BRIGGS & STRATTON®

Familiarization & Troubleshooting Guide
GENERATOR

FORWARD

This guide has been written and published by Briggs & Stratton Corporation to aid our dealers' mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures for these products, or like or similar products, manufactured by Briggs & Stratton Power Products. It is also assumed that they have been trained in the recommended servicing procedures for these products, which includes the use of mechanics hand tools and any special tools that might be required.

Proper service and repair is important to the safe, economical and reliable operation of all engine driven systems. The troubleshooting, testing, service and repair procedures described in this guide are effective methods of performing such operations.

We could not possibly know of and advise the service trade of all conceivable procedures or methods by which a service might be performed, nor of any possible hazards and/or results of each procedure or method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a procedure or method not described by the manufacturer must first satisfy himself that neither his safety, nor the safety of the product, will be endangered by the service or operating procedure selected.

All information, illustrations, and specifications contained in this guide are based on the latest production information available at the time of publication. However, Briggs & Stratton Corporation reserves the right to change, alter, or otherwise improve the product at any time without prior notice.

Some components or assemblies of the product described in this guide may not be considered repairable. Disassembly, repair and reassembly of such components may not be included in this guide.

Service and repair instructions for the engines used to power these products are not covered in this guide. Engine service and repair instructions are furnished by the engine manufacturer.

GENERAC® PORTABLE PRODUCTS

Generator Fundamentals

Generator Components And Systems

GENERAC® PORTABLE PRODUCTS

Generator Diagnostics And Adjustments

Generator Assemblies

Appendix A

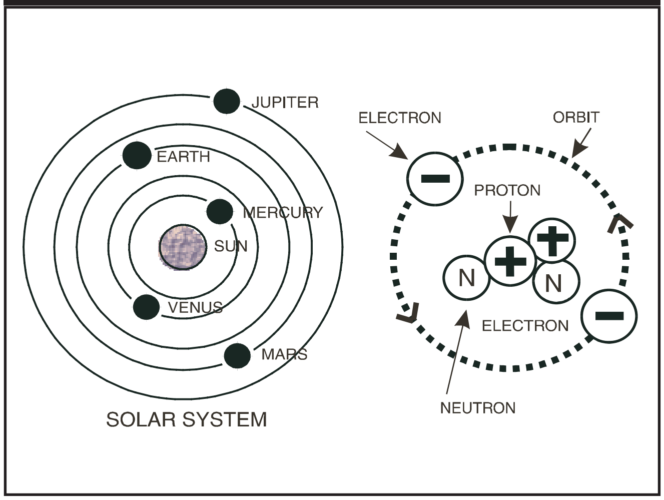
BASIC ELECTRICITY

The Atom

All matter is made up of atoms. An atom may be compared to a solar system that has several planets revolving around the sun. There are more than 100 different kinds of atoms. The various atoms combined together form all known substances.

The structure of the helium atom is shown in Figure 1.1.

Figure 1.1 — The Helium Atom



Negatively (-) charged particles called **electrons** revolve around a positively charged **nucleus**. The nucleus is made up of both **protons**, which have a positive (+) electrical charge, and **neutrons**, which have a neutral (N) electrical charge. The negative and positive particles that make up an atom act much like the north and south poles of a magnet, in which the **north pole** is positive (+) and the **south pole** is negative (-).

Every child who has played with a magnet knows that **like poles repel each other and unlike poles attract each other.**

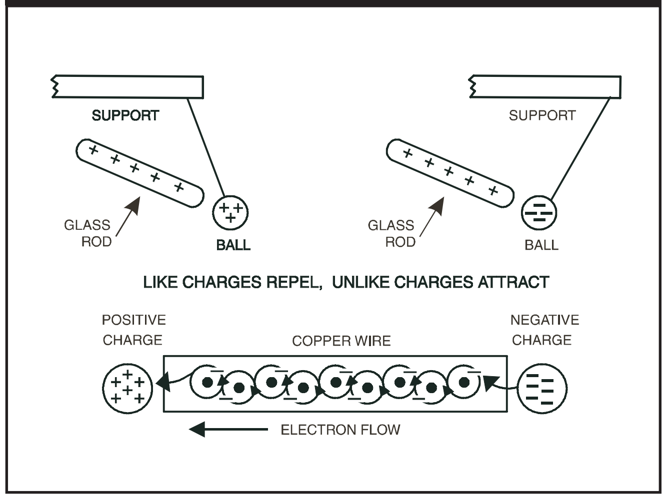
Magnetism and Electricity

Like the poles of a magnet, atomic particles with the same charges repel each other and the particles with different charges attract each other. In a normal atom, the positive charge of the nucleus exactly balances the negative charge of the electrons that rotate around it.

Borrowing Of Electrons

If an atom loses electrons, the positive (+) charge of the nucleus and the negative (-) charge of the electrons revolving around it is no longer balanced. The atom then becomes positively charged. The natural tendency of the positively charged atom is to attract any other negative charges, such as an electron from another atom (Figure 1.2).

Figure 1.2 — Magnetism and Electricity



The positively charged atom attempts to return to a balanced (or neutral) state and will "borrow" an electron from a neighboring atom. When an atom borrows an electron from its neighbor, the neighbor then becomes positively charged. This starts a "chain reaction" in which each atom in turn borrows an electron from its neighboring atom.

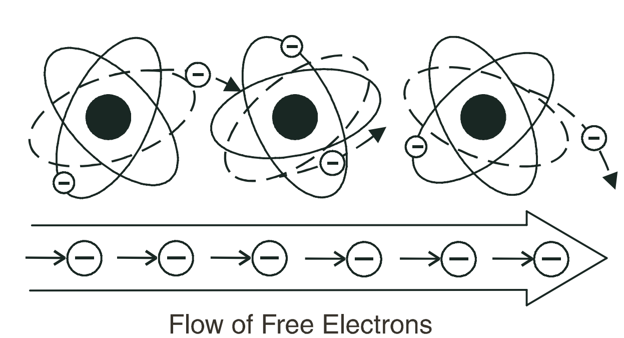
This borrowing of electrons creates a flow of current that continues until all the atoms have achieved a state of balance.

Figure 1.3 illustrates the transfer of electrons from one atom to the next and the resulting flow of free electrons that occurs. This may be difficult to visualize, unless you remember that an electron is so small that it finds great empty spaces for free travel, even in a solid substance.

Electrical current flow is based on the principle:

That atoms have the ability to readily transfer and borrow electrons

Figure 1.3 — Transfer of Electrons



Conductors and Non-Conductors

Some materials (such as copper or silver) will readily transfer electrons from atom to atom. These materials are called **conductors**. Other materials hold their electrons very tightly and are said to have "bound" electrons. These **non-conductors**, materials such as wood, glass or rubber, are often used as **insulators**.

Current Flow Versus Electricity

Electricity is created by the action of electrons in motion. **Current flow** is the flow of free electrons through a conductive path (circuit). Thus, electricity is a form of energy while current flow is the harnessing of that energy.

Two Theories of Current Flow

The Electron Theory: As previously discussed, current flow is based on the fact that: **"like charges repel and unlike charges attract."** An electron, a negatively (-) charged particle, is attracted to a proton, a positively(+) charged particle. The Electron Theory of Electricity states that electron or current flow in a circuit goes from the negative side of that circuit to the positive side.

The Conventional Theory: This theory states that current or electron flow in a circuit goes from the positive side of that circuit to its negative side.

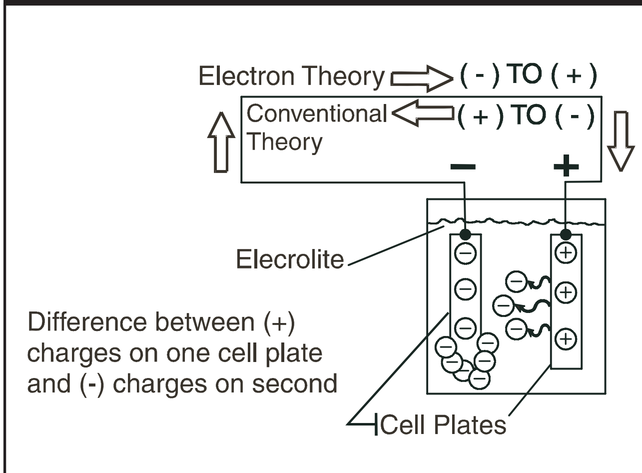
The difference between conventional and electron theories is mentioned because the conventional theory is more commonly used in everyday applications. For this guide, however, we will use the Electron Theory.

Electro-Motive Force

Current flow occurs in a conductor only when there is a difference in electrical "potential" and when there is a complete path or circuit for electron flow. The force that causes the electrons to flow is called:
"Electro-Motive Force" or "EMF." This force is equal to the difference in electrical potential across the circuit.

To illustrate the difference in potential, consider a storage battery as a model. This type of battery consists of two metal plates of different elements immersed in a fluid. A chemical reaction causes an electrical charge to be created on each of the metal plates. The fluid (called "electrolyte") carries electrons away from one plate and deposits them on the other plate (Figure 1.4).

Figure 1.4 — Electron Flow



The plate that has gained electrons has become negatively charged. This creates a difference in electrical potential between the two metal plates. If a conductor is now connected across the two metal plates, a circuit is completed and the result is a flow of electrons to the positively charged plate.

As long as there is a difference in electrical potential between the two plates (positive versus negative charge), current continues to flow.

CREATING CURRENT FLOW

Several basic methods may be used to create an electrical current flow. Four methods will be discussed here. All of these methods are based on a fundamental law that energy can never be created or destroyed but can be changed into other forms of energy. Thus, chemical, heat, light and magnetic energy can be changed into electrical energy.

The four basic methods of creating electrical current flow are:

- Chemical energy (e.g., storage battery)
- Heat energy (e.g., thermocouple)
- Light energy (e.g., photo-electric)
- Magnetic energy (e.g., alternator or generator)

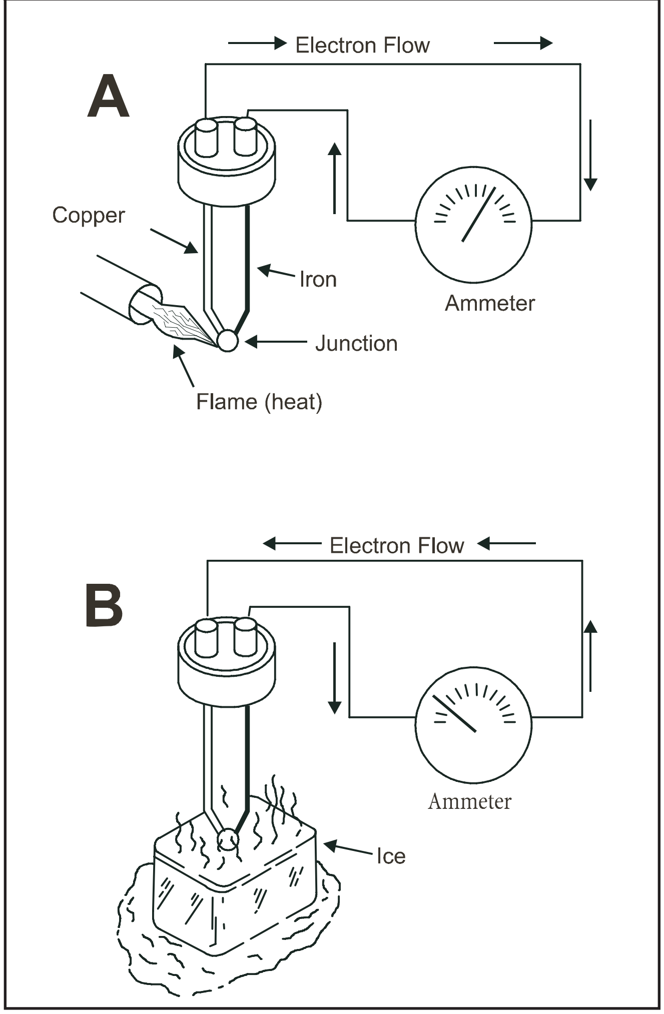
The Thermocouple

When two dissimilar metals are welded together and the welded junction is heated or cooled, an electro-motive force (EMF) is produced. The joining process appears to disturb the atomic orbits at the junction, so that the outer electrons in both metals are loosely held. Any small addition or subtraction of heat energy will set these electrons free.

Figure 1.5 shows a union between iron and copper wires, this union forms a thermocouple. In Figure 1.5A, the heat of the flame has caused the copper atoms to lose electrons. The copper draws electrons from the iron and a current flow in one direction is produced.

In Figure 1.5B, the wire junction has been cooled, causing the iron atoms to lose electrons and attract electrons from the copper. The resulting current flow is then reversed from that of Figure 1.5A.

Figure 1.5 — The Thermocouple



Photoelectric Cell

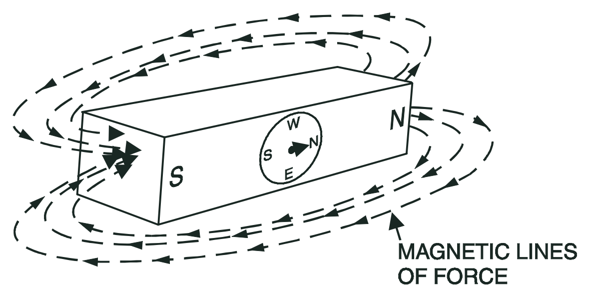
Copper oxide and selenium oxide are sensitive to rays of light. Materials that create a current flow when exposed to light are said to be **"photo-voltaic."**

Magnetic Energy

Magnetism is closely related to electricity. It can be used to produce electricity and electricity can be used to produce magnetism. A study of one must, therefore, include a study of the other.

Magnetic "lines of force" surround a magnet. These lines of force are concentrated at the magnet's NORTH and SOUTH poles and are often called "lines of flux" (Figure 1.6).

Figure 1.6 — Lines of Flux Around A Magnet



The flux lines are directed away from the magnet at its north pole and re-enter the magnet at its south pole. Like the positive (+) and negative (-) electrical charges previously discussed, the same magnetic poles repel each other and unlike poles attract each other.

When discussing magnetism, two terms should be defined:

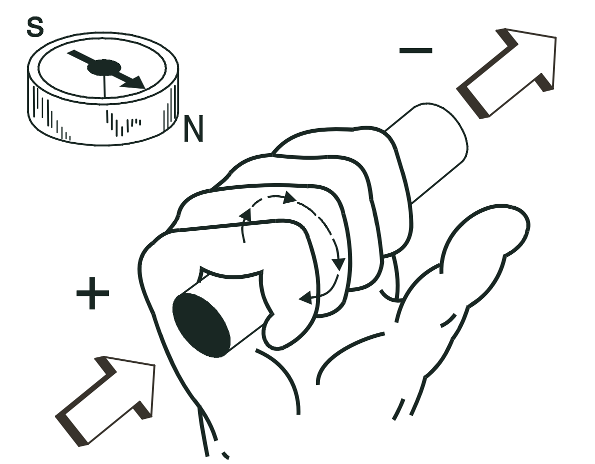
- **Permeability:** The ease with which any given substance can be magnetized.
- **Retentivity:** The ability of a substance to retain its magnetism when an external magnetic field is removed (also known as "Residual Magnetism").

Current Flow and Magnetism

All conductors through which an electrical current is flowing have a magnetic field surrounding them. The greater the current (electron) flow, the stronger or more concentrated the magnetic field. To determine the direction of magnetic lines of force around a wire, you can use a simple rule called the **"Right Hand Rule."** Simply place your right hand around the wire with your thumb pointing in the direction of the current flow (positive to negative). The fingers then point in the direction of the magnetic lines of force (Figure 1.7).

When conductor wires are formed into a coil, a north magnetic pole is created in half of the coil and a south magnetic pole is created in the other half.

Figure 1.7 — The Right Hand Rule

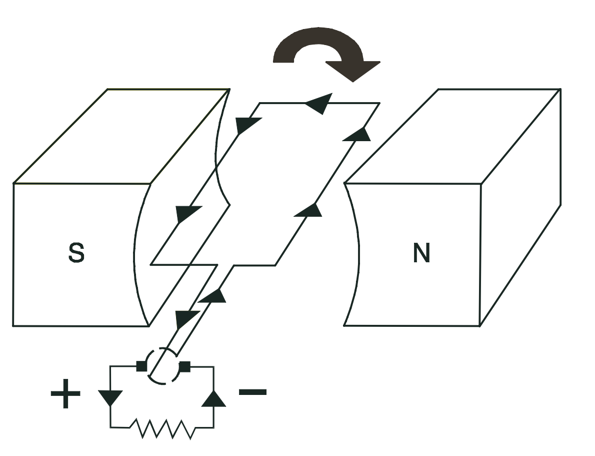


Determine polarity (direction of the lines of force) in the coil by grasping it in the right hand with the fingers pointing in the direction of current flow. The thumb then points to the coil's north pole.

Simple Permanent Magnet Generator

When a wire is moved so that it intersects (cuts across) a magnetic field, an electro-motive force (EMF) is induced in that wire (Figure 1.8). This is the principle upon which a rotating armature generator is based.

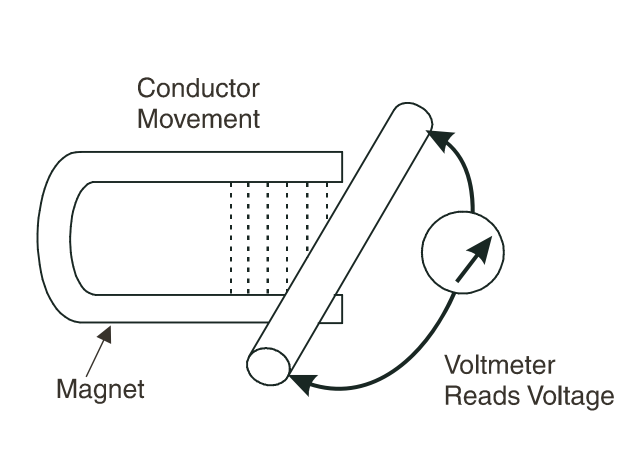
Figure 1.8 — Simple Revolving Armature Generator



Electromagnetic Induction

In 1831, scientists observed that a conductor moving through a magnetic field would have a voltage or electro-motive force (EMF) induced into itself. Electromagnetic induction may be defined as the action of inducing of a voltage into a conductor by moving it through a magnetic field. This principle is illustrated in Figure 1.9.

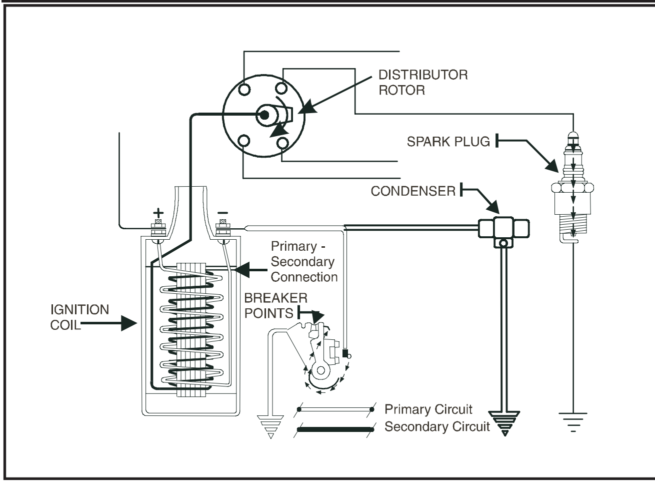
Figure 1.9 — Electromagnetic Induction



A straight wire conductor is moving through the magnetic field of a horseshoe magnet. If a sensitive voltmeter were attached to the ends of the wire conductor, a small voltage would be indicated as the wire moved through the magnetic field. However, if the wire conductor were moved parallel to the lines of magnetic force, no voltage would be indicated. The greater the strength of the magnetic field through which the wire conductor is moved, the greater the induced voltage in the conductor.

Another familiar form of electromagnetic induction is the automotive engine ignition coil. Current flow through a primary coil of wires creates a magnetic field around that coil, which then cuts through a secondary coil of wires. When the current flow through the primary wire coil is interrupted, by opening a set of breaker points, the collapse of the magnetic field induces an electro-motive force (EMF) in the secondary coil (Figure 1.10)

Figure 1.10 — Typical Automotive Ignition System

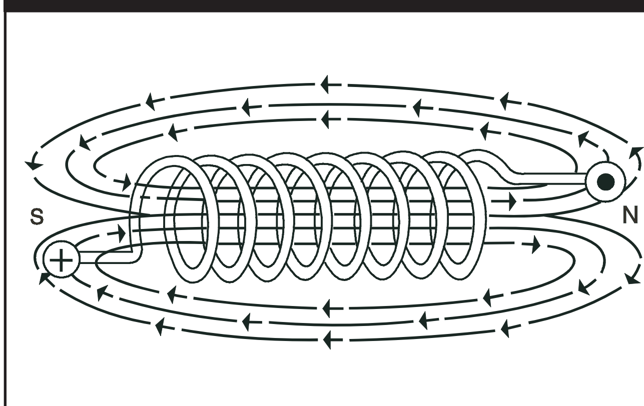


Electromagnetism

The previous paragraph explained that magnetic lines of force, cutting through the stationary windings of the stator assembly, would induce an EMF into those windings. Conversely, when a current flows through a wire conductor, a magnetic field is created around that wire. The number of lines of magnetic force, or strength of the magnetic field, increases as the current is increased through the conductor.

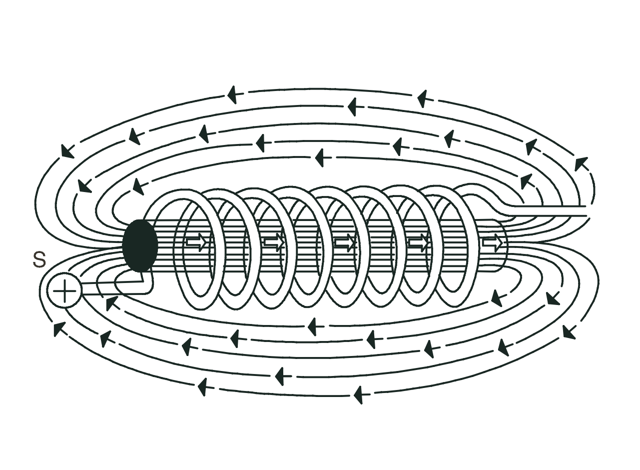
When a current-carrying wire is wound into a number of loops, to form a coil, the magnetic field created is the sum of all single-loop magnetic fields added together. With lines of magnetic force entering the coil at one end and leaving at the other end, a north and south pole are formed at the coil ends, as in a bar magnet (Figure 1.11).

Figure 1.11 — Magnetic Field Around A Coil Of Wire



If the coil is wound around a core of magnetic material, such as iron, the strength of the magnetic field at the north and south poles is greatly increased (Figure 1.12).

Figure 1.12 — Iron Core Increases Strength of Field



This happens because air is a poor conductor of magnetic lines and iron is a very good conductor. Using iron in a magnetic path may increase the magnetic strength of a coil by 2500 times over that of air.

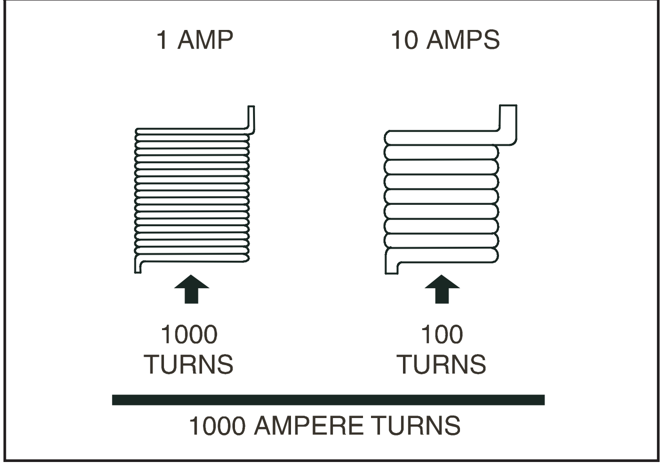
The strength of the magnetic poles in a coil of wire is directly proportional to:

The number of turns of wire.

The current (in amperes) flowing through the wire.

A coil carring a current of one ampere through 1000 turns of wire and another coil carring 10 amperes through 100 coils of wire will each create a magnetic field strength 1000 ampere-turns (Figure 1.13).

Figure 1.13 — Example of "Ampere-Turns"



The term **"ampere-turns"** is the measure of the strength of a magnetic field.

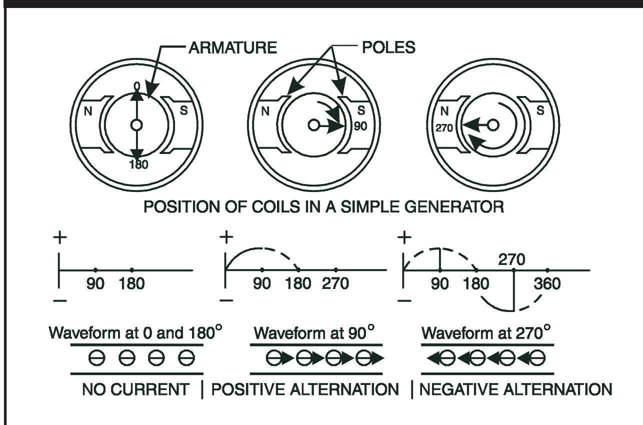
Direct Current (DC)

The current flow created by a storage battery flows through a conductor in one direction only. This type of current flow is called **direct current** or **(DC)**.

Alternating Current (AC)

Alternating current or (AC) is the flow of electrons through a conductor first in one direction and then in the other. This can be explained by showing the operation of a simple alternating current (AC) generator (Figure 1.14).

Figure 1.14 — An Aternating Current Generator



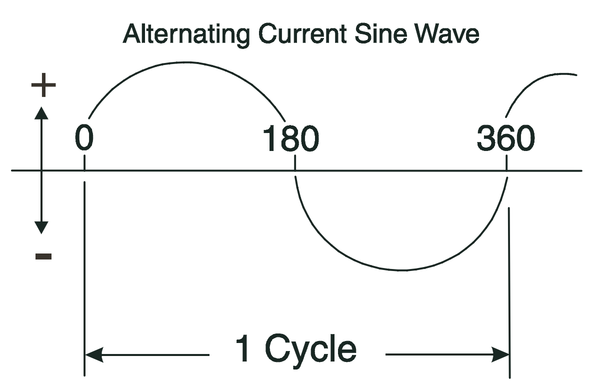
The flow of electrons changes direction according to the rotating armature's position in relation to the poles of a magnetic field (See the Table 1.1).

Table 1.1 — Current Flow Pattern

ARMATURE POSITION	CURRENT OR ELECTRON FLOW
0°	No current or electron flow occurs
90°	Armature becomes aligned with magnet's NORTH pole and current (electron) flow reaches its maximum value.
180°	Current flow drops to zero.
270°	Armature becomes aligned with magnet's SOUTH pole and current (electron) flow reaches its maximum value, but is reversed from flow direction that occurred at 90 degrees.
360°	Current flow drops to zero.

A wave diagram (sine wave) of alternating current shows that current goes from a zero value to maximum positive value (0°- 90° degrees), and then returns to zero (Figure 1.15). Two such current reversals (1 positive and 1 negative) are called "one cycle." The number of cycles per second, is called **frequency** and is often stated as '**Hertz** or "**CPS**."

Figure 1.15 — An Alternating Current Sine Wave



NOTES

UNITS OF ELECTRICAL MEASUREMENT

Just as a hydraulic system must have specific values:

- Rate of flow.
- Pressure.
- Resistance to flow.

Relavent established values can also be expressed for an electrical circuit. Fluid flow values in a hydraulic system are generally expressed as:

- Gallons per minute.
- Pounds per square inch.
- Pressure drop or pressure differential.

Electron flow (current) through a conductor can be compared to the flow of hydraulic fluid through a hose (Table 1.2).

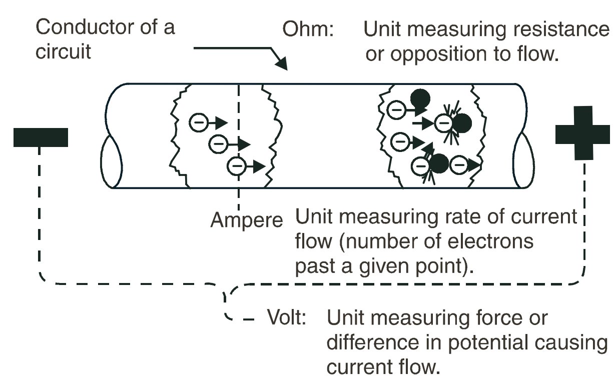
Table 1.2 — Hydraulic Flow Versus Current Flow

	UNIT OF MEASUREMENT	
	HYDRAULIC	ELECTRICAL
PRESSURE	Pounds per square in. (Psi)	Volts (E)
RATE OF FLOW	Gallons per minute (gpm)	Amperes (I)
RESISTANCE TO FLOW	Pressure drop	Ohms (R)

The units of measure for an electrical circuit are:

- Volts - Pressure.
- Amperes - Rate of Flow.
- Ohms - Resistance to Flow. (Figure 1.16)

Figure 1.16 — Electrical Measurement Units



Ampere - Unit of Current Flow

The rate of electron flow through a conductor is measured in amperes, which is a measurement of electrons flowing past a given point in a given time. One ampere is equal to a little over six thousand million billion electrons per second! Written numerically, the figure looks like this: 6,000,000,000,000,000,000.

Volt - Unit of Pressure

The volt is a measurement of the difference in electrical potential (EMF) that causes electrons to flow in a circuit. This difference in electrical potential (or electro-motive force) may be described as the difference between the number of positive charges and the number of negative charges. Thus, voltage may be described as the potential of electrical unbalance and current flow is the attempt to regain that balance.

One volt is the amount of electro-motive force (EMF) that will result in a current (electron) flow of one ampere through a resistance of one ohm.

Ohm - Unit of Resistance

The electron may be compared to an individual trying to make his way through a crowd of people, meeting the resistance of human bodies every step of the way. In any conductor or circuit, there is a resistance to electron flow.

A conductor's resistance depends on:

- Its construction.
- It's cross-sectional area.
- It's length.
- It's temperature.

One ohm is the amount of resistance that will permit one ampere of current to flow in a conductor when one volt of electro-motive force is applied.

Ohm's Law

In any circuit through which electrical current is flowing, consider these three factors:

- **Pressure** (EMF) (in volts) is the potential that causes current to flow.
- **Resistance** (in ohms) is the opposition that must be overcome before current can flow.
- **Flow** (in amperes) is the rate which is maintained as long as pressure or volts, can overcome resistance (ohms).

All of the above factors are related. If any two of the values are known, the remaining value can be determined using Ohm's Law.

Ohm's Law may be stated as follows:

> **"Amperage will increase whenever voltage increases and resistance remains the same. Amperage will decrease whenever resistance increases and voltage remains the same."**

Ohm's Law can be expressed mathematically as follows:

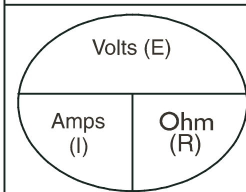
IxR=V

Volts (V) = Amperes multiplied by Ohms
Amperes (I) = Volts divided by Ohms
Ohms (R) = Volts divided by Amperes

Use the circle diagram in Figure 1.17 to help you remember Ohm's Law. Simply cover the unknown factor and the other two will remain in their proper relationship.

Figure 1.17 — Ohms Law Expressed Mathematically

Measuring Unit - Symbols	Equations
Current Flow = Amperes = I	Amperes = $\frac{\text{Volts}}{\text{Ohms}}$
Pressure = Volts = E	Volts = Amperes x Ohms
Resistance = Ohms = R	Ohms = $\frac{\text{Volts}}{\text{Amperes}}$



Current flow in a circuit is directly proportional to the pressure and inversely proportional to the resistance.

When two values are known, cover the unknown to obtain the formula.

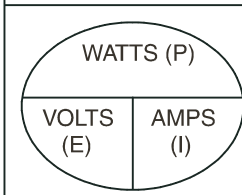
The Watt - Unit of Electrical Power

One watt is equal to one ampere of current flow under pressure of one volt. Exactly 746 Watts of electrical power is equal to one horsepower (Figure 1.18). Calculate electrical power by using this formula:

Watts = Volts x Amperes

Figure 1.18 — The Watts Formula

WATTS - The Measuring Unit of Electrical Power



EQUATIONS

Watts = Volts x Amperes

Amperes = $\frac{\text{Watts}}{\text{Volts}}$

Volts = $\frac{\text{Watts}}{\text{Amperes}}$

ELECTRICAL FORMULAS

TO FIND	KNOWN VALUES	1-PHASE	3-PHASE
KILOWATTS (kw)	Volts, Current, Power Factor	$\frac{E \times I}{1000}$	$\frac{E \times I \times 1.73 \times PF}{1000}$
KVA	Volts, Current	$\frac{E \times I}{1000}$	$\frac{E \times I \times 1.73}{1000}$
AMPERES	kW, Volts, Power Factor	$\frac{kW \times 1000}{E}$	$\frac{kW \times 1000}{E \times 1.73 \times PF}$
WATTS	Volts, Amps, Power Factor	Volts x Amps	E x I x 1.73 x PF
NO. OF ROTOR POLES	Frequency, RPM	$\frac{2 \times 60 \times \text{Frequency}}{\text{RPM}}$	$\frac{2 \times 60 \times \text{Frequency}}{\text{RPM}}$
FREQUENCY	RPM, No. of Rotor Poles	$\frac{\text{RPM} \times \text{Poles}}{2 \times 60}$	$\frac{\text{RPM} \times \text{Poles}}{2 \times 60}$
RPM	Frequency, No. of Rotor Poles	$\frac{2 \times 60 \times \text{Frequency}}{\text{Rotor Poles}}$	$\frac{2 \times 60 \times \text{Frequency}}{\text{Rotor Poles}}$
kW (required for Motor)	Motor Horsepower, Efficiency	$\frac{HP \times 0.746}{\text{Efficiency}}$	$\frac{HP \times 0.746}{\text{Efficiency}}$
RESISTANCE	Volts, Amperes	$\frac{E}{I}$	$\frac{E}{I}$
VOLTS	Ohm, Amperes	I x R	I x R
AMPERES	Ohms, Volts	$\frac{E}{R}$	$\frac{E}{R}$

E = VOLTS   I = AMPERES   R = RESISTANCE (OHMS)   PF = POWER FACTOR

ELECTRICAL CIRCUITS

Electrical conductors and resistances (loads) can be arranged to form any of three following types of circuits:

- A Series Circuit
- A Parallel Circuit
- A Series-Parallel Circuit

The Series Circuit

A series circuit provides only one path in which current can flow. A break in any part of the circuit stops current flow in the entire circuit (Figure 1.19). The following basic laws may be applied to a series circuit:

- Current flow (in amperes) is the same in every part of the circuit.
- The **total resistance** of all resistances (loads) in a series circuit is the sum of the individual resistances.
- The **total voltage** across all resistances (loads) in series is the sum of the voltages across the individual resistances.

Thus, total resistance may be determined as follows:

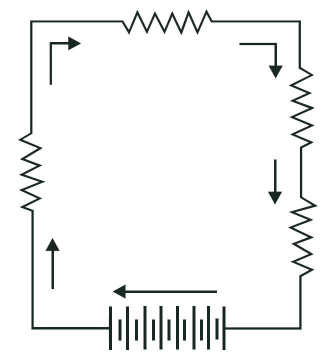
$$R_T = R_1 + R_2 + R_3 + R_4$$

Find the **voltage drop** across each resistor in a series with the formula **E=IR**.

Current flow (in amperes) in a series circuit is the same at every point in the circuit. Find the **current flow** with the formula:

$$I = \frac{E}{R}$$

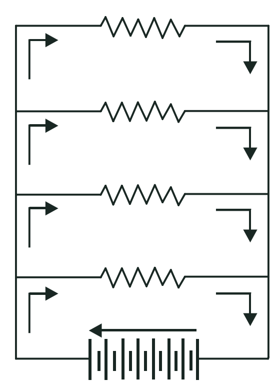
Figure 1.19 — The Series Circuit



The Parallel Circuit

The **parallel** circuit provides two or more branches in which current can flow (Figure 1.20). Resistances (loads) in the individual branches are completely independent of others in separate branches. If a shorted or open condition occurs in any branch of the circuit, the remaining branches may continue operating.

Figure 1.20 — The Parallel Circuit



Resistance in a parallel circuit is <u>less</u> than the resistance of any of the individual branches or paths. To find **total resistance** in any parallel circuit, use the following formula:

$$\frac{1}{R} = \frac{1}{r} + \frac{1}{r2} + \frac{1}{r3}$$

$$\frac{1}{R} = \frac{1}{10} + \frac{1}{20} + \frac{1}{60}$$

$$\frac{1}{R} = \frac{6 + 3 + 1}{60}$$

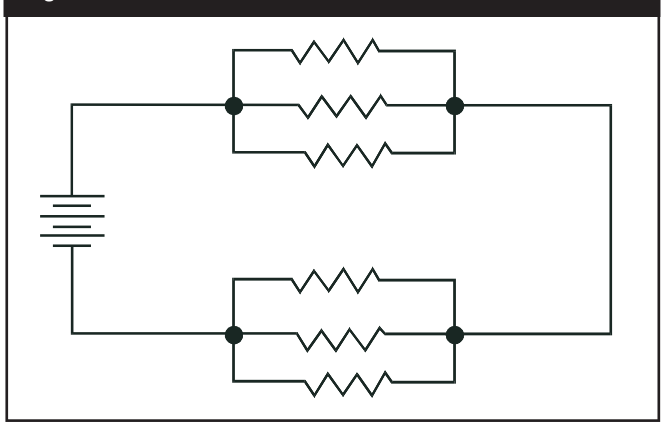
The voltage applied to each component in a parallel circuit is the same as the voltage supplied by the source. The same voltage will be applied to all components in the circuit.

Total current flow (in amperes) through the branches of a parallel circuit is the sum of the current flow through individual components.

The Series-Parallel Circuit

Figure 1.21 shows a series-parallel circuit, in which two groups of "paralleled" resistors are connected in series. To find the **total resistance** of such a circuit, first determine the resistance of each group. **The sum of the two group resistances is the total circuit resistance.** You can treat the two groups of resistances exactly the same as a pair of resistances in series.

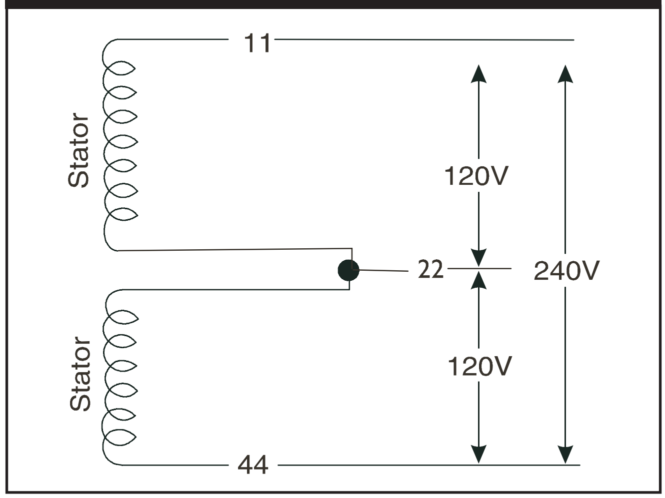
Figure 1.21 — The Series-Parallel Circuit



3-Wire Circuit

Many buildings and AC alternators that have a single phase output are connected in a 3-wire circuit (Figure 1.22). The 3-wire circuit provides "dual voltage," which means it provides both 120 Volts AC and/or 240 Volts AC (120VAC and/or 240VAC).

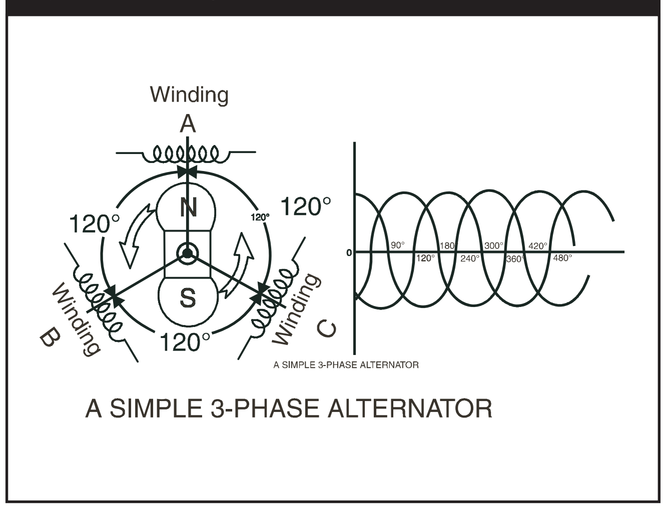
Figure 1.22 — Three Wire Circuit



3-Phase Circuits

Three-phase circuits generate three sine waves which are 120 degrees "out-of-phase" with one another (Figure 1.23).

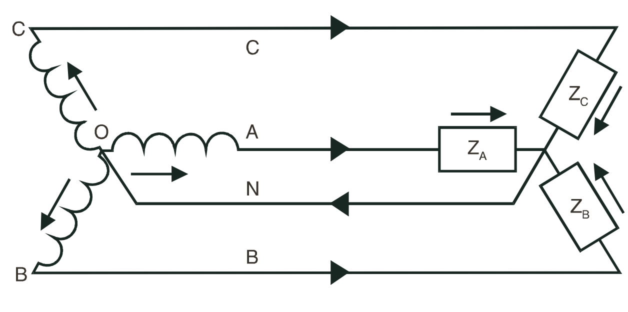
Figure 1.23 — Simple Three-Phase Alternator



A 3-phase circuit has the following advantages:

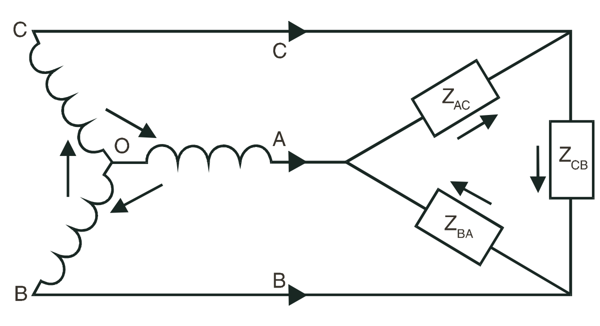
- When the load is balanced in all three legs of a 3-phase circuit, instantaneous power is constant. This provides better capabilities for motor starting and running.
- Current flow in a 3-phase circuit produces a constant flux density, making it more effective than single phase circuits for starting and running electric motors.
- A **wye-connected**, 3-phase circuit supplies two different values of 3-phase voltage in one system.
    - To apply 120 Volts to a load, connect it as a 4-wire Wye load, as shown in Figure 1.24.

Figure 1.24 — 4-Wire Wye Load (120 Volts Applied)



- To apply 208 Volts to a load, connect the load in DELTA fashion (Figure 1.25).

Figure 1.25 — Load Connected In DELTA Fashion



The 3-phase connection systems or circuits may be:

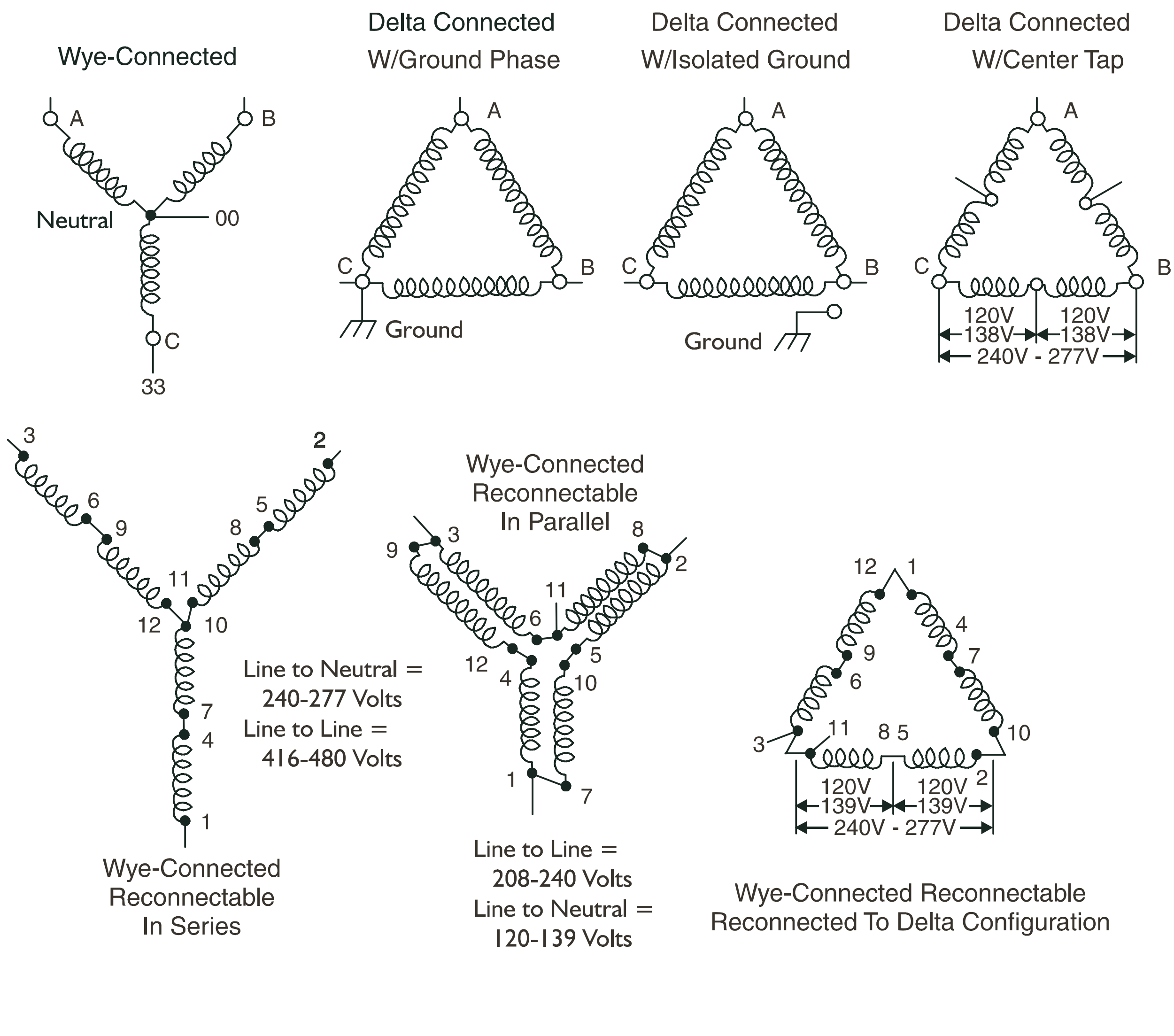
- Wye-Connected
- DELTA-Connected or
- Wye-Connected Re-connnectable (Figure 1.26).

Connections Affecting Circuits

It is necessary to become familiar with some of the terms used to describe conditions which adversely affect the operation of electrical circuits. Some of the more common terms are:

- **Open Circuit:** An incomplete circuit.
- **Partially Open Circuit:** A circuit where a high resistance has developed due to loose or corroded connections, or a partially broken wire. The resulting increase in resistance causes current flow to decrease.
- **Shorted Circuit:** A condition that exists when there is a DECREASE in resistance across some part of the circuit. Since electrical current flow "seeks" the path of least resistance, current will tend to flow across the shorted section of the circuit.
- **Partially Shorted Circuit:** A condition where positive and negative sides of a circuit only contact slightly, bypassing a small amount of current.

Figure 1.26 — Some Examples of 3-Phase Connection System

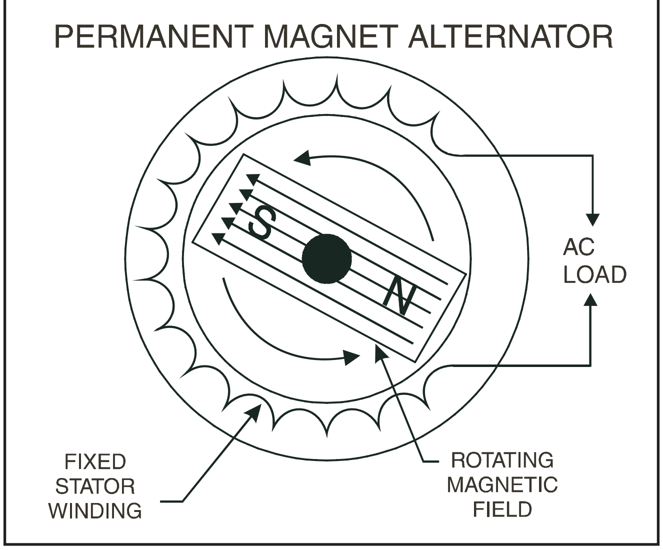


SIMPLE ALTERNATOR OPERATION

Simple Alternator

In an alternator (Figure 1.27), a revolving magnetic field called a **rotor** is moved through a stationary coil of wires called a **stator**. This movement induces an electro-motive force (EMF) into the stator coils.

Figure 1.27 — Simple Revolving Field Alternator



As the magnetic lines of flux cut across the stationary windings, a difference in electrical "potential" is induced into the stator windings. When a complete circuit is formed (by connecting a load to the stator windings) current flow occurs. The current (in amperes) delivered to the load is affected by:

- The number of wire turns in the stator.
- The strength of the magnetic field in the rotor.

