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# TM 11-2206

WAR DEPARTMENT TECHNICAL MANUAL

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# TELEGRAPH TERMINAL SET AN/TCC-1, TELEGRAPH TERMINAL TH-1/TCC-1, AND FILTER F-2/GG

**RESTRICTED.** DISSEMINATION OF RESTRICTED MATTER. The information contained in restricted documents and the essential characteristics of restricted materiel may be given to any person known to be in the service of the United States and to persons of undoubted loyalty and discretion who are cooperating in Government work, but will not be communicated to the public or to the press except by authorized military public relations agencies. (See also par. 23b AR 380–5, 15 Mar 1944.)

*WAR DEPARTMENT 18 OCTOBER 1944*

*WAR DEPARTMENT TECHNICAL MANUAL*

*TM 11-2206*

*This manual supersedes TM 11-2206 dated 26 June 1944 and 29 September 1944*

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WAR DEPARTMENT,
WASHINGTON 25, D. C., 18 October 1944.

TM 11–2206, Telegraph Terminal Set AN/TCC–1, Telegraph Terminal TH–1/TCC–1, and Filter F–2/GG, is published for the information and guidance of all concerned.

[A. G. 300.7 (13 September 44).]

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IC 11 (3): T/O 11-500, Sig Sv Org—Rad Carr Terminal Team (EF); Tp Carr and Repeater Team (CN); Tp and Tg Instl Team (GO); Spiral 4 Cable Team (GP).

IC 11 (2): T/O 11-500, Sig Sv Orgn—Dep Team, M (CB); Storage & Issue Team (CC); Inspection & Maint Team (CD); Large TT Team (GK).

IC 11 (1): T/O 11-500, Sig Sv Orgn—Dep Team, Small (CA); Rad Link Repeater Team (EO); M TT Team (GJ); Wire Rep Team (GQ).

(For explanation of symbols, see FM 21–6.)

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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.

**HOW** —1. Smash —Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut —Use axes, handaxes, machetes.

3. Burn —Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives —Use firearms, grenades, TNT.

5. Disposal —Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

**USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.**

**WHAT** —1. Smash —Meters, controls, panels.

2. Cut —Cables and all wiring.

3. Burn —Resistors, capacitors, all technical manuals, instruction books, tube charts.

4. Bury or scatter—Any or all of the above pieces after destroying their usefulness.

## DESTROY EVERYTHING

---

# SAFETY NOTICE

**VOLTAGES USED IN THIS EQUIPMENT ARE HIGH ENOUGH TO ENDANGER LIFE AND MAY BE FATAL IF CONTACTED BY OPERATING PERSONNEL. OPERATORS MUST BE CAREFUL NOT TO CONTACT HIGH-VOLTAGE PLATE CIRCUITS OR 115-VOLT, A-C INPUT CONNECTIONS WHILE CHECKING OR SERVICING EQUIPMENT. MAKE CERTAIN THAT POWER IS TURNED OFF WHEN DISASSEMBLING ANY PART OF THE EQUIPMENT.**

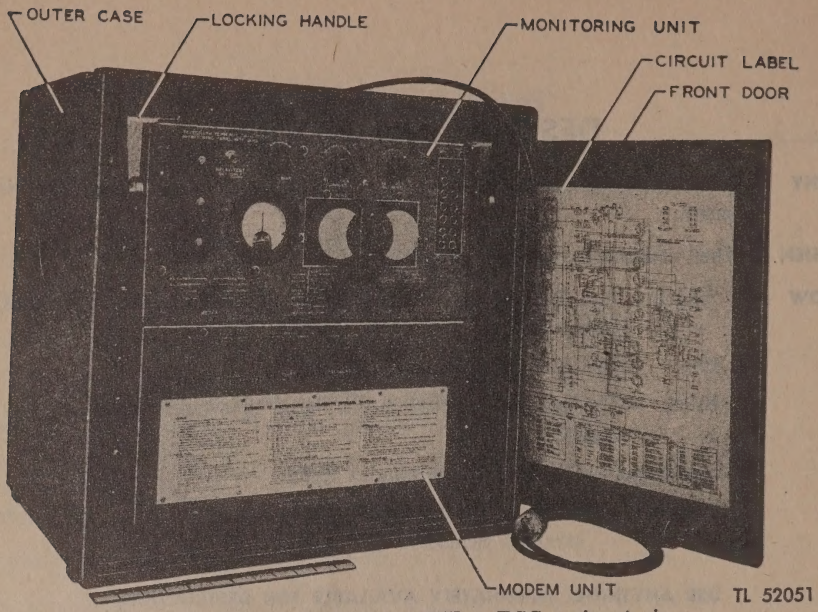



*Figure 1. Telegraph Terminal TH–1/TCC–1, front view.*

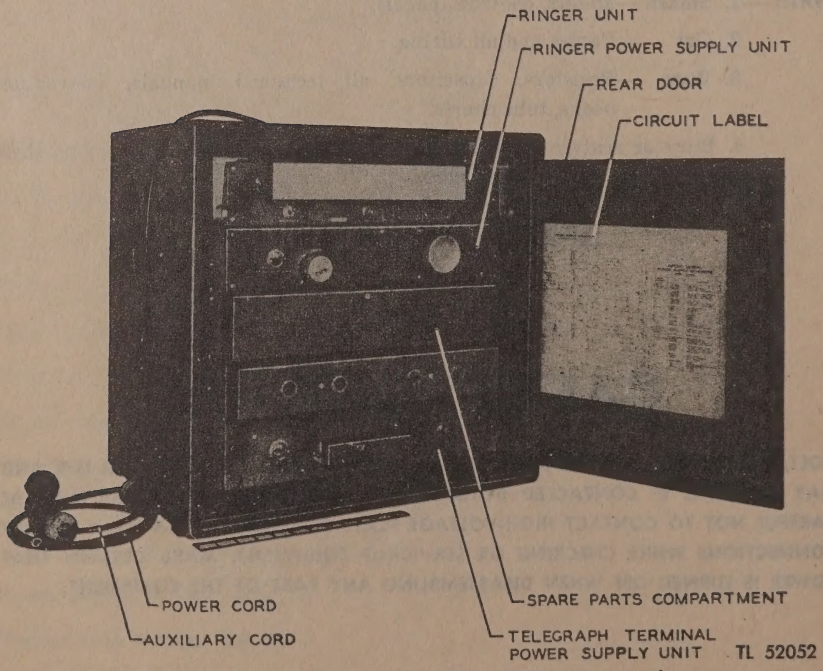


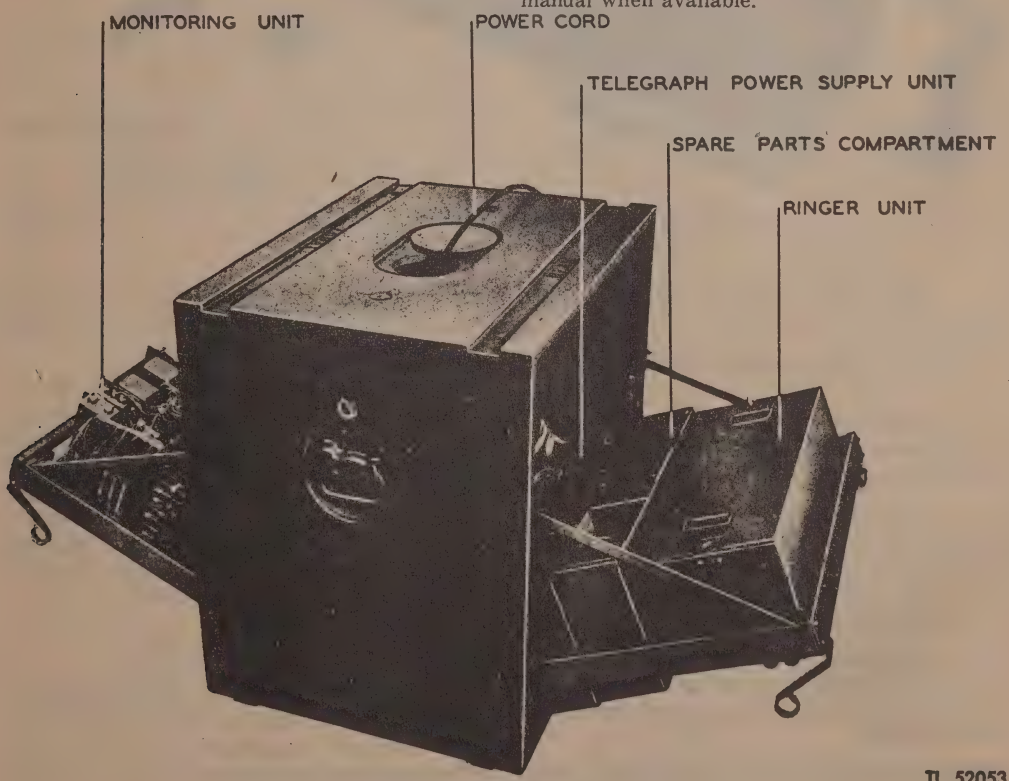

*Figure 2. Telegraph Terminal TH–1/TCC–1, rear view.*

*This manual supersedes TM 11-2206, dated 26 June 1944, and 29 September 1944*

# SECTION I
# DESCRIPTION

**1. GENERAL.**

**a.** Telegraph Terminal TH–1/TCC–1 (figs. 1, 2, and 3) is designed to provide two-way voice-frequency carrier telegraph communication by utilizing a portion of the frequency range (about 1,500 to 2,000 cycles) of a voice-frequency telephone circuit and, at the same time, retaining the use of the telephone circuit. The facilities required for this dual service, known as *speech plus duplex*, do not, in general, differ from the requirements for a satisfactory voice-frequency telephone circuit obtained from wire or carrer facilities. Nomenclature Telegraph Terminal Set AN/TCC-1 has been assigned to this equipment when issued for field use. Component parts in addition to Telegraph Terminal TH-1/TCC-1 have not yet been designated, but will be published in a change to this manual when available.




TL 52053

*Figure 3. Telegraph Terminal TH–1/TCC–1 open.*

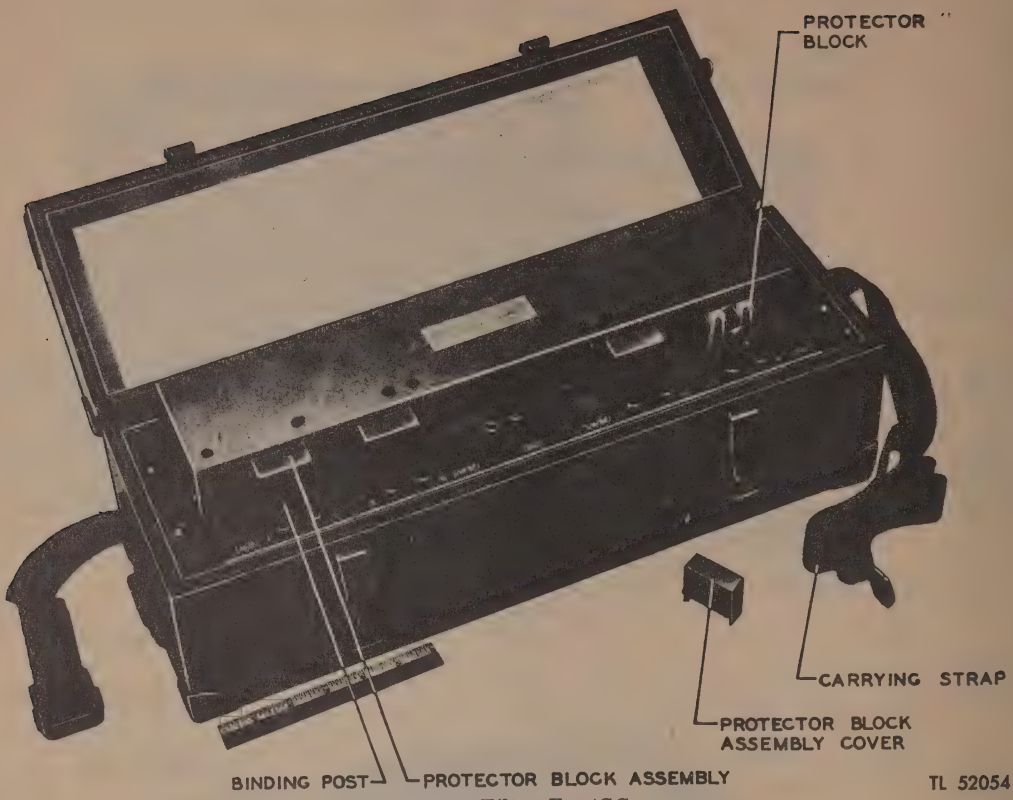



*Figure 4. Filter F–2/GG.*

**b.** Telegraph Terminal TH–1/TCC–1 is used principally at:

(1) Terminals of telephone and telegraph circuits.

(2) Intermediate points, where the telephone circuit extends through but the telegraph circuit terminates or transfers to other circuits.

**c.** Filter F–2/GG (fig. 4) is required at intermediate points in the telephone circuit where a separation of the telegraph and telephone circuit frequency bands is necessary. It is used principally at:

(1) Intermediate points, where the telephone circuit terminates or is connected to another telephone circuit and the telegraph circuit extends through.

(2) Intermediate points, where there is a bridged telephone station and the telegraph circuit extends through. (In this case, only one band stop section of Filter F–2/GG is required and is connected into the bridge.)

**d.** The telegraph terminal or filter may be located in the vicinity of the telephone and telegraph stations or at a point some distance away. The circuits connecting the telegraph terminal to the telephone and telegraph stations are referred to as *loop* circuits. Figure 5 shows in block diagrams various telephone circuits equipped with Telegraph Terminal TH–1/TCC–1 and Filter F–2/GG.

## 2. APPLICATION.

**a.** The telegraph terminal can be used in connection with any line facilities over which good telephone transmission is possible and, from a telegraph transmission standpoint only, where the attenuation of the line is not in

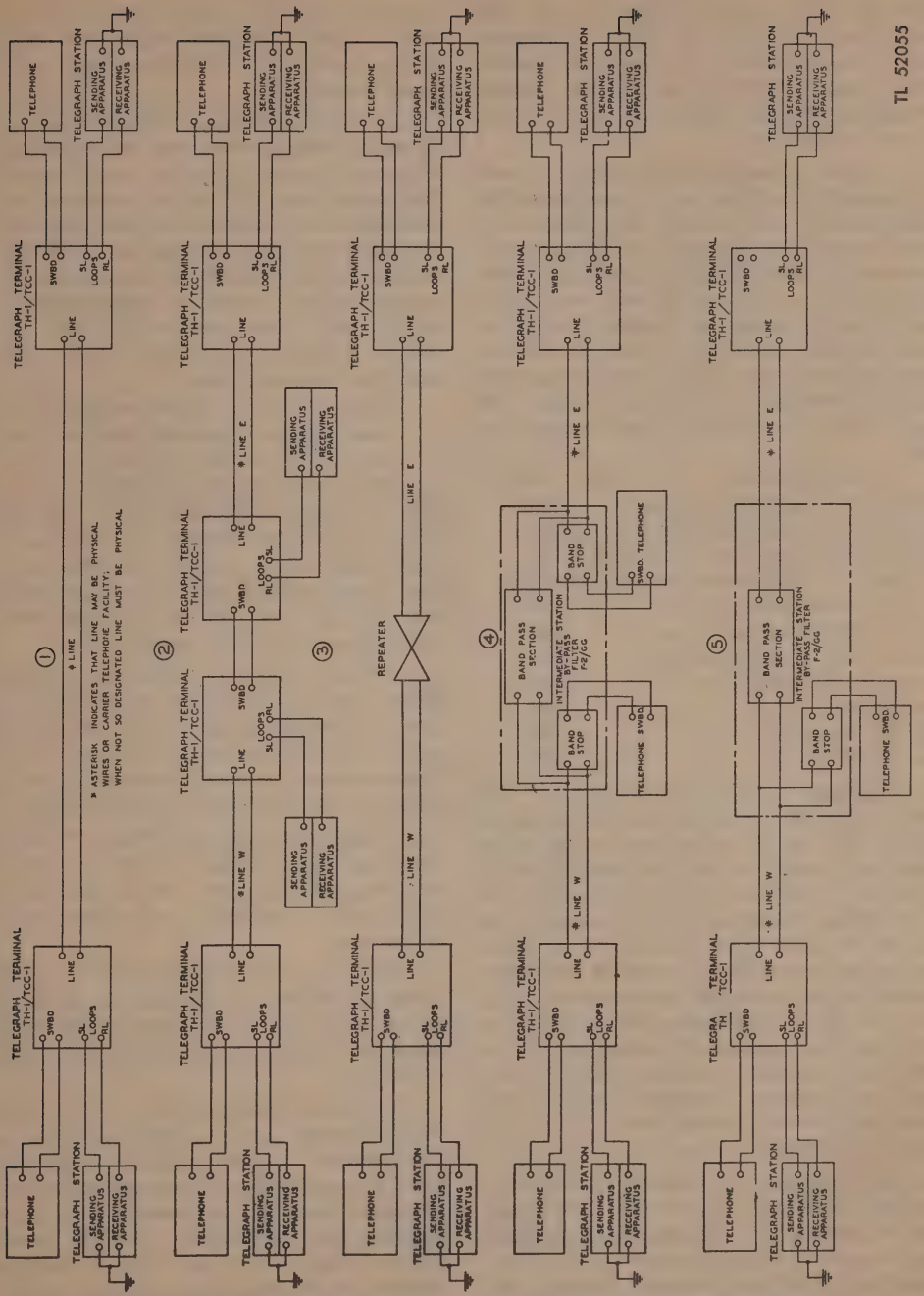



*Figure 5. Telegraph Terminal TH–1/TCC–1 applications, block diagram.*

excess of 50 db. These facilities may be open wire, cable, field Wire W–110–B, repeatered lines, or lines equipped with carrier equipment. These circuits must be satisfactory talking circuits not having excessive noise, crosstalk, or other interference.

**b.** A table of maximum distances of operation between two telegraph terminals over the more common line facilities is given below. These figures are computed on the basis of a 50–db loss for each type of facility; open wire facilities are assumed to be well constructed with negligible noise or interference. When excessive noise, crosstalk, or other interference is present, these ranges will be reduced accordingly. Connection of Filter F–2/GG in the circuit will also reduce the effective operating range.

| *Type of facility* | *Range in miles* |
|---|---|
| 104–mil hard copper open wire | 620 |
| 104–mil 30% copper-steel open wire | 240 |
| 104–mil 40% copper-steel open wire | 275 |
| 128–mil 30% copper-steel open wire | 295 |
| 83–mil galvanized iron wire | 132 |
| 83–mil galvanized hard steel wire | 135 |
| 81–mil, 40% copper-steel wire | 200 |
| 19–gauge H–88–50 cable | 145 |
| Wire W–143 | 42 |
| Wire W–110–B | 22 |
| Wire W–130 | 10 |

**c.** Telegraph Terminal TH–1/TCC–1′ will normally provide a satisfactory transmission medium for teletypewriter signals up to 66 words per minute over any line whose attenuation does not exceed 50 db. Provision is made for increasing the output level of the telegraph terminal oscillator from —3 dbm to +4 dbm, thus making it possible to operate the telegraph terminal over a line having an extreme attenuation of 57 db. To compensate for varying line conditions and consequent variation in line losses, an automatic volume control is provided which enables operation over circuits having variations in attenuation of ±10 db without readjusting the set.

**d.** For signaling over lines equipped with Telegraph Terminal TH–1/TCC–1, d-c current, 20–cycle ringing, or voice-frequency signaling may be used. A voice-frequency ringer is included as part of the telegraph terminal and provides for 1,000— or 500–cycle signals interrupted at 19 cycles per second for lines equipped with voice-frequency or carrier equipment or both. When this ringer is in the non-operate position, all ringing signals are bypassed around it.

**e.** Telegraph Terminal TH–1/TCC–1 can be operated in connection with other d-c loop or extension circuits either on a full-duplex or half-duplex basis, full-duplex providing for the simultaneous transmission of telegraph signals from each end and half-duplex providing for the transmission of only one message at a time from either end. Switching arrangements permit operating the terminal with any of the following full-duplex and half-duplex services over the telegraph loops:

> NOTE: Neutral operation refers to those telegraph systems utilizing line current for *marking* signals and no line current for *spacing* signals.

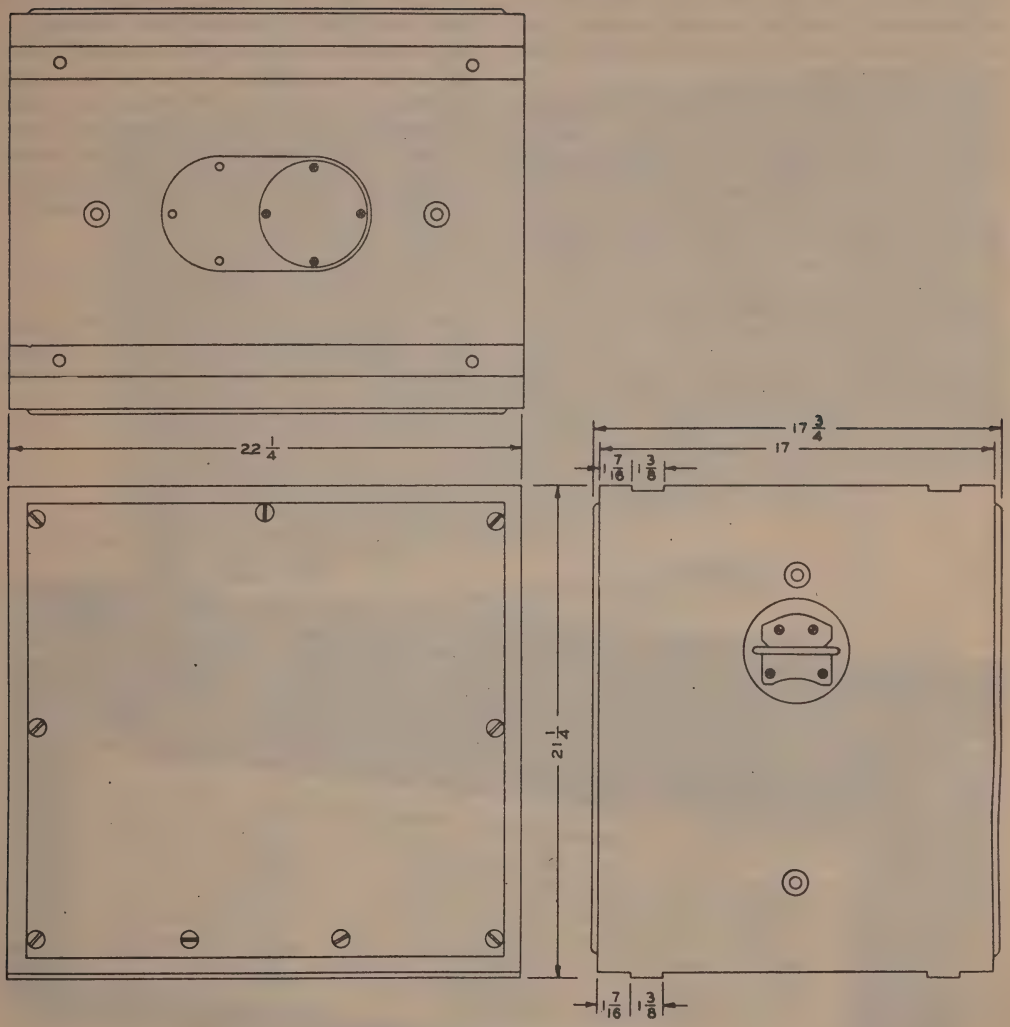
(1) HALF-DUPLEX, NEUTRAL TO POSITIVE BATTERY OPERATION utilizes one loop circuit ground return. The telegraph station is equipped to supply 115–volt positive battery to loop. Messages can be transmitted in either direction but not simultaneously.

(2) FULL-DUPLEX, NEUTRAL TO POSITIVE BATTERY OPERATION utilizes two loop circuits, each with ground return. The telegraph station is equipped to supply 115–volt positive battery to loop. Messages can be transmitted in both directions simultaneously.

(3) HALF-DUPLEX, NEUTRAL TO NEGATIVE BATTERY OPERATION is the same as subparagraph (1) above except that the telegraph station supplies 115–volt negative battery to the loop.

(4) FULL-DUPLEX, NEUTRAL TO NEGATIVE BATTERY OPERATION is the same as subparagraph (2) above except that the telegraph station supplies 115–volt negative battery to the loop.

(5) POLARENTIAL HALF-DUPLEX OPERATION utilizes one loop circuit ground return. The telegraph station is equipped with a polarential telegraph set which supplies ground to the telegraph loop for the marking signal and 115–volt positive battery for the spacing signal. Polar transmission from the telegraph terminal to the telegraph station and differential transmission from the telegraph station to the telegraph terminal are used.




WEIGHT OF UNIT 200 LBS.

SHIPPING WEIGHT 277 LBS.

TL 52056

*Figure 6. Outline dimensions of outer case.*

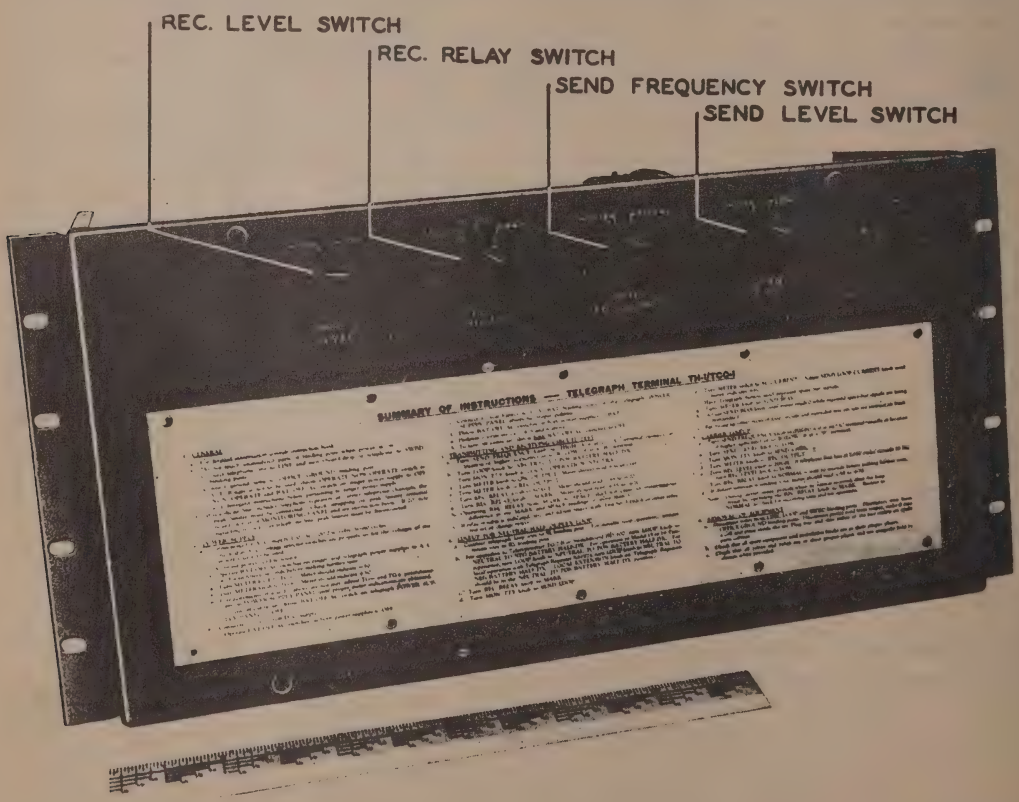
(6) TWO-PATH POLAR OPERATION utilizes two loop circuits, each loop grounded at receiving end. The telegraph station is equipped with a polar telegraph set which supplies 75–volt negative battery for the marking signal and 75–volt positive battery for the spacing signal to the sending loop.

(7) HALF-DUPLEX NEUTRAL OPERATION WITH NO LINE BATTERY AT OUTLYING POINT is similar to half-duplex, neutral to positive or neutral to negative system, except that it uses a metallic return. The telegraph terminal is arranged to supply either +130–volt or —130–volt battery.

### 3. FEATURES OF TELEGRAPH TERMINAL TH–1/TCC–1.

**a. Mechanical Details.** (1) OUTER CASE. The outer case is used to house the telegraph terminal units and spare parts compartment. It is made of ¾–inch plywood with removable front and rear doors and is finished in olive drab. A steel framework, consisting of like front and back structures and secured by rubber shock mounting, is fitted inside the case and serves for mounting the units comprising the telegraph terminal. Felt pads are spaced at intervals between the framework and case for additional shockproofing. Outline dimensions of the outer case are shown in figure 6. The over-all weight of the terminal is approximately 200 pounds.

(2) MODEM UNIT. The modem unit (fig. 7) located on the lower front side of the telegraph terminal, consists of a chassis and panel assembly on which are mounted the sending and receiving equipments of the telegraph terminal. The sending circuit includes a carrier




TL 52057

*Figure 7. Modem unit, panel view.*

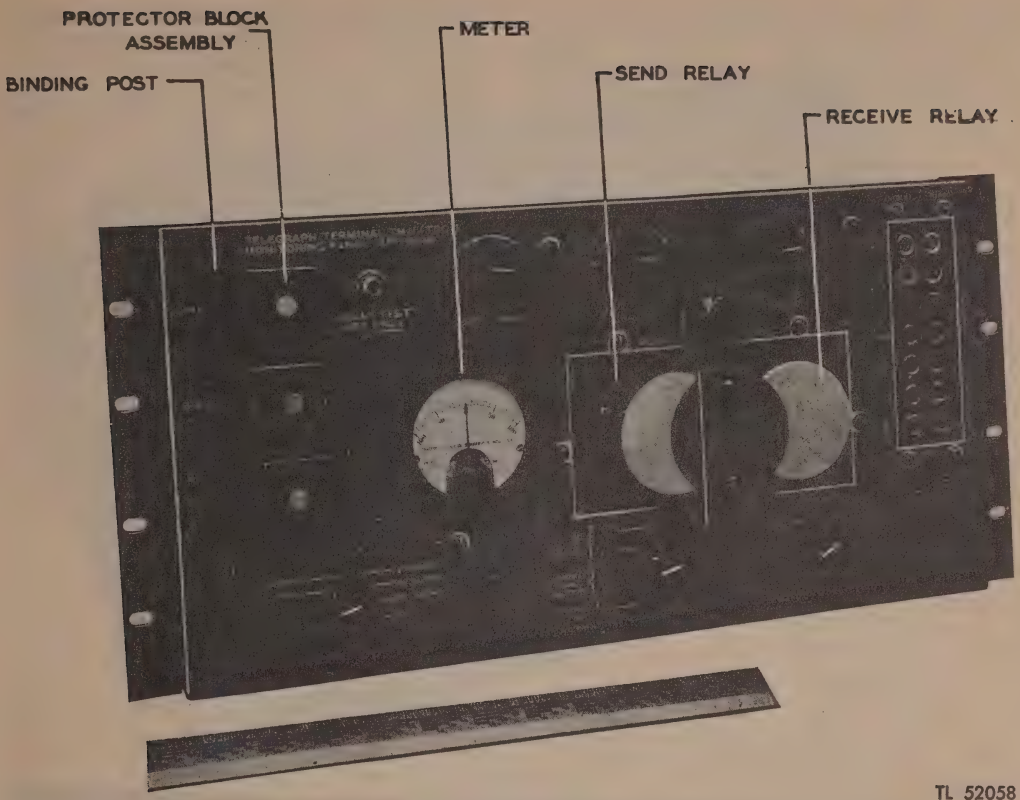



*Figure 8. Monitoring unit, panel view.*

oscillator, modulator, and sending band-pass filters. The receiving equipment includes a receiving amplifier, detector, and receiving band-pass filters. Other equipment which is associated with both the receiving and sending elements includes a hybrid coil, balancing network, high-pass filter, and band-stop filter. The approximate over-all size of the modem unit, including end mounting brackets, is 19 inches by 7¼ inches by 8¾ inches. The weight of the modem panel is approximately 38¾ pounds.

(3) MONITORING UNIT. The monitoring unit (fig. 8) located on the upper front side of the telegraph terminal is similar in general design to the modem unit. It consists of a steel chassis and front panel of the same over-all size as the modem panel. The approximate weight is 24½ pounds. On the panel are mounted the meter for measuring the various currents and voltages in the telegraph loop circuits; control switches for metering, teletypewriter monitoring, and telegraph loop selection; and control rheostats, one for adjusting the bias current through the sending relay, one for sending, and one for receiving loop currents. Also mounted on the panel are the miscellaneous monitoring, telephone, and telegraph jacks required for testing and connecting the lines and equipment, and binding posts LINE, SWBD, and LOOPS with associated protector blocks. The panel is recessed to mount the SEND and REC. relays associated with the telegraph loops. Miscellaneous resistors and capacitors associated with the monitoring circuit, spark killers for protecting the relay contacts, and radio-frequency sup-

pression units are mounted on the chassis. A jack, designated RELAY TEST SET ONLY, is provided on the panel for supplying +130-volt grounded battery for operating Test Set I-193-A.

(4) RINGER UNIT. The ringer unit (fig. 9) located on the upper rear side of the telegraph terminal consists of a voice-frequency ringer and an associated power supply unit electrically interconnected and having common end mounting brackets and dustproof cover. The ringer and power supply unit each consist of a 3½-inch by 19-inch panel with steel chassis 5⅝-inches deep; the combined weight with end brackets and cover is approximately 26.5 pounds. The ringer consists of the equipment necessary for transmitting and receiving voice-frequency signals and includes 20-cycle and 1,000/500-cycle filters, 1,000/500-cycle oscillator, receiver input transformer, switching relays, detector, and amplifier tubes with their associated capacitors and resistors. On the panel are mounted the LINE and SWBD binding posts, the OPERATE-NON-OPERATE switch, and the BIAS control. The panel is cut out to provide access to the vacuum tubes, relays, and control switches which mount in back on the chassis. A cover plate with a white lacquered writing surface fits over the cut-out and is fastened to the panel with two cowl fasteners. Direct wiring connections between units are made by a short cable connection between terminal blocks mounted on each unit. The power unit chassis mounts the power transformer, selenium rectifiers, and associated filters, and 100-cycle and 19-cycle vibrators. The panel of the power unit mounts the BAT-

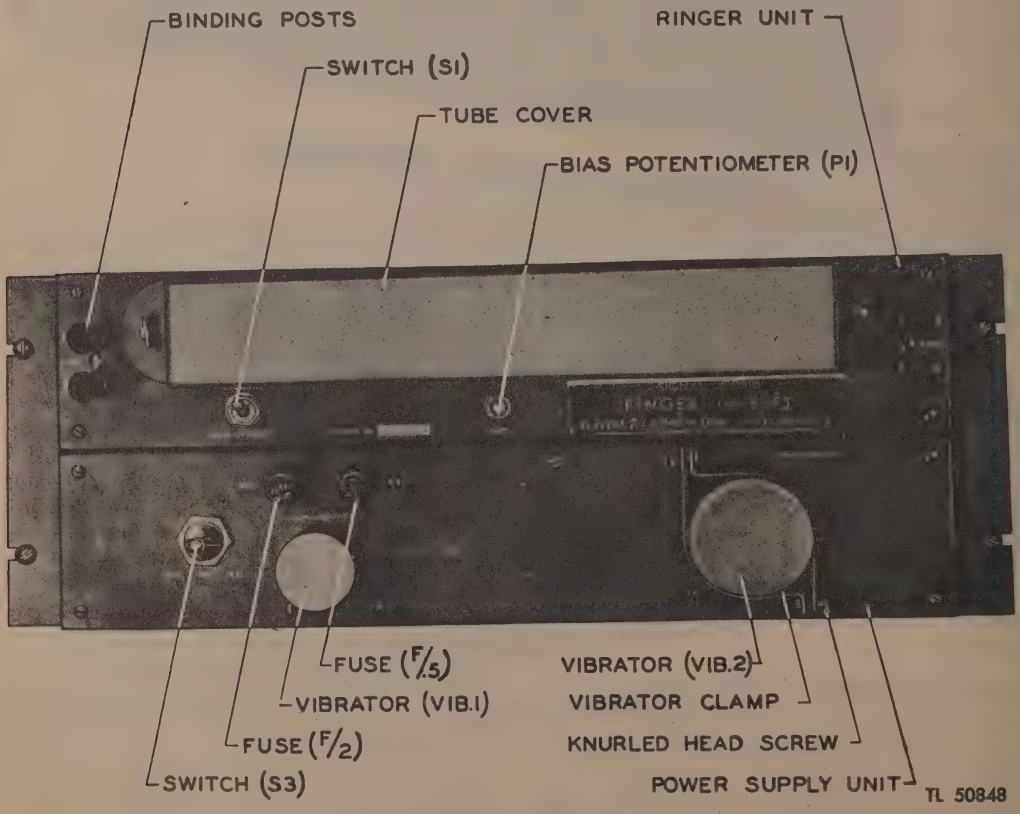



*Figure 9. Ringer unit, panel view.*

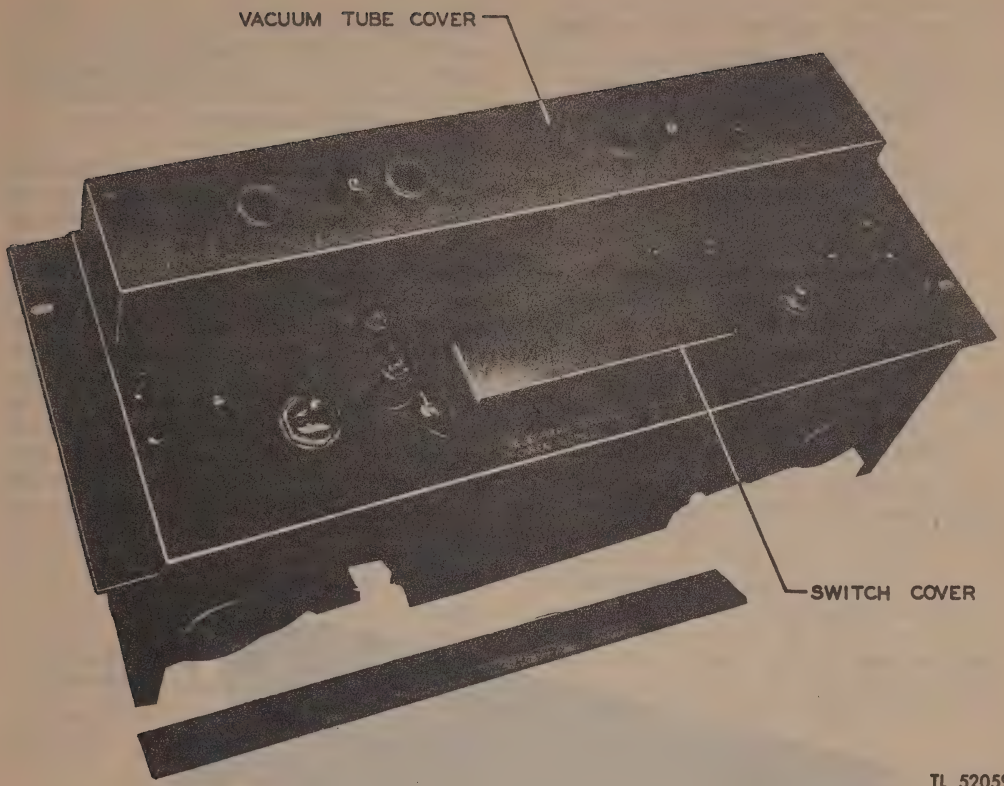



*Figure 10. Power supply, panel view.*

OFF-A.C. switch and line fuses. A terminal strip is provided at the rear of the unit for a-c and d-c connections. The power unit is arranged for connecting to a 60-cycle supply voltage of 100 to 130 or 200 to 250 volts or to an external 12-volt storage battery. The ringer unit may be operated independently, but when operated in conjunction with the telegraph terminal the ringer power supply source is derived from the telegraph terminal.

(5) POWER SUPPLY. The telegraph power supply unit (fig. 10) located on the lower rear side of the telegraph terminal is a chassis and panel assembly 19 inches by 7 inches by 5¼ inches; it weights approximately 24¾ pounds. It includes the power transformer, selenium rectifiers, tubes, and regulating equipment necessary to supply d-c potentials for the telegraph loop circuits and carrier transmitter and receiver (modem unit). Control switches, fuses, potentiometers, and binding posts constitute the panel equipment while such equipment as transformers, chokes, rectifiers, resistors, and capacitors mount on the chassis. Vacuum tubes mount on the chassis but extend through an opening in the panel, for accessibility. A tube cover plate which fastens to the panel covers the tubes. A perforated cover fits over the back of the unit.

(6) SPARE PARTS COMPARTMENT. (*a*) A spare parts compartment (fig. 11) located between the ringer and telegraph terminal power supply panels consists of a metal container 19 inches by 7 inches by 3 inches, and has a recessed removable cover. This compartment holds the following spare relays, vacuum tubes,

vibrators, fuses, protector blocks, and tools:

1 Neutral relay (MONITOR).
1 Polar relay (SEND or RECEIVE).
7 Tubes VT-198-A (6G6–G).
4 Tubes 2050 (RCA).
2 Tubes VR105–30 or OC3/VR105.
10 Fuses, ¼-ampere.
10 Fuses, ½-ampere.
10 Fuses, 15 ampere.
10 Fuses, 2-ampere.
6 No. 26 protector blocks.
6 No. 27 protector blocks.
1 Vibrator, 19-cycle.
1 Vibrator, 100-cycle.
1 Vibrator, 120-cycle.
1 WE No. 259 tool (spring bender).
1 WE No. 340 tool (relay adjusting).

(*b*) In addition to the above spare parts, four vacuum tubes 6G6-G and four vacuum tubes 2050 are supplied in individual cartons and shipped inside the telegraph terminal. Two hundred feet of No. 18 gauge twisted pair wire is furnished for making external connections to the telegraph terminal.

**b. Power Arrangement.** Telegraph Terminal TH–1/TCC–1 can be operated from a 12–volt storage battery or from any 50-or 60-cycle a-c supply with a voltage within the range of 100 to 130 or 200 to 250 volts. The maximum power consumption on a-c operation is 160 watts. The maximum current consumption is 12.5 amperes on 12-volt storage battery operation. Power connections to the telegraph terminal are made by a pair of wires from the battery to the 12-volt binding posts on the telegraph terminal power supply unit in cases where battery operation is necessary. For a-c operation, connection is made from the a-c

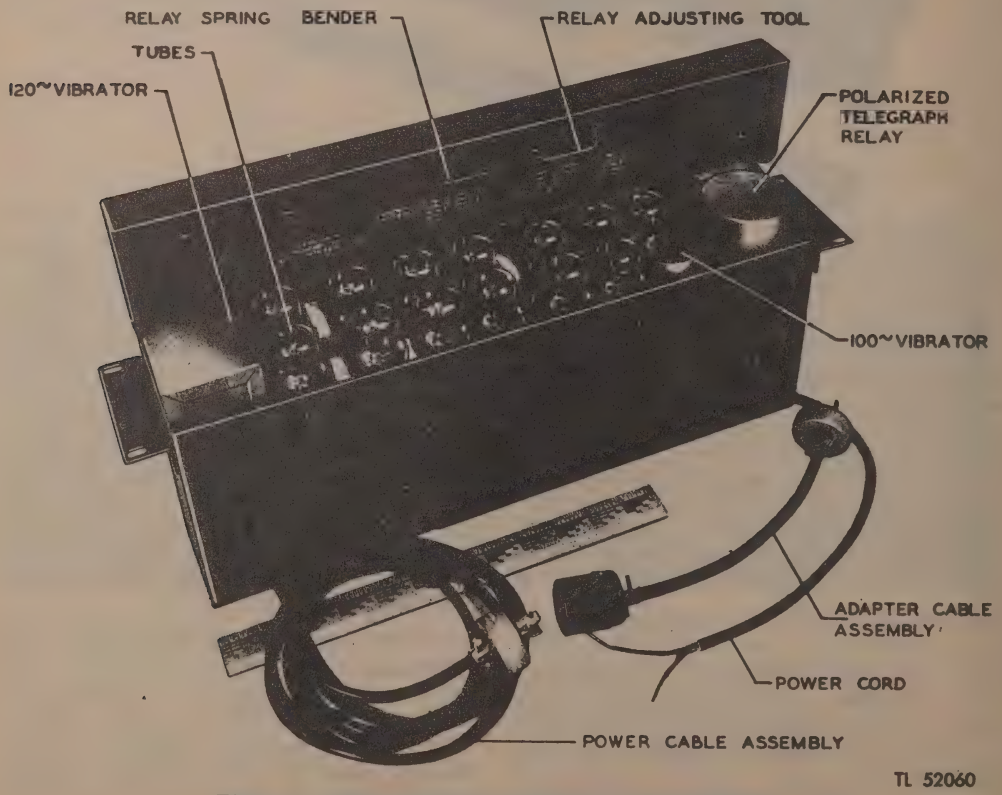



*Figure 11. Spare parts compartment, front cover open.*

outlet by a line cord attached to the terminal unit. A short adapter cord is provided which can be attached to the line cord for use with straight terminal receptacles.

**c. Equipment Arrangement.** Telegraph Terminal TH–1/TCC–1 is an assembly of steel panel and chassis units housed in a portable plywood case; the over-all dimensions are 22¼ inches by 17¾ inches by 21¼ inches. The weight of the assembly is approximately 200 pounds. The monitoring and modem units mount on the hinged framework inside and at the front of the case with the monitoring unit at the top (fig. 3). The ringer unit mounts at the top of the framework in the rear, and the terminal power supply unit at the bottom. Between the ringer and terminal power supply units is mounted the spare parts compartment. All controls and patching jacks thus are available when the doors of the cabinet are removed. Controls subject to frequent adjustment and jacks appear on the panels at the front; those used less often are at the rear of the cabinet. The spare parts compartment is equipped with a double receptacle to which the a–c power can be connected through the line cord which is permanently connected at the receptacle end (fig. 11). The terminals of the receptacle are connected to supply terminals on the power supply units. A receptacle-ended cord is attached to the same terminals on the power supply unit. This arrangement results in a paralleled a-c supply to all units in service, any one of which can be readily removed for test or repair.

#### 4. FEATURES OF FILTER F–2/GG.

Filter F–2/GG (fig. 4) is an assembly of three filter unit sections housed in a ½-inch plywood weatherproof case 22 inches by 7¼ inches by 7¼ inches. The case has a removable hinged cover in the recess of which is mounted the operating instruction label. Each filter unit section consists of a network of inductances and capacitors in a 5¼-inch by 5¼-inch by 3¼-inch sealed metal can. The three filter unit sections are mounted on the underside of a 5¼-inch by 19-inch panel which is equipped with end brackets for mounting on the angle brackets of the other case. The outer case is finished in olive drab and is equipped with a carrying strap. Panel binding posts are provided for line and switchboard connections at intermediate telephone stations. Protector blocks provide protection against high-voltage disturbances occurring on lines or switchboard loops.

