

EUCLID INDUSTRIES

TECH TIPS

ELECTRICAL SYSTEMS

Includes:

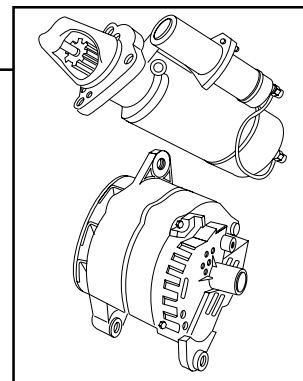
Alternators

Starters

MODULE SEVEN

The Euclid logo is a stylized, bold, black-outlined wordmark in a yellow and red shield-like shape. The letters are white with black outlines, set against a red background with a yellow border.

EUCLID



HEAVY-DUTY ELECTRICAL SYSTEMS BASICS

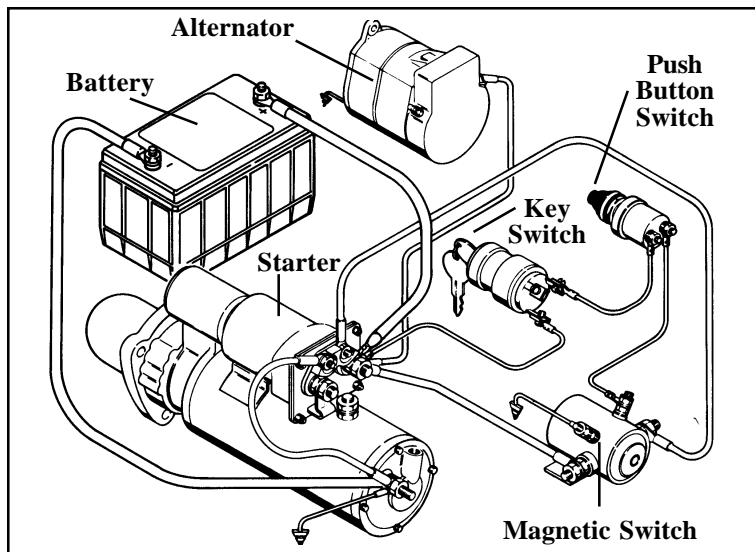


Fig. 1

Today's basic heavy-duty electrical system consists of batteries, a starting motor, an alternator, and the control circuit. The control circuit includes a magnetic switch, ignition switch, push button switch, and all the required wiring.

The batteries provide the high electrical current needed by the starting motor. The magnetic switch controls the battery current into the starter solenoid. The ignition and push button switch activate the magnetic switch, which in turn activates the starting motor. If all functions work properly, the engine should turn over. Mechanical energy from the running engine provides the power needed to operate the

alternator. The alternator creates electrical energy that recharges the batteries and provides the current for the vehicle's electrical accessories and loads. The wiring should be of adequate size to carry the amount of current needed in each circuit.

When these components are properly matched, they provide a balanced electrical system that will perform well through out its life expectancy.

SYSTEM COMPONENT FUNCTIONS

BATTERY

A battery is a storage unit that can store and produce electrical energy. With use, they gradually deteriorate and become less capable of performing their important task.

There are three basic types of batteries used in heavy duty electrical systems:

Filler cap

These are lead- acid batteries with a high degree of a base element called antimony in the grid alloy. Because of this base element, they require frequent servicing, particularly the need for adding water.

Semi-maintenance free

These are conventional batteries with reduced amounts of antimony in the grid alloy. Consequently, servicing is reduced but water still must be added periodically.



Fig. 2

Maintenance free

These batteries use a lead- calcium grid alloy without antimony. They never need water, nor are provisions provided for adding water.

STARTER

All starters, from the smallest to the largest; automotive, industrial, heavy truck, off road equipment, are virtually the same. They are simply electrical motors that convert electrical energy into mechanical energy to crank the engine.