The Stationary Magnetic Field

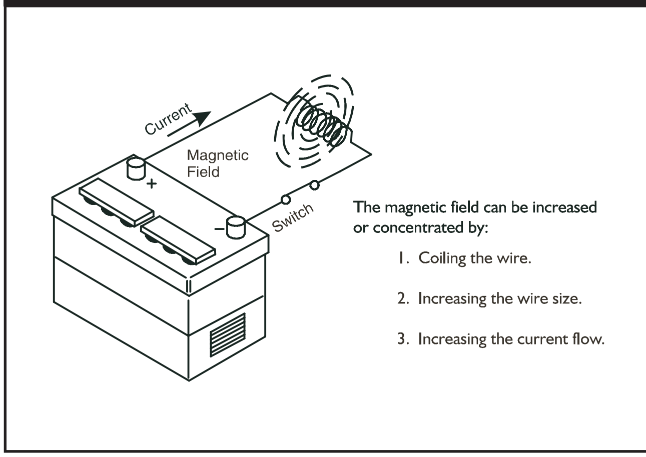
The number of wire turns in a stator winding are determined when it is manufactured. A typical stator assembly may be a single phase type, or a 3-phase type, as previously discussed. The greater the number of wire turns in the stator, the greater the induced EMF in the stator. This is because the magnetic field of the rotor has more wire turns to cut through on the stator.

The Revolving Magnetic Field

The **rotor** is essentially an electro-magnet. The flow of direct current (DC) through its windings creates a magnetic field around the rotor core (Figure 1.28). The strength of this magnetic field can be increased by:

- Forming the rotor wires into a coil.
- Increasing the wire size.
- Increasing the current flow through the rotor wires.

Figure 1.28 — Basic Principles Of Operation



The number of wire turns in a rotor, as well as the wire size, are established when the rotor is manufactured. When the alternator is operating, you can vary the strength of the rotor's magnetic field by increasing or decreasing the current flow through the rotor windings. Thus, **by controlling current flow through the rotor windings, the EMF induced into the stator windings can be regulated and/or controlled.** Because EMF (electro-motive force) is the equivalent of voltage, it can then be said that voltage regulation is accomplished by controlling rotor winding current flow.

Several methods may be employed to regulate current flow through rotor windings. They include:

- Direct Excitation.
- Reactor.
- Electronic Voltage Regulator.
- Brushless/Capacitor.

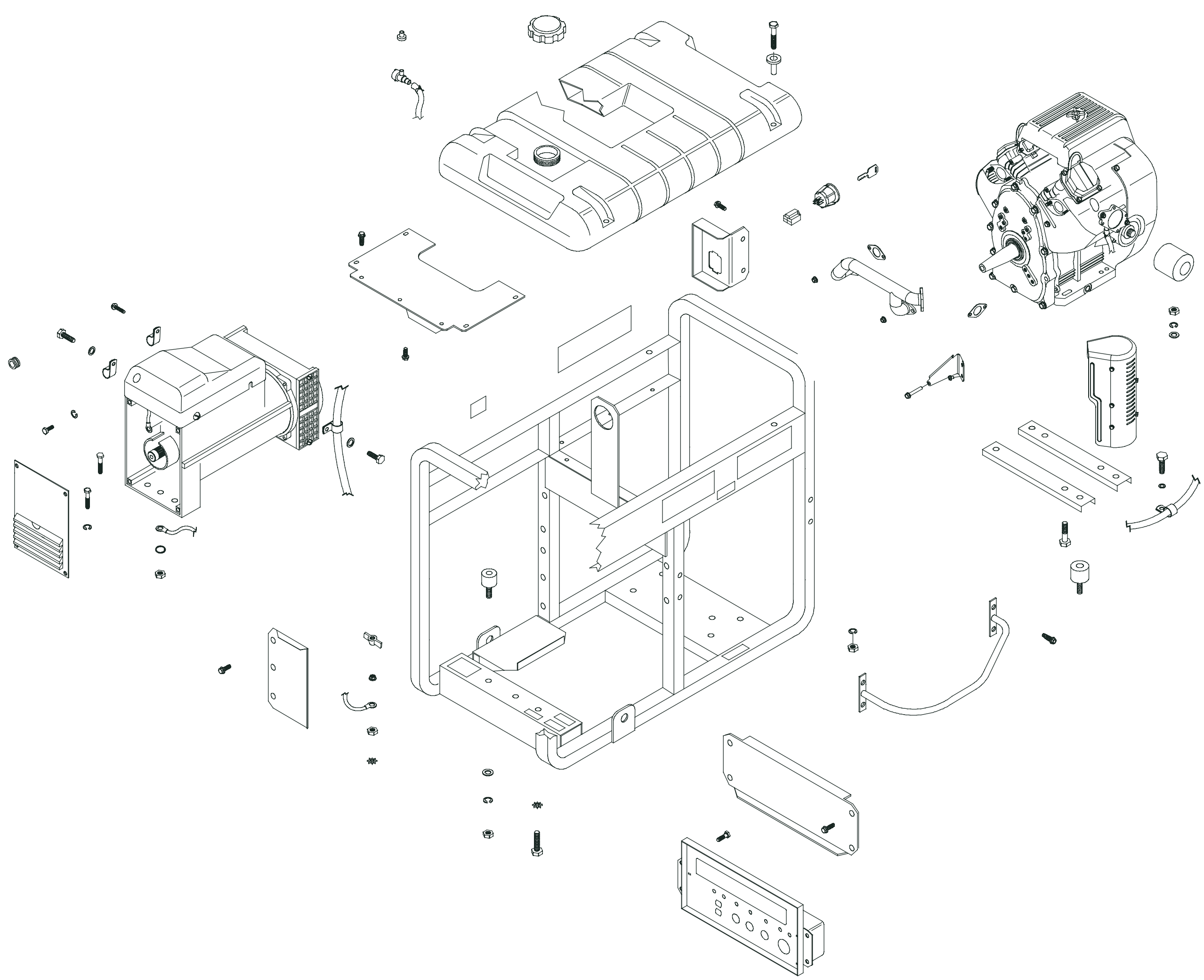
NOTES

GENERATOR COMPONENTS

Introduction

Portable generators do not have a large number of parts. However, these parts are expensive and should not be replaced needlessly. Replacement of parts as a result of "guesswork" while troubleshooting is not cost effective and should be avoided. Figure 2.1 is an exploded view of a typical portable generator set. Some differences in construction may exist between various models.

Figure 2.1 — Exploded View of a Typical Generator



Engine Assembly

As a general rule, the engine must deliver approximately 2 horsepower for each 1000 watts (1.0 kW) of generator output power. With this in mind, the following horsepower to output ratios are common:

- 2400 watt unit / 5 horsepower
- 3500 watt unit / 7 horsepower
- 4000 watt unit / 8 horsepower
- 5000 watt unit / 10 horsepower
- 8000 watt unit / 16 horsepower

The engine "power takeoff shaft" (PTO), on most portable generators, is directly connected to the rotor assembly. Usually, the engine's PTO shaft is tapered and doesn't have a keyway. The rotor assembly is tightened to the shaft by means of a long rotor bolt.

A mechanical, fixed speed, engine governor maintains actual engine speed at approximately 3720 RPM for 60 Hertz units or 3100 RPM for 50 Hertz units with no electrical loads connected to the generator ("no-load" condition). Rated operating speed is 3600 RPM, at which the 2-pole rotor will supply a rated frequency of 60 Hertz or 3000 RPM for a rated (AC) frequency of 50 Hertz. The slightly high "no-load" speed (3720 RPM) for 60 Hertz units will provide a frequency of about 62 Hertz. Setting the no-load speed slightly high helps prevent excessive RPM and frequency "droop," when heavy electrical loads are applied.

Several different engine manufacturers may be found on the various **Generac Portable Products®** generator models. They include:

- Briggs & Stratton®
- Tecumseh®
- Kawasaki®
- Honda®
- Robin®
- Generac Power Systems®

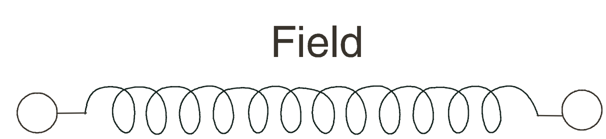
Rotor Assembly

A pre-lubricated and sealed ball bearing is pressed onto the rotor shaft. No additional lubrication is required for the life of the bearing. The bearing supports the rotor at the "rear bearing carrier." Slip rings on the rotor shaft permit excitation current to be delivered to the rotor windings. Although residual magnetism is always present in the rotor, this excitation current flow through the rotor produces a magnetic field strength that is additive (in addition) to residual magnetism.

A typical rotor (Figure 2.2) can be a rotating permanent magnet having no electrical current flow.

In practice, most rotors are a rotating electromagnet with a direct current flowing through its coiled wires.

Figure 2.2 — A Typical Rotor Schematic Symbol



Concerning electromagnetism in regards to rotors, these general statements can be made:

- The strength of the magnetic field is directly proportional to the number of turns of wire in the rotor.
- The strength of the magnetic field is directly proportional to the current (in amperes) flowing through the rotor windings.

From these statements, we can deduce that the field strength of the rotor's magnetic field may be increased by:

- Increasing the number turns of wire in the rotor.
- Increasing he current flow (in amperes) through the rotor windings.

Two-Pole Rotors:

A 2-pole rotor has a single north and a single south magnetic pole. One revolution of the 2-pole rotor creates a single cycle of alternating current flow in the stator windings. To determine the rotor speed required for a given (AC) frequency, use the following formula:

RPM = Desired Frequency times 60

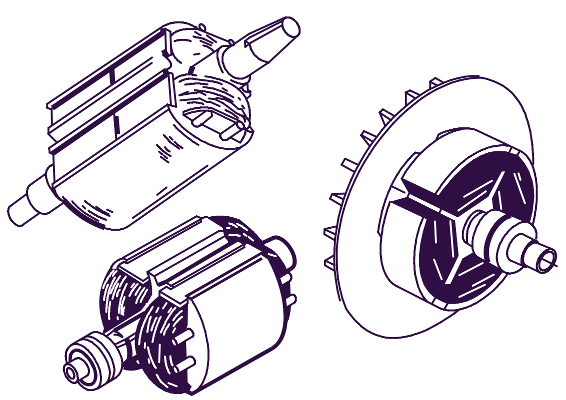
Hertz: The complete set of values through which an alternating current (AC) repeatedly passes.

Example: An alternator with a 2-pole rotor must produce a USA standard of 60 Hertz. To find the required driven speed of the rotor, multiply 60 times 60 to obtain 3600. The required driven speed of of the rotor is 3600 RPM.

Four-Pole Rotors:

A 4-pole rotor has two south and two north poles. These rotors provide the same frequency as the 2-pole rotor, but at half the driven speed of the 2-pole rotor (Figure 2.3).

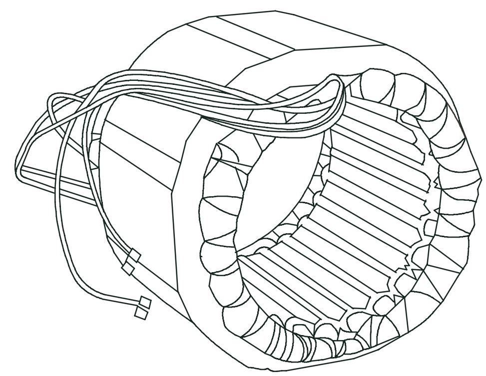
Figure 2.3 — Typical 2-Pole And 4-Pole Rotors



Stator Assembly

The word "stator" means stationary winding. A voltage or electromotive force (EMF) is induced into the stator by the action of rotating the magnetic field created by the rotor. A typical stator assembly is shown in Figure 2.4. Stators differ greatly, depending on the ratings and design of the specific alternator on which they will be used.

Figure 2.4 — Typical Stator Assembly

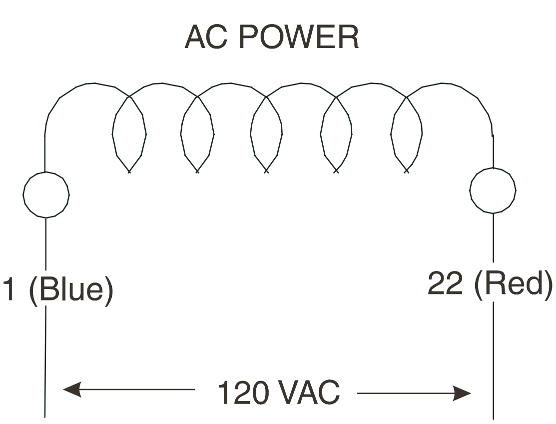


Typical stators may contain:

- An "excitation" winding (DPE)
- An (AC) "power" winding
- A "battery charge winding" (BCW)

A "single voltage" stator (AC) power winding schematic is shown in Figure 2.5.

Figure 2.5 — Single Voltage, 1-Phase Stator Winding

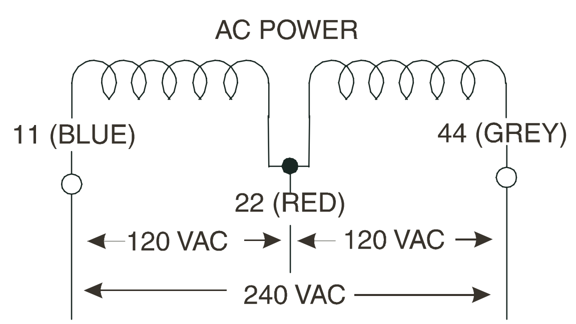


It consists of a single winding, capable of supplying 120VAC only to a panel receptacle.

Figure 2.6 represents a "dual voltage" stator (AC) power winding schematic.

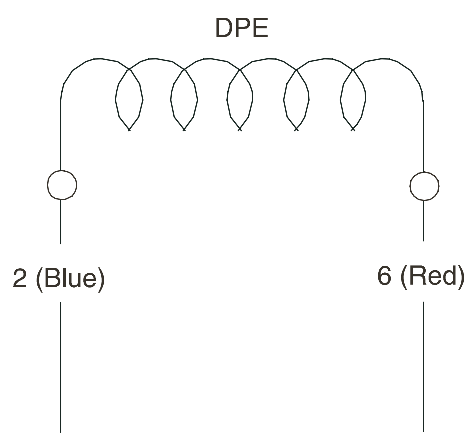
It is made up of two windings and has the ability to supply a dual output voltage (such as 120VAC and/or 240VAC).

Figure 2.6 — Dual Voltage AC Power Winding



A typical "Displaced Phase Excitation" (DPE) winding is shown schematically in Figure 2.7.

Figure 2.7 — Displaced Phase Excitation (DPE)



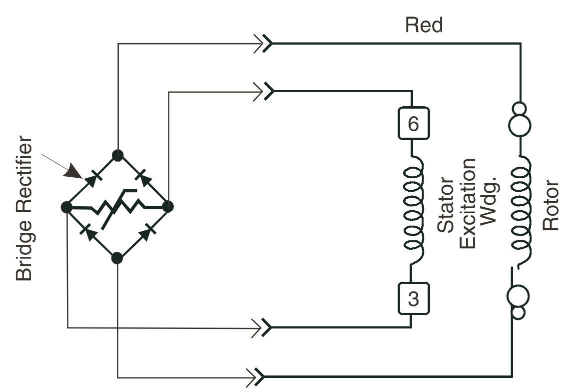
Output (AC) from this winding is rectified and delivered to the bridge rectifier rotor windings as direct current (DC).

Stator Excitation Winding

Direct Excited Units: Excitation winding (AC) output is delivered to a bridge rectifier (Figure 2.8), which converts its output to direct current (DC).

The rectifier direct current output is delivered to the rotor windings.

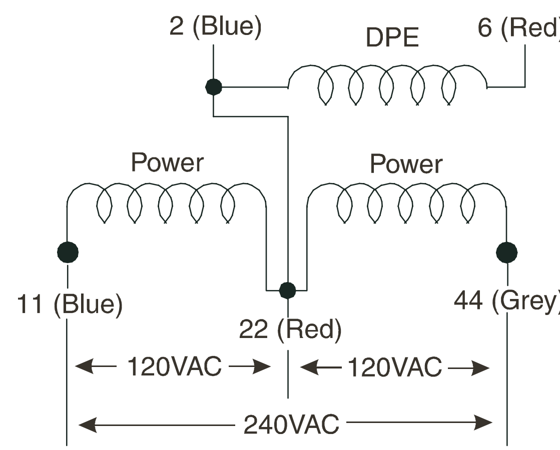
Figure 2.8 — Direct Excited Units



"XL" & "MC" Series Stators

Some "XL" and "MC" series stators are equipped with excitation" (DPE) windings that interconnect with the stator (AC) power windings. This is shown in the schematic in Figure 2.9.

Figure 2.9 — (AC) / (DPE) Windings ("XL" and "MC")



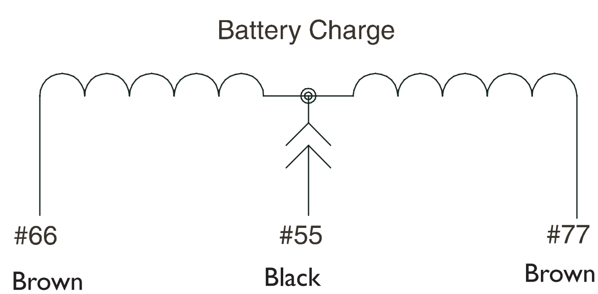
NOTE: During tests, this type of stator will show "continuity" between the (AC) power and (DPE) windings. Other types of stators are defective if "continuity" is indicated between the windings. Always refer to the schematic of the unit being tested.

Stator Battery Charge Windings

Some alternator units may be equipped with battery charge windings (BCW). These units may be used to charge a connected battery. Figure 2.10 shows a schematic of a typical battery charging circuit.

The stator battery charge winding delivers a rectified 12 Volts DC (12VDC) through a circuit breaker or fuse to the connected battery.

Figure 2.10 — Stator Battery Charge Circuit



Switches

A switch may be defined as a device used to open, close or divert an electrical circuit. You can actuate switches manually or automatically. This discussion is devoted solely to manually operated switches.

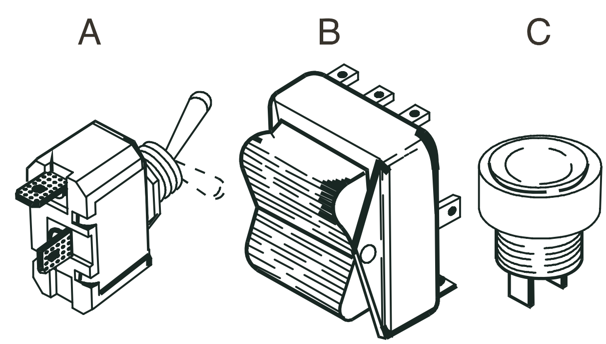
Generally, switches are classified according to how they are actuated, their number of poles and their number of throws.

Actuating Switches

Figure 2.11 shows:

- A Toggle Switch (A)
- A Rocker Switch (B) and
- A Push Button Switch (C).

Figure 2.11 — Switches Classified By Actuation



These switches are named by how they are actuated.

Switches Classified By Poles and Throws

The following types of switches are shown in both pictures and schematics.
(See Figures 2.12 through 2.17)

- Single Pole, Single Throw (SPST)
- Single Pole, Double Throw (SPDT)
- Double Pole, Single Throw (DPST)
- Double Pole, Double Throw (DPDT)
- Three Pole, Double Throw (3PDT)
- Four Pole, Double Throw (4PDT)

Figure 2.12 — Single Pole, Single Throw (SPST)

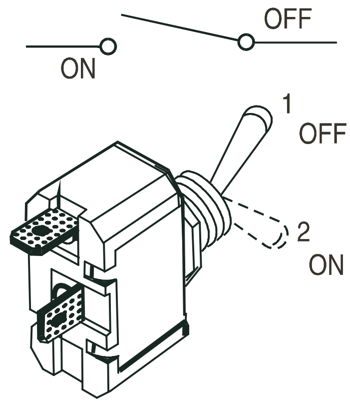


Figure 2.13 — Single Pole, Double Throw (SPDT)

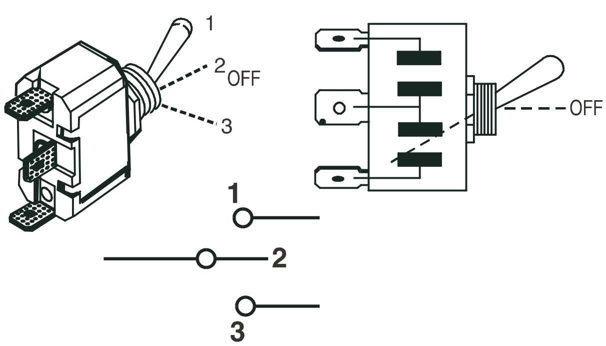


Figure 2.14 — Double Pole, Single Throw (DPST)

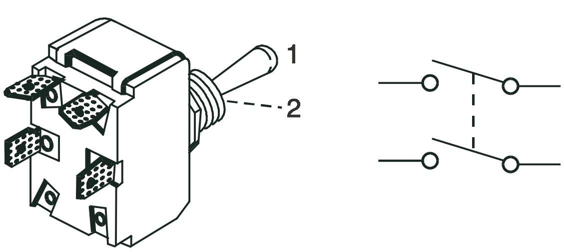


Figure 2.15 — Double Pole, Double Throw (DPDT)

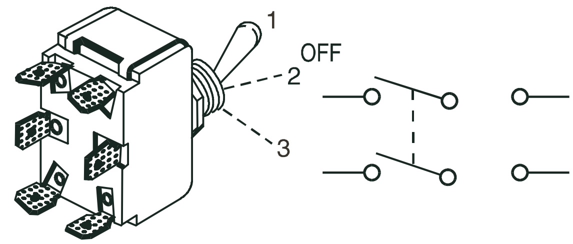


Figure 2.16 — Three Pole, Double Pole (3PDT)

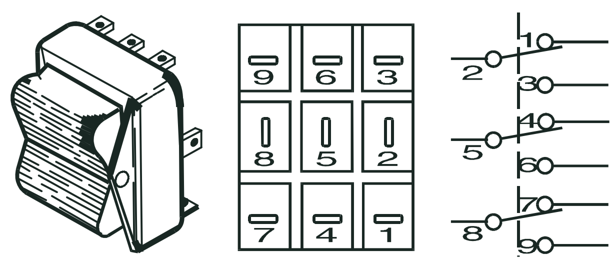
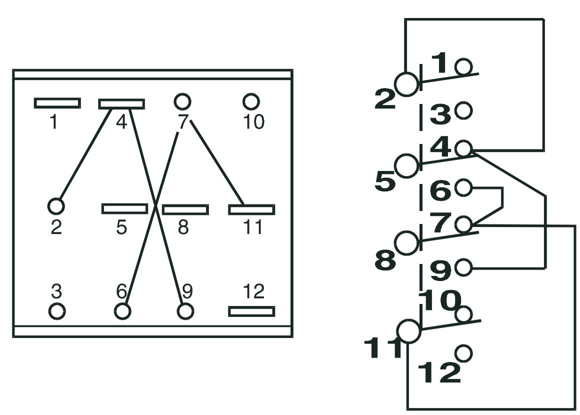


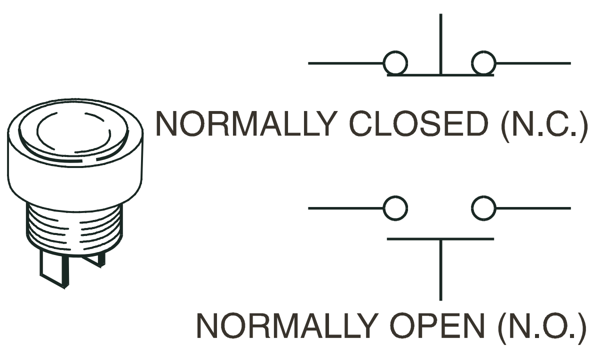
Figure 2.17 — Four Pole, Double Throw (4PDT)



Push Button Switches

Push button switches may be classified generally as "normally-open" (NO) or "normally-closed" (NC) type switches. Both types are illustrated in Figure 2.18.

Figure 2.18 — Push Button Switches



Rotary Switches

Some typical rotary switches are shown in Figure 2.19. In general, this type of switch may be classified by:

- The number of poles.
- The number of positions.

Figure 2.19 — Some Typical Rotary Switches

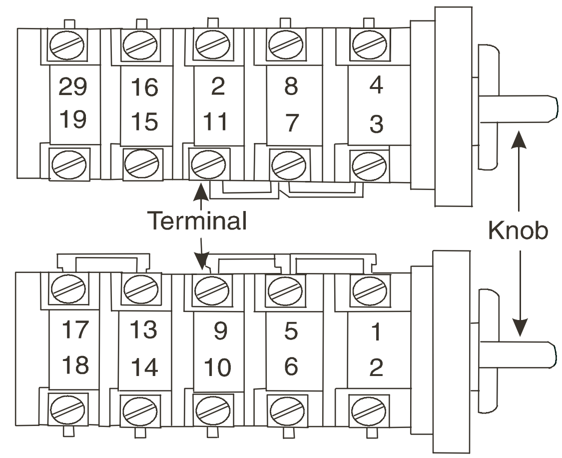
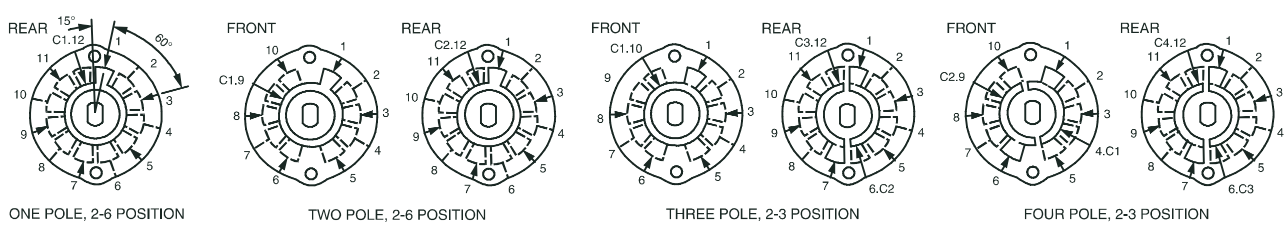


Figure 2.20 illustrates single-pole, double-pole, 3-pole and 4-pole rotary switches.

Figure 2.20 — Examples Of Rotary Switch Classifications

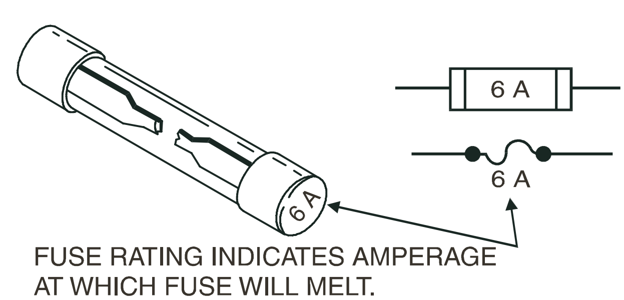


Protective Switches

Fuses

A fuse could be called a switch because it functions to open an electrical circuit when current flow becomes excessive. The fuse in Figure 2.21 is a strip of metal with a known melting point that has been installed in series with the circuit it is meant to protect.

Figure 2.21 — A Typical Fuse



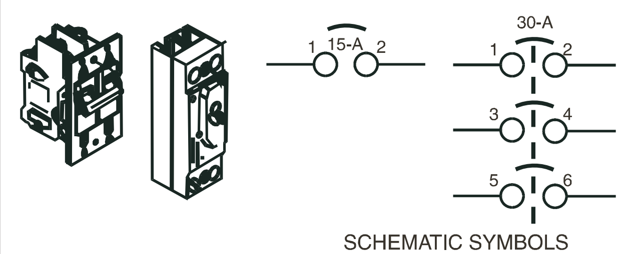
Should current flowing through the fuse exceed a specific value, the fuse element (strip of metal) melts which opens the circuit. Generally, fuses are rated at the current value (in amperes) at which its element will melt open.

Circuit Breakers

Circuit breakers (Figure 2.22) protect one or more circuits against overloads or short circuits.

One type of circuit breaker consists of an electromagnet with coil windings that are in series with the circuit to be protected. When current flow exceeds a pre-determined value, the coil's magnetic field becomes strong enough to open a set of contact points and open (or break) the circuit before damage can be occur.

Figure 2.22 — Typical Circuit Breakers



NOTE: A "circuit breaker" may be reset manually while a "fuse" must, generally, be replaced.

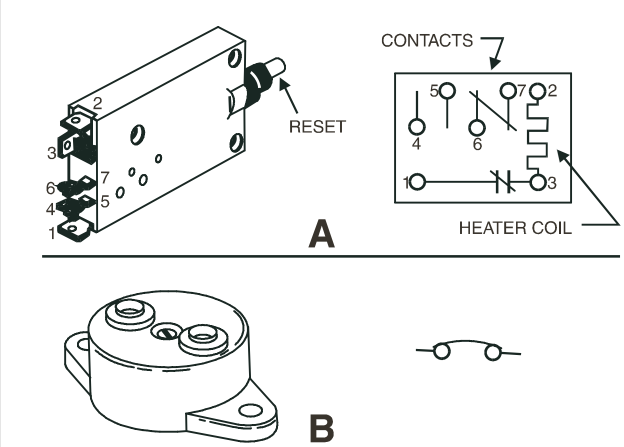
Thermal Switches

Thermal switches react to changes in temperature. One type of thermal switch consists of a fine metal strip in which two different metals having different expansion rates are welded together. When the two different metals are heated, the metal strips bend, which then opens (breaks) a set of contacts.

Figure 2.23 illustrates two different types of thermal switches.

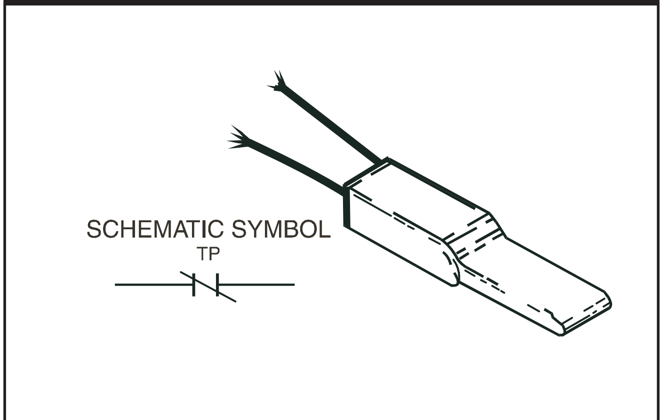
The switch shown in "A" must be reset manually once it has been tripped. In "B," the thermal switch resets automatically after the metal has cooled to a pre-established temperature.

Figure 2.23 — Examples of Thermal Switches



Some stators may have a thermal protector imbedded in their wire windings and electrically connected in series with the excitation winding output to the voltage regulator. This thermal switch opens at a pre-determined temperature to terminate excitation current output to the rotor. The switch closes automatically when the internal stator temperature decreases to a safe value (Figure 2.24).

Figure 2.24 — Thermal Protector

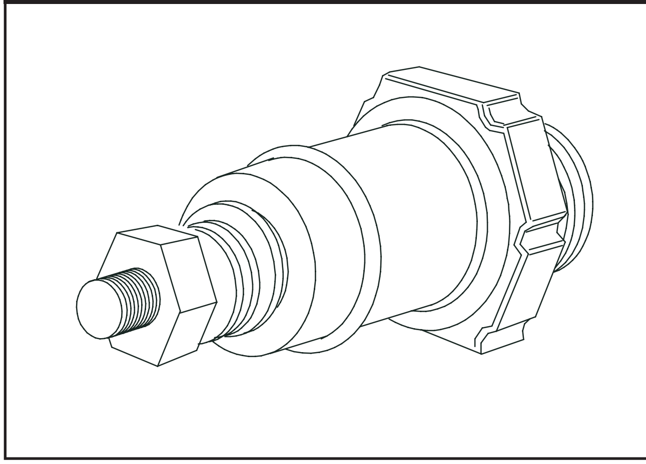


Another type of thermal switch may sense engine coolant temperature. This switch is the "normally-open" (NO) type and closes if coolant temperature exceeds a pre-determined safe value. It grounds the engine's ignition circuit and causes the engine to shut down.

Pressure Switches

One example of a pressure switch is the low oil pressure shutdown switch used on some generator engines. This type of switch is normally-closed (NC), and is held open by engine oil pressure during engine operation. Should engine oil pressure drop below a pre-determined safe value, the switch closes to ground the engine ignition circuit, causing the engine to shut down (Figure 2.25).

Figure 2.25 — Typical Pressure Switch



Solenoids

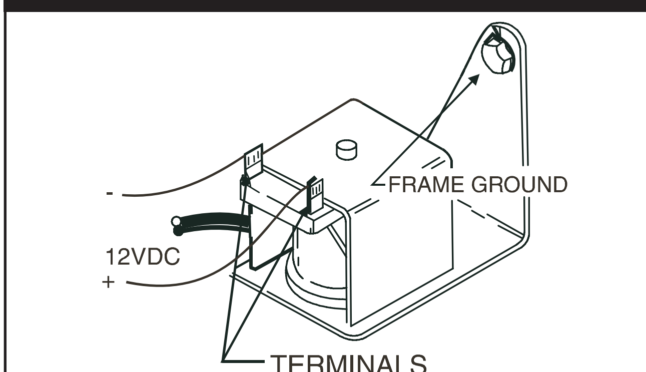
A solenoid is a device used to convert electrical energy into mechanical movement. It is based on the principle that when current flows through a conductor, a magnetic field is created around that conductor. Solenoids may be used in the following applications:

- Fuel shutoff valves
- Electric chokes
- Engine throttle controls
- Engine anti-dieseling devices.

Fuel Shutoff Valves

This type of valve is energized open by a 12VDC signal during engine cranking and running. A spring causes it to close when the (DC) signals are removed as the engine shuts down (Figure 2.26).

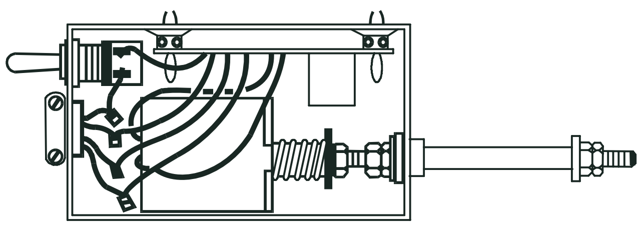
Figure 2.26 — Typical Fuel Shutoff Valve



Engine Throttle Control

Some generator units may be equipped with an automatic idle (throttle) control device. **This device uses a solenoid to pull the carburetor throttle lever against its idle stop when the alternator unit is not powering any electrical loads.** When an electrical load is connected to the generator, the solenoid is de-energized and the engine governor takes control of engine speed. Thus, the unit operates at its governed speed only when electrical loads are connected and turned **ON**. The engine decelerates to idle speed when loads are disconnected (Figure 2.27).

Figure 2.27 — Typical Idle Control Solenoid



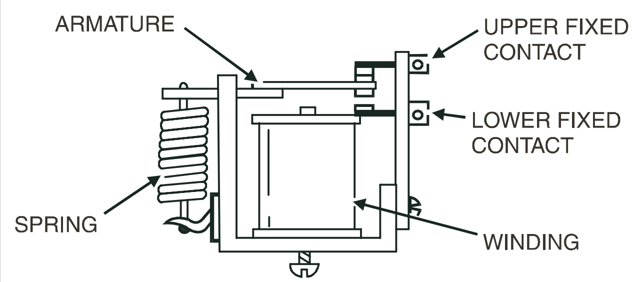
Relays

You can compare relays to solenoids because a relay is an electromagnet that also creates mechanical movement. The relay, however, utilizes its magnetic field to open or close a set (or sets) of electrical contacts.

A typical relay operates as follows (Figure 2.28):

- With no voltage applied to the relay winding, the spring holds the armature contacts against the upper fixed contact.
- When current flow is applied to the winding, a magnetic field is created. The winding becomes an electromagnet that overcomes spring tension and pulls the armature contacts down against the lower fixed contact.

Figure 2.28 — Construction Of A Typical Relay

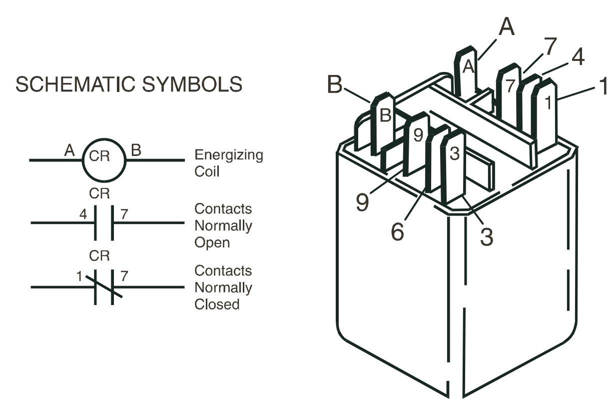


- Removing the current collapses the magnetic field. The spring tension then acts to pull the armature contacts to their original position against the upper fixed contacts.

A relay thus functions as an electrically actuated switch to open or close a circuit.

A typical relay is shown in Figure 2.29, along with the schematic symbols for the relay's winding (energizing coil) and contacts.

Figure 2.29 — Typical Relay With Schematic Symbols



The terms "normally open" (NO) and "normally closed" (NC) refer to the condition of the contacts when no current is flowing through the energizing coils.

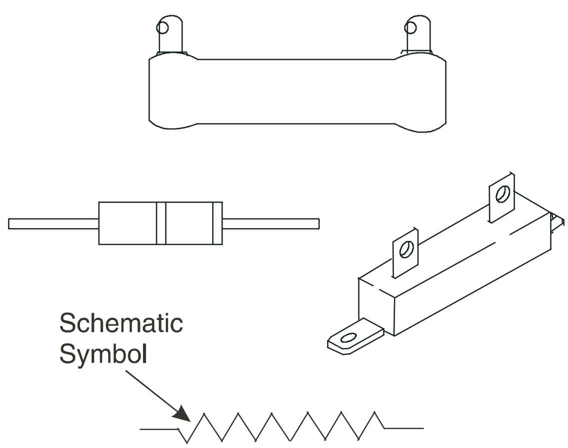
Resistors

Resistors are used to introduce resistance into a circuit, thereby limiting current flow. Resistance is dependent upon the length, cross sectional area, and physical properties of a conductor. These factors are used in the construction of resistors.

The physical size of a resistor depends on its wattage rating, not on its resistance value (ohms).

A resistor may have fixed or variable resistance. A fixed resistor (Figure 2.30) establishes a certain fixed resistance in the circuit.

Figure 2.30 — Some Typical Fixed Resistors



A variable resistor is provided with some means of manipulating the length of the resistor element. One type of variable resistor is called a potentiometer or rheostat, which is usually wire-wound.

The amount of resistance provided by the rheostat (Figure 2.32) can be changed by means of a moveable wiper arm which varies the number of turns of wire through which current is permitted to flow.

Figure 2.31 — Resistor Color Bands

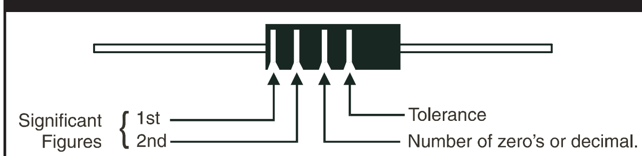
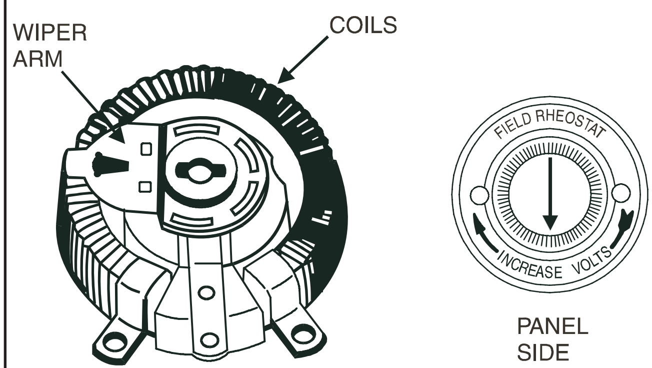


Figure 2.32 — Typical Rheostat



Identification Of Resistors

Resistors may be marked with their resistance, tolerance and wattage values or they may be color-coded. Figure 2.31 and 2.33 shows the method used to color-code a resistor. The accompanying chart gives the value for each color band.

Figure 2.33 — Resistor Color Coding

COLOR	SIGNIFICANT FIGURE OR NUMBER OF ZEROS	
Black	0	
Brown	1	
Red	2	
Orange	3	
Yellow	4	
Green	5	
Blue	6	
Violet	7	
Gray	8	
White	9	
COLOR	DECIMAL MULTIPLIER	RESISTANCE TOLERANCE
Gold	0.1	±5%
Silver	---	±10%
(No Color)	---	±20%

The Varistor

Varistors are unique types of resistors that present high resistance to normal voltages and a low resistance to excessive voltages in circuits. You could call them "voltage-sensitive." Figure 2.34 shows a silicone carbide resistor, along with its schematic symbol.

This type of variable resistor is often used to protect diodes in a "bridge rectifier" (discussed later in this section) by permitting normal voltage to pass through diodes, but shunting excessively high voltages to ground.

Figure 2.34 — A Silicone Carbide Varistor

NOTES

Transformers

A transformer increases (steps up) or decreases (steps down) an applied voltage. Transformers use the principles of **electromagnetic induction** and, more precisely, **mutual induction**. An automobile ignition coil (as briefly discussed on page 7) is just one example of a transformer.

A typical transformer consists of a metal core, which has two coils of wire wrapped around it. These are called the **primary** and **secondary** windings. To help understand the operation of a transformer, a discussion of mutual induction is offered here:

If a changing (collapsing or expanding) magnetic field in one coil cuts across the windings of a second coil, a voltage is induced into the second coil. This is the principle of **mutual induction**.

The winding in Figure 2.35 indicated by the letter "S" is wound over an iron core. This is the secondary winding. Another winding (called the primary winding) is wound **over** the first winding and is indicated by the letter "P." When the switch is closed, current flow through the primary winding increases, which expands lines of magnetic force that cut across the secondary winding. This causes a voltage to be induced into the secondary winding <u>in one direction</u>.

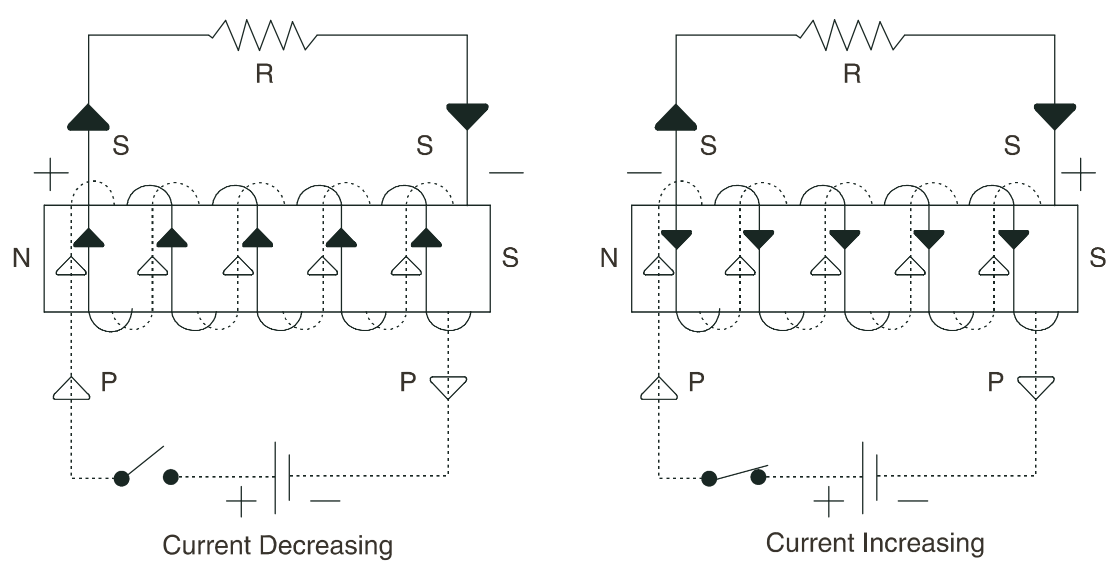
If the switch is opened, however, the sudden decrease in current flow through the primary winding (and the resulting collapse of magnetic lines of flux) **also** induces a voltage into the secondary winding <u>in the other direction</u>. The secondary winding then becomes a source of voltage and supplies (AC) current to resistor "R". The magnitude of the voltage induced into the secondary winding is primarily determined by the number of turns in the primary (P) <u>in relation to</u> the secondary windings (S).

For Example:

(Both windings using the same wire size)

If 12VAC is applied to the primary winding and the secondary winding has 100 times as many turns of wire as the primary, the secondary voltage is about (12 X 100) = 1200VAC.

Figure 2.35 — The Principle Of Mutual Induction

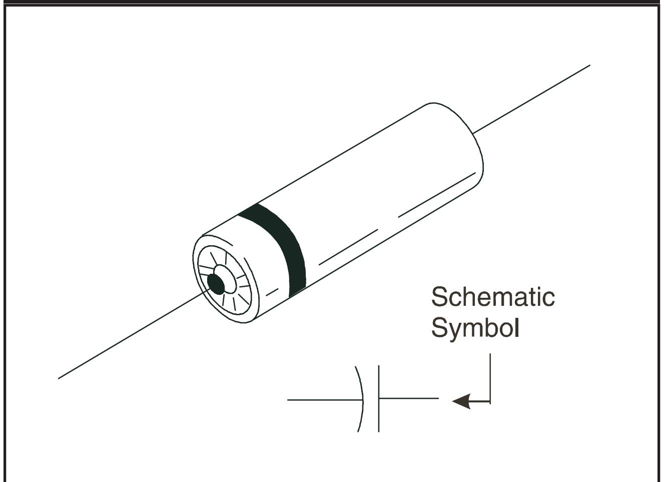


Condensers

The terms "condensers" and "capacitors" may be used interchangeably. They are electrical devices that store energy within themselves (Figure 2.36).

A simple condenser (capacitor) consists of two metal plates separated by a small air space or a layer of insulating material called a "dielectric."

Figure 2.36 — Typical Condenser With Symbol

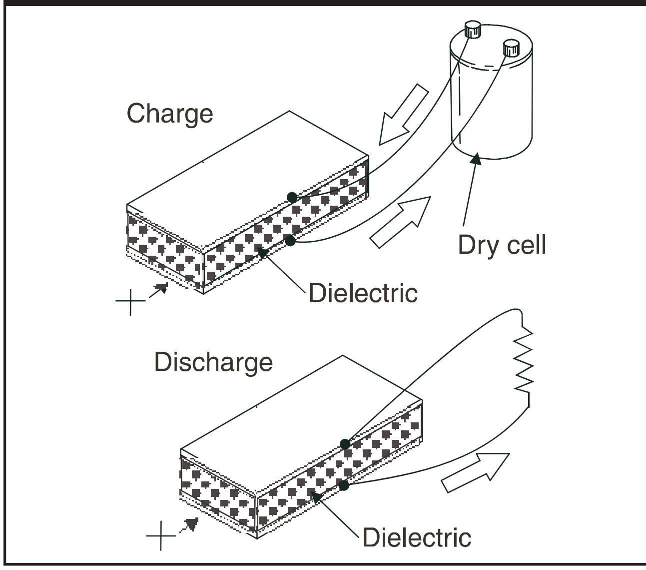


Condenser Operation

Whenever two conducting materials are separated by an insulating material (dielectric), they have the ability to store electrical energy. If a source of (DC) voltage is connected between the two conducting materials of a capacitor (condenser), a current will flow for a certain length of time. The current initially will be relatively large but will rapidly diminish to zero. A certain amount of electrical energy will then be stored in the capacitor.

If the source of the voltage is removed and the conductors of the capacitor are connected to the two ends of a resistor, a current will flow from the capacitor through the resistor for a certain length of time. The current initially will be relatively large but, will rapidly diminish to zero. When the current reaches zero, the capacitor will have dissipated the energy it had stored as heat energy in the resistor. The capacitor will then be said to be "discharged" (Figure 2.37).

Figure 2.37— Charge and Discharge of a Condenser



However, if a wire is connected between the two plates, (if you touch the two capacitor wires together) the excess electrons of the negative plate pass through the wire as current flow to neutralize the positive charge on the positive plate.

Condensers in a DC Circuit

A condenser in a (DC) circuit permits current to flow only while the plates are being charged, which is momentarily. After the plates are fully charged, the condenser becomes an "open," -in a (DC) circuit.

Condensers in an AC Circuit

In an (AC) circuit, the continuous reversal of polarity causes the plates to charge first in one direction, then the other. Thus, in an (AC) circuit, there is a constant current flow to and from the plates, although current does not actually flow through the dielectric.

The Use of Condensers

Condensers can cause current to "lead" voltage. (Voltage "lead" is discussed later in "Generator Systems") They are sometimes used in (AC) circuits to neutralize the undesirable effects of lagging current or inductive reactance. Condensers are also used to block (DC) current from entering a circuit.

