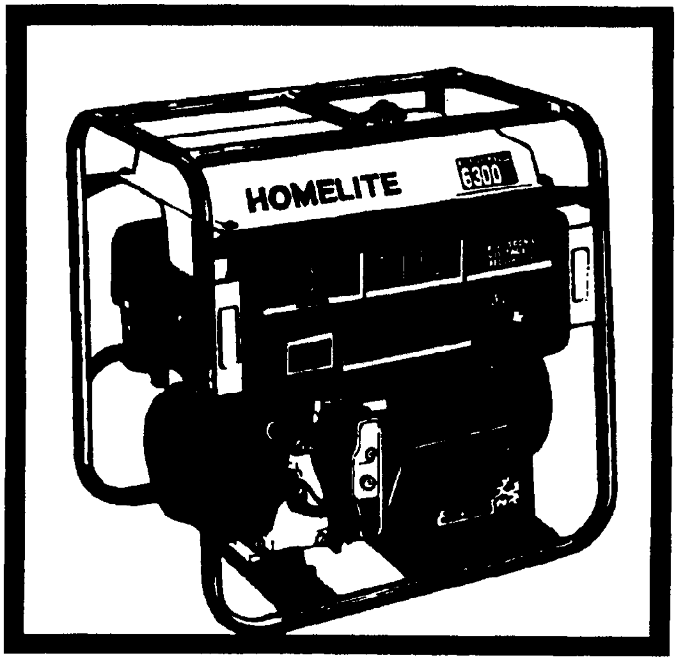
Homelite®



Generator Basics

THE IMPACT OF ELECTRICITY

In the history of man, there have been few forces which have produced so great an effect in so brief a period as has electricity. Since 1881, when the Brush Electric Light Company in Philadelphia initiated the first Central Station Service in the U.S., electricity has become the single most essential force in our economy. Without electrical power, our cities would be paralyzed.

Our near-total dependence on electrical power to operate appliances, tools and equipment for both home and on the job, has led to the development of stand-by generators to provide electricity when regular line power has failed or is not available.

Charles H. Ferguson designed a small, lightweight gasoline engine-driven generator in 1921 to light homes in rural areas where electrical power was not available. His company, the Home Electrical Lighting Company, was renamed Homelite in 1924. By 1941, the company was manufacturing eight different products, including generators, pumps and blowers. In 1946, Homelite entered the chain saw market with an electric driven chain saw powered by their latest development, a new Hi-Cycle Generator!

CONTENTS

BASIC ELECTRICITY

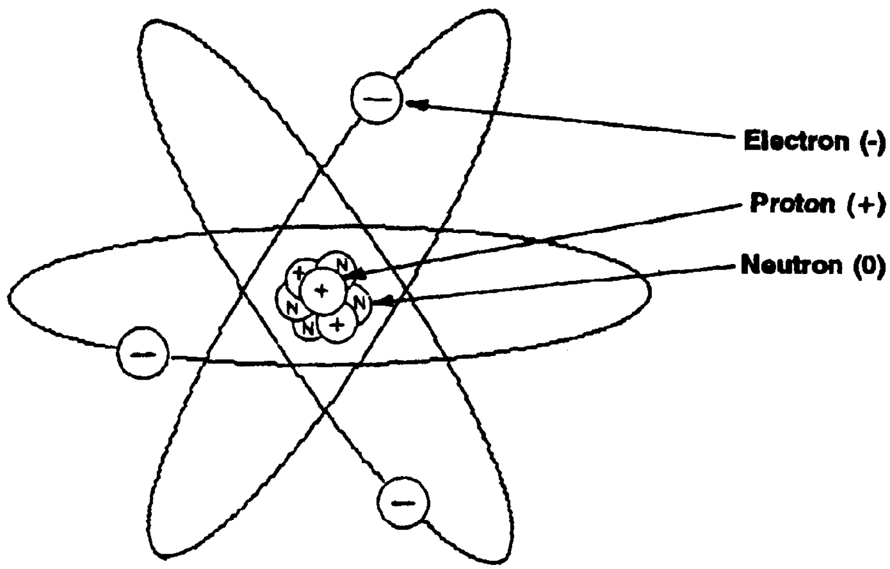
Electricity is a basic "ingredient" of **ALL** matter. To more easily understand the nature of electricity, we must first (briefly) examine the Basic Building Blocks of Matter itself.

Normally, an Atom has equal numbers of electrons and protons. Therefore it's net charge is neutral. **ATOMS WANT TO BE NEUTRAL!**

It is possible to "dislodge" one or more electrons from most atoms. When this occurs, the atom is left with a positive (+) net charge and is referred to as a **POSITIVE ION**. If a stray electron combines with a neutral atom, the atom takes on a negative (-) net charge and is referred to as a **NEGATIVE ION**.

LITHIUM ATOM

3 Protons
3 Electrons
4 Neutrons



ATOMS DON'T LIKE BEING IONS !!

A Negative ion seeks to rid itself of it's extra electron. A Positive ion seeks to re-gain it's missing electron. Ah yes, a marriage made in Heaven!

Under the right conditions, an Electron can be transferred from the Negative ion to the Positive ion, resulting in two happy (and neutral) atoms.

THIS IS THE BASIC PHYSICS BEHIND ELECTRICITY !

Rather simple, isn't it?

In short:

Electricity is the flow of Electrons from a point relatively rich in electrons to a point relatively low in electrons. (Usually)

ELECTRICAL VOLTAGE (V)

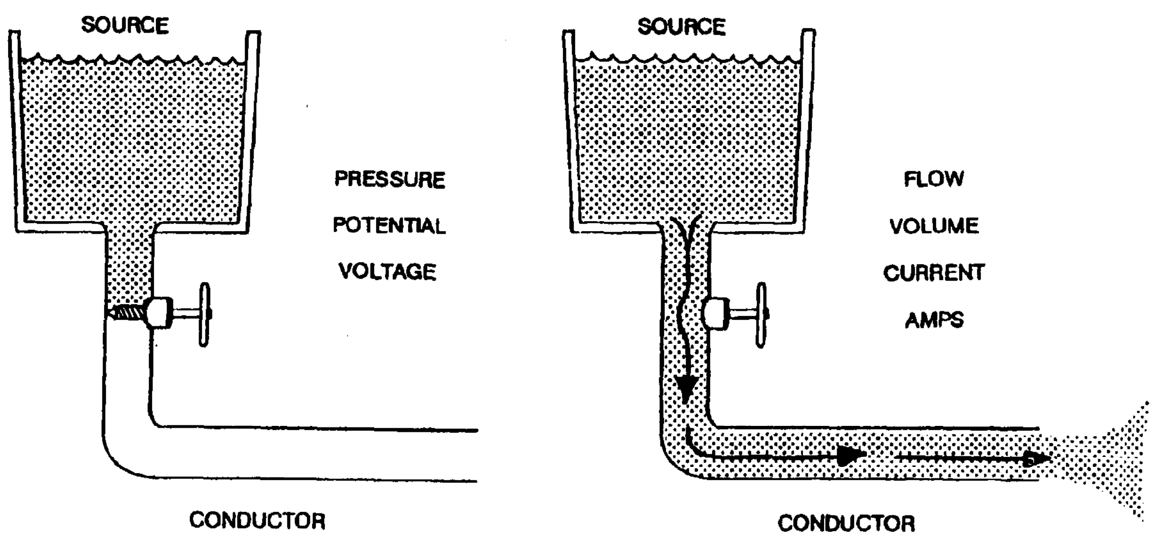
Voltage is electrical pressure or force. Voltage basically refers to the Potential for current to flow from one point to another - for that reason, voltage is sometimes called **ELECTRICAL POTENTIAL**.

Electrical current tends to flow from points of high **POTENTIAL** to points of lower **POTENTIAL**, i.e. from an area with a surplus of Electrons to an area low in Electrons: - to +.

Unfortunately, many years ago, before anyone knew what an Electron was, the direction of current flow was chosen by convention to be from + to -. (They thought the Positive Ions traveled to combine with the Electrons.) Although confusing, we are stuck with the "Backwards" standard.

Voltage is measured in units of Volts, which is abbreviated "V". Likewise, the symbol for voltage is "V". Sometimes, voltage is also referred to as Electro-Motive Force or **EMF** (symbol is "E").

The following "Water Analogy" may be helpful in understanding electrical terms:



ELECTRICAL CURRENT (I)

Electrons can easily travel through metals or conductive materials.

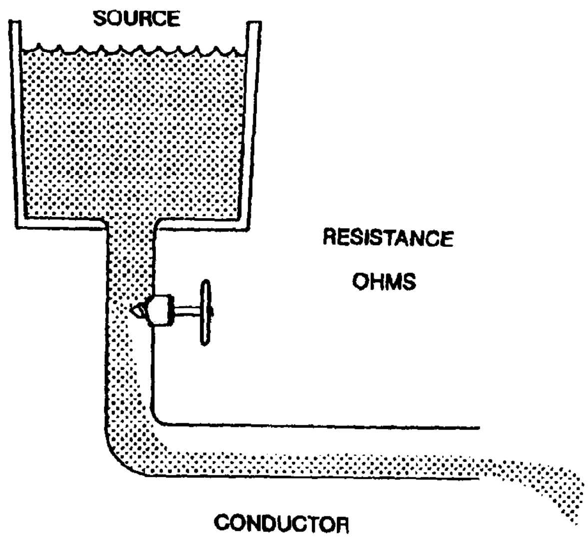
Naturally, electrons cannot easily travel through an insulator (like glass, plastic or rubber).

The quantity of Electrons flowing past a given point in a conductor is known as **CURRENT**. Electrical current is measured in units of: **AMPERES** (abbreviated **AMPS** or "**A**"). The symbol for electric current is "I".

Fascinating Fact: One Ampere is 6,250,000,000,000,000,000 electrons passing a point in one second!

RESISTANCE (R)

Conductors are not perfect. They resist, to some degree, the flow of current. The degree to which a conductor resists the flow of current is known as Resistance (abbreviated "R"). Resistance is measured in units known as OHMS. The symbol for the OHM is the greek letter Omega: Ω



OHM'S LAW

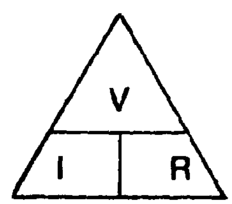
A potential of 1 volt will force a current of 1 AMP through a resistance of 1 OHM.

This relationship is called **OHM'S LAW** and is mathematically:

Volts = Amps X Ohms or

Amps = Volts / Ohms or

Ohms = Volts / Amps



POWER (W) OR (P)

The work performed by an electrical current is called **POWER**. The unit for power is the **WATT (W)**. The power of a direct current is its voltage times its current.

P = I x V

WATTS (POWER) = AMPS x VOLTS

The 178V152 is rated for 4600 W continuous POWER at 120 V. How many AMPS can it supply at full load?

P = I x V

4600 W = I x 120 V

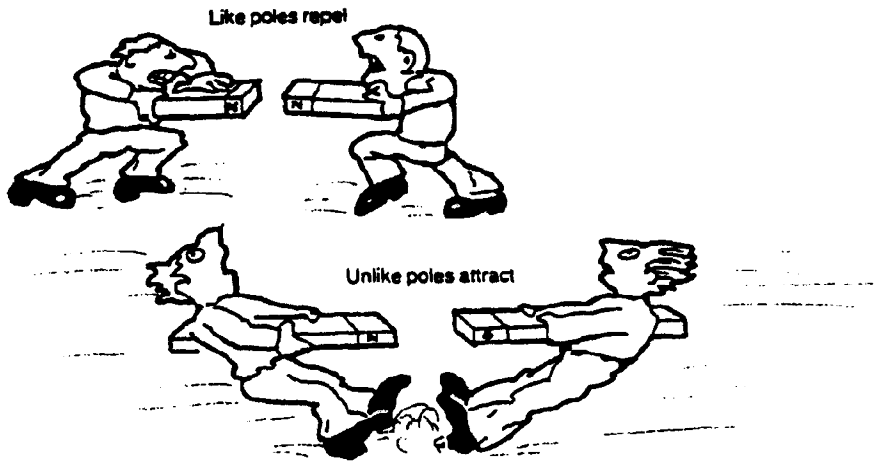
4600 W / 120 V = I

38.3 A = I

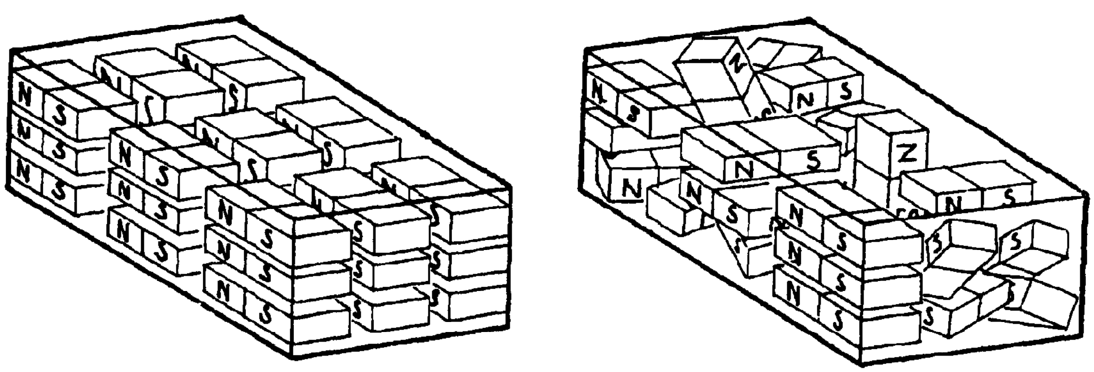
THE MAGNETIC CONNECTION

In the first section we learned some of the basic principles of electricity. We are now ready to to learn how generators "produce" electricity. We will begin with Magnetism.

A magnet is any material that attracts iron and steel. The attraction of magnets, greatest at the ends (or poles), occurs according to the following principle: like poles of magnets oppose each other, while unlike poles attract each other.



When the atoms in certain magnets are aligned with each other in a particular manner, magnetism results. The second bar illustrated has non-aligned atoms, therefore it has no magnetism.

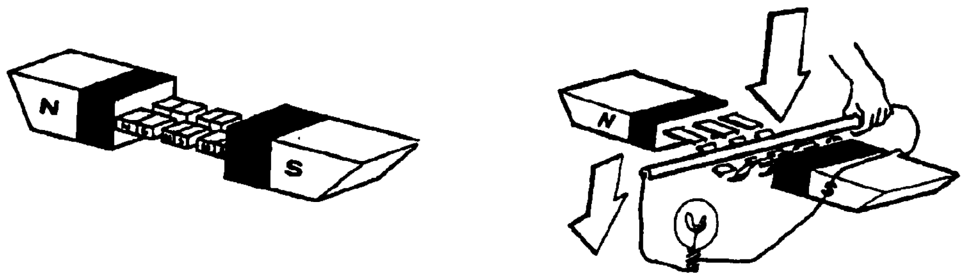


Magnetized Bar **Un-magnetized Bar**

ELECTROMAGNETIC INDUCTION

Around every magnet is a magnetic field. One can actually "see" the magnetic lines of force if a magnet is covered with a thin sheet of paper and soft-iron filings are sprinkled on the paper.

If a conductor cuts through the lines of force in a magnetic field, a voltage will be induced in the conductor. This is called **ELECTROMAGNETIC INDUCTION.**



Put Simply:

To generate voltage, we need:

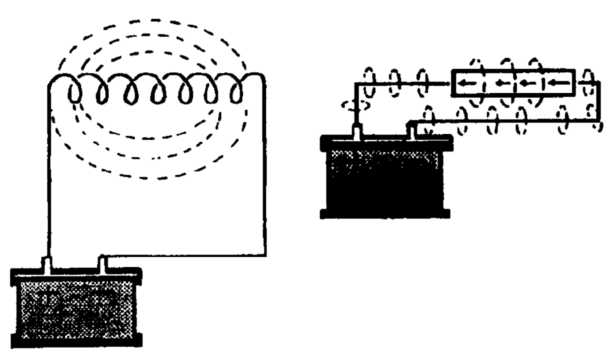
1. A conductor
2. A magnetic field
3. MOTION of the magnetic field OR conductor which causes the conductor to cross the magnetic line of force.

A current flowing through a wire creates a **MAGNETIC FIELD** around the wire.

The direction (or polarity) of the magnetic field depends on the direction of the current.

We can make an even stronger magnetic field by wrapping many turns of wire around an iron core. The iron core "concentrates" the magnetic field. This is called an **ELECTROMAGNET.**

Notice that the iron still retains some magnetism after the coil is de-energized. This will become important later!



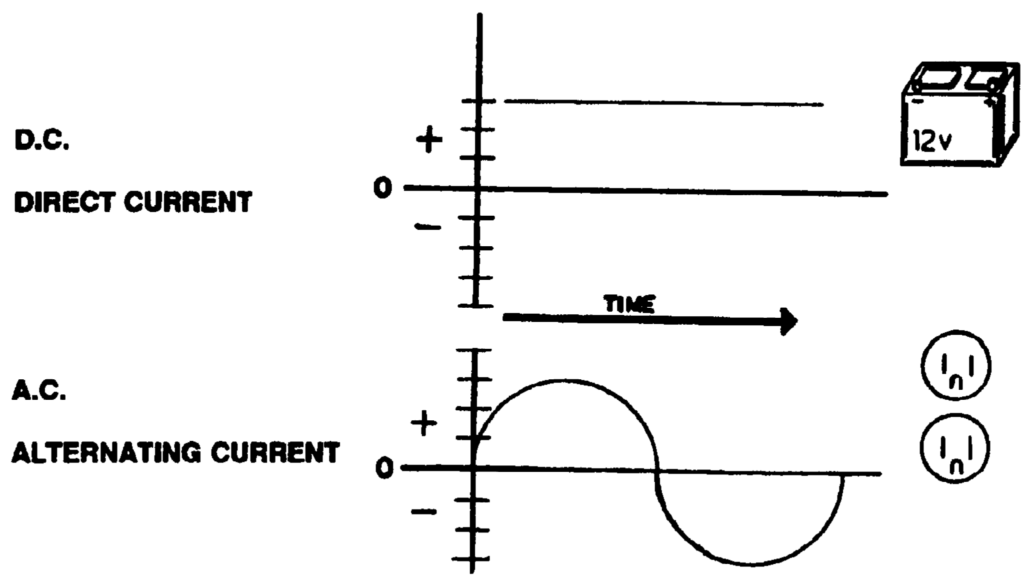
A.C. vs D.C.

When a voltage is at a (more or less) constant level, and does not change polarity (direction of current flow), it is known as a D.C. voltage. D.C. stands for **Direct Current**, which refers to the fact that the current flows "directly" or in one direction only.

When a voltage changes polarity back and forth, it is known as A.C. voltage. A.C. stands for **Alternating Current**, which refers to the fact that the current flows back and forth, in alternating directions.

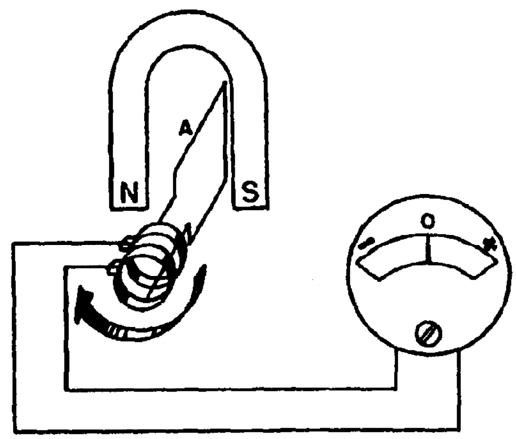
One complete reversal of an alternating current is known as a CYCLE. The number of times this complete reversal takes place in one second is known as **Frequency** and is expressed in units of Hertz (Hz) - which simply means "CYCLES PER SECOND".

Household power is A.C.. In the U.S., the frequency of the A.C. has been chosen to be 60 Hz. In Europe, the frequency is 50 Hz. Also, household A.C. power varies in voltage and reverses in such a way as to follow a sine wave pattern. Below, is what one cycle (1/60th of a second) of A.C. voltage looks like.

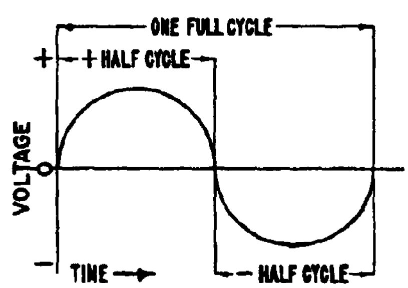


THE GENERATOR

A simple generator can be built with a single wire loop and a permanent magnet. If you connect the ends of the wire loop to collector rings and let a brush ride on each ring, you can observe the output of this simple generator on a sensitive meter. As you rotate the wire loop through the magnetic field which exists between the poles of a horseshoe magnet, current starts to flow through the meter. It gets stronger as leg A of the loop approaches the South Pole of the magnet and the needle of the meter is deflected toward the + side. The current reaches maximum + value as loop A passes opposite the S pole. Then the current gets smaller and reaches O as leg A is now centered on the bottom between the two poles of the magnet. As leg A approaches the North Pole of the magnet, current again rises but this time it deflects the meter to the - side. It reaches a maximum value and then drops to zero when leg A is back in its original position. We have completed 1 revolution and 1 cycle.



Why does the voltage build up and fall like this? If you could see a magnetic field, you would see that the magnetic lines of force are concentrated near the poles (ends) of the magnet, and they spread out as they get near the center between the two poles of the magnet. If the loop is rotated at a constant speed, the number of lines of force being cut is greatest when the loop is nearest the North or South Pole and no lines of force are being cut when the loop is vertical as the loop is traveling parallel to the lines of force. The intensity of current is directly proportional to the number of lines of force being cut. If we were to graph one revolution we would get a sine curve that looks like this:



This is one cycle. If we rotate our loop 60 times per second, we have 60 cycles alternating current or more commonly called 60 A.C.. Most recently the electrical terminology has changed and a cycle is being referred to as a Hertz (Hz). So the modern designation is 60 Hz.

A.C. or alternating current describes a current which has a + value part of the time and a - value part of the time, or a current which changes direction. Our one loop A.C. generator does not produce a great deal of electrical energy so we must find ways to increase the output.

The electrical energy can be increased in these ways:

1. **By using a stronger magnet field.**
2. **By using more loops of wire.**
3. **By increasing the speed with which we cut the magnetic lines of force.**

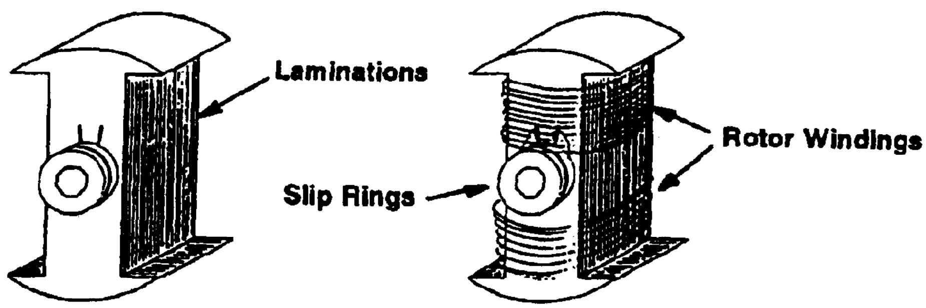
Number 3 above can be eliminated because we have decided that 60 Hz is the standard frequency that we want to use, and increasing the speed would change the frequency.

In order to increase the number of loops of wire we simply wind many more turns of wire on a suitable holder.

Turning a loop of wire in a magnetic field will create a current and likewise, turning a magnet in a coil will also create a current. **In our Homelite generators we have chosen to turn a magnet inside of a coil to generate power in the coil.** The coil is wound on a laminated steel core which is known as the stator. The stator is the stationary part of the generator, and is the power producing part as well.

We increase the amount of electrical energy that we generate by increasing the magnetic field.

In order to increase the magnetic field we press steel laminations onto a shaft and wind coils around the steel. This is called an Electro-Magnet, and is used because the strength of the magnet can be controlled by the amount of current flowing through the coils.



This assembly is better known as the **ROTOR**. It is known as a rotor because it is the part that rotates inside of the stator. It is also the part that produces the magnetic field needed to generate power in the stator coils.

Since this whole assembly rotates, we cannot simply connect wires to it in order to energize it. So, **slip rings and brushes are provided in order to transfer the necessary current to the rotating rotor.**

Think of a rotor as a powerful rotating magnet which takes electric current to generate the magnetism. The strength of the magnetic field is determined by how much current is sent through the rotor coils.

