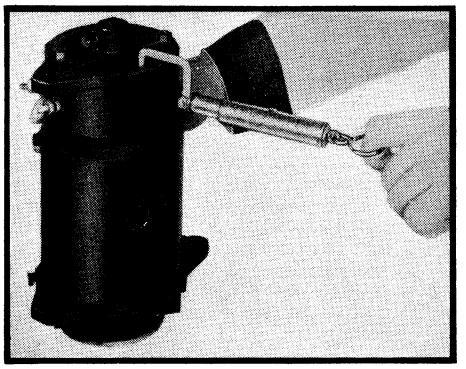

Fig. 24 Checking brush spring tension on new Delco-Remy generator with special type spring scale

output. This mounting must have sufficient friction to hold it in place after adjustments are completed.

24. Assemble the generator, being sure that all internal connections are clean and tight, and the armature is free to rotate in the bearings before the brushes are placed against the commutator.
25. Be sure the brush leads are bent so they will follow the brushes as they wear shorter. Be sure also that the leads do not run against any part of the armature.
26. Run the generator as a motor by connecting it as shown in Fig. 25. When the jumper wire from the field is grounded the armature should "motor" or rotate slowly. If it does not, something is wrong with the assembly, which must be located and corrected.
27. After running the generator for a few minutes, stop it and lift the brushes to examine the contact surfaces. If the brush shows that it is wearing in on one side only, slightly twist the brush tension arm to equalize the pressure on the brush to obtain uniform wear.
28. If a generator test bench is available, mount the generator on it, being sure the pulleys are in alignment. For a third brush type generator, no regulator is necessary. For a shunt type generator, connect it to a regulator of the same specifications it will have when on the car, being sure the polarity is correct. Run the generator at maximum speed, same as when on the vehicle. Then adjust the voltage and ampere output according to the highest voltage the specifications call for. Note the action of the brushes; if sparking occurs, check the brush seat, spring tension and brush spring tension arm. Make any necessary adjustment to obtain satisfactory commutation.

Service Note

If a generator test stand is not available, install the generator on the car, being sure the pulleys are in perfect alignment. Then check the output in the same manner as you would on a test stand, adjusting the current and voltage as described in the *Generator Regulators* chapter.

Installing Generator

If the regulator mounts on the generator, connect the lead from the insulated main brush to the armature terminal and connect the field lead to the field terminal. Then mount the regulator on the generator, being sure to use lock washers on the mounting screws as the regulator must be firmly mounted to assure a good ground on the generator.

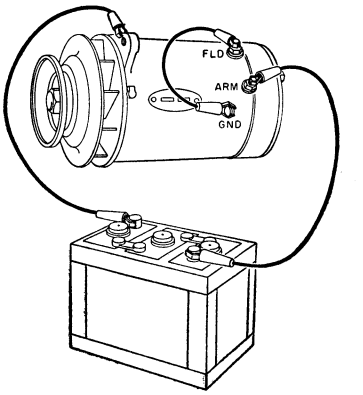

Fig. 25 Connections for running generator as a motor. Be sure to connect the generator with the same polarity that it will have when it is installed on the vehicle

Install the generator on the engine and connect the leads. Adjust the drive belt tension so that there is approximately one inch deflection in the center of its longest span.

After the generator is installed and before starting the engine, it should be polarized according to the instructions outlined previously.

GENERATOR REGULATORS

A generator regulator is designed for one purpose only and that is to regulate or control the charging rate in the generator-battery circuit. When a good battery is low, the regulator will automatically increase the charging rate until the battery becomes fully charged. As soon as the battery is charged up, the regulator will automatically cut down the charging rate.

The modern regulator consists of three units, Figs. 1 and 2. A cut-out relay (otherwise known as a circuit breaker), a voltage regulator unit, and a current regulator unit. The circuit breaker (or cut-out relay) is the same type that has always been used on cars; it automatically closes the circuit between the generator and battery when the engine is running a little above idling speed, and it opens the circuit when the engine is idling or stopped. In other words, it is simply a magnetic switch.

The voltage and current regulators, regardless of type, are automatic magnetic switches that weaken or strengthen the generator field circuit according to the requirements of the battery. This is accomplished by means of resistances that automatically cut into or out of the field circuit. In other words, when the battery is not fully charged, resistance is cut out of the circuit, thereby allowing the generator to recharge the battery. When the battery becomes fully charged, resistance is automatically cut into the circuit, reducing the charging rate of the generator so that the battery voltage is held within safe limits. This design provides a steady generator voltage, depending upon the proportionate time the resistance is in and out of the circuit. This method of control is inherently sensitive and, therefore, controls the voltage within very close limits.

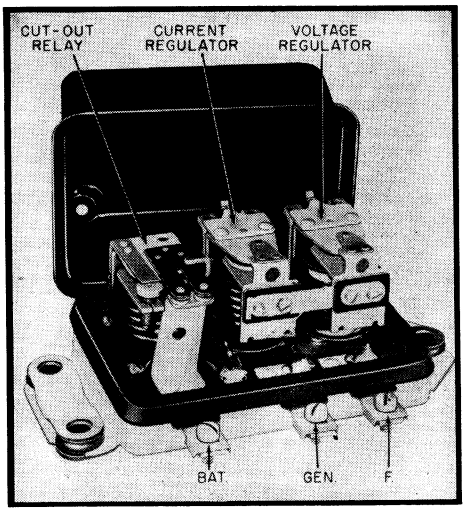

Fig. 1 Delco-Remy vibrating voltage and current regulator with cover removed

When a vibrating type regulator is used for a third brush generator it consists of two units, a circuit breaker and voltage regulator. For shunt-type gene-

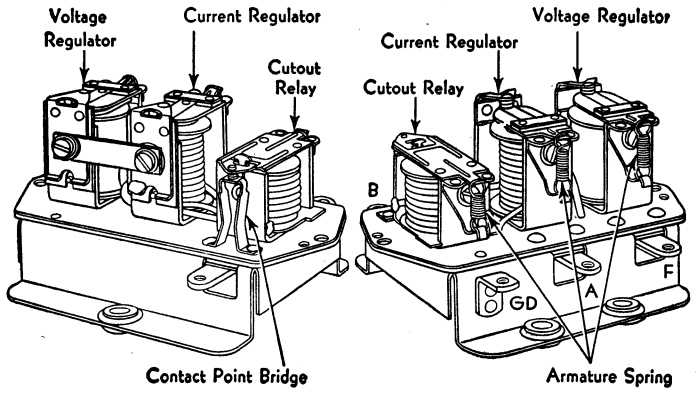

Fig. 3 Typical Auto-Lite regulator with a special ground (GD) terminal which is connected by a wire to a ground connection on the generator housing. Regulators without this ground terminal are usually grounded by the screws by which the regulator is attached to the vehicle body

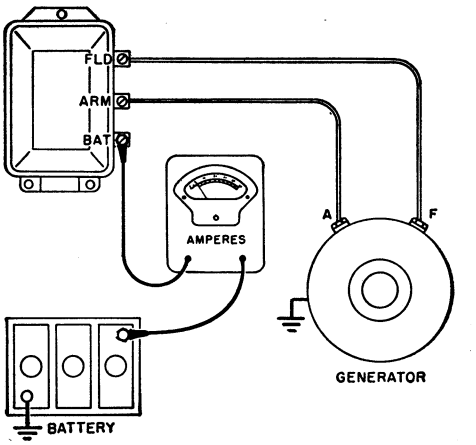

Fig. 4 Ammeter connected in circuit for testing purposes when vehicle has a "Charge Indicator Light" instead of a dash ammeter

rators, a third unit for current regulation is needed to prevent exceeding the safe ampere output of the generator when the battery is discharged, Figs. 1 and 2.

Regulator Terminal Markings

Before we discuss the service requirements of regulators, it is well to become acquainted with the terminal markings on the various makes of regulators.

Fig. 1, for example, shows the location and terminal markings on a late model Delco-Remy regulator. These marks vary with regulators of the same make and regulators of different makes.

The "BAT" terminal is sometimes marked "B", and it may also be located on the other side of the regulator as shown in Fig. 3. In any case, this is always the connection to the battery through the circuit breaker.

The "GEN" terminal may be marked "A" or "ARM". On Auto-Lite regulators, the identifying marks are usually stamped on the regulator cover. Regardless of how it is marked, however, this terminal always connects to the armature terminal on the generator.

The "F" terminal may also be marked "FLD", which is the case on Auto-Lite regulators. Whichever mark is used, this terminal always connects to the field terminal on the generator.

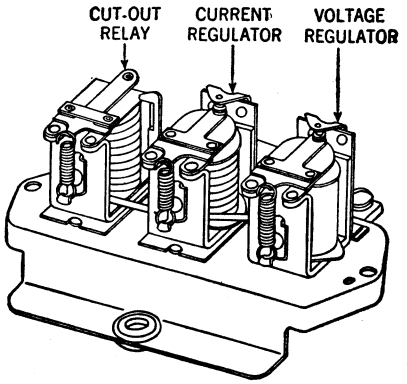

Fig. 2 Auto-Lite vibrating voltage and current regulator with cover removed

TROUBLE SHOOTING

When a car is having charging trouble, either of the following conditions may be present:

No charge comes through the generator. In this case, the trouble may be either in the generator itself, in the regulator or in a broken battery connection.

A charge comes through from the generator but it is either too high or too low. In this case, the trouble may be either in the battery or in the regulator.

To isolate the trouble, the procedure is simple and no instruments are required.

NOTE—Some cars have a "Charge Indicator Light" instead of a dash ammeter. Therefore, when reference is made to the dash ammeter not indicating "Charge", the light should glow. When the generator is charging, the light should go out. But since the light cannot indicate the amount of charge coming through the generator, it will be necessary to insert an ammeter in the circuit between the battery and circuit breaker. As shown in Fig. 4, remove the wire from the battery terminal of the regulator and connect an ammeter in series.

Isolating "No Charge" Trouble

First make sure the regulator base is properly grounded, as without a ground there can be no action of the regulator. Do not take the ground for granted—temporarily connect a wire from the regulator base to a good ground, Fig. 5. If the regulator has a ground terminal, make sure the connections at both the regulator and generator are clean and tight. Now run the engine at a speed which approximates 20 mph, and if the ammeter now shows a charge, the trouble was a defective grounding of the regulator. But if no charge comes through:

Connect a wire from the field terminal on the regulator to a good ground, Fig. 6. This completes the field circuit of the generator outside of the regulator. In other words, it converts the generator into an old type non-regulated generator and cuts out the voltage regulator. Again run the engine at about 20 mph, and if you now get a charge, the voltage regulator is at fault. However, if there is still no charge:

Connect a wire from the regulator armature terminal to the regulator battery terminal, Fig. 7. This shorts out the circuit breaker and current regulator winding. This gives a direct circuit from the regulator to the battery. Now run the engine at about 20 mph and if you now get a charge, the regulator is at fault. However, if a charge still does not come through, the trouble is elsewhere in the charging circuit or in the generator itself, such as an open field or defective brushes, or in an open connection in the charging circuit.

