VINCE RIOLO

TM 11-2006

WAR DEPARTMENT

TECHNICAL MANUAL

TELEPHONE REPEATER EE-89-A

July 14, 1943

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WASHINGTON, July 14, 1943

TM 11-2006, Telephone Repeater EE-89-A is furnished for the information and guidance of all concerned.

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TELEPHONE REPEATER EE-89-A

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DESTRUCTION NOTICE

WHY—

To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—

When ordered by your commander or when you are in immediate danger of capture.

HOW—

1. Smash—Use hand axes or other heavy tools.
2. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades, etc.
3. Disposal—Bury in slit trenches, fox-holes, other holes. Throw in streams. Scatter.
4. USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT—

1. Smash chassis and case.
2. Burn outer case.
3. Bury or scatter all of the above pieces after breaking.

DESTROY EVERYTHING

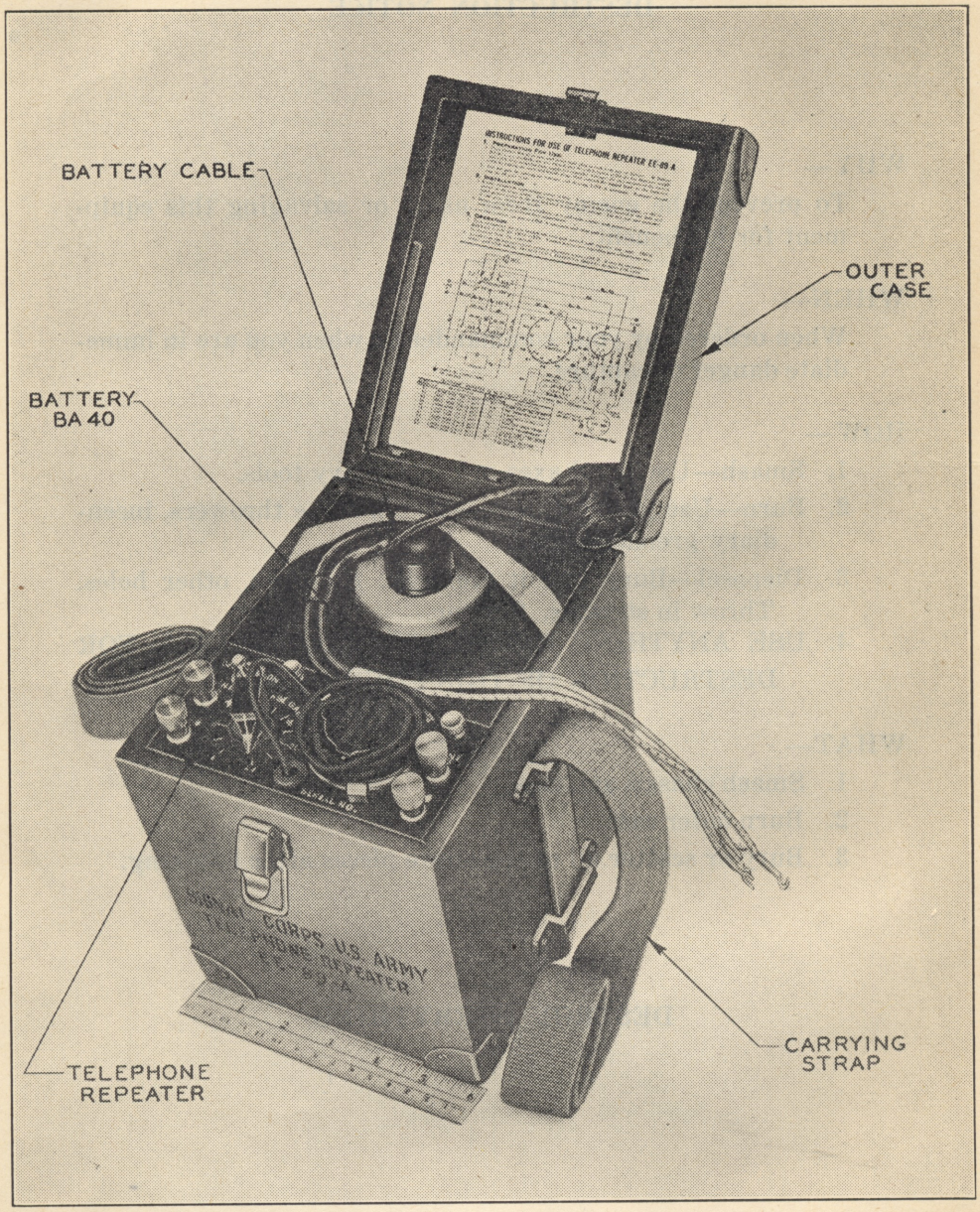


Fig. 1—*Telephone Repeater EE-89-A—Assembled for Operation*

Section I
DESCRIPTION

1. General.—

Telephone Repeater EE-89-A, Fig. 1, is used to give improved transmission and extend the talking range over Wire W-110-B or other facilities. Two-wire transmission is used; that is, the same pair is used for transmission in both directions. The repeater is for use as an intermediate repeater and for best results should be located approximately centrally with respect to adjacent line sections, the characteristics of which are similar.

Normal simplex telegraph operation and twenty cycle ringing are possible over lines equipped with one or more of these repeaters.

COMPONENT PARTS

Stock No.	Quantity	Article	Approx. Shipping Size (Inches)	Approx. Weight (lbs.)
	1	Telephone Repeater EE-89-A (Note 1)	8½ x 9 x 7	8
	2	Vacuum Tube VT-221 (3Q5-GT) (Note 2)		
	2	Technical Manual TM 11-2006 Telephone Repeater EE-89-A		

NOTES

1. No battery furnished with this item. One Battery BA-40 is required for operating Telephone Repeater EE-89-A.
2. Includes one spare tube.

2. Theoretical Considerations.—

The repeater is theoretically similar to the commercial "21-type" repeater. A single amplifying element is used, connected into the line through the windings of a hybrid coil. Figure 2 shows a functional diagram of this type of repeater. Incoming signals divide at the repeater, one half entering the input of the amplifying circuit and the other half being dissipated in the output circuit of the amplifier. The energy which enters the amplifier input circuit is amplified and is reintroduced into the line through the output circuit. There the energy divides, half flowing back to the line from whence it came, where it serves no useful purpose, and the other half flowing on to the distant line. As the amplified part of the energy may be many times greater than the original energy, the result is a net increase in the energy which flows out over the line. The energy from the output circuit of the amplifying element flows through the circuit consisting of the four windings L_1, L_2, L_3, L_4 in the hybrid coil and the lines

A and B. If lines A and B are of exactly equal impedance, there will be no potential between the input terminals of the amplifying element due to current flowing in the amplifier output circuit, and the amplification will not be cumulative in its effect. If, however,

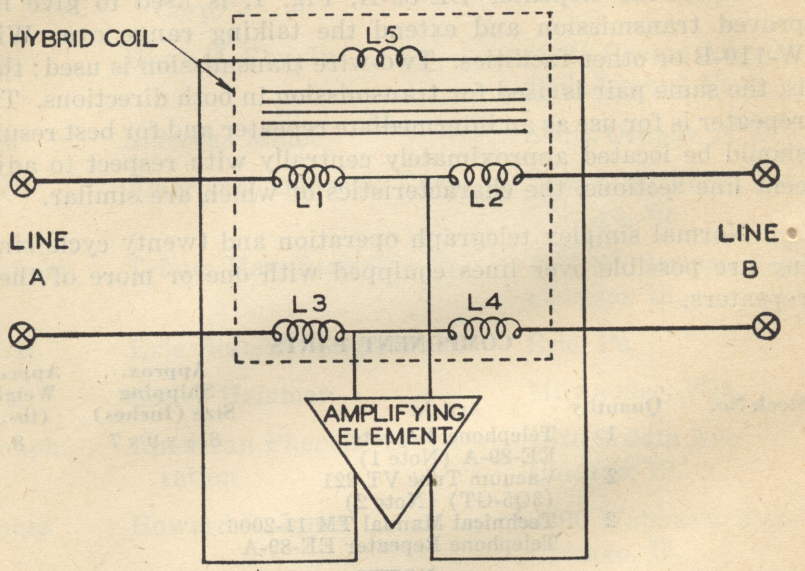


Fig. 2—*Telephone Repeater EE-89-A—Functional Diagram*

the impedances of the lines A and B are not identical, there will be a difference of potential between the terminals of the input circuit and part of the output energy will re-enter the input circuit. This will be amplified, and will result in additional energy in the output circuit, leading to cumulative repeatered amplification which will cause the repeater to howl or sing to such an extent that the telephone line cannot be used. It is necessary, therefore, when Telephone Repeater EE-89-A is used, that it work into lines of approximately equal impedance. This predicates that the repeater should be used only between lines of the same type and not, for example, between field wire and open wire. Further the lines on each side of the repeater should be of approximately the same length.

3. Equipment Arrangement.—

a. Repeater Assembly.—

The complete Telephone Repeater EE-89-A assembly, illustrated in Fig. 1, consists of a plywood case arranged for housing

the repeater chassis and battery. The repeater chassis is inserted in the front of the case and the battery in the rear. The overall dimensions of the repeater unit are approximately 7½ inches high, by 5⅛ inches wide, by 2½ inches deep. The total weight of the complete assembly is approximately 14 pounds, including the 6½ pound battery. In Fig. 3 are shown the various component parts removed from the case.

b. Case.—

The case is made of plywood and has a hinged top cover which when opened provides access to the line binding posts and control equipment mounted on the repeater unit panel. The cover is held closed by a pull-down catch. A web carrying strap which is provided may also be used to fasten the repeater to a tree or post. A circuit label including a combined schematic-wiring diagram and condensed operating instructions is mounted inside the case cover. (See Fig. 4.)

c. Chassis.—

The repeater chassis (Figs. 5 and 6) is made of steel and designed to mount the transformers, condensers, vacuum tubes, and resistors associated with the repeater. The control switches are mounted on a steel panel which is riveted to the chassis and thus supported vertically below the panel in the assembly. An auxiliary steel panel on which functional designations are engraved is riveted to the main panel.

4. Power Supply.—

The repeater requires a 1½-volt supply for the filament of the vacuum tube and 90 volts for the plate and screen supply. These are normally derived from Battery BA-40 housed in the repeater case. Power connections between the battery and repeater are made by a four conductor cable equipped with a male plug for insertion in the socket on top of the battery.

In case Battery BA-40 is not available, any 1½-volt and 90-volt batteries connected by means of the additional battery cable furnished may be used.

