training chart manual

SECTION e

GENERATORS

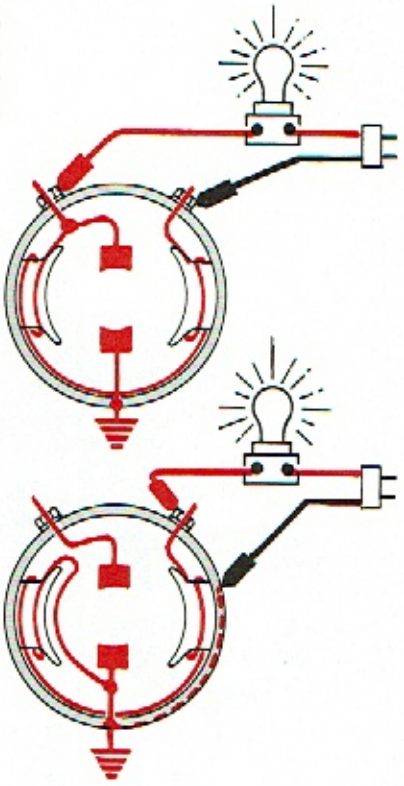
DELCO-REMY · ANDERSON, INDIANA, U.S.A.
DIVISION OF GENERAL MOTORS CORPORATION

FIELD COIL TESTING

Failure of the field coil circuit can be caused by either an open field circuit, a grounded field circuit, short circuited field coils, or a field circuit with a high resistance. Any of these conditions has a definite adverse effect upon generator output and must be eliminated to obtain proper generator operation.

Current cannot flow if there is an open circuit in the field coil winding, therefore the magnetic field between the pole shoes can not be strengthened and residual magnetism provides the only magnetic field. Consequently, voltage developed under these conditions will be insufficient to close the cut-out relay points and complete the charging circuit to the battery.

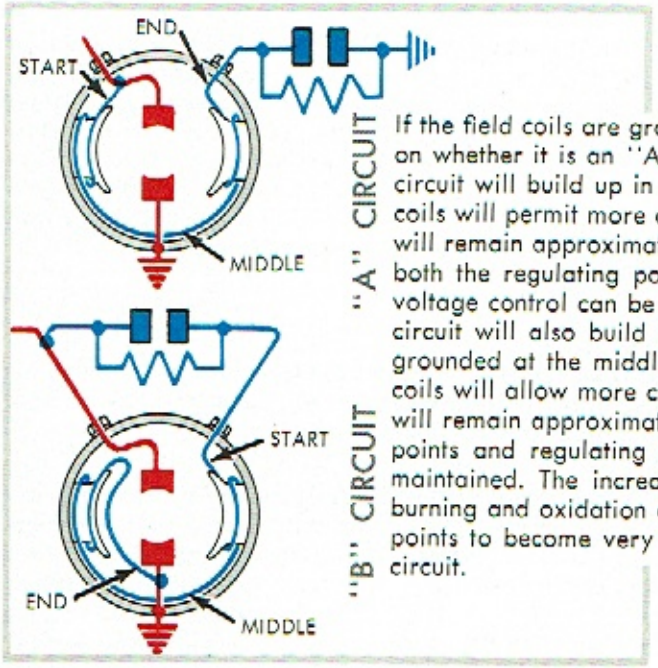
A test lamp connected to either end of the field coils will reveal a break or open in the field coil circuit. Illustrations for testing both "A" and "B" circuit generators are shown. A lighted test lamp indicates a continuous circuit but does not indicate a shorted circuit.



"A" CIRCUIT

"B" CIRCUIT

A ground field circuit has different effects upon generator output, depending upon where it is grounded. Consider all circuits as starting at the insulated brush of the generator. If the field is grounded before the field coils, there will be little flow of current in the field coils, and generator voltage will not build up. In this condition, the armature circuit would also be grounded since the field wire is connected to the armature circuit.



