



# SPEECH-INVERSION EQUIPMENT

MI-7181

375

AND

# HYBRID UNIT

85

MI-7182

Manufactured by

**RCA Manufacturing Company, Inc.**

Camden, N. J., U. S. A.

"A SERVICE OF THE RADIO CORPORATION OF AMERICA"

\$ 275

J.F.

# **SPEECH-INVERSION EQUIPMENT**

**MI-7181**

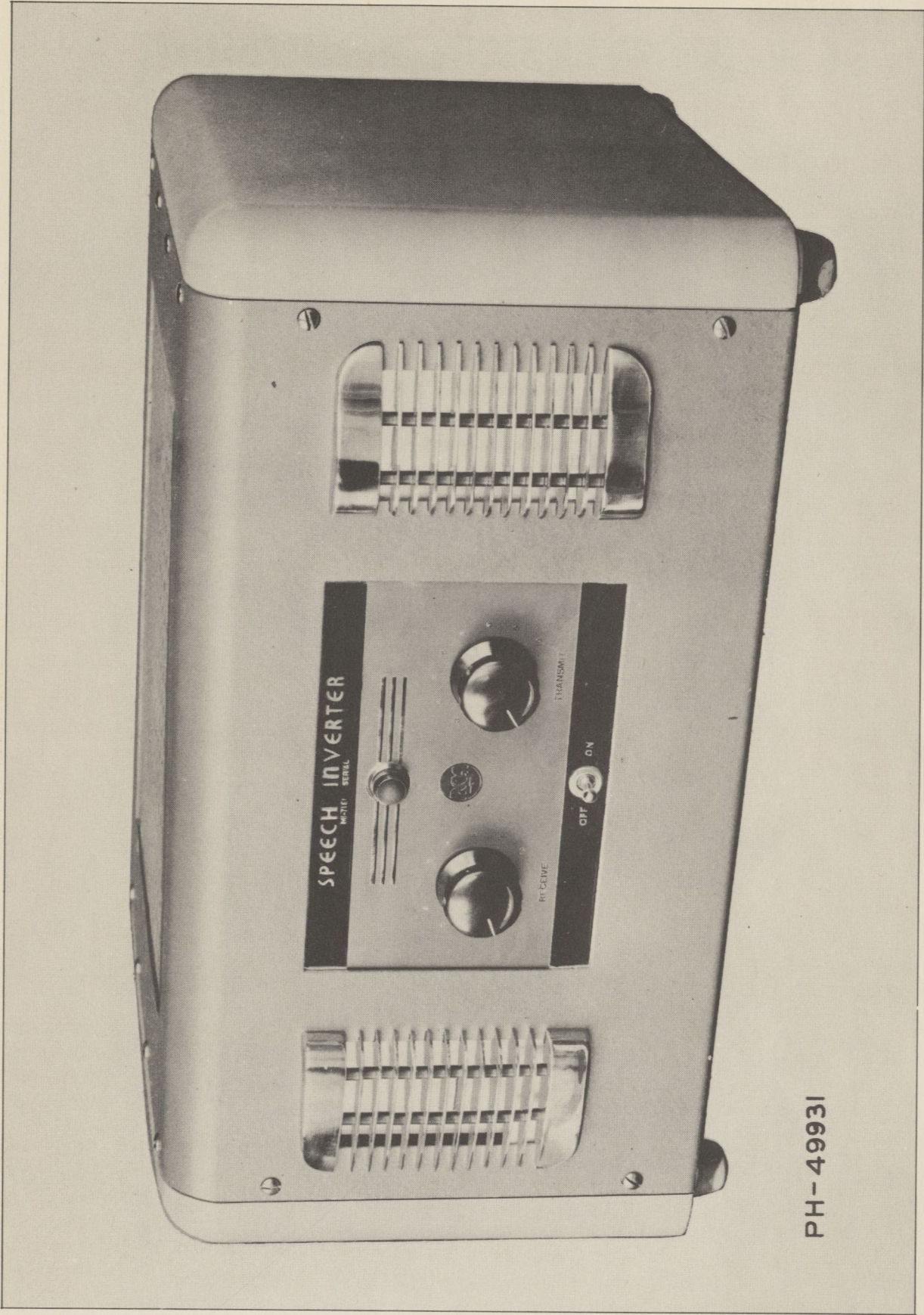
**AND**

# **HYBRID UNIT**

**MI-7182**

## **INSTRUCTIONS**

Manufactured by  
**RCA Manufacturing Company, Inc.**  
Camden, N. J., U. S. A.



PH-4993I

FIGURE 1 - SPEECH INVERTER

# SPEECH-INVERSION EQUIPMENT

MI-7181

## TECHNICAL SUMMARY

### ELECTRICAL CHARACTERISTICS -

Inversion Frequency . . . . .	3000 cycles
Input Impedance . . . . .	600/150 ohms
Output Impedance . . . . .	600/150 ohms
Power Supply Requirements -	
Voltage . . . . .	100-110-120 volts
Frequency . . . . .	50-60 cycles
Phase . . . . .	1 phase
Power Required . . . . .	50 watts
Input Level (min. for max. output) . . . . .	-10 v.u.*
Output Level (max.) . . . . .	+10 v.u.*
Fidelity . . . . .	Approximately $\pm 5$ db from 300 to 2700 cycles
Distortion . . . . .	Approximately 5% r-m-s at 400 cycles input

### TUBE COMPLEMENT -

2 RCA-6B7 . . . . .	Inverter Amplifiers
2 RCA-6C8-G . . . . .	Amplifiers
1 RCA-1603 . . . . .	Oscillator
1 RCA-80 . . . . .	Rectifier

\* v.u. = db from a 1 mw reference.

## DESCRIPTION

The MI-7181 Speech-Inversion or Privacy Equipment has been designed to permit private two-way radio voice communication from two pairs of lines (microphone and headset lines) at each end of a communication system.

By means of an optional accessory item, MI-7182 Hybrid Unit, operation may be had from a single pair of lines at each end of the system. The equipment is simple, rugged, efficient, of conservative design, and will function well in any climatic condition. It will provide unflinching service for an indefinite period.

The speech inverter is housed in a modern cabinet designed for table mounting. Removable rubber feet are provided. This permits rigid mounting of the cabinet to the table by means of four large machine screws. The rear cover is held in place by thumb screws. Adequate ventilation is provided by louvers on the front and back and by a grill on the top.

The parts are mounted on a metal chassis, which may easily be removed for cleaning and inspection. The tubes are accessible from the rear. All wiring and small components are under the chassis. A terminal board is provided for interconnections to other equipment. These interconnections should be made through four large rubber-grommeted holes in the bottom of the cabinet near the terminal board.

## INSTALLATION

The speech inverter should be connected through the four grommeted holes in the bottom of the cabinet, see Figure 5. Removing the rear cover of the cabinet by means of thumb screws will give access to the terminal board. The terminal board numbers correspond to the terminal board numbers shown in Figure 5. Insert the tubes in their sockets according to the numbers which are stamped near the sockets.

Since the cabinet is supplied with four rubber feet it may be installed on an operating table without fear of scarring the table. However, the feet may be removed and the cabinet bolted down rigidly. A good ground should be provided to the cabinet or chassis in order to eliminate external pick-up noise.

