INSTRUCTION BOOK
FOR
MANUAL TELEPHONE SWITCHBOARD
SB-86/P

ORDER NO. 1669-P-51
ORDER NO. 6505-P-51
ORDER NO. 96-P-52

24 September 1954

CONTENTS

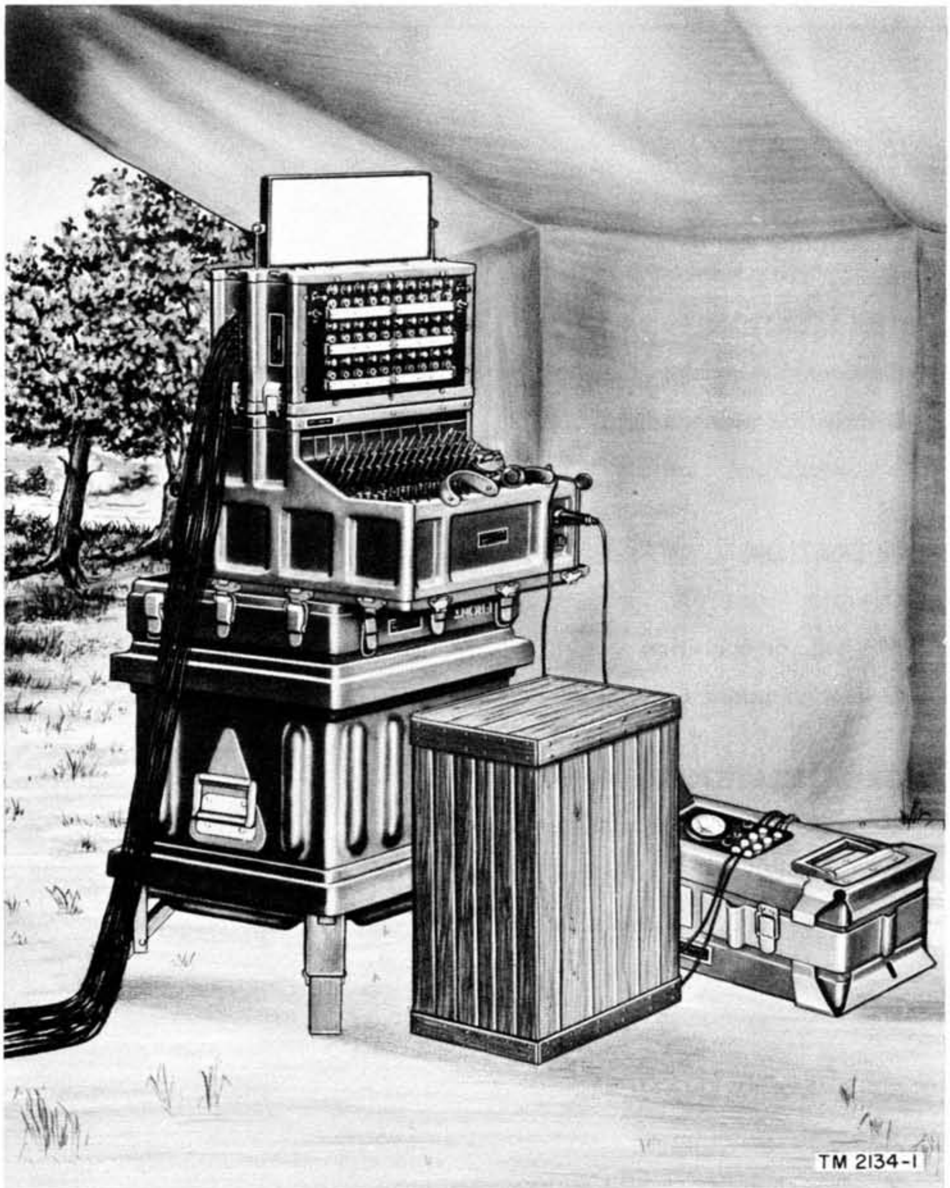

Figure 1. Manual Telephone Switchboard SB-86/P, set up for use.

Note. This instruction book will be replaced by TM 11-2134, Operators Manual, and TM 11-4134, Repair Manual, which, when published, will be listed in SR 310-20-4.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This instruction book is published for the information and guidance of all concerned. It contains the information necessary to install, operate, maintain, and repair Manual Telephone Switchboard SB-86/P. The book includes seven chapters and an index.

b. A list of nomenclature assignments for the major components of Manual Telephone Switchboard SB-86/P is given below. A common usage name is indicated after each component.

Nomenclature	*Common name*
Switchboard Signal Assembly TA-207/P	Jack field section
Cord Telephone Circuit TA-208/P	Cord pack
Operator's Telephone Circuit TA-220/P	Operator's pack
Manual Telephone Switchboard Section SB-248/P	Keyshelf section
Headset-Microphone H-91/U	Operator's telephone set
Power Supply PP-990/G	Power pack

Note. Basic nomenclature followed by (*) is used to indicate all models of an item of equipment covered in this manual. Thus, Telephone EE-8-(*) represents Telephones EE-8, EE-8-A, and EE-8-B.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army equipment and in performing preventive maintenance.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745-45-5 (Army); Navy Shipping Guide, Article 1850-4 (Navy); and AFR 71-4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700-45-5.

c. AF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700-45-5 and AFR 65-26.

d. DA Form 11-246, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Telephone Switchboard), will be prepared in accordance with instructions on the back of the form (fig. 20).

e. DA Form 11-247, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Telephone Switchboard), will be prepared in accordance with instructions on the back of the form (fig. 21).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

The SB-86/P is a portable, field-type, local battery telephone switchboard which can be rapidly installed or dismantled for quick moves. It also can be used to interconnect voice-frequency teletypewriter circuits.

a. One jack field section of 30 jacks is provided for field telephones or trunks to other switchboards. A rotary switch, mounted beneath each jack, provides a selection of common battery or magneto supervision for each circuit. Two of the circuits can be used as trunks to civilian exchange line circuits.

b. The SB-86/P can be expanded to a 60-line switchboard by stacking a second jack field section above the first one.

c. Eight cord packs and the operator's pack are mounted in the keyshelf section. Each cord pack contains two cord circuits.

d. The power pack provides signaling battery and ringing current (par. 14).

4. System Application
(fig. 2)

The relative location of the SB-86/P in an army trunking plan is shown in figure 2. This is a typical telephone system and may be changed as required by the tactical situation.

5. Technical Characteristics

a. Characteristics of the SB-86/P follow:

Lines served .... 30, using 1 jack field section.
60, using 2 jack field sections.

Telephone cord circuits . 16.

Power requirements:

Common battery signaling (CBS) .. 20-26.5 volts dc (5 dry cells in power pack).

Magneto signaling .... 15-26.5 volts dc (5 dry cells in power pack).

Operator's telephone . 3 volts dc (2 dry cells in operator's pack).

Night alarm and panel lamps .... 3 volts dc (2 dry cells in jack field section).

Ringing facilities:

Automatic ringing .... 20 cycles per second (cps) vibrator in power pack.

Manual ringing .... Hand generator in operator's pack.

Protection .... 2 lightning arrestors for each line.

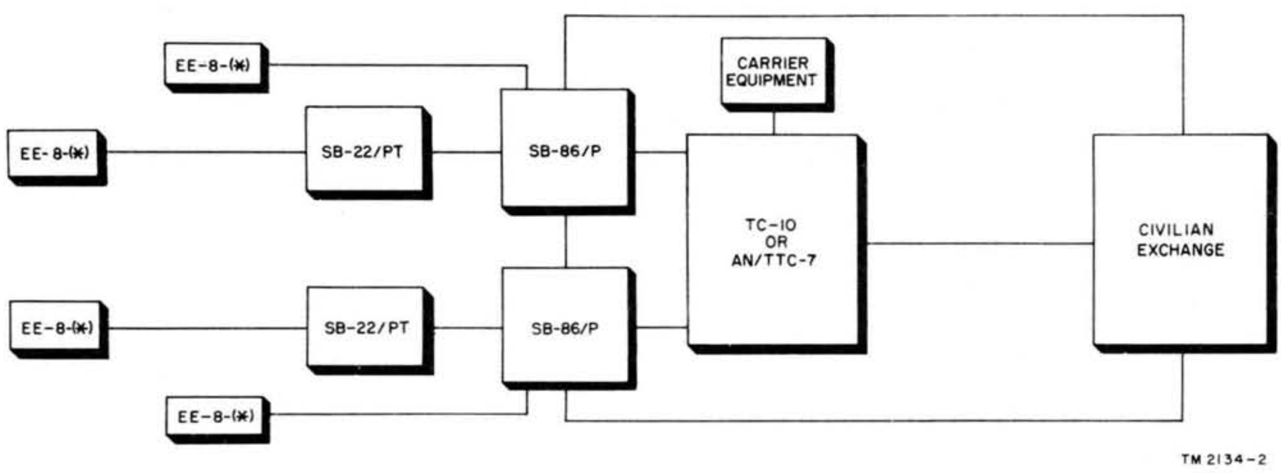

Figure 2. Simplified system block diagram.

Table Error
Common Battery Line should be C
Common Battery Trunks should be T

b. The working limits for the jack field circuits, when used with various types of signaling, are shown in the chart below.

Type of signaling	Line selector switch setting	Working limits	
		Maximum loop (ohms)	Minimum leak (ohms)
Magneto signaling	M	5,000	10,000
Common battery signaling line	T	1,000	10,000
Common battery signaling trunk	C	2,000	10,000
Common battery signaling trunk (civilian)	C	1,000	10,000

6. Packing Data

When packed for domestic or export shipment, the SB-86/P is packed in a single wooden crate as illustrated in figure 13. The size, weight and volume of the domestic and export crated switchboards are shown in the following chart. For detailed instructions concerning the packing and unpacking, refer to paragraph 19.

Packed for	Height (in.)	Width (in.)	Depth (in.)	Volume (cu ft)	Weight (lb)
Domestic	25	21-1/2	29	14.37	235
Export	35-1/4	29-5/8	38-1/2	19.95	300

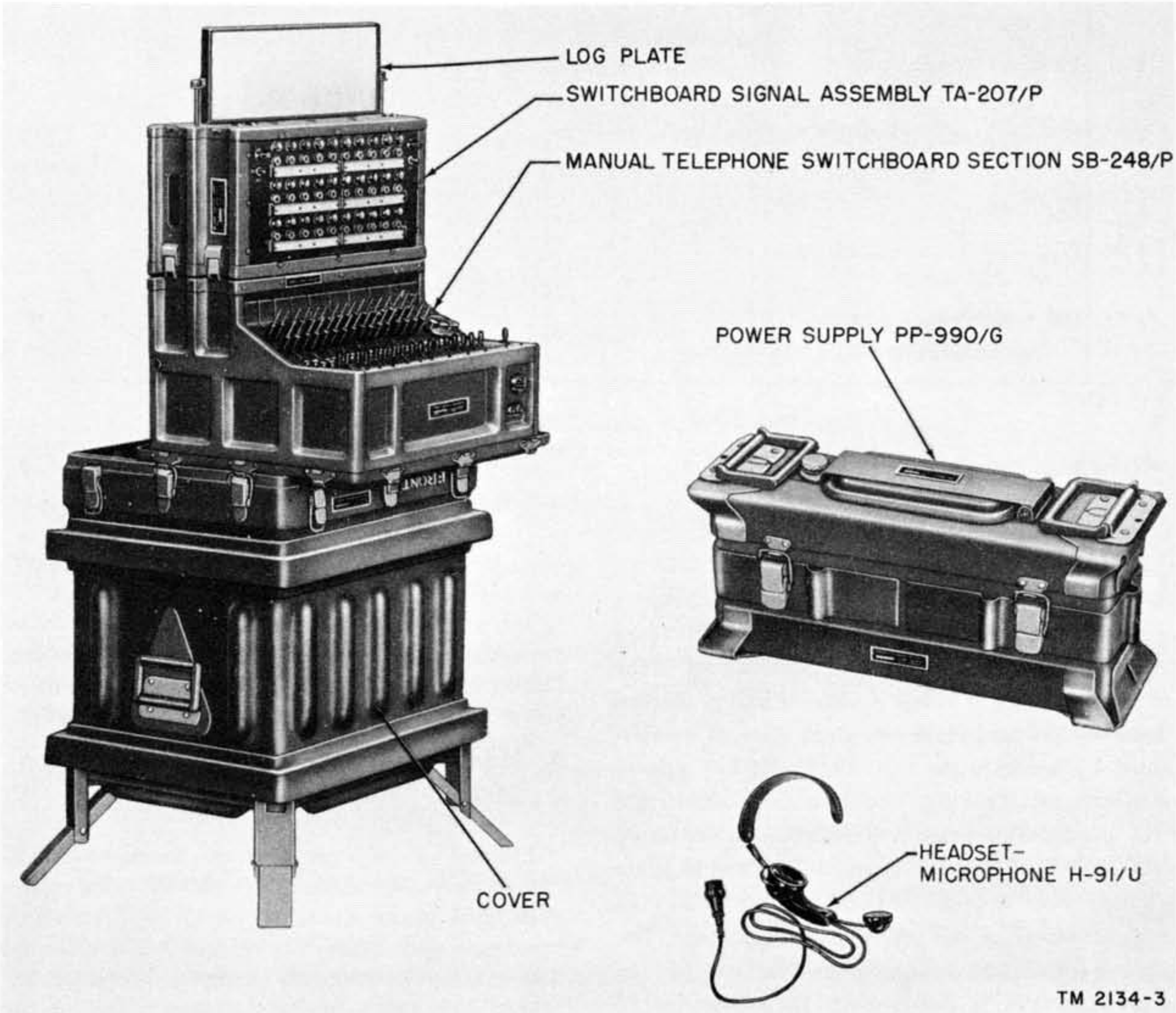

Figure 3. Manual Telephone Switchboard SB-86/P, components less power cords and spare parts.

7. Table of Components for Manual Telephone Switchboard SB-86/P

Quantity	Component	Height (in.)	Width (in.)	Depth (in.)	Weight (lb)
1	Manual Telephone Switchboard Section SB-248/P, containing:	21	23-1/2	18-1/2	65
	1 Operator's Telephone Circuit TA-220/P	10	4	14-1/2	6
	8 Cord Telephone Circuit TA-208/P	10	2	14-1/2	4
1	Three-conductor cord	6 ft (long)	9/32 (dia)		.7
1	Two-conductor cord	6 ft (long)	9/32 (dia)		.5
1	Switchboard Signal Assembly TA-207/P	9-1/4	21	7-1/8	31
1	Headset-Microphone H-91/U				.4
1	Power Supply PP-990/G	10	21	7-1/8	29 (less batteries)
1	Outer cover	22	24	18-3/4	41
1	Log plate (excluding positioning rods)	6-1/4	21	5/8	2
1	Canvas roll (containing spare parts par. 16)				1

Note. This list is for general information only. See appropriate supply publication for information pertaining to the requisition of spare parts.

