# Attention:



**miller2001@sbcglobal.net**

**Ryan Miller**
**Arlington, TX 76002**

**Wes Knettle and Ryan Miller**

DELCO-REMY

SERVICE BULLETIN

BULLETIN 1R-123A
Date 6-2-53
20 Pages Page 1
File Under:
R-RELAYS AND REGULATORS

# D-R HEAVY-DUTY

# REGULATORS

## (Truck Type—Circuit B)

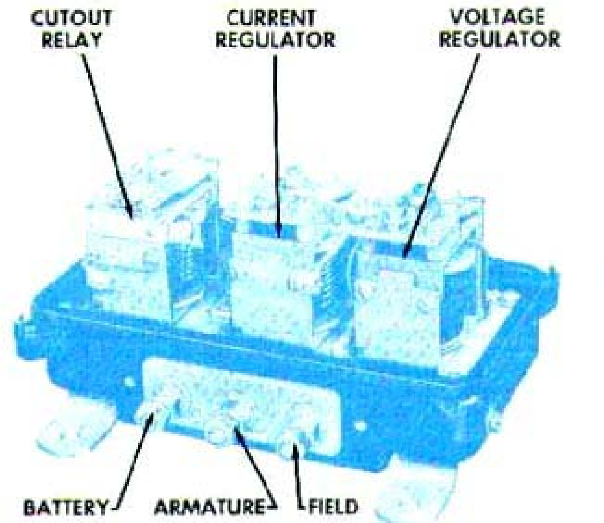


**Figure 1—Delco-Remy heavy-duty, truck type three-unit regulator with cover removed so the three units can be seen. Note relationship of the BATTERY, ARMATURE, and FIELD terminals which is different from other Delco-Remy heavy-duty regulators.**

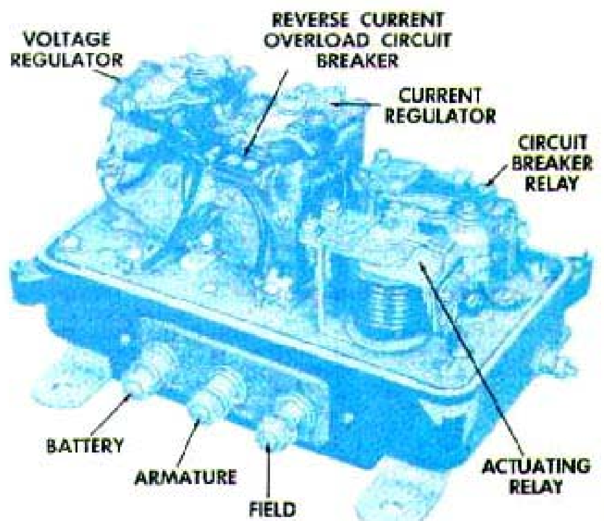


**Figure 2—Delco-Remy heavy-duty, truck type four-unit regulator with the cover removed so the four units can be seen. Note the relationship of the BATTERY, ARMATURE, and FIELD terminals.**

The Delco-Remy heavy-duty generator regulators shown in Figures 1 and 2 differ from those described in Bulletin 1R-124A mainly in the internal connections of the generator field circuit. In these regulators, which are identified as "Circuit B" units, the generator field circuit passes through the regulator and returns to ground inside the generator itself. They must, therefore, be used only with "Circuit B" generators in which the field is internally grounded. These regulators are dust and moisture-proofed. However, on applications where excessive vibration occurs, it may be necessary to use special shock mounts to obtain satisfactory regulator operation. When shock mounts are used in grounded systems the regulator must be grounded by a lead since the shock mount insulates the regulator from the vehicle frame or engine. Excessive vibration is indicated by burned or pitted cutout relay points, chafed parts such as windings, and by unsteady voltage readings while system is operating.

The regulator in Figure 1 consists of three units, a cutout relay, a current regulator, and a voltage regulator. While the internal wiring circuit is similar for all regulators of this type, the internal connections vary somewhat according to whether the regulator is designed for use with a one-wire or grounded system (Fig. 3), or a two-wire or insulated system (Fig. 4). The essential difference between the two systems is that in the one-wire or grounded system, the circuits are completed through "ground" or the vehicle frame and engine, while in the two-wire or insulated system, the circuits are completed through a second wire and all electrical circuits are insulated from the frame and engine of the vehicle.

In the regulator, the cutout relay is designed to close the circuit from the generator to the battery when the generator voltage is sufficient to charge the battery, and to open the circuit when the generator slows or stops. The current regulator is a current limiting device which prevents the generator from exceeding its specified maximum. The voltage regulator is a voltage limiting device which prevents the system voltage from exceeding a specified maximum, thus causing a tapering charge rate to the battery as it approaches full charge and protecting electrical units from excessive voltage.

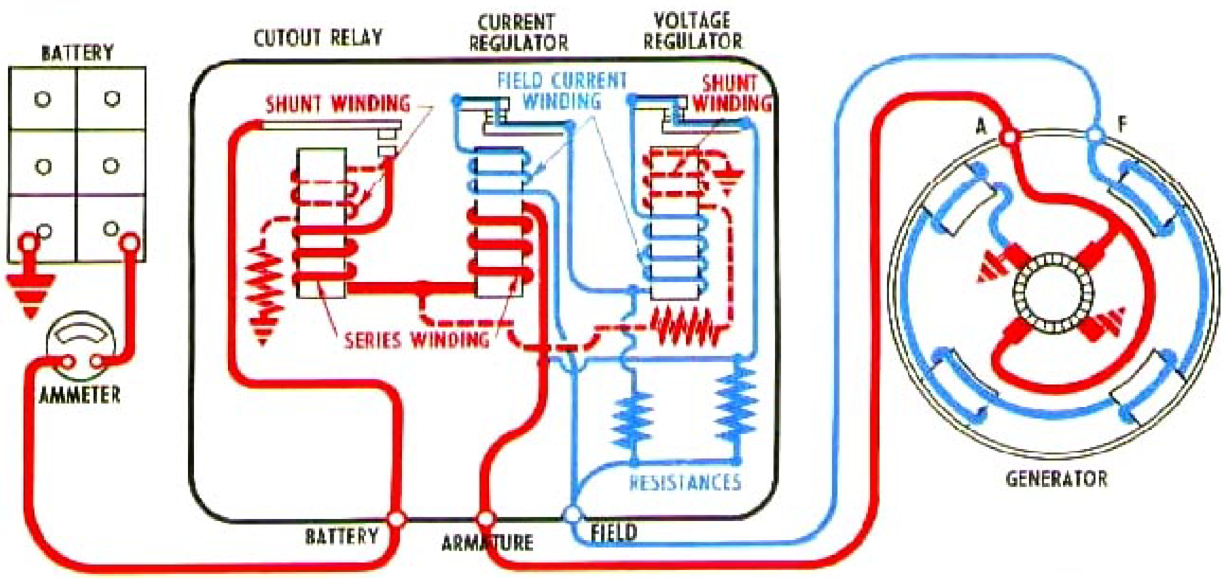


**Figure 3—Wiring circuit of Delco-Remy heavy-duty, truck type three-unit regulator designed for use with a one-wire or grounded system. The series windings in the cutout relay and current regulator are shown in solid red—all output from the generator passes through these windings. The cutout relay shunt winding is shown in dotted red. The field current windings in the current and voltage regulator units, through which the generator field current passes when both sets of regulator points are closed, are shown in blue. The voltage regulator shunt winding is shown in dotted red.**

The type regulator shown in Figure 2 consists of four units, an actuating relay, a circuit breaker relay, a current regulator, and a voltage regulator.

