

## VOLTAGE REGULATOR

### CENTRIFUGAL TYPE—AUTOMATIC

### REPLACEMENT PARTS AND PROCEDURES

#### 1. GENERAL

**1.01** This section covers the information necessary for ordering parts to be used in the maintenance of KS-5293- and KS-5376-Type centrifugal automatic voltage regulators. It also covers approved procedures for replacing these parts.

**1.02** This section is reissued to include information contained in the addendum and to update it with information on piece-parts and other changes made since the section was last issued.

**1.03** Part 2 of this section covers the various parts which may be replaced in the field in the maintenance of this equipment. Aside from screws, nuts, bolts and other small parts which can be obtained locally, the parts not designated herein are of a character which should ordinarily not be replaced by the regular maintenance forces. Part 2 also contains explanatory figures showing the different parts. This information is called Replacement Parts.

**1.04** Part 3 of this section covers the approved procedures for the replacement of parts listed under Part 2. This information is called Replacement Procedures.

**1.05** The only voltage regulators available on order are the KS-5293-02 L3, a dc regulator, and the KS-5376-01 L11, an ac regulator.

**1.06** Both ac and dc voltage regulator models whose serial numbers terminate with the letter "A" are equipped with inseparable type bearings. Older models whose serial numbers do not end with the letter "A" are equipped with separable-type bearings.

**1.07** The separable-type bearing, G. E. Co. Cat. #3512104 is no longer available from G. E. Co. An exact duplicate of this bearing may be obtained from the Barden Corporation, Danbury, Conn. Cat. #E8T.

**1.08** The Inside Bearing Plate Felt Washer, G. E. Co. Cat. 2075274 is no longer available from G. E. Co. When this washer needs replaced, 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.

#### 2. REPLACEMENT PARTS

**2.01** The figures included in this part show the various replacement parts in their proper relation to other parts of the apparatus with their corresponding names.

**2.02** When ordering replacement parts, give the name of the part as shown in the figures of this section and the complete nameplate data of the machine, including the serial and KS number. When parts used at both the commutator end and the end opposite the commutator have the same name, the end of the machine on which the part is to be used should also be given; for example, one inseparable bearing for commutator end of the voltage regulator having the following nameplate data: a-c, voltage regulator model NO. 5BY9B4A; type BY; volts 78-108; No. JFC33, KS-5376-01 L11.

**2.03** The following index lists the figures on which ordering information for all replaceable parts is shown. References are also given to the replacement procedures of parts covered in Part 3 of this section.

INDEX		
PART	ORDERING INFORMATION (FIG. NO.)	REPLACEMENT PROCEDURE (COVERED IN PART 3)
<b>BRUSH</b>		3.01
Motor brush	9	
Collector ring brush	9	
Brush holder screw cap	1,9	
<b>BRUSH HOLDERS</b>		3.02
Motor brush holder	9	
Collector ring brush holder	9	
<b>SPEED REGULATOR</b>	1,6,7,8,9	3.03
Insulating cover and associated parts	1.67	
Fixed speed regulator contact	1,9	
Rotating element	7.89	
<b>MACHINE BEARINGS</b>		
Inseparable type	2,5	3.04
Separable type and associated parts	2,4	3.05
End shield	3	3.05
<b>ARMATURE</b>	4,5	3.06
<b>RESISTANCE UNIT</b>	10	3.07
<b>BALLAST LAMP</b>	10	3.08
<b>MOTOR FIELD</b>	11	3.09

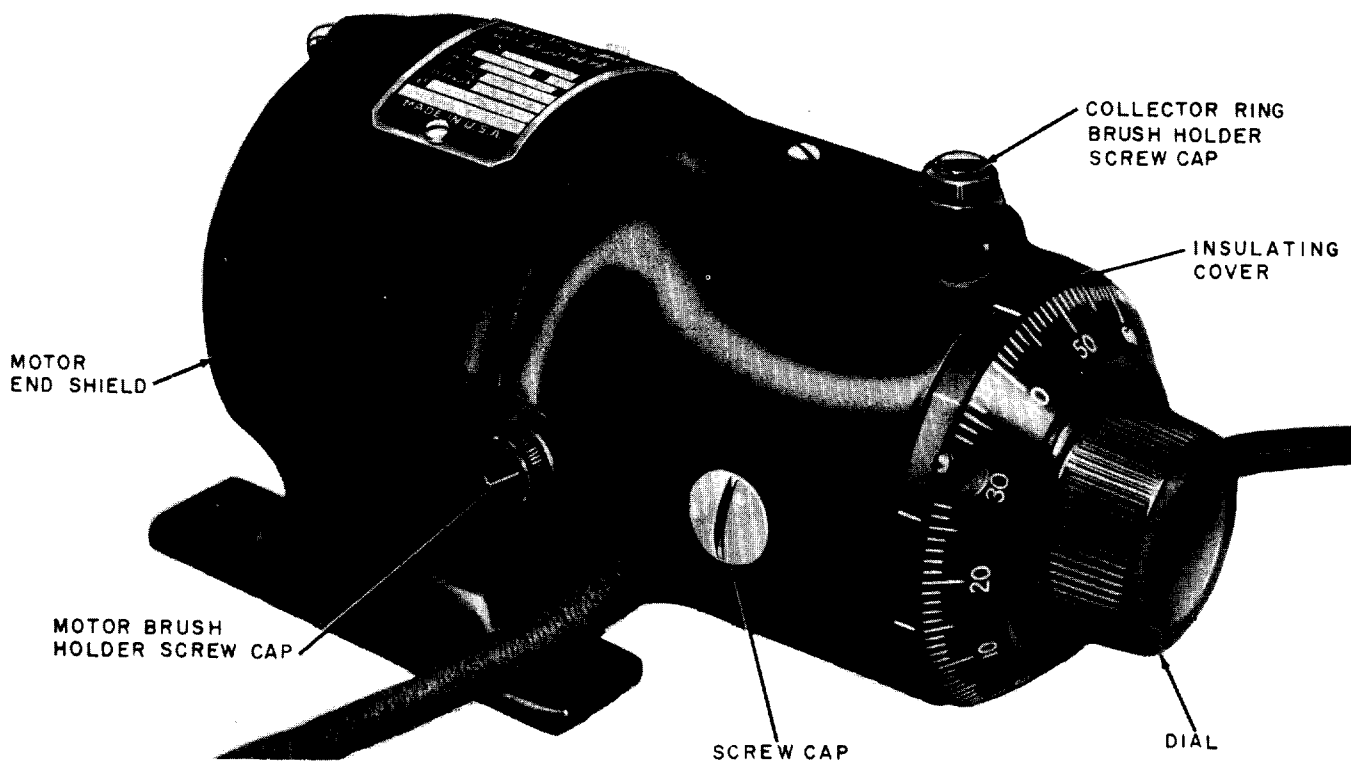
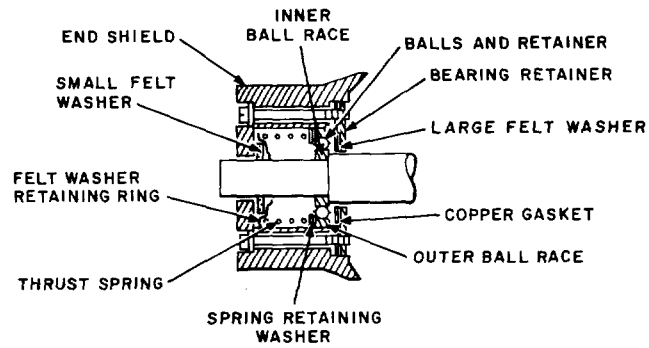
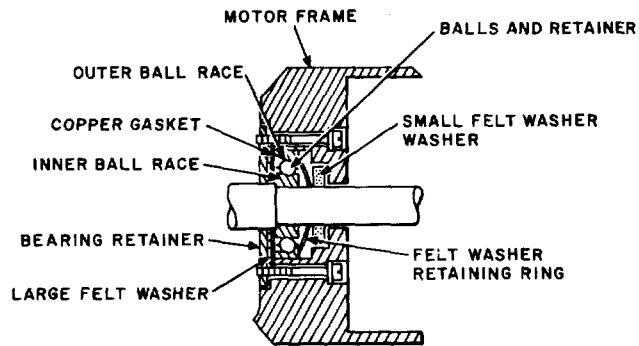