8. Description of Cover

a. Exterior (fig. 4). The switchboard exterior is an olive-drab, splashproof metal case. The case forms the protective cover for all components of the switchboard when it is not in service and is used as a base for the switchboard when it is in service. Figure 4 illustrates the top, front, and left side of the metal case. The legs, which increase the height of the switchboard when it is installed, are recessed in the top of the metal case and are locked in place by a cam lever. A pressure relief valve is located in the right center of the top of the metal case. The bottom of the case, which forms the base for the keyshelf section is clamped to the cover by 12 trunk-type latches. A carrying handle on each side of the case enables two men to carry the SB-86/P.

b. Interior (fig. 5). The interior of the cover is equipped with rubber silencing pads to prevent the power pack and the keyshelf section from shifting or rattling when packed for storage or transport. Lock rods on each side of the interior secure the power pack in position as illustrated in figure 5.

9. Manual Telephone Switchboard Section SB-248/P

(fig. 6)

Manual Telephone Section Switchboard SB-248/P (keyshelf section) consists of eight replaceable cord packs (par. 10) and one replaceable operator's pack (par. 11) mounted in a steel case. The rear of the keyshelf section is protected by a hinged door which provides mounting for two plastic circuit labels and a canvas bag for the operator's telephone set. Four trunk-type latches are pro-

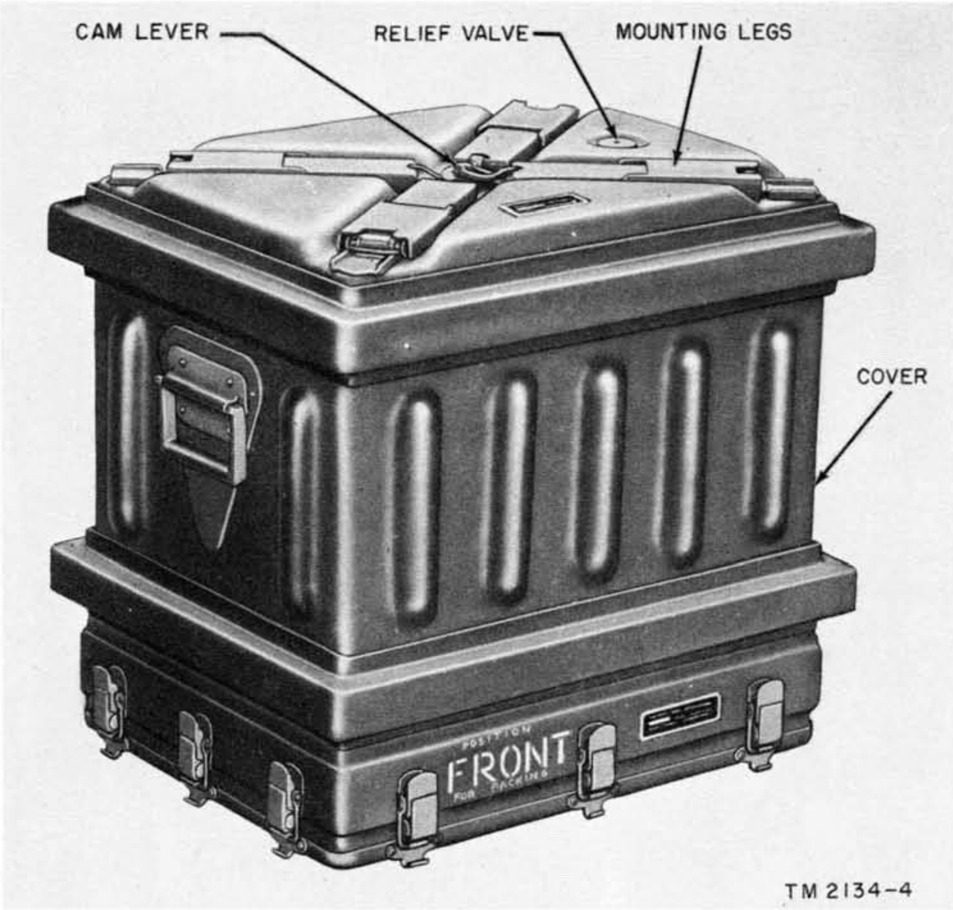

Figure 4. Manual Telephone Switchboard SB-86/P, assembled for carrying.

vided on the top of the keyshelf section for securing the jack field section to the SB-248/P during operation.

10. Cord Telephone Circuit TA-208/P

(fig. 7)

Cord Telephone Circuit TA-208/P (cord pack) contains two complete cord circuits. A single plug-type connector on the rear of the cord pack is used to connect the cord pack to the operator's pack. The cord pack is fastened into the keyshelf section by one captive screw on the front and one on the rear of the cord pack.

11. Operator's Telephone Circuit TA-220/P

(fig. 8 and 9)

Operator's Telephone Circuit TA-220/P (operator's pack) contains the operator's telephone circuit, ringing circuit, trunk signaling circuit, and the direct-current (dc) circuits which distribute the dc to the line and supervisory signals. The controls, switches, and Hand Ringing Generator G-42/PT are mounted on the top of the operator's pack; the operator's telephone set connector and emergency telephone binding posts are mounted on the front. Binding posts on the rear of the operator's pack provide connections for power to the SB-86/P; a terminal strip on the rear of the pack connects the operator's pack to the cord packs.

12. Headset-Microphone H-91/U

(fig. 3)

Headset-Microphone H-91/U (operator's telephone set) is equipped with a headband and may be used either as a headset or a handset. A 5-foot cord provides the connection to the operator's pack. The transmitter support shaft is not adjustable.

13. Switchboard Signal Assembly TA-207/P and Log Plate

(fig. 10)

a. Switchboard Signal Assembly TA-207/P (jack

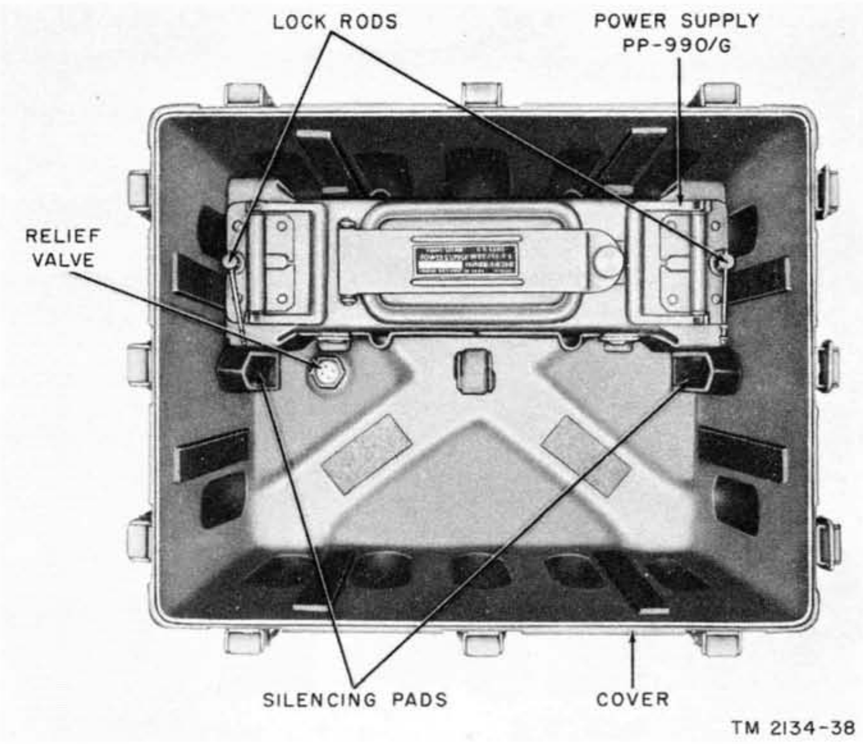

Figure 5. Cover, interior view.

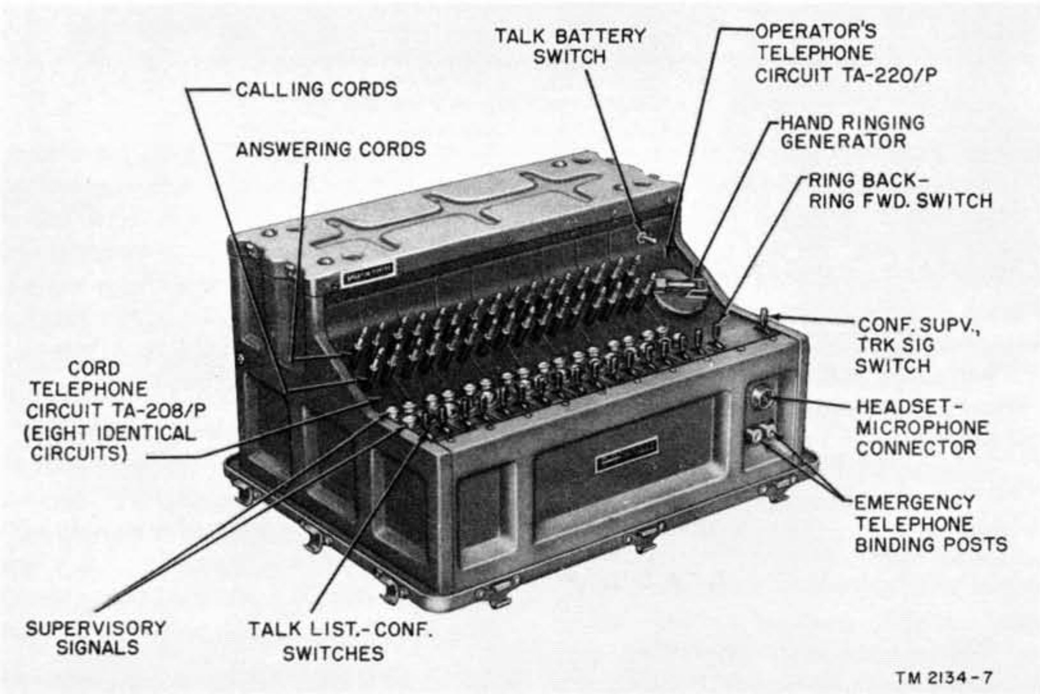

Figure 6. Manual Telephone Switchboard Section SB-248/P (keyshelf section).

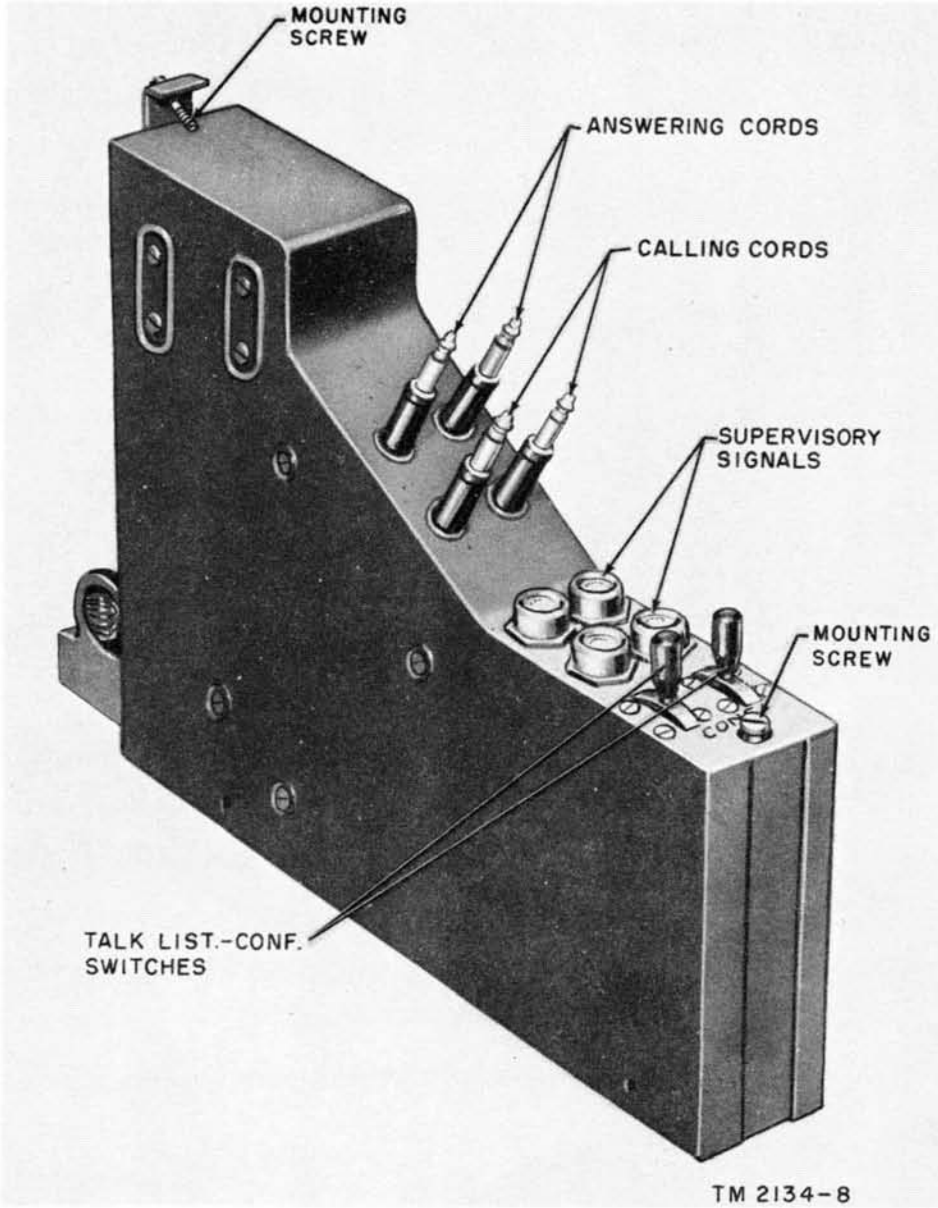

Figure 7. Cord Telephone Circuit TA-208/P (cord pack).

field section) contains 30 complete line circuits. The front panel contains the jacks, line signals, designation strips, panel lamps, and the switches necessary for the operation of the switchboard. Binding posts mounted on the rear panel are provided for connecting the incoming lines to the jack field section. Lightning arrestors on each line protect the equipment and personnel against high-voltage surges. Two latches on each end of the jack field section are used to fasten it to the top of the key-shelf section.

b. A metal log plate for indicating data is mounted on the top of the jack field section by two supporting rods fitted into two holes.