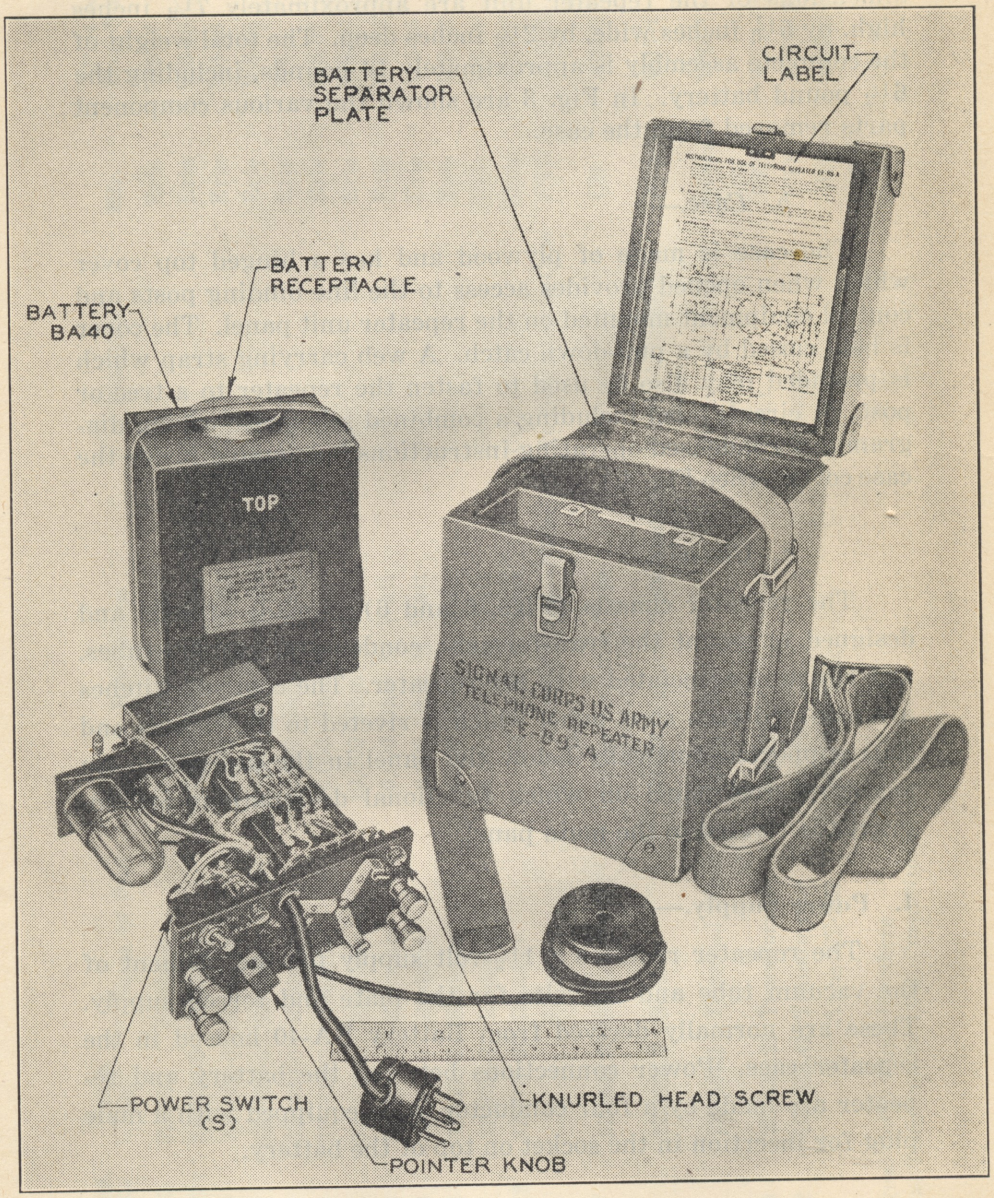


Fig. 3—*Telephone Repeater EE-89-A—Unassembled*

INSTRUCTIONS FOR USE OF TELEPHONE REPEATER EE-89-A

1. PREPARATION FOR USE.

a. Place Battery BA-40 in case, and insert male plug in socket on top of battery. If Battery BA-40 is not available, use any 1½-volt and 90-volt batteries (1-BA-23 for filament supply and 2-BA-36 in series, for plate supply, for example). Connect the two sections of the battery cable by joining the male and female plugs, then connect the tagged leads to the batteries.

b. Test for gain by turning on repeater and shorting LINE A terminals. Repeater should sing on all gain steps.

2. INSTALLATION

a. Locate repeater in approximate center of line. A short line will require location of the repeater at the exact center. Two repeaters may be used if they are located at the first and third quarter points in the line and used at equal gain settings. Do not use two repeaters if one gives satisfactory results.

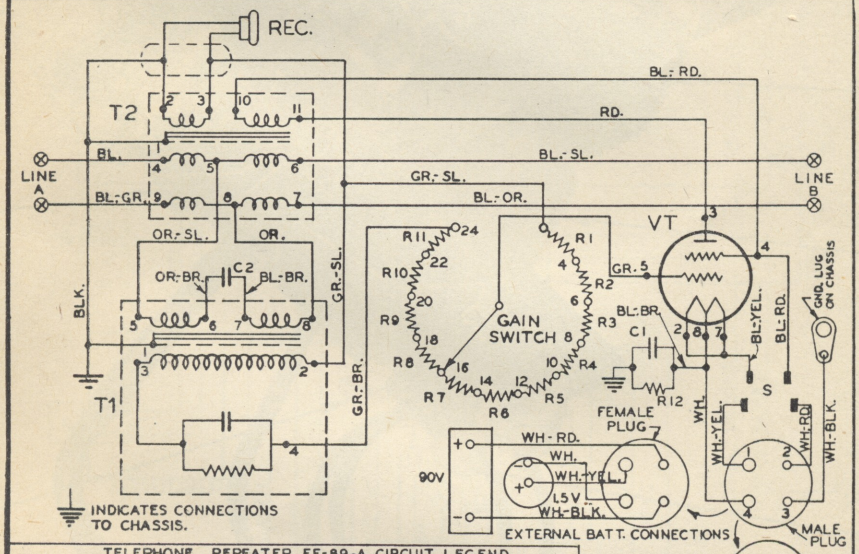
b. Before cutting line, bridge a telephone on it and make contact with personnel at the terminals in order to co-ordinate final adjustments.

c. Cut line, connect one pair to LINE A terminals and other pair to LINE B terminals.

3. OPERATION

a. Turn on repeater, listen in headphone, turn gain control until repeater just sings. THEN REDUCE GAIN BY TWO STEPS. Further instructions regarding gain adjustments may be received from the terminals.

b. To talk from the repeater station, connect telephone across LINE B. It may be necessary to reduce gain while talking. DO NOT LEAVE TELEPHONE BRIDGED ACROSS THE LINE.



TELEPHONE REPEATER EE-89-A, CIRCUIT LEGEND

CIRCUIT DESIGNATION	DESCRIPTION	CIRCUIT DESIGNATION	DESCRIPTION
R1	24000 OHMS ±5% 1/2 WATT	R11	51000 OHMS ±5% 1/2 WATT
R2	6200 OHMS ±5% 1/2 WATT	R12	750 OHMS ±5% 1/2 WATT
R3	8200 OHMS ±5% 1/2 WATT	C1	2 MFD BOTH IN ONE CAN
R4	10000 OHMS ±5% 1/2 WATT	C2	2 MFD
R5	13000 OHMS ±5% 1/2 WATT	T1	EQUALIZED INPUT TRANS.
R6	16000 OHMS ±5% 1/2 WATT	T2	OUTPUT TRANSFORMER
R7	20000 OHMS ±5% 1/2 WATT	VT	VACUUM TUBE VT-221 3Q5GT
R8	27000 OHMS ±5% 1/2 WATT	B	BA-40 BATTERY
R9	33000 OHMS ±5% 1/2 WATT	REC	TELEPHONE RECEIVER
R10	39000 OHMS ±5% 1/2 WATT	S	ON-OFF SWITCH

