Training Manual

Standby Generator Sets

Model:
COM 6

KOHLER.
POWER SYSTEMS

TP- 5892 9/97

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INTRODUCTION

This manual covers general operation, and features of the Model COM-6/24 generator set.

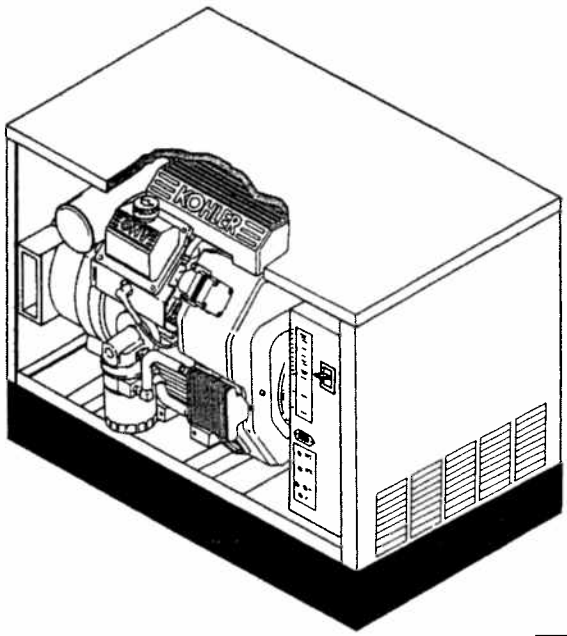
The manual is intended as a training guide and does not necessarily contain all available service and installation information.

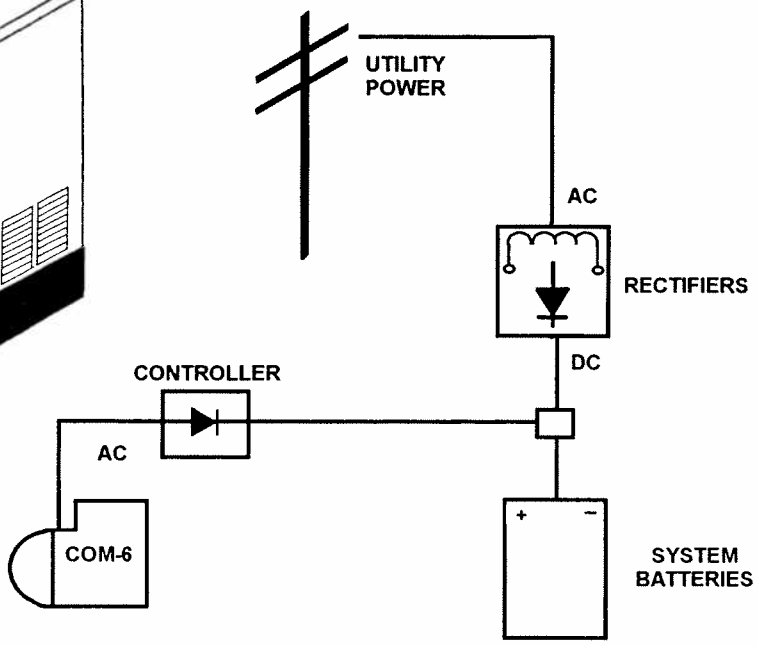
Pictures, illustrations and wiring diagrams in this manual are only representative and may differ from the current production models.

All information found in this publication is based on data available at time of printing. Kohler Co. reserves the right to make changes to this literature and the products represented at any time without notice and without incurring obligation.

SYSTEM CONCEPT

The COM-6/24 Generator Set installation can supply up to 230 amps of battery charging to 24 volt telecommunication site battery systems in the event of a utility power failure.





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. Below are some general precautions relating to the operation of a generator set. SAVE THESE INSTRUCTIONS.

⚠ DANGER

Danger indicates the presence of a hazard that *will* cause *severe* personal injury, death, or substantial property damage if the danger is ignored.

⚠ WARNING

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

⚠ CAUTION

Caution indicates the presence of a hazard that *will* or *can* cause *minor* personal injury or property damage if the caution is ignored.

NOTE

Note communicates installation, operation, or maintenance information that is important but not hazard related.

Safety decals are affixed to the generator set in prominent places to advise the operator or service technician of potential hazards. The decals are reproduced here to improve operator recognition. For a further explanation of decal information, refer to the safety precautions throughout this manual. Before operating or servicing the generator set, be sure you understand the messages of these decals. Replace decals if missing or damaged.

Accidental Starting

⚠ WARNING

Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe injury or death. Turn generator set master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator set. The generator set can be started by site power system or remote start/stop switch unless these precautions are followed.

Battery

⚠ WARNING

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

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

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

Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc., to prevent burns and 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. Sparks could ignite battery gases or fuel vapors. Ventilate any compartment containing batteries to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being changed. Always turn battery charger off before disconnecting battery connections. Remove negative lead first and reconnect it last when disconnecting battery.

Engine Backfire / Flash Fire

⚠ WARNING

Fire.
Can cause severe injury or death.

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

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

Exhaust System

⚠ WARNING

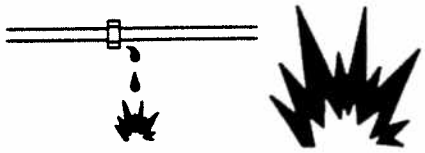
Carbon monoxide.
Can cause severe nausea, fainting, or death.

The exhaust system must be leakproof and routinely inspected.

Carbon monoxide can cause severe nausea, fainting, or death. Never operate the generator set inside a building unless the exhaust gas is piped safely outside. Never operate in any area where exhaust gas could accumulate and seep back inside an occupied building. 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. Be aware that it can cause death if inhaled for even a short time.

Fuel System

⚠ WARNING



Explosive fuel vapors.
Can cause severe injury or death.

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

Explosive fuel vapors can cause severe injury or death. All fuels are highly explosive in a vapor state. Use extreme care when handling 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 since spilled fuel may ignite on contact with hot parts or from ignition spark. Do not smoke or permit flame or spark to occur near potential sources of spilled fuel or fuel vapors. Keep fuel lines and connections tight and in good condition. Do not replace flexible fuel lines with rigid lines. Flexible sections are used to avoid breakage due to vibration. If any fuel leakage, fuel accumulation, or electrical sparks are noted, DO NOT OPERATE GENERATOR SET. Repair systems before resuming generator set operation

Explosive fuel vapors can cause severe injury or death. Take additional precautions when using the following fuels:

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

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

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). Do not use test solutions that contain ammonia or chlorine, since the soap will not bubble for an accurate leakage test.

Hazardous Voltage/ Electrical Shock

⚠ WARNING

Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

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

Hazardous voltage can cause severe injury or death. Whenever electricity is present, there is the hazard of electrocution. Open main circuit breaker on all power sources before servicing equipment. Electrically ground the generator set and electrical circuits when in use. Never come into contact with electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution is increased under such conditions.

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.

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 perform installation.

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

Heavy Equipment

⚠ WARNING

Unbalanced weight.
Improper lift can cause severe injury or death or equipment damage.

Use a sling under skid to lift generator set.

Hazardous Noise

⚠ CAUTION

Hazardous noise.
Can cause loss of hearing.

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

Hot Parts

⚠ WARNING

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

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

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.

Moving Parts

⚠ WARNING

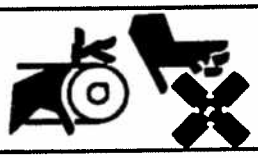
Hazardous voltage.

Moving rotor.

Can cause severe injury or death.

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

⚠ WARNING



Rotating parts.
Can cause severe injury or death.

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

Flying projectiles can cause severe injury or death. Retorque all crankshaft and rotor hardware after servicing. Do not loosen crankshaft hardware or rotor thrubolt when making adjustments or servicing generator set. Rotate crankshaft manually in a clockwise direction only. Loose hardware can result from turning crankshaft bolt or rotor thrubolt counterclockwise. Personal injury can occur from loose hardware causing hardware or pulley to come off engine when generator set is running.

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

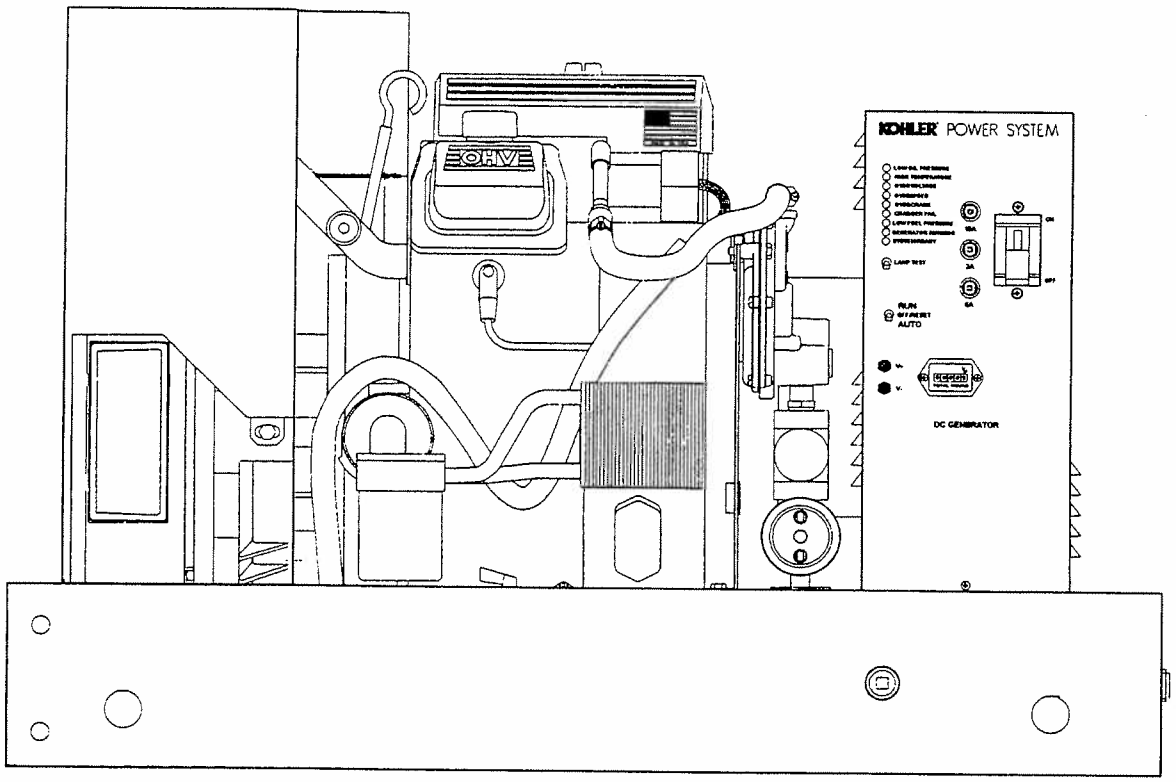
GENERAL

The Com-6 Standy Power System operates on Natural Gas and consists of two major functional assemblies: The Generator Set (engine and alternator) and the Controller assembly which rectifies and filters the alternator output as well as controlls the engine operation.

The Alternator provides 3 phase, variable frequency (360 - 720 htz) AC to the Controller which rectifies and filters the output. Nominal DC output is 24vdc.

An Electronic governor system monitors the battery voltage and increases or decreases the engine speed to regulate the charging current.

The unit is designed for both local and remote annunciation and control.



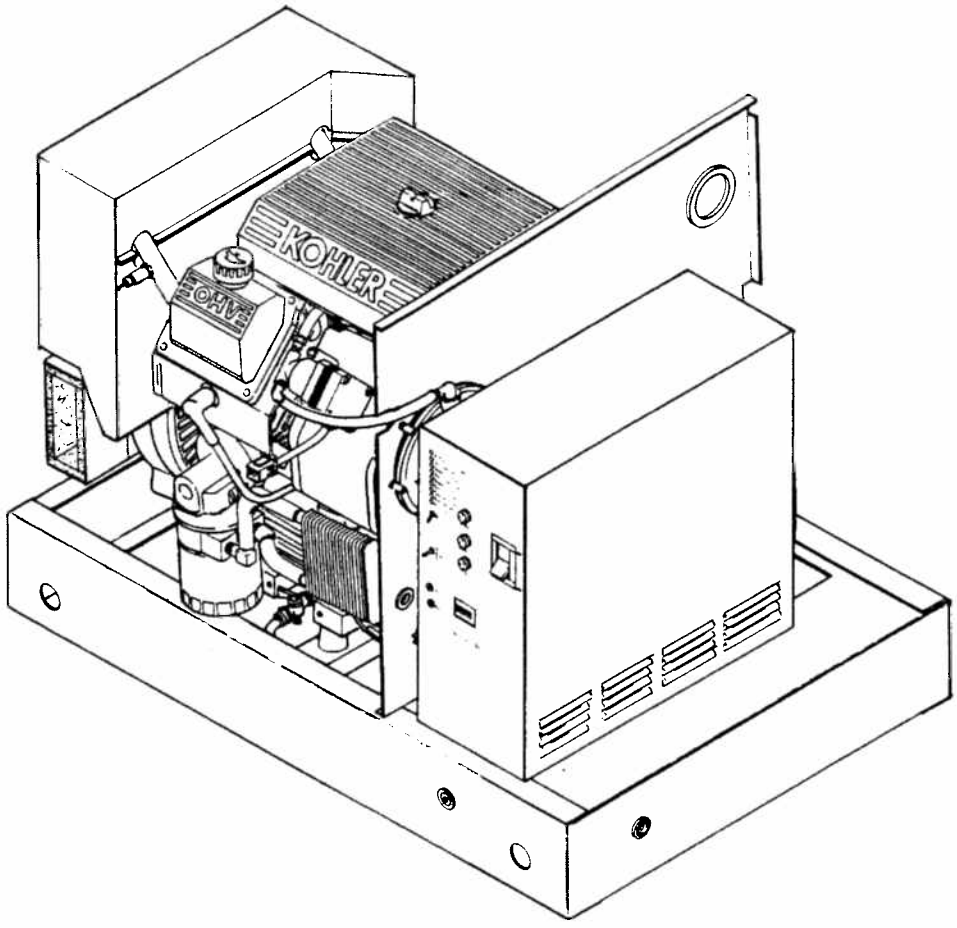
SPECIFICATIONS

Following are some general Generator Set, Engine and Alternator specifications. Refer to the appropriate service manual for specific service details.

DERATION: All units are rated 1.0 power factor. Derate approximately 3.5% per 1000 ft. (300m) over 1000 ft. (300m) above sea level. Derate 1% for each 10° F (5.5° C) increase in temperature above 120°F (49°C).

Generator Set Specifications

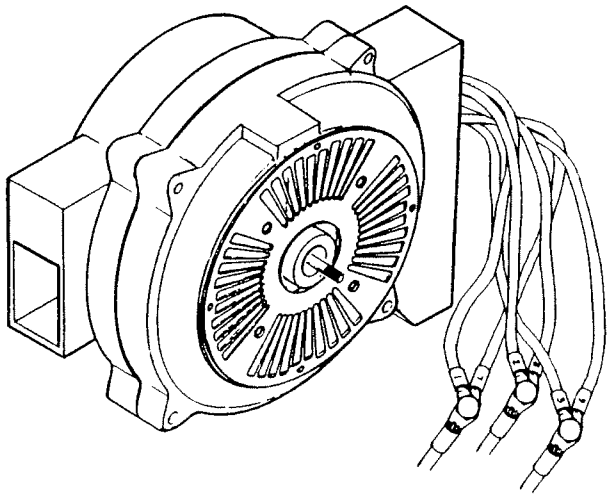
Manufacturer	Kohler
Dimensions DxWxH - in. (mm)	20.2 (488) x 24.7 (627) x 23.1 (588)
Weight - lbs. dry (kg)	380 (172.4) shipping weight
Rated kW	6
Frequency - Hz	500 - 720
Rated Voltage (rectified)	26.2 vdc
Rated Amps	229



