RINGING MACHINES—
SMALL CAPACITY
KS-5510, KS-5546, AND KS-5659
REQUIREMENTS AND ADJUSTING
PROCEDURES

1. GENERAL

1.01 This section covers the KS-5510, KS-5546, and KS-5659 ringing machines.

1.02 This section is reissued to add a cleaning procedure for the interrupter shaft bearings, to delete a lubrication procedure for the interrupter shaft bearings, to revise Figure 15, and to add the information that was included in the addendum. This reissue does affect 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 ***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 dismantling or dismounting of the apparatus, or would affect the adjustment involved, or other adjustments. No check should 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 The low-speed interrupter shaft is not supported in bearings at the ends of the shaft. Care must be taken to avoid bending the shaft extensions outside of the bearings in handling the machine during installation or maintenance.

1.07 Before starting work on the ringing machine, disconnect the power supply in any convenient manner to avoid unexpected starting.

1.08 ***Caution: To avoid damaging spring pack assemblies when manual rotation of the interrupter shaft is required, always turn the high-speed shaft in the normal direction of rotation.***

2. REQUIREMENTS

General

2.01 ***Lubrication***

(a) Delete

(b) ***Bumper Pin Rollers and Nylon Cams and Cam Followers:*** These parts require no lubrication.

(c) ***Worm and Worm Gear:*** The worm and worm gear shall be lubricated with KS-16832 L2 lubricant avoiding any excess of lubricant which might get on the interrupter contact springs or bumper pin rollers. Lubricate worm and worm gear at the time of installation and every 4 months thereafter. This lubrication interval may be extended if periodic inspections have indicated that local conditions are such as to ensure that the worm and worm gear will be adequately lubricated during the extended interval.

(d) ***Bearings:*** Lubricate bearings as follows.

(1) ***Wool-Packed Sleeve Bearings:*** The wool-packed sleeve bearings shall be lubricated with 130-190 S100 oil. Ten drops shall be applied in the oil hole at the time of installation and three to six drops every 4 to 6 weeks thereafter. The lubrication interval may be changed if periodic inspections have

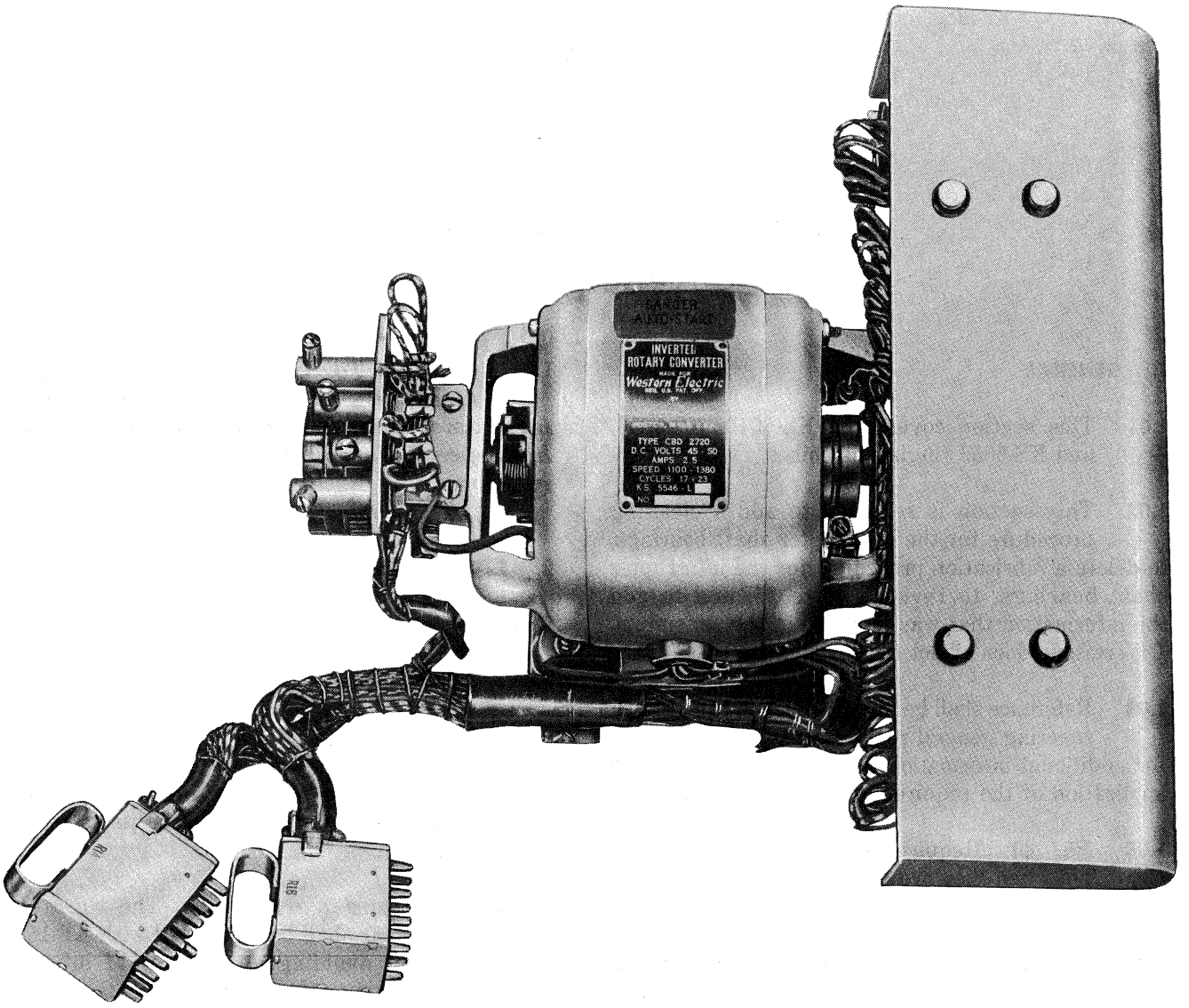


Fig. 1—Wiring of KS-5546 and KS-5659 Machines

indicated that local conditions ensure that the requirements will be met during these intervals.

Note: Where there is objectionable creepage of oil along the shaft, possibly due to bearing wear, 50-55 S210 oil may be substituted in place of the 130-190 S100 oil.

(2) ***Ball Bearings:*** Sealed ball bearings require no lubrication. Open ball bearings shall be lubricated with 260-300P grease before operation of the ringing machine at the time of installation, if the machine has been in storage for more than one year, and every three years thereafter.

2.02 ***Cleaning Interrupter Shaft Bearings:*** The interrupter shaft bearings shall be cleaned annually to prevent the buildup of foreign particles that might damage the bearings.

2.03 ***Freedom of Rotating Parts***

(a) The armature shaft and interrupter shaft shall rotate without bind (see 1.08).

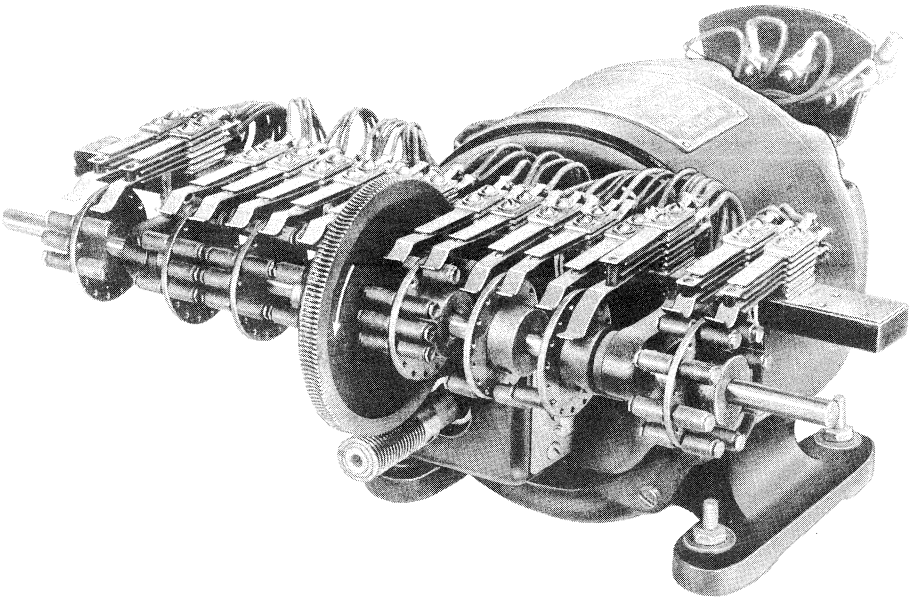


Fig. 2—KS-5546 Ringing Machine

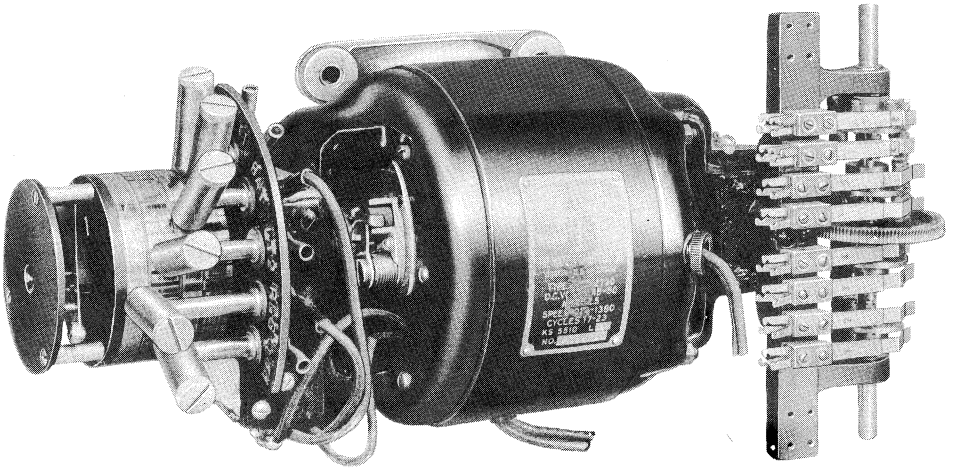


Fig. 3—KS-5510 Ringing Machine

Gauge by eye and 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.

2.04 ***End Play:*** End play shall not exceed 1/16 inch and shall not be enough to permit brushes to override the edges of the commutator, collector rings, or tone drum surfaces.

Gauge by eye.