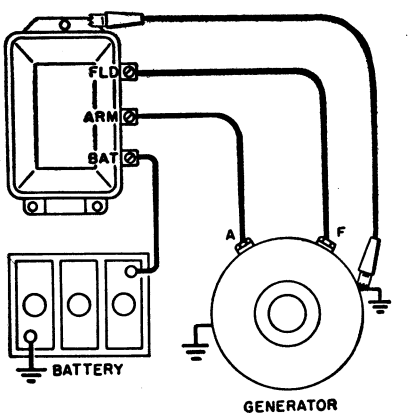

Fig. 5 Temporary connection for checking for a good ground on regulators not having a special ground terminal

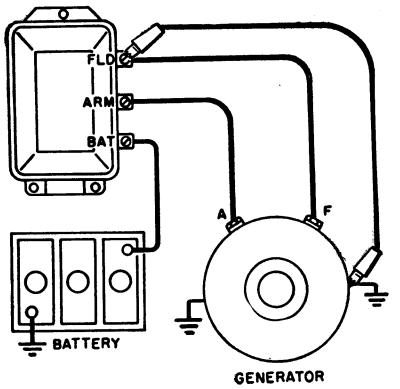

Fig. 6 Temporary connection to eliminate the voltage regulator from the circuit when isolating "no charge" trouble. If the regulator has a special ground terminal, connect a jumper wire from the regulator ground terminal to the regulator field terminal

Isolating Trouble When Charge Is Too High or Too Low

When the rate of charge is in question, the following conditions may be encountered:

Battery is fully charged and charging rate is low.

Battery is fully charged and charging rate is high.

Battery is low and charging rate is low.

Quick checks of these conditions can be made without the use of instruments. However, if the car is equipped with a "Charge Indicator Light", an ammeter will have to be inserted in the circuit, as shown in Fig. 4.

Battery Fully Charged, Charging Rate Low—When this conditon is observed, it indicates that the generator and regulator are operating satisfactorily.

Battery Fully Charged, Charging Rate High—When this occurs, the indication is that the charging rate is not being reduced when it should be. This condition will cause armature trouble, will injure ignition coils, burn ignition breaker points and shorten the life of headlight bulbs. To localize the trouble:

Run the engine at about 20 mph. Remove the wire from the regulator field terminal. If the charging rate now drops to zero, the regulator is at fault. If the high charging rate continues with the wire removed from the field terminal of the regulator, the generator is faulty or there is a grounded wire in the wiring harness.

Battery Low, Charging Rate Low—In order to localize the trouble with this condition, a preliminary check-up of the battery and battery cables must be made. After the battery has been checked and the terminals and cables cleaned, proceed as follows:

Run the engine at about 20 mph. Temporarily ground the regulator field terminal, Fig. 6, and increase engine speed somewhat. If the charging rate now increases, the trouble is in the voltage regulator. If the charging rate remains low, the trouble is either in the generator or in some other connection in the charging circuit. (Don't overlook the possibility of a loose fan or generator belt.)

The foregoing checks are conclusive in determining whether the regulator is at fault or whether the trouble lies elsewhere. But assuming that the regulator is at fault, we'll remove it from the car and examine it to see whether it can be repaired or whether it should be replaced.

Caution—On Delco-Remy regulators with dual voltage regulator contacts, never ground the generator field with the regulator connected to the generator. This will instantaneously burn up the lower set of contact points on the voltage regulator. An output check on these units requires that the "GEN" lead to the regulator be disconnected *before* the field is grounded.

Removing Regulator from Car

Disconnect all wires from their respective terminals. If the regulator has a ground terminal, extreme care must be exercised to see that the battery terminal wire does not touch, even for an instant, the ground terminal. Since this will produce a direct short circuit, the regulator will be damaged. To prevent this, either disconnect one of the battery cables or disconnect the ground wire last. Likewise, do not touch the battery wire to the field terminal as this will burn the regulator armature reeds on Auto-Lite regulators, which will ruin the regulator.

Inspecting Regulator

If the following procedure is made in the step-by-step manner in which it is given, it will uncover any trouble as you progress so that by the time the preliminary tests are made, you will know whether or not the regulator should be replaced or repaired and thus save time in making final adjustments. No equipment other than a battery is required for the tests described.

NOTE—Although practically all component parts of regulators are available (although not readily) for rebuilding purposes, the labor cost plus the cost of the parts for such a major operation is scarcely warranted when compared to the cost of a new regulator. From a practical standpoint, therefore, repairs to regulators are usually confined to replacing contacts, springs and resistors.

Remove regulator cover and inspect for any indication that the regulator has been damaged, such as a dented cover, burned paint on inside of cover, terminals in bad condition, any evidence of burning or poor soldering in any part of the regulator.

Tighten the nuts on the bottom of Auto-Lite and Ford regulators, Fig. 8. These nuts, if loose, will create high resistance in the circuit, affecting the performance of the regulator.

If the regulator is equipped with carbon resistors, Fig. 8, remove them from

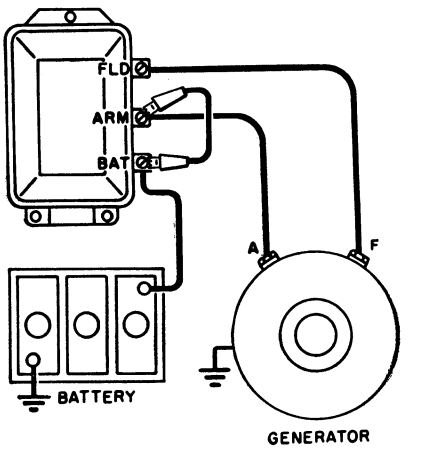

Fig. 7 Temporary connection to eliminate the circuit breaker and current regulator from the circuit when isolating "no charge" trouble

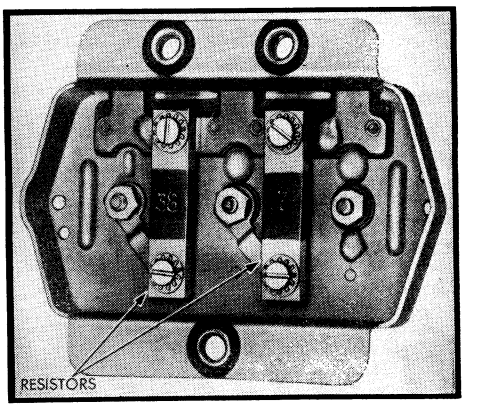

Fig. 8 Bottom view of Auto-Lite regulator with carbon resistors. The three nuts shown must be tight to eliminate high resistance. Resistors must not be cracked and the attaching screws and connections must be clean and tight for the same reason

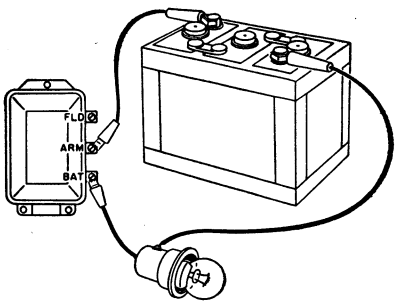

Fig. 9 Hook-up for checking continuity of series winding. Bulb should not light. Bulb should light when circuit breaker contacts are closed by hand. If it doesn't, replace regulator

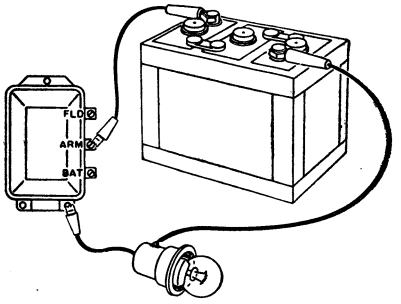

Fig. 10 Hook-up for checking continuity of voltage regulator shunt winding. Voltage regulator contacts should move. If not, replace regulator

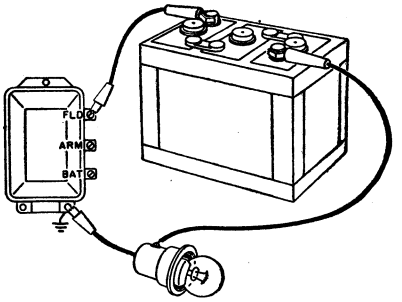

Fig. 11 Hook-up for checking efficiency of insulators on strap which connects current and voltage regulator units. Bulb should light. When the voltage regulator contacts are opened (by hand) light should go out. Closing current regulator contacts should cause light to go out or dim

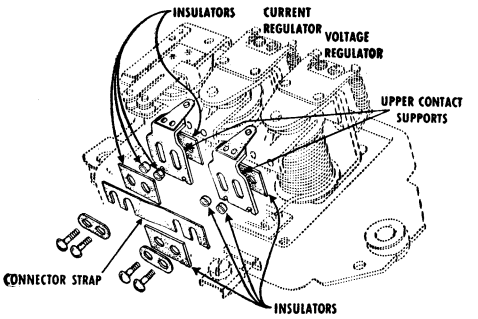

Fig. 12 Relationship of insulators and connector strap on Delco-Remy regulators

the base as they can be checked for cracks that do not show when on the regulator. When installing, be sure to attach them to their proper places and with the marked numerals facing you. These numerals indicate the nominal resistance in Ohms, and the one with the higher number belongs on the voltage regulator side of the base. Also, make certain the contact surfaces are clean, and tighten the screws securely.

If the foregoing inspection shows that the regulator appears to be serviceable, the next step is to make a continuity test of the windings. To do this, all you need is a battery of the proper voltage and a small light bulb connected in series with it.

To check the continuity of the series winding, clip one lead to the armature terminal and the other to the battery terminal, Fig. 9. With this hook-up, the bulb should not light. But by closing the circuit breaker contacts by hand, the bulb should light. If it does not, replace the regulator.

To check the continuity of the voltage regulator shunt winding, move the lead from the battery terminal and ground it to the regulator base, Fig. 10. With this hook-up, the voltage regulator contacts should move. If they do not, replace the regulator.

Without changing the connections, lightly touch the circuit breaker armature with one of your fingers. If the assist of the finger closes the circuit breaker contacts, it proves that the shunt winding of the circuit breaker is continuous. If the contacts do not close, replace the regulator.

To check the efficiency of the insulators on the strap which connects the voltage regulator to the current regulator, connect one lead to the field terminal and ground the other to the regulator base, Fig. 11. With this hook-up, the bulb should light. But when the voltage regulator contacts are opened (by hand) the light should go out. Similarly, when the current regulator contacts are closed, the light should dim or go out. If the conditions do not coincide with the foregoing, either the insulators are no good or they are improperly positioned. Figs. 12, 13 and 14 show how these parts should be installed on Delco-Remy regulators, and Fig. 15 illustrates the arrangement on Auto-Lite regulators. (Ford regulators have riveted construction.)

If the regulator checks O.K. thus far, the next step is to clean the contacts and to make the necessary mechanical adjustments.

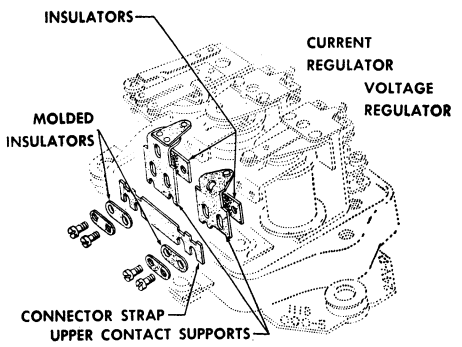

Fig. 13 Relationship of insulators and connector strap on late model Delco-Remy units with single contact voltage regulator

AUTO-LITE MECHANICAL ADJUSTMENTS

Fig. 16 is a layout of the tools needed to adjust all Auto-Lite regulators.

Cleaning Regulator Contacts

Although it can be done without removing the contacts, a more thorough job can be done by removing the stationary contacts and cleaning each one separately.

