HOMELITE®

GENERATOR BASICS

The Impact of Electricity

In the history of man, there have been few forces which produced so great an effect in so brief a period as has electricity. Since 1881, when the Brush Electric Light Co. in Philadelphia initiated the first central station service in the U.S., electricity has become the single most dependent force in our economy. Without electric power, our cities would become paralyzed, transportation and communications functions would cease, water supplies would be threatened, industrial operations would collapse, and life as we know it would grind to a halt.

Our near-total dependence on electrical power to operate appliances, tools and equipment for both the home and the job inevitably led to the development of standby generators which could provide electricity when regular line power failed.

This in turn led to the evolution of relatively small, compact, mobile electric power sources, portable electric generators, which today provide not only emergency or stand-by power, but also permit us to take our power with us to jobsite or campsite.

What is an electric circuit?

In order to utilize electric currents for transmitting power, insulated conductors are arranged to form paths for the flow of current. These paths in which electric currents may flow are called electric "circuits."

In Fig. 2, a simple electric circuit is diagrammatically illustrated. This consists of a generator, motor, switch, and series of wire conductors. In Fig. 1 is shown a water system consisting of a pump, water turbine, pipes and valve which corresponds to this electric circuit.

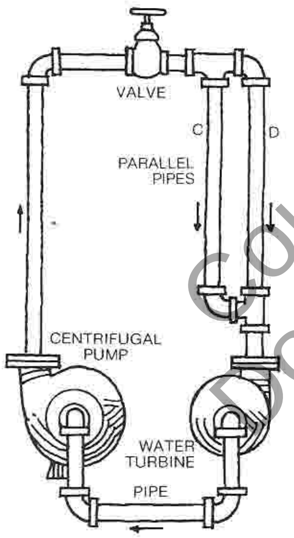


Fig. 1. A system of machines and pipes for transmitting hydraulic power

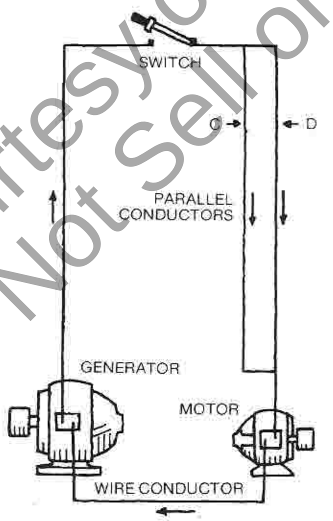


Fig. 2 A system of machines and conductors for transmitting electric power

These two illustrations show the similarity between a closed hydraulic power system and an electric power system. The pump corresponds to the generator. Pressure in the water is similar to voltage. The pipes are analogous to the wire conductors. The rate of flow of water corresponds to the electric current. Friction in the pipes may be likened to resistance in the conductors. The valve is similar to the switch. The water turbine corresponds to the motor. The parallel pipes may be compared to parallel conductors.

What is a Generator?

A generator is a machine which converts mechanical energy into electrical energy. In earlier years, large central station generators were known as dynamos.

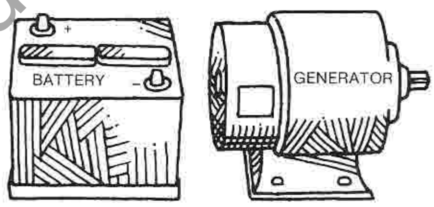
How is Electrical Energy Generated?

Every body in nature has a definable electrical potential. When two bodies are connected by a conductor, they tend to equalize their different potentials, causing a flow of electrons from one body to the other. The force that causes this flow of current is known as electromotive force (EMF).

Once that equalization has occurred, the potential of one of the bodies must be raised if there is to be further current flow. That increase of potential requires energy, which can be supplied by a battery or a generator.

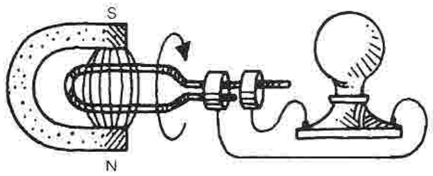
What is EMF?