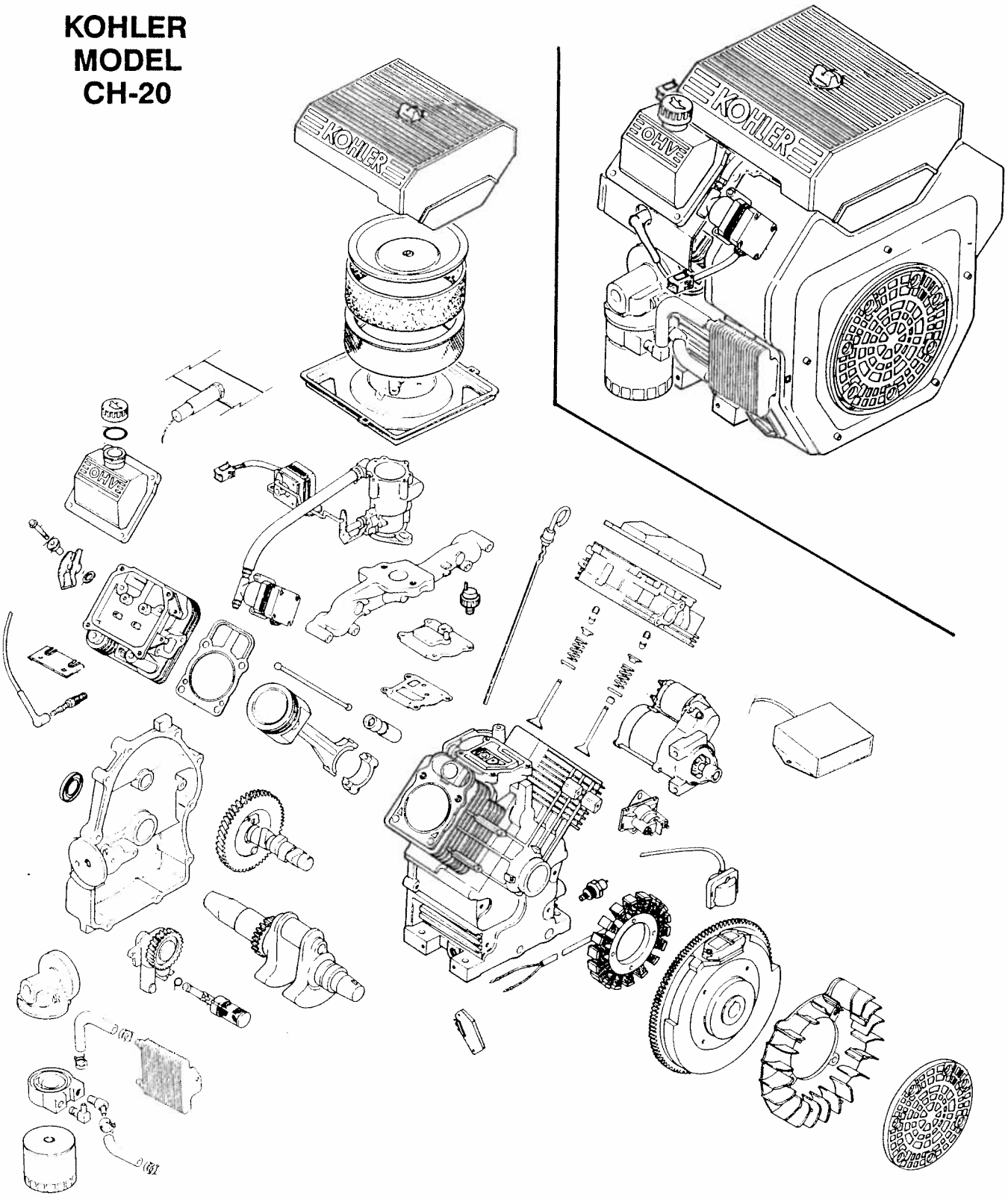
Alternator Specifications

Stator Resistance (ohms) Leads: 1-2, 2-3, 3-1, 7-8, 8-9, 9-7	0.025 ohms
Excitation Method (Rotor)	Permanent Magnet, Brushless
Coupling Type	Direct
Insulation (Stator)	Class 155, Epoxy Varnish, Vacuum Impregnated
Winding Material	Copper
Bearing, number and type	1, Replaceable ball

PHASE - 3
VOLTS - 26.2
AMPS 230
WATTS - 6000
POLES - 24
FREQ. - 360 - 720



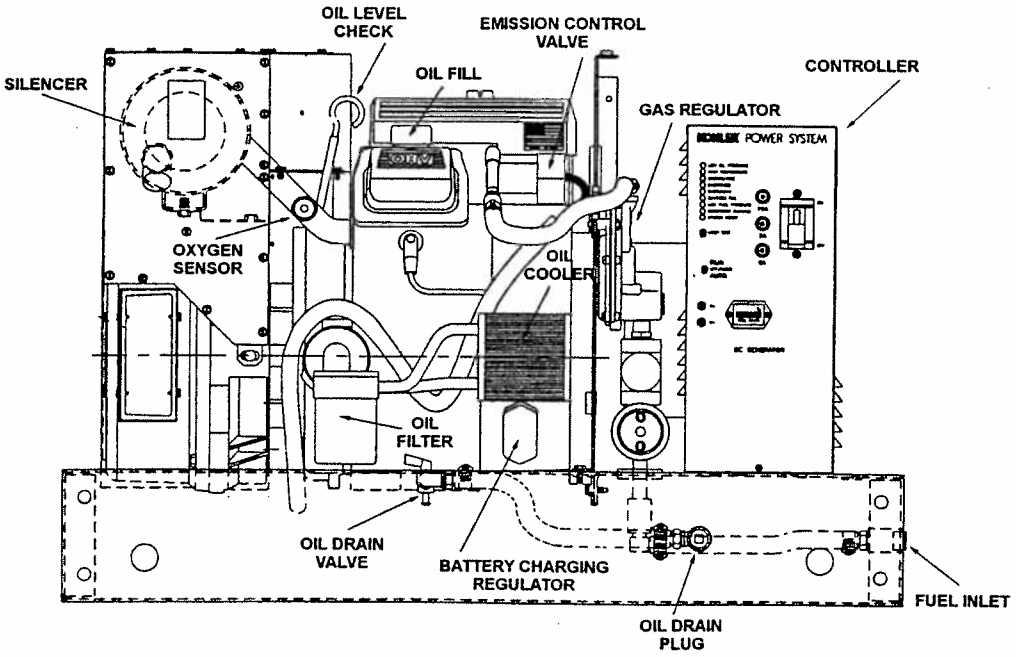
KOHLER
MODEL
CH-20

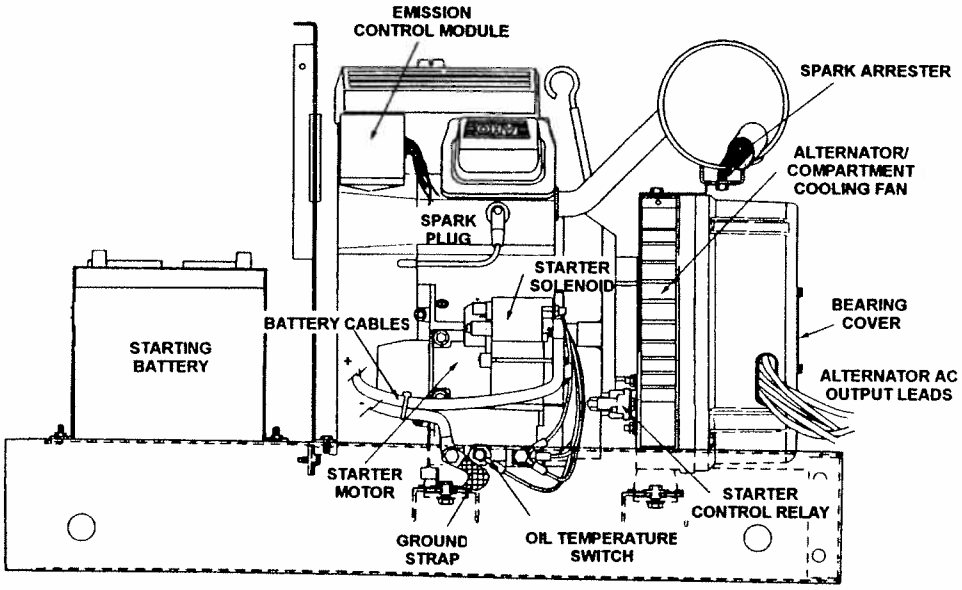


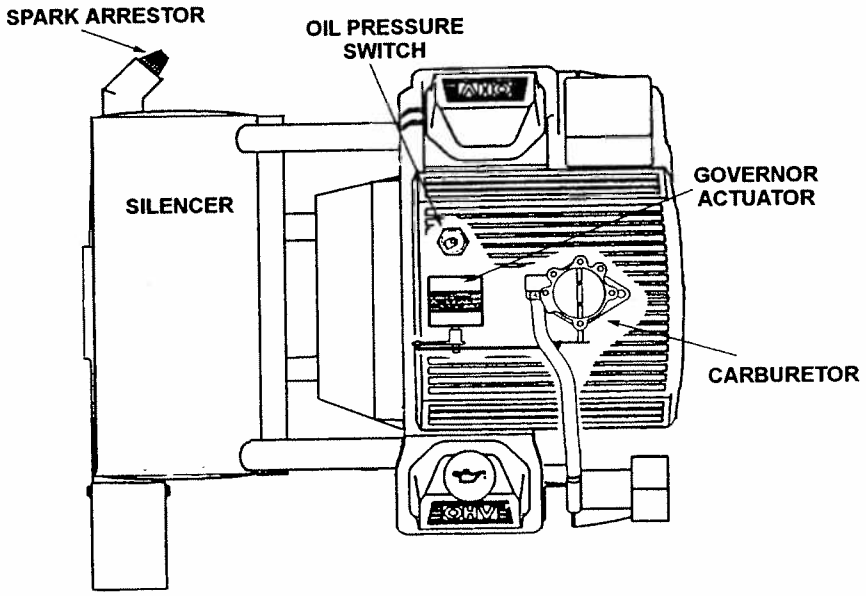
SPECIFICATIONS

Engine Specifications

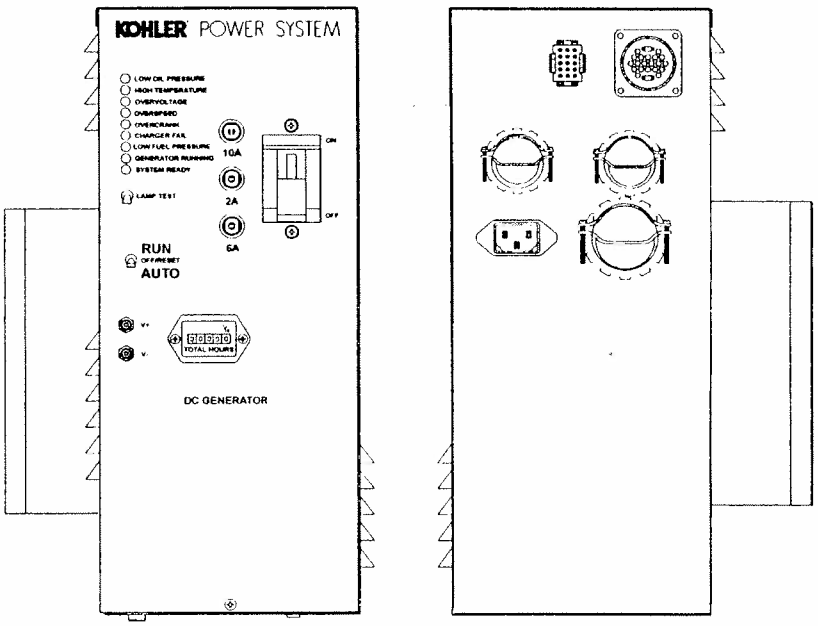
Model	CH20
Cycle	4
Number Cylinders	2
Compression Ratio	8.5:1
Displacement—cu.in. (cc)	38 (624)
Rated Horsepower	15
RPM	1800 - 3600
Bore—in. (mm)	3.03 (77)
Stroke—in. (mm)	2.64 (67)
Valve Material:	
Intake	Steel
Exhaust	Stellite®
Valve Train	Overhead Valve
Cylinder Block Material	Aluminum w/Cast Iron Liners
Cylinder Head Material	Aluminum
Piston Rings	2 Compression, 1 Oil
Crankshaft Material	Heat Treated, Ductile Iron Casting
Bearings, Number & Type	2, Replaceable Sleeve
Governor	Electronic
Lubrication System	Full Pressure
Oil Capacity (with filter and cooler)—qts. (L)	2 (1.9)
Oil Type (Summer/Winter)	Mobil 1, 5W-30
Oil Pressure—psi (kPa)	25-35 (172-241)
Fuel Type	Natural Gas
Fuel Pressure oz/sq.in. (in. w.c.)	4-6 oz. (7-11 in.)
Battery Voltage	12
Battery Ground	Negative
Battery Recommendation (min.)	510 CCA at 0°F
Spark Plug Type (Kohler Part No.)	24 132 01
Spark Plug Gap in. (mm)	0.040 (1.02)
Spark Plug Tightening Torque—ft. lbs (Nm)	18-22 (24.4-29.8)
Ignition System	Capacitor Discharge
Engine Driven Battery Charger	15 Amp, Regulated
Starter Motor	Electric, Solenoid Shift
Cooling System	Integrated Air Cooling


OIL LEVEL CHECK
EMISSION CONTROL VALVE
CONTROLLER
SILENCER
OIL FILL
GAS REGULATOR
POWER SYSTEM
OXYGEN SENSOR
OIL COOLER
OIL FILTER
OIL DRAIN VALVE
BATTERY CHARGING REGULATOR
FUEL INLET
OIL DRAIN PLUG


EMISSION CONTROL MODULE
SPARK ARRESTER
ALTERNATOR/ COMPARTMENT COOLING FAN
SPARK PLUG
STARTER SOLENOID
BEARING COVER
BATTERY CABLES
STARTING BATTERY
ALTERNATOR AC OUTPUT LEADS
STARTER MOTOR
STARTER CONTROL RELAY
GROUND STRAP
OIL TEMPERATURE SWITCH


SPARK ARRESTOR
OIL PRESSURE SWITCH
SILENCER
GOVERNOR ACTUATOR
CARBURETOR

CONTROLLER


KOHLER POWER SYSTEM
LOW OIL PRESSURE
HIGH TEMPERATURE
OVERVOLTAGE
OVERSPEED
OVERCRANK
CHARGER FAIL
LOW FUEL PRESSURE
GENERATOR RUNNING
SYSTEM READY
LAMP TEST
10A
2A
6A
ON
OFF
RUN
AUTO
TOTAL HOURS
DC GENERATOR

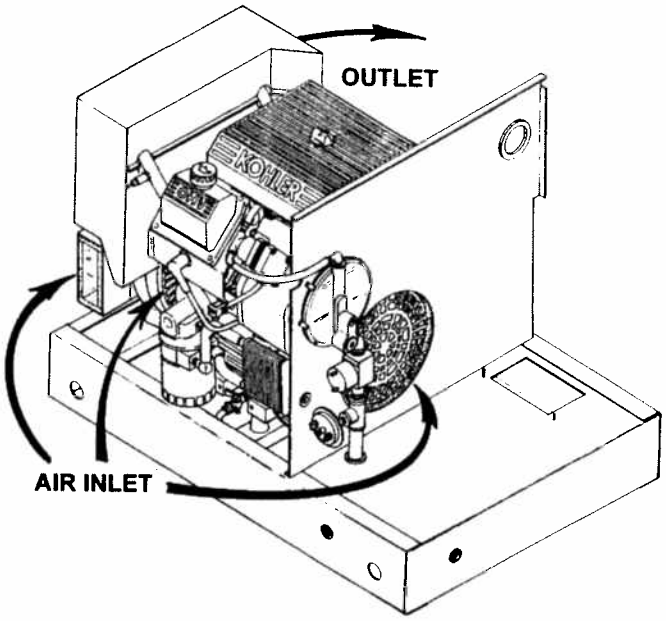
COOLING SYSTEM

The unit is cooled by a directed air system.

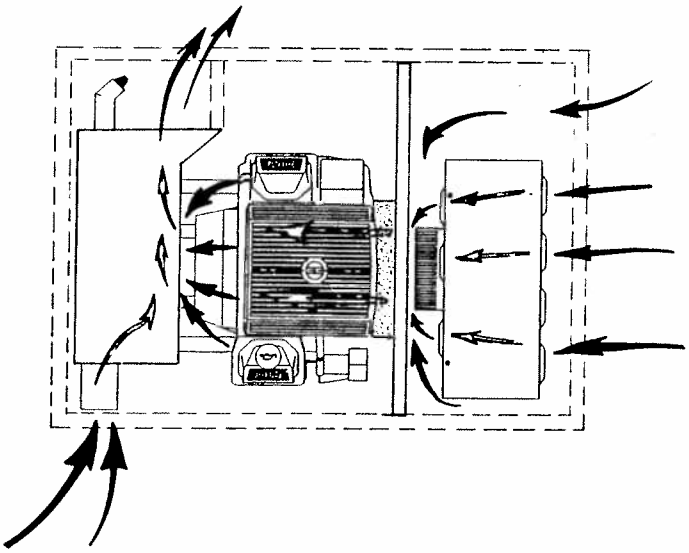
Two fans, one attached to the engine flywheel and the other to the alternator rotor draw in ambient air to cool the engine, alternator, and controller as well as purge the compartment of hot air.

The flywheel fan draws air thru the controller and compartment inlet louvers and forces it across the engine cooling fins. A foam ring provides a seal between the engine blower housing and compartment baffle.

The alternator fan cools the stator windings as well as evacuates the compartment air.



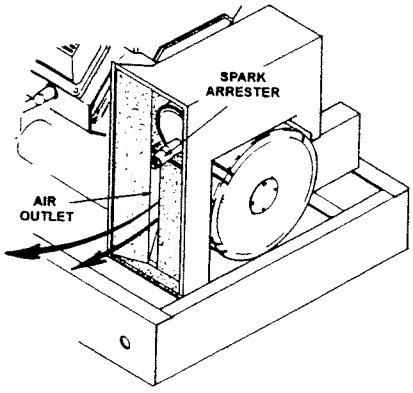
The hot air is forced into the exhaust silencer compartment and outside the cabinet.



Shrouding around the engine block and heads are designed to provide efficient air flow across the cooling fins and should not be removed.

It is important that all cooling air inlet and outlet openings are unrestricted. These openings are designed to allow sufficient air flow and also restrict noise from exiting the compartment as well as small animals from nesting in the compartment.

An oil cooler is provided to maintain acceptable lube oil temperatures when operating under severe ambient temperatures.



If the oil temperature exceeds the unsafe range a sensor switch will shut down the unit.