Fig. 1—General Assembly

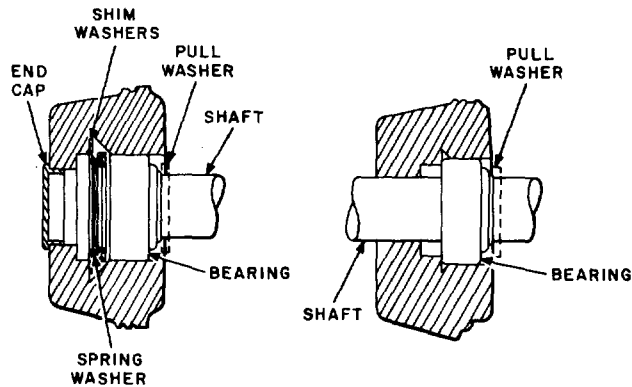


END OPPOSITE COUPLING



COMMUTATOR END

SEPARABLE SEALED TYPE BEARINGS



END OPPOSITE COUPLING

COMMUTATOR END

INSEPARABLE SEALED TYPE BEARINGS

Fig. 2—Bearing Assemblies—Separable and Inseparable

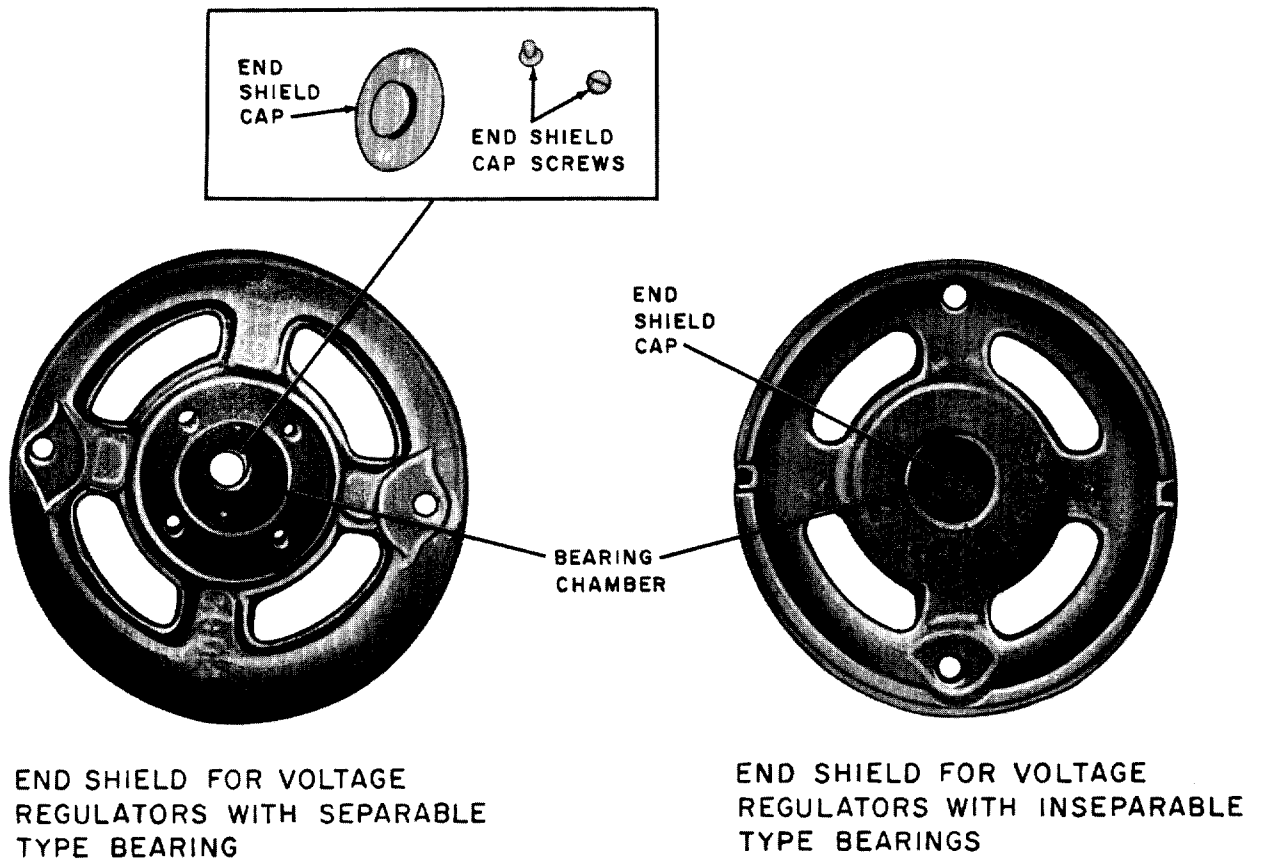