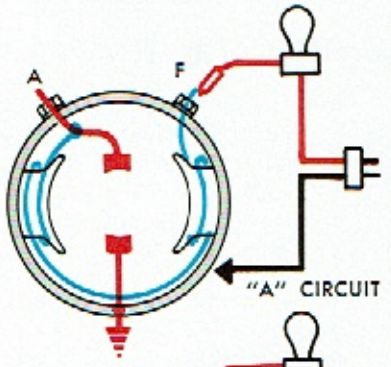
If the field coils are grounded at a middle or half-way point, the effect will depend on whether it is an "A" or "B" circuit generator. A generator with an "A" type circuit will build up in voltage as in normal operation. Less resistance in the field coils will permit more current to flow, and the ampere-turn ratio of the field circuit will remain approximately the same. The ground would by-pass the circuit through both the regulating points and the regulating resistance and neither current nor voltage control can be obtained over the generator. A generator with a "B" type circuit will also build up in voltage as in normal operation with its field circuit grounded at the middle or half-way point. The decreased resistance of the field coils will allow more current to flow, and the ampere-turn ratio in the field circuit will remain approximately the same. There will be a circuit through the regulating points and regulating resistance, therefore, current and voltage control can be maintained. The increased current flow in the field circuit will, however, cause burning and oxidation of the regulator points. This will cause the resistance of the points to become very high and the field circuit will eventually become an open circuit.

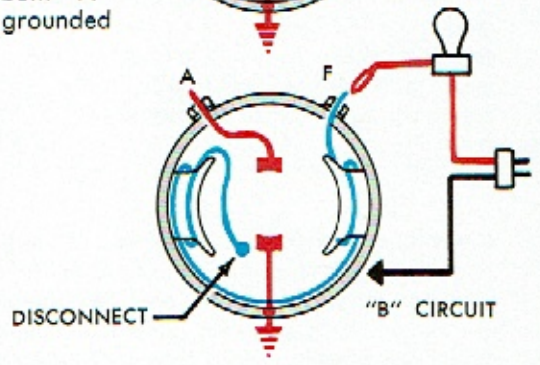
CONTINUED

FIELD COIL TESTING

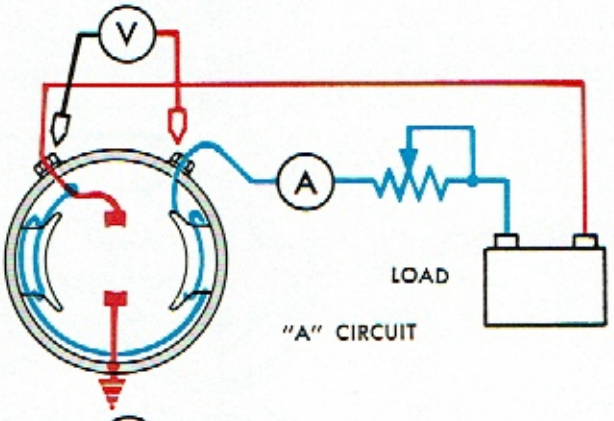
If the field coils are grounded at the end of the field coil windings, the effect on the generator will again depend on whether it is an "A" or "B" circuit generator. An "A" circuit generator will have its field circuit grounded before the regulator and no current or voltage control can be obtained. A "B" circuit generator will have its field circuit grounded in the normal place and operation will be normal.