# SECTION II
# INSTALLATION AND OPERATION

#### 5. LOCATING THE TELEGRAPH TERMINAL.

**a.** Select a sheltered location which is free from excessive vibration. Remove the unit from the shipping case and locate it near an available power supply. Allow sufficient clearance around the terminal for operating purposes. The markings FRONT and REAR are stamped on the outer case of the terminal units. A pair of longitudinal skids are provided on the bottom of the case while the top is grooved correspondingly to fit over the skids, thus permitting a maximum of four chests to be stacked on top of one another. Holes 3½ inches in diameter in the top and bottom of the chest are provided for making power and line connections between adjacent chests in the same stack. Waterproof disks are provided for covering the holes when not in use. Remove the front and rear doors by loosening the door fasteners. Schematic diagrams of the individual units and interunit connections are attached to the inside of the front and rear doors.

**b.** After removing the unit from the shipping case, the case and all packing material should be carefully stored for future use in repacking the unit.

#### 6. CONNECTIONS TO TELEGRAPH TERMINAL TH–1/TCC–1.

**a. Line, Loop, and Switchboard Connections.** For

tactical installations, all external connections except power connections are made at binding posts on the monitoring panel. Connect the line wires to the LINE binding posts and connect the telephone set or switchboard to the SWBD binding posts. For full-duplex operation, connect the sending loop to binding posts LOOPS-SL and the receiving loop to binding post LOOPS-RL. For half-duplex operation, connect the loop to binding post LOOPS-SL. For half-duplex with metallic return, connect one loop wire to binding post LOOPS-SL and the return wire to binding posts LOOPS-RL. For fixed plant installations, terminate external connections on the terminal block mounted on the inside of the case. Connect line wires to terminals 1 and 2; connect switchboard wires to terminals 3 and 4; connect send loop to terminal 5 and receive loop to terminal 6.

**b. Power Connections.** (1) Before making any power connections, make sure that the switches (fig. 12) on the power supply units of all telegraph terminals are set in the following positions:

(*a*) Switch BAT-OFF-A.C. (S3) to OFF.

(*b*) Switch S4 to agree with local source.

(*c*) Switches S2 and S5 to low position if measured value of a-c supply is lower than nominal value; otherwise throw switch to high position.

(2) At the power supply panel run a wire from binding post OFFICE GROUND to the office ground. For a-c operation where only one telegraph terminal is to be installed, connect the plug-ended power cord which is attached to the double receptacle on the spare parts compartment to the local a-c supply. For installations of two or more telegraph terminals, the power supply for succeeding units is picked up from the preceding unit by connecting the power cord of each successive unit to the receptacle-ended cord which extends from the power supply unit of the preceding telegraph terminal. This multiple power supply arrangement

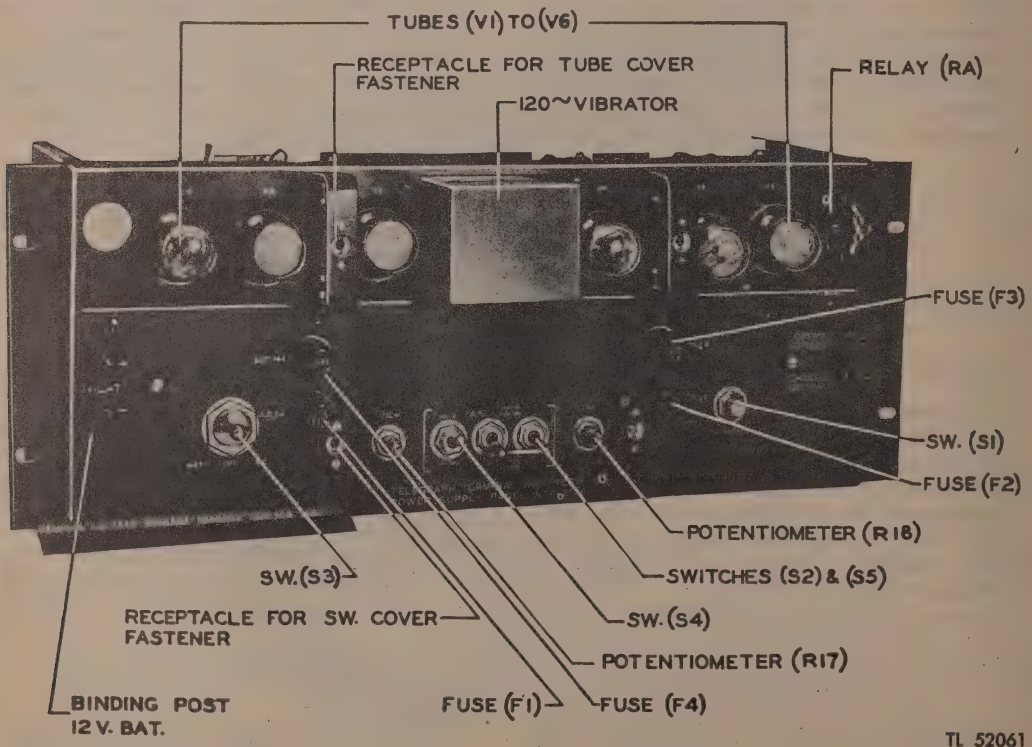



*Figure 12. Power supply, front view.*

provides for disconnecting any one telegraph terminal in a group while maintaining operation of the remaining terminals.

**c. Installation of Strap Wires.** Since the peak limiter is designed to pass voice-frequency currents only, it may be connected into or disconnected from the terminal circuit by means of the peak limiter strap wires.

(1) When the terminal is used with telephone circuits which use d-c or 20–cycle signaling on the line, disconnect the peak limiter by strapping terminals 1 to 5 and 4 to 8.

(2) In all other cases, connect the peak limiter into the circuit by strapping terminals 1 to 2, 3 to 4, 5 to 6, and 7 to 8.

## 7. POWER ADJUSTMENTS.

**a. Power Supply Voltages.** Throw switch BAT-OFF-A.C. to position A.C. if the power source is alternating current, or to BAT if the source of power is 12–volt storage battery. Wait approximately 10 seconds to allow the gas tetrode tubes to heat. Turn the METER switch on the monitoring panel (fig. 8) to position TG+ and then to TG—, and observe the meter readings. Readings of +50 and —50 on the meter correspond to +130 volts and —130 volts, respectively. If meter readings other than +50 and —50 are indicated, readjust the telegraph supply voltages.

**b. Adjustment of Telegraph Current Supply.** Using a screwdriver, turn the control rheostats designated TG+ and TG— on the power supply unit panel, with the METER switch on the monitoring panel in position TG+ or TG—, as required, until the correct readings of +50 for TG+ and —50 for TG— are obtained. If the correct adjustment cannot be obtained within the range of the rheostats, measure the a-c supply voltage with a voltmeter, if available, and check that switches S2 and S5 on the power unit panel are in the correct position for the particular value of supply voltage just measured. If a voltmeter is not available, determine the correct position of switches S2 and S5 by throwing them from the high position to the low position while turning the rheostat controls and noting the meter readings. Leave the switches in that position which permits the adjustment of the TG+ and TG— voltages to their specified values.

## 8. PRELIMINARY CHECKS AND ADJUSTMENTS.

**a.** Remove the bags of silica gel from the unit.

**b.** Tighten any loose screws and nuts.

**c.** Check that vacuum tubes are firmly seated in their sockets.

**d.** Check relays as outlined in paragraphs 34, 35, and 36. Pay particular attention to the adjustment of the monitoring relay as regards spring tension and operating current.

**e.** If the meter needle does not indicate the zero position with the METER switch in position OFF, use a screwdriver to obtain the zero indication by turning the zero adjustment screw of the meter.

## 9. ADJUSTMENTS FOR LOCAL OPERATION.

When the equipment is operated locally, the switch LOOP is operated to NEUTRAL TO POS. BATTERY, either HALF-DX or FULL-DX, and the receiving plug (red) is inserted in the appropriate LOOP-EQ jack. This insures that the direction of current in the line relay winding is correct. The circuit associated with the receiving MON R(RED) jack is designed for operation with selector magnets and is unsuitable for use with a line relay. Teletypewriters not equipped with line relays should be plugged into the MON jack only. Teletypewriters equipped with line relays should be plugged into the LOOP or LOOP-EQ jack, whichever permits operation with the LOOP switch setting. The high inductance of a selector magnet inserted in series with the loop by plugging into the LOOP or LOOP-EQ jacks will cause excessive distortion, where a line relay having much lower inductance will not.

**a. Neutral, Half-duplex.** (1) Turn the MON. TTY switch to position LOCAL OPERATION NEUTRAL.

(2) Turn the LOOP switch to position NEUTRAL TO POS. BATTERY-HALF DX or to position NEUTRAL TO NEG. BATTERY-HALF DX, depending upon the type of operation involved.

(3) Put the red teletypewriter plug into the SL-LOOP jack and the black plug of the keyboard cord into the SL-EQ jack.

(4) Turn REC. RELAY switch to position MARK. Turn METER switch to position SEND BIAS. Transmit repeated space signals and at the same time adjust the SEND BIAS rheostat until the meter indicates zero.

(5) Turn the REC. RELAY switch to position NORMAL and proceed with the lining up of the carrier circuit as described in paragraph 11.

**b. Full-duplex.** (1) Turn the MON. TTY switch to position LOCAL OPERATION NEUTRAL.

(2) Turn the LOOP switch to position NEUTRAL TO POS. BATTERY-FULL DX or to position NEUTRAL TO NEG. BATTERY-FULL DX, depending upon the type of operation involved.

(3) Put the black teletypewriter plug into the SL-LOOP jack and the red plug into the SL-EQ jack. Plug the receiving teletypewriter cord into the RL-LOOP jack.

(4) Perform the operations indicated in subparagraph *a*(4) and (5) above.

**10. LOOP CIRCUIT LINE-UP.**

**a. Line-up for Half-duplex, Neutral to Positive Battery.** (1) Turn the LOOP switch on the monitoring unit panel to position NEUTRAL TO POS. BATTERY-HALF DX to correspond with the particular type of service selected.

(2) Turn the REC. RELAY switch on the modem unit panel to position MARK and turn the METER switch on the monitoring panel to position S.L. CURRENT.

(3) Adjust the SEND LOOP CURRENT rheostat on the monitoring panel until the meter reads +60. The position of the MON. TTY switch during this adjustment is immaterial. This gives the proper loop current for the marking signals.

(4) Plug the black plug and the red plug associated with the teletypewriter in to MON jacks S(BLK) and R(RED), respectively, on the monitoring panel. Turn the MON. TTY switch to position SEND LOOP.

(5) If the pointer of the meter is oscillating, indicating that the teletypewriter station is sending signals, and the printing as received is garbled, turn the SEND BIAS rheostat as necessary until clear copy is received.

(6) When contact with the teletypewriter station has been established, have the teletypewriter station attendant send repeated space signals by holding the teletypewriter space bar operated. Turn METER switch to SEND BIAS and adjust the SEND BIAS rheostat at the telegraph terminal until the meter reads zero. This insures that the SEND relay will repeat the telegraph signals to the carrier line without bias. Turn METER switch to REC. OUTPUT.

(7) Check that the loop circuit is in proper working order by communicating with the teletypewriter station on the teletypewriter.

(8) Turn the REC. RELAY switch to position NORMAL if carrier tone is being received from the distant telegraph terminal; switch to position MARK when communicating over the loop to the telegraph station.

**b. Line-up for Full-duplex, Neutral to Positive Battery.** (1) Turn the LOOP switch on the monitoring unit panel to position NEUTRAL TO POS. BATTERY-FULL DX.

(2) Perform operation described in subparagraph *a*(2) above.

(3) Perform operation described in subparagraph *a*(3) above.

(4) Turn METER switch to position R.L. CURRENT and adjust REC. LOOP CURRENT rheostat until the meter indicates +60.

(5) Perform the operations described in subparagraphs *a*(4) through (8) above.

**c. Line-up for Half-duplex, Neutral to Negative Battery.** (1) Turn the LOOP switch to position NEUTRAL TO NEG. BATTERY-HALF DX.

(2) Perform the operations described in subparagraphs *a*(2) to (8) above. The sending loop current in this case will actuate the meter to the left of the zero mark on the scale instead of to the right.

**d. Line-up for Full-duplex, Neutral to Negative Battery.** (1) Turn the LOOP switch to position NEUTRAL TO NEG. BATTERY-FULL DX.

(2) Perform the operations described in subparagraphs *a*(2), *a*(3), *b*(4), and *b*(5) above. The sending and receiving loop currents in this case will actuate the meter to the left of the zero mark on the scale instead of to the right.

**e. Line-up for Polarential Half-duplex.** (1) Turn the LOOP switch to position POLARENTIAL-HALF DX.

(2) Turn the REC. RELAY switch to position MARK and turn the METER switch to position S.L. CURRENT.

(3) Adjust the SEND LOOP CURRENT rheostat until the meter indicates +30. For making this adjustment, the sending relay at the telegraph station must be in the mark position. This condition will normally prevail since the sending relay is held in the mark position except during the time when the telegraph stations might be sending.

(4) Put the red teletypewriter plug into the R(RED)-MON jack and the black plug into the S(BLK)-MON jack and turn the MON. TTY switch to position SEND LOOP.

(5) Establish contact with the telegraph station on the teletypewriter. If the meter indicates that the distant station is sending and the printing is garbled, it may be that the SEND LOOP CURRENT adjustment performed in accordance with subparagraph (3) above was made while the subscriber's station was applying spacing battery to the line. If this was the case, repeat the adjustment of the SEND LOOP CURRENT as described in subparagraph (3) above while marking battery is being applied to the line from the telegraph station.

(6) Perform the operations indicated under subparagraphs *a*(7) and (8) above.

**f. Line-up for Two-path Polar.** (1) Turn the LOOP switch to position TWO PATH POLAR.

(2) Turn REC. RELAY switch to position MARK; turn METER switch to position R.L. CURRENT; adjust REC. LOOP CURRENT rheostat until the meter indicates +30.

(3) Turn METER switch to position S.L. CURRENT. The meter should indicate a substantial current when the sending loop is intact and battery is being applied at the telegraph station.

(4) Make rheostat adjustment at *the teletypewriter station* until the meter at the teletypewriter station indicates 30 milliamperes. If the send loop current cannot be adjusted as high as 30 milliamperes, adjust for the maximum value obtainable.

(5) Perform the operations indicated in subparagraphs *a*(7) and (8) above.

**11. CARRIER CIRCUIT LINE-UP.**

**a. General.** In operation, the carrier link between telegraph terminals uses frequencies of 1,860 and 1,680 cycles per second for sending and receiving, either value of which may be selected for sending or receiving. If station A sends at a frequency of 1,860 cps, it must receive at 1,680 cps. Station B at the distant end of the line must therefore send at 1,680 cycles and receive at 1,860 cycles.

**b. Switch Settings.** The following procedure for lining up the carrier link assumes that the loop circuits have been lined up (or adjusted for local operation) in accordance with paragraphs 9 and 10.

(1) SETTING OF SEND FREQUENCY SWITCH. Turn the SEND FREQUENCY switch to A(HIGH) if at an A terminal (usually the terminal of higher command) or to B(LOW) if at a B terminal. The distant terminal must have the opposite setting of the SEND FREQUENCY switch.

(2) SETTING OF SEND LEVEL SWITCH. For normal lines having an attenuation not greater than 50 db at the sending carrier frequency, turn the SEND LEVEL switch to position LOW. When the line attenuation is greater than 50 db, or if the noise level is high as compared to the signal strength, turn the SEND LEVEL switch to position HIGH.

(3) OSCILLATOR OUTPUT. Turn the METER switch to position OSC. OUTPUT. The meter should indicate +30 or over for a marking signal in the sending loop and 0 for a spacing signal in the loop.

(4) LOCAL TEST ON RECEIVER. Turn the METER switch to position REC. OUTPUT. Turn REC. RELAY switch to position SPACE. The meter should indicate —55 to —75. Turn REC. RELAY switch to position MARK. The meter should indicate a plus reading. The difference between the spacing and marking meter readings should not be greater than ±5. In each of these tests, the armature of the REC. RELAY should follow the REC. OUTPUT meter readings. Return the REC. RELAY switch to position NORMAL.

(5) RECEIVER CURRENT FROM DISTANT TELEGRAPH TERMINAL. Turn METER switch to position REC. OUTPUT. If the distant telegraph terminal is not sending tone

to the line (spacing signal), the meter should read —55 to —75. If the distant station is sending tone to the line (marking signal), the meter should indicate a plus reading. The difference between the spacing and marking readings should be not more than ±5. Marking REC. OUTPUT meter readings should be taken after marking tone has been received long enough for the automatic gain control to adjust the gain to the correct operating point (several seconds). Ordinarily, the REC. LEVEL switch should be in position LOW. If, however, the incoming signal is exceptionally strong, causing distortion, turn the REC. LEVEL switch to position HIGH which should appreciably reduce the distortion.

(6) COMMUNICATION WITH DISTANT TERMINAL. Put the red plug of the monitoring teletypewriter into the R(RED)-MON jack and the black plug into the S(BLK)-MON jack. Turn the MON. TTY switch to position SEND CARR.

> EXCEPTION: When the LOOP switch is set for two-path polar operation and it is desired to communicate over the carrier line from the monitoring teletypewriter, turn the MON. TTY switch to position LOCAL OPERATION NEUTRAL, thereby cutting off the loop circuits, and change the LOOP switch to position NEUTRAL TO POS. BATTERY-HALF DX or any other of the NEUTRAL positions.

When communications over the carrier line have been completed, restore the LOOP switch to TWO PATH POLAR and the MON. TTY switch to position SEND LOOP. Turn the METER switch to position REC. OUTPUT. Check that the REC. RELAY switch is in position NORMAL. Establish contact with the distant terminal on the monitor teletypewriter. If meter indicates that the distant terminal is sending but the message is not being received on the teletypewriter, check that the loop circuits have been lined up in accordance with paragraph 10.

### 12. CARRIER TELEGRAPH SYSTEM OPERATION (MONITORING).

**a.** After the system has been lined up and placed in operation in accordance with paragraph 11, message signals in either direction can be intercepted and observed on the monitor teletypewriter without causing interference to traffic. Message transmission from the monitor keyboard over the carrier line or the loop circuit is also possible whenever the circuit is not in use. To establish the monitoring circuit, plug the red teletypewriter cord into the R(RED)-MON jack and the black cord into the S(BLK)-MON jack. To send or receive over the loop, turn the MON. TTY switch to position SEND LOOP. To send or receive over the carrier line turn the MON. TTY switch to position SEND CARR.

> EXCEPTION: When the LOOP switch is in position TWO PATH POLAR, it is not possible to transmit signals from the monitor keyboard over the carrier line without first changing the position of the LOOP switch to one of the NEUTRAL position (par.11*b*(6)).

**b.** The MON. TTY switch can remain in either the SEND LOOP or SEND CARR position when the teletypewriter is not in use.

### 13. TELEPHONE CHANNEL ADJUSTMENTS.

**a. Ringing.** (1) If voice-frequency ringing is to be used in connection with the telephone channel, the peak limiter should be strapped in as outlined in paragraph 14*b*.

(2) Remove the cover plate which covers the vacuum tubes and relays from the ringer unit and, using a screwdriver, turn the S2 (1,000–500–cycle) switch to correspond with the frequency desired. Turn the S4 (+6 dbm, 0 dbm) switch to the position corresponding to the output level desired. If a storage battery is being used as the power source, throw the BAT-OFF-A.C. switch on the ringer power supply panel to position BAT; for operation from the a-c mains, throw the switch to position A.C. Adjust the bias on vacuum tube V4 as follows:

(*a*) Set the OPERATE-NON-OPERATE switch to position NON-OPERATE.

(*b*) Using a screwdriver, turn the BIAS control slowly to the right until the relay marked REC operates.

(*c*) Turn the BIAS control slowly to the left until relay REC of the ringer panel just

releases. This gives the proper bias for tube V4 which controls the operation of this REC relay. The operation of the relay can be detected by listening for the clicks when it operates and releases.

NOTE: Do not confuse this REC. relay with the polar relay on the monitoring unit.

(*d*) Return the OPERATE-NON-OPERATE switch to position OPERATE.

(3) Have a ringing signal of the proper frequency (1,000- or 500-cycle) transmitted from the distant terminal and check the operation of the REC. relay. If the relay releases too slowly, causing prolonged ringing, turn the BIAS switch slightly to the left after rechecking the bias adjustment.

(4) Send a ringing signal over the telephone loop from the local switchboard or telephone set and check that the SEND relay on the ringer panel operates in response to the 20–cycle ringing signal.

**b. Telephone Circuit Operation.** Ring the distant station from the local switchboard or telephone set which connects to the SWBD binding posts on the telegraph terminal and try to talk with the distant terminal. If contact with the distant station cannot be established, proceed as follows:

(1) Check that connections to the telephone or switchboard have been made properly.

(2) Check the ringer adjustments as described in subparagraph *a* above.

(3) Check that the armature of the SEND relay (on ringer unit) is fully released when 20–cycle ringing signals are not being received from the switchboard.

(4) Check that the armature of the REC. relay (on ringer unit) is fully released when voice-frequency ringing signals are not being received from the line.

### 14. INSTALLATION OF FILTER F–2/GG.

**a.** Where Filter F–2/GG is required, connect the ground wire to binding post GND or terminal 11, connect the east line to binding posts LINE 1 and 2 or terminals 1 and 2, connect west line to binding posts LINE 3 and 4 or terminals 3 and 4, connect telephone (or switchboard) to binding posts SWBD 5 and 6 or terminals 5 and 6 for communication over the east line, connect telephone (or switchboard) to binding posts SWBD 7 and 8 or terminals 7 and 8 for communication over the west line (fig. 5 ⑨).

**b.** Since the peak limiters are designed to pass voice-frequency currents only, they may be connected into or disconnected from the terminal circuit.

(1) When the telephone circuit involved uses d-c signalling or 20–cycle signalling, the peak limiter associated with that line must be disconnected by strapping terminals 1 to 5 and 4 to 8 (fig. 44).

(2) In all other cases, connect the peak limiter into the circuit by strapping terminals 1 to 2, 3 to 4, 5 to 6, and 7 to 8 (fig. 44).

### 15. PERIODIC OPERATION CHECKS.

To insure proper functioning of parts, periodic checks on the operating equipment should be made.

**a.** Note meter readings of the telegraph power supply, loop, bias, and receive currents, and oscillator output.

**b.** Check the quality of the received and transmitted signals in the monitoring teletypewriter and keyboard.

**c.** Inspect relay contacts for sparking.

### 16. REMOVAL OF EQUIPMENT AND PREPARATION FOR TRANSIT.

**a.** Turn power off and disconnect the power supply.

**b.** Disconnect any connections between stacked terminals.

**c.** Securely tighten all binding posts and connection terminal screws.

**d.** Unstack the units.

**e.** Replace and fasten doors.

# SECTION III
# FUNCTIONING OF PARTS

### 17. THEORETICAL CONSIDERATIONS.

**a.** Telegraph Terminal TH–1/TCC–1 makes possible the simultaneous transmission of speech and telegraph signals over the same pair of wires by superposing the d-c telegraph signals on a carrier current within the voice-frequency range. To prevent interference between the voice and telegraph currents, it is necessary to isolate the band of frequencies used for telegraph from other frequencies in the voice range. This is accomplished by band-stop and band-pass filters which, when connected in the line, effectively remove from the voice channel the band of frequencies used for the telegraph channel. For Telegraph Terminal TH–1/TCC–1, frequency bands of 1,680 ±60 cycles and 1,860 ±60 cycles are used by the two-way telegraph channel, one for each direction of transmission, and these frequency bands are removed from the normal speech channel by the band-pass and band-stop filters. There is some loss of intelligibility in telephone conversation because of the removal of the telegraph frequencies from the speech band.

**b.** The oscillator output, which is the carrier current, is varied in magnitude or modulated in accordance with the applied d-c telegraph signal, and the modulated current is transmitted to the line. At the distant terminal, the modulated signal is received, amplified, and rectified or demodulated to convert it to the pulsating current required to operate the receiving telegraph relay.

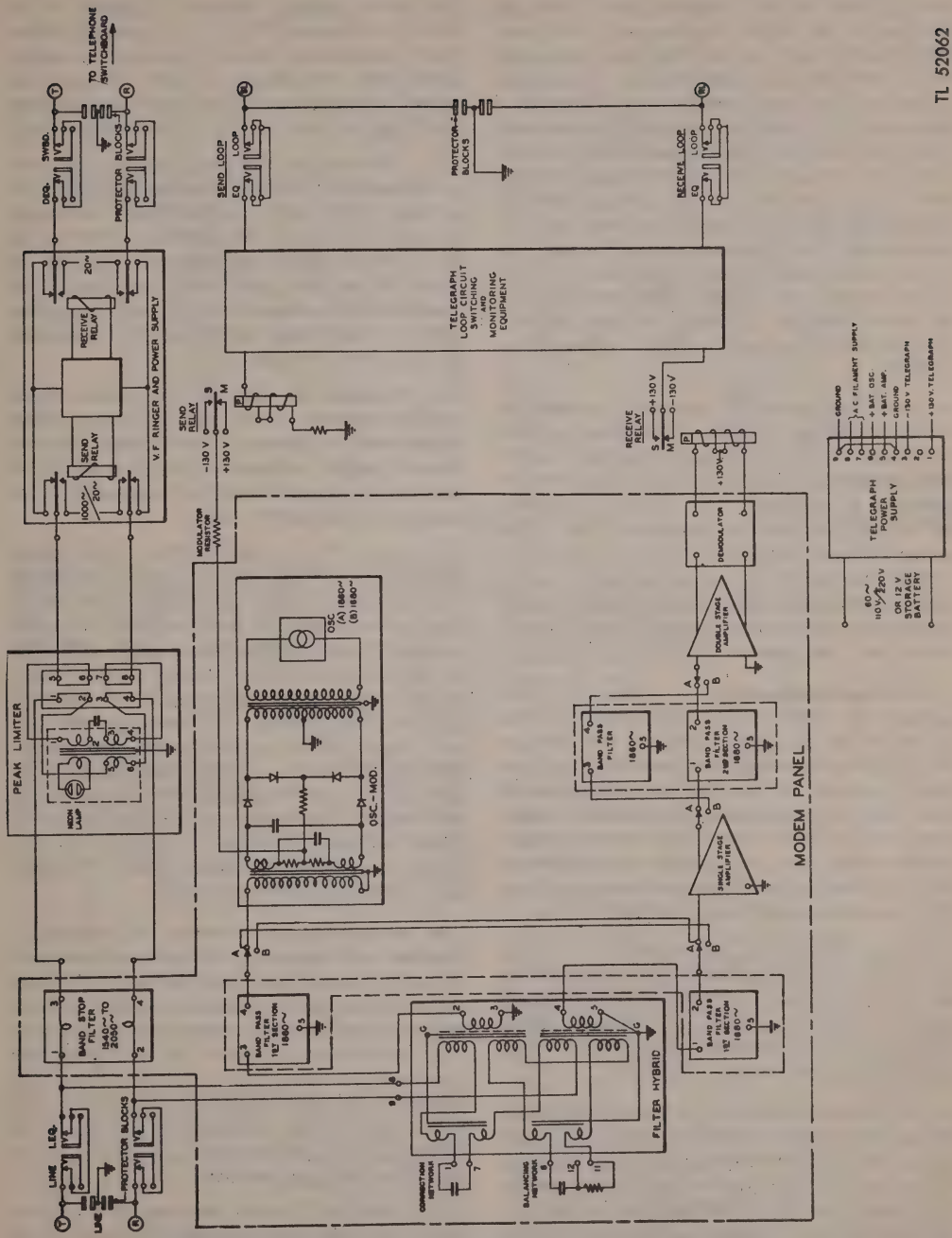
**c.** Since the combined telephone and telegraph channels utilize the same band of frequencies which would ordinarily be assigned to a telephone channel alone, it follows that any type of facility which will provide good telephone service can be used with Telegraph Terminal TH–1/TCC–1 as far as the frequency characteristics of the facility are concerned. Thus, open wire, cable, or carrier telephone facilities can be used. If the make-up of the facility involves repeaters, modulators, or loading coils which may overload and produce frequency components due to intermodulation between the various telephone or telegraph currents entering these devices, it is possible that a particular facility might be usable for ordinary telephony although unsuitable for combined telephone and telegraph operation. However, these are extraordinary cases. In general, the sending level used for telegraphy and the speech level as limited by the peak limiter in the telephone branch are so fixed that the telegraph terminal usually can be utilized on any facility capable of providing good telephone service. The telegraph receiver will operate over a circuit having a loss of 53 db when the REC. LEVEL switch is in position LOW. When the REC. LEVEL switch is in position HIGH, an attenuator pad reduces the over-all sensitivity so that the receiver will operate over a circuit having a loss of approximately 20 db. Normal transmitting level is —3 dbm at the LINE terminals of the set (SEND LEVEL switch in position LOW).

**d.** The general association of the telephone, telegraph, and line is shown in the block diagram (fig. 5). A detailed functional schematic diagram of Telegraph Terminal TH–1/TCC–1 is shown in figure 13.

### 18. POWER SUPPLY.

The power supply furnishes the d-c potentials required for operating all the units of the telegraph terminal except the ringer, which has its own separate power supply; it supplies positive and negative 130 volts for the d-c telegraph circuits, positive 130 volts for the plate and screen circuits of the amplifier tubes in the modem unit, positive 140 volts for the plate and screen circuits of the oscillator, and 12 volts alternating current for the filaments of all the tubes. A voltage regulation feature controls the 130–volt supply for the telegraph loops so that the output will not vary more than 5 volts with a change of 10 percent in the a-c input voltage. The d-c load will vary from no load to 0.2 ampere. The schematic diagram for the power supply appears in figure 48.

**a. Power Connections.** (1) The external source of power for operating the power supply may be either 100–130– or 200–250–volt, 50–60–




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*Figure 13. Telegraph Terminal TH–1/TCC–1, functional diagram.*

cycle alternating current, or a 12–volt storage battery. An 8–foot, two-conductor cord is attached to the double receptacle in the spare parts compartment and the free end is equipped with a twistlock polarized plug for connecting to the local a-c supply outlet. An 8–inch auxiliary cord with plug and receptacle is provided which can be attached to the main cord to adapt it for use with a-c outlets with straight terminals. The a-c power cord may be brought out through the top or bottom of the chest, but for permanent or semi-permanent installations, the bottom hole should be used (par. 6*b*(2)). Two binding posts (±12 V BAT) are used for making connections to a 12-volt storage battery when batteries are used instead of alternating current.

(2) Terminal board D furnishes connections for all the output voltages of the power supply. Terminals 1 and 3 furnish +130 and —130 volts, respectively, to the telegraph loop circuits. Terminal 5 furnishes +130 volts to the plate and screen circuits of the amplifier tubes in the modem unit, and terminal 6 furnishes +140 volts to the oscillator tube in the modem unit. Terminals 7 and 8 furnish 12 volts alternating current to the filaments of all the vacuum tubes. Terminals 4 and 9 are ground.

**b. Fusing Arrangements.** (1) Fuse F1, designated A.C. 2A. on the front panel, is connected in the a-c input circuit of transformer T1. This fuse prevents the power supply from injury incurred by drawing too much current from the a-c power source. Fuse F4, designated BAT. 15 A. on the front panel, is connected in the d-c input circuit of transformer T1. This fuse protects the power supply when it is being operated from a battery source.

(2) Fuses F2 and F3, designated +TG ¼A. and —TG ¼A., respectively, are connected in series with the output of the regulated power supply for the telegraph loop circuits. These fuses protect the regulated supply from being damaged by overloading.

**c. Switching Circuits.** (1) A four-pole, double-throw switch (S3) is used to turn the power on and off and for switching from an a-c source to a 12-volt battery source. When the switch is in the A.C. position, voltage from one side of the power source is applied to terminal 4 of the primary winding of the power transformer (T1). When the switch is in the BAT. position, the 12-volt battery voltage is applied to the 120-cycle vibrator (VIB. 1). The vibrator alternately connects the battery voltage to the power transformer windings 1–2 and 2–3, and the proper voltages are induced in the secondary windings for operating the telegraph terminal.

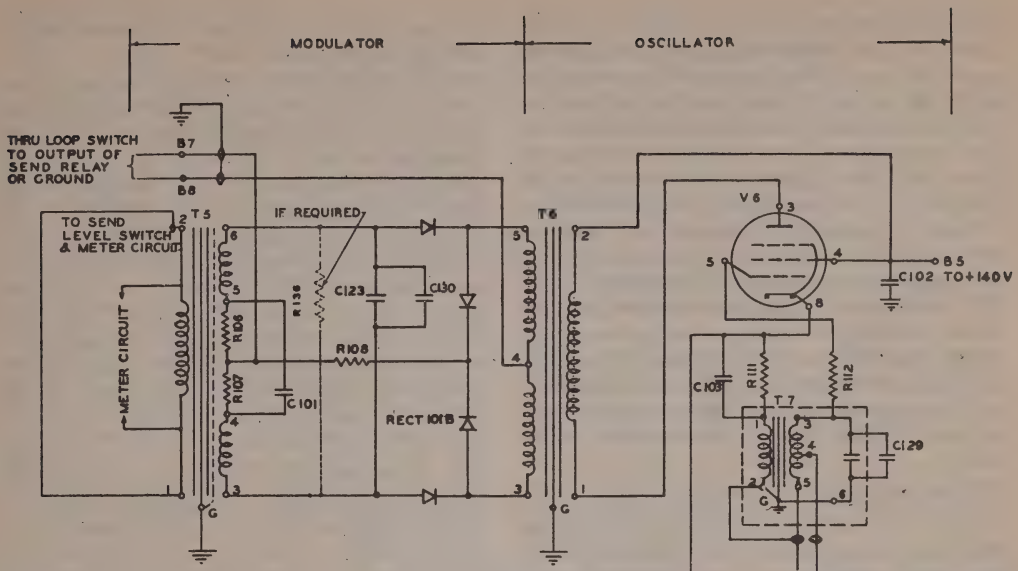
(2) A double-pole, double-throw switch (S4) is connected in the other side of the line. The purpose of this switch is to connect the proper primary winding of the power transformer so that the telegraph terminal will operate on either 115 or 230 volts alternating current. It also makes the proper connections to the power supply in the ringer unit so that it will operate at the correct voltage.

(3) Switches S2 and S5 are mechanically coupled together. These switches make compensation for variations in the nominal value of the a–c supply voltage by changing the turns ratio of the transformer to correspond to the voltage of the power source.

(4) Switch S1 is a push-button switch designated TG. SUPPLY. The purpose of this switch is to provide a quick check on the condition of the power supply in case no power is being applied to the telegraph loop circuits. When the switch is operated, a 9,100–ohm resistor (R25) is connected in series with relay RA and ground. This action will energize relay RA, and power will be applied to the loop circuits provided the power supply is functioning properly. If no power is applied to the loops when the switch is operated, the trouble lies in the power supply; if power is applied when the switch is operated, the trouble lies in the oscillator circuit in the modem unit.

**d. Voltage Regulator Circuits.** To maintain a constant line current in the telegraph loop circuits, the power supply for these circuits uses automatic voltage regulation. Both the negative and positive 130–volt power supplies use two type 2050 gas tetrodes and a VR105 voltage regulator tube. In addition to the voltage regulation in these circuits, a time delay relay is provided which prevents operation of the telegraph loops until the oscillator in the modem unit is operating properly.

(1) Relay RA (fig. 48) is connected in series with the plate circuit of the oscillator in the modem unit and the supply voltage for the os-




| CIRCUIT DESIGNATION | ITEM | DESCRIPTION | CIRCUIT DESIGNATION | ITEM | DESCRIPTION |
|---|---|---|---|---|---|
| C101 C103 | CAPACITOR | 0.5 MF +20%- 10% 500 V | R 108 | RESISTOR | 1500 OHMS ±5% 2 WATT |
| C102 | CAPACITOR | 1.0 MF +20%- 10% 500 V | R 111 | RESISTOR | 680 OHMS |
| C 103 | CAPACITOR | .05 MF +20%-10% 500 V | R 112 | RESISTOR | 270000 OHMS + 10% 1/2 WATT |
| | | | R 136 | RESISTOR | VALUE DETERMINED AT FACTORY |
| C129 C130 | CAPACITOR | MICA TRIMMER | T5 | TRANSFORMER | MODULATOR OUT PUT |
| RECT. 101 B | RECTIFIER | SELENIUM | T6 | TRANSFORMER | OSCILLATOR OUTPUT |
| R106 R 107 | RESISTOR | 3 000 OHMS ±5% 1 WATT | T7 | TRANSFORMER | OSCILLATOR FREQUENCY |
| | | | V6 | VACUUM TUBE | 6G8-G |

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*Figure 14. Oscillator-modulator, simplified schematic diagram.*

cillator. The contacts of this relay are connected in series with the output of the regulated power supplies. When no current is flowing through the coil of the relay, these contacts are open and no voltage is applied to the telegraph loops. When the oscillator has warmed up so that it is drawing current (about 12 ma), however, the relay is energized, the contacts close, and voltage is applied to the telegraph loops. In this way, the operation of the telegraph loops is delayed until the oscillator has warmed up sufficiently to transmit the carrier current.

(2) The voltage for the positive 130–volt supply to the telegraph loops is obtained from two type 2050 gas tetrodes (V2 and V3) connected as a full-wave rectifier and a voltage regulator tube, type VR105 (V1). The negative 130–volt supply uses the same types of vacuum tubes. Two control potentiometers (R17 and R18), designated TG+ and TG—, regulate the output of the 130-volt supply. Fuses F2 and F3 provide the necessary protection to the circuits.

(3) To consider the action of the voltage regulator circuit, refer to the positive 130–volt supply (fig. 48). The gas tetrodes (V2 and V3) are connected as a full-wave rectifier across winding 13–15 of the power transformer. The output voltage of the rectifier is taken from the cathodes of these tubes and fed to terminal 1 of terminal board D. Resistors R15 and R17 form the load resistance for the rectifier.

(4) A portion of the output voltage is taken from the center tap of R17 and is applied in series with the voltage across V1 to the grids of V2 and V3. By varying the amount of voltage applied to the grids, the bias on the two tubes is varied and thus the output voltage is controlled. If the output voltage dropped to 125 volts, the potential on the cathodes of V2 and V3 would be decreased by 5 volts but the voltage applied to the grids of the tubes from

R17 would drop only about 1 volt. The resulting increase in positive bias on the tubes would cause them to conduct more current, and thus raise the output voltage back to its original value. Conversely, an increase in output voltage would cause a more negative bias on the tubes and the output voltage would be decreased. In order to maintain a constant action, V1 is a voltage regulator tube which is supplied with rectified voltage by Rect. 1. This tube has a constant voltage drop of 105 volts.

(5) In order to provide more control over the output voltage, a small a–c voltage is superposed upon the d–c bias on tubes V2 and V3. This a–c voltage is taken from winding 21–22 of the power transformer and applied through a phase-shifting network to the grids of the tube.

(6) The negative 130–volt supply, composed of tubes V4, V5, and V6 and their respective transformer windings, differs from the positive 130–volt supply only in that the output voltage is taken from the center tap of the transformer winding instead of from the cathodes of the tubes. The voltage regulating action is similar to that of the negative 130–volt supply.

### 19. TELEGRAPH SENDING.

The outgoing telegraph signals originating at the telegraph station as d–c impulses are transmitted over the sending loop to the telegraph terminal where they actuate the armature of the SEND relay. A description of the d–c telegraph apparatus and the nature of the signals in the loop circuit follows in paragraphs 28 to 30.

**a. Oscillator.** The oscillator which generates the carrier frequency consists of a 6G6–G tube and the associated transformers, resistors, and capacitors. The simplified schematic diagram of this circuit appears in figure 14. The oscillator circuit also appears in the schematic diagram for the modem unit (fig. 49).

(1) The oscillator in the telegraph terminal is an electron-coupled oscillator in which feedback is obtained by magnetically coupling the cathode circuit to the grid circuit through transformer T7. The grid circuit of the transformer is tuned by a capacitor connected internally between terminals 3 and 6, and a trimmer capacitor C129 is connected externally between these terminals. Bias voltage for the oscillator is developed across R111 in the cathode circuit and R112 in the grid circuit.

(2) To change the frequency of oscillation, terminals 4 and 5 of transformer T7 are connected to the SEND FREQUENCY switch (SW–101). When the switch is in the HIGH position, terminal 4 is grounded through the shield of the wire running from pin 3 of SW–101 to terminal 5 of the transformer. The frequency of oscillation is determined by the amount of inductance in winding 3–4; in this case it is 1,860 cycles. When the switch is in the LOW position, terminal 4 is ungrounded and terminal 5 is connected to ground. In this case the frequency of oscillation is determined by the amount of inductance in winding 3–5; the frequency is 1,680 cycles.

(3) When the REC. RELAY is in the MARK position, it is necessary to provide current for marking the receive relay. To accomplish this, a small audio voltage from the cathode of the oscillator tube (V6) is applied through R133 and SW–103 to terminal 2 of transformer T3 in the receiving amplifier (fig. 49).

(4) The output of the oscillator is transformer coupled to the modulator through transformer T6. The power source for the oscillator is the 140–volt supply in the power supply. Connection is made at terminal 5 of terminal board B in the modem unit.

**b. Modulator.** The modulator makes use of the fact that a selenium disk will change its resistance from a very high value when voltage is applied in one direction to a very low value when voltage is applied in the reverse direction. The simplified schematic diagram of the modulator appears in figure 14. The circuit of the modulator also appears in the complete schematic diagram of the modem unit (fig. 49).

(1) The modulator consists of two selenium disk rectifier elements connected in series between the secondary winding of transformer T6 and the primary winding of transformer T5. In addition, two elements of the rectifier are connected in parallel with the secondary winding of T6. The polarity of the d–c signals applied to the modulator from the armature of the SEND relay determines whether the carrier frequency is suppressed or allowed to pass on to the line.

(2) When the voltage applied to the junction of resistors R106 and R107 is positive, the

series elements of the rectifier will not conduct. Since these elements are the ones which rectify the signal input to transformer T5, no signal will be passed to the line under this condition. When the voltage applied to the junction of the resistors in negative, the series elements of the rectifier will conduct and signals will be passed on to the line. The switching of the d–c potentials is accomplished by the SEND relay. For more detailed information of the operation in each of the telegraph loop circuits, refer to the schematic diagrams, figures 19 through 25, and paragraphs 22 through 24. Resistors R106 and R107 are introduced for the purpose of providing a high d–c voltage drop across the two shunt elements of the rectifier, and resistor R8 accomplishes the same action for the two series elements. In this way the selenium elements are operated on the most favorable portions of their characteristic curves. The carrier frequency current is bypassed around resistors R106 annd R107 by capacitor C101.

(3) The output of the modulator passes through the SEND LEVEL switch either directly or through the attenuator pad, and through the SEND FREQUENCY switch to the first section of the band-pass filter. The SEND LEVEL switch is used for adjusting the strength of the outgoing signal. With the switch in the LOW position, the attenuator pad consisting of resistors R101, R102, and R103 is connected in series with the output of T5. In this case the output level is —3 dbm. When the switch is in the HIGH position, the attenuator pad is switched out of the circuit and the output level is +4 dbm.

(*a*) Resistor R136 shown on the modem circuit is furnished only when required to maintain the output level within the limits of +4 dbm and +2 dbm. The value of this resistor is determined at the factory during test.

(*b*) External capacitors furnished with transformers T1 and T3 on the modem unit are trimmers used to obtain the proper transformer resonant frequency band.

(4) It will be noted from the schematic diagram (fig. 49) that the wires which connect the output of the oscillator from transformer T5 to the band-pass filter are shielded. When the SEND FREQUENCY switch (SW–101) is in the HIGH position, the shield is grounded at the 1,860-cycle portion of filter F2. The ground at terminal 5 of filter F2 is connected to the shield of the conductor connecting pin 4 of the filter with pin 7 of SW–101. From the schematic diagram it can be seen that this ground connection on the shield extends all the way back to pin 2 of transformer T5. When the SEND FREQUENCY switch is in the LOW position, the shield on the output connection from the output of transformer T5 to the band-pass filter F2 is similarly connected to ground at the 1,680-cycle portion of the filter. The purpose of grounding the shield in the two different ways for the high- and low-frequency settings of the SEND FREQUENCY switch is to eliminate interference in the home receiver circuit by the transmitter. It will also be noted that the shield on the connections in the receiver input circuit are also grounded at different points for different settings of the SEND FREQUENCY switch.

**c. Filter Sections.** (1) The process of modulation generates a band of frequencies which extends well into the frequency spectrum both above and below the carrier frequency. Since only the sideband frequencies very close to the carrier are necessary for telegraph transmission, the band-pass filter passes only this narrow band and suppresses the remaining frequencies. The telegraph frequencies which are permitted to pass through the sending filter fall within the attenuating range of the band-stop filter in the telephone branch and are therefore not heard in the telephone. The frequency-attenuation curves of the sending band-pass filter are shown in figure 15.

(2) The switching of the filter sections to correspond to the proper oscillator frequency is accomplished by the SEND FREQUENCY switch (SW–101). When the switch is in the HIGH position, the 1,860-cycle section of the sending band-pass filter F2 is connected in series with the secondary of T5 and the hybrid coil T9. When the switch is in the LOW position, the 1,680-cycle section of the filter is connected in that position.

**d. Hybrid Coil.** (1) To prevent the outgoing telegraph signals from actuating the home receiving circuit, separate frequencies are used for the two directions of transmission. The hybrid coil and associated balancing network is utilized as an additional safeguard to prevent

false operation of the home receiving circuit by the outgoing signal. In this arrangement, the outgoing signal which would normally tend to cause false operation is cancelled out by a neutralizing current at the input of the receiving circuit.

(2) The hybrid coil consists of two identical transformers and correction networks, the coils of which are mounted in the same case with the transformers. Outgoing signals from the sending band-pass filter enter winding 2–3 of the transformer, inducing a current in secondary winding 8–1 so that the signal is transmitted to the line. From the secondary winding 8–1 in series with the line a balancing network is permanently adjusted to approximate the impedance of the line at telegraph frequencies.

