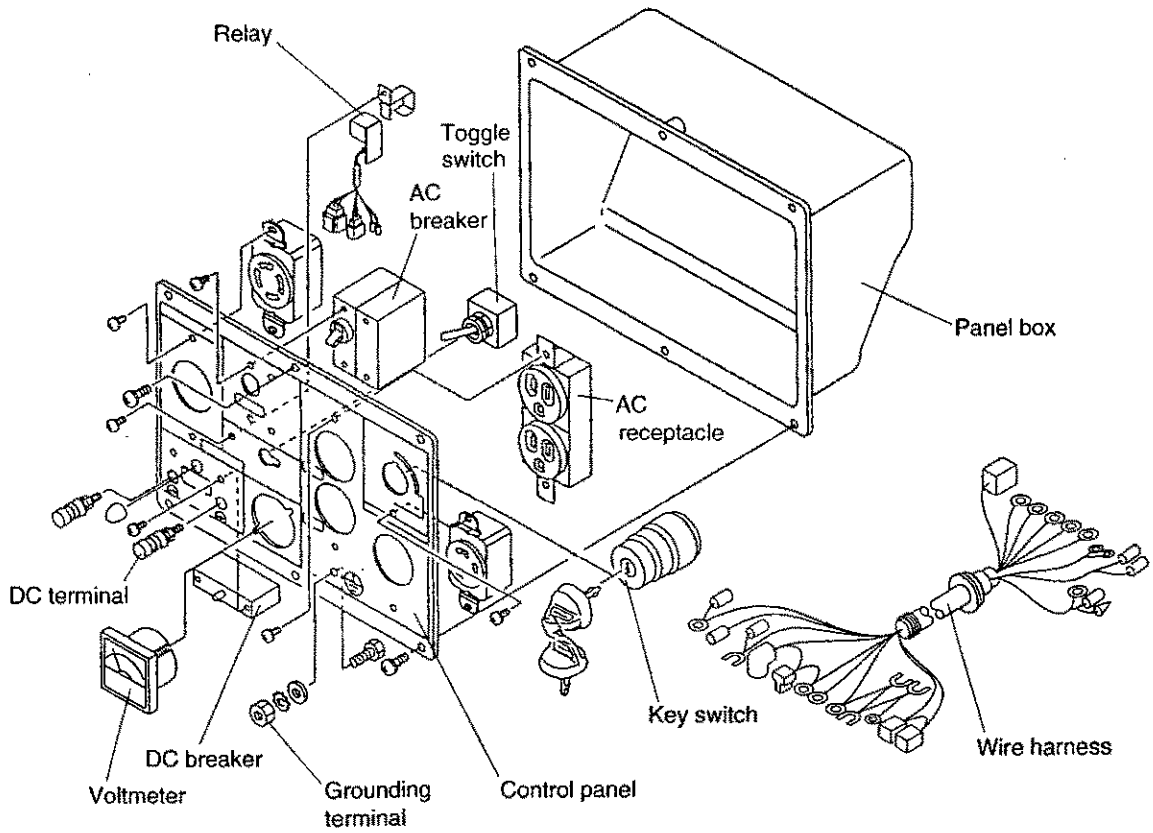


Fig. 4.3 Control panel unit

4.4 Generator Unit

A self-exciting, single-phase AC generator with brush is adopted as the generator.
On the side of the generator is the rear housing containing exclusive electrical parts for the generator, the stator with band, a cooling fan which is supported by a shielded, grease enclosed ball bearing at its end, a through bolt which connects the rotor to the engine crankshaft, and the front housing which fixes the generator to the engine. (Fig. 4.4)
The electrical parts mounted in the rear housing include the automatic voltage regulator (AVR), terminals and the rectifier, all of which are protected by the protective cover with the brush holder and brush.

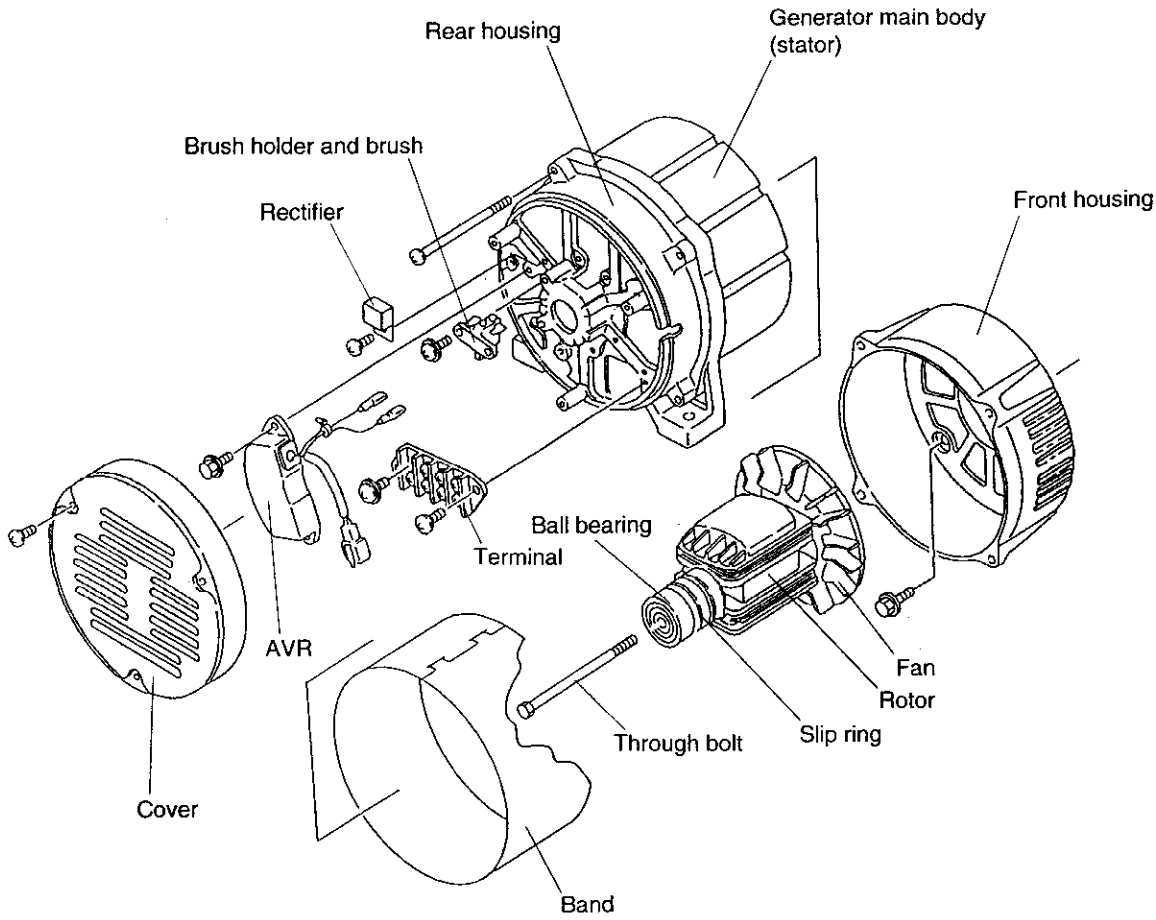


Fig. 4.4 Generator unit

4.5 Engine Unit

An air cooled, OHV, direct injection type 4-cycle diesel engine is adopted as the engine.
The engine consists of the main body, the air intake/exhaust system, the lubrication system, the governor & drive system and the cooling & starting system.

4.5.1 Engine Body

The engine body consists of the crankshaft operating with the connecting rod, the cam balancer shaft driven by the crankshaft, and the aluminum cylinder block, cylinder head and crankcase cover which house all of these parts. (Fig. 4.5.1)
The cylinder head installed on top of the block is installed with the intake/exhaust valves, the rocker arm which operates the valves through push rods, and the bonnet which covers them.

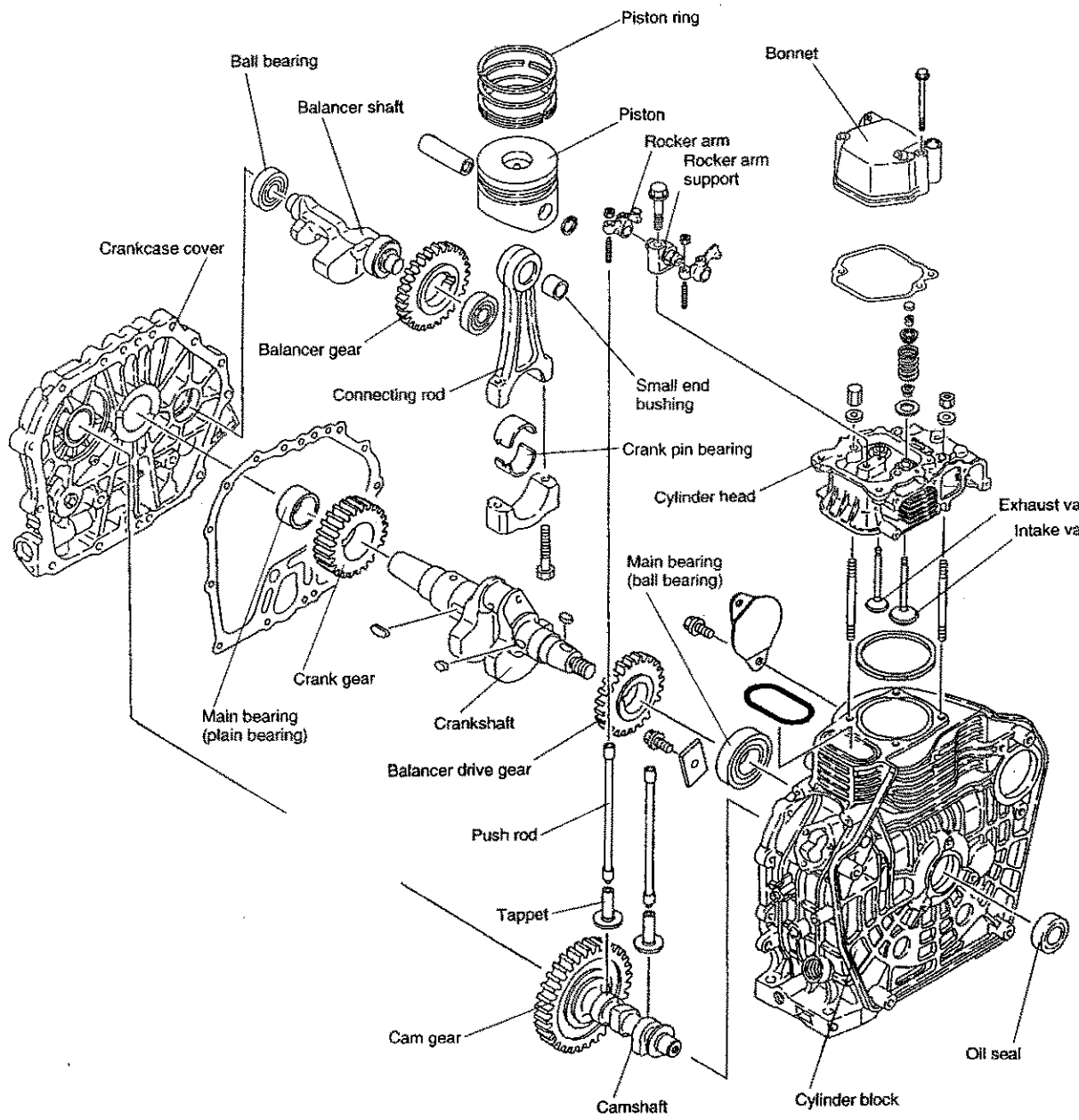


Fig. 4.5.1 Engine body

4.5.2 Intake and Exhaust System

The air intake and exhaust system consists of the muffler, air cleaner and adopter. (Fig. 4.5.2)
The expansion type muffler is mounted on the side of cylinder head together with the muffler cover. On the opposite side is the wet paper type air cleaner containing elements through the adopter which also functions as the air-cooling duct.

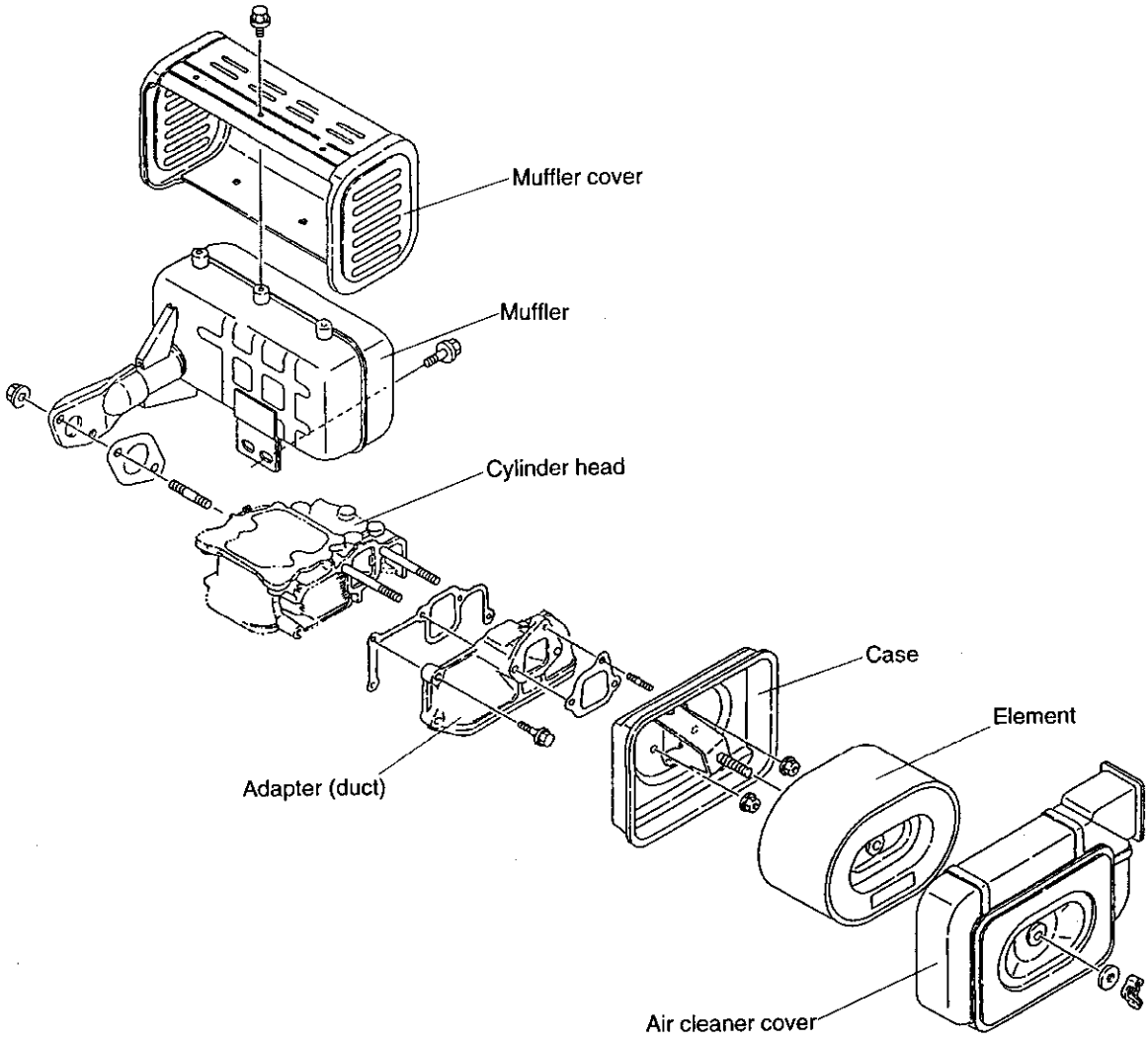


Fig. 4.5.2 Intake and exhaust system

4.5.3 Lubricating System

The lubrication system consists of the oil pan composed by the cylinder block and crankcase cover, oil drain plug, lubrication pump, lubrication oil filter, oil pressure sender and breather.
(Fig. 4.5.3)
The cam gear driven, trochoid type lubrication pump mainly consists of the drive gear, drive shaft and rotor cover, and is built in the crankcase cover which also functions as the pump housing.
The lubricant flows into the plain baring for the crankshaft through the inlet pipe and oil filter, and then into the crank pin for forced lubrication of both bearings. On the other hand, the splash system is adopted for lubricating sliding portions of the engine parts.
The oil moisture (mist) flows to the air intake path of the cylinder head via the through hole in the push rod, rocker arm and check valve located inside the bonnet.

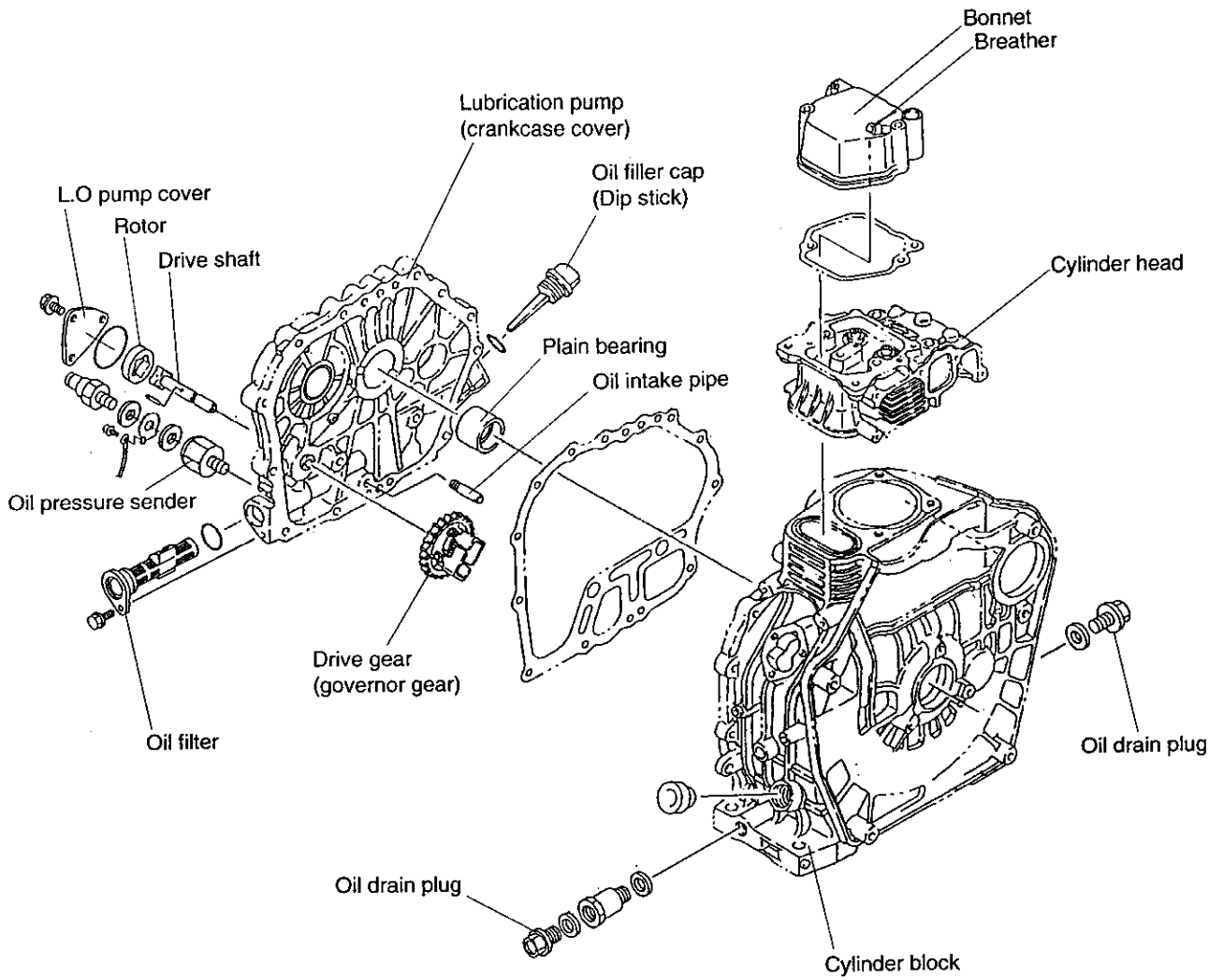


Fig. 4.5.3 Lubrication system

4.5.4 Fuel System

The fuel system mainly consists of the fuel tank located above the frame, fuel injection pump, fuel injection nozzle and fuel filter. (Fig. 4.5.4)
The fuel flows in the order of the filter located at the entrance and exit of fuel tank, the fuel hose containing the orifice type air separator near the exit, the fuel injection pump driven through the cam for camshaft pump and tappet, and the fuel injection pipe for supplying fuel to the direct injection type fuel injection nozzle. The fuel leaked from the injection nozzle is returned to the fuel tank through the fuel hose.

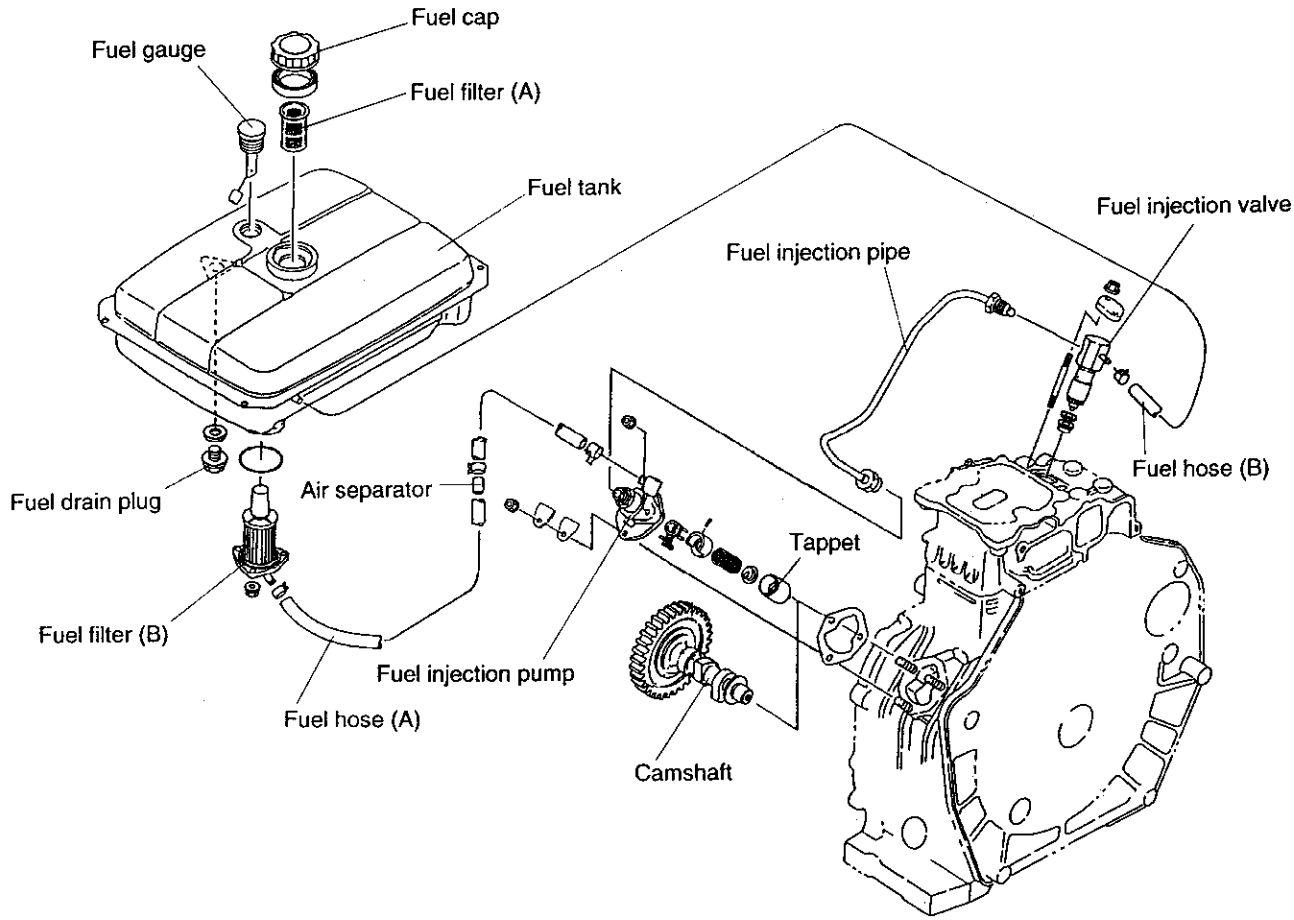


Fig. 4.5.4 Fuel system

4.5.5 Governor and Operating System

The governor and operating system mainly consists of the governor, speed control lever, stop lever, fuel limiting screw and automatic engine emergency stop unit. (Fig. 4.5.5)
The mechanical (centrifugal type) governor consists of the governor gear driven by the cam gear, governor weight mounted on the gear, governor lever for controlling the fuel of the injection pump slider which transfers the weight centrifugal force to the governor lever, governor spring which balances with the slider force, and various types of links.
At the end of the governor system link (side of the cylinder block) are the speed control lever for controlling the drive and the stop lever for stopping the engine, and, at the link middle is the fuel limiter (fuel limiting screw) for protecting the engine from overload.
The oil alert (automatic emergency stop unit) which protect the engine from insufficient lubrication consists of the sender, relay, DC solenoid, Bowden wire and stop lever linked with the cable.
For electrically starting models, the key switch is provided to a part of electrical circuit of this unit, which is also used for normal engine stopping.

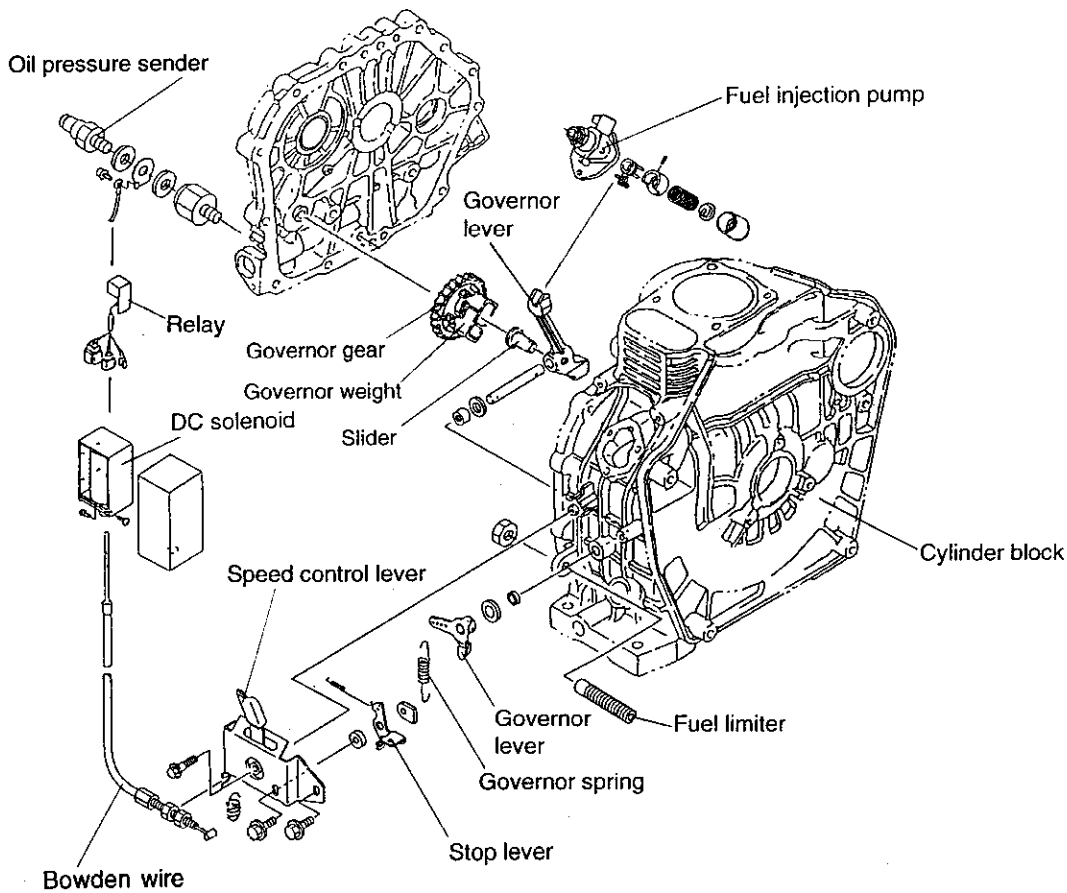


Fig. 4.5.5 Governor and operating system

4.5.6 Cooling and Starting System

The cooling system mainly consists of the flywheel, fan case, duct and cover. (Fig. 4.5.6)
The fan blade of the flywheel and fan case generate the cooling air, which flows through the fan case, duct, fin portions of cylinder block and cylinder head, and cover in this order to cool the engine.
The manual or electrical starting system is provided, of which component parts vary. The manual starting system consists of starter main body, pulley, flywheel and decompression parts. The starter is a recoil starter which is composed of the starter main body mounted on the fan case, and the pulley that transfers the drive energy of the starter main body to the crankshaft via the flywheel.
The decompressor which is actuated at manual starting consists of the decompression lever, rod and decompression shaft. The shaft drives the exhaust valve through the rocker arm.
On the other hand, the electrical starting system consists of the solenoid shift type starting motor, alternator for charging the battery, flywheel with ring gear, rectifier and decompression parts.
The alternator stator is fixed on the cylinder block while the rotor, on the crankshaft through the flywheel.

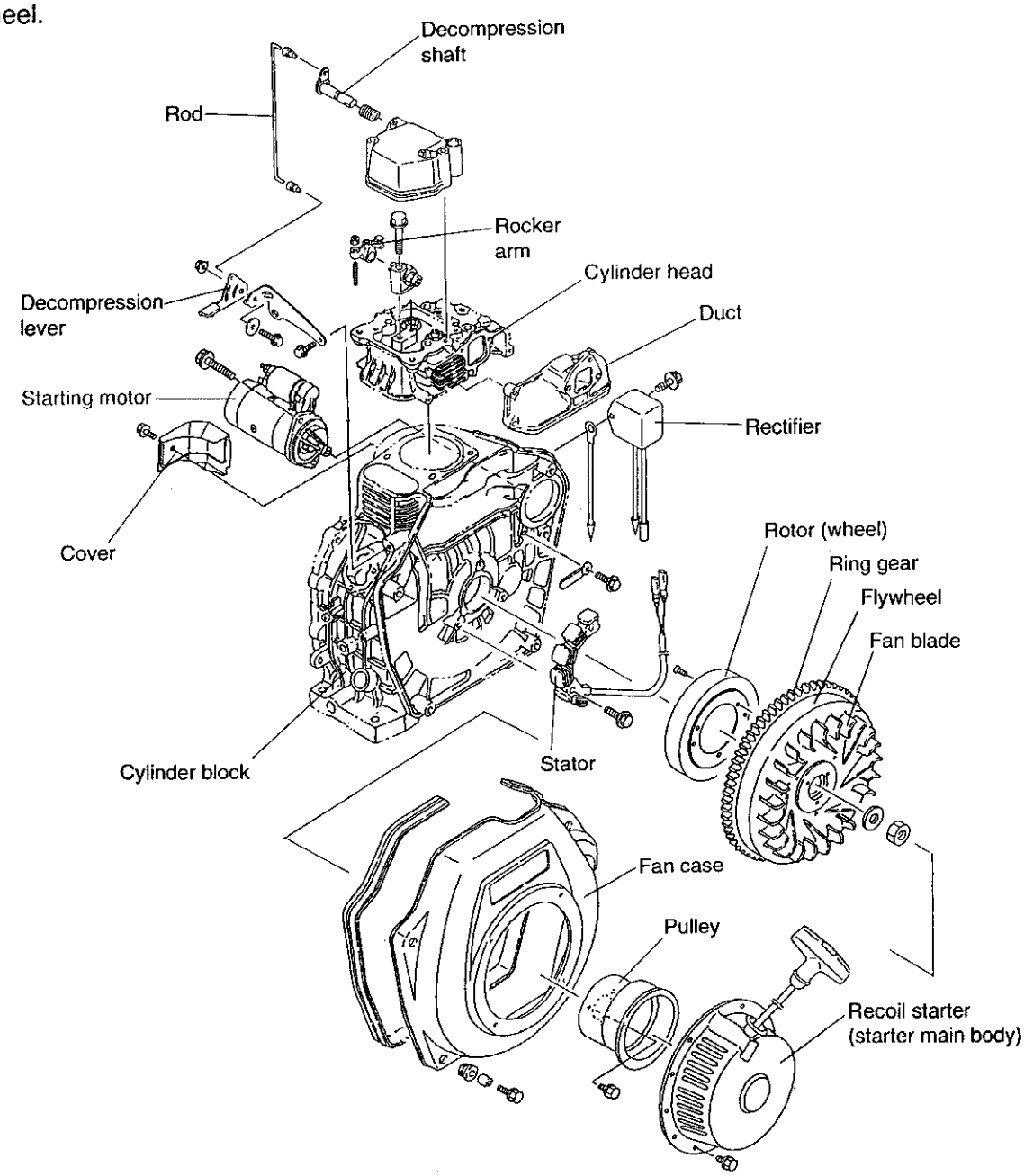


Fig. 4.5.6 Cooling and starting systems

5. Disassembly and Assembly

5.1 Before Starting Operation

Sufficient safety related knowledge is needed for servicing and for ensuring safe quality of the generator. Be sure to carefully read Section 1, Safety, and the following notes before beginning the work.

5.1.1 Grasp of Service History

Understand the history of the services on the generator prior to the work by the records, in order to ensure efficient and correct work.

- Reasons for and contents of previous services
- Date of previous services
- Period and operating hours from previous services
- Parts which would require replacement during the work

5.1.2 Preparing the Necessary Tools, Parts and Materials

- Prepare the necessary general tools, special tools and measuring instruments, referring to Section 12, Machines, Tools, Instruments and Other Materials for Inspection and Maintenance.
- Prepare a case for storing disassembled parts and a container for collecting waste oil. Locate them at appropriate places.
- Prepare the materials necessary at washing, inspection and reassembly such as the engine oil, grease, washing fluid, liquid packing and color check (for flaw detection).
- Prepare parts which should normally be replaced at every overhaul maintenance such as the packing, gasket, O-ring and oil seal as well as those of which replacement is forecasted from the maintenance records. Make sure that all parts prepared are genuine ones.

5.2 Disassembly and Assembly Procedures

This manual mainly gives the disassembly procedures. Reassemble each unit in the reverse order of the disassembly procedure. As components vary from model to model, refer to Section 3, Outline of Generator Set, and Section 11, Circuit Diagram, for details.
Prior inspection and adjustment of parts are required for reassembly. For the inspection and adjustment procedures, see Section 6, Inspection and Maintenance.

5.2.1 General Instructions

1) Disassembly

- Begin disassembly after the generator is cooled down sufficiently. If a generator is disassembled immediately after operation, a burning accident may occur.
- Disconnect the battery cables from battery terminals before disassembly without fail. Disconnect the (–) terminal and then the (+) one (in the reverse order when reassembling) and be careful so as not to cause short-circuiting.
- Drain the fuel and lubrication oil into a container before beginning disassembly of the frame and engine.

2) Reassembly

- Thoroughly clean parts before beginning reassembly.
- Pay sufficient attention to punched or match marks when they are indicated on the parts during assembly.
- Reassemble movable parts, checking their movements at each stage.
- Make sure to tighten nuts and bolts to the specified torque, whenever the tightening torque is instructed. See Section 14, Bolts and Nuts Tightening Torques.
- Firmly tighten the terminals of the electrical circuits even if no tightening torque is instructed. Incomplete reassembly will result in a large electrical resistance, resulting in poor electrical connection or possible melting of terminals.

5.2.2 Frame Unit

- Fig. 5.2.2 illustrates the scope of work and parts configuration.
- Drain the fuel in the fuel tank into a container.

① Disconnect battery cable 1.

Note: Always disconnect the (–) terminal (black) first and then the (+) one (red). Connect in the reverse order when reassembling.

② Disconnect battery 2.
③ Remove engine cover 3.
④ Disconnect fuel hoses 5 and 6 from the engine and then remove fuel tank 4.

Note 1: Install hose 5 at the correct direction when both ends of the hose are disconnected during disassembly. The air separator in the hose must be located near the fuel injection pump. (The orifice type air separator is located about 50 mm from the end of hose and is fixed by the hose clamp.)

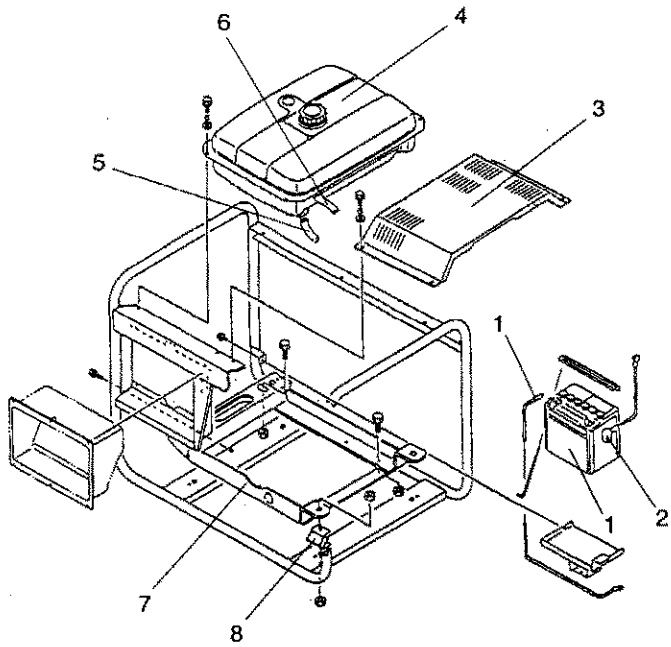


Fig. 5.2.2 Frame unit components

Note 2: After installation of hose 5, purge air from hose 5 together with the injection pump of the engine.

⑤ Remove sub-frame 7.
⑥ Remove damper 8.

5.2.3 Control Panel Unit

- Fig. 5.2.3 illustrates the scope of work and parts configuration.
- Make sure to disconnect the battery cables even for maintenance of the control panel or electrical equipment only, to prevent short-circuiting of electrical equipment.
- Remove wiring harnesses from terminals of the generator and engine prior to the work. Next, remove four screws from all corners of the control panel and then the control panel unit as a set.

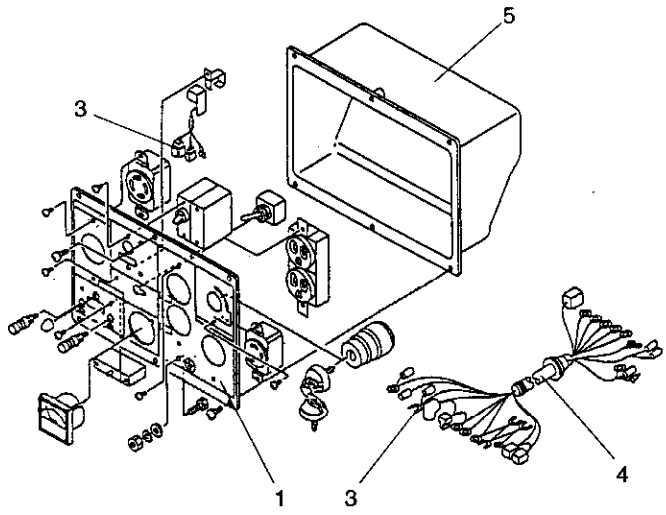


Fig. 5.2.3 Control panel unit components

① Remove control panel 1 from panel box 2.
② Disconnect all terminals 3 connected to respective electrical devices.
③ Disconnect wiring harness 4 from panel box 2.

5.2.4 Generator Unit

- Fig. 5.2.4 illustrates the scope of work and parts configuration.
- Take notes of lead colors together with colors of the connecting leads, so that they will be reconnected correctly when reassembling.

① Remove cover 1.
② Disconnect terminal 2 for each electrical equipment.
③ Remove AVR 3 and rectifier 4.
④ Remove brush holder 5 together with the brush.
⑤ Remove stator 6 together with rear housing 7 and band 8.
⑥ Remove through bolt 9 by loosening it.

Note: Observe the tightening torque specified below when reassembling:
Tightening torque:
2.0 to 2.5 kgf-m

⑦ Remove rotor 10 using the special tool.

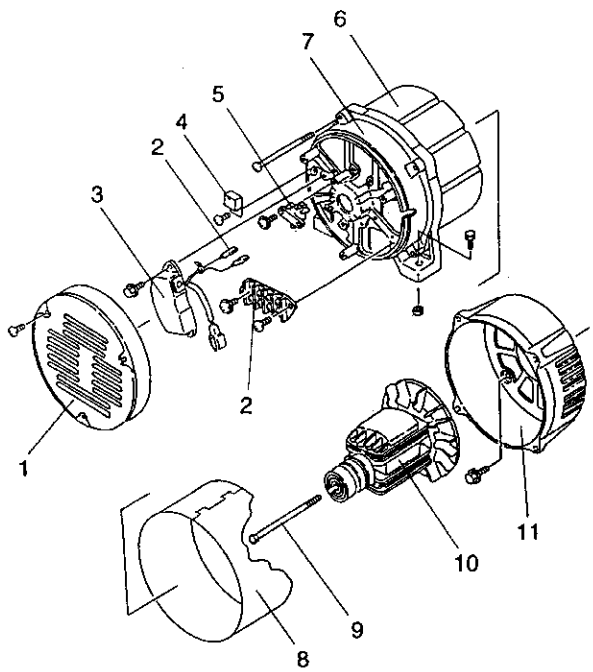


Fig. 5.2.4 Generator unit components

Note 1: The special tool varies according to the generator model. Use the correct tool referring to Section 12, Machines, Tools, Instruments and Other Materials for Inspection and Maintenance.

Note 2: Appropriately tighten the special tool and then tap with a plastic hammer. Repeat the tightening and tapping steps several times to remove the rotor. If you use the tightening step only, the rotor may jump out suddenly, which is dangerous.

⑧ Remove front housing 11.

5.2.5 Engine Unit

- Only the procedure for the oil pressure sender shown in Fig.5.2.5 is described here as there are many work scopes and component parts for the engine. For other procedures, refer to the service manual referred to in the INTRODUCTION.
- Drain the lubrication oil and fuel before beginning the work.
- When removal of the generator and engine from the frame is needed, disconnect the wiring harnesses at terminals on the generator and engine for easier work.

① Disconnect leads 1 and 2.

② Loosen insulator joint 3 and remove oil pressure sender 4 together with washer 5, ground terminal 6 and rubber washer 7.

Note: Apply the screw locking agent and tighten to the specified torque when reassembling.
Tightening torque: 0.8 to 1.0 kgf-m

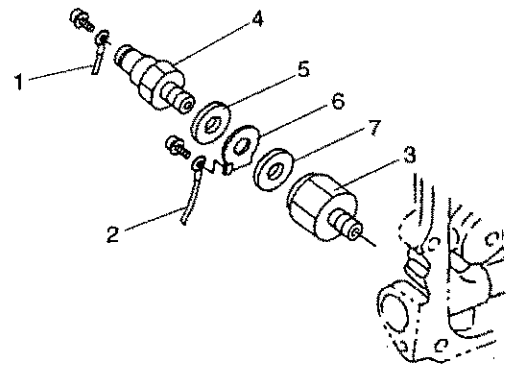


Fig. 5.2.5 Oil pressure sender unit components

③ Remove the oil pressure sender from the insulator joint.

Note: Avoid unnecessary disassembly as the insulator inside the joint may be damaged during removal.

6. Inspection and Maintenance

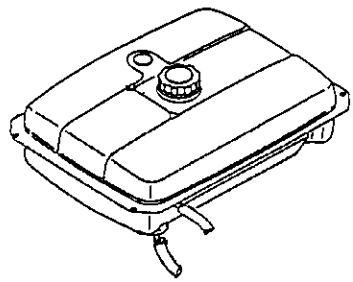
This section gives part of daily maintenance procedures as well as the inspection and overhaul adjustment procedures.
Unlike the maintenance inspection, overhaul inspection and adjustment generally require disassembly and reassembly. Thoroughly read and understand Section 5, Disassembly and Assembly before beginning the work.

- This section sequentially gives inspection and servicing procedures for main units.
- The Inspection/Servicing section describes practical procedures for checking functional abnormalities of components and actions to be taken.
- After inspection of external views of disassembled parts, wash them and check for excessive wear, deformation, damage or flaws as well as electrical resistances. Repair or replacement of faulty parts is required as needed.
- As for judgment criteria for repair or replacement of main components, see Section 13, Service Standards.

6.1 Frame Unit

6.1.1 Fuel Tank

1) Inspection/Servicing



- Check welded portions for cracks.
  If cracks are discovered, weld again or replace.
- Check the inside for residual such as foreign matter and water. If residual matter is discovered, clean.

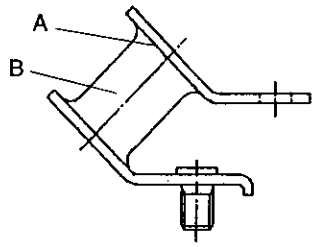
6.1.2 Fuel Hose

1) Inspection/Servicing

- Check for cracks and hardening. If excessive, replace the hose.

6.1.3 Damper

1) Note



- The butyl rubber having excellent shock absorption performance is used as the damper. Prevent contaminating the damper with diesel oil or gasoline as much as possible during work, to prevent deterioration of the rubber damper.

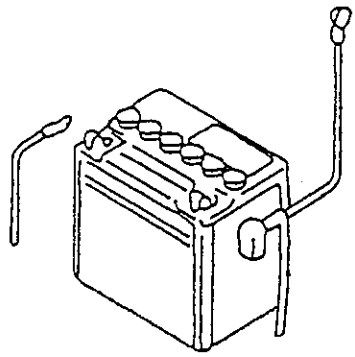
2) Inspection/Servicing

- Check for separation at rubber baked portion (A). If any, replace.
- Check rubber part (B) for cracks. If any, replace it.
- Check the rubber part subject to vibration and deflection for permanent deformation. If excessive deformation is discovered, replace.

6.1.4 Battery and Battery Cable

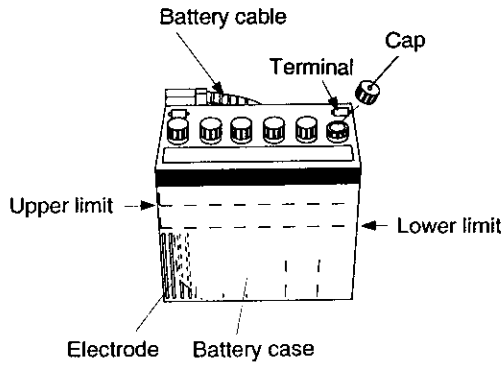
1) Notes

- Charge the battery at a well ventilated place without fire sources.
- Avoid contamination of your eyes and skin by the battery electrolyte.
- Pay attention so as not to cause short-circuiting.



2) Inspection/Servicing

- Check battery cable terminals for corrosion and increase in electrical resistance.
  If corroded, clean. If the terminal sectional area has been reduced excessively by corrosion, replace because the electrical resistance has increased.
- Check the battery case for deformation and cracks. If any, replace the battery.
- Check for low battery electrolyte level. If any, replenish distilled water up to the specified level (upper limit) indicated on the battery.



Note: If the electrode is exposed 30 mm or more from the electrolyte level, it is likely to be deteriorated. So, replace the battery.

- Check the room-temperature converted specific gravity of the battery electrolyte and decrease in the terminal voltage.
  If it has been lowered, charge the battery or replace the battery electrolyte, referring to Table 6.1.4 as guidance. Remove the cap during charging, for preventing electrolyte leakage.