14. Power Supply PP-990/G

(fig. 11)

Power Supply PP-990/G (power pack) is encased in a steel box which contains the switches, voltmeter, binding posts, and compartments for two banks of batteries. One bank of batteries provides dc for the operation of the line and supervisory

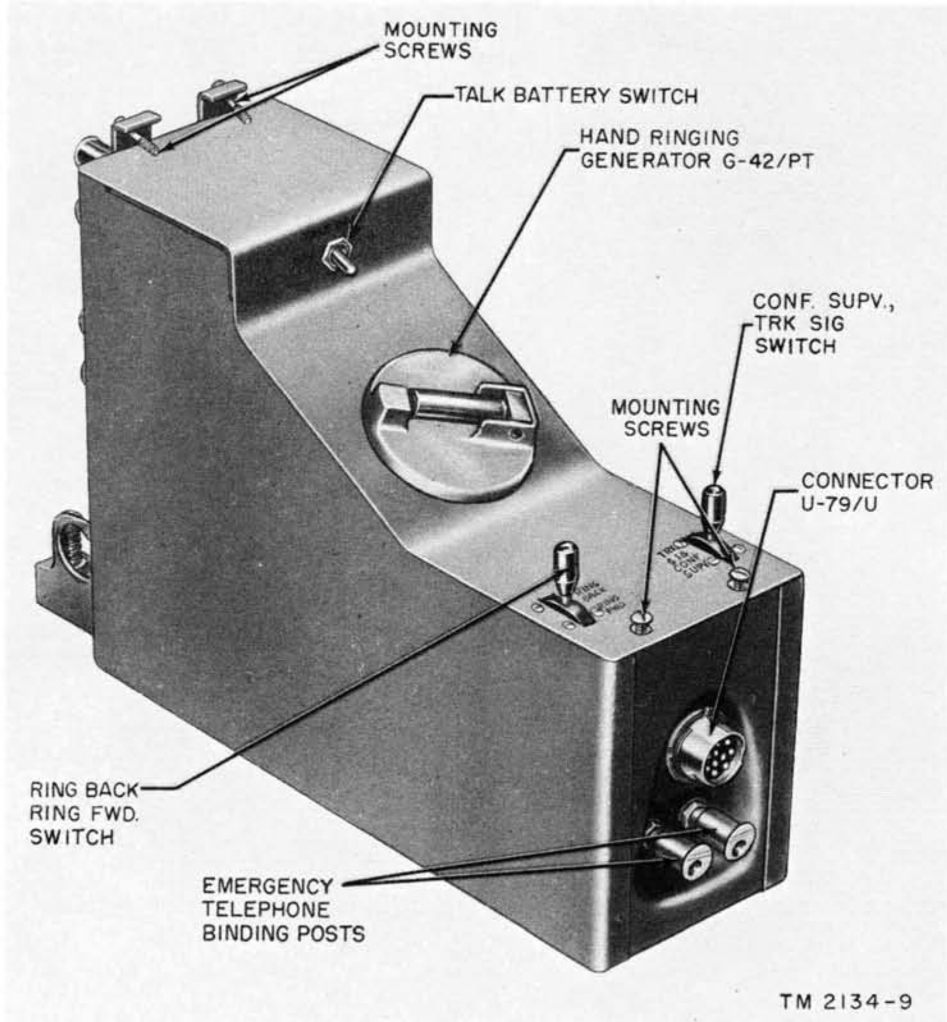

Figure 8. Operator's Telephone Circuit TA-220/P (operator's pack).

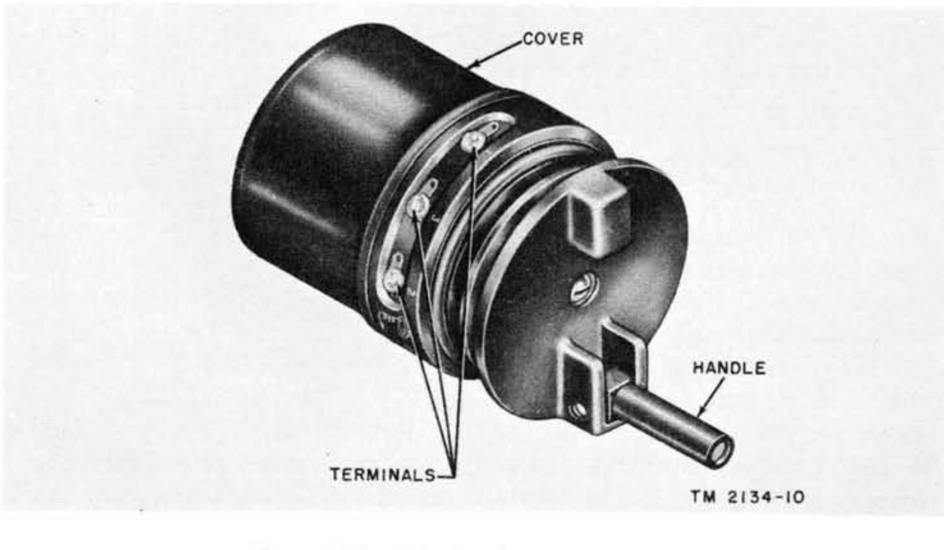

Figure 9. Hand Ringing Generator G-42/PT.

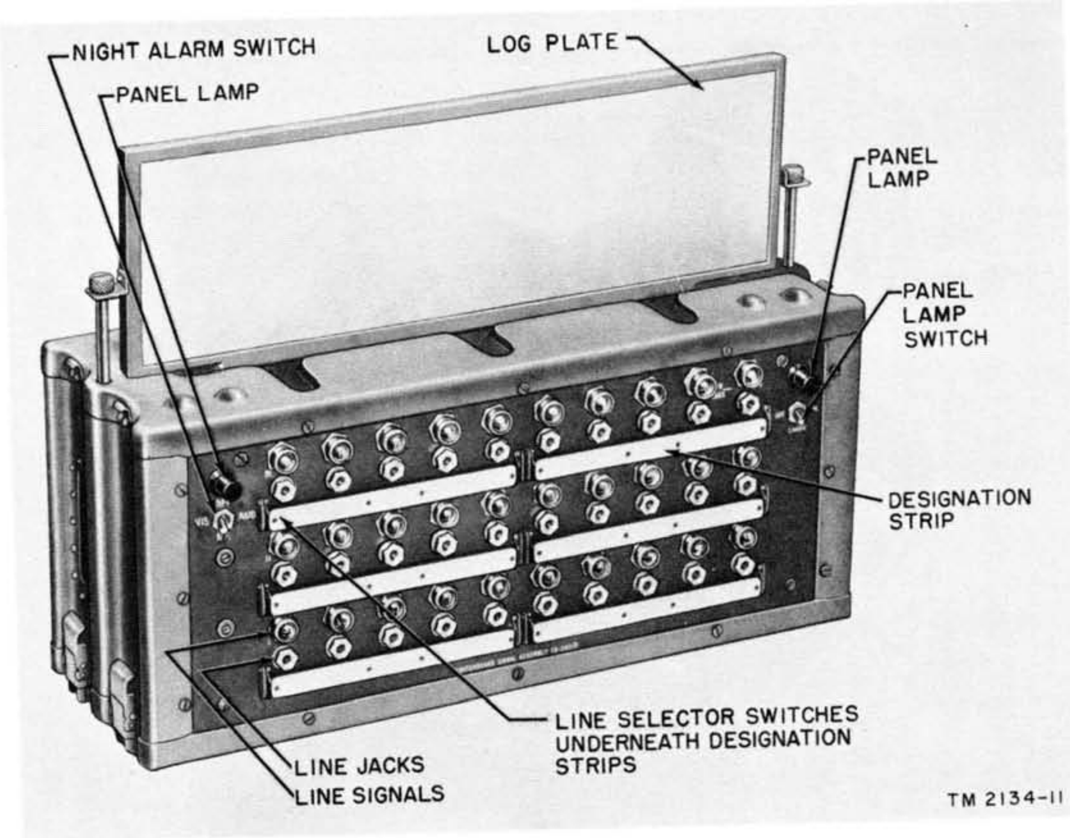

Figure 10. Switchboard Signal Assembly TA-207/P (jack field section).

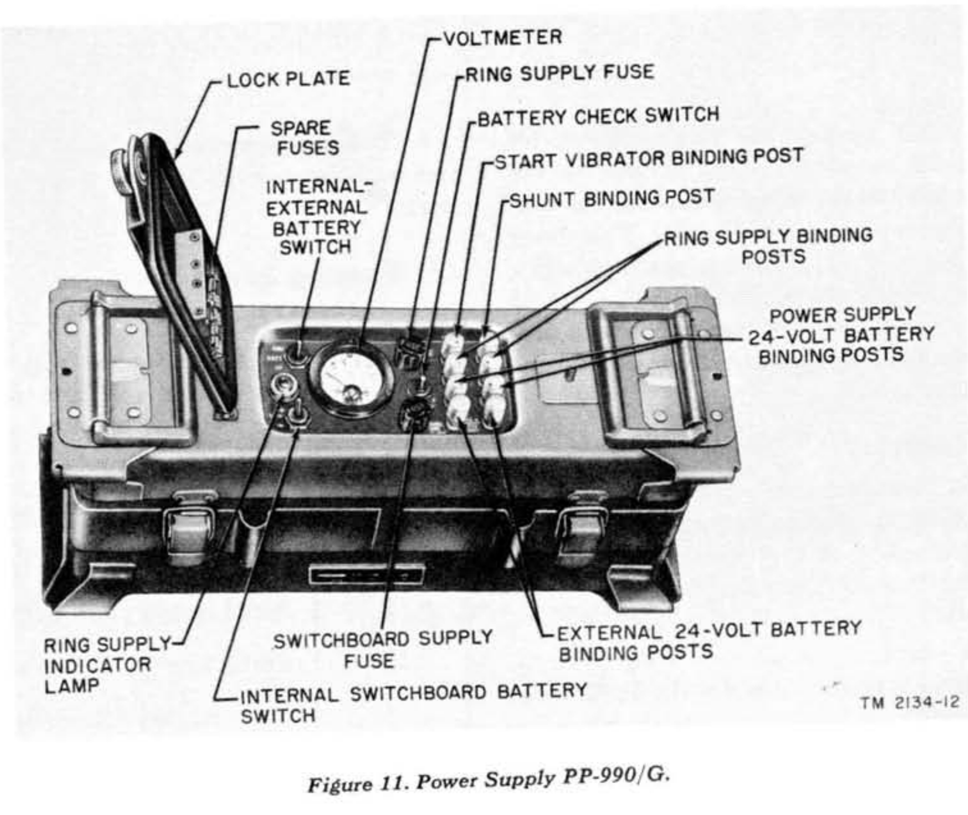

Figure 11. Power Supply PP-990/G.

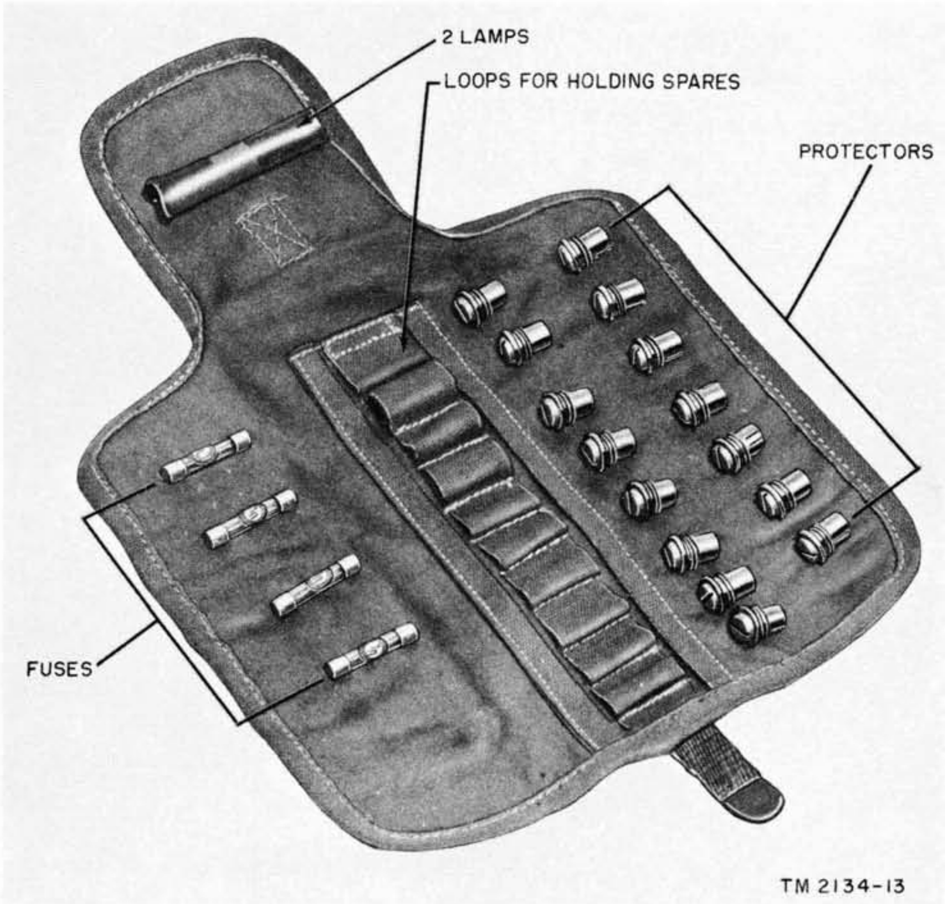

Figure 12. Running spares.

signals; the other powers the ringing converter (vibrator) which supplies ringing current to the SB-86/P for signaling the telephone users. The batteries are not supplied with Manual Telephone Switchboard SB-86/P. The binding posts, switches, and voltmeter, which are mounted on the top of the case, are covered by a gasketed door which provides protection from dirt, dust, moisture, and damage during shipment.

15. Power Cords

a. A 6-foot, two-conductor cord (Sig C stock No. 3E4000.355) is used to connect the ringing current binding posts of the power pack to the ringing current binding posts on the rear of the operator's pack.

b. A 6-foot, three-conductor cord (Sig C stock No. 3E4000.356) is used to connect the dc binding posts on the power pack to the dc binding posts on the rear of the operator's pack.

c. The power cords are packed in the jack field section when the SB-86/P is being transported or stored.

16. Running Spares
(fig. 12)

a. The running spares for the switchboard, which are packed in a canvas roll and placed in the 22-1/2-volt battery compartment of the jack field section, are listed below.

Quantity	Item
2	Panel lamps (jack field section).
15	Protectors (jack field section).
4	1-1/4 ampere (jack field section and operator's pack).

b. The four 1-1/4-ampere fuses mounted on the underside of the power pack cover are spare fuses for Power Supply PP-990/G.

17. Additional Equipment Required

The following equipment is not supplied as part of Manual Telephone Switchboard SB-86/P, but is required for its installation and operation. The batteries listed in the chart below must be requisitioned separately through normal channels.

Quantity	Item
4	Battery BA-30
1	Battery BA-2
10	Battery BA-200/U

CHAPTER 2
INSTALLATION

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

18. Siting

Manual Telephone Switchboard SB-86/P can be installed in any location where adequate shelter is provided for the equipment and the operating personnel. Areas should be selected that are free from excessive amounts of dust and moisture. If possible, the site should have heating facilities to keep the equipment warm and dry in cold weather. The switchboard should be located centrally with respect to the lines and trunks to be served.

19. Uncrating and Unpacking New Equipment
(fig. 13)

Manual Telephone Switchboard SB-86/P may be shipped in an export packing case or a domestic packing case. The instructions in subparagraph *a* below apply to switchboards packed in export packing cases and the instructions in subparagraph *b* below apply to the switchboards packed in domestic packing cases.

a. Step-by-step Instructions for Uncrating and Unpacking Equipment Packed for Export.

(1) Cut or break the steel straps which encircle the wooden packing case.

(2) Remove the nails from the top and sides of the wooden packing case with a nail puller.

(3) Remove the top and sides from the wooden packing case.

