RINGING MACHINES
KS-15804, KS-15905, AND KS-15985 TYPES
REPLACEMENT PARTS AND PROCEDURES

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1. GENERAL

1.01 This section covers the information necessary for ordering parts to be used in the maintenance of the KS-15804, KS-15905, and KS-15985 type ringing machines. It also covers the approved procedures for replacing these parts.

1.02 This section is reissued to include information on the KS-15804 L5 and L6 ringing machines. Change arrows are used to emphasize the more significant changes. This reissue does not affect the Equipment Test List.

1.03 The KS-15804 L1 ringing machine is primarily intended for use in the 812A PBX. The KS-15804 L4 ringing machine is similar to the KS-15804 L3 ringing machine except that the L4 machine is equipped with a 115-volt, single phase 60-Hz ac motor. ▶The KS-15804 L5 and L6 ringing machines provide stutter dial tone for the 812A PBX system per J58877DA. With the exception of the stutter dial tone, the L5 and L6 machines are identical to the L3 and L4 machines, respectively.◀

1.04 Part 2 of this section covers the parts which are practicable to replace in the field in the maintenance of these ringing machines. No attempt should be made in the field to replace parts not designated. Part 2 also contains explanatory figures showing the parts. This information is called Replacement Parts.

NOTICE
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1.05 Part 3 of this section covers the approved procedures for the replacement of parts listed in Part 2. This information is called Replacement Procedures.

2. REPLACEMENT PARTS

Note: The Electric Speciality Co., Electronic Specialty Co., and Radiation International Inc., are all past names given to the present Tech Systems Corp.

2.01 The figures included in this part of the section show the various parts in their proper relation to other parts of the ringing machine together with the names of the parts which are practical to replace in the field.

2.02 Information enclosed in parentheses is not ordering information. It may be references to notes, parts referred to in other portions of the section and not considered replaceable, or where the name in general use in the field differs from the part name assigned by the manufacturers.

2.03 When ordering parts, give the following information.

(a) Order brushes in accordance with Section 171-110-802.

(b) When ordering parts other than brushes, give the name of the part and the complete nameplate data on the ringing machines, including the KS number and the name of the manufacturer. For example, Interrupter Gear for KS-15804 L1 Ringing Machine—Holtzer-Cabot Corp.—Type MG-251-DC Input Volts 44-52, DC Input Amps 1.75, AC Output Volts 90-65, AC Output 0.25A-20 Hz, Tone 600/130 Hz, 3.3 and 1.1 Volts, Cont Duty 40°C Rise, No. 1797311.

2.04 On Holtzer-Cabot and Electronic Specialty ringing machines manufactured initially, the worm gear and cams are secured to the interrupter shaft by setscrews and are replaced individually. On later Electronic Specialty machines and on all General Electric machines, the worm gear and cams are molded on the interrupter shaft and this assembly is replaceable as a unit. Since these two types of interrupter shaft assemblies are not interchangeable, order individual cams and the worm gear or the complete interrupter shaft assembly as required. Ordering information for the individually mounted interrupter shaft parts is shown in Fig. 1, 2, and 3, and for interrupter shaft assemblies having parts molded on the shaft in Fig. 4, 5, 6, and 7.

2.05 A worm gear repair kit is available for the KS-15985 Holtzer-Cabot ringing machine equipped with a plastic worm gear. The fine pitch plastic worm gear on the KS-15985 Holtzer-Cabot ringing machine may experience excessive wear. The plastic worm gear may be replaced with a bronze worm gear by using the worm gear repair kit. The worm gear repair kit (Part Number F7074) is available from the following source:

COMMERCIAL ELECTRIC PRODUCTS CORP.
1738 E. 30TH STREET
CLEVELAND, OHIO 44114

The repair kit includes a bronze worm gear, a steel worm, and a replacement interrupter shaft. All parts in the kit should be installed at the time of the replacement.

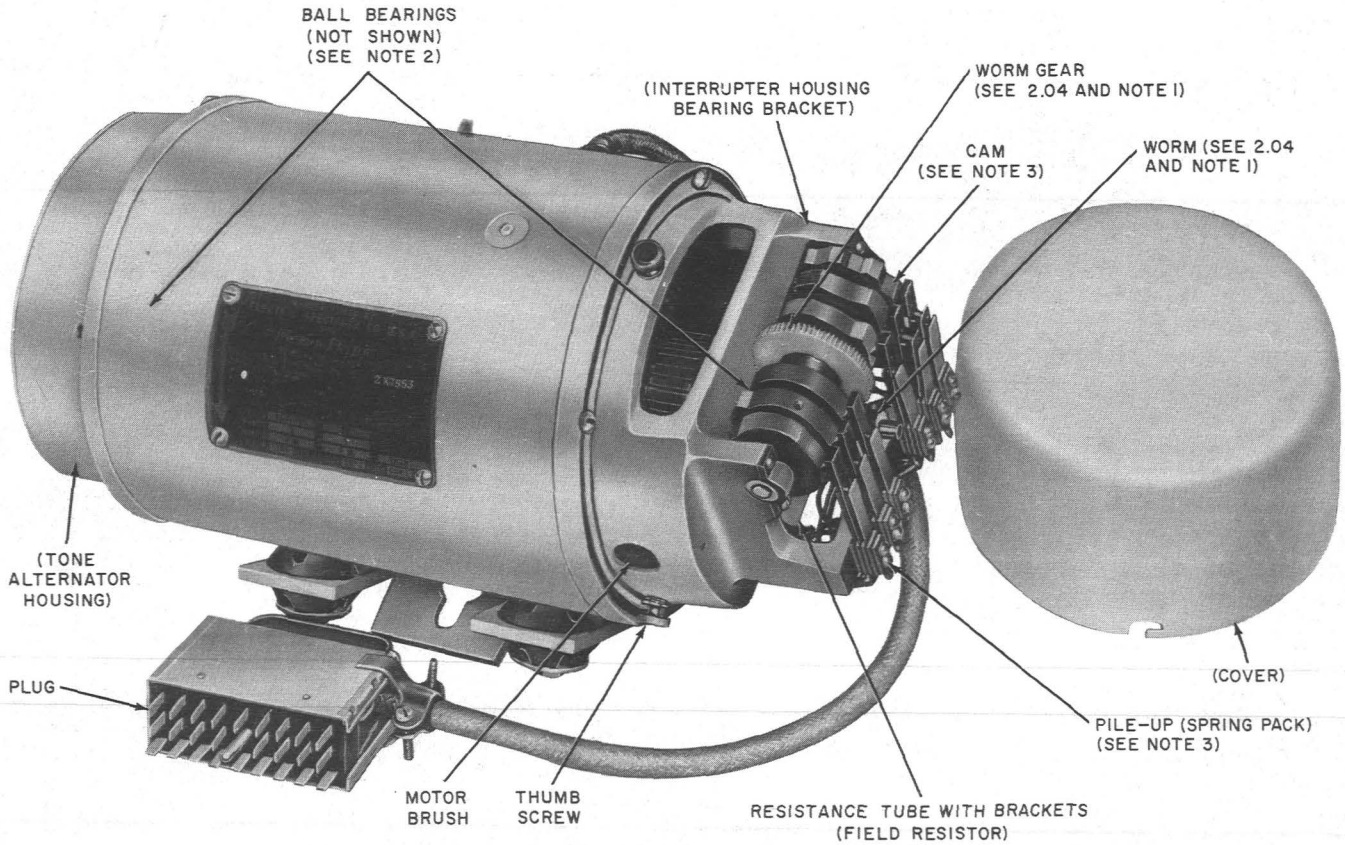
2.06 Spring packs on General Electric ringing machines are mounted in groups of two or four. Each group has common insulators and may have common plates connecting corresponding springs of each spring pack in the group. If a spring pack in a group requires replacement, order the complete group by listing the numbers of the individual spring packs in the group as stamped on the outer spring of each spring pack.

