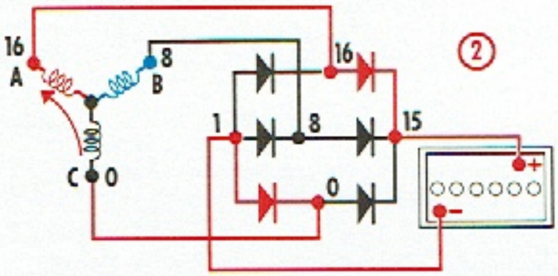
training chart manual

SECTION K

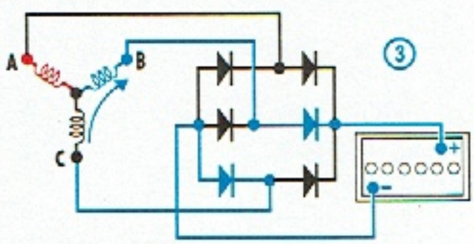
FUNDAMENTALS OF DELCOTRON® GENERATORS

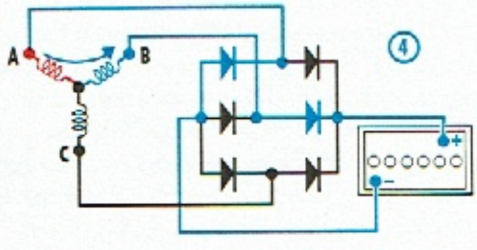
Delco Remy

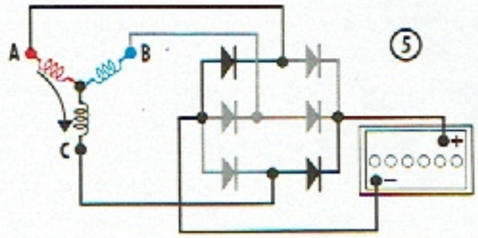
An inspection of the phase voltage curves will reveal that between periods 1 and 2 the maximum voltage being impressed across the diodes changes or switches from phase BA to phase AC. This means that as the maximum voltage changes the current flow will change from BA to CA.

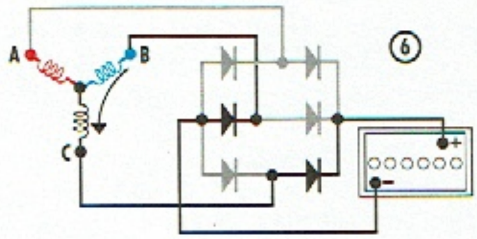


It is important to note that the maximum voltage being produced in the stator windings during period 2 appears across phase AC and that this voltage is negative from A to C. Taking the instant of time at which this voltage is 16 volts, the potential at A is 16, and at C is zero (A to C, or 16 to 0, is 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.



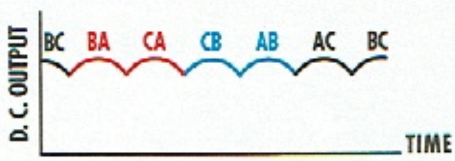






Following the same procedure for periods 3–6, the current flow conditions can be determined, and are shown in the illustrations. These are the six major current flow conditions for a three-phase "Y"-connected stator and rectifier combination.

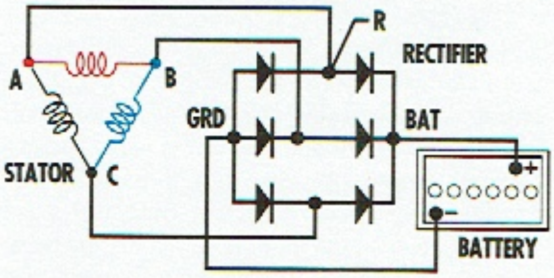
The voltage obtained from the stator-rectifier combination when connected to a battery is not perfectly "flat," but is so smooth that for all practical purposes the output may be considered to be a non-varying D. C. voltage. The voltage, of course, is obtained from the phase voltage curves, and can be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

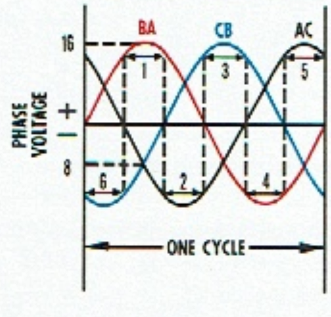


An alternate method of establishing the direction of current flow through the rectifier for a "Y"-connected stator is to refer to the illustration showing the loop voltage curves. During period 1 the two loop windings having the largest voltages are A_1A and B_1B, with the voltage in loop C_1C always 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.

