VOLTAGE REGULATOR
CENTRIFUGAL TYPE—AUTOMATIC
REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers centrifugal-type automatic voltage regulators with separately excited dc motors, KS-5293, KS-5293-01, and KS-5376-01, L1 and L2, and with permanent-magnet type direct current motors KS-5293-02 and KS-5376-01, other than L1 and L2. (Fig. 1)

1.02 This section is reissued to:

- Delete five old figures and add seven new figures
- Revise Reqt. 2.02
- Add a requirement for maximum eccentricity of movable contact
- Revise List of Tools and Gauges

This issue affects the Equipment Test List.

1.03 Reference shall be made to Section 020-010-711 covering General Requirements and Definitions for additional information necessary for the proper application of the requirements listed herein.

***1.04** Requirements and associated procedures marked with an asterisk (*) need not be checked during maintenance unless the apparatus or part is made accessible for other reasons or performance indicates that such a check is advisable.

#1.05 Requirements and associated procedures marked with a number sign (#) need not be checked by the installer unless it is thought that the requirement is not being met or performance indicates that such a check is advisable.

1.06 ***Successful commutation*** for the purpose of this section may be said to have been obtained if neither the brushes nor the commutator is injured in normal service to the extent that abnormal maintenance is required. The presence of some visible sparking is not necessarily evidence of unsuccessful commutation.

1.07 ***Normal operating voltage*** as used in this section refers to the voltage of the associated generator or battery at the point of regulation.

1.08 Before starting a machine which has not been adjusted for automatic voltage regulation, open regulator contacts by turning regulator dial to maximum clockwise position. This is to avoid excessive wear on regular contacts.

1.09 The adjustments of the generator field rheostat and regulator contacts as outlined in this section are intended to secure maximum life of the regulator contacts for the conditions of each particular installation rather than regulation for both floating and charging over the full range of generator rated output.

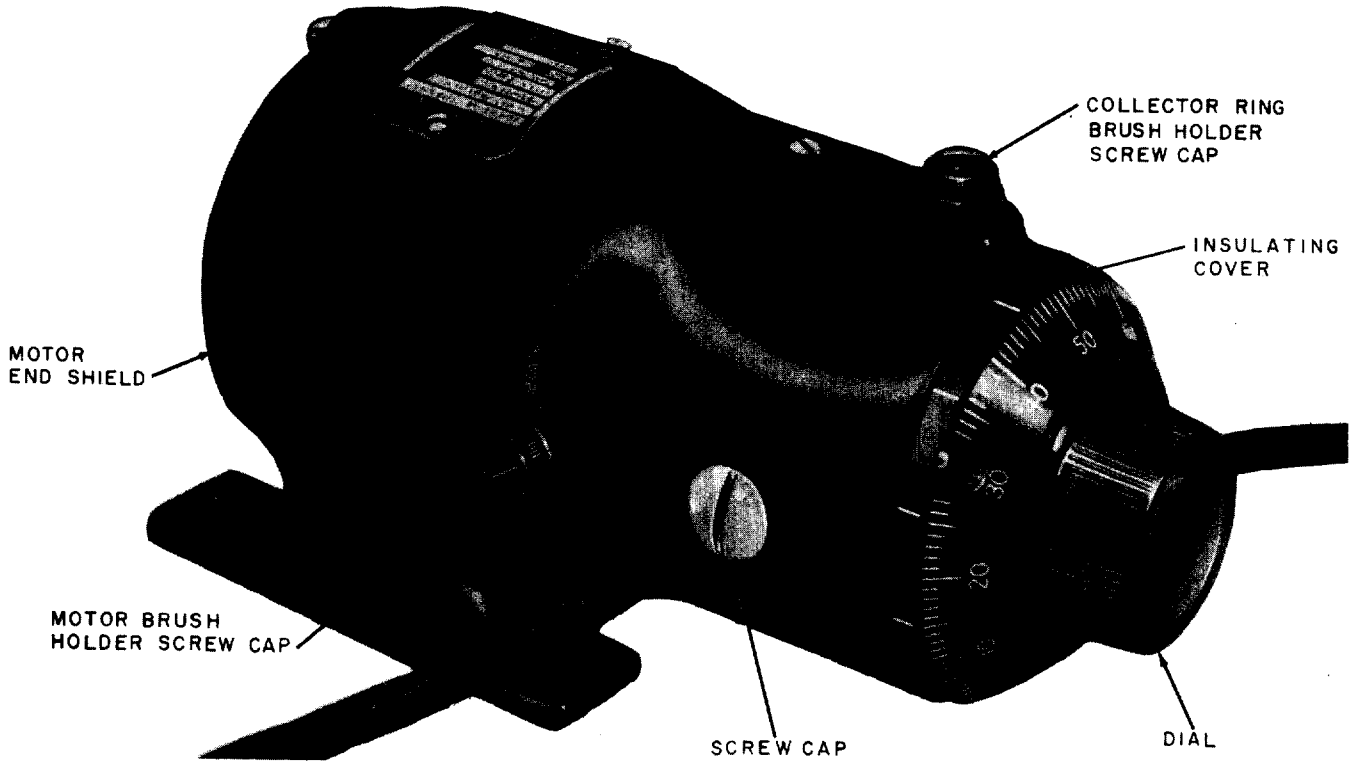


Fig. 1—Voltage Regulator

1.10 ***Index:*** The following index lists the items covered in Part 2 of this section. Part 3 is not covered in the index as these items are the procedures corresponding to the individual requirements of Part 2.

INDEX

2. REQUIREMENTS

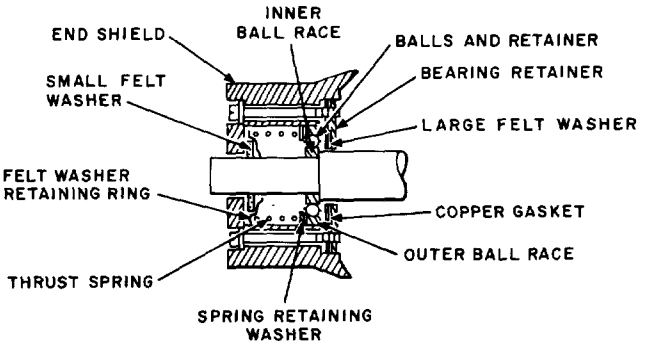
#2.01 *Lubrication*

(a) The motor bearings (see Fig. 2 and ◗3◖) shall be adequately lubricated with grease.

Caution: The amount of lubricant used at any time shall not be sufficient to cause it to run or creep out of the housing.

(b) After turnover, it is recommended the motor bearings be cleaned and repacked with Andok C grease every three years.

(c) Relubrication of motors equipped with inseparable type sealed bearings ◗(Fig. 4)◖ is not required. Replace these bearings when noisy.



