Service Manual

RV/Mobile Generator Sets

Models:

15CCO
15CCFO
15CCOZ
15CCFOZ
20CCO
20CCFO
20CCOZ
20CCFOZ

KOHLER®
POWER SYSTEMS

TP-5606 12/93

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Safety Precautions and Instructions

A generator set, like any other electro-mechanical device, can pose potential dangers to life and limb if improperly maintained or imprudently operated. The best way to prevent accidents is to be aware of the potential dangers and to always use good common sense. In the interest of safety, some general precautions relating to the operation of a generator set follow. Keep these in mind. This manual contains several types of safety precautions which are explained below.

⚠ DANGER

Danger is used to indicate the presence of a hazard that *will* cause *severe* personal injury, death, or substantial property damage if the warning is ignored.

⚠ WARNING

Warning is used to indicate the presence of a hazard that *can* cause *severe* personal injury, death, or substantial property damage if the warning is ignored.

⚠ CAUTION

Caution is used to indicate the presence of a hazard that *will* or *can* cause *minor* personal injury or property damage if the warning is ignored.

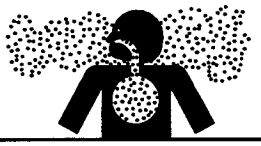
NOTE

Note is used to notify people of installation, operation, or maintenance information that is important but not hazard-related.

Safety decals are affixed to the generator set in prominent places to advise the operator or service technician of potentially hazardous situations. The decals are reproduced here to improve operator recognition and thereby increase decal effectiveness. For a further explanation of decal information, reference the accompanying safety precautions. Before operating or servicing the generator set, be sure you understand the message of these decals. Replace decals if missing or damaged.

EXHAUST SYSTEM

⚠ WARNING



Carbon monoxide.
Can cause severe nausea, fainting, or death.

The exhaust system must be leakproof and routinely inspected.

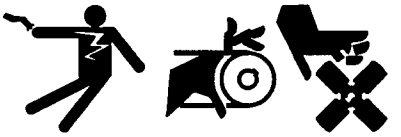
Carbon monoxide can cause severe nausea, fainting, or death. Install exhaust system tail pipe so discharged exhaust gases will not be drawn into vehicle interior through windows, doors, air conditioners, etc. Do not use flexible tail piping since this type could crack and allow lethal exhaust fumes to enter the vehicle.

Carbon monoxide can cause severe nausea, fainting, or death. Never operate the generator set inside a building unless the exhaust gas is piped safely outside. Never operate in any area where exhaust gas could accumulate and seep back inside an occupied building or vehicle. Be careful when parking your vehicle to avoid obstructing the exhaust outlet. The exhaust gases must discharge freely, otherwise carbon monoxide may deflect into the vehicle. Avoid breathing exhaust fumes when working on or near the generator set. Carbon monoxide is particularly dangerous because it is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short period of time.

Carbon monoxide can cause severe nausea, fainting, or death. Diesel fumes can rapidly destroy copper tubing in diesel exhaust systems. Do not use copper tubing in diesel exhaust systems. Exhaust sulphur will cause rapid deterioration and this could result in exhaust leakage.

ACCIDENTAL STARTING

⚠ WARNING



Accidental starting.
Can cause severe injury or death.
Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe injury or death. Disconnect battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator. The generator set can be started by remote start/stop switch unless this precaution is followed.

MOVING PARTS

⚠ WARNING

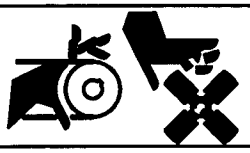
Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

⚠ WARNING



Rotating parts.
Can cause severe injury or death.

Do not operate generator set without all guards, screens, or covers in place.

Exposed moving parts can cause severe injury or death. Keep hands, feet, hair, clothing, and test leads away from belts and pulleys when unit is running. Replace guards, covers, and screens before operating generator set.

Flying projectiles can cause severe injury or death. Retorque all crankshaft and rotor hardware after servicing. When making adjustments or servicing generator set, do not loosen crankshaft hardware or rotor thru-bolt. If rotating crankshaft manually, direction should be clockwise only. Turning crankshaft bolt or rotor thru-bolt counterclockwise can loosen hardware and result in serious personal injury from hardware or pulley flying off engine while unit is running.

ENGINE BACKFIRE/FLASH FIRE

⚠ WARNING

Fire.
Can cause severe injury or death.

Do not smoke or permit flame or spark to occur near fuel or fuel system.

A sudden backfire can cause severe injury or death. Do not operate with air cleaner removed.

HAZARDOUS VOLTAGE/ ELECTRICAL SHOCK

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

⚠ WARNING

Hazardous voltage.
Backfeed to utility system can cause severe injury, death, or property damage.
Do not connect to any building electrical system without connecting through an approved device and after building main switch is open.

Hazardous voltage can cause severe injury or death. The heat sink of the voltage regulator contains high voltage. Do not touch voltage regulator heat sink when testing or electrical shock will occur.

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule—replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

Hazardous "backfeed" voltage can cause severe injury or death. The generator must not be used to "backfeed" by connecting it to building/campground electrical circuits. Install a transfer switch in vehicle generator installations to prevent connection of vehicle and other sources of power. Electrical backfeed into a utility electrical system can cause serious injury or death to utility personnel working on transmission lines.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

FUEL SYSTEM

⚠ WARNING

Explosive fuel vapors.
Can cause severe injury or death.

Use extreme care when handling, storing, and using fuels.

Explosive fuel vapors can cause severe injury or death. All fuels are highly explosive in a vapor state. Use extreme care when handling, storing, and using fuels. Store fuel in a well-ventilated area away from spark-producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running since spilled fuel may ignite on contact with hot parts or from ignition spark. Do not smoke or permit flame or spark to occur near potential sources of spilled fuel or fuel vapors. Keep fuel lines and connections tight and in good condition—don't replace flexible fuel lines with rigid lines. Flexible sections are used to avoid breakage due to vibration. Should any fuel leakage, fuel accumulation, or electrical sparks be noted, DO NOT OPERATE GENERATOR SET. Have systems repaired before resuming generator operation.

Explosive fuel vapors can cause severe injury or death. Spilled fuel can cause an explosion. Use a container to catch fuel when draining fuel system. Wipe up all spilled fuel after draining system.

HAZARDOUS NOISE

⚠ CAUTION

Hazardous noise.
Can cause loss of hearing.
Never operate generator without a muffler or with faulty exhaust system.

BATTERY

⚠ WARNING

Sulfuric acid in batteries.
Can cause severe injury or death.

Use protective goggles and clothes. Can cause permanent damage to eyes, burn skin, and eat holes in clothing.

Sulfuric acid in batteries can cause severe injury or death. Sulfuric acid in battery can cause permanent damage to eyes, burn skin, and eat holes in clothing. Always wear splash-proof safety goggles when working around the battery. If battery electrolyte is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large quantities of clean water. In the case of eye contact, seek immediate medical aid. Never add acid to a battery once the battery has been placed in service. Doing so may result in hazardous spattering of electrolyte.

Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc. to prevent burns and to prevent sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling battery. Never connect negative (–) battery cable to positive (+) connection terminal of starter solenoid. Do not test battery condition by shorting terminals together or sparks could ignite battery gases or fuel vapors. Any compartment containing batteries must be well ventilated to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being charged and always turn charger off before disconnecting battery connections. When disconnecting battery, remove negative lead first and reconnect it last.

HOT PARTS

⚠ WARNING

Hot coolant and steam.
Can cause severe injury or death.

Before removing pressure cap stop generator, allow to cool and loosen pressure cap to relieve pressure.

⚠ WARNING

Hot engine and exhaust system.
Can cause severe injury or death.

Do not work on generator set until unit is allowed to cool.

Fire can cause severe injury or death. Hot exhaust system can ignite adjacent combustible materials. Do not locate electrical wiring, fuel lines, or combustible material above the exhaust muffler. Be careful when parking your vehicle to prevent grass fires started by exhaust system and hot exhaust gases.

Fire can cause severe injury or death. Hot generator can ignite debris in compartment. Keep the compartment and generator set clean and free of debris and combustible materials to minimize chances of fire. Do not block fuel/oil drain opening in generator mounting tray. If sub-flooring is used, cut a corresponding hole in the sub-flooring for drain opening.

Hot parts can cause severe injury or death. Do not touch hot engine parts. An engine gets hot while running and exhaust system components get extremely hot.

Hot coolant can cause severe injury or death. Allow engine to cool and release pressure from cooling system before opening pressure cap. To release pressure, cover the pressure cap with a thick cloth then turn it slowly counterclockwise to the first stop. After pressure has been completely released and the engine has cooled, remove cap. If generator set is equipped with a coolant recovery tank, check coolant level at tank.

NOTES

NOTICE

This generator set has been rewired from its nameplate voltage to:

246242

NOTICE

This is a positive terminal only.
Do not attach negative lead!

NOTE

This generator set does not comply with United States Coast Guard (U.S.C.G.) requirements and must not be used for marine applications. Use only generator sets specified for marine use in marine installations. U.S.C.G. Regulation 33CFR183 requires a generator set to be "ignition protected" when used in a gasoline-fueled environment.

NOTE

Do not "tee" into fuel injected fuel systems. Use a two dip tube arrangement for fuel supply. Consult an Authorized Kohler Service Dealer for further fuel system installation information.

NOTE

Wipe up all spilled diesel fuel after bleeding system. Wash hands after any contact with fuel oil.

NOTE

ENGINE DAMAGE! Failure to bleed air from cooling system may cause overheating and subsequent damage to engine.

NOTE

Special attention should be given when checking for proper coolant level. After the coolant has been drained, it normally requires some time before complete refill of the engine water jacket takes place.

NOTE

HARDWARE DAMAGE! Engine and generator may make use of both American Standard and metric hardware. Be sure to use the correct size tools to prevent rounding of bolt heads and nuts.

NOTE

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. American Standard hardware uses a series of markings and metric hardware uses a numeric system to indicate hardness. Check markings on bolt head and nuts for proper identification.

Routine Service Parts

Your Kohler generator dealer/distributor has a complete listing of parts for your generator set. Contact him for service.

Part Description	Kohler Part No.
Air Cleaner Element	258646
Oil Filter	229841
Fuel Filter	225010
Alternator V-belt	225626
Black spray paint	221292

Glossary of Abbreviations

Abbreviations are used throughout this manual. Normally they will appear in the text in complete form with the abbreviation following in parentheses the first time they are used. After that they will appear in the abbreviated form. The commonly used abbreviations are shown below.

Abbreviation	Description
ABDC	after bottom dead center
AC	alternating current
AISI	American Iron and Steel Institute
AHWT	anticipatory high water temp.
ALOP	anticipatory low oil pressure
AM	amplitude modulation
amp	ampere
amps	amperes
ANSI	American National Standard Institute
API	American Petroleum Institute
approx.	approximate, approximately
A/R	as required, as requested
A/S	as supplied, as stated, as suggested
ASA	American Standards Association (former name of ANSI)
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
aux.	auxiliary
A/V	audio-visual
AWG	American Wire Gauge
AWM	appliance wiring material
BBDC	before bottom dead center
BDC	before dead center
bhp	brake horsepower
bmep	brake mean effective power
B.&S.	Brown & Sharpe Wire Gauge
BTDC	before top dead center
Btu	British thermal unit
5C	Celsius degree
cc	cubic centimeter
CCA	cold cranking Amps.
CEC	Canadian Electrical Code
cfh	cubic feet per hour
cfm	cubic feet per minute
CID	cubic inch displacement
cm	centimeter, centimeters
cmm	cubic meters per minute
co.	company
cont'd.	continued
CPVC	chloropoly vinyl chloride
CRT	cathode ray tube
C.S.A.	Canadian Standards Association
CT	current transformer
cu. in.	cubic inch, cubic inches
cyl.	cylinder

Abbreviation	Description
dBA	decibels
DC	direct current
DCR	direct current resistance
deg.	degree
dept.	department
dia.	diameter
DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
e.g.	example given
EIA	Electronic Industries Association
EMI	electromagnetic interference
EPA	Environmental Protection Agency
etc.	etcetera, (and so forth)
ext.	external
5F	Fahrenheit degree
fl. oz.	fluid ounce, fluid ounces
FM	frequency modulation
ft.	foot, feet
ft. lbs.	foot pound, foot pounds
fs	full scale
ga.	gauge (meters, wire size)
gal., gals.	gallon, gallons
gal./hr.	gallons per hour
gph	gallons per hour
gpm	gallons per minute
gr.	grade
grd.	ground
HCHT	high cylinder head temperature
HET	high exhaust temperature
Hg	mercury (element)
H_2O	water
hp	horsepower
hr, hrs	hour
HWT	high water temperature
Hz	hertz (cycles per second)
ID	inside diameter
IEEE	Institute of Electrical and Electronics Engineers
in.	inch(es)
inc.	incorporated
in. lbs.	inch pounds
int.	internal
int.-ext.	internal-external
ISO	International Standards Organization
J	joule, joules
JIS	Japanese Industry Standard
kg	kilogram, kilograms

Abbreviation	Description
kg/cm^2	kilograms per square centimeter
kgm	kilogram meter(s)
km	kilometer, kilometers
kPa	kiloPascal, kiloPascals
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt amperes
kW	kilowatt, kilowatts
kWH	kilowatt hour
L	liter, liters
L x W x H	length x width x height
LED, LEDs	light emitting diode
lb., lbs.	pound, pounds
L/hr.	liter per hour, liters per hour
L/min.	liter(s) per minutes,
LOP	low oil pressure
LP	liquefied petroleum
LWT	low water temperature
m	meter, meters
m^3	cubic meter, cubic meters
max.	maximum
MCM	one thousand circular mils.
MHz	megahertz
mi.	mile, miles
mil	one one-thousandth of an inch
min.	minimum
mJ	milli joule, milli joules
MJ	mega joule, mega joules
mm	millimeter, millimeters
m^3/min	cubic meters per minute
MPa	megaPascal
MPG	miles per gallon
mph	miles per hour
MS	military standard
mW	milliwatt, milliwatts
MW	megawatt, megawatts
N/A	not available
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
meggar	megohmmeter
misc.	miscellaneous
NFPA	National Fire Protection Association
Nm	Newton meter, Newton meters
no., nos.	number, numbers
NPT	National Standard taper pipe thread per general use

Abbreviation	Description
N/R	not required
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OS	overspeed, oversize
OSHA	Occupational Safety and Health Act
OV	overvoltage
oz.	ounce, ounces
PF	power factor
PMG	permanent magnet generator
pot.	potentiometer
ppm	parts per million
psi	pounds per square inch
pt., pts.	pint, pints
PVC	polyvinyl chloride
qt., qts.	quart, quarts
qty.	quantity
ref.	reference
RFI	radio frequency interference
r.h.m.	round head machine (screw)
rms	root mean square
rpm	revolutions per minute
RV	recreational vehicle
SAE	Society of Automotive Engineers
SCR	silicon controlled rectifier
sec.	second, seconds
spec, specs	specification
sq.	square
sq. cm	square centimeters
sq. in.	square inch, square inches
tach	tachometer
TDC	top dead center
tech. pub.	technical publications
temp.	temperature
TIF	telephone influence factor
TP, TPs	technical publications
turbo	turbocharger
UHF	ultra high frequency
UNC	Unified coarse thread (was NC)
UNF	Unified fine thread (was NF)
UL	Underwriter's Laboratories, Inc.
US	undersize
V	volt, volts
VAC	volts alternating current
VDC	volts direct current
VHF	very high frequency
W	watt, watts

Section 1. Specifications

Introduction

This vehicle is equipped with a dependable Kohler alternating-current RV/Mobile Generator Set. Service requirements of the generator set are minimal, but it is important that the required services be performed at the prescribed intervals. Please take a few moments to read through this manual; then carefully follow all service recommendations to keep the set in top condition. In the space provided, record the MODEL, SPECIFICATION, SERIAL and ENGINE SPEC. numbers as found on the nameplate attached to the belt guard of the engine for remote-radiator models and on the radiator bracket for in-line-radiator models (see Section 8 "Service Ordering Instructions"). This information will enable a Kohler Generator Service Dealer/Distributor to supply the correct part or data for this particular version. Keep this manual in the vehicle for future reference. The illustrations in this manual are representative of most units. This generator set may differ slightly from those shown.

General Specifications

	15 kW (60 Hz) Model	20 kW (60 Hz) Model
Dimensions L x W x H in. (mm):		
Remote Radiator (Single Phase)	39.57 x 20.89 x 25.61 (1005 x 531 x 650)	39.57 x 20.89 x 27.25 (1005 x 531 x 692)
Remote Radiator (Single Phase) Airbag Mounted	39.57 x 22.00 x 25.61 (1005 x 559 x 650)	39.57 x 22.00 x 27.25 (1005 x 559 x 692)
In-line Radiator (Single Phase)	45.02 x 20.99 x 28.00 (1144 x 533 x 711)	45.02 x 20.99 x 28.00 (1144 x 533 x 711)
In-line Radiator (Three Phase)	46.62 x 20.99 x 28.00 (1184 x 533 x 711)	46.62 x 20.99 x 28.00 (1184 x 533 x 711)
Weight—dry, lbs. (kg):		
Remote Radiator (Single Phase)	684 (310)	695 (315)
Remote Radiator (Single Phase) Airbag Mounted	684 (310)	695 (315)
In-line Radiator (Single Phase)	719 (326)	730 (331)
In-line Radiator (Three Phase)	719 (326)	730 (331)
Air Requirements CFM (M^3/min):		
Combustion	70 (2)	70 (2)
Cooling	1930 (55)	1930 (55)
Fuel Inlet Size in. (mm)	1/4-18 N.P.S.F	1/4-18 N.P.S.F
Fuel Return Size in. (mm)	1/4-18 N.P.S.F	1/4-18 N.P.S.F

Fuel Consumption gph (Lph):

Load	25%	50%	75%	100%
15 kW	0.6 (2.3)	0.8 (3.0)	1.1 (4.2)	1.4 (5.3)
20 kW	0.9 (3.4)	1.2 (4.5)	1.5 (5.7)	1.9 (7.2)

DERATION: All units are rated 1.0 power factor. The kilowatts of the generator set will decrease 3.5% for each 1,000 feet (305 meters) above 500 feet (152 meters) above sea level and 1% for each 10°F (5.5°C) above 85°F (30°C).

Engine

Some general engine specifications are listed below. Refer to the appropriate service section and the engine service manual for specific service details.

	15 kW Model	20 kW Model
Manufacturer	Yanmar	
Model	4TN84E-RK	4TN84TE-TK
Type	Water-cooled, 4-cycle diesel engine	
Number Cylinders	4	
Firing Order	1-3-4-2	1-3-4-2
Compression Ratio	17.79:1	16.99:1
Displacement cu. in. (cm^3)	116 (1910)	
Rated Horsepower (60 Hz)	27.4	36.3
RPM (60 Hz)	1800	
Bore in. (mm)	3.307 (84)	
Stroke in. (mm)	3.386 (86)	
Combustion System	Direct Injection	
Valve Clearance in. (mm)		
Intake	0.0079 (0.2)	
Exhaust	0.0079 (0.2)	
Cylinder Block Material	Cast Iron	
Cylinder Head Tightening Torque ft. lbs. (Nm)		
Step 1:	25.23–31.1 (3.5–4.3)	
Step 2:	54.23–61.46 (7.5–8.5)	
Cylinder Head Material	Cast Iron	
Connecting Rod	Forged Carbon Steel	
Piston Rings	2 Compression/1 Oil	
Main Bearings, Number and Type	4, Replaceable Sleeves	
Governor	Mechanical	
Lubrication System	Full Pressure	
Oil Capacity (with filter) qts. (L)	6.1 (5.8)	
Oil Type (API)	CC or CD	
Oil Pressure psi (kPa)	42.66–56.88 (294–392)	
Fuel Recommendation	Diesel–ASTM D975 No. 2-D (Cetane No. > 45)	
Aspiration	Natural Aspiration	Turbocharged
Fuel Injection Pump	Yanmar YPES	
Battery Voltage	12	
Battery Ground	Negative	
Battery Recommendation (min.)	625 Cold Cranking Amps 100 Amp Hr.	
Starter Motor	Bendix Automotive Type	
Cooling System Capacity qts. (L)		
Remote Radiator (Engine Water Jacket)	2.85 (2.7)	
In-line Radiator	4 qts. 16 oz. (4.26 L)	
Timing	16° ±1°	12° ±1°
Air Cleaner	Dry Paper Element	

Generator

Models 15CCO/CCFO/CCOZ/CCFOZ

Model Series	Voltage Code	Voltage	Wire	Amps/ Pole	kW	PH
60 Hz Models:						
15CCO	61	120/240	3	62.5	15.0	1
15CCO	101	100/200	3	75.0	15.0	1
15CCOZ	01	120/240	4	45.1	15.0	3
15CCOZ	51	139/240	4	45.1	15.0	3
15CCOZ	51	127/220	4	49.2	15.0	3
15CCOZ	71	227/480	4	22.6	15.0	3
15CCOZ	71	240/416	4	26.0	15.0	3
15CCOZ	81	120/208	4	52.0	15.0	3
50 Hz Models:						
15CCFO	101	120/240	3	52.1	12.5	1
15CCFO	61	110/220	3	56.8	12.5	1
15CCFO	11	100/200	3	62.5	12.5	1
15CCFO	41	220	2	56.8	12.5	1
15CCFOZ	51	110/190	4	47.5	12.5	3
15CCFOZ	51	115/200	4	45.1	12.5	3
15CCFOZ	71	220/380	4	23.7	12.5	3
15CCFOZ	71	230/400	4	22.6	12.5	3
15CCFOZ	71	240/416	4	21.7	12.5	3
15CCFOZ	81	120/208	4	43.4	12.5	3
15CCFOZ	81	110/220	4	41.0	12.5	3

Models 20CCO/CCFO/CCOZ/CCFOZ

Model Series	Voltage Code	Voltage	Wire	Amps/ Pole	kW	PH
60 Hz Models:						
20CCO	61	120/240	3	83.3	20.0	1
20CCO	101	100/200	3	100.0	20.0	1
20CCOZ	01	120/240	4	60.1	20.0	3
20CCOZ	51	139/240	4	60.1	20.0	3
20CCOZ	51	127/220	4	65.6	20.0	3
20CCOZ	71	227/480	4	30.1	20.0	3
20CCOZ	71	240/416	4	34.7	20.0	3
20CCOZ	81	120/208	4	69.4	20.0	3
50 Hz Models:						
20CCFO	101	120/240	3	69.4	16.5	1
20CCFO	61	110/220	3	75.8	16.5	1
20CCFO	11	100/200	3	83.3	16.5	1
20CCFO	41	220	2	75.8	16.5	1
20CCFOZ	51	110/190	4	62.7	16.5	3
20CCFOZ	51	115/200	4	59.6	16.5	3
20CCFOZ	71	220/380	4	31.4	16.5	3
20CCFOZ	71	230/400	4	29.8	16.5	3
20CCFOZ	71	240/416	4	28.7	16.5	3
20CCFOZ	81	120/208	4	57.3	16.5	3
20CCFOZ	81	110/220	4	54.2	16.5	3

Note: 3 phase ratings at 0.8 power factor and
1 phase ratings at 1.0 power factor

Generator Models 15/20 kW

	Single-Phase Models	Three-Phase Models
RPM (60-Hz Models)	1800	1800
RPM (50-Hz Models)	1500	1500
Stator Resistance (ohms)** Leads:		
1-2, 3-4, 33-44	0.07	N/A
1-4, 2-5, 3-6, 7-10, 8-11, 9-12	N/A	0.04
55-33	1.3	N/A
B1-B2	0.06	0.06
Rotor Resistance (ohms)	3.0	3.0
Exciter Field Resistance	N/A	1.6
Exciter Armature Resistance	N/A	0.51

Generator Models 15/20 kW (continued)

	15CCO Single-Phase Models (60/50 Hz)	15CCOZ Three-Phase Models (60/50 Hz)
Rotor field voltage/current readings at rated voltage (hot)		
No load (63 Hz)	19V/5.5 Amps	8V/1.1 Amps
Full load (60 Hz)	38V/9.0 Amps	20V/2.5 Amps

	20CCO Single-Phase Models (60/50 Hz)	20CCOZ Three-Phase Models (60/50 Hz)
Rotor field voltage/current readings at rated voltage (hot)		
No load (63 Hz)	19V/5.5 Amps	8V/1.1 Amps
Full load (60 Hz)	44V/10.2 Amps	30V/4.3 Amps

	20CCFO Single-Phase Models (50 Hz)
Rotor field voltage/current readings at rated voltage (hot)	
No load (53 Hz)	23V/5.0 Amps
Full load (50 Hz)	60V/11 Amps

	Single-Phase Models
Stator output voltages with separately excited rotor using 12-volt battery (cold)	
1-2, 3-4, 33-44	79V
33-55	110V
B1-B2	10V

	Three-Phase Models
Stator output voltages with separately excited exciter field using 12-volt battery (cold)	
1-4, 2-5, 3-6, 7-10, 8-11, 9-12	160V
B1-B2	21V
V0-V7, V0-V8, V0-V9	160V
55-66	185V

	Single-Phase Models	Three-Phase Models
Excitation Method	Static Excited	Rotating Exciter
Overbolt Torque	25 ft. lbs. (300 in. lbs.)	
Voltage Regulator Type	PowerBoost™ IIIE	PowerBoost™ V
Insulation (Rotor and Stator)	Class 155, Epoxy Varnish, Vacuum Impregnated	
Winding Material	Copper	
Bearing (Number and Type)	1, Replaceable Ball	
Circuit Protection:		
Controller	10-Amp Fuse	10-Amp Circuit Breaker
Optional AC Output	Manual-Reset Circuit Breaker	
Voltage Regulator	10-Amp Fuse	N/A
Fuel Solenoid	10-Amp Fuse	

** Most ohmmeters will not give accurate readings when measuring less than 1 ohm. The stator can be considered good if a low resistance reading (continuity) is obtained and there is no evidence of shorted windings (discoloration). Do not confuse a low resistance reading with a reading indicating a shorted winding.

NOTES

Service View Components
Remote-Radiator Model (See Figure 1-1)

1. Optional AC Circuit Breaker
2. Voltage Regulator Fuse
3. Start-Stop/Preheat Switch
4. Fuel Solenoid Fuse
5. Controller Fuse
6. Hourmeter
7. Controller
8. Remote Connection (at rear of controller)
9. Air Cleaner
10. Lifting Eye
11. Intake Heater
12. Fuel Solenoid
13. Oil Fill
14. Lifting Eye
15. High Water Temperature Shutdown
16. Coolant Inlet
17. Oil Fill
18. Generator Nameplate
19. Mechanical Governor
20. Oil Filter
21. Fuel Filter
22. Ground Connection
23. Oil Drain
24. Fuel Pump
25. Fuel Inlet Connection Point
26. Fuel Return Connection Point
27. Oil Check
28. Heater Coil Relay
29. Low Oil Pressure Shutdown
30. Voltage Regulator (inside junction/circuit breaker box)
31. Coolant Outlet
32. Exhaust Outlet
33. Battery-Charging Alternator (behind guard)
34. Starter

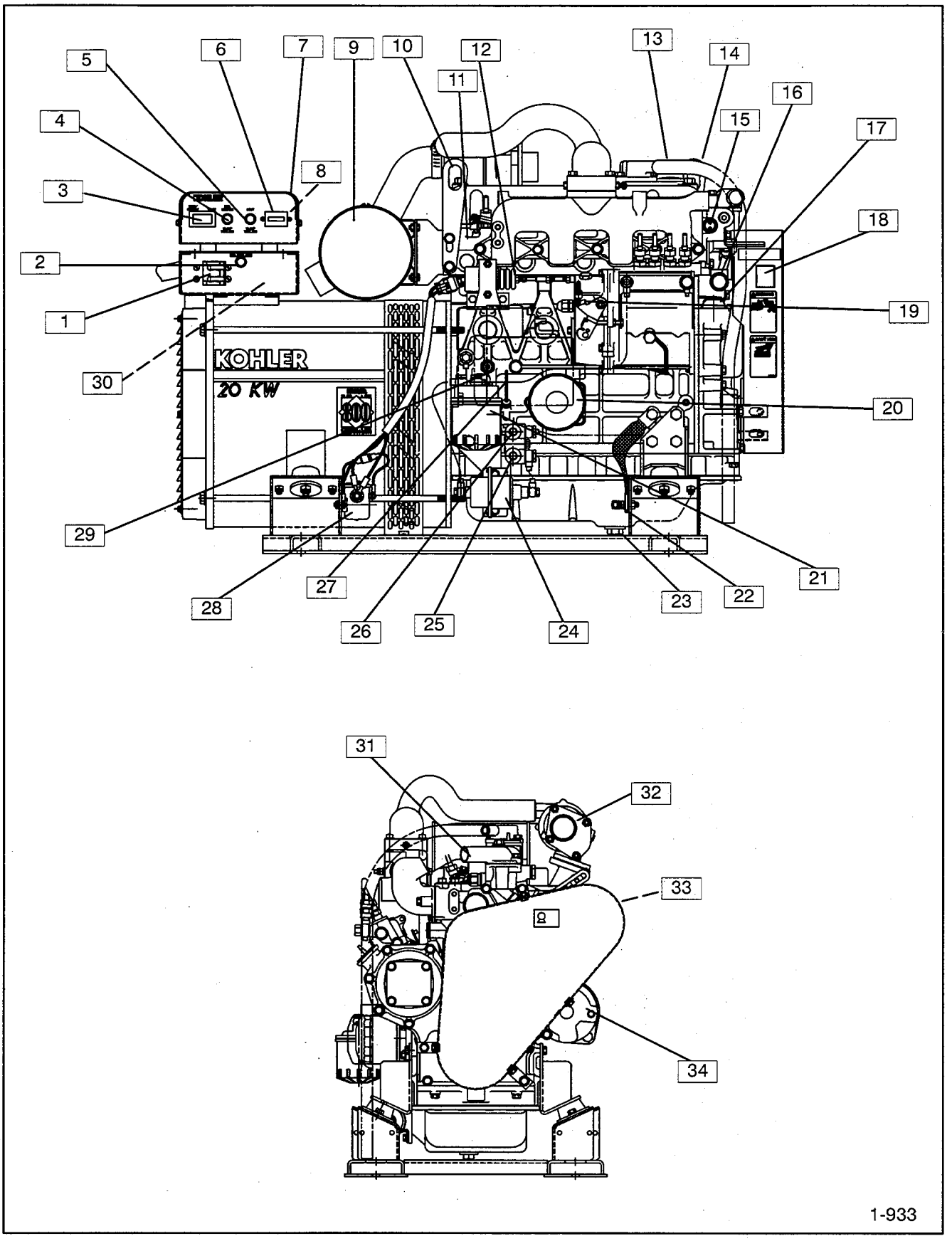


Figure 1-1. Service View of 20CCO-RV with Remote Radiator (Typical)

Service View Components
In-line-Radiator Model (See Figure 1-2)

1. Optional AC Circuit Breaker
2. Voltage Regulator Fuse
3. Start-Stop/Preheat Switch
4. Fuel Solenoid Fuse
5. Controller Fuse
6. Hourmeter
7. Controller
8. Remote Connection (at rear of controller)
9. Air Cleaner
10. Lifting Eye
11. Intake Heater
12. Fuel Solenoid
13. Oil Fill
14. Lifting Eye
15. High Water Temperature Shutdown
16. Pressure Cap/Initial Coolant Fill
17. Generator Nameplate
18. Oil Fill
19. In-line Radiator
20. Mechanical Governor
21. Oil Filter
22. Coolant Drain
23. Ground Connection
24. Oil Drain
25. Fuel Inlet Connection Point
26. Fuel Pump
27. Fuel Return Connection Point
28. Oil Check
29. Fuel Filter
30. Heater Coil Relay
31. Low Oil Pressure Shutdown
32. Voltage Regulator (inside junction/circuit breaker box)
33. Exhaust Outlet
34. Battery Charging Alternator (behind guard on non-service side of unit)
35. Starter (on non-service side of unit)

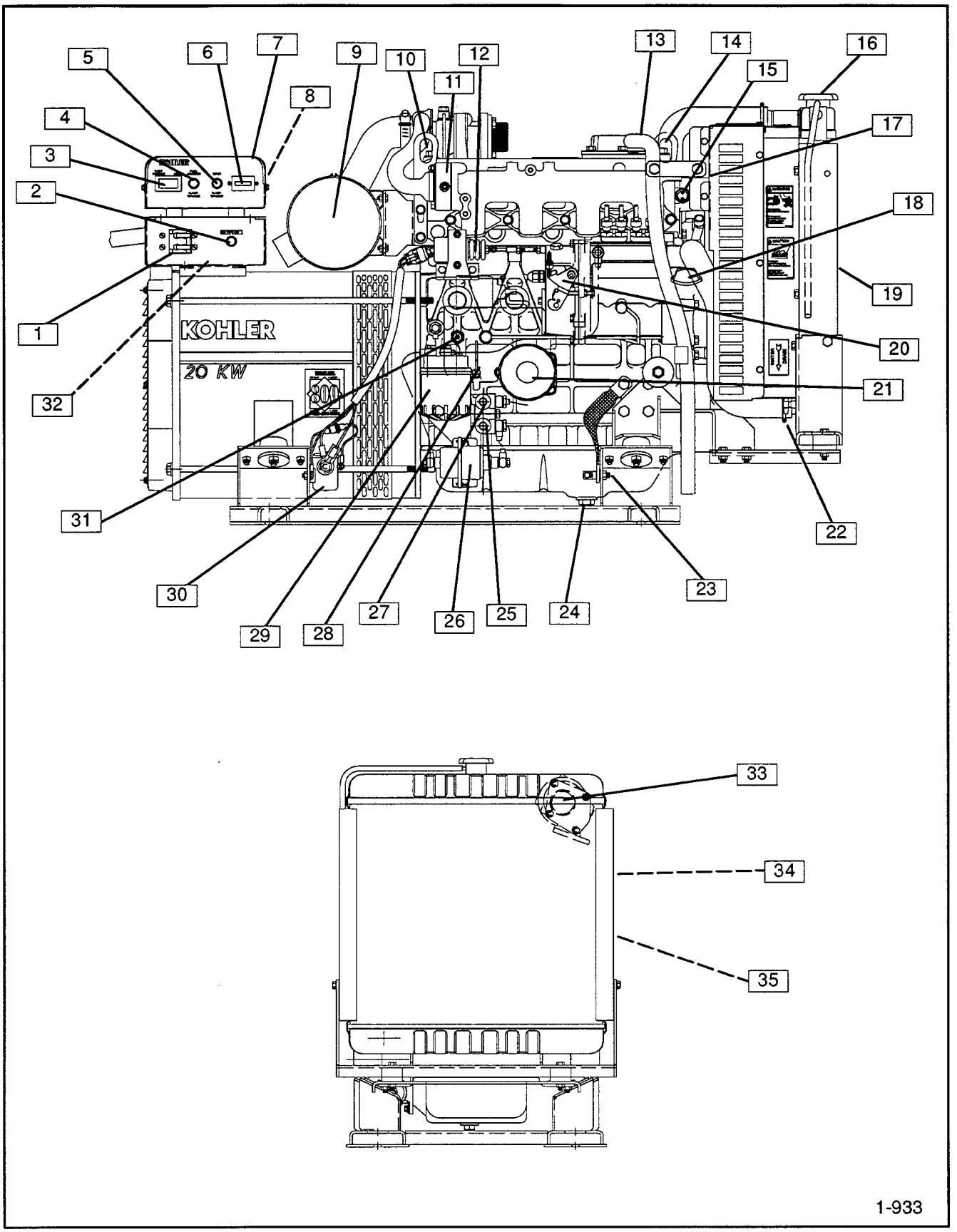


Figure 1-2. Service View of 20CCO-RV In-line Radiator (Typical)

Section 2. Operation

To insure continued satisfactory operation, the following items should be checked before each start-up.

Prestart Checklist

OIL LEVEL: Should be at or near full mark (not over).

AIR INLETS: Must be clear and unobstructed.

COMPARTMENT: Interior must be clean. Check the condition of fuel system, exhaust piping, hoses, and muffler. If fuel leaks, fumes, exhaust gases, or electrical sparks are noted, contact a qualified service technician before operating generator set.

AIR CLEANER: Must be clean and properly installed to prevent unfiltered air from entering the engine.

ELECTRICAL: All connections (including battery) must be tight.

FUEL LEVELS: Make sure the fuel tank(s) are full and the fuel system primed for operation.

DRIVE BELT: Check radiator fan, water pump and battery-charging belt to make sure it is properly tensioned and in good condition.

COOLANT LEVEL: If the cooling system is equipped with a coolant recovery tank, check coolant level (and refill coolant as necessary) at tank. Maintain level according to markings on the tank. Coolant level should be just below the filler neck [approx. 3/4 to 1 1/2 in. (19.38 mm)] when the engine is cold.

BATTERY: Check connections and level of battery electrolyte.

OPERATING AREA: Make sure there are no obstructions that could block the flow of cooling air. Make sure the area is clean. Rags, tools, or debris must not be left on or near the generator set.

EXHAUST SYSTEM: Exhaust outlet must be clear; silencer and piping must be tight and in good condition. Exhaust gas must be vented safely outside.

Exercising the Generator

Run the generator set once a week for one hour (under load). The operator should be in attendance during this period. Be sure to make all "Prestart Checks" before starting the exercise procedure. Start the generator set according to the procedure given for the generator controller.

Controller (Single Phase)

Depending on application, the Kohler relay controller may be located at the set or at a location remote from the generator. Remote harnesses for the controller are available in 7.5- and 15-foot (2.3- and 4.6-meter) lengths. If the generator set has automatically stopped due to high water temperature (230°F/110°C) or low oil pressure (6.8 psi/46.9 kPa or less), the cause must be corrected before the set can be restarted.

Refer to Figure 2-1 and the following descriptions to identify controller components.

1. **Generator Start and Stop/Preheat Switch** serves the dual function of generator operation and generator preheat. When pressed to the "preheat" position, the preheat switch aids in cold weather starting. Refer to "Start/Stop" and "Preheating" procedures following.
2. **Fuel Solenoid Fuse.** 10-amp fuse protects fuel solenoid circuitry.
3. **Controller Fuse.** 10-amp fuse protects controller circuitry against damage if a short develops in the engine wiring system or the wiring to the remote start/stop switch.
4. **Remote Switch Connection** (located at rear of controller). Connect the remote start/stop switch to operate the generator set at a location remote from the set. Controller connections are made through the plug connector at the rear of the unit.
5. **Hourmeter.** Records total generator set operating hours for reference in maintenance schedule.

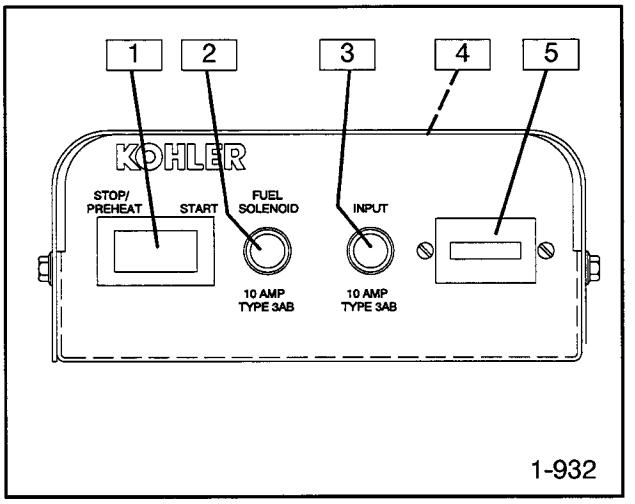


Figure 2-1. Single-Phase Controller

Controller (Three Phase)

For identification of three-phase controller, see Figure 2-2.

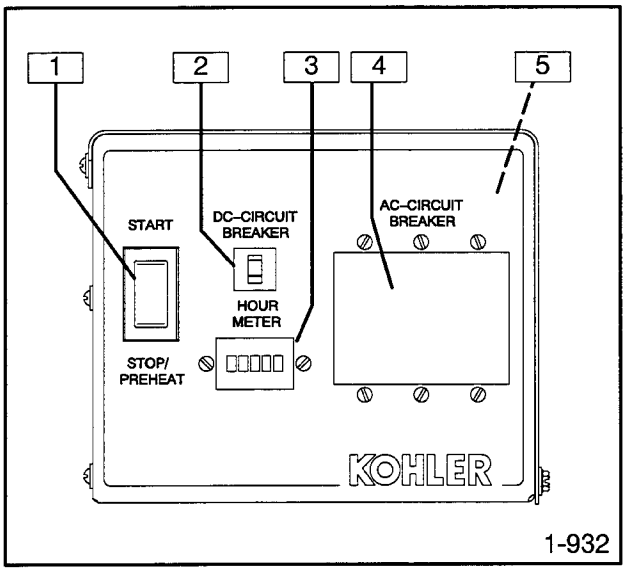


Figure 2-2. Three-Phase Controller

1. **Generator Start and Stop Preheat Switch** serves the dual function of generator operation and generator preheat. When pressed to the "preheat" position, the preheat switch aids in cold weather starting. Refer to "Start/Stop" and "Preheating" procedures following.
2. **DC Circuit Breaker**–the generator set will shutdown automatically after fault. See "Circuit Protection" following.
3. **Hourmeter.** Records total generator set operating hours for reference in maintenance schedule.
4. **AC Circuit Breaker (optional)** will trip when a fault is detected in the output circuit. Used to disconnect generator set during maintenance of vehicle wiring. To close circuit breaker(s), place in ON position.
5. **Fuel Solenoid Fuse** (located inside the controller). 10-amp fuse protects fuel solenoid circuitry.

Preheat Feature

During cold weather starts (below 23°F [–5°C]), place controller start switch in STOP/PREHEAT position for 15 to 20 seconds before attempting to start the generator set. This provides energizing of the air heater coil. Do not energize preheat feature for more than 30 seconds or damage may occur.

Starting Procedure

Move the START-STOP/PREHEAT switch to the START position and hold in this position until the engine is running, then release. Do not crank engine continuously for more than 10 seconds at a time. If the engine does not start, allow a 60-second cooldown period between cranking attempts. If the unit fails to start after three attempts, contact an authorized service dealer/distributor for repair. Failure to follow these guidelines may result in burnout of the starter motor.

NOTE

If the engine starts and then stops, allow the engine to come to a complete stop before making a restart attempt. If the flywheel ring gear is still rotating when the starter pinion gear is engaged, the pinion gear will clash which may damage the ring gear teeth.

NOTE

If ambient temperature is below 23°F (–5°C), see "Preheat Feature".

Stopping Procedure

Whenever possible, allow a brief cooling period by running the set at low or no load for a few minutes just prior to shutdown. To stop, move the switch to the STOP position and hold until the set comes to a complete halt. If the generator set shuts down automatically, identify and correct the problem before attempting to restart.

NOTE

Do not place Start-Stop/Preheat switch in Stop/Preheat position for more than 30 seconds or damage to the preheat feature may occur.

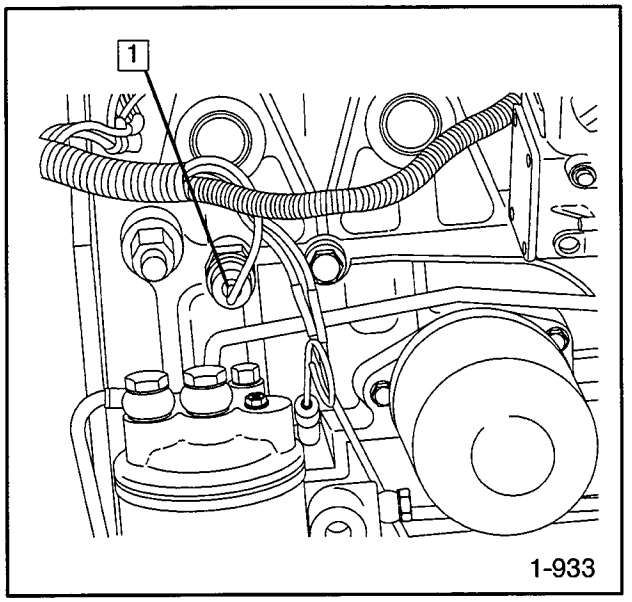
Fault Shutdowns

Low Oil Pressure Shutdown Switch

The low oil pressure (LOP) shutdown feature protects the engine against internal damage if the oil pressure drops below 6.8 psi (46.9 kPa) due to an oil pump fault or other engine malfunction. The LOP shutdown does not protect the set from damage due to operating with the oil level below the safe range—*IT IS NOT A LOW OIL LEVEL SHUTDOWN.* The only protection against running out of oil is to check the oil level regularly and add oil as needed. Location of the LOP shutdown switch is shown in Figure 2-3.

NOTE

This is not a low oil *level* shutdown. Proper oil level must be maintained for low oil pressure shutdown switch to function.



1. Low Oil Pressure Switch

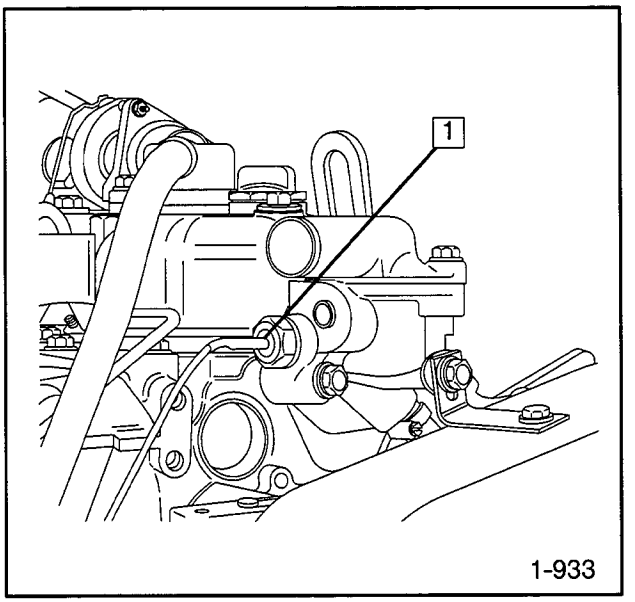
Figure 2-3. Low Oil Pressure Shutdown Switch

High Water Temperature Shutdown Switch

The generator set is also equipped with a high water temperature (HWT) shutdown switch. See Figure 2-4. The unit will automatically shut down when the engine coolant temperature exceeds 230°F (110°C). Cause of the shutdown must be corrected before the generator can be restarted.

