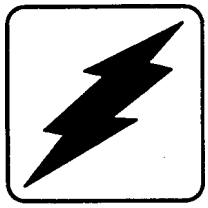
Training Manual

Residential / Commercial Generator Sets



8.5RY / 11RY

ISO 9001
KOHLER GENERATORS
INTERNATIONALLY REGISTERED
U.S.A. Plant ISO Registered

KOHLER®
POWER SYSTEMS

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Table Of Content

Introduction

This manual covers operation, troubleshooting, and features of Kohler Commercial / Residential Generator Sets.

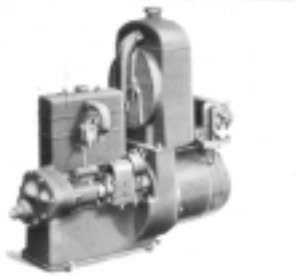
This manual is only intended as a training guide and is to be used as a supplement to classroom material. This is not a service manual and does not contain all available product information. **Do not attempt to service generator sets without consulting the service manual and following all safety warnings.**

Pictures, illustrations, and wiring diagrams in this manual are only representative of the various models and may differ slightly even within the same model designation series.

This manual is not intended as an installation or troubleshooting guide.

Kohler Company History
Founded by John Michael Kohler on Dec. 3, 1873, Kohler Co. has grown to become the nation's largest manufacturer of plumbing and specialty products as well as a major producer of generators and four-cycle engines. In recent years, the company has also acquired two distinguished furniture manufacturers and opened a variety of highly successful hospitality businesses. Headquartered in Kohler, Wis., Kohler Co. is one of the oldest and largest privately held companies in the country and employs more than 20,000 people.

Power Systems Group
Kohler Co., a major producer of engines, generators and electrical products, entered the power systems market in the early 1900's. Its first power systems products included cast iron internal combustion engines and Automatic Power and Light, a remarkable improvement in auxiliary power in its day. Generators, then known as electrical plants, supplied power during Admiral Richard Byrd's Antarctic exploration in the late 1920's. In the post-war years, Kohler expanded its engine and generator product lines and continued to improve the durability and performance of all of its power systems units. Consequently, the number of markets for Kohler power systems products grew throughout the United States and beyond. Today, Power Systems International, created in 1989 and based in Kohler, Wis., is responsible for all Kohler generator and engine product sales outside of the United States.



Generator Division
In use throughout the world, Kohler generators are available for the marine, home, mobile, commercial, and industrial markets. In addition to generator sets, Kohler also manufactures transfer switches, switchgear and accessories for all product lines. Kohler generators are produced in a manufacturing facility located in the town of Mosel, eight miles north of Kohler, Wis. In 1997 Kohler opened and operates a manufacturing facility in Singapore for the international product line.

Engine Division
One of the world's major manufacturers of air-cooled, four-cycle engines, Kohler Co. produces models ranging from 4 horsepower single-cylinder engines to 26 horsepower twin-cylinder engines. These engines are used by major manufacturers to power lawn and turf, agricultural, industrial construction and recreational equipment. The Kohler engine is also used in Kohler generator models, specifically the residential/ commercial product lines. Kohler engines are manufactured in Kohler, Wis. and Hattiesburg, Miss.

Kohler de Mexico, S.A. de C.V.
Created in 1964 and located in Mexico City, Kohler de Mexico manufactures four-cycle engines.

Safety Precautions and Instructions

A generator set, like any other electromechanical 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 that are explained below.

DANGER

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

CAUTION

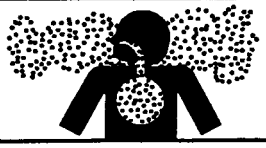
Caution is used to indicate the presence of a hazard, which will or can cause minor personal injury or property damage if the warning is ignored.

NOTE

Note is used to notify people of installation, operation, or maintenance information, which 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.

⚠ WARNING



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

The exhaust system must be leakproof and routinely inspected.

Generator set operation. 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 a potentially occupied building. 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 symptoms. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is a poisonous gas which is present in exhaust gases. Carbon monoxide poisoning symptoms include but are not limited to the following:

• Light-headedness, dizziness

• Physical fatigue, weakness in joints and muscles

• Sleepiness, mental fatigue, inability to concentrate or speak clearly, blurred vision

• Stomach ache, vomiting, nausea

If experiencing any of these symptoms and carbon monoxide poisoning is possible, affected persons should seek fresh air immediately. They should remain active. They should not sit, lie down, or fall asleep. Alert others to the possibility of carbon monoxide poisoning. If the condition of affected persons does not improve within minutes of breathing fresh air, they should seek medical attention.

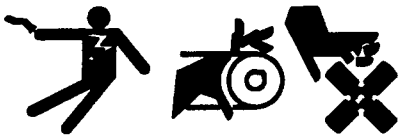
⚠ CAUTION

Hazardous noise.
Can cause loss of hearing.

Never operate generator without a muffler or with faulty exhaust system.

Engine noise. Hazardous noise can cause loss of hearing. Generator sets not equipped with sound enclosures can produce noise levels greater than 105 dBA. Prolonged exposure to noise levels greater than 85 dBA can cause permanent hearing loss. Wear hearing protection when near an operating generator set.

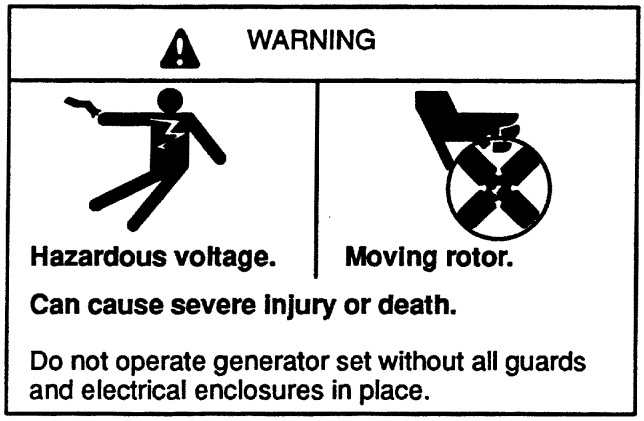
⚠ WARNING

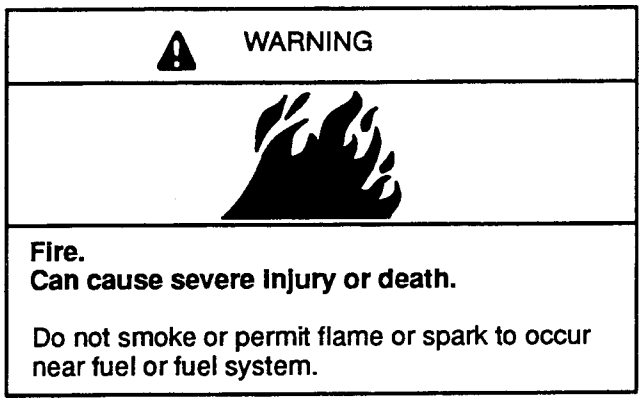


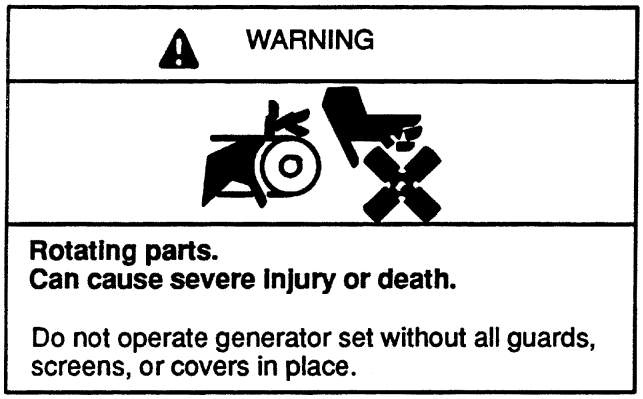
Accidental starting.
Can cause severe injury or death.

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. Place controller MASTER switch to OFF position. The generator set can be started by remote start/ stop switch unless this precaution is followed.







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. Some scheduled maintenance procedures require the generator set to be running while performing service. If the sound shield has been removed leaving belts and pulleys exposed, be especially careful of this area.

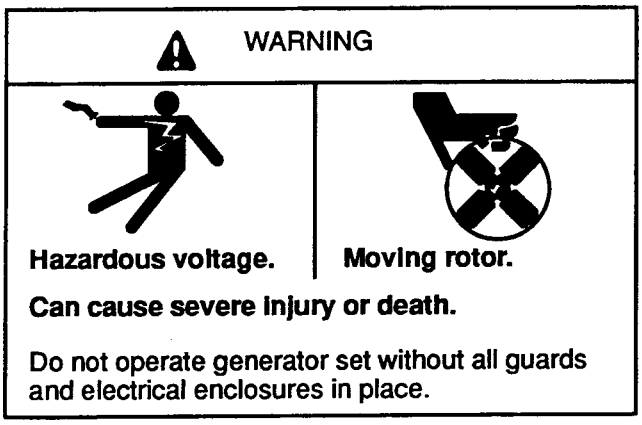
Flying projectiles can cause severe Injury or death. Retorque all crankshaft and rotor hardware after servicing. When making adjustments or servicing generator set, do not loosen crankshaft hardware or rotor thru-bolt. If rotating crankshaft manually, direction should be clockwise only. Turning crankshaft 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.

A flash fire can cause severe injury or death. Do not Smoke or permit flame or spark to occur near carburetor, fuel line, fuel filter, fuel pump, or other potential sources of spilled fuel or fuel vapors. When removing fuel line or carburetor, use a proper container to catch all fuel.

A sudden backfire can cause severe Injury or death. Do not operate with backfire flame arrestor removed. *(gasoline models only)*

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

A sudden flash fire can cause severe Injury or death. Do not smoke or permit flame or spark to occur near fuel system. Keep the compartment and generator set clean and free of debris to minimize chances of fire. Wipe up



Grounding generator set. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Open main circuit breakers of all power sources before servicing equipment. Configure the installation to electrically ground the generator set and electrical circuits when in use. Never contact electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution increases under such conditions.

High voltage test. Hazardous voltage can cause severe injury or death. Follow instructions of test equipment manufacturer when performing high-voltage test on rotor or stator. An improper test procedure can damage equipment or lead to future generator set failures.

Installing battery charger. Hazardous voltage can cause severe injury or death. Electrical shock may occur if battery charger is not electrically grounded. Connect battery charger enclosure to ground of a permanent wiring system. As an alternative, install an equipment grounding conductor with circuit conductors and connect to equipment grounding terminal or lead on battery charger. Perform battery charger installation as prescribed in equipment manual. Install battery charger in compliance with local codes and ordinances.

Connecting battery and battery charger. Hazardous voltage can cause severe injury or death. Reconnect battery correctly to avoid electrical shock and damage to battery charger and battery(ies). Have a qualified electrician install battery(ies).

Testing voltage regulator. Hazardous voltage can cause severe injury or death. High voltage is present at the voltage regulator heat sink. Do not touch voltage regulator heat sink when testing voltage regulator or electrical shock will occur. *(PowerBoost-, PowerBoost- ///, and PowerBoost- V voltage regulator models only.)*

Engine block heater. Hazardous voltage can cause severe injury or death. Engine block heater can cause electrical shock. Remove engine block heater plug from electrical outlet before working on block heater electrical connections.

Electrical backfeed to utility. Hazardous backfeed voltage can cause severe injury or death. Install a transfer switch in standby power installations to prevent connection of standby 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.

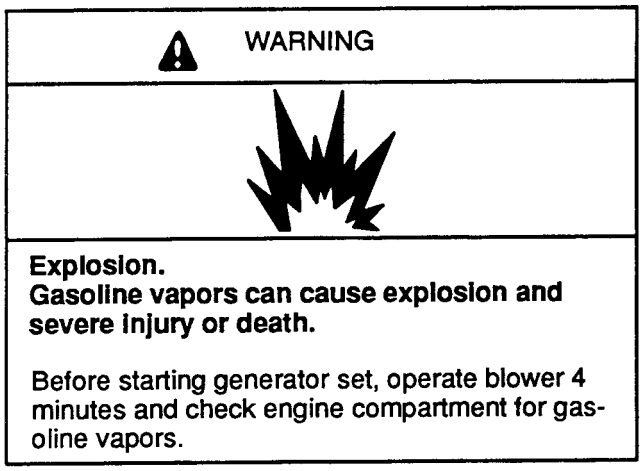
Fuel system. Explosive fuel vapors can cause severe injury or death. All fuels are highly explosive in a vapor state. Use extreme care when handling and storing fuels. Store fuel in a well-ventilated area away from spark-producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running because spilled fuel may ignite on contact with hot parts or from spark. Do not smoke or permit flame or spark to occur near sources of spilled fuel or fuel vapors. Keep fuel lines and connections tight and in good condition. Do not replace flexible fuel lines with rigid lines. Use flexible sections to avoid breakage caused by vibration. Do not operate generator set in the presence of fuel leaks, fuel accumulation, or sparks. Repair systems before resuming generator set operation.

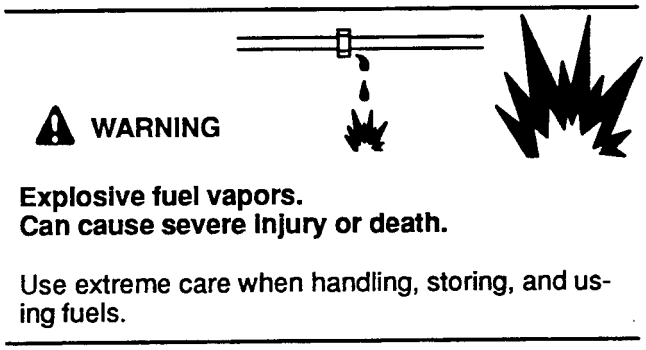
Explosive fuel vapors can cause severe injury or death. Take additional precautions when using the following fuels: Gasoline - Store gasoline only in approved red containers clearly marked GASOLINE.

Propane (LP)-Adequate ventilation is mandatory. Propane is heavier than air; install propane gas detectors low in room. Inspect detectors often.

Natural Gas-Adequate ventilation is mandatory. Natural gas rises; install natural gas detectors high in room. Inspect detectors often.

Gas fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check LP vapor gas or natural gas fuel system for leakage using a soap-water solution with fuel system test pressurized to 6-8 ounces per square inch (10-14 inches water column). Use a soap solution containing neither ammonia nor chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.





LP liquid withdrawal fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check LP liquid withdrawal gas fuel system for leakage using a soap-water solution with fuel system test pressurized to at least 90 psi (621 kPa). Use a soap solution containing neither ammonia nor chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.

⚠ 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.

Battery acid. Sulferic acid in batteries can cause severe injury or death.
If battery acid 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.

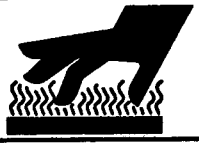
Explosion can cause severe Injury or death.
Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc. to prevent bums and to prevent sparks that could cause an explosion. 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.

⚠ 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



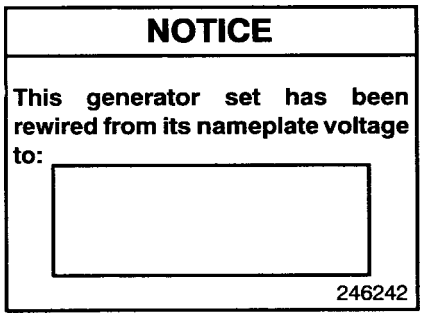
Hot engine and exhaust system.
Can cause severe injury or death.

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

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 ft 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 in tank.

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.

Notice

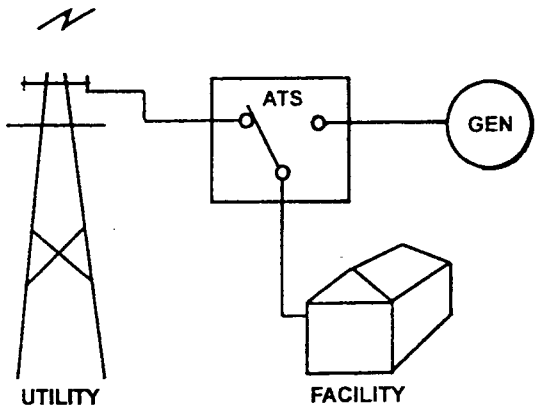


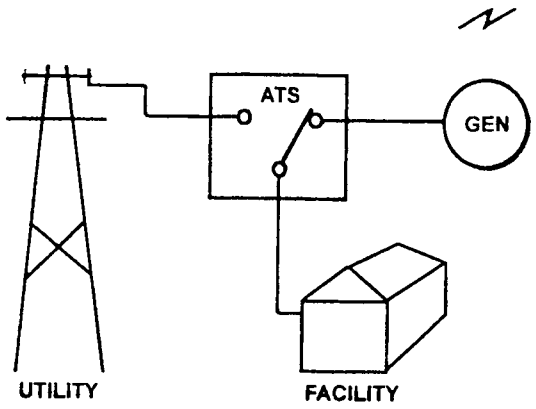
NOTICE
Voltage reconnection! Affix notice to generator set after reconnecting to a voltage different from the nameplate. Order voltage reconnection decal 246242 from authorized service distributors/dealers.

NOTICE
Hardware damage! Engine and generator set may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of bolt heads and nuts.

NOTICE
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 identification.

NOTICE
Canadian installations only: For standby service connect output of generator set to a suitably rated transfer switch in accordance with Canadian Electrical Code, Part 1.



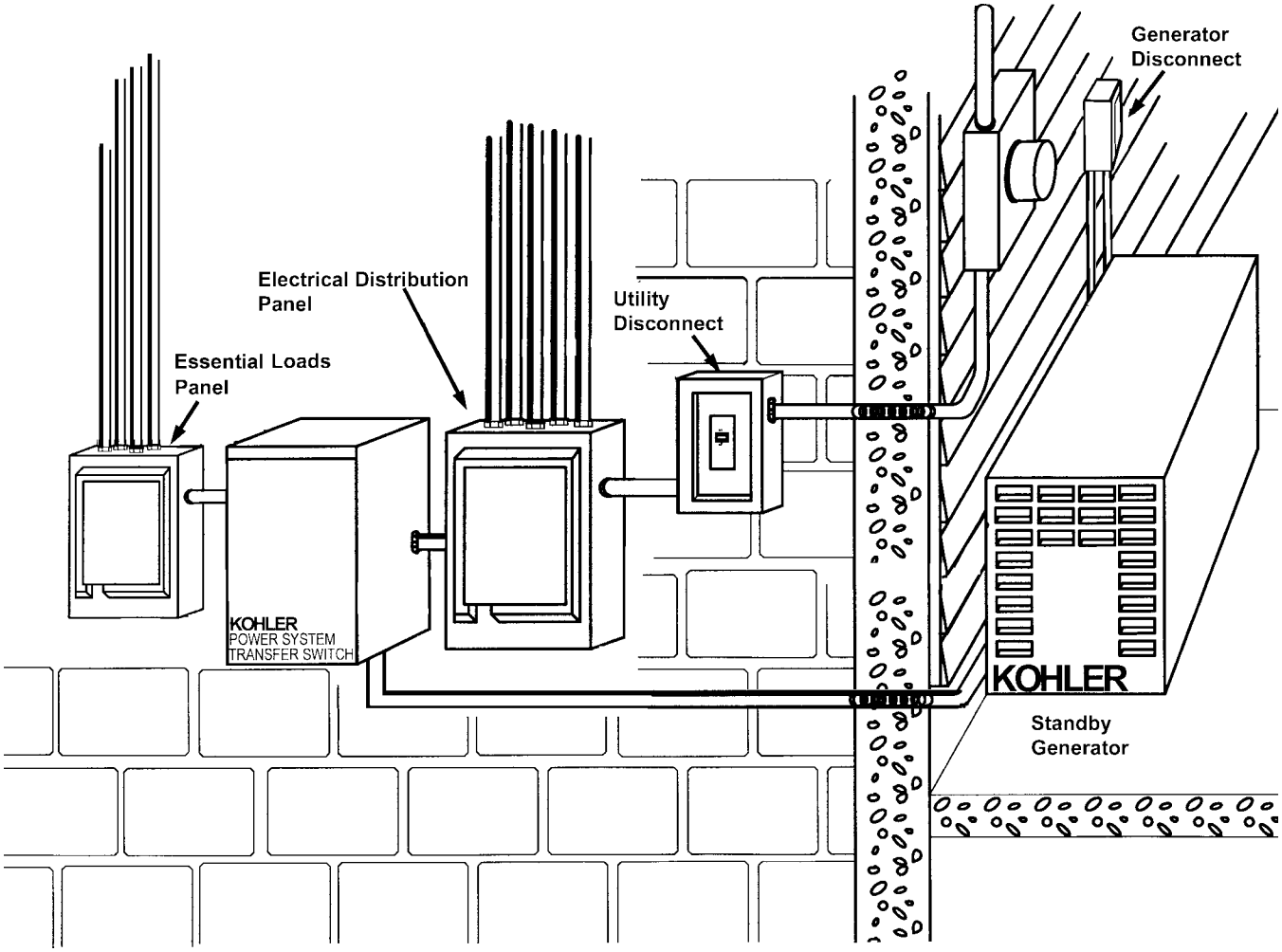


System Concept

The system concept features a utility (primary) source, generator (backup) source, and an automatic transfer switch connected to a building load.

The generator is designed to provide a dependable alternate source of electrical power. When connected to an automatic transfer switch (ATS) the generator will be signaled to start and building load transferred to the generator if the utility supply fails or falls below a specified level. When utility returns the ATS will transfer back to utility and allow the generator to go into a cooldown mode before shutting down the generator. The system is designed to require no manual intervention from the homeowner when operating automatically.

Note: when planning an installation of a home standby generator and ATS the installer must follow all municipal codes for the region. Installers must be familiar with and comply to all Natural or LP fuels codes as well as all electrical safety codes.



Essential Loads Panel

Prior to installing a Kohler power system the installer should carefully determine the size generator and ATS required. The generator will be sized to meet one of two electrical designs. Essential loads application (shown above) or Whole House Power (following page). The "essential loads" refers to providing power for those devices that a customer designates as essential during an emergency utility power outage. Sump pumps, furnaces, air conditioning, refrigerators, freezers and security lighting could all be considered essential.

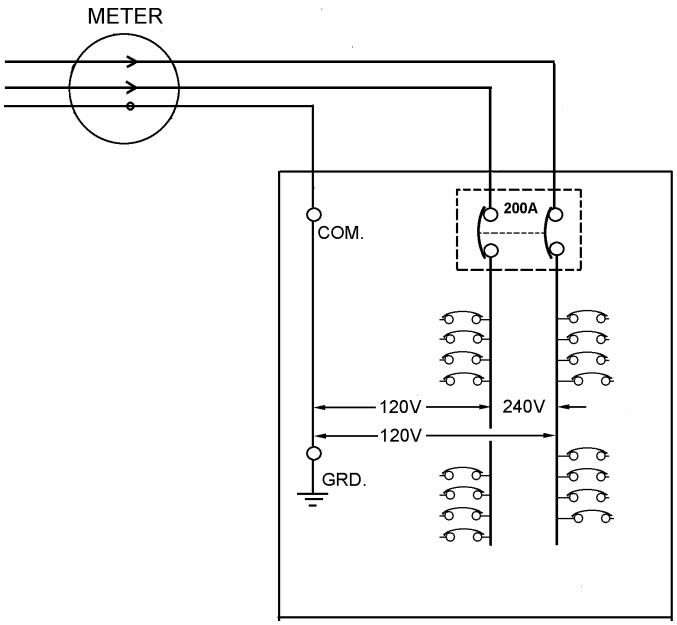
During installation these devices are wired through an "essential loads" distribution panel, which in turn is wired to the generator and ATS.

