training chart manual

SECTION K

FUNDAMENTALS OF DELCOTRON® GENERATORS

Delco Remy

Delco Remy

SECTION K

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introduction

The Delcotron® generator 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.

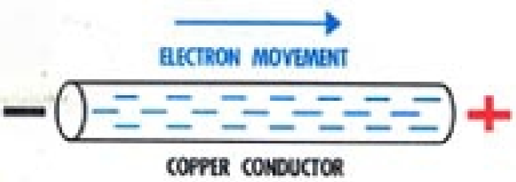
Constructed essentially of a rotor mounted on bearings in two end frames, a stator assembly, and six silicon diodes, the Delcotron generator develops A. C. voltages which are rectified by the diodes to a single D. C. voltage and D. C. current output. This manual covers the operating principles by which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

review of electricity and magnetism

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

current

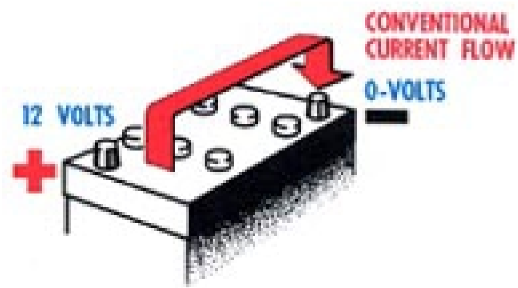
Electric current is defined as a movement of electrons through a conductor such as a copper wire. Current flow is measured in amperes, and when 6.28 billion billion electrons pass a certain point in a conductor in one second, the current flow is one ampere. Electrons, however, will not move through a 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 battery or generator positive terminal through the external circuit, and then back to the negative terminal of the battery or generator. 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.

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

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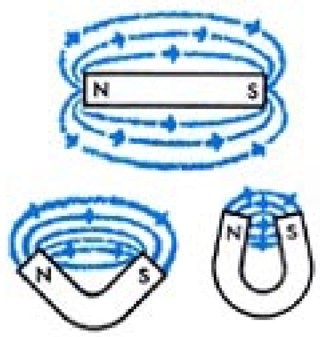
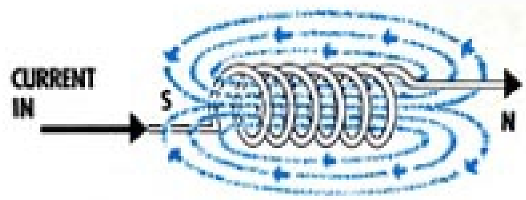
magnetism

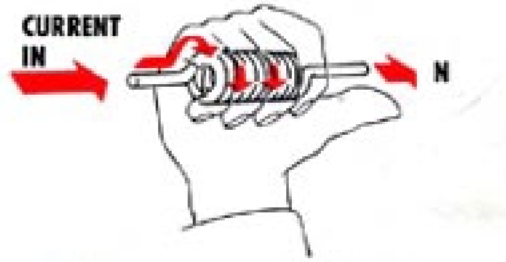
Magnetism, like electricity, is invisible. Its effects, however, are well known. An example is the attraction of a bar magnet for iron filings. A magnet has a North pole, designated as "N," and a South pole, designated as "S." The space around the magnet in which iron filings are attracted is called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



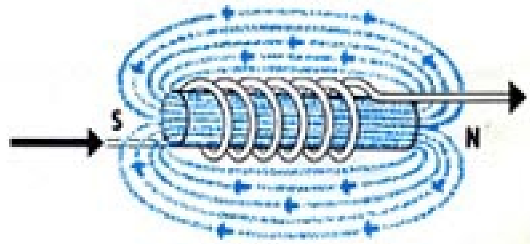
Electricity and magnetism are very closely associated, because when electric current passes through a wire a magnetic field is created around the wire.

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.





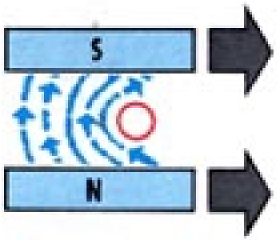
Using the "Right Hand Rule" — wrapping the fingers around the coil in the direction of current flow, the thumb will point towards the North or N pole.



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.

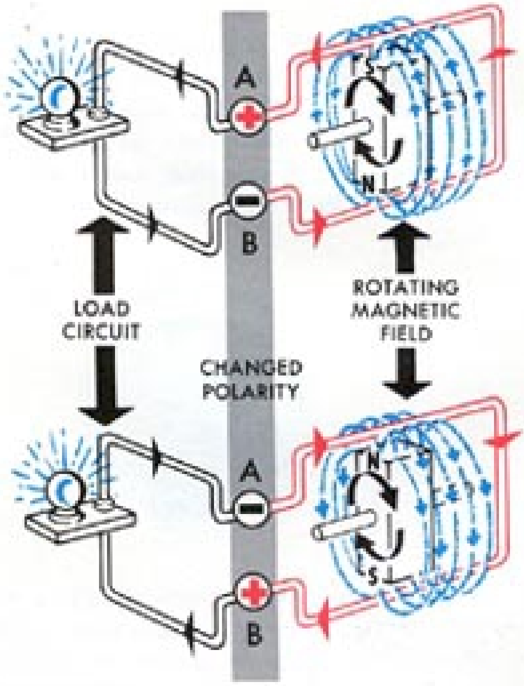
The direction of current flow can be determined by applying the Right Hand Rule as follows: Grasp the conductor with the right hand with the fingers on the leading side of the conductor, and pointed in the direction of the magnetic lines of force. The thumb will then point in the direction of current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

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

Although our coverage of basic electrical principles has been limited and rather brief, it will serve as a useful background for the next section covering the operating principles of Delcotron generators. For a more thorough coverage of electrical fundamentals, refer to the Delco-Remy Training Chart Manual, DR-5133A, entitled, "Fundamentals of Electricity and Magnetism."

operating principles of Delcotron generators

In the review of electrical fundamentals, it was observed that a voltage will be induced in a conductor when a magnetic field is moved across the conductor. For example, consider a bar magnet with its magnetic field rotating inside a loop of wire.

