training chart manual

SECTION S

# INTEGRAL CHARGING SYSTEM

Delco Remy

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® A Delco-Remy Trademark for
Diode Rectified A.C. Generators

# introduction

The Delcotron® Integral Charging System is a lightweight, high-performance machine that supplies electrical power for charging the battery and operating accessories in gasoline and diesel engine electrical systems. Featuring an output at engine idle, a high output per pound of weight, and a very minimum of periodic maintenance requirements, it is a reliable and dependable member of the charging circuit team.

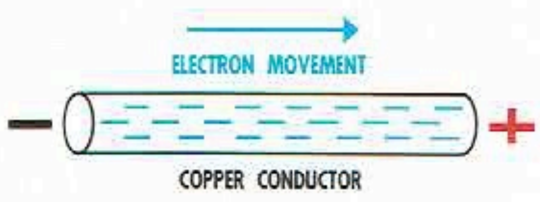
Constructed essentially of a rotor mounted on bearings in two end frames, a stator assembly, six silicon diodes, and a regulator mounted internally, the Delcotron Integral Charging System develops A. C. voltages which are rectified by the diodes to a single D. C. voltage and D. C. current output. This manual covers the operating principles by which the Delcotron Integral Charging System produces voltage and current, and also includes a section devoted to the different types and designs of Delcotron Integral Charging Systems.

# review of electricity and magnetism

In order to understand the operating principles of Delcotron® Integral Charging Systems, it will be helpful to review briefly the fundamentals of electricity, magnetism, and semiconductors.

## current

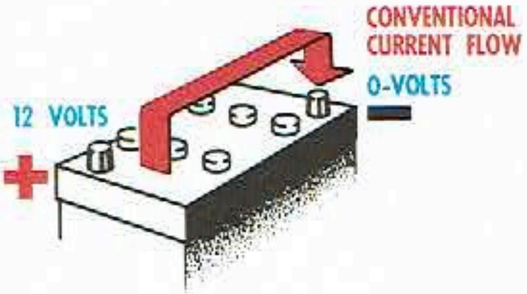
Electric current is defined as a movement of electrons through a conductor such as a copper wire. Current flow is measured in amperes, and when 6.28 billion billion electrons pass a certain point in a conductor in one second, the current flow is one ampere. Electrons, however, will not move through a conductor of their own free will. There must be some kind of force to cause the electrons to move.




## voltage

The force which causes electrons to flow in a conductor is called voltage. The voltage is the difference in electrical pressure measured between two points in a circuit. Thus, using a 12-volt battery as an example, the voltage measured between the two battery posts is 12 volts.

An important concept is "voltage potential" at a certain point in the electrical circuit. This simply means the voltage or electrical pressure at a particular point with respect to another point. If the voltage potential of one post of the 12-volt battery is zero, the voltage potential at the other post is 12 volts with respect to the first post.



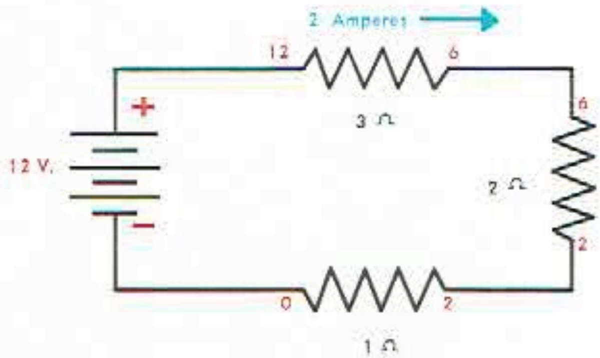

Another important concept is polarity. One post of a battery is said to be positive, and the other negative. By conventional theory the direction of current flow in a circuit is from the positive terminal through the external circuit, and then back to the negative terminal of the battery. This direction is opposite to the direction of electron flow.