The speech inverter, as shipped, is connected for 110-volt operation. The primary of transformer T<sub>1</sub>, Figure 4, is provided with taps for 100, 110 or 120-volt operation. A check should be made to determine the actual line voltage available, and the power supply transformer primary should be reconnected, if necessary, to conform to the line voltage. The power transformer supply leads as indicated in Figure 4 are as follows:

Black . . . . .	100 volts
Red and Black . . . . .	50/50-110 volts
Red-Black Tracer . . . . .	120 volts

## OPERATION

Upon completion of the installation, apply power to the equipment by throwing power switch to the "ON" position. The pilot lamp should light and, within a few minutes, the cathodes of all tubes should glow. If these conditions do not exist, shut off the power and locate the trouble before proceeding.

Removal of the chassis from the cabinet will permit a check on operating potentials. The d-c operating potentials, as measured to the chassis, should be approximately as follows:

Capacitor C <sub>1</sub> . . . . .	175 volts
Capacitor C <sub>2</sub> . . . . .	147 volts
Capacitor C <sub>3</sub> . . . . .	147 volts
V <sub>2</sub> , Plate (RCA-1603) . . . . .	105 volts

V3 and V5 (RCA-6B7) -	
Plate . . . . .	108 volts
Screen Grid . . . . .	112 volts
Cathode . . . . .	5.5 volts
V4 and V6 (RCA-6C8G) -	
Plate #1 . . . . .	150 volts
Cathode #1 . . . . .	2.5 volts
Plate #2 . . . . .	80 volts
Cathode #2 . . . . .	2.5 volts

All filaments are 6.3 volts a.c., except the RCA-80 which is 5 volts a.c.

*CAUTION - The RCA-80 tube filaments are approximately 200 volts d.c. above the chassis.*

The MI-7181 speech inverter actually comprises two speech inverter circuits, one for transmitting, comprising tubes V5 and V6, and one for receiving, comprising tubes V3 and V4. An oscillator, V2, and a rectifier, V1, is common to both of the inverter circuits.

Inversion is accomplished by restricting the range of transmitted audio-frequencies between the limits of approximately 300 and 2700 cycles, and heterodyning these audio signals with a carrier of exactly 3000 cycles. All frequencies excepting the difference frequency are highly attenuated. Thus for example: an input frequency of 700 cycles will result in an output of 2300 cycles, and 2600 cycles will yield 400 cycles. With inversion, speech fed into the transmitting inverter circuit will feed the radio transmitter with unintelligible signals, which will remain so until they issue from a receiving inverter circuit at the other end of the communication channel to again become intelligible speech.

The operating controls on the front panel of the inverter are as follows:

1. A power "ON-OFF" switch (S1).
2. A power "ON-OFF" indicator lamp (A2).
3. A gain control for the "TRANSMIT" circuit (R23).
4. A gain control for the "RECEIVE" circuit (R3).

### MAINTENANCE AND SERVICE

In order to assure trouble-free operation, a regular inspection of the equipment should be made. All tubes should be tested and, if necessary, should be replaced. Dust and dirt should be blown out of the equipment.

Should the power "ON-OFF" indicator burn out, it can be replaced from the front of the panel by removing the red lens.

The inverter is provided with the following adjustments:

1. Hum adjustment (R35).

2. 3000 cycle oscillator mixing bridge balance adjustment (R20).
3. Transmitting inversion adjustments, switch (S3) and rheostat (R24).
4. Receiving inversion adjustments, switch (S2) and rheostat (R4).
5. 3000 cycle oscillator frequency adjustment (C4).

All these adjustments have been carefully checked at the factory before shipment, but they should be checked at installation in order to take care of any disturbances which may have affected them during shipment. When the correct settings have been obtained, readjustments will be required very infrequently.

**HUM ADJUSTMENT** - This adjustment is located on the left-hand side of the back of the chassis, see Figure 2. By means of the slotted shaft, the rheostat (R35) should be adjusted to give minimum power line hum in the output of the inverter circuits, terminals 9-11 and 14-16.

**MIXING BRIDGE BALANCE** - In order to prevent cross talk between the transmitting and receiving circuits, and yet permit mixing the 3000 cycle oscillator output with each of the inversion circuits, a bridge comprised of resistors R18, R19, R20, R21, R22 and R41, is employed. The potentiometer R20 is used to balance the bridge. This potentiometer is mounted on the chassis directly in front of tube V5 (RCA-6B7) and is provided with a screwdriver slot for adjustment, see Figure 3. To make this adjustment remove the grid clip from the grid cap of the RCA-1603 tube (V2) in order to stop the 3000 cycle oscillator. Place the power switch in the "ON" position, apply a signal to terminals 4 and 6, and adjust R20 for minimum output at terminals 1 and 3. A pair of earphones may be used if a sensitive vacuum tube voltmeter is not available. The signal applied at terminals 4 and 6 may be voice, but preferably should be 0.1 volts at a frequency of 1000 cycles. This will result in approximately 0.001 volts at terminals 1 and 3 with R3 and R23 set for maximum gain.

**INVERSION BALANCE** - The method of inversion employed in this equipment depends upon balanced diode rectification for the elimination of the fundamental signal in the inverted output of both inversion circuits. A potentiometer and a switch are employed in both circuits to obtain this balance.

1. Receiving Inversion Circuit - Connect a 600-ohm load to terminals 14 and 16. Apply 400 cycles from an external audio oscillator to terminals 1 and 3. Adjust the level of the oscillator so that 2.5 volts is obtained at terminals 14 and 16. By means of a General Radio Company, Type 636, Wave Analyzer, or aurally by means of high impedance earphones, adjust the potentiometer R4 and the switch S2 for a minimum of 400 cycles at terminals 14 and 16. The potentiometer R4 is located on the back of the chassis on the lower right-hand side. The switch S2 is near the potentiometer and is the left-hand switch of the group of two.

2. Transmitting Inversion Circuit - Connect a 600-ohm load to terminals 9 and 11. Apply 400 cycles from an external audio oscillator to terminals 4 and 6. Adjust the level of the oscillator so that 2.5 volts is obtained at terminals 9 and 11. By means of a General Radio Company, Type 636, Wave Analyzer, or aurally by means of high impedance earphones, adjust the potentiometer R24 and the switch S3, see Figure 2, for a minimum of 400 cycles

at terminals 9 and 11. The potentiometer R<sub>24</sub> is located directly above R<sub>4</sub>, the switch S<sub>3</sub> is located to the right of S<sub>2</sub>.

**OSCILLATOR FREQUENCY ADJUSTMENT** - The frequency of the inversion oscillator is 3000 cycles. Two screwdriver adjustments are provided to adjust its frequency, should it deviate from 3000 cycles. These adjustment screws are found on the chassis near the right-hand rear corner (when viewed from the rear). A pair of terminals, 7 and 8, are provided to facilitate this adjustment, since a portion of the oscillator output is applied to these terminals. No specific means will be given for the measurement of the frequency of the oscillator, since the method will vary greatly with the equipment available. The oscillator has been designed to maintain constant frequency within a few cycles with replacement of the tube and with wide changes in applied voltage and ambient temperature.