FLASHING THE FIELD

In Homelite generators, the steel laminations used to construct the rotor are designed to retain a little magnetism when the rotor is powered down. This **residual magnetism** is first put into the unit during the manufacturing process, by applying an external source of DC voltage of the proper polarity to the rotor. This is called **Flashing the Field**.

Occasionally, a generator will lose its residual magnetism (due to vibration during shipping, for instance), and it will be necessary to again flash the field. This can be accomplished using a 6, 9, or 12 Volt Lawn and Garden battery. With the generator running, touch a lead connected from the positive battery terminal to the positive brush terminal, and a lead from the negative battery terminal to the negative brush terminal. The D.C. voltage fed through the rotor windings should restore magnetism. If the generator does not show any output after flashing the field, refer to the troubleshooting section for that generator.

Some manufacturers build small permanent magnets into their rotors in order to insure the presence of a residual magnetic field. Occasionally, even these units will require flashing due to the "permanent" magnet losing its magnetism.

CLASS "F" WINDINGS

"Class F windings" refers to the insulation class of our rotor and stator windings. Electrical insulation is classified by it's ability to withstand high temperatures.

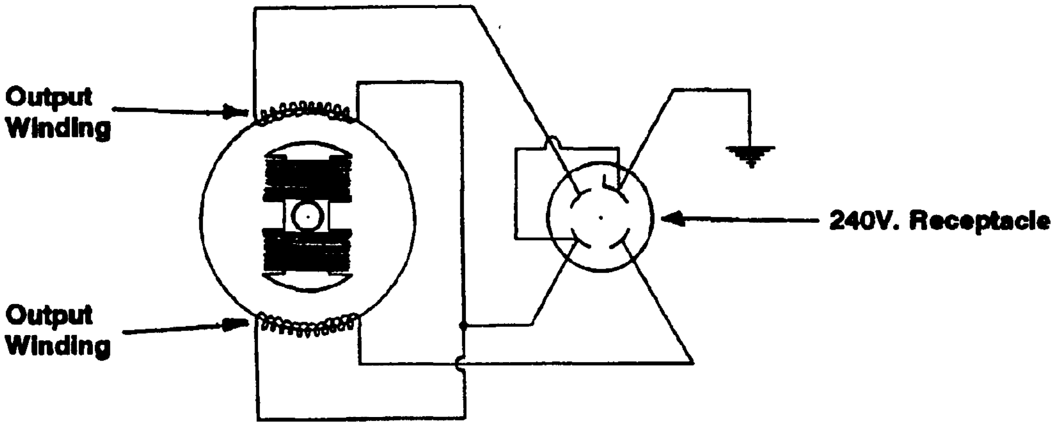
The most common insulation classes are as follows:

Class A:	105 Deg.C
Class B:	130 Deg.C
Class F:	155 Deg.C
Class H:	180 Deg.C

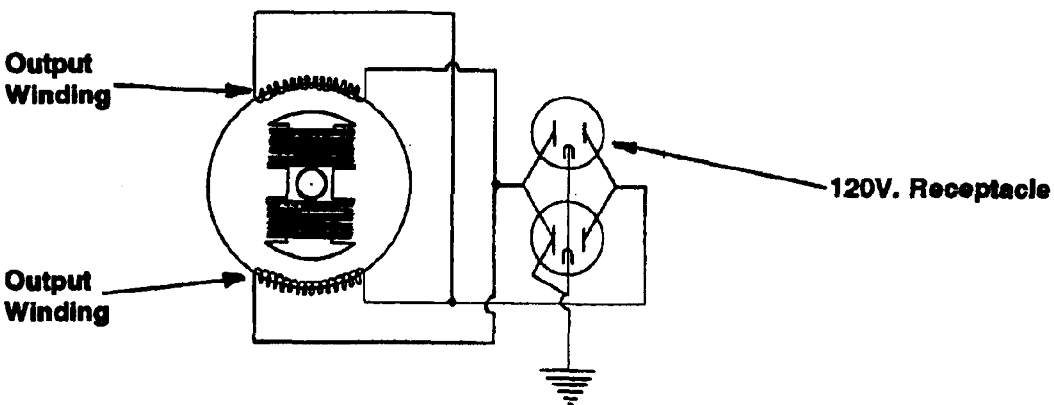
An insulation system is classified by its weakest link. That is, if all of the different insulating parts that make up a generator meet Class H requirements, except one which meets only Class B requirements, the generator is only considered to meed Class B insulation requirements. As advertised, the insulation system used in our contractor series generators meets and exceeds Class F requirements.

Naturally, the generator does not run that hot. Under normal circumstances, generator temperatures rarely exceed 125 C. However, if something should go wrong (i.e., an extreme overload, repetitive short circuits, etc.), the high temperature capability of these units will allow them to survive where lower class insulation systems may not.

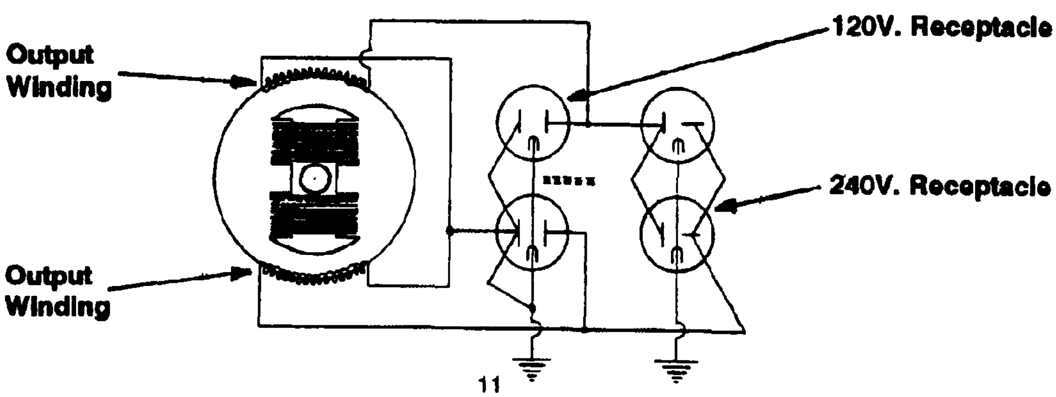
In order to obtain 240 volt output, another winding identical to the first winding is wound in the stator. If we hook the two windings in series, so that the start of the second winding is attached to the end of the first winding, we will in effect double the number of windings, therefore doubling the voltage.



If we hook the two windings in parallel, that is the start of the second winding is hooked to the start of the first winding and the end of the second winding is hooked to the end of the first winding, we will maintain the same voltage but double the current capabilities, because we have effectively doubled the size of the wire. Homelite contractor series generators utilize a "Max Power Switch" which allows the output windings to be placed in series for 240V. use, or parallel for obtaining maximum rated output from the 120V. receptacles.



In Homelite consumer generators with 240V. output, the stator windings are hard wired to provide 120V. and 240V.. Notice in the illustration that the tab is removed on the "hot" side of the receptacle so that the two windings can not oppose each other. Full power can be drawn from the 240V. receptacle.



VOLTAGE REGULATION

In the previous sections we learned basic electricity and generator principles. In this section we will learn of topics specifically related to Homelite generators.

Voltage regulation refers to a generator's ability to maintain a **constant output voltage** from **no-load to full-load** conditions.

Voltage regulation is usually expressed as a percent and is calculated by:

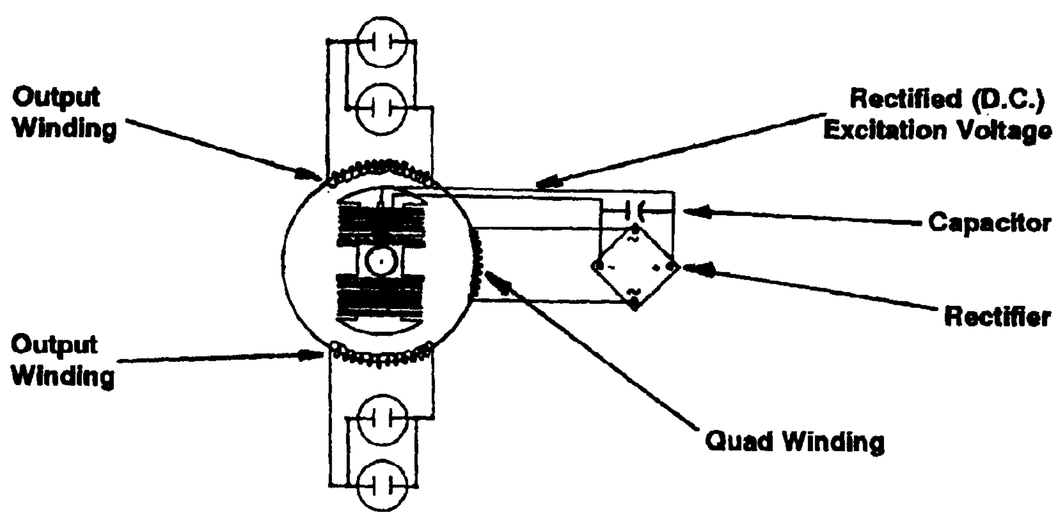
$$\text{Percent Voltage Regulation} = \frac{V_{nl} - V_{fl}}{V_{fl}} \times 100$$

Vnl = Voltage @ no load
Vfl = Voltage @ full load

Through the years, many different methods to regulate the voltage of a generator have been devised. Currently, we only employ two different methods:

Inherent Voltage Regulation:

Homelite's HL, EH, HRL and EHRL series of generators employ this method of voltage regulation. Basically, a separate exciter coil is wound on the stator. This exciter coil (known as a quadrature or quad winding) produces AC power which is rectified by a bridge rectifier and then filtered by a capacitor. This D.C. voltage is then supplied directly to the rotor through the slip rings. Under no-load conditions, the quad winding is only excited by the rotating field. As load is added to the main windings, a little extra magnetic flux is produced by the load current flowing through the main windings which tends to "boost" the output of the quad winding. In this way, the generator can give itself a little extra exciter voltage (and thus output voltage) during heavy loads. Voltage regulation tends to be between 15% and 20% for this series of generators. This boils down to no-load voltages as high as 145 VAC and full load voltages as low as 110 VAC (these figures include manufacturing tolerances). In short, **the generator's voltage is controlled by the inherent qualities of the winding design.**

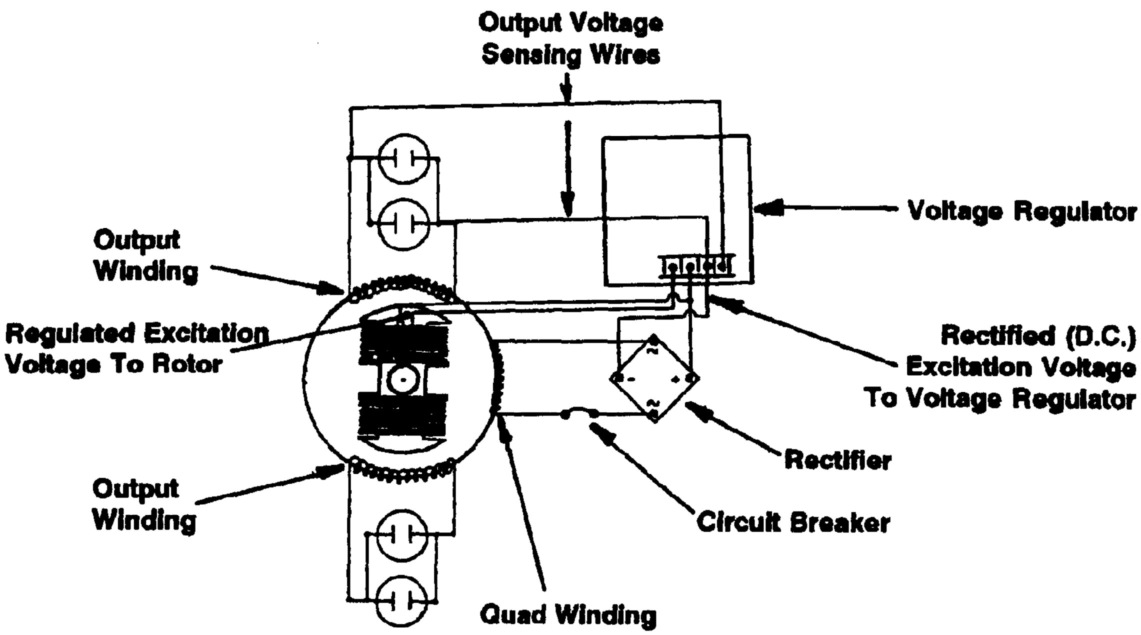


Electronic Voltage Regulation

Homelite's contractor series of generators employ an electronic voltage regulator to maintain output voltage levels. In this method, a separate exciter winding is also wound on the stator. Current from an overly powerful quad circuit after being rectified, is "reduced" by an electronic voltage regulator to a more appropriate level.

The patented Homelite electronic voltage regulator (EVR) utilizes generator field control for regulating the output voltage of an AC generator, providing improved motor starting ability. The EVR makes it possible to regulate the output voltage of the generator to 2% and provides motor starting ability of about 0.75 hp/kw.

When a load is applied to the generator, the AC output voltage will tend to decrease. This decrease is sensed by the voltage regulator through connections to the receptacles. When a voltage drop is detected, rectified quad voltage is allowed to pass through the voltage regulator to the rotor windings, increasing it's magnetic strength. This increase compensates for the additional load and maintains the generator's constant AC output voltage.

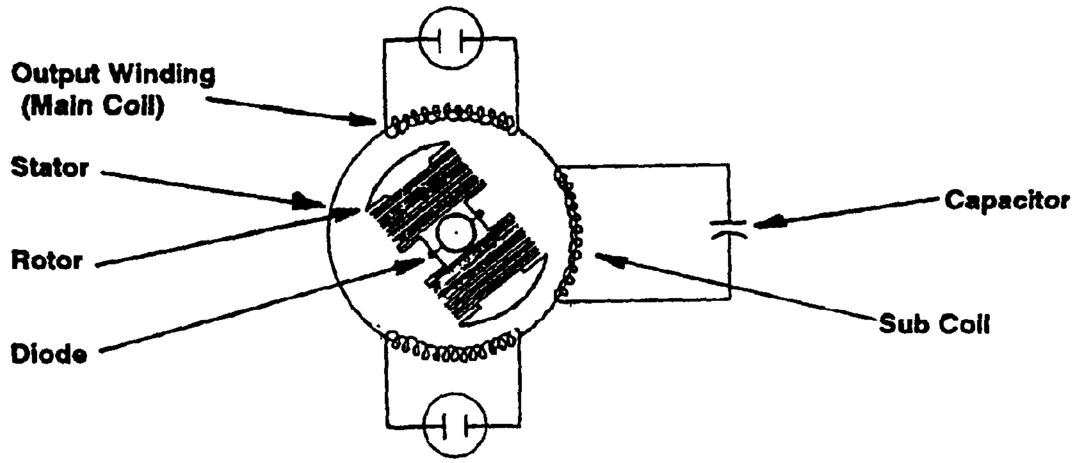


The regulator also has a bypass circuit for facilitating generator start-up by allowing the residual voltage of the generator to feed unimpeded into the generator field until the output voltage of the generator has built up. The Homelite electronic voltage regulator gives exceptionally good regulation of less than 2%. Power companies only maintain 6% regulation. In addition, the unique design of this regulator gives our generators extremely good motor starting capability. Voltage regulation is important to the user in that most appliances and tools are designed with the local power company's regulation of 6% in mind.

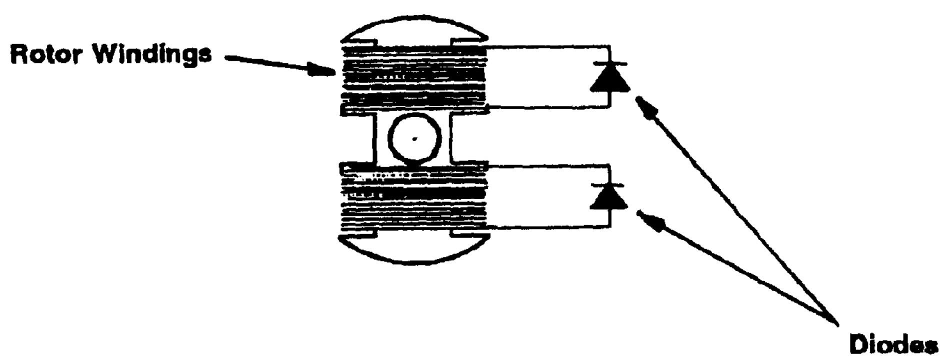
Although most appliances and tools will run perfectly well on reduced or increased voltage, the overall life and performance may be degraded. Also, there is nothing more annoying than watching the lights dim every time you pull the trigger on your electric drill. For this reason, serious generator users generally prefer electronically regulated models. Inherently regulated models, however, still offer a low cost alternative for users who may not be as concerned about voltage fluctuations.

BRUSHLESS GENERATOR THEORY

As the rotor begins turning, the residual magnetism retained by the rotor core causes the stator sub-coil (similar to quad winding) to produce a voltage. This voltage is applied to the condenser (capacitor) connected to the sub-coil. The condenser builds a charge and then releases it when it reaches a certain value. This building of a charge causes a current to flow in the sub-coil, which creates a strong magnetic field just as the rotor coils begin to pass by the sub-coil.



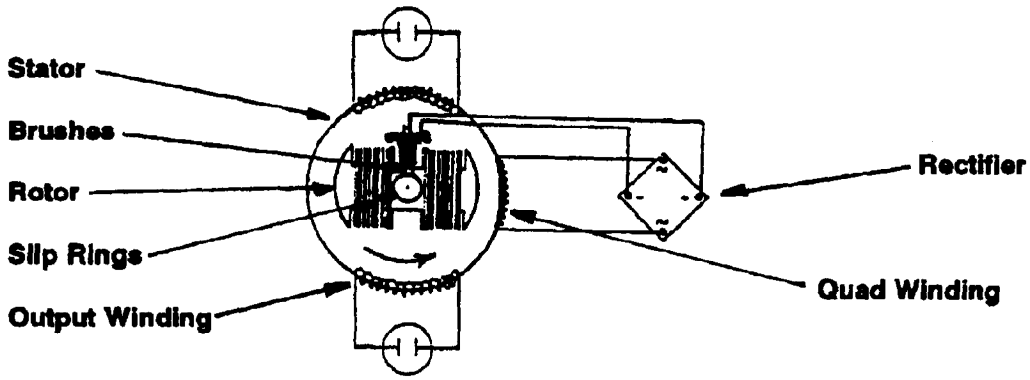
The magnetic field in the sub-coil induces an A.C. voltage which is rectified to D.C. by two diodes on the rotor. This D.C. is fed through the rotor windings, boosting the strength of the rotor magnet, and increasing output to the rated voltage.



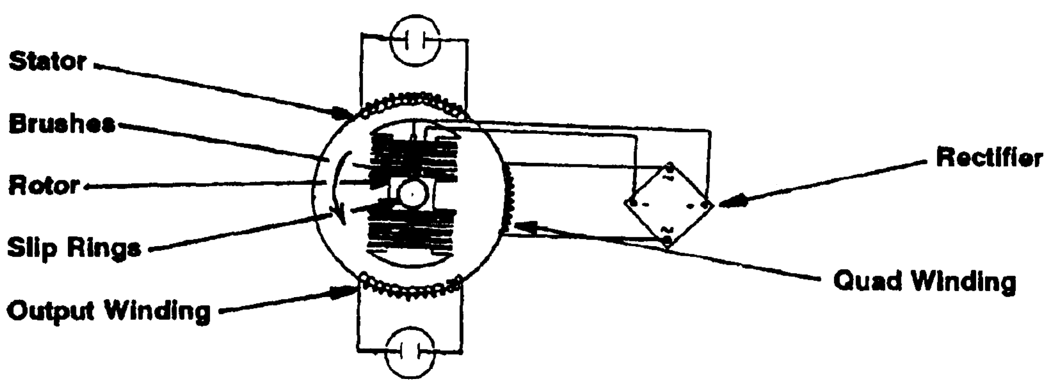
When a load is applied to the receptacle, the main coil is magnetized by the current. Since the main coil and sub-coil share a common core, the main coil acts as a primary winding, inducing a current flow in the sub-coil. This current flow increases the strength of the magnetic field in the sub-coil, which increases the strength of the field in the rotor coils by induction. When the rotor's magnetic strength is increased, the generator's output is increased.

"BRUSH" GENERATOR THEORY

As the rotor begins turning, the residual magnetism retained by the rotor induces (causes) a voltage in the quad winding. The A.C. voltage from the quad winding is then converted to D.C. by the bridge rectifier. The rectified quad voltage is then applied to the rotor windings through the brushes and slip rings, causing the rotor's magnetic strength to increase.



This increase in the rotor's magnetism is induced into the output windings at the same time. A proportionate number of turns of wire in the rotor, quad and output windings results in a build-up of voltage to a useful level (120v. A.C.) when the rotor reaches it's magnetic saturation point.



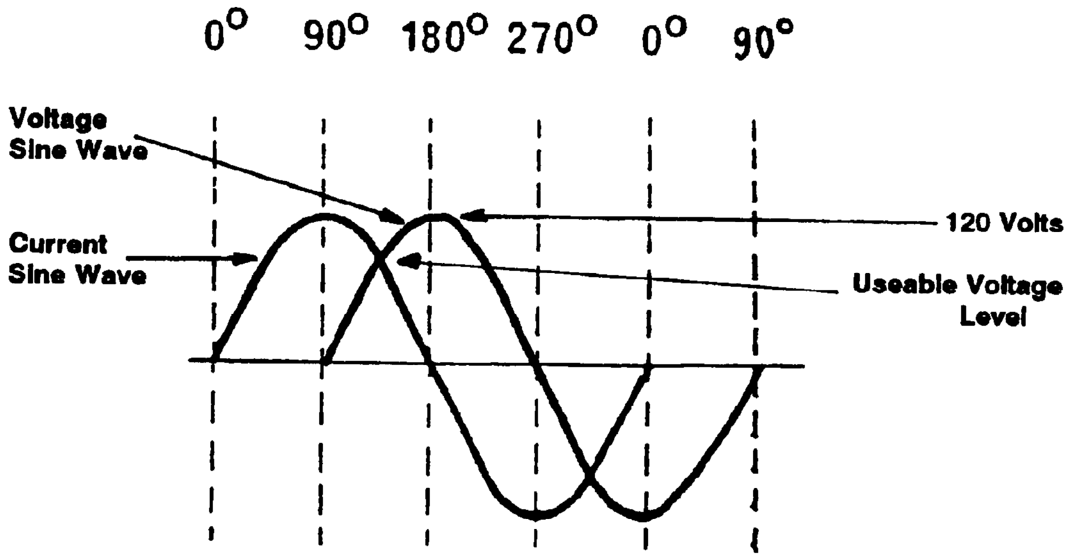
"BRUSH" VS. "BRUSHLESS" DESIGN

There seems to be a common belief that brushless generators are better than generators that employ brushes for excitation. The facts are that during extensive testing of Homelite generator ends, brushes typically last for more than 1000 hours of operation, which is more than adequate. Also, generators that use brushes have better control of the rotor magnetism which allows for better voltage regulation (both inherent and electronic), and much better motor starting.

MOTOR STARTING

So far we have only considered loads which are resistive in nature. If a capacitor or inductor is used as a load in an AC circuit, current flows, but very little power is delivered to the load. This is due to the tendency of inductive or capacitive loads to shift the current out of phase with the voltage. That is, when the voltage across the load is peaking, the current flowing at that time is very low, and vice versa.

The nature of an inductive load (such as a motor) is that the current lags behind the voltage. Picture it as a kind of time delay where it takes awhile for the voltage across the inductive load to produce a current, and by that time, the voltage has subsided. Only where the two "cross" will any power be expended in the load (and work be done).



How far the current and voltage are out of phase is quantified by the term **POWER FACTOR**. A power factor of 1.0 (100%) means that the load is purely resistive. A power factor of 0.0 (0%) means that the load is purely inductive or capacitive. (The voltage and current are completely out of phase). Naturally, a load consisting of a combination of resistive and inductive components would produce a power factor somewhere between 0% and 100%

Low power factors are usually avoided since a high current would be required to deliver any appreciable power. This high current demand produces higher heating losses, and consequently the system operates at a lower efficiency.

When a motor is first started, the rotor of the motor is essentially stalled and extremely high currents (far in excess of the rated currents) flow. These currents are nearly 90 degrees out of phase with the generator voltage so very little "real" power is expended. As the motor begins to turn these high currents begin to drop off and come into phase until the motor comes up to speed, at which point the motor current will level off at a more reasonable level.