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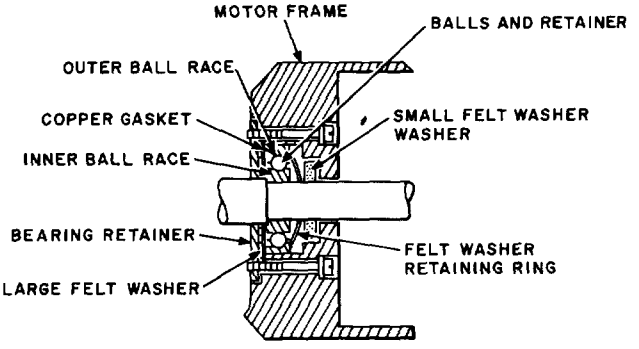
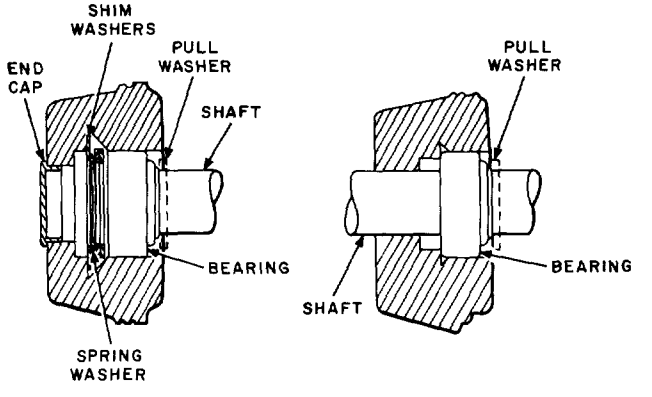


COMMUTATOR END

SEPARABLE SEALED TYPE BEARINGS



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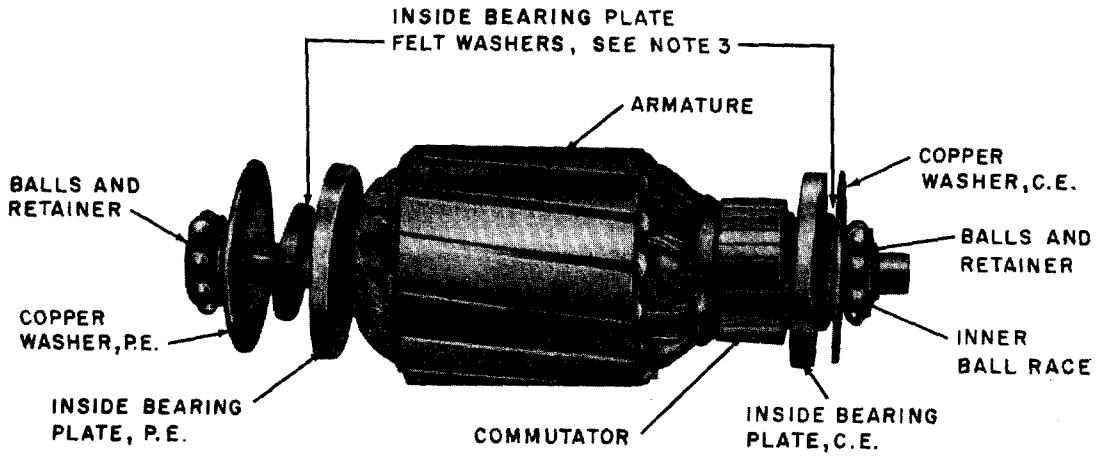
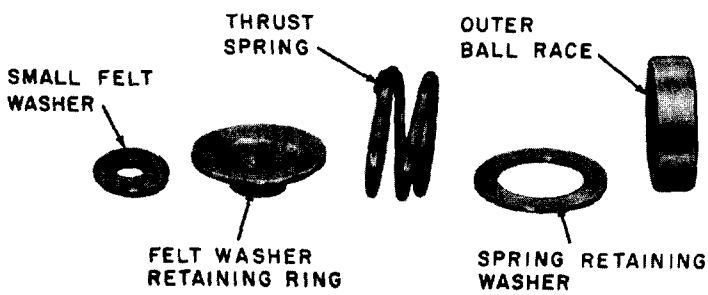
COMMUTATOR END

INSEPARABLE SEALED TYPE BEARINGS

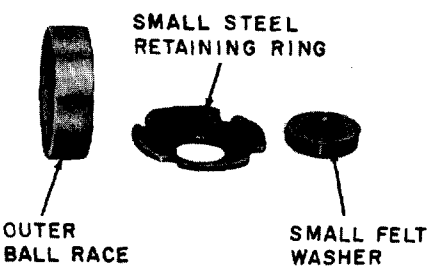
Fig. 2—Bearing Assemblies—Separable and Inseparable



ARMATURE ASSEMBLY



END OPPOSITE COMMUTATOR



COMMUTATOR END

Note 1: When a bearing is required, e.g., the inner ball race, the balls and retainer or the outer ball race, it is advisable to order the complete bearing. This may be ordered as bearing #E8T from the Barden Corp., Danbury, Conn.

Note 2: When parts used at both the commutator end and the end opposite the commutator have the same name, the end of the machine for which the part is to be used should also be specified in the order.

Note 3: The Inside Bearing Plate Felt Washer, G.E. Co. Cat. 2075274 is no longer available for G.E. Co. When this washer needs replacement, it must be made up locally from 1/8-inch thick, felt cut to a 15/16-inch O.D. having a 3/8-inch I.D.

Fig. 3—Armature & Separable Bearing Details

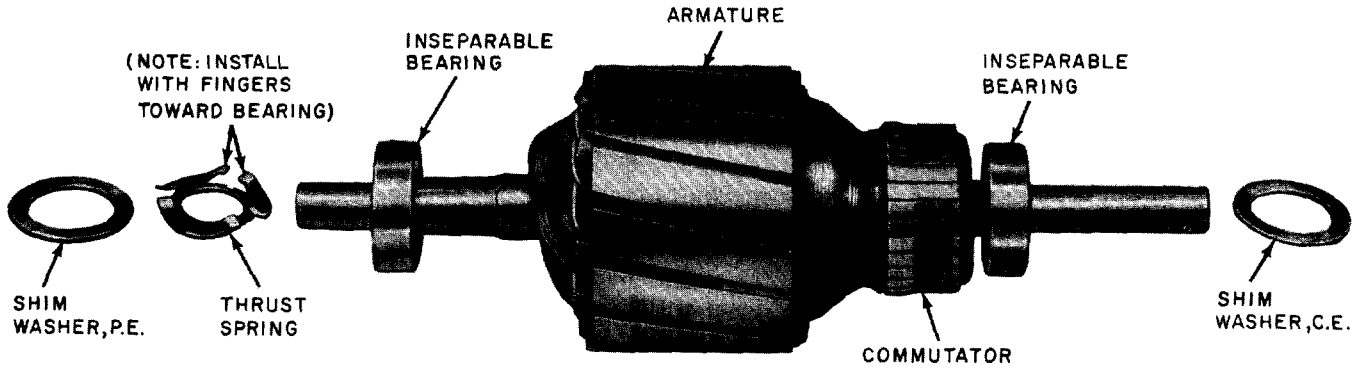


Fig. 4—Armature & Inseparable Bearing Details

#2.02** ***Speed and Rotation

(a) With normal operating voltage the speed shall be:

KS	MIN. RPM	MAX. RPM
5293	1800	2450
5293-01	1800	2450
5293-02	1800	2800
5376-01 L1 & L2	1800	2450
5376-01 All Others	→2000←	2800

Use Hasler speed indicator.

(b) The rotation shall be counterclockwise when facing the dial.

2.03 ***Voltage:*** With the machine operating at full load at some voltage within its operating range and at any temperature, the regulator shall keep the machine output voltage from rising more than 2 percent when all load is removed. This requirement shall be 1 percent when machines are first installed.

#2.04 ***Bearings:*** The condition of the bearings shall be such as to allow the motor to operate satisfactorily under all conditions of normal load. If requirements 2.05 to 2.07 inclusive, 2.17 and 2.18 are met, the bearings shall be considered to be in a satisfactory condition.