(4) Open the heat-sealed vaporproof barrier and remove the corrugated paper cushioning material. Do not damage the barrier material unnecessarily.

(5) Cut or break the steel straps holding the equipment to the double frame pallet. The pallet is fastened to the bottom of the packing case by four hold-down bolts.

(6) Lift the equipment from the pallet.

(7) Remove the manual from the top of the switchboard cover.

b. Unpacking Domestic Packing Cases. The switchboard may be received in domestic packing cases. The domestic packing case consists of a corrugated carton and a wooden packing case. The lumber used for the domestic packing case is not as thick as that used for the export packing case. The wooden case is opened as described in subparagraphs *a*(1) and (2) above.

20. Checking New Equipment

Follow the procedures outlined in subparagraphs *a* through *h* below when checking new equipment for damage that may have been incurred during shipment.

a. Move the SB-86/P to the vicinity where the equipment is to be inspected.

b. Release the 12 trunk-type latches, lift the cover from the keyshelf section and jack field section, and set the cover on the ground with the open end down.

c. If desired, unlatch the jack field section from the keyshelf section for inspecting and convenience in handling.

d. Unlock the switchboard legs and lock them in the extended position as explained in subparagraphs (1) through (3) below.

(1) Release the cam lever (fig. 4).

(2) Rotate the retaining plate until the legs are released.

Caution: Do *not* attempt to turn the cam lever to release the legs; *only* the retaining plate turns.

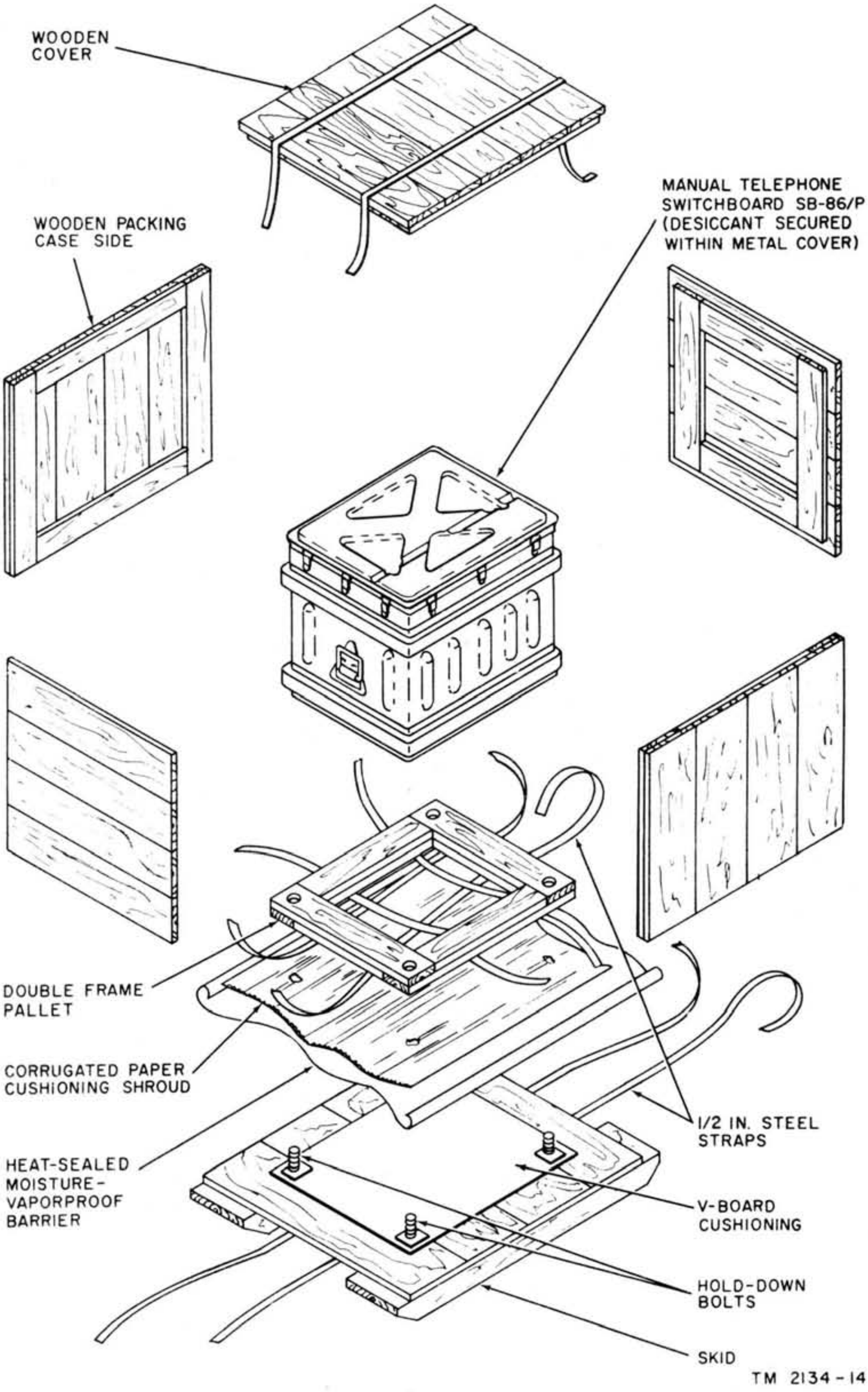

Figure 13. Manual Telephone Switchboard SB-86/P, packaging diagram for export shipping.

(3) Open the legs by swinging them outward until they lock into position.

(4) Inspect the legs, cam lever, and retaining plate for damage that may have been incurred during shipment.

e. Lift the cover from the ground, turn it over, and replace it on the ground with the open end up.

f. Remove the power pack from the inside of the cover (fig. 5) by following the steps outlined in subparagraphs (1) and (2) below.

(1) Unscrew the lock rods until they are free from the lock nuts of the cover. Use the sliding bar handle, mounted on each locking rod, as a lever to turn the rod.

(2) Lift the power pack out of the cover by grasping the handles mounted on top of the power pack.

g. Inspect the exterior of the power pack for damage to the case.

h. Unscrew the knurled nut on the power pack cover, lift the cover, and inspect the binding posts, meter, and switches on the power pack.

Section II. INSTALLATION PROCEDURES

21. General

Personnel installing the SB-86/P should familiarize themselves with the following detailed instructions before attempting to install the various components. In general, the installation consists of placing the components in the correct operating positions (par. 22) and then removing their covers to install the batteries (par. 23) and connecting the necessary wiring and cabling (par. 24).

22. Switchboard Assembly

(fig. 14 and 15)

Move the SB-86/P to the area where it is to be installed and operated. Follow the step-by-step procedures explained in paragraph 20 and then proceed as follows to assemble the switchboard:

a. Place the cover in position (with the open end up) where the switchboard is to be installed. The surface should be as level as possible; however, if a level surface is not available, use small blocks of wood as shims under the legs to level the cover.

b. Place the keyshelf section on the open end of the cover (switchboard base) in either of the two positions described in subparagraphs (1) and (2) below.

(1) Place the switchboard squarely on the base so that the front and rear of the keyshelf sections are flush with the base. Lock the three latches on each side of the switchboard. This method provides very little leg room for the operator.

(2) Place the keyshelf on the switchboard base so that the front of the keyshelf section extends approximately 4 inches to the front of the base as illustrated in figure 15. The front latch on the base should line up with the center latch on the keyshelf section. Lock the two latches on each side of the switchboard. This method provides more leg room for the operator.

c. Place the jack field section on top of the keyshelf section in the space provided and secure it to the keyshelf section with the trunk-type latches on each end of the jack field section.

d. A second jack field section, if available, may be installed by stacking it on top of the first one and securing it with the trunk-type latches on each end of the jack field section. This will provide an additional 30 lines for use with the SB-86/P.

e. Install the log plate on the top of the jack field section as shown in figure 10.

f. Open the rear door of the jack field section by unlocking the camlocs with a screw driver or a thin coin. Lift the door out of the hinged position and lay it on the top of the switchboard to clear the rear of the jack field section.

g. Open the rear door of the keyshelf section by turning the camlocs with a screw driver or thin coin. Lift the door from the hinges and allow it to hang by the cord on each side of the door so that it will clear the rear of the keyshelf section.

h. Open the slide fastener on the two-compartment canvas bag located on the rear door of the keyshelf section, and remove the headband from one compartment and the operator's telephone set from the other compartment.

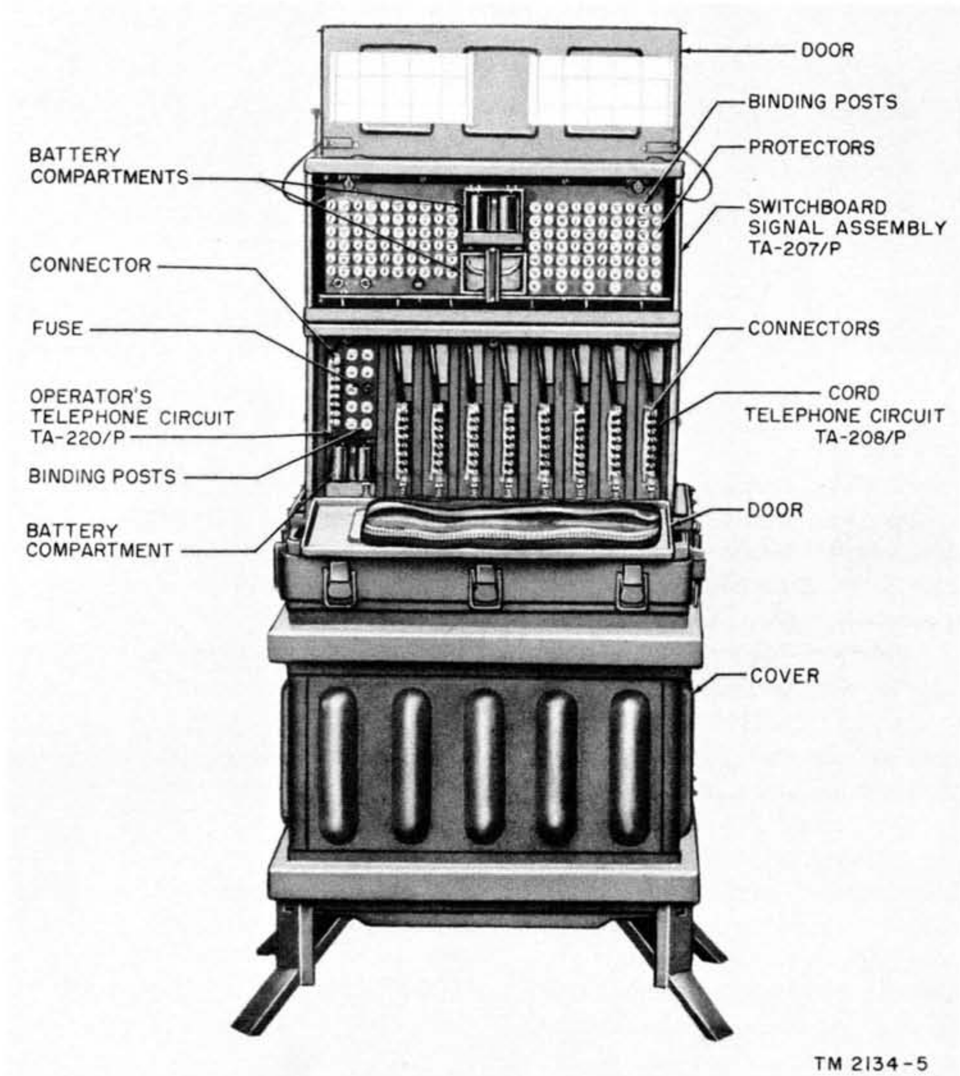

Figure 14. Manual Telephone Switchboard SB-86/P, rear view.

i. Loosen the latch on the lower battery compartment of the jack field section, and remove the canvas roll containing the spare parts for the SB-86/P.

23. Battery Installation

a. Power Pack (fig. 16 and 34). Batteries BA-200/U are installed in the power pack in two banks; an upper bank and a lower bank. The upper bank provides current for the operation of the line and supervisory signals, and the lower bank powers the vibrator which supplies ringing current to the SB-86/P. The step-by-step procedure for installing the batteries in the power pack is outlined below.

(1) Open the four latch fasteners on the top of the power pack.

(2) Lift the cover assembly and power supply chassis from the case. The battery compartments are located on both sides of the power supply chassis.

(3) Each Battery BA-200/U is installed as follows:

(a) Turn the door holder (fig. 34) 1/4 turn so that it releases the lock plate.

(b) Swing the lock plate out until the flange is clear of the slot in the catch plate. The door assembly will open so that the battery can be installed.

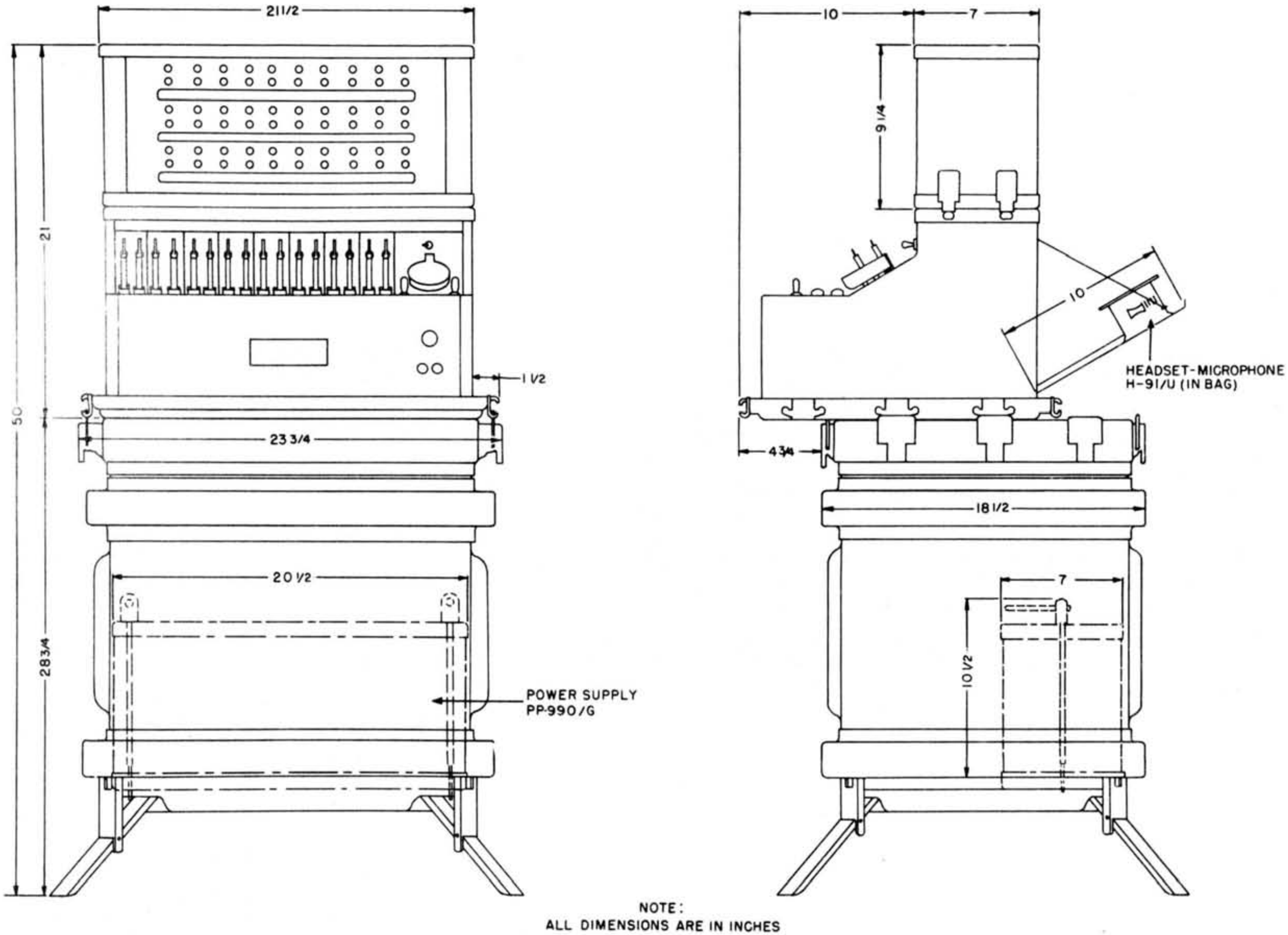

Figure 15. Manual Telephone Switchboard SB-86/P, dimensions of the equipment installed.