Figure 5 is the wiring diagram of the one-wire or grounded regulator of this type, while Figure 6 is the wiring diagram of the two-wire or insulated regulator of this type. The actuating relay and circuit breaker relay function together to perform the same duty as the cutout relay in other regulators. They close the circuit between the generator and battery when the generator voltage is sufficient to charge the battery. They open the circuit when generator voltage falls below battery voltage. The current regulator and the voltage regulator function as already described. A second type of four-

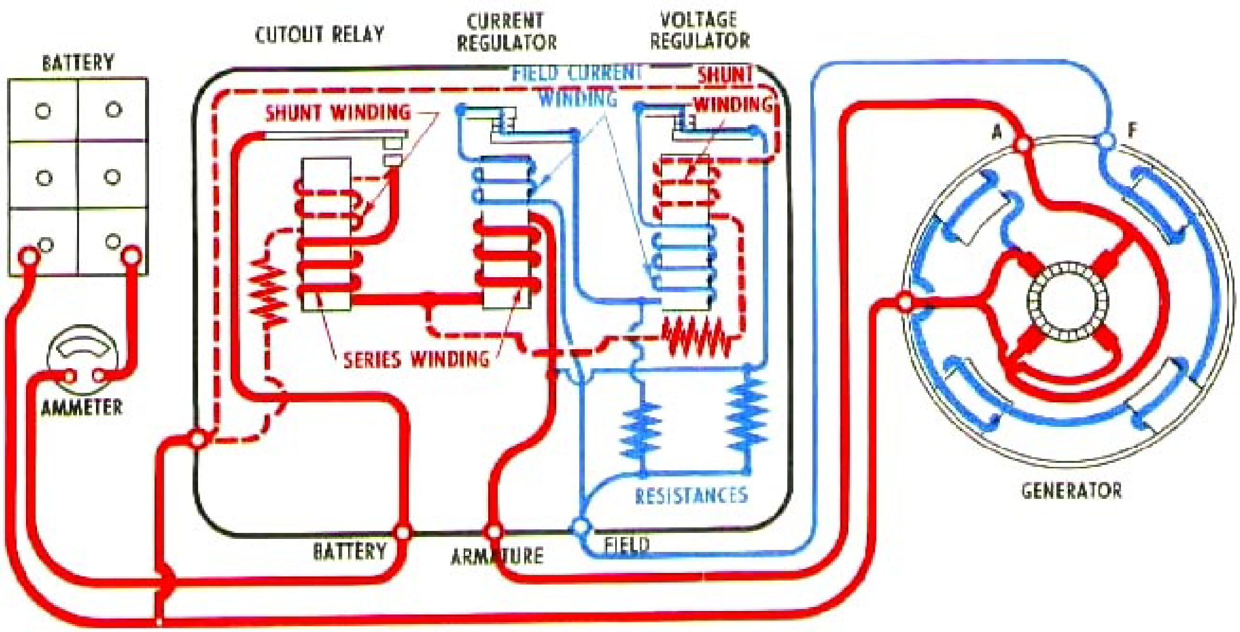


**Figure 4—Wiring circuit of Delco-Remy heavy-duty, truck type three-unit regulator designed for use with a two-wire or insulated system. The various windings in this wiring system are indicated in color in the same manner as those shown in Figure 3.**

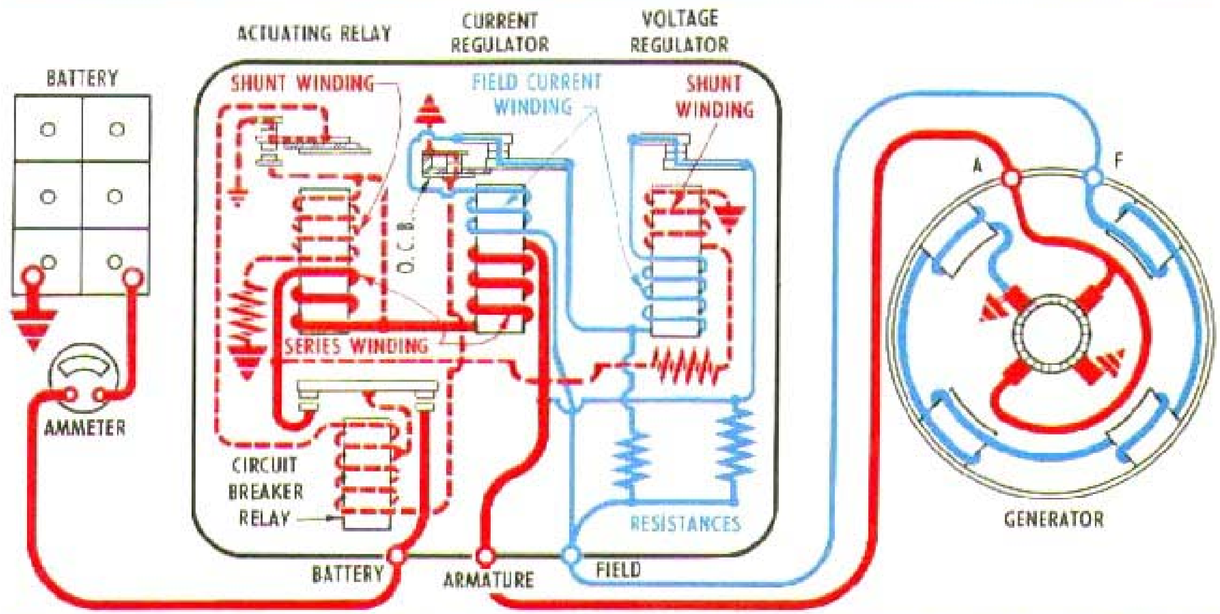


Figure 5—Wiring circuit of Delco-Remy heavy-duty, truck type four-unit regulator designed for use with a one-wire or grounded system. The shunt windings in the actuating relay, circuit breaker relay, and voltage regulator and the connections of the reverse current overload circuit breaker (O.C.B.) are shown in dotted red. The series windings in the actuating relay and current regulator are shown in solid red—all output from the generator passes through these windings. The field current windings in the current and voltage regulator units, through which the generator field current passes when both sets of regulator points are closed, are shown in blue.

unit insulated, or two-wire, regulator also is used and is the same as shown in Figure 6 except for having two return terminals. One terminal is marked "30 volt," and the second terminal is marked "32 volt." The regulator, therefore, can be used in either a 30-volt system or 32-volt system by simply connecting the return circuit to the proper terminal.

The 32-volt terminal is connected within the regulator to the 30-volt terminal through a fixed

