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SUPERSEDED FILE

INSTRUCTION BULLETIN

FOR

RINGER TP-8 (VOICE FREQUENCY)

MANUFACTURED BY

International Telephone & Radio Mfg. Corp.

UNITED STATES OF AMERICA

Order No. 17559 - Phila - 42

DESTRUCTION OF ABANDONED MATERIAL IN THE COMBAT ZONE

In case it should become necessary to prevent the capture of this equipment, and when ordered to do so,

DESTROY IT SO THAT NO PART OF IT CAN BE SALVAGED, RECOGNIZED, OR USED BY THE ENEMY, BURN ALL PAPERS AND BOOKS.

MEANS:

1. Explosives, when provided.
2. Hammers, axes, sledges, or whatever heavy object are readily available.
3. Burning by means of incendiaries such as gasoline, oil paper, or wood.
4. Grenades and shots from available arms.

PROCEDURE:

1. Obliterate all identifying marks. Destroy nameplates and circuit labels.
2. Demolish all panels, castings, switch-and instrument-boards.
3. Destroy all controls, switches, relays, connecting means and meters.
4. Rip out all wiring in electrical equipment. Smash gas, oil, and water cooling systems in gas-engine generators, etc.
5. Smash every electrical or mechanical part whether rotating, moving or fixed.
6. Break up all operating instruments such as keys, phones, microphones, etc.
7. Destroy all classes of carrying cases, straps, containers, etc.

DISPOSAL:

1. Where possible, and time permits bury all debris or dispose of it in streams or other bodies of water.

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NOT TO BE PUBLISHED

The information given in this document is not to be communicated either directly, or indirectly, to the Press or to any person not holding an official position in His Majesty's Service.

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CONTENTS

LIST OF ILLUSTRATIONS

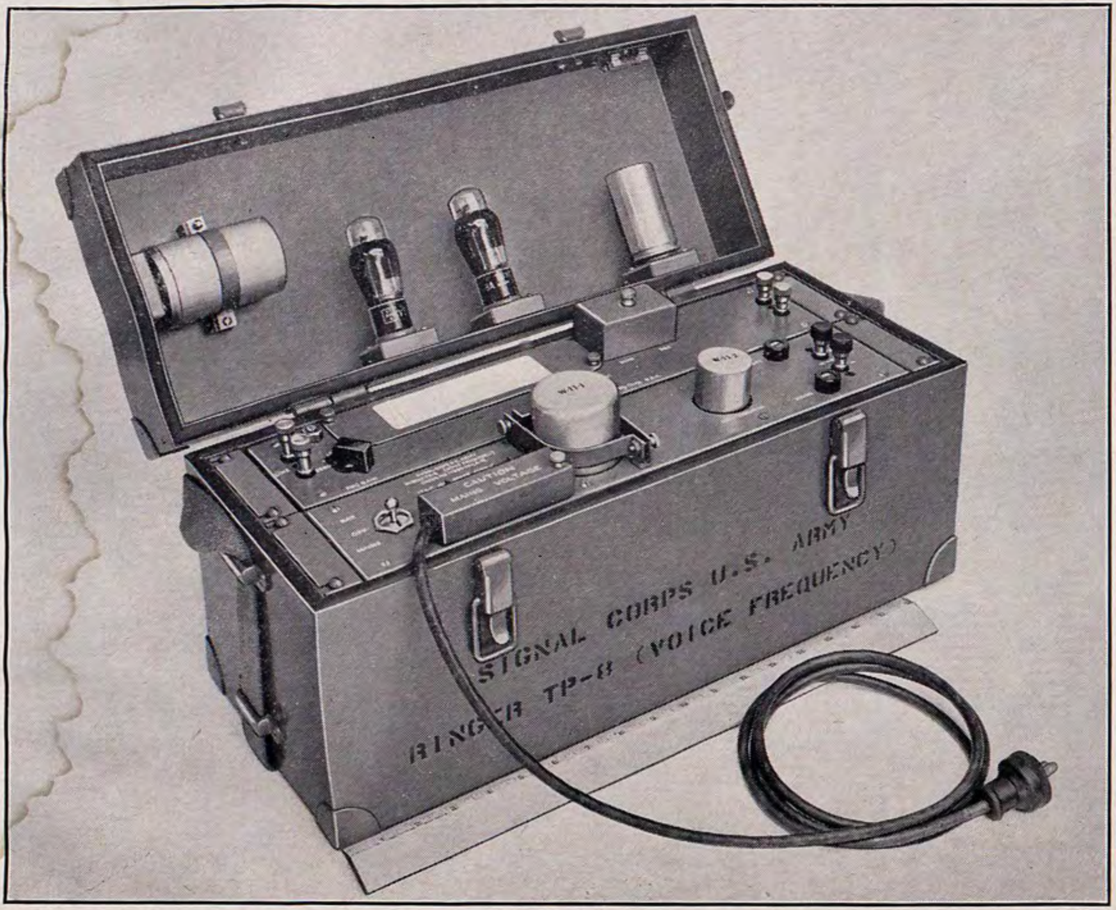


FIG. 1—*Ringer in Case—(Cover Open)*

SECTION I—DESCRIPTION

1. GENERAL

Ringer TP-8 (Voice Frequency) is to be used for signalling on lines which will not pass the ringing current available at switchboards or magneto telephone sets. This ringing current is usually low frequency between 16 and 20 cycles and at comparatively high voltage.

Lines equipped with repeaters or carrier telephone apparatus will not pass such low frequency currents sufficiently well to operate the receiving signalling equipment. This ringer, when inserted between the switchboard or telephone set and the line, will be operated by the low frequency current from the switchboard and in turn will send into the line a frequency within the voice range which the line is designed to pass efficiently. The current at this frequency is amplified and detected at the distant end by a similar ringer which in turn sends out a low frequency current to operate the bell or signal at the switchboard.

This voice frequency ringer is a vacuum tube device and consists of a sending circuit, a receiving circuit with switching relays mounted on one unit and a power unit to supply power for the tubes and relays. It is designed to send and receive currents of 1000 or 500 cycles interrupted at 19 cycles as required. Fig. 1 shows the ringer in the case with the cover open.

2. MECHANICAL DESCRIPTION

a. Ringer Unit

The ringer unit is mounted on a chassis type assembly 17″ by 5$\frac{3}{16}$″ by 3½″ as shown on Figs. 2A and 2B. This chassis has mounted on it the component parts of (1) the 16-20 cycle circuit, (2) the 1000 and 500 cycle oscillator, and (3) the receiver. The two relays RA/3 and RB/3 for the necessary switching are also mounted on the chassis. The chassis and equipment are enclosed in a metal cover shown in Fig. 3. The panel on top contains the terminals for making connections to the line, switch REC GAIN (S1) for changing the sensitivity of the receiver and variable resistance BIAS (P1) arranged for screwdriver operation. The switch S2 for changing the frequency is mounted inside the unit. A plug for conecting the power to the ringer unit is mounted at the bottom of the chassis.

b. Power Unit

The equipment for the power supply is assembled on a chassis similar in design to the ringer unit as shown in Fig. 4. It