2.05 ***Operating Noise and Vibration:*** The noise and vibration of the ringing machine, while

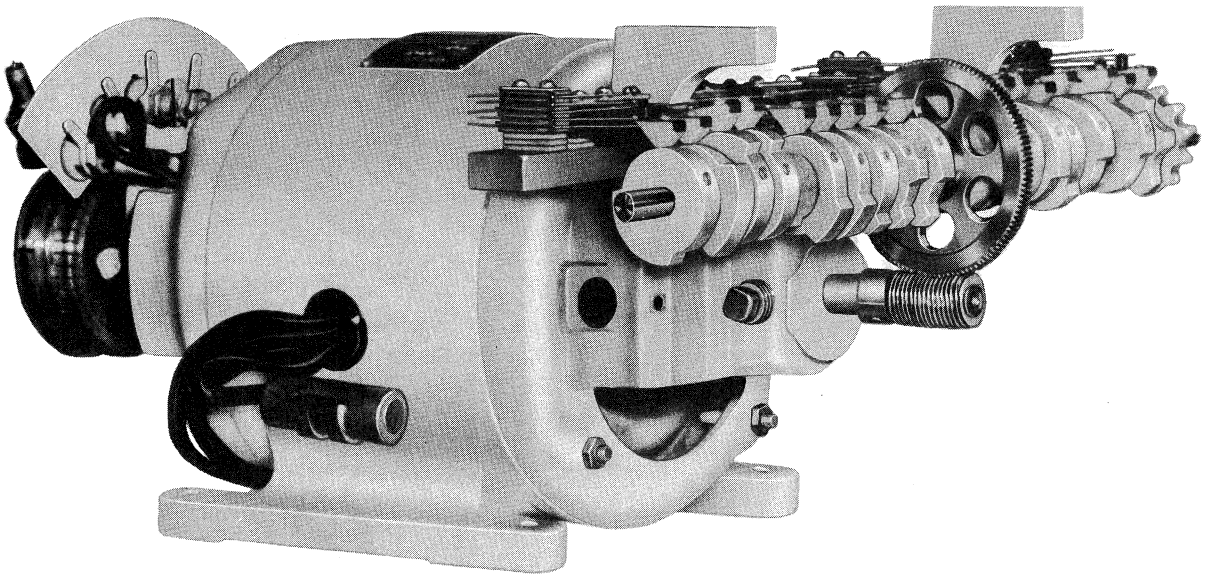


Fig. 4—KS-5659 Ringing Machine

operating under normal conditions, shall not be excessive.

Gauge by sound and feel.

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

RINGING MACHINE	MIN (rpm)	MAX (rpm)
KS-5510	1020	1380
KS-5546	1100	1380
KS-5659	1100	1320

Use Boulin Instrument Corp. Type A tachometer.

2.07** ***Capacity and Voltage

(a) These machines are designed to provide output voltages listed in Table A, on any one pair of transformer output taps.

(b) Resistance values representing full load on the various output transformer taps are given for each machine for test purposes. However, only one test per machine is necessary to determine satisfactory operation.

(c) On KS-5546 L3 through L7 ringing machines, the output current shall not exceed 0.25 ampere for more than 1 hour, after which 0.10 ampere should not be exceeded.

(d) The KS-5659 L1 ringing machine output current requirement applies when the machine output is connected to taps 1 and 2 of the KS-5655 regulator and the load is connected to taps 3 and 4 of the regulator output.

To check this requirement, proceed as follows.

(1) To check in-service voltages, connect an ac voltmeter across the transformer output taps. The output may be read with a 1-ampere ac ammeter in an output lead from the transformer, but it may be more convenient to apply a fixed load [see (2)] and avoid the reading of small ac values. Instruments should not be connected between the machine output and the transformer.

(2) To check output voltage with a fixed load, remove the office load and connect the specified resistance (see Table A) across the indicated taps. If output voltage is within

TABLE A — OUTPUT VOLTAGE AND CURRENT

RINGING MACHINE	LIST NO.	INPUT VOLTAGE		OUTPUT VOLTAGE		ALTERNATOR OUTPUT		
						OUTPUT CURRENT (ampere)	TEST LOAD	
		MIN	MAX	FULL LOAD	NO LOAD		RESISTANCE (ohms)	TRANSFORMER TAPS
KS-5510	All	45	50	64	80	0.30	213	3 – 4
				72	88		240	3 – 5
				72	88		240	6 – 6A
				90	115		300	6 – 7
KS-5546	1	45	50	65	90	0.25	260	3 – 4
				90	120		360	5 – 6
	2	45	50	65	90	0.25	260	3 – 4
				90	130		360	3 – 5
	3 and 4	45	50	75	110	0.25	300	3 – 4
				65	90		260	5 – 6
				90	130		360	5 – 7
	5,6,7, and 13	45	52	75	110	0.25	300	3 – 4
				65	90		260	5 – 6
				90	130		360	5 – 7
	11, 12, 14, and 15	45	50	72	88	0.25	288	3 – 4
		45	52	75	110	0.50	150	3 – 5
		45	52	65	90	0.50	130	6 – 7
		45	50	72	88	0.25	288	6 – 7
		45	52	90	130	0.50	180	6 – 8
KS-5659	1	45	50	84	88	0.50	168	3 – 4

limits, the machine is performing satisfactory. In the case of KS-5659 machines, the output voltage (taps 3 and 4) of the KS-5655 regulator should be adjusted to 87 volts by means of the regulator ADJ volts rheostat.

ϕ2.08 ***Condition of Commutators and Collector Rings:*** The commutator and collector rings shall meet the applicable requirements covered in Section 171-110-701.

2.09** ***Position of Brush Holders and Yoke

(a) The tone drum brush holders and speed-regulator brush holders of the KS-5510 ringing machines shall be mounted radially to the drum, that is, the center line of the brush holder, if extended, shall pass through the axis of the shaft, or as nearly so as is feasible to determine without the use of gauges.

(b) The brush holder yoke shall be located so that the position marks on the yoke and motor frame are in line.

Gauge by eye.

(c) The clearance between the commutator, tone drum, or collector ring and the adjacent edge of the brush holder shall be

Min 1/32 inch

Max 5/64 scale.

Use R-8550 scale.

ϕ2.10 ***Brush Fit:*** The brushes shall meet the applicable requirements covered in Section 171-110-701.

2.11** ***Brush Length: Brushes shall have the following minimum lengths as measured overall except that the length of the brush used in a tubular-type holder is measured up to the shoulder where the spring is attached.

BRUSHES	MIN LENGTH (Inches)
Commutator	3/8
Collector Ring (20 cycles)	1/4
Tone Drum	3/8
Speed Regulator (KS-5510)	1/4

Use R-8550 scale.

2.12** ***Brush Pressure: The brush pressure on each brush shall be sufficient to keep the brush in good contact with the commutator, tone drum,or collector ring.

2.13** ***Temperature: The temperature of parts shall not exceed the following values.

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

Use R-1032 thermometer.

To check the requirement, apply the bulb of the thermometer against the part. Cover the portion of the bulb which is not in contact with the part

with an asbestos pad. Observe the maximum temperature reading.

Interrupter Requirements

2.14** ***Tightness of Spring Pack Mounting Screws: The spring packs shall be securely mounted.

Gauge by eye.

2.15** ***Cleaning of Contacts: The contacts shall be cleaned when necessary.

Gauge by eye.

2.16** ***Contact Alignment

(a) ***Point-Disc Contacts:*** The point of contact shall fall entirely within the circumference of the opposing contact disc.

(b) ***Bar Contacts:*** The width of the contact surface of each contact bar shall fall entirely within the length of its mating bar.

Gauge by eye.

2.17 ***Contact Follow:*** There shall be visible follow of all contact springs after closure of the contacts.

Gauge by eye.

2.18** ***Timing Requirements: The contacts of each spring pack shall close in accordance with the applicable timing chart shown in Fig. 5 through 19.

To check the timing, proceed as follows.

(a) Make sure the power is disconnected from the machine before turning the shaft with the crank or wrench as covered in (b). See caution covered in 1.08.

(b) Initially these ringing machines were provided with a crank which is screwed into a threaded hole in the end of the high-speed shaft opposite the interrupter end of the machine. The interrupter end of the shaft on later machines has a hexagonal hole into which is inserted an Allen wrench to serve as a crank.

(c) Check the timing by using the 81A test set or an indicating lamp connected across the contacts to indicate opening or closure of contacts. Check the intervals by counting the number of revolutions of the high-speed shaft while turning it by hand with the crank or proper size Allen wrench. The timing of each spring pack should be checked for a complete revolution of its associated cam or bumper wheel.

3. ADJUSTING PROCEDURES

3.001 *List of Tools, Gauges, and Materials*

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
81A	Test Set
246	1/2-Inch Open Single-End Flat Wrench
265C	Contact Burnisher Holder
417A	1/4- and 3/8-Inch Hex. Open Double-End Flat Wrench
507A	Spring Adjuster
KS-2663	File
KS-6015	Pliers
KS-6320	Orange Stick
KS-8097	7/16- and 5/8-Inch 12-Point Offset Box Wrench
KS-14208	Brush
R-1051	File
R-2670	3/32-Inch Allen Wrench
R-2959	5/64-Inch Allen Wrench
R-2969	Typewriter Brush
—	Grease Gun, Lincoln Engineering Co No. 5958
—	3-Inch C Screwdriver (or the replaced 3-inch cabinet screwdriver)
—	4-Inch E Screwdriver (or the replaced 4-inch regular screwdriver)

CODE OR SPEC NO.	DESCRIPTION
GAUGES	
79C	0-200 Gram Push-Pull Tension Gauge
R-1032, Detail 1	Thermometer
R-8550	6-Inch Steel Scale
—	Tachometer, Boulin Instrument Corp., Type A
—	Voltmeter, DC, Weston Model 931, Range 30/300 Volts
—	Voltmeter, AC, Weston Model 528, Range 150/300 Volts
MATERIALS	
KS-7860	Petroleum Spirits
KS-14666	Cleaning Cloth
KS-16326 L1	Oil
KS-16832 L2	Lubricant
—	Asbestos Pad
—	Grease, 260-300P
—	Oil, 50-55 S210
—	Oil, 130-190 S100

3.002 While making adjustments in which sudden starting might cause injury to personnel or equipment, disconnect the power supply from the machine by removing fuses, blocking transfer relays, or disconnecting plugs, where furnished.

3.003 In some cases, it will be necessary to dismount the ringing machine and place it on a bench for checking requirements and making adjustments. To dismount the machine, first disconnect the machine from the circuit by removing the plug from the socket; then remove the machine from its mounting bolts. Remount the machine after making checks and re-insert the plug into its associated jack.

3.004 Care should be exercised when using petroleum spirits in power rooms where there are dc machines, since 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.

General

3.01 ***Lubrication*** (Reqt 2.01)

(1) ***Worm and Worm Gear:*** To clean and lubricate the worm and worm gear, proceed as follows.

(a) ***Cleaning:*** Periodic cleaning of the worm and worm gear is normally unnecessary, but when first lubricating or when the lubricant appears gummy or excessively dirty, cleaning is recommended. Remove as much of the old lubricant as possible from the worm and worm gear, using the R-2969 typewriter brush moistened with KS-7860 petroleum spirits. If there is an accumulation of caked or hard lubricant which cannot be removed with petroleum spirits and a typewriter brush, use a clean cloth wrapped around a KS-6320 orange stick and moistened with petroleum spirits to clean the individual teeth of the worm gear. Wipe the parts with a clean dry KS-14666 cloth.