Table 6.1.4

Item		Specific gravity difference (Δψ)	Maintenance method	
		Max-Min	Charge	Replace
Mean specific gravity(ψ)	<1.20	<0.06	O	—
		≧0.06	—	O
	≧1.20	<0.04	O*1	—
		≧0.04	—	O
Terminal voltage	<12.0V	—	—	O
	≧12.0V	—	O*2	—

*1: Charging is unnecessary when the mean specific gravity is 1.24 or more.
*2: Charging is unnecessary when the terminal voltage is 12.5V or more.

Note 1: Measure specific gravity (ρ) of each battery cell within the battery case and obtain the mean specific gravity (ψ) and specific gravity difference (Δψ). As the specific gravity varies with the battery electrolyte temperature (t°C), calculate the mean specific gravity and specific gravity difference using room-temperature converted values. Obtain the room-temperature converted specific gravity (ξ) using Fig. 6.1.4, based on the measured specific gravity (ρ) and the electrolyte temperature (t°C).

(An example is shown by a dotted line, where: ρ=1.27, t=30°C → ξ =Approx. 1.28)

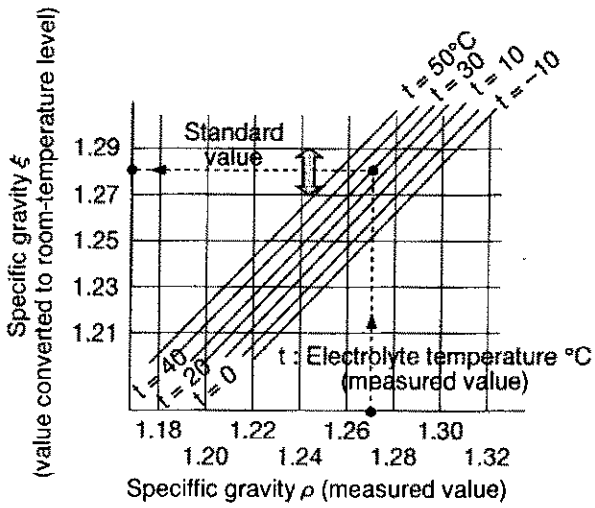


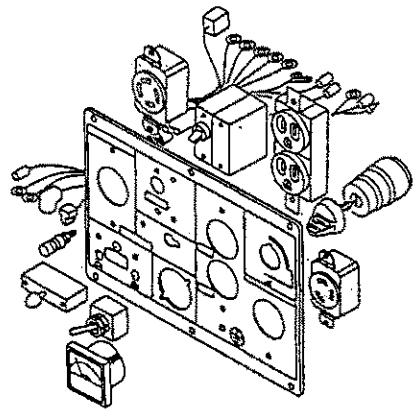
Fig 6.1.4

Note 2: Check the room-temperature converted specific gravity during charging in order to avoid battery failures caused by overcharging. Terminate charging when the mean specific gravity reaches the standard range of 1.27 to 1.29. When completion of charging is determined by measuring the terminal voltage, measure after waiting for cool-down of the battery electrolyte (for 30 to 60 min).

Note 3: Disconnect battery cables during charging for preventing electrical equipment from over-charge.

Note 4: Halt charging if the battery is overheated (battery electrolyte temperature is 50°C or above). For rapid charging, the limit is set to 55°C. In this case, the charging time must be within 1 hour.

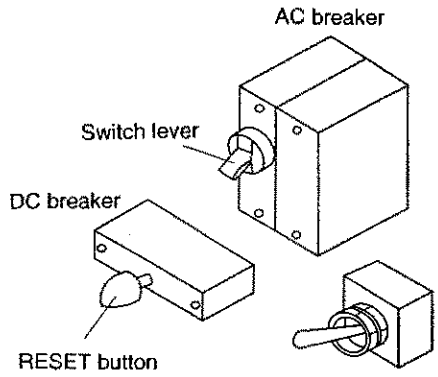
6.2 Control Panel Unit



Check for hardened lead insulation, rusting of terminals, faulty operations of mechanical parts of switches, abnormal resistances (electrical continuity) of electrical circuits and invasion by rain water.

6.2.1 Breaker and Switches

The no-fuse type breaker with switch function is used as the AC breaker while the no-fuse thermostat type breaker without switch function is adopted for the DC breaker which has the reset function.



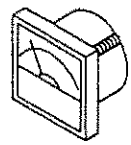
1) Inspection/Servicing

- Check terminals for rusting. If any, clean.
- Check mechanical parts such as levers and knobs for abnormal operations.
  If needed, replace faulty parts.
- Check the resistance (continuity) between terminals.
  If judged abnormal based on the requirements shown in Section 11, Circuit Diagram, replace.

Note: The DC breaker cannot be reset for about 10 sec after operation since the thermostat type breaker is adopted. Since no switch function is provided, carefully check during the continuity check.

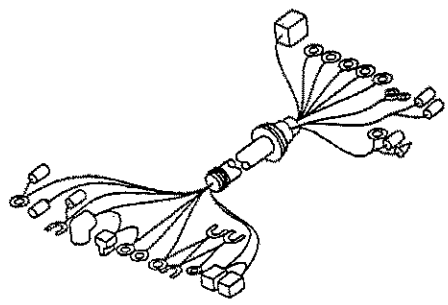
6.2.2 Voltmeter

1) Inspection/Servicing



- Check terminals for rusting. If any, clean.
- Check internal parts such as the pointer for water drop or invasion of rain water. If any, replace.
- Check the pointer for faulty "0" indication. If faulty, replace.

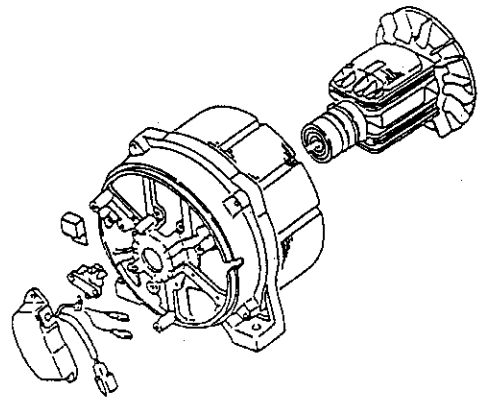
6.2.3 Wire Harness



- Check terminals for rusting. If any, clean.
- Check the resistance (electrical continuity) between terminals.
  If the resistance has increased because of an open circuit or excessive corrosion of terminals, replace.
- Check the cable insulator for cracks and hardening. If excessive, replace.

6.3 Generator Unit

Check mainly voltages and resistances (electrical continuity) of electrical parts including coils of rotor and stator, AVR and rectifier as well as wear of bearings and brush which is a consumable parts.



6.3.1 General Instructions

- Use the standard voltage and resistance values and wear limits listed in Table 6.3.7 as the criteria for checking electrical parts.
- All of the standard voltages listed in Table 6.3.7 as the voltage and resistance check criteria are at no-load, maximum speed.
  For this reason, always measure the voltage at no-load and maximum speed conditions.
  The standard no-load maximum speed is 3175±25 rpm for the 50-cycle model or 3775± 25 rpm for the 60-cycle model.

Note: If the speed is out of the standard range, adjust the speed by referring to Section 7, Adjustment Procedure.

- Use an analog circuit tester having less measurement errors for measuring the voltage and resistance which are very small. As for the ∞Ω resistance measurement, use the x1Ω measurement range. Since the resistance measurement is largely affected by the temperature, measure at a cool place (at 20°C) and compare the measured values with the standard value and operation limit.
- Both the AC and DC circuits exist. Make sure to confirm polarities (+) and (–) of the circuit before contacting test pins of the circuit tester when measuring a DC circuit. Pay attention to measurements and judgments of electrical parts containing diodes as measured values vary in the forward and reverse directions.

6.3.2 Electrical Parts Inspection and Quality Check Procedure

For measurements relative to inspections and OK/NG judgment based on measured results, use the standard voltage and resistance and operation limit list of Table 6.3.7 and Fig. 11.1.2, Circuit Diagram in Section 11 .

[Example]

Model:

YDG6600TE-5EB

Part name:

Rectifier, auto voltage regulator (AVR)

Table used:

Table 6.3.7-1 Standard voltages and resistances and operation limits

Figure used:

Fig. 11.1.2-5 Electrical Circuit diagram

Table 6.3.7-1 Standard voltage, resistance and operation limit (extraction)

Model	Classification			Rear housing						
	Product name			Rectifier		Auto voltage regulator (AVR)				Brush
	Measurement condition		Item	Voltage	Resistance	Resistance				Length
			Unit	V (DC)	Ω*1	Ω*1	Ω*1	Ω*1	Ω*2	mm
		Measurement point	Single-phase spec.	5-6	15-16 15-17	7-8	9-8 10-8		Other combi-nations	
			3-phase spec.			7-8	7-9 7-10	7-13 7-14		
		Disconnection specified parts		①,②,③	⑥-⑧	④-⑨,⑤-⑨,⑨-⑩,⑨-㉓				
YDG6600TE-5EB				135	20	20	20	20	∞	
Operation limit (% against standard value)				±10	±30	±30				

Note: The exemplified table and figure are simply called the table or figure in the description below.

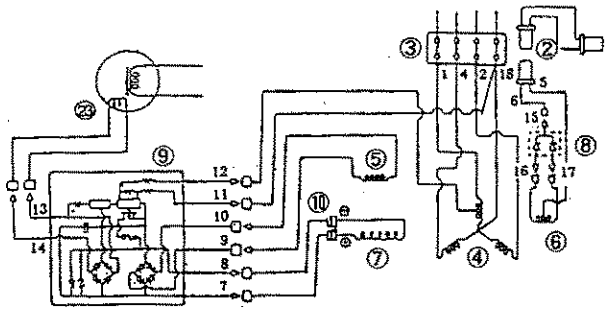
1) Rectifier (Judgment procedure by voltage check)

[1] Find the rectifier in the product name column of the table and read numerals indicated in the part identification column under the measurement condition, which are ①,② and ③.

[2] Find the product names, of ①, ②,③ locations and wiring diagrams using the figure. (Parts and wiring diagrams vary according to models. If those of a part are not founded, the part is excluded from the inspection and judgment.)

[3] Disconnect the specified parts ② and ③.

- ☐ Disconnection of coupler (Ⅱ) ②
- ☐ Disconnection of terminal ③



Parts name

② Coupler (Ⅱ) ③ Terminal ④ Armature coil
⑤ Exciter coil ⑥ DC coil ⑦ Field coil
⑧ Rectifier ⑨ Auto voltage regulator ⑩ Brush ㉓ Charging coil

Fig. 11.1.2-5 Circuit diagram (extraction)

[4] Next, read numerals indicated in the measurement point column under the measurement condition, which are 5-6.

[5] Find locations of measurement points 5 and 6 on the figure and measure voltages near these points.

☐ Measure voltages at terminals of coupler (II) ② to which leads 5 and 6 are connected.

[6] Make OK/NG judgment of the parts based on the measured values.
For judgment, use the standard values and operation limit indicated in the table.

☐ Multiply the standard value of 13.5V by ±10% operation limit to obtain tolerance of ±1.35V . Next, obtain the operation limit (tolerance range) based on the standard value and tolerance as: 13.5 ± 1.35V = 12.15 to 14.85V

[7] If the measured value is out of the specified operation limit, replace.

2) Rectifier (Judgment procedure by checking resistance)

The inspection and judgment procedures are the same as those for rectifier judgment by checking the voltage.

[1] Carry out steps [1] through [4] of the voltage check procedure using the table and figure. (Select ⑥ and ⑧ and obtain measurement points of 15-16 and 15-17.)

[2] Confirm locations of measurement points 15, 16 and 17 on the figure and measure each resistance.

☐ Measure the resistance between measurement points 15 (coupler) and 16, and between 15 and 17.

[3] For judgment, use the standard value and operation limit indicated under the model column in the table.

☐ Multiply 20Ω as the standard value (forward direction) by operation limit of ±30% to obtain ±6Ω as the tolerance. Next, obtain the operation limit (tolerance range) of 20±6Ω = 14 to 26Ω based on the standard value and tolerance. Make a judgment by collating with the measured values.

Note: The rectifier is composed of diodes. Therefore, measure both in the forward and reverse directions for making judgment. Obtain the operation limit in the reverse direction in the same manner as the forward direction. See Table 6.3.7 for standard values (standard voltage and resistance values and operation limit) in the reverse direction.

[4] Replace the rectifier if even one of the values measured in the forward and reverse directions fails to satisfy the operation limit.

3) Automatic voltage regulator (judgment procedure by resistance check)

The inspection and judgment procedures are the same as those of voltage check of the rectifier .

[1] Carry out steps [1] through [4] of the voltage check procedure using the table and figure. (Disconnect ④-⑨, ⑤-⑨, ⑨-⑩, and ⑨-㉓ and measure the resistance at 7-8, 7-9, 7-10, 7-13, 7-14 and other combination.)

Note: Be sure to read the 3-phase spec. column in step [4] above as all of our models are 3-phase specifications.

[2] Confirm locations of measurement points 7, 8, 9, 10, 11, 12, 13 and 14 on the figure and measure each resistance.
- ☐ Measure the resistance between measurement points 7 (coupler) and 8 through 10, between 7 and 13, between 7 and 14, and between other pairs.

[3] For judgment, use the standard value and operation limit indicated under the model column in the table.
- ☐ Multiply 20Ω as the standard value (forward direction) by operation limit of ±30% to obtain ±6 Ω as the tolerance. Next, obtain the operation limit (tolerance range) of 20±6Ω = 14 to 26Ω based on the standard value and tolerance. Make a judgment by collating with the measured values.

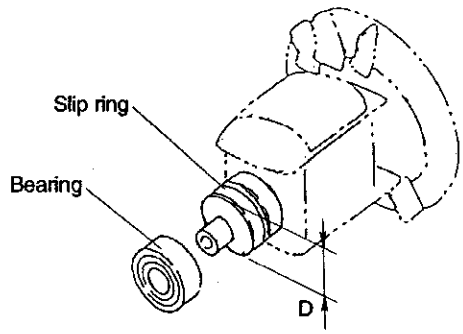
Note: The auto voltage regulator contains diodes. Therefore, measure both in the forward and reverse directions for making judgment. Obtain the operation limit in the reverse direction in the same manner as the forward direction. See Table 6.3.7 for standard values (standard voltage and resistance values and operation limit) in the reverse direction.

[4] Replace the auto voltage regulator if even one of measured values in the forward and reverse directions fails to satisfy the operation limit.

6.3.3 Ball Bearing

1) Inspection/Servicing

- Check for continuous or intermittent noises while the bearing is rotating.
  If any, replace the bearing.
- Check the bearing for play between inner and outer laces. If any, replace the bearing.
- Check the bearing for discoloration.
  If any, replace.



6.3.4 Slip Ring

1) Inspection/Servicing

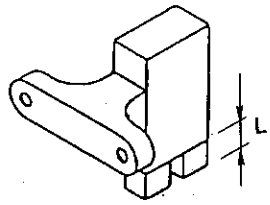
- Check the sliding surface for dirt, rough surface and dents/projections.
  If dirty, clean. If rough surface or dents/projections are observed, correct using sandpaper (#300 to #500).
- Measure diameter D for checking wear. If the wear exceeds the wear limit, replace the slip ring.

  Standard diameter D : 37.6 mm (YDG2700E, 3700E), 44.6 mm (YDG5500E, 6600TE)
  Operating D tolerance: 36.6 mm (YDG2700E, 3700E), 42.8 mm (YDG5500E, 6600TE)

6.3.5 Brush

1) Inspection/Servicing

- Measure length L for checking total wear and one-sided wear.
  If the total wear is excessive or wear is excessively one-sided, replace the brush.



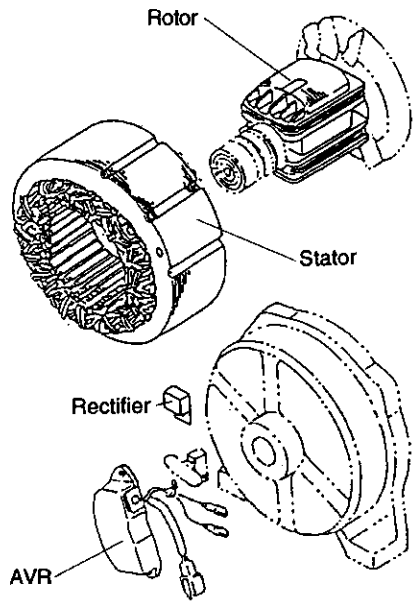
  Standard length of L : 9 mm
  Operating tolerance of L : 4 mm

- Check for faulty contact with the slip ring.
  If poor contact is causing an excessive resistance, replace the brush.

6.3.6 Coil, AVR and Rectifier

1) Inspection/Servicing

- Check terminals for rusting. If any, clean.
- Check cores and coils of the rotor and stator for contact each other and discoloration.
  If they contact each other, overloading is anticipated. So, check voltage and resistance (electrical continuity) of the coil (armature, exciter, DC or field coil) or AVR.
  If the voltage or resistance is abnormal or discoloration of the field core near the magnet mounted on the rotor is found, replace the faulty part.
- Check abnormal voltages and resistance, collating with the standard values.
  If voltage or resistance of a part exceeds the limit, replace the faulty part.



Note 1: See Table 6.3.7 for standard voltage and resistance values and the operation limit.

Note 2: Determine OK/NG of a part and necessity of replacement based on the standard voltage and resistance values and operation limit listed in Table 6.3.7.

6.3.7 Voltage and Resistance Table

1) Southeast Asia and Philippines

Table 6.3.7-1 Voltage, resistance and operation limit

Model	Classification		Stator						Rotor			Rear housing						
	Product name		Armature coil		Exciter coil		DC coil		Field coil		Slip ring	Rectifier		Auto voltage regulator (AVR)				Brush
	Measurement condition: Item		Volt-age	Resist-ance	Volt-age	Resist-ance	Volt-age	Resist-ance	Volt-age	Resist-ance	Dia-meter	Volt-age	Resist-ance	Resistance				Length
	Unit		V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	mm	V(AC)	Ω*1	Ω*1	Ω*1	Ω*1	Ω*2	mm
	Measurement point	Single-phase spec.	1-2 3-4	1-2 3-4	9-10	9-10	16-17	16-17	7-8	7-8		5-6	15-16 15-17	7-8	9-8 10-8		Other combi-nations	
		3-phase spec.	1-2 1-4 2-4	1-2 1-4 2-4										7-8	7-9 7-10	7-13 7-14		
	Disconnection specified parts		①,② ③	①,② ③	①,② ③	⑤-⑨	①,② ③ ⑥-⑧	⑥-⑧	①,② ③	⑨-⑩		①,② ③	⑥-⑧	④-⑨,⑤-⑨,⑨-⑩,⑨-㉓				
YDG2700E-5B			118	1.19	97	3.56	32	0.94	12	18.6	37.6	24	20	20	20	—	∞	9
YDG2700E-6B			118	0.79	97	3.02	32	0.74	12	18.6	37.6	24	20	20	20	—	∞	9
YDG3700E-5B			118	0.54	141	3.32	30	0.55	21	22.3	37.6	25	20	20	20	—	∞	9
YDG3700E-6B			118	0.39	141	2.81	30	0.47	21	22.3	37.6	25	20	20	20	—	∞	9
YDG5500E-5B			118	0.25	131	2.63	23	0.87	35	27.6	37.6	13.5	20	20	20	—	∞	9
YDG5500E-6B			118	0.17	131	2.27	23	0.68	35	27.6	37.6	13.5	20	20	20	—	∞	9
YDG2700E-5EB			118	1.19	97	3.56	32	0.94	12	18.6	37.6	24	20	20	20	—	∞	9
YDG2700E-6EB			118	0.79	97	3.02	32	0.74	12	18.6	37.6	24	20	20	20	—	∞	9
YDG3700E-5EB			118	0.54	141	3.32	30	0.55	21	22.3	37.6	25	20	20	20	—	∞	9
YDG3700E-6EB			118	0.39	141	2.81	30	0.47	21	22.3	37.6	25	20	20	20	—	∞	9
YDG5500E-5EB			118	0.25	131	2.63	23	0.87	35	27.6	44.6	13.5	20	20	20	—	∞	9
YDG5500E-6EB			118	0.17	131	2.27	23	0.68	35	27.6	44.6	13.5	20	20	20	—	∞	9
YDG6600TE-5EB			400	2.32	128	2.53	36	0.43	25	27.6	44.6	13.5	20	20	20	20	∞	9
YDG6600TE-6EB			400	1.69	128	2.39	36	0.40	25	27.6	44.6	13.5	20	20	20	20	∞	9
Operation limit (% against standard value)			±10	±20	±10	±20	±10	±20	±10	±20	-4	±10	±30	±30				-55

Note 1: Measure the voltage at no-load maximum speed.

Note 2: The standard resistance value is for the room temperature (20°C).

Note 3: Resistance of the rectifier and automatic voltage regulator (both with built-in diodes) vary with the measuring direction, forward or reverse.
Therefore, pay attention to polarities (+) and (–) of the probes of the circuit tester in use.

*1: The standard resistance value is indicated when measured with the former of the two numerals being the (+) polarity (forward direction).
Both the standard value and operation limit are ∞Ω when measured polarities are reversed (measurement in the reverse direction with the circuit tester set to x1Ω range)

*2: Both the standard value and operation limit in the forward and reverse directions are ∞Ω with the measurement range of circuit tester set to x1Ω.

*3: Measurement points and disconnction specified parts are indicated by numerals.
For actual locations and parts, see Fig. 11.1.2-1 through -5 in Section 11, Circuit Diagram.

2) Taiwan

Table 6.3.7-2 Voltage, resistance and operation limit

Model	Measurement condition	Classification	Stator						Rotor			Rear housing						
		Product name	Armature coil		Exciter coil		DC coil		Field coil		Slip ring	Rectifier		Auto voltage regulator (AVR)				Brush
		Item	Volt-age	Resist-ance	Volt-age	Resist-ance	Volt-age	Resist-ance	Volt-age	Resist-ance	Dia-meter	Volt-age	Resist-ance	Resistance				Length
		Unit	V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	mm	V(AC)	Ω*1	Ω*1	Ω*1	Ω*1	Ω*2	mm
	Measurement point: Single-phase spec.		1-2 3-4	1-2 3-4	9-10	9-10	16-17	16-17	7-8	7-8		5-6	15-16 15-17	7-8	9-8 10-8		Other combi-nations	
	Measurement point: 3-phase spec.		1-2 1-4 2-4	1-2 1-4 2-4										7-8	7-9 7-10	7-13 7-14		
	Disconnection specified parts		①,② ③	①,② ③	①,② ③	⑤-⑨	①,② ③ ⑥-⑧	⑥-⑧	①,② ③	⑨-⑩		①,② ③	⑥-⑧	④-⑨,⑤-⑨,⑨-⑩,⑨-㉓				
YDG2700E-6C			118	0.79	97	3.02	32	0.74	12	18.6	37.6	24	20	20	20	—	∞	9
YDG3700E-6C			118	0.39	141	2.81	30	0.47	21	22.3	37.6	25	20	20	20	—	∞	9
YDG5500E-6C			118	0.17	131	2.63	23	0.68	35	27.6	37.6	13.5	20	20	20	—	∞	9
YDG2700E-6EC			118	0.79	97	3.02	32	0.74	12	18.6	37.6	24	20	20	20	—	∞	9
YDG3700E-6EC			118	0.39	141	2.81	30	0.47	21	22.3	37.6	25	20	20	20	—	∞	9
YDG5500E-6EC			118	0.17	131	2.63	23	0.68	35	27.6	44.6	13.5	20	20	20	—	∞	9
Operation limit (% against standard value)			±10	±20	±10	±20	±10	±20	±10	±20	−4	±10	±30	±30				−55

Note 1: Measure the voltage at no-load maximum speed.

Note 2: The standard resistance value is for the room temperature (20°C).

Note 3: Resistance of the rectifier and automatic voltage regulator (both with built-in diodes) vary with the measuring direction, forward or reverse.
Therefore, pay attention to polarities (+) and (–) of the probes of the circuit tester in use.

*1: The standard resistance value is indicated when measured with the former of the two numerals being the (+) polarity (forward direction).
Both the standard value and operation limit are ∞Ω when measured polarities are reversed (measurement in the reverse direction with the circuit tester set to x1Ω range)

*2: Both the standard value and operation limit in the forward and reverse directions are ∞Ω with the measurement range of circuit tester set to x1Ω.

*3: Measurement points and disconnection specified parts are indicated by numerals.
For actual locations and parts, see Fig. 11.1.2-6 through -9 in Section 11, Circuit Diagram.

3) Australia

Table 6.3.7-3 Voltage, resistance and operation limit

Model	Classification		Stator						Rotor			Rear housing						
	Product name		Armature coil		Exciter coil		DC coil		Field coil		Slip ring	Rectifier		Auto voltage regulator (AVR)				Brush
	Item		Voltage	Resistance	Voltage	Resistance	Voltage	Resistance	Voltage	Resistance	Diameter	Voltage	Resistance	Resistance				Length
	Unit		V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	mm	V(AC)	Ω*1	Ω*1	Ω*1	Ω*1	Ω*2	mm
Measurement condition	Measurement point	Single-phase spec.	1-2 3-4	1-2 3-4	9-10	9-10	16-17	16-17	7-8	7-8		5-6	15-16 15-17	7-8	9-8 10-8		Other combinations	
		3-phase spec.	1-2 1-4 2-4	1-2 1-4 2-4										7-8	7-9 7-10	7-13 7-14		
	Disconnection specified parts		①,② ③	①,② ③	①,② ③	⑤-⑨	①,② ③ ⑥-⑧	⑥-⑧	①,② ③	⑨-⑩		①,② ③	⑥-⑧	④-⑨,⑤-⑨,⑨-⑩,⑨-㉓				
YDG2700E-5F			128	1.30	97	3.56	32	0.94	12	18.6	37.6	24	20	20	20	—	∞	9
YDG3700E-5F			128	0.59	141	3.32	30	0.55	21	22.3	37.6	25	20	20	20	—	∞	9
YDG5500E-5F			128	0.29	131	2.63	23	0.87	35	27.6	44.6	13.5	20	20	20	—	∞	9
YDG2700E-5EF			128	1.30	97	3.56	32	0.94	12	18.6	37.6	24	20	20	20	—	∞	9
YDG3700E-5EF			128	0.59	141	3.32	30	0.55	21	22.3	37.6	25	20	20	20	—	∞	9
YDG5500E-5EF			128	0.29	131	2.63	23	0.87	35	27.6	44.6	13.5	20	20	20	—	∞	9
Operation limit (% against standard value)			±10	±20	±10	±20	±10	±20	±10	±20	-4	±10	±30	±30				-55

Note 1: Measure the voltage at no-load maximum speed.

Note 2: The standard resistance value is for the room temperature (20°C).

Note 3: Resistance of the rectifier and automatic voltage regulator (both with built-in diodes) vary with the measuring direction, forward or reverse.
Therefore, pay attention to polarities (+) and (–) of the probes of the circuit tester in use.

*1: The standard resistance value is indicated when measured with the former of the two numerals being the (+) polarity (forward direction).
Both the standard value and operation limit are ∞Ω when measured polarities are reversed (measurement in the reverse direction with the circuit tester set to x1Ω range)

*2: Both the standard value and operation limit in the forward and reverse directions are ∞Ω with the measurement range of circuit tester set to x1Ω.

*3: Measurement points and disconnection specified parts are indicated by numerals.
For actual locations and parts, see Fig. 11.1.2-10 through -13 in Section 11, Circuit Diagram.

4) Saudi Arabia

Table 6.3.7-4 Voltage, resistance and operation limit

Model	Classification		Stator						Rotor			Rear housing						
	Product name		Armature coil		Exciter coil		DC coil		Field coil		Slip ring	Rectifier		Auto voltage regulator (AVR)				Brush
	Item		Voltage	Resistance	Voltage	Resistance	Voltage	Resistance	Voltage	Resistance	Diameter	Voltage	Resistance	Resistance				Length
	Unit		V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	mm	V(AC)	Ω*1	Ω*1	Ω*1	Ω*1	Ω*2	mm
Measurement condition	Measurement point	Single-phase spec.	1-2 3-4	1-2 3-4	9-10	9-10	16-17	16-17	7-8	7-8		5-6	15-16 15-17	7-8	9-8 10-8		Other combinations	
		3-phase spec.	1-2 1-4 2-4	1-2 1-4 2-4										7-8	7-9 7-10	7-13 7-14		
	Disconnection specified parts		①,② ③	①,② ③	①,② ③	⑤-⑨	①,② ③ ⑥-⑧	⑥-⑧	①,② ③	⑨-⑩		①,② ③	⑥-⑧	④-⑨,⑤-⑨,⑨-⑩,⑨-㉓				
YDG2700E-6CS			118	0.79	97	3.02	32	0.74	12	18.6	37.6	24	20	20	20	—	∞	9
YDG3700E-6CS			118	0.39	141	2.81	30	0.47	21	22.3	37.6	25	20	20	20	—	∞	9
YDG5500E-6ECS			118	0.17	131	2.27	23	0.68	35	27.6	44.6	13.5	20	20	20	—	∞	9
Operation limit (% against standard value)			±10	±20	±10	±20	±10	±20	±10	±20	-4	±10	±30	±30				-55

Note 1: Measure the voltage at no-load maximum speed.

Note 2: The standard resistance value is for the room temperature (20°C).

Note 3: Resistance of the rectifier and automatic voltage regulator (both with built-in diodes) vary with the measuring direction, forward or reverse.
Therefore, pay attention to polarities (+) and (–) of the probes of the circuit tester in use.

*1: The standard resistance value is indicated when measured with the former of the two numerals being the (+) polarity (forward direction).
Both the standard value and operation limit are ∞Ω when measured polarities are reversed (measurement in the reverse direction with the circuit tester set to x1Ω range)

*2: Both the standard value and operation limit in the forward and reverse directions are ∞Ω with the measurement range of circuit tester set to x1Ω.

*3: Measurement points and disconnection specified parts are indicated by numerals.
For actual locations and parts, see Fig. 11.1.2-14 through -15 in Section 11, Circuit Diagram.

5) Germany, Holland and Italy

Table 6.3.7-5 Voltage, resistance and operation limit

Model	Classification		Stator						Rotor			Rear housing						
	Product name		Armature coil		Exciter coil		DC coil		Field coil		Slip ring	Rectifier		Auto voltage regulator (AVR)				Brush
	Measurement condition	Item	Volt-age	Resist-ance	Volt-age	Resist-ance	Volt-age	Resist-ance	Volt-age	Resist-ance	Dia-meter	Volt-age	Resist-ance	Resistance				Length
		Unit	V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	mm	V(AC)	Ω*1	Ω*1	Ω*1	Ω*1	Ω*2	mm
		Measurement point: Single-phase spec.	1-2 3-4	1-2 3-4	9-10	9-10	16-17	16-17	7-8	7-8		5-6	15-16 15-17	7-8	9-8 10-8		Other combi-nations	
		Measurement point: 3-phase spec.	1-2 1-4 2-4	1-2 1-4 2-4										7-8	7-9 7-10	7-13 7-14		
		Disconnection specified parts	①,② ③	①,② ③	①,② ③	⑤-⑨	①,② ③ ⑥-⑧	⑥-⑧	①,② ③	⑨-⑩		①,② ③	⑥-⑧	④-⑨,⑤-⑨,⑨-⑩,⑨-㉓				
YDG2700E-5BG			123	1.25	97	3.56	32	0.74	12	18.6	37.6	24	20	20	20	—	∞	9
YDG3700E-5BG			123	0.57	141	3.32	30	0.47	21	22.3	37.6	25	20	20	20	—	∞	9
YDG5500E-5BG			123	0.23	124	2.48	30	0.52	35	27.6	44.6	25	20	20	20	—	∞	9
YDG2700E-5EBG			123	1.25	97	3.56	32	0.74	12	18.6	37.6	24	20	20	20	—	∞	9
YDG3700E-5EBG			123	0.57	141	3.32	30	0.47	21	22.3	37.6	25	20	20	20	—	∞	9
YDG5500E-5EBG			123	0.23	124	2.48	30	0.52	35	27.6	44.6	25	20	20	20	—	∞	9
YDG6600TE-5EBG			420	2.36	132	2.53	37	0.42	25	27.6	44.6	12	20	20	20	20	∞	9
Operation limit (% against standard value)			±10	±20	±10	±20	±10	±20	±10	±20	-4	±10	±30	±30				-55

Note 1: Measure the voltage at no-load maximum speed.

Note 2: The standard resistance value is for the room temperature (20°C).

Note 3: Resistance of the rectifier and automatic voltage regulator (both with built-in diodes) vary with the measuring direction, forward or reverse.
Therefore, pay attention to polarities (+) and (–) of the probes of the circuit tester in use.

*1: The standard resistance value is indicated when measured with the former of the two numerals being the (+) polarity (forward direction).
Both the standard value and operation limit are ∞Ω when measured polarities are reversed (measurement in the reverse direction with the circuit tester set to x1Ω range)

*2: Both the standard value and operation limit in the forward and reverse directions are ∞Ω with the measurement range of circuit tester set to x1Ω.

*3: Measurement points and disconnection specified parts are indicated by numerals.
For actual locations and parts, see Fig. 11.1.2-16 through -20 in Section 11, Circuit Diagram.

6) Norway

Table 6.3.7-6 Voltage, resistance and operation limit

Model	Classification		Stator						Rotor			Rear housing						
	Product name		Armature coil		Exciter coil		DC coil		Field coil		Slip ring	Rectifier		Auto voltage regulator (AVR)				Brush
	Measurement condition: Item		Volt-age	Resist-ance	Volt-age	Resist-ance	Volt-age	Resist-ance	Volt-age	Resist-ance	Dia-meter	Volt-age	Resist-ance	Resistance				Length
	Unit		V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	mm	V(AC)	Ω*1	Ω*1	Ω*1	Ω*1	Ω*2	mm
	Measurement point	Single-phase spec.	1-2 3-4	1-2 3-4	9-10	9-10	16-17	16-17	7-8	7-8		5-6	15-16 15-17	7-8	9-8 10-8		Other combi-nations	
		3-phase spec.	1-2 1-4 2-4	1-2 1-4 2-4										7-8	7-9 7-10	7-13 7-14		
	Disconnection specified parts		①,② ③	①,② ③	①,② ③	⑤-⑨	①,② ③ ⑥-⑧	⑥-⑧	①,② ③	⑨-⑩		①,② ③	⑥-⑧	④-⑨,⑤-⑨,⑨-⑩,⑨-㉓				
YDG6600TE-5EBN			240	0.76	132	2.53	37	0.42	25	27.6	44.6	12	20	20	20	20	∞	9
Operation limit (% against standard value)			±10	±20	±10	±20	±10	±20	±10	±20	−4	±10	±30	±30				−55

Note 1: Measure the voltage at no-load maximum speed.

Note 2: The standard resistance value is for the room temperature (20°C).

Note 3: Resistance of the rectifier and automatic voltage regulator (both with built-in diodes) vary with the measuring direction, forward or reverse.
Therefore, pay attention to polarities (+) and (–) of the probes of the circuit tester in use.

*1: The standard resistance value is indicated when measured with the former of the two numerals being the (+) polarity (forward direction).
Both the standard value and operation limit are ∞Ω when measured polarities are reversed (measurement in the reverse direction with the circuit tester set to x1 Ω range)

*2: Both the standard value and operation limit in the forward and reverse directions are ∞Ω with the measurement range of circuit tester set to x1 Ω.

*3: Measurement points and disconnection specified parts are indicated by numerals.
For actual locations and parts, see Fig. 11.1.2-21 in Section 11, Circuit Diagram.

7) U.S.A. and Canada

Table 6.3.7-7 Voltage, resistance and operation limit

Model	Classification		Stator						Rotor			Rear housing						
	Product name		Armature coil		Exciter coil		DC coil		Field coil		Slip ring	Rectifier		Auto voltage regulator (AVR)				Brush
	Measurement condition	Item												Resistance				Length
		Unit	V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	V(AC)	Ω	mm	V(AC)	Ω*1	Ω*1	Ω*1	Ω*1	Ω*2	mm
		Measurement point: Single-phase spec.	1-2 3-4	1-2 3-4	9-10	9-10	16-17	16-17	7-8	7-8		5-6	15-16 15-17	7-8	9-8 10-8		Other combi-nations	
		Measurement point: 3-phase spec.	1-2 1-4 2-4	1-2 1-4 2-4										7-8	7-9 7-10	7-13 7-14		
		Disconnection specified parts	①,② ③	①,② ③	①,② ③	⑤-⑨	①,② ③ ⑥-⑧	⑥-⑧	①,② ③	⑨-⑩		①,② ③	⑥-⑧	④-⑨,⑤-⑨,⑨-⑩,⑨-㉓				
YDG2700E-6EH			128	0.97	97	3.02	32	0.74	12	18.6	37.6	24	20	20	20	—	∞	9
YDG3700E-6EH			128	0.44	141	2.81	30	0.47	21	22.3	37.6	25	20	20	20	—	∞	9
YDG5500E-6EH			128	0.21	131	2.27	23	0.68	35	27.6	44.6	13.5	20	20	20	—	∞	9
Operation limit (% against standard value)			±10	±20	±10	±20	±10	±20	±10	±20	−4	±10	±30	±30				−55

Note 1: Measure the voltage at no-load maximum speed.

Note 2: The standard resistance value is for the room temperature (20°C).

Note 3: Resistance of the rectifier and automatic voltage regulator (both with built-in diodes) vary with the measuring direction, forward or reverse.
Therefore, pay attention to polarities (+) and (−) of the probes of the circuit tester in use.

*1: The standard resistance value is indicated when measured with the former of the two numerals being the (+) polarity (forward direction).
Both the standard value and operation limit are ∞Ω when measured polarities are reversed (measurement in the reverse direction with the circuit tester set to x1Ω range)

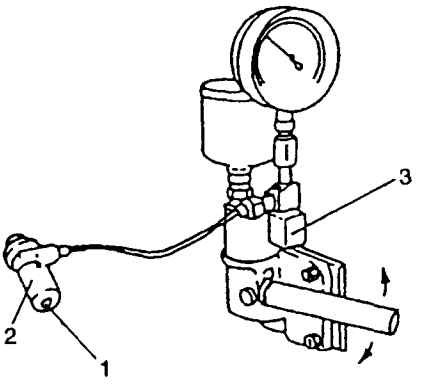
*2: Both the standard value and operation limit in the forward and reverse directions are ∞Ω with the measurement range of circuit tester set to x1Ω.

*3: Measurement points and disconnection specified parts are indicated by numerals.
For actual locations and parts, see Fig. 11.1.2-22 through -23 in Section 11, Circuit Diagram.

6.4 Engine Unit

This section describes only several component parts of the engine including the fuel injection valve, fuel injection pump and filters. For other component parts, refer to the service manual described in the FOREWORD of this manual. And for the EPA and ARB-OR certified engines, the fuel injection valve, fuel injection pump and injection timing adjustment are especially important, so refer to the L48EE, L70EE, L100EE service manual.

6.4.1 General Instructions



- Pay special attention to safety as you will handle high-pressure fuel during the work instructed in this section. Wear protective goggles during spray test of the fuel injection valve without fail, to protect your eyes.
  Also, avoid direct contact of your skin to injected fuel. Otherwise, your eyes may be damaged or your skin may be burnt.
- When disassembly, reassembly and adjustment are needed as a result of inspection, see Section 7, Adjustment Procedures.
- Generally, air remains in the fuel path after disassembly inspection of the fuel system components. Therefore, make sure to completely purge the remaining air at the end of the work.

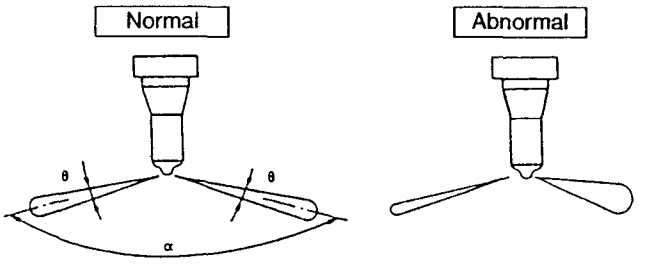
6.4.2 Fuel Injection Valve

1) Preparation for cleaning and inspection

- Clean carbon from nozzle 1.
- Connect fuel injection valve 2 to nozzle tester 3.

2) Inspection/Servicing

- Spray pattern
  Inject the fuel once or twice a second and check the spray pattern. If the shape is abnormal, clean the inside and adjust the injection pressure, or replace the valve.



• Uniform spray from all nozzles

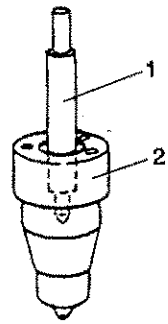
• Excessive angle difference (θ)
• Excessive difference of injection angle (α)
• Non-atomized spray throughout the entire spray pattern
• Poor shut-off of injection

- Fuel injection starting pressure
  Check the fuel injection starting pressure P.
  If the P value is out of the standard range, clean the inside and adjust the injection pressure or replace the valve.

  Standard pressure : 200 to 210 kgf/cm^2

Note: Be careful of the pressure as the standard range for a new nozzle is set to 210 to 220 kgf/cm^2 under consideration of conditioning during the initial period.

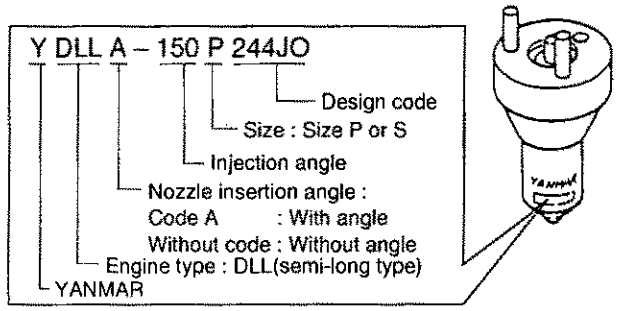
- Oil tightness at nozzle seat
  After 2 or 3 injections, hold at a pressure about 20 kgf/cm^2 lower than the injection starting pressure for 5 seconds and check for fuel leakage from the injection portion. If leakage is observed, clean the inside and adjust the injection pressure or replace the nozzle.
- Needle valve operation
  Clean the needle valve by the fuel and insert the tip of needle valve 1 (by about 1/3 of the overall length). Check that the needle valve drops by its weight.

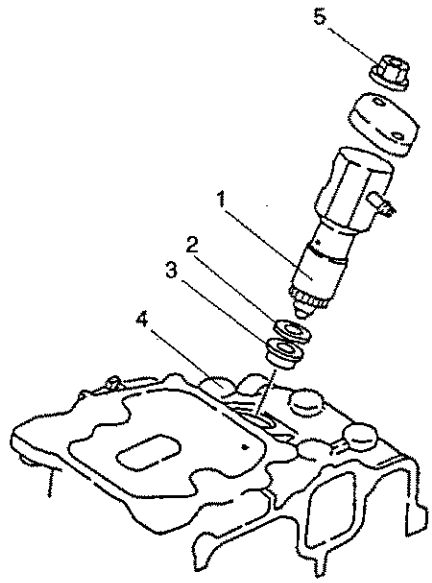


3) Replacement and reassembly

- Nozzle replacement
  Remove the seal peel from the outer periphery of a new nozzle and wash off the rust-proof oil from the needle valve and nozzle using the fuel. For detailed replacement procedure, see 7.3 Fuel Injection Valve in Section 7.
- Marking in nozzle
  The type, size, injection angle, etc. are marked in the nozzle.
  Check the marks in addition to the product code with the used one when replacing the nozzle.
- Reassembly of fuel injection valve
  Insert injection valve 1 into head 4, together with nozzle spacer 2 and nozzle packing 3. Then, tighten with injection valve set nut 5.

  Tightening torque: 1.1 to 1.3 kgf-m



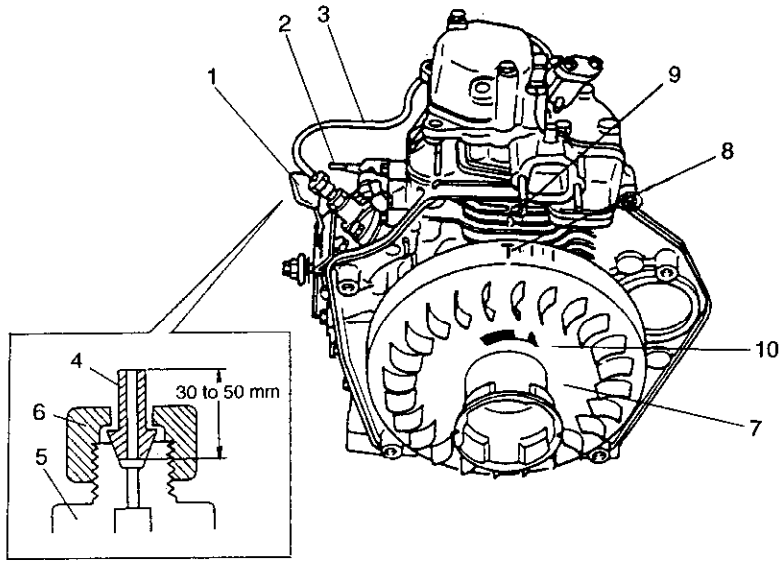


Note: The nozzle packing also functions to shut off heat from the cylinder head, to protect the nozzle. Make sure also to replace the nozzle packing whenever the fuel injection valve is reassembled.

6.4.3 Fuel Injection Pump

1) Inspection/Servicing

- Pump injection timing :
  Check the injection timing using the following procedure:
  ① Remove the fan case.
  ② Set governor lever 1 to the RUN position.
  ③ Set decomp lever 2 to the no compression position.
  ④ Remove fuel injection pipe 3.
  ⑤ Fix inspection injection pipe 4 to delivery valve holder 5 of the injection pump using nut 6.



Note: When the delivery valve holder is loosened during removal of the inspection injection pipe, retighten to the specified torque.

Tightening torque : 3.0 to 3.5 kgf-m

⑥ Align T marking 8 of flywheel 7 to U-groove 9 of the cooling fin (top dead center of compression). Check that the fuel is injected when the flywheel, under the above condition, is moved 30-deg back and forth.

⑦ Turn the flywheel in the direction of arrow 10 and check the fuel injection starting timing θ (angle difference between T marking and U-groove) by stopping the flywheel at the moment the fuel is injected from the inspection injection pipe.
If the injection timing is out of the specified range, adjust.

Standard θ range : 13 to 15 deg. (YDG2700E, 3700E)
12 to 14 deg. (YDG5500E, 6600TE)

Note: One scale of lines following the T marking represents 5 deg.

2) Air purging procedure from fuel path

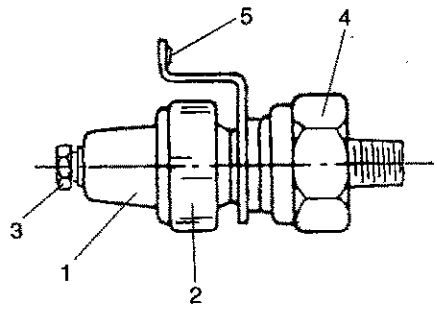
Purge the air from the fuel path using the following procedure:

① Loosen the cap nut (on the injection valve side) of the fuel injection pipe.
② Set the governor lever to the RUN position.
③ Set the decomp lever to the no compression position.
④ Rotate the flywheel (crankshaft) and check that the fuel leaks out of the cap nut.
⑤ Tighten the cap nut.

6.4.4 Oil Pressure Sender

The oil pressure sender contains a switch function in it.
Check resistance at switch ON/OFF during inspection, as the yardstick.