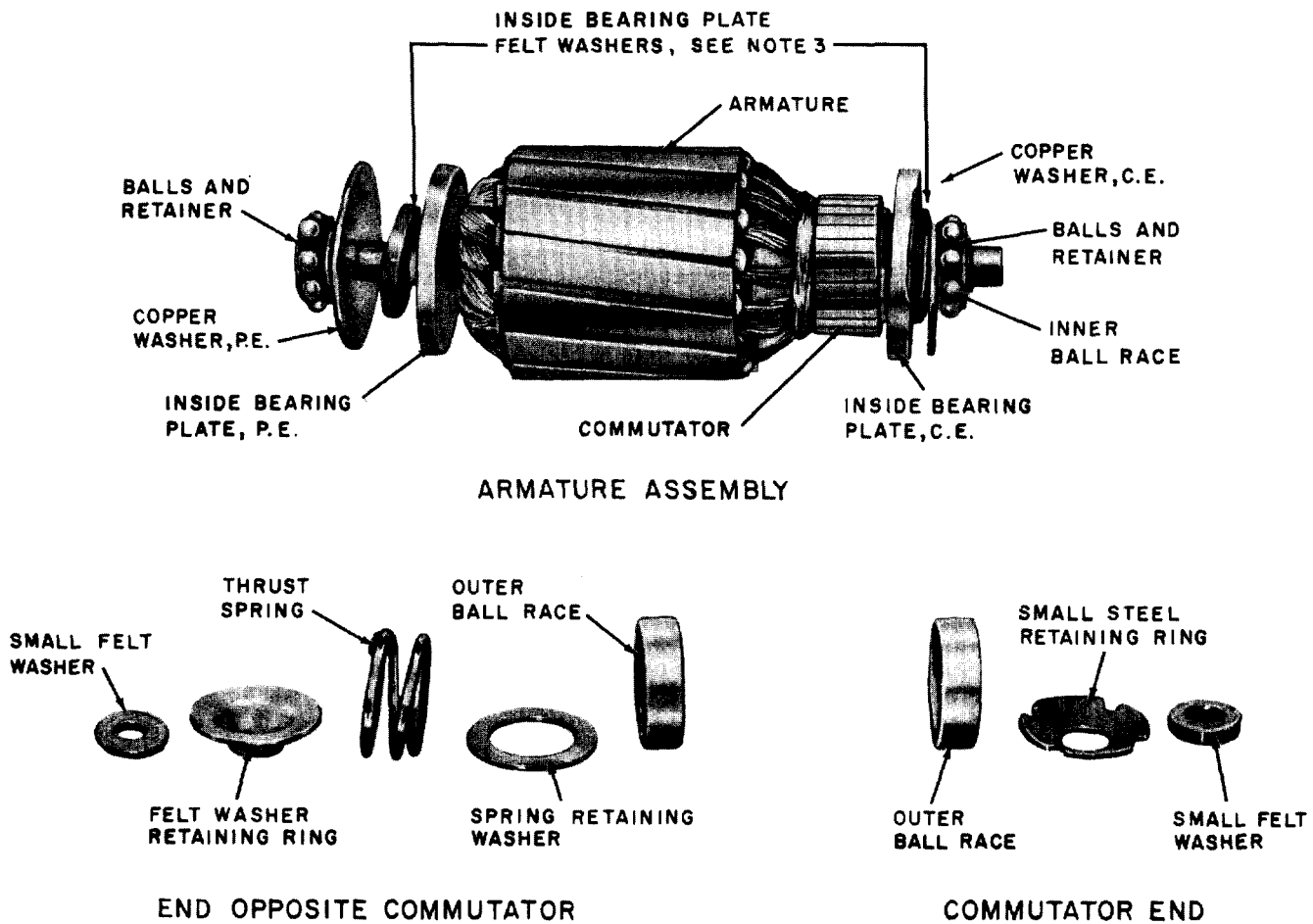


Fig. 3—End Shields—Two Types



**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 from G. E. Co. When this washer needs replacing, it must be made up locally from 1/8-inch thick felt, cut to 15/16-inch O.D. and having a 3/8-inch I.D.