#2.05 ***End Play:*** The motor shall have the end play taken up by the thrust spring.

2.06 ***Freedom of Rotating Parts:*** The motor armature shall turn freely in its bearings. Gauge by feel.

#2.07 ***Air Gap:*** The minimum air-gap between the armature and the pole face shall not be less than one half of the maximum air-gap. Use thickness gauge.

#2.08 ***Brush Holders***

(a) The distance from the nearer edge of the brush holder to the collector ring or commutator shall be

Minimum—1/32 inch

Maximum—5/64 inch.

Use scale.

(b) The brush holders shall be firm in their housings. Gauge by feel.

*(c) Two sides of the square hole in each motor and collector ring brush holder shall be approximately parallel to the axis of the motor shaft. Gauge by eye.

2.09 ***Brush Length***

(a) At the time of turnover, the motor and collector ring brushes shall be

Minimum—7/16 inch long outside of the spring.

Use scale.

#(b) After turnover, the motor and collector ring brushes shall be

Minimum—5/16 inch long outside of the spring.

Use scale.

2.10 ***Brush Fit:*** Brushes shall be free in their holders and shall fit so as to ensure successful commutation. Gauge by eye or by feel.

2.11 ***Brush Pressure:*** With the brush holder screw cap removed and the brush in its holder and resting against the commutator or collector ring, the brush spring shall extend outside of its holder

Minimum—1/8 inch.

Use scale.

*#**2.12** ***Cummutator and Collector Ring Surfaces*** shall be clean and free from scores, pits, or other deformation of the surface or structure except that caused by normal wear.

*#**2.13** ***Commutation:*** The motor shall commutate successfully.

*#**2.14** ***The Polarity of the Rotating Contact*** shall be negative with respect to the fixed regulator contact to minimize contact wear. Use dc voltmeter.

*#**2.15** ***Length of Contacts,*** either fixed or rotating, including the mounting metal shall be

Minimum—1/16 inch.

Use scale.

*#**2.16** ***Contact Surfaces*** shall be clean and smooth.

*#**2.16.1** ***Eccentricity of Movable Contact*** shall not be more than

0.010 in. for KS-5293 type
0.015 in for KS-5376 type

2.17 ***Noise and Vibration*** of the motor under any normal operating condition shall not be excessive. Gauge by sound and feel.

2.18 ***Temperature***

(a) When in continuous operation within its voltage limits, the temperature of any part of the machine as measured by feel shall not be excessive. If the fingers can be held on the bearing housing, frame, or part under discussion, the machine temperature may be assumed to be within specified limits.

*#(b) If the temperature is thought to be excessive, measure by thermometer. The temperature of the various parts shall not exceed the following. Use thermometer.

Bearings 80C (176F)

Frame 90C (194F)

#**2.19** ***Ballast Lamp:*** (KS-5293 and KS-5293-01 motors) In the absence of local instructions to the contrary, replace the ballast lamp after approximately one year of service.

2.20 ***Percent Contact Operation***

*#(a) ***Regulators*** ***(See Fig. 1, 5, 6, and 7) furnished with an ac generator and having a marked rheostat*** are expected to meet requirements under (b) below, but these requirements should be checked when voltage regulation (Reqt. 2.03) cannot be met, when contact wear is thought to be excessive, or when a regulator is added to a generator in the field. A machine set correctly at the factory should not require resetting on the job. Varying conditions, particularly during the installation period make a check appear inadvisable.

(b) ***Regulators applied on dc generators*** shall meet the following. These checks should be made at normal operating line voltage and frequency, and with the regulator adjusted to the operating voltage.

(1) The no-load percent contact operation with the voltage in the upper half of the operating range and the machine cold shall be

Minimum—2%

Maximum—15%

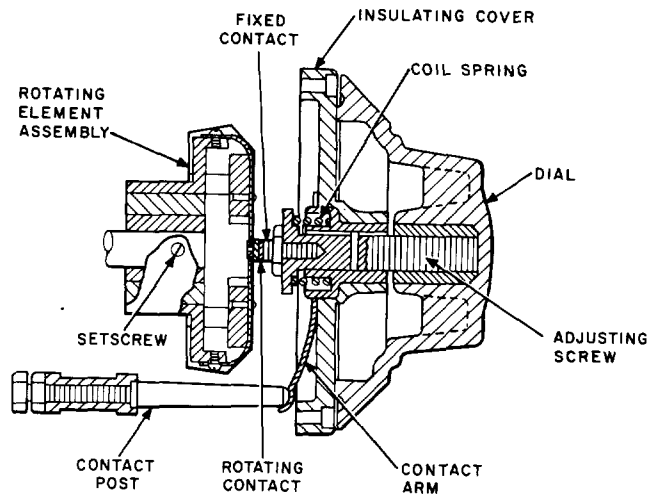
In the case of the ringing and coin control generators, the voltage may be adjusted in the lower half of the operating range, if necessary in order to secure a favorable coin control voltage.

(2) The full-load percent contact operation shall be

Preferably 30-40% cold

Preferably 50-60% hot

Maximum—70% cold.



Note: Removable contacts are provided on regulators of later design for both the rotating and fixed contacts. Replace the complete rotating element whenever any part is defective except if the contacts are of the replaceable type. If either contact is worn, replace both rotating and fixed contacts.