Fig. 4—*Telephone Repeater EE-89-A—Circuit Label*

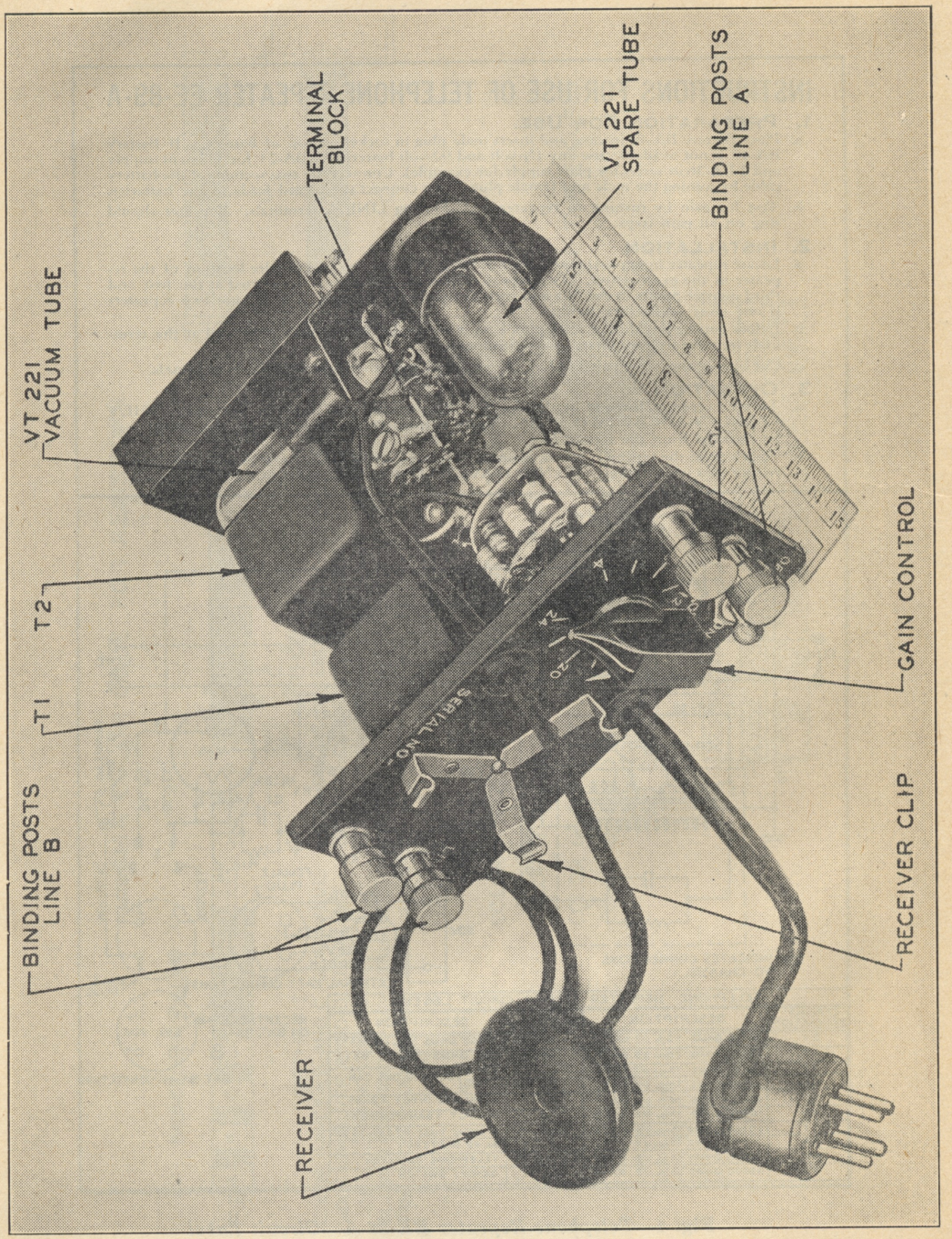


Fig. 5—*Telephone Repeater EE-89-A—Front View of Panel & Chassis*

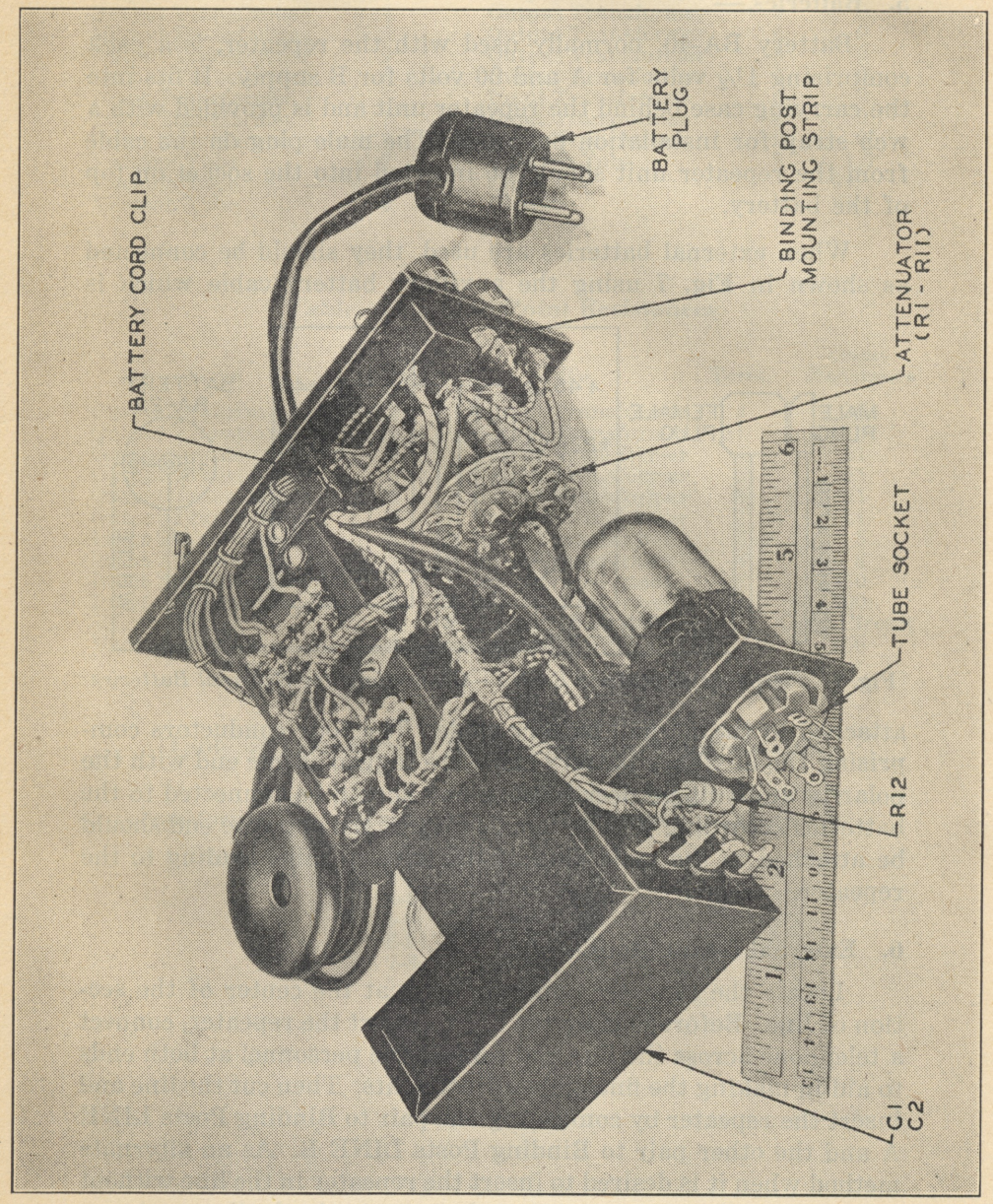


Fig. 6—*Telephone Repeater EE-89-A—Rear View of Panel & Chassis*

Section II

INSTALLATION AND OPERATION

5. Batteries.—

Battery BA-40, normally used with the repeater, is a pack comprising 1½ volts for A and 90 volts for B supply. It fits into the carrying case behind the repeater unit and is provided with a web strap for installation purposes. The male plug on the cable from the repeater unit should be inserted into the socket on top of the battery.

When external batteries are used, they should be connected as shown in Fig. 7 using the auxiliary battery cable which is

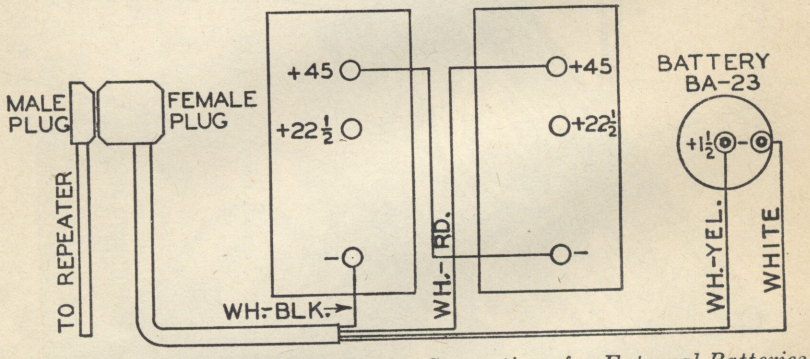


Fig. 7—*Telephone Repeater EE-89-A—Connections for External Batteries*

attached to the normal battery cable. The four conductors comprising the auxiliary battery cable are tagged at one end with the polarity and voltage designations and should be connected to the batteries accordingly. The female plug at the opposite end should be attached to the male plug of the battery cable leading to the repeater.

6. External Connections.—

Locate the repeater approximately at the center of the section of line. Before cutting the line to insert the repeater, connect a telephone across the line and contact the personnel at both ends to aid in making the final gain adjustments. Then cut the line and insert the repeater by connecting one pair to Binding Posts LINE A and the other pair to Binding Posts LINE B. As an alternate method when it is desired to insert the repeater in the line without interrupting the circuit, connect the repeater in the line as shown in Fig. 8. In this case, set the gain control knob on the lowest gain

step, turn repeater on, cut wires between binding posts and advance gain control knob as necessary to obtain good transmission.

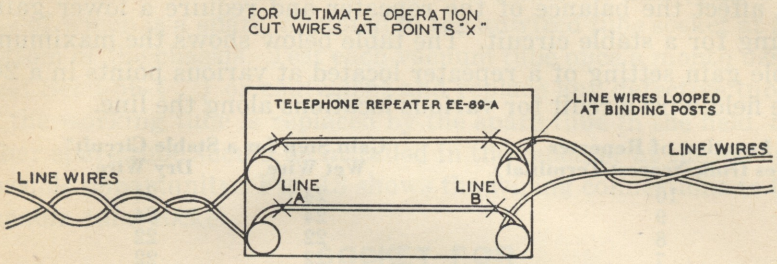


Fig. 8—*Telephone Repeater EE-89-A—Alternate Method of Installing*

7. Gain Adjustments.—

Check that the battery cable is connected properly between the battery and repeater. Turn the repeater on by throwing Switch OFF ON to the ON position. Listen with the monitoring receiver (normally mounted in a clip on the panel) and adjust Switch INCREASE GAIN until the repeater just starts to sing. Then reduce the gain by turning Switch INCREASE GAIN counter clockwise two steps (4 db). Observe the quality of speech between the two ends of the circuit and further adjust the gain if so directed from the terminals. By reducing the gain two steps (4 db) from the singing point, with possibly further reduction when talking tests are made, a reasonable margin against singing should be obtained. This margin will be a minimum when the wire is dry, and therefore allowances should be made for line conditions and probable changes with weather. In general, adjust the gain for a wide margin when the wire is wet so that the repeater will not sing when the wire becomes dry. If the wire is dry when the gain adjustments are made, the gain may be set higher, thereby giving less margin. When the gain has been satisfactorily adjusted, restore the monitoring receiver to its retaining clip on the panel.

8. Limitations of Use.—

Telephone Repeater EE-89-A is for use only with lines of similar impedance on either side of the repeater. The usable gain will depend upon the relative impedance unbalance between the two lines and the distance from the repeater to the nearest terminal. The greatest gain can be realized when the repeater is located in the exact center of the line. (See Fig. 9.) For field wire lines longer than 15 miles this requirement may be relaxed to allow placing the repeater at any point in the middle third of the line.

When the repeater is placed close to one terminal, the nature of the termination at that end (i. e. switchboard or telephone set) will affect the balance of the repeater and require a lower gain setting for a stable circuit. The table below shows the maximum stable gain setting of a repeater located at various points in a 20 mile field wire circuit for various locations along the line.

Location of Repeater (Miles from Nearest Terminal)	Gain Step for a Stable Circuit* Wet Wire	Dry Wire
10	24	24
9	24	24
8	22	22
7	22	22
6	20	20
5	20	16
4	16	12
3	12	8
2	8	4
1	Do not use Telephone Repeater EE-89-A	
0	Do not use Telephone Repeater EE-89-A	

*A stable circuit is defined as one in which the repeater will not sing regardless of the terminations that may be placed at either or both ends.