Sizing the generator for "essential loads" allows the customer to use a smaller generator to meet the homes electrical power needs during a power outage.

System Concept

The majority of newer residential utility service entrances in the United States are protected by a 100 or 200 amp circuit breaker. This main disconnect circuit breaker is generally located in a panel with the distribution circuit breakers.

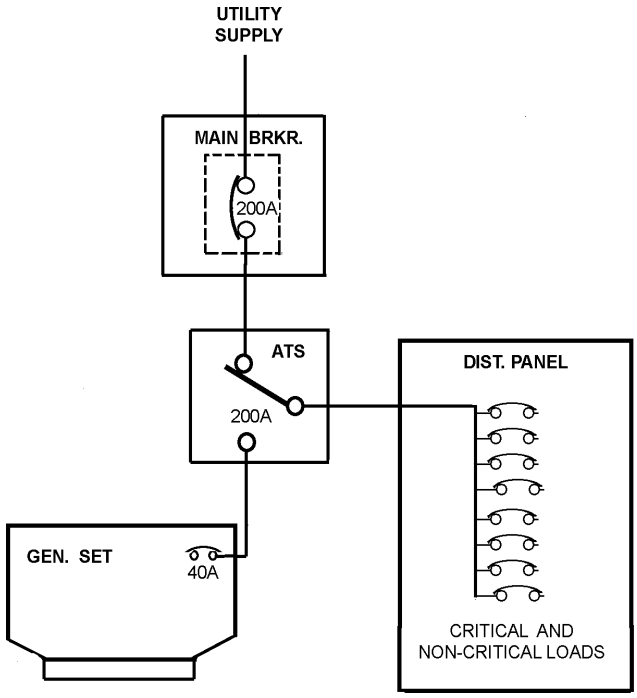
The Normal 60 Hz. voltage supply from the meter is usually single phase , 3 wire, 220 to 240 volts measured line to line and 110 to 120 volts line to neutral. The neutral or common is tied to a ground lug.



When designing a Standby Power System the Emergency Generator set must match the voltage and frequency of the Normal source.

The Transfer switch must also have the same voltage and frequency rating of the Normal and Emergency power supplies for operation of the transfer mechanism.

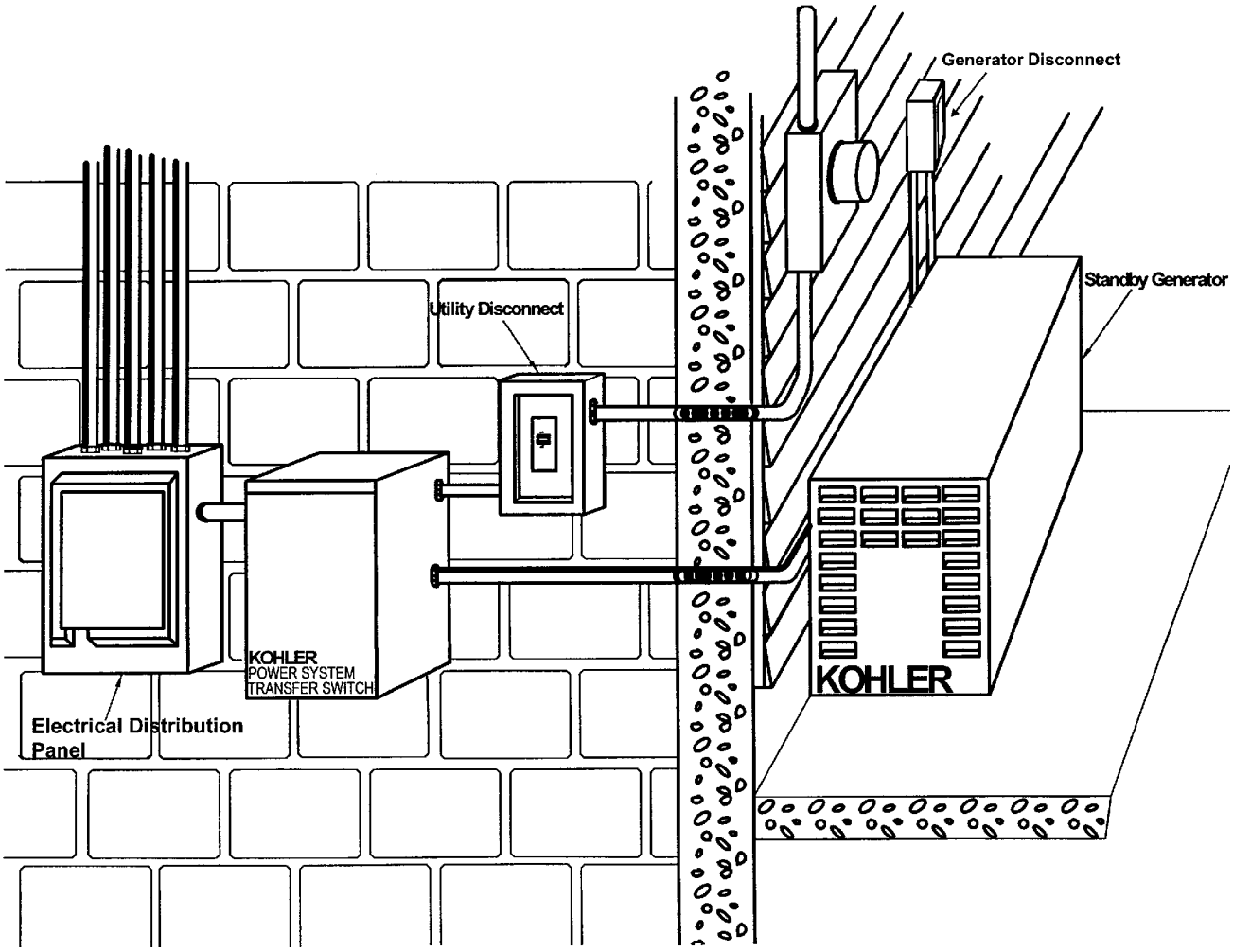
If the total load of a 200 amp service is connected to the transfer switch, the switch must meet or exceed the 200 amp rating even though the generator may only be capable of supplying 40 amperes.



The load applied to the generator can be reduced if required by manually opening distribution breakers.

Normally not all circuits are considered as critical loads and therefore need not be powered by the generator. An emergency supply of 8 to 11kW in most cases is more than adequate.

There are various design schemes that an electrical contractor can offer that can meet customers particular needs.



Whole House Power

When the customer decides that the generator should power the whole house, just as if normal utility power is working, the generator and ATS must be wired directly into the homes electrical distribution panel (as shown). Care must be taken when sizing the generator and ATS switch for each application, refer to the specification sheets of the generator and automatic transfer switch to make sure the current and voltage ratings meet the energy needs of the installation. Typically when sizing a whole house system, the generator current ratings should be equal to the main circuit breaker rating. If not then the installer should calculate current draw of all electrical devices that may be on during an emergency power outage and size the generator accordingly. Failure to do so will result in the generator being overloaded causing possible harm to the generator or electrical load.

How much power does my home need during an emergency?

This wattage chart is intended to help you determine the essential requirements for typical home appliances. Things like heating, air conditioning, your security system, freezer, refrigerator, sump pump, microwave or predetermined lighting, etc. The chart also allows you to determine or "stagger" special loads by alternating the usage of specific appliances.

Typical AC electrical requirements for a residential installation.

Appliance		Wattage Requirement
Air Conditioner (Central)		
10,000 BTU		*2200
20,000 BTU	1.7 Ton	*3300
24,000 BTU	2.0 Ton	*4950
32,000 BTU	2.7 Ton	*6500
40,000 BTU	3.4 Ton	*7800
48,000 BTU	4.0 Ton	*9400
Air Conditioner (Window)		
5,000 BTU		*1400
7,000 BTU		*1800
10,000 BTU		*3000
18,000 BTU	1.5 Ton	*5700
24,000 BTU	2.0 Ton	*6000
Clothes Dryer		
Gas		*2500
Electric		*7550
Coffee Maker		1750
Computer (Home)		500 to 1200
Dehumidifier		*1450
Dish Washer		*2100 to 2850
Electric Blanket		400
Electric Fry Pan		1100 to 1500
Electric Range		
6 in. element		1500
8 in. element		2100
Broiler		1400
Oven		6000
Fan		
Attic		350
Window		100 to 200
Furnace (Gas or Oil)		
1/8 Hp Fan		*800
1/6 Hp Fan		*1250
1/4 Hp Fan		*1600
1/3 Hp Fan		*2100
1/2 Hp Fan		*3225

Appliance	Wattage Requirement
Garage Door Opener	
1/4 Hp	*2000
1/3 Hp	*2500
1/2 Hp	*4000
Hair Dryer	300 to 1500
Iron	1200
Light Bulbs	Watts on Bulbs
Microwave Oven	
625 Watt Power	*2500
850 Watt Power	*3200
Radio	50 to 200
Refrigerator/Freezer	*3100
Security System	250
Space Heater	1200
Sump Pump	
1/3 Hp	*2150
1/2 Hp	*3200
Television	300
Toaster	
2 Slice	1050
4 Slice	1650
Vacuum Cleaner	800 to 1100
Water Heater	4500 Per element
Well Pump	
1/3 Hp	*2150
1/2 Hp	*3100

*Starting Wattage (Appliance needs more current to start than to run.)

These estimates are intended to assist in the specification phase of assessing your generator requirements. Actual appliance wattage will vary depending on the manufacturer and application. Consult your local KOHLER Generator Distributor or Dealer for exact specifications.

Calculating Loads

To assist in determining how much power your customer will need to operate an emergency standby system use the wattage chart to calculate power consumption for the application. This chart will give you estimated power consumption for various appliances including the motor starting requirements.

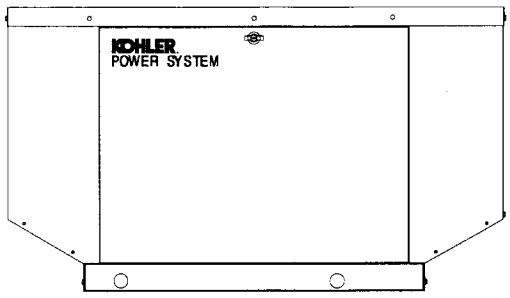
FEATURES AND SPECIFICATIONS

Models 8.5 and 11RMY are powered by V-Twin, Kohler Command ™ CH20 and CH25 air cooled, overhead valve engines.

The generator set can utilize either LP or Natural Gas for the fuel supply. The model designation corresponds with the full load kW rating of a 60 hertz unit operating on LP gas. Due to the lower BTU rating of Natural gas approximately 12% less than the LP rating is normal when fueled by Natural gas.

Systems are available for both single phase, 3 wire 120/240 volt, 60 hertz and 110/220 volt, 50 hertz applications. Both voltage and frequency are field adjustable to closely match the utility supply.

G120
The Automatic Transfer Switch provides the interfacing between the facility, utility and generator set. 100 and 200 amp models are offered in the G120 series of Kohler automatic transfer switches. Both models feature solid state controls and time delays, 240 volt actuated contactors and NEMA type 1 (indoor) and 3R (outdoor) enclosures.



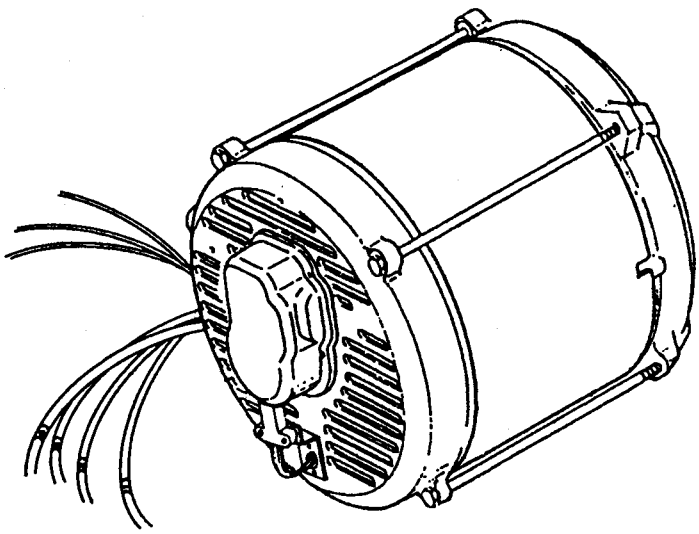
Generator Ratings

Model Series	Voltage	Phase	Hz	Standby Amps		Generator Model	Standby Ratings, kW/kVA	
				Nat. Gas	LP Gas		Nat. Gas	LP Gas
8.5RMY	120/240	1	60	29	35	2F4	7.0/7.0	8.5/8.5
8.5RMY	110/220	1	50	29	34	2F4	6.3/6.3	7.5/7.5
11RMY	120/240	1	60	40	46	2F4	9.5/9.5	11.0/11.0
11RMY	110/220	1	50	39	44	2F4	8.5/8.5	9.6/9.6

RATINGS: Standby ratings are continuous for the duration of any power outage. No overload capacity is specified at this rating. All single-phase units are rated at 1.0 power factor. Availability is subject to change without notice. Kohler Co. reserves the right to the design or specifications without notice and without any obligation or liability whatsoever. Contact your local Kohler Co. generator distributor for availability. GENERAL GUIDELINES FOR DERATION: *ALTITUDE*: Derate 4% per 1000 ft. (305 m) elevation above 500 ft. (153 m). *TEMPERATURE*: Derate 1% per 10° F (5.5° C) temperature increase above 77° F (25° C).

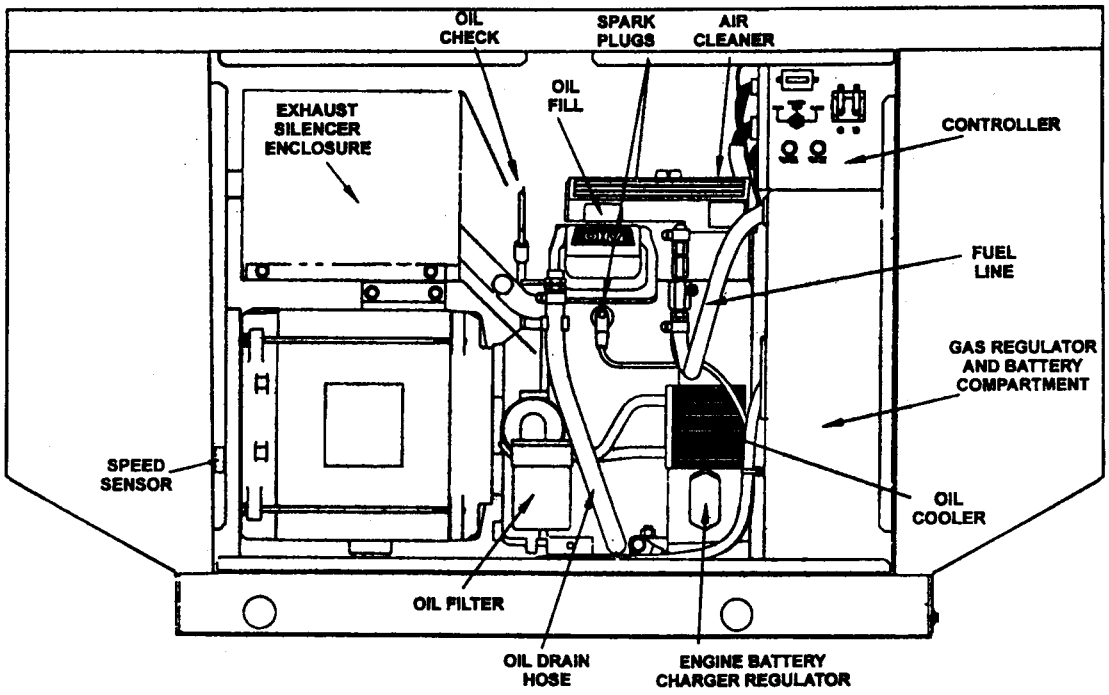
Alternator Specifications

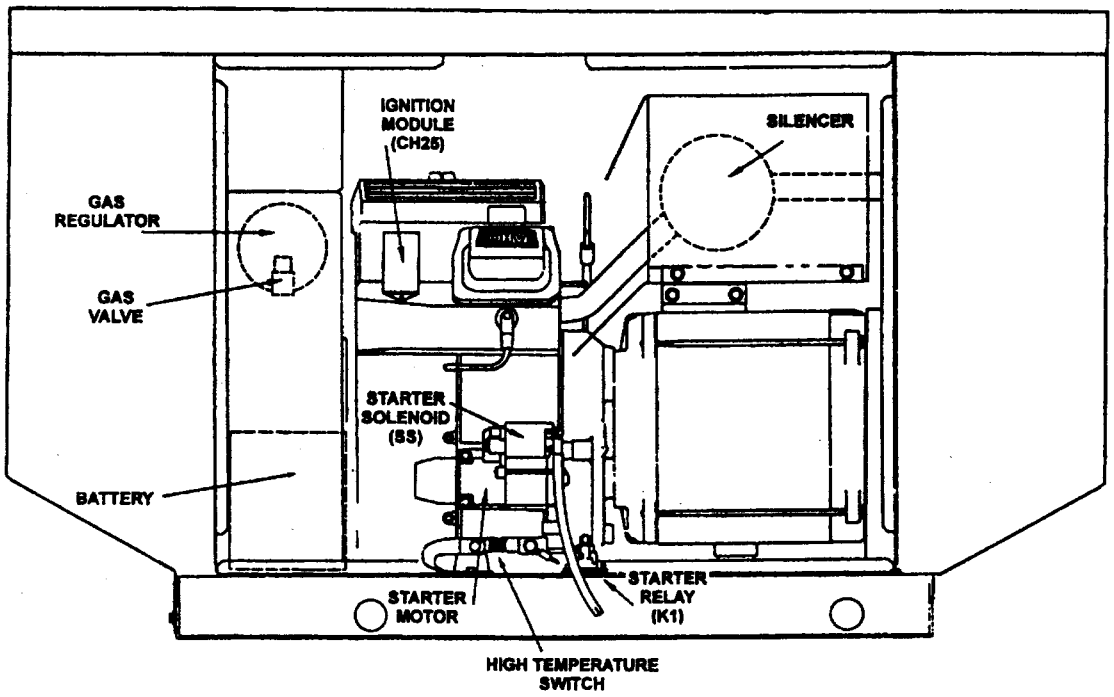
- Compliance with NEMA, IEEE, and ANSI standards for temperature rise.
- Self-ventilation and drip-proof construction.
- Vacuum-impregnated windings with fungus-resistant epoxy varnish for dependability and long life.
- Superior voltage waveform and minimum harmonic distortion from skewed alternator construction.
- PowerBoost voltage regulator with ±2% no load to full load regulation.
- A rotating-field alternator with static exciter- for excellent load response.



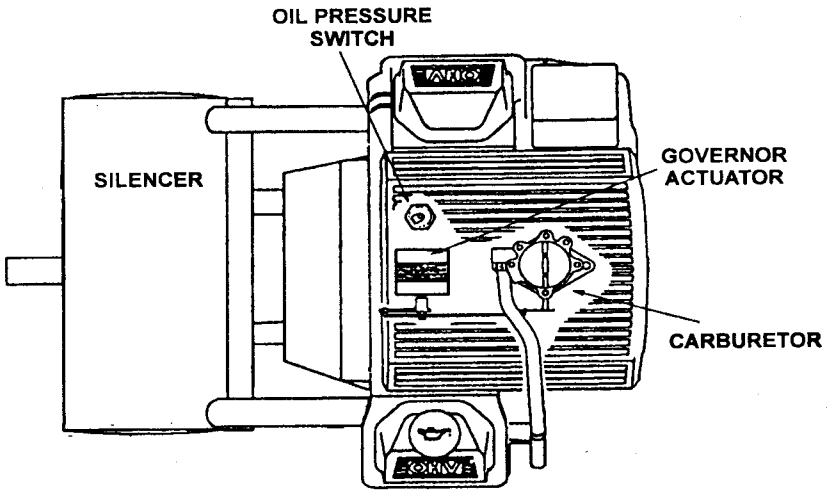
Specifications	PowerBoost™ Generator 1-Phase (2F4)
Manufacturer	Kohler
Output reconnectable	120/240
Type	2-Pole, Rotating Field
Number of leads	4
Voltage regulator	Solid State
Insulation: NEMA MG1 -1.66,	
Material	Class F
Temperature rise	Class F
Bearing, number, type	1, Sealed Ball
Coupling	Direct
Amortisseur windings	Full
Voltage regulation,no load to full load	± 2%
One-step load acceptance per NFPA1	100% of Rating
Peak motor starting kVA: 60Hz	11

Components and Features

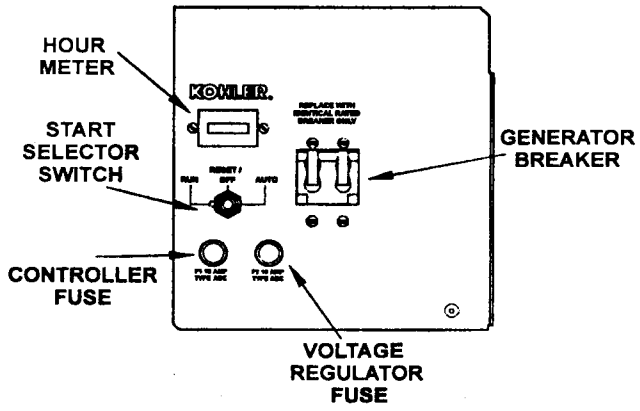




Components and Features



CONTROLLER



Air Intake

Cooling

The enclosed unit is cooled by a directed air flow system.