(b) ***Lubricating:*** Apply the KS-16832 L2 lubricant to the entire circumference of the worm gear, making numerous applications with the KS-14208 brush. Rotate the worm gear electrically or manually to obtain unobstructed access to all teeth of the worm gear. Start and run the machine to permit the lubricant to spread over the mating surface of the worm. After the lubricant has expanded fully, stop the machine and remove excess oil from the sides of the worm gear and the bottom of the worm with a clean KS-14666 cloth.

Note: When cleaning and lubricating the worm and worm gear, care shall be exercised to prevent dirt or oil from dropping onto any apparatus below.

(2) ***Wool-packed Bearings:*** To lubricate wool-packed bearings having an overflow hole in the lower part of the bearing housing, add sufficient oil at the top of the bearing so that a trace of oil will come from the overflow hole some time before the next scheduled oiling. Any excess will probably appear within a day after oiling. Wipe off excess oil, using a clean KS-14666 cloth. On wool-packed bearings not having an overflow hole, the amount of oil added periodically will have to be based on experience or the assumption that four to five drops of oil will be required for every 1000 hours of operation.

(3) ***Ball Bearings (bearing housing equipped with pressure fitting):*** Where the ball bearing housing is equipped with a pressure fitting and drain plug, proceed as follows with the machine stopped.

(a) Wipe off the pressure fitting with a clean KS-14666 cloth to avoid forcing dirt into the bearing chamber.

(b) Remove the drain plug and with an orange stick scoop out as much of the old grease from the drain hole as possible. This should remove old coagulated grease and provide pressure relief as the new grease is forced in.

(c) ***Caution: While pumping new grease into the pressure fitting, watch the drain hole and the shaft adjacent to the bearing housing carefully. Stop greasing when grease appears at the drain hole or if grease oozes out along the shaft before it appears at the drain hole. If grease does ooze along the shaft before it appears at the drainhole, remove the pressure fitting to relieve the grease pressure. Wipe off any grease that may have oozed along the shaft.***

(d) Start and run the machine until hot. This will expand the grease and force the excess grease out of the drain hole (or pressure fitting hole if this fitting was removed). After the grease has expanded fully and stopped coming out, stop the machine and scoop out as much grease from the drain hole (or pressure fitting hole) as possible with an orange stick. Replace the drain plug and pressure fitting, if removed.

(4) ***Ball Bearings (bearing housing equipped with grease cup):*** Where the ball bearing housing is equipped with both grease cup and drain plug, proceed as follows with the machine stopped.

(a) Remove the grease cup cap and drain plug and scoop out as much of the grease as possible with an orange stick.

(b) With the machine running, fill the grease cup with grease. Then force the grease into the bearing by screwing down the cap.

Repeat this procedure until grease begins to drip from the drain hole. Run the machine long enough for excess grease to be expelled from the drain hole. Remount the drain plug. Using a clean cloth, wipe off any grease that might have oozed along the shaft.

3.02 ***Cleaning Interrupter Shaft Bearings*** (Reqt 2.02): Apply two drops of KS-16326 L1 oil to the interrupter shaft bearings annually. Wipe off any excess oil.

3.03 ***Freedom of Rotating Parts*** (Reqt 2.03)

(1) If binding is present, examine the machine and remove any foreign matter. Tighten bolts and screws, including the machine mounting bolts and the interrupter bracket mounting screws of machines on which they are not sealed. If the worm is loose on the armature shaft, the setscrew on the spot on the shaft or flat of the shaft should be tightened first.

(2) If the armature shaft binds, check lubrication and end play, see requirements 2.01 and 2.04. If trouble cannot be located, a complete overhaul of the machine may be necessary. See Section 163-704-801.

(3) If a vertically mounted low-speed interrupter shaft binds, it may be due to the spacing between the worm gear and the bumper wheel or nylon cam that rests on the bracket bearing and supports the weight of the low-speed shaft. The distance should be such that the worm gear operates smoothly with the worm and carries none of the weight of the low-speed shaft. On horizontally mounted low-speed shafts, the two bumper wheels or nylon cams next to the bracket bearings should be close enough to the bearings to avoid appreciable end play but not so close as to cause binding. If the binding is due to oil having been applied to the oilless low-speed shaft bearings, it will be necessary to replace the bearings. A bent low-speed shaft would also have to be replaced.

(4) If rollers bind, they should be removed and the pin cleaned with sandpaper and petroleum spirits. The pin should be allowed to dry before replacing the roller as petroleum spirits are detrimental to these rollers.

(5) Recheck interrupter timing after any change in interrupter bearings or bumper pin rollers.

3.04 ***End Play*** (Reqt 2.04)

(1) Excessive armature end play in machines having sleeve bearings may be taken up by adding one or more washers on the armature shaft between the bearings and the shoulder of the shaft. After adding washers, recheck requirement 2.03(a).

(2) Excessive armature end play in machines having ball bearings may be taken up by installing a new spring thrust washer or coil spring as covered in Section 163-704-801.

3.05 ***Operating Noise and Vibration*** (Reqt 2.05): If the requirement is not met, check for tightness of all bolts and screws. Tighten bolts and screws if necessary. If this does not correct the trouble, the bearings may require replacement. Replace the bearings, if necessary, as covered in Section 163-704-801.

3.06 ***Motor Speed*** (Reqt 2.06): If the requirement is not met, check requirements 2.01 through 2.05, and 2.07 through 2.12. If these requirements are met and the speed is still outside the specified limits, refer the matter to the supervisor.

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

(1) If input is within the limits and the output voltage from the transformer with load applied is not within limits, check the machine for brush condition, commutator condition, temperature of machine, and freedom of rotation. On KS-5510 machines, check the regulator brushes and check that the motor brush-holder yoke is in the marked position. If trouble cannot be found, report to the supervisor. If voltages are within bounds with the specified test load but are low under office conditions, the office load may be too high for the machine.

(2) The voltage and speed of the KS-5546 machine depend mainly on the battery voltage inherent regulation, and the position of the motor brush-holder yoke which is set at the factory. No field adjustments are required other than maintaining good commutation. The KS-5510 machine, in addition, has a centrifugal speed regulator which cuts in and out a resistance

connected in the armature circuit. The regulator resistance is fixed at the factory. The only adjustment required in the field for this machine is made with the small screw which adjusts the regulator and is accessible by inserting a screwdriver through the hole in the center of the regulator guard. As a matter of information, the nominal speed is 1200 rpm and the speed is expected to be between 1020 and 1380 for the KS-5510 machine and between 1100 and 1380 for the KS-5546 machine. If the regulator contacts on the KS-5510 machine are rough, smooth with a jeweler's file before adjusting. In adjusting the regulator screw, a portion of a turn will make considerable change in the voltage. It is to be noted that the regulator on the KS-5510 machines is controlled by speed and varies the effective voltage applied to the armature. It therefore controls not only the speed and frequency but also the output voltage.

3.08 ***Condition of Commutators and Collector Rings*** (Reqt 2.08): For maintenance and reconditioning of commutators and collector rings, see Sections 171-110-701 and 171-110-801.

3.09 ***Position of Brush Holders and Yoke*** (Reqt 2.09)

(1) If a brush holder is only slightly out of alignment, this will usually not interfere with commutation and readjustment would not be necessary since any change in the position of the holder necessitates refitting the brush. If the holder is realigned or moved to obtain proper clearance, securely tighten the holder mounting nut and recheck requirement 2.10.

(2) To adjust the position of the yoke, loosen the yoke clamping screw, shift the yoke as necessary, and securely retighten the clamping screw.

3.10 ***Brush Fit*** (Reqt 2.10): If the requirement is not met, fit the brushes to the commutator, tone drum, or collector rings as covered in Section 171-110-701.

3.11 ***Brush Length*** (Reqt 2.11): Replace any short brushes.

3.12 ***Brush Pressure*** (Reqt 2.12): If the requirement is not met, adjust the pressure by increasing or decreasing the tension of the brush spring.

3.13 ***Temperature*** (Reqt 2.13): If the temperature exceeds the specified limits, see that other requirements are met. If these requirements are met and the temperature is still outside the specified limits, refer the matter to the supervisor.

Interrupter Procedures

3.14 ***Tightness of Spring Pack Mounting Screws*** (Reqt 2.14): Securely tighten the spring pack mounting screws using the 3-inch C screwdriver. Check requirements 2.17 and 2.18 after tightening the screws.

3.15 ***Cleaning of Contacts*** (Reqt 2.15)

(1) To clean the contacts, burnish them using the 373D contact burnisher holder with the 374A or 374B contact burnisher blade, depending on which can be conveniently inserted between the contacts.

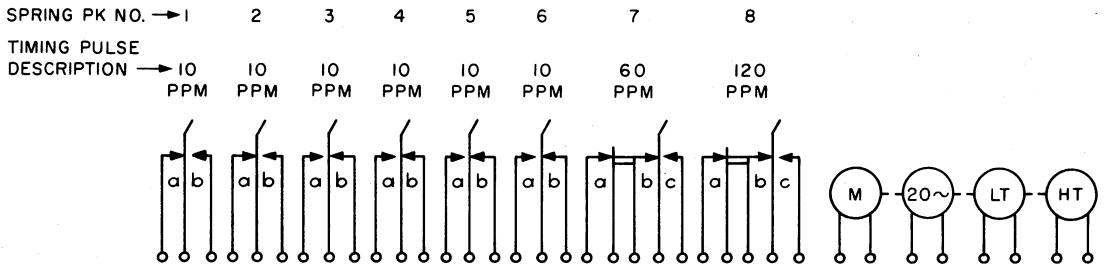
(2) Rotate the high-speed shaft until the contacts to be cleaned are closed. Insert the burnisher blade between the contacts and move it back and forth three or four times.

(3) Check requirements 2.17 and 2.18 after burnishing the contacts.

3.16 ***Contact Alignment*** (Reqt 2.16)

3.17 ***Contact Follow*** (Reqt 2.17)

3.18 ***Timing Requirements*** (Reqt 2.18): If these requirements are not met, adjust the contact springs using the 507A spring adjuster or the KS-6015 pliers if the individual springs are slightly deformed. Bend the springs as required to meet the requirements, taking care not to disturb adjacent springs.