Electricity is comprised of two quantities: voltage and amperage. Voltage, or EMF, is the electrical "pressure" that causes current to move along the conductor. The two most common sources of EMF are batteries and electric generators.



Amperage, on the other hand, is the measure of the intensity (or flow rate) of the electric current.

In 1831, Michael Faraday discovered that an EMF is produced by moving a conductor through a magnetic field. In a simple generator, the magnetic field is established by stationary poles. A conductor is moved through this magnetic field, creating or inducing an electromotive force. The voltage created will produce a current flow when an external circuit is completed.



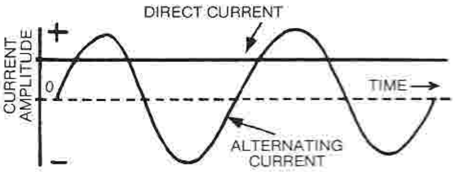
There are variations of this principle, but in each case there must be a conductor and a magnetic field with one or the other in motion. This process is known as electromagnetic induction, and is the fundamental principle on which generators of all types function.

A generator, then is essentially a mechanical device which generates the relative movement between a conductor and a magnetic field, and which leads the current produced to an electric circuit.

Current

Electric current is of two types, alternating (AC) and direct (DC). AC is current which flows in continually reversing directions.

DC flows continuously in one direction. Battery supplied power is always DC. Generators can provide either AC or DC. A double current generator supplies both AC and DC.



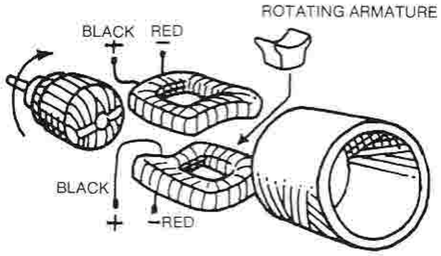
Types of Generators

All generators, regardless of size, are one of three basic types: AC, DC, and AC/DC (double current).

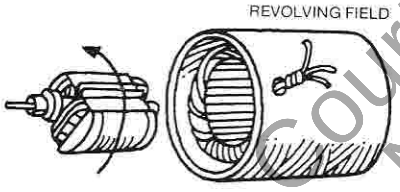
AC Generators

AC generators are either of two types: Rotating armature or Revolving field.

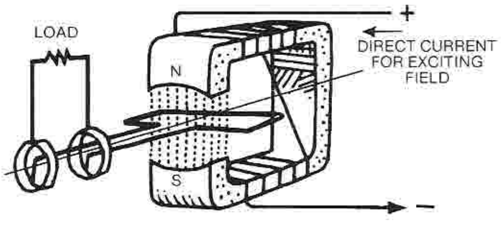
A rotating armature simply consists of a core of steel laminations which are affixed to a shaft, around which are wound the conductors.



The revolving field type is basically one in which the armature remains stationary (and is called a stator) and the field coils rotate on a rotor assembly.



The principle of AC current generation is illustrated with the simplest form of generator. The conductor is a coil of wound wire which rotates between the poles of a magnet. As it rotates, the coil passes through the magnetic field first in one direction and then, 180° later, in the opposite direction.

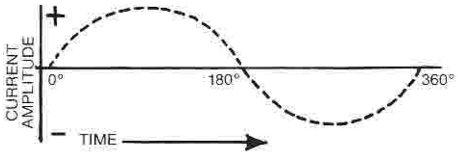


The current induced also moves in one direction and then in the other. Thus, alternating current.

The strength of the current varies, too. As any given point on the coil approaches the magnet's north pole, the current builds. It peaks as the point passes the pole, then diminishes to zero when the point is midway between the poles. As the same point approaches the south pole (going in the other direction), the current rebuilds in the opposite direction. The current flow can be traced as a sine curve:

As the coil continues to rotate, the current is continually reversing.

Either the magnet or the coil can be the moving part, so long as the other remains stationary.



The rotating armature generator has a series of these coils wound about the rotor. At the end of each coil is a plain metal ring (collar or slip ring) which rotates with the coil. As these slip rings turn, they rub against a spring-held brush, which picks up the alternating current and conducts it on toward its eventual end use.