Every induction motor greater than 1/20 HP has a "code" letter on its name plate. This code letter indicates how high the inductive currents will be during start-up. This "motor code" is a **NEMA** standard for induction motors which relates the locked rotor (or start) **KVA** (**KiloVolt Amp**) required per horsepower of running power (1 KVA = 1000 Volt Amps). Starting a Code "G" motor at 65% of the rated voltage is standard in the generator industry which started with a military specification for generators.

Basically speaking, a Code "G" motor of a given horsepower is more easily started than a Code "H" (or any letter above "G") motor of the same horsepower. A Code "F" motor is more easily started than a Code "G" motor. During this start sequence, a generator must be capable of delivering these high inductive powers for this short period of time.

Our 180RIE62 generator has a rated output wattage of 5500 watts continuous which equals about 7.3 horsepower. However, one can only expect to be able to run a 4.2 HP motor because a higher power motor cannot be started due to the high instantaneous in rush power required to start a 4.2 HP motor. As much as 24,000 VA (for a Code "G" type) are required - but just for an instant.

Power-factors for some electrical apparatuses

Electrical apparatus	Power-factor
Incandescent lamp	1.0
Neon tube lamp	0.4 – 0.5
Fluorescent lamp (with stabilizer)	0.6
Three-phase induction motor	0.7 – 0.9
AC are welder	0.4 – 0.5
Electric heater	1.0

The letter designations for locked rotor KVA per horsepower as measured at full voltage and rated frequency are as follows:

Letter Designation	KVA per Horsepower*
A	0-3.15
B	3.15-3.55
C	3.55-4.0
D	4.0 -4.5
E	4.5 -5.0
F	5.0 -5.6
G	5.6 -6.3
H	6.3 -7.1
J	7.1 -8.0

Letter Designation	KVA per Horsepower*
K	8.0- 9.0
L	9.0-10.0
M	10.0-11.2
N	11.2-12.5
P	12.5-14.0
R	14.0-16.0
S	16.0-18.0
T	18.0-20.0
U	20.0-22.4
V	22.4-and up

* Locked KVA per horsepower range includes the lower figure up to, but not including, the higher figure. For example, 3.14 is designated by letter A and 3.15 by letter B.

FLASHING THE FIELD

In Homelite generators, the steel laminations used to construct the rotor are designed to retain a little magnetism when the rotor is powered down. This **residual magnetism** is first put into the unit during the manufacturing process, by applying an external source of DC voltage of the proper polarity to the rotor. This is called **Flashing the Field**.

Occasionally, a generator will lose its residual magnetism (due to vibration during shipping, for instance), and it will be necessary to again flash the field. This can be accomplished using a 6, 9, or 12 Volt Lawn and Garden battery. With the generator running, touch a lead connected from the positive battery terminal to the positive brush terminal, and a lead from the negative battery terminal to the negative brush terminal. The D.C. voltage fed through the rotor windings should restore magnetism. If the generator does not show any output after flashing the field, refer to the troubleshooting section for that generator.

Some manufacturers build small permanent magnets into their rotors in order to insure the presence of a residual magnetic field. Occasionally, even these units will require flashing due to the "permanent" magnet losing its magnetism.

CLASS "F" WINDINGS

"Class F windings" refers to the insulation class of our rotor and stator windings. Electrical insulation is classified by it's ability to withstand high temperatures.

The most common insulation classes are as follows:

Class A:	105 Deg.C
Class B:	130 Deg.C
Class F:	155 Deg.C
Class H:	180 Deg.C

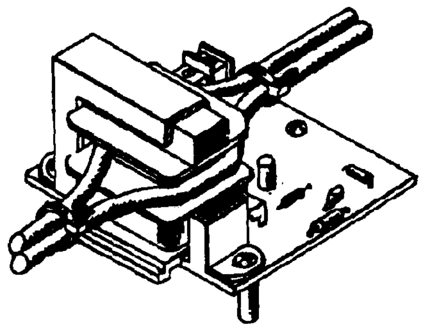
An insulation system is classified by its weakest link. That is, if all of the different insulating parts that make up a generator meet Class H requirements, except one which meets only Class B requirements, the generator is only considered to meed Class B insulation requirements. As advertised, the insulation system used in our contractor series generators meets and exceeds Class F requirements.

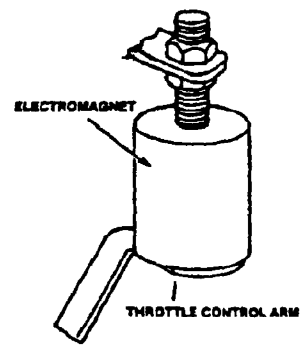
Naturally, the generator does not run that hot. Under normal circumstances, generator temperatures rarely exceed 125 C. However, if something should go wrong (i.e., an extreme overload, repetitive short circuits, etc.), the high temperature capability of these units will allow them to survive where lower class insulation systems may not.

LOADAMATIC IDLE CONTROL SYSTEM

Homelite's patented Loadamatic idle control system idles the engine under no load conditions to prolong engine life and increase fuel economy.

The Loadamatic idle control system consists of three components: idle control board, electromagnet/leads, and the idle control switch. Shown below is the electrical diagram and line drawing for the idle control system.

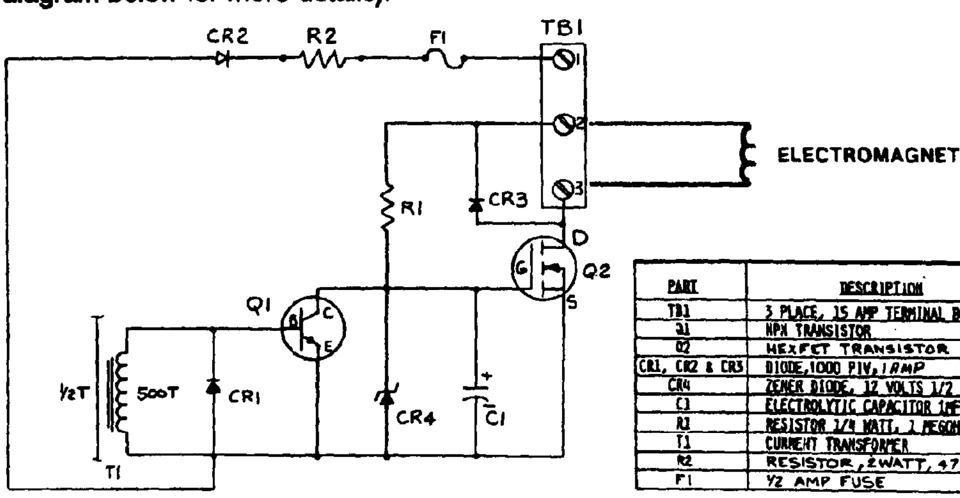




How it works:

With the generator running and the idle control switch in the "auto" position, the output of the generator energizes the idle control board (via terminal board terminals #1 and #2). The Field Effect Transistor (FET) is biased "on" due to its source (S) being at a lower potential than its Gate (G). The gate is at a neutral potential because of the Resistor (R1). The source voltage is also clamped using a Zener Diode (CR4). This allows voltage to flow to the electromagnet, which in turn, pulls the engine's throttle arm to the idle position.

When a load is applied, voltage is induced in the secondary winding of the idle control board transformer. This induced voltage turns on the NPN Transistor (Q1) that in turn equalizes the voltage at the FET's gate and source, causing the FET to turn off the electromagnet and release the throttle arm. This allows the engine's governor to bring the generator up to speed (see the diagram below for more details).



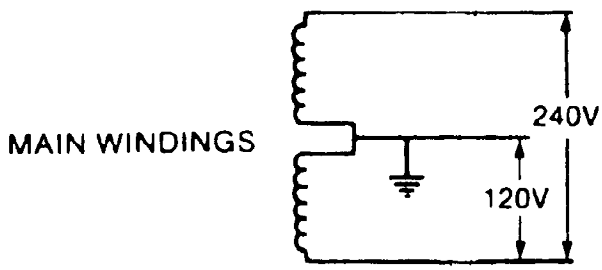
PART	DESCRIPTION
TB1	3 PLACE, 15 AMP TERMINAL BOARD
Q1	NPN TRANSISTOR
Q2	HEXFET TRANSISTOR
CR1, CR2 & CR3	DIODE,1000 PIV, 1 AMP
CR4	ZENER DIODE, 12 VOLTS 1/2 WATT
C1	ELECTROLYTIC CAPACITOR 1MFD, 50 WVDC
R1	RESISTOR 1/4 WATT, 1 MEGOHM
T1	CURRENT TRANSFORMER
R2	RESISTOR, 2WATT, 47OHMS
F1	½ AMP FUSE

MAXIMUM (FULL) POWER SWITCH

The maximum (max) or full power switch is used on certain models of our contractor (170/180) series of generators. The maximum power switch in the 120V position parallels the two 120V stator windings. This, in effect, doubles the amperage available at the 120V duplex and twist lock receptacles. So, in the 120V position, the generator is wired as a single voltage generator. No output is available at the 240V receptacle, so the load does not have to be split.

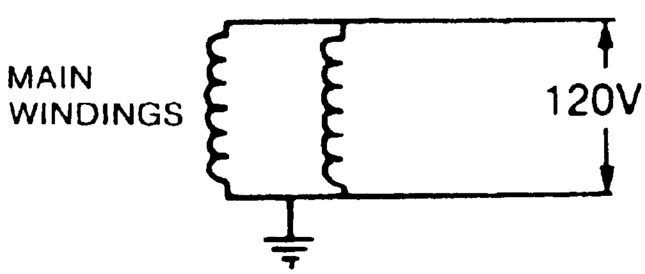
With the maximum power switch in the 120/240V position, the two 120V windings are now hooked in series. It is now possible to draw both 120 and 240 volts at the same time. However, the load must be split between the 120 and 240 volt receptacles in order to pull rated load.

CONVENTIONAL WIRING



The above illustration shows a conventional 120/240V generator. If it is rated at 3,000 watts, each 120V winding has a 1,500 watt maximum capacity, and each winding is carrying one half the load. It would not be possible to use a 120V 2,500 watt load because it would overload either of the stator windings and cause excessive heat build-up in the generator.

MAXIMUM POWER SWITCH PARALLELS 120V WINDINGS



In the first illustration, the conventionally wired generator could not handle a 2,500 watt load because output was split between the two windings. With the maximum power switch in the 120V AC position, this load is easily handled by a 30 amp twist lock receptacle.

In the 120V/240V mode, the windings are switched to a series connection so that 240V is available. This means that maximum power can only be drawn by splitting the load between the 120V and 240V receptacles. For example: If 2,000 watts is being drawn off the 240V receptacle, 1,000 watts must be drawn off the 120V side to achieve maximum power.

GFCI PRINCIPLES OF OPERATION

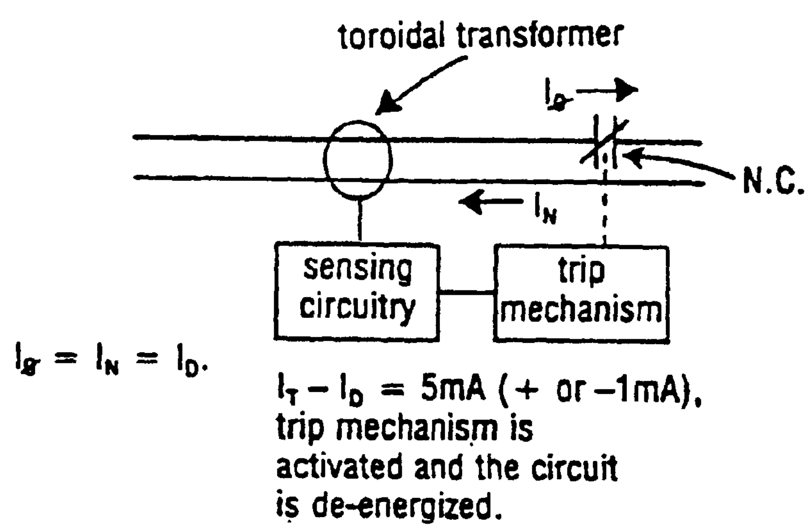
Ground Fault Circuit Interrupters (GFCI) generally operate on the principle that any ground fault will create a difference in current flow between the phase conductor (hot leg) and neutral conductor (return leg) in an AC circuit. For example, in a circuit supplying single phase, 120V load, under normal conditions, current flows from the circuit source (generator, distribution panel, etc) to the lead and back through the neutral (return) conductor.

Under normal conditions (no ground fault), the current flow in the phase conductor and neutral conductor are of equal value and 180o out of phase. This results in zero difference between the electromagnetic fields produced by the two conductors. However, if a ground fault should occur as a result of insulation breakdown or equipment being fed, a differential current is created because the phase conductor, which is supplying the fault, is greater than the current flow in the neutral conductor. When the GFCI senses the difference in current flow between the two conductors (caused by the ground fault), it activates a trip mechanism to interrupt supply.

In order to sense the difference in current flow between phase and neutral conductors (or two phase conductors), most GFCI's use what is known as a "Toroidal Transformer". A Toroidal Transformer is a donut-shaped piece of magnetic material with a very fine wire coil wrapping. This type of transformer is very sensitive and small enough to fit within the receptacle or as a circuit breaker.

A GFCI must be capable of detecting and interrupting fault currents as low as 5 mA (.005A) and ignore those below 4 mA, and that differential must be detected where the load supplied can be rated for 15A, or more.

The phase and neutral conductors are passed through the "Toroidal Transformer" within the GFCI. This permits sensing of current flow downstream (see the diagram below for more details). Remember, any difference in the phase or neutral current flow that exceeds 5 mA will cause the GFCI to operate.



Simplified diagram of a GFCI protective device

GENERATOR COMPONENTS AND FUNCTIONS

A. OUTPUT CIRCUIT

1. *OUTPUT WINDINGS:* Deliver voltage induced by the rotating field of the rotor magnet to the receptacles.

2. *RECEPTACLES, SWITCHES, METERS:* Allow access to and control of output. "Max Power Switch" allows output windings to be placed in series for 240V. use or parallel to obtain maximum rated output from the 120V. receptacles.

B. EXCITATION CIRCUIT

1. *QUAD WINDINGS:* Pick up a charge (A.C.) from the rotating field of the rotor magnet for the purpose of returning it to the rotor windings after it has been rectified (changed to D.C.) and regulated (to control the strength of the rotors magnetism and ultimately the output of the generator).

2. *ROTOR:* Turns within the stator supplying a charge to the output and quad windings in the stator through induction.

   a. *MAGNET:* Initial source of energy when the generator starts up, inducing voltage in the stator's quad windings (The generator "magnet" is actually laminated steel with magnetic properties, not a true permanent magnet.)

   b. *ROTOR WINDINGS:* allow voltage to be fed around the rotor magnet to increase it's strength and to control or regulate the generator output.

   c. *SLIP RINGS:* Since the rotor is moving and the excitation voltage is coming from the non-moving quad windings, the slip rings allow contact between the stationary stator and moving rotor.

3. *BRUSHES:* Feed excitation voltage through the slip rings into the rotor windings (after it has been rectified) so that the proper control over output voltage level can be maintained.

4. *RECTIFIER:* The quad windings produce A.C. like the output circuit, but the magnet (rotor) must be charged with D.C. The rectifier changes the quad's A.C. to D.C. using a series of four diodes. The diodes block electrical flow in one direction and allow it to flow in the other.

5. *ELECTRONIC VOLTAGE REGULATOR:* Senses output voltage and regulates the amount of D.C. voltage that goes to the rotor windings. The negative (white) wire from the rectifier is connected to the voltage regulator and the voltage needed is allowed back to the brushes through the black wire. The natural output (unregulated) is approximately 150 V.A.C.

6. *CIRCUIT BREAKER:* Interrupts the excitation voltage at the quad winding when it heats up from an overload. This usually happens when the excitation circuit is working too hard to keep the rotor sufficiently boosted. NOTE: The output should still be approximately 3 V.A.C. because the rotor magnet is still turning within the output windings, it's just not being excited.

7. *CAPACITOR:* Smooths out or filters the pulsating D.C. current from the rectifier to the rotor for improved motor starting.

C. IDLE CONTROL

1. *BOARD:* Sends 60 V.D.C. to the electromagnet when there is no current sensed in the output circuit. The board runs on 120 V. output voltage. (At idle it's more like 90V.)

   a. *TRANSFORMER:* Senses output current by induction, having two output leads pass through it.

   b. *FUSE:* Protects the idle control board from short circuited electromagnet leads.

2. *ELECTROMAGNET:* When energized, magnetically pulls governor arm to itself to reduce engine R.P.M.'s to around 2650. When the transformer senses a load, it shuts off voltage to the electromagnet, causing the electromagnet to release control of the engine speed to the governor and load.

D. GROUND FAULT CIRCUIT INTERRUPTER

1. *RECEPTACLE:* Measures voltages in the "hot" wire and the "neutral" wire. When the voltage in the measured is greater in the "hot" wire than the "neutral", the circuit breaker trips, cutting off power to the receptacle.

SELECTING THE GENERATOR

HOW TO SELECT THE RIGHT SIZE GENERATOR

The biggest problem in selecting a generator is determining the power requirements that must be met under operating conditions.

Undersizing of the generator is the single most common mistake and can be avoided by considering **ALL** the loads to be connected to the generator and by calculating the starting requirements (motor start) of electric motor operated equipment.

An estimate of the total load that will be connected to the generator can be made by getting the nameplate amperage of all equipment or tools to be used. The nameplate is found on all electric powered tools or electric motors. It lists such information as amperage (running) speed at which the tool operates, hertz, phase, and code number (electric motors only).

Once the total amperage draw for all tools and equipment is known, the following can be used to establish starting amperage required:

1. Running amperage x 1, if the equipment is for heating or lighting. Heaters, light bulbs, coffee maker, hot plate, are resistive loads. They draw a constant amount of current while operating.

2. Running amperage x 2, if hand tools or other universal motors are connected to the generator. They typically draw twice their normal (free running) amperage when used at full capacity.

3. Running amperage x 3, if electric motor driven equipment is being used. They generally attach to a piece of stationary equipment and require up to three times their running amperage when starting, until they come up to speed.

Generator wattage required = (amps) x (volts) x (1, 2 or 3)

EXAMPLE: A customer wants to operate the following equipment and tools on a generator: (1) Radiant Heater, (2) 3/4 HP Air Compressor, (3) 3/8" Drill, (4) 6" Circular Saw.

Tools/Equipment	Name Plate Running Watts	Times (x) 1, 2, 3	Starting Watts
Radiant Heater	1,300	1	1,300
3/4 HP Air Compressor	850	3	2,550
3/8" Drill	300	2	600
6" Circular Saw	850	2	1,700
Total	3,300		6,150

A total of 6,150 starting watts is required if all tools and equipment were started simultaneously. This would require the use of the 180HI63 Generator. However, if the highest starting load (3/4 HP air compressor) is started first, followed by the second highest load, third highest load, etc., a 178HI48 Generator could be used in this application.

Start-up of multiple pieces of equipment would still require the use of the 180HI63 Generator.

LOAD APPLICATION

Always be sure (by checking the generator and equipment name plates) that the voltage, amperage and frequency requirements of the equipment to be used can be satisfied by the generator.

Refer to the two tables, "Cable Size" and "Wattage Consumption for Typical Equipment" to be sure that the loads you are connecting are within the capacity of the generator. Incandescent lights, electric motors, and resistance coil devices, such as heaters, draw much greater current for start-up than after they are operating. Inadequate size connecting cables, which cannot carry the required load, can cause a voltage drop which can burn out the appliance and overheat the cable.

CABLE SIZE

Equipment damage can result from low voltage. Therefore, to prevent excessive voltage drop between the generator and the equipment, the cable should be of adequate gauge for the length used. The table below gives the maximum cable length for various gauges of wire.

CURRENT IN AMPERES	LOAD IN WATTS AT 120 VOLTS	LOAD IN WATTS AT 240 VOLTS	MAXIMUM ALLOWABLE CABLE LENGTH #8 WIRE	#10 WIRE	#12 WIRE	#14 WIRE	#16 WIRE
2.5	300	600		1000 ft.	600 ft.	375 ft.	250 ft.
5	600	1200		500	300	200	125
7.5	900	1800		350	200	125	100
10	1200	2400		250	150	100	50
15	1800	3600		150	100	65	
20	2400	4800	175 ft.	125	75	50	
25	3000	6000	150	100	60		
30	3600	7200	125	65			
40	4800	9600	90				

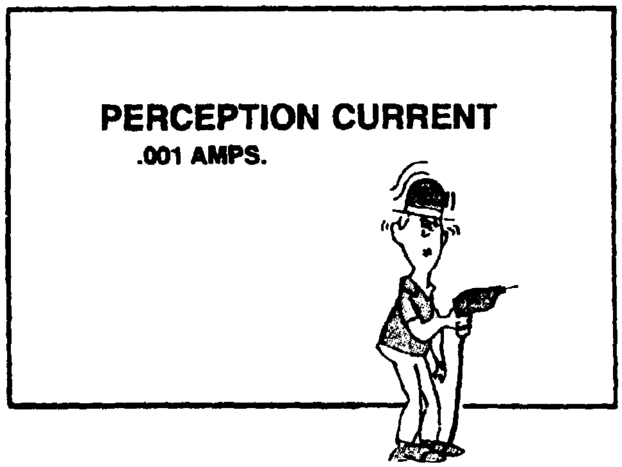
NOTE: Amperage will be limited by receptacle rating and the cable which will fit the mating plug.

POWER CONSUMPTION FOR TYPICAL EQUIPMENT

Appliance	Watts	Appliance	Watts
Light Bulb	See Bulb	Coffeemakers	400-700
Window Fan	200	Clothes Dryer (Electric)	5000-10,000
Radio	50-200	Iron (Hand)	500-1500
Air Conditioner (10,000 BTU)	2000-3000	Portable Heater	600-4800
Automatic Washer	150-1500	Toasters	900-1650
Refrigerator	600-2000	6-1/2 inch Hand Saw	1000-2500
Television	100-500	Water Heater	3000-5000
Vacuum Cleaner	200-300	Water Pump	1000-3000
Electric Drill	225-1000	Sump Pump	400-3000
Hot Plate	330-1100	Food Freezer	300-500

Motor HP Rating	Approx. Running Watts	APPROXIMATE STARTING WATTS REQUIRED: Universal Motors	Repulsion Induction Motors	Capacitor Motors	Split Phase Motors
1/8	275	400	600	850	1200
1/4	400	500	850	1050	1700
1/3	450	600	975	1350	1950
1/2	600	750	1300	1800	2600
3/4	850	1000	1900	2600	
1	1000	1250	2300	3000	

Electrical Safety



Electrocutions are few in this country, about 1,000 per year, but there are 30 times that many people injured through electrical shock. Portable, electrically-operated tools account for the second largest number of injuries, with the plug or cord at fault in two-thirds of the incidents.

Insurance company statistics indicate that rental equipment is involved in a high percentage of such accidents, and it is important to realize that the rental operator is liable for those defects of which he is aware, as well as those which would have been disclosed by a reasonable investigation.

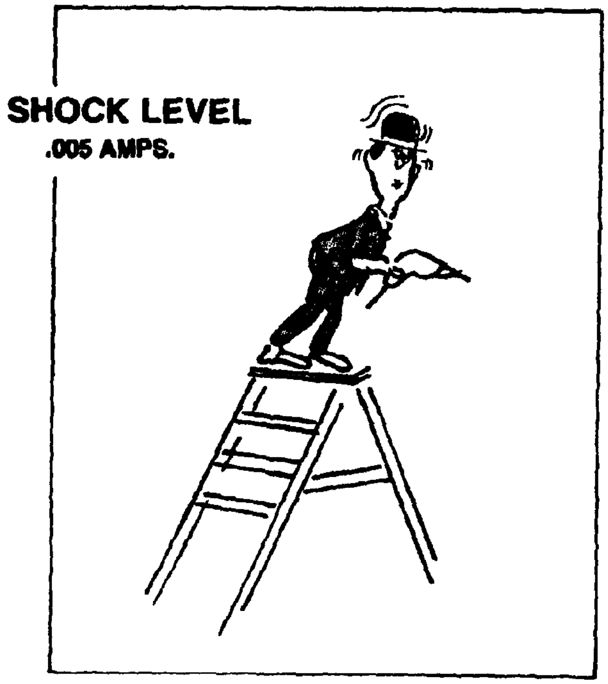
Leakage Current

One of the most important checks to be sure a tool is safe is for excessive leakage current. Leakage current flows from the internal wiring to metal portions of the equipment housing or enclosure.