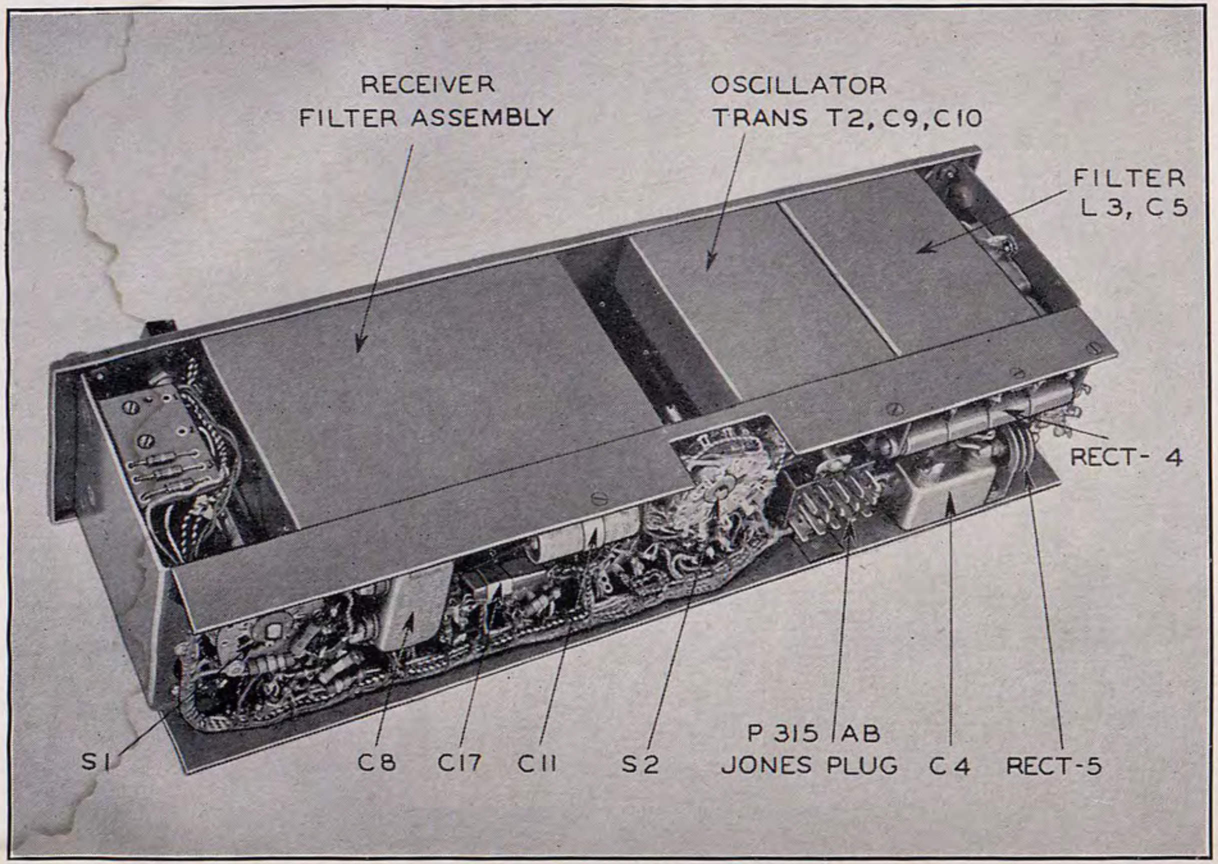


FIG. 2A—*Front View of Ringer Unit Without Dust Cover*

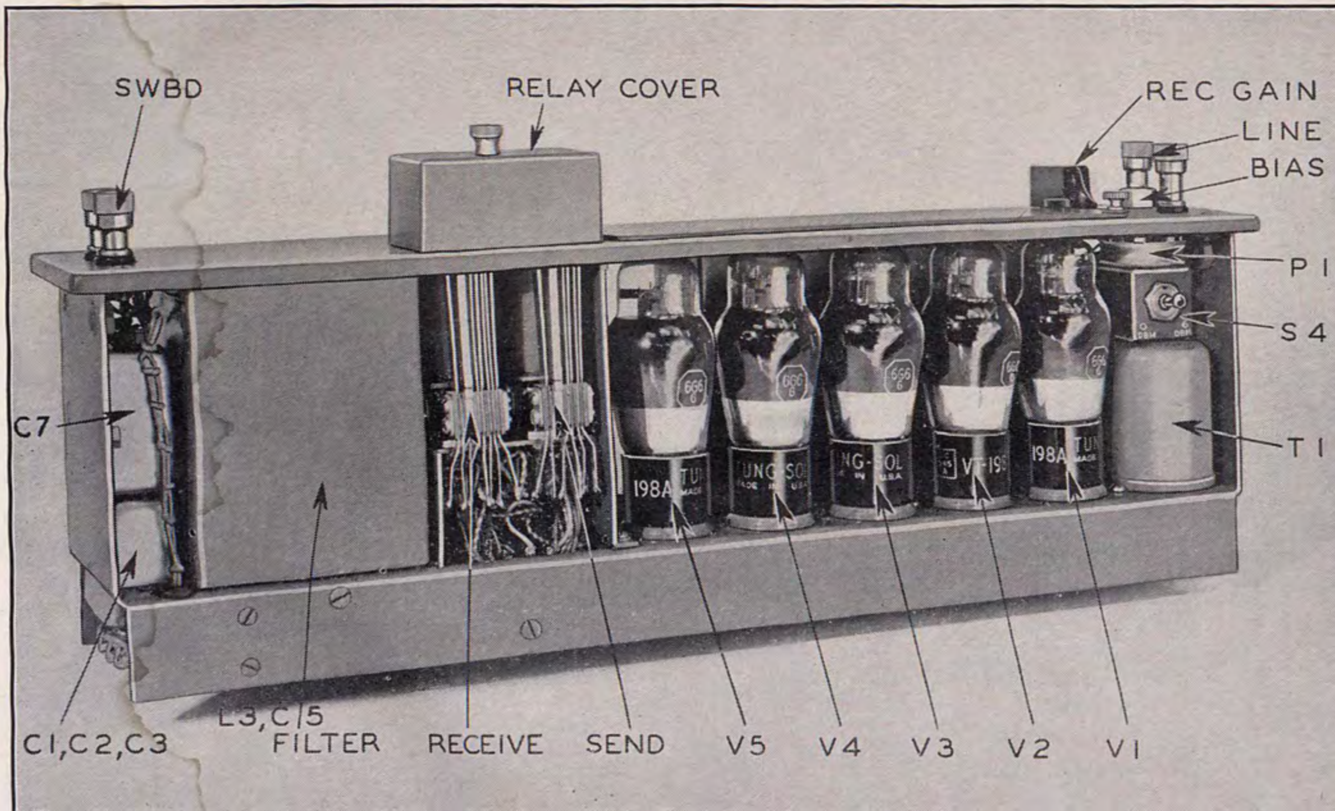


FIG. 2B—*Rear View of Ringer Unit Without Dust Cover*

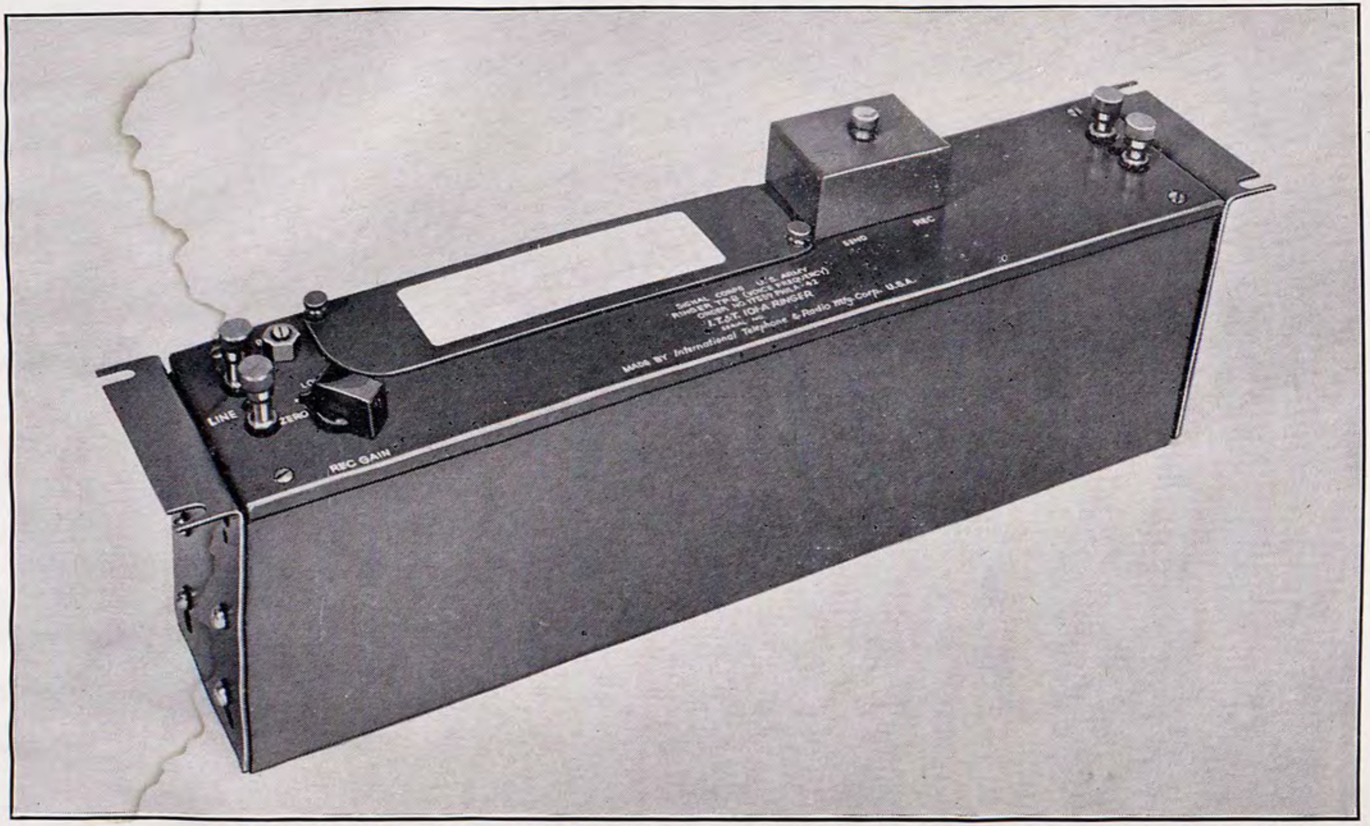


FIG. 3—*Ringer Unit*

contains a power transformer T3, rectifiers RECT. 1, RECT. 2, RECT. 3, and filtering arrangements L5, C21, C22, C23, C24 and R20 for supplying the power for operating the tubes and the included 19 cycle vibrator VIB.2 from the a-c mains. It also includes a 100 cycle vibrator VIB.1 for supplying this power from a 12-V battery. The chassis and equipment are enclosed in a metal cover as shown in Fig. 5. On the top of the chassis is a panel on which are mounted the terminals for connecting the a-c mains, battery, fuses and a switch for connecting the power either from a-c mains or from the 12-V battery. A socket for connecting power to the ringer is mounted at the bottom of the chassis.

3. LIST OF COMPONENT PARTS

Quantity	Description	Dimensions	Weight in Lbs.
1	Ringer Unit	18½″ x 3½″ x 5⅝″	17.2
1	Power Unit	18½″ x 3½″ x 5⅝″	18.2
1	Case	20″ x 8″ x 10″	12.5
			Total 47.9 lbs.

Vacuum Tubes and Vibrators

	Code		
Quantity	Signal Corps	Commercial	Use
1	VT-198A	6G6-G	Amplifier
3	VT-198A	6G6-G	Detectors
1	VT-198A	6G6-G	Oscillator
2	VT-198A	6G6-G	Spares
1+1 Spare		Vibrator W11-1	19 cycle Generator
1+1 Spare		Vibrator W11-2	Battery Power Converter

4. CURRENT DRAINS

The current drains for the different conditions of supplying power are as follows:

Power Supply	Voltage	Current
AC (Mains)	110	110 milliamperes
AC (Mains)	220	55 milliamperes
Battery	12	1 ampere

SECTION II—EMPLOYMENT

5. INSTALLATION

a. Assembled Units

Both the ringer and power unit have brackets at the ends so that they can be mounted on a relay rack or in a case. A wooden case is provided for mounting both the ringer unit and power unit. This case is 20″ by 8″ by 10″ and is equipped with straps so that it is readily portable as shown in Fig. 6. The case