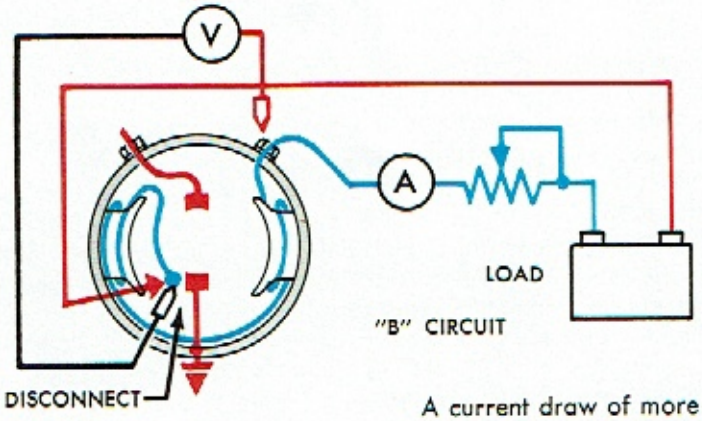
A test lamp is used to determine if the field circuit is grounded. All *intended* ground connections of the field coil circuit must be disconnected. Illustrations for both "A" and "B" type generators are shown. The lamp will light if the field circuit is grounded but will not light if the field circuit is not grounded.





A short circuited field coil has little effect on the generator output. The resistance of the field circuit is decreased by the number of turns shorted out of the circuit, which allows more current to flow in the field circuit and the ampere-turn ratio of the circuit remains approximately the same.





Increased current in the field circuit will cause burning and oxidation of regulator points. Eventually oxidation will cause the points to become very high in resistance, and the field circuit will become an open circuit.

Test specifications for all Delco-Remy generators are published in book DR-324S and its supplement DR-324S-1. Included in the specifications is information on the "field current draw". All published information is based on the field coil temperature of 80 degrees F. Any deviation from this temperature will alter the results of this test.

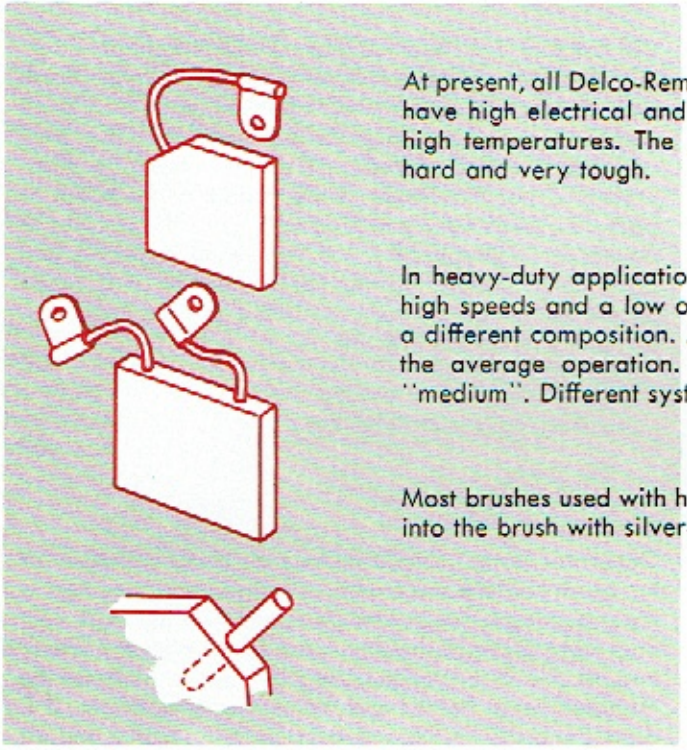
This illustration shows the proper hook-up to measure current flow in the field coils when a specified voltage is applied. Specified voltage is obtained by adjusting the variable resistor until the reading of the voltmeter, in the position shown, is correct. Current flow through the coil is measured by an ammeter and should agree with published specification. Any deviation in current from the specifications indicates a defect in the field current.

A current draw of more than that specified indicates the resistance of the circuit is too low and that some of the turns are shorted. Repair or replacement of the field coil involved is required for proper generator operation.

A current draw less than that specified indicates the resistance of the circuit is too high and a bad connection or damaged wire is in the circuit. Repair or replacement of the field coil involved is required. High resistance in the field circuit decreases field coil current and, thereby, decreases the strength of the magnetic field between the pole pieces. The decrease of magnetic strength within the generator will require a higher speed of rotation to develop the rated voltage and current from the generator.