1) Inspection/Servicing



- Measure resistance R1 between main body 2 and terminal 3, and between main body 4 of the insulator joint and ground terminal 5 of sender 1. If measured values are below the standard value, replace the oil pressure sender.

  Standard R1 resistance :
  Infinite (at 1 x Ω measurement range)

- Measure resistance R2 between terminal 3 and ground terminal 5. If the measured value exceeds the operation limit, replace the sender.

  Standard R2 resistance : 0.2 Ω (at 1 x Ω measurement range)
  Operation limit for R2 : 0.4 Ω (at 1 x Ω measurement range)

- Install the sender to the engine (leave the lead disconnected), start the engine and measure resistance R3 between terminal 3 and ground terminal 5 while the engine is running. If the measured value is below the standard value, replace the sender.

  Standard R3 resistance : ∞ Ω (at 1 x Ω measurement range)

Note: In order to avoid use of a joint with damaged internal insulator, always replace the oil pressure sender and insulator joint as a set.

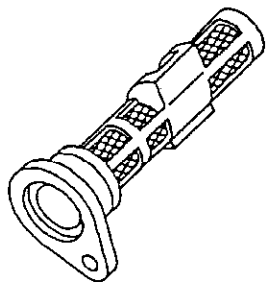
6.4.5 Filters

Inspection and overhaul maintenance of filters are essential to maintain the engine's initial performance and durability. It is recommended to conduct inspection and overhaul maintenance at appropriate intervals under consideration on the operating conditions, in addition to the periodic maintenance.

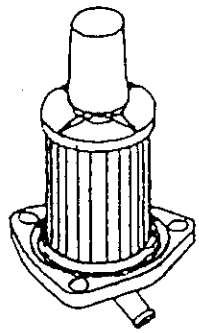
1) Inspection/Servicing

- Oil filter and fuel filter:
  Check for dirty element, contamination by foreign matter and breakage.
  If they are dirty or contaminated by foreign matter, wash with kerosene or diesel oil.
  If they are broken or their lives have expired, replace.

  Standard service life L :
  400 hrs (fuel filter)
  1000 hrs (oil filter)



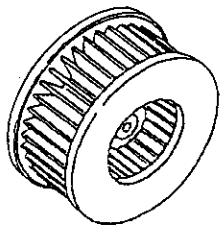
Oil filter

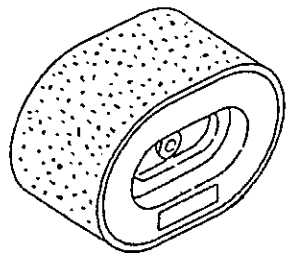


Fuel filter

- Air cleaner
  Check for dirty element, contamination by foreign matter and breakage.
  If contaminated by large-particle foreign matter, remove by air blow.
  If the element is excessively dirty or broken or the life has expired, replace.

  Standard service life L : 400 hrs





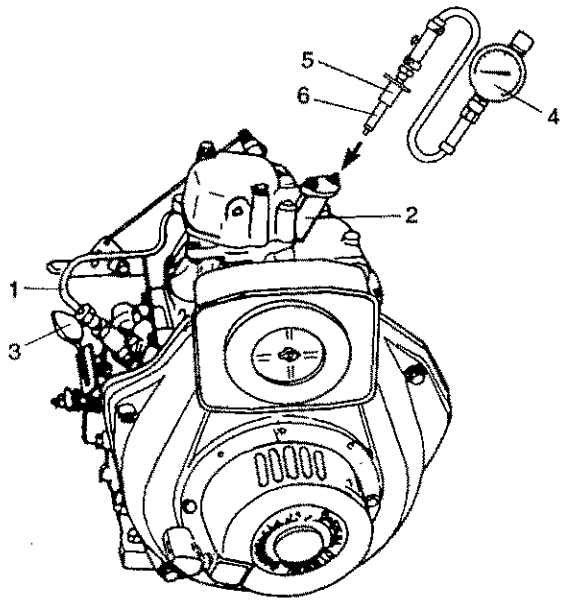
Note: Maintain the air pressure for air blow below 2 kg/cm^2, to protect the element from damage. The wet type element is used on the condition that it is used as the throwaway part. Therefore, avoid reuse the element after washing by diesel oil.

6.4.6 Liner, Piston and Intake/Exhaust Valve

Worn seats of liner, piston and intake valve or deformation and breakage of the cylinder head gasket lower the compression pressure, causing blow-by, poor starting and low output. This section gives the procedure for measuring the compression pressure, which is essential for diagnosing abnormalities of the engine. Use the compression pressure as the measure for judging necessity of engine overhaul inspection and maintenance.

1) Inspection/Servicing

- Compression pressure
  Measure the compression pressure using the following procedure:
  ① Start the engine and maintain at idling. Remove fuel injection pipe 1 and fuel injection valve 2.
  ② Set the governor lever 3 to the STOP position and carry out cranking 5 or 6 times.
  ③ Fix adapter 5 of compression gage 4 to the fuel injection valve joint, together with gasket 6.



Note: Pay attention so that the tip of the adapter does not protrude into the combustion chamber.

④ After cranking, wait until the pressure stabilizes and read the compression pressure P.
If the measured pressure exceeds the operation limit (range) shown in Fig. 6.4.6, repair or replace the parts including related parts.

Standard pressure P :
30 kgf/cm²/300 rpm
(starting motor specification)
25 kgf/cm²/500 rpm
(recoil starter specification)
Operation limit P :
25 kgf/cm²/300 rpm (starting motor specification)
20 kgf/cm²/500 rpm (recoil starter specification)

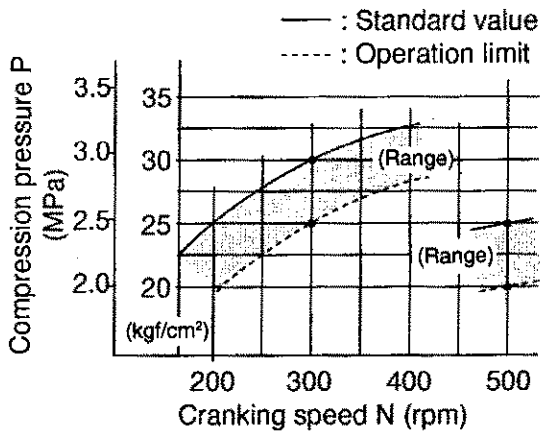


Fig.6.4.6 Compression pressure

Note: Continuous cranking for the starting motor specification engine must be completed within 15 seconds. Otherwise, the motor will be burnt. To repeat cranking, always cool down the motor at least for 15 seconds.

7. Adjustment Procedures

This section gives the adjustment procedures conducted after factory assembly. All adjustments are made on the engine. For the adjustment work, knowledge relative to safety and necessary for ensuring excellent performance is essential. Thoroughly read Section 1, Safety, Section 4, Structure of Generator Set and the following pages before beginning adjustments.

7.1 Before Starting Operation

7.1.1 Preparing Tools, Parts and Materials

- Prepare the necessary general tools, special tools and measuring instruments, referring to Section 12, Machines, Tools, Instruments and Other Materials for Inspection and Maintenance.
- Prepare a case for storing disassembled parts and a container for collecting waste oil.
- Prepare necessary materials such as the engine oil, grease and washing fluid at the time of adjustment.
- Prepare packing basically requiring replacement and parts which are estimated to be replaced at the time of adjustment. Always prepare genuine parts.

7.2 Intake/Exhaust Valve

The valve clearance adjustment procedure is described below. Carry out the work according to 4.5.1 Engine in Section 4 and 4.5.6 Cooling and Starting Systems.

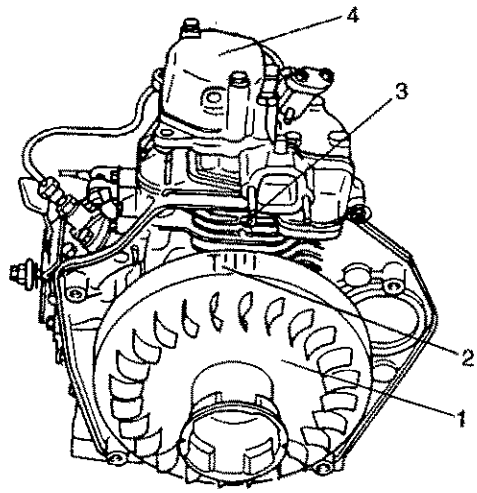
7.2.1 Adjustment Procedure

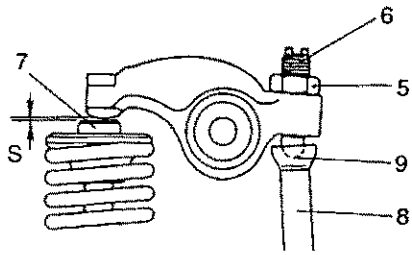
Always carry out the clearance adjustment while the engine is cool. If adjusted while the engine is hot, the correct clearance will not be obtained even if you adjust exactly to the standard value.

① Remove the fan case and turn the flywheel once to position the piston at the compression top dead center (the T marking 2 of flywheel aligns with the U-groove 3).
② Remove bonnet 4.
③ Loosen lock nut 5 of the rocker arm and adjusting screw 6.
④ Insert the clearance gage (0.15 mm thick) into the gap S of the intake/exhaust valve head 7 and adjust the clearance by the adjusting screw.

Standard clearance S: 0.10 to 0.20 mm

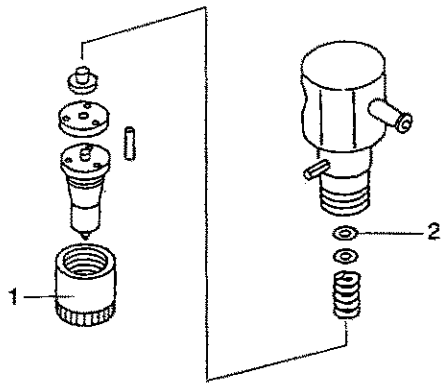
⑤ Secure the adjusting screw and tighten the lock nut.
⑥ Apply the engine oil to contact surface 9 of push rod 8.





7.3 Fuel Injection Valve

The procedure for adjusting the fuel injection pressure is explained below.
As for performance check after adjustment, see Section 6, Inspection and Maintenance.



7.3.1 Adjustment Procedure

① Remove nozzle case 1.
② Change thickness T of adjustment shim 2 based on the measurement result of fuel injection pressure P using the nozzle tester.

Standard pressure P: 200 to 210 kgf/cm^2
Shim thickness T: 0.15, 0.40, 0.50, 0.60, 0.70 and 0.80 mm

Note: Injection pressure P increases approximately 20 kgf/cm^2 per 0.1 mm of shim thickness increment.

③ Tighten the nozzle case.

Tightening torque: 4.0 to 4.5 kgf-m

④ Check the performance using the nozzle tester.

7.4 Fuel Injection Pump

This section gives the adjustment procedures for the injection timing at lowland and highland as well as the model selection accommodating the lower output at highland.
As for the injection timing check and air purging procedures, see Section 6 Inspection and Maintenance.

7.4.1 Adjustment Procedure

1) Flatland specification

All diesel generators shipped from the factory are lowland specifications.
When the generator is used at a high altitude, change of the injection timing is required as explained later.

① Loosen pump set nut 1 and remove injection pump 2.

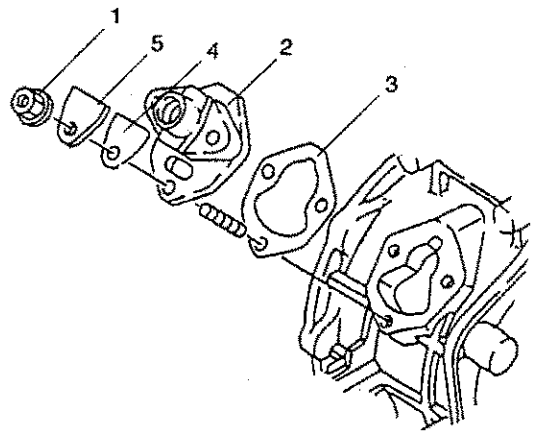
② Change thickness T of adjustment shim 3 based on the measured injection timing θ.

Standard θ:

13 to 15 deg. (YDG2700E, 3700E)
12 to 14 deg. (YDG5500E, 6600TE)

Shim thickness T:

0.10, 0.15, 0.20, 0.25, 0.30 and 0.35 mm



Note 1: To shorten the injection timing (to increase θ), reduce shim thickness T.
For slow injection timing, increase shim thickness T.

Note 2: Injection timing θ is varied by 1 deg. for each 0.10 mm change in shim thickness.

③ Tighten the injection pump together with packing 4 and cover 5, by the pump set nut.

Tightening torque: 1.1 to 1.3 kgf-m

④ Confirm the injection timing and carry of air purging.

2) Highland specification

As the atmospheric pressure is low causing the air supplied to the engine to be reduced at a high altitude, the injection time should be shorter than the lowland. Insufficient air supply can become the cause of incomplete combustion resulting in blue-white smoke at idling and black smoke at overload operation and increase in exhaust temperature caused by delay of combustion, which is dangerous as a fire may occur. As the engine output also is reduced (failure caused by overload operation and adversely affected durability). Make sure to adjust the injection timing using the procedure explained below whenever a diesel generator is used at a high altitude place. The procedure is described on the assumption that the injection timing θ (shim thickness T) is properly adjusted for use at lowland.

Note 1: Adjustment of injection timing does not prevent reduction in engine output. Note that the adjustment only improves combustion performance such as the exhaust color and temperature.

Note 2: Make sure to return to the original injection timing when the generator is reused at lowland.

① Complete adjustment of injection timing θ for the lowland and take note of adjustment shim thickness T.

② Obtain shim slickness ΔT to be decreased and injection timing Δθ to be increased based on the altitude H where the diesel generator is used and the correction shim thickness shown in Fig. 7.4.1.

[Example]
Assume that the conditions for use are:
Altitude: H = 2150 m
Injection timing (lowland):
θ = 14 deg.
Shim thickness (lowland):
T = 0.50 mm

ΔT and Δθ are obtained from the figure as,
ΔT = 0.3 mm, Δθ = 3 deg.

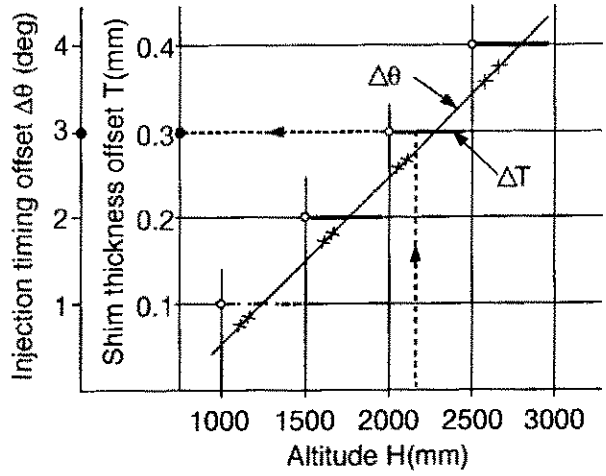


Fig. 7.4.1 Offset shim thickness

Consequently, the shim thickness and injection timing required at that high altitude are,

Shim thickness (highland): $T_h = T - \Delta T = 0.2$ mm
Injection timing (highland): $\theta_h = \theta + \Delta\theta = 17$ deg.

Note: When altitude H is below 1500 m, no shim thickness correction is needed.

③ Other than the above are the same as those for the lowland.

7.4.2 Output Decrease and Model Selection for Use in Highland

The diesel generator output lowers as shown below when a diesel generator is used at a high altitude place. For this reason, a model should be selected under thorough consideration on the load to be used and drop of the output. Since there are cases where overload operations are forced to generators because of poor model selection, begin repair after confirmation of the injection timing and taking the overloaded operation into account.

1) Calculating the decrease in output

The output of a generator at a high altitude place is obtained based on the output NE and NG at lowland .

[Example]

Assume that the operating conditions are:

Model: YDG3700E-5B
Altitude: H = 2150 m
Engine output (lowland):
NE = 4.0 kW
Generator output (lowland):
NG = 3.0 kVA

Output reduction ratio δ is calculated based on the altitude H and output reduction relationships shown in Fig. 7.4.2:

δ = 28%

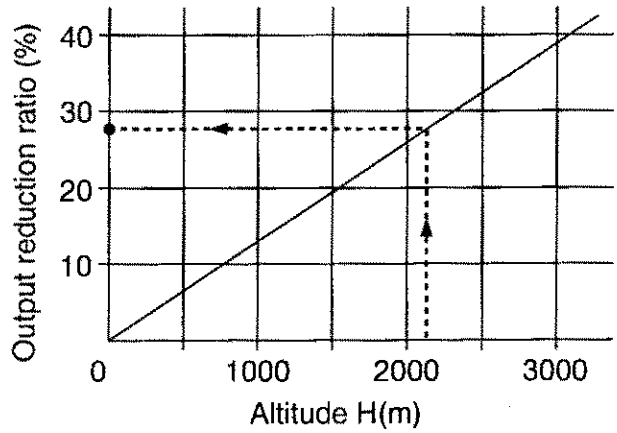


Fig. 7.4.2 Altitude vs output reduction

Consequently, the output at the high altitude is:

Engine output (highland): $NE_h = NE - (NE \times \delta) = 4.0–1.1 = 2.9$ kW
Generator output (highland): $NG_h = NG - (NG \times \delta) = 3.0–0.8 = 2.2$ kVA

2) Method for model selection

Before selecting a model, it is important to obtain the necessary output required for the generator based on the types and number of loads and their characteristics. Next, obtain the output of a generator at the altitude to be used. Then, select a model of which output is sufficiently greater than the required output.

7.5 Fuel Injection Controller

The fuel injection controller (limiter) restricts the amount of fuel injected to obtain the rated output at the rated revolution. The fuel limiter therefore must be adjusted correctly using the procedure described below, in order to avoid insufficient output and drop in durability caused by overloading.

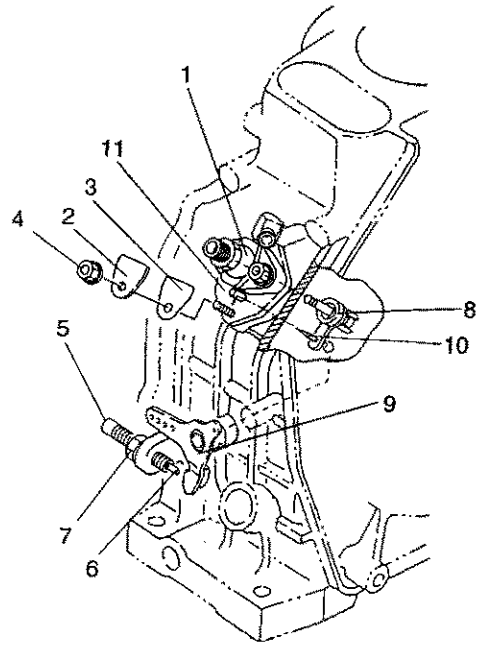
7.5.1 Adjustment Procedure

① Remove cover 2 of fuel injection pump 1 and packing 3 together with nut 4.
② Confirm operation of piece 6 installed to fuel limiter 5 and then loosen nut 7.

Note: A spring is built in the fuel limiter, and the piece is always pushed outwards. If the piece operation is abnormal, apply grease to the piece sliding surfaces or replace it.

③ Operate governor lever 9 linked with control lever 8 of the fuel injection pump to align the needle 10 with marking 11 indicated on the fuel pump inspection window.
④ With the needle being aligned, hold the governor lever, make the tip of the fuel limiter piece to contact with the governor lever and tighten the nut.

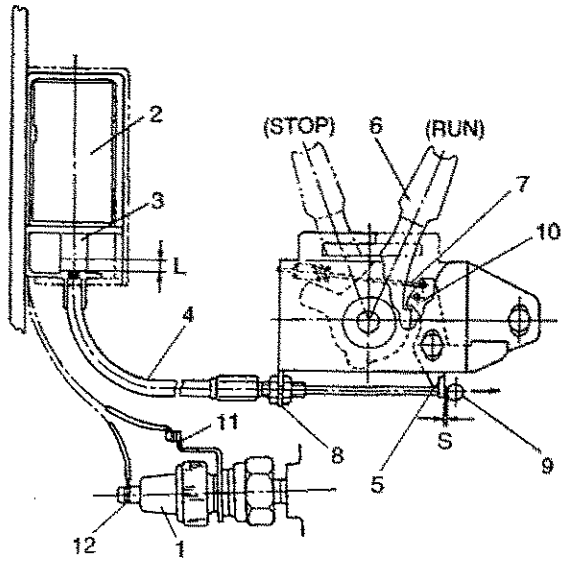
Note: Pay attention that the piece contacts without being pushed in.



7.6 Emergency Stop Function

The function automatically stops the diesel generator when the lubrication oil level is lower than the specified lower limit.

7.6.1 Outline of Emergency Stop System



The delivery pressure of the lubricant pump drops when its intake volume decreases as the oil level decreases. The emergency stop system uses this phenomenon. The system uses the oil pressure sender as the base, which detects the lubricant pressure, for stopping the diesel generator in the following sequence.

- ☐ The circuit of oil pressure sender 1 turns ON upon sensing low oil level (insufficient lubrication oil quantity).
- ☐ When the circuit turns on, the DC power of the engine is fed to DC solenoid 2 through the relay.
- ☐ The plunger 3 of the solenoid is pulled to activate stop lever 5 through Bowden wire 4.
- ☐ The activated stop lever releases the locking to make speed control lever 6 to automatically return from RUN to STOP position.

7.6.2 Adjustment Procedure

① Check the return spring 7 mounting position (upper hole).

② Set the speed control lever 6 to the RUN position.

③ Loosen nut 8 of Bowden wire 4.

④ Pull tip piece 9 of the inner wire in the direction of arrow, adjust the nut to ensure clearance S between the piece and stop lever 5 and tighten the nut.

Standard clearance S: 0 to 0.5 mm

⑤ Push up plunger 3 of DC solenoid 2 and check the lock releasing operation of the speed control lever. Make judgment based on the plunger travel L needed for releasing the locking.

Standard dimension L: 4.4 to 4.8 mm

Note: When the lock releasing operation is unstable or stop lever related parts are disassembled, apply grease to sliding surfaces and nail 10.

⑥ After completion of the adjustment, start the engine and check operation of the auto stopping function during the engine is running. To check during engine operation, check by short-circuiting terminals 11 and 12 of oil pressure sender 1.

7.7 Governor

This section gives the adjustment procedure at no-load maximum speed.

7.7.1 Preparation for Adjustment

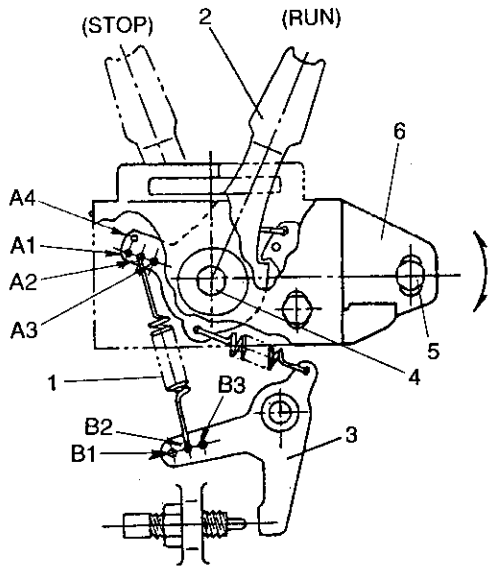
① Prepare a speedometer.

Note: Select a contact, photoelectric, or fuel injection pipe clamp type speedometer.

② Check the hole A or B to which governor spring 1 is mounted.

Note: Be careful since holes A and B vary according to the model and specification. There are 4 holes, A1 through A4, for speed control lever 2 and 3 holes, B1 through B3, for speed control lever 3, and each one of them is selected.

- ☐ YDG2700E, 3700E, 5500E:
  A1-B3 (50 Hz specification)
  A1-B2 (60 Hz specification)
- ☐ YDG6600TE:
  A2-B3 (50 Hz specification)
  A2-B2 (60 Hz specification)



7.7.2 Adjustment Procedure

① Set the speed control lever 2 to the RUN position and start the engine.

② Slightly loosen bolts 4 and 5 and move bracket 6 in the direction of arrow to obtain the specified no-load maximum speed N.

Standard speed N:
3175 ± 25 rpm (50 Hz specification), 3775 ± 25 rpm (60 Hz specification)

Note: Since increase of the magnetic current is enforced to the diesel generator when the no-load maximum speed N is lower than the standard, causing malfunctions to the AVR, in an attempt to decrease the engine load, always observe the specified N value.

③ Hold the bracket while maintaining the specified speed and tighten bolts 5 and 4.

8. Quality Standards for Fuels and Lubricants

This section gives the quality standards for fuels and lubricants used for the engine.
To ensure and maintain good qualities of fuel and lubricant are essential for maintaining the initial engine performance. Section 16 describes in detail why their qualities are important.
Read through the explanations for describes operators who often lack such knowledge and as reference for troubleshooting, inspection and servicing.

8.1 Fuels

In order to operate the engine, the diesel oils having the standards listed below are required.

8.1.1 Standards and Characteristics

Table 8.1.1-1 lists the fuel oil standards. Fuels are standardized according to characteristics representing their qualities and affecting the engine performance including the cetane number (or cetane index), sulfur content and CFPP (or pour point).

- As standards of fuel oils used for the engine are listed in Table 8.1.1-1, use one of them, i.e., JIS K2404 (Japan), BS2869 (England) or EN590 (EU) or fuels satisfying the standard.

Table 8.1.1-1 Diesel Engine Fuel standards and characteristics list

Standard Title	*1 Type	Characteristic													Country
		Cetane Number	Cetane Index	Sulfur Content %	*2 CFPP (plugging point) °C	Pour Point °C	10% Residual Carbon %	Ash Content %	Kinematic Viscosity cSt 30°C	Kinematic Viscosity cSt 40°C	Distillation Performance °C 90%	Distillation Performance °C 95%	Flash Point °C		
		Min	Min	Max	Max	Max	Max	Max	Min		Max		Min		
JIS K2404 (1996)	No.2	45	—	0.2	-5	-7.5	0.1	—	2.5	—	350	—	50		Japan
	No.3				-12	-20			2.0		330		45		
	Special No.3				-19	-30			1.7						
BS 2869	Summer	50	—	0.3	—	0	0.2	0.01	—	1.5 to 5.0	—	357	56		England
	Winter					-9									
EN590 (1993)	A	49	46	0.2	5	—	0.3	0.01	—	2.0 to 4.5	—	370	55		EU
	B				0										
	C				-5										
	D				-10										
	E				-15										
	F				-20										

*1: Pour point of fuel varies according to the temperature. So, fuels are classified by CFPP (or pour point) and oil companies supply fuels matching the temperature and season to the market. Therefore, it is unnecessary to specify the type when purchasing the fuel, unless the area or season is different.

*2: The CFPP represents the plugging point (temperature) of the fuel.
(Reference) Temperature conversion equation: t°C=(9t+160)/5°F

If the fuel listed in the standard table above is unavailable, use the fuel standardized in each country and listed in Table 8.1.1-2.

Table 8.1.1-2 Diesel Engine Fuel standards and characteristics list by country (1/2)

Region	Country	Standard Title	Type	Characteristic															
				(*1) Cetane Number	(*2) Cetane Index	(*3) Sulfur Content	(*4) CFPP	Pour Point	(*3) 10% Residual Carbon	(*3) Ash Content	Kinematic Viscosity cSt				Distillation Performance °C				Flash Point
											20°C	30°C	38°C	40°C	40%	50%	90%	95%	
				Min	Min	Max	Max	Max	Max	Max	—	Min	—		Max				Min
Asia	Philippines	PNS 20	—	40	45	0.8	17	—	1.0		—	—	—	1.7 to 6.0	—	—	—	—	52
	Indonesia	MIGAS	—	45	48	0.5	—	18.3	0.1		—	—	1.6 to 5.8	—	300	—	—	—	66
	Malaysia	MS123	—	50	—	0.5			0.2		—	—	—	1.5 to 5.8	—	370	—	—	60
	Thailand	TSI	—	47	—	0.25	—	10	0.05		—	—	—	1.8 to 4.1	—	—	357	—	52
	Saudi Arabia	Industrial standard	May to Sept.	—	55	1.0	—	2	0.2		—	—	—	1.9 to 4.1	—	—	357	—	60
			Oct. to Apr.					−4											
	Taiwan	CNSK 5024	—	46	—	0.3	—	−3.9	0.1		1.7 to 4.1	—	—	—	—	—	330	—	50
	S. Korea	KS-M -2610	Special No.1	45	—	0.2	—	5	0.1		—	2.7	—	—	—	—	360	—	45
			No.1					−5				2.7					360		
			No.2					−10				2.5					350		
			No.3					−20				2.0					330		
			Special No.3					−30				1.7					330		
	China	GB252 -87	Premium No.0	45	—	0.2	4	—	0.3		3.0 to 8.0	—	—	—	—	300	355	365	65
			Premium No.10				−5												
			Premium No.20				−14												
Europe	Germany	DIN EN590: 1993	Summer	49	—		0	—			—	—	—	2.0 to 4.5	—	—	—	370	55
			Intermediate				−10												
			Winter				−20												
	Holland	—	Summer		—		0	—			—	—	—		—	—	—	370	
			Intermediate				−5												
			Winter				−15												
	Italy	UNICUN A:EN590	Summer	49	—		0	—			—	—	—	2.0 to 4.5	—	—	—	370	55
			Winter				−10												
	Norway	NS EN590	Summer	49	—		−10	—			—	—	—	2.0 to 4.5	—	—	—	370	55
			Winter				−24												

*1: *The cetane number must be 45 or more.*

*2: *The cetane index must be 48 or more.*

*3: *The sulfur content, residual carbon and ash content should be as small as possible.*

*4: *The CFPP represents the fuel filter plugging point (temperature).*
(Reference) Temperature conversion equation: t°C=(9t+160)/5°F

Table 8.1.1-2 Diesel Engine Fuel standards and characteristics list by country (2/2)

Region	Country	Stand-ard Title	Type	Characteristic																
				(*1) Cetane Number	(*2) Cetane Index	(*3) Sulfur Content	(*4) CFPP	Pour Point	(*3) 10% Residual Carbon	(*3) Ash Content	Kinematic Viscosity cSt				Distillation Performance °C				Flash Point
											20°C	30°C	38°C	40°C	40%	50%	90%	95%	
				Min	Min	Max	Max	Max	Max	Max	—	Min	—		Max				Min
Europe	Sweden	SIS 155435	D10 for summer	49	—		−10	—			—	—	—	2.0 to 4.5	—	—	—	370	55
			D26 for winter	47			−26							1.5 to 4.0				340	
	Austria	EN590: 1994	Summer	49	—		5	—			—	—	—	2.0 to 4.5	—	—	—	370	55
			Intermediate				−15												
			Winter				−20												
	Switzerland	SN EN590	Summer	49	—		−10	—			—	—	—	2.0 to 4.5	—	—	—	370	55
			Annual	47			−20							2.0 to 4.0				340	
	France	EN590: 1993	Summer	49	—		0	—			—	—	—	2.0 to 4.5	—	—	—	370	55
			Winter				−15												
			Annual				−20												
North America	U.S.A.	ASTM D975-94	No.2-D	40	—	0.5	—	2	0.35	0.01	—	—	—	1.9 to 4.1	—	—	338	—	52
	Canad	CGSG CAN2-6-M83	B	40	—	0.7			—		—	—	—	1.4 to 4.1	—	—	360	—	
Oceania	Australia	AIP PPTC	—	45	—	0.5			—		—	—	—	1.5 to 5.5	—	—	365	—	

*1: *The cetane number must be 45 or more.*

*2: *The cetane index must be 48 or more.*

*3: *The sulfur content, residual carbon and ash content should be as small as possible.*

*4: *The CFPP represents the fuel filter plugging point (temperature).*
(Reference) Temperature conversion equation: t°C=(9t+160)/5°F

Note: In some countries, the standard cetane number (index) is below 45 (48). The cetane numbers (indexes) listed above are the minimum. Fuel oils sold in the market are generally higher than the standards. It is requested to purchase fuel after confirmation that the cetane number (index) is 45 (48) or more.

8.1.2 Notes Relative to Storage

Avoid storing fuel for a long period of time since the fuel type sold in the market varies for matching the ambient temperature and other operating condition when the engine is operated.
If fuel is stored for a long period of time over the summer or winter, the quality is deteriorated causing poor start of engine or other engine performance by increased moisture and sludge generated by condensation, gathering mold and discoloration, in addition to improper ambient temperature at operation.
If storing fuel for considerable period is unavoidable, store only the minimum quantity in a way to prevent contamination by foreign matter. When using fuel stored for a long period, do not use up to the bottom where foreign matter deposit is accumulated.

8.2 Lubricants

The diesel lubrication oils listed in the following list are required in order to operate the diesel generator. Generally, the lubricant quality is specified by indicating both the API service class and SAE viscosity class.
Therefore, it is necessary to specify both classes.

8.2.1 API Service Classification (Standard)

Table 8.2.1 lists the API service classes. The quality required for the lubricant varies by the engine type (diesel or gasoline), application, specification and operating condition.
The lubricant quality is classified into several classes identified by class codes from CC to CG-4, based on the deposit and sludge resistance or other characteristics.

- Select the lubricant (quality level) from CC, CD or CF listed in the table below (avoid selecting CE).

Table 8.2.1 API service class (standard) list for diesel engine lubricant

Class code	Engine	Lubricant quality level
CC	For diesel engine operated under relatively severe condition	Has good deposit resistance at high temperature.
CD	For diesel engine operated under severe condition	Has good bearing corrosion resistance and deposit resistance when used for a wide range of fuels.
CE	For diesel engine operated under severe conditions such as low-speed high-output and high-speed high-output	Has less lubricant consumption and improved deposit and sludge resistance compared with the CD class.
CF	For diesel engine mounted to construction and agricultural machines	Has improved performance to replace the CD class.
CF-4	For diesel engine operated under the most severe condition	Has improved lubricant consumption, deposit/sludge resistance and heat stability over the CE class.
CG-4	For diesel engine operated under severe condition such as high-speed high-output and mounted on construction and agricultural machines	Has improved deposit, wear, corrosion, bubble, oxidation and soot gathering resistances for a wide range of fuel oils (*1).

*1: *Including low sulfur fuel oil (0.5% or less for general industrial use, 0.05% or less for heavy vehicle)*

8.2.2 SAE Viscosity Classification (Standard)

Fig. 8.2.2 illustrates the SAE viscosity classification. Since the engine temperature varies according to the operating condition and ambient temperature, the viscosity of lubricant existing in the engine also changes to drop the lubrication performance. Lubricant oils are classified based on the influence by temperature changes for selection of matching operating condition (ambient temperature), and viscosity codes such as 5W-50 and 40 are assigned to respective classes.

- Select a lubricant oil having the viscosity class matching the ambient temperature for operating the diesel generator.

Note: Lubricant oils are mainly classified into those for winter to which W (winter) is affixed, those that can be used both in the winter and summer (multigrade having a wide operating range) and those for summer to which W is not affixed (single grade having a narrow operating range).

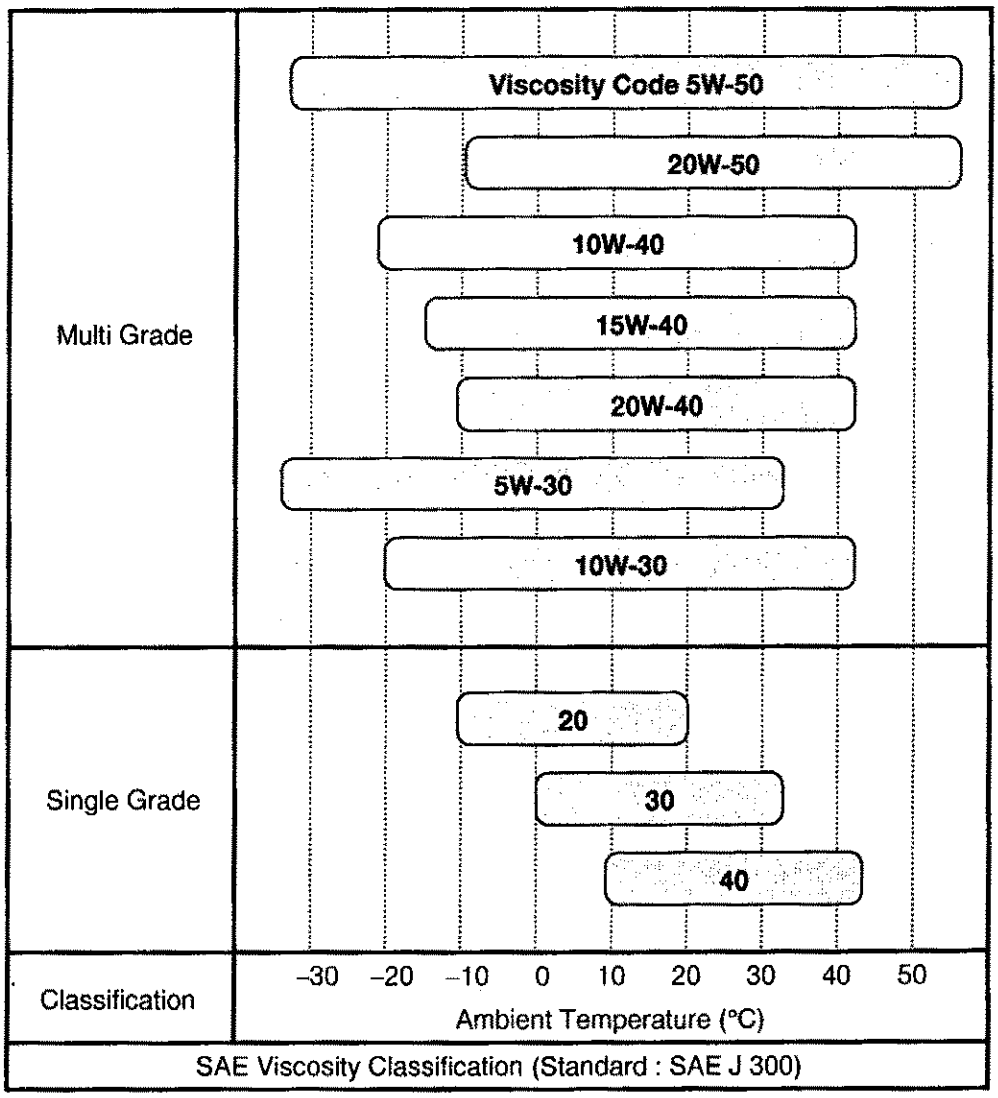


Fig. 8.2.2 Viscosity codes and operating temperature ranges

8.2.3 Notes on Lubricant Selection

While the lubricant oil deteriorates as it is used, it is considered that contamination by foreign matter and oxidation of oil itself are the major causes.
For this reason, various types of additives are added to prevent deterioration.
The lubricant oil qualities listed in Table 8.2.1 (API service classification) are ensured by characteristics of additives and the number of additives used. The lower the row in the figure, the more the lubrication functions.
It is, therefore, recommended to select the CD or CF lubricant (avoid selecting the CE).

1) Notes on API service class selection

- There are lubricant oils having C as the initial letter followed by A or B, which are for the diesel engine use. These have poor quality levels than CC. So, never use such lubricant oils.

- In addition to the diesel engine use, there are class codes which begin by initial letter of S such as SC, SD and SE. These are for the gasoline engine use, of which additives used for improving the quality are different from those used for the diesel engine. Be careful so as not to use such lubricant oils by mistake.

2) SAE viscosity class selection

When the temperature changes are large by the winter/summer (season), low/highland (place) and day/night (time), it is required to use two types of viscosities (viscosity codes) or more. It is convenient if you use the multigrade which has a wide operating temperature range.

3) Lubricant selection and fuel

When a fuel having a high sulfur content (over 0.5%) is used, it is recommended to use a lubricant oil having excellent acid neutralization characteristic (class CD or CF) for preventing wear caused by corrosion.

4) Replenishment and replacement

When the lubricant type (different class code or viscosity code) is changed or a lubricant supplied by other maker is used while the type is the same, do not replenish, but replace entirely so that both oils are not mixed since their additives and characteristics are different.

9. Operation and Storage Methods and Load Selection

Descriptions in this section are similar to that contained in the instruction manual given to users of the diesel generator.

Malfunctions or reduced performance of the diesel generator are often caused by insufficient skill or knowledge of the user. For this reason, descriptions are given more in detail on the inspection and servicing items, safety notes on repair and operation, engine performance and operation for conditioning, and loading by the load, although contents frequently overlap with the instruction manual.

Read through this section for instructing operators who often lack such knowledge and as reference for troubleshooting, inspection and servicing.

9.1 General Notes

The diesel generator must be handled carefully as unexpected accident or failure may occur if inspection and preparation are conducted incorrectly even if disassembly/reassembly servicing, inspection, and overhaul and adjustment are conducted correctly.

The check of service quality by running the diesel generator should be implemented after reviewing Section 1, Safety.

- Execution of inspection before beginning the operation
- Ensuring safety of operating place and workshop
- Review of operation conditions for ensuring safety

9.2 Inspection and Preparation for Operation

This section gives part of daily maintenance and inspection items to be conducted by the user and important notes for ensuring safety.

9.2.1 Addition of Fuel

1) Notes on fuel addition

- Add oil after stopping the diesel generator.
- Avoid places subject to fire sources.
- Confirm that it is the specified fuel oil for the diesel engine use.

  Note: Never mistake with gasoline or other fuel oils having low flash points.
- Add the oil to the specified level.
- Avoid use of oil with sludge accumulation and prevent invasion by moisture, dust, dirt and other foreign matter.

- If water, foreign matter and other residue are remaining in the fuel tank, remove the drain plug to drain them.
- Wipe off any spilled fuel oil.

2) Fuel tank capacity

Table 9.2.1 Fuel tank capacity

Model		YDG2700E	YDG3700E	YDG5500E	YDG6600TE
Capacity (liter)	Maximum	7.2	13.0	←	←
	Effective	7.0	12.5	←	←

Note: The capacity is when the diesel generator is placed horizontally.

3) Fuel addition procedure

- Add the fuel to the specified level (within the upper limit). (Fig. 9.2.1)
- If the fuel tank is empty, conduct air purging of the fuel circuit (path) after filling the fuel. As for the air purging procedure, see Section 6, 6.4.3 Fuel Injection Pump.

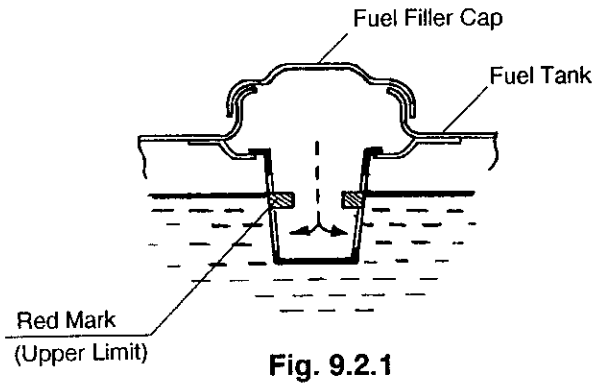


Fig. 9.2.1

9.2.2 Lubricant Supply

1) Notes on lubricant supply

- Add oil after stopping the diesel generator.
- Confirm that it is the specified lubricating oil for the diesel engine use.
- Never add lubricating oil having different types (class code or viscosity code) or supplied by other makers. To change to a different type lubricating oil, **always replace entirely to avoid mixture.**

  Note: Be careful as the lubrication function will be changed if different types of lubricants are mixed.
- Add the oil to the specified level.
- Avoid invasion of moisture, dust, dirt and other foreign matter.
- Wipe off any spilled lubricating oil.

2) Inspection and replacement timing and oil pan capacity

- Check, replenishment and replacement intervals are as shown below.
  - **Check and replenishment: Daily**
  - **Replacement: Every 3 months or 200-hour operation**
    (After 1 month or 50-hour operation for a new engine)

- The oil pan capacity is as listed below.

Table 9.2.2 Oil pan capacity (lubricant capacity)

Model		YDG2700E	YDG3700E	YDG5500E	YDG6600TE
Capacity (liter)	Upper Limit	0.80	1.10	1.65	←
	Lower Limit	0.55	0.70	1.05	←
	Effective	0.25	0.40	0.60	←

Note 1: The capacity is when the diesel generator is placed horizontally.

Note 2: Excessive or insufficient oil level causes drop in the engine performance. Note that the diesel generator with built-in emergency stop function does not start if the oil level is insufficient.

3) Inspection, replenishment and replacement procedures

Observe the following procedure for replacing (checking or replenishing) the lubricating oil. (Fig. 9.2.2-1)

① Remove oil filler cap 1 (oil dipstick).
② Remove drain plug 2 to drain the oil. (Drain while the engine is idling.)
③ Reinstall and tighten the drain plug.
④ Fill oil up to the upper limit shown to the oil filler cap. (Fig. 9.2.2-2)
⑤ Tighten the oil filler cap.
⑥ Carry out the cranking after filling the oil as needed using the following procedure. (This is conducted for supplying the lubricant to each sliding portion of the engine, which is needed after overhaul of the engine body or before operation of a new engine or after storage for a long period of time.)
   1) Press down stop lever 3 and set the governor lever 4 to the STOP position (left end).
   2) Hold the no-compression state by pressing down decomp lever 5.
   3) Pull grip 7 of recoil starter 6 to carry out cranking for about 10 times.

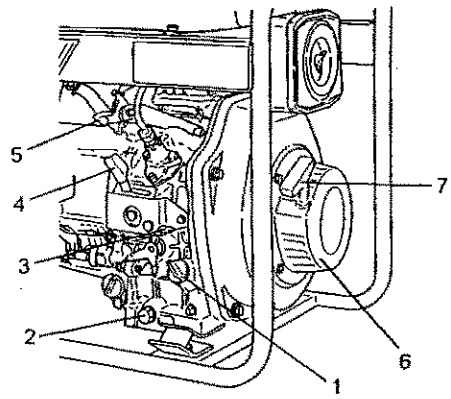


Fig. 9.2.2-1

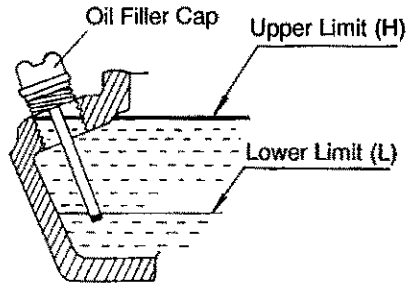


Fig. 9.2.2-2

Note 1: Check the oil level without screw in the oil filler cap (oil dipstick).
Note 2: Add oil or check the oil level with the diesel generator set horizontally. If it is inclined, excessive or insufficient oil level may occur.

9.2.3 Cleaning and Replacement of Filters

This paragraph gives the filter installation and removal procedures. As for the composition of each assembly, cleaning and replacement procedures and inspection and replacement intervals, see Section 4, Structure of Generator Set, Section 6, Inspection and Maintenance, and Section 10, Periodic Inspection Items, respectively.

1) Fuel filter

The removal and installation procedures are as follows: (Fig. 9.2.3)

① Remove three nuts 1 and pull out fuel filter 2 together with the O-ring.
② Install in the reverse order of the removal procedure.

Note: Make sure to install the O-ring without fail.