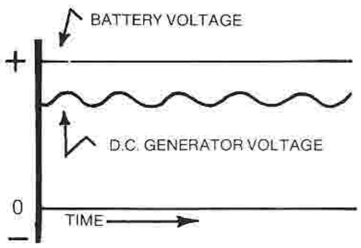
DC Generators

DC generators are also of the rotating armature type. Direct current produced by a generator tends not to be the smooth constant flow that characterizes the direct current produced by the chemical action of a storage battery; rather it's a pulsating type current.

The basic difference between DC and AC generators is in the brush rings. In the DC unit rings are not continuous; they are split into insulated segments, and are called commutators. Each coil end is connected to a segment, and the brushes are positioned so that as the current reverses, these brushes slide from one segment of the commutator to the other.

This converts the flow of current to one direction. With only two segments, current pulsates from maximum flow to zero flow.

To counter this condition, DC generators are designed with a series of coils, and the commutator is split into more segments, thus producing a more uniform current.



The Magnets

Permanent magnets are normally used only in magnetos. Most AC and DC generators utilize electromagnets which are magnets constructed of insulated conductor wire wound around a laminated steel core. Electric current (called field current) is passed through these wire-wound electromagnets to create the magnetic field (a kind of induction in reverse). Except for those rare circumstances where the output characteristics of the generator must satisfy special requirements, the field current is not supplied from an external source. Instead, all or part of the current the generator produced passed through the electromagnets, making it self-excited.

Series Wound Generator

In this generator, all of the current output passes through the field windings and external circuit.

When the machine is idle, there is no current flow in the field windings. There is however, a small, residual magnetism in the core of the field. As the armature first rolls over, it produces a small induced current in the armature windings and ultimately causes the current to flow through the series field windings and load. The build-up of both the field magnetism and the induced voltage in the armature is very fast. But as the magnetic capacity of the field becomes saturated, both voltage and current tend to become constant.

With the operating speed of the generator constant, both voltage and produced current will vary with the changes to the resistance of the external circuit. Each time the resistance is changed, the field current changes and this in turn changes the induced voltage.

The series generator can be designed to supply nearly constant voltage over a wide load range, but it is not considered a practical machine and is not widely used.

Shunt Wound Generator

In a shunt wound generator, only part of the output current passes through the field windings.

This machine differs from the series wound generator in that the field windings are connected in parallel to the armature circuit (instead of in series). The basic principle of operation is the same, but when the current is led from the armature of the shunt generator, it follows two routes: one to the field windings, and the other to the external circuit.

The field windings are designed to have a high resistance. Thus, when the output current divides to follow the two routes, the majority of the current will seek the path of least resistance to the external circuit.

The same residual magnetism described before is present in the field core. And, as the shunt generator builds speed, the voltage build-up is rapid.

But after the magnetic capacity of the field is saturated, voltage changes occur in direct proportion to generator speed, so at constant speed, the shunt generator will supply virtually constant voltage over a wide current demand range.

Compound Wound Generator

A compound wound generator is literally a combination series and shunt machine. It has two sets of windings: one set in series with the armature and the other set in parallel.

If the shunt and series windings are designed in the proper proportion, this variation is reduced and the machine will deliver nearly constant voltage.

3600 vs. 1800 RPM

There is very little difference in the life of the generators regardless of speed. However there are many moving and wearing parts in the engine, therefore the slower speed 1800 RPM units have significantly longer life, less maintenance, lower noise levels, heavier weight and are a bit more expensive. If low initial cost, lightweight and small size are your first considerations, the 3600 RPM units may be your logical choice.

Electric Generators and Electric Motors

The principles of design of an electric generator and an electric motor are essentially the same.

The motor, if current is fed into it, converts the electrical energy to a mechanical energy output.

The generator, conversely, utilizes mechanical energy to drive the rotor and produces electrical energy as its output.

How is the Generator Powered?

In broad terms, generators are powered by wind, water, solar energy, or by machines which convert the heat content of nuclear or fossil fuels to mechanical energy. Large central station generators do produce electricity by all these methods.