2.07 When ordering replacement starting relays for KS-15985 L1 and KS-15905 L3 ringing machines manufactured by the Holtzer-Cabot Corp., include the month and year of manufacture with the nameplate data. The Holtzer-Cabot Corp. KS-15985 L1 and KS-15905 L3 ringing machines manufactured from September, 1970, require a different starting relay than machines manufactured before September, 1970.

3. REPLACEMENT PROCEDURES

3.01 *List of Tools and Materials*

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
R-1542	6-Inch Adjustable Wrench

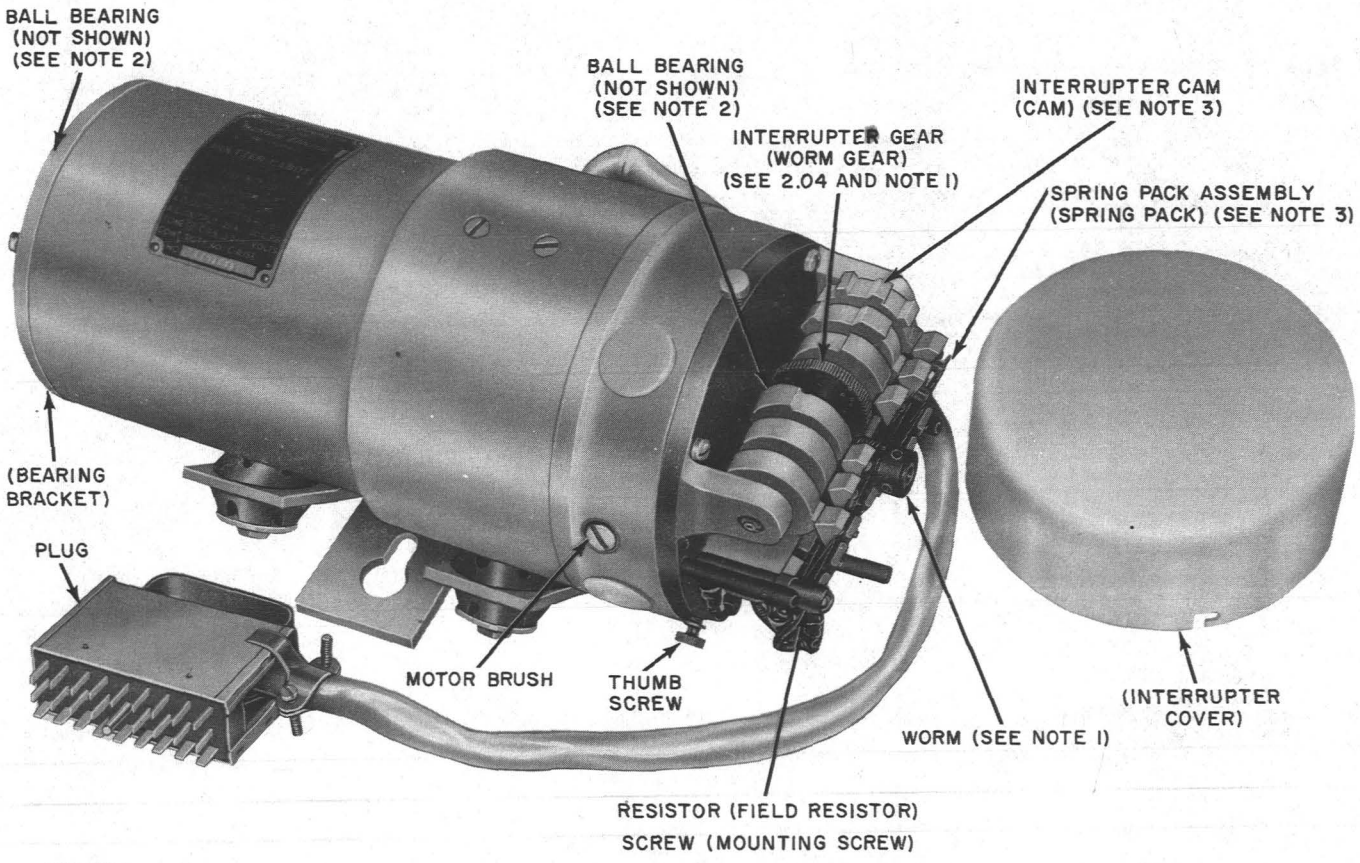


NOTES:

1. IF EITHER WORM OR WORM GEAR REQUIRES REPLACEMENT, ORDER BOTH PARTS.
2. IF BEARING AT ONE END OF SHAFT REQUIRES REPLACEMENT, ORDER BEARING FOR OTHER END ALSO.
3. WHEN ORDERING CAMS OR PILE-UPS (SPRING PACKS) SPECIFY THE POSITION NUMBER OF THE PARTS. THE CAMS AND SPRING PACKS ARE NUMBERED 1 THROUGH 6, LEFT TO RIGHT, AS VIEWED FROM THE INTERRUPTER END OF THE MACHINE.