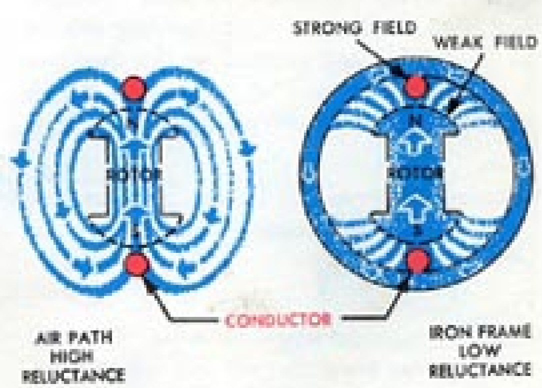


With the magnet rotating as indicated, and with the S pole of the magnet directly under the top portion of the loop and the N pole directly over the bottom portion, the induced voltage, as determined by the Right Hand Rule, will cause current to flow in the circuit in the direction shown. Since current flows from positive to negative through the external or load circuit, the end of the loop of wire marked "A" will be positive (+) polarity and the end marked "B" will be negative (—).

After the bar magnet has moved through one-half revolution, the N pole will have moved directly under the top conductor and the S pole directly over the bottom conductor. The induced voltage as determined by the Right Hand Rule will now cause current to flow in the opposite direction. The end of the loop of wire marked "A" will become negative (—) polarity, and the end marked "B" will become positive (+). Therefore, the polarity of the ends of the wire has changed. After a second one-half revolution, the bar magnet will be back at the starting point where "A" is positive (+) and "B" negative (—).

Consequently, current will flow through the load or external circuit first in one direction and then in the other. This is an alternating current which is developed internally by a Delcotron generator.

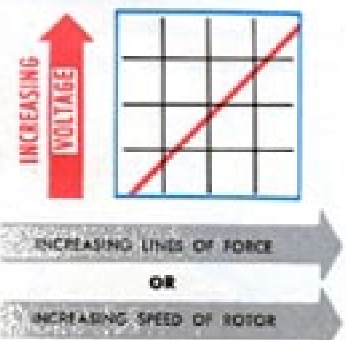
A Delcotron generator made with a bar magnet rotating inside a single loop of wire is not practical, since very little voltage and current are produced. The performance is improved when both the loop of wire and the magnet are placed inside an iron frame. The iron frame not only provides a place onto which the loop of wire can be assembled, but also acts as a conducting path for the magnetic lines of force. Without the iron frame, magnetism, after leaving the N pole of the rotating bar magnet, must travel through air to get to the S pole. Because air has a high reluctance to magnetism, only a few lines of force will come out of the N pole and enter the S pole. Since iron conducts magnetism very easily, adding the iron frame greatly increases the number of lines of force between the N pole and the S pole. This means that more lines of force will be cutting across



the conductor which lies between the bar magnet and the frame.

It is important to note that a very large number of magnetic lines of force are at the center of the tip of the magnet, whereas there are only a few lines of force at the leading and trailing edges of the tips. Thus, there is a strong magnetic field at the center and a weak magnetic field at the leading and trailing edges. This condition results when the distance, called the air gap, between the magnet and field frame is greater at the leading and trailing edges than at the center of the magnet.

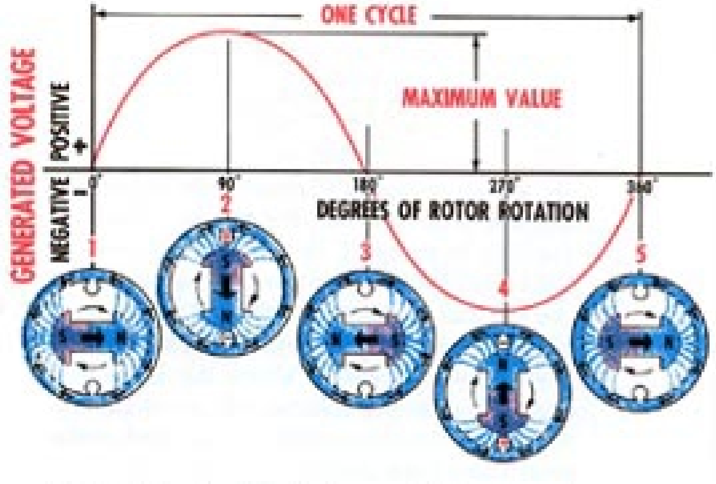
The amount of the voltage induced in a conductor is proportional to the number of lines of force which cut across the conductor in a given length of time. Therefore, if the number of lines of force is doubled, the induced voltage will be doubled.



The voltage will also increase if the bar magnet is made to turn faster because the lines of force will be cutting across the wire in a shorter period of time.

It is important to remember that either increasing the speed of rotation of the bar magnet, or increasing the number of lines of force cutting across the conductor, will result in increasing the voltage. Similarly, decreasing the speed of rotation or decreasing the number of lines of force will cause the voltage to decrease.

The rotating magnet in a Delcotron generator is called the rotor, and the loop of wire and outside frame assembly is called the stator.



Pictured in the illustration are different positions of the rotor as it rotates at constant speed. In the top portion of the illustration is a curve showing the magnitude of the voltage which is generated in the loop of wire as the rotor revolves.

The voltage curve shows the generated voltage or electrical pressure which can be measured across the ends of the wire, just as voltage can be measured across the terminal posts of a battery.

With the rotor in the first position (1), there is no voltage being generated in the loop of wire because there are no magnetic lines of force cutting across the conductor. As the rotor turns and approaches position (2), the rather weak magnetic field at the leading edge of the rotor starts to cut across the conductor, and the voltage increases. When the rotor reaches position (2), the generated voltage has reached its maximum value, as shown above the horizontal line in the illustration. The maximum voltage occurs when the rotor poles are directly under the conductor. It is in this position that the conductor is being cut by the heaviest concentration of magnetic lines of force.

It should be noted in particular that the magnitude of the voltage varies because the concentration of magnetic lines of force cutting across the loop of wire varies. The voltage curve shown is not a result of a change in rotor speed, because in the illustration the rotor is considered to be turning at a constant speed.

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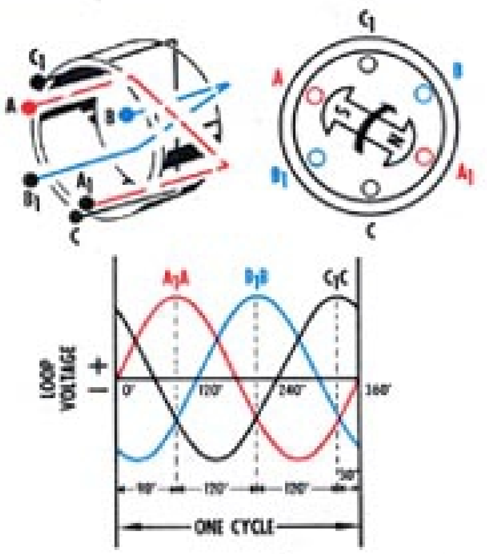
By applying the Right Hand Rule to position (2), it is seen that the direction of current in the loop of wire will be out of the top end of the conductor, and into the bottom end. Thus, the top end of the conductor will be positive, and the bottom end negative. The voltage curve which is shown above the horizontal line represents the positive voltage at the top end of the wire loop which is generated as the rotor turns from position (1) to position (3).