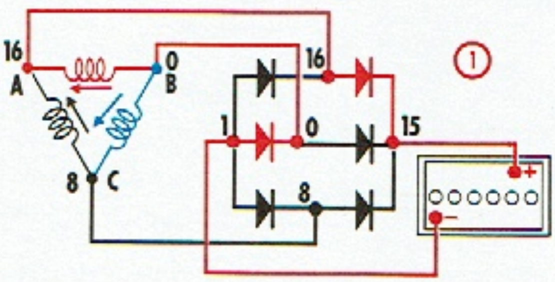
Referring again to the loop voltage curves, the two loop windings having the largest voltages during period 2 are A_1A and C_1C. Since the voltage in A_1A is positive, and C_1C is negative (positive from C to C_1), the current will flow from C to A during period 2. In this same manner, the current flow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





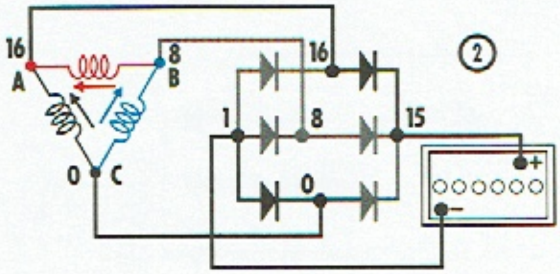
A delta-connected stator wound to provide the same output as a "Y"-connected stator also will provide a smooth voltage and current output when connected to a six-diode rectifier. For convenience, the three-phase A. C. voltage curves obtained from the basic delta connection for one rotor revolution are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

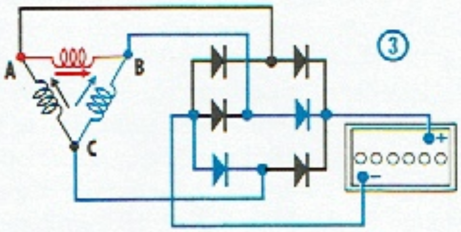
An inspection of the delta stator, however, reveals a major difference from the "Y" stator. Whereas the "Y" stator conducts current through only two windings throughout period 1, the delta stator conducts current through all three. The reason for this is apparent, since phase BA is in parallel with phase 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.

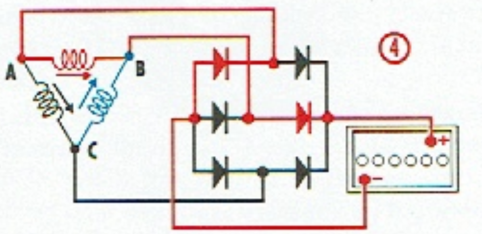
During period 2, the maximum voltage developed is in phase AC, and the voltage potentials are shown on the illustration at the instant the voltage is maximum. Also shown are the other phase voltages, and again, the current flow through the rectifier is identical to that for a "Y" stator, since the voltages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

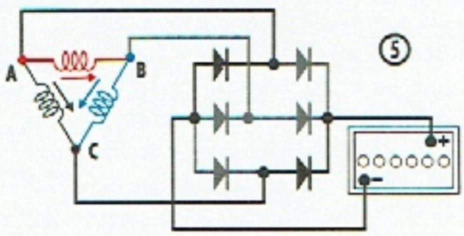


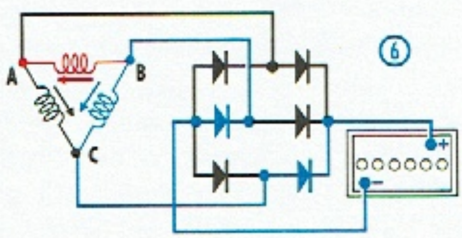
all three delta phases conduct current as illustrated.

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.

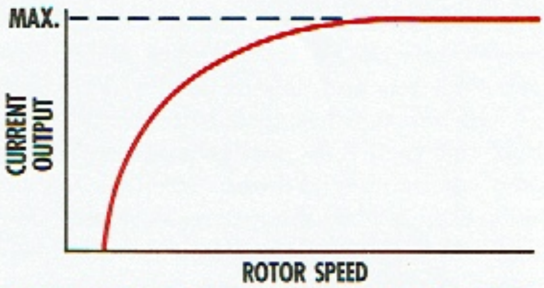
The Delcotron generator is constructed with more than just a bar magnet as a rotor and three single loops of wire as a stator. In the next section we will direct our attention to the basic types and designs of Delcotron generators, and to the construction features of each.

types and designs

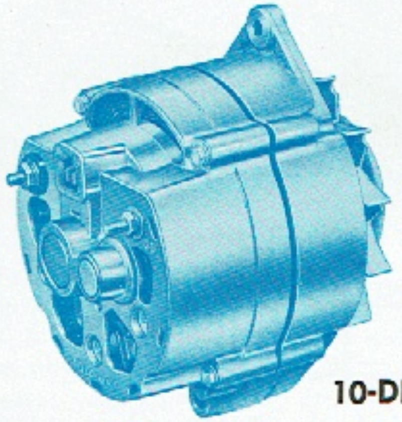
The Delcotron generator has only one function to perform in the electrical system—to supply current to charge the battery and operate electrical accessories. Since each application makes its own special requirements on the generator, there are many different types and designs of Delcotron generators. 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

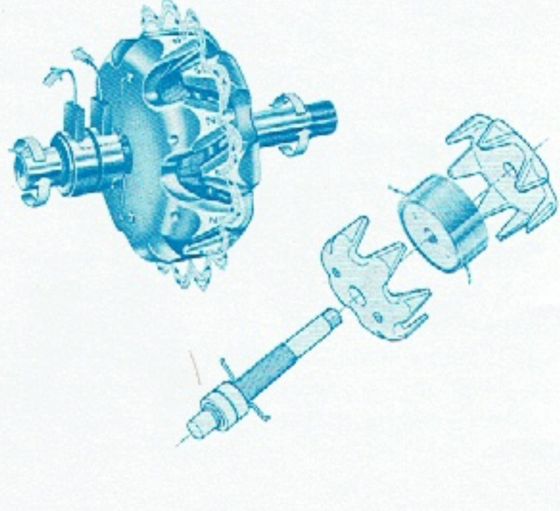


in the stator windings opposes in polarity and approaches in value the magnetic field provided by the rotor as the generator output increases. This causes the generator to limit its own output to a maximum value.