Fig. 5—Voltage Regulating Assembly

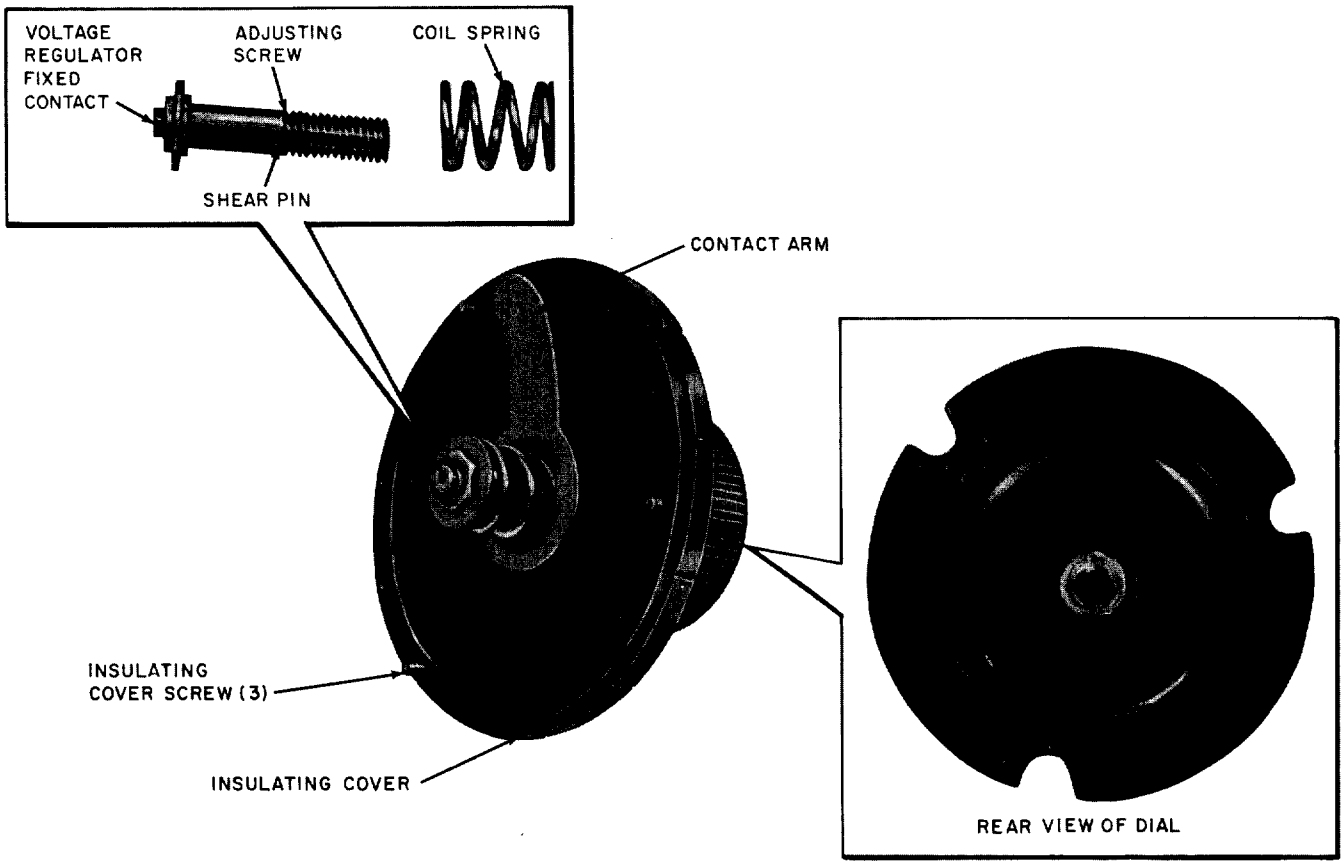


Fig. 6—Insulating Cover Assembly Details With Fixed Contact & Adjustable Mechanism

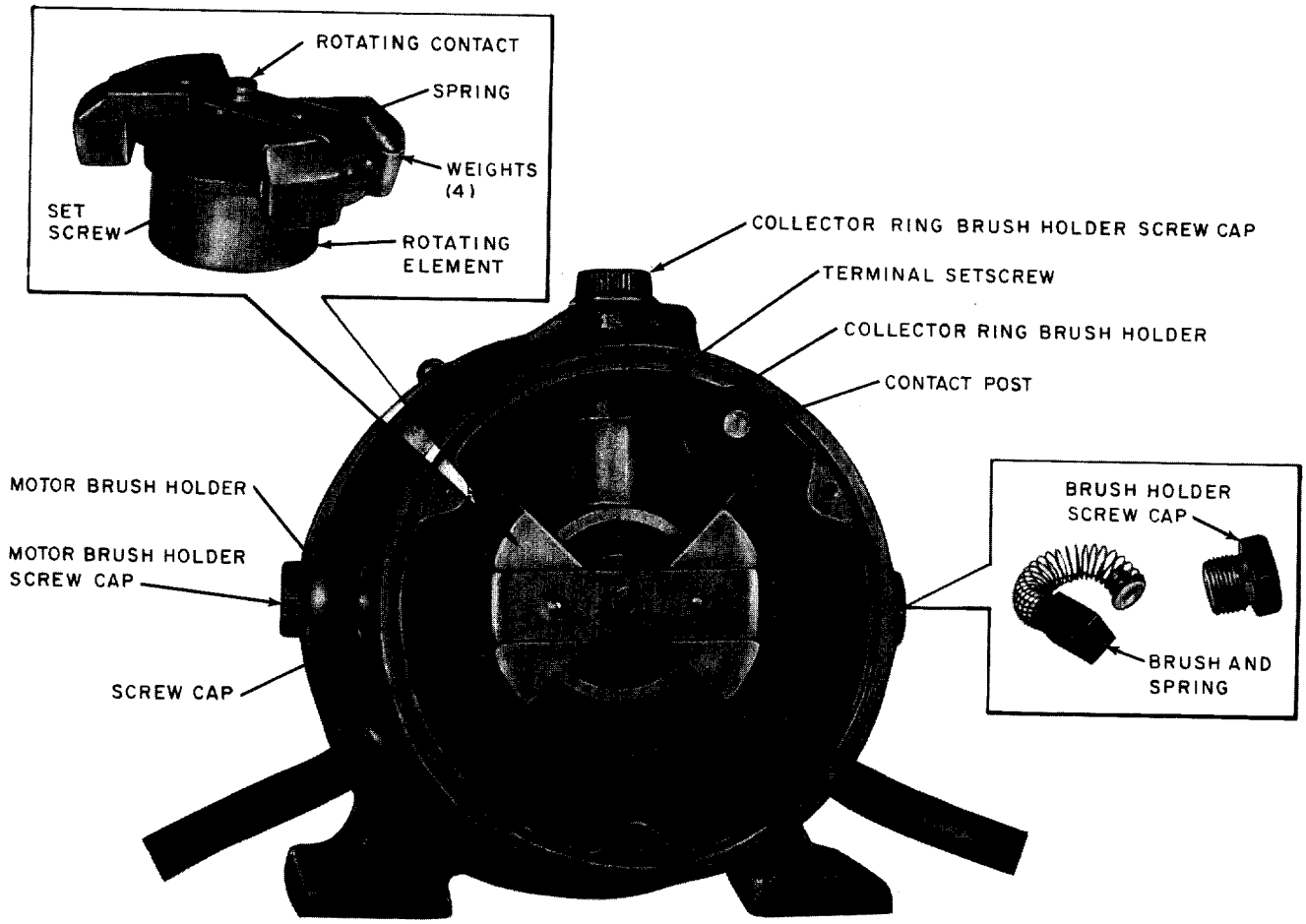


Fig. 7—Regulator Housing—Later Models

3. ADJUSTMENT PROCEDURES

3.001 *List of Tools, Gauges, and Materials*

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	10-Inch Hand Bellows
R-2969	6-Inch Typewriter-Type Brush
—	1-Pound Claw Hammer
AT-7860	B Long-Nose Pliers
—	Keeper for Magnetic Field (where required)
—	4-Inch E Screwdriver
R-1005	Jewelers Screwdriver
TOOLS (Cont)	
KS-6320	Orange Stick
309	Threaded-Stud
45B	5/16-Inch Hex. Single-End Socket Wrench
GAUGES	
Weston Model 528	AC Ammeter, Scale 0-10 Amperes
Weston Model 280	DC Ammeter, Scale 1.5-3-30 Amperes
Weston Model 622	AC-DC Thermocouple Voltmeter Scale 3/30/150/300-volts
KS-6909	Thickness Gauge Nest
Hasler Style A	Speed Indicator

GAUGES (Cont)	
R-8550	6-Inch Scale
R-1032	Thermometer, Detail 1 or 2, —5C to 150C
Weston Model 280	DC Voltmeter, Scale 150-60-3 with Multiplier 300 Volts
—	Indicator, Test, Universal Type L. S. Starrett Co. 196A (or Equivalent)

MATERIALS	DESCRIPTION
—	White Chalk
D-98063	Twill Jean Cleaning Cloth
195P	Andok C Grease
—	Felt Pad
—	4/0 Sandpaper
KS-7860	Petroleum Spirits
87698M	Carborundum Stone

#3.01 ***Lubrication*** (Reqt. 2.01)

(1) The bearings are packed with grease when shipped and should require no attention until the regular cleaning period.

Note: Grease plugs furnished on some of the early machines should not be removed.