**20. TELEGRAPH RECEIVING.**

**a. Switches.** Incoming telegraph signals arriving at the LINE terminals of the set cannot pass the band-stop filter so they are not heard in the telephone. The received signal is applied to the hybrid coil windings 8–1 and 7–9 in series with the impedance correcting network and are induced into windings 4–5 and 2–3. From the winding of the hybrid coil, the signal passes through the first section of the band-pass filter (F2), through the SEND FREQUENCY and REC. LEVEL switches, to the input circuit of the amplifier, winding 1–2 of transformer T1 (fig. 16). The SEND FREQUENCY switch is used to select the sending and receiving frequencies. The REC. LEVEL switch is used to reduce the signal strength of very strong signals to minimize distortion in the receiver circuit. When the switch is in position HIGH, an attenuator pad of approximately 20 db is inserted between the receiving filter and transformer T1. For low level input signals, the pad is switched out by turning the REC. LEVEL switch to position LOW.

**b. Amplifier.** (1) The signal arriving at terminals 1–2 of transformer T1 is amplified by vacuum tube V1. Amplifier output transformer T2 is connected through a second filter section, the output of which is connected to the input transformer T3 of the two-stage amplifier consisting of vacuum tubes V2 and V3. The plate circuit of vacuum tube V2 is connected to an automatic volume control network consisting of winding 1–2 of transformer T8 and a rectifier, resistor, and capacitor voltage doubler. The signal for further amplification through tube V3 is developed across winding 3–4 of transformer T8 and fed to the grid of tube V3 across winding 5–6 of T8.

(2) The output from amplifier output transformer T4 separates into two functional branches. One branch consisting of windings 3–4 and 5–6 of the transformer goes to the demodulator circuit and detector tubes V4 and V5 (fig. 18). The other branch from winding 7–8 of transformer T4 is connected to a network which automatically controls the grid bias on tubes V4 and V5 to block the current in tube V5 (spacing tube) while current is flowing in tube V4 (marking tube) under the influence of a marking signal. Conversely, the current in tube V4 is blocked while tube V5 is conducting. In addition to the selectivity offered by the two band-pass filter sections, the secondaries of transformers T1 and T3 are broadly tuned by a capacitor connected across the coils. The over-all selectivity of the receiving circuit is shown by the curves in figure 17 which take into account the selectivity contributed by tuning transformers T1 and T3.

**c. Automatic Gain Control Circuit.** (1) The automatic gain control for the amplifier tubes V1, V2, and V3, figure 16, utilizes the signal voltage developed across winding 4–3 of transformer T3 and operates to change the grid bias of the tubes in proportion to the level of the incoming signal. The signal used for gain control, after being amplified by tube V2, is rectified by selenium rectifier RECT. 102 connected in a voltage doubler circuit consisting of capacitors C113 and C114, voltage dropping resistors R116, R117, R119, and R120 and a time delay network consisting of capacitors C112 and C114 and resistors R118, R115, and R123. The grid return wires of tubes V1, V2, and V3 are brought back to tapped points on the automatic gain control voltage dividing resistors R116, R117, R119, and R120.

(2) The rectifiers are connected so that the voltages at the tapped points are negative with respect to ground for tubes V1, V2, and V3. If the level of the incoming signal is increased, the negative control voltage becomes greater and reduces the gain of the amplifier tubes V1, V2, and V3 in accordance with the negative bias impressed on the tube grids. This tends to maintain a constant voltage in the demodu-

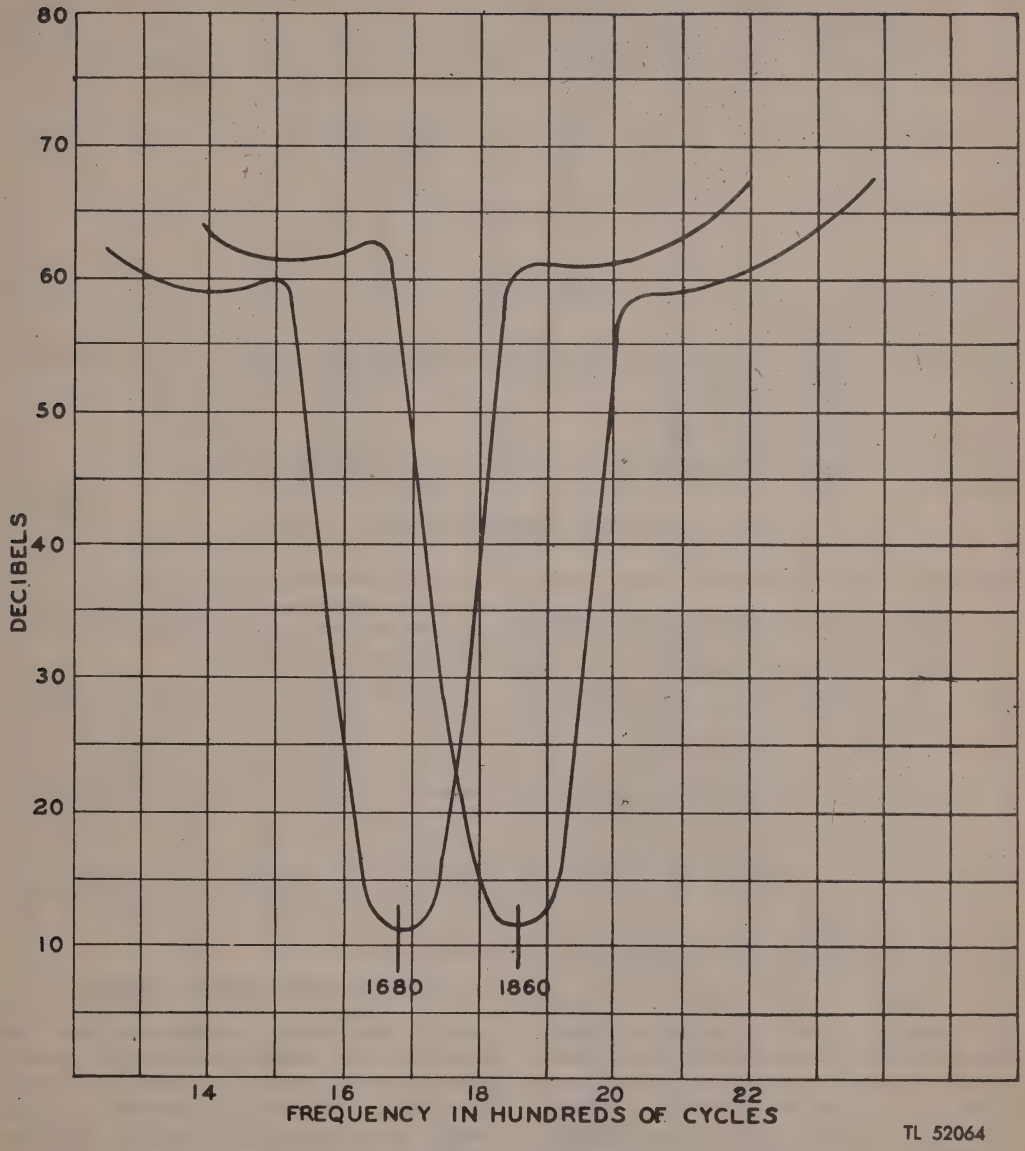
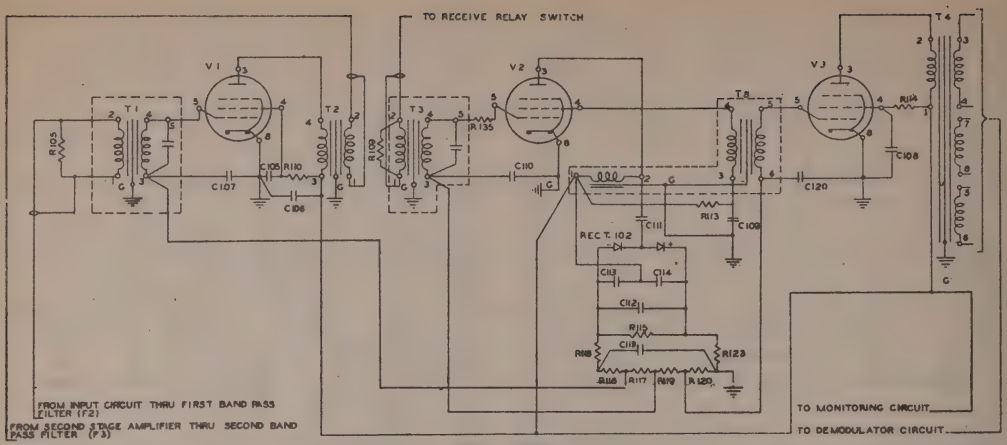



*Figure 15. Sending filter attenuation characteristics.*




CIRCUIT LEGEND

| CIRCUIT DESIGNATION | ITEM | DESCRIPTION |
|---|---|---|
| C105 C106 C107 C108 C109 C110 | CAPACITOR | .01MF ± .25 MF + .1 MF + 20% - 10% 500 V. |
| C113 C114 | CAPACITOR | .005 MF ± 10% MICA |
| C112 | CAPACITOR | .2 MF + 20% - 10% 500 V. |
| C119 | CAPACITOR | .6 MF + 20% - 10% 500 V. |
| C111 C120 | CAPACITOR | .1 MF + 20% - 10% 500 V. |
| R105 R109 | RESISTOR | 1500 OHMS ± 5% 1/2 WATT |
| R110 R113 R114 | RESISTOR | 20 000 OHMS ± 5% 1/2 WATT |
| R115 | RESISTOR | 270 000 OHMS ± 10% 1/2 WATT |
| R116 R123 R135 | RESISTOR | 3.3 MEG ± 5% 1/2 WATT |

| CIRCUIT DESIGNATION | ITEM | DESCRIPTION |
|---|---|---|
| R117 | RESISTOR | .68 MEG ± 5% 1/2 WATT |
| R118 | RESISTOR | 2 MEG ± 5% 1/2 WATT |
| R119 | RESISTOR | 0.27 MEG ± 5% 1/2 WATT |
| R120 | RESISTOR | 1.3 MEG ± 5% 1/2 WATT |
| RECT. 102 | RECTIFIER | SELENIUM |
| T1 T3 | TRANSFORMER | INPUT V1 INPUT V2 |
| T2 | TRANSFORMER | OUTPUT V1 |
| T4 | TRANSFORMER | OUTPUT V3 |
| T5 | TRANSFORMER | OUTPUT V2 |
| V1 V2 V3 | VACUUM TUBE | 6G6-G |

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*Figure 16. Amplifier, simplified schematic diagram.*

lator circuit over a wide range of signal levels.

(3) The purpose of the automatic gain control is to compensate for gradual variations in the signal level. The control voltage should not change appreciably when the signal level is reduced to zero for the short period of time required to transmit a spacing signal. To accomplish this, the time constant of the circuit which develops the control voltage is made comparatively long by using large values of resistance and capacity. It takes several seconds for the capacitors in this circuit to become fully charged after the set is first turned on and signal voltage is applied. It is necessary, therefore, on lines equipped with Telegraph Terminal TH–1/TCC–1 that tone be applied to the line continuously except during the relatively short intervals actually required to transmit spacing signals. The application of continuous tone to the line during the idle periods provides a pilot signal by which the automatic gain control in the receiver adjusts itself in accordance with the average strength of the carrier signal. After the capacitors are charged, the control voltage developed across the resistors remains practically constant during short spacing signal intervals. When a change in the average value of the signal voltage occurs over a comparatively long period of time, however, the automatic gain control voltage will respond accordingly.

**d. Demodulator.** In the demodulator circuit (fig. 18), incoming carrier signals are converted to d–c impulses for operating the polar relay REC. Relay winding 3–6 is connected in the plate circuit of the marking tube V4 and the relay operates to the mark position when current flows in the plate circuit of tube V4. Relay winding 7–2 is similarly connected in the plate circuit of tube V5 and when current flows in tube V5, the relay operates to the spacing position.

## 21. TELEGRAPH LOOP CIRCUITS, GENERAL.

**a.** The association of sending and receiving apparatus at the telegraph station with respect to the telegraph terminal is shown in figure 5. The sending and receiving apparatus may be located in the immediate vicinity of the telegraph terminal and connected thereto by short switchboard cords. This is called *local operation.* In many cases, however, the telegraph station may be located at a distance from the telegraph terminal and connected to the ter-

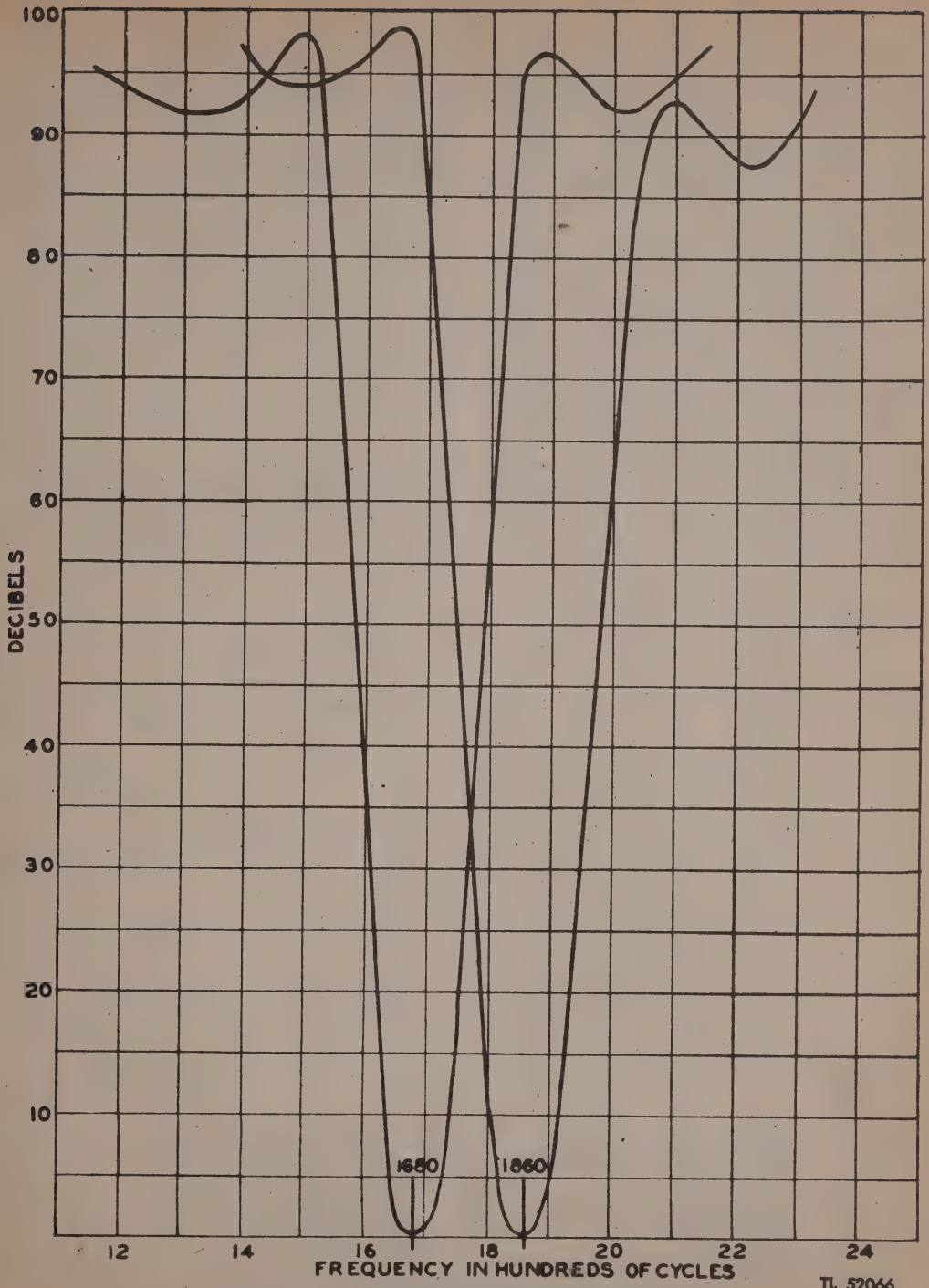
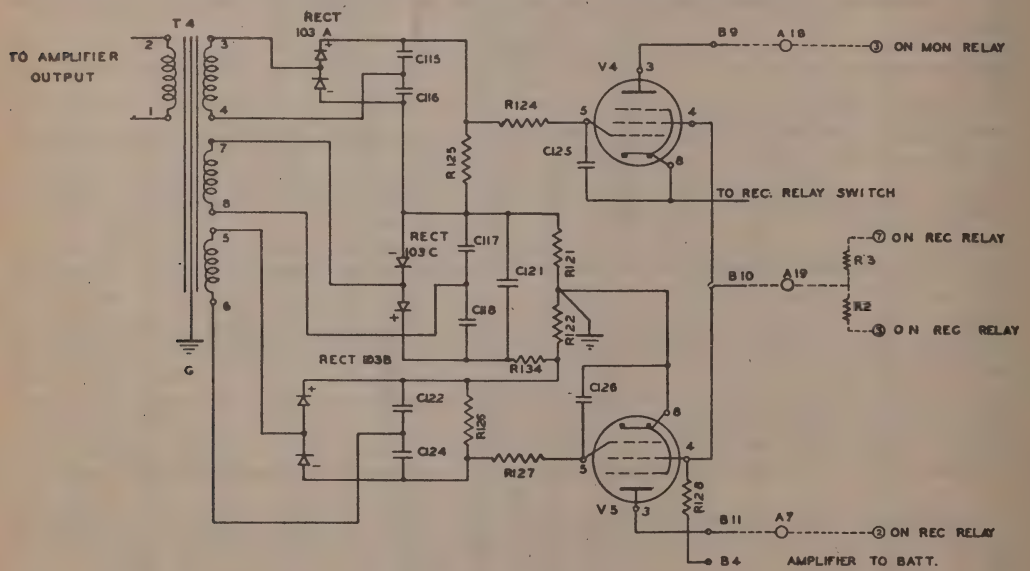



*Figure 17. Receiver selectivity characteristics.*

minal by long loops. D–c signaling is used on the loops which may be constructed of open wire, field wire, or cable. In most cases, the loops are worked with a ground-return path. The transmission problem involves consideration of the loop resistance, line to earth capacitance, wet weather leakage, and interference from adjacent circuits.

**b.** Various types of terminal apparatus and circuits have been devised to overcome transmission difficulties over long exposed loops. Three of the systems in common use are called *neutral, polar,* and *polarential.* The particular system used at one end of the loop must correspond to the type of apparatus in use at the distant end. By turning the LOOP switch on Telegraph Terminal TH–1/TCC–1, the relays and associated terminal apparatus may be connected to provide *neutral, polar,* or *polarential* operation. The position of the LOOP switch also determines whether the apparatus is connected for full- or half-duplex service. *Full-duplex* service provides for simultaneous sending and receiving at the telegraph station and requires a sending loop and a receiving loop. *Half-duplex* service requires only one loop and permits alternate sending or receiving at the telegraph station. The polarity of the power supply which furnishes line battery at the telegraph station can be positive or negative. The LOOP switch at the telegraph terminal should be turned to the position which corresponds to the polarity applied at the telegraph station. Figures 19 to 25 show how the loops and apparatus are connected for various positions of the LOOP switch.

**c.** The relays used for sending and receiving are moistureproof polar relays. In this type of relay, the magnetic circuit is polarized by a permanent magnet. Movement of the armature to either the spacing or marking contact depends upon the direction of current through




| CIRCUIT DESIGNATION | ITEM | DESCRIPTION |
|---|---|---|
| C115, C116 | CAPACITOR | .005 MF. ± 10% MICA |
| C117, C118 | | |
| C122, C124 | | |
| C121 | CAPACITOR | 2 MF. + 20% – 10% 500 V. |
| C125, C126 | CAPACITOR | .0005 MF. ± 20% MICA |
| RECT. 103A | RECTIFIER | SELENIUM |
| RECT. 103B | | |
| RECT. 103C | | |
| R125, R126 | RESISTOR | .5 MEG. ± 10% ½ WATT. |

| CIRCUIT DESIGNATION | ITEM | DESCRIPTION |
|---|---|---|
| R134 | RESISTOR | .5 MEG. ±10% ½ WATT |
| R124 | RESISTOR | 3.3 MEG. ± 10% ½ WATT. |
| R127 | RESISTOR | 5.1 MEG. ± 5% ½ WATT. |
| R121 | RESISTOR | 3.3 MEG. ± 5% ½ WATT. |
| R122 | RESISTOR | 1.2 MEG. ± 5% ½ WATT. |
| R128 | RESISTOR | 8,200 OHMS ± 5% ½ WATT. |
| T4 | TRANSFORMER | OUTPUT V3 |
| V4, V5 | VACUUM TUBE | 6G6-G |

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*Figure 18. Demodulator, simplified schematic diagram.*

the windings. Two 136-ohm windings are connected to terminals (2–7) and terminals (3–6). Positive potential applied to the low-numbered terminal of either winding operates the armature of the relay to the marking contact. Negative potential applied to the low-numbered terminals operates the armature to the spacing contact. Arcing at the contacts of the relays is reduced by spark killers S1 and S2, each consisting of a 0.5-mf capacitor in series with a 1,600-ohm resistor, connected across each pair of contacts.

**d.** The source of current for operating the REC relay depends upon the position of the REC. RELAY switch which is mounted on the modem panel. When the REC. RELAY switch is in position NORMAL, the REC relay circuiit is under the control of the incoming carrier signals. With the switch in position MARK, the receiving relay input circuit is disconnected from the incoming line and a local signal from the oscillator is applied to the receiving circuit to hold the REC relay armature on the marking contact. When the REC. RELAY switch is in position SPACE, the receiving relay input circuit is disconnected from the incoming line and then short-circuited, causing the armature to rest on the spacing contact.

### 22. TELEGRAPH LOOP CIRCUITS, NEUTRAL OPERATION.

**a.** In the neutral method of signaling used in this set a marking interval is formed when the polarities of the line batteries at the two ends of the loop are aiding. Spacing intervals are formed when the polarities of the batteries are opposing. If the voltages applied to the loop at the telegraph terminal and telegraph station are equal and there is no leakage, the line current will vary from a maximum value during the marking interval to zero during the spacing interval. In this case the power supply voltage at the telegraph station is 115 volts and at the telegraph terminal it is 130 volts, so a small line current (about 3 milliamperes) flows during the spacing interval. The schematic circuit for a typical case of neutral operation is shown on figure 19. This circuit is worked half-duplex and the polarity of the power supply at the telegraph station is positive 115 volts. The LOOP switch at the telegraph terminal is turned to NEUTRAL TO POS. BAT–HALF DX.

**b.** When signals are transmitted from the telegraph terminal to the telegraph station, the keyboard contacts at the telegraph station are kept closed and positive battery is applied continuously to the loop. Incoming carrier signals actuate the armature of the RECEIVE relay. When the armature moves to the marking contact, negative battery is applied to the loop by the circuit which goes from the armature of the RECEIVE relay through inductance coil L1, SEND relay winding 6–3, resistor R21 and SEND LOOP CURRENT rheostat R33, through the EQ and LOOP patching jacks to the SL binding post. Thus, for a marking signal, the polarities of the line batteries at the two ends of the loop are series aiding. The SEND LOOP CURRENT rheostat is adjusted so that the loop current is 60 milliamperes. Inductance L shapes the waveform of the transmitted signals so that interference to adjacent telephone circuits is reduced especially when the loop forms part of a simplex circuit. At the telegraph station, the loop current through the relay winding overcomes the tension of the armature spring and moves the armature to the marking contact. A local circuit of the teletypewriter actuates the teletypewriter magnet when the armature touches the marking contact. When the armature of the RECEIVE relay moves to the spacing contact, positive battery is applied to the loop, provided the armature of the SEND relay is touching the marking contact which will be the case as long as the keyboard contacts at the telegraph station are closed. For the spacing interval the polarities of the line batteries at the two ends of the loop are opposing and the loop current goes nearly to zero, assuming no leakage on the loop. At the teletypewriter station, the relay armature spring moves the armature to the spacing contact, thereby breaking the local circuit to the teletypewriter magnet.

**c.** Outgoing signals from the telegraph terminal to the loop should not actuate the SEND relay. To prevent this, signals from the armature of the RECEIVE relay pass through SEND relay winding 2–7 and an artificial line network to ground. This network comprises resistor R25 in parallel with resistor R27 and

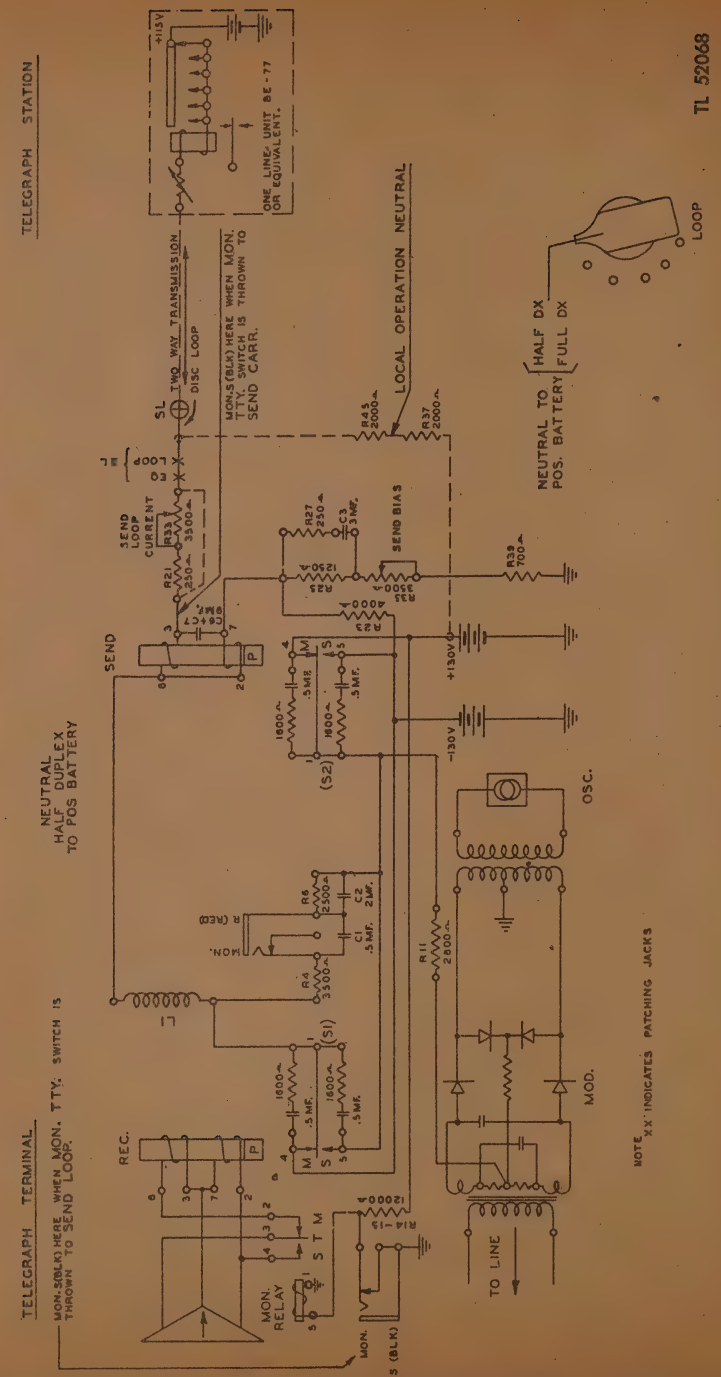



*Figure 19. Loop circuit, neutral half-duplex to positive battery, schematic diagram.*

capacitor C3 in series and this combination in series with rheostat ASB and resistor R39. The impedance of the artificial line network will approximate the impedance of the loop at telegraph frequencies when rheostat SEND BIAS is adjusted for the particular loop being used. When the incoming carrier signal is marking, negative battery is applied to SEND relay winding 6–3 in series with the loop and to winding 2–7 in series with the artificial line network. The current through winding 6–3 will be 60 milliamperes and in a direction which tends to move the SEND relay armature to marking. The current through winding 2–7 will be 30 milliamperes, provided the resistance of the artificial line network equals the resistance of the loop. The direction of current through winding 2–7 is such that it tends to move the armature to spacing. The SEND relay armature will move to the marking contact by virtue of the difference between the currents in the two windings. When the incoming carrier signal is spacing, positive battery is applied to SEND relay winding 6–3, but no appreciable current flows through this winding because an opposing polarity is applied to the distant end of the loop. Positive battery from the armature of the RECEIVE relay is applied also to winding 2–7 and the current will be 30 milliamperes in a direction which holds the SEND relay armature to marking. Thus, while signals of either polarity are being transmitted from the armature of the RECEIVE relay to the telegraph station, the SEND relay armature is held to marking provided the keyboard contacts at the telegraph station remain closed.

**d.** When signals are transmitted from the telegraph station to the telegraph terminal, the armature of the RECEIVE relay at the telegraph terminal remains in the marking position and negative battery is continuously applied to the loop. When the keyboard contact closes at the telegraph station during a marking interval, the current through SEND relay winding 6–3 will be 60 milliamperes and the direction will be such that it tends to move the relay armature to marking. The 60-milliampere current in winding 3–6 will be opposed by a current of 30 milliamperes through winding 7–2. The SEND relay armature will move to the marking contact by virtue of the difference between the currents in the two windings. When the keyboard contact opens during a spacing interval the loop current will be reduced to zero, assuming no leakage on the loop. The armature of the SEND relay will be moved to the spacing contact by the 30 milliampere current flowing in winding 2–7. Thus, the SEND relay at the telegraph terminal responds to signals from the telegraph station. The armature of the SEND relay is connected through a 2,800-ohm resistor to the modulator circuit. The modulator controls the oscillator output, and carrier signals are transmitted to the line. Capacitors C6 plus C7 shape the signals arriving over the loop from the telegraph station and counteract signal distortion occurring on long loops having large electrostatic capacities to ground.

**e.** The receiving operator at the telegraph station can interrupt the circuit during the reception of signals to signal the sending operator by opening the loop circuit. This is called breaking. When the loop is opened, the SEND relay armature will move to the spacing contact immediately if the RECEIVE relay armature is touching the marking contact. When the armature of the SEND relay moves to spacing, negative battery is applied to the spacing contact of the RECEIVE relay. Thus, the polarity applied to both the spacing and marking contacts of the RECEIVE relay is negative. Even though the sending station continues to transmit signals, negative battery only will be applied to SEND relay winding 2–7 and the armature will remain on the spacing contact so long as the receiving operator keeps the loop open. A clean-cut break signal is thus transmitted over the carrier to the sending operator. If the receiving operator initiates a break signal when the RECEIVE relay is on the spacing contact, the break signal becomes effective upon receipt of the next succeeding marking signal.

**f.** Figure 20 shows the connections for full-duplex neutral to positive battery operation. Two loops are used. Transmission from the telegraph terminal to the telegraph station over the receiving loop and transmission in the reverse direction over the sending loop is essentially the same as for the half-duplex circuit described in the above paragraphs. Figures 21 and 22 show the connections for full- and half-duplex neutral operation when the power supply at the telegraph station is negative 115 volts.

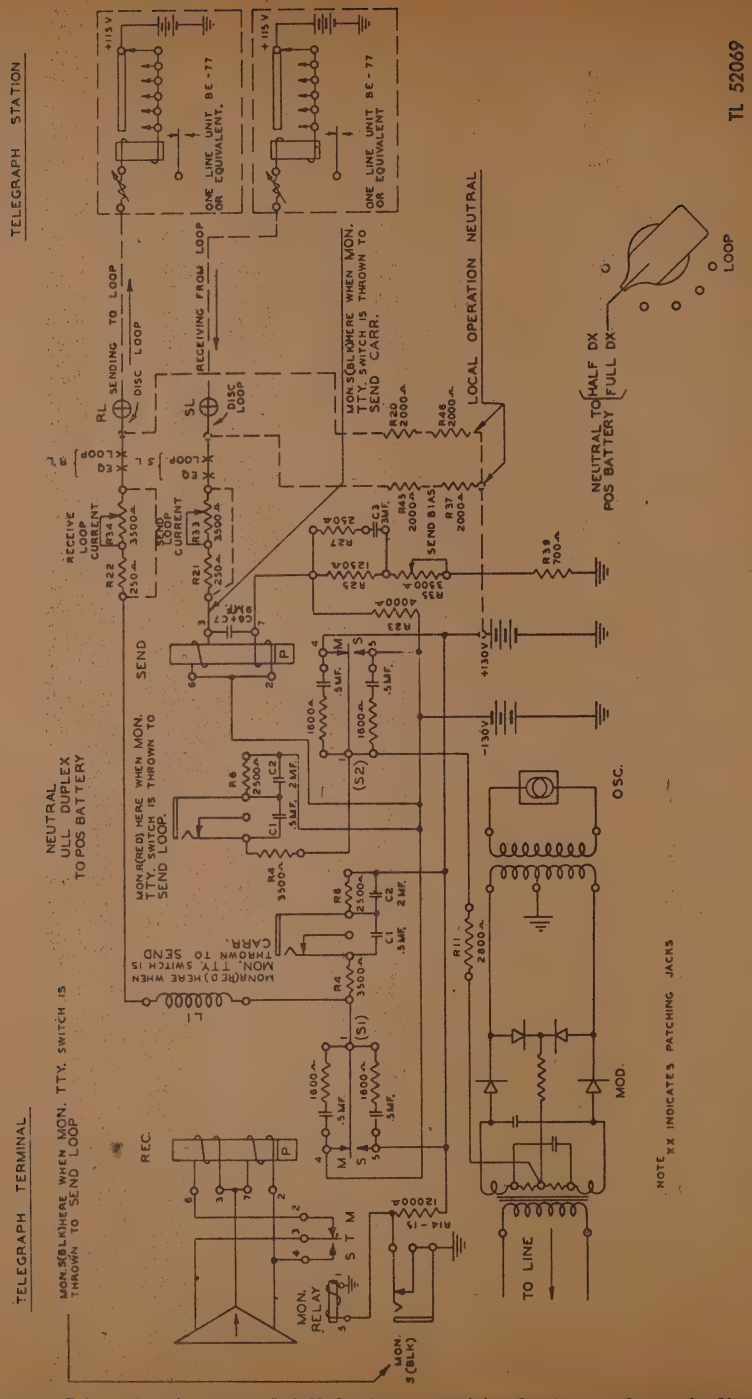



*Figure 20. Loop circuit, neutral full-duplex to positive battery, schematic diagram.*

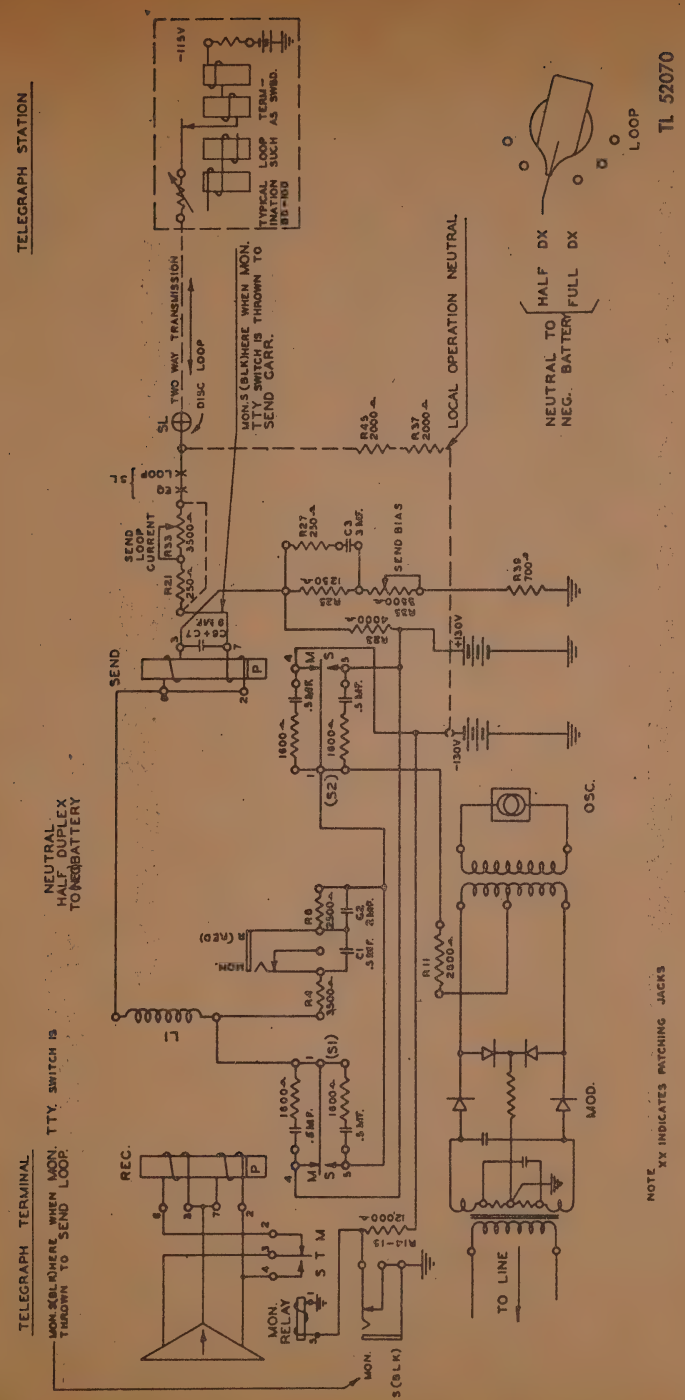



*Figure 21. Loop circuit, neutral half-duplex to negative battery, schematic diagram.*

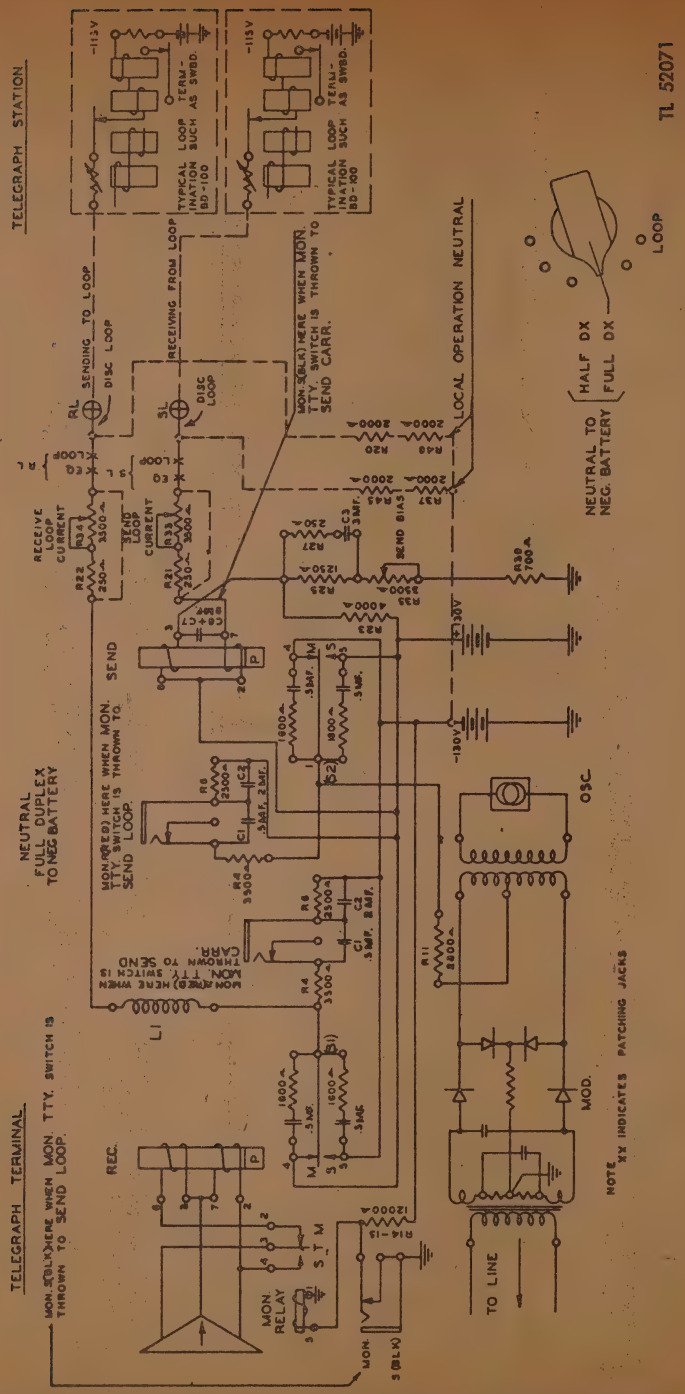



*Figure 22. Loop circuit, neutral full-duplex to negative battery, schematic diagram.*

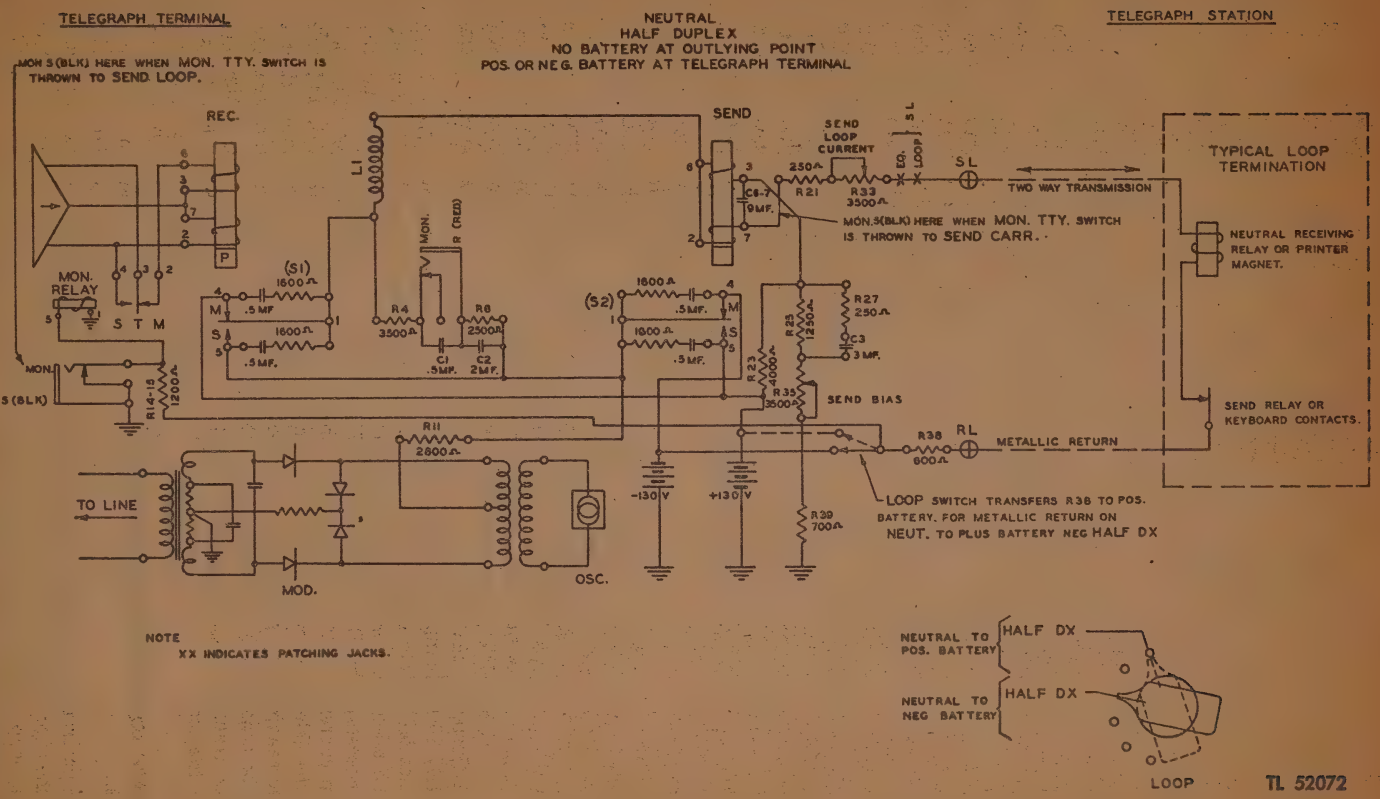



*Figure 23. Loop circuit, neutral half-duplex with metallic return, schematic diagram.*

g. Figure 23 shows the connections to the loops when the LOOP switch is turned to NEUTRAL TO POS. BAT-HALF DX (or to NEUTRAL TO NEG. BAT-HALF DX) and a second loop wire is used instead of the ground as the return path. Line battery is supplied at the telegraph terminal.

### 23. TELEGRAPH LOOP CIRCUITS, POLAR OPERATION.

a. In the polar method of signaling used in this set, the marking interval is formed by applying a negative potential to the sending end of the loop and the spacing interval by applying a positive potential. Two loops are required, one for each direction of transmission. Each loop is connected permanently to ground at the receiving end. The line current varies from a maximum negative value during the marking interval to maximum positive during the spacing interval. At the receiving end, the winding of the polar receiving relay is in series with the loop, and the position of the armature is determined by the direction of current through the windings.

b. Figure 24 shows the association of telegraph terminal, loops, and telegraph station when the LOOP switch is turned to TWO PATH POLAR. The receiving loop current is adjusted at the telegraph terminal to approximately 30 milliamperes by means of rheostat REC. LOOP CURRENT. The sending loop current is adjusted at the telegraph station to approximately 30 milliamperes. If this adjustment does not fall within the range of the line rheostat, the telegraph terminal can assist by adjusting rheostat SEND LOOP CURRENT until a loop current of 30 milliamperes is obtained at the telegraph station. The current value in the sending loop at the telegraph terminal may be considerably lower than the current at the transmitting end when there is leakage on the loop.