Portable generators, however, are generally powered by either two-cycle or four-cycle gasoline or diesel internal combustion engines.

Diesel vs. Gasoline

Homelite produces both gasoline and diesel-powered engine-driven generators. There are distinct advantages for both. Gasoline engines are lower in initial cost and are easily maintained and serviced by thousands of competent service dealers. Diesel engines have a higher initial cost than gasoline but the fuel is normally 10% per gallon lower than gasoline. The diesel engine is more efficient and therefore uses less fuel than gasoline engines. The fuel consumption per horsepower of a diesel engine at full load is up to 46% lower than an equivalent gasoline engine. Since no spark-type ignition systems are used on diesel engines, maintenance is less since spark plugs, points, condensers and distributors are eliminated.

Generator Rating

Generators are generally rated in terms of their output power, which is measured in watts. A watt is the amount of power equal to a current of one amp driven by a "pressure" of one volt.

Larger power outputs are measured in kilowatts (one thousands watts).

Modern portable generators can provide outputs up to 15,000 watts.

How much Output is Enough?

A generator must be capable of providing an adequate power supply to whatever it must service. Load requirements of electric motors differ, but all motors require more power to start than they do to run. Motors of the split phase type require more starting power than do capacitor start or repulsion induction motors.

The following table is based on average motor requirements. For difficult starting conditions (compressors, air conditioners, deep freezers) allow twice the normal wattage requirements for starting.

WATTAGE REQUIRED BY MOTORS

Horsepower*	Starting	Running
1/6 H.P.	600	275
1/4 H.P.	800	400
1/3 H.P.	1200	500
1/2 H.P.	1500	700
3/4 H.P.	2100	950
1 H.P.	2500	1200
1-1/2 H.P.	3000	1600
2 H.P.	3500	2200

**1725 RPM Motor. For 3450 RPM Motors Increase Above Figures 15%.*

Choosing a Generator

To choose a generator of adequate size, add up all the watts which may be on at one time using the starting load of all automatic equipment such as furnaces, refrigerators, freezers, or power tools. For domestic emergency or standby operations the running watts of motors for water pumps and air conditioners may be used, assuming they will be operating manually, one at a time during an emergency. However, the generator must be of sufficient capacity to handle the individual starting load of any of these.

Portable Generators

A properly designed portable generator should be able to provide a non-fluctuating power supply at the proper rated voltage and frequency. Most reliable manufacturers rate their generators below the actual wattage capability. This avoids tool burnout due to frequent starting and stopping of the tool, and assures consistent performances and longer tool life.

The most commonly used generator is the single phase, 60 cycle alternating current type. Generating 120 volt current or what is usually referred to as "utility power supply," these units will operate most tools and appliances. Some generators provide dual voltage (120/240 volts single phase), which meets many customer requirements for a 240 volt power source and are ideal to operate lights, standard power tools and appliances.

High Cycle Generators

The Homelite high cycle AC generator provides 180 cycle, 230 volt, 3 phase alternating current in either 3000 or 5000 watts, or 2500 watts of direct current. These units are truly dual purpose generators, providing not only the power to drive standard power tools and appliances with universal motors (115 volts AC-DC), but also for continuous wattage output (180 cycles AC) to drive high cycle electric tools such as impact wrenches ...concrete vibrators...drills...grinders... and paving breakers.

The dual purpose feature on high cycle generators makes it possible to operate high cycle tools from the AC output and simultaneously run lights and standard electric tools from the 115 volt DC output. High cycle generators offer a distinct advantage by providing high cycle AC power, plus direct current.

Standby Generators

Generators are often used as standby or emergency power sources for applications where loss of the utility power supply would endanger life or cause extensive damage to expensive equipment or supplies. When the utility power supply fails or falls below rated service requirements, the standby unit is started and becomes the power supply.

In any fixed installation, a transfer switch must be installed between the generator and the utility power. Otherwise, when utility power is off, the generator can feed out to the utility lines, and possibly shock or injure utility men working on the lines.

