PART TWO—ENGINE AND ELECTRICAL

SECTION IV—GENERATING SYSTEM

1. BATTERY

Before making any test on the condition of the battery, make certain the battery and the terminal posts are free of corrosion, dirt, and oxidation. This is necessary to insure the lowest possible resistance for all electrical connections. See Figure 1.

TESTING WITH HYDROMETER

The state of charge of the battery should be checked with a hydrometer. The following readings show the state of charge (Specific Gravity):

Fully charged	1.260
Half charged	1.205
Dangerously low	1.130

When reading a hydrometer, hold the barrel in vertical position. A sufficient amount of electrolyte must be present to lift the float. Take the reading at eye level and disregard the curvature of liquid at the edges.

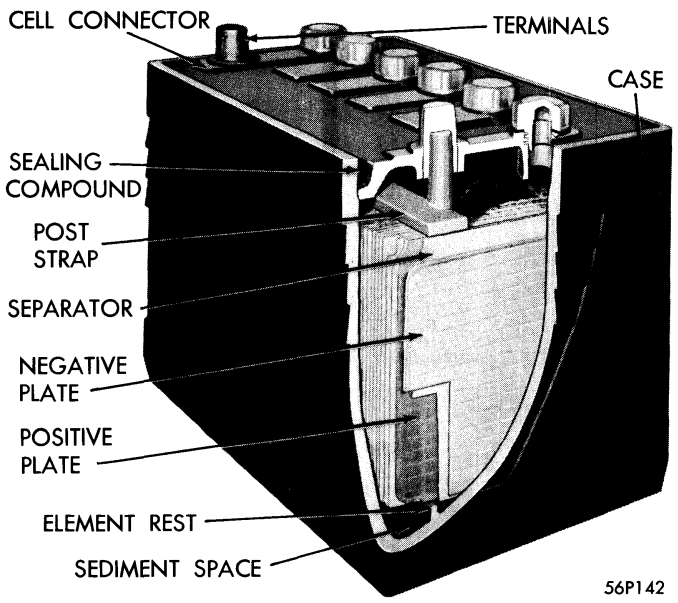

Figure 1—Battery

The reading of the hydrometer will vary with the temperature of the electrolyte. An ordinary dairy thermometer may be used to take electrolyte temperature readings from the center cell.

Hydrometer floats are calibrated to indicate correctly only at one fixed temperature. A hydrometer reading of a cell with electrolyte above 80° F. will be less than a reading with the electrolyte at 80° F. The opposite holds true where the temperature of the electrolyte is below 80° F. See Figure 2. A temperature correction amounts to .004 specific gravity for each 10° change in temperature. See examples.

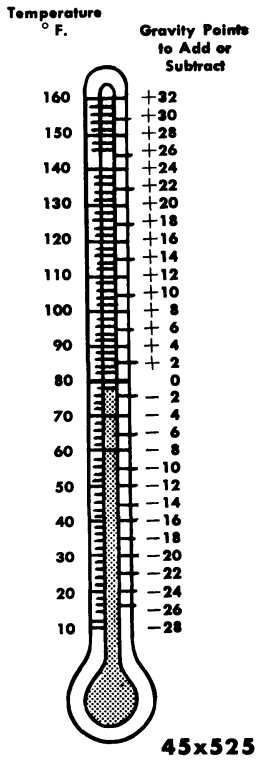

Figure 2—Hydrometer Reading Correction Chart

Example No. 1	Hydrometer reading	1.260
	Acid temperature	20° F.
	Subtract .024 Sp. Gr.	
	Corrected Sp. Gr. is	1.136
Example No. 2	Hydrometer reading	1.255
	Acid temperature	100° F.
	Add. .008 Sp. Gr.	
	Corrected Sp. Gr. is	1.263

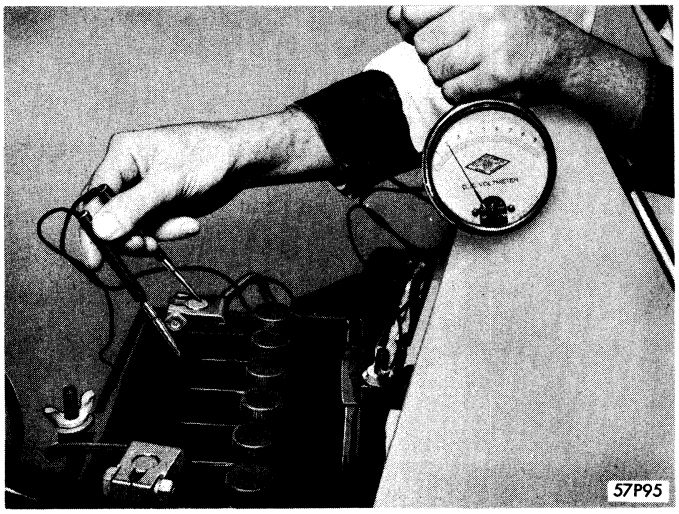

Figure 3—Battery Open Circuit Test

OPEN CIRCUIT VOLTAGE TESTER

An open circuit voltage tester (Tool No. MT-310) can be used to determine the state of charge of the battery and the condition of the battery. See Figure 3.

VOLTAGE TEST

Connect a voltmeter from the positive post to the negative post of the battery. Be sure the clips or prods make a solid connection with a clean portion of the battery posts.

Under a no load condition, a fully charged battery should read at least 12.0 volts, 2.0 volts per cell. If the reading is low, connect a voltmeter across each individual cell. If all cells are low but have equal readings, the battery is low and should be charged. If some cell readings are 2.0 volts and another cell is discharged more than .5 volt, it indicates a short or the electrolyte is low in that cell.

BATTERY MAINTENANCE

Long life and efficient service can be obtained from the battery, providing it is serviced regularly.

ELECTROLYTE—The electrolyte must be kept above the plates at all times. Only pure distilled water, or water that is chemically pure, and free from sediment, should be used.

Never add acid unless it is known that the acid has been lost through spillage.

OVERCHARGING—High terminal heat resulting from overcharging, will speed the corrosion of the positive plate grids, and cause damage to the separators and negative plates. In addition, the case may become distorted and the sealing compound displaced.

Excessive water evaporation may leave the acid in concentrated form. Over a period of time concentrated acid and high temperatures are harmful to the wood separators and negative plate material.

Liquid may be forced from the cells, resulting in corrosion of cables, battery support and other vital electrical or engine parts.

Severe warping or buckling of the positive plates and perforations of the separators may result if the battery is overheated. This would cause an initial short circuit.

BATTERY CARRIER HOLD DOWN BOLTS

Do not tighten the battery carrier hold down bolts more than two to three foot pounds. When the bolts are tightened excessively, tension on the battery support hold down cover and frame, plus engine heat, will cause the battery to expand, forcing the sealing compound out of the sealing walls.