### 24. TELEGRAPH LOOP CIRCUITS, POLARENTIAL OPERATION.

a. In the polarential method of operation, the nature of the signals transmitted from the two ends of the loop is different. From the telegraph terminal to the telegraph station, polar transmission is used. From the telegraph station to the telegraph terminal, a differential current system of transmission is used. Figure 25 shows the association of telegraph terminal, loop, and telegraph station when the LOOP switch is turned to POLARENTIAL HALF DX.

b. While signals are being transmitted from the telegraph terminal to the telegraph station, the armature of the sending relay at the telegraph station rests on the marking contact, thereby grounding the loop. Incoming carrier signals actuate the armature of the RECEIVE relay. When the armature moves to the marking contact, negative battery is applied to the loop by the circuit which goes from the armature of the RECEIVE relay through inductance coil L1, resistor R29, SEND relay winding 3–6, resistor R21, and SEND LOOP CURRENT, rheostat R33, through the EQ and LOOP patching jacks to the SL binding post. The SEND LOOP CURRENT rheostat is adjusted for a loop current of 30 milliamperes. Loop current through the winding of the receiving polar relay at the telegraph terminal moves the armature to the marking contact. When the incoming carrier signal is spacing, positive battery is applied to the loop provided the armature of the SEND relay is touching the marking contact, which will be the case so long as ground is applied to the loop at the telegraph station. The armature of the receiving relay at the telegraph station moves to the spacing contact.

c. Outgoing signals from the telegraph terminal to the loop should not operate the SEND relay. To prevent this, positive battery is applied to SEND relay winding 2–7 in series with resistors R31, R26, and R32 to bias the relay. The current through the bias winding is 50 milliamperes and in a direction which tends to hold the SEND relay to the marking contact. When the RECEIVE relay armature is on the marking contact, the current through SEND relay winding 3–6 is 30 milliamperes in a direction which tends to move the armature to spacing. The 50 milliampere current through bias winding 2–7 tends to move the armature to marking. The SEND relay armature will be held to marking by virtue of the 20 milliampere difference between the currents in the

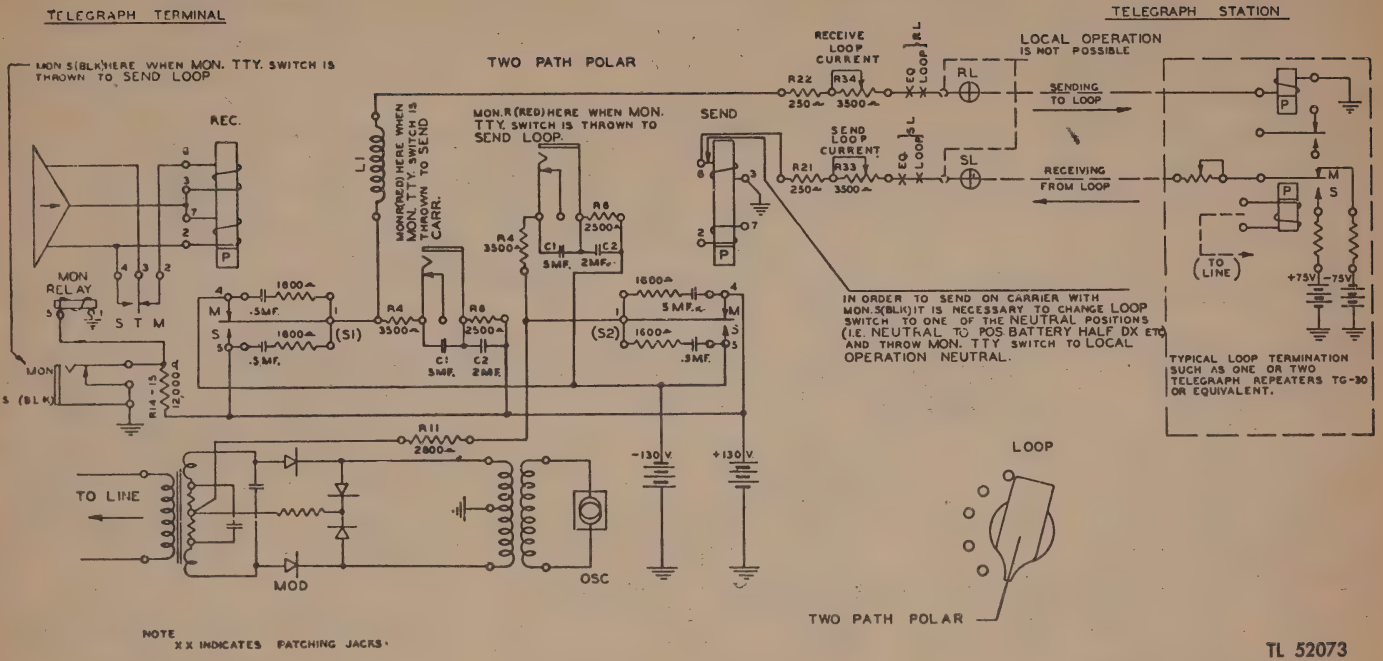
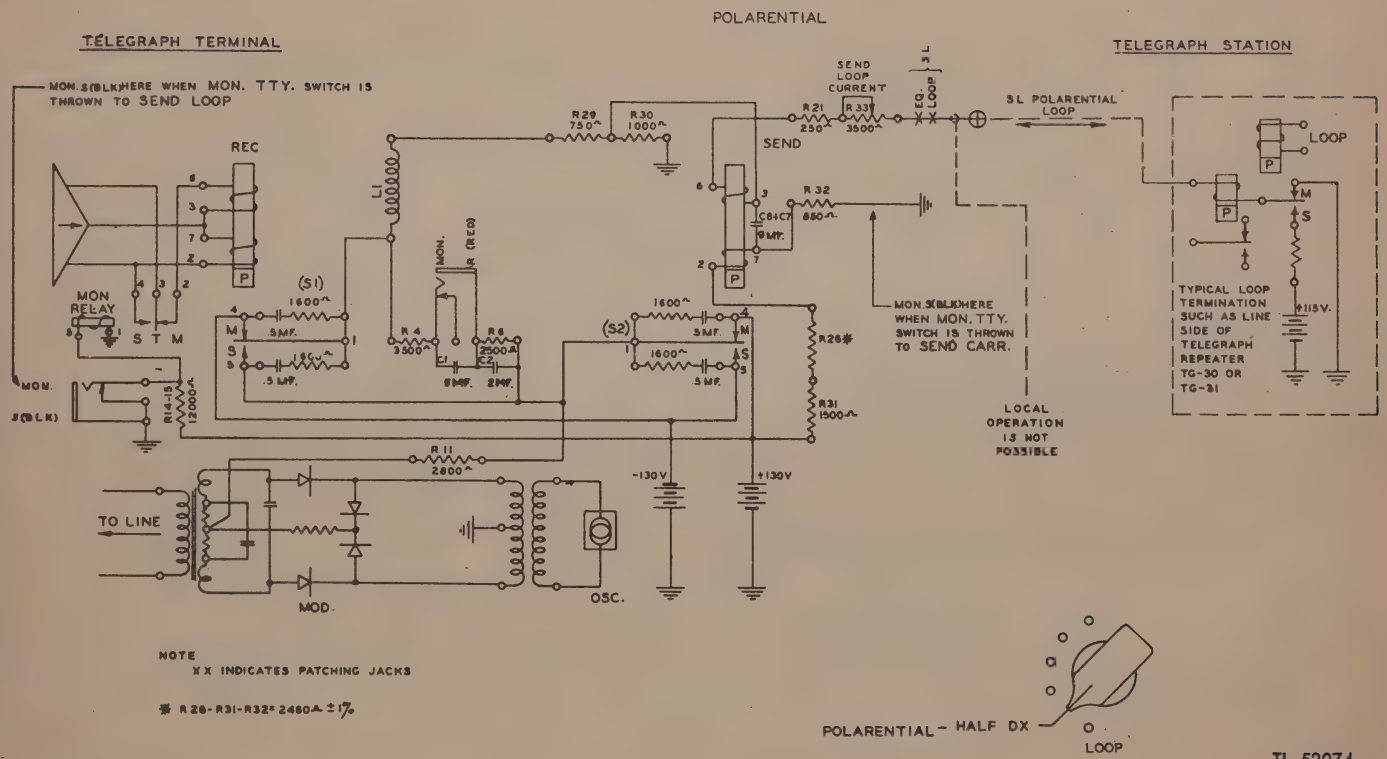



*Figure 24. Loop circuit, two-path polar, schematic diagram.*




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*Figure 25. Loop circuit, polarential, schematic diagram.*

two windings. When the RECEIVE relay armature is on the spacing contact, the current through SEND relay loop winding 3–6 is 30 milliamperes in a direction which tends to move the armature to marking. The armature will be held to the marking contact by virtue of the sum of the currents in the loop and bias windings which amounts to 80 milliamperes. Thus, while signals of either polarity are being transmitted from the RECEIVE relay contacts to the telegraph station the SEND relay armature is held to marking, provided ground is applied to the distant end of the loop.

**d.** While signals are being transmitted from the telegraph station to the telegraph terminal, the armature of the RECEIVE relay at the telegraph terminal rests on the marking contact and negative battery is applied continuously to the loop. Ground is applied to the loop at the telegraph station for a marking signal. The loop current of 30 milliamperes flows through SEND relay winding 3–6 which tends to space the relay. A 50-milliampere current through the bias winding 2–7 tends to mark the relay. The SEND relay armature will move to the marking contact by virtue of a current difference of 20 milliamperes flowing in the two windings. Positive battery is applied to the loop for a spacing signal. Fixed resistors R29 and R30 and the d-c resistance of inductance coil L1 are so chosen that a loop current of 70 milliamperes will flow in SEND relay winding 6–3 provided the SEND LOOP CURRENT rheostat has been previously adjusted for a loop current of 30 milliamperes for the marking signal. The 70-milliampere loop current tends to space the relay. The 50-milliampere bias current tends to mark the relay. The SEND relay armature will move to the spacing contact by virtue of the current difference of 20 milliamperes.

**e.** Within limits, polarential transmission is not susceptible to signal bias resulting from leakage on the loop during wet weather. In the direction of polar transmission, both the marking and spacing signals are attenuated equally as the line leakage increases, so no bias results. In the direction of differential transmission, the marking loop current increases and the spacing loop current decreases by approximately equal amounts when leakage occurs. The following table shows typical loop and bias currents in the windings of the SEND relay for dry and wet weather:

DRY WEATHER

| *Marking* | | *Spacing* | |
|---|---|---|---|
| Loop current | 30 ma | Loop current | 70 ma |
| Bias current | 50 ma | Bias current | 50 ma |
| Difference | 20 ma | Difference | 20 ma |

WET WEATHER

| *Marking* | | *Spacing* | |
|---|---|---|---|
| Loop current | 40 ma | Loop current | 60 ma |
| Bias current | 50 ma | Bias current | 50 ma |
| Difference | 10 ma | Difference | 10 ma |

**25. MONITORING.**

Jacks and switches are provided on the telegraph terminal for teletypewriter monitoring. These facilities permit interception of the message passing in either direction over the circuit for observation on the monitor teletypewriter. When traffic is idle, the monitor keyboard can be used for sending over either loop or carrier. Figures 19 through 25 indicate the points in the circuit where the monitor teletypewriter and keyboard are connected for the various positions of the LOOP and MON. TTY switches. Figure 19 shows the monitoring connections where the LOOP switch is turned to the NEUTRAL TO POS. BAT-HALF DX position and is typical for the other LOOP switch positions.

**a.** The MON-S (BLK) jack accommodates the teletypewriter black plug and the MON-R (RED) jack accommodates the red teletypewriter plug. The MON. TTY switch controls the direction of transmission and reception. The REC. RELAY switch provides a local source of tone for holding the REC. relay armature to the marking contact if carrier tone is off the line at the time monitoring is required. The layout of jacks and switches is shown in figure 8.

**b.** When the MON. TTY switch is turned to SEND LOOP, the monitor keyboard jack S (BLK) is connected to the winding of the MONITOR relay. If the black plug is plugged into the jack, signals from the keyboard will actuate the armature of the MON relay. The circuit between the plate of the MARK tube

and RECEIVE relay winding 6–3 passes through MON RELAY contacts T and M. Furthermore, MON relay contact S is connected to RECEIVE relay winding terminal 2. Signals from the monitor keyboard will be repeated into the S LOOP by the RECEIVE relay provided steady carrier current is received from the line. The action of the MON relay contact T is to alternately connect one or the other of the RECEIVE relay windings to the plate of the MARK tube in accordance with signals from the keyboard. Plate current flowing in winding 3–6 marks the RECEIVE relay while this same current flowing in winding 7–2 spaces the relay. If carrier current is not being received from the line, it can be supplied locally by turning the REC. RELAY switch to MARK. The circuit for supplying local carrier current to the receiver for the purpose of causing a steady plate current to flow in the MARK tube goes from terminal 1 of transformer T7 through resistor R11, capacitor C103 in parallel, resistor R133, and REC. RELAY switch contacts 11 and 8 to terminal 2 on transformer T3 (fig. 50). The MON relay is a neutral relay having a resistance of 2,000 ohms. The operating current is fixed at approximately 10 milliamperes.

c. When the MON. TTY switch is turned to SEND CARR, the jack MON-S(BLK) is connected in series with the sending loop, making it possible for impulses from the monitoring teletypewriter to interrupt the current flowing in SEND relay winding 6–3. This actuates the armature of the SEND relay and modulated carrier signals will be transmitted over the carrier line.

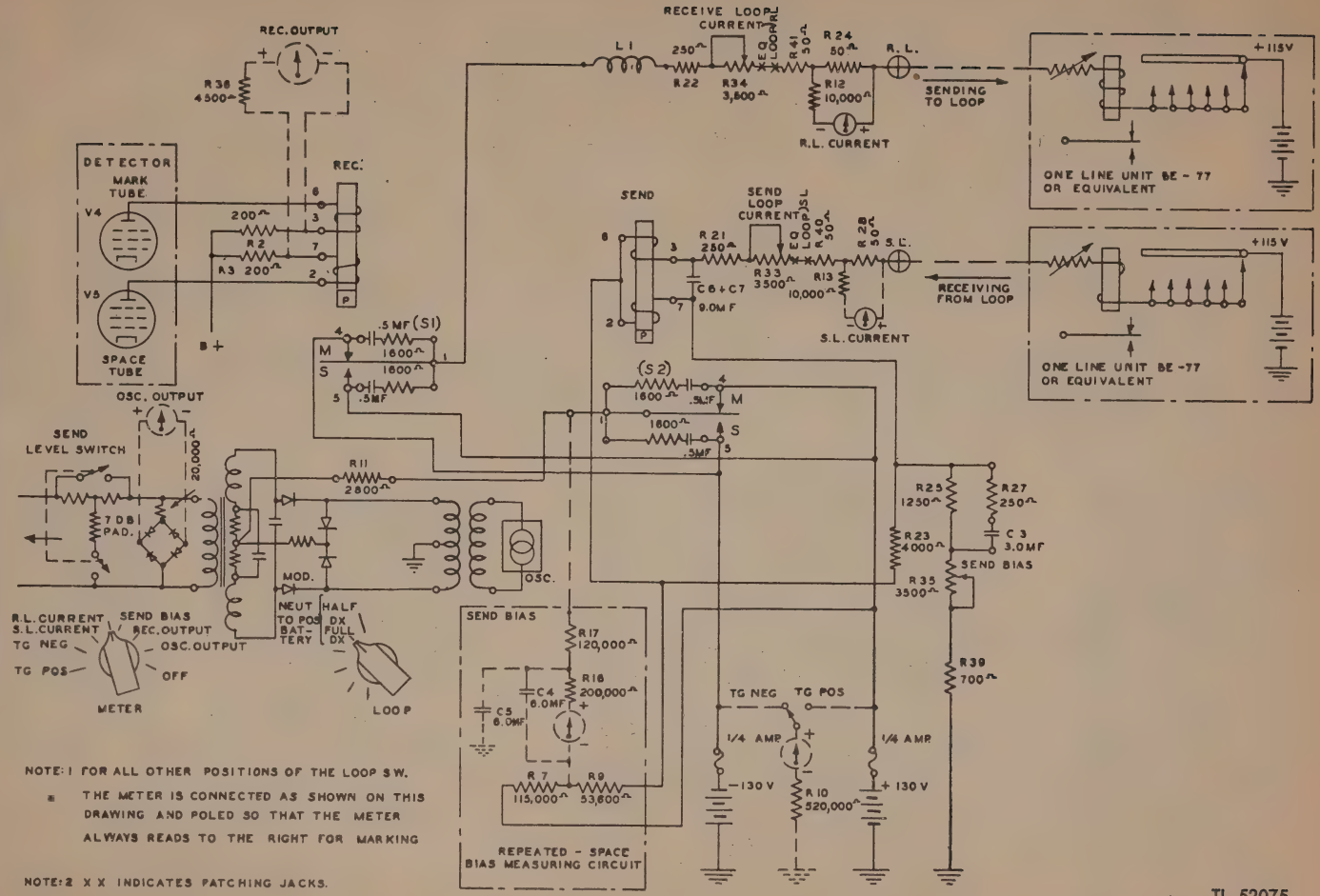
d. When the MON. TTY switch is turned to either SEND LOOP or SEND CARR, the MON-R(RED) printer jack is connected between the armature of the RECEIVE relay and the armature of the SEND relay. When both armatures are on their respective marking contacts, current flows through the monitor teletypewriter magnet plugged into the MON-R(RED) jack. This circuit goes from positive 130 volts on the SEND relay marking contact, through the MON-R(RED) teletypewriter jack circuit to negative 130 volts on the RECEIVE relay marking contact. If the armature of either relay moves to its spacing contact, the teletypewriter magnet becomes deenergized because it is short-circuited. Resistors R4 and R6 limit the current in the monitor teletypewriter circuit. Capacitors C1 and C2 are used in conjunction with resistor R6 and the inductance of the teletypewriter magnet as a wave-shaping network.

e. While the home teletypewriter station is sending, the armature of the RECEIVE relay will rest on the marking contact. Signals from the loop actuate the armature of the SEND relay, thereby interrupting the current through the monitor teletypewriter circuit, and signals from the home teletypewriter station will be recorded on the teletypewriter. While the teletypewriter station associated with the distant teletypewriter terminal is sending, the armature of the SEND relay will rest on the marking contact. Incoming signals actuate the armature of the RECEIVE relay, and signals from the far end of the carrier line will be recorded on the teletypewriter. When the LOOP switch is turned to TWO PATH POLAR, it is not possible to send over the carrier from the monitor keyboard. The method of operation must be changed to LOCAL OPERATION NEUTRAL to send from the monitor keyboard, but incoming signals from either direction can be recorded on the monitor teletypewriter in the usual manner when the circuit is being worked TWO PATH POLAR.

f. Monitoring as ordinarily carried out on a working circuit assumes that the loops are intact and that carrier tone is on the line. To send on the loops while carrier tone is off the line, the RECEIVE relay armature can be held on the marking contact by turning the REC. RELAY switch to MARK. This applies a local tone to the receiver as explained in paragraph 19*a*(3). To send on the carrier when the loops are open or in trouble, the method of operation should be changed to LOCAL OPERATION NEUTRAL as described in paragraph 26.

### 26. LOCAL OPERATION NEUTRAL.

a. For local operation, the loop wires are disassociated from the telegraph terminal and replaced by dummy loops in the set when the MON. TTY switch is turned to LOCAL OPERATION NEUTRAL and the LOOP switch to any one of the NEUTRAL methods of operation.




NOTE: 1 FOR ALL OTHER POSITIONS OF THE LOOP SW.
* THE METER IS CONNECTED AS SHOWN ON THIS DRAWING AND POLED SO THAT THE METER ALWAYS READS TO THE RIGHT FOR MARKING

NOTE: 2 X X INDICATES PATCHING JACKS.

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*Figure 26. Metering circuit, schematic diagram.*

**b.** The connections for local operation are indicated on figures 19 through 25 by dotted lines running from the SL and RL binding posts through protective resistors R37–R45 or R20–R46 to battery. The sending and receiving loop jacks are used for making connections to the teletypewriters. The monitor jacks MON-S(BLK) and MON-R(RED) can also be used at the same time if required.

### 27. METERING CIRCUITS.

The meter circuits for measuring various currents and voltages in the telegraph terminal are shown in figure 26. The meter is a Weston Model 301 0.5–0–0.5 milliammeter with an arbitrary 100–0–100 scale. The METER switch connects the meter into the circuit at selected points. The proper series and shunt resistors are provided at the selected points for keeping the meter current within the range of the instrument. Figure 26 shows the meter connected for measuring R.L. CURRENT. The connections to the meter when the METER switch is thrown to other positions are indicated by dotted lines. When the METER switch is turned to SEND BIAS, the meter is connected to the SEND relay contacts and it indicates percentage bias in a repeated signal coming in over the sending loop.

### 28. TELEPHONE CHANNEL.

**a.** Speech currents from the telephone set arrive at the SWBD binding posts of the telegraph terminal and are transmitted to the line after passing through the peak limiter and band-stop filter. The usual range of frequencies from the telephone is approximately 200 to 2,700 cycles per second. The band-stop filter is tuned to remove the band of frequencies from 1,540 to 2,050 cycles per second and to pass all other frequencies to the line. The frequency-attenuation curve for the band-stop filter is shown in figure 27.

**b.** The peak limiter which is provided in the telephone circuit reduces the amplitude of high peak impulses to +4 dbm so that amplifiers along the line will not overload and modulate the telegraph signals. The peak limiter will not pass 20-cycle or d-c signaling, either of which is usually used on nonrepeatered telephone circuits. Therefore, the peak limiter must be disconnected when the terminal is connected to circuits of this type.

### 29. RINGER UNIT.

**a. Theory.** (1) Voice-frequency signaling systems depend for efficient operation upon their ability to transmit and receive signals within the voice range and yet prevent false operation of the ringer equipment by speech currents of the same frequency. Since the voice-frequency ringer is bridged across the line, usually near the switchboard, it is subject to operation by frequencies of the voice which correspond to the signaling frequency. This tendency toward false ringer operation exists at both terminals, since the voice energy may be equal to or greater than the amount of energy required to operate the signaling equipment at either terminal.

(2) To prevent such false operation, some voice-frequency signaling systems are designed to interrupt the 1,000-cycle or 500-cycle signal at approximately a 19-cycle rate. The resulting 19-cycle pulsations of 1,000-cycle energy are of a somewhat longer duration than those caused by the voice and, coupled with a certain amount of delay in the operation of the circuit, constitute a time interval which is required to operate the signal. Since voice currents are usually in the form of pulses of short duration, false operation of the ringer from this source or from the switch-hook clicks or other short line pulses is prevented.

(3) This ringer unit uses an alternate method of preventing interference from voice currents while still incorporating the 19-cycle interruption feature. The receiving circuit of the ringer unit is arranged to pass a band of frequencies in the voice range, but can be operated only by the signaling frequencies since a sharply tuned filter and a negative grid bias on a vacuum tube are associated with a receiving relay. Although the ringer unit will function in the same way with the same sensitivity and freedom from false operation with a continuous 1,000- or 500-cycle signal as with an interrupted 1,000- or 500-cycle signal, the 19-cycle interruption feature is retained to provide for operation on systems using the interrupted type signaling current.

**b. Application.** (1) The ringer unit is a voice-frequency ringer used for signaling over lines

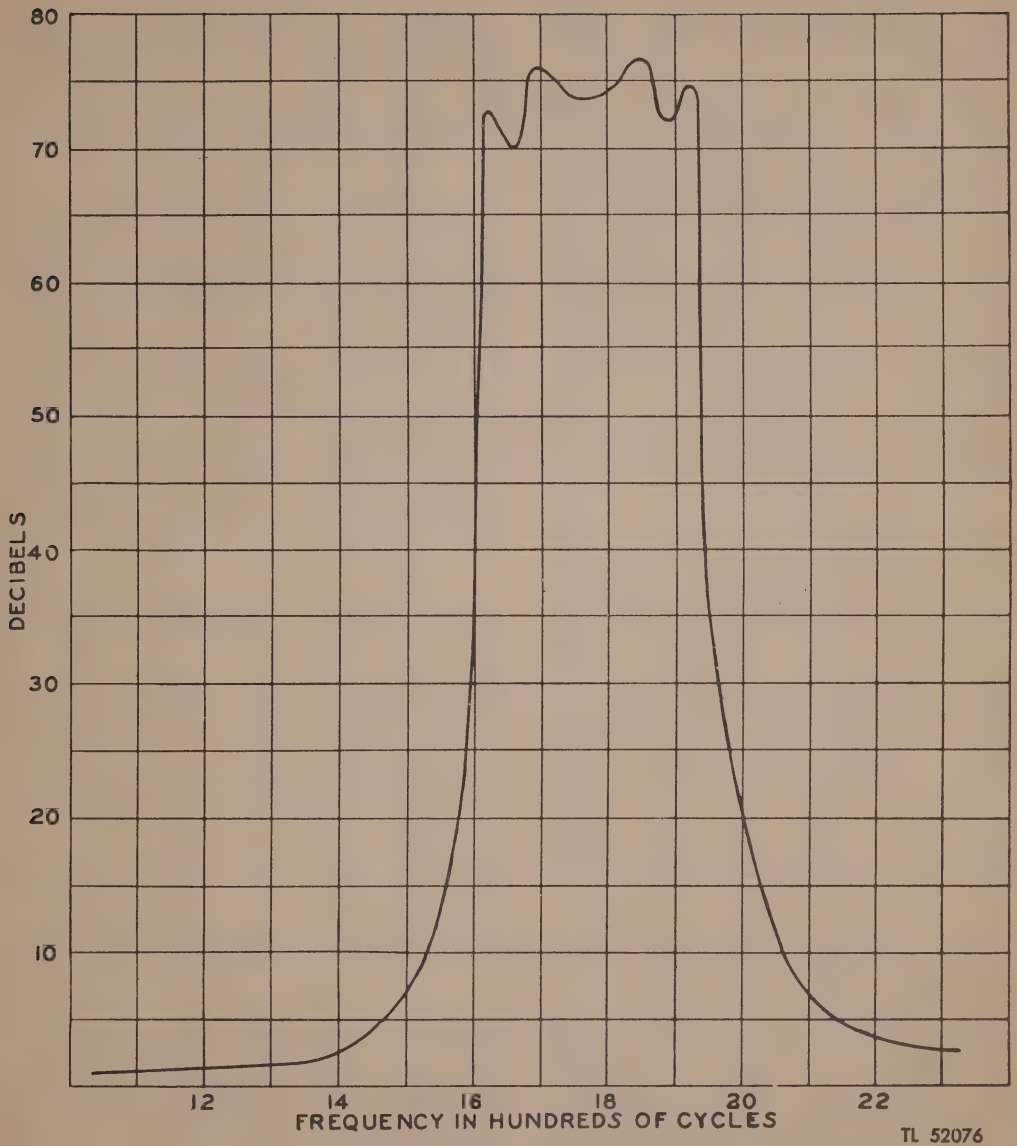



*Figure 27. Band-stop filter attenuation characteristics.*

equipped with telephone repeaters or carrier equipment which prevent, in most cases, the satisfactory operation of low-frequency ringing equipment. The block diagram (fig. 28) shows the connections of the voice-frequency ringer unit as used with Telegraph Terminal TH–1/TCC–1.

(2) The ringer unit consists essentially of two main elements: a sending circuit and a receiving circuit. In its application, the ringer operates to receive the low-frequency signal from the switchboard and translate it to either 1,000 or 500 cycles depending on the position of selector Switch SW–2. The ringer also operates to receive 1,000- or 500-cycle tone and retranslate it to the low-frequency signals to operate the bell or signal at the switchboard. The sending circuit includes a 20-cycle rectifier, a 20-cycle filter, a 1,000-500-cycle oscillator, and a switching relay. The receiving circuit includes a single-stage amplifier, vacuum tube detectors, a 1,000-500-cycle filter, and a 19-cycle vibrator for operating the signal at the terminal.

(3) The ringer is equipped with an OPERATE-NON-OPERATE switch which when thrown to the NON-OPERATE position, shunts the ringer and permits 20-cycle ringing or d-c signaling to be bypassed around the ringer from the switchboard if the peak limiter is disconnected. When the telegraph terminal is used on lines not equipped with telephone repeaters, carrier equipment, or any equipment requiring voice-frequency signaling, throw the OPERATE-NON-OPERATE switch to the NON-OPERATE position. Power for operating the ringer is derived from its associated ringer power supply unit which is connected to the power supply in the telegraph terminal.

**c. Sending Circuit.** (1) To signal on the line, connect a 20-cycle signaling current from the switchboard, magneto, or similar source to the ringer unit terminals 11 and 12. This connects a ringing supply of 1,000/ or 500/ 19 cycles to the line (fig. 28). To simplify the description, figure 28 shows the sending equipment only at one terminal and the receiving equipment at the other terminal. It should be understood, however, that the ringer unit includes both the sending and receiving elements.

(2) The 20-cycle ringing current is rectified by the bridged circuit marked RECTIFIER. The output of the rectifier operates the SEND relay (RB–3) to disconnect the line from the switchboard, to render the receiver circuit inoperative by disconnecting the cathodes of the amplifier tube V1 and detector tube V3 from ground, to connect the oscillator to the line, and to send a tone interrupted at 19 cycles into the line. This tone may be either 1,000 or 500 cycles, depending upon the setting of the 1,000-500 switch (S2). In this description, a 1,000-cycle tone is assumed to be used.

**d. Rectifier Circuit.** The rectifier circuit functions to rectify the low-frequency ringing signal from the switchboard for operating the SEND relay RB–3, thereby connecting the oscillator across the line. The rectifier circuit is shown in simplified form in figure 29. The inductance L3, together with capacitor C5, constitute a 20-cycle filter which offers a low impedance to 20-cycle signaling currents and a comparatively high impedance to frequencies in the voice range. Since the rectifier circuit is always bridged across the line, this high impedance to voice frequencies is necessary to keep the loss to voice currents at a minimum.

**e. Oscillator Circuit.** The oscillator circuit (fig. 30) consists of 1,000/500-cycle oscillator equipment connected to a 19-cycle vibrator in such a way as to interrupt the 1,000- or 500-cycle current at a 19-cycle rate. The 1,000/500-cycle oscillator equipment consists of Tube VT–198–A (6G6–G), designated V5, and a tuned circuit using the primary winding of transformer T2 and sufficient capacity (C9) to tune it to 1,000 or 500 $\pm$20 cycles.

(1) When no signal is being sent over the line, the oscillator is prevented from oscillating by a ground connection to the screen of the oscillator tube through the normally closed contact of the SEND relay RB–3. When relay RB–3 operates in response to 20-cycle ringing current from the switchboard, this ground connection is transferred from the screen of the oscillator tube to the positive side of the d-c path of rectifier 3. This completes a circuit from ground (positive end of rectifier voltage) through the coil of the 19-cycle vibrator to the negative side of the rectifier, thereby starting the vibrator. When the vibrating element makes contact to the left (fig. 30) the grid of oscillator tube V5 is connected to ground through

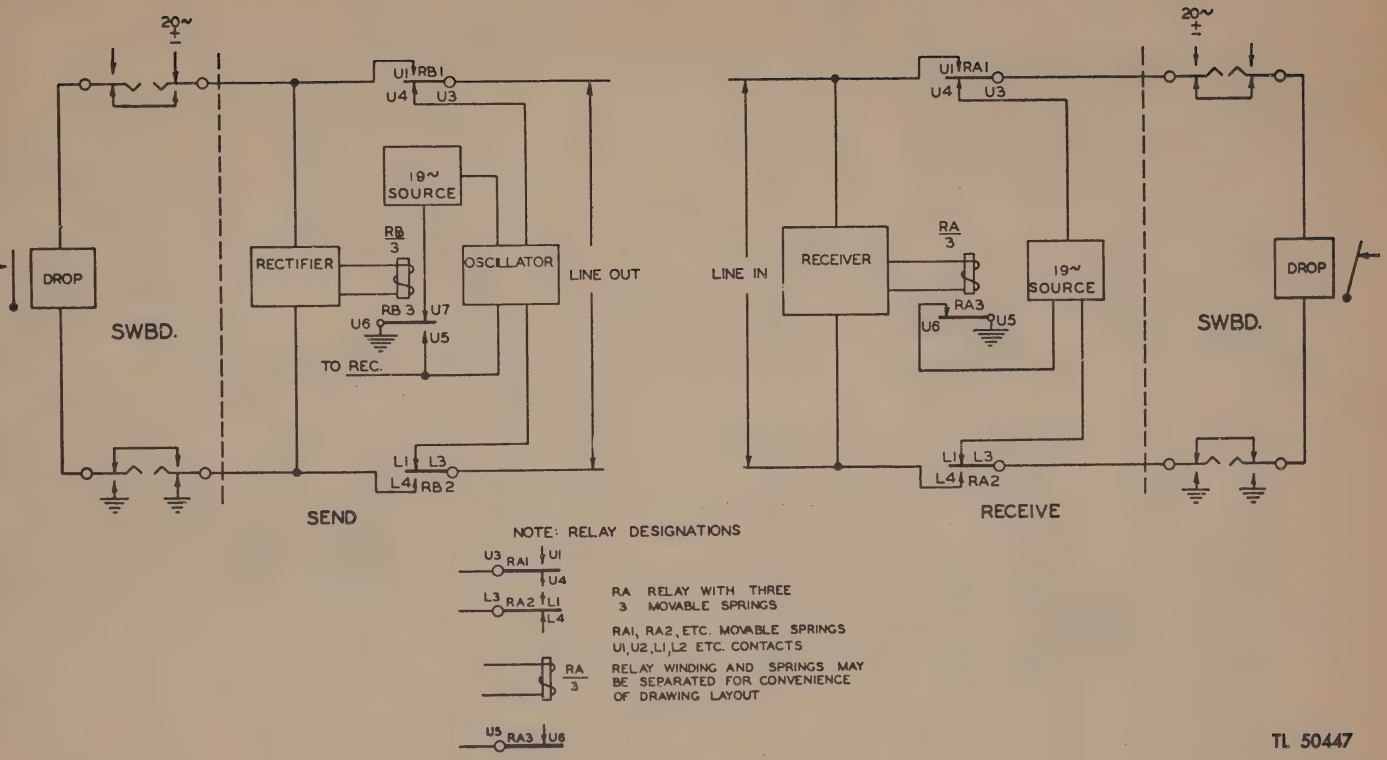



*Figure 28. Ringer unit, block diagram.*

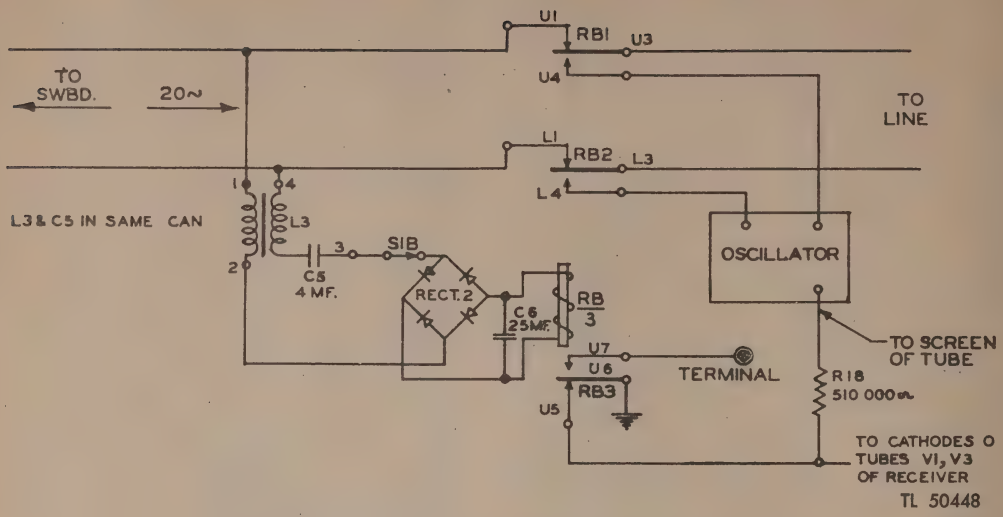



*Figure 29. 20-cycle rectifier, simplified schematic diagram.*

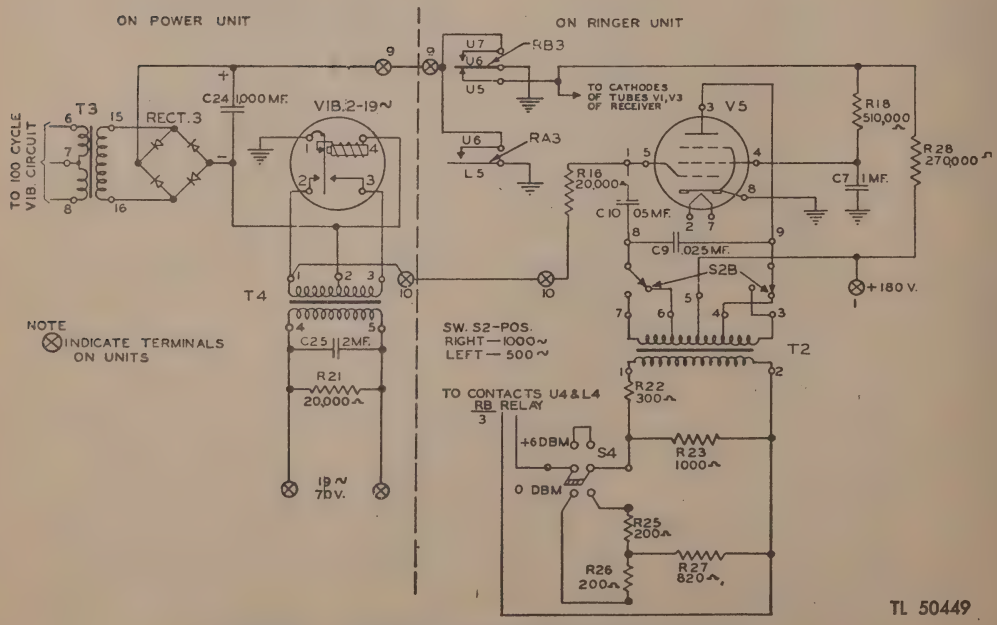



*Figure 30. Oscillator, simplified schematic diagram.*

the vibrator. This causes the tube circuit to oscillate at 1,000 or 500 cycles, as determined by the setting of switch S2. When the vibrating element makes contact to the right, current flows from ground through the vibrator contact, through the winding 3–2 of transformer T4, and to the negative side of rectifier 3, generating a voltage between terminals 1 and 3 of transformer T4. This voltage impresses a larger negative bias on the grid of oscillator tube V5 and stops the circuit from oscillating during the time this contact is made. As a result, 1,000/19-cycle or 500/19-cycle power is furnished at the output winding transformer T2. The operation of the SEND relay RB–3 connects this power to the line through relay contacts U3, U4, and L3, L4, and it is sent over the line to the receiver at the distant end.

(2) The output level or signal strength of the ringer can be adjusted to give either zero dbm (1 milliwatt) or +6 dbm[1] for either the 1,000- or 500-cycle frequency setting. This is done by means of resistance pads inserted between transformer T2 and the line, and connected to switch +6 dbm zero so that the desired parallel or tandem combination of resistors may be connected to the line. The output impedance of the ringer at either the 1,000- or 500-cycle setting is approximately 600 ohms.

**f. Receiving Circuit.** (1) The receiving equipment of the ringer unit is bridged across each end of the 2-wire line (fig. 31). It functions to amplify the weak 1,000/19- or 500/19-cycle incoming signal, filters out extraneous line currents above and below approximately 1,000 or 500 cycles, rectifies the signal, and operates the REC relay RA–3. Relay RA–3, in turn, makes the necessary connection to transmit 19-cycle current to signal the switchboard or telephone. The incoming 1,000/19- or 500/19-cycle current passes into the low side of input transformer T1 which has an input impedance so high that the bridging loss to voice currents is negligible. The voltage of the signal is stepped up by the transformer, and then amplified by tube V1. The two-position OPERATE-NON-OPERATE switch S1 is connected across the secondary of transformer T1, and in the NON-OPERATE position grounds the grid of tube V1, rendering the receiver inoperative during tests.

(2) The output of the amplifier tube is separated into two circuits, A and B. The A circuit carries the 1,000- or 500-cycle tones through a sharply tuned 1,000- or 500-cycle filter to the grid of detector tube V2, and the B circuit carries all other frequencies to the grid of detector tube V3. Because of sharp tuning, the 1,000-or 500-cycle filter is also effective in limiting any 1,000- or 500-cycle current from passing into circuit B. The 1,000- or 500-cycle filter equipment and connections are shown in the complete ringer schematic (fig. 32). Capacitor C7F and resistor R10 form a grid leak rectifier circuit for tube V2. The plates of vacuum tubes V2 and V3 are connected electrically by two fixed resistors R12 and R13, and a potentiometer P1, designated BIAS. This variable resistor P1 can be adjusted with respect to the voltage drops in the plate circuit resistors R12 and R13 so that, with no signal current flowing in the tube circuit, sufficient negative bias is applied to the grid of tube V4 to prevent current from flowing in the plate circuit of tube V4 and, consequently, through the winding of REC relay RA–3. When signaling currents are impressed on the grid of tube V2 the plate current is reduced, causing a decrease in the voltage drop across plate resistor R12. The difference of potential resulting from the difference in voltage drops across R12 and R13 causes the grid of tube V4 to become less negative. Thus, current flows in the plate circuit of tube V4 through the winding of the REC relay RA–3 and operates it. The operation of the contacts of the REC relay RA–3 in the receiving circuit connects a 19-cycle ringing supply to the switchboard or telephone, signaling the operator or attendant. It also disconnects the line from the switchboard during the ringing interval so that ringing current cannot be sent back into the line.

(3) A feedback circuit consisting of capacitor C17 and resistor R7 is connected between the plate circuit of tube V3 and the grid input of tube V2 through the 1,000- or 500-cycle filter. The feedback circuit functions to increase the sensitivity of the ringer to signals within the signaling range and to decrease its sensitivity to signals outside the signal band, thus helping to prevent false ringing. Capacitor C4, bridged

[1] Decibels above or below 1 milliwatt in 600 ohms; positive sign indicates above, negative sign below.

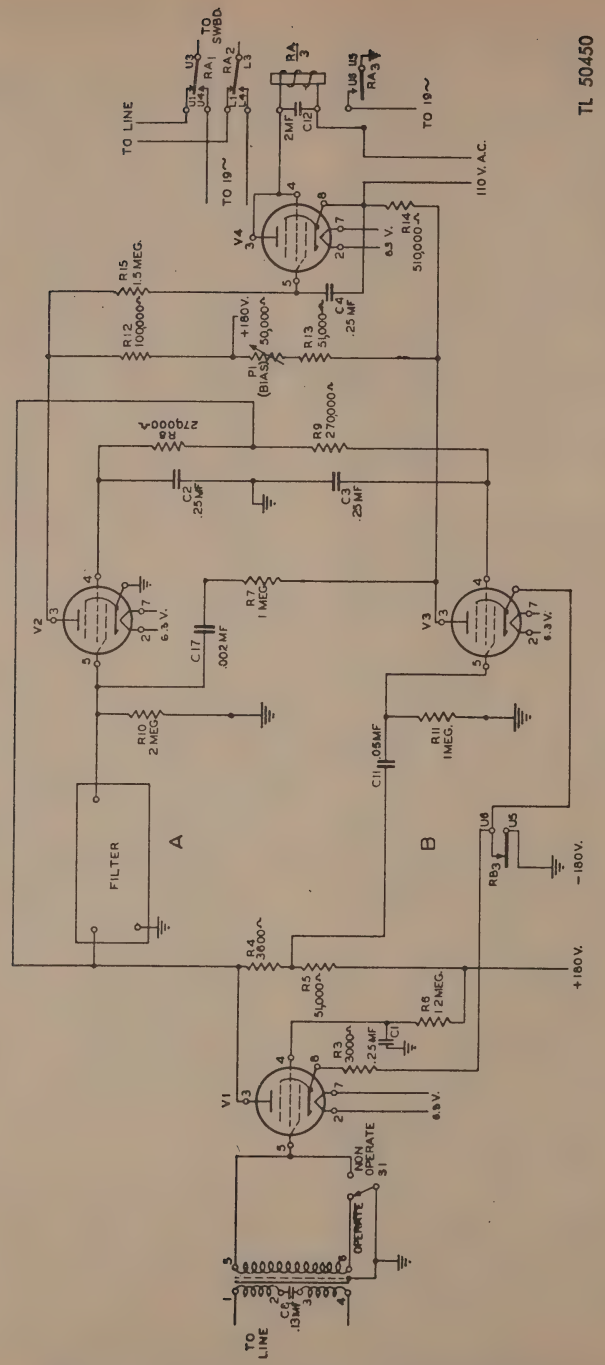



*Figure 31. Receiver, simplified schematic diagram.*

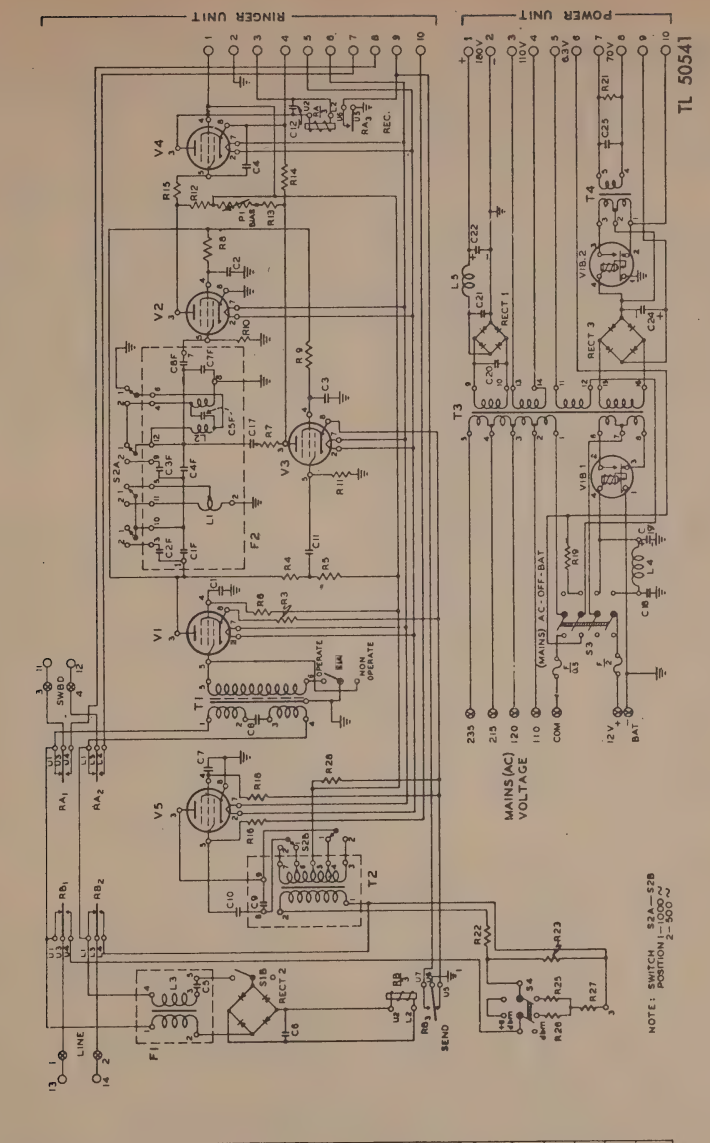



*Figure 32. Ringer unit, complete schematic diagram.*

from grid to cathode of tube V4, together with resistors R14 and R15, provide the required delay in the operation of REC relay RA–3. This delay helps to prevent false operation from speech currents within the frequency range of the ringer.