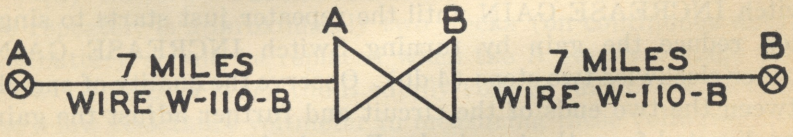


Fig. 9—*Typical Circuit Employing One Repeater*

In circuits from 18 to 25 miles in length, two repeaters may be operated in tandem provided certain precautions are observed. The repeaters should be placed at the quarter points in the line as illustrated in Fig. 10. They should be inserted in the line so that

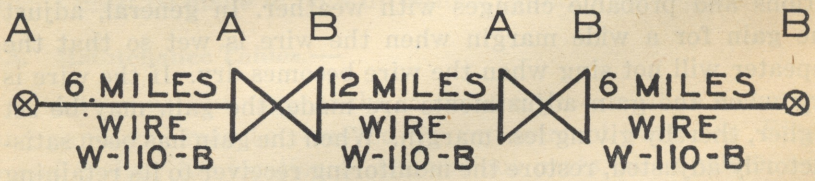


Fig. 10—*Typical Circuit Employing Two Repeaters*

the Line A side of each repeater is toward the same terminal, i. e. AB-AB not AB-BA. Both repeaters should be set on the same gain step. The maximum usable gain will depend upon the distance from each repeater to the nearest terminal as indicated in the preceding table.

The operation of more than two repeaters in tandem in the same circuit is not recommended.

The repeater may be used in a loaded line if the repeater is located at the exact center of a loading section near the middle

of the line. The use of this repeater at a junction of a loaded facility and a non-loaded line is not recommended. However, a loaded line and a non-loaded line, each having a repeater at its center, may be connected together at a switchboard in the customary manner.

In general, repeatered circuits may be connected to other circuits at switchboards. However, in the case of two connected repeatered circuits it is possible that the intersection between the two repeaters may cause singing if the loss of the circuit between repeaters is less than the average gain of the two repeaters. Hence, if it is known in advance that repeatered circuits are to be connected, their respective repeater gains should be set at the time of installation to prevent singing under these conditions.

9. Talking from Repeater Station.—

If it is desired to talk to either terminal from the repeater, Telephone EE-8-A or EE-8-B may be bridged across the repeater. Always connect across Binding Posts LINE B, regardless of which terminal is to be contacted. If the telephone is bridged across Binding Posts LINE A, the repeater will probably sing and make the circuit useless. It may be found necessary to reduce the gain when the telephone is connected. If the line unbalance is so great that the repeater sings even with the telephone connected across Binding Posts LINE B, turn the repeater OFF and communication will be possible but without the advantage of the gain of the repeater. In this case it is advisable to remove the repeater and connect the telephone directly to the line over which it is desired to communicate.

Always disconnect the telephone from Binding Posts LINE B when not in use.

10. Simplex Telegraph and Ringing.—

Normal operation of simplex telegraph circuits is possible on a line equipped with one or more repeaters. For through operation no external simplex coils nor strapping are necessary at the repeater. Where the D.C. telegraph circuit must be dropped or a telegraph repeater must be inserted at the telephone repeater point, the use of external simplex coils (coils C-161 or equal) on each side of the repeater is necessary. In this case, connect the coils with the switchboard side toward the repeater.

Twenty cycle ringing will operate through the repeater with a loss equivalent to approximately 4 miles of Wire W-110-B.

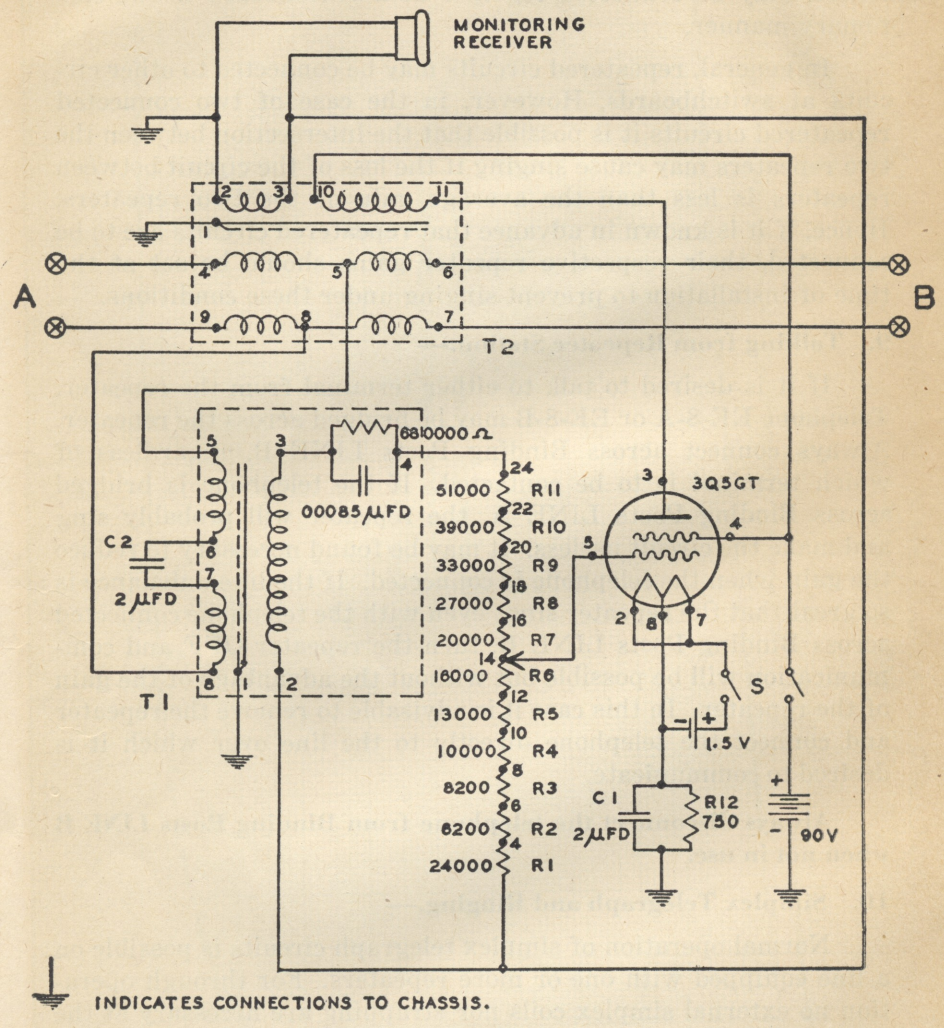


Fig. 11—*Telephone Repeater EE-89-A—Schematic Diagram*

SECTION III
FUNCTIONING OF PARTS

11. Circuit Features

a. Hybrid Coil.—

The hybrid coil, sometimes referred to as a three-winding transformer, is shown schematically in Fig. 2. The theory of the use of the hybrid coil in connection with the 21-type repeater is explained in paragraph 2. In the design of this repeater the hybrid coil actually performs two other duties in addition to serving as a bridge transformer. First, the winding L5 matches the plate impedance of the tube to the line impedance thus serving as an output transformer. Second, a fourth winding 2, 3 (shown in Fig. 11) serves as a monitoring and feed-back winding. This is a low impedance winding and the loss due to the high impedance monitoring receiver connected to it is negligible.

b. Amplifier.—

The amplifier consists of a one stage amplifier using a single-beam, power-tetrode Tube VT-221 (3Q5-GT). The amplifier circuit is shown in Fig. 11. The maximum gain of the amplifier is approximately 31 db for an output power level up to +15 db above one milliwatt. The hybrid coil introduces a 7 db loss, so that the maximum net gain through the repeater is approximately 24 db. The gain frequency characteristic curve is shown in Fig. 12.

c. Gain Control.—

The gain is controlled by means of an eleven position switch located on the panel and calibrated in steps of 2 db. The calibrations indicate the approximate gain of the repeater. The gain switch is a rotary type switch using stepped resistors connected through the movable contact arm of the switch to the grid of the vacuum tube.

SECTION IV
MAINTENANCE

12. Test and Repair.—

a. Preliminary Check.—

Connect the battery cable to the battery supply; operate Switch OFF ON to position ON. Strap Binding Posts LINE A together and listen in with the monitoring receiver. Singing or howling of the repeater on all settings of Switch INCREASE GAIN indicates that the repeater is operating properly.

