RINGING MACHINES

KS-5159, KS-5319 and KS-5352 TYPES

REQUIREMENTS AND ADJUSTING PROCEDURES

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1. GENERAL

1.01 This section covers the Holtzer-Cabot (Fig. 1) QD-type ringing machines per KS-5159, KS-5159-01, KS-5319, KS-5319-01, KS-5319-02, KS-5319-03, KS-5319-04, and KS-5352. It also covers the Electric Specialty Co., (Fig. 2) KS-5319-04 machine ▶and the Commercial Electric Products Corp. KS-5319-04 machine.◀

1.02 This section has been reissued to:

(a) Add information on the KS-5319-04 machine as manufactured by the Commercial Electric Products Corp.

(b) Update specified lubricants.

Change arrows are used to emphasize the more important changes. This reissue does not affect the Equipment Test List.

1.03 Reference shall be made to the sections listed below for additional information necessary for the proper application of the requirements listed herein.

020-010-711—General Requirements and Definitions

163-320-801—Replacement Parts and Procedure-Ringing Machines-QD Type

163-704-801—Replacement Parts and Procedures-Ringing Machines-Small Capacity

171-110-701—Commutators, Collector Rings, Interrupters, and Brushes

171-110-801—Resurfacing Commutators and Collector Rings

171-110-802—Brush Replacements for Rotating Machines

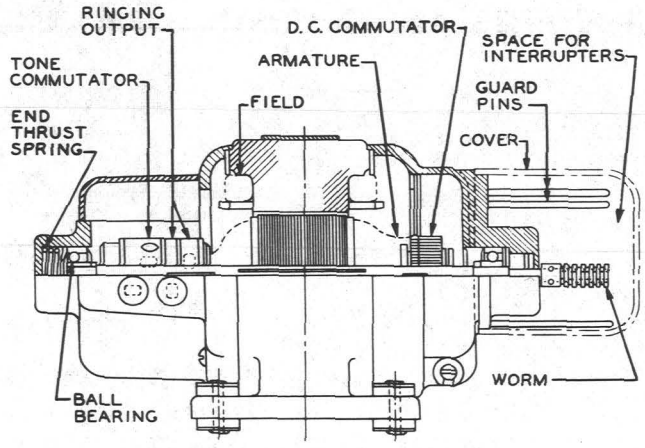

Fig. 1—Assembly (Holtzer-Cabot Machines)

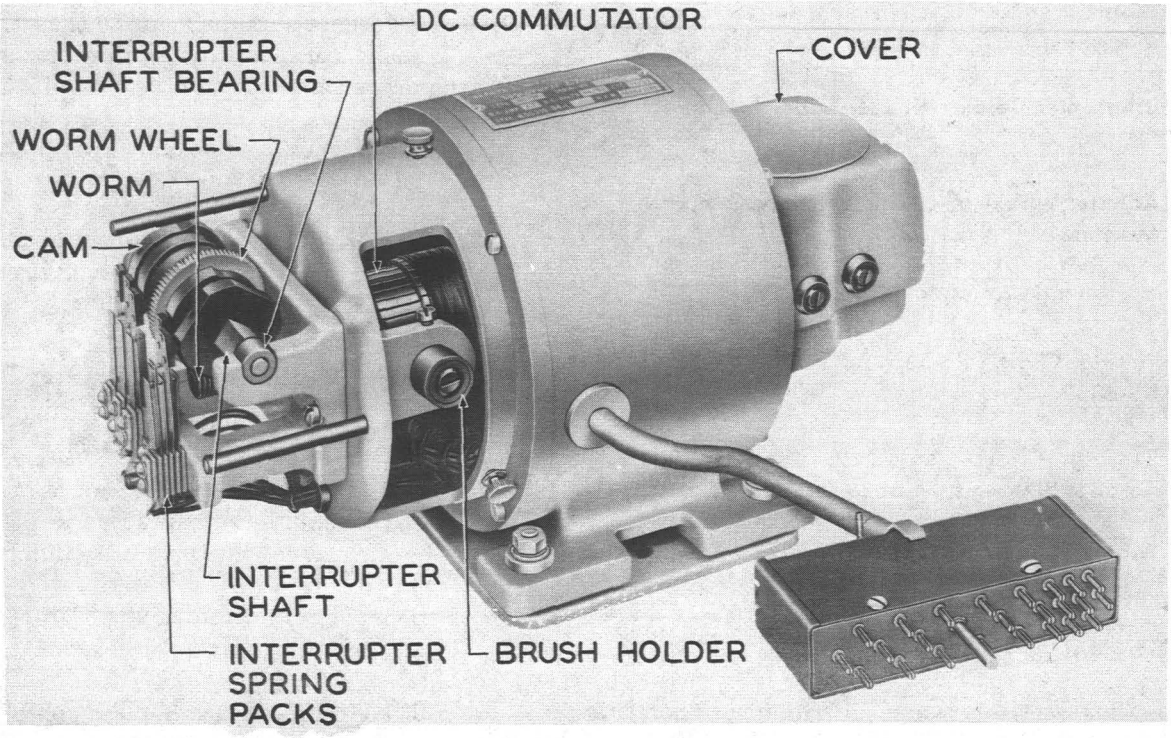

Fig. 2—Assembly (Electric Specialty Company, KS-5319-04)

1.04 ***Phi*** (ϕ): Requirements are marked with a phi when they are not required to be checked before turnover.