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

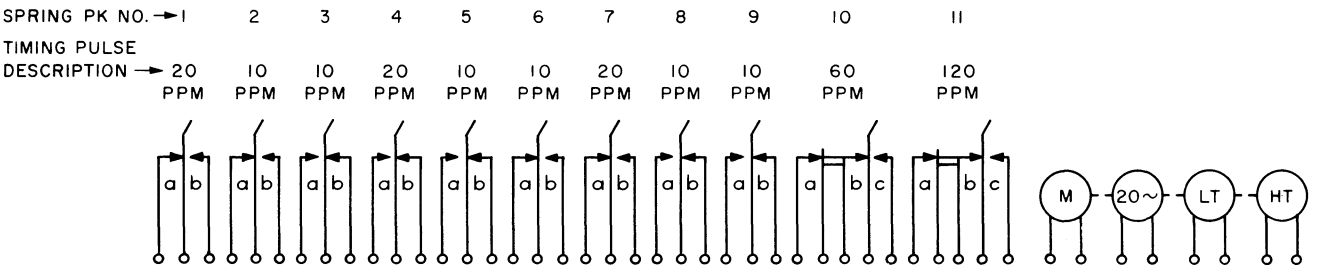
FIG. 5A - RINGING MACHINE SCHEMATIC

TIMING PULSE NO.	TIMING SEQUENCE — REVOLUTIONS OF HIGH SPEED SHAFT (0 20 40 60 80 100 120)	ALLOWABLE VARIATIONS FROM VALUES INDICATED ON CHART — START OF PULSE (REV OF HIGH SPEED SHAFT)	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MIN	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MAX.	PULSES PER MINUTE
1a 1b		REFERENCE *	36	40	10 PPM
2a 2b		±2 *	36	40	10 PPM
3a 3b		±2 *	36	40	10 PPM
4a 4b		±2 *	36	40	10 PPM
5a 5b		±2 *	36	40	10 PPM
6a 6b		±2 *	36	40	10 PPM
7a 7b 7c		SEE NOTE 3 *	8	10	60 PPM
8a 8b 8c		SEE NOTE 3 *	4	7	120 PPM
	0 1 2 3 4 5 6 ELAPSED TIME IN SECONDS; ONE REVOLUTION OF CAM				

NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 4 REVOLUTIONS OF THE HIGH SPEED SHAFT.
2. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.
3. TIMING PULSES NO. 7 AND 8 NEED NOT BEAR ANY RELATION TO THE ZERO REFERENCE.

FIG. 5B - TIMING CHART

Fig. 5—KS-5510 L1 and L11 Ringing Machines



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

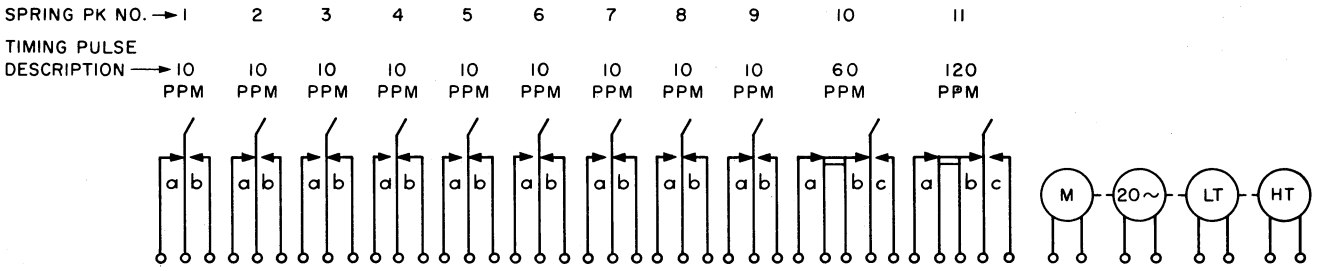
FIG. 6A - RINGING MACHINE SCHEMATIC

TIMING PULSE NO.	TIMING SEQUENCE — REVOLUTIONS OF HIGH SPEED SHAFT (0 20 40 60 80 100 120)	ALLOWABLE VARIATIONS FROM VALUES INDICATED ON CHART — START OF PULSE (REV OF HIGH SPEED SHAFT)	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MIN	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MAX.	PULSES PER MINUTE
1a 1b		REFERENCE *	16	20	20 PPM
2a 2b		±2 *	36	40	10 PPM
3a 3b		±2 *	56	60	10 PPM
4a 4b		±2 *	16	20	20 PPM
5a 5b		±2 *	36	40	10 PPM
6a 6b		±2 *	56	60	10 PPM
7a 7b		±2 *	16	20	20 PPM
8a 8b		±2 *	36	40	10 PPM
9a 9b		±2 *	56	60	10 PPM
10a 10b 10c		SEE NOTE 3 *	8	10	60 PPM
11a 11b 11c		SEE NOTE 3 *	4	7	120 PPM
	0 1 2 3 4 5 6 ELAPSED TIME IN SECONDS ONE REVOLUTION OF CAM				

NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 4 REVOLUTIONS OF THE HIGH SPEED SHAFT.
2. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.
3. TIMING PULSES NO. 10 AND 11 NEED NOT BEAR ANY RELATION TO THE ZERO REFERENCE.

FIG. 6B - TIMING CHART

Fig. 6—KS-5510 L2 and L12 Ringing Machines



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

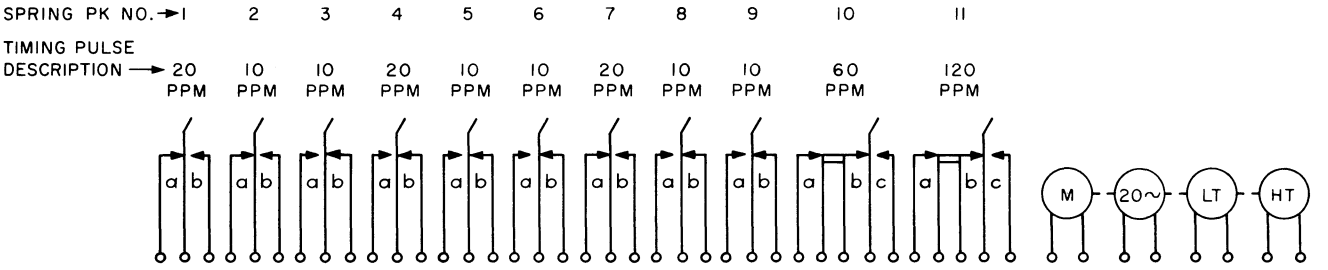
FIG. 7A - RINGING MACHINE SCHEMATIC

TIMING PULSE NO.	TIMING SEQUENCE — REVOLUTIONS OF HIGH SPEED SHAFT (0 20 40 60 80 100 120)	ALLOWABLE VARIATIONS FROM VALUES INDICATED ON CHART — START OF PULSE (REV OF HIGH SPEED SHAFT)	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MIN	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MAX.	PULSES PER MINUTE
1 a 1 b		REFERENCE *	36	40	10 PPM
2 a 2 b		±2 *	36	40	10 PPM
3 a 3 b		±2 *	36	40	10 PPM
4 a 4 b		±2 *	36	40	10 PPM
5 a 5 b		±2 *	36	40	10 PPM
6 a 6 b		±2 *	36	40	10 PPM
7 a 7 b		±2 *	36	40	10 PPM
8 a 8 b		±2 *	36	40	10 PPM
9 a 9 b		±2 *	36	40	10 PPM
10 a 10 b 10 c		SEE NOTE 3 *	8	10	60 PPM
11 a 11 b 11 c		SEE NOTE 3 *	4	7	120 PPM
	0 1 2 3 4 5 6 ELAPSED TIME IN SECONDS ONE REVOLUTION OF CAM				

NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 4 REVOLUTIONS OF THE HIGH SPEED SHAFT.
2. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.
3. TIMING PULSES NO. AND 11 NEED NOT BEAR ANY RELATION TO THE ZERO REFERENCE.