### PARTS LIST

Item	Description	Stock No.
C1, C2	Capacitor, 4 mfd	16673
C3	Capacitor, 4 mfd	13502
C4	Capacitor, 170-600 mfd	19434
C5, C6	Not used	
C7	Capacitor, 0.03 mfd	AF-30003
C8	Capacitor, 0.07 mfd	30858
C9	Capacitor, 2200 mmfd	12951
C10	Capacitor, 0.01 mfd	4858
C11	Capacitor, 820 mmfd	12536
C12, C13	Capacitor, 0.5 mfd	30860
C14	Capacitor, 150 mmfd	12725
C15	Capacitor, 270 mmfd	12488
C16	Capacitor, 0.25 mfd, 300 volts	30849
C17	Capacitor, 0.035 mfd	5196
C18	Capacitor, 0.025 mfd	4870
C19	Capacitor, same as C10	
C20	Capacitor, same as C11	
C21, C22	Capacitor, same as C12	
C23	Capacitor, same as C14	
C24	Capacitor, same as C15	
C25	Capacitor, same as C16	
C26	Capacitor, same as C17	
C27	Capacitor, same as C18	
F1, F2	Fuse, 3 amperes	10907
L1, L2	Coil, inductance, 102 mh	19436
R1	Resistor, 4400 ohms, 10 watts	19437
R2	Resistor, 8200 ohms, 1 watt, insulated	30149
R3	Potentiometer, dual	19439
R4	Potentiometer, 25,000 ohms	19438
R5	Resistor, 2.2 megohms, 1/2 watt	30649
R6	Resistor, 47,000 ohms, 1/2 watt	30787

Item	Description	Stock No.
R7	Resistor, 1200 ohms, 1/2 watt	30731
R8	Resistor, 560 ohms, 1/2 watt	5164
R9	Resistor, 470,000 ohms, 1/2 watt	30648
R10	Resistor, 18,000 ohms, 1/2 watt	3219
R11	Resistor, 270 ohms, 1/2 watt	30929
R12	Resistor, 270,000 ohms, 1/2 watt	30651
R13	Resistor, same as R7	
R14	Resistor, same as R5	
R15	Resistor, same as R2	
R16	Resistor, same as R9	
R17	Not used	
R18	Resistor, 620 ohms, 1/2 watt	11485
R19	Resistor, 300 ohms, 1/2 watt	3792
R20	Potentiometer, 600 ohms	19440
R21, R22	Resistor, same as R19	
R23	Potentiometer, same as R3	
R24	Potentiometer, same as R4	
R25	Resistor, same as R5	
R26	Resistor, same as R6	
R27	Resistor, same as R7	
R28	Resistor, same as R8	
R29	Resistor, same as R9	
R30	Resistor, same as R10	
R31	Resistor, same as R11	
R32	Resistor, same as R12	
R33	Resistor, same as R7	
R34	Resistor, same as R5	
R35	Potentiometer, 50 ohms	19441
R36, R37, R38, R39	Resistor, same as R18	
R40	Resistor, same as R2	
R41	Resistor, same as R19	
S1,S2,S3	Switch, D.P.S.T.	19442
T1	Transformer, XT-3246	19443
T2	Transformer, audio, XT-3238	19444
T3	Transformer, oscillator, XT-2728	19098
T4	Transformer, XT-3240	19445
T5	Transformer, XT-3241	19446
T6	Transformer, same as T2	
T7	Transformer, XT-3242	19447
T8	Transformer, same as T4	
T9	Transformer, same as T5	
T10	Transformer, same as T2	
T11	Transformer, same as T7	
V1	Socket, 4-contact, tube	19448
V2	Socket, 6-contact, tube	19449
V3	Socket, 7-contact, tube	19450
V4	Socket, 8-contact, tube	31319
V5	Socket, same as V3	
V6	Socket, same as V4	

Item	Description	Stock No.
X1,X2,X3, X4,X5,X6	Not used	
X7,X8	Reactor, filter, XT-3243	19451
X9,X10, X11,X12	Filter, low pass, XT-3245	19452
	Knob, variable resistor	17268
	Lamp, pilot lamp	11891
	Socket, pilot light socket complete with ruby jewel for mounting on 1/8" panel	34258