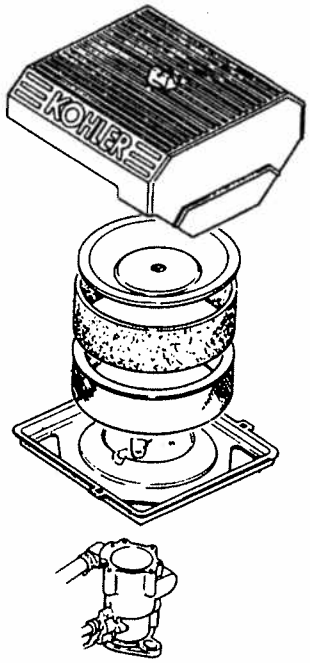
AIR INTAKE

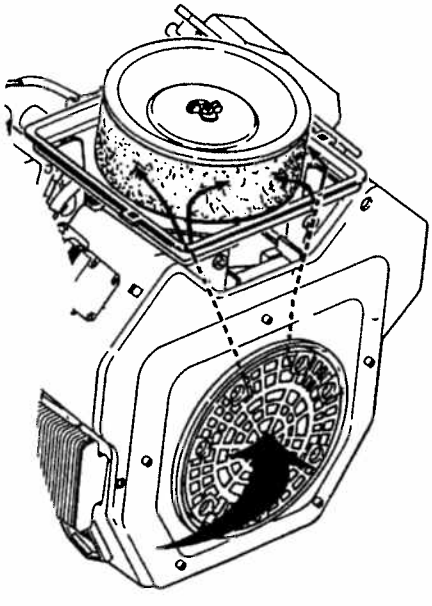
A portion of the outside ambient air is directed from the flywheel fan to the Gas/Air mixer (carburetor) for combustion.

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 standard fuel is Natural Gas which is supplied to the cabinet inlet pipe at approximately 4 to 6 oz. (7 - 11" water column) via a primary regulator and a manual shutoff valve located outside the enclosure.

Prior to entering the Carburetor (Mixer) the gas is first routed through; an Emission Control Valve, a secondary Regulator, Electric Shut-off Solenoid and a Low Pressure Switch.

The **Pressure Switch** provides a set of normally closed contacts which open at normal operating pressure and close if pressure falls below engine operating requirements. The switch then provides a signal to the control circuit for an annuncitor indication of low fuel presssure and an engine shut-down.

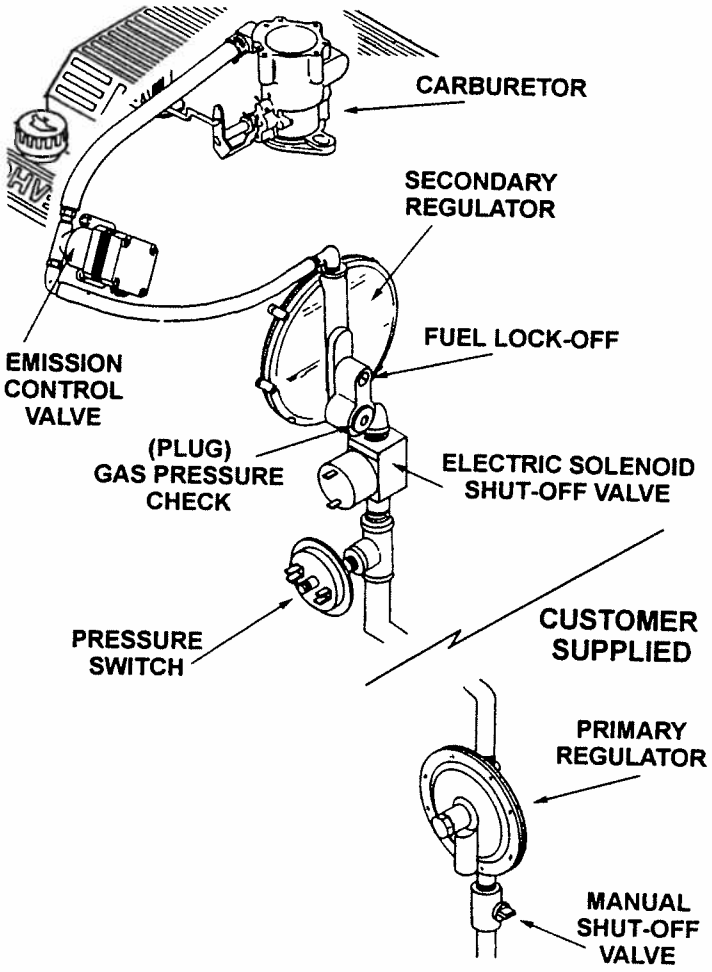
The **Electric Shut-Off Solenoid** is a normally closed valve and is energized to open when an engine Start/Run signal is received from the control circuit. The valve is powered from the 12vdc supply.

The **Secondary Regulator** further reduces the pressure in accordance with the engine demand.

Pressure to the input of the regulator should not exceed 6 oz. A plug is provided at the regulator input for gauge or manometer readings if a pressure check is necessary. System pressure is determined by the Primary regulator setting.

A Fuel lock-off is also included in the regulator to prevent 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.

The manual shut-off valve must always be closed prior to removing any fuel line or component of the gas system.



Gas flows from the Regulator to the **Emission Control Valve** which automatically controls the gas flow entering the mixer.

The Emission Control valve is driven by a stepper motor powered by an **Electronic Control Unit (ECU).**

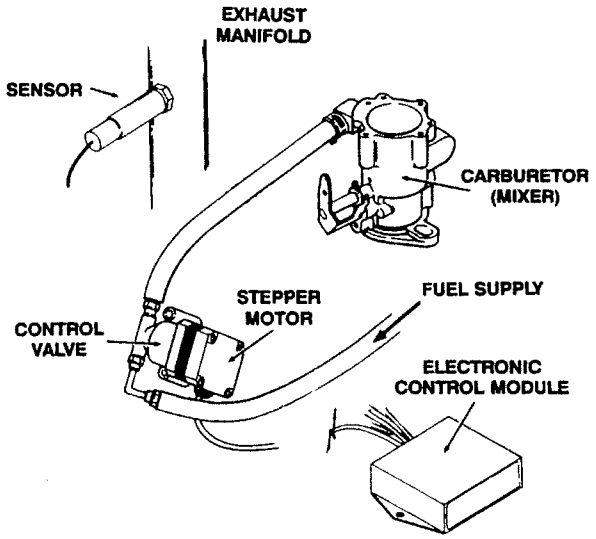
Input signal to the module is received from an **Oxygen Sensor** located in the exhaust manifold. The sensor continuously monitors the exhaust emissions.

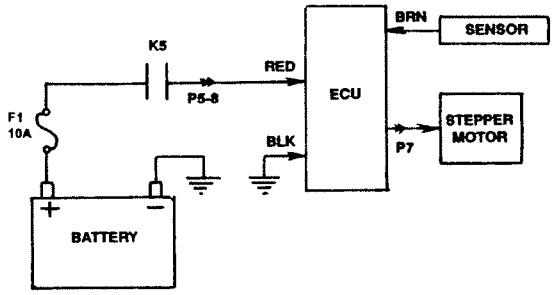
The ECU is powered by 12vdc from the n.o. contacts of the K5 relay located on the Main Control Board. Power to the Emissions System is inhibited during cranking and for 30 seconds after an engine start.

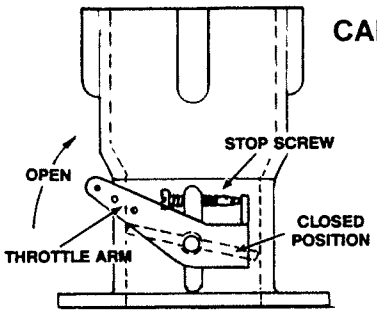
The fuel is precisely metered so the engine will always operate at peak performance levels regardless of changing load or ambient conditions.

The Carburetor venturi and throttle valve control the air/fuel ratio supply to the engine cylinders.

Increasing the load requires further opening of the valve to increase fuel mixture resulting in an increase in engine speed.







CARBURETOR (MIXER)

VOLTAGE REGULATION

The potential output of the alternator is regulated by an Electronic engine speed control system.

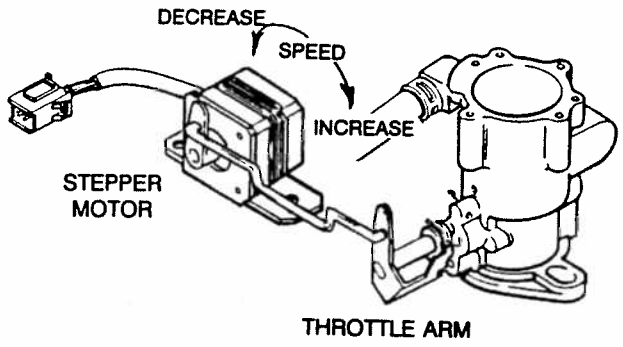
A stepper motor linked to the engine carburetor provides precise control of the throttle valve.

The motor is bi-directional and rotates in small incremental steps from signals received from the main control board.

The DC is monitored at the circuit breaker and supplied to the main control board as a sensing signal. Speed will increase or decrease when the ouput voltage deviates from rated voltage.

If the sensing signal is lost during normal running an engine shutdown will occur.

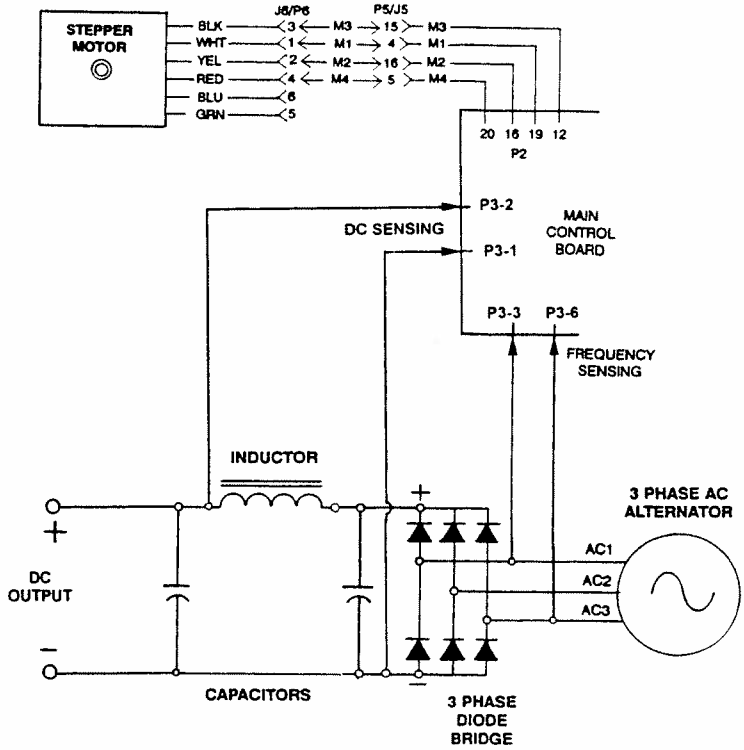
On a new installation or whenever the starting battery is reconnected the control system will reset itself by closing the throttle valve. An audible click will result.



OVERSPEED

The AC is also monitored at the main control board for frequency level. If a frequency in excess of 730 Hz (3650 RPM) is sensed, the unit will be signaled to shut down as an "Overspeed" fault.

If the AC signal is lost during normal running a shut-down as well as an "Overspeed" indication will also occur.



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.

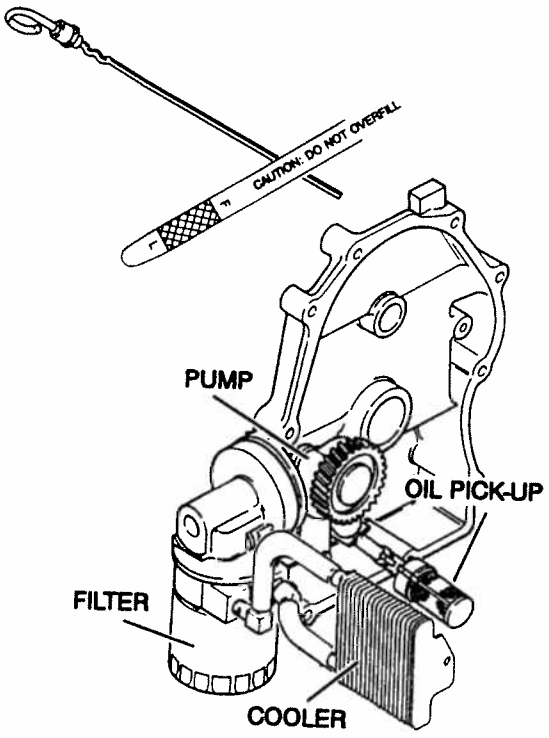
To aid in operating under high ambient conditions an oil cooler is provided. Heat is transferred to the fins and dissipated in the air flow.

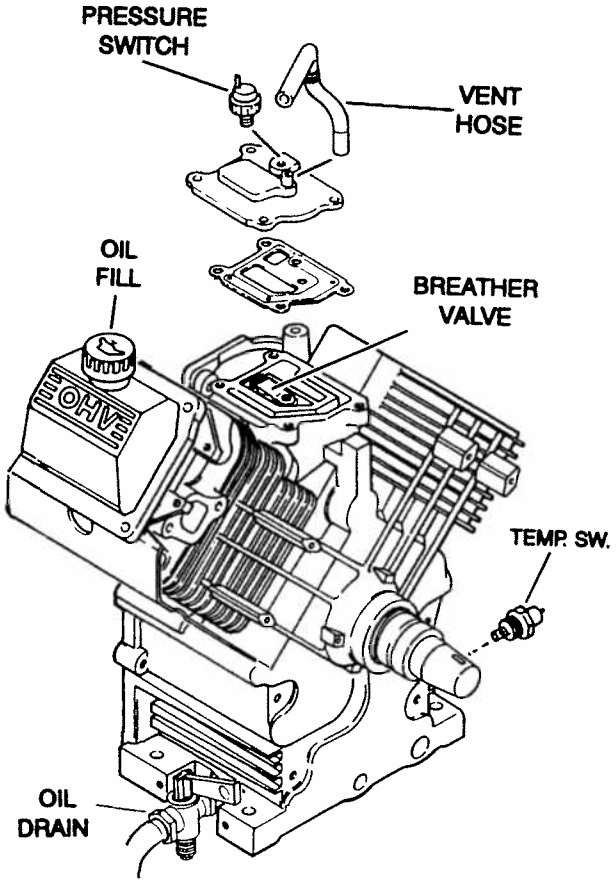
The engine operates with a partial vacuum in the crankcase. This is controlled by a "breather" assembly consisting of a reed valve. A pressurized crankcase due to a faulty or clogged valve could cause oil leaks at seals and gaskets.

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 as well as a "low oil pressure" panel indication.

A temperature sensitive switch with normally open contacts is located in the crankcase to monitor the engine lubeoil. The contacts will close to initiate an engine shut-down when the temperature reaches the predetermined level.

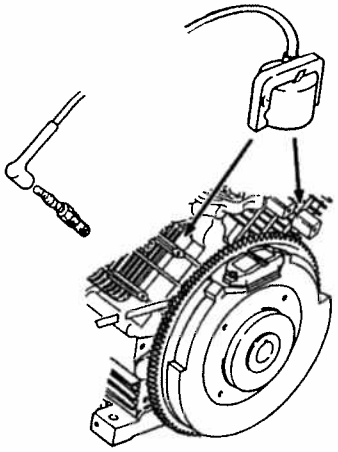




IGNITION SYSTEM

The engine is equipped with dual capacitor discharge ignition modules to fire the two spark plugs. 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 system.

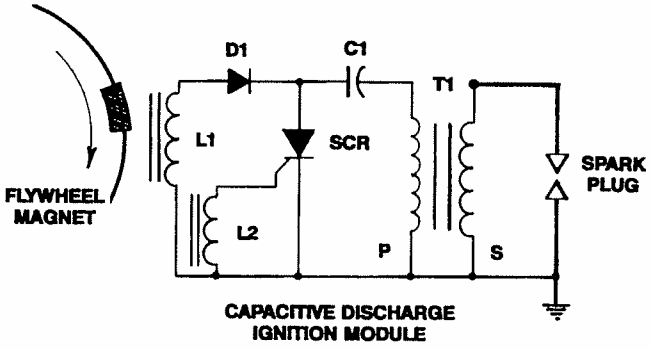


As the magnet approaches the L1 coil a potential is generated which is rectified by the D1 diode and stored in the C1 capacitor.

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.

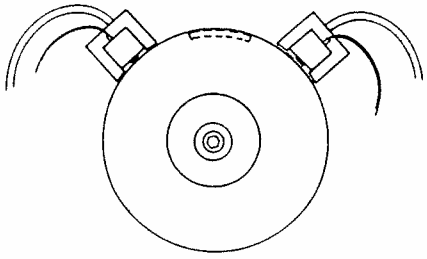
This rapid flow of current in the primary induces a very high voltage in the T1 secondary windings sufficient to jump the spark plug gap and ignite the cylinder fuel mixture.

This firing occurs on every revolution of the flywheel.



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.



Ignition is terminated by shorting the high side of the primary circuit to ground.

STARTING SYSTEM

The generator set will start automatically upon a power failure or can be started locally at the control cabinet.

The electric Starter Motor requires a 12 volt lead acid battery with a minimum 510 cold cranking amps rating.

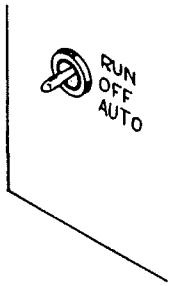
The engine start cables must be connected as a negative ground configuration. The controls will not allow an engine crank with a reversed polarity, and system damage may occur. Red battery lead is positive and the black lead is negative.