- The inspection, cleaning and replacement intervals are as follows:
  - **Inspection and cleaning: Every 3 months or 200-hour operation**
  - **Replacement: Every 6 months or 400-hour operation**

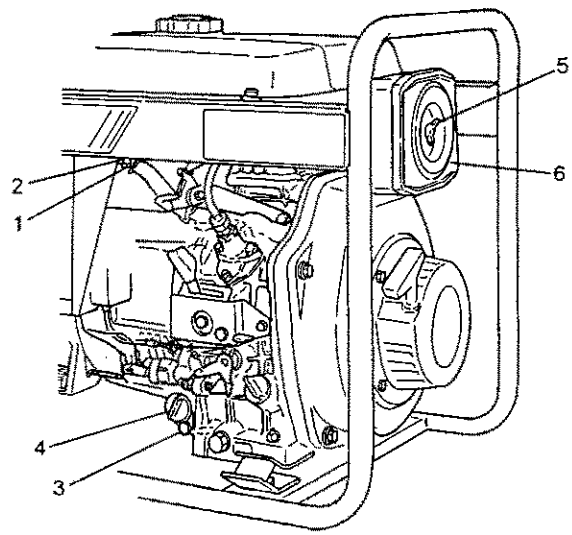


Fig. 9.2.3

2) Oil filter

The removal and installation procedures are as follows: (Fig. 9.2.3)

① Remove one bolt 3 and pull out oil filter 4 together with the O-ring.
② Install in the reverse order of the removal procedure.

Note: Make sure to install the O-ring without fail.

- The inspection, cleaning and replacement intervals are as follows:
  - **Inspection and cleaning: Every 6 months or 400-hour operation (After 1 month or 50-hour operation for a new engine)**
  - **Replacement: Annually or every 1000-hour operation**

3) Air cleaner

The removal and installation procedures are as follows: (Fig. 9.2.3)

① Loosen nut 5 and remove air cleaner cover 6.
② Remove the element.
③ Install in the reverse order of the removal procedure.

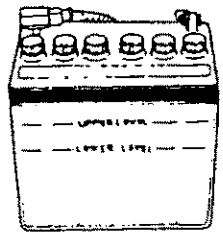
- The inspection and replacement intervals are as follows:
  - **Inspection: Every 3 months or 200-hour operation**
  - **Replacement: Every 6 months or 400-hour operation**

Note: The wet type element is used, which is a throwaway type. So, never reuse the element after cleaning or washing.

9.2.4 Battery and Starter Motor Inspection

The starters are important components used for starting the diesel generator. Check the following components before beginning the operation.

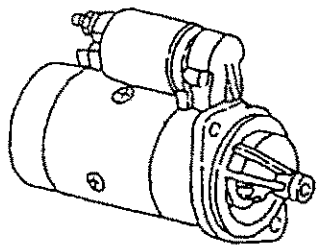
1) Battery



The battery fluid is consumed as the battery is used.
Check the following as the voltage of the battery drops by self-discharging even if it is not used.

- As for the battery fluid level and specific gravity, and voltage and acceptance judgment criteria, see Section 6, Inspection and Maintenance.
- Use the battery specified in Section 3, Outline of Generator Set, or one having the equivalent capacity and size when replacing the battery. Handle the replacement battery correctly according to the instruction manual attached to it.

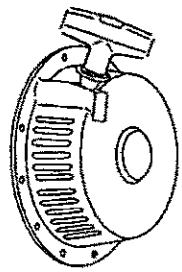
2) Starter motor



Check the following items at starting the diesel generator.
If any failures are discovered, take the necessary action according to the service manual described in the Foreword.

- Check that the pinion gear operates correctly (coming out and in and engagement with the ring gear).
- Check for dropped starting rate (cranking rate).
- Check for abnormal sounds during revolution.

3) Recoil starter



Check the following. If any failures are discovered, take the necessary action according to the service manual described in the Foreword.

- Check the rope for damage and that it is wound up appropriately.

- Check that the ratchet operates correctly (coming out and in and engagement with the pulley).

9.2.5 Operating Place Selection and Hoisting and Installation Procedures

Select an appropriate place for safe operation when using or servicing the diesel generator. Hoist the diesel generator as needed and fix to a stable condition.

1) Operating place

Avoid using the diesel generator at the following places, which cause malfunctions in addition to unsafe operation:

- Places with poor ventilation and subject to exhaust gas accumulation such as inside a tunnel (Indoors and inside the tunnel are dangerous as toxic gas accidents can occur.)
- Places near the explosive, igniting or inflammable materials, or subject to harmful gas
- Places subject to direct shower of rain (Operating a wet diesel generator can cause electrical shocks.)
- Places seriously affected by sea breeze
- Places with poor ventilation and ambient temperature below –10°C or over +40°C)
- Places other than the land
- Places subject to excessive dust and dirt

2) Hoisting

- When hoisting the diesel generator is needed, pay sufficient attention to damage to the generator set by shocks.

  Note: Never enter under the generator set during hoisting to prevent an accident by dropping machine.

3) Installation

- Do not locate the exhaust port towards the path when installing the generator set outdoors.
- Ensure a distance of at least 1 meter between the generator set or the exhaust port of the generator set and a building, obstacle and inflammable matter such as dry grass to prevent a fire accident or overheating.
- Install the generator set horizontally to protect it from movement during operation.

  Note 1: If inclined installation is unavoidable, the inclination must be within 10 degrees and fix the generator set to prevent movement during operation.

  Note 2: For the specification with wheels, always provide the wheels with stoppers for fixing the generator set securely.

9.2.6 Grounding

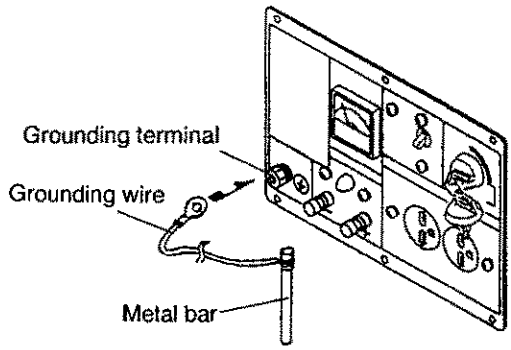
The grounding plays important roles such as prevention of electric shocks, fire accident caused by current leakage and malfunctions of the diesel generator and loads. Therefore, it is required to connect to the ground as instructed below before operating the diesel generator.

1) General notes

- Locate the grounding at least 2 meters away from a lightning rod.
  (For prevention of malfunctions of the diesel generator and its loads)
- Avoid common grounding with telephone unit. (For prevention of telephone failures)
- Ensure safety by grounding both the diesel generator and its loads independently.

2) Procedure for grounding

The grounding resistance should be minimized to obtain the intended function of the earth.
For this reason, use the grounding wire and bar specified below and ensure electrical continuity between the ground terminal of the diesel generator and the earth surface.



- Standard values of the sectional areas of grounding wire, and diameter D and length L of the grounding bar to be connected to the ground terminal and driven into the earth are as listed below or more:

  Standard S : 1.25 mm^2
  Standard D : 6 mm
  Standard L : 200 mm

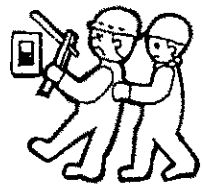
- Drive in the grounding bar about 200 mm from the ground surface.

3) Emergency action against electrical shock

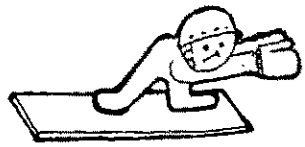
Use the following procedure to rescue a person under electrical shock:

① Turn off the power switch (breaker) of the diesel generator and stop it by operating the stop lever.

Note: When the person under influence by electrical shock is standing, ask assistance for rescue. The assisting person must take the action upon completion of the power switch operation to avoid electrical shock.



② If the power switch (breaker) is not found, confirm insulation of your feet (a dry wooden plate is acceptable for 200 V or less), wear thick gloves (avoid bare hands) and pull the person under electrical shock off from the machine or load.



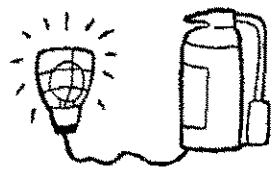
③ Lay the electrically shocked person near the machine and urgently consult a doctor.

④ If he has fallen unconscious, continue artificial respiration until a doctor arrives.

4) Action against fire caused by leakage

Basically, water should not be used for fighting a fire caused by current leakage. Otherwise, an electrical shock accident may occur.

- Before beginning fire fighting, turn off the power switch of diesel generator and stop it by operating the stop lever.
- Always prepare the fire extinguisher for electrical fire use available in the market and use it for fire fighting.



- Also, prepare fire extinguishing sand in addition to the fire extinguisher.
- If the fire extinguisher is not sufficiently effective, use water while paying sufficient attention to avoid shock hazard.

9.3 Load Condition and Preparation

Strictly observe the following requirements since drop of the performance or malfunction occurs to the diesel generator when the load and other operating conditions are not satisfied.

9.3.1 Load Condition

1) General notes

- Never connect the AC power supply of the diesel generator to the general commercial power sources. Never connect a load to the power supplies of the diesel generator and commercial power source at a time to use both power supplies simultaneously.
  Further, two diesel generators or more must not be connect in parallel.

  Note: The above ways of use generate periodic deviation of the waveforms (sinewaves) of AC power supplies between the commercial and diesel generator or the two diesel generators. Since the following malfunctions can occur to the diesel generator, such use shall be avoided.

  - Burnt starter motor
  - Decrease in self-excitation magnet of the rotor
  - Break down of electrical devices of the diesel generator, such as the automatic voltage regulator (AVR)

- Since overloading can cause malfunction of the AVR which is related to increase of the magnetic field current, observe the rated output (also the requirements for the auxiliary power supply) indicated in the table in Section 3, Outline of Generator Set.

- Use the DC power supply exclusively for charging the battery and not for any other purposes. While this power supply is in use, do not use the AC power supply to prevent increase of the DC voltage.
- A floodlight must not be used with other loads at the same time.
  Otherwise, other loads may be damaged as the voltage can increase due to phase advance of the current (by about 40%) when the floodlight is turned on immediately after turning off.

9.3.2 Load Estimation for Operating Load

Generally, a load requires a power greater than the indicated capacity (output=kW).
If a load is operated with an estimation that the indicated capacity is correct, the diesel generator is enforced to overloading. So, it is needed to obtain the required power for operating a certain load beforehand to confirm that the obtained value is below the indicated capacity.

1) Indicated load capacity and required power

Use Table 9.3.2 for obtaining required power of a load. There are two types of required power, those are that at start (input) and at rated operation. The required power at start is always greater, except for a resistor load where the two values are the same.
Therefore, always use the power coefficient (ρ_1) when estimating the required power.
As for the meaning of the power coefficient, see Section 16, Appendix.

Obtain the required power by multiplying the power coefficient (ρ_1) to the indicated capacity (Mc) of the load, which are listed in Table 9.3.2.

Tale 9.3.2 Data for calculating required power of a load (*1)

Load Specification (AC Specification)			Load Type	Resistor Load	Discharging Load	Motor Load		
						Single Phase		Three Phases
						Rectifier Type	Induction Type	Induction Type
Item		Symbol	Name / Unit	Incandes-cent Lamp, Pot, Heater, Solder Iron	Mercury Lamp, Floodlight	Drill, Grinder, Cutter, Winch	Com-pressor, Under-water Pump, Water Pump, Blower	Com-pressor, Under-water Pump, Blower
Indicated Capacity of Load (per unit)		Mc (*2)	kW	0.2	0.4 (*3)	0.4	0.75	1.5
Power Factor of Load	At Start	ρ_1		1.0	2.0	3.0	4.5	6.0
	Rated Operation	ρ_2		1.0	1.5	1.5	2.0	2.0

**1: Required power of a load (required output for diesel generator) is obtained by calculating Mc × ρ_1 .*
**2: Reference values are shown.*
**3: Use the value indicated on the regulator of the load.*

Note 1: Be careful as the required power at start and rated operation varies even for similar lamps such as the floodlight and luminescent lamp, except the incandescent lamp that is resistor load type.

Note 2: The required power largely varies for motor driven loads according to the motor type and power supply type. Be careful as the motor will not start if the power coefficient at start is excessively small.

Note 3: Note that the indicated capacity can be regarded as the required power only for a single, resistor load.

2) Power required for multiple loads

When two types of loads or more or two loads or more of the same type are connected to a diesel generator, obtain the total required power and confirm that the obtained value is below the rated output of the diesel generator beforehand. To calculate the total required power, obtain that of each load and then the sum.

9.3.3 Load Connection Conditions and Methods

There are varieties of loads having different types and capacities. When two loads or more are used in combination, advanced check to avoid insufficient capacity (output) of the diesel generator is needed as well as calculation of the total required power.

Even if the generator capacity is seemed sufficient, malfunctions of the diesel generator may occur by overloading if loads are connected incorrectly.

So, select loads within the rated output of the diesel generator and observe the following instructions.

A breaker is provided to the diesel generator as a measure against overloaded operation. Sufficient attention, however, should be paid since there are cases where the breaker fails to function because of the entrainment phenomenon (*1) under an overloaded state, causing breakdown of the AVR or burning of the starter motor.

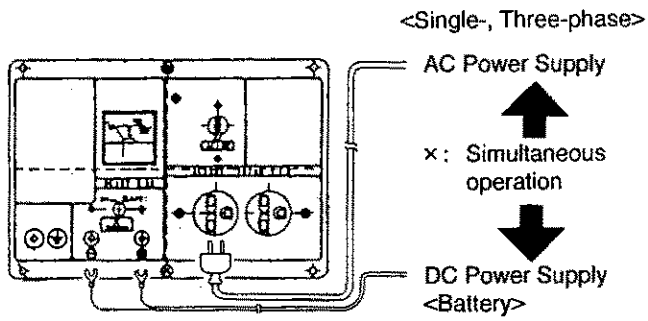
*1: This is the phenomenon that both the output voltage and current of the diesel generator are below the rated output when an excessively large load is applied rapidly.

1) Connection condition and method

The indication of the rated output (V-A) of the diesel generator is as indicated in the table of Section 3, Outline of Generator Set. The indicated rated output is the sum of multiple sockets (terminals) independently for the single or three phase. Pay attention to the indicated rated output and observe the permissible current of each socket when connecting loads to two sockets or more.

- DC power supply
  The DC power supply must be used only for charging the battery.
  Avoid simultaneous use with the AC power supply.

- As no voltage regulator is provided to the DC power supply (12 VDC, 8.3 A), the rated voltage (12 V) fluctuates when the current fails to satisfy the rated condition (8.3 A).
  Therefore, use of the DC power supply is restricted to the battery built in the diesel generator or to those having the same level capacities.
  If the capacity varies excessively, insufficient charging or overcharging of the battery will occur, resulting in malfunctions.

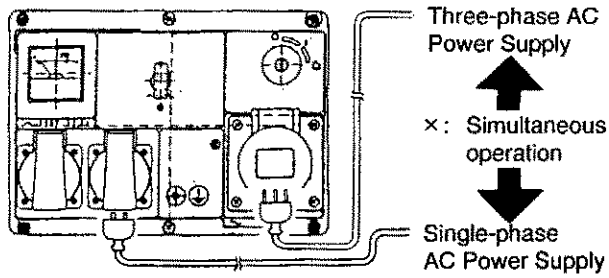


● Single-phase AC diesel generator
Connect operating loads to the DC or AC power supply within the rated output shown in the table in Section 3, Outline of Generator Set.

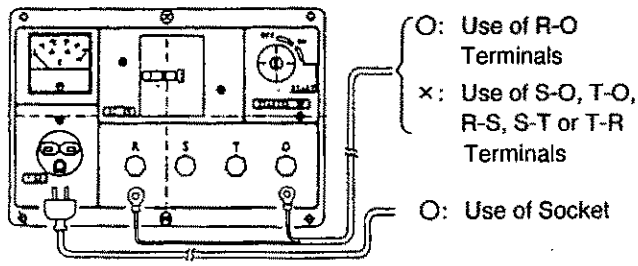
● Three-phase AC diesel generator
Connect operating loads to the DC or AC power supply within the rated output shown in the table in Section 3, Outline of Generator Set.

- If the motor of a load revolves in the reverse direction, change connections of two leads of the 3-phase power supply.

- The single-phase AC is the supplementary power supply. Since the coil of supplementary power supply can generally be burnt easily by overloading, pay attention to required power when connecting loads.
  Avoid use of the single-phase and 3-phase power supplies at a time.
  Otherwise increase of the AC voltage and other malfunctions can occur as the diesel generator is affected by the AVR.



- For the diesel generator with terminal type power taking out system, the 4-terminal system of R, S, T and O terminals is adopted for the 3-phase AC while the socket system of combinations by R and O terminals is used for the single-phase AC. The AVR is provided to the R terminal circuit.



Therefore, the single-phase AC power should be taken from the socket.
Always use the R-O terminals when taking out power from the terminals. Confirm that the sum of output from the terminals and socket are within the rated single-phase AC output.

2) Extension cable size selection method

A cable has an electrical resistance which varies according to its length (L), thickness and material used. The resistance affects the permissible current and voltage drop.

So, when an extension cable is used, select a cable having a thickness (sectional area S of conductor) marginal to the required current obtained beforehand based on the required power of the load connected to the cable (voltage (V) × current (A)), using Table 9.3.3.

Note 1: If the cable is used exceeding the permissible current, it may be burnt by heat generation or malfunctions or drop in performance of the load be caused by voltage drop resulting from excessive resistance.

Note 2: Since the voltage drop becomes larger as the cable is longer, provided the thickness is the same, avoid use of excessively long cable.

Note 3: If the conductor sectional area obtained from the selection chart does not exist, use a cable having a size greater than the obtained value.

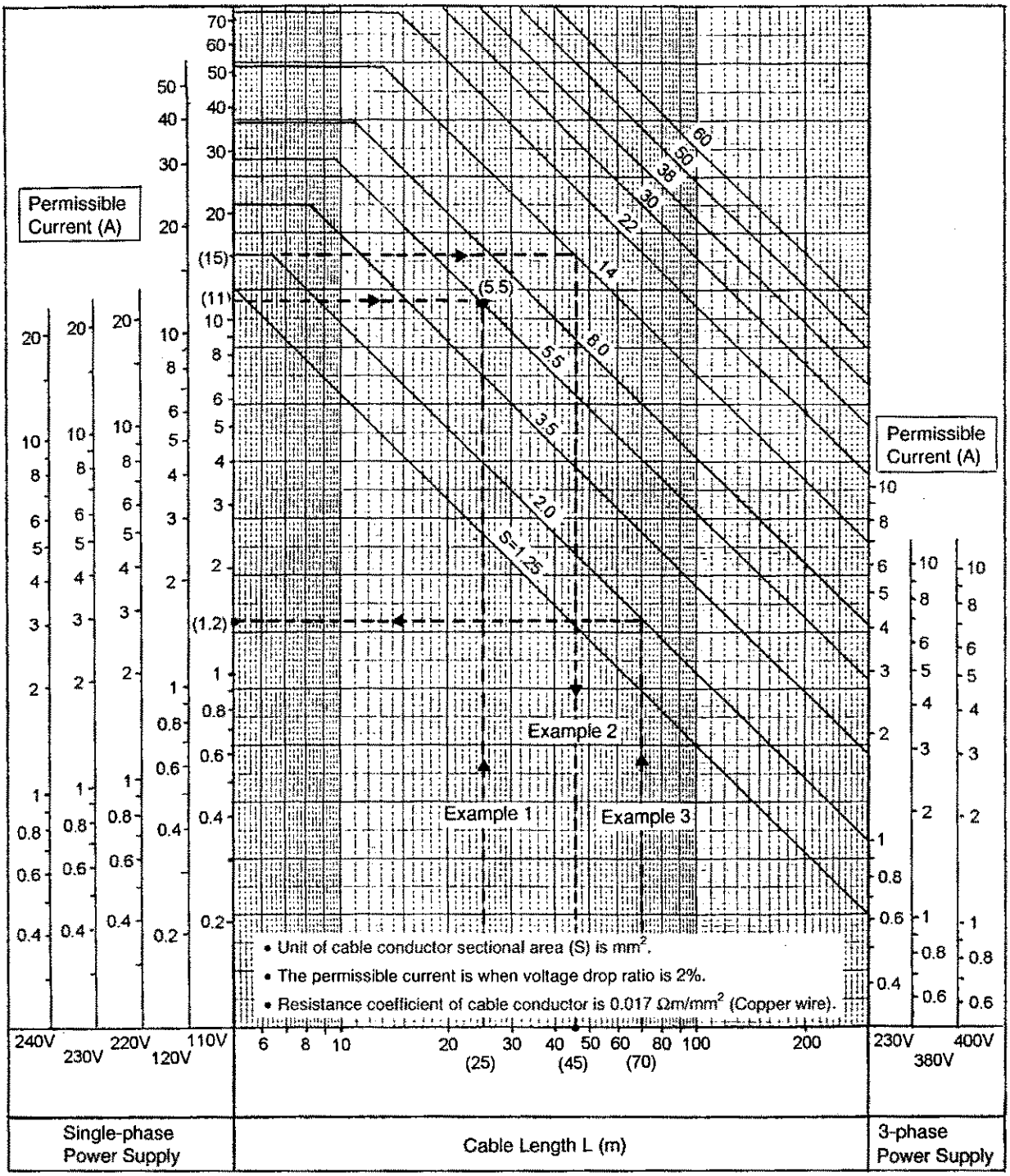


Fig. 9.3.3 Cable size selection chart

Example cable selections

Example 1: To obtain the cable thickness:
When required current and length are known (110V, A=11, L=25)

Example 2: To obtain the cable length:
When thickness and required current are known (110V, A=15, S=14)

Example 3: To obtain the cable permissible current:
When thickness and length are known (110V, S=2.0, L=70)

9.4 Starting, Stopping and Loading Procedures

9.4.1 General Notes

1) Safety

- Complete the following jobs before beginning the operation for ensuring safety and preventing electrical shocks:
  - Driven machine : Turn the power switch off and then connect to the diesel generator.
  - Diesel generator : Turn the power switch (breaker) off.
- For safety reasons, avoid moving the diesel generator even if it is a portable type.
- Avoid handling the diesel generator including its loads by wet hands to prevent electrical shocks.
- Check for leakage of fuel oil and lubricant.
- Check for loose nuts and bolts.
- Check the electrical circuits for open circuit, short-circuiting and poor continuity of terminals.
- Check safety of the operating place, referring to 9.2.5 and other relevant descriptions.

2) Performance

The performance of the diesel generator is defined under the following operating conditions. If the conditions are not satisfied, the performance may be degraded.
This should be taken into consideration at quality check to prevent wrong judgment as abnormal performance or malfunction at inspection under operation with loads.

It is necessary to correctly understand the capacity (output) of the diesel generator to obtain the expected performance of the load.

The correction methods when the operating conditions are not satisfied are explained below, for reference.

- Standard atmospheric conditions : 20°C atmospheric temperature, 65% relative humidity, 99 KPa atmospheric pressure
- Conditioning operation : 30 hrs
- Operating temperature range (ambient temperature) : –10 to +40°C
- Max. operating altitude (above sea level) : 150 m or less
- Min. starting temperature : 0°C for manual start specification, –10°C for electrical start specification
- Capacity correction (corrected rated output) : See Table 9.4.1.

Table 9.4.1 Capacity (output) drop rate of diesel generator by temperature change

Temperature (°C)	Drop rate (%)
20	0
30	–5
40	–10
50	–15

**1: As for correction relative to the altitude (for correction by atmospheric temperature change, see 7.4.2 of Section 7.*
Further, adjustment as instructed in 7.4.1 may be needed as correction by altitude sometimes affects the injection timing.

3) Conditioning and load operation

When fitting between components immediately after replacement of the piston, cylinder (cylinder block) or bearing or for a new diesel generator, it is recommended to conduct the conditioning operation by 50% to 70% load during the initial 50 hours.

Generally, an ideal conditioning is conducted by changing the operating conditions such as repeating load and no-load operations as well as idling and at rated speed.

During the conditioning operation, care should be taken to avoid rapid temperature increase by stopping the engine after no-load operation.

Note: After the conditioning operation, it is ideal to avoid continuous operation for long hours even at idling or no-load operation.
There are optimum operating temperature and fuel atomization state (injection condition) for the engine. Conditions at idling and no-load operations are out of the optimum conditions.

While long-hour operation at light load seems to be a preferable condition for the diesel generator, low-temperature corrosion of sliding parts and poor conditioning can be caused by the too low temperature, resulting in increased consumption of the lubrication oil. Further, low fuel economy can occur, causing blue white smoke and generation of a large amount of non-combustive exhaust, as well as engine performance degradation such as insufficient load power and lower durability.

The above have to be understood well for performing the inspection and servicing.

9.4.2 Inspection Before and After Operation

1) Before starting the generator

- Carry out manual cranking to check for abnormal sounds.

2) Before load operation

- Check for fuel oil and lubricant leakage.
- Check for abnormal vibration and sounds.
- Check for fluctuated revolution.
- Check the exhaust color for abnormalities. The judgment criteria are as shown below:
  - Colorless or light blue : Normal
  - Blue white or white : Abnormal
    (Possible cause: Oil up or oil down)
  - Black : Abnormal
    (Possible cause: Incomplete combustion or overloading)
- When electrical equipments and circuits are checked and serviced, check the reference voltage at no-load maximum speed and make judgment according to Table 6.3.7.
  Also, check the voltmeter reading of the diesel generator and the operation status.
- Carry out the warm-up run for at least 3 minutes and then connect the load.

3) Before stopping the generator

- Carry out the cool-down run for at least 3 minutes before stopping to prevent rapid temperature increase of the engine.

4) After stop of the generator

- Make sure to turn off the power switch (breaker) of the diesel generator for ensuring safety at starting it at the next time.
- When the engine unit immediately after disassembly and reassembly or a new diesel generator or after a long-period storage is operated, the lubrication oil is fed to all moving parts, thereby, the oil level decreases compared with that before starting the engine. For this reason, check the oil level after start and replenish the oil as needed.

9.4.3 Starting and Stopping Procedures

Observe the following procedures for starting and stopping the engine.

1) Manual start specification

- Start

① Turn breaker 1 of the diesel generator off. If loads are connected, turn power switch 2 of all loads off. (Fig. 9.4.3-1)

Note: For safety reasons, all power switches need to be turned off to prevent sudden start of loads upon start of the engine.

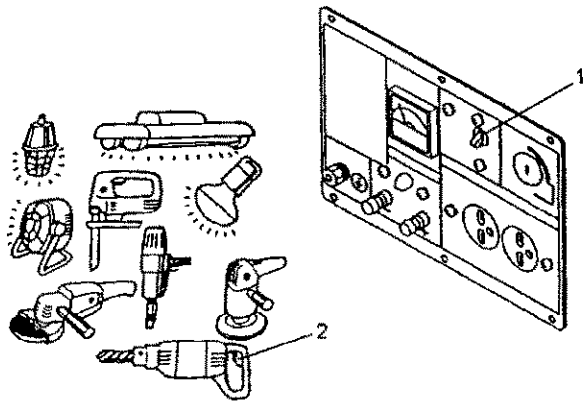


Fig. 9.4.3-1

② Set the governor lever 3 to RUN. (Fig. 9.4.3-2)

③ Slowly pull the grip 5 of recoil starter 4 until it is felt heavy (compression start position).

④ Return the group to the original position 6.

⑤ Set the decompression lever 7 to the no-compression position.

Note: The lever is the auto return type which automatically returns to the original position at the starting operation carried out next.

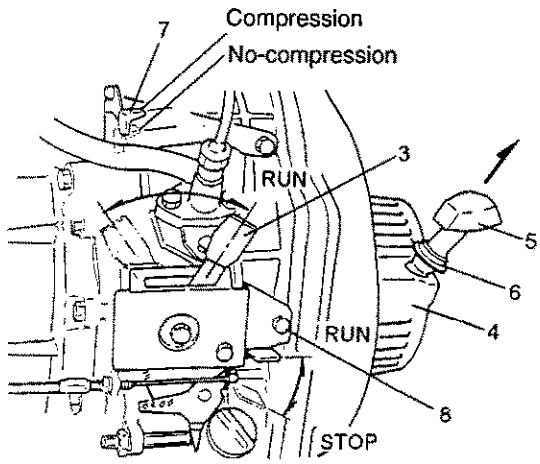


Fig. 9.4.3-2

⑥ Quickly pull the grip.

Note: There are cases that the engine fails to start although it is normal. At this time, check the fuel line for invasion by air, low lubrication oil level, use of improper lubricant viscosity and the grip operation speed.

- Stop

① Turn off switch 1 of the load and breaker 2 of the diesel generator. (Fig. 9.4.3-1)

② Press down the stop lever 8 and return the governor lever 3 to the STOP position. (Fig. 9.4.3-2)

Note: Never stop using the decompression lever. Otherwise, the decompressor may be damaged.

2) Electrical start specification

- Start

① Turn breaker 1 of the diesel generator off. If loads are connected, turn power switch 2 of all loads off. (Fig. 9.4.3-3)

Note: For safety reasons, all power switches need to be turned off to prevent sudden start of loads upon start of the engine.

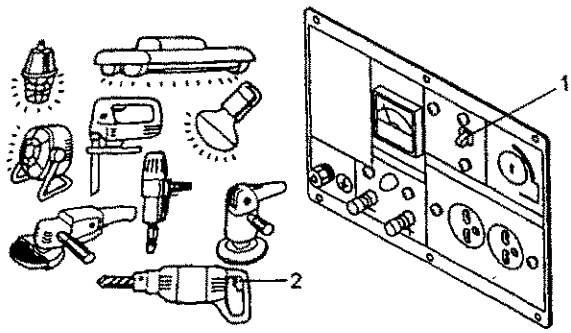


Fig. 9.4.3-3

② Set the governor lever 3 to RUN. (Fig. 9.4.3-4)

③ Insert the starter key 5 into key switch 6 and turn it to the START position. (Fig. 9.4.3-5)

Note 1:
Never activate the starting motor over 15 seconds. Otherwise, the motor may be burnt.
If the starting operation is to be repeated, ensure at least 15-second intermission.

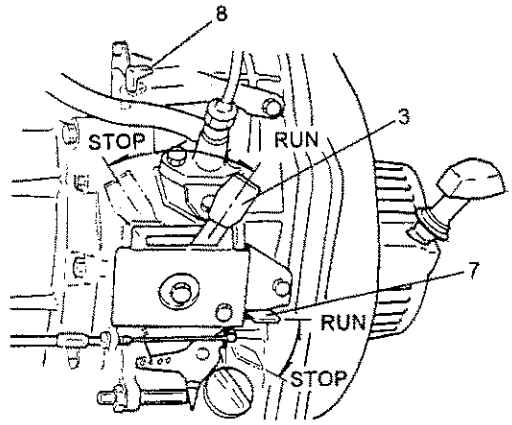


Fig. 9.4.3-4

Note 2:
There are cases that the engine fails to start although it is normal.
At this time, check the fuel line for invasion by air, low lubrication oil level, use of improper lubricant viscosity and drop of battery voltage.

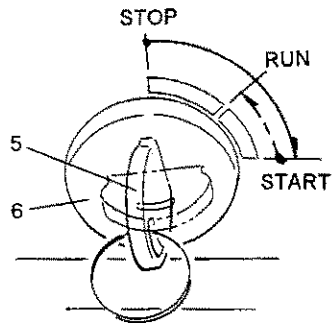


Fig. 9.4.3-5

- Stop

① Turn off switch 1 of the load and breaker 2 of the diesel generator. (Fig. 9.4.3-3)

② Return the key switch to the STOP position and remove the starter key 5. (Fig. 9.4.3-5)

Note 1: As an alternate stopping operation, use the stop lever 7 (see the manual start specification). It may be used when the starter key is faulty or an emergency stop is needed. When stopped using this method, make sure to return the starter key to the STOP position to prevent discharge of the battery. (Fig. 9.4.3-4)

Note 2: Never stop using the decompression lever 8.
Otherwise, the decompressor may be damaged. (Fig. 9.4.3-4)

9.4.4 Loading Procedure

1) Connection of load during operation

- To connect a load to a running diesel generator, turn off the power switch of the load beforehand and carefully connect it, paying attention to electrical shocks.
- To connect an additional load, check the capacity (required power) of that load beforehand to avoid overloading to the diesel generator.

2) Loading and operational notes

- When two loads or more are used, turn on one by one to prevent rapid loading (rapid current changes).
- Use the power switch (breaker) of the diesel generator only for starting or stopping the generator. For normal AC power supply ON/OFF, use the switch on the load side.
  If the power switch (breaker) is repeatedly used, malfunctions may occur.
- When the DC power supply is to be used, press the RESET button 1 as the DC breaker might be activated. (Fig. 9.4.4)

  Note 1: Note that the thermostat type DC breaker cannot be reset for about 10 sec after start.

  Note 2: Unlike the AC breaker, the DC breaker has no switch function.
  So, note that the power will not be shut off even if the RESET button is pressed unless the breaker is activated.

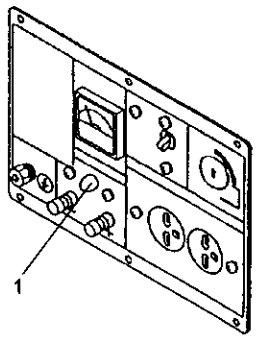


Fig. 9.4.4

9.5 Action Before and After Long-period Storage

Instruct the user who will store the diesel generator for a long period of time, under consideration that it will be used again after storage, to inspect and service the following items.

9.5.1 Storage Procedure

Use the following procedure when storing the diesel generator:

① Carry out inspection of components of which periodic inspection intervals will expire shortly.

② Warm up the engine for about 3 minutes and replace the lubrication oil while the engine is warm.

③ Remove the drain plug of the fuel tank to discharge the fuel oil and accumulated foreign matter. (For preventing fire accidents and rusting inside the fuel tank)

④ Operate the starting handle of the recoil starter to stop at the compression start position. (To prevent rusting inside the cylinder by setting intake and exhaust valves at closed positions)

⑤ Clean the exterior by removing oil, dirt and dust.

⑥ Disconnect the battery cable (minus side) from the battery terminal. (Since the battery discharges by itself, replenish the battery fluid and charge the battery about monthly during storage period.)

⑦ Protect the generator unit, air cleaner and electrical equipment from water and dust by covers.

⑧ Store the generator set at a place having low relative humidity and the ambient temperature ranging from –20 to +70°C.

9.5.2 Action After Storage

Before beginning operation of the diesel generator after long-period storage, thoroughly check for abnormalities in addition to the daily inspection items. The following mainly describes check items on long period storage.
For operation after storage, also refer to 9.2, Preparation of Generator Set.

1) Fuel related items

- Purge the air from the fuel circuit (path), using the procedure instructed in 6.4.3.
- If the diesel generator has been stored for a long period without discharging the fuel oil, poor starting caused by deteriorated fuel or unmatching of fuel to the current ambient temperature is anticipated. If so, carry out the inspection and servicing, and use new fuel.

2) Lubricant related items

- Carry out cranking after lubrication, using the procedure instructed in 9.2.2.
- After completion of the cranking operation above, check the oil level again and replenish as needed.

3) Others

- Check the battery voltage and the battery fluid level. For inspection and servicing procedures, see 6.1.4.

10. Periodic Inspection Items

This section gives the minimum inspection items that should be checked in order to maintain the diesel generator at excellent operating quality.
Contents of inspection vary greatly according to the operating conditions including the total operating hours, load conditions and place of operation. Here, inspection items and intervals are described on the assumption that the diesel generator is operated at the normal condition.
Understand the generator's maintenance history and condition by checking past records before beginning a periodic inspection in order to ensure appropriate overhaul maintenance and adjustments.

10.1 Inspection Items and Intervals

Table 10.1 Periodic maintenance schedule

Items and inspection intervals

●: Executed by dealer ○: Executed by user

Item			Inspection interval Month (or hrs)				
System	Checking component	Content of work	Daily	1 (50)	3 (200)	6 (400)	12 (1000)
Engine and intake/ exhaust system	Piston	Check and replacement of piston ring					●
	Intake/exhaust valve	Check and adjustment of valve clearance				●	
		Check and lapping of valve seat					●
	Muffler	Check of exhaust gas color	○				
	Air cleaner	Check of element			○		
		Replacement of element				○	
Lubrication system	Oil pan	Check and replenishment of lubricating oil	○				
		Replacement of lubricating oil		○ *1	○		
	Oil filter	Check and cleaning		○ *1		○	
		Replacement					●
	Lubrication system	Check for oil leakage	○				
Fuel system	Fuel tank	Check and replenishment of fuel	○				
		Check of drain		○ *2			
	Fuel filter	Check and cleaning			○		
		Replacement				○	
	Fuel hose	Check for cracks and hardening and replacement					●
	Fuel system	Check for fuel leakage	○				
	Fuel injection valve	Check and adjustment of pressure and spray pattern				●	
	Fuel injection pump	Check and adjustment of injection timing				●	
		Check of components					●
Generator	Brush	Check of wear and replacement				●	
	Slip ring	Check, correction of rough surface and wear and replacement				●	
	Coils and AVR	Check of resistances and replacement				●	
Electrical equipment	Wiring harness	Check, repair of terminal rusting and hardened insulation and replacement				●	
	Voltmeter	Check of reading errors and replacement				●	
	Battery	Check and replenishment of battery fluid	○				
		Check of battery fluid specific gravity				●	
Others	Main/ sub-frames	Check of deformation and cracks					●
	Damper	Check of deflection and cracks and replacement					●
	Nuts and bolts	Check of loose nuts and bolts and retightening				●	

*1: Initially only *2: Monthly

11. Circuits

This section describes electrical, lubrication and fuel circuits. Use this section as reference for inspection, overhaul maintenance and troubleshooting of the diesel generator.

11.1 Electrical Circuit

Electrical circuits contain the AD and DC output power supplies, battery charging, engine starting and emergency stop circuits.

11.1.1 How to Read Electrical Circuit Diagrams

Voltage and resistance measuring points, part names and insulator colors are expressed by codes on circuit diagrams.

- Measuring points related to voltage and resistance measurements for inspection and overhaul maintenance are indicated by Gothic numerals.
- Parts names are represented by numerals in circles.
- Lead colors are indicated by alphabetical codes (Example: Y/G = Yellow/Green)

11.1.2 Electrical Circuit Diagrams

Fig. 11.1.2 shows the circuit diagram for each specification.

1) Southeast Asia and Philippines

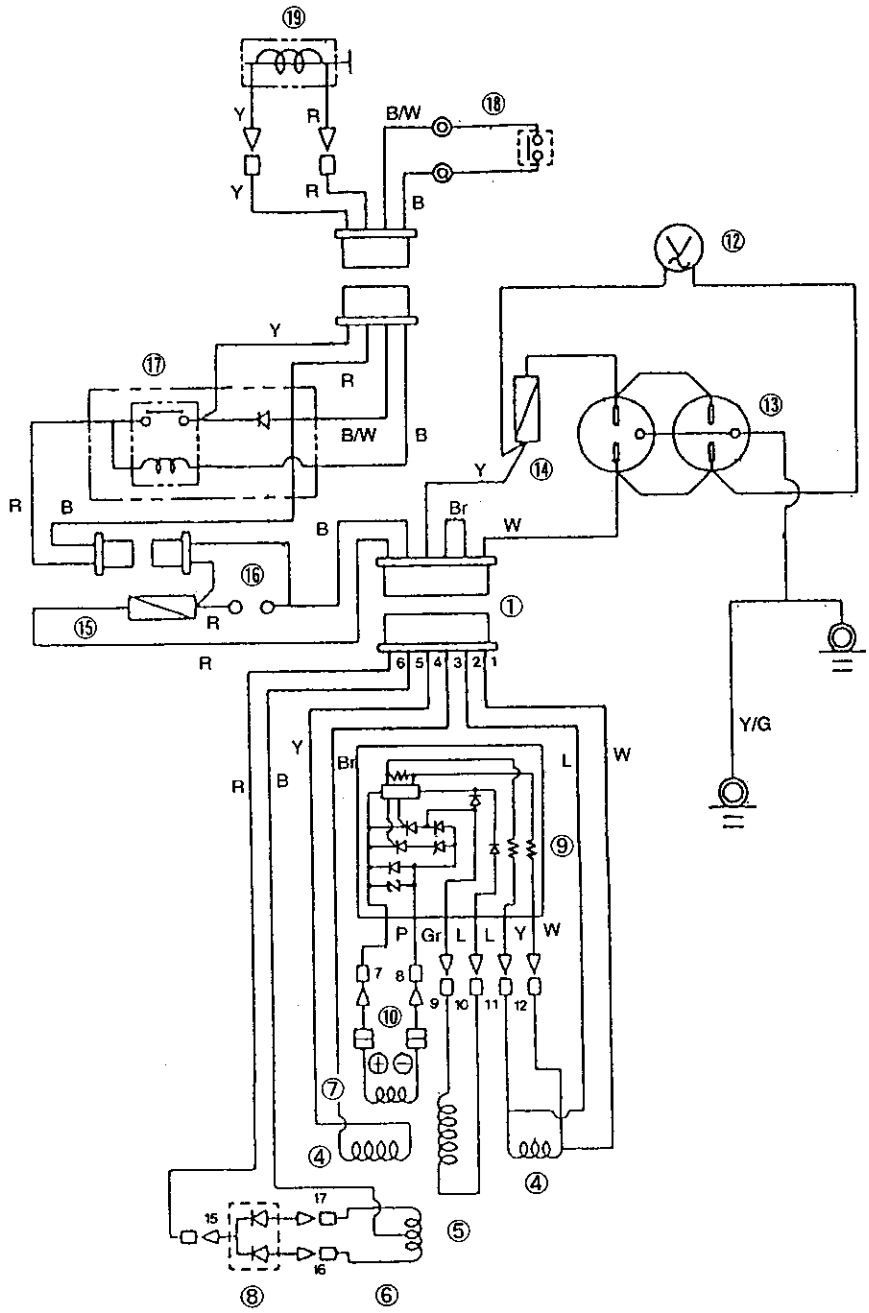


Fig. 11.1.2-1 YDG2700E-5B/6B

Part names:

① Coupler (I)	④ Armature coil	⑤ Exciter coil	⑥ DC coil
⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator	⑩ Brush
⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker	⑮ DC breaker
⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

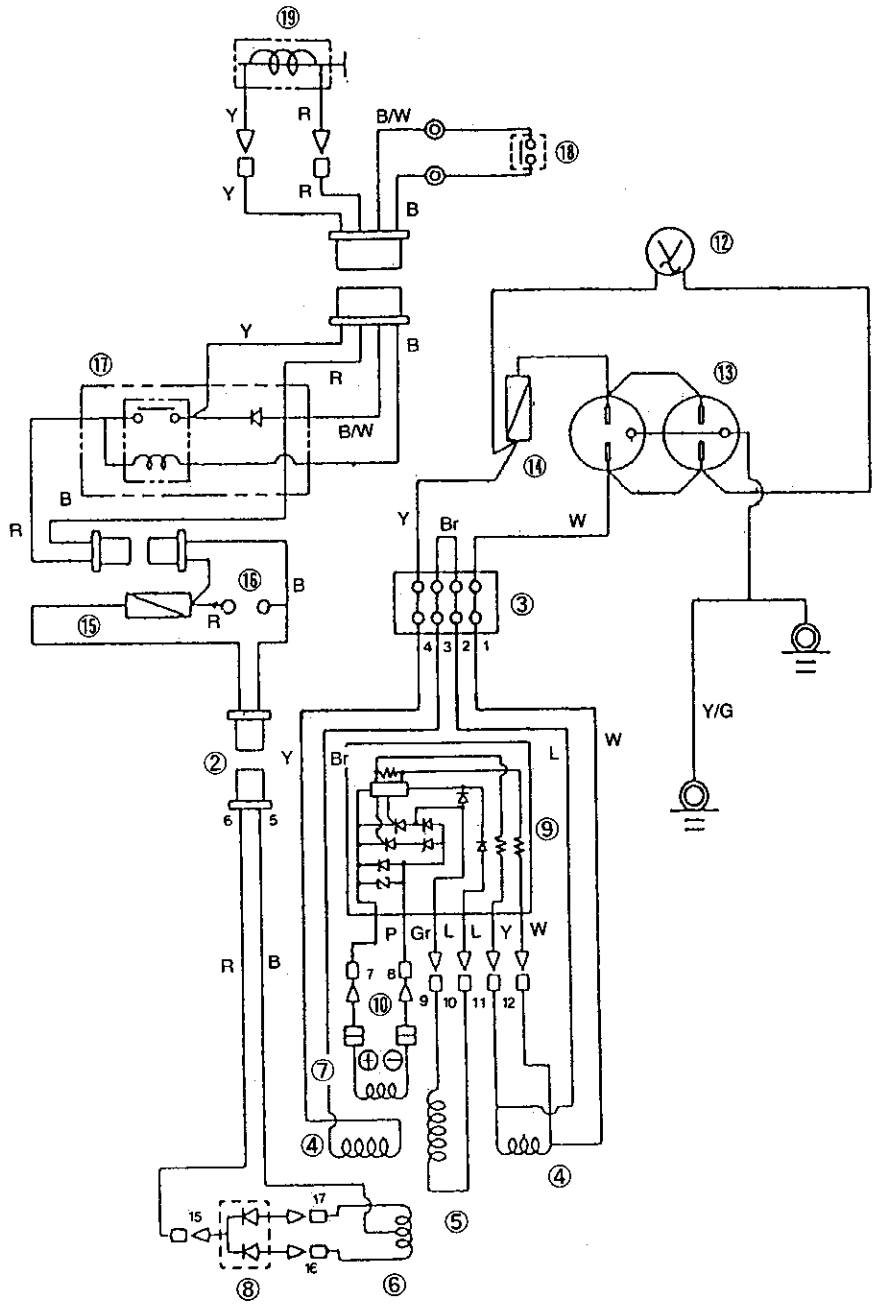


Fig. 11.1.2-2 YDG3700E-5B/6B, 5500E-5B/6B circuit diagram

Part names:

② Coupler (II)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator
⑩ Brush	⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker
⑮ DC breaker	⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch
⑲ Stop solenoid			