(2) To clean and repack the motor bearings, remove the machine from service. Remove and immediately mark each brush so it may be put back in the same position in the same brush holder from which it was removed. Wipe all brushes with a cloth. Note position of dial with respect to regulator housing marking. Turn the dial if necessary until the screws are accessible. Remove the screws which hold the insulating cover to the motor frame. These screws should be loosened evenly so as to relieve the strain on the cover. With a piece of chalk, mark any screw hole on the insulating cover, and also a corresponding point on the motor frame and remove the cover.

Note: If the mark is erased the proper position of the insulating cover may be ascertained by aligning the contact arm with the contact post.

(3) Remove the screw cap on the side of the regulator housing, insert a jewelers screwdriver through this opening, loosen the setscrew which secures the rotating element to the motor shaft extension and remove the rotating element.

Machines With Inseparable Type Bearings

Note: Machines with inseparable type bearings may be distinguished by lack of the four bearing retainer screws. Where inseparable bearings are of the sealed type, do not attempt to relubricate but replace when noisy. Where inseparable bearings are of the unsealed type and access to the balls can be obtained, proceed as follows:

(4) To clean and repack a motor bearing, remove the bolts holding the end shield in place and pry the end shield off by inserting a screwdriver in the slots between the frame and end shield. Remove the armature from the end shield and frame and wipe with a cloth. Clean out of the bearings as much of the old grease as possible with an orange stick and clean cloth. Wipe as dry as possible with a clean dry cloth and relubricate. Before reassembling, wipe the bearing chamber ▶(Fig. 8)◀ with a cloth on which there is a small amount of grease. Apply fresh grease around the balls, filling the space between the inner and outer ball races flush with the sides of the races. Make no attempt to force grease into the spaces between the balls. Reassemble the armature and bearings in the frame.

(5) In replacing the rotating element of the regulator, care should be taken to see that the setscrew registers on the spot on the shaft provided for that purpose. Replace the insulating cover. Draw the screws up evenly so as to relieve any strain on the cover. Insert all brushes in their respective brush holders.

Machines With Separable Type Bearings

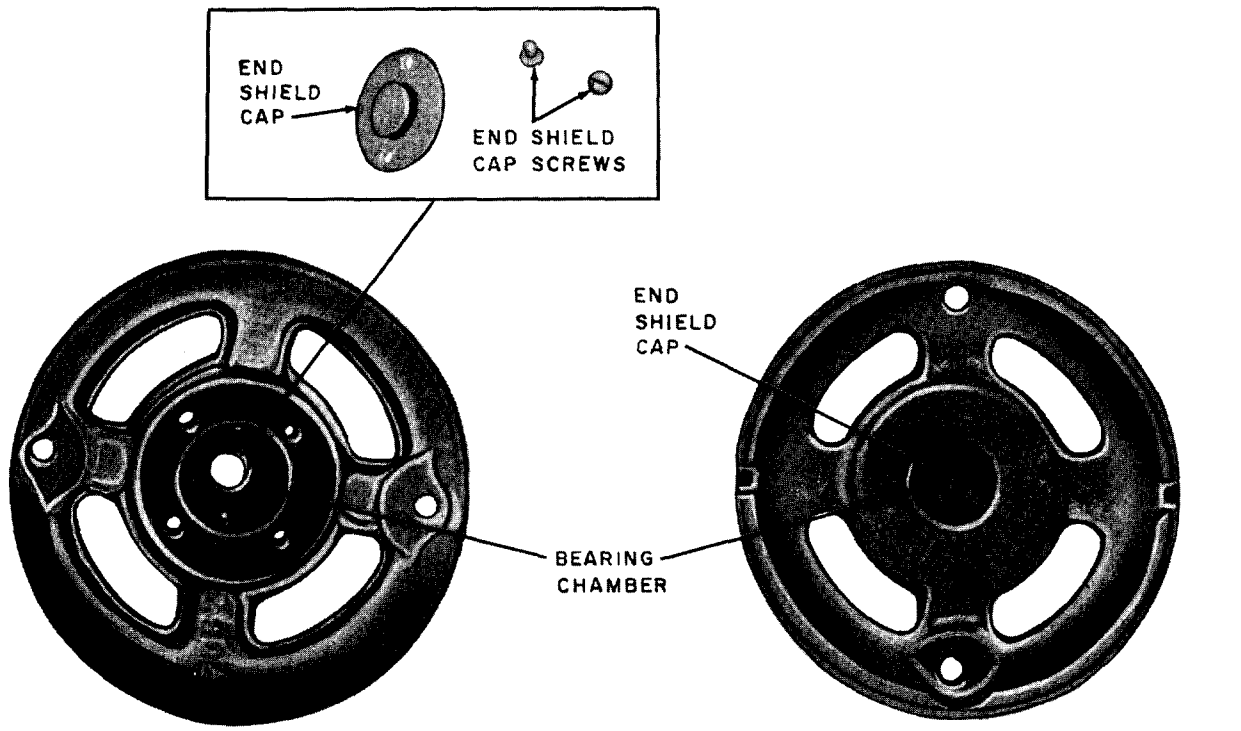
(6) Remove the screws from the bearing housings at both ends of the motor which secure the bearing retainers to the motor frame, being careful not to lose the lockwashers. In removing the armature, use may be made of a 309 tool to prevent the bearing retainer on the commuator end from turning so the round portion of the retainer binds against the motor brush holders.

This tool is a threaded stud which is introduced through one of the holes in the bearing housing on the commutator end and screwed into one of the holes of the bearing retainer. Remove the nuts or screws from the end shield on the end opposite the commutator using the No. 458 socket wrench for acorn nuts or a suitable wrench or screwdriver. Remove the end shield. If it sticks, pry it off by inserting a screwdriver in the small opening on the side between the frame and the end shield. The armature can now be removed from this end.

(7) On KS-5376-01 machines and all dc regulators having the permanent magnet type field, the armature should not be left out of the stator for any appreciable length of time without putting a keeper across the pole faces. Keepers are available on order if desired. However, a short piece of iron pipe, approximately the same diameter as the armature, slid into the space normally occupied by the armature, makes a satisfactory keeper.

(8) Remove the outer ball race, the small retaining ring which holds the felt washer and felt washer from the bearing housing on the commutator end which is part of the solid frame, and the outer ball race, spring retaining washer, thrust spring, the retaining ring which holds the felt washer, and the small felt washer from the end shield on the end opposite the commutator. Wipe off grease and clean the bearings with a clean cloth. Clean the bearing housings with a cloth moistened with petroleum spirits and dry thoroughly. If the grease is caked or sticks in the bearings or housings, it may be removed with an orange stick. Wipe the inner surfaces of the bearing housings with a cloth on which there is a small amount of grease.

(9) Place the balls and retainer on the inner ball race. Fill the spaces between the balls on the retainer with grease. Wipe all excess grease from the outer sides of the retainer with a cloth. Reassemble the parts in the reverse order from that in which they were taken down, making



END SHIELD FOR VOLTAGE REGULATORS WITH SEPARABLE TYPE BEARING

END SHIELD FOR VOLTAGE REGULATORS WITH INSEPARABLE TYPE BEARINGS

Fig. 8—End Shields—Two Types

certain that all associated parts are assembled in their same relative positions.

Caution: In replacing the regulator contacts, care should be taken to remove any finger marks by wiping the contact surfaces with a cloth moistened with petroleum spirits.