**Fig. 4—Armature and Separable Bearing Details**

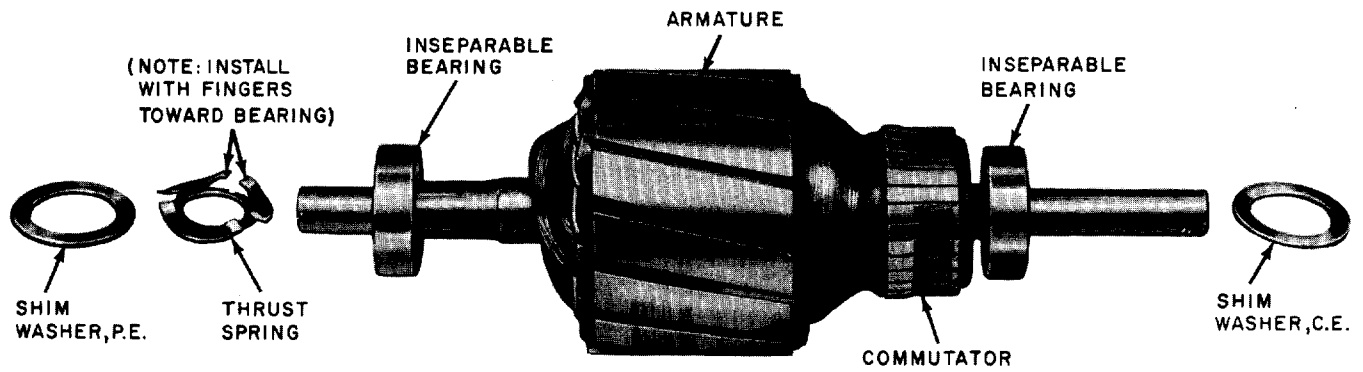


Fig. 5—Armature and Inseparable Bearing Details

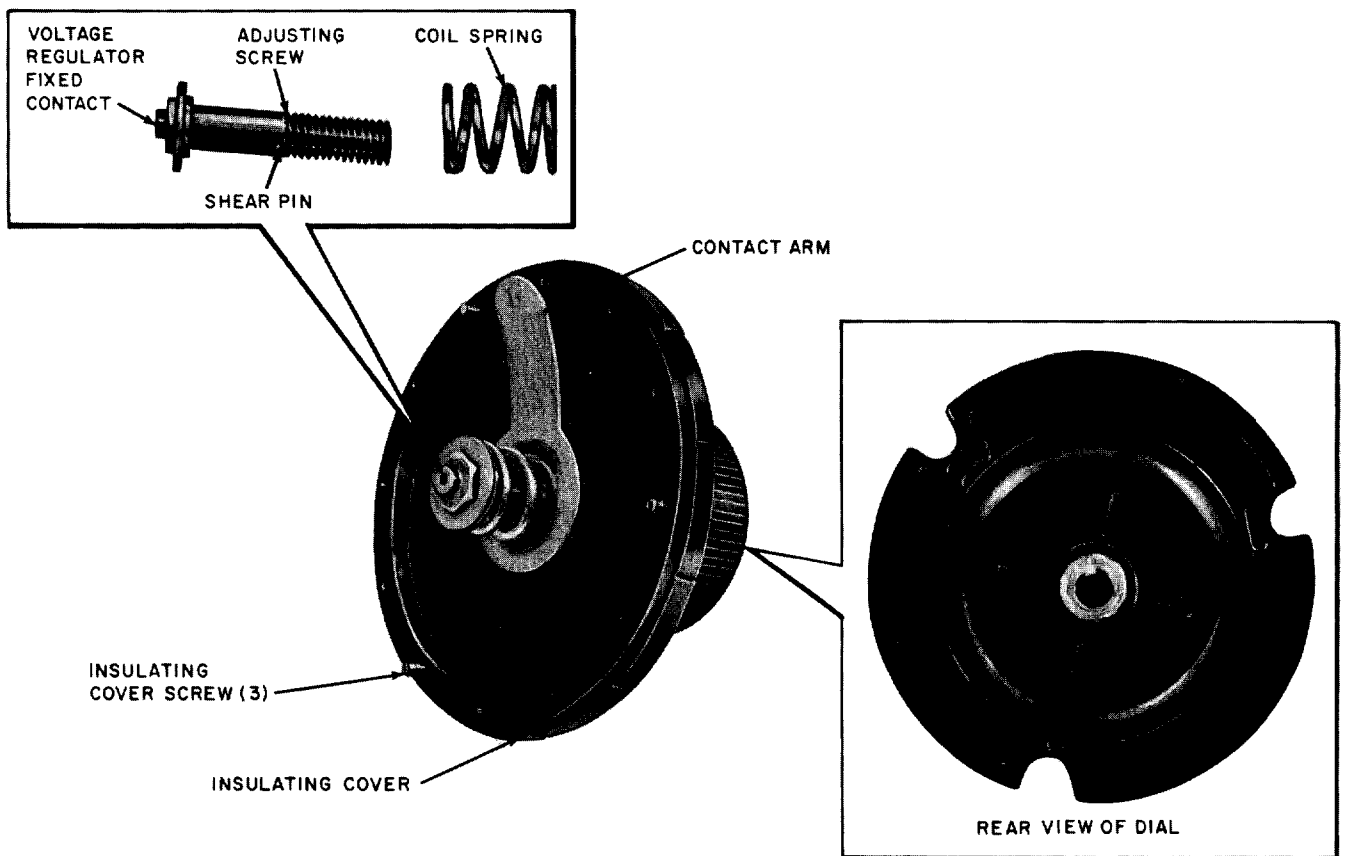
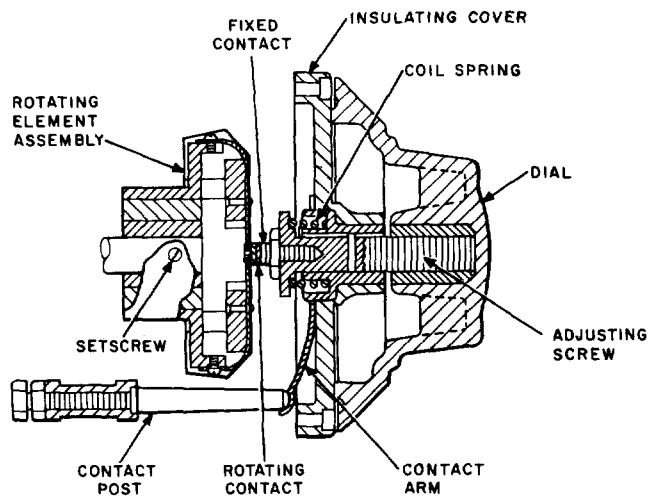