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

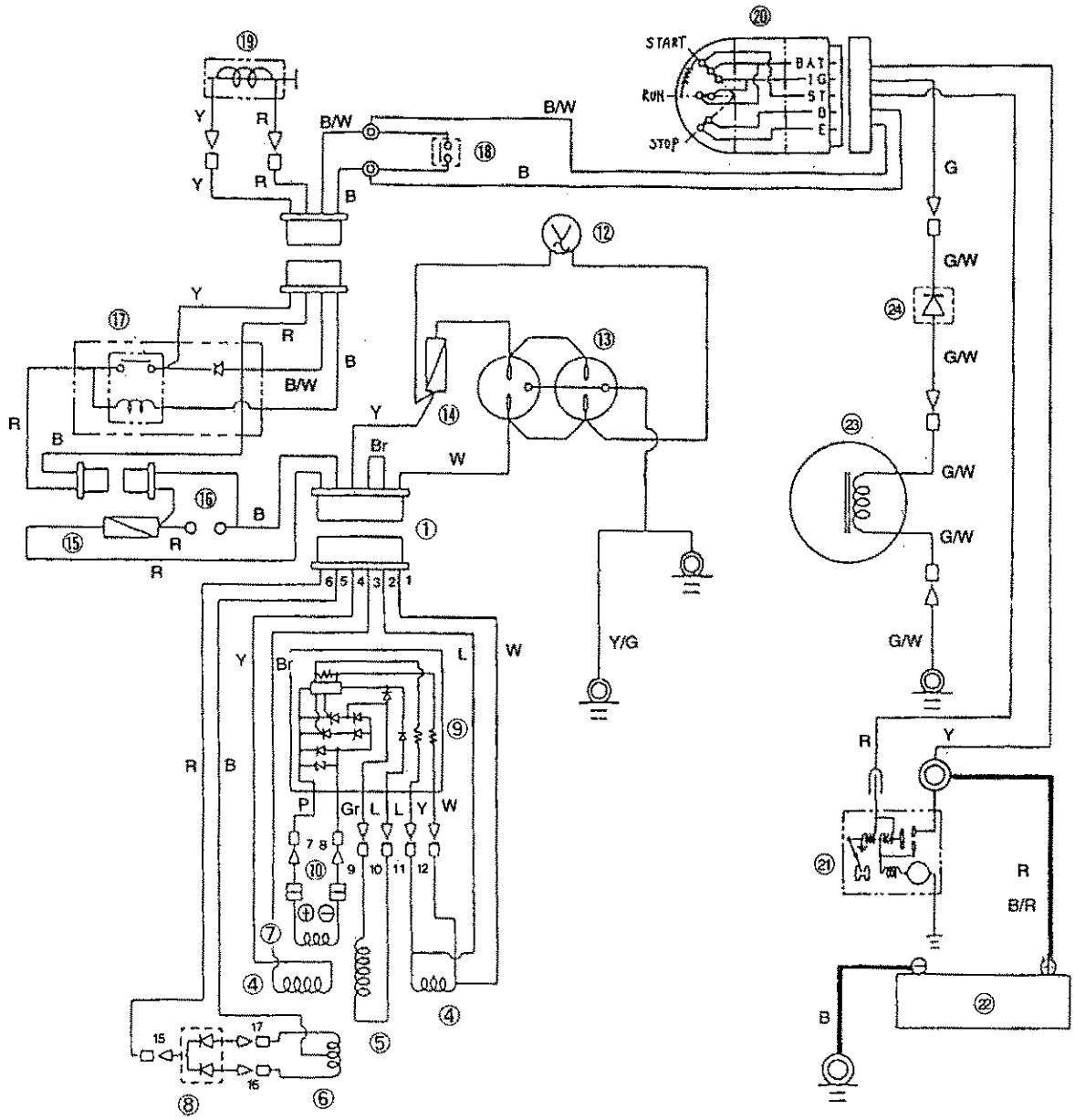


Fig. 11.1.2-3 YDG2700E-5EB/6EB circuit diagram

Part names:

① Coupler (I)	④ Armature coil	⑤ Exciter coil	⑥ DC coil
⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator	⑩ Brush
⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker	⑮ DC breaker
⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid
⑳ Starter switch	㉑ Starter motor	㉒ Battery	㉓ Charging coil
㉔ Rectifier (II)			

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

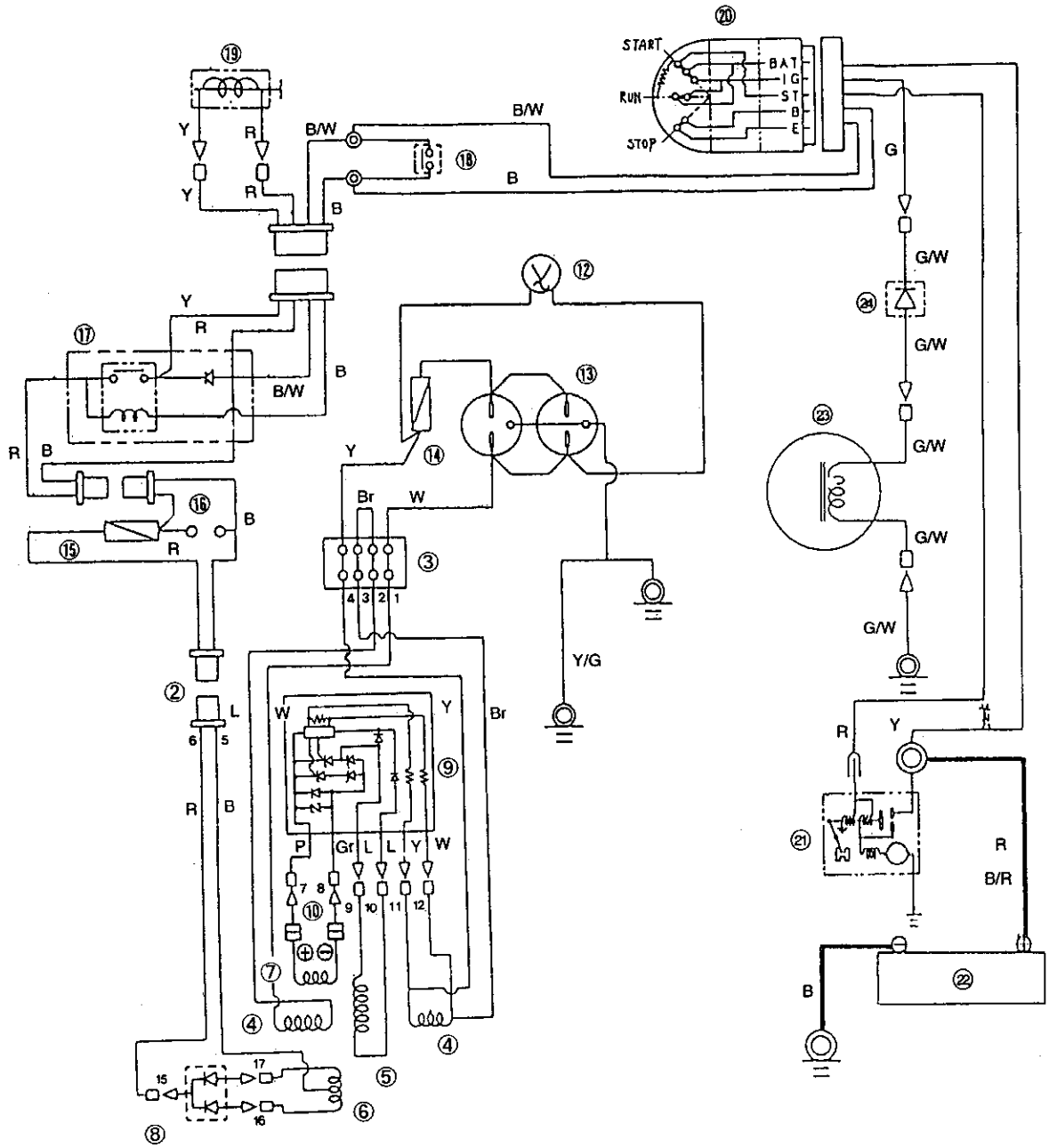


Fig. 11.1.2-4 YDG3700E-5EB/6EB, 5500E-5EB/6EB circuit diagram

Part names:

② Coupler (II)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator
⑩ Brush	⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker
⑮ DC breaker	⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch
⑲ Stop solenoid	⑳ Starter switch	㉑ Starter motor	㉒ Battery
㉓ Charging coil	㉔ Rectifier (II)		

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

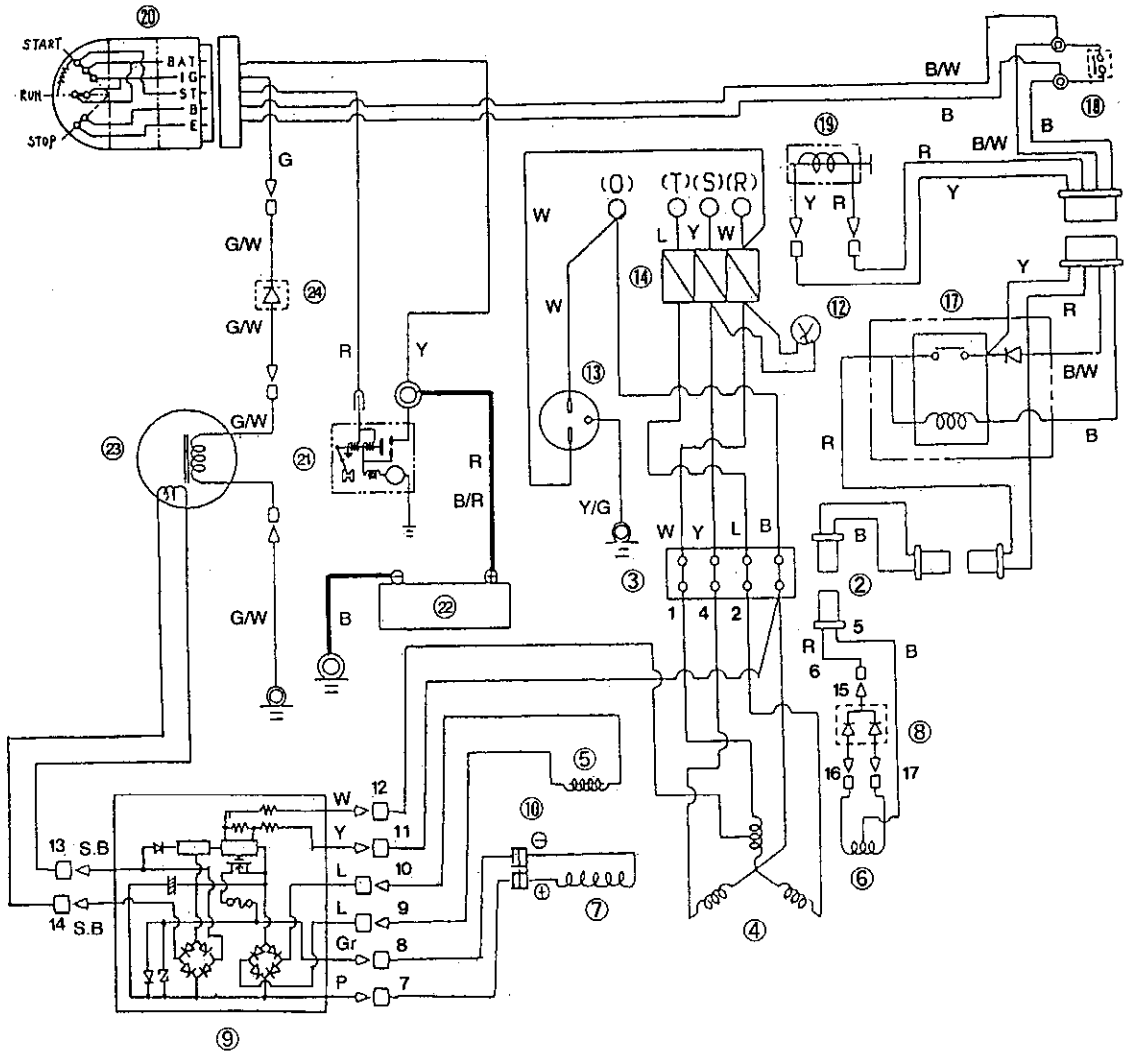


Fig. 11.1.2-5 YDG6600TE-5BE/6EB circuit diagram

Part names:

② Coupler (Ⅱ)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (Ⅰ)	⑨ Auto voltage regulator
⑩ Brush	⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker
⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid	⑳ Starter switch
㉑ Starter motor	㉒ Battery	㉓ Charging coil	㉔ Rectifier (Ⅱ)

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

2) Taiwan

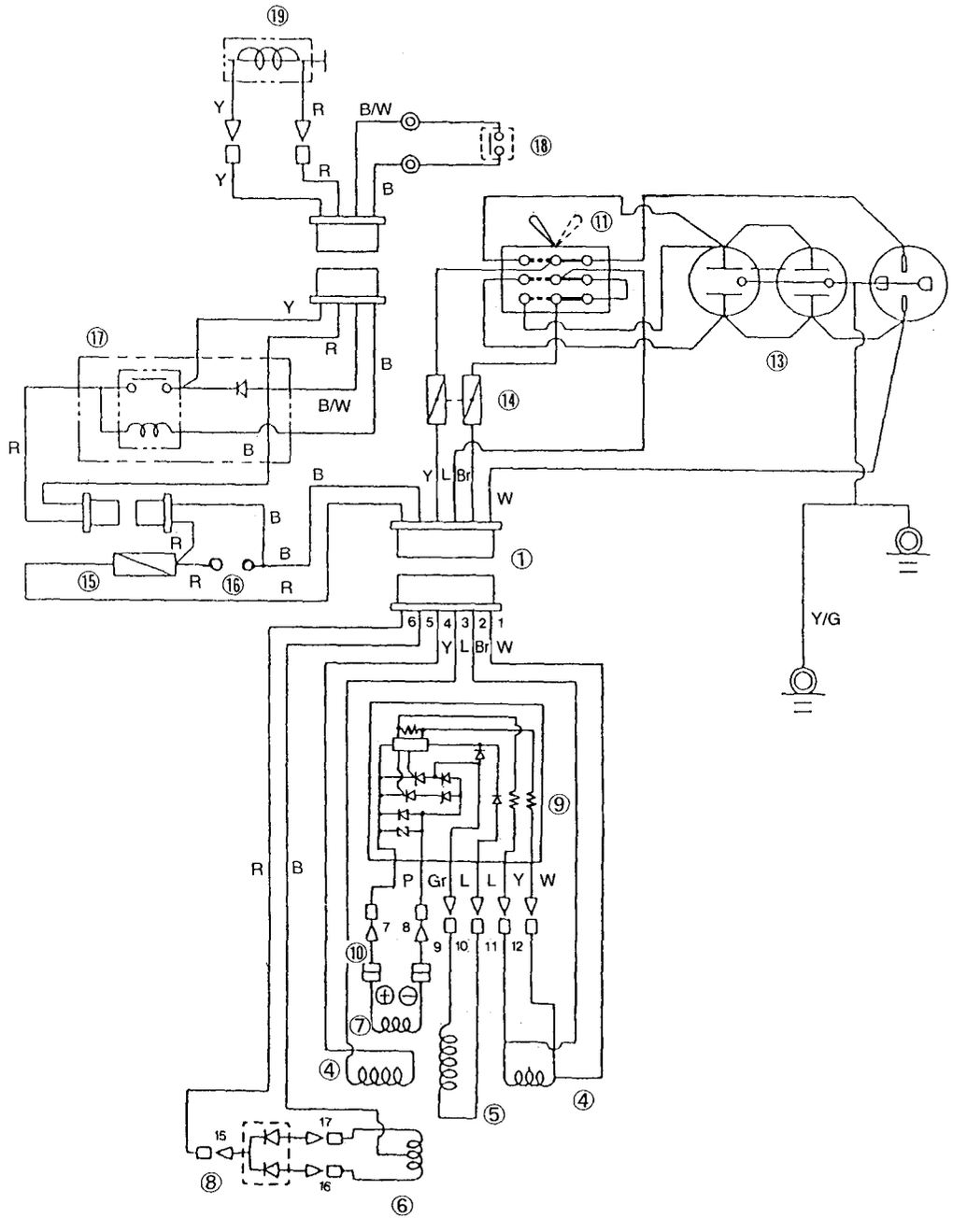


Fig. 11.1.2-6 YDG2700E-6C circuit diagram

Part names:

① Coupler (I)	④ Armature coil	⑤ Exciter coil	⑥ DC coil
⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator	⑩ Brush
⑪ Toggle switch	⑬ Receptacle	⑭ AC breaker	⑮ DC breaker
⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

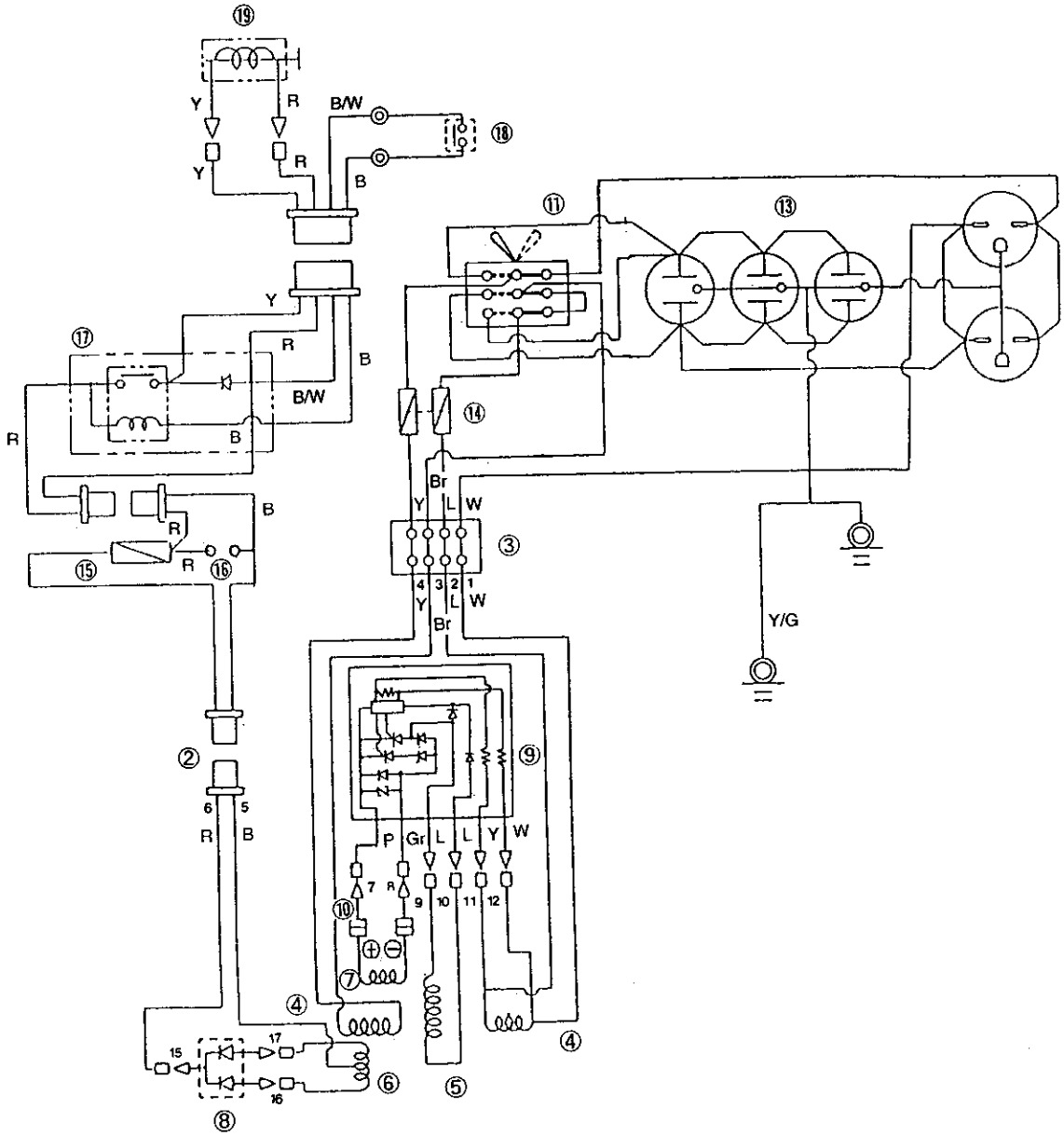


Fig. 11.1.2-7 YDG3700E-6C, 5500E-6C circuit diagram

Part names:

② Coupler (Ⅱ)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (Ⅰ)	⑨ Auto voltage regulator
⑩ Brush	⑪ Toggle switch	⑬ Receptacle	⑭ AC breaker
⑮ DC breaker	⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch
⑲ Stop solenoid			

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

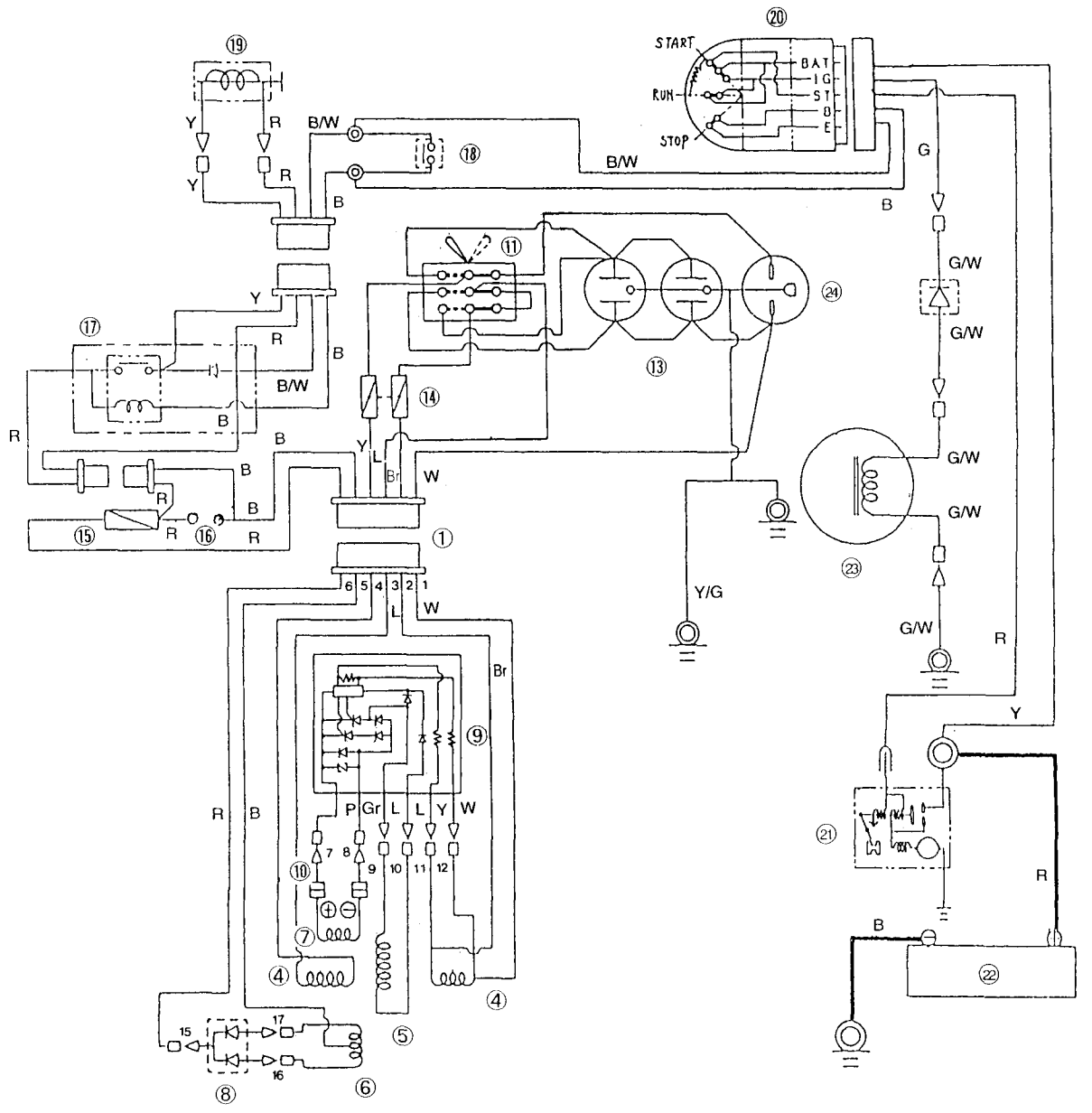


Fig. 11.1.2-8 YDG2700E-6EC circuit diagram

Part names:

① Coupler (I)	④ Armature coil	⑤ Exciter coil	⑥ DC coil
⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator	⑩ Brush
⑪ Toggle switch	⑬ Receptacle	⑭ AC breaker	⑮ DC breaker
⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid
⑳ Starter switch	㉑ Starter motor	㉒ Battery	㉓ Charging coil
㉔ Rectifier (II)			

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

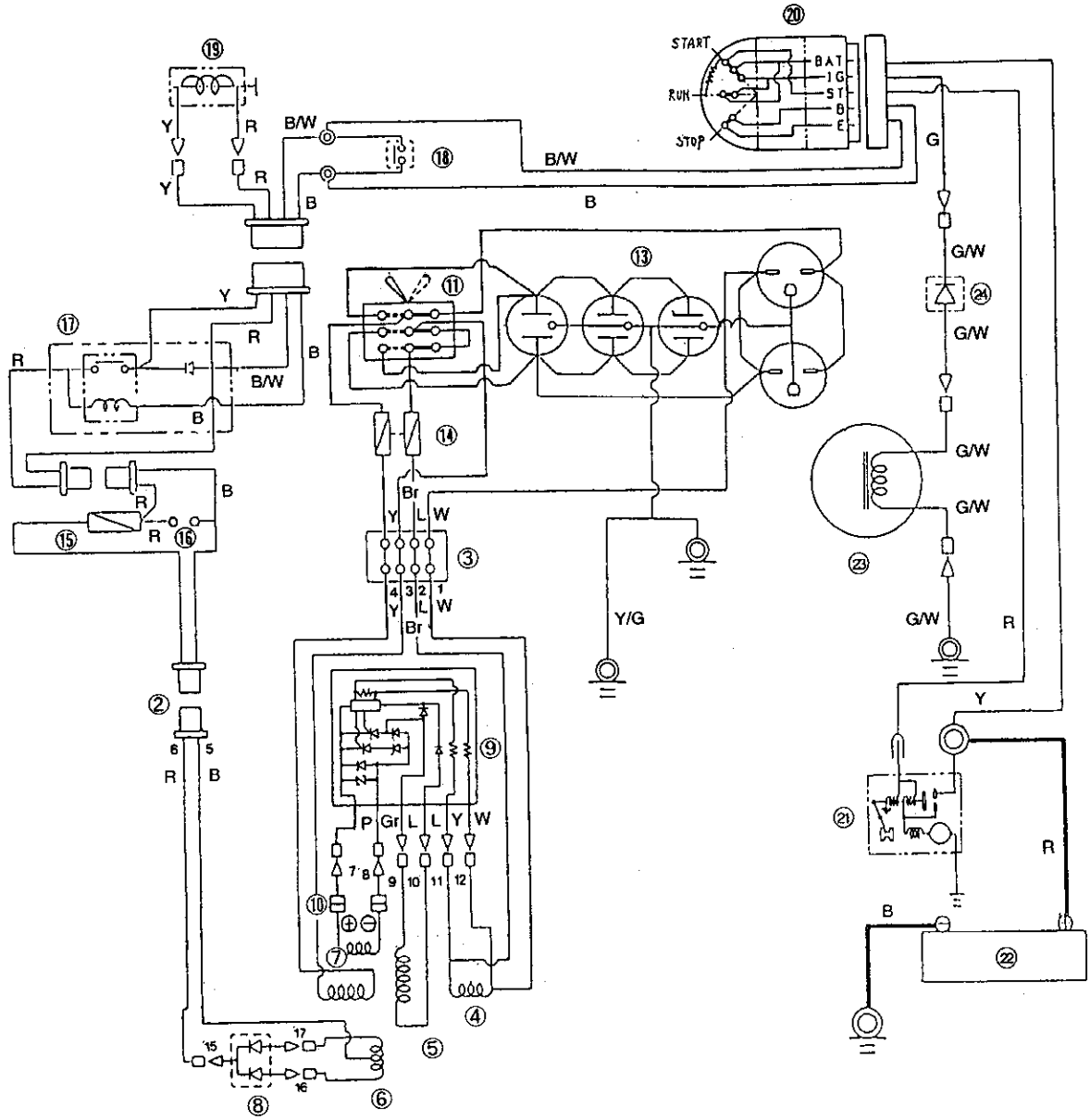


Fig. 11.1.2-9 YDG3700E-6EC, 5500E-6EC circuit diagram

Part names:

② Coupler (Ⅱ)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (Ⅰ)	⑨ Auto voltage regulator
⑩ Brush	⑪ Toggle switch	⑬ Receptacle	⑭ AC breaker
⑮ DC breaker	⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch
⑲ Stop solenoid	⑳ Starter switch	㉑ Starter motor	㉒ Battery
㉓ Charging coil	㉔ Rectifier (Ⅱ)		

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

3) Australia

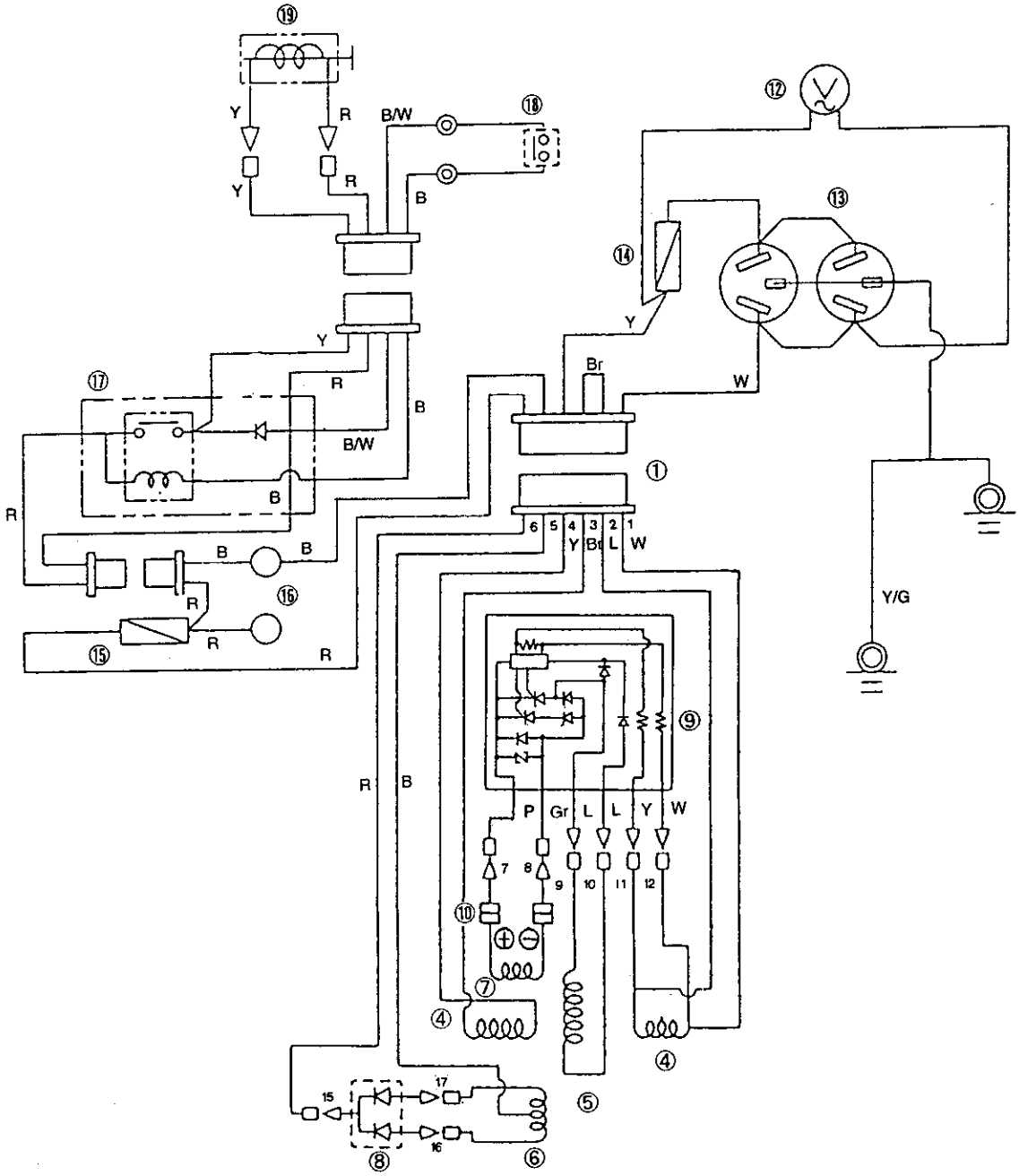


Fig. 11.1.2-10 YDG2700E-5F circuit diagram

Part names:

① Coupler (I)	④ Armature coil	⑤ Exciter coil	⑥ DC coil
⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator	⑩ Brush
⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker	⑮ DC breaker
⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

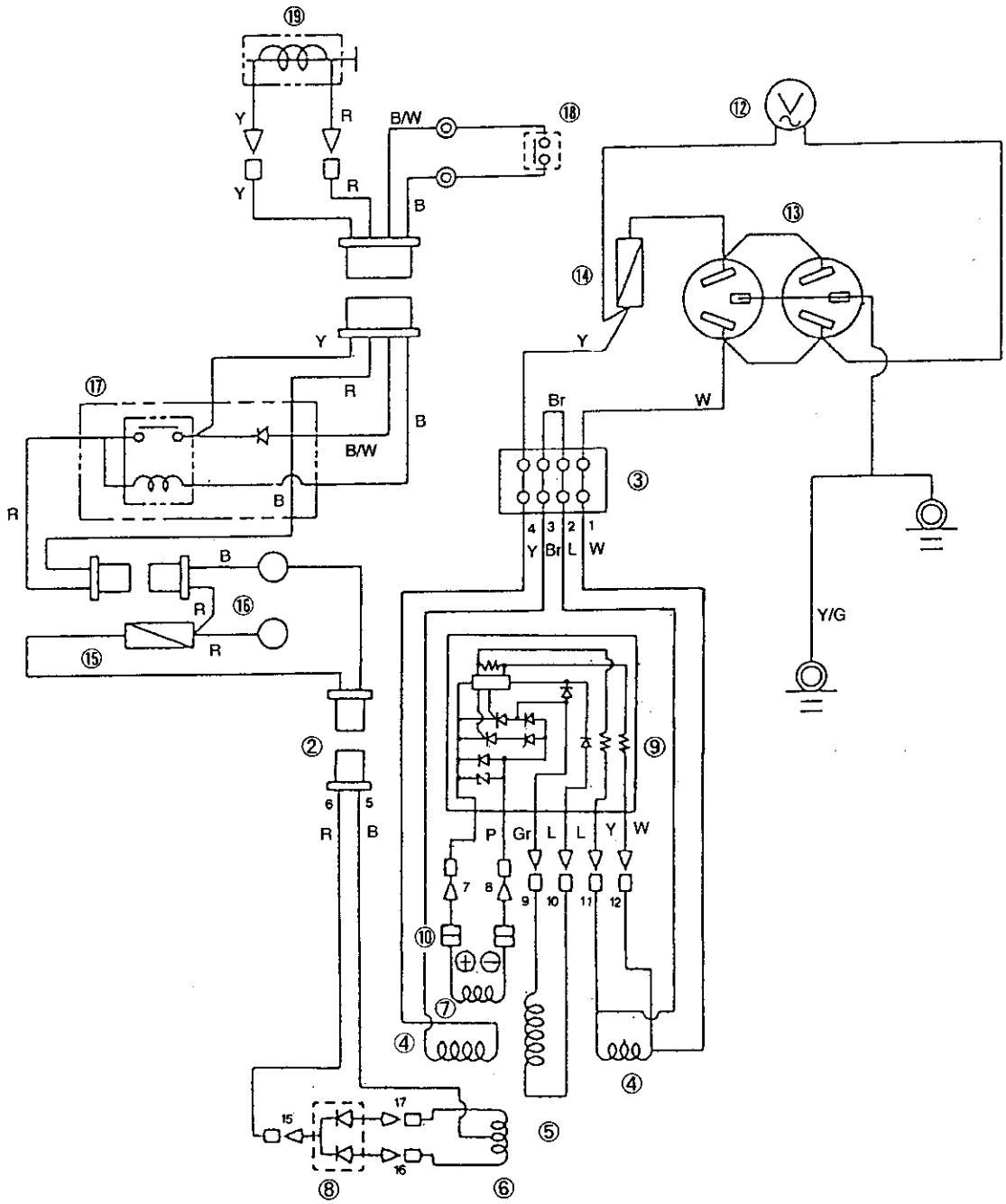


Fig. 11.1.2-11 YDG3700E-5F, 5500E-5F circuit diagram

Part names:

② Coupler (II)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator
⑩ Brush	⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker
⑮ DC breaker	⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch
⑲ Stop solenoid			

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

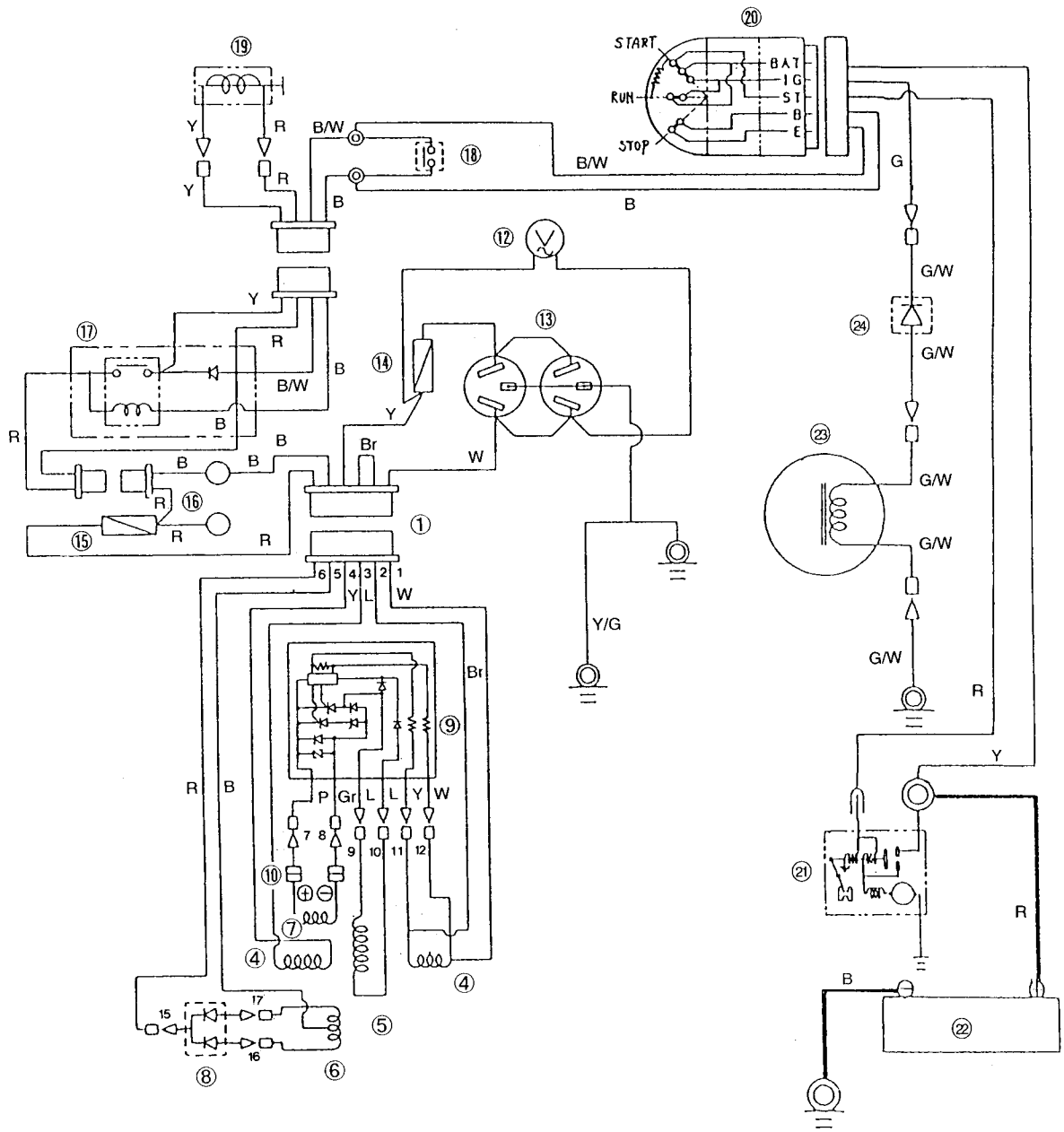


Fig. 11.1.2-12 YDG2700E-5EF circuit diagram

Part names:

① Coupler (I)	④ Armature coil	⑤ Exciter coil	⑥ DC coil
⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator	⑩ Brush
⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker	⑮ DC breaker
⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid
⑳ Starter switch	㉑ Starter motor	㉒ Battery	㉓ Charging coil
㉔ Rectifier (II)			

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

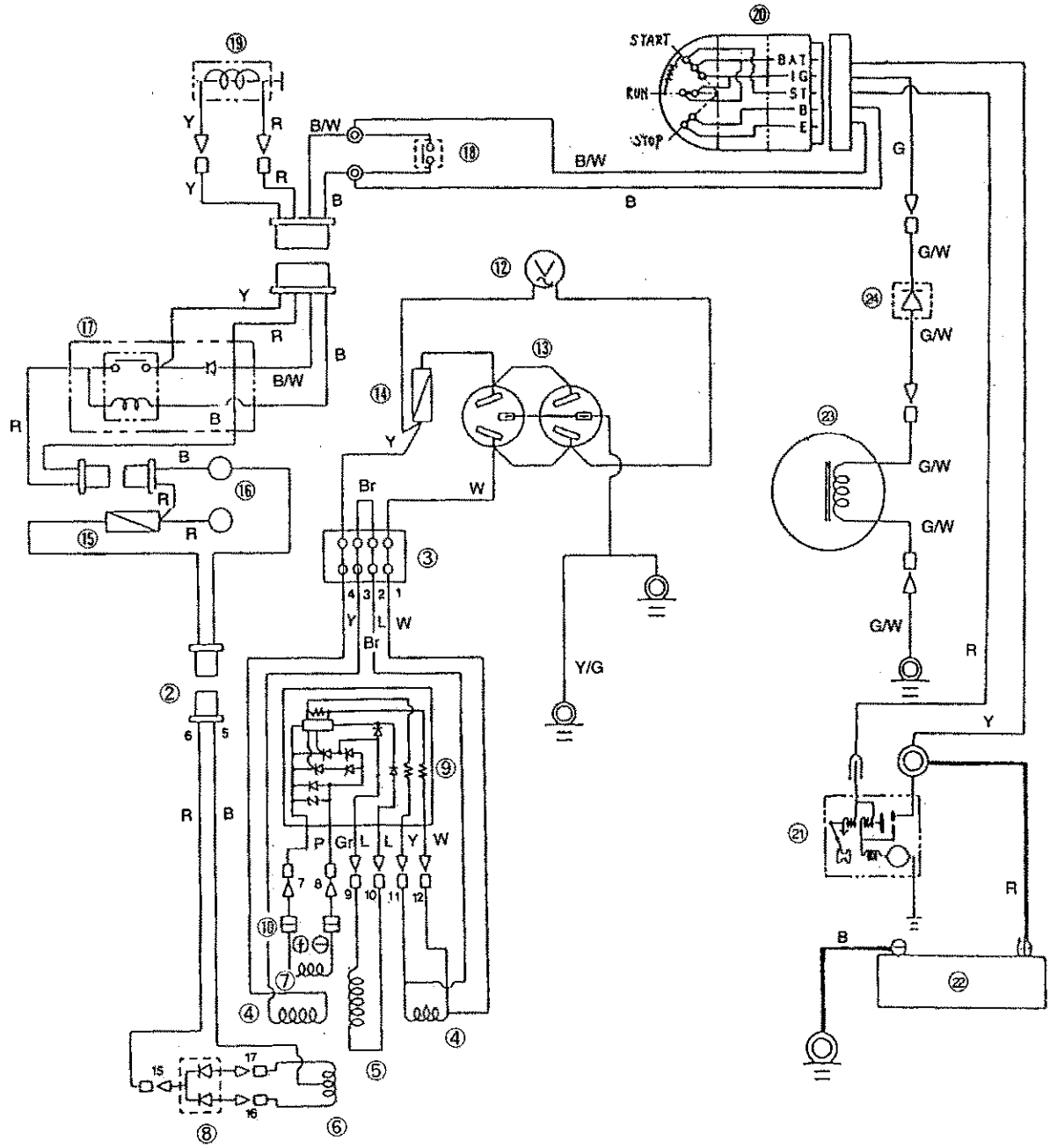


Fig. 11.1.2-13 YDG3700E-5EF, 5500E-5EF circuit diagram

Part names:

② Coupler (Ⅱ)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (Ⅰ)	⑨ Auto voltage regulator
⑩ Brush	⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker
⑮ DC breaker	⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch
⑲ Stop solenoid	⑳ Starter switch	㉑ Starter motor	㉒ Battery
㉓ Charging coil	㉔ Rectifier (Ⅱ)		

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

4) Saudi Arabia

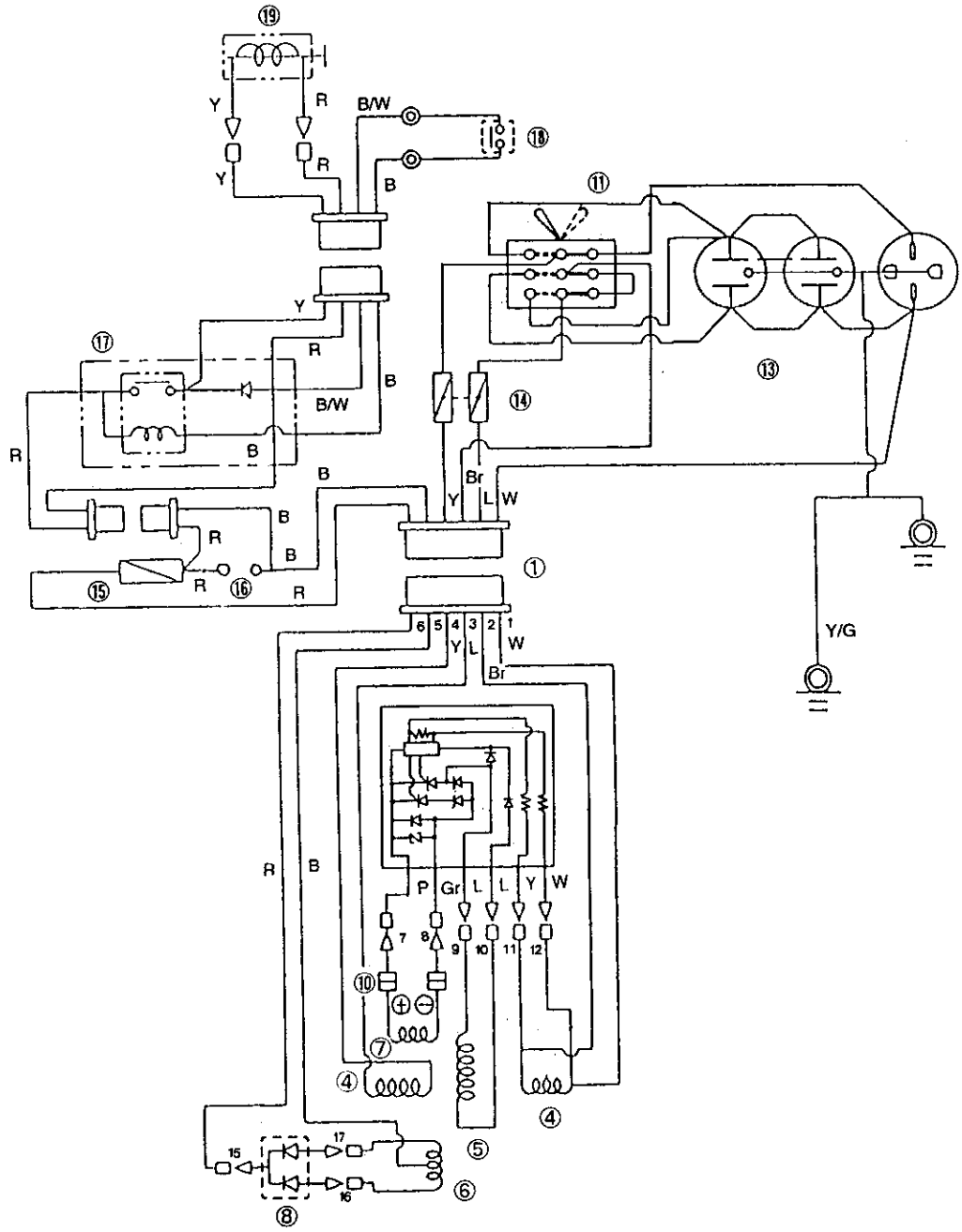


Fig. 11.1.2-14 YDG2700E-6CS, 3700E-6CS circuit diagram

Part names:

① Coupler (I)	④ Armature coil	⑤ Exciter coil	⑥ DC coil
⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator	⑩ Brush
⑪ Toggle switch	⑬ Receptacle	⑭ AC breaker	⑮ DC breaker
⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

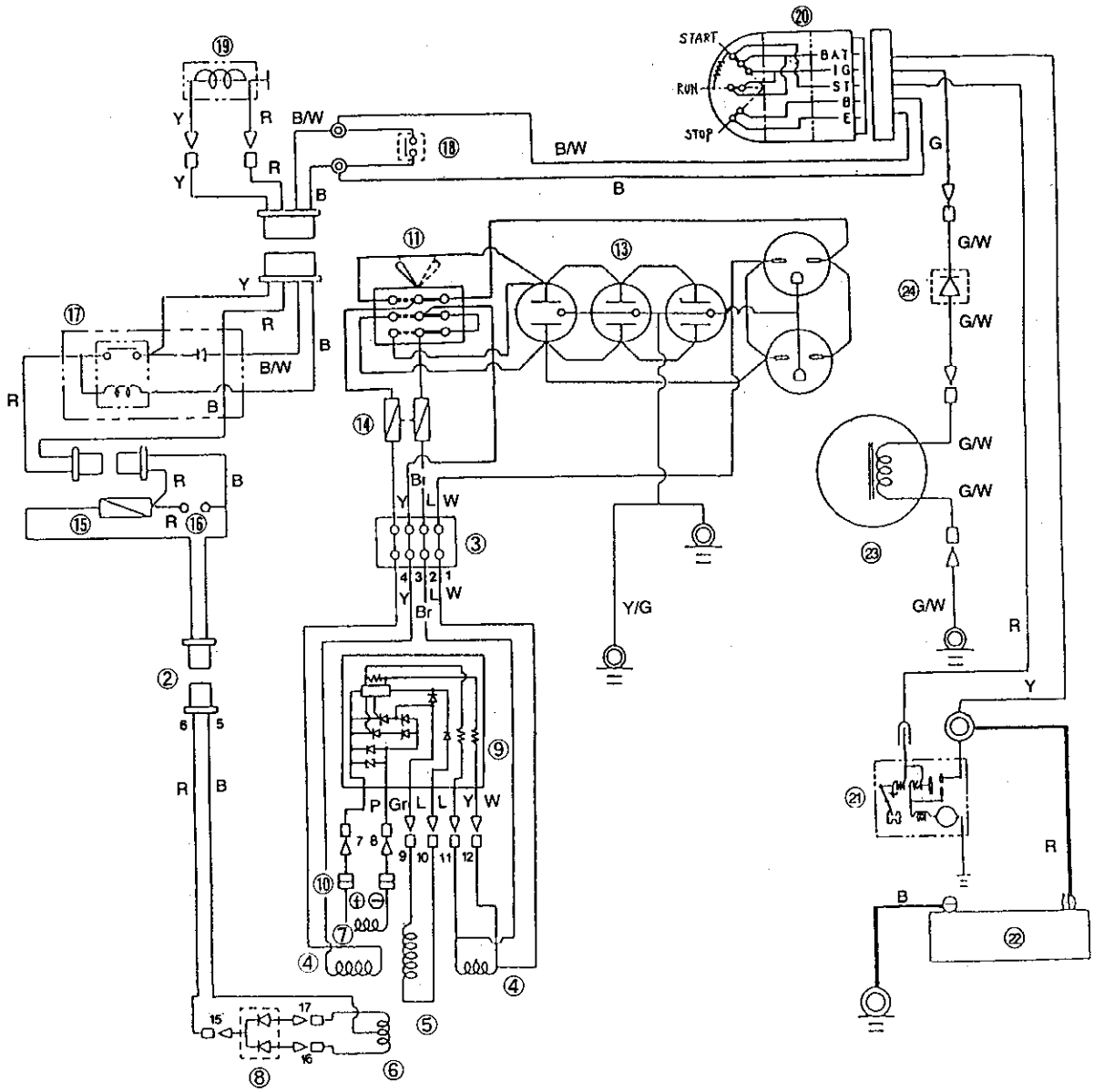


Fig. 11.1.2-15 YDG5500E-6ECS circuit diagram

Part names:

② Coupler (Ⅱ)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (Ⅰ)	⑨ Auto voltage regulator
⑩ Brush	⑪ Toggle switch	⑬ Receptacle	⑭ AC breaker
⑮ DC breaker	⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch
⑲ Stop solenoid	⑳ Starter switch	㉑ Starter motor	㉒ Battery
㉓ Charging coil	㉔ Rectifier (Ⅱ)		

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

5) Germany, Holland and Italy

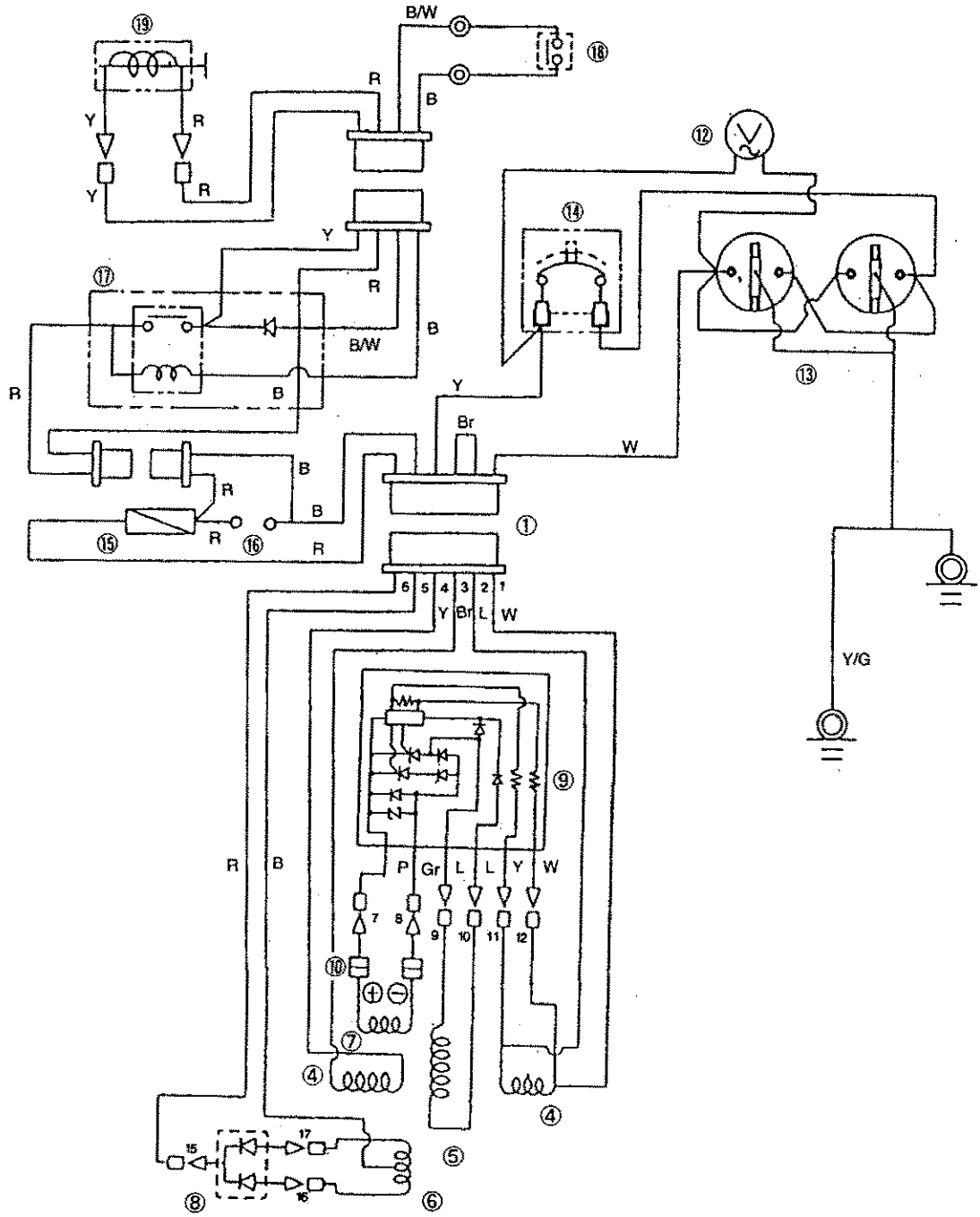


Fig. 11.1.2-16 YDG2700E-5BG circuit diagram

Part names:

① Coupler (I)	④ Armature coil	⑤ Exciter coil	⑥ DC coil
⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator	⑩ Brush
⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker	⑮ DC breaker
⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

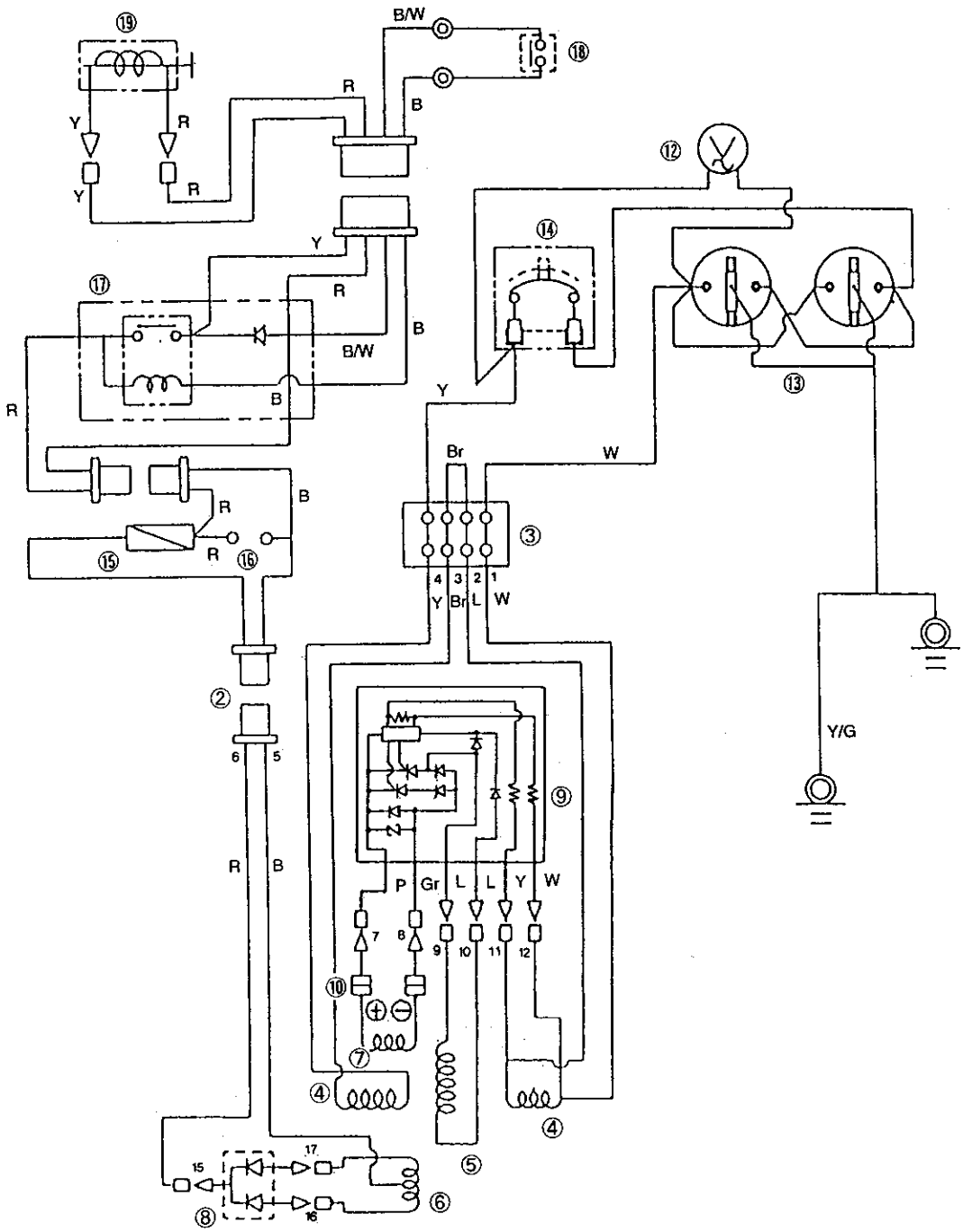


Fig. 11.1.2-17 YDG3700E-5BG, 5500E-5BG circuit diagram

Part names:

② Coupler (Ⅱ)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (Ⅰ)	⑨ Auto voltage regulator
⑩ Brush	⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker
⑮ DC breaker	⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch
⑲ Stop solenoid			

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

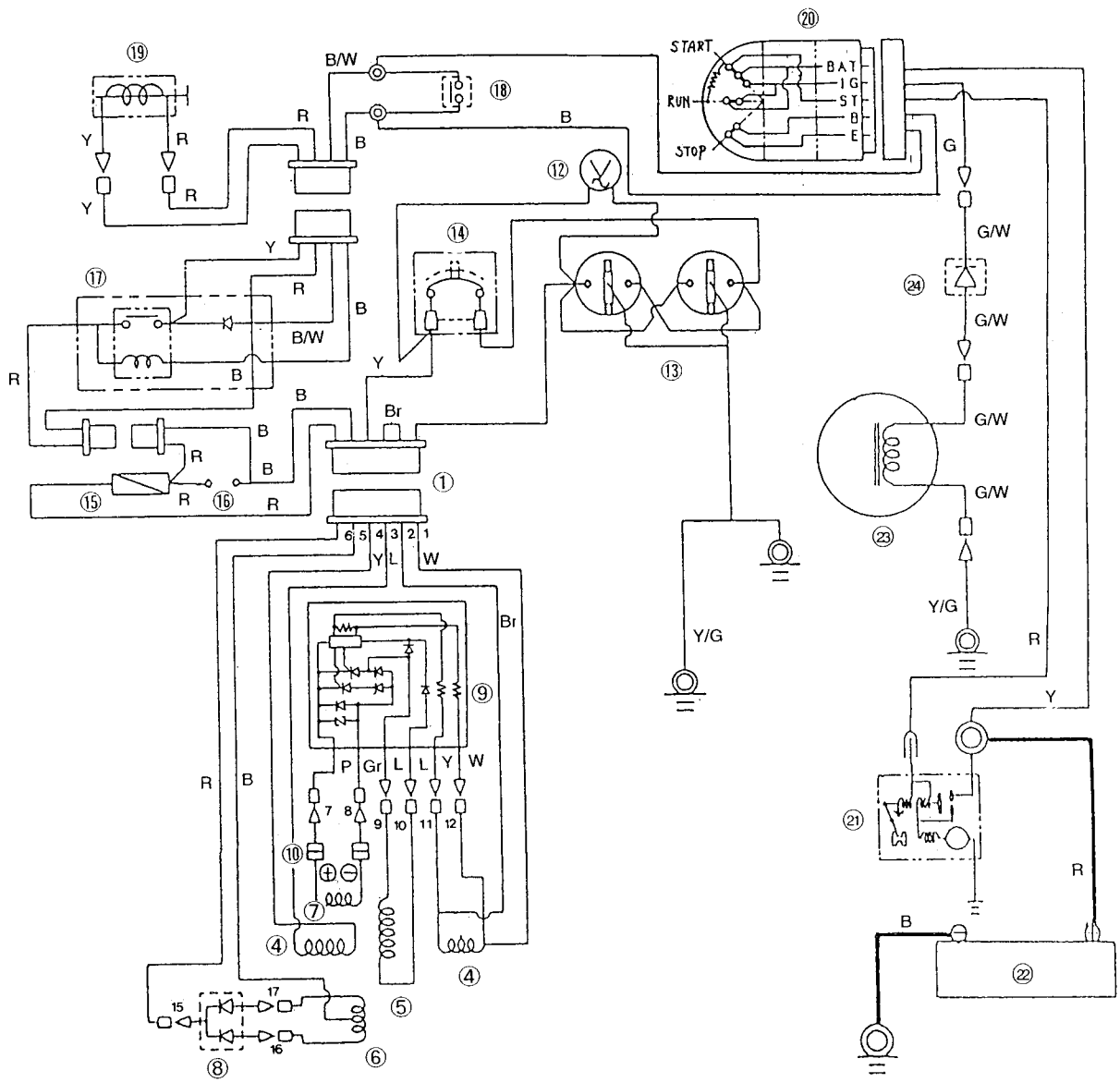


Fig. 11.1.2-18 YDG2700E-5EBG circuit diagram

Part names:

① Coupler (I)	④ Armature coil	⑤ Exciter coil	⑥ DC coil
⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator	⑩ Brush
⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker	⑮ DC breaker
⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid
⑳ Starter switch	㉑ Starter motor	㉒ Battery	㉓ Charging coil
㉔ Rectifier (II)			

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

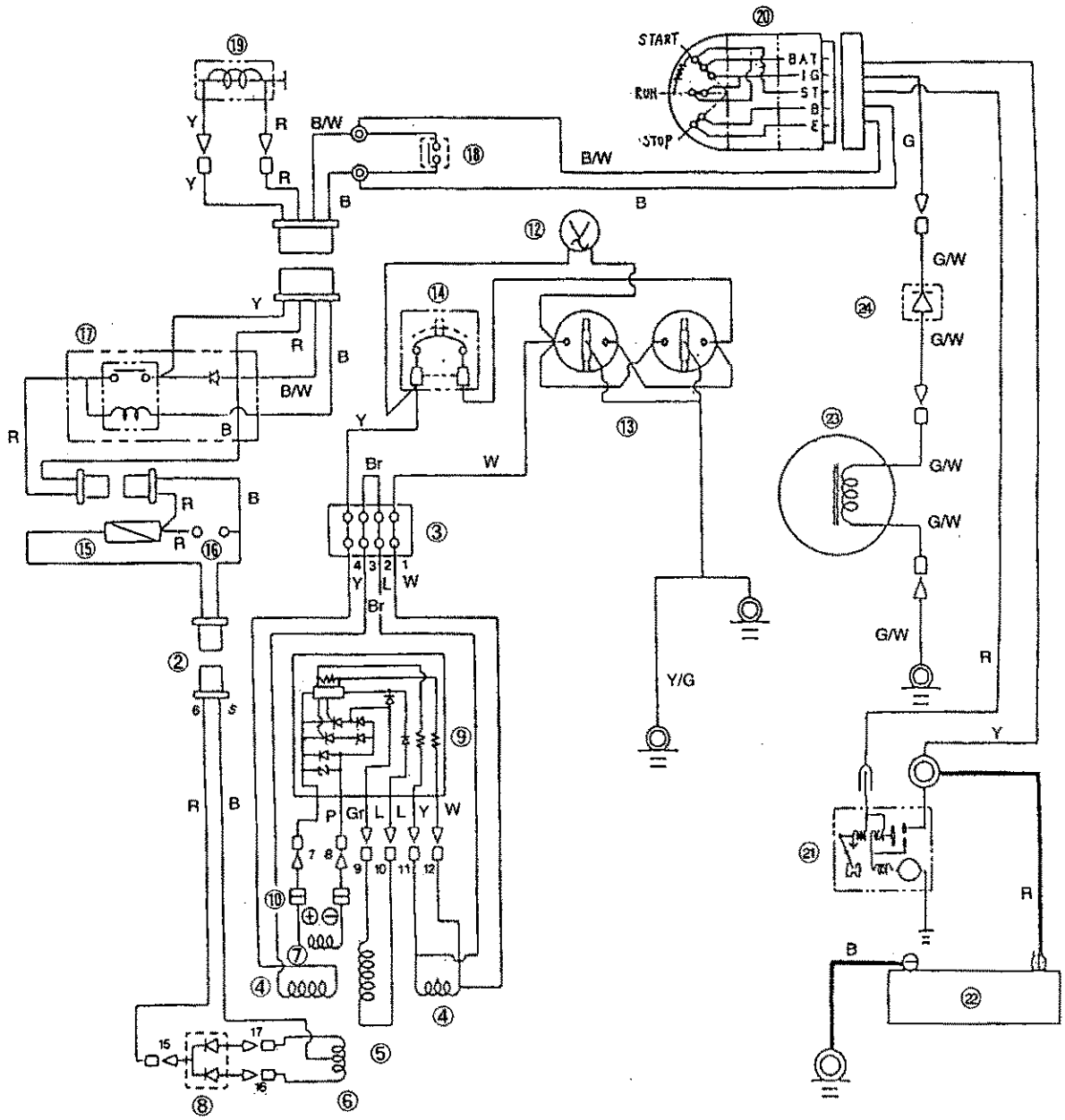


Fig. 11.1.2-19 YDG3700E-5EBG, 5500E-5EBG circuit diagram

Part names:

② Coupler (Ⅱ)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (Ⅰ)	⑨ Auto voltage regulator
⑩ Brush	⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker
⑮ DC breaker	⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch
⑲ Stop solenoid	⑳ Starter switch	㉑ Starter motor	㉒ Battery
㉓ Charging coil	㉔ Rectifier (Ⅱ)		

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

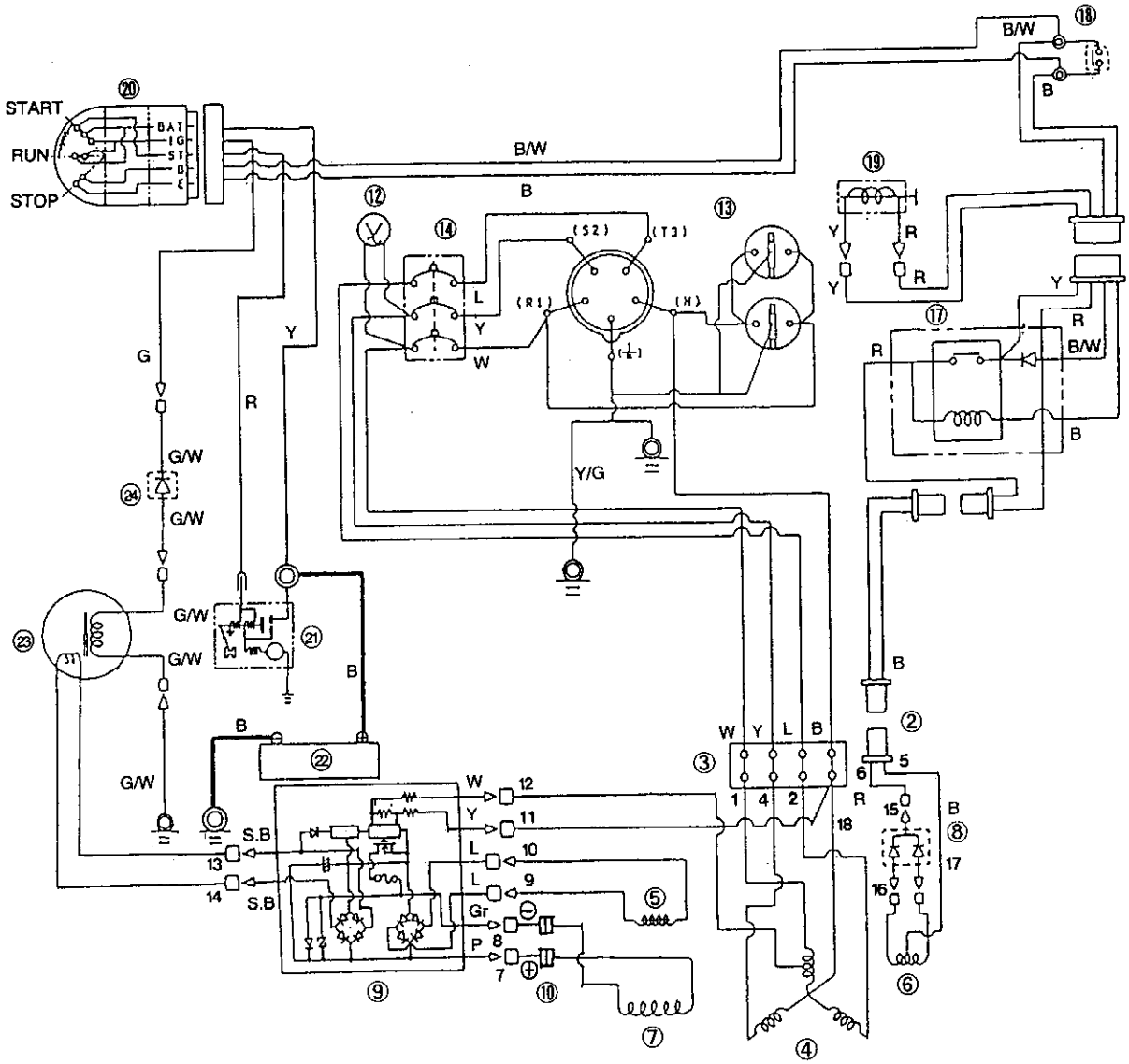


Fig. 11.1.2-20 YDG6600TE-5EBG circuit diagram

Part names:

② Coupler (Ⅱ)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (Ⅰ)	⑨ Auto voltage regulator
⑩ Brush	⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker
⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid	⑳ Starter switch
㉑ Starter motor	㉒ Battery	㉓ Charging coil	㉔ Rectifier (Ⅱ)

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

6) Norway

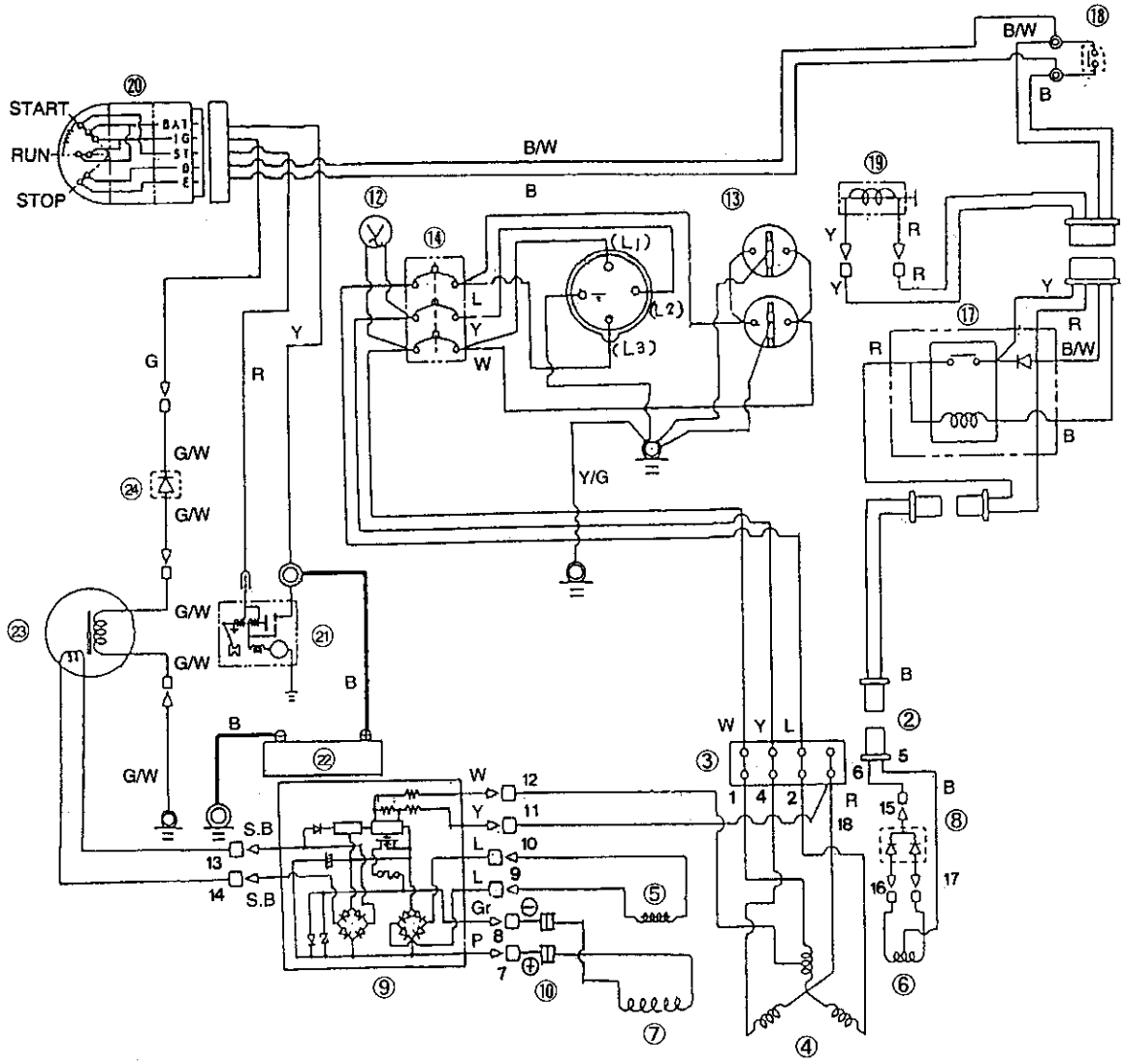


Fig. 11.1.2-21 YDG6600TE-5EBN circuit diagram

Part names:

② Coupler (Ⅱ)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (Ⅰ)	⑨ Auto voltage regulator
⑩ Brush	⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker
⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid	⑳ Starter switch
㉑ Starter motor	㉒ Battery	㉓ Charging coil	㉔ Rectifier (Ⅱ)

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

7) U.S.A. and Canada

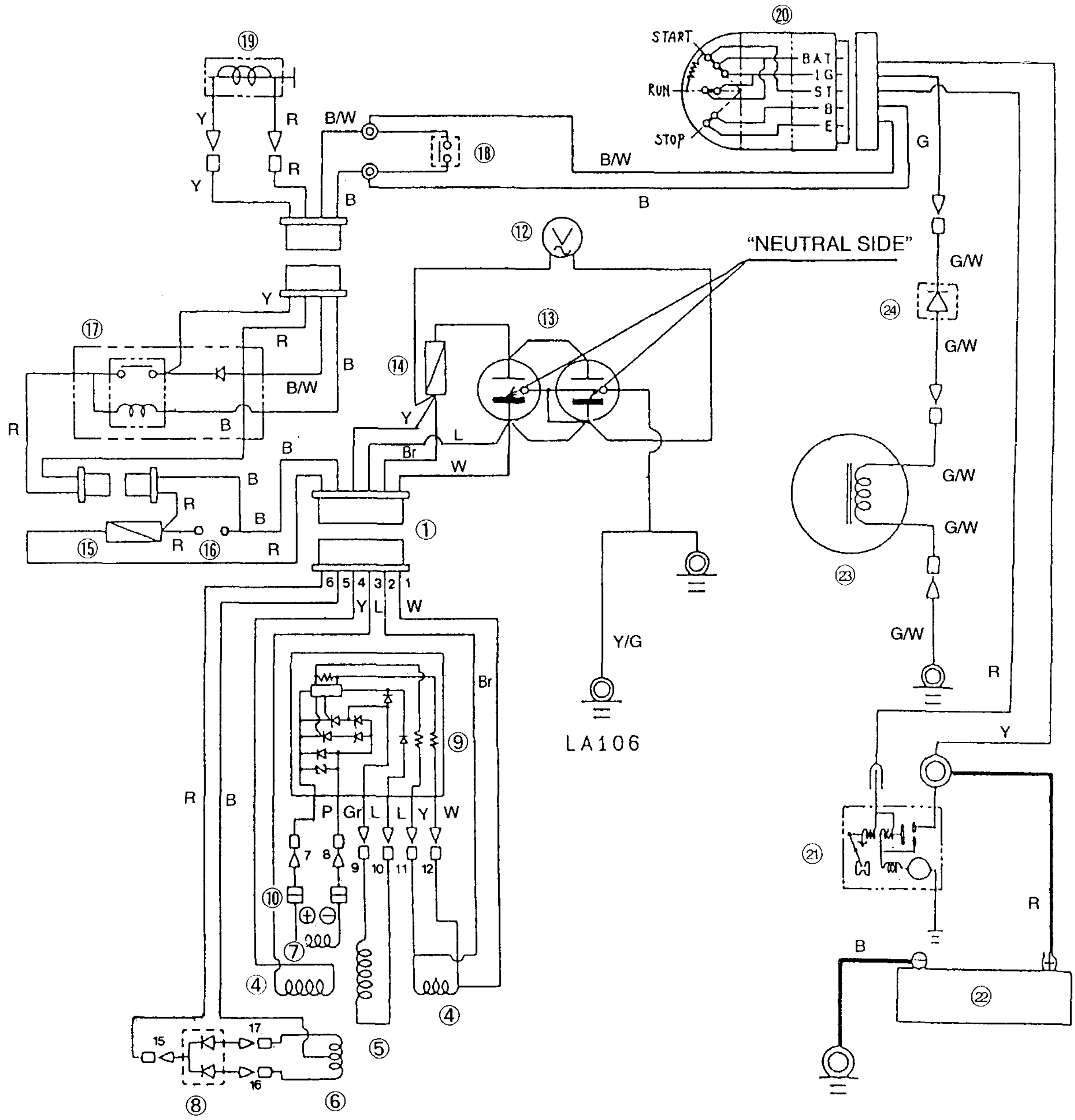


Fig. 11.1.2-22 YDG2700E-6EH circuit diagram

Part names:

① Coupler (I)	④ Armature coil	⑤ Exciter coil	⑥ DC coil
⑦ Field coil	⑧ Rectifier (I)	⑨ Auto voltage regulator	⑩ Brush
⑫ Voltmeter	⑬ Receptacle	⑭ AC breaker	⑮ DC breaker
⑯ DC terminal	⑰ Relay	⑱ Oil pressure switch	⑲ Stop solenoid
⑳ Starter switch	㉑ Starter motor	㉒ Battery	㉓ Charging coil
㉔ Rectifier (II)			

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

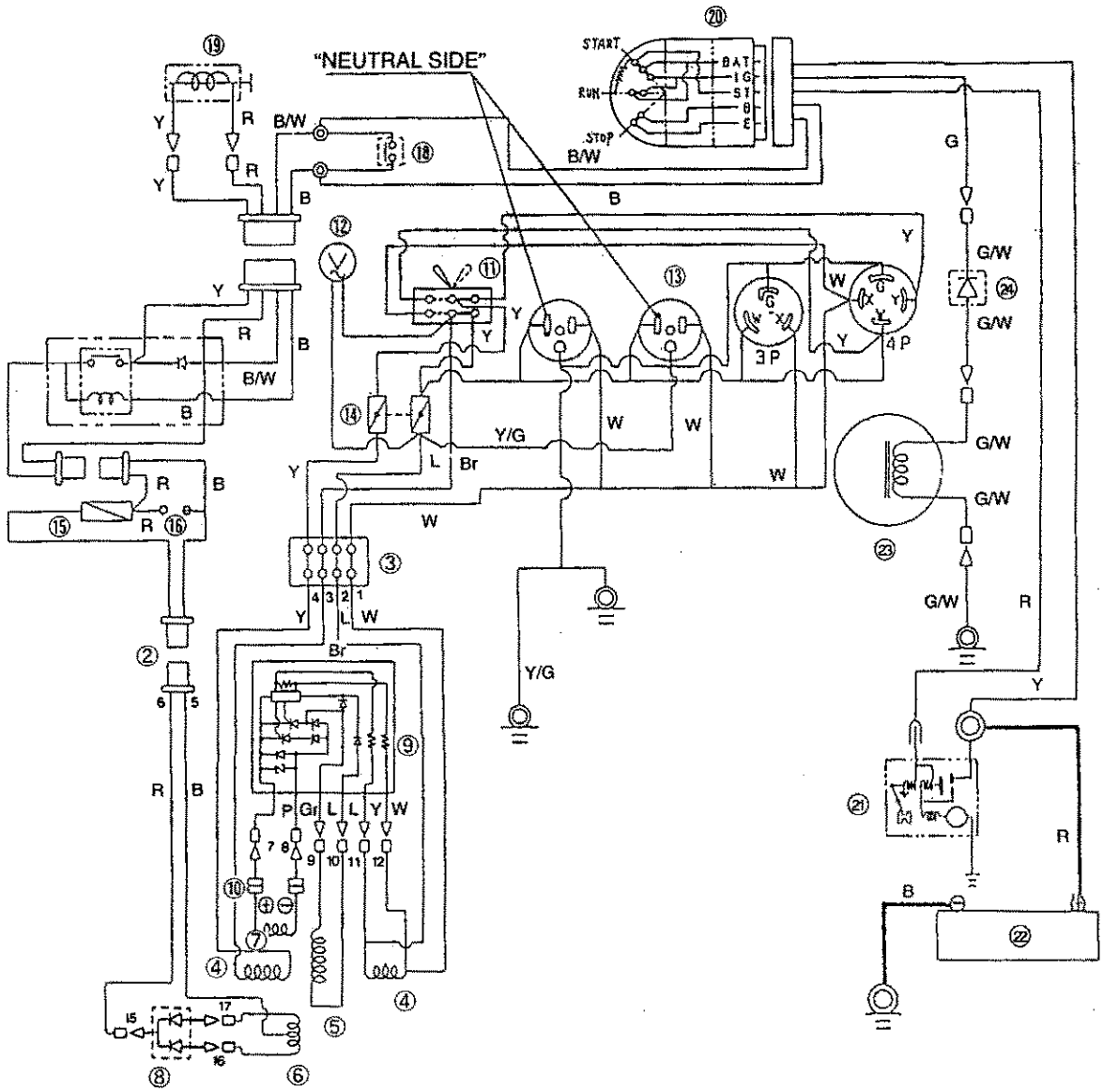


Fig. 11.1.2-23 YDG3700E-6EI, 5500E-6EI circuit diagram

Part names:

② Coupler (Ⅱ)	③ Terminal	④ Armature coil	⑤ Exciter coil
⑥ DC coil	⑦ Field coil	⑧ Rectifier (Ⅰ)	⑨ Auto voltage regulator
⑩ Brush	⑪ Toggle switch	⑫ Voltmeter	⑬ Receptacle
⑭ AC breaker	⑮ DC breaker	⑯ DC terminal	⑰ Relay
⑱ Oil pressure switch	⑲ Stop solenoid	⑳ Starter switch	㉑ Starter motor
㉒ Battery	㉓ Charging coil	㉔ Rectifier (Ⅱ)	

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

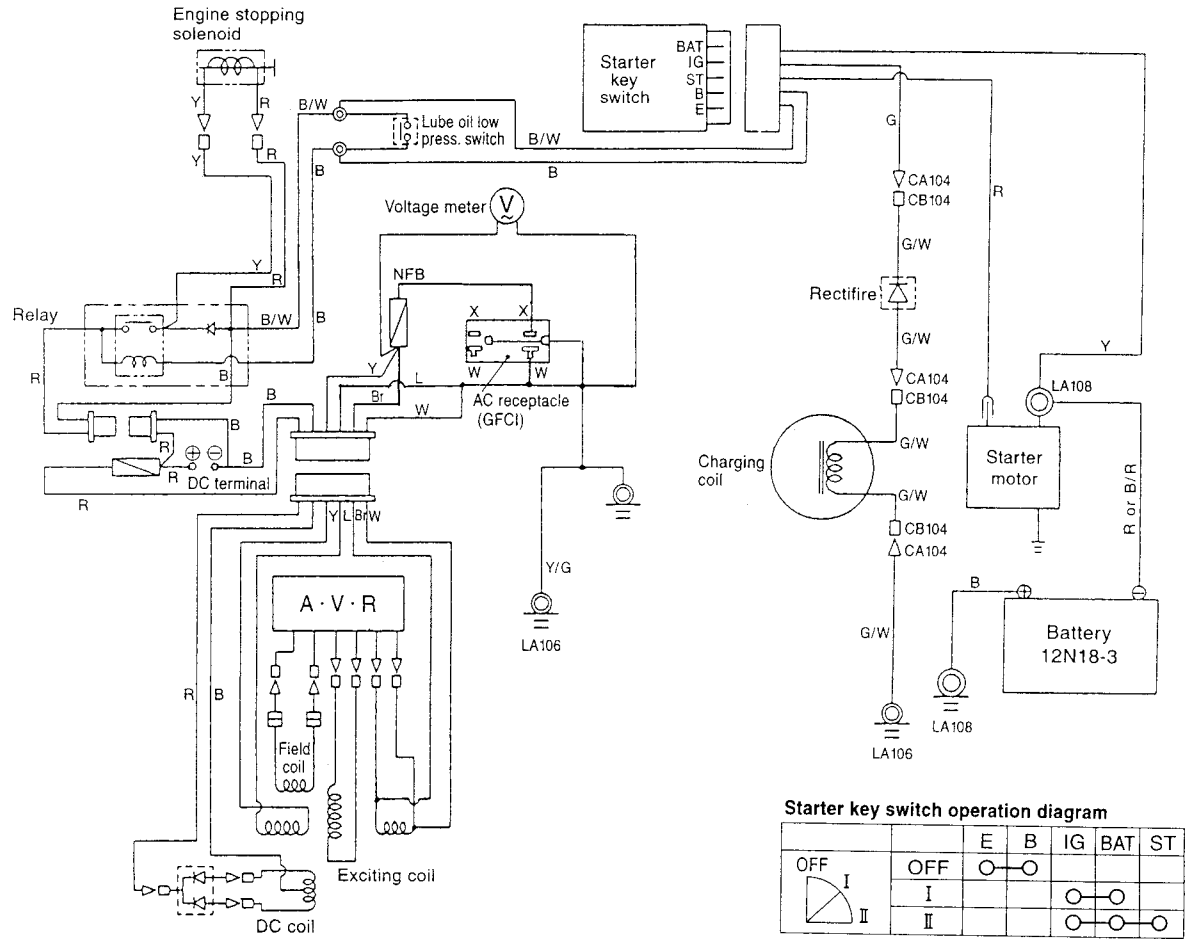


Fig. 11.1.2-24 YDG2700EE-6EH Circuit diagram

Lead colors:

B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

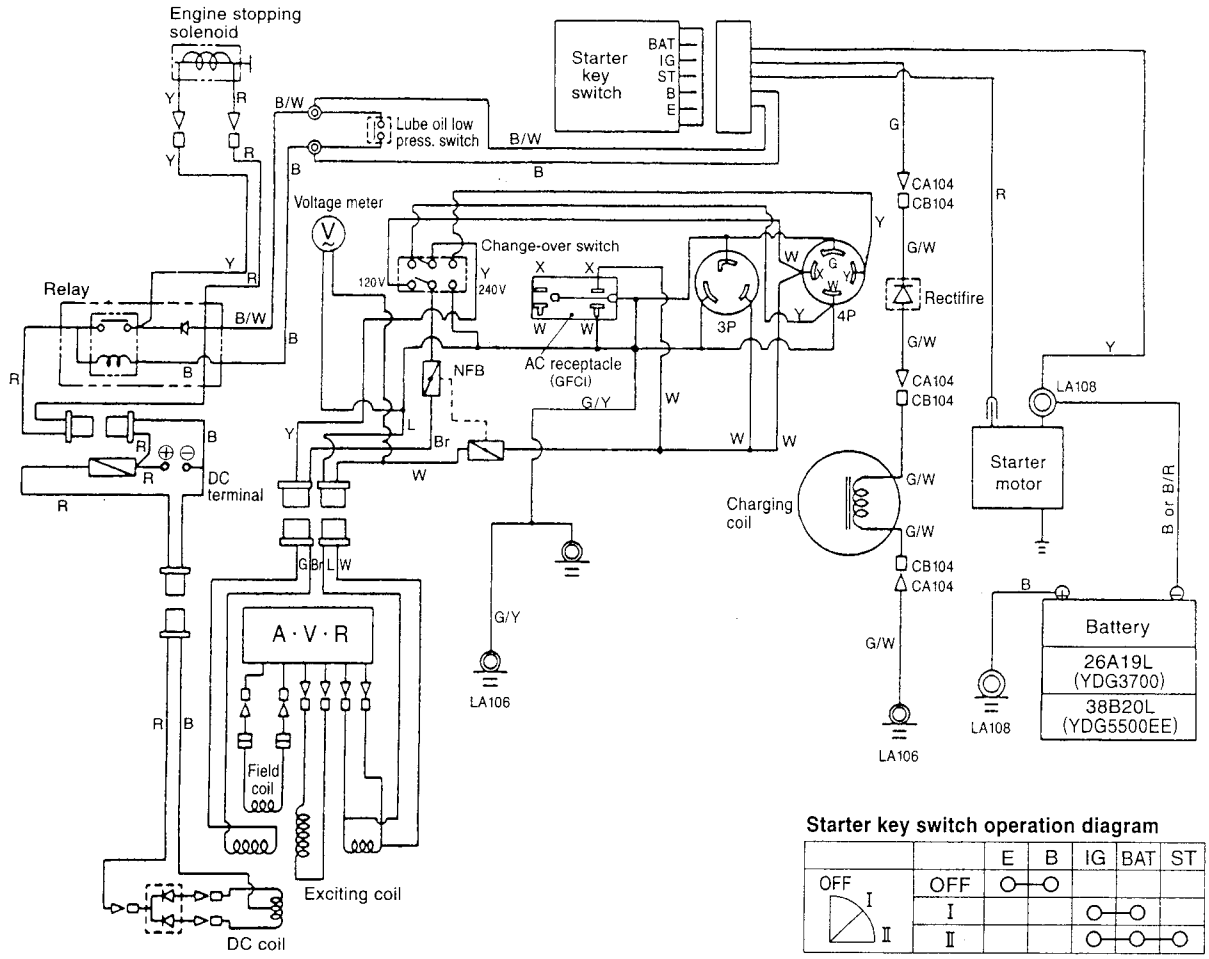


Fig. 11.1.2-25 YDG3700EE-6EI/5500EE-6EI

Lead colors:

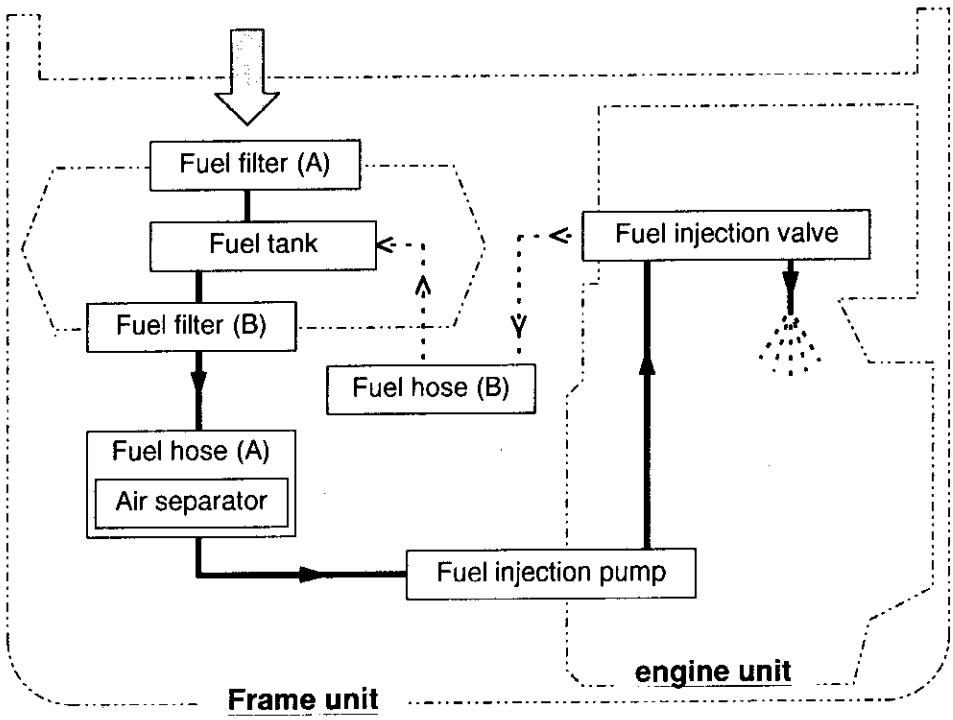
B : Black	Br : Brown	G : Green	L : Blue	P : Pink
Y : Yellow	R : Red	W : White	Gr : Gray	S.B : Sky blue
B/W : Black/White	B/R : Black/Red	G/W : Green/White	Y/G : Yellow/Green	

11.2 Fuel Circuit

The fuel circuit extends over the frame and engine units.