(4) The function of path B (fig. 31) is to prevent operation of the REC relay RA–3 by frequencies other than 1,000 or 500 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 of tube V3, thereby increasing 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 to operate the REC relay RA–3. Variation of the plate current between tubes makes necessary a different balance point for zero current in the plate circuit of tube V4. The proper balance can be effected by the BIAS potentiometer P1. When a signal is being sent over the line, the receiver circuit is made inoperative to extraneous voltages by removal of the ground connection of the cathodes of tubes V1 and V3 through the contacts of the SEND relay RB–3, which is operated only by 20-cycle current sent out from the terminal.

**g. Power Circuit.** (1) Power for operating the ringer unit is derived from an associated power unit, operated from 60-cycle a-c mains of 100–130 or 200–250 volts, or from a 12-volt storage battery. The power unit supplies +120 volts, with negative grounded, for the plates and screens of vacuum tubes V1, V2, and V3; +180 volts for the plate of tube V5; 110 volts alternating current between the plate and cathode of tube V4; 6.3 volts alternating current for the filaments of all tubes; 19 cycles at 70 volts alternating current for ringing. These voltages are nominal since they depend upon the voltage at the supply source.

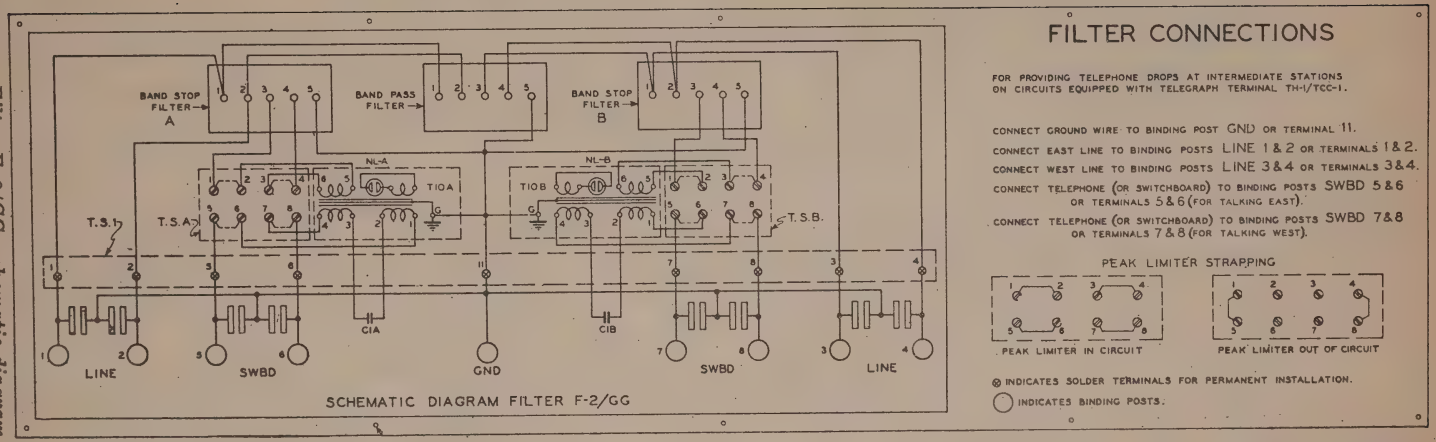
(2) When the a-c mains are used and connected to the power unit terminals corresponding to the local line voltage available, power is connected to the primary of the power transformer through power switch S3 (in position A.C.). This voltage is transformed by the power transformer T3 and is connected to the ringer unit terminals either directly, for those parts of the circuit requiring alternating current or through rectifiers and filters for the required d-c supply to the ringer.

(3) When a 12-volt storage battery is used at the power source and the battery is connected to terminals —12 V and +12 V on the power unit, power is supplied through the BAT. —OFF–A.C. switch S3 (in position BAT.) and a 100-cycle vibrator. The vibrator interrupts the 12-volt supply through a primary winding of power transformer T3, generating an a-c voltage which is stepped up by the transformer to give the required voltage for the operation of the ringer.

### 30. FILTER F–2/GG.

**a.** Filter F–2/GG is used at intermediate points in the line and serves to terminate the telephone channel. It consists of two band-stop and one band-pass filter units. The band-stop filter units effectively block the carrier telegraph frequency band and permit free passage of the remaining voice frequencies. The band-pass filter passes the telegraph frequency band and blocks all other frequencies in the voice range. Two peak limiters control the voltage of the telephone currents. Four sets of protector blocks provide protection for the filter against excessive line voltages. For filter connections, see figure 33.

**b.** Filter F–2/GG is used when termination of a telephone channel is required at an intermediate station on a circuit equipped with Telegraph Terminal TH–1/TCC–1; figure 5 shows the association of lines, terminal sets, and intermediate filters. Carrier telegraph signals of 1,680 and 1,860 cycles are bypassed around the telephone drops at the intermediate station by the band-pass section of the filter. Frequencies outside the 1,680- to 1,860-cycle band are attenuated. Intermediate telephone sets are connected to their respective lines through band-stop sections of the filter. These filter sections suppress any 1,680- and 1,860-cycle frequency components which may be present in the speech currents. This prevents interference to the carrier telegraph by the telephones. The band-stop filter also prevents noticeable crosstalk between the east and west telephone sets at the intermediate station.




TL 52077

*Figure 33. Filter F-2/GG, schematic diagram.*

# SECTION IV
# MAINTENANCE

**NOTE: Failure or unsatisfactory performance of equipment will be reported on W.D., A.G.O. Form No. 468. If this form is not available, see TM 38–250.**

**31. LUBRICATION.**

None required.

**32. SERVICING.**

**a. General.** Be careful in handling the equipment during installation and operation to reduce the possibility of service failures. When replacing or adjusting apparatus on any of the units, do not disturb the wiring more than necessary. In soldering, be careful that no splashes of solder drop on apparatus parts or wiring terminals. Keep all parts, especially contact springs of relays and switches, free from dirt and grease. The relays should not require readjustment normally, and no attempt at readjustments should be made unless trouble is definitely traced to them.

**b. Inspection.** (1) Before placing the telegraph terminal in service, and at regular intervals thereafter, inspect the equipment to insure proper working of parts.

(2) Check to see that all vacuum tubes are firmly seated in their sockets.

(3) Test vacuum tubes at least once a month and replace when necessary. Use Weston Model 685 tube checker or equivalent. When inserting tubes into their sockets, be sure that the key on the base of the tube is aligned with a keyway of the tube socket.

(4) Replace transformers, capacitors, resistors, and switches only as necessary.

(5) To locate trouble in any of the units, swing the front or back equipment assembly out of the outer case as required. This operation is performed by raising the two handles which extend downward from the top of the unit to a horizontal position and then pulling the two handles toward the center of the case and slowly lowering the framework unit which is hinged at the bottom. Catches are provided on the two sides of the framework which engage the large holes in the angle framework inside the case. These catches hold the unit assembly at an angle for inspection purposes. Disengaging the catches permits the units to be lowered to a horizontal position. By releasing the slotted guide pins from their grooves, the entire front or rear assembly can be lifted from the case. When the front or rear assembly is restored to its normal vertical position in the case, push the two handles away from the center and then pull them down to a vertical position. This insures that the panel assemblies are securely locked.

(6) A trouble location and remedy chart is supplied in paragraph 41. Wiring diagrams and interior views of the various units to aid in trouble location are shown in figures 36 through 53.

**33. POLAR RELAY INSPECTION AND CLEANING.**

To inspect and clean the polar relays, follow this procedure:

**a.** Remove the cover from the relay by turning the cover to the left and pulling it forward. To clean the relay cover, invert it and tap on it to loosen the dirt. Then wipe the cover with a clean, dry, lintless cloth.

> NOTE: Do not disturb the setting of the relay contacts or pole pieces unless it is possible to keep the relay out of service for readjustment as outlined in paragraph 34.

**b.** Inspect the contacts. If they are pitted or built up, recondition them by filing. To do this, back up the contact screw on the side where pitting or build-up is present to permit the file (such as Signal Corps Stock No. 6Q37104) to enter easily between the contact and the armature. Insert a tapered stick between the contact springs to prevent damage to them, taking care not to insert the stick far enough to separate the contact springs. Insert the file far enough into the axis of the armature. File the contacts one at a time; be careful to move the file in and out far enough into the axis of the armature. Since the contacts of the armature are made of moderately soft alloy

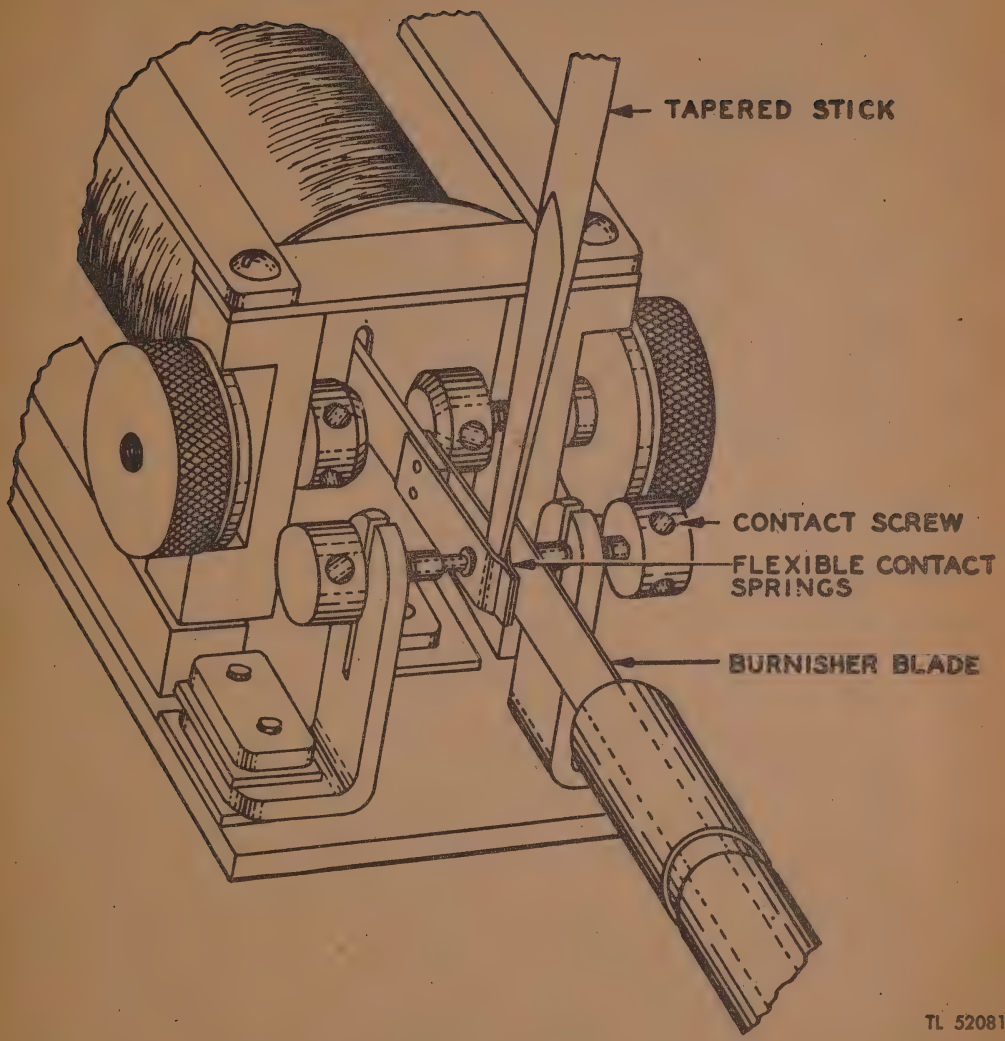



*Figure 34. Method of burnishing polar relay contacts.*

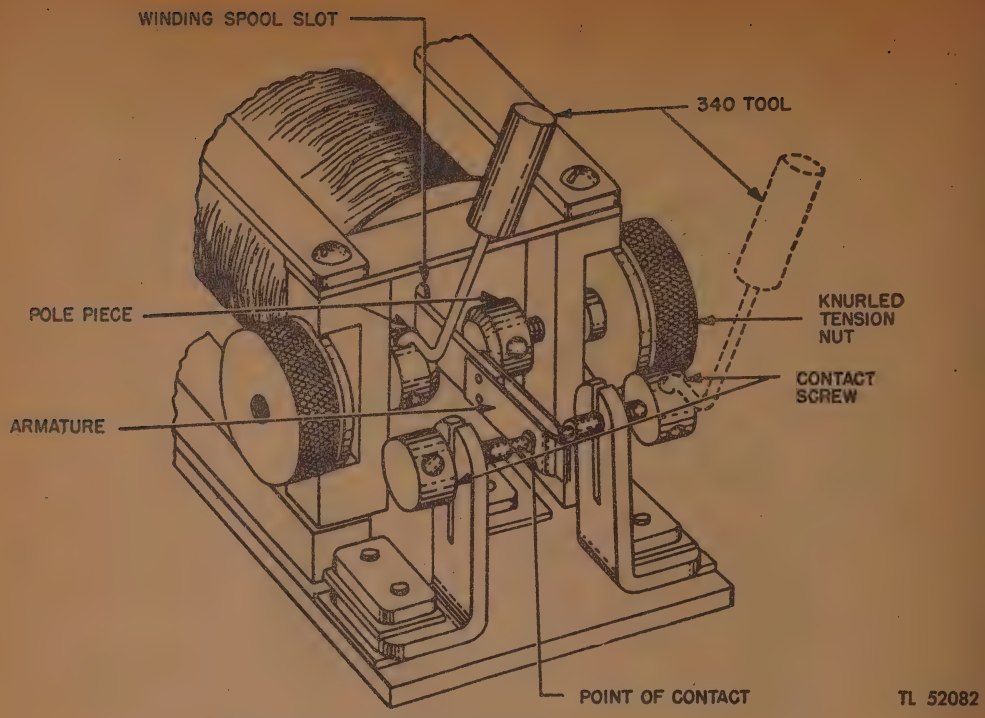



*Figure 35. Method of using 340 tool on polar relay.*

care should be taken not to remove too much material.

c. After filing, burnish the contacts. The blade of the burnisher (such as Signal Corps Stock No. 6R41065C) should not be handled by the fingers and should be cleaned before using with a clean lintless cloth moistened with carbon tetrachloride if available. Move the blade of the burnisher in and out far enough into the surface of the armature (fig. 34).

d. To clean the pole-piece surfaces, loosen the knurled tension nuts on the pole-piece screw as far as they will go with the No. 340 tool (fig. 35). Remove any foreign materials on the pole pieces with a thin piece of metal covered with friction tape by pressing it against the pole piece. Use the tape only once and do not rub the pole piece with it.

## 34. POLAR RELAY TEST AND ADJUSTMENT.

When a relay has been completely reconditioned, or when the relay cannot be made to meet electrical requirements after the inspection and cleaning operations have been made, it is necessary to make readjustments. The polar relays in the telegraph terminal may be adjusted in relay Test Set I–193–A, or in the relay test circuit of Telegraph Terminal CF–2–( ). Complete test and adjustment instructions are furnished with these equipments. When no relay test set is available, the relay may be readjusted according to the procedure given in subparagraph *a* below. If the armature, contact, or pole pieces are not properly aligned, they may be realigned before readjusting the relay, according to the procedure given in subparagraphs *b* through *d* below.

a. **Relay Adjustment.** (1) Loosen the knurled tension nuts and back off the pole-piece screws as far as they will go with the 340 tool. Back off the contact screws on each side several turns. Unfold the 0.005-inch blade in the 74D thickness gauge and place the blade between the front ends of the flexible contact springs of the armature. The gauge should be held in posi-

tion by the tension of the springs. Turn in each contact screw until it *just touches the armature contact.* Remove the 0.005-inch blade and replace it in the 74D thickness gauge. See that the clearance between each contact screw and the armature is approximately the same. Armature travel limits may be checked by using the 0.003-inch and the 0.005-inch blades of the 74D gauge. Before using, clean the blades with a clean lintless cloth moistened with clean carbon tetrachloride. Hold the armature lightly against one contact and check the contact gap. The 0.003-inch blade of the 74D gauge should pass easily between the armature and the contact and the 0.005-inch blade should pass through with pressure. Repeat with the other contact.

(2) Advance the right-hand pole-piece screw with the 340 tool until the pole piece is near the armature. With the fingers tighten the knurled tension nut on the outside end of the pole-piece screw only until a noticeable increase in force on the 340 tool is required to turn the pole-piece screw. Continue to advance the right-hand pole-piece screw with the 340 tool until the armature just touches the left-hand contact screw. Then back off the pole-piece screw more than one-quarter and less than one-half turn. Advance the left-hand pole-piece screw until the pole piece is near the armature, then tighten the tension nut on the left-hand pole-piece screw. Then advance or retract the left-hand pole-piece screw until the armature sticks to each contact when moved there by hand. If this adjustment cannot be obtained, advance the right-hand pole-piece screw one-eighth turn and then advance or retract the left-hand pole-piece screw and attempt to meet the adjustment requirement.

**b. Armature Alignment.** (1) Back off the pole-piece screws as far as they will go. Back off both contact screws several turns with the No. 340 tool. Remove the armature by loosening the screws in the supporting bracket in the armature heel piece. Remove the armature through the winding and spool slot. See that the armature is straight, and that the rivets holding the armature contact springs to the body of the armature are tight. See that there are no irregular projections from the portion of the armature surfaces held by the clamping piece. See that the flexible springs are flat and in contact for at least 25 percent of their width. If these requirements are not met, the armature should be replaced with a new one. Insert the new armature and tighten the screws, being sure that the requirements in subparagraphs *b* and *c* below are met.

(2) Back off the contact screws several turns with the No. 340 tool and check that the armature is held approximately equidistant from the contact screw supporting brackets. See that the armature is centered properly in the spool slot. If the armature is not in the center between the contact supporting brackets, loosen the screws holding the armature heel piece and realign to meet the above requirement. Tighten the screws. If the armature is not centered horizontally in the spool slot, loosen the screws that hold the front and rear spool-heads to the frame of the relay and move the coil to the right or left as required. Tighten the screws. If the armature is not centered vertically in the spool slot, slightly loosen the screws holding the armature to its heel piece and move the armature up or down to bring the stationary screw contacts and the armature contacts in proper alignment. Tighten the screws.

**c. Contact Alignment.** The right and left screw screw contacts should be entirely within the area of the larger (armature) contact. If this requirement is not met, loosen the screws holding the armature to its heel piece and move the armature up or down or to the front or rear to line up with the contacts and still center the armature in the slot. Tighten the screws. If it is impossible to align the contacts in this manner, or if the contact screws are not in line, loosen the screws holding the contact screw bracket to the base of the relay. Then move the bracket until the contacts line up properly. In making these adjustments, it is desirable to set the contact screw brackets so that the contact screws strike the contact on the armature as near to the center as possible. Retighten all the screws.

**d. Pole Piece Alignment.** Right- and left-hand pole-piece screws should be in line and at right angles to the armature. Check with the pole-piece screws advanced near the armature. If they are not in line, loosen the screws on top and bottom. Hold the pole-piece screw support

and move by hand until this requirement is met. Tighten the screws. If the contact screws do not seem to hold adjustment, remove the screws from the bracket and force the split ends of the bracket closer with pliers.

### 35. MONITORING RELAY ADJUSTMENTS.

For proper operation, the relay should be adjusted to the following mechanical specifications:

**a.** The armature gap in the deenergized position should be adjusted to 0.024 ±0.001 inch. To make this adjustment, remove the relay cover. Adjust the left-hand contact screw with a hexagonal wrench or, if none is available, with a screwdriver.

**b.** The contact gap in the deenergized position should be adjusted to 0.003 ±0.0005 inch. To make this adjustment, turn the right-hand contact screw.

**c.** The normal contact pressure should be adjusted to 25 ±1 gram. To make this adjustment, turn the spring located on the bracket extending over the armature. The pressure is measured by a tension gauge No. 70H (Signal Corps Stock No. 6R40870H) or equivalent.

**d.** After these adjustments have been made and checked, replace the relay cover.

> CAUTION: The relay is a delicate instrument. It must be handled very carefully. Avoid touching the spring contact and the armature with the fingers. Moisture and dirt at the relay contacts and on the springs will prevent satisfactory operation. No attempt at readjustment of the relay should be made unless trouble is definitely traced to it.

### 36. RINGER RELAY ADJUSTMENTS.

In case it becomes necessary to adjust either of the ringer relays, proceeds as follows:

**a.** Adjust the air gap between the armature and pole faces to 0.022 ±0.003 inch with the relay in the released position.

**b.** Adjust the air gap between contacts to a minimum of 0.008 inch.

**c.** Check to see that the contacts close before the armature touches the core. Check to see that as the relay releases, the normal break contacts close before the armature reaches its backstop.

**d.** Adjust the contact pressure to a minimum of 20 grams.

### 37. WIRING DIAGRAMS.

**a.** Most wiring diagrams in this manual are of the airline type. They show in a semi-pictorial manner the actual physical arrangement of the equipment as viewed from the wiring side. Each piece of apparatus has the same marking as that stamped on the equipment, and the wiring terminals on each piece of apparatus are shown in their proper relative location as viewed from the wiring side. In addition, each piece of apparatus is assigned an arbitrary identification number. Feed lines, representing the individual wires between terminals of the apparatus, are carried a short distance from the terminals and are terminated in a baseline which runs at right angles to the feed lines. These feed lines are marked with the color of the wire and have a number near the baseline which is the same as the identification number of the piece of apparatus to which the other end of the wire is connected. It is not necessary to trace a connection through the baseline; by noting the color and identification number of the feed line it is possible to move directly to the other end of the wire. When a wire is shielded, color coding is impossible, and in this case, each shielded wire is assigned an identification number. By using this number instead of the color code as is the case with other wires, it is possible to trace the wire as explained below.

**b.** To become more familiar with the airline system, refer to the wiring diagram of the modem unit (fig. 52). To trace the wire from terminal 4 of T1 to pin 5 of V1, first locate T1 on the diagram. Identification number 25 has been assigned to the transformer. The feed line between terminal 4 and the baseline is designated 33 BL. This is a blue wire terminating in a piece of apparatus designated 33. Next find the apparatus numbered 33. A feed line designated BL 25 extends from the base line to pin 5 of the tube socket. This means that the blue wire from 25 is connected to pin 5 of the socket.

Remember that it is not necessary to trace the connection through the baseline; move directly from one piece of apparatus to the other according to the identification numbers on the feed lines.

**c.** In general, wire colors shown on the wiring diagram are followed; occasionally other colors are substituted. For instance, solid colors such as green or blue may be replaced by corresponding colors with white tracers such as green-white and blue-white respectively.

## 38. MOISTUREPROOFING AND FUNGIPROOFING.

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

(1) Resistors, capacitors, coils, chokes, transformer windings, etc., fail.

(2) Electrolytic action takes place in resistors, 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. The treatment involves the use of a moisture- and fungi-resistant varnish applied with a spray gun or brush. Refer to 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.

## 39. STEP-BY-STEP INSTRUCTIONS FOR TREATING TELEGRAPH TERMINAL TH–1/TCC–1.

**a. Preparation.** Make all repairs and adjustments necessary for proper operation of the equipment.

**b. Disassembly.**

(1) Open the front and rear covers of the carrying case.

(2) Remove the two polar relays from the monitoring panel. (These relays are not to be treated. Treatment will impair operation.)

(3) Tilt the monitoring and modem rack assembly out and secure it in the open position. Raise the levers and slide them in towards the center of the rack about 1 inch. This action releases the top of the rack. Tilt the rack out and down. Bracket arms, located at the rear of the rack sides and attached to the retaining pins, provide a means for securing the rack assembly in the open position. Hook these arms into the circular cut-outs in the sides of the main supporting framework.

(4) Remove the small plug-in relay (MON) from the rear of the monitoring panel. (This relay is to be treated.)

(5) Remove the six vacuum tubes from the rear of the modem panel.

(6) Take off the tube compartment covers of the ringer and power supply panels.

(7) Remove the five vacuum tubes and the two vibrators from the ringer panel. (The vibrators are to be treated.)

(8) Remove the six vacuum tubes and the vibrator from the power supply panel. (The vibrator is to be treated.)

(9) Remove the spare parts compartment (not to be treated).

(10) Release the ringer panel from its mounting. Allow it to drop two holes in the rack, and refasten it in this position temporarily. DO NOT DISCONNECT.

(11) Operate the rack release mechanism above the ringer panel, tilt the rack assembly out, and secure it in the open position.

(12) Remove the rear covers from the ringer and power supply panel.

(13) Clean all dirt, dust, rust, fungus, oil, grease, etc., from the equipment to be processed.

**c. Masking.** (1) Mask these items on the front of the ringer panel:

(*a*) The LINE and SWBD binding posts (four in all).

(*b*) The screwdriver adjustment of the BIAS potentiometer.

(*c*) The BAT. and A.C. fuseholder caps.

(*d*) Both switch toggles.

(*e*) The two adjusting screws of the vibrator clamp.

(*f*) The two catches for the tube compartment cover.

(2) Mask or cover these items on the top of the ringer subpanel:

(*a*) Mask the tops of the vibrator sockets and the bearing surfaces of the vibrator clamping plates.

(*b*) Mask the toggle of the S4 switch located behind the two relays.

(*c*) Mask the slotted shaft and the mounting bushing of the S2 selector switch located behind the V4 and V5 vacuum tube sockets.

(*d*) Mask the top of each vacuum tube socket (five in all).

(*e*) With the exception of the soldering lugs, cover the RA–3 and RB–3 relays completely.

(3) Mask or cover these items on the bottom of the ringer subpanel:

(*a*) Mask the locating pin opening in the bottom of each vacuum tube socket.

(*b*) Cover the S2 selector switch completely.

(*c*) Cover the bottoms of the vibrator sockets completely.

(4) Mask or cover these items on the front of the power supply panel:

(*a*) Cover the whole face of the front panel *below* the vacuum tube compartment.

(*b*) Mask the two catches for the vacuum tube compartment cover.

(5) Mask these items on the rear of the power supply panel:

(*a*) The tops of the vibrator and vacuum tube sockets (seven in all).

(*b*) The locating pin opening in the bottom of each vacuum tube socket.

(*c*) The bottom of the vibrator socket.

(*d*) The catches for the rear dust cover.

(6) To provide room for covering the selector switches of the monitoring and modem panels, cut the tie cords of the interpanel cable at the side of the modem panel and remove the monitoring panel from its mounting (do not disconnect). Without placing undue stress on the interpanel cable, separate the monitoring panel from the modem panel just far enough to provide room for covering the three selector switches at the bottom rear of the monitoring panel and the four selector switches at the top rear of the modem panel. After these have been covered, remount the monitoring panel and complete the masking as set forth in the following paragraphs:

(7) Cover the face of the front of the monitoring panel completely.

(8) Mask or cover these items in the rear of the monitoring panel:

(*a*) Mask each of the three potentiometers.

(*b*) Mask the vacuum tube socket provided for the small plug-in type relay.

(*c*) Cover the small jack mounted near the meter.

(*d*) Cover the seven double jacks mounted in a group at one end of the panel, so that their spring contacts are protected and their soldering lugs and insulating spacers are exposed.

(9) Cover the face of the front of the modem panel completely.

(10) Mask these items in the rear of the modem panel:

(*a*) The tops of the vacuum tube sockets and their locating pin openings in the bottoms.

(*b*) The slotted shaft and mounting bushing of the potentiometer mounted at the lower left rear of the unit.

**d. Drying.** Dry the equipment and the removed MON. relay for 4½ to 5½ hours at 135° F. *Do not exceed 135° F.*

**e. Varnish Application.** Apply three coats of Lacquer, Fungus-resistant, Spec. No. 71-2202 (Stock No. 6G1005.3) or equal, as follows:

CAUTION: Do not use varnish containing mercury on this equipment.

(1) Spray all exposed wiring and small parts.

(2) After three spray coats have been applied, remove all masking.

(3) Brush all wires and solder connections which were protected by the masking.

(4) Inspect all wiring, small parts, and terminal strips for coverage. Brush any doubtful point.

(5) Brush the insulating collar at the base of each front panel binding post.

(6) Remove the cover of the MON. relay and brush as much of the relay as possible without impairing its operation. Do not brush plug or spring contacts.

(7) Brush the bases of the removed vibrators. Do not brush the base pins.

(8) Brush the following items on the ringer panel:

(*a*) The tubular electrolytic capacitor C6 located next to the S2 selector switch. Pay particular attention to the sealing of the positive end.

(*b*) The surfaces of the RA–3 and RB–3 relays as completely as possible without impairing their operation. When brushing the spring contact spacers, be very careful not to allow the varnish to enter into the armature hinges.

(9) Seal these portions of the meter on the monitoring panel with a full brush:

(*a*) The joint between the back plate and the meter shell.

(*b*) The heads of the back plate retaining screws.

(*c*) The edge of the meter glass and the zero-set adjustment.

(10) Brush the insulating spacers of the small jack near the meter on the monitoring panel. Do not allow the varnish to run onto the spring contacts.

(11) Pay particular attention to the coverage of the gray shielded wires on the modem panel. Brush these if necessary.

**f. Reassembly.**

(1) Retie the interpanel cable to the side of the modem panel and proceed to reassemble the equipment by reversing the sequence given in subparagraph *a* above.

(2) Subject the equipment to its routine test. Make all necessary repairs and adjustments and rebrush any portion of the protective varnish coat which may have been disturbed.

**g. Marking.** Mark "MFP" and date of treatment.

*Example:* MFP—2 Jan 44.

### 40. STEP-BY-STEP INSTRUCTIONS FOR TREATING FILTER F–2/GG.

**a. Preparation.** Make all repairs and adjustments necessary for proper operation of the equipment.

**b. Disassembly.**

(1) Remove the filter from its carrying case.

(2) Remove the protector caps (four in all).

(3) Clean all dirt, dust, rust, fungus, oil, grease, etc., from the equipment to be processed.

**c. Masking.** Mask or cover the following items:

(1) Cover the face of the front panel.

(2) Mask the terminal strip, leaving the wired side open.

**d. Drying.** Dry the filter for 2 to 3 hours at 160° F. *Do not exceed 160° F.*

**e. Varnish Application.**

CAUTION: Do not use varnish containing mercury on this equipment.

(1) Apply three spray coats of Lacquer, Fungus-resistant, Spec No. 71–2202 (Stock No. 6G1005.3) or equal, to all wires and connections.

(2) Remove all masking, and brush the insulating collars of the binding posts on the front panel.

(3) Brush the bases of the protectors on the front panel.

(4) Brush the edges of the terminal strip.

**f. Reassembly.** Reassemble the equipment and test its operation.

**g. Marking.** Mark "MFP" and the date of treatment.

*Example:* MFP—2 Jan 44.

# SECTION V
# SUPPLEMENTARY DATA

## 41. TROUBLE LOCATION AND REMEDY CHART.

### a. Telegraph Terminal.

| Indication | Probable source of trouble | Suggested test | Remedy |
|---|---|---|---|
| None of the tubes light. | Power cords not plugged in. | Inspect power cords, plugs, and receptacles. | Insert power plugs, in correct voltage source. Replace defective cables, plugs, or receptacles. |
| Do. | Switches incorrectly positioned, or not making proper contacts. | Inspect switches on power supply panel for correct positioning. Check to see whether switches make proper contacts. | Turn switch BAT-OFF-A-C to appropriate position. Turn switch S2, S4, and S5 to positions corresponding to the voltage source used. Adjust switch contacts. |
| | Fuse F1 on power supply blown. | Check fuse. | Replace broken fuse. |
| Power supply tubes light, but tubes in modem panel do not light. | Leads to terminals B1 or B2 broken. | Check d-c continuity and voltage across terminals B1 and B2. If test shows open circuit, check continuity between D7 and B1 and D8 and B2. | Repair broken leads. |
| | Shorted, grounded, or open winding 11–12 on power transformer T1. | Check d-c continuity of this transformer winding. | Replace defective power transformer. |
| Some, but not all tubes light. | Tube filaments are broken. | Use tube checker to determine the defective tube. Note: The filaments of tubes V1 and V2, tubes V4 and V5, and tubes V3 and V6 are in series. If the filament of one of a pair of tubes in series is broken, neither of the pair will light. Both tubes must be checked to determine the defective one. | Replace tube if found to be defective. |
| Meter on Monitor Panel fails to indicate when test on receiver is made in accordance with paragraph 11*b*. | No voltages applied to tubes of modem unit because of defects in power supply: | Check voltages across terminals B3 and B4. Approximately 140 volts should be indicated. | Replace defective items and repair broken leads. |
| | Open switch or grounded power transformer winding 9–10. | Check voltage and d-c resistance across winding 9–10 of power transformer. | Do. |
| | Shorted or leaky capacitors C16 or C3. | Check capacitors C16 or C3 for shorts or grou... | |
| | Open choke CH–1. | Check d-c resistance of choke. | Do. |
| | Leads to modem terminals B4 and B3 from power supply terminals D5 and D4 broken. | Check continuity between terminals D5 and B4 and between D4 and B3. | Do. |

**a. Telegraph Terminal (Cont'd)**

| Indication | Probable source of trouble | Suggested test | Remedy |
|---|---|---|---|
| Meter on monitor panel fails to indicate when test on receiver is made in accordance with paragraph 11*b*. | No voltages exist in screen and plate circuits of tubes in modem unit because of one or more of the following:<br>(1) Open winding 3–4 of transformer T8.<br>(2) Shorted capacitor C109.<br>(3) Grounded resistor R113.<br>(4) Open winding 1–2 of transformer T4.<br>(5) Open resistor R114.<br>(6) Shorted or leaky capacitor C108.<br>(7) Resistor R128 open.<br>(8) Terminal B10 grounded.<br>(9) Broken lead B10 to A19.<br>This fact would be indicated by the presence of screen voltages but no plate voltages on tubes V4 and V5. | Check voltages from plate to cathode and screen to cathode of each tube. If no voltage is found across any of the tubes, test the parts in that circuit for open or ground. | Replace defective items and repair broken leads. |
| | Resistors R2 or R3 in monitor panel open. | Check voltages from plate to cathode and screen to cathode of each tube. If no voltage is found across any of the tubes, test the parts in that circuit for open or ground. | Do. |
| | Windings of receive relay are open or grounded. | | |
| | Leads from B9 to A18 or from B10 to A19 may be open. | | |
| Do. | Grounded, shorted, or open elements in grid circuit. | Check windings of transformers in the grounded circuits of the tubes. | Do. |
| Do. | Defective vacuum tubes. | Check vacuum tubes for open, shorts and low emission. | Do. |
| Do. | Defective vacuum tube sockets. | Check to see whether tubes are properly inserted in sockets. Check for poor contacts. | Do. |
| Polar relay does not meet requirements. | Relay needs readjustment. | Make relay adjustments in accordance with instructions given in paragraph 34. | Do. |
| Meter does not indicate loop current. | Blown +130-volt or −130-volt fuse. | Check suspected parts. | Replace defective parts |

## a. Telegraph Terminal (Cont'd)

| Indication | Probable source of trouble | Suggested test | Remedy |
|---|---|---|---|
| Meter does not indicate loop current. | Loop open or in spacing condition. | Check positions of switches and potentiometers. | Make line and loop adjustments in accordance with instructions given in paragraph 10. |
| Do. | Loop not terminated in proper polarity. | Do. | Do. |
| Do. | Loop wires not properly connected to binding posts. | Do. | Do. |
| Send bias cannot be adjusted to zero. | Station or telegraph switchboard not sending repeated space signal. | Do. | Do. |
| Do. | Large amount of bias in repeated space signal being transmitted from station or switchboard. | Do. | Do. |
| Received current less than 30. | Distant terminal not sending carrier. | Do. | Do. |
| Do. | Distant terminal sending wrong carrier frequency. | Do. | Do. |
| Do. | Distant terminal sending incorrect level. | Do. | Do. |
| Do. | Line trouble. | Do. | Do. |
| Teletypewriter runs open. | Blown +130-volt or −130-volt fuse. REC relay not operated to marking contact. | Do. | Do. |
| Do. | Blown +130 volt or −130 volt fuse.<br>REC. relay not operated to marking contact.<br>Loop circuit is open or in spacing condition. | Do. | Do |
| No voltage across terminals A14–A27 or across A15—A27. | A-c supply may be interrupted (no power supply or blown fuse). Cover switch open, possibly because can cover screws are not tight.<br>Failure of a filter capacitor by short-circuiting.<br>Failure of tube, possibly filament lighted but no emission from tube.<br>Relay RA not operated. | Do. | Do. |

**a. Telegraph Terminal (Cont'd)**

| Indication | Probable source of trouble | Suggested test | Remedy |
|---|---|---|---|
| Low output voltage. | A-c supply voltage may be low.<br>Load current may be too high.<br>Low emission in tube, though still lighted.<br>Regulating circuit may be in trouble. | Check positions of switches and potentiometers.<br><br>Try to raise and lower voltage with TG+ and TG− rheostats. | Make, line and loop adjustments in accordance with instructions given in paragraph 10. |
| | Low reference voltage. | Check positions of switches and potentiometers. | Do. |
| High output voltage. | A-c supply voltage high.<br>Grid emission. Rheostat has no control.<br>Regulating circuit may be in trouble. | Try to change voltage by moving TG+ and TG− rheostats. | |
| Erratic output voltage. | Tube has high firing point or other trouble.<br>Trouble in reference voltage circuit.<br>Loose connections, probably at one of the capacitors | Check positions of switches and potentiometers. | Do. |

**b. Ringer.**

| | | | |
|---|---|---|---|
| Ringer not operating (receiving). | Grounded line. | Check continuity between chassis and binding posts 13 and 14. Test should show open circuit. If ohmmeter shows zero ohms or a low value of resistance, the line is grounded. | Disconnect external line. If meter returns to normal (resistance) the ground is in the line. If meter does not return to normal the ground is in ringer. Inspect binding post mounting strip. Replace if broken. |
| Do. | SEND relay RB-3 contacts dirty, or making poor contact. | Continuity test between line binding post 13 and terminal 14 of transformer T1, should show zero ohms. Continuity test between line binding post 14 and terminal 4 of T1 should show zero ohms. Continuity test from socket terminal 8 of vacuum tube V3 to ground should show zero ohms. If some other value or resistance is shown, poor contact exists between U1 and U3 of RB-1, L1 and L3 of RB-2 and U5 and U6 of RB-3. | Clean and adjust relay contacts |
| Do. | Switch S1A in NON-OPERATE position. | Inspection. | Throw switch in operating position. |
| Do. | Switch S1A defective. | Connect terminals 6 and 7 of transformer T1, i.e., ground terminal 6. If ringer now operates, the switch is defective. | Replace switch S1. |

**b. Ringer (Cont'd)**

| Indication | Probable source of trouble | Suggested test | Remedy |
|---|---|---|---|
| Ringer not operating (receiving). | REC relay RA–3 contacts dirty, or making poor contacts. | Place short across contacts U3 and U4 of RA–1. Place short across contacts L3 and L4 of RA–2. Place short across contacts U6 and U5 of RA–3. If ringer now operates, the contacts are dirty or defective. | Clean and adjust contacts. |
| Do. | Defective transformer T1. | Test winding 1–2 for open or short.<br>Test winding 3–4 for open or short.<br>Test winding 5–6 for open or short. | Replace T1 if defective. |
| Do. | | Check continuity of terminal 7 on transformer T1 to ground. | Solder terminal 7 firmly to ground. |
| No signal. Ringer not functioning (to receive). | None of tubes light. | Check whether a-c plug is properly inserted.<br>Check for correct position of S3.<br>Check fuses.<br>Check continuity between terminals 5 and 6 of power supply. | Insert plug properly.<br>Put S3 in correct position. Replace broken fuses. Replace defective transformer.<br>Connect terminals on power supply to corresponding ringer terminals. |
| Do. | Some tubes do not light. | Check to see whether tubes are properly inserted.<br>Check continuity of tube filaments.<br>Check tube sockets. | Insert tubes properly.<br>Replace tubes having broken filaments.<br>Adjust contacts, replace defective contacts. |
| Do. | Other tube defects:<br>(1) Open elements.<br>(2) Shorted elements.<br>(3) Low emission. | Check tubes (with tube checker). | Replace defective tubes. |
| Do. | Improper bias. | See paragraph 13*a*. | See paragraph 13*a*. |
| Do. | Capacitor C12 is shorted (leak developing across C12 short circuiting relay coil and making it inoperative). | Check capacitor C12 for d-c leakage resistance. Test should show open or very high resistance. | Replace C12 if defective. |
| Do. | Relay coil RA–3 short or open. | Test coil of RA–3 for open or short. With C12 disconnected d-c resistance across coil should be 2,700 ohms. A considerably higher reading shows open circuit. A considerably lower reading shows a short circuit. | Replace if defective. |
| Do. | Incorrect voltages applied to tube and circuit elements. | Check voltages at socket terminals (par. 43*c*). | If any abnormal voltages appear at socket terminals check voltages at power supply terminals 1 to 10. |

**b. Ringer (Cont'd)**

| Indication | Probable source of trouble | Suggested test | Remedy |
|---|---|---|---|
| No signal. Ringer not functioning (to receive). | Broken power supply leads. | Check connections from power supply terminals to ringer terminals for continuity. | Replace any broken or shorted and frayed wires. |
| Do. | Defective power supply elements. | Check voltages at terminals 1 to 10 of power supply. | If any abnormal voltages appear at any terminals, check the circuit elements involved. |
| Do. | Shorted filter capacitors causing sharply reduced voltages to appear at output terminals. | Test C22 for short or open.<br>Test C21 for short or open.<br>Test C20 for short or open.<br>Test C25 for short or open.<br>Test C24 for short or open. | Replace defective capacitor. |
| Do. | Shorted or open transformer T3 windings cause sharply reduced voltages to appear at corresponding output terminals. | Test transformer T3 windings for open or short. | Replace power transformer T3 if defective. |
| Do. | Shorted L5 will cause excessively high voltage to appear at terminals 1–2 of power supply. | Test L5 for short. | Replace L5 if defective. |
| Do. | Open L5 will cause zero volts to appear at terminals 1–2 of power supply. | Test L5 for open. | |
| Do. | Defective 19-cycle vibrator. | Substitute spare vibrator. | Replace defective vibrator. |
| Do. | When ringer is battery operated: 100-cycle vibrator may be defective; capacitors C18 and C19 may be shorted. | Substitute spare vibrator. If trouble disappears 100-cycle vibrator is defective. Check C18 and C19 for open or short. | Replace defective vibrator. Replace capacitors if defective. |
| Do. | Choke L4 may be open. | Check choke L4 for open or short. | Replace if shorted. |
| Do. | Battery fuse (2 amp) may be broken. | Check fuse for continuity. | Replace fuse if broken. |
| Ringer not operating (sending). | Grounded switchboard (SWBD) terminals. | Check from each binding post to ground should show open. Insert binding post mounting strip. | Inspect and remove cause of ground. Replace binding post mounting strip, if broken. |
| Do. | Defective or dirty contacts on RA-1 and RA-3 of receive relay RA-3. | Continuity test between switchboard terminals and corresponding terminals 1 and 4 on 20-cycle filter should show zero ohms. | Clean and adjust relay contacts. |
| Do. | 20-cycle filter open, short or grounded. | Check across terminals 1–2 and 3–4 for open, short, or grounded. | Replace 20-cycle filter if defective. |

## b. Ringer (Cont'd)

| Indication | Probable source of trouble | Suggested test | Remedy |
|---|---|---|---|
| Ringer not operating (sending). | Switch S1 in incorrect (NON-OPERATE) position. | Inspection. | Put switch in OPERATE position. |
| Do. | Switch S1B makes imperfect contact. | Short across switch. If relay operates when signal is sent out at switchboard terminals, the switch is defective. | Replace switch S1. |
| Do. | Shorted C6. | Test C6 for short. | Replace C6 if defective. |
| Do. | Shorted or open relay coil. | Test relay coil for short and open. | Replace relay if coil proves to be defective. |
| Do. | Grounded contact U5 on relay RB–3. | Insert a small piece of paper between contacts U5 and U6 of RB–3. If signal is then removed at line terminals, the contact U5 was grounded. | Adjust contacts of RB–3. |
| Do. | Shorted capacitor C7. | Test C7 for short. | Replace C7 if defective. |
| Do. | Open or shorted C10. | Test C10 for open and short. | Replace C10 if defective. |
| Do. | Switch S2 in incorrect operating position, i.e., S2 set for 1,000-cycle operation but detector at line terminals set for 500-cycle operation, or vice versa. | Inspection. Also check frequency at line terminals if measuring instrument is available. | Place switch in correct position |
| Do. | Switch S2 defective. Improper contact. | For 1,000-cycle operation, place short across transformer T2 8 to 6 and 9 to 4. For 500-cycle operation place short across transformer terminals 8 to 7 and 9 to 3. If ringer operates, the S2 switch is defective. | Replace switch S2. |
| Do. | Defective transformer T2. | Test transformer T2 for short or open circuits across terminals 1–2, 7–3, 6–4, and 8–9. | Replace defective transformer T2. |
| Do. | Open resistors R22, R25, R26. | Test R22, R25, R26 for open circuit. | Replace if defective. |
| Weak signal sent out on line. | Defective vacuum tube. Low emission. | Check vacuum tubes V5. | Replace if defective. |
| Do. | Improper voltages at tube elements. | Check voltage at tube socket terminals. | If appreciable lower (or higher) voltages are observed, further tests are necessary. |
| Do. | Defective oscillator transformer: open or short windings. | Test T4 transformer for open or shorted windings. | Replace T4 if defective. |

**b. Ringer (Cont'd)**

| Indication | Probable source of trouble | Suggested test | Remedy |
|---|---|---|---|
| Weak signal sent out on line. | Shorted R23. | Test R23 for short. | Replace R23 if defective. |
| Do. | Shorted R27. | Test R27 for short. | Replace if defective. |
| Spontaneous signal received at switchboard. Relay RA–3 operated even though no signal is coming over the line. | Incorrect bias applied to V4. | Check bias control setting (par. 13*a*). | Readjust BIAS control (par. 13*a*). |
| Do. | Grounded plate terminal of vacuum tube V1. | Check vacuum tube V1. Check voltages and resistance values from socket terminals to ground. | Replace V1 if defective. |
| Do. | Defective (dead) vacuum tube V1. | Check vacuum tube V1 for open filament, low emission, or shorted elements. Check resistance values and voltages at tube socket terminals. | Replace V1 if defective. |
| Ringer not operating (sending). | Shorted resistors R23 and R27. | Test resistors R23, R27 for short circuits. | Replace R23, R27, if defective. |
| Do. | Switch S4 defective. Improper contacts. | Test for continuity between corresponding switch terminals in the HIGH position. | Replace switch if defective. |
| Do. | Defective or dirty contacts L3–L4 and U3–U4. | Short across L3–L4 and U3–U4. If ringer operates, RB–1 and RB–2 contacts are open. | Clean and adjust contacts. |
| Weak signal received at switchboard. | Shorted R21 resistor. | Check resistance value of R21. | Replace R21 if defective. |
| Do. | Defective connections between terminals 7 and 8 of power supply unit and ringer unit. | Check for continuity between corresponding terminals. Check for short across terminals 7 and 8. | Replace defective leads. |
| Do. | Shorted C25 capacitor. | Test C25 for short or leak. | Replace C25 if leaky. |
| Do. | Defective T4 transformer. | Test winding 4–5 for open or short. Test winding 3–2 and 2–1 for short or open. | Replace T4 transformer if defective. |
| Do. | Shorted or open winding 15–16 of power transformer T3. | Test winding 15–16 for short or open. | Replace T3 if winding is found to be defective. |

### b. Ringer (Cont'd)

| Indication | Probable source of trouble | Suggested test | Remedy |
|---|---|---|---|
| Weak signal received at switchboard. | Shorted or open primary winding or power transformer T3. | Test primary winding for open or short. | |
| Do. | Defective VIB. 2. | Substitute spare vibrator. | Replace if defective. |

## 42. POINT-TO-POINT RESISTANCE CHART.

### a. Power Supply.

| From | Part | To | Part | Resistance (ohms) |
|---|---|---|---|---|
| 4 | T1 | 5 | T1 | 2.2 |
| 5 | T1 | 6 | T1 | 0.025 |
| 7 | T1 | 8 | T1 | 1.25 |
| 1 | T1 | 2 | T1 | 0.09 |
| 2 | T1 | 3 | T1 | 0.09 |
| 9 | T1 | 10 | T1 | 0.0 |
| 11 | T1 | 12 | T1 | 0.6 |
| Across | Choke | CH1 | | 640.0 |
| 19 | T1 | 20 | T1 | 40 |
| 21 | T1 | 22 | T1 | 0.5 |
| 13 | T1 | 14 | T1 | 50 |
| 14 | T1 | 15 | T1 | 56 |
| 23 | T1 | 24 | T1 | 130 |

| From | Part | To | Part | Resistance (ohms) |
|---|---|---|---|---|
| 7 | V1 | 20 | T1 | 42 |
| 5 | V1 | 7 | V2 | 10,000 |
| 2 | V1 | 5 | V1 | 115,000 |
| 3 | V2 | GND | | 275.0 |
| 3 | V3 | GND | | 275.0 |
| 5 | V2 | 21 | T1 | 30,000 |
| 5 | V3 | 22 | T1 | 30,000 |
| 5 | V2 | 5 | V3 | 60,000 |
| 17 | T1 | D3 | | 200.0 |
| 3 | V6 | GND | | 80,000 |
| 3 | V5 | GND | | 75,000 |
| D3 | D9 | | | 80,000 |
| D1 | | D9 | | 80,000 |

### b. Modem Unit.

| From | Part | To | Part | Resistance (ohms) |
|---|---|---|---|---|
| 1 | F1 | 3 | F1 | 10.0 |
| 2 | F1 | 4 | F1 | 10.0 |
| 1 | F1 | 1 | T9 | 50.0 |
| 2 | F1 | 7 | T9 | 42.5 |
| 6 | T9 | 11 | T9 | 85.0 |
| 2 | T9 | 5 | F2 | 26.5 (Note 1.) |
| 4 | T9 | 5 | F2 | 26.0 (Note 1.) |
| 4 | F2 | 1 | T5 | 500.0 (Note 1.) |
| 4 | F2 | 5 | F2 | 500.0 (Note 1.) |
| 4 | F2 | 1 | T1 | 500.0 (Note 1.) |
| 6 | T5 | 3 | T5 | 6,100 |
| 6 | T5 | 5 | T5 | 50.0 |
| 3 | V6 | GND | | (Note 2.) |
| 5 | T6 | 3 | T6 | 35.0 |
| 5 | V6 | 2 | T7 | 270,000 |

| From | Part | To | Part | Resistance (ohms) |
|---|---|---|---|---|
| 8 | V6 | 2 | T7 | 900 |
| 3 | V1 | GND | | (Note 2.) |
| 4 | V1 | GND | | (Note 2.) |
| 5 | V1 | GND | | 2,000,000 |
| 3 | V2 | GND | | 800 |
| 4 | V2 | B4 | T.B. | 20,750 |
| 5 | V2 | GND | | 1,380,000 |
| 8 | V2 | GND | | (Note 2.) |
| 4 | V3 | GND | | 1,150,000 |
| 4 | V4 | B4 | T.B. | 8,000 |
| 5 | V4 | GND | | 6,000,000 |
| 5 | V5 | GND | | 7,500,000 |
| 3 | T4 | 4 | T4 | 250 |
| 7 | T4 | 8 | T4 | 250 |
| 5 | T4 | 6 | T4 | 260 |

Note 1. SEND LEVEL switch in position LOW.
Note 2. Meter kicks over and gradually returns to infinity.