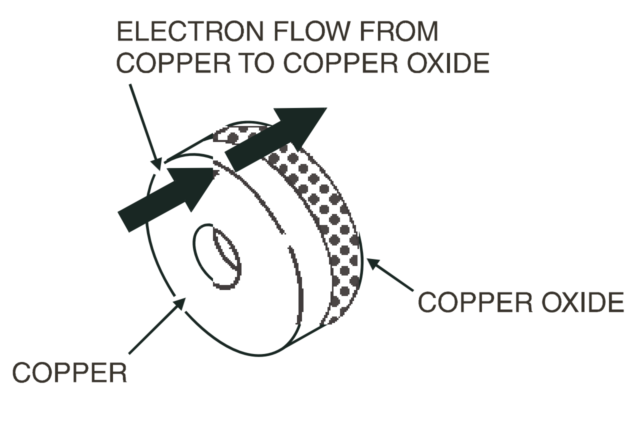
Rectifiers

Rectifiers, also known as diodes, are used to convert alternating current (AC) to direct current (DC). A simple rectifier consists of a thin film of metallic oxide which is deposited on a thicker plate of metal, such as iron. Selenium is often used as the metallic oxide in a rectifier.

Rectifier Operation

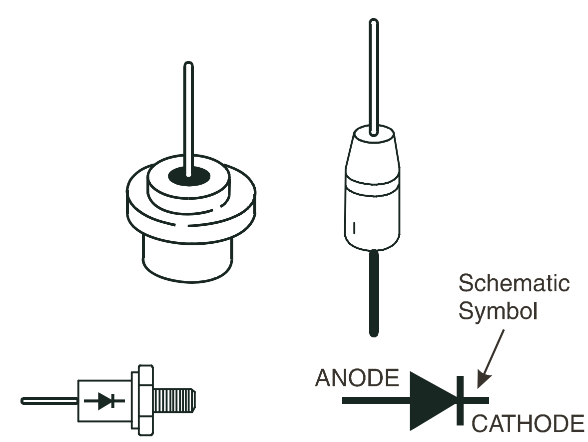
A copper oxide rectifier is illustrated in Figure 2.38.

Figure 2.38 — Example Of Copper Oxide Rectifier



When alternating current is applied to the opposite faces of the two discs, current can flow from the copper to the copper oxide face; it cannot flow in the opposite direction. The rectifier thus permits one alternating current to pass but blocks the reverse alternation. This action results in a "pulsating" direct current (DC) flow. A rectifier that allows only one alternation of current to pass is called a "blocking" diode or "half-wave" rectifier (Figure 2.39).

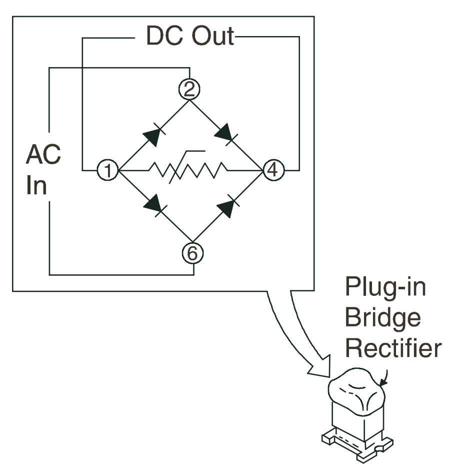
Figure 2.39 — Typical Blocking Diodes



A "plug-in" type of bridge rectifier is shown in Figure 2.40.

Notice that a **varistor** has been added to this rectifier, to protect the diodes against voltage surges.

Figure 2.40 — Plug-In Bridge Rectifier With Varistor

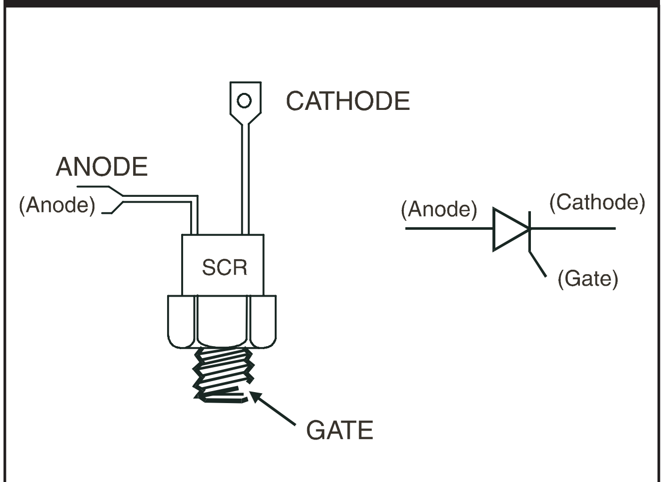


Silicone-Controlled Rectifiers

The silicone-controlled rectifier is often referred to as simply an "SCR" (Figure 2.41).

The SCR permits current to flow in one direction when a voltage is applied at its "gate." Applying a small (DC) voltage to the SCR gate is said to "turn on" the SCR; it then permits only direct current (DC) to flow.

Figure 2.41 — Silicone-Controlled Rectifier



Reverse current alternations are blocked by the diode action of the SCR. When the current again reverses itself, a small (DC) voltage must pulse the gate once more before current can flow. Thus, the SCR acts much like a hydraulic check valve that must be opened to permit fluid flow but blocks the flow of fluid in the opposite direction.

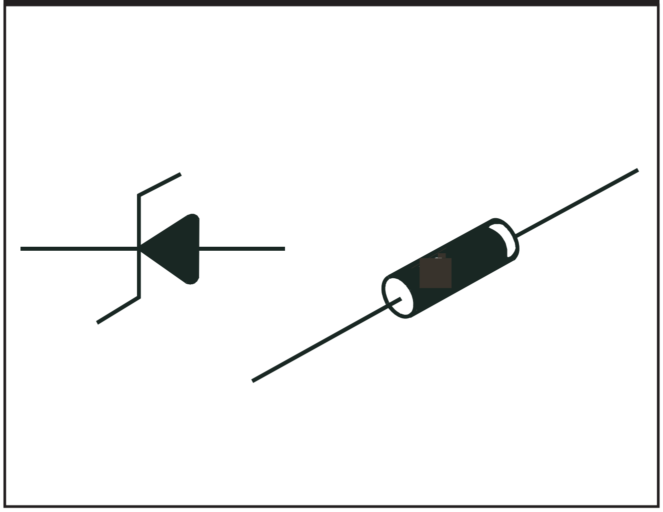
The Zener Diode

The zener diode (Figure 2.42) is often used to provide protection against over voltage that might damage some components in a circuit, or to protect transistors against excessive current flow.

For example:

A zener diode rated at 10VAC acts much like any other diode up to 10VAC. However, if the applied voltage should exceed 10VAC, the diode begins to pass current to maintain the 10VAC level. Thus, if 15VAC is applied to the 10VAC zener diode, it shunts five volts to ground while permitting 10VAC to pass.

Figure 2.42 — The Zener Diode

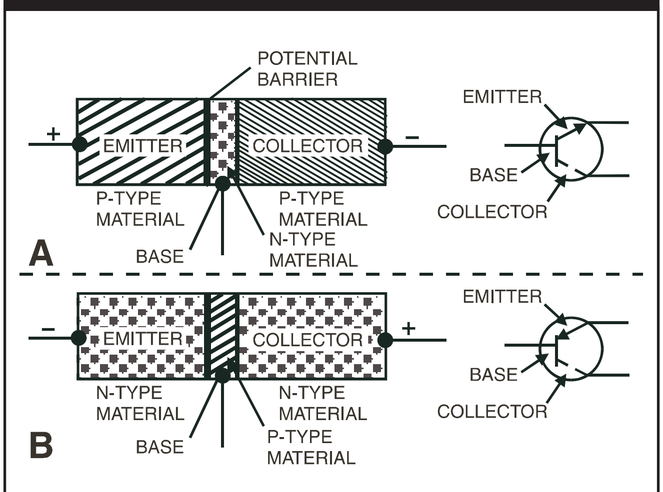


Transistors

The construction of a transistor is similar to that of a diode. A diode is made up of two layers of metal. However, a transistor consists of three metallic layers and is called a "triode."

As illustrated in Figure 2.43, a "triode" (or transistor) consists of a wafer "N-Type" material sandwiched between two thicker sections of "P-Type" material.

Figure 2.43 — Construction Of A Transistor



It might also be a wafer of "P-Type" material sandwiched between two sections of "N-Type" material. The thin part of the transistor is called the base. The left portion is the emitter. The portion on the right is the collector.

The term "P-Type" material identifies a material that contains positively charged (+) electrons. The term "N-Type" material denotes the presence of negatively charged (-) electrons. Certain manufacturing processes cause "P-Type" atoms to seize electrons from the "N-Type" atoms at the junction of the two materials. This action causes the "P" atoms to gain a negative (-) charge, while the "N" atoms gain a positive (+) charge. The negatively charged "P" atoms tend to repel any electrons that seek to pass from the "N" side, resulting in a potential barrier to electron or current flow.

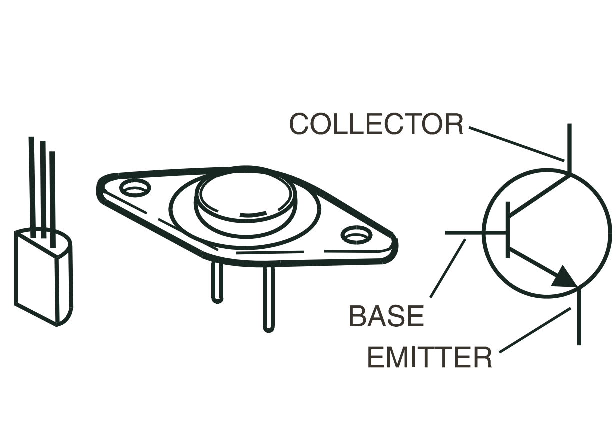
Functions Of A Transistor

Transistors may be used in a circuit to amplify or step up voltage. You may also use them as switches (i.e., to open or close a circuit). By changing the voltage applied to the transistor base, you can turn **ON** or **OFF** a much larger current flow across the emitter/collector.

Some Typical Transistors

Some typical transistors are displayed in Figure 2.44. Generally, the larger the transistor's physical size, the more current it can to pass. Sometimes the transistor is mounted onto a metal plate called a "heat sink." The heat sink dissipates heat and increases the ability of the transistor to carry current.

Figure 2.44 — Some Typical Transistors

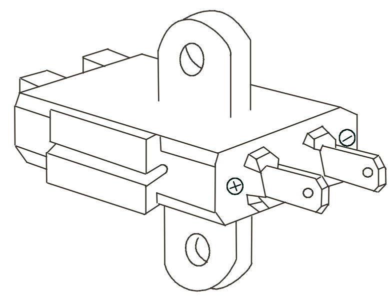


Brushes and Brush Holders

The brush holder is usually attached to the rear bearing carrier. The positive (+) brush rides on the slip ring nearest the rotor bearing (Figure 2.45).

Also, the (+) and the (-) indicators are moulded into the holder.

Figure 2.45 — Brush Holder

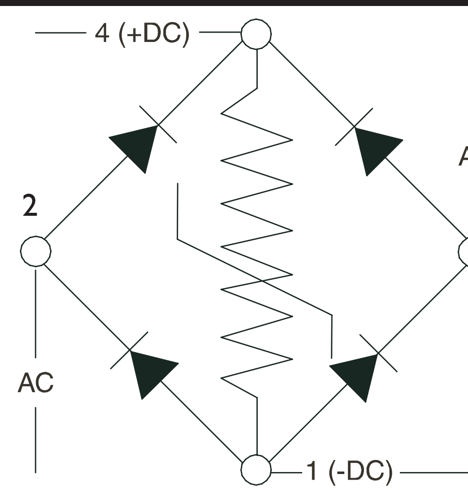


The Bridge Rectifier

The bridge rectifier is made up of four (4) diodes and a varistor, shown schematically in Figure 2.46.

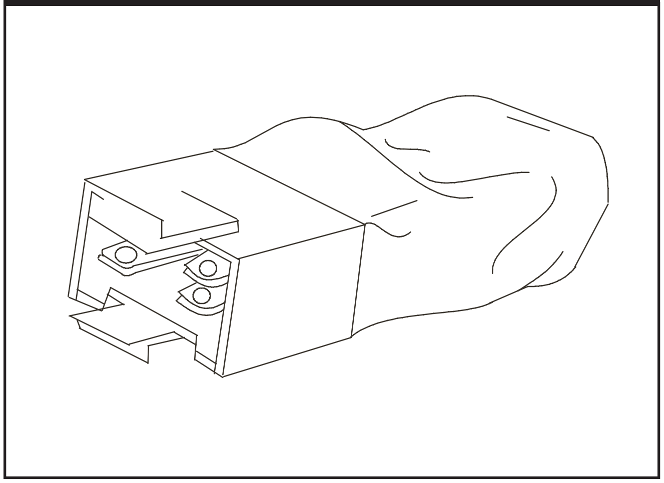
The diode (rectifier) permits current flow in one direction only. Excitation winding (AC) output is delivered <u>to</u> terminals 2 and 6. Direct current (DC) is taken <u>from</u> terminals 1 and 4 and applied to the rotor. The varistor is a "variable resistor" which protects the diodes against high voltage surges.

Figure 2.46 — Bridge Rectifier Schematic



Early production units were equipped with a plug-in type rectifier that plugged into the top side of the stator (Figure 2.47).

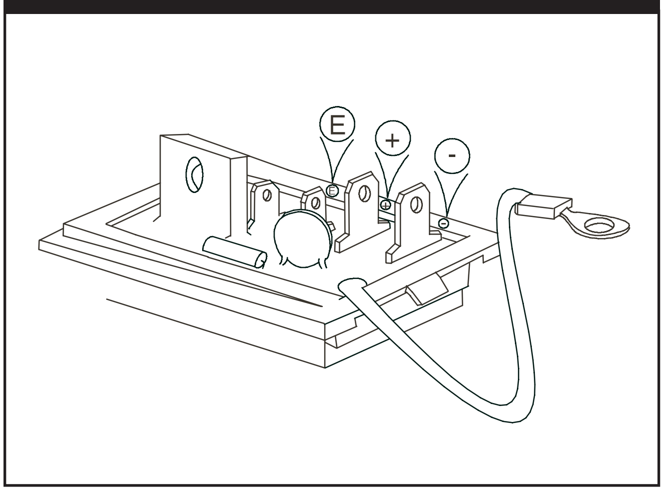
Figure 2.47 — Plug-In Rectifier



The bridge rectifier shown in Figure 2.48 is retained in a slot in the generator's rear bearing carrier.

Stator excitation winding (AC) output leads connect to the two terminals indicated by an "E". Wire # 4 from the positive (+) brush connects to the terminal indicated by a (+). Brush lead # 1 connects to the (-) terminal.

Figure 2.48 — Typical Bridge Rectifier



More recent units are equipped with a rectifier and brush holder assembly, shown in Figure 2.49.

Stator excitation winding (AC) output leads connect to the two terminals labeled J1 and J2 located on top of the bridge rectifier.

Figure 2.49 — Brush Rectifier

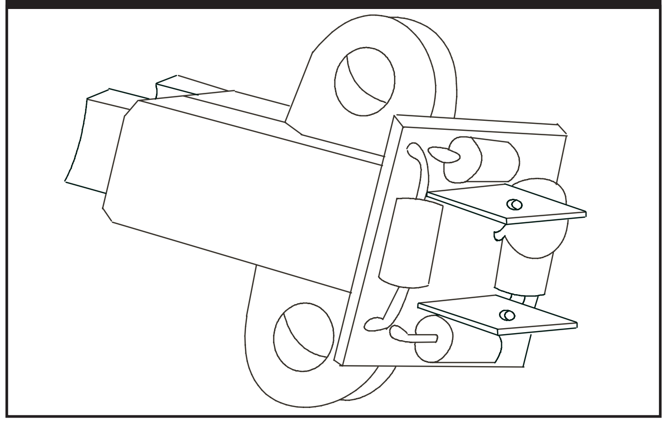
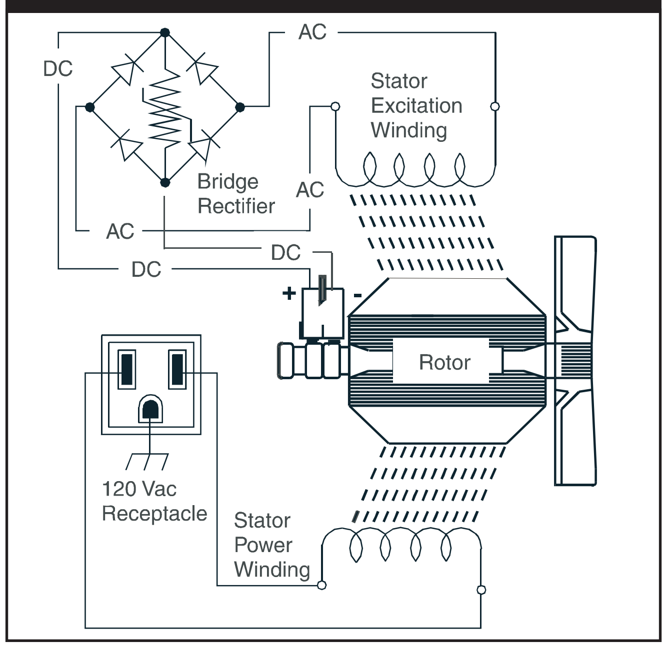


Figure 2.50 represents a revolving field (AC) generator with a bridge rectifier.

Figure 2.50 — Generator with a Bridge Rectifier



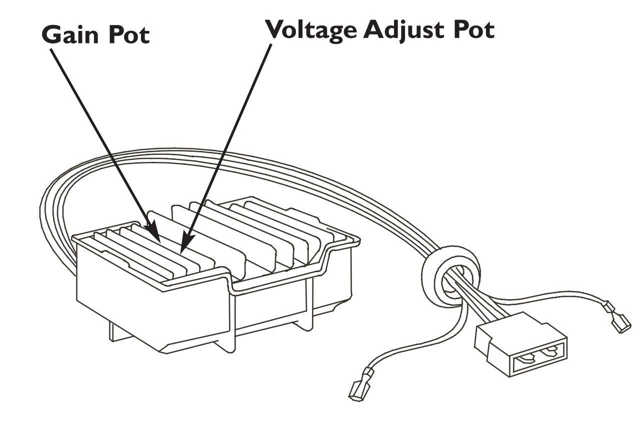
The rotor may be considered a permanent magnet since some residual magnetism is always present. The stator has two coils of wire. One is called an "excitation winding" and the other is called the "power winding." Output current (AC) from the excitation winding is changed to direct current (DC) by the bridge rectifier and is then delivered to the rotor windings via the brushes and slip rings, strengthening the magnetic field.

Voltage Regulator

There are three variations of the voltage regulator shown in Figure 2.51.

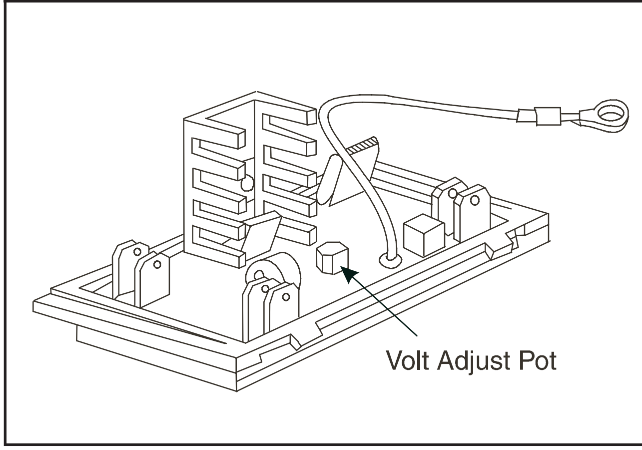
The regulator itself is the same for each one. Only the connector harness is different.

Figure 2.51 — Voltage Regulator



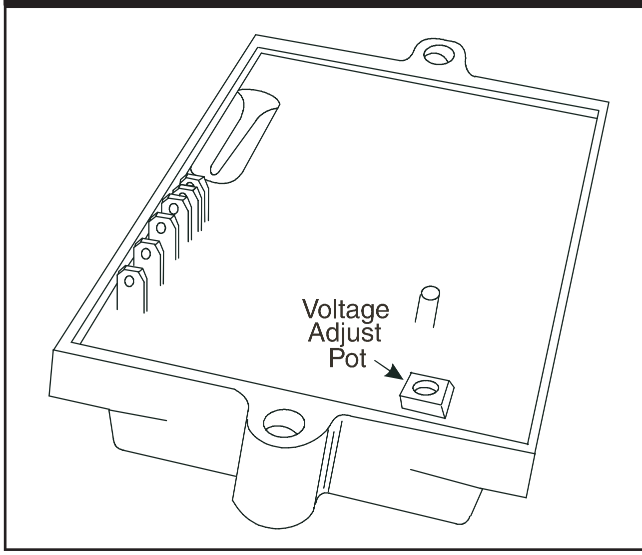
Used on many of our portable generators produced in the late 1980's, a black square box that has six terminals is retained in a slot of the generator's rear bearing carrier (Figure 2.52).

Figure 2.52 — Voltage Regulator



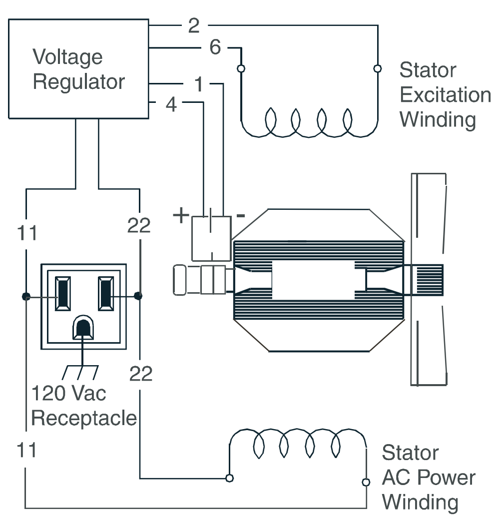
A metal square box with six terminals is found in the control panel of the generators used on models produced in the early 1990's (Figure 2.53).

Figure 2.53 — Voltage Regulator



Some generators employ an electronic voltage regulator to "regulate" current flow to the rotor windings (Figure 2.54).

Figure 2.54 — Generator With Voltage Regulator



By regulating current flow through the rotor windings, the rotor's magnetic field is controlled. This controls the voltage developed in the stator windings. The voltage regulator senses actual stator (AC) output voltage via two "sensing" leads (11 and 22). Stator excitation winding (AC) output is also delivered to the regulator, where it is rectified (converted to DC). The regulator electronically compares the "actual" stator (AC) power winding voltage to a preset "reference" voltage and delivers a regulated direct current (DC) to the rotor windings as follows:

- If **actual** (AC) power winding voltage is **greater** than the preset **reference** voltage, regulator action will decrease direct current (DC) flow to the rotor. This will reduce the strength of the rotor's magnetic field and cause stator (AC) power winding voltage to decrease.
- If **actual** (AC) power winding voltage is **less** than the preset **reference** voltage, regulator action will increase direct current (DC) flow to the rotor. This will increase the strength of the rotor's magnetic field and cause stator (AC) power winding voltage to increase.

Solid State Voltage Regulation

This type of voltage regulator is often called a "Voltage-over-Frequency" or "V/F" regulator. The regulator provides a constant voltage-to-frequency characteristic:

- An alternator rotating at the speed required to provide a 60 Hertz (AC) frequency will provide a 120VAC output.
- An alternator rotating at the speed required to provide a 30 Hertz (AC) frequency will provide a 60VAC output, and so on.

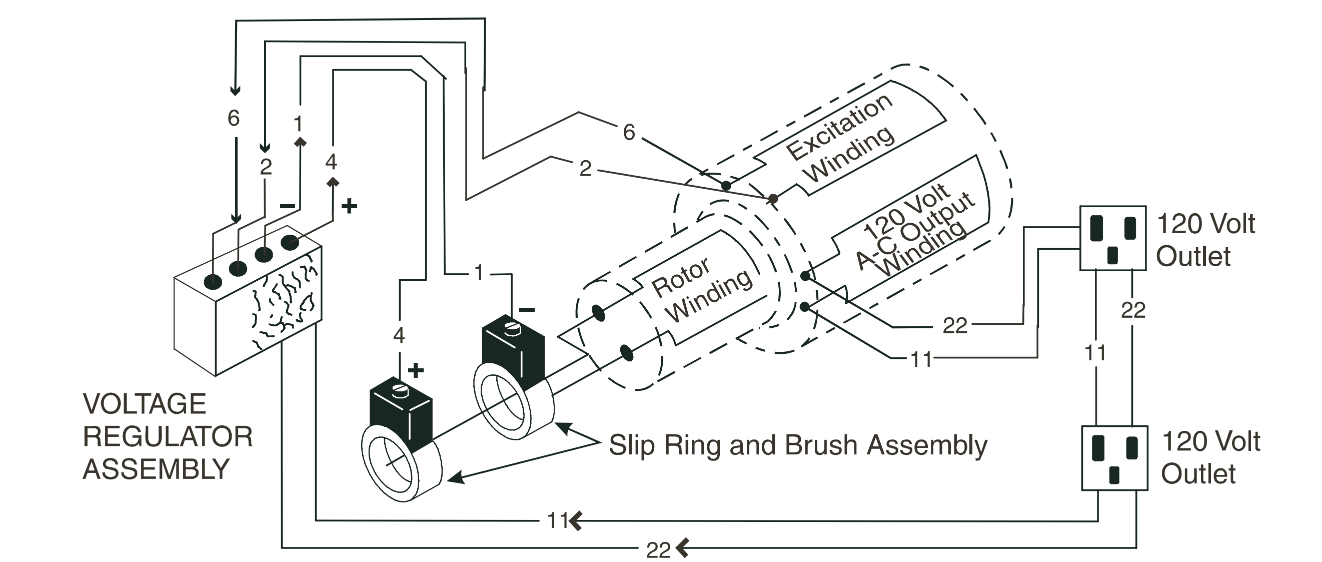
(A conventional voltage regulator provides a fixed voltage output, regardless of frequency). If output frequency is held constant, voltage will remain constant over the entire electrical load range.

Figure 2.55 is an operating diagram for alternators equipped with a "Voltage-over-Frequency" type of regulator. Notice that the unit still has an excitation winding, just as was the case with direct excited units.

The operating sequence for this type of unit may be described as follows:

- The rotor turns at a pre-determined speed.
- EMF (voltage) is induced into the stator windings by residual magnetism in the rotor.
- Voltage from the120VAC output stator winding is available through Wires #11 and #22 to the 120VAC outlets. Any electrical load connected to the 120VAC outlets will complete the circuit.
- Alternating current voltage and frequency signals are delivered from the 120VAC outlets to the Voltage Regulator.
- Excitation winding output is delivered through wires #2 and #6 and then to the voltage regulator.
- The voltage regulator converts the (AC) excitation winding output to (DC) and delivers the (DC) output to the rotor via Wire #4, the (+) brush and slip ring, then through the rotor and the (-) brush and slip ring assembly through Wire #1. The (DC) output from the voltage regulator to the rotor is based on the voltage and frequency signals received from the 120VAC outlets.
- Thus, the Voltage Regulator acts to increase or decrease current flow to the rotor windings based on the demands of the load connected across the 120VAC outlets. The increase or decrease in current flow

Figure 2.55 — Operating Diagram (“Voltage Over Frequency”)



through the rotor results in a proportional increase or decrease in the rotor’s magnetic field strength, which is what induces (AC) current in the output windings of the stator.

Power Regulator and System Control Board

The power regulator is retained in a slot in the generator’s rear bearing carrier. Units with a power regulator will also have a system control circuit board, which is usually housed in the control or receptacle panel. Operation of this type of system is similar to the conventional voltage regulator system. However, voltage regulation functions are shared by the power regulator and system control board (Figure 2.56 & 2.57).

Figure 2.56 — Power Regulator Circuit Board

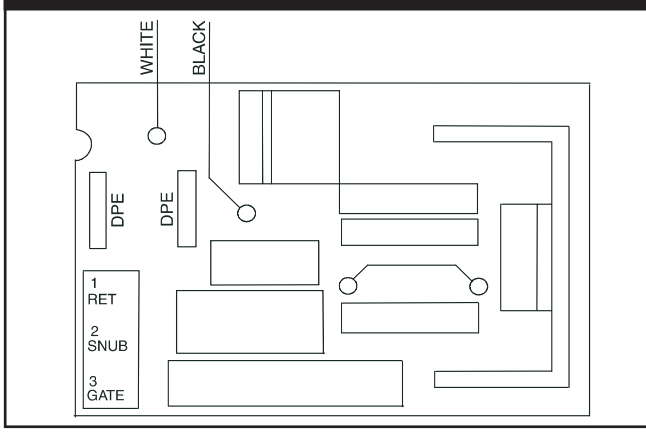
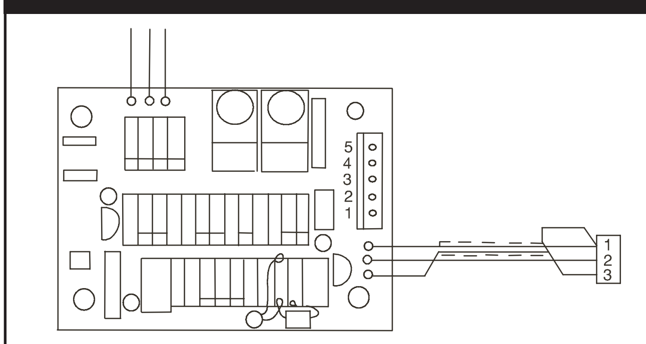


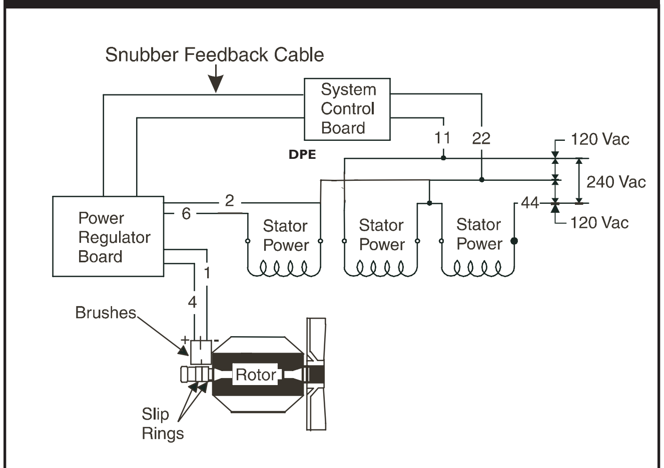
Figure 2.57 — System Control Circuit Board



Some portable generators, such as the "XL" and "MC" series, are equipped with a power regulator circuit board and a system control circuit board (Figure 2.58). Operationally, this system is the same as units with an electronic voltage regulator. However, some of the electronic regulator functions are handled by the power regulator board, while other regulator functions are handled by the system control board.

Operation of this type of system can be described briefly as follows:

Figure 2.58 — Regulator And System Control Boards



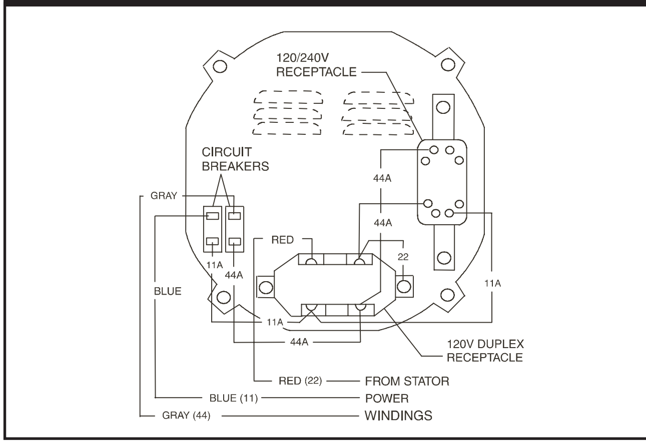
- An actual (AC) power winding voltage signal is delivered to the system control circuit board.
- Stator excitation (DPE) winding (AC) output is delivered to the power regulator circuit board. The power regulator board rectifies this current (converts it to DC).
- The system control circuit board electronically compares the actual (AC) power winding voltage to a preset reference voltage. If actual voltage is less than the preset reference voltage, the system control board signals the power regulator board to turn on and increase current flow to the rotor. This causes the rotor's magnetic field strength to increase and actual voltage to increase. When actual voltage is more than reference voltage, system control board action signals the power regulator to shut down.

RECEPTACLE PANEL

Some portable generators use the rear bearing carrier cover plate as the receptacle panel.

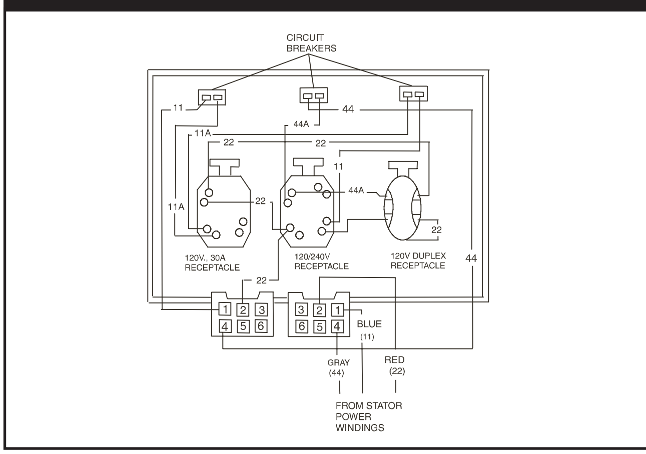
Other models employ a separate receptacle panel. When electrical receptacles are mounted on the bearing carrier cover, stator (AC) output leads are routed out of the stator and connect directly to the receptacles or to receptacle circuit breakers (Figure 2.59).

Figure 2.59 — Receptacles On Bearing Carrier Plate



When a separate sheet metal control and receptacle panel is used (Figure 2.60), stator (AC) power winding output leads will usually be attached to a black connector plug.

Figure 2.60 — Receptacles On Separate Control Panel



The black connector plugs into a 6-pin receptacle on the control panel. Other units have voltage regulator sensing leads #11 and #22 and the excitation leads (2, 6, 1 and 4) attached to a 9-pin connector plug. That plug is then connected into a 9-pin connector on the panel.

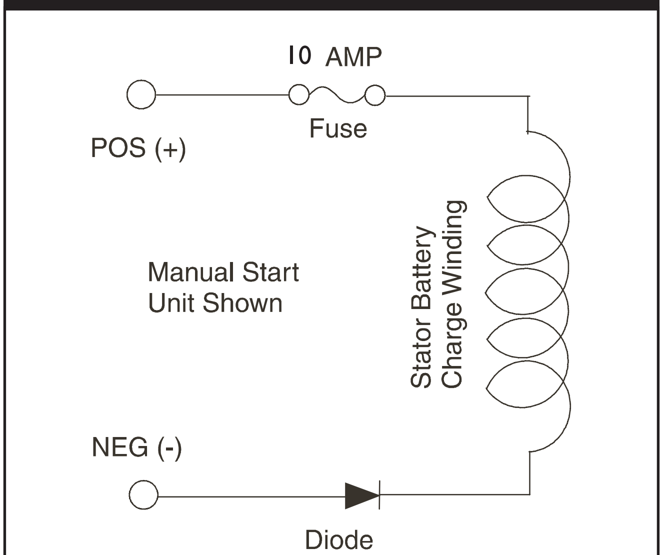
GENERATOR SYSTEMS

Battery Charge Circuits

Some portable generators may have battery charge capability. If so, the stator assembly will include a battery charge winding in addition to the (AC) power and excitation (DPE) winding. With the engine running, a charging current will be delivered to the unit's starting battery (electric start units) or to a 12VDC receptacle on the receptacle panel (manual start units). Measured battery charge winding (AC) output is approximately 8-9VAC (RMS). To find "Root Mean Square," multiply 8 - 9 x 1.414 = 12.762. The (AC) output from the stator battery charge winding is changed to direct current (DC) by one or more diodes in the circuit.

Early production units were equipped with battery charge circuits, as shown in Figure 2.61, consisting of a single winding and a single diode.

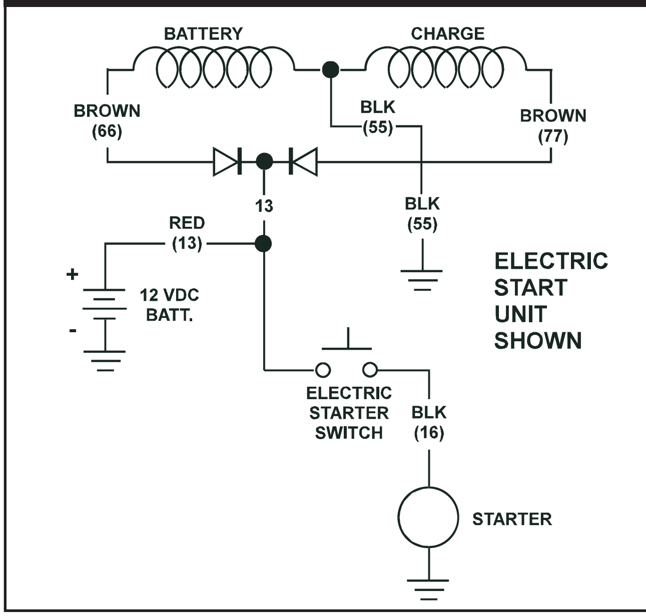
Figure 2.61 — Battery Charge Windings (BCW)



Later production generators may be equipped with dual battery charge windings and a pair of diodes (Figure 2.62). These units are equipped with dual stator windings and dual diodes, to provide "full-wave" rectification.

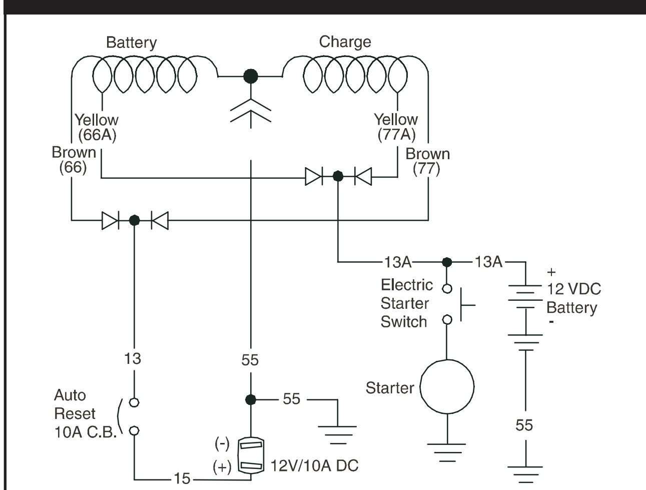
Some battery charge windings are made up of four "multi-tap" windings. Leads 66 and 77 (brown) are used for 12VDC output to a charging receptacle on the unit panel.

Figure 2.62 — Electric Start Unit



Leads 66A and 77A (yellow) are used when the winding output is delivered to the generator's own battery (Figure 2.63).

Figure 2.63 — Multi Tap Battery Charge Windings



Revolving Field Excitation Methods

Up to this point, we have observed the following:

- The strength of the revolving magnetic field is directly proportional to the current flow (in amperes) through the rotor windings.
- The electromotive force, or voltage, induced into the stator windings is directly proportional to the strength of the revolving field.

With these observations in mind, it is then possible to regulate voltage induced into the stator windings by regulating current flow through the rotor windings. Several methods are available to accomplish such voltage regulation including the following:

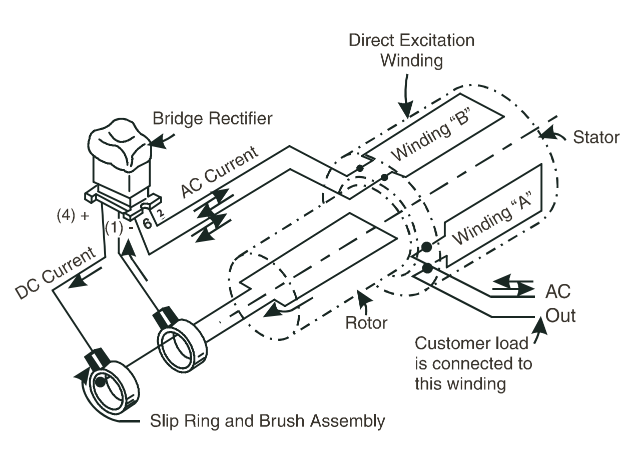
- Direct Excitation
- Reactor Method
- Electronic Voltage Method (Solid State Voltage Regulation)
- Brushless Excitation Method.

Direct Excitation

Figure 2.64 is an operating diagram of a revolving field alternator that has the direct excitation feature.

Its operation may be described as follows:

Figure 2.64 — Operation Of Direct Excited Alternator



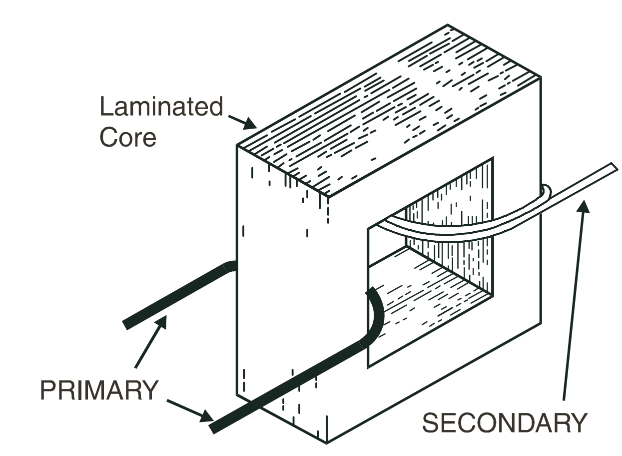
- The rotor is rotated at a pre-determined speed.
- Residual or "stored" magnetism in the rotor creates magnetic lines of flux which cut through stator windings "A" and "B", to induce an EMF into both windings.
- Winding "B" is the Direct Excitation Winding. The EMF induced into this winding produces an alternating current flow, which is applied to a Bridge Rectifier.
- The Bridge Rectifier changes alternating current (AC) back into direct current (DC).
- Direct current (DC) from the bridge rectifier is applied to the Rotor windings via the slip ring and brush assembly, to create a magnetic field that is stronger than that created by the residual magnetism of the rotor.
- This stronger magnetic field induces a greater EMF (and resultant current flow) into both stator windings "A" and "B." The cycle then repeats itself until a pre-determined (AC) output is reached. Any loads connected across the (AC) output wires from winding "A" (called the power winding) completes the winding "A" circuit.

Reactor Excitation (Early Production Units)

Figure 2.65 illustrates a very simple reactor (also known as a transformer).

It consists of a primary and secondary coil of wire wound

Figure 2.65 — A Simple Reactor



around a laminated iron core. The core concentrates the magnetic lines of force created by current flow through the coils.

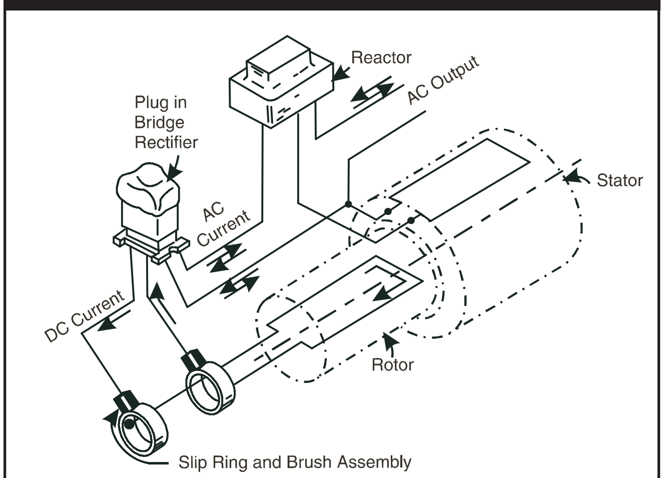
The alternating current flowing through the primary windings creates a magnetic field which cuts through the secondary coil thereby inducing a current flow into the secondary windings.

The amount of induced EMF (voltage or current flow) depends on:

- The current flow through the primary winding.
- The number of wire turns in the secondary coil.
    - The greater the current flow through the primary coil, the greater the current flow induced in the secondary coil.
    - The larger the number of wire turns in the secondary coil (proportional to the wire turns in the primary coil), the greater the induced current flow in the secondary windings.

The reactor method of excitation uses a current transformer (also known as a reactor). This type of transformer changes current from one level to a higher or lower level. In a **Generac®** circuit, it serves as a voltage regulator (Figure 2.66).

Figure 2.66 — Operation Of Reactor-Excited Alternator



This type of alternator differs from the direct excited type in two basic ways.

- Reactor Excitation requires a reactor (current transformer) as an additional component in the circuit.
- The (AC) output to the load (using reactor excitation) is taken from the same stator winding that the excitation current is taken from (instead of having an "A" and "B" winding).

Compare Figure 2.64 with 2.66.

The operation of a "Reactor-Excited" alternator may be described as follows;

- The Rotor turns at a pre-determined speed.
- Residual or "stored" magnetism in the rotor creates magnetic lines of flux which cut through the stator windings.
- The reactor is an additional component connected in series with the (AC) output to the load. The greater the flow of current to the load, the greater the current flow through the reactor's primary winding. The greater the current flow through the reactor's primary winding, the greater the current induced into the reactor's secondary winding. Thus, the greater the current demand of the connected load, the greater the current flow through the plug-in bridge rectifier.
- The bridge rectifier then converts the alternating current (AC) output of the reactor to direct current (DC). This direct current (DC) is then applied to the rotor via the slip ring and brush assembly.
- The current flow through the rotor creates a stronger magnetic field which, in turn, induces more current flow (EMF) in the stator.
    - The greater the current flow demanded by the load, the greater the current flow through the rotor and the stronger the magnetic field that induces current flow in the stator.

Thus, the more current required by the load, the higher the current flow delivered by the stator.

The Brushless Excitation Method

As the engine spins the rotor, residual magnetism induces an (AC) Voltage into the DPE winding. This voltage is sent to the excitation capacitor via wires # 2 and # 6. The excitation capacitor builds up a charge to the point where they equalize. (The excitation winding and capacitor voltage are equal.) This builds a magnetic field in the excitation winding that is intersected by the rotor winding as it is spun by the engine.

That induces an (AC) voltage in the rotor winding that is converted to a (DC) voltage by a diode in the rotor winding. This creates an electromagnet in the rotor assembly. As the rotor continues to spin, this electromagnetic field intersects the power winding, inducing an (AC) voltage in the power winding.

The voltage is regulated by the amount of turns in the windings and the size of the capacitor and engine RPM. Figure 2.67 represents the unit schematically. Figure 2.68 illustrates a typical "brushless excitation system."

Figure 2.67 — Schematic Of Brushless Excitation System

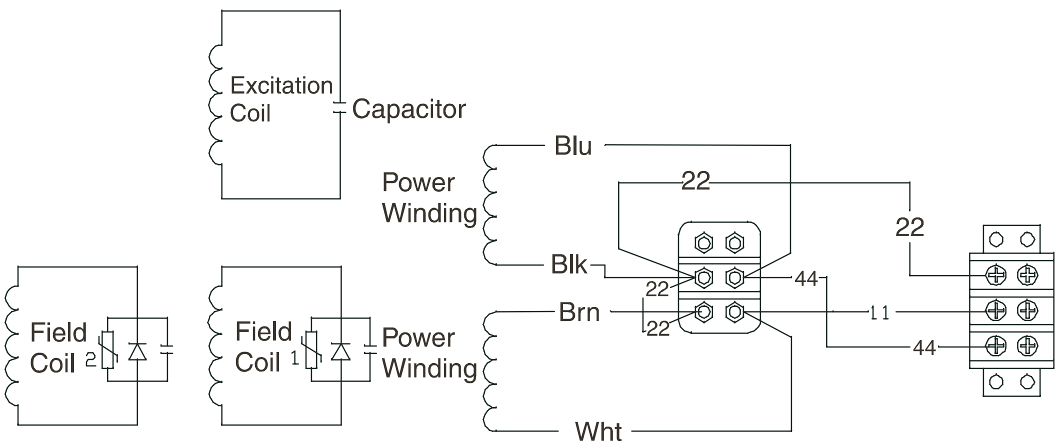
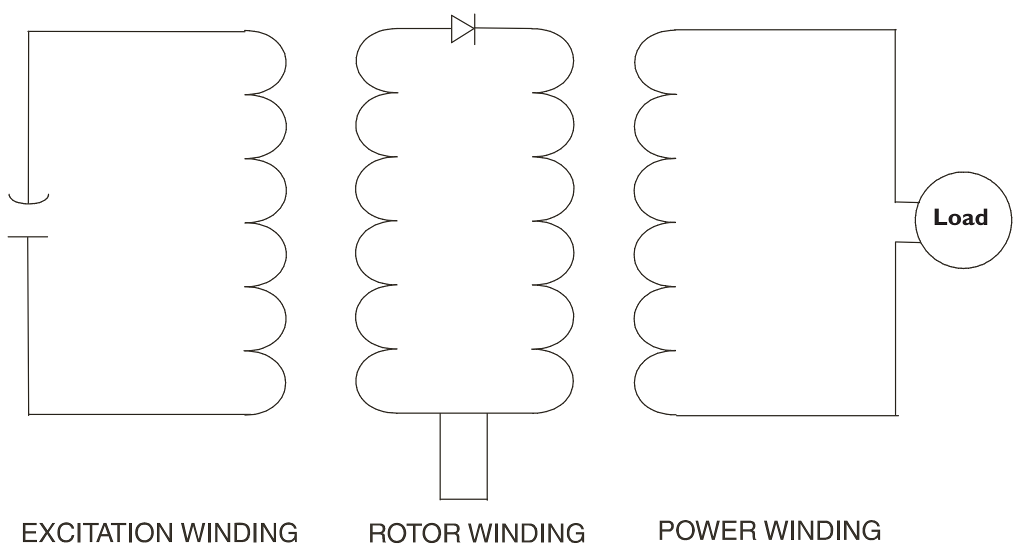


Figure 2.68 — A Brushless Excitation System



Field Boost Assembly

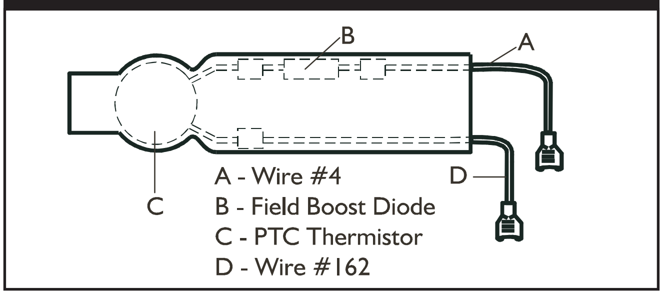
Some types of voltage regulators require approximately 12VAC before they turn on. Residual output voltage may not be sufficient to produce this minimum voltage. A field boost circuit may be included on these generator models to excite the regulator and turn it on. The circuit uses a thermistor device called a "PTC" (positive temperature coefficient) and a diode.