1.05 ***Asterisk*** (*): Requirements are marked with an asterisk when to check for them would necessitate the dismantling or dismounting of apparatus or would affect the adjustment involved or other adjustments. No check need be made for these requirements unless the apparatus or part is made accessible for other reasons or its performance indicates that such a check is advisable.

1.06 For the purpose of this section, successful commutation is attained if neither the brushes nor the commutator are burned or 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 When doing any work on a ringing machine, disconnect the power supply in any convenient manner to avoid unexpected starting.

1.08 Before inserting or removing the connector plug of KS-5319-03 machines having an associated No. 275A mercury relay, either remove the battery fuses supplying power to the relay or block relays (on SD-80946-01 block No. 1A and 2A relays nonoperated) to disconnect power from the mercury relay while installing or replacing a machine on the panel. Remove blocks when plug is in place.

2. REQUIREMENTS

(ϕ)2.01 *Lubrication*

Note: Lubrication ***shall not*** be applied to the following parts.

1. Composition roller on interrupter bumper pins
2. Graphite interrupter bearings (darker and less hard than bronze bearings)
3. Interrupter bearings of Electric Specialty Company machines (porous bronze bearings)
4. Double-sealed ball bearings (no grease fittings or drain plug). Replace worn bearings.

(a) The worm and worm wheel (Fig. 3) shall be lubricated with ▶KS-74714◀ grease, avoiding any collection of grease which might get on the interrupter contact springs or bumper-pin rollers. Lubricate at installation. Lubrication every 4 to 6 weeks thereafter is suggested.

(b) The two interrupter shaft bearings (Fig. 4) on the Holtzer-Cabot ▶and Commercial Electric Products Corp.◀ machines are phosphorbronze type bearings (not porous bronze). Although the machines do not have interrupter bearing oil holes, this type of bearing does require lubrication and shall be lubricated with ▶No. 190-230-SUS at 210°F◀ oil. After installation, lubrication on the same schedule as for the worm and wheel is recommended.

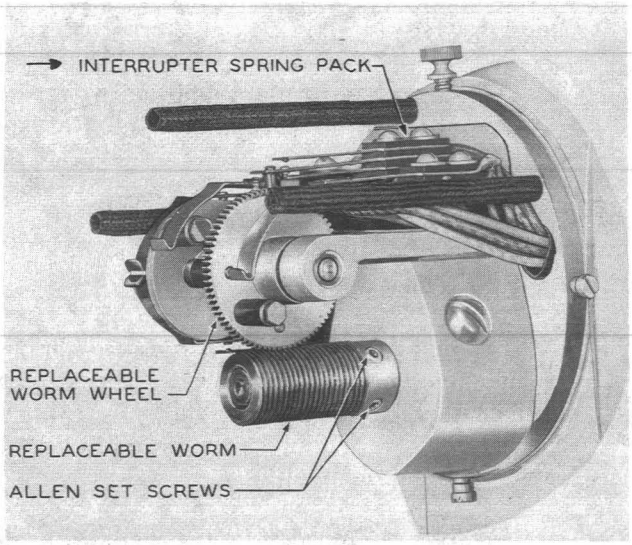

Fig. 3—Worm and Worm Wheel (Holtzer-Cabot Machines)

(c) On armature shaft bearings where separable or single-sealed ball bearings are used, they shall be cleaned and repacked with fresh ▶KS-74711◀ grease every 3 years while in service or, after the motor has been in storage a year or more, before being put into service.

2.02 *Freedom of Rotating Parts*

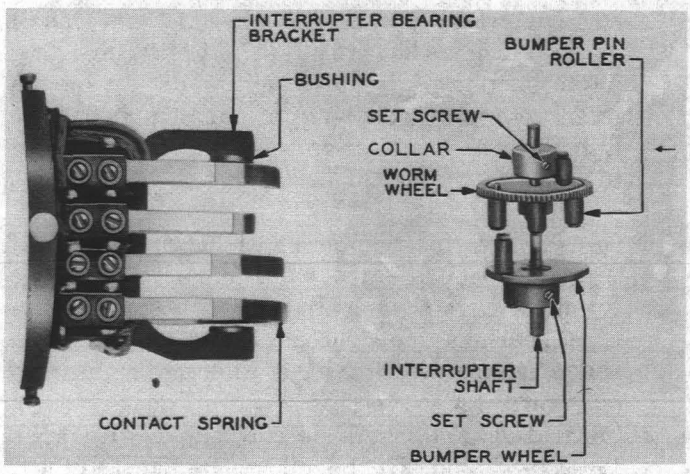

Fig. 4—Interrupter Details (Holtzer-Cabot Machines)

(a) The motor armature and interrupter shaft shall turn freely in their bearings.