COLD WEATHER CARE

A battery operated in an under-charged condition may freeze during severe winter weather. The freezing point of the electrolyte varies with specific gravity. A fully charged battery with 1.260 specific gravity corrected to 80° F. will freeze at —70° F. The following chart indicates the freezing points at various readings:

Specific Gravity (Corrected to 80° F.)	Freezing Point of Battery
1.260	—70° F.
1.250	—62° F.
1.200	—16° F.
1.150	+ 5° F.
1.100	+19° F.

BATTERY RESEALING

Remove the old sealing compound from the case and covers for approximately one inch beyond the leak, or until the sealing compound is forming a tight seal.

Thoroughly dry the covers and all portions of the container where the sealing compound will make contact. Since the sealing compound will not stick to a wet or dirty surface, special care should be taken in cleaning to assure a clean, dry surface.

IMPORTANT

Be sure to remove the battery covers and blow out any hydrogen gas which may be present above the electrolyte. Flames or sparks coming in contact with this gas will cause an explosion.

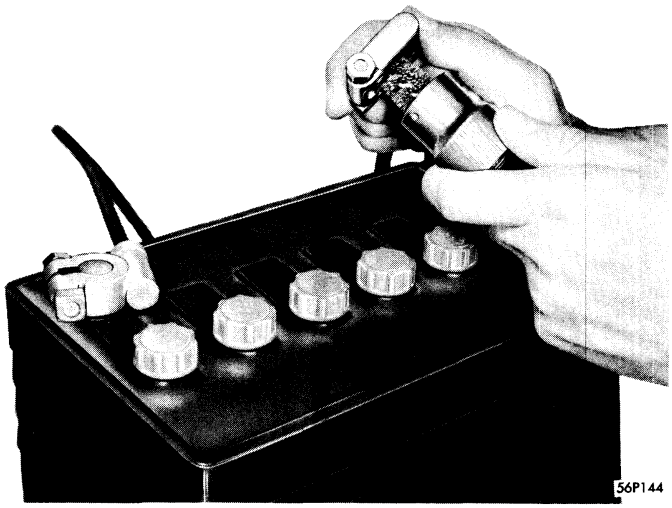

Figure 4—Cleaning Inside of Cable Clamp

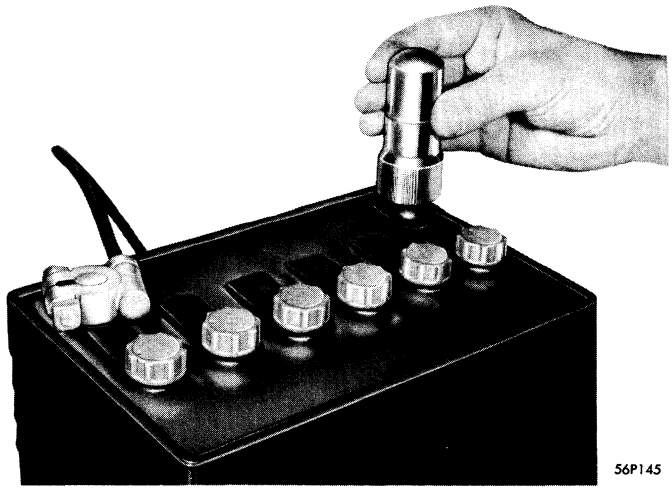

Figure 5—Cleaning Outside of Battery Post

Use a torch and carefully heat the groove where the sealing compound is to be poured. Do not scorch the case or cover.

The sealing compound should be quite hot—about 325° F. But, it must not be heated until it smokes. Inspect the covers and the groove where the hot compound will be poured, and make sure that the hot seal will not run into the cell.

Pour the hot seal into the groove until the proper level is obtained. If the seal should sing slightly, let the first pour cool. Then, level up with more hot seal. Always use new sealing compound when resealing a battery.

BATTERY TERMINALS

Before replacing or repairing generator or generator regulator, always examine condition of battery terminals for evidence of corrosion. Corrosion of the terminals results in either an open circuit or high resistance connections causing erratic operation of the generating system, as the circuit will be completely closed at one instance and open the next.

Clean terminals with a terminal cleaning tool as shown in Figure 4 and Figure 5 with Tool MX-75.

After cleaning, connect cable clamps to battery posts and tighten securely, then coat connections with grease to retard corrosion.

NOTE

If the positive battery terminal is equipped with a felt washer, soak the washer in medium engine oil. Squeeze excess oil out before installing over terminal.

2. GENERATOR

PERFORMANCE TESTS

OUTPOST TEST—Connect a test lamp between the armature terminal on the generator and ground. Be sure to clean the armature terminal to remove any oxidation or scale caused by overheating, which may have been caused by a loose connection. Operate the engine between speeds of 800 to 1,000 RPM, and ground the field terminal on the generator. If the test lamp does not light, make sure the brushes are making contact on the commutator. While the armature is turning, use a piece of wood and a strip of 00 sandpaper to clean the commutator. Never use emery cloth to clean the commutator.

Repeat the output test. If the test lamp still fails to light, it will be necessary to remove the generator for further inspecion and tests.

MOTORING TEST—Remove the fan belt and disconnect the armature and field wires from the generator. Connect a jumper wire between the battery terminal on the starter solenoid switch and the armature terminal on the generator. Connect a jumper wire from the field terminal on the generator to ground. When the jumper wire from the field terminal is grounded, the armature should "motor" or rotate slowly. If the armature does not motor, disassemble the generator for further inspection.

INSPECTION AND BENCH TESTS

Disassemble the generator and thoroughly clean all parts. It is not necessary to remove the field coils from the generator frame at this time. Use a cloth dampened with a suitable cleaning fluid and then dry the parts with compressed air.

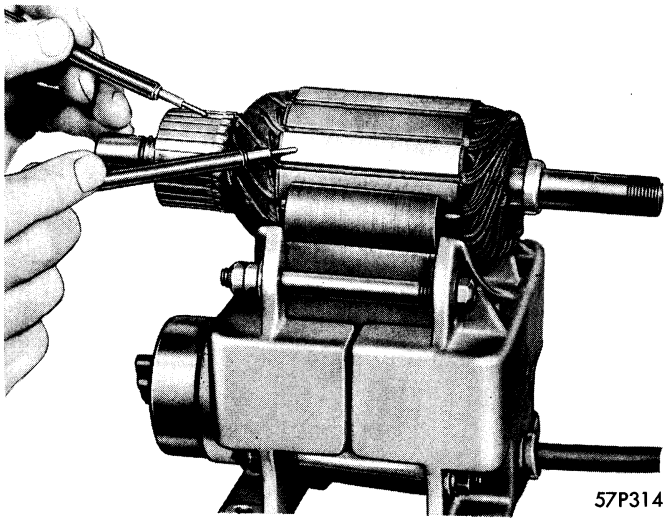

Figure 6—Testing Armature for Ground

Do not immerse the field coils, armature, felt washer, or insulating parts in fluid or dry them with heat. Never steam clean the generator.