Fig. 1—KS-15804 Type Ringing Machine—Electric Specialty Co.—Interrupter Shaft Assembly With Individually Mounted Parts (KS-15804 L1 DC Machine Shown)

TOOLS		TOOLS	
R-2485	5/32-Inch Hex Socket Screw Wrench	—	3-Inch C Screwdriver (or the replaced 3-Inch Cabinet Screwdriver)
R-2670	3/32-Inch Hex Socket Screw Wrench	—	4-Inch E Screwdriver (or the replaced 4-Inch Regular Screwdriver)
		—	4-Ounce Riveting Hammer
R-2958	5/64-Inch Hex Socket Screw Wrench	—	1/16-Inch Drive Pin Punch, L. S. Starrett Co., No. 5665 (or equivalent)
R-2959	1/16-Inch Hex Socket Screw Wrench	—	P Long Nose Pliers



NOTES:

1. IF EITHER WORM OR WORM GEAR REQUIRES REPLACEMENT, ORDER BOTH PARTS.
2. IF BEARING AT ONE END OF SHAFT REQUIRES REPLACEMENT, ORDER BEARING FOR OTHER END ALSO.
3. WHEN ORDERING CAMS OR SPRING PACK ASSEMBLIES, SPECIFY THE POSITION OF THE PARTS. THE CAMS AND SPRING PACK ASSEMBLIES ARE NUMBERED 1 THROUGH 6, LEFT TO RIGHT, AS VIEWED FROM THE INTERRUPTER END OF THE MACHINE.

Fig. 2—KS-15804 Type Ringing Machine—Holtzer Cabot Corp. and Commercial Electric Products Corp.—Interrupter Shaft Assembly With Individually Mounted Parts (KS-15804 L1 DC Machine Shown)

TOOLS

—	Puller, Group-O-Matic, Owatonna Tool Co., No. 1002, Equipped with 1002-L1 Single-End Arms with Bearing Pulling Attachment, Owatonna Tool Co., No. 950

MATERIALS

KS-7860	Petroleum Spirits
KS-14666	Cleaning Cloth
—	Brass or Copper Tube (approximately 2-1/2 inches long with diameter as required, one end smooth)

3.02 In many cases it will be necessary to dismount the ringing machine and place it on a bench for replacement of parts. To dismount the machine, disconnect it from the circuit by removing the plug (dc machines) or the plugs (ac machines) from the sockets. Then lift and remove the machine from its mounting bolts.

3.03 After making any replacement of parts, the new part or parts shall meet the requirements

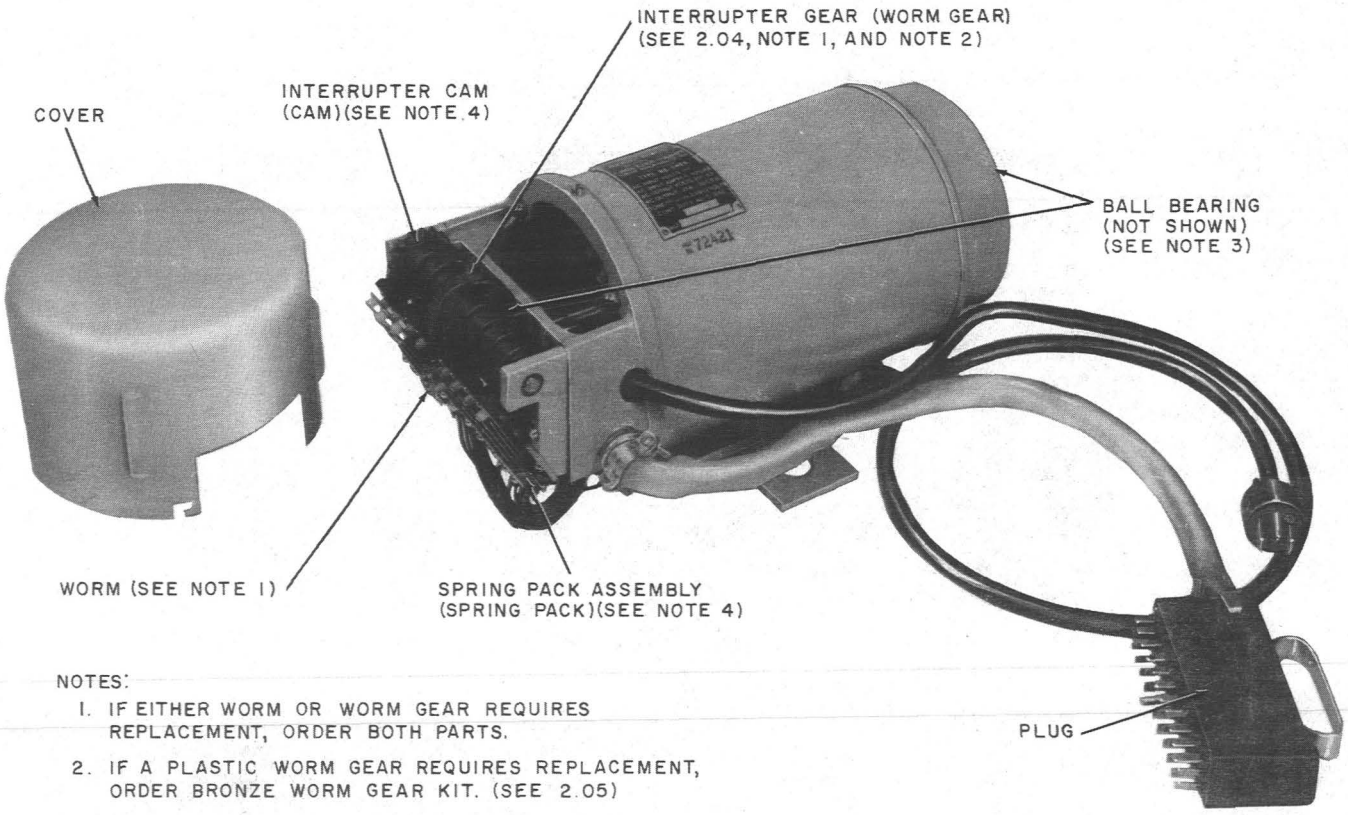


Fig. 3—KS-15985 Type Ringing Machine—Holtzer Cabot Corp. and Commercial Electric Products Corp.—Interrupter Shaft Assembly With Individual Mounted Parts (KS-15985 L1 AC Machine Shown)

specified in Section 163-530-701. Other parts whose adjustment may have been directly disturbed by the replacement operation should be checked to the applicable requirements.

3.04 No replacement procedures are specified for screws or parts where the replacement procedure consists of a simple operation.

3.05 ***Caution: Care should be exercised when using petroleum spirits in power rooms where there are dc machines. Commutation may be adversely affected by softening of commutator film by the fumes. To avoid the need for burnishing the commutators of dc machines after doing any cleaning called for in this section, provide adequate ventilation. Use the absolute minimum amount of petroleum spirits required for the cleaning operation and keep the container closed when not in use.***

3.06 If it is necessary to remove a brush from its holder, for reasons other than replacement of the brush, mark or record the position of the brush with respect to its associated brush holder to insure remounting the brush in its original position.