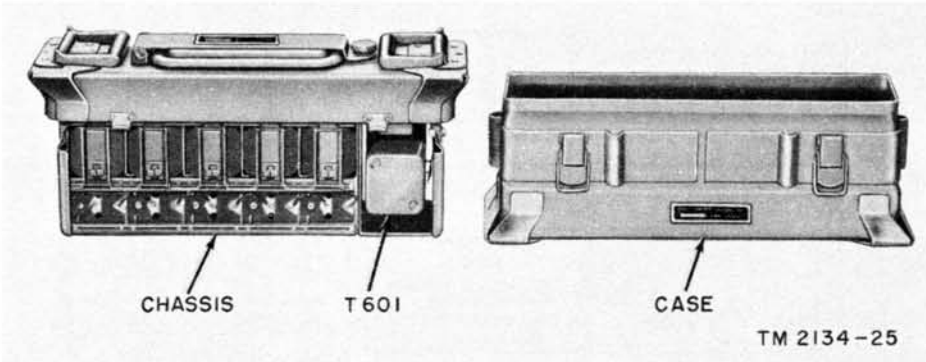

Figure 16. Power Supply PP-990/G, case removed for battery installation.

(c) Insert the battery into the compartment with the terminal end toward the rear of the compartment. Further positioning of the battery is unnecessary because the battery compartment is equipped with circular battery terminals.

Note. Batteries BA-200/U have a wax coating. Be *sure* to remove all traces of wax from the terminals of the batteries before installing them in the power pack. If wax is permitted to collect on the terminals inside the battery compartments, it may cause an interruption of service.

(d) Close and lock the door assembly by reversing the procedure explained above. The door will have to be forced closed since the spring terminals on the battery must be compressed.

b. Replacing Batteries in Power Pack. The batteries in the power pack can be replaced without interrupting the operation of the switchboard. Use the following procedure:

(1) Connect a jumper wire between the binding posts labeled SHUNT on the power pack.

(2) Follow the instructions in subparagraph *a* above to replace either the upper or lower bank of batteries. Do *not* attempt to replace both battery banks at the same time.

(3) Remove the jumper as soon as the battery banks have been replaced because the common source of dc for the vibrator and the line and supervisory signals will cause interference on all of the lines each time the vibrator operates.

c. Operator's Pack (fig. 17). Two Batteries BA-30 are installed in the battery compartment, located in the back of the operator's pack, which supply the dc for the operator's transmission circuit. The step-by-step procedure outlined below is used when installing or replacing the batteries.

(1) Open the rear door of the keyshelf section.

(2) Place the bottom (positive terminal) of the battery against one of the spring terminals on the bottom of the compartment.

(3) Press the battery down, thereby compressing the spring terminal; push the top of the battery into the compartment so that the top terminal will make contact with the top terminal in the compartment.

d. Jack Field Section (fig. 17). Two Batteries BA-30 are installed in the upper battery compartment, located in the rear of the jack field section, to supply the dc for the operation of the night alarm and the lights on the face of the switchboard. Use the procedure outlined in subparagraph c above to install the batteries in the jack field section.

e. Battery Supply Not Using Power Pack (fig. 17). When it is necessary to operate the SB-86/P without a power pack, dc for the line and supervisory signals is supplied from Battery BA-2 (22-1/2 volts) installed in the lower battery compartment in the rear of the jack field section. Use the step-by-step procedure below when installing or replacing the BA-2.

(1) Open the rear door of the jack field section.

(2) Loosen the two screws that hold the battery retaining bracket, and slide the

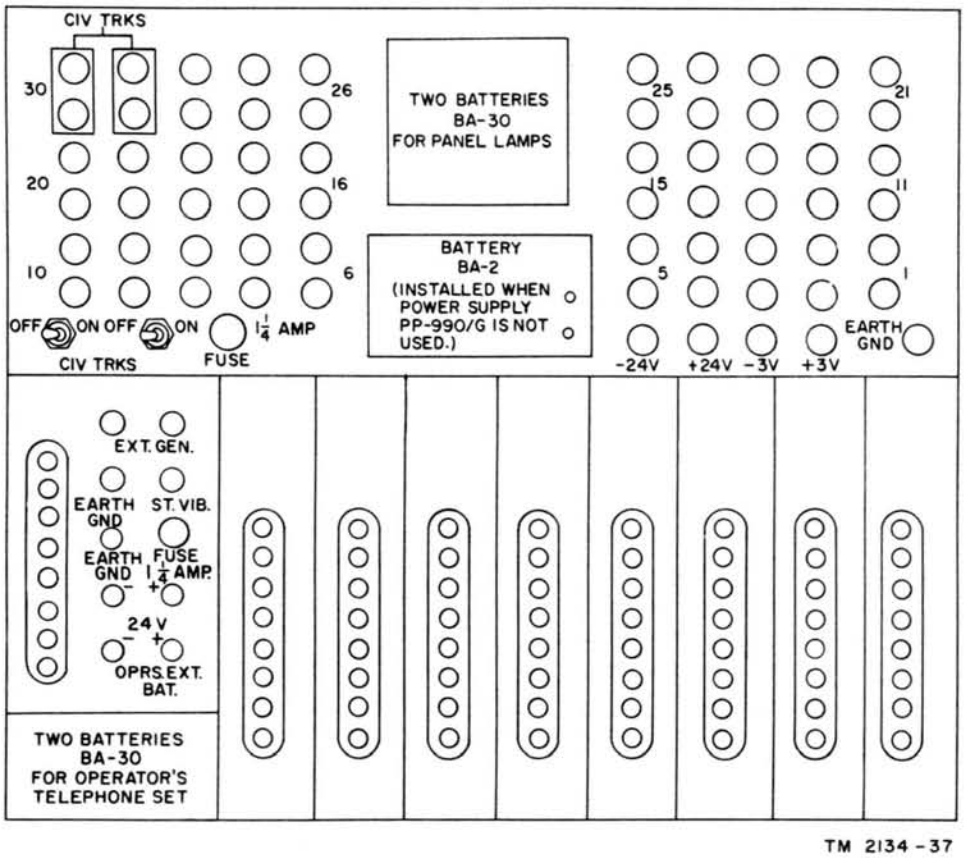

Figure 17. Jack field section and keyshelf section showing panel markings and battery compartments.

bracket down to release it from the upper screw.

(3) Place the battery in the compartment so that the leads are exposed. Position the battery so that the negative lead will reach the —24V binding post, and the positive lead will reach the +24V binding post.

(4) Replace the battery retaining bracket, and tighten the screws.

(5) Connect the battery leads to the —24V and +25V binding posts.

f. Use of Storage Batteries. When storage batteries and charging equipment are available, they may be used to supply the dc to the power pack and to the operator's pack in order to conserve the dry cell batteries. Use the following step-by-step procedure to connect the storage batteries to the SB-86/P.

(1) Select enough fully charged storage batteries to supply 24 volts (two 12-volt batteries, or four 6-volt batteries).

(2) Connect the storage batteries in series.

(3) Connect the 24-volt battery to the **EXT. BATT.** binding posts on the power pack observing polarity.

(4) Operate the battery switch to the **EXT.** position.

(5) Remove the conductor which is connected to the —24V binding post. This prevents ringing tone from being picked up from the vibrator placed on the telephone lines through the battery supply. This happens when the vibrator and the switchboard have a common battery supply.

(6) Connect a separate 24-volt storage battery (subparagraph (1) and (2) above) to the —24V and +24V binding posts on the rear of the operator's pack to provide dc for the operation of the line and supervisory signals.

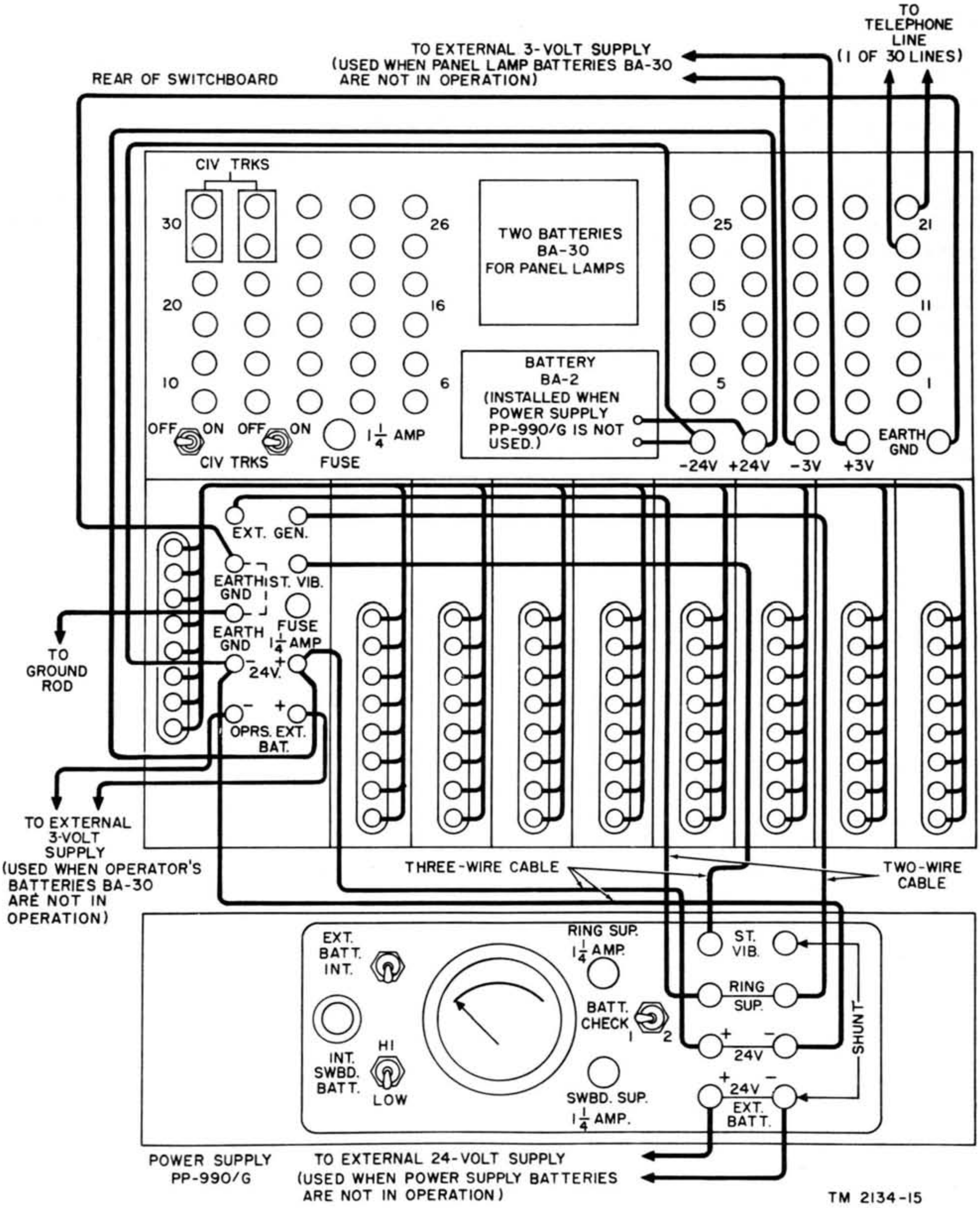

Figure 18. Manual Telephone Switchboard SB-86/P, cording diagram.

24. Connections

(fig. 18)

Make the following connections when the switchboard is being installed. Use field Wire WD-1/TT or some other suitable conductor for the connections that have no cable or wire provided. Pass all wires through the gasketed openings at the ends of the case and through the fanning rings to the terminals so that the rear doors may be closed to protect the equipment during inclement weather. To make the connections, remove about 1/2 inch of insulation from each of the conductors and twist the strands together to prevent spreading. Depress the spring-loaded binding post and insert the skinned portion of the wire into the hole in the cap of the binding post; release the binding post and allow the wire to be engaged by the knurled edges inside the binding post.

a. Grounding.

(1) Connect a wire from the EARTH GND binding post on the jack field section to the upper EARTH GND binding post on the operator's pack.

(2) Connect a wire from the lower EARTH GND binding post on the operator's pack to the ground rod.

(3) For further information on grounding procedures, refer to TM 11-676, Grounding Procedures and Protective Devices.

b. Battery and Ringing Supply to SB-86/P (With Power Pack).

(1) Connect two wires from the −24V and +24V binding posts on the jack field section to the corresponding binding posts on the operator's pack.

(2) Connect the three-conductor rubber-covered cable from the power pack to the operator's pack.

(*a*) Connect the white lead from the −24V binding post on the power pack to the corresponding binding post on the operator's pack.

(*b*) Connect the black lead from the +24V binding post on the power pack to the corresponding binding post on the operator's pack.

(*c*) Connect the red lead from the ST. VIB. binding post on the power pack to the corresponding binding post on the operator's pack.

(3) Connect the two-conductor rubber-covered cable from the RING SUP. binding posts on the power pack to the EXT. GEN. binding posts on the operator's pack.

c. Battery Supply (Without Power Pack).

(1) Connect two wires from the −24V and +24V binding posts on the jack field section to the corresponding binding posts on the operator's pack.

(2) When external 3-volt batteries are used, connect them to the −3V and +3V binding posts on the jack field section (properly poled) and to the OPRS. EXT. BAT. binding posts on the operator's pack.

d. Battery and Ringing Supply from Storage Batteries.

(1) *Ringing supply.*

(*a*) Connect the batteries to the power pack as explained in paragraph 23*f*.

(*b*) Make all other connections, except the three-conductor rubber-covered cable, as explained in subparagraph *b* above. Do *not* connect the lead to the −24V binding posts.