1. ARMATURE—Inspect the core for scored or damaged laminations, out of place or loose windings, or loose connections at the commutator. Inspect the commutator for roughness, excessive wear or run-out and improperly undercut mica. Check for bent or worn shaft.

TEST FOR GROUND—Test for a grounded armature with a test lamp and probes. Place one probe on the shaft and check each commutator bar. If the lamp lights, a short is indicated and a new armature should be installed. Do not touch the probes to the brush surface of the commutator or to the bearing surface of the shaft. See Figure 6.

TEST FOR SHORT—Place the armature on a growler. Turn the armature slowly and hold a hack saw blade or thin strip of steel over each segment of the core.

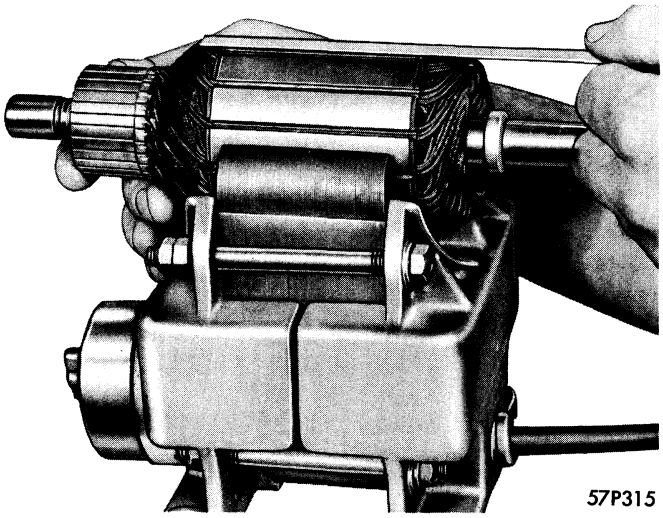

Figure 7—Testing Armature for Short

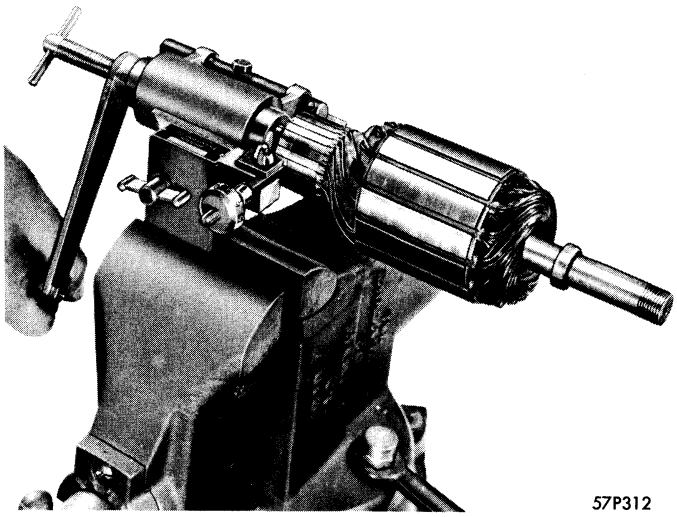

Figure 8—Refacing Commutator

Vibration of the blade or strip of steel will indicate a short and the armature should be replaced. See Figure 7.

COMMUTATOR RUN-OUT—Place the armature shaft ends in Vee blocks and check commutator run-out with a dial indicator. If the run-out exceeds .0005 inch, the commutator should be refaced in a lathe or with Tool C-770 shown in Figure 8.

NOTE

Remove only sufficient metal from the commutator to provide a clean smooth surface.

After refacing the commutator, or if the mica was even with or above the brush surface, undercut the mica to a depth of $\frac{1}{32}$ inch with tool C-770 shown in Figure 9, or a fine tooth hack saw blade. Be sure to undercut the