As the rotor turns from position (2) to position (3), the voltage decreases until at position (3) it again becomes zero.

As the rotor turns from position (3) to position (4), note that the N pole of the rotor is now passing under the top part of the wire loop, and the S pole under the bottom part. From the Right Hand Rule, the top end of the loop of wire is now negative, and the bottom end positive. The negative voltage at the top end of the loop is pictured in the illustration by the curve which is below the horizontal line.

The voltage again returns to zero when the rotor turns from position (4) to position (5).

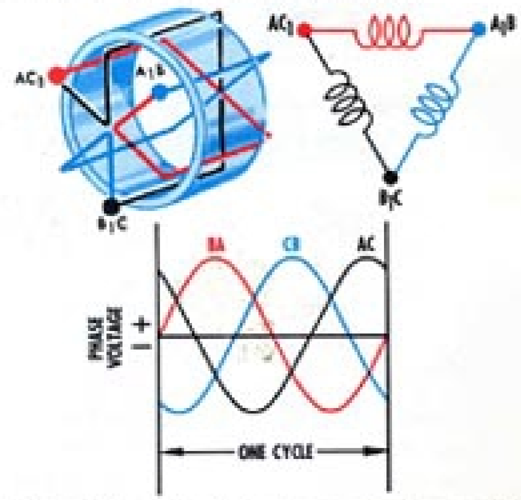
The voltage curve in the illustration represents one complete turn or cycle of the rotor.



With the rotor making 60 complete turns in one second, there will be 60 such curves, one coming right after the other, resulting in 60 cycles per second. The number of cycles per second is called the frequency. Since the generator speed varies in automotive type applications, the frequency also varies.

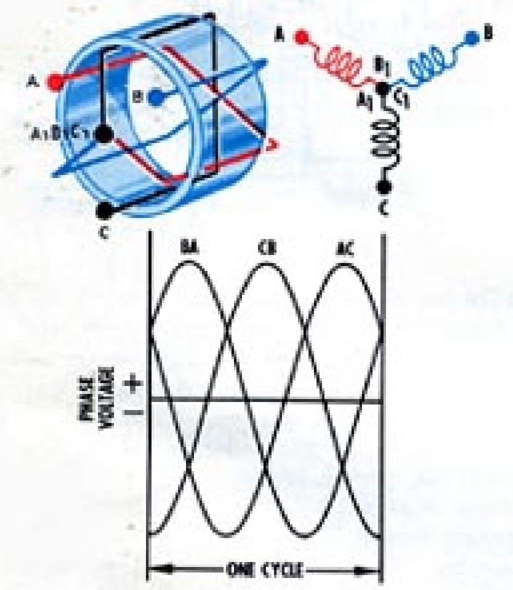
The single loop of wire acting as a stator winding, and the bar magnet acting as the rotor, serve to illustrate how an A. C. voltage is produced in a basic generator. When two more separate loops of wire, spaced 120 degrees apart, are added to our basic generator, two more separate voltages will be produced.

With the S pole of the rotor directly under the A conductor the voltage at A will be maximum in magnitude and positive in polarity. After the rotor has turned through 120 degrees, the S pole will be directly under the B conductor and the voltage at B will be maximum positive. Similarly, 120 degrees later, the voltage at C will be maximum positive. This means that the peak positive voltages at A, B and C in each loop of wire occur 120 degrees apart. These loop voltage curves are shown in the illustration.



When the ends of the loops of wire marked A_1, B_1 and C_1 are connected to the ends marked B, C and A respectively, as illustrated, a basic three phase "delta"-connected stator is formed. The three A. C. voltages available from the delta-connected stator are identical to the three voltages previously discussed, and may now be denoted as the voltages from B to A, C to B, and A to C, or more simply BA, CB and AC. An inspection of the illustration will show the logic of this notation. Example: The voltage formerly called A_1A may now be called BA.

When the ends of the loops of wire marked A_1, B_1 and C_1 are connected together, a basic three-phase "Y"-connected stator is formed. The three voltages available from the "Y"-connected stator may be labeled BA, CB and



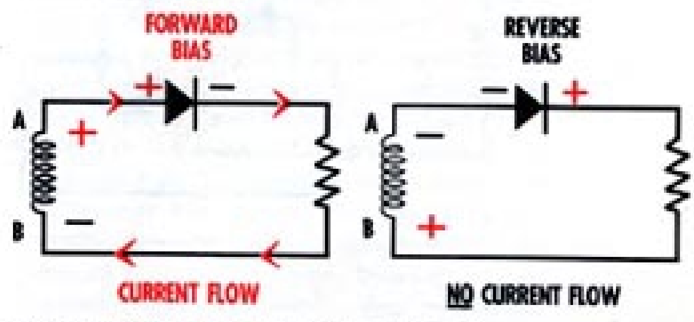
AC. From the illustration it may be seen that each of these voltages consists of the voltages in two loops of wire added together. For example, the voltage measured from B to A consists of the voltages in loops B_1B and A_1A added together. This addition yields a voltage curve BA similar in shape and form to the individual loop voltages, except that the voltage curve BA will be approximately 1.7 times as large in magnitude as an individual loop voltage. The addition of the loop voltages involves a mathematical process which will not be presented here, since it is only necessary to remember that three A. C. voltages spaced 120 degrees apart are available from the "Y"-connected stator, as illustrated. These voltage curves will be considered in more detail in the following sections.

At this point in our discussion we have developed the two basic types of stator windings, and have shown how three separate complete cycles of A. C. voltage spaced 120 degrees apart are developed for each complete revolution of the rotor. We now turn our attention to the diode, and will see how six diodes connected to the stator winding change the three A. C. voltages to a single D. C. voltage needed for the D. C. electrical system.