The Field Boost assembly consists of:

- Wire #4
- Field Boost Diode
- The (PTC) thermistor device
- Wire #162

The device is connected across terminals 11 and 4 of the electronic voltage regulator (Figure 2.69).

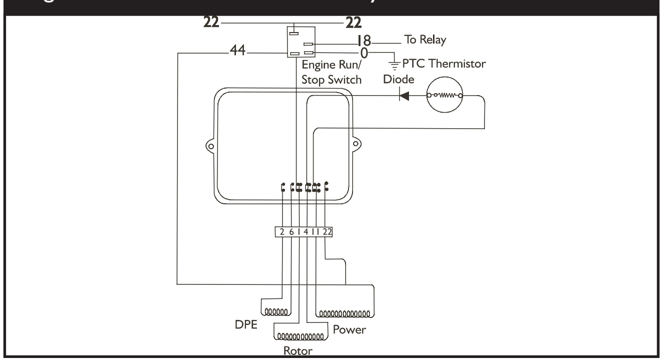
Figure 2.69 — Field Boost Assembly



The (PTC) and diode are enclosed in a "field boost assembly," which is housed in the receptacle panel (Figure 2.70).

Field boost voltage is delivered to the rotor on every startup. This current flow "flashes the field" every time the engine is started.

Figure 2.70 — Field Boost Assembly Schematic



"Field Boost" operation may be briefly described as follows:

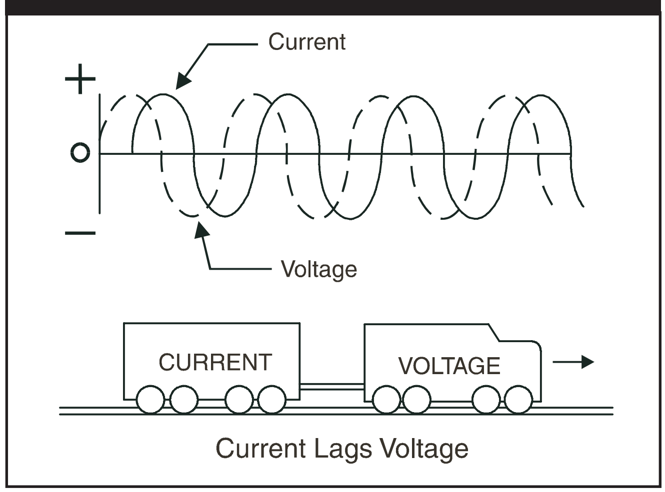
- During start up, residual (AC) voltage is delivered to the (PTC) and diode from the stator power winding.
- When the thermistor is cold, resistance is low. Current can flow to the diode where the (AC) current is rectified to direct current (DC) and delivered to the rotor winding via wire # 4. This causes the rotor's magnetic field strength to increase which causes the power winding voltage to increase.
- The increase in power winding output voltage is then enough to turn on the voltage regulator.
- As the thermistor warms up, its resistance increases until the device becomes, in effect, an open circuit. Field boost current flow to the rotor windings then ceases.

Inductive Reactance

Inductive reactance may be defined as the condition that exists when current lags behind voltage.

Magnetic lines of force called "flux" are created around a current-carrying conductor. Since alternating current is constantly increasing to a maximum negative value, the magnetic field around the conductor must also increase, collapse to zero, then increase again in the opposite direction (polarity) (Follow Figure 2.71).

Figure 2.71 — Inductive Reactance



Each time the magnetic field around an (AC) conductor collapses, a voltage (EMF) is induced into that conductor. This induced voltage causes current to continue flowing as voltage drops, forcing voltage to lead current.

If a conductor is formed into a coil, the magnetic lines of flux are concentrated in the center of the coil. The greater density of flux lines causes an increase in magnetically induced voltage without increasing current flow. Coils, therefore, cause inductive reactance.

Capacitive Reactance

Capacitive reactance is the condition that exists when current is leading voltage. Capacitance may be defined as the ability to oppose a change in voltage. It exists because some electrical components can store electrical charges when voltage is increased and discharge those electrical charges when voltage drops.

Power Factor

The phrase **"unity power factor"** describes a circuit where current and voltage are "in phase." Such a circuit would have a power factor of "1." The **true power** (in watts) of a unity power factor circuit is the product of volts times amperes.

When an "out-of-phase" condition exists, the product of volts times amperes is the **apparent power** (in watts) rather than the true power.

Such a condition would exist when a reactance condition occurs in a circuit.

To help explain the reason for apparent and true power ratings of reactance circuits, mechanical work can be related to electrical power. Figure 2.72 shows an airplane towing a glider. If the airplane pulls the glider in position A, with the tow cable at a 45° angle, more pulling force must be exerted. In position B, no tow cable angle exists and force and motion are in the same direction.

A situation similar to the airplane and glider exists in reactance circuits because current either leads or lags voltage. Thus, current and voltage never reach their maximum values at the same time in a reactance circuit. If we attempt to calculate watts with the volts times amperes method, we will not obtain true power because when voltage is at its peak, amperage is not. To determine true power, the number of degrees that current (amperes) is "out-of-phase" with voltage must be used as a correction factor.

This correction factor is called the power factor in (AC) circuits. It is the cosine of the phase angle (the cosine of any angle is given in chart form in many math and electrical books). The cosine of a 45° angle is 0.7077 so, stated electrically, this is a power factor of 0.707.

Apparent Power is the term applied to the product of voltage and current in an (AC) circuit. It is expressed in volt-amperes (VA) or in kilovolt-amperes (KVA) or megavolt-amperes (MVA) (Figure 2.73).

Figure 2.72 — Example of True vs. Apparent Power

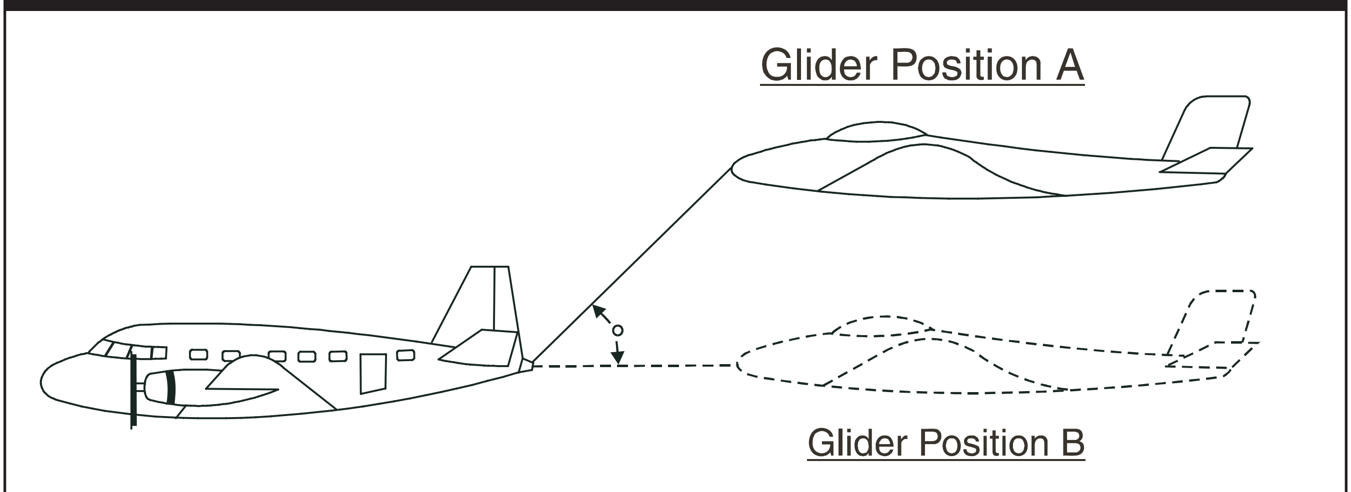


Figure 2.73 — Determining The Power Factor

This correction factor is called the power factor in AC circuits. It is the cosine of the phase angle (the cosine of any angle is given in chart form in many math and electrical books). The cosine of a 45-degree angle is 0.707 or, stated electrically, a power factor of 0.707.

Example: Find the apparent and true ratings of a 240 volts, 55 ampere alternator when volts is 45 degrees "out-of-phase" with amperes:

1. Find KVA

$$KVA = \frac{Volts \times Amperes}{1000}$$

$$KVA = \frac{240 \times 55}{1000}$$

$$KVA = 13.2$$

2. Find the phase angle between Amperes and Volts. A 45-degree angle between the two is shown below.

3. Find the cosine of the phase angle (0.707).

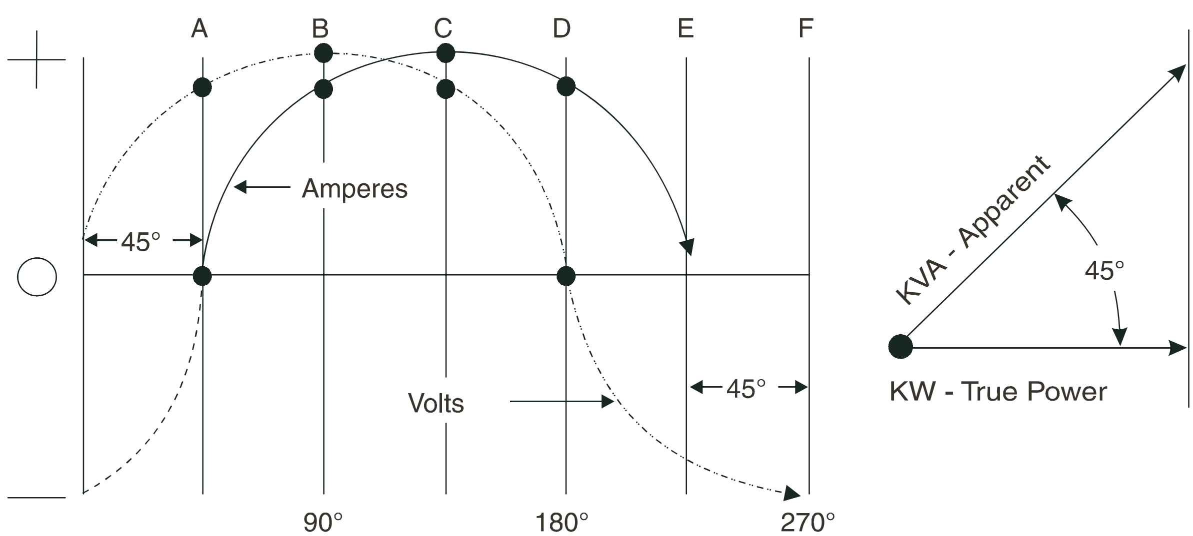
4. Determine TRUE POWER.

True power = Kilowatts (kW)

5. Find the APPARENT rating.

$$Kilowatts = \frac{Volts \& Amperes \times Power Factor}{1000}$$

$$Kilowatts = 9.33$$

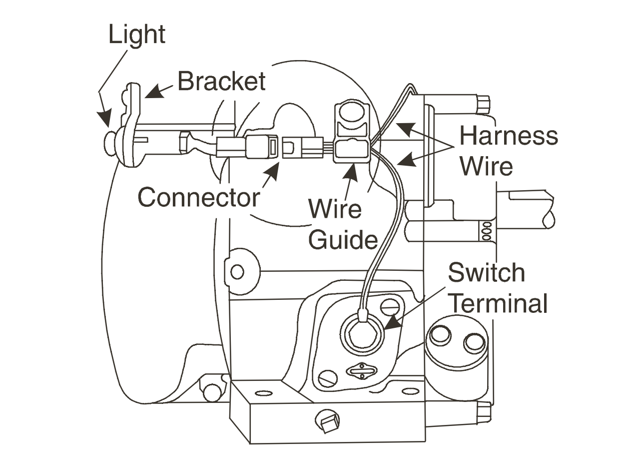


Power factor determined by degree volts are "Out of Phase" with amperes.

A TYPICAL LOW OIL LEVEL SYSTEM

Figure 2.74 is typical of the low oil level shutdown system used on Briggs & Stratton engines.

Figure 2.74 — Typical Low Oil Level System



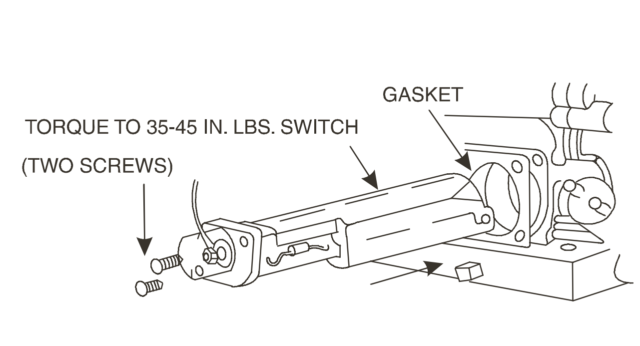
The system consists of:

- A float switch
- Interconnecting wires

The light is mounted on the engine blower housing. Some models may have the light mounted on the generator cradle frame. It is desirable to have the light located where it is visible while cranking the engine.

The float switch (Figure 2.75), along with a gasket, is installed in a mounting boss on the engine cylinder block.

Figure 2.75 — Float Switch And Gasket

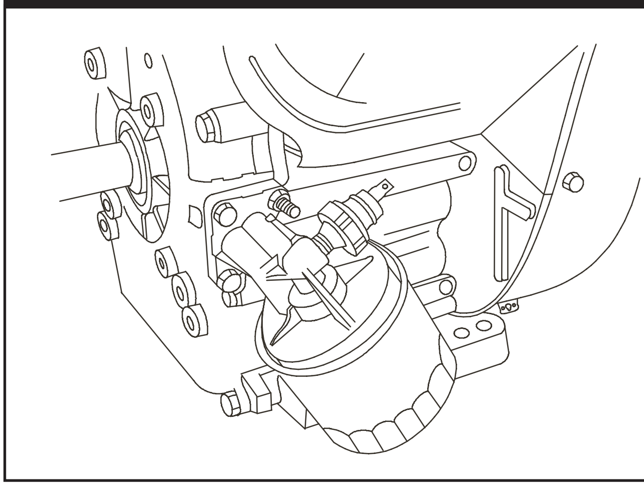


Should the engine oil level drop below a specified level, the switch will actuate and ground the engine ignition circuit, causing the engine to shut down. If the oil level is low, the light will flash while the engine is cranking. To reset the float switch and allow the engine to start, fill the crankcase to the proper level with the recommended oil

THE V-TWIN ENGINE SYSTEM

The V-Twin engine has an oil pressure switch mounted on its oil filter adapter. The switch is normally-closed (NC) but is held open by engine oil pressure during operation (Figure 2.76).

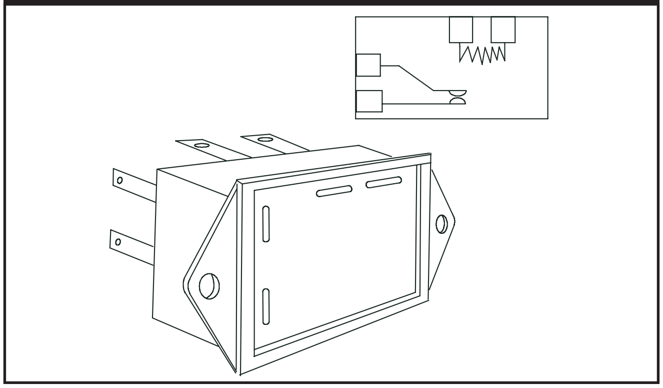
Figure 2.76 — The V-Twin Engine Pressure Switch



Should oil pressure drop below approximately 4.5 psi (0.32 kg per cm2), the switch contacts will close and engine shutdown will occur.

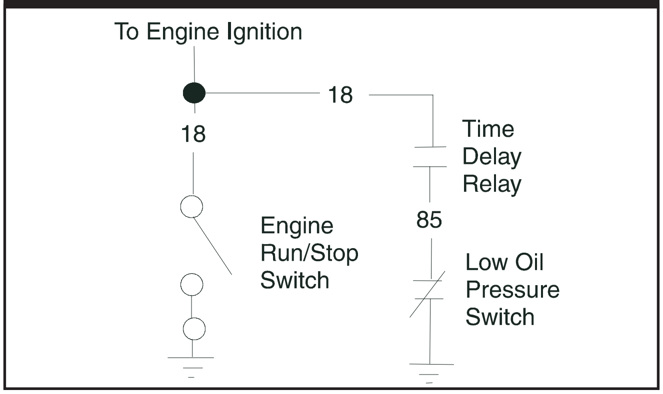
A thermostatic time delay relay is also part of the V-Twin low oil pressure system. The relay allows ignition to occur when cranking is first initiated by keeping the oil pressure switch from grounding the ignition. When 120VAC is applied to the relay's heater coil, the relay's contacts close in approximately eight seconds. Reset delay time is also about eight seconds (Figure 2.77).

Figure 2.77 — V-Twin Engine's Time Delay Relay



The V-Twin engine's low oil pressure circuit is shown schematically in Figure 2.78.

Figure 2.78 — V-Twin Time Delay Relay Schematic



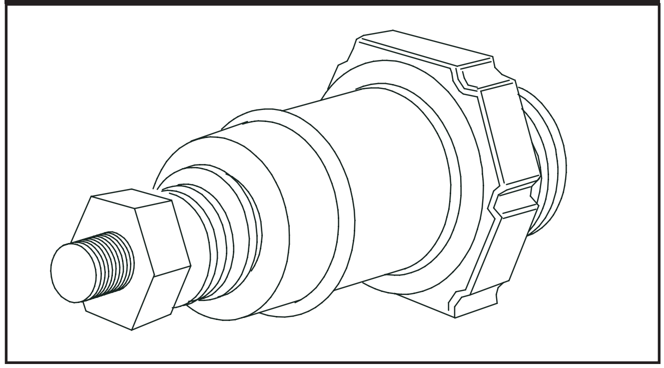
During initial cranking, the relay contacts are open but close after the relay heater coil warms up. The low oil pressure switch will be opened when engine oil pressure reaches approximately 10 psi (0.32 kg per cm2).

Should oil pressure drop after startup, the oil pressure switch contacts will close. On contact closure, the ignition circuit will be grounded and shutdown will occur.

Oil Pressure Switch On "GN" Engines

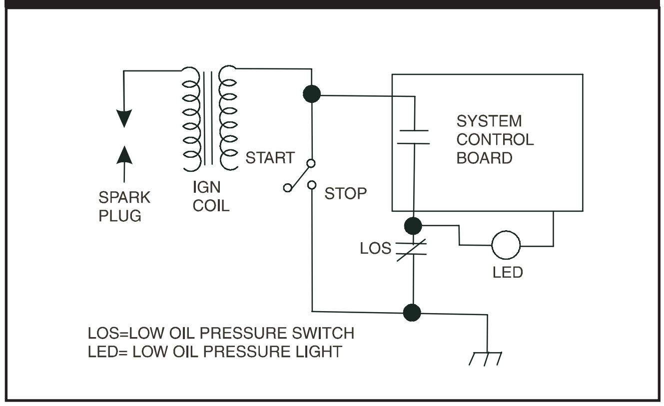
The "XL" and "MC" series generators use an oil pressure switch and a warning light similar to the ones used on the V-Twin engine (Figure 2.79).

Figure 2.79 — "XL" Series Oil Pressure Switch



However, the functions of the time delay relay are built into a system control circuit board (Figure 2.80).

Figure 2.80 — "XL" Oil Pressure Switch Schematic



The low oil pressure system will shut down the engine automatically when oil pressure drops below approximately 10 psi (0.32 kg per cm2).

The system control circuit board provides a time delay that allows oil pressure to build during initial cranking. The delay permits the engine to run for about 10 seconds before oil pressure is sensed.

During operation, a low oil pressure condition will result in engine shutdown. The low oil light will then come on and remain on while the engine is rotating. Once engine rotation has terminated, the light will go out. Any attempt to restart the engine within five seconds will not work. The system requires five to ten seconds to reset. If you restart the engine after a low oil pressure shutdown and have not corrected the low oil pressure condition, the engine will run for about ten seconds and then shut down.

Typical Automatic Idle Control System

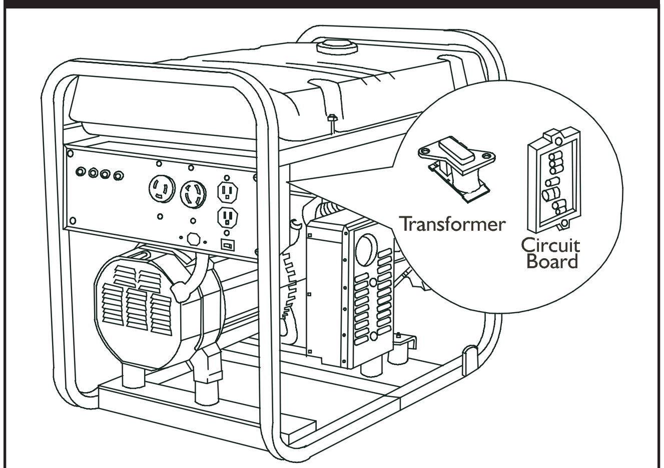
Some portable generators may be equipped with an automatic idle control system. Such a system provides greatly improved fuel economy by running the engine at normal governed speed only when electrical loads are plugged in and turned on. When electrical loads are disconnected or turned off, reduction to idle speed will occur.

A typical idle control system consists of:

- A Sensing Transformer
- An Idle Control Circuit Board
- An On-Off switch
- An Idle Control Coil

The sensing transformer and circuit board (Figure 2.81) are housed in an idle control box located just behind the unit's receptacle panel.

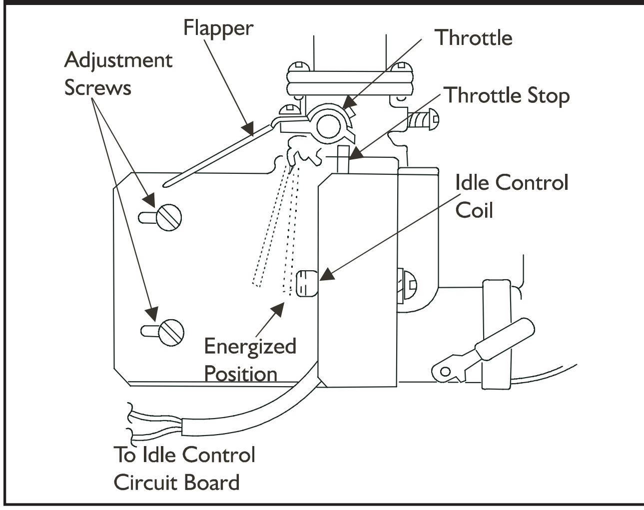
Figure 2.81 — Idle Control System Components



The on-off switch is usually mounted to the idle control box as well.

The idle control coil is attached to a bracket on the engine carburetor. A flapper attaches to the throttle. When the engine is shut down, the throttle is held against the high speed side of a throttle stop. During operation at "no-load" and with the idle control switch set to **OFF**, the flapper will be at approximately the "no-load" position (Figure 2.82).

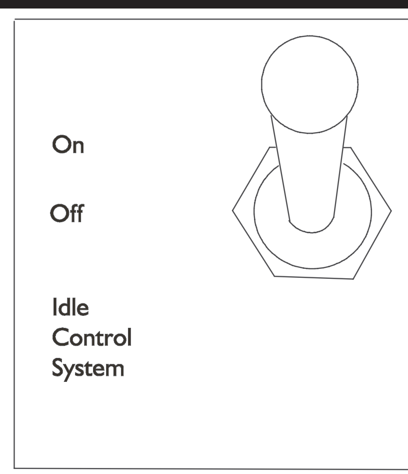
Figure 2.82 — Idle Control Coil And Flapper



To run at high governed speed with the unit loaded and at no-load, set the idle control switch to **OFF.**

To operate at idle speed with the electrical load disconnected and at high governed speed with electrical loads turned on, set the idle control switch to **ON** (Figure 2.83).

Figure 2.83 — Idle Control Switch



Always start the engine with the idle control switch set to **OFF**. Set the switch to **ON** after the engine has stabilized at governed speed. If the engine is started with the switch at **ON**, it may start and then shut down. In some cases, surging or hunting may occur as the idle control solenoid energizes and de-energizes.

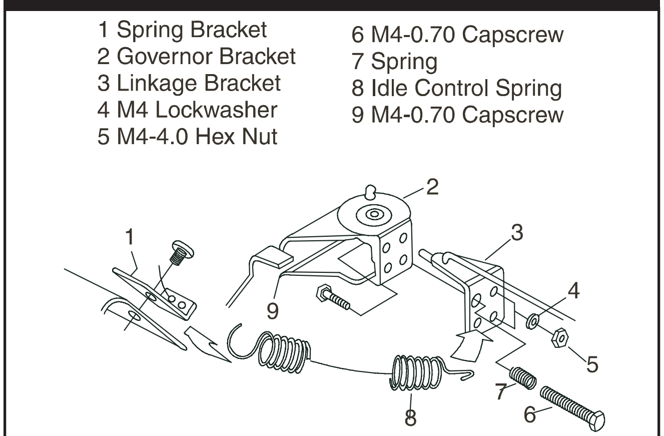
Operation of the idle control system may be briefly described as follows:

- Power for system operation is delivered to the circuit board via the idle switch and wires 11D and 22. With the idle switch ON and no load on the generator, a (DC) voltage is sent to the idle control coil via wires 81 and 82. The coil becomes an electromagnet, pulling throttle or governor linkage and lowers idle speed.
- Current flows through wires 11, 44 and through the transformer primary coils only when an electrical load is connected. This current flow induces a voltage and current flow into the transformer secondary coil, which is sensed by the circuit board. The circuit board opens wire 81 and 82 circuits, to de-energize the coil. When electrical loads are disconnected, current flow through the transformer coil is terminated. Circuit board action then closes wires 81 and 82 circuits to energize the coil and reduce engine speed to idle.

Early V-Twin Engine Idle Control

The V-Twin idle control system operates in a fashion similar to the idle control on other portable generators. For units with idle control, the governor has been reworked to accept a linkage mounting bracket (Figure 2.84, Item 3).

Figure 2.84 — V-Twin Engine Links And Springs



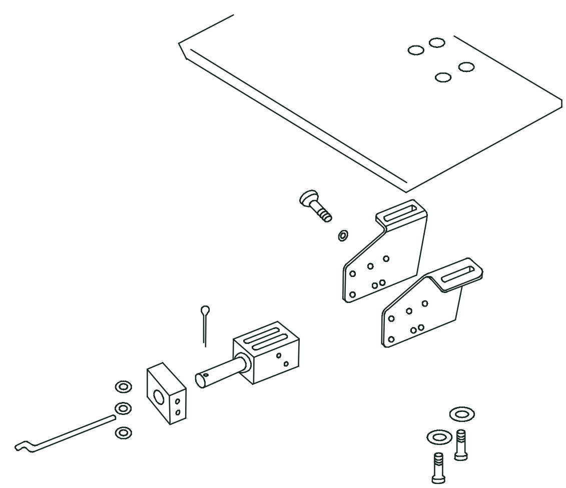
A link from the idle control solenoid is routed through an opening in the heat deflector shield and connects to the linkage mounting bracket.

Solenoid movement will actuate the linkage mounting bracket and the governor control.

A governor return spring connects to the linkage mounting bracket (Item 3) and to a spring bracket (Item 1).

Two solenoid mounting brackets are retained to the fuel tank heat shield. The brackets are slotted to permit axial adjustment of the idle control solenoid. The solenoid, along with a solenoid cover, is sandwiched between the two brackets and retained by screws (Figure 2.85).

Figure 2.85 — V-Twin Idle Control Solenoid



IDLE CONTROL ON GN 190, 220, 320, 360, & 410 ENGINES

Figure 2.86 shows the governor and idle control coil used on the single cylinder GN Engines.

Figure 2.86 — GN-190 Governor And Idle Control

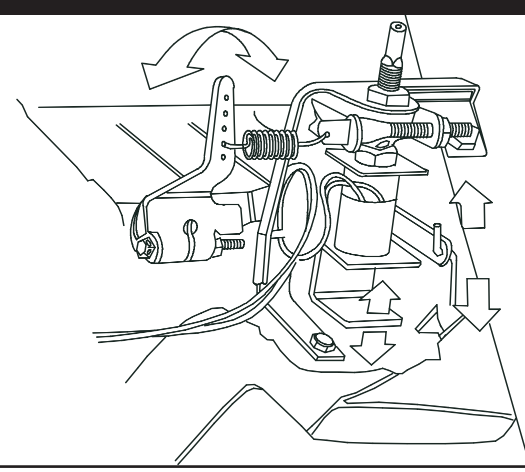
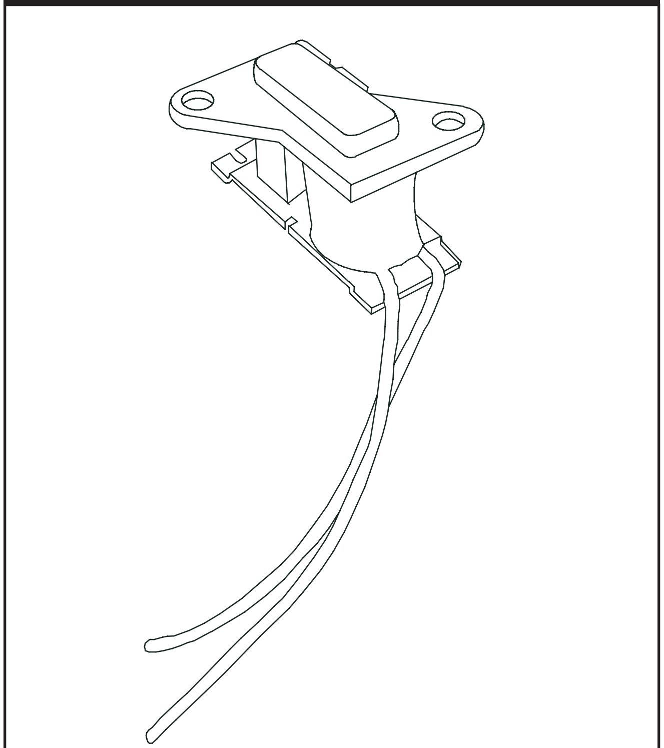


Figure 2.87 shows the idle control transformer which is housed in the generator control panel.

Figure 2.87 — Idle Control Transformer



Operation may be briefly described as follows:

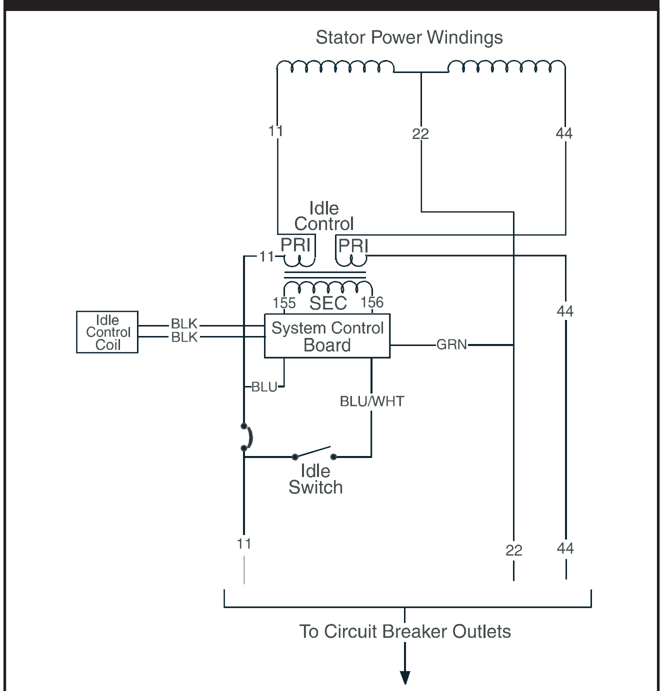
Idle control operation is controlled by the multi-function system control board, which is housed in the generator control panel (Figure 2.88). Power for system operation is taken from the stator's 120VAC power windings and delivered to the circuit board via wires 11, 22 and the idle control switch.

With the idle control switch **ON** (closed) power is available to the circuit board for idle control system operation.

- When no electrical loads are connected to the generator, current does not flow through the primary winding of the idle control transformer. Consequently, no current flow will be induced into its secondary windings. System control board action will then complete (close) the circuit to the idle control coil, delivering 120VDC to the coil. With the coil energized, the governor lever will be pulled in to reduce engine speed to idle (about 40-45 Hertz).
- When electrical loads are applied to the generator, current will flow through the transformer's primary windings, inducing a current in the secondary windings. The system control board senses this current via wires 155 and 156. It then opens the circuit to the idle control coil. That coil will de-energize and the engine will return to normal governed speed.

When the idle control switch is set to **OFF** (open), the circuit board is not powered and no power is available to energize the idle control solenoid. The solenoid will then remain in a de-energized state whether electrical loads are connected or not. The engine will then always run at normal governed speed.

Figure 2.88 — Idle Control Schematic



XL And MC Idle Control On 480 & 570 V-Twin Engines

Figure 2.89 shows the stepper motor used on the V-Twin GN-Engines.

Figure 2.89 — Stepper Motor

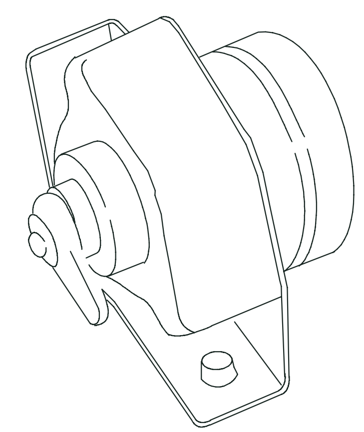
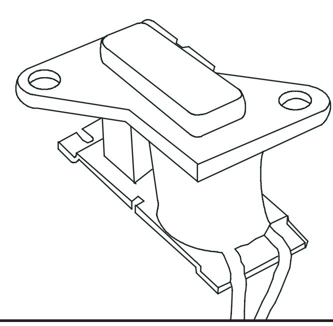


Figure 2.90 shows the idle control transformer, housed in the generator control panel. This is the same transformer used on single cylinder GN-engines.

Figure 2.90 — Idle Control Transformer

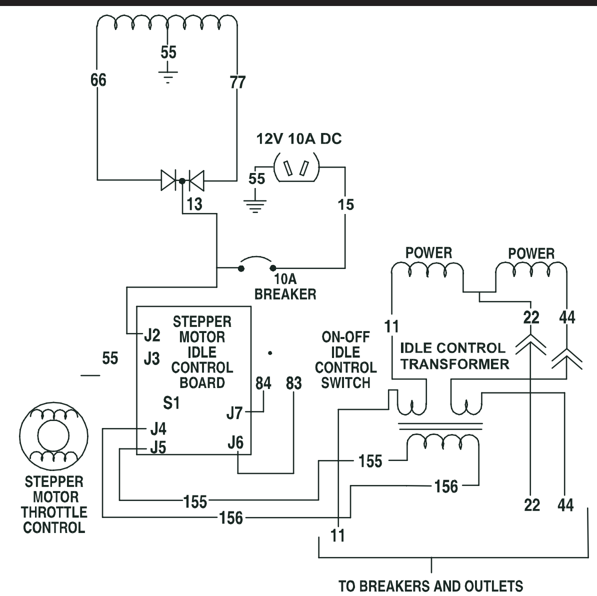


Idle control operation is controlled by the idle control circuit board, which is housed in the generator control panel (Figure 2.91). Power for system operation is taken from the generators 12VDC, 10 amp battery charge winding. Power is available to the circuit board for idle control system operation any time the generator is running.

With the idle control switch **ON** (closed), and no electrical loads connected to the generator, operation may be described as follows:

- Current does not flow through the primary windings of the idle control transformer and no current flow will be induced into the transformer's secondary windings.
- The idle control board will "sense" there is no load on the generator and will send a signal to the idle control stepper motor.
- The stepper motor will move to the low idle position, which will move the governor linkage, reducing governor spring tension, and lowering engine speed to idle (about 40-45 Hertz).

Figure 2.91 — Stepper Motor



When an electrical load is applied to the generator:

- Current will flow through the idle control transformer's primary windings, inducing a current in the secondary windings
- The idle control board "senses" this current via wires 155 and 156.
- It sends a signal to the idle control stepper motor to move to the high speed position.
- This moves the governor linkage, increase governor spring tension and increases engine RPM to normal governed speed.

When the idle control switch is set to **OFF** (open):

- The circuit board moves the stepper motor to the high speed position.

NOTES

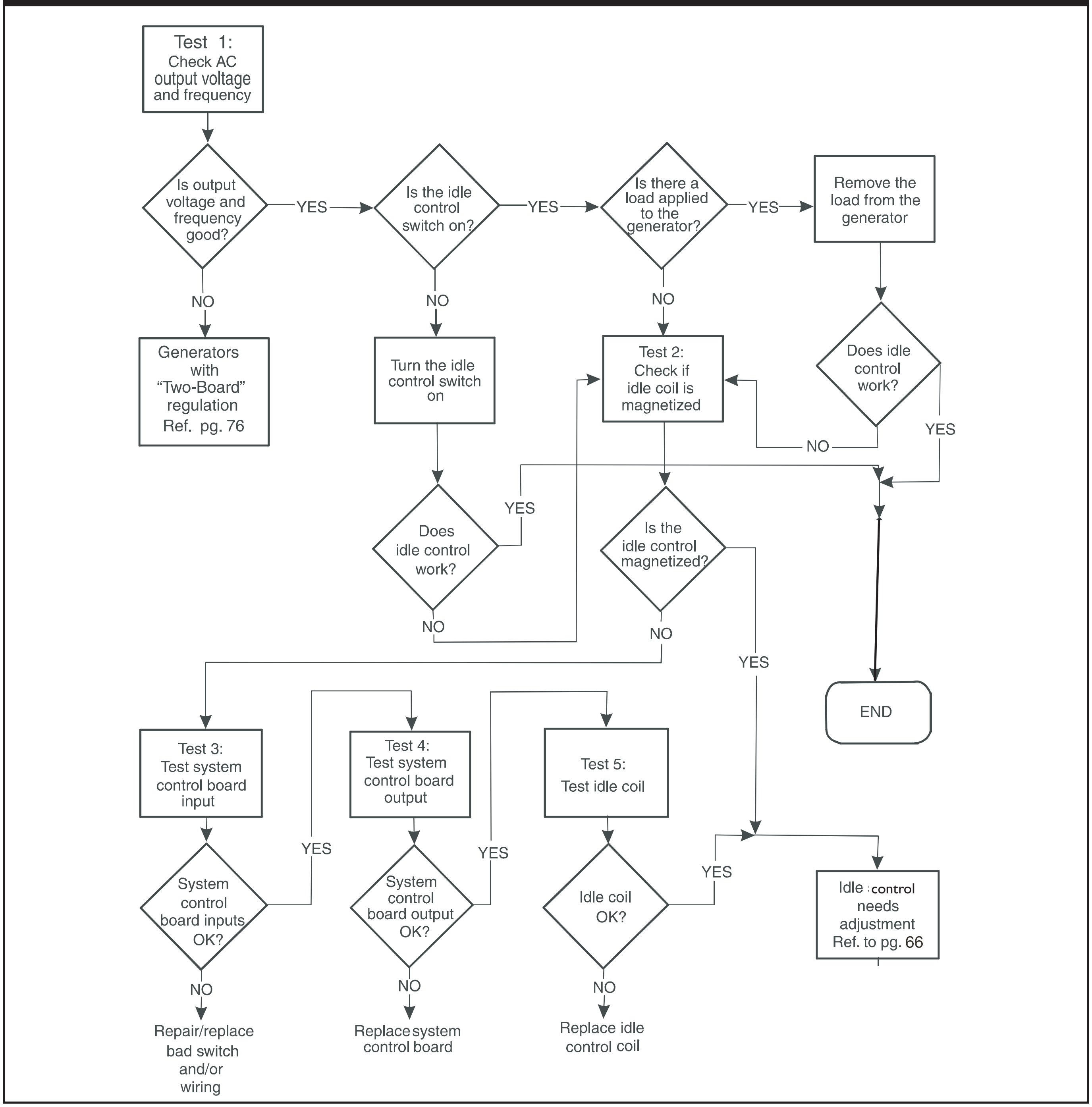
GENERATOR DIAGNOSTICS AND ADJUSTMENTS

Safety Practices

- Generator exhaust gases contain DEADLY carbon monoxide gas. This dangerous gas, if breathed in sufficient concentrations, can cause unconsciousness or even death. Operate and service this equipment only in the open air where adequate ventilation is available.
- Each generator was designed and manufactured for a specific application. Do not attempt to modify the unit or use it for any application it was not designed for. If you have any questions about your generator's application, ask your dealer or consult the factory.
- The manufacturer could not possibly anticipate every circumstance that might involve a hazard. For that reason, warnings in manuals and warnings on tags or decals affixed to the units are not all-inclusive. If you intend to handle, operate or service a unit by a procedure or method not specifically recommended by the manufacturer, first make sure that such a procedure or method will not render the equipment unsafe or pose a threat to you and others.
- Read these procedures carefully and become familiar with your generator set. Know its applications, its limitations and any hazards involved.
- Portable generators produce a very powerful voltage that can cause an extremely dangerous electrical shock. Avoid contact with bare wires, terminals, etc. Never permit an untrained person to service or assist with the procedures discussed in this guide.
- Never handle any kind of electrical cord or device while standing in water, while barefoot, or while hands or feet are wet.
- Do not use worn, bare, frayed or otherwise damaged electrical cord sets with any generator set. Using a defective cord may result in an electrical shock or damage to the test equipment and/or the unit.
- Operate and service these units only on level surfaces and where they will not be exposed to excessive moisture, dirt, dust or corrosive vapors.
- Gasoline is highly flammable and its vapors are EXPLOSIVE. Do not permit smoking, open flames, sparks or heat in the vicinity while handling gasoline. Avoid spilling gasoline on a hot engine. Comply with all laws regulating storage and handling of gasoline.
- Do not overfill the fuel tank. Always allow room for fuel expansion. If the tanks are overfilled, fuel can overflow onto a hot engine and cause FIRE or EXPLOSION.
- These units require an adequate flow of cooling air for their continued proper operation. Never operate or service any unit while inside any enclosure where the free flow of cooling air into and out of the unit might be obstructed. Without sufficient cooling airflow, the units quickly overheat, damaging the generator and/or nearby property.
- Never start or stop a unit with electrical loads connected to receptacles **AND** with the connected devices turned **ON**. Start the engine and let it stabilize before connecting any electrical loads. Disconnect all electrical loads before shutting down any generator.

TROUBLESHOOTING IDLE CONTROLS

Figure 3.1 — Idle Control Troubleshooting Flow Chart (3500-7500 Watt Generators)



XL&MC Generators, 3500-7500 Watt

Refer to Figure 3.1.

Test 1: — Check (AC) Frequency and Voltage

Connect an accurate (AC) frequency meter across the two parallel blades of one of the panel 120VAC receptacles.

- Start the engine and let it stabilize.

Read the (AC) frequency. A frequency reading of **61-63** Hertz should be obtained.

With the generator engine running:

- Connect the VOM test probes across the parallel blades of one 120VAC receptacle. A reading of approximately 122-124VAC should be indicated.

If voltage checks as specified:

- Discontinue test.

Test 2: — Check If Idle Control Coil Is Magnetized

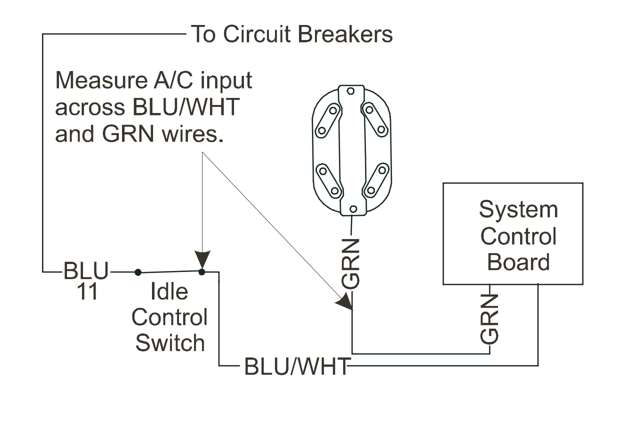
With the generator running, no electrical load on the generator, and the idle control switch **ON**, the idle control coil is energized and becomes an electromagnet. Touch the shaft of a screwdriver to the idle control coil. If the solenoid is energized, the screwdriver should stick to the side of the coil. If the screwdriver sticks but the engine does not go to "low idle:"

- The idle control needs adjustment. (See Page 66)

Test 3: — Check System Control Board Input

Measure the (AC) input to the system control board across the **BLU/WHT** tracer wire, (located by the idle control switch) and **GRN** wire (located on the locking outlet mounting tab). With the idle control switch is **ON** and the generator running (Figure 3.2), 120VAC should be measured.

Figure 3.2 — Check System Control Board Input



If voltage is not present:

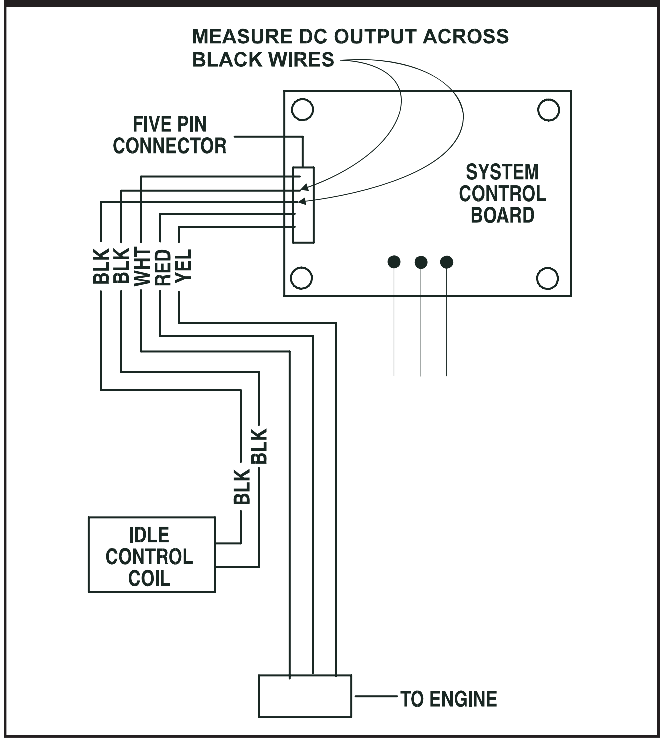
- Check for (AC) output
- Check idle switch input/output operation
- Check related connections and wiring

NOTE: Always refer to the wiring diagram of the unit being tested.

Test 4: — Check System Control Board Output

Measure the (DC) voltage across the two **BLK** wires on the system control board. These wires go to the idle control coil (Figure 3.3). Leave this connector plugged in while measuring voltage output.

Figure 3.3 — Check System Control Board Output



Approximately 120VDC should be measured with the idle control switch turned **ON** and the generator running with no load applied.

If 120VDC is present:

The system control board is working.

If 120VDC is not present at the **BLK** wires, but 120VAC is present on the **BLU/WHT** and **GRN** wires (Figure 3.2) with the idle control switch **ON**:

The system control board is bad.

- Check the idle control coil for shorts.