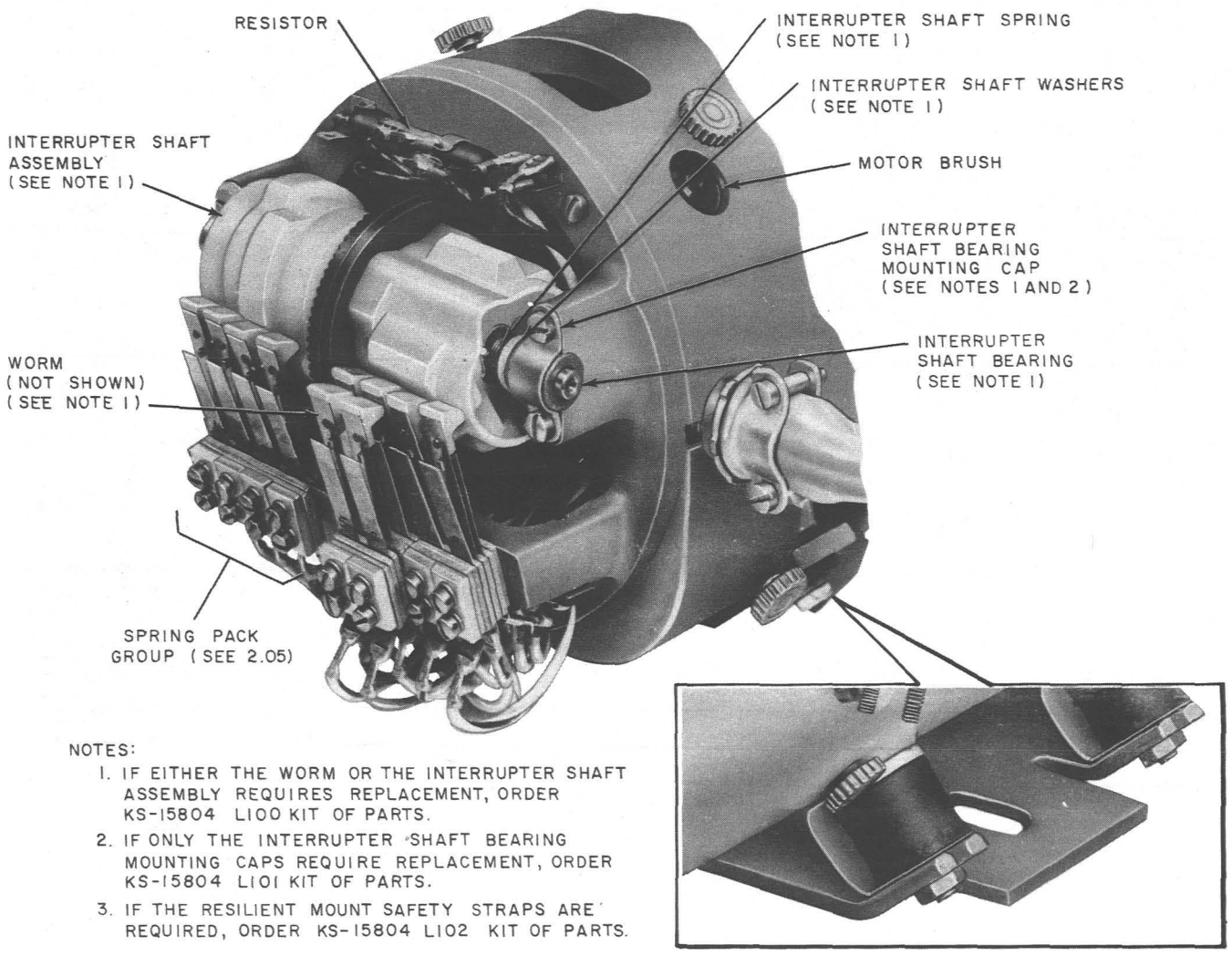


Fig. 4—KS-154804 Type Ringing Machine—General Electric Co.—Interrupter Shaft Assembly Furnished as a Unit (KS-15804 L3 DC Machine Shown)

3.07 ***Motor Brushes:***

(a) To replace a brush, remove the brush holder cap and then remove the brush. Insert the new brush and remount the brush holder cap.

(b) Check the brush with the applicable requirements covered in Section 163-530-701.

3.08 ***Spring Pack:***

(a) ***Holtzer-Cabot and Commercial Electrical Products Corp. Machines:***

(1) Tag and disconnect the spring pack leads.

(2) Remove the spring pack mounting screw using the 3-inch C screwdriver and remove the spring pack.

(3) Mount the new spring pack with the head of the cap screw inserted in the associated hole of the interrupter frame. Center the cam follower on its associated cam and securely tighten the mounting screw.

(4) After mounting the spring pack, reconnect the spring pack leads.

(b) ***Electronic Specialty Machines:***

(1) Tag and disconnect the spring pack leads.