## resistance

The voltage or electrical pressure needed to produce current flow in a circuit is necessary to overcome the resistance in the circuit. Resistance to the flow of current is measured in ohms. One volt will cause one ampere to flow through a resistance of one ohm. This is an expression of Ohm's Law, which can be written as illustrated.

$$\text{AMPERES} = \frac{\text{VOLTS}}{\text{OHMS}}$$

RESISTOR SYMBOL

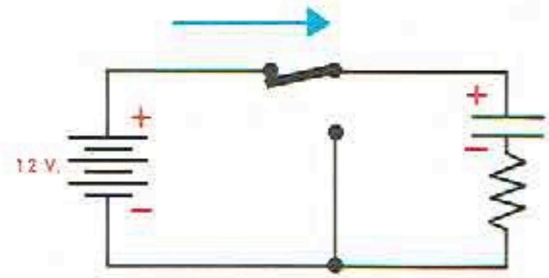


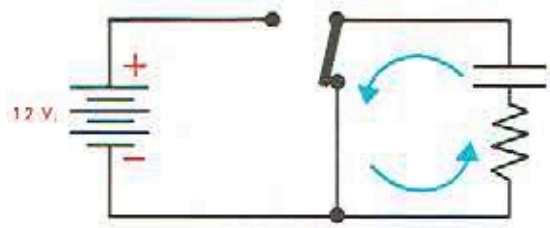

When three resistors are connected to a battery as shown, the total circuit resistance is six ohms. Applying Ohm's Law to the entire circuit, the current flow through each resistor is two amperes. Applying Ohm's Law to the one-ohm resistor, the voltage drop across the resistor is two volts. The voltage potentials across this resistor and the other resistors are shown.

## capacitor

CAPACITOR SYMBOLS

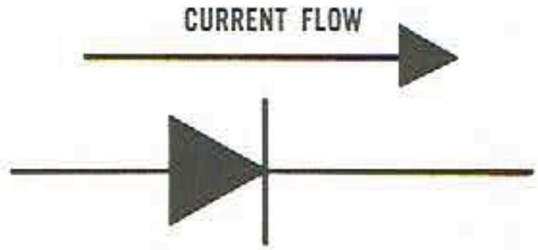
A capacitor, sometimes called a condenser, is a device in which electricity is stored. A capacitor consists of two conductors separated by an insulating material. Since the two conductors of a capacitor are electrically insulated, current flows in a capacitive circuit only when the voltage across the capacitor is changing.



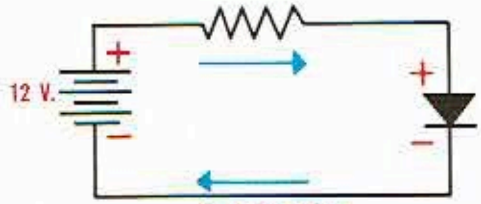




To illustrate the operation of a capacitor, consider a circuit consisting of a capacitor, a resistor, and a switch connected to a battery. When the switch is closed to the battery, the voltage across the capacitor will increase from zero to 12, and a current will flow in the circuit causing the capacitor to be charged. The positive and negative charges on the capacitor plates represent stored energy. When the capacitor voltage reaches 12 volts, the current flow will stop. When the switch is thrown to the shorting position, the capacitor will discharge through the resistor. When all the stored energy in the capacitor has been dissipated by the resistor, the current flow will stop.

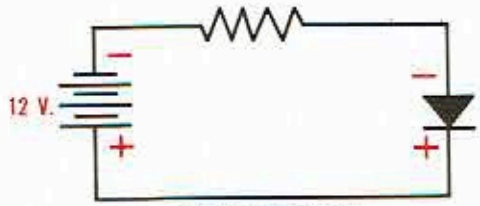
## diode




DIODE SYMBOL




CURRENT FLOW
(FORWARD BIAS)

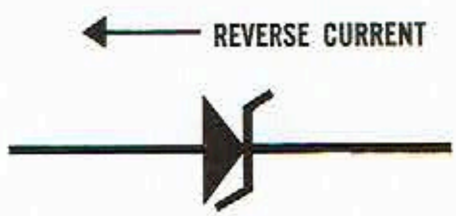



NO CURRENT FLOW
(REVERSE BIAS)

The diode is a semiconductor that will allow current to flow through itself in one direction only. When a battery is connected to a diode with the polarities as shown, called "forward bias," the diode offers only a very small resistance to the flow of current. When the battery polarity is reversed, called "reverse bias," the diode resistance is very high and no appreciable current will flow.

## zener diode

The zener diode is a specially designed type of diode that will satisfactorily conduct current in the reverse direction.