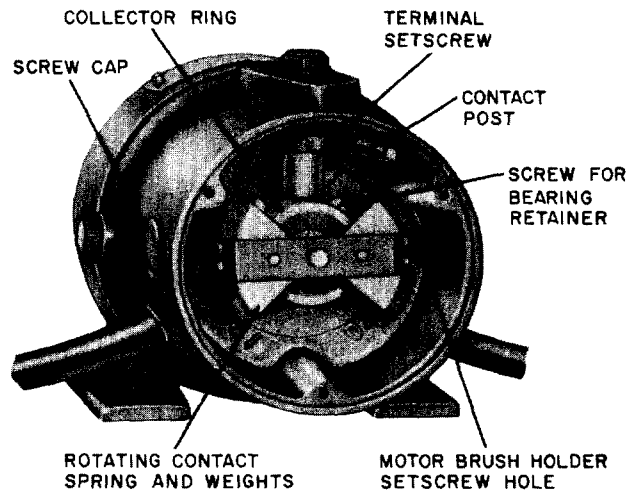
Fig. 6—Insulating Cover Assembly Details With Fixed Contact and Adjusting Mechanism



TPA 485995

**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 unless the contacts are of the replaceable type. If either contact is worn, replace both rotating and fixed contacts.

**Fig. 7—Voltage Regulating Unit Assembly**



**Fig. 8—Regulator Housing—Earlier Models**



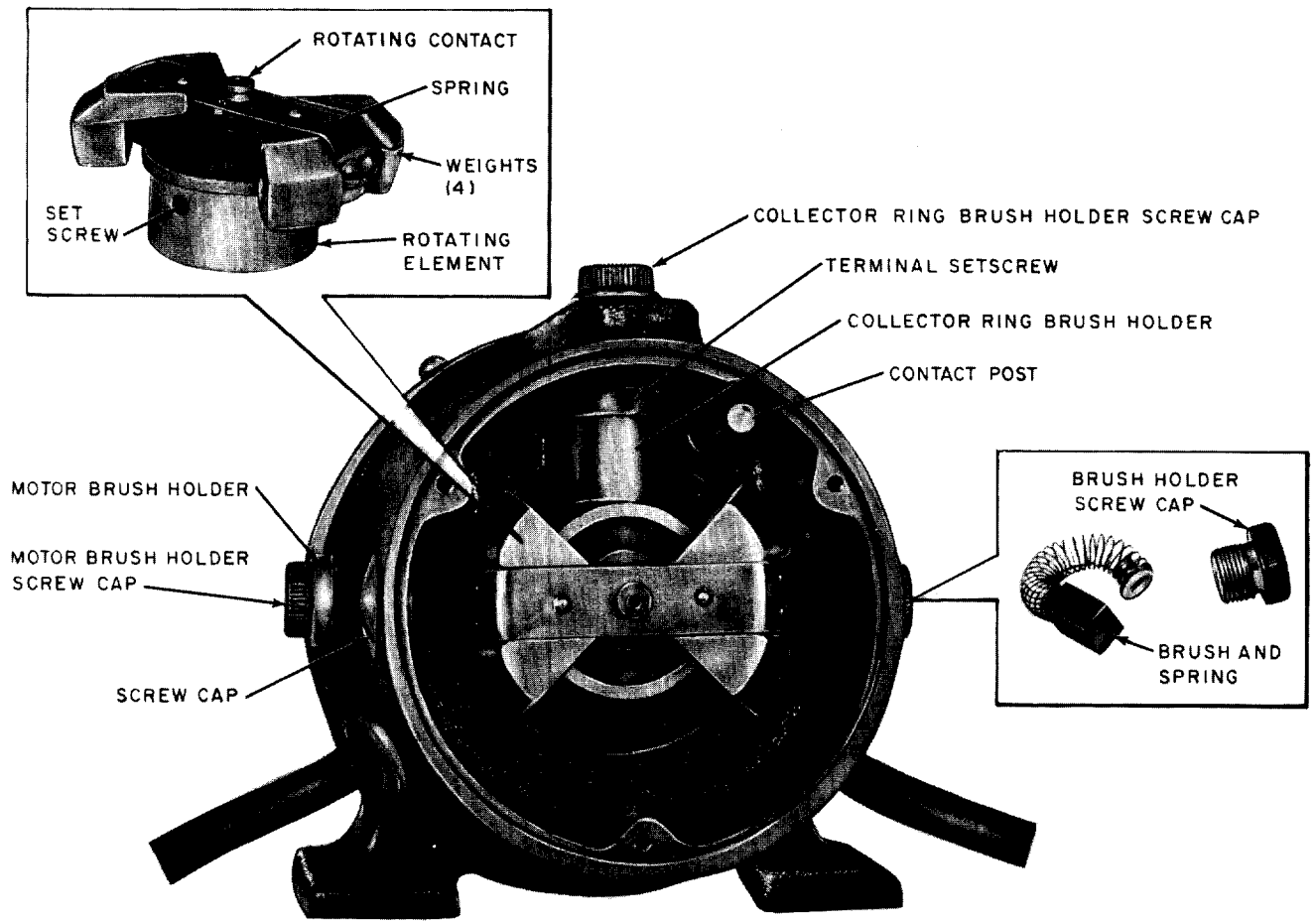


Fig. 9—Regulator Housing—Later Models

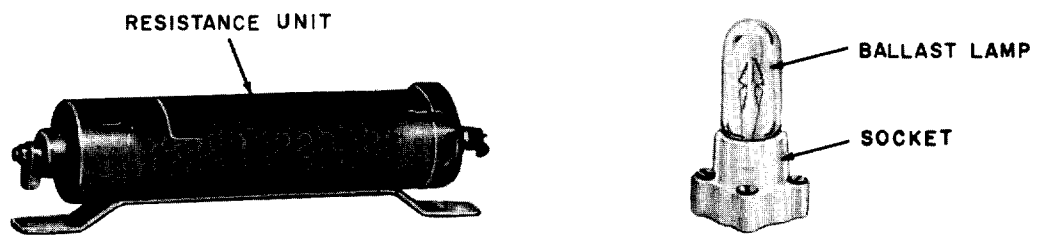


Fig. 10—Resistance Unit and Ballast Lamp

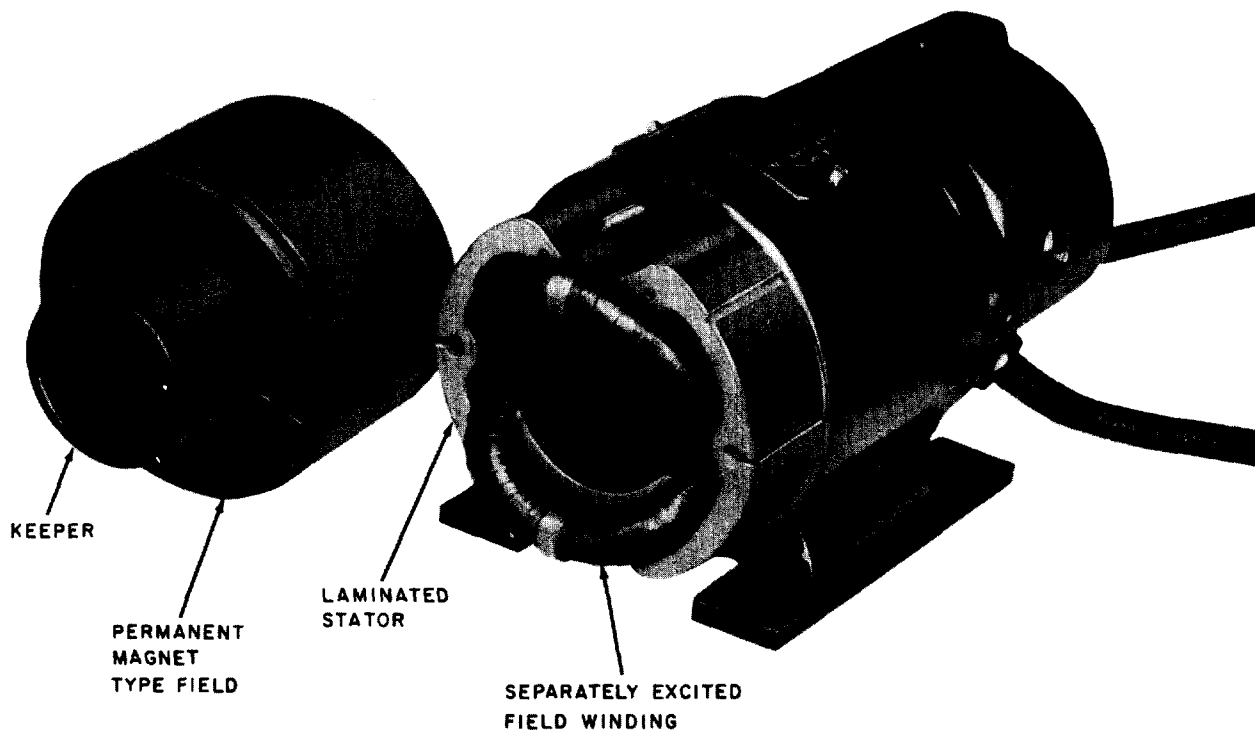


Fig. 11—Magnetic Field Details

**3. REPLACEMENT PROCEDURES**

**3.001 List of Tools and Materials**

CODE OR SPEC NO.	DESCRIPTION	TOOLS (Cont)	DESCRIPTION
		45B	Wrench, socket, 5/16-inch
		—	Wrench, open-end, flat, 13/32-inch, Williams #24
<b>TOOLS</b>		<b>MATERIAL</b>	
R-2969	Brush, typewriter type	—	Chalk, white
—	1-Pound claw hammer	KS-2423	Cloth, cleaning
AT-7860	◆B Long-nose pliers◆	195P	Andok C grease
—	Puller, gear, Owatonna Tool Co. No. 1000 1/2-L or No. 1002 with No. 1002-L1 single-ended arms	—	Petroleum spirits
—	4-Inch E screwdriver	<b>3.002</b>	Remove the apparatus from service before making any replacements.
R-1005	Screwdriver, jewelers	<b>3.003</b>	After making any replacement of parts, the apparatus should be checked and where necessary, readjusted to meet the requirements specified in Section 024-462-701, which covers the
309	Threaded stud		

requirements and adjusting procedures for this equipment.