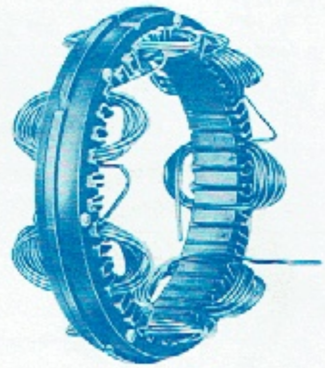
10-DN

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.

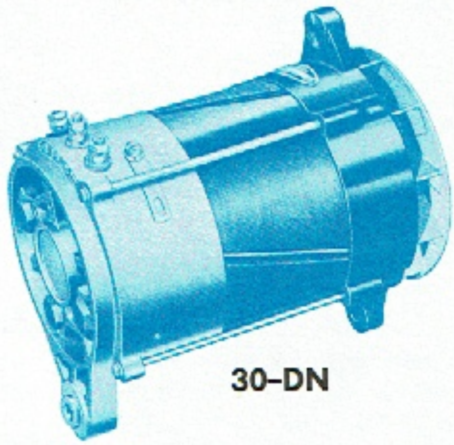
Two more identical windings mounted on the iron frame complete the assembly. These windings are spaced so that the "Y"-connected stator delivers three-phase A. C. voltage as covered in the previous section.

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.

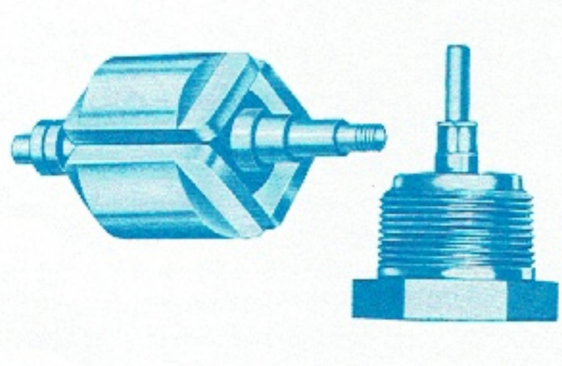
20–DN

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.

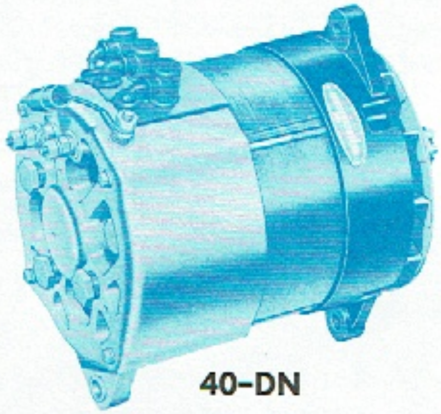


30–DN

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.

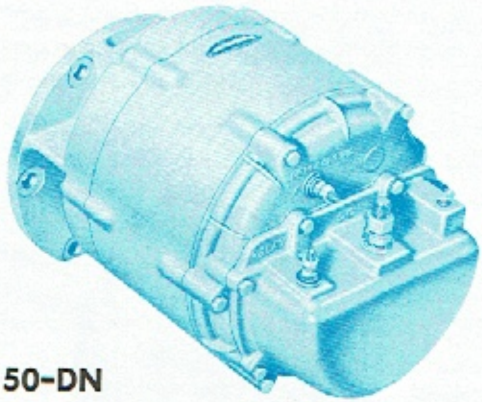


A four-pole rotor, containing many turns of metal foil wound to produce strong alternate North and South poles, is used on this type of generator. The "Y"-connected stator will provide two complete cycles of voltage across each phase for each revolution of the rotor. The diodes have screw threads and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



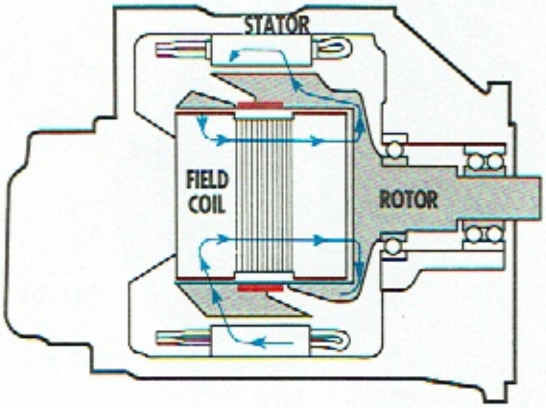
40-DN

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.