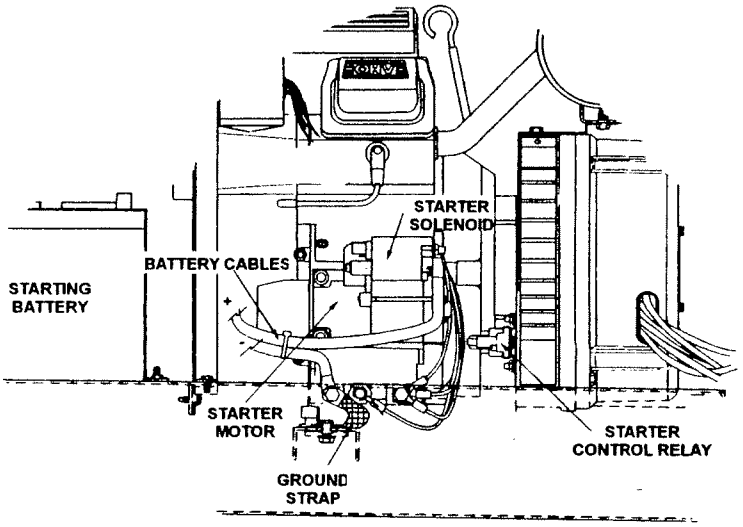
On a start command from the main control board the Starter Relay located on the alternator adapter is energized.

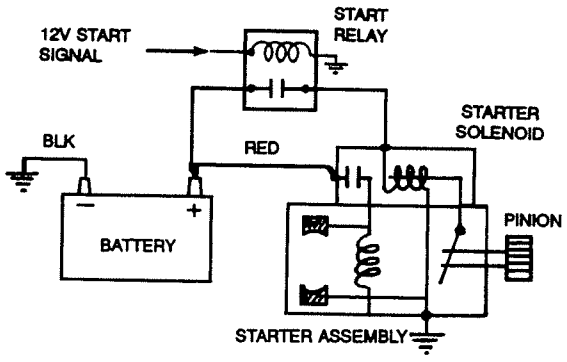
Closing of the starter relay contacts will energize the starter motor Solenoid.

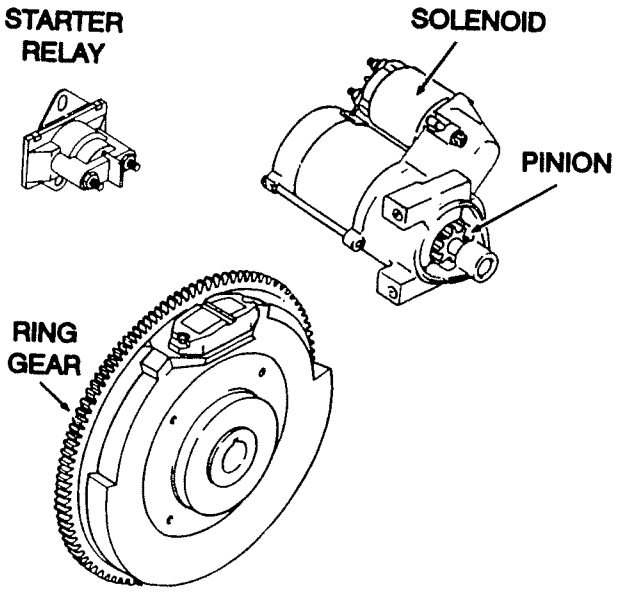
The solenoid assembly contains contacts that connect the battery to the starter brushes and a spring loaded drive mechanism which engages the starter motor pinion to the flywheel ring gear.

The controls will automatically terminate cranking upon a successful engine start. This is determined when a frequency above the normal engine cranking speed is detected. (180Hz.)









CYCLIC CRANKING

If the engine is signaled to start from a remote location (AUTO) and does not start after 20 seconds of cranking, the start signal will be interrupted to allow a 5 second rest period. The crank-rest cycle will then repeat for a total time of 70 seconds followed by an OVERCRANK fault indication and shutdown.

LOCKED ROTOR

Cranking will also terminate if the controller does not receive a frequency signal from the alternator after 2 seconds of cranking.

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.

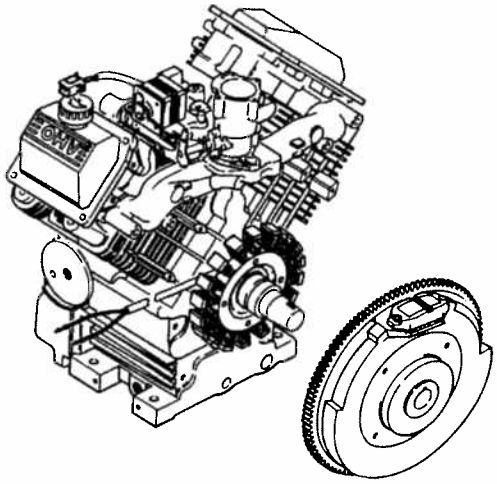
The Alternator will produce approximately 30VAC at 3600 RPM.

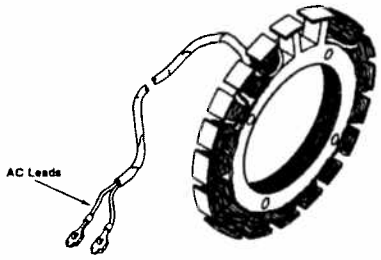
This AC is rectified and regulated to provide a safe DC recharge rate. Nominal charging voltage is 14.2vdc.

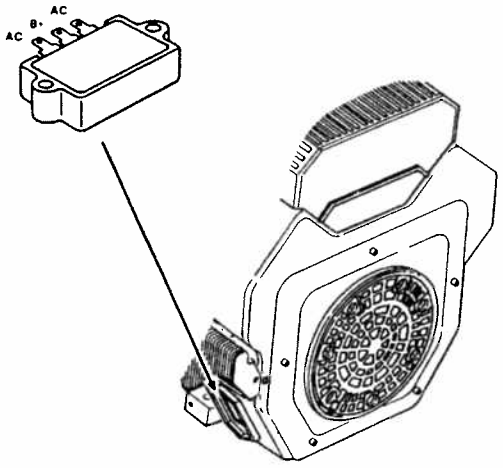
Maximum charging capabilities is 15 Amps.

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

A maintenance charger located in the control cabinet is also provided to keep the starting battery fully charged while the set is in the standby mode.







ALTERNATOR

The Alternator is specifically designed as a power source for battery charging. It is rated at 229 amps and regulated by an electronic engine speed control.

It features a permanent magnet rotor and develops a nominal 24 volt 3 phase AC which is supplied to a Power Rectifier/Filter assembly.

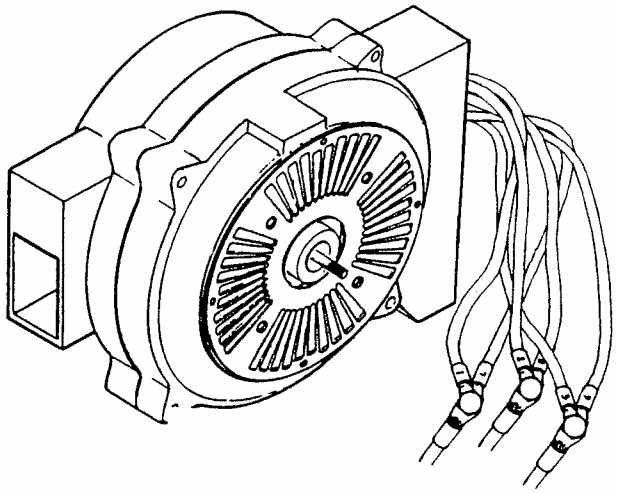
The output voltage is dependent on rotor speed and therefore regulated by the engine . Engine speed will vary depending on load demand from the alternator.

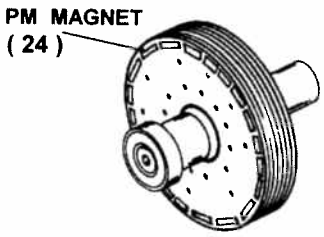
The Rotor contains 24 permanent magnets alternately polarized and pressed into the perimeter of the laminated steel discs. creating a frequency of 720 Hz at 3600RPM.

It is directly connected to the tapered crankshaft stub of the engine and held in position by a thru-bolt. The rotor is supported by a ball bearing in the end bracket.

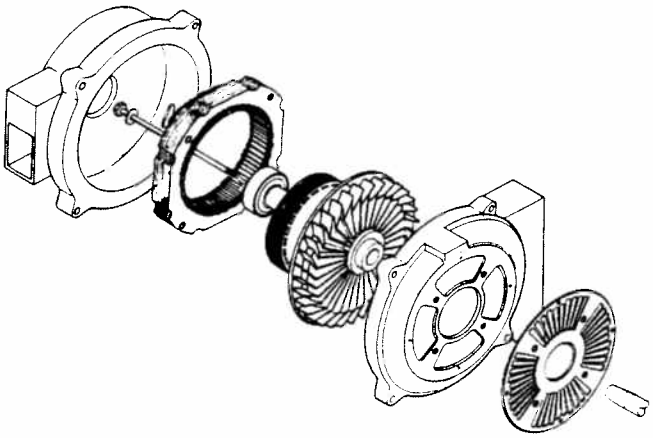
An anti-seize compound is used on the taper and the rotor is removed by a sharp blow to the thru-bolt after first loosening the bolt.

A double sided fan permanently installed on the shaft draws in outside air for cooling the stator windings as well as vacating the compartment of hot air.





ROTOR

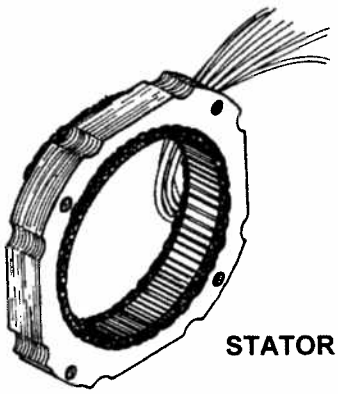


6 windings are overlapped in the insulated slots to provide two 3 phase Wye connections.

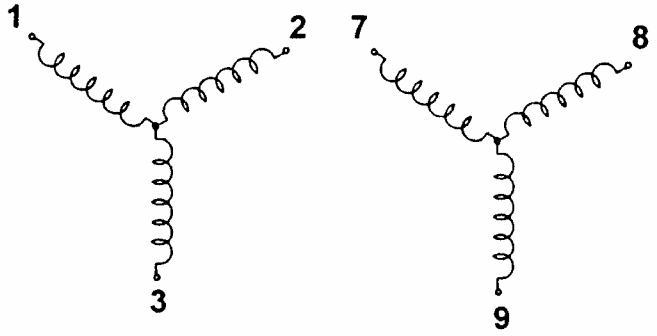
The 6 stator leads exit the end bracket assembly and spliced to three load leads prior to connection in the Controller box. **1-7, 2-8, 3-9**

The stator assembly is bolted in the engine adapter casting.

If the Stator is removed or installed over the rotor assembly caution must be taken due to the great side pulling forces exerted by the rotor magnets.



STATOR



CONTROL CABINET

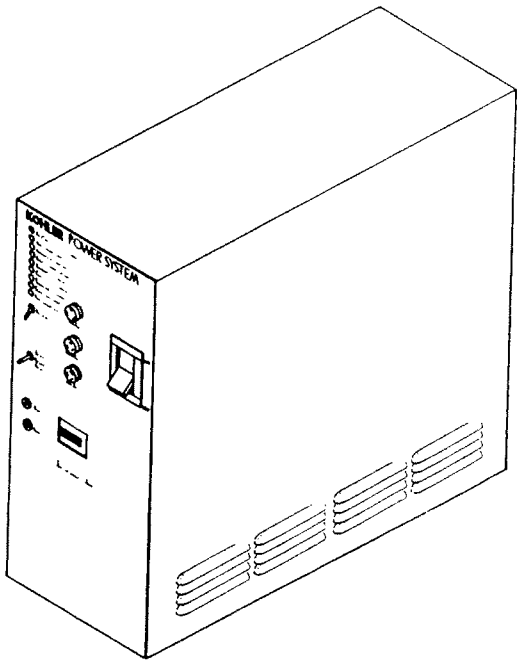
The Control cabinet contains the components and circuitry to rectify and filter the 3 Phase Alternator AC output to DC.

Alternator engine control circuitry, 12v maintenance battery charger and miscellaneous support circuitry are also located in the cabinet.

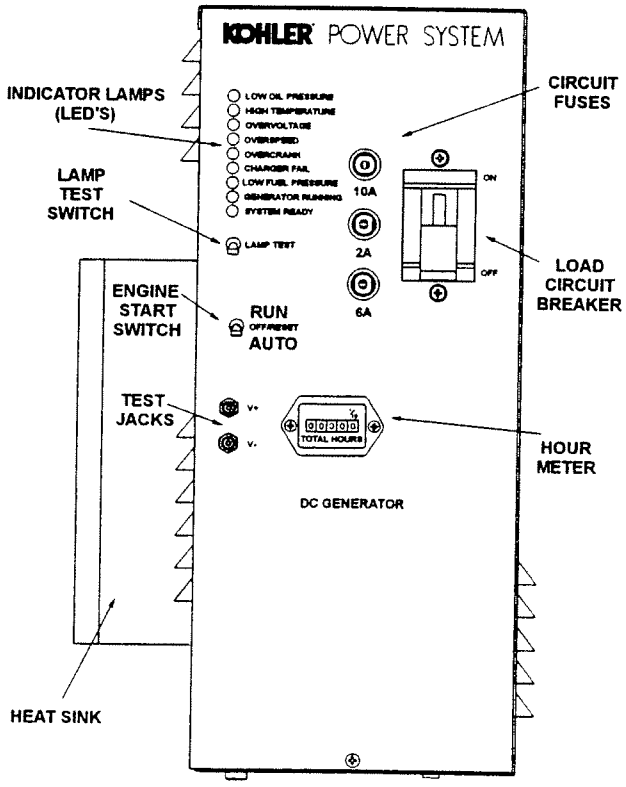
The face of the cabinet contains the circuit protection fuses and main line circuit breaker.

Visual indication for fault conditions of the generator set are provided by corresponding LED's . The "lamp test" switch is located below the LED's.

Also contained in the front panel are the Run - Off- Auto switch, DC power test jacks and a total running time meter.



- INDICATOR LAMPS:
  LED will light when the indicated condition exists.
- LAMP TEST SWITCH:
  Will light all LED's to insure power is available to the circuit.
- ENGINE START SWITCH:
  Selects engine starting mode.
  RUN (local) AUTO (Remote)
- TEST JACKS:
  Allow connection of a voltmeter across DC output.
- CIRCUIT FUSES:
  10A (F1) Control circuit protection.
  2A (F2) 120vac Utility recepticle (12v battery charger input)
  6A (F3) 12v Battery charger output.
- LOAD CIRCUIT BREAKER:
  Protects alternator and rectifier circuit from overloads. Allows manual ON/OFF switching of DC loads.
- HOURMETER:
  Indicates total engine running time.



CONTROL CABINET

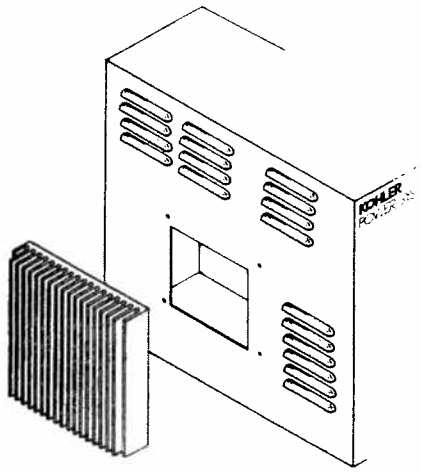
The 3-phase **Alternator Cables** and DC **Output Cables** enter and exit the control box at the rear of the cabinet.

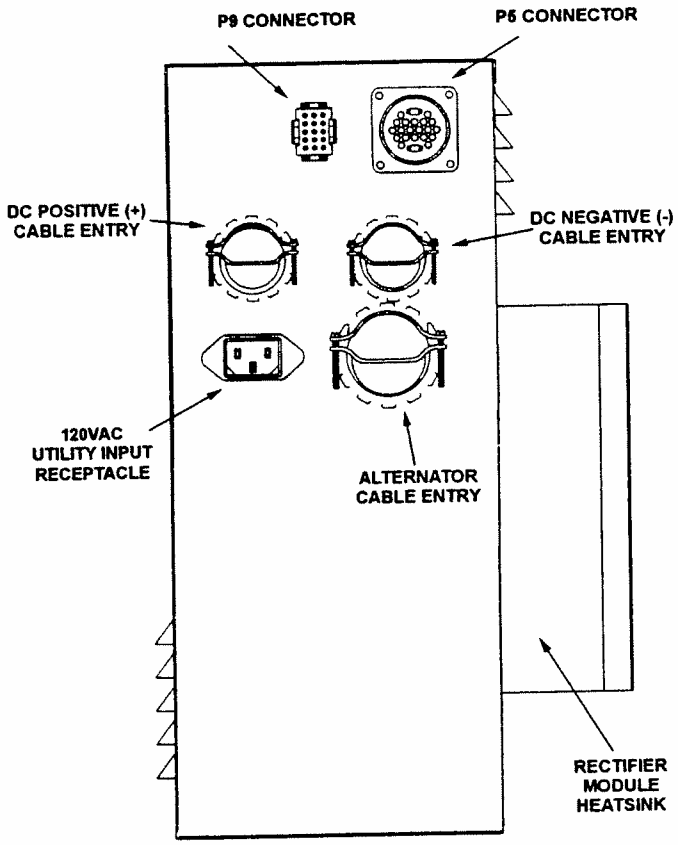
The **P5 connector** provides interconnection between the controller and the engine electrical components.

Remote operation and monitoring is provided through the **P9 connector**.