Gauge by feel.

(b) The bumper-pin rollers shall turn freely on the pins and there shall be no flat spots worn on the rollers.

Gauge by eye and feel.

* **2.03** ***End Play***

(a) The end play of the armature shaft on machines not provided with a thrust spring shall be just barely perceptible.

Gauge by eye and feel.

(b) Machines equipped with a thrust spring shall have the end play taken up by the thrust spring.

Gauge by feel.

* **2.04** ***The worm and worm wheel*** shall operate together without binding or excess wear.

Gauge by eye and feel.

2.05 ***Noise and Vibration:*** The noise and vibration of the machine under all normal operating conditions shall not be excessive.

Gauge by sound and feel.

* **2.06** ***Motor Speed:*** The motor speed under all conditions of load and supply voltage as specified on the nameplate shall be

Min 1020 rpm

Max 1380 rpm

Use tachometer.

* **2.07** ***Capacity and Voltage:*** These machines are designed for a rated ac output from the transformer secondaries of 250 milliamperes. The output may be assumed to be satisfactory when the output voltage from the transformer secondary is within the limits given below, with the dc input voltage within the limits given and with 250 ohms of noninductive resistance connected across the transformer terminals specified below.

MACHINE	DC VOLTS INPUT	TRANS TERMS	AC VOLTS OUTPUT
KS-5159	44-50	Sec	60-90
KS-5159-01	44-50	Sec	60-90
KS-5319	45-50	Sec	64-80
KS-5319-01	45-50	3 & 4	64-80
KS-5319-01	44-52	3 & 5	65-90
KS-5319-02	45-50	3 & 4	64-80
KS-5319-02	44-52	3 & 5	65-90
KS-5319-03	44-52	3 & 5	65-90
KS-5319-04,L1,→L3←	45-50	3 & 4	64-80
KS-5319-04,L1,→L3←	44-52	3 & 5	65-90
KS-5319-04,L2,→L4←	45-50	3 & 4	64-80
KS-5319-04,L2,→L4←	44-52	3 & 5	65-90
KS-5352	45-52	Sec	60-90

2.08 ***Commutation:*** The ringing machine shall commutate successfully at any current between no load and full load with the voltage and temperature within the limits prescribed for the machine.

Gauge by eye.

2.09 ***Sparking:*** The sparking between brushes and commutators shall be kept to a minimum. There shall be no sparking between brushes and collector rings.

2.10 ***Commutator Color:*** The commutator shall have a clean smooth surface which is free from any discoloration other than the dark bronze or chocolate color which indicates the best commutating condition.

2.11 ***Commutator Slots:*** The slots between the commutator bars shall be free of any dirt, oil, graphite, carbon dust, copper dust, copper dragging, etc. On machines now being furnished, the mica between the commutator segments is usually undercut.

Gauge by eye.

2.12 ***Commutator Surface:*** The commutator shall be free from scoring, pitting, streaking, grooving, cutting, etching, burning, copper dragging, or other deformation of the surface or structure except that caused by normal wear.

Gauge by eye and feel.

2.13 ***Commutator Cleaning and Care:*** The commutator shall be cleaned and otherwise cared for periodically and when necessary to meet the other requirements of the section. The commutator shall be burnished after any cell in the same room has been charged at 2.35 volts or higher if the ringing machine covers have been removed.

2.14 ***Physical Defects:*** The commutator shall have no high, low, or loose segments or flat spots. Eccentricity of the commutator shall not be enough to cause poor commutation or poor operation of the machine.

Gauge by eye.

2.15 ***Brush Condition:*** The brushes shall be free of dirt, dust, grease, oil, carbon particles, and copper picking.

* **2.16** ***Brush Holders and Yokes (Fig. 5):*** The clearance between the commutator and the lower edge of the brush holders shall be

Min 1/32 inch

Max 5/64 inch

Use scale.