The ampere rating of the transfer switch must at least equal the total ampere rating of the main utility distribution panel. If certain lines are segregated for use on the generator, then the ampere rating of the transfer switch must at least equal the total amperes drawn by all equipment on those lines.

Electrical output of the generator must match incoming utility power in voltage, frequency and phase.

The generator should be located close to the normal electrical service. Location of the generator should provide adequate ventilation and cooling; otherwise overheating can damage engine and/or generator.

Care should be taken to vent exhaust away from enclosed areas. Local codes should be observed for installation.

Here is a list of wattage requirements for some typical household appliances:

APPLIANCE	Watts
Air-Conditioning (central)	5000
Air-Conditioning (window)	1300
Blanket	150
Broiler	1400
Clothes Dryer (electric)	4800
Clothes Dryer (gas)	400
Coffee Maker	850
Dehumidifier	250
Dishwasher	1200
Drill (hand)	500
Electrostatic Cleaner	60
Fan (attic)	375
Fan (furnace)	270
Fan (window)	200
Food Freezer	300
Frying Pan	1200
Hair Dryer	300
Heat Lamp (infrared)	250
Heater (radiant)	1300
Heating Pad	600
Hot Plate	1250
Humidifier	70
Oil Burner or Stoker	260
Radio	80
Range (per element)	1250
Refrigerator Freezer	330
Refrigerator Freezer (Frostless)	425
Sump Pump	400
Television	255
Television (color)	300
Toaster	1100
Vaporizer	75
Washing Machine	375
Water Heater	3000
Water Heater (quick recovery)	4500
Water Pump	335

POWER FACTOR — The ratio of true power (watts to the volt-amperes of an AC circuit.

When current (amps) and voltage (volts) are in phase, the power factor is 1 (watts = volts x amps).

In AC circuits, the inductances and capacities may cause the point at which the current wave passes through zero to differ from the point at which the voltage wave passes through zero. When the current wave precedes the voltage wave a leading power factor results, as in the case of a capacitive load or over-excited synchronous motors. When the voltage wave precedes the current wave, a lagging power factor results. This is generally the case. The power factor expresses the extent to which voltage zero differs from the current zero. Considering one full cycle to be 360 degrees, the difference between the zero points can then be expressed as an angle θ. Power factor is calculated as the cosine of the θ between zero points and is expressed as a decimal fraction (.8) or as a percentage (80%). It can also be shown to be the ratio of KW, divided by the KVA. In other words, KW = KVA x P.F.

RATED POWER — The stated or guaranteed net electric output which is obtainable continuously from a generator set when it is functioning at rated conditions. If the set is equipped with additional power producing devices, then the stated or guaranteed net electric power must take into consideration that the auxiliaries are delivering their respective stated or guaranteed net output simultaneously, unless otherwise agreed to. See EFFICIENCY.

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.

REAL POWER — A term used to describe the product of current, voltage and the power factor, expressed in KW.

RECTIFIER — A device that converts AC to DC. See DIODE.

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. See OHM.

RESIDUAL VOLTAGE — Voltage generated with zero field current.

ROTOR — The rotating element of a motor or generator.

SERIES CONNECTION — An electrical connection in which the output terminal of one element is connected to the input terminal of another element, thereby providing one path for current flow.

SERIES WOUND — A generator in which all of the current output passes through the field windings. See text.

SHORT CIRCUIT — Generally an unintentional electrical contact between current carrying parts resulting in the passage of current through an undesirable path.

SHUNT CONNECTION — Parallel connection in which the terminals of two or more devices are connected together.

SHUNT WOUND — A generator in which the field current is supplied from the armature potential.

SINGLE PHASE — A single phase alternating current system has a single voltage in which voltage reversals occur at the same time and are of the same alternating polarity throughout the system.

STATOR — The stationary part of a generator or motor.

THREE PHASE — Three complete, separate sine waves spaced 120 electrical degrees apart.

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.

UNITY POWER FACTOR — A power factor of 1.

UNIVERSAL MOTOR — An electrical motor which can be used on either AC or DC supply.