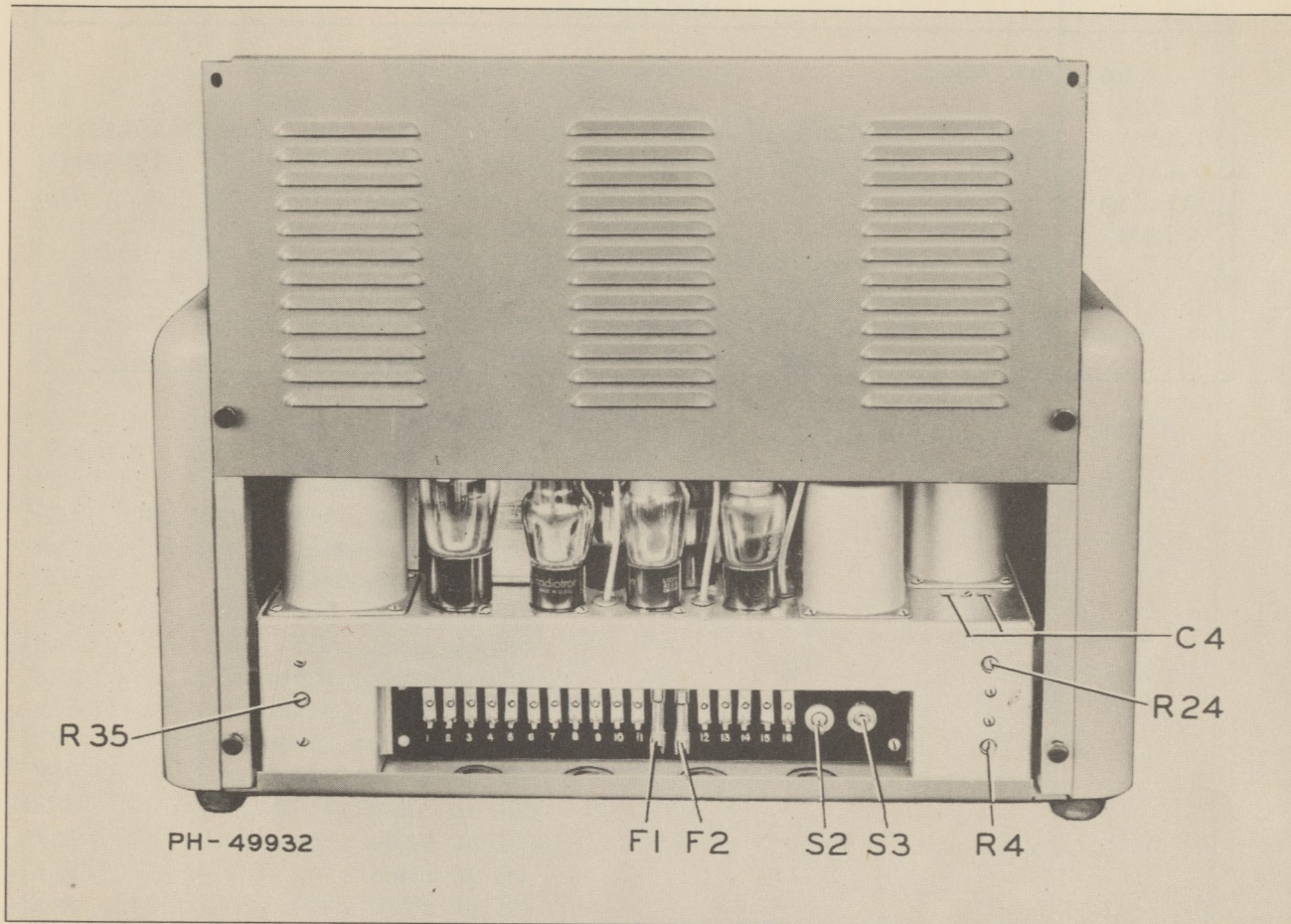
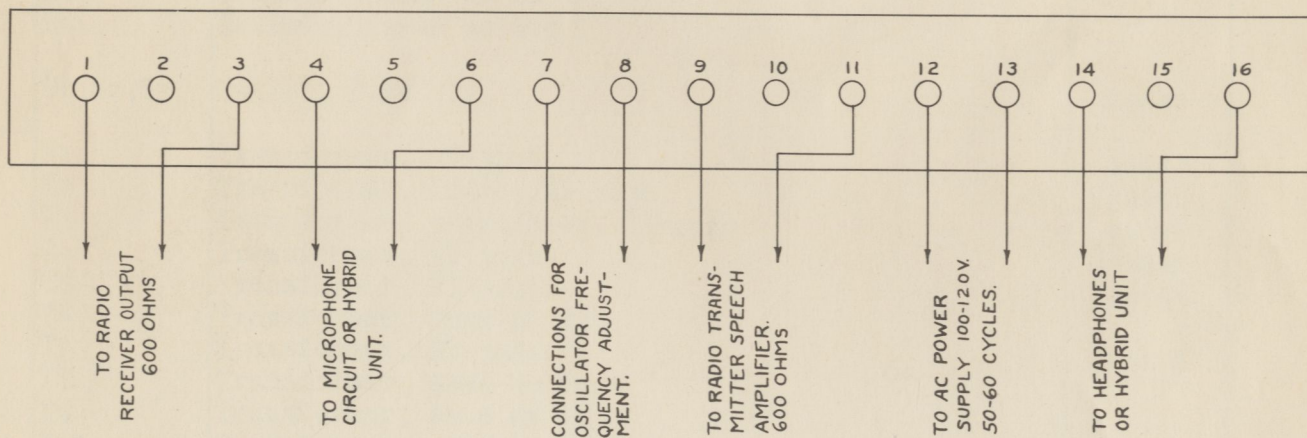
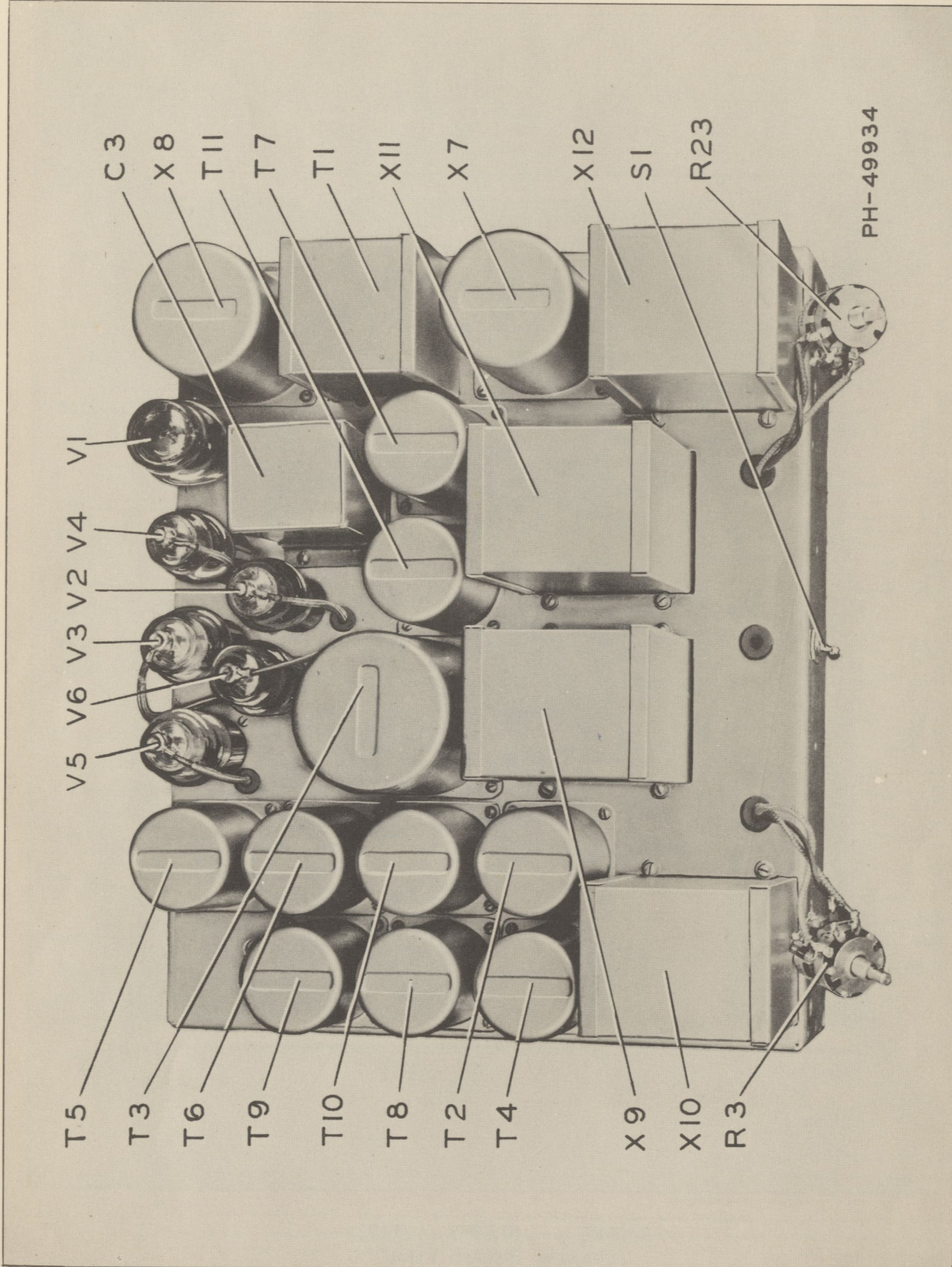


FIGURE 2 (a) - SPEECH INVERTER  
(Rear View)