(2) *Battery supply.* Connect the 24V battery supply to the −24V and +24V binding posts on the rear of the operator's pack to provide the dc necessary for the operation of the line and supervisory signals.

e. Telephone and Trunk Circuit Line Wires.

(1) Connect each pair of line or trunk wires to the assigned pair of line or trunk binding posts (1-28) located on the back of the jack field section. This assignment normally will be made by the organizational wire chief.

(2) Connect the commercial or civilian trunks to lines 29 and 30. These lines are specially equipped to provide service to a commercial or common battery switchboard. If no commercial trunks are provided, lines 29 and 30 can be used for magneto lines.

f. Operator's Telephone Set. Connect the operator's telephone set to the receptacle located in the front of the operator's pack. To do this, position the connector on the operator's telephone set cord on the receptacle, and tighten the knurled nut. Tighten the knurled nut only fingertight.

25. Connection of Teletypewriter Line Circuits

Manual Telephone Switchboard SB-86/P may be used to interconnect teletypewriter circuits by using special equipment. The equipment and its use are explained in TM 11-2239, Telegraph-Telephone Terminal AN/TCC-14. The same method is used to connect the teletypewriter lines to the SB-86/P as is described in paragraph 24e for telephone lines.

26. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 19 for uncrating, unpacking, and checking the switchboard.

b. Check a used or reconditioned switchboard for tags or other indications pertaining to defects or changes in the wiring and parts of the equipment. If any changes have been made, note these changes in the manual and, if possible, on the circuit label.

Section III. PREOPERATIONAL CONTROLS

27. General

Paragraphs 28 and 29 list the controls and instruments, and their functions, which must be operated by the installer before the installation is complete. These controls include the battery switches, line selector switches, and trunk circuit switches. Paragraph 30 is a detailed explanation for setting the controls.

28. Switchboard Signal Assembly TA-207/P

(fig. 10 and 17)

Control	Function
Line selector switches	Arrange the circuit to provide the type of service desired.
CIV. TRKS. OFF-ON switches (lines 29 and 30)	Prepare associated line circuit to place a dc holding bridge on line when operator inserts plug into line jack (line switch is in M position). Used on trunks to civilian manual switchboard. Lines 29 and 30 may be used the same as any other line. The civilian trunk connection is an optional feature available only on lines 29 and 30.

29. Power Supply PP-990/G

(fig. 18)

Controls and instruments	Function
BATT. EXT.-INT. switch	Switches battery supply leads to external or internal battery connections.
BATT. CHECK switch	Places voltmeter across either battery. (See fig. 38.)
INT. SWBD. BATT. HI-LOW switch	Switches one dry Battery BA-200/U of internal battery (upper group) in or out of switchboard supply to provide limited control of voltage.
Voltmeter	Indicates battery voltage.
Indicator lamp	Indicates when the vibrator is operating.

30. Control Settings and Indications

a. Line Selector Switches (A, fig. 19). The line selector is a three-position thumb-wheel switch located behind the hinged designation strip and below the associated line jack. A circuit selector switch is provided for each line circuit. The thumb wheel extends through the front panel and may be rotated in either direction to obtain the proper setting. Subparagraphs (1) through (3) explain each position of the switch.

(1) The line selector switch is operated to the C position when the line circuit is to be used for common battery signaling. When the line selector switch is in this position, the calling party lifts the handset from the hookswitch and the line signal is operated from the 24-volt battery supply at the SB-86/P. The transmission (talking) battery *must* be supplied at the telephone set.

(2) The line selector switch is operated to the M position when the line circuit is to be used as a magneto line. When the circuit selector switch is in this position,

the calling party *must* operate the hand ringing generator on the telephone set to operate the line signal.

(3) The line selector switch is operated to the T position when the line circuit is to be used for a common battery signaling trunk. When the line selector switch is in this position, the distant switchboard operator operates the line signal by inserting the calling cord of one of the cord circuits into the associated jack.

b. Civilian Trunk Switch (fig. 18). The civilian trunk switches (CIV. TRKS. OFF-ON) which are located on the rear of the jack field section, are provided on lines 29 and 30. When either of these lines is connected to a civilian trunk circuit, which is to be operated as a common battery trunk, the associated trunk switch is operated to the ON position. When the line circuit is to be operated under these conditions, the associated *line selector switch must* be operated to the *M position.*

c. External-Internal Battery Switch (fig. 11 and 18). The external battery switch (BATT. EXT.-INT.) which is located on the panel of the power pack, is operated to the EXT. position when external batteries are used with the power pack. When Batteries BA-200/U are installed in the power pack, the switch must be operated to the INT. position.

d. Battery Check Switch (fig. 11 and 18). The battery check switch (BATT. CHECK) is located on the panel of the power pack. The switch is operated to position 1 to check the voltage of battery A (upper bank) and to position 2 to check the voltage of battery B (lower bank). The voltage of an external battery is checked by operating the switch to position 1.

e. Internal Switchboard Battery Switch (fig. 11 and 18). The internal switchboard battery switch (INT. SWBD. BATT. HI-LOW) is located on the panel of the power pack. This switch normally is operated to the LOW position. If the voltmeter reading for battery A bank is below 20 volts, it is operated to the HI position. When it is operated from the LOW position to the HI position, the switch adds a 6-volt battery in series with battery A to increase the voltage of battery A.

f. Voltmeter (fig. 11). The voltmeter is located in the center of the power pack panel and indicates the voltage of the internal and external batteries when the battery check switch is operated (subpar. e above).

g. Indicator Lamp (fig. 11). The indicator lamp is located on the power pack panel and is lighted by the vibrator when ringing current is being supplied to the SB-86/P.

CHAPTER 3
OPERATION

Section I. OPERATOR'S CONTROLS

31. General

Paragraphs 32 through 34 list the controls and instruments and their functions. These controls must be operated by the switchboard operator during the operation of the SB-86/P. Paragraph 34 is a detailed explanation of the operation of each control.

32. Switchboard Signal Assembly TA-207/P
(A, fig. 19)

Control	Function
N. A. VIS-OFF-AUD switch	Provides selection of visible or audible night alarm signals to operator on line circuits. Has neutral OFF position.
LAMPS OFF-ON switch	Closes and opens circuit of panel lamps. When panel lamps are used for illumination purposes, they cannot be used as a visible night alarm signal.
Line signals (1-30)	Indicate incoming line signal.
Line jacks (1-30)	Permit connection of cord to line.

33. Cord Telephone Circuit TA-208/P
(B, fig. 19)

Control	Function
TALK LIST.-CONF. switches (two for each cord pack)	TALK LIST.: Permits operator to talk during progress call. CONF.: Interconnects cord circuits for conference call.
Supervisory signals (two for each cord circuit, four for each cord pack)	Provides supervison for front and rear cords.
Answering cords (two for each cord pack)	Used to answer incoming calls.
Calling cords (two for each cord pack)	Used to ring called party, and to connect called party and operator (if necessary) to calling party.

34. Operator's Telephone Circuit TA-220/P
(B, fig. 19)

Control	Function
CONF. SUPV.-TRK SIG swich	Used to supervise conference calls and ring for common battery operation.
RING FWD.-RING BACK switch	Selects direction of ringing: front cord (calling) or rear cord (answering).
TALK BATT. OFF-ON switch	Closes talking battery to operator's telephone circuit.
Hand generator crank	Provides an emergency source of ringing current.

35. Operator's Control Settings

a. *Jack Field Section* (A, fig. 19).

(1) The night alarm switch (N.A. VIS-OFF-AUD) is a three-position toggle switch located in the upper left corner of the front panel. This switch should be operated when the traffic load is light or when the operator is away from the switchboard. When operated to the AUD position, a buzzer sounds when a line signal operates; when it is operated to the VIS. position, the panel lights are lighted, indicating an incoming call.

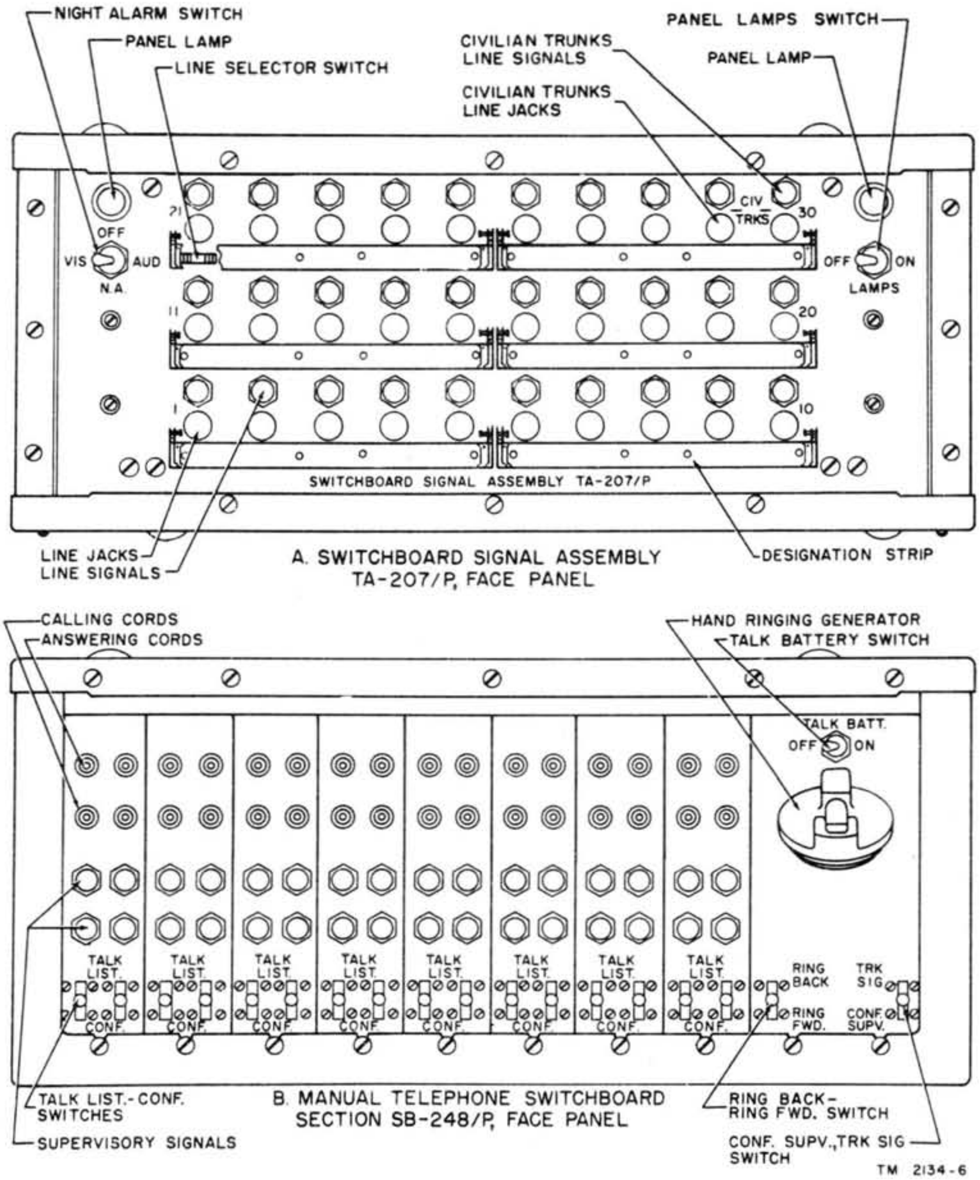

Figure 19. Jack field section and keyshelf section, showing operator's controls.

(2) The panel lamp switch (LAMPS OFF-ON) is located in the upper right corner of the front panel. This switch controls the panel lamps that can be used to illuminate the front panel and the keyshelf. When the panel lamps are being used to illuminate the switchboard, they cannot be used as visual night alarm signals.

b. Keyshelf Section (B, fig. 19)

(1) The operator's battery switch (TALK BATT. OFF-ON) is located at the top of the operator's pack. This switch controls the battery supply to the operator's transmission circuit. It must be operated to the **ON** position so that the operator can transmit. The switch must be operated to the **OFF** position, to conserve the battery, when the switchboard operator is not transmitting.

(2) The hand ringing generator is located on the operator's pack below the operator's battery switch. It provides ringing current for the SB-86/P when the power pack is not used.

(3) The conference supervisory and trunk signaling (CONF. SUPV.-TRK. SIG)

switch is located in the right front corner of the operator's pack.

(a) When operated to the CONF. SUPV. position, the operator can monitor a conference call without being heard.

(b) When operated to the TRK SIG position, the switch signals the operator at the distant switchboard over a common battery trunk.

(4) The RING BACK-RING FWD. switch is located in the left front corner of the operator's pack. It is used to signal either the called party or the calling party. When the switch is operated to the RING FWD. position, ringing current is connected to the calling cord; when it is operated to the RING BACK position, ringing current is connected to the answer cord. This occurs if the switch is operated at the same time that the TALK LIST.-CONF. switch (subpar. (5) below) is in the TALK LIST. position.

(5) A TALK LIST.-CONF. switch located at the front of the keyshelf section, is provided for each cord circuit. Each switch is in line with the associated cord and supervisory signals.

(a) When operated to the TALK LIST. position, the switchboard operator can talk and listen to the calling and called parties. The switch also is operated to this position when it is necessary to signal either party.

(b) When the switch is operated to the CONF. position, the cord circuit is connected to the conference circuit.

Section II. METHODS OF OPERATION

36. Operating Procedures

a. General.

(1) When both cords are returned to the plug well, the supervisory signals operate to *black*. This applies to all operations.

(2) On common battery signaling lines and trunks, a cord supervisory signal may, under certain conditions, fail to show disconnect *(white)* if all five encircling signals are operated *white*. The clearing of adjoining cord circuits will allow the signal to function properly. On a common battery signaling line and trunk, the line signal may blink or stay *white* if a call is abandoned before the operator plugs in.

(3) If the TALK LIST.-CONF. switch is in the TALK LIST. position, the signals either will go *black* if they are in the *white* position, or remain *black* if they are in the *black* position.

(4) To ring the calling party (originating party), operate the TALK LIST.-CONF. switch to the TALK LIST. position and the RING BACK-RING FWD. switch to the RING BACK position. To ring the called party, operate the TALK LIST.-CONF. switch to the TALK LIST. position and the RING BACK-RING FWD. switch to the RING FWD. position.

b. Completing Calls between Field Telephones on Magneto Signaling Lines and Trunks.

(1) When the originating station initiates a call, the visual signal in the associated line circuit operates to *white*. The night alarm signal also operates if the N.A. switch is in either the VIS or AUD position.

(2) Operate the cord circuit switch of an idle cord circuit to the TALK LIST. position. Insert the plug of the associated answering cord (rear) into the calling party's line jack. The line signal should go *black*.

(3) Obtain the number of identification of the desired station. The operator's TALK BATT. switch must be in the ON position to supply power to the operator's telephone set.

(4) Insert the plug of the calling cord (front) of the same cord circuit into the line jack of the called party. The TALK LIST.-CONF. switch remains in the TALK LIST. position.

(5) Ring the called station by either of the following methods:

(*a*) Operate the ringing switch on the operator's pack to the **RING FWD.** position, if the power pack is connected to provide power ringing.