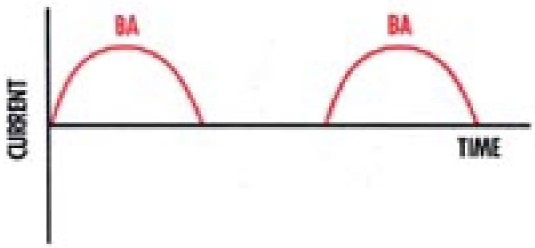
A complete description of the operating principles of diodes is covered in Delco-Remy Training Chart Manual DR-5133J, entitled, "Fundamentals of Semiconductors." For the purposes of this section, we need know only that a diode is an electrical device that will allow current to flow through itself in one direction only. The diode is often pictured by this symbol, and current can flow through the diode only in the direction indicated by the arrow.

DIODE SYMBOL

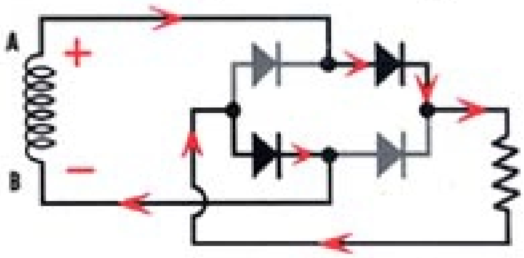
When a diode is connected to an A. C. voltage source having ends marked A and B, current will flow through the diode when A is positive (+) and B is negative (−). The diode is said to be "forward-biased," and with the voltage polarity across the diode as shown, it will conduct current. When the voltage at A is negative and at B is positive, the diode is said to be "reverse-biased" and it will not conduct current.

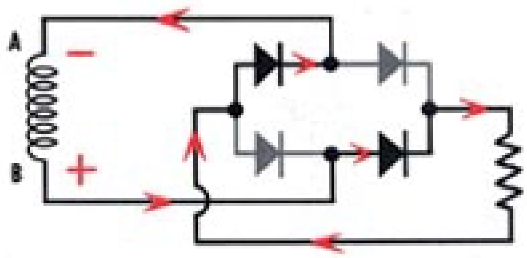


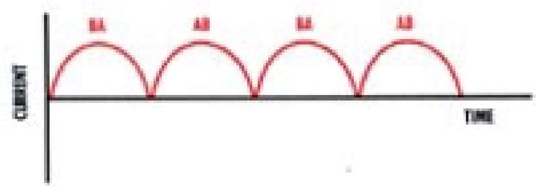
The current flow that would be obtained from this arrangement is illustrated. Since the current flows only half the time, the diode provides what is called "half-wave rectification." A generator having only one diode would provide very limited output.

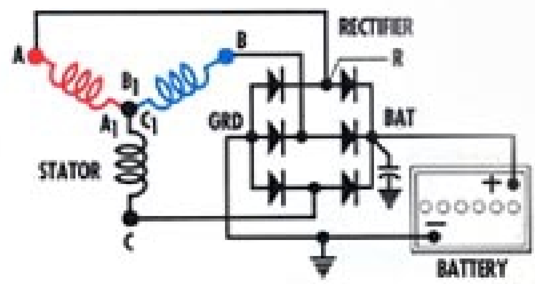


The output is increased when four diodes are used to provide "full wave rectification." Note that the current is more continuous than with one diode, but that the current varies from a maximum value to a zero value. It is particularly important to observe that the current flow through the external load resistor is in one direction only. The A. C. voltage and current have, therefore, been rectified to a unidirectional or D. C. voltage and current. This circuit arrangement could be used to charge a D. C. battery, but it does not produce the most output that can be obtained in a generator.



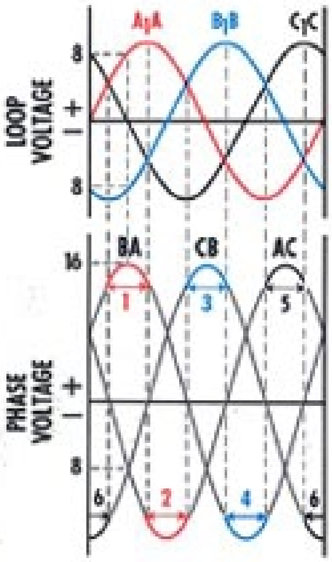


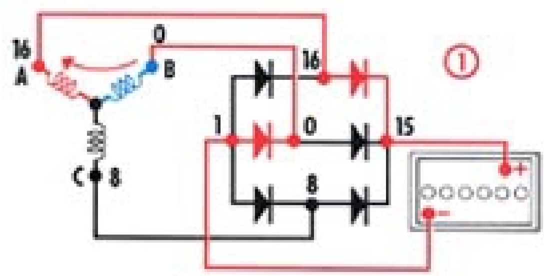




In order to obtain a higher output and a smoother voltage and current, a three-phase stator is connected to six diodes which together form a "three-phase full-wave bridge rectifier." The operation of the "Y"-connected stator will be illustrated first, then that of the delta-connected stator. A battery connected to the D. C. output terminal will have its energy restored as the generator provides charging current. Note that the blocking action of the diodes prevents the battery from discharging directly through the rectifier.

In order to explain the direction of current flow in the stator-rectifier combination, we will review briefly our previous discussion concerning the three A. C. voltage curves produced in the "Y"-connected stator winding. Our first reference was to the voltages developed in each loop. These loop voltage curves A_1A, B_1B and C_1C are reproduced here for reference. However, these individual loop voltages do not appear across the rectifier diodes, because the rectifier is connected only to the A, B and C terminals of the stator. Therefore, the voltages which appear across the rectifier diodes are the phase voltages BA, CB and AC.





The phase voltage curves BA, CB and AC are also reproduced here, and are obtained as previously explained by adding together each pair of loop voltages. As an example, phase voltage BA is obtained by adding together the voltages in loops A_1A and B_1B. In order to obtain the phase curve BA, we add together the voltage from B to B_1, and the voltage from A_1 to A. Consider the instant when the voltage in curve BA is maximum in magnitude and positive in polarity. At this same instant the voltage B_1B is minus 8, or the voltage from B to B_1 is plus 8. This value added to the A_1A loop voltage of plus 8 volts yields a maximum positive voltage of 16 volts for curve BA. By taking different instants of time, the entire curve BA and curves CB and AC, can be obtained in this same manner.

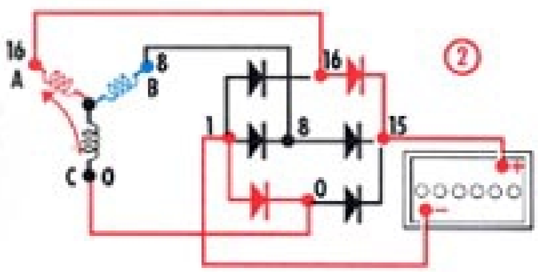
For convenience, the three A. C. voltage curves provided by the "Y"-connected stator for each revolution of the rotor have been divided into six periods, 1 through 6. Each period represents one-sixth of a rotor revolution, or 60 degrees.