If there has been metal transfer, creating a crater on one contact and a projection on its mate, file off the projection so that the contact is smooth. Also file a smooth surface on the contact with the crater, Fig. 17.

After filing, reinstall the contacts so they just touch each other. Then clean them with a narrow strip of clean lintless tape saturated with an approved cleaning fluid (carbon tetrachloride, for example) applied to the tape with an eye dropper. Draw the wet portion of the tape back and forth across the contact surfaces, Fig. 18, to remove any oil, grease or dirt. Then draw a dry piece of the tape between the contacts to remove any residue that may remain. Open the contacts to remove the tape so that the pressure on the contacts will not retain small threads between them.

Circuit Breaker Contact Gap

The minimum gap between the circuit breaker contacts should be .015", Fig. 19. The adjustment is made by bending the bridge which is attached to the lower contact. This will be discussed more fully when we make the electrical adjustments.

Circuit Breaker Armature Air Gap

Set the circuit breaker armature air gap with the proper gauge of the group shown in Fig. 16, and to the dimension given in the *Generator and Regulator Specifications* table for the regulator being serviced. With the flat side of the gauge up, between the armature and

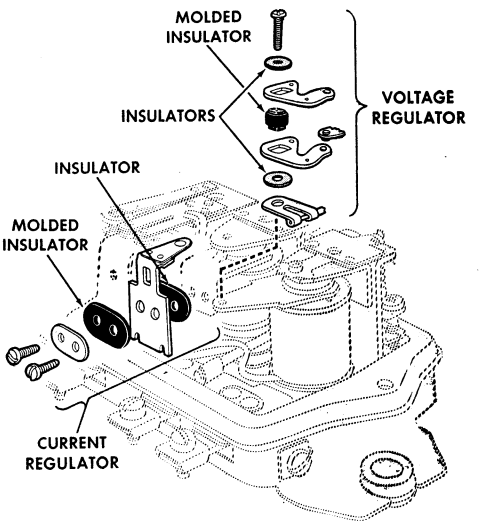

Fig. 14 Regulator contact mounting on Delco-Remy units with dual contact voltage regulator

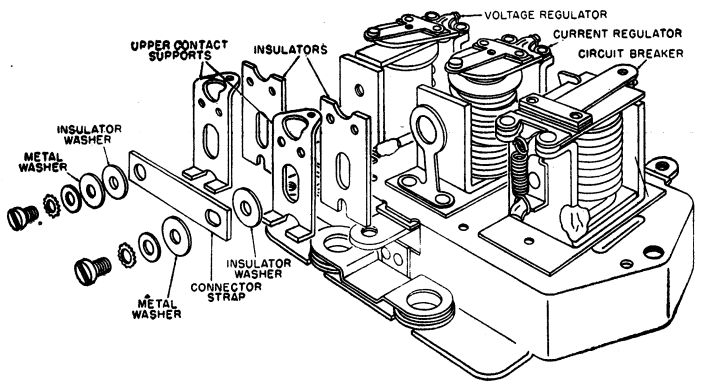

Fig. 15 Relationship of insulators and connector strap on Auto-Lite regulators

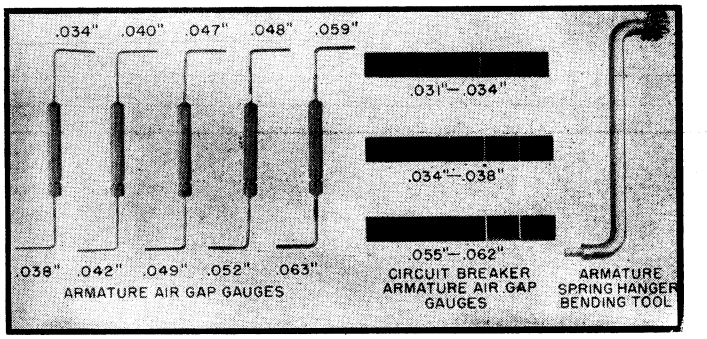

Fig. 16 Tool kit for adjusting Auto-Lite regulators

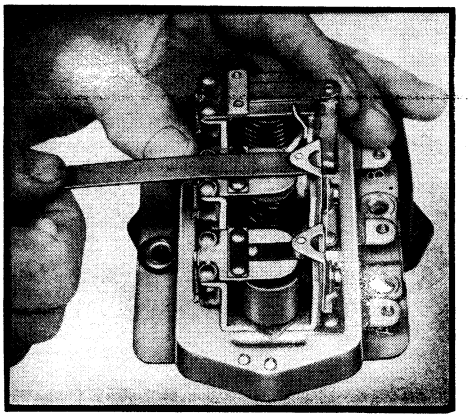

Fig. 17 Auto-Lite regulator contacts should be filed parallel with the length of the armature since they produce a wiping movement when in action

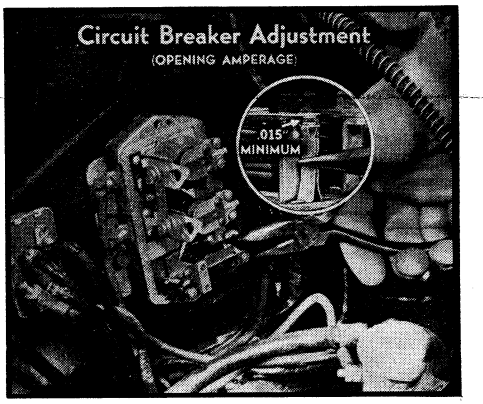

Fig. 19 Minimum gap between circuit breaker contacts on Auto-Lite regulators should be .015" and is adjusted by expanding or contracting the bridge attached to the lower bracket

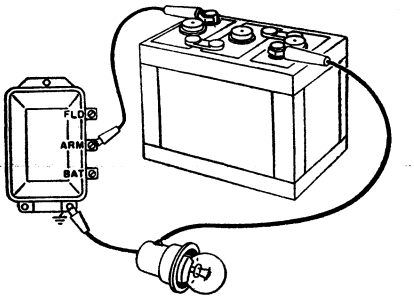

Fig. 21 Checking Auto-Lite voltage regulator armature air gap with the aid of a battery and lamp bulb of the proper voltage connected in series

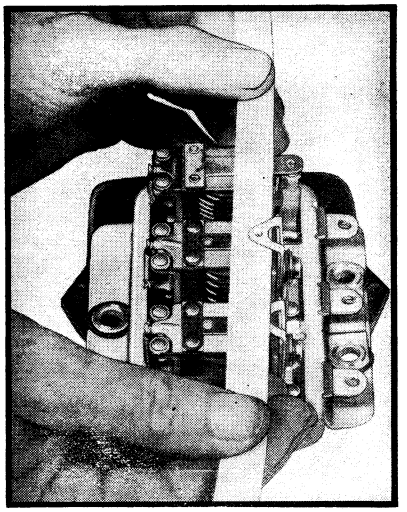

Fig. 18 Clean Auto-Lite contacts with lintless tape, using first a length saturated with cleaning fluid and then with a dry strip. Be sure no fragments of tape remain between the contacts

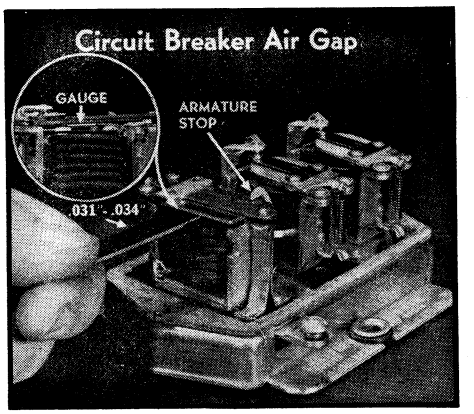

Fig. 20 Checking Auto-Lite circuit armature air gap with special gauge

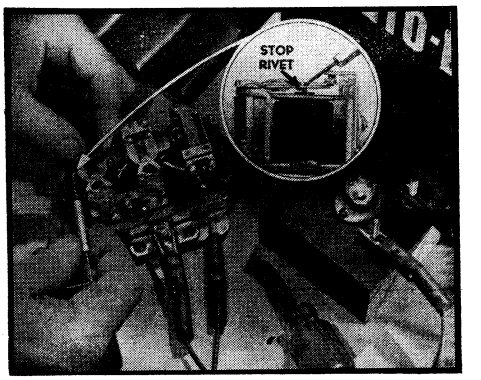

Fig. 22 Checking Auto-Lite voltage regulator armature air gap. Insert gauges on the contact side of the stop rivet and press down on the two hinge rivets as shown. The light should burn normally with the larger gauge and dim or go out with the smaller

magnet core, Fig. 20, and the edge of the gauge against the ends of the bimetal hinges, the air gap should permit the gauge to just slide in. Adjustment is made by bending the armature stop, which should be so located that it will not interfere with the operation of the armature.

Voltage Regulator Armature Air Gap

The most accurate way to check the voltage regulator air gap is with a 3 candlepower, 6-8 volt bulb connected in series with a six-volt battery, across the field terminal and the ground connection of the regulator, Fig. 21. (On 12-volt systems, use a 12-volt battery and 12-volt bulb.)

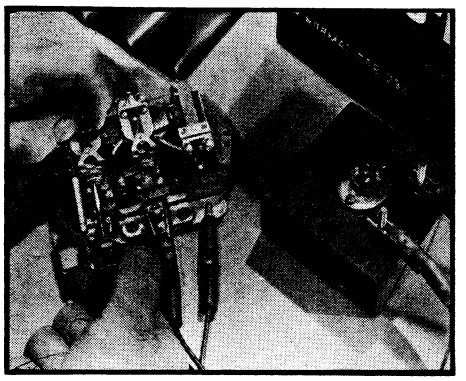

Fig. 23 To adjust Auto-Lite voltage regulator armature air gap, loosen contact attaching screw and slide bracket up or down. Be sure to keep contact faces square

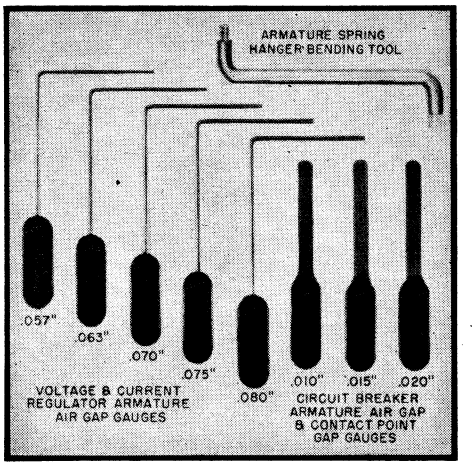

Fig. 24 Tool kit for adjusting Delco-Remy regulators

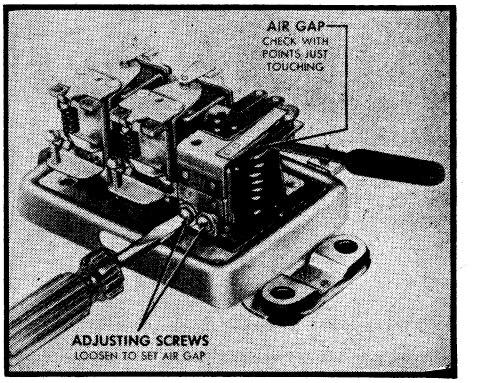

Fig. 26 Checking and adjusting Delco-Remy circuit breaker armature air gap

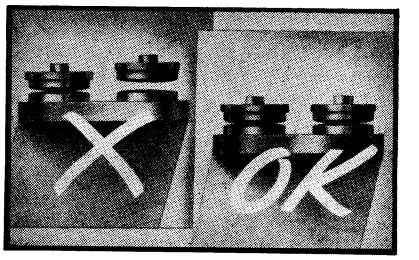

Fig. 27 Delco-Remy circuit breaker contacts should close at the same instant. If they do not, bend the spring fingers on the armature as required