(*b*) Operate the ringing switch in the operator's pack to the **RING FWD.** position and turn the crank of the hand generator if the power pack is not used.

Note. All ringing is done with the TALK LIST.-CONF. switch in the TALK LIST. position.

(6) Restore the TALK LIST.-CONF. switch to the neutral position, after the call is answered.

(7) The magneto signaling stations ring off when the conversation is finished. The associated supervisory signals in the cord circuits will go *white*.

(8) Pull down the cords and *restore the plugs to the plug well*. The supervisory signals will go *black*.

c. Completing Calls Between Field Telephones on Common Battery Signaling (CBS) Lines. Calls on CBS are handled in the same manner as for magneto signaling lines except that less supervision is required by the operator.

(1) Ring the called party in the same manner as listed for the magneto signaling line.

(2) Restore the TALK LIST.-CONF. switch to the neutral position; the supervisory signal of the called party will go *white* (if the called party has not answered). The signal will go *black* when the called party answers.

(3) Replace the handsets on the hookswitch at the station telephones; the associated supervisory signals in the cord circuit will go *white*. This indicates to the operator that the conversation is finished.

(4) Pull down the cords in the same manner as listed for magnetic signaling lines.

d. CBS Trunk (Calls between Two Manual Telephone Switchboards SB-86/P). The local lines may be either magneto or CBS. The procedure for handling a local incoming call is the same for magneto or CBS. The switch of the cord circuit involved will be in the TALK LIST. position, and the plug of the answering cord will be in a local line jack. The operator has already determined that the call must be completed over a CBS trunk to a second Manual Telephone Switchboard SB-86/P. The plug of the calling cord (front) of the associated cord circuit must be inserted into the trunk jack, and the CONF. SUPV.-TRK SIG switch must be operated to the TRK SIG position.

(1) This will cause the trunk signal of the distant switchboard to go *white*. The originating operator may cause it to flash by repeated operation and restoral of the CONF. SUPV.-TRK SIG switch between the TRK SIG and neutral position.

(2) The operator at the distant switchboard completes the call to the called line in the same manner as another incoming call.

(3) Either operator may disconnect the cords by pulling them down when the supervisory signal associated with the local line goes *white*. The first operator to pull down the cords will cause the supervisory signal associated with the trunk at the distant switchboard to go *white*. The supervisory signals of the associated cord circuit go *black* when the plugs are returned to the plug seat. However, the trunk line signal at the end which disconnected first, remains *black* until another call is initiated at the distant end of the trunk. When the signal goes *white*, the operator at the other switchboard pulls down the cords and the circuits are normal.

Note. This switchboard contains a supervisory signal locked-in disconnect feature. If the calling and answering cords are removed from one switchboard and the second switchboard operator *fails* to *disconnect*, a *new call* initiated by the first operator, over the same trunk, will *fail* to have any effect on the *supervisory signals* of the *second switchboard*. When the second operator disconnects, the line signal of the trunk being called by the first operator will operate to *white*.

e. Civilian Trunk (CIV. TRKS.) Option Line 29 or 30 Only (Manual Telephone Switchboard SB-86/P to Civilian Manual Common Battery Switchboard 24 or 48 Volts). The local lines may be either magneto or CBS lines or trunks. The procedure for handling the initiation of a call, therefore, will be the same as described for magneto or CBS.

(1) The switch of the cord circuit involved will be in the TALK LIST. position, and the plug of the answering cord will be in the jack of the calling line.

(2) The operator has already determined that that the call must be completed over a trunk connected to a civilian manual common battery switchboard.

(3) The plug of the calling cord (front) must be inserted into the line jack of either line 29 or 30 which has been connected to a civilian manual common battery switchboard. A holding coil, in the jack field section, places a dc bridge on the trunk to seize the central office equipment. The operator of the civilian manual common battery office answers the incoming trunk signal and completes the call.

(4) The supervisory signal of the *local line* will go *white* when the local party disconnects to notify the operator to pull down the cords. Restoration of the plugs to the plug well causes the supervisory signals to go *black*.

f. Conference Connection. A conference is established by connecting three or more lines to the conference circuit. Only *one* conference circuit may be established at a *time*.

(1) Ring each line of the desired conference group and inform each party to stand by for conference.

(2) Connect the conference lines together by operating the associated TALK LIST.-CONF. switches to the CONF. position. Any number of cord circuits may be switched to the conference circuit. Each cord circuit provides facilities for connecting two lines to the conference circuit. The answering cord is used to connect one party and the calling cord is used to connect another party to the conference circuit.

(3) Monitor the conference connection without disturbing the cord circuits by operating the CONF. SUPV.-TRK SIG switch in the operator's pack to the CONF. SUPV. position.

(4) Pull down the cords when the supervisory signals go *white*. Return the plugs to the plug seat; the signals will go *black*.

(5) If there is an odd number of participants, use the answering cord to make the last connection.

37. Emergency Operation

a. If no power supply is available and the operator's telephone set becomes inoperative and no replacement is available, a field telephone may be used as an operator's telephone.

(1) Disconnect the operator's telephone set from the operator's pack during such emergency.

(2) Connect the field telephone to the spring-loaded binding posts at the front of the operator's pack.

b. Use the generator on the operator's pack, if possible. If the generator on the field telephone is used while attached to the operator's pack binding posts, the operator cannot get directional ringing over the front or rear cords. If only the generator of the switchboard is bad, but the operator's telephone set is good, the field telephone must be connected across the EXT. GEN. binding posts in the rear of the operator's pack. This will permit directional ringing.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

38. General

When operating Manual Telephone Switchboard SB-86/P in regions where extreme cold, heat, humidity, moisture, or dust conditions prevail, special precautions must be taken to keep the equipment in operating condition at all times. Instructions for minimizing the effect of these unusual operating conditions are given in paragraphs 39 through 41.

39. Operation in Arctic Climates

When possible, house and use the equipment in a heated shelter. If the equipment has been exposed to the cold, it will sweat until it reaches room temperature. This condition also arises when the equipment warms during the day after exposure during a cold night. If moisture collects on the equipment, dry it thoroughly before attempting to operate the unit.

40. Operation in Desert Climates

The main problem when operating the equipment in desert climates is to prevent dirt, dust, and sand from filtering into the equipment. If possible, house and use the equipment in a dustproof shelter. If a suitable shelter is not available, make the shelter as dust free as possible. To do this, hang wet sacking over the windows and doors, cover the inside walls with heavy paper, and secure the side walls of tents with sand to prevent them from flapping in the wind.

41. Operation in Tropical Climates

When operated in tropical climates, the equipment should be operated in a building or shelter. The high relative humidity of such climates often causes moisture to condense on the equipment whenever the temperature of the equipment becomes lower than that of the surrounding air. Inspect and clean the equipment frequently to keep it free from condensed moisture, corrosion, and fungus growth. Keep the equipment as dry as possible.

CHAPTER 4
ORGANIZATIONAL MAINTENANCE

Section I. ORGANIZATIONAL MAINTENANCE SERVICES

42. Tools and Materials

a. Tool Equipment TE-73 is used but not supplied with the SB-86/P. The tools contained in Tool Equipment TE-73 are listed in Department of the Army Supply Catalog SIG-6-TE-73.

b. Multimeter TS-297/U is used but not supplied with the SB-86/P. Instructions for using the TS-297/U are covered in TM 11-5500, Multimeter TS-297/U.

43. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working condition so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring. See AR 750-5, Maintenance Responsibilities and Shop Operation.

44. General Preventive Maintenance Techniques

Most preventive maintenance techniques pertain to specific areas of preventive maintenance, such as inspection of specific parts, and are covered thoroughly in later sections. However, the following general instructions should be helpful.

a. Use #0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except the electrical contacts, moisten the cloth or brush with Solvent, Dry Cleaning (SD); then wipe the parts dry with a cloth.

(2) Clean electrical contacts with a burnisher or a toothpick moistened with carbon tetrachloride. Never touch electrical contacts with the fingers.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. See that adequate ventilation is provided.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

d. Use electrical tape to make temporary repairs to frayed, cut, or damaged insulation.

e. Tighten all loose assembly screws and apparatus mounting screws.

45. Use of Preventive Maintenance Forms
(fig. 20 and 21)

a. The decision as to which items on DA Forms 11-246 and 11-247 are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for use of each form appear on the reverse side of the form.

b. Circled items in figures 20 and 21 are partially or totally applicable to Manual Telephone Switchboard SB-86/P. References in the ITEM column refer to paragraphs in text which contain additional maintenance information.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

TELEPHONE SWITCHBOARD

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: MANUAL TELEPHONE SWITCHBOARD SB-86/P

EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.

NOTE: Strike out items uot applicable.

DAILY

NO.	ITEM	S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*switchboard, head and chest sets, straps, carrying cases*). PAR. 46							
2	CLEAN DIRT, DUST, GREASE, GRIME, MOISTURE FROM OUTSIDE OF SWITCHBOARD; HEAD AND CHEST SETS; STRAPS; CARRYING CASES; BATTERIES. PAR. 46a(1)							
3	CLEAN RUST, CORROSION, FUNGUS, DIRT, MOISTURE FROM ALL EXTERNAL ELECTRICAL CONNECTIONS; TERMINALS AND BINDING POSTS; PLUGS AND JACKS. PAR. 46a(3)							
4	INSPECT CORDS AND CABLES FOR LOOSE TERMINALS; FRAYED, CUT, OR DAMAGED INSULATION; MILDEW; MOISTURE. PAR. 46a(9)							
5	TIGHTEN ALL LOOSE ASSEMBLY SCREWS AND APPARATUS MOUNTING SCREWS. PAR. 46a(2)							
6	CHECK NIGHT ALARM BY ALLOWING ANY SIGNAL DROP TO FALL. PAR. 46a(10)							
7	CHECK TO DETERMINE IF SIGNALS ARE RESTORED WHEN PLUG IS INSERTED IN JACK. PAR. 46a(8)							
8	INSPECT ALL LINE CIRCUITS FOR SATISFACTORY RINGDOWN AND TALK-UP OPERATION. PAR. 46a(6)							
9	INSPECT ALL EXTERNAL CABLING AND WIRING FOR CORRECT POSITION; KINKS, STRAINS, SHARP BENDS. PAR. 46a(15)							
10	INSPECT WRITING ON DESIGNATION STRIP FOR LEGIBILITY. PAR. 46b(8)							
11	INSPECT GROUND ROD FOR TIGHT CONNECTION, FIRM EMBEDDING; FRACTURES, BENDS, RUST. PAR. 46b(4)							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
12	INSPECT FOR CHIPS, CRACKS, DAMAGE SWITCHBOARD; HEAD AND CHEST SETS; PLUGS; GROUND ROD. PAR. 46a(4) AND b(1) AND(4)		13	CHECK SIGNAL DROPS TO WORK FREELY AND REMAIN LATCHED WHEN SWITCHBOARD IS JARRED.	

14 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-246 REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 2134-16

Figure 20. DA Form 11-246.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

TELEPHONE SWITCHBOARD

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.
MANUAL TELEPHONE SWITCHBOARD SB-86/P	

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; I Adjustment, repair or replacement required; I Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*switchboard, head and chest sets, straps, carrying cases*). PAR. 46		12	INSPECT FOR CHIPS, CRACKS, DAMAGE - SWITCHBOARD; HEAD AND CHEST SETS; PLUGS; GROUND ROD. PAR. 46a(1),(4),AND b(1)	
2	CLEAN DIRT, DUST, GREASE, GRIME, MOISTURE FROM OUTSIDE OF SWITCHBOARD; HEAD AND CHEST SETS; STRAPS; CARRYING CASES; BATTERIES. PAR. 46a(1)		13	CHECK SIGNAL DROPS TO WORK FREELY AND REMAIN LATCHED WHEN SWITCHBOARD IS JARRED.	
3	CLEAN RUST, CORROSION, FUNGUS, DIRT, MOISTURE FROM ALL EXTERNAL ELECTRICAL CONNECTIONS; TERMINALS AND BINDING POSTS; PLUGS AND JACKS. PAR. 46a(3)		14	INSPECT HAND GENERATOR FOR OUTPUT; FREE TURNING; PROPER LUBRICATION IN ACCORDANCE WITH LATEST APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER. PAR. 46a(11)	
4	INSPECT CORDS AND CABLES FOR LOOSE TERMINALS; FRAYED, CUT OR DAMAGED INSULATION; MILDEW; MOISTURE. PAR. 46c(3)		15	INSPECT SWITCHBOARD UNITS FOR BINDING, WARPING, DIRT, DUST, GREASE, GRIME, CORROSION. PAR. 46a(1)	
5	TIGHTEN ALL LOOSE ASSEMBLY SCREWS AND APPARATUS MOUNTING SCREWS. PAR. 46a(2)		16	CLEAN GROUND-STRIP AIR-GAP.	
6	CHECK NIGHT ALARM BY ALLOWING ANY SIGNAL DROP TO FALL. PAR. 46a(10)		17	INSPECT ALL KEY CONTACTS FOR PITTING, WEAR, PROPER CONTACT, DIRT, GREASE, CORROSION, FUNGUS, OPERATIONS. PAR. 46	
7	CHECK TO DETERMINE IF SIGNALS ARE RESTORED WHEN PLUG IS INSERTED IN JACK. PAR. 46a(8)		18	CLEAN INTERIOR AND APPARATUS, OF ALL DIRT, DUST, FUNGUS, GRIME. PAR. 46c(3)	
8	INSPECT ALL LINE CIRCUITS FOR SATISFACTORY RING-DOWN AND TALK-UP OPERATION. PAR. 46a(6)		19	INSPECT INTERIOR ELECTRICAL CONNECTIONS FOR TIGHTNESS, MOISTURE, FUNGUS. PAR. 46c(6)	
9	INSPECT ALL EXTERNAL CABLING AND WIRING FOR CORRECT POSITION; KINKS, STRAINS, SHARP BENDS. PAR. 46a(15)		20	INSPECT TELEGRAPH CIRCUITS FOR SATISFACTORY OPERATION BY SETTING UP AND OPERATING.	
10	INSPECT WRITING ON DESIGNATION STRIP FOR LEGIBILITY. PAR. 46a(5)		21	INSPECT SWITCHBOARD FOR PROPER SEASONAL MAINTENANCE WEATHERPROOFING, DUST PROOFING. PAR. 47	
11	INSPECT GROUND ROD FOR TIGHT CONNECTION, FIRM EMBEDDING; FRACTURES, BENDS, RUST. PAR. 46a(4)		22	INSPECT ALL CIRCUITS FOR PROPER OPERATION. PAR. 46a(6) AND (8)	

23 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-247 REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 2134-17

Figure 21. DA Form 11-247.

46. Performing Preventive Maintenance

Subparagraphs *a* through *c* below are a suggested schedule of preventive maintenance on the SB-86/P. The operations indicated should be performed by organizational personnel at the intervals indicated, unless the intervals are changed by the local commander.

Caution: Screws, blots, and nuts should not be tightened beyond the pressure for which they were designed or they will be damaged or broken.

a. Daily.