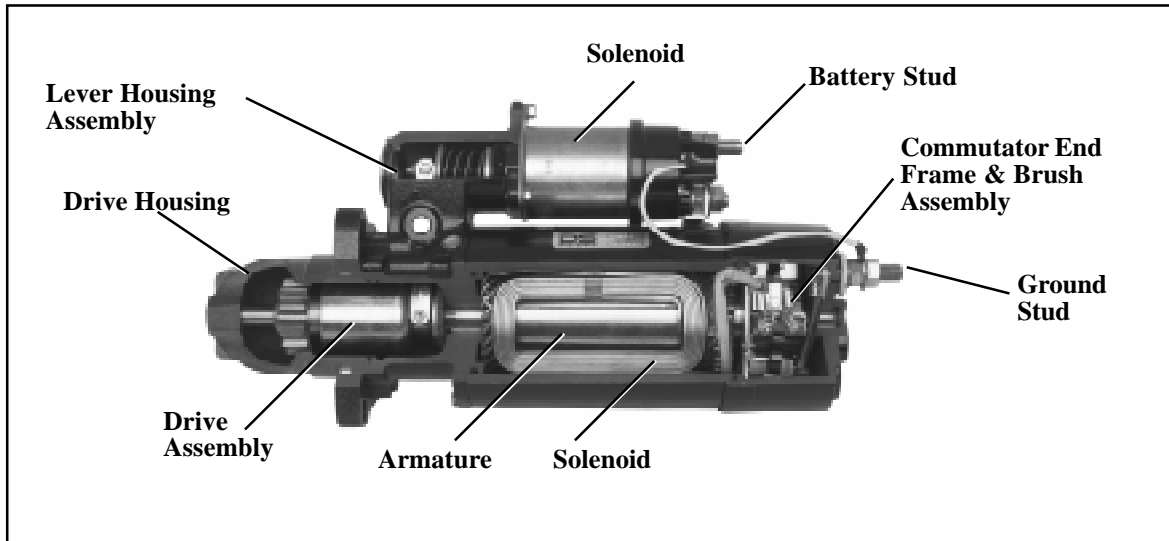


Fig. 3

ALTERNATOR

An alternator is a generator that produces alternating current from mechanical energy. The use of rectifiers or diodes converts the alternating current to direct current. The direct current is used to maintain a charge in the battery and handle the electrical loads of the vehicle.

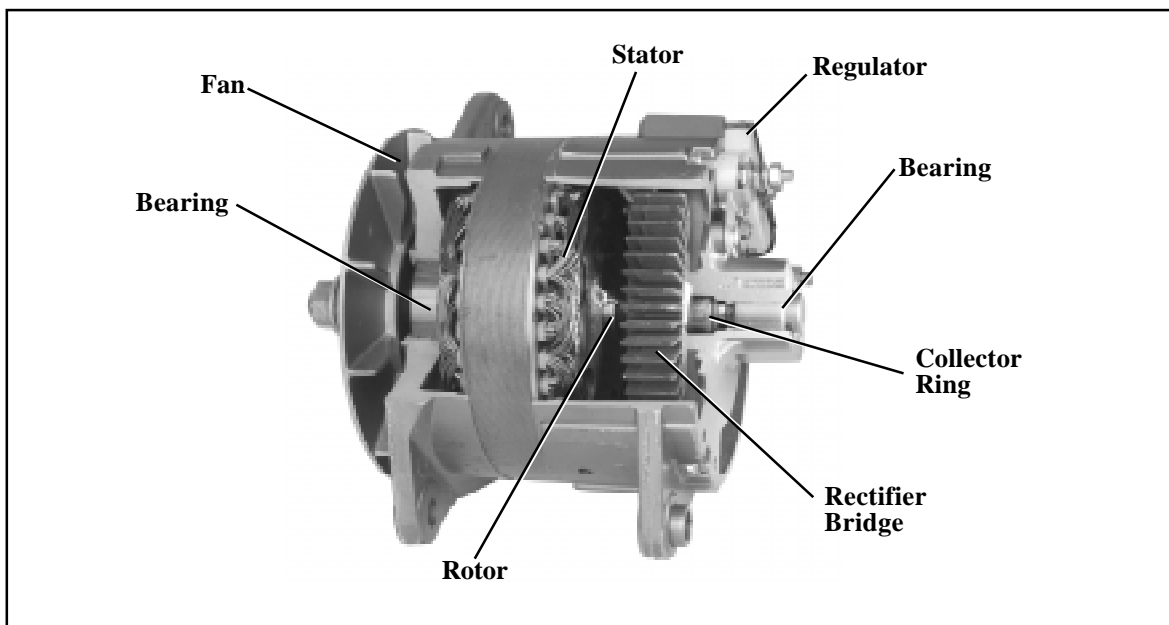


Fig. 4

WIRING CIRCUITS

Cranking circuit

The cranking circuit consists of large cables that carry the high starter current from the battery to the solenoid. Excessive voltage loss in the circuit causes slow cranking speeds, especially in cold weather. Slow cranking can lead to starter burn up if cranked over 30 seconds. Batteries that become deeply discharged can cause the same problem.