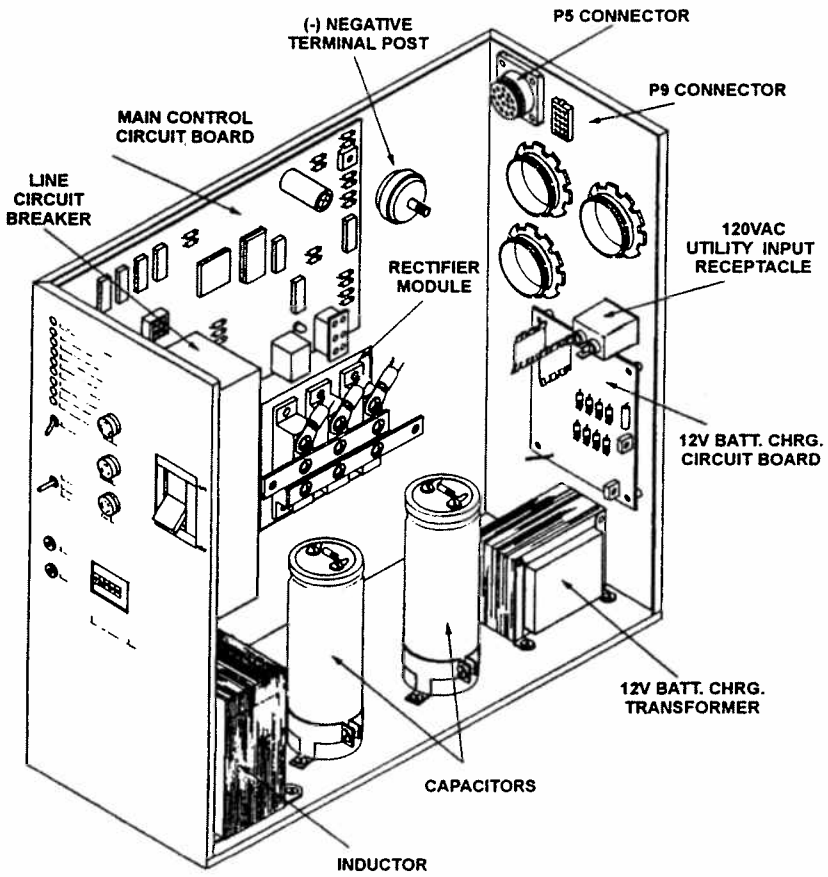
The **Utility Receptacle** allows for input of an external 120vac supply required to power the 12 volt system battery charger.

The power rectifier assemblies are mounted to the **Rectifier Module Heatsink** located on the side of the controller cabinet

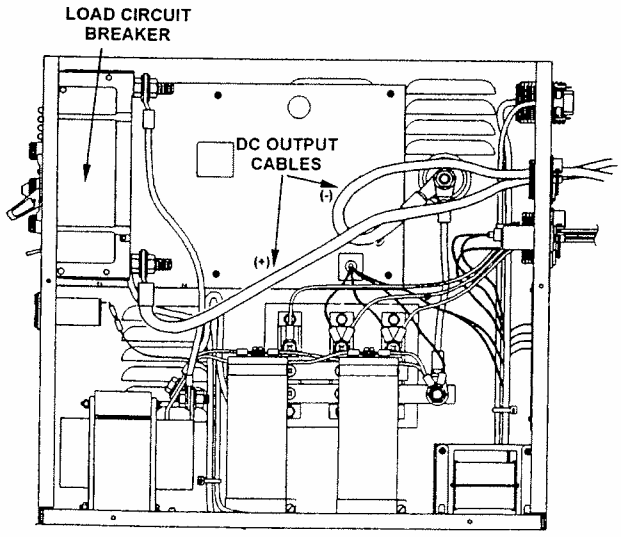




CONTROL CABINET



The DC Output Load Cables are connected to an isolated terminal post (-) and the output terminal of the Load Circuit Breaker (+).



The control cabinet contains components which support three separate functions:

- **POWER CONVERSION & PROTECTION:**
  - Rectifier Module
  - Inductor
  - Capacitors
  - Load Circuit Breaker
- **ENGINE CONTROL & MONITORING**
  - Main Control Circuit Board
- **12 VOLT BATTERY CHARGING:**
  - Circuit Board
  - Transformer
  - 120v Receptacle

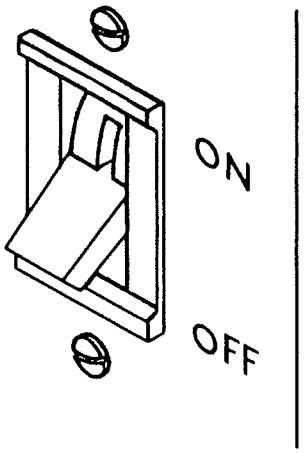
CIRCUIT BREAKER

The Circuit Breaker interfaces the System batteries and Alternator. It is used for the manual disconnect switch between the alternator and system batteries as well as providing overload protection for the alternator.

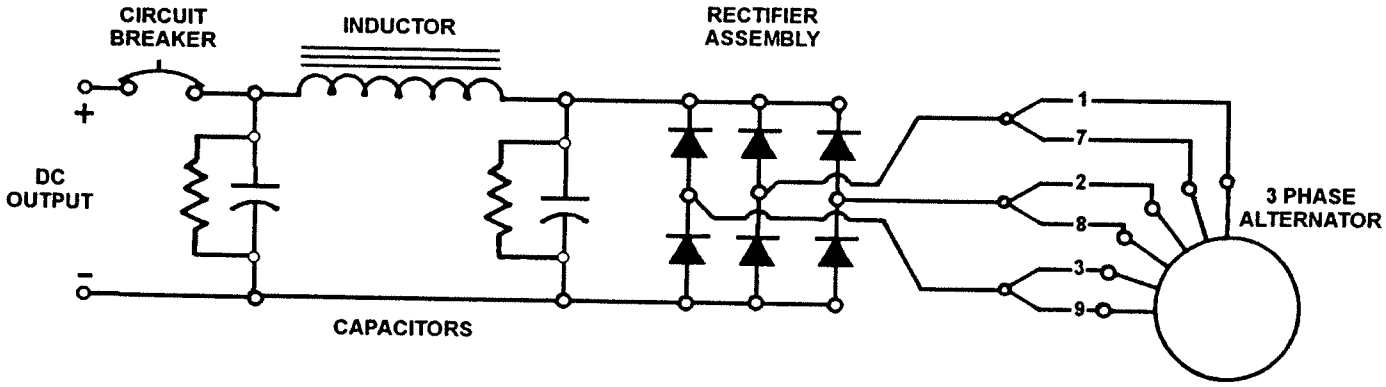
The Breaker interrupts the Positive leg of the generated DC line power and battery positive Load.

If a fault trip occurs the handle will spring to the mid position. The Breaker must be reset by moving it to the full "off" position before it can be latched in the "on" position.

Always place the breaker in the open or "off" position when servicing or making connections to the Control/Power Cabinet.



WARNING:
Battery potential is present at the LOAD side of the breaker at all times when unit is connected to an operational system.



The Rectifier/Filter components are located in the Control/Power Conditioner Cabinet.

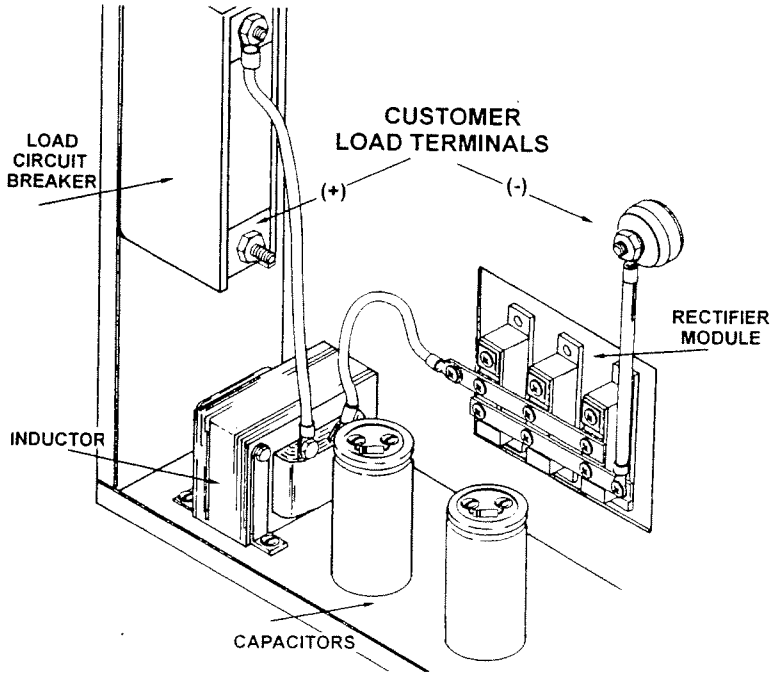
The 3 Phase relatively high frequency AC generated by the alternator is converted to DC by a Rectifier Module.

An Inductor connected in series, and Capacitors connected in parallel with the output, provide an Inductive circuit that filters or smoothes the pulsating DC to a slight ripple.

POWER TERMINALS

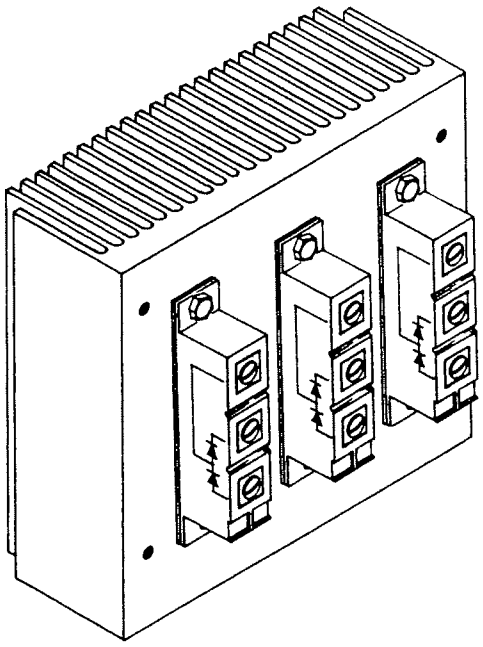
The system batteries connect to the DC breaker terminal (+) and Negative insulator (-).

ALL TERMINAL CONNECTIONS MUST BE TIGHT AND THE CORRECT POLARITY OBSERVED.



The **Rectifier Module** consists of 3 diode assemblies mounted to an aluminum heat sink. Each assembly contains two diodes to provide a 3 phase full wave bridge.

The Module is located on the side of the cabinet and positioned adjacent to the engine air inlet cooling fan to provide maximum heat dissipation.

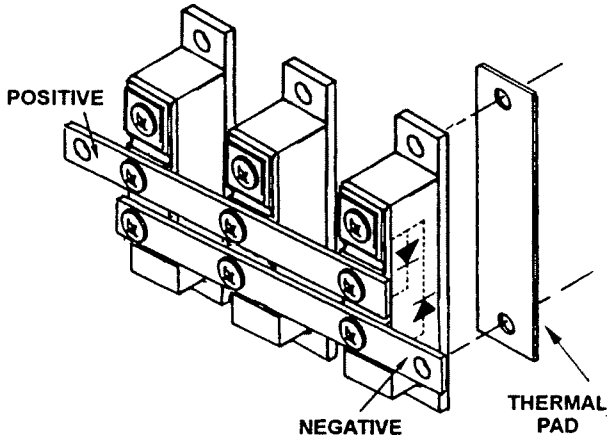


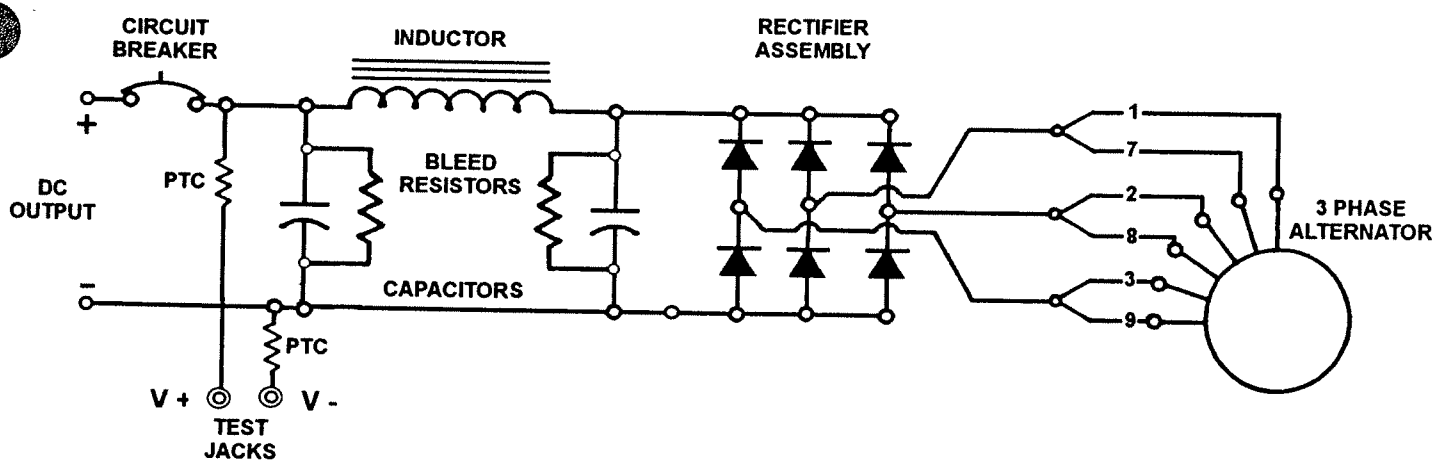
Bus bars are used to interconnect the diode assemblies to form a 3 phase bridge.

The common Anode bar provides the Negative to an Isolator terminal and the common Cathode bar provides the Positive DC supply to the Load Circuit Breaker.

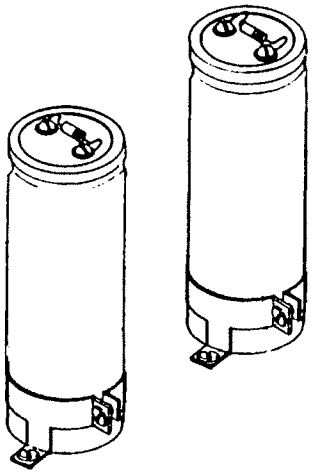
Thermal pads are placed between the assemblies and the heat sink to aid in the heat transfer.

The assemblies are electrically isolated from the heat sink.





The **Capacitors** will store the DC potential applied across their terminals until a path for discharge is provided. When the generator is not operating and the circuit breaker is opened, resistors connected across the terminals will bleed off the stored energy discharging the capacitors.



CAUTION; The capacitors are electrically hot whenever the circuit breaker is in the "on" position or the generator set is operating. Insure the capacitors are completely discharged prior to servicing to prevent an electrical shock.

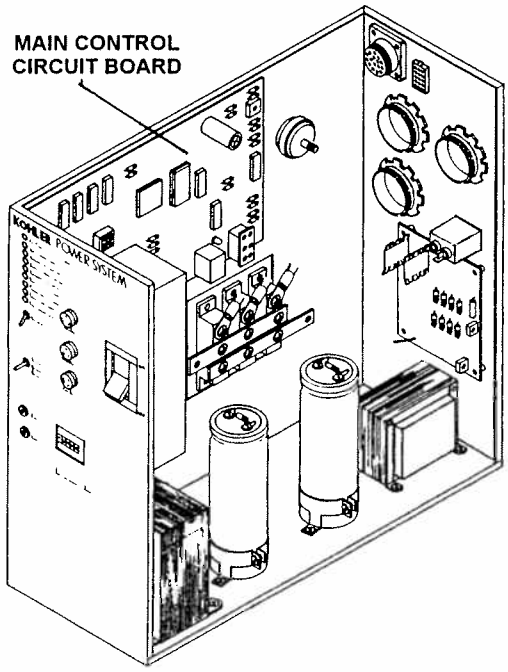
The DC Voltage on the Rectifier side of the breaker can be measured at the **Test** jacks on the front of the control cabinet.
The terminals are current limited by the PTC posistors.

CONTROL BOARD

The Main Control board mounted on the interior side panel contains the logic circuitry for remote and local monitoring and operation of the generator set.

A series of status LED's located at the board edge extend through the face of the cabinet and provide visual indication of various system conditions.

The LAMP TEST switch located beneath the indicators provides assurance power is available to the (9) Gen Status indicators.



STATUS INDICATORS.

- **LOW OIL PRESSURE**. Red LED lights if generator set shuts down due to insufficient oil pressure. Shut-down occurs 5 seconds after pressure falls below switch rating. Circuit is not active during the first 30 seconds after start-up. This is not a protection for low oil level.

- **HIGH ENGINE TEMP**. Red LED lights if engine has shut down because of high engine lubricant temperature or if cabinet fan is not turning when generator is running. Shut-down occurs 5 seconds after temperature reaches switch rating. Circuit is not active during the first 30 seconds after start-up.

- **OVERVOLTAGE**. Red LED lights if generator set shuts down because of generator overvoltage condition.

- **OVERSPEED**. Red LED lights if generator set shuts down due to excessive engine speed. Indication and shut down will also occur if speed sensing signal is lost.