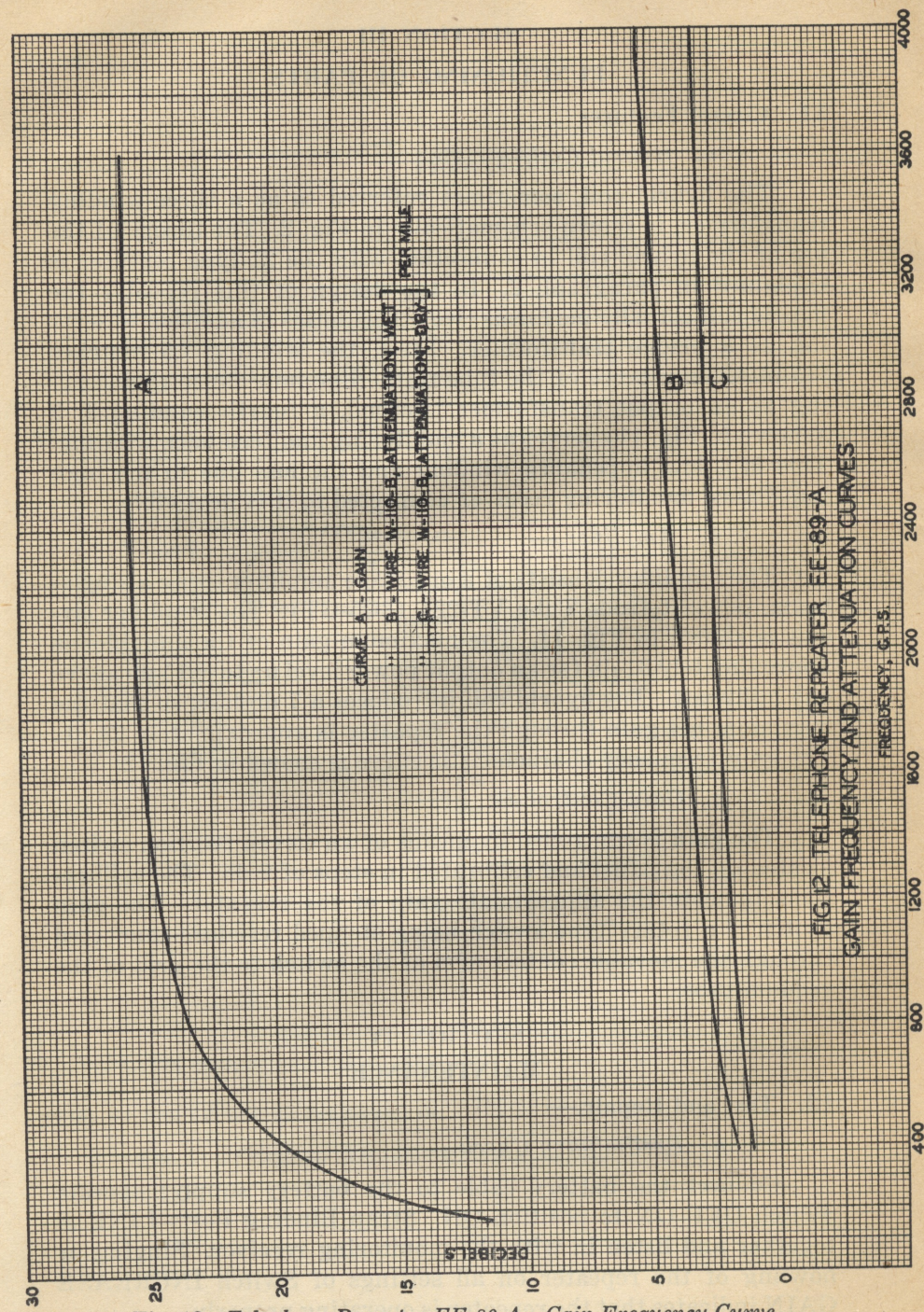


Fig. 12—*Telephone Repeater EE-89-A—Gain Frequency Curve*

b. Vacuum Tube.—

The repeater is furnished with two Tubes VT-221 (3Q5-GT) one of which is a spare, mounted in the unwired tube socket at the bottom of the chassis. Test each vacuum tube once a month using Test Set I-56-( ) or equivalent and replace any defective tubes. If the working tube is replaced by the spare tube in the field, another spare tube should be installed in the repeater at the earliest possible opportunity. Fig. 13 shows the wiring connections to the vacuum tube socket.

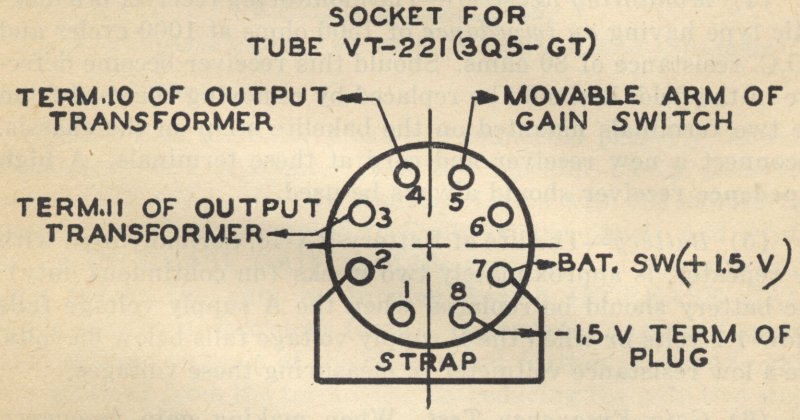


Fig. 13—*Telephone Repeater EE-89-A—Wiring of Vacuum Tube Socket*

c. Apparatus Components.—

Such items as transformers, capacitors, resistors, switches, and monitoring receiver shall be replaced as necessary. In order to facilitate the location of troubles in the circuit and wiring of the repeater chassis, release the two knurled head screws which secure the panel and chassis in the case. Remove the chassis from the case. This will give access to the various components of the repeater. See Figs. 5 and 6.

(1) *Transformers*—The winding continuity of the two transformers may be tested with an ohmmeter.

CAUTION: When testing transformers with an ohmmeter use the highest range available (0-100,000 ohms or higher), otherwise the characteristics of the transformer core material may be permanently changed, thus destroying the frequency characteristic and the balance conditions of the repeater.

(2) *Capacitors*—There are two 2 microfarad capacitors (C1, C2) used in the repeater, mounted in a common case. C1 is a signal by-pass condenser. If this capacitor is open circuited the gain of the repeater will be reduced appreciably. C2 is provided

to prevent short circuiting of the ringing voltage. The repeater will not function if this capacitor is open circuited.

(3) *Resistors*—The resistors R1 through R11 making up the gain control switch may be tested with an ohmmeter for continuity, but should be disconnected from the repeater circuit during test. **Disconnect the wire from terminal 4 of the input transformer T1 when testing the gain switch resistors.** Resistor R12 may be tested by connecting the ohmmeter directly across it.

(4) *Monitoring Receiver*—The monitoring receiver is a magnetic type having *an impedance* of 7500 ohms at 1000 cycles and a D.C. resistance of 80 ohms. Should this receiver become defective in the field, it should be replaced by removing the cord from the two terminals mounted on the bakelite strip on the chassis. Reconnect a new receiver and cord at these terminals. A **high impedance** receiver should always be used.

(5) *Battery*—The life of Battery BA-40, normally used with the repeater, is approximately two weeks (on continuous duty). The battery should be replaced when the A supply voltage falls below 1.1 volts or when the B supply voltage falls below 65 volts. Use a low resistance voltmeter in measuring these voltages.

(6) *Gain Frequency Test*—When making gain frequency tests using transmission measuring equipment, **balanced** attenuators must be used. The power level from the audio-frequency oscillator must be at least 15 db below one milliwatt. Measurements must be made in both directions through the repeater.

13. Maintenance Tables.—

All component parts of the repeater are mounted on a chassis and panel and may be removed for replacement purposes. Figs. 5 and 6 show the location of the various parts, all of which are accessible when the chassis is removed from the case as explained under paragraph 12 c. The wiring diagram is shown in figure 14 and the resistor color code in figure 15.

Table of Point to Point Voltages—Repeater Turned On

From	Term.	To	Term.	Voltage
Output Transformer	2	Output Transformer	3	0
Output Transformer	10	Output Transformer	11	5
Output Transformer	4	Output Transformer	5	0
Output Transformer	5	Output Transformer	6	0
Output Transformer	9	Output Transformer	8	0
Output Transformer	8	Output Transformer	7	0
Input Transformer	5	Input Transformer	6	0
Input Transformer	7	Input Transformer	8	0
Input Transformer	3	Input Transformer	2	0
Vacuum Tube	2	Vacuum Tube	7	1.5
Vacuum Tube	4	Chassis		90.
Vacuum Tube	3	Chassis		85

Table of Point to Point Resistances

From	Term.	To	Term.	Ohms Resistance
Output Transformer	2	Output Transformer	3	36
Output Transformer	10	Output Transformer	11	870
Output Transformer	4	Output Transformer	5	21
Output Transformer	5	Output Transformer	6	21
Output Transformer	9	Output Transformer	8	21
Output Transformer	8	Output Transformer	7	21
Input Transformer	5	Input Transformer	6	3
Input Transformer	7	Input Transformer	8	3
Input Transformer	3	Input Transformer	2	1350
Input Transformer	3	Input Transformer	4	680,000
Vacuum Tube	3	Ground (Switch Open)		Open Circuit
Vacuum Tube	8	Ground (Switch Open)		750

Table of Transformer Ratios and Nominal Resistances

Transformer	Winding	D.C. Resistance ±20% Ohms	Turn Ratio To Primary
T2	10-11 (Pri.)	870	1
	2-3	36	.04
	4-5	21	.075
	5-6	21	.075
	8-9	21	.075
	7-8	21	.075
T1	5-6 (Pri.)	3	1
	7-8	3	1
	2-3	1350	54.5

14. Servicing—Trouble Location and Remedy Chart.—

Indication	Probable Source of Trouble	Suggested Test	Remedy
No Signal in Monitoring Receiver	Defective Receiver	Operate Switch ON OFF to OFF. Connect Telephone EE-8-A to LINE A binding posts, talk into the telephone, and listen for speech in monitoring receiver. If no speech is heard the receiver is inoperative	Replace Receiver
Oscillation	Transformer T2 Line Wire Open	Test Continuity of T2 Transformer Windings	Replace Transformer
Improper Functioning of Control Increase Gain	Equalizer Resistor Open	Test for Continuity	Strap T1 Transformer 3 & 4 Terminals Temporarily
	Open Gain Control	Check Resistors R1 Through R11	Replace Defective Resistors
No Output from Amplifier	Defective Tube	Install Spare Tube	Replace Tube
	Resistor R12 Open	Measure Bias Voltage (4.5 V.) across R12	Replace R12
	Battery Connection or Defective Battery	Check Voltage Across Tube Terminals	Clean & Tighten Battery Connections or Replace Battery
	Battery Switch (S)	Short Circuit Switch Terminals & Measure Voltages Across Tube Terminals	Replace Switch
	Faulty Transformers	Test Transformers T1 & T2 for Continuity	Replace Defective Transformer
	Open Capacitor C2	Short Capacitor C2 Terminals and Check Operation of Repeater	Replace with Proper Capacitor