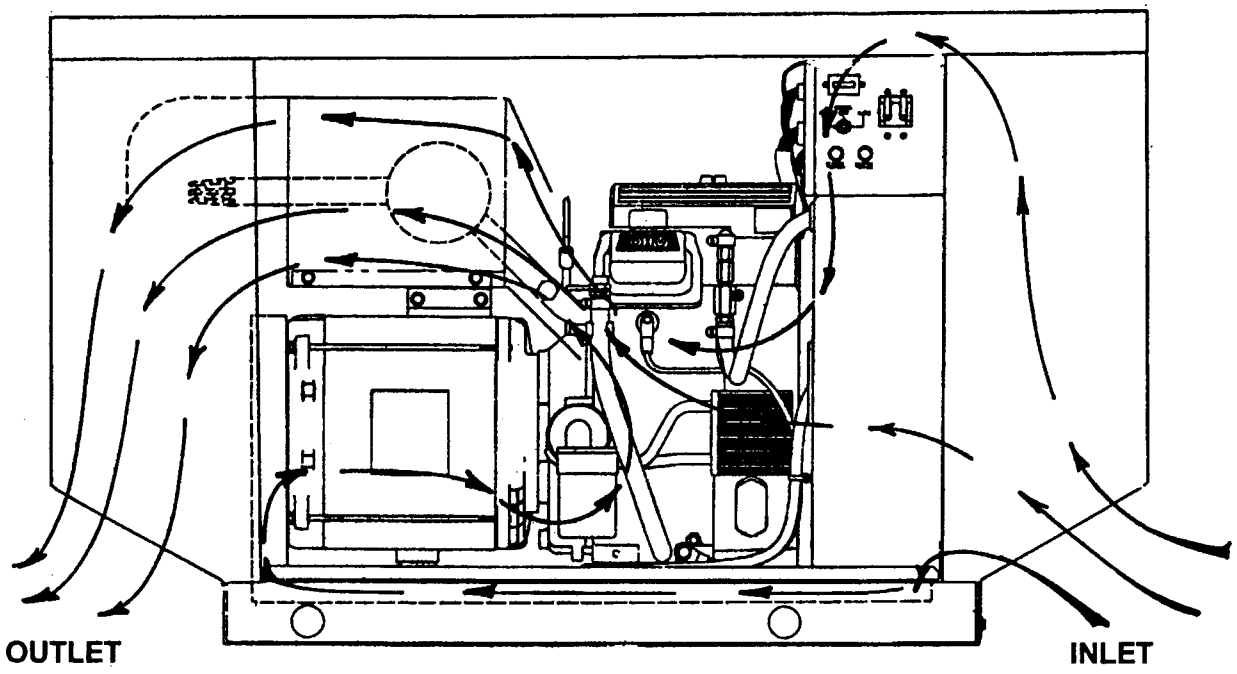
Two fans, one attached to the engine flywheel and the other to the alternator rotor draw in ambient air to cool the engine, alternator, and controller, as well as purge the compartment of hot air.

The engine fan draws air from the housing inlet and forces it across the cylinder cooling fins. A portion of air is also directed through the controller . An opening in the controller shelf provides air flow for the voltage regulator.

The Alternator fan draws cool air into openings in the end bracket to cool the rotor and stator windings via a duct located in the skid. The hot air is expelled into the compartment where it and the engine air is pressurized and forced past the exhaust silencer and directed out the housing outlet opening with the engine exhaust.

The enclosure is designed to provide optimal cooling with the access door closed.

<u>It is important that both inlet and outlet openings are not obstructed.</u>



Air Intake

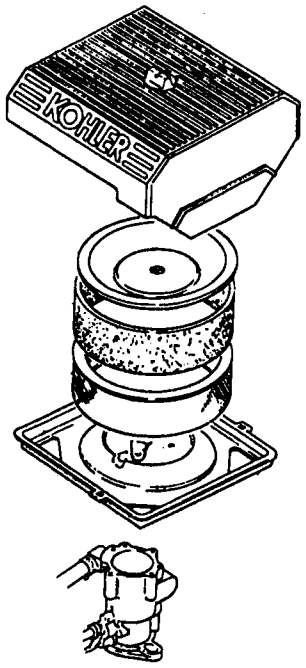
Air Cleaner

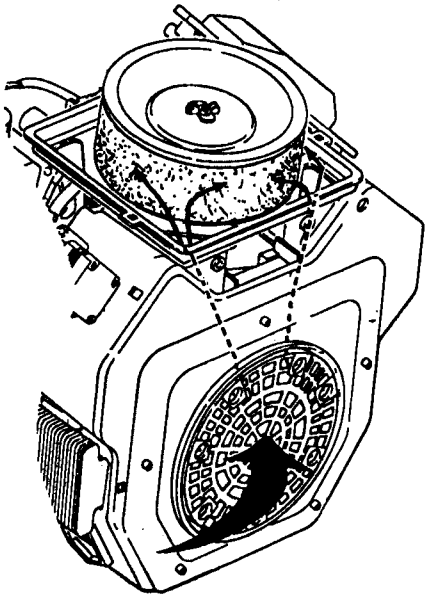
A portion of the outside ambient air is directed from the flywheel fan to the Gas/Air mixer (carburetor) for combustion.

The air is first filtered by an oiled-foam precleaner and replaceable paper element air cleaner.

It is important that the filters are serviced at the recommended scheduled times and that the unit is not operated with the filters removed. Dirt particles entering the intake will cause premature engine wear and failure.

A clogged filter may cause excessive fuel consumption and a loss of engine power.





Fuel System

The generator set will operate on either Natural or LP fuel in a gaseous state. Manual shut-off valves and Primary regulators are installed by the fuel supplier.

A secondary regulator and 12vdc solenoid valve are located in the front inlet air compartment. The solenoid valve is energized from the controller to open at start and deenergize at shutdown. A ½" NPT inlet is provided.

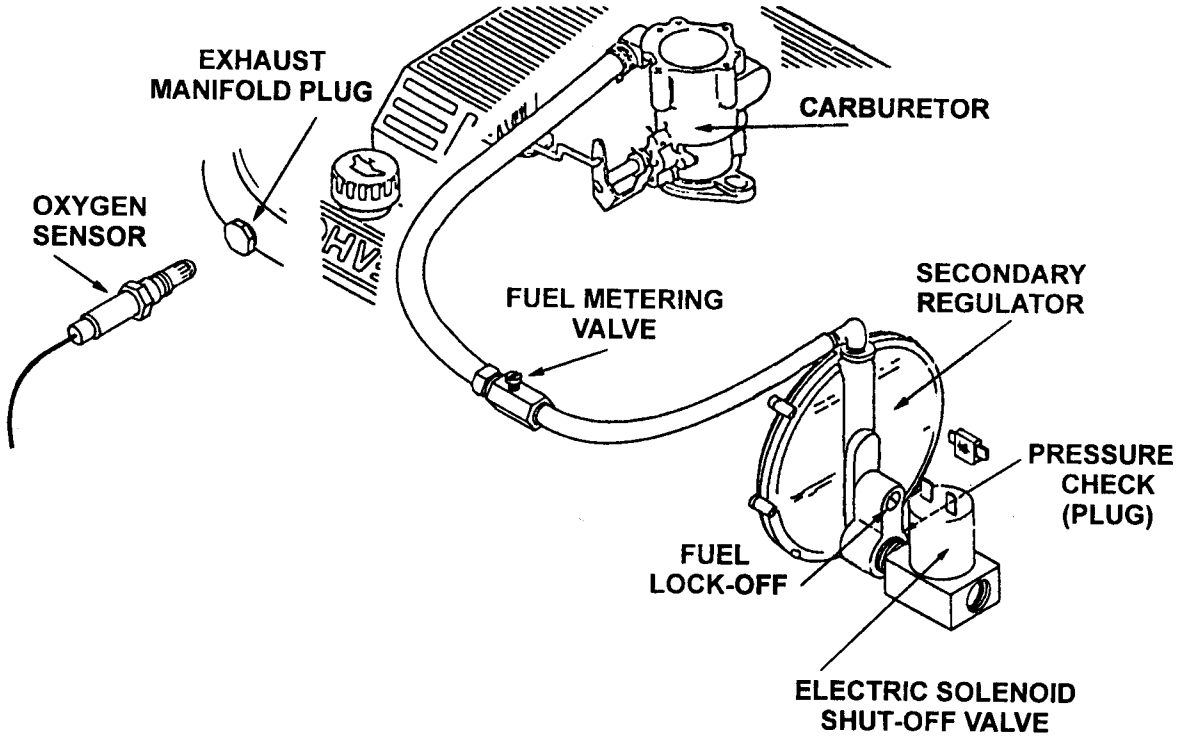
Inlet gas pressure to the regulator should not exceed 6oz. The regulator controls the pressure on engine demand. A plug is provided at the regulator input for installation of a gauge or manometer if a pressure check is required.

A fuel lock-off is also located in the regulator which prevents fuel flow when the engine is not operating. This is adjusted at the factory and should not be used in an attempt to adjust fuel mixture or engine speed.

It is not possible to adjust fuel metering of CARB/EPA certified generator sets. Fuel metering is factory set to meet requirements and perform at optimum efficiency.

Units which are not certified have an inline adjustable fuel metering valve which can be field adjusted to compensate for abnormal temperature, altitude or fuel quality. This is accomplished with the aid of a digital volt meter and oxygen sensor. (A-345052)

The sensor can be installed at the plugged opening location in the exhaust manifold. At full load, normal operating temperature, the voltage output read at the sensor lead to ground should be 0.5vdc. A higher voltage indicates an over-rich mixture. Lesser reading indicates too lean a mixture. The mixture richness (voltage) is increased by turning the Fuel Metering Valve counterclockwise and decreased by a clockwise rotation.



Natural Gas System

The natural gas as supplied from the utility is in a vapor state. The primary regulator for a natural gas system will be the responsibility of the utility that supplies the natural gas.

The heating value of Natural gas should be 1000BTU per cubic foot. When heating content falls below 1000BTU the set will not produce rated power and will need to be derated. Always check the specification sheet for the rating of the generator while running on natural gas, many applications require derating of the full load power on natural gas.

When installing or troubleshooting the fuel system the following factors must be considered.

- Pressure loss due to length of pipe
- Pressure loss due to other appliances on same fuel supply
- Pressure loss due to number of fittings or elbows

Measured pressure at the inlet to the secondary regulator should be 4 – 6 ounces per square inch or 7 – 11 inches water column. The outlet or carburetor side of the secondary regulator should measure 4-5 inches water column under load.

Physical Property @ 60°F (15°C)	**Natural Gas**
Normal Atmospheric State	Gas
Boiling Point	
Initial	–259°F (–162°C)
End	–259°F (–162°C)
Heating Value, Btu's per:	
Gallon (Net – LVH)	63,310
Gallon (Gross)	
Cubic Foot (Gas)	1000
Density	
Cubic feet of Gas per Gallon (Liquid)	57.75
Weight (lbs.) per Gallon Liquid	2.65
Octane Number:	
Research	110+
Motor	

LP Gas

LP gas is supplied as a liquid in pressure tanks, which makes it easily adaptable to stationary generator applications where complete independence of a fuel source is required.

LP gas is propane, butane, or a mixture of the two gases. The ratio of butane to propane is especially important when an outdoor tank is used. LP gas suppliers may supply the tank in warm summer months with a mixture composed mostly of butane, this mixture my work well in summer but may not provide sufficient vaporized pressure at cold temperatures (below 32°) to start and run the engine. Check with you LP gas supplier for mixture content when hard starting symptoms exist.

The heating value for propane is 2,516 BTU per cubic foot with a boiling point of -44° F and butane is 3,264 BTU per cubic foot with a boiling point of 32° F.

Inlet pressure into the secondary regulator should be 4 – 6 ounces per square inch or 7 – 11 inches water column. Outlet pressure to the carburetor will be a negative pressure of about –11/2 inches water column.

Physical Property @ 60°F (15°C)	**Butane**	**Propane**
Normal Atmospheric State	Gas	Gas
Boiling Point		
Initial	+32°F (0°C)	–44°F (–42°C)
End	+32°F (0°C)	–44°F (–42°C)
Heating Value, Btu's per:		
Gallon (Net – LVH)	94,670	83,340
Gallon (Gross)	102,032	91,547
Cubic Foot (Gas)	3264	2516
Density Cubic feet of Gas per Gallon (Liquid)	31.26	36.39
Weight (lbs.) per Gallon Liquid	4.81	4.24
Octane Number:		
Research	94	110+
Motor	90	97

Pipe Size Requirement for Gaseous System

When installing the generator and laying the pipe for a gaseous system a few things need to be considered, the type of fuel, the distance it must travel from gas meter or tank to the fuel shutoff solenoid, and the amount of fuel consumed by the engine. To figure the correct pipe size for a specific installation, refer to the chart and follow the procedure outlined.

1. Determine length of pipe between gas meter/tank and fuel shutoff solenoid at generator set. Example: 35ft.

2. Find figure closest to pipe length in "Length of Pipe" column on chart. Example: For 35ft it would be 40ft.

3. Refer to fuel consumption from the generator specification sheet. Note type of fuel, and consumption of fuel at 100% load. Example: The 8.5RMY for natural gas operating at 100% full load uses 132cfh (cubic feet per hour).

4. Refer to correction factors below. Locate factor for specific gravity of fuel used. Example: natural gas specific gravity - .65, correction factor - .962.

5. Divide consumption figure (132cfh) by the correction factor (.962).

   132÷.962= 137cfh.

6. Move vertically across page to determined point in "length of pipe" column (40ft) go down column and stop at first figure equal to or greater then corrected consumption figure (137cfh).

7. Move to left column from figure (137cfh) to determine correct pipe size. The correct pipe size for a 8.5RMY with a pipe run of 35 ft. should be 3/4 inch.

Correction Factors

Fuel	Specific Gravity	Factor
Sewage Gas	0.55	1.040
Natural Gas	0.65	0.962
Air	1.00	0.775
Propane	1.50	0.633
Butane	2.10	0.535

Maximum capacity of Pipe in Cubic Feet of gas per Hour for a Gas pressure of 0.5Psig or less

(Based on a 0.60 Specific Gravity Gas)

Nominal Iron Pipe Size, Inches	Internal Diameter, Inches	Length of Pipe, Feet						
		10	20	30	40	50	60	70
1/4	.364	43	29	24	20	18	16	15
3/8	.493	95	65	52	45	40	36	33
1/2	.622	175	120	97	82	73	66	61
3/4	.824	360	250	200	170	151	138	125
1	1.049	680	465	375	320	285	260	240
1–1/4	1.380	1,400	950	770	660	580	490	460
1–1/2	1.610	2,100	1,460	1,180	990	900	810	750
2	2.067	3,950	2,750	2,200	1,900	1,680	1,520	1,400
2–1/2	2.469	6,300	4,350	3,520	3,000	2,650	2,400	2,250
3	3.068	11,000	7,700	6,250	5,300	4,750	4,300	3,900
4	4.026	23,000	15,800	12,800	10,900	9,700	8,800	8,100

Nominal Iron Pipe Size, Inches	Internal Diameter, Inches	Length of Pipe, Feet						
		80	90	100	125	150	175	200
1/4	.364	14	13	12	11	10	9	8
3/8	.493	31	29	27	24	22	20	19
1/2	.622	57	53	50	44	40	37	35
3/4	.824	118	110	103	93	84	77	72
1	1.049	220	205	195	175	160	145	135
1–1/4	1.380	460	430	400	360	325	300	280
1–1/2	1.610	690	650	620	550	500	460	430
2	2.067	1,300	1,220	1,150	1,020	950	850	800
2–1/2	2.469	2,050	1,950	1,850	1,650	1,500	1,370	1,280
3	3.068	3,700	3,450	3,250	2,950	2,650	2,450	2,280
4	4.026	7,500	7,200	6,700	6,000	5,500	5,000	4,600

A pressure drop of 0.5 inch water column has been calculated into the chart to make allowances for a nominal number of fittings.

Governor System

The frequency of the alternator output is determined by the speed of the engine. A 2-pole alternator must be driven at 3600 RPM to provide 60 hertz. (3000 rpm/50 Hz)

The engine speed is maintained by an electronic governor system consisting of a magnetic pickup, electric actuator and electronic control assembly.

The Electronic control board is energized with a 12vdc supply from the K25 start/run relay contacts.

The magnetic pick-up, which monitors the flywheel ring gear, provides the speed reference signal to the electronic control board.

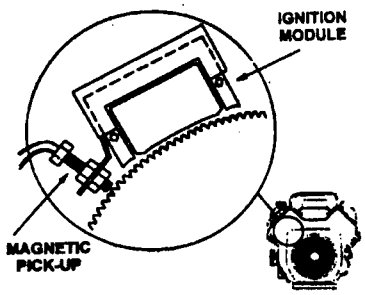
The control board provides regulated power to the bi-directional stepper motor actuator, which is linked, to the carburetor throttle arm.

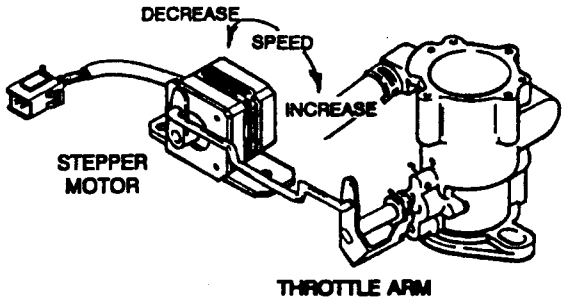
Failure or loss of the input speed signal from the pick-up will result in a low or idle speed condition.

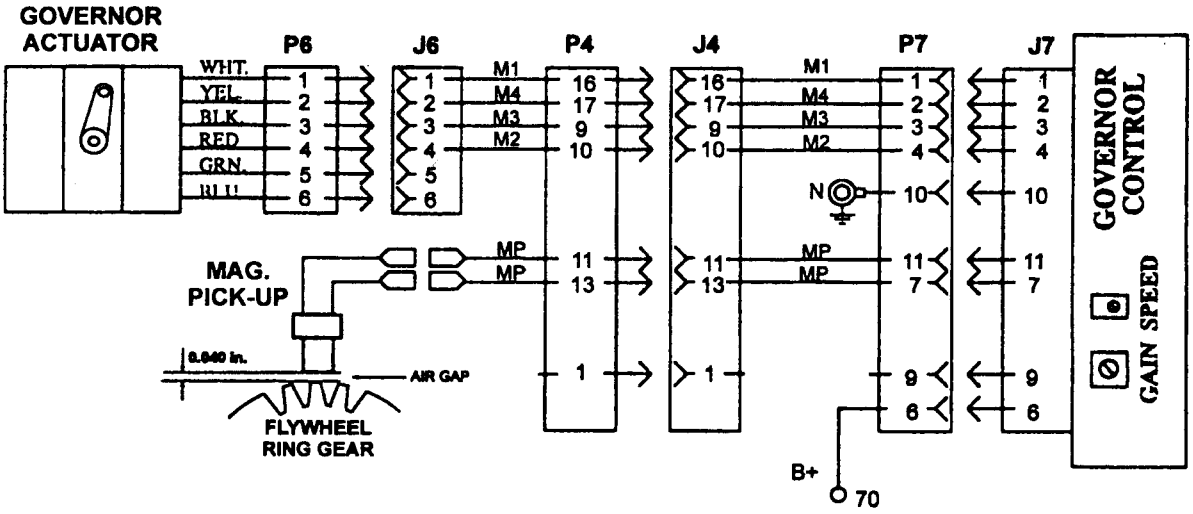
At cranking speed a properly adjusted pick-up should produce a minimum of 1.75vac. Air gap is factory set at 0.040 in. (1.02mm).

Engine speed is adjustable within the 50/60-hertz range by a potentiometer on the control board.

A Gain adjustment is provided if an unstable condition occurs. (hunting or surging)
Making a gain adjustment may require readjustment of engine speed.







Lube System

The Kohler Command engine features a pressurized oil lubrication system.

The gear driven pump is located in the sump and supplies approximately 25-35 psi of lubricant to the internal components at nominal engine speed. Pressure is limited by a relief valve.

A dipstick is provided for periodic oil level checks. As with any engine do not operate with the level below or above the designated markings.

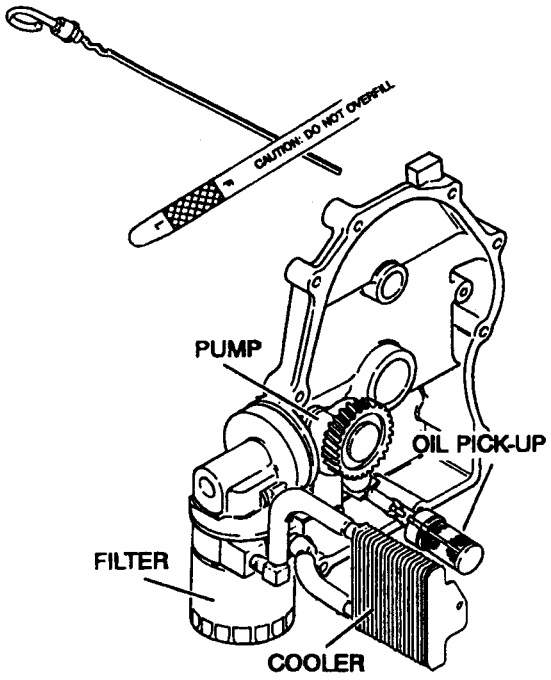
It is also very important to adhere to a good maintenance program. Replace the oil and filter at the recommended intervals.

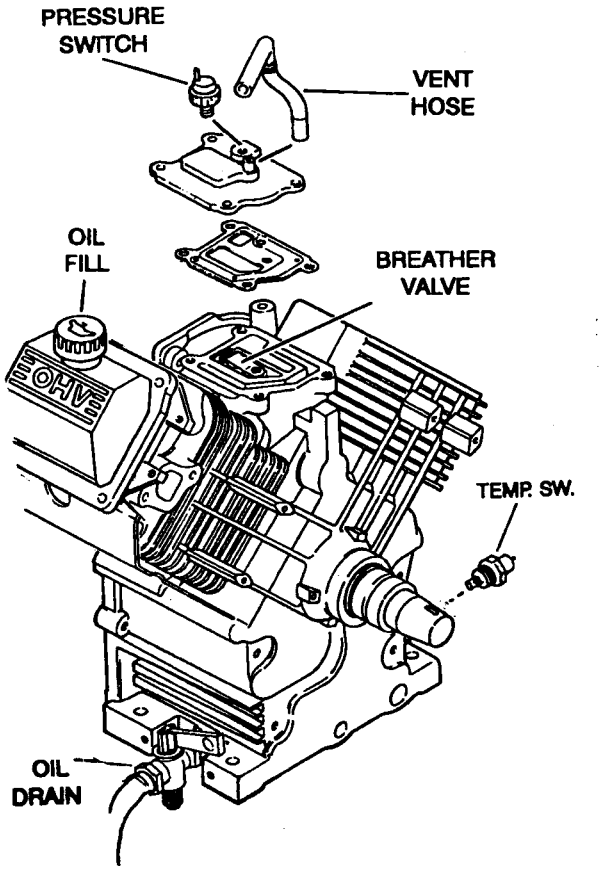
To aid in operating under high ambient conditions an oil cooler is provided, Heat is transferred to the fins and dissipated in the air flow.

The engine operates with a partial vacuum in the crankcase. This is controlled by a "breather" assembly consisting of a reed valve. A pressurized crankcase due to a faulty or clogged valve could cause oil leaks at seals and gaskets.

A hose attached to the valve vents the crankcase fumes to the mixer air intake for ingestion into the combustion chambers.

A pressure switch is installed in an oil passage in the breather cover to protect the engine in the event of a fault which would cause oil pressure to drop to an unsafe operating level. Contacts in the switch will close when the pressure drops below 3 to 5 psi and will initiate an engine shutdown.





Ignition System

The CH20 and CH25 engines feature dual capacitor discharge ignition modules to fire the two sparkplugs. They are installed on the cylinders in close proximity to the flywheel.