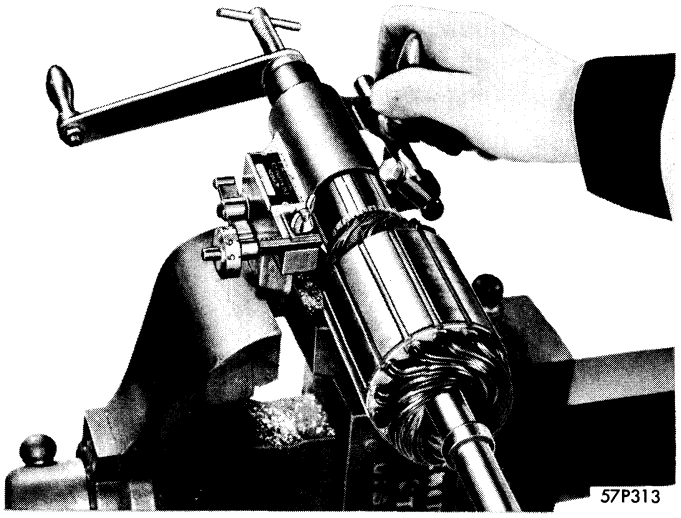

Figure 9—Undercutting Mica

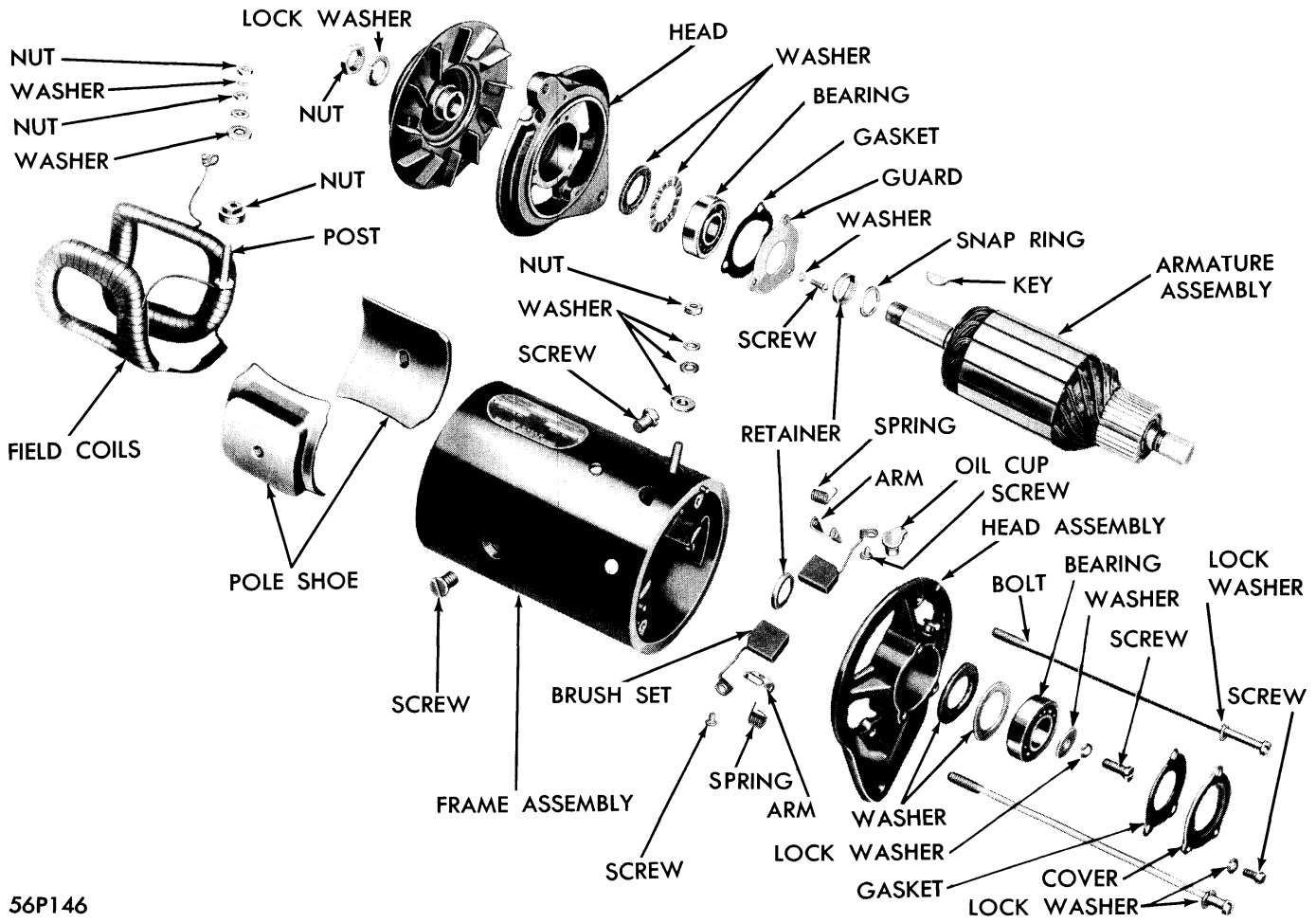

Figure 10—Generator Disassembled

mica square and the full width of the slot. After undercutting, polish the commutator with No. 00 sandpaper to remove possible burred edges.

2. *TESTING FIELD COIL FOR GROUND*—Check for a ground in the field coils by connecting test light prods between the field terminal stud and the generator frame. If the test lamp lights, remove the terminal stud and check the insulating bushing and washers for cracks or damage. If the field terminal stud was properly insulated, separate the coil leads and test each coil by connecting one end of the test light to the individual lead and the other end to the generator frame. Remove the pole shoe screw and slide the grounded coil out of the frame.

Inspect the field coils, terminal leads and brush leads for broken, frayed, chafed insulation or loose connections. Resolder all loose connections and repair any frayed or chafed insulation, provided the wire has not been damaged. If the wire has been damaged, the field coil assembly should be replaced.

3. *TESTING FIELD COILS FOR OPEN CIRCUIT*—Connect one test lamp probe to the field coil terminal lead and the other probe to the brush lead. If the test lamp does not light, the coil is open or the lead connections are loose or broken. Lead connections may be repaired. If the coil circuit is open, the assembly should be replaced.

4. *TESTING FIELD COIL RESISTANCE*—Be sure that all connections are tight and soldered. Connect an ammeter and a variable resistance control between the positive post on the battery and both field coil brush leads. Connect a voltmeter between the field coil brush leads and terminal leads.

Connect a jumper wire between the field coil terminal leads and the negative post of the battery. Adjust the voltage with the variable resistance control. The field coil amperage draw should read as indicated in the Generator Data and Specifications. If the amperage does not come within these specifications test each coil separately in the manner outlined above. When testing one

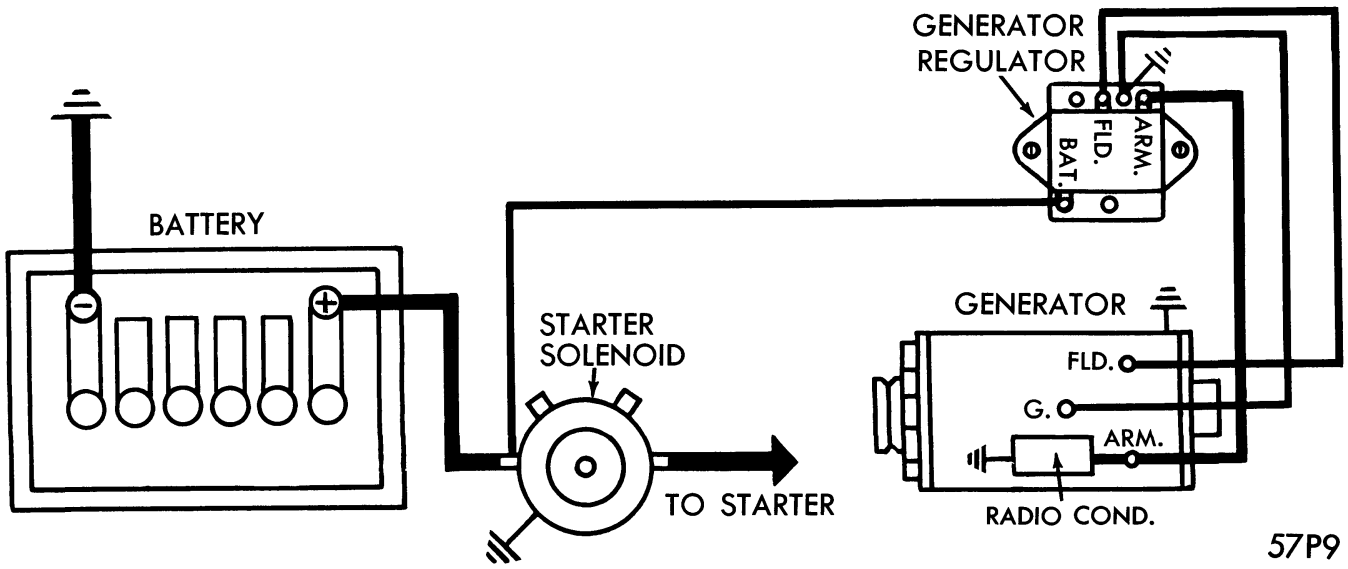

Figure 11—Generating Circuit

coil only, the amperage should read twice the amperage as when testing two coils. If a coil does not meet these specifications, it should be replaced.