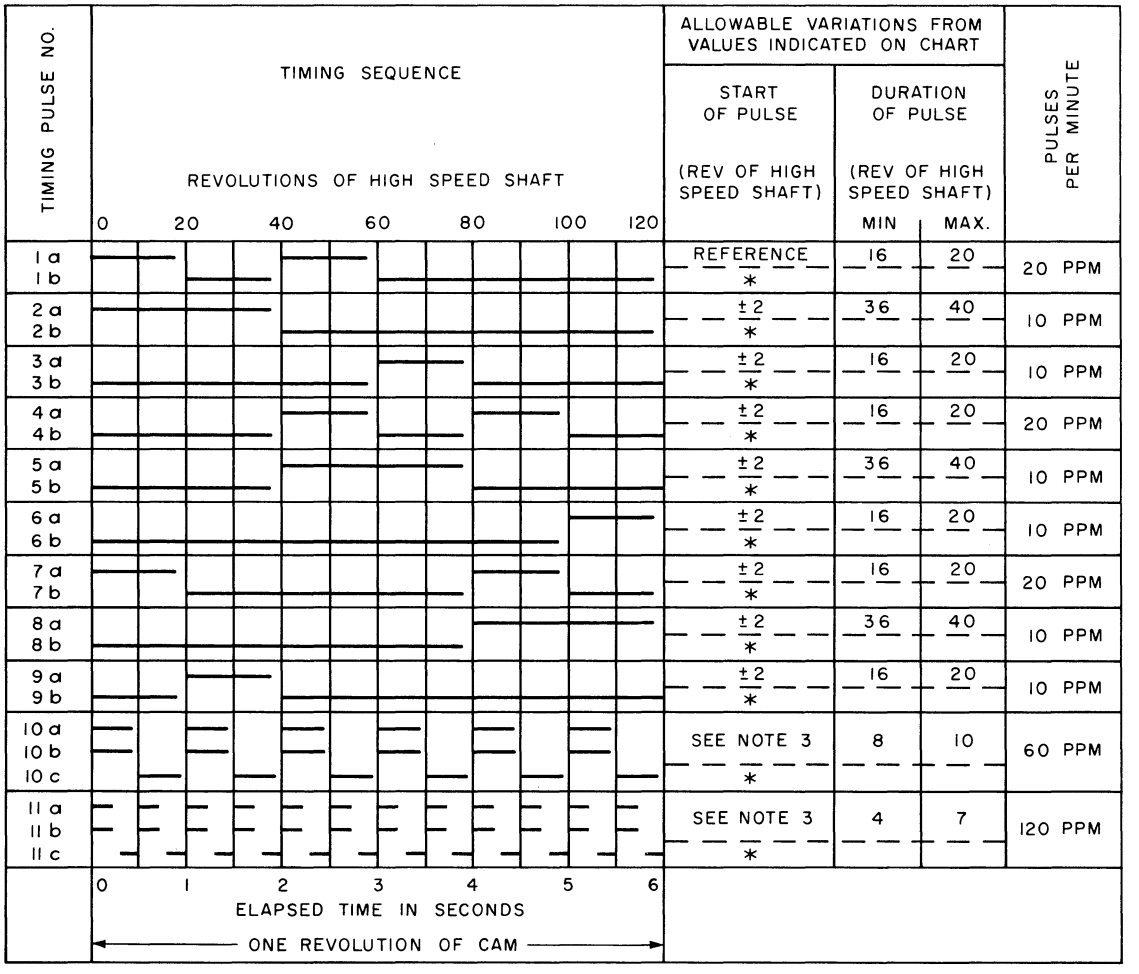
FIG. 7B - TIMING CHART

Fig. 7—KS-5510 L3 and L13 Ringing Machines



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

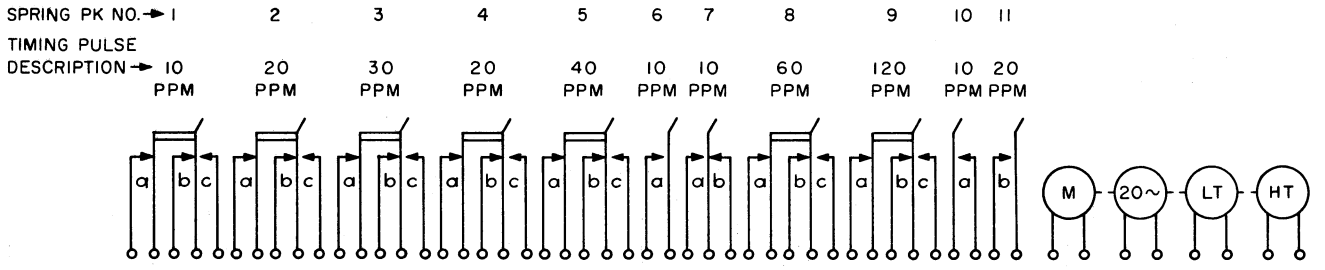
FIG. 8A - RINGING MACHINE SCHEMATIC



NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 4 REVOLUTIONS OF THE HIGH SPEED SHAFT.
2. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.
3. TIMING PULSES NO. 10 AND 11 NEED NOT BEAR ANY RELATION TO THE ZERO REFERENCE.

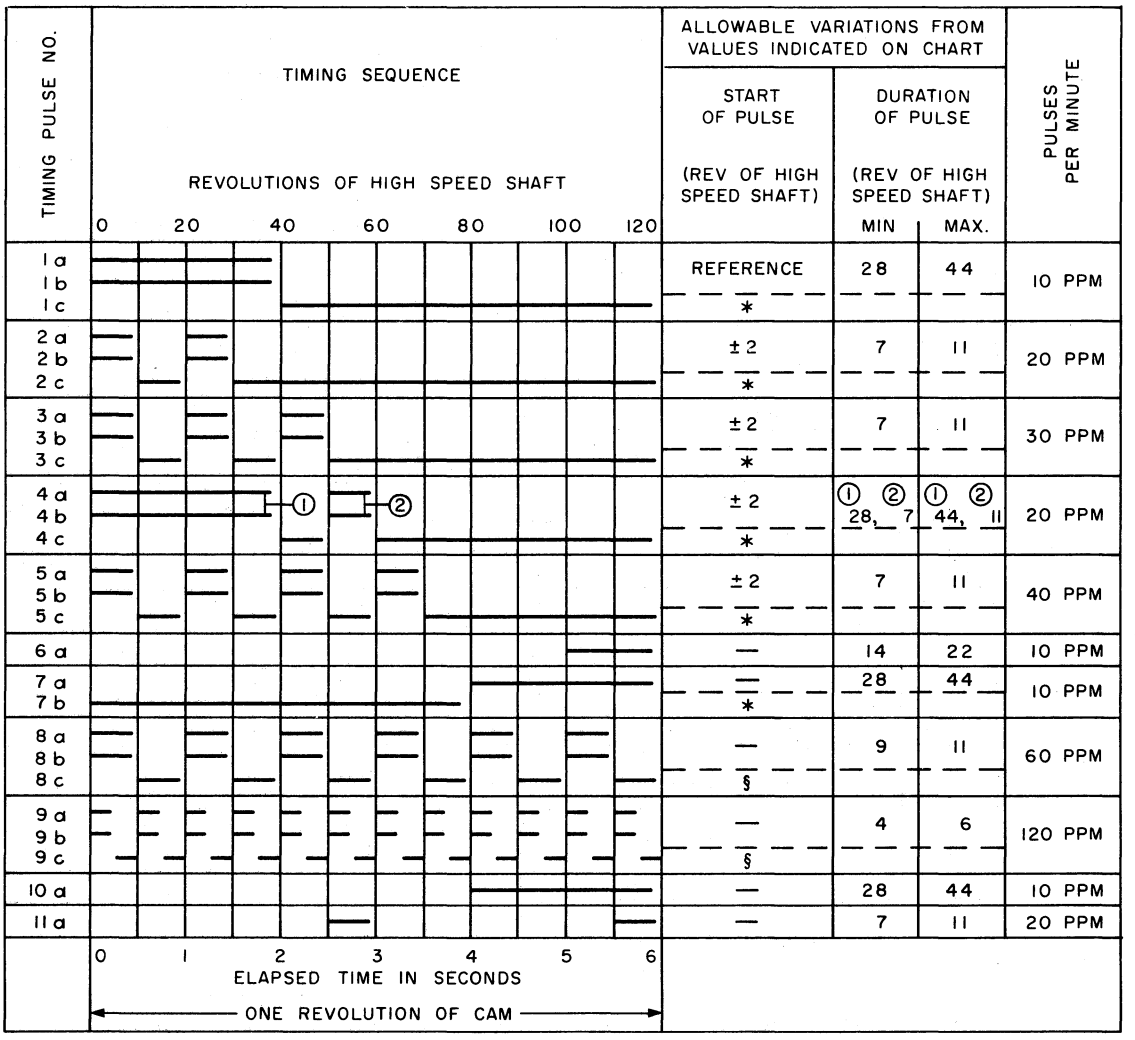
FIG. 8B - TIMING CHART

Fig. 8—KS-5510 L4 and L14 Ringing Machines



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

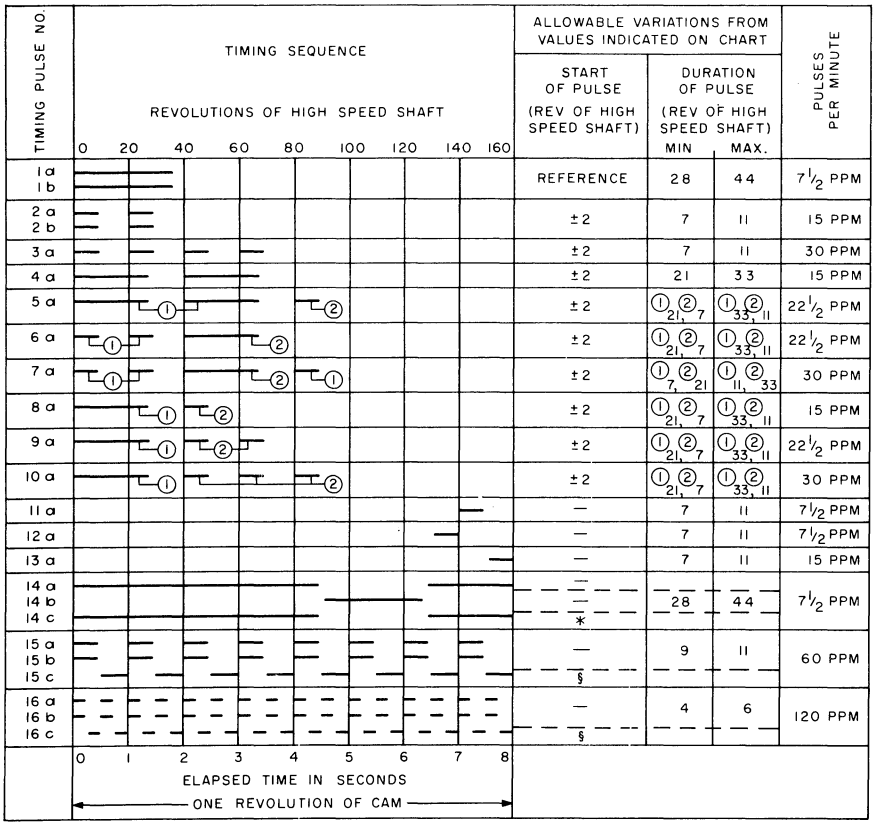
FIG. 9A - RINGING MACHINE SCHEMATIC



NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 REVOLUTIONS OF THE HIGH SPEED SHAFT.
2. § TRANSFER INTERVALS: NO REQUIREMENT ON TRANSFER INTERVAL FOR BREAK BEFORE MAKE. MAKE BEFORE BREAK OF MAXIMUM 3/4 REVOLUTION OF HIGH SPEED SHAFT PERMISSIBLE.
3. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

FIG. 9B - TIMING CHART

Fig. 9—KS-5546 L1 Ringing Machine



NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 REVOLUTIONS OF THE HIGH SPEED SHAFT.

2. § TRANSFER INTERVALS: NO REQUIREMENT ON TRANSFER INTERVAL FOR BREAK BEFORE MAKE. MAKE BEFORE BREAK OF MAXIMUM 3/4 REVOLUTION OF HIGH SPEED SHAFT PERMISSIBLE.

3. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

FIG. 10B - TIMING CHART

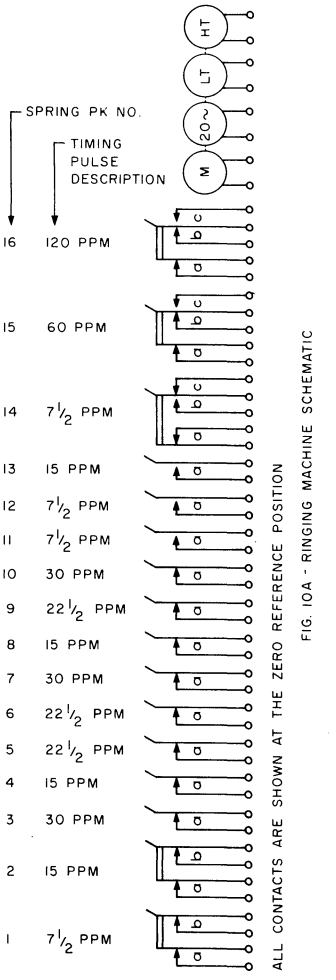
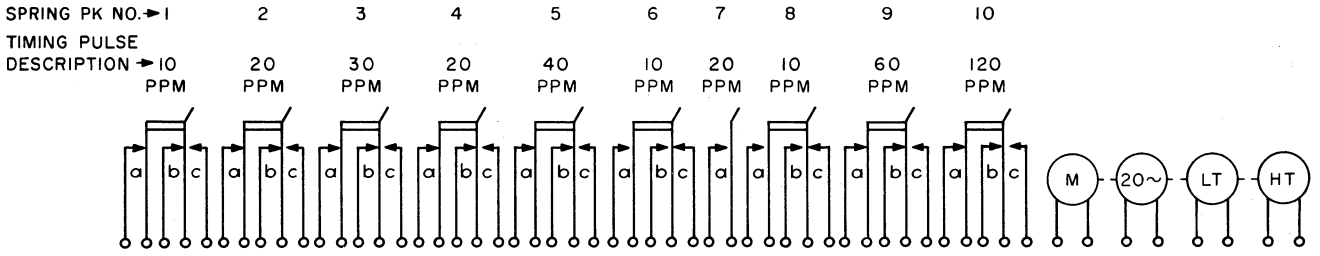