A permanent magnet is located on the flywheel which is keyed to the crankshaft providing a fixed timed ignition. (CH20)

As the magnet approaches the L1 coil a potential is generated which is rectified by the D1 diode and stored in the C1 capacitor.

Further rotation of the flywheel causes a current to be induced in the L2 coil which triggers the SCR discharging the capacitor to the primary of the T1 ignition coil.

This rapid flow of current in the primary induces a very high voltage in the T1 secondary windings sufficient to jump the spark plug gap and ignite the cylinder fuel mixture.

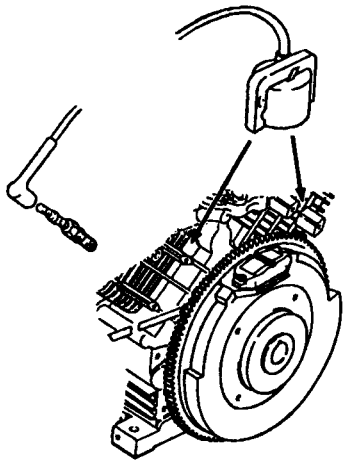
This firing occurs on every revolution of the flywheel.

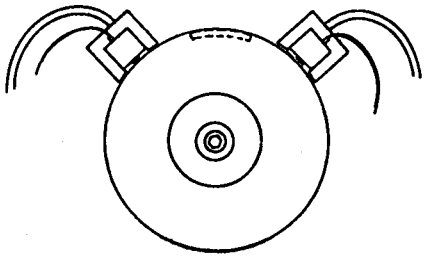
Ignition is terminated by shorting the high side of the primary circuit to ground. This is accomplished by the **K5** relay contacts.

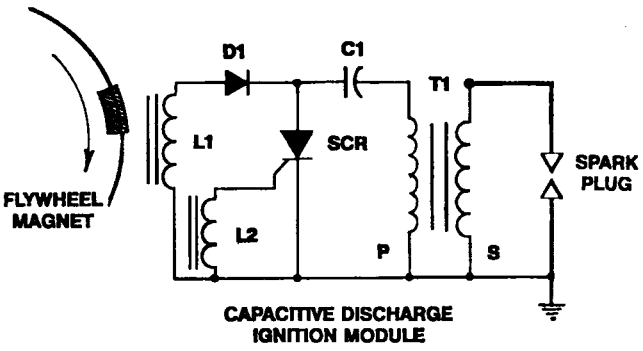
Air gap between the core of the modules and the magnet is .010 in. (0.25mm)

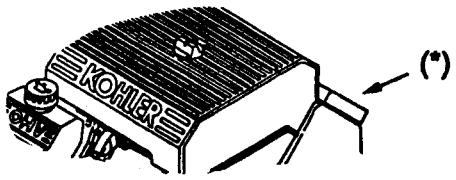
This magneto type ignition requires no external battery supply or timing adjustments.

The CH25 engine features a “SMART SPARK” module mounted externally at the rear cylinder shroud. Operation is the same except a spark advance circuit is provided to the triggering circuit and a battery voltage supply is required. (70a)





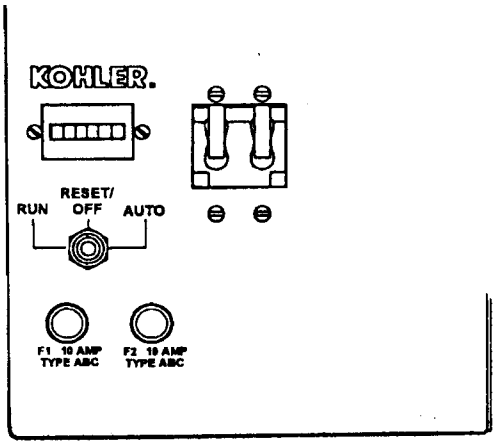




Starting System

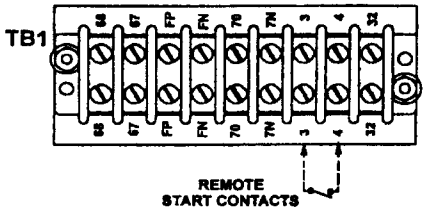
The generator set can be started locally by placing the start selector switch in the “RUN” position.

When placed in the “AUTO” position the generator set can be started from a remote location (automatic transfer switch) by contact closure between terminals 3 & 4 on the controller terminal stripTB1. The F1 fuse protects the Crank/Run circuit.



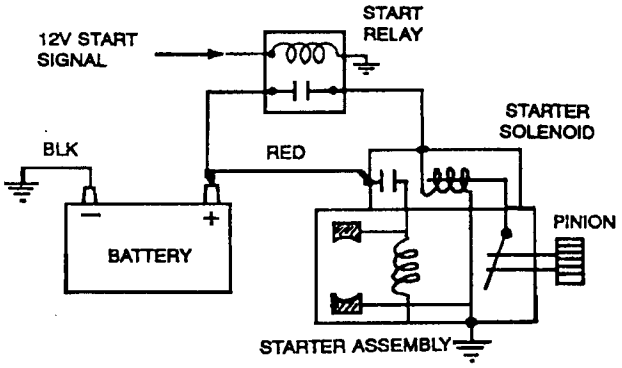
The electric starting system requires a 12 volt lead acid battery with a minimum 670 cold cranking amp rating.

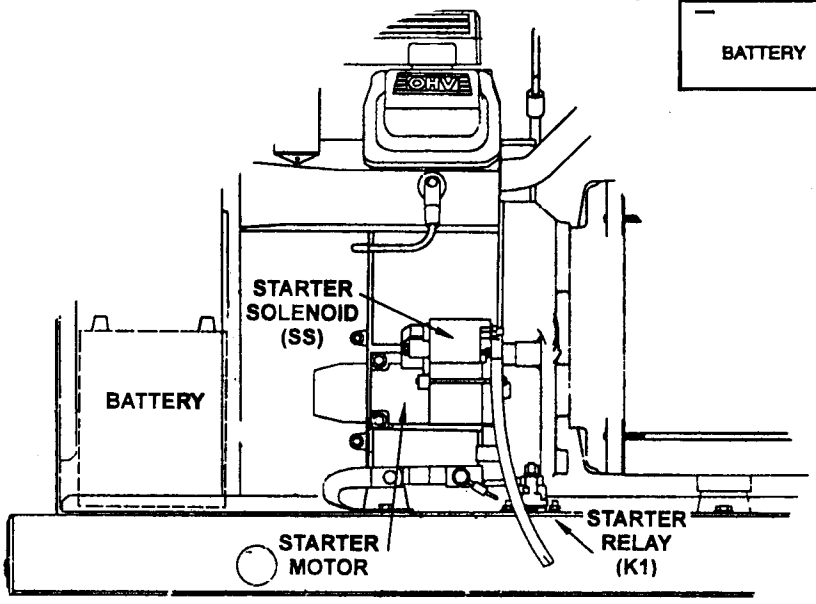
The unit is designed for negative ground connections . The controller will not allow an engine crank with a reversed battery connection, and system damage may occur.



The Starter Solenoid (SS) contains contacts that connect the battery to the starter brushes and a spring loaded drive mechanism which engages the starter motor pinion to the flywheel ring gear.

To insure a successful start-up the battery must be properly maintained and kept fully charged. A good 12v. float charger is recommended. If an Automatic Transfer Switch is part of the application the charger may be installed in the switch enclosure.





Cyclic Cranking

A cyclic cranking feature is provided which allows the starter to be energized for a preset time followed by a preset rest time. This cycle will repeat until the total time allocated by the controller (30 sec.) has lapsed or a successful start occurs.

Cranking time (ON) is factory set for 8 sec., Rest period (OFF) is set for 3 sec. Times are approximate and depend on battery and temperature conditions. They may be field adjusted if required. The feature will not function if both adjustment pots are turned fully counterclockwise.

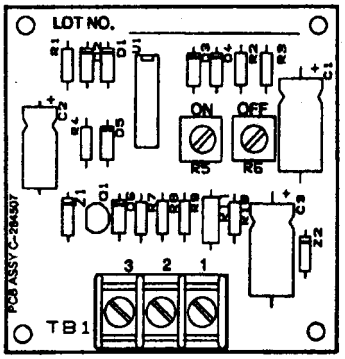
If the engine does not start within the total cyclic time the starting attempt will be terminated and an indication of "overcrank" will result. The selector switch must be placed in the "Reset/Off" position prior to attempting another start cycle.

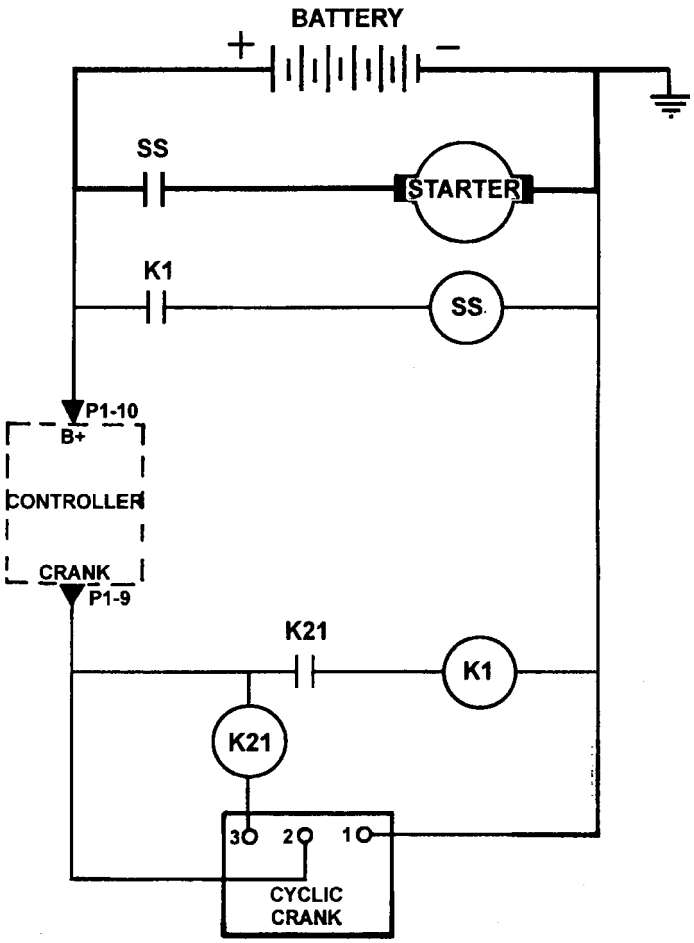
Cyclic cranking provides the starting components a rest or reset period to prevent overheating and allows more efficient use of available battery power before it is depleted. This is important especially for remote starting of an unattended unit.

When a start signal is provided, voltage is applied to the cyclic cranking circuit. During the "crank" cycle the K21 relay contacts will close energizing the cranking control relay K1. When the K1 contacts close the starter solenoid and Starter Motor will be energized.

If the engine starts within the cranking time of the cycle the K21 relay will deenergize removing power from the coil of the K1 relay and terminate engine cranking.

The Gas valve, Governor control and K5 relay (ignition ground disconnect) will also be energized during the cranking cycle.





12V. Battery Charging
Engine Flywheel Alternator

A Permanent Magnet, rotating field alternator is enclosed under the engine flywheel to provide recharging of the unit battery while the engine is operating.

The stator assembly is located over the shaft and secured to the crankcase. The magnets are mounted in the inner circumference of the flywheel.

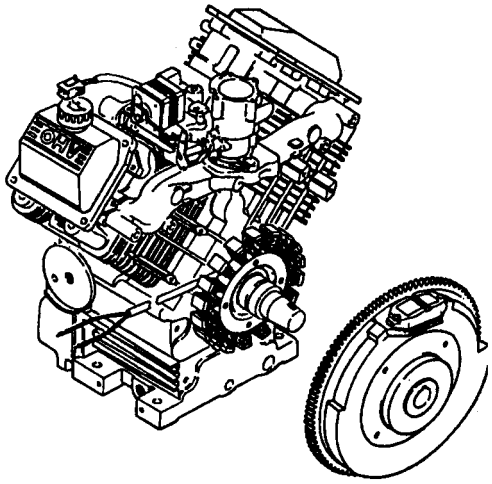
The Alternator will produce approximately 30vac at 3600 RPM.

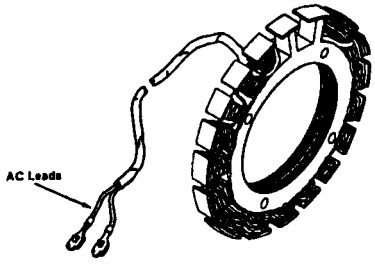
This AC is rectified and regulated to provide a safe DC recharge rate. Nominal charging voltage is 14.2vdc.

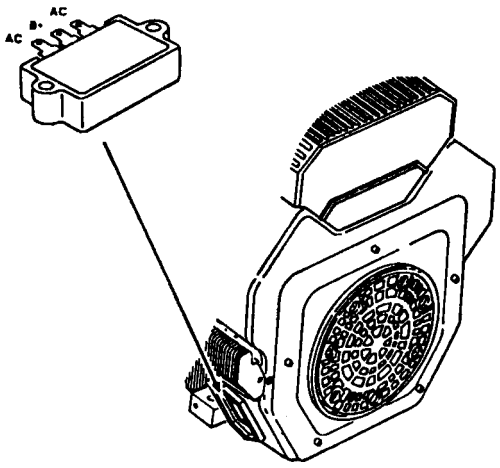
Maximum charging capabilities is 15 Amps.

The case of the Regulator/Rectifier provides the negative connection and must be securely fastened to the engine. (ground)

A maintenance charger is also required to keep the starting battery fully charged while the set is in the standby mode.







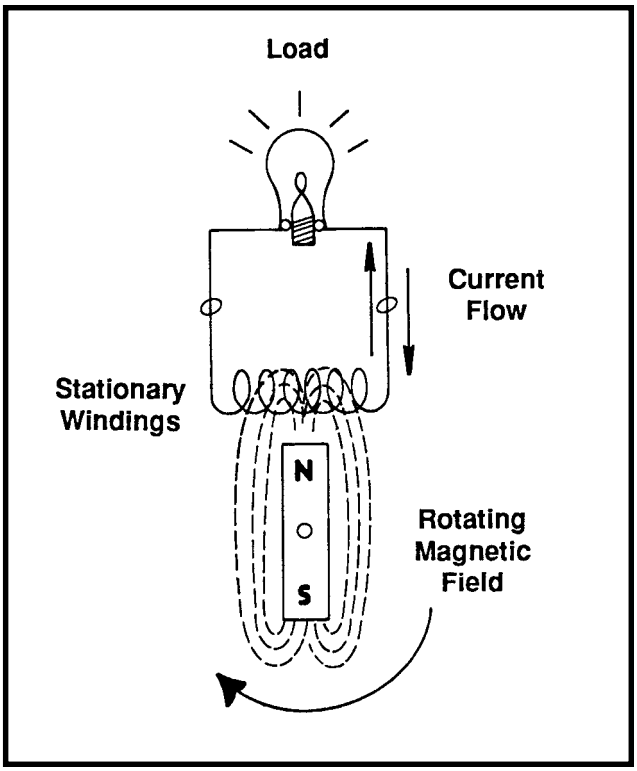
Alternator Design

Mechanical alternators or generators that produce an AC output are either the rotating armature or the rotating field design and require 3 basic things.

1. Conductors
2. A magnetic field
3. Movement between the two.

1. The **conductors** are copper wires wound in slots of laminated steel referred to as the armature and provide the generated output voltage.
2. The **field** is the invisible magnetic force produced by electro-magnetic pole pieces.
3. **Movement** between the field and conductors is necessary to create current flow in the armature windings and is usually provided by a gas or diesel engine.

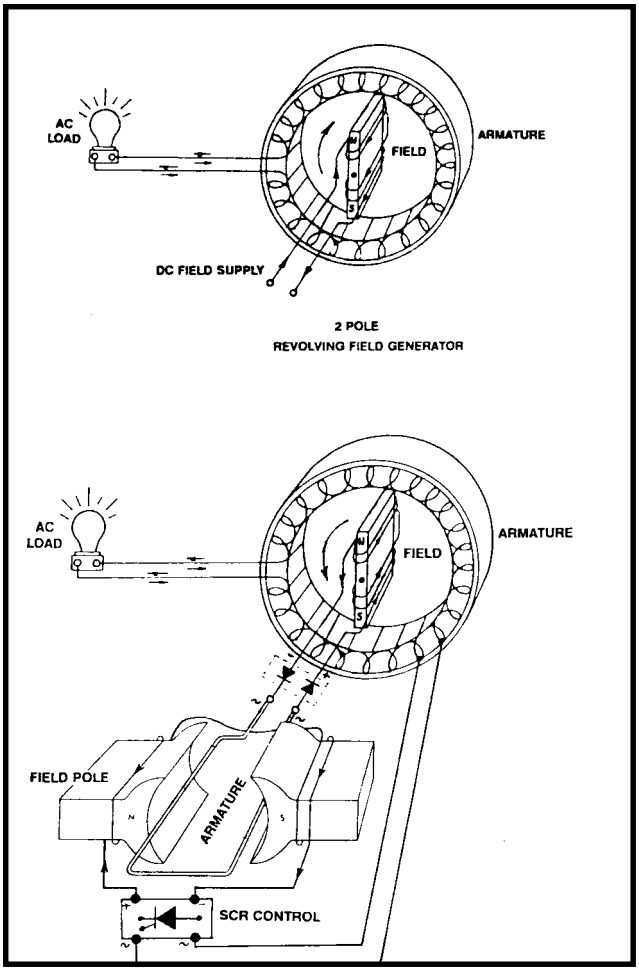
Kohler residential generators are of the rotating field design.



Rotating Field Generators

Alternators used on most generator sets today are of the rotating field design. The magnetic poles of the rotor rotate past the armature windings of the stator. The rotor is energized with a DC field by some type of excitation. As the field rotates the magnetic flux lines cut the conductors, which are distributed so as to induce a sinusoidal voltage in the stator. The armature windings are stationary, no brushes are required for a transfer of AC power to the customer load.

The stationary armature also allows for easy reconnection of the windings to permit various three phase or single phase voltages.



Alternator

The Alternator is of the Rotating Field design and consists of two major components, the Rotor and Stator.

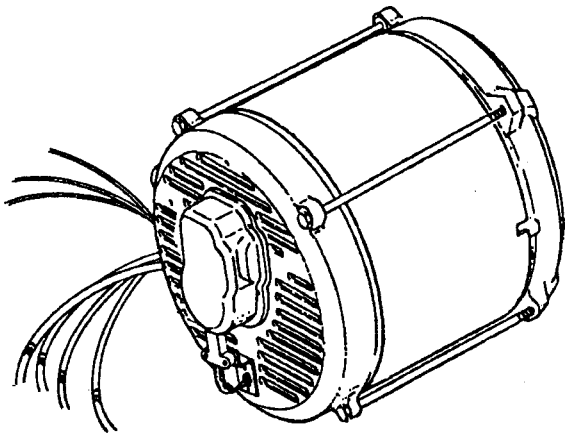
The Rotor which is located within the Stator is of the 2 pole design and is directly coupled to the tapered engine crankshaft stub with a thru-bolt.

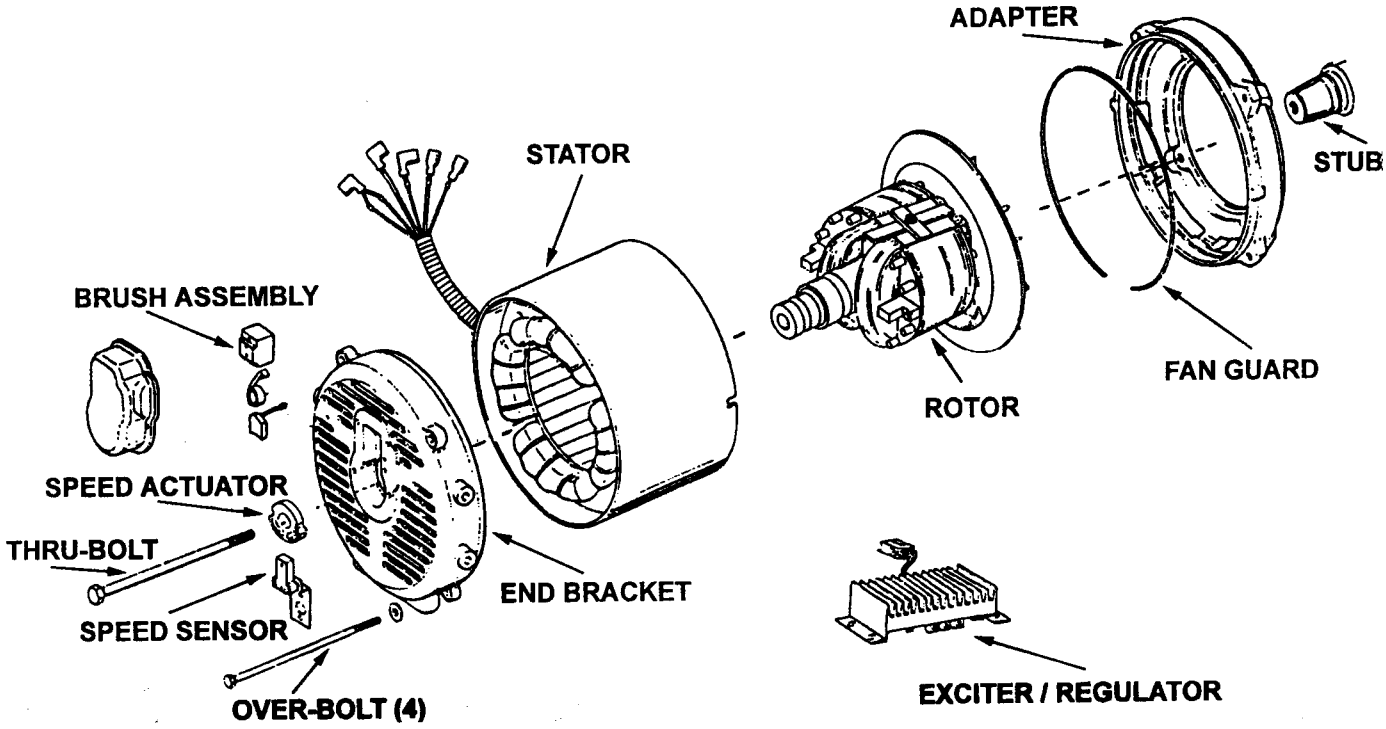
Excitation slip rings are mounted outboard of the end bearing and accessible from the exterior of the end bracket. The fan is permanently mounted to the rotor shaft

The Stator contains the copper windings which provide the load current and is assembled to the engine adapter with an end bracket and overbolts.

The 4 lead stator is wound for single phase applications only and is factory connected to provide a 3 wire 110/220 to 120/240 volt supply.

The DC excitation to the rotor slip rings is supplied by an adjustable static exciter/regulator.