5. *COMMUTATOR END HEAD*—Test the brush holders for ground. Connect one probe of a test lamp to the brush holder and the other probe to the commutator end head. If the test lamp lights, the holder is grounded and a new commutator end head should be installed. Do not attempt to tighten brush holders. If the brush holders are loose, the end head must be replaced. Check the Oilite bushing for excessive wear. If the bushing is worn to less than ½ inch in length, they should be replaced. When new brushes are installed, they should be sanded to obtain a correct fit against the commutator. To seat the brush against the commutator, use a strip of No. 00 sandpaper as wide as the finished surface of the commutator. Lift the brush and slide the sandpaper—grit side—between the commutator and the brushes. See Figure 12. With spring pressure against the brushes, slowly turn the armature in correct rotation, pulling the sandpaper from under the brushes. Repeat operation until the brushes seat at least 75 per cent over the entire contact face. (Excessive use of sandpaper will shorten life of the brushes and should be avoided.) Blow out all sand and carbon dust from the generator with compressed air and then tighen pigtain connections securely.

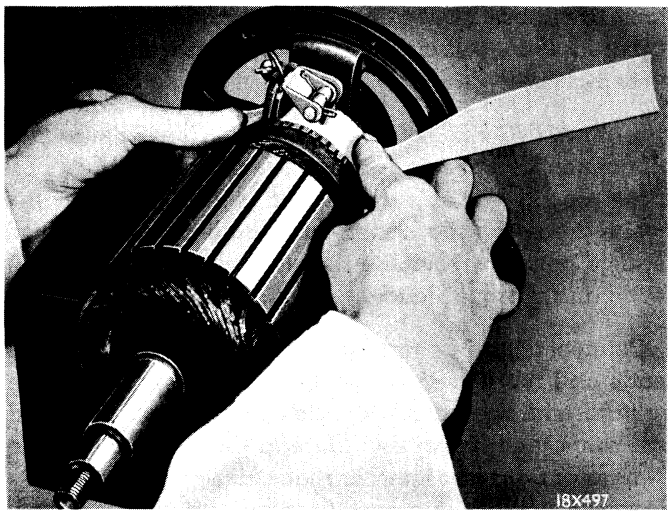

Figure 12—Seating Generator Brushes

Brush spring tension should be checked with the commutator end head and brushes installed on the armature. The brushes should be examined to make sure they are free in the holders. To check tension, hook a spring scale under the brush spring and pull upward. Take the scale reading just as the spring leaves the brush. Discard springs that do not meet specifications. Too much tension will cause rapid wear of the commutator and the brushes. Too little tension will cause arcing and low generator output.

6. *DRIVE END HEAD*—Clean the ball bearing in a suitable solvent and dry with compressed air. Do not spin the bearing with air pressure. Inspect the bearing for pitting or looseness. Check the fit of the bearing in the drive end head. If it is loose, check the recess with a new bearing before discarding the old one.

ASSEMBLY OF GENERATOR

Soak the felt washers and the Oilite bushing in clean engine oil. Pack the ball bearing about half full with high temperature non-fibre grease. Compress felt slightly to remove excess oil before installing.

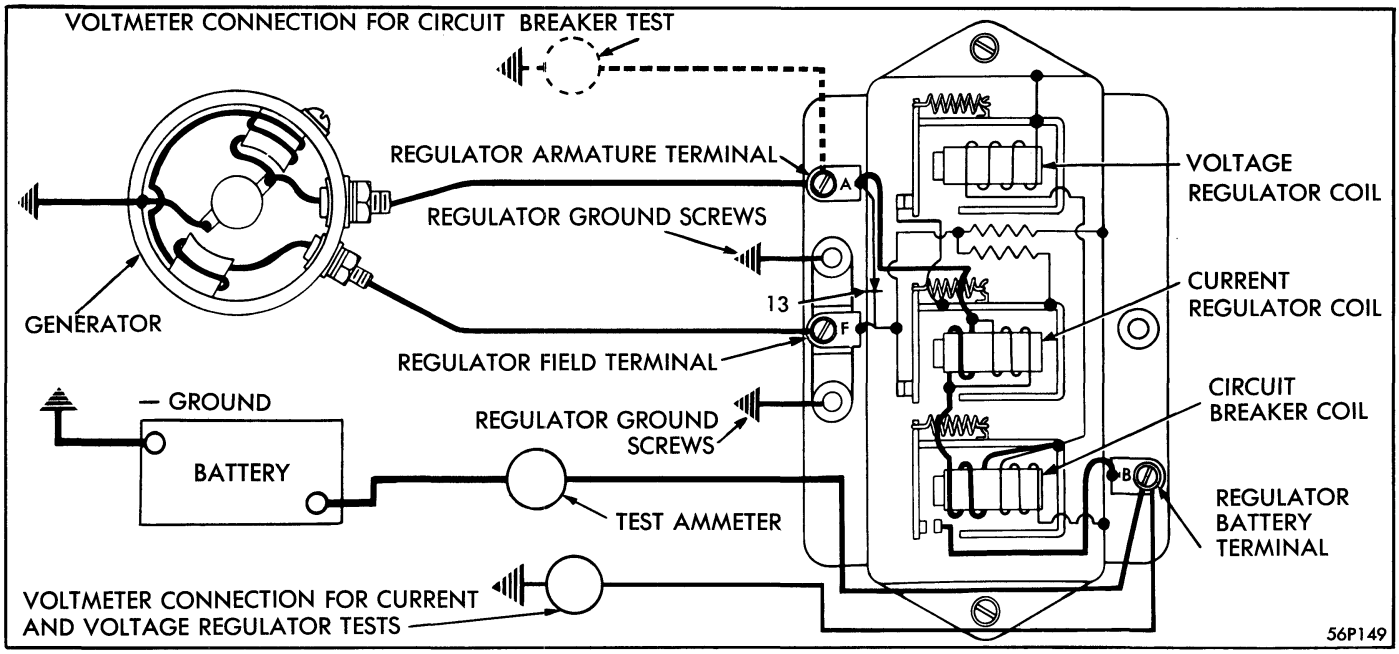

Figure 13—Generator Regulator Wiring and Test Connection Diagram

IMPORTANT

When assembling armature and drive end head, install felt washer retainer on shaft over snap ring before pressing shaft into bearing. This retainer turns with the shaft and inner race and prevents snap ring from tearing the felt washer. Be sure that the snap ring on the armature shaft is pressed firmly against the inner race of the bearing.

When installing the through bolts, make sure that the lower bolt is installed under the loop in the field connection insulation to prevent grounding of the field coils by the bolts.

When installing commutator end head, remove the felt wick and reinstall it after the head and armature are assembled on the generator. This will prevent the wick from being damaged when the shaft is inserted. Before installing the generator in the car, perform the motoring test.

3. GENERATOR REGULATOR

The generator regulator assembly contains three units —the circuit breaker, the current regulator and the voltage regulator. Each unit performs a separate function.

THE CIRCUIT BREAKER acts as an automatic switch. It closes the charging circuit when the generator is charging and opens the circuit when the generator is not charging. This prevents the battery discharging back through the generator.