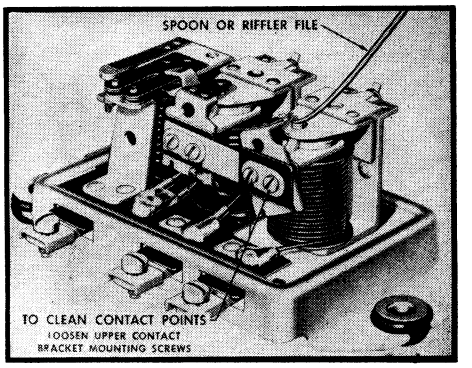

Fig. 25 Cleaning Delco-Remy regulator contacts. To reach the contacts, loosen the contact bracket mounting screws and tilt the bracket to one side

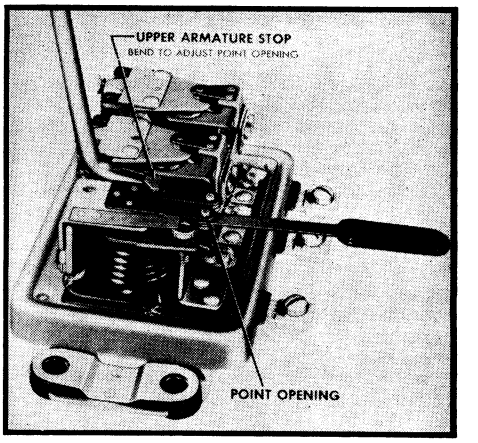

Fig. 28 Checking and adjusting Delco-Remy circuit breaker point gap. If necessary, bend upper armature stop with tool shown

To adjust the armature air gap, insert the large end of the gauge specified for the regulator being serviced between the magnet core and the armature on the contact side of the brass armature stop rivet, Fig. 22. Then press down on the cross bar riveted to the armature near the hinge end of the armature. With the larger gauge placed thus, the *light should not go out or dim.* Then place the small end of the gauge at the same place and press down on the armature; the light should go out or dim.

If the bulb does not react to the foregoing, loosen the contact attaching screw, Fig. 23, and move the bracket up or down, being sure to keep the contact faces square. When the desired result is obtained, securely tighten the attaching screw and again check the gap.

Current Regulator Armature Air Gap

This air gap is checked and adjusted in the same manner as for the voltage regulator and according to the specifications given in the *Generator and Regulator Specifications* table.

DELCO-REMY MECHANICAL ADJUSTMENTS

Fig. 24 illustrates a complete tool kit for adjusting Delco-Remy regulators.

Cleaning Contacts

The current and voltage regulator flat points should be cleaned with a spoon or riffler file, Fig. 25. To reach the contacts, loosen the contact bracket mounting screws and tilt the bracket to one side to allow cleaning of points.

When cleaning the lower (or armature) contacts, inspect the upper contacts in the support bracket as well, as they may require cleaning. A thin fine cut ignition point file should be used and the upper rounded points should not be filed excessively. For greater accessibility in cleaning, the contact support brackets may be removed. However, great care must be exercised to reinstall them properly.

Circuit Breaker Armature Air Gap

To check the air gap, place a finger on the armature directly above the winding core and move the armature down until the contacts just close, Fig. 26. Measure the air gap between the armature and the center of the core with a feeler gauge. Do not press on the armature any harder than is necessary to just close the points. If both sets of points do not close at the same instant, bend the spring fingers on the armature slightly until both sets do meet simultaneously, Fig. 27.

To adjust the air gap, loosen the two adjusting screws at the back of the circuit breaker and raise or lower the armature as required to bring the gap opening to the specification given in the *Generator and Regulator Specifications* table. After adjustment, securely tighten the adjusting screws, making sure the contacts align properly.

Circuit Breaker Contact Gap

This adjustment, which usually calls for .020", is made as follows: With the armature at rest against the upper armature stop, measure the contact opening, Fig. 28. If not according to specifications, bend the upper armature stop with the tool shown. To increase the opening, bend the stop up, or down to increase it.

Regulator Armature Air Gap

On units with single contact voltage regulators, both the current and voltage regulator units are checked and adjusted in the same manner, Fig. 29. To check the armature air gap, push down the armature until the contacts open. Then slowly release until they barely touch. With

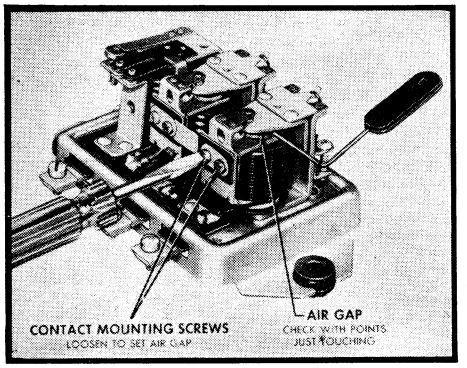

Fig. 29 Checking and adjusting Delco-Remy single contact voltage regulator armature air gap. Check and adjust current regulator in the same manner

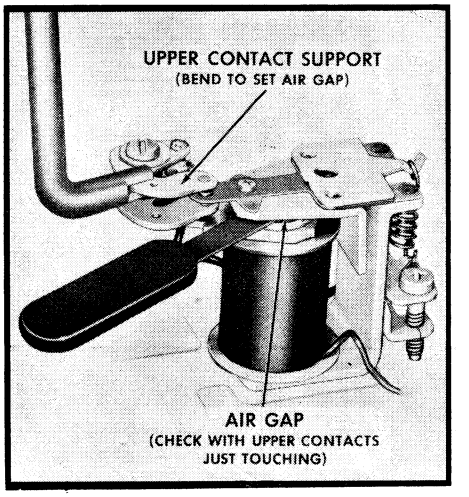

Fig. 30 Checking and adjusting Delco-Remy dual contact voltage regulator armature air gap

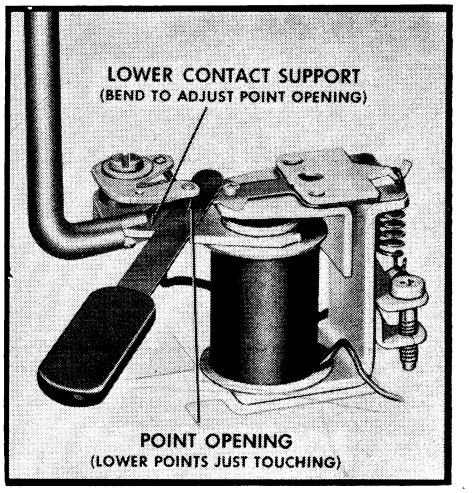

Fig. 31 Adjusting Delco-Remy dual contact voltage regulator point opening

the contacts just touching, measure the air gap between the center of the magnet core and the armature with the proper pin type gauge according to the specifications given in the *Generator and Regulator Specifications* table.

If adjustment is required, loosen the contact mounting screws slightly to allow movement of the contact support. Insert the feeler gauge between the armature and magnet core and press the armature down against the gauge. Adjust the contact support up or down until the contacts barely touch. Secure the adjustment by tightening the two mounting screws.

Dual Contact Voltage Regulator

Armature Air Gap—Make sure the air gap adjusting screw on top of the armature is turned all the way in a clockwise direction before checking the gap. Then with the upper contacts just touching, measure the air gap between the armature and winding core as shown in Fig. 30. Adjust by bending the upper contact support.

Point Opening — Push the armature down until the lower set of contacts are just touching and measure point opening between the upper set of contacts, Fig. 31. Adjust by bending the lower contact support.

FORD MECHANICAL ADJUSTMENTS

NOTE—Two types of Ford regulators have been produced. Those manufactured for 1949 and earlier models have provisions for making mechanical adjustments. The later type, Fig. 32, have no provisions for making mechanical adjustments, only electrical.

To mechanically adjust the earlier type, proceed as follows:

Regulator Armature Air Gap

Both the current and voltage regulator armature air gap adjustment is made exactly the same, Fig. 33. Bend the adjusting arm down until the armature spring is clear of the adjusting arm. Place a .035" pin gauge between the armature and core. Then press down on the regulator armature with a pencil as shown. Finally, lower the upper contact until it just touches the lower contact, and tighten the lock nut.

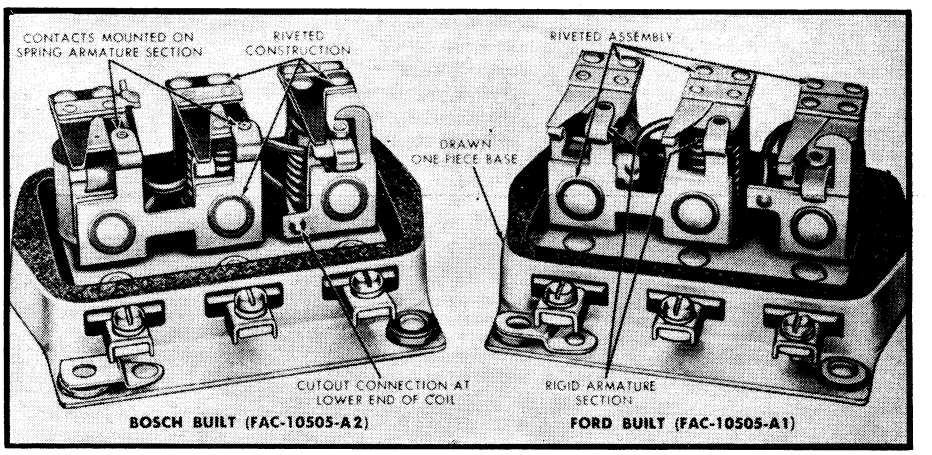

Fig. 32 Ford 1950 and later three-unit regulators. There is no provision for making mechanical adjustments on these units—only electrical

NOTE—The voltage regulator armature is provided with a brass rivet to prevent the armature from actually touching the core. When setting this air gap, therefore, be sure the gauge is not under the brass rivet.

After setting the air gaps, check the alignment of the contacts. Note the angle at which the contacts break. If the contacts are not breaking or contacting squarely, bend or twist the arm which supports the upper contact as required.

Circuit Breaker Armature Air Gap & Contact Opening

To make these adjustments, place a .017" pin gauge between the armature and core, Fig. 34. Lower the armature stop until it is resting on top of the armature. At the same time, raise the lower contact until the contact opening is .010". When this is done, tighten the two screws which secure the lower contact.

After making the foregoing adjustments, check the alignment of the contacts. Note the angle at which they break. If they are not breaking or contacting squarely, bend the lower contact as required. If this has to be done, it will be necessary to recheck and possibly reset the armature air gap and point opening.

ELECTRICAL TESTS & ADJUSTMENTS

After completing the mechanical adjustments, the regulator must be set up electrically either on the car or on a regulator test stand. A number of reliable and accurate test stands are commercially available and the manufacturer of each one furnishes complete instructions as to its use. We will discuss how the job is done on the car for each make regulator.