**c. Monitoring Unit.**

| From | To terminal | Control and position | Half-duplex neutral to + Battery | Full duplex neutral to + Battery | Half-duplex neutral to — Battery | Full duplex neutral to — Battery | Polarential | Polar |
|---|---|---|---|---|---|---|---|---|
| SL Binding Post | 3 SEND Relay | SEND LOOP CURRENT Control all in circuit. | 4,000 ohms | 4,000 ohms | 4,200 ohms | 4,200 ohms | 4,000 ohms | 4,000 ohms |
| SL Binding Post | 3 SEND Relay | SEND LOOP CURRENT Control all out of circuit. | 300 ohms | 300 ohms | 600 ohms | 600 ohms | 450 ohms | 450 ohms |
| SL Binding Post | 7 SEND Relay | SEND LOOP CURRENT Control all in circuit. MON. TTY on SEND LOOP. | 4,250 ohms | 4,000 ohms | 3,800 ohms | 3,800 ohms | 5,500 ohms | ∞ |
| SL Binding Post | 7 SEND Relay | SEND LOOP CURRENT Control all out of circuit. MON. TTY on SEND LOOP. | 600 ohms | 600 ohms | 350 ohms | 350 ohms | 2,100 ohms | ∞ |
| SL Binding Post | 7 SEND Relay | SEND LOOP CURRENT Control all in circuit. MON. TTY on SEND CARR and plug in MON-S (BLK) jack. | ∞ | ∞ | ∞ | ∞ | 5,000 ohms | ∞ |
| SL Binding Post | 7 SEND Relay | SEND LOOP CURRENT Control all in circuit. MON. TTY on SEND CARR. | 4,200 ohms | 4,000 ohms | 4,000 ohms | 4,000 ohms | 5,500 ohms | |
| SL Binding Post | 7 SEND Relay | SEND LOOP CURRENT Control all out of circuit. | 600 ohms | 600 ohms | 320 ohms | 320 ohms | 2,100 ohms | ∞ |
| SL Binding Post | 7 SEND Relay | MON. TTY Control on LOCAL OPERATION NEUTRAL. | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| SL Binding Post | 7 SEND Relay | Plug in MON-S (BLK) Jack. MON. TTY switch on SEND LOOP. | 600 ohms | 600 ohms | 350 ohms | 350 ohms | 2,000 ohms | ∞ |
| SL Binding Post | 27 (GND) Terminal Block | SEND LOOP CURRENT Control all in; SEND BIAS on S; MON. TTY Control on SEND LOOP; REC. LOOP CURRENT all in circuit. | 5,700 ohms | 5,800 ohms | 5,800 ohms | 5,800 ohms | 4,800 ohms | 3,800 ohms |

## c. Monitoring Unit (Cont'd)

| From | To terminal | Control and position | Half-duplex neutral to + Battery | Full duplex neutral to + Battery | Half-duplex neutral to — Battery | Full duplex neutral to — Battery | Polarental | Polar |
|---|---|---|---|---|---|---|---|---|
| SL Binding Post | 27 (GND) Terminal Block | SEND LOOP CURRENT all in circuit; SEND BIAS on M; MON. TTY Control on SEND LOOP; REC LOOP CURRENT all in Circuit. | 9,000 ohms | 9,000 ohms | 9,000 ohms | 9,000 ohms | 4,800 ohms | 3,800 ohms |
| SL Binding Post | 27 (GND) Terminal Block | SEND LOOP CURRENT all out; SEND BIAS on M; MON. TTY Control on SEND LOOP; REC LOOP CURRENT all in circuit. | 5,800 ohms | 5,800 ohms | 5,800 ohms | 5,800 ohms | 1,400 ohms | 500 ohms |
| SL Binding Post | 27 (GND) Terminal Block | MON. TTY Control on LOCAL OPERATION NEUTRAL. | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| SL Binding Post | 27 (GND) Terminal Block | PLUG in MON-S (BLK) Jack; MON. TTY Switch on SEND CARR. | ∞ | ∞ | ∞ | ∞ | 4,800 ohms | 4,000 ohms |
| SL Binding Post | 14 Terminal Block | SEND BIAS on S; SEND LOOP CURRENT all in; REC. LOOP CURRENT all in; MON. TTY on SEND LOOP; SEND relay on MARK; REC. relay on SPACE. | 4,000 ohms | 16,000 ohms | 7,800 ohms | 3,800 ohms | 4,800 ohms | 15,000 ohms |
| SL Binding Post | 14 Terminal Block | SEND BIAS on S; SEND LOOP CURRENT all in; REC. LOOP CURRENT all in; MON. TTY on SEND LOOP; SEND relay on SPACE; REC relay on MARK. | 16,000 ohms | 16,000 ohms | 3,800 ohms | 3,800 ohms | 6,800 ohms | 15,000 ohms |
| SL Binding Post | 14 Terminal Block | SEND BIAS on M, SEND LOOP CURRENT all in; REC. LOOP CURRENT all in; MON. TTY on SEND LOOP; SEND Relay on SPACE; REC Relay on MARK. | 18,000 ohms | 18,000 ohms | 4,000 ohms | 4,000 ohms | 6,800 ohms | 15,000 ohms |
| SL Binding Post | 15 Terminal Block | SEND BIAS on S; SEND LOOP CURRENT all in; REC. LOOP CURRENT all in; MON. TTY on SEND LOOP; SEND Relay on MARK; REC Relay on SPACE. | 7,800 ohms | 3,800 ohms | 3,800 ohms | 16,000 ohms | 10,000 ohms | 9,500 ohms |

## c. Monitoring Unit (Cont'd)

| From | To terminal | Control and position | Half-duplex neutral to + Battery | Full duplex neutral to + Battery | Half-duplex neutral to — Battery | Full duplex neutral to — Battery | Polarential | Polar |
|---|---|---|---|---|---|---|---|---|
| SL Binding Post | 15 Terminal Block | SEND BIAS on S; SEND LOOP CURRENT all in; REC. LOOP CURRENT all in; MON. TTY on SEND LOOP; SEND Relay on SPACE; REC Relay on MARK. | 4,000 ohms | 3,800 ohms | 16,000 ohms | 16,000 ohms | 4,500 ohms | 9,500 ohms |
| SL Binding Post | 15 Terminal Block | SEND BIAS on M; SEND LOOP CURRENT all in; REC. LOOP CURRENT all in; MON. TTY on SEND LOOP; SEND Relay on SPACE; REC Relay on MARK. | 3,800 ohms | 3,800 ohms | 19,000 ohms | 19,000 ohms | 4,500 ohms | 12,500 ohms |
| RL Binding Post | 15 Terminal Block | SEND BIAS on S; SEND LOOP CURRENT all in; REC. LOOP CURRENT all in; MON. TTY on SEND LOOP; SEND relay on MARK; REC Relay on SPACE. | 4,500 ohms | 16,000 ohms | 600 ohms | 3,700 ohms | ∞ | 19,000 ohms |
| RL Binding Post | 15 Terminal Block | SEND BIAS on S; SEND LOOP CURRENT all in; REC. LOOP CURRENT all in; MON. TTY on SEND LOOP; SEND Relay on SPACE; REC Relay on MARK. | 13,000 ohms | 3,800 ohms | 600 ohms | 16,000 ohms | ∞ | 3,800 ohms |
| RL Binding Post | 15 Terminal Block | SEND BIAS on M; SEND LOOP CURRENT all in; REC. LOOP CURRENT all in; MON. TTY on SEND LOOP; SEND Relay on SPACE; REC Relay on MARK. | 16,000 ohms | 3,800 ohms | 600 ohms | 1,900 ohms | ∞ | 3,800 ohms |

**d. RINGER.**

| From | Part | To | Part | Control and position | Ohms resistance |
|---|---|---|---|---|---|
| 3 | V–1 | Ground. | Chassis. | RB/3 released (no current). | 324,600 |
| 4 | V–1 | Do. | Do. | Do. | 1,470,000 |
| 5 | V–1 | Do. | Do. | S1A in OPERATE position. | 4,300 |
| 5 | V–1 | Do. | Do. | S1A in NON-OPERATE position. | 0 |
| 8 | V–1 | Do. | Do. | RB/3 released (no current). | 3,000 |
| 3 | V–2 | Do. | Do. | Do. | 370,000 |
| 4 | V–2 | Do. | Do. | Do. | 594,600 |
| 5 | V–2 | Do. | Do. | | 2,000,000 |
| 8 | V–2 | Do. | Do. | | 0 |
| 3 | V–3 | Do. | Do. | P1 set all in. | 371,000 |
| 3 | V–3 | Do. | Do. | P1 set all out. | 321,000 |
| 4 | V–3 | Do. | Do. | RB/3 released (no current). | 594,600 |
| 5 | V–3 | Do. | Do. | | 1,000,000 |
| 8 | V–3 | Do. | Do. | RB/3 released (no current). | 0 |
| 3 | V–4 | | | RB/3 released, P1 all out. | 835,500 |
| 3 | V–4 | Ground. | Chassis. | RB/3 released; P1 all in. | 885,500 |
| 3 | V–4 | 4 | V–4 | | 0 |
| 5 | V–4 | Ground. | Chassis. | RB/3 released. | 1,870,000 |
| 8 | V–4 | Do. | Do. | RB/3 released; P1 all out. | 831,000 |
| 8 | V–4 | Do. | Do. | RB/3 released; P1 all in. | 881,000 |
| 3 | V–5 | Do. | Do. | RB/3 released; S2 in 1,000 position. | 273,000 |
| 3 | V–5 | Do. | Do. | RB/3 released; S2 in 500 position. | 275,000 |
| 4 | V–5 | Do. | Do. | RB/3 released. | 510,000 |
| 5 | V–5 | Terminal 10. | Ringer unit. | Power supply disconnected. | 20,000 |
| 5 | V–5 | Ground. | Chassis. | Power supply connected. | 22,700 |
| 8 | V–5 | Do. | Do. | | 0 |
| Terminal 1. | Ringer unit. | Terminal 2. | Ringer unit. | RB/3 released (no current). | 270,000 |
| 3 | V–2 | 3 | V–3 | P1 all out. | 151,000 |
| 3 | V–2 | 3 | V–3 | P1 all in. | 201,000 |
| 4 | V–2 | 4 | V–3 | | 540,000 |
| Terminal. 4 | Ringer unit. | Ground. | Chassis. | P1 all in. | 881,000 |
| 4 | V–1 | 5 | T–2 | | 1,200,000 |
| 2 | T–2 | 1 | S4 | S4 switch on +0 dbm. | 480 |
| 2 | T–2 | 1 | S4 | S4 switch on 6 dbm. | 245 |
| 3 | Power supply. | 4 | Power supply. | | 20 |
| 5 | Do. | 6 | Power supply. | S3 in a-c position. | 0.5 |
| 5 | Do. | Do. | Do. | S3 in BAT. position. | 2.5 |
| 9 | Do. | Ground. | Chassis. | | 505 |
| 10 | Do. | Do. | Do. | | 200 |
| 9 | Do. | 10 | Do. | | 40 |
| COM. | Do. | 100 –115 | Power supply. | S3 in a-c position. | 48 |
| Do. | Do. | 115 –130 | Do. | Do. | 52 |
| Do. | Do. | 200 –225 | Do. | Do. | 132 |
| Do. | Do. | 225 –250 | Do. | Do. | 150 |
| +12 V | Do. | –12 V | Do. | S3 in BAT. position. | 40 |

## 43. POINT-TO-POINT VOLTAGE CHART.

(Measured with 110 volts, a-c across MAINS terminals and all units connected)

### a. Power Supply.

| From | Part | To | Part | Volts | From | Part | To | Part | Volts |
|---|---|---|---|---|---|---|---|---|---|
| 4 | T1 | 5 | T1 | 107.5 ac | 25 | T1 | 26 | T1 | 13.0 ac |
| 5 | T1 | 6 | T1 | 14.5 ac | 23 | T1 | 24 | T1 | 165.0 ac |
| 7 | T1 | 8 | T1 | 31.5 ac | 7 | V1 | 20 | T1 | 167.5 ac |
| 1 | T1 | 2 | T1 | 9.5 ac | 3 | V1 | GND | | 87.0 ac |
| 2 | T1 | 3 | T1 | 9.5 ac | 2 | V1 | 5 | V1 | 105.0 dc |
| 9 | T1 | 10 | T1 | 205.0 ac | 3 | V2 | GND | | 226.0 ac |
| 11 | T1 | 12 | T1 | 12.5 ac | 3 | V3 | GND | | 213.0 ac |
| Across | Choke | CH1 | | 34.0 dc | 3 | V4 | GND | | 50.0 ac |
| 19 | T1 | 20 | T1 | 167.5 ac | 3 | V5 | GND | | 258.0 ac |
| 21 | T1 | 22 | T1 | 12.0 ac | 3 | V6 | GND | | 266.0 ac |
| 13 | T1 | 14 | T1 | 230.0 ac | D3 | T.B. | D9 | T.B. | −130.0 dc |
| 14 | T1 | 15 | T1 | 222.5 ac | D1 | T.B. | D9 | T.B. | +130.0 dc |
| | | | | | D1 | T.B. | 14 | T1 | 140.0 dc |

### b. Modem Unit.

| From | To | Voltage | | Current | |
|---|---|---|---|---|---|
| | | At −53 db | At −33 db | At −53 db | At −33 db |
| *At 1,860 Cycles.* | | | | | |
| Power supply | | 135 V | 135 V | | |
| Through R115 (AVC) | | | | 0.115 ma | 0.175 ma |
| Terminal 1—Transformer T3 | Terminal 2—Transformer T3 | 0.019 V | 0.022 V | | |
| Terminal 5—Transformer T4 | Terminal 6—Transformer T4 | 12.2 V | 12.5 V | | |
| Terminal 1—Transformer T8 | Terminal 2—Transformer T8 | 25 V | 35.5 V | | |
| Across R115 | | 57 V | 84 V | | |
| Through R125 | | | | 0.042 ma | 0.044 ma |
| Across R125 | | 20 V | 19 V | | |
| Through R126 | | | | 0.047 ma | 0.048 ma |
| Across R126 | | 19 V | 19 V | | |
| Across R134 | | 2 V | 2 V | | |
| Mark | | | | 7.5 ma | 7.7 ma |
| *At 1,680 Cycles.* | | | | | |
| Power supply | | 135 V | 135 V | | |
| Through R115 | | | | 0.115 ma | 0.175 ma |
| Terminal 1—Transformer T3 | Terminal 2—Transformer T3 | 0.021 V | 0.02 V | | |
| Terminal 5—Transformer T4 | Terminal 6—Transformer T4 | 11 V | 11.3 V | | |
| Terminal 1—Transformer T8 | Terminal 2—Transformer T8 | 29.3 V | 40 V | | |

NOTE: 1. Energy fed into line = +3 dbm.

2. Receive level switch on low.

c. Ringer.

| From terminal | Part | To terminal | Part | Control and position | Volts |
|---|---|---|---|---|---|
| 1 | Power supply. | 2 | Power supply. | | 80 D-C |
| 3 | Do. | 4 | Do. | | 110 A-C |
| 5 | Do. | 6 | Do. | | 6.3 A-C |
| 7 | Do. | 8 | Do. | | 70 A-C |
| 9 | Do. | 10 | Do. | No ground on terminal No. 9. | 15.1 A-C |
| 9 | Do. | 10 | Do. | Terminal No. 9 grounded. | 13.1 A-C |
| 2 | V-1 | 7 | V-1 | Switch S3 in a-c position. | 6.3 A-C |
| 2 | V-1 | Ground. | Chassis. | Relay RB/3 not operated. | 108 D-C |
| 4 | V-1 | Do. | Do. | Do. | 36 D-C |
| 5 | V-1 | Do. | Do. | Switch S1 in OPERATE position. | 0 D-C |
| 5 | V-1 | Do. | Do. | Switch S1 in NON-OPERATE position. | 0 D-C |
| Across resistor RA. | | | | | 5.90 D-C |
| 3 | V-1 | 5 | T-2 | | 82 |
| 4 | V-1 | 5 | T-2 | | 146 |
| 3 | V-2 | Ground. | Chassis. | | 25 |
| 4 | V-2 | Do. | Do. | | 19.5 |
| 5 | V-2 | Do. | Do. | | −0.1 |
| 8 | V-2 | Do. | Do. | | 0 |
| 3 | V-2 | 3 | V-3 | Bias control P1 all in. | 102 |
| 3 | V-2 | 3 | V-3 | Bias control P1 all out. | 105 |
| 3 | V-2 | 3 | V-3 | Bias control correctly adjusted. | 112 |
| 4 | V-2 | 4 | V-3 | | 14.5 |
| 3 | V-3 | 12 | 1,000/500 cycle filter | | 140 |
| 3 | V-2 | 5 | V-4 | | 30 |
| 3 | V-3 | Ground. | Chassis. | RB/3 in receiving position (not operated). | 142 |
| 3 | V-3 | 8 | V-4 | | 88 |
| 4 | V-3 | Ground. | Chassis. | | 33 |
| 8 | V-3 | Do. | Do. | RB/3 in receiving position (not operated). | 0 |
| 5 | V-3 | Do. | Do. | | −0.56 |
| 3 | V-4 | Ground. | Chassis. | RB/3 in receiving position (not operated). | 111 |
| 3 | V-4 | 8 | V-4 | | 110 |
| 5 | V-4 | Ground. | Chassis. | RB/3 in receiving position (not operated). | 1.5 |
| 3 | V-4 | 3 | Ringer T. B. | No signal being received. | 0 |
| 3 | V-5 | Ground. | Chassis. | S2B in 1,000 cycle position. | 199 |
| 3 | V-5 | Do. | Do. | S2B in 500 cycle position. | 199 |
| 4 | V-5 | Do. | Do. | RB/3 in receiving position (not operated). | 0 |
| 4 | V-5 | Do. | Do. | RB/3 in sending position (operated). | 11.5 |
| 5 | V-5 | Do. | Do. | RB/3 in receiving position (not operated). | 1 |
| 5 | V-5 | Do. | Do. | RB/3 in sending position (operated). | 26 |
| 8 | V-5 | Do. | Do. | | 0 |

**44. VACUUM TUBE CHARACTERISTICS.**

**a.** Vacuum Tube 6G6–G (VT–198–A) is a power amplifier pentode of the heater-cathode type housed in a glass bulb. Its small-shell, 7-pin base fits the standard octal socket. It may be used as an amplifier, detector, or oscillator.

| *Characteristics* | |
|---|---|
| Heater voltage (ac or dc) | 6.3 v |
| Heater current | 0.15 amp |
| Grid to plate capacitance | 0.50 mmf |
| Input capacitance | 5.5 mmf |
| Output capacitance | 7.0 mmf |

(1) Maximum operating conditions as an amplifier:

| *Characteristic* | *As pentode* | *As triode (screen tied to plate)* |
|---|---|---|
| Plate voltage | 300 max v | 180 max v |
| Screen voltage | 250 max v | |
| Plate dissipation | 2.75 max w | 2.5 max w |
| Screen dissipation | 0.75 max w | |

(2) Typical operation and characteristics as class A amplifier:

| *Characteristic* | *As Pentode* | | *As Triode* |
|---|---|---|---|
| Plate voltage | 135 v | 180 v | 180 v |
| Screen voltage | 135 v | 180 v | |
| Grid voltage | —6 v | —9 v | —12 v |
| Peak a-f grid voltage | 6 v | 9 v | 12 v |
| Amplification factor | | | 9.5 v |
| Plate current (no signal) | 11.5 ma | 15 ma | 11 ma |
| Screen current (no signal) | 2 ma | 2.5 ma | |
| Plate resistance | 0.170 megohms | 0.175 megohms | 4,750 ohms |
| Transconductance | 2,100 μmhos | 2,300 μmhos | 2,000 μmhos |
| Load resistance | 12,000 ohms | 10,000 ohms | 12,000 ohms |
| Total harmonic distortion | 7.5% | 10% | 5% |
| Max signal power output | 0.6 w | 1.1 w | 0.25 w |

**b.** Tube 0C3/VR–105 (VT–200) is a gas-filled voltage regulator having a glow-discharge type cathode. It is housed in a glass envelope. The base is of the small-shell, octal, 6-pin phenolic type.

(1) Operating conditions:

| | |
|---|---|
| Starting supply voltage | 127 (min) d-c v |
| Operating voltage | 105 (approx) d-c v |
| Operating current | 5 (min) d-c ma |
| | 10 (max) d-c ma |

(2) Socket connections (bottom view) (fig. 36).

*Note:* Pins 3 and 7 are tied internally by the jumper. With suitable socket connections, the jumper acts as a switch to open power supply circuit when the voltage regulator tube is removed from socket.

**c.** Tube 2050 is a gas tetrode of the hot-cathode type designed for grid controlled rectifier service. The base is of the small-shell type. It has eight pins and fits into a standard octal socket (fig. 36).

(1) *Characteristics:*

| | |
|---|---|
| Heater voltage (ac or dc) | 6.3 v |
| Heater current | 0.6 amp |
| Grid to anode capacitance | 0.2 mmf |
| Heating time | 10 seconds (min) |

*Note:* The heater voltage should be applied at least 10 seconds before current is drawn.

(2) Typical operation as a grid controlled rectifier:

| | |
|---|---|
| Peak forward anode voltage | 650 max v |
| Peak inverse anode voltage | 1,300 max v |

| | |
|---|---|
| Shield grid (grid No. 2) voltage | 0 v |
| Peak anode current | 500 max ma |
| Average anode current (over 30 seconds max) | 140 max ma |
| Tube voltage drop | 8 ma |
| Grid resistor | 0.01 megohm (min)<br>10 megohm (max) |

*Note:* The grid resistor must be placed directly at the socket terminal to make the grid to anode capacitance as small as possible. Connect pins 4 and 8 together at the socket.

(3) For socket connections (bottom view) see figure 36.

## 45. VACUUM TUBE SOCKET CONNECTIONS.

The vacuum tube socket connections for the tubes used in Telegraph Terminal TH–1/TCC–1 are shown in figure 36.

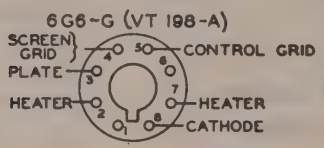



TABLE OF EXTERNAL CONNECTIONS

MODEM UNIT

| | V1 | V2 | V3 | V4 | V5 | V6 |
|---|---|---|---|---|---|---|
| TERM 1 | | | | | | |
| 2 | | | | | | |
| 3 | 4 ON T2 | 2 ON T8 | 2 ON T4 | TERM. 3 MON. REL. | TERM. 2 REC. REL. | 1 ON T8 |
| 4 | C 105 R110 | 4 ON T8 | C 108 R114 | MIDPOINT R2, R3 | MIDPOINT R2, R3 | + BAT. OSC. |
| 5 | 5 ON T1 | 5 ON T3 | 5 ON T8 | C125 R124 | C126 R127 | R112 |
| 6 | | | | | | |
| 7 | | | | | | |
| 8 | GND. | GND. | GND. | GND. | GND. | R133 |

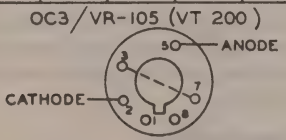



TABLE OF EXTERNAL CONNECTIONS

POWER SUPPLY UNIT

| | V1 | V4 |
|---|---|---|
| TERM 1 | | |
| 2 | RECT-1 | RECT-2 |
| 3 | RECT.-1 | RECT-2 |
| 4 | | |
| 5 | MIDPOINT R1, R23 | MIDPOINT R2, R24 |
| 6 | | |
| 7 | 18 ON T1 | 24 ON T1 |
| 8 | | |

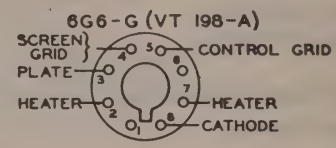



TABLE OF EXTERNAL CONNECTIONS

TA-3 FT RINGER

| | V1 | V2 | V3 | V4 | V5 | |
|---|---|---|---|---|---|---|
| TERM 1 | | | | | | |
| 2 | RINGER TERM. 5 | RINGER TERM. 5 | RINGER TERM. 5 | RINGER TERM. 5 | RINGER TERM. 5 | |
| 3 | R4 | R12, R15 | R13, R14 | 2 ON RA C12 | 11 ON 328 9 ON T2 | |
| 4 | R6, C1 | C2, R8 | C3, R9 | 3 ON V4 | C7, R18 | |
| 5 | 5 ON T1 6 ON S1 | 7 ON F2 R10 | R11, C11 | C4, R15 | R16, C10 | |
| 6 | | | | | | |
| 7 | RINGER TERM. 6 | RINGER TERM. 6 | RINGER TERM. 6 | RINGER TERM. 6 | RINGER TERM. 6 | |
| 8 | R3 | GND. | 5 ON R8 | R14, C4 | GND. | |

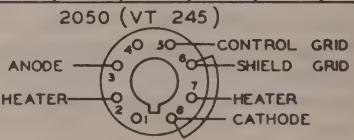



TABLE OF EXTERNAL CONNECTIONS

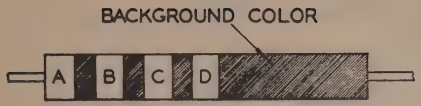
POWER SUPPLY UNIT

| | V2 | V3 | V5 | V6 |
|---|---|---|---|---|
| TERM 1 | | | | |
| 2 | FILAMENT SUPPLY | FILAMENT SUPPLY | FILAMENT SUPPLY | FILAMENT SUPPLY |
| 3 | RFC-1 | RFC-1 | RFC-2 | RFC-2 |
| 4 | | | | |
| 5 | C4 | C5 | C7 | C8 |
| 6 | | | | |
| 7 | FILAMENT SUPPLY | FILAMENT SUPPLY | FILAMENT SUPPLY | FILAMENT SUPPLY |
| 8 | CONTACT U3 ON RA | CONTACT U3 ON RA | CONTACT L3 ON RA | CONTACT L3 ON RA |

TL 52087

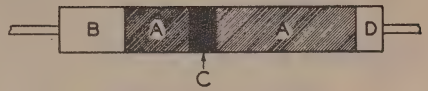
*Figure 36. Vacuum tube socket wiring diagram.*

# RMA COLOR CODE FOR RESISTORS



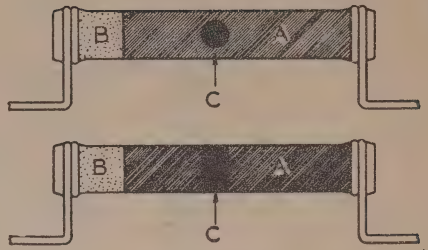

METHOD I

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.




| 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.

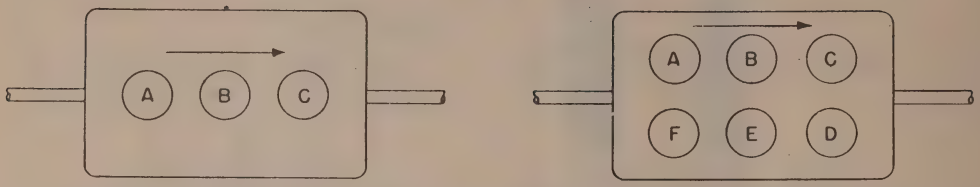
COLOR B GIVES SECOND FIGURE OF RESISTOR VALUE.

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.

TL 50455

## 47. CAPACITOR COLOR CODE.




| ONE ROW DOTS | COLOR | TWO ROWS OF DOTS |
|---|---|---|
| DOT A | INDICATES FIRST SIGNIFICANT FIGURE OF CAPACITANCE VALUE IN MICROMICROFARADS | DOT A |
| DOT B | INDICATES SECOND SIGNIFICANT FIGURE | DOT B |
| | INDICATES THIRD SIGNIFICANT FIGURE | DOT C |
| DOT C | INDICATES MULTIPLIER | DOT D |
| USUAL TOLERANCE ±20% | INDICATES TOLERANCE IN PER CENT OF THE NOMINAL CAPACITANCE VALUE. IF NO COLOR APPEARS TOLERANCE IS 20% | DOT E |
| RATED VOLTAGE USUALLY 500 VOLTS | INDICATES THE RATED VOLTAGE | DOT F |

| COLOR | SIGNIFICANT FIGURE | MULTIPLIER | TOLERANCE PER CENT (IF GIVEN) | RATED VOLTAGE (IF GIVEN) |
|---|---|---|---|---|
| BLACK | 0 | 1 | | |
| BROWN | 1 | 10 | 1 | 100 |
| RED | 2 | 100 | 2 | 200 |
| ORANGE | 3 | 1000 | 3 | 300 |
| YELLOW | 4 | 10,000 | 4 | 400 |
| GREEN | 5 | 100,000 | 5 | 500 |
| BLUE | 6 | 1,000,000 | 6 | 600 |
| VIOLET | 7 | 10,000,000 | 7 | 700 |
| GRAY | 8 | 100,000,000 | 8 | 800 |
| WHITE | 9 | 1,000,000,000 | 9 | 900 |
| GOLD | | 0.1 | 5 | 1,000 |
| SILVER | | 0.01 | 10 | 2,000 |
| NO COLOR | | | 20 | 500 |

TL 35619

## 48. MAINTENANCE PARTS LIST FOR TELEGRAPH TERMINAL TH–1/TCC–1.

| Reference symbol | Signal Corps stock No. | Name of part and description | Quantity per unit | Mfrs part and code No. | | †Station stock | †Region stock |
|---|---|---|---|---|---|---|---|
| | 4A2895 | TELEGRAPH TERMINAL TH-1/TCC-1 | | | | | |
| | | RINGER UNIT | | | | | |
| | 3Z246A1 | BINDING POST: rubber-covered; 5/16" stem; No. 8-32 thread; tumble nickel-finish; knurled base. | 4 | W27-2 | (F1) | | * |
| C1, 2, 3 | 3DA250-99 | CAPACITOR: paper; 0.25-mf (3 sections); 500 v dc (working). | 1 | | (A57) | | * |
| C4 | 3DA250-98 | CAPACITOR: paper; 0.25-mf, 500 v dc (working). | 1 | | (A57) | | * |
| C6 | 3DB25-14.1 | CAPACITOR: electrolytic; 25-mf, 25 v dc (working). | 1 | PAS-25 | (A1) | | * |
| C7, 10 | 3DB1.1874 | CAPACITOR: paper; 1-mf + 0.05-mf, 500 v dc (working). | 1 | | (A57) | | * |
| C8 | 3DA130-6 | CAPACITOR: paper; 0.13-mf, 500 v dc (working). | 1 | | (A57) | | * |
| C11 | 3DA50-39 | CAPACITOR: paper; 0.05-mf, 500 v dc (working). | 1 | | (A57) | | * |
| C12 | 3DB2.68 | CAPACITOR: paper; 2-mf, 500 v dc (working); lugs on top and bottom. | 1 | | (A57) | | * |
| C17 | 3DA2-130 | CAPACITOR: mica; 0.002-mf, 500 v dc (working). | 1 | 1462 | (A1) | | * |
| C18 | 3DA50-113.1 | CAPACITOR: paper; 0.05-mf, 400 v dc (working). | 1 | XTM6 | (A1) | | * |
| C19, 24 | 3DB1000-7 | CAPACITOR: electrolytic; 1,000-mf, 25 v dc (working). | 2 | AF | (A1) | * | * |
| C20 | 3DA100-101 | CAPACITOR: paper; 0.1-mf, 1,000 v dc (working). | 1 | | (A57) | | * |
| C21, 25 | 3DB2.6200-6 | CAPACITOR: paper; 2-mf, 500 v dc (working); lugs on sides. | 2 | | (A57) | | * |
| C22 | 3DB25-37 | CAPACITOR: electrolytic; 25-mf, 300 v dc (working). | 1 | EP#9 | (A1) | | * |
| L4 | 3C315-52 | CHOKE: filter; 400-mh inductance; 1.8-ohm d-c resistance. | 1 | W12-10 | (F1) | | * |
| L5 | 3C315-23 | CHOKE: filter; 9,300 mh; 120-ohm d-c resistance. | 1 | W12-8 | (F1) | | * |
| 21 | 3E4390-7 | CORD: 6'; 2-conductor; No. 18 stranded, 16 strands, 0.01" copper wire; rubber-covered type SJ with Hubbell plug No. 9972 on one end. | 1 | W93-16 | (F1) | | * |
| F1 | 3Z1891-15.3 | FILTER ASSEMBLY: 20 cps; includes transformer, 1:1 ratio, 2,500 turns, No. 36 gauge; two capacitors, paper, 2-mf, 500 v dc (working). | 1 | W12-12 | (F1) | | * |
| F2 | 3Z1891-15.4 | FILTER ASSEMBLY: 1,000/500 cps; includes L1 (ct), 6.5 h, 243-ohm d-c resistance, 4.5 h, 67-ohm d-c resistance; L2, 2 windings ea 0.4 h, 36-ohm d-c resistance; C1F, 0.005-mf; C2F, 0.01-mf; C3F, C4F, 0.001-mf; C5F, 0.0045-mf; C7F, C8F, 0.063-mf. | 1 | W12-11 | (F1) | | * |
| F/2 | 3Z1927 | FUSE: 2-amp, 250 v; nonrenewable. | 1 | 3AG2 | (B9) | | * |
| F/.5 | 3Z1946 | FUSE: ½-amp, 250 v; nonrenewable. | 1 | 3AG½ | (B9) | | * |
| P1 | 2ZK7263-14 | POTENTIOMETER: variable; 50,000-ohm. | 1 | J | (A5) | | * |
| Rect. 1 | 3H4856-6 | RECTIFIER: selenium; dry-disk; 180-v output. | 1 | 22DO815 | (F1) | | * |
| Rect. 2 | 3H4856-5 | RECTIFIER: selenium; dry-disk; 14-ma @ 8-v output. | 1 | 22DO814 | (F1) | | * |
| Rect. 3 | 3H4856-7 | RECTIFIER: selenium; dry-disk; 12.52-v output. | 1 | 3DO816 | (F1) | | * |

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## 48. MAINTENANCE PARTS LIST FOR TELEGRAPH TERMINAL TH–1/TCC–1 (Cont'd).

| Reference symbol | Signal Corps stock No. | Name of part and description | Quantity per unit | Mfrs part and code No. | †Station stock | †Region stock |
|---|---|---|---|---|---|---|
| RA/3 | 4C7820-1068 | RELAY: 2 sets break-before-make contacts; 1 set make contacts; coil, 2,700-ohm, 7-ma. | 1 | UR-1068 (F1) | | * |
| RB/3 | 4C7820-1066 | RELAY: 3 sets break-before-make contacts; coil, 620-ohm, 14-ma. | 1 | UR-1066 (F1) | | * |
| R3 | 3RC20BE302J | RESISTOR: 3,000-ohm ± 5%, ½-w; carbon. | 1 | EB (A5) | | * |
| R4 | 3RC20BE362J | RESISTOR: 3,600-ohm, ½-w; carbon. | 1 | EB (A5) | | * |
| R5, 13 | 3RC20BE513J | RESISTOR: 51,000-ohm ± 5%, ½-w; carbon. | 2 | EB (A5) | | * |
| R6 | 3RC20BE125J | RESISTOR: 1.2-megohm ± 5%, ½-w; carbon. | 1 | EB (A5) | | * |
| R7, 11 | 3RC20BE105J | RESISTOR: 1-megohm ± 5%, ½-w; carbon. | 2 | EB (A5) | | * |
| R8, 9, 28 | 3RC20BE274J | RESISTOR: 270,000-ohm ± 5%, ½-w; carbon. | 3 | EB (A5) | | * |
| R10 | 3RC20BE205J | RESISTOR: 2-megohm ± 5%, ½-w; carbon. | 1 | EB (A5) | | * |
| R12 | 3Z6700-61 | RESISTOR: 100,000-ohm, ½-w; carbon. | 1 | EB (A5) | | * |
| R14, 18 | 3RC20BE514J | RESISTOR: 510,000-ohm ± 5%, ½-w; carbon. | 2 | EB (A5) | | * |
| R15 | 3RC20BE155J | RESISTOR: 1.5-megohm ± 5%, ½-w; carbon. | 1 | EB (A5) | | * |
| R16 | 3RC20BE203J | RESISTOR: 20,000-ohm, ½-w; carbon. | 1 | EB (A5) | | * |
| R19 | 3Z5991-54 | RESISTOR: 1.6-ohm ± 5%, 2-w; wire-wound. | 1 | BW (I2) | | * |
| R21 | 3ZK6620-80 | RESISTOR: 20,000-ohm, 1-w; carbon. | 1 | GB (A5) | | * |
| R22 | 3RC20BE301J | RESISTOR: 300-ohm ± ½-w. | 1 | EB (A5) | | * |
| R23 | 3RC20BE102J | RESISTOR: 1,000-ohm ± 5%, ½-w. | 1 | EB (A5) | | * |
| R25, 26 | 3RC20BE201J | RESISTOR: 200-ohm ± 5%, ½-w; carbon. | 2 | EB (A5) | | * |
| R27 | 3RC20BE821J | RESISTOR: 820-ohm ± 5%, ½-w; carbon. | 1 | EB (A5) | | * |
| | 2Z8674.93 | SOCKET: vibrator; 4-prong; standard; molded in steel plate. | 1 | M1P4H (A13) | | * |
| 27 | 2Z8654.7 | SOCKET: tube; octal; mica-filled bakelite. | 5 | S8TM (A13) | * | * |
| 28 | 2Z8674.72 | SOCKET: vibrator; 4-prong; laminated bakelite. | 1 | 2164 (C6) | | * |
| S1, 4 | 3Z8401 | SWITCH: toggle; DPDT. | 2 | 8363 (C18) | | * |
| S2 | 3Z9550.44 | SWITCH: rotary; 6-pole; 2-position. | 1 | H (O1) | | * |
| S3 | 3Z9858-8.76 | SWITCH: 4PDT and neutral position. | 1 | 27947-1 (A17) | | * |
| T1 | 2Z9631.118 | TRANSFORMER: onput; 2 pri 50-ohm ea; 1 sec 1,250-ohm. | 1 | W15-45 (F1) | | * |
| T2 | 2Z9638-20 | TRANSFORMER: pri 830-ohm d-c resistance, 4.32-h inductance, tapped at 184 ohms, 192 ohms, 211 ohms, and 244.5 ohms; sec 25.6-ohm d-c resistance, 17.6-mh inductance; output impedance 600 ohms @ 1,000 cps, 500 ohms @ 500 cps. | 1 | W15-48 (F1) | | * |
| T3 | 2Z9602-11 | TRANSFORMER: power; pri No. 1: tapped 100-115 v, 115-130 v, 200-225 v, and 225-230 v; pri No. 2: 12-v vibrator input; sec No. 1: 120 v @ 102 ma; sec No. 2: 7.5 v @ 750 ma; sec No. 3: 175 v @ 10 ma; sec No. 4: 10.5 v @ 500 ma. | 1 | W15-47 (F1) | | * |
| T4 | 2Z9621-57 | TRANSFORMER: 19 cps; pri 16 v no load, 11-ohm, ct; sec 60 v no load, 103.6-ohm. | 1 | W15-46 (F1) | | * |
| V1, 2, 3, 4, 5 | 2J6G6-G | TUBE JAN-6G6-G. | 5 | 6G6-G (R2) | * | * |
| V1B-1 | 3H6694-13 | VIBRATOR: 100 cps; 12-v; non-synchronous. | 1 | V6197-18KS (O1) | | * |

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## 48. MAINTENANCE PARTS LIST FOR TELEGRAPH TERMINAL TH–1/TCC–1 (Cont'd).

| Reference symbol | Signal Corps stock No. | Name of part and description | Quantity per unit | Mfrs part and code No. | | †Station stock | †Region stock |
|---|---|---|---|---|---|---|---|
| VIB-2 | 3H6694-12 | VIBRATOR: 19 cps; 12-v; non-synchronous. | 1 | 6260 | (O1) | | * |
| 31 | 2Z2727-12 | VIBRATOR CLIP. | 1 | M1P4H | (A13) | | * |
| | | MONITORING UNIT | | | | | |
| | 3Z246A.1 | BINDING POST: rubber-covered; 9/16″ stem; No. 8-32 thread; tumble nickel-finish; knurled base. | 6 | W27-2 | (F1) | * | * |
| P1 to P6 | 4E926 | BLOCK: protector; carbon. | 6 | 26 | (W5) | * | * |
| P7 to P12 | 4E927 | BLOCK: protector; porcelain. | 6 | 27 | (W5) | * | * |
| C1 | 3DA500-196 | CAPACITOR: paper; 0.5-mf, 500 v dc (working). | 1 | AH-99 | (A57) | | * |
| C2 | 3DB2.68 | CAPACITOR: paper; 2-mf, 500 v dc (working). | 1 | AH-99 | (A57) | | * |
| C3, 7 | 3DB3.29 | CAPACITOR: paper; 3-mf, 500 v dc (working). | 2 | AH-99 | (A57) | | * |
| C12 | 3DB1.1965 | CAPACITOR: paper; 1-mf, 500 v dc (working). | 2 | | (A57) | | * |
| C4, 5, 6 | 3DB6-23 | CAPACITOR: paper; 6-mf, 500 v dc (working). | 3 | AH-99 | (A57) | * | * |
| C8, 9, 10, 11 | 3DA100-168.4 | CAPACITOR: non-inductive; 0.1-mf (2 sections), 600 v dc (working). | 2 | AH | (A57) | | * |
| L1 | 3C315-54 | CHOKE: 1.3 h, 50-ohm d-c resistance. | 1 | W12-20 | (F1) | | * |
| J1 to J14 Incl | 2Z5524 | JACK: telephone; 2-conductor; single-break spring. | 14 | 218-A | (W5) | * | * |
| J15 | 2Z5533A | JACK: relay test; 3-conductor; long-frame type. | 1 | JK33A | (M1) | | * |
| SEND BIAS, SEND LOOP CURRENT, REC LOOP CURRENT, METER, LOOP, MON. | 2Z5788-40 | KNOB: bar pointer; 1 1/4″ long x 3/8″ high; No. 8-32 x 1/4″ fil head machine screw. | 6 | 13053 | (E8) | | * |
| | 3F875-13 | METER: 100-0-100, 105-ohm. | 1 | 301 | (W6) | | * |
| SEND RELAY REC RELAY | 2Z7585-18 | RELAY: polar; 2 coils, 3,600 turns ea, 138-ohm d-c resistance ea; 8-pin base; coils series min. operating current 1.75 ma; reverse soak current 5 ma. | 2 | D-163119-A | (W5) | | * |
| MON RELAY | 4A2895/R1 | RELAY: 2,000-ohm contacts; bakelite mounting base for standard plug-in 5-prong tube. | 1 | 4A | (S63) | | * |
| R2, 3 | 3Z6020-91 | RESISTOR: 200-ohm, 1-w; wire-wound. | 2 | S | (P8) | | * |
| R4 | 3Z6350-34 | RESISTOR: 3,500-ohm, 20-w; wire-wound. | 1 | | (L5) | | * |
| R6 | 3Z6250-29 | RESISTOR: 2,500-ohm, 20-w; wire-wound. | 1 | | (L5) | | * |
| R7 | 3Z6711E5-2 | RESISTOR: 115,000-ohm ± 1%, 1-w; wire-wound. | 1 | S | (P8) | | * |
| R9 | 3Z6653F6 | RESISTOR: 53,600-ohm ± 1%, 1-w; wire-wound. | 1 | S | (P8) | | * |
| R10 | 3Z6752 | RESISTOR: 520,000-ohm ± 1%, 1-w; wire-wound. | 1 | S | (P8) | | * |
| R11 | 3Z6280-4 | RESISTOR: 2,800-ohm ± 5%, 10-w; wire-wound. | 1 | S | (P8) | | * |