An inspection of the voltage curves during period 1 reveals that the maximum voltage being produced appears across stator terminals BA. This means that the current flow will be from B to A in the stator winding during this period, and through the diodes as illustrated.

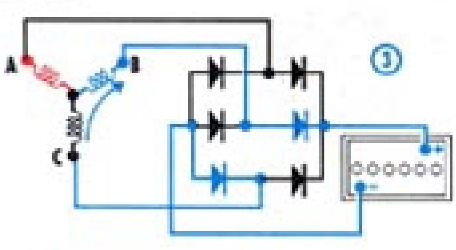
In order to see more clearly why the current flows during period 1 as illustrated, assume that the peak phase voltage developed from B to A is 16 volts. This means that the potential at B is zero volts, and the potential at A is 16 volts. Similarly, from the curves the phase voltage from C to B at this instant is minus 8 volts. This means that the potential at C is 8 volts, since C to B, or 8 to zero, represents a minus 8 volts. At this same instant the phase voltage from A to C is also minus 8 volts. This checks, since A to C, or 16 to 8, represents minus 8 volts.

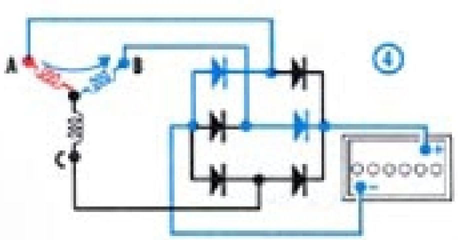
Neglecting voltage drops in the wiring, and assuming a one volt drop in the conducting diodes, the voltage potentials are noted on the rectifier. Only two of the diodes will conduct current, since these diodes are the only ones in which current can flow in the forward direction. The other diodes will not conduct current *because they are reverse biased.* For example, the lower right-hand diode is reverse biased by 7 volts ($15 - 8 = 7$), and the right-hand middle diode is reverse biased by 15 volts ($15 - 0 = 15$). *It is the biasing of the individual diodes, provided by the stator, that determines how current flows in the stator-rectifier combination.* Throughout period 1 the current flows as indicated, because the bias direction across the diodes does not change from that shown. Although the voltage potentials across the diodes will vary numerically, this variation is not sufficient during period 1 to change a diode from reverse bias to forward bias and from forward bias to reverse bias.

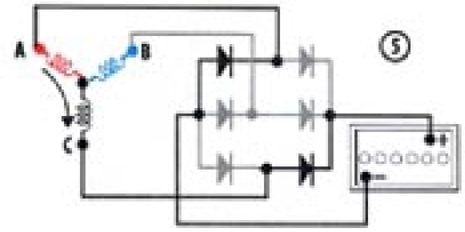
An inspection of the phase voltage curves will reveal that between periods 1 and 2 the maximum voltage being impressed across the diodes changes or switches from phase BA to phase AC. This means that as the maximum voltage changes the current flow will change from BA to CA.

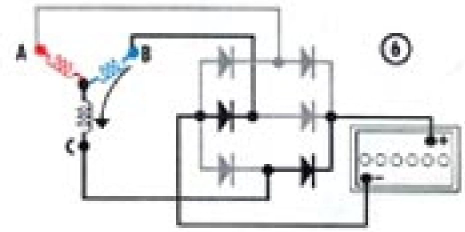


It is important to note that the maximum voltage being produced in the stator windings during period 2 appears across phase AC and that this voltage is negative from A to C. Taking the instant of time at which this voltage is 16 volts, the potential at A is 16, and at C is zero (A to C, or 16 to 0, is a negative or minus 16). Similarly, at this same instant, the voltage across phase BA is 8 volts, and across phase CB is 8 volts. This means that the potential at B is 8 volts, as shown. The direction of current flow during period 2 is illustrated.



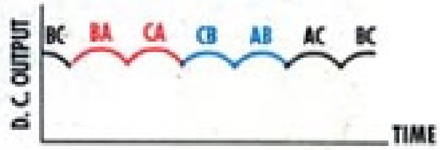






Following the same procedure for periods 3–6, the current flow conditions can be determined, and are shown in the illustrations. These are the six major current flow conditions for a three-phase "Y"-connected stator and rectifier combination.

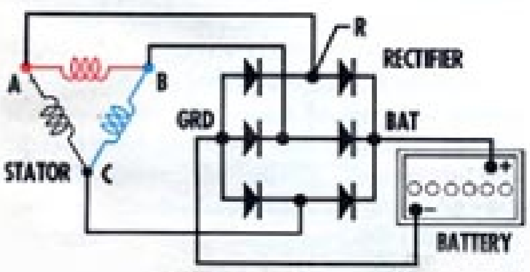
The voltage obtained from the stator-rectifier combination when connected to a battery is not perfectly "flat," but is so smooth that for all practical purposes the output may be considered to be a non-varying D. C. voltage. The voltage, of course, is obtained from the phase voltage curves, and can be pictured as illustrated.

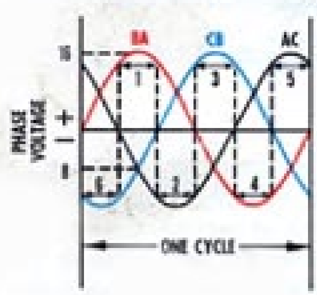


An alternate method of establishing the direction of current flow through the rectifier for a "Y"-connected stator is to refer to the illustration showing the loop voltage curves. During period 1 the two loop windings having the largest voltages are A_1A and B_1B, with the voltage in loop C_1C always being less than the voltages in the other two loops. Since the voltage in A_1A is positive, and in B_1B is negative (positive from B to B_1), the current will flow from B to A during period 1. The phase voltage curve BA, of course, is simply a picture of the actual voltage that the two loop voltages A_1A and B_1B added together impress across the rectifier diodes.

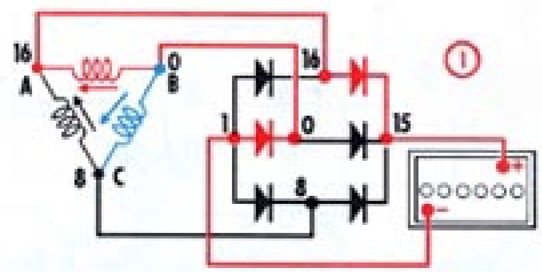
Referring again to the loop voltage curves, the two loop windings having the largest voltages during period 2 are A_1A and C_1C. Since the voltage in A_1A is positive, and C_1C is negative (positive from C to C_1), the current will flow from C to A during period 2. In this same manner, the current flow directions can be determined for the remaining four periods.