The first step, of course, is to install the regulator on the car in its proper

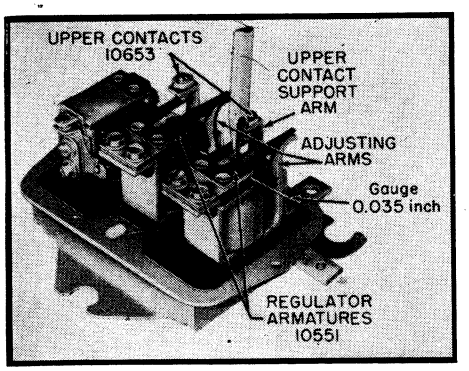

Fig. 33 Checking and adjusting Ford regulator armature air gap on 1949 and earlier units

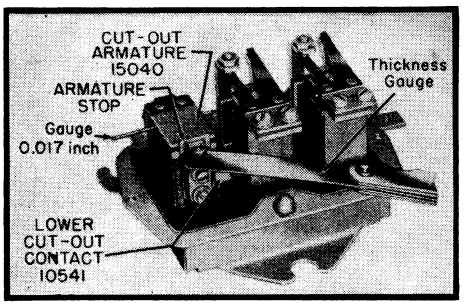

Fig. 34 Adjusting circuit breaker armature air gap and contact opening. Ford 1949 and earlier units

position. Be sure to observe the precautions for installing them as outlined later on in this chapter. Then, before commencing the tests, we must reproduce as nearly as possible the same conditions under which the regulator will operate on the car. These include:

1. Run the engine at about 20 mph for at least 15 minutes to bring the regulator up to normal operating temperature. The current flowing through the windings at this engine speed will provide enough heat to accomplish this.
2. The regulator must be mounted in the proper position on the car. If the regulator is being tested on a test stand, it must be mounted in the same position as when on the car.
3. The cover and cover gasket must be in place. The cover, which forms part of the magnetic circuit, must be on because there is a difference of from .2 to .4 of a volt with the cover off and on. Therefore, always have the cover on when final tests are made.
4. Make sure the units are correctly hooked up and check the ground polarity of the battery. Consult the regulator specifications for the correct polarity as regulators must not be used on systems with the polarity opposite to that for which they were designed. Most regulators have different materials for the contacts in each set. Reversing the polarity of the system reverses the direction of the current flow and causes transfer of metal from one contact to the other. Also on some of the high output Auto-Lite regulators using a rectifier in the field circuit, incorrect polarity would make the regulator inoperative (more about rectifiers later).
5. Check the part numbers stamped on the name plates of the generator and regulator to make sure the correct regulator is installed. Regulators are designed for use with a generator having a specified field draw, output, internal connections and speed range, and may not function properly if an incorrect substitution is made.
6. Make sure the battery is fully charged and otherwise in good condition. An old battery, one partially discharged or one subjected to excessive heat will cause high charging rate, while one subjected to excessive cold, hard plates, high resistance separators or sulphation will cause low charging rate. If the battery is not up to operational standards, substitute temporarily for test purposes a fully charged battery in good condition of the same type and capacity.
7. Make sure the generator operates correctly without the regulator in the circuit. Remove the armature and battery leads from the regulator and connect an ammeter between them. This will cause a discharge through the generator and the engine should be *immediately operated at idle speed.* Remove the field lead from the regulator and, *while operating at idling speed,* touch the field lead to the regulator base. (On Delco-Remy units with dual contact points on the voltage regulator, *never* ground the generator field with regulator connected to the generator as the lower set of contacts will burn instantaneously. An output check requires that the "GEN" lead to the regulator be disconnected *before* the field is grounded.) Then increase the speed slowly, noting the charging rate. *Do not increase the output above the rated output of the generator* because, if prolonged, would burn up the armature. If the generator will not build up to its rated output, inspect the wiring for shorts, opens and incorrect connections, and remove the generator for an overhaul. Also make a voltage drop test of the wiring.

Use of Headphone—An accurate method of noting the exact instant the circuit breaker contacts open and close is to connect a suitable headphone (2000 ohms or more) to the battery and armature terminals of the regulator. When the contacts open and close, a click will be heard.

In using the headphone to obtain an accurate indication of the operation of the voltage regulator contacts, it should be connected between the regulator field terminal and regulator base. The clicks which indicate the opening and closing of the contacts should be regular and clear without missing. If not, it indicates that the contacts are dirty, misaligned or otherwise need attention.

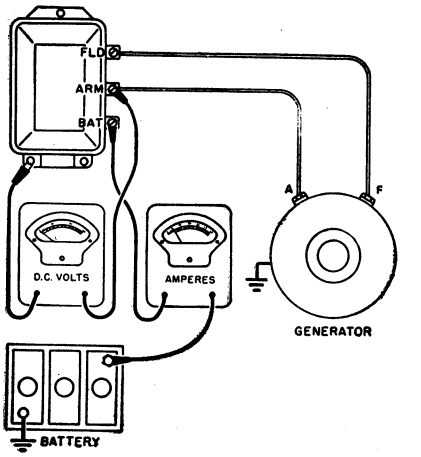

Fig. 35 Hook-up for testing Auto-Lite circuit breaker

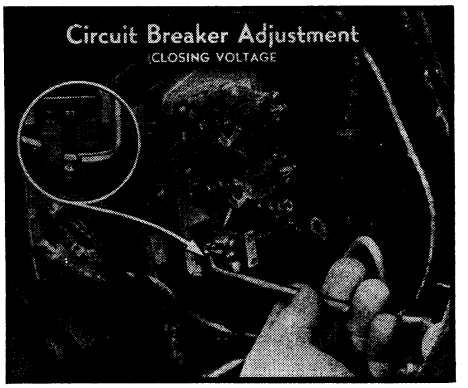

Fig. 36 To adjust closing voltage on Auto-Lite regulators, change the spring tension by bending the lower spring hanger. Increasing the tension raises the closing voltage

AUTO-LITE TESTS & ADJUSTMENTS

The following describes how these regulators are tested and adjusted on the car. In the accompanying diagrams, only the instruments required are illustrated. Bear in mind, too, that the specifications given in the text are only approximate and are given merely as a guide. Consult the data for each model regulator listed in the *Generator and Regulator Specifications* table and adjust accordingly.

Circuit Breaker

Connect a test ammeter and voltmeter into the circuit as shown in Fig. 35. Slowly increase engine speed and observe the voltage when the contacts close—which should be about 6.5 volts (12.8 on 12-volt systems.) Now slowly decrease engine speed and observe the discharge amperage just before the contacts open—which should be 4 to 6 amperes.

To adjust the closing voltage, change

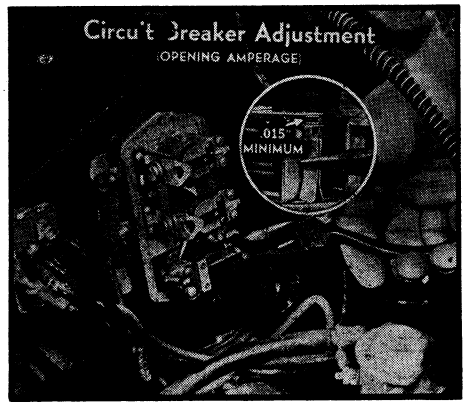

Fig. 37 To adjust opening amperage on Auto-Lite regulators, increase or decrease the contact gap. Decreasing the gap lowers the opening amperage. Keep the contacts square, and in no case must the circuit breaker contact gap be less than .015"

the armature spring tension by bending the lower hanger, Fig. 36. Increase the spring tension (bend hanger down) to raise the closing voltage, and bend it up to lower the closing voltage.

To adjust the opening amperage, raise or lower the stationary contact, Fig. 37, keeping the contacts perfectly aligned. Change the gap by expanding or contracting the stationary contact bridge. But in no case must the gap be less than .015". Increasing the gap lowers the opening amperage and lessening the gap raises it.

Voltage Regulator

Shift the voltmeter lead from the armature terminal to the battery terminal, Fig. 38. Run the engine at one-half maximum generator output for 15 minutes to make sure the regulator is at normal operating temperature. Have the cover on the regulator during the warm-up period and when taking readings.

Reduce engine speed to break the field circuit. Then increase it to 20 mph. Turn on enough lights and accessories to obtain slightly more than one-half the maximum output of the generator. At this point, the voltage should be a steady 7.3 volts (14.5 on 12-volt systems.)

NOTE—The purpose of reducing the engine speed before taking the voltage reading is because we want to reproduce the conditions present when the car is operating. To accomplish this, therefore, we must start from scratch by getting rid of *almost* all of the magnetism in the generator before we speed up the engine again in order to build up magnetism and to get a true voltage reading. (The only remaining magnetism is the residual magnetism present in the generator field pole pieces.) The field current is broken, of course, when the circuit breaker contacts open.

CAUTION—There are some generators designed to charge when the engine is idling, as, for example, those found on many door-to-door delivery vehicles. Reducing engine speed to break the field circuit cannot be accomplished because the circuit breaker contacts will not open. The only alternative, therefore, is to stop the engine and then restart it again to build up the magnetism.

To adjust the voltage regulator, bend the hanger at the lower end of the armature spring, Fig. 39. Bending the hanger up decreases voltage and bending it down increases voltage.

After each adjustment, reduce engine speed to open the circuit breaker contacts. Then speed it up and check the voltage.

Current Regulator

With the regulator and instruments still connected as for the voltage regulator test, Fig. 38, crank the engine with the starter and with the ignition off for not more than 30 seconds at a time (allowing the starter to cool off each time) to partly discharge the battery. Then run the engine fast enough, with lights and accessories turned on, to allow the generator to operate at its full maximum output during the test. If the ammeter does not indicate the full rated output of the generator:

Adjust the operating amperage by changing the spring tension on the current regulator in the same manner as for the voltage regulator, Fig. 40. After each adjustment, reduce engine speed until the circuit breaker contacts open. Then speed it up and take a reading.

If the current regulator is temperature compensated, operate at full charge for 15 minutes before checking. At the end of this period, amperage should have fallen to within one ampere of the hot maximum.

DELCO-REMY TESTS & ADJUSTMENTS

The following procedure describes how Delco-Remy regulators are adjusted on the car. The regulator must be at operating temperature before taking a voltage or current reading. Operating temperature may be assumed to exist after not less than 15 minutes continuous operation with a charging rate of about 10 amperes.

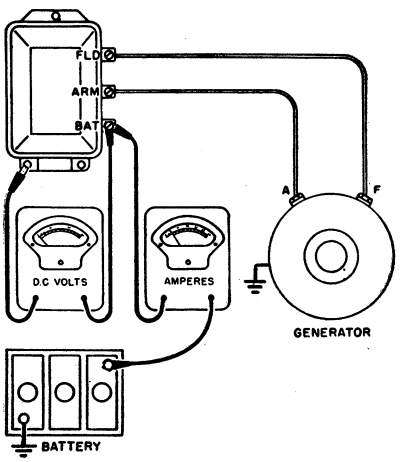

Fig. 38 Hook-up for testing Auto-Lite voltage and current regulators

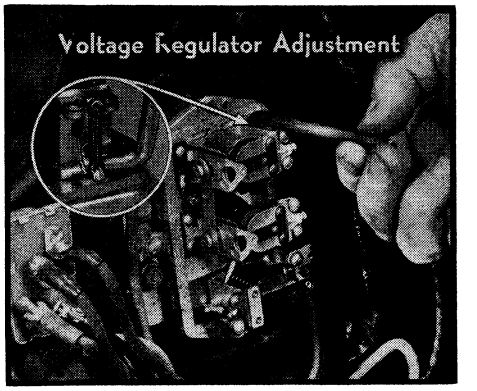

Fig. 39 To adjust Auto-Lite voltage regulators, increase or decrease spring tension as shown. Increasing tension raises voltage

Circuit Breaker

To check and adjust the closing voltage of the circuit breaker, connect a voltmeter as shown in Fig. 41. Start the engine and slowly increase speed, noting the voltage at the instant the circuit breaker contacts close (voltage when ammeter begins to show reading). If the reading is not within specifications adjust as follows:

Units Without Adjusting Screw—The closing voltage is adjusted on these units, Fig. 42, by bending the spring post on which the armature spring rests. Bending the spring post upward increases closing voltage, and bending it downward decreases voltage.