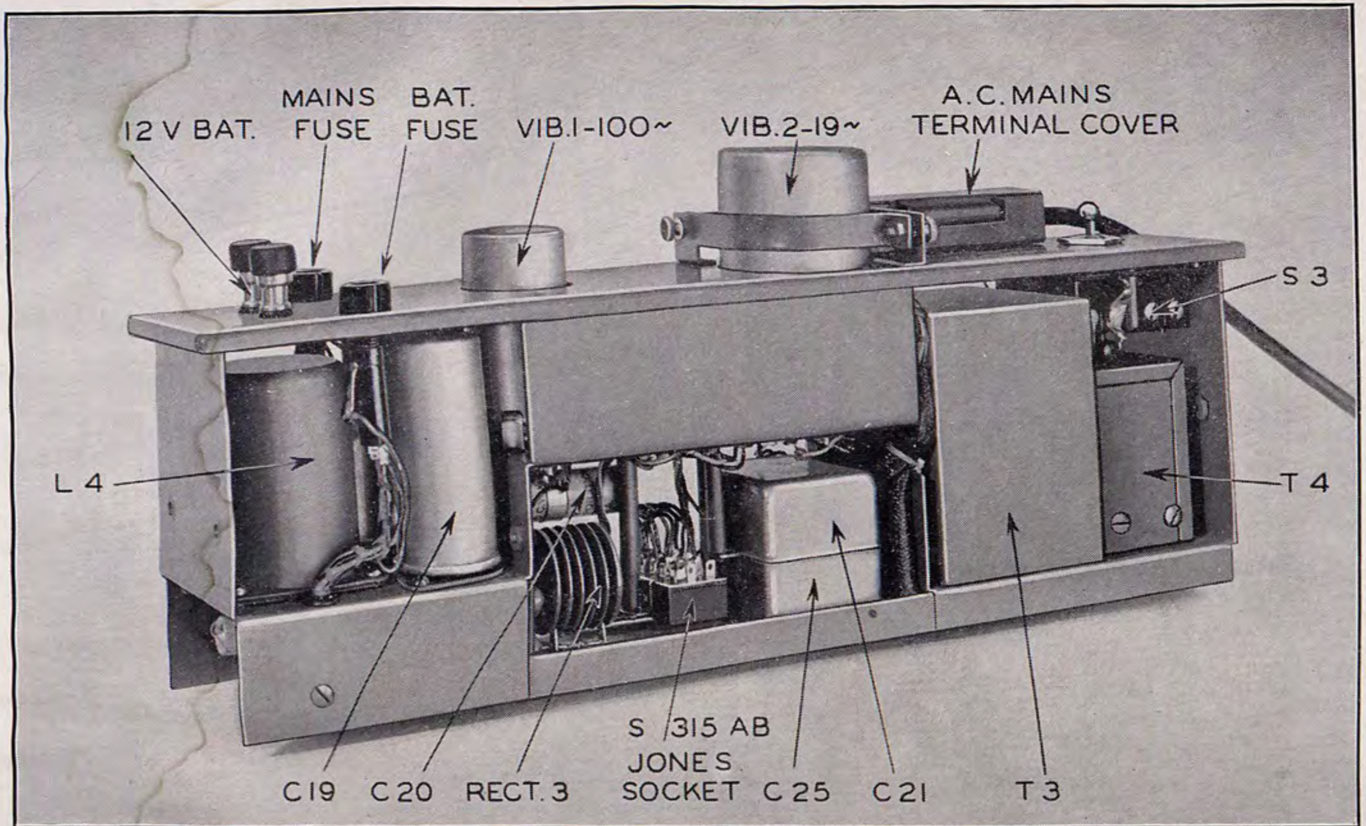


FIG. 4—*Power Unit Without Dust Cover*

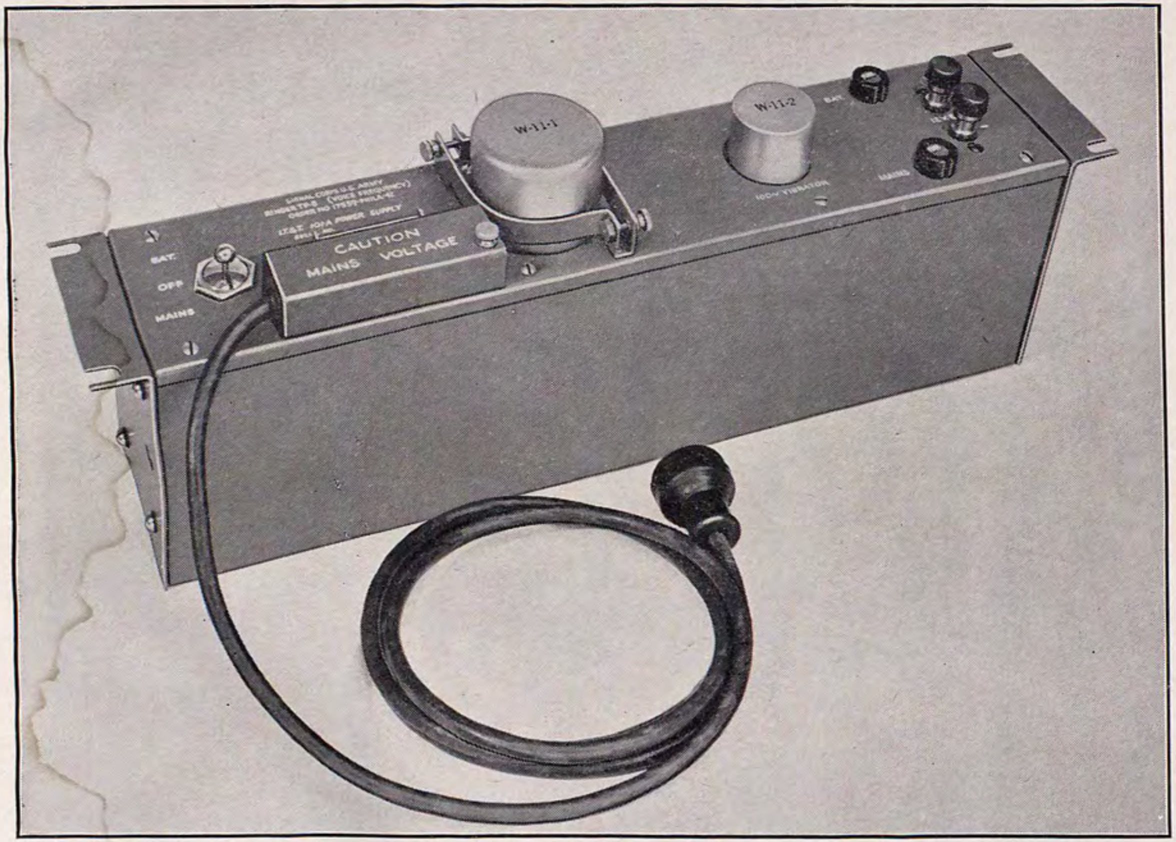


FIG. 5—*Power Unit*

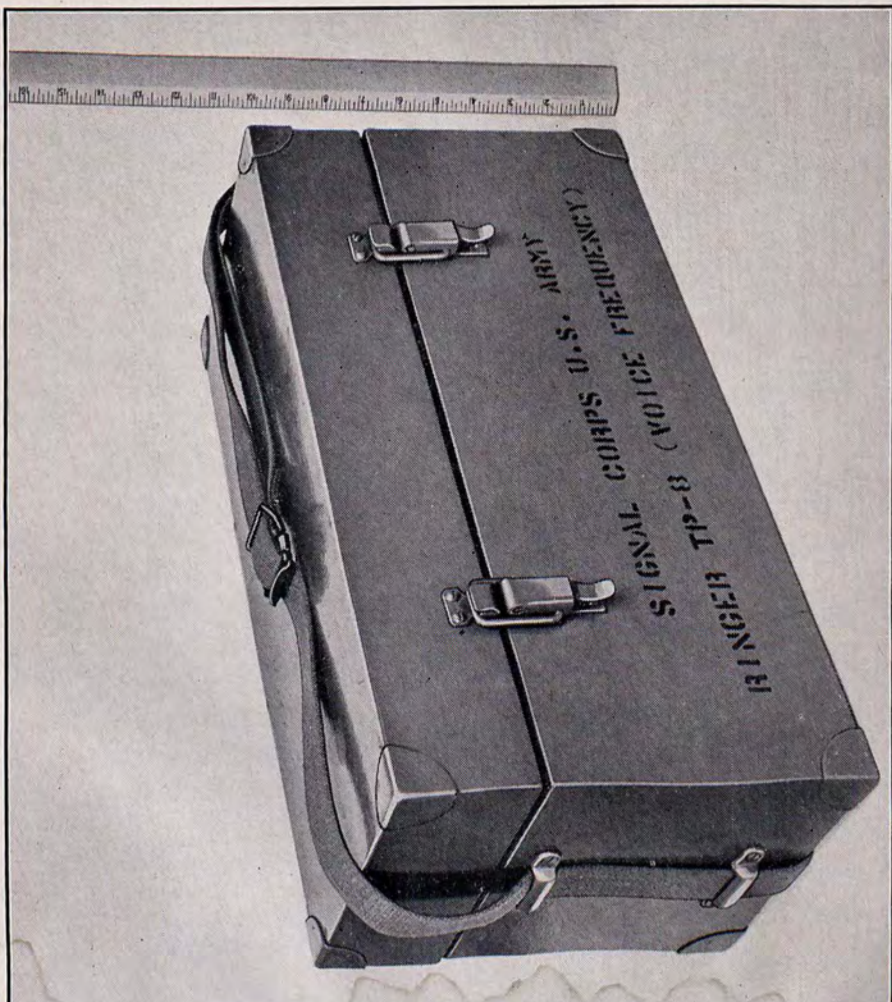


FIG. 6—*Case (Cover Closed)*

with ringer and power unit mounted in it weighs about 48 pounds. When the cover is opened the terminals, switches, and controls are exposed so that they are readily available for making connections and operation as shown in Fig. 1. The power from the power unit is supplied to the ringer unit by means of a connecting cable with a plug on one end and a socket on the other which matches the receptacles mounted on the bottom of the units. When the ringer and power units are mounted together on a relay rack as shown in Fig. 7 the same connecting cable may be used. A longer cable may be required if any other arrangement is used.

Two spare tubes, two spare fuses, and two spare vibrators are mounted in the cover of the case.

The ringer should be connected in the circuit so that relay SEND (RB/3) will always respond to ringing signal from the switchboard. The circuit away should not be more than two miles in length and less if apparatus such as repeating coils are used between the ringer and switchboard.

The sensitivity of the receiver is such that it will operate over a line with a loss of 30 db; it will operate over a range of 15 db without readjustment. A switch is provided to reduce the sensitivity by about 15 db when used on a line where this sensitivity will be satisfactory. These sensitivity values determine the distance between the ringers.

b. **Power Connection**

When the ringer is installed at the required place it may be put in operation by connecting power from the a-c mains or a 12-V battery to the power unit. If the mains are used determine the voltage and connect by means of the line cord from the outlet to the terminal marked COM. and to the one marked within the voltage range of the supply under the CAUTION MAINS VOLTAGE cover as shown in Fig 8. If the battery is used connect it to the terminals marked 12-V BAT. with the polarity as indicated. If the ringer unit and power unit are to be mounted in the wooden case, they must be connected by the connecting cable before mounting so that power will be supplied to the tubes when operating the power switch S3 marked MAINS OFF BAT. to MAINS or BAT. depending on the source of power. If the units are relay rack mounted, before closing the power switch S3, interconnect them by means of the same connecting cable that is used when the units are in the case.