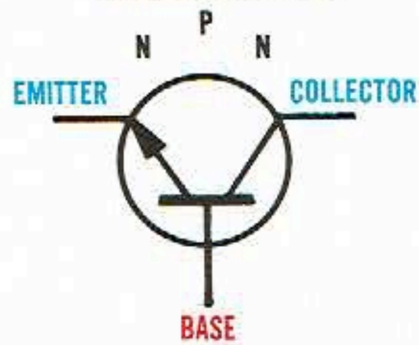

ZENER DIODE SYMBOL

The zener diode symbol is shown.

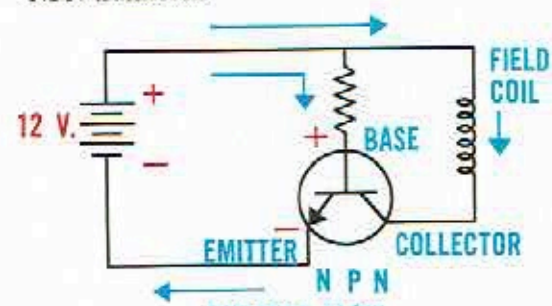
The unique operating characteristic of the zener diode is that it will not conduct current in the reverse direction below a certain predetermined value of reverse bias voltage. As an example, a certain zener diode may not conduct current if the reverse bias voltage is below six volts, but when the reverse bias voltage becomes six volts or more, the diode suddenly conducts reverse current.

## transistor

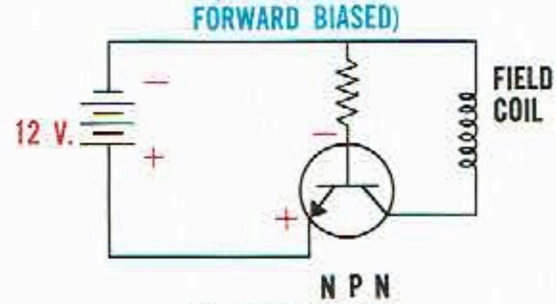
TRANSISTOR SYMBOL




The transistor is a semiconductor that consists of two diodes "back to back," or two diodes sharing a common base material. In the symbol shown, the emitter-base junction represents one diode, and the collector-base junction the second diode. Current flows through the emitter in the direction of the arrow; hence the positive side of a battery is connected to the base, and the negative side to the emitter, as shown. The symbol shown represents an NPN transistor.




CURRENT FLOW
(EMITTER-BASE
FORWARD BIASED)




N P N
NO CURRENT FLOW
(EMITTER-BASE
REVERSE BIASED)

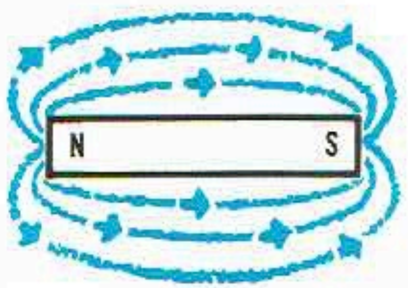
In the first illustration, the emitter-base is forward biased by the battery, and the entire transistor has very low resistance. Current will flow through the circuit as shown.

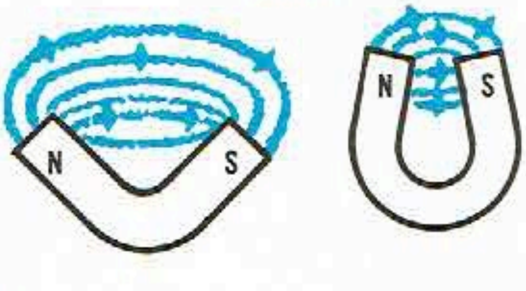
If the battery is connected to the emitter-base in the reverse direction, the transistor has a very high resistance, and no current at all will flow through the transistor.

The important thing to observe about the transistor is that the voltage across the field coil, as illustrated, can be "turned on" and "turned off" by reversing the voltage bias across the emitter-base. The transistor thus can be made to behave like a relay, or a closed or open switch.