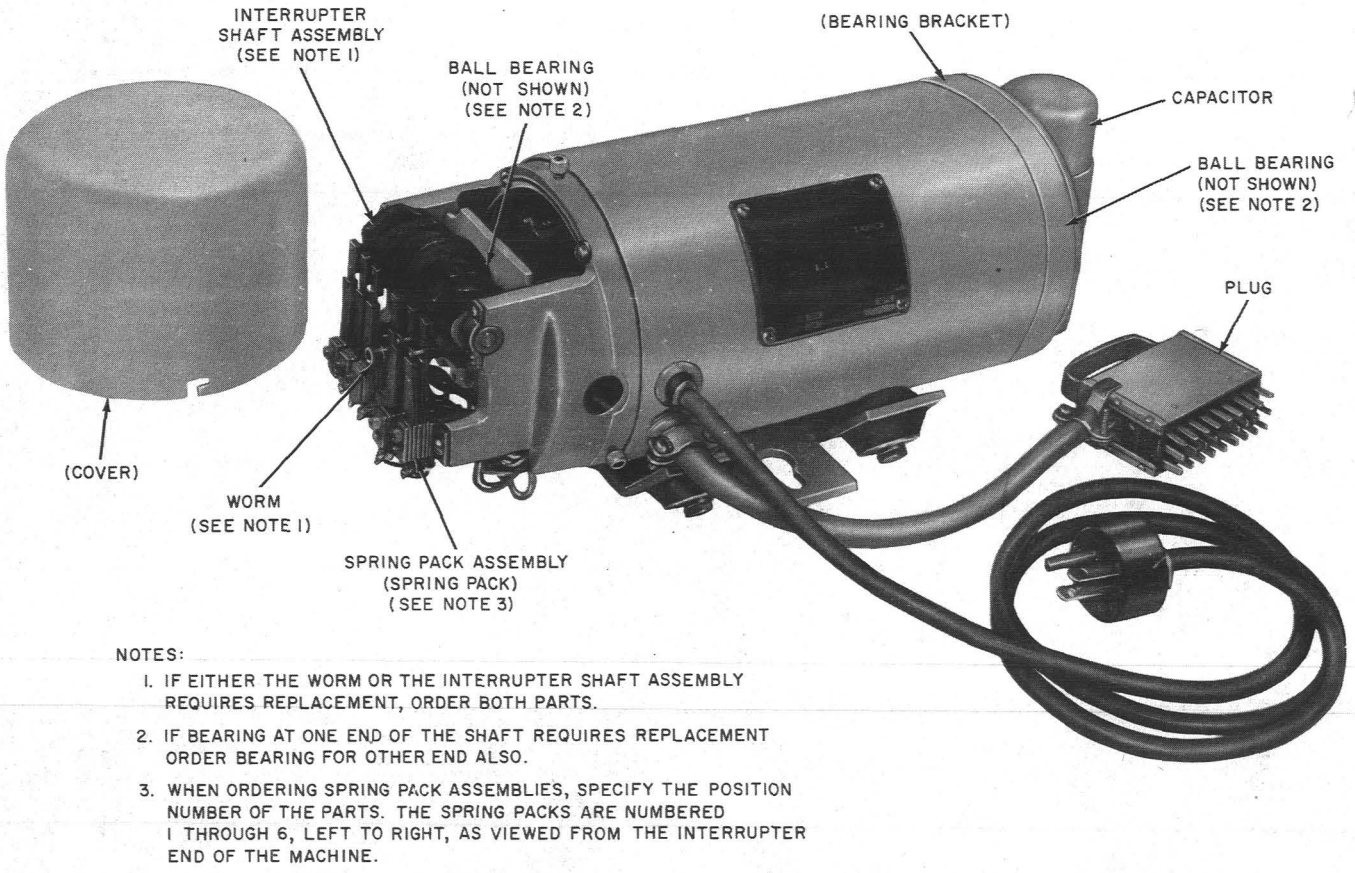


Fig. 5—KS-15905 Type Ringing Machine—Electric Specialty Co.—Interrupter Shaft Assembly Furnished as a Unit (KS-15905 L1 AC Machine Shown)

(2) Remove the spring pack mounting screws using the 3-inch C screwdriver and remove the spring pack.

(3) The new spring pack is furnished with nuts on the mounting screws to hold the assembly together during shipment. Remove the nuts, taking care to hold the spring pack as a unit. Mount the spring pack on the ringing machine so that the springs are in alignment and the cam follower of the spring pack is centered on its associated cam, and securely tighten the mounting screws.

(4) After mounting the spring pack, reconnect the spring pack leads.

(c) ***General Electric Machines:*** If a spring pack requires replacement, replace the complete group containing this spring pack as covered in (1) through (4).

(1) Tag and disconnect all spring pack leads in the group.

(2) Remove the group mounting screws using the 3-inch C screwdriver and remove the group of spring packs.

(3) The new group of spring packs is furnished with nuts on the mounting screws to hold the group together during shipment. Remove the nuts, taking care to hold the group as a unit. Mount the group of spring packs on the ringing machine so that the springs are in alignment and the cam followers of each spring pack are centered on their associated cams, and securely tighten the mounting screws.

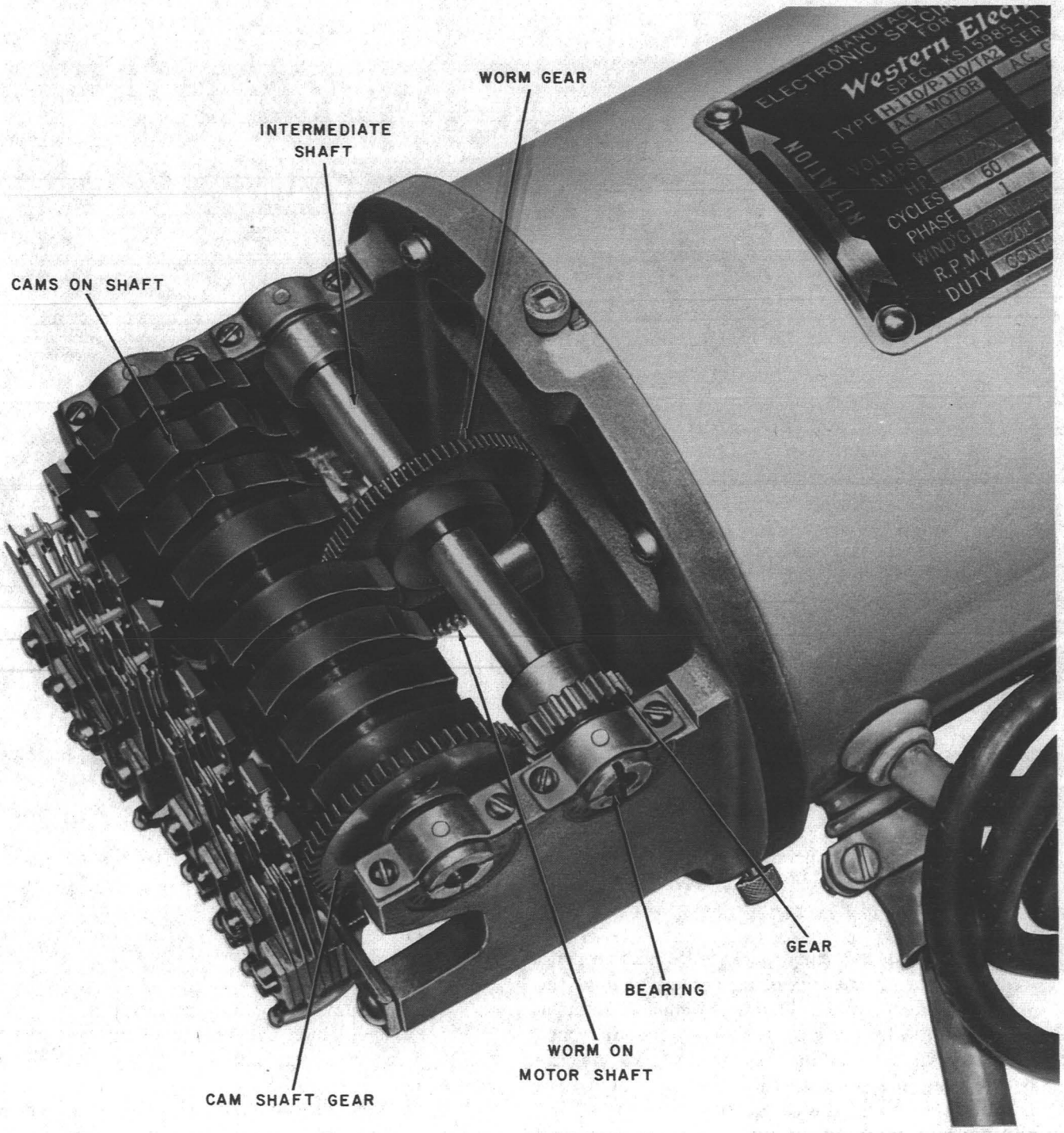
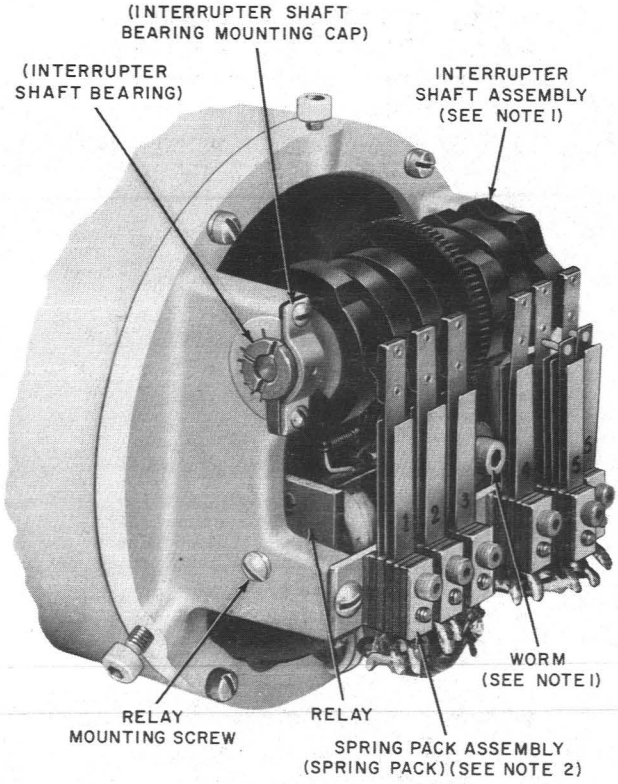