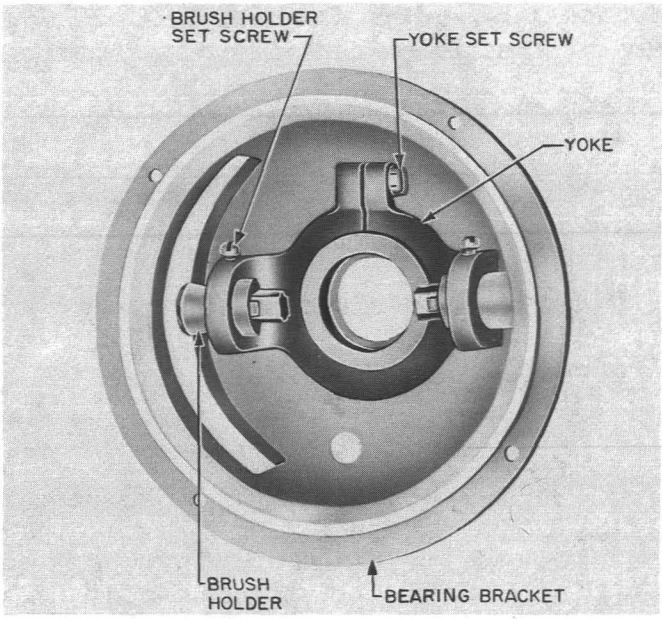

Fig. 5—Adjustable Yoke of Electric Specialty Company Machine

2.17 ***Brush Fit***

(a) Brushes shall not bind in their holders; neither shall they be loose enough to cause poor commutation.

(b) The contact surfaces of the brushes shall be fitted to the commutator so as to insure successful commutation.

ϕ **2.18** ***Brush Length:*** The length of the brushes outside of the spring on the long side shall be

Min 1/2 inch

for all except Electric Specialty Company KS-5319-04 machine which shall have

Min 1/4 inch

Use scale.

2.19 ***Brush Pressure:*** There is no requirement for the pressure of brushes on machines equipped with tubular-type brush holders. The compression on the spring shall be sufficient to give successful commutation.

2.20 ***Interrupter Contacts and Springs (Fig. 6)***

(a) Contacts shall be clean and smooth.

(b) Spring packs shall be tight.

(c) Make contacts shall have visible follow.

(d) The point of contact shall fall wholly within the circumference of the opposing contact disc.

Note: For the purposes of this section, the terms referring to contacts are illustrated in Fig. 5. The timing of the spring contacts is expressed in the figures and text in seconds or in revolutions of the high-speed shaft, the seconds being based on 1200 rpm (20 revolutions equals 1 second).

2.21 ***The timing of interrupter springs on KS-5159, KS-5159-01, and KS-5352 machines*** shall be in accordance with Fig. 7 and (a) through (d) of this paragraph, unless otherwise specified on the circuit drawing.

(a) The normally open contact of only one ringing spring shall be closed at a time, and there shall be more than eight revolutions between the opening of one normally open contact and the closing of the next succeeding normally open contact.

(b) On interrupter spring numbers 1, 2, 3, and 4, the transfer contacts of any one spring pack shall not make at the same time and the period during which neither the normally open nor the normally closed contacts make shall not exceed four revolutions.

(c) On KS-5159 and KS-5959-01 machines, the break periods of the 120-ipm tone interrupter when both transfer contacts are open at the same time shall be 2-1/2 ±1 revolution.

(d) On KS-5352 machines, the contacts of the busy tone interrupter (120 ipm) shall make contact for 4-1/2 ±1 revolution and shall be open for the succeeding 4-1/2 ±1 revolution.

2.22 ***The timing of interrupter springs on KS-5319, KS-5319-01, KS-5319-02, and KS-5319-04 machines*** shall be in accordance with Fig. 8, and KS-5319-03 shall be in accordance