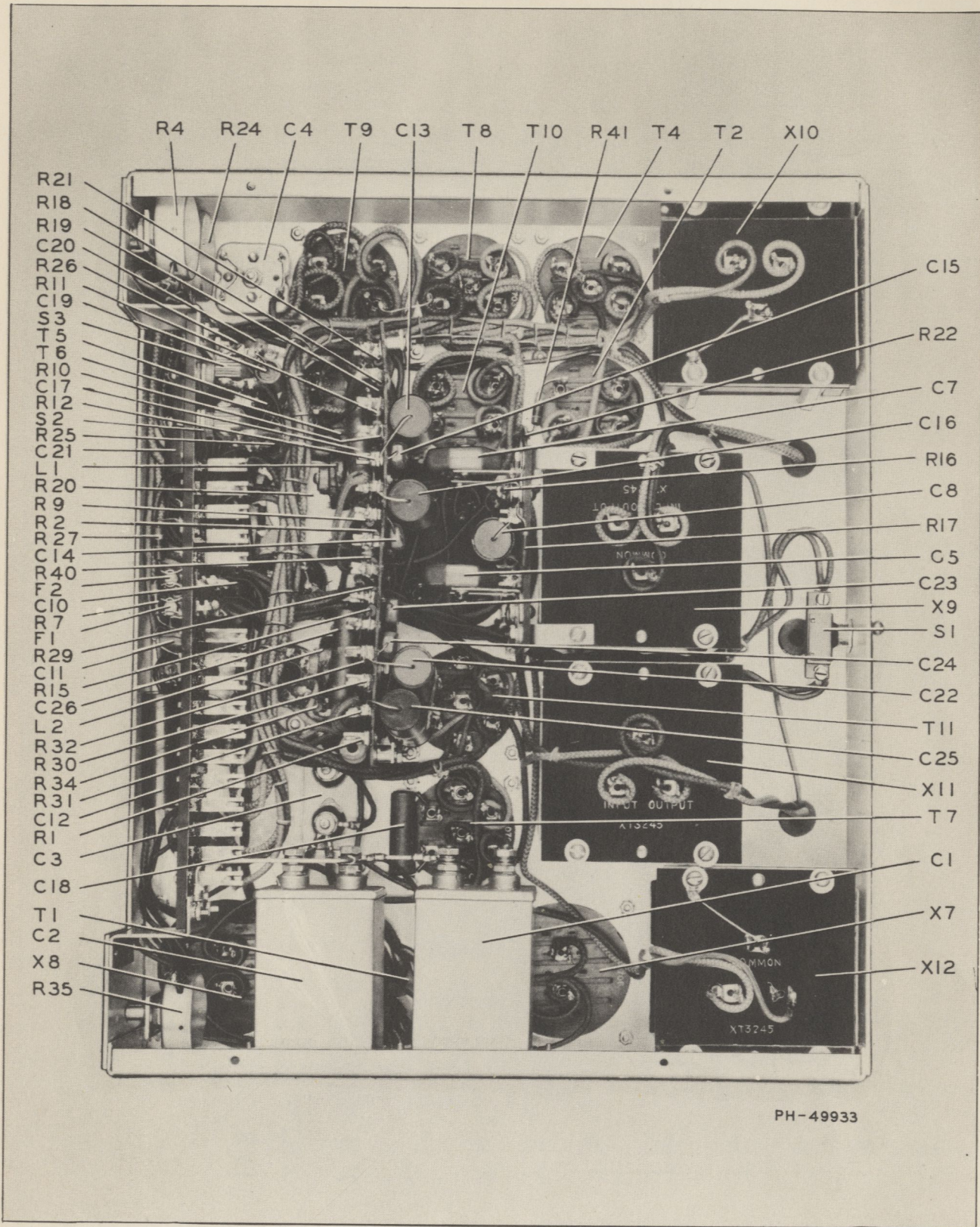
NOTE:- TERMINALS #2,5,10 AND 15 ARE THE CENTER TAP LEADS AND MAY BE USED FOR GROUNDING PURPOSES OR FOR BETTER MATCHING, IF ASSOCIATED CIRCUITS ARE OF LOW IMPEDANCE (APPROX. 150 OHMS).

FIGURE 2 (b) - TERMINAL BOARD



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FIGURE 3 - SPEECH INVERTERE  
(Chassis Top View)



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FIGURE 4 - SPEECH INVERTER  
(Chassis Bottom View)

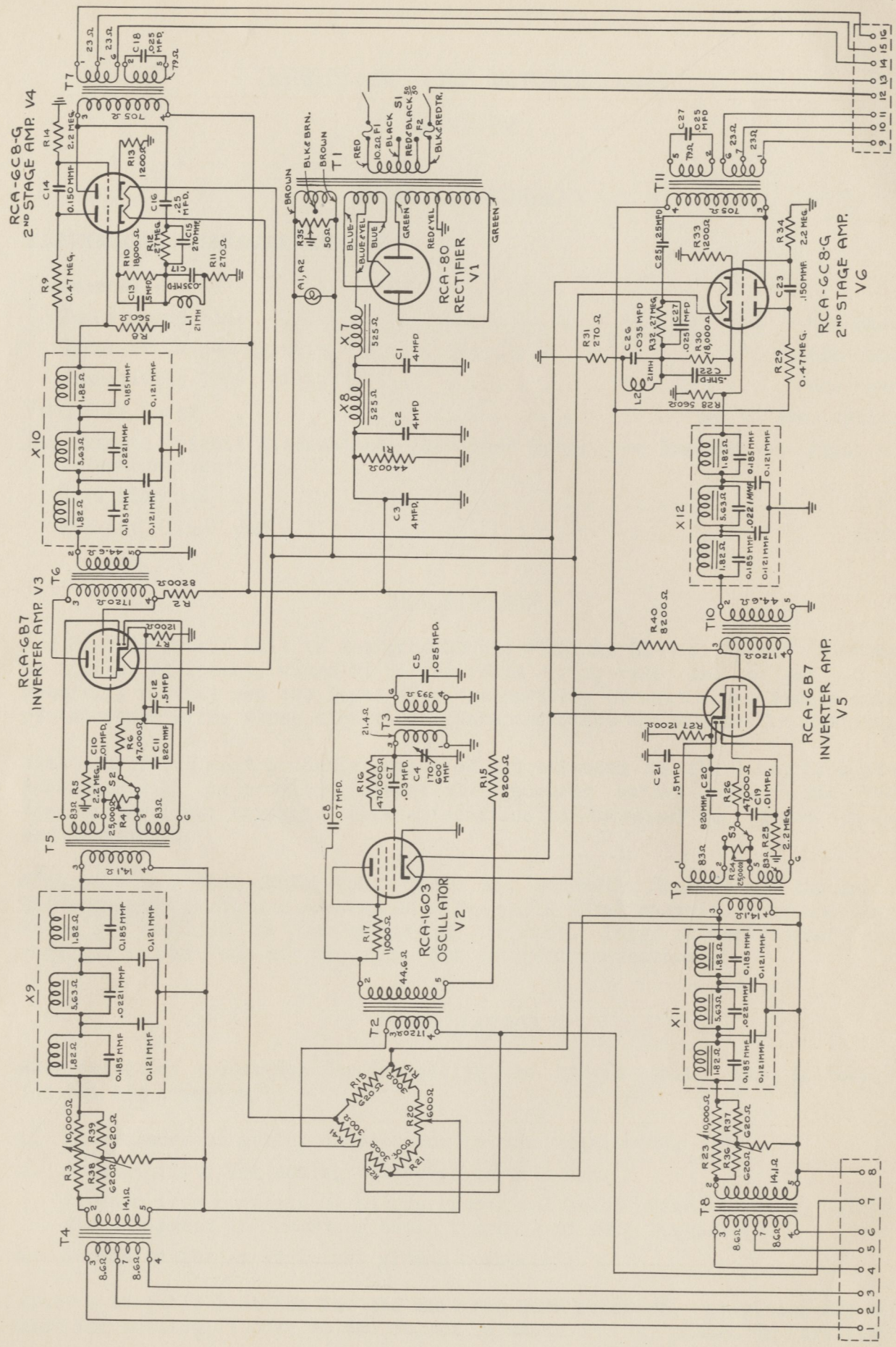


FIGURE 5 - SPEECH INVERTER  
(Schematic P-714474)

# HYBRID OR LINE MATCHING UNIT

MI-7182

## TECHNICAL SUMMARY

### ELECTRICAL CHARACTERISTICS -

#### Impedances -

Telephone Line . . . . .	600 ohms
Receiver Output Circuit . . . . .	600 ohms
Transmitter Input Circuit . . . . .	600 ohms
Frequency Range . . . . .	300 to 3000 cycles
Approximate Circuit Attenuation (Receiver Output or Transmitter Input to telephone line) -	
With line pad . . . . .	14 db
Without line pad . . . . .	6 db

### DESCRIPTION

The MI-7182 Hybrid Unit is designed for use with the MI-7181 Speech Inverter or similar equipment, where it is desirable to operate the output of a receiving circuit and the input of a transmitting circuit with a single pair of telephone wires whose electrical characteristics are essentially constant.