THE CURRENT REGULATOR limits the maximum current output of the generator in amperes. When the generator output reaches a predetermined maximum, the regulator points are opened, cutting in a resistance in the generator field circuit—reducing the output. Then, the instant that the output drops, the points close, cutting out the resistance, and the output rises. These cycles occur so rapidly that the points vibrate at a high frequency. Thus, the output is held constant at a predetermined maximum.

THE VOLTAGE REGULATOR is used to hold the voltage of the electrical system constant within close limits. When the voltage rises to a predetermined value, the regulator contact points vibrate. Thus, a resistance is cut in and out of the generator field circuit.

PERFORMANCE TESTS

1. VOLTAGE REGULATOR — Operate the engine until the regulator is up to normal operating temperature. Connect a voltmeter from the battery terminal of the regulator to ground. See Figure 13.

Connect a variable resistance across the battery posts. Run engine at a speed equivalent to 30 miles an hour until voltage remains constant and the charging rate has dropped from its peak of 14.90—14.58 at 70° F. The cover must be on the regulator during the warm-up period and when taking test readings. Take temperature of air two inches from regulator. The voltage regulator must control the voltage at 14.58 at 70° F.

2. CIRCUIT BREAKER — Disconnect the wire from the "B" terminal of the regulator, connect the test am-

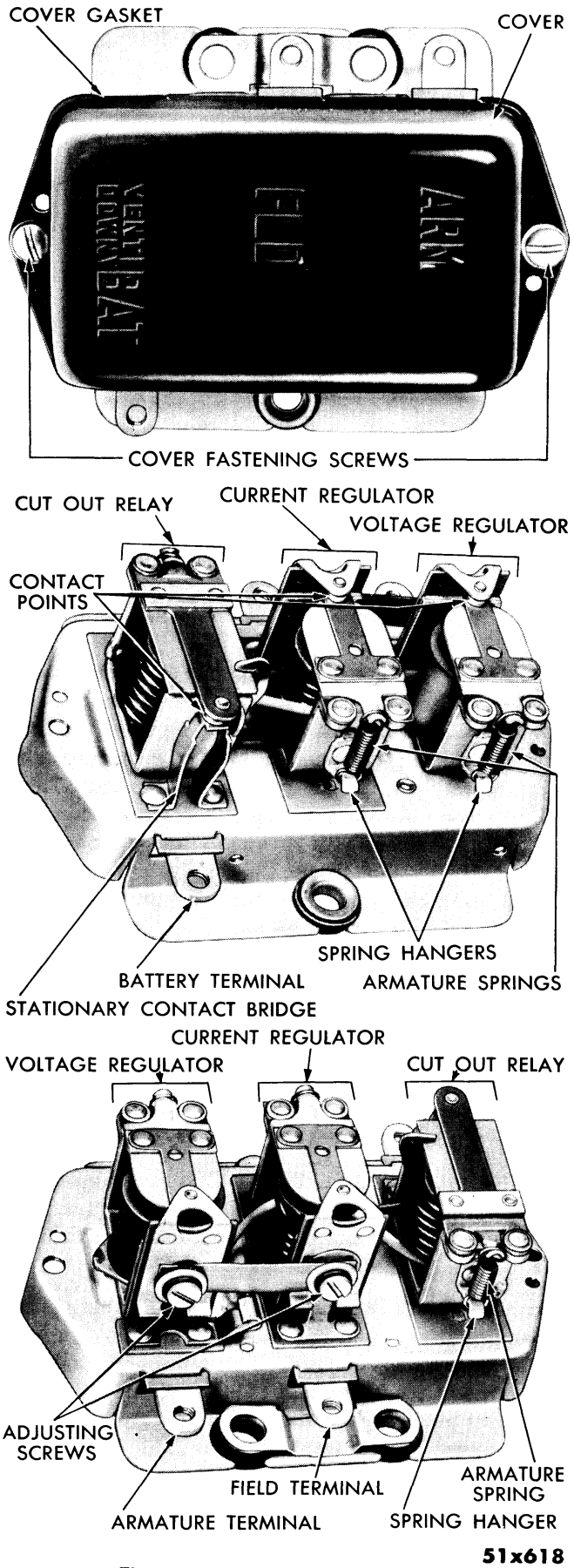

Figure 14—Generator Regulator

meter to the wire that was removed and to the regulator "B" terminal as illustrated in Figure 13.

NOTE

Do not attempt to adjust the regulator assembly unless its operation is thoroughly understood and accurate meters are available. Even a slight error in the setting of the unit may cause improper functioning, resulting in a run down or an overcharged battery, or damage to the generator and regulator.

Connect the test voltmeter to the "A" terminal of the regulator and the regulator housing ground. See Figure 13.

Start the engine and be sure it idles smoothly. Then, increase the engine speed slowly to determine when the circuit breaker points close. When the hand on the voltmeter kicks back slightly, it indicates the points have closed. This should occur at 13—13.75 volts at 70° F. Reduce the engine speed until the contact points open as noted on the voltmeter. Points should open at 8.2—9.3 volts with a 0—6 amps discharge.

If adjustment is necessary, remove the regulator cover and inspect the contact points of all three units. In normal use, the contacts will become grayed. If the contact points are burned, dirty, or pitted, replace the regulator contact points.

3. *CURRENT REGULATOR*—Remove the lead from the battery terminal on the regulator. Connect an ammeter between the regulator battery terminal and the lead that was removed. Connect a voltmeter from the regulator battery terminal to ground.

Run the engine at a speed equivalent to 30 miles an hour for 15 additional minutes, applying enough resistance load across the battery to maintain a voltmeter reading of 14.4—15 volts.

At 70° F., the current regulator should operate at the lower figure indicated on the regulator nameplate, plus or minus 2 amperes at the conclusion of the warm-up period.

INSPECTION

If test indicates that the generator regulator is at fault, an inspection should be made to determine if any of the following conditions exist:

Loose or broken connections, evidence of burning or excessive heat, broken or loose carbon resistors, improperly installed armature springs, distorted spring hangers, bent armatures, yokes or hinges or evidence of moisture or corrosion.

IMPORTANT

When electrical tests are made at the terminals of the generator regulator, there is great danger of short circuiting the regulator and burning the contact reeds inside the unit. Whenever possible, it is better to connect test apparatus where there is no danger of damaging the regulator. For example:

(1) When checking generator output, ground the field terminal at the generator, rather than at the regulator, to avoid the possibility of grounding the regulator battery terminals with a screw driver. Never attempt to check generator output by shorting between the field and armature or battery terminal of the regulator.

(2) Timing or trouble lights should be connected at the starter solenoid terminal rather than at the battery terminal of the regulator. This will avoid danger of the clip connector slipping off and simultaneously touching the battery and field terminal of the regulator.