BRUSHES AND BRUSH HOLDERS

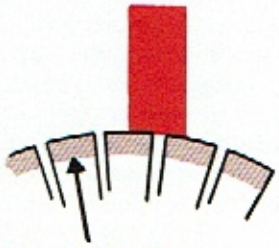
The brush is a small but very important part of the generator and does not always receive the attention it requires for good generator operation. All brushes are by no means alike. They cannot be used indiscriminately, although they may have the same physical dimensions. Brushes are selected for each type generator after tests are conducted under the most severe operating conditions to determine their length of life.



At present, all Delco-Remy high output generators use electrographitic brushes which have high electrical and thermal conductivity. They can withstand high loads and high temperatures. The process under which they are manufactured makes them hard and very tough.

In heavy-duty applications there are two extremes of operation: a high output at high speeds and a low output at low speeds. Each condition requires a brush with a different composition. A brush with a third composition is made to take care of the average operation. These brushes are designated as "hard", "soft" and "medium". Different system voltages may require brushes with other compositions.

Most brushes used with high output generators have leads called "pigtails" tamped into the brush with silver-plated copper flakes to form a low resistance connection.



COPPER OXIDE FILM

One factor common to all brushes is the sliding friction between them and the bars of the commutator. Normal current flow causes enough oxidation to maintain a copper oxide film, which has little friction. At no load or current flow, the brushes may abrade this film away and bring on a high friction condition which causes brush chatter, heat and wear.

Under conditions of operation where extremely low currents are commutated, insufficient copper oxide is produced between the brush and the commutator for an adequate film and there is a tendency for the brushes to chatter. Under such conditions, the brush leads may loosen in the brush, forming a high resistance connection, causing the current to pass through the brush surface area and brush holders instead of the "pigtails". Consequently, corrosion and etching takes place between the brush and holder, which unless corrected, will eventually prevent good brush contact with the commutator and may cause a burned brush, brush holder, or brush holder arm. When replacing brushes due to this condition, the brush holder should also be replaced, as well as the brush arm. When replacing worn brushes, the brush holder rails must be polished to allow free movement of the brush.

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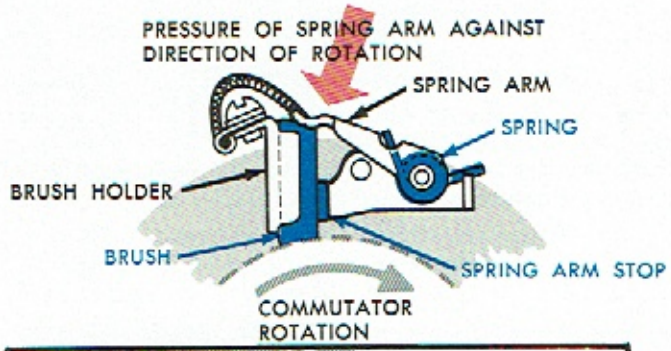
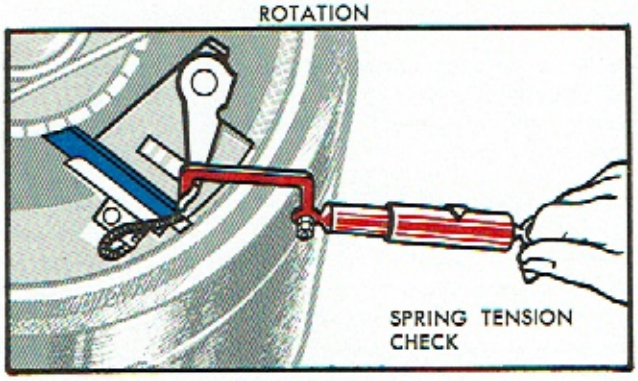
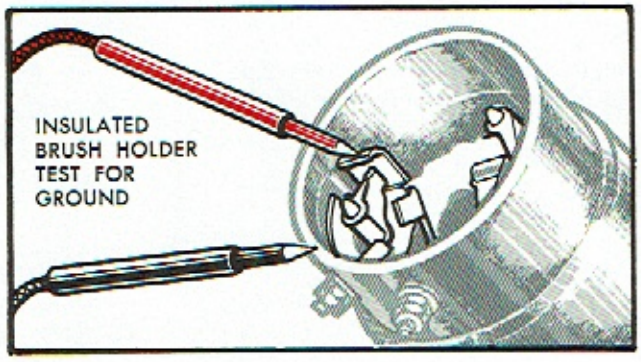