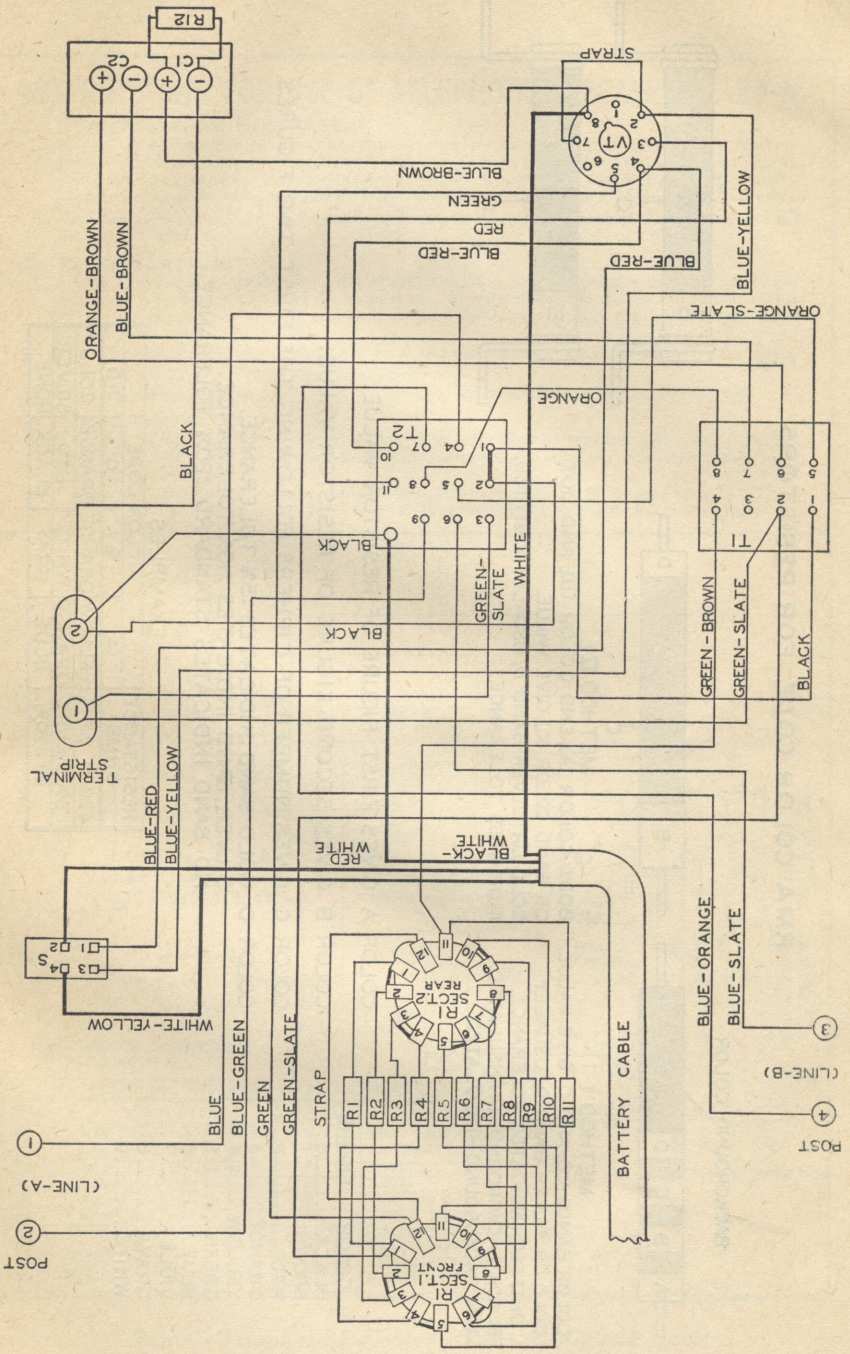
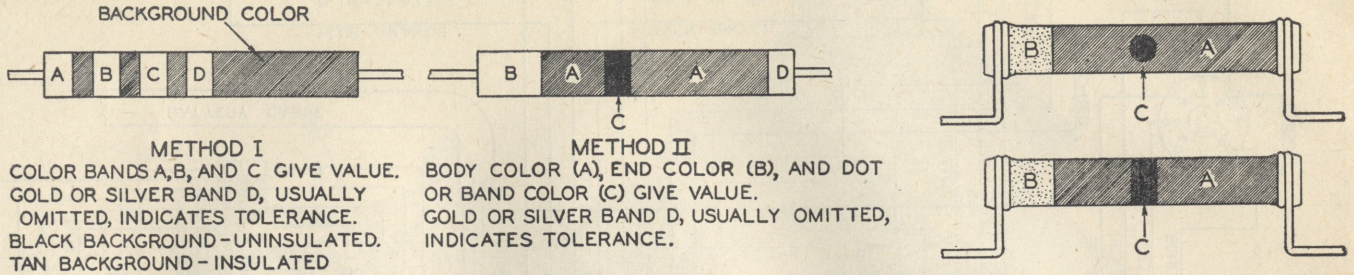


Figure 14—*Telephone Repeater EE-89-A—Wiring Diagram*

RMA COLOR CODE FOR RESISTORS



METHOD I

COLOR BANDS A, B, AND C GIVE VALUE.
GOLD OR SILVER BAND D, USUALLY OMITTED, INDICATES TOLERANCE.
BLACK BACKGROUND - UNINSULATED.
TAN BACKGROUND - INSULATED

METHOD II

BODY COLOR (A), END COLOR (B), AND DOT OR BAND COLOR (C) GIVE VALUE.
GOLD OR SILVER BAND D, USUALLY OMITTED, INDICATES TOLERANCE.

Fig. 15—*Resistor Color Code*

COLOR	FIGURE
BLACK	0
BROWN	1
RED	2
ORANGE	3
YELLOW	4
GREEN	5
BLUE	6
VIOLET	7
GRAY	8
WHITE	9

COLOR A GIVES FIRST FIGURE OF RESISTOR VALUE.

COLOR B GIVES SECOND FIGURE OF RESISTOR VALUE.

COLOR C GIVES NUMBER OF CIPHERS FOLLOWING THE FIRST TWO FIGURES.

COLOR D: GOLD BAND INDICATES ±5% TOLERANCE.
SILVER BAND INDICATES ±10% TOLERANCE.
NO BAND INDICATES STANDARD ±20% TOLERANCE.

EXAMPLES

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

15. Table of Replaceable Parts.—

SECTION V
SUPPLEMENTARY DATA

Quan.	Ref. No.	Stock No.*	Name of Part	Description	Function	Mfr.	Part or Dwg. No.**
1			Battery Separator Plate	#24 Ga. Bent Sheet Steel	To Mount and Protect Repeater Unit	FTR	WTD-2973
1		3E4390-1	Battery Cable Assembly	Battery Plug & Cable	Power Supply	FTR	WTD-2966
1	B		Battery BA-40	1.5 V. & 90 V.	Power	S.C. Issue	
4		3Z246A.1	Binding Post	Type TM-146, $\frac{9}{16}$" Stem 8-32 Thread ½" Dia. Head—Sergeant 14-GD	Line Connection	Eby	W27-3
2			Binding Post Mtg. Strips	Black Phenolic Bar	To Hold Binding Post	Eby	W28-12
1			Case	⅜" Plywood—6¼" x 7⅝" x 9"	House Battery & Receiver	FTR	W93-53
1			Circuit Label	Vinylite	Circuit Instructions	SM	W63-22
3			Clip	Metal	Hold Monitor Receiver	FTR	WTA-2965
1	C1, C2	3DEB20-1	Condenser Block	2 x 2 μfd, 500 V.D.C. Metal Case	Blocking & Cathode Bypass	AC	W3-55
1	R1-R11	2Z395.6	Attenuator	Oak Switch with 11 Tapped Resistors	Adjust Gain	FTR	WTA-2964
1			Knob	Bakelite Pointer Type	To Operate Control	Eby	W26-4
1	REC	4B3030.1	Monitoring Receiver	Watch Case Type with Cord	Monitoring	Trimm	W66-9

Quan.	Ref. No.	Stock No.*	Name of Part	Description	Function	Mfr.	Part or Dwg. No.**
1	R11	3Z6651	Resistor	51,000 Ohm ½ Watt	Gain	Erie	W6-17
1	R10	3Z6639-9	Resistor	39,000 Ohm ½ Watt	Gain	Erie	W8-26
1	R9	3Z6633-6	Resistor	33,000 Ohm, ½ Watt	Gain	Erie	W6-48
1	R8	3Z6627-5	Resistor	27,000 Ohm ½ Watt	Gain	Erie	W8-16
1	R7	3Z6620-5	Resistor	20,000 Ohm ½ Watt	Gain	Erie	W6-7
1	R6	3Z6616-3	Resistor	16,000 Ohm ½ Watt	Gain	Erie	W8-37
1	R5	3Z6613-2	Resistor	13,000 Ohm ½ Watt	Gain	Erie	W8-36
1	R4	3Z6610-55	Resistor	10,000 Ohm ½ Watt	Gain	Erie	W6-24
1	R3	3Z6582-7	Resistor	8,200 Ohm ½ Watt	Gain	Erie	W8-35
1	R2	3Z6562-2	Resistor	6,200 Ohm ½ Watt	Gain	Erie	W8-13
1	R1	3Z6624-3	Resistor	24,000 Ohm ½ Watt	Gain	Erie	W6-55
1	R12	3Z6075-30	Resistor	750 Ohm ½ Watt	Cathode Bias	Erie	W6-28
2			Screws	8-32 Knurled Head—Nickel Plated	To Hold Unit in Case	FTR	W53-90
1	S	3Z9849.30	Switch DPST	Cutler Hammer Type #8360K4SW	Power Switch	CH	W21-2
2		2Z8654.7	Sockets	S8TM, Vacuum Tube Socket	To Hold Vacuum Tubes	Amph	W17-1
1		2Z9463.1	Terminal Block	Jones #2-50	Terminate Receiver Leads	Jones	W28-15
1	T1	2Z9631.29	Transformer	Input	Input	FTR	WTA-2960
1	T2	2Z9632.41	Transformer	Output	Output	FTR	WTA-2961
1			Tube VT-221	3Q5-GT, Tetrode	Amplifier	HS or Equal	W72-3

* Signal Corps Stock Numbers
** Federal Telephone & Radio Corp. Numbers

Table of Standard Nuts, Bolts, Screws, and Washers

Quantity	Description	Size	Length	Thread	Where Used
3	Lockwashers (Phs. Br.)	.164			Transformer
4	R. H. B. Machine Screw	.138	1/4"	32	
2	Lockwashers (Phs. Br.)	.164			Mount Condenser
2	Brass Hex Nut	.164		ANC 8	
1	Brass Washer	.375			Attenuator
1	Brass Hex Nut	.375		32	Attenuator
4	R. H. B. Machine Screw	.164	2/16"	32	Mount Binding Post
2	O. H. B. Machine Screw	.138	3/8"	ANC 6	Mount Binding Post Strip
2	Lockwashers (Phs. Br.)	.138			
2	Brass Hex Nut	.138		ANC 6	
2	Lockwasher (Phs. Br.)	.164			Terminal Block
2	Brass Hex Nut	.164		ANC 6	

LIST OF MANUFACTURERS

Abbreviations	*Name*	*Address*
FTR	Federal Telephone & Radio Corp.	East Newark, N. J.
Eby	Hugh H. Eby, Inc.	18 W. Cheton Ave. Philadelphia, Pa.
SM	Sillcocks Miller	South Orange, N. J.
AC	American Condenser Corp.	2508 S. Michigan Ave. Chicago, Ill.
Trimm	Trimm Manufacturing Co.	1770 W. Berteau Ave. Chicago, Ill.
Erie	Erie Resistor Corporation	Erie, Pa.
CH	Cutler Hammer	Milwaukee, Wis.
Amph	American Phenolic Corporation	1830 S. 54th Ave. Chicago, Ill.
Jones	Howard B. Jones	2300 Wabansia Ave. Chicago, Ill.
HS	Hygrade Sylvania or equal	500 Fifth Ave. New York, N. Y.

[A. G. 300.7 (15 July 1943)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION: X
(For explanation of symbols see FM 21-6)

NOTES

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NOTES

NOTES

TECHNICAL MANUAL

TELEPHONE REPEATER EE-89-A

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON 25, D. C., 29 September 1944.