Solenoid Control Circuit

The solenoid circuit consists of the wiring from the batteries through a push button or magnetic switch to the battery "SW" (switch) terminal of the starter solenoid and back to the battery. Excessive voltage loss in this current can cause the solenoid to shift in and out (chattering) which will result in the vehicle not starting. This condition can result in a burned contact disc or terminals of the starter solenoid. When a magnetic switch is used, excessive voltage loss will also cause this switch to open and close continuously. Again, batteries that become deeply discharged or worn out will cause the same condition.

Charging Circuit

The charging circuit consists of the wiring between the alternator and battery. Excessive voltage loss in the circuit will prevent the batteries from being properly charged. Complete failure of the charging circuit can cause alternator damage and/or failure.

Battery cable size and connections

The connections and cable size have a significant effect on the electrical system. The jumper lines between batteries should be at least #00 gauge cable. The length of the circuit has a bearing on the amount of voltage loss which occurs in each cable. Be sure that all the circuits can handle the required load. (Refer to chart A2). The total length of a circuit is the sum of both sides of the circuit.

TOTAL CIRCUIT LENGTH GAUGE	CABLE GAUGE
Up to 144"	#00
144" to 180"	#000
180" to 230"	#0000

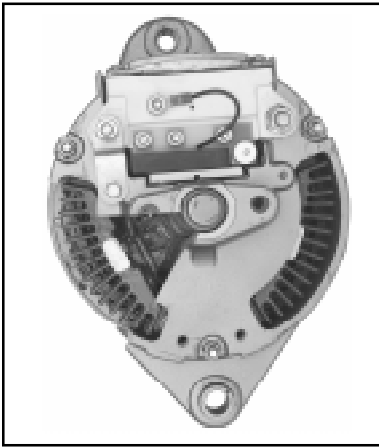
Chart A2

Corrosion and loose connections, the two largest failure causes, can be minimized by taking precautions when installing cable ends. Many times these two go hand in hand. Corrosion will cause the connections

to loosen. Corrosion travels through cables, causing voltage losses. To prevent corrosion trouble, seal all exposed areas. When using crimp style ends that are open ended, seal by soldering them closed. Wire that is exposed to the elements should be sealed by using shrinkable tubing.



Fig. 5



Energizing Alternators

Sometimes a new alternator will not charge because the magnetic field has been lost through long shelf life or jarring during shipping and handling. The magnetic field can be energized by following these steps.

Momentarily connect a jumper lead from the battery positive terminal (+) on the alternator to the relay (R) or indicator (I) terminal. This procedure will restore the normal residual magnetism.

Fig. 6

BASIC ELECTRICITY

Current = Electron Flow

Current is the flow or movement of electrons. You can compare this to the flow of water. Without pressure (voltage), the current will not flow. Ampere (amps) is the unit of measure for electrical current.

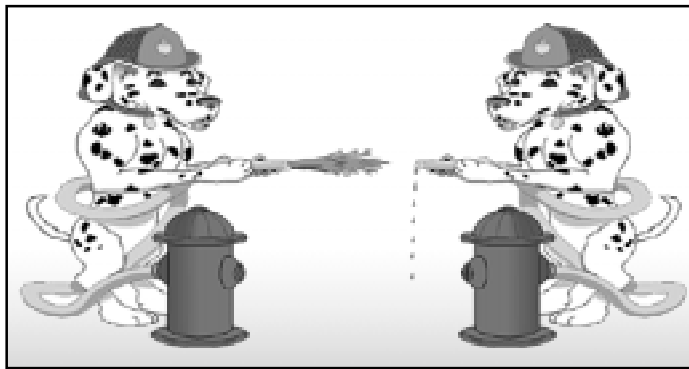


Fig. 7

Voltage = Electrical Pressure

Voltage provides the electrical pressure or force that causes current to flow. Voltage is the difference in electrical pressure between two points in a circuit.



Fig. 8

Resistance

Resistance is a restriction of current flow. If resistance increases, current flow decreases. This can be detected by voltage loss in a circuit. Ohm is the unit of measure for resistance.