NOTE

This is not a low coolant level switch. Proper coolant level must be maintained for high water temperature shutdown switch to function.



1. High Water Temperature Switch

Figure 2-4. High Water Temperature Shutdown Switch

Circuit Protection

Refer to Figure 2-5 and the following descriptions to identify controller components.

1. **10-Amp Fuel Solenoid Fuse.** A replaceable 10-amp fuse protects the fuel solenoid. (On three-phase models the in-line fuse is mounted inside the controller.) If this fuse is blown, the generator will shut down. If the fuse is replaced then blows again, have the generator set examined by an authorized Kohler service dealer/distributor.
2. **10-Amp Controller-Input Fuse (Single Phase) or Circuit Breaker (Three Phase).** The controller circuitry is protected by a replaceable 10-amp fuse or circuit breaker. If the generator will not crank and the battery and/or connections appear okay, the controller fuse/breaker may be blown or tripped. Contact an authorized Kohler service dealer/distributor if fuse/breaker blows/trips repeatedly.
3. **10-Amp PowerBoost™ IIIE Voltage Regulator Fuse (Single-Phase Models Only).** A replaceable 10-amp fuse protects the voltage regulator circuitry. If this fuse is blown, the generator set will shut down. If this fuse is replaced then blows again, have the generator set examined by an authorized Kohler service dealer/distributor.
4. **Optional AC Circuit Breaker(s)** will trip when a current overload is detected in the AC output circuit. See Section 4–Troubleshooting to determine cause of fault. After fault is corrected, reset AC circuit breaker by placing in "ON" position.

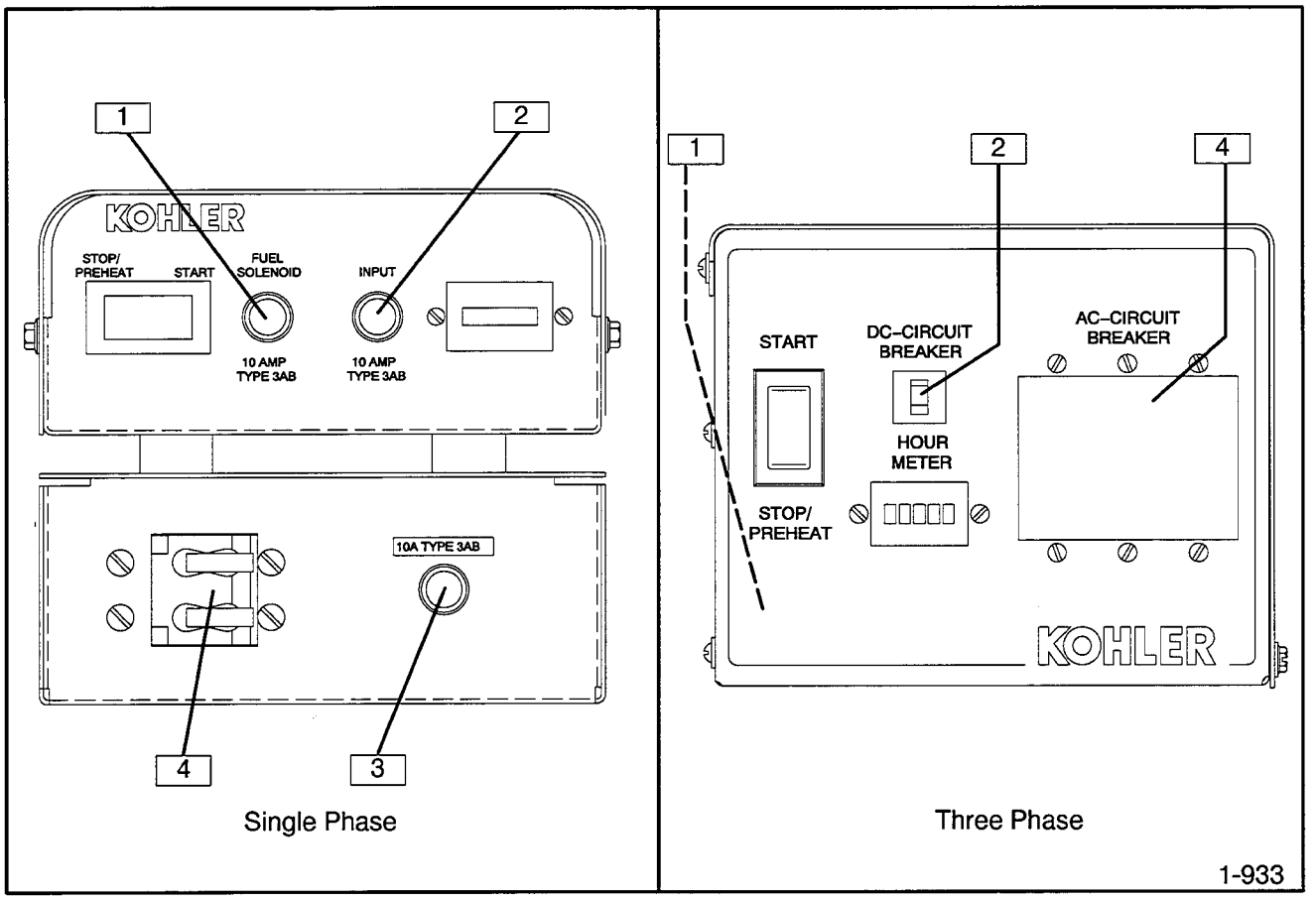


Figure 2-5. Circuit Protection

Accessories

Several accessories are available to finalize the installation or to add convenience to operation and service. All the most current information can be obtained by contacting your local Kohler dealer/distributor. Available accessories at the time of print of this publication are as follows.

Remote Connection/Extension Harness

Provides additional wiring between all remote panels and controller connector in 15 ft. (4.6 m) or 25 ft. (7.6 m) increments. One required for each Remote Meter Panel Kit.

Engine Sender Kit

Provides gauge senders for the Remote Start and Two-Meter Panel kit, and the Remote Start and Four-Meter Panel kit. The gauge sender kit is required to make the oil pressure and water temperature gauges functional.

12-Inch Remote Wiring Harness

This one-foot (0.3-m) wiring harness has a 6-pin connector on one end which is keyed to controller box connector. The other end has pigtails for connection to customer-supplied start switch, generator "ON" light, hourmeter, etc.

Exhaust Systems

This silencer is engineered and designed specifically for your Kohler RV generator set to assure optimal performance and sound attenuation. Stainless steel flexible exhaust connectors help to absorb shock and prevent damage to your genset's exhaust system. Exhaust connectors are both corrosion and heat resistant.

Remote Panels (Optional)

Remote Start Panel

Allows starting/stopping from a location remote of the generator set. Supplied with 15 ft. (4.6 m) connection harness. Overall mounting dimensions are 4.06 in. (103 mm) by 2.12 in. (54 mm). Generator sets are equipped with a 6-pin connector on controller for connection of the kit. See Figure 1-6 and Figure 1-7.

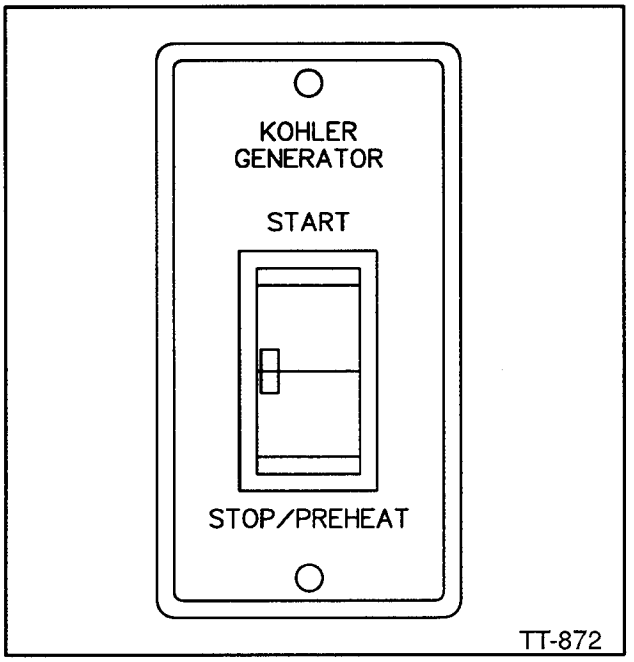
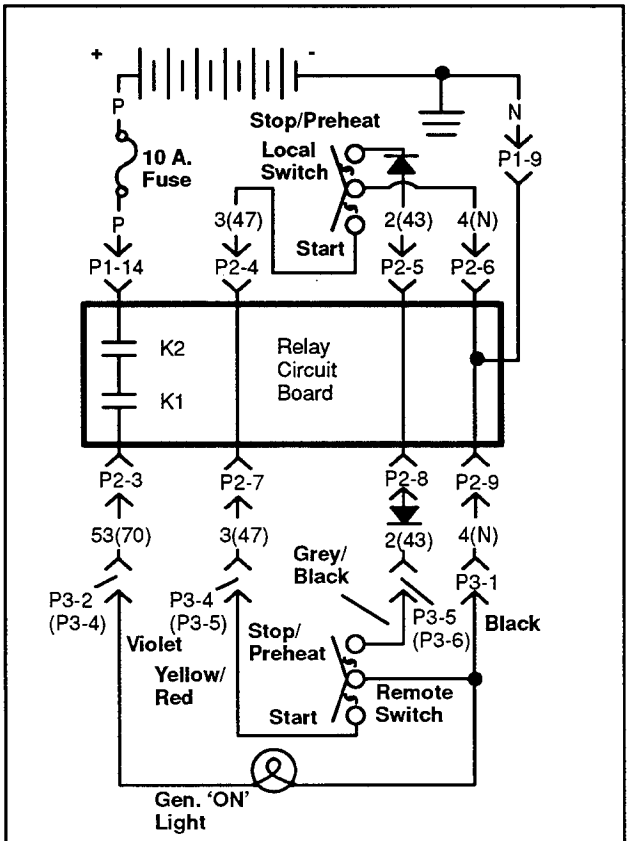


Figure 1-6. Remote Start Panel



NOTE

Wire and pin numbers for single-phase systems may differ from those for three-phase systems, where they are different, the single-phase numbers are shown first followed by the three-phase numbers in parentheses.

NOTE

Remote Start Panel harness is not color coded. Lead 2(43) connects to J3-6. Lead 3(47) connects to J3-5. Lead 4(N) connects to J3-1. Lead 53(70) connects to J3-4. Color coded leads used on remote harnesses only.

NOTE

When the Start-Stop/ Preheat Switch is in the Start position, contacts 3 and 4 are closed.

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Figure 1-7. Remote Start Panel Kit

Remote Start and Two-Meter Panel Kit

Allows starting/stopping from a location remote of the generator set. The illuminated gauges include engine oil pressure gauge and water temperature gauge. Generator sets come equipped with a 6-pin connector on controller for connection of the kit. Overall dimensions are 6 in. (152 mm) by 6 in. (152 mm) with a minimum mounting depth of 2.75 in. (70 mm). Requires Remote Connection/Extension Harness and sender kit. See Figure 1-8 and Figure 1-9 for remote start and two-meter panel kit.

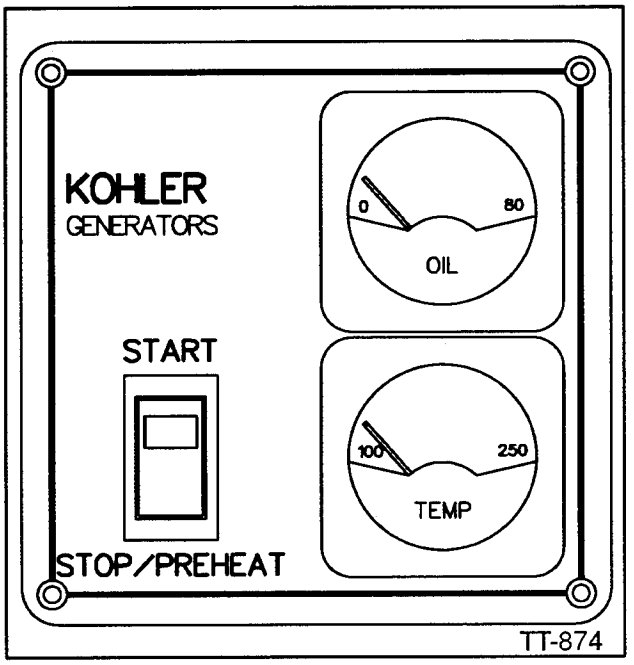


Figure 1-8. Remote Start & Two-Meter Panel Kit

Start-Stop/Preheat Switch–Rocker-type switch with "ON" light used to start and stop generator set.

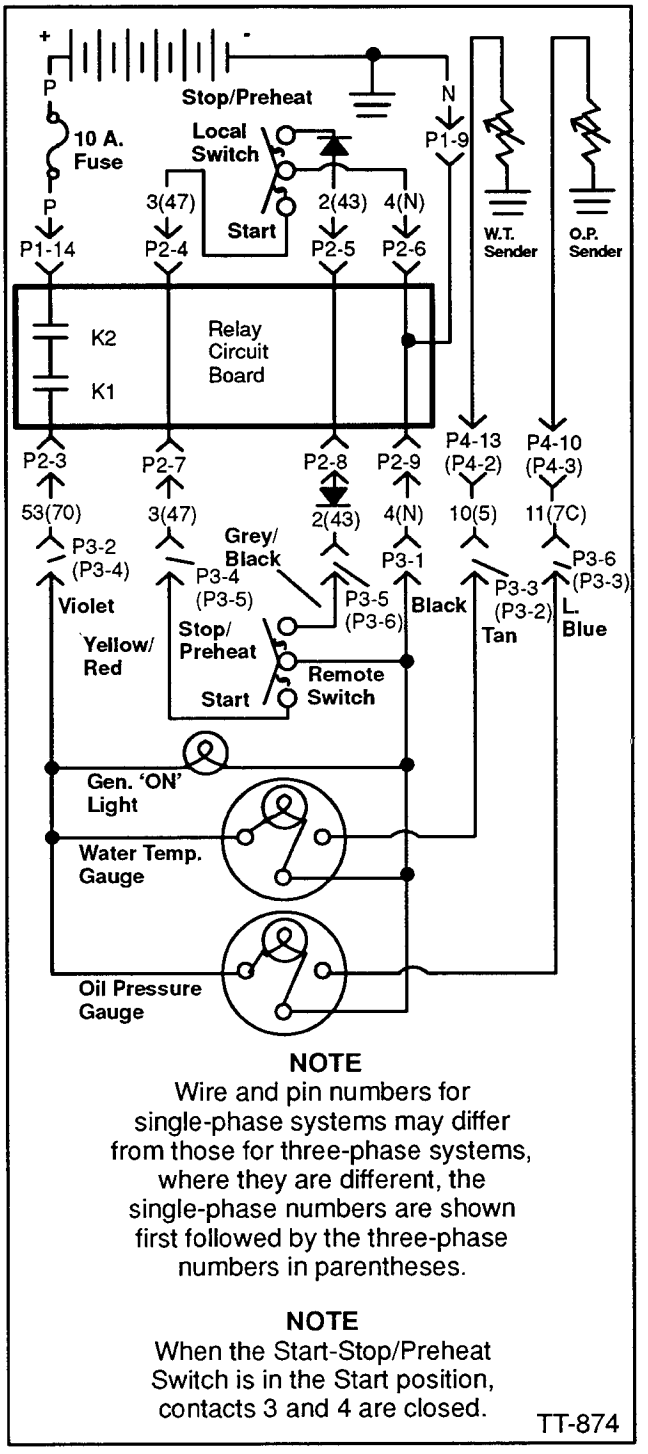
During cold weather starts (below 50°F [10°C]): Place controller start switch in STOP/PREHEAT position for 15–20 seconds before attempting to start generator set. This provides energizing of the glow plugs.

Engine Oil Pressure Gauge–Measures engine oil pressure. Normal engine operating range is 36–50 psi (248–345 kPa).

NOTE

During the engine break-in period, it is normal for the engine to produce higher oil pressure readings.

Water Temperature Gauge–Measures engine coolant temperature. Normal engine operating range is 180–205° F (82–96°C).



NOTE

Wire and pin numbers for single-phase systems may differ from those for three-phase systems, where they are different, the single-phase numbers are shown first followed by the three-phase numbers in parentheses.

NOTE

When the Start-Stop/Preheat Switch is in the Start position, contacts 3 and 4 are closed.

Figure 1-9. Remote Start and Two-Meter Panel Kit

Remote Start and Four-Meter Panel Kit

Allows starting/stopping from a location remote of the generator set. The illuminated gauges include a DC voltmeter, engine oil pressure gauge, water temperature gauge, and generator running time hourmeter which records total generator set operating hours. Generator sets come equipped with a 6-pin connector on controller back panel for connection of the kit. Overall dimensions are 9 in. (229 mm) by 6 in. (152 mm) with a minimum depth of 4 in. (102 mm). Requires Remote Connection/Extension Harness and sender kit. See Figure 1-10 and Figure 1-11 for remote start and four-meter panel features.

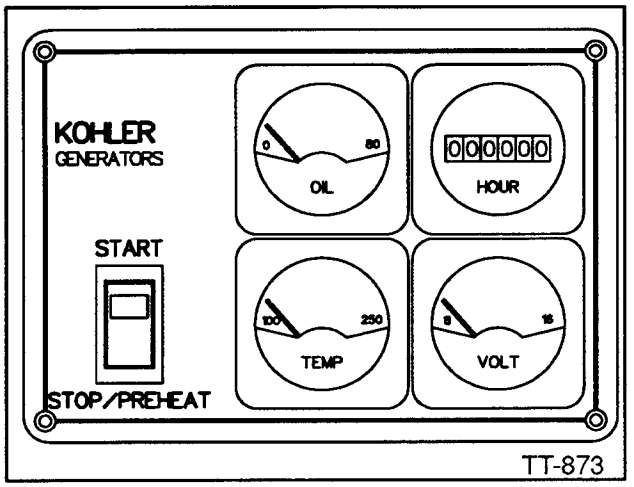


Figure 1-10. Remote Start and Four-Meter Panel Features

Start-Stop/Preheat Switch–Rocker-type switch with "ON" light used to start and stop the generator set. During cold weather starts (below 50°F [10°C]): Place controller start switch in STOP/PREHEAT position for 15–20 seconds before attempting to start generator set. This provides energizing of the glow plugs.

DC Voltmeter–Measures voltage of starting battery(ies). Normal battery operating range is 12–14 Volts.

Engine Oil Pressure Gauge–Measures engine oil pressure. Normal engine operating range is 36–50 psi (248–345 kPa).

NOTE

During the engine break-in period, it is normal for the engine to produce higher oil pressure readings.

Water Temperature Gauge–Measures engine coolant temperature. Normal engine operating range is 180–205° F (82–96° C).

Hourmeter–Records total generator set operating hours for reference in maintenance scheduling.

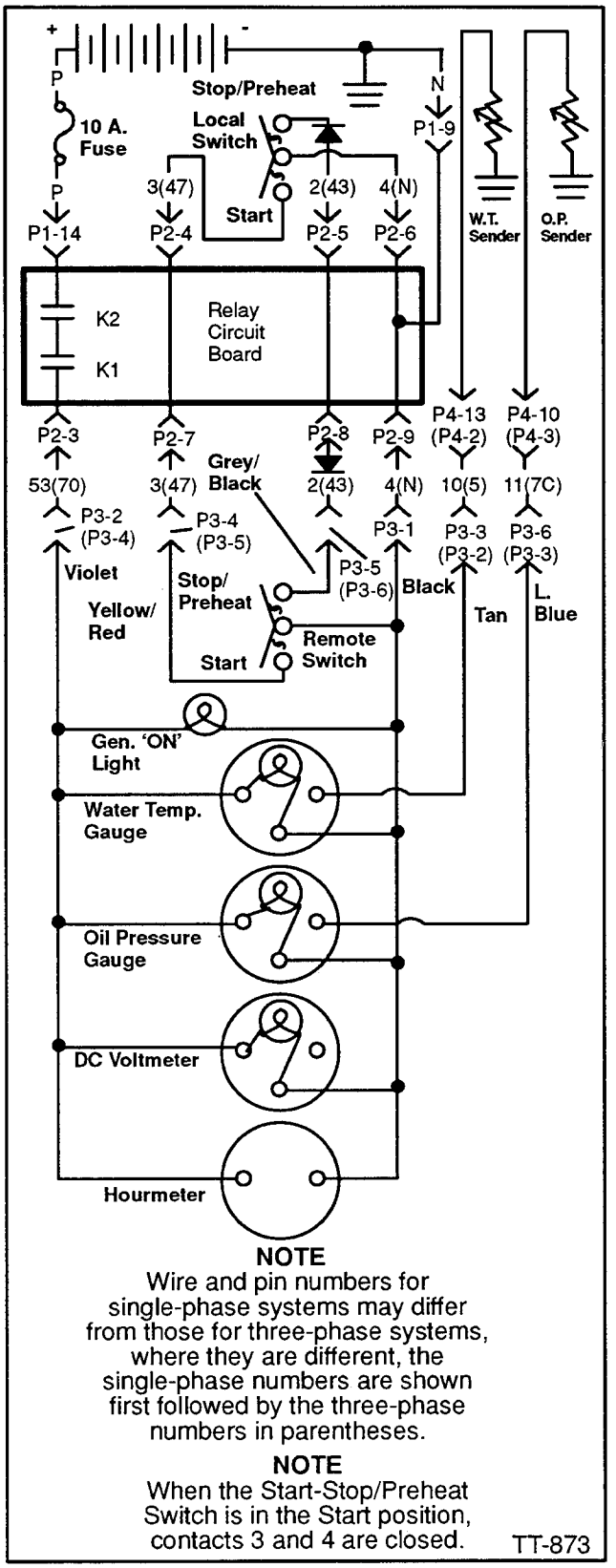


Figure 1-11. Remote Start & Four-Meter Panel Kit

Section 3. Scheduled Maintenance

General

Schedule routine maintenance using the Maintenance Schedule following and the hourmeter located on the generator controller. If the generator will be subject to extreme operating conditions, service the unit more frequently. Instructions to perform most of the scheduled services are provided in the following pages. Items in the maintenance scheduled marked with an asterisk (*) should be performed more often if the generator set is operated in dirty, dusty conditions. Items identified with asterisks (**) should be performed only by an authorized Kohler service dealer/distributor. Tools and instruments required for these additional steps are usually not available to the generator set owner. For this reason, the set should be returned periodically to an authorized service dealer/distributor for complete servicing and tune-up. The benefits of such service will be improved performance and continuous satisfactory operation during a long trouble-free service life.

NOTE

The items listed in the maintenance schedule must be performed at the designated intervals for the life of the generator. For example, an item to be serviced "every 100 hours or 3 months" must also be serviced after 200 hours or 6 months, 300 hours or 9 months, etc. The generator will eventually accumulate enough hours to warrant a complete overhaul. The exact time at which extensive service will be necessary cannot be predicted. However, rough operation, lack of power, and excessive oil use indicate serious generator set problems. As part of a preventive maintenance program, service the engine (clean cylinder head, inspect valves, check compression, etc.) and generator (replace bearing, inspect wiring, remove debris, etc.) at the earliest indication that a serious problem exists.

Perform Service at Intervals Indicated (X)	Before Each Start-up	Every 50 Hours or 1 Month	Every 100 Hours or 3 Months	Every 300 Hours or 6 Months	Every 500 Hours or Yearly
FUEL SYSTEM					
Check the fuel level	X				
Fill fuel tank	X				
Remove sediment from fuel tank	X				
Replace the fuel filter element		X (Break-in Period)		X	
Check the injection timing**					X
Check governor operation and adjust as necessary**					X
Check the injection spray condition**					X
LUBRICATION SYSTEM					
Check the oil level in crankcase	X				
Replace the oil in crankcase*		X (Break-in Period)	X		
Replace the lube oil filter element*		X (Break-in Period)	X		
COOLING SYSTEM					
Check coolant level	X				
Adjust the tension of water pump V-belt		X (Break-in Period)	X		
Change coolant					X
Clean radiator fins, inspect hoses			X		
AIR CLEANER					
Replace the air cleaner element*				X	
Clean the breather pipe*			X		
ELECTRICAL SYSTEM					
Verify proper operation of gauges (if equipped)	X				
Check the electrolyte level in the battery	X				
Check the electrical connections		X			
Check the battery specific gravity			X		
Adjust battery charging alternator V-belt		X (Break-in Period)	X		
CYLINDER HEAD					
Check for leakage of water and oil	X	X			
Retighten all major nuts and bolts		X (Break-in Period)			X
Check mounting bolts and vibro mounts for tightness				X	
Retighten the cylinder head bolts**					X
Adjust intake and exhaust valve clearance**				X	
GENERATOR					
Blow dust out of generator*					X
Clean slip rings and inspect brushes (Single-phase units only)**					X

* Service more frequently if operated in dusty areas.
** Should be performed by an authorized Kohler service dealer/distributor.

Lubrication System

Oil Selection

The selection of engine oil is very important to a diesel engine. If an unsuitable oil is used or an oil change is neglected, damage and a shorter engine life may result. Oil must meet the American Petroleum Institute (API) classification of CC or CD. Avoid mixing different brands of oils and lubricants; oils of different manufacturers may be incompatible and deteriorate when mixed. Recommended SAE viscosity designations for given temperature ranges in which the generator set will be operated are listed in Figure 3-1.

NOTE

Failure to observe these standards may cause inadequate oil pressure and cold-starting difficulties.

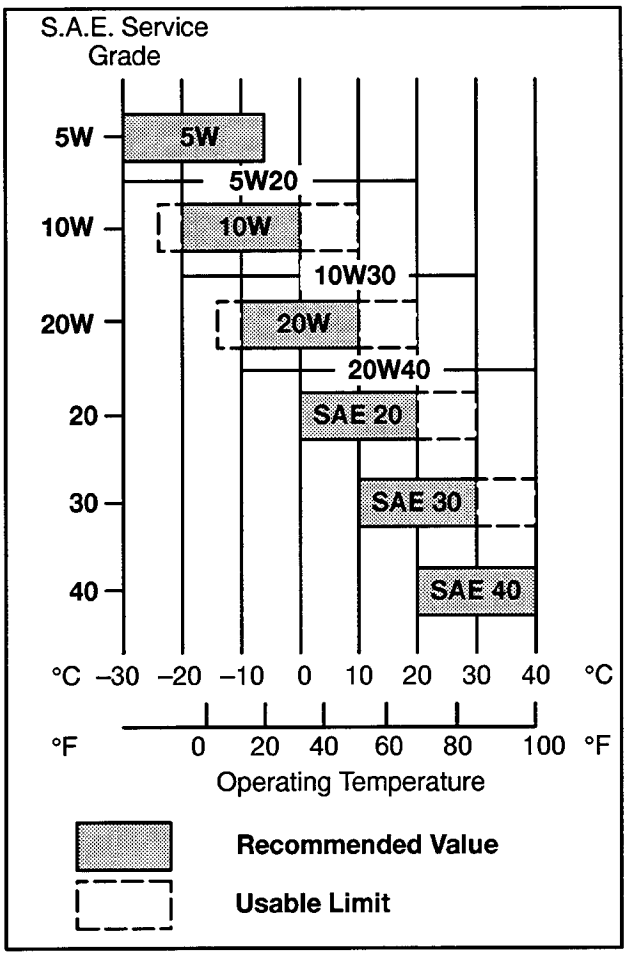
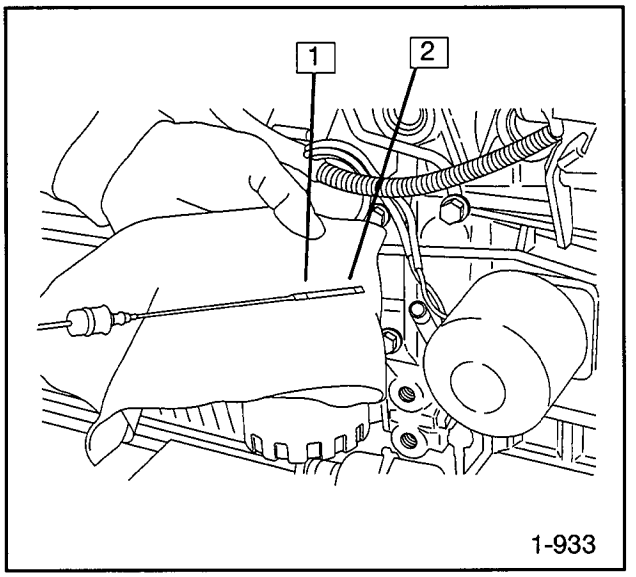


Figure 3-1. Engine Oil Selection

Oil Check

Check crankcase oil level daily or before each start to insure that the level is in the safe range. To check oil level, remove oil dipstick and wipe dipstick clean (see Figure 3-2). Reposition dipstick in crankcase and push it all the way down into the tube. Remove dipstick and check the level. Oil level should read between MIN and MAX marks on dipstick. Do not operate set if oil level exceeds the MAX mark or registers below the MIN mark on dipstick.



1. MAX Level 2. MIN Level

Figure 3-2. Oil Level Check

NOTE

Do not check oil level when the set is in operation. The engine must be stopped and on a level surface when checking oil. Most accurate oil reading is obtained by shutting down the generator and waiting several minutes before checking oil.

Oil Change

On a new engine, change the oil after the first 50 hours of operation and thereafter at 100-hour intervals or 3 months, whichever occurs first. Change oil more frequently under dirty, dusty conditions. Change oil while the engine is still warm.

1. Place a container below the oil drain hole and remove oil drain plug. Allow sufficient time for the old oil to drain completely. Replace oil drain plug. Dispose of used engine oil in an environmentally safe manner. Take used oil to a suitable collection facility in the area. *DO NOT POUR USED OIL ON THE GROUND, DOWN SEWERS, OR INTO STREAMS OR OTHER BODIES OF WATER.*

2. Remove oil fill cap. One is located on the rocker-arm cover and one is located near the fuel injector pump. See Figure 3-4.

3. If the engine oil filter is to be replaced, see "Oil Filter" following.

4. Fill crankcase with proper amount and type of oil, see Figure 3-3 and "Oil Selection."

NOTE

To avoid overfilling, check dipstick before adding the last quart of oil. Add oil gradually and check oil level several times.

5. Start the generator set and check for oil leaks.

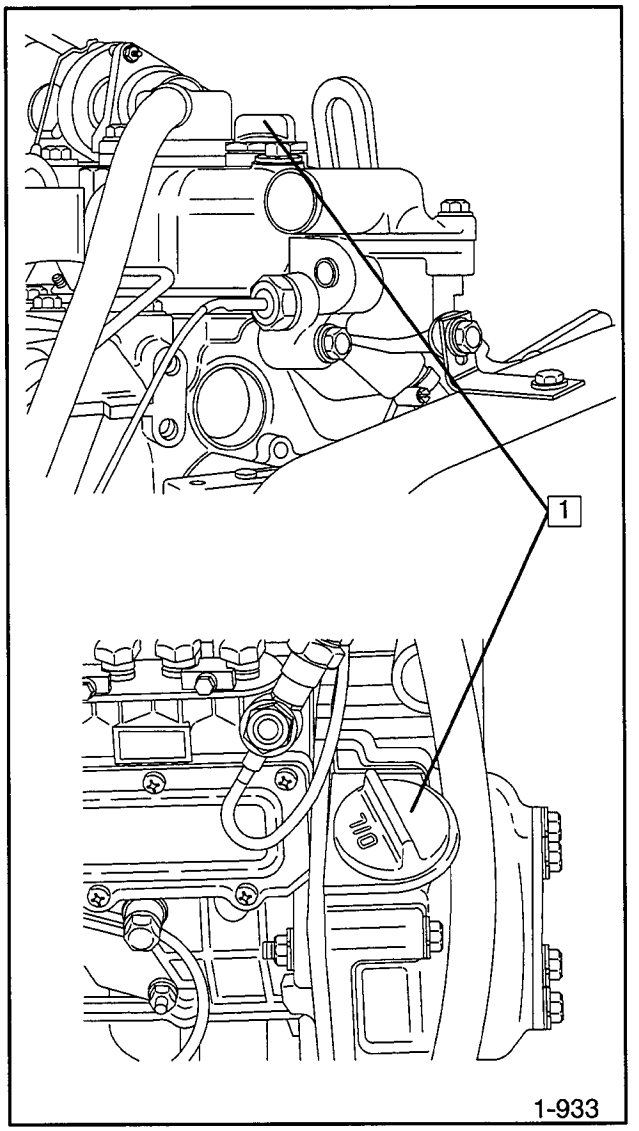
6. Stop the generator set. Remove the dipstick and wipe clean, reinsert as far as possible, and remove to check oil level. Add oil, as necessary, to bring level up to MAX mark.

OIL CAPACITY (with Filter) qts. (L)	
15 kW	6.1 (5.8)
20 kW	6.1 (5.8)

Figure 3-3.

NOTE

Too high an oil level causes high oil consumption and carbonizing of the engine. Low oil level will cause engine damage.

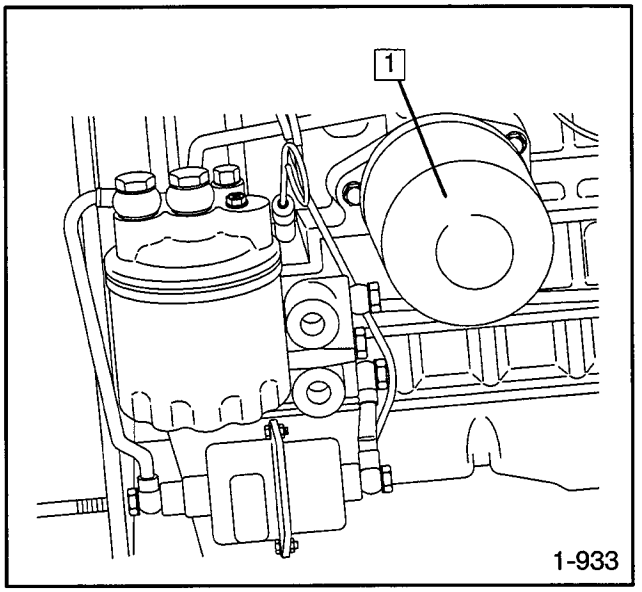


1. Oil Fill

Figure 3-4. Oil Fill Locations

Oil Filter

Replace the oil filter for the first time after 50 hours or 1 month of operation and then every 100 hours or 3 months. Change more frequently if operating in dirty, dusty conditions. See Figure 3-5 and refer to the following procedure.



1. Oil Filter

Figure 3-5. Oil Filter Location

1. Loosen oil filter by turning with a filter wrench in a counterclockwise direction. Use rags to clean up spilled oil. Remove and discard.
2. Clean contact surface on oil filter adapter.
3. Lightly lubricate the gasket surface of the new oil filter with the fresh engine oil. Thread oil filter to adapter until gasket makes contact, hand tighten an additional one-half turn.
4. Fill crankcase with fresh oil and check for leaks as detailed in steps 4 thru 6 of Oil Change procedure on previous page.

Fuel System

Specification

Use a clean, good quality No. 2-D (DIN 51 601) diesel fuel oil. The fuel must meet the requirements of the American Society of Testing and Materials (ASTM) diesel fuel classification D975 (Federal Specification W-F-800a). Cleanliness of the fuel is especially important on diesel engines which have easily clogged precision fuel injectors and pumps. See chart below.

United States	ASTM/D975	No. 2-D Diesel
United Kingdom	BS2869	Class A1 or Class A2

Other Considerations:

Sulfur Content ..... Less than 0.5%
Sediment/Water Content ..... Not to exceed 0.1%
Cetane Number ..... 45 minimum
Pour point ..... At least 10°F (5.6°C) Below the lowest outside air temperature

NOTE

Never store diesel fuel in galvanized containers; diesel fuel and the galvanized coating react chemically to produce flaking which quickly clogs filters or causes failure of the fuel pump or injectors. Do not run the generator set out of fuel; air will be drawn into the fuel lines and the entire system will have to be bled before the unit can be restarted.

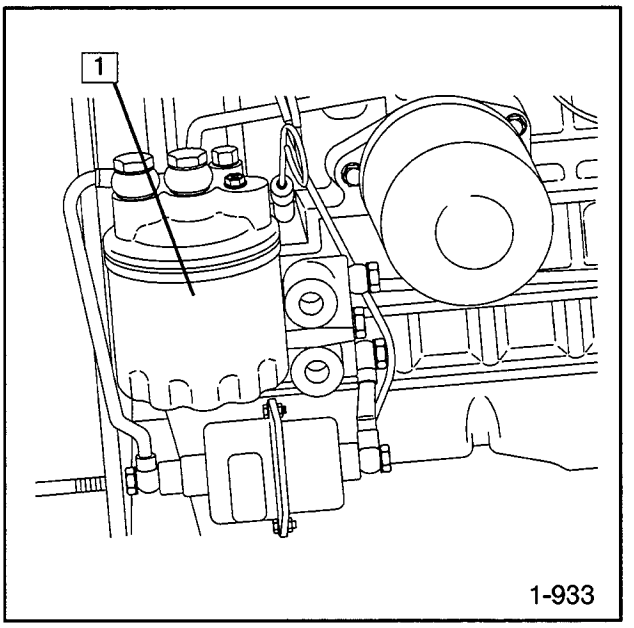
NOTE

Avoid storing fuel over long periods of time. Take special precautions to keep all dirt, water, and other contaminants out of the fuel. Storage tanks containing diesel fuel contaminated with water may cause the growth of "microbes." The presence of microbes will form a slime which will clog fuel filters and lines.

Fuel Filter

The fuel filter serves to remove water and dirt contained in the fuel. The fuel filter element is paper and no attempt should be made to clean it. Its useful life will be determined largely by the quality and condition of the fuel used. Under normal conditions, the fuel filter element should be replaced for the first time after 50 hours or one month and then every 300 hours or six months. See Figure 3-6 for location and use the following procedure to service the fuel filter.

1. Loosen the fuel filter by turning in a counterclockwise direction. Use rags to clean up spilled fuel oil. Remove and discard filter.
2. Clean contact surface on the fuel filter adapter.
3. Lightly lubricate the gasket surface of the new fuel filter with fresh fuel oil. Thread the fuel filter to the adapter until the gasket makes contact, hand tighten an additional one-half turn.
4. See "Bleeding" section following.



1. Fuel Filter

Figure 3-6. Fuel Filter Location

Bleeding the Fuel System

If the generator set engine runs out of fuel, air leaks develop in the suction side of the fuel system, or the fuel filter is replaced, it will be necessary to bleed the entire system to prevent starting failures and/or erratic operation. See Figure 3-7 and refer to the following procedure.

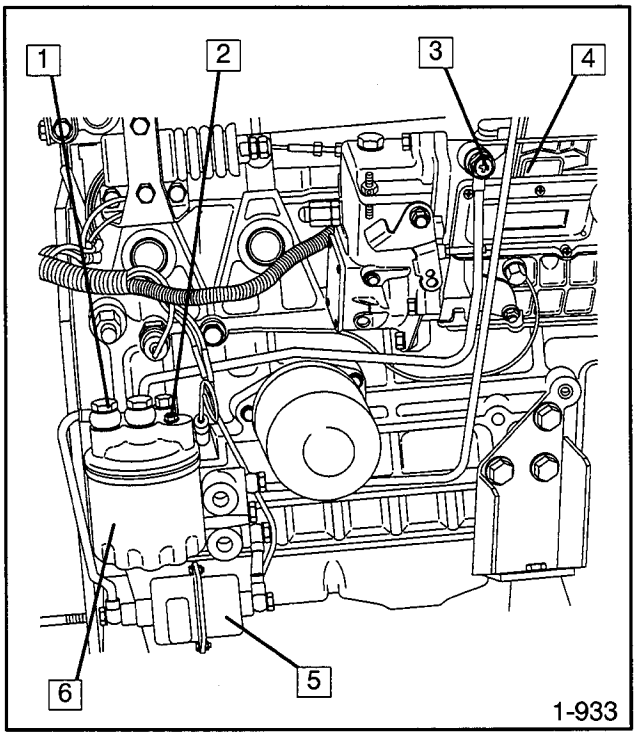
1. Disconnect lead 5 (single phase) or 71A (three phase) from the starter relay to disable cranking during the bleeding procedure.
2. Fill the fuel tank.
3. Loosen the line connection at the fuel filter.
4. Crank the engine until fuel (free from bubbles) flows from the loosened connection. Tighten the fuel line connection.
5. Loosen the small vent screw (with Phillips head) on the fuel filter.
6. Crank the engine until fuel (free from bubbles), flows from this point. Tighten vent screw.
7. Loosen the line connection (bleed point) at the fuel injection pump inlet.
8. Crank the engine to operate the fuel pump until fuel (free from bubbles) flows from this loosened connection. Tighten line connection.
9. Reconnect lead 5 or 71A to the starter relay.

⚠ WARNING

Explosive fuel vapors.
Can cause severe injury or death.

Use extreme care when handling, storing, and using fuels.

Explosive fuel vapors can cause severe injury or death. Spilled fuel can cause an explosion. Use a container to catch fuel when draining fuel system. Wipe up all spilled fuel after draining system.



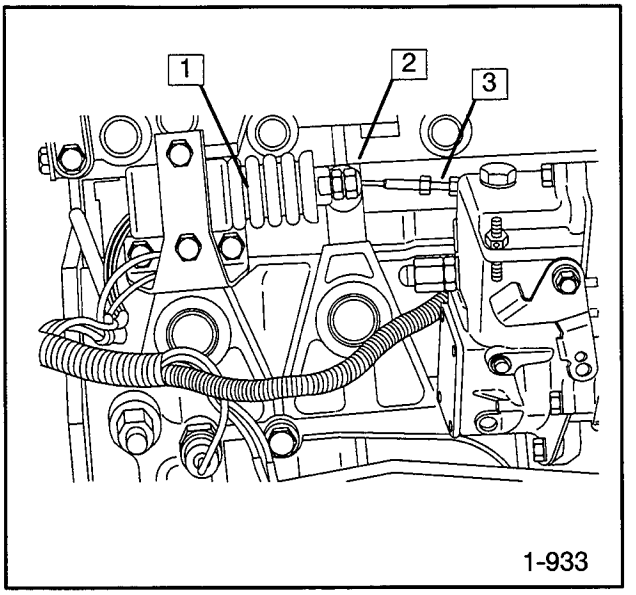
1. Line Connection (Bleed Point)
2. Vent Screw
3. Line Connection (Bleed Point)
4. Fuel Injection Pump
5. Electric Fuel Pump
6. Fuel Filter

Figure 3-7. Bleeding the Fuel System

Fuel Solenoid

The fuel solenoid (Figure 3-8) serves to stop fuel flow through the fuel injection pump when the start-stop/preheat switch is placed in the STOP position. If the fuel solenoid is removed or the setting is believed incorrect, readjust according to the following procedure. Do not modify the solenoid linkage during reconnection.

1. Disconnect the ball joint from the fuel solenoid plunger.
2. Pull the linkage toward the fuel solenoid until the fuel control lever contacts its internal full-open stop.
3. Push the linkage back toward the fuel control lever 1/16 in. (1.6 mm) and hold the linkage in this position.
4. Push the plunger fully into the solenoid.
5. Adjust the linkage length so the ball joint can be attached to the fully depressed plunger while the fuel control lever is still 1/16 in. (1.6 mm) from the full-open position.
6. Re-attach the ball joint to the solenoid plunger.

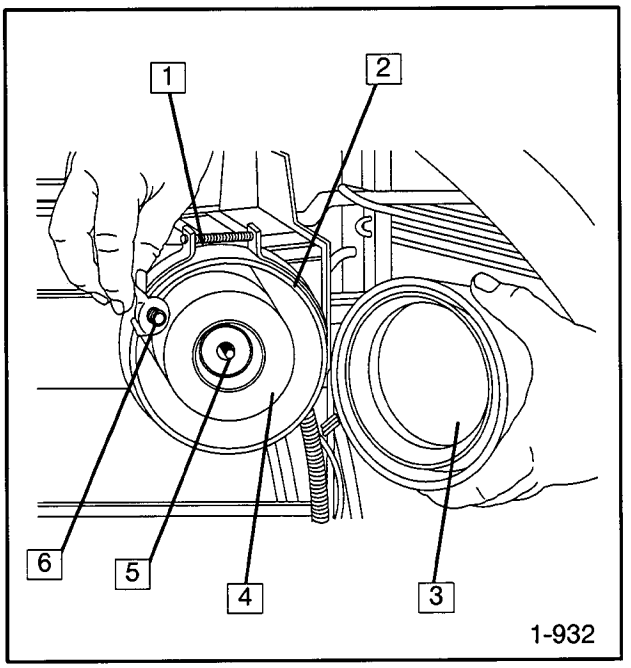


1. Fuel Solenoid
2. Ball Joint
3. Linkage

Figure 3-8. Fuel Solenoid Location

Air Cleaner Service

The paper element should be replaced at 300-hour or 6-month intervals; change more frequently if operating under dirty, dusty conditions. Operating the set with a dirty air cleaner element may cause engine damage and increased fuel consumption. At the time of service, clean the air cleaner breather pipe and remove all dust and foreign matter from the air cleaner housing. See Figure 3-9 and refer to the following procedure.