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## 48. MAINTENANCE PARTS LIST FOR TELEGRAPH TERMINAL TH–1/TCC–1 (Cont'd).

| Reference symbol | Signal Corps stock No. | Name of part and description | Quantity per unit | Mfrs part and code No. | | †Station stock | †Region stock |
|---|---|---|---|---|---|---|---|
| R12, 13 | 3Z6610-196 | RESISTOR: 10,000-ohm ± 1%, 1-w; wire-wound. | 2 | S | (P8) | | * |
| R14, 15 | 3RC41BE243J | RESISTOR: 24,000-ohm ± 5%, 2-w; carbon. | 2 | | (T25) | | * |
| R16 | 3Z6720-37 | RESISTOR: 200,000-ohm ± 1%, wire-wound. | 1 | S | (P8) | | * |
| R17 | 3Z6712-25 | RESISTOR: 120,000-ohm ± 1%, 1-w; wire-wound. | 1 | S | (P8) | | * |
| R20, 37, 45, 46 | 3Z6200-43 | RESISTOR: 2,000-ohm, 20-w; wire-wound. | 4 | | (L5) | * | * |
| R21, 22 | 3Z6025-42 | RESISTOR: 250-ohm; 10-w, wire-wound. | 2 | | (L5) | | * |
| R23 | 3Z6400-39 | RESISTOR: 4,000-ohm, 10-w; wire-wound. | 1 | | (L5) | | * |
| R24, 28, 40, 41 | 3Z6005-104 | RESISTOR: 50-ohm ± 1%, 1-w; wire-wound. | 4 | S | (P8) | * | * |
| R25 | 3Z6125-8 | RESISTOR: 12,50-ohm, 10-w; wire-wound. | 1 | | (L5) | | * |
| R26 | 3RC31AE101M | RESISTOR: 100-ohm, 1-w; carbon. | 1 | | (T25) | | * |
| R27 | 3Z6025-31 | RESISTOR: 250-ohm, 1-w; carbon. | 1 | | (T25) | | * |
| R29 | 3Z6075-6 | RESISTOR: 750-ohm ± 5%, 20-w; wire-wound. | 1 | | (L5) | | * |
| R30 | 3Z6100-95 | RESISTOR: 1,000-ohm ± 5%, 10-w; wire-wound. | 1 | | (O2) | | * |
| R31 | 3Z6150-86 | RESISTOR: 1,500-ohm, 10-w; wire-wound.[9] | 1 | | (O2) | | * |
| R32 | 3Z6085-3 | RESISTOR: 850-ohm, 10-w; wire-wound. | 1 | | (L5) | | * |
| R33, 34, 35 | 3Z7335-3 | RHEOSTAT: 3,500-ohm, 50-w; wire-wound. | 3 | J | (O2) | * | * |
| R36 | 3Z6450-16 | RESISTOR: 4,500-ohm ± 1%, 1-w; wire-wound. | 1 | S | (P8) | | * |
| R38 | 3ZK6060-39 | RESISTOR: 600-ohm, 10-w; wire-wound. | 1 | | (L5) | | * |
| R39 | 3Z6070-20 | RESISTOR: 700-ohm, 10-w; wire-wound. | 1 | | (L5) | | * |
| S1, 2 | 2Z9054.13 | SPARK KILLER: 2 capacitors, 0.5-mf, 500 v dc (working); 2 resistors, 1,500-ohm ea. | 2 | | (A57) | | * |
| S3, 4 | 2Z9054.14 | SUPPRESSOR UNIT: r-f; includes 2 capacitors (ea) 0.1-mf, 500 v dc (working); mica, 2 coils (ea) 1.6 mh. | 2 | W12-21 | (F1) | | * |
| SW-1 | 3Z9550.51 | SWITCH: rotary; 10-section; 20-pole; 6-position. | 1 | DH | (O1) | | * |
| SW-3 | 3Z9550.54 | SWITCH: rotary; 4-wafer; 12-pole; 3-position. | 1 | DH | (O1) | | * |
| SW-2 | 3Z9550.52 | SWITCH: rotary; 3-wafer; 3-pole; 8-position. | 1 | DH | (O1) | | * |
| T10 | 2Z9637.34 | TRANSFORMER: peak limiter; three windings, 1 to 2: 14.2 ohms, 3 to 4: 14.2 ohms, 5 to 6: 4,900 ohms. | 2 | W15-62 | (F1) | | * |
| — | 3F875-13 | METER: 100-0-100 scale; 105 ohms. | 1 | 301 | (W6) | | * |
| | | MODEM UNIT | | | | | |
| C101, 103 | 3DA500-196 | CAPACITOR: paper; 0.5-mf, 500 v dc (working). | 2 | AH99 | (A57) | | * |
| C102 | 3DB1.1965 | CAPACITOR: paper; 1-mf, 500 v dc (working). | 1 | | (A57) | | * |
| C105, 106, 107, 108, 109, 110 | 3DA250-121 | CAPACITOR: paper; 0.1-mf, 0.25-mf, 0.01-mf (3 sections), 500 v dc (working). | 2 | | (A57) | | * |
| C111, 120 | 3DA100-269 | CAPACITOR: paper; 0.1-mf, 500 v dc (working). | 2 | AH82 | (A57) | | * |
| C112, 121 | 3DB2.68 | CAPACITOR: paper; 2-mf, 500 v dc (working). | 2 | W3-68 | (A57) | | * |

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## 48. MAINTENANCE PARTS LIST FOR TELEGRAPH TERMINAL TH–1/TCC–1 (Cont'd).

| Reference symbol | Signal Corps stock No. | Name of part and description | Quantity per unit | Mfrs part and code No. | | †Station stock | †Region stock |
|---|---|---|---|---|---|---|---|
| C113, 114, 115, 116, 117, 118, 122, 124 | 3DA5-10 | CAPACITOR: mica; 0.005-mf, 300 v dc (working). | 8 | 1W3D5 | (C15) | * | * |
| C119 | 3DB6-23 | CAPACITOR: paper; 6-mf, 500 v dc (working). | 1 | | (A57) | | * |
| C123 | 3DA50-39 | CAPACITOR: paper; 0.05-mf, 500 v dc (working). | 1 | W3-70 | (A57) | | * |
| C125, 126 | 3D9500-44 | CAPACITOR: mica; 0.0005-mf, 500 v dc (working). | 2 | 5W5T3 | (C15) | | * |
| F101 | 3Z1891-15.5 | FILTER: bandstop; 1,500 to 2,040 cps. | 1 | W12-19 | (F1) | | * |
| F102 | 3Z1891-15.6 | FILTER: bandpass; 1,680 ± 5 cycles or 1,860 ± 5 cycles (used in conjunction with hydrid coil). | 1 | W12-23 | (F1) | | * |
| F103 | 3Z1892-9 | FILTER: bandpass; 1,860 ± 50 cycles and 1,680 ± 25 cycles. | 1 | W12-18 | (F1) | | * |
| REC LEVEL REC RELAY SEND FREQ SEND LEVEL | 2Z5788-40 | KNOB: bar pointer; 1¼″ long x ⅜″ high; No. 8-32 x ¼″ fil head machine screw. | 4 | 13053 | (E8) | | * |
| Rect. 101A, 101B | 3H4839-14 | RECTIFIER ASSEMBLY: includes 4 No. 27DO855 rectifiers; 10-mm disks with 7-mm type spots. | 1 | W92-284 | (F1) | | * |
| Rect. 102 | 3H4839-17 | RECTIFIER ASSEMBLY: 1 No. 27DO855 rectifier; 10-mm disks with 7-mm type spots. | 1 | W92-282 | (F1) | | * |
| Rect. 103A, 103B, 103C | 3H4839-13 | RECTIFIER ASSEMBLY: includes 2 No. 27DO855 rectifiers; 10-mm disks with 7-mm type spots. | 1 | W92-283 | (F1) | | * |
| R101, 102 | 3RC21BE221J | RESISTOR: 220-ohm ± 5%, ½-w; carbon. | 2 | | (I2) | | * |
| R103, 111 | 3Z6068 | RESISTOR: 680-ohm ± 5%, ½-w; carbon. | 2 | | (I2) | | * |
| R104, 110, 113, 114 | 3RC21BE203J | RESISTOR: 20,000-ohm ± 5%, ½-w. | 4 | | (I2) | * | * |
| R105, 109 | 3RC21BE152J | RESISTOR: 1,500-ohm ± 5%, ½-w; carbon. | 2 | | (I2) | | * |
| R106, 107 | 3RC31BE302J | RESISTOR: 3,000-ohm ± 5%, 1-w; carbon. | 2 | | (I2) | | * |
| R108 | 3RC41BE152J | RESISTOR: 1,500-ohm ± 5%, 2-w; carbon. | 1 | | (I2) | | * |
| R112 | 3RC21BE274J | RESISTOR: 270,000-ohm ± 5%, ½-w; carbon. | 1 | | (I2) | | * |
| R115, 125, 126, 134 | 3Z6750-4 | RESISTOR: 0.5-megohm, ½-w; carbon. | 4 | | (I2) | * | * |
| R116, 121, 123, 135 | 3RC21BE335J | RESISTOR: 3.3-megohm ± 5%, ½-w; carbon. | 4 | | (I2) | * | * |
| R117 | 3RC21BE684J | RESISTOR: 0.68-megohm ± 5%, ½-w; carbon. | 1 | | (I2) | | * |
| R118 | 3RC21BE205J | RESISTOR: 2-megohm ± 5%, ½-w; carbon. | 1 | | (I2) | | * |
| R119 | 3RC21BE274JK | RESISTOR: 0.27-megohm ± 5%, ½-w; carbon. | 1 | | (I2) | | * |
| R120 | 3RC21BE135J | RESISTOR: 1.3-megohm ± 5%, ½-w; carbon. | 1 | | (I2) | | * |
| R122 | 3RC21BE125J | RESISTOR: 1.2-megohm ± 5%, ½-w; carbon. | 1 | | (I2) | | * |
| R124 | 3RC21BE335K | RESISTOR: 3.3-megohm ± 10%, ½-w; carbon. | 1 | | (I2) | | * |
| R127 | 3RC21BE515J | RESISTOR: 5.1-megohm ± 5%, ½-w; carbon. | 1 | | (I2) | | * |

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## 48. MAINTENANCE PARTS LIST FOR TELEGRAPH TERMINAL TH–1/TCC–1 (Cont'd).

| Reference symbol | Signal Corps stock No. | Name of part and description | Quantity per unit | Mfrs part and code No. | | †Station stock | †Region stock |
|---|---|---|---|---|---|---|---|
| R128 | 3RC21BE822J | RESISTOR: 8,200-ohm ± 5%, ½-w; carbon. | 1 | | (I2) | | * |
| R129, 130 | 3RC21BE511J | RESISTOR: 510-ohm ± 5%, ½-w; carbon. | 2 | | (I2) | | * |
| R131 | 3RC31AE121J | RESISTOR: 120-ohm ± 5%, ½-w; carbon. | 1 | | (I2) | | * |
| R132 | 3Z6060-2 | RESISTOR: 600-ohm ± 5%, ½-w; carbon. | 1 | | (I2) | | * |
| R133 | 3RC21BE753J | RESISTOR: 75000-ohm, ½-w; carbon. | 1 | | (I2) | | * |
| | 2Z8637 | SOCKET: tube; octal; low loss; mica-filled bakelite. | 6 | S8TM | (A13) | * | * |
| S101 | 3Z9550.56 | SWITCH: rotary; 8-pole; 2-position; 2-section. | 1 | DH | (O1) | | * |
| S102, 104 | 3Z9550.55 | SWITCH: 2-pole; 2-position. | 2 | H | (O1) | | * |
| S103 | 3Z9550.53 | SWITCH: rotary; 2-pole; 3-position. | 1 | DH | (O1) | | * |
| T1, T3 | 2Z9631.133 | TRANSFORMER: input; pri 5.4 mh, 5.4-ohm d-c resistance; sec 7.3 mh, 1,400-ohm d-c resistance; turns ratio pri to sec 1:17 | 2 | W15-42 | (F1) | | * |
| T2 | 2Z9632.193 | TRANSFORMER: output; pri 8.3-ohm d-c resistance; sec 1,010-ohm d-c resistance; turns ratio pri to sec 1:17. | 1 | W15-44 | (F1) | | * |
| T9 | 4A2895/C5 | TRANSFORMER: filter hybrid; d-c resistance, 2 to 3 & 4 to 5, 27.5 ohms ea; 8 to 1 & 9 to 7, 30 ohms ea; 6 to 11, 90 ohms. | 1 | W15-54 | (F1) | | * |
| T4 | 2Z9632.190 | TRANSFORMER: output; pri: 337-ohm d-c resistance; sec No. 1: 675-ohm d-c resistance; sec No. 2: 675-ohm d-c resistance. | 1 | W15-50 | (F1) | | * |
| T5 | 2Z9632.188 | TRANSFORMER: modulator output; pri No. 1 and No. 2: 134 ohms ea; sec: 16.8 ohms. | 1 | W15-51 | (F1) | | * |
| T6 | 2Z9633.192 | TRANSFORMER: osc output; 2 pri windings; 1 sec ct; turns raio 1:1. | 1 | W15-43 | (F1) | | * |
| T7 | 2Z9638-25 | TRANSFORMER ASSEMBLY: coupling includes pri 0.6-ohm d-c resistance; sec 150-ohm d-c resistance; one 0.001-mf, mica capacitor; one 0.0008-mf, mica capacitor. | 1 | W15-53 | (F1) | | * |
| T8 | 2Z9632.191 | TRANSFORMER: output; windings 1 to 2: 12 h, 700-ohm d-c resistance; 3 to 4: 215 mh, 18-ohm d-c resistance; 5 to 6: 250 mh, 22-ohm d-c resistance. | 1 | W15-61 | (F1) | | * |
| V1, 2, 3, 4, 5, 6 | 2J6G6G | TUBE JAN-6G6-G. | 6 | 6G6-G | (R2) | * | * |
| | | POWER SUPPLY UNIT | | | | | |
| | 3Z246A.1 | BINDING POST: rubber-covered; 9/16" stem; No. 8-32 thread; tumble nickel-finish; knurled base. | 4 | W27-2 | (F1) | | * |
| C1, 2, 3, 16 | 3DB25-41 | CAPACITOR: electrolytic; 25-mf, 300 v dc (working). | 4 | UP-4AJ83 | (C15) | * | * |
| C4, 5, 6, 7 | 3DA5-10 | CAPACITOR: mica; 0.0005-mf, 500 v dc (working). | 4 | | (C15) | * | * |
| C8, 9, 19, 20 | 3DA250.98 | CAPACITOR: paper; 0.25-mf, 500 v dc (working). | 4 | | (A57) | * | * |
| C10, 11 | 3DA30-33 | CAPACITOR: paper; 0.03-mf, 1,000 v dc (working). | 2 | | (A57) | | * |
| C12, 13 | 3DB500-2 | CAPACITOR: electrolytic; 500-mf, 200 v dc (working). | 2 | C-36 | (M1) | | * |

† Parts not stocked in station or region stock are carried in depot stock.
* Indicates stock available.

## 48. MAINTENANCE PARTS LIST FOR TELEGRAPH TERMINAL TH–1/TCC–1 (Cont'd).

| Reference symbol | Signal Corps stock No. | Name of part and description | Quantity per unit | Mfrs part and code No. | | †Station stock | †Region stock |
|---|---|---|---|---|---|---|---|
| C14, 15 | 3DA500-196 | CAPACITOR: paper; 0.5-mf, 500 v dc (working). | 2 | | (A57) | | * |
| C17 | 3DA20-50.1 | CAPACITOR: paper; 0.02-mf, 600 v dc (working). | 1 | 439 | (A55) | | * |
| C18 | 3DB2.68 | CAPACITOR: paper; 2-mf, 500 v dc (working). | 1 | | (C15) | | * |
| CH-1 | 3C315-56 | CHOKE: filter; 10 h, 10 ma. | 1 | W12-8 | (F1) | | * |
| RFC-1, 2 | 3C315-55 | CHOKE: filter; r-f. | 2 | W12-14 | (F1) | | * |
| F1 | 3Z1927 | FUSE: 2-amp, 250 v; type 3AG. | 1 | 3AG2 | (B9) | * | * |
| F2, 3 | 3Z2587.1 | FUSE: ¼-amp; type 3AG. | 2 | 3AG¼ | (B9) | * | * |
| F4 | 3Z2015-1 | FUSE: 15-amp, 250 v; type 3AG. | 1 | 3AG15 | (B9) | * | * |
| Rect. 1, 2 | 3H4839-15 | RECTIFIER: selenium; average v 160 d-c. | 2 | 22DO919 | (F1) | | * |
| Rect. 3 | 3H4839-16 | RECTIFIER: selenium; 8 arms; 14 disks (10-mm type); 22 per arm. | 1 | | (F1) | | * |
| RA | 2Z7592-28 | RELAY; 4 make contacts; coil 1,200-ohm, 12 ma. | 1 | UR1147 | (FI) | | * |
| R1, 2 | 3RC41BE103K | RESISTOR: 10,000-ohm ± 10%, 2-w; carbon. | 2 | | (I2) | | * |
| R3, 4, 5, 6 | 3RC21BE203J | RESISTOR: 20,000-ohm ± 5%, ½-w; carbon. | 4 | | (I2) | * | * |
| R7 to 14, incl. | 3RC21BE512J | RESISTOR: 5,100-ohm ± 5%, ½-w; carbon. | 8 | | (I2) | * | * |
| R15, 16 | 3RC21BE563J | RESISTOR: 56,000-ohm, ½-w; carbon. | 2 | | (I2) | | * |
| R17, 18 | 2Z7270.117 | RESISTOR: pot; 20,000-ohm; carries 3 ma. | 2 | | (S24) | | * |
| R19, 20, 21, 22 | 3Z6010-19 | RESISTOR: 100-ohm, 20-w; wire-wound. | 4 | | (L5) | * | * |
| R23, 24 | 3RC21BE103K | RESISTOR: 10,000-ohm, ± 10%, ½-w; carbon. | 2 | | (I2) | | * |
| R25 | 3Z6591-7 | RESISTOR: 9,100-ohm, 2-w; carbon. | 1 | | (I2) | | * |
| R26 | 3Z6050-117 | RESISTOR: 500-ohm, 5-w; wire-wound. | 1 | Navy D | | | * |
| T1 | 2Z9625-27 | TRANSFORMER: power; | 1 | W15–49 | (F1) | | * |

| *Winding* | *No load v* | *D-c resistance* |
|---|---|---|
| 1–2 | 10.3 | 0.09-ohm |
| 2–3 | 10.3 | 0.09-ohm |
| 4–8 | 244 tapped @ 107.5 v, 122 v, 215 v | 7.8-ohm |
| 9–10 | 198 | 65-ohm |
| 11–12 | 13.1 | 0.6-ohm |
| 13–14 | 218 | 52-ohm |
| 14–15 | 218 | 55-ohm |
| 16–17 | 218 | 57-ohm |
| 17–18 | 218 | 55-ohm |
| 19–20 | 160 | 40-ohm |
| 21–22 | 13.1 | 0.75-ohm |
| 23–24 | 160 | 140-ohm |
| 25–26 | 13.1 | 0.6-ohm |

† Parts not stocked in station or region stock are carried in depot stock.
* Indicates stock available.

## 48. MAINTENANCE PARTS LIST FOR TELEGRAPH TERMINAL TH–1/TCC–1 (Cont'd).

| Reference symbol | Signal Corps stock No. | Name of part and description | Quantity per unit | Mfrs part and code No. | †Station stock | †Region stock |
|---|---|---|---|---|---|---|
| V1, 4 | 2JOC3/VR105 | TUBE JAN-OC3/VR105. | 2 | OC3/VR105 (R2) | * | * |
| V2, 3, 5, 6 | 2J2050 | TUBE JAN-2050. | 4 | 2050 (R2) | * | * |
| V1B-1 | 3I6691S | VIBRATOR: 120 cps. | 1 | MSJ1489 (E14) | | * |
| | 2Z8637 | SOCKET: tube; octal; mica-filled bakelite. | 6 | S8TM (A13) | * | * |
| | 2Z8676.70 | SOCKET: vibrator; 6-prong. | 1 | S6TM (A13) | | * |
| S1 | 3Z9812-2 | SWITCH: push-button; momentary contact; 3-amp, 250-v. | 1 | 3592D (A17) | | * |
| S2, 5 | 3Z9859-38.1 | SWITCH: toggle; DPDT; 9/16" bat handle with hole drilled 1/8" from top; 11/32" bushing, 15/32" thread. | 1 | 8363 (C18) | | * |
| S3 | 3Z9858-8.88 | SWITCH: 4PDT, 3-position. | 1 | 80985 (A17) | | * |
| S4 | 3Z9845-28.4 | SWITCH: toggle; DPDT. | 1 | 8363 (C18) | | * |

## 49. MAINTENANCE PARTS LIST FOR FILTER F–2/GG.

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3Z1893-10 | FILTER F-2/GG. | | F-2/GG (F1) | | |
| LINE, SWBD, GRD | 3Z246A.1 | BINDING POST: rubber-covered; 9/16" stem; No. 8-32 thread; tumble nickel-finish; knurled base. | 9 | W27-2 (F1) | | * |
| LINE, SWBD | 4E926 | BLOCK: protector; carbon. | 8 | 26 (W5) | * | * |
| LINE, SWBD | 4E927 | BLOCK: protector; porcelain. | 8 | 27 (W5) | * | * |
| C1A, C1B | 3DB1.1965 | CAPACITOR: paper; bathtub type; 1-mf +20%, —10%, 500 v dc (working). | 2 | W5-13 (F1) | | * |
| A, B | 3Z1891-15.5 | FILTER: bandstop; 1,500 to 2,040 cps. | 2 | W12-19 (F1) | | * |
| BAND PASS | 3Z1891-15.7 | FILTER: band-pass; 1,500 to 1,900 cps. | 1 | W12-24 (F1) | | * |
| T10A, T10B | 2Z9637.34 | TRANSFORMER: peak limiter; 3 windings, 1 to 2: 14.2 ohms, 3 to 4: 14.2 ohms, 5 to 6: 4,900 ohms. | 2 | W15-62 (F1) | | * |

## 50. LIST OF MANUFACTURERS.

| *Code* | *Name of manufacturer* | *Code* | *Name of manufacturer* | *Code* | *Name of manufacturer* |
|---|---|---|---|---|---|
| A1 | Aerovox Corp. | C18 | Cutler-Hammer Inc. | O2 | Ohmite Mfg. Co. |
| A5 | Allen-Bradley Co. | E8 | Hugh H. Eby, Inc. | P8 | Precision Resistor Co. |
| A13 | American Phenolic Corp. | E14 | Electronic Lab., Inc. | R2 | RCA Mfg. Co. |
| A17 | Arrow-Hart & Hegeman Co. | F1 | Federal Telephone & Radio Corp. | S24 | Stackpole Carbon Co. |
| A55 | Aero Electric Corp. | I2 | International Resistance Co. | S63 | Sigma Instrument Corp. |
| A57 | American Condenser Co. | L5 | Lectrohm, Inc. | T25 | Tilton |
| B9 | Bussman Mfg. Co. | M1 | P. R. Mallory & Co. | W5 | Western Electric Co. |
| C15 | Cornell-Dubilier Electric Corp. | O1 | Oak Mfg. Co. | W6 | Weston Electric Instrument Corp. |

† Parts not stocked in station or region stock are carried in depot stock.
* Indicates stock available.