### 3.01 *Brushes:*

- (1) To remove a *motor* brush or *collector ring* brush (Fig. 9), remove the brush holder screw cap which holds the brush and spring in place, withdraw the old brush and spring, insert a new brush and spring, and replace the brush holder screw cap.
- (2) It is advisable to wear the new brushes in for several hours, if practicable, with no current passing through the collector ring brush, in order to get a good brush fit.

### 3.02 *Brush Holders:*

- (1) To replace a *motor brush holder*, remove the armature as outlined in 3.06. With a watchmaker screwdriver, loosen the setscrew that secures the brush lead to the brush holder. Loosen the setscrew which secures the brush holder in the motor frame by inserting a screwdriver through the brush holder setscrew hole in the regulator housing. Remove the brush holder and replace with a new one. Tighten the brush holder setscrew. Slip the brush lead back on the brush holder and tighten the brush lead setscrew. Check the brush holder clearance as outlined in Section 024-462-701 which covers the Requirements and Adjusting Procedures for this equipment. Reassemble the armature in the reverse order.
- (2) To replace a *collector ring brush holder*, remove the rotating element as outlined in 3.03(4). With a small screwdriver, loosen the setscrew which secures the brush lead connection to the brush holder and lay the lead aside. Loosen the brush holder setscrew and remove the brush holder. Replace with a new brush holder. Tighten the brush holder setscrew. Slip on the brush lead and tighten the brush lead setscrew. Reassemble the rotating element and insulating cover in the reverse order.