TM 11-2006, 14 July 1943, is changed as follows:

13. Maintenance Tables.—

* * * * * * *

Table of Point to Point Voltages—Repeater Turned On

From	Term.	To	Term.	Voltage
* * *	*	* *	*	*
Input Transformer	3	Input Transformer	2	0
Vacuum Tube	2	Vacuum Tube	8	1.5
* * *	*	* *	*	*

Table of Point to Point Resistances

From	Term.	To	Term.	Ohms Resistance
* * *	*	* *	*	*
Input Transformer	3	Input Transformer	2	1350
Input Transformer	3	Input Transformer	4	182,000
* * *	*	* *	*	*

14.1. Moistureproofing and Fungiproofing (Added).—

a. General.—

The operation of Signal Corps equipment in tropical areas where temperature and relative humidity are extremely high require special attention. The following items represent problems which may be encountered in operation:

(1) Resistors and capacitors fail.

(2) Electrolytic action takes place in coils, chokes, transformer windings, etc., causing eventual break-down.

(3) Hook-up wire and cable insulation break down. Fungus growth accelerates deterioration.

(4) Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flash-overs and crosstalk.

(5) Moisture provides leakage paths between battery terminals.

b. Treatment.—

A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture.

AGO 25C 610303°—44

The treatment involves the use of a moisture- and fungi-resistant varnish applied with a spray gun and brush. See TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, for a detailed description of the varnish-spray method of moistureproofing and fungiproofing.

Caution. Varnish spray may have toxic effects if inhaled. To avoid inhaling spray, use respirator if available; otherwise, fasten cheesecloth or other cloth material over nose and mouth.

c. Step-by-Step Instructions for Treating Telephone Repeater EE-89-A.—

(1) *Preparation of the Repeater.*—(*a*) Test and repair the repeater by the routine methods to insure its correct operation under normal conditions. If the set does not function normally after all repairs have been made, dry it in the oven (4) below, and retest. *Never treat a defective unit.*

(*b*) Clean off all dirt, dust, rust, grease, and corrosion.

(2) *Disassembly.*—(*a*) Disconnect and/or unscrew and remove the following items. See (fig. 16):

1. Battery pack.
2. Repeater chassis.
3. Battery separator plate.

(*b*) Unclip the battery connector covers and loosen the cable clamp. Strip off all the vinylite tubing on the battery cables.

(*c*) Remove both of the vacuum tubes.

(*d*) Disconnect and remove the monitoring receiver cord.

(*e*) Remove the power switch and the receiver terminal strip from their mountings, and allow them to hang free on their attached wiring.

(*f*) Cut off all of the cable sewing and the short length of vinylite tubing near the spare tube socket. Provide cable protection at this point by masking the chassis edge with two thicknesses of masking tape.

(3) *Masking.*—Mask the following items:

(*a*) The toggle and the mounting bushing of the power switch. (See fig. 17①.)

(*b*) The complete receiver terminal strip. (See fig. 17②.)

(*c*) The ends of the terminal strip mounting brackets. (See fig. 17③.)

(*d*) The top of each of the vacuum tube sockets. (See fig. 17④.)

(*e*) The locating-pin opening in the bottom of each of the vacuum tube sockets. (See fig. 17⑤.)

(*f*) The complete inner assembly of the gain switch. (See fig. 17⑥.)

(*g*) The gain switch knob and shaft above the panel. (See fig. 17⑦.)

(*h*) The four line binding posts. (See fig. 17⑧.)

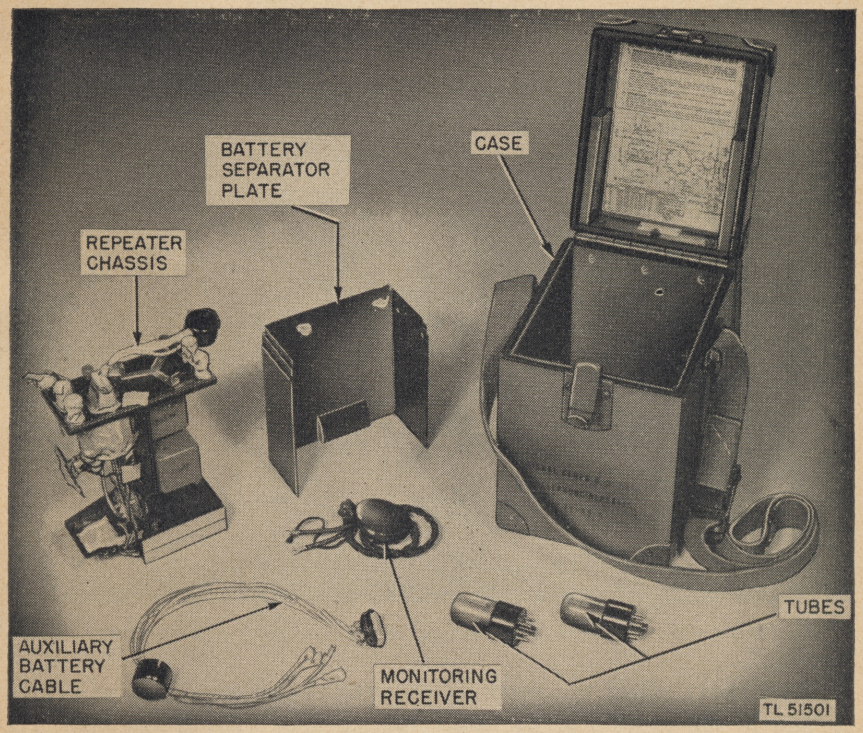

Figure 16. Telephone Repeater EE-89-A—disassembled and masked for the moistureproofing and fungiproofing treatment

(*i*) Both of the rubber grommets in the panel and the threads of the panel mounting screws. (See fig. 179 and 10.)

(*j*) The spade tips of the battery cable (fig. 1711).

(*k*) The prongs and contact openings of the battery cable connectors. (See fig. 1712 and 13.).

(*l*) The threaded angle pieces of the battery separator plate. (See fig. 1714.)

(4) *Drying*—Place the repeater chassis and the battery separator plate in an oven and dry for 2 to 2½ hours at 160° F. *Do not exceed 160° F.* Watch for indications of melting wax. If this becomes evident, lower the temperature accordingly and lengthen the drying time by 1 hour for every 10° drop. When possible, change the position of the equipment every ½ hour to obtain uniform heating of all parts.

(5) *Varnishing*—Apply three coats of moistureproofing and fungiproofing varnish.

(*a*) *Spray* all exposed parts and wiring of the equipment.

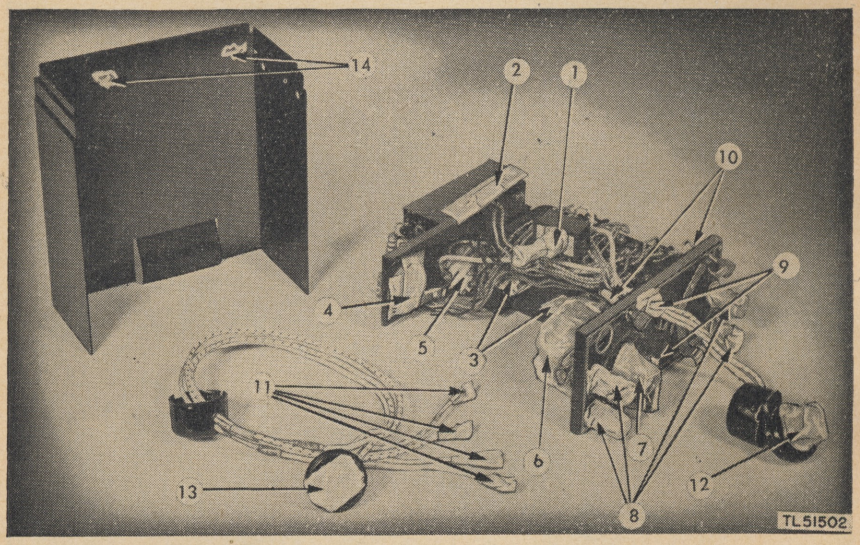

Figure 17. Telephone Repeater EE-89-A—masking of components

(*b*) Remove all of the masking except that which serves as a protection to the cable near the spare tube socket. *Brush* the following parts with varnish. *Do not allow any varnish to run* over onto the electrical contacts, bearing surfaces, and terminals.

1. The gain switch assembly.
2. All resistor ends and as much of the resistor bodies as possible.
3. The edges of the vacuum tube sockets.
4. The monitoring receiver terminal strip.
5. The bottom bead and the insulating washer of each line binding post.

6. The portion of the battery cable running under the cable clamp and through the panel.
7. The battery cables.

(6) *Final Tests and Reassembly*—(*a*) Check the electrical continuity of the gain switch and the mechanical actions of all moving parts. Remove excess varnish from the switch contacts by using varnish remover, and burnish the contacts.

(*b*) Re-form and resew the chassis cable.

(*c*) Inspect all cable connections and repair all cases of breakage and/or crystallization of wires which may have occurred.

(*d*) Sew the battery cables, using cord in place of the original vinylite tubing.

(*e*) Place a small piece of the vinylite tubing around the battery cable which is under the clamp, and tighten the clamp screw.

(*f*) Complete the reassembly of the repeater by reversing the sequence given in (2) above.

(*g*) Test the repeater and correct any trouble which may have occurred during the processing of the equipment.

(7) *Marking*—Mark MFP and date of treatment on both the inside and the outside of the repeater.

Example: MFP—30 September 1944.

15. (Superseded) Maintenance Parts List for Telephone Repeater EE–89–A.—

Ref symbol	Signal Corps stock No.	Name of part and description	Orgn stock	3d ech	4th ech	5th ech	Depot stock	Quan per unit
R	2Z395.6	ATTENUATOR: includes oak switch and resistors R1 to R11 (gain control).	-----	-----	(*)	(*)	(*)	1
	3E4390–1	BATTERY CABLE ASSEMBLY: includes lugs and plugs (power supply connection).	-----	(*)	(*)	(*)	(*)	1
	3Z246A.1	BINDING POST TM–146 (line terminating)	-----	(*)	(*)	(*)	(*)	4
C1, C2	3DEB20–1	CAPACITOR: paper; 2-section; 2 mf per section; 500 v dc (test) (line bypass and cathode bypass).	-----	(*)	(*)	(*)	(*)	1
	4B3289A/G1	GASKET: for base and lid	-----	-----	(*)	(*)	(*)	2
	2Z5848	KNOB: bakelite; pointer-type (gain control handle); Eby Inc.	-----	(*)	(*)	(*)	(*)	1
REC	4B3030.1	RECEIVER: telephone; "featherweight" watchcase type; 7,500 ohms impedance at 1,000 cycles; includes cord (monitoring); Trimm No. 161.	-----	(*)	(*)	(*)	(*)	1
R12	3Z6075–30	RESISTOR: carbon; insulated; 750 ohms ±5 percent; ½-watt (cathode-bias); American War Standard type RC20BE751J.	-----	(*)	(*)	(*)	(*)	1
	2Z8654.7	SOCKET: tube; octal (vacuum tube mounting); Amphenol No. 88TM.	-----	-----	(*)	(*)	(*)	2
	2ZK8678.70	SOCKET: tube; octal (vacuum tube mounting); Cinch No. 9880 (furnished with Telephone Repeaters EE–89–A on Order No. 17731–Phila–44).	-----	-----	(*)	(*)	(*)	2
	6Z8472–6	STRAP ASSEMBLY: webbing; includes buckle and tip; 1¼" wide, 80" long.	-----	(*)	(*)	(*)	(*)	1
S	3Z9849.30	SWITCH: toggle; double-pole, single-throw (power switch); Cutler-Hammer No. 8360K45W.	-----	(*)	(*)	(*)	(*)	1
T1	2Z9631.29	TRANSFORMER: audio; input; iron core; Federal No. WTA–2960.	-----	-----	(*)	(*)	(*)	1

T2	2Z9631.41	TRANSFORMER: audio; output; iron core; Federal No. WTA–2961.		(*)	(*)	(*)	1
	6R57400	WRENCH: socket; for No. 8 sockethead setscrew; Allen Mfg. Co.		(*)	(*)	(*)	1
		GENERAL HARDWARE					
	6L6632–4.5	SCREW: machine; brass-nickel; roundhead; No. 6–32 x ¼″ (transformer mounting).		(*)	(*)	(*)	4
	6L72906	WASHER: lock; bronze; for No. 6 screw; Shakeproof Lockwasher Company No. 1906 (internal teeth; transformer mounting).		(*)	(*)	(*)	4
	2J3Q5GT	TUBE JAN–(3Q5GT): VT–221 (power amplifier)		(*)	(*)	(*)	1

* Indicates stock available.