Fig. 6—KS-15985 Type Ringing Machine—Electronic Specialty Co.—Interrupter Shaft Assembly Furnished as a Unit (KS-15985 L1 AC Machine Shown)



NOTES:

1. IF EITHER THE WORM OR THE INTERRUPTER SHAFT ASSEMBLY REQUIRES REPLACEMENT, ORDER BOTH PARTS.
2. WHEN ORDERING SPRING PACK ASSEMBLIES, SPECIFY THE POSITION NUMBER OF THE PARTS. THE SPRING PACKS ARE NUMBERED 1 THROUGH 6, LEFT TO RIGHT AS VIEWED FROM THE INTERRUPTER END OF THE MACHINE.

Fig. 7—KS-15985 Type Ringing Machine—Electric Speciality Co.—Interrupter Shaft Assembly Having Parts Furnished as a Unit (KS-15905 L1 AC Machine Shown)

(4) After mounting the group of spring packs, reconnect the spring pack leads.

(d) ***Cam Follower Bottoming:*** The cam follower shall not bottom in the low dwell portions of the cams after all other interrupter and timing requirements have been met.

3.09 ***Cams and Worm Gear (Individually Mounted on Interrupter Shaft)*** (See 2.04)

(a) ***Cams (Holtzer-Cabot and Commercial Electrical Products Corp. Machines):***

(1) Loosen the worm gear and all cam setscrews using the proper size hex socket screw wrench.

(2) While holding the worm gear in engagement with the worm, slide the interrupter shaft sufficiently to the right or left to permit removal of the cam to be replaced. Take care in removing cams to avoid distorting the interrupter springs.

(3) Place the new cam on the shaft with the side of the cam having the stamped designation to the left (as viewed from the interrupter end of the machine) and the setscrew in alignment with the V groove of the shaft. Similarly, mount the other cams which were removed, taking care to place them in their proper position on the shaft with respect to the spring packs.

(4) Position each outer cam against its associated bearing flange to obtain only perceptible end play of the interrupter shaft and securely tighten the outer cam setscrews in the V groove of the shaft.

(5) Center all other cams on their associated cam followers and securely tighten the cam setscrews in the V groove of the shaft.

(6) Hold the No. 1 cam against the bearing flange and position the worm gear so that it is centered with respect to the worm and securely tighten its setscrew in the V groove.

(b) ***Cams (Electronic Specialty Machine):***

(1) Remove the mounting screws of each spring pack and carefully swing the spring packs away from the cams to permit removal of the interrupter shaft assembly. Take care to avoid disturbing the spring pack assemblies or damaging the leads.

(2) Remove the interrupter shaft bearing cap mounting screws using the 3-inch C screwdriver and remove the bearing caps.

(3) Remove the shaft assembly and remove the bearings from both ends of the shaft.

(4) The cams are mounted on the square portion of the shaft; it is necessary to mark the cams before removal in order to insure remounting them in proper alignment. To do this, mark a straight pencil line across the periphery of all cams.

(5) Using the proper size hex socket screw wrench, loosen the setscrew of the cam to be replaced. Also loosen the setscrews of other cams which are between this cam and the nearer end of the shaft. Remove these cams from the shaft.

(6) Hold the cam being replaced against the new cam with the sides of the cams having indentations to the right and the lobes of the cams in alignment. Extend the reference line across the periphery of the new cam.

(7) All cams must be placed on the shaft with the sides having the indentations to the right when the shaft is mounted on the ringing machine and with the reference lines on all cams in alignment. Mount the cams in this way making sure that the cams are properly positioned on the shaft with respect to their associated spring packs on the machine.

(8) Place a bearing on each end of the shaft, mount the shaft on the ringing machine with the bearing caps, and securely tighten the bearing cap mounting screws.

(9) Mount the spring packs on the machine and securely tighten the mounting screws. Center the cams on their associated cam followers and securely tighten the cam setscrews.

(10) If necessary, reposition the worm gear so that it is centered with respect to the worm and securely tighten its setscrew.

(c) ***Worm Gear (Holtzer-Cabot ▸and Commercial Electric Products Corp.◂ Machine):***

Note 1: The KS-15985 ringing machine, ▸manufactured by Holtzer-Cabot,◂ may be equipped with a fine pitch plastic worm gear. If the plastic worm gear binds or shows sign of wear, replace the plastic worm with a worm gear repair kit available from Commercial Electric ▸Products Corp.◂ (see 2.05).