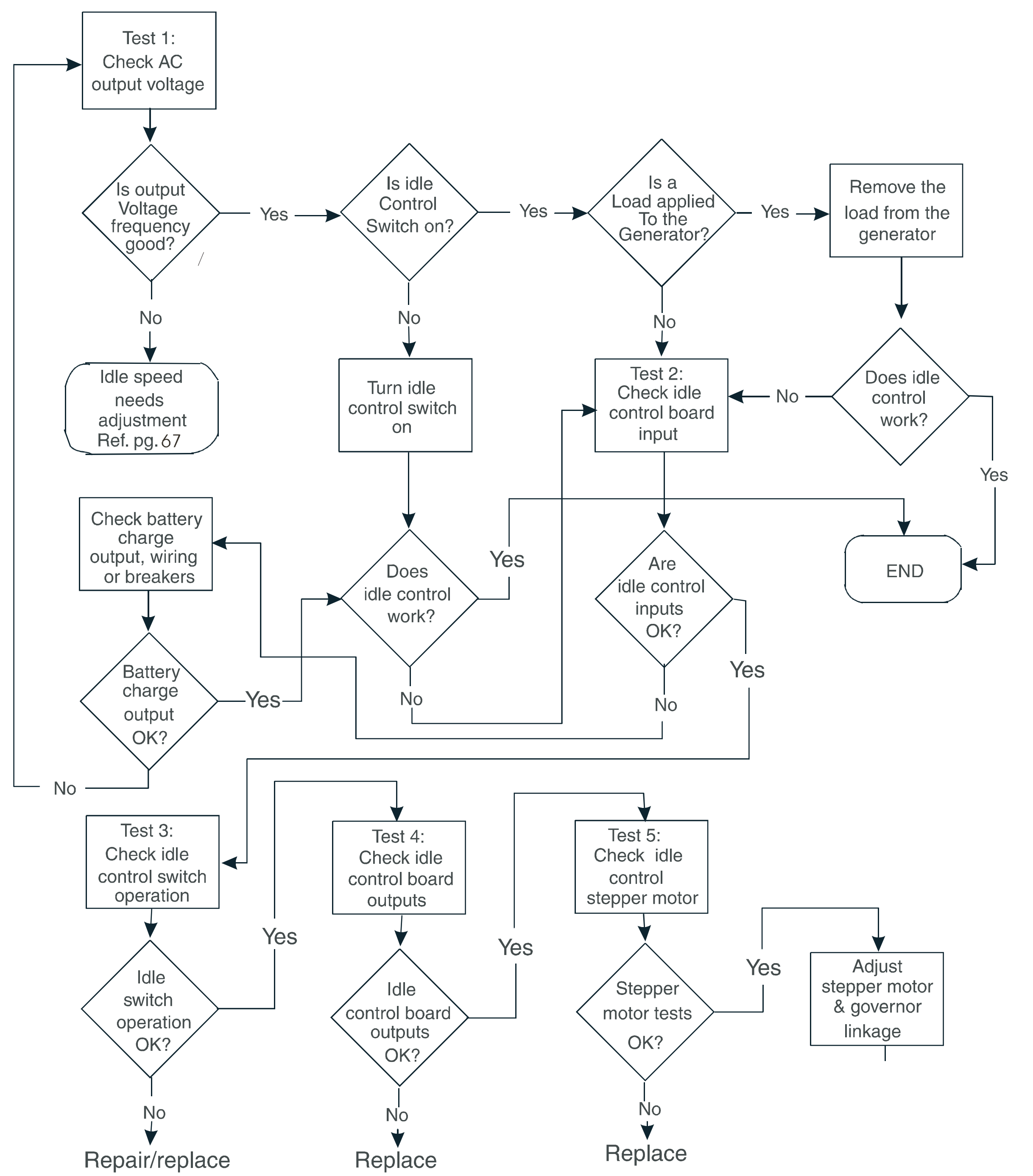
NOTE: A shorted coil can damage the system control board. Be sure to adjust the voltage potentiometer when replacing the system control board.

Test 5 — Check Idle Control Coil

Remove the five pin connector from the system control board. Measure the resistance across the two **BLK** wires. Approximately 1500 ohms should be measured. Also, measure between the **BLK** wires and ground. A reading of infinity should be measured. Any other reading indicates a bad idle control coil.

NOTES

Figure 3.4 — Idle Control Troubleshooting Flow Chart (480 & 570 V-Twin GN Engines 8000-10000 Watt Generators



XL&MC Generators, 8000-10000 Watt

Refer to Figure 3.4.

Test 1: — Check (AC) Frequency and Voltage

Connect an accurate (AC) frequency meter across the two parallel blades of one of the panel 120VAC receptacles.

- Start the engine and let it stabilize.

Read the (AC) frequency. A frequency reading of **61-63** Hertz should be obtained.

With the generator engine running:

- Connect the VOM test probes across the parallel blades of the panel 120VAC receptacles. A reading of approximately 130-140VAC should be indicated.

If voltage checks as specified:

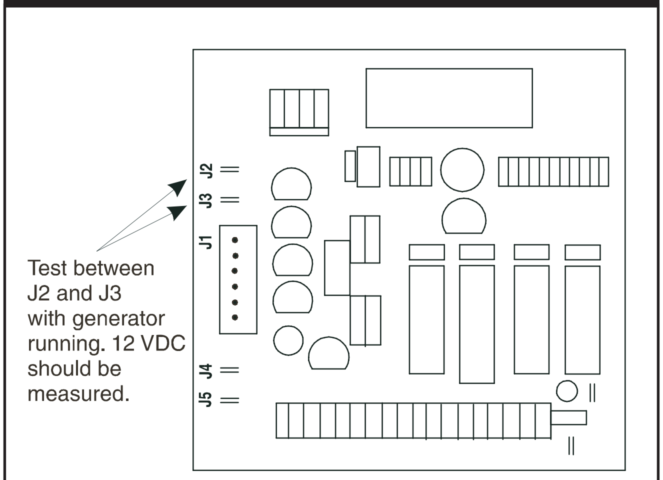
- Discontinue test.

Test 2: — Check Idle Control Board Input

Using a digital volt meter set to the VDC scale,

- Connect the positive test lead to pin J2 on the idle control circuit board. Connect the negative test lead to J3 on the idle control circuit board. Pin J3 is the ground terminal of the board (Figure 3.5).

Figure 3.5 — Testing Idle Control Board Input



- Start the generator and note the reading. The reading should measure 12VDC (See note on top of page 62). If no voltage is present, check to see if the generator is producing (AC) voltage.

If the unit does produce (AC,) but (DC) voltage is not present at pins J2 and J3, check for a failure in the battery charge circuit of the generator.

Test 3: — Check Idle Control Switch Operation

Remove wires 83 and 84 from the idle control board. Set a VOM to measure ohms. Connect the meter test leads to wires 83 and 84. Turn the idle switch **ON**. A reading of less than 0.3 ohms should be measured. Turn the idle switch **OFF**. A reading of "Infinity" should be measured.

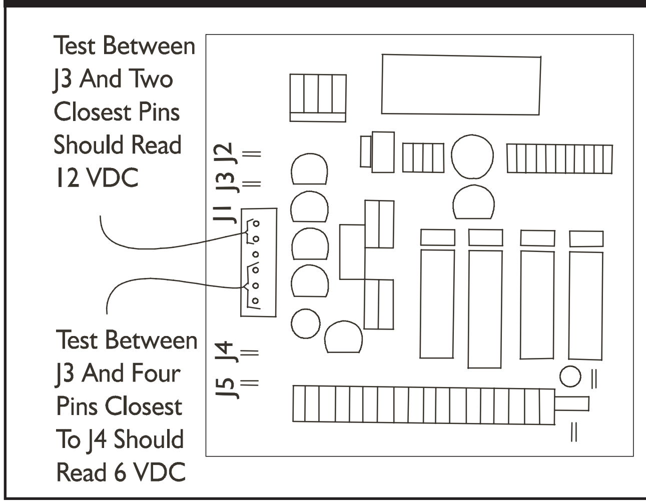
Test 4: — Check Idle Control Board Outputs

Using a digital volt meter set to the "DC Volts" scale,

- Connect the negative test lead to pin J3 on the idle control circuit board.

Referring to Figure 3.6, connect the positive test lead as follows:

Figure 3.6 — Testing Idle Control Board Outputs



- Individually test the two pins in connector J1 on the idle control board closest to pin J3. Approximately 12VDC should be measured **only while** the stepper motor is moving in either direction.
- Individually test the four pins in connector J1 closest to pin J4 on the idle control board. Approximately 6VDC should be measured **only while** the stepper motor is moving in either direction.

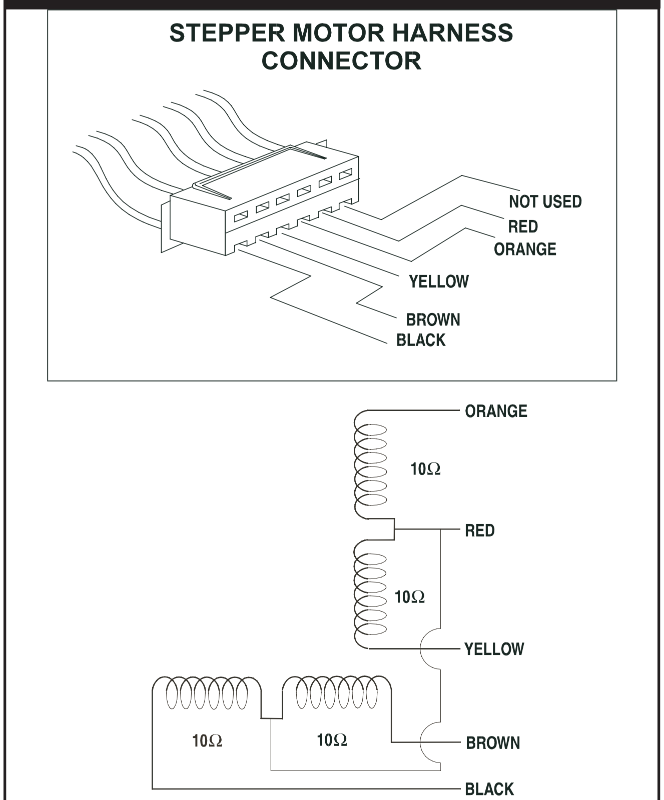
NOTE: To get an accurate measurement, you may need to keep turning the idle control switch on and off in order to keep the stepper motor moving.

Test 5: — Check Idle Stepper Motor

- Disconnect the stepper motor harness from the idle control board.
- Set a VOM to its ohm scale.

Refer to Figure 3.7.

Figure 3.7 — Checking Stepper Motor



- Connect one VOM test lead to the connector pin on the stepper motor harness to which the RED wire attaches.

Connect the other VOM test lead as follows:

- To the ORANGE wire connector pin. Approximately 10 ohms.
- To the YELLOW wire connector pin. Approximately 10 ohms.
- To the BROWN wire connector pin. Approximately 10 ohms.
- To the BLACK wire connector pin. Approximately 10 ohms.

When connecting the VOM to any pin in the stepper motor harness and the stepper motor housing (ground), the VOM should read "infinity."

- If any reading other than listed is noted, replace the stepper motor and harness as an assembly.

Early Idle Control Adjustment (Except V-Twin Engine)

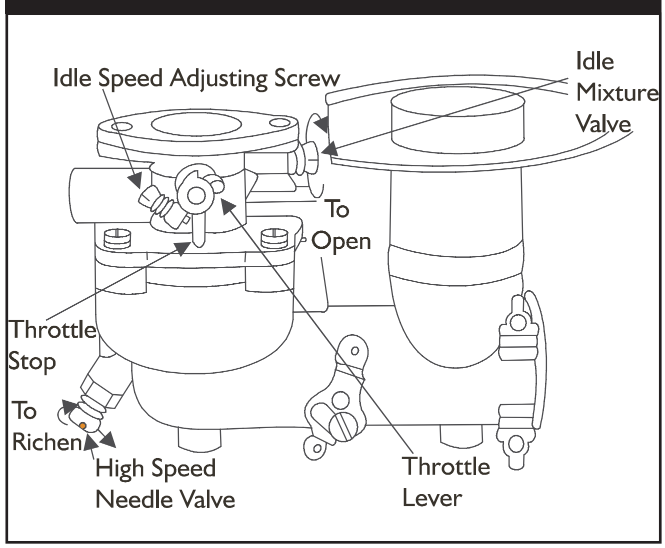
NOTE: The following carburetor adjustment procedures apply to most early Briggs & Stratton engines. For other engine makes, comply with the engine manufacturer's instructions.

These initial adjustments will allow the engine to get started and warmed up.

Before starting the engine:

- Gently turn the idle mixture valve and needle valve (Figure 3.8) clockwise until they just bottom. **Do not force or valves will be damaged!**
- Open the needle valve one and one half turns counterclockwise and the idle mixture valve one turn counterclockwise.

Figure 3.8 — Carburetor Adjustment



Connect an accurate (AC) frequency meter to one of the generator receptacles.

Then, complete adjustments as follows:

- Start the engine and let it run at "no-load" with the idle control switch set to **OFF**.

The frequency meter should read approximately **62** Hertz (on 60 Hertz units) or 51 Hertz (on 50 Hertz units). Adjust engine governed speed, if necessary. Perform these next two operations and take note of where these positions are.

- Turn the needle valve clockwise (lean) until engine RPM just starts to slow.
- Turn the needle valve counterclockwise (rich) until the engine starts to run unevenly.
- Set the needle valve midway between rich and lean.

Idle Speed Adjustment

- Set the idle control switch to **ON**.

The engine should decelerate to idle speed and the frequency meter should read approximately **35-40** Hertz.

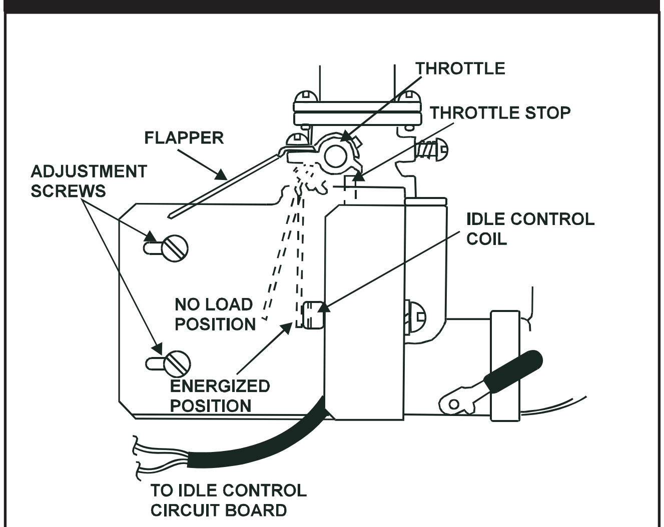
If necessary:

- Loosen the three screws that retain the idle control coil bracket (Figure 3.9) and slide the bracket axially to adjust speed to **35-40** Hertz.

To increase frequency: Slide bracket to the left.

To decrease frequency: Slide bracket to the right.

Figure 3.9 — Idle Control Coil And Flapper



With the engine running at correct idle speed:

- Turn the idle mixture valve in (lean) until the engine begins to roughen and then out (rich) until it roughens. Take note of these positions.
- Set idle mixture valve midway between rich and lean.

Recheck idle speed and, if necessary, adjust by moving the coil bracket, as before.

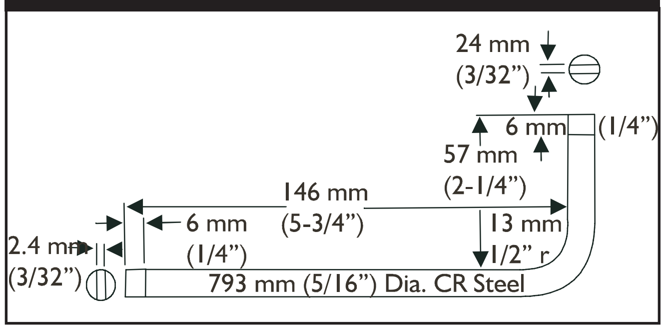
- Turn the idle control switch **OFF** and check acceleration.

Engine should accelerate smoothly. If not, readjust carburetor mixture slightly richer.

Idle Control Adjustment (Early V-Twin Engine)

To adjust V-Twin engine units with idle control, an (AC) frequency meter and a tang bending tool are required. Fabricate the tang bending tool locally per Figure 3.10.

Figure 3.10 — Tang Bending Tool



NOTE: Use of a load bank is recommended. If a load bank is not available, some other means of applying a known electrical load to the generator must be used.

Setting Idle Mixture

The following adjustments will permit the engine to be started and warmed up. Final adjustments will be made with the engine running.

Before starting the engine:

- Turn the idle mixture valve clockwise until it just bottoms. **Do Not Force.**
- Then, turn the idle mixture valve counterclockwise one and one quarter turns.

Adjustment at "No Load" Frequency

Check that all springs and linkages are properly installed. The capscrews that retain the solenoid mounting brackets to the fuel tank heat shield must be tight. Then connect an (AC) frequency meter into one of the generator's (AC) output recepticals.

- Set the idle control switch to **OFF**.
- Unplug all electrical loads.

Initial settings will be accomplished at "no-load."

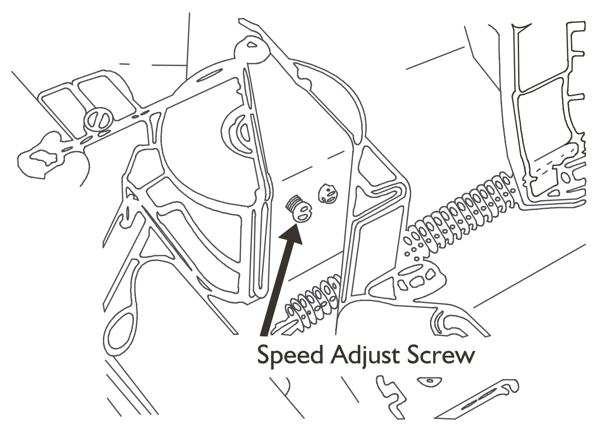
- Start the engine, let it stabilize and warm up.
- Check the "no-load" (AC) frequency.

Meter should read about **62.0-62.5** Hertz (on 60 Hertz units) or **51.0-51.5** Hertz (on 50 Hertz units).

If necessary:

- Adjust the "no-load" frequency adjustment screw to obtain the correct (AC) frequency (See Figure 3.11).

Figure 3.11 — No Load Frequency Adjustment Screw



Adjustments at "Rated Load" Frequency

NOTE: The "Rated Load" frequency adjustments should only be done after successfully completing the "No Load" adjustments.

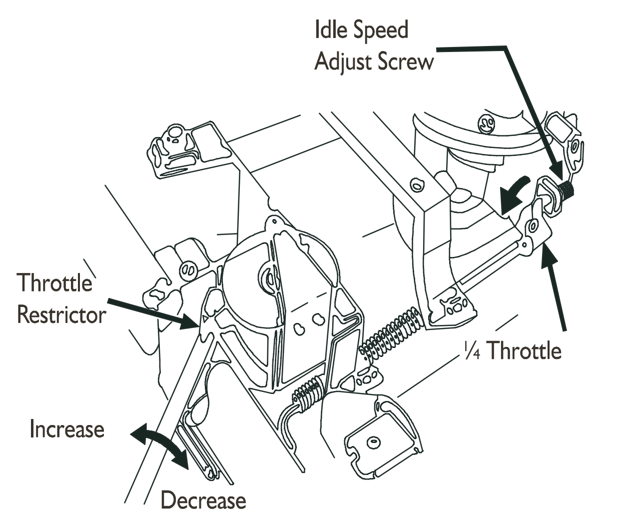
Refer to Figure 3.12. Perform steps with the engine running at its correct "no-load" frequency.

Then proceed as follows:

- Apply an electrical load to the generator equal to the unit's rated wattage/amperage capacity.

If engine frequency "droops" below **57** Hertz (on 60 Hertz units) or **48** Hertz (on 50 Hertz units):

Figure 3.12 — Throttle Restrictor Tang



- Disconnect the load.
- Bend the throttle restrictor tang about 1/16 inch toward the "decrease" side.
- Re-adjust the "no-load" frequency adjust screw to obtain **62.0-62.5** Hertz (on 60 Hertz units); or **51.0-51.5** Hertz (on 50 Hertz units).
- Re-apply the electrical load.
- Check frequency droop against the values stated.

If frequency droops below the stated values, repeat the adjustment procedures mentioned. Be careful not to bend the throttle restrictor tang more than 1/16 inch each time. Complete this adjustment to your satisfaction before proceeding to the "Low Idle Frequency Adjustment."

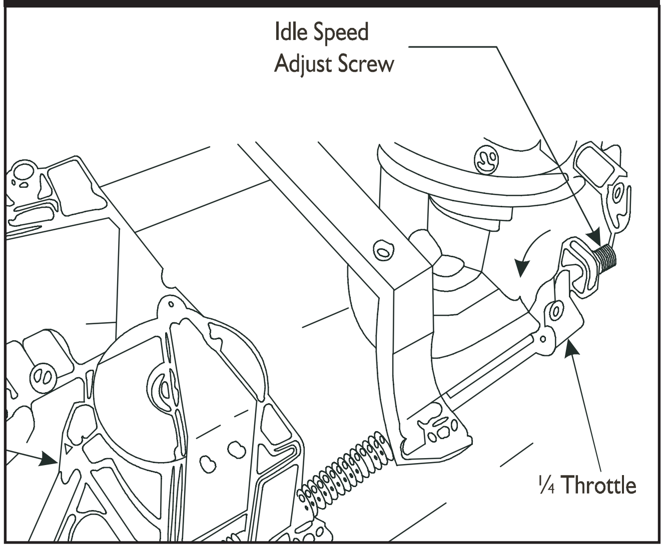
Adjustment at "Low Idle" Frequency

NOTE: The "Low Idle" Frequency adjustment should only be done after successfully completing "No Load" and "Rated Load" adjustments.

With the unit running and no loads connected to the generator:

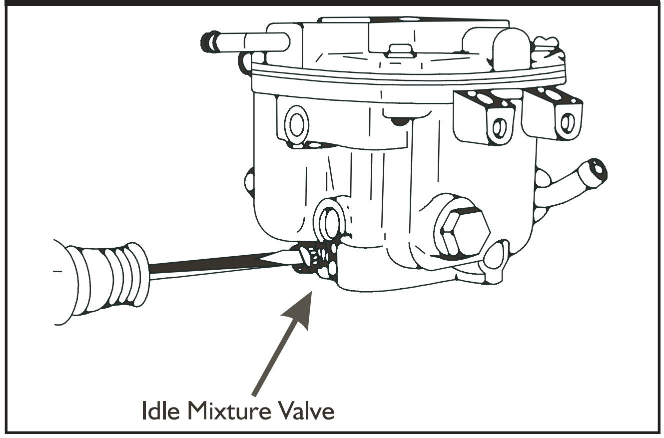
- Hold the throttle against the idle speed adjust screw.
- While holding the throttle, turn the idle speed adjust screw (Figure 3.13) until unit is idling at **24-28** Hertz (for both 50 and 60 Hertz units).

Figure 3.13 — Throttle Restrictor Tang



- Turn the carburetor's idle mixture valve (Figure 3.14) clockwise (lean) until frequency starts to drop.

Figure 3.14 — Idle Mixture Adjustment



Take note of this position.

- Turn the idle mixture valve counterclockwise until frequency starts to drop.

Take note of this position.

- Set idle mixture valve at the midpoint between the two previous positions.

Idle Control Switch Adjustment

NOTE: The "Idle Control Switch" adjustment should only be done after successfully completing "No Load, Rated Load and Low Idle" frequency adjustments.

Proceed with the idle control switch adjustments with the unit running, warmed up and stabilized.

- Set the idle control switch to **ON**.

Idle control solenoid should pull in and engine frequency should drop to idle.

- Check the frequency reading.

Engine should be running at **40-45** Hertz.

If not:

- Loosen the four screws that retain the idle control solenoid mounting brackets.
- Move the brackets toward the engine to increase frequency or away from engine to decrease frequency.
- Secure bracket screws.

With idle control switch **ON** and no electrical loads connected, the unit should be running at its correct idle frequency of **40-45** Hertz.

GN-190, 220, 320 , 360 & 410 Engine Idle Control

Idle speed adjustments consist of first adjusting the position of the idle control solenoid to maintain approximately **40-45** Hertz (2100 rpm).

Adjustment Procedure

- Set the idle control switch to **OFF**.
- Unplug all electrical loads from the generator set.
- Connect an (AC) frequency meter into one of the generator's (AC) output receptacles
- Crank and start the engine as outlined in the appropriate owner's manual.

The engine should start and accelerate to high governed speed. Let the engine stabilize and warm up for a few moments.

- Check the frequency meter reading:

For units rated at 60 Hertz: Meter should read About **61.5-63.5** Hertz (3690-3810 rpm).

For units rated at 50 Hertz: Meter should read About **50.5-51.5** Hertz (3030-3090 rpm).

- Set the idle control switch to **ON**.

The idle control solenoid should energize to pull the governor lever in and engine should decelerate to idle speed.

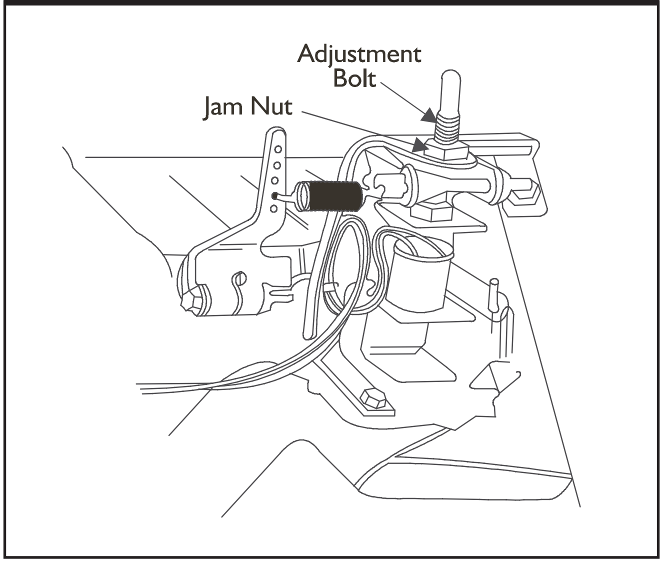
- Check the frequency meter reading.

Meter should indicate **40-45** Hertz (2100-2400 rpm).

If idle speed is not within the stated range:

Adjust the idle control solenoid (Figure 3.15).

Figure 3.15 — Idle Control Solenoid



- Loosen the solenoid jam nut, then turn the solenoid bolt clockwise (faster speed) or counterclockwise (slower speed).

When engine is idling at **40-45** Hertz (2400-2700 rpm):

- Hold that setting and tighten the jam nut against the solenoid bracket.

With solenoid jam nut tightened:

- Check that engine speed is still **40-45** Hertz (2400-2700 rpm).

Adjusting Idle Control
8KW EXL & 10KW EXL

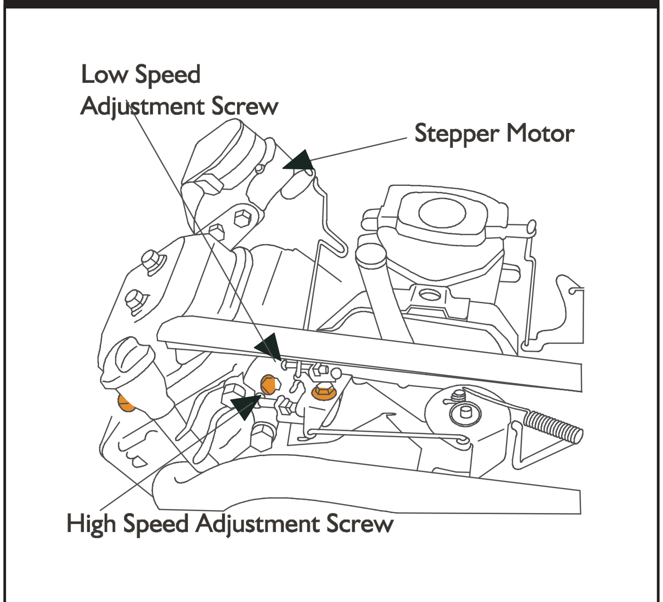
Back out both high and low speed adjustment screws several turns.

- Turn idle switch **OFF**.
- Start engine and allow to run at "no load" until stabilized and warmed up.
- Turn the idle switch **ON**.

Using a phillips screwdriver:

- Adjust the low speed adjustment screw (Figure 3.16) to **45** Hz.
- Turn the Idle Switch to **OFF**.
- Adjust the high speed adjustment screw (Figure 3.16) to **62** Hz "no load."
- Cycle the idle control switch **ON** and **OFF** several times and re-check frequency adjustments.

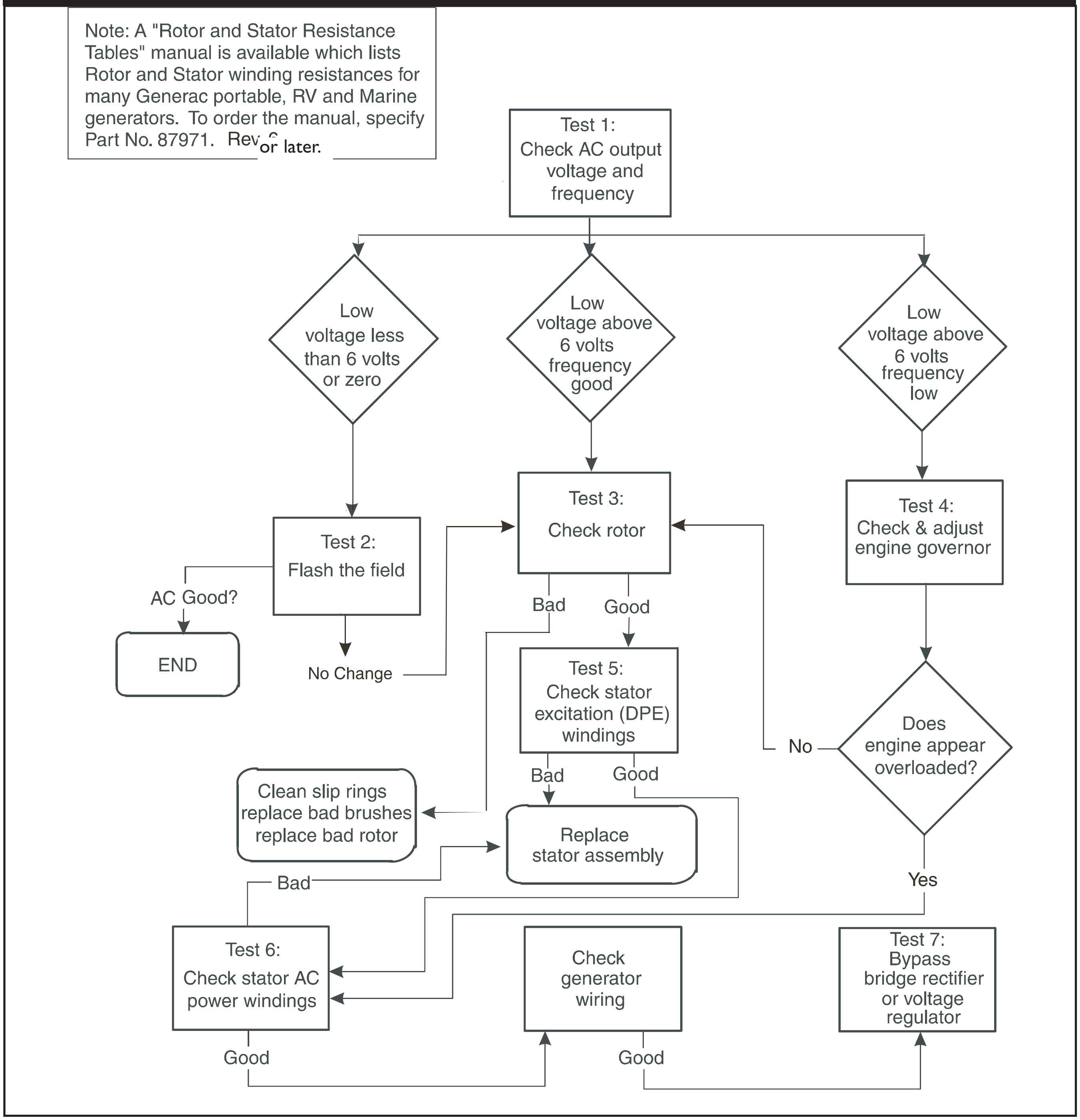
Figure 3.16 — Idle Control (8KW & 10KW EXL)



NOTES

TROUBLESHOOTING GENERATOR UNITS

Figure 3.17 — Troubleshooting Flow Chart For "Direct Excited" (Brush Type) Generators



Troubleshooting "Direct Excited" (Brush Type) Generators

Refer to Figure 3.17

Test 1: — Check AC Output Voltage & Frequency

Connect the test leads of an AC voltmeter or a volt-ohm-millimeter VOM into a generator receptacle. Also connect an (AC) frequency meter. Disconnect any electrical loads.

- Start the generator engine, let it stabilize and warm up.

Read the "no-load" voltage and frequency, and analyze the results as follows:

- If zero volts or less than 6VAC is indicated:
  Go to Test 2.
- If low voltage is indicated, but reading is above 6VAC and AC frequency is normal:
  Go to Test 3.
- If low voltage is indicated, but reading is above 6VAC and AC frequency is low:
  Engine Governor may need adjustment.
  (Refer to the appropriate engine manual)

Test 2: — Flash The Field

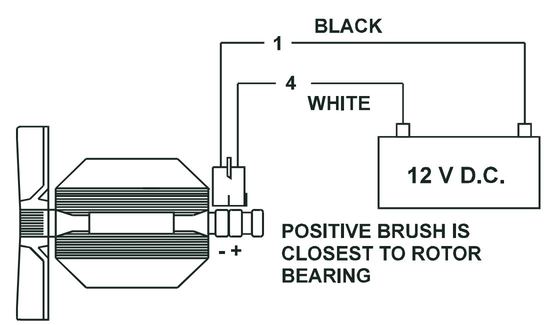
In normal generator operation, upon startup there is some "residual" magnetism in the rotor to get the generating process started. Residual magnetism is the magnetism left in the rotor after the unit is shut down. When residual magnetism is lost, the unit will have an output voltage that will remain at zero. If residual magnetism is lost it can usually be restored by "flashing the field" with a simple process involving a (DC) battery. This usually occurs if the unit is out of use for a long period of time.

NOTE: Some units are equipped with "FIELD BOOST" and should never lose residual magnetism unless a field boost failure has occurred. Field boost current flashes the field on every startup (see "Field Boost" on Page 45). Refer to the appropriate electric schematic and/or wiring diagram to determine if a unit has field boost.

If the unit is equipped with a voltage regulator or a bridge rectifier, flash the field as follows:

- Obtain a 12VDC battery.
- Get two jumper leads that can go from the battery to the brushes (wires with alligator clips work well).
- Find the brushes inside the alternator portion of the unit.
- Start the engine and get it up to running speed.
- Connect the battery positive (+), to the positive brush, which will be the brush closest to the rotor bearing.
- Connect the battery negative (-), to the negative brush, which is the brush farthest away from the rotor bearing. (Refer to Figure 3.18).

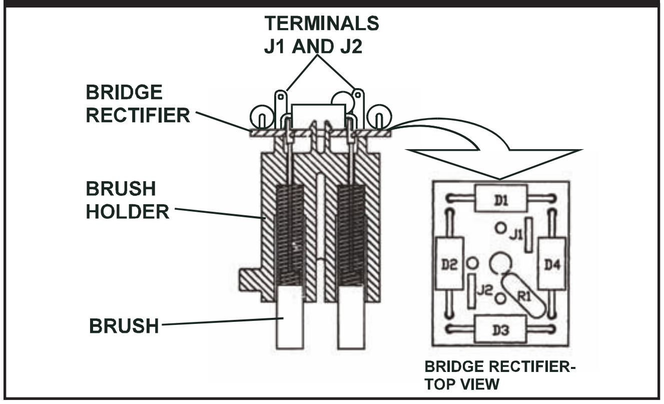
Figure 3.18 — Restoring Residual Magnetism



- After about five seconds, disconnect the battery wires from the brushes and check for proper (AC) output voltage.
- Shut the engine down. Restart the unit and check once again for proper (AC) output voltage.

If the unit is equipped with a brush/bridge rectifier (refer to Figure 3.19), proceed as follows:

Figure 3.19 — Brush & Rectifier Combination



- Locate the brush/bridge rectifier inside the alternator portion of the unit.
- Remove the DPE wires 2 & 6 (or red and blue) from the rectifier terminals J1 and J2.
- Start the engine and get it up to running speed.
- Apply 12VDC across terminals J1 and J2. (Polarity is not important.)
- After about five seconds, disconnect the 12VDC from the rectifier, and stop the engine.
- Reconnect the DPE wires to the rectifier terminals. Wire number 2 (blue) connects to J1, and wire number 6 (red) connects to J2.
- Restart the unit and check once again for proper (AC) output voltage.

Test 3: — <u>Check Rotor</u>

Little or no (AC) output voltage can be caused by a rotor failure.

NOTE: The voltage surge that occurs at the moment of rotor failure can result in damage to the bridge rectifier or voltage regulator. For that reason, if a rotor has failed, be sure to check the bridge rectifier, voltage regulator, or power regulator board.

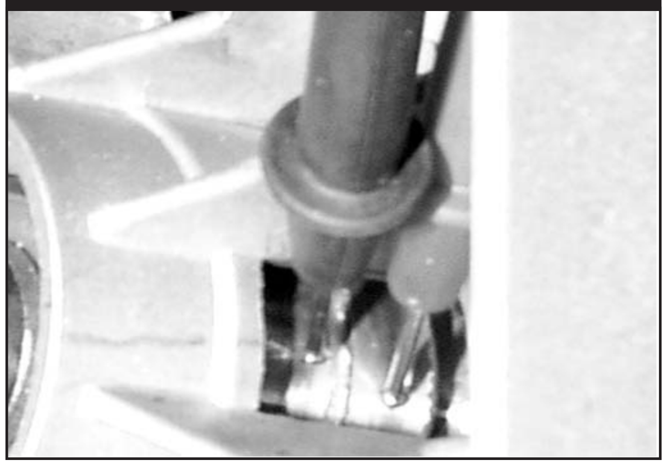
Before testing the rotor, inspect the brushes and slip rings. Replace brushes if they are worn excessively, or if they are cracked or damaged. <u>Do not use any metallic grit to clean up slip rings.</u>

To test the rotor with a volt-ohm-milliameter VOM, set the VOM to its "OHM" scale and zero the meter. Then, test for an open, shorted or grounded condition as follows:

•• Step 1: Checking Rotor Resistance

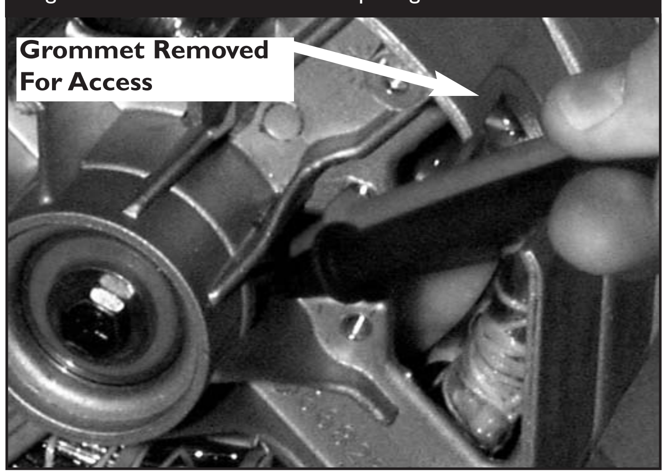
- Remove the brush assembly.
- Set the VOM to its "OHM" scale.
- Connect the test leads to the rotor slip rings (See Figure 3.20).

Figure 3.20 — Checking Rotor Resistance



Because of the cramped quarters inside the rear bearing carrier, it is necessary to remove the power cable grommet as shown in Figure 3.21.

Figure 3.21 —Access To Rotor Slip Rings



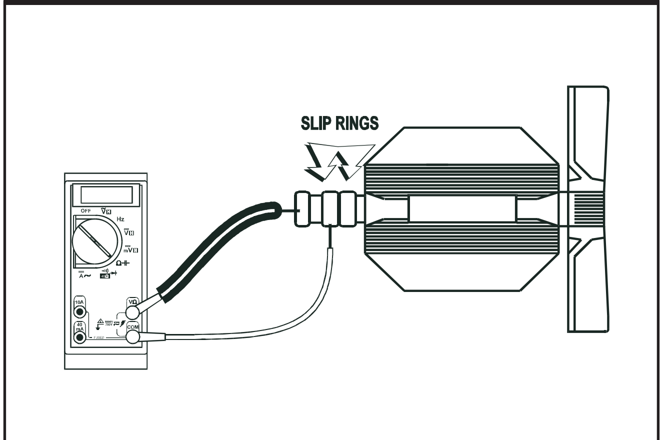
Measure the rotor resistance and compare it to the nominal resistance from the appropriate resistance table (Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later).

A reading of "infinity" or a very high resistance indicates an open circuit or a partially open condition in the rotor windings.

A very low resistance indicates a shorted rotor.

- Connect one test lead to the rotor shaft and the other test lead to either rotor slip ring (Figure 3.22).

Figure 3.22 — Checking Rotor Short To Ground



A reading of "infinity" should be measured. A reading other than infinity indicates a rotor winding shorted to the rotor shaft. → **Replace Rotor**

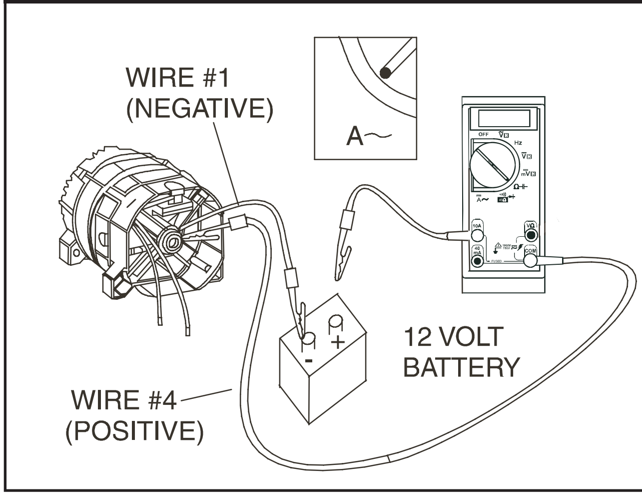
NOTE: Sometimes a rotor may only fail while it is spinning at rated RPM. This condition is called a "Flying Open" or "Flying Short."

To diagnose, use the "Rotor Current Draw Test."

•• **Step 2: Rotor Current Draw Test**

- Locate the brush wires. (Normally these wires are #4 and #1.) Isolate the brushes from the bridge rectifier or voltage regulator.
- Connect a (DC) amp meter between the positive brush wire #4, and the positive post on a 12VDC battery.
- Connect a jumper wire between the negative brush and the negative post on the battery (See Figure 3.23).

Figure 3.23 — Rotor Current Draw Test



- Start the engine and monitor amp draw.

It should not change while the unit is running or static. The (DC) amp draw will be determined by the specified resistance of the rotor being tested.

To find the desired amp draw, use Ohms Law:

Voltage divided by amperage equals resistance.

For example: 12VDC divided by a rotor resistance of 24 ohms equals an amp draw of 0.5 amp.

NOTE: Amp draw may vary slightly due to exact battery voltage, rotor resistance, and meter calibration etc. Look for extreme differences.

Analyze the test results as follows:

If the rotor current draw is higher than specified, a flying short exists in the rotor. → **Replace Rotor**

If current draw is lower than specification, a flying open exists in the rotor. → **Replace Rotor**

If current draw is within specifications, rotor is OK.

Test 4: — Check And Adjust Governor

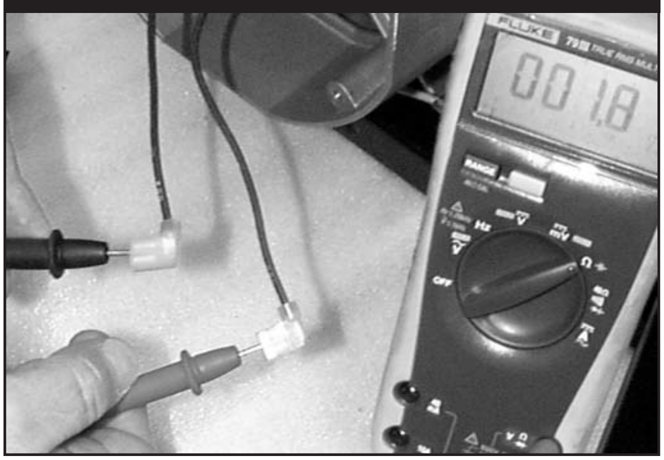
Refer to the appropriate engine manual.

Test 5: — Check Stator Excitation (DPE) Windings

NOTE: The excitation wires may be colored or numbered. The numbered wires are #2 and #6. The colored wires are blue and red. Be sure not to confuse the colored excitation wires with the colored power wires. The excitation wires are the wires connected to the bridge rectifier or voltage regulator.

- Set the VOM to its "OHM" scale.
- Connect the test leads to the stator excitation wires (Figure 3.24).

Figure 3.24 —Checking DPE Resistance



Measure the resistance and compare it to the nominal resistance from the appropriate table

(Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later).

A reading of infinity or high resistance indicates an opening in the excitation winding. → **Replace Stator**

A low reading indicates a shorted stator winding.

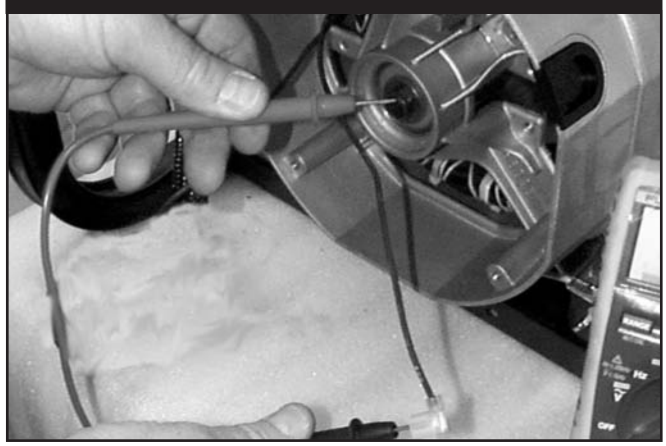
- Connect one test lead to a stator power wire. Connect the other test lead to one of the stator excitation wires (Figure 3.25).

Figure 3.25 — Testing For Short Between Windings

A reading of infinity should be measured. A reading other than infinity indicates a power winding shorted to an excitation winding. → **Replace Stator**

- Connect one test lead to an excitation wire. Connect the other test lead to a good metal ground. (Figure 3.26)

Figure 3.26 — Checking DPE "Short To Ground"



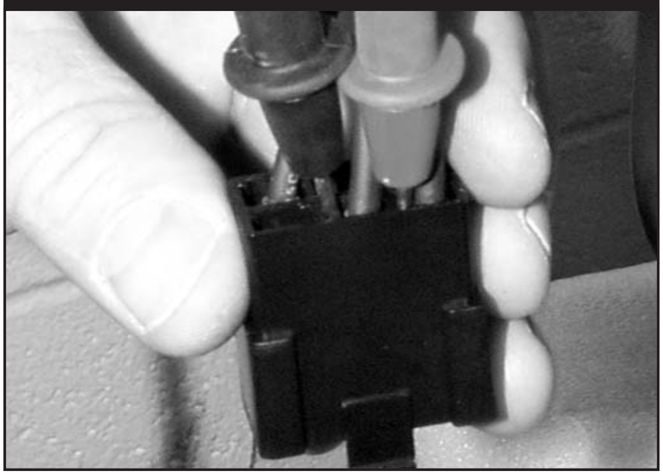
A reading of "infinity" should be measured. A reading other than infinity indicates a winding shorted to ground. → **Replace Stator**

Test 6: — Testing Stator AC Power Windings

Testing Single Voltage Type Power Winding

- Set a VOM to its "OHM" scale.
- Connect the meter test leads across the (AC) power wires. (Wire #11 and wire #22 or blue and red wires (Figure 3.27).

Figure 3.27 — Checking Power Winding Resistance



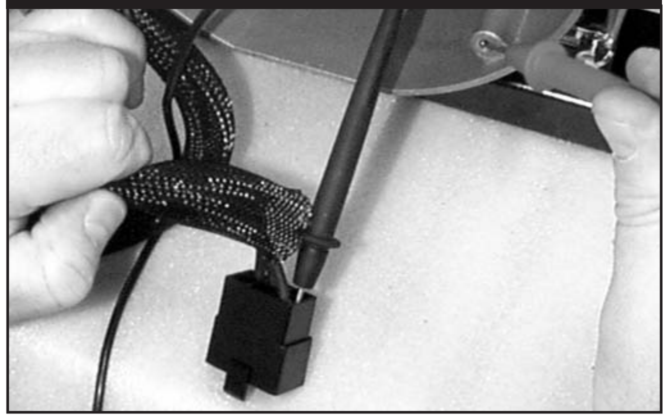
Measure the resistance and compare it to the nominal resistance from the appropriate table (Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later).

A reading of infinity or high resistance indicates an opening in the stator winding. → **Replace Stator**

A low reading indicates a shorted stator winding. → **Replace Stator**

- Connect one meter test lead to a good ground. Connect the other test lead to the stator power winding (Figure 3.28).

Figure 3.28 — Testing For Short To Ground



A reading of infinity should be measured. A reading of other than infinity indicates a stator winding shorted to ground. → **Replace Stator**

Testing Dual Voltage Type Power Windings

- Set a VOM to the "OHM" scale.
- Connect the test leads to the stator wires #11 and #22.

Measure the resistance and compare it to the nominal resistance from the appropriate table (Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later).

- Connect the test leads to the stator wires #22 and #44.

Measure the resistance and compare it to the nominal resistance from the appropriate table. Analyze the results the same as in "Testing Single Voltage Type Power Winding".

- Connect one meter test lead to a good ground. Connect the other test lead to the stator power winding. (Refer back to Figure 3.28).

A reading of infinity should be measured. A reading other than infinity indicates a stator winding shorted to ground. → **Replace Stator**

Testing Battery Charge Windings

- Set VOM to "OHM" scale.

If a single winding is used:

- Connect the meter test leads across wires No. 55 and 66.

Compare the reading obtained with the resistance value from the Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables" Pub. #87971 Rev 6 or later.

If dual Battery Charge Windings are used, take meter readings as follows:

- Read across Wires No. 55 (black) and 66 (brown).
- Read across Wires No. 55 (black) and 77 (brown).