(3) When flashing the generator field to cause the generator to build up residual magnetism, first remove the lead from the generator field terminal. Then ground the generator field terminal and attach a jumper from the battery negative post to the armature terminal on the generator.

Check the contact points and the armature air gap for correct clearance.

Before testing or adjusting the regulator, be sure all connections in the charging current are clean and tight, and that the battery is fully charged. Check the generator output and be sure the regulator is ihe correct unit for use with the particular generator. Be sure regulator is properly grounded.

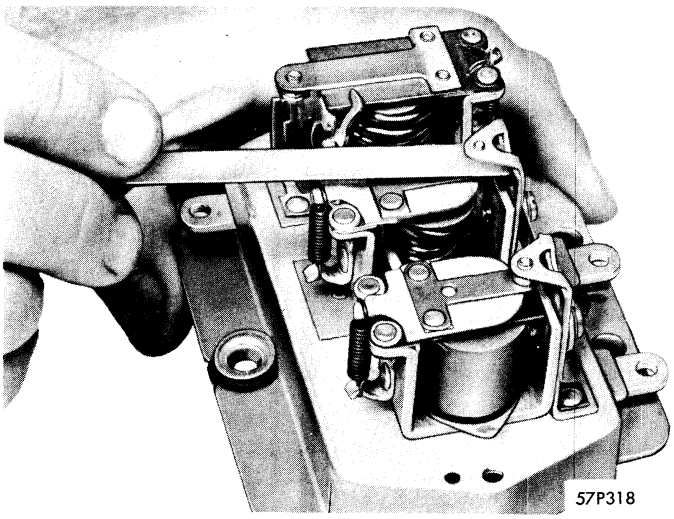

Figure 15—Refacing Regulator Contact Points

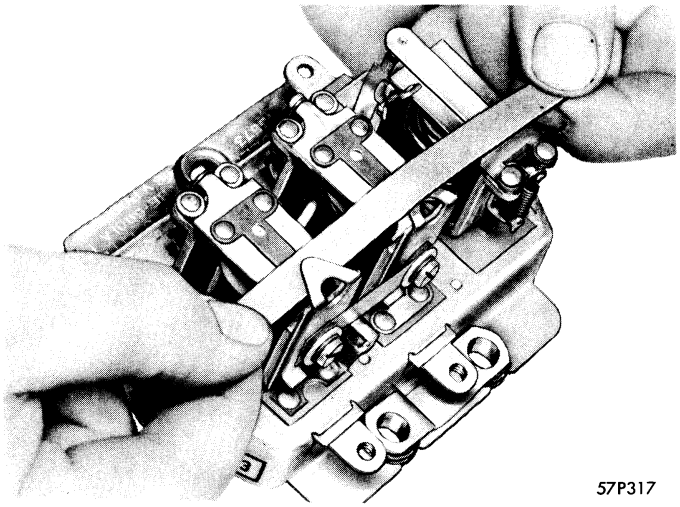

Figure 16—Cleaning Regulator Contact Points

NOTE

Always make the voltage regulator test before making the current regulator test. When removing or installing the regulator cover, do not let the cover touch the regulator parts, as this might cause a short circuit and damage the assembly.

ADJUSTMENT AND REPAIR

In normal use, the contact points will become grayed. If the contact points are burned, dirty or pitted, reface them wtih a clean, fine file.

1. *REFACING CONTACT POINTS*—File lengthwise and parallel to the armature, as shown in Figure 15, until the contact points present a smooth, flat surface toward each other. It will not be necessary to remove all traces of pitting.

Do not file crosswise as grooves may form which would tend to cause sticking and erratic operation.

Clean contact points (Figure 16) after filing, with a strip of linen, or lintless bond tape. Make sure no lint remains between the points after cleaning.

After the contact points are refaced and cleaned, readjust the armature air gaps to compensate for the metal removed from the points.

CAUTION

Never use sandpaper or emery cloth, or a file that has been used on other metal. Particles of emery, sand, or metal may become embedded in the points and cause them to burn rapidly—resulting in an open circuit, or welding of the points together.