1. Eyebolt/Clamp
2. Base
3. Cover
4. Element
5. Threaded Rod
6. Wing Nut

Figure 3-9. Air Cleaner Components

1. Loosen eyebolt and clamp enough to remove the air cleaner cover.
2. Remove wing nut and slide air cleaner element from the threaded rod.
3. Clean dry element by tapping edges on a hard surface. Replace if damaged or very dirty.

NOTE

Do not attempt to clean dry-type element in any liquid or with compressed air as this will damage paper filter material.

4. Wipe dirt or dust accumulation from cover and base. Check that all clamps are tight on inlet/outlet connections.
5. Install air cleaner element on threaded rod. Tighten wing nut making sure parts fit properly.
6. Position cover with arrow up; place clamp over base and cover, and tighten eyebolt.

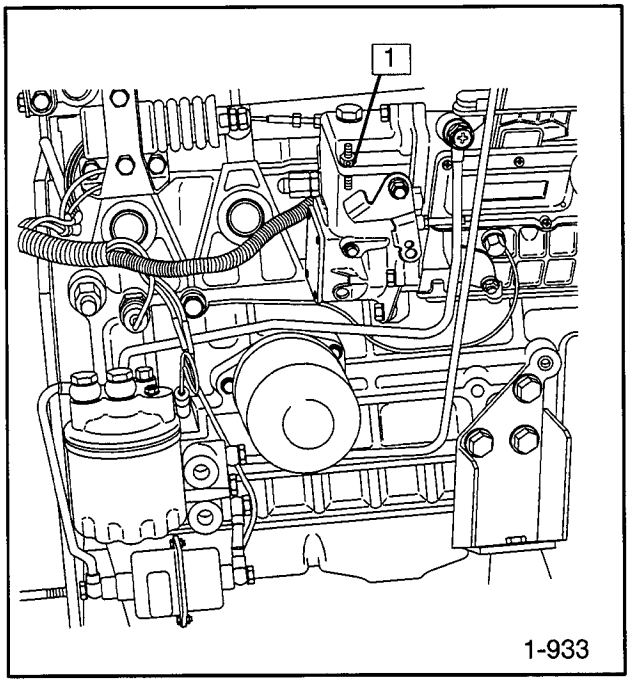
Governor

The centrifugal, mechanical-type governor serves to keep the engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load. No regular service is required on the unit. The governor is adjusted during run-in at the factory, and further adjustment should not be needed unless greatly varying load conditions are encountered or if poor governor control develops after extended usage.

60-Hz generator sets are designed to operate at 60–63 Hz, 1800 rpm under full load and 1890 rpm under no load.

50-Hz generator sets are designed to operate at 50–52.5 Hz, 1500 rpm under full load and 1575 rpm under no load.

To check speed, use a hand-held tachometer or frequency meter. See Figure 3-10. Loosen the locking nut on the speed-adjusting screw. Turn the screw in a counterclockwise direction to increase speed (and frequency) or in a clockwise direction to decrease speed. Tighten the locknut to secure at new setting.



1. Locking Nut

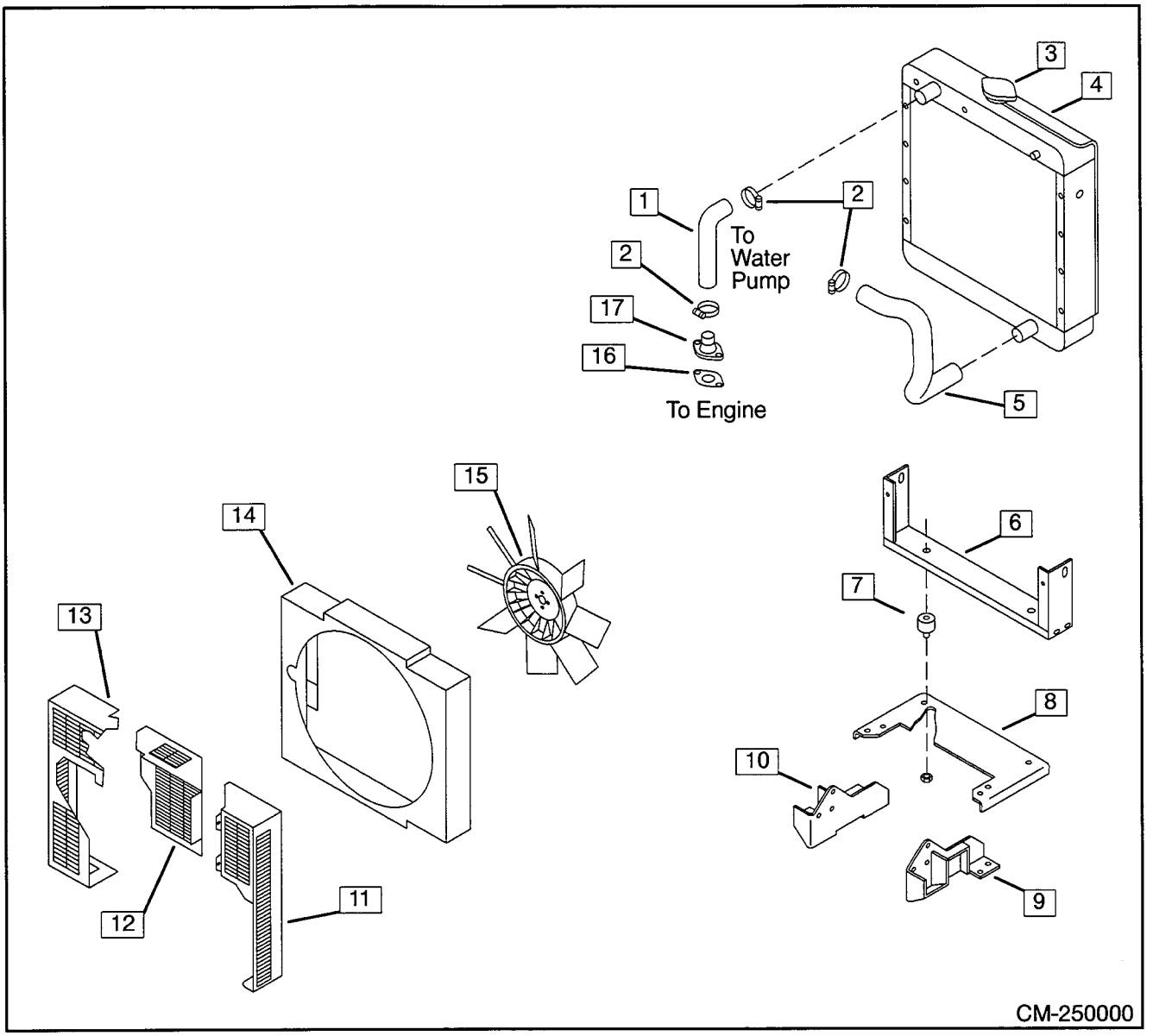
Figure 3-10. Governor

Cooling System

Cooling System Description

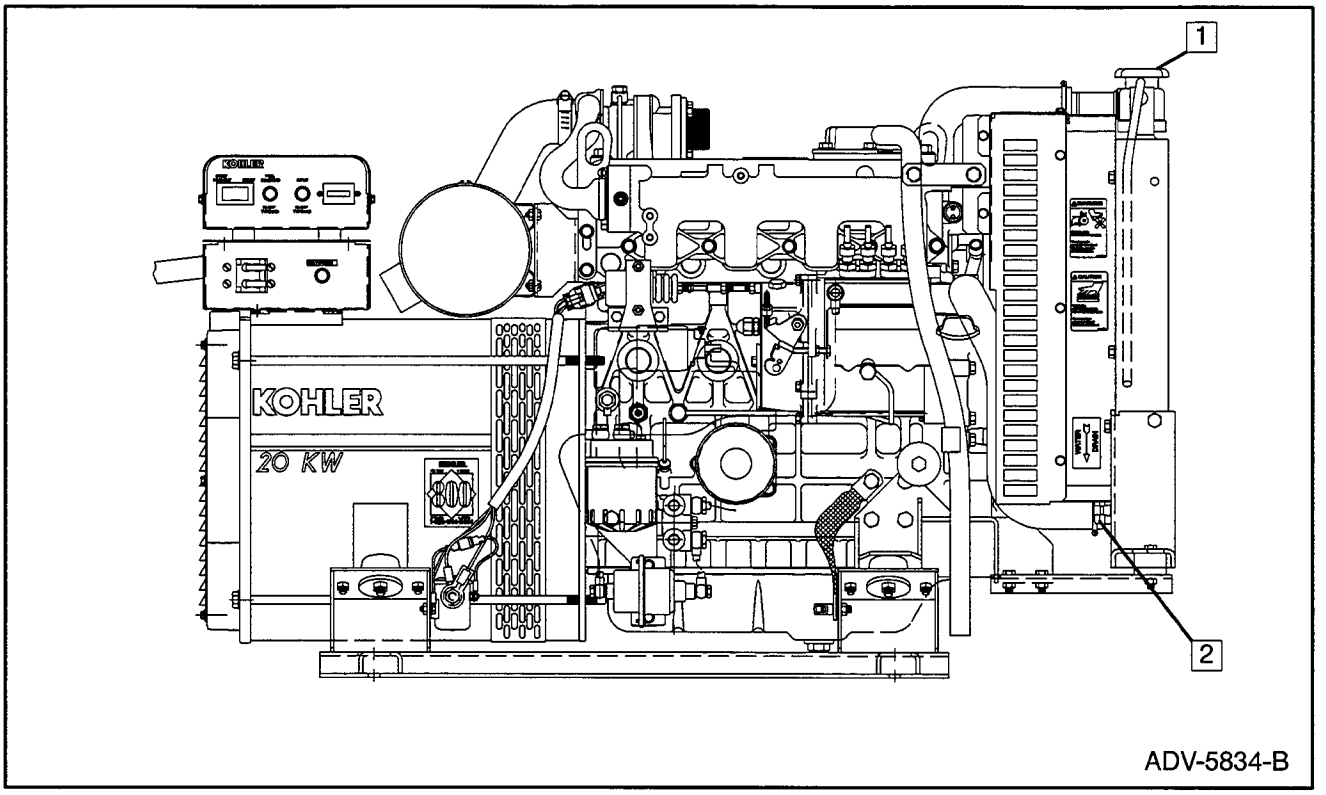
The generator set engine is water cooled. The closed loop cooling system includes the engine water pump, which circulates the cooling water, and the engine thermostat which opens and closes the cooling water flow to maintain a constant engine temperature. Depending upon the installation requirements, the fan may be pusher type that blows air away from the engine or a suction type that draws air toward the engine.

Hot water from the engine is cooled in a radiator and then returned to the water pump for recirculation in the cooling passages of the engine. Depending upon the generator set model, the radiator may be mounted in-line (on the front of the engine) or at a remote location by the coach manufacturer. Components of the cooling system with an in-line radiator are shown in Figure 3-11 and Figure 3-12. For a cooling system with a remote radiator, the radiator and its mounting provisions on the engine are replaced by a belt guard. See Figure 3-13. Hoses then connect the water pump and thermostat ports to the remote radiator. Either system may include an optional overflow tank connected to the overflow tube from the radiator.



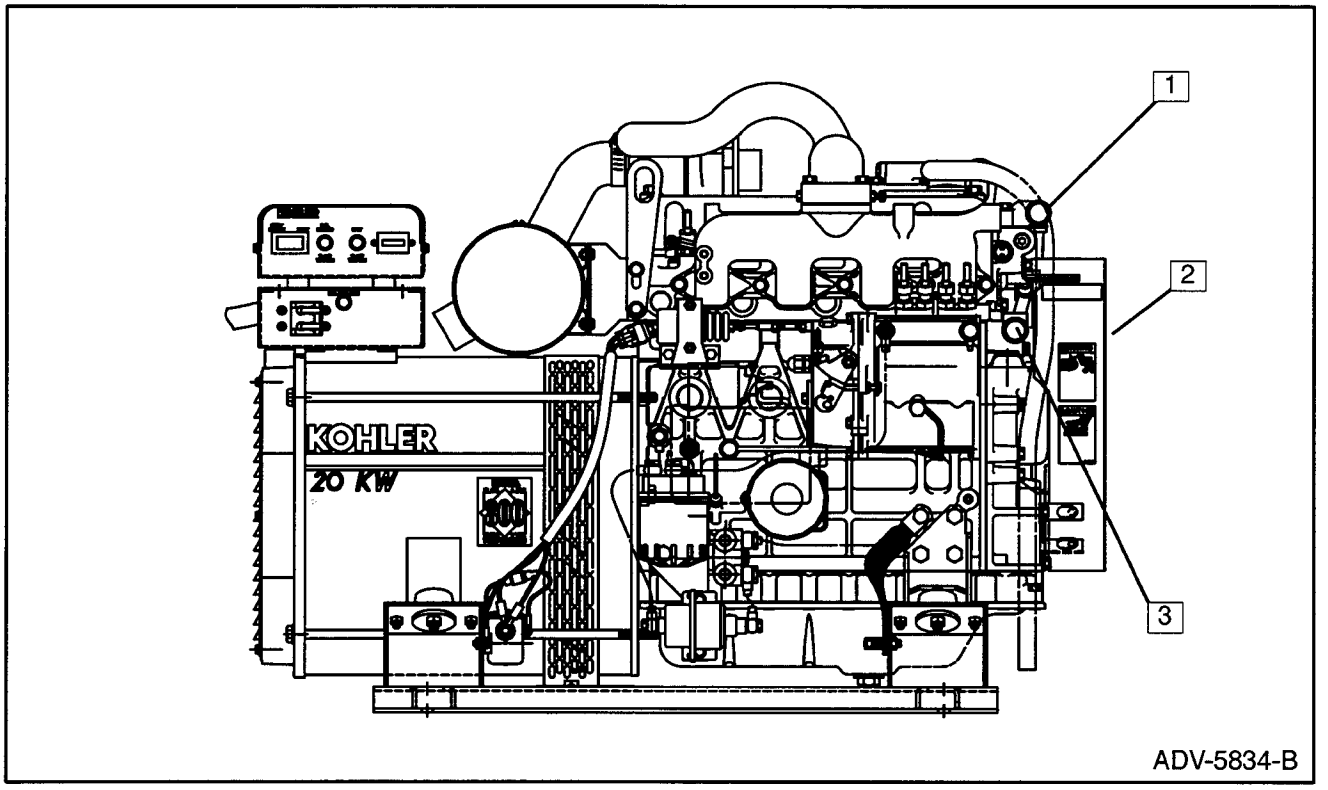
1. Upper Radiator Hose
2. Hose Clamp
3. Radiator Pressure Cap
4. Radiator Assembly
5. Lower Radiator Hose
6. Radiator Mounting Bracket
7. Vibro Mount
8. Radiator Bracket
9. Engine Mounting Bracket
10. Engine Mounting Bracket
11. Right Belt Guard
12. Top Belt Guard
13. Left Belt Guard
14. Fan Shroud
15. Fan
16. Gasket
17. Thermostat Housing

Figure 3-11. In-Line Radiator Cooling System Components



1. Initial Coolant Fill
2. Coolant Drain

Figure 3-12. Initial Coolant Fill and Coolant Drain Locations (In-line-Radiator Model)



1. Coolant Outlet (Thermostat Housing)
2. Belt Guard
3. Coolant Inlet (Water Pump)

Figure 3-13. Coolant Inlet and Outlet Connections (Remote-Radiator Model)

Cooling System Servicing

⚠ WARNING

Hot coolant and steam.
Can cause severe injury or death.

Before removing pressure cap stop generator, allow to cool and loosen pressure cap to relieve pressure.

Hot coolant can cause severe injury or death. Allow engine to cool and release pressure from cooling system before opening pressure cap. To release pressure, cover the pressure cap with a thick cloth then turn it slowly counterclockwise to the first stop. After pressure has been completely released and the engine has cooled, remove cap. If generator set is equipped with a coolant recovery tank, check coolant level at tank.

Clean Radiator Fins/Inspect Hoses

To prevent the inconvenience of having the generator set shut down or become damaged due to overheating, keep the cooling air inlets clean and unobstructed at all times. Inspect the exterior of the radiator for obstructions; remove all dirt and foreign material with a soft brush or cloth (to avoid damaging radiator fins). Check all hoses and connections for leaks and replace any hoses that are cracked, frayed, or feel spongy. When coolant level checks are made, check condition of the radiator cap rubber seal; replace if cracked or deteriorating. Remove dirt and other debris from the radiator cap and filler neck.

Change Coolant

Coolant capacity for the 15/20 kW in-line radiator model is 4 qts. 16 oz. (4.26 L). Consult the coach manufacturer for remote radiator cooling system capacity. Drain petcocks are provided on the bottom tank of the radiator and another in the engine block to drain the system. When draining the coolant, remove the radiator cap and open the block drain located near the flywheel housing; this will allow the entire system to drain and prevent air pockets from forming and restricting coolant passage in the block. To refill the cooling system, close the drain petcocks and fill the radiator to the proper level with the recommended coolant mixture. Install the radiator cap and operate the engine until the thermostat opens and the radiator upper hose becomes hot. Stop the engine and allow to cool. Add coolant to the radiator to just below the overflow tube on the filler neck. Install the radiator cap.

A coolant solution of 50% ethylene glycol and 50% clean, softened water is required to inhibit corrosion, prevent freezing to –34°F (–37°C), and to improve cooling. The antifreeze should contain a rust inhibitor and be changed every two years. Do not use alcohol or methanol antifreeze or mix them with the coolant. Do not add coolant to an engine that has overheated until the engine has cooled. Adding coolant to an extremely hot engine can cause a cracked block or cylinder head.

Check Coolant Level

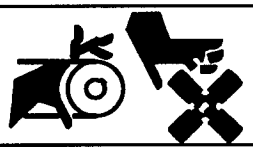
Check coolant level frequently and add antifreeze solution as needed to maintain level just below the overflow tube and at the min. level in the coolant recovery tank when cold (max. when hot).

NOTE

Special attention should be given when checking for proper coolant level. After a radiator has been drained, some time is normally required before complete refill of all air cavities take place.

Battery Charging

⚠ WARNING

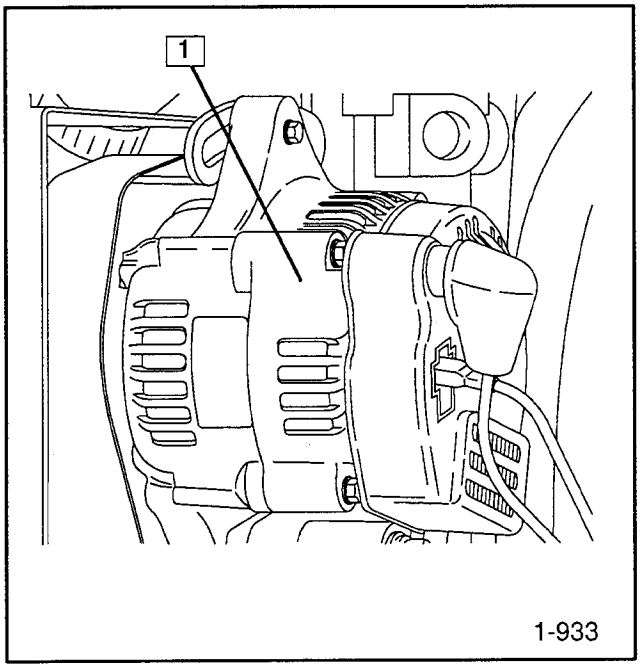


Rotating parts.
Can cause severe injury or death.

Do not operate generator set without all guards, screens, or covers in place.

Exposed moving parts can cause severe injury or death. Keep hands, feet, hair, and clothing away from belts and pulleys when unit is running. Replace guards, covers, and screens before operating generator set.

The generator is equipped with a 40-amp, belt-driven battery charging alternator. See Figure 1-14. It is attached to the engine block by a bracket and serves to keep the battery constantly charged. Be sure to observe battery polarity when connecting the battery to the generator set. The alternator requires no maintenance other than maintaining belt tension. To adjust the alternator belt tension, see "Belt Tension."

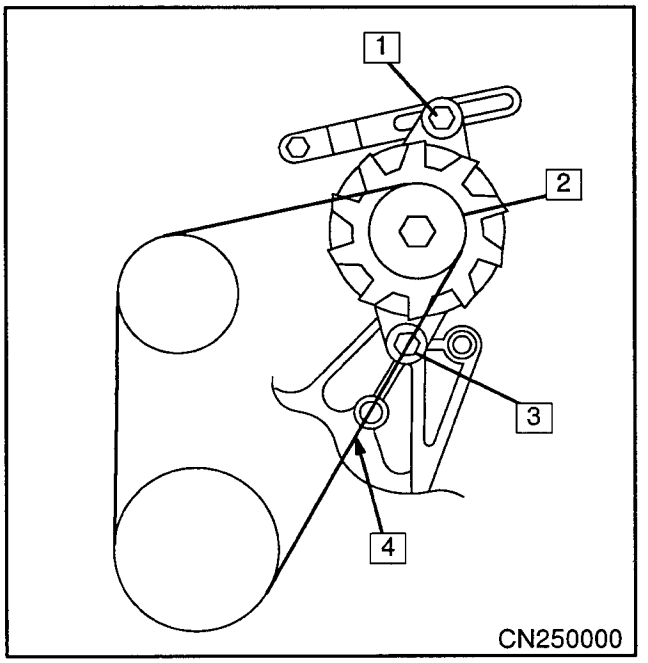


1. Battery-Charging Alternator

Figure 1-14. Battery-Charging Alternator

Belt Tension

The tension of the alternator/fan belt should be adjusted so that it can be depressed about 0.4–0.6 in. (10–15 mm) when finger pressure is applied. See Figure 1-15. Use the following procedure to adjust the belt.



1. Adjusting Screw
2. Battery-Charging Alternator Pulley
3. Pivot Screw
4. Check Alternator Belt Tension Here

Figure 1-15. Belt Tension

1. Disconnect battery, negative lead first.
2. Loosen pivot and adjusting screws.
3. While prying battery-charging alternator outward to attain proper tension, tighten adjusting screw.
4. Tighten pivot screw.
5. Recheck and adjust as necessary.
6. Reconnect battery, negative lead last.

NOTE

Also, check fan belt for cracks or tears and replace if necessary.

Battery

Use a 12-volt battery with a rating of at least 625 cold cranking amps. When using a Maintenance-Free battery, it is not necessary to check the specific gravity or electrolyte level. Otherwise these procedures should be done at the intervals specified in the Maintenance Schedule. A negative ground system is used. Battery connections are shown on the wiring diagrams. Make sure that the battery is properly connected and the terminals are tight.

NOTE

The generator set will not start if the battery connections are made in reverse.

⚠ WARNING

Sulfuric acid in batteries.
Can cause severe injury or death.

Use protective goggles and clothes. Can cause permanent damage to eyes, burn skin, and eat holes in clothing.

Sulfuric acid in batteries can cause severe injury or death. Sulfuric acid in battery can cause permanent damage to eyes, burn skin, and eat holes in clothing. Always wear splash-proof safety goggles when working around the battery. If battery electrolyte is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large quantities of clean water. In the case of eye contact, seek immediate medical aid. Never add acid to a battery once the battery has been placed in service. Doing so may result in hazardous spattering of electrolyte.

Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc. to prevent burns and to prevent sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling battery. Never connect negative (–) battery cable to positive (+) connection terminal of starter solenoid. Do not test battery condition by shorting terminals together or sparks could ignite battery gases or fuel vapors. Any compartment containing batteries must be well ventilated to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being charged and always turn charger off before disconnecting battery connections. When disconnecting battery, remove negative lead first and reconnect it last.

Cleaning

Keep battery clean by wiping it with a damp cloth. Keep all electrical connections dry and tight. If corrosion is present, disconnect cables from battery and remove corrosion with a wire brush. Clean battery and cables with a solution of baking soda and water. Be careful that cleaning solution does not enter battery cells. When cleaning is complete, flush battery and cables with clean water and wipe with a dry cloth. After the battery cables are reconnected, coat terminals with petroleum jelly or other nonconductive grease.

Checking Electrolyte Level

Check the level of electrolyte before each start-up. Remove filler caps and check to see that electrolyte level is up to bottoms of filler holes. See Figure 3-16. Refill as necessary with distilled water or clean tap water. DO NOT add fresh electrolyte! Be sure filler caps are tight.

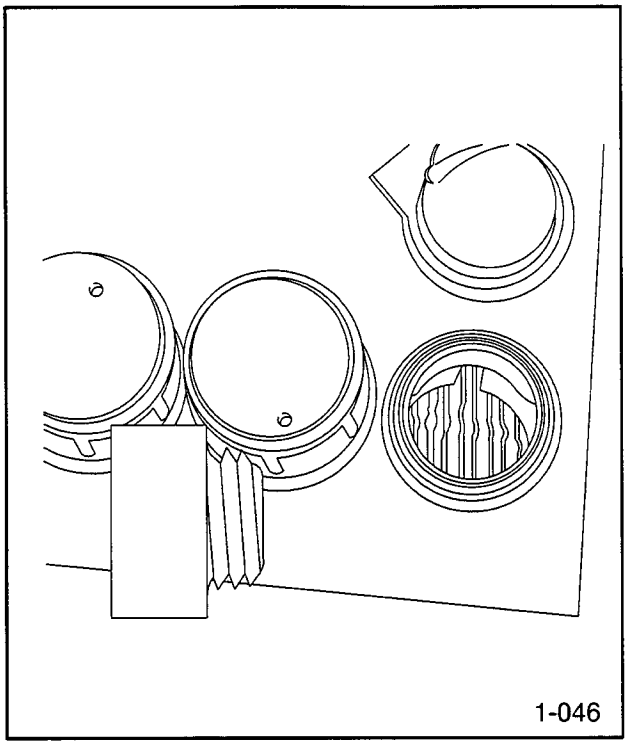


Figure 3-16. Battery Electrolyte Level

Checking Specific Gravity

Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell. While holding the hydrometer vertical, read the number on the glass bulb at the top of the electrolyte level. If the hydrometer used does not have a correction table, use the one in Figure 3-17. Determine specific gravity and electrolyte temperature of battery cells. Locate temperature in Figure 3-17 and adjust specific gravity by amount shown. The battery is fully charged if the specific gravity is 1.260 at an electrolyte temperature of 80°F (26.7°C). The difference between specific gravities of each cell should not exceed ±0.01. The battery should be charged if the specific gravity is below 1.215 at an electrolyte temperature of 80°F (26.7°C).

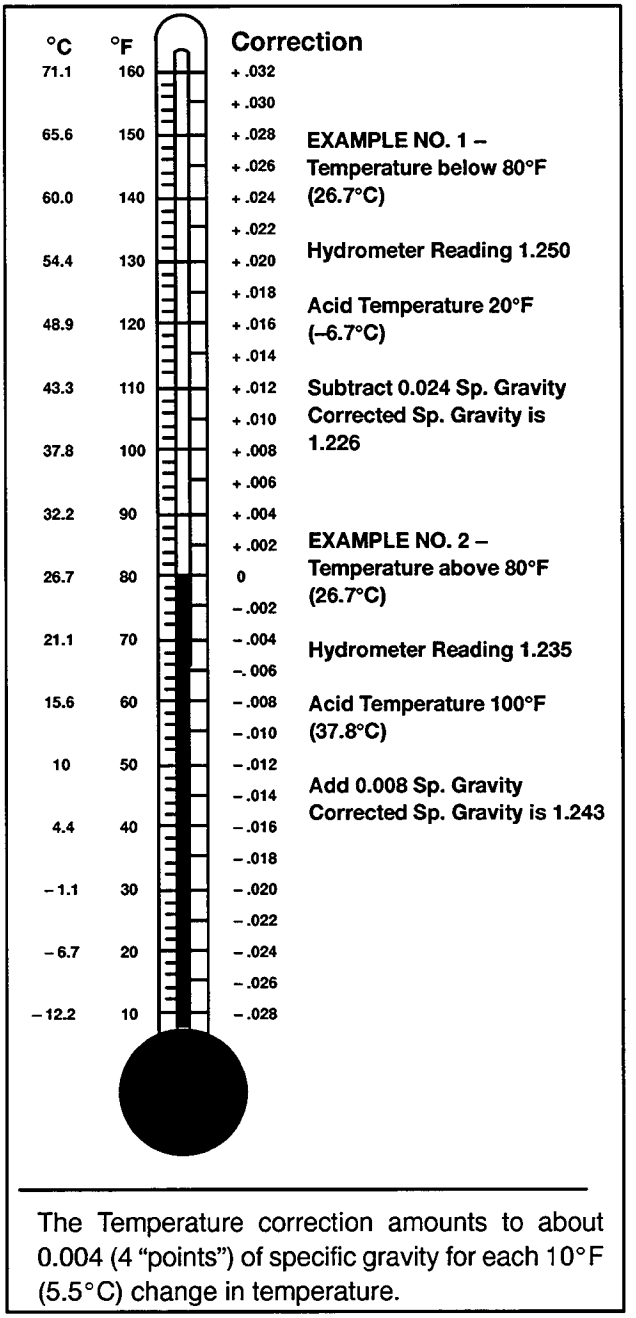
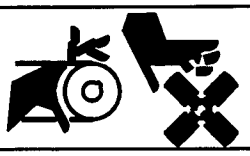


Figure 3-17. Specific Gravity Temperature Correction

Engine Cylinder Head

⚠ WARNING



Rotating parts.
Can cause severe injury or death.

Do not operate generator set without all guards, screens, or covers in place.

Flying projectiles can cause severe injury or death. Retorque all crankshaft and rotor hardware after servicing. When making adjustments or servicing generator set, do not loosen crankshaft hardware or rotor thru-bolt. If rotating crankshaft manually, direction should be clockwise only. Turning crankshaft bolt or rotor thru-bolt counterclockwise can loosen hardware and result in serious personal injury from hardware or pulley flying off engine while unit is running.

Valve Clearance

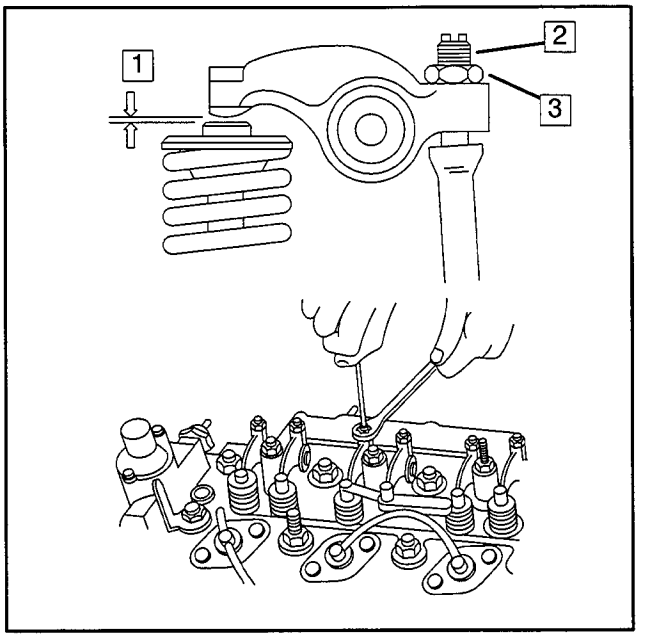
The engine uses poppet-type valve mechanisms which are adjusted as follows:

1. Remove screws and carefully lift rocker-arm cover off engine.

NOTE

Be careful not to damage gasket or mating surfaces. Gasket must be replaced if damaged.

2. Turn engine over to obtain maximum clearance between intake/exhaust valves and related rocker arms. This occurs during the period between the closing of the intake valve and the opening of the exhaust valve.
3. Using a feeler gauge, check the clearance between each rocker arm and its related valve. See Figure 3-18. The clearance should be 0.0079 in. (0.2 mm). If not, loosen the locknut, turn the adjusting screw, and retighten the locknut. Then recheck the clearance again.
4. After checking the clearance of all eight valves, realign the gasket, install the rocker-arm cover, and secure by installing and tightening the cover screws.



1. Clearance
2. Adjusting Screw
3. Locknut

Figure 3-18. Valve Clearance Adjustment

Head Bolt Torque

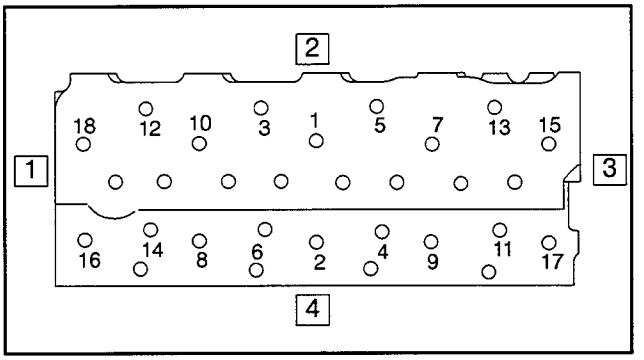
The head bolts should be retightened as follows:

1. Remove screws and carefully lift rocker-arm cover off engine.

NOTE

Be careful not to damage gasket or mating surfaces. Gasket must be replaced if damaged.

2. Retighten each head bolt in the sequence shown in Figure 3-19 to a torque of 54.2 to 65.1 ft. lbs. (73.5 to 83.3 Nm).
3. Realign the gasket, install the rocker-arm cover, and secure by installing and tightening the cover screws.



1. Generator End
2. Exhaust Manifold Side
3. Fan End
4. Intake Manifold Side

Figure 3-19. Head Bolt Tightening Sequence

Wattage Requirements

If the rated capacity of the generator is exceeded, the circuit breaker(s) located in the controller will trip to protect the generator against damage. This could be caused by a short in the AC circuit in the vehicle or simply by having too many appliances (or tools) turned on at the same time resulting in an overload condition. If the circuit breaker(s) trip, the set may continue running but there will be no AC output to the protected circuit. Before resetting the circuit breaker(s), turn off some of the appliances (or tools) and lights inside the vehicle to bring the load down within the rated limits of the set. If this is done and the circuit breaker(s) trips again after being reset, a short circuit is indicated. In this event, turn off the set and have a qualified electrician locate and correct the cause of the short circuit.

The average wattage requirements of some common RV/Mobile appliances/tools and motor loads are listed in the following charts. Use these figures to calculate the total load on this set to avoid the inconvenience of having the circuit breaker trip due to overload. The lighting load is easily determined by adding the wattage rating of each bulb in the circuit. Check the nameplate rating on motors and appliances in this vehicle for exact wattage requirements.

Electrical Appliance	Rating (Watts)
Blanket	50–250
Blender	600
Broiler	1350
Fan, Air Circulating	25–100
Fan, Furnace	270
Heater, Space	750–1500
Heater, Water	1500
Pan, Frying	1200
Percolator, Coffee	650
Radio	50–100
Television	300–750
Toaster	750–1200

Figure 3-20. Appliance Average

Wattage Ratings

Construction Tools	Motor Starting Watts	Running Watts
Air Compressor (Small)	1500	725
Air Compressor 3/4 hp	4000+	2000
Drill, 1/4 in.	500	250
Drill, 3/8 in.	600	350
Drill, 1/2 in.	800	600
Grinder 1/2 hp	1500	1200
Hammer, Demolition	2000	1800
Hammer, HD Rotary	1500	1200
Paint Sprayer (Airless)	400	240
Polisher, Orbit	500	360
Power Paint Roller	120	90
Power Plane	600	450
Router	900	700
Saw, Circular 6 1/2 in.	2200	1000
Saw, Circular 7 1/4 in.	2500	1200
Saw, Table 10 in.	4000	1500
Saw, Sabre (Worm Drive)	2500	1200
Sander, Belt	1500	600
Sander, Finishing	900	360
Screwdriver, Power	1000	530
Shear, 12 gauge	1800	720
Soldering Gun	—	250
Vacuum Cleaner, Wet/Dry	1500	1260
Wrench, Impact 1/2 in.	2000	840

Figure 3-21. Construction Tool Average Wattage Ratings

NOTE

Motor-driven equipment generally takes 2 to 3 times the listed running amperage or wattage to start the motor. Always check the tool or motor nameplate to be sure.

Generator Service

General

Under normal conditions, generator service will not be required on a regular basis. If operating under dusty and dirty conditions, use dry compressed air to blow dust out the generator at frequent intervals. Do this with the generator set operating and direct the stream of air in through the cooling slots at the end of the generator.

Storage Procedure

If the generator set is to be out of service for a considerable length of time (2 months or more), the following steps should be taken to preserve the set before placing it in storage.

1. Drain the oil (while hot) from the crankcase then refill with regular grade oil. See Section 3, "Oil Selection" in this manual.

2. Drain the fuel from the fuel tank to prevent accumulated moisture from mixing with the fuel.

3. Check the engine coolant protection. See Section 3, "Cooling System" for additional information.

4. Disconnect battery (negative lead first) and place in storage.

5. Seal all openings in the engine with non-absorbent adhesive tape. Mask off all areas to be used for electrical contact.

6. Clean exterior surface of the generator. Spread a light film of oil over unpainted metallic surfaces which could rust or corrode.

Section 4. General Troubleshooting

Use the following tables as a quick reference in troubleshooting individual problems. Generator set faults are listed by specific groups and include likely causes and remedies. The source of more detailed information needed to correct a problem is indicated. These sources include various sections of this manual, the Operation and Installation Manual (TP-5605), and the Yanmar Engine Service Manual (TP-5365).

When troubles occur, don't overlook simple causes. A starting problem could be caused, for example, by improper fuel or an empty fuel tank. Make sure all electrical connections are secure. Remember the battery negative must have a good ground.

Corrective action and testing in many cases requires knowledge of electrical and electronic circuits. It is recommended that service be done only by authorized Service dealers/distributors. Improper repair by unqualified personnel can lead to additional failures.

Problem	Possible Cause	Corrective Action	Reference
ENGINE			
Will not crank (dead)	Controller 10-amp supply fuse blown	Replace fuse. If fuse failure continues, replace fuse and troubleshoot DC circuit and wiring.	Section 7. Engine/ Generator Components Section 8. Wiring Diagrams
	Battery disconnected or improperly connected	Check connections	Section 9. Wiring Diagrams Section 3. Battery
	Dead battery	Check electrolyte level and specific gravity (batteries with filler caps only). Perform load test	Section 3. Battery
	Corroded or loose battery connections	Clean or replace	Section 3. Battery
	Defective battery charging alternator	Replace alternator	Section 3. Battery Charging
	Loose battery charging alternator belt	Check/tighten or replace belt	Section 3. Drive Belt
	Open wiring, terminal, pin, foil, etc.	Check continuity	Section 7. Component Testing Section 9. Wiring Diagrams
	Defective starter	Service or replace	Engine Service Manual
	Defective starter solenoid	Check continuity of circuit. Bypass solenoid using jumper wire. If starter cranks, replace solenoid.	Section 7. Engine/ Generator Components Section 9. Wiring Diagrams Engine Service Manual
	Defective start/stop switch	Check continuity	Section 7. Component Testing Section 9. Wiring Diagrams
	Defective K2, K3, or K25 relay	Check/replace defective relay	Section 7. Controller Circuit Board Section 7. Engine/Generator Components Testing

Problem	Possible Cause	Corrective Action	Reference
Will not start (cranks okay)	No fuel in tank	Replenish	
	Defective fuel solenoid	Check continuity	Section 7. Fuel Solenoid
	Defective fuel pump	Replace fuel pump **NOTE:** Fuel pump is polarity sensitive and will fail if the lead connections are made in reverse.	Engine Service Manual
	Air cleaner clogged	Clean or replace element	Section 3. Air Cleaner Service
	Air in fuel system	Bleed air	Section 3. Fuel System
	Water, dirt in fuel system	Drain, flush fuel system	
	Improper type of fuel	Use proper type of fuel; consult fuel supplier	Section 3. Fuel System
	Dirty or faulty injectors	Check injectors	Engine Service Manual
	Improper valve timing	Correct or replace timing gear	Engine Service Manual
	Incorrect injection timing	Adjust injection timing	Engine Service Manual
	Defective injection timing	Repair/replace injection pump	Engine Service Manual
	Fuel cam shaft worn	Replace fuel cam shaft	Engine Service Manual
	Fuel leak	Tighten fittings	Engine Service Manual
	Improper compression	Check compression	Engine Service Manual
	Improper type of crankcase lube oil	Use proper lube oil	Section 3. Lubrication System
	Improper valve clearance	Check valve clearance	Section 3. Valve adjustment/ Engine Service Manual
	Clogged fuel filter	Replace filter	Section 3. Fuel Filter Service/Engine Service Manual
	Open wiring, terminal, or pin (P2 connector)	Check continuity	Section 9. Wiring Diagrams
	K4 relay defective (K2 relay must be energized)	Check relay coil continuity	Section 7. Controller Circuit Board Section 9. Wiring Diagrams

Problem	Possible Cause	Corrective Action	Reference
Will not start (cranks okay) (continued)	Weak or dead battery	Recharge battery. Check electrolyte level and specific gravity (batteries with filler caps only). Perform load test, or replace battery.	Section 3. Battery
	Defective air heater	Check/replace air heater	Engine Service Manual
	Defective C1 relay	Check/replace C1 relay	Section 7. Engine/Generator Components

Problem	Possible Cause	Corrective Action	Reference
Engine starts, but stops after start switch is released	Incorrect generator output voltage	Check AC output voltage.	Section 9. Wiring Diagrams Section 7. Component Testing–Separate Excitation
	Open wiring (P1 or P2 connector)	Check continuity	Section 9. Wiring Diagrams
	K1 relay coil defective	Check continuity	Section 7. Controller Circuit Board Section 9. Wiring Diagrams
	If LED1 is not lit, K1 relay is not receiving power from stator B1/B2 winding	Test stator	Section 7. Stator Section 7. Engine/ Generator Components
	No/low oil pressure	Check oil level; add oil if low Check/repair oil pump	Section 3. Lubrication System Engine Service Manual
	High water temperature	Check engine cooling system	Engine Service Manual
	Low oil pressure switch, high engine temperature switch	Disconnect lead from one switch and isolate the lead from ground. If engine continues to run, replace that switch. **NOTE:** Verify proper pressure or temperature before replacing switch.	

Problem	Possible Cause	Corrective Action	Reference
Hard starting	Stale or bad fuel	Replace	
	Air in fuel system	Bleed air	Section 3. Fuel System
	Water, dirt in fuel system	Drain fuel system and/or replace fuel filters	
	Dirty or faulty injectors	Check injectors	Engine Service Manual
	Improper type of fuel	Use proper type of fuel; consult fuel supplier	Section 3. Fuel System
	Air cleaner clogged	Clean or replace element	Section 3. Service Air Cleaner
	Worn piston rings, valves, etc.	Check compression and oil consumption	Engine Service Manual
	Improper cooling (hot engine only)	Inspect cooling system	Section 3. Cooling System
	Defective air heater	Check/replace air heater	Engine Service Manual
	Defective C1 relay	Check/replace C1 relay	Section 7. Engine/Generator Components

Problem	Possible Cause	Corrective Action	Reference
Generator set shuts down by itself	No fuel in tank	Replenish	
	Fuel line restriction	Inspect fuel lines and tank	
	Clogged fuel filter	Replace filter	Section 3. Fuel System
	Defective fuel pump	Check fuel pump **NOTE:** Fuel pump is polarity sensitive and will fail if the lead connections are made in reverse.	Engine Service Manual
	Air in fuel system	Bleed air	Section 3. Fuel System
	Engine overloaded	Reduce electrical load	Section 3. Wattage Requirements
	Engine overheated (hot engine only)	Check air intake, governor adjustment, oil level, etc.	Section 3. Scheduled Maintenance Engine Service Manual
	Loss of generator output voltage to K1 relay (LED1 not lit)	Check AC voltage at B1/B2 winding Check continuity of B1/B2 stator leads	Section 9. Wiring Diagrams Section 7. Stator
	Air cleaner clogged	Clean or replace element	Section 3. Servicing Air Cleaner

Problem	Possible Cause	Corrective Action	Reference
Generator set shuts down by itself (continued)	No/low oil pressure	Check oil level, oil pressure, and oil pump,	Engine Service Manual
	High water temperature shutdown	Check engine cooling system	Engine Service Manual
	Low oil pressure switch, high engine temperature switch	Disconnect lead from one switch and isolate the lead from ground. If engine continues to run, replace that switch. **NOTE:** Verify proper pressure, or temperature before replacing switch.	