Note 2: ▸The following replacement procedure applies to machines manufactured by Holtzer-Cabot and Commercial Electric Products Corp.◂

(1) If the worm gear requires replacement, also replace the worm.

(2) Loosen the worm gear and all cam setscrews using the proper size hex socket screw wrench.

(3) While holding the worm gear in engagement with the worm, slide the interrupter shaft sufficiently to the right or left to permit removal of the cams on one side of the worm gear. Remove these cams, noting their position with respect to their associated spring packs and taking care not to distort the springs. Slide the shaft further and remove the worm gear.

(4) Place the new worm gear on the shaft with the hub of the gear to the right and the worm gear setscrew in alignment with the V groove. Take care to mount the cams with respect to their associated spring packs.

(5) Position each outer cam against its associated bearing flange to obtain only perceptible end play of the interrupter shaft and securely tighten the outer cam setscrews in the V groove of the shaft.

(6) Center all other cams on their associated cam followers and securely tighten the cam setscrews in the V groove of the shaft.

(7) Hold the No. 1 cam against the bearing flange and position the worm gear so that it is centered with respect to the worm and securely tighten its setscrews.

(8) Replace and position the worm to obtain perceptible backlash as covered in (e).

(9) Lubricate worm and worm gear in accordance with 163-530-701.

(d) ***Worm Gear (Electronic Specialty Machine):***

(1) Remove the interrupter shaft assembly from the ringing machine as covered in (b)(1) through (b)(3). Then mark the cams as covered in (b)(4).

(2) Loosen the setscrews of the worm gear and cams on one side of the gear using the proper size hex socket wrench. Remove the cams and worm gear from the shaft noting the position of the cams with respect to their associated spring packs on the machine.

(3) Place the new worm gear on the shaft so that the hub of the gear will be to the left when the shaft is mounted on the ringing machine. Remount the cams so that the sides of the cams having the indentations will be to the right when the shaft is mounted and so that the reference lines on the cams are in alignment. Take care that the cams are properly positioned on the shaft with respect to their associated spring packs on the machine.

(4) Place a bearing on each end of the shaft, mount the shaft on the ringing machine with the bearing caps, and securely tighten the mounting screws.

(5) Mount the spring packs and securely tighten the mounting screws. Center all cams on their associated cam followers and securely tighten the cam setscrews.

(6) Position the worm gear so that it is centered with respect to the worm and securely tighten its setscrew.

(7) Position the worm to obtain perceptible backlash between worm and worm gear as covered in (e).

(e) ***Positioning Worm:*** After replacing the worm gear as covered in (c) for the Holtzer-Cabot ▶and Commercial Electric Products Corp.◀ machines and in (d) for the Electronic Specialty machine, position the worm on the shaft so that there is perceptible backlash between the worm and the worm gear. Since the worm is slightly tapered, the backlash is determined by the longitudinal position of the worm on the shaft. Securely tighten the worm setscrews on the flats of the shaft.

3.10 ***Interrupter Shaft Assembly (Parts Molded on Interrupter Shafts):***

(a) If the interrupter shaft assembly requires replacement, also replace the worm. Replace the interrupter shaft assembly as covered in (b) or (c).

(b) ***Electronic Specialty Machine:***

(1) Remove the spring pack assembly bracket mounting screws and carefully swing the assembly away from the interrupter frame taking care not to damage the leads.

(2) If the interrupter shaft bearings are adjustable, note the position of the indicator line on each bearing with respect to the radial graduations on the interrupter frame before removing the interrupter shaft assembly.

(3) Remove the interrupter bearing cap mounting screws and remove the bearing caps. Remove the interrupter shaft assembly and remove the washers, if provided, from both ends of the shaft. Replace worn bearings and washers.

(4) Place the washers and bearings on the new interrupter shaft. Mount the interrupter shaft assembly on the ringing machine with the bearing caps, taking care that the indicator line on each interrupter shaft bearing is aligned with the radial graduation on the interrupter frame as noted in (2). Securely tighten the bearing cap mounting screws.

(5) Remount the spring pack bracket on the machine taking care to center the cam followers of the spring packs on their associated cams. Securely tighten the spring pack bracket mounting screws.

(6) Check the requirement covering freedom of rotating parts in Section 163-530-701.

(c) ***General Electric Machine:***

(1) Using the proper size hex socket screw wrench, rotate the high-speed shaft so

that as many spring packs as possible are in their unoperated position.

(2) Remove the interrupter shaft bearing cap mounting screws and remove the bearing caps. Remove the interrupter shaft assembly as follows. Grasp the interrupter shaft bearings and move the shaft assembly sufficiently toward the interrupter springs to remove the bearings from their housings. Then carefully raise and remove the shaft assembly.

(3) Remove the bearings, washers, and the compression spring, noting the order of their removal. Replace worn bearings, washer, or compression spring.

(4) Place the compression spring, washers, and bearings on the new interrupter shaft. Mount the shaft on the ringing machine with the bearing caps and securely tighten the bearing cap mounting screws.

(5) Check the requirement covering freedom of rotating parts in Section 163-530-701.

3.11 ***Worm:***

(a) If the worm requires replacement, also replace the worm gear or the interrupter shaft asembly (see 2.04).

(b) ***Holtzer-Cabot ◗Commercial Electric Products Corp.◖ and Electronic Specialty Machines:***

(1) Using the proper size hex socket screw wrench, loosen the worm setscrews and remove the worm from the high-speed shaft.

(2) Mount the new worm on the shaft and position it as covered in 3.09(e).

(3) Check the requirement covering freedom of rotating parts in Section 163-530-701.

(c) ***General Electric Machine:***

(1) To replace the worm, remove the motor brushes as covered in 3.06 and 3.07. Then remove the rotor as covered in (2) and remove the worm as covered in (3). Mount the new worm as covered in (4).

(2) ***Removing Rotor:*** On the end of the ringing machine opposite the interrupter, mark lines on the motor frame and the bearing bracket to insure remounting the bracket in its original position. Remove the bearing bracket mounting screws and remove the bearing bracket. Remove the rotor from the machine, taking care to avoid damaging the windings, laminations, or the commutator on dc machines.

(3) Using the adjustable wrench, if necessary, disengage the worm clamping nut from the threaded portion of the rotor shaft. Remove the worm from the rotor shaft. Due to the close fit between the shank of the worm and the bore of the shaft, considerable pull may be required to remove the worm.

(4) Insert the new worm into the rotor shaft, taking care that the pin through the shank of the worm engages the slot of the rotor shaft. Screw the worm clamping nut hand-tight on the threaded portion of the rotor shaft.