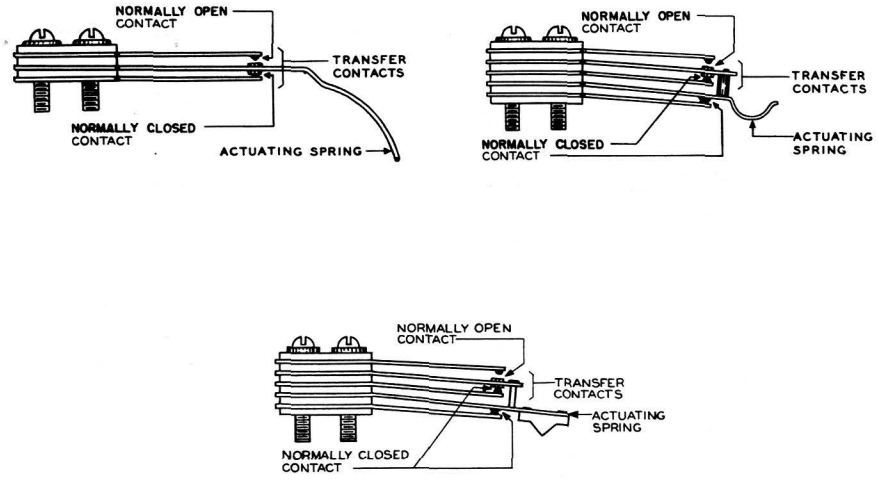

Fig. 6—Typical Interrupter Spring Packs

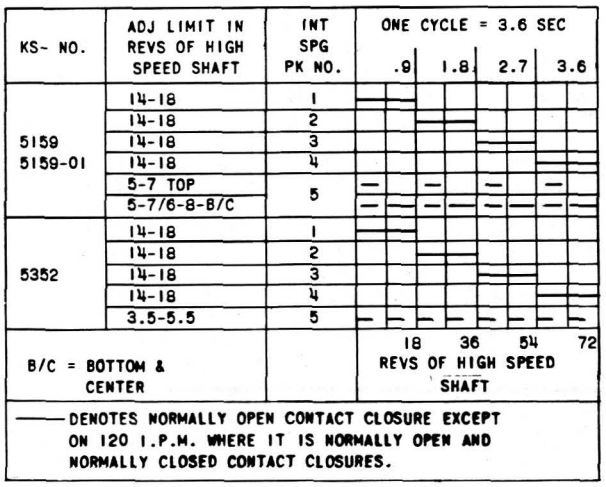

Fig. 7—Timing Chart—KS-5159, KS-5159-01, and KS-5352

with Fig. 9 and (a) through (d) of this paragraph unless otherwise specified on the circuit drawing.

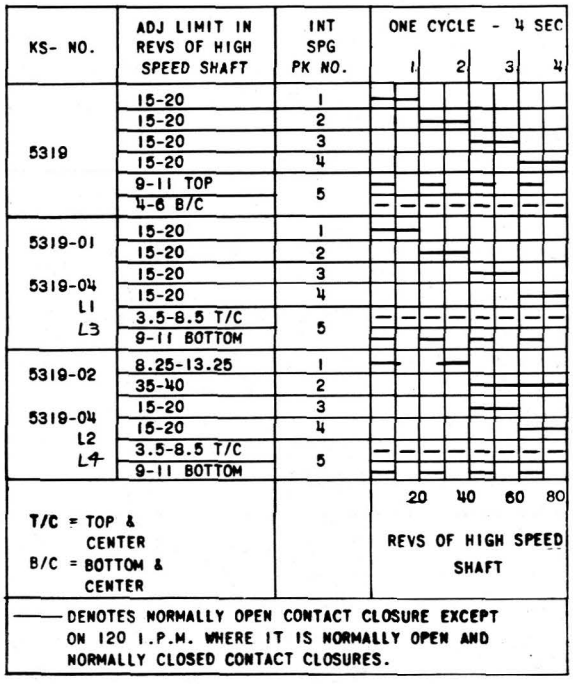

Fig. 8—Timing Chart—KS-5319, KS-5319-01, KS-5319-02, and KS-5319-04

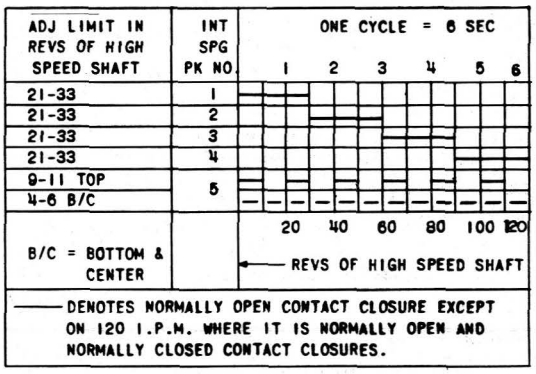

Fig. 9—Timing Chart—KS-5319-03

(a) The normally open contact of only one ringing spring (spring 1, 2, 3, or 4 of KS-5319, KS-5319-01, KS-5319-03, KS-5319-04, L1 ▶and KS-5319-04, L3◀ or spring 1, 3, or 4 of KS-5319-02, KS-5319-04, L2 ▶and KS-5319-04, L4)◀ shall be closed at the same time and there shall not be more than ten revolutions between the opening of one normally open contact and the closing of the next succeeding normally open contact.

(b) On interrupter spring numbers 1, 2, 3, and 4, the transfer contacts of any one spring assembly shall not make at the same time and the period during which neither the normally open nor the normally closed contacts (nearest the bumper wheel or cam) make shall not exceed four revolutions.

(c) The break periods of the 120-ipm interrupter when both contacts are open shall be three or five revolutions.

(d) On the KS-5319-02, KS-5319-04, L2, ▶and KS-5319-04, L4◀ machines, the closure of spring 2 normally open contact shall not overlap the closure of spring 1 normally open contact, but shall occur within five revolutions after the end of the second make period of spring 1 normally open contact.

*2.23 ***Temperatures***

(a) The temperatures of parts shall not exceed the following values.