The skin offers a barrier to the flow of leakage current. It is not until the voltage exceeds about 48 volts that a hazard exists. At a common supply voltage of 120 volts, current can easily pass through the skin. Once the current starts to flow, the skin resistance decreases further, allowing an increasing flow of current to pass through the body.

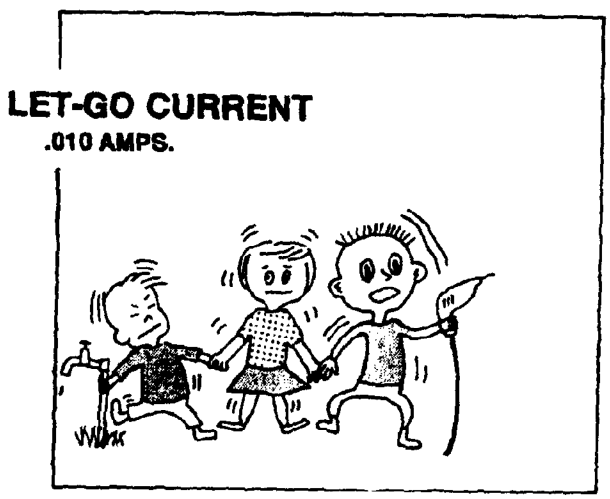
Perception Current

One milliampere (1/1000 of an ampere) will be felt by most individuals as a slight tingling sensation. A defective hand drill or floor polisher might allow this amount of current to flow through a person standing on a dry wooden floor. Not bothered by it, he continues to use the equipment, until he happens to touch a water connection, heating register, metal window sash or other grounded metal object. He has now completed the circuit to ground and a much larger current will flow through his body.



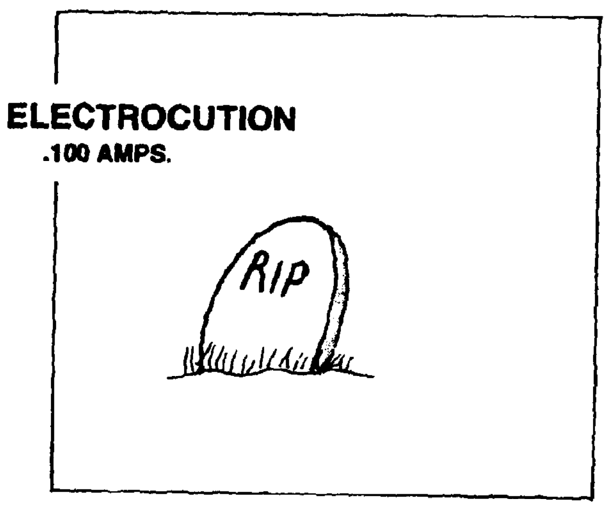
Shock Level

If only five milliamperes (1/43 of the current required to operate a 25-watt lamp) flow through his body, it will result in a violet muscle reaction, throwing him away from the equipment.



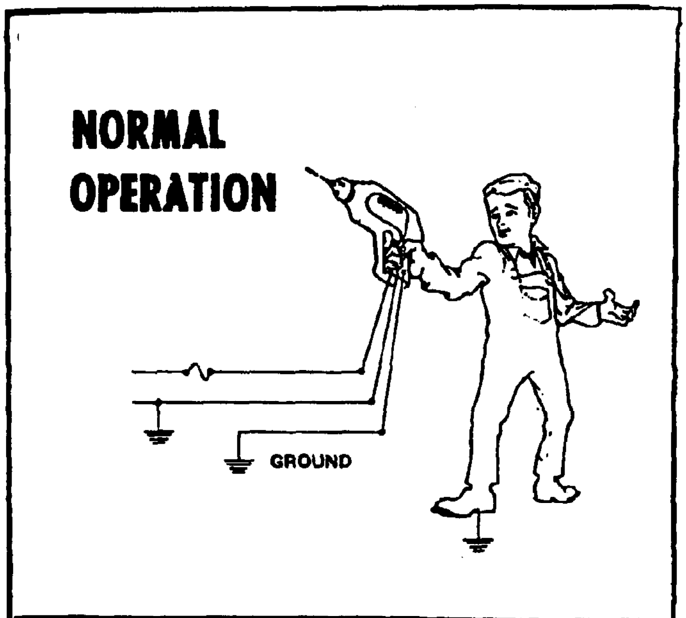
Let-Go Current

If the current is much above 10 milliamperes, the person will lose his ability to release his grip on the electrical equipment. While the heart normally can continue to function, fatigue sets in, followed by death if no help is available.

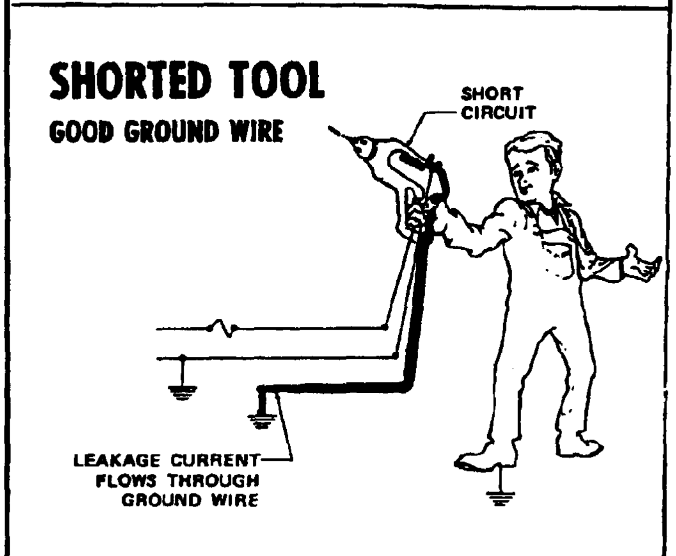


Electrocution

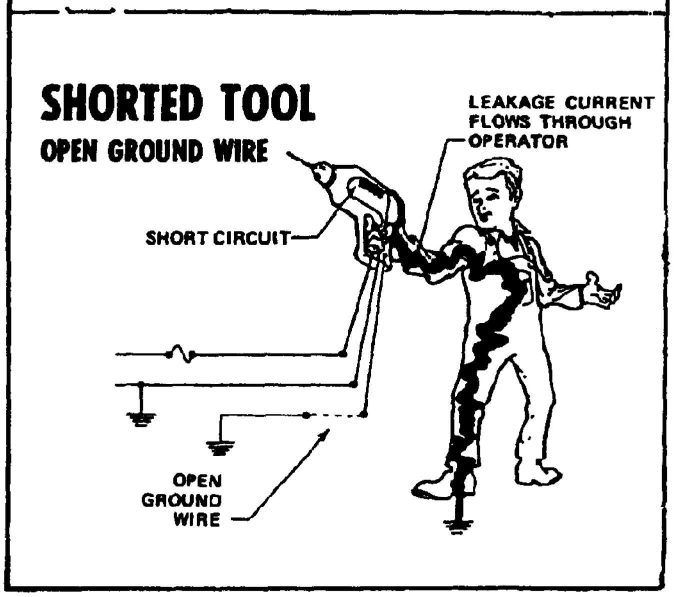
At about 100 milliamperes (less than half that used by a 25-watt lamp) ventricular fibrillation occurs, the muscle fibers lose control and the heart is *no longer* able to pump blood.



When a tool is operating normally, electricity passes through one wire into the tool and back out the second wire. Little or no current should travel down the ground wire.



If a tool's insulation becomes defective, some of the electrical current will pass through the tool's case to the ground wire and back to the ground. The person holding the tool will not be injured. If enough leakage current flows, the line fuse will open. The only problem is that this depends on a good ground path all the way back to the ground itself.



If the ground wire does not make a perfect contact all the way back to the ground, the leakage current will flow through the operator to the ground. The amount of shock the person receives will depend on how defective the tool's insulation is and how well grounded the main is.

GENERAL SAFETY PRECAUTIONS FOR HOMELITE GENERATORS

- Before starting the generator, study all of the instructions in the Owner's Manual and the engine Operating and Maintenance instructions supplied with the unit. Make sure you thoroughly understand how to operate the machine. Proper preparation, operation and maintenance will result in operator safety, optimum performance and long unit life.
- Use only genuine product manufacturer's replacement parts. Failure to do so may cause poor fit and possible injury.
- This generator is equipped with a grounding terminal for your protection. Always complete the ground path from the generator to an external ground source as instructed in the selection labeled "Grounding the Generator".
- Be sure each person who operates the machine is properly instructed in its safe operation.
- Always keep the machine and all associated equipment clean, properly serviced and maintained.
- Observe all safety regulations for the safe handling of fuel. Handle fuel in safety containers. If container does not have a spout, use a funnel. Do not refill fuel tank while the engine is running. Fill the tank only on an area of bare ground. While filling the tank, keep heat, sparks and open flame away. Carefully clean up any spilled fuel before starting the engine.
- Never operate the machine in an explosive atmosphere, near combustible materials, or where ventilation is not sufficient to carry away exhaust fumes.
- Always be sure that the machine is on secure footing so that it cannot slide or shift around, endangering workers.
- Keep the immediate area free of all bystanders.
- When starting the machine, be sure that nothing is in a position to be hit by the operator's hand or arm.
- Avoid contacting the hot exhaust manifold, muffler or cylinder. Keep clear of all rotating parts.
- Unless the tool or appliance is double insulated, ground it. Tools and appliances which have 3 prong plugs must be plugged into extension cords and electrical receptacles with 3 holes. Before operating any electrical item, be sure that it is in good repair.
- Do not operate this machine or any electrical tool in any area where water or similar materials constitute an electrical hazard to the operator. Do not operate on wet surfaces or in the rain.
- Be sure the switch on electric power tools is in "OFF" position before plugging them into the machine.
- Never operate machine with any guard removed.
- Shut off the engine and disconnect the spark plug wire before working on any part of the machine.
- If the generator is to be used for temporary stand-by service, it must be connected only after opening the main switch. If the generator is to be used as a permanent stand-by, a double throw transfer switch must be installed between the utility power service and the generator. The transfer switch not only prevents utility power from feeding into the generator, but also prevents the generator from feeding out into the utility company's lines. This is intended to protect a life. This installation must be done by a licensed electrician and all local codes must be followed. Generator users are required to notify the local electrical utility company of the presence of a generator on the premises. Fill out the card supplied and mail it to your local electric utility company.
- Follow instructions in this manual when testing Ground Fault Circuit Interrupter to insure reliable operation.

GROUND FAULT INTERRUPTERS

These generators are equipped with a GFCI (Ground Fault Circuit Interrupter) located at the 120V duplex receptacle for protection against the hazards of electrical shock from defective attachments such as tools, cords and cables.

WARNING

The GFCI will not function unless the generator is properly grounded. Follow the correct grounding procedure specified below.

The GFCI is a device that interrupts electricity from either the utility or generator by means of a special type of circuit breaker if a fault current flow to the ground occurs.

WARNING

ONLY THE 120V DUPLEX RECEPTACLE IS PROTECTED BY THE GFCI.

For additional protection against shock hazards due to defective equipment attached to the twist-lock receptacles, consider the use of a GFCI on each of these receptacles as well.

A GFCI can be used only with generators that have the neutral wire internally grounded to the frame, and the frame properly grounded to the earth. A GFCI will not work on generators that do not have the neutral wire grounded to the frame, or on generators which have not been properly grounded.

A GFCI may be required by OSHA regulations; the National Electric Code and/or local and federal codes when operating a generator.

GFCI's and GFCI protected cord sets and cables may be purchased from local electrical supply houses.

As with any other safety devices, the GFCI supplied with these generators must be checked every month to insure hat it is functioning properly. To test the GFCI, follow the instructions below.

1. With the generator running with the loadamatic switch in the "START" position, push the black "TEST" button. The red "RESET" button should pop out. This should result in the power being off at both outlets of the duplex receptacle. Verify this by plugging a test lamp into each outlet.

WARNING

If the "RESET" button does not pop out or the test lamp lights when the "RESET" button does pop out, DO NOT USE EITHER OF THE TWO OUTLETS OF THE DUPLEX RECEPTACLE. Have the units serviced by an authorized servicing dealer immediately.

2. If the GFCI tests correctly, restore power by FIRMLY pushing the "RESET" button back in until you hear or feel a distinctive "click". IF THE GFCI FAILS TO RESET PROPERLY, DO NOT USE EITHER OUTLET OF THE DUPLEX RECEPTACLE. Have the unit serviced by an authorized servicing dealer immediately.
3. High vibration or severe mechanical shock loads may cause the GFCI to trip. If THE GFCI TRIPS BY ITSELF AT ANY TIME, reset it and perform test procedures 1 and 2.

WARNING

Although the above test procedures will indicate proper GFCI operation on an ungrounded or improperly grounded generator, the generator MUST still be properly grounded for the GFCI to function properly and protect the user from electrical faults.

NOTE

Situations exist where the GFCI will not afford any protection against the hazards of electrical shock. EXAMPLE: If a person touches two or more conductors from a damaged cord set and is not in direct contact with the ground, he may receive a shock. Since there is no path to ground for a ground fault current to flow through, the GFCI will not operate an serious injury may result.

The GFCI is merely an added safety precaution. There are no substitutes for good safety precautions, correct electrical practices and proper maintenance of cords, equipment and connections.

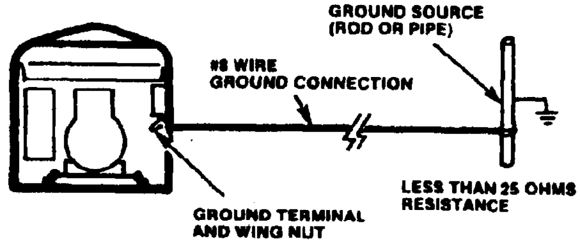
GROUND THE GENERATOR - The wing nut and ground terminal on the control box must always be used to connect the generator frame to a suitable ground source. The ground path should be made with #8 size wire. Connect the terminal of the ground wire between the lock washer and the wing nut, and tighten the wing nut fully. Connect the other end of the wire securely to a suitable ground source. The National Electric Code contains several practical ways in which to establish a good ground source. Examples given below illustrate a few of the ways in which a good ground source may be established.

A metal underground water pipe, in direct contact with the earth for at least 10 feet, can be used as a grounding source. If an underground water pipe is unavailable, an eight foot length of pipe or rod may be used as the ground source. The pipe should be 3/4 inch trade or later and the outer surface must be noncorrosive. If a steel or iron rod is used, it should be at least 1/2 inch diameter and must be listed as material approved for grounding. Drive the rod or pipe to a depth of 8 feet. If a rock bottom is encountered less than 4 feet down, bury the rod or pipe in a trench.

All electrical tools and appliances, operated from this generator, must be properly grounded by use of a third wire or be "Double Insulated". It is recommended that:

1. Extension cords with a 3 hole receptacle and a 3 prong at opposite ends, to ensure continuity of the ground protection from generator to appliance, must be used with electrical devices with 3 prong power cords.
2. Two prong extension cords, used with "Double Insulated" tools, be rated as suitable for use with double insulated tools.

We strongly recommend that all applicable Federal, State and local regulations relating to grounding specifications be checked and adhered to.



USING A VOLT-OHM-MILLIAMP METER COMPONENTS AND COMPONENT TESTING

Standardized components frequently encountered in electrical equipment are capacitors, resistors, and diodes, all of which can be tested on a multimeter.

Using a VOM Meter

The clip leads of a multimeter are plugged into the terminals marked COM and VOM. The markings on the range switch refer to full-scale readings.

Measuring Resistance

Place the selector in the "ohm" X1 position. The top scale is read directly: 0-500 omhs. If more sensitivity is desired, the X100 setting can be used, adding two zeros on to each reading: 0-50,000 ohms.

If the 1K setting is used, add three zeros to each reading: 5,000-500,000 ohms.

Before using the meter on any of the ohms scale, touch the leads together and adjust the meter to zero ohms.

Some Rules

1. When the meter is in one of the ohms scales, never connect the leads across a battery or any other live circuit.
2. Always reset the zero adjustment on each scale.

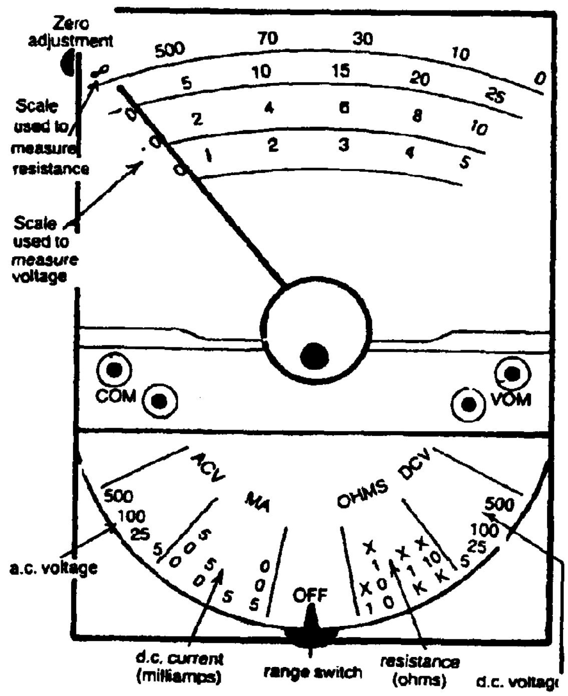
Measuring Voltage

The voltage markings on the range switch refer to the full-scale reading.

With the range switch set at 5VAC, the lower voltage scale is read. A reading of 5 would indicate 5 volts. If the switch is set at 100 VAC, the middle voltage is read and one zero added. For example, a reading of 10 would be 100 volts.

With the switch set at 500, the lower scale is read by adding two zeros. For example, 0-500 volts.

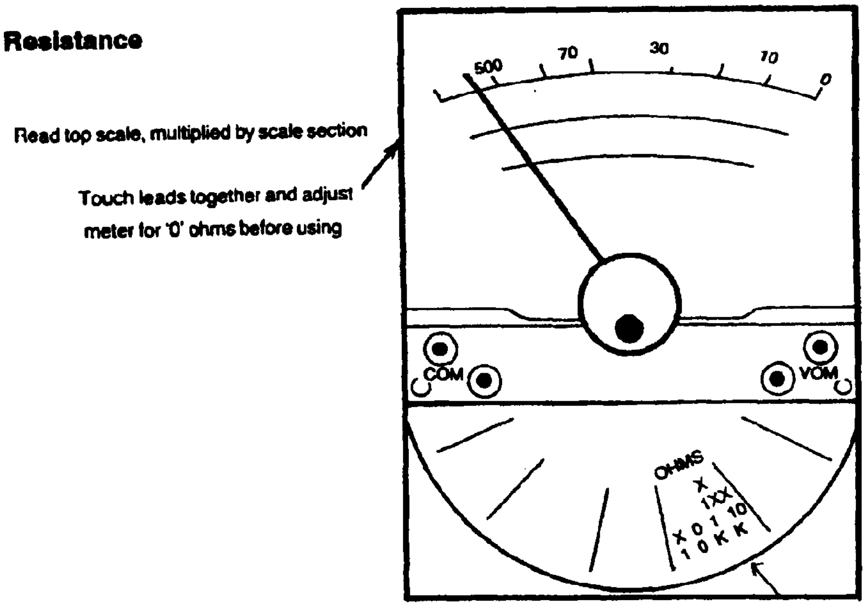
Direct current voltage can be read in the same way by placing the switch in one of the DCV positions.



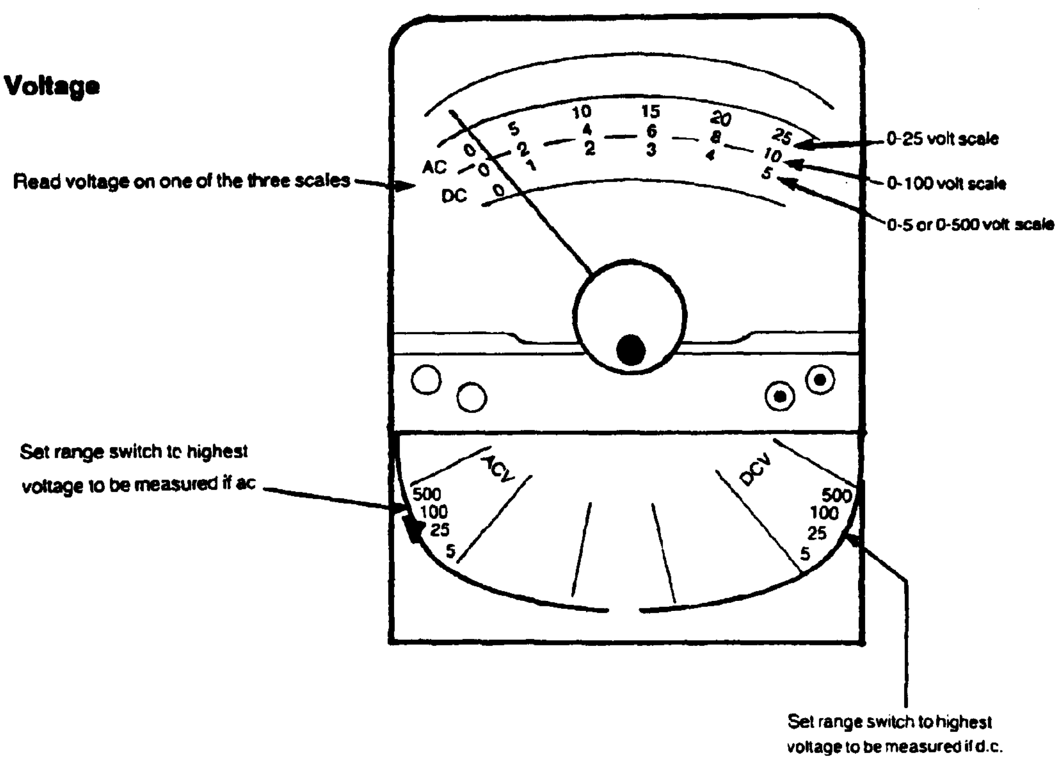
Some Rules

1. If you are not sure of the voltage, always use the highest scale and switch down if necessary for a reading.
2. Always use great care when measuring voltage. Avoid touching the metal part of the clip leads or any part of the circuit.

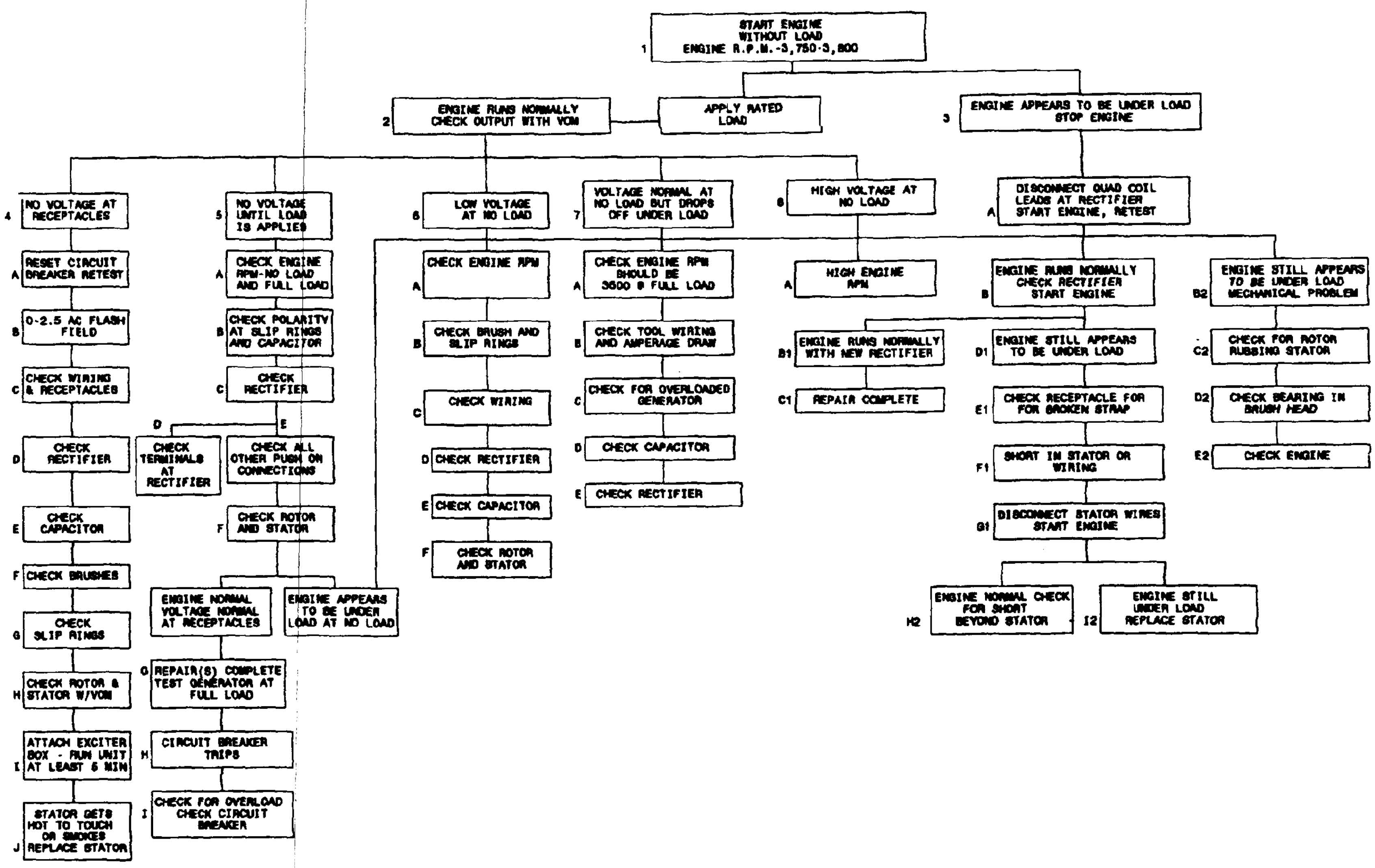
Measuring Resistance



Measuring Voltage



EH/HL GENERATOR TROUBLESHOOTING GUIDE



EH/HL GENERATOR TROUBLESHOOTING

1 START ENGINE WITHOUT LOAD
ENGINE R.P.M. - 3,750 - 3,800

Start and run the generator; use a tachometer (Homelite Part Number 18416) to check engine RPM. No-load RPM should be 3,750-3,800 RPM.