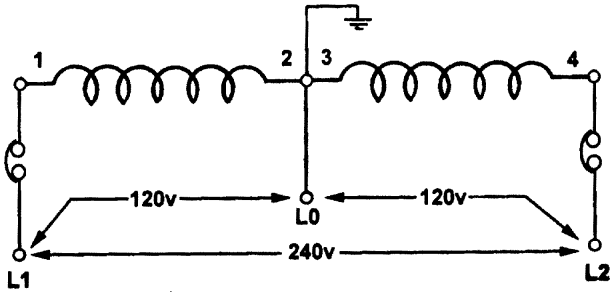
Stator

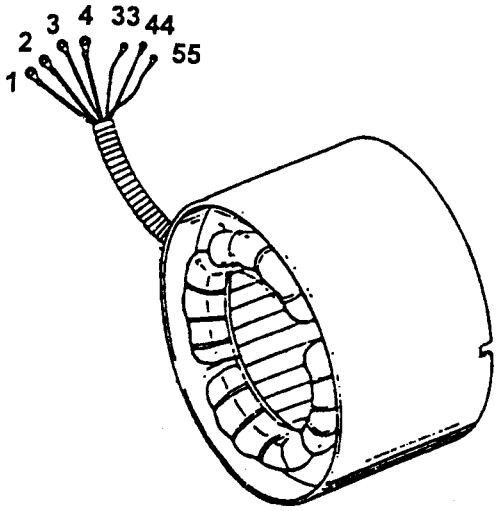
120 / 240 v 3 Wire.
110 / 220 v 3 Wire.

The 4 lead stator is factory connected to provide two low voltage (110-120) circuits and one high (220-240) voltage circuit. The rated load amps can be divided between these three circuits.

A 2 pole circuit breaker is provided for load disconnect. Customer load connections are made at the breaker.

Most Standby applications require a 240 volt circuit including the G120 Automatic Transfer Switch.

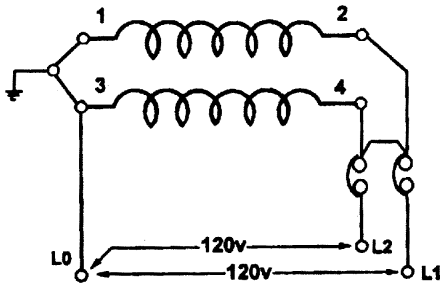




Stator leads 33, 44 are common to stator leads 3 and 4 and provide the voltage sensing for the voltage regulator circuit. Lead 55 provides the excitation power supply for the Exciter / Regulator.

120 v 3 Wire.
110 v 3 Wire.

The Stator can be reconnected to a straight single voltage 2 wire or 3 wire configuration if required. A jumper is placed on the line side of the circuit breaker to balance the load between the two windings.



Rotor

The rotor is a powerful electromagnet which when rotating induces current flow in the stator windings.

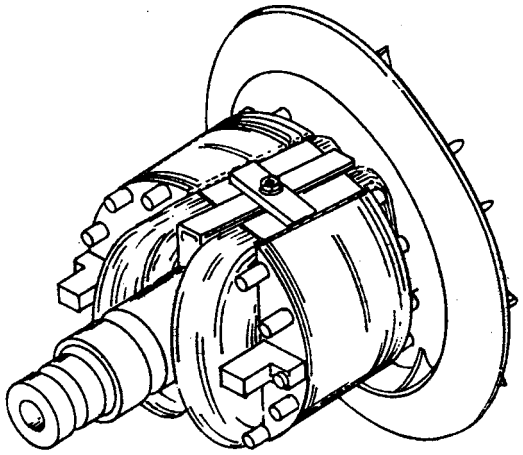
The rotor windings (field coils) are energized by a DC supply from the Exciter/Regulator via brushes and slip rings and magnetize the two laminated iron pole pieces.

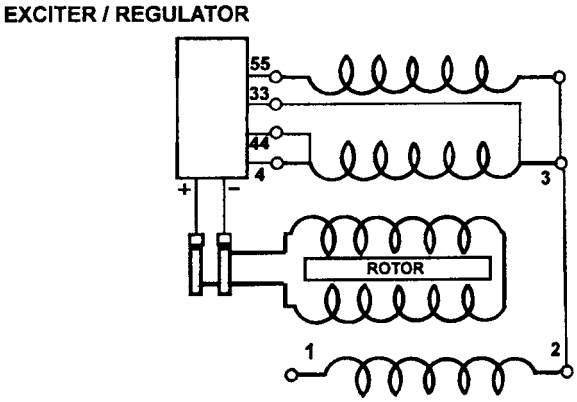
The DC supply is increased or decreased depending on load demand applied to the generator and is automatically controlled or regulated by the voltage regulating portion of the Exciter / Regulator.

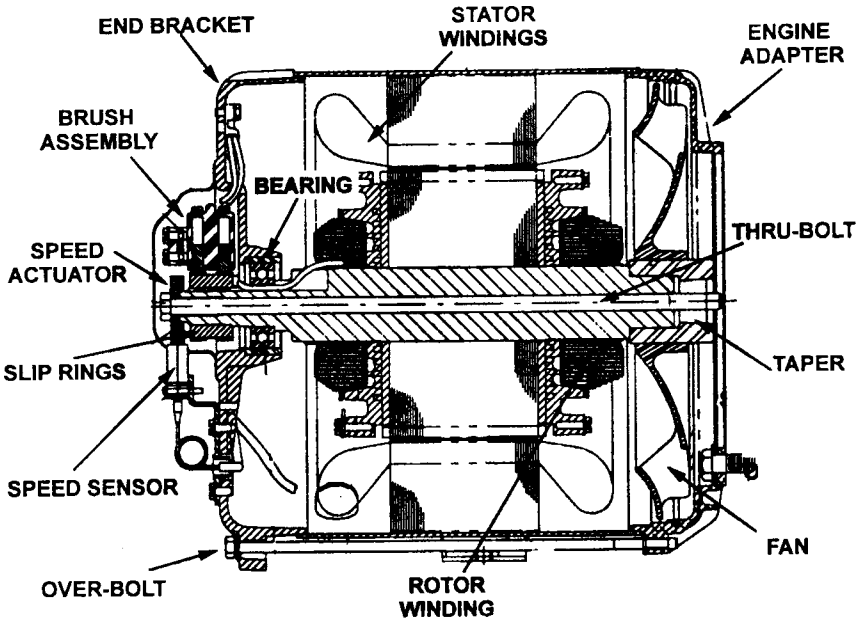
The rotating speed of the rotor determines the frequency of the alternator output. A two pole rotor must rotate at 3600 RPM to produce 60Hz. (3000 RPM / 50Hz)

The rotor, which is directly coupled to the engine tapered stub shaft, is supported by a bearing in the end bracket assembly.

The thru-bolt, which holds the rotor to the stub shaft, also retains the actuator for the speed sensor.







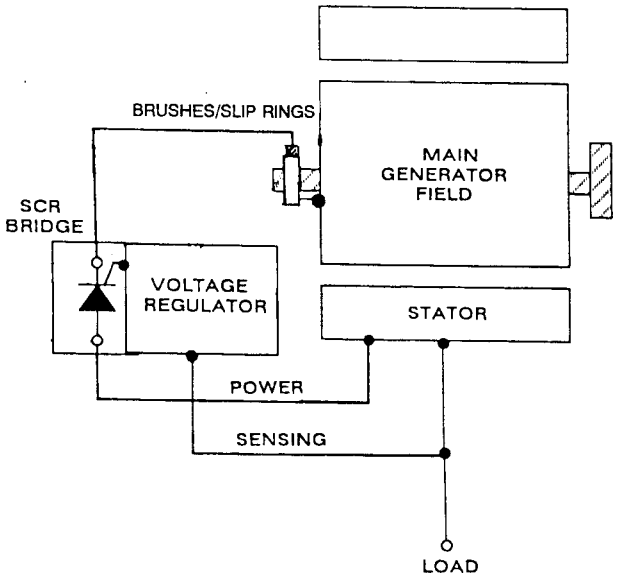
Field Excitation

The rotor field windings are energized through field excitation. Field excitation comes from a variable DC source called an exciter. By varying the exciter voltage we can control the voltage and current induced into the rotor thus controlling the voltage generated in the stator. To control the exciter voltage a voltage regulator is incorporated into the alternator design and its selection is based on the type of excitation used on the alternator and the application of the generator.

Static Excited (Brush Type)

This system rectifies AC power from the output of the generator and sends a controlled DC current to the rotating field through brushes/ collector rings. This exciter is typically an SCR bridge controlled by a solid state voltage regulator circuit. This system can be designed to have excellent load response and voltage regulation.

The disadvantages of static excited designs are found in the brushes and collector rings. These components are subject to routine maintenance such as inspections of brush wear and buildup of dirt and carbon on the collector rings.



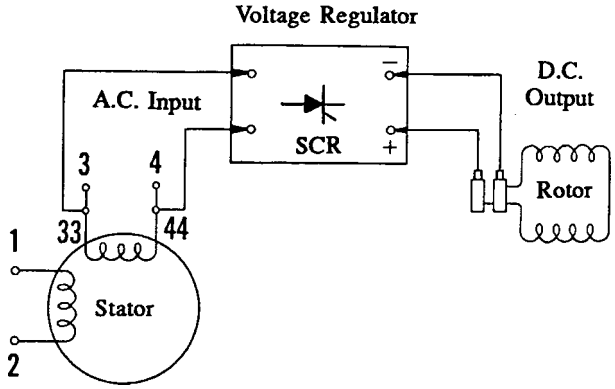
(Power boost)

The Kohler version of static excited generators feature a patented Power Boost exciter regulator. It employs a separate auxiliary stator winding (independent of the main output) to power the field during fluctuations caused by load-on load-off situations. This system provides excellent motor starting ability and maintains virtually constant voltage.

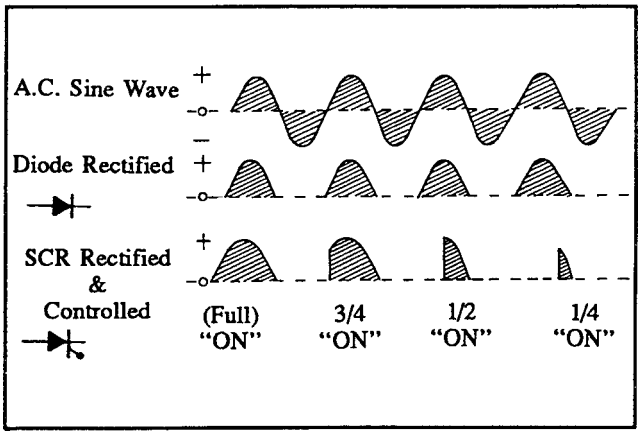
SCR Rectification

SCR's (silicon controlled rectifiers) are used to rectify the AC output voltage to a DC input voltage for rotor excitation.

A sensing circuit in the voltage regulator monitors the generator output voltage and provides a signal for controlled gating or conduction of the SCR's.



The Regulator will provide a DC output to the rotor whenever the voltage monitored is below the nominal setting. A voltage above the setting will turn the regulator (DC output) off. The regulator is constantly turning on and off in its attempt to maintain its nominal setting.



Voltage regulator

The rotor provides the magnetic field flux. The DC supply required to produce the magnetic field is provided to the rotor from the Power Boost exciter/regulator.

Initial excitation at engine start-up (field flash) is supplied to the rotor bush and slip ring assembly from the starting battery via relay contacts (K21).

On sensing a successful engine start and alternator build-up the battery supply is disconnected and excitation is provided from regulated rectified output of the Exciter/Regulator.

The voltage regulator and static exciter are contained in one package.

The excitation component (SCR) rectifies AC from the auxiliary power coil (55) of the stator. The voltage regulator circuit monitors the alternator AC output (33 – 44) and controls the firing of the SCR providing regulated DC to the rotor slip rings.

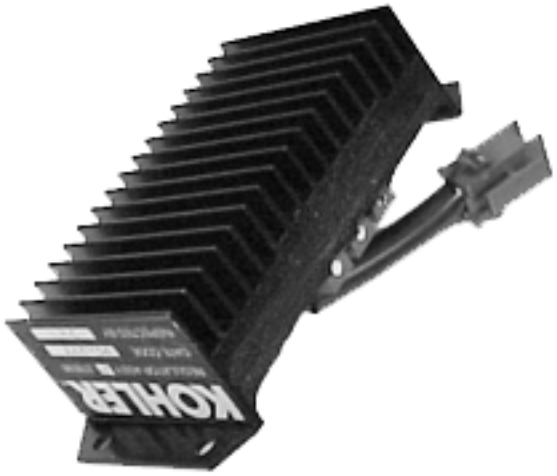
The regulator provides ± 2% Voltage Regulation.

A potentiometer is provided which allows voltage output adjustment from 100 to 130 volts (200 to 260v).

The regulator can also be field adjusted for minimum voltage fluctuation and light flicker. (stability)

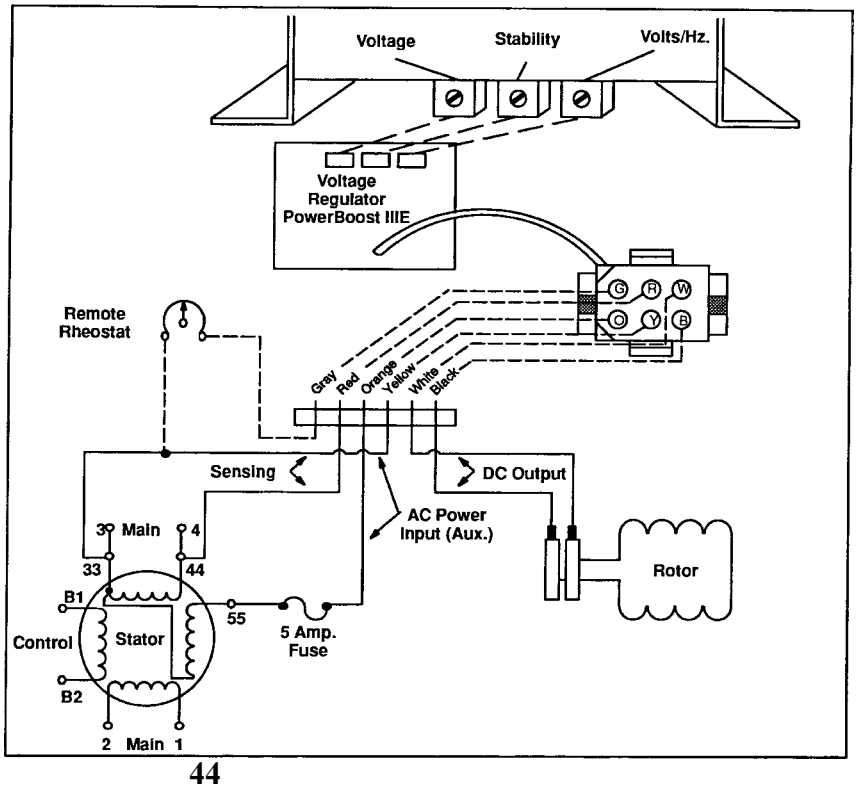
A Volts per Hertz feature automatically reduces the voltage if an overload causes the frequency to drop below a preset level. (factory set at 57 hertz)

A 10-amp fuse (F2) is provided to protect the power input circuit.



Specifications:

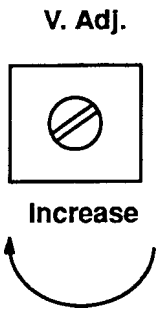
- Voltage regulation +/- 2%
- voltage adjust range 100-130 volts
- remote rheostat (optional) 10K ohms 1/2 watt
- remote rheostat range 5 volts
- stability adjust
- volts-per-hertz adjust factory set at 57.5 hertz



Voltage Adjustments

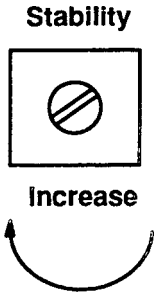
PowerBoost™ IIIE

Volts adjustment - provides an output selection from 100 to 130 VAC.

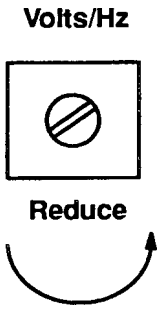


Stability - "fine tunes" regulator for minimum light flicker and voltage fluctuation.

To set stability:
1. With generator off rotate stability pot fully counterclockwise.
2. Start generator.
3. Turn stability pot clockwise until minimum flicker is obtained.

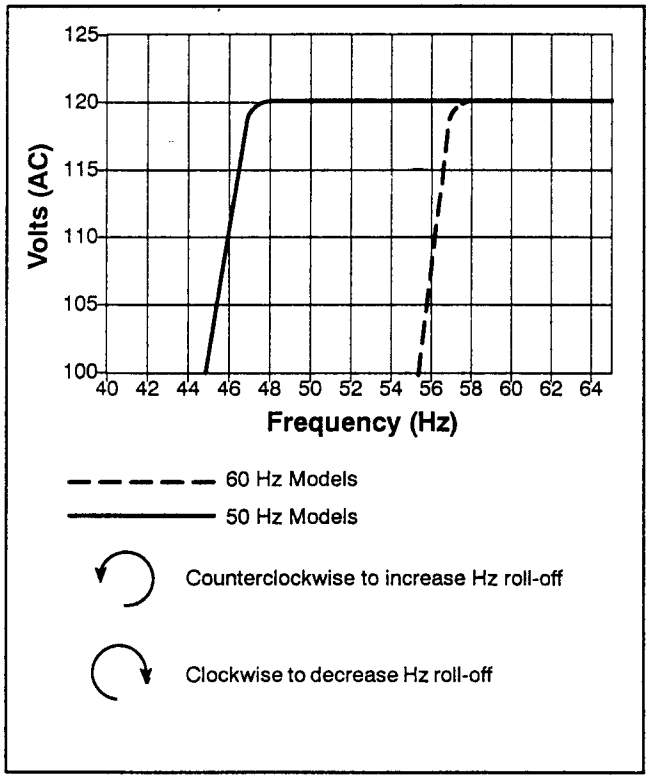


Volts-per-hertz -These regulators are factory set to reduce the generator output voltage if the frequency drops below 57.5 hertz. Field adjustments are typically not necessary.



To set Volts/Hz
1. With generator set off, rotate Volts/Hz pot. fully couterclockwise.
2. Connect voltmeter to AC circuit or an electrical outlet.
3. Connect frequency meter to AC circuit or an electrical outlet.
4. Start generator set and adjust engine speed to desired frequency (factory setting 57.5 Hz for 60 Hz operation; 47.5 Hz for 50 Hz operation) as measured on frequency meter. Generator load does not affect this adjustment.
5. Rotate Volts/Hz pot. clockwise until voltage level begins to drop (as measured on voltmeter). Once voltage drop is measured stop adjusting pot.
6. Return frequency back to desired setting.

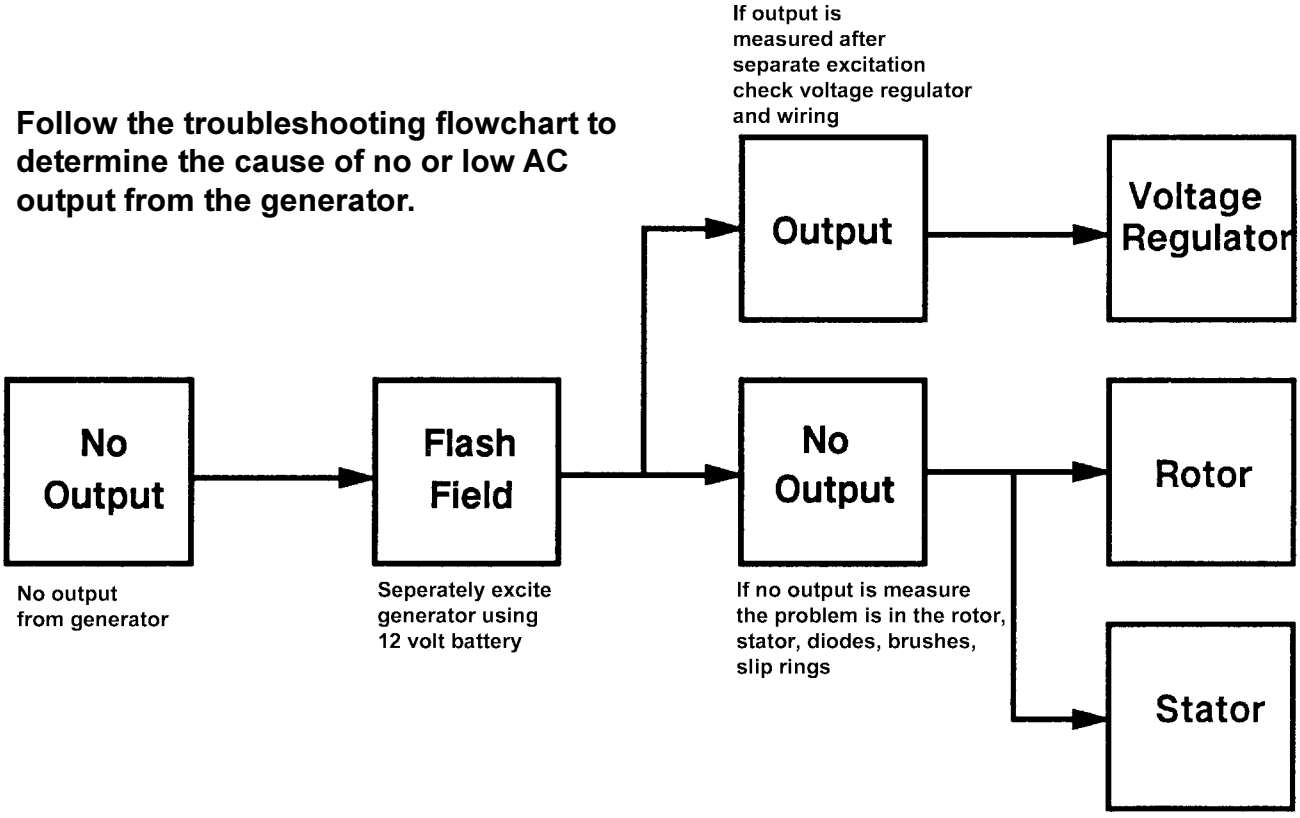
Adjustment is complete, when set to these specifications the generator will attempt to maintain nominal output until engine speed drops to the adjusted cutout point.



General Troubleshooting

This section will cover general troubleshooting fundamentals used when diagnosing alternator problems. When servicing a generator use specified service manual and follow all safety precautions.

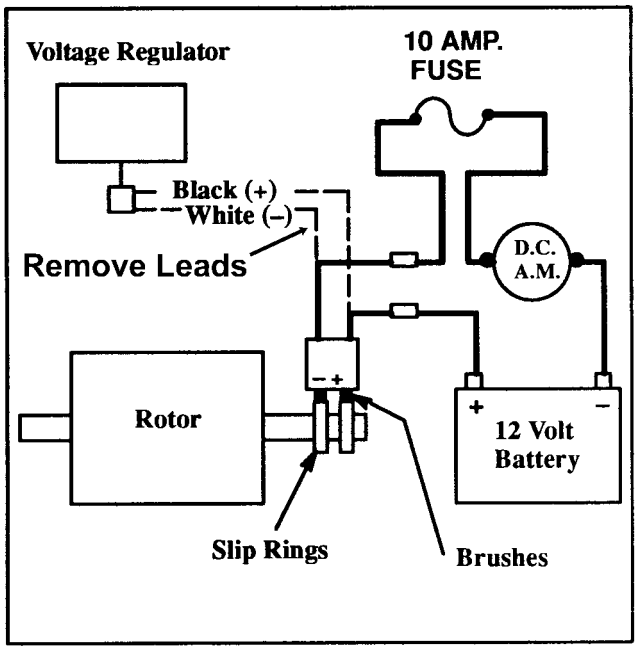
Follow the troubleshooting flowchart to determine the cause of no or low AC output from the generator.