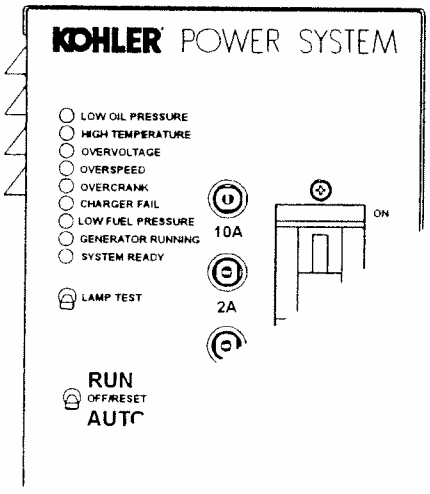
- **OVERCRANK**. Red LED will light and engine cranking will stop if engine does not start after 70 seconds of cyclic cranking (crank 20 seconds, rest 5 seconds, crank 20 seconds, etc., for a total of 70 seconds). Indicator will light and cranking will cease after 2 seconds if starter or engine does not turn (locked rotor).

- **CHARGER FAIL**. Red LED illuminates if 12v float battery charger malfunctions. (battery is below 11.5v or above 15.0v.)

- **LOW FUEL PRESSURE**. Red LED lights if gas supply pressure is low.

- **GENERATOR RUNNING**. Green LED will light when the generator set is running.

- **SYSTEM READY**. Green LED will light when Gen. master switch is in AUTO position and no faults are detected.



LOCAL START/STOP

The generator set can be started locally by placing the MASTER SWITCH in the "RUN" position. The unit will shut-down when the switch is moved to the center "OFF/RESET" position.

AUTO START/STOP

When the MASTER SWITCH is placed in the "AUTO" position the SYSTEM READY status indicator will be lit and the generator set can be started and stopped by a remote signal.

TDES

Engine cranking will be delayed by a factory set time of 4 minutes after a remote "AC power fail" start command. This time delay on engine start (TDES) can be field adjusted for 2, 4, 8 and 16 minutes by the SW3 dip switch located on the Main Control Board.

TIME DELAY ENGINE COOLDOWN

Upon receiving a remote stop signal the unit will run for a cooldown period of five minutes and then shut down returning to the SYSTEM READY state.

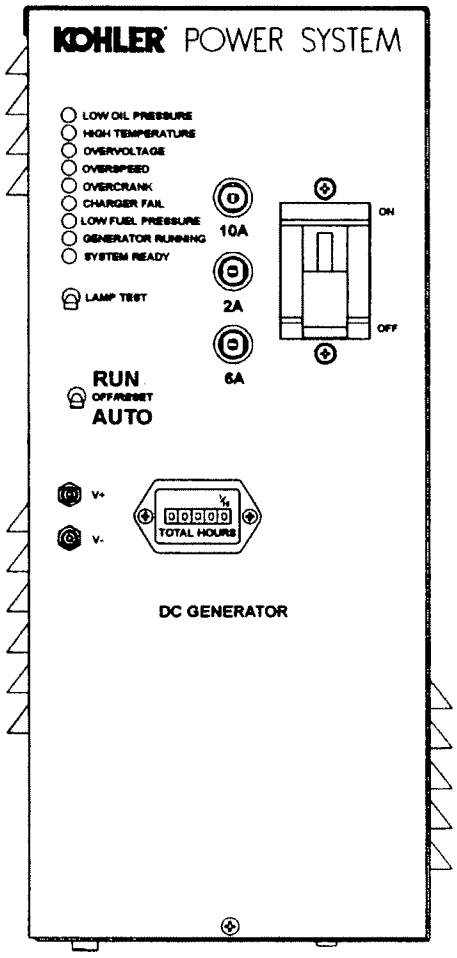
RESET

If the generator set shuts down due to a fault, it can not be restarted until the fault has been corrected and the system reset by moving the Master Switch to the center OFF/RESET position.

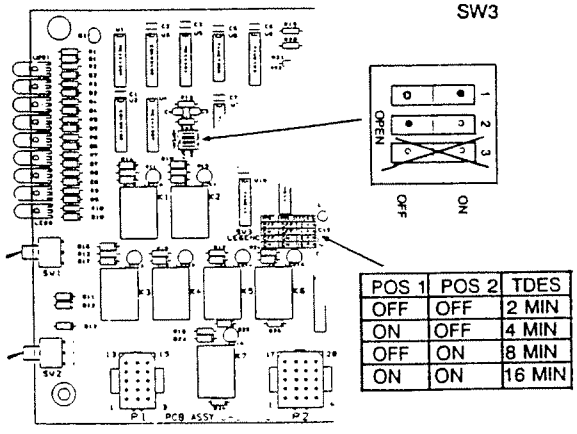
VOLTAGE SENSING

The System Battery voltage is constantly monitored and engine speed automatically regulated to maintain the level predetermined by the factory voltage sensing adjustment.

DO NOT CHANGE THE SETTING.



TDES Selector Switch

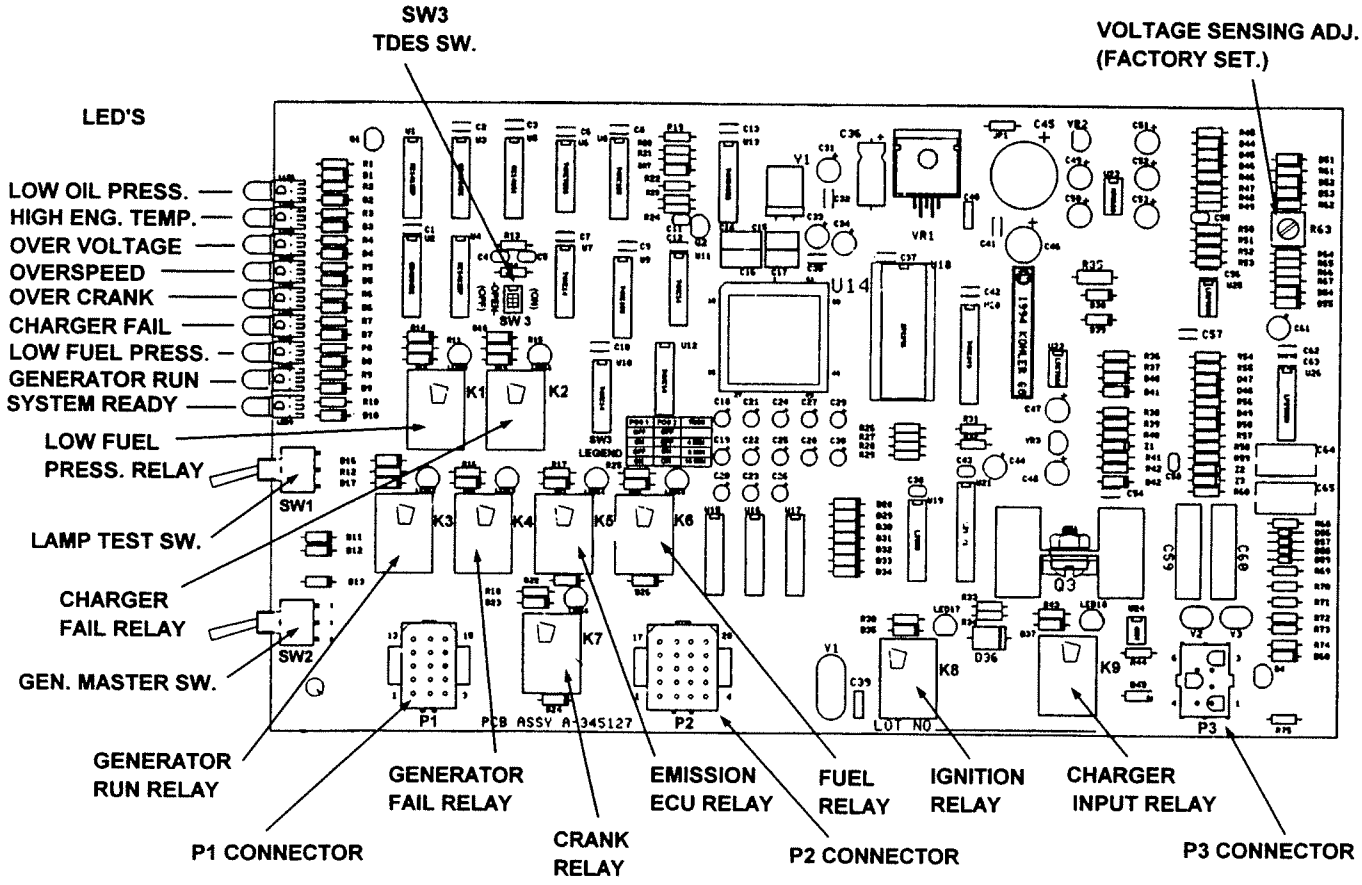


POS 1	POS 2	TDES
OFF	OFF	2 MIN
ON	OFF	4 MIN
OFF	ON	8 MIN
ON	ON	16 MIN

Note: Pos. 3 toggle is non-functional.

CONTROL BOARD

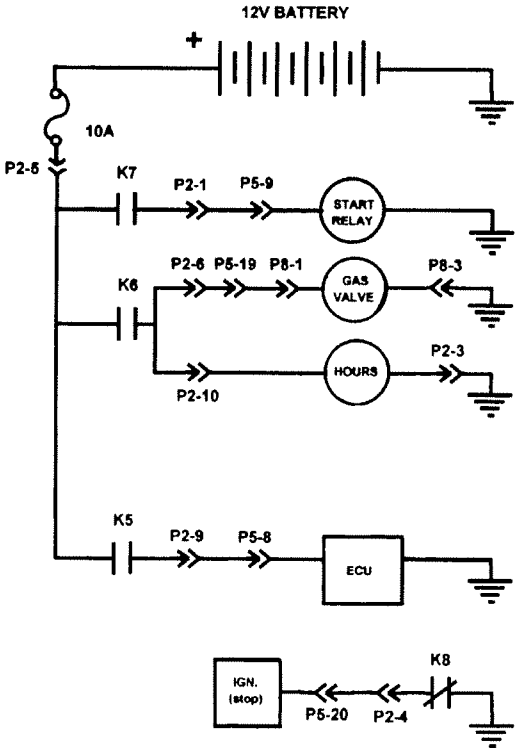
The MAIN CONTROL circuit board is mounted to the side panel of the cabinet.



Nine sealed relays permanently mounted to the board provide power to the engine starting, fuel, ignition, speed and status indicator control circuits.

LED's located at the upper right of each relay indicate when power is available to the relay coil. The LED's provide a visual diagnostic aid for the service technician.

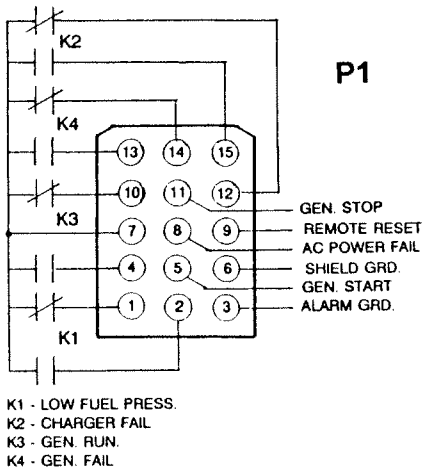
K1 - LOW FUEL PRESSURE
K2 - CHARGER FAIL
K3 - GENERATOR RUN
K4 - GENERATOR FAIL
K5 - EMISSION ECU
K6 - FUEL, - FAN CONTROL
K7 - CRANK
K8 - IGNITION
K9 - BATTERY CHARGER



Three harness connectors, P1, P2, and P3 located at the bottom of the board provide interconnection of input and output power signals between the board and system.

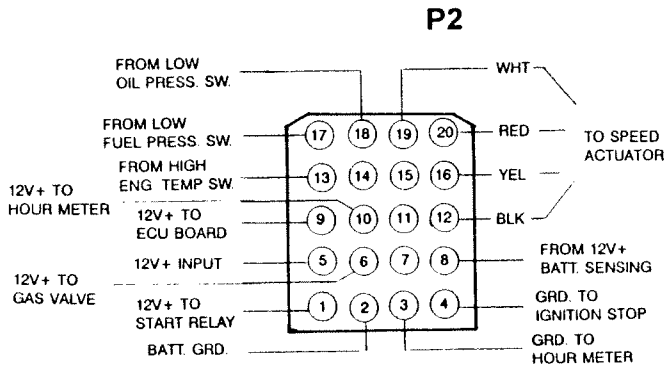
P1 CONNECTOR

The P1 connector provides the interfacing between the generator set controls and the remote system.
Relay contacts provide signal outputs including low fuel pressure, 12volt battery charger failure, generator running and generator fail.
Remote signal inputs for starting and stopping are also routed through the P1 connector



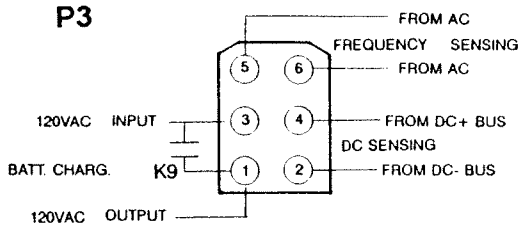
P2 CONNECTOR

The P2 connector interfaces the engine start-run and stop signals and components to the main control board.



P3 CONNECTOR

The P3 connector provides the connection of the AC Alternator and DC Bus voltage sensing and 12v. Battery charging input connections.



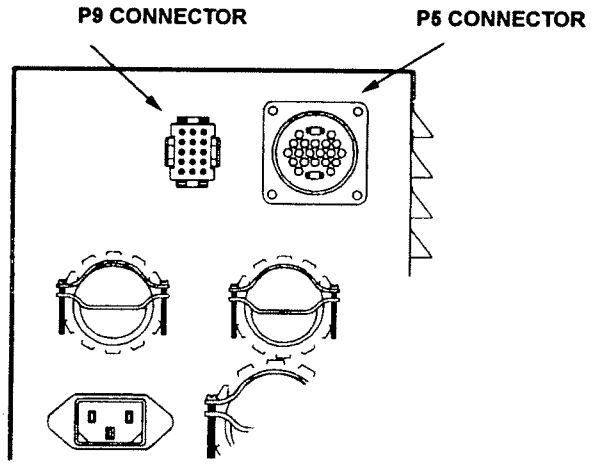
REMOTE CONTROL & ANNUNCIATION

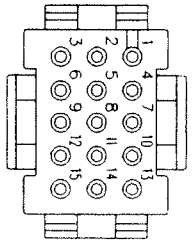
The two external cabinet wiring harnesses and plug connectors, **P5** and **P9** provide interconnection between the Engine/Generator, Control Cabinet and a Modem.

The **P9** harness connector allows interfacing for remote operation and monitoring of the generator set.

Dry contacts of main board relays K1, K2, K3 and K4 are accessed via the P9 connector to provide remote annunciation of: **Low Fuel Pressure, 12v Charger Fail, Generator Running and Generator Fail.**

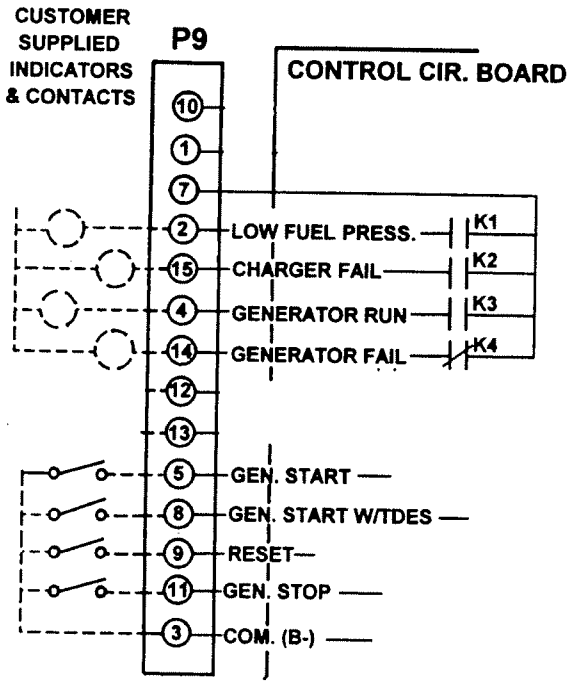
The P9 connector also provides the input terminals for various Remote Starting and Stopping commands:
- **GENERATOR START.** (no delay)
- **GENERATOR START.** (delay)
- **GENERATOR STOP.**
- **RESET.**





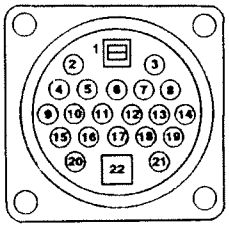
P9 Pin connections:

- 1
- 2 - Low Fuel Pressure - K1 relay n.o.
- 3 - Control Common
- 4 - Generator Run - K3 relay n.o.
- 5 - Generator Start - (no time delay)
- 6 - Shield B -
- 7 - K1, K2, K3, K4 relay com.
- 8 - Start on AC Power Fail (with TDES)
- 9 - Remote Reset (hold for 2 sec.)
- 10 -
- 11 - Stop (Hold for 2 Sec.)
- 12 -
- 13 -
- 14 - - K4 relay n.c.
- 15 - Charger Fail - K2 relay n.o.



The **P5** harness connector interconnects the Engine/Generator to the control circuit board.