2 ENGINE RUNS NORMALLY
CHECK OUTPUT WITH VOM — APPLY RATED LOAD

Check rated output. Use a volt-ohm-milliamp (VOM) meter set on AC volts scale and insert the VOM probes into the 120V receptacle. Voltage at no-load should be 135-140 volts AC. 240 duplex receptacle output should be 263-268 volts AC.

Apply rated load (2,300, 4,000 or 5,000 watts) to the generator. If the engine speed drops below 3,550 RPM, the problem is low engine power. Check the engine to find the cause of low power.

SERVICE NOTE: If the speed and voltage are correct, use an ammeter to check the amperage draw of the tool or tools being used. Also, check to make sure the total amperage draw (starting and running) does not exceed the generator rated capacity. Check extension cords for proper size; look for long extension cord lengths, damaged insulation, exposed conductors or strained plugs.

4 NO VOLTAGE AT
RECEPTACLE

A RESET CIRCUIT BREAKER
RETEST

If the running test indicated no output, reset the circuit breaker(s) and re-test for voltage.

To test the circuit breakers, remove the red and black wires from each circuit breaker terminal. Use a VOM meter on RX1 scale and place the meter probes on the two circuit breaker terminals. There should be straight continuity. Replace the circuit breaker if no continuity or high resistance is shown.

B 0-2.9V AC, FLASH FIELD

If voltage readings are below 3 volts AC or if there is 0 volts AC, the generator has lost it's residual magnetism. See the section on "Flashing the Field" for more details on residual magnetism and generator operation.

Residual magnetism can be restored by using a 6 or 12 volt battery, and two test leads (with probes) attached to the battery.

Start and run the generator. Hold the negative battery lead probe on the silver pin protruding from the brush holder (with the black negative brush lead attached to the other end of the pin).

Now, momentarily touch the positive battery lead probe to the other silver pin (with the red positive brush lead attached to the pin).

This will feed the rotor (via the brushes) with 6 or 12 volts DC which will energize the rotor.

A "Field Flasher", composed of batteries, magnetic switch, plug and case may be made that simply plugs into the 120V AC receptacle of a running generator. Refer to the "Reference" section at the end of the book for a schematic layout and construction material list.

C — CHECK WIRING AND RECEPTACLES

No voltage at either 120V or 240V receptacles can be caused by broken or loose wires, or burned or broken receptacles. This is especially true when voltage is present at one receptacle and not another. This is why it is necessary to check voltage at <u>all</u> receptacles and outlets when testing the generator output.

Inspect all output wires from the stator to the receptacles. Also, inspect the quad winding and brush lead terminals at the rectifier. If wire terminals are loose, flow solder onto the terminal and wire to give a good electrical connection.

D — CHECK RECTIFIER

Remove the two yellow AC leads and the black (negative) and red (positive) brush leads from the rectifier.

Place a VOM on the RX1 scale or equivalent. Touch the VOM probes to any two rectifier terminals that are next to each other.

If there is continuity, note the resistance reading. Now, switch the leads between the two terminals. There should be <u>no</u> continuity. If there was no continuity when the meter probes were placed on the rectifier, switch the VOM probes between the two terminals. There should now be continuity. Once again, the resistance reading should be noted. This test should be performed on all four rectifier terminals. When completed, the test should look like this:

Terminals 1 and 2:	Continuity, No Continuity
Terminals 2 and 3:	Continuity, No Continuity
Terminals 3 and 4:	Continuity, No Continuity
Terminals 4 and 1:	Continuity, No Continuity

If the diode under test shows continuity each time the leads are switched, the diode is shorted out and the rectifier should be replaced. If there is no continuity in either direction, the diode is open, and the rectifier should be replaced. If one or more resistance reading is much lower than the rest, replace the rectifier.

SERVICE NOTE: If diodes in the rectifier were shorted out, the rotor may have been fed AC current. Residual magnetism will have to be re-established by flashing the field.

E CHECK CAPACITOR

Place VOM on RX100 minimum or highest ohm scale on the meter. Disconnect the capacitor leads from the circuit. Place the two VOM lead probes on each capacitor lead. The needle should swing sharply from straight continuity towards infinity. The needle should rise until resistance in the capacitor stops the rise, then the VOM should show a stable, charged state (no increase or decrease). NOTE: Analog meters will show a rise to infinity, then the needle will drop towards zero once resistance is high enough in the capacitor. Digital meters will rise towards infinity until the capacitor is fully charged, then the meter will go to the overscale/no continuity mode.

Switch the VOM leads. There should be a rapid decrease in value until the VOM reads zero ohm. If the VOM reads straight continuity at the capacitor leads, the capacitor is shorted. If the VOM reading fluctuates between straight continuity and infinity, the capacitor is leaking. If either of these conditions exist, replace the capacitor.

F CHECK BRUSHES

Inspect the brush lead connections with the brush holder. The prongs on the brush leads must be locked in place on the brush holder, otherwise the leads can loose contact with the brush springs.

Use a VOM meter on RX1 scale to check continuity through each brush lead and brush. Place one VOM probe on the lead (disconnected from the rectifier) and one probe on the slip ring. There should be straight continuity. If not, disconnect the brush lead(s) from the brush holder and test the leads and brushes separately.

Examine the brushes. If they are worn to 9/16" (14mm) or less, replace them. Worn brushes can "bounce" on the slip rings causing intermittent or low output.

G CHECK SLIP RINGS

Examine the slip rings for excessive wear and/or damage. Grooves in the slip rings are not acceptable. Use #00 fine grit sand paper to smooth the surface of the slip rings if damaged. A carbon path (black discoloration) on the slip rings is normal, however a severe build up of carbon may cause the brushes to lose contact with the slip rings. Clean as shown above.

H **CHECK ROTOR AND STATOR WITH VOM**

Visually inspect the rotor for broken wires at the slip rings and field coil. Re-solder the connections or replace the rotor if any connections are broken.

Put VOM selector switch in the RX1 position or equivalent. Place one VOM lead probe on each slip ring. The rotor should read one of the following resistances:

Model	Resistance in ohm's	Model	Resistance in ohm's
HL2500	43.8 +/- 6%	EH2500	46.7 +/- 6%
HL4400	61.1 +/- 6%	EH4400	67.0 +/- 6%
HL5000	71.8 +/- 6%	EH5500	76.0 +/- 6%

If the resistance reading is lower than that specified, the rotor has shorted turns and should be replaced.

Touch one rotor slip ring with one of the VOM probes. Place the other VOM probe on the rotor shaft. There should be no continuity. If continuity exists on either slip ring, the coil is shorted to the shaft. The rotor must be replaced.

Disconnect the two yellow AC quad winding leads from the rectifier. Select RX1 or lowest ohm scale on the VOM. Measure the quad winding resistance. The resistance should be:

Model	Resistance in ohm's	Model	Resistance in ohm's
HL2500	1.089 +/- 6%	EH2500	1.177 +/- 6%
HL4400	.888 +/- 6%	EH4400	.999 +/- 6%
HL5000	.843 +/- 6%	EH5500	.973 +/- 6%

If the readings are below those specified, replace the stator.

With the VOM set on RX1 or lower, touch one VOM probe to a yellow quad winding lead. Touch the other probe to the stator laminations. Test both wires in turn. If continuity exists on either wire, the stator windings are shorted and the stator must be replaced.

With VOM selector switch in the RX1 position or lowest scale possible, measure the resistance between the stator coil (EH, HL2500) or coils (EH, HL4400, EH, HL5500).

Model	Stator Lead Color Codes	Resistance in ohm's	
HL2500	White, Black	.458 +/- 6%	EH2500 .389 +/- 6%
HL4400	White, Black	.313 +/- 6%	EH4400 .278 +/- 6%
HL4400	Red, Brown	.313 +/- 6%	EH4400 .278 +/- 6%
HL5500	White, Black	.228 +/- 6%	EH5500 .208 +/- 6%
HL5500	Red, Brown	.228 +/- 6%	EH5500 .208 +/- 6%

If continuity is substantially less than the specified resistance or if there is no continuity, replace the stator.

Place one VOM probe on each of the stator leads in turn and the other VOM probe on the stator laminations. There should be no continuity. If continuity exists, replace the stator.

I ATTACH EXCITER BOX TO UNIT RUN AT LEAST FIVE MINUTES

Attach the red and black leads (w/alligator clips) of the exciter box through a slot on the brush head. Clip each exciter box lead to their respective positive and negative brush/capacitor lead pins that are extended beyond the brush holder.

Start and run the generator. Turn on the exciter box. Run the generator at least 5 minutes, unless problems with the rotor or stator are visible or the engine is stalled.

J STATOR GETS HOT TO TOUCH OR SMOKES - REPLACE STATOR

If the generator engine is stalled or the stator or rotor gets hot to the touch once the exciter box is turned on, the stator or rotor has a layer short and must be replaced.

5 NO VOLTAGE UNTIL LOAD IS APPLIED

A CHECK ENGINE RPM NO LOAD AND FULL LOAD

Check engine speed to make sure it meets the 3,750-3,800 RPM no load and 3,600 RPM full load.

B | CHECK POLARITY AT SLIP RING AND CAPACITOR

Inspect the polarity of the brush/capacitor leads at the brush holder. The red or positive leads should be attached to the brush that is closest to the brush head bearing. This brush rides on the outer slip ring. The black brush/capacitor lead should be attached to the brush closest to the stator. This brush rides on the inner slip ring.

Check the polarity of the brush leads at the rectifier. The red (+) lead goes on the + terminal of the rectifier. The black (-) lead goes on the - terminal of the rectifier.

SERVICE NOTE: Care must be taken to establish proper polarity of the brush leads as improper installation will blow the capacitor.

C | CHECK RECTIFIER

The rectifier check is the same as shown in section 4D.

D | CHECK TERMINALS AND RECTIFIER

Flag terminal on the AC (yellow) quad winding leads and the brush leads (red and black) can be loose and cause a loss of field build up in two ways.

First, the flag terminals can be loose on the rectifier terminals, resulting in an intermittent loss of the electrical path. When a load is applied the boost in quad winding output can jump a loose terminal resulting in output. The flag terminals must be tight on the rectifier terminals.

Second, the flag terminals can be loose on the AC or brush wires and not making a 100% electrical connection. If the terminals are loose, flow solder into the terminal/wire joint to make sure a good connection is maintained.

E | CHECK ALL OTHER PUSH ON CONNECTIONS

Check all other push on connections, including at the 120V AC receptacle (white and brown stator leads) and the black and red leads at the circuit breaker(s).

F | CHECK ROTOR AND STATOR

Visually inspect the rotor slip ring and rotor coil connections. A loose connection can cause output when a load is applied.

Use a VOM meter to measure continuity in the rotor. The VOM meter uses a small electrical current to measure continuity; if there is a bad electrical connection that is made when a load is applied, it will show as no continuity with a VOM meter. As with the rotor, the stator wires can have a small break and only show output when a load "boost" is applied to the stator windings. It is much like the arcing that is generated when a light switch is thrown.

Use a VOM meter to test stator continuity; any bad electrical connections will show as no continuity.

G | REPAIR(S) COMPLETE - TEST GENERATOR AT FULL LOAD

When completing repairs on a generator, it is a must that full load be drawn. This tests generator output, engine performance and proper voltage levels and hertz.

H | CIRCUIT BREAKER TRIPS

The circuit breaker(s) are in series with the output of the generator and will protect the generator from severe overloads, bad tools or equipment and dead shorts.

I | CHECK FOR OVER LOAD CHECK CIRCUIT BREAKER

If there is more than one load on the generator, reduce the load. If the circuit breaker trips, examine the tools or equipment with an ammeter to determine amperage draw.

Use an ammeter to determine what amperage draw is tripping the circuit breaker. If it is below rated amperage, replace the circuit breaker.

6 | LOW VOLTAGE AT NO LOAD

A | CHECK ENGINE R.P.M.

Engine RPM must be 3,750-3,800 RPM No-load. Use a good quality tachometer (Homelite P/N 18416) to test the no load speed.

Low engine RPM will result in low voltage under load; this can damage the generator. Tools and equipment may also be damaged.

B **CHECK BRUSHES AND SLIP RINGS**

Follow the test and inspection procedures as outlined in sections 4F and 4G.

Brushes or springs that are worn can "bounce" on the slip rings, causing the voltage at no load to be low or intermittent.

C **CHECK WIRING**

Examine the wiring carefully for chafing, loss of insulation, and separated wires and terminals.

For example, if the capacitor is not in the circuit because of a loose connection or broken wire, no load voltage will decrease to approximately 90V AC.

D **CHECK RECTIFIER**

Use the "Go-No Go" test method as outlined in section 4D.

A diode failure (open) can cause half-wave rectification, so that generator output is reduced by approximately one-half.

E **CHECK CAPACITOR**

Capacitor test instructions are located in section 4E.

An open capacitor can reduce AC output by causing a distortion in the AC wave form, which reduces the effective DC power to the rotor. This can reduce AC output by 25%.

A shorted capacitor can cause rectifier and rotor failure, as the capacitor is parallel to the rotor windings. Generally, the capacitor will blow, because amperage draw to the capacitor is greater than the design limits of the canister.

F **CHECK ROTOR**

A layer short within the rotor coils can reduce AC output by reducing the strength of the magnetic field.

Use the test instructions in sections 4H and 5F to troubleshooting the rotor.

G **CHECK STATOR CONTINUITY**

Use a VOM meter to test the stator windings. A layer short in the stator can reduce AC output, although in most cases, there will be no output. Test the stator as in sections 4H and 5F.

H **ATTACH EXCITER BOX RUN AT LEAST 5 MINUTES**

The exciter box is an external DC power supply, (110V DC, 2.5 A) that energizes the generator so that any layer shorts in the stator or rotor can be detected (the unit will smoke or get extremely hot).

Small layer shorts, those involving few turns of wire, are harder to detect. That is why the generator must run approximately 5 minutes with the exciter box operating.

Refer to section 4F for testing instructions.

I **STATOR GETS HOT TO TOUCH OR SMOKES- REPLACE STATOR**

A layer short in stator windings will always be a point of high resistance. The exciter box "forces" current flow through the stator and the stator windings will become extremely hot or the varnish will burn and the stator will smoke.

7 **VOLTAGE NORMAL BUT DROPS OFF UNDER LOAD**

A **CHECK ENGINE RPM-SHOULD BE 3,600 RPM AT FULL LOAD**

No load engine speed must be set slightly above full load speed of 3,600 RPM in order to maintain 60 Hertz at full load. No load speed should be 3,750-3,800 RPM.

B **CHECK TOOL WIRING AND AMPERAGE DRAW**

Examine all tools and/or equipment drawing amperage from the generator. Faulty cord sets, worn tools can cause short circuits and heavy amperage draw. Use an ammeter to test the current draw of the tools and/or equipment.

C **CHECK FOR OVERLOADED GENERATOR**

Check the nameplate ratings of tools or equipment being used with the generator. The nameplate amperage rating indicates running amperage draw only. Use the following rough estimate to determine starting amperage for various tools and equipment.

1. Multiply x 1 - if the generator is operating heating or lighting equipment. Example: 10-100 watt light bulbs draw a constant 8.3 amps (10 x 100 / 120 = 8.3 amps).

2. Multiply x 2 - if a hand tool is being used. They typically use twice their rated amperage under full load as they do under no load conditions. Example: a hand drill that requires 7 amps no load may require up to 14 amps at full load use.

3. Multiply x 3 - if an electric motor is used to operate a piece of equipment. They require up to three times their rated amperage to start as they do when they come up to speed. Example: a 1 HP capacitor start motor typically requires approximately 9 amps to run, 27 amps to start.

Generator watts required = amps x volts x 1, 2 or 3. This is a good minimum estimate of equipment or tool amperage draw. Remember, the total amperage draw must not exceed the amperage rating of the 120 or 240 volt receptacles.

Large generator loads should always be started first, followed by the next largest load. The smallest loads should be started last.

D | CHECK CAPACITOR

If the capacitor is breaking down under load, voltage will drop as load is applied. Use test instructions in section 4E for troubleshooting information.

E | CHECK RECTIFIER

No load voltage may appear normal, however as load is applied a marginal diode can fail, causing a drop or loss of the magnetic field, reducing voltage at the receptacles. Use section 4D for testing the rectifier.

8 | HIGH VOLTAGE AT NO LOAD

A | HIGH ENGINE RPM

Engine must be run at no load which should be 3,750-3,800 RPM.

Run the generator under full load (2300 watts - HL/EH2500; 4000 watts - HL/EH4400; 5000 watts - HL/EH5500); the unit should run at 3,600 RPM.

3 ENGINE APPEARS TO BE UNDER LOAD - STOP ENGINE

A DISCONNECT QUAD COIL LEADS AT RECTIFIER-START ENGINE-RETEST

B ENGINE RUNS NORMALLY, CHECK RECTIFIER, START ENGINE

A rectifier that is shorted to ground will overload the generator. Up to 100 amps can flow through a shorted rectifier, so the simplest way to test for this fault is to disconnect the two yellow (AC) quad winding leads from the rectifier.

Perform the Go-No Go rectifier test shown in Section 4D.

B1 ENGINE RUNS NORMALLY WITH NEW RECTIFIER

C1 REPAIR COMPLETE

D1 ENGINE STILL APPEARS TO BE UNDER LOAD

E1 CHECK RECEPTACLE FOR BROKEN STRAP

Dual voltage units (EH, HL4400, EH, HL5500) must have the strap on the hot (brass screw) side of the 120V receptacle broken prior to installation or the two stator output windings will oppose one another causing a load on the engine. Examine.

F1 SHORT IN STATOR OR WIRING

A loaded condition on start up indicates a miswiring problem (neutral, hot wires on same side of receptacle), or a short to ground in the stator winding.

G1 DISCONNECT STATOR WIRES START ENGINE

To determine where the short to ground is (wiring or stator) disconnect the stator leads from the brush head components. Use electrical tape to insulate each stator lead from possible grounding.

Just prior to brush head re-installation, route the four leads through a slot in the brush head so they are hanging outside. Start the engine.

H1 **ENGINE NORMAL - CHECK FOR SHORT BEYOND STATOR**

If the engine runs normally, there is miswiring in the brush head. Use the electrical schematic for the unit to check for wiring faults.

I1 **ENGINE STILL UNDER LOAD REPLACE STATOR**

Check the four wires for signs of chafing or rubbing; shorted wires may cause an artificial load. Use a VOM meter to test each stator lead to ground. Continuity with any lead indicates a short to ground. Replace the stator.

B2 **ENGINE STILL APPEARS TO BE UNDER LOAD; MECHANICAL PROBLEM**

C2 **CHECK FOR ROTOR RUBBING STATOR**

If the generator is running, listen for abnormal noise coming out of the generator end. If the unit is not running, pull on the starter grip (high tension lead disconnected) to listen for possible mechanical noises.

Remove the four stator bolts (nuts) and brush head. Find and remove the two brushes and springs from the brush head. Physically inspect the leading edge of the rotor and stator for signs of rubbing. It may be necessary to remove the stator to thoroughly inspect the rotor and stator.

Causes of rotor and stator rubbing are: end bell misalignment (bolts loose, bolt holes mis-drilled), incorrect stator manufacturing, brush head misalignment, or brush head bearing failure.

D2 **CHECK BEARING IN BRUSH HEAD**

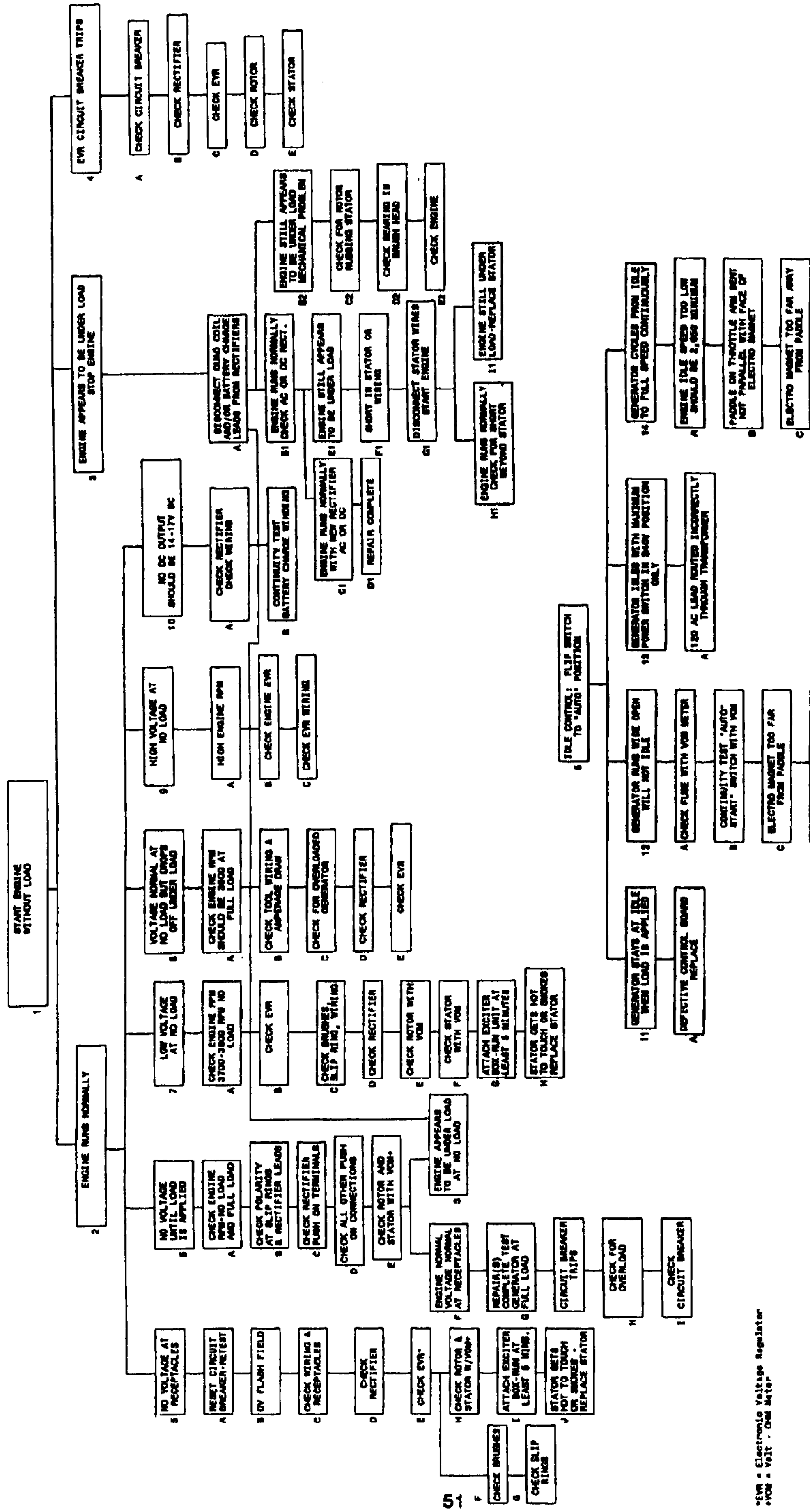
Inspect the bearing and/or rotor shaft (where it runs on bearing I.D.*) for signs of burning, blueing or scoring. A worn or damaged bearing can cause abnormal loading on the engine.