	MAX
Bearings	80°C (176°F)
Machine frame	90°C (194°F)
Transformer	95°C (203°F)

Use thermometer.

(b) If the temperature is thought to be excessive, measure by a thermometer. To check the requirement, hold the bulb of the thermometer, with machine running, against the part in question. Cover the part of the bulb which is not in contact with the machine with a piece of felt. Observe the temperature reading.

3. ADJUSTING PROCEDURES

3.001 *List of Tools, Gauges, Materials, and Test Apparatus*

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
129B	1/4-inch Hex. Open Double-end Offset Wrench
246	1/2-inch Hex. Open Single-end Flat Wrench
265C	Contact Burnisher
KS-6015	Pliers
KS-6320	Orange Stick
R-2969	Typewriter Brush
—	3-inch Cabinet Screwdriver
GAUGES	
R-8550	Steel Scale, 6 Inches
—	Tachometer, No. 5 or Type A, Boulin Instrument Corp. or equivalent
R-1032, Detail 1	Thermometer
MATERIALS	(See Sections 065-330-101 and 065-370-101)
KS-7860	Petroleum Spirits
KS-14666	Cleaning Cloth
—	Felt Pad
◗ KS-7471 ◖	Grease
—	Oil, Light Mineral, No. 90-110 ◗SUS at 100°F◖
—	Oil, No. 190-230 ◗SUS at 210°F◖
—	Abrasive Paper—Garnet 4/0
TEST APPARATUS	
◗ KS-20599 L4	Digital Multimeter or the older◖ Voltmeter DC, Weston Model No. 931, 300/150/75/30-V
	◗and◖
	Voltmeter, AC, Weston Model No. 528, 300/150-V
—	Resistor, Ward Leonard Type B, 250 Ohms, 20 Watts ◗or equivalent◖

3.002 If the machine is provided with plugs to attach it to a panel equipped with jacks, it will generally be convenient to move the machine to a bench for major maintenance work. If the panel is hinged at the bottom, remove the machine before releasing the panel; otherwise, the machine may drop to the floor.

3.003 When using petroleum spirits for cleaning purposes in the power room, provide as much ventilation as practicable. After using the petroleum spirits, the commutators of all dc machines in the power room should be burnished in accordance with approved procedures for the machines involved since the fumes from the petroleum spirits may soften commutator film and thus adversely affect commutation.

3.01 *Lubrication* (Reqt 2.01)

(1) To clean and lubricate the worm and worm wheel:

(a) ***Cleaning:*** Normally, periodic cleaning of the worm and worm wheel is unnecessary, but when first applying ◗KS-7471◖ grease or whenever the old grease appears gummy or excessively dirty, cleaning is recommended. Use petroleum spirits (see 3.003) and a typewriter brush to clean the old grease out of the gear teeth. A cloth may be used both in applying the petroleum spirits and in removing the excess in order to speed up drying. After cleaning, make sure that the gear teeth are thoroughly dry before applying the lubricant.

(b) ***Lubricating:*** Initially and periodically thereafter, lubricate the worm and worm wheel with ◗KS-7471◖ grease. Apply the grease sparingly to the teeth of the worm wheel over its entire circumference. The grease can be applied with the fingers with the machine stopped, but it will have to be momentarily started several times or advanced manually to obtain unobstructed access to all of the teeth on the worm wheel. The space between the teeth of the worm wheel need not be completely filled with grease since contact with the worm after the machine is started will spread the grease over the entire tooth surface. It is not necessary to apply grease directly to the teeth of the worm. After the grease has been applied, the machine should be run for a few minutes to squeeze the excess grease out of the gear teeth. The excess grease shall be wiped off the sides of the worm wheel with a clean cloth wrapped tightly around an orange stick.

Warning: If the excess grease is wiped off while the machine is in motion, care shall be taken to prevent the cloth or orange stick from getting near the point of engagement of the worm and worm wheel.

(2) Periodic lubrication of the interrupter shaft bearing on the same schedule as worm and wheel should be done by applying one drop of the ◗No. 190-230SUS at 210°F◖ oil to each shaft bearing except for the Electric Specialty Company machines and machines which have the type interrupter-shaft bearings on which no oil should be used. After a few minutes of operation, wipe off excess oil.

(3) At the time of installation and occasionally (about once a year) thereafter, give the interrupter-shaft bearings, except on the machines referred to above, a special lubrication as follows.

(a) Loosen one bumper wheel by unscrewing the setscrew and slide the shaft out enough to expose the shaft-bearing surface. Clean with a cloth moistened with petroleum spirits. Cover the shaft-bearing surface with ◗No. 190-230 SUS at 210°F◖ oil and slide shaft back into position. Wipe off excess oil. Relocate the bumper wheel in its previous position and tighten the setscrew onto the flat of the shaft. The bumper wheel should be close enough to the bracket bearing to avoid appreciable end play of the shaft but not so close as to cause binding.