**3.03 *Speed Regulator*** (Fig. 1, 6, 7, 8, and 9) consists of an insulating cover, a fixed speed regulator contact, a rotating element with regulator contact, a coil spring, a contact arm and adjusting screw, and a dial.

- (1) To remove an insulating cover, first mark the insulating cover and a corresponding point on the regulator housing with a piece of white chalk. Remove the speed regulator brush (3.01). Turn the dial until the three cutouts on the dial expose the screws which secure the insulating cover and fixed speed regulator contact assembly against the housing. Remove the screws and carefully remove cover and assembly.

**Note:** If the chalk mark is erased, the proper position of the insulating cover may be determined by lining up the contact arm with the contact post.

- (2) To replace the *fixed speed regulator contact*, remove the insulating cover as outlined in (1). With a wrench, turn the nut upon which the fixed speed regulator contact is mounted in a counterclockwise direction until it is removed. Screw the new contact in carefully until it is firm against the outer end of the adjusting screw and remount the insulating cover.
- (3) To replace an *insulating cover*, coil spring, contact arm, adjusting screw or dial, remove the insulating cover as outlined in (1). Measure the distance from the top of the fixed-speed regulator contact to that portion of the contact arm that comes in contact with the coil spring under this particular setting. Turn the dial in a counterclockwise direction (facing the dial) until it comes off. Before removing the coil spring, observe its position on the inner end of the adjusting screw. Replace the damaged or worn part with a new part and see that the adjusting screw is replaced so that the small pin slides freely in the adjustable screw keyway. Screw the dial on in a clockwise direction (facing the dial) until the measured distance is obtained. Remount the insulating cover and assembly.
- (4) ***Rotating Element:*** On regulators of later design, the rotating contact is mounted on a threaded stud removable by turning it counterclockwise in its mounting. Use pliers. Replace with a new contact. On regulators of older design, the rotating contact was not renewable and it is necessary to replace the rotating element until it has been modified for a renewable contact. See Note on Fig. 7. To replace a rotating element, remove the insulating cover and fixed contact assembly as outlined in (1) and the screw cap on the side of the regulator

## SECTION 024-462-801

housing. Insert a screwdriver through the screw cap opening and loosen the rotating element setscrew which secures the rotating element to the motor shaft extension, and remove the rotating element. Replace with a new or repaired rotating element assembly consisting of the rotating speed regulator contact, contact spring and weights and collector ring, and reassemble in the reverse order.

### Machine Bearings (See Fig. 2, 3, 4, and 5)

**3.04 Inseparable-type ball bearing** regulators will have no screws in the end of the bearing housing. To replace a bearing, remove the insulating cover and rotating element as outlined in 3.03. Remove the nuts holding the end shield on the frame and remove the end shield. Withdraw the armature. The bearings, being a press fit on the shaft, will also be withdrawn. Be careful to observe the location of any washers on the shaft. To remove the bearing, use a gear puller. Do not reuse bearings removed from the shaft. ♦Replacement part number for bearing is G. E. Co. Cat. No. 625A836ACP1.♦ Slip the new bearing on the shaft. Using a short piece of clean pipe having a smooth end which will push against the inner but not the outer ball race, tap the new bearing into place against the shoulder on the shaft. New bearings are normally properly lubricated when received. Clean the bearing housings thoroughly, then wipe the inside surfaces with a slight amount of grease and reassemble the unit.

### Separable Type (See Note)

**3.05 Felt Washer**  
**Felt Washer Retaining Washer**  
**Thrust Spring**  
**Thrust Washer**  
**Spring Retaining Washer**  
**Outer Ball Race**  
**Balls and Retainer**

(1) Separable-type ball bearing regulators may be identified by screws in the end of the bearing housing. (See Fig. 3.) To replace a felt washer, felt washer retaining washer, thrust spring, spring retaining washer, balls and retainer, or outer ball race on the end opposite the commutator, it will be necessary to remove the end shield as follows: Remove the screws from

the bearing housing which secure the inside bearing plates to the motor frame, being careful not to lose the lockwashers. Remove the nuts using the 45 tool. Remove the end shield. If it sticks, pry it off by inserting a screwdriver between the frame and end shield. Remove the outer ball race, spring retaining washer, thrust spring, felt washer retaining washer, and felt washer from the end shield and wipe off the grease and clean the bearings and bearing housings with a cloth wet with petroleum spirits. If the grease is caked or sticks in the bearings or housings, use may be made of a tooth brush-type typewriter brush wet with petroleum spirits. Replace any worn or damaged parts and be sure all petroleum spirits have been thoroughly removed from the reused parts, relubricate, and reassemble in the reverse order.

**Note:** If any part of the bearing needs replacement, other than the thrust springs or washers, it is recommended that the complete bearing including inner and outer ball race and balls and retainer be replaced as a unit. ♦This assembly can be ordered from the Barden Corporation, Danbury, Conn., catalog #E8T.♦

(2) To replace a felt washer, felt washer retaining washer, balls and retainer, or outer ball race on the commutator end, it will be necessary to remove the end shield opposite the commutator as outlined in procedure (1).

(3) Remove the insulating cover and rotating element as outlined in 3.03. Remove the screws from the bearing housings on the regulator end which secure the inside bearing plate to the housing. The armature can now be withdrawn from the end opposite the regulator housing. In removing the armature, use may be made of a 309 tool to prevent the inside bearing plate on the commutator end from turning, thereby preventing the round portion of the plate from binding 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 inside bearing plate. Replace any worn or damaged parts and reassemble in the reverse order. See note in (1).