With the hybrid unit properly connected and balanced to the line, high attenuation will be provided between the receiver output circuit and the transmitter input circuit. Such attenuation is necessary to prevent echoes and "singing".

Figures 6 to 9 show photographic views and schematic diagram of the unit. All component parts are mounted on a removable metal chassis. Four mounting holes are provided in the bottom of the case. Large rubber grommets are provided in the back of the case for external connections.

### INSTALLATION

When selecting a location for installing the hybrid unit, the following factors are important:

1. Convenience of making connections to other equipment.
2. Accessibility for making balancing adjustments.
3. Freedom from presence of strong electrical fields in the vicinity, (since the equipment is carrying audio currents of very low level).
4. Provision for an efficient ground connection.

After a suitable location for the unit has been selected, provision may be made for bolting it down to the object on which it is placed by drilling

suitable holes for machine screws in the base plate.

A good ground connection must be provided, and attached to terminal 12. The ground wire should be no smaller than 12 gauge.

The external leads may now be attached. These may be of small gauge wire since only low currents are carried by them. However, since these are audio currents, each pair should be twisted and shielded wherever possible.

The following terminals are provided for external connections, see Figure 9:

- 1 and 3 - to be connected into a 600-ohm transmitting input circuit.
- 9 and 11 - to be connected into a 600-ohm receiving output circuit.
- 7 and 8 - 600-ohm telephone line, if the line pad R<sub>1</sub> is not to be used.
- 4 and 6 - 600-ohm telephone line, if the line pad R<sub>1</sub> is to be employed.
- 12 - chassis ground.
- 2, 5 and 10 - optional grounds, their use depends upon conditions which vary with each installation.

If this equipment is used with the MI-7181 speech inverter, the following interconnections are used:

- Hybrid terminals 1 and 3 are connected to speech inverter terminals 4 and 6.
- Hybrid terminals 9 and 11 are connected to speech inverter terminals 14 and 16.

## OPERATION

**THEORY** (see Figures 7, 8 and 9) - The hybrid unit is electrically similar to an a-c bridge consisting of four arms. Three of the arms are composed of 600-ohm fixed resistances, and the fourth arm is an adjustable resistance R<sub>2</sub>. The receiver output is fed across two arms of the bridge and the input to the transmitter is connected to the opposite two arms. When the bridge is balanced, no signal is transferred from the receiver output to the transmitter input. The telephone line is connected to one of the fixed arms of the bridge. During operation the receiver output passes to the telephone line, with a 6 db loss, half voltage; and the output from the telephone line passes to the transmitter input circuit, with approximately a 6 db loss, half voltage. However, the receiver output will not pass to the transmitter input.

Since the telephone line has reactance, capacitors C<sub>1</sub> to C<sub>10</sub> may be placed across either the variable arm R<sub>2</sub> or the arm to which the telephone line is attached by means of S<sub>11</sub>, in order to balance the reactance of the telephone line and any small stray reactance present. The exact value of capacity required depends upon the magnitude of the line reactance. Switches S<sub>1</sub> to S<sub>10</sub> are provided to permit capacity adjustments in small steps. The values in microfarads are marked beside each controlling switch. Switching the capacity by means of S<sub>11</sub> from one arm to the other provides for cancellation of capacity reactance when in one position, and inductive reactance when in the other.

Any change in the telephone line impedance will cause an unbalance to exist in the bridge, the magnitude of the unbalance depending on the magnitude of the telephone line impedance change. If such variations of telephone line impedance do exist, their unbalancing effect may be materially decreased by utilizing the 8 db line pad R1. A change in line impedance of one hundred ohms in six hundred will reflect only approximately 2% change in impedance as indicated by the bridge. The telephone line connections when employing the pad are 4 and 6, and when not employing the pad are 7 and 8.

**PROCEDURE** - After installation the hybrid unit must be balanced. The procedure for this is to apply a signal to the receiving output circuit, and then to make adjustments until the signal disappears or is minimized in the transmitting circuit.

These adjustments consist of the following steps:

1. Adjust rheostat R2 so that a signal in the receiving circuit will cause a minimum signal in the transmitting circuit.
2. Using various combinations of S1 to S10 in the "IN" position, adjust for a further reduction in signal strength.
3. With switch S11 in the opposite position to that in step 2, repeat step 2 for a still further reduction in signal. Leave switch S11 and switches S1 to S10 set where minimum signal in the transmitting circuit is obtained.
4. Repeat steps 1 and 2 for further reduction in signal.
5. Grounding one or more of terminals 2, 5 and 10 may lead to a better balance.

Trial operation will indicate whether or not the line pad R1 is required. Using the pad causes an approximate additional 8 db circuit loss.