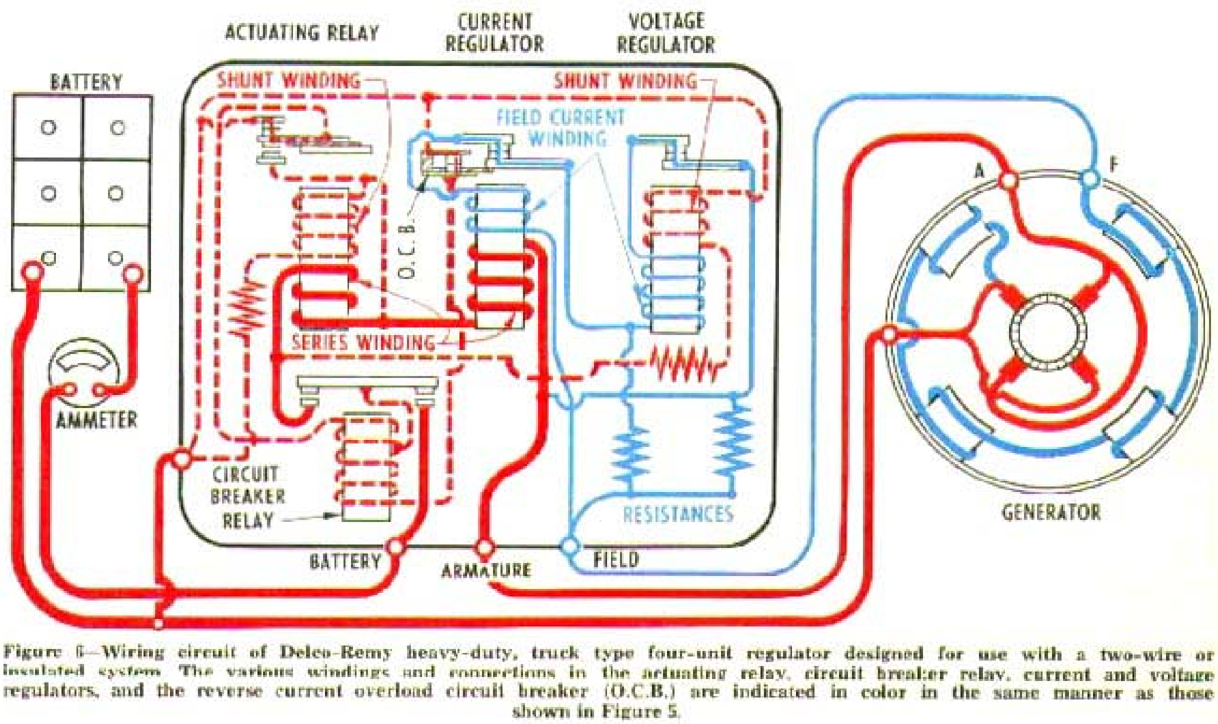


Figure 6—Wiring circuit of Delco-Remy heavy-duty, truck type four-unit regulator designed for use with a two-wire or insulated system. The various windings and connections in the actuating relay, circuit breaker relay, current and voltage regulators, and the reverse current overload circuit breaker (O.C.B.) are indicated in color in the same manner as those shown in Figure 5.

resistor. Whenever the external return circuit is connected to the 32-volt terminal, this resistor is automatically placed in series electrically which has the effect of increasing the voltage settings to values suitable for a 32-volt system.

The diagrams in Figures 5 and 6 include the reverse current overload circuit breaker which is used in a limited number of models. The reverse current overload circuit breaker (O.C.B.) is a safety switch for emergency opening of the circuit breaker relay contact points. Regulators not using this device have the circuit breaker relay shunt winding connected directly to ground (or return wire in insulated systems). Detailed explanations of the operation of unit follow.

## THREE-UNIT REGULATOR OPERATION

### CUTOUT RELAY

The cutout relay (Fig. 7) has two windings assembled on one core, a series winding of a few turns of heavy wire (shown in solid red, Figs. 3 and 8) and a shunt winding of many turns of fine wire (shown in dotted red). The shunt winding is connected in series with a resistance. The shunt winding and resistance are, together, shunted across the generator. This imposes generator voltage on the two at all times. The series winding is connected in series with the charging circuit (shown in solid red) so that generator output passes through it.

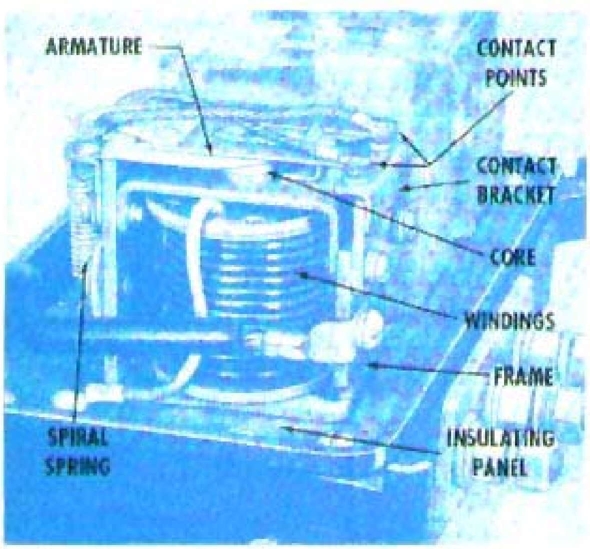


Figure 7—Construction of the cutout relay used in the heavy-duty, truck type three-unit regulator.

The relay core and windings are assembled into a frame (Fig. 7). A flat steel armature is attached to the frame by a hinge so that it is centered just above the end of the core. The armature has two or more contact points which are located just above a similar number of stationary contact points. When the generator is not operating the armature contact points are held away from the stationary points by means of a spiral spring.

When the generator voltage builds up to a value great enough to charge the battery, the magnetism induced in the windings (Fig. 8), particularly the shunt winding, is strong enough to overcome the spiral spring tension and pull the armature toward the core. The armature contact points are brought down against the stationary contact points thus completing the circuit between the generator and the battery. The current which flows from the generator to the battery passes through the series winding and adds to the magnetism holding the contact points closed. In Figure 8, the red arrows indicate the direction of current flow through the series (solid red) winding and the shunt (dotted red) winding. The black vertical arrows indicate the magnetic fields from the two windings. It will be noted that both are in the same direction and add to exert magnetic attraction on the armature.

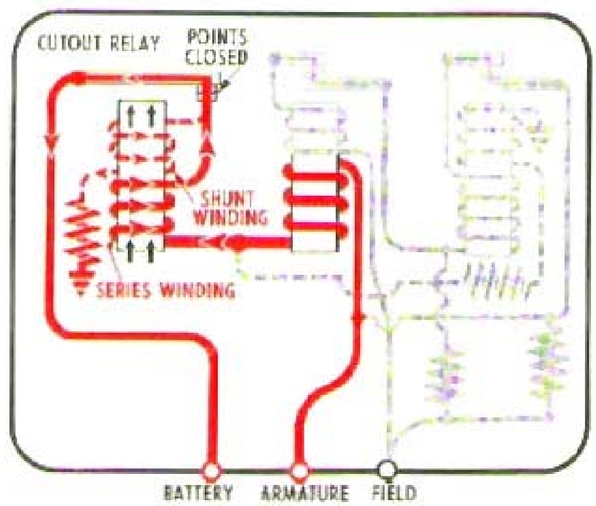


Figure 8—Wiring circuit of heavy-duty, truck type three-unit regulator with the cutout relay contact points closed and the relay windings shown in color. The shunt winding is in dotted red and the series winding in solid red. The red arrows indicate current flow through the two windings, and the black arrows indicate the magnetic fields resulting from this current flow.

When the generator slows down or stops, current begins to flow from the battery to the generator. This reverses the flow of current through the relay series winding, causing a reversal of the magnetic field produced by this winding. (The lower vertical black arrows in Figure 8 would then point downward instead of upward as shown.) The magnetic field of the shunt winding is not reversed. As a consequence, the magnetic fields of the two windings no longer help each other but oppose each other instead. (Upper and lower black arrows point in opposite directions instead of in same direction as shown in Figure 8.) As a consequence the resultant magnetic field is insufficient to hold the armature down. The spiral spring tension pulls the armature away from the core so that the armature contact points and stationary contact points are separated. This opens the circuit between the generator and the battery.

### VOLTAGE REGULATOR

The voltage regulator (Fig. 9) contains two windings assembled on a single core. One of these is a shunt winding consisting of many turns of fine wire (shown in dotted red, Fig. 10) which, in series with a resistor, is shunted across the generator at all times. The second winding, the field current winding (shown in blue), is connected into the generator field circuit when the regulator points are closed so that field current passes through it.