E2 **CHECK ENGINE**

Low engine power is obvious once full load is applied. If voltage is normal, but engine speed drops below 3,550 RPM, then the engine needs servicing. Severe engine damage may cause hard starting and the appearance of being under a slight load.

I.D. = Inside Diameter

170/180 CONTRACTOR (BRH) SERIES GENERATOR TROUBLESHOOTING GUIDE



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*EVR = Electronic Voltage Regulator
+VOM = Volt - OHM Meter

170/180 CONTRACTOR (BRH) SERIES TROUBLESHOOTING

1 START ENGINE WITHOUT LOAD

2 ENGINE RUNS NORMALLY

5 NO VOLTAGE AT RECEPTACLE

A RESET CIRCUIT BREAKER - RETEST

The 170/180 (BRH) series generators utilize a single field circuit breaker. If tripped by an overload or dead short, this circuit breaker will open the excitation circuit and output will cease.

Reset the circuit breaker (if tripped), start the engine and use a VOM* meter to measure 120/240 volt output. If 120/240 volt output is now normal, apply rated load. Run the generator at least five minutes. If the circuit breaker trips again, go to Section 4 and test the EVR and circuit breaker. If the circuit breaker does not trip, find out what loads are being put on the generator, inspect and test all tools and equipment being used on the generator.

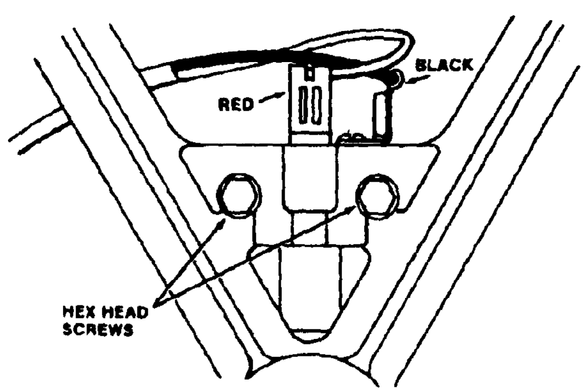
B O-V FLASH FIELD

Check voltage at each receptacle, 120V and 240V. If there is no voltage (0-volts), the generator has lost its residual magnetism.

Residual magnetism can be restored by applying 3-12V DC to the positive and negative brush terminals located on the brush head.

Remove the fan cover, fan and rotor bolt. Reinstall the rotor bolt and washer. Torque the rotor bolt. Do not run the generator without the rotor bolt installed.

Disconnect the positive and negative brush leads from the brush terminals (see illustration below). Place the two leads away from the rotor, so they will not contact the rotor at start-up.



*VOM = Volt - Ohm - Milliamp
+EVR = Electronic Voltage Regulator

Start and run the generator. Place the negative battery terminal probe on the innermost brush terminal. Then, place the positive battery terminal lead on the outside brush terminal. As soon as contact is made with the positive brush terminal, the field will be flashed.

A "Field Flasher" can be made that plugs into the 120V AC receptacle and flashes the field without disassembling the fan cover, fan or rotor bolt. See the reference section for Design and Construction Details.

C **CHECK WIRING AND RECEPTACLES**

It is very important to visually inspect all wiring and terminals inside the control panel. Handle each wire, tug on the wire and terminal where it attaches to the terminal block, receptacle or board. Suspect a wiring problem if there is voltage at one receptacle and not another.

Check all push-on terminals in the control panel and brush head. There must be a 100% electrical connection between the push-on terminal and component.

Place a jumper across each outlet (generator side), and continuity test the receptacle between each hot leg or neutral. Also, test between each current carrying leg and ground.

D **CHECK RECTIFIER**

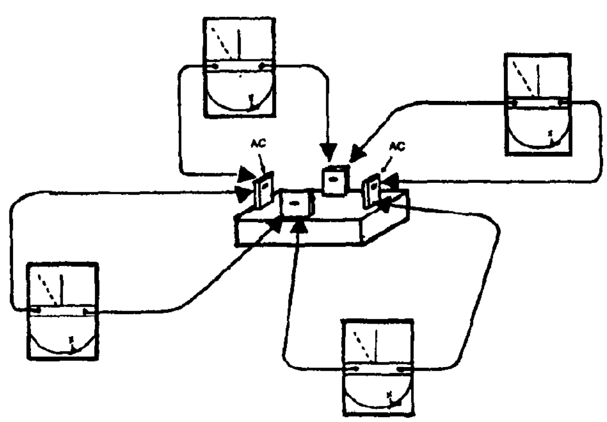
Use a VOM meter to test the rectifier. Use the Go-No-Go method to continuity check the rectifier.

Remove the quad winding leads (blue/yellow) and the two brush leads (black/red) from the exciter rectifier. Use the following procedure and illustration to test the rectifier.

Place a VOM on the RX1 scale or equivalent. Touch the VOM probes to any two rectifier terminals that are adjacent to each other.

If there is continuity, note the resistance reading. Now, switch the leads between the two terminals. There should be no continuity. If there was no continuity when the meter probes were placed on the rectifier, switch the VOM probes between the two terminals. There should now be continuity. Once again, the resistance reading should be noted. This test should be performed on all four rectifier terminals. When completed, the test should look like this:

Terminals 1 and 2:	Continuity, No Continuity
Terminals 2 and 3:	Continuity, No Continuity
Terminals 3 and 4:	Continuity, No Continuity
Terminals 4 and 1:	Continuity, No Continuity



If the diode under test shows continuity each time the leads are switched, the diode is shorted out and the rectifier should be replaced. If there is no continuity in either direction, the diode is open, replace the rectifier. If one or more resistance readings is abnormally lower than the rest, replace the rectifier.

A good practice is to go around the rectifier twice to insure that all terminals are checked.

SERVICE NOTE: If diodes in the rectifier were shorted out, the rotor may have been fed AC current. Residual magnetism will have to be re-established by flashing the field.

E CHECK EVR

Certain components on the EVR board can fail (Q1 Transistor, build-up circuit components, etc.) causing no output. We can remove the EVR from the circuit and then test for output.

1. Remove the yellow and white wires going from the EVR board (VR1) to the terminal board (TB1) at the terminal board end. Remove the red wire at the EVR board (VR1). Tape this lead terminal with plastic tape.

2. Remove the small black wire on the EVR board terminal strip (position #1) and move it to the terminal strip (position #3) where it joins the two small white leads.

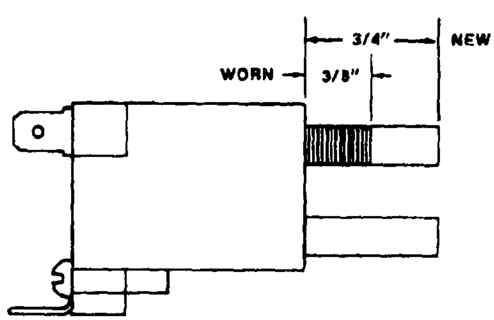
3. Start and run the generator. With a VOM meter set on the 300 volt scale, measure the output at the 120V receptacle. This is unregulated voltage and should read approximately 150-160V AC.

No voltage indicates a problem in the excitation circuit (brushes, rectifier, slip rings/rotor) or stator.

F CHECK BRUSHES

Generally, brushes should be replaced every 1,000 hours or when the brush length is 3/8" (10 mm) or less (see diagram below). If the brushes are worn short enough, they can "bounce" causing intermittent output. Broken brushes, brush leads, or loose terminals, can also cause the loss of magnetic field resulting in no output.

Use a VOM meter on RX1 scale to check continuity through each brush lead and brush. Place one VOM probe on the positive (+) brush lead (disconnect from the rectifier), and the other probe on the slip ring. Repeat this same step for the black (-) brush lead.



*EVR = Electronic Voltage Regulation

There should be straight continuity. If not, disconnect each brush lead from the brush terminals and remove the brushes from the brush holder. Continuity test each lead, examine brushes for breakage, and spring tension on the brushes. Make sure the brushes slide up and down easily in the brush holder.

G CHECK SLIP RINGS

Inspect the slip rings for grooves, bumps or excessive carbon build-up. Use #00 fine grit sandpaper to clean the slip rings. A carbon path (black discoloration) on the slip rings is normal; however, a severe build-up of carbon can cause the slip rings to lose contact with the slip rings.

H CHECK ROTOR AND STATOR WITH VOM

Inspect the rotor slip ring wire connections with the field coil. Re-solder the connection(s) or replace the rotor if continuity cannot be established.

Use a VOM with the selector switch in the RX1 position. Place the red VOM probe on one slip ring, and the black VOM on the other slip ring. The rotor resistance should be as follows:

TEST ROTOR CONTINUITY

Model	Rotor Part No.	Rotor Resistance* (ohms)
HG1500	A49653	29.0
HG2100	A49653	29.0
HG2500(A)	A49475-S	32.0
HG(E)3500	A49099-S	33.5
170R18	A49653	29.0
172B26	A49475-S	32.0
172R24	A49475-S	32.0
176B(I)40	A49089-S	37.4
176R(I)42	A49095-S	42.5
178B(I)48, 178HI48	A49095-S	42.5
178V152	A49095-S	42.5
180R(E)62, 180HI(E)62	A49094-S	50.0

*All readings are +/-6% at + 77°F. (25°C.)

If the resistance is lower than those specified, the rotor has shorted turns and should be replaced.

Touch one slip ring with one of the VOM meter probes. Place the other VOM meter probe on the rotor shaft, there should be no continuity. Test each slip ring in turn; if continuity exists with either slip ring, replace the rotor.

TEST STATOR QUAD WINDING CONTINUITY

Remove the yellow and blue wires from the exciter rectifier. Use a VOM on RX1 scale or lowest scale to measure quad winding resistance at the yellow and blue wires. The quad winding resistance should be:

Model	Resistance* (ohms)
HG1500, HB2100, 170RI18	2.20
HB2500(A), 172B26, 172R24	1.80
176B(I)40	1.49
176R(I)42, 178B(I)48, 178(H)48	1.18
180R(IE)62, 180HI(E)62	1.10
HG(E)3500	1.33

*All readings are +/-6% at 77oF. (25oC.)

If the readings are below those specified, replace the stator.

SERVICE NOTE: If there is no continuity in the quad winding, disconnect the yellow quad winding at the circuit breaker. This will bypass the circuit breaker. If continuity now exists between the two yellow wires, use a VOM meter to test the circuit breaker and blue wire.

With the VOM set on RX1 or lower, touch one VOM probe to a yellow or blue quad winding lead. Touch the other probe to the stator laminations. Test both wires in turn. If continuity exists on either wire, the stator windings are shorted and the stator must be replaced.

TEST STATOR MAIN WINDING CONTINUITY

With VOM selected switch in the RX1 position, or lowest scale possible, measure the resistance between the stator coil or coils. Remove the four stator leads at the terminal block (TB1) or remove the stator leads from the receptacles (see schematics section). Main winding resistance should be as follows:

Model	Stator Part No.	Resistance* (ohms)
HG1500, HG2100, 170RI8	A49637-S	.82
172B26, 172R24, HG2500	A49476-S	.53
HG2500A	A49793-S	.53
176B(I)40	A49128-S	.67 x 2**
176R(I)42, 178VI52	A49330-S	.358 x 2
178B(I)48, 178HI48	A49124-S	.358 x 2
180R(IE)62, 180HI(E)62	A49331-S	.225 x 2
HG(E)3500	A49127-S	.75 x 2

*All readings are +/-6% at 77oF. (25oC.)

**x 2 = Two stator windings each with this resistance.

If continuity is substantially less than the specified resistance, or if there is no continuity, replace the stator.

Place one VOM probe on each of the stator leads in turn, and the other VOM probe on the stator laminations. There should be no continuity. If continuity exists, replace the stator.

I | ATTACH EXCITER BOX RUN AT LEAST 5 MINUTES

Remove the fan cover, fan, rotor bolt/washer, plus the red and black brush leads (from brush holder terminals). Reinstall the rotor bolt and torque per specifications. Attach the exciter box leads (black and red) in the same position as the brush leads: red towards fan, black towards rotor. Start and run the generator, turn the exciter box on, then run the generator at least five minutes, unless problems with the rotor or stator are visible or the engine stalls.

J | STATOR GETS HOT TO TOUCH OR SMOKES - REPLACE STATOR

If the generator engine is stalled or the stator or rotor gets hot to the touch once the exciter box is turned on, the stator or rotor has a layer short and must be replaced.

6 | NO VOLTAGE UNTIL LOAD IS APPLIED

A | CHECK ENGINE RPM - NO LOAD AND FULL LOAD

Check engine speed to make sure it meets the 3,750-3,800 RPM no load and 3,600 RPM full load specification.

B | CHECK POLARITY AT SLIP RINGS AND RECTIFIER LEADS

Inspect the polarity of the brush leads at the brush holder. The red or positive lead should be attached to the brush that is closest to the fan. The brush rides on the outer slip ring. The black brush lead should be attached to the brush closest to the rotor. This brush rides on the inner slip ring.

Check the polarity of the brush leads at the rectifier. The red (+) lead goes on the + terminal of the rectifier. The black (-) lead goes on the - terminal of the rectifier.

SERVICE NOTE: Care must be taken to establish proper polarity of the brush leads as improper installation will blow the capacitor.

C | CHECK RECTIFIER PUSH ON TERMINAL

Flag terminals on the brush leads (red and black) can be loose and cause a loss of field build-up in two ways:

First, the flag terminals can be loose on the rectifier terminals, resulting in an intermittent loss of electrical path. When a load is applied, the "boost" in quad winding output can jump a loose terminal resulting in output. The flag terminals <u>must</u> be tight on the rectifier terminals.

Second, the flag terminals can be loose on the AC or brush wires and not making a 100% electrical connection. If the terminals are loose, flow solder into the terminal/wire joint to make sure a good connection is maintained.

D | CHECK ALL OTHER PUSH ON CONNECTIONS

Visually inspect the quad winding terminals (blue/yellow) at the rectifier. Crimp the flag terminals if they are loose on the rectifier terminals. A 100% electrical connection is required. Also, arcing can burn out loose flag terminals.

E | CHECK ROTOR AND STATOR WITH VOM

Visually inspect the rotor slip ring and rotor coil connections. A loose connection can cause output when a load is applied.

Use a VOM meter to measure continuity in the rotor. The VOM meter uses a small electrical current to measure continuity. If there is a bad electrical connection that is made when a load is applied, it will show as no continuity with a VOM meter. As with the rotor, the stator wires can have a small break and only show output when a load "boost" is applied to the stator windings.

Use a VOM meter to test stator continuity; any bad electrical connections will show as no continuity.

F | ENGINE NORMAL VOLTAGE NORMAL AT RECEPTACLES

G | REPAIR(S) COMPLETE TEST GENERATOR AT FULL LOAD

When completing repairs on a generator, it is a <u>must</u> that full load be drawn. This tests generator output, engine performance, proper voltage levels, and Hertz.

CIRCUIT BREAKER TRIPS

H | CHECK FOR OVER LOAD

Test all tools and equipment with an ammeter to determine total amperage requirements or for worn tools or equipment drawing excessive current.

If an ammeter is not available, get the nameplate amperage draw (running) for each tool and piece of equipment.

A general rule of establishing starting load current is:

<u>Running amperage x 1</u> = for a purely resistive circuit (light bulbs, heaters). Starting up or operating amperage is the same.

<u>Running amperage x 2</u> = tools with universal type AC/DC motors. Requires up to two times their free running amps as when they are operating under load.

<u>Running amperage x 3</u> = equipment that uses motors. They can use up to three times their running amps to start as to run.

*VOM = Volt - Ohm - Milliamp

These are the minimum amperage requirements. Find out the total length and AWG ratings for extension cords. The IR (voltage) drop across long cord runs can overload a generator. Use the chart below to determine cord applications:

CURRENT IN AMPERES	LOAD IN WATTS AT 120 VOLTS	LOAD IN WATTS AT 240 VOLTS	MAXIMUM ALLOWABLE CABLE LENGTH #8 WIRE	#10 WIRE	#12 WIRE	#14 WIRE	#16 WIRE
2.5	300	600		1000 ft.	600 ft.	375 ft.	250 ft.
5	600	1200		500	300	200	125
7.5	900	1800		350	200	125	100
10	1200	2400		250	150	100	50
15	1800	3600		150	100	65	
20	2400	4800	175 ft.	125	75	50	
25	3000	6000	150	100	60		
30	3600	7200	125	65			
40	4800	9600	90				

I CHECK CIRCUIT BREAKER

Generally, the circuit breaker will only trip if amperage across the circuit breaker exceeds 2.5A (3.0A on models 180R(IE)62, 180H(E)63. This can be a result of a short circuit in the quad windings or shorted diode in the rectifier, or an excessive overload to the generator. If the generator has normal output and the unit is not overloaded, the circuit breaker must be tested.

Disassemble the control panel to gain access to the circuit breaker. Start and run the generator, apply rated load, then place an ammeter probe around the blue or yellow lead that is connected to the circuit breaker. At rated load, the circuit breaker should not trip below 2.5 or 3.0 (180 series) amps. If it trips, replace the circuit breaker.

7 LOW VOLTAGE AT NO LOAD

A CHECK ENGINE RPM 3700-3800 RPM NO LOAD

B CHECK EVR

The electronic voltage regulator has several components (capacitor, transistors, diodes) that can fail, producing low voltage in the output.

Use the Troubleshooting Information in Section 5E to test the EVR.

C CHECK BRUSHES, SLIP RINGS, WIRING

The brushes eventually wear out (after approximately 1,000 hours) causing the brushes to "bounce" and lose contact with the slip rings. Use Section 5F information to test the brushes.

Damaged slip rings (grooves, carbon build-up) can provide a loss of electrical contact, resulting in low voltage. Examine the slip rings and clean, if required. See Section 5F for more details.

Partial contact between wires, connectors, terminals and receptacles can cause low or intermittent output. Use Section 5C for more information.

D **CHECK RECTIFIER**

An open diode in the exciter rectifier can cause a loss of approximately one-half of the normal voltage. Use the "Go-No-Go" method as outlined in Section 5D to test the rectifier.

E **CHECK ROTOR WITH VOM**

A layer short within the rotor coils can reduce AC output by reducing the strength of the magnetic field.

Use the test instructions in Section 4H to troubleshoot the rotor.

F **CHECK STATOR WITH VOM**

Remove the blue (T1), Brown (T2), White (T3) and Black (T4) stator leads from the terminal board. Also, remove the two quad winding leads (yellow) from the circuit breaker and rectifier.

Use a VOM meter to test the stator windings. A layer short in the stator can reduce AC output, although in most cases, there will be no output. Test the stator as in Sections 4H and 6E.

G **ATTACH EXCITER BOX**
RUN UNIT AT LEAST 5 MINUTES

The exciter box is an external DC power supply (110V DC, 2.5A), that energizes the generator so that any layer shorts in the stator or rotor can be detected (the unit will smoke or get extremely hot).

Small layer shorts, those involving few turns of wire are harder to detect. That is why the generator must run approximately five minutes with the exciter box operating.

Refer to Section 5I for testing instructions.

H **STATOR GETS HOT TO TOUCH**
OR SMOKES - REPLACE STATOR

A layer short in stator windings will always be a point of high resistance. The exciter box "forces" current flow through the stator and the stator windings will become extremely hot or the varnish will burn and the stator will smoke.

B **VOLTAGE NORMAL AT NO LOAD**
BUT DROPS OFF UNDER LOAD

A **CHECK ENGINE RPM - SHOULD**
BE 3600 AT FULL LOAD

Engine speed should always be checked under full load conditions. Apply the rated load. Engine RPM should be 3,600. If engine speed drops below 3,550, the problem is low engine power. If engine speed remains constant, but voltage drops, there is a problem in the excitation circuit.

B **CHECK TOOL WIRING AND AMPERAGE**

Examine all tools and/or equipment drawing amperage from the generator. Faulty cord sets or worn tools can cause short circuits and heavy amperage draw. Use an ammeter to test the current draw of the tools and/or equipment.

C **CHECK FOR OVERLOADED GENERATOR**

Check the nameplate ratings of tools or equipment being used with the generator. The nameplate amperage rating indicates running amperage draw only. Use the following rough estimate to determine starting amperage for various tools and equipment.

1. Multiply x 1 - if the generator is operating heating or lighting equipment. Example: 10-100 watt light bulbs draw a constant 8.3 amps (10 x 100/120 = 8.3 amps).

2. Multiply x 2 - if a hand tool is being used. They typically use twice their rated amperage under full load as they do under no load conditions. Example: a hand drill that requires 7 amps no load may require up to 14 amps at full load use.

3. Multiply x 3 - if an electric motor is used to operate a piece of equipment. They require up to three times their rated amperage to start. Example: a 1 HP capacitor start motor typically requires approximately 9 amps to run, 27 amps to start.

Generator watts required = amps x volts x 1, 2 or 3. This is a good minimum estimate of equipment or tool amperage draw. Remember, the total amperage draw must not exceed the amperage rating of the 120 or 240 volt receptacles.

Large generator loads should always be started first, followed by the next largest load. The smallest loads should be started last.

D **CHECK RECTIFIER**

A diode within the exciter rectifier can break down under load causing low output. Use Section 5D for testing the rectifier.

E **CHECK EVR**

The electronic voltage regulator controls the strength of the magnetic field produced by the rotor. Component failure on the EVR board can cause loss of voltage as a load is applied. Follow the test procedures as outlined in Section 5E.

9 **HIGH VOLTAGE AT NO LOAD**

A **HIGH ENGINE RPM**

Engine RPM must be 3,750-3,800 RPM No-Load. Use a good quality tachometer (Homelite Part Number 18416) to test the no load speed.

Low engine RPM will result in low voltage under load. This can damage the generator. Tools and equipment drawing amperage off the generator may also be damaged.

B CHECK EVR

If the EVR is faulty, it can cause unregulated voltage of 150-160V at the 120V receptacle and 300+ volts AC at the 240V receptacle. Replace the board if the wiring is OK.

C CHECK EVR WIRING

The yellow and white wires going from the EVR terminal strip to the terminal board (TB1) are part of the sensing circuit. If the terminals are loose or the wires are broken, unregulated voltage will go to the receptacles (see the wiring schematic for details).

10 NO DC OUTPUT

A CHECK RECTIFIER AND WIRING

DC output is dependent on rectified AC from the battery charge winding to the 12V DC terminal posts. The DC rectifier is the same component that is used in the excitation circuit. See Section 5D for test instructions.

Examine the rectifier wires. Check each push-on terminal for tightness. Look for possible chafing and/or sorted wires from interference with the fan.

B CONTINUITY TEST BATTERY CHARGE WINDING

Remove the fan cover, rotor bolt/washer and fan. Use a pair of needle nose pliers to disconnect the two black wires from the DC charging rectifier. With a VOM meter set on RX1 or lowest scale, measure resistance between the two black wires. Battery charge winding resistance should be:

Model	Resistance (ohms)
HG1500, HG2100, 170R18	.100
HG3500, HGE3500	.140
172B26, 172R24, HG2500(A)	.160

Replace the stator if the readings are substantially below those specified or there is no continuity. Place one VOM meter probe on either black battery charge winding lead. Place the other VOM probe to a suitable ground (stator laminations, brush head, etc.).

3 ENGINE APPEARS TO BE UNDER LOAD STOP ENGINE

A DISCONNECT QUAD COIL AND/OR BATTERY CHARGE FROM THE RECTIFIER

B1 ENGINE RUNS NORMALLY CHECK AC OR DC RECTIFIER

Use the "Go-No-Go" method with a VOM meter as outlined in Section 5D. Both AC and DC rectifiers are the same parts and testing is identical.

C1 ENGINE RUNS NORMALLY WITH NEW RECTIFIER AC OR DC

D1 REPAIR COMPLETE

E1 ENGINE STILL APPEARS TO BE UNDER LOAD

F1 SHORT IN STATOR OR WIRING

G1 DISCONNECT STATOR WIRES START ENGINE

Disconnect all stator winding wires (main, quad, battery charge) from the panel and brush heads. Tape each wire carefully and route any wires away from rotating parts (rotor, fan, etc.).