A brush arm stop is provided to protect the commutator bars from being scored by the brush arm when the brush is worn away. The brush arm stop also prevents the brush arm from applying pressure on the brush when the brush becomes too short for satisfactory service. The brush should not be allowed to wear down until the brush arm touches the stop.



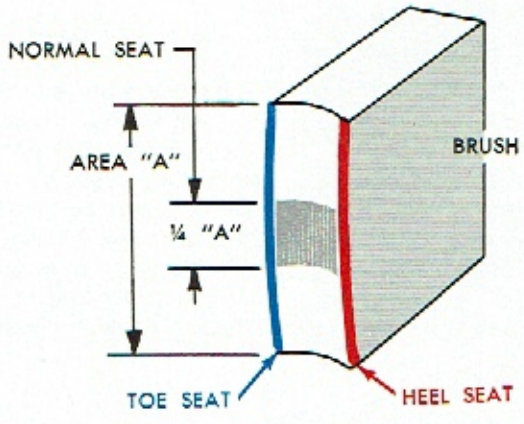
Delco-Remy Test Specification booklets contain information on the proper spring tension applied to the brush arm. A check of the tension should be made during all generator repair to assure proper generator efficiency and long brush life. Brush arm tension should be measured at a point as close to the middle of the brush as possible. Weak spring tension will cause the brushes to bounce at high speeds which will result in arcing and poor commutation. Strong spring tension will cause excessive friction between the brush and the commutator, and short brush life will result.



Generator testing should include an electrical check of the brush holders and frame. A test lamp placed across the grounded brush holder and frame *should* light. If it does not, the brush holder is insulated from the frame and all circuits are open. A test lamp placed across the insulated brush holder and frame *should not* light. If it does, the brush holder is grounded to the frame and all circuits will be grounded at this point.

Maximum current output at high speeds causes a commutation problem of heat which greatly increases wear of the brushes. Similarly, extremely short brush life results from friction when a generator is operated at low or zero current output. Brushes are designed for efficient and long-lasting service. Lubricating ingredients are built into some brushes where low output operation predominates. Where both low and high output operation predominates, laminated brushes are sometimes used.

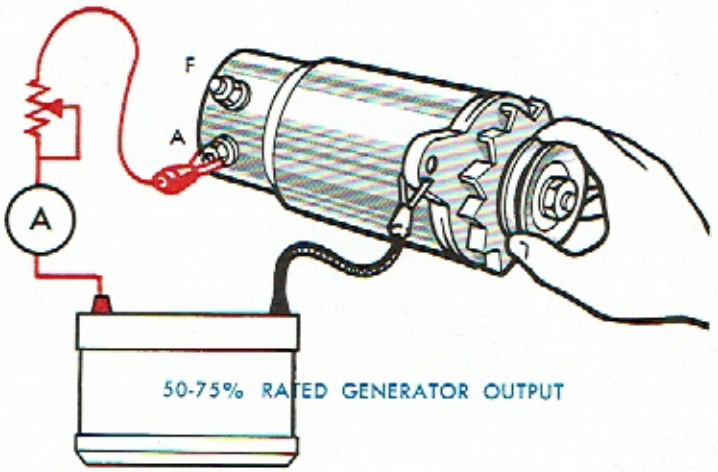
When replacing brushes, be sure that a brush seat is obtained across the thickness of the brush from front to back. A 25% contact area is satisfactory. However, a seat of the same area across the heel or toe of the brush would not be satisfactory. Heel or toe seating of a brush changes the neutral position, and will result in excessive arcing. Satisfactory brush seating may be obtained by the proper use of brush seating stones or seating compounds. The abrasive action of these materials will produce a perfect fit between the brush and the commutator.