Units With Adjusting Screw—The manner of adjusting the closing voltage on these units is shown in the inset in Fig. 42. The spring rests on a left-hand thread, cross-headed screw. Turning the screw to the right increases closing voltage, and turning it to the left decreases the voltage.

Voltage Regulator Single Contact Type

There are two methods of testing Delco-Remy voltage regulators, the fixed resistance method, and the variable resistance method. With the fixed resistance method, the resistance takes the place of the battery in the circuit. With the variable resistance method, the resistance is inserted in the circuit between the battery and test ammeter.

Fixed Resistance Method—Substitute a ¾ (¼ ohm on 1118800 and later units Series) ohm resistance capable of carrying 10 amperes and having a constant resistance with temperature changes for the external charging circuit. As shown in Fig. 43, disconnect the wire from the "BAT" terminal of the regulator and connect the fixed resistance between this "BAT" terminal and ground in parallel with the voltmeter.

Start the engine and operate at a speed where the generator will be running 25% over the rated output speed (which is about 1500 engine rpm.) Take

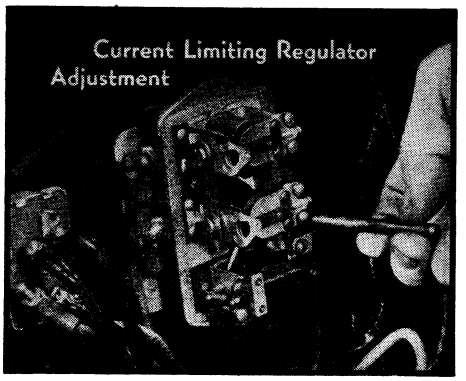

Fig. 40 Auto-Lite current regulator is adjusted in the same way as the voltage regulator. Increasing spring tension raises current setting

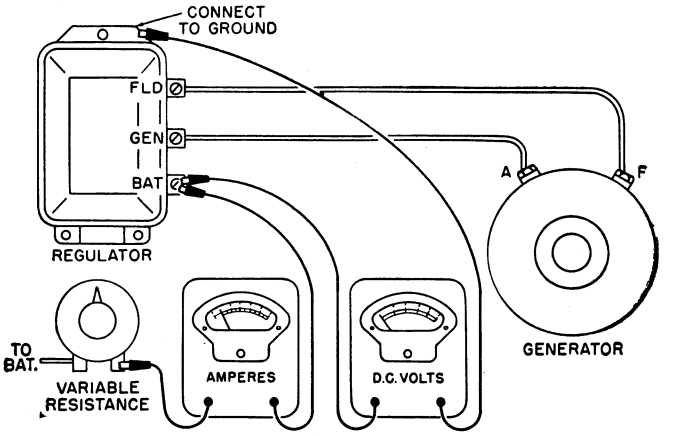

Fig. 44 Hook-up for checking Delco-Remy voltage regulator by the variable resistance method

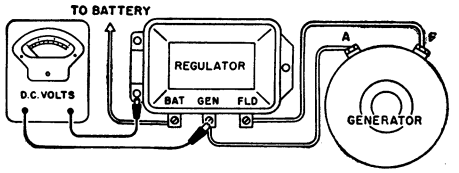

Fig. 41 Hook-up for checking closing voltage on Delco-Remy regulators

the reading with the cover on. If the reading is not within specifications adjust as outlined below. After each adjustment and before taking another voltage reading, reduce speed until the circuit breaker contacts open (breaking field circuit). Then bring engine back to speed again and take a reading.

Variable Resistance Method — Remove the wire from the "BAT" terminal of the regulator, Fig. 44, and connect an ammeter and a ¼ ohm variable resistance in series with the "BAT" terminal as shown. Attach the wire removed from the regulator to the other terminal of the resistance unit. Connect a voltmeter from the "BAT" terminal to ground.

To make the test, start the engine and increase its speed to where the generator will be running at 25% over the rated output speed, which would be about 1500 engine rpm.

If less than 8 amperes is indicated on the ammeter, turn on lights to increase generator output. Cut in the resistance until output is reduced to 8-10 amperes. Then reduce engine speed until circuit breaker contacts open, increase speed again and note the voltage. If the voltage is not within specifications adjust as described below.

NOTE—In using the variable resistance method, it is necessary to readjust the resistance after each voltage adjustment, and then reduce and increase generator speed before taking a voltage reading. Current flow must be about 10 amperes when reading is taken.

1118200 Series Regulators—On these units, Fig. 45, the voltage setting is adjusted by bending the spiral spring hanger of *one* spring down to increase the voltage setting, or up to decrease it. Normally, all adjustments must be confined to one spring only and the other spring should not be touched. This reduces the possibility of throwing the two springs out of balance. Each spring should carry approximately half the total spring tension required.

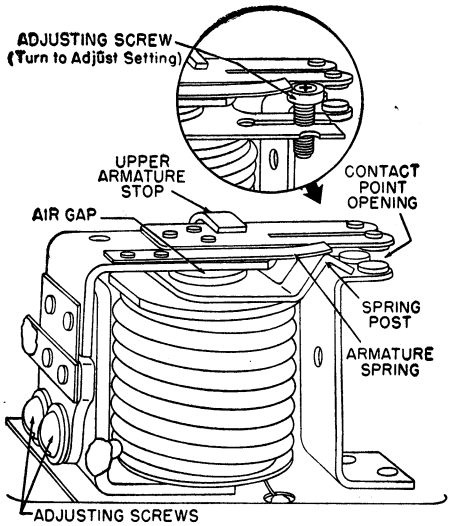

Fig. 42 Closing voltage on some Delco-Remy regulators is adjusted by bending the spring post on which the armature spring rests. On later units, an adjustment is made by turning the screw shown in the inset

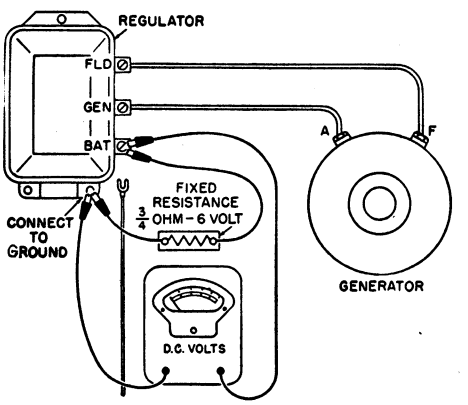

Fig. 43 Hook-up for checking Delco-Remy voltage regulator by fixed resistance method. Note that the fixed resistance is used in place of the battery

NOTE—If the regulator is badly out of adjustment, remove one spring and, with a voltmeter connected from the regulator base to the "GEN" terminal, increase generator speed to 3500 rpm. Then adjust the spring hanger until the regulator is operating at approximately two-thirds of the specified setting. Install the second spring and reconnect the voltmeter lead to the regulator "BAT" terminal, with the other lead still connected to ground on the regulator base. Then operate the generator at the specified speed and, confining all adjustments to the second spring, adjust the voltage to the specified setting. The regulator, of course, must be at operating temperature for checks and adjustments and the cover must be in place when voltage readings are taken.

1118300, 1118700 & 1118800 Series Regulators—The voltage setting is changed by means of an adjusting screw, Fig. 46. Turning the screw clockwise increases voltage setting and counterclockwise decreases it. After each adjustment, reduce engine speed until the circuit breaker contacts open and then bring it up to speed again before taking a reading.

CAUTION—If the adjusting screw is turned down beyond the normal adjustment range, the spring support may fail to return when the pressure is relieved. In such a case, turn the screw counterclockwise until there is clearance between the screw head and spring support. Then bend the spring support up carefully with small pliers until contact is made with the screw head. The final setting always should be approached by increasing the spring tension, never by reducing it. If the setting is too high, adjust the unit below the required value and then raise it to the exact setting by increasing spring tension.

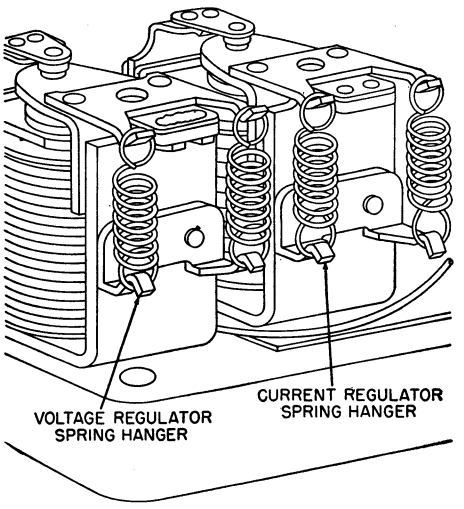

Fig. 45 Setting is adjusted by bending spiral spring hanger of one spring

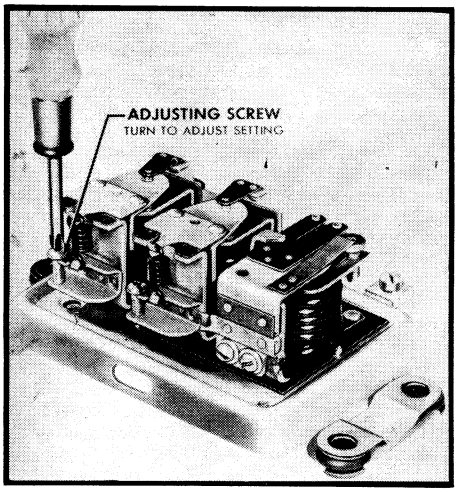

Fig. 46 Turning the adjusting screw clockwise increases voltage setting. The same method is used to set the current regulator (center unit). Turning screw clockwise increases current setting

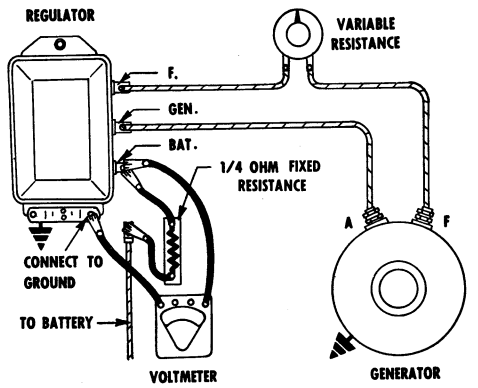

Fig. 47 Connections for checking voltage on Delco-Remy dual contact voltage regulator

Dual Contact Voltage Regulator

1. To adjust this type of regulator the battery must be fully charged to limit the charge rate to 1 to 10 amperes. If above 10 amperes, insert a ¼ ohm resistor in series with the battery, Fig. 47.
2. Connect a voltmeter from regulator "BAT" terminal to ground.
3. Connect a 25 ohm (25 watt) variable resistance (which has an "open" position) between the regulator "F" terminal and the field lead from the generator.
   (Connections to the variable resistance should be made so that all the resistance can be inserted into the circuit before opening the circuit.)
4. With variable resistance turned out, operate generator at medium speed so that the voltage regulator is operating on the lower set of contacts. Continue to operate for 15 minutes to establish operating temperature of voltage regulator.
5. Cycle the generator by turning the variable resistance to the "open" position momentarily, then slowly cut out all resistance. Regulator should be operating on the lower contacts on the voltage given in the *Specifications* chart (in truck chapters). The setting may be adjusted in the conventional manner by turning the screw to adjust spring tension, Fig. 48.
6. Increase the resistance slowly until the regulator begins to operate on the upper contacts. The voltmeter should indicate a slight drop in voltage of .3 to .5 volts. This differential voltage may be increased by turning the air gap adjusting screw, Fig. 49, in a clockwise direction and decreased by turning it counterclockwise. Air gap adjustment should seldom be necessary on this type regulator. However, if the adjustment screw is turned, it will also affect the setting of the regulator so that the voltage adjustment procedure must be repeated. The regulator must be cycled each time before taking voltage readings —as previously described.
7. If the condition ever exists where the voltage setting of the upper contacts is higher than that of the lower contacts, turn the air gap adjusting screw in a clockwise direction. If adjustment is taken up, it is necessary to reset the nominal air gap by bending the contact supports. Fig. 50 shows a wiring diagram of this type regulator.