Problem	Possible Cause	Corrective Action	Reference
Will not carry load or runs rough	Excessive load connected to generator	Reduce electrical load	Section 3. Wattage Requirements
	Improper cooling (hot engine only)	Inspect cooling system	Section 3. Cooling System
	Governor not properly adjusted or defective (Engine not operating at rated rpm)	Check speed using tachometer or frequency meter. **NOTE:** For 60 Hz–1800 RPM For 50 Hz–1500 RPM	Section 3. Governor
	Engine in need of overhaul	Contact Kohler distributor	Engine Service Distributor

Problem	Possible Cause	Corrective Action	Reference
Will not carry load or runs rough (continued)	Fuel line restriction	Inspect fuel lines and tank.	
	Vent in fuel tank cap obstructed	Clean cap in solvent, blow dry	
	Dirty fuel filter	Replace fuel filter	Section 3. Fuel System
	Improper type of fuel	Use proper type of fuel; consult fuel supplier	Section 3. Fuel System
	Water, dirt, or air in fuel system	Drain, fill, and bleed air in the system Replace fuel filters	Section 3. Fuel System
	Defective fuel pump	Check fuel pump **NOTE:** Fuel pump is polarity sensitive and will fail if the lead connections are made in reverse	Engine Service Manual
	Fuel leak	Tighten fittings	Engine Service Manual
	Valves not sealing	Compression test	Engine Service Manual
	Air cleaner clogged	Clean or replace element	Section 3. Air Cleaner Service
	Incorrect fuel injection timing	Check injection timing	Engine Service Manual
	Dirty or faulty injectors	Check injectors	Engine Service Manual
	Improper cylinder top clearance	Check clearance	Engine Service Manual
	Defective piston or piston rings	Check compression	Engine Service Manual
	Defective crankshaft bearing or piston pin bearing	Check components	Engine Service Manual
	Improper valve clearance	Adjust proper valve clearance	Section 3. Valve Clearance Engine Service Manual

Problem	Possible Cause	Corrective Action	Reference
Will not carry load or runs rough (continued)	Defective injection pump	Check injection pump	Engine Service Manual
	Improper lube oil	Use proper viscosity oil	Section 3. Lubrication System

Problem	Possible Cause	Corrective Action	Reference
Lacks power	Governor not properly adjusted or defective (Engine not operating at rated RPM)	Check engine speed using frequency meter or tachometer. **NOTE:** For 60 Hz–1800 RPM For 50 Hz–1500 RPM	Section 3. Governor
	Air cleaner clogged	Clean or replace element	Section 3. Air Cleaner Service
	Improper cooling	Inspect cooling system	Section 3. Cooling System
	Engine overloaded	Reduce electrical load	Section 3. Wattage Requirements
	Stale or bad fuel	Replace	
	Fuel line restriction	Check fuel lines and tank	
	Dirty fuel filter	Replace fuel filter	Section 3. Fuel System
	Incorrect injection timing	Adjust injection timing	Engine Service Manual
	Uneven fuel injection	Repair/replace injectors and/or injection pump	Engine Service Manual
	Compression leak	Replace head gasket. Tighten cylinder head bolt, air heater, and nozzle holder	Engine Service Manual

Problem	Possible Cause	Corrective Action	Reference
Overheats	Low coolant	Replenish cooling system	Section 3. Cooling System
	Air cleaner clogged	Clean or replace element	Section 3. Air Cleaner Service
	Fan belt broken or loose	Tighten/replace fan belt	Section 3. Drive Belt
	Radiator clogged or dirty	Clean radiator (inside and outside)	
	Radiator cap defective	Replace radiator cap	
	Defective water pump	Check water pump	Engine Service Manual
	Engine malfunction	Troubleshoot engine	Engine Service Manual
	Defective K30 relay (remote radiator system)	Check/replace K30 relay	Section 3. Engine/Generator Component Testing

Problem	Possible Cause	Corrective Action	Reference
Operates erratically	Air cleaner clogged	Clean or replace element	Section 3. Air Cleaner Service
	Stale or bad fuel	Replace	
	Governor not properly adjusted or defective (Engine not operating at rated RPM)	Check engine speed using frequency meter or tachometer. **NOTE:** For 60 Hz–1800 RPM For 50 Hz–1500 RPM	Section 3. Governor
	Fuel line restriction	Inspect fuel lines and tank.	

Problem	Possible Cause	Corrective Action	Reference
Unit is noisy	Exhaust system leak	Check and replace as necessary	Operation and Installation Manual–Exhaust Systems
	Broken or damaged vibromounts	Check and replace as necessary	Section 8. Disassembly/ Reassembly
	Loose or vibrating sheet metal/housing	Retighten screws	
	Inadequate compartment clearances	Check clearances	Operation and Installation Manual–Compartment Size
	Exhaust piping or air inlets/outlets not securely installed	Inspect for loose parts	Operation and Installation Manual–Exhaust Systems
	No compartment sound insulation	Install fireproof insulation	Operation and Installation Manual–Compartment Size
	Excessive vibration–engine/generator	Check rotor, crankshaft, bearing, etc. (Disassembly of engine and/or generator may be required)	Section 8. Disassembly/ Reassembly Engine Service Manual Kohler Service Distributor

Problem	Possible Cause	Corrective Action	Reference
ELECTRICAL SYSTEM			
Battery will not charge or goes dead	Loose or corroded connections	Clean and tighten connections	Section 3. Battery
	Sulfated or worn-out battery	Check electrolyte level and specific gravity (batteries with filler caps only)	Section 3. Battery
	Defective alternator	Test and replace, if necessary	Engine Service Manual
	Loose or defective alternator belt	Adjust belt tension or replace belt	Section 3. Belt Tension
	Defective alternator voltage regulator	Test and replace, if necessary	Engine Service Manual
	Loose or corroded engine ground strap	Clean and tighten	Section 3. Battery

Problem	Possible Cause	Corrective Action	Reference
Starter does not work properly	Loose or corroded connections	Clean and tighten loose connections	Section 3. Battery
	Low battery output	Check electrolyte level and specific gravity (batteries with filler caps only)	Section 3. Battery
	Defective starter solenoid	Check starter solenoid Replace starter solenoid, as necessary	Section 7. Component Testing Engine Service Manual
	Defective start/stop switch	Replace switch	Section 7. Component Testing
	Defective wiring	Check wiring	Section 9. Wiring Diagrams
	Defective starter	Replace starter	Engine Service Manual
	Battery cables undersize	Select proper size cable	Section 1. Specifications Chart–Installation Operation and Installation Manual–Electrical System
	Loose or corroded engine ground strap	Clean and tighten	Section 3. Battery

Problem	Possible Cause	Corrective Action	Reference
Starter cranks slowly	Low battery output	Check electrolyte level and specific gravity (batteries with filler caps only)	Section 3. Battery
	Too heavy viscosity lube oil	Use proper viscosity oil	Section 3. Lubrication System
	Loose or corroded wiring	Clean and tighten loose connections	Section 3. Battery
	High starter current draw	Repair/Replace starter	Engine Service Manual
	Battery cable undersize	Select proper size cable	Operation and Installation Manual–Electrical Systems

Problem	Possible Cause	Corrective Action	Reference
GENERATOR			
No generator output voltage	Optional AC output circuit breaker open or defective	Check position of circuit breaker Check AC voltage on generator side of circuit breakers	Section 2. Circuit Protection Section 9. Wiring Diagrams
	Optional AC circuit breaker tripping due to overload on unit	Reduce load Reset and attempt startup	Section 3. Wattage Requirement
	No battery voltage to field during cranking	Check flashing current	Section 7. Separate Excitation Test
	Open flashing diode (D4 or D7; D5 or D8)	Check for open or shorted diode (a good diode has high resistance one way and low resistance the other way, when tested with ohmmeter)	Section 9. Wiring Diagrams Section 7. Circuit Board
	K1 relay (Normally Closed) contacts open	Check continuity	Section 9. Wiring Diagrams Section 7. Circuit Board
	Defective rotor (open, grounded, or shorted windings)	Test and/or replace	Section 7. Rotor
	Defective stator (open, grounded, or shorted windings)	Test and/or replace	Section 7. Stator
	Defective exciter field (3-phase models only)	Test and/or replace	Section 7. Exciter Field Section 8. Disassembly/ Assembly
	Defective exciter armature (3-phase models only)	Test and/or replace	Section 7. Exciter Armature Section 8. Disassembly/ Assembly
	Defective diode board (3-phase models only)	Check for open or shorted diode (a good diode has high resistance one way and low resistance the other way, when tested with ohmmeter).	Section 8. Disassembly/ Assembly
	Brushes sticking in holder (1-phase models only)	Check alignment	Section 8. Brushes

Problem	Possible Cause	Corrective Action	Reference
GENERATOR No generator output voltage (continued)	Rotor slip rings dirty or corroded (1-phase models only)	Check and/or service	Section 8. Brushes
	Broken, weak, or missing brush spring (1-phase models only)	Check condition	Section 8. Brushes
	Fuse blown in voltage regulator circuit (lead 55)	Replace fuse. If fuse blows again, check voltage regulator and stator aux. windings	Section 7. Voltage Regulator Section 9. Wiring Diagrams
	Defective voltage regulator Misadjusted voltage regulator	Excite (rotor) separately	Section 7. Separate Excitation Section 7. Voltage Regulator Test/ Alignment

Problem	Possible Cause	Corrective Action	Reference
Low generator output voltage	Low engine rpm	Check engine speed using frequency meter or tachometer. **NOTE:** For 60 Hz–1800 RPM For 50 Hz–1500 RPM	Section 3. Governor Adjustments
	Set overloaded	Make sure capacity is not being exceeded	Section 3. Wattage Requirements
	Defective rotor	Test and/or replace	Section 7. Rotor
	Defective stator	Test and/or replace	Section 7. Stator
	Defective voltage regulator	Test and/or replace	Section 7. Voltage Regulator
	Improperly adjusted voltage regulator	Readjust	Section 7. Voltage Regulator

Problem	Possible Cause	Corrective Action	Reference
High generator output voltage	Defective voltage regulator	Test and/or replace	Section 7. Voltage Regulator
	Voltage regulator misadjusted	Readjust	Section 7. Voltage Regulator
	Open or poor splice connection at regulator sensing terminals on stator or poor pin connection at voltage regulator	Check continuity and clean connections	Section 7. Stator Section 9. Wiring Diagrams

Section 5. Controller Troubleshooting

Data in this section describes the controller sequence of operation during starting, running, and stopping of the generator set. The controller for a single-phase generator is different than the controller for a three-phase generator. Therefore, separate sequence of operation information is provided for single-phase and three-phase generators. Use this data as a starting point for controller fault identification.

Single-Phase Generator Sequence of Operation

Starting

Preheating—A heater mounted on the intake manifold is used to preheat intake air during starting in cold weather. Preheating is initiated by rocking the Start/Stop switch on the control panel to the STOP/PREHEAT position for the time period specified in Section 2. This action energizes the C1 relay. As a result, normally open contacts of the C1 relay close to energize the air heater.

At the end of the specified time period, the Start/Stop switch is released or rocked out of the STOP/PREHEAT position. Either of these actions opens the ground path to the C1 relay, de-energizing the C1 relay and the air heater.

Engine Start-up—The engine is started by rocking the start/stop switch on the control panel to the START position. At this point, the 10-ampere fuse must be good. If not, power to the starting circuits is interrupted and none of the following actions described below occur.

Setting the Start/Stop switch to the START position energizes the K2 relay (LED2 lights). As a result, normally open contacts of K2 close to energize the K3 relay, the K25 relay, and the FP (Fuel Pump) motor.

Energizing the K3 relay (LED3 lights) causes a set of normally open contacts to close and energize relay K20. A set of normally open contacts of K20 then close to energize the S solenoid (Starter Solenoid). As a result, normally open contacts of the S relay close to energize the M (starter) motor and the starter motor gear engages the ring gear on the engine flywheel to begin cranking the engine. At the same time, the power supplied to the starter motor also energizes the pull-in coil of the FS (Fuel Supply) Solenoid.

Energizing the K25 relay closes a set of normally open contacts to energize the hold coil of the fuel solenoid to complete the conditions necessary for engine start-up.

For units with remote radiators, energizing K2 also energizes the K30 relay. Energizing the K30 relay closes a set of normally open contacts to energize a 12 VDC fan. This fan provides cooling for the remote radiator.

Releasing the Start/Stop switch allows the switch to return to its neutral position. If the switch is released before the engine starts (the K1 relay is still de-energized), the K2 relay de-energizes. The normally open contacts of the K2 relay then open to interrupt power to the engine start-up circuits. As a result the K3 relay, the K25 relay, the K20 relay, the K30 relay, the Fuel Pump, the Fuel Solenoid, and the Starter Solenoid all de-energize to cease start-up of the engine.

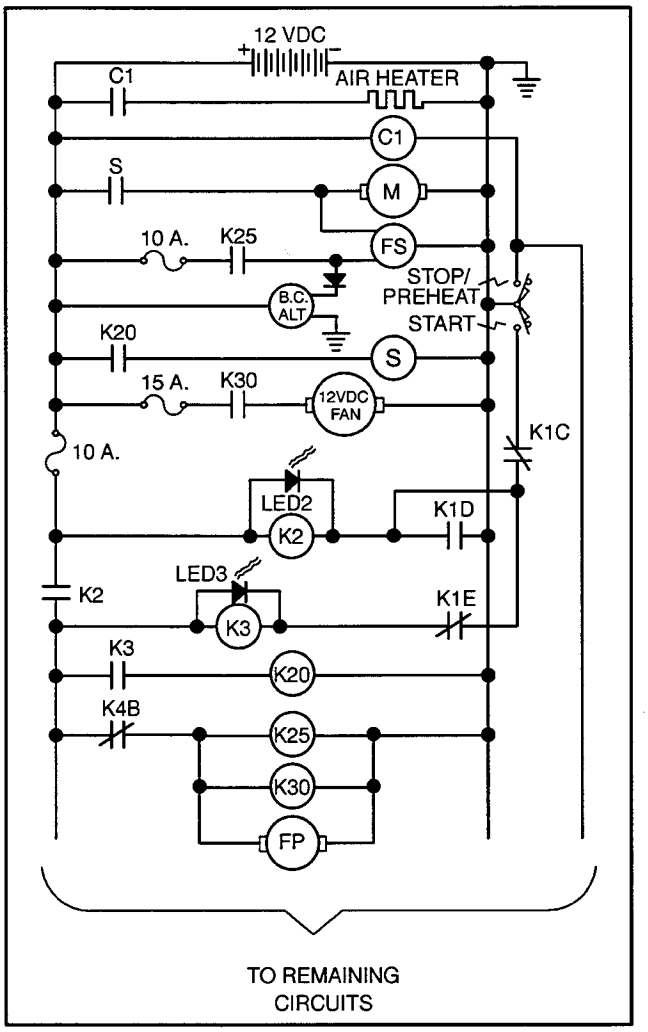


Figure 5-1. Single-Phase Generator Sequence of Operation, Starting

Running

During engine start-up, flashing current is provided to the generator field through a normally open contact of the K2 relay, two diodes, and the normally closed K1A and K1B contacts. The flashing current plus the rotation of generator rotor induce electrical currents in the generator stator windings. The resulting generator output from the B1/B2 stator winding, rectified and regulated to a 12 VDC level, energizes the K1 relay (LED1 lights). After a 5- to 10-second delay, the same signal energizes the K5 relay (LED5 lights). Both relays remain energized during normal running.

Energizing the K1 relay opens the normally closed K1A and K1B contacts that supply flashing current to the generator exciter field. Field current for continued operation is then supplied by the voltage regulator, operating from an input supplied by generator stator winding 55/66.

Energizing the K1 relay also opens the normally closed K1C contacts between the Start/Stop switch and the K2 relay in the engine start-up circuit. However, at the same time, the normally open K1D contacts close to keep the K2 relay energized in order to maintain operating power for the other relays and hourmeter of the controller.

Energizing the K1 relay also opens the normally closed K1E contacts to de-energize the K3 relay. As a result, K20 and the S (Starter) solenoid de-energize to disengage and de-energize the starter motor, even when the Start/Stop switch is held in the Start position. The other devices energized during engine starting, that is the K25 relay, the K30 relay (and 12 VDC fan), the fuel pump, and the fuel solenoid, remain energized to keep the engine running and to supply excitation to the B.C. Alt (battery-charging alternator).

Finally, energizing the K1 relay also closes the normally open K1F contacts to activate the hourmeter, oil pressure gauge, water temperature gauge, and battery voltage gauge on an optional remote panel.

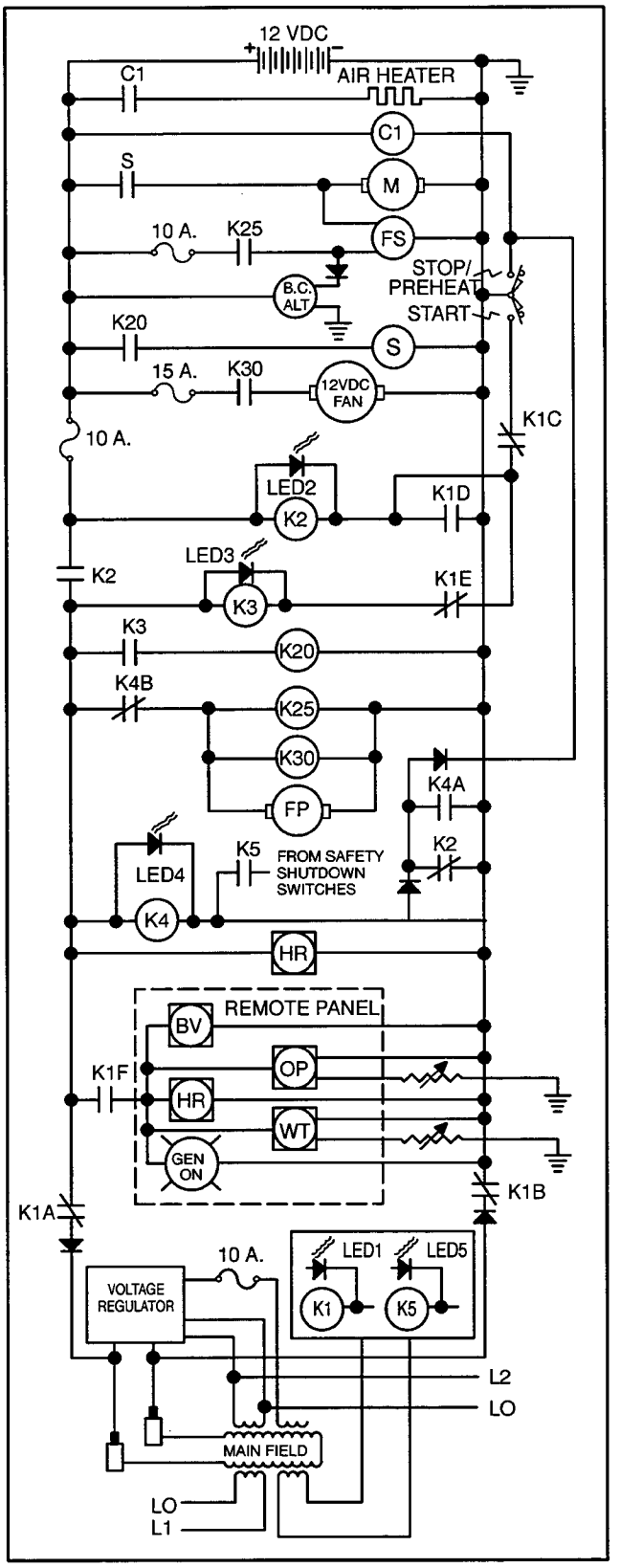


Figure 5-2. Single-Phase Generator Sequence of Operation, Running

Stopping

A normal stop is initiated by rocking the Start/Stop Switch on the controller front panel to the Stop position and then releasing the switch. ***Holding the switch in the Stop position energizes the C1 relay, causing further, unnecessary heating of the intake manifold.*** In the Stop position, the Start/Stop switch provides a ground through two blocking diodes to energize the K4 relay (LED4 lights). The normally open K4A contacts then close, latching the K4 relay in an energized condition.

At the same time, normally closed K4B contacts open to de-energize the FP (fuel pump) motor, the K25 relay, and the K30 relay. The normally open K30 relay contacts open to de-energize the 12 VDC fan for the remote radiator. The normally open K25 contacts open to de-energize the FS (fuel) solenoid, turning off the flow of fuel. With the fuel supply and fuel pump both turned off, the engine turns off.

When the engine turns off, the generator output decays and causes relays K1 and K5 to de-energize (LED1 and LED5 go out). The normally open K1D contacts then open, de-energizing the K2 relay (LED2 goes out). When the K2 relay de-energizes, the normally open K2 contacts open to interrupt power to the remaining controller relay circuits, including relay K4. As a result, the latch-up of the K4 relay is broken to return the controller circuits to a normal prestart condition.

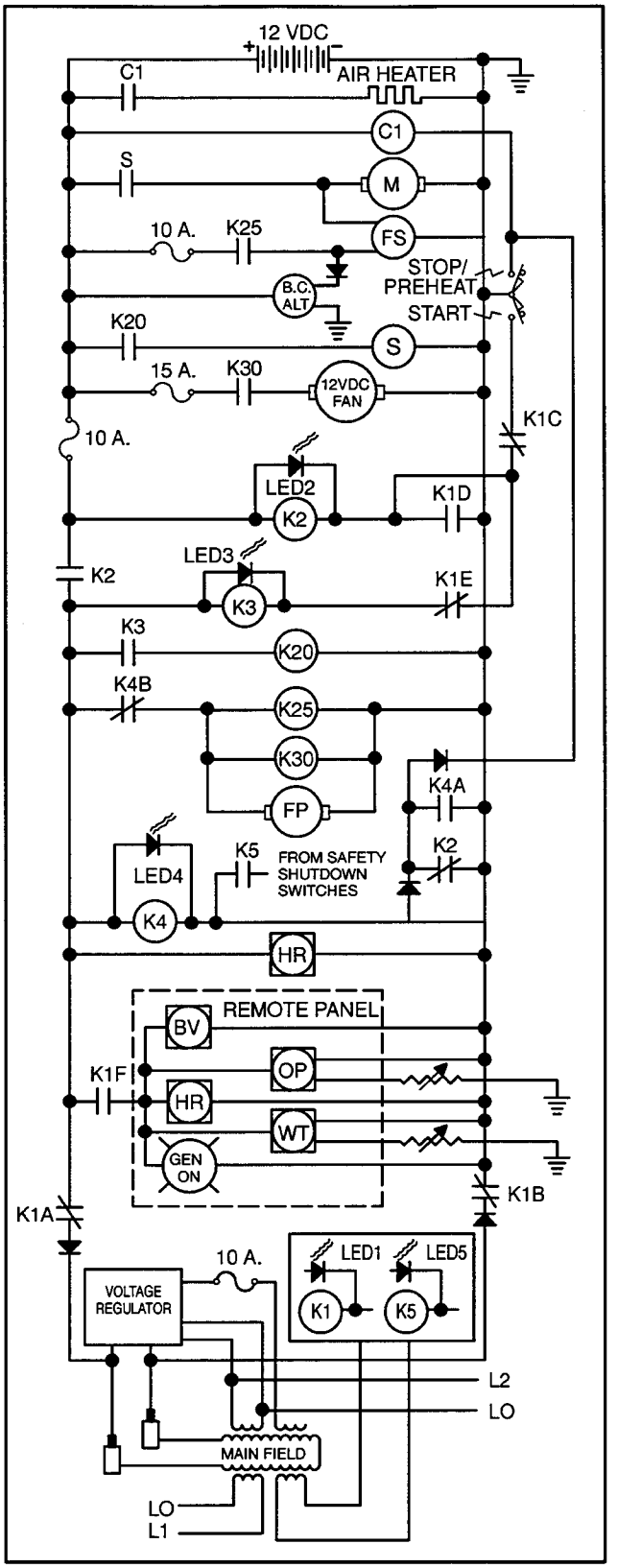


Figure 5-3. Single-Phase Generator Sequence of Operation, Stopping

Automatic Safety Shutdowns

The engine is equipped with two switches that monitor critical operating conditions. These switches are:

- A High Engine Temperature Switch that closes when engine coolant temperature rises toward an unsafe level.
- A Low Oil Pressure Switch, which closes when the oil pressure is insufficient, to indicate inadequate lubrication of the engine.

During normal running, closing either of the above switches results in an engine shutdown. During start-up, this shutdown function is disabled by normally open contacts of the K5 relay until 5 to 10 seconds after the engine starts in order to allow the monitored conditions to stabilize.

Once the normally open contacts of K5 close, the engine safety switches are enabled. If either switch then closes, the K4 relay is energized (LED4 lights). Energizing relay K4 causes the normally open K4A contacts to close, latching the K4 relay in an energized condition.

At the same time the K4A contacts close, the normally closed K4B contacts open to de-energize the FP (fuel pump) motor and the K25 relay. The normally open K25 contacts then open to de-energize the FS (fuel supply) solenoid, turning off the flow of fuel. With the fuel supply and fuel pump both turned off, the engine shuts off.

When the engine shuts off, the generator output decays and causes relays K1 and K5 to de-energize (LED1 and LED5 go out). The normally open K1D contacts then open, de-energizing the K2 relay (LED2 goes out) and opening the normally open K2 contacts to interrupt power to the remaining controller relay circuits, including relay K4. As a result, the latch-up of the K4 relay is broken to return the controller circuits to a normal prestart condition.

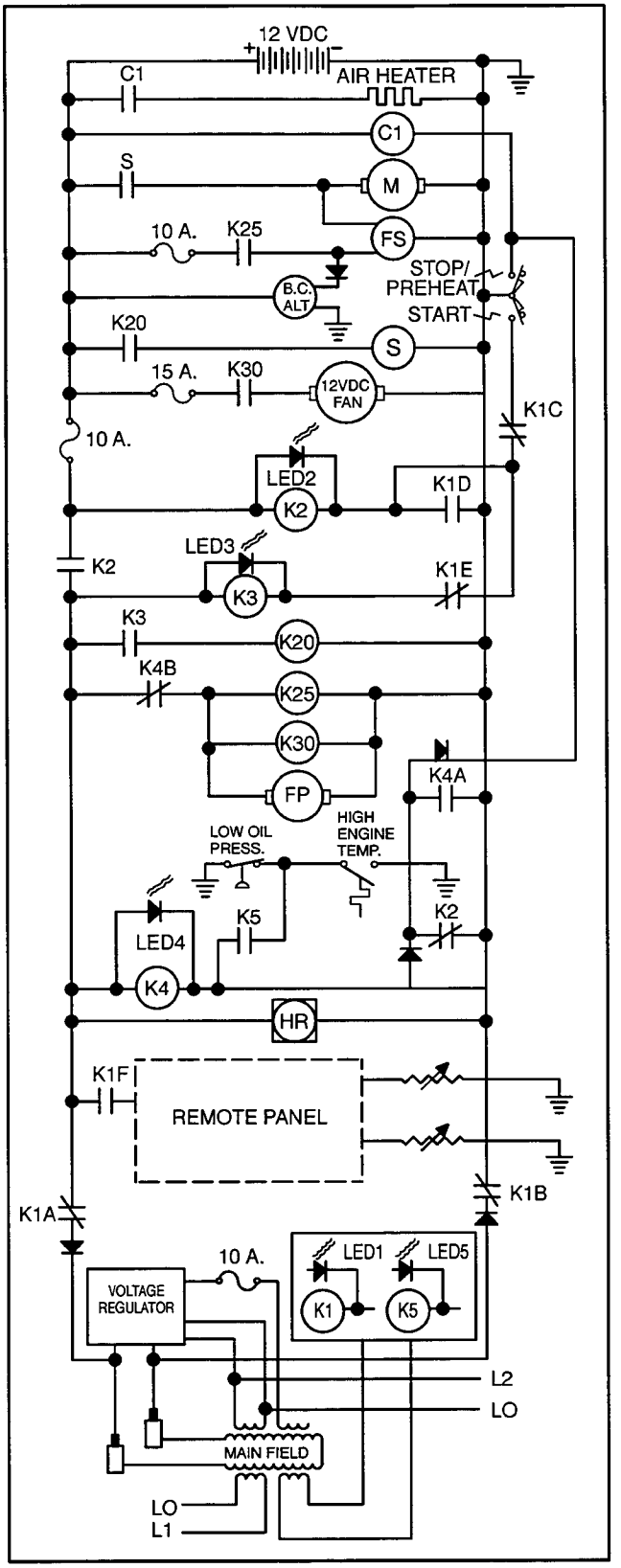


Figure 5-4. Single-Phase Generator Sequence of Operation, Emergency Shutdowns

Three-Phase Generator Sequence of Operation

Starting

Preheating—Preheating of the air heater in the diesel engine is initiated by rocking the start/stop switch on the control panel to the STOP/PREHEAT position for the time period specified in Section 2. This action energizes the AH relay. As a result, normally open contacts of the AH relay close to energize the air heater.

At the end of the specified time period, the start/stop switch is released or switched out of the STOP/PREHEAT position. Either of these actions opens the ground path to the AH relay, de-energizing the AH relay and the air heater.

Engine Start-up—The engine is started after air heater preheating by rocking the start/stop switch on the control panel to the START position. At this point, the 10-ampere fuse must be good. If not, power to the starting circuits is interrupted and none of the following actions described in this section occur.

Setting the Start/Stop switch to the START position energizes the K2 relay (LED2 lights). As a result, normally open contacts of K2 close to energize the K3 relay, the K25 relay, and the FP (Fuel Pump) motor.

Energizing the K3 relay (LED3 lights) causes a set of normally open contacts to close and energize relay K20. A set of normally open contacts of K20 then close to energize the S solenoid (Starter Solenoid). As a result, normally open contacts of the S relay close to energize the M (starter) motor and the starter motor gear engages the ring gear on the engine flywheel to begin cranking the engine. At the same time, the power supplied to the starter motor also energizes the pull-in coil of the FS (Fuel Solenoid).

Energizing the K25 relay closes a set of normally open contacts to energize the hold coil of the fuel solenoid to complete the conditions necessary for engine start-up.

Releasing the Start/Stop switch allows the switch to return to its neutral position. If the switch is released before the engine starts (the K1 relay is still de-energized), the K2 relay de-energizes. The normally open contacts of the K2 relay then open to interrupt power to the engine start-up circuits. As a result the K3 relay, the K25 relay, the K20 relay, the Fuel Pump, the Fuel Solenoid, and the Starter Solenoid all de-energize to cease start-up of the engine.

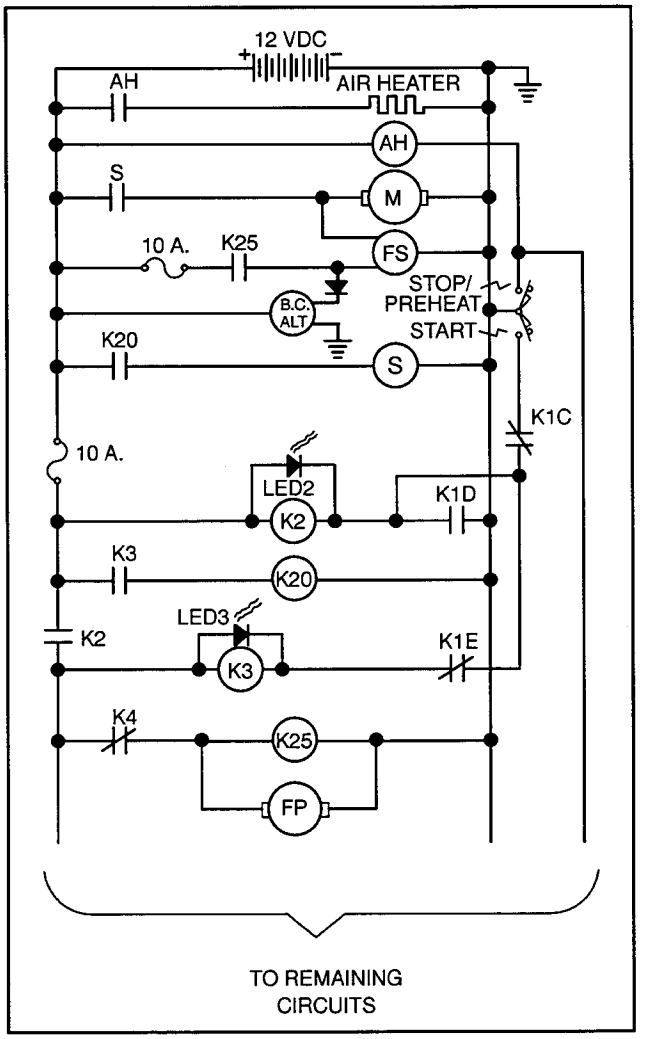


Figure 5-5. Three-Phase Generator Sequence of Operation, Starting

Running

During engine start-up, flashing current is provided to the generator exciter field through a normally open contact of the K2 relay and normally closed contacts of the K1 relay. The resulting generator output from the B1/B2 stator winding, rectified and regulated to a 12 VDC level, energizes the K1 relay (LED1 lights). After a 5- to 10-second delay, the K5 relay is energized (LED5 lights). Both relays remain energized during normal running.

Energizing the K1 relay opens the normally closed K1A and K1B contacts that supply flashing current to the generator exciter field. Field exciter current for continued operation is then supplied by the voltage regulator, operating from an input supplied by generator stator winding 55/66.

Energizing the K1 relay opens the normally closed K1C contacts between the Start/Stop switch and the K2 relay in the engine start-up circuit. However, at the same time, the normally open K1D contacts close to keep the K2 relay energized. Energizing K1 also closes the normally open K1F contact to activate BV, OP, HR, WT, and Gen. on light on the remote panel.

Energizing the K1 relay opens the normally closed K1E contacts to de-energize the K3 relay. As a result, K20 and the S (Starter) solenoid de-energize to disengage and de-energize the starter motor, even when the Start/Stop switch is held in the Start position. The other devices energized during engine starting, that is relay K25, the fuel pump, and the fuel solenoid, remain energized to keep the engine running and to supply excitation to the B.C. Alt (battery-charging alternator).

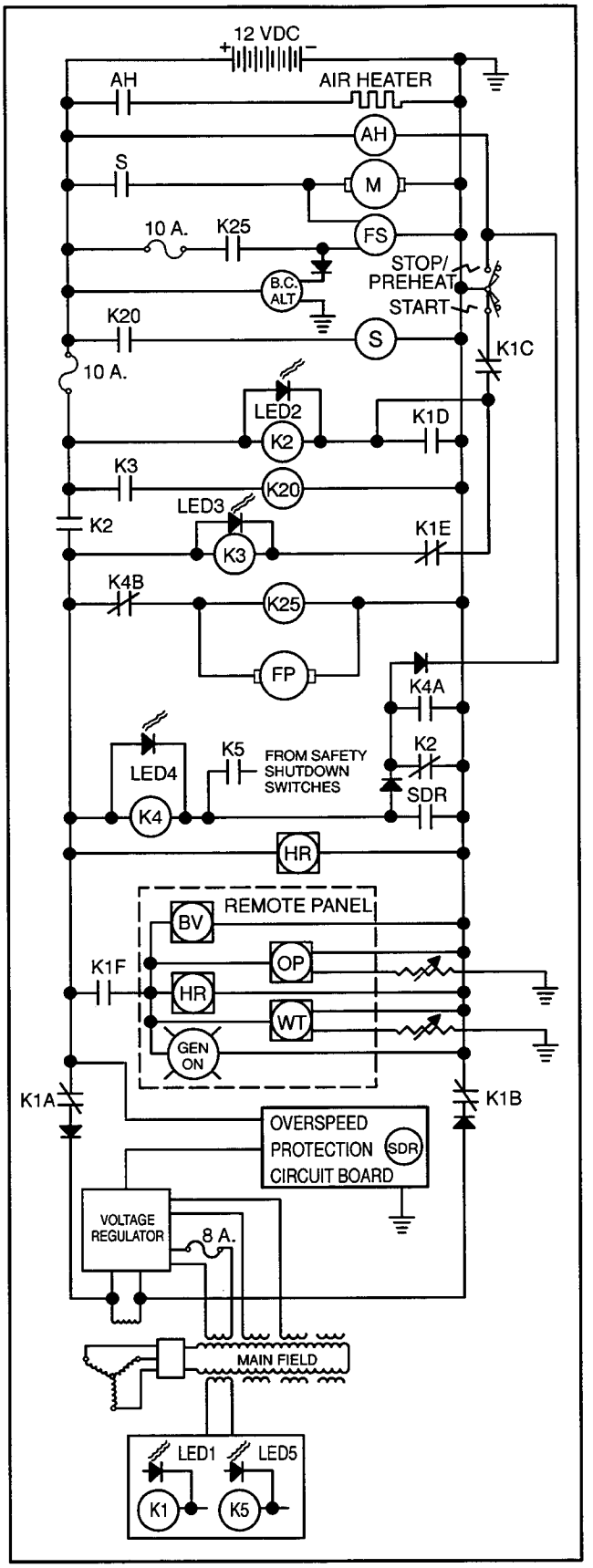


Figure 5-6. Three-Phase Generator Sequence of Operation, Running

Stopping

Normal Stop—A normal stop is initiated by rocking the Start/Stop Switch on the controller front panel to the Stop position and then releasing the switch. ***Holding the switch in the Stop position energizes the AH relay, causing further, unnecessary heating of the air heater.*** In the Stop position, the Start/Stop switch provides a ground through two blocking diodes to energize the K4 relay (LED4 lights). The normally open K4A contacts then close, latching the K4 relay in an energized condition.

At the same time, normally closed K4B contacts open to de-energize the FP (fuel pump) motor and the K25 relay. The normally open K25 contacts then open to de-energize the FS (fuel supply) solenoid, turning off the flow of fuel. With the fuel supply and fuel pump both turned off, the engine turns off.

With the engine turned off, the generator output decays and causes relays K1 and K5 to de-energize (LED1 and LED5 go out). The normally open K1D contacts then open, de-energizing the K2 relay (LED2 goes out) and opening the normally open K2 contacts to interrupt power to the remaining controller relay circuits, including relay K4. As a result, the latch-up of the K4 relay is broken to return the controller circuits to a normal prestart condition.

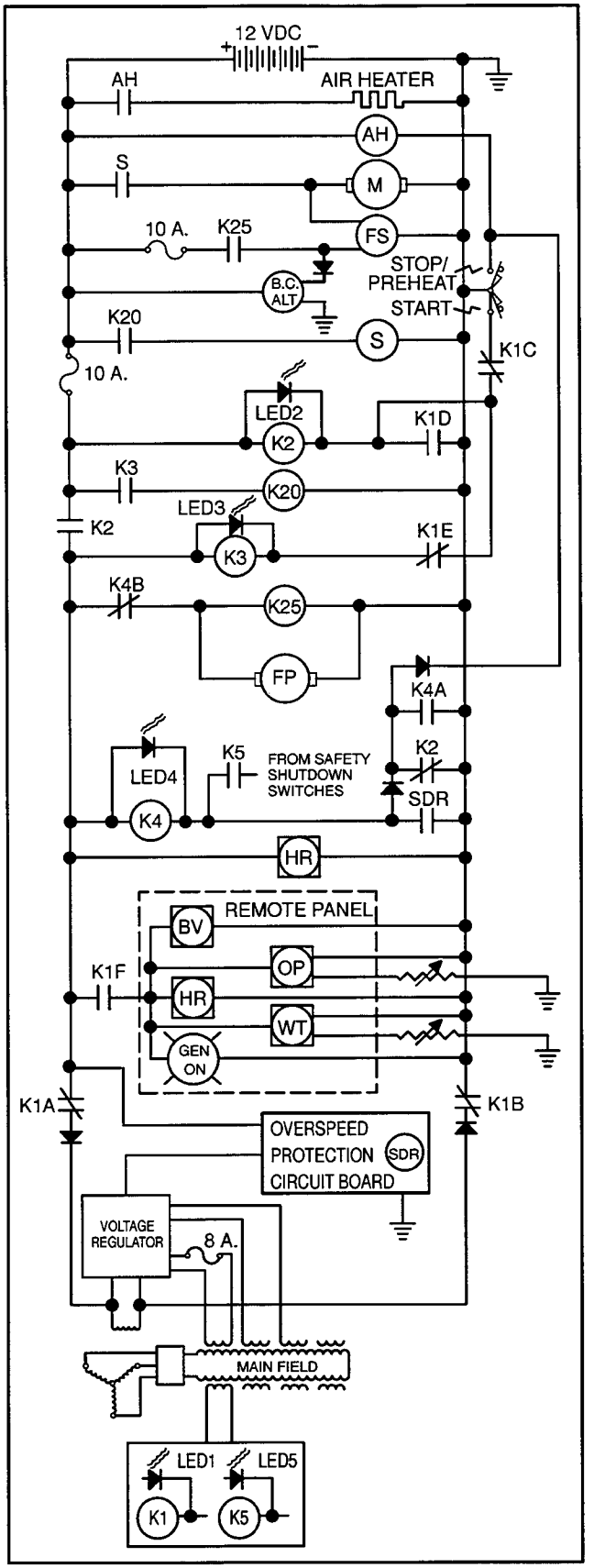


Figure 5-7. Three-Phase Generator Sequence of Operation, Stopping

Automatic Safety Shutdowns

Overspeed—The overspeed protection circuit board monitors the output frequency of the generator set. If the frequency is too high, the SDR relay on the circuit board energizes. Normally open SDR contacts then close to energize the K4 relay (LED4 lights). As a result, the normally open K4A contacts close to latch the K4 relay energized.

At the same time the K4A contacts close, normally closed K4B contacts open to de-energize the FP (fuel pump) motor and the K25 relay. The normally open K25 contacts then open to de-energize the FS (fuel supply) solenoid, turning off the flow of fuel. With the fuel supply and fuel pump both turned off, the engine turns off.

With the engine turned off, the generator output decays and causes relays K1 and K5 to de-energize (LED1 and LED5 go out). The normally open K1D contacts then open, de-energizing the K2 relay (LED2 goes out) and opening the normally open K2 contacts to interrupt power to the remaining controller relay circuits, including relay K4. As a result, the latch-up of the K4 relay is broken to return the controller circuits to a normal prestart condition.

Engine Safety Switches—The engine is equipped with two switches that monitor critical operating conditions. These switches include:

- A High Engine Temperature Switch that closes when the cooling water is not circulating properly and the engine temperature rises toward an unsafe level.

- A Low Oil Pressure Switch, which closes when the oil pressure is insufficient, to indicate inadequate lubrication of the engine.

During normal running, closing any one of the above switches results in an engine shutdown. During start-up, this shutdown function is disabled by normally open contacts of the K5 relay until 5 to 10 seconds after the engine starts in order to allow the monitored conditions to stabilize.

Once the normally open contacts of K5 close, the engine safety switches are enabled. If any of the switches close, the K4 relay is energized to produce a shutdown in the same manner as described above for an overspeed condition.

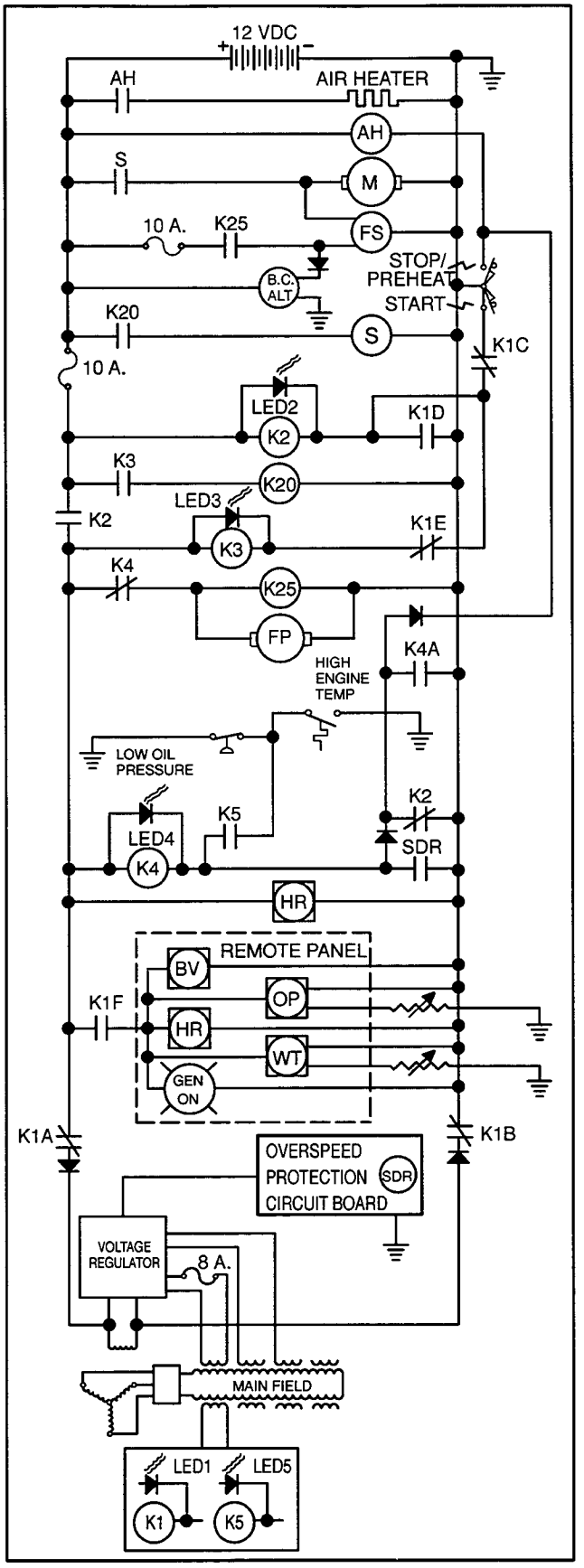


Figure 5-8. Three-Phase Generator Sequence of Operation, Emergency Shutdowns

Section 6. Generator/Controller Troubleshooting

The section contains flow charts to troubleshoot the generator set including the controller circuit board. Before beginning the troubleshooting, read all safety precautions at the beginning of this manual. Additional safety precautions are included with the tests; DO NOT NEGLECT THESE PRECAUTIONS.

Controller Circuit Board

The controller circuit board is equipped with LEDs (light emitting diodes) to indicate the presence of relay coil power and aid in circuit board and generator fault detection. See Figure 6-1.

When K1, K2, K3, K4, or K5 relays are receiving power, the corresponding LED will light. The LED does not indicate whether the relay coil is good or bad. This conclusion can only be reached through analysis of the fault.

Use the flow chart (Figure 6-2) as an aid in troubleshooting the generator set.

Where a check or test is referenced, go to the procedure for detailed instructions.