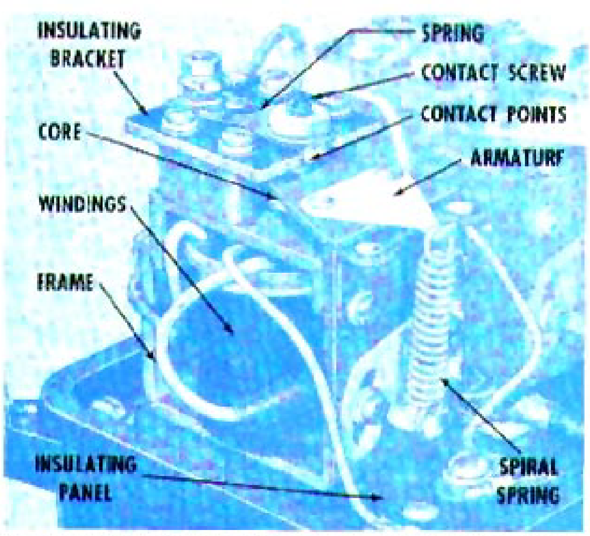


**Figure 9—Construction of the voltage regulator unit used in the heavy-duty, truck type regulator.**

The windings and core are assembled into a frame. A flat steel armature is attached to the frame by a hinge so that it is just above the end of the core. The armature contains a contact point which is located just beneath a stationary contact point. When the voltage regulator is not operating, the spiral spring tension holds the armature away from the core so that the armature contact point and stationary contact point are touching. The stationary contact point is assembled into a flat spring which rises slightly above the fiber mounting bracket when the contact points are together. This arrangement permits a wiping action between the points as they close and open which assures better contact between them.

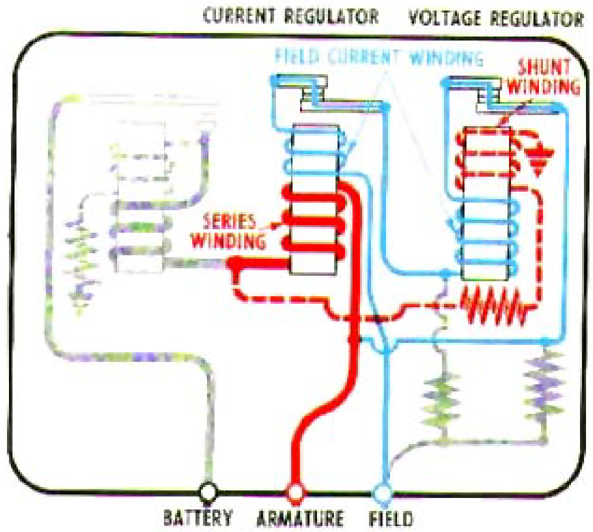


**Figure 10—Wiring circuit of the heavy-duty, truck type three-unit regulator with both sets of regulator contact points closed and with the regulator windings shown in color. The current regulator series winding is shown in solid red and the voltage regulator shunt winding is shown in dotted red. The field current windings of both regulator units are shown in blue.**

When the generator voltage reaches the value for which the voltage regulator is adjusted, the combined magnetic field produced by the shunt winding and the field current winding overcomes the armature spring tension, pulls the armature down, and separates the voltage regulator contact points.

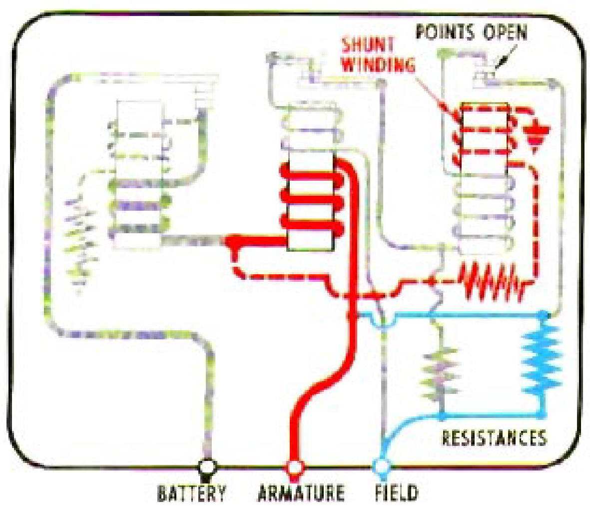


**Figure 11—Wiring circuit in heavy-duty, truck type three-unit regulator with the voltage regulator contact points open. The circuits in action at this moment are shown in color. The current regulator series winding is in solid red and the voltage regulator shunt winding is in dotted red. The generator field circuit through the regulator is in blue and extends from the connection at the charging circuit through the right-hand resistance to the field terminal; the resistance is in series with the generator field circuit.**

This inserts resistance into the generator field circuit so the generator field current and generator voltage are reduced. Let us examine more closely the changes in connections that take place when the voltage regulator contact points open.

The field circuit through the generator regulator, when both the current regulator and voltage regulator contact points are closed, is shown in blue (Fig. 10). When the voltage regulator contact points open, the field current is required to flow through the resistance shown to the right in Figure 11. This reduces generator field current and voltage. As soon as the generator voltage is reduced the voltage regulator shunt winding magnetic strength is reduced. In addition, the magnetic field of the field current winding collapses completely as the points open. This twofold magnetic field reduction so weakens the magnetic field that the armature spring pulls the armature up causing the contact points to close. This re-establishes the original circuit through the regulator, shorts out the resistance and permits the generator voltage to increase. The above cycle is again repeated. The complete cycle takes place at the rate of 50 to 150 times a second, thus limiting generator voltage to a predetermined maximum value. With the generator voltage limited, the generator supplies varying amounts of current to meet the requirements of varying states of battery charge and electrical loads.

## CURRENT REGULATOR

The current regulator contains two windings assembled on one core, a series winding (shown in solid red, Fig. 10) and a field current winding (shown in blue). The series winding consists of a few turns of heavy wire and it is connected into the charging circuit (shown in solid red) so that full generator output passes through it. The field current winding is connected in series with the generator field circuit so that the field current flows through it when the regulator contact points are closed.

The core and windings are assembled into a frame. Above the core is an armature and a stationary point which are identical in construction to those used on the voltage regulator (Fig. 9).

The current regulator unit is adjusted to operate when the generator current output reaches a predetermined maximum. When this output is reached, the magnetic pull on the armature produced by current flow through the two windings causes the current regulator contacts to separate. When the current regulator contacts open, two parallel resistors are inserted into the field circuit so that generator current output is reduced. The path for field current flow through the regulator with the current regulator contacts open is shown in Figure 12. Otherwise, the action of the current regulator unit is like that of the voltage regulator unit already discussed in detail.

## ACCELERATOR WINDINGS

On late model Delco Remy regulators of the type discussed in this bulletin, an "accelerator" winding instead of a "field current" winding is used on the current and voltage regulator units (Figs. 40 and 42). On these units, accelerator windings with added series resistors are connected between the upper contact supports of both units and ground (or the return circuit on two-wire systems).

The field current windings already discussed have a variable effect on the magnetic field attracting the regulator armature (depending on the amount of field current). An accelerator winding connected across the charging circuit has a more constant influence on the strength of the magnetic

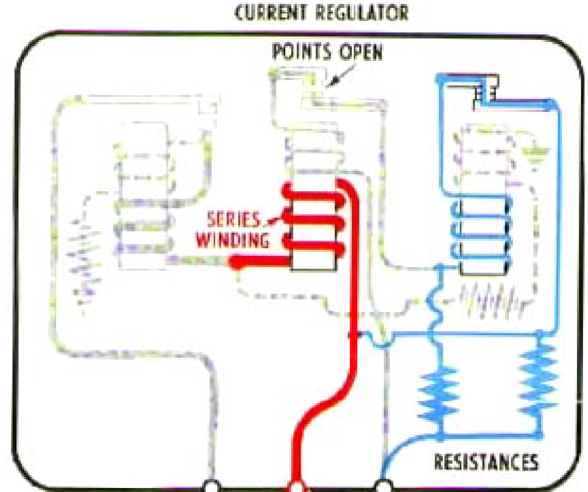


**Figure 12—Wiring circuit in heavy-duty, truck type three-unit regulator with the current regulator contact points open. The windings in effective operation at this moment are shown in color in the two regulator units. The current regulator series winding is shown in red and the voltage regulator field current winding is shown in blue. At this moment the generator field circuit through the regulator extends from the connection at the charging circuit, through the two resistances in parallel, to the field terminal. The left-hand resistance is paralleled with the right-hand resistance through the voltage regulator contact points and field current winding.**

field, since its effect varies only with operating voltage. For this reason, a regulator unit using an accelerator winding offers more satisfactory control throughout its required operating range.