Caution—Never ground the generator field with this regulator connected to the generator as the lower set of contacts will burn instantaneously.

Current Regulator

To check this setting, the voltage regulator must be prevented from operating. The simplest method is to remove the regulator cover and connect a jumper lead across the voltage regulator contacts, Fig. 51. Turn on lights and accessories to prevent high voltage during the test. Then with the generator operating at medium speed, note the current reading on the ammeter. If the current output is not within specifications, make the adjustment in the same manner outlined for the voltage regulator, Fig. 46.

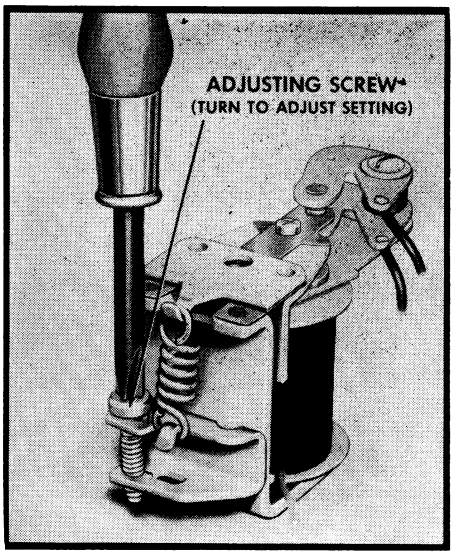

Fig. 48 Adjusting voltage regulator setting (lower contacts)

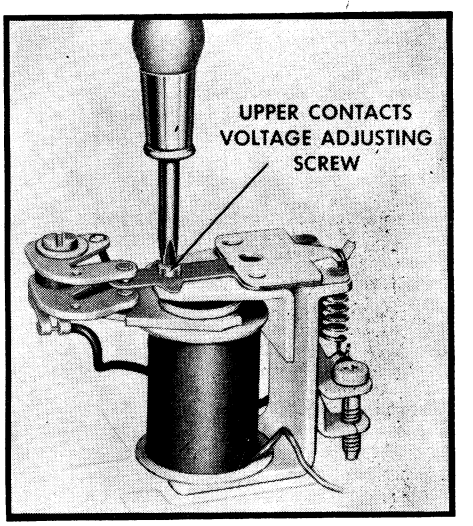

Fig. 49 Adjusting voltage setting of upper contacts

FORD TESTS & ADJUSTMENTS

The following describes the procedure for testing Ford regulators on the car. The accompanying diagrams show only the instruments needed for each test.

Circuit Breaker

Connect a voltmeter across the regulator armature terminal to the regulator base, Fig. 52. Slowly increase engine speed and observe the voltage when the contacts close—which should be about 6.5 volts (12.8 on 12-volt system). If an

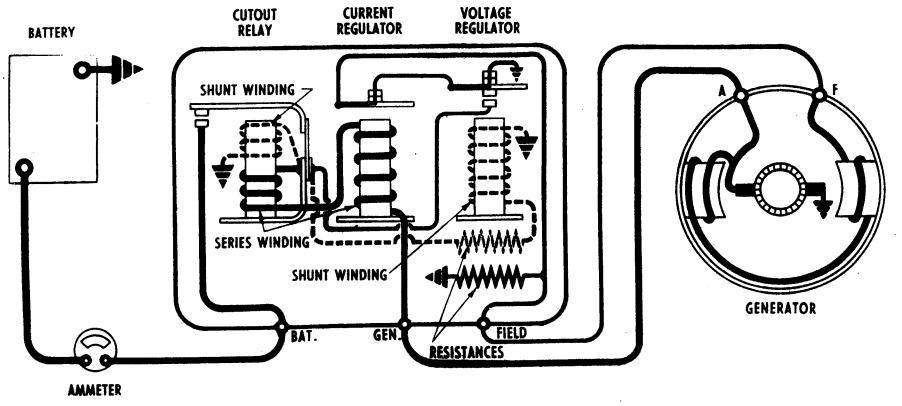

Fig. 50 Wiring diagram of Delco-Remy unit with dual contacts on voltage regulator

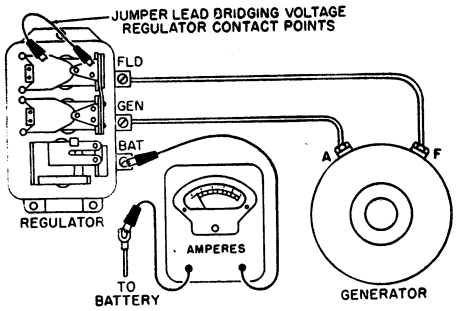

Fig. 51 Hook-up for checking current regulator on Delco-Remy regulators

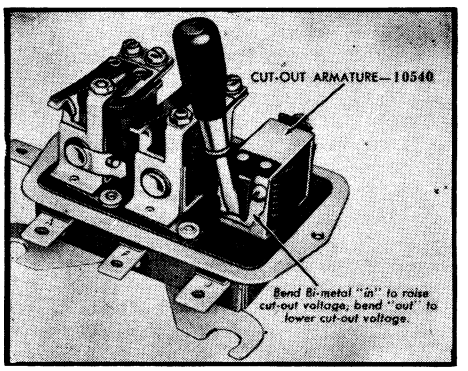

Fig. 53 Adjusting closing voltage on Ford 1949 and earlier units

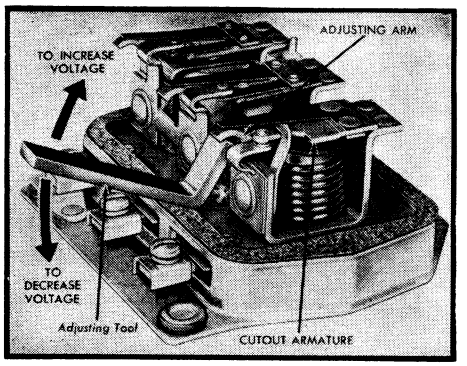

Fig. 54 Adjusting closing voltage on Ford 1950 and later units

adjustment is indicated, proceed as follows:

For 1949 and earlier model regulators, the adjustment is made by bending the bimetal bracket inward to increase voltage or outward to decrease it, Fig. 53.

For 1950 and later model regulators, Fig. 54, the adjustment is made by bending the adjusting arm. Bending the arm upward increases voltage and bending it downward decreases voltage.

Voltage Regulator

Shift the voltmeter lead from the armature terminal to the battery terminal, Fig. 55. Run the engine at one-half maximum generator output for at least 15 minutes to make sure the regulator is at normal operating temperature. Have the cover on the unit during the warm-up period and when taking readings.

Reduce engine speed until the circuit breaker contacts open—which breaks the field circuit. Then increase engine speed to about 20 mph. Turn on enough lights and accessories to obtain slightly more than one-half the maximum output of the generator. At this point, the voltage should be a steady 7.3 volts (14.5 on 12-volt system).

NOTE—If the generator is one which is designed to charge even when the engine is idling—such as a door-to-door delivery vehicle—it will be necessary to stop the engine in order to break the field circuit.

To adjust the voltage setting, increase the spring tension by bending the adjusting arm upward to increase voltage, Fig. 56. To decrease voltage, bend the adjusting arm downward. This adjustment is the same for both early and late model regulators.

Current Regulator

With the regulator and instruments still connected as for a voltage regulator test, Fig. 55, crank the engine with the starter (ignition off) for not more than 30 seconds at a time to partly discharge the battery. Then run the engine fast enough, with lights and accessories turned on, to allow the generator to operate at full charge during the test. If the ammeter does not indicate the full rated output of the generator, adjust as follows:

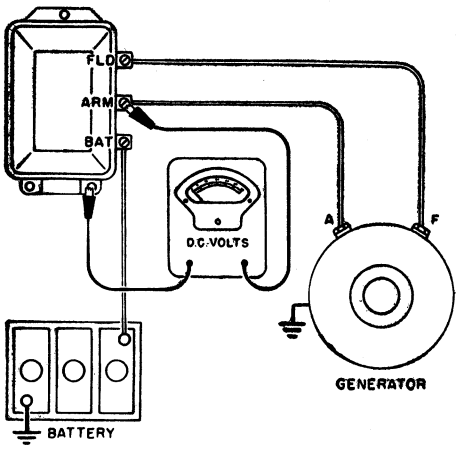

Fig. 52 Hook-up for checking circuit breaker closing voltage on Ford regulators

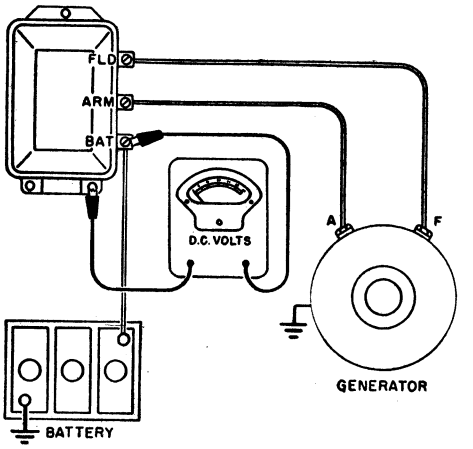

Fig. 55 Hook-up for testing voltage regulator on Ford units

If the current limit is less than specified, increase the spring tension by bending the adjusting arm upward, Fig. 56. To decrease the current, bend the adjusting arm downward. This adjustment is the same for both early and late model regulators.

INSTALLING REGULATORS

Mount and tighten the regulator in its proper place on the car before any connections are made. Connect all wires to their respective terminals. If the regulator being installed has a ground terminal, extreme caution must be exercised to see that the battery terminal wire does not touch, even for an instant, the ground terminal. Should this happen, a direct short circuit would be produced and the regulator would be damaged. To prevent this, either disconnect a battery cable or connect the ground wire first. Likewise, don't touch the battery wire to the field terminal as this will burn the reeds on Auto-Lite regulators, which will ruin the regulator beyond repair.