## magnetism

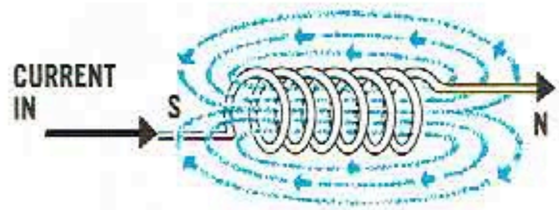
Magnetism, like electricity, is invisible. Its effects, however, are well known. An example is the attraction of a bar magnet for iron filings. A magnet has a North pole, designated as "N," and a South pole, designated as "S." The space around the magnet in which iron filings are attracted is called the "field of force" or magnetic field, and is described as lines which come out of the North pole and enter the South pole.

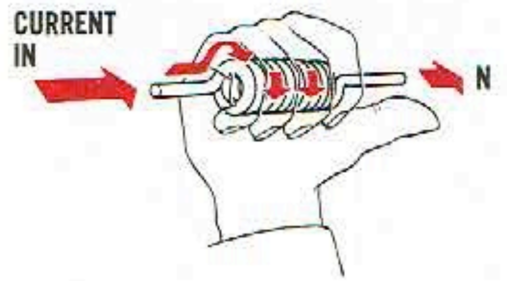


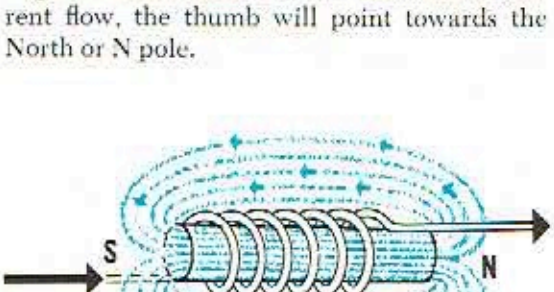

Electricity and magnetism are very closely associated, because when electric current passes through a wire a magnetic field is created around the wire.


When a wire carrying electric current is wound into a coil, a magnetic field with N and S poles is created just as in a bar magnet.



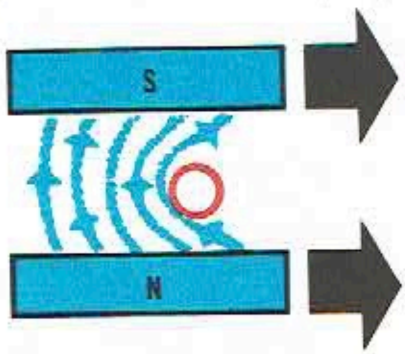

Using the "Right Hand Rule" — wrapping the fingers around the coil in the direction of current flow, the thumb will point towards the North or N pole.




If an iron core is placed inside the coil, the magnetic field becomes much stronger, because iron conducts magnetic lines much easier than air. This arrangement, called an electromagnet, is used in generators to create strong magnetic fields by winding many turns of current-carrying wire around iron cores called pole pieces.

## electromagnetic induction

We have seen that a magnetic field, made up of lines of force, is created around a wire when current is passed through it. If a magnetic field is moved so that the lines of force cut across a wire conductor, a voltage will be induced in the conductor. The induced voltage will cause current to flow when an electrical load, such as a resistor, is connected across the conductor.




The direction of current flow is determined by the direction of the magnetic lines of force and the direction of motion of the magnetic field with respect to the conductor. To visualize this, note the illustration, where magnetic pole pieces are being moved so that the magnetic lines of force are cutting across a conductor.

The direction of the magnetic lines of force is upward, since magnetic lines leave the North pole and enter the South pole. The direction of motion of the magnetic field is toward the right, as indicated by the gray arrows. With this direction of motion, the magnetic lines are striking the conductor on its left side, which is called the leading side.


The direction of current flow can be determined by applying the Right Hand Rule as follows: Grasp the conductor with the right hand with the fingers on the leading side of the conductor, and pointed in the direction of the magnetic lines of force. The thumb will then point in the direction of current flow.

**Voltage is generated in Delcotron generators by moving strong magnetic fields across stationary conductors.**

## summary

Although our discussion has been limited and rather brief, it will serve as a useful background for the explanations which follow. For more detailed information, refer to the following Delco-Remy Training Chart Manuals:

- DR-5133A — Fundamentals of Electricity and Magnetism
- DR-5133B — Batteries and Energizers
- DR-5133J — Fundamentals of Semiconductors
- DR-5133K — Fundamentals of Delcotron Generators
- DR-5133L — Transistor Regulators