***Inner Ball Race******Copper Washer******Inside Bearing Plate******Inside Bearing Plate Felt Washer (See Note)***

- (4) To replace an inner ball race, copper washer, inside bearing plate or associated felt washer on either end, it will be necessary to remove the armature as outlined in (1), (2) and (3). Then remove the inner ball races which have a press fit on the shaft. Preferably, to get these off, use a gear puller. If it is necessary to use a large screwdriver, hold the screwdriver flat along the shaft against the edge of the inner ball race and hit the screwdriver a series of sharp blows with a hammer, turning the shaft as this is done, so that the inner ball race may be driven off uniformly. Remove the copper washer, inside bearing plate and washer, and replace any damaged or worn parts. See note in (1).

**Note:** If for any reason an inner ball race, copper washer, or inside bearing plate is replaced by a new one, the felt washer between the copper washer and the inside bearing plate should always be replaced at the same time. This washer is the inside bearing plate felt washer and must be made locally from 1/8-inch thick felt cut to a 15/16-inch O.D. and having a 3/8-inch I.D. The small felt washers on the outside of the bearings should be ordered as G.E. Co. catalog number 2075277.

**Caution:** *The inside bearing plate having the flat sides is placed on the commutator end.*

- (5) Place the machined surface of the inside bearing plate outward on the shaft followed by the inside bearing plate felt washer and the copper washer. Slip the inner ball race on the shaft and preferably use a short piece of clean pipe, which is a free fit on the shaft and has a smooth end to put against the ball race. Tap it carefully back into place tapping the pipe with a hammer. Care should be taken not to damage the inner ball race surface. It should be driven back until it rests against the shoulder of the

shaft. Before reassembling the machine, 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. Make certain that all associated parts are assembled in their same relative positions. The inside bearing plate screws may be replaced more readily if a 309 tool is used in reassembling the machine. Introduce this tool through one of the holes in the copper washer and screw it into one of the inside bearing plates on the commutator end. Place the armature in its proper position in the machine frame. In replacing the armature, this tool passes through one of the holes in the housing provided for the inside bearing plate screw; and the four holes in each of the three parts (bearing housing, inside bearing plate and copper washer) are brought into alignment. Three of the screws of the inside bearing plate 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 on the opposite end, the 309 tool is introduced through one of the holes in the opposite copper washer and screwed into one of the holes in the opposite inside bearing plate and slid through one of the holes in the end shield. Insert the inside bearing plate screws in the same manner as described above. Screw on the acorn nuts. All screws and nuts should then be securely tightened. Push the shaft inward on the end facing the regulator housing and make certain that the thrust spring returns the shaft to its original position when this pressure is released.

**Caution:** *In replacing the speed regulator, care should be taken to remove any finger marks by wiping the contacts with a clean cloth wet with petroleum spirits followed by a dry cloth.*

In replacing the rotating element care should be taken to see that the setscrew registers on the spot on the shaft provided for that purpose. Replace the insulating cover and assembly. Insert all brushes in their respective brush holders.

**3.06 Armature** (See Fig. 4)

- (1) To replace the armature, remove all brushes from the motor and speed regulator collector ring brush holders and wipe with a cloth. Mark each brush so that it may be put back in the same position in the same brush holder from

## SECTION 024-462-801

which it was removed. Remove the end shields and bearings as outlined in procedure 3.05. Replace with a new or reconditioned armature and reassemble in the reverse order.

### 3.07 *Resistance Unit* (See Fig. 10)

(1) To replace a voltage regulator resistance unit, loosen the connections, and remove the resistor from the panel. Remove the resistor from its cage noting which resistor taps are strappd out, which are not used and which are brought out to the terminals. Mount the new resistor unit and connect all taps in a similar manner as on the old resistor. Cut off excess length on taps not used (leaving length enough for any future connections which may be required) and make sure that the pigtailed do not ground on the resistor cage and that all connections are firm.

**Note:** When the nominal voltage is 24 volts, no field resistance is supplied. When the nominal voltage is 48 or 130 volts, a field resistance unit of approximately 87.4 or 317.5 ohms, respectively, is supplied in the motor field circuit.

### 3.08 *Ballast Lamp* (See Fig. 10.)

(1) The ballast lamp located in the back of the panel may be removed by unscrewing in a counterclockwise direction. Replace by turning in a clockwise direction until firm in its socket.

### 3.09 *Motor Field* (See Fig. 11.)

(1) To replace a separately excited field winding with one of the permanent-magnet type is a simple matter and one which may readily be done in the field. The permanent-magnet field, however, should be handled carefully and should not be dropped or subjected to excessive jarring, as this will tend to reduce the magnetism of the field. Remove the armature of the regulator in the usual manner. Loosen the setscrews, holding the stator laminations in place. These

setscrews are located on the side of the housing just above the mounting feet. The stator laminations on which the separately excited field winding is mounted have a sliding fit in the machine housing and may usually be drawn out of the housing without the aid of tools. Should the laminations bind, they may be driven out by inserting a short length of small wooden dowel rod or equivalent through the hole for the shaft in the housing on the regulator end and tapping lightly with a hammer, making sure that the end of the rod rests against the laminations instead of the field coil windings and that internal connections to the brush holders, etc. are not damaged. The rod should be rotated around the stator laminations so that the stator is driven out uniformly and not made to bind in the housing.

(2) As the stator is withdrawn from the housing, cut the two leads to the field winding close to the end of the lead in cable and tape the ends remaining in the housing and otherwise insure that the loose ends will not interfere with the operation of the machine when reassembled. Insert the permanent-magnet type field in the housing with its keeper still in place, passing the through bolts through the holes provided for the same. The proper position of the new field is indicated by a stamping on one end. It should be inserted so that this stamping is at the top and on the end toward the end shield. Slide the field in until it rests firmly against the shoulder in the housing and tighten the setscrews firmly. If binding is present, see that any burrs around the inner end of the setscrew holes or any excess paint on the outer surfaces of the new stator are removed.

(3) Remove the keeper and immediately insert the armature between the pole faces as the fields will be injured if left for any length of time without the armature or a keeper across the pole faces. Retain the keeper for future use in case it is necessary to remove the armature at some later date. Reassemble in the usual manner.