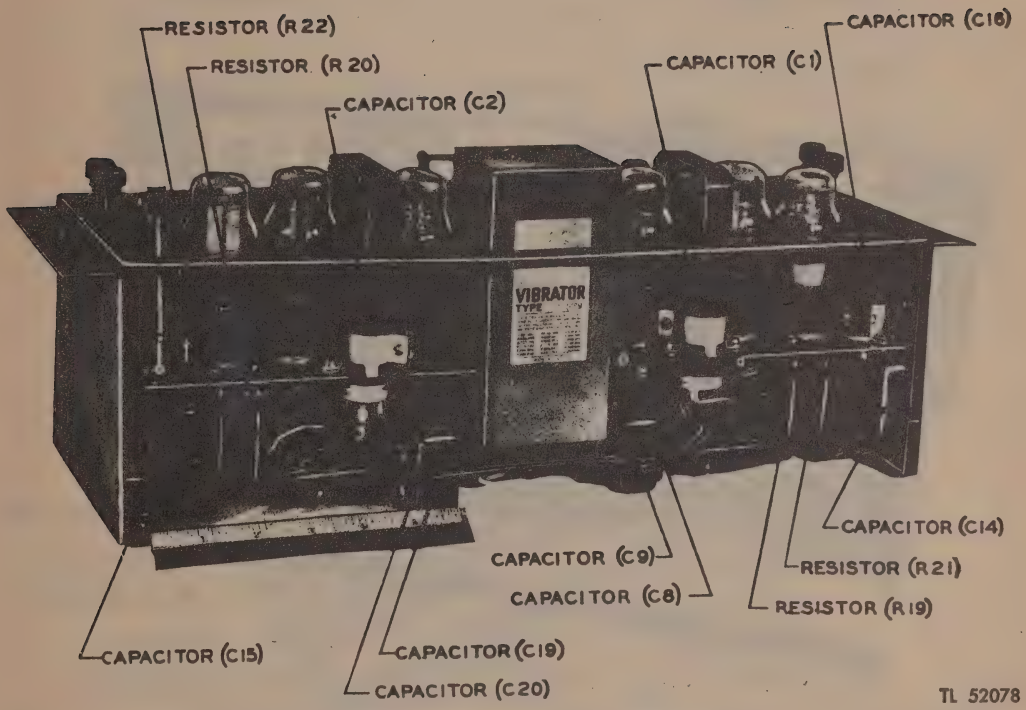



*Figure 37. Power supply, rear view, location of parts.*

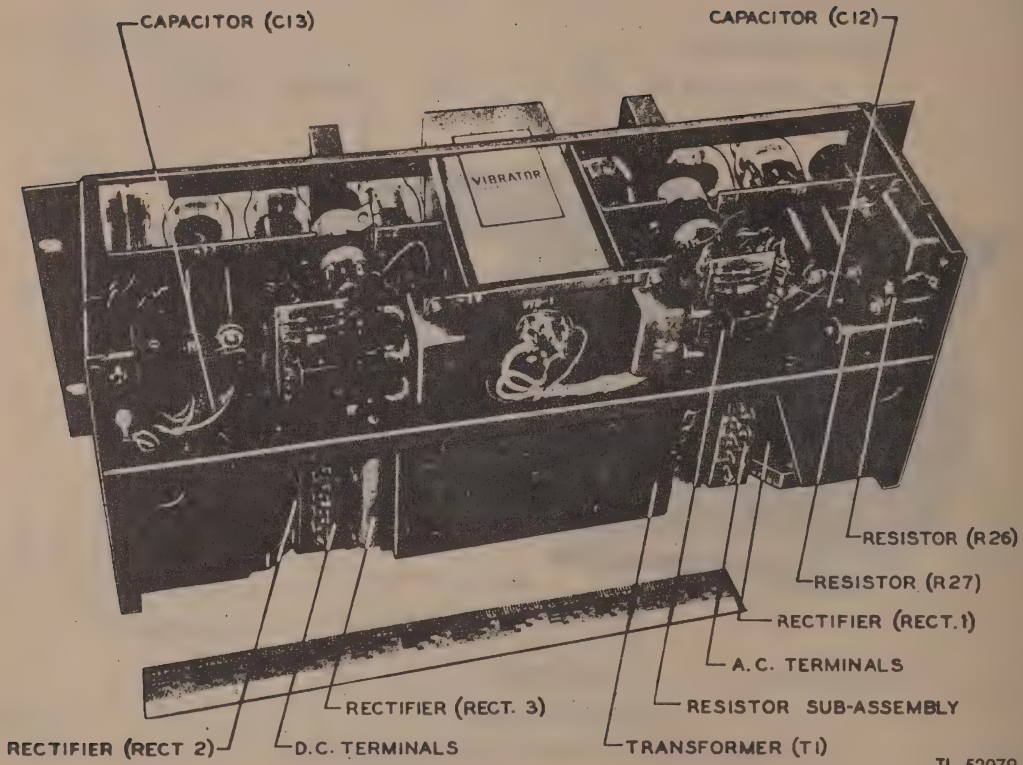



*Figure 38. Power supply, bottom view, location of parts.*

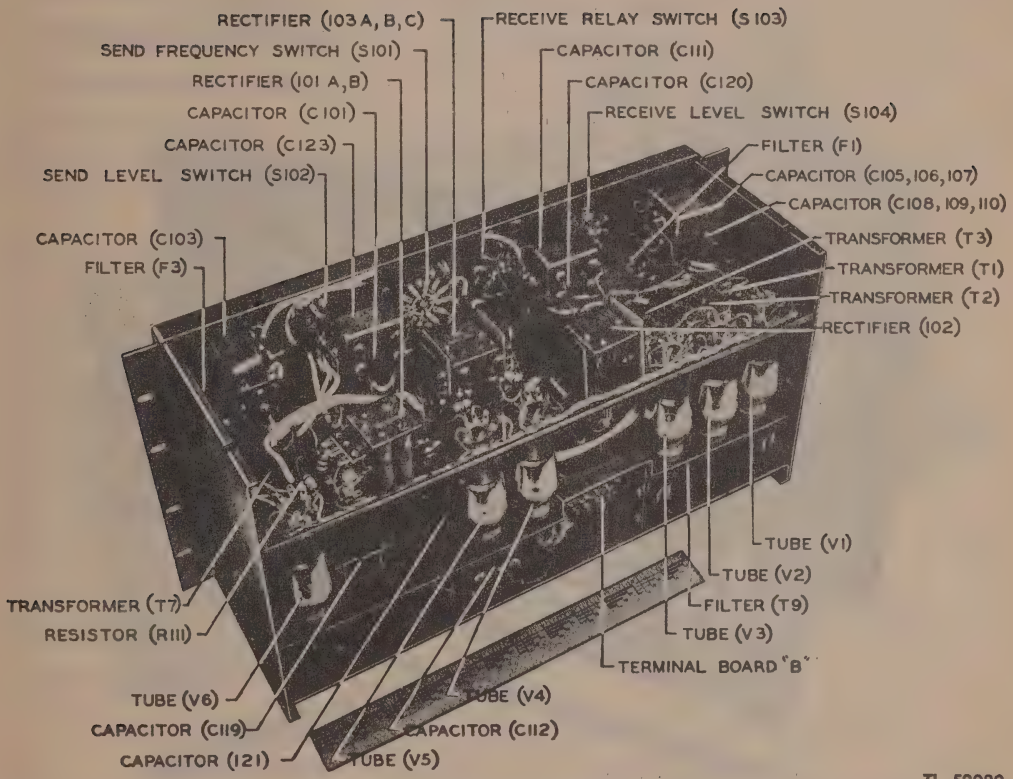



*Figure 39. Modem unit, rear view, location of parts.*

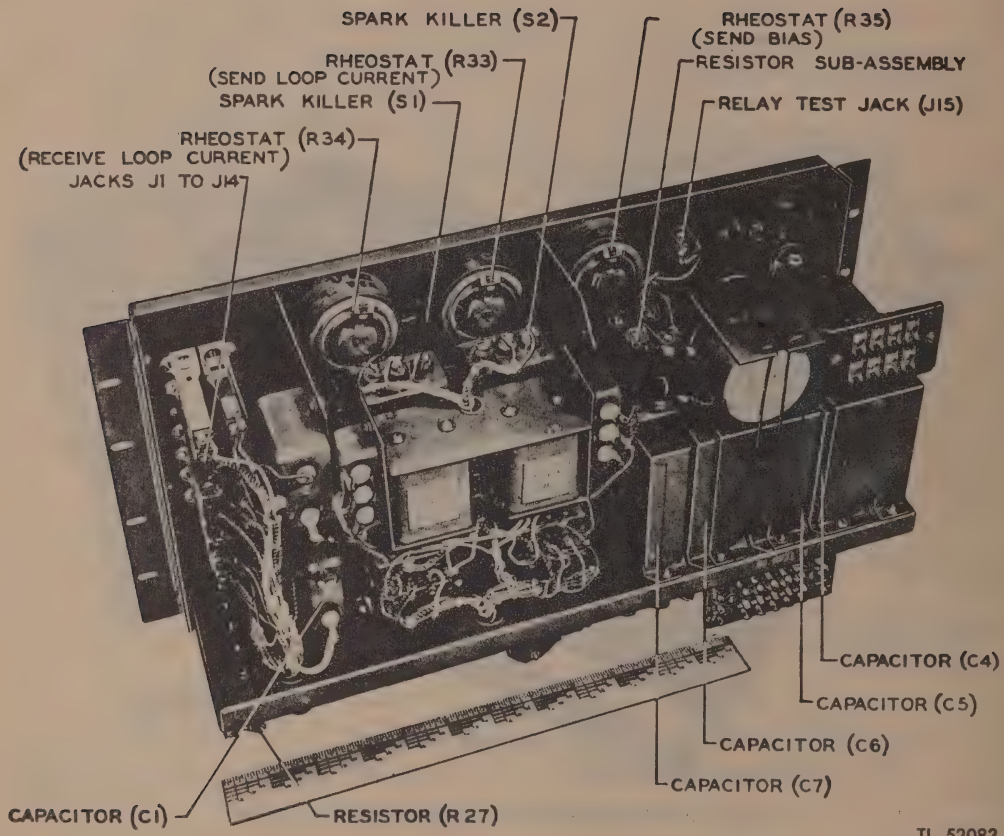



*Figure 40. Monitoring unit, rear view, location of parts.*

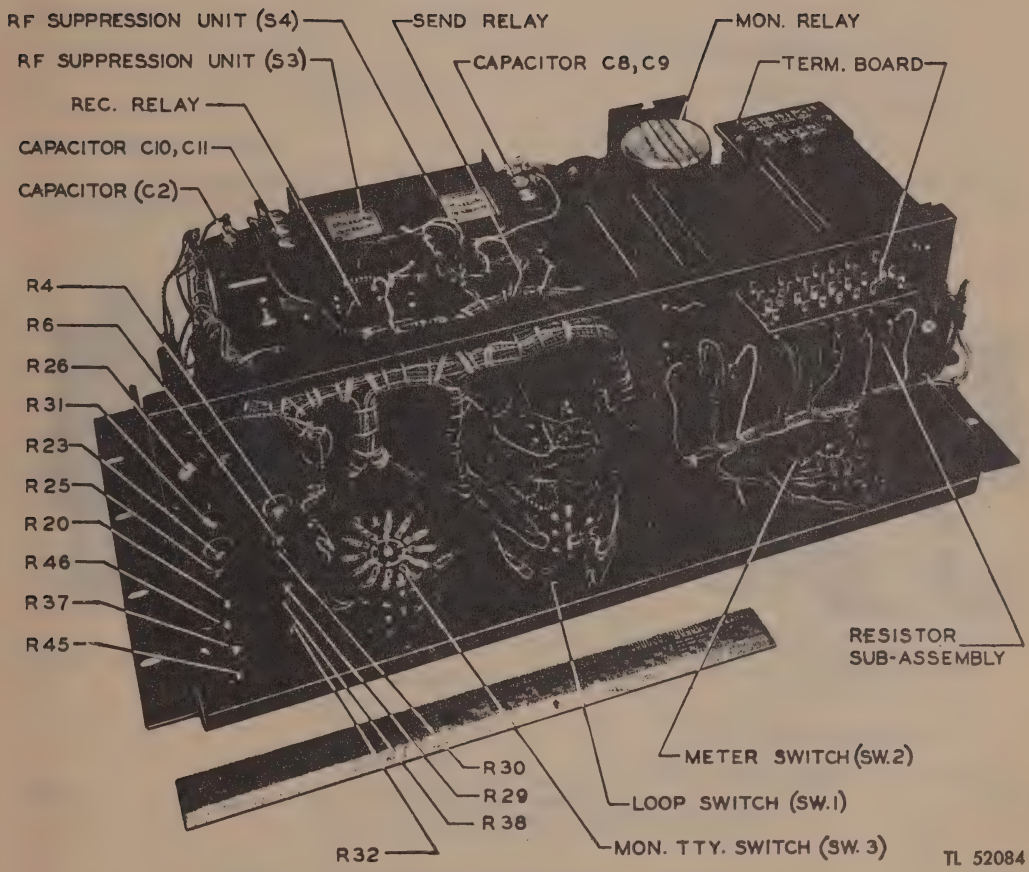



*Figure 41. Monitoring unit, bottom view, location of parts.*

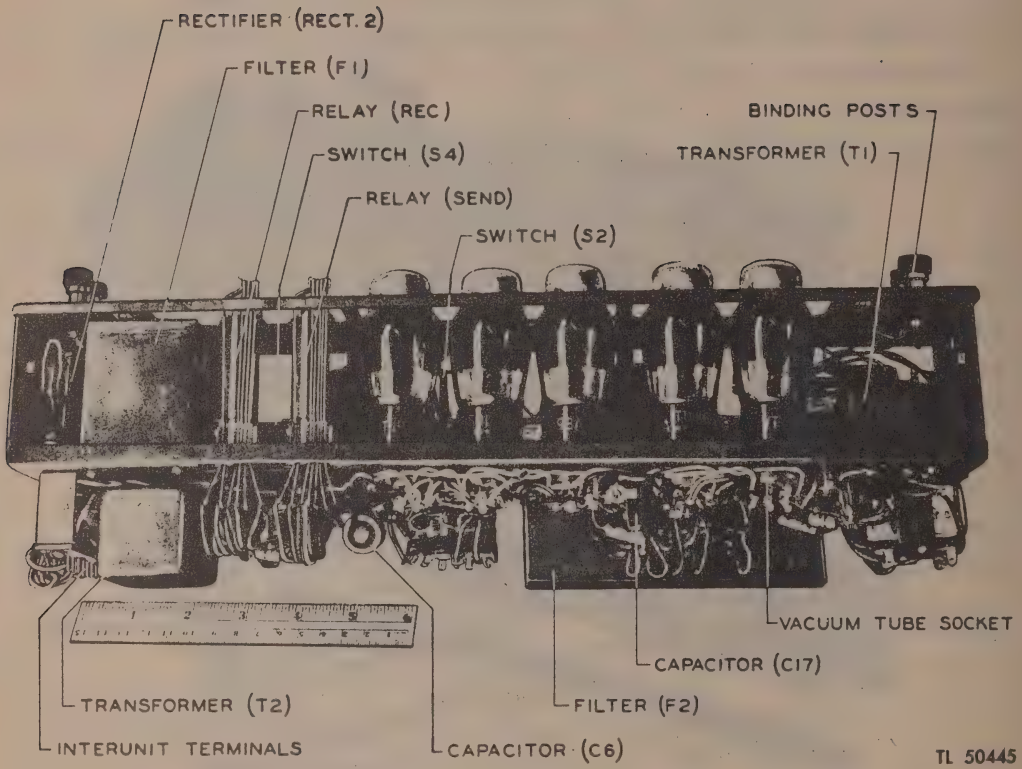



*Figure 42. Ringer unit, location of parts.*

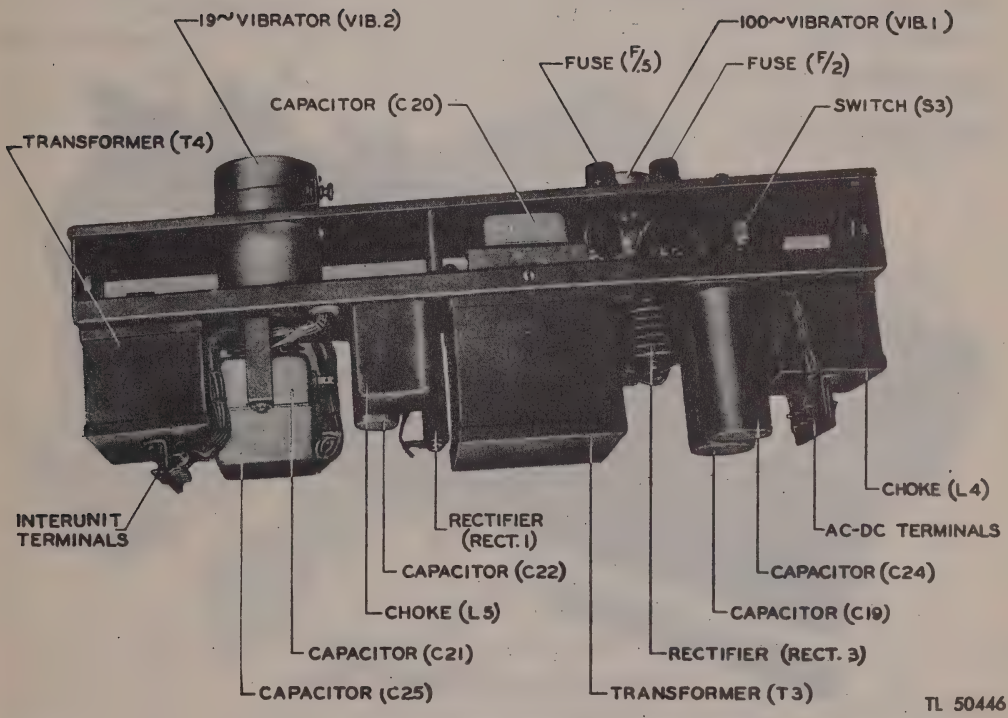



*Figure 43. Ringer power supply, location of parts.*

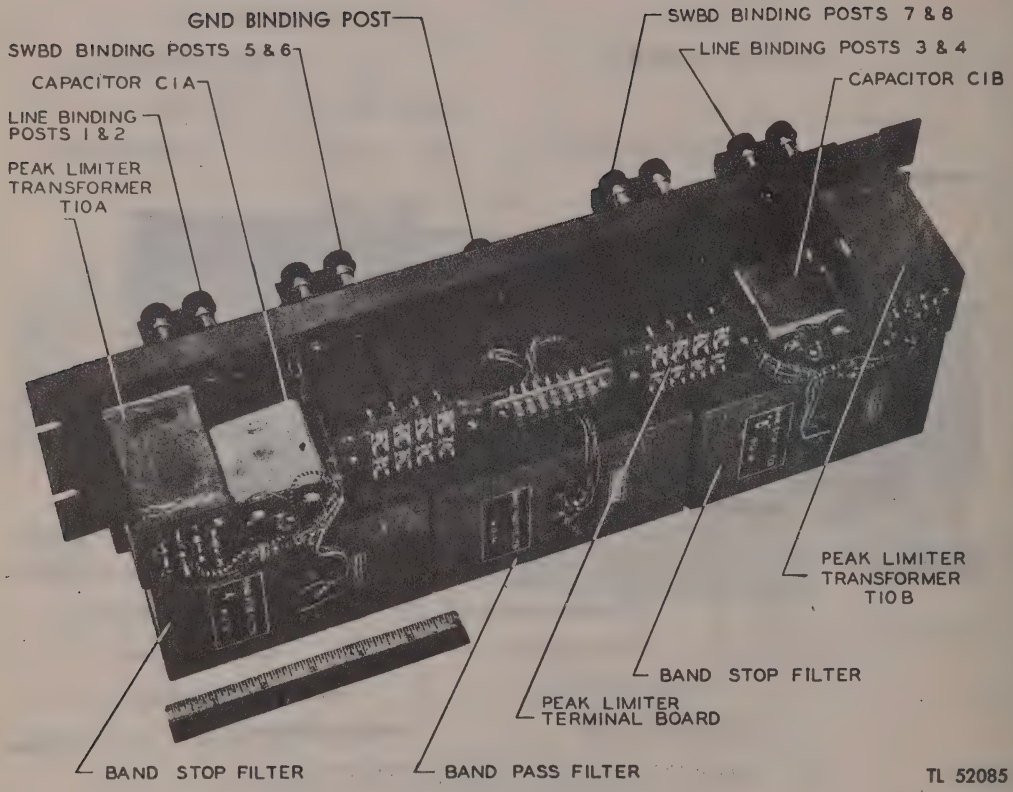



*Figure 44. Filter F–2/GG, location of parts.*

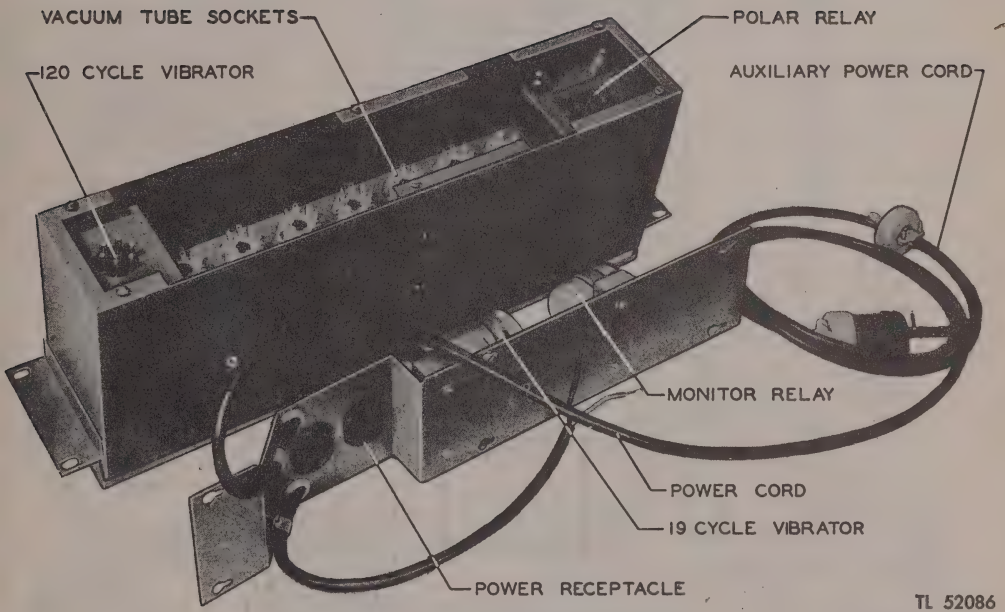



*Figure 45. Spare parts compartment.*

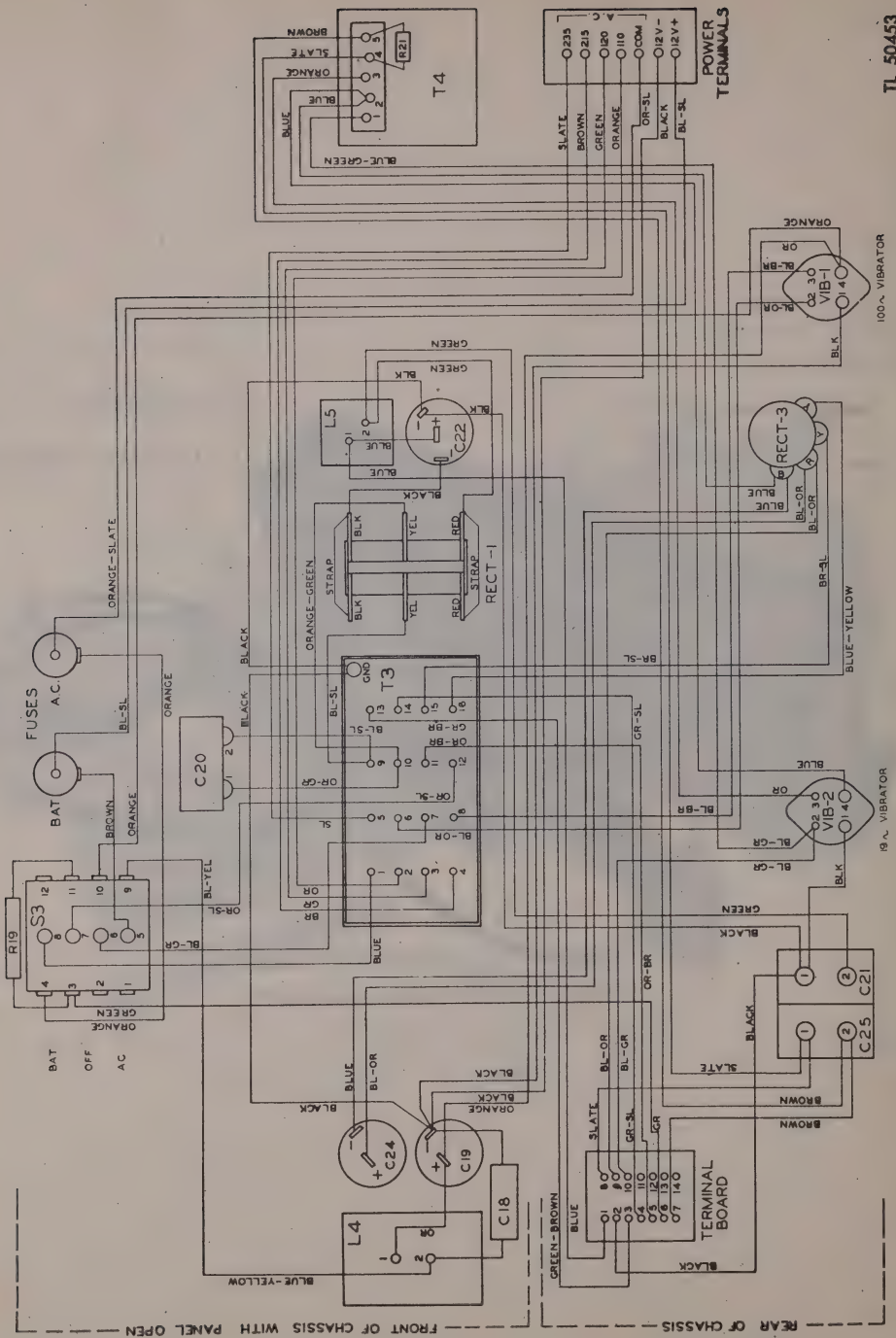



*Figure 46. Ringer power supply, wiring diagram.*


TE

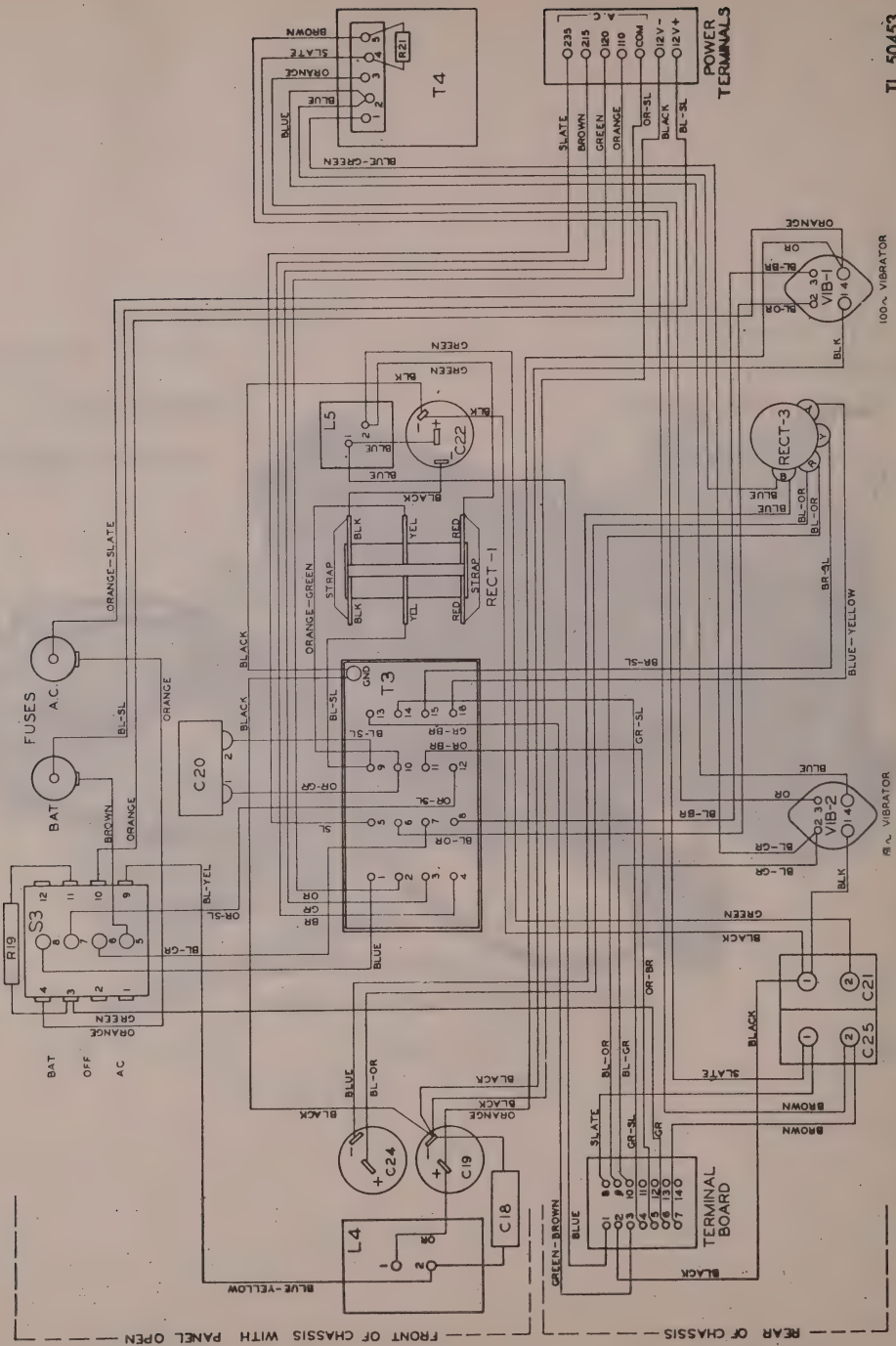



*Figure 46. Ringer power supply, wiring diagram.*

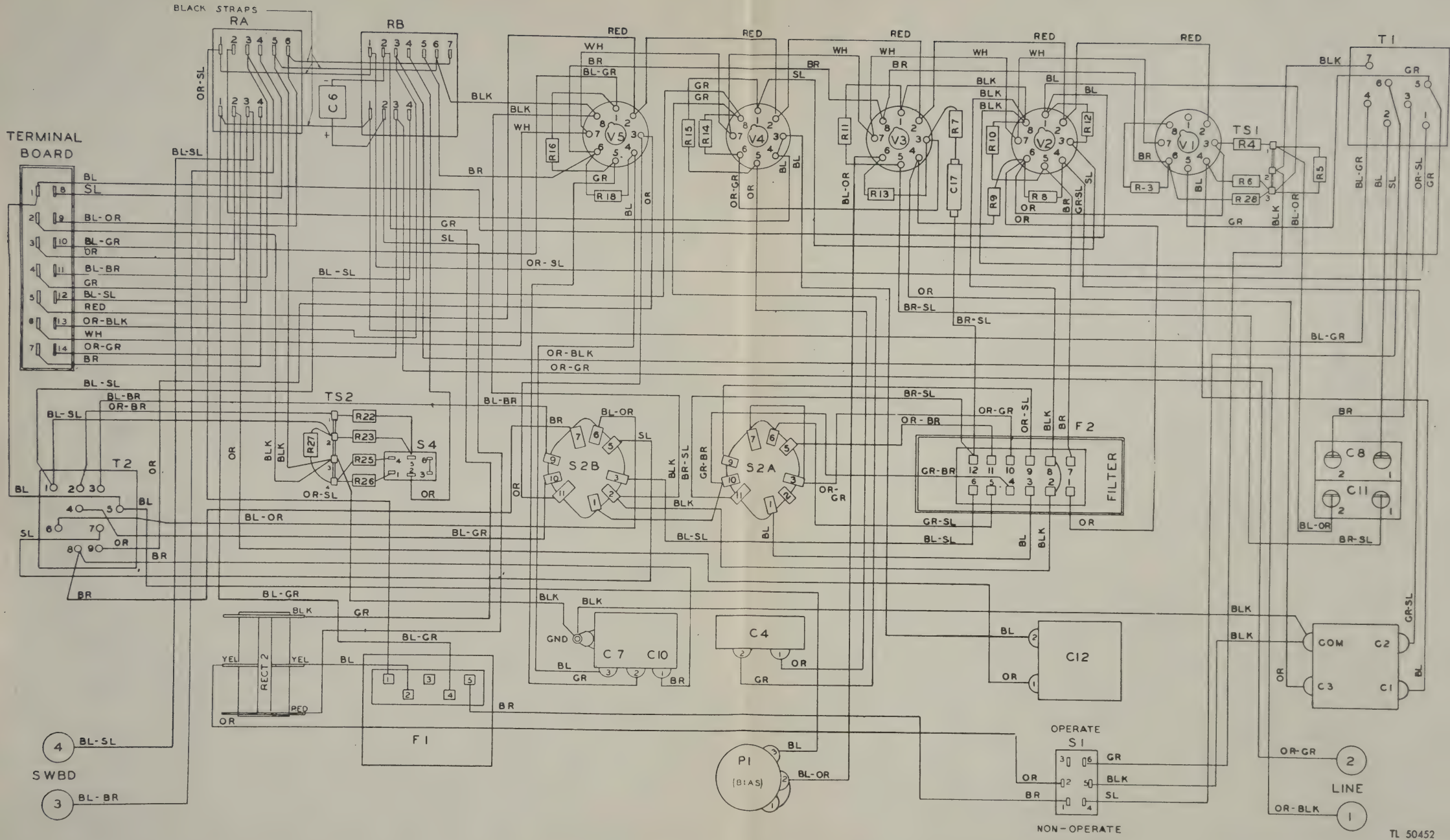
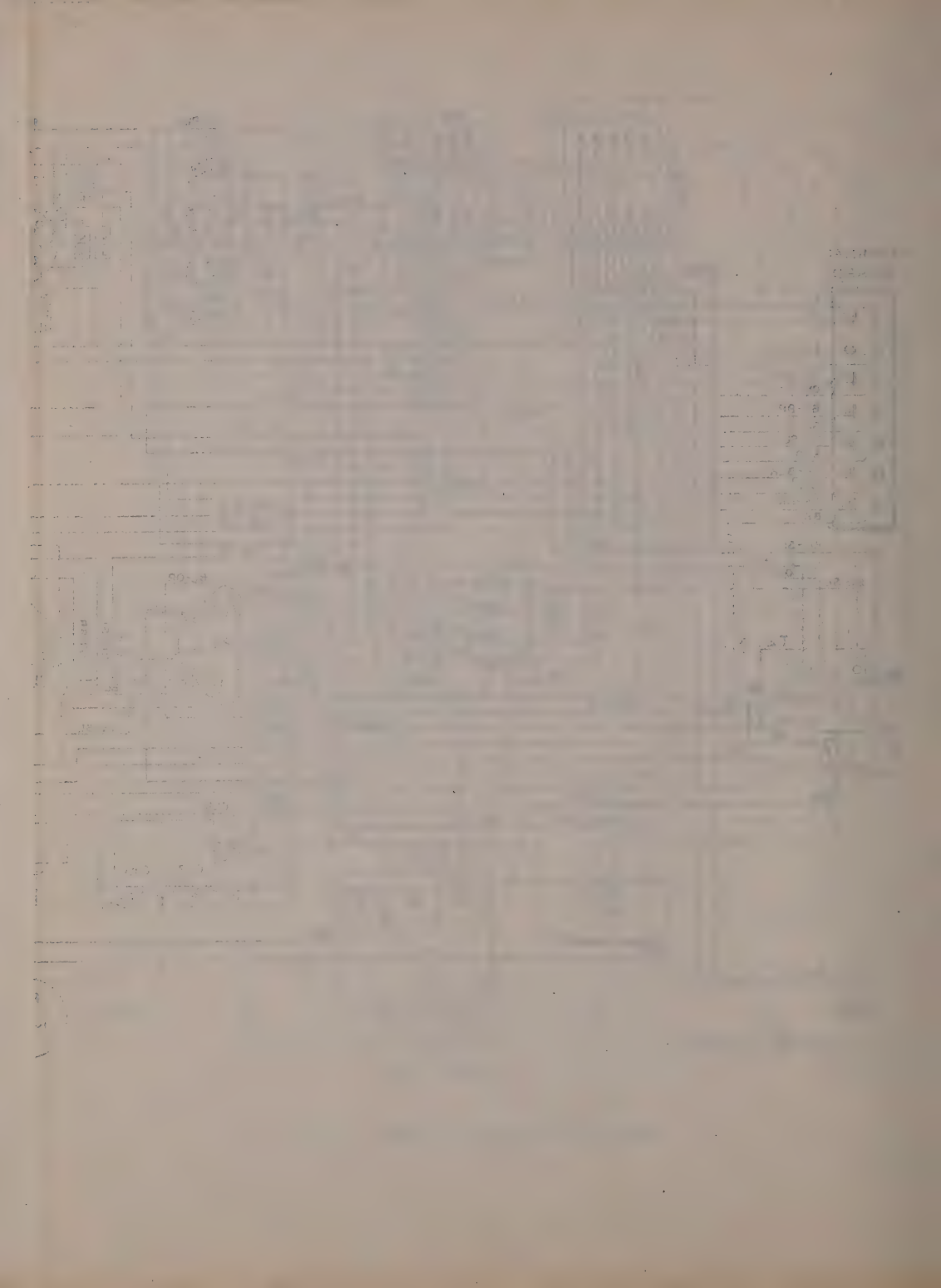
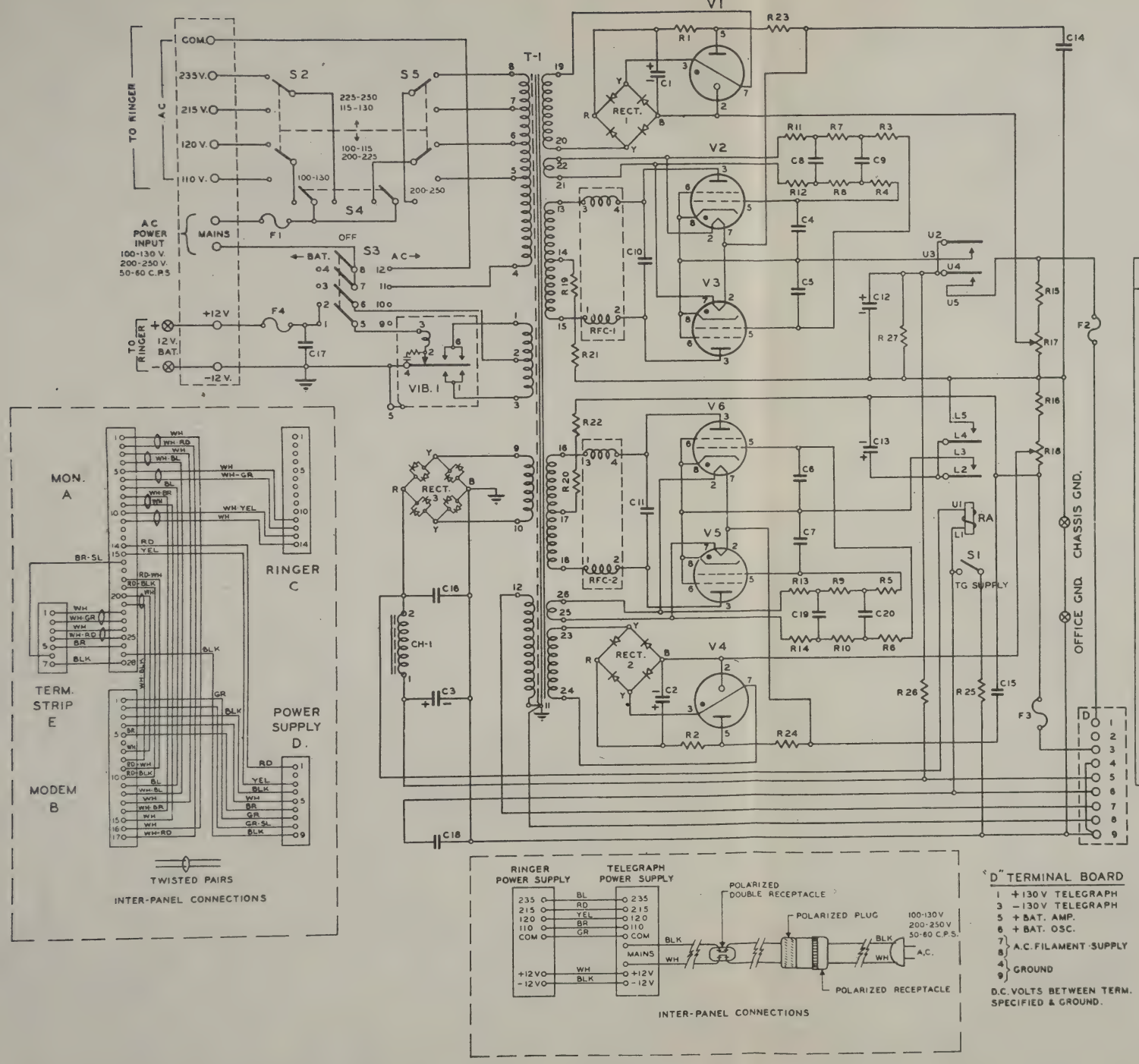



*Figure 47. Ringer unit wiring diagram.*










"D" TERMINAL BOARD

| | |
|---|---|
| 1 | +130 V TELEGRAPH |
| 3 | −130 V TELEGRAPH |
| 5 | + BAT. AMP. |
| 6 | + BAT. OSC. |
| 7, 8 | A.C. FILAMENT SUPPLY |
| 4, 9 | GROUND |

D.C. VOLTS BETWEEN TERM. SPECIFIED & GROUND.

## CIRCUIT LEGEND

| CIRCUIT DESIGNATION | ITEM | DESCRIPTION |
|---|---|---|
| C1, C2, C3 | CAPACITOR | 25 MF, 300 W. V. |
| C4, C5, C6, C7 | CAPACITOR | .005 MF, ±10%, 500 W. V. |
| C8, C9, C19, C20 | CAPACITOR | 0.25 MF, +20% −10%, 500 W. V. |
| C10, C11 | CAPACITOR | 0.03 MF, +20% −10%, 1,000 W. V. |
| C12, C13 | CAPACITOR | 500 MF, 200 W. V. +50% −10% |
| C14, C15 | CAPACITOR | 0.5 MF, +20% −10%, 500 W. V. |
| C16 | CAPACITOR | 25 MF, 300 W. V. |
| C17 | CAPACITOR | 0.02 MF, +20% −10%, 400 W. V. |
| C18 | CAPACITOR | 2.0 MF, +20% −10%, 500 W. V. |
| CH-1 | CHOKE | "B" FILTER CHOKE |
| RFC-1, RFC-2 | CHOKE | R. F. CHOKE |
| F1 | FUSE | 2.0 AMP. |
| F2, F3 | FUSE | 0.25 AMP. |
| F4 | FUSE | 15 AMP. |
| Rect. 1, Rect. 2 | RECTIFIER | SELENIUM |
| Rect. 3 | RECTIFIER | SELENIUM |
| RA | RELAY | 1,100 OHMS, 12 MA |
| R1, R2 | RESISTOR | 10,000 OHMS, ±10%, 2 WATT |
| R3, R4, R5, R6 | RESISTOR | 20,000 OHMS, ±5%, ½ WATT |
| R7, R8, R9, R10 | RESISTOR | 5,100 OHMS, ±5%, ½ WATT |
| R11, R12, R13, R14 R15, R16 | RESISTOR | 56,000 OHMS, ±10%, ½ WATT |
| R17, R18 | POTENTIOMETER | 20,000 OHMS, ±20% |
| R19, R20, R21, R22 | RESISTOR | 100 OHMS, ±10%, 20 WATT |
| R23, R24 | RESISTOR | 10,000 OHMS, ±10%, ½ WATT |
| R25 | RESISTOR | 9,100 OHMS, ±10%, 2 WATT |
| R26 | RESISTOR | 500 OHMS, ±10%, 5 WATT |
| R27 | RESISTOR | 10,000 OHMS, ±10%, 20 WATT |
| S1 | SWITCH | PUSH TO MAKE |
| S2, S5 | SWITCH | D.P.D.T. TOGGLE |
| S3 | SWITCH | 4 POLE, D.T. 3 POSITION |
| S4 | SWITCH | D.P.D.T. TOGGLE |
| T1 | TRANSFORMER | POWER |
| V1, V4 | TUBE | VOLTAGE REGULATOR #OC3/VR-105 |
| V2, V3, V5, V6 | TUBE | GAS TETRODE #2050 |
| VIB-1 | VIBRATOR | 120 C.P.S. |

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*Figure 48. Power supply, schematic diagram.*



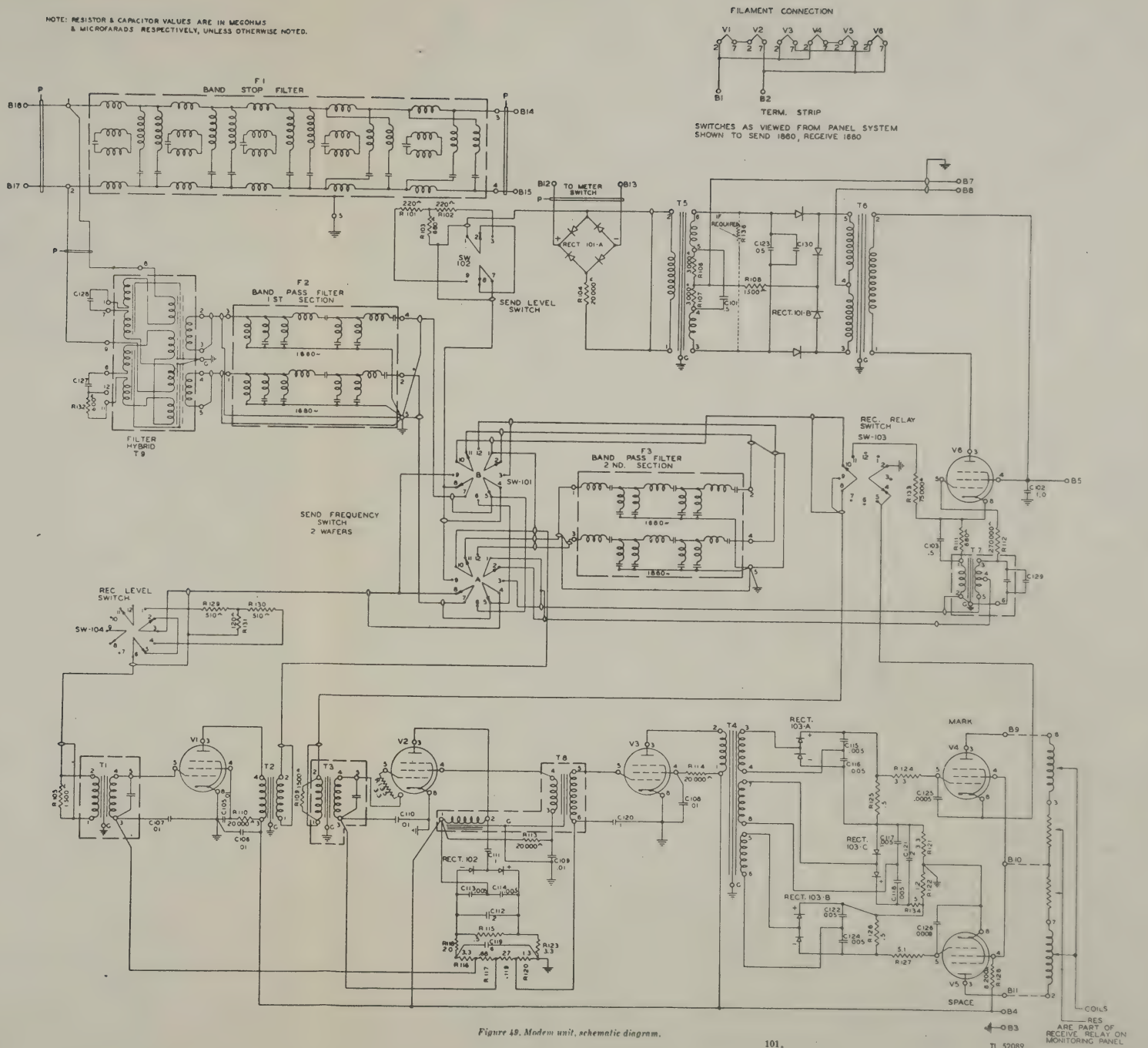
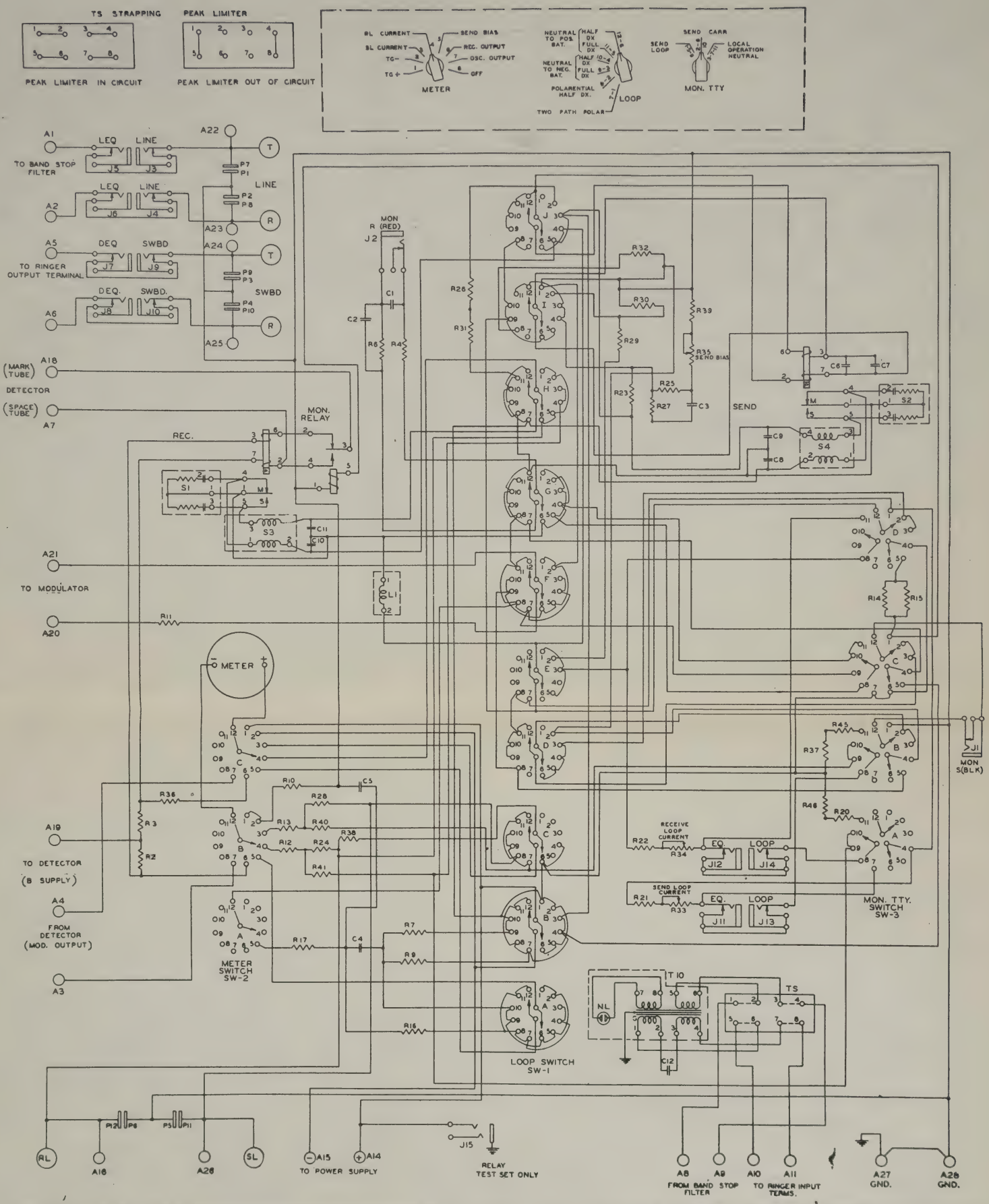



*Figure 49. Modem unit, schematic diagram.*




| Ref.No. | Item | Description | Ref.No. | Item | Description | Ref.No. | Item | Description |
|---|---|---|---|---|---|---|---|---|
| C1 | CAPACITOR | 0.5 MF, 500 W.V. | R4 | RESISTOR | 3,500 OHMS, ± 10%, 20 WATT | R26 | RESISTOR | 100 OHMS, 1 WATT • |
| C2 | CAPACITOR | 2 MF, 500 W.V. | R6 | RESISTOR | 2,500 OHMS, ± 10%, 20 WATT | R27 | RESISTOR | 250 OHMS, ± 10%, 1 WATT |
| C3,7 | CAPACITOR | 3 MF, 500 W.V. | R7 | RESISTOR | 115,000 OHMS, ± 1%, 1 WATT | R29 | RESISTOR | 750 OHMS, ± 5%, 20 WATT |
| C4,5,6 | CAPACITOR | 6 MF, 500 W.V. | R9 | RESISTOR | 53,600 OHMS, ± 1%, 1 WATT | R30 | RESISTOR | 1,000 OHMS, ± 5%, 10 WATT |
| C8,9,10,11 | CAPACITOR | 0.1 MF, 600 W.V., Non-Inductive | R10 | RESISTOR | 520,000 OHMS, ± 1%, 1 WATT | R31 | RESISTOR | 1,500 OHMS, 20 WATT • |
| C12 | CAPACITOR | 1 MF, 500 W.V. | R11 | RESISTOR | 2,800 OHMS, ± 10%, 10 WATT | R32 | RESISTOR | 850 OHMS, 10 WATT • |
| L1 | CHOKE | 1.3 H, 50 OHMS D. C. | R12,13 | RESISTOR | 10,000 OHMS, ± 1%, 1 WATT | R33,34,35 | RHEOSTAT | 3,500 OHMS, 50 WATT |
| METER | MILLIAMMETER | RANGE .5-0-.5 MA, SCALE 100-0-100 | R14,15 | RESISTOR | 24,000 OHMS, ± 5%, 2 WATT | R36 | RESISTOR | 4,500 OHMS, ± 1%, 1 WATT |
| MON RELAY | RELAY | 2,000 OHMS | R16 | RESISTOR | 200,000 OHMS, ± 1%, 1 WATT | R38 | RESISTOR | 600 OHMS, ± 10%, 10 WATT |
| NL | LAMP | NEON | R17 | RESISTOR | 120,000 OHMS, ± 1%, 1 WATT | R39 | RESISTOR | 700 OHMS, ± 10%, 10 WATT |
| P1 to P6 | PROTECTOR BLOCK | CARBON | R20,37,45,46 | RESISTOR | 2,000 OHMS, ± 10%, 20 WATT | S1,2 | SPARK KILLER | 2 CAPACITORS, 0.5 MF,500 W.V., AND 2 RESISTORS, 1,600 OHMS, ± 10%, 0.5 WATT |
| P7 to P12 | PROTECTOR BLOCK | PORCELAIN | R21,22 | RESISTOR | 250 OHMS, ± 10%, 10 WATT | | | |
| REC RELAY | RELAY | 2 WINDINGS, EA 136 OHMS D.C. | R23 | RESISTOR | 4,000 OHMS, ± 10%, 10 WATT | | | |
| SEND RELAY | | | R24,28,40,41 | RESISTOR | 50 OHMS, ± 1%, 1 WATT | S3,4 | R.F.SUPPRESSOR | 2 CHOKE COILS, 16 MH, ± 10% |
| R2,3 | RESISTOR | 200 OHMS, ± 1%, 1 WATT | R25 | RESISTOR | 1,250 OHMS, ± 10%, 10 WATT | T10 | TRANSFORMER | PEAK LIMITER, (1-2) AND (3-4) 14-2 OHMS EA, (5-6) 4,900 OHMS |

• RESISTORS R26,31,32 SHOULD TOTAL 2,460 OHMS, ± 1%.

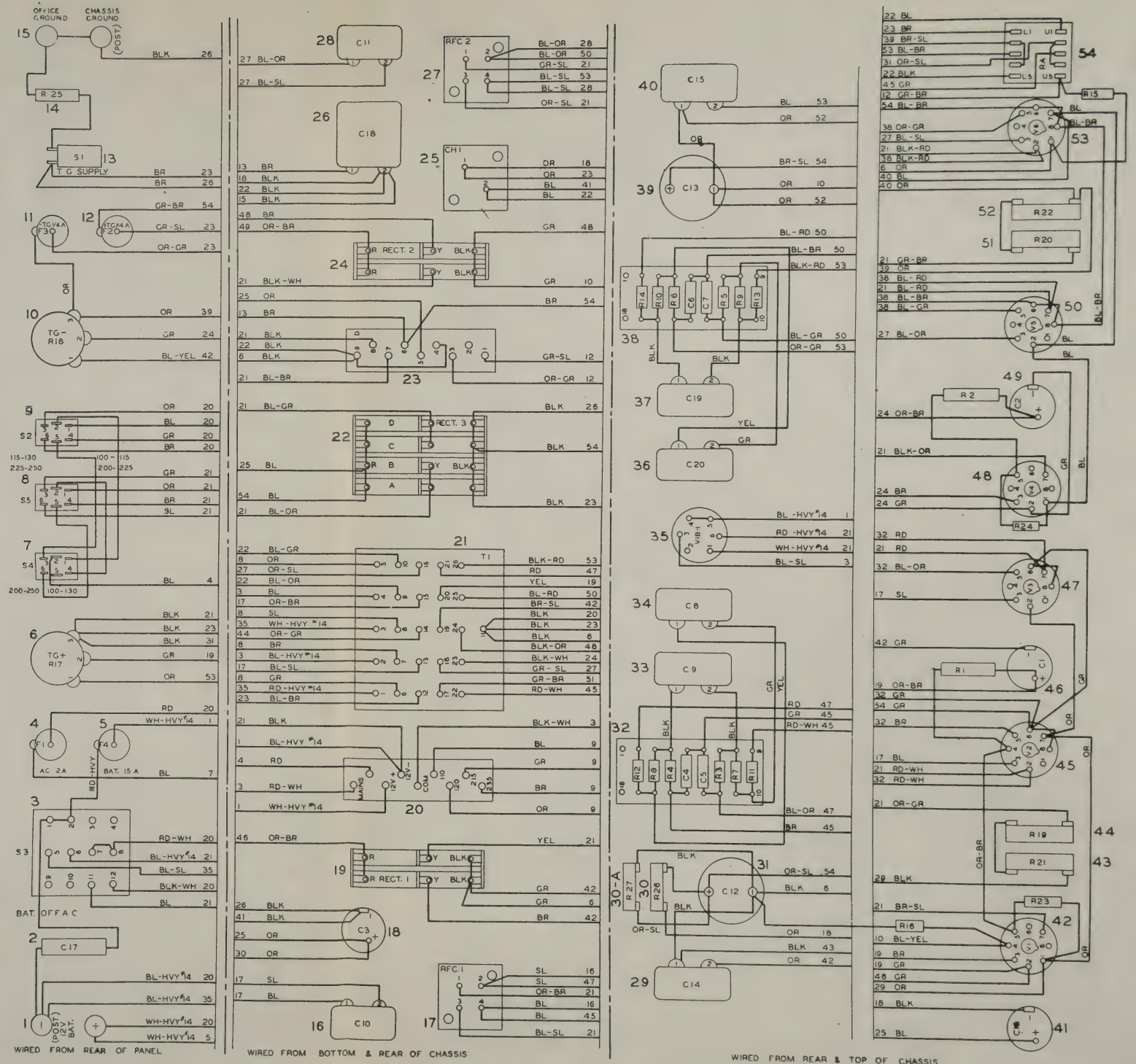



*Figure 51. Power supply, wiring diagram.*

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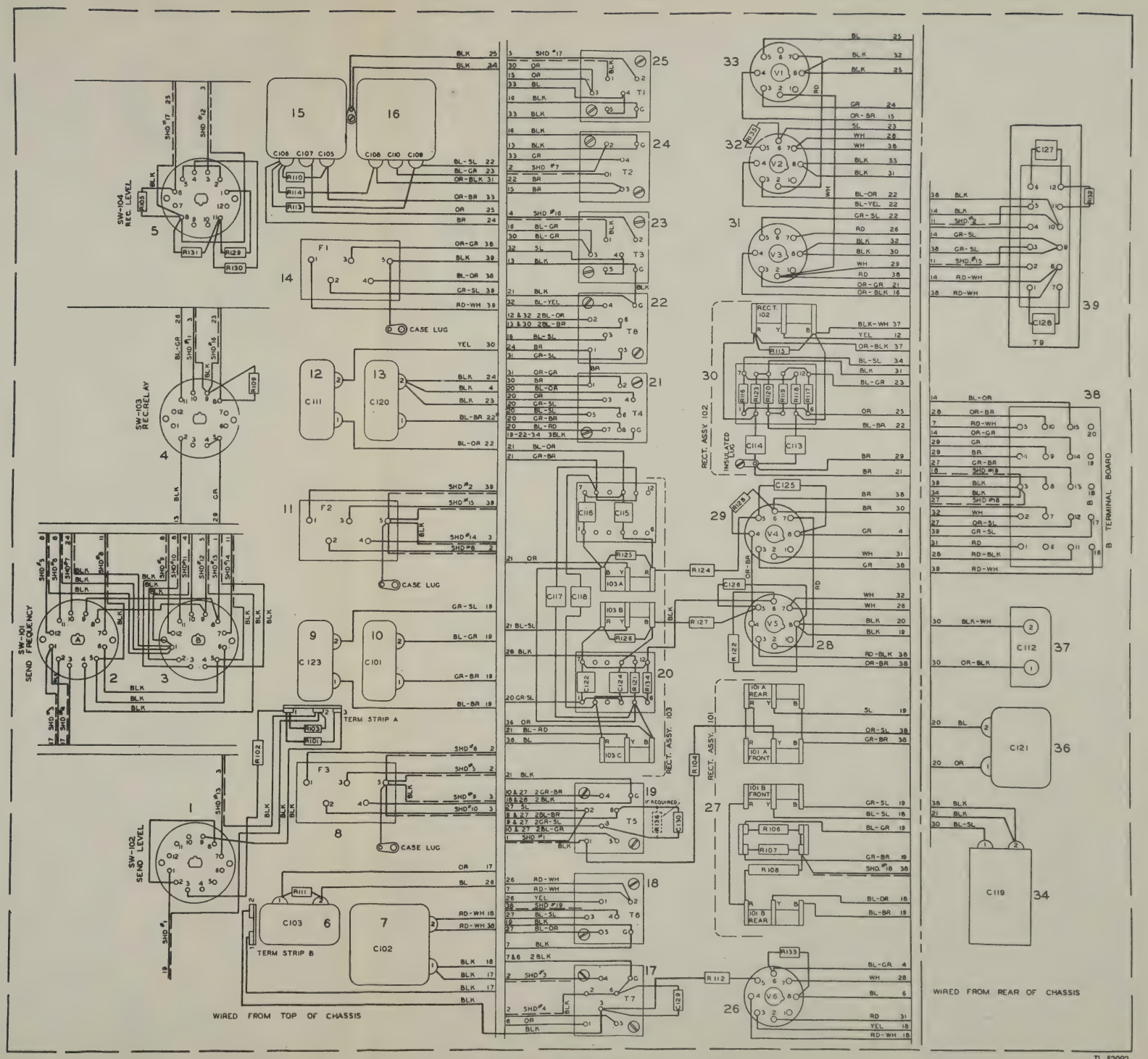



*Figure 52. Modem unit, wiring diagram.*

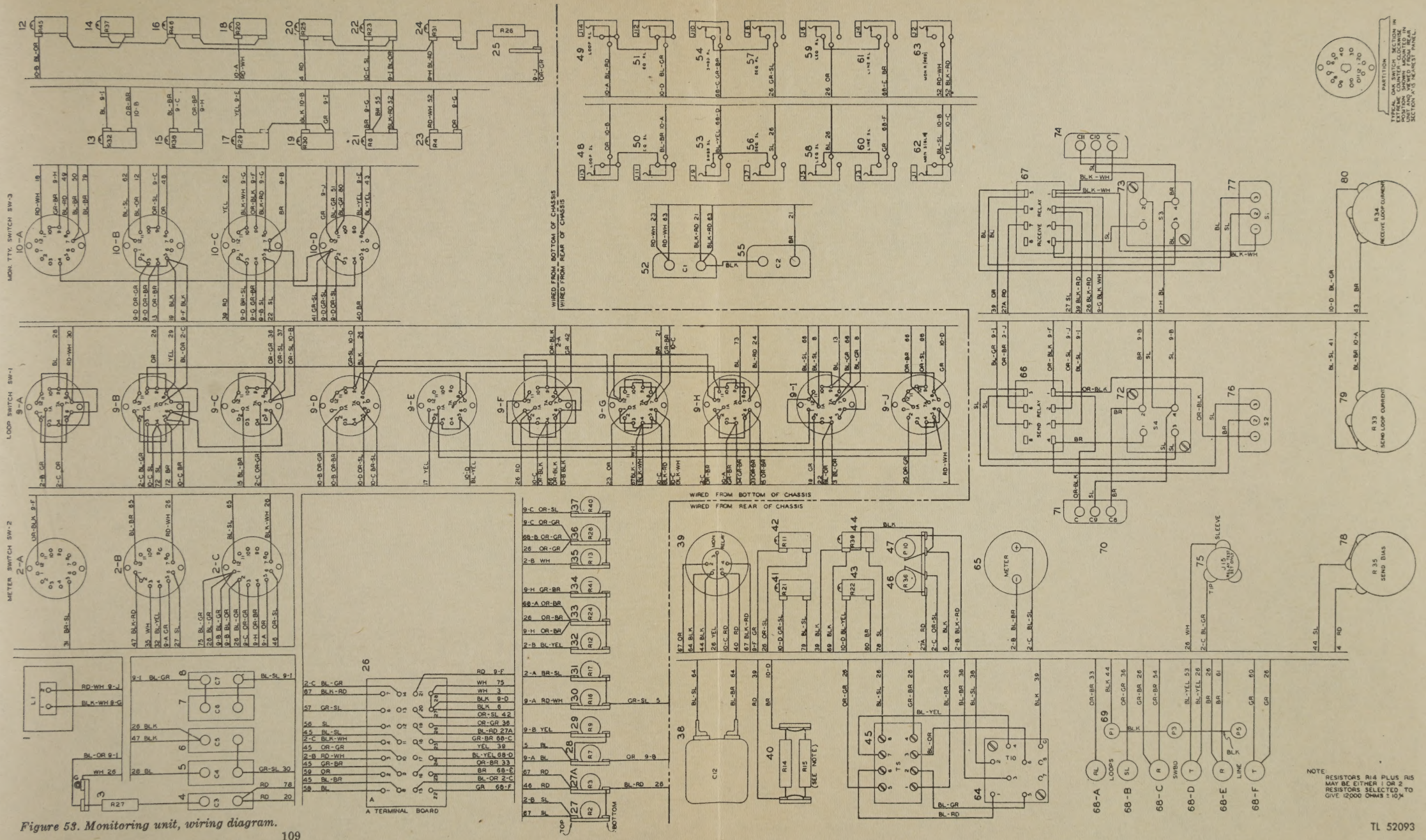



*Figure 53. Monitoring unit, wiring diagram.*