Disconnect generator starting battery before testing any parts of the alternator assembly!!!!

Separate Excitation
Power Boost IIIE
PowerBoost™ V

To determine the cause of no or low AC output, separately excite the generator. The generator field (rotor) may be magnetized using an alternative DC power source (12-volt automotive battery) and following the procedure below. 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 that appears 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.



PowerBoost™ IIIE

Procedure for separate excitation:

1. Disconnect all leads from voltage regulator.
2. Connect an ammeter and a 12-volt automotive battery to the (+) and (-) brush leads. Include a 10amp fuse in the circuit in case of a shorted rotor.
3. The appropriate ammeter reading should be battery voltage divided by specified rotor resistance. Consult service manual for resistance specifications.
4. Start generator and check that ammeter remains stable. An increase indicates a shorted rotor. A decreasing or erratic meter reading indicates a running open.
5. If Ammeter reading is stable compare the stator winding output results with the specifications for the specific alternator found in the service manual. If output readings vary from specification the stator is likely to be at fault.
6. If the rotor and stator test good the voltage regulator is probably defective.

Testing Stator

The stator consists of a series of wire coils placed in a laminated steel frame. The stator leads can supply voltage to the AC load, voltage regulator, or controller depending on the function of that output coil. Prior to testing, inspect the stator for heat discoloration and visible damage to housing, exposed coil windings and exposed varnished areas of frame laminations. If visible damage exists the stator will need to be repaired or replaced.

Checking Stator Continuity and Resistance

Tools required: Ohmmeter, Megger
The example illustrates a single phase alternator.

Note: Refer to service manual for all specifications with reguards to winding resistance values.

Continuity

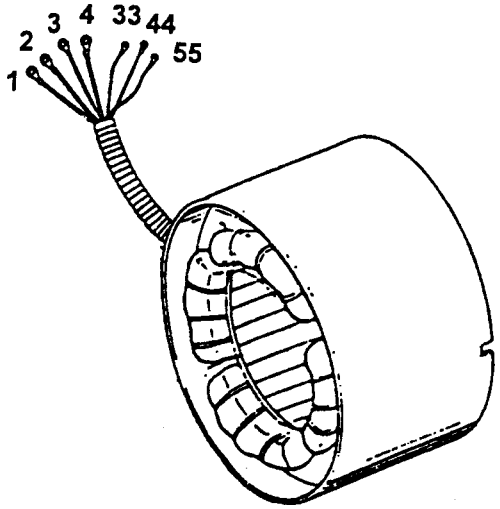
1. To check stator continuity, set ohm meter to a low resistance setting. This test will check if any coils are shorted to each other or there is a short to ground.
2. Dissconnect all stator leads prior to performing measurements.

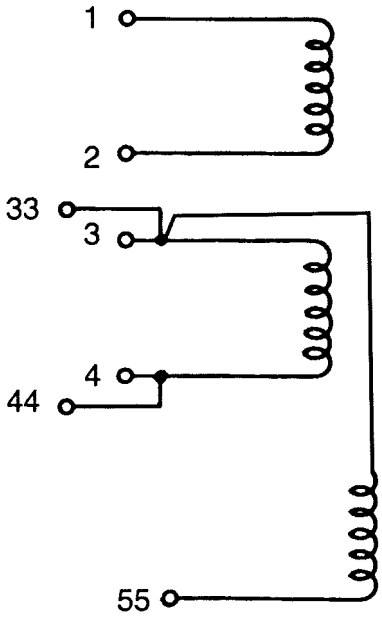
Leads1, 2, 3, and 4 are the generator output leads. Leads 33, 44, are the voltage regulator sensing. Lead 55 is control power for the voltage regulator.

3. Check continuity of all windings, the meter should show continuity when checking between leads 1-2, 3-4, 33-44, 55-33.
4. Check for continuity between coil groups, meter should show no continuity. If the meter indicates continuity this means the two coil groups are shorted together.
5. Check continuity between each coil group and the frame of the stator, meter should show no continuity. If the meter shows continuity this indicated the coil is shorted to ground.

Resistance

Most ohmmeters will not provide acurate readings when measuring less then 1 ohm, which is typical for a stator winding. The stator can be considered good if a low resistance reading is obtained in each coil group and there is no evidence of an internally shorted winding (heat discoloration).





Megger Testing

The purpose of insulation is to prevent shorting between the windings, lamination slots and any conductive material used in the generator construction. If this insulation deteriorates or breaks down a current path can be created between the copper windings and the frame structure. This breakdown may not be detected when performing a continuity test.

Dirt, grease, chemical fumes, aging and moisture are some of the contributing factors that can lead to the insulation breaking down.

A megger can be used to test for possible current leakage to ground that was not detected during continuity testing. Meggers apply a voltage between the insulated conductor and the material they are insulated from, usually ground. They determine the resistance flow across the insulation of the conductor. These resistance values are very high, in the millions of ohms.

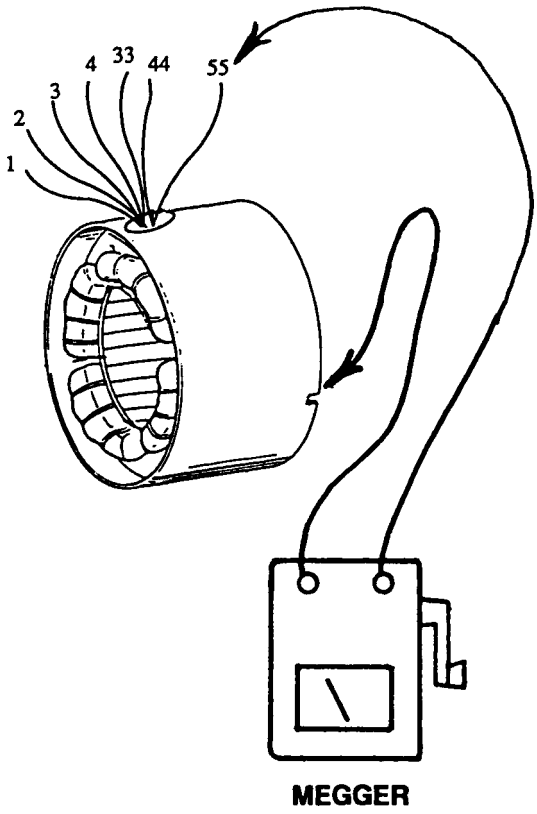
1. Prior to operating a megger disconnect all stator leads

2. You can keep the load leads connected together but it is recommended that you disconnect all individual coils and test each one individually.

3. The positive lead of the megger should be attached to the lead coil being tested on the alternator and the ground lead attached to the frame.

4. Perform the megger test following the instrument instructions.

5. As a general guideline if the insulation resistance is greater then 1.5 megohms the insulation leakage is considered acceptable. If it is below 1.5 megohms the stator needs to be serviced. Always refer to instrument instruction or generator specification when determining when insulation leakage is suffcient to warrant repair or replacement.



Testing Rotor (Brush Type)

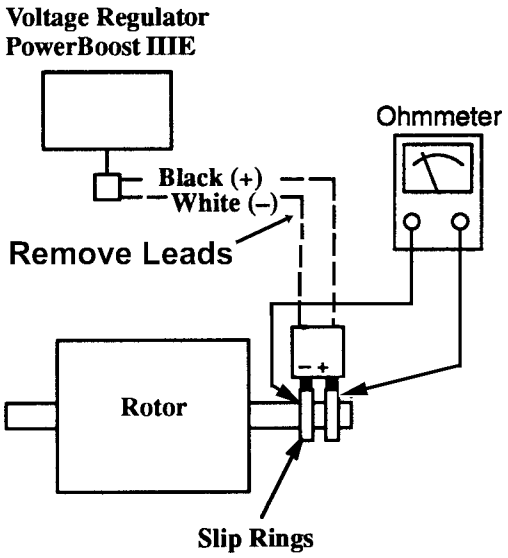
Prior to testing the rotor, inspect exposed coil windings, brushes and collector ring surfaces. Check rotor bearing for noisy operation, excessive wear, and heat discoloration. Replace or repair if needed.

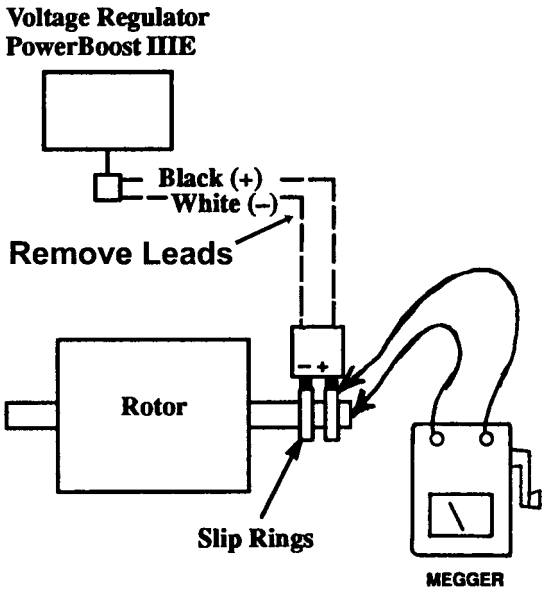
To check the rotor for continuity place the meter leads on the two collector rings. Set meter to lowest setting for measuring resistance. If a high resistance reading is found this indicates an open winding. Typical measurement readings can be found in the specification section of the service manual for the particular rotor being tested.

To test for a grounded rotor place one meter lead to a collector ring and the other lead to the rotor shaft. Meter should register no continuity.

Megger readings can also be taken by placing one lead of the megger to a collector ring and the other to the rotor shaft. If reading is above .5 megohms the insulation leakage is acceptable. If reading is below .5 megohms this indicates there may be current leakage to ground and servicing is needed. The rotor may have moisture and needs to be dried out or the insulation is weak and the rotor will need to be serviced or replaced.

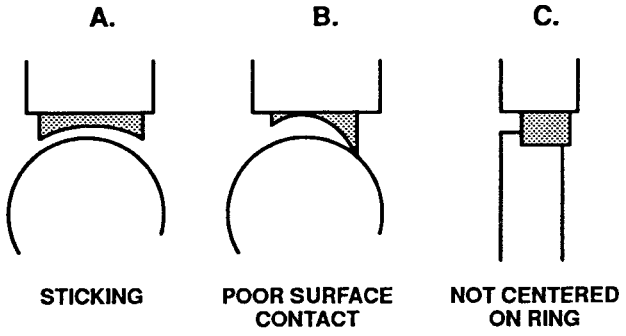
Note: Make sure when taking resistance readings or performing a megger test that the brushes are not in contact with the slip rings.





Brush / Collector Ring Maintenance

When performing inspection on brushes it is important to note the brushes are not sticking, have good surface contact with the rings, and the brushes are centered and riding completely on the rings. Severe arching on the brushes may cause regulator to fail and also damage the slip rings.
Collector rings acquire a glossy brown finish in normal operation and cleaning to maintain a bright machined surface is unnecessary. If grooves have developed on the collector rings a commuter stone should be used to level the surface. Never use emery cloth or carborundum paper to level or clean collector rings.



BRUSH CONTACT

Controller Cabinet

The control cabinet contains both engine and alternator control components.

Input and output control connections are provided at the P harness plug connectors.

P2 - Speed sensor
P8 - Voltage regulator **P4 -** Engine components

Alternator output leads are routed through a grommet located below the P4 connector and terminate at the circuit breaker (LI - L2) and **LO** terminals.

Connections requiring battery negative are made at the **GRD** terminal.

The **FI** fuse (10amp) protects the control circuits supplied by the 12-volt battery.

The **F2** fuse (10amp) protects the power-input circuit to the Voltage regulator. (55)

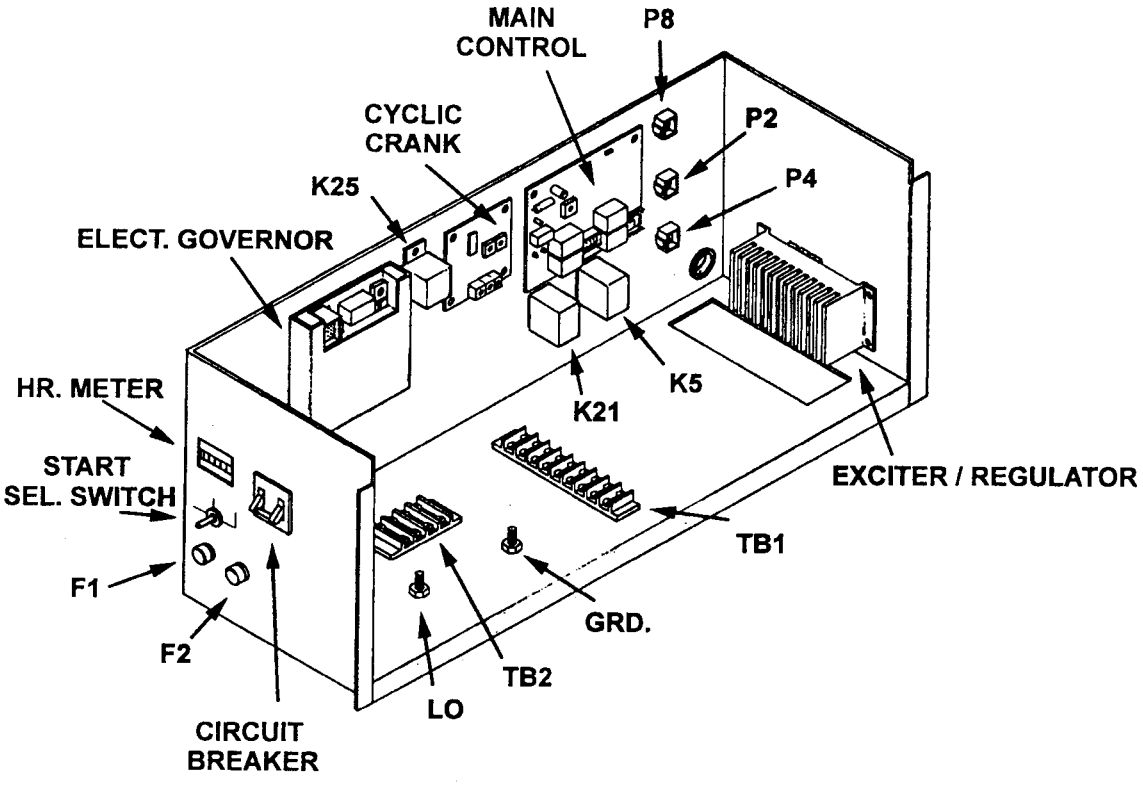
The **HOUR METER** is energized on a start/run signal (12vdc) and provides a recorded total run time. The meter has polarized terminals (+ -).

The **START SELECTOR SWITCH** is a three-position device. The generator set can be started locally by placing the switch in the RUN position.

When an Automatic Transfer Switch or remote start switch is utilized the generator will be signaled to start when the selector switch is in the AUTO position and a contact closure occurs across TB1 terminals **3 - 4.**

The engine will shut down when the switch is placed in the OFF/RESET position when started locally or remotely.

If the unit shuts down due to a fault condition, (overcrank, overspeed, over temperature, low oil pressure) the system must be reset by moving the switch to the OFF/RESET position before a restart can be made.



Control Board

The main control board contains relays for starting and stopping the Generator set.

The board features a timer to provide 30 seconds of total engine cranking time and terminates cranking if a successful run signal is not received.

A circuit is also provided which after an engine start, allows a 5 second delay prior to sensing the Oil Pressure and Engine Temperature condition. This is to allow time for the engine to stabilize and build up oil pressure.

The control circuit provides starter motor reengagement protection when the engine is running via input signals of generated AC as well as shaft rotation.

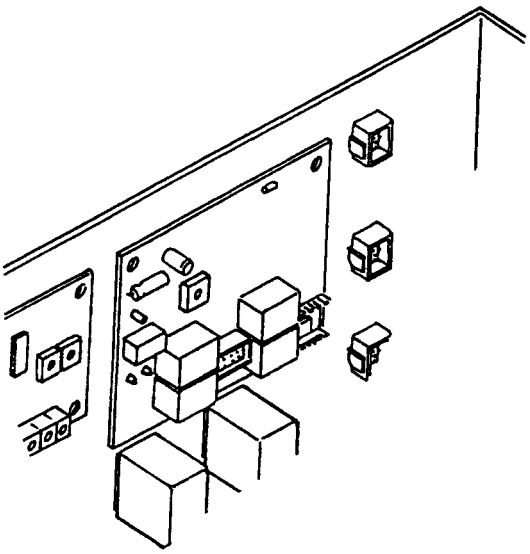
An engine overspeed circuit is provided and factory set to shut down the generator set if engine speed exceeds 4200 RPM (70 Hz).

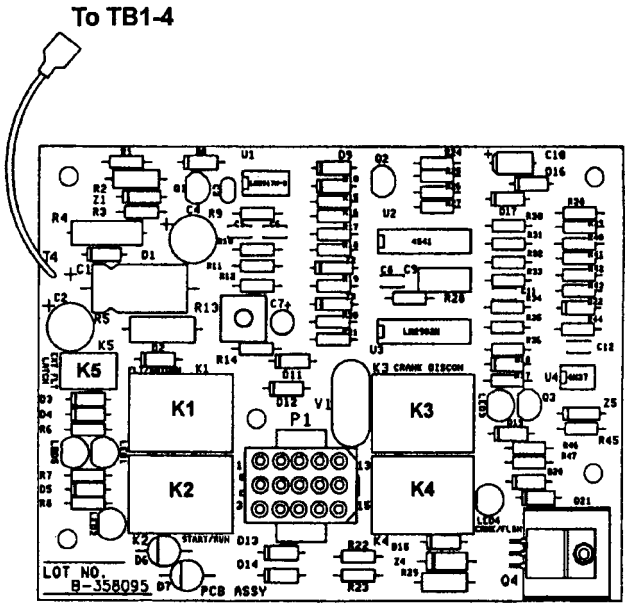
Five relays are hard connected to the board for control of Engine Cranking (K4), Cranking Disconnect (K3), Start/Run (K2), Fault Shut-Down (Kl) and Remote Latch (K5).

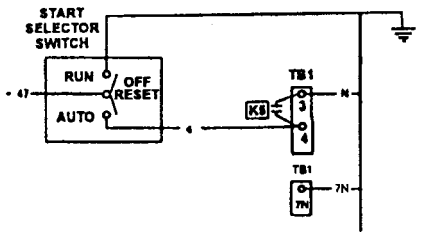
LED's are connected across the relay coils for visual operational analysis.

Placing the switch to the OFF/RESET position after a normal run will shut down the engine and deenergize all control relays. If the engine is shut down due to a fault the K2 and K5 relays will remain energized until the selector switch is placed in the OFF position.

The RUN LATCH feature, lead T4 provides (K5) contact closure across start contacts 3 and 4 when a fault shutdown occurs. This is to prevent resetting the logic and restarting the engine from a remote location without first correcting the cause of failure.

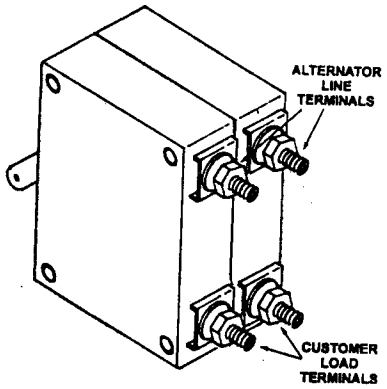




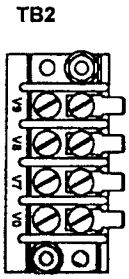


Controller (Misc)

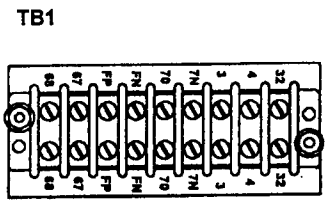
The **CIRCUIT BREAKER** is a two-pole device with trip elements in each pole and is used as a circuit disconnect between the load and alternator. The toggles are tied together. Moving the toggle will open or close both poles. An over current fault exceeding the trip rating of the breaker will also trip both poles. Current and trip ratings are located on the terminal side of the breaker.



The **TB2** terminal strip provides terminating points (V7 - VO) for the 120vac sensing to the control circuit board. Voltage present at these terminals indicates the unit is running and output voltage is being generated.

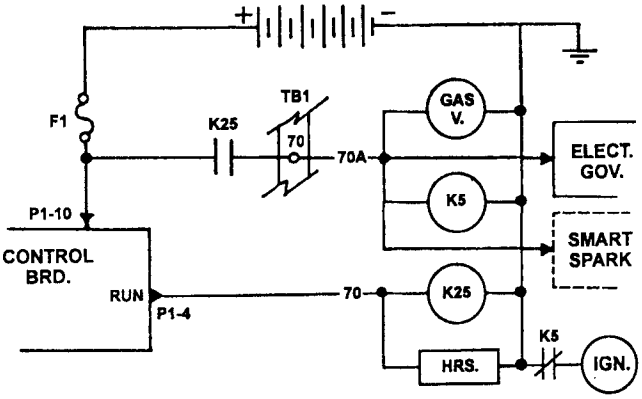


The **TB1** terminals provide connections for the REMOTE START (3 - 4), FIELD FLASH (FP-FN) and DC SUPPLY (70 - 7N) to supply the Electric Governor, Gas valve and Ignition relay (K5).



The **K25** is the power control relay. It is energized from the control circuit board on a start run command. The contacts provide the DC supply to components connected to TB1 - 70 terminal.

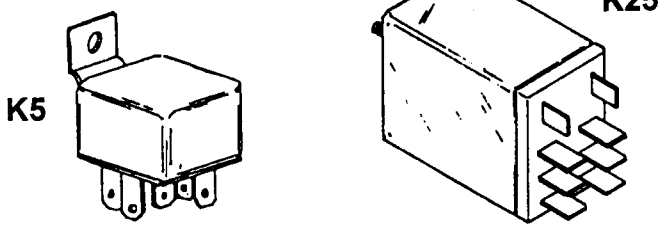
The normally closed contacts of the **K5** IGNITION RELAY connect the ignition coil to ground, preventing ignition spark. The contacts open when the relay is energized on a start run command.



The **CYCLIC CRANKING** board is an adjustable ON / OFF timer. It is energized on a crank signal from the control board.

The contacts of the **K21** relay provide the control circuit to the KI engine cranking control relay coil.

The K21 relay is energized during the “ON” cycle For engine cranking and deenergized during the “OFF” cycle.