Except for the differences described, the accelerator windings act much like the field current windings already discussed. When energized from the charging circuit, the accelerator winding strengthens the pull on the regulator armature. When the contacts open and the winding is no longer energized, the magnetic pull on the armature produced by the winding collapses completely, resulting in the desired effect.

### RESISTANCE UNITS

The controlling resistances indicated in each diagram have been shown as single resistors for convenience. Actually the regulator may use two resistors in parallel at either location for design reasons.

## FOUR-UNIT REGULATOR

### ACTUATING AND CIRCUIT BREAKER RELAYS

The actuating and circuit breaker relays operate together to perform the same function as the cutout relay on other regulators. When the actuating relay operates it "actuates" or causes the circuit breaker relay to operate. The circuit breaker relay then functions to close or open the circuit between the generator and the battery. Detailed descriptions of the operation of these two units follow:

The actuating relay (Fig. 13) contains two windings and an upper and lower set of contact points. One of the windings is a series winding of a few turns of heavy wire (shown in solid red in Fig. 15) which is connected into the charging circuit (also shown in solid red). The second winding is a shunt winding consisting of many turns of fine wire (shown in dotted red), which, in series with a resistor, is shunted across the generator. One or the other set of contact points is always closed excepting when the armature is in motion between the two extreme armature positions.

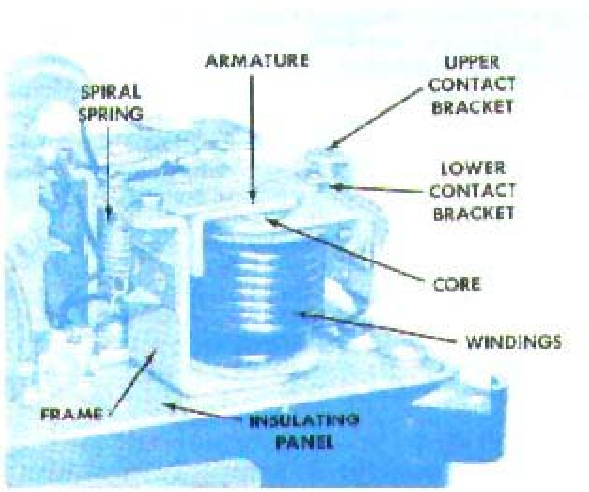


**Figure 13—Construction of the actuating relay having an armature with one flat spring used in the heavy-duty, truck type four-unit regulator. For earlier designs see Bulletin 1R-122.**

The circuit breaker relay (Fig. 14) contains a shunt winding (shown in dotted red, Fig. 15) on a core above which is an armature with two heavy contact points. Beneath these are two stationary contact points. One of these is connected through the regulator to the generator insulated terminal,

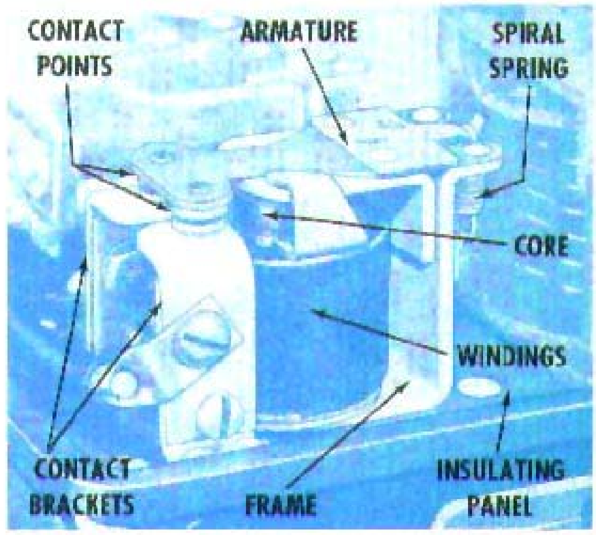


**Figure 14—Construction of the circuit breaker relay used in the heavy-duty, truck type four-unit regulator.**

and the other is connected to the battery through the wiring circuit.

When the generator is not operating, the actuating relay armature is held in the upper position by the tension of a spiral spring so that the upper contact points are closed and the lower contact points are open. When the generator begins to operate, a magnetic field builds up in the actuating

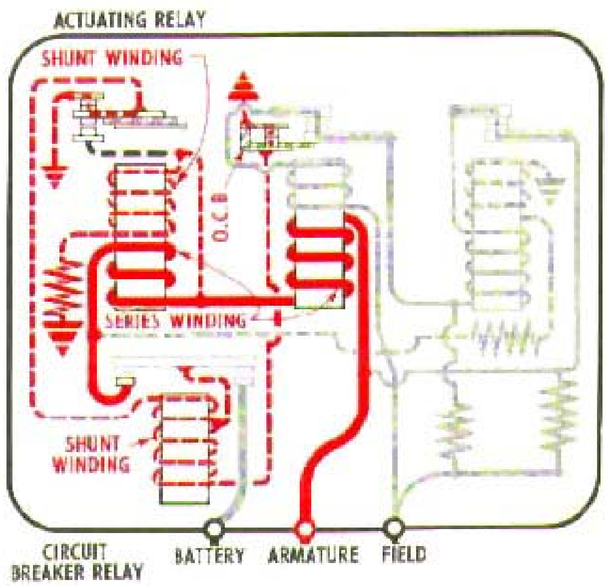


**Figure 15—Wiring circuit of actuating relay and circuit breaker relay in the heavy-duty, truck type four-unit regulator with the actuating relay lower contact points open and the circuit breaker relay contact points open. The actuating relay and circuit breaker relay shunt windings are shown in dotted red and the actuating relay series winding is shown in solid red. For earlier models see Bulletin 1R-122.**

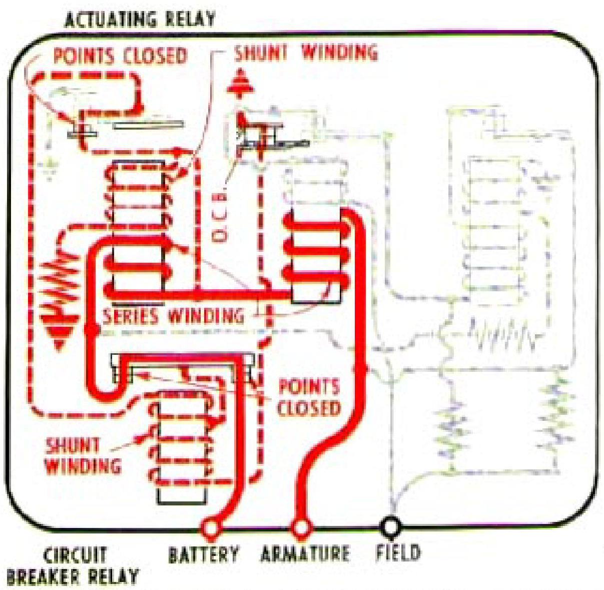


**Figure 16—Wiring circuit of actuating relay and circuit breaker relay in the heavy-duty, truck type four-unit regulator with the actuating relay lower contact points closed and the circuit breaker relay contact points closed. The magnetic field of the actuating relay shunt winding (dotted red) and series winding (solid red) add to hold the actuating relay armature down and the lower points closed. The magnetic field of the circuit breaker relay shunt winding (dotted red) holds the circuit breaker relay armature down so its contact points are closed.**

relay shunt winding. When the voltage reaches the value for which the relay is adjusted, the magnetism is sufficiently strong to pull the armature down toward the core causing the upper contact points to open and the lower contact points to close (Fig. 16).