Measure the resistance and compare it to the nominal resistance from the appropriate table. Analyze the results the same as in "Testing Single Voltage Type Power Winding".

NOTE: The resistance table gives only two resistance values for "multi-tap" Battery Charge Windings, even though there are actually four (4) windings. The difference in resistance between 55-66A and 55-77A, and 55-66 and 55-77 is minimal and insignificant.

Test 7: — Bypassing the Voltage Regulator or Bridge Rectifier

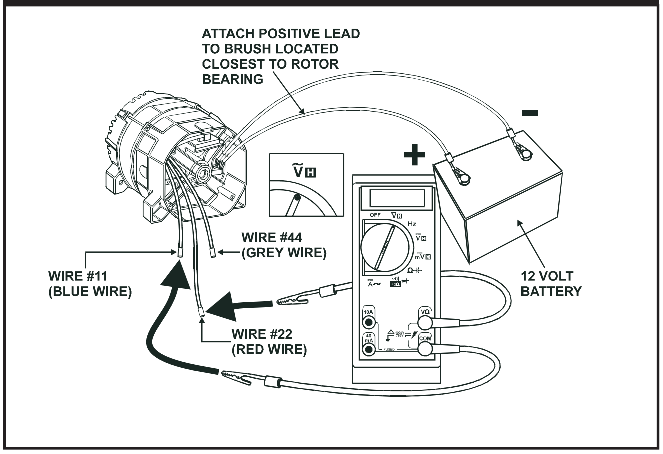
NOTE: Bypassing the bridge rectifier and voltage regulator are similar tests, the difference being that six wires are unplugged from the voltage regulator where only two or four are removed from the bridge rectifier. During the bridge rectifier test you measure (AC) output at the stator power and excitation windings only, there are no sensing wires on a bridge rectifier system.

Verify that the field flash has taken place (Voltage Regulator types only). Watch the light on the Voltage Regulator. If it comes on at all, field flash has occurred.

- Disconnect all wires from the Voltage Regulator or Bridge Rectifier and keep them completely isolated from the circuit.
- Apply 12VDC to the brush wires, normally wires #4 (+), and #1 (-).
- Start the generator (make sure the remaining wires are not touching each other or the control panel, etc.).

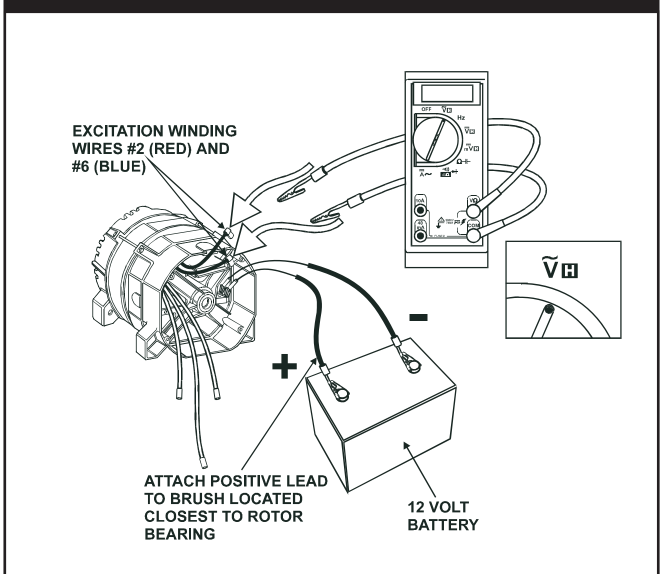
Measure (AC) output across sensing wires #11 and #22 (on voltage regulator types only). On bridge rectifier types, measure (AC) output at the 120VAC receptacle. At least 60VAC should be measured, slightly higher is ok (Figure 3.29).

Figure 3.29 — Testing Power Winding Output



Measure (AC) output across excitation winding wires #2 and #6. At least 60VAC should be measured. It can be higher (Figure 3.30).

Figure 3.30 — Testing Excitation Winding Output



Analyze the test results as follows:

If any of the (AC) voltage readings are below 60VAC (slightly higher is ok) and rotor current draw is within specification:

- The problem is in the stator windings. → **Replace Stator**

If the rotor current draw (Test 3) is higher than specified:

- A "flying short" exists in the rotor. → **Replace Rotor**

If current draw (Test 3) is lower than specification:

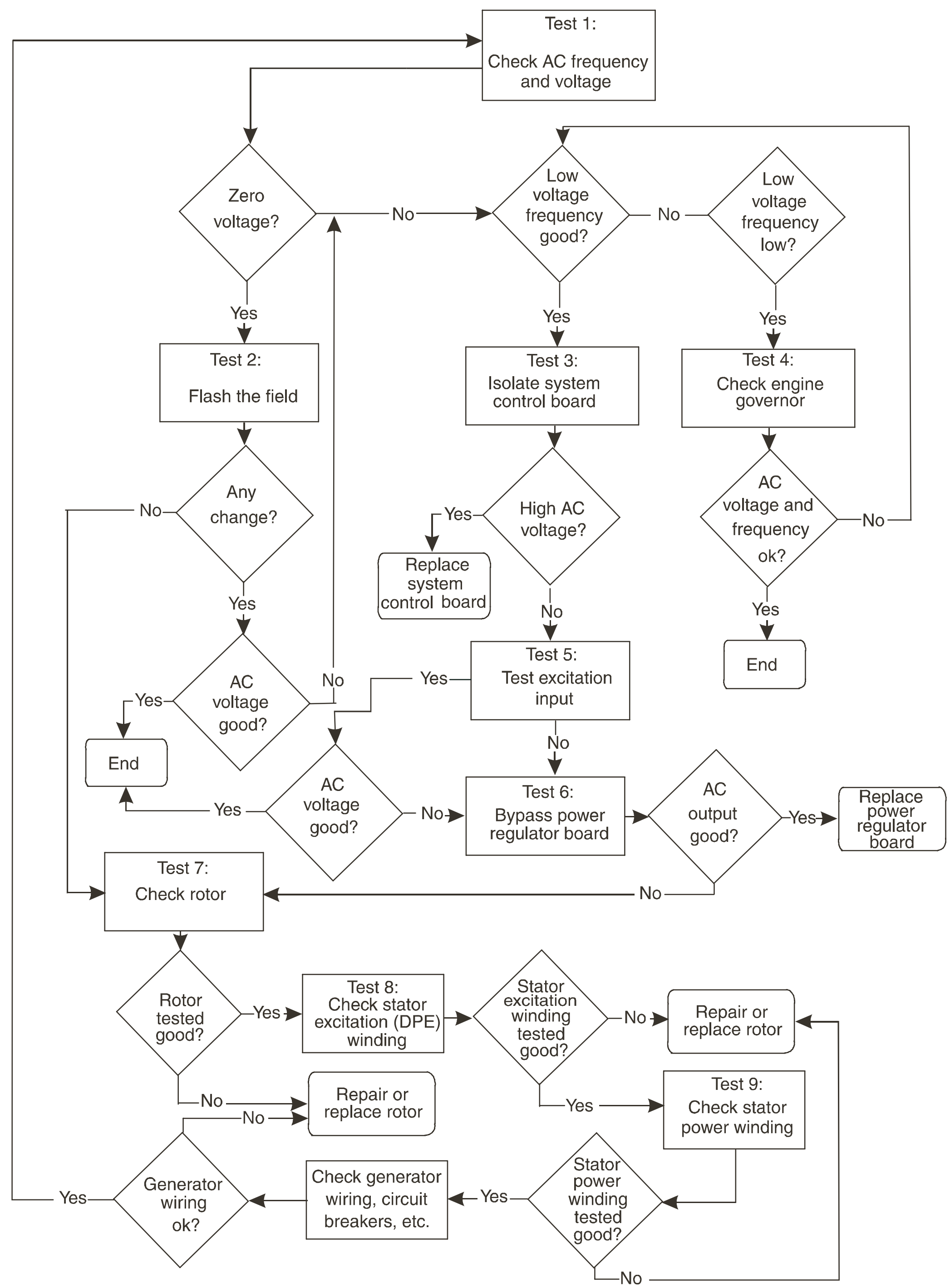
- A "flying open" exists in the rotor. → **Replace Rotor**

If (AC) output and current draw are within specifications and the rotor and stator are ok:

- The voltage regulator is defective.

NOTES

Figure 3.31— Troubleshooting Flow Chart For (Brush Type) Generators With "Two-Board" Regulation



Troubleshooting "Two Board" Regulation Generators (Brush Type)

Refer to Figure 3.31.

Test 1: — Check (AC) Frequency and Voltage

Connect an accurate (AC) frequency meter across the two parallel blades of one of the panel 120VAC receptacles.

- Start the engine and let it stabilize.

Read the (AC) frequency. A frequency reading of **61-63** Hertz should be obtained.

If frequency is not within specifications:

- Consult the appropriate engine service manual for adjustment.

With the generator engine running, connect the VOM test probes across the parallel blades of the panel 120VAC receptacles. A reading of approximately 130-140VAC should be indicated.

If voltage checks as specified:

- Discontinue test.

If voltage reading is zero:

- Go to Test 2: "Flash The Field."

If voltage reading is low:

- Go to Test 7: "Check The Rotor."

Test 2: — Flash The Field

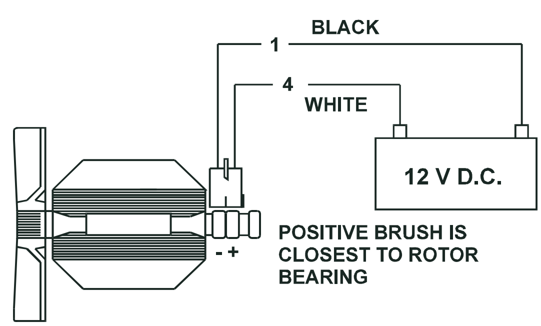
In normal generator operation, upon startup there is some "residual" magnetism in the rotor to get the generating process started. Residual magnetism is the magnetism left in the rotor after the unit is shut down. When residual magnetism is lost, the unit will have an output voltage that will remain at zero. If residual magnetism is lost, it can usually be restored by "flashing the field" with a simple process involving a (DC) battery. This usually occurs if the unit is out of use for a long period of time.

NOTE: Some units are equipped with "FIELD BOOST" and should never lose residual magnetism unless a field boost failure has occurred. Field boost current flashes the field on every startup (see "Field Boost" on page 45). Refer to the appropriate electric schematic and/or wiring diagram to determine if a unit has field boost.

If the unit is equipped with a voltage regulator or a bridge rectifier, flash the field as follows:

- Obtain a 12VDC battery.
- Get two jumper leads that can go from the battery to the brushes. (Wires with alligator clips work well.)
- Find the brushes inside the alternator portion of the unit.
- Start the engine and get it up to running speed.
- Connect the battery positive (+), to the positive brush, which will be the brush closest to the rotor bearing.
- Connect the battery negative (-), to the negative brush, which is the brush farthest away from the rotor bearing (Refer to Figure 3.32).

Figure 3.32 — Restoring Residual Magnetism



- After about five seconds, disconnect the battery wires from the brushes and check for proper (AC) output voltage.
- Shut the engine down. Restart the unit and check once again for proper (AC) output voltage.

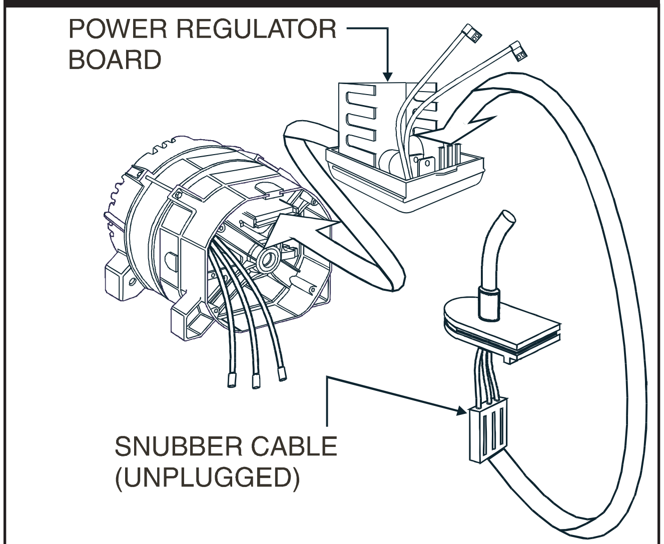
Test 3: — Isolate the System Control Board

Locate the power regulator circuit board inside the rear bearing carrier. This board is similar to the bridge rectifier on some other models.

- Disconnect the 3-prong white plastic plug.

This is called the snubber feedback cable (Figure 3.33).

Figure 3.33 — Disconnecting Snubber Cable



- Start the engine.

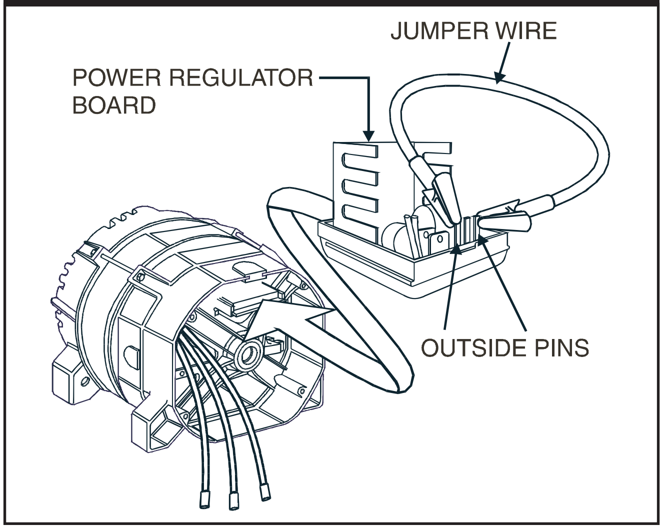
Measure the (AC) voltage at the VAC panel receptacle. Voltage should be between 130-150VAC.

If the voltage reading is less than 130VAC:
Go to "Step 5: Testing the Excitation Input."

If the voltage reading is between 130-150 VAC:

- Shut down the unit.
- Connect a jumper wire across the two outside pins of the Power Regulator Board (from where the snubber cable was disconnected (Figure 3.34).

Figure 3.34 — Installing Jumper Wire



- Start the engine.

Measure the voltage at the 120VAC panel receptacle. It should read less than 10VAC.

If the voltage is less than 10VAC:
The failure is in the System Control Board.

If the voltage is still between 130-150VAC:
Replace the Power Regulator Board.

Test 4: — Check And Adjust Governor

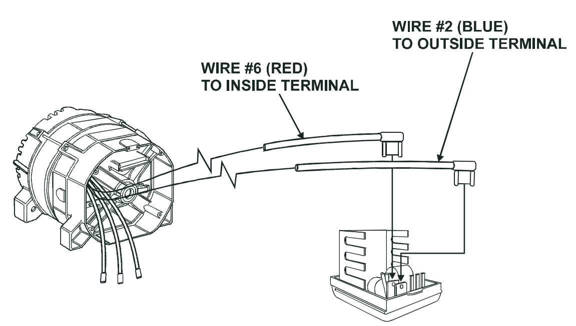
Refer to the appropriate engine manual.

Test 5: — Testing the Excitation Input

NOTE: The Excitation Winding is connected to the stator power winding inside of the stator assembly. Because of this, there is a phase relationship between the two windings and the excitation leads must be installed in the correct position on the Power Regulator Board.

If the leads are not in the correct position as noted in Figure 3.35:

Figure 3.35 — Power Regulator Board Connections



Install them correctly.

If leads are installed correctly:

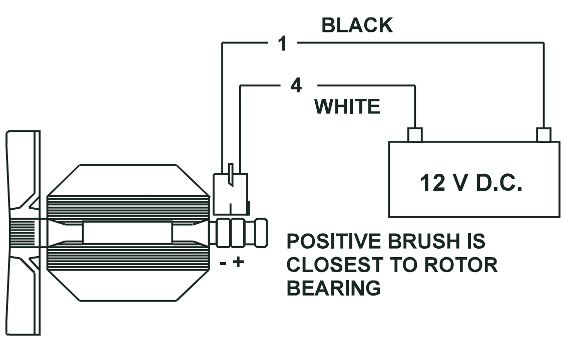
Go to "Step 6: Bypassing the Power Regulator Board".

Test 6: — Bypassing the Power Regulator Board

Remove the Power Regulator Board and keep it totally isolated from the generator.

- Connect 12VDC to the brush leads (Figure 3.36).

Figure 3.36 — Bypassing Power Regulator Board



- Connect the positive (+) 12 volt battery terminal to the positive (+) brush (nearest the rotor bearing).
- Connect the negative (-) 12 volt battery terminal to the negative (-) brush.
- Start the engine.

Measure the voltage at the excitation wire #2 and #6 (blue and red). At least 60VAC should be measured.

Measure the voltage at the 120VAC receptacle. At least 60VAC should be measured.

If voltage measured at the outlets and excitation leads is 60VAC or greater, and winding resistances are within specification:

- The rotor and stator windings are alright. Replace the power regulator board.

If voltage at both the excitation winding and (AC) outlets are low:

- There is a failure in the rotor and stator windings. Refer to "Checking Rotor Resistance", "Checking Stator Windings", and/or "Rotor Current Draw Test."

If the voltage is below 60VAC at the outlets, but above 60VAC at the excitation leads:

- Shut the unit down.
- Disconnect the stator power leads from the control panel (wires #11, #22, and #44 or blue, red, and grey wires).
- Start the engine.

Measure the (AC) output across wires #11 and #22, or the blue and red wires.

Measure the (AC) output across wires #44 and #22, or the grey and red wires.

If the voltage is above 60VAC at the stator power leads but not at the (AC) outlets:

- There is a failure in the control panel, (i.e. wiring, circuit breakers, etc.).

If voltage is below 60VAC at the stator power leads:

- The failure is in the stator power windings.

Test 7: — Check Rotor

Little or no (AC) output voltage can be caused by a rotor failure.

NOTE: The voltage surge that occurs at the moment of rotor failure can result in damage to the Power Regulation Board. For that reason, if a rotor has failed, be sure to check the power regulator board.

Before testing the rotor, inspect the brushes and slip rings. Replace brushes if they are worn excessively, or if they are cracked or damaged. Do not use any metallic grit to clean up slip rings.

To test the rotor with a volt-ohm-milliameter VOM, set the VOM to its "OHM" scale and zero the meter. Then, test for an open, shorted or grounded condition as follows:

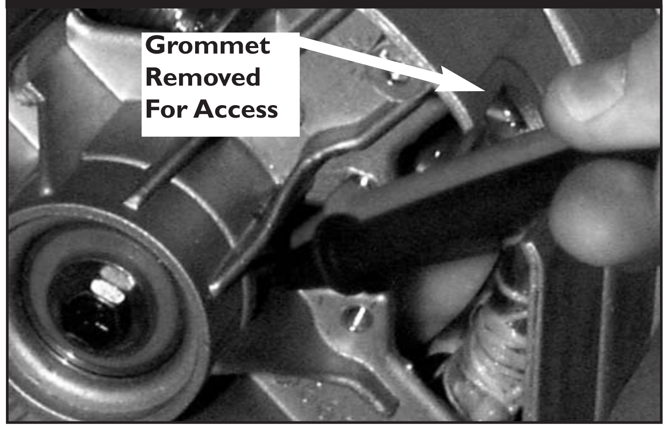
•• Step 1 Checking Rotor Resistance

- Remove the brush assembly.
- Set the VOM to its "OHM" scale.
- Connect the test leads to the rotor slip rings (See Figure 3.37).

Figure 3.37 — Checking Rotor Resistance

Because of the cramped quarters inside the rear bearing carrier, it is necessary to remove the power cable grommet as shown in Figure 3.38.

Figure 3.38 — Access To Rotor Slip Rings



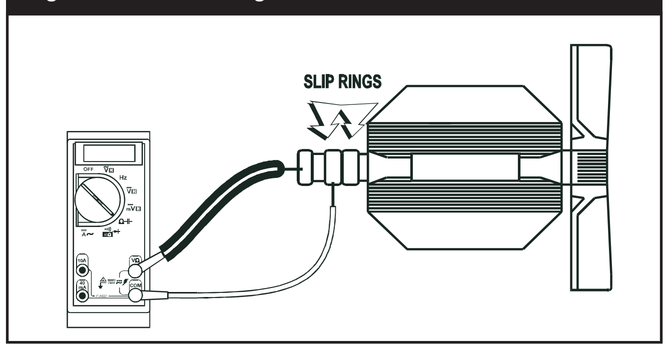
Measure the rotor resistance and compare it to the nominal resistance from the appropriate resistance table (Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later).

A reading of "infinity" or a very high resistance indicates an open circuit or a partially open condition in the rotor windings. → **Replace Rotor**

A very low resistance indicates a shorted rotor. → **Replace Rotor**

- Connect one test lead to the rotor shaft and the other test lead to either rotor slip ring (Figure 3.39).

Figure 3.39 — Checking Rotor Short To Ground



A reading of "infinity" should be measured. A reading other than infinity indicates a rotor winding shorted to the rotor shaft. → **Replace Rotor**

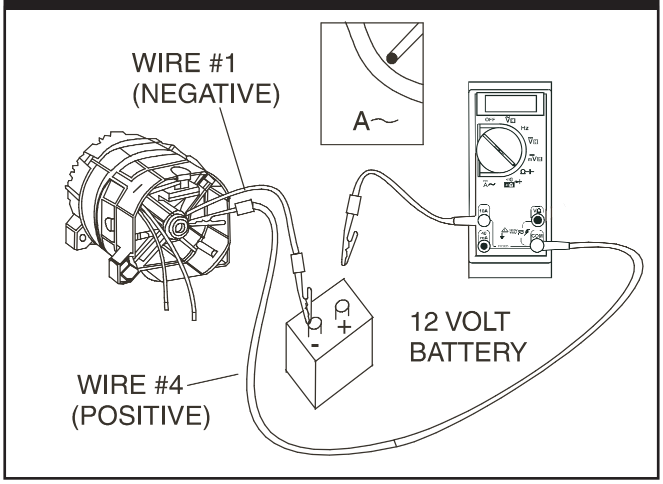
NOTE: Sometimes a rotor may only fail while it is spinning at rated RPM. This condition is called a "Flying Open" or "Flying Short."

To diagnose, use the "Rotor Current Draw Test."

•• **Step 2 Rotor Current Draw Test**

- Locate the brush wires. (Normally these wires are #4 and #1.) Isolate the brushes from the bridge rectifier or voltage regulator.
- Connect a (DC) Amp Meter between the positive brush wire #4, and the positive post on a 12VDC battery.
- Connect a jumper wire between the negative brush and the negative post on the battery (See Figure 3.40).

Figure 3.40 — Rotor Current Draw Test



- Start the engine and monitor amp draw.

It should not change while the unit is running or static. The (DC) Amp draw will be determined by the specified resistance of the rotor being tested.

To find the desired amp draw, use Ohms Law:

Voltage divided by amperage equals resistance.

For example: 12VDC divided by a rotor resistance of 24 ohms equals an amp draw of 0.5 amp.

NOTE: Amp draw may vary slightly due to exact battery voltage, rotor resistance, and meter calibration etc. <u>Look for extreme differences.</u>

Analyze the test results as follows:

If the rotor current draw is <u>higher</u> than specified, a flying short exists in the rotor. → **Replace Rotor**

If current draw is <u>lower</u> than specified, a flying open exists in the rotor. → **Replace Rotor**

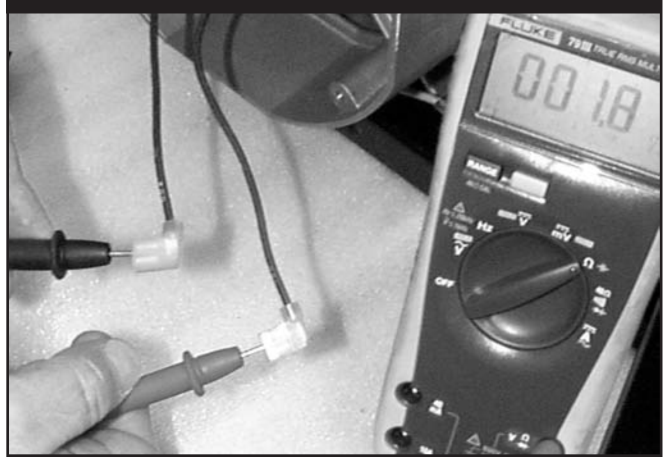
If current draw is <u>within</u> specifications, rotor is OK.

Test 8: — <u>Check Stator Excitation (DPE) Windings</u>

NOTE: The excitation wires may be colored or numbered. The numbered wires are #2 and #6. The colored wires are blue and red. Be sure not to confuse the colored excitation wires with the colored power wires. The excitation wires are the wires connected to the power regulator board.

- Set the VOM to its "OHM" scale.
- Connect the test leads to the stator excitation wires (Figure 3.41).

Figure 3.41 — Checking DPE Resistance



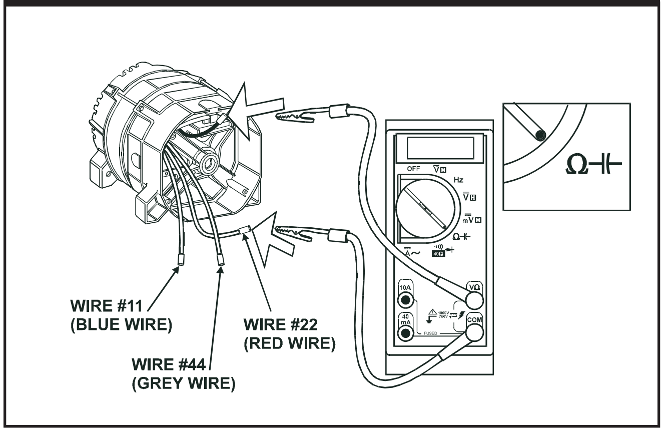
Measure the resistance and compare it to the nominal resistance from the appropriate table (Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later).

A reading of infinity or high resistance indicates an opening in the excitation winding. → **Replace Stator**

A low reading indicates a shorted stator winding.

- Connect one test lead to a stator power wire. Connect the other test lead to one of the stator excitation wires (Figure 3.42).

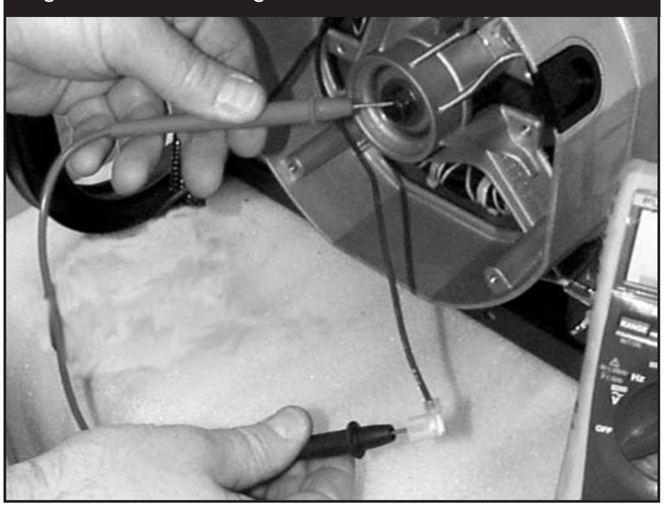
Figure 3.42 — Testing For Continuity Between Windings



NOTE: On units that have two board regulation, the stator power and excitation windings are connected internally. On these units, a reading of continuity would be a normal condition. (See schematic on page 22, figure 2.6).

- Connect one test lead to an excitation wire. Connect the other test lead to a good metal ground (Figure 3.43).

Figure 3.43 — Checking DPE "Short To Ground"



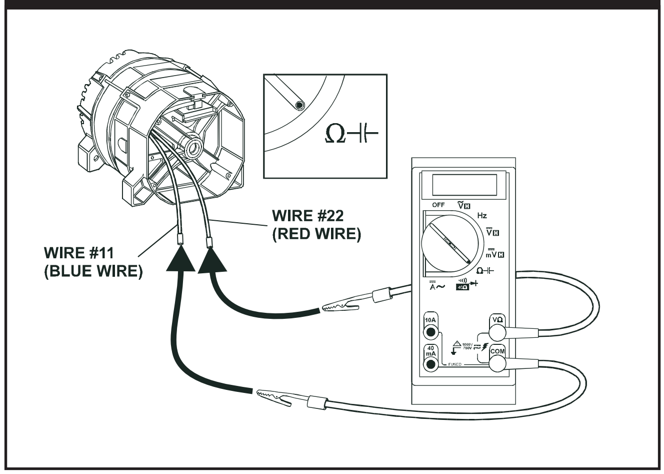
A reading of "infinity" should be measured. A reading other than infinity indicates a winding shorted to ground. → **Replace Stator**

Test 9: — Testing Stator AC Power Windings

Testing Single Voltage Type Power Winding

- Set a VOM to its "OHM" scale.
- Connect the meter test leads across the (AC) power wires. (Wire #11 and wire #22 or blue and red wires (Figure 3.44).

Figure 3.44 — Checking Power Winding Resistance



Measure the resistance and compare it to the nominal resistance from the appropriate table

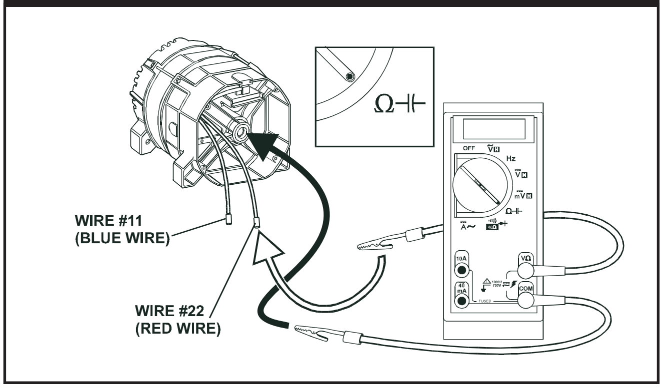
(Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later).

A reading of infinity or high resistance indicates an opening in the stator winding. → **Replace Stator**

A low reading indicates a shorted stator winding. → **Replace Stator**

- Connect one meter test lead to a good ground. Connect the other test lead to the stator power winding (Figure 3.45).

Figure 3.45 — Testing For Short To Ground



A reading of infinity should be measured. A reading of other than infinity indicates a stator winding shorted to ground. → **Replace Stator**

Testing Dual Voltage Type Power Windings

- Set a VOM to the "OHM" scale.
- Connect the test leads to the stator wires #11 and #22.

Measure the resistance and compare it to the nominal resistance from the appropriate table (Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later).

- Connect the test leads to the stator wires #22, and #44.

Measure the resistance and compare it to the nominal resistance from the appropriate table. Analyze the results the same as in "Testing Single Voltage Type Power Winding".

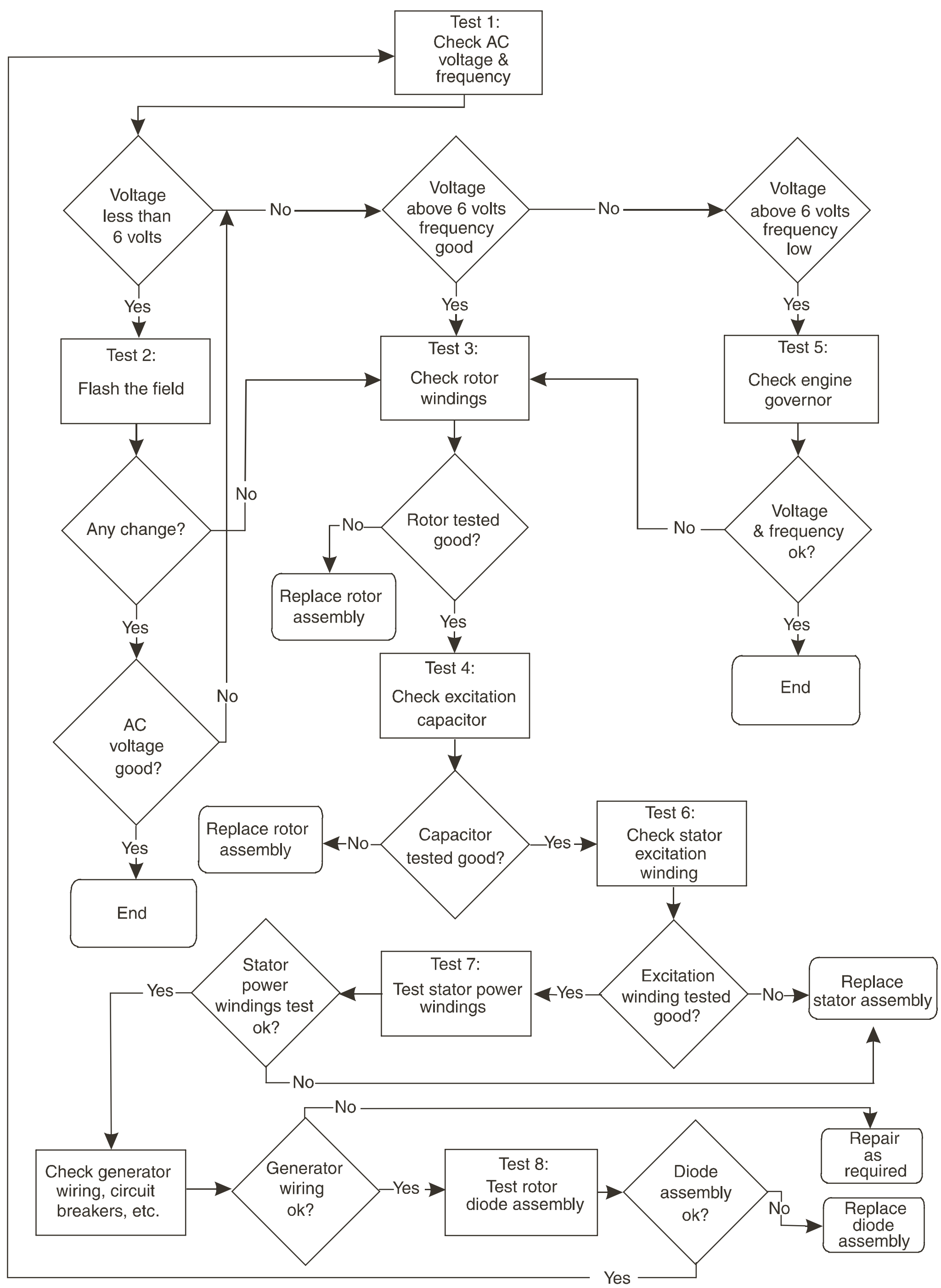
- Connect one meter test lead to a good ground. Connect the other test lead to the stator power winding. (Refer back to Figure 3.45).

A reading of infinity should be measured. A reading of other than infinity indicates a stator winding shorted to ground.

→ **Replace Stator**

NOTES

Figure 3.46 — Troubleshooting Flow Chart For "Sincro® Wound" (Brushless Type) Generators



Troubleshooting Sincro® Wound Generators (Brushless Type)

Refer to Figure 3.46

Test 1: — Check (AC) Frequency and Voltage

Connect an accurate (AC) frequency meter across the two parallel blades of one of the panel 120VAC receptacles.

- Start the engine and let it stabilize.

Read the (AC) frequency. A frequency reading of **61-63** Hertz should be obtained.

If frequency is not within specifications:

- Consult the appropriate engine service manual for adjustment.

With the generator engine running, connect the VOM test probes across the parallel blades of the panel 120VAC receptacles. A reading of approximately 130-140VAC should be indicated.

If voltage checks as specified:

- Discontinue test.

If voltage reading is zero:

- Go to Test 2: "Flash The Field."

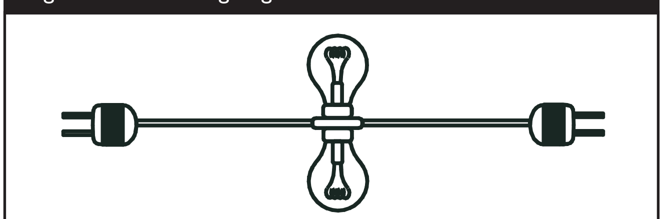
If voltage reading is low:

- Go to Test 3: "Check The Rotor."

Test 2: — Flash The Field

To restore magnetism in a generator having a capacitor excitation system, an energizing cord may be made locally (Figure 3.47).

Figure 3.47 — Energizing Cord

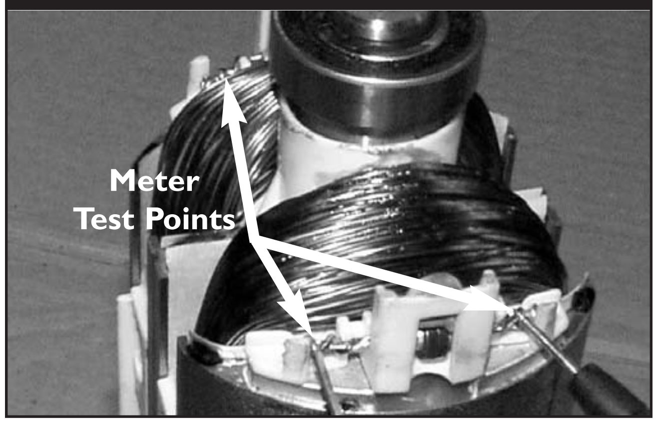


- Make sure the generator is completely assembled.
- Plug one end of the energizing cord into one of the panel 120VAC receptacles.
- Start the generator engine.
- Plug the opposite end of the energizing cord into a 120VAC wall receptacle.
- Run the engine for 10 seconds, then shut the engine **OFF**.
- Unplug the energizing cord from the generator receptacle and from the wall receptacle.
- Restart the generator engine and check (AC) voltage.

Test 3: — Check Rotor Resistance

- Set your VOM to its "OHM" scale.
- Check both coils of the rotor individually (Figure 3.48).

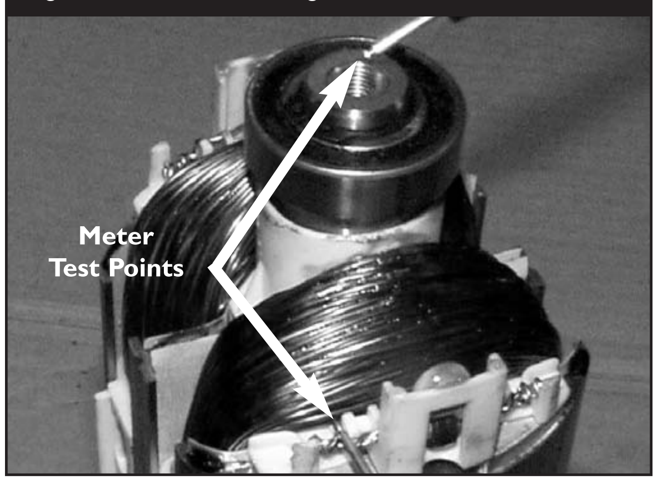
Figure 3.48 — Rotor Winding Resistance



- Compare readings with those found in the Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later.

Check the rotor for a "short to ground" as shown in Figure 3.49.

Figure 3.49 — Rotor Winding Resistance

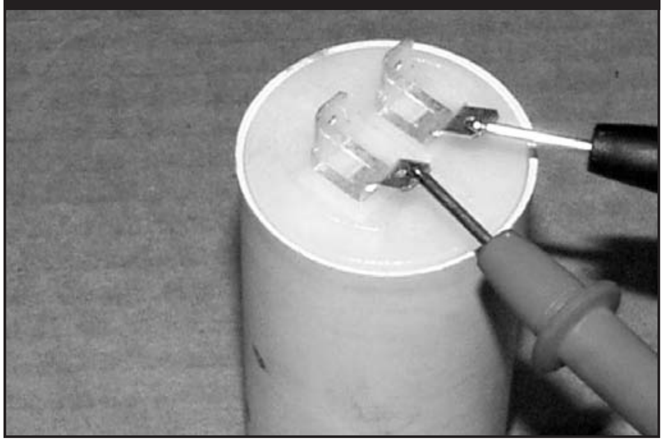


Test 4: — Testing Capacitor

NOTE: Consult the owners manual of the meter you are using for capacitor test procedures.

Test capacitor as shown in Figure 3.50 and compare with specifications found on capacitor.

Figure 3.50 — Checking The Capacitor



Test 5: — Check And Adjust Governor

Refer to the appropriate engine manual.

Test 6: — Check Stator Excitation (DPE) Windings

NOTE: The excitation wires may be colored or numbered. The numbered wires are #2 and #6. The colored wires are blue and red. Be sure not to confuse the colored excitation wires with the colored power wires. The excitation wires are the wires connected to the bridge rectifier or voltage regulator.

- Set the VOM to its "OHM" scale.
- Connect the test leads to the stator excitation wires (Figure 3.51).

Figure 3.51 — Checking Excitation Resistance

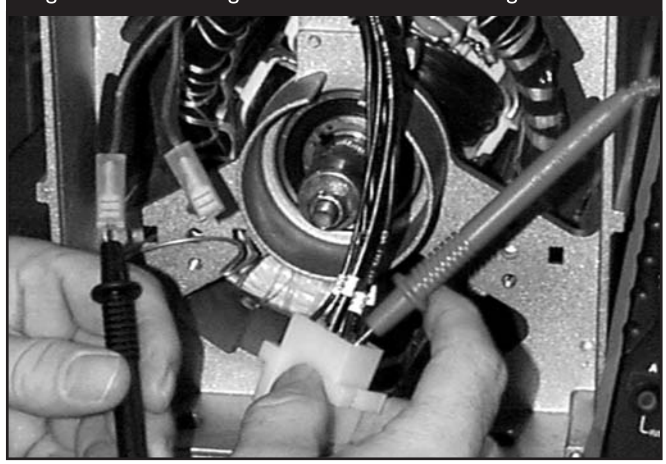
Measure the resistance and compare it to the nominal resistance from the appropriate table (Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later).

A reading of infinity or high resistance indicates an opening in the excitation winding. → **Replace Stator**

A low reading indicates a shorted stator winding.

- Connect one test lead to a stator power wire. Connect the other test lead to one of the stator excitation wires (Figure 3.52).

Figure 3.52 — Testing For Short Between Windings



A reading of infinity should be measured. A reading other than infinity indicates a power winding shorted to an excitation winding. → **Replace Stator**

- Connect one test lead to an excitation wire. Connect the other test lead to a good metal ground (Figure 3.53).

Figure 3.53 — Checking DPE "Short To Ground"

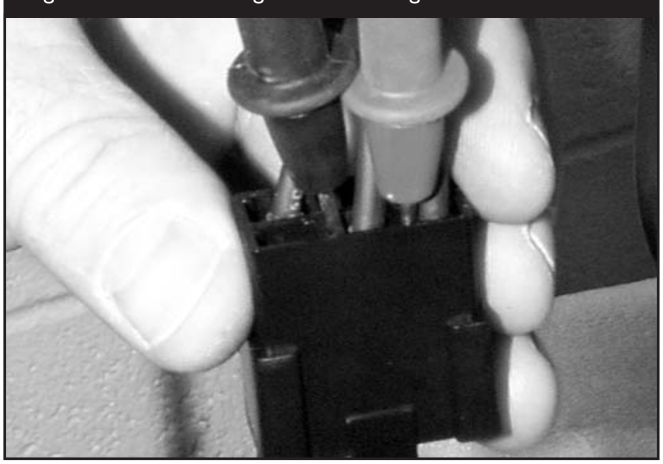
A reading of "infinity" should be measured. A reading other than infinity indicates a winding shorted to ground → **Replace Stator**

Test 7: — Testing Stator AC Power Windings

Testing Single Voltage Type Power Winding

- Set a VOM to its "OHM" scale.
- Connect the meter test leads across the (AC) power wires. (Wire #11 and wire #22 or blue and red wires (Figure 3.54).

Figure 3.54 — Checking Power Winding Resistance



Measure the resistance and compare it to the nominal resistance from the appropriate table

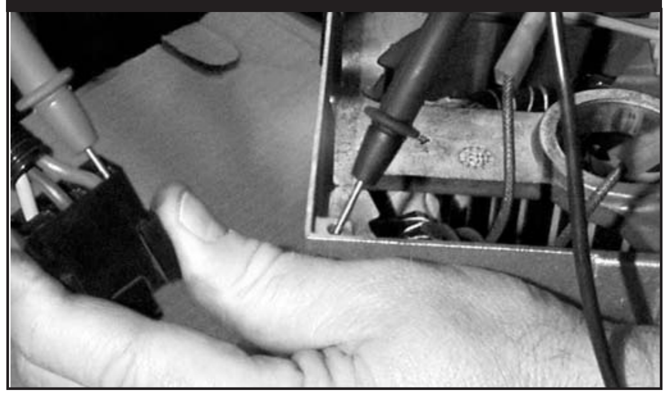
(Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later).

A reading of infinity or high resistance indicates an opening in the stator winding. → **Replace Stator**

A low reading indicates a shorted stator winding. → **Replace Stator**

- Connect one meter test lead to a good ground. Connect the other test lead to the stator power winding. (Figure 3.55).

Figure 3.55 — Testing For Short To Ground



A reading of infinity should be measured. A reading of other than infinity indicates a stator winding shorted to ground. → **Replace Stator**

Testing Dual Voltage Type Power Windings

- Set a VOM to the "OHM" scale.
- Connect the test leads to the stator wires #11 and #22.

Measure the resistance and compare it to the nominal resistance from the appropriate table.

- Connect the test leads to the stator wires #22 and #44.

Measure the resistance and compare it to the nominal resistance from the appropriate table. Analyze the results the same as in "Testing Single Voltage Type Power Winding".

- Connect one meter test lead to a good ground. Connect the other test lead to the stator power winding. (Refer back to Figure 3.55).

A reading of infinity should be measured. A reading of other than infinity indicates a stator winding shorted to ground . ⟶ **Replace Stator**

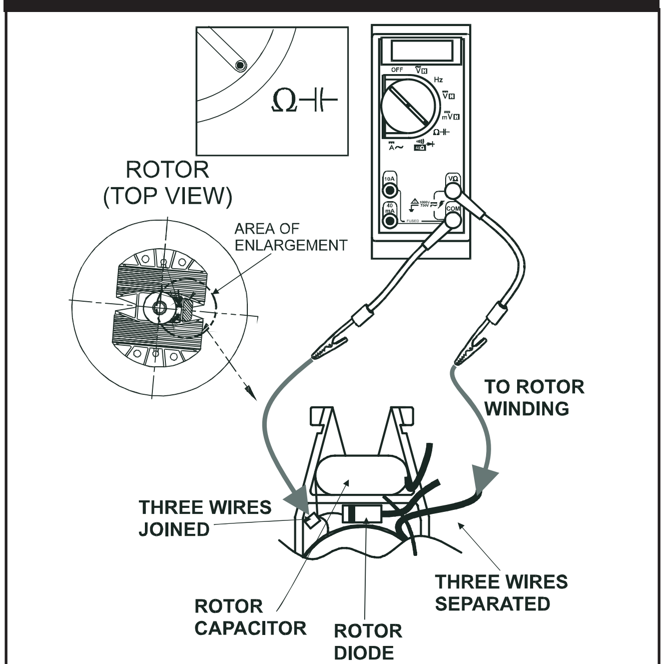
Test 8: — Test Rotor Diode Assembly

A rotor diode is crimped in series with the rotor windings. The capacitor protects the diode against high voltage spikes. The rotor windings, diode, and capacitor may be tested as follows:

•• Step 1: Testing Rotor Windings

- Locate the connections that retain the diode and capacitor to the rotor windings (Figure 3.56).
- Remove one end of the connection to electrically isolate the rotor winding, diode, and rotor capacitor from each other.

Figure 3.56 — Testing Rotor Windings



- Set a VOM meter to the ohm scale
- Connect the VOM test probes across the rotor winding previously disconnected from the rotor diode and capacitor.

(Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables Pub. #87971 Rev 6 or later)

•• Step 2: Testing Rotor Capacitor

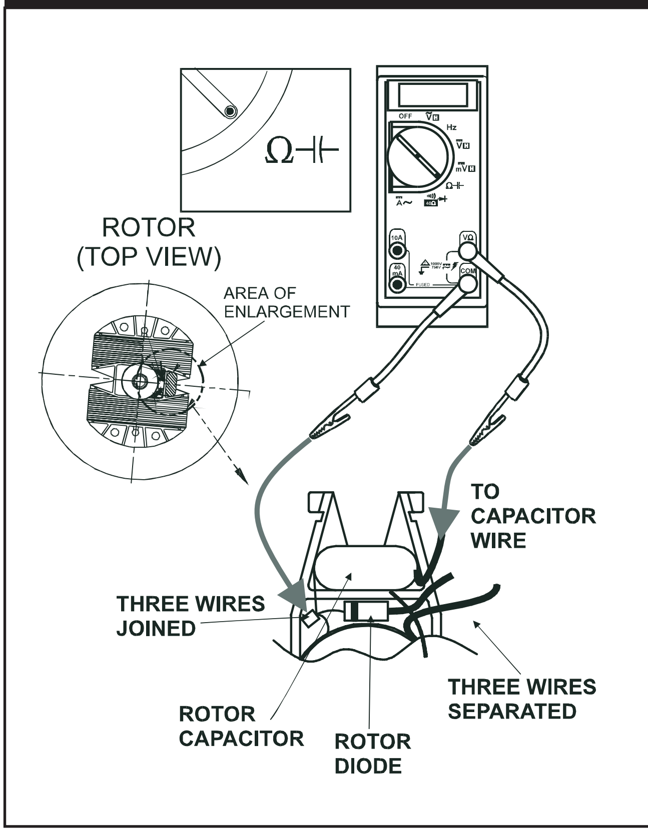
NOTE: Consult the owners manual of the meter you are using for capacitor test procedures. Check the capcitance that is found on the capacitor.