SPEED SENSOR
(Proximity Sensor)

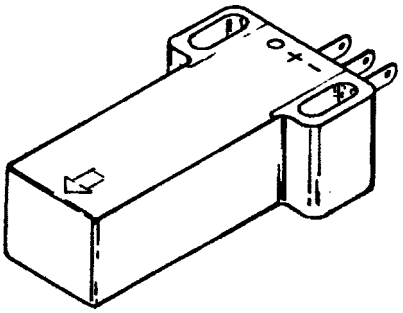
The Speed Sensor provides the Main Control board with digital information on the rotating status of the generator set.

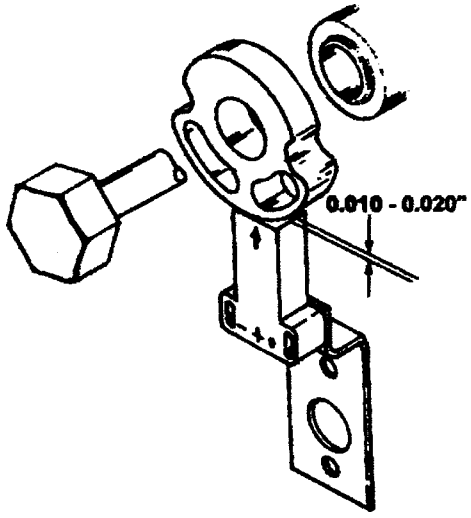
Input voltage to the sensor (+/-) is battery potential (12vdc). During engine cranking and running a pulsed voltage signal via (+/o) is sent to the controller each time the proximity sensor comes into contact with the ferrous metal speed actuator. Controller circuitry takes this input information and provides overcrank and overspeed protection to the genset.

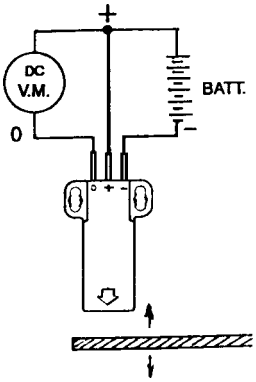
The sensor is located on the end bracket and mounted so an air gap of 0.010 - 0.020 in. is between the sensor and actuator. The actuator is mounted to the rotor shaft with the thrubolt.

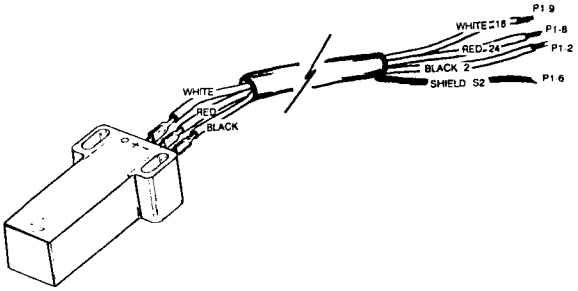
A shielded harness is required between the sensor and the controller. Connections to the controller are made through the P2 connector at the rear of the controller.

The device can be bench checked by applying 12vdc to the input (+/-)and observing an output (o/+) when the internal circuit is triggered by placing a piece of steel or iron in close proximity to the sensing surface.

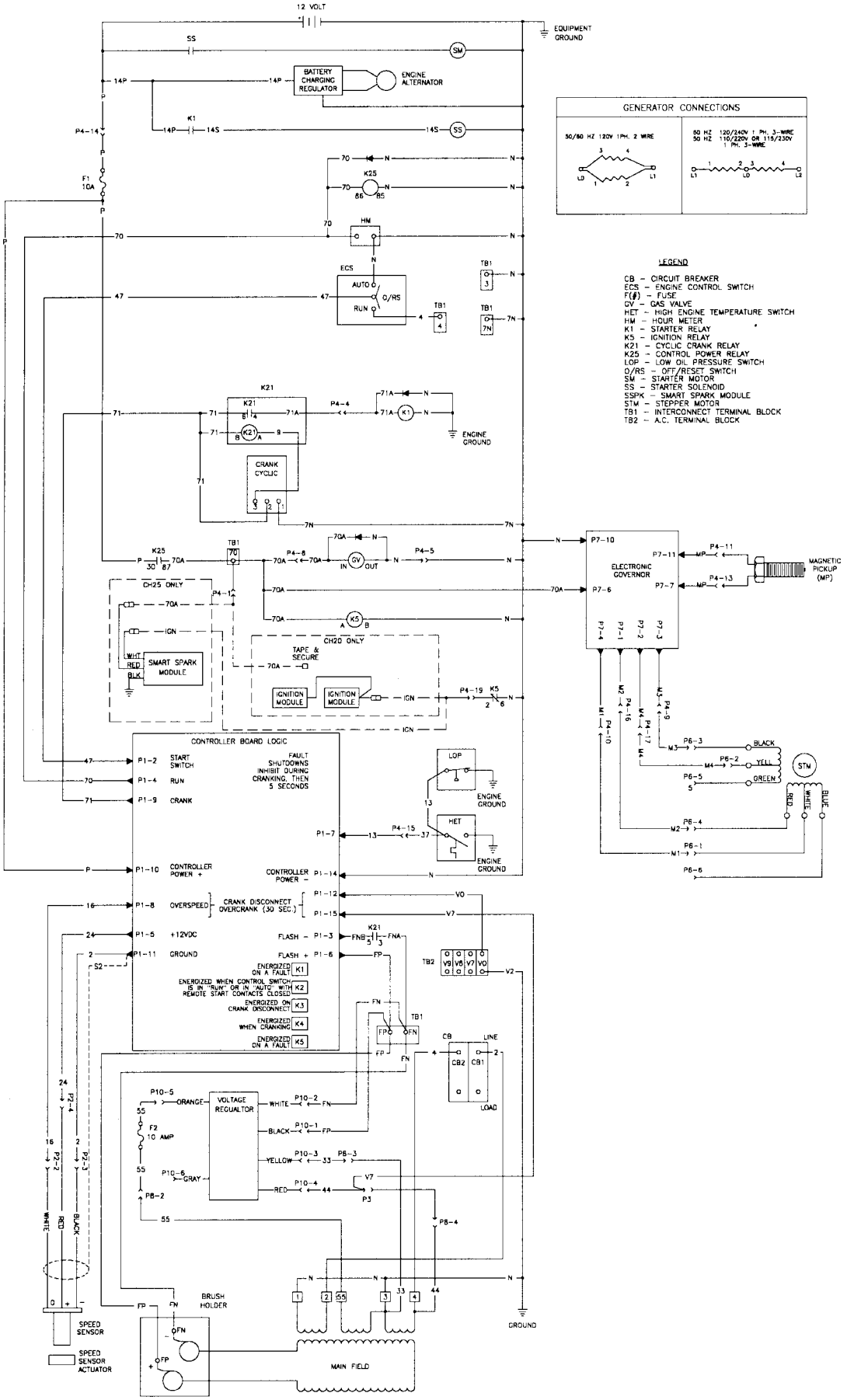








Controller


12 VOLT
EQUIPMENT GROUND
SS
SM
BATTERY CHARGING REGULATOR
ENGINE ALTERNATOR
14P
K1
14S
SS
F1 10A
K25
HM
ECS
AUTO
O/RS
RUN
TB1
47
71
K21
71A
K1
ENGINE GROUND
CRANK CYCLIC
7N
K25
30
87
70A
GV
IN
OUT
CH25 ONLY
IGN
WHT
RED
BLK
SMART SPARK MODULE
CH20 ONLY
TAPE & SECURE
IGNITION MODULE
IGNITION MODULE
CONTROLLER BOARD LOGIC
P1-2 START SWITCH
P1-4 RUN
P1-9 CRANK
FAULT SHUTDOWNS INHIBIT DURING CRANKING, THEN 5 SECONDS
P1-10 CONTROLLER POWER +
CONTROLLER POWER -
P1-8 OVERSPEED
CRANK DISCONNECT OVERCRANK (30 SEC.)
P1-5 +12VDC
P1-11 GROUND
FLASH - P1-3
FLASH + P1-6
ENERGIZED ON A FAULT K1
ENERGIZED WHEN CONTROL SWITCH IS IN "RUN" OR IN "AUTO" WITH REMOTE START CONTACTS CLOSED K2
ENERGIZED ON CRANK DISCONNECT K3
ENERGIZED WHEN CRANKING K4
ENERGIZED ON A FAULT K5
LOP
HET
ENGINE GROUND
P7-10
P7-11
P7-6
P7-7
ELECTRONIC GOVERNOR
MAGNETIC PICKUP (MP)
BLACK
YELL
GREEN
STM
RED
WHITE
BLUE
TB2
V9 V8 V7 V0
CB
LINE
CB2
CB1
LOAD
VOLTAGE REGULATOR
ORANGE
WHITE
BLACK
YELLOW
GRAY
RED
F2 10 AMP
SPEED SENSOR
SPEED SENSOR ACTUATOR
BRUSH HOLDER
MAIN FIELD
GROUND
GENERATOR CONNECTIONS
50/60 HZ 120V 1PH. 2 WIRE
60 HZ 120/240V 1 PH. 3-WIRE
50 HZ 110/220V OR 115/230V
1 PH. 3-WIRE
LEGEND
CB - CIRCUIT BREAKER
ECS - ENGINE CONTROL SWITCH
F(#) - FUSE
GV - GAS VALVE
HET - HIGH ENGINE TEMPERATURE SWITCH
HM - HOUR METER
K1 - STARTER RELAY
K5 - IGNITION RELAY
K21 - CYCLIC CRANK RELAY
K25 - CONTROL POWER RELAY
LOP - LOW OIL PRESSURE SWITCH
O/RS - OFF/RESET SWITCH
SM - STARTER MOTOR
SS - STARTER SOLENOID
SSPK - SMART SPARK MODULE
STM - STEPPER MOTOR
TB1 - INTERCONNECT TERMINAL BLOCK
TB2 - A.C. TERMINAL BLOCK

Understanding the Schematic

1. Battery power enters what pin connections to the relay control board?

2. Field flashing is controlled by which relay?

3. The Field flashing is required when?

4. Fuse F1 protects the voltage regulator circuitry. T or F

5. When is wire #70 energized? When is wire #70A energized?

6. When is wire #71 energized?

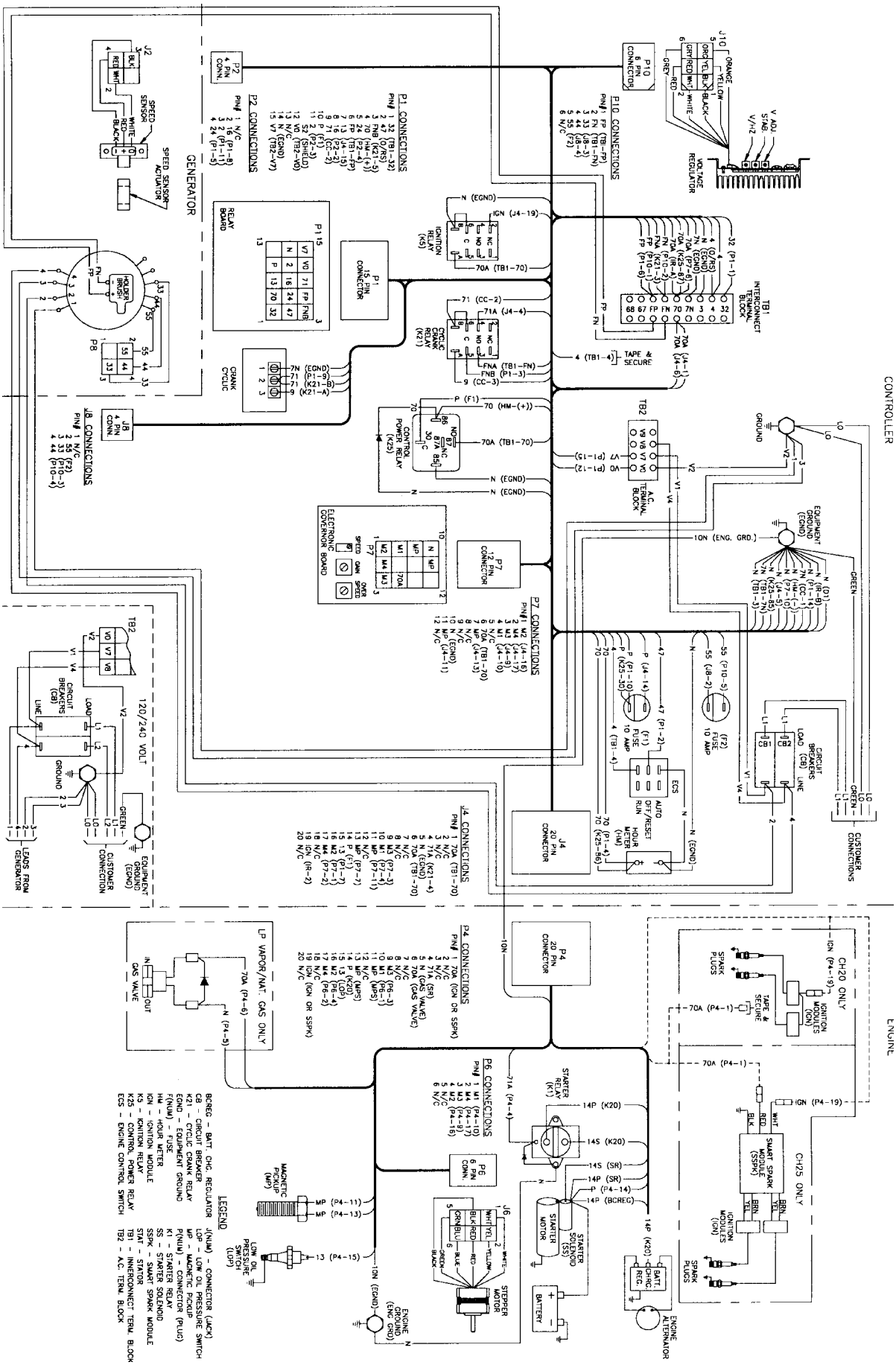
7. What is the purpose of the speed sensor?

8. Input power to the voltage regulator is from what source?

9. When is the K5 relay energized?

10. What symptoms will be observed if the Gas Valve coil electrically opens?

Controller


CONTROLLER
GENERATOR
ENGINE
CH20 ONLY
CH25 ONLY
120/240 VOLT
LP VAPOR/NAT. GAS ONLY
LEGEND
BCREG - BATT. CHG. REGULATOR
CB - CIRCUIT BREAKER
K21 - CYCLIC CRANK RELAY
EGND - EQUIPMENT GROUND
F(NUM) - FUSE
HM - HOUR METER
IGN - IGNITION MODULE
K1 - STARTER RELAY
K25 - IGNITION POWER RELAY
ECS - ENGINE CONTROL SWITCH
J(NUM) - CONNECTOR (JACK)
LOP - LOW OIL PRESSURE SWITCH
MP - MAGNETIC PICKUP
P(NUM) - CONNECTOR (PLUG)
SS - STARTER SOLENOID
SSPK - SMART SPARK MODULE
TB1 - INTERCONNECT TERM. BLOCK
TB2 - AC TERM. BLOCK

To read the point to point diagram start at any device in the diagram. The wire at the component will have a wire number followed in parentheses by the component the wire goes to and to where it terminates.

Reading the Diagram

1. You want to check the control voltage to the control power relay (K25), what termination points should your meter leads be on?

2. Field flashing leads FNA-FNB are controlled by a normally closed contact on relay (K21). T or F

3. Looking at the P1 connector plug, where does wire #71 terminate. List the starting and ending point.

4. You need to check the magnetic pick-up voltage. How would you do this? What voltage should be measured during crank?

5. What wire energizes the Starter Relay?

6. What is the point to point connection for LOP, list the starting and ending points.

7. At what pin location does positive voltage enter the relay control board? Is this a fused input?

8. What does the F2 fuse provide protection for?

9. Where on the generator is the voltage regulator mounted?

10. Is wire 14P a fused power source? What is the purpose of 14P?

Automatic Transfer Switch

Concept

The Transfer Switch is a required component of an emergency or standby electrical power system. It not only serves to transfer the load between electrical supplies but also to prevent the sources from being connected together resulting in destruction of the system.

An Automatic Transfer Switch (ATS) consists of three major components.

1. Stationary and movable heavy duty CONTACT ASSEMBLIES.

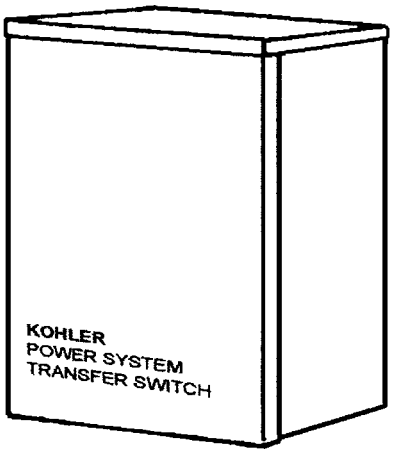
2. An OPERATING MECHANISM for the moveable contacts.

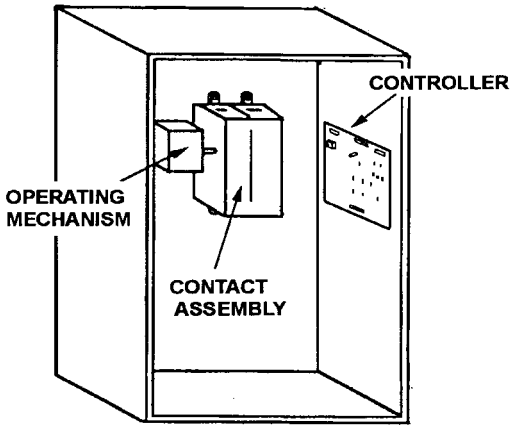
3. A CONTROLLER to monitor the system and provide signals for engine start and contact transfer.

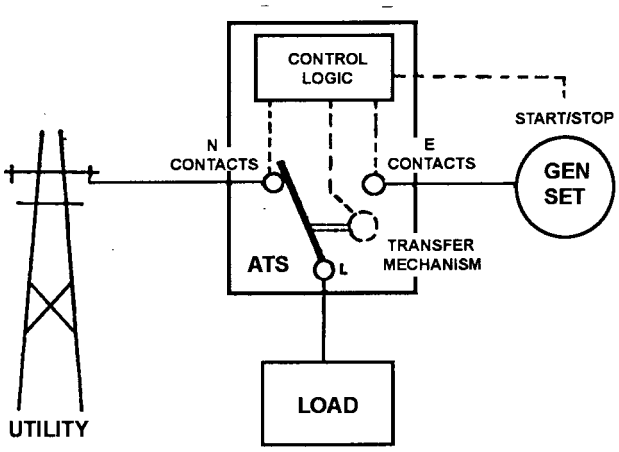
The controller logic constantly monitors the condition of the utility or normal power supply. A signal for an engine start will be give when the voltage or frequency is not at a predetermined level or fails completely.

When the Generator voltage and frequency are acceptable to the monitoring circuit, the transfer operating mechanism will be energized, causing a Load (L) transfer from the Normal (N) to the Emergency (E) source.

The controller will seek the primary source and on return of acceptable power will retransfer the load back to the normal source and initiate an engine shutdown.





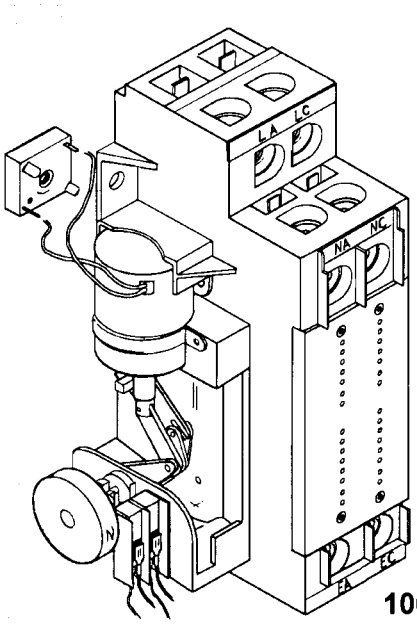


Contactor

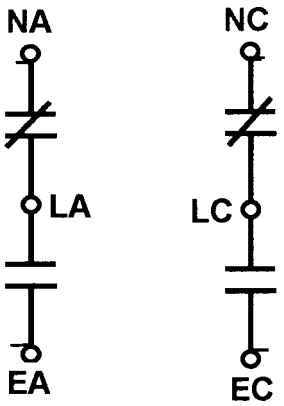
The 2-pole, **G120 Series** contactor is available for 100 and 200 amp Standby Systems.

This contactor is designed for use on line to line 220 - 240 volt single phase utility systems as provided to the majority of residences. The emergency source or generator set must also provide this same power. Three pole and other voltage ratings are also available.

Normal or utility Power connections are made to terminals NA and NC. Generator or **E**mergency Power is connected to terminals EA and EC and the **L**oad is connected to Terminals LA and LC. Push-on tab terminals are provided at each of these terminals for controller voltage sensing and the transfer operator coil **TS** supply.

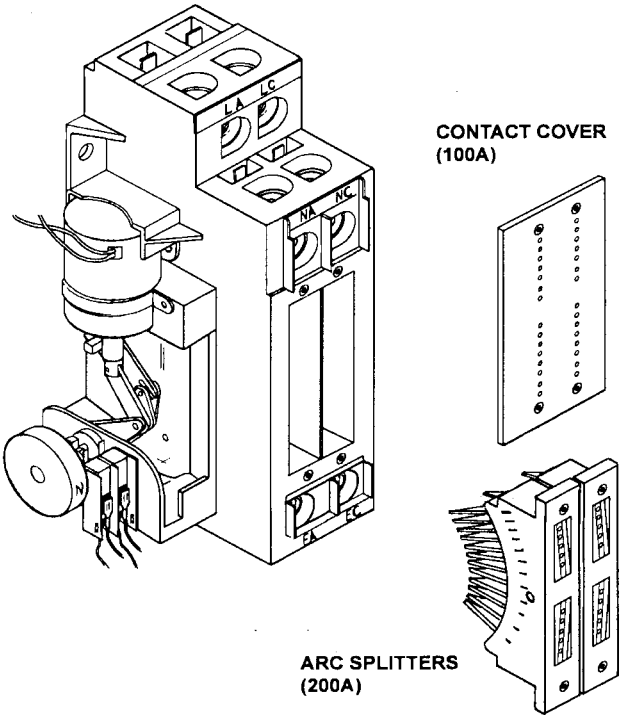


100 A
CONTACTOR



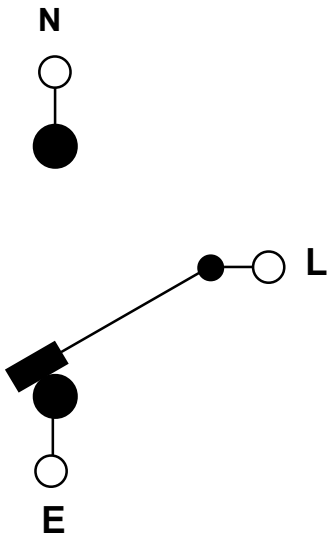
Due to the higher current interruption requirements arc splitters are used on the 200 amp contactors.