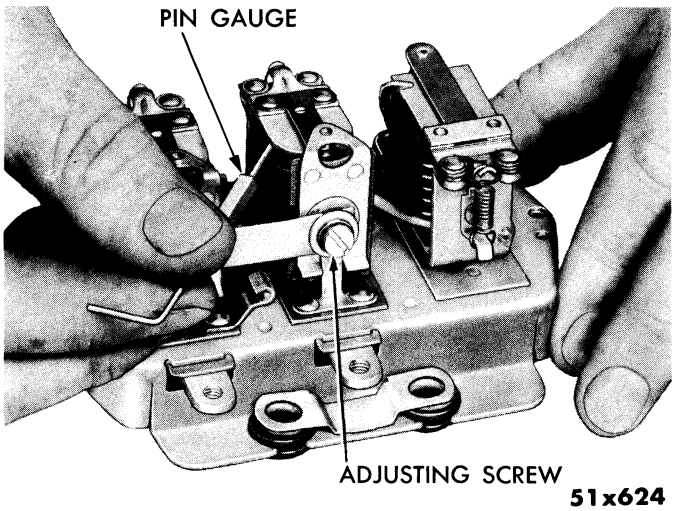

Figure 17—Checking Regulator Air Gaps

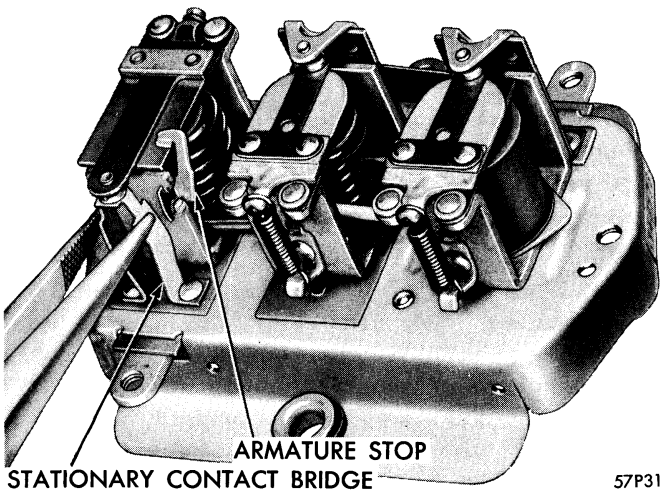

Figure 19—Adjusting Circuit Breaker Air Gap

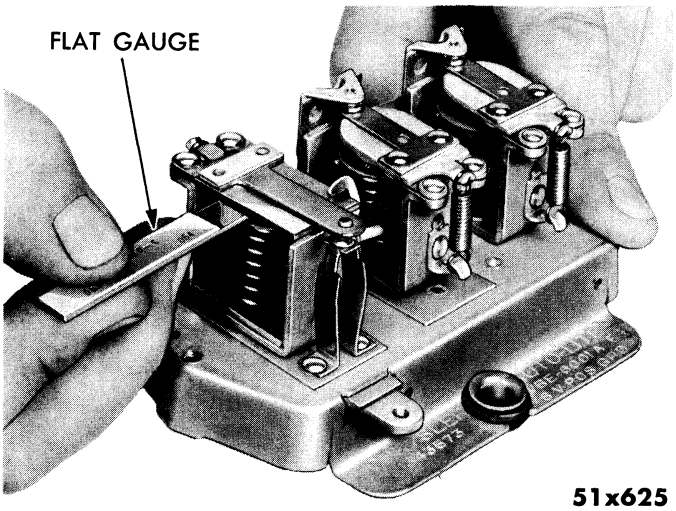

Figure 18—Checking Circuit Breaker Air Gap

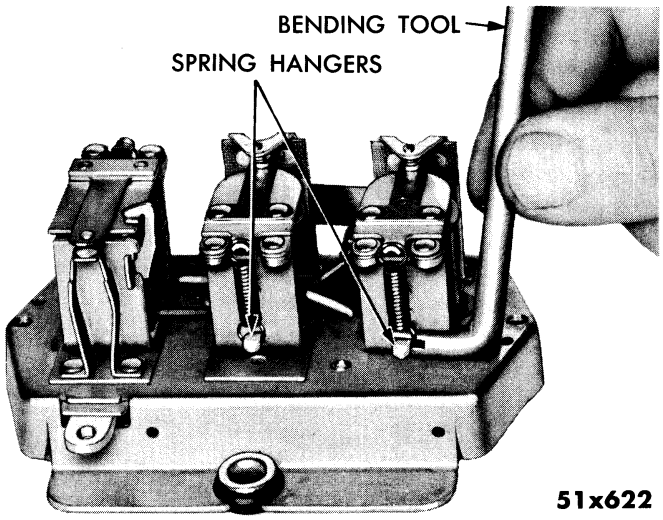

Figure 20—Adjusting Armature Spring Tension

2. *CHECKING CURRENT AND VOLTAGE REGULATOR AIR GAPS*—Use the pin type gauge (from Kit C-828) which measures from .048 to .052 inch. Insert gauge on point side of air gap and next to armature stop pin with the contact points just separating. See Figure 17.

3. *ADJUSTING CURRENT AND VOLTAGE AIR GAPS*—Loosen the bracket screws and raise or lower the contact point brackets until the desired clearance is obtained. Tighten these screws securely after adjustment is made. With the armature held down so that the stop rivet rests on the magnet core, the point gap should be .015 inch when checked with a feeler gauge.

4. *CHECKING CIRCUIT BREAKER AIR GAP*—Use the flat gauge (from Kit C-828) which measures from .031 to .034 inch. Insert the gauge between the armature and magnet core. See Figure 18. Place the gauge as near to the hinge as possible.

5. *ADJUSTING CIRCUIT BREAKER AIR GAP*—Bend the armature stop so that the space between the core and armature is within the limits specified. The stop must not interfere with the movement of the armature. Adjust the contact point gap to .015 inch by expanding or contracting the stationary contact bridge. See Figure 19. When adjusting the contact gap, keep the contact points in alignment.

NOTE

By increasing the contact gap, the opening voltage is lowered and the closing reverse current is raised.

6. *ADJUSTING ARMATURE FOR PROPER OPENING AND CLOSING VOLTAGES*—Use bending tool (from Kit C-828). With slot in end of tool placed over the lower

spring hanger (Figure 20), bend the hanger to decrease or increase the spring tension until the desired opening or closing voltage is obtained.

RESISTANCE IN CHARGING CIRCUIT

The wiring harness between the generator, regulator, ammeter and battery should be inspected for loose connections, breaks at terminals, frayed or damaged insulation. Special attention should be given to battery terminals. Numerous causes of corroded battery terminals have been confused with a defective generator or regulator.

4. DIAGNOSIS PROCEDURES

TEST AMMETER SHOWS DISCHARGE

(ENGINE RUNNING AT FAST IDLE)

If test ammeter indicates generator is not charging, first make certain the ammeter is operating properly. If the ammeter is operating correctly but still shows discharge, make the following tests to locate trouble:

1. GENERATOR REGULATOR

(a) Field Circuits—Connect a jumper wire from base of regulator to frame of generator. Increase engine speed slowly to fast idle. If ammeter shows charge, the ground of the regulator is defective.

(b) Regulator Ground—Tighten mounting screws and examine regulator ground strap for break. Replace strap if necessary.

(c) Regulator—Connect a jumper wire from regulator base to field terminal at regulator. If this causes the ammeter to show a charge when engine speed is increased, install a new regulator.

(d) Regulator Field Terminal and Connections—With the jumper still grounded at the regulator, connect the other end of the wire to the field terminal at the generator (small terminal stud). Increase the engine speed; if the ammeter registers a charge, the cable from generator field terminal to regulator field terminal is defective or connections are loose.

2. BATTERY—Test for a weak or discharged battery. Inspect cables in charging circuit for looseness and battery terminals for corrosion.

3. FAN BELT—Make sure fan belt is tight and in good condition.

4. WIRING—Inspect wiring for frayed or worn insulation in the generating circuit.

5. REGULATOR—With the engine at fast idle, connect a jumper test lead from the field terminal on generator to ground. If ammeter now shows charge, the regulator may be at fault. Test regulator as described in (1).

6. GENERATOR—If above tests do not determine cause of trouble, remove and test generator.

TEST AMMETER SHOWS HIGH CHARGE

(BATTERY FULLY CHARGED)

If the test ammeter continues to indicate a high charge after the engine has run for a short time, examine the following parts for possible loose connections or grounds:

1. GENERATOR—Remove the field lead from the field terminal at generator. If the ammeter shows a charge on fast idle, remove generator and test field coils for ground.

2. WIRING—Inspect wiring from the generator to the regulator for loose terminal connections or frayed and worn insulation. Remove field lead from field terminal at regulator and protect it from grounding. If ammeter shows charge on fast idle, it's an indication that there is a grounded condition.

3. REGULATOR—If test ammeter fails to show charge under tests described in paragraphs 1 and 2 above, the regulator should be removed and tested.

EXCESSIVE LOSS OF BATTERY FLUID

If the battery is continually low on fluid or will not hold fluid, look for the following possible causes:

1. BATTERY CASE—Inspect for a broken or cracked battery.

2. VOLTAGE REGULATOR—Inspect for an improperly adjusted voltage regulator. Excessive evaporation of battery fluid will occur when battery becomes overheated, due to too high a charging rate.

CONTINUAL LOSS OF BATTERY CHARGE

If the battery can be fully charged but will not retain the charge, one of the following conditions may exist:

SHORT CIRCUIT — Inspect for a short circuit in the wiring system. Make sure top surface of battery is clean.