NEUTRAL POSITIONING OF BRUSHES

The final position for the brushes in non-interpole type automotive generators is usually ¼ to 1 full commutator bar ahead of the mechanical neutral point. This location will produce the least amount of arcing at the brushes and will give the longest brush life and greatest generator efficiency. Passenger car generators have their brush position fixed and no adjustment can be made.

Where brush adjustment is provided, it is necessary to first locate the mechanical neutral point. A practical method of doing this is to pass a high current, 50—75% of rated output, through the armature and brushes only. Current must not be allowed to pass through the field coils. With this current flowing, the armature should be spun by hand in both directions. The position of the brush should be adjusted until the turning effort in either direction is the same. In this position, the brushes are set in the mechanical neutral locations. Brush position is then moved in the direction of generator rotation the amount of ¼ to 1 full commutator bar depending upon the design of the particular generator involved. Brushes must have a good seat across the thickness of the brush when making this check.



MECHANICAL PROBLEMS

In the repair or servicing of any generator, a good visual inspection should be made to assure that the mechanical operation will be satisfactory.

Proper lubrication and cleanliness of bearings is required. Worn bearings should be replaced to prevent the armature from shifting its position and rubbing against the pole faces.

The interior of the generator should be thoroughly cleaned to allow the maximum amount of air circulation for ventilation and cooling. Many cases of burned up generators have resulted from dirt being packed inside the generator, restricting the flow of air.

VISUAL INSPECTION

- WORN BRUSHES
- WORN BEARINGS
- DIRTY COMMUTATOR
- DIRT IN GENERATOR
- PROPER LUBRICATION
- OIL ON WIRES
- BURNED SEGMENT ON COMMUTATOR

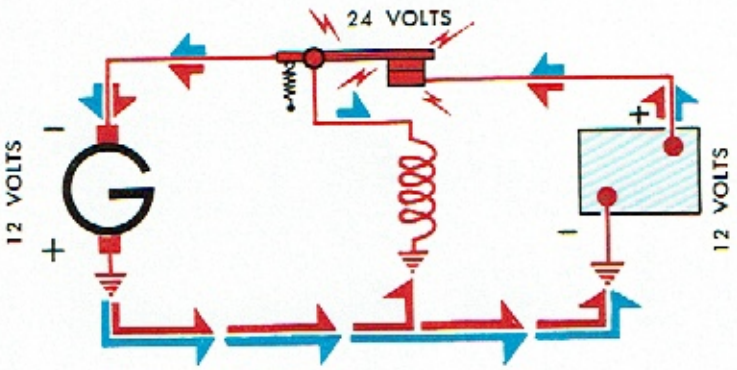
Oil inside the generator is highly destructive to the insulation on the wires. Any entry of oil into the generator should be blocked to insure long generator life. Oil cooled generators are, of course, an exception to this rule.

Cleanliness and proper lubrication are vital to the life of any generator. Regular servicing periods will greatly increase generator life and decrease the possibility of failures on the road.

GENERATOR POLARITY

The magnetism of the pole pieces is determined by the field coil's current and its direction of flow. The residual magnetism and the polarity of each pole will remain the same as induced from the magnetism of its field coil the last time current was passed through it. Generators, therefore, will build up voltage that will cause current to flow in either direction depending upon residual magnetism in the poles. This was discussed in the section entitled, "What's Polarity". When working on electrical units, and when "ringing out" circuits with a small battery and bell, it is possible for current to accidentally flow through the field coils in the wrong direction and the generator will become improperly polarized with respect to the battery in the vehicle. An instantaneous flash is all that is required to create a reverse polarity of the generator.