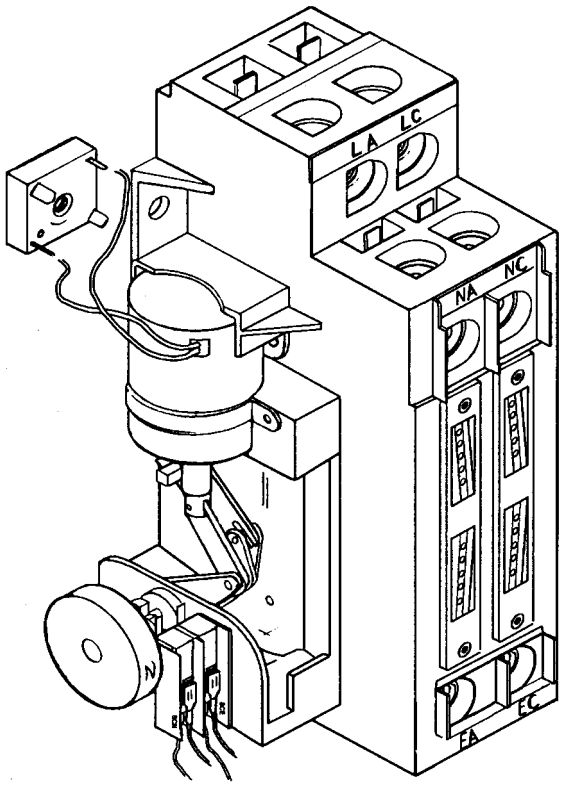
The arc splitters insure any arcing which is present when contacts open under load will be extinguished before the contacts close to the other source.



Contactor

These contactors are electrically operated double throw switching devices. The Normal and Emergency power sources are connected to stationary contacts and the movable Load contacts assembled to a pivot shaft. This provides a mechanical interlock to assure both power sources cannot be connected simultaneously.





200amp Contactor

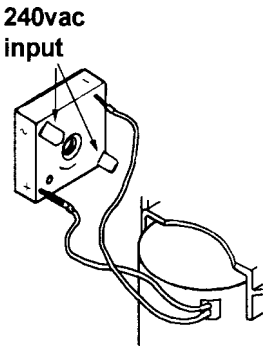
An electric solenoid operates the linkage to flip the moveable contact between the power sources. A complete transfer occurs within 50 milliseconds.

The solenoid is powered by 240V rectified line voltage from the source to which the load will be transferred. (Normal or Emergency)

Coil resistance of the 240v solenoid is 28.8 ohms ± 5% and can be measured at the + and – terminals of the BR bridge rectifier assembly.

A full wave bridge assembly rectifies the AC line voltage to DC. Input is to terminals labeled AC. There is no polarity preference of the solenoid to the + and - rectifier output terminals.

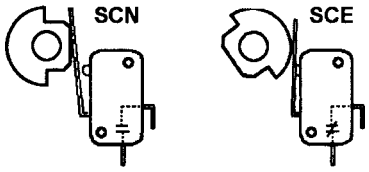
The DC Voltage to the solenoid coil is supplied only momentarily. The circuit is disrupted by cam actuated limit switches prior to full travel of the solenoid plunger. Flywheel inertia completes the transfer.



Automatic Transfer Switch

Contactor

When the contactor is in the Normal position the cams allow limit contacts SCN to be open and SCE to be closed. The opposite occurs when in the Emergency position.

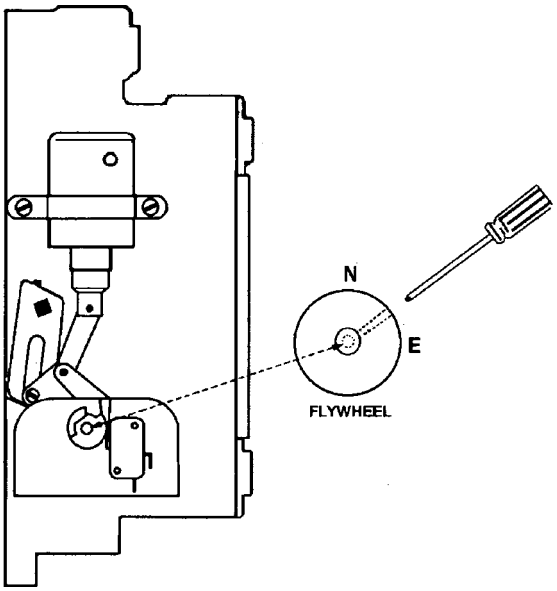


Contactor in
Normal Position

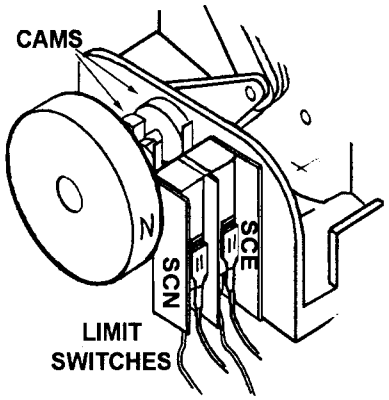
The limit switch assemblies are factory set and non-adjustable. They are wired in series with control relay contacts NR and ER.

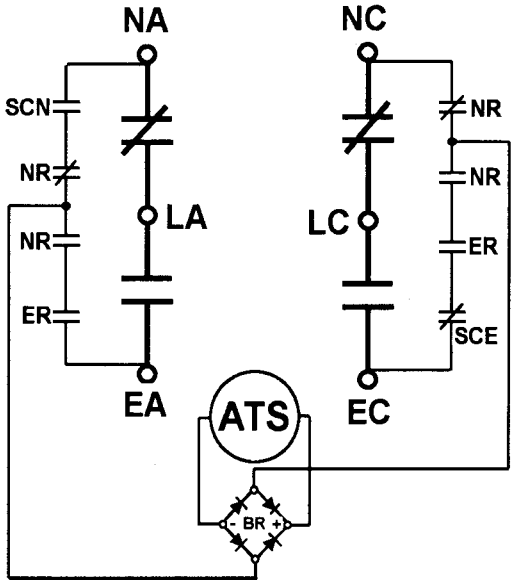
The contactor is always mechanically latched in position after a transfer.

During installation or when servicing the contactor a manual transfer can be performed by inserting a #2 Phillips screw driver or similar tool in the hole provided in the flywheel and rotating the shaft. *



ILLUSTRATED IN THE EMERGENCY POSITION





Switch in Normal position with Normal source available.

*

ELECTRICAL POWER MUST BE DISCONNECTED FROM THE CONTACTOR WHEN MANUALLY TRANSFERRING

The position to which the Load contacts are connected (N or E) are stamped in the flywheel and visible from the front .

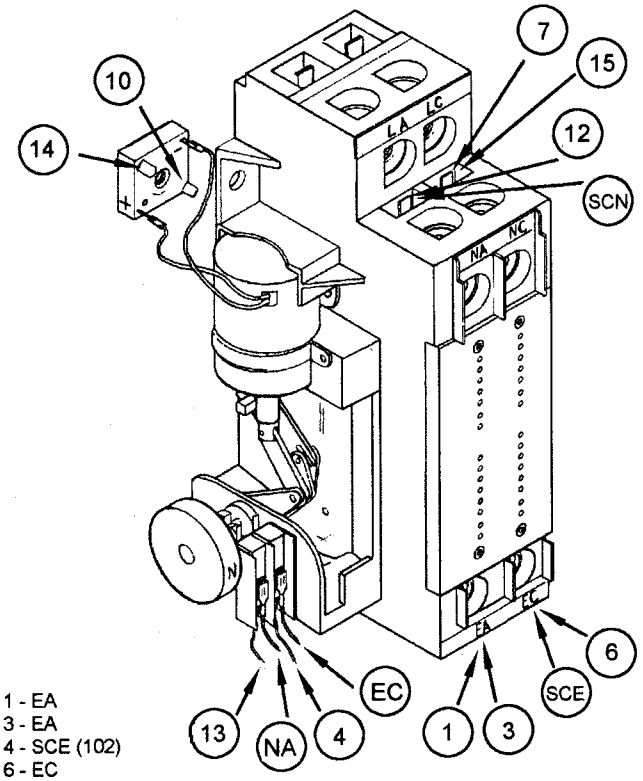
Harness

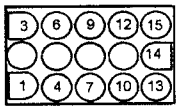
The contactor assembly is interconnected to the controller by a harness and plug connector.

Connections at the contactor assembly are made with push-on tab terminals. A 15 pin plug connector designated as J1 is attached at the controller end of the harness .

Pin 9 is used to sense B phase of the Normal source in 3 phase applications and therefore not terminated on the 2 pole contactor.

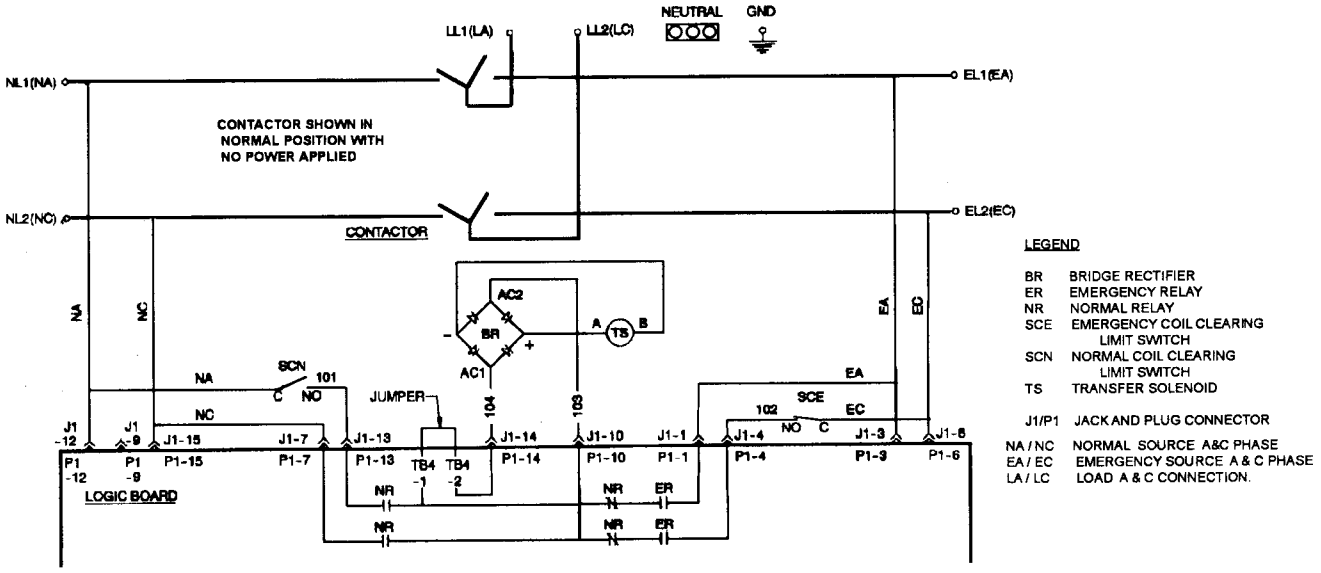
Use caution when testing for voltage or continuity between plug pins. Any **voltage present on the normal or emergency contacts is also preset at the connector pins.**





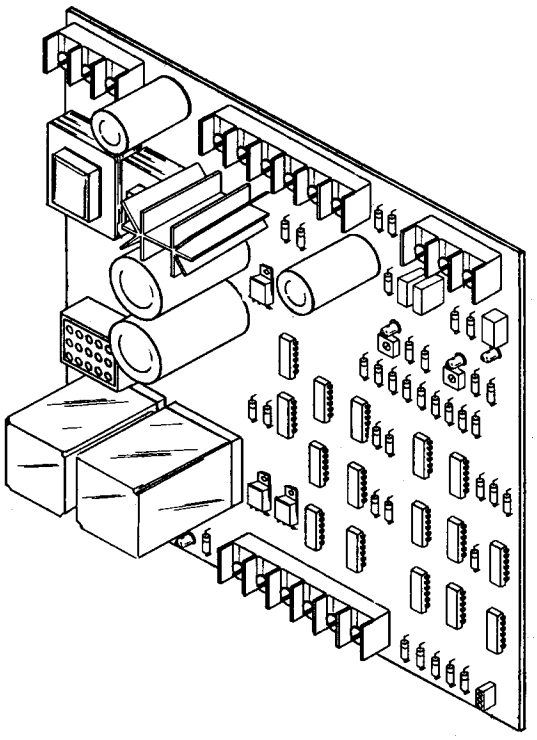
J1

1 - EA
3 - EA
4 - SCE (102)
6 - EC
7 - NC
9 - NB (NOT USED)
10 - BR (103)
12 - NA
13 - SCN (101)
14 - BR (104)
15 - NC



Automatic Transfer Switch

G120 Controller



The decision making process of the automatic transfer switch is performed by the Controller.

The controller monitors the systems electrical sources and logically energizes control relays for engine starting and switch transfer. Voltage supply to the transfer mechanism is provided by the source to which the switch is transferring.

The Utility is the NORMAL or Primary source and the control circuit will always seek the normal source.

The controller is sensitive to the system voltage. Transformers reduce the line voltage to low more managable voltage for the sensing and control circuits. Logic circuitry is both relay and solid state.

STANDARD FEATURES

Normal and Emergency voltage sensing is factory set at 160VAC drop-out and 190VAC pick-up.

DROP-OUT :
If the Normal utility voltage fails completely or drops below 160 volts (line to line) a signal for an engine start would be initiated.

PICK-UP:
When the Emergency Generator voltage reaches 190VAC A transfer to the Emergency source will be initiated.

The same specifications apply for pick-up on return of the Normal source voltage. (190VAC)

TDES:
3 second time delay on engine start.

This feature prevents nuisence engine start attempts if only a momentary (under 3 seconds) loss of power occurs.

If the Normal source returns prior to completion of the timimg no engine start will be attemped and the timer will reset.

TDNE:
2 second time delay on a Normal to Emergency transfer.

After a successful engine start a delay of 2 seconds is provided to allow the engine to attain operating speed and stabilize prior to applying load.

TDEN:
12 second time delay on an Emergency to Normal transfer.

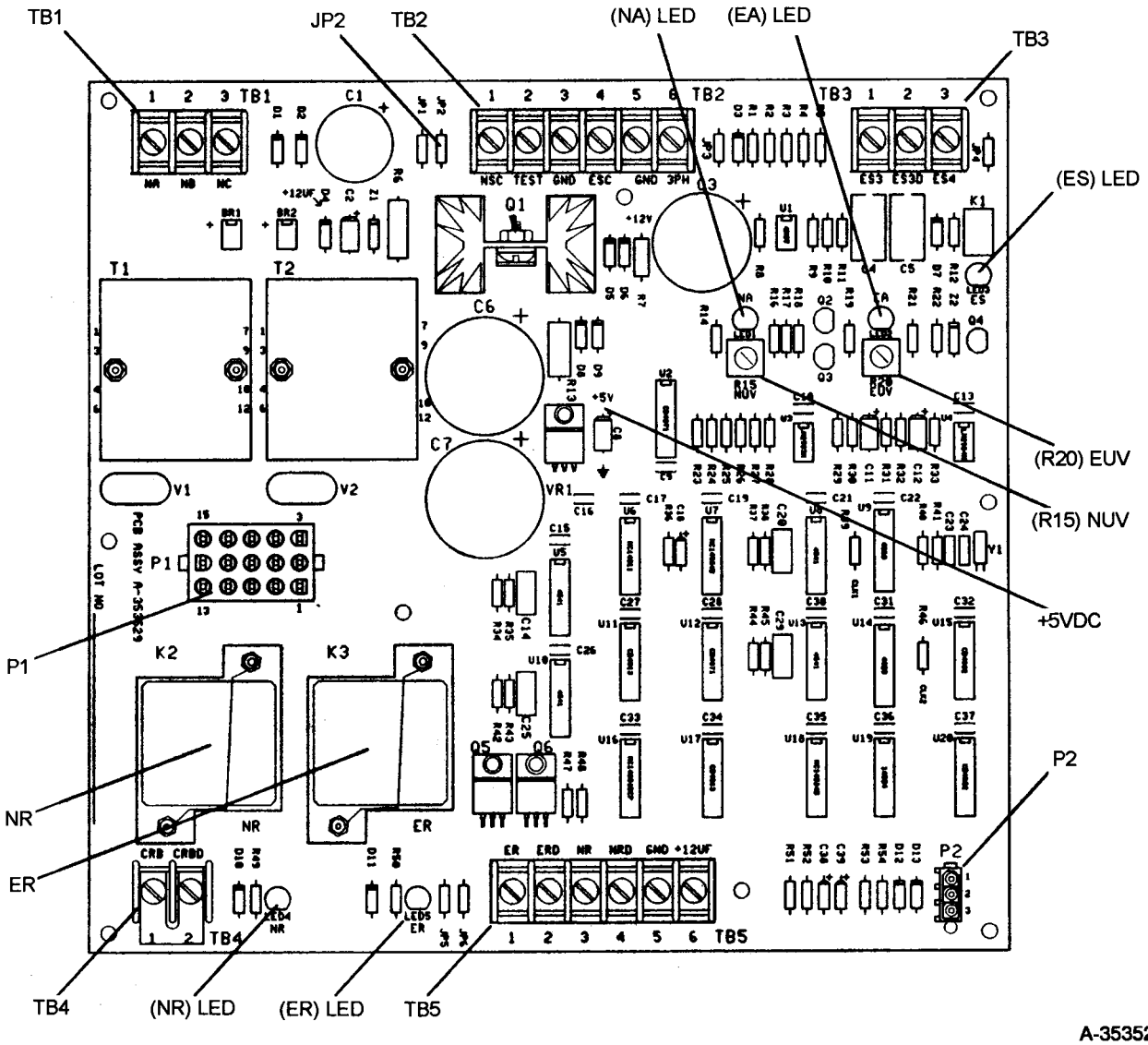
When Normal power returns to the Pick-up voltage (190VAC) a delay of 12 seconds will commence before allowing a transfer back to the Normal Source. This is to allow the Utility power to stabilized. If Normal power fails within this timing period, timing will be terminated and reset.

TDEC:
2 minute time delay for Engine cooldown.

On a succeesful retransfer back to the Utility the engine will operate for two minutes unloaded to allow a cooldown period prior to shutting down.

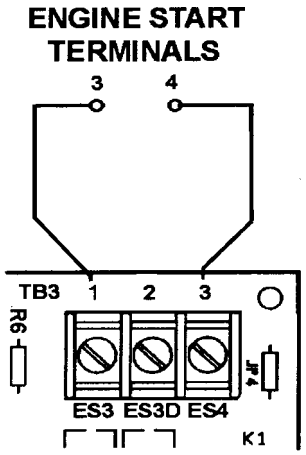
Circuit Board

The main control board contains the intelligence logic as well as transformers, relays, jumpers and terminal strips. Not all terminals and components are used in this application.



Circuit Board

TB3
Connections to the engine start circuit are made to terminals 1&3 . A dry set of K1 relay contacts will close between terminals 1&3 when an engine start is required.



(ES) LED
The ES LED will light when the K1 is energized.

(NR) LED
The NR LED will light when the NR relay coil is energized.

(ER) LED
The ER LED will light when the ER relay coil is energized.

(NA) LED
The NA LED will light when the Normal source voltage is at the acceptable level.

(EA) LED
The EA LED will light when the Emergency source voltage is at the acceptable level.

NR
Normal source control relay

ER
Emergency source control relay.

(R20) EUV
Emergency source voltage pick-up adjust. (Factory set)

(R15) NUV
Normal source voltage pick-up adjust. (Factory set)

+ 5VDC
5v. logic voltage test point.

P2
Plant exerciser selector switch harness connector.

TB5
Power supply and relay status terminal strip.

TB4
Transfer disable option jumper terminal strip.

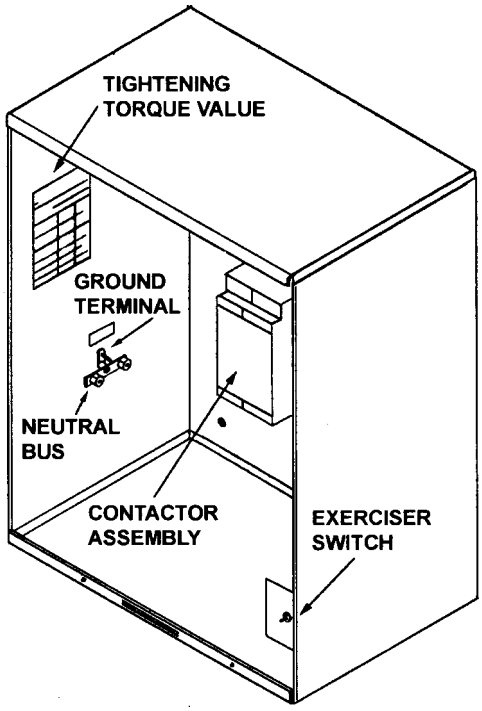
TB2
Test switch option terminals.

TB1
3 phase sensing module terminal strip.

JP2
Test switch jumper.

Neutral / Ground

An equipment ground terminal and Neutral bus is provided in the enclosure.

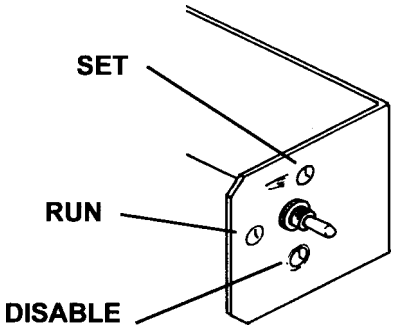


Engine Exerciser Feature

To insure the generator set will start and perform when needed, a circuit is provided which allows the engine to automatically start and run for 20 minutes a week. The engine will run unloaded. The switch will not transfer unless a power failure occurs during the exercise period.

The day and time of day that the feature was set will be the day and time the exercise will occur each week until reset or disabled.

A 3-position switch provides the setting and disabling functions.



SET

Placing the switch in this momentary position will set the start time as well as the day of week the exercise will occur.

RUN

The switch will return to this positiion when released from setting. This is the normal position when the weekly exercise option is selected.

DISABLE

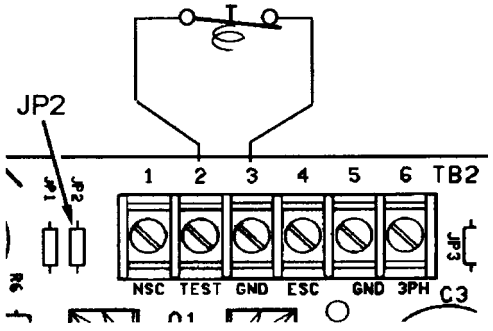
If the exercise option is not desired it can be turned off when left in this position. The disable positiion effects the exercise option only. It has no effect on transfer switch operation.

The internal exercise clock requires either the Normal or Emergency source to be present to maintain its memory.

If both sources are absent for longer than 90 seconds the time and day selected will be lost and automatically reset to the time and day power was restored.

Transfer Test Switch

The complete system can be tested by removing the JP2 jumper and installing an optional toggle switch between terminals 2 (TEST) and 3 (GRD) of the TB2 terminal strip on the Controller board. A normally closed push button or momentary toggle is recommended. Opening the switch contacts will simulate a loss of the Utility power and initiate an engine start-up and transfer of load to the Generator set.



Automatic Transfer Switch