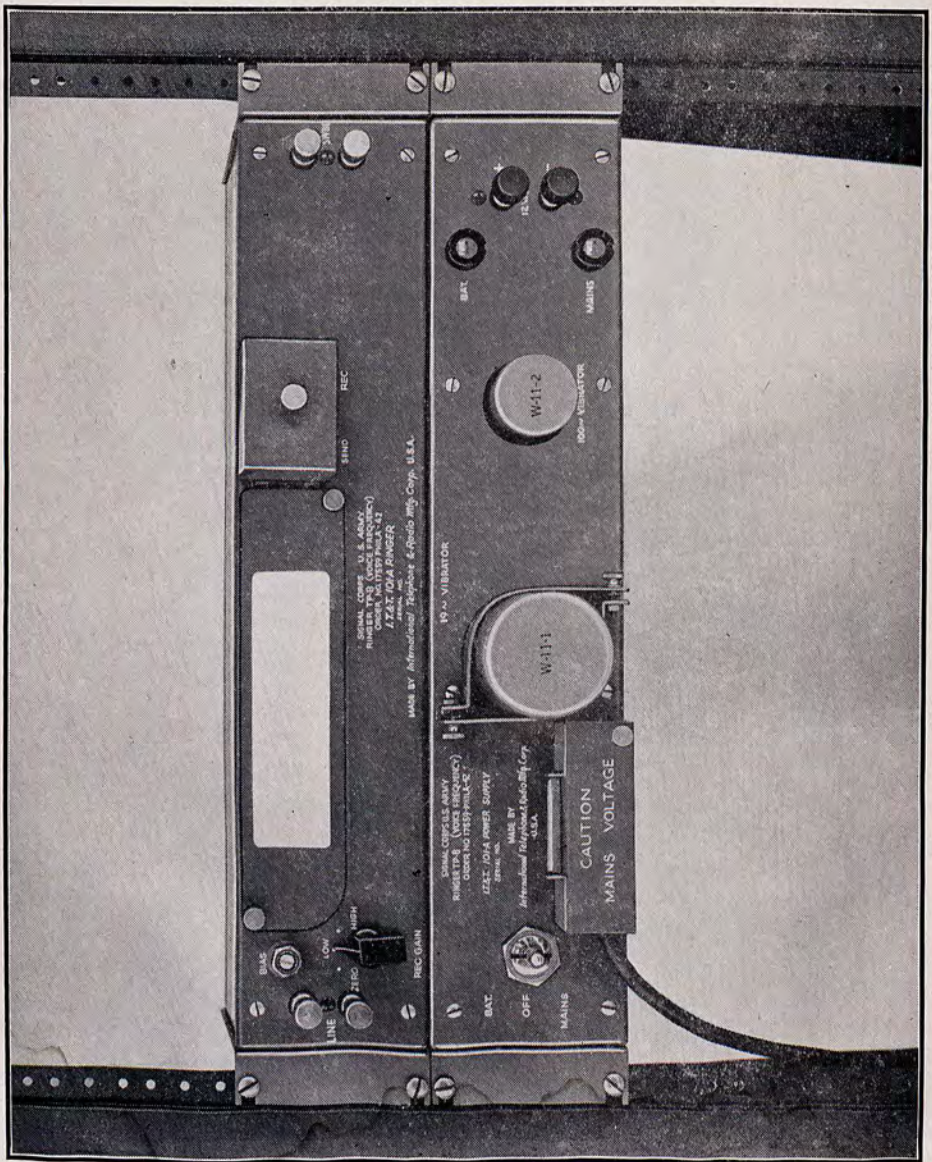


FIG. 7—*Ringer and Power Units on Relay Rack*

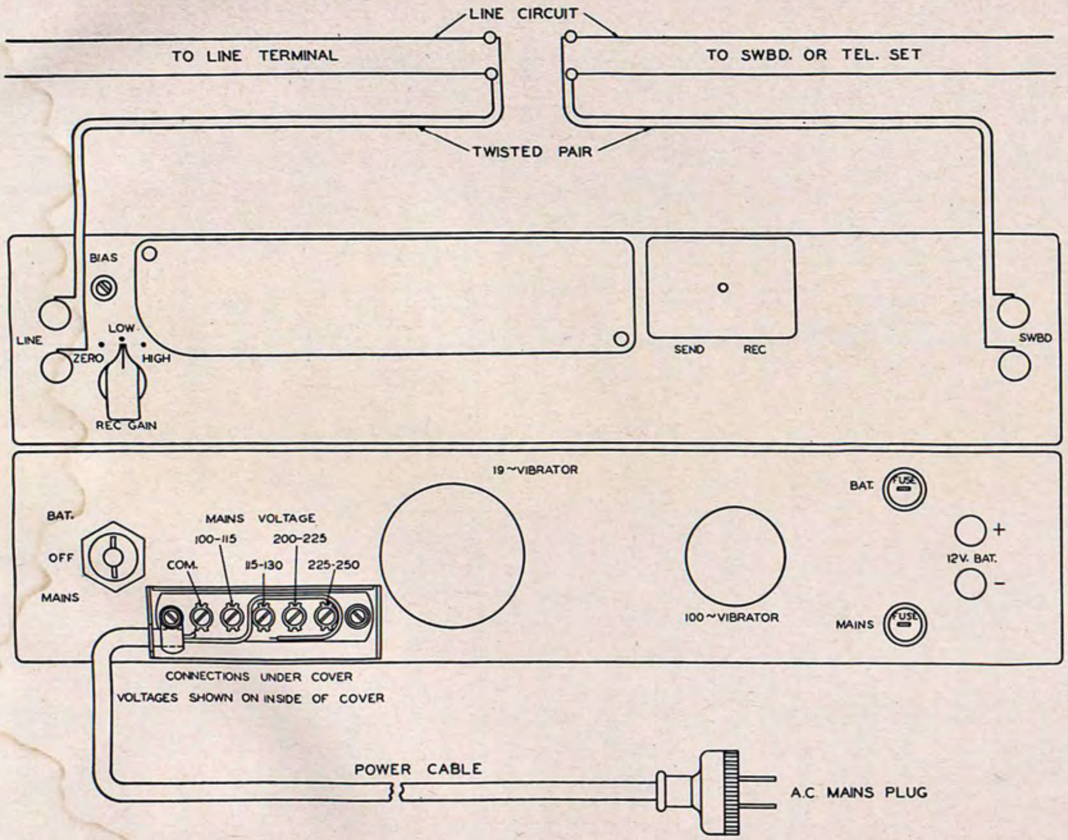


FIG. 8—*Power and Line Connections*

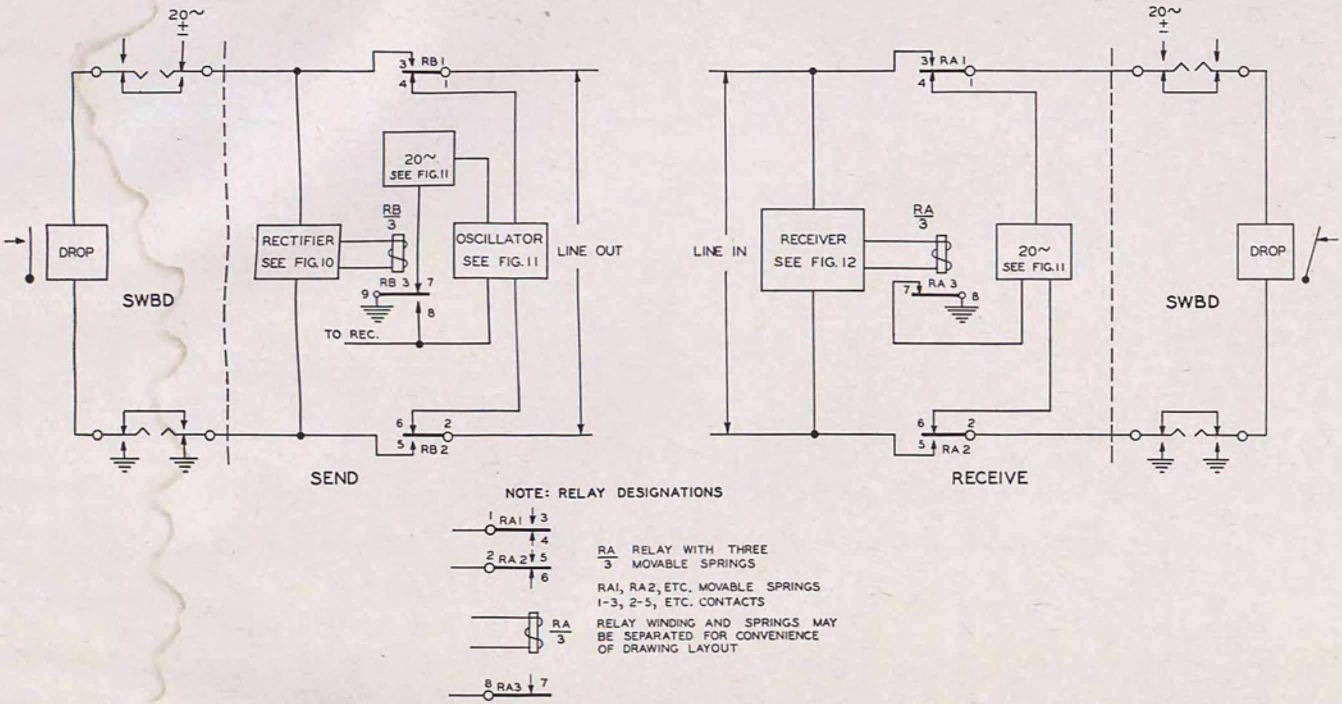


FIG. 9—*Block Schematic of Voice Frequency Ringer*

c. Line Connection

Ringer TP-8 (Voice Frequency) should be installed at the end of the line for which it is required to signal as shown in Fig. 8. The terminals marked SWBD should be connected to the line looking towards the switchboard and the terminals marked LINE to the line looking towards the terminal equipment of this line.

6. OPERATION OF THE CIRCUIT

With the power and line connections made for the ringers at each end of the line determine the length of the line over which the signalling is to function and set switch REC GAIN (S1) of the receiver unit to position HIGH or LOW for each ringer depending on whether the line is maximum length (—30 db) or a length of not more than — 15 db loss. (Variations in the loss of the line being taken into consideration in each case.) If the system is to work on 1000 cycles set switch S2 to position marked 1000 and if on 500 cycles set it to position marked 500. This switch is mounted on the chassis underneath the panel. In order to change its position remove the tube cover plate and make the change with a screwdriver. To change the power output of the oscillator take the ringer unit out of the case, remove the dust cover, and operate switch S4 to desired level. Give the system an overall test in both directions before using for regular operation. To do this have the required frequency sent intermittently from the distant end and note if relay REC (RA/3) in the receiver operates and releases satisfactorily. Do this with power supplied to the system from both a-c mains and the 12-V battery if both are available. Since the ringer is carefully adjusted and tested at the factory, in general, it should function satisfactorily unless damaged in transit in which case the methods used in section IV on maintenance should be applied to determine the trouble.