11.2.1 Fuel Circuit Diagram

The fuel circuit forms a circulation circuit where the fuel flows through the fuel filter, fuel injection pump and fuel injection valve and then returns to the original fuel tank.



——— : Fuel supply circuit
- - - - - - - : Fuel return circuit from fuel injection valve

Fig. 11.2.1 Fuel circuit diagram

11.3 Lubrication Circuit

Only the lubrication circuit for the engine unit is described. Since the grease lubrication is used for ball bearings supporting the rotor of the generator unit, description is omitted.

11.3.1 Lubrication Circuit Diagram

The lubricating oil flows in the directions shown by arrows to lubricate components of the cylinder block, crank case cover, cylinder head and bonnet. The lubrication methods vary from component to component as shown below.

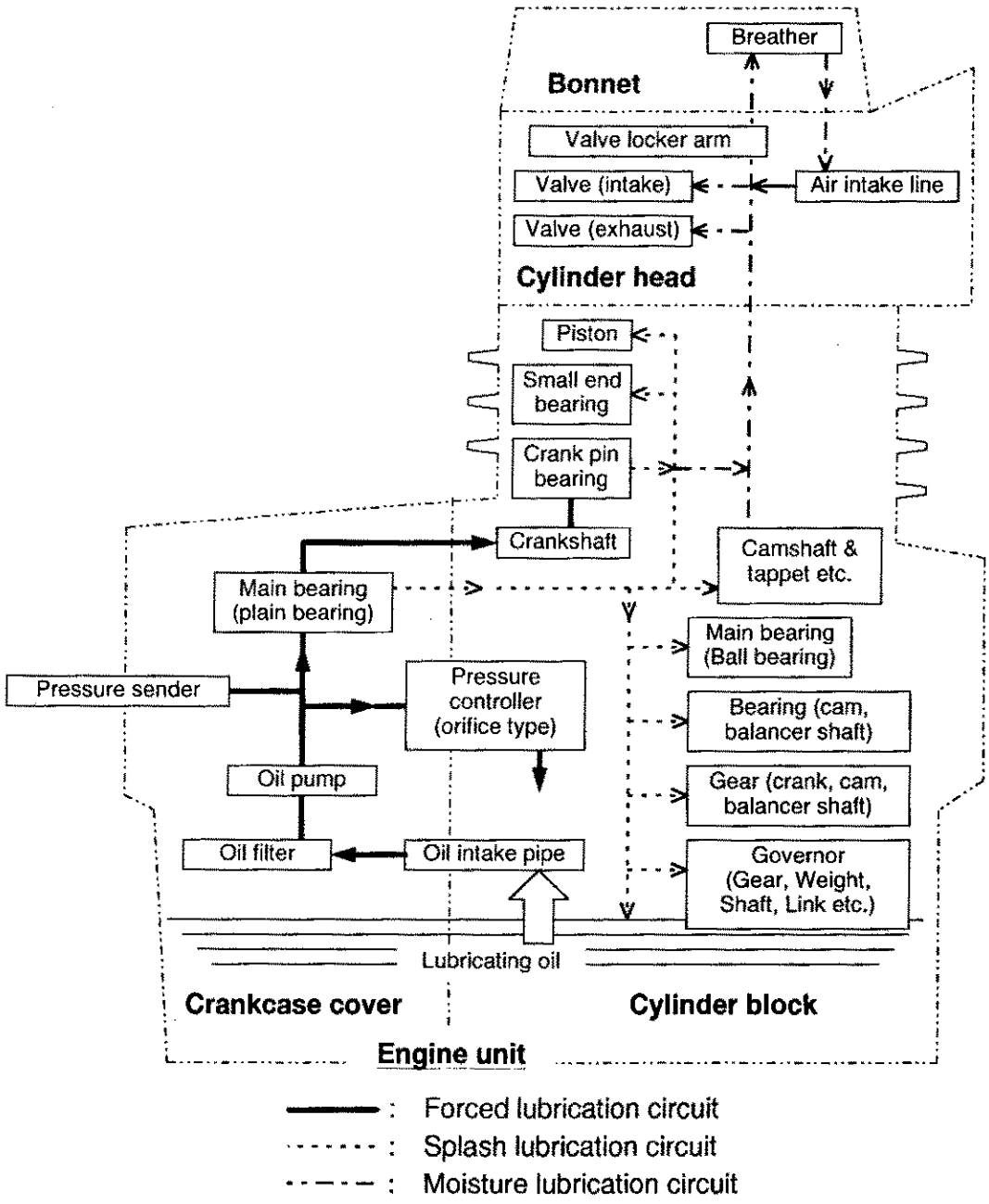


Fig. 11.3.1 Lubrication circuit diagram

12. Machines, Tools, Instruments and Other Materials for Inspection and Maintenance

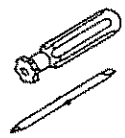
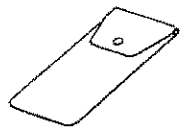
Use of improper machines, tools and other materials not only causes injury accidents, but also, damages to parts and failures in assembly and adjustment. Make sure to use appropriate tools for ensuring excellent maintenance quality.
Description herein omits a part of tools required for servicing the engine unit. For tools necessary for servicing inside of the engine, refer to the service manual instructed in the INTRODUCTION.

12.1 Machines, Tools and Instruments

12.1.1 General Tools

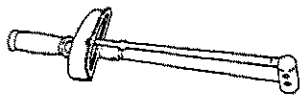
1) Tools supplied with the generator set

Table 12.1.1-1 Tools provided with generator set

Tool name	Screwdriver	Spanner		Oiler	Tool bag
		10 × 12	14 × 17		
Schematic drawing					
Part code	104200-92350	28110-100120	28110-140170	28210-000150	114250-92600

2) Other general tools

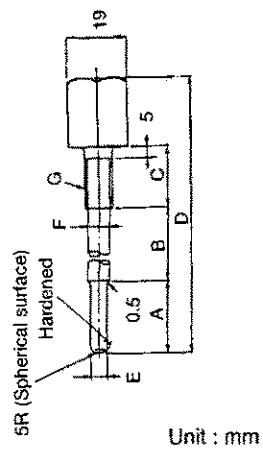
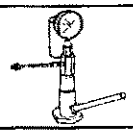
Table 12.1.1-2 General tools

Tool name	Schematic drawing	Description	Part code
Torque wrench		• Box size : 10 to 27 mm (2-way width) • Torque range : 0.7 to 23 kgf-m (6.9 to 23 N-m)	Available in the market

12.1.2 Special Tools

Table 12.1.2 Special tools

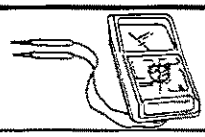
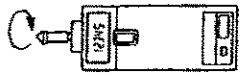
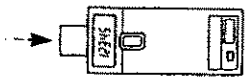
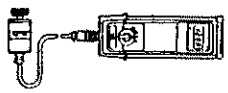
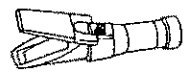
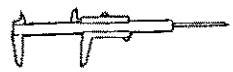
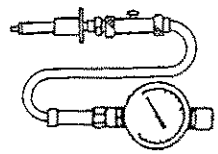
For generator unit (GU) and engine unit (EU)

Item			Schematic drawing	Description	Part code
Classification	Tool name	Applicable model(YDG)			
GU	Rotor remover	2700E		A=35mm, B=155mm, C=25mm, D=235mm, E=6.5mm, F=8mm, G=M10 × 1.5	183754-92350
		3700E		A=40mm, B=154mm, C=30mm, D=244mm, E=8.2mm, F=10mm, G=M112 × 1.5	183854-92350
		5500E to 6600TE		A=40mm, B=200mm, C=50mm, D=310mm, E=8.2mm, F=10mm, G=M112 × 1.5	183976-92350
EU	Nozzle cleaner	2700E to 6600TE		A=0.19mm	Available in the market
	Nozzle tester	2700E to 6600TE		Main body	737600-93502
				Injection pipe	124223-93400
	Flywheel remover	2700E to 6600TE		With bolt and nut	114250-92130
	Flywheel locker	2700E to 6600TE		—	114250-92101

12.1.3 Measuring Instruments

Table 12.1.3 Measuring instruments

For generator unit (GU) and engine unit (EU)

Item			Schematic drawing	Description	Part code
Classification	Instrument name	Applicable model(YDG)			
GU and EU	Circuit tester	2700E to 6600TE		—	Available in the market
	Speedometer	2700E to 6600TE		• Contact type • Model : HT-341	95500H-T3410
				• Photoelectric type • Model : HT-441	95500H-T4410
				• Reflection mark (10 sheets)	955000-01041
				• Injection pipe clamping type • Model : GE-450	955000-01045
	Battery coolant tester	2700E to 6600TE		• Model : UFB-N_2	955000-000013
	Calipers	2700E to 6600TE		• Measurement range: 0 to 150 mm • Minimum unit : 0.05 mm	Available in the market
EU	Compression gauge	2700E to 6600TE		• BANZAI Motor Co. • Model : DG-8S*1 • Pressure range : 0 to 70 kgf/cm^2	Available in the market
	Thickness gauge	2700E to 6600TE		• Measurement range : 0 to 3 mm • Minimum unit : 0.05 mm	Available in the market

*1 : Of the 7 types of adapters, use the T-4DG after reshaping it.
The procedure for reshaping is as follows:
- O Shorten the length of the lead edge (7.3 mm dia.) from 18 mm to 13-13.5 mm.
- O After the above, chamfer the 7.3mm diameter by 1.5mm radius.

12.2 Materials Required

Table 12.2 Other materials

For generator unit (GU) and engine unit (EU)

Item			Schematic drawing	Description	Part code
Classification	Material name	Applicable model(YDG)			
GU and EU	Color check(flaw detection agent)	2700E to 6600TE		Penetration liquid	97550-004510
				Development liquid	97550-004520
				Washing liquid	97550-004530
				3-piece set	97550-004560
EU	Screw locking agent	2700E to 6600TE		Three Bond Co. Product name: Anaerobic Adhesive and Sealant 1324	Available in the market
	Grease	2700E to 6600TE		—	Available in the market

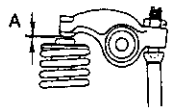
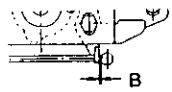
13. Service Standards

This section gives the adjustment and general standards and wear limits which are bases of the servicing. Use these standards and limits for judging if parts and units are acceptable or require repair or replacement at servicing or adjustment. Most of standards for the engine unit are not described. When you need to service inside the engine, refer to the service manual instructed in the INTRODUCTION.

13.1 Adjustment Standards

Table 13.1 Adjustment standards

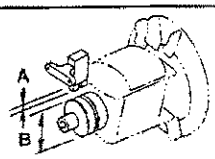
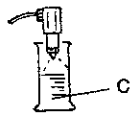
For engine unit (EU)

Classification	Item		Standard and model (YDG)		Unit	Schematic drawing	Standard			
							2700E	3700E	5500E	6600TE
EU	Intake/ Exhaust valve	Open/Close timing	Intake	Open (b.T.D.C)	deg		25		20	
				Close (a.B.D.C)			59		53	
			Exhaust	Open (b.B.D.C)			59		53	
				Close (a.T.D.C)			25		20	
		Valve clearance	Intake		mm		A=0.15 (0.1 to 0.2)			
			Exhaust				A=0.15 (0.1 to 0.2)			
	Fuel injection valve	Valve opening pressure	Initial (new machine)		kgf/m²	—	210 to 220			
			After conditioning				200 to 210			
	Fuel injection pump	Injection timing			deg	—	14 (13 to 15)		13 (12 to 14)	
	Emergency stop unit	Clearance between wire piece and lock lever			mm		B=0.25 (0 to 0.5)			
	No-load maximum speed		50 Hz		rpm	—	3175 (3150 to 3200)			
			60 Hz				3775 (3750 to 3800)			

13.2 General Standards and Wear Limits

Table 13.2 Standards and wear limits

For frame unit (FU), generator unit (GU) and engine unit (EU)

Classification	Item / Standard and model (YDG)			Unit	Schematic drawing	Standard				Wear limit
						2700E	3700E	5500E	6600TE	
FU	Battery		Specific gravity voltage	V	—	See 6.4.1 Battery of Section 6.				
GU	Brush		Length	mm		A = 9				4
	Slip ring		Diameter	mm		B = 37.6		—		36.6
						—		B = 44.6		42.8
	Coil	Armature	Voltage Resistance	V•Ω	—	See voltage, resistance and operating limits in Tables 6.3.7-1 to -7 of Section 6.				
		Exciter								
		Field								
		DC								
	Rectifier		Resistance	Ω						
	Auto voltage regulator		Resistance	Ω						
EU	Oil pressure sender		Resistance	Ω	—	See 6.4.4 Oil Pressure Sender in Section 6.				
	Insulator Joint		Resistance	Ω						
	Combustion chamber	Electrical start	Compression pressure	kgf/cm² (Mpa)	—	See 6.4.6 Liner, Piston and Intake/ Exhaust Valve in Section 6.				
		Manual start		kgf/cm² (Mpa)						
	Fuel injection pump	50 Hz	★ Injecting fuel quantity	cc/ 1000st • 3000rpm		C = 13.2 to 13.8	C = 18.1 to 18.9	*C = 27.9 to 29.1		—
		60 Hz		cc/ 1000st • 3600rpm		C = 12.2 to 12.8	C = 17.1 to 17.9	C = 27.9 to 29.1		—

★ : Indicates the fuel injection (limited injection quantity) quantity at rated speed and rated output.

* : Indicates the quantity at 3600 rpm crankshaft speed.

14. Bolts and Nuts Tightening Torques

The essential requirement for ensuring high quality servicing is to use appropriate tools such as the torque wrench and special tools and observe the tightening torque requirements. Thoroughly read the following cautions for correct servicing.

14.1 General Instructions

Torque standards need to be changed even for the same sized nuts and bolts according to the materials (strength), materials of tightening parts and mating parts, and shapes and friction of the threaded portions. It is also necessary to specify the conditions at tightening for ensuring the accurate and consistent parts holding forces or preventing loose nuts and bolts as well as protecting bolts and mating parts from damages. As requirements are indicated under the tables, observe them carefully, in addition to the specified tightening torques.

14.2 Major Bolts and Nuts

Table 14.2 Standard tightening torque list

For major bolts and nuts of generator unit (GU) and engine unit (EU)

Item				Thread diameter x pitch	Head surface width (mm)	Tightening torque kgf-m(N-m)
Classification	Name		Model (YDG)			
GU	Rotor	Set bolt (through bolt)	2700E	M10 × 1.5	19	2.0 to 2.5 (19.6 to 24.5)
			3700E to 6600TE	M12 × 1.5		
EU	Cylinder head	▼ Set bolt (built-in bolt)	2700E	M8 × 1.25	—	1.3 to 1.5 (12.7 to 14.7)
			3700E	M9 × 1.25	—	1.3 to 1.5 (12.7 to 14.7)
			5500E to 6600TE	M10 × 1.5	—	1.3 to 1.5 (12.7 to 14.7)
		◆ Set nut	2700E	M8 × 1.25	12	3.0 to 3.4 (29.4 to 33.3)
			3700E	M9 × 1.25	14	4.2 to 4.6 (41.2 to 45.1)
			5500E to 6600TE	M10 × 1.5	17	5.4 to 5.8 (52.9 to 56.8)
	Rocker arm support	Mounting bolt	2700E to 3700E	M8 ×1.25	12	2.0 to 2.3 (19.6 to 22.5)
			5500E to 6600TE	M10 × 1.5	14	4.5 to 4.7 (44.1 to 46.1)
	Crank case cover	Set bolt	2700E	M6 × 1.0	10	1.1 to 1.3 (10.8 to 12.7)
			2700E to 6600TE	M8 × 1.25	12	2.6 to 2.8 (25.5 to 27.4)
	Connecting rod	◆ Set nut	2700E to 3700E	M7 × 1.0	10	1.8 to 2.1 (17.6 to 20.6)
		◆ Set bolt (rod bolt)	5500E to 6600TE	M8 × 1.0	13	4.0 to 4.3 (39.2 to 42.1)
	Flywheel	#Set nut (end nut)	2700E	M16 × 1.5	24	14 to 15 (137 to 147)
			3700E	M16 × 1.5	24	16 to 17 (157 to 167)
			5500E to 6600TE	M18 ×1.5	27	22 to 23 (216 to 225)
	Fuel injection valve	Nozzle case	2700E to 6600TE	0.605-0UNS-2B	15	4.0 to 4.5 (39.2 to 44.1)
		▼ Mounting bolt (built-in bolt)	2700E to 6600TE	M6 × 1.0	—	0.7 to 1.0 (6.9 to 9.8)
		Mounting nut	2700E to 6600TE	M6 × 1.0	10	1.1 to 1.3 (10.8 to 12.7)
	Fuel injection pump	Delivery valve holder	2700E to 6600TE	M14 × 1.5	17	3.0 to 3.5 (29.4 to 34.3)
		▼ Mounting bolt (built-in bolt)	2700E to 6600TE	M6 × 1.0	—	0.7 to 1.0 (6.9 to 9.8)
		Mounting nut	2700E to 6600TE	M6 × 1.0	10	1.1 to 1.3 (10.8 to 12.7)
	★Insulator joint	—	2700E to 6600TE	PT 1/8	25.4	0.8 to 1.0 (7.8 to 9.8)

◆ : Apply lubricating oil to threaded portions and seats at tightening.
★ : Apply the screw locking agent to threaded portions at tightening.
▼ : Apply the screw locking agent to threaded portions of built-in bolts at tightening.
: Use the special tool.

14.3 General Bolts and Nuts

- The requirements in the table below are applied only to hexagon bolts with "7" marked in their heads.

- If the material of the tightening and mating parts is aluminum, the tightening torques are 80% of those listed in the table.

Table 14.3 Specified tightening torque list

For general nuts and bolts

Name	Thread diameter × pitch	Head surface width (mm)	Specified torque kgf-m (N-m)
Hexagon nuts and bolts	M6 × 10	10	0.8 to 1.0 (7.8 to 9.8)
	M8 × 1.25	12	2.6 to 2.8 (25.5 to 27.4)
	M10 × 1.5	14	5.0 to 5.4 (49.0 to 52.9)

Note : Regardless of the materials of tightening and mating parts, the tightening torque must be 60% of values listed above for hexagon nuts and bolts without "7" markings in their heads.

15. Troubleshooting

When a malfunction occurs to the generator set, it is necessary to isolate the part (position) causing the failure. Further, the true cause must be identified from the symptom of the part for correct recovery action under consideration on recurrence prevention.
This section gives two troubleshooting methods for efficient troubleshooting work, for each unit. Select the easy-to-understand method according to difficulty in finding the problem cause and the experience of the worker.
As for the engine unit, also refer to the engine service manual instructed in the INTRODUCTION.

15.1 Trouble Phenomena and Defective Parts

The figure below summarizes possible faulty parts causing respective failures and their contents of failures for quick reference.
When two malfunctions or more are occurring at a time, it is efficient to begin with the part having more number of possible failure causes.

Table 15.1 Symptoms and failures of related parts (1/4)

For frame unit (FU)

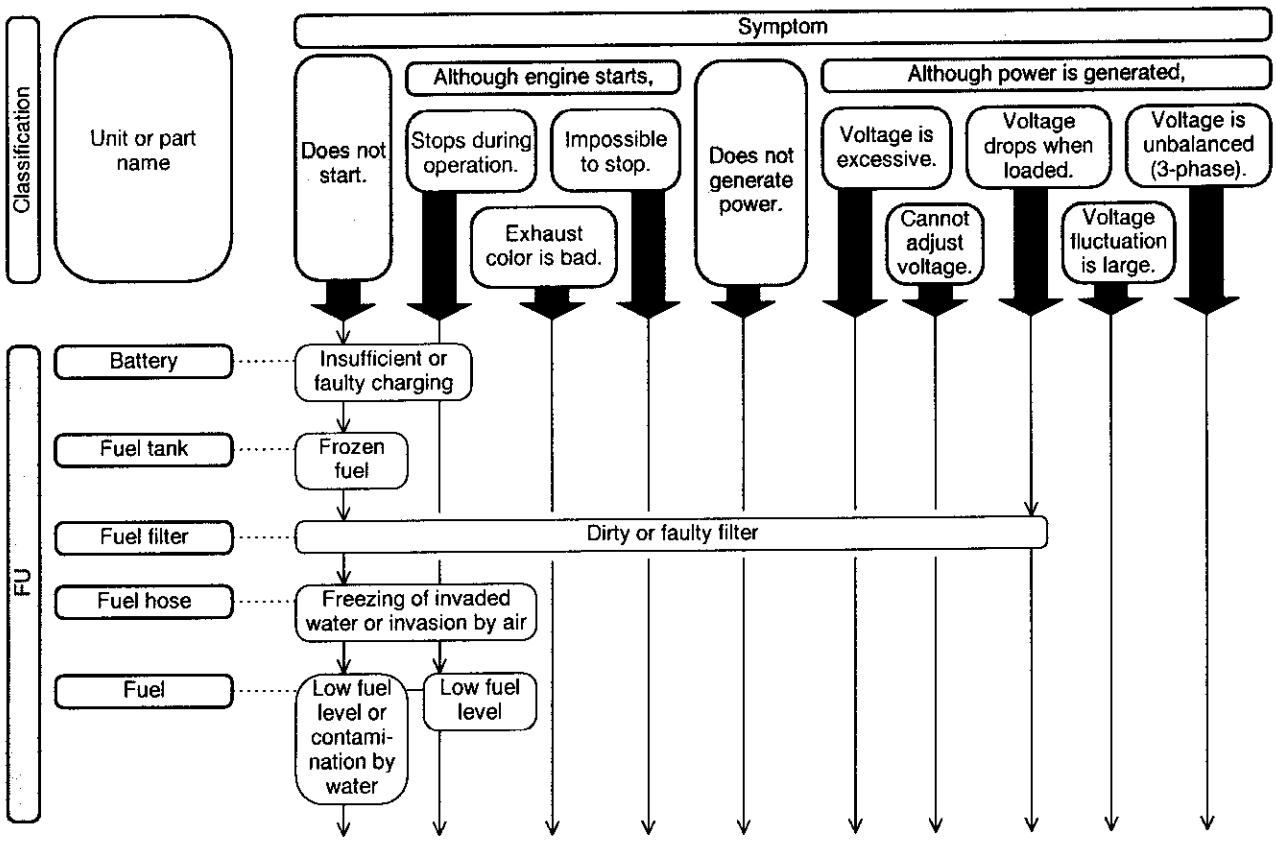


Table 15.1 Symptoms and failures of related parts (2/4)

For engine unit (EU)

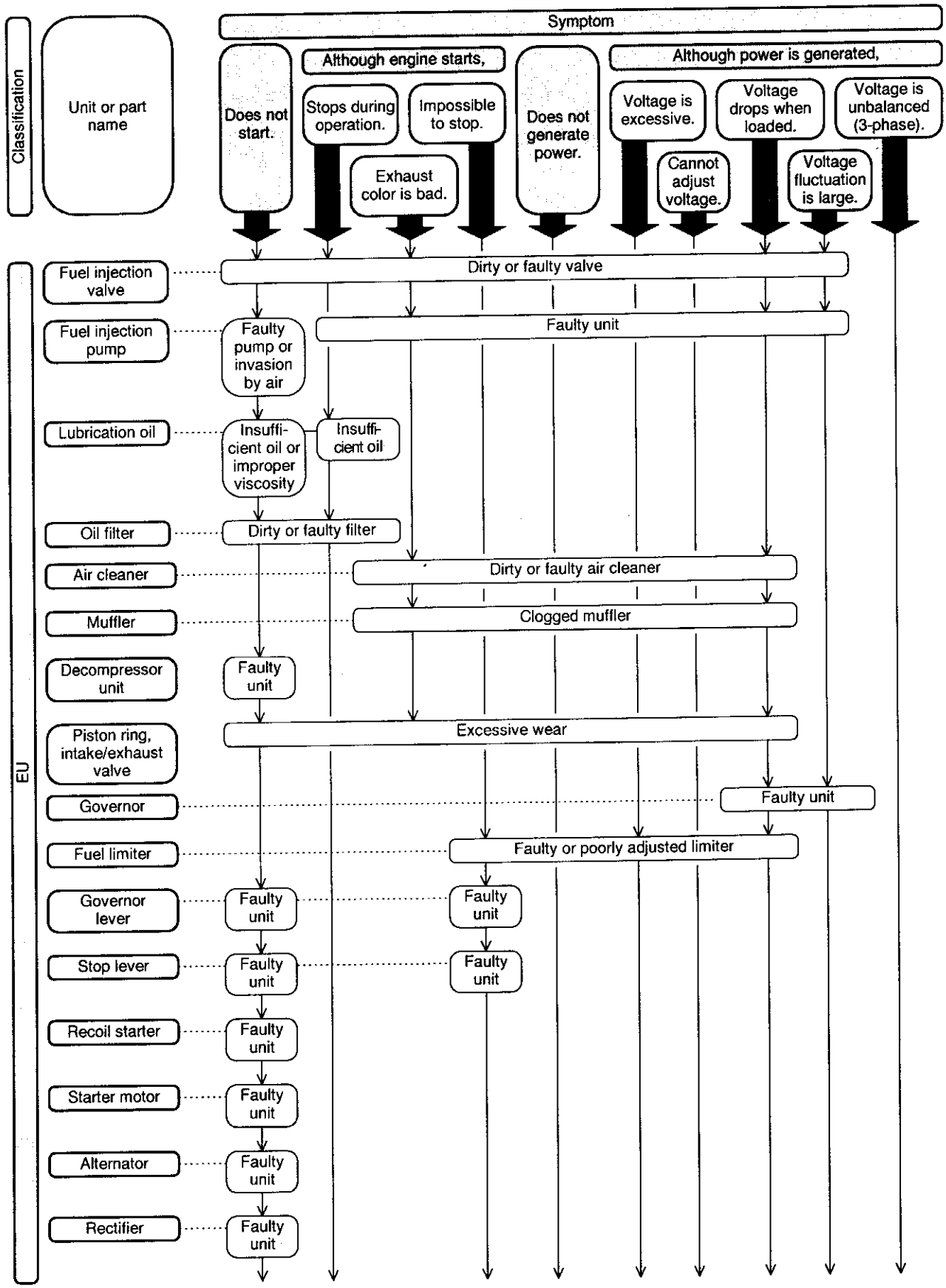


Table 15.1 Symptoms and failures of related parts (3/4)

For engine unit (EU), frame unit (FU), control panel unit (CU)

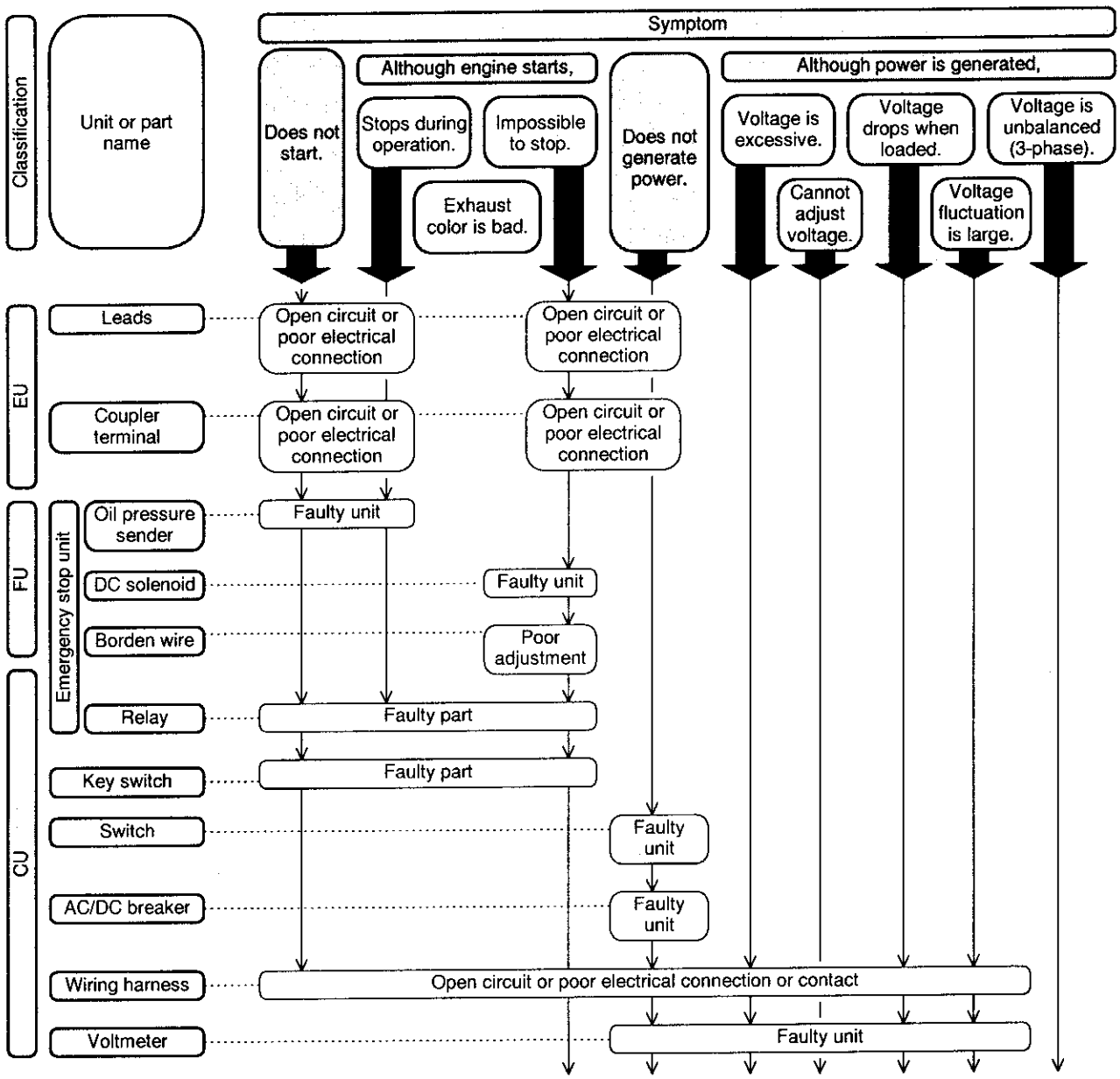
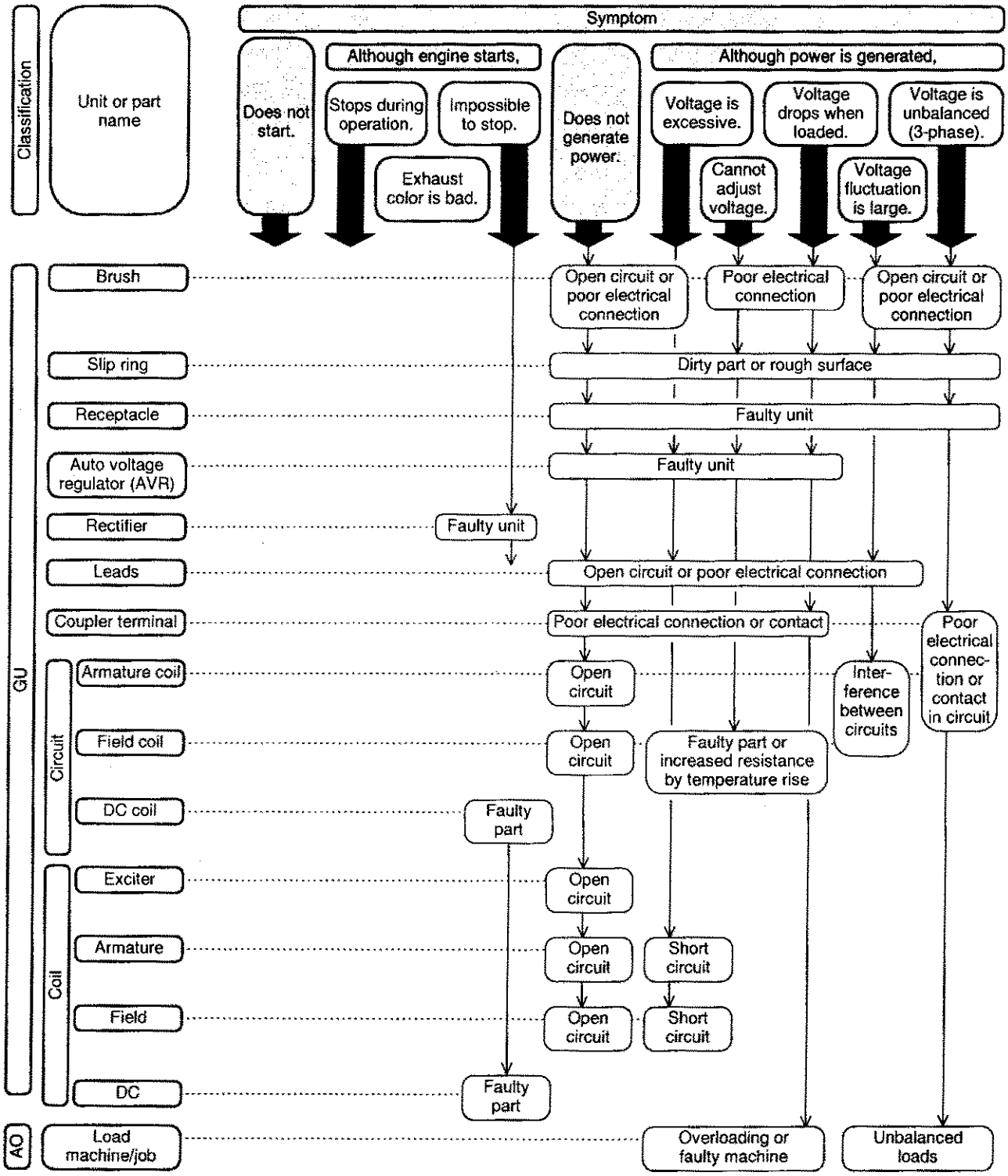


Table 15.1 Symptoms and failures of related parts (4/4)

For generator unit (GU) and others (AO)



15.2 Troubleshooting Procedures

If isolating the problem cause or faulty part is difficult, it is necessary to sequentially check component parts in an orderly manner. The figure below illustrates the check sequence.
First read the question in the text box and go to be next text box in the direction of Y if the answer is Yes or N if the answer is No. At the end, some component parts which possibly can cause the problem are listed.
Check them and then isolate the true cause of the problem.

Table 15.2 Troubleshooting chart (1/6)

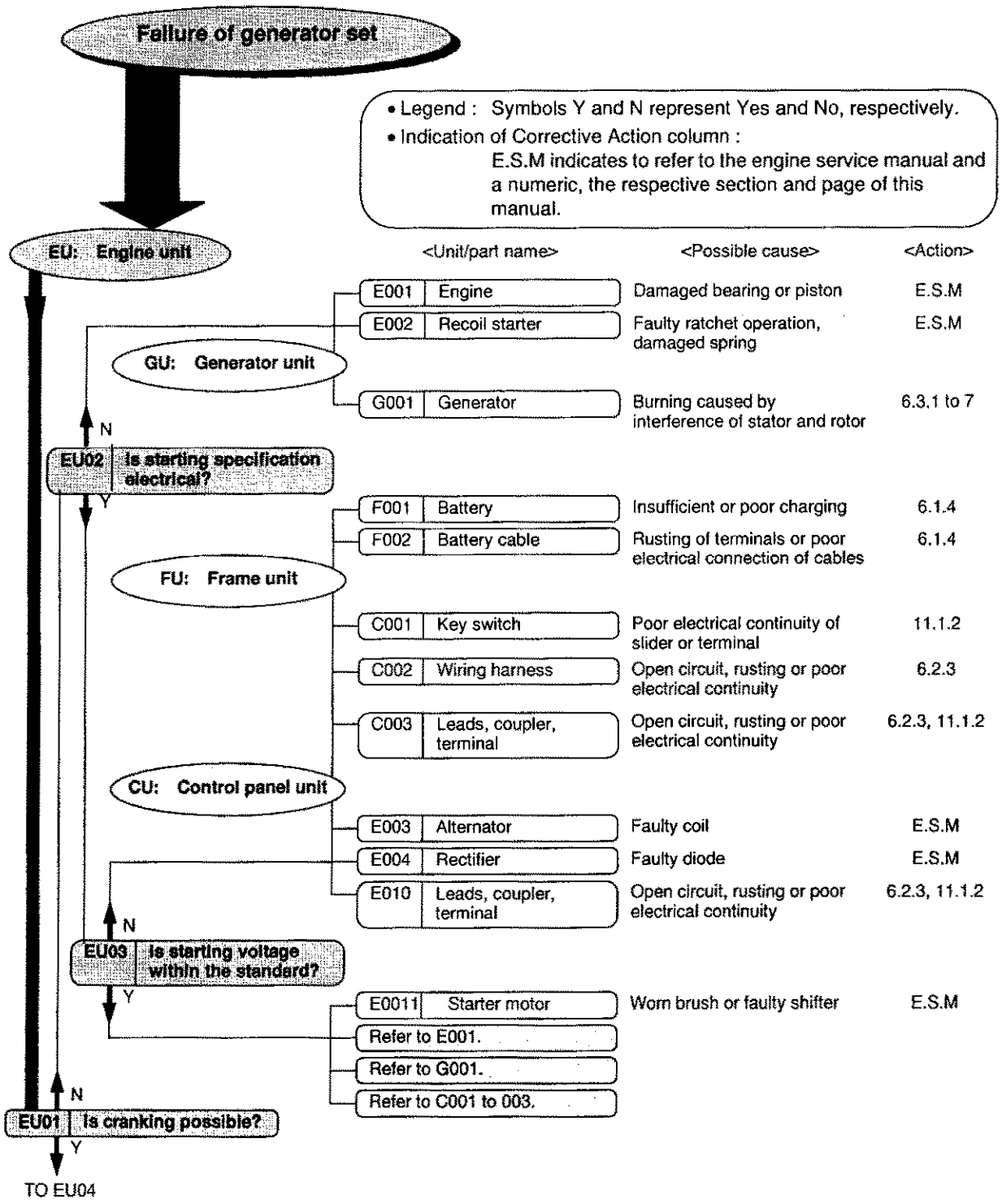


Table 15.2 Troubleshooting chart (2/6)

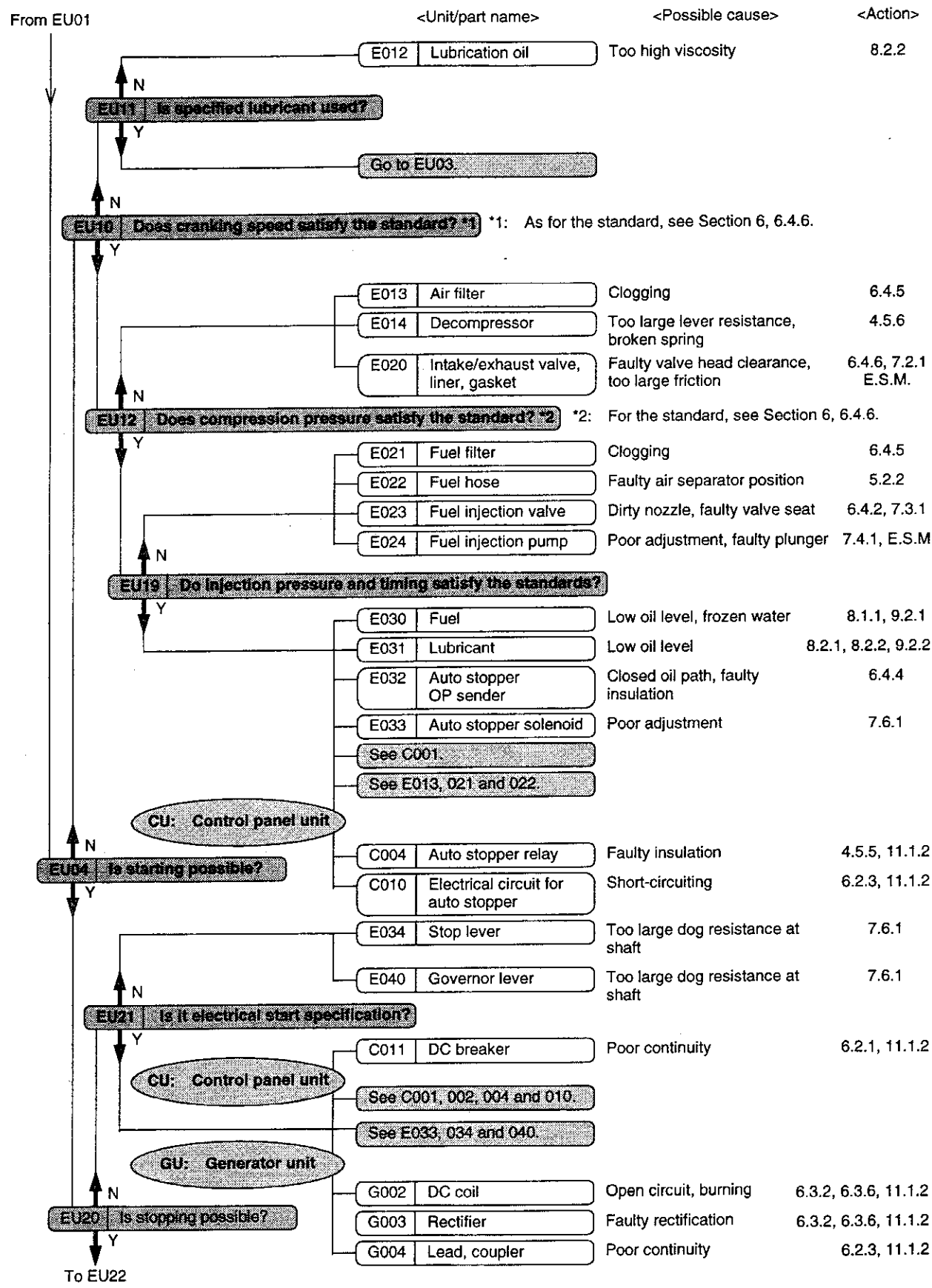


Table 15.2 Troubleshooting chart (3/6)

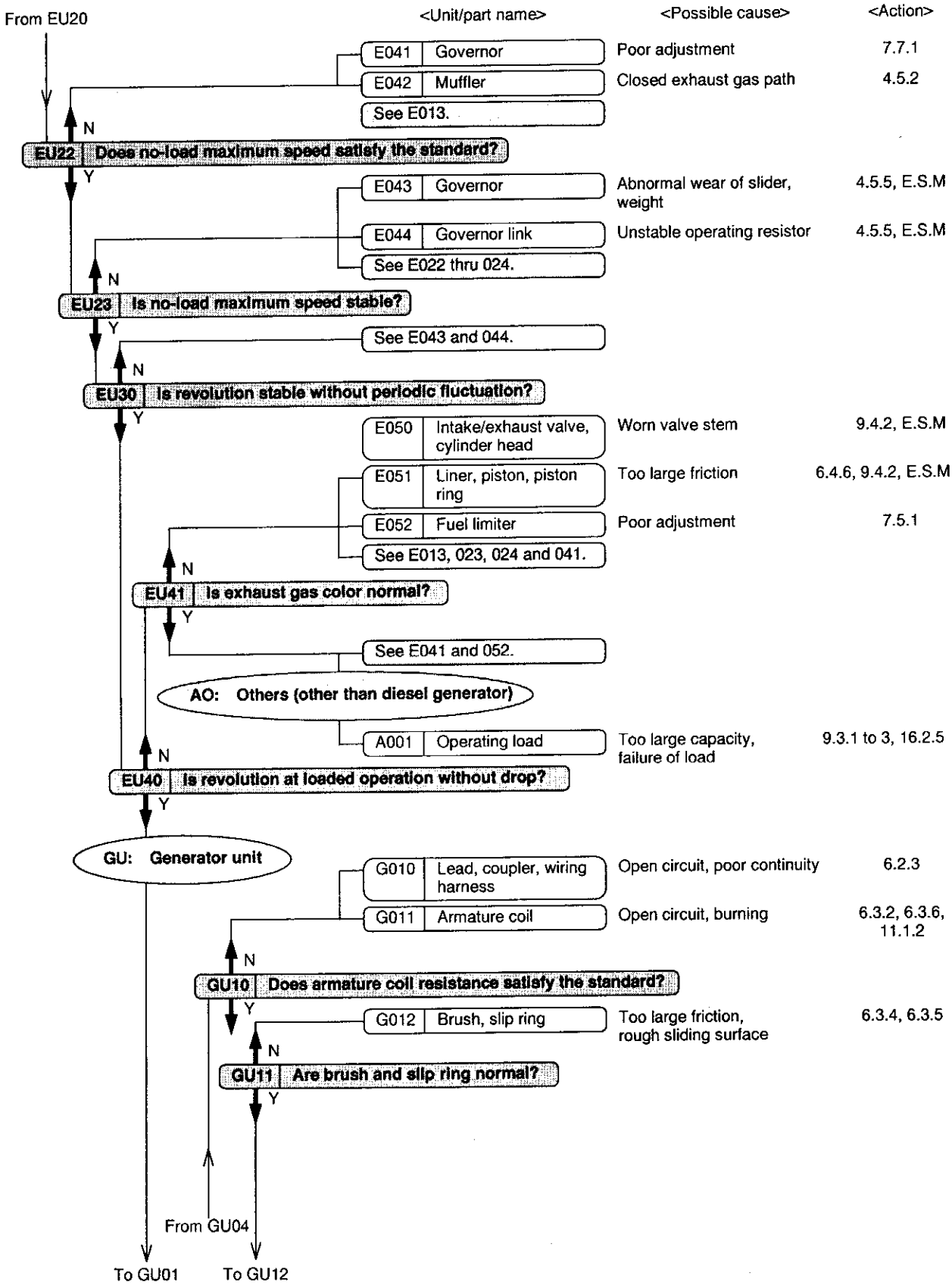


Table 15.2 Troubleshooting chart (4/6)