P5-1 - Battery 12v +
2 - Low Oil Pressure switch n.c.
3 - HI Engine Temp. Switch n.o.
4 - Speed Control (WHT)
5 - Speed Control (RED)
6 - - -
7 - - -
8 - ECU Fuel Control
9 - Start relay 12v +
10 - - -
11 - Battery Charger 12v +
12 - Battery Charger 12v -
13 - - -
14 - Battery Sensing 12v +
15 - Speed Control (BLK)
16 - Speed Control (YEL)
17 - - -
18 - Battery 12v -(grd.)
19 - Gas Valve 12v +
20 - Ignition (Stop) Batt. -
21 - Low Fuel Pressure Switch n.o.
22 - - -



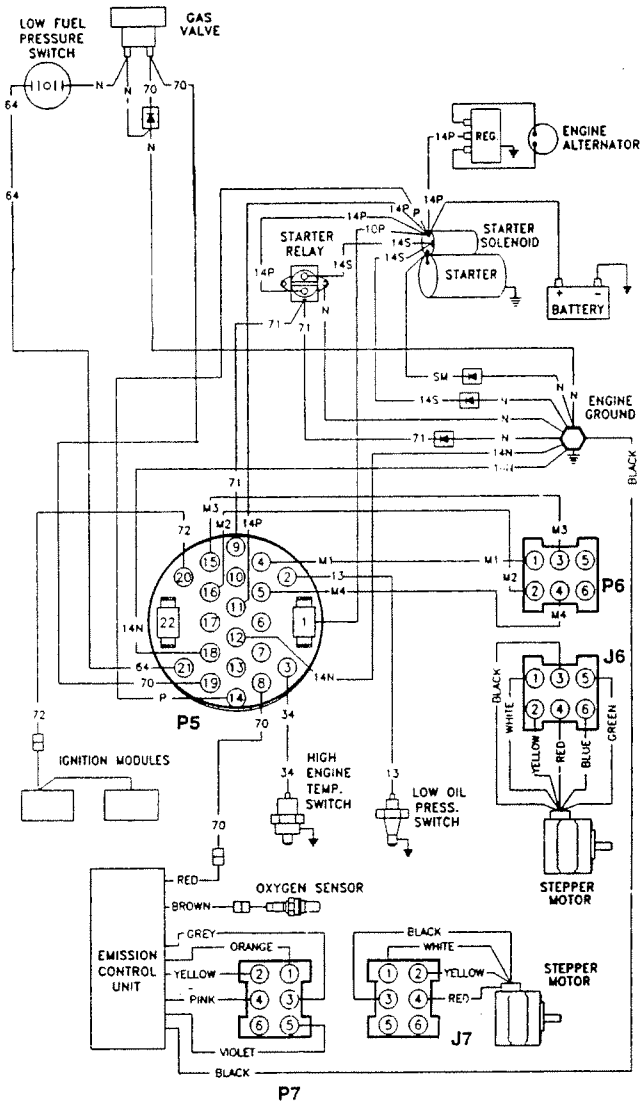
P5

Smaller plug and in-line connectors located in the engine harness are used to interconnect various engine components, and interface them to the main control board via the **P5** harness/connector assembly.

P6/J6- ENGINE SPEED ACTUATOR

P7/J7- EMISSION CONTROL SYSTEM.

For proper generator set system operation it is essential that a good component and unit battery ground (-) be maintained.



12v BATTERY CHARGING

A 2 amp float charger is located in the Control/Power Conditioner cabinet. It consists of a circuit board and power transformer.

The function of this charger is to insure the engine start battery is in a fully charged condition when an engine start signal is given.

The charger will operate in a constant-voltage float mode (13.2v) until the current required to maintain the battery at the float voltage setting exceeds 2 amps. The charger will then switch to the constant-current mode until the battery voltage again raises to the preset float level.

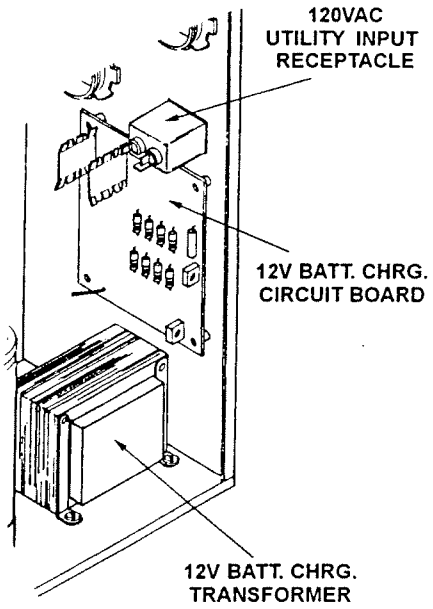
Charging current is automatically limited to a maximum of 2 amps regardless of load and is reverse polarity protected.

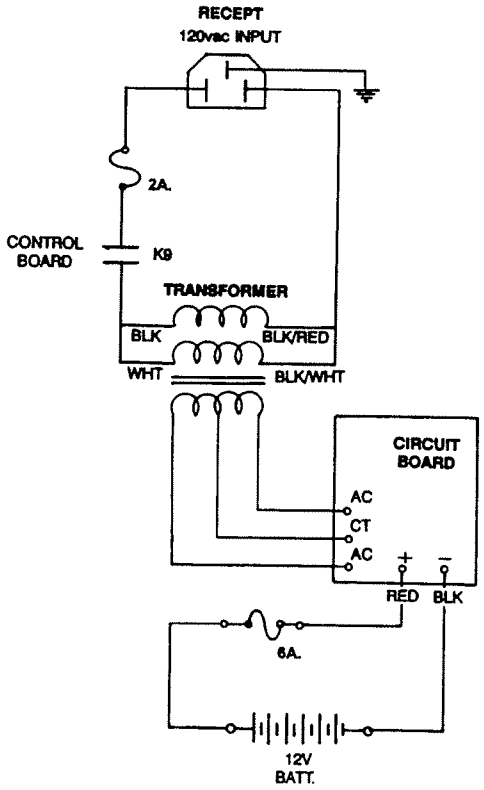
The control circuitry is temperature compensated to automatically adjust the float voltage setting to prevent the battery from being overcharged at high ambient temperatures and undercharged at low ambient temperatures.

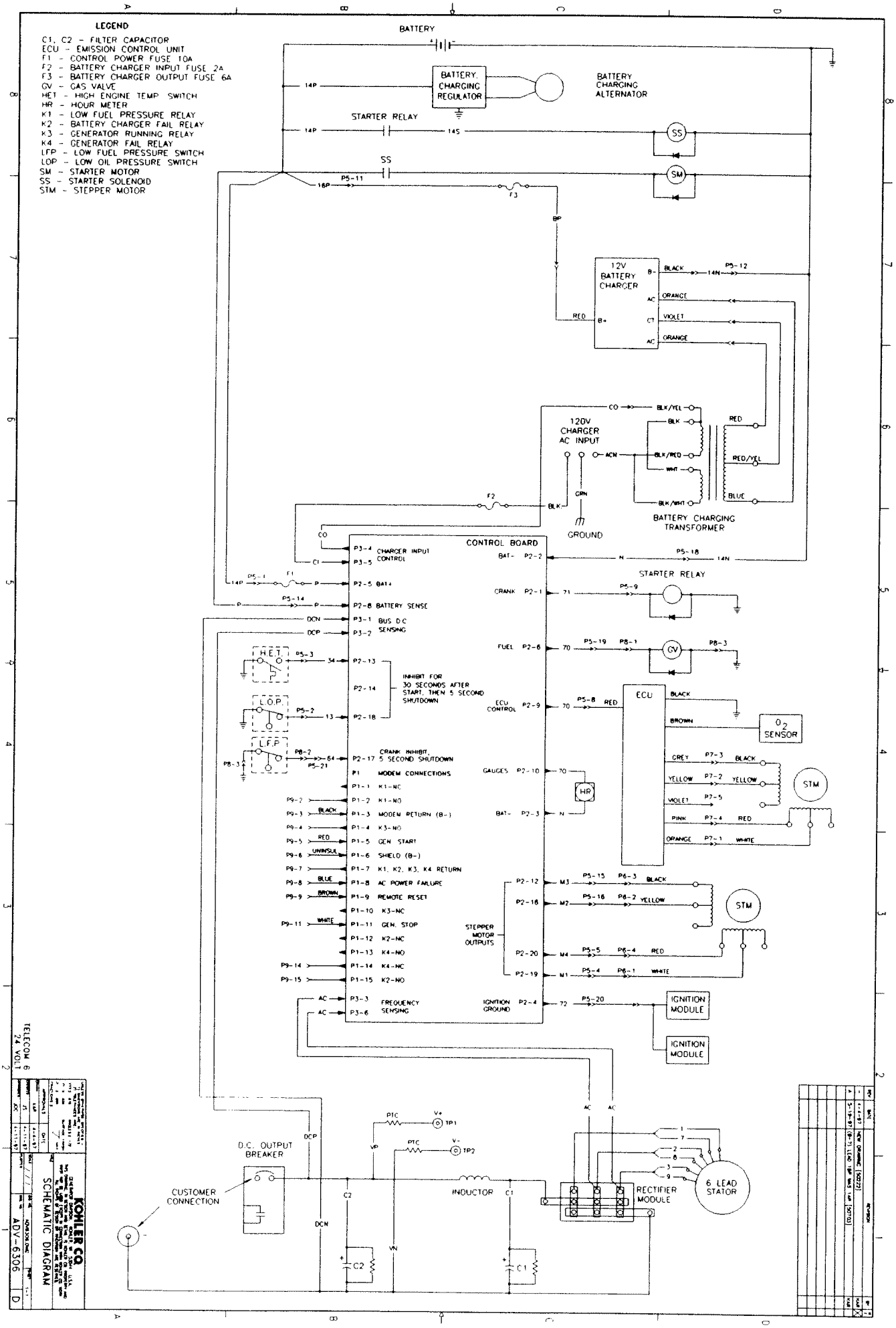
120vac power is provided to the charger from the three prong receptacle on the rear of the cabinet.

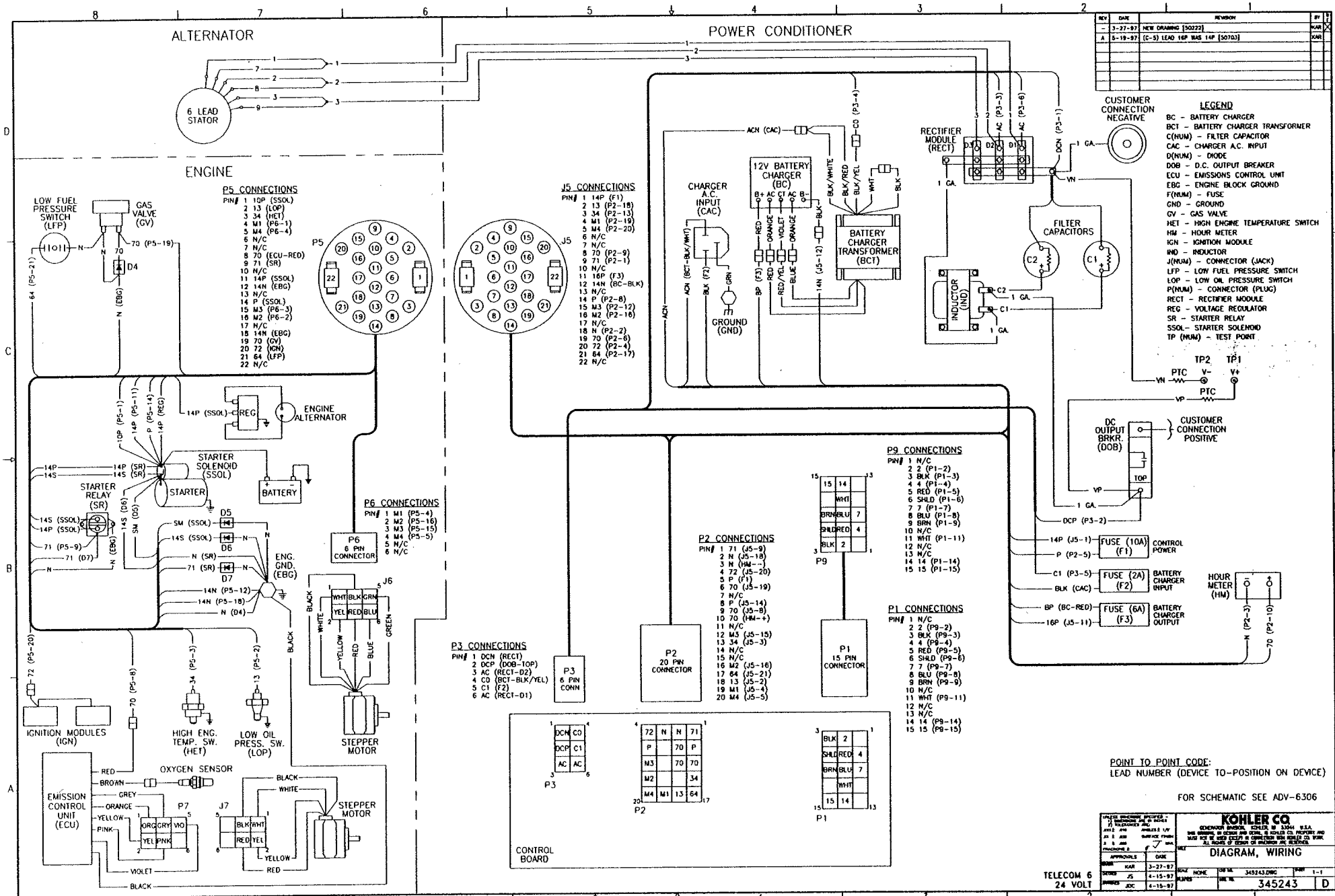
The AC circuit is protected by the 2 amp F2 panel fuse and supplied to the charger transformer primary via the K9 relay contacts located on the main control board.

If the charger DC output is shorted for an extended period of time or a defect occurs in the current limiting circuit the power transformer will be protected by the F3 panel fuse.

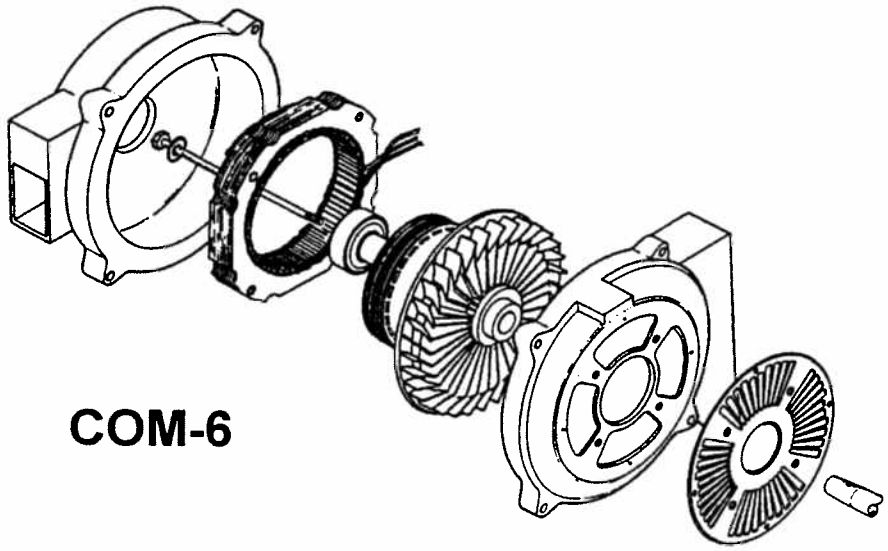





LEGEND
C1, C2 - FILTER CAPACITOR
ECU - EMISSION CONTROL UNIT
F1 - CONTROL POWER FUSE 10A
F2 - BATTERY CHARGER INPUT FUSE 2A
F3 - BATTERY CHARGER OUTPUT FUSE 6A
GV - GAS VALVE
HET - HIGH ENGINE TEMP SWITCH
HR - HOUR METER
K1 - LOW FUEL PRESSURE RELAY
K2 - BATTERY CHARGER FAIL RELAY
K3 - GENERATOR RUNNING RELAY
K4 - GENERATOR FAIL RELAY
LFP - LOW FUEL PRESSURE SWITCH
LOP - LOW OIL PRESSURE SWITCH
SM - STARTER MOTOR
SS - STARTER SOLENOID
STM - STEPPER MOTOR
BATTERY
BATTERY CHARGING REGULATOR
BATTERY CHARGING ALTERNATOR
STARTER RELAY
SS
SM
12V BATTERY CHARGER
120V CHARGER AC INPUT
BATTERY CHARGING TRANSFORMER
GROUND
CONTROL BOARD
CHARGER INPUT CONTROL
BUS DC SENSING
BATTERY SENSE
INHIBIT FOR 30 SECONDS AFTER START, THEN 5 SECOND SHUTDOWN
CRANK INHIBIT, 5 SECOND SHUTDOWN
MODEM CONNECTIONS
STEPPER MOTOR OUTPUTS
FREQUENCY SENSING
ECU
O2 SENSOR
HR
STM
IGNITION MODULE
IGNITION MODULE
TELECOM 8
24 VOLT
D.C. OUTPUT BREAKER
CUSTOMER CONNECTION
INDUCTOR
RECTIFIER MODULE
6 LEAD STATOR
KOHLER CO.
SCHEMATIC DIAGRAM
ADV-6306
D