Closing of the lower contact points connects the circuit breaker relay shunt winding (shown in dotted red) across the generator. This creates a strong magnetic field which pulls the circuit breaker relay armature down so that its points close completing the circuit between the generator and the battery (Fig. 16).

During the small fraction of a second that the circuit breaker relay points are closing, generator voltage is impressed across the entire circuit breaker relay shunt winding. This causes a very rapid relay action.

When the circuit breaker relay points have closed the major part of the winding is shunted across the generator by means of a connection to the relay armature. This manner of connecting the winding assures better relay operation, since any shock or vibration which might cause the actuating relay points to bounce open will not cause the circuit breaker relay points to open as long as the actuating relay upper contact points do not close.

When the generator voltage drops below battery voltage current flows from the battery to the generator. This reverses the flow of current through the actuating relay series winding (shown in solid red, Fig. 16). As a result, the series winding (solid red) and the shunt winding (dotted red) no longer help each other, but become magnetically opposed. The resultant magnetic field becomes too weak to hold the actuating relay armature in the lower position. The armature spring tension opens the lower points and closes the upper points. The upper contact points, in closing, connect the insulated end of the circuit breaker relay winding to ground. This causes the upper part of the circuit breaker relay shunt winding (dotted red) to magnetically oppose the lower part so that the resultant magnetic field becomes too weak to hold the circuit breaker armature down. The armature is released and the spring tension opens the points. This design of relay provides rapid and positive relay action.

The current regulator and voltage regulator units operate in a manner similar to the units on the three-unit regulator which has already been discussed. Some units use two paralleled resistances between the current regulator points and field terminal instead of the single resistance shown in Figure 16.

## REVERSE CURRENT OVERLOAD CIRCUIT BREAKER

The reverse current overload circuit breaker is a mechanical switch attached to the current regulator and actuated by excessive movement of the current regulator armature. It is made up of insulated upper and lower contact point support assemblies riveted to a mounting bracket. The upper contact support is rigid, but the lower contact support is a flat steel spring which allows vertical movement of the lower contact point. The lower contact point is connected to one end of the circuit breaker relay winding and the upper point is connected directly to ground, or in insulated regulators to the insulated return (Fig. 16). The reverse current overload circuit breaker is primarily a safety switch which opens the circuit breaker relay should it fail to open normally. Failure of the circuit breaker to open normally often results from a very sudden decrease in generator voltage and the consequent rapid build-up of reverse current from the battery. Such a rapid build-up of reverse current causes the actuating relay to reclose before the circuit breaker relay has a chance to open. The sudden decrease of generator voltage may be caused by (1) interruption of the field circuit with generator charging, (2) grounding of the generator armature circuit while charging, or (3) very rapid deceleration of the generator, such as occurs when the vehicle is braked severely, when skidding occurs with the wheels locked, or when fuel is shut off with the engine operating above idling speed (Diesels).

Electrically the reverse current overload circuit breaker is connected in series with the circuit breaker relay winding. Because of its physical position, the contact points of the reverse current overload circuit breaker are opened mechanically by movement of the current regulator armature as excessive current draws it down to the core. Interruption of the current in the winding of the circuit breaker relay allows the armature spring tension to open the circuit breaker relay contact points immediately, regardless of the actuating relay.

### PARALLELING RELAY

Some regulators for specialized applications have provisions for parallel operation of two or more generators with a common battery bank. The paralleling relay is part of the special circuit; its function, test, and adjustment are explained in detail under paragraph "Paralleling Regulators," appearing at the end of this bulletin.

## REGULATOR MAINTENANCE

### GENERAL INSTRUCTIONS

1. Mechanical checks and adjustments (air gaps, point openings) must be made with *battery disconnected* and regulator preferably off vehicle.

   CAUTION: The cutout relay contact points must never be closed by hand with the battery connected to regulator. This would cause a high current to flow through the units and seriously damage them.

2. Electrical checks and adjustments may be made either on or off the vehicle, *but the regulator must always be operated with the type generator for which it is designed.* All voltage checks must be made with the regulator on open circuit (battery disconnected). Voltage and current regulator checks must be made at specified speed.

   **Specified Speed**

   Voltage and current regulator checks must be made at a generator speed (1) equal to maximum operating speed in service or (2) a speed 50 per cent above the rated output speed given in generator test specifications, whichever is lower.

3. The regulator must be in operating position when electrical settings are checked and adjusted and *it must be stabilized at operating temperature.* Failure to observe these rules will cause serious errors in checking and adjusting voltage regulator settings.

   **Operating Temperature**

   A regulator may be considered to be stabilized at operating temperature after it has operated continuously for 30 minutes (cover in place) with normal to full load, or *immediately* after the vehicle has completed a run of several hours and *before* the engine is shut down. If the engine has been shut down after a run, operating temperature may be re-established by operating the regulator at normal to full load for a period equal to the down time (up to 30 minutes). This procedure may also be used to make up for time lost in hooking up test equipment or making minor adjustments.

4. After any tests or regulator adjustments requiring leads to be disconnected, the generator must be repolarized, after leads are reconnected but BEFORE THE ENGINE IS STARTED, as follows:

   **Polarizing Caution**

   To polarize Circuit B generators, disconnect the lead from the FIELD terminal of the regulator and momentarily touch this lead to the BATTERY terminal of the regulator. This allows a momentary surge of current to flow through the generator field windings in the proper direction. Failure to do this may result in severe damage since reversed generator polarity causes vibration, heavy arcing and burning of the relay contact points.

## QUICK CHECKS OF GENERATOR AND REGULATOR

In analyzing complaints on generator-regulator operation any one of several basic conditions may be found.

(1) Fully Charged Battery and Low Charging Rate—This is an indication of normal generator-regulator operation. Regulator settings may be checked as outlined in the following section.


(2) Fully Charged Battery and a High Charging Rate—This indicates that the voltage regulator is not reducing the generator output as it should. A high charging rate to a fully charged battery will damage the battery and the accompanying high voltage is very injurious to all electrical units.

| Spec. No. | CURRENT REGULATOR Current Setting (Amps.) | VOLTAGE REGULATOR Voltage Setting (Open Circuit) 135°-145° F. | CUTOUT RELAY Points Close (Volts) | Spec. No. | CURRENT REGULATOR Current Setting (Amps.) | VOLTAGE REGULATOR Voltage Setting (Open Circuit) 135°-145° F. | CUTOUT RELAY Points Close (Volts) |
|---|---|---|---|---|---|---|---|
| 2002* | ‡ | 14.6 | 13.5 | 2015 | 50 | 15.0 | 13.5 |
| 2003 | 25 | 37.5 | 33.0 | 2016 | 12 | 30.0 | 26.0 |
| 2004 | 25 | 7.5 | 6.5–6.9 | 2017* | 75 | 28.0 | 26.0 |
| 2005 | 25 | 7.5 | 6.5–6.9 | 2018 | 15 | 30.0 | 26.0 |
| 2006 | 17 | 14.6 | 13.5 | 2019 | 40 | 7.5 | 6.5–6.9 |
| 2007 | 25 | 15.0 | 13.5 | 2020 | 50 | 30.0 | 26.0 |
| 2008 | 25 | 15.0 | 13.5 | 2021 | ... | † | — |
| 2009 | 35 | 7.5 | 6.5–6.9 | 2022 | 50 | 30.0 | 26.0 |
| 2010 | 55 | 15.5 | 13.5 | 2023 | 50 | 30.0 | 26.0 |
| 2011 | 14 | 40.0 | 35.0 | 2026* | 55 | 14.6 | 13.5 |
| 2012 | 15 | 30.0 | 26.0 | 2030‖ | ... | 28.0 | — |
| 2013* | 50 | 14.6 | 13.5 | 2034 | 55 | 14.6 | 13.5 |
| 2014 | 14 | 37.5 | 33.0 | 2035 | 50 | 14.6 | 13.5 |

*On these units set Voltage Regulator Air Gap .018-.020 in. and Point Opening .006-.008 in., Cutout Relay Air Gap .050 in., Field Relay Air Gap .010 in., and Field Relay Open Circuit Voltage 8 volts on 12 volt systems and 20 volts on 24 volt systems. Set Field Relay before Voltage Regulator. See 1R-120 and 1R-133.
‡Voltage Regulator unit only. Set on closed circuit at 14.7 volts with 30 amperes current and generator operating at 2500 r.p.m.
†Must be set hot (operating temperature to 57 amperes). See 1 R-120.
‖Set Air Gap .078-.080 in.; Point Opening .018 in. minimum.