Refer to Figure 3.57:

If any tests are not within specifications:

- Replace the rotor as an assembly.

Figure 3.57 — Testing Rotor Capacitor

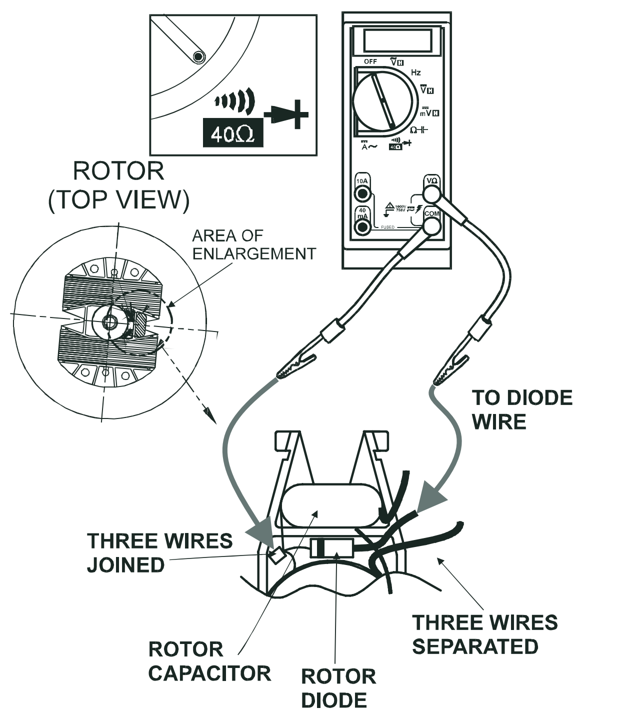


•• Step 3: Testing Rotor Diode

NOTE: Consult the owners manual of the meter you are using for diode test procedures.

Refer to Figure 3.58.

Figure 3.58 — Testing Rotor Diode



NOTE: If Diode, varistor or capacitor fails, and the winding is ok, replace the diode assembly.
If the rotor tests are OK:
Re-solder the three leads that were removed from the crimp and proceed to Test 5: "Check & Adjust Engine Governor."

NOTES

VOLTAGE REGULATOR ADJUSTMENTS

To adjust the regulator, proceed as follows:

Connect an (AC) voltmeter and frequency meter to panel electrical receptacles or to the stator (AC) power winding leads.

- Start the engine and let it stabilize and warm up at "no-load."

The "no-load" frequency should be approximately:
62 Hertz (60 Hertz units); or **51** Hertz (50 Hertz units).

If necessary:

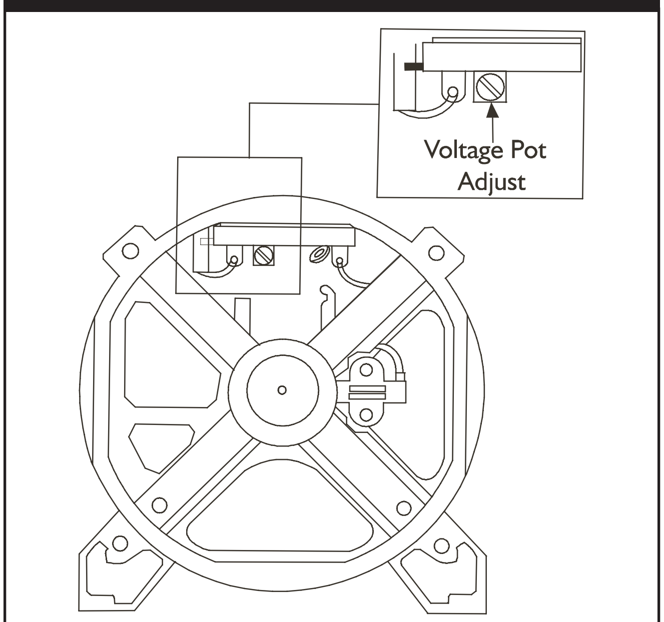
- Adjust the engine carburetor and/or governor to obtain the correct frequency at "no-load."

Units rated 120/240VAC:

With engine running at its correct "no-load" speed:

- Slowly turn the voltage adjust pot (Figure 3.59) until "no-load" voltage is:
  124VAC (line-to-neutral) or
  248VAC (line-to-line).

Figure 3.59 — Voltage Regulator

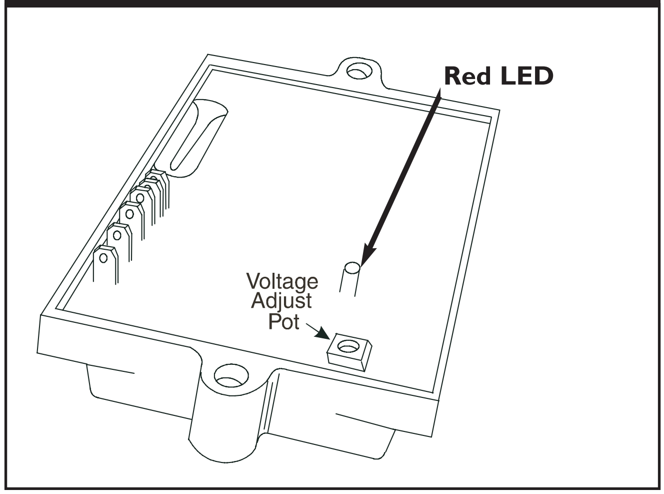


Units rated at 110/220 VAC:

With engine running at its correct "no-load" speed:

- Slowly turn the voltage adjust pot (Figure 3.60) until "no-load" voltage is:
  115VAC (line-to-neutral) or
  230VAC (line-to-line).

Figure 3.60 — Voltage Regulator



Voltage regulators with Gain Adjustment

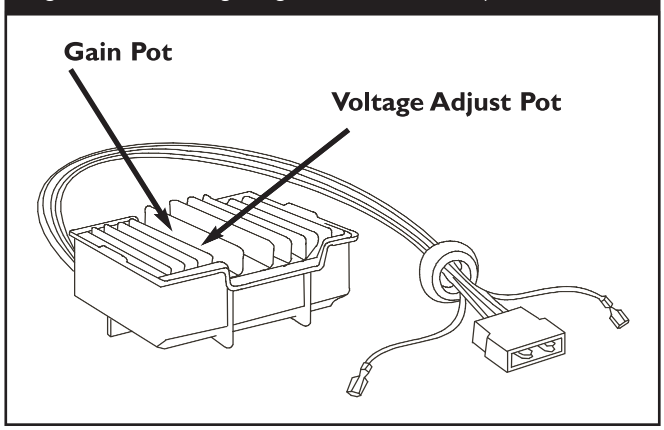
If the regulator is equipped with a gain adjust pot, repeat the previous procedure and do the following:

- Connect a 60 watt light bulb to the generator.

If the light bulb flickers:

- Adjust the "GAIN" potentiometer (Figure 3.61) until the flicker is eliminated.

Figure 3.61 — Voltage Regulator With Gain Adjust



Units with power regulator and system control boards

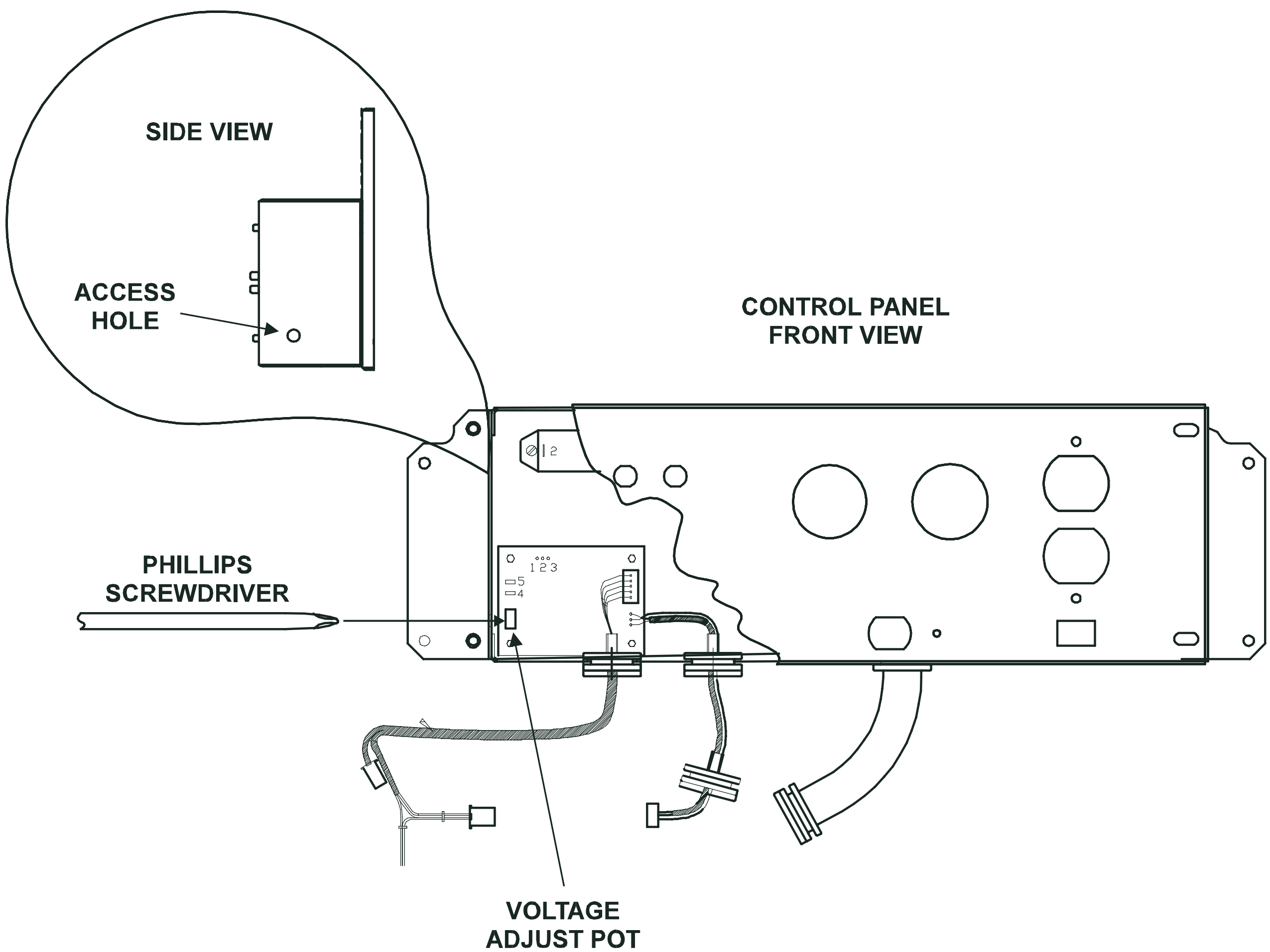
Some generators, such as the "XL" series, are equipped with a power regulator and a system control circuit board. These two components "share" the voltage regulation process.

(See "UNITS WITH POWER REGULATOR & SYSTEM CONTROL CIRCUIT BOARD" on page 39).

Although the voltage regulation process is "shared" by two circuit boards, the process is the same as when a one piece regulator is used.

The voltage adjust pot is located on the system control circuit board (Figure 3.62).

Figure 3.62 — Location Of The System Control Circuit & Access to The Voltage Control Pot



NOTES

DISASSEMBLY PROCEDURES

General Recommendations

For the most part, portable generators are heavy and awkward to work on. It is for that reason that basic safety considerations must be incorporated into all handling and servicing procedures.

Work Area

Good lighting and an elevated work table will help you gain access to much of the mounting hardware and accessories found on most portable generator units. Certainly, larger is better but a good minimum size table top would be 20in. X 30in. If casters are applied to the legs of a work table, be sure they are secure and sturdy enough to support not only the generator but also allow for the work being done.

CAUTION: Never attempt to lift a generator unit without help. Always ask for assistance and use proper lifting techniques and equipment when moving, lifting or servicing any generator.

Recommended Hand Tools

A minimum collection of standard mechanic's hand tools should include:

3/8" drive socket set (SAE)

3/8" drive socket set (Metric)

A 3/8" drive ratchet

Short, medium and long 3/8" drive extensions

A large (heavy) "soft" mallet

A collection of wooden blocks

A common screwdriver (medium length)

A phillips screwdriver (medium length)

A phillips screwdriver (short- "stubby")

A large (heavy duty) screwdriver suitable for mild prying

Medium external snap ring pliers

Available Service Kits:

Rotor Removal Kit Part # 41079

Electronic Measuring Equipment

The measuring equipment used in troubleshooting should be of industrial quality and have the sensitivity to measure electronic values to the third decimal. Its accuracy should be within acceptable tolerances.

Procedure Overview

What follows is a general procedure for the disassembly and reassembly of units using the standard **Generac®** wound generators, as well as units using the Sincro® wound generators.

The **Generac®** wound units may be categorized as those using brush and slip ring assemblies. The Sincro® wound units fall into the "brushless" category.

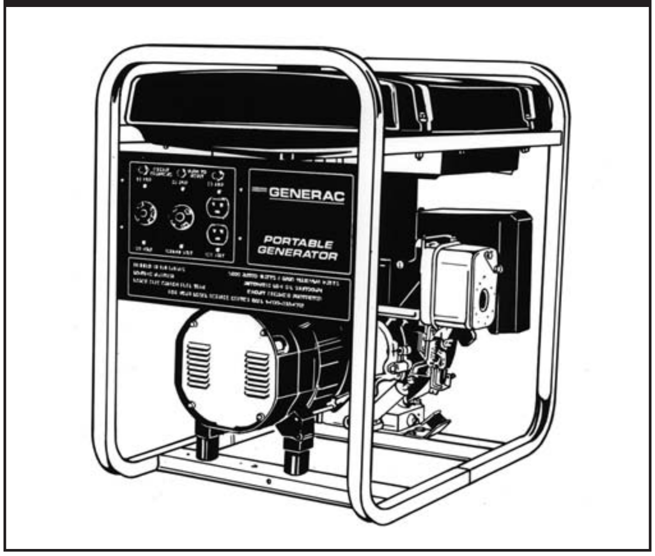
This section includes the steps necessary to gain access to constituent parts such as the capacitor, stator connections, and main rotor components for both types of generator units. Although complete unit disassembly is shown, the individual electrical tests which can be performed at specific stages, are mentioned in order to help expedite the troubleshooting process.

The specific models used in this discussion share general similarities that apply to most other **Generac®** generators. Some variations will be noted from model to model.

These procedures assume that you have a suitable work area as well as the necessary tools described earlier in this section.

GENERAC® WOUND GENERATORS

Figure 4.1 — **Generac**® Wound Generator



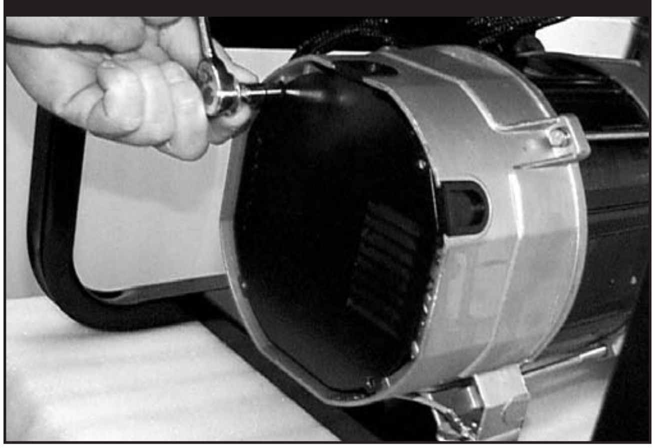
Disassembly

DANGER: Before servicing any **Generac®** equipment, always remove the spark plug lead. Unintentional ignition can cause severe personal injury.

Removing The Generator Access Cover

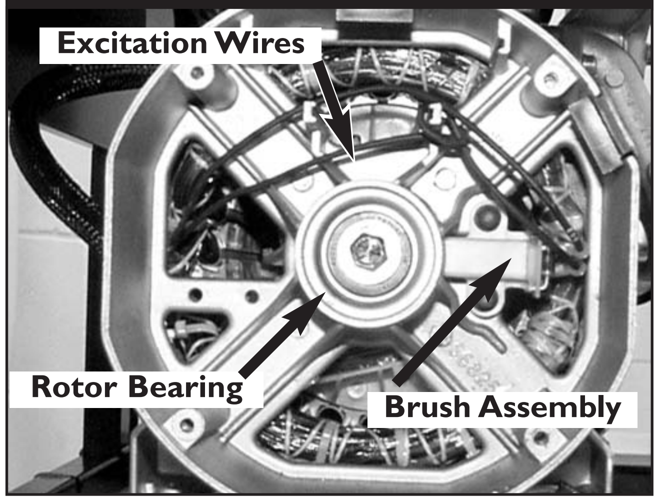
- Remove the four retaining screws that secure the access cover to the rear bearing carrier Figure 4.2.

Figure 4.2 — Remove Access Cover



This exposes the components described in Figure 4.3.

Figure 4.3 — Rear Bearing Carrier Exposed



They include:

- The Brush Assembly and its mounting hardware.
- The Brush wires and terminals.
- The Rotor Bearing.

A visual inspection of this area can reveal both mechanical problems as well as problems with wiring connections.

Before continuing with the disassembly process, visually inspect for the following:

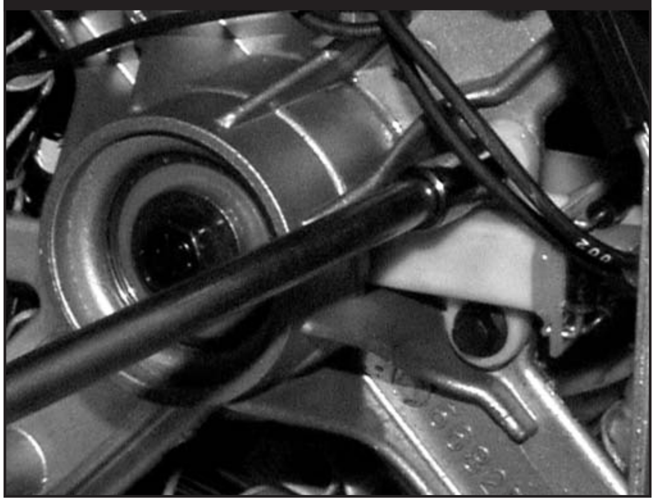
- Evidence of bearing failure. (Very fine metallic "dust" that generally accumulates around the bearing carrier assembly.)
- Loose or broken connector at all wire ends and insertion points into plug assemblies.
- Vibration damage (chafing) to any components due to rubbing or other contact friction.
- Burned varnish or lacing on stator winding.

Removing Brush Assembly

It is best to leave the DPE wires connected to the brush assembly during removal.

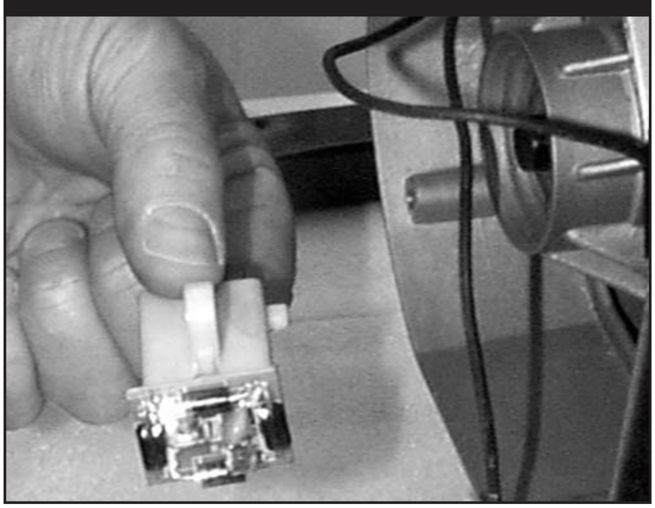
- Remove the two screws that hold the brush assembly to the rear bearing carrier (Figure 4.4).

Figure 4.4 — Removing Brush Assembly



- Carefully work the brush assembly out of its mounting in the rear bearing carrier.
- Disconnect the DPE wires and set brush holder aside (Figure 4.5).

Figure 4.5 — Brush Assembly



Disconnecting Power Wires

- Disengage the locks that secure the connector housing to the plug on the back of the control panel (Figure 4.6).

Figure 4.6 — Power Cable Connector

- Remove the connector housing from the plug.

Electrical Measurements

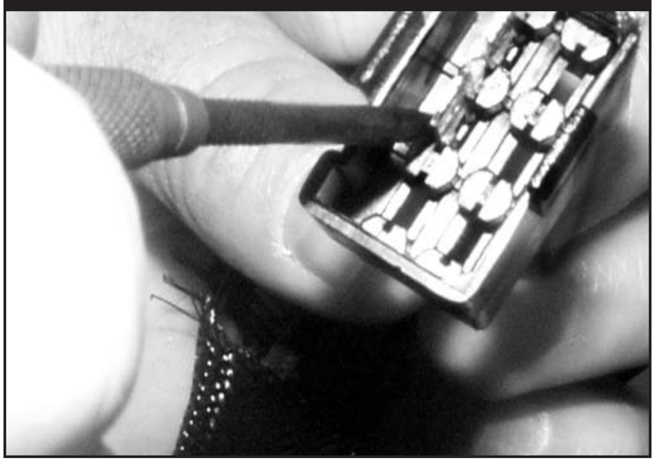
NOTE: Many of the electrical measurements that are necessary to accurately troubleshoot the **Generac®** wound generator are accessible at this point. In order to help avoid needless disassembly, please refer to the "Diagnostics and Adjustments" section of this guide for specific details. The values for individual tests can be found in the Briggs & Stratton Power Products® "Portable Generator Rotor/Stator Resistance Tables," Publication #87971 Rev 6 or later.

Remove Wire Terminals From Connector Housing

There may be occasions where it is necessary to remove the wire terminals from the connector housing. This would be the case if stator replacement was required. Remove the wire terminals from the connector housing as follows:

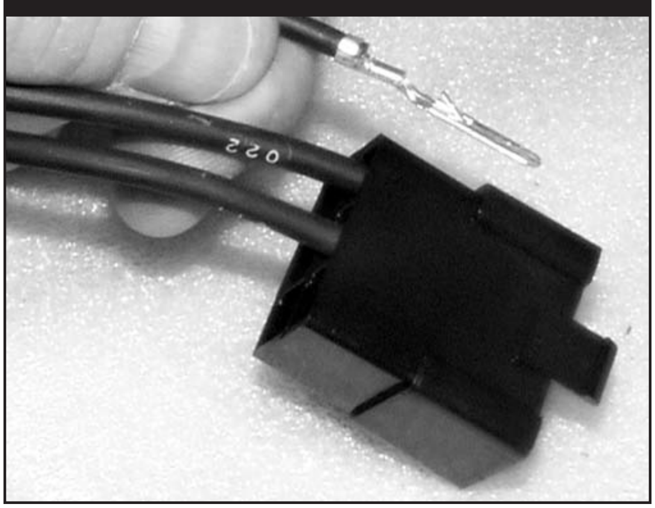
- With a small screwdriver or a sharp pick, bend the locking tabs on the wire terminals back so they can slide back through the connector housing (Figure 4.7).

Figure 4.7 — Locking Tabs On Connector Housing



When done correctly, the wire terminal will slide out of the connector housing as shown in Figure 4.8.

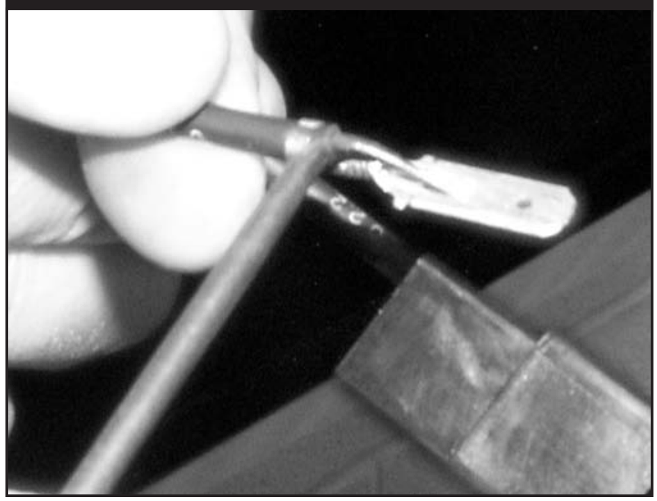
Figure 4.8 — Terminal Out Of Connector Housing



- Repeat this process until all the terminals are removed from the connector housing.

- When all of the terminals are free of the housing, bend each of the locking tabs back to their original position as shown in Figure 4.9.

Figure 4.9 — Terminal Locking Tabs



Vibration Mounts

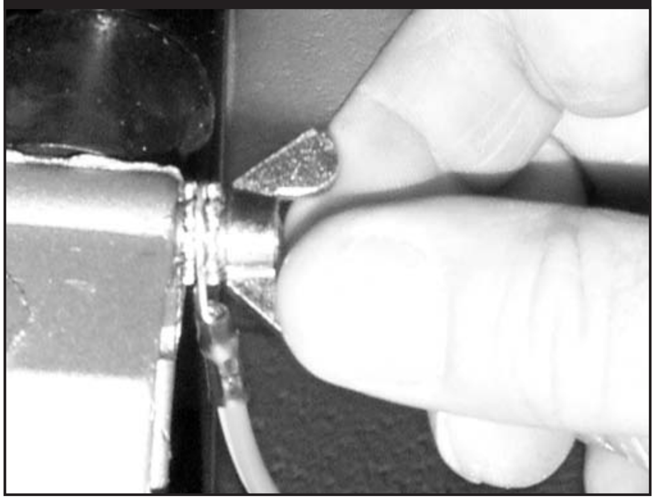
- Remove the nuts holding the vibration mounts to the underside of the cradle frame as shown in Figure 4.10.

Figure 4.10 — Vibration Mount Hardware

Grounding Wire

- Remove wing nut that secures the grounding wire to the cradle and save both of the locking star washers as shown in Figure 4.11.

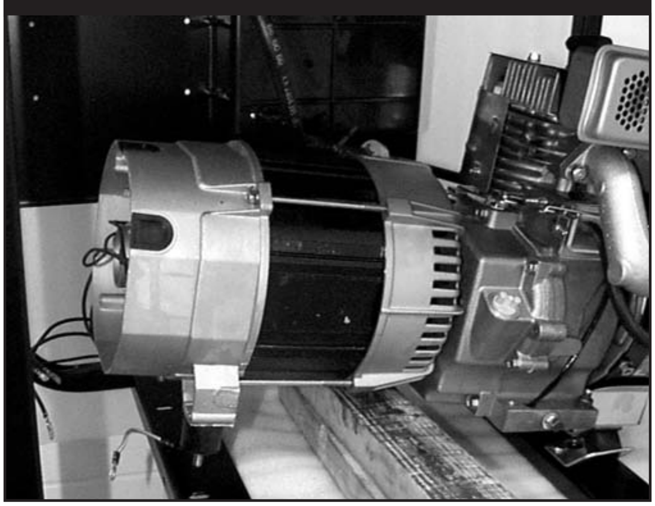
Figure 4.11 — Grounding Wire Hardware



Supporting The Generator

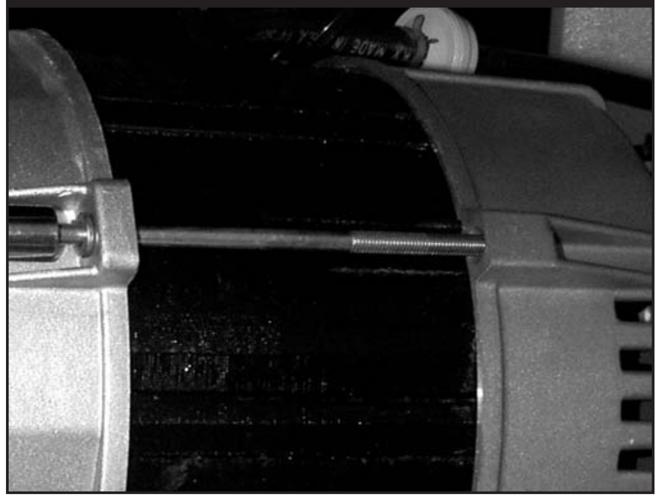
- Lift the generator assembly and support with wooden blocks as shown in Figure 4.12.

Figure 4.12 — Supporting The Generator



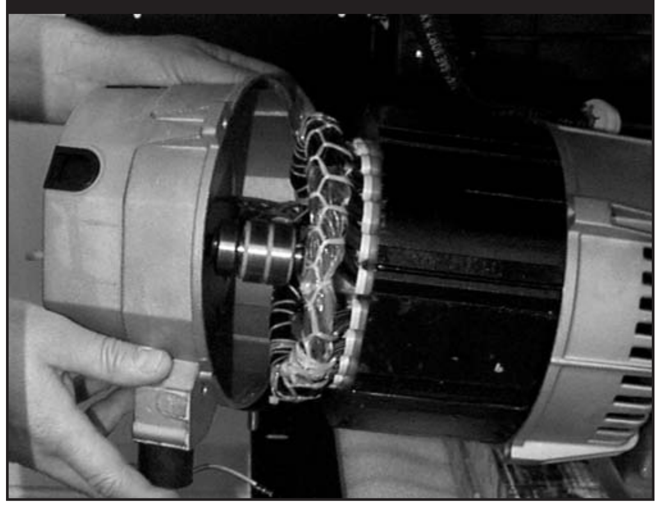
- With the generator secure on the blocks, remove the four stator bolts that hold the rear bearing carrier and stator to the engine adapter (Figure 4.13).

Figure 4.13 — Stator Bolts



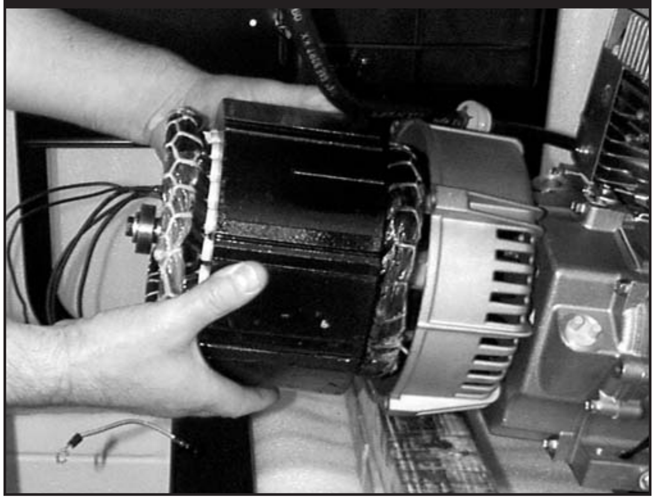
- With the stator bolts removed, grip the rear bearing carrier and work it free from the rotor bearing as well as its mounting on the stator (Figure 4.14).

Figure 4.14 — Removing Rear Bearing Carrier



- Grip the stator and work it free from the engine adapter (Figure 4.15).

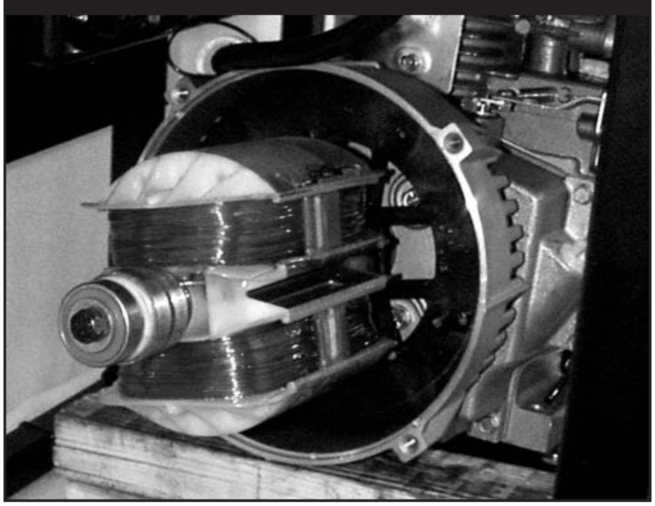
Figure 4.15 — Removing The Stator



- When the stator comes free of the adapter, carefully remove it off the rotor and set it aside.

At this point the rotor is exposed (Figure 4.16).

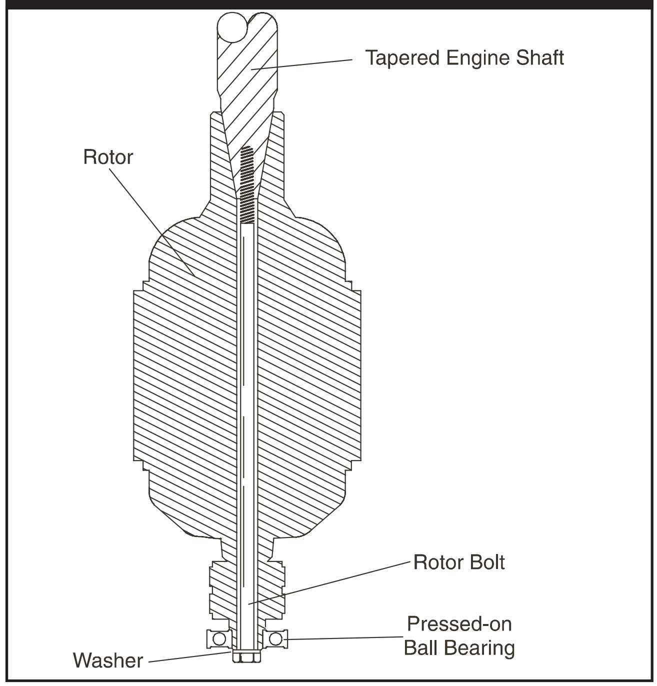
Figure 4.16 — Exposed Rotor



Removing The Rotor

The rotor is secured to a tapered shaft by means of a long through-bolt (Figure 4.17).

Figure 4.17 — Rotor Assembly... Cross Section



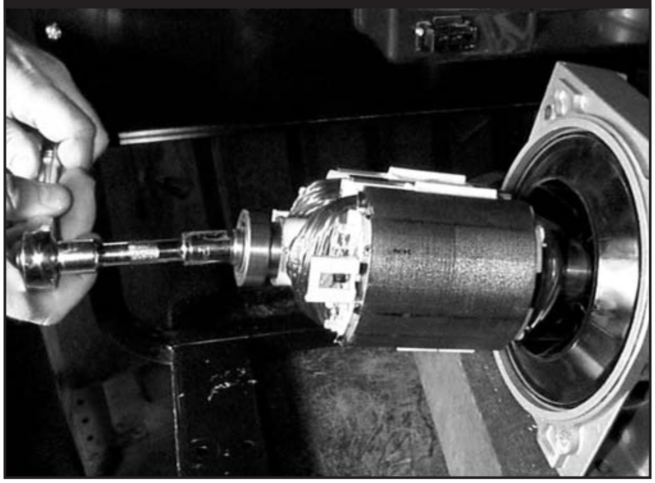
There is no key or keyway driving the rotor.

Very often, removing the through-bolt leaves the rotor attached to the tapered shaft. This is due to heat of operation and the compression of the rotor bolt when it is properly torqued. The following instructions assume that you have at your disposal the Rotor Removal Kit (#41079) mentioned at the beginning of this section.

Using the "Rotor Removal Kit," proceed as follows:

- Remove the rotor bolt and its washer (Figure 4.18).

Figure 4.18 — Remove Rotor Bolt



If the internal diameter of the rotor shaft is not threaded, select a tap from the kit as follows:

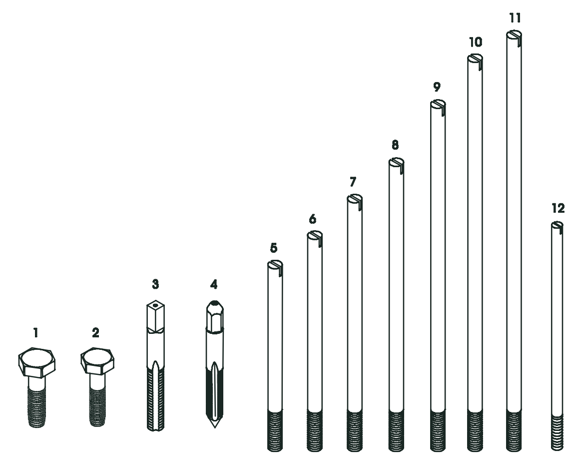
If the rotor bolt diameter is1/4 inch:

- Use the 3/8"-24 tap (Figure 4.19, Item 4) to cut internal threads at the bearing end of the rotor shaft.

If the rotor shaft is 5/16 inch:

- Use the7/16"-20 tap (Figure 4.19, Item 3) to cut threads at the end of the rotor shaft.

Figure 4.19 — Kit 41079 Components



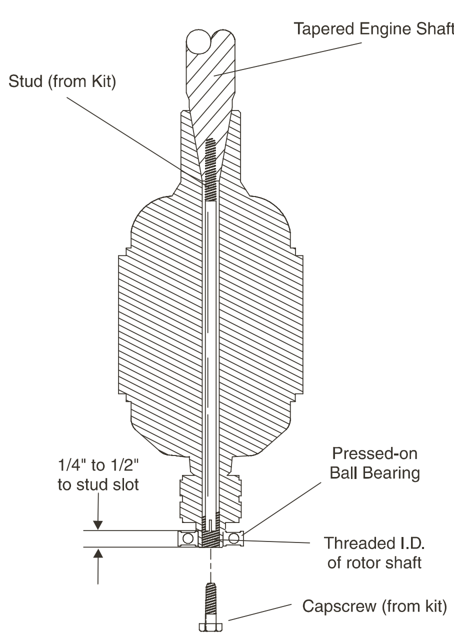
Item	Part #	Qty	Description
1	63184	1	Capscrew, hex head 7/16"-20x1-1/2"
2	49472	1	Capscrew, hex head 3/8"-24x1-1/2"
3	63183	1	Tap, 7/16"-20
4	63182	1	Tap, 3/8"-24
5	63181	1	Stud, 5/16"-24x4-7/8" long
6	63181-F	1	Stud, 5/16"-24x5-1/4" long
7	63181-A	1	Stud, 5/16"-24x5-7/8" long
8	63181-B	1	Stud, 5/16"-24x6-7/8" long
9	63181-E	1	Stud, 5/16"-24x8-7/8" long
10	63181-C	1	Stud, 5/16"-24x10-1/4" long
11	63181-D	1	Stud, 5/16"-24x11" long
12	63181-G	1	Stud, 1/4"-20x5-3/8" long

- Carefully cut threads into the bearing end of the rotor shaft (Figure 4.20).

Figure 4.20 — Cutting Threads In The Rotor Shaft

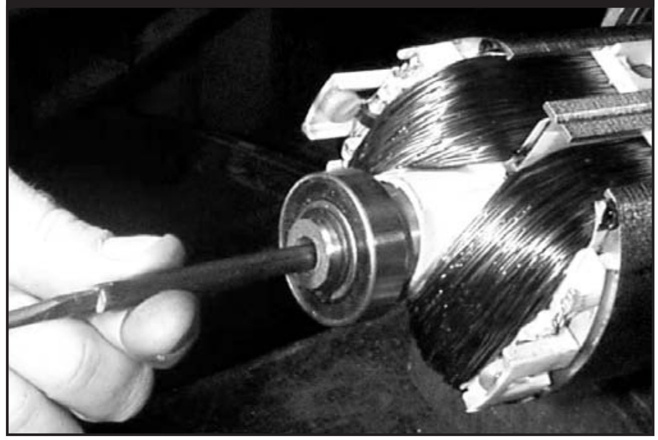
NOTE: Select a stud from the kit (Figure 4.19, Items 5 thru 12) of the correct length so that when threaded into the tapered shaft, its slotted end will be recessed about 1/4 to 1/2 inch into the rotor shaft diameter (See Figure 4.21).

Figure 4.21 — Rotor Removal Kit Installation



- Insert and install the stud into the tapered shaft as shown in Figure 4.22.

Figure 4.22 — Insert And Install Stud Into Tapered Shaft



With the stud threaded into the tapered shaft:

- Insert a capscrew of the appropriate thread pitch (Figure 4.19, Item 1 or 2) into the threaded I.D. of the rotor shaft.
- Tighten the capscrew firmly against the slotted end of the stud (See Figure 4.23)

Figure 4.23 — Tighten Capscrew Against Slotted Stud

- Strike the head of the capscrew sharply with a hammer.

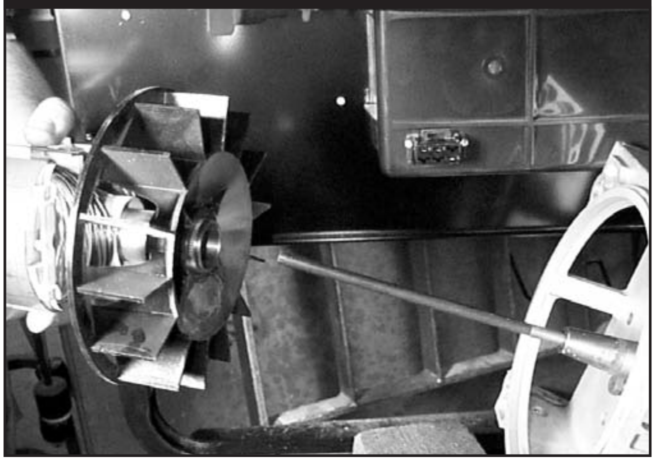
This should free the rotor from the shaft.

If not:

- Tighten it again and continue this procedure until the rotor comes free of the tapered shaft.

• Remove rotor assembly (Figure 4.24)

Figure 4.24 — Remove Rotor Assembly



• Remove capscrew from rotor shaft.
• Remove stud from tapered engine shaft.

Assembly

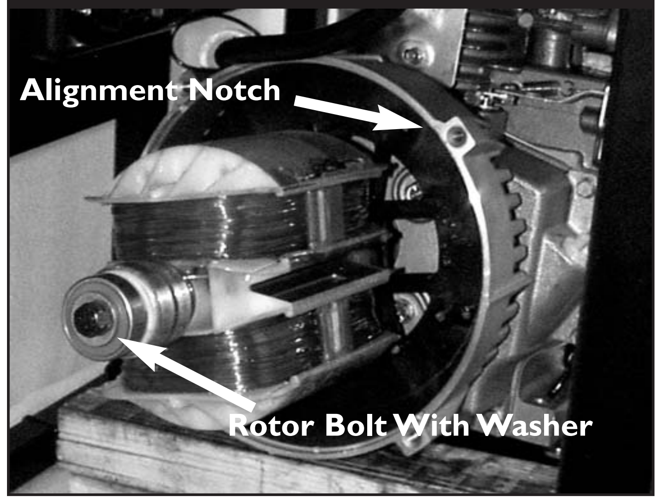
NOTE: Inspect for any loose debris, obstructions or flaws on the engine adaptor, stator laminations, rear bearing carrier, the threaded hole in the tapered shaft and the surface of the mating surface of the rotor before proceeding with the rotor installation.

Rotor Installation

Installation of the rotor is accomplished by placing the rotor on the end of the tapered drive shaft. There is no concern for timing the rotor to the engine.

• Slip the washer on the rotor bolt.
• Insert the rotor bolt and washer through the bearing end of the rotor (Figure 4.25).
• Start the bolt into the threads of the tapered shaft by hand, being careful not to "crossthread" the bolt.
• Torque to specifications.

Figure 4.25 — Rotor In Housing



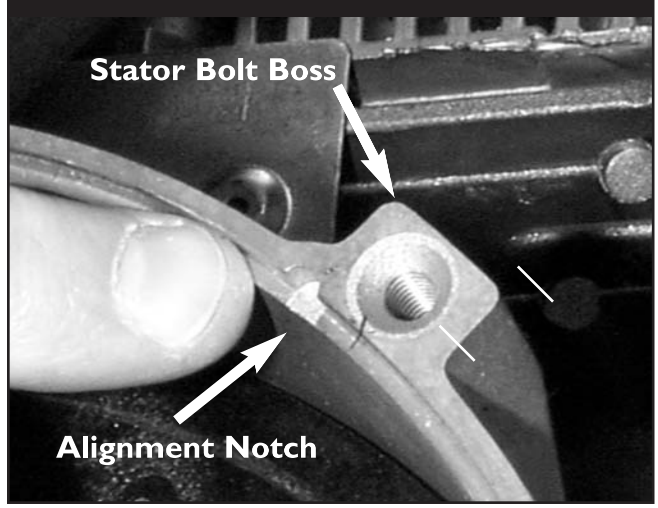
NOTE: Torque specifications can be found in the appendix of this guide.

Stator Installation

There are a number of alignment marks that should be noted when installing the stator assembly. The first of these is located on the engine adapter housing.

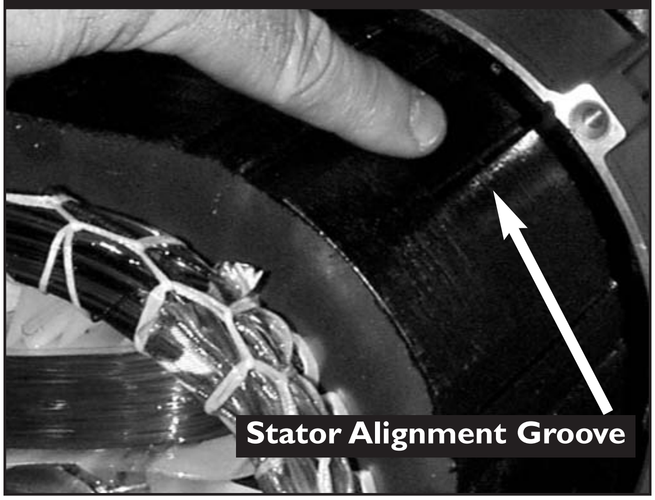
Looking straight at the unit as it is assembled thus far, you should notice a small notch just above and inboard of the stator bolt boss, at the 2 o'clock position (See Figures 4.25 and 4.26).

Figure 4.26 — Engine Adapter Housing Alignment



This notch aligns with a groove in the stator laminations (Figure 4.27) that is approximately 1.5 inches long.

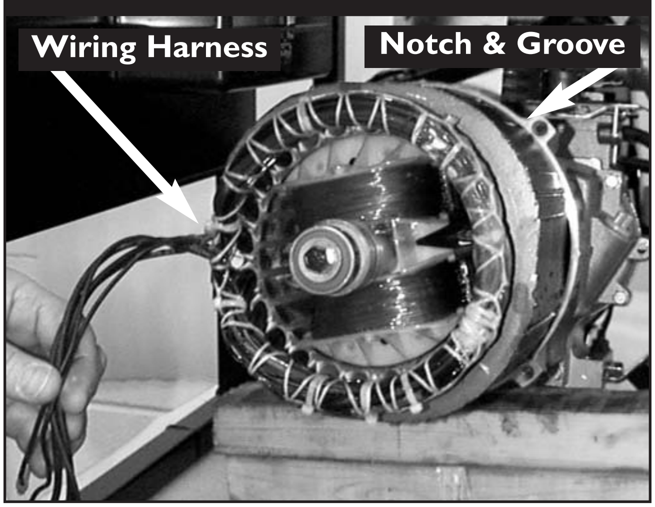
Figure 4.27 — Stator Alignment



To ensure that the stator is properly mounted and aligned, look for the following indicators:

- The stator wiring harness is located at the 9 o'clock position.
- The notch in the engine adapter is indexed with the groove in the stator laminations.
- The stator is seated squarely into the flange of the engine adapter (Figure 4.28).

Figure 4.28 — Indexing The Stator



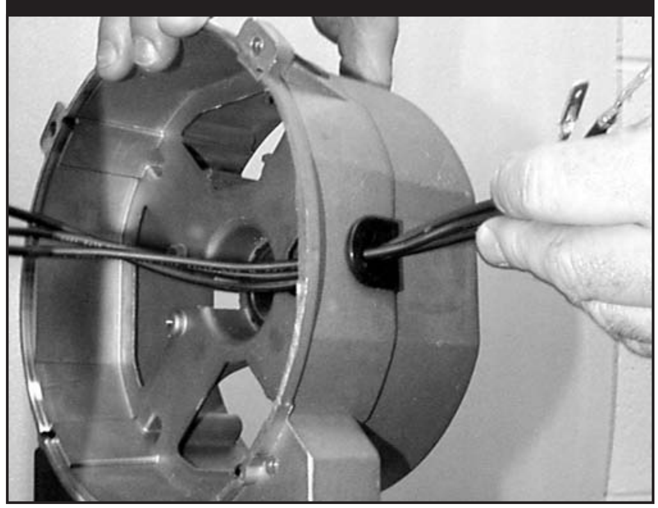
Installing The Rear Bearing Carrier

The index mark on the rear bearing carrier consists of a "roll pin" pressed into the inside flange. Viewed from the outside of the carrier, it would located at the 7 o:clock position just inboard and slightly below the isolation mount casting (Figure 4.29).

Figure 4.29 — Indexing The Rear Bearing Carrier

- Take note of the roll pin's position and thread the stator wiring harness through the cable grommet in the rear bearing carrier as shown in Figure 4.30.