(4) To clean and lubricate separable and single-sealed ball bearings, remove the ringing machine from service and take off the covers over the commutator, collector rings, and interrupter spring packs. Remove all brushes, marking them so they may be replaced in the same holders and in the same position in the holders from which they were removed. Take off the tone drum and the worm if it is separable from the shaft. Remove the bearing brackets. In some cases, it may be necessary to loosen the screws holding the brush holders and to push the holders outward to secure clearance for the inside bearing plates when the bearing brackets are removed. Be careful to note the disassembly of the parts so that they may be reassembled properly. Do not attempt to remove the inner ball race from the shaft unless the bearing is being replaced. Since 1951, the bearings on KS-5319-01 and KS-5319-02 machines have been double-sealed (enclosed on both sides) instead of single-sealed (enclosed on one side only) as previously supplied. Replacement bearings are of the double-sealed type with thin spacers. These spacers must be substituted for the old thicker spacers when replacing single-sealed bearings with double-sealed bearings.

(5) The ball-bearing parts, spacers, washers, and the inside of the bearing brackets and machine frame should now be cleaned as thoroughly as possible with a cloth moistened with petroleum

spirits (see 3.003). Use may be made of a stiff brush and petroleum spirits, if necessary, to remove the grease from the bearing or bearing housing. With separable ball bearings, it may be convenient to place the outer race and balls in their retainer in a small pan and to cover them with petroleum spirits. Soak for about 5 minutes. Then brush and wipe the bearings with a clean cloth and dip in oil such as light mineral oil, ⧫No. 90-110 SUS at 100°F.⧫ Soaking in petroleum spirits or other solvents is not recommended for sealed- or shielded-type ball bearings. Renew the felt washers in the bearing plates or in the bearing brackets if lubricant has been escaping from the bearing chamber along the shaft to the armature or the worm.

(6) Wipe the inside of the bearing chamber with a slight amount of grease or oil such as light mineral oil on the end of the finger and reassemble bearings and machine. Apply ⧫KS-7471⧫ grease to the ball races and ball retainers of bearings and pack the housing one-third full with fresh grease.

(7) The armature shaft of newer machines is equipped with double-sealed bearings which do not require relubrication. When worn out, they shall be replaced as explained in Section 163-320-801.

3.02 ***Freedom of Rotating Parts*** (Reqt 2.02)

(1) If binding is present, examine the machine and remove any foreign matter. Also check to see that all bolts and screws are firm. Tighten if necessary. Where the worm fastens to the shaft with two setscrews, the one on the flat or at the spotted point on the shaft should be tightened first. Binding may be due to pitted or dirty commutator or collector ring surfaces, damaged bearings, or gummed or caked grease in the bearings. Roughened or pitted commutator or collector ring surfaces should be smoothed. See Section 171-110-701. Gummed or caked grease in the bearings should be thoroughly removed, the bearings cleaned, and new grease placed in the bearings. (See 3.01) If the rotor continues to bind, after performing above procedure, the trouble may be due to worn bearings which should be replaced.

(2) Composition bumper-pin rollers that do not turn freely should be removed and the pin cleaned using abrasive paper—Garnet 4/0 and petroleum spirits. Wipe off thoroughly and be sure the pin is dry before replacing the roller, since both petroleum spirits and oil are detrimental to the rollers. Rollers with flat spots should be replaced with new rollers.

3.03 ***End Play*** (Reqt 2.03)

(1) If there is excessive end play on machines not equipped with thrust springs, loosen the lockout on the adjusting setscrew in the end plate; then, carefully turn the setscrew clockwise until the end play is only barely perceptible. Test to make certain that the armature rotates freely. There were no setscrews on some older machines. In such cases, there is no adjustment except that severe cases can sometimes be corrected by adding shims or washers.

(2) On machines equipped with thrust springs, press against the end of the shaft on the worm end of the motor and see that the thrust spring in the opposite bearing bracket 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, including condition of bearing grease, or replace the thrust spring.

3.04 ***Worm and Worm Wheels*** (Reqt 2.04)

(1) The factory setting of the worm and worm wheel normally gives the necessary clearance between shaft center lines for proper engagement of the teeth without binding and also locates the center line of the worm shaft in the center plane of the worm wheel. While some field adjustment of the worm and worm wheel relationship is possible by tightening the worm wheel bracket assembly screws if they are loose or removing shims if they are present, it is suggested that cases of worn gears or of poor adjustment be referred to the supervisor who may wish to order a replacement worm and worm wheel or, in severe cases, to return the machine to the manufacturer for repair and adjustment. The most satisfactory condition exists when the gear meshes as completely as possible with the worm but the gear teeth do not quite touch the bottom of the groove in the worm. If more information on this subject is desired, see Section 163-704-801 where similar

gears are discussed and Section 163-320-801 which describes the new replaceable worm and worm gear.