## TABLE 3A—HEAVY-DUTY REGULATOR TRUCK TYPE TEST SPECIFICATIONS

Read paragraph of Instructions under Table 3.

Regulators for which specifications are listed in this table must be checked and adjusted according to Bulletins 1R-122, 1R-222, 1R-123, 1R-123A (Circuit B Regulators) and 1R-124, 1R-124A (Circuit A Regulators).

All electrical checks and adjustments must be made with the regulator at operating temperature, and voltage settings must be made on open circuit. If voltage and current settings are found to be within the ranges given in this table, the regulator is operating satisfactorily and need not be disturbed. When settings are found to be outside the ranges, the regulator should be adjusted to the value specified. All mechanical values have an allowable variation of plus or minus 10 per cent unless otherwise stated. (See back page of this bulletin for explanation of air gap variation.)

| | |
|---|---|
| Voltage Regulator Air Gap | .064 in. |
| Current Regulator Air Gap | .064 in. |
| Cutout Relay Air Gap (3 unit reg.) | .055 in. |
| Cutout Relay Point Opening (3 unit reg.) | .040 in. |
| Circuit Breaker Air Gap (4 unit reg.) | .042 in. |
| Circuit Breaker Point Opening (4 unit reg.) | .040 in. |
| Circuit Breaker Back Air Gap (4 unit reg.) | .008 in. |
| Actuating Relay Air Gap (4 unit reg.) | .037 in. |
| Actuating Relay Point Opening (4 unit reg.) | .037 in. |
| Actuating Relay Back Air Gap (4 unit reg.) | .008 in. |
| Overload Circuit Breaker Point Opening | .020 in. |
| Overload C.B. Initial Contact Tension | 7-9 oz. |
| Paralleling Relay Air Gap | .013 in. |
| Paralleling Relay Point Opening | .025 in. |

| Spec. No. | Cutout Relay or Actuating Relay Closing Voltage Range | Cutout Relay or Actuating Relay Closing Voltage Adjust | Circuit Breaker Closing Voltage Range | Circuit Breaker Sealing Voltage Range | Setting (Volts) Voltage Regulator Range | Setting (Volts) Voltage Regulator Adjust | Setting (Amps.) Current Regulator Range | Setting (Amps.) Current Regulator Adjust | Overload C. B. Amps. Overload To Open |
|---|---|---|---|---|---|---|---|---|---|
| 1468 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 38–42 | 40 | 8–24 |
| 1538 | 25–27 | 26.0 | — | — | 27.5–29.5 | 28.2 | 23–27 | 25 | — |
| 1547 [a] | 12.5–13.5 | 13.0 | 7.0–8.5 | 1–3 above closing | 13.9–14.9 | 14.3 | 98–102 | 100 | — |
| 1548 [b] | 11.8–13.6 | 12.8 | — | — | 13.9–14.9 | 14.3 | 22–27 | 25 | — |
| 1561 [c,d] | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 18–22 | 20 | 4–13 |
| 1564 [d] | 5.9–6.8 | 6.4 | — | — | 6.9–7.5 | 7.2 | 37–43 | 40 | — |
| 2027 | 25–28 | 26.5 | 14–17 | 2–5 above closing | 28.8–30.3 | 29.3 | 48–52 | 50 | — |
| 2028 | 5.9–6.8 | 6.4 | — | — | 7.0–7.7 | 7.4 | 38–42 | 40 | — |
| 2029 | 12.5–13.5 | 13.0 | 7.0–8.5 | 1–3 above closing | 14.3–15.3 | 14.7 | 53–57 | 55 | — |
| 2031 | 11.8–13.6 | 12.8 | — | — | 13.9–14.9 | 14.3 | 23–27 | 25 | — |
| 2032 | 5.9–6.8 | 6.4 | — | — | 7.0–7.7 | 7.4 | 23–27 | 25 | — |
| 2036 | 11.8–13.6 | 12.8 | — | | 13.9–14.9 | 14.3 | 38–42 | 40 | — |
| 2037 | 25–27 | 26.0 | 14–17 | 19.5–23 | 28.0–29.5 | 28.5 | 9–11 | 10 | — |
| 2038 | 33–36.5 | 34.5 | 19–22.5 | 25–30 | 37.8–39.7 | 38.3 | 9–11 | 10 | — |
| 2039 | 11.8–13.6 | 12.8 | — | — | 13.9–14.9 | 14.3 | 18–22 | 20 | — |
| 2040 | 33–36.5 | 34.5 | 19–22.5 | 25–30 | 37.8–39.7 | 38.3 | 23–27 | 25 | — |
| 2041 | 33–36.5 | 34.5 | 19–22.5 | 25–30 | 37.8–38.7 | 38.3 | 38–42 | 40 | — |
| 2042 | 25–27 | 26.0 | 14–17 | 19.5–23 | 28.0–29.5 | 28.5 | 13–15 | 14 | — |
| 2043 | 31–34 | 32.5 | 18–21 | 23.5–28.5 | 35.2–37.0 | 35.9 | 9–11 | 10 | — |
| 2046 | 25–27 | 26.0 | 14–17 | 19.5–23 | 28.0–29.5 | 28.5 | 48–52 | 50 | — |
| 2047 [a] | 12.5–13.5 | 13.0 | 7.0–8.5 | 1–3 above closing | 13.9–14.9 | 14.3 | 78–82 | 80 | — |
| 2048 | 25–27 | 26.0 | 14–17 | 19.5–23 | 28.0–29.5 | 28.5 | 23–27 | 25 | — |
| 2049 | 31–34 | 32.5 | 18–21 | 23.5–28.5 | 35.2–37.0 | 35.9 | 23–27 | 25 | — |
| 2050 | 31–34 | 32.5 | 18–21 | 23.5–28.5 | 35.2–37.0 | 35.9 | 38–42 | 40 | — |
| 2051 | 12.5–13.5 | 13.0 | 7.0–8.5 | 1–3 above closing | 13.9–14.9 | 14.3 | 53–57 | 55 | — |

a—Circuit breaker air gap .038"
b—Cutout relay air gap .048", point opening .035"
c—Paralleling relay operating range 15-20 volts, adjust to 17
d—Current regulator air gap .105"