SECTION III—FUNCTIONING OF PARTS

7. GENERAL

In voice frequency ringers the receiving part of the circuit is bridged across the line near the switchboard, it is, therefore, subject to operation by the frequency in the voice of a talker corresponding to the signalling frequency under certain conditions. Since the talker may be electrically near the ringer, the energy of the voice may be equal to or greater than the energy required to operate the ringer, especially when it is adjusted to operate over a long line. This is true as the signalling frequency chosen is either 1000 cycles or 500 cycles, both of which are voice frequencies. In order to prevent such interference, some systems require that the signalling frequency be interrupted at approximately a 20 cycle rate (18.3-20). Since the voice currents are usually in the form of pulses of short duration, the 20 cycle interruption rate of the signalling frequency, together with a certain amount of delay in the circuit, prevents the false operation of the ringer by voice frequencies on the line as well as from switchhook clicks or other short pulses that may occur. This delay requires a duration of signal greater than these before the receiving circuit will operate. An alternative method of preventing interference is used in Ringer TP-8 (Voice Frequency) in which the signalling frequency need not be interrupted at the 20 cycle rate. In this method the receiving circuit is arranged so that it passes a band of frequencies in the voice range but can only be operated by the signalling frequency. All other frequencies are detected by the receiving circuit in such a way as to prevent operation. This arrangement, together with delay in the receiving circuit, will prevent false operation. Satisfactory operation will be obtained over about 30 db of line when the receiver is set on its most sensitive position. Another position is provided for operation over not more than 15 db of line. Fig. 9 is a block diagram showing the sequence of the signal when the ringer is operated.

8. CIRCUIT DESCRIPTION

a. Sending Circuit

In order to signal on the line the operator at the switchboard presses the ringing key which sends a current of about 20 cycles (18.3-20) on the line as shown in Fig. 9. This current is rectified by the bridged circuit marked RECTIFIER, the output of which operates relay RB/3 which breaks the line from the switchboard, desensitizes the receiver circuit, connects the oscillator to the line and sends a tone interupted at 19 cycle rate into the line. This tone may be either 1000 or 500 cycles, but 1000 cycles will be assumed in the following description.

b. Rectifier Circuit

The bridged circuit marked RECTIFIER in Fig. 9 is shown in Fig. 10. It consists of an inductance L3 and capacitor C5 in series with rectifier RECT. 4, the d-c output of which is connected to the winding of relay RB/3 and operates it. While this circuit offers a comparatively low impedance to 20 cycles, at frequencies in the voice range the impedance increases so that the complete bridged circuit causes only a negligible loss to the

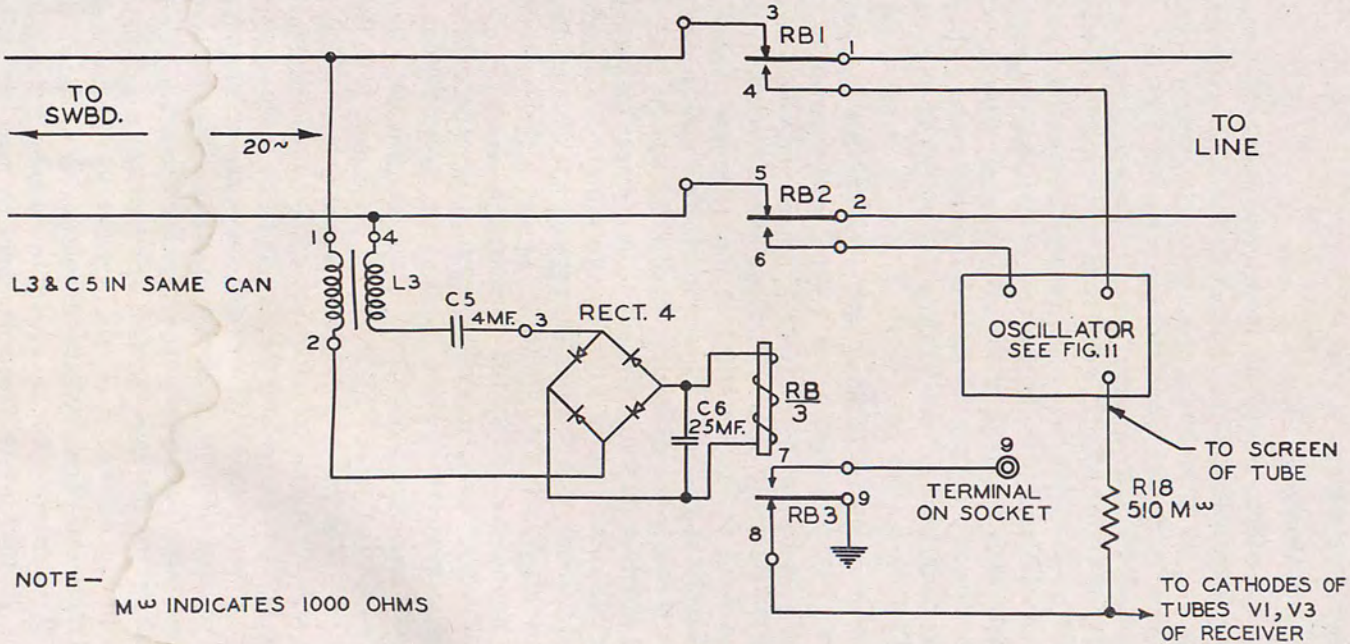


Fig. 10—20 *Cycle Rectifier Circuit*

voice current on the line. This is important because this circuit is always bridged on the line.

c. Oscillator Circuit

The oscillator circuit is shown in Fig. 11. It consists of a 1000 cycle oscillator connected to a 19 (18.3-20) cycle vibrator in such a way as to interrupt the 1000 cycle current at a 19 cycle rate. This 1000 cycle oscillator uses a tube VT-198A (6G6-G) designated V5 with a tuned circuit consisting of the primary winding of transformer T2 and sufficient capacity C9 to tune it to 1000 $\pm$ 20 cycles. The plate battery is connected to the mid-point of the tuning coil; one end of this coil is connected to the plate and the other to the grid through capacitor C10. The grid of the tube is also connected through resistances R16 and R17 to terminal 1 of the winding 1-3 of the 20 cycle transformer T4.

When no signal is being sent over the line the oscillator is prevented from oscillating by grounding the screen of the tube through the contact 9-8 of relay RB/3. The rectified 20 cycle current from the switchboard operates this relay, which removes the ground from the screen and transfers it to the positive side of the d-c path of RECT. 3. This completes the path of the rectifier circuit through the operating winding of the 19 cycle vibrator VIB.2, starting it. When the vibrating element makes contact to the left, as shown in Fig. 11, the grid circuit of V5 is connected to ground through the vibrator. The tube circuit will then oscillate at 1000 cycles. When the vibrating element makes contact to the right, current flows from the ground on the vibrator through the winding 3-2 of transformer T4 and through RECT. 3 to ground through contact 9-7 of relay RB/3, generating a voltage between terminals 1 and 3 of transformer T4, which provides a large negative bias for the grid of V5 and stops the circuit from oscillating during the time this contact is made. As a result 1000/19 cycle power is furnished at the output winding of the transformer T2. At the junction of resistances R16 and R17 rectifier RECT. 5 is connected to ground. This rectifier smooths out irregularities in the modulated 1000/19 cycle wave due to the effect of the vibrator VIB.2 contacts. The operation of relay RB/3 connects this 1000/19 cycle power to the line through relay contacts 1-4 and 2-6, as shown in Fig. 10, and it is sent over the line to the receiver at the distant end. The oscillator frequency is adjusted to either 1000/19 cycles or 500/19 cycles by switch S2 as shown in Fig. 11 so that either frequency may be used for the sending