Although this alternate method of using loop voltages can be used to determine the current flow directions, it cannot be used to explain why the current flows as it does through the stator-rectifier combination. In order to explain why, it is necessary to determine the voltages that actually exist at the rectifier, because it is these voltages and the biasing of the diodes that determine the current flow directions. These voltages are represented by the phase voltage curves, which are the voltages that actually appear at the rectifier diodes. Again, as we have already seen, the phase voltage curves are simply the loop voltage curves added together.





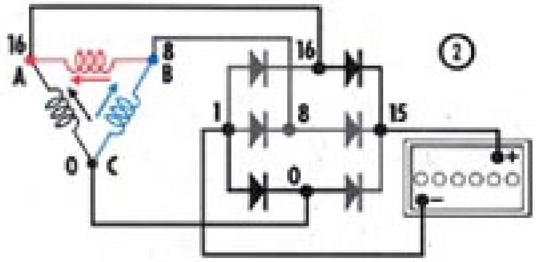
A delta-connected stator wound to provide the same output as a "Y"-connected stator also will provide a smooth voltage and current output when connected to a six-diode rectifier. For convenience, the three-phase A. C. voltage curves obtained from the basic delta connection for one rotor revolution are reproduced here and have been divided into six periods.



During period 1, the maximum voltage being developed in the stator is in phase BA. To determine the direction of current flow, consider the instant at which the voltage during period 1 is a maximum, and assume this voltage to be 16 volts. The potential at B is zero, and at A is 16. From the curve, it can be seen that the voltage of phase CB is a negative or minus 8 volts. Therefore, the potential at C is 8 (C to B or 8 to 0 is a minus 8 volts). Similarly, the voltage of phase AC is minus 8 volts. This checks, since A to C, or 16 to 8, is a minus 8. These voltage potentials are shown in the illustration. The current flow through the rectifier is exactly the same as for a "Y"-connected stator, since the voltage potentials on the diodes are identical.

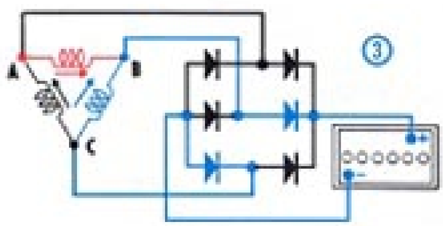
An inspection of the delta stator, however, reveals a major difference from the "Y" stator. Whereas the "Y" stator conducts current through only two windings throughout period 1, the delta stator conducts current through all three. The reason for this is apparent, since phase BA is in parallel with phase BC plus CA. Note that since the voltage from B to A is 16, the voltage from B to C to A also must be 16. This is true since 8 volts is developed in each of these two phases.

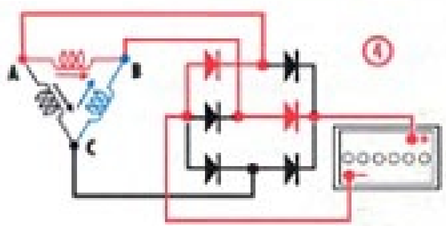
During period 2, the maximum voltage developed is in phase AC, and the voltage potentials are shown on the illustration at the instant the voltage is maximum. Also shown are the other phase voltages, and again, the current flow through the rectifier is identical to that for a "Y" stator, since the voltages across the diodes are the same. However, as during period 1,

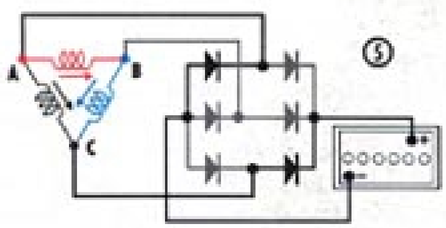


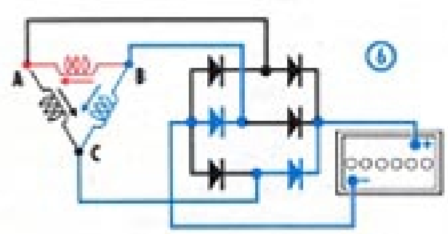
all three delta phases conduct current as illustrated.

Following the same procedure for periods 3–6, the current flow directions are shown. These are the six major current flow conditions for a delta stator.









This concludes our study of the fundamental principles by which a simple, basic generator develops three A. C. voltages which are then rectified to a single D. C. voltage and current for use in the electrical system. Although the typical voltage values used in the recent illustrations ignore line drops, they serve very well to show in simplified fashion the sequence and direction of current flow through the stator and diodes.

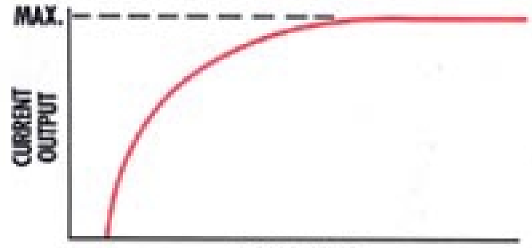
The Delcotron generator is constructed with more than just a bar magnet as a rotor and three single loops of wire as a stator. In the next section we will direct our attention to the basic types and designs of Delcotron generators, and to the construction features of each.

types and designs

The Delcotron generator has only one function to perform in the electrical system—to supply current to charge the battery and operate electrical accessories. Since each application makes its own special requirements on the generator, there are many different types and designs of Delcotron generators. Some of the factors which determine generator design are type of mounting, vibration, belt loading, minimum and maximum rotor speeds, current output, service life required, and environmental factors such as dust, dirt, road splash, and the presence of explosive mixtures in the atmosphere. This section covers the basic types and designs of Delcotron generators, and the primary construction features of each.

All Delcotron generators have the rotor mounted on ball or roller bearings, and each bearing has a supply of lubrication to provide long periods of service. Current to the coil winding mounted on the rotor is supplied through brushes riding on smooth slip rings.

All Delcotron generators develop three-phase A. C. voltage which is then rectified to a single D. C. voltage available at the output terminals on the generator. Also, all Delcotron generators are designed to provide an output at engine idle, the amount depending on the application. The Delcotron generator is "self-limiting" in its maximum output—this occurs as the magnetic field produced by the current



in the stator windings opposes in polarity and approaches in value the magnetic field provided by the rotor as the generator output increases. This causes the generator to limit its own output to a maximum value.