UTILITY LINE — The wires provided and owned by a utility company, and which carry the utility power supply.

UTILITY POWER SUPPLY — The electric service provided by a public utility. See HOUSE CURRENT.

VOLT — The unit of electromotive force. That electromotive force which when steadily applied to a conductor whose resistance is one ohm will produce a current of one ampere.

VOLTAGE — Electric potential or potential difference expressed in volts.

VOLTAGE DROP — The reduction in voltage, caused by the current which flows through a resistance. Equal to the product of current and resistance.

WATT — Unit of electric power. In direct current equals volts times amperes. In alternating current equals effective volts times effective amps times power factor times a constant dependent on the number of phases. 1,000 watts equals 1 kilowatt.

WATT-HOUR — Unit of electrical energy equal to one watt of power consumed during an hour.

WINDING — All the coils of a generator. Stator winding consists of a number of stator coils and their interconnections. Rotor windings consist of all windings and connections on the rotor poles.

ELECTRICAL FORMULAS

DESIRED DATA	ALTERNATING CURRENT		DIRECT CURRENT
	SINGLE PHASE	THREE PHASE	
I	$\frac{E}{Z}$	$\frac{E}{Z}$	$\frac{E}{R}$
E	I x Z	I x Z	I x R
R(Z)	$\frac{E}{I}$	$\frac{E}{I}$	$\frac{E}{I}$
W	I x E x PF	I x E x 1.73 x PF	I x E
KW	$\frac{I \times E \times PF}{1000}$	$\frac{I \times E \times 1.73 \times PF}{1000}$	$\frac{I \times E}{1000}$
KVA	$\frac{I \times E}{1000}$	$\frac{I \times E \times 1.73}{1000}$	—

I = Ampere
E = Volts
R = Resistance (OHMS)
W = Watt
X = Reactance

KW = Kilowatt (1 KW = 1000 Watt)
PF = Power Factor, i.e. .7, .8, .9, .95, 1.0 etc.
KVA = Kilovolt Ampere (1 KVA = 1000 Volt Amp)
$Z = \sqrt{R^2 + X^2}$ (OHMS)

HOMELITE
TEXTRON

Homelite Division of Textron Inc.

Glossary

AC — Alternating current.

ALTERNATING CURRENT (AC) — Current which varies from zero to a positive maximum to zero to a negative maximum to zero, a number of times per second, the number being expressed in cycles per second or Hertz (Hz).

ALTERNATOR — A device for converting mechanical energy into electrical energy in the form of alternating current. It may be called an AC generator.

AMMETER — An instrument designed to measure electric current flow.

AMP — See Ampere.

AMPERAGE — The strength or intensity of an electric current, measured in amperes. See ampere.

AMPERE — The unit of electric current flow. One ampere will flow when one volt is applied across a resistance of one ohm.

ARMATURE — That part of a dynamo or generator which carries the conductors. Usually consists of a core of laminated steel around which are wound the conductors.

A rotating armature is affixed to a shaft, around which are wound the conductors.

A stationary armature is called a stator and the field coils rotate on a rotor assembly.

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

COMMUTATOR — A device made up of segmented conductors, which make selective connections to revolving armature coils through the brushes.

In a DC generator the commutator and brushes make up a rotating switch that converts armature induced AC voltage to DC.

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

CONTINUOUS CURRENT — A steady, non-pulsating direct current.

CONTINUOUS LOAD — Any load up to and including full rated load that the generator set is capable of delivering for an indefinitely long period, except for shutdown for normal preventative maintenance.

CONTINUOUS RATING — The load rating an electric generating system is capable of supplying without exceeding its specified maximum temperature rise limits.

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

CURRENT — The rate of flow of electricity. See AMPERE.

CYCLE — One complete reversal of an alternating current or 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).

DC — Direct current.

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

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

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

EDDY CURRENT — Current circulating in conducting materials, caused by magnetic fields. They represent losses in generators and are reduced by the use of thin laminations of special steel.

EFFICIENCY — The efficiency of a generator set shall be defined as the ratio (expressed as a percentage) of its useful power output to its total power input.