Fig. 9

Magnetic Field

When forcing current through a conductor, a magnetic field is produced. Magnetic fields and direction of current flow are factors to consider when using ammeters, especially when using induction pick up ammeters.

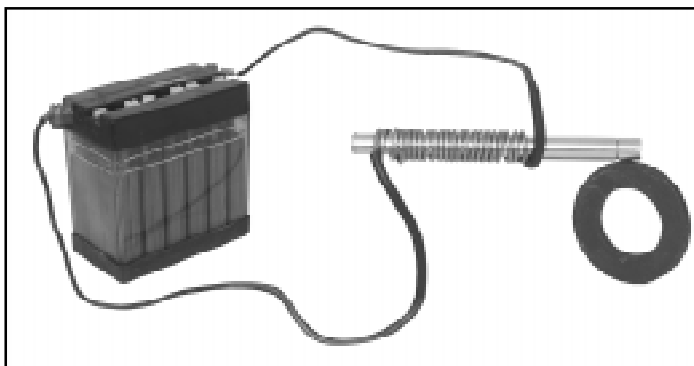


Fig. 10

Formulas and Definitions

All the electrical characteristics are interrelated. The basic formulas are:

$I = E / R$	Amperes = Volts / Ohms
$E = R I$	Volts = Ohms x Amperes
$R = E / I$	Ohms = Volts / Amperes

Amps (Amperage) — measure of current flow in a circuit

Ohms (Resistance) — measure of resistance in a circuit

Volts (Electromotive force) — measure of the force that drives current flow in a circuit

QUICK REFERENCE TROUBLE SHOOTING GUIDE

Symptom	Cause
Starter drags, slow or sluggish cranking	Discharged battery Loose or dirty connections Corroded or damaged cables
Solenoid chatters, won't engage the starter drive	Discharged battery Loose or dirty connections Problems in the solenoid or magnetic switch circuit
Starter will not operate at all	Starter relay problem Burned out solenoid Faulty ignition switch Open wire in cranking circuit Completely dead battery
Starter motors but will not engage the engine flywheel	Damaged or worn ring gear Wrong starter drive Incorrect mounting hole size
Starter will not disengage when key is released	Damaged or worn ring gear Starter loose on mounting hardware Starter relay or solenoid problem Faulty ignition switch
Batteries won't hold a charge	Loose or dirty connections Corroded or damaged cables Bad cell or cells in battery(s) Bad ground Loose or worn out belts or pulley
Alternator will not charge	Alternator rotor has lost residual magnetism Pulley is worn Loose or worn belts Bad ground Corroded or dirty connections
Alternator doesn't charge at low RPM	Wrong pulley diameter which causes alternator to spin too slowly at low engine RPM
Alternator is overcharging	Discharged battery or batteries Bad cell(s) in battery Regulator has failed
High Alternator noise level	Worn out bearing in alternator Frayed or worn belt Loose fan or pulley Alternator mounting loose

ELECTRICAL GLOSSARY

THE LANGUAGE OF CHARGING AND STARTING SYSTEMS

ALTERNATOR — A device which converts mechanical energy to electrical energy. It maintains the battery in a fully charged state.

AMPERE — The unit measure of electrical current flow. This movement can be compared to the flow of water through a pipe.

ARMATURE — Any part moved by magnetic attraction or repulsion. An example is the armature in a starter.

BATTERY — A device for storing energy and converting chemical energy into electrical energy.

BRUSH — A block of conducting substance, usually made of carbon, which picks up or delivers electric current from, or to, the commutator or slipper ring.

BRUSH HOLDER — Holds the brushes on an alternator or starter in position on the commutator or slipper rings.

CHARGE RATE — The amperage flowing from the alternator to the battery.

CIRCUIT — The path over which a current of electricity flows.

COLD CRANKING AMPS. — The number of amperes a battery at zero degrees fahrenheit can deliver for 30 seconds and maintain a voltage of 1.2 volts per cell or higher.

COMMUTATOR — A cylindrical device mounted on one end of an armature shaft. It is composed of copper segments insulated from each other. The ends of the armature windings are soldered to pairs of segments.

DRIVE END — The end of a starter that contains the pinion gear or "Bendix", or the end of an alternator which is driven by a belt or a gear.

ELECTROLYTE — A solution of sulfuric acid and water used in batteries.

FIELD COILS — A coil of insulated wire which forms the windings of a starter.