H1 ENGINE RUNS NORMALLY CHECK FOR SHORT BEYOND STATOR

Examine all wiring in the panel against the electrical schematic for your generator. Test each stator winding for a short to ground. See Sections 5H and 6F for details.

I1 STATOR STILL UNDER LOAD REPLACE STATOR

B2 ENGINE STILL APPEARS TO BE UNDER LOAD MECHANICAL PROBLEM

C2 CHECK FOR ROTOR RUBBING STATOR

Remove the fan cover, rotor bolt/washer and fan. Pull on the stator rope. Look into the generator end. The rotor travel should be concentric. Any wobbling will cause the rotor to rub the stator as there is only .020" (0,5 mm) clearance between the two components.

Causes of misalignment are end bell misalignment (bolt holes mis-drilled), incorrect manufacturing of the stator, brush head misalignment or bearing failure.

D2 CHECK BEARING IN BRUSH HEAD

Listen for abnormal mechanical noises when running the unit or pulling the engine over by hand. The rotor shaft may be bad, causing the rotor to rub the stator. Examine the bearing for signs of burning or blueing. It may be necessary to remove the brush head in order to thoroughly inspect the bearings.

E2 CHECK ENGINE

Low power from the engine is made apparent by fully loading the generator. If voltage is normal but engine speed drops below 3,550 RPM, then the engine needs servicing. Severe engine damage may cause hard starting, poor idling, and the appearance of being under a slight load.

1 START ENGINE WITHOUT LOAD

4 EVR CIRCUIT BREAKER TRIPS

A CHECK CIRCUIT BREAKER

Remove the blue and yellow wires from the circuit breaker terminals. With a VOM meter on RX1 scale or equivalent, place the black VOM probe on one male circuit breaker terminal and the red VOM probe on the other male terminal. There should be straight continuity. If not, replace the circuit breaker.

B CHECK THE RECTIFIER

A shorted diode in the rectifier can draw up 100 amps; this will trip the circuit breaker. Test the rectifier following the directions in Section 5D.

C CHECK EVR

Certain EVR board components can fail, causing unregulated output that could trip the circuit breaker.

Start and run the generator. Use a VOM meter with the selector switch on the 300V scale. Measure output at the 120V receptacle. If the output is high (150-160V AC), stop the engine. Open up the control board panel, physically inspect the two sensing leads (yellow and white) where they connect to the EVR board and Terminal Board (TB2). Use a VOM meter on RX1 to test these two wires for continuity. If the wiring is correct, replace the EVR board and re-test.

D CHECK ROTOR

If the rotor has shorted to ground, amperage draw will increase causing the circuit breaker to trip. Test the rotor according to the steps as listed in Section 5H.

E CHECK STATOR

A shorted stator can, under certain conditions, cause the circuit breaker to trip. Use the instructions found under Section 5H to test the stator.

5 IDLE CONTROL: FLIP SWITCH TO "AUTO" POSITION

11 GENERATOR STAYS AT IDLE WHEN LOAD IS APPLIED

A DEFECTIVE CONTROL BOARD - REPLACE

If the generator remains at idle when a load is applied (50 watt minimum), the control board must be replaced as certain components on the board have failed.

12 GENERATOR RUNS WIDE OPEN WILL NOT IDLE

A CHECK FUSE WITH A VOM METER

Inspect the fuse to see if it is blown. If you are not sure, use a VOM meter on RX1 scale to test fuse continuity. If the fuse is blown, carefully inspect the electromagnet lead wires (yellow and red) for shorts to ground or each other. Replace the fuse with Homelite Part Number 49318 or 1/2 amp fuse only. Higher rated fuses will not protect the control board from possible damage.

B CONTINUITY TEST "AUTO-START" SWITCH WITH VOM

Remove the two leads attached to the "Auto-Start" switch. Note which two switch terminals were occupied by the two yellow switch leads.

With a VOM meter on RX1 scale, place the VOM probes on each of the two switch terminals. There should be continuity in the "run" position only.

C ELECTROMAGNET TOO FAR FROM PADDLE

The electromagnet is attached to a bracket and can slide in and out of the bracket for adjustments to the distance between the electromagnet and the paddle on the throttle arm (see illustration below). With the idle speed set at 2,650 RPM (minimum), adjust the electromagnet towards the paddle until the electromagnet will hold the paddle at idle.

D FAULTY ELECTROMAGNET OR ELECTROMAGNET WIRES

Remove the two electromagnet wires (yellow and red) from the idle control boards. With the VOM meter set on RX1 ohm scale, place each VOM probe on each electromagnet wire. The resistance rating should be 240-260 ohms. Remove one VOM probe and place it on the electromagnet casing. Test each wire in turn. There should be no continuity. Note: Electromagnet resistance on the 178VI52 is 150-160 ohms.

If the resistance figure you obtained is abnormally low, replace the electromagnet. Continuity between any electromagnet lead and the electromagnet casing constitutes a short to ground. Replace the electromagnet.

Inspect both red and yellow electromagnet leads for loss of insulation, changing, or shorts to ground.

E CONTROL BOX WIRING

Inspect the yellow wire between the idle control board (1C1) and the "auto-start" switch. Look for broken connections, chafing, rubbing, etc. Also examine the yellow wire from the switch to the terminal board (TB1), and the white wire from the idle control board (1C1) to the terminal board (TB1). Poor or no connections at these points will render the idle control system inoperative.

F DEFECTIVE IDLE CONTROL BOARD

Certain components on the idle control boards can fail, causing the idle control to quit working. Make sure all other tests have been completed prior to board replacement.

13 GENERATOR IDLES WITH MAX. POWER SWITCH IN 240V POSITION ONLY

A 120 AC LEAD ROUTED INCORRECTLY THROUGH TRANSFORMER

One of the two primary wires (#1 or #4) has been routed through the transformer from the wrong direction. To correct this problem, remove either #1 or #4 lead from the terminal board (TB1) or receptacle. Pull the wire out of the transformer bobbin and route it back through the transformer from the opposite direction. Use a Cable Tie (Homelite Part Number 46840) to secure the wire to the transformer.

14 GENERATOR CYCLES FROM IDLE TO FULL SPEED CONTINUOUSLY

A ENGINE IDLE SPEED TOO LOW SHOULD BE 2,650 RPM MINIMUM

If the engine idle speed is too low, voltage to the idle control board and electromagnet is insufficient to hold the paddle. The engine will hunt, as the paddle is alternately held, then released. Adjust idle speed to 2,650 RPM minimum. Do not exceed 2,800 RPM. Note: 178VI52 idle speeds are 2,200-2,400 RPM.

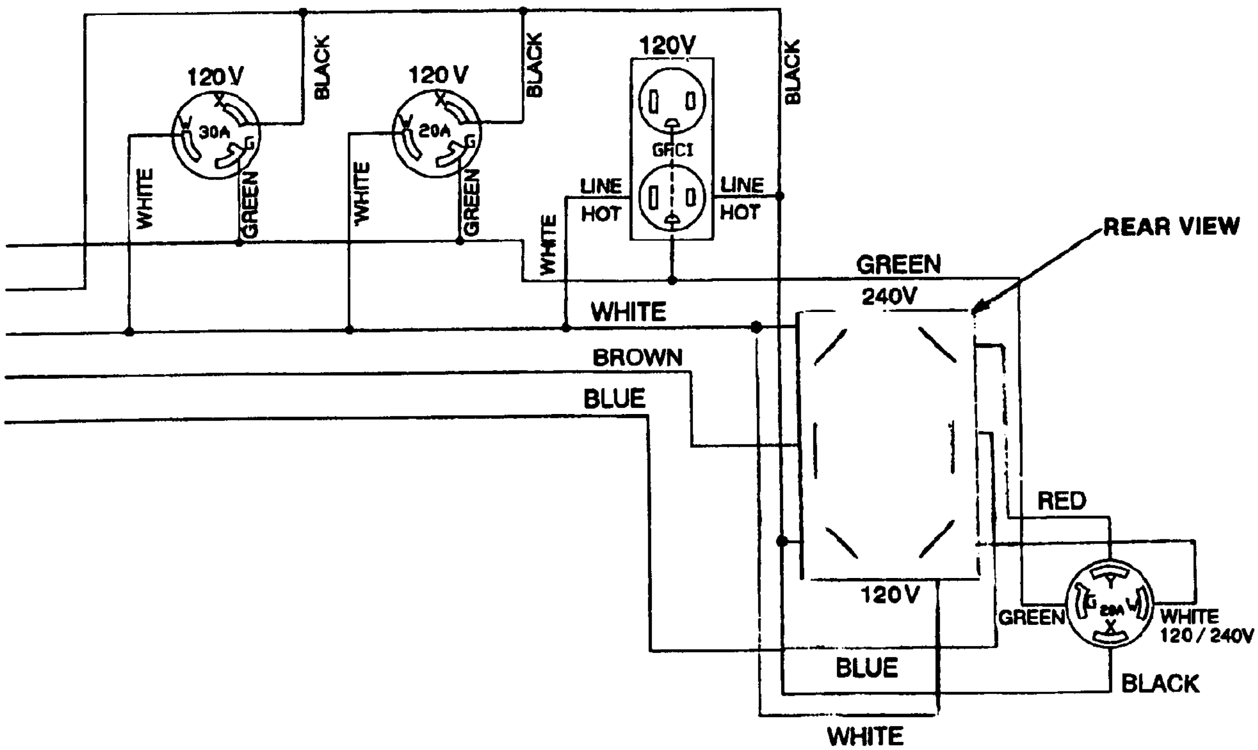
B PADDLE ON THE THROTTLE ARM BENT, NOT PARALLEL WITH FACE OF ELECTROMAGNET

Pull the electromagnet paddle (throttle arm) up to the electromagnet. It should be parallel to the face of the electromagnet. If it is not parallel, the engine will hunt from full speed to idle and back to full speed. This will occur even though the electromagnet is properly adjusted. Bend the paddle until it is parallel to the face of the electromagnet.

C ELECTROMAGNET TOO FAR FROM PADDLE

The electromagnet must be positioned close enough to the paddle (throttle arm) to insure proper speed at idle (2,650-2,800) (2,200-2,400 = 178VI52). Use the illustration below to set the electromagnet.

TESTING THE MAXIMUM (FULL) POWER SWITCH



With the maximum (full) power switch in the 120V AC only position, continuity (VOM* meter = RX1) should exist between the center terminals (Brown, Blue), and each adjacent 120V terminal:

Brown - Black = Continuity
Blue - White = Continuity

There should be no reading between the Black and White or Brown and Blue terminals. If there is, replace the switch.

With the maximum power switch in the 120/240 position, there should be continuity between the center terminals (Brown, Blue), at each adjacent 240V terminal:

Brown - White = Continuity
Blue - Red = Continuity

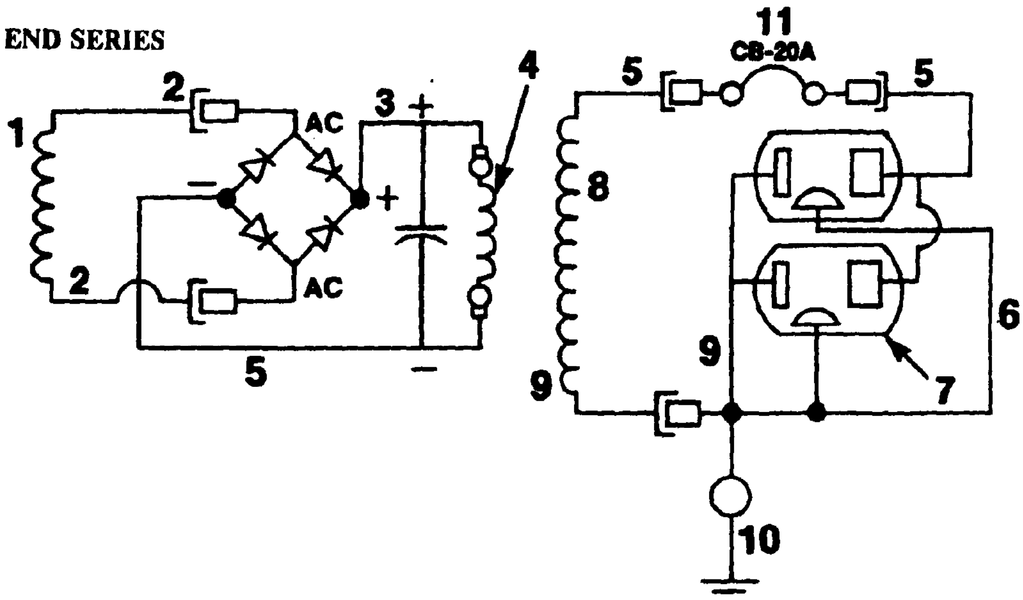
There should be no continuity between the Red and White or Blue and Red terminals. If there is, replace the switch.

*VOM = Volt - Ohm - Milliamp

WIRING DIAGRAM

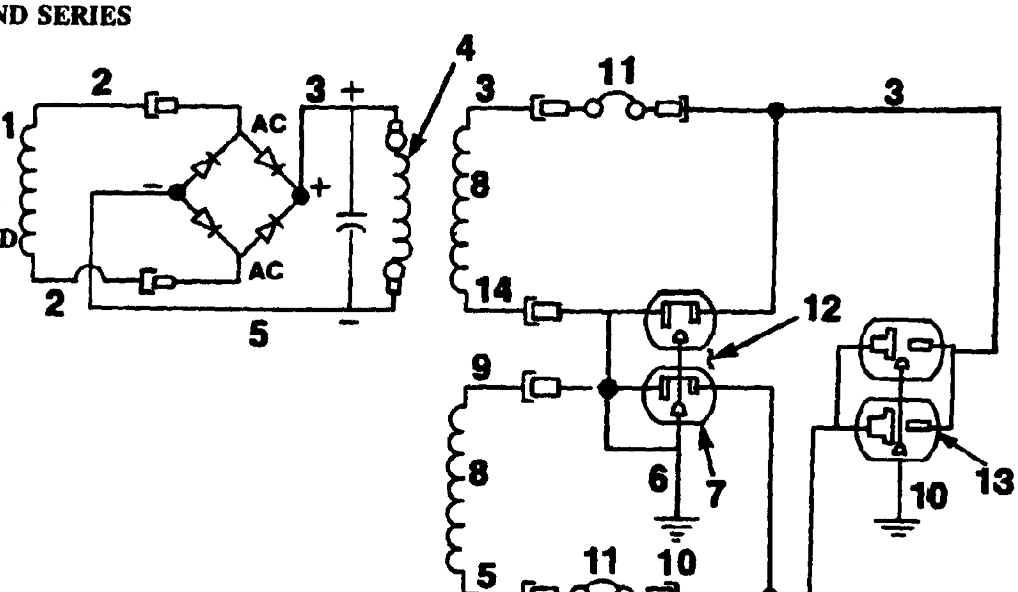
SQUARE END SERIES

EH2500
HL2500



SQUARE END SERIES

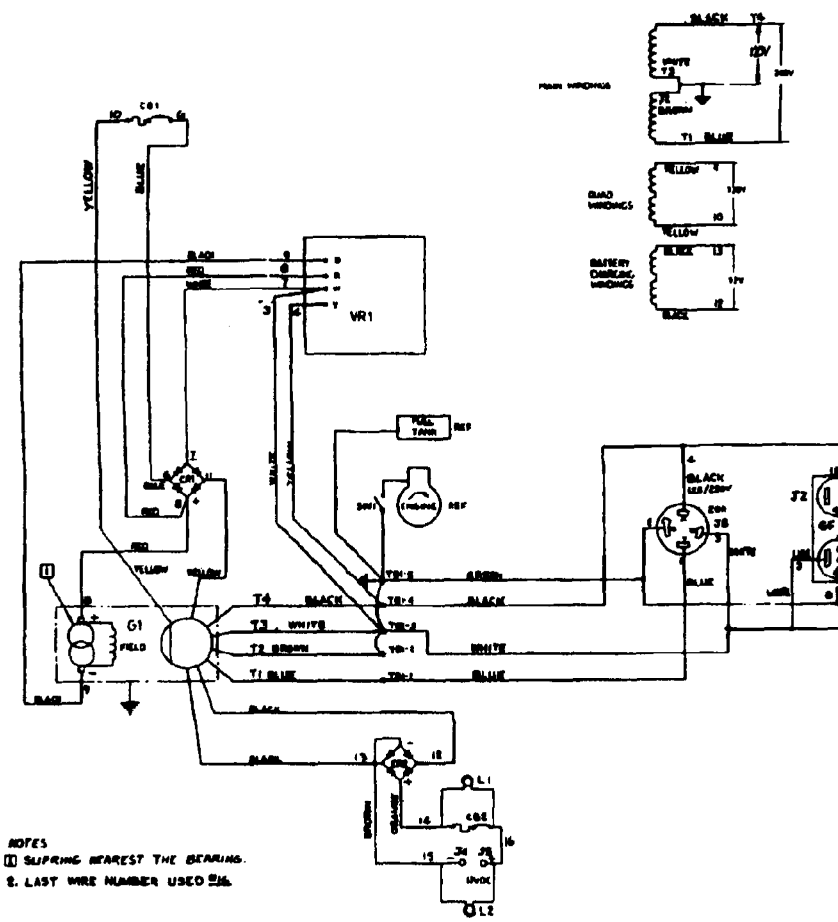
EH4400HD
HL4400
EH5500HD
HL5500
HRL4400HD
EHRL4400HD



1. QUAD
2. YELLOW
3. RED
4. FIELD COIL
5. BLACK
6. GREEN
7. 120V. RECEPTACLE
8. MAIN COIL 120V.
9. WHITE
10. GROUND
11. CIRCUIT BREAKER
12. TAB BROKEN
13. 240V. RECEPTACLE
14. BROWN

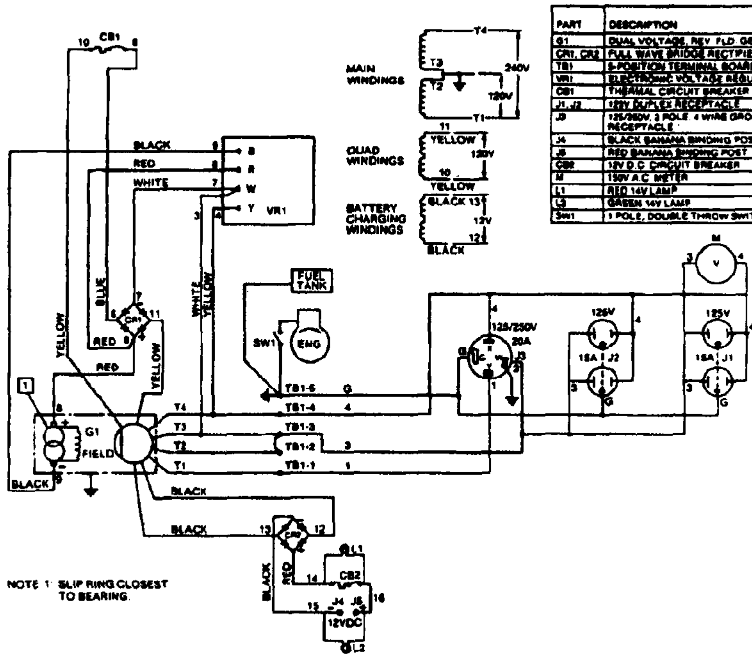
WIRING DIAGRAM

HG3500A



PART	DESCRIPTION
G1	DUAL VOLTAGE, REVOLVING FIELD GENERATOR
CR1, CR2	FULL WAVE BRIDGE RECTIFIER
TB1	5-POSITION TERMINAL BOARD
VR1	ELECTRONIC VOLTAGE REGULATOR
CB1	THERMAL CIRCUIT BREAKER
J1, J2	125 VOLT DUPLEX RECEPTACLE, GFCI
J3	125/250 VOLT, 3 POLE, 4 WIRE GROUNDING RECEPTACLE.
J4	BLACK BANANA BINDING POST
J5	RED BANANA BINDING POST
CB2	12 VOLT D.C. CIRCUIT BREAKER
M	150 VOLT A.C. METER
L1	RED 14 VOLT LAMP
L2	GREEN 14 VOLT LAMP
SW1	1 POLE, DOUBLE THROW SWITCH

HG3500



PART	DESCRIPTION
G1	DUAL VOLTAGE, REV. FLD. GEN.
CR1, CR2	FULL WAVE BRIDGE RECTIFIER
TB1	5-POSITION TERMINAL BOARD
VR1	ELECTRONIC VOLTAGE REGULATOR
CB1	THERMAL CIRCUIT BREAKER
J1, J2	125V DUPLEX RECEPTACLE
J3	125/250V, 3 POLE, 4 WIRE GROUNDING RECEPTACLE
J4	BLACK BANANA BINDING POST
J5	RED BANANA BINDING POST
CB2	12V D.C. CIRCUIT BREAKER
M	150V A.C. METER
L1	RED 14V LAMP
L2	GREEN 14V LAMP
SW1	1 POLE, DOUBLE THROW SWITCH

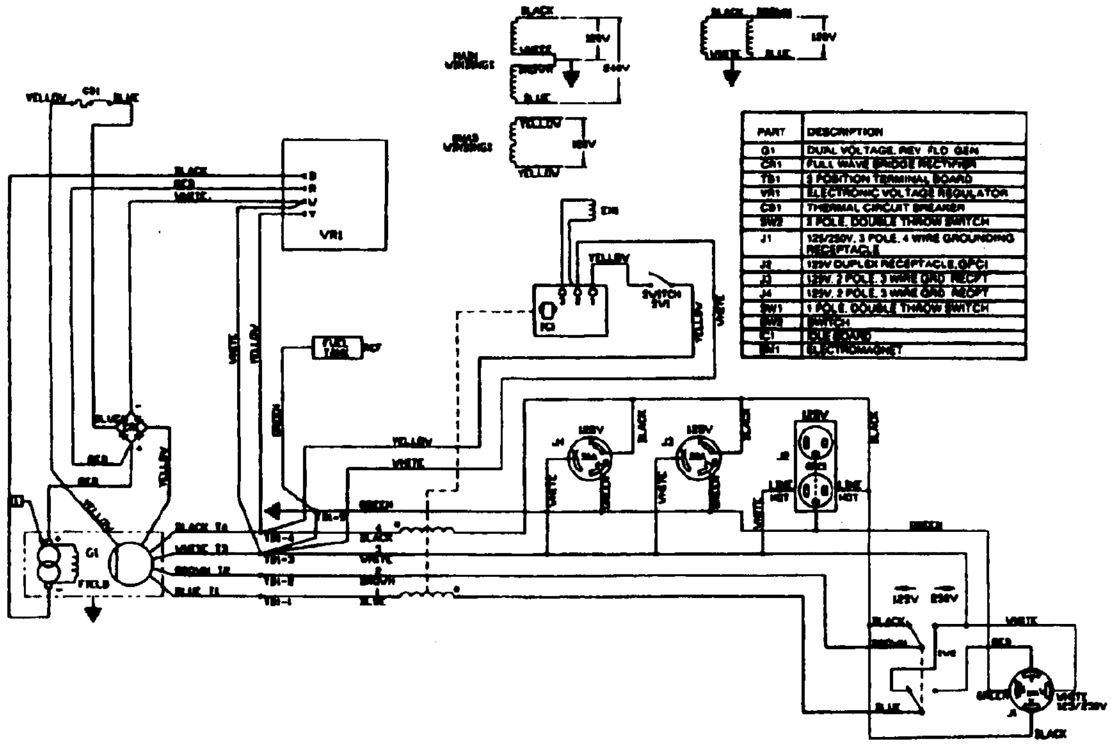
WIRING DIAGRAM

176BI40C

178VI52

178HI48

180HI(E)63

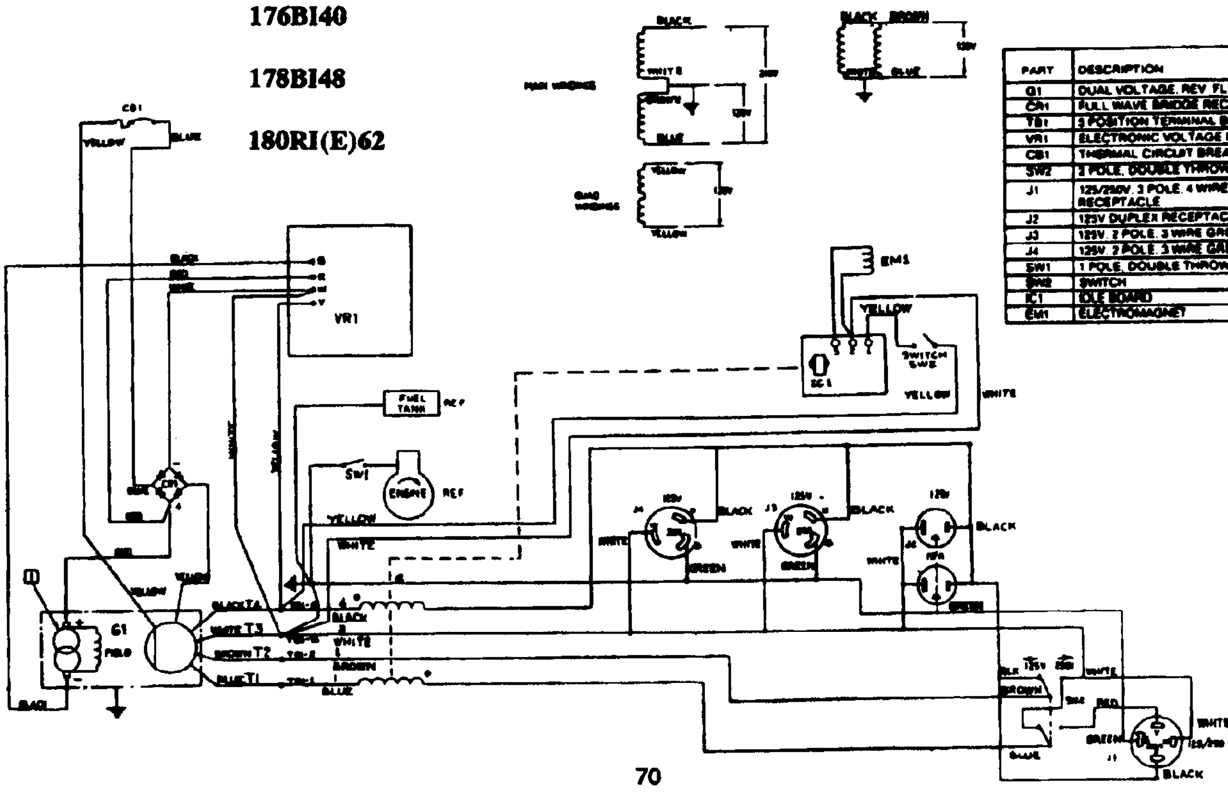


PART	DESCRIPTION
G1	DUAL VOLTAGE, REV FLD GEN
CR1	FULL WAVE BRIDGE RECTIFIER
TB1	5 POSITION TERMINAL BOARD
VR1	ELECTRONIC VOLTAGE REGULATOR
CB1	THERMAL CIRCUIT BREAKER
SW2	2 POLE, DOUBLE THROW SWITCH
J1	125/250V, 3 POLE, 4 WIRE GROUNDING RECEPTACLE
J2	125V DUPLEX RECEPTACLE,GFCI
J3	125V, 2 POLE, 3 WIRE GRD RECPT
J4	125V, 2 POLE, 3 WIRE GRD RECPT
SW1	1 POLE, DOUBLE THROW SWITCH
SW2	SWITCH
IC1	IDLE BOARD
EM1	ELECTROMAGNET