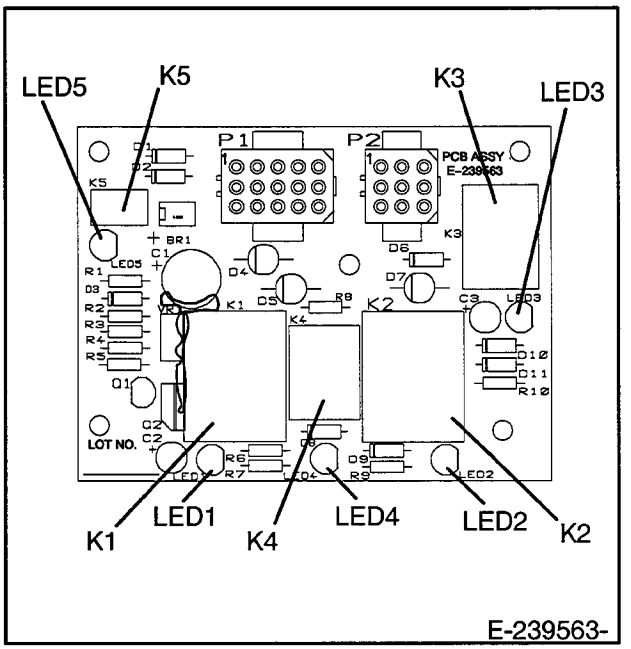


Figure 6-1. Controller Circuit Board E-239563

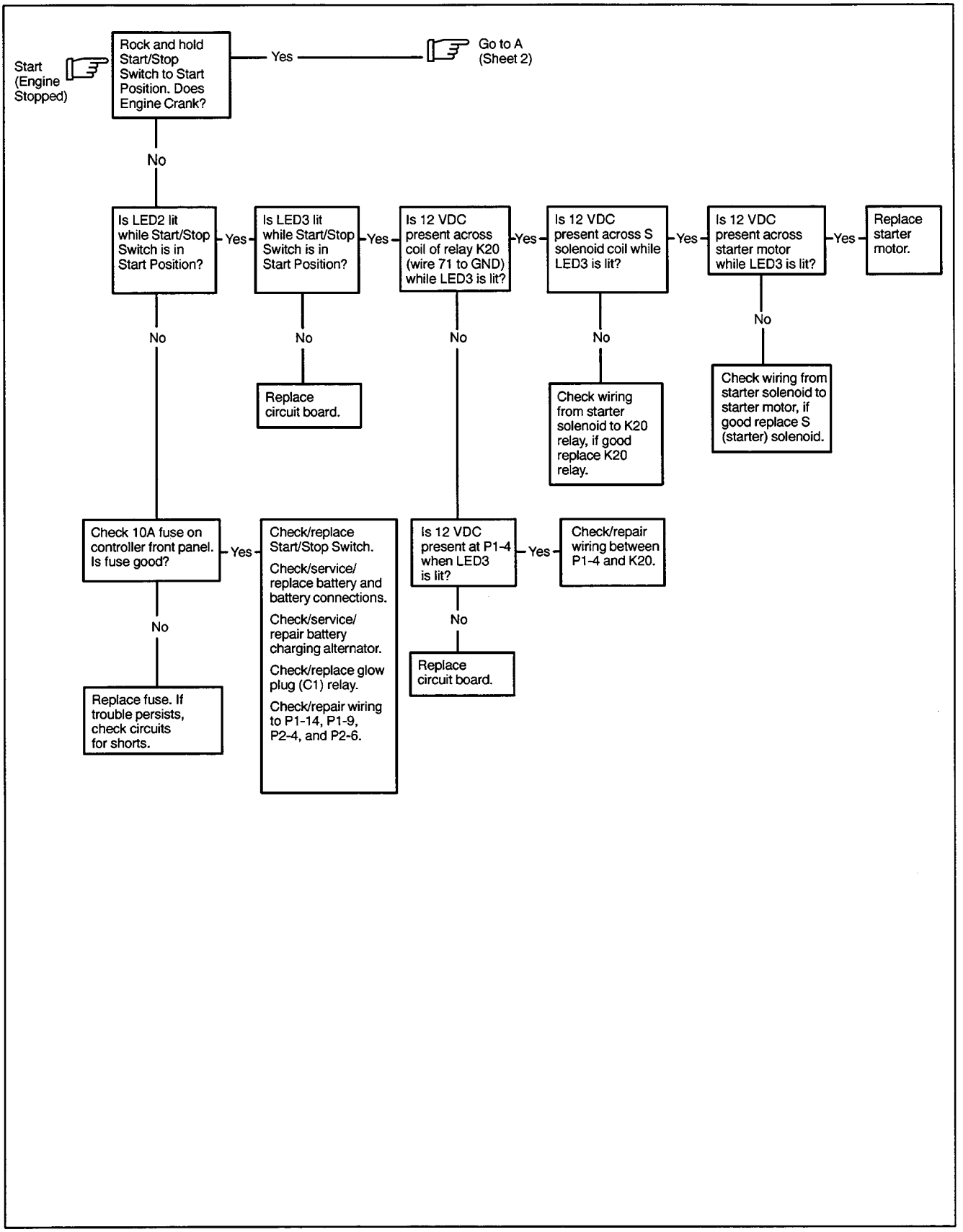


Figure 6-2. Troubleshooting Flow Chart (Sheet 1 of 4)

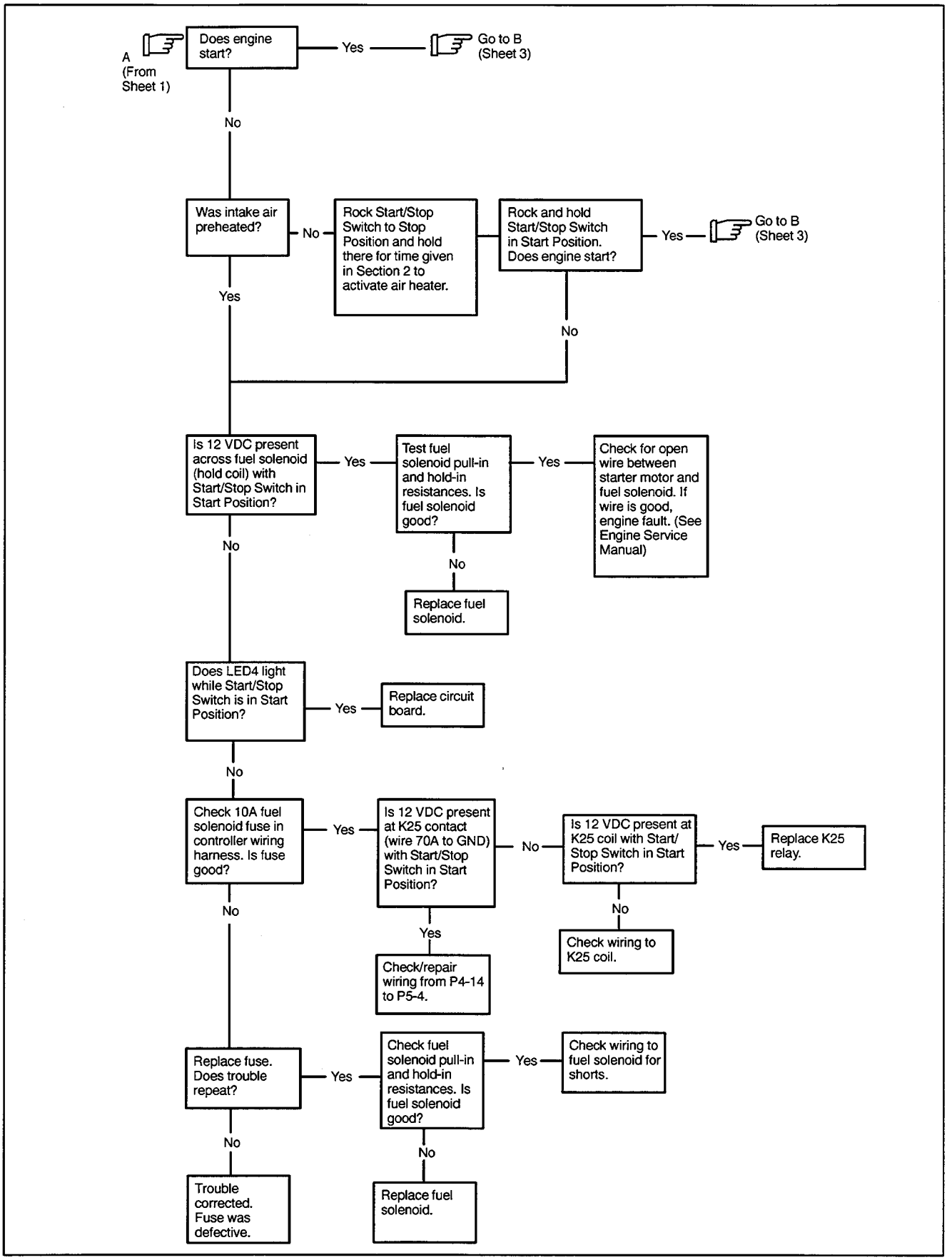


Figure 6-2. Troubleshooting Flow Chart (Sheet 2 of 4)

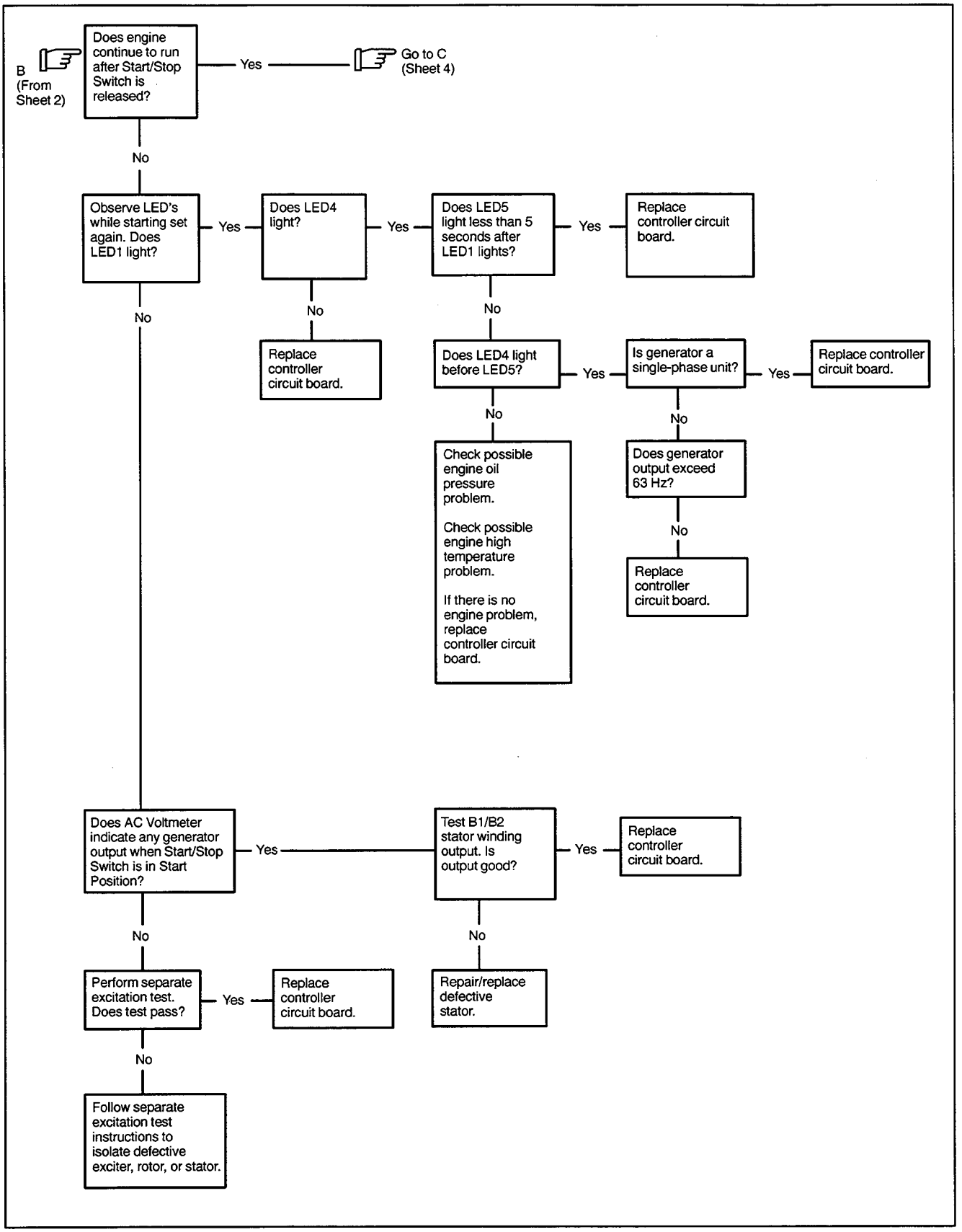


Figure 6-2. Troubleshooting Flow Chart (Sheet 3 of 4)

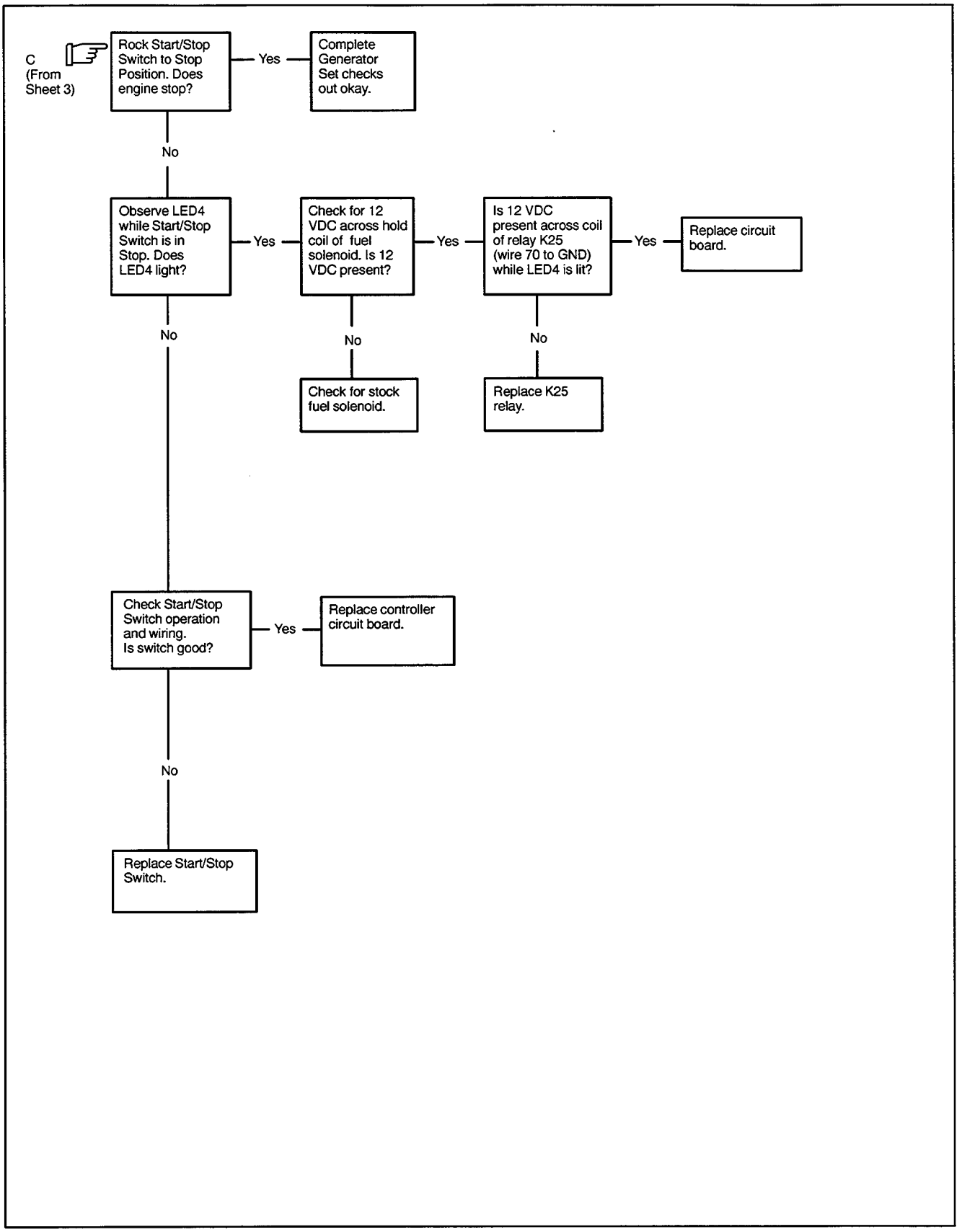


Figure 6-2. Troubleshooting Flow Chart (Sheet 4 of 4)

Section 7. Component Testing and Adjustment

This section is a guide for checking generator, controller, and some engine components for improper operation. Follow the safety precautions at the beginning of this manual during all test procedures. Additional safety precautions are included with the tests; OBSERVE THESE PRECAUTIONS!

Separate Excitation

To determine the cause of no AC output, separately excite the generator. The generator field (rotor) may be excited (magnetized) using an outside DC power source or 12-volt automotive battery and the following procedures. While separately exciting the generator to determine the presence of a faulty voltage regulator, it is possible to determine if a running fault exists in the rotor and/or stator. A generator component appearing good while static (stationary), may exhibit a running open or short while dynamic (moving). This fault can be caused by centrifugal forces acting on the windings while rotating or insulation breakdown as temperatures increase.

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule—replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

⚠ WARNING

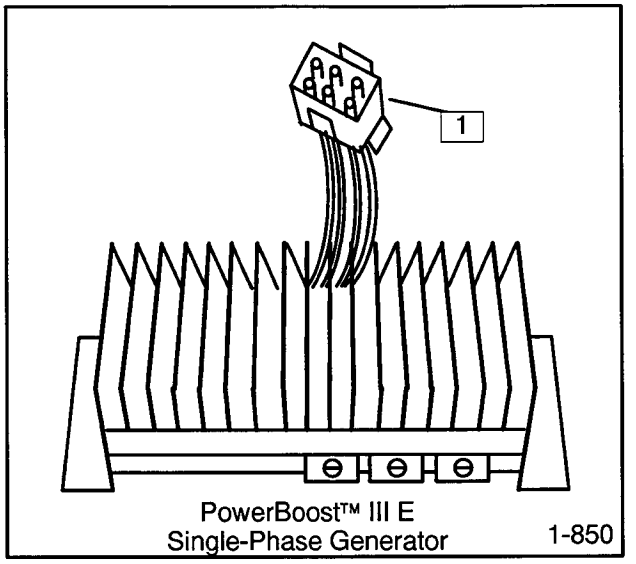
Sulfuric acid in batteries.
Can cause severe injury or death.

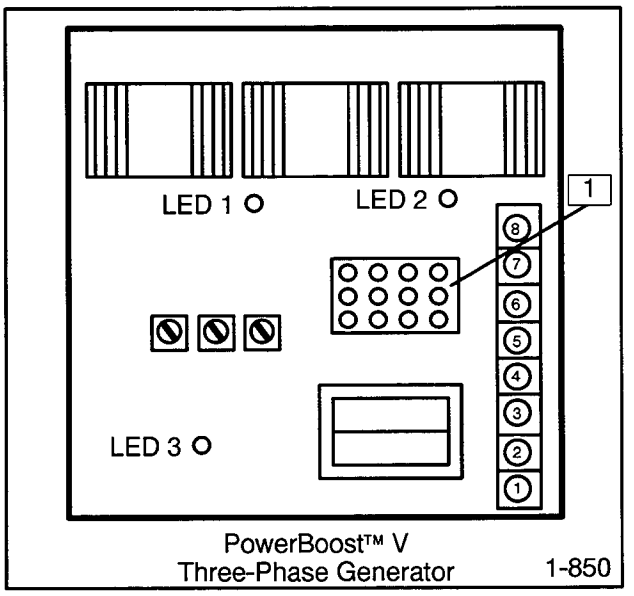
Use protective goggles and clothes. Can cause permanent damage to eyes, burn skin, and eat holes in clothing.

Sulfuric acid in batteries can cause severe injury or death. Sulfuric acid in battery can cause permanent damage to eyes, burn skin, and eat holes in clothing. Always wear splash-proof safety goggles when working around the battery. If battery electrolyte is splashed in the eyes or on skin, immediately flush the affected area for 15 minutes with large quantities of clean water. In the case of eye contact, seek immediate medical aid. Never add acid to a battery once the battery has been placed in service. Doing so may result in hazardous spattering of electrolyte.

Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc. to prevent burns and to prevent sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling battery. Never connect negative (–) battery cable to positive (+) connection terminal of starter solenoid. Do not test battery condition by shorting terminals together or sparks could ignite battery gases or fuel vapors. Any compartment containing batteries must be well ventilated to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being charged and always turn charger off before disconnecting battery connections. When disconnecting battery, remove negative lead first and reconnect it last.

1. Disconnect wiring harness plug from connector on voltage regulator. See Figure 7-1. Also disconnect plug P7.

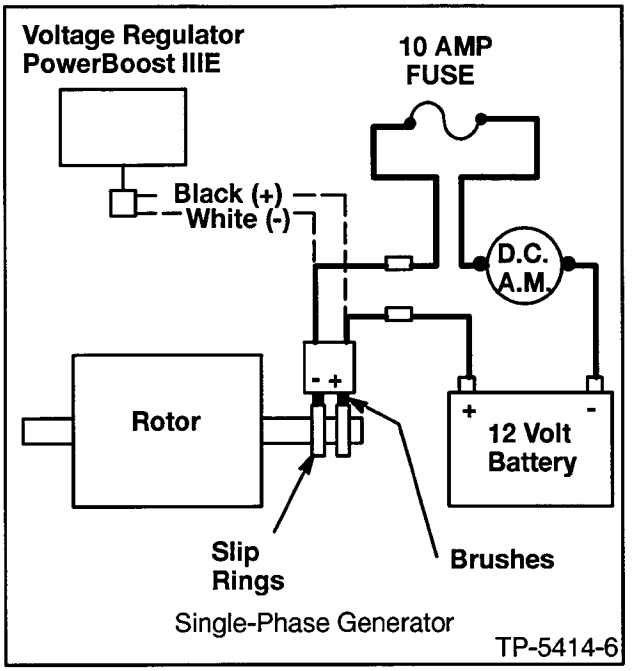




1. Connector

Figure 7-1. Voltage Regulator

2. Connect an ammeter and a DC power supply 12-volt automotive battery to the positive (+) and negative (-) brushes or exciter leads. Include a 10-amp fuse to protect the circuit in case of a shorted rotor. Refer to Figure 7-2. Note and record the ammeter reading.



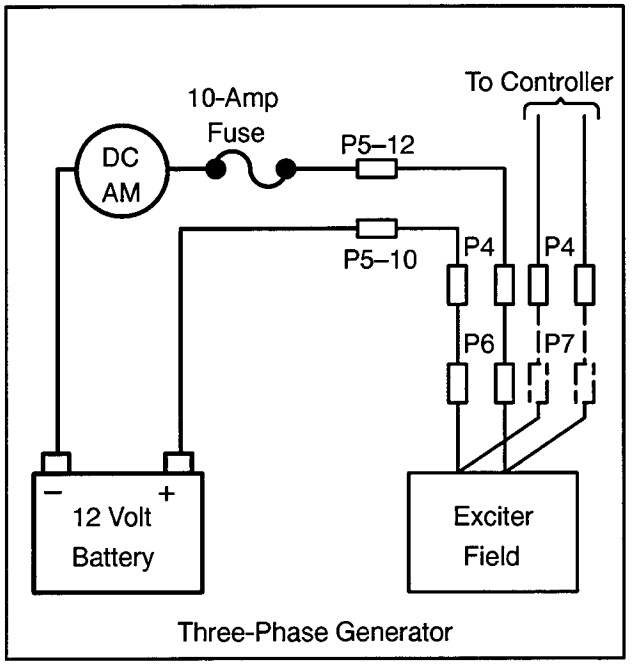


Figure 7-2. Separate Excitation Connections

3. The approximate ammeter reading should be battery voltage divided by specified rotor (single-phase generator) or exciter field (three-phase generator) resistance. For resistances, see Specifications–Generator in Section 1.

Example:

$$\frac{\text{12 Volts (Battery Voltage)}}{\text{4.7 Ohms (Rotor or Exciter Field Resistance)}} = \text{2.6 Amps (Rotor Current)}$$

4. Start engine and check that ammeter reading remains stable. An increasing meter reading indicates a shorted rotor or exciter field. A decreasing meter reading to zero or an unstable reading suggests a running open (see Rotor or Exciter Field heading later in this section). If ammeter is stable proceed to Step 5.

5. Check for AC output across stator leads (see Stator heading later in this section) and compare to readings in Specifications–Generator of Section 1. If readings vary considerably from specified values, a faulty stator is likely (see Stator heading later in this section).

6. If rotor and stator test good in prior steps, the voltage regulator is probably defective. (Refer to appropriate Voltage Regulator heading later in this section.)

NOTE

Stator output voltages found in Specifications–Generator of Section 1 are based on a battery voltage of 12 volts. Should actual battery voltage vary (11-14 volts), resulting values will also vary.

NOTE

You'll need to hold the fuel rack in to maintain engine operation.

PowerBoost™ IIIE Voltage Regulator

The voltage regulator used on single-phase generator models is the Powerboost™ IIIE. The voltage regulator monitors output voltage magnitude and frequency to supply current to the generator exciter field. To test the voltage regulator the following components will be needed:

- Variable Transformer, 0–140 volts (0.5-amp Minimum)
- 120-volt AC Plug
- 120-volt, 100-watt Lamp
- AC voltmeter
- #14 AWG Copper Wire (minimum)

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule—replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

Hazardous voltage can cause severe injury or death. The heat sink of the voltage regulator contains high voltage. Do not touch voltage regulator heat sink when testing or electrical shock will occur.

PowerBoost™ IIIE Voltage Regulator Test Procedure

1. Disconnect P10 of wiring harness from connector on voltage regulator. (See Figure 7-1.)
2. Connect components as shown in Figure 7-3.
3. Turn variable transformer setting to zero. Plug in variable transformer.
4. Turn variable transformer on. Slowly increase variable transformer voltage to 100 volts. The lamp should go on between 30 to 40 volts up to 100 volts. If the lamp does not light, turn the voltage adjustment pot clockwise. If the light still does not go on, the voltage regulator is defective and should be replaced. This would correspond to a low- or no-voltage output condition.
5. Slowly increase voltage to 120 volts. The lamp should go out and stay out as voltage is further increased. If the lamp does not go out, turn the voltage adjustment pot counterclockwise. If the light still does not go out, the voltage regulator is defective and should be replaced. This would correspond to a high voltage output condition.
6. Turn variable transformer to zero and unplug AC cord.

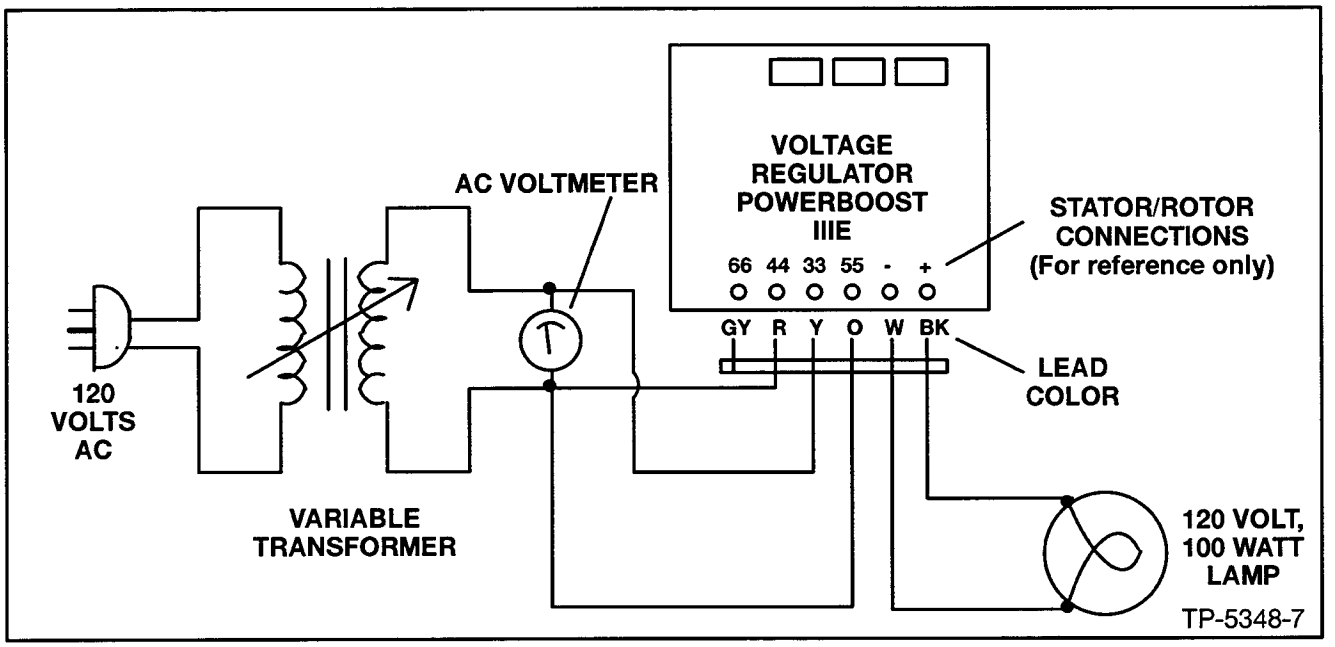


Figure 7-3. PowerBoost IIIE Voltage Regulator Test

PowerBoost™ IIIE Voltage Regulator Adjustment

The voltage regulator is factory set for proper generator operation under a variety of load conditions. Under normal circumstances, no further adjustment is necessary. However, if the regulator is replaced or has been tampered with, readjust according to the following procedure. Voltage regulator components are identified in Figure 7-4 and described in the following paragraphs.

NOTE

The voltage regulator is located in the junction box. Adjustments are possible without removing the regulator from the junction box. See Figure 7-5.

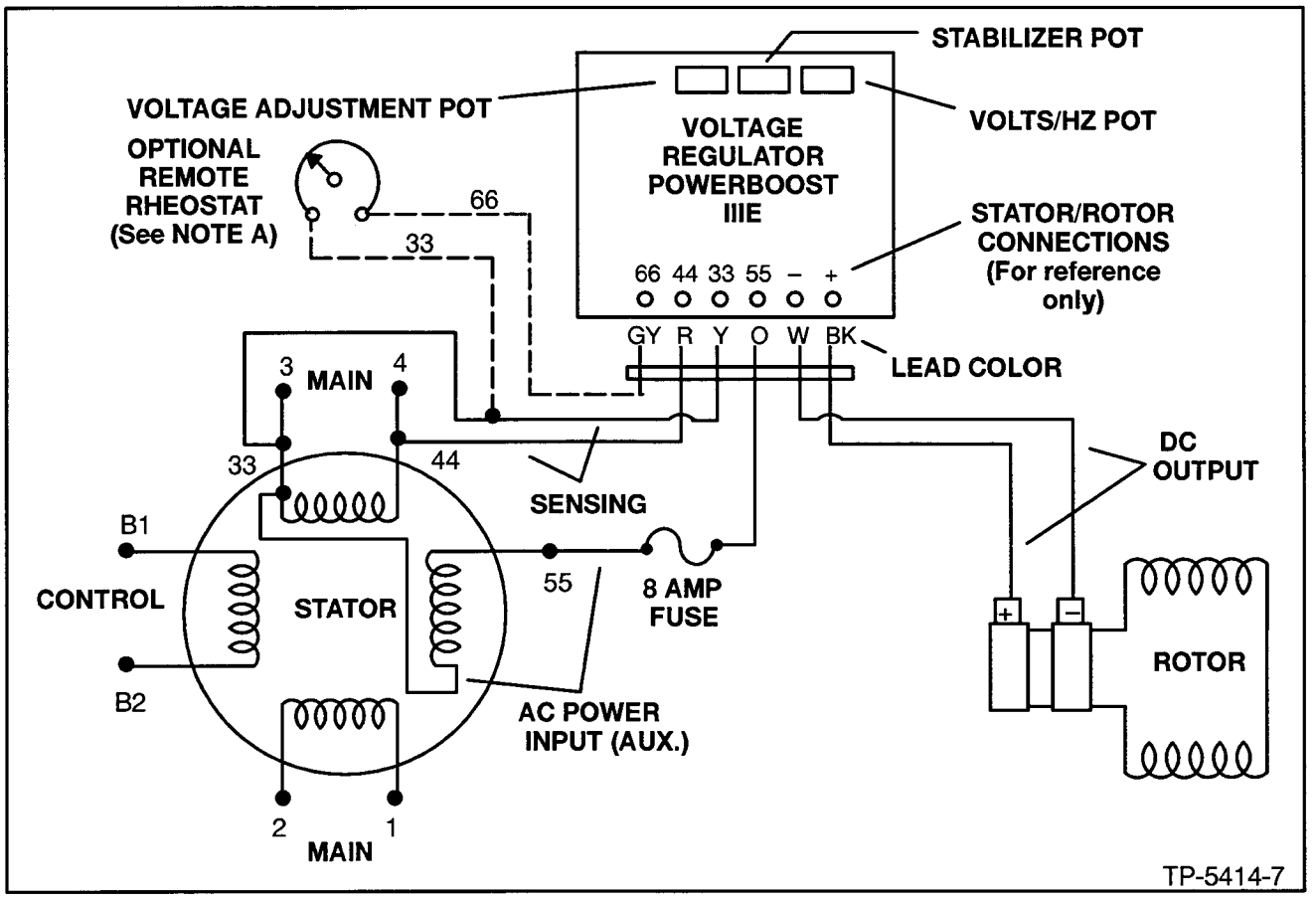
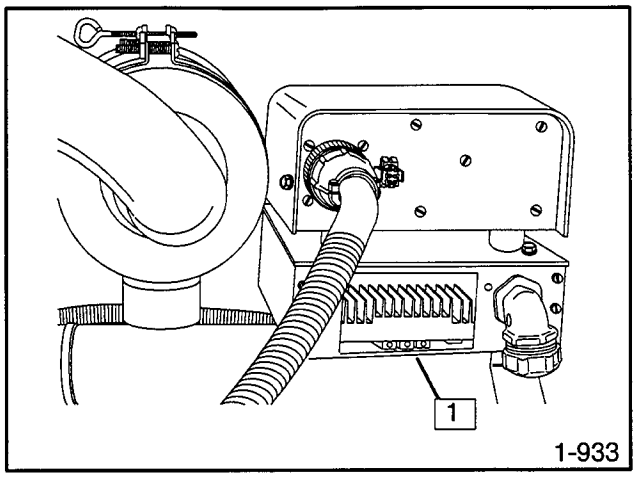


Figure 7-4. PowerBoost™ IIIE Voltage Regulator



1. Voltage Regulator

Figure 7-5. PowerBoost™ IIIE Voltage Regulator Installed

NOTE A

A customer-provided rheostat may be connected across regulator leads/terminals 33 and 66 to adjust generator output voltage from a location remote from the set. The rheostat (10k ohms, 1/2-watt minimum) will provide a 5-volt adjustment range.

Voltage Adjustment Pot–Adjusts generator output within range of approx. 100–130 Volts.

Stabilizer Pot–Fine-tunes regulator circuitry to reduce light flicker.

Volts/Hz Pot–Adjustment determines engine speed (Hz) at which generator output voltage will begin to drop.

The 15/20CCO generator sets have the Volts/Hz feature disabled by turning the Volts/Hz pot out (fully counterclockwise).

NOTE

For optimum results, full load should be applied when adjusting stability pot.

1. With generator set off, turn remote rheostat (if equipped) to midpoint. Turn **Voltage and Stability pots** fully counterclockwise. Connect voltmeter and frequency meter to AC circuit or an electrical outlet.
2. Start generator set. Rotate **voltage adjustment pot** clockwise to increase voltage (counterclockwise to decrease voltage) until desired output voltage is achieved.
3. Rotate **stability pot** clockwise until minimum light flicker is obtained.
4. Readjust **voltage adjustment pot** (if necessary).
5. Readjust engine speed to normal (1800 rpm for 60 Hz or 1500 rpm for 50 Hz).
6. Readjust **voltage adjustment pot** (if necessary).
7. Readjust **stability pot** (if necessary).
8. Use optional remote rheostat (if equipped) to make final voltage adjustments. STOP GENERATOR SET.

PowerBoost™ V Voltage Regulator

The voltage regulator used on three-phase generator models is PowerBoost™ V. See Figure 7-6.

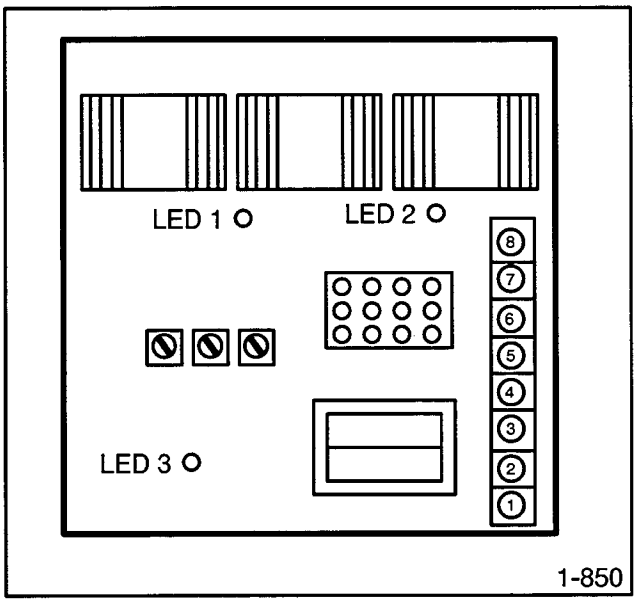


Figure 7-6. PowerBoost™ V Voltage Regulator

The PowerBoost™ V voltage regulator monitors output voltage magnitude to control current to the generator exciter field. The voltage regulator has an underfrequency unloading feature which is referred to as Volts-per-Hz (V/Hz). To determine if the voltage regulator is functioning properly, reduce engine speed (Hz) and watch for a corresponding drop in AC voltage. AC voltage should remain constant until engine speed drops below 57.5 Hz (on 60 Hz models) or 47.5 Hz (on 50 Hz models). When frequency drops below 57.5/47.5 Hz, AC voltage should decline. To further check the voltage regulator for proper function, perform the following test to check regulator output. To test the voltage regulator the following components will be needed:

- Step-up Transformer, 1:2, 120 to 240 Volts (1.0 Amp minimum)
- Variable Transformer, 0–140 Volts (1.0 Amp minimum)
- 120 Volt, 100 watt Lamp
- AC Voltmeter 250 Volt (minimum)
- 1 Amp Fuse
- 1 SPST Switch, 1 Amp (minimum)
- 120 Volt AC Plug
- #14 AWG Copper Wire (minimum)

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule—replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

Hazardous voltage can cause severe injury or death. The heat sink of the voltage regulator contains high voltage. Do not touch voltage regulator heat sink when testing or electrical shock will occur.

PowerBoost™ V Voltage Regulator Test Procedure

1. Disconnect P5 of wiring harness from connector on voltage regulator. (See Figure 7-1.)

2. Connect components as shown in Figure 7-7.

3. Turn variable transformer setting to zero. Plug in variable transformer. Plug in power source to terminals 5 and 6.

4. Turn variable transformer on. Turn SPST switch on. Slowly increase variable transformer voltage. The lamp should go on. Continue to increase variable transformer voltage and when the preset voltage is reached (observe voltmeter) the lamp will turn off and continue to stay off as voltage is further increased. The preset voltage is determined by the setting of the **Volts** adjustment pot on the voltage regulator. The preset voltage for a 120/240 volt system is 240 volts, for a 110/220 volt system it would be 220 volts, etc. If the voltage regulator functions as described, the voltage regulator is okay.

   If the lamp does not turn on, turn the voltage regulator **Volts** adjustment pot to the approximate midpoint and repeat test. If the lamp fails to go on after adjusting the **Volts** pot, replace the voltage regulator. A voltage regulator testing bad as described would cause a generator to have a no/low voltage condition.

   If the lamp fails to turn off as voltage is increased, turn the voltage regulator **Volts** adjustment pot to the approximate midpoint and repeat test. If the lamp fails to go off after adjusting the **Volts** pot, replace the voltage regulator. A voltage regulator testing bad as described would cause a generator to have a high voltage condition.

5. Turn variable transformer to zero and unplug AC cord. Turn SPST switch off and unplug cord.

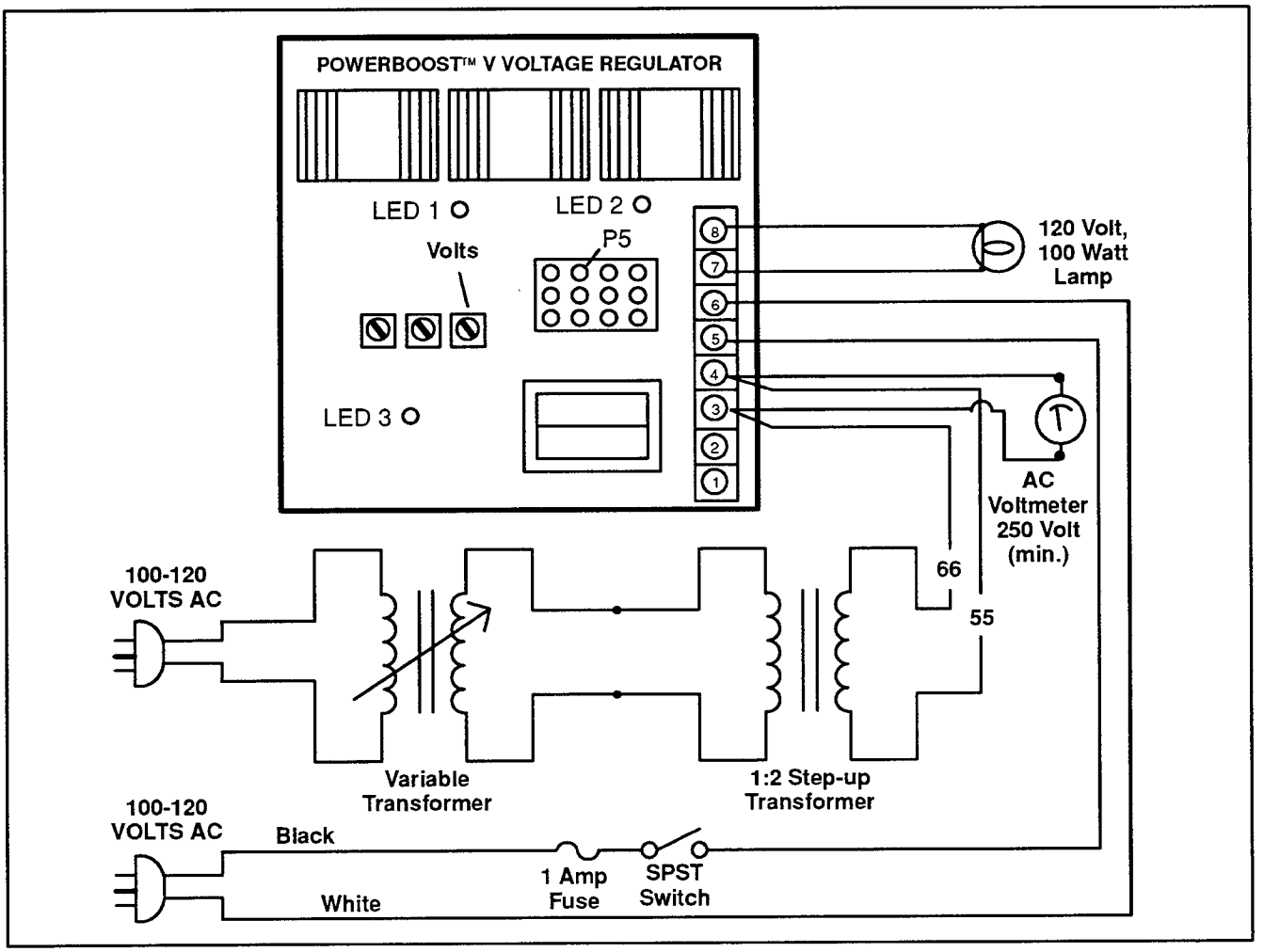


Figure 7-7. PowerBoost™ V Voltage Regulator Test

PowerBoost™ V Voltage Regulator Adjustment

The PowerBoost™ V voltage regulator monitors generator output to control current flow to the generator field. PowerBoost™ V maintains generator output under load until the generator engine speed drops to a preset level (factory setting 57.5 Hz on 60 Hz models and 47.5 Hz on 50 Hz models). At this point (under factory settings) the regulator allows generator voltage and current to drop to a level sufficient to handle load. When the generator speed returns to normal (60 Hz or 50 Hz) as load is accepted, generator output also returns to normal. The voltage regulator is factory set for proper generator operation under a variety of load conditions. Under normal circumstances, no further adjustment is necessary. However, if the regulator is replaced, has been tampered with, or voltage/frequency reconnection has been done, readjust according to the following procedure. Voltage regulator components are identified in Figure 7-8 and Figure 7-9 and described in the following paragraphs.