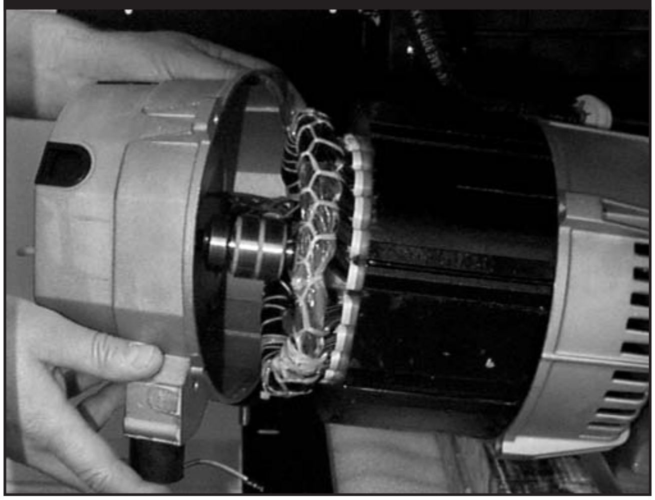
Figure 4.30 — Threading Harness Through Grommet



With the harness in the grommet:

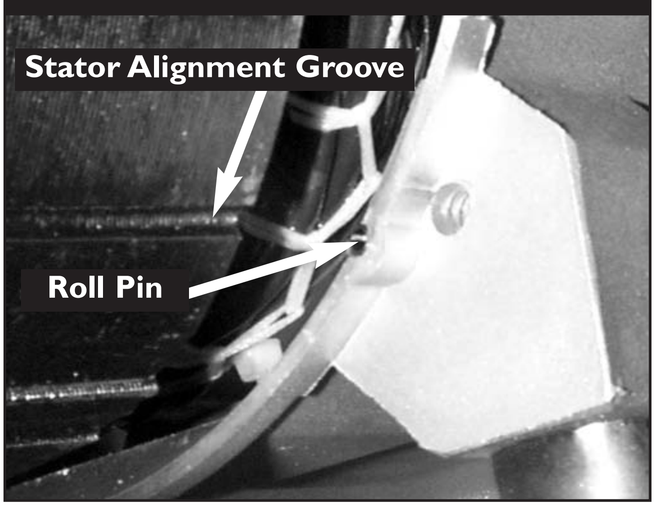
- Carefully start the rotor bearing into the rear bearing carrier (Figure 4.31).

Figure 4.31 — Starting The Bearing Into Its Carrier



- Align the roll pin with the groove in the stator laminations that is located at the 7 o'clock position (Figure 4.32).

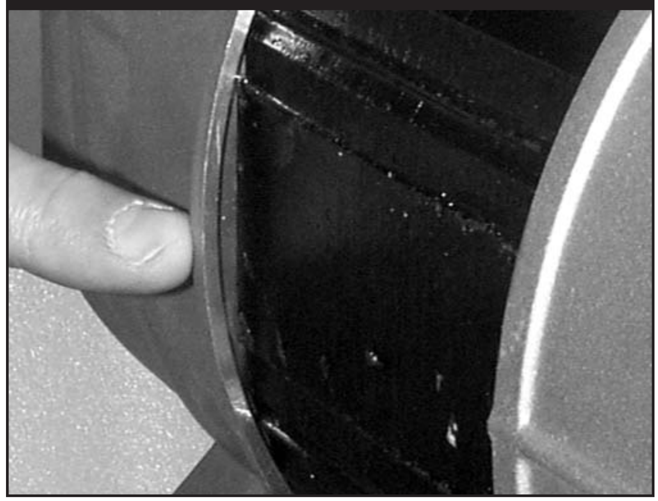
Figure 4.32 — Roll Pin To Stator Alignment



- Ensue that all the alignment marks are correct and seat the rear bearing carrier on the stator.

When the rear bearing carrier is properly positioned on the stator, the inner flange of the carrier will mount directly against the actual laminations of the stator without any gap inside the flange of the carrier
(Figure 4.33).

Figure 4.33 — Bearing Carrier and Flange



- All the alignment pins and notches should be in their proper orientation.
- All the assembly components will be in full contact at each of their mating surfaces.

When you are satisfied that all the above conditions have been met, you are ready to install the stator bolts.

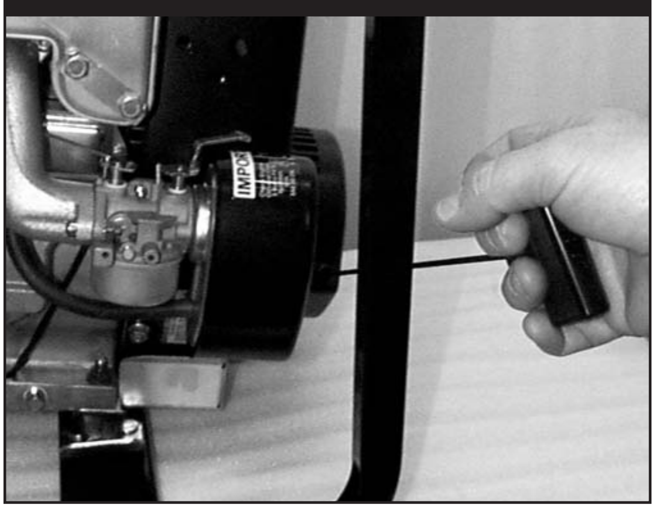
- Install all the stator bolts by hand and only torque them to “finger tight.”
- Then tighten them (Figure 4.34) to the specified torque as outlined in the torque chart in the appendix of this guide.

Figure 4.34 — Install Stator Bolts

- Remove the spark plug from the cylinder head.

IMPORTANT: Before proceeding to any other step, check to make sure that no internal obstructions are present. Pull the motor/generator assembly through (Figure 4.35) several revolutions to ensure that nothing is internally bound, grating or rubbing.

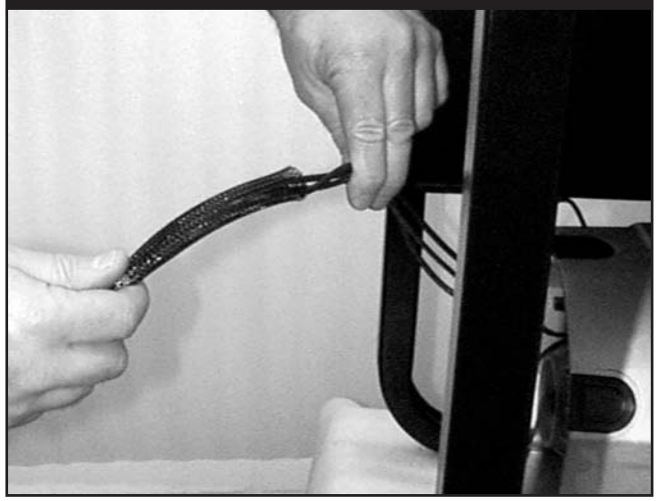
Figure 4.35 — Pull Test



Assembling The Wiring Harness

- Install the protective mesh over the power wires as shown in Figure 4.36.

Figure 4.36 — Install Mesh On Cable



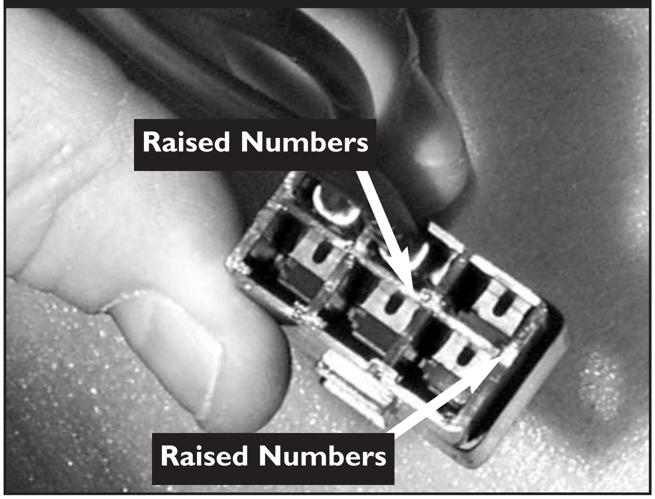
NOTE: Refer to the specific wiring schematic that applies to the unit you are working on, before proceeding with the following steps.

- Push the appropriate “spade terminals” into their designated compartments on the connector plug as shown in Figure 4.37.

Figure 4.37 — Spade Terminals

The back of the connector plug has raised numbers that identify its specific compartments (Figure 4.38).

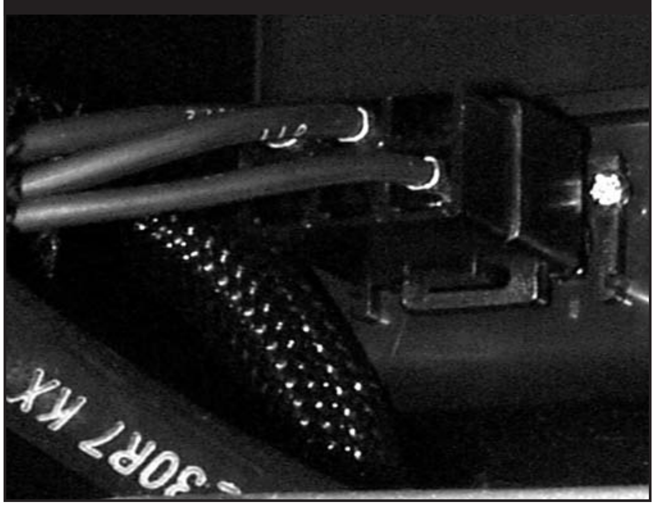
Figure 4.38 — Connector With Raised Numbers



When you have installed the terminal connector into the connector housing:

- Secure the power leads and connector housing to the back of the power control panel (Figure 4.39).

Figure 4.39 — Connector Housing To Control Panel



Reinstall Generator Ground Wire

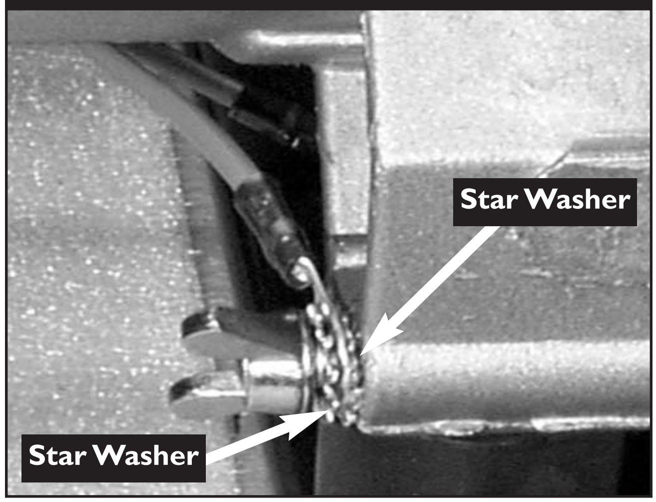
Remove any supporting blocks that might still be holding the generator from resting in its cradle.

You should have retained two star washers and 1 wing nut from disassembly.

- Install one star washer on the grounding lug.
- Then, the terminal lug for the grounding wire and the other star washer.

Secure all of these with the "Wing nut" as shown in Figure 4.40.

Figure 4.40 — Grounding Connection



Installing the Brush Assembly

Figure 4.41 shows the brush assembly with its terminal wires installed.

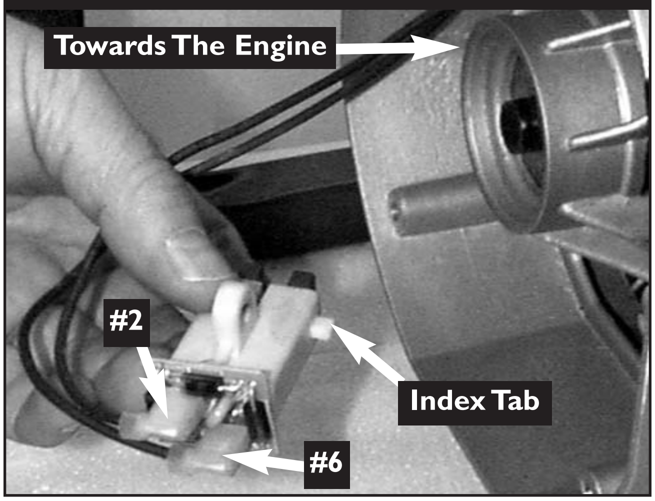


Figure 4.41 — Brush Assembly With Wire Terminals

Note: The brush housing has an index tab that should be installed towards the engine.

With the index tab facing as shown:

- DPE wire #2 is positioned on the upper tang of the brush housing.
- DPE wire #6 is positioned on the lower tang.
- Carefully work the brush assembly into its mounting while taking care to position the wires as shown in Figure 4.42 and tighten screws "finger-tight."

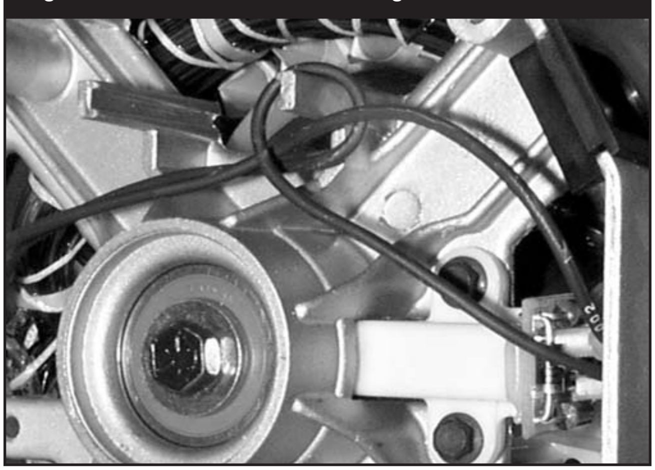


Figure 4.42 — Brush Holder Mounting

- Torque mounting screws (Figure 4.43) to specifications in the torque chart found in the appendix of this guide.

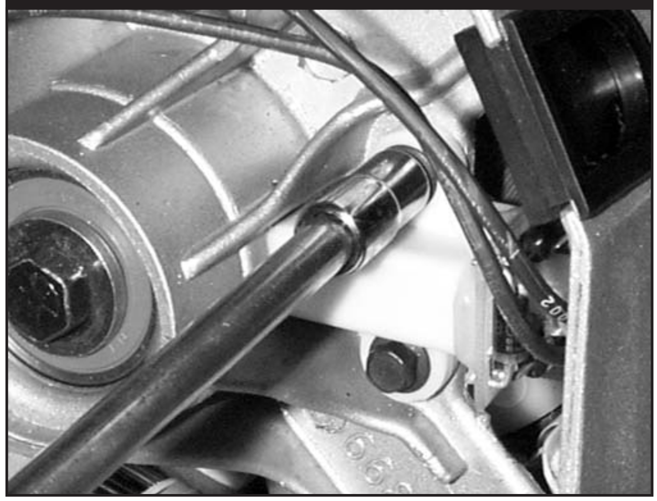


Figure 4.43 — Torque Brush Holder Assembly

Install Vibration Mounts to Cradle

At this point the generator should be resting in its cradle. The mounting lugs should be through their holes in the cradle frame (Figure 4.44).

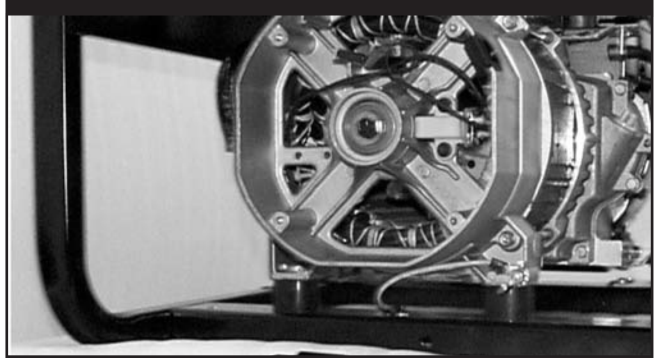


Figure 4.44 — Generator Vibration Mounts

- Install the lock washers and nuts to the vibration mount studs under the cradle frame arm (Figure 4.45).

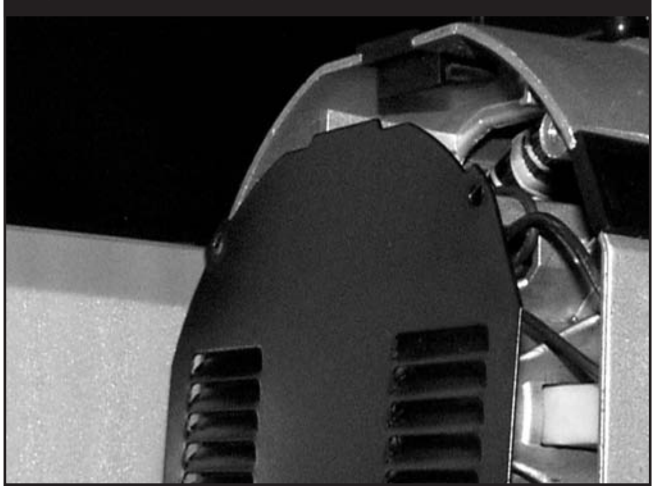
Figure 4.45 — Tighten Vibration Mounts

- Torque to specifications found in the appendix of this guide.

Installing End Cover to Bearing Carrier.

The louvers on the end cover should be facing in towards the generator as shown in Figure 4.46.

Figure 4.46 — Installing End Cover



- Ensure that the louvers are up as shown.
- Place the tab at the top of the cover over the grommet.
- Install the cover with the screws you retained from disassembly.
- Torque to specifications found in the torque chart in the appendix of this guide.
- Reinstall spark plug into cylinder head.
- Install spark plug lead.
- Start and test unit.

NOTES

SINCRO® WOUND GENERATORS

DANGER: Before servicing any **Sincro®** equipment, always remove the spark plug lead. Unintentional ignition can cause severe personal injury.

Disassembly

Removing Spark Plug Lead

- Remove the spark plug lead as illustrated in Figure 4.47 and Figure 4.48.

Figure 4.47 — Sincro® Wound Generator

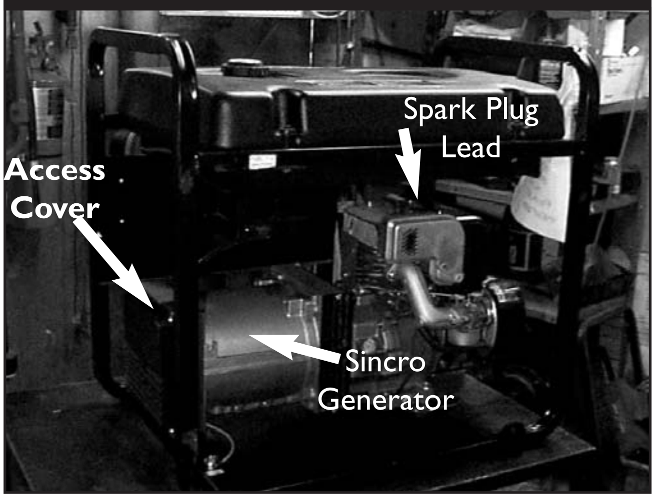
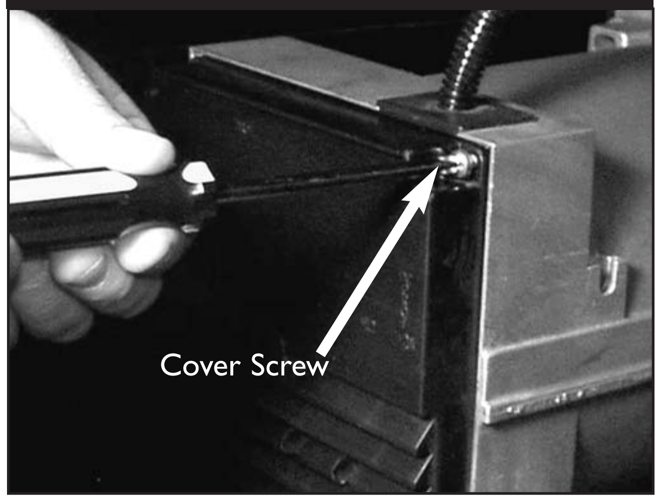


Figure 4.48 — Disconnect Spark Plug Lead

Removing Sincro® Access Cover

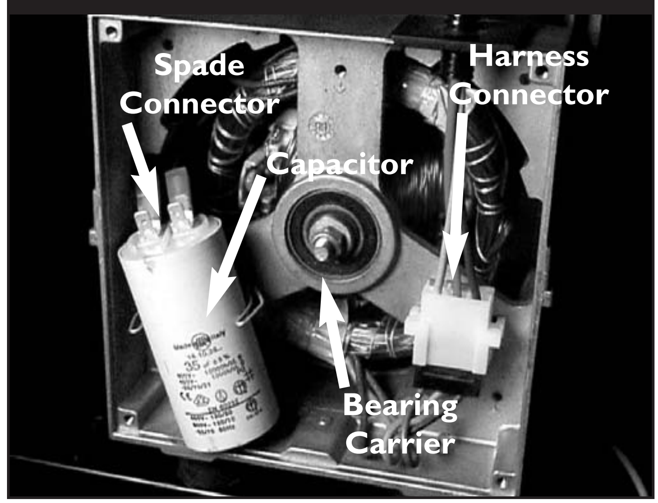
- Remove the four screws holding the access cover to the end of the sincro-generator (Figure 4.49).

Figure 4.49 — Sincro® Access Cover



This exposes the components shown below in Figure 4.50.

Figure 4.50 — Sincro® Components And Connections



A visual inspection of this area can reveal both mechanical problems as well as problems with wiring connections.

Before continuing with the disassembly process, visually inspect for the following:

- Evidence of bearing failure.
  - (Very fine metallic "dust" that generally accumulates around the bearing carrier assembly.)
- Loose or broken connector at all wire ends and insertion points into plug assemblies.
- Vibration damage (chafing) to any components due to rubbing or other contact friction.

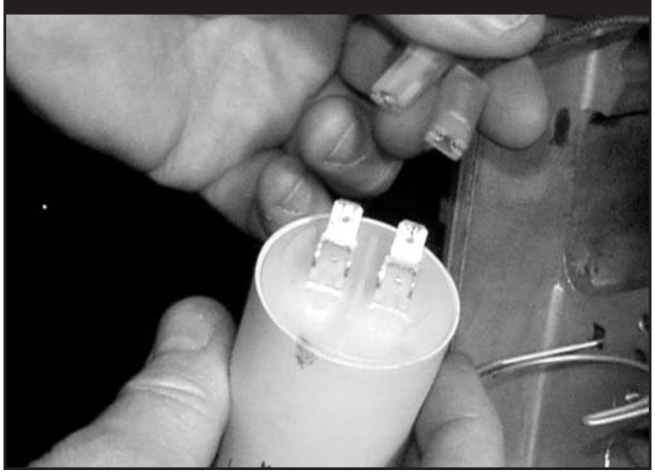
As well as a thorough visual inspection, there are a number of electrical tests that can be performed at this point of disassembly.

The actual measurement locations are described in the section titled "Troubleshooting Flow Chart For Sincro® Wound (Brushless Type) Generators," which begins on page 84.

Removing The Capacitor

- Remove the capacitor from its mounting clip and carefully disconnect the wiring harness spade connectors (Figure 4.51).

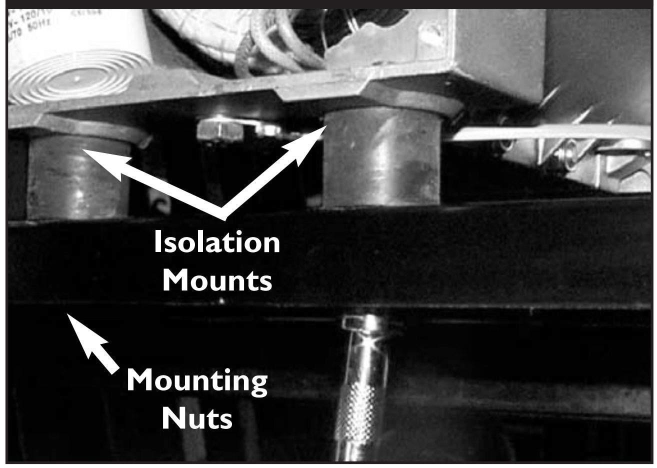
Figure 4.51 — Removing The Capacitor



Isolation Mounts

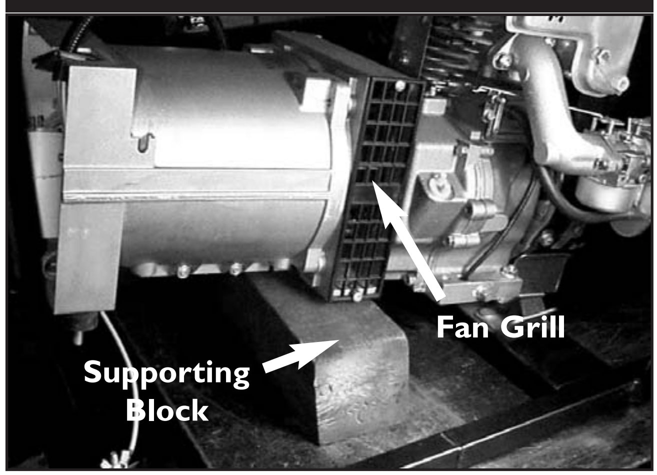
- Remove the two nuts that secure the isolation mounts to the cradle frame (Figure 4.52).

Figure 4.52 — Isolation Mount Hardware



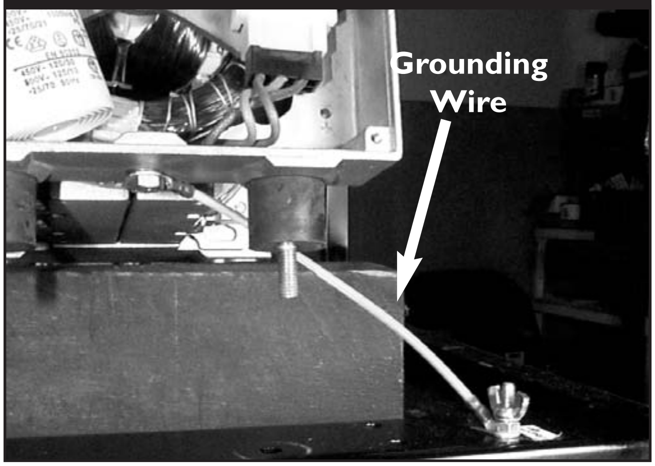
- Support Sincro® generator with a wooden block as shown in Figure 4.53.

Figure 4.53 — Supporting Sincro-Generator



• Disconnect the frame grounding wire (Figure 4.54).

Figure 4.54 — Disconnect Frame Grounding Wire



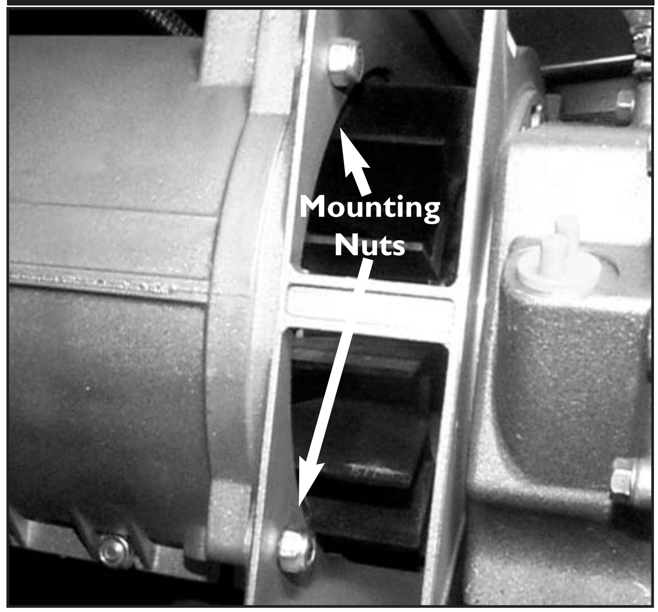
With the unit supported as described above:

• Remove the fan guards on both the left and right side of unit. (Left side is shown in Figure 4.55.)

Figure 4.55 — Removing The Fan Grills

This exposes the four nuts that secure the stator housing to the engine adapter (Figure 4.56.)

Figure 4.56 — Stator Housing Mounting Hardware



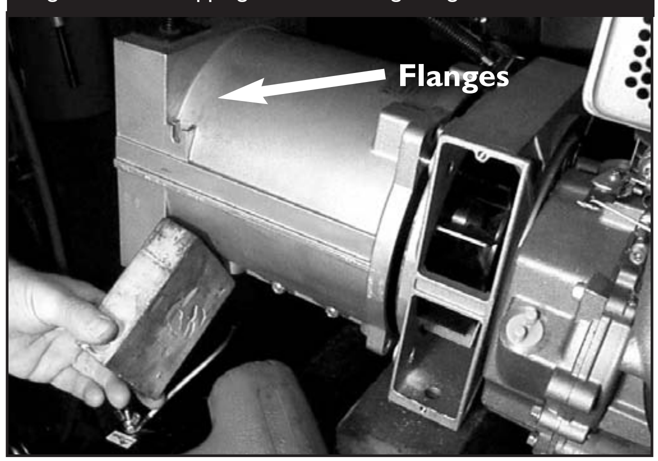
• Remove the mounting nuts.

NOTE: There will be times when the mounting stud breaks free before the nut. It is ok to remove the nut and stud together.

With an assistant to help secure the complete unit, a short block of wood and a large soft mallet:

• Tap the stator housing corner flanges as shown in Figure 4.57.

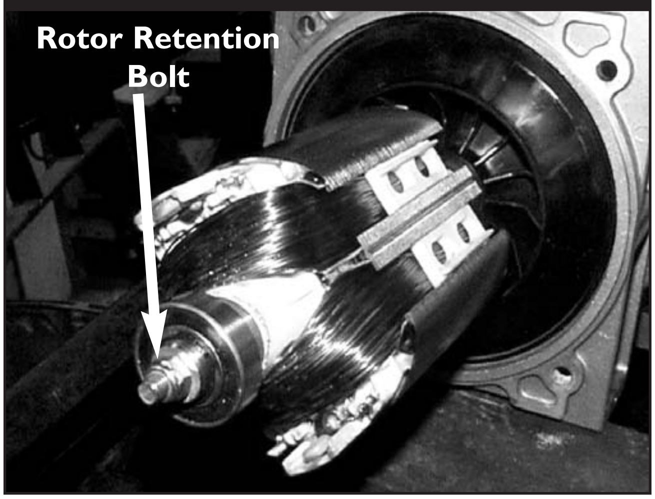
Figure 4.57 — Tapping Stator Housing Flanges



- Continue tapping all the flanges on the housing until it comes free from the engine adapter.
- Carefully remove the stator housing.

Once the housing is removed, the rotor assembly will be exposed (Figure 4.58).

Figure 4.58 — Exposed Rotor Assembly



NOTE: If you were unable to get satisfactory electrical measurements earlier, it is recommended that you take your rotor measurements now as this might save you the time in removing the rotor needlessly.

Removing The Rotor

The procedure for removing the rotor is the same as described for the **Generac®** wound generators. Please refer to page 98 "Removing the Rotor" for these steps.

Assembly

NOTE: The rotor bearing is secured to the end of the shaft by means of an external snap-ring (Figure 4.59). The bearing need not be removed from the rotor unless of an obvious failure or for rotor replacement. Inspect for any loose debris, obstructions or flaws on the engine adaptor, stator laminations, rear bearing carrier, the threaded hole in the tapered shaft and the surface of the mating surface of the rotor before proceeding with the rotor installation.

Figure 4.59 — Rotor Bearing Snap-Ring

Installing The Rotor

- Place the rotor on the tapered drive shaft. (There is no concern for timing the rotor to the engine.)
- Insert the rotor retention bolt and torque to the specifications found in the appendix of this guide.

Mounting The Stator Housing

- Carefully place the stator housing over the rotor and align the mounting studs (or holes) with the engine adapter (Figure 4.60).

Figure 4.60 — Aligning The Stator Housing

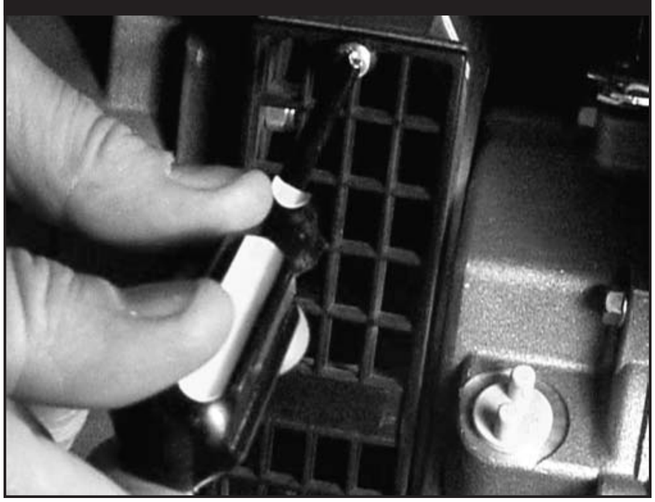
- Be sure that the rotor bearing slips into its encasement on the stator housing.

- Secure the stator housing with the studs and nuts you retained from disassembly (Figure 4.61).

Figure 4.61 — Secure Stator Housing

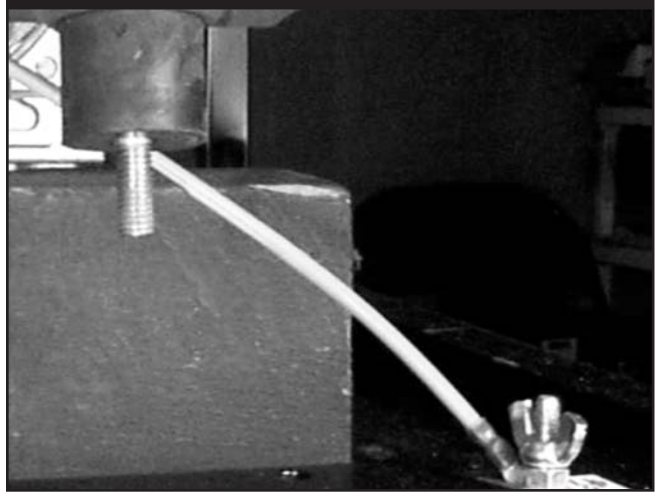
- Torque the mounting studs and nuts to specifications found in the appendix of this guide.
- Remove the spark plug wire and pull engine recoil to ensure no binding or obstructions.
- Install the fan guards as shown (Figure 4.62).

Figure 4.62 — Install The Fan Grills



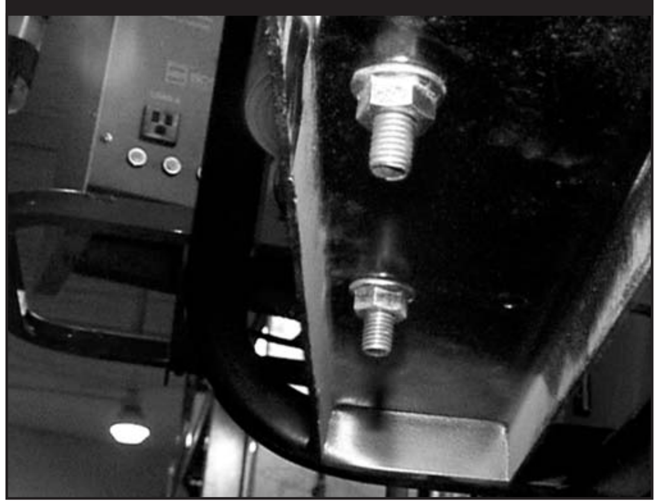
- Reinstall the grounding wire as shown in Figure 4.63.

Figure 4.63 — Install Grounding Wire



- Remove the supporting blocks and seat the isolation mount studs through their holes in the cradle frame.
- Install the nuts you retained from disassembly and torque to specifications found in the appendix of this guide (Figure 4.64).

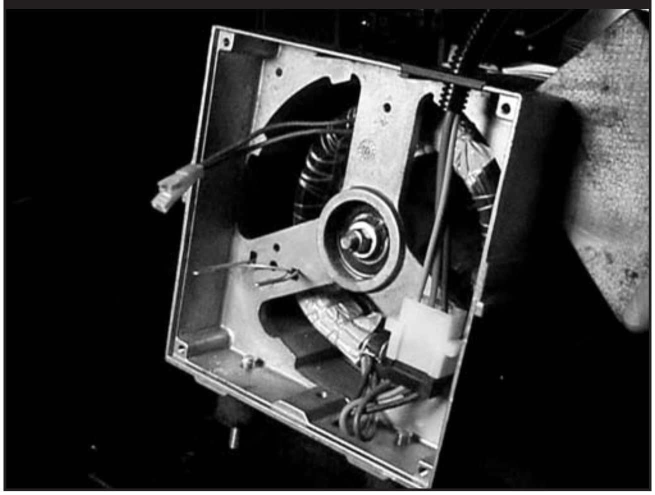
Figure 4.64 — Isolation Mounts



Power Harness Cable

- Reinstall the power harness cable connector as shown in Figure 4.65.

Figure 4.65 — Install Power Harness Cable

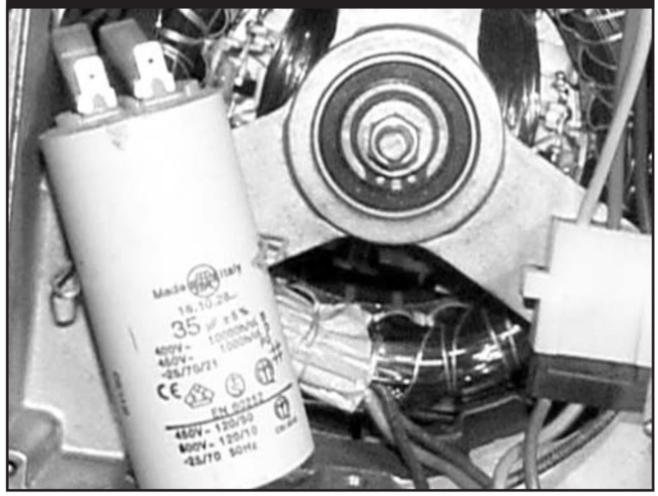


- Connect the other end of the cable to the back of the control panel (Figure 4.66).

Figure 4.66 — Connect Cable to Control Panel

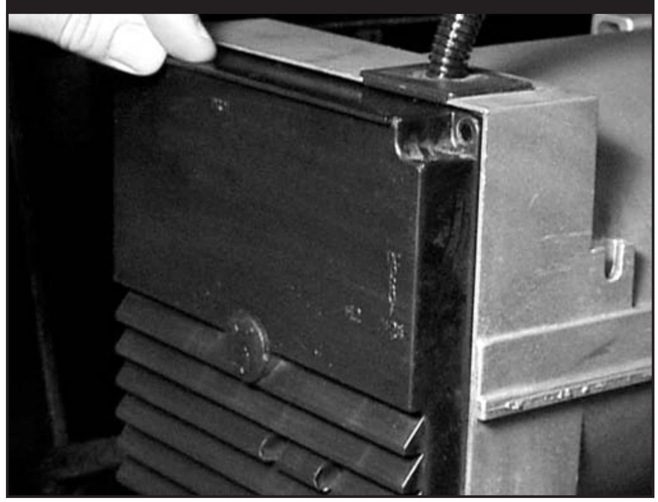
- Reinstall capacitor and connect terminal ends as shown in Figure 4.67.

Figure 4.67 — Install Capacitor



- Check all connections and install the access cover with the louvered half down as shown in Figure 4.68.

Figure 4.68 — Install Access Cover



- Reinstall access cover with the hardware you retained from disassembly.
- Insure that there are no obstructions to the rotation of the rotor.
- Reinstall the sparkplug lead.
- Start and test unit.

NOTES

NOTES

GENERAC® TORQUE TABLE

VIBRATION/ISOLATION

THREAD TYPE	FASTENER TYPE	SIMILAR USES	TORQUE RANGE
M-1.25	Flng & Lock Flng Nut	Post style vib. Mount to painted surface	12-17 FT/LB
M8-1.25, 3/8 - 16	Hex Nut, HHCS	Used with lockwasher	12-17 FT/LB

PUMP/GENERATOR ADAPTER TO ENGINE

5/16 - 24	HHCS, SHCS	Aluminum generator adapter casting, extl, mnt.	12-20 FT/LB
3/8 - 16	HHCS, SHCS	Aluminum generator adapter casting, extl, mnt.	15-23 FT/LB
3/8 - 16	Thread Forming Stud	Small frame vertical pump	12-20 FT/LB

BATTERY TERMINALS

M5 - 0.8	Flange Nut, Hex Nut	Long battery	8 -14 FL/LB

ALTERNATOR FASTENERS

5/16 - 24	HHCS	Generac 200MM designed rotor bolt, sincro	12-20 FT/LB
M6 - 1.0	HHCS Sems	Generac 200MM designed stator bolt	2-6 FT/LB
M5 - 0.8	Tap Tite	Generac 200MM designed brush, RBC cover, bat chrg rect	20-70 IN/LB

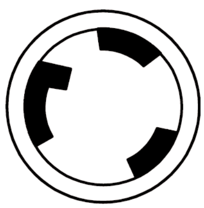
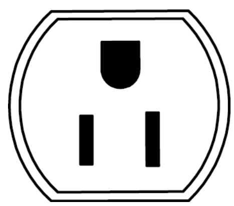
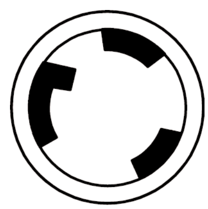
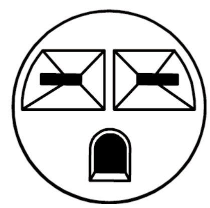
MUFFLER FLANGE/ BRACKETS/ HANDLES/ WHEEL KITS

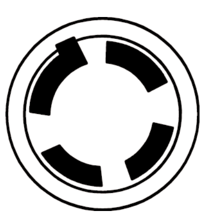
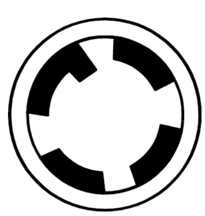
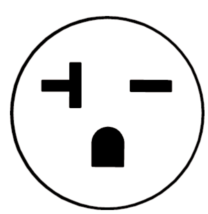
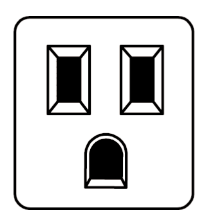
M8 - 1.25	SHCS/ Flange Nut	All mufflers	15-20 FT/LB
M8 - 1.25	Flange Nut, Hex Nut	Muffler brackets, wheel kit mnt legs, handles	15-20 FT/LB

ACCESSORIES

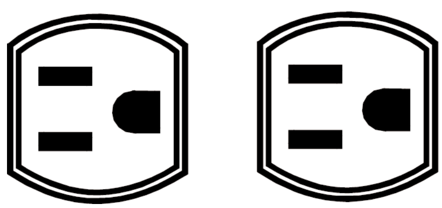
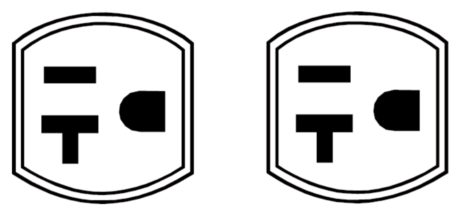
M6 - 1.0	Flange Nut	Generac blow molded fuel tanks	4-0 FT/LB
M6 - 1.0	Flange Nut	Ground thumb screw on Generac rear bearing carrier	8-14 FT/LB

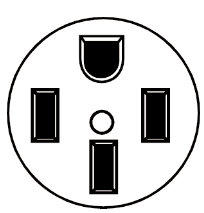
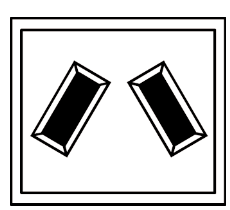
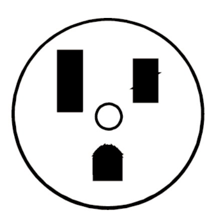
GENERAC® RECEPTACLES AND PLUGS

Receptacle No.	68868	22693 58888	74190	58889
NEMA	L5 - 30P	5 - 15P	L5 - 20P	6 - 15P
Plug Part No.	66883	26338	93568	58890
Volts	120	120	125	240
Amps	30	15	20	15
Configuration	L5 - 30R 	5 - 15R 	L5 - 20R 	6 - 15R 

Receptacle No.	43482 68867 77360	43437	68735	66818
NEMA	L14 - 20P	L14 - 30P	6 - 20P	
Plug Part No.	43483	43438	71744	
Volts	240	240	240	120
Amps	20	30	20	15
Configuration	L14 - 20R 	L14 - 30R 	6 - 20R 	

GENERAC® RECEPTACLES AND PLUGS

Receptacle No.	63025	68759
NEMA	5 - 15P	5 - 20P
Plug Part No.	26338	
Volts	120	120
Amps	15	20
Configuration	5 - 15R DUPLEX 	5 - 20R DUPLEX 

Receptacle No.	43629	66821	74191	
NEMA	14 - 50P		6 - 50P	
Plug Part No.	43630	65787	87848	
Volts	240	12	250	
Amps	50	10	50	
Configuration	14 - 50R 		6 - 50R 	

GLOSSARY

ALTERNATING CURRENT (AC)
Current which varies in value from zero to a positive maximum and then back down through zero to a negative maximum and back up to zero a number of times per second. The value being expressed in "cycles per second" or Hertz (Hz).

ALTERNATOR
A device for converting mechanical energy into electrical energy.

AMPERAGE
The strength or intensity of an electric current, measured in amperes (AMPS).

BATTERY CHARGE RECTIFIER
A component which changes (AC) voltage from the battery charge windings (within the STATOR) to (DC) voltage. This voltage could be used to charge a battery.

BRUSH
A conducting element, usually graphite and/or copper, which maintains sliding electrical contact between a stationary and a moving element.

CONDUCTOR
A wire or cable designed for the passage of electrical current.

CORE
The laminations in the generator constituting the magnetic structure thereof.

CRADLE
The metal frame that surrounds and protects the generator/engine.

CURRENT
The flow rate of electricity.

CYCLE
One complete reversal of alternating current of voltage, from zero to a positive maximum to zero to a negative maximum back to zero. The number of cycles per second is the frequency, expressed in Hertz (Hz).

DIODE
A solid state device which allows current to pass in one direction only. Since it allows only one halfcycle of an alternating current to pass, its output will be "unidirectional" and it may be considered a rectifying element.

DIRECT CURRENT (DC)
An electric current flow in one direction only. DC is produced by chemical action (i.e. a storage battery) or by electromagnetic induction.

DYNAMO
A machine for converting mechanical energy into electrical energy by electromagnetic induction. A generator.

ELECTRO-MOTIVE FORCE (EMF)
The force which causes current to flow in a conductor; in other words, the voltage potential.

GENERATOR
A general name for a device that converts mechanical energy into electrical energy. The electrical energy may be direct current (DC) or alternating current (AC).

GROUND
A connection, intentional or accidental, between an electrical circuit and the earth or some conduction body serving in the place of the earth.

HOUSING ADAPTER
The part located between the engine and the alternator which facilitates their connection.

IDLE CONTROL
A system which controls the idle speed of the engine in direct relation to the electrical load.

IDLE CONTROL ASSY
The components used in the idle control circuit. Such as: brackets, springs, printed circuit board, solenoid, transformer and mounting hardware.

IDLE CONTROL PCB
The printed circuit board which operates the idle control system.

IGNITION COIL
A device used to supply (DC) voltage to the spark plugs for engine cylinder ignition.

IGNITION SHUTDOWN ASSY
A component used to shut down the engine by grounding the ignition circuit.

MAGNETO
An alternator with permanent magnets used to generate current for ignition in an internal combustion engine.

OHM
Unit of electrical resistance. One volt will cause a current of one ampere to flow through a resistance of one ohm.

PHASE
The uniform periodic change in amplitude or magnitude of an alternating current. Three phase alternating current consists of three different sine wave current flows, different in phase by 120 degrees from each other.

RATED SPEED
Revolutions per minute at which the set is designed to operate.

RATED VOLTAGE
The rated voltage of an engine generator set is the voltage at which it is designed to operate.

REAR BEARING CARRIER
The casting which houses the rotor bearing which supports the rotor shaft.

RECTIFIER
A device that converts (AC) to (DC).

RELAY
An electrically operated switch usually used in control circuits and whose contacts are considered low amperage, compared to a contactor.

RESISTANCE
Opposition to the flow of current.

ROTOR
The rotating element of a motor or generator.

SINGLE PHASE
An (AC) load or source of power normaly having only two input terminals, if a load or two output terminals, if a source.

STATOR
The stationary part of a generator or motor.

TRANSFORMER
A component consisting of two or more coils that are coupled together by magnetic induction and used to transfer electric energy from one circuit to another without change in frequency but usually with changed values of voltage and current.

VIBRATION MOUNT
A rubber device located between the engine or generator and the cradle to minimize vibration.

VOLT
The unit of elecro-motive force. That electromotive force which, when steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

VOLTAGE
Electrical potential or potential difference expressed in volts.

VOLTAGE REGULATOR
A component which automatically maintains proper generator voltage by controlling the amount of (DC) excitation to the rotor.

WATT
Unit of electrical power. (In DC), equals volts times amperes. (In AC) equals effective volts times effective amps times power factor times a consistent dependent on the number of phases. 1 kilowatt = 1,000 watts.

WINDING
All the coils of a generator. Stator winding consists of a number stator coils and their interconnections. Rotor windings consist of all windings and connections on the rotor poles.

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Look for these other repair manuals from the Briggs & Stratton line:

B3277GS Pressure Washer Familiarization & Troubleshooting Guide

190275 Hand-Held Generator Familiarization & Troubleshooting Guide

275110 Outboard Motor Repair Manual

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Printed in U.S.A.