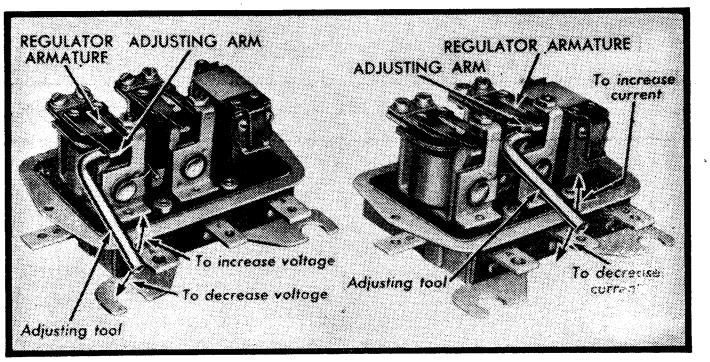

Fig. 56 Adjusting voltage regulator (left) and current regulator (right) on Ford units

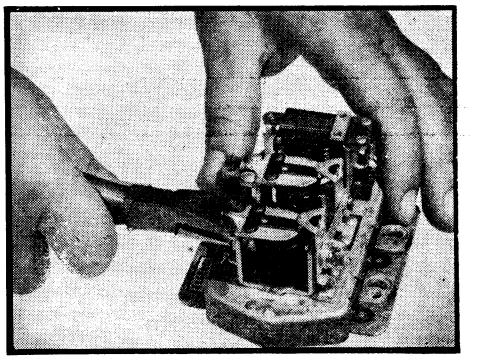

Fig. 57 Showing a pair of glass pliers machined to form a tool for floating Auto-Lite regulator armatures. The drilled holes form around the rivets and the slot cut between the holes straddle the armature spring hanger. This tool may also be used to float Delco-Remy armatures of the 1118300 and 1118700 series

POLARIZING GENERATOR

Whenever a regulator is installed on a car, the generator must be polarized with it. If this is not done, the current will pass through the regulator in the wrong direction and quickly burn the contacts.

Polarizing should be done before connecting any wires to the regulator.

On Auto-Lite and Delco-Remy Standard Duty generators, ground the "F" terminal while touching a "hot" jumper wire to the "A" or "GEN" terminal.

On all Ford generators as well as Auto-Lite and Delco-Remy Heavy Duty generators, the generator is polarized by touching a "hot" jumper wire to the "F" terminal.

Caution—On vehicles equipped with the new Delco-Remy regulator having dual contacts on the voltage regulator, insulate the brushes from the commutator before polarizing the generator.

GENERAL NOTES ON REGULATORS

Use Correct Regulator—Always use the regulator designed for the generator on the car. Bear in mind that it is the generator that determines the proper regulator to be used and not the car model.

When Switching Batteries—If the original equipment battery is replaced with one of a different make, size or classification, very often the regulator must be adjusted. Therefore, whenever batteries are switched in this manner, always check the performance of the regulator according to its specifications.

Use Accurate Gauges—Gap gauges and feeler gauges used for regulator measurements must be up to precision standards in order to make the accurate adjustments required for regulators. If they are battered by long use or careless handling, they should be replaced with accurate new ones.

Meters Must Be Accurate—Voltmeters should have an accuracy of ½% between 6 and 9 volts and 1% for other parts of the scale. To assure the accuracy of voltmeters, they should be tested periodically against another voltmeter known to be accurate. If not convenient or possible to do this, have the manufacturer of the meter check its accuracy and make any necessary adjustments.

The accuracy of voltmeters is very important because if one is low by one-half volt, and regulators are adjusted with it, the batteries these regulators control will have much shorter lives. Of course, test ammeters, ohmmeters, etc., should also be checked periodically.

Burned Regulators—In cases where the regulator is almost completely burned up, look for a ground on the armature connection between the generator and regulator. Such a ground short circuits the series windings of the circuit breaker and current regulator, quickly destroying the regulator.

Burned Regulator Contacts—Contrary to the opinion of many service men, regulators will not be burned up if the contacts stick. The reason being that the resistance of the generator and series windings in the regulator is such that about 15 amperes will be drawn from the battery when the generator is not running and circuit breaker contacts closed. This will discharge the battery but no damage will be done to the regulator that cannot be corrected by servicing the circuit breaker contacts.

Radio Installations—The installation of radios on cars by men who are not familiar with regulator functions has caused regulator failures. In some cases, radio by-pass condensers have been installed across the field circuit of the generator, causing destruction of the voltage regulator contacts. These condensers should be connected to the armature terminal of the generator.

Some radio men have the habit of testing to see which is the armature circuit and which is the field circuit by using a screwdriver to ground the terminals on the generator. A big flash indicates the armature, a small flash the field. In some cases, the big flash caused by grounding the armature terminal passes so much current through the circuit breaker contacts that they will fuse together or create a burned spot, which will eventually cause sticking of contacts.

Cleaning Contacts—Never use emery cloth or sandpaper to dress or clean regulator contacts. Use only a fine cut ignition point file and follow the method approved by the manufacturer of the regulator being serviced. These methods have been outlined elsewhere in this chapter.

Regulator Armatures Must Float—On Auto-Lite regulators, after the armature

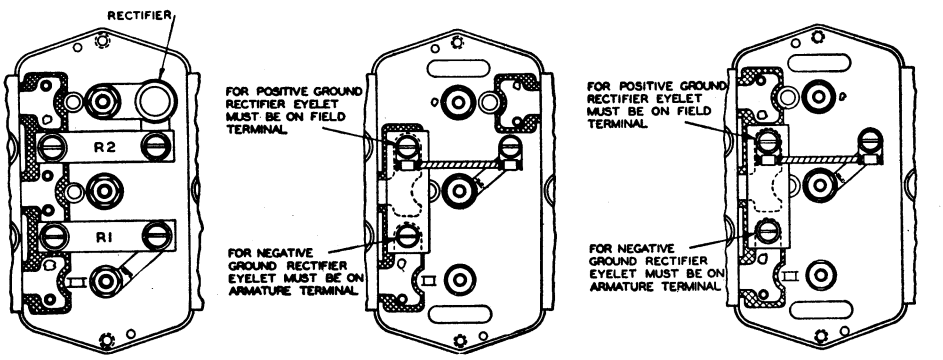

Fig. 58 Location of rectifier on bottom of several Auto-Lite regulators. It is imperative that these rectifiers be installed correctly, otherwise the regulator will not function

air gap and contact adjustments have been made, the armatures should be checked to see if they float. This means that with the spiral armature springs removed from their hangers, you should see daylight between the contacts and between the magnet core and bottom of armature. If an armature does not float the contacts will snap closed, giving an "oil can" effect, which is much too violent an action for the contacts.

A suitable tool for floating armatures may easily be made by machining a pair of glass pliers by drilling holes in the jaws so the holes fit over the rivets on the armature. It may then be used to bend the back end of the armature up or down, Fig. 57, until daylight can be seen at the places mentioned.

Regulator Armature Springs—Whenever these springs are removed, care must be exercised to see that they get back on their correct spring hangers. These springs, particularly on Auto-Lite regulators, very often do not have the same tension values, which can easily be determined by counting the number of spirals each one has. If springs are not installed on the proper hangers, the regulator will not function properly.

Auto-Lite Rectifiers—On some of the newer high output Auto-Lite regulators, a rectifier, Fig. 58, has been added to the field circuit. These rectifiers make an alternate, low resistance path for the field current to continue when the regulator contacts open. This limits the build-up of voltage across the contacts and reduces the arc when the contacts separate, making for much longer contact life.

Two types of rectifiers have been used: copper sulphide and selenium. Both are connected between the field and armature terminals but the connections are made at different points as it is necessary to connect a resistance in series with the copper sulphide type in order to obtain best overall performance.

Since the rectifier is connected from the armature terminal to ground (through the regulator contacts) it is imperative that it has the correct polarity. For positive ground systems, the rectifier eyelet must be on the field terminal. If the system is negative grounded, the rectifier eyelet must be on the armature terminal, Fig. 58. If installed incorrectly, the wrong polarity would make the regulator inoperative.

STARTING MOTORS

WHEN trouble develops in the starting motor circuit, and the starter cranks the engine slowly or not at all, several preliminary checks can be made to determine whether the trouble lies in the battery, in the starter, in the wiring between them, or elsewhere. Many conditions besides defects in the starter itself can result in poor cranking performance.

To make a quick check of the starter system, turn on the headlights. They should burn with normal brilliance. If they do not, the battery may be run down and it should be checked with a hydrometer.

If the battery is in a charged condition so that the lights burn brightly, operate the starting motor. Any one of three things will happen to the lights: (1) They will go out, (2) dim considerably or (3) stay bright without any cranking action taking place.

If Lights Go Out—If the lights go out as the starter switch is closed, it indicates that there is a poor connection between the battery and starting motor. This poor connection will most often be found at the battery terminals. Correction is made by removing the cable clamps from the terminals, cleaning the terminals and clamps, replacing the clamps and tightening them securely. A coating of corrosion inhibitor (vaseline will do) may be applied to the clamps and terminals to retard the formation of corrosion.

If Lights Dim—If the lights dim considerably as the starter switch is closed and the starter operates slowly or not at all, the battery may be run down, or there may be some mechanical condition in the engine or starting motor that is throwing a heavy burden on the starting motor. This imposes a high discharge rate on the battery which causes noticeable dimming of the lights.

Check the battery with a hydrometer. If it is charged, the trouble probably lies in either the engine or starting motor itself. In the engine, tight bearings or pistons or heavy oil place an added burden on the starting motor. Low temperatures also hamper starting motor performance since it thickens engine oil and makes the engine considerably harder to crank and start. Also, a battery is less efficient at low temperatures.

In the starting motor, a bent armature, loose pole shoe screws or worn bearings, any of which may allow the armature to drag, will reduce cranking performance and increase current draw.

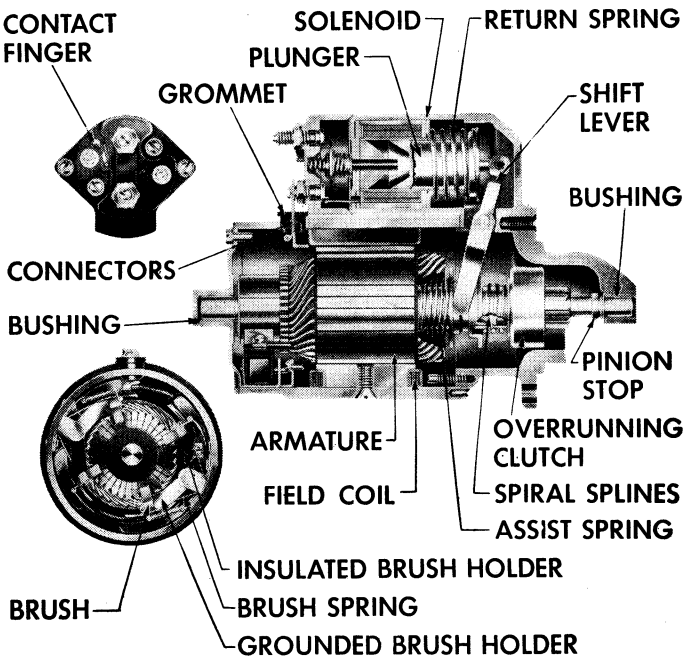

Fig. 1 Sectional view of starter with overrunning clutch drive

In addition, more serious internal damage is sometimes found. Thrown armature windings or commutator bars, which sometimes occur on over-running clutch drive starting motors, Fig. 1, are usually caused by excessive over-running after starting. This is the result of such conditions as the driver keeping the starting switch closed too long after the engine has started, the driver opening the throttle too wide in starting, or improper carburetor fast idle adjustment. Any of these subject the over-running clutch to extra strains so it tends to seize, spinning the armature at high