Generators of this type are designated as the 10-DN Series, and are used on many applications, including automotive, light truck, farm tractor and aircraft. Some models feature enclosed brushes and slip rings to meet the requirements of marine and other applications where explosive mixtures may be present.

The rotor assembly consists of two iron pole pieces with interlacing fingers mounted over many turns of wire which are wound over the rotor core mounted on the shaft. The rotor coil is connected electrically to the two slip rings, which are then connected to the battery through the brushes and leads. When energized, the rotor coil is an electromagnet which produces alternate North and South poles. The rotor shown has a total of 14 poles.

The stator assembly consists of three separate windings mounted on a laminated iron frame. The windings are connected together to form a "Y" connected stator. An incomplete stator assembly with only one of the windings is illustrated.

Each winding consists of seven coils, and each coil contains many turns of wire. There is one coil for each pair of rotor poles. A complete cycle of A. C. voltage will be generated in each coil as a North and South pole pass by the coil. With seven coils in series, each being influenced by a North and South pole simultaneously, there will be seven coil voltages adding together to provide a complete winding voltage. In the previous section, a two-pole magnet type of rotor was used to show that a complete cycle of A. C. voltage will be produced for each rotor revolution. With a 14-pole rotor, seven complete cycles of A. C. voltage will be produced for each rotor revolution.

Two more identical windings mounted on the iron frame complete the assembly. These windings are spaced so that the "Y"-connected stator delivers three-phase A. C. voltage as covered in the previous section.

The stator is connected to six press-in type diodes. Three of these diodes are mounted in the end frame, and the other three are mounted in an electrically insulated heat sink. The entire generator is cooled by an external fan mounted on the shaft.

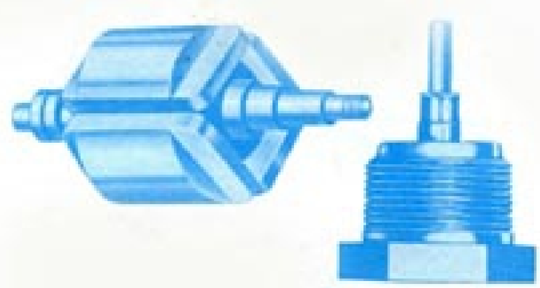
With a 14-pole rotor having strong magnetic fields, a stator containing many turns of wire, and adequate cooling, the generator is a high output source of electricity.

20–DN

The 20-DN Series of generators use a 16-pole rotor similar to the 14-pole type, a "Y"-connected stator, and press-in diodes. This type of assembly is of rugged construction, with dual internal fans for cooling, and with fully enclosed dual brush sets featured on some models. The diodes are assembled into two separate heat sinks attached to the generator shell or outer frame. This type of generator is normally used on automotive, light and heavy-duty truck, marine, and industrial applications requiring higher current outputs than the preceding assembly.

30–DN

Shown in the illustration is a 30-DN Series generator used in truck, marine, industrial, and other heavy-duty applications where a high output at idle is required. This type of assembly has mounting lug spacing to meet specific requirements, an external fan for cooling, and on some models, fully enclosed dual brush sets.



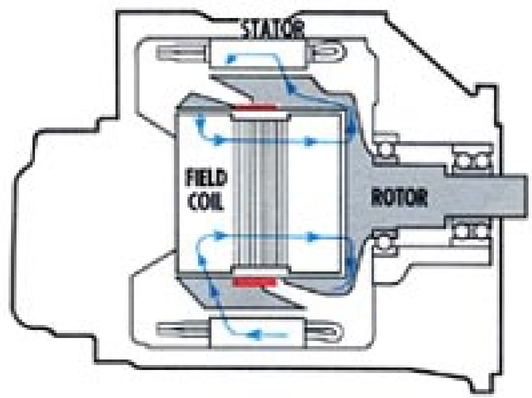
A four-pole rotor, containing many turns of metal foil wound to produce strong alternate North and South poles, is used on this type of generator. The "Y"-connected stator will provide two complete cycles of voltage across each phase for each revolution of the rotor. The diodes have screw threads and a hex head to facilitate mounting into the end frame and heat sink.

40-DN

A generator in the 40-DN Series designed for automotive, truck, marine and industrial applications having high electrical loads is shown. This type of assembly uses a 12-pole rotor similar to the 14-pole type, and either a "Y"- or a delta-connected stator. The diodes are of the threaded type, and some models have fully enclosed dual brush sets.

50-DN

A 50-DN Series, totally enclosed, brushless generator in which all current-carrying conductors are stationary is used on motor coach applications. This type of generator is cooled by engine oil circulating through the assembly.



The brushless construction is made possible by a special rotor having the North and South poles connected by a non-magnetic ring. The principle by which this generator operates is illustrated.

The field coil and core assembly, which supplies the magnetic field needed to cut across the stator windings, is mounted on the end frame, which is stationary. The rotor pole pieces mounted on the shaft are similar in construction to the 12-pole rotor, and are made to fit very closely over the stationary field coil winding. The rotor is mounted on bearings, both of which are located in the drive end frame.

The non-magnetic ring supports the rotor segment opposite the drive end without providing a path for magnetic lines to go from the North poles to the South poles. When the stator windings mounted on an iron frame are positioned over the rotor with a very close air gap between the stator and rotor, the magnetic lines from the North poles follow the easy path into the stator assembly and then into the South poles. With very small air gaps between the field and rotor, and between the rotor and stator, magnetic poles having many lines of force are created. As the rotor turns, the magnetic field cuts across the "Y"-connected stator windings and a three phase A. C. voltage is generated. This voltage is then rectified by six large threaded diodes to a single D. C. voltage and current output.


30-SI

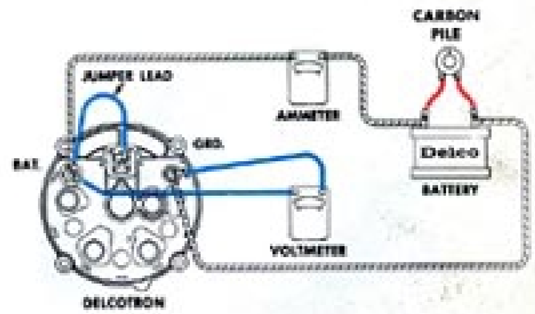
A generator used on construction equipment in the 30-SI Series is similar to the oil-cooled type, except it is air-cooled by a fan and has a completely static semi-conductor regulator built onto the generator assembly. It is of brushless construction with all current-carrying conductors being stationary. This type of design represents a completely integrated, compact unit having high current output capacity.