The bearing retainer screws may be replaced more readily if a 309 tool is used in reassembling the motor. Introduce the tool through one of the holes in the copper gasket and screw into one of the holes of the bearing retainer on the commutator end. In replacing the armature, this tool passes through one of the holes in the bearing housing provided for the bearing retainer screws and the four holes in each of the three parts (bearing housing, bearing retainer, and copper gasket) are brought into alignment. Three of the screws of the bearing retainer are then put in place and set nearly tight, after which the 309 tool is removed and the fourth screw replaced. In replacing the end shield, the 309 tool is introduced into one of the holes in the opposite bearing retainer and slid through one of the holes in the end shield. Insert the bearing retainer screws in the same manner as described above. Screw on the holding nuts. All screws and nuts should then be securely tightened. Push the shaft inward toward the end opposite the commutator and make certain the thrust spring returns the shaft to its original position when the pressure is released.

(10) Replace the rotating element of the regulator as in Step (5).

#3.02** ***Speed and Rotation (Reqt. 2.02)

To check the speed of the voltage regulator, adjust the regulator dial to give normal operating voltage on the associated generator. Remove the screw cap in the end shield on the end opposite the dial (where provided). Insert a Hasler speed indicator lightly against the end of the shaft and read the speed. Be sure the pressure of the indicator against the shaft does not affect the operating voltage. The rubber tip on the speed indicator should be chalked before inserting the indicator to prevent slipping. If the speed is not within the limits specified and a resistance unit is provided, check the serial number on the resistance unit. This should have the same serial number as the associated regulator motor. If the correct unit cannot be located, replace the regulator. If a wound field with a ballast lamp is used, check the ballast lamp as outlined in 3.03 (3). Allow the regulator to run for an hour and remeasure the speed. If after these checks the speed of the regulator is incorrect, the regulator should be replaced.

3.03 ***Voltage*** (Reqt. 2.03)

(1) To decrease the generator voltage turn the regulator dial in a clockwise direction. To increase the generator voltage, turn the regulator dial in a counterclockwise direction. The normal wear of the contacts causes a gradual decrease in the voltage of the associated regulated generator.

(2) With the machine operating at or near full load, disconnect the load and observe that the voltage does not rise more than specified.

(3) If the generator voltage is outside the specified limits, proceed as follows: Check to see that the generator field rheostat is in its marked position (see 3.20); check the generator for proper commutation and operation as outlined in the section covering that particular apparatus; check regulator terminals (arm—and arm+) for correct voltage. If there is no voltage at regulator terminals, check for blown fuse in armature circuit of the regulator. Check requirements 2.04 to 2.16 inclusive. When a ballast lamp is used, check with an ammeter and a voltmeter to see that the filament current is approximately 1/2 ampere, and that the drop in potential across the lamp terminals is minimum 3.0 volts, maximum 10.0 volts. If the voltage requirement is met but the filament current is not, substitute a new ballast lamp and remeasure the filament current after the lamp has heated for five minutes. If there is no current, the series resistance may be open. If the voltage drop is not within limits, replace the ballast lamp. If, after the above check, the generator voltage is still outside the limits, replace the voltage regulator.

(4) When the 100 mark on the dial coincides with the mark on the frame, it will be necessary to reset the insulated cover. To do this proceed as follows: Disconnect or stop the regulator and if necessary, its associated generator. Without removing the insulating cover, rotate

the dial (counting the turns) counterclockwise (at the same time bearing down lightly on the dial in the direction of the cover) until a distinct "click" is heard, this requiring several complete revolutions of the dial. As soon as the "click" is heard, turn the dial in a clockwise direction the same number of turns as was made in the counterclockwise direction. With the regulator operating, adjust the dial to obtain the desired regulation. The stud on which the dial is screwed has a triple thread, therefore each "click" represents shifting the position of the dial 120 degrees with respect to the cover and contact arm.

Note: As a matter of record, very old regulators were adjusted by setting the dial so the 95 mark coincided with the mark on the frame; removing the cover without disturbing this dial setting; moving the contact arm, in a counterclockwise direction facing the dial, to the hole corresponding with the 50 mark on the dial; and replacing the cover so the 55 mark on the dial coincides with the mark on the frame.

(5) Other voltage adjustments made as part of Percent Contact Operation will be found under 3.20.

#3.04 ***Bearings*** (Reqt. 2.04)

Replace any worn bearings.

#3.05 ***End Play*** (Reqt. 2.05)

Remove the insulating cover as outlined in procedure 3.01 (2). Press against the end of the shaft on the commutator end and see that the thrust spring in the opposite end shield works freely and returns the armature to its original position when the pressure is released. If the spring does not return the armature, examine for binding or replace the thrust spring.

Caution: See that the screws that secure the end shield cap on the end opposite the commutator do not project through the housing and strike the retaining ring which holds the felt washer. Screws which are too long will materially lessen or even prohibit any end thrust.

3.06 ***Freedom of Rotating Parts*** (Reqt. 2.06)

If binding is present, examine the motor and remove any foreign matter. Also check to see that all bolts and screws are tight. Binding may be due to the fixed regulator contact being screwed in too far against the rotating regulator contact. Check 2.04, 2.09, 2.12, and 2.16.

#3.07 ***Air-Gap*** (Reqt. 2.07)

With the armature in any position, measure the air-gap between the armature and each pole-face with a feeler gauge. Remove the feeler gauge, rotate the armature slightly and repeat. Checks should be made with the armature in at least four different positions. Particular care should be taken in measuring the air-gap between the armature and the pole-faces mounted in the lower half of the motor frame, as this is where the bearing wear will be most noticeable. If the air-gap is too small new bearings should be installed.

#3.08 ***Brush Holders*** (Reqt. 2.08)

(1) To adjust the brush holder on the collector ring, remove the insulating cover as outlined in 3.01 (2). With a screwdriver, loosen the setscrew which secures the brush holder in the motor frame. Move the brush holder in or out to give the proper clearance. In shifting a brush holder, see that two sides of the square hole in the brush holder remain parallel to the axis of the motor shaft. Tighten the setscrew after an adjustment has been made.

(2) To measure the distance between the commutator and brush holder, insert a small wire with a slight lip on the end against the commutator in place of the brush. The clearance of the brush holder is the thickness of the lip plus the distance the lip can move between the commutator and the inner end of the brush holder.

(3) To adjust a motor brush holder, insert a screwdriver in the hole in the motor frame on the dial end. Loosen the setscrew which secures the brush holder in the motor frame and move the brush holder in or out to give the proper clearance. In shifting a brush holder, see that two sides of the square hole in the brush holder remain parallel to the commutator bars. Tighten the setscrew. Reassemble the motor.

3.09 ***Brush Length*** (Reqt. 2.09)

Renew all brushes which are too short.

3.10 ***Brush Fit*** (Reqt. 2.10)

(1) If a brush binds, remove the brush from its holder and clean the brush and brush holder with a cloth. Any rough projection may be removed with sandpaper before wiping.

(2) In replacing the brushes, see that they are put back in the same holder and in the same position in which they were originally. Be careful the pigtail does not protrude between the coils of the spring and catch on the threads in the brush holder preventing the brush from seating properly. Tighten the brush-holder screw cap firmly with a screwdriver. Brushes which are too loose in their holders shall be replaced by new brushes.

3.11 ***Brush Pressure*** (Reqt. 2.11)

Usually a shortened spring is the result of a twisted pigtail and the desired spring extension may be obtained by untwisting the copper pigtail.