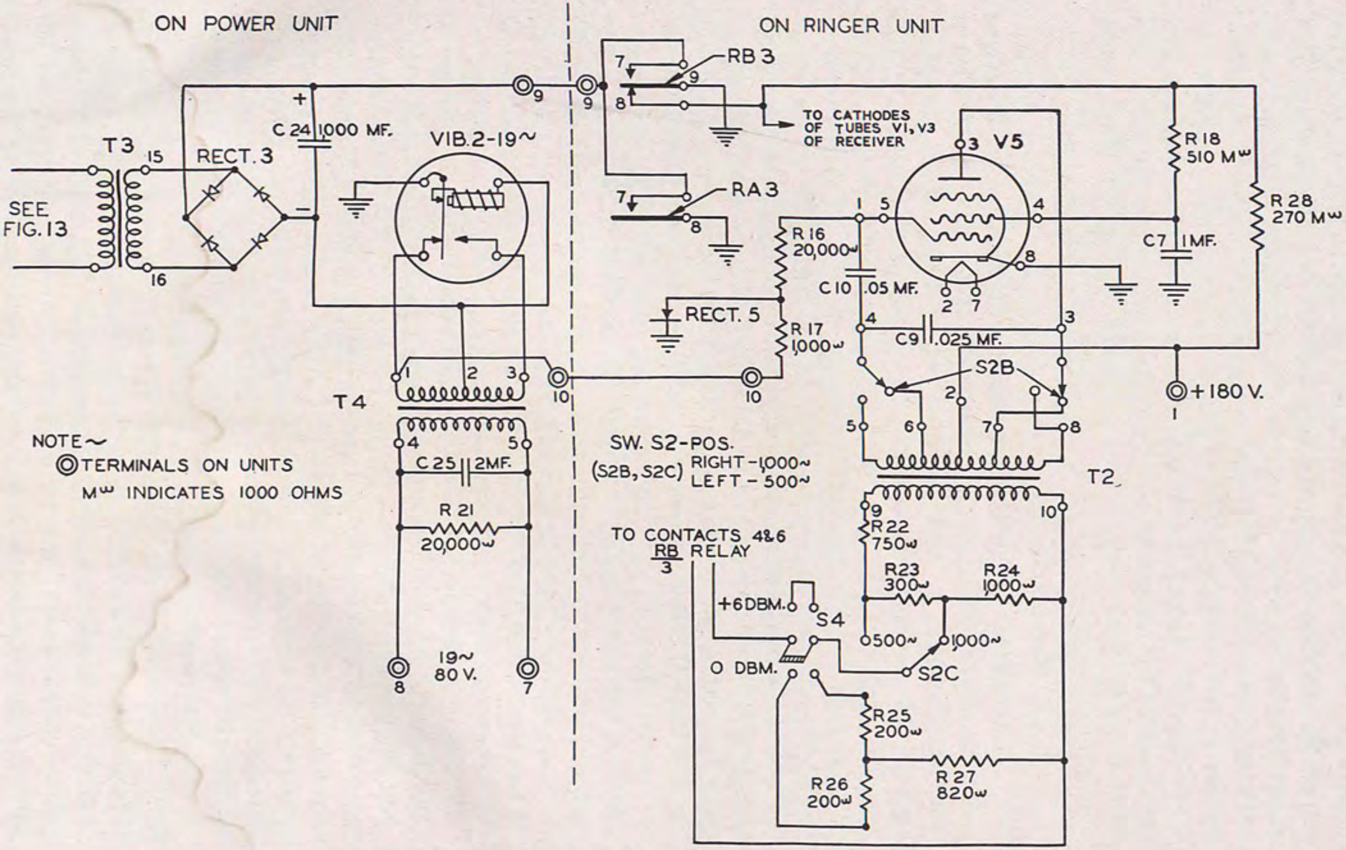


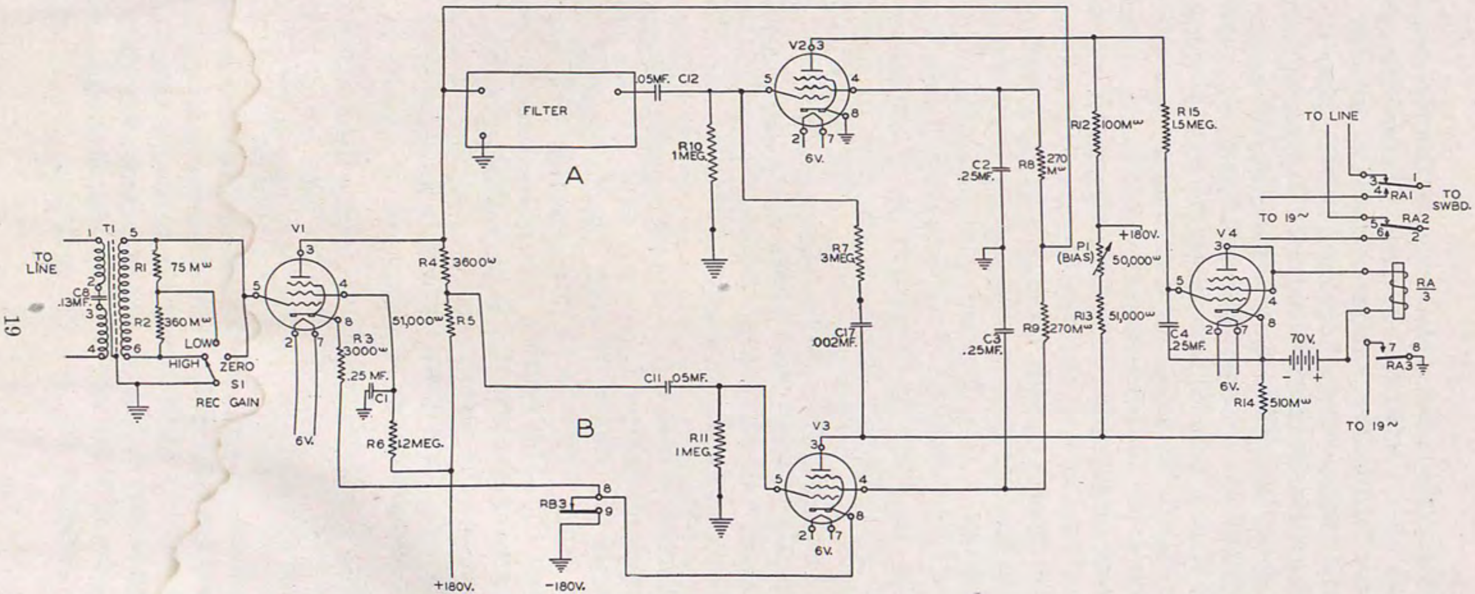
FIG. 11—*Oscillator Circuit*

signal. This output may be adjusted to give either 0 dbm (1 milliwatt) or + 6 dbm. To obtain + 6 dbm output at 500 cycles R22 is in series between the transformer and the line and R23 and R24 are connected in series across the line. To obtain + 6 dbm output at 1000 cycles R22 and R23 are in series between the transformer and the line and R24 is across the line. Switch S4 is operated to + 6 dbm. A 6 db pad consisting of resistances R25, R26, and R27 is inserted by means of switch S4 to give 0 dbm for either the 500 cycle or 1000 cycle output as shown in Fig. 11. The output impedance at either frequency is about 600 ohms.

d. **Receiver Circuit**

The receiver is bridged across the distant end of the two-wire line as shown in Fig. 9. It amplifies the weak 1000/19 cycle current, detects it, and operates relay RA/3 which, in turn, makes the necessary connections to send out 19 cycles to the switchboard to operate a bell or drop to signal the attendant. The circuit for the receiver is shown in Fig. 12. The received 1000/19 cycle current passes into the low side of the input transformer T1 which has an input impedance so high that the bridging loss to voice currents is negligible. The voltage of the signalling frequency is stepped up by the transformer and amplified by the tube V1. Resistances R1 and R2 across terminals 5 and 6 of transformer T1 are connected at their junction to a contact on the three position switch S1, so that by switching the ground connection from the point on this switch marked HIGH to that marked LOW the sensitivity can be reduced by 15 db. When the switch S1 is set on ZERO the grid of tube V1 is shorted to prevent operation of the receiver while testing it or testing on the line. The output of this tube is divided between circuits A and B, each going to a detector tube. Between the amplifier tube and the detector tube V2 a filter is connected. This filter is sharply tuned to 1000 cycles and passes this frequency through the circuit A to tube V2. It is also effective in limiting the 1000 cycles passing into circuit B while passing efficiently all other frequencies into circuit B. This may be seen from the complete schematic circuit Fig. 14. Capacitor C12 and resistance R10 form a grid leak rectifier circuit for the tube V2.

The plates of tubes V2 and V3 are connected by two fixed resistances R12 and R13 and a variable resistance P1. The plate battery is connected between resistances R12 and P1 so that plate current flows through resistor R12 to the plate of tube V2 and through resistor R13 and variable resistance P1 to the plate



NOTE -
Mω INDICATES 1000 OHMS

FIG. 12—*Receiver Circuit*

of tube V3. The plate end of resistance R12 is also connected to the grid of tube V4 through resistor R15 and the plate end of resistance R13 to the cathode of tube V4 through resistor R14. The difference in the voltage drop in these plate resistances due to plate current in tubes V2 and V3 furnishes sufficient negative bias for the tube V4 so that normally no current flows in its plate circuit and the winding of relay RA/3. The variable resistance in the plate of tube V3 is to adjust the relative voltage drops in the tube V2 and V3 plate resistances to give the required polarity and value of the biasing voltage for tube V4. The 1000/19 cycle signal voltage on the grid of the tube V2 reduces the plate current of this tube and so increases the potential at the grid of tube V4. This makes the difference of potential between the grid and cathode less negative so that current flows through relay RA/3 to operate it. The feedback path consisting of resistance R7 in series with capacitor C17 between plate of tube V3 and the grid of tube V2 increases the sensitivity of the ringer to signals within the signalling range and decreases its sensitivity to signals outside this band thus helping to prevent false ringing. Capacitor C4 bridged from grid to cathode of tube V4, together with resistances R14 and R15, provide the required delay in the relay operation. This delay helps to prevent false operation from 1000 cycle current present in speech.

The function of path B is to prevent operation of relay RA/3 by frequencies other than 1000 cycles which may be present in speech during the talking interval. The voltage of such frequencies is rectified by tube V3 in conjunction with resistor R11 and capacitor C11. This rectified voltage decreases the plate current and increases the potential at the cathode of tube V4 which in effect increases the negative bias between the grid and cathode of this tube so that no current can flow in its plate circuit and relay RA/3 to operate it.

Variation of plate current between tubes necessitates a different balance point for zero current in the plate circuit of tube V4. This is taken account of by the BIAS adjustment P1.

The cathodes of tubes V1 and V3 are grounded through contacts 8-9 of the relay RB/3. When sending a signal from the ringer this relay is operated and the ground is taken off these cathodes as shown in Fig. 11 so that during this time the receiver is inoperative and not subject to false operation from any extraneous voltage.

The receiver will function in the same way with the same sensitivity and freedom from false operation with a continuous 1000 cycle signal as with a 1000/19 cycle signal. If this were the only system installed in a territory, it would not be necessary to provide a means for interrupting the 1000 cycle current in the sending circuit. The interrupted 1000 cycle signal is required only when this system is to work with other systems using that type of signalling current. However, the fact that this receiving circuit will operate on continuous signalling current satisfactorily has some advantage in that it will operate even if the "no current" intervals of the interrupted signalling currents tend to fill up from reflected currents on the line.

The receiver will also function satisfactorily on either a continuous 500 cycle or a 500/19 cycle signal. In order to make it function on the latter it is only necessary to change the switch S2 to position marked 500 which changes the tuning of the circuit in the interstage filter to 500 cycles by adding the required inductance and capacity for tuning at that frequency.

The operation of relay RA/3 by the receiving circuit connects, through contacts 1-4 and 2-6, 19 cycles to the drop or bell at the switchboard, signalling the operator or attendant. It also disconnects the line through contacts 1-3 and 2-5 and the relay RB/3 so that it will not be operated to send 1000 cycles or 500 cycles back on the line.

The tubes used in the receiver are all alike and are coded VT-198A (6G6-G).

e. **Power Circuit**

The circuit for furnishing power to the various elements of the ringer is shown in Fig. 13. It is arranged for operation either from the a-c mains of 100-130 or 200-250 volts or from a 12-V battery. It supplies + 180 volts, with negative grounded for the plates and screens of tubes V1, V2, and V3, + 180 volts for the plate of tube V5, 70 volts d-c ungrounded between the plate and cathode of tube V4, 6.3 volts a-c for the filaments of the tubes, and 19 cycles at 80 volts for ringing. When the a-c mains are used and connected to the terminals corresponding to the line voltage, they are connected to the primary terminals of power transformer T3 by throwing switch S3 to MAINS. This voltage is stepped up by transformer T3 and the high voltage from coil terminals 9 and 10 is rectified by rectifier RECT. 1 and filtered by the choke L5 and capacitors C21 and C22 combination to give

180 volts d-c between the terminals 1 and 2 of the unit. The voltage at the coil terminals 13 and 14 of transformer T3 is also rectified by a rectifier, RECT. 2, and filtered by means of a capacitor C23 and resistance R20, each bridged across the circuit to give 70 volts d-c between terminals 3 and 4 of the unit. Terminals 11 and 12 of transformer T3 provide 6.3 volts a-c at terminals 5 and 6 of the unit for the heaters of the tubes, and terminals 15 and 16 provide the voltage which when rectified by RECT. 3 operates vibrator VIB.2 to give 80 volts at 19 cycles at the terminals 7 and 8 of the unit through transformer T4. This rectified voltage also supplies the negative bias through vibrator VIB.2 for interrupting the 1000 cycle current from the oscillator as shown in Fig. 11.