After a generator has been repaired and installed on a vehicle, or at any time after a generator has been tested, it must be polarized. This is to make sure that it has correct polarity to develop voltage that will cause current to flow in the proper direction to the battery it is to charge. Failure to polarize the generator in agreement with the battery on the vehicle may result in burned cut-out relay points, a run-down battery, and possible serious damage to the generator itself. If the direction of current flow from the generator to the battery is correct, the battery will be charged. However, if the direction of current flow from the generator to the battery is wrong, voltages of the battery and generator will be added together to give approximately double voltage across the contact points of the cut-out relay.



What can happen when the generator is of the opposite polarity from that of the battery is shown in the illustration. Plus and minus symbols are used to indicate the direction of current flow. It is assumed that current will flow from plus to minus.

As the generator builds up in voltage, current will flow in the operating coil of the cut-out relay causing the contact points of the relay to close, completing the circuit between the battery and generator. The battery and generator are now connected together in series and their respective voltages are added together. Approximately double system voltage is now obtained across the contact points and extremely high currents will result from the high voltage short circuited in the battery and generator circuit. This high current produces heat that can weld the contact points together instantly.

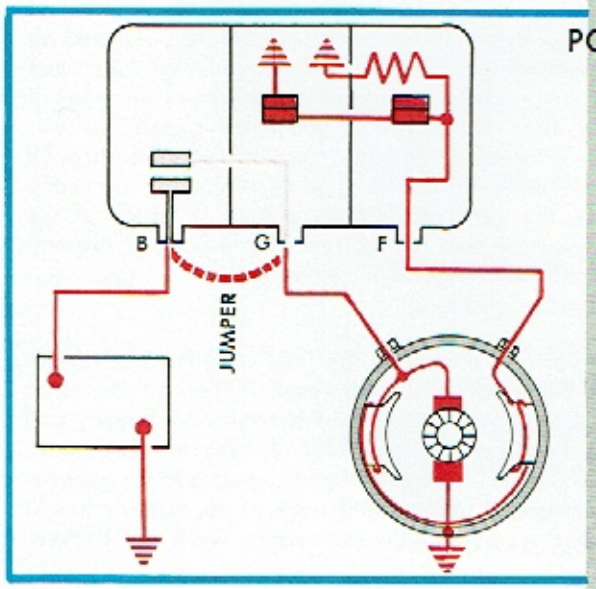
However, as the illustration shows, at the instant the points of the relay close, there is battery voltage on the insulated side of the operating coil of the cut-out relay and generator voltage (which will be approximately the same as battery voltage) on the ground side of the operating coil. Since there is little or no difference in voltage between the ends of the coil, the current flow in the coil is insufficient to hold the points of the relay closed and spring pressure may open them.

Generator voltage will again close the points and the action is repeated. The points of the relay thus open and close very rapidly with voltage and current present. Eventually heat and arcing from the high current and voltage will cause the points to actually weld together.

Relay points welded together allow the battery and generator to be connected together at all times. Since resistance of the generator is low, the battery has a very low resistance path back to the battery and large discharge current will flow from the battery through the generator and back to the battery. This, in a short time, completely discharges the battery and the large current may develop enough heat to burn the armature of the generator and render it inoperative for future use.

The importance, therefore, of polarity cannot be stressed too highly. Lack of understanding generator polarity and its relationship to the vehicle battery has been responsible for many unnecessary electrical failures in the cut-out relay, battery, and generator.

The procedure to follow in correcting generator polarity depends upon the generator regulator wiring circuits—that is, whether the generator field is internally grounded or is grounded through the regulator. Procedures for polarizing "A" and "B" type circuit generators differ.