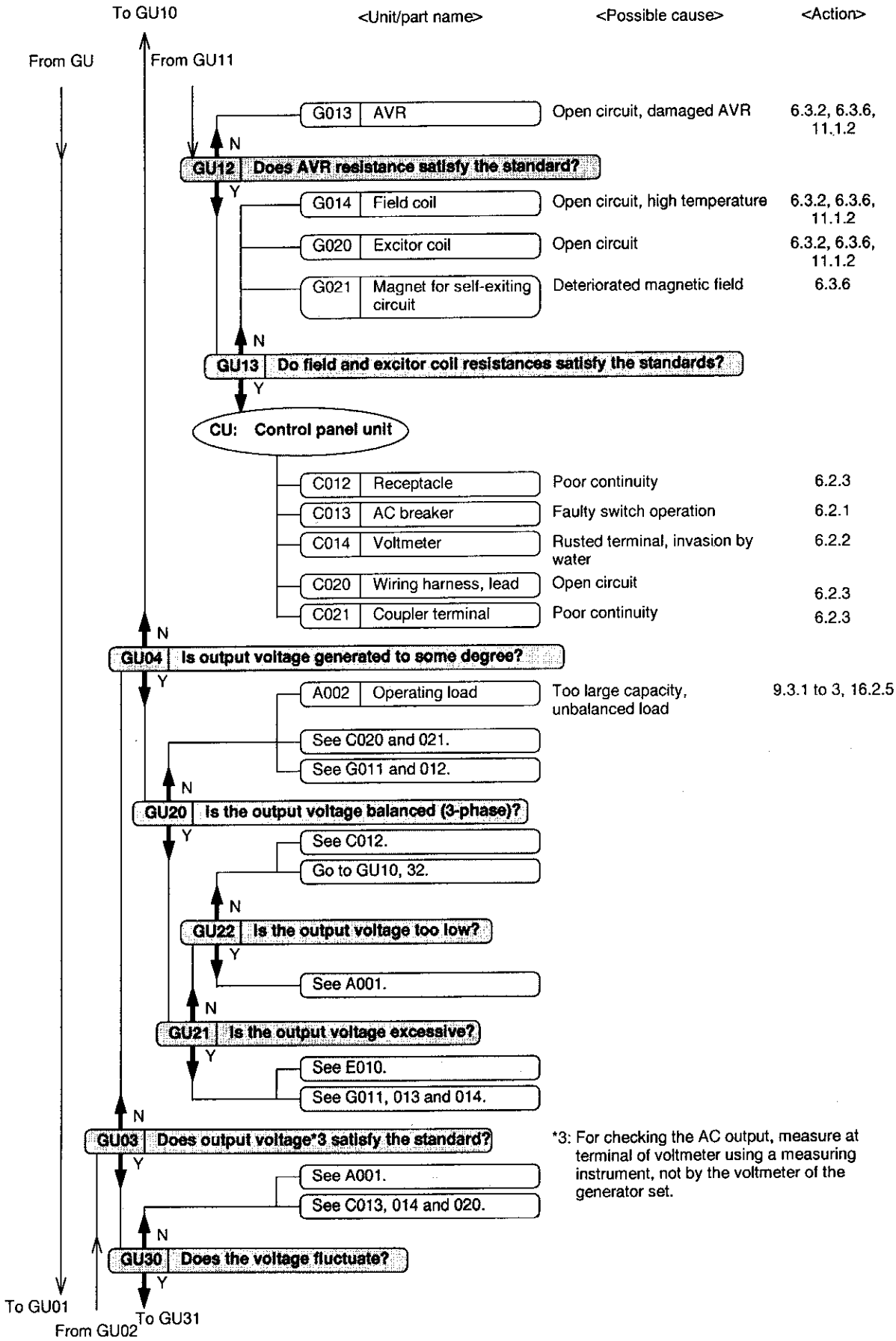


Table 15.2 Troubleshooting chart (5/6)

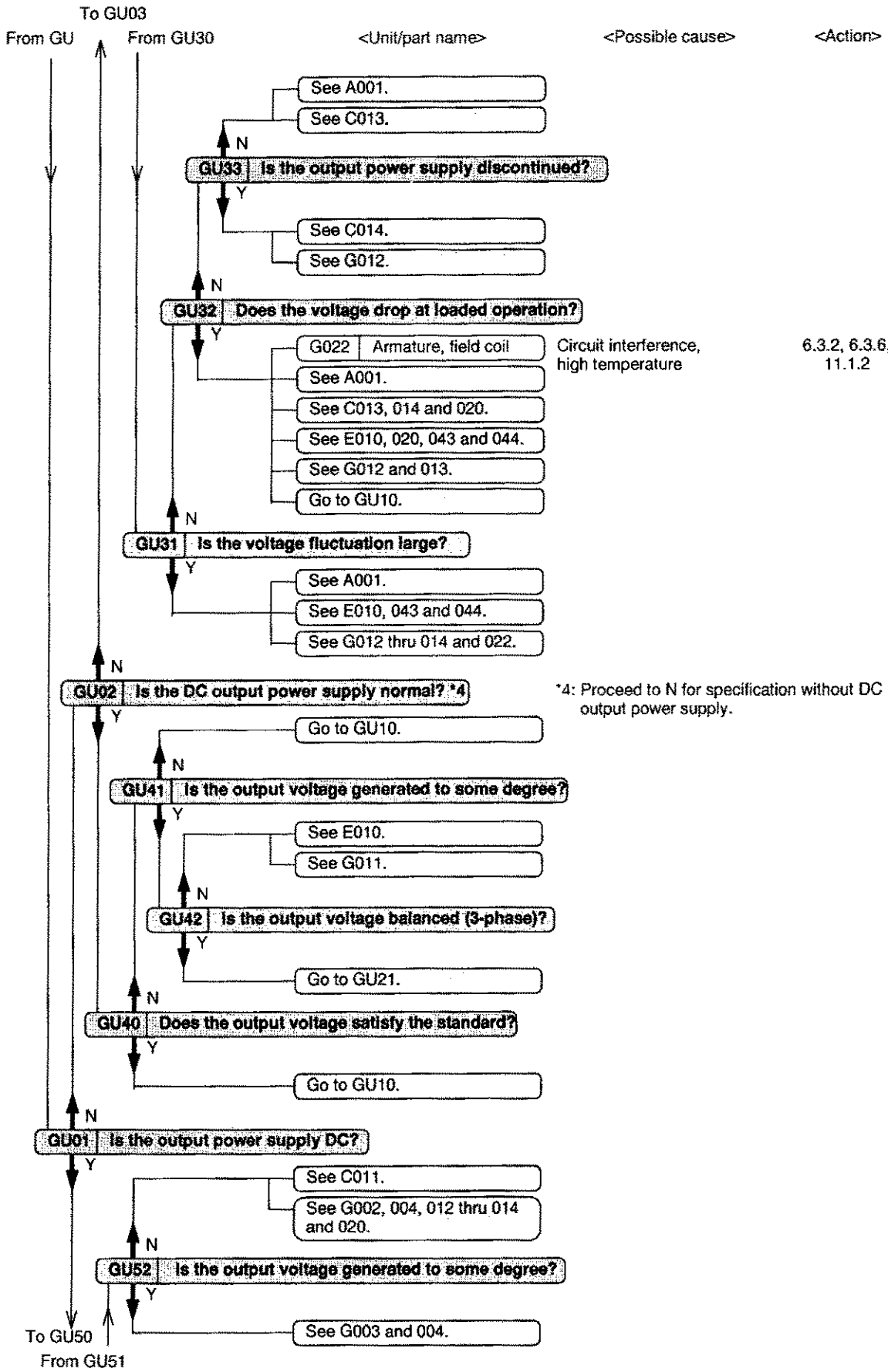
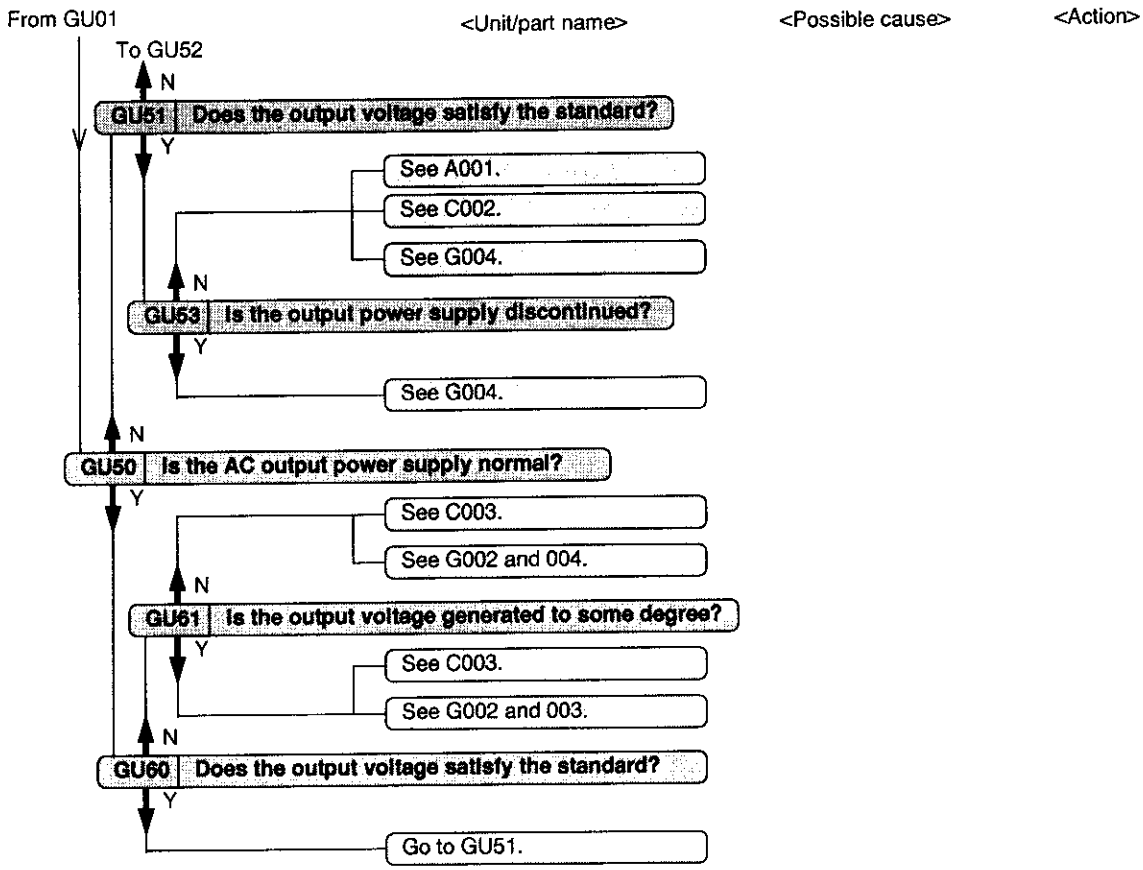


Table 15.2 Troubleshooting chart (6/6)



16. Appendix

This appendix supplements descriptions in this manual. The texts of this manual instruct what to be executed and notes relative to them. However, the reasons why they are required or necessary and what would happen if such instructions are not observed are not described in detail.

So, items relative to the quality of fuel and lubrication oils as well as those related to loads connected to the diesel generator are explained.

It is recommended to thoroughly read this section for better understanding of cautions to be observed and reasons why operations specified in the manual are necessary.

16.1 Fuel and lubricant qualities are important.

The engine produces byproducts by combustion of the fuel. The byproducts generated by combustion are released into the atmosphere as the exhaust gas, causing atmospheric pollution. We are, therefore, continuously making effort for improving the engine combustion performance. We also consider it very important to provide the correct engine operation and maintenance methods to users and servicemen in order to "maintain the living-thing oriented and easy-to-live global environment."

In order to decrease the atmospheric pollution, it is essential to ensure and maintain the fuel and lubricant qualities appropriately in addition to excellent inspection of and servicing to the engine. If these are neglected, the engine performance will be adversely affected considerably and pollute the atmosphere directly and indirectly.

How the fuel and lubricant qualities affect the atmospheric pollution and engine performance are explained below, using figures. Please read through to understand the importance of the qualities and use the knowledge as reference for your inspection and servicing activities.

16.1.1 Composition of illustrations

Fig. 16.1.1 illustrates the relationships between the fuel/lubricant qualities and the atmospheric environment and how the engine relates to the latter. The illustration is composed so that the correlation among the engine, fuel, lubricant and atmosphere can be understood.

What are indicated in the illustration

- ★ Upper part: Fuel oil (characteristics and components) and fuel tank, and types of additives and their effects
- ★ Lower part: Lubrication oil (characteristics and components) and oil pan, and types of additives and their effects
- ★ Left hand side: Engine components are located. The upper part is related to the fuel system while the lower part, the lubricant system.
- ★ Left center: The byproduct of fuel and lubricant is indicated, i.e., blow-by (gas) which divides the illustration into the upper and lower portions.
- ★ Upper right: Atmosphere, air and engine parts related to the intake and exhaust systems
- ★ Lower right: Practical adverse influence to the engine performance by fuel and lubricant qualities
- ★ Center: Combustion byproduct, factor for causing deterioration to the lubricant and deterioration process, and influence by deteriorated lubrication oil

16.1.2 How to and what to read from the illustration

The illustration uses lines and arrows to indicate how the fuel and lubricant qualities affect the atmosphere and engine (parts), their causes and results, phenomenon, generating progress and their effects. You can read what are illustrated by following lines. Only the main contents are described below, so, read out detailed contents not explained herein by observing Fig. 16.1.1.

1. Air and dust deteriorate the fuel and lubricant, adversely affect the atomization and generate nitrogen oxide.

- The air (steam) and dust go towards the left to generate sludge, rust and mold in the fuel tank to deteriorate the fuel oil.
- The sludges become causes of incomplete combustion by clogging, corrosion and deposit which cause the fuel system parts to wear, resulting in poor atomization.
- The air (nitrogen) suctioned into the combustion chamber generates nitrogen oxide during combustion of the fuel supplied from the upper portion.
- The air and dust advancing downwards generate sludge to deteriorate the lubrication oil.

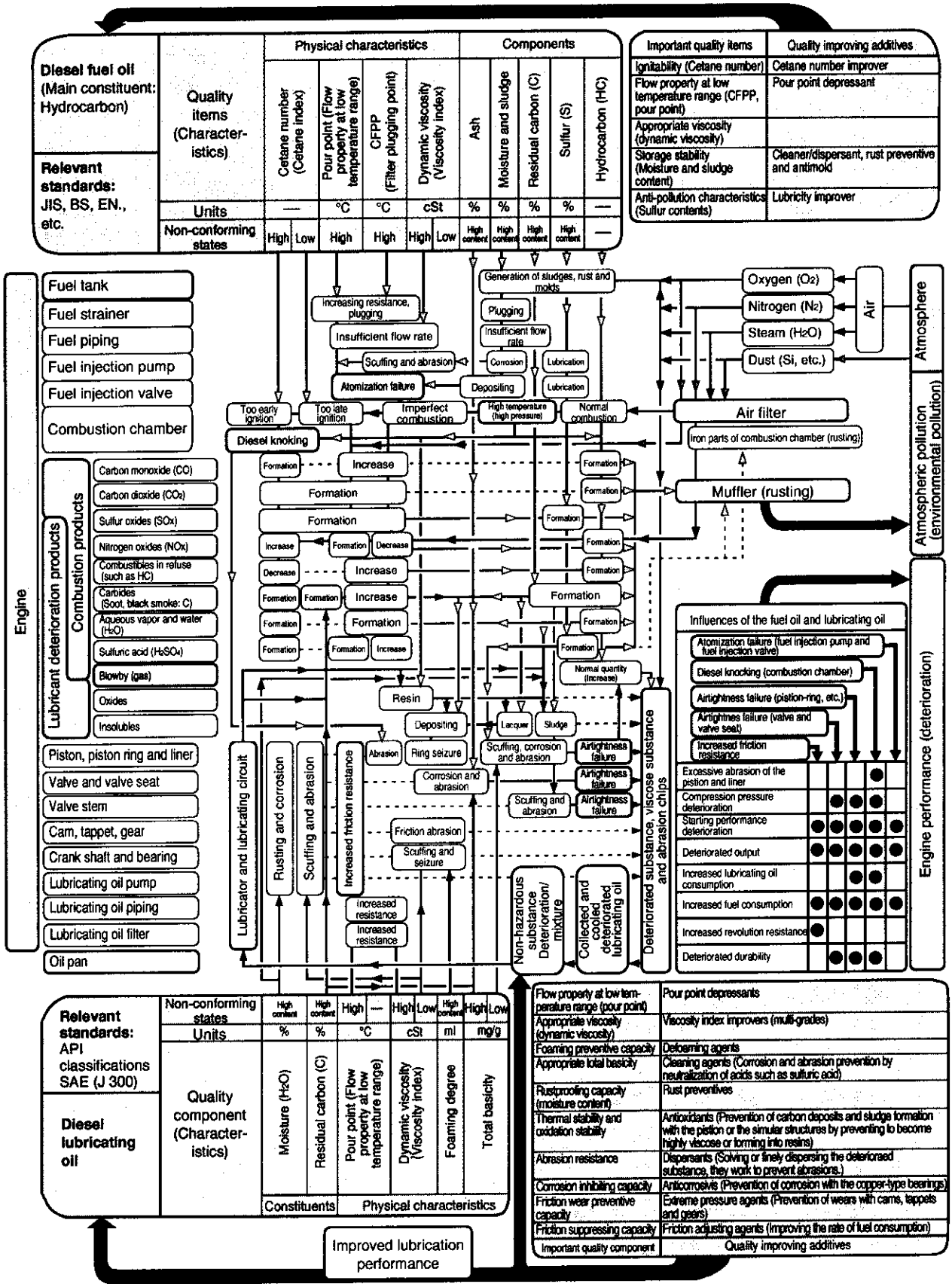


Fig. 16.1.1 Correlation among fuel/lubricant qualities, atmosphere and engine

2. Fuel pollutes the atmosphere, generates the diesel knocking and corrosion wear, adversely affects the atomization and deteriorates the lubricant.

- Both the physical characteristics and components of fuel advance downwards to be injected into the combustion chamber, where abnormal combustion and combustion byproducts are generated.
  - Carbon hydrogen and residual carbon: : These produce carbide materials (soot, black smoke, black lead), which cause the ring to stick.
  - Sulfur : This is the cause material of sulfuric acid that corrodes iron parts of the cylinder and combustion chamber, resulting in the corrosion wear.
  - Ash : This functions as the grinding powder to wear the valves and valve seats.
  - Water and sludge : These play roles for generation of deposit which can be the cause of poor atomization.
  - Filter plugging point : This has effects on the insufficiency of flow, which may cause poor atomization.
  - Cetane number : This has effects on the tendency of early ignition and slow ignition which are the causes of diesel knocking and excessive wear.
- The combustion byproducts advance towards the right in the illustration together with the heat and are divided into two directions. One of them contaminates and corrodes the muffler and then exhausted as the pollution gas to pollute the atmosphere.
- The other of the above two advances downwards to leak into the oil pan by the blow-by phenomenon (*1) , to deteriorate the lubrication oil.

*1: *The blow-by represents leakage of gases from the combustion chamber to the oil pan side.*

3. Lubricant causes the sticking ring, scuff, corrosion and corrosion wear to cause poor air tightness and increased friction resistance.

- The lubricant is indicated by two flows. One represents the physical characteristics and components of the lubricating oil, which advances upwards while the other composes the lubricating oil circuit that surrounds the former in the clockwise direction.
- The lubricating oil in the lubricant circuit deteriorates by the heat and combustion byproducts delivered by the blow-by.
  - The lubrication oil becomes resin like material by the heat generated by combustion of the fuel.
  - The soot, one of combustion byproducts, combines to the resin above to yield lacquer (*1) deposit (*2) , which is further delivered to the sludge (*3) when sulfuric acid and water are added.
  - This deposit adheres onto the piston and other parts to cause poor air tightness by sticking the ring.
  - Further, the deposit causes the liner to generate scuff and corrosion wear when combined with sulfuric acid and sludges.
- Physical characteristics of the lubricating oil are affected by the components and additives contained in the oil.
  - Water content : This corrodes the lubricant paths.
  - Residual carbon : This is changed to carbide materials by burning caused by oil up and oil down phenomenon.
  - Low-temperature fluidity : This increases the friction resistance which can be the cause of increased drive loss of the lubrication pump.
  - Foaming degree : This affects the lubricity which can be the cause of scuff and burning of bearings.
  - Total basicity : This affects the neutralization of sulfuric acid which can be the cause of corrosion and corrosion wear.
  - Additives : These play roles to make various deteriorating byproducts in the lubrication oil into harmless materials.

*1: *The main component of the lacquer is the resin which is brown after addition of soot.*

*2: *The main component of the deposit is the soot to which resin is added to become black.*

*3: *The main components of the sludge are the lubricating oil and soot, to which the resin and water are added.*

16.1.3 Why does fuel pollute the atmosphere by combustion and become harmful to living things?

The fuel oil mainly composed of hydrocarbon is injected into the combustion chamber and is burnt by the oxygen contained in the air suctioned into the chamber (the oxygen oxides the fuel). The high-temperature and high-pressure condition created by the combustion activates the fuel and air to yield varieties of combustion byproducts.

As shown at the central part of Fig. 16.1.1, the main component of the fuel, hydrocarbon is decomposed into carbon mono-oxide, carbon dioxide (gas), soot (black lead) and black smoke. In addition, it reacts with nitrogen in the air to create nitrogen oxides. Further, the sulfur generates sulfur dioxide by combustion, which is further changes into sulfuric acid by reacting with the steam generated by reaction between hydrocarbon and oxygen.

These combustion byproducts are discharged into the atmosphere as the exhaust gas from the muffler through the exhaust valve. The exhaust gas pollutes the atmosphere. So, we are making continuous effort to reduce the types and quantities of byproducts. When the byproduct quantities increase, they directly affect the man and other living things and cause the environment pollution as listed below.

Byproducts bring the following environmental pollutions to us and other living things:

- Carbon mono-oxide (toxic) : Causes breath failures and cerebral paralysis.
- Carbon dioxide : Main factor material of the warmer earth, and causes difficulty in breathing and paralysis when its content reaches 5% to 8%.
- Soot and black smoke : Stimulate mucus membranes of eyes and throat.
- Nitrogen oxides and non-combusted materials : Produces the photochemical smog that causes eye problems.
- Sulfur dioxide and sulfur : Causes acidic rain to fall, which damages the plant.
- Non-combusted hydrocarbon : Oxidant and non-combusted hydrocarbon react to yield aldehyde which makes the man feel dullness and headache.

16.1.4 Why is lubricant also deteriorated by fuel?

The combustion byproducts also flow to the oil pan side by the blow-by phenomenon. As shown on the center of Fig. 16.1.1, the lubrication oil is sent from the oil pan to each sliding part by the lubrication pump, where the oil is affected by the heat. Since the oil also comes into contact with high-temperature wall of each component to be deteriorated by oxidation. Thus, the lubrication oil becomes the resin and lost the lubricity.

The resin having no lubricity generates the lacquer, deposit and sludge when combined with the combustion byproducts, carbides (residual carbon flown in by the oil up and oil down phenomenon (*1) and carbides produced by combustion), to deteriorate the lubrication oil.

In addition, the sulfuric acid having strong corrosion power also flows to the oil pan side by the blow-by phenomenon, to deteriorate the lubrication oil.

Since the deteriorated lubrication oil lubricates the piston and cylinder, the air tightness is decreased by the sticking ring and corrosion, to increase the blow-by gas quantity. The above vicious cycle is repeated to rapidly drop the engine performance.

*1: *The oil up is reverse of the blow-by and means the leakage of lubrication oil to the combustion chamber side. The oil down means leakage of lubrication oil from stems of intake and exhaust valves to the combustion chamber and intake/exhaust paths.*

16.1.5 What are influences and effects by viscosity and additives of fuel and lubricant?

Even if the engine is supplied by the same maker, it requires different types of fuel and lubricating oils according to its operating condition as well as the type, application, specification and performance. This is why oil companies introduce excellent refining methods and develop various types of fuel and lubricating oils by adding additives for improving qualities and to send them to the market to satisfy the market needs.

Quantities and types of additives vary by oil companies and fuel/lubricating oil specifications (listed in Tables 8.1.1, 8.2.1 and 8.2.2 of Section 8). Generally, the quantities and types of additives especially for the lubricating oil are large, reaching some tens percentages against the base oil (lubrication oil without additives). The number of additive types is larger as the function and quality (high performance) are higher, reaching some tens types.

Why are lubricating oils containing varieties of additives needed? Recent high-performance engines require severe operating conditions (high temperature, high pressure and high load) to the lubricating oil.

It is generally said that the lubricating oil plays six functions. For obtaining the optimum functioning, or effects of a lubricating oil, the factor that effects all functions, i.e., the viscosity is the most important. It is known from the following description that the viscosity is the essential factor which greatly effects the lubricating oil quality and as important as the additive.

1. Six functions of lubricant and correlation with additives

1: Friction reducing effect
[Friction adjusting agent]
[Viscosity index improving agent]
= Forms thin oil film at extremely small gap of sliding part to prevent direct contact between metal parts.
- If the viscosity is too low, the oil film is too thin, causing direct contact between metal parts.

2: Cooling effect
[Anti-oxidant agent]
= Remove the heat generated at extremely small gap of sliding part to prevent temperature increase.
- If the heat resistance (anti-oxidation characteristic) is low, the oil deteriorates. If the viscosity is too high, the amount of oil that flows the gap is reduced, causing the temperature to increase, resulting in burning.

3: Corrosion prevention effect
[Anti-corrosion agent]
= Covers metal parts by oil film to protect them from rusting by the air and water.
- If the viscosity is too low, the oil film is too thin, allowing rusting to occur.

4: Air sealing effect
[Viscosity improving agent]
= Forms oil film at gap of piston ring groove, etc. to prevent air leakage for higher air tightness.
- If the viscosity is too low, the oil film is too thin to prevent air leakage. If the viscosity is too high, the oil cannot flow into the gap, resulting in poor air tightness.

5: Load distribution effect
[Extreme pressure agent]
[Viscosity index improving agent]
= Distributes the partial load at cam, gear and bearing to reduce the partial stress.
- If the viscosity is too low, the oil film is too thin, resulting in wear and damage. If the viscosity is too high, the friction resistance becomes high, causing large friction loss.

6: Dust preventing effect
[Viscosity index improving agent]
[Dispersion agent]
= Disperses foreign matter at the sliding part and contained in the oil into fine particles and cover them by oil film, to prevent wear and damage.
- If the viscosity is too low, the oil film is too thin, making it impossible to completely cover fine particles. If the viscosity is too high, dispersion of foreign matter becomes difficult, resulting in wear and damage.

As explained above, the roles given to additives are many and vary according to the types of additives as shown on the upper and lower right portions of Fig. 16.1.1. The methods for achieving the effects can be classified mainly into the following two.

2. Methods for achieving effects of additives

- Additives (*1) that change deteriorating matter into harmless materials as it contaminates the oil
  - Fuel : Cleaning, dispersing agent, etc.
  - Lubricant : Cleaning (*2), anti-oxidant (*3), dispersing agent, etc.
- Additives of which effects are effective from the beginning
  - Fuel and lubricant : Pour point decreasing agent, etc.
  - Fuel : Lubricity improving agent (*4), etc.
  - Lubricant : Viscosity index improving agent, etc.

*1: This type of additives gradually looses their effects as the operating hours and condition. So, fuel oil should not be stored for a long period and lubrication oil be replaced periodically.

*2: This type of additives neutralizes acid such as sulfuric acid to maintain at an appropriate total base value (degree of neutral), to prevent corrosion wear.
The neutralization performance varies according to the quality level (classification code) of the API service classification in Table 8.2.1 of the text.
Then, what is the difference?
It is shown in Fig. 16.1.5-1, using wear of the ring as an example.
The total base value is indicated by the amount (mg) of potassium hydroxide (KOH) equivalent to the acid that is required to neutralize the total base components.

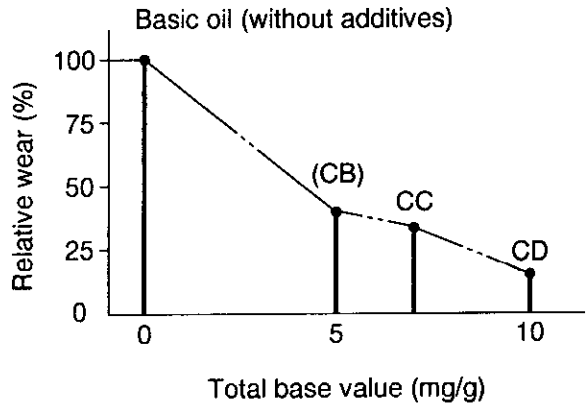


Fig. 16.1.5-1 Wear of top ring

*3: This type of additives prevents change into the resin, thus, preventing generation of lacquer, deposit and sludge.
The prevention performance varies according to the quality level (classification code) of the API service classification in Table 8.2.1 of the text.
Then, what is the difference?
It is shown in Fig. 16.1.5-2, using deposit generation at piston as an example.

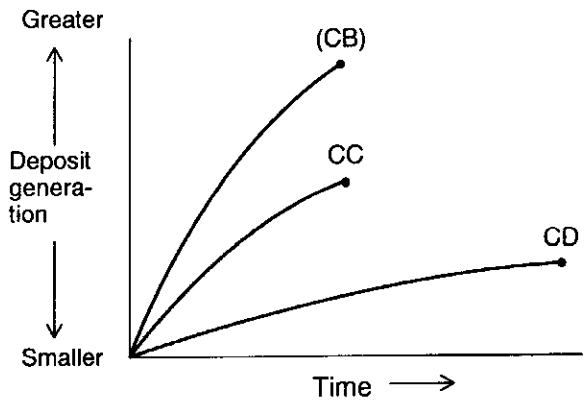


Fig. 16.1.5-2 Deposit generation at piston

*4: Reduction of the sulfur content is desired for low pollution. The sulfur in the fuel oil, however, contributes to lubrication of the injection pump and nozzle. So, the trends are to add lubricity improving agents to low-sulfur fuel oil.

As described above, it can be said that qualities of fuel and lubrication oils are produced by additives, indicating the importance of functions and effects of the additives.

16.1.6 Why is the engine performance adversely affected by poor fuel or lubricant quality?

Subjects explained herebefore are important items for the engine and the problems including poor atomization, diesel knocking, poor air tightness and increase of friction resistance considerably reduce the engine performance as shown at the lower right of Fig. 16.1.1.

Such problems described as important issues for the engine are caused by the fuel and lubrication oil qualities. In other words, it can be said that these problems are the results of use of poor quality fuel and lubrication oils.
Most qualities of fuel and lubrication oils are ensured by the effects of the additives as shown in 16.1.5.

There are types of additives of which effects are gradually lost by the operating and storage time. So, it is needed to avoid storing fuel and lubricant for a long period of time and to replace the lubrication oil periodically.

It should be realized that to strictly observe the specified qualities of fuel and lubrication oils is extremely important as well as to maintain and control the qualities.

16.2 Is required power of load machine estimated correctly?

Unless the load machines and diesel generator are handled correctly, malfunctions of load madchines can be caused by insufficient power and reduced performance of the diesel generator because of overloading.

Generally, this kind of problems is caused by incorrect estimation of required power of the load machine.

The practical procedures how to determine the required capacity of load macnine (capacity required for diesel generator=rated output), the number of loads that can be connected and the sequence of load connection are described below in detail.

Read through the description to understand the importance of how the loead madchine type, capacity and number of load machines are determined, as reference for inspection and servicing of the diesel generator.

16.2.1 Required power of load machine is greater than the indicated capacity.

Generally, the capacity indicated to a load machine (indicated capacity=output) represents the capacity that can be output by the load itself and does not indicate the power required for operating the load machine. Since a load machine is affected by the characteristics of the power supply in use, performance and efficiency of built-in motors, coils and capacitors as well as the efficiency of the entire loadmachine, the required power is normally greater than the indicated capacity. Therefore, it is necessary to obtain the required power under consideration on such influences by multiplying the indicated capacity by the power factor listed in Table 16.2.3.

16.2.2 The power factor greatly varies by load machine type and at rated operation and at start.

The power factors vary by single- or 3-phase, the load machine type (load characteristics), and operating condition. Further the operating condition is classified into two, one at the rated operation and the other at the start (input). It is important to recognize that the power factor at the start is extremely greater than that at the rated operation.

Why the power factor varies? It is because the power factor is determined under consideration of aforementioned load machine characteristics and efficiencies, as detailed below.

Why does power factor vary by power supply type and by load machine?

- ★ Power factor (*1) that varies by the power supply type such as DC or AC, single- or 3-phase, and the load machine type and capacity
- ★ Total load efficiency and total load power factor that effect the power required at motor rated operation and vary by the type such as the capacity and number of poles (revolution)
- ★ Starting grade (starting input/rated output=kVA/kW) which effects the power at start of motor and varies by the capacity and type, transition reactance of generator set which is the transient phenomenon at start, and instantaneous voltage drop

*1: This is specific to AC power supply. When phase difference occurs between the power supply current and voltage (expressed as advanced phase where the current advances the voltage when a capacitor is contained in the circuit or, delayed phase where the current delays when a coil exists in the circuit), invalid power is generated. So, the remaining effective power is expressed by percentage (%) which is called the power factor.

*2: This is the resistance generated (inductive resistance) when the AC current flows into a coil or circuit.

16.2.3 Method for obtaining required power of load machine

The power required for an operating load machine is obtained by multiplying the indicated capacity by the power factor (ρ_1) for each load type, using Table 16.2.3 (identical to Table 9.3.2). When two load machines or more are connected to a single diesel generator, it is needed to obtain the total required power.

The total required power is obtained by multiplying the number of load machines by the required power of each load machine type and calculating their sum.

Note that the power factors listed in Table 16.2.3 are reference values obtained under precondition that the listed load types (types, specifications, capacities, etc.) are possibly used for the diesel generator (5 kVA class). When a load machine not listed in the table is to be used, make sure to select an appropriate power factor according to the load type classification shown in the upper-most column and then obtain the required power.

Tale 16.3.2 Data for calculating required power of load machine(*1)

Load Specification (AC Specification)			Load Type	Resistor Load	Discharging Load	Motor Load		
						Single Phase		Three Phases
						Rectifier Type	Induction Type	Induction Type
Item		Symbol	Name / Unit	Incandes-cent Lamp, Pot, Heater, Solder Iron	Mercury Lamp, Floodlight	Drill, Grinder, Cutter, Winch	Com-pressor, Under-water Pump, Water Pump, Blower	Com-pressor, Under-water Pump, Blower
indicated Capacity of Load (per unit)		Mc	kW	0.2	0.4 (*2)	0.4	0.75	1.5
Power Efficiency of Load	At start	ρ_1	–	1.0	2.0	3.0	4.5	6.0
	Rated operation	ρ_2	–	1.0	1.5	1.5	2.0	2.0

*1: *Required power of a load (required output for diesel generator) is obtained by calculating* $Mc \times \rho_1$.

*2: *Use the value indicated on the regulator of the load.*

As shown in the table, the incandescent lamp and heater are the resistor load type units and are the simple loads. So, the power factor both at the start (input) and rated operation are 1.0, indicating that the indicated capacity can be regarded as the required power.

Although the mercury lamp and floodlight are used for illumination, they are the discharging type units and both the required power at start (input) and rated operation is greater than the indicated capacity, because of the aforementioned characteristics.

Further, the required power at rated operation of motor driven units ranges from 1 to 2 folds the indicated capacity. At the start, the required power jumps up to 3 to 6 folds the indicated capacity as the transient current (rush current) is needed.

Therefore, a large power exceeding that at the rated operation is required for motor driven units, although it is instantaneous. If the available power is lower than the required value, the unit cannot be started. So, the required power must be correctly grasped before use.

16.2.4 Practice of obtaining required power

Description hereafter is made using the required powers shown in Table 16.2.4 that are obtained from the example combination of load machines and the diesel generator shown below and from Table 16.2.3, for the purpose of making the contents easy-to-understand.

Example: Load machines and diesel generator

Load machine A : Incandescent lamp (indicated capacity: 200 W) × 10 bulbs
Load machine B : Drill (indicated capacity: 400 W, single phase) × 1
Load machine C : Compressor (indicated capacity: 750 W, single phase) × 1
Diesel generator : YDG5500E-5B (capacity: 5 kVA) × 1

The required power for each load machine is listed below.

Table 16.2.4 Required power for each load machine and capacity required for diesel generator

Load Type				Incan-descent Lamp (A)	Drill (B)	Com-pressor (C)	Combination (simultaneous start)			
Item		Symbol	Unit				(A+B)	(A+C)	(B+C)	(A+B+C)
Total Indicated Capacity of Load (indicated capacity per unit × number of loads)		M (Mc×n)	kW	2.0 (0.2×10)	0.4 (0.4×1)	0.75 (0.75×1)	2.4	2.75	1.15	3.15
Power Factor of Load	At start	ρ_1	–	1.0	3.0	4.5	–	–	–	–
	Rated operation	ρ_2	–	1.0	1.5	2.0	–	–	–	–
Required Power for Load (capacity required to diesel generator)	At start	M×ρ_1	kVA (kW)	2.0	1.2	3.4	3.2	5.4	4.6	6.6
	Rated operation	M×ρ_2	kVA (kW)	2.0	0.6	1.5	2.6	3.5	2.1	4.1

When all of the example loads are connected to a diesel generator, what are the load machines that can be used (started)? As the capacity of the diesel generator is 5 kVA, the answer can be obtained as below.

Load machins that can be started determined from the table

★ If only one type of load machine is started :
Either load machines A, B and C can be used. (The required power for each load is below the capacity of the diesel generator.)

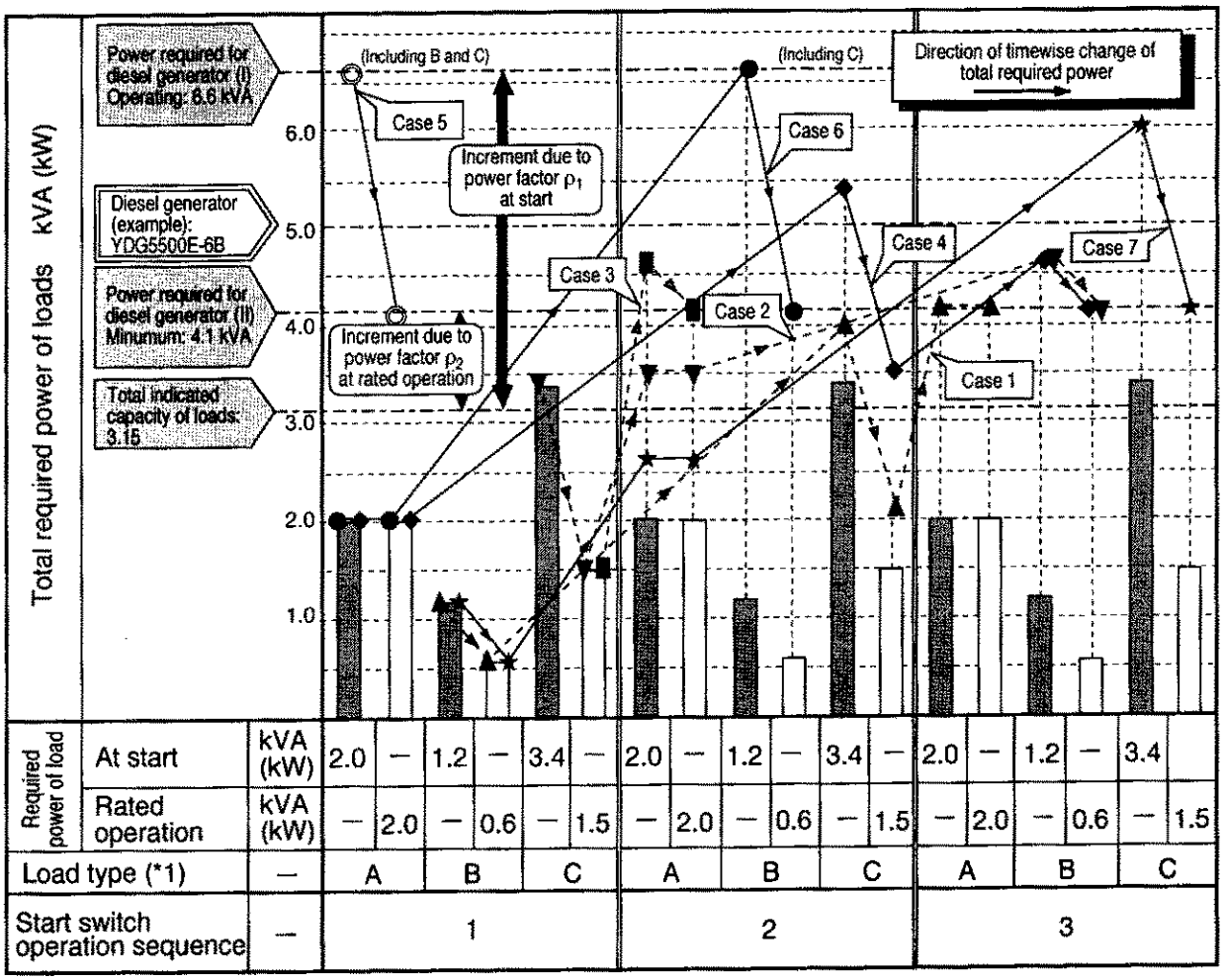
★ When two types of load machines are simultaneously started:
Usable under condition. (Combination of loads A+B and B+C are operable. However, combination of A+C is not.)

★ When all of 3 load machines are simultaneously started:
Not usable. (The total required power is 6.6 kVA, which is over the diesel generator capacity.)

As stated above, there are seven methods for starting each one load machine of the three types of load machines by a single starting operation. Then, can all of the three types of load machines can be operated if the starting method where the required power for each load machine is accumulated at a time is taken, under the condition that all three types are operated?

16.2.5 Total required power varies by the order of starting load machines

When multiple load machines are connected to a single diesel generator, it is likely that the order of start is different at each operation such as starting all load machines at a time or by different starting order even if the load machines are started sequentially one by one. If a load machine requiring a starting power greater than the rated power such as a motor driven unit is contained, the capacity (rated output) required for the diesel generator varies according to the starting order, causing insufficient power or overloading. Then, how the total required power of multiple load machines changes after start and is starting possible when the starting order is changed?
Fig. 16.2.5 illustrates the trends of changes based on Table 16.2.4.



Required power of load																		
	At start	kVA (kW)	2.0	—	1.2	—	3.4	—	2.0	—	1.2	—	3.4	—	2.0	—	1.2	—	3.4	
	Rated operation	kVA (kW)	—	2.0	—	0.6	—	1.5	—	2.0	—	0.6	—	1.5	—	2.0	—	0.6	—	1.5
Load type (*1)		—	A		B		C		A		B		C		A		B		C	
Start switch operation sequence		—	1						2						3					

*1: *A represents incandescent lamp (simultaneous ON of 10 bulbs), B drill and C compressor.*

Fig. 16.2.5 Relationships between load machine starting sequence and power required for diesel generator

When a part of aforementioned seven methods is added, there are 13 start operation methods. Unique 7 methods are selected in Fig. 16.2.5 and are shown as Cases 1 through 7.

Among them, starting is possible for cases 1, 2 and 3, while it is impossible for cases 4 through 7.

How to read the figure?

- Cases are identified by marks such as ▲ , ● , and ◆ . Start possible cases are shown by dotted lines while impossible cases are indicated by solid lines.
- The starting operation sequence is shown by numerals in the lower-most column and advances from the left to the right. The advancing directions are shown by arrows both for the dotted and solid lines.
- As for the starting operation, all of the total required power at start (capacity required for diesel generator I=Operating) 6.6 kVA and the total required power at rated operation (capacity required to diesel generator II=Minimum) 4.1 kVA may be included in start switch operation sequence column 1, as there are cases that load machines A, B and C are started simultaneously as in the case 5. Carefully read the figure since the cases such as load machines B and C are simultaneously started after start of load machine A are included in case 6.
- The bar graph in the figure indicates the required power of each load. The gray indicates that at start while white, at rated operation.
- How to read the line graph (dotted and solid lines) in the figure is described using case 1 as an example and in the starting sequence.
  - Load B which is started at the first is operated at the 0.6kVA rated power after start.
  - Load C which is started next needs a 3.4kVA starting power. So, the total required power at start of load machine C is 4.0 kVA as the rated power of load B is accumulated. The total required power after start is 2.1 kVA since 0.6 kVA rated power of load machine B is accumulated to the 1.5 kVA rated power of load C.
  - Load A which is started last is the resistor type incandescent lamp, having the same start and rated power (2.0 kVA). The total required power of load machines A, B and C is 4.1 kVA, which is identical to case 7.

What are known from the figure?

- When load machines are started from those having difference or large difference between required power at start and at rated operation, all load machines can be started as shown in case 1 (starting order: B → C → A). Further, all loads can be started when the resistor type load machine A is started like in case 2 (starting order: C → A → B) or load machines A and B are started simultaneously as in case 3 (starting order: C → A/B).
- Even if a load machine having difference in required power is started, if the load having less difference is started at the first: The breaker is activated upon start of load machine C and operation of all load machines stops as in case 7 (starting order: B → A → C).
- If a load machine having difference between required power at start and at rated operation is started after start of the resistor type load: Even if load machines are started one by one like in case 4 (starting order: A → C → B), all load machines cannot be operated. Naturally, all loads cannot be operated even if load machines are started in two steps as in case 6 (starting order: A → B/C) or they are started at a time as in case 5 (starting order: A/B/C simultaneous).

Note 1: Success or fail of start vary greatly according to each case.
While success/fail is described mainly by the starting order and load machine type, note that the trends change when the load machine capacities and number of loads are exceeded even if the same load machines as the examples are used, since many more factors affect the success or fail.

Note 2: Be careful since there are compressors and water pumps of which auto switches are activated automatically by detecting the pressure. For such units, although the operation sequence of the main switch can be observed, the starting sequence cannot be observed since the auto switch functions during operation.

Note 3: In the example, only 5 methods (40%) among the 13 methods can successfully start the load machines. Since the starting sequence cannot be observed practically, causing faulty start, drop in performance and malfunction of the diesel generator, it is known that the load machines shown in the example should not be used by the starting methods shown above.

16.2.6 Notes for operating load machines without causing malfunctions to the generator

As described above load machines may or may not be successfully started if the required power of each load machine is ignored or loads are used on the precondition of a certain starting method, resulting in drop of load machine performance and faulty start by insufficient power (insufficient current and voltage drop) of the diesel generator and malfunctions of the diesel generator because of overloaded operation.

To ensure successful start of load machines

- ★ Estimate the required capacity of each load machine correctly using Table 16.2.3.
- ★ For estimation of required capacity of load machine, always use the power factor ρ_1 at start to prevent insufficient power of the diesel generator.
- ★ Always obtain the total required power when two or more load machines are used.
- ★ The total required power of load machines used must always be below the capacity (rated output) of the diesel generator.
- ★ When two or more load machines are simultaneously operated, start them one by one whenever possible, for ensuring successful start.

16.2.7 Method for determining the generator specification

Determine a diesel generator based on the total required power of load machines to be used.
If inappropriate required power values are used such as the indicated capacities and required power at rated operation to determine the total required power, what would happen when starting the load machines?
What are indicated by Fig. 16.2.5 are:

If determined using indicated capacities of load machines:

Starting may result in failure or malfunction of diesel generator may occur.

Diesel generator capacity = 3.15 kVA

If a diesel generator is determined assuming that the sum of capacities indicated on load machines are the total required power:

- ★ The load machine that can be used is only A or B.

If determined based on the total required power at rated operation:

Starting may result in failure or malfunction of diesel generator may occur.

Diesel generator capacity = 4.1 kVA

If the total required power is estimated based on power factors at rated operation and a diesel generator is determined:

★ In case 1 (starting order: B → C → A) and case 8 (starting order: C → B → A), load machines can be used. In all other cases, however, all load machines cannot be used. The percentage of successful cases is only 15% among all cases.

If determined based on the total required power at start:

Successful start can be ensured without malfunctions of the diesel generator.

Diesel generator capacity = 6.6 kVA

When the total required power is estimated based on power factors at start and a diesel generator is determined:

★ All load machines can be operated even at the worst starting condition among 13 methods as shown in case 5 (starting order: A/B/C simultaneous).

It is known from the above that the total required power is obtained using power factors at start ρ_1 and based on which a diesel generator having appropriate specification should be determined.

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