Although there are many design and structural variations from those presented in this section, the more popular and basic design features have been described.

generator tests

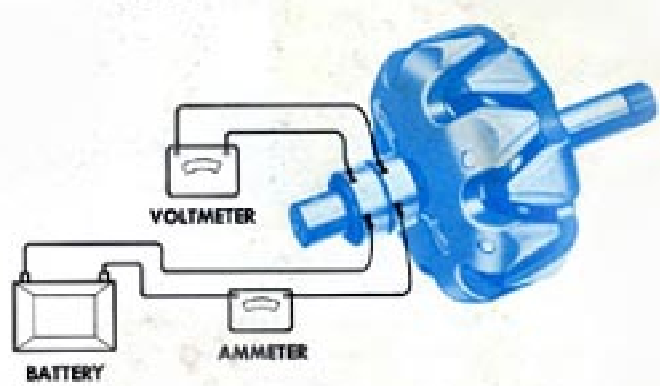
When making tests on Delcotron generators, reference should be made to the appropriate Delco-Remy service bulletin for specifications.

output check



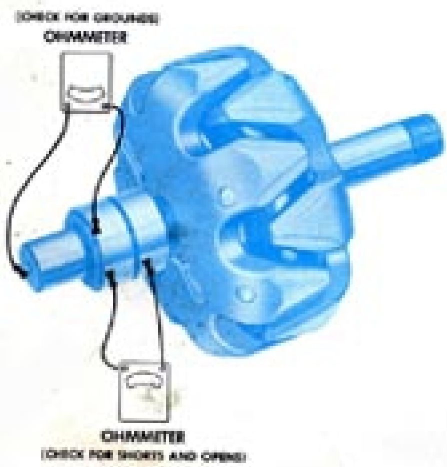
To check a Delcotron generator for output, connect a jumper lead from the generator output or "BAT" terminal to the field or "F" terminal, a voltmeter from the "BAT" terminal to ground, and an ammeter in the circuit at the "BAT" terminal. If two field terminals are present, ground the other field terminal with a jumper lead. Operate the generator at specified speed, adjust the variable load connected across the battery to obtain specified voltage, and observe the current output. If the output does not meet specifications, disassemble the generator for checks of the rotor, stator, and diodes.

rotor



The rotor windings may be checked by connecting a battery, ammeter and voltmeter to the edge of the slip rings. If the current draw is above specifications, the windings are shorted, and if the current draw is low, excessive resistance is indicated.

An ohmmeter may be used in place of the battery and ammeter. The specified resistance may be calculated by dividing the voltage by the current listed in the specifications booklet. A low resistance indicates shorted windings, and a high resistance an open or poor connection.

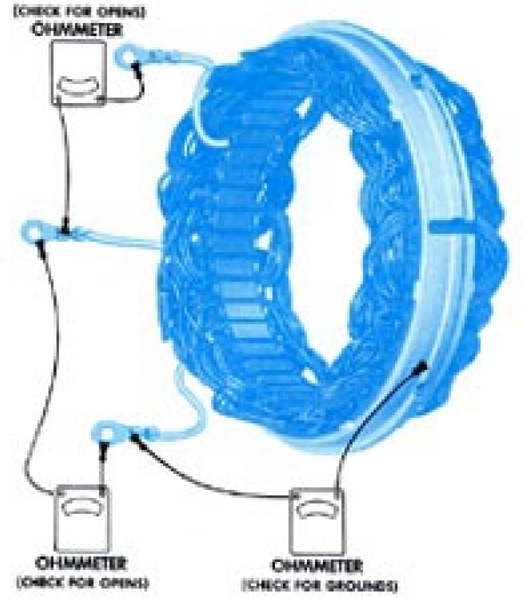


An ohmmeter connected from either slip ring to the shaft should show a high resistance. A low resistance indicates the field windings are grounded.

A test light may be used in place of an ohmmeter to check for opens and grounds, but the test light will not check for shorts. When connected across the slip rings, failure to light indicates an open. The windings are grounded if the lamp lights when connected from either slip ring to the shaft.

stator

Checks on the stator should be made with all diodes disconnected from the stator. It is not practical to check the stator for shorts due to the very low resistance of the windings. Also, it is not practical to check the delta stator for opens because the windings are connected in parallel.



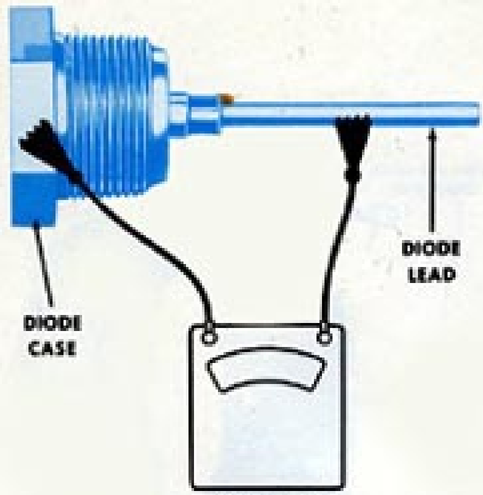
To check the "Y"-connected stator for opens, connect an ohmmeter or test light across any two pairs of terminals. A high ohmmeter reading, or no light, will reveal an open winding.

Either type of stator winding may be checked for grounds by connecting an ohmmeter or test light from either terminal to the stator frame. The windings are grounded if the ohmmeter reads low, or if the lamp lights.

If all checks are satisfactory, including the diode tests listed below, but the generator fails to provide rated output, a shorted "Y"- or delta stator winding, or an open delta winding, can be suspected.

diodes

Diodes when disconnected from the stator can be checked for defects with an ohmmeter having a 1½ volt cell. Using the lowest range scale, connect the ohmmeter leads to the diode case and the diode stem, and then reverse



the connections. On push-in type diodes, if both readings are very low, the diode is shorted. If both readings are very high, the diode is open. On threaded-type diodes, if both readings are below 300 ohms, or if both readings are above 300 ohms, the diode is defective. The 300 ohm value should be near mid-scale for accuracy. A good diode will give one very low and one very high reading. CAUTION: Do not use high voltage such as a 110 volt test light to check diodes.

summary

The above checks are general. When checking Delcotron generators, always follow the specific procedures given in the appropriate Delco-Remy Service Bulletin.