FIELD HOUSING — The center section of a cranking motor (starter) that holds the field coils.

GROUND — The part of an electrical circuit used to return current from the participating unit to its source.

HYDROMETER — The instrument which measures specific gravity. In a battery it measures the weight of the electrolyte in relation to the weight of pure water.

INDUCTION — The current induced in a conductor when the conductor cuts across a magnetic field.

MAGNETIC FIELD — The gap or space around a magnet in which the magnetic lines of force travel.

OHM — The unit of electrical measurement of resistance to the flow of current in a circuit.

OPEN CIRCUIT — A circuit which is broken so that electric current cannot flow.

OVER-CRANK PROTECTION — A temperature limiting switch built into a starter. It prevents internal damage due to extended operation caused by extreme low temperatures or batteries in a low state of charge.

PARALLEL CIRCUIT — An electrical circuit in which the electrical units and conductors are connected so that the current flows over several independent paths.

PINION — The gear portion of the starter drive mechanism which engages the flywheel ring gear when rotated by the starting motor armature.

RECTIFIER — Any device, such as the diode in an alternator, which changes alternating current to direct current.

RESISTANCE — The opposition offered to the passage of electrical current through a body or substance. The ohm is the unit of resistance.

REGULATOR — A device for sensing a battery's supply of electrical energy. The regulator limits the alternator's output voltage and keeps the current output of the alternator in step with the speed of the vehicle and the demand of the various accessories and the battery.

ROTOR — The rotating member of an alternator that provides the magnetic field needed to produce an electrical current.

ELECTRICAL GLOSSARY

THE LANGUAGE OF CHARGING AND STARTING SYSTEMS

SERIES CIRCUIT — A circuit in which the current passes through each electrical unit in succession.

SHORT CIRCUIT — A path of lesser resistance which allows current to bypass its prescribed path.

STARTER — The electrical motor which converts the electrical energy of the battery to the mechanical energy required to start the engine. Also called a cranking motor or starting motor.

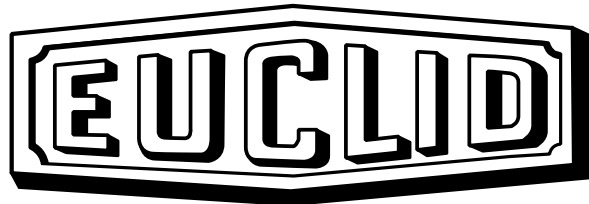
STATOR — The name of the laminated steel ring with loops of copper wire that surrounds the rotor in an alternator.

SOLENOID — An electromagnetic device used to perform a mechanical operation. A truck starter solenoid moves the drive pinion to mesh with the flywheel ring gear and holds it in position while the armature of the starter motor rotates to start the engine.

SLIP RING — A collector ring on the end of a rotor upon which the brushes ride.

VOLT — The unit of electrical pressure or electromotive force.

WATT — This unit of electrical power is calculated by multiplying amperes times voltage in a circuit. One horsepower equals 746 watts.



The Most Trusted Name In Truck Parts.

**Other Euclid Technical
Training Modules Available:**

Module One - Foundation Air Brakes

Includes:

Foundation Air Brake Hardware Kits
Camshafts/Camshaft Repair Kits
Automatic Slack Adjusters
Air Wedge Brakes

Module Two - Hydraulic Brakes

Includes:

Hydraulic Wheel Cylinders
Master Cylinder
Hydraulic Disc Brake Rotors
Hydraulic Disc Brake Calipers

Module Three - Wheel Attaching Parts

Includes:

Disc Wheel Parts
Spoke Wheel Parts

Module Four - Suspensions

Includes:

Four-Spring Suspensions
Neway Air Suspensions
Mack Camel Back
Spring Suspension
U-Bolts
Uni-Rods/Maxi-Rods
Air Springs
Shock Absorbers

Module Five - Front End Parts

Includes:

King Pin Sets
Tie Rod Ends
Drag Links
Light-Duty Front End Parts

**Module Six - Air Conditioning
and Heating Parts**

Module Eight - Engine Cooling Systems

Includes:

Water Pumps



EUCLID INDUSTRIES, INC.
6660 Beta Drive, Cleveland, OH 44143-2321
(216) 451-4300 FAX (216) 461-4307

EUCLID INDUSTRIES CANADA Ltd.
Toronto • Edmonton • Montreal • Vancouver