176BI40

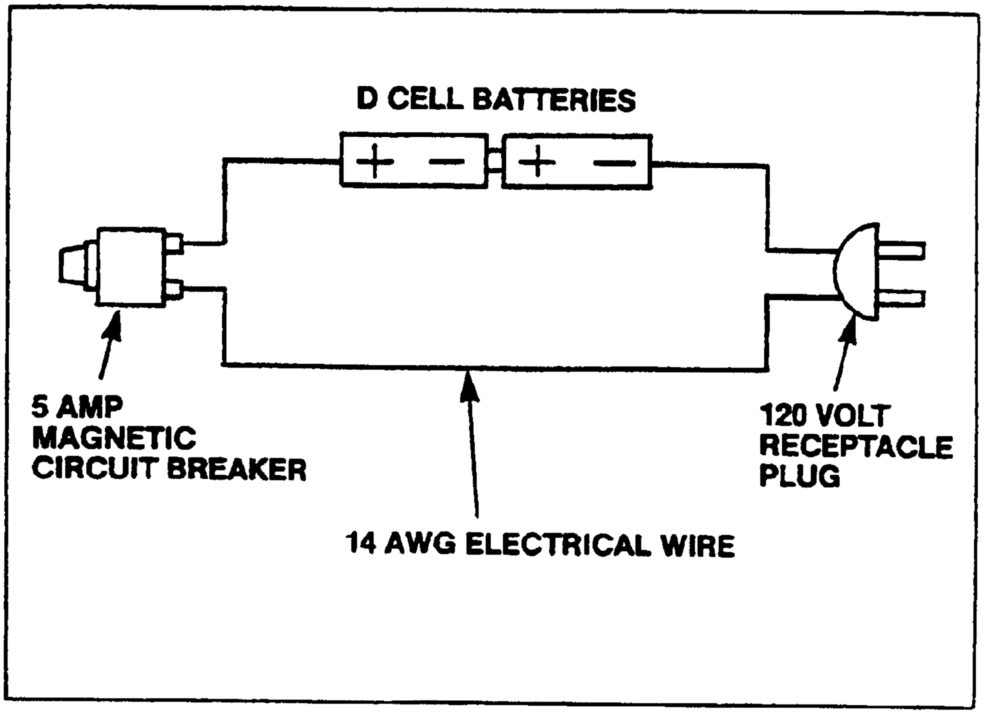
178BI48

180RI(E)62



PART	DESCRIPTION
G1	DUAL VOLTAGE, REV FLD GEN
CR1	FULL WAVE BRIDGE RECTIFIER
TB1	5 POSITION TERMINAL BOARD
VR1	ELECTRONIC VOLTAGE REGULATOR
CB1	THERMAL CIRCUIT BREAKER
SW2	2 POLE, DOUBLE THROW SWITCH
J1	125/250V, 3 POLE, 4 WIRE GROUNDING RECEPTACLE
J2	125V DUPLEX RECEPTACLE,
J3	125V, 2 POLE, 3 WIRE GRD RECPT
J4	125V, 2 POLE, 3 WIRE GRD RECPT
SW1	1 POLE, DOUBLE THROW SWITCH
SW2	SWITCH
IC1	IDLE BOARD
EM1	ELECTROMAGNET

HOMELITE
GENERATOR FIELD FLASHER



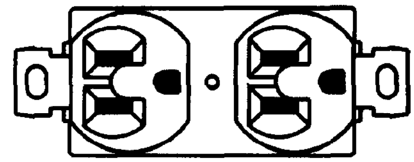
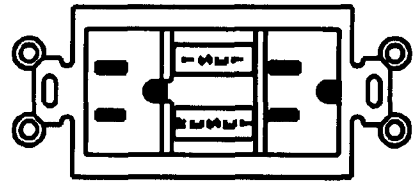
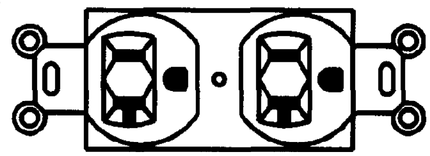
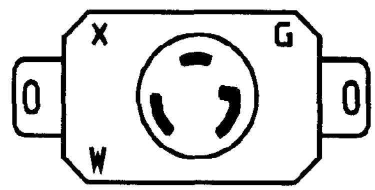
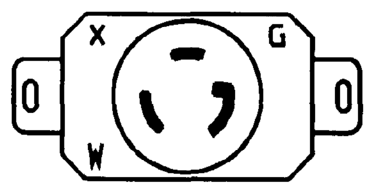
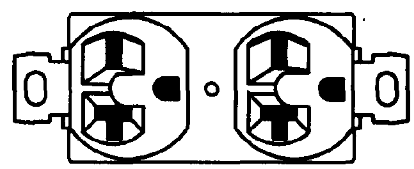
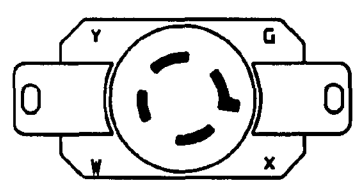
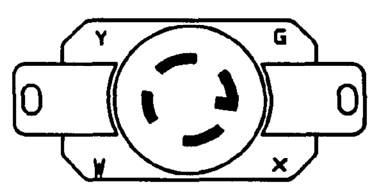
Material:

(1)	270-223	Box	(Radio Shack)
(1)	270-386	Battery Holder	(Radio Shack)
(2)	64-3046	Female Flag Quick Disconnect	(Radio Shack)
(1)	5266C	Hubbell Plug	(Hubbell, Inc., Bridgeport, CT 06605)
(1)	90F3389	(Newark Electronics) LA1D3BA000503A, Heinmann Hydraulic/Magnetic Circuit Protector (Newark Electronics, 500 N. Pulaski, Chicago, IL 60624)	
(2)	"D" Cell Alkaline Batteries		
	14" AWG Electrical Wire		

SPECIAL TOOLS

S00394	Jack Screw	Source	Homelite
22272	Rotor Removal Pin	Source	Homelite
18416	Digital Tachometer	Source	Homelite
627	10,000 Watt Tester	Source	Sotcher
640	Exciter Power Supply Sotcher Measurements, Inc. 1038 Kiel Ct. - Sunnyvale, CA 94089	Source	Sotcher
3T111	Etcon Brand (CT101) Conventional/GFIC Receptacle Tester	Source	Grainger
VOM	Digital-Fuse Protected Analog - RX1 - RX10K Minimum	Source	Radio Shack

GENERATOR PLUGS AND RECEPTACLES

SIZE / PART NUMBER	RECEPTACLE	PLUG	CONFIGURATION
VOLTAGE/AMPERAGE NEMA STANDARD HOMELITE P/N	120V 15AMP 5-15R 50991A	120V 15AMP 5-15P PURCHASE LOCALLY	
VOLTAGE/AMPERAGE NEMA STANDARD HOMELITE P/N	120V 15AMP 5-15R A08633	120V 15AMP 5-15P PURCHASE LOCALLY	
VOLTAGE/AMPERAGE NEMA STANDARD HOMELITE P/N	120V 20AMP 5-20R 51373	120V 20AMP 5-20P PURCHASE LOCALLY	
VOLTAGE/AMPERAGE NEMA STANDARD HOMELITE P/N	120V 20AMP TWIST LOCK L5-20R 48978	120V 20AMP TWIST LOCK L5-20P PURCHASE LOCALLY	
VOLTAGE/AMPERAGE NEMA STANDARD HOMELITE P/N	120V 30AMP TWIST LOCK L5-30R 42601	120V 30AMP TWIST LOCK L5-30P 43326	
VOLTAGE/AMPERAGE NEMA STANDARD HOMELITE P/N	240V 20AMP 6-20R 02863	240V 20AMP 6-20P 49709	
VOLTAGE/AMPERAGE NEMA STANDARD HOMELITE P/N	240V 20AMP TWIST LOCK L14-20R 46508	240V 20AMP TWIST LOCK L14-20P 47600	
VOLTAGE/AMPERAGE NEMA STANDARD HOMELITE P/N	240V 30AMP TWIST LOCK L14-30R 46718	240V 30AMP TWIST LOCK L14-30P 47601	

GENERATOR ROTOR AND STATOR RESISTANCE VALUES

MODEL #	UNIT #	ROTOR #	STATOR #	ROTOR Ω	MAIN Ω	QUADΩ	DC Ω
170A15-1A	03615	A53784S	A42917BS	30.5	.510		.240
170R18	03634	A49653S	A49638AS	29.0	T1.T2=.82	2.20	.100
172A20-1A&B	03585	A42215S	A43993AS	34.2	0.315		
172R24 & B26	03626 & 7	A49475S	A49476AS	32.0	T1,T2=.53	1.80	
174A27-1A&B	03597	A53785S	A42605AS	29.5	.56 X 2		
176A35-1A,B,C	03598	A53786S	A42606A	33.0	.31 X 2		
176B40	03620	A49089S	A49128S	37.4	T1,T2= .67 T3,T4 = .67	1.49	
176BI40	03629-A	A49089S	A49128S	37.4	T1,T2= .67 T3,T4 = .67	1.49	
176R42	03624	A49095S	A49330S	42.5	T1,T2=.358 T3,T4=.358	1.18	
176RI42	03631-A	A49095S	A49330S	42.5	T1,T2=.358 T3,T4=.358	1.18	
177D38-1	03581	A53787S	A42608-1	30.0	.352 X 2		
178A50-1A	03560	A53787S	A42608	30.0	.352 X 2		
178A50-1B	03599	A53787S	A47345AS	30.0	.352 X 2		
178B48	03621	A49095S	A49124S	42.5	T1,T2=.358 T3,T4=.358	1.18	
178BI48, HI48	03630A, 03762	A49095S	A49124S	42.5	T1,T2=.358 T3,T4=.358	1.18	
178VI52	03758	A49095S	A49124S	42.5	T1,T2=.358 T3,T4=.358	1.18	
180A75-1	03538	A42724S	A42728AS	22.8	.25 X 2		
180A75-1A&1B	03600	A42724S	A42728AS	22.8	.25 X 2		
180R62	03625	A49094S	A49331S	50.0	T1,T2=.225 T3,T4=.225	1.10	
180RI62, HI63	03632A, 03763	A49094S	A49331S	50.0	T1,T2=.225 T3,T4=.225	1.10	
180RIE62,HIE63	03643, 03764	A49094S	A49331S	50.0	T1,T2=.225 T3,T4=.225	1.10	
9A34-3	03320	A53789	A51134	33.0	31 X 2		
9A34-3A	03323	A53789	A51134	33.0	31 X 2		
E1350-1	03575	A53781S	A43985BS	46.5	.56	3.50	
E1700-1	03614	A53781S	A46644AS	46.5	.50	4.50	
E2250-1	03576-A	A53782S	A43990BS	52.6	.56		
E3000-1	03595	A46142S	A46144AS	64.2	.80 X 2	1.60	
E3000-1A	03595	A46142S	A47615AS	64.2	.326 X 2	1.63	
E4000-1	03596	A43427S	A43438A	76.0	.206 X 2	1.63	
E4000-1A	03596	A43427S	A47773AS	76.0	.206 X 2	1.61	
EH2500	03644	01209-03	01209-01	23.0	.60	7.20	
EH2500HD	03686	01209-03	01209-01	23.0	.60	7.20	
EH2500HD	03700	A02800AS	A02797AS	46.7	.389	1.18	
EH4400	03638	00782-04	00782-02	51.0	.71	1.20	
EH4400HD	03687	00782-04	00782-02	51.0	.71	1.20	
EH4400HD	03701	A02799AS	A02796AS	67.0	.278	0.999	
EH5500HD	03689	00782-43	01209-39	56.0	.47	1.10	
EH5500HD	03702	A02798AS	A02795AS	76.0	.208	0.973	
EHE4400	03637	00782-04	00782-02	51.0	.71	1.20	
EHE4400HD	03688	00782-04	00782-02	51.0	.71	1.20	
EHE4400HD	03705	A02799AS	A02796AS	67.0	.278	0.999	
EH5500HD	03690	00782-43	01209-39	56.0	.47	1.10	
EH5500HD	03706	A02798AS	A02795AS	76.0	.208 X 2	0.973	
EHRL4400HD	03756	A02799AS	A02796AS	67	0.278	0.888	
G11800-1	03567	A47224S	A47226S	15.8	.0694 X 2		
G12000-2	03572	A47224S	A47274	15.8	.0694 X 2		
G3600-1	03578	A47077S	A47081S	52.3	.25 X 2		
G3600-2	03562	A47077S	A04781S	52.3	.25 X 2		
G4800-1	03563	A47076S	A47082S	35.5	T1,T2=.069 T3,T4=.069		

GENERATOR ROTOR AND STATOR RESISTANCE VALUES

MODEL #	UNIT #	ROTOR #	STATOR #	ROTORΩ	MAIN Ω	QUADΩ	DC Ω
G4800-2	03564	A47076S	A47082S	35.5	T1,T2=.069 T3,T4=.069		
G7200-1	03565	A47078S	A47083S	29.1	.153 X 2		
G7200-2	03566	A47078S	A46061	29.1	.153 X 2		
GD12000-1	03571	A47224S	A47226S	15.8	.0694 X 2		
GD12300-2	03572	A47224S	A47274	15.8	.0694 X 2		
GD7200-1	03569	A47078S	A47083S	29.1	.153 X 2		
GD7400-2	03570	A47078S	A46061	29.1	.153 X 2		
HG1400	04007	49027-51	49027-48	4.29	.69	2.61	.247
HG1500	03635	A49653S	A49638AS	29.0	T1,T2=.82	2.20	.100
HG2000	04018	A49030-75	49030-74	4.25	.47	1.80	.130
HG2100	03636	A49653S	A49638AS	29.0	T1,T2,=.82	2.20	.100
HG2500	03628	A49475S	A49476AS	32.0	T1,T2=.53	1.80	.160
HG2500A	03628-A	A49475S	A49793S	32.0	T1,T2=.53	1.80	.160
HG3500	03623	A49099S	A49127AS	33.5	T1,T2=.75 T3,T4=.75	1.33	.140
HG600	04005	49024-29	49024-28	13.9	2.1	4.00	.800
HGE3500	03639	A49099S	A49127AS	33.5	T1,T2=.75 T3,T4=.75	1.33	.140
HL2500	03681	01209-03	01209-01	23.0	.60	7.20	
HL2500	03697, & A	A02428AS	A02431AS	43.8	.458	1.09	
HL4400	03698 & A	A02429AS	A02432AS	61.1	.313 X 2	0.888	
HL5500	03699	A02430AS	A02433S	71.8	.228 X 2	0.843	
HLE4400	03703 & B	A02429AS	A02432AS	61.1	.313 X 2	0.888	
HLE5500	03704	A02430AS	A02433S	71.8	.228 X 2	0.843	
HRL4400HD	03751	A02799AS	A02796AS	67.0	.278 X 2	0.999	
HSB50-1	03593	A53787S	A42608-1	30.0	.325 X 2		
LR2500	03773	A02800AS	A02797AS	46.7	0.389	1.18	
LRI2500	03777	A02800AS	A06772S	46.7	0.4768	1.6643	
LR4400	03781	A02799AS	A02796AS	67	0.278	0.999	
LRE4400	03783	A02799AS	A02796AS	67	0.278	0.999	
LRI4400	03787	A02799AS	A06771S	67	0.3718	1.4274	
LR5500	03774	A02798AS	A02795AS	76	0.208	0.973	
LRI5500	03791	A02798AS	A06770S	76	0.2981	1.389	
LRE5500	03775	A02798AS	A02795AS	76	0.208	0.973	
LRIE4400	03789	A02799AS	A06771S	67	0.3718	1.4274	
LRIE5500	03778	A02798AS	A06770S	76	0.2981	1.389	
CG4800	03762	A49330S	A49095S	42.5	T1,T2=.358 T3,T4=.358	1.18	
CG5200	03794	A49330S	A49095S	42.5	T1,T2=.358 T3,T4=.358	1.18	
CG6300	03763	A49331S	A49094S	50	T1,T2=.225 T3,T4=.225	1.10	
CGE6300	03764	A49331S	A49094S	50	T1,T2=.225 T3,T4=.225	1.10	

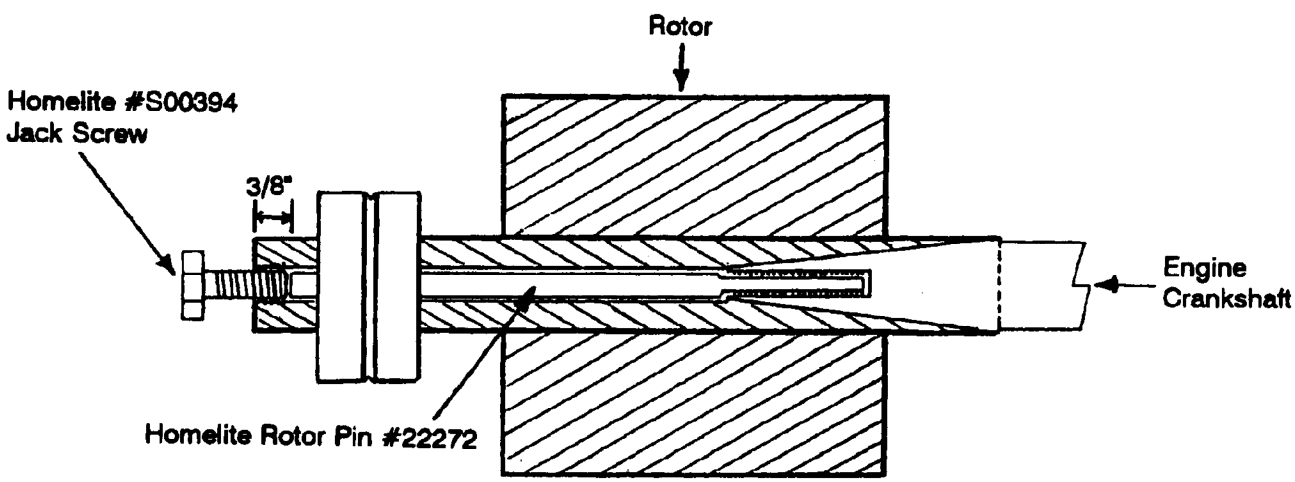
REMOVING GENERATOR ROTOR

Prior to removing the generator rotor, Homelite rotor pin (#22272) must be cut to length.

From machined end, cut pin to a length of 4 1/2". Cut the left over length of rotor pin into the following pieces: 1/4", 1/2", 3/4", 1", & 2 1/2".

To remove rotor (generator) from engine crankshaft.

- A. Remove rotor retaining bolt
- B. Insert the rotor pin and add pieces of the pin to obtain an overall length which is 3/8" shorter than the rotor shaft.
- C. Install Homelite jack screw (#S00394) and tighten against the rotor pin to force the rotor away from the crankshaft.



Total length of the rotor pin (pieces) is dependent on length of the rotor shaft and must always be 3/8" shorter than the rotor shaft.

GENERATOR DOLLY KITS

Part Number	Fits Models	Fits UT #'s
A-07422	HL2500	03697, 03697-A & 03697-B
	HL2500/CARB	03795
	HG2200-50	03811
	EH2500HD/CSA	103707, 03707-A & 03707-B
	EH4000HD/CSA	03754 & 03754-A
	HL4400	03698 & 03698-A
	HL4400/CARB	03796
	HLE4400	03703, 03703-A & 03703-B
	HLE4400/CARB	03797
A-07423	LR2500	03773 & 03773-A
	LR2500/CARB	03798
	LR2500/CSA	03793
	LRI2500	03777 & 03777-A
	LRI2500/CARB	03799
	LRI2500/CSA	03780
	250G (DEERE)	03808
A-07424	HG3800-50	03812
	LR4400	03781 & 03781-A
	LR4400/CARB	03800
	LR4400/CSA	03782
	LRE4400	03783 & 03783-A
	LRE4400/CARB	03801
	LRE4400/CSA	03784
	LR5500	03774 & 03774-A
	LR5500/CARB	03802
	LR5500/CSA	03785
	LRE5500	03775 & 03775-A
	LRE5500/CARB	03803
	LRE5500/CSA	03786
	LRI4400	03787 & 03787-A
	LRI4400/CARB	03804
	LRI4400/CSA	03788
	440G (DEERE)	03809 & 03809-1
	LRIE4400	03789 & 03789-A
	LRIE4400/CARB	03805
	LRIE4400/CSA	03790
	LRI5500	03791 & 03791-A
	LRI5500/CARB	03806
	LRI5500/CSA	03792
	LRIE5500	03778 & 03778-A
	LRIE5500/CARB	03807
	LRIE5500/CSA	03779
	550GE (DEERE)	03810 & 03810-1
A-07425	CG4800	03762-A
	CG5200	03794
	CG6300	03763-A
	CGE6300	03764-A
	CHY5000	03772-A

GENERATOR SOUND LEVELS

MODEL		DECIBEL RATING dB(A)*
CONTRACTOR GENERATORS		
	178HI48	76
	CG4800	76
	180HI63	76
	180HIE63	73
	CG6300	73
	CGE6300	73
	190HHY50	73
	CHY50	73
HL SERIES		
	HL2500	72
	HL4400	81
	HLE4400	81
LR SERIES		
	LR2500	70
	LR4400	75
	LRE4400	75
	LR5500	74
	LRE5500	74
LRI SERIES		
	LRI2500	71
	LRI4400	76
	LRIE4400	76
	LRI5500	75
	LRIE5500	75

*At 50' feet