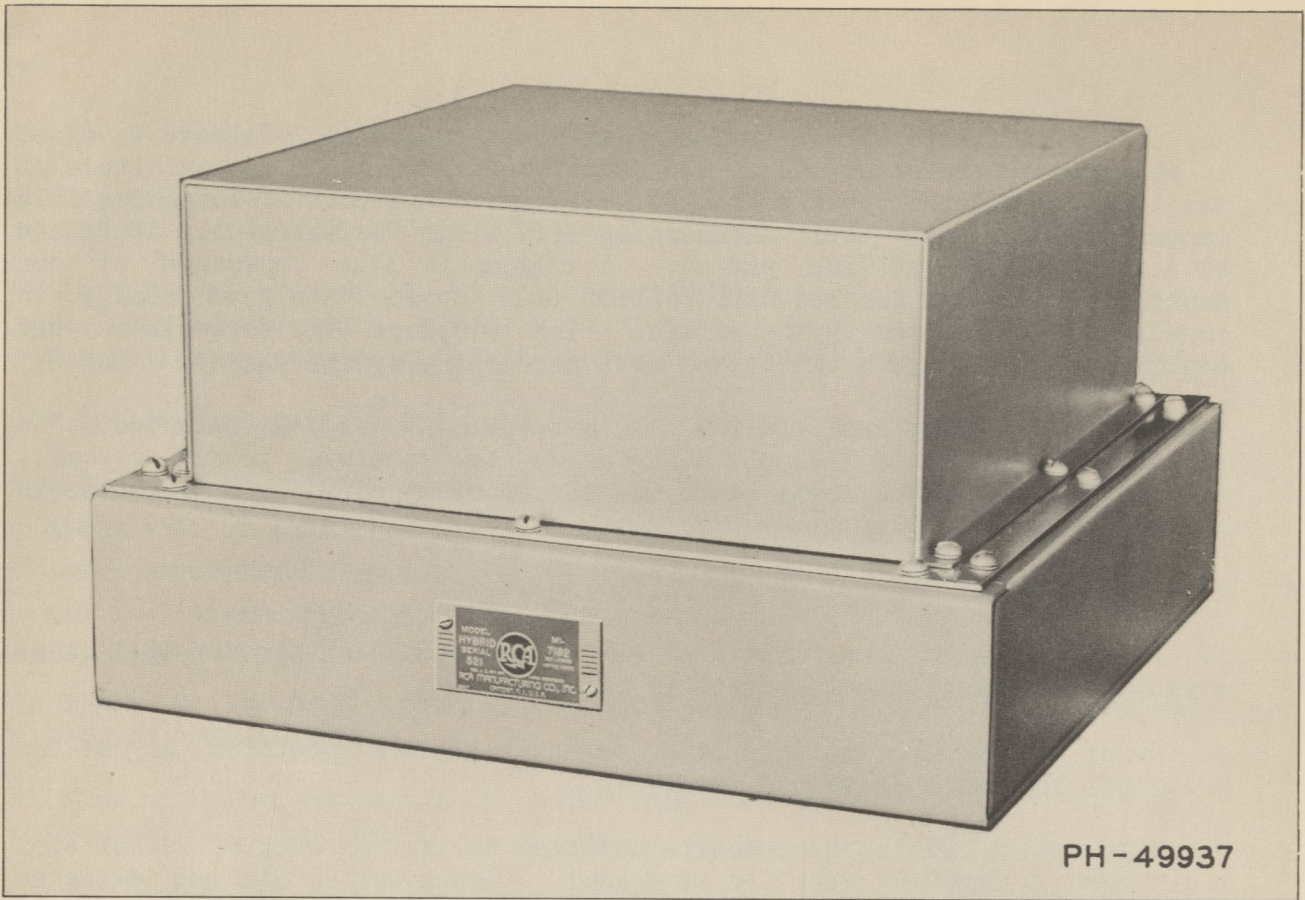
### MAINTENANCE AND SERVICE

Regular inspection of the equipment should be made to maintain tight connections and to assure removal of dust and dirt.

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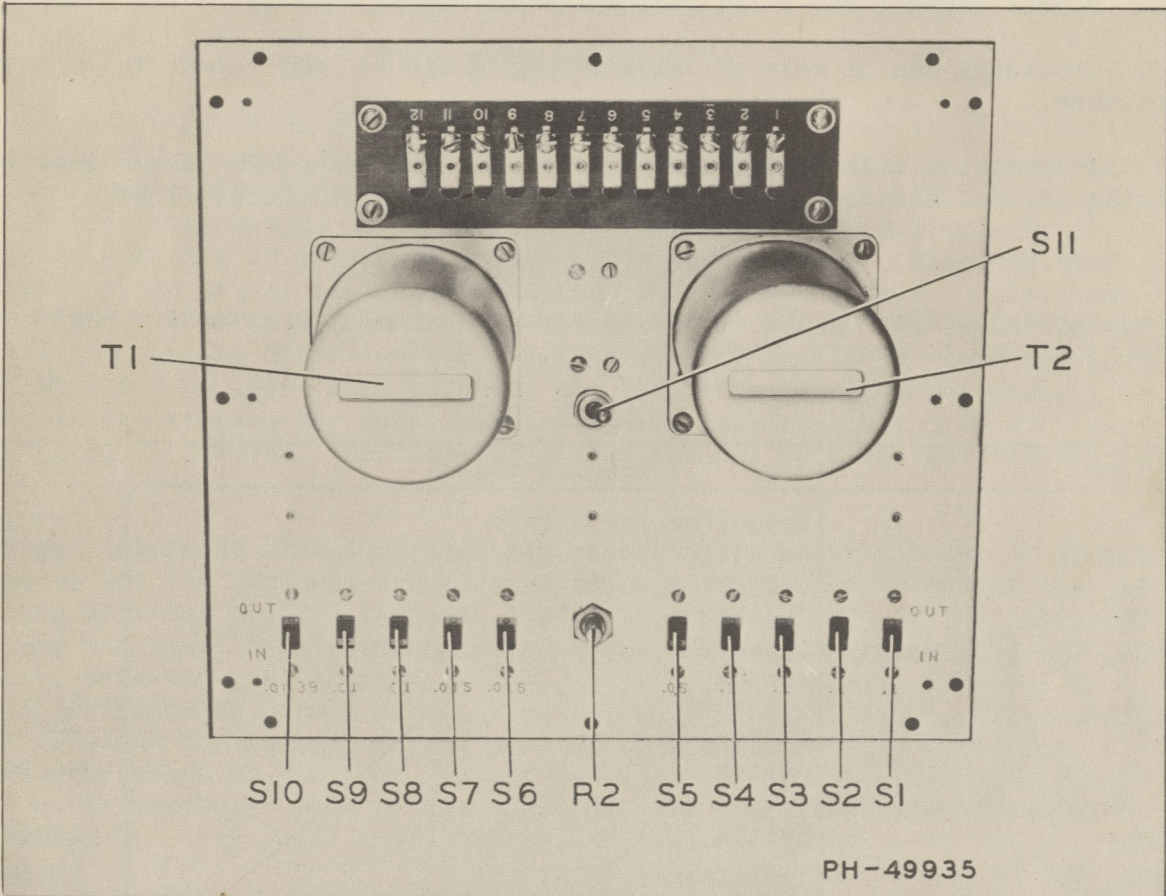
### PARTS LIST

Item	Description	Stock No.
C1	Capacitor, 3900 mmfd	13763
C2, C3	Capacitor, 0.01 mfd, 500 volts	4858
C4, C5	Capacitor, 0.015 mfd, 400 volts	11315
C6	Capacitor, 0.05 mfd, 200 volts	4886
C7, C8, C9, C10	Capacitor, 0.01 mfd, 200 volts	4791
R1	Fixed attenuator	17061
R2	Potentiometer, 1000 ohms	18002
S1, S2, S3, S4, S5, S6, S7, S8, S9, S10	Switch, S.P.S.T.	32119
S11	Switch, D.P.D.T., rear lug	27999
T1, T2	Transformer, XT-1811A	19108