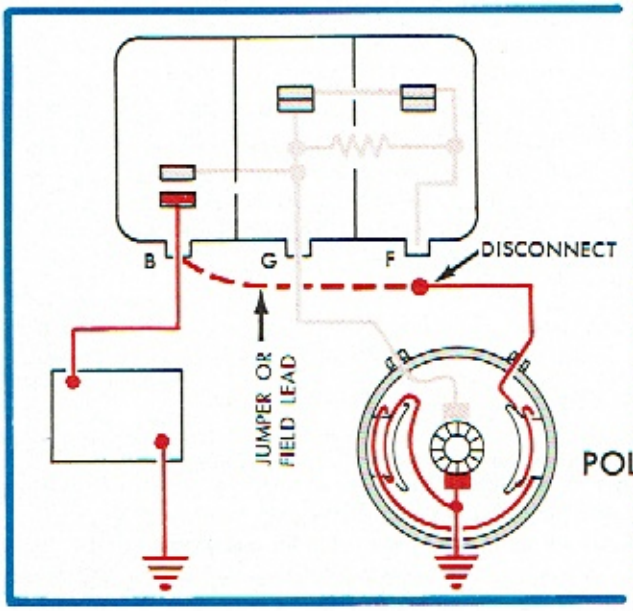


POLARIZATION OF "A" CIRCUIT GENERATORS

Generators using an "A" circuit are polarized by connecting a jumper lead from the insulated or "hot" side of the battery to the armature or "A" terminal of the generator. The battery, generator and regulator grounds must be connected. On the vehicle this is done through the frame. This causes current to flow in the normal direction through the field coils which will correctly polarize the generator's pole shoes. A touch of the jumper lead is all that is required and a flash or arc will be noted when the lead is removed.

Insulating the brushes is recommended with all 24 or 32 volt generators of circuit "A" construction during polarizing. If the brushes are not insulated, low resistance of the generator armature will cause an extremely high discharge current through the armature when the jumper lead is connected between the battery and generator terminal. This can result in a badly burned armature. With the brushes insulated, only field current will flow.

An easily accessible place to polarize the generator when it is located on a vehicle is at the regulator. A short jumper lead between the battery and armature terminals of the regulator is all that is required.



POLARIZATION OF "B" CIRCUIT GENERATORS

Generators designed for a "B" circuit are polarized by disconnecting the field lead from the regulator and momentarily flashing this lead to the battery terminal of the regulator. Battery and generator ground circuits must be connected together. Current will flow through the field coils in the proper direction to correctly polarize the generator's pole pieces. A touch of the field lead is all that is required, and a flash or arc will be noted when the lead is removed.

It is important to remove the field lead from the regulator. Failure to do so will result in burned regulator points if a jumper lead is used between the battery and field terminals of the regulator. A very low resistance circuit from the battery through the points to the generator armature to ground and back to the battery would carry high current if the connection were not broken.

The importance of generator polarity cannot be stressed too greatly. For proper polarization, the rule should be to pass current through the field coils in a direction that will have the ground side of the coils connected to the ground side of the vehicle battery.

the Delco-Remy education program

The Delco-Remy Education Program is designed to provide to mechanics and students up-to-date technical information on automotive electrical equipment.

This manual, one of a series, is a part of the program. Used in a classroom in conjunction with training charts, these manuals aid in explaining the theory of operation and construction of electrical units.

Also available to servicemen and students is a series of Maintenance Service Bulletins. They serve as a reference in the maintenance and testing of electrical units.

Test Specification Booklets contain service test data for the electrical units manufactured by Delco-Remy. These booklets are designed for automotive electricians engaged in maintenance and testing.

Strip films with records and film booklets cover the basic operation and maintenance of units in electrical systems. There are many pictures and a wealth of information in diagrams and legends.

Other booklets cover various phases of maintenance and testing procedures for Delco-Remy electrical units and their related circuits.

Delco-Remy

ELECTRICAL EQUIPMENT

FOR

PASSENGER CARS • COMMERCIAL CARS

MOTOR COACHES • MARINE ENGINES

INDUSTRIAL ENGINES • AIRCRAFT

TRACTORS • TRUCKS

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