When the battery is used switch S3 is thrown to position marked BAT. and the battery connected to the terminals marked 12-V with polarity as shown. This operates vibrator VIB. 1 which interrupts the 12 volts through the windings 6-7 and 7-8 of transformer T3, generating an a-c voltage which is stepped up by the transformer to give the required voltages for the operation of the system as described for the case of operation from the a-c mains. The terminals numbered 1 up to 10 are on a 15 terminal socket mounted on the unit so that they can be readily connected to a similarly numbered plug on the ringer unit by means of a cable with suitable receptacles. The complete schematic circuit of the ringer is shown in Fig. 14.

SECTION IV—MAINTENANCE

9. GENERAL

It is assumed that any unit which develops trouble that cannot be corrected by visible inspection or simple electrical tests will be returned to a central location where testing apparatus will be available. Spare tubes, vibrators, and fuses are mounted in the cover of the ringer unit for replacement when required. The tubes are covered with a plate on the panel which can readily be removed in order to change a tube.

a. Tube Replacement

If any one of tubes V1, V2, V3, or V4 in the receiver is replaced the operation of relay REC (RA/3) should be checked as follows:

1. Set the switch REC GAIN (S1) to ZERO.
2. Turn the control marked BIAS clockwise until the relay marked REC operates.

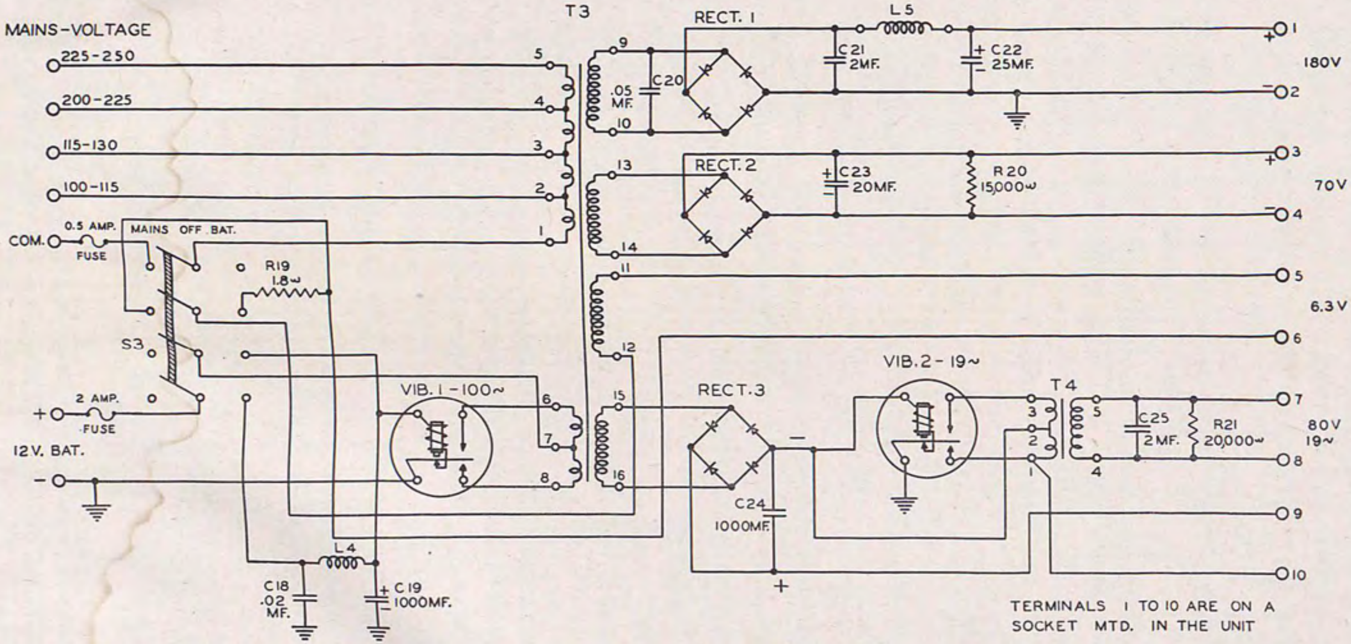
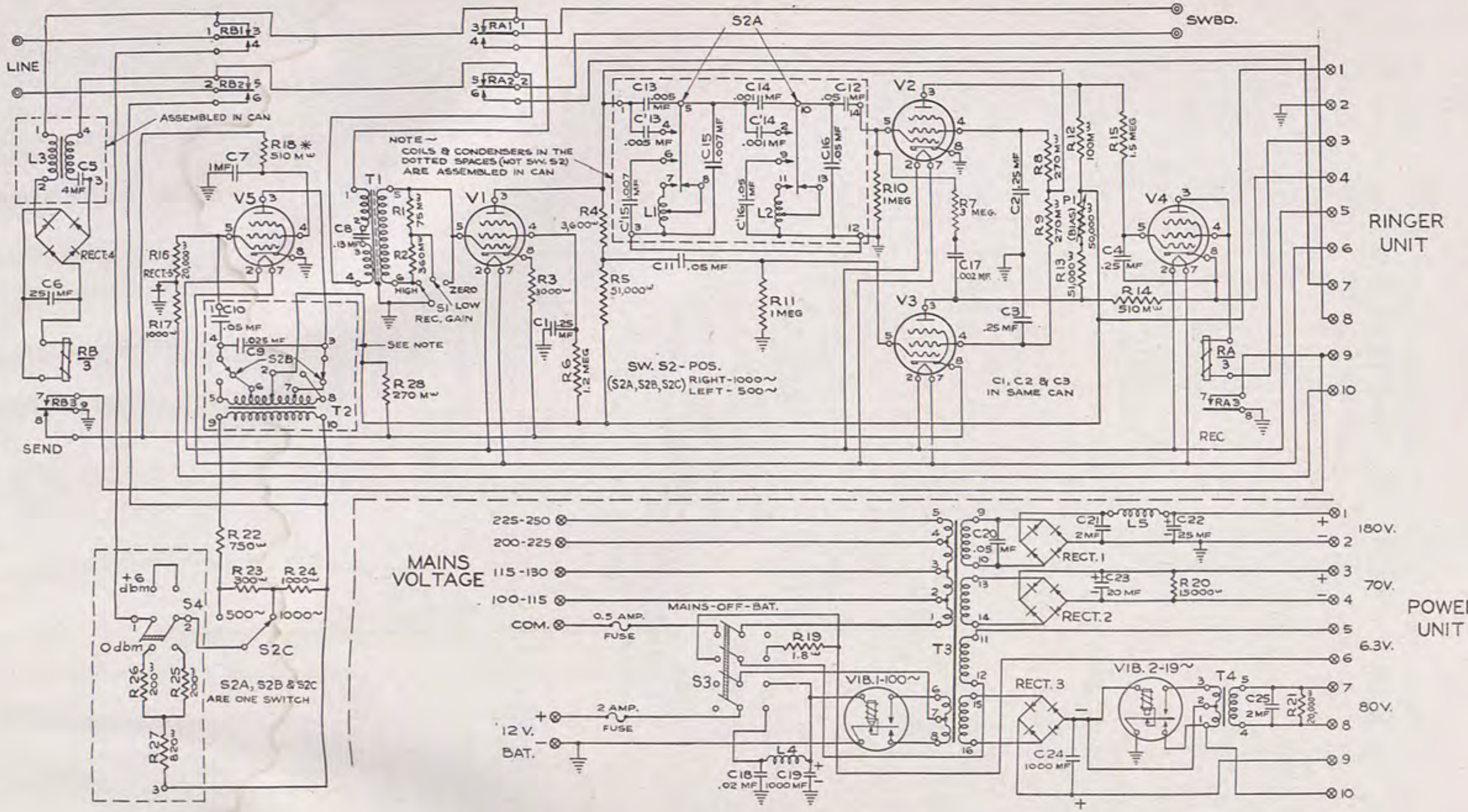


FIG. 13—*Schematic of Power Unit*



SIGNAL CORPS U.S. ARMY
RINGER TP-8 (VOICE FREQUENCY)

* Mω INDICATES 1000 OHMS

SCHEMATIC

I.T.& T. 101-A VOICE FREQUENCY RINGER

FIG. 14

3. Turn the control marked BIAS counter clockwise until the relay marked REC just releases which gives the proper bias on tube V4 for no current in the relay with no signal on the receiver.

The operation of the relay can be detected by listening for the clicks when it operates and releases.

The relays should not ordinarily require readjustment and no attempt at readjustment should be made unless trouble is definitely traced to them. The most common cause of relay failure is small particles of lint or dust in the contacts, so it is important always to keep the cover on the relays. If it is necessary to clean the contacts, the relay cover should be removed and the cleaning done by means of a steel contact burnisher. A few rubs with the burnisher at light pressure is usually sufficient.

b. **Relay Requirements**

If it becomes necessary to check the adjustments of the relays the following requirements should be met:

1. The air gap between the armature and pole faces when the relays are released should be between .018 inches and .025 inches.

2. The air gap between contacts should be minimum .008 inches.

3. When the relays are operated, all make contacts should close before the armature touches the core. When the relays release, all break contacts should close before the armature reaches its back stop.