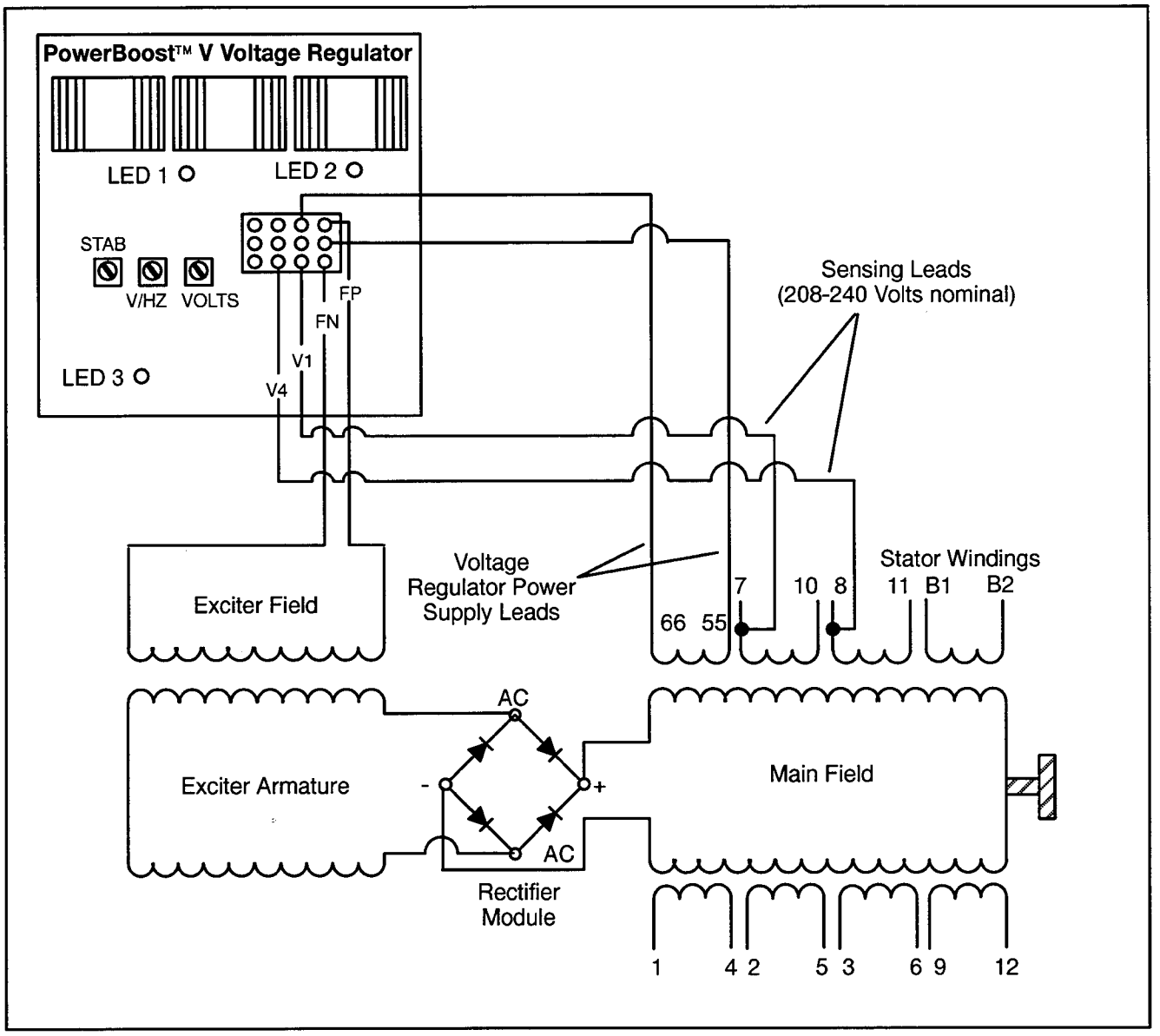
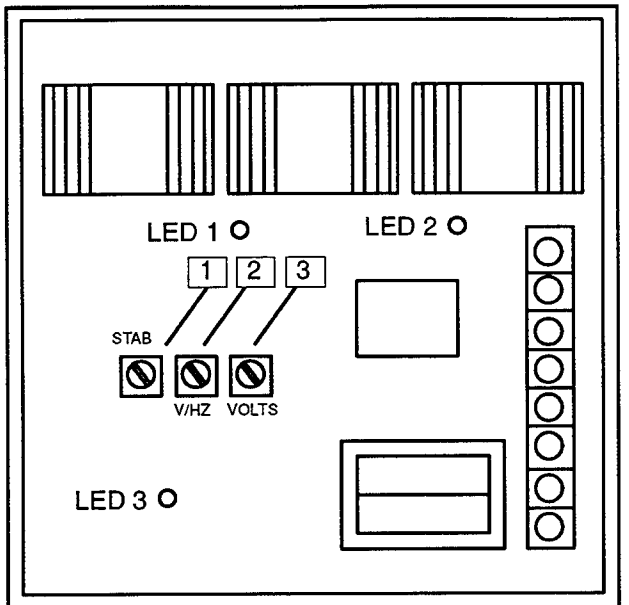


Figure 7-8. PowerBoost™ V Voltage Regulator



NOTE

The voltage regulator is located in the generator junction box and is serviceable by removing four screws.

1. **Stability Pot–** "Fine-tunes" regulator to reduce light flicker.
2. **Volts/Hz Pot–**Adjustment determines engine speed (Hz) at which generator output voltage will begin to drop.
3. **Voltage Adjustment Pot–**Adjusts generator output within range of 190–270 Volts (line-to-line).

Figure 7-9. PowerBoost™ V Adjustments

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

Hazardous voltage can cause severe injury or death. The heat sink of the voltage regulator contains high voltage. Do not touch voltage regulator heat sink when testing or electrical shock will occur.

Adjustment Procedure

1. Turn **Voltage, Volts/Hz, and Stability pots** fully counterclockwise. Connect voltmeter to AC circuit or an electrical outlet.
2. Start generator set. **Rotate Voltage Adjustment pot** clockwise (increase voltage) or counterclockwise (decrease voltage) until desired output voltage is achieved.
3. Rotate **Stability pot** clockwise until minimum light flicker is obtained.
4. Readjust **Voltage Adjustment pot** (if necessary).
5. **Mechanical Governor:** Adjust engine speed to desired cut-in frequency (factory setting 57.5–58 Hz for 60 Hz models or 47.5–48 Hz for 50 Hz models) as measured on frequency meter. See Section 3. Governor.
6. Rotate **Volts/Hz Adjustment pot** clockwise until voltage level begins to drop (as measured on voltmeter). When set to these specifications, the generator will attempt to maintain normal output until engine speed drops below the frequency set in step 5 (as load is applied).
7. **Mechanical Governor:** Readjust engine speed to normal (63 Hz/1890 rpm for 60 Hz or 52.5 Hz/1575 rpm for 50 Hz). See Section 3. Governor.
8. Readjust **Voltage Adjustment pot** (if necessary).
9. Readjust **Stability pot** (if necessary).
10. STOP GENERATOR SET.

Controller Circuit Board

It is possible to check some controller circuit board components (relays) without removing the component from the board. These checks should be made prior to installing a new board and attempting startup. Most of the tests are referenced in Section 4. General Troubleshooting. Use a high quality multimeter and follow the manufacturer's instructions. To obtain accurate readings when testing, remove all circuit board connectors and conformal coating (transparent insulation) from component terminals. Use the chart, Figure 7-10, and refer to the controller circuit board layout and schematic in Figure 7-11.

Component	Ohmmeter Connections	Remarks	Results
K1 Relay Coil	K1 coil terminals (See relay schematic)	Ohmmeter on R x 10 scale	If good–approx. 160 ohms. Low resistance (continuity)–shorted coil. High resistance–open coil.
K2 Relay Coil	K2 coil terminals (See relay schematic)	Ohmmeter on R x 10 scale	If good–approx. 160 ohms. Low resistance (continuity)–shorted coil. High resistance–open coil.
K3 Relay Coil	K3 coil terminals (See relay schematic)	Ohmmeter on R x 10 scale	If good–approx. 400 ohms. Low resistance (continuity)–shorted coil. High resistance–open coil.
K4 Relay Coil	K4 coil terminals (See relay schematic)	Ohmmeter on R x 10 scale	If good–approx. 125 ohms. Low resistance (continuity)–shorted coil. High resistance–open coil.
K5 Relay Coil	K5 coil terminals (See relay schematic)	Ohmmeter on R x 10 scale	If good–approx 510 ohms. Low resistance (continuity)–shorted coil. High resistance–open coil.

Figure 7-10. E-239563 Circuit Board Tests

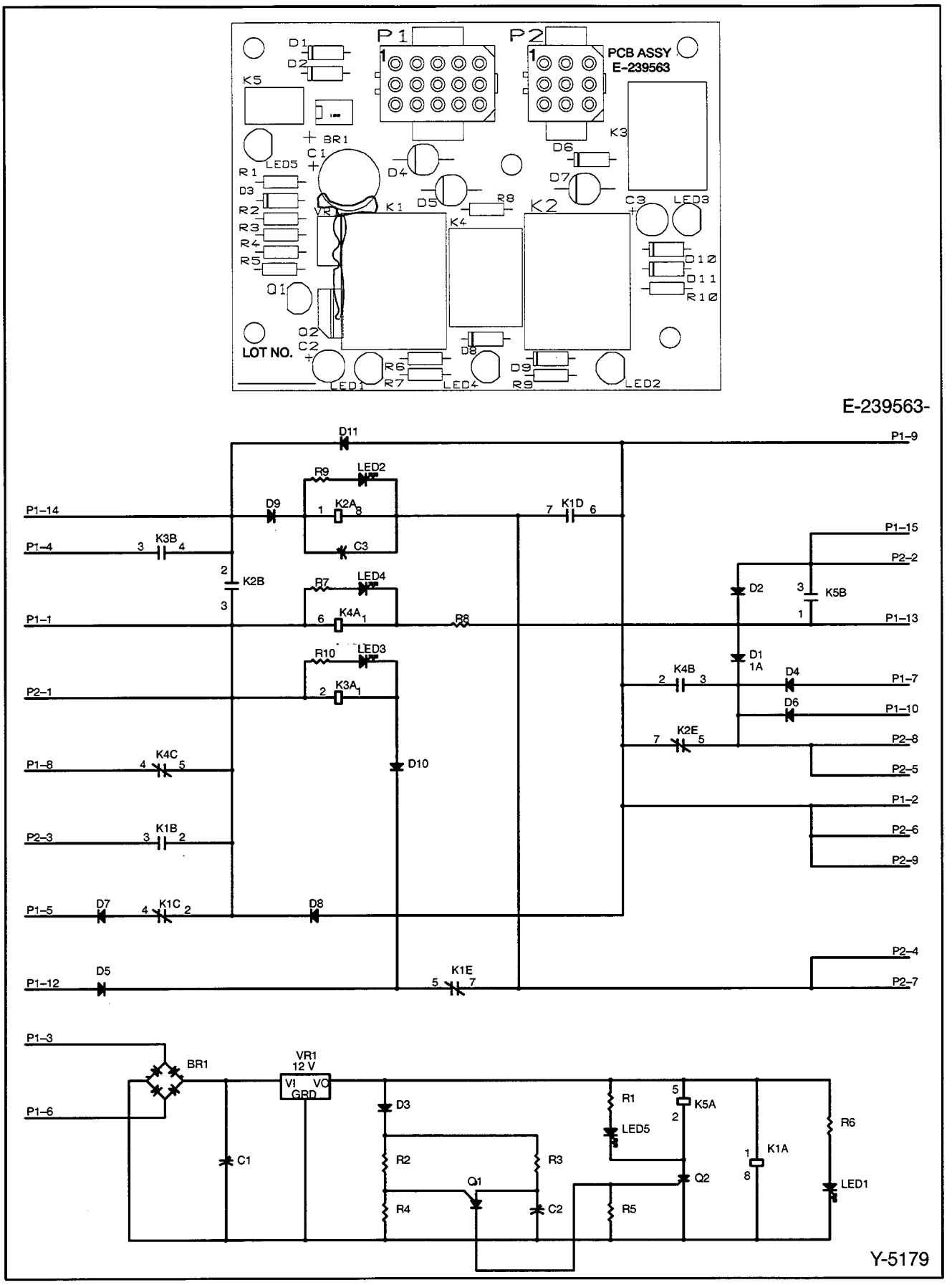


Figure 7-11. Controller Circuit Board Testing

Engine/Generator Components

With the generator set battery connected, the wiring harness and some engine/generator components can be checked with a voltmeter as described in Figure 7-12. Place the controller or remote start/stop switch in the prescribed position and check for 12 volts DC at each component using a DC voltmeter. This will verify that the switches function and 12 volt DC is present at each component.

Component	Voltmeter Connections	Remarks	Results
Hourmeter and wiring	Red test clip to hourmeter (+) terminal. Black test clip to (–) terminal.	Voltmeter setting 12 volts.	If wiring harness is good–12 volts DC or greater. To determine if hourmeter is good, proceed to next step.
	None (see Remarks)	Disconnect hourmeter leads and apply 12 volts DC to hourmeter. **NOTE:** Hourmeter is polarity sensitive.	If good–hourmeter will operate.
B1 and B2 stator auxiliary winding	Disconnect B1/B2 leads. Connect AC voltmeter to leads. **NOTE:** Voltage can only be measured momentarily since unit will not continue to run after start switch is released.	Voltmeter setting 20 volts AC or greater. Start generator set by holding Start/Stop switch in Start and allow to reach proper speed. Take reading and then stop generator.	Reading of 12–15 volts indicates B1/B2 winding is good.
Fuel solenoid (three-lead)	Red test clip to #6 lead of solenoid and black test clip to engine block (ground). Place controller switch to Start position. STOP generator set.	Voltmeter setting 12 volts or greater. If lead can not be disconnected, cut leads and crimp-on fully insulated push-on terminals.	If wiring is good–12 volts DC. To determine if fuel solenoid is good, proceed to next step.
	None (see Remarks)	Push out leads #6 and "P" at the 4-pin connector. Apply 12 volts DC to #6 lead and momentarily apply 12 volts DC to "P" lead. **NOTE:** Apply voltage only momentarily to "P" lead to prevent fuel solenoid damage. This coil draws 50 amps and is intended only to energize the solenoid.	If good–fuel solenoid will energize and move plunger when voltage is applied to "P" lead and remain held in after "P" lead is disconnected as long as #6 lead has voltage applied to it.

Figure 7-12. Engine/Generator Component Testing with Voltmeter

⚠ WARNING

Sulfuric acid in batteries.
Can cause severe injury or death.

Use protective goggles and clothes. Can cause permanent damage to eyes, burn skin, and eat holes in clothing.

Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc. to prevent burns and to prevent sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling battery. Never connect negative (–) battery cable to positive (+) connection terminal of starter solenoid. Do not test battery condition by shorting terminals together or sparks could ignite battery gases or fuel vapors. Any compartment containing batteries must be well ventilated to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being charged and always turn charger off before disconnecting battery connections. When disconnecting battery, remove negative lead first and reconnect it last.

To further check generator set components, disconnect the battery and remove wiring harness plugs from the controller circuit board. Use an ohmmeter to check continuity and to isolate defective components as described in Figure 7-13. Also refer to the proper wiring diagram in Section 9.

NOTE

Before performing ohmmeter checks, disconnect generator set battery to prevent damage to the ohmmeter.

Component	Ohmmeter Connections	Remarks	Results
Controller switch	P2-6 and P2-4	Ohmmeter on R x 1 scale. Place rocker switch in START position.	If good–zero ohms (continuity). Any resistance other than zero or very low ohms–replace switch.
	P2-6 and P2-5	Ohmmeter on R x 1 scale. Place rocker switch in STOP position.	If good–zero ohms (continuity). Any resistance other than zero or very low ohms–replace switch.
K20 relay coil	P1-4 and P1-9	Ohmmeter on R x 1 scale	If good–85 ohms. Low resistance–shorted K20 relay coil and/or wiring. High resistance–open K20 relay and/or wiring.
K25 relay coil	P1-8 and P1-9	Ohmmeter on R x 1 scale	If good–85 ohms. Low resistance–shorted K25 relay coil and/or wiring. High resistance–open K25 relay and/or wiring.
Starter solenoid ('S' relay)	P4-4 and battery (–) cable. **NOTE:** J4 and P4 must be disconnected to perform this test.	Ohmmeter on R x 1 scale.	If good–approx. 0.20–0.35 ohms at 80° F (27° C).
Controller 10-amp fuse and wiring	Battery positive (+) cable and P1-14 **NOTE:** J4 and P4 must be connected to perform this test.	Ohmmeter on R x 1 scale.	If good–zero or very low ohms. No reading (infinity)–open circuit or fuse blown.
Air heater relay (C1 on single phase and AH on three phase)	P4-8 and P4-1	Ohmmeter on R x 1 scale.	If good–approx. 16–20 ohms at 80°F (27°C).

Figure 7-13. Engine/Generator Set Component Testing with Ohmmeter (Sheet 1 of 2)

Component	Ohmmeter Connections	Remarks	Results
P1 ground connection	P1-9 and ground	Ohmmeter on R x 1 scale.	If good–zero ohms (continuity). Any other reading indicates a poor ground connection.
Low oil pressure (LOP) safety shutdown switch	P1-15 and engine block (ground) **NOTE:** J4 and P4 must be connected to perform this test.	Ohmmeter on R x 1 scale. This test is not conclusive until the temperature shutdown switches are checked.	If good–zero ohms (continuity). Then, disconnect LOP switch lead and isolate terminal. Meter reading reading should show an open circuit.
High water temperature (HWT) safety shutdown switch	P1-15 and engine block (ground) **NOTE:** LOP switch lead should be removed and isolated. **NOTE:** J4 and P4 must be connected to perform this test.	Ohmmeter on R x 1 scale.	If good–open circuit. Any continuity suggests that temperature switch(es) are defective. Disconnect individual leads to determine which switch is defective.
Rotor	See separate paragraph with same title.	See separate paragraph with same title.	See separate paragraph with same title.
Stator	See separate paragraph with same title.	See separate paragraph with same title.	See separate paragraph with same title.
Exciter Field	See separate paragraph with same title.	See separate paragraph with same title.	See separate paragraph with same title.
Exciter Armature	See separate paragraph with same title.	See separate paragraph with same title.	See separate paragraph with same title.
Fuel Solenoid	See separate paragraph with same title.	See separate paragraph with same title.	See separate paragraph with same title.

Figure 7-13. Engine/Generator Set Component Testing with Ohmmeter (Sheet 2 of 2)

Rotor

The four-pole rotor creates the magnetic field needed to sustain alternating current in the stator windings. Prior to testing, inspect the rotor for visible damage to pole shoes, insulation, exposed coil windings, and slip ring surfaces. Check rotor bearing for noisy operation, excessive wear, and heat discoloration. Replace or repair these components if any of the above conditions exist.

Single-Phase Rotor Tests

Slip rings acquire a glossy brown finish in normal operation. Do not attempt to maintain a bright, newly machined appearance. Ordinary cleaning with a dry, lint-free cloth is usually sufficient. Very fine sandpaper (#00) may be used to remove roughness. Use light pressure on the sandpaper. Do not use emery or carborundum paper or cloth. Clean out all carbon dust from the generator. If the rings are black or pitted, remove the rotor and remove some of the surface material using a lathe.

Check the rotor for continuity and resistance. Measure the rotor resistance (ohms) between the two slip rings (Figure 7-14). See Specifications–Generator in Section 1 for typical readings.

NOTE

Since ohmmeters do vary in their accuracy, use values in Section 1 as a reference for approximate readings. Readings must be at room temperature or about 70° F (21° C). Rotor resistance will vary directly with increase in temperature.

To check for rotor shorted to ground, adjust ohmmeter to zero ohms. Touch one ohmmeter lead to either slip ring and other lead to rotor poles or shaft. Meter should register no continuity.

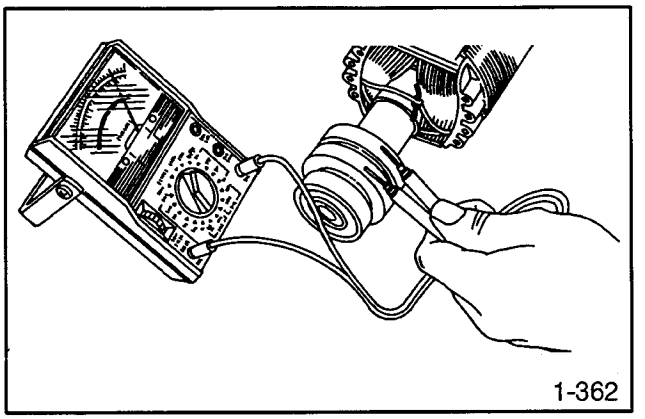


Figure 7-14. Rotor Resistance Check

NOTE

When checking rotor resistance with rotor installed, brushes must not be in contact with rotor slip rings. Use brush retainer on brushes for accurate resistance readings.

The rotor must be repaired or replaced if any faults are detected in the previous tests.

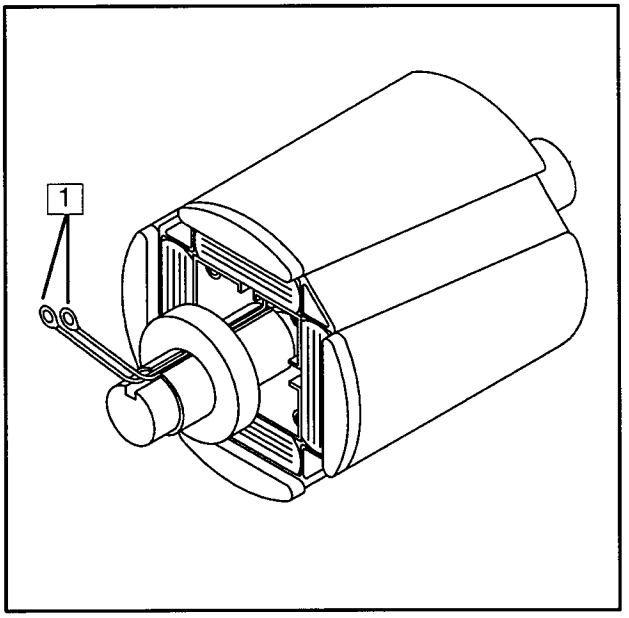
Three-Phase Rotor Tests

Check the rotor for continuity and resistance. To perform check, disconnect rotor leads from rectifier module circuit board and then measure the rotor resistance (ohms) between the two rotor leads (Figure 7-15). See Specifications–Generator in Section 1 for typical readings.

NOTE

Since ohmmeters do vary in their accuracy, use values in Section 1 as a reference for approximate readings. Readings must be at room temperature or about 70° F (21° C). Rotor resistance will vary directly with increase in temperature.

To check for rotor shorted to ground, adjust ohmmeter to zero ohms. Touch one ohmmeter lead to either rotor lead and other lead to rotor poles or shaft. Meter should register no continuity.



1. Rotor Leads

Figure 7-15. Rotor Resistance Check

The rotor must be repaired or replaced if any faults are detected in the previous tests.

Stator

The stator consists of a series of coils of wire placed in a laminated steel frame. The stator leads supply voltage to the AC load and exciter regulator.

Prior to testing, inspect the stator for heat discoloration and visible damage to housing lead wires, exposed coil windings, and exposed and varnished areas of frame laminations. Be sure the stator is securely riveted in the stator housing.

Checking Single-Phase Stator Continuity and Resistance

1. To check stator continuity, set ohmmeter on R x 1 scale. Contact the red and black meter leads; adjust ohmmeter to zero ohms. Check stator continuity by connecting meter leads to stator leads as shown in Figure 7-16.

NOTE

Disconnect all stator leads prior to performing stator continuity tests.

Leads 1, 2, 3, and 4 are the generator output leads. Leads 33 and 44 are the voltage regulator sensing leads. Leads 33 and 55 are the voltage regulator power supply. Leads B1 and B2 are the generator output interlock circuit for the controller. Refer to the schematic in Figure 7-17 when performing the following tests.

- There must be continuity between leads 1 and 2.
- There must be continuity between leads 3 and 4.
- There must be continuity between leads 33 and 44.
- There must be continuity between leads 33 and 55.
- There must be continuity between leads B1 and B2.
- There must be NO continuity between lead 1 and leads 3, 4, 33, 44, and 55.
- There must be NO continuity between lead 1 and leads B1 and B2.
- There must be NO continuity between lead 4 and leads B1 and B2.
- There must be NO continuity between any stator lead and ground on stator housing or frame laminations.
- If any check fails, the stator must be repaired or replaced.

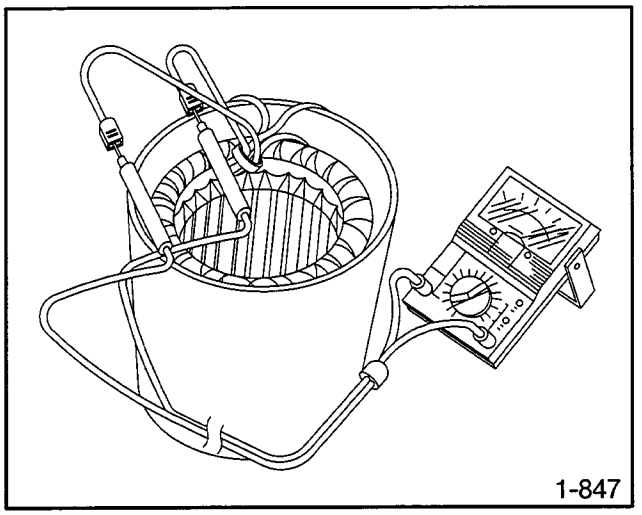


Figure 7-16. Stator Resistance Check

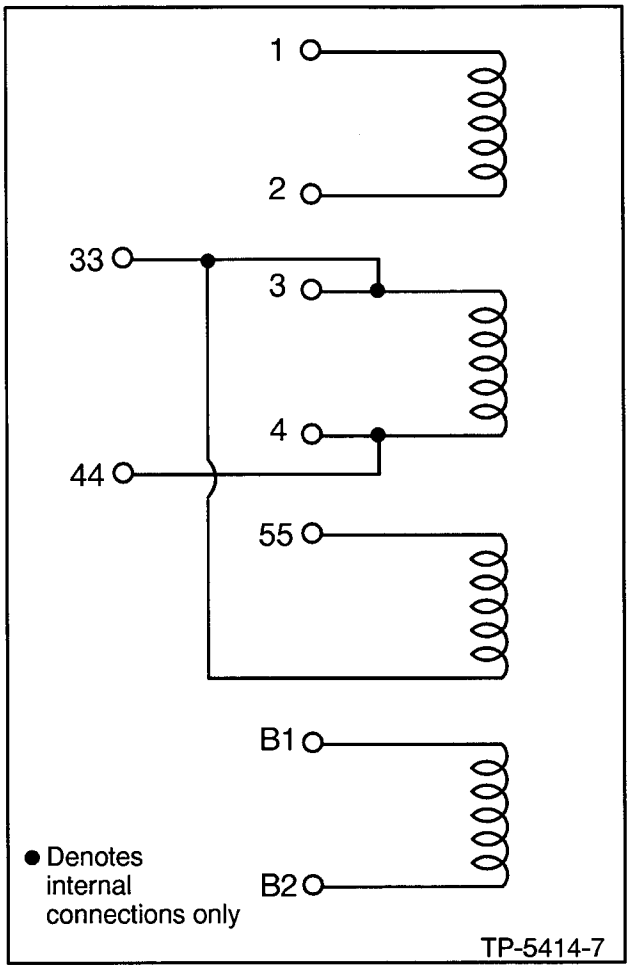


Figure 7-17. Generator Stator Leads

Checking Three-Phase Stator Continuity and Resistance

1. To check stator continuity, set ohmmeter on R x 1 scale. Contact the red and black meter leads; adjust ohmmeter to zero ohms. Check stator continuity by connecting meter leads to stator leads.

NOTE

Disconnect all stator leads prior to performing stator continuity tests.

Leads 1, 2, 3, and 4 are the generator output leads. Leads 55 and 56 are the voltage regulator power supply. Leads B1 and B2 are the generator output interlock circuit for the controller. Refer to the schematic in Figure 7-18 when performing the following tests.

- There must be continuity between leads 1 and 4.
- There must be continuity between leads 2 and 5.
- There must be continuity between leads 3 and 6.
- There must be continuity between leads 7 and 10.

- There must be continuity between leads 8 and 11.
- There must be continuity between leads 9 and 12.
- There must be continuity between leads 55 and 66.
- There must be continuity between leads B1 and B2.
- There must be NO continuity between lead 1 and leads 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 55, 66, B1, or B2.
- There must be NO continuity between lead 2 and leads 3, 6, 7, 8, 9, 10, 11, 12, B1, B2, 55, or 56.
- There must be NO continuity between lead 3 and leads 7, 8, 9, 10, 11, 12, B1, B2, 55, or 56.
- There must be NO continuity between lead 7 and leads 8, 9, 11, 12, B1, B2, 55, or 56.
- There must be NO continuity between lead 8 and leads 9, 12, B1, B2, 55 or 56.
- There must be NO continuity between lead 9 and leads B1, B2, 55 or 56.
- There must be NO continuity between lead B1 and leads 55 or 56.
- There must be NO continuity between any stator lead and ground on stator housing or frame laminations.
- If any check fails, the stator must be repaired or replaced.

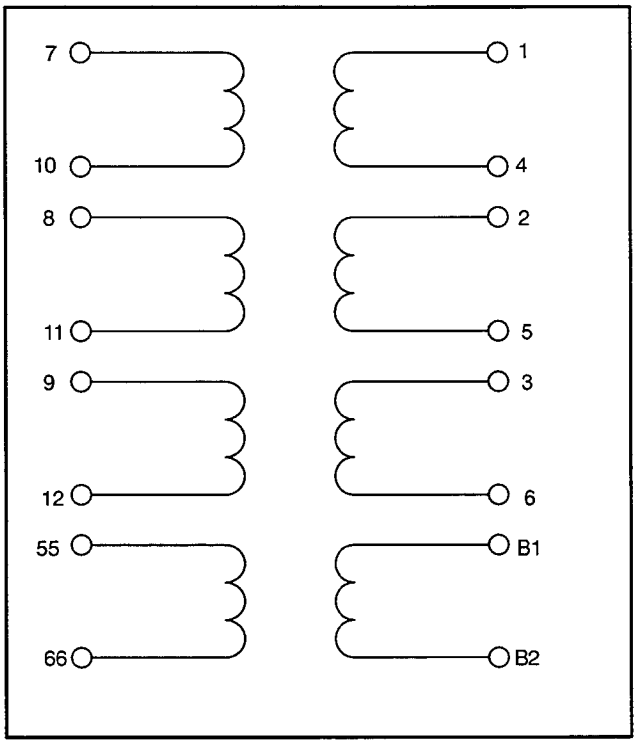


Figure 7-18. Stator Resistance Check

Exciter Field

The exciter field, used only on three-phase generator sets, is magnetized by DC current. When the exciter armature is rotated within the magnetized exciter field windings, an electrical current develops within the exciter armature. Test the exciter field according to the following procedure.

1. Disconnect generator starting battery (negative lead first) and power to battery charger (if equipped). Disconnect plug P5 of wiring harness from the voltage regulator.
2. Check exciter field resistance by connecting an ohmmeter across exciter field F1 and F2 (pins 10 and 12 of P5). See Figure 7-19. The resistance reading for a cold exciter field is found in Specifications–Generator of Section 1. A low reading indicates an internal short and a high reading indicates an open winding. Repair or replace exciter field if ohmmeter readings indicate exciter field is defective. If resistance test proves inconclusive, perform a megohmmeter test on exciter field as described in the next step.

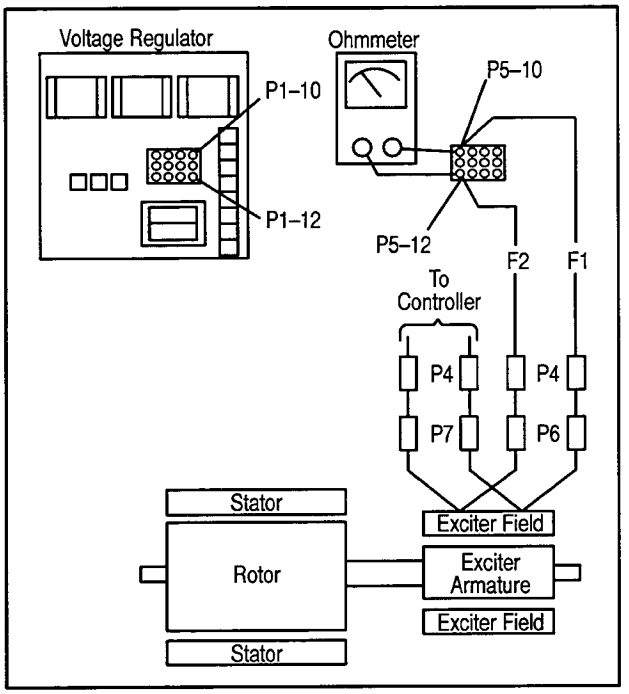


Figure 7-19. Checking Exciter Field Resistance

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule–replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

3. Check exciter field for a grounded condition. Disconnect P5, P6, and P7. Using a megohmmeter, apply 500 volts DC to F1 or F2 lead and exciter field frame. See Figure 7-20. (Follow the instructions of the megohmmeter manufacturer when performing this test.) A reading of approximately 500K ohms (1/2 megohm) and higher indicates the field winding is good. A reading of less than 500K ohms (approximately) indicates deterioration of winding insulation and possible current flow to ground. Repair or replacement of the exciter field is necessary.

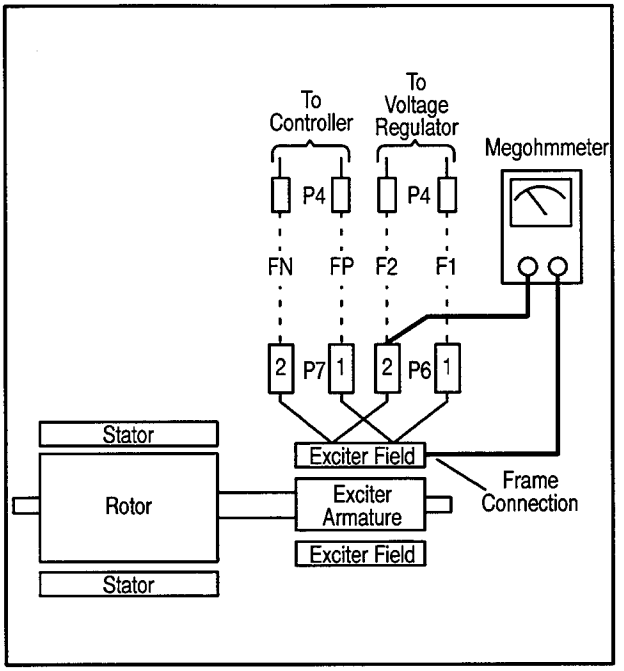


Figure 7-20. Megohmmeter Connections on Exciter Field

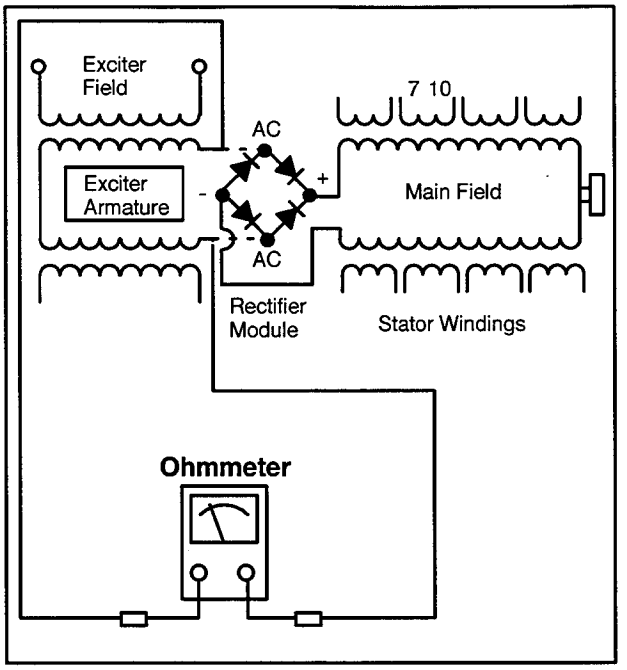


Figure 7-21. Exciter Armature Ohmmeter Test

Exciter Armature

The exciter armature, used only on three-phase generator sets, supplies excitation current to the generator main field (through the rectifier module). Test the exciter armature as described in the following steps. (The generator must be disassembled prior to performing this test.)

1. With generator disassembled, disconnect armature leads from rectifier module AC terminals.

2. With an ohmmeter on the R x 1000 scale, check resistance across exciter armature leads. See Figure 7-21. The armature resistance is found in Specifications–Generator of Section 1. No continuity indicates an open armature winding. If the resistance test proves inconclusive, perform a megohmmeter test on the exciter armature as described in the next step.

NOTE

Most ohmmeters will not provide accurate readings when measuring less than one ohm. The exciter armature can be considered good if a low resistance reading is obtained (continuity) and there is no evidence of shorted windings (heat discoloration).

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule–replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

3. Check exciter armature for a grounded condition. Using a megohmmeter, apply 500 volts DC to either armature lead and armature frame. (Follow the instructions of the megohmmeter manufacturer when performing this test.) See Figure 7-22. A reading of approximately 500K ohms (1/2 megohm) and higher indicates the exciter armature is good. A reading of less than 500K ohms (approximately) indicates deterioration of winding insulation and possible current flow to ground. Repair or replacement of the exciter armature is necessary.

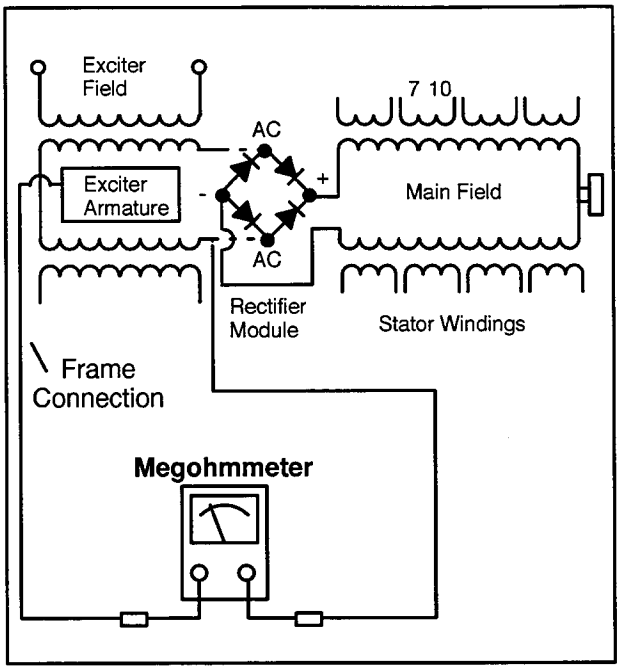


Figure 7-22. Megohmmeter Connections on Exciter Armature

Fuel Solenoid

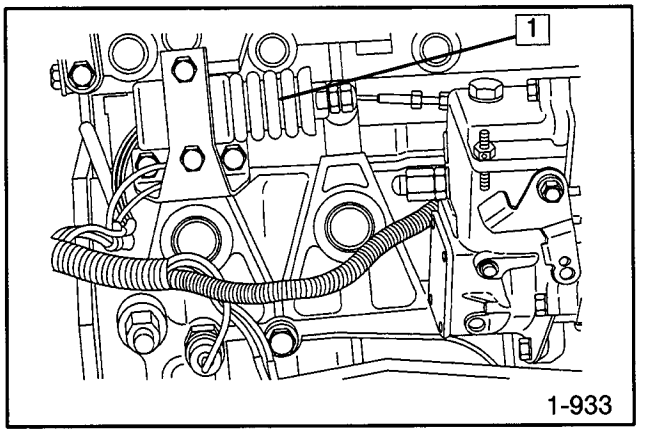
The fuel solenoid serves to pull the injector pump lever to the "fuel on" position when energized. The fuel solenoid is spring loaded to return the injector pump lever to the "fuel off" position when de-energized.

The 15/20CCO models use a three-lead fuel solenoid. This solenoid has a white lead marked "P," which energizes the "pull" coil only during cranking. During operation, the red lead marked "6" on single-phase sets or "14" on three-phase sets energizes the "hold" coil and the black lead marked "N" is the common ground.

Current (amps) and resistance readings are shown in Figure 7-23. Resistance readings can be taken to determine if the solenoid windings are open or shorted. These tests must be made with fuel solenoid disconnected from engine wiring harness. See Figure 7-24 for fuel solenoid location.

Fuel Solenoid	Reading
"pull" current	31 amps
"hold" current	0.8 amps
Plunger "pull" resistance	0.387 ohms
Plunger "hold" resistance	14.94 ohms

Figure 7-23. Fuel Solenoid Readings



1. Fuel Solenoid

Figure 7-24. Fuel Solenoid Location

Remote Start Panels (Optional)

Three remote panels are offered. The first uses a start/stop switch. The second has a start/stop switch and two gauges. The third incorporates a start/stop switch and four gauges. If difficulty with remote operation occurs, the switch, gauges, and gauge senders can be tested for proper function. Prior to testing, disconnect J3/P3 connector.

Sender Tests

To test water temperature sender, connect ohmmeter to controller socket P3-1 and P3-3 (P3-2 for three phase). See Figure 7-25 for resistance by varying temperatures. Start generator set to change temperature. STOP generator set when test is complete.

To test oil pressure sender, connect ohmmeter to controller socket P3-1 and P3-6 (P3-3 for three phase). See Figure 7-26 for resistances by varying pressure. Start generator set to change pressure. STOP generator set when test is complete.

Generally, senders can be presumed good if they change their resistance values as their respective pressure/temperature change. A defective sender will either be open or shorted.

Panel Tests

Panels can be tested with an ohmmeter as described in Figure 7-27 or with a voltmeter as detailed in Figure 7-28.

Temperature @	VDO (2-Meter, 4-Meter Panel)
140°F (60°C)	134 ± 10%
194°F (90°C)	51.5 ± 4%
212°F (100°C)	38 ± 3%

Figure 7-25. Water Temperature Sender Resistance (in Ohms)

Pressure @	VDO (2-Meter, 4-Meter Panel)
0 PSI (0 kPa)	5–15
25 PSI (172 kPa)	43–53
50 PSI (345 kPa)	77–87
75 PSI (517 kPa)	105–115
100 PSI (690 kPa)	130–140

Figure 7-26. Oil Pressure Sender Resistance (in Ohms)

Component	Ohmmeter Connections	Remarks	Results
Remote switch	P3-1 and P3-4 (P3-5 for three phase) (Plug side). Place remote rocker switch to START position.	If good–continuity	Ohmmeter on R x 1 scale
	P3-1 and P3-5 (P3-6 for three phase) (Plug side). Place remote rocker switch to STOP position.	If good–continuity	Ohmmeter on R x 1 scale

Figure 7-27. Remote Panel Testing with Ohmmeter

Component	Voltmeter Connections	Remarks	Results
Remote switch "ON" light, gauge lights, DC voltmeter, and hourmeter (if equipped)	Red test lead to P3-2 (P3-4 for three phase) (socket side) and black test to P3-1 (socket side). Place controller start/stop switch to start position. STOP generator set when test is completed.	If 12 volt DC is present and component does not function after P3 plug is connected to controller –replace	Voltmeter setting 12 volts or greater. Generator set does not need to be running, just cranking for this test. **NOTE:** Hourmeter is not illuminated. To further test components, connect to 12-volt battery. **NOTE:** Hourmeter is polarity sensitive.
Water temperature gauge	Red test lead to P3-2 (P3-4 for three phase) (socket side) and black test lead to P3-3 (P3-2 for three phase) (socket side). Start generator set for test. STOP unit when test is completed.	If 0.5–12 volts DC is present and gauge does not function after P3 is connected to controller –replace gauge.	Voltmeter setting 12 volts or greater.
Oil pressure gauge	Red test lead to P3-2 (P3-4 for three phase) (socket side) and black test lead to P3-6 (P3-3 for three phase) (socket side). Start generator set for test. STOP unit when test is completed.	If 0.5-12 Volts is present and gauge does not function after P3 plug is connected to controller –replace gauge.	Voltmeter setting 12 volts or greater.

Figure 7-28. Remote Panel Testing with Voltmeter

Section 8. Disassembly/Reassembly

Prior to disassembly, the generator set must be unbolted from the vehicle compartment. Disconnect all external connections—battery cables at battery (negative lead first), AC output leads in controller, remote start panel at controller connector, fuel line at fuel pump filter inlet, and exhaust connections. Observe all safety precautions listed at the beginning of this manual during the disassembly/reassembly procedure.

NOTE

Several models are covered in this manual and the procedure for disassembly/reassembly may vary due to product updates and assembly variations. Major differences are noted where appropriate.

NOTE

HARDWARE DAMAGE! Engine and generator may make use of both American Standard and metric hardware. Be sure to use the correct size tools to prevent rounding of bolt heads and nuts.

Single-Phase Generator Disassembly

NOTE

The voltage regulator is located in the junction box on these models. Adjustments are possible without removing the junction box or controller.