#3.12** ***Commutator and Collector Ring Surfaces (Reqt. 2.12)

(1) The commutator may be cleaned of dust by directing air through one of the brush holders with the brush removed, at the same time turning the armature slowly by hand. If necessary, dismantle the machine as outlined in 3.01 and clean the commutator with a clean cloth.

(2) If the commutator surface becomes sufficiently roughened or pitted to cause poor commutation, it will be necessary to remove the armature as outlined in 3.01 (4) or (6) and reface the commutator in a lathe. The minimum diameter to which a commutator can safely be turned is 29/32 inch.

(3) The collector ring may be cleaned by blowing out the accumulated dust or wiping with a clean cloth after removing the insulating cover. If the collector ring is rough, remove the collector ring as outlined in 3.01, and polish in a lathe with sandpaper or heavy duck canvas. The ring can safely be turned down only to a minimum diameter of 1.04 inches.

#3.13** ***Commutation (Reqt. 2.13)

If the commutation is not satisfactory, see that the brushes are of the latest type as specified in the section on Brush Replacement. If the brush is of the proper type, check requirements 2.03 to 2.12.

3.14** ***Polarity of Rotating Contact (Reqt. 2.14)

The polarity of the rotating contact should be checked with the contacts open and the generator operating. Connect the negative terminal of a dc voltmeter under the brush holder cap and connect the other voltmeter terminal to the positive side of rheostat R1 at the most convenient point. (The positive side of the rheostat may be determined from inspection of the circuit or by connecting a voltmeter across the rheostat.) If the voltmeter has a positive reading, the polarity is correct.

#3.15** ***Length of Contacts (Reqt. 2.15)

On machines of older design, if the rotating contact is too short, replace the rotating element assembly. A new replaceable rotating contact can be installed at the factory. This is practicable only if the diameter of the slip ring is more than 1.11 inches. On machines of later design, both contacts can be replaced in the field. See Section 024-462-801. If a contact is less than the specified length, replace it.

#3.16** ***Contact Surfaces (Reqt. 2.16)

To clean the contacts remove the insulating cover as outlined in procedure 3.01 (2). Clean by wiping with a clean cloth wet with petroleum spirits. If the rotating contact is pitted, the burrs should be removed by using a medium carborundum stone held against the contact while the machine is running. The burrs on the fixed contact may be removed by holding the insulating cover in one hand and the carborundum stone in the other. Rotate the stone between the fingers exerting a slight pressure against the contact. Make certain the holes in the center of the contacts are clean and free from dirt.

Caution: Be sure and remove any finger marks by wiping the contacts with a clean cloth moistened with petroleum spirits.

#**3.16.1** ***Eccentricity of Movable Contact*** (Reqt. 2.16.1)

If eccentricity of contact exceeds 0.010 for KS-5293-type or 0.015 for KS-5376-type, then replace contact or rotating element. If replacement does not meet requirement, refer matter to supervisor.

3.17 ***Noise and Vibration*** (Reqt. 2.17)

See that all bolts, nuts, and screws are tight. Examine for chattering brushes. If the noise and vibration continues, the trouble is probably due to worn bearings which should be replaced or the matter referred to the supervisor.

*#**3.18** ***Temperature*** (Reqt. 2.18)

The temperature of any part of the machine should be measured by a thermometer. With the machine running, hold the bulb of the thermometer as near as possible to the part. Cover that part of the bulb which does not make contact with a piece of felt. Observe the maximum temperature reading. If the temperature exceeds the specified limits, see that requirements 2.01 to 2.13 are met.

#**3.19** ***Ballast Lamp*** (Reqt. 2.19)

Replace a defective ballast lamp. In replacing the lamp, make sure an 8A ballast lamp is inserted and not an 8A resistor lamp. The code number is etched on the bulb. Sealed in the bulb there is a paper strip marked, "Ballast Lamp—Western Electric—U.S.A."

3.20 ***Percent Contact Operation*** (Reqt. 2.20)

General

(1) The percent contact operation equals the current read on the ammeter in the regulator circuit (Ammeter 2 in Fig. 9) divided by that read on the ammeter in the generator field circuit (Ammeter 1 in Fig. 9) times 100.

(2) All adjustments under percent contact operation should be with the machine cold, that is with not more than five minutes of operation out of each half hour.

(3) The addition of a regulator to an existing charging generator other than a 75-ampere, 33-volt machine requires substitution of a special rheostat. The testing and adjustment of this new rheostat is covered separately below.

(4) The addition of a regulator to an existing 75-ampere, 33-volt machine can usually be made using the same generator field rheostat as used for manual regulation. The rheostat marking however may have to be changed.

Note: When a regulator is added to an existing installation, the overload feature must be removed from the circuit breaker and the reverse current feature checked and readjusted if necessary.

(5) During normal operation, some ac machines in offices having a large PBX ringing load, may require additional adjustment of the field rheostat (R_1 of Fig. 9) to stay within the voltage requirements under actual load conditions after turnover.

(6) Loading of dc generators, if permitted by the supervisor, may be obtained by discharging the battery with normal office load where practical until the voltage of the battery approaches minimum circuit limits. Use emergency cells where feasible to permit the battery to be discharged further and yet maintain the necessary voltage limits at the fuse panel. Where the office load is not sufficient to reduce the battery voltage in a reasonable time or when such discharge is not permitted, an artifical load may be necessary. For information on artifical loads, see the section on test loads for power equipment.

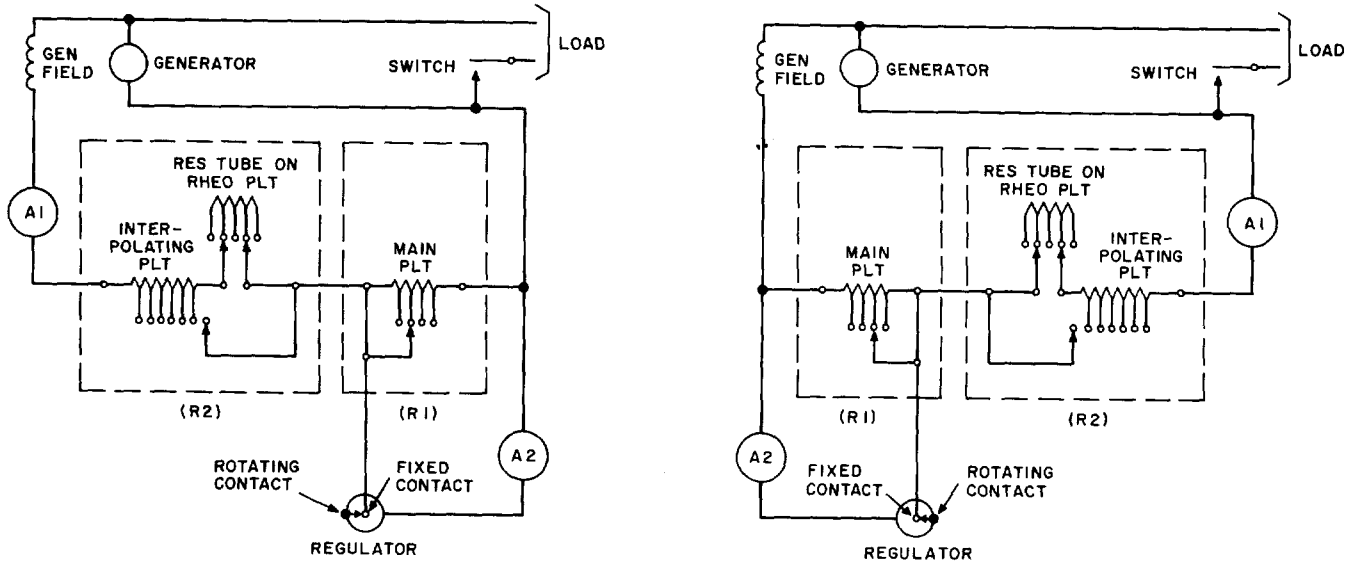


Fig. 9—Schematic Connections for Calculations Percent Contact Current

(7) Loading of ac machines is obtained by artifical load of suitable capacity to give current values as shown in the table below. Load on the ac side of the generator should be connected on the same tap of the transformer that the regulator is controlling. The coin control load (dc load) should be connected from +c.c. to ground and from −c.c. to ground (ground being tap 2 on KS-5396-01 transformers). Each side should be loaded equally.