S E R V I C E B U L L E T I N

| Spec. No. | Cutout Relay or Actuating Relay Closing Voltage Range | Adjust | Circuit Breaker Closing Voltage Range | Circuit Breaker Sealing Voltage Range | Setting (Volts) Voltage Regulator Range | Adjust | Setting (Amps.) Current Regulator Range | Adjust | Overload C. B. Amps. Overload To Open |
|---|---|---|---|---|---|---|---|---|---|
| 2055[dc] | 25–27 | 26.0 | 14–17 | 2–5 above closing | 27.5–29.5 | 28.2 | 23–27 | 25 | 4–13 |
| 2061 | 31–34 | 32.5 | 18–21 | 23.5–28.5 | 35.2–37.0 | 35.9 | 14–16 | 15 | ...... |
| 2062 | 11.8–13.6 | 12.8 | .. | ...... | 13.9–14.9 | 14.3 | 16–19 | 18 | ...... |
| 2064 | 33–36.5 | 34.5 | 18.0–22.5 | 25–30 | 37.8–39.7 | 38.3 | 28–32 | 30 | ...... |
| 2067[ac] | 27.5–30.0 | 28.9 | 16–18 | 18–22 | 28.0–29.5 | 28.5 | 58–62 | 60 | ...... |
| 2068[ag] | 12.5–13.5 | 13.0 | 7.0–8.5 | 1–3 above closing | 13.9–14.9 | 14.3 | 53–57 | 55 | ...... |
| 2071[d] | 11.8–13.6 | 12.8 | ...... | ...... | 13.9–14.9 | 14.3 | 23–28 | 25 | ...... |
| 2074 | 31–34.5 | 33.0 | 18–21 | 23.5–28.5 | 35.2–37.0 | 35.9 | 28–32 | 30 | . |
| 2077 | 11.8–13.4 | 12.8 | ...... | ...... | 13.6–14.5 | 14.0 | 53–57 | 55 | ...... |
| 2078 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 9–11 | 10 | 2–8 |
| 2079 | 33–36.5 | 34.5 | 19–22.5 | 3–8 above closing | 37.8–39.7 | 38.3 | 9–11 | 10 | 2–6 |
| 2080 | 33–36.5 | 34.5 | 19–22.5 | 3–8 above closing | 37.8–39.7 | 38.3 | 23–27 | 25 | 5–15 |
| 2081 | 33–36.5 | 34.5 | 19–22.5 | 3–8 above closing | 37.8–39.7 | 38.3 | 38–42 | 40 | 7–20 |
| 2082 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 13–15 | 14 | 2–8 |
| 2083[p] | 31–34 | 32.5 | 18–21 | 3–8 above closing | 35.2–37.0 | 35.9 | 9–11 | 10 | 2–6 |
| 2084 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 48–52 | 50 | 8–24 |
| 2086 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 23–27 | 25 | 4–13 |
| 2087[p] | 31–34 | 32.5 | 18–21 | 3–8 above closing | 35.2–37.0 | 35.9 | 23–27 | 25 | 5–15 |
| 2088[p] | 31–34 | 32.5 | 18–21 | 3–8 above closing | 35.2–37.0 | 35.9 | 38–42 | 40 | 7–20 |
| 2089[p] | 31–34 | 32.5 | 18–21 | 3–8 above closing | 35.2–37.0 | 35.9 | 14–16 | 15 | 2–6 |
| 2090 | 33–36.5 | 34.5 | 19–22.5 | 3–8 above closing | 37.8–39.7 | 38.3 | 28–32 | 30 | 5–15 |
| 2091[d] | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 23–26 | 25 | 4–13 |
| 2092[p] | 31–34 | 32.5 | 18–21 | 3–8 above closing | 35.2–37.0 | 35.9 | 28–32 | 30 | 5–15 |
| 2095 | 11.8–13.6 | 12.8 | ...... | ...... | 13.9–14.9 | 14.3 | 37–43 | 40 | ...... |
| 2096 | 11.8–13.6 | 12.8 | ...... | ...... | 13.9–14.9 | 14.3 | 45–53 | 50 | ...... |
| 2097 | 5.9–6.8 | 6.4 | ...... | ...... | 6.9–7.5 | 7.2 | 53–57 | 55 | ...... |
| 2101 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 57–63 | 60 | 8–24 |
| 2104 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 18–22 | 20 | 4–13 |
| 2108 | 12.5–13.5 | 13.0 | 7–8.5 | 1–3 above closing | 13.9–14.9 | 14.3 | 53–57 | 55 | |
| 2111 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 48–52 | 50 | 8–24 |
| 2112[h] | ...... | ...... | 4.7–5.5 | 6–8 | 13.9–14.9 | 14.3 | 98–102 | 100 | . |
| 2114[i] | 12.5–13.5 | 13.0 | 7–8.5 | 1–3 above closing | 13.9–14.9 | 14.3 | 48–52 | 50 | ...... |
| 2116 | 11.8–13.6 | 12.8 | ...... | ...... | 13.9–14.9 | 14.3 | 28–32 | 30 | ...... |
| 2117[bn] | 25–27 | 26.0 | ...... | ...... | 27.5–29.5 | 28.2 | 16–20 | 18 | ...... |
| 2119[i] | 12.5–13.5 | 13.0 | 7–8.5 | 1–3 above closing | 13.9–14.9 | 14.3 | 18.5–21.5 | 20 | ...... |
| 2120 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 16–20 | 18 | 4–13 |
| 2121 | 11.8–13.6 | 12.8 | ...... | ...... | 13.9–14.9 | 14.3 | 28–32 | 30 | ...... |
| 2124 | 12.5–13.5 | 13.0 | 7–8.5 | 1–3 above closing | 13.9–14.9 | 14.3 | 48–52 | 50 | ...... |
| 2128 | 11.8–13.4 | 12.8 | ...... | ...... | 13.6–14.5 | [k] | 53–57 | 55 | ...... |
| 2129 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 5–7 | 6 | 2–8 |
| 2135[bm] | 25–27 | 26.0 | ...... | ...... | 27.5–29.5 | 28.2 | 23–27 | 25 | ...... |
| 2141 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 27.5–29.5 | 28.0 | 23–27 | 25 | 4–13 |
| 2142[h] | ...... | ...... | 4.7–5.5 | 6–8 | 13.9–14.9 | 14.3 | ...... | ...... | ...... |
| 2147 | 25–27 | 26.0 | 14–17 | 2–5 above closing | 28.0–29.5 | 28.5 | 18–22 | 20 | 4–13 |
| 2153[dp] | 33–36.5 | 34.5 | 19–22.5 | 3–8 above closing | 37.8–39.7 | 38.3 | 14–16 | 15 | 2–6 |
| 2156 | 11.8–13.6 | 12.8 | ...... | ...... | 13.9–14.9 | 14.3 | 18–22 | 20 | |
| 2162 | ...... | 35 | 16.5–20 | 3–8 above closing | 42–44.5 | 43 | 14–16 | 15 | 2–6 |
| 2163 | 37–41 | 39 | 20–26 | 3–8 above closing | ...... | ...... | ...... | ...... | . |
| 2164 | 5.9–6.8 | 6.4 | ...... | ...... | 7.0–7.7 | 7.4 | 23–27 | 25 | ...... |
| 2169 | 11.8–13.4 | 12.8 | ...... | ...... | 13.9–14.9 | 14.3 | 16–20 | 18 | ...... |
| 2170[o] | 33.0–36.5 | 34.5 | 19–22.5 | 3–8 above closing | 37.8–39.7 | 38.3 | 9–11 | 10 | 2–6 |
| 2173[b] | 11.8–13.4 | 12.8 | ...... | ...... | 13.9–14.9 | 14.3 | 16–20 | 18 | ...... |
| 2178[bp] | 31–34 | 32.5 | 18–21 | 3–8 above closing | 35.2–37 | 35.9 | 38–42 | 40 | 7–20 |

a—Circuit breaker air gap .038"
b—Cutout relay air gap .048", point opening .035"
c—Actuating relay air gap .045", point opening .027"
d—Current regulator air gap .100"
f—Circuit breaker relay air gap and point opening .035"
g—Actuating relay air gap .043", point opening .032"
h—Circuit breaker relay air gap .038", point opening .033"
i—Paralleling relay operating range 7.0–10.0 volts, adjust to 8.5
k—If internal adjustment is required, place external adjusting screw in "MED" position and adjust to 14.0 volts.
m—Current regulator air gap .115"
n—Voltage and current regulator air gap .087"
o—Paralleling relay operating range 22–30 volts, adjust to 26
p—Settings given are for 30-volt system. On a 32-volt system, the actuating relay and circuit breaker relay settings should be approximately 2 volts higher and the voltage regulator setting should be approximately 2.5 volts higher.