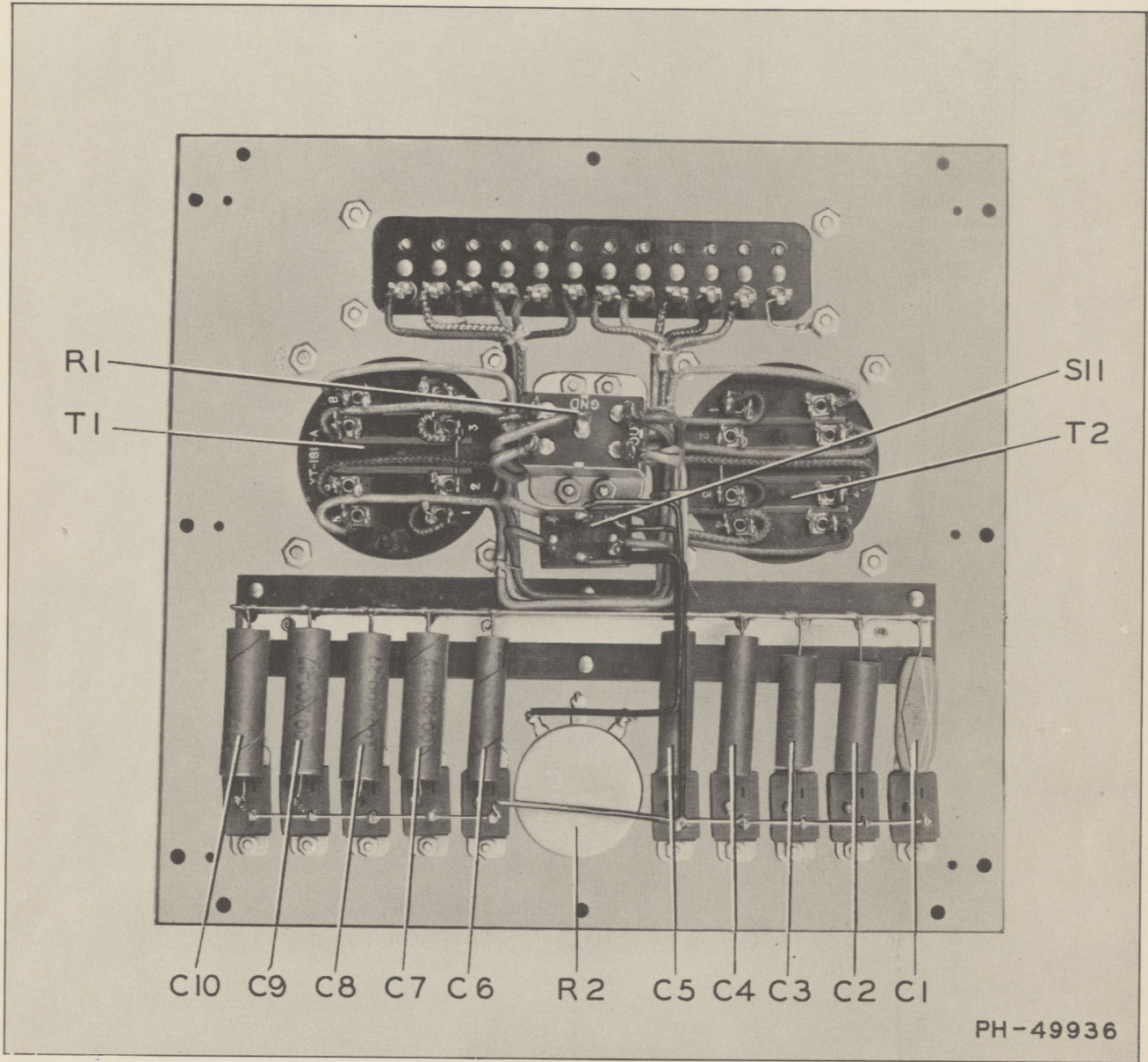
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FIGURE 6 - HYBRID UNIT



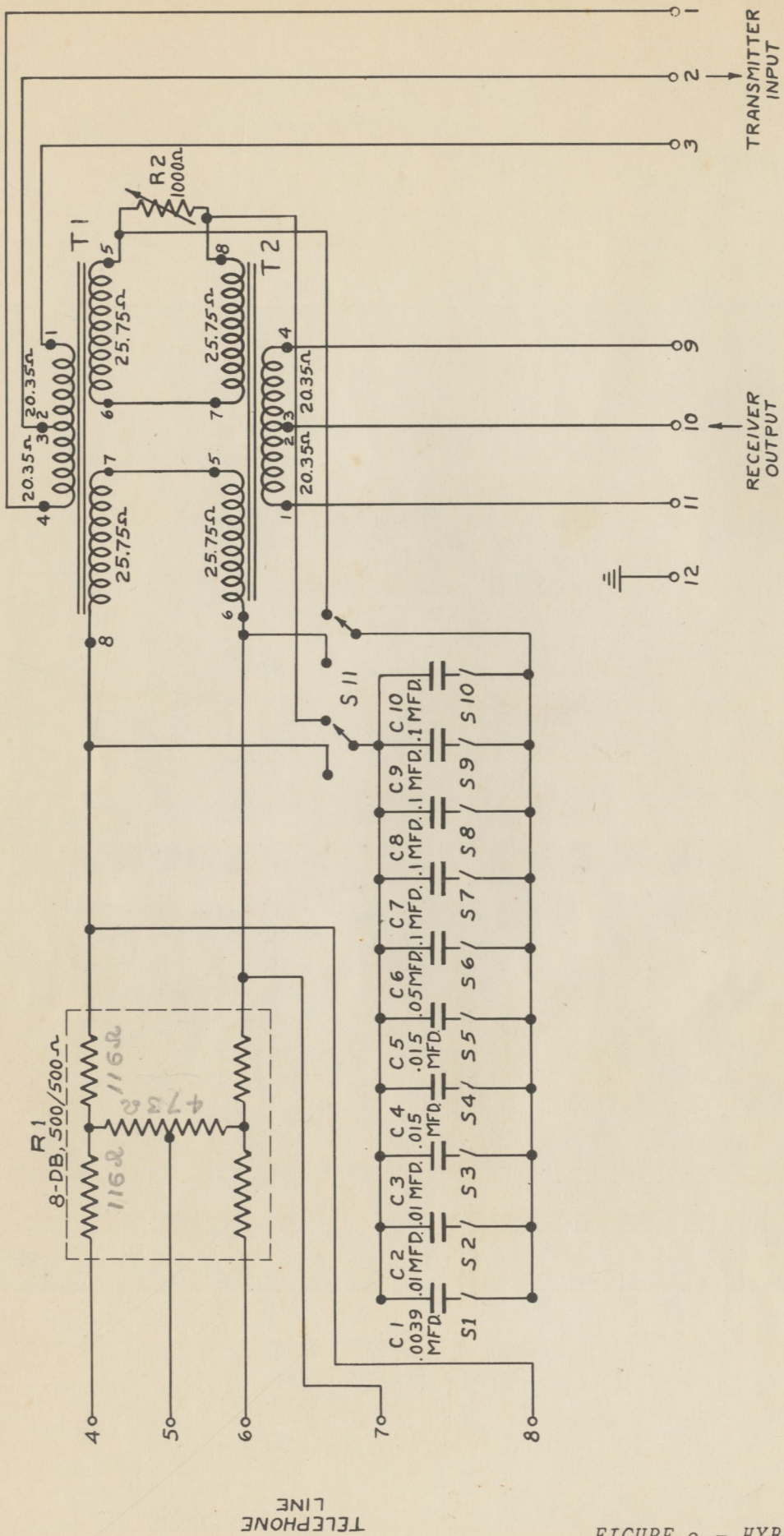
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FIGURE 7 - HYBRID UNIT  
(Chassis Top View)



PH-49936

FIGURE 8 - HYBRID UNIT  
 (Chassis Bottom View)



TELEPHONE LINE

FIGURE 9 - HYBRID UNIT  
(Schematic M-418466)