FIG. 10A - RINGING MACHINE SCHEMATIC

Fig. 10—KS-5546 L2 Ringing Machine



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

FIG. IIA - RINGING MACHINE SCHEMATIC

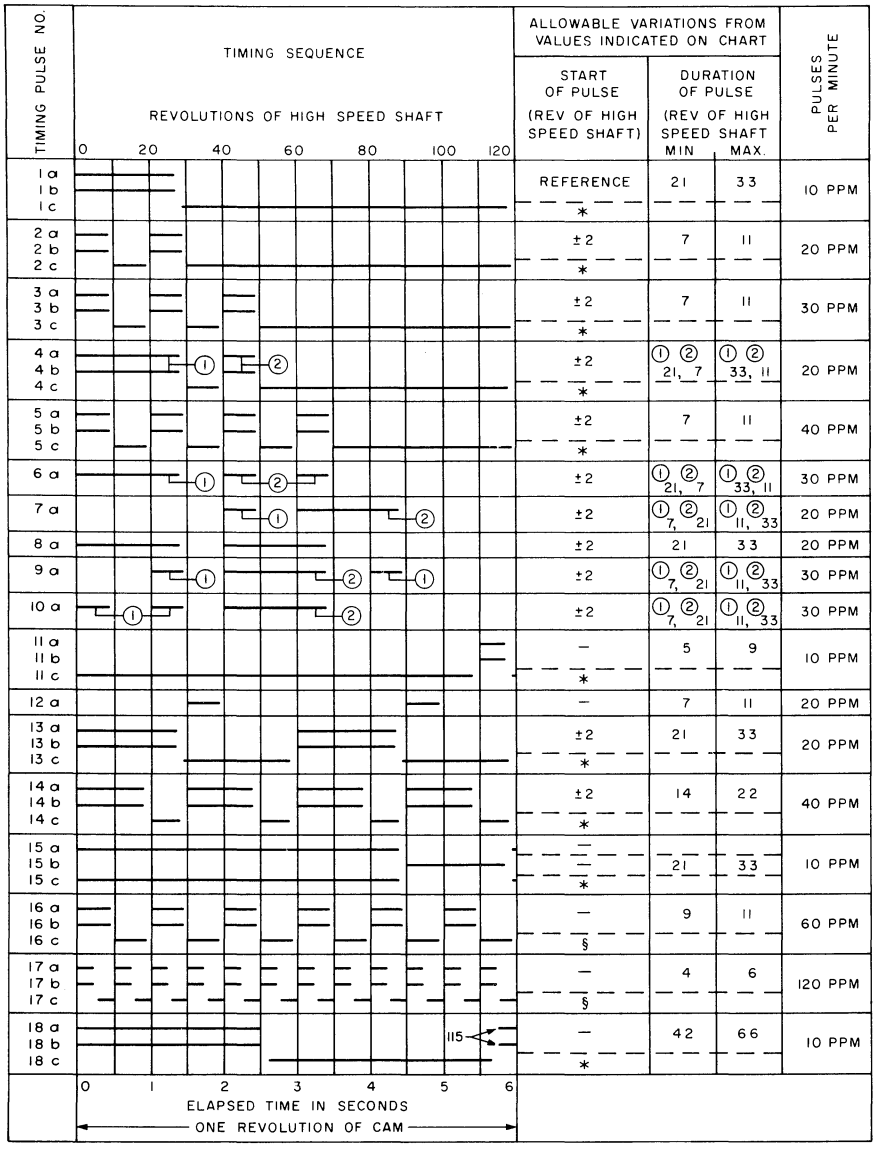
TIMING PULSE NO.	TIMING SEQUENCE — REVOLUTIONS OF HIGH SPEED SHAFT (0 20 40 60 80 100 120)	ALLOWABLE VARIATIONS FROM VALUES INDICATED ON CHART — START OF PULSE (REV OF HIGH SPEED SHAFT)	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MIN	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MAX.	PULSES PER MINUTE
1 a, 1 b, 1 c		REFERENCE, *	21	33	10 PPM
2 a, 2 b, 2 c		± 2, *	7	11	20 PPM
3 a, 3 b, 3 c		± 2, *	7	11	30 PPM
4 a, 4 b, 4 c	① ②	± 2, *	① ② 21, 7	① ② 33, 11	20 PPM
5 a, 5 b, 5 c		± 2, *	7	11	40 PPM
LIST 3 ONLY → 6 a, 6 b, 6 c		—, *	12	19	10 PPM
LIST 7 ONLY → 6 a, 6 b, 6 c		—, *	3	6	10 PPM
7 a		—	7	11	20 PPM
8 a, 8 b, 8 c		—, *	21	33	10 PPM
9 a, 9 b, 9 c		—, §	9	11	60 PPM
10 a, 10 b, 10 c		—, §	4	6	120 PPM

0 1 2 3 4 5 6
ELAPSED TIME IN SECONDS
ONE REVOLUTION OF CAM

NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 REVOLUTIONS OF THE HIGH SPEED SHAFT.
2. § TRANSFER INTERVALS: NO REQUIREMENT ON TRANSFER INTERVAL FOR BREAK BEFORE MAKE. MAKE BEFORE BREAK OF MAXIMUM 3/4 REVOLUTION OF HIGH SPEED SHAFT PERMISSIBLE.
3. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

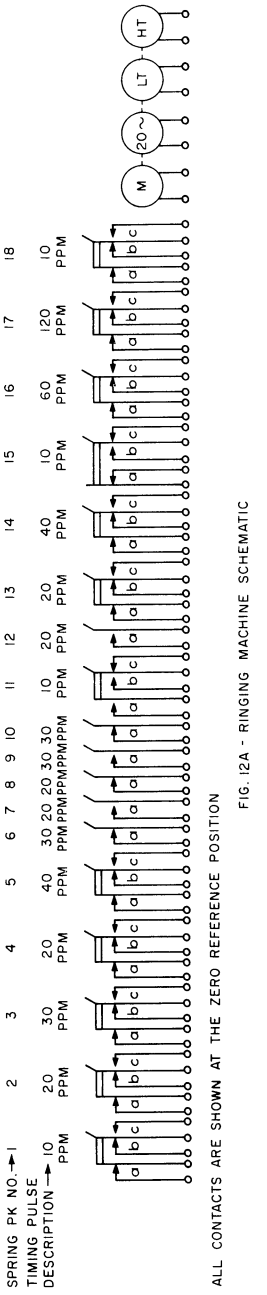
FIG. IIB - TIMING CHART

Fig. 11—KS-5546 L3 and L7 Ringing Machines



NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 REVOLUTIONS OF THE HIGH SPEED SHAFT.
2. § TRANSFER INTERVALS: NO REQUIREMENT ON TRANSFER INTERVAL FOR BREAK BEFORE MAKE, MAKE BEFORE BREAK OF MAXIMUM 3/4 REVOLUTION OF HIGH SPEED SHAFT PERMISSIBLE.
3. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

FIG. 12B - TIMING CHART



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

FIG. 12A - RINGING MACHINE SCHEMATIC

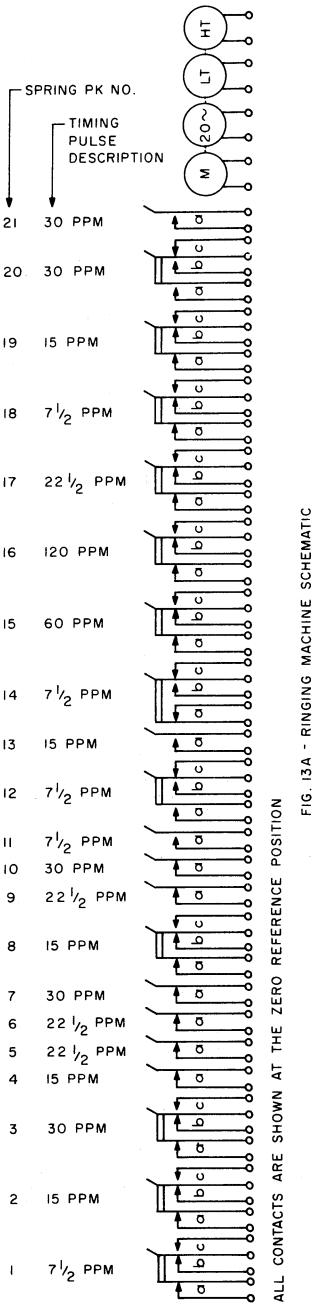
Fig. 12—KS-5546 L4 Ringing Machine

TIMING PULSE NO.	TIMING SEQUENCE — REVOLUTIONS OF HIGH SPEED SHAFT (0 20 40 60 80 100 120 140 160)	ALLOWABLE VARIATIONS FROM VALUES INDICATED ON CHART — START OF PULSE (REV OF HIGH SPEED SHAFT)	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MIN	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MAX.	PULSES PER MINUTE
1a, 1b, 1c		REFERENCE *	21	33	7 1/2 PPM
2a, 2b, 2c		±2 *	7	11	15 PPM
3a, 3b, 3c		±2 *	7	11	30 PPM
4a		±2	21	33	15 PPM
5a		±2	①21, ②7	①33, ②11	22 1/2 PPM
6a		±2	①7, ②21	①11, ②33	22 1/2 PPM
7a		±2	①7, ②21	①11, ②33	30 PPM
8a, 8b, 8c		±2 *	①21, ②7	①33, ②11	15 PPM
9a		±2	①21, ②7	①33, ②11	22 1/2 PPM
10a		±2	①21, ②7	①33, ②11	30 PPM
11a		—	7	11	7 1/2 PPM
12a, 12b, 12c	112	— *	3	6	7 1/2 PPM
13a		—	7	11	15 PPM
14a, 14b, 14c		— *	21	33	7 1/2 PPM
15a, 15b, 15c		— §	9	11	60 PPM
16a, 16b, 16c		— §	4	6	120 PPM
17a, 17b, 17c		— *	7	11	22 1/2 PPM
18a, 18b, 18c		— *	56	88	7 1/2 PPM
19a, 19b, 19c		— *	21	33	15 PPM
20a, 20b, 20c		— *	14	22	30 PPM
21a		—	7	11	30 PPM