1. Remove the mounting screws securing the controller cover. Separate the cover from the controller. See Figure 8-1.

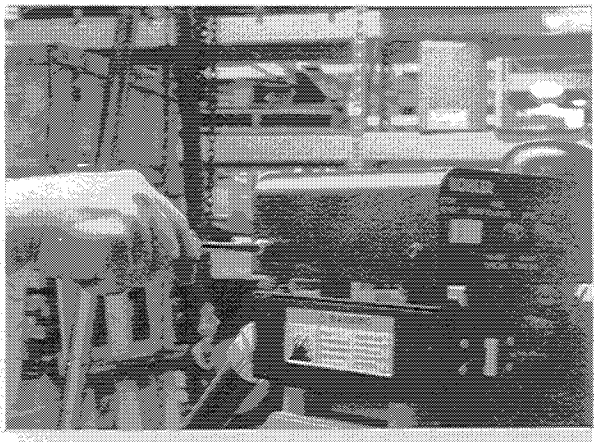


Figure 8-1. Removing the Controller Cover

2. Disconnect the 22-pin controller harness (P4) located at the back of the controller. See Figure 8-2.

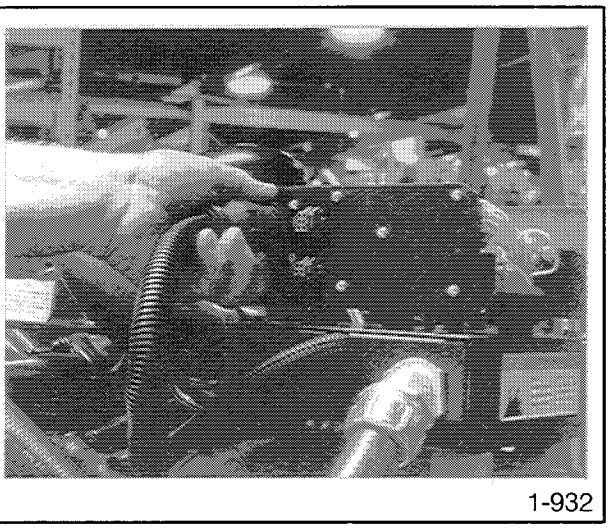


Figure 8-2. Disconnecting the 22-Pin Connector

3. Loosen the screws on the junction box cover using a 5/16-inch nut driver or 5/16-inch wrench. See Figure 8-3.

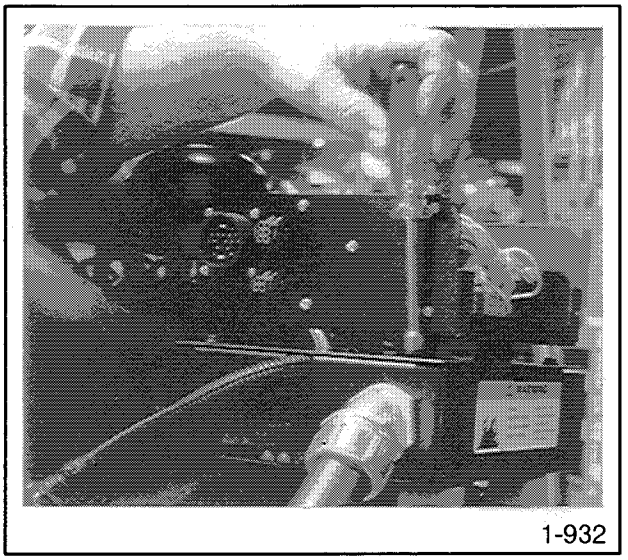


Figure 8-3. Removing the Junction Box Cover

4. Slide the junction box cover (and controller box) forward and lift to remove.
5. Inside the junction box, cut the cable tie and disconnect leads 9 and 20 at the white plastic connector.
6. Disconnect leads 33 and 44.
7. Disconnect the 6-pin connector (P10) to the voltage regulator.
8. Disconnect B1 and B2 battery charging leads.
9. Disconnect lead 55 from the fuse holder.
10. Remove the negative lead from the hazard ground stud using a 7/16-inch nut driver.
11. Disconnect stator leads 1 and 4 from the line side of the circuit breaker using a 5/16-inch wrench. Disconnect stator leads 2 and 3 from L0 ground stud using a 7/16-inch nut driver.
12. Remove the four junction box mounting screws using a 7/16-inch ratchet to remove the junction box from the stator mounting bracket. See Figure 8-4.

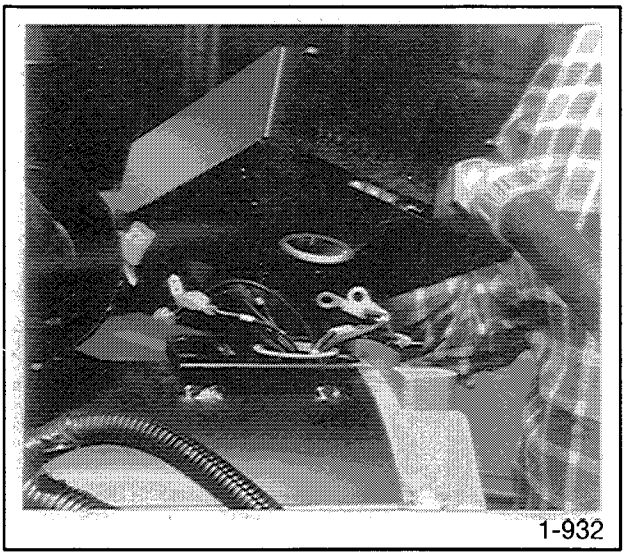


Figure 8-4. Removing the Junction Box

13. Remove the six screws securing the end bracket panel to the unit using a 5/16-inch nut driver. Remove the panel to expose the end bracket assembly. See Figure 8-5.

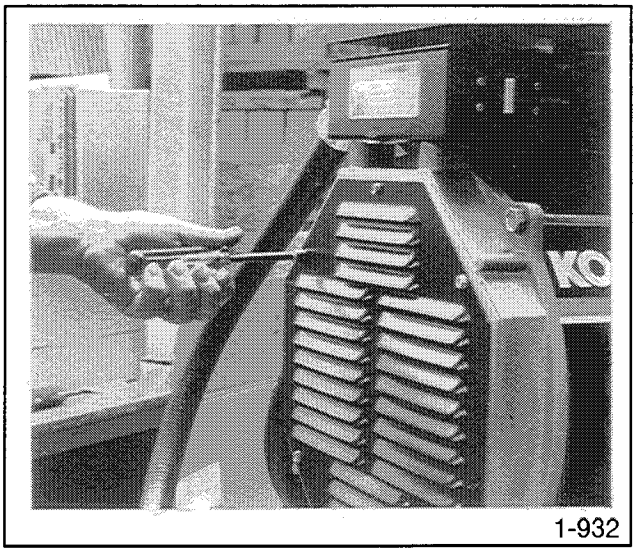


Figure 8-5. End Bracket Removal

14. Raise brushes in holders (two sets) by pushing leads upward in the slots. Retain brushes by inserting a length of wire or a paper clip. See Figure 8-6.

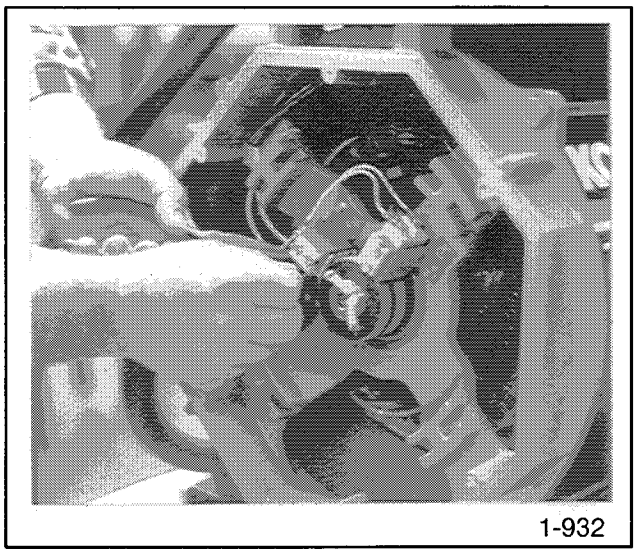


Figure 8-6. Raising Brushes

15. Remove the bolts from the two generator vibromounts using a 1/2-inch wrench. See Figure 8-7.

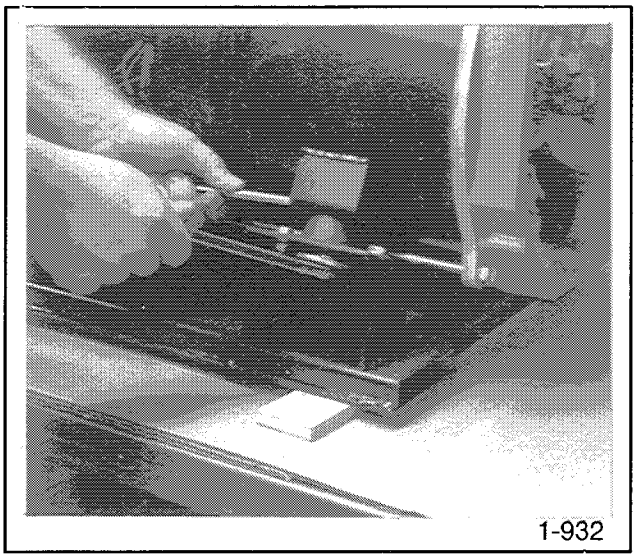


Figure 8-7. Removing the Vibromounts

16. Place the hoist hook into the generator hoisting eye and raise generator end, see Figure 8-8. Place a wood block under flywheel housing and lower generator until housing is supported by block. See Figure 8-8.

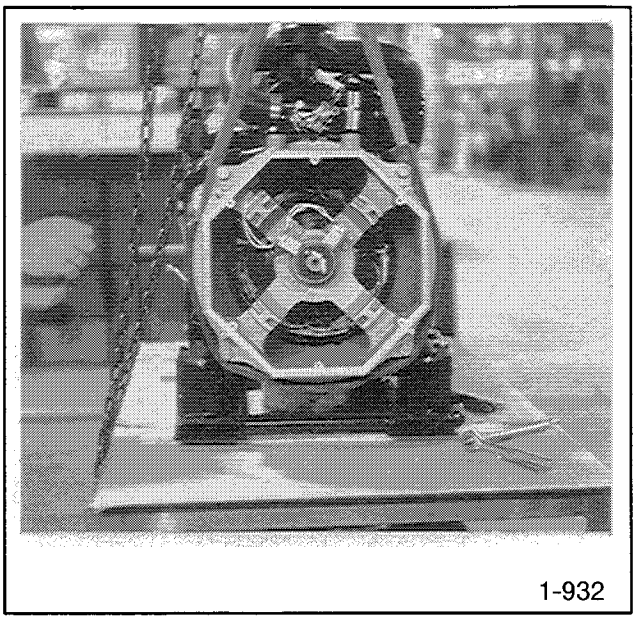


Figure 8-8. Using Hoist to Raise Generator Set

NOTE

Hoist capacity should be rated at one-half ton or greater.

17. Remove the four overbolts securing the end bracket using a 17-mm ratchet. See Figure 8-9.

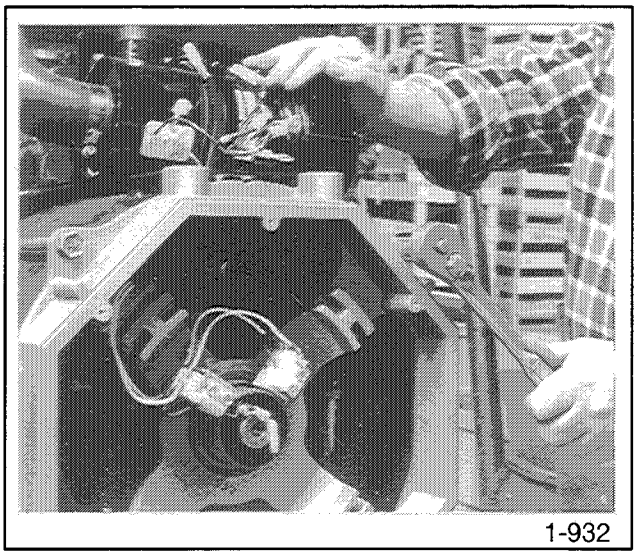


Figure 8-9. Removing the Overbolts

18. Pull the brush lead harness (containing leads 9 and 20) through hole in stator.

19. Remove the end bracket by bumping with a soft rubber mallet on end bracket flanges. See Figure 8-10.

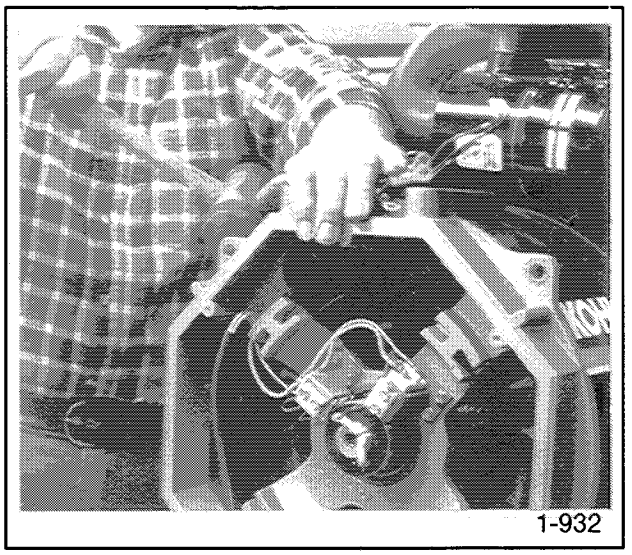


Figure 8-10. Removing the End Bracket

20. Carefully remove the stator by pulling the stator over the rotor assembly. See Figure 8-11.

NOTE

Due to the weight of the stator, it is recommended that it be placed on a hoist during removal to prevent damage to stator, rotor, and/or drive disks.

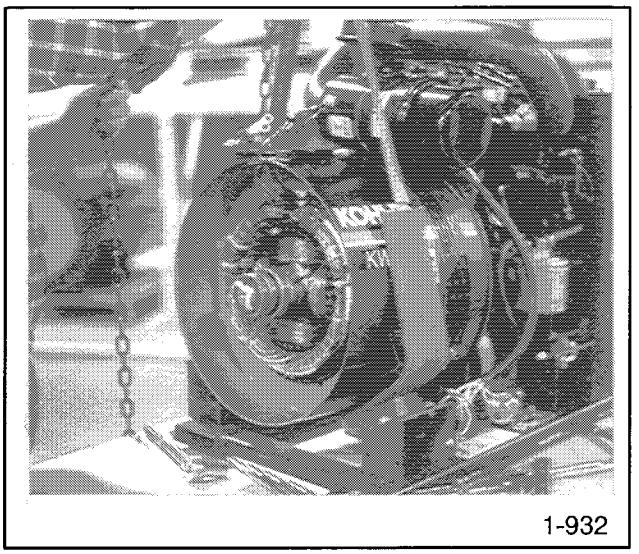


Figure 8-11. Removing the Stator

21. Remove the generator cooling fan by removing eight screws and four spacers. See Figure 8-12.

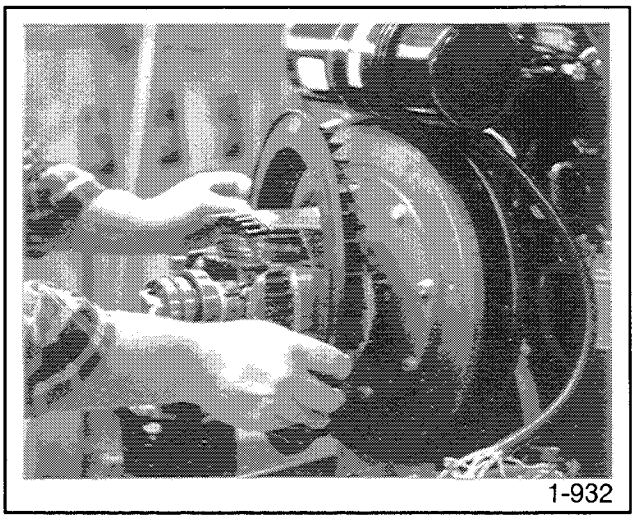


Figure 8-12. Removing the Cooling Fan

22. Support the rotor with a strap and hoist. Remove eight bolts connecting the drive disk to the engine flywheel using a 13-mm ratchet.

23. Remove the rotor drive disk from the engine flywheel. See Figure 8-13.

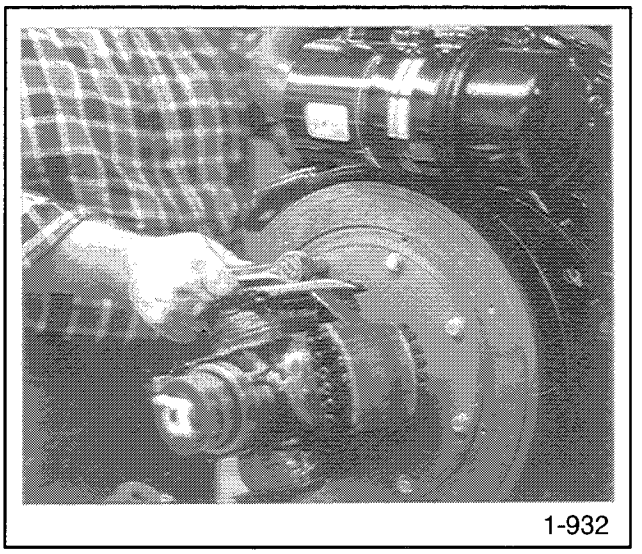


Figure 8-13. Removing the Rotor

24. Remove the drive disk from the rotor by removing eight bolts using a torque wrench with a 14-mm socket. See Figure 8-14.

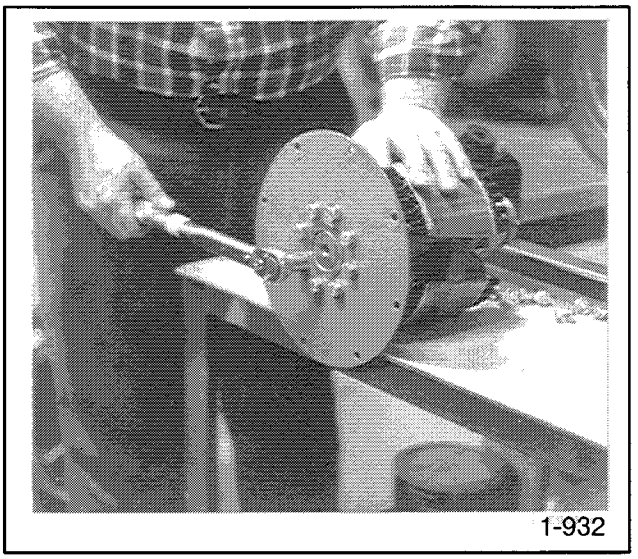


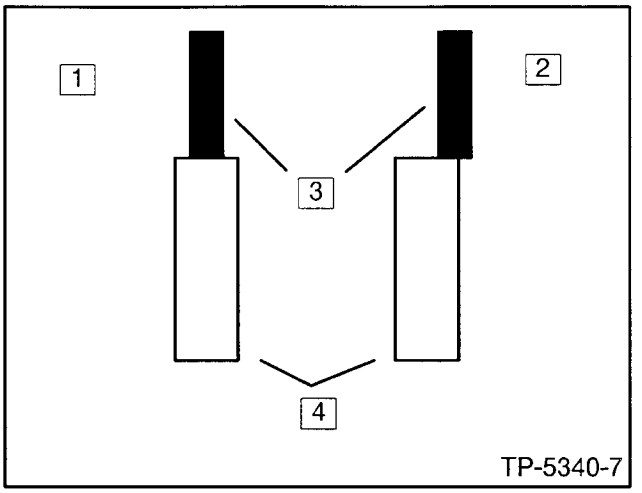
Figure 8-14. Removing the Drive Disk

Single-Phase Generator Brushes

The brushes transfer current from the voltage regulator to the slip rings. Since the brushes carry a low current, they should last the life of the generator. Abrasive dust on the slip rings could, however, shorten the life of the brushes. Excessive arcing at the brushes could damage the voltage regulator. Arcing could be caused by weak springs, damaged slip rings, sticking brushes, loose holder, or poor brush contact due to dirt.

The brushes must be free to move within the holder and be held in proper contact by the springs. When properly positioned, spring pressure on the brush surface will cause the brush to wear evenly. Brushes must ride 100% on the rings or arcing will occur and cause burned rings or failure of the voltage regulator. Figure 8-15 shows the correct positioning of the brushes. Add or remove shims as necessary to center brushes on slip rings.

Replace brushes if they show excessive or uneven wear.



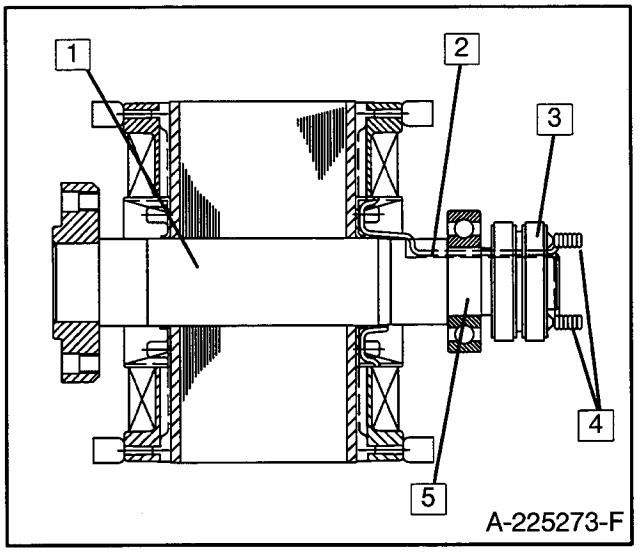
1. Correct Positioning
2. Improper Positioning
3. Brushes
4. Generator Slip Rings

Figure 8-15. Brush Positioning

Single-Phase Generator Slip Ring

If slip ring replacement is necessary, have the rotor removed from the unit (follow the generator disassembly procedure found in Section 8). Using a soldering gun, heat the wires around the two terminal ends of the slip ring. Carefully unravel the wires to remove from each terminal. Pull off the slip ring using a gear puller and clean the rotor shaft surface.

Replace the new slip ring (Kohler part number 238134) onto the rotor shaft (with the terminal end pointing outward) using a press with a proper size fixture. Position slip ring onto the rotor shaft as far as the collar permits. Exhibit care in routing the rotor leads through the keyway (the lengthwise groove on the rotor shaft) so as not to pinch or cut through insulation. Rewrap the wires around each terminal on the slip ring and resolder. See Figure 8-16. Mount the rotor onto a lathe and turn the slip ring outer diameter to the dimension shown in Figure 8-17 with a surface finish of 64 micro-inch.



1. Rotor Shaft
2. Wires
3. Slip Ring
4. Terminals on Slip Ring
5. Ball Bearing

Figure 8-16. Slip Ring Replacement on Rotor Assembly

Allowable size of Slip Ring after being turned down on a lathe:	
Maximum Size Allowed	2.391 inches
Minimum Size Allowed	2.360 inches

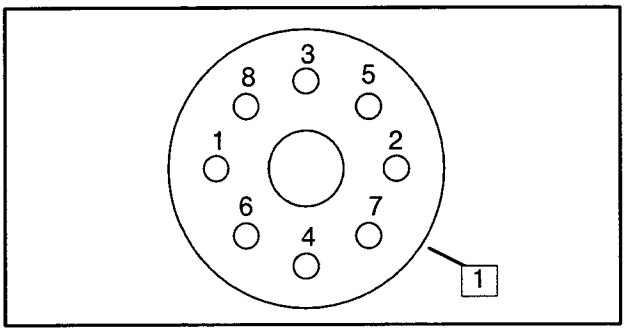
Figure 8-17. Proper Slip Ring Size

Single-Phase Generator Reassembly

1. Secure the drive disk to the rotor using eight bolts. Torque bolts to 28 ft. lbs. (338 in. lbs.). Be sure to follow the proper tightening sequence.

NOTE

Check condition of drive disks for flatness. If disks are uneven or bent, then replace. Bent disks will cause vibration and premature wear to end bearing in end bracket.



1. Drive Disk

Figure 8-18. Drive Disk Tightening Sequence

2. Position the rotor with the drive disk onto the engine flywheel using eight bolts. Torque bolts to 14 ft. lbs. (168 in. lbs.). Follow the tightening sequence as shown above.
3. Attach the generator cooling fan using eight screws and four spacers. Reassemble applying Loctite® #271 to screws.
4. Reposition the stator over the rotor and onto the adapter lip. Be careful to avoid damaging the rotor. When the stator is properly positioned, the stator leads should be at the 12 o'clock position.
5. Route the stator leads through the opening in the end bracket. Use a rubber mallet to secure the end bracket onto the stator. Replace the overbolts securing the end bracket and stator to the generator adapter. Torque the overbolts to 25 ft. lbs. (300 in. lbs.).
6. Pull the brush lead harness and stator leads through the hole in the stator.
7. Use a hoist to raise the alternator end of the generator set. Remove the wood block(s) from underneath the alternator. Lower the generator set.
8. Replace the bolts securing the generator vibromounts to the stator mounting brackets.
9. Run the stator leads (1, 2, 3, 4, 55, B1, B2, 33, 44, 9, 20, and N) into the junction box through the hole in the bottom of the box.
10. Position the junction box onto the stator mounting bracket and secure using four mounting screws.
11. Inside the junction box, reconnect stator leads 1 and 4 to the line side of the circuit breaker and reconnect stator leads 2 and 3 to the L0 ground stud.
12. Reconnect the negative lead to the hazard ground stud.
13. Reconnect lead 55 to the fuse holder.
14. Reconnect leads B1 and B2 battery charging leads.
15. Reconnect the 6-pin connector (P10) to the voltage regulator.
16. Reconnect leads 33 and 44.
17. Reconnect the white plastic connector containing leads 9 and 20.
18. Reposition the junction box cover onto the junction box and secure.
19. Reconnect the 22-pin controller harness (P4) to the back of the controller.

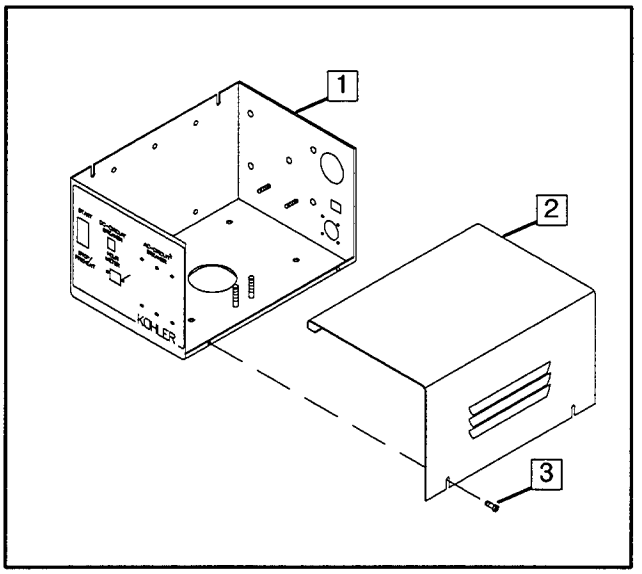
20. Replace the mounting screws securing the controller cover to the controller.
21. Remove the retaining wires from the brush holders in the end bracket. Be sure that the brushes are centered on the slip rings. Improper brush position will cause premature wear.
22. Replace the six screws securing the end bracket panel.

Three-Phase Generator Disassembly

NOTE

The voltage regulator is located in the controller. Adjustments are possible without removing the controller.

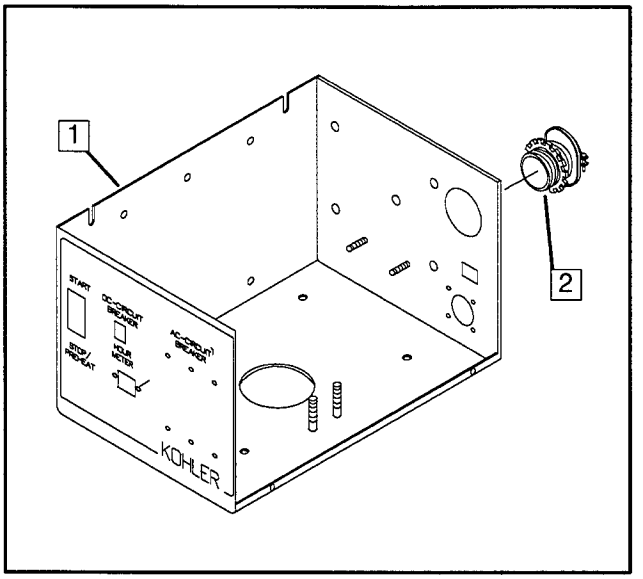
1. Loosen the four screws securing the controller cover. Separate the cover from the controller. See Figure 8-19.



1. Controller
2. Cover
3. Screw

Figure 8-19. Removing the Controller Cover

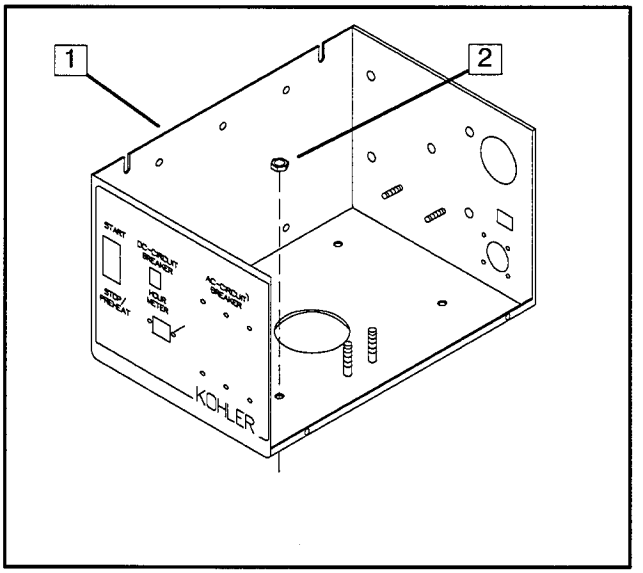
2. Disconnect the 22-pin harness connector from the stationary connector at the back of the controller. See Figure 8-20.



1. Controller
2. 22-Pin Connector

Figure 8-20. Disconnecting the 22-Pin Connector

3. Remove the nuts securing the controller to the bumpers using a 3/8-inch wrench or nut driver. See Figure 8-21.

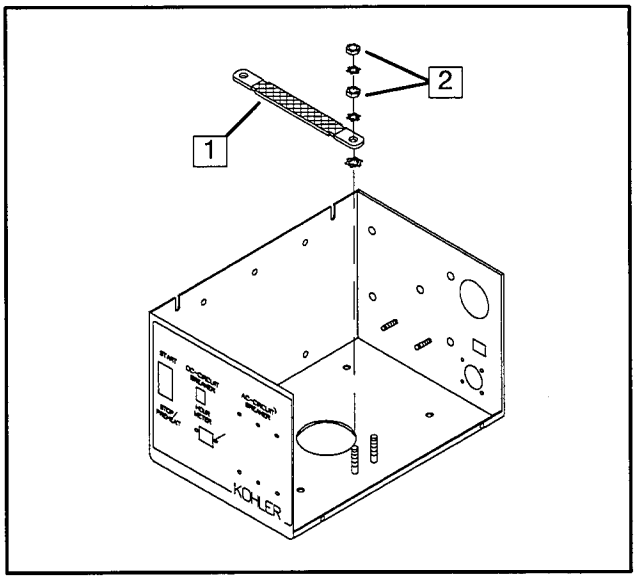


1. Controller
2. Bumper Nuts

Figure 8-21. Removing the Bumper Nuts

4. Disconnect stator leads from terminals within the controller.

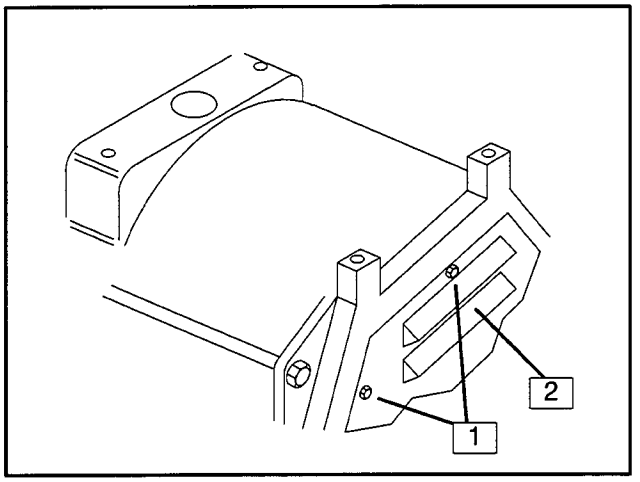
5. Remove the nuts using a 3/8-inch wrench and disconnect the ground strap from the controller. See Figure 8-22.



1. Ground Strap 2. Nuts

Figure 8-22. Disconnecting the Controller Ground Strap

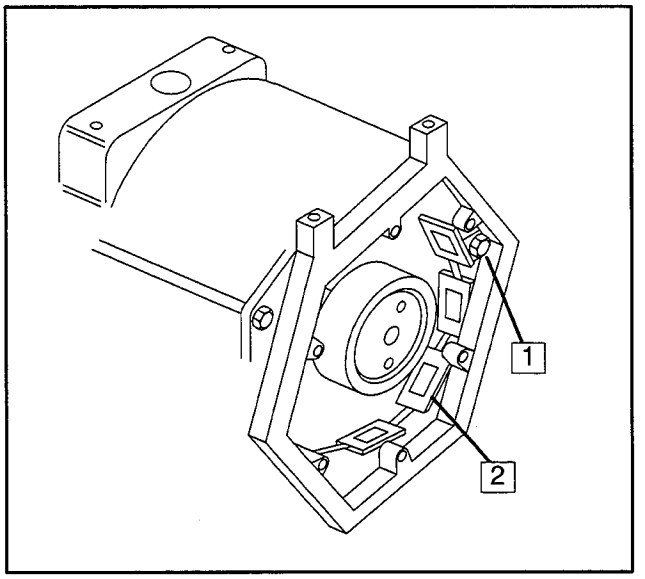
6. Remove the controller.
7. Disconnect P8 from J8.
8. Remove the six screws securing the end bracket panel to the end bracket using a 5/16-inch wrench or nut driver. Remove the end bracket panel to expose the exciter. See Figure 8-23.



1. Screw 2. End Bracket Panel

Figure 8-23. Removing the End Bracket Panel

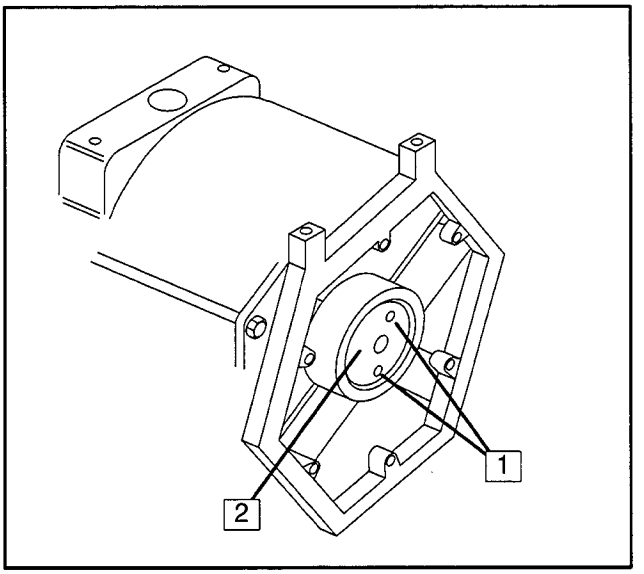
9. Disconnect P6 from J6 and P7 from J7.
10. Remove the four screws securing the exciter field to the end bracket. Carefully remove the exciter field from the generator. See Figure 8-24.



1. Screw 2. Exciter Field

Figure 8-24. Removing the Exciter Field

11. Remove the three screws and spacers securing the rotating diode circuit board to the rotor armature. See Figure 8-25.

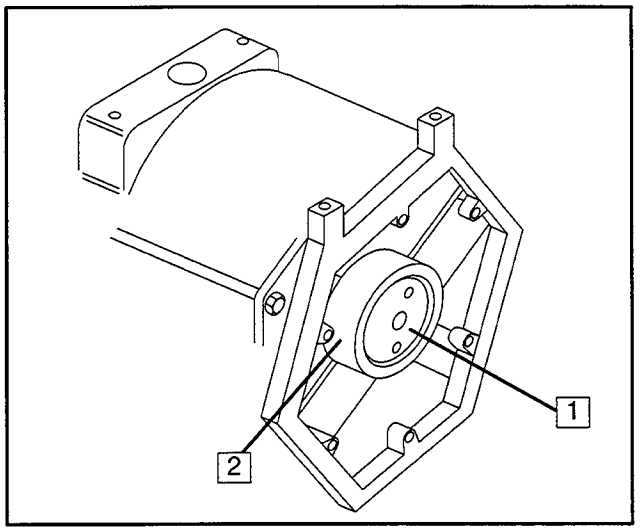


1. Screw 2. Diode Circuit Board

Figure 8-25. Removing the Diode Circuit Board

12. Remove the five screws securing the leads to the rotating diode circuit board. Carefully separate the rotating diode circuit board from the rotor assembly.

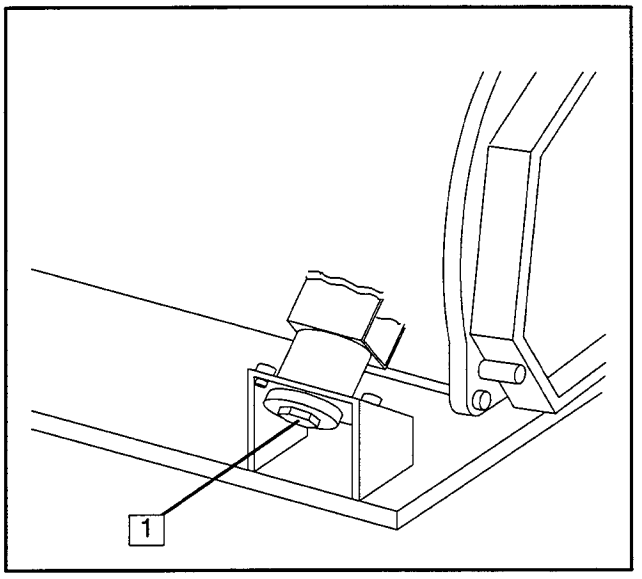
13. Remove the screw and flat washer securing the exciter armature using a 9/16-inch wrench. Remove the exciter armature from the rotor assembly. See Figure 8-26.



1. Screw 2. Exciter Armature

Figure 8-26. Removing the Exciter Armature

14. Remove the bolts from the two generator vibromounts using a 1/2-inch wrench. See Figure 8-27.



1. Vibrmount Bolt

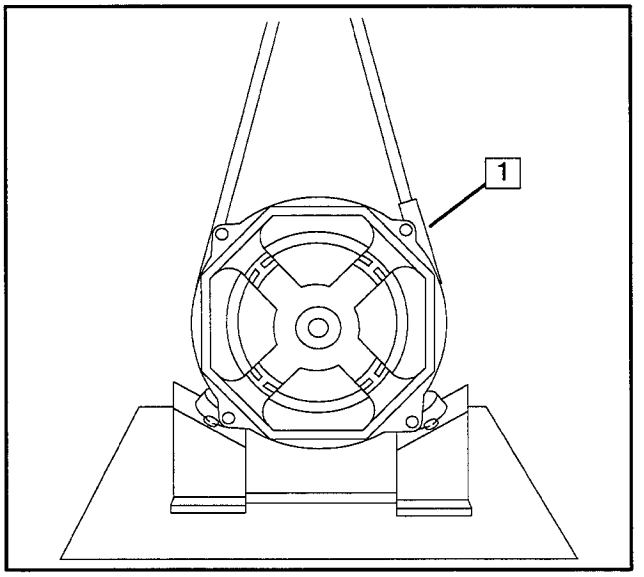
Figure 8-27. Removing the Vibromount Bolts

15. Using a hoist, raise the alternator end of the generator. See Figure 8-28.

NOTE

Use a hoist with a lifting capacity of one-half ton or greater.

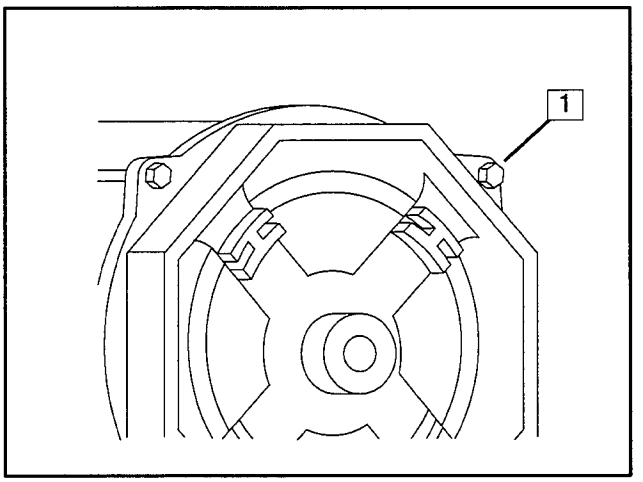
16. Place a wood block under the flywheel housing and lower generator until block supports alternator.



1. Sling

Figure 8-28. Using Hoist to Raise Generator Set

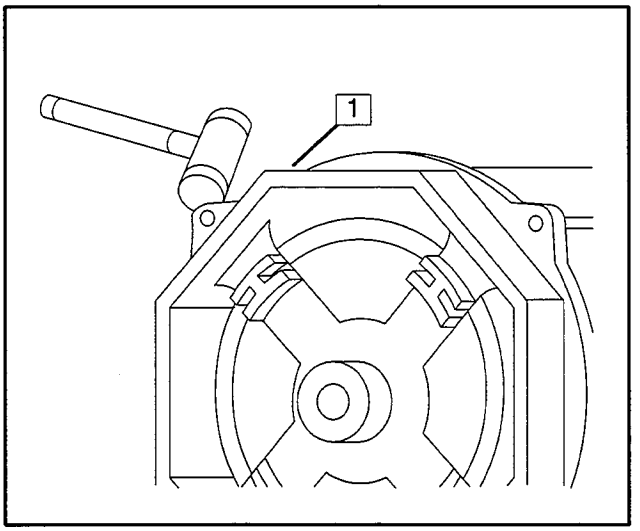
17. Remove the four overbolts securing the end bracket using a 17-mm socket and ratchet. See Figure 8-29.



1. Overbolt

Figure 8-29. Removing the Overbolts

18. Remove the end bracket by bumping the end bracket flanges with a soft rubber mallet. See Figure 8-30.



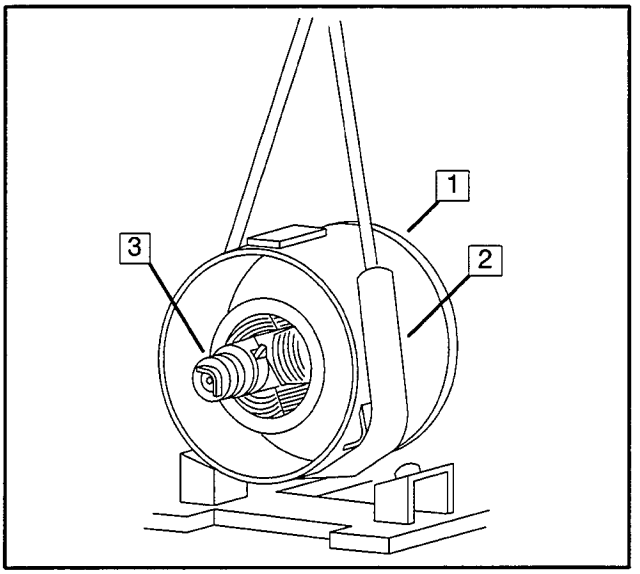
1. End Bracket

Figure 8-30. Removing the End Bracket

19. Carefully remove the stator by pulling the stator over the rotor assembly. See Figure 8-31.

NOTE

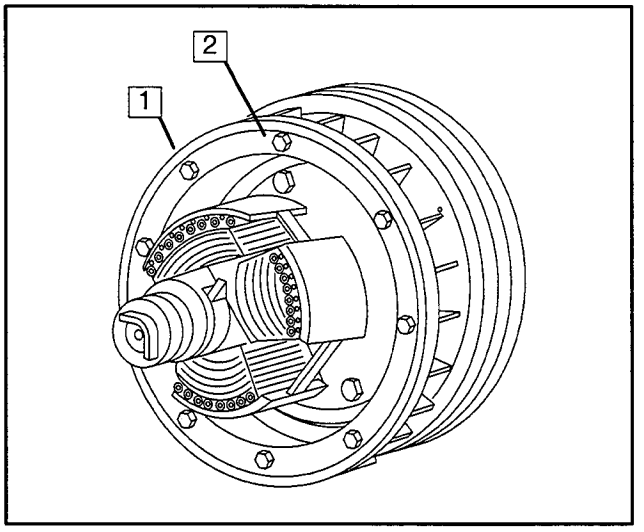
Due to the heavy weight, it is recommended that the stator be supported by a hoist during removal to prevent damage to the stator, rotor, and/or armature drive disks.



1. Stator
2. Sling
3. Rotor

Figure 8-31. Removing the Stator

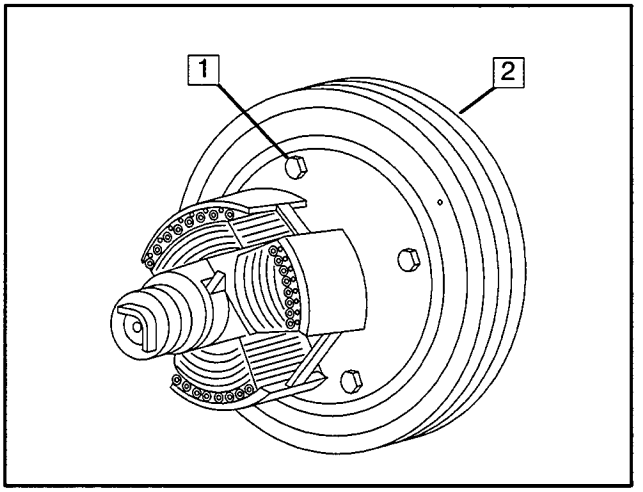
20. Remove the eight screws and four spacers securing the generator fan. Then carefully remove the cooling fan. See Figure 8-32.



1. Fan
2. Screw

Figure 8-32. Removing the Generator Cooling Fan

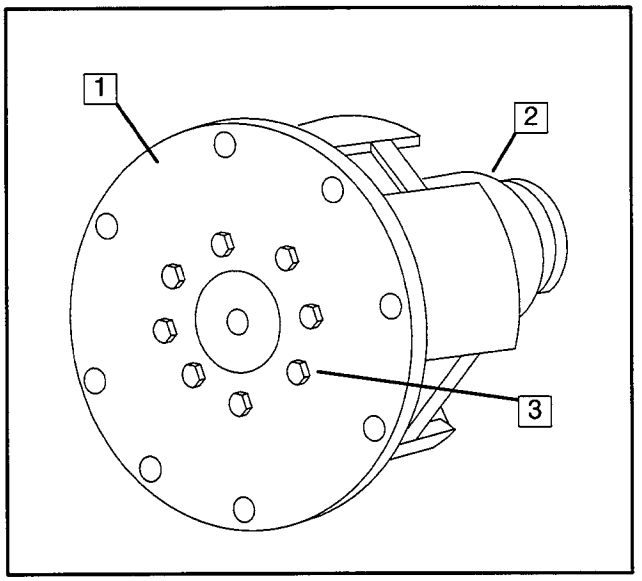
21. Support the rotor assembly with a strap and hoist. Remove the eight screws securing the armature drive disks to the engine using a 13-mm socket wrench and ratchet. Remove the rotor assembly and place it on a bench. See Figure 8-33.