ALTERNATOR
6 LEAD STATOR
POWER CONDITIONER
ENGINE
LOW FUEL PRESSURE SWITCH (LFP)
GAS VALVE (GV)
D4
P5 CONNECTIONS
PIN# 1 10P (SSOL)
2 13 (LOP)
3 34 (HET)
4 M1 (P6-1)
5 M4 (P6-4)
6 N/C
7 N/C
8 70 (ECU-RED)
9 71 (SR)
10 N/C
11 14P (SSOL)
12 14N (EBG)
13 N/C
14 P (SSOL)
15 M3 (P6-3)
16 M2 (P6-2)
17 N/C
18 14N (EBG)
19 70 (GV)
20 72 (IGN)
21 64 (LFP)
22 N/C
J5 CONNECTIONS
PIN# 1 14P (F1)
2 13 (P2-18)
3 34 (P2-13)
4 M1 (P2-19)
5 M4 (P2-20)
6 N/C
7 N/C
8 70 (P2-9)
9 71 (P2-1)
10 N/C
11 16P (F3)
12 14N (BC-BLK)
13 N/C
14 P (P2-8)
15 M3 (P2-12)
16 M2 (P2-16)
17 N/C
18 N (P2-2)
19 70 (P2-6)
20 72 (P2-4)
21 64 (P2-17)
22 N/C
ENGINE ALTERNATOR
REG
STARTER SOLENOID (SSOL)
STARTER
STARTER RELAY (SR)
BATTERY
D5
D6
D7
ENG. GND. (EBG)
P6 CONNECTIONS
PIN# 1 M1 (P5-4)
2 M2 (P5-16)
3 M3 (P5-15)
4 M4 (P5-5)
5 N/C
6 N/C
P6 6 PIN CONNECTOR
J6
STEPPER MOTOR
IGNITION MODULES (IGN)
HIGH ENG. TEMP. SW. (HET)
LOW OIL PRESS. SW. (LOP)
OXYGEN SENSOR
EMISSION CONTROL UNIT (ECU)
P7
J7
STEPPER MOTOR
CHARGER A.C. INPUT (CAC)
12V BATTERY CHARGER (BC)
BATTERY CHARGER TRANSFORMER (BCT)
GROUND (GND)
RECTIFIER MODULE (RECT)
CUSTOMER CONNECTION NEGATIVE
FILTER CAPACITORS
C2
C1
INDUCTOR (IND)
DC OUTPUT BRKR. (DOB)
CUSTOMER CONNECTION POSITIVE
TP2
TP1
PTC
P9 CONNECTIONS
PIN# 1 N/C
2 2 (P1-2)
3 BLK (P1-3)
4 4 (P1-4)
5 RED (P1-5)
6 SHLD (P1-6)
7 7 (P1-7)
8 BLU (P1-8)
9 BRN (P1-9)
10 N/C
11 WHT (P1-11)
12 N/C
13 N/C
14 14 (P1-14)
15 15 (P1-15)
P9
P2 CONNECTIONS
PIN# 1 71 (J5-9)
2 N (J5-18)
3 N (HM--)
4 72 (J5-20)
5 P (F1)
6 70 (J5-19)
7 N/C
8 P (J5-14)
9 70 (J5-8)
10 70 (HM-+)
11 N/C
12 M3 (J5-15)
13 34 (J5-3)
14 N/C
15 N/C
16 M2 (J5-16)
17 64 (J5-21)
18 13 (J5-2)
19 M1 (J5-4)
20 M4 (J5-5)
P2 20 PIN CONNECTOR
P1 CONNECTIONS
PIN# 1 N/C
2 2 (P9-2)
3 BLK (P9-3)
4 4 (P9-4)
5 RED (P9-5)
6 SHLD (P9-6)
7 7 (P9-7)
8 BLU (P9-8)
9 BRN (P9-9)
10 N/C
11 WHT (P9-11)
12 N/C
13 N/C
14 14 (P9-14)
15 15 (P9-15)
P1 15 PIN CONNECTOR
P3 CONNECTIONS
PIN# 1 DCN (RECT)
2 DCP (DOB-TOP)
3 AC (RECT-D2)
4 CO (BCT-BLK/YEL)
5 C1 (F2)
6 AC (RECT-D1)
P3 6 PIN CONN
CONTROL BOARD
FUSE (10A) (F1) CONTROL POWER
FUSE (2A) (F2) BATTERY CHARGER INPUT
FUSE (6A) (F3) BATTERY CHARGER OUTPUT
HOUR METER (HM)
LEGEND
BC - BATTERY CHARGER
BCT - BATTERY CHARGER TRANSFORMER
C(NUM) - FILTER CAPACITOR
CAC - CHARGER A.C. INPUT
D(NUM) - DIODE
DOB - D.C. OUTPUT BREAKER
ECU - EMISSIONS CONTROL UNIT
EBG - ENGINE BLOCK GROUND
F(NUM) - FUSE
GND - GROUND
GV - GAS VALVE
HET - HIGH ENGINE TEMPERATURE SWITCH
HM - HOUR METER
IGN - IGNITION MODULE
IND - INDUCTOR
J(NUM) - CONNECTOR (JACK)
LFP - LOW FUEL PRESSURE SWITCH
LOP - LOW OIL PRESSURE SWITCH
P(NUM) - CONNECTOR (PLUG)
RECT - RECTIFIER MODULE
REG - VOLTAGE REGULATOR
SR - STARTER RELAY
SSOL- STARTER SOLENOID
TP (NUM) - TEST POINT
POINT TO POINT CODE:
LEAD NUMBER (DEVICE TO-POSITION ON DEVICE)
FOR SCHEMATIC SEE ADV-6306
TELECOM 6
24 VOLT
KOHLER CO.
DIAGRAM, WIRING
345243
D

ALTERNATOR BASICS



COM-6

The two major components in an Alternator are the Rotor and Stator.

To produce an electrical output from a generator or alternator three things are necessary:
1. **Conductors** (copper windings) connected in a completed circuit.
2. A Magnetic **Field.**
3. **Motion** between them.

The Rotor provides the magnetic "field" and the Stator contains the stationary copper windings. The engine provides the controlled speed or motion between the two.

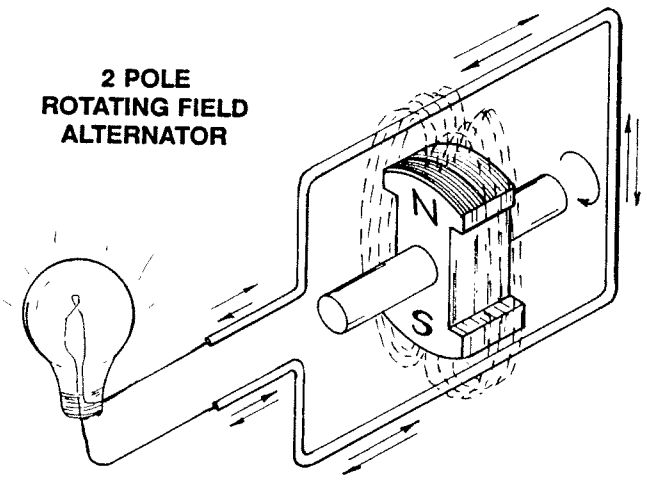
An alternating current will flow in the stator windings when the alternating field flux from the north and south poles pass through the stator windings.

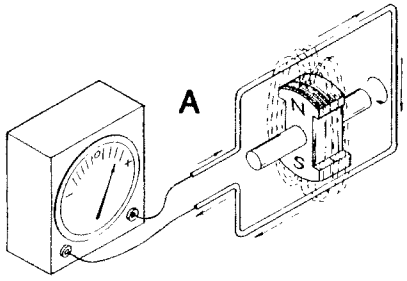
The magnetic flux is referred to as the excitation circuit or "field."

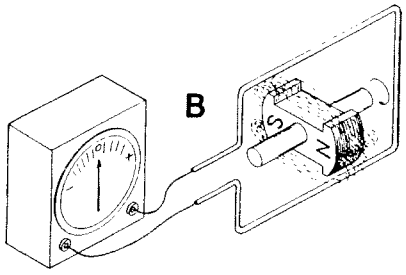
The direction of current flow in the conductors is determined by the polarity of the magnetic flux as it passes through the conductor.

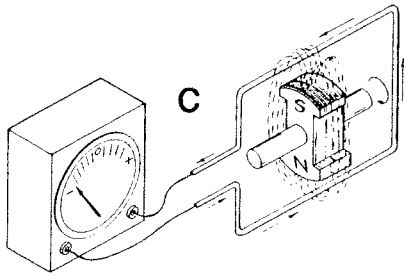
When the conductor is not being excited by the field flux no current will flow.

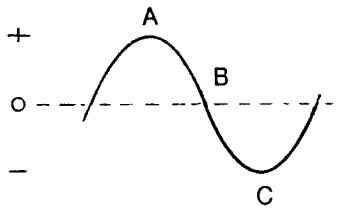
The current flow will reverse its direction as the magnetic north and south poles alternately pass the conductors. The result is an alternating or AC current.





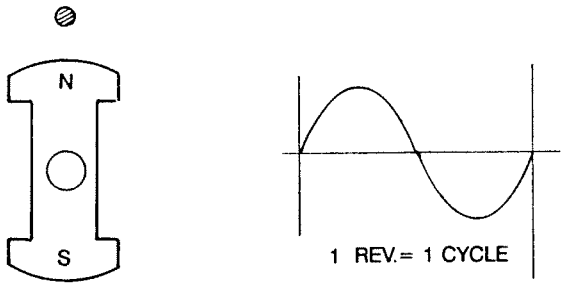






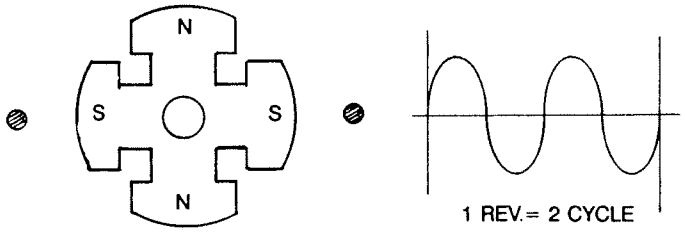
ALTERNATOR BASICS

One complete revolution of the 2 pole alternator will produce 1 cycle of alternating current.



If a second set of poles and conductors are added, (4 pole alternator) 2 cycles can be produced with every rotor revolution.

Speed and the number of magnetic poles determines the frequency output of an alternator.



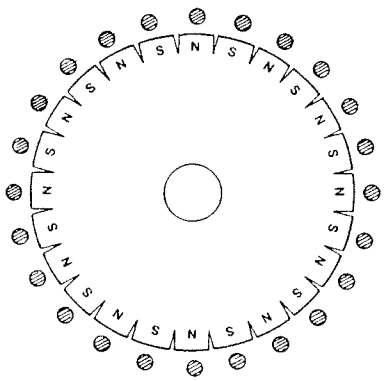
To produce 60 Hertz (60 cycles per second), the 2 pole alternator would have to rotate at 3600 RPM, where as the 4 pole would produce 60 hertz at 1800 RPM.

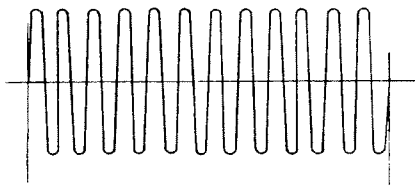
The COM-6 Alternator contains 24 magnetic poles in its rotor. (12 north & 12 South) This results in 12 cycles per revolution.

At an engine speed of 3600 RPM the 24 pole alternator will provide a frequency output of 720 Hertz.

This higher frequency provides a more efficient power for conversion or rectification to DC.

24 POLE ALTERNATOR

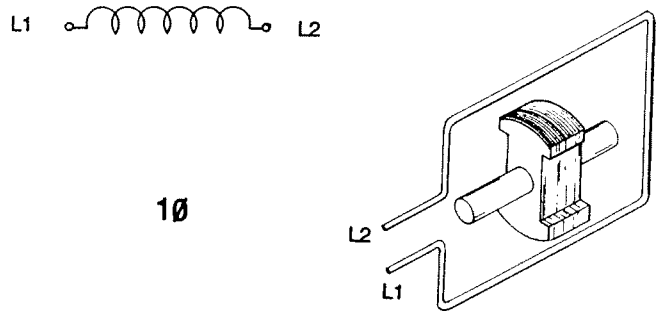




1 REV.= 12 CYCLES

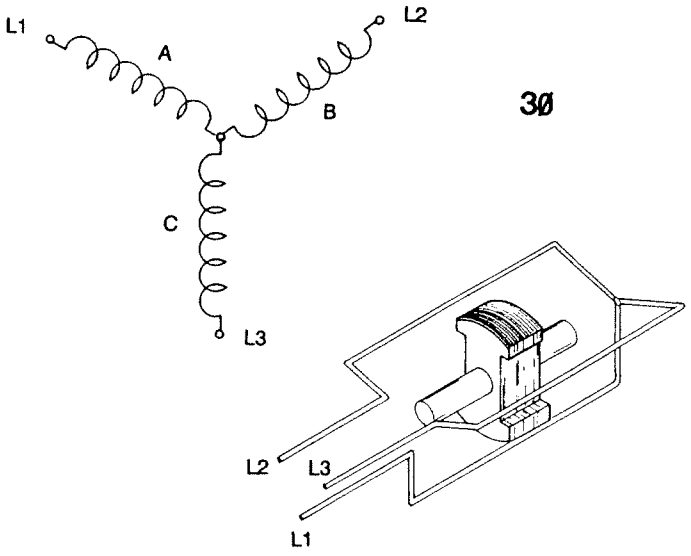
SINGLE PHASE

The basic alternator discussed to this point produces a single phase (1Ø) voltage from the two stator leads labeled L1 and L2.



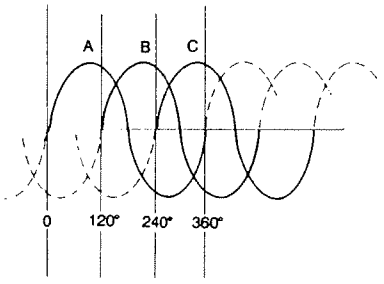
THREE PHASE

To further increase the power efficiency alternators can be wound in a 3 phase (3Ø), "Y" configuration.



The Three individual windings are located in the stator so they overlap and produce 3 separate voltages 120 electrical degrees apart. (A, B, C,)

One end of each phase is internally connected together and the L1, L2, and L3 coil ends provide an equal voltage between them.



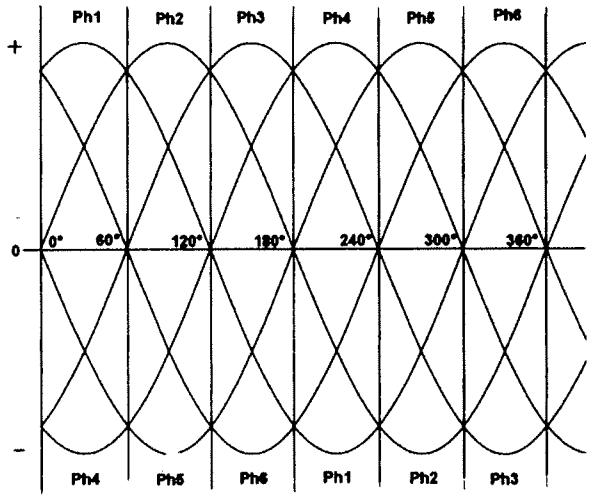
This 3 phase supply provides less ripple for a more efficient rectification to DC than obtainable from a single phase machine.

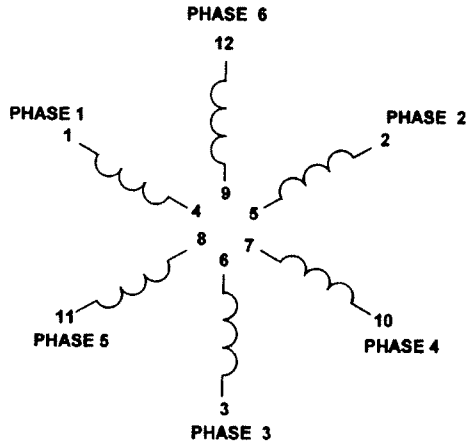
SIX PHASE

A Six Phase Alternator will produce six individual voltages which are 60 electrical degrees apart.

The 4th phase will be 180 degrees out of phase with the 1st, likewise the 5th with the 2nd and the 6th with the 3rd.

The phases which are 180 degrees apart will however be at maximum potential at the same time but of the opposite polarity.



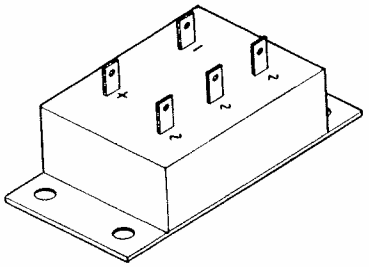


VOLTAGE REGULATION

The potential output of an alternator excited by a permanent magnet will decrease as load on the stator windings increase or speed is decreased. Conversely, potential output will increase when load is decreased or speed is increased.

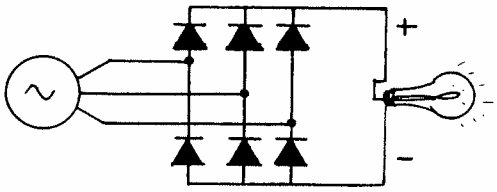
The alternator output of a permanent magnet excited alternator can therefore be controlled or regulated by governing the engine speed.

To rectify a 3 phase AC power supply a block of 6 diodes is used and connected as illustrated.

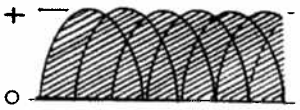


3Ø BRIDGE RECTIFIER

As with the single phase full wave bridge the three phase bridge allows full utilization of the alternating cycle.

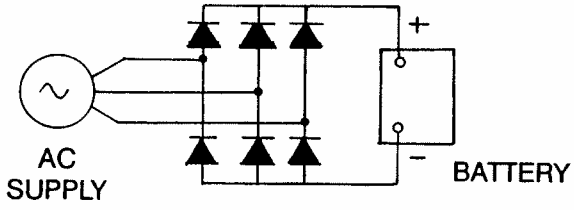


This scheme will provide full rectification of all three phases resulting in a very efficient DC output supply with even less "ripple" than the single phase full wave bridge.



When the bridge is used in a battery charging circuit the diodes act as a check valve or reverse current relay.

They allow current to flow to the battery when required yet prevent the battery from discharging back to the AC supply.



Utilizing 6 diodes with a 6 phase alternator will provide the same DC ripple as a 3 phase full wave rectified scheme.