(5) Remount the other parts in reverse order of removal.

3.12 ***Ball Bearings:***

(a) If one ball bearing requires replacement, replace both bearings.

(b) To replace the bearings, remove the motor brushes from dc machines as covered in 3.06 and 3.07. Remove the rotor as covered in (c), (d), or (e), and then remove the bearings as covered in (f). Mount the new bearings as covered in (g).

(c) ***Removing Rotor From Holtzer-Cabot ◗and Commercial Electric Products Corp.◖ Machines:***

(1) Loosen the worm setscrews using the proper size hex socket screw wrench and remove the worm.

(2) On the end of the ringing machine opposite the interrupter, mark lines on the frame and the bearing bracket to insure remounting the bracket in its original position. Remove the bearing bracket mounting screws using

the 4-inch E screwdriver. Carefully pry the bearing bracket away from the frame with the screwdriver. Take care not to lose any of the washers which were mounted between the bearing and the bearing bracket.

(3) Remove the rotor, taking care to avoid damaging the windings, laminations, or the commutator on dc machines.

(d) ***Removing Rotor From Electronic Specialty Machine:***

(1) Loosen the worm setscrews using the proper size hex socket screw wrench and remove the worm.

(2) If the machine is equipped with a tone alternator, remove the tone alternator rotor as covered in (3) and (4) or (3) and (5). If the machine is not equipped with a tone alternator, proceed as covered in (6) and (7).

(3) Remove the end plate from the tone alternator end of the machine using the proper size hex socket screw wrench.

(4) If the tone alternator rotor is secured to the shaft by setscrews, loosen the setscrews using the proper size hex socket screw wrench. Insert the proper size hex socket screw wrench in the interrupter end of the shaft; hold the shaft stationary with the wrench and rotate the tone alternator rotor counterclockwise to disengage it from the threaded portion of the shaft. Carefully remove the tone alternator rotor from the shaft.

(5) If the tone alternator rotor is keyed to the shaft, remove the screw from the end of the shaft using the 4-inch E screwdriver; remove the washer; and then carefully slide the rotor off the shaft.

(6) Remove the interrupter housing bearing bracket mounting screws with the 4-inch E screwdriver. Carefully pry the bearing bracket away from the frame with the screwdriver. Move the bearing bracket away from the frame to clear the end of the shaft and then carefully swing it sufficiently to the right to permit removal of the rotor. Take care not to strain the cable.

(7) Remove the rotor, taking care to avoid damaging the windings, laminations, or the commutator on dc machines.

(e) ***Removing Rotor From General Electric Machine:*** On the end of the ringing machine opposite the interrupter, mark lines on the frame and the bearing bracket to insure remounting the bracket in its original position. Remove the bearing bracket mounting screws and remove the bearing bracket. Remove the rotor from the machine taking care to avoid damaging the windings, laminations, or the commutator on dc machines.

(f) ***Removing Ball Bearings:***

(1) After removing the rotor from the ringing machine, place it on a bench on several thicknesses of KS-14666 cleaning cloth.

(2) Remove the bearings using the No. 1002 bearing puller and the No. 950 bearing puller attachment, if necessary.

(g) ***Mounting Ball Bearings:*** Start the bearing on the shaft and position it against the shoulder as follows. Use a brass or copper tube approximately 2-1/2 inches long which just fits over the shaft and engages the inner race of the bearing only. The ends of the tube should be at right angles to the length, and one end of the tube should be smooth. Place the smooth end of the tube against the inner race of the bearing, and tap the tube lightly with a 4-ounce riveting hammer to force the bearing into position against the shoulder.

(h) Remount all parts in reverse order of removal.

3.13 ***Field Resistor:*** To replace the field resistor, tag and unsolder the leads. Then proceed as covered in (a) or (b).

(a) ***Holtzer-Cabot and Commercial Electric Products Corp. Machines:***

(1) Remove the field resistor mounting screw using the 4-inch E screwdriver and remove the resistor.

(2) Mount the new resistor so that the slider clamp screw is accessible and then securely tighten the mounting screw.

(3) Connect and solder the leads.

(b) ***Electronic Specialty and General Electric Machines:***

(1) Remove the field resistor bracket mounting screws using the 3-inch C screwdriver. Remove the resistor, together with the resistor brackets and insulator.

(2) Place the new resistor on the mounting brackets furnished with it so that the slider clamp screw will be accessible when the resistor is mounted on the machine. Using a new insulator if necessary, mount the resistor with the insulator under the brackets. Securely tighten the mounting screws.

(3) Connect and solder the leads. On some machines one of the leads is connected directly to the resistor slider terminal. Connect this lead to the terminal on the right end of the resistor and strap this terminal to the slider terminal, providing sufficient slack in the strap for adjustment of the slider.

3.14 ***Plug:***

(1) Loosen the cable clamp screws on the plug using the 3-inch C screwdriver.

(2) Remove the drive pins which hold the cover to the plug body with the 1/16-inch drive pin punch and the 4-ounce riveting hammer.

(3) Slide the cover back along the cable to expose the plug terminals. Tag the leads and unsolder them from the terminals. Remove the cover from the cable.

(4) Remove the cover from the new plug by removing the drive pins with the 1/16-inch drive pin punch and the 4-ounce riveting hammer. Insert the cable through the clamp on the cover. Move the cover back along the cable.

(5) Solder the leads to the proper terminals.

(6) Remount the cover on the plug. Insert the drive pins and, using the hammer, lightly tap them until the heads are flush with the side of the cover. Tighten the cable clamp screws.

3.15 ***Capacitor:***

(1) To replace the capacitor, first remove the bearing bracket from the end of the machine opposite the interrupter as follows. Mark lines on the frame and the bearing bracket to insure mounting the bracket in its original position. Remove the bearing bracket mounting screws and remove the bearing bracket.

(2) Discharge the capacitor by sliding the sleeving on the leads back and shorting the leads with a screwdriver. Then tag and disconnect the capacitor leads. Remove the capacitor mounting screw using the 4-inch E screwdriver and remove the capacitor.

(3) Mount the new capacitor on the bearing bracket and securely tighten the mounting screw.

(4) Connect and insulate the capacitor leads and then remount the bearing bracket.

3.16 ***Relay:***

(1) Remove the relay mounting screw using the 3-inch C screwdriver and carefully withdraw the relay from the bottom of the interrupter, taking care not to damage the leads.

(2) Tag and disconnect the relay leads.

(3) Connect the leads to the proper terminals of the new relay. Mount the relay on the interrupter frame and securely tighten the relay mounting screw.