1. Screws
2. Rotor Assembly

Figure 8-33. Removing the Rotor Assembly

22. Remove the eight screws securing the armature drive disks to the rotor assembly using a 9/16-inch socket wrench and ratchet. See Figure 8-34.



1. Drive Disk
2. Rotor
3. Screw

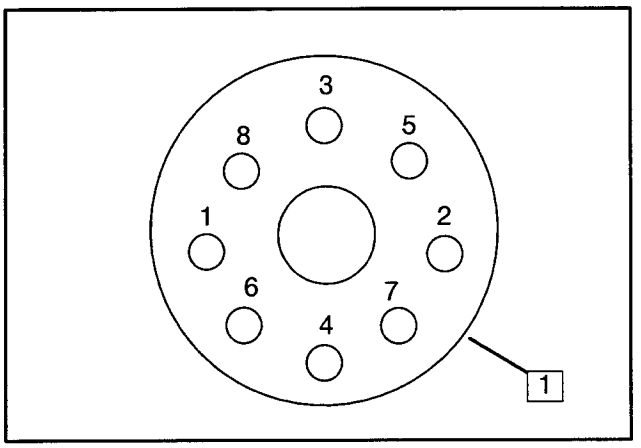
Figure 8-34. Removing the Armature Drive Disks

Reassembly

1. Secure the armature drive disks to the rotor assembly with eight screws. Tighten the screws to a torque of 28 ft. lbs. (338 in. lbs.) in the sequence shown in Figure 8-35.

NOTE

Check the armature drive disks for flatness. Replace the disks if they are uneven or bent. Disks that are not flat will cause vibration and excessive wear of the end bracket bearing.



1. Drive Disk

Figure 8-35. Tightening Sequence for Drive Disks

2. Position the rotor assembly on the engine flywheel. Align holes in armature disks and flywheel and secure the rotor assembly by installing eight screws. Tighten these screws to a torque of 14 ft. lbs. (168 in. lbs.) in the sequence shown in Figure 8-35.
3. Slide the generator cooling fan over the rotor assembly with the blades facing the flywheel. Coat the threads of the eight mounting screws with Locktite® #271. Then use the eight mounting screws and four spacers to secure the cooling fan to the flywheel.
4. Using a hoist, carefully reposition the stator over the rotor assembly and onto the adapter lip. When installed, the screened portion of the stator should be over the generator cooling fan and the stator leads should exit the top of the housing.
5. Position the end bracket over the open end of the stator and use a rubber hammer to drive the rim of the end bracket into the stator housing.
6. Install the overbolts to secure the end bracket and stator. Tighten the overbolts to a torque of 25 ft. lbs. (300 in. lbs.).
7. Use a hoist to raise the alternator end of the generator. Remove the wood block(s) below the flywheel housing. Then lower the generator back onto the vibromounts.
8. Install the two bolts to secure the stator mounting brackets to the vibromounts.
9. Install a new O-ring in the groove of the end bracket.
10. Place the exciter armature on the end of the rotor shaft. Install a flat washer and screw to secure the exciter armature. Tighten the screw to a torque of 35 ft lbs.
11. Route the two main field leads through the exciter armature. Connect these two leads to terminals marked "+" and "–" on the diode assembly. Connect the three leads of the exciter armature to the terminals marked "A", "B", and "C" on the diode assembly. Secure each lead using a 8-32 x 3/4 screw and a No. 8 lockwasher.
12. Slide the diode assembly onto the exciter armature. Secure the diode assembly in place to the exciter assembly using three spacers and self-tapping screws.
13. Secure the exciter field to the end bracket using four screws. Tighten these screws to a torque of 26 in. lbs.
14. Install the end bracket panel and secure it to the end bracket with six self-tapping screws.

15. Reconnect P6 to J6, P7 to J7, and P8 to J8.
16. Place the controller atop the rubber bumpers.
17. Route any external leads into the controller and secure the ground cable to the controller chassis.
18. Install the four nuts to secure the controller to the mounting bumpers.
19. Reconnect stator and load leads.
20. Connect 22-pin harness connector J4 to fixed connector at rear of controller.
21. Reinstall cover on controller and secure by tightening four screws.

Section 9. Wiring Diagrams

⚠ WARNING

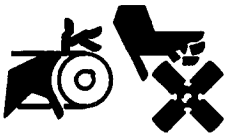
Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

Do not operate generator set without all guards and electrical enclosures in place.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.
Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Hazardous voltage can cause severe injury or death. Perform electrical service only as prescribed in equipment manual. Be sure that generator is properly grounded. Never touch electrical leads or appliances with wet hands, when standing in water, or on wet ground as the chance of electrocution is especially prevalent under such conditions. Wiring should be inspected at the interval recommended in the service schedule—replace leads that are frayed or in poor condition. The function of a generator set is to produce electricity and wherever electricity is present, there is the hazard of electrocution.

Accidental starting can cause severe injury or death. Disconnect battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator. The generator set can be started by remote start/stop switch unless this precaution is followed.

To illustrate the proper connection of generator sets, the following information is provided. In all cases, the National Electrical Code (NEC) should be followed.

NOTE

When a generator set is connected to a voltage different than nameplate voltage, notice should be placed on the unit indicating this change. A decal (part no. 246242) is available for this purpose from Authorized Kohler Dealers/Distributors.

Four-Lead (Single-Phase) Generator Sets Where Generator Output Can Be 120/240 volt, 110/220 volt, 100/200 volt 60 Hz; or 110/220 volt, 120/240 volt, 100/200 volt 50 Hz

Diagrams provided to support this configuration are as follows:	
Schematic Wiring Diagram (Single-Phase Models)	Figure 9-1
Point-to-Point Wiring Diagram (Single-Phase Models)	Figure 9-2
Output Wiring, 100–120/200–240 Volt	Figure 9-3
Output Wiring, 200–240 Volt	Figure 9-4

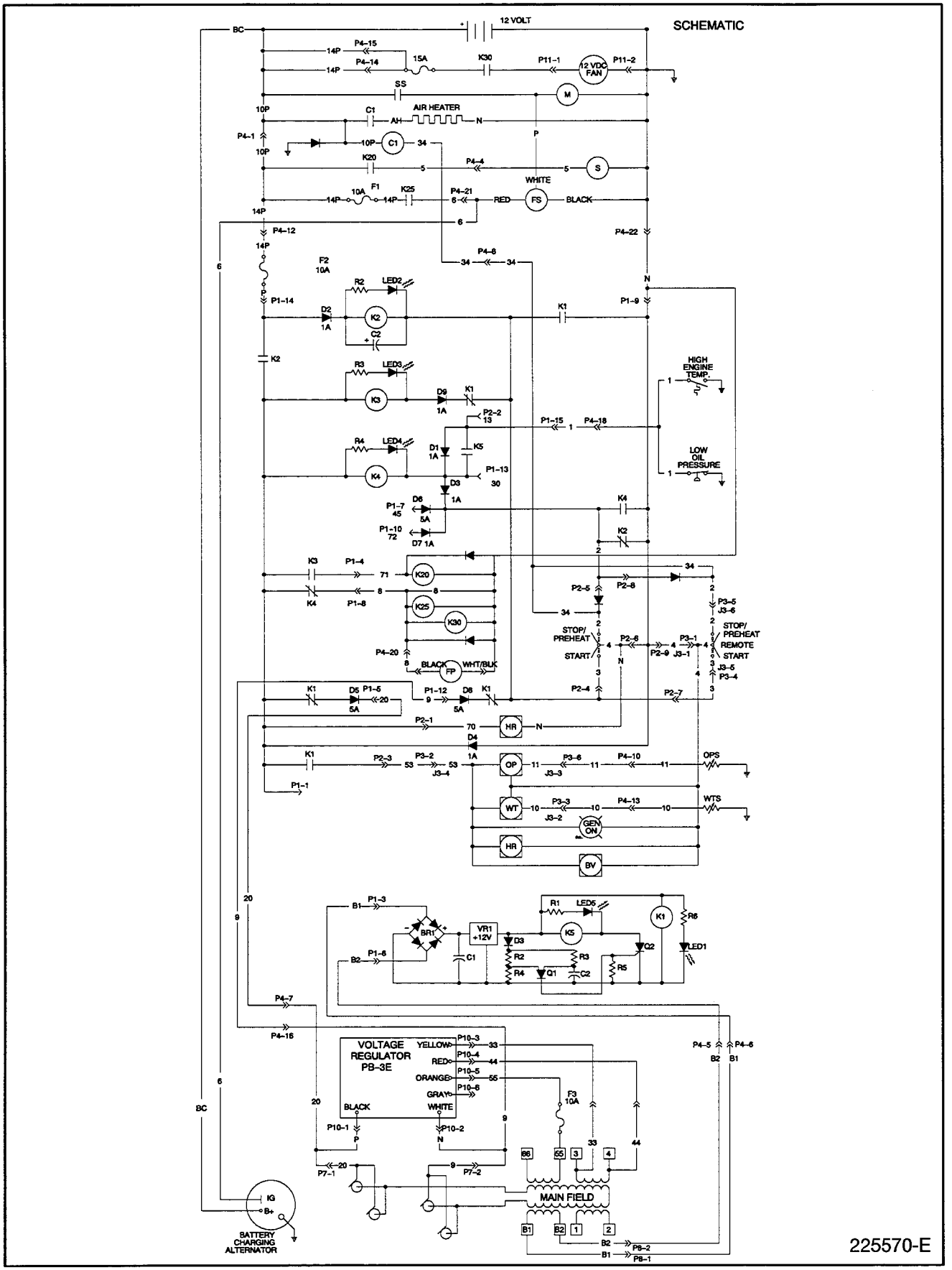


Figure 9-1. Wiring Diagram (Schematic) for 15/20CCO-RV Single Phase

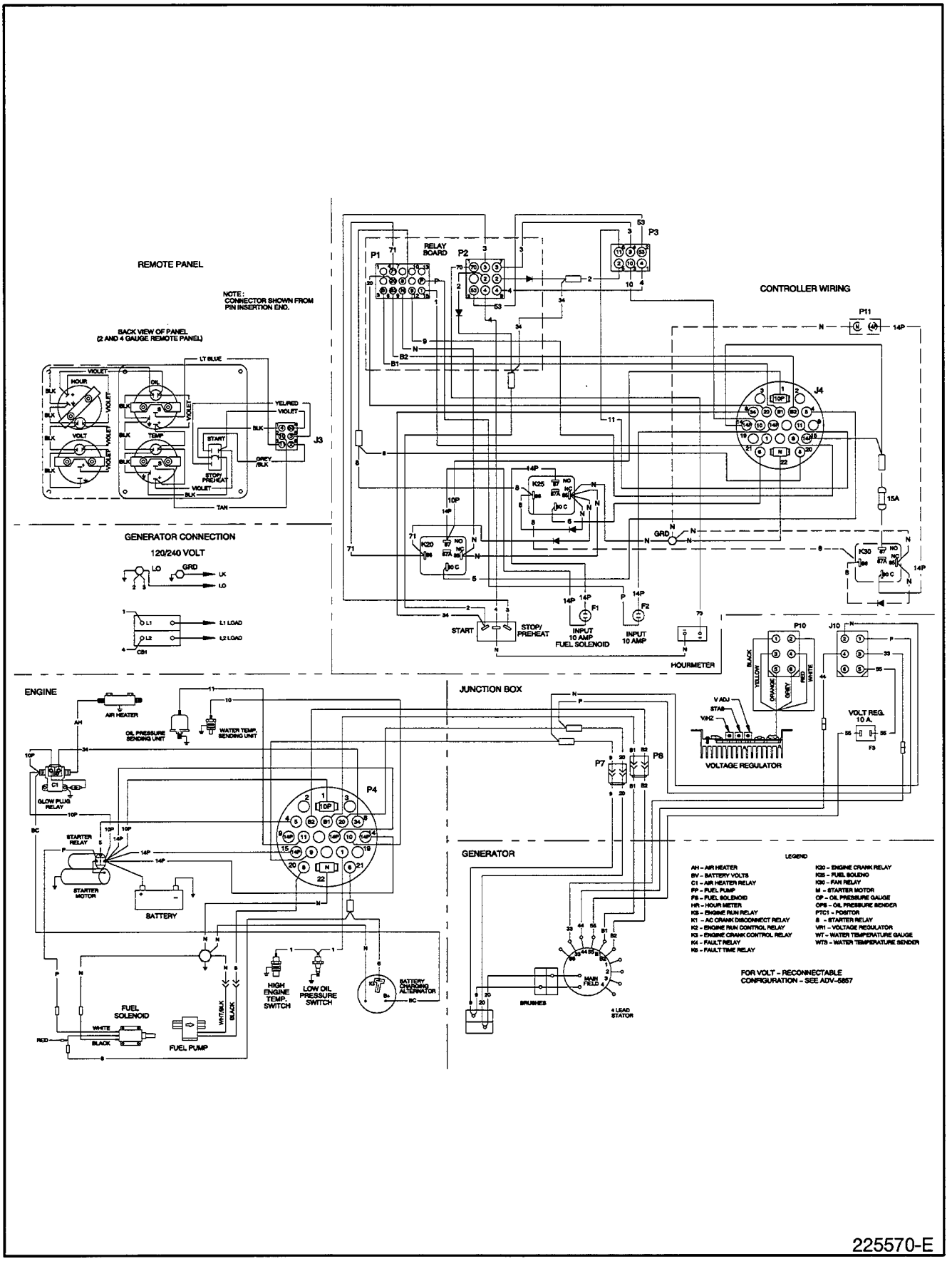
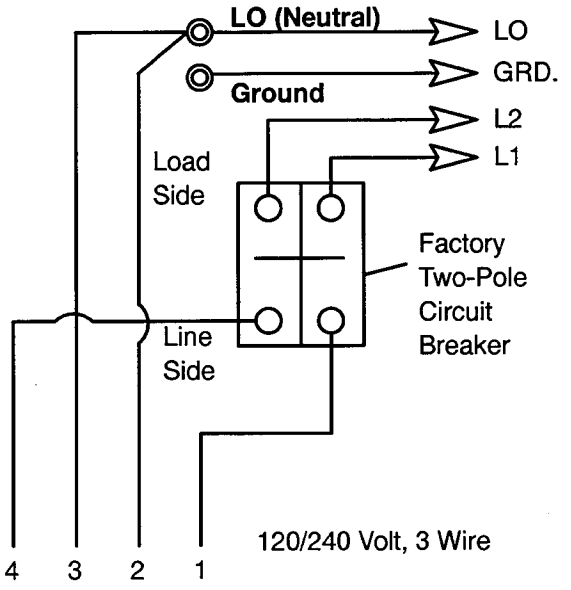


Figure 9-2. Wiring Diagram (Point-to-Point) for 15/20CCO-RV Single Phase

NOTE

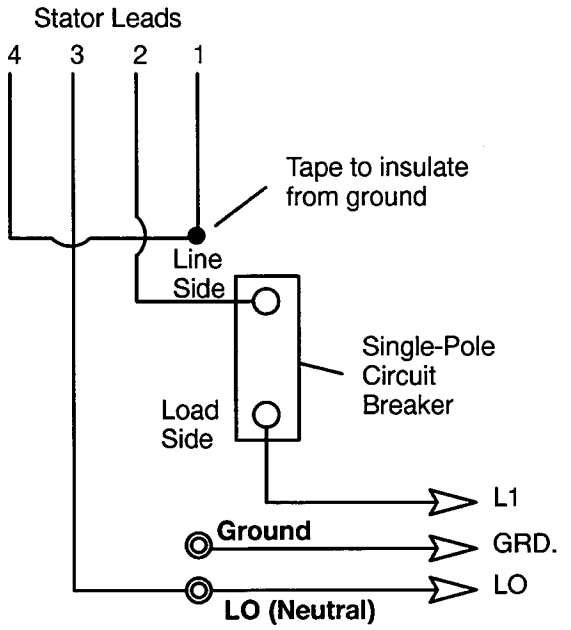
Circuit breaker MUST be a circuit breaker manufacturer two-pole circuit breaker. Two single-pole circuit breakers do not conform to NEC requirements when supplying a 240-volt (or 220-volt) load. This is true even if they are mechanically attached together. Leads L1 and L2 are different phases and must *never* be connected together.



Leads	60 Hz	50 Hz
L0-L1	120 volt	110 volt
L0-L2	120 volt	110 volt
L1-L2	240 volt	220 volt

Figure 9-3. Output Wiring, 120/240-Volt (or 110/220-Volt, 100/200-Volt) Configurations

This system uses a single-pole circuit breaker with 200–240 Volt, 2 Wire.



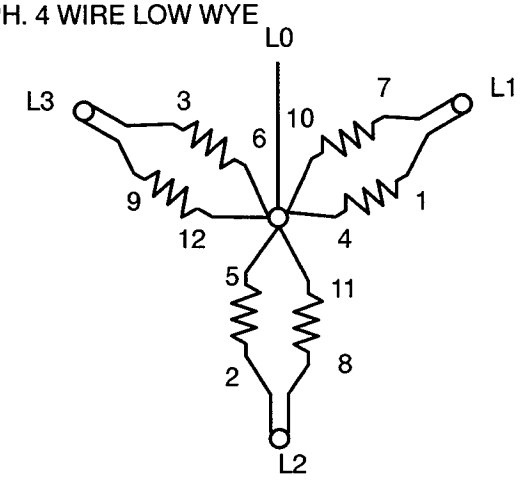
Leads	60 Hz	50 Hz
L0-L1	not used	200–240 volt

Figure 9-4. Output Wiring, 200–240-Volt Configurations

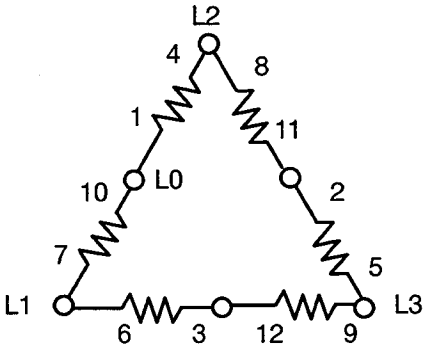
Twelve-Lead (Three-Phase) Generator Sets

Diagrams provided to support this configuration are as follows:	
Output Wiring	Figure 9-5
Schematic Wiring Diagram (Three-Phase Models)	Figure 9-6
Point-to-Point Wiring Diagram (Three-Phase Models)	Figure 9-7

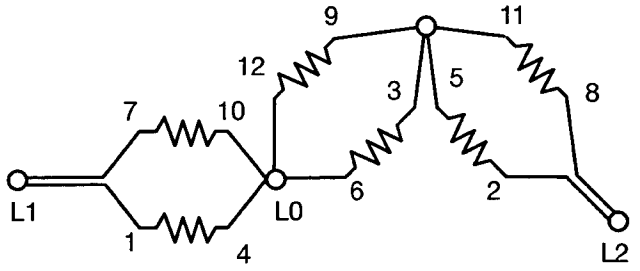
12 LEAD STATOR
60 Hz–120/208 volt or 139/240 volt
3 PH. 4 WIRE LOW WYE
50 Hz–120/208 volt or 110/190 volt
3 PH. 4 WIRE LOW WYE



12 LEAD STATOR
60 Hz–120/240 volt, 3 PH. 4 WIRE DELTA
50 Hz–110/220 volt, 3 PH. 4 WIRE DELTA



60 Hz–120/240 volt, 1 PH. 3 WIRE
50 Hz–110/220 volt, 1 PH. 3 WIRE



12 LEAD STATOR
60 Hz–277/480 volt, 3 PH. 4 WIRE HIGH WYE
50 Hz–220/380 volt, 3 PH. 4 WIRE HIGH WYE

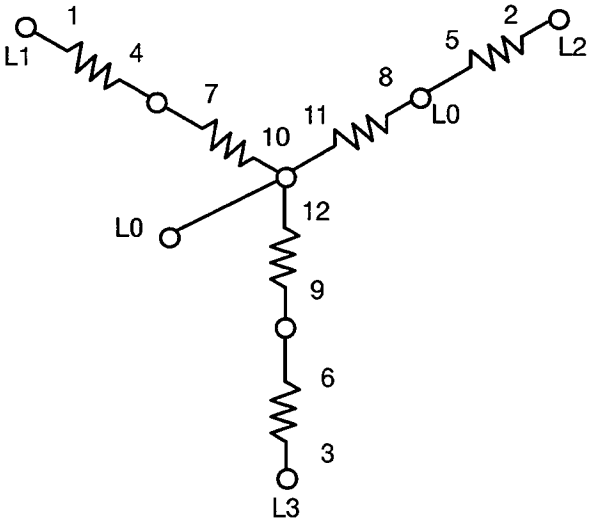


Figure 9-5. Three-Phase Voltage Reconnections

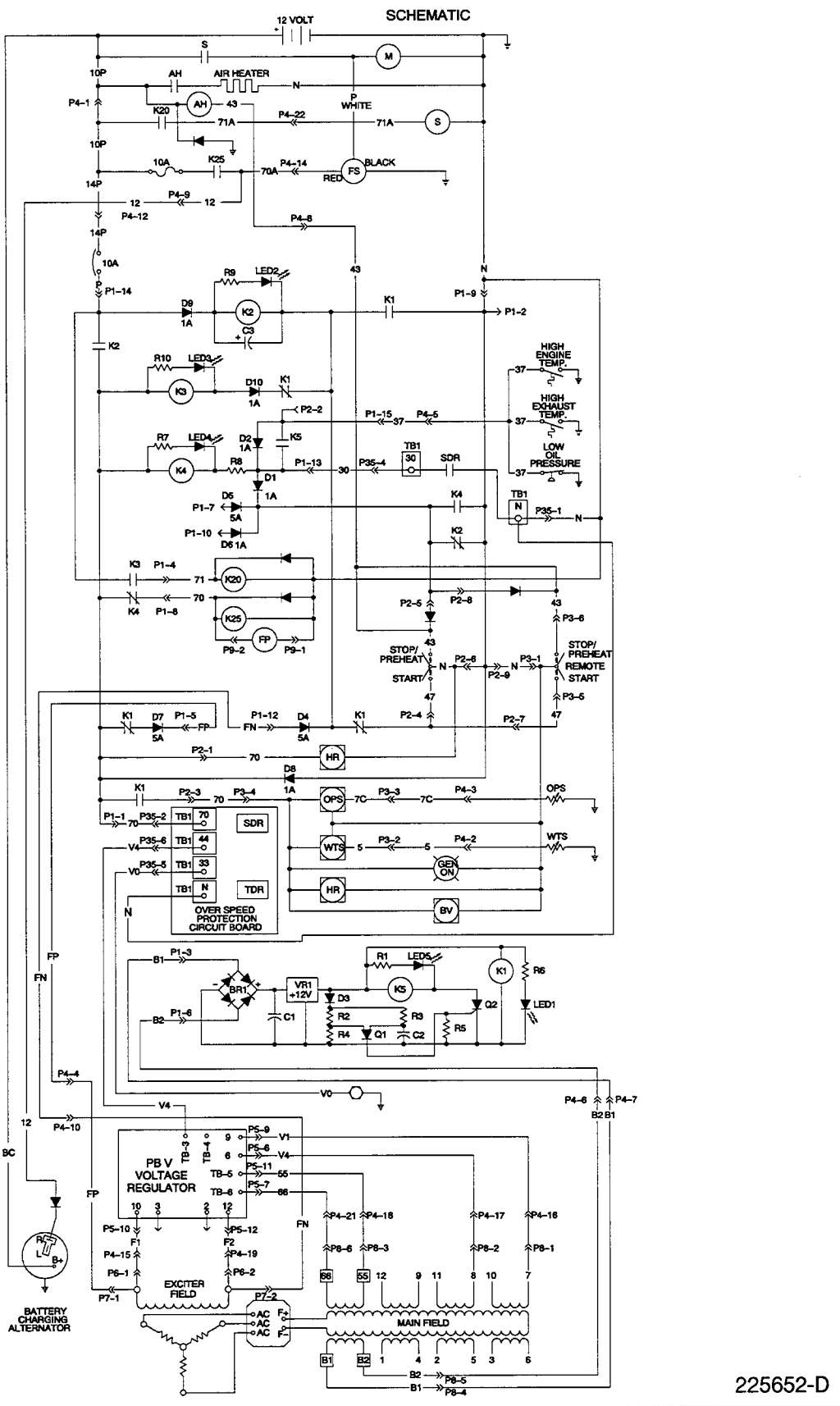


Figure 9-6. Wiring Diagram (Schematic) for 15/20CCOZ-Mobile Three Phase

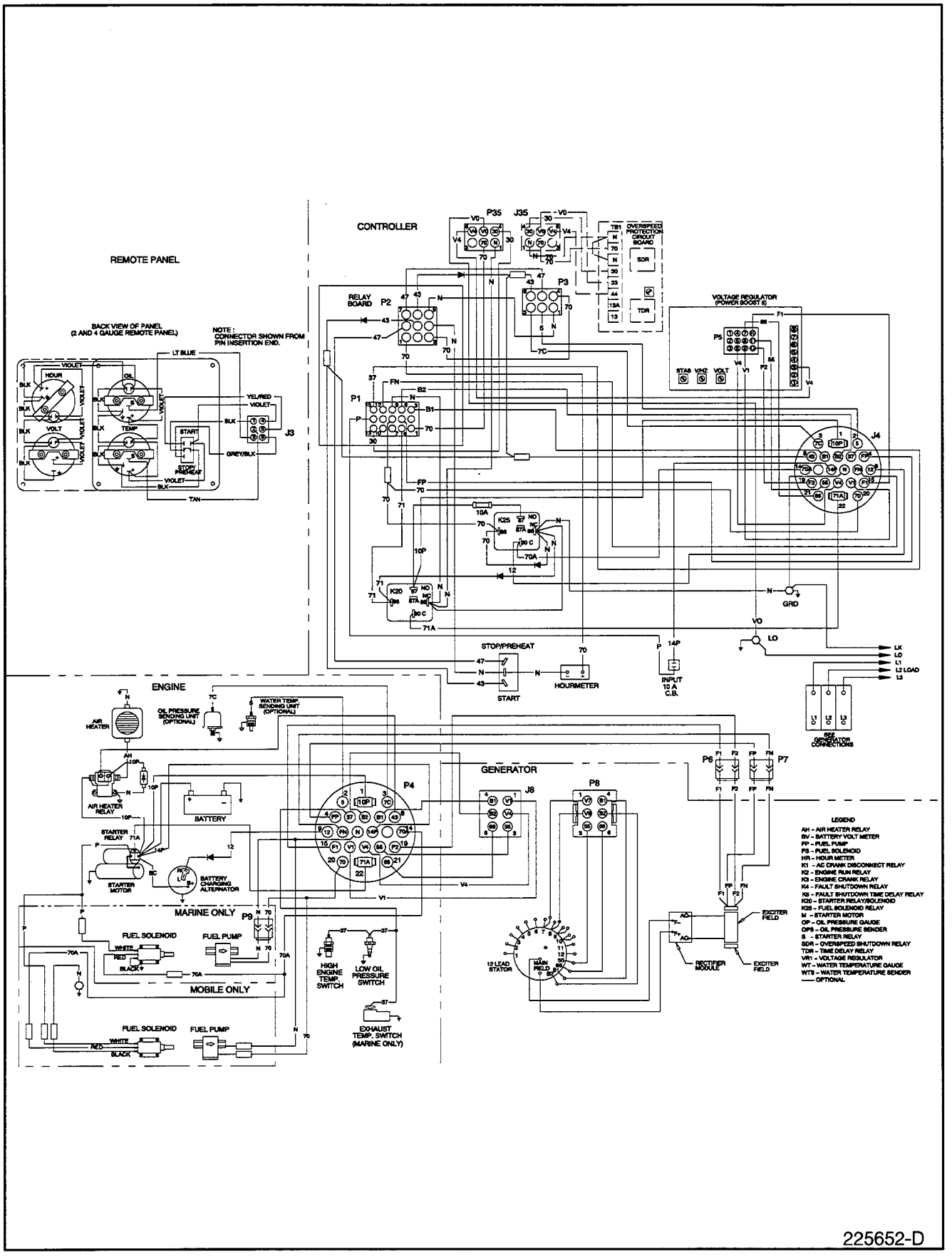


Figure 9-7. Wiring Diagram (Point-to-Point) for 15/20CCOZ-Mobile Three Phase

Section 10. Common Hardware

Application Guidelines, Specification G-585

Starting late 1991, many Parts Catalogs and Service Manuals will contain common hardware entries and hardware references (see "Hardware References") instead of part numbers for common hardware.

Kohler Specification G-585 gives common hardware application guidelines. Use the information below and on the following pages to identify proper fastening techniques when no specific reference for reassembly is made.

- *Bolt/Screw Length*: When bolt/screw length is not given, use Figure 10-1 as a guide. As a general rule, a minimum length of one thread beyond the nut and a maximum length of 1/2 the bolt/screw diameter beyond the nut is the preferred method.
- *Split Lock Washers*: Split lock washers will no longer be used as a locking device. For hardware up to 1/2 in. diameter a whiz nut (serrated flange) will be used. The locking method used for hardware above 1/2 in. diameter will be SAE flat washers with preloading (torque) of the bolt/screw. See "General Torque Specifications" and other torque specifications in the service literature.
- *Common Hardware Entries*: When hardware size (diameter and threads per inch) is given but no indication of type of additional hardware is shown, use the illustration in Figure 10-2 as a guide.

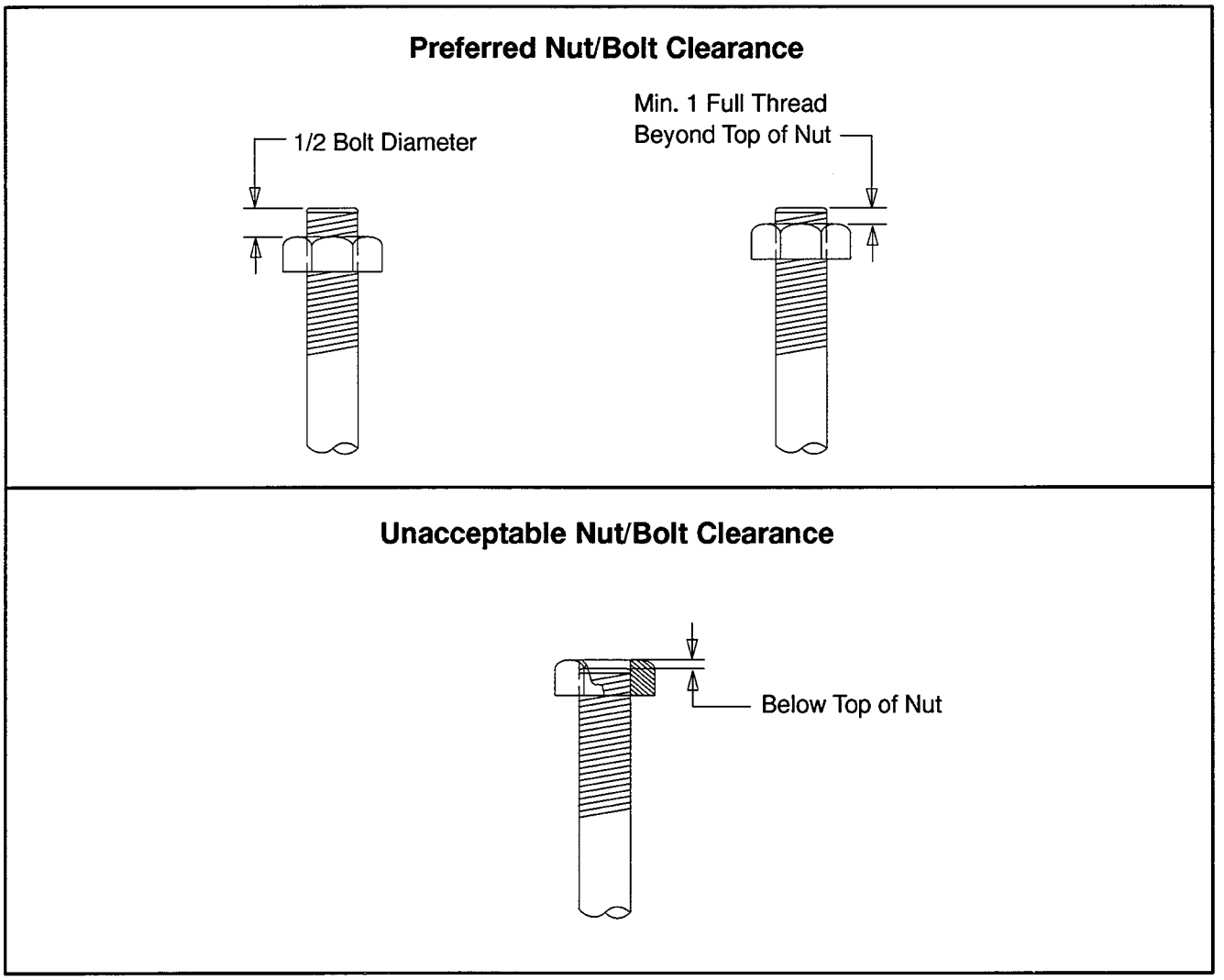


Figure 10-1. Acceptable Bolt Lengths

Common Hardware Application (G-585)

Steps for common hardware application:

1. Determine entry hole type: round, or slotted.

2. Determine exit hole type: fixed female thread (weld nut), round, or slotted.

   For round and slotted exit holes, determine if hardware is greater than 1/2 in. in diameter, or 1/2 in. in diameter or less. Hardware that is *greater than 1/2 in.* in diameter takes a standard nut and SAE washer. Hardware *1/2 in. or less* in diameter can take a properly torqued whiz nut. See the diagram below.

3. Follow these SAE washer rules after determining exit hole type:

   a. Always use a washer between hardware and a slot.
   b. Always use a washer under a nut (see 2. above for exception).
   c. Use a washer under a bolt when the female thread is fixed (weld nut).

4. Refer to the diagram below, which depicts the preceding hardware configuration possibilities.

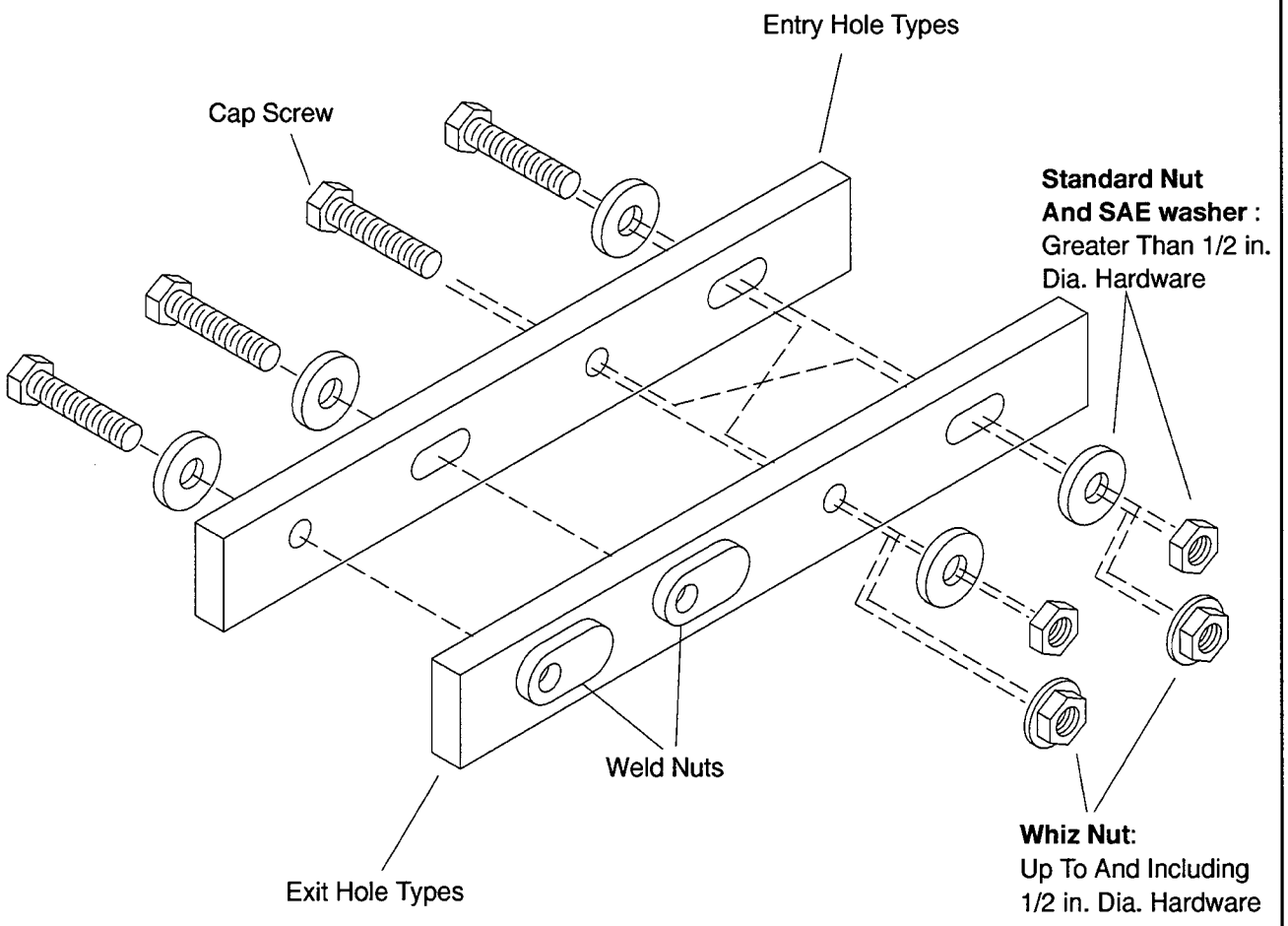


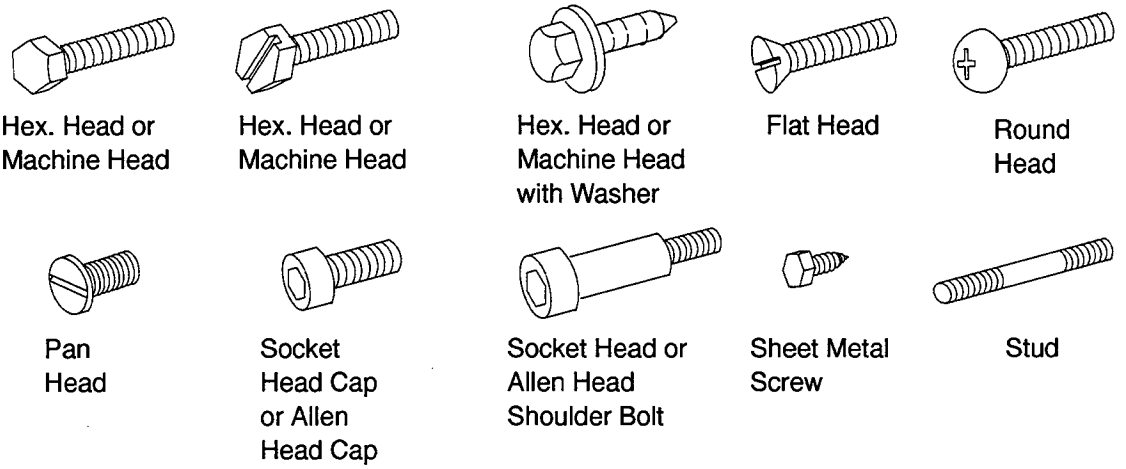
Figure 10-2. Acceptable Hardware Combinations

Common Hardware Identification

Common hardware has many different head, drive, and grade (hardness) styles. Some of the more common types are shown in Figure 10-3, below, and in Figure 10-4, next page. This is a guide for identification purposes. Not all generator hardware used is shown.

Screws/Bolts/Studs

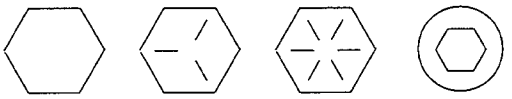
HEAD STYLES



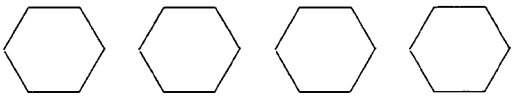
DRIVE STYLES

GRADE (HARDNESS)

American Standard



Metric



SAMPLE DIMENSIONS

American Standard

Major Thread Diameter In Fractional Inches Or Screw Number Size — 1/4-20 x 1 — Length In Inches; Threads Per Inch

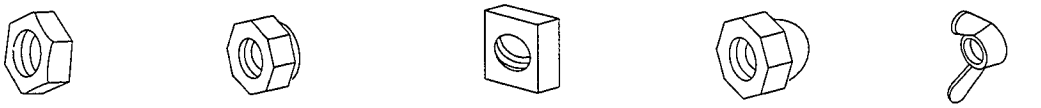
Metric

Major Thread Diameter In Millimeters — M8-1.25 x 20 — Length In Millimeters; Distance Between Threads In Millimeters

Figure 10-3. Screws/Bolts/Studs

Nuts

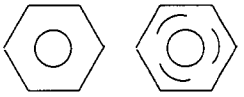
STYLES



Hex. Head | Lock Nut or Nylock Nut | Square Nut | Cap Nut or Acorn Nut | Wing Nut

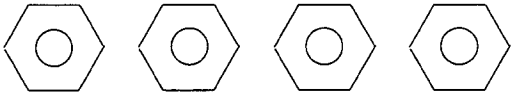
GRADE (HARDNESS)

American Standard



Grade 2 | Grade 5

Metric



6.8 | 8.8 | 10.9 | 12.9

SAMPLE DIMENSIONS

American Standard

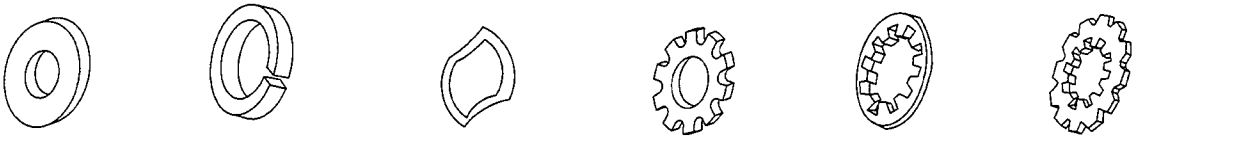
Major Thread Diameter In Fractional Inches Or Screw Number Size — 1/4-20 — Threads Per Inch

Metric

Major Thread Diameter In Millimeters — M8-1.25 — Distance Between Threads In Millimeters

Washers

STYLES



Plain Washer | Split Lock Washer or Spring Washer | Spring Washer or Wave Washer | External Tooth Lock Washer | Internal Tooth Lock Washer | Internal-External Tooth Lock Washer

GRADE (HARDNESS)

There is no marking to identify hardness. Usually hardened washers have a black oxide or black phosphate finish rather than a zinc (silver-colored) finish.

SAMPLE DIMENSIONS

Plain Washers

Internal Dimension — 9/32 x 5/8 x 1/16 — Thickness

External Dimension

Lock Washers

5/8

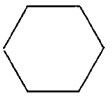
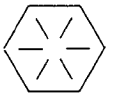
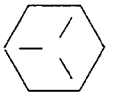
Internal Dimension

Figure 10-4. Nuts and Washers

General Torque Specifications

The values given are for clean, dry threads.

AMERICAN STANDARD

		Assembled in Cast Iron or Steel			Assembled in Aluminum
					 
Size	**Measurement**	**Grade 2**	**Grade 5**	**Grade 8**	**Grade 2 or 5**
8-32	in. lbs. (Nm)	20 (2.3)	25 (2.8)	-	20 (2.3)
10-24	in. lbs. (Nm)	32 (3.6)	40 (4.5)	-	32 (3.6)
10-32	in. lbs. (Nm)	32 (3.6)	40 (4.5)	-	-
1/4-20	in. lbs. (Nm)	70 (7.9)	115 (13)	165 (18.6)	70 (7.9)
1/4-28	in. lbs. (Nm)	85 (9.6)	140 (15.8)	200 (22.6)	-
5/16-18	in. lbs. (Nm)	150 (17)	250 (28.2)	350 (40)	150 (17)
5/16-24	in. lbs. (Nm)	165 (18.6)	270 (30.5)	360 (41)	-
3/8-16	ft. lbs. (Nm)	22 (30)	35 (45)	50 (65)	
3/8-24	ft. lbs. (Nm)	25 (35)	40 (54)	60 (80)	
7/16-14	ft. lbs. (Nm)	35 (45)	55 (75)	80 (108)	
7/16-20	ft. lbs. (Nm)	45 (54)	75 (105)	105 (142)	
1/2-13	ft. lbs. (Nm)	50 (65)	80 (110)	115 (155)	
1/2-20	ft. lbs. (Nm)	70 (95)	105 (140)	165 (224)	
9/16-12	ft. lbs. (Nm)	75 (105)	125 (165)	175 (237)	
9/16-18	ft. lbs. (Nm)	100 (136)	165 (224)	230 (312)	
5/8-11	ft. lbs. (Nm)	110 (149)	180 (244)	260 (353)	
5/8-18	ft. lbs. (Nm)	140 (190)	230 (312)	330 (447)	
3/4-10	ft. lbs. (Nm)	150 (203)	245 (322)	350 (475)	
3/4-16	ft. lbs. (Nm)	200 (271)	325 (440)	470 (637)	

Sample Dimensions

American Standard

Major Thread Diameter In Fractional Inches Or Screw Number Size — 1/4-20 x 1 — Length In Inches

Threads Per Inch

TP-5606 12/93

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