[A. G. 300.7 (8 Aug 44).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:

As prescribed in paragraph 9a, FM21–6; Armies (Sig) (5); Sv C IBn 1 (3); IC 11 (3); (Sig) (5); Depts (Sig) (5); Def C (Sig) (2); D (2); Tech Sv (2); Arm & Sv Boards (2); Posts, Camps & Stas (2); ROTC (5); Sp Sv Schs (10); T of Opns (5); Base C (5); Sig C Dep (2); Gen Oversea, SOS Dep (Sig Sec) (2); Sig C Labs (2); Sig C Rep Shs (2); PE (Sig) (2).

IBn 1: T/O & E 1–1027.

IC 11: T/O & E 11–7; 11–47; 11–18; 11–217; 11–247; 11–257; 11–287; 11–400, Sig AW Orgn; 11–57; 11–107; 11–127; 11–237; 11–587; 11–592; 11–597.

For explanation of symbols, see FM 21–6.

U. S. GOVERNMENT PRINTING OFFICE: 1944

SUPPLEMENT

to

TECHNICAL MANUAL

TELEPHONE REPEATER EE-89-A

14 JULY 1943

The following information, published on Orders No. 17080-Phila-44 and No. 21180-Phila-44, supplements TM 11-2006, 14 July 1943. Personnel using the equipment and having custody of this technical manual will attach this supplement securely inside the front cover of the TM, and will enter suitable notations beside each changed paragraph in the TM to indicate the presence of of this supplementary information.

Page 17, Par. 13. Change line 10 of Table of Point to Point Resistances to read as follows:

Input Transformer	3	Input Transformer 4	182,000

Page 18, Par. 14:

(1) Delete (S) after Faulty Transformer in column two, item nine.

(2) Delete (S) after Replace Transformer in column four, item nine.

Page 18. Add the following after paragraph 14:

14.1 Moistureproofing and Fungiproofing.—

a. General.—

Communication failures commonly occur when Signal Corps equipment is operated in tropical areas where temperature and relative humidity are extremely high. The following problems are typical:

(1) Resistors and capacitors fail.

(2) Electrolytic action takes place in coils, chokes, transformer windings, etc., causing eventual break-down.

(3) Hook-up wire and cable insulation break down. Fungus growth accelerates deterioration.

(4) Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flash-overs and crosstalk.

(5) Moisture provides leakage paths between battery terminals.

b. Treatment.—

A moistureproofing and fungiproofing treatment has been devised which, if properly applied, will provide a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture. The treatment involves the use of a moisture- and fungi-resistant varnish applied with a spray gun and/or a brush. A detailed description of the moistureproofing and fungiproofing treatment is contained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, dated 7 March 1944. Supplementary information pertaining only to the treatment of Telephone Repeater EE-89-A is given in the following step-by-step instructions.

c. Step-by-step Instructions.—

(1) *Preparation of the Repeater—(a)* Test and repair the repeater by the routine methods to insure its correct operation under normal conditions. If the set does not function normally after all repairs have been made, dry it in the oven (subpar. (4) below) and retest. *Never treat a defective unit.*

(b) Clean off all dirt, dust, rust, grease, and corrosion.

(2) *Disassembly—(a)* Disconnect and/or unscrew and remove the following items:

1. Battery pack.
2. Repeater chassis.
3. Battery separator plate.

(b) Unclip the battery connector covers and loosen the cable clamp. Strip off all the vinylite tubing on the battery cables.

(c) Remove both vacuum tubes.

(d) Disconnect and remove the monitoring receiver cord.

(e) Remove the power switch and the receiver terminal strip from their mountings, and allow them to hang free on their attached wiring.

(f) Cut off all the cable sewing and the short length of vinylite tubing near the spare tube socket. Provide cable protection at this point by masking the chassis edge with two thicknesses of masking tape.

(3) *Masking*—Mask the following items:

(a) The toggle and the mounting bushing of the power switch.

(b) The complete receiver terminal strip.

(c) The ends of the terminal strip mounting brackets.

(d) The top of each of the vacuum tube sockets.

(e) The locating pin opening in the bottom of each of the vacuum tube sockets.

(f) The complete inner assembly of the gain switch.

(g) The gain switch knob and shaft above the panel.

(h) The four line binding posts.

(i) Both of the rubber grommets in the panel and the threads of the panel mounting screws.

(j) The spade tips of the battery cable.

(k) The prongs and contact openings of the battery cable connectors.

(l) The threaded angle pieces of the battery separator plate.

(4) *Drying*—Place the repeater chassis and the battery separator plate in an oven and dry for 2 to 2½ hours at 160° F. *Do not exceed 160° F.* Watch for indications of melting wax. If this becomes evident, lower the temperature accordingly and lengthen the drying time by one hour for each 10° drop. When possible, change the position of the equipment every half-hour to obtain uniform heating of all parts.

(5) *Varnishing*—Apply three coats of moistureproofing and fungiproofing varnish.

(a) Spray all exposed parts and wiring of the equipment.

(b) Remove all the masking except that which serves as a protection to the cable near the spare tube socket. *Brush* the parts listed below with varnish. *Do not allow any varnish to run over onto the electrical contacts, bearing surfaces, or terminals.*

1. The gain switch assembly.
2. All resistor ends and as much of the resistor bodies as possible.

3. The edges of the vacuum tube sockets.

4. The monitoring receiver terminal strip.

5. The bottom bead and the insulating washer of each line binding post.

6. The portion of the battery cable running under the cable clamp and through the panel.

7. The battery cables.

(6) *Final Tests and Reassembly—(a)* Check the electrical continuity of the gain switch and the mechanical actions of all moving parts. Remove excess varnish from the switch contacts by using varnish remover, and burnish the contacts.

(b) Re-form and resew the chassis cable.

(c) Inspect all cable connections and repair all cases of breakage and/or crystallization of wires which may have occurred.

(d) Sew the battery cables, using cord in place of the original vinylite tubing.

(e) Place a small piece of the vinylite tubing around the battery cable which is under the clamp, and tighten the clamp screw.

(f) Complete the reassembly of the repeater by reversing the sequence given in subparagraph (2) above.

(g) Test the repeater and correct any trouble which may have developed during the processing of the equipment.

(7) *Marking*—Mark MFP and date of treatment on both the inside and outside of the repeater.

Example: MFP—30 April 1944.

Page 21. Delete paragraph 15 and substitute the following:

15. Maintenance Parts List for Telephone Repeater EE-89-A.—

Note: Order maintenance parts by stock number, name and description. Only maintenance parts can be requisitioned.

Ref. symbol	Signal Corps stock No.	Name of part and description	Running spares	Orgn. stock	3d echelon	4th echelon	5th echelon	Depot stock	Quan. per unit
R	2Z395.6	ATTENUATOR: oak switch and resistors R1 to R11				*	*	*	1
	3E4390-1	BATTERY CABLE ASSEMBLY: plug and cable			*	*	*	*	1
	3Z246A.1	BINDING POST TM-146: 9/16" stem, 8-32 thread, 1/2" diam. head; Sergeant 14GD			*	*	*	*	4
C1, C2	3DEB20-1	CAPACITOR: paper; 2-section, 2 uf per section; 500 v d-c (working); (line bypass and cathode bypass)			*	*	*	*	2
	4B3289A/G1	GASKET: for base and lid				*	*	*	2
	2Z5848	KNOB: bakelite; pointer-type; (5/8" radius, with 1/4" brass bushing and 8-32 set screw)			*	*	*	*	1
REC	4B3030.1	RECEIVER: telephone; ("featherweight" watch-case type with 24" cord; 7,500 ohm impedance); Trimm No. 161			*	*	*	*	1

* Indicates stock is available.

Ref. symbol	Signal Corps stock No.	Name of part and description	Running spares	Orgn. stock	3d echelon	4th echelon	5th echelon	Depot stock	Quan. per unit
R12	3Z6075-30	RESISTOR: carbon; insulated; 750 ohms ±5%; ½-watt; (cathode bias); American War Standard No. RC20BE751J			*	*	*	*	1
	2Z8654.7	SOCKET: tube; octal; (vacuum tube mounting); Amphenol No. S8TM	1			*	*	*	1
	6Z8472-6	STRAP ASSEMBLY: webbing; includes buckle and tip; (1¼″ wide, 80″ long)			*	*	*	*	1
S	3Z9849.30	SWITCH: toggle; (power switch; DPST); Cutler-Hammer No. 8360K4SW			*	*	*	*	1
T1	2Z9631.29	TRANSFORMER: audio; input; iron-core; FTR No. W15-40				*	*	*	1
T2	2Z9632.41	TRANSFORMER: audio; output; iron-core; FTR No. W15-41				*	*	*	1
	2V3Q5GT	TUBE JAN-3Q5GT: VT-221; (power amplifier)	1		*	*	*	*	1
	6L6632-4.5	SCREW: machine; brass-nickel; round-head; 6-32 x ¼″; (transformer mounting)				*	*	*	4
	6L72906	WASHER: lock; bronze; internal teeth; for No. 6 screw; (transformer mounting); Shakeproof Lockwasher Co.				*	*	*	4

* Indicates stock is available.