0 1 2 3 4 5 6 7 8 — ELAPSED TIME IN SECONDS — ONE REVOLUTION OF CAM

NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 REVOLUTIONS OF THE HIGH SPEED SHAFT.
2. § TRANSFER INTERVALS: NO REQUIREMENT ON TRANSFER INTERVAL FOR BREAK BEFORE MAKE. MAKE BEFORE BREAK OF MAXIMUM 3/4 REVOLUTION OF HIGH SPEED SHAFT PERMISSIBLE.
3. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

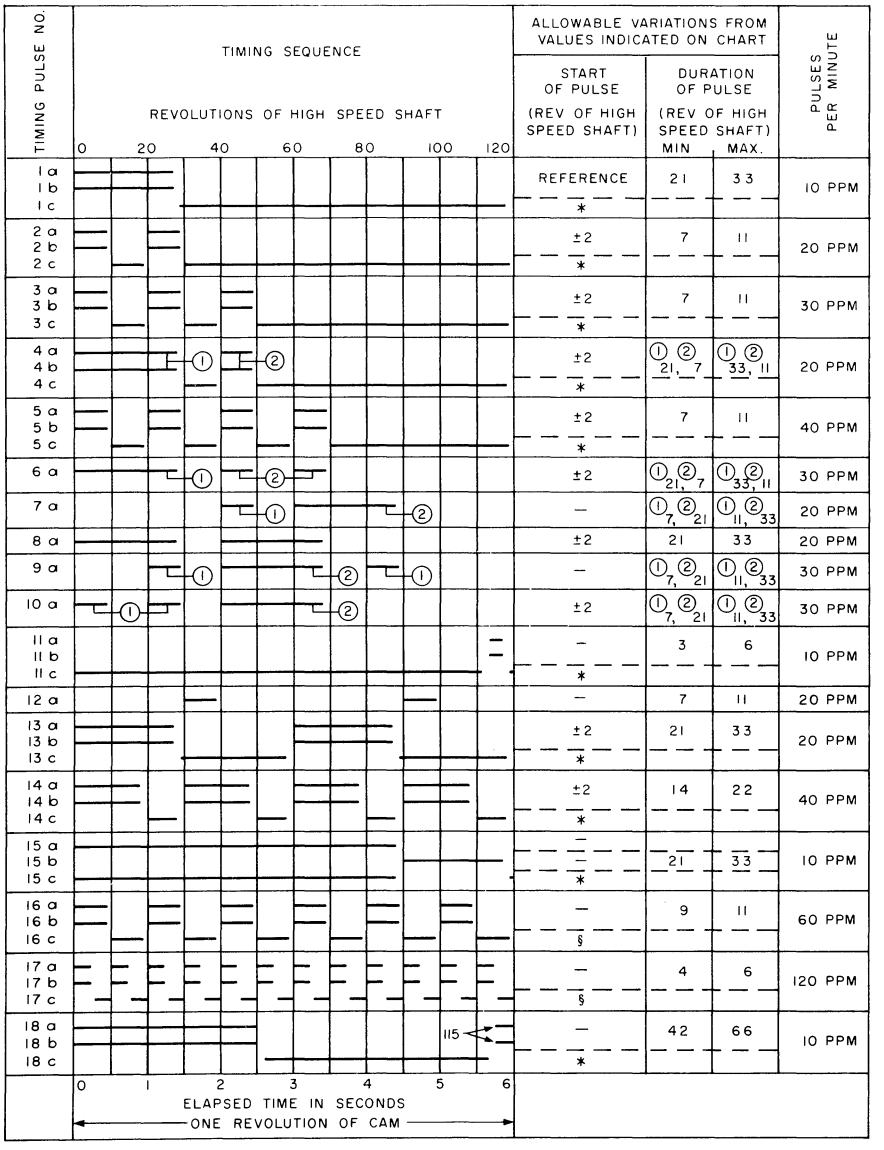
FIG. 13B - TIMING CHART



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

FIG. 13A - RINGING MACHINE SCHEMATIC

Fig. 13—KS-5546 L5 Ringing Machine

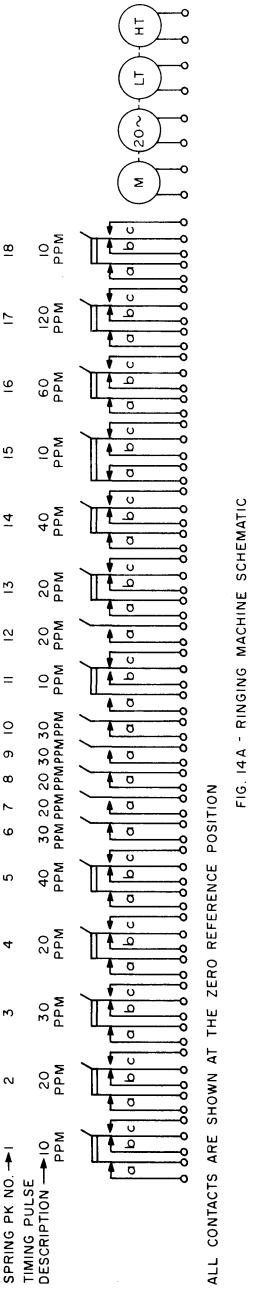


NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 REVOLUTIONS OF THE HIGH SPEED SHAFT

2. § TRANSFER INTERVALS: NO REQUIREMENT ON TRANSFER INTERVAL FOR BREAK BEFORE MAKE. MAKE BEFORE BREAK OF MAXIMUM 3/4 REVOLUTION OF HIGH SPEED SHAFT PERMISSIBLE.

3. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

FIG. 14B - TIMING CHART



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

FIG. 14A - RINGING MACHINE SCHEMATIC

Fig. 14—KS-5546 L6 Ringing Machine

TIMING PULSE NO.	TIMING SEQUENCE — REVOLUTIONS OF HIGH SPEED SHAFT	ALLOWABLE VARIATIONS FROM VALUES INDICATED ON CHART — START OF PULSE (REV OF HIGH SPEED SHAFT)	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MIN	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MAX.	PULSES PER MINUTE
1a 1b 1c		REFERENCE *	21	33	10 PPM
2a 2b 2c		±2 *	7	11	20 PPM
3a 3b 3c		±2 *	7	11	30 PPM
4a 4b 4c	① ②	±2 *	① 21, ② 7	① 33, ② 11	20 PPM
5a 5b 5c		±2 *	7	11	40 PPM
6a 6b 6c 6d	112 112	— *	3	6	10 PPM
7a		—	7	11	20 PPM
8a 8b		±2 *	21	33	10 PPM
9a 9b		— *	21	33	10 PPM
10a 10b 10c		±2 *	21	33	20 PPM
11a 11b 11c		±2 *	14	22	40 PPM
12a 12b 12c		— *	21	33	10 PPM
13a 13b 13c		— §	9	11	60 PPM
14a 14b 14c		— §	4	6	120 PPM
15a 15b 15c	115	— *	42	66	10 PPM

0 20 40 60 80 100 120 — REVOLUTIONS OF HIGH SPEED SHAFT

0 1 2 3 4 5 6 — ELAPSED TIME IN SECONDS

ONE REVOLUTION OF CAM

NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 REVOLUTIONS OF THE HIGH SPEED SHAFT.

2. § TRANSFER INTERVALS: NO REQUIREMENT ON TRANSFER INTERVAL FOR BREAK BEFORE MAKE. MAKE BEFORE BREAK OF MAXIMUM 3/4 REVOLUTION OF HIGH SPEED SHAFT PERMISSIBLE.

3. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

FIG. 15B - TIMING CHART

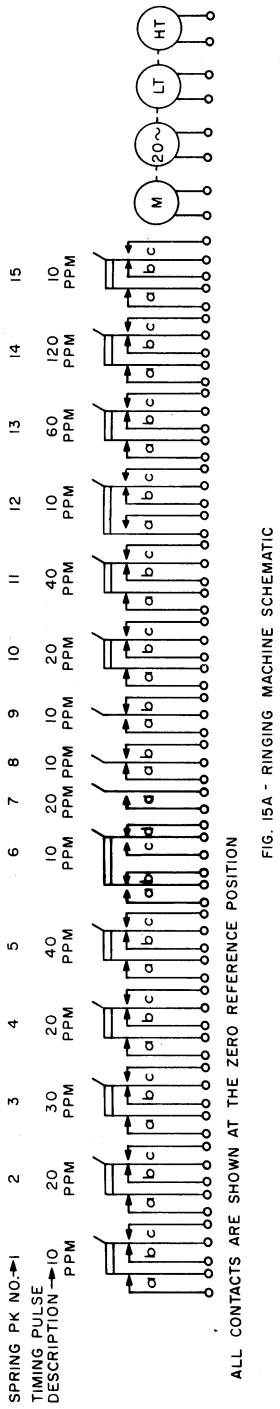


FIG. 15A - RINGING MACHINE SCHEMATIC

Fig. 15—KS-5546 L11 Ringing Machine

TIMING PULSE NO.	TIMING SEQUENCE — REVOLUTIONS OF HIGH SPEED SHAFT (0 20 40 60 80 100 120)	ALLOWABLE VARIATIONS FROM VALUES INDICATED ON CHART — START OF PULSE (REV OF HIGH SPEED SHAFT)	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MIN	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MAX	PULSES PER MINUTE
1a 1b 1c		REFERENCE	28	44	10 PPM
		*			
2a 2b		±2	28	44	10 PPM
		*			
3a 3b		±2	28	44	10 PPM
		*			
4a 4b		±2	28	44	10 PPM
		*			
5a 5b		±2	28	44	10 PPM
		*			
6a 6b 6c		±2	28	44	10 PPM
		*			
7a 7b 7c		±2	28	44	10 PPM
		*			
8a 8b 8c		±2	28	44	10 PPM
		*			
9a 9b		±2	28	44	10 PPM
		*			
10a 10b 10c		±2	14	22	20 PPM
		*			
11a 11b		±2	14	22	10 PPM
		*			
12a 12b 12c		—	9	11	60 PPM
		§	§		
13a 13b 13c		—	4	6	120 PPM
		§	§		
	0 1 2 3 4 5 6 ELAPSED TIME IN SECONDS — ONE REVOLUTION OF CAM				

NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 REVOLUTIONS OF THE HIGH SPEED SHAFT.

2. § TRANSFER INTERVALS: NO REQUIREMENT ON TRANSFER INTERVAL FOR BREAK BEFORE MAKE. MAKE BEFORE BREAK OF MAXIMUM 3/4 REVOLUTION OF HIGH SPEED SHAFT PERMISSIBLE.

3. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

FIG. 16B - TIMING CHART

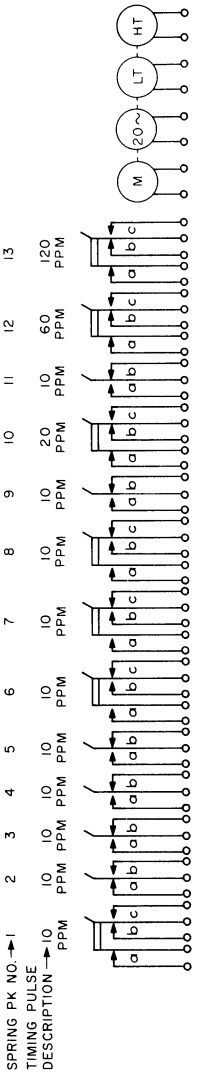


FIG. 16A - RINGING MACHINE SCHEMATIC

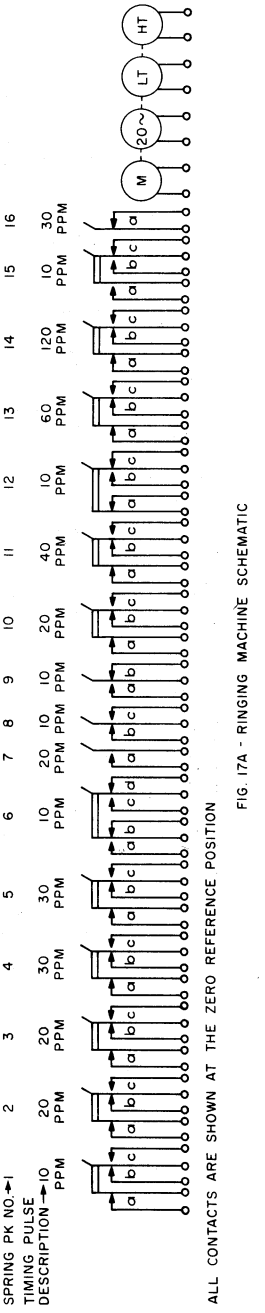
Fig. 16—KS-5546 L12 and L13 Ringing Machines

TIMING PULSE NO.	TIMING SEQUENCE — REVOLUTIONS OF HIGH SPEED SHAFT (0 20 40 60 80 100 120)	ALLOWABLE VARIATIONS FROM VALUES INDICATED ON CHART — START OF PULSE (REV OF HIGH SPEED SHAFT)	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MIN	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MAX.	PULSES PER MINUTE
1a, 1b, 1c		REFERENCE	26	28	10 PPM
2a, 2b, 2c		±1 *	26	28	20 PPM
3a, 3b, 3c	① ②	±1 *	① ② 26, 8	① ② 28, 10	20 PPM
4a, 4b, 4c	① ②	±1 *	① ② 26, 8	① ② 28, 10	30 PPM
5a, 5b, 5c	① ② ①	±1 *	① ② 26, 8	① ② 28, 10	30 PPM
6a, 6b, 6c, 6d	112 112	±1 — ; ±1 *	4 ; 4	6 ; 6	10 PPM
7a	29 89	—	8	10	20 PPM
8a, 8b		±1 *	26	28	10 PPM
9a, 9b		±1 —	26	28	10 PPM
10a, 10b, 10c		±1 *	26	28	20 PPM
11a, 11b, 11c		±1 *	17	19	40 PPM
12a, 12b, 12c		— ; ±1 *	26	28	10 PPM
13a, 13b, 13c		±1 *	9	11	60 PPM
14a, 14b, 14c		±1 *	5	6	120 PPM
15a, 15b, 15c	115	±1 *	59	61	10 PPM
16a		—	35	36	30 PPM

0 1 2 3 4 5 6
ELAPSED TIME IN SECONDS
ONE REVOLUTION OF CAM

NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 1/4 REVOLUTIONS OF THE HIGH SPEED SHAFT. —
2. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

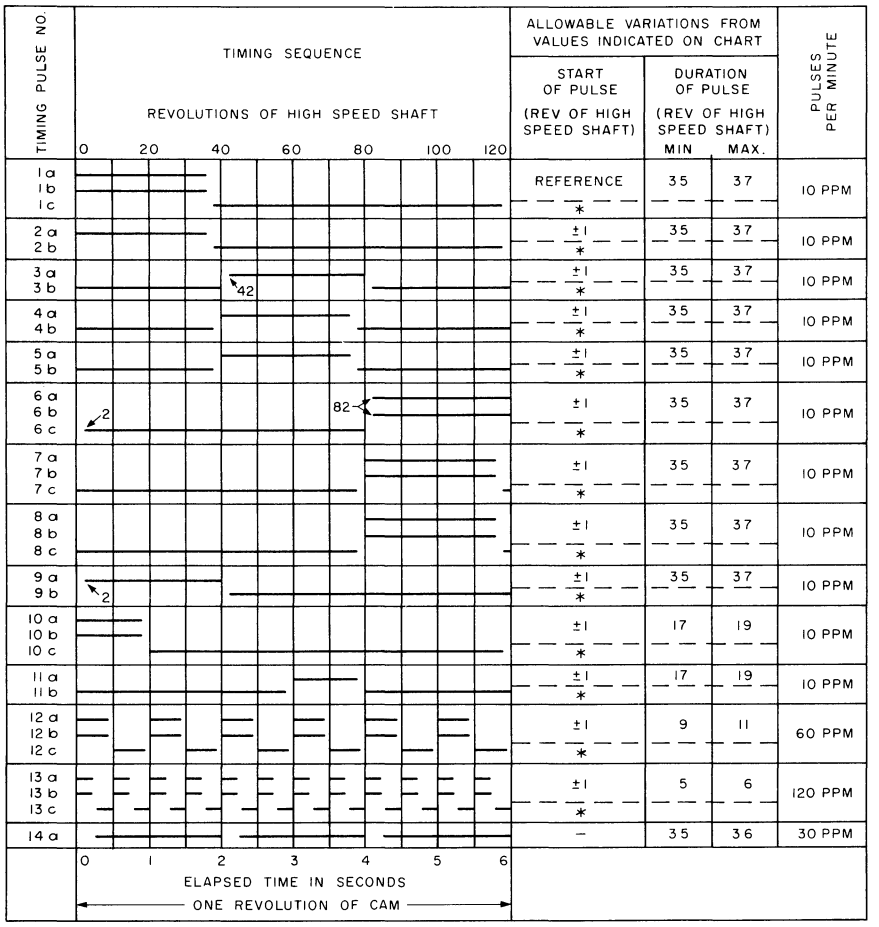
FIG. 17B - TIMING CHART



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

FIG. 17A - RINGING MACHINE SCHEMATIC

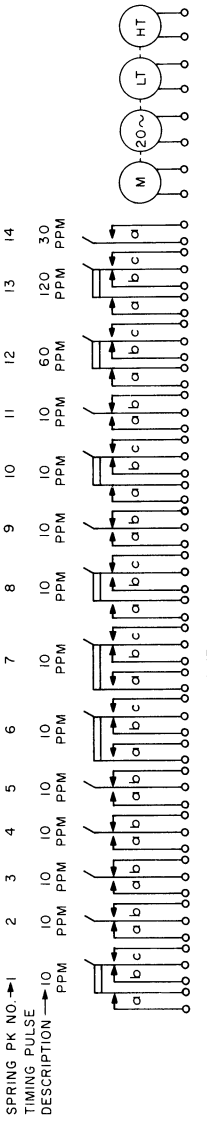
Fig. 17—KS-5546 L14 Ringing Machine



NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 1/4 REVOLUTIONS OF THE HIGH SPEED SHAFT.

2. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

FIG. 18B - TIMING CHART



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

FIG. 18A - RINGING MACHINE SCHEMATIC

Fig. 18—KS-5546 L15 Ringing Machine

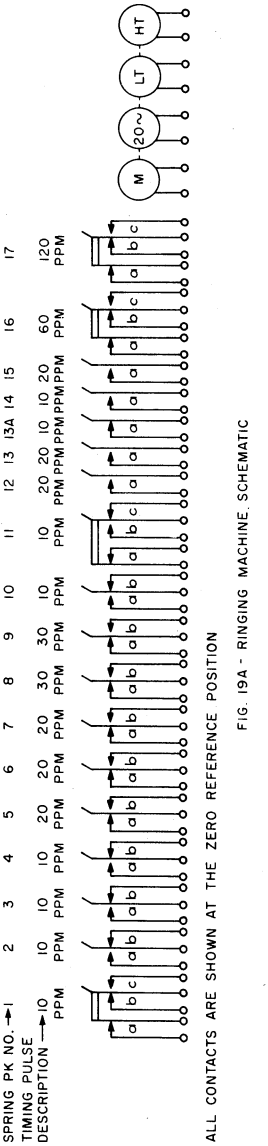
TIMING PULSE NO.	TIMING SEQUENCE — REVOLUTIONS OF HIGH SPEED SHAFT (0 20 40 60 80 100 120)	ALLOWABLE VARIATIONS FROM VALUES INDICATED ON CHART — START OF PULSE (REV OF HIGH SPEED SHAFT)	DURATION OF PULSE (REV OF HIGH SPEED SHAFT) MIN	MAX.	PULSES PER MINUTE
1a 1b 1c		REFERENCE *	28	44	10 PPM
2a 2b		— *	28	44	10 PPM
3a 3b		— *	28	44	10 PPM
4a 4b		— *	28	44	10 PPM
5a 5b		±2 *	14	22	20 PPM
6a 6b		±2 *	14	22	20 PPM
7a 7b	① ②	±2 *	①21,②7	①33,②11	20 PPM
8a 8b	① ② ②	±2 *	①21,②7	①33,②11	30 PPM
9a 9b	① ② ①	±2 *	①21,②7	①33,②11	30 PPM
10a 10b	112	— *	3	6	10 PPM
11a 11b 11c		— *	14	22	10 PPM
12a		—	7	11	20 PPM
13a		—	42	66	10 PPM
13Aa		—	14	22	20 PPM
14a		—	28	44	10 PPM
15a		—	14	22	20 PPM
16a 16b 16c		— §	9	11	60 PPM
17a 17b 17c		— §	4	5	120 PPM
	0 1 2 3 4 5 6 ELAPSED TIME IN SECONDS — ONE REVOLUTION OF CAM				

NOTES 1. * TRANSFER INTERVALS: BREAK BEFORE MAKE AT EACH TRANSFER. THE TRANSFER INTERVAL SHALL NOT EXCEED 2 REVOLUTIONS OF THE HIGH SPEED SHAFT.

2. § TRANSFER INTERVALS: NO REQUIREMENT ON TRANSFER INTERVAL FOR BREAK BEFORE MAKE. MAKE BEFORE BREAK OF MAXIMUM 3/4 REVOLUTION OF HIGH SPEED SHAFT PERMISSIBLE.

3. THE CLOSURE OF TIMING PULSE NO. 1a IS CONSIDERED AS THE ZERO REFERENCE.

FIG. 19B - TIMING CHART



ALL CONTACTS ARE SHOWN AT THE ZERO REFERENCE POSITION

FIG. 19A - RINGING MACHINE SCHEMATIC

Fig. 19—KS-5659 L1 Ringing Machine