ELECTROMAGNET — A core of magnetic material, usually soft iron, surrounded wholly or in part by a coil of wire through which an electric current is passed which magnetizes the core.

ELECTRO-MAGNETIC FIELD — A magnetic field generated by the passage of current through a coil surrounding a ferrous pole structure.

ELECTRO-MAGNETIC INDUCTION— The process by which an electrical conductor becomes electrified when in the presence of a magnetically charged body; an electromotive force is produced in a circuit by varying the magnetic field connected with the circuit.

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

ELECTRON — An elementary particle consisting of a charge of negative electricity.

ELECTRON THEORY — Founded on the premise that like charges repel and unlike charges attract, this theory holds that the electron (a negative particle) is attracted to a positive particle, resulting in a negative to positive flow. This is in direct contradiction to the conventional theory which is commonly accepted in practical every day practice, and which holds that current flows from positive to negative.

EMF — See Electro-motive Force.

FIELD — A region of space under magnetic influence resulting in a distribution of magnetic lines or flux in that space. The field may be produced electrically or by means of permanent magnets.

FIELD COIL — A conductor wound around a field pole.

FIELD CURRENT — That current passed through the field windings of a dynamo or generator to create a magnetic field.

FIELD WINDING — The conductors of a dynamo or generator so arranged as to produce a magnetic field in the presence of a flow of current through them.

FREQUENCY — a) In physics, the number of vibrations or cycles per unit of time. b) Specifically, the number of cycles per second of an alternating electric current. See Hertz.

FREQUENCY CONVERTER — A device for transforming electical current from one frequency to another.

FLUX — Magnetic lines of force.

FLUX DENSITY — Magnetic lines of force per unit of area.

GENERATOR — A general name for a device for converting mechanical energy into electrical energy. The electrical energy may be direct current (DC) or alternating current (AC). An AC generator may be called an alternator.

GROUND — A connection, either intentional or accidental, between an electric circuit and the earth or some conducting body serving in place of the earth.

HERTZ — A unit representing the measurement of one cycle per second.

HIGH CYCLE GENERATOR — An electric generator with a 180 Hz, 3 phase output.

HOUSE CURRENT — The electric service delivered to a residence or place of business by a public utility. See Utility Power Supply.

HZ — See Hertz.

IDLER — A device to reduce the engine speed when a generator set is not being operated under load. An idler conserves fuel, reduces noise and saves wear and tear on the engine.

INDUCTION — The process in which a conductor passes through a magnetic (or electro-magnetic) field, inducing a current. If the conductor continues to rotate in the field, an alternating voltage is induced.

INDUCTION MOTOR — An AC electric motor in which the rotor has a current induced into it by the alternating electric fields of the stator.

INSULATOR — A non-conducting body or substance used to prevent current flow.

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

NO LOAD POWER — No load power for a generator set is a state of operation at rated speed wherein all control, monitoring and excitation circuits or devices are energized and functioning and it is only necessary to close the output switching device to provide power to the load. In the event that the generator set is equipped with more than one power producing device, such as a battery charger, then these devices shall be treated as separate power producing devices whose no load state shall be as described above.

NON-CONDUCTOR — See insulator.

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

OHM'S LAW — The law that states the intensity (amperage) of an electrical current is directly proportional to the electromotive force (voltage) and inversely proportional to the resistance (ohms). (Amps = volts/ohms) or ($I = E/R$).

OVERLOAD POWER — Overload power is that load in excess of rated load which the generator set is capable of delivering for a specified period of time. It should be recognized that the voltage, frequency and operating temperature may differ from normal rated values.

OUT-OF-PHASE — A condition in which the AC voltage waves of two generating systems do not coincide.

PARALLEL CONNECTION — An electrical connection in which the input terminal of one element is connected to the input terminal of another element and the output terminals are similarly connected together, thereby providing two paths for current flow. See SHUNT CONNECTION.

PF — Power factor.

PHASE — The number of complete voltage and/or current sine waves generated per 360 electrical degrees. Each phase requires a complete set of windings.