3.05 ***Noise and Vibration*** (Reqt 2.05)

(1) Where excessive noise or vibration is present, see that all bolts, nuts, and screws are tight. If the noise and vibration continues after this check, it may be due to damaged bearings and the machine should be completely overhauled.

3.06 ***Motor Speed*** (Reqt. 2.06)

(1) If speed is thought to be outside of limits, remove the cover from the interrupter and apply the tachometer or speed counter to the end of the worm shaft.

(2) If speed is outside of limits, check to see if the supply voltage is within limits. Check the condition of brushes, machine temperature, and freedom of rotation. If speed is low, remove the office load and apply the test load. (See 3.07.) If the machine is within limits when the test load is applied and runs slowly with the office load, it indicates that the office load is excessive. If the trouble cannot be found, report it to the supervisor.

3.07 ***Capacity and Voltage*** (Reqt 2.07)

(1) Connect a 250-ohm resistor, such as a Ward Leonard type B resistor across the secondary terminals of the transformer and check input dc voltage to the machine and ac voltage at the loaded transformer terminals. If voltages are within limits, the machine is assumed to be satisfactory. On transformers having two sets of secondary terminals, either 3 and 4 or 3 and 5 may be used for the test; but, in such case, the other pair of secondary terminals should be on open circuit. No ammeter or voltmeter should be connected between the machine output and the transformer primary.

(2) If the input is within limits and the output voltage with the test load applied is not within limits, check the machine for brush condition, commutator condition, temperature of machine, and freedom of rotation. If the trouble cannot be found, report it to the supervisor.

3.08 ***Commutation*** (Reqt 2.08)

3.09 ***Sparking*** (Reqt 2.09)

3.10 ***Commutator Color*** (Reqt 2.10)

3.11 ***Commutator Slots*** (Reqt 2.11)

3.12 ***Commutator Surface*** (Reqt 2.12)

3.13 ***Commutator Cleaning and Care*** (Reqt 2.13)

3.14 ***Physical Defects*** (Reqt 2.14)

3.15 ***Brush Condition*** (Reqt. 2.15)

See Sections 171-110-701 and 171-110-801 for information on these topics.

3.16 ***Brush Holders and Yokes*** (Reqt 2.16)

(1) To check the brush holder clearances, remove the covers over the motor commutator and collector rings and note the clearance between the edges of the brush holders and the commutator and collector ring surfaces. If adjustment is necessary, loosen the brush holder setscrew and move the brush holders in or out to obtain the proper clearance. After adjusting, be sure that the setscrews are firmly tightened and reseat the brushes affected. (See 3.17.)

(2) On the Electric Specialty Company machine, the brush yoke is adjustable. To adjust the yoke, loosen the yoke setscrew and rotate the yoke as required to reduce any sparking. After adjustment, check that the yoke seats tightly against the bearing bracket and tighten the yoke setscrew.

3.17 ***Brush Fit*** (Reqt 2.17)

3.18 ***Brush Length*** (Reqt 2.18)

See Section 171-110-701 for information on these topics.

3.19 ***Brush Pressure*** (Reqt 2.19)

(1) There should be a reasonable amount of pressure by each brush on the rotating surface on which it slides. It is impractical to measure the pressure; but, in general, there will be satisfactory pressure if the brush length is more than the minimum specified length, if the

brush shunt is not badly twisted, kinked, or broken, and if the brush spring is not burned, deformed, or broken.

3.20 ***Interrupter Contacts and Springs*** (Reqt 2.20)

3.21 ***Timing of Interrupter Springs*** (Reqt 2.21)

3.22 ***Timing of Interrupter Springs*** (Reqt 2.22)

(1) Tighten the interrupter spring pack screws with a screwdriver, as necessary. Timing of the interrupter springs must be rechecked after tightening of the spring packscrews.

(2) The contacts may be smoothed by using a contact burnisher and then wiping with a clean cloth. If the contacts are in poor condition or if the contact springs are badly bent, they shall be replaced. Shape the contact springs that are slightly bent or out of adjustment with a pair of duck-bill pliers.

(3) The springs may be adjusted by shaping. The adjustment may be determined by using a buzzer test set or equivalent such as a tester receiver or indicating lamp connected across the contacts. Check the intervals by counting the number of revolutions of the motor shaft while turning it by hand. It is suggested that a chalk mark be made on the drum to facilitate counting the turns. The timing of each spring pack should be checked for a complete revolution of the associated bumper wheel or cam.

3.23 ***Temperatures*** (Reqt 2.23)

(1) If the temperature reading exceeds the limit, see that requirements 2.02 through 2.15 are met. If the temperature is still outside the limit, refer the matter to the supervisor.