4. The contact pressure shall be 20 grams minimum.

5. The minimum operating current of the relay SEND (RB/3) is 14 milliamperes and of relay REC (RA/3) is 7 milliamperes.

SECTION V—SUPPLEMENTARY DATA

10. REPLACEABLE PARTS

a. **General**

The reference designations shown in the first column of the table in Par. 10c and 10d correspond to the designation shown on the schematic diagram Fig. 14.

b. **List of Manufacturers and Addresses**

No.	Name	Address
1.	Hugh H. Eby Inc.	Philadelphia, Pa.
2.	Tung Sol Mfg. Co.	Newark, N. J.
3.	American Phenolic Corp.	Chicago, Ill.
4.	Thordarson Electric Mfg. Co.	Chicago, Ill.
5.	International Telephone & Radio Mfg. Corp.	East Newark, N. J.
6.	Aerovox Manufacturing Co.	New Bedford, Mass.
7.	Oak Manufacturing Corp.	Chicago, Ill.
8.	Howard B. Jones	Chicago, Ill.
9.	Allen, Bradley Inc.	Milwaukee, Wis.
10.	Consolidated Wire Associates Corp.	Chicago, Ill.
11.	Arrow Hart & Hegeman Co.	Hartford, Conn.
12.	New York Transformer Co.	New York, N. Y.
13.	Cinch Manufacturing Co.	Chicago, Ill.
14.	Littelfuse Inc.	Chicago, Ill.
15.	Clarostat Mfg. Co.	Brooklyn, N. Y.
16.	Cutler Hammer Mfg. Co.	Milwaukee, Wis.

c. List of Parts—Ringer Unit

Ref. No.	Stock No.	Name of Part	Description	Function	Mfr. See 10b	Mfr.* Part No.
		Terminal Posts	TM146-D	LINE and SWBD Connection	1	W27-3
V1	VT-198A	Vacuum Tube	Pentode	Amplifier	2	6G6-G
V2	VT-198A	Vacuum Tube	Pentode	Detector	2	6G6-G
V3	VT-198A	Vacuum Tube	Pentode	Detector	2	6G6-G
V4	VT-198A	Vacuum Tube	Pentode	Detector	2	6G6-G
V5	VT-198A	Vacuum Tube	Pentode	Oscillator	2	6G6-G
		Tube Socket	S 8T M		3	W17-1
T2, C9, C10		Transformer	Transformer & 2 Condensers	Oscillator 1,000 or 500 cycles	4	W15-8
L3, C5		Filter	Coil and Condenser	Low Frequency Receiver	4	W15-11
T1		Transformer	Input Transformer	Input to Receiver	4	W15-7
$\frac{RB}{3}$		Relay	Send Relay	Switching	5	UR-1066
$\frac{RA}{3}$		Relay	Receive Relay	Switching	5	UR-1068
C1, C2, C3		Capacitor	3x0.25 mf. 400 V in 1 can	By pass	6	W3-18
C4		Capacitor	.25 mf. 400 V	Delay in Receiver	6	W3-8
C17		Capacitor	.002 mf. Mica Type 1462	Feedback between tubes V3 and V2	6	W5-5
C8		Capacitor	.13 mf. 400 V	Blocking	6	W3-1
C7		Capacitor	1 mf. 400 V	By pass tube V5	6	W3-9

Ref. No.	Stock No.	Name of Part	Description	Function	Mfr. See 10b	Mfr.* Part No.
P1		Potentiometer	50,000 ohms, Type J	Bias Control for Tube V4	9	W7-3
S1		Switch	2 Pole, 3 Position	Sensitivity Control of Receiver	7	W20-11
S2		Switch	6 Pole, 2 Position	Change Frequencies	7	W20-12
S4		Switch	2 Pole 2 Throw	Change Output Level	16	W21-3
		Plug	15 Contacts, P-315 AB	To Connect Cable from Power Unit	8	W19-13
Rect. 5		Rectifier	Selenium Rectifier	Smooth 1000/20 cycle wave	5	2H1BV1
Rect. 4		Rectifier	Selenium Rectifier	Rect. 20 cycle	5	22DO521
C6		Capacitor	Electrolytic Condenser 25 mf. 25 V	Smooth Rectified 20 cycles	6	W2-4
C11		Capacitor	.05 mf. 400 V	Coupling	6	W3-16
R17		Resistor	1000 ohm ½ watt	Grid of Oscillator Tube V5	9	W8-11
R3		Resistor	3,000 ohm ½ watt	Cathode Bias	9	W6-2
R4		Resistor	3,600 ohm ½ watt	Plate of Tube V1	9	W6-32
R16		Resistor	20,000 ohm ½ watt	Grid of Oscillator Tube V5	9	W6-7
R13		Resistor	51,000 ohm ½ watt	Plate of Tube V3	9	W6-17
R5		Resistor	51,000 ohm ½ watt	Plate of Tube V1	9	W6-17
R12		Resistor	100,000 ohm ½ watt	Plate of Tube V2	9	W6-10
R1		Resistor	75,000 ohm ½ watt	Grid Shunt for Tube V1	9	W8-22

Ref. No.	Stock No.	Name of Part	Description	Function	Mfr. See 10b	Mfr.* Part No.
R8		Resistor	.27 megohm ½ watt	Screen of Tube V2	9	W8-24
R9		Resistor	.27 megohm ½ watt	Screen of Tube V3	9	W8-24
R2		Resistor	.36 megohm ½ watt	Grid Shunt for Tube V1	9	W8-18
R14		Resistor	.51 megohm ½ watt	Cathode of Tube V4	9	W6-18
R18		Resistor	.51 megohm ½ watt	Screen of Tube V5	9	W6-18
R7		Resistor	3 megohm ½ watt	Feedback Limiter	9	W6-33
R10		Resistor	1 megohm ½ watt	Grid Leak Tube V2	9	W9-2
R11		Resistor	1 megohm ½ watt	Grid Leak Tube V3	9	W9-2
R6		Resistor	1.2 megohm ½ watt	Screen of Tube V1	9	W9-1
R15		Resistor	1.5 megohm ½ watt	Grid of Tube V4	9	W9-4
R22		Resistor	750 ohm ½ watt	Power Adjustment	10	W6-28
R23		Resistor	300 ohm ½ watt	Power Adjustment	10	W8-1
R24		Resistor	1000 ohm ½ watt	Power Adjustment	10	W8-11
R25		Resistor	200 ohm ½ watt	Power Adjustment	10	W6-20
R26		Resistor	200 ohm ½ watt	Power Adjustment	10	W6-20
R27		Resistor	820 ohm ½ watt	Power Adjustment	10	W6-29

Ref. No.	Stock No.	Name of Part	Description	Function	Mfr. See 10b	Mfr.* Part No.
R28		Resistor	270,000 ohm ½ watt	Screen of Tube V5	9	W8-24
		Filter	Filter Assembly	1000 cycle & 500 cycle Selection	5	W93-15

* Indicates International Telephone & Radio Mfg. Corp. parts numbers.

d. List of Parts—Power Unit

S3		Switch	4 Pole Double Throw Switch No. 80985	Power Switch	11	W20-6
T3		Transformer	Six Windings 2 Pri. & 4 Sec.	Power Transformer	12	W15-5
T4		Transformer	Transformer for 19 cycle Vibrator	To give 19 cycle voltage	12	W15-10
L4		A Choke	40 mh. at 1 amp. d-c	Battery Filter	5	W12-2
L5		B Choke	10 h at 10 milliamp. d-c	Power Filter	12	W12-3
C19, C24		Capacitor	1000 mf. 25 V Electrolytic	Filter	6	W3-15
C22		Capacitor	25 mf. 300 V Electrolytic	Filter	6	W3-19
C23		Capacitor	20 mf. 150 V Electrolytic	Filter	6	W3-13
C20		Capacitor	.05 mf. 1000 V	Filter	6	W3-5
C21, C25		Capacitor	2 mf. 400 V	Filter	6	W3-10
C18		Capacitor	.02 mf. 400 V	Filter	6	W3-17

Ref. No.	Stock No.	Name of Part	Description	Function	Mfr. See 10b	Mfr.* Part No.
R20		Resistor	15,000 ohm 1 watt	Filter	9	W6-13
R21		Resistor	20,000 ohm 1 watt	Filter	9	W6-14
R19		Resistor	1.8 ohms wire wound 2 watt	Heater Voltage Adjuster	15	W8-31
Vib.1		Vibrator	100 cycles, V-6197-18XS	Furnish Power from 12-V Battery	7	W11-2
Vib.2		Vibrator	19 cycles, V 6260	Furnish 19 cycle power	7	W11-1
		Socket	Socket #2164	Socket for Vibrator	13	W17-3
		Fuse	Battery Fuse 2 Amp.	Protection	14	W79-4
		Fuse	A-c Line Fuse ½ Amp.	Protection	14	W79-5
			Fuse Holder—No. 1075		14	W17-6
		Socket	Socket S-315	On Power Unit to Connect Cable	8	W17-5
Rect. 2		Rectifier	Selenium Rectifier	To get 70-V d-c	5	22DO507
Rect. 3		Rectifier	Selenium Rectifier	To get 12-V d-c for 19 cycle Vibrator	5	3B1AV1
Rect. 1		Rectifier	Selenium Rectifier	To get 180-V d-c	5	22DO496
			Rubber Covered Terminal Post	Battery Connection	1	W27-4
			Line Cord Assembly	For Connecting a-c to Power Unit	5	W93-16
			Connecting Cable Assembly	For Connecting Ringer and Power Unit	5	W92-9

* Indicates International Telephone & Radio Mfg. Corp. parts numbers.

FIG. A

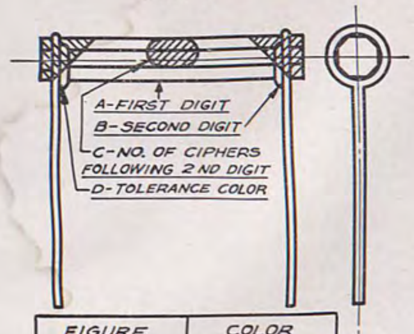


FIG. B

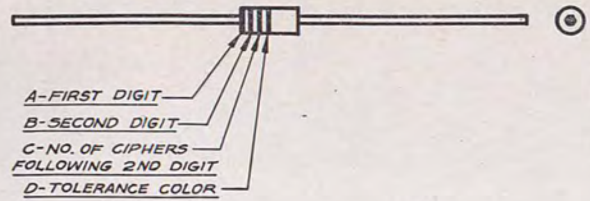


FIGURE	COLOR
0	BLACK
1	BROWN
2	RED
3	ORANGE
4	YELLOW
5	GREEN
6	BLUE
7	VIOLET
8	GRAY
9	WHITE
TOLERANCE	COLOR
± 5 %	GOLD
± 10 %	SILVER
± 20 %	NONE

STANDARD COLOR CODE

A - COLOR REPRESENTS FIRST FIGURE OF RESISTANCE VALUE
B - COLOR REPRESENTS SECOND FIGURE OF RESISTANCE VALUE
C - COLOR REPRESENTS NUMBER OF CIPHERS FOLLOWING FIRST TWO FIGURES.

D - COLOR REPRESENTS RESISTANCE TOLERANCE.
ALL COLORS ARE LOCATED ON THE BODY OF THE RESISTOR AS SHOWN IN FIG. A AND FIG. B.

EXAMPLES

RESISTANCE OHMS	COLOR CODE			
	A	B	C	D
43000 ± 5%	YELLOW	ORANGE	RED	GOLD
3900 ± 10%	ORANGE	WHITE	RED	SILVER
68 ± 20%	BLUE	GRAY	BLACK	NONE

RESISTOR COLOR CODE
FIG. 15

NOTES