(8) Proper regulator adjustment should be obtained readily with generators designed for use with regulators but difficulties may be experienced with generators whose inherent regulation exceeds 50 to 60 percent. Inherent regulation equals no-load voltage minus full-load voltage divided by full-load voltage without changing the generator field rheostat. Excessive contact wear will result if the percent contact operation is higher than necessary to secure regulation for the particular conditions at the installation.

(9) When local conditions are such that the generator to be regulated will not be required

KS	TRANSFORMER TAP	GENERATOR	AC LOAD AMPERES	DC AMPERES +C.C.	DC AMPERES −C.C.
5396-01	4 & 8	BY-107	1.50	0.25	0.25
	or	BY-108	3.50	0.38	0.38
	4 & 7	BY-109	6.50	0.50	0.50
	4 & 6	BY-107	1.75	0.25	0.25
	or	BY-108	4.50	0.38	0.38
	4 & 5	BY-109	8.50	0.50	0.50
5396-02	4, 4A or	BY-108	2.00	0.25	0.25
	4B & 5	BY-109	4.00	0.38	0.38
		BY-144	6.00	0.50	0.50
5133-01	3 & 7		0.47		
	3 & 6		0.50		
	3 & 5 or		0.60		
	1 & 2				
	3 & 4		0.60		

to deliver full rated ampere load, increased life of the regulator contacts will be secured if in the following adjustments, the term "full-ampere load" is taken as the maximum amperes which will be delivered in normal service. For dc generators, the adjustments should be made for the floating voltage of associated battery and no attempt should be made to try to cover both floating and charging conditions with a single setting of the generator field rheostats.

(10) Disconnect the regulator (both armature and contact circuits) from its associated generator. This may usually be accomplished for dc generators by throwing the regulator switch to the OFF position or for ac generators by removing the collector ring brush and the fuse in the regulator transformer circuit.

(11) Insert ammeters in series with the generator field and regulator contact leads as shown schematically in Fig. 9. In general, these ammeters should have a full-scale reading of approximately 2 percent of the full-ampere rating of the associated dc generator, and of about 1-1/2 amperes for ac machines.

DC Machines

(12) With the regulator disconnected, after first discharging the battery or otherwise obtaining a load as outlined in (6), adjust the field rheostats as required to maintain full ampere load on the generator until the normal operating voltage to be regulated is obtained. Without changing the field rheostat settings, disconnect the generator from its load and observe the no-load voltage. In the event that the power-board meter scale is inadequate to read this higher voltage, a dc portable voltmeter capable of reading 2-1/2 times the normal regulated voltage should be connected across the generator brushes.

(13) With the generator carrying no load and the arm of the interpolating plate R_2 in the resistance ALL IN position, short circuit the main plate of the rheostat R_1 and adjust the tapped resistor associated with the interpolating plate until the generator voltage is 1.25 to 1.35 times the no-load voltage observed in Step (12). For generators with high inherent regulation, this may be excessive and a lower voltage may be used provided the other requirements can be met. Make R_1 resistance as small as possible and still meet the percent contact in order to reduce the voltage on the contacts and secure longer life. With 75 ampere generators, no tapped resistor is usually provided and the interpolating rheostat is put in the resistance ALL IN position.

(14) With the generator carrying no load and with the tapped resistor associated with the interpolating rheostat R_2 set as outlined in Step (13), remove the short circuit around the main plate and adjust the main plate until the generator voltage is as near as possible to but does not exceed 99 percent of normal operating voltage. This setting should be made with decreasing rather than increasing voltage. This is accomplished by turning the main plate of the rheostat to the ALL OUT position and then gradually cutting in resistance until the desired value of voltage is obtained. Reconnect the regulator and adjust the regulator dial to secure the normal operating voltage.

AC Machines

(15) Disconnect the regulator armature and contact circuits from its associated generator. After at least an hour run, with the generator carrying full load, short circuit the main plate R_1 of the rheostat. Adjust the interpolating plate R_2 to give approximately 1.25 times the normal operating ac voltage to be regulated on that tap.

(16) With the above setting of the interpolating plate, remove the load and remove the short circuit around the main plate and adjust the main plate until the generator ac voltage is as near as possible but does not exceed 99 percent of normal operating voltage. This setting should be made with decreasing rather than increasing voltage. This is accomplished by turning the main plate of the rheostat to the ALL OUT position and then gradually cutting in resistance until the desired value of voltage is obtained. Reconnect the regulator and adjust the voltage to about two volts below the maximum permitted for the circuit.

All Machines

(17) In the following checks, be sure that both the ac and dc voltages are within the operating limits for all loads and temperatures.

(18) Read the generator no-load field amperes and the regulator contact amperes.

(19) If the no-load percent contact operation is outside the limits, attempt to get it inside by operating the dial disregarding the voltage momentarily.

(20) When the no-load percent contact operation is satisfactory, see that the voltage is still at the normal operating voltage. Adjust if necessary, with the main plate of the generator field rheostat R_1 of Fig. 9. If high, bring to about 14 percent, if low to about 3 percent and recheck the percent contact and voltage with the machine cold.

(21) When the no-load percent contact operation and voltage are satisfactory, proceed with the full-load test. Connect the discharged battery or artificial load to the regulated machine. When a discharged battery is first connected, initial current will probably exceed the full-load current rating of the generator but will gradually decrease. With the output current at full load for the machine, read the generator field amperes and regulator contact amperes.

(22) If the full-load percent contact operation is outside the specified limits, change the interpolating plate R_2 or preferably, where provided, the taps on the tapped resistor associated with the interpolating plate, reducing the resistance until 70 percent or less contact operation is secured. Maximum contact life is expected with the full-load circuit operation about 30-40 percent with the generator cold. This usually results in contact operation about 50-60 percent when the generator is hot. The adjustments made with the generator cold should be checked with it hot and, if changes are made, rechecked when cold again. More than 70 percent contact operation will cause excessive contact wear.

(23) When the percent contact operation is satisfactory, see that the voltage is at the normal operating voltage or can be brought to it by operation of the regulator dial.

(24) If an adjustment has been made on the interpolating plate or on the tapped resistor after checking the full-load contact operation, recheck the no-load percent contact operation and readjust if necessary.

(25) When a satisfactory setting of the generator field rheostats has been secured, the positions of the contact arms should be painted on the plates and the positions of any handwheel pointers on the front of the panel should be marked. Locking or clamping devices on rheostats, where provided, should be tightened.