(1) Remove dirt, grease, and moisture from the exterior of the switchboard, operator's telephone set, and cover.

(2) Inspect and tighten all mounting bolts and screws of the cord packs and the operator's pack.

(3) Inpect all terminal strips, and binding post-type terminals for loose or bent binding posts, dirt, and corrosion.

(4) Inspect ground rods to see that connections have been made properly. Check to see that ground rods are imbedded firmly in the earth.

(5) Check the panel markings and the marking on the switchboard designation strip for legibility.

(6) Check all line and trunk circuits for satisfactory ring and talk operation.

(7) Inspect the switches for smooth operation and positive action.

(8) Check the operation of the magnetic line and supervisory signals for positive operation.

(9) Lift the cords as far as possible and check for free travel and spring loading of the cord reel. Clean the cord jackets if they are dirty.

(10) Observe the night alarm for proper operation. The night alarm bell should ring with each incoming call.

(11) Check the hand ringing generator by signaling a telephone from the switchboard.

(12) Inspect the power pack for dust, dirt, and corrosion.

(13) Check the operation of the vibrator in the power pack by signaling a telephone from the switchboard.

(14) Check the battery voltage by operating the battery check switch to positions 1 and 2.

(15) Inspect all exterior wiring and cabling for kinks, bends, loose connections, and frayed insulation.

b. Weekly.

(1) Inspect the outside surfaces of all of the components for rust, chipped paint, corrosion, loose or missing screws, and cracks.

(2) Clean the jack sleeves with carbon tetrachloride. Wrap a clean cloth around an orange stick and dampen it with the solution. Rotate the cloth in the jack sleeve; be careful not to contact the jack springs. Wipe the sleeve dry with a clean cloth.

(3) Remove dust from the interior of the switchboard with a soft dry brush.

(4) Inspect the operator's telephone for loose connections, dust, dirt, and corrosion.

(5) Check the battery compartments in the power pack for dust, dirt, and corrosion.

(6) Inspect the lightening arrester receptacles for dirt, or carbon dust. Clean with a dry brush.

(7) Inspect the trunk-type latches, which secure the jackfield section to the keyshelf section, for positive action.

(8) Check the panel markings for legibility. Remove any dust, dirt, or grease that may render the panel markings or designation strips unreadable.

c. Monthly.

(1) Clean the cord plugs with a rouge polish until the contact surfaces are bright and clean. Be sure to remove all traces of the polish.

(2) Inspect the plug shells and insulators for cracks or chips; if they are damaged, replace them.

(3) Inspect the connectors on the cord packs for loose terminals, dust, dirt, and corrosion. Clean and tighten the terminals if required.

(4) Inspect the fuses and fuse receptacles for dust, dirt, corrosion, and blown fuses.

(5) Inspect all switches for mounting tightness and secure wiring.

(6) Inspect the moisture-fungiproofing for general condition. Whenever a loose connection is soldered or a break in the protective coating is found, it should be moisture-fungiproofed. Apply the varnish with a small brush.

Section II. WEATHERPROOFING AND LUBRICATION

47. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained fully in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

c. Arctic Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained fully in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained fully in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

48. Painting

When painted finishes have been badly marred or damaged, prevent corrosion by touching up bared surfaces as follows:

a. Use #0000 sandpaper to clean the surface down to the bare metal. Obtain a bright, smooth finish.

Caution: Do not use steel wool to clean the metal. Small particles of metal may fall into the equipment and cause shorting or grounding of circuits.

b. Clean corroded metal with solvent (SD). In severe cases, it may be necessary to use solvent (SD) to soften the deposit, and sandpaper to complete the preparation for painting.

c. For a touch-up job, use a small brush to apply paint to the bared surfaces. Use authorized paint, consistent with existing regulations.

49. Lubrication

No lubrication is required for Manual Telephone Switchboard SB-86/P. Do not attempt to lubricate the hand generator.

Section III. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

50. General

The trouble shooting and repairs that can be performed at the organizational maintenance level (operators and repairmen) are limited in scope by the tools, test equipment, and replaceable parts issued, and by the existing tactical situation. With the exception of replacing operated fuses, Cord Telephone Circuit TA-208/P, and Operator's Telephone Circuit TA-220/P, trouble shooting by the operator is based on the performance of the equipment and is merely a general identification of the trouble and a recommendation that the trouble in the equipment and the replaced units be repaired by qualified repair personnel.

51. Visual Inspection

a. Inspect the equipment visually for one or more of the following faults:

(1) Worn, broken, or disconnected cords or plugs.

(2) Loose or broken wires, poorly soldered

connections, frayed or burned insulation, and stretched leads.

(3) Broken lugs and signs of arcing at terminal boards.

b. Burned-out parts, such as resistors and capacitors, may be detected by touch or smell. Be careful when touching such parts because they may be extremely hot.

52. System Sectionalization

a. General. Before attempting to trouble shoot a defective switchboard, the trouble first should be sectionalized to a major component. Then, detailed trouble shooting of the circuits of the component can be made (par. 69). Use the following procedures to sectionalize the trouble.

b. Wires, Cables, and Connections. Check the condition of all wires, cables, and connections.

c. Power Pack. Check the power pack and its batteries.

d. Jack Field Section. Check the jack field section. The line signals of the jack field section may be a chief source of trouble.

e. Cord Pack. Check the cord pack. The supervisory signals of the cord pack may be a chief source of trouble.

f. Operator's Pack. Check the operator's pack. The battery and hand generator of the operator's pack may be a chief source of trouble.

53. Trouble Shooting (Using Equipment Performance Check List)

a. General. The equipment performance check list (par. 54) will help to locate trouble in the equipment. The list gives the item to be checked, the normal indications and tolerances of correct operation, and the corrective measures that can be taken by the operator. *To use this list, follow the items in numerical sequence.*

b. Action or Condition. For some items, the information given in the *Action or condition* column consists of various switch and control settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indications given in the *Normal indication* column.

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator should perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those which the operator can make without turning the equipment in for repairs. A reference in the table to chapter 6 indicates that trouble shooting by an experienced repairman is necessary. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting is necessary. However, if the tactical situations requires that communication be maintained, and if the set is not completely inoperative, the operator must keep the set in operation as long as it is possible to do so.

54. Equipment Performance Check List

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Voltmeter on Power Supply PP-990/G.	Operate BATT. CHECK switch to position 1. (note 7, fig. 38).	Voltmeter should indicate approximately 20 to 26.5 volts.	If meter indicates above 26.5 volts, set INT. SWBD. BATT. switch to LOW. If meter indicates below 20 volts, set switch to HI. Then, if voltage is still below 20 volts, replace battery. Refer to paragraph 23*b*.
			Operate BATT. CHECK switch to position 2. (note 7, fig. 38).	Voltmeter should indicate approximately 20 to 26.5 volts.	If meter indicates above 26.5 volts, set INT. SWBD. BATT. switch to LOW. If meter indicates below 20 volts, set switch to HI. Then, if voltage is still below 20 volts, replace battery. Refer to paragraph 23*b*.
	2	Neon lamp on Power Supply PP-990/G.	Operate ringing switch of operator's pack.	Lamp should light.	Replace lamp, batteries, or fuse. Refer to paragraph 23*d*.
	3	Operator's Telephone Set.	Connect Plug PL-79/R to connector U-79/U.	Connector and and plug should fit properly.	Replace operator's telephone set.
START	4	Operator's Talk Battery switch.	Operate switch to ON position.	Sidetone should be heard in the receiver of the operator's telephone set.	Replace operator's battery. Refer to paragraph 23*c*.
EQUIPMENT PERFORMANCE	5	Line signals 1 through 30.	Switchboard operator calls each line separately by inserting plug of calling cord into corresponding line jack, operating the TALK LIST.-CONF. switch to the TALK LIST. position and operating the ringing switch to the RING FWD. position. Request called station operator to signal operator.	Line signal operates to *white* position.	If other line circuits are unassigned, change connections from faulty circuit to an unused line circuit and repeat checking procedure. If no other line circuits are available, call wire chief. Refer to paragraph 74.

54. Equipment Performance Check List (cont)

	Item No.	Item	Action or condition	Normal indications	Corrective measures
			Remove plug from jack and wait for call. If line signal operates to *white* position, insert plug of answering cord into line jack.	Line signal restores to *black* position.	
EQUIPMENT PERFORMANCE	6	Line signals CIV. TRKS. 29 and 30.	Operate line selector switch to position M, and operate toggle switch in rear of signal assembly to ON. Repeat *Action* for item 5 for lines 29 and 30.	Line signal operates to *white* position. Line signal restores to *black* position.	If both lines 29 and 30 already are assigned as trunks to a civilian common battery switchboard, refer the case to the wire chief. If no other suitable line circuit is available, refer to paragraph 74.
	7	Night alarm.	Operate N. A. switch to AUD position. Test night alarm buzzer in conjunction with line signal tests in item 5.	Line signal operates to *white* position, night alarm buzzer sounds.	Replace N. A. batteries.
			Operate N. A. switch to VIS position, and repeat test above.	Line signal operates and panel lamp lights.	Replace lamps or batteries.
	8	Panel lamps.	Operate LAMPS switch to ON position.	Panel lamps light.	Replace lamps, fuse, or battery.

54. Equipment Performance Check List (cont)

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	9	Supervisory signals.	Station users ring off, or if common battery signaling line, restore handset. Remove calling and answering plugs from line jacks. Answering plugs must return to plug seats.	Supervisory signals operate to *white*. Supervisory signals restore to *black*.	Replace cord pack. Refer to paragraph 75.
STOP	10	Talk Battery switch.	Operate to OFF position.	Sidetone stops.	
	11	Panel Lamp switch.	Operate to OFF position.	Panel lamps are extinguished.	

55. Replacement of Components in the SB-86/P

Manual Telephone Switchboard SB-86/P is designed so that complete circuit units can be replaced without disturbing adjacent circuits or the operation of the switchboard. The chart in subparagraph *a* below lists the component and its location. Subparagraphs *b* through *h* below describe the removal of each of the components.

a. Location of Components.

Components	Location
Batteries BA-30 (panel lights)	Top compartment, rear of jack field section.
Batteries BA-30 (operator's telephone)	Rear of operator's pack.
Batteries BA-200/U	Power pack.
Vibrator pack	Power pack.
Cord pack	Keyshelf section.
Fuses	Power pack and rear of operator's pack.
Operator's pack	Keyshelf section.
Lamps	Jack field section.

b. Batteries BA-30 (Panel Lights). Batteries BA-30 are removed from the compartment by pushing down on the top of the dry cell and pulling the top out of the compartment. The spring in the bottom of the compartment holds the battery in the space provided and serves as the positive battery contact. The second dry cell is removed in the same manner.

c. Batteries BA-30 (Operator's Telephone). Batteries BA-30 are removed from the compartment in the rear of the operator's pack according to the directions given in subparagraph *b* above.

d. Batteries BA-200/U. Batteries BA-200/U are removed from the power pack in the same manner described in paragraph 23*b*.

e. Cord Pack. The cord pack is fastened into the keyshelf section by one captive screw in the front and two captive screws in the rear of the cord pack. To remove the cord pack, follow the directions given in subparagraphs (1) through (3) below.

(1) Loosen the captive screws in the front and the rear of the cord pack.

(2) Loosen the eight captive screws in the terminal strip on the rear of the cord pack.

(3) Hold the cable form and terminal strip clear of the cord pack and slide it to the rear.

Note. It may be necessary for the switchboard operator to push the cord pack part of the way out of the keyshelf section.

(4) To install the replacement for the cord pack, reverse the instructions for the removal of the cord pack.

f. Operator's Pack. To remove the operator's pack from the keyshelf, disconnect the wiring from the terminals in the rear of the operator's pack and continue as described in subparagraph *e* above.

g. Fuses. To remove the fuses, turn the cap to the left until it is loose and pull the fuse and fuse holder out of the receptacle.

h. Panel Lamps. To remove a panel lamp from its socket, push in on the lamp and turn it to the left until it is disengaged from the socket.

i. Jack Field Section. The jack field section is secured to the top of the keyshelf section by four latches (fig. 3). To remove the jack field section, proceed as follows.

(1) Open the rear door of the jack field section and disconnect the wires from the binding posts.

(2) Release the four latches and lift the jack field section from the top of the keyshelf section.

(3) To replace, reverse the procedure above and connect all wires as described in paragraph 24.

CHAPTER 5
THEORY

56. General

a. Manual Telephone Switchboard SB-86/P supplies switching facilities for magneto lines, CBS lines, and either magneto or CBS common battery signaling trunks. Two of the line circuits (29 and 30) may be connected to civilian trunks. Civilian trunks permit connections to common battery line circuits in a manual civilian exchange. Carrier equipment also may be connected to the switchboard by using the CBS trunks.

b. The selection of the different types of line and trunk operation is accomplished by using the three-position line selector switch (S3 through S32) (fig. 22, 23, 24, and 40) associated with each of the line circuits (1 through 30). The cord circuits of the switchboard do not supply talking battery for the local telephones; therefore, only local battery telephones or local battery talking and CBS telephones may be used with Manual Telephone Switchboard SB-86/P.

c. The magnetic signal used in Manual Telephone Switchboard SB-86/P has been developed specially for this application. Its function is described in paragraph 57.

d. Paragraphs 58 through 64 contain circuit descriptions of the types of lines, trunks and power supply. Only a typical line or trunk of each particular type is described. Figure 40 is the schematic of one of the 30 line circuits. Figure 42 is the schematic of the operator's telephone circuit and one of the 16 telephone cord circuits. All the circuit descriptions will refer to these schematics.

57. Magnetic Signal Description

a. The signal device used in the line circuits and cord circuits of this switchboard is operated electrically and restored electrically. Each signal consists of a two-winding coil, a soft iron core, a rotating target with black and white portions (which are visible through a transparent plastic cap), and a contact switch.

b. Operation generally is affected by using dc. When it is desired to operate the device with alternating current (ac), it is necessary, for some operations, to insert a rectifier in series with the coil of the signal. However, the signal will operate on ac without a rectifier provided the operating circuit is arranged so that when the signal operates, the signal contacts open the operating circuit. *In this switchboard, the battery which operates and restores the signal is not connected to earth ground.*

c. The rotating target contains a permanent magnet which always is positioned so that either its north or its south pole is in the vicinity of the front pole of the coil core. Movement of the target is brought about by passing current through one or both of the coil windings in a direction that causes the magnetic flux induced in the core to oppose the flux of the permanent magnet. This repels the permanent magnet and causes it to rotate the target to a position in which the permanent magnet is attracted to the core. For example, if the permanent magnet N pole is nearest the core, movement is caused by energizing the signal coil so that the polarity of the target end of the core also becomes N. The opposing forces cause the target to rotate so that the S pole of the permanent magnet will be close to the N pole of the core. Once positioned, the target tends to remain static until an opposing force again is established in the coil and core. The permanent magnet is prevented, by the mechanical arrangement, from assuming a *dead center* position. The target is permitted to rotate in an arc which is restricted, but the arc is sufficient to allow the target to change from a *black* to a *white* indication or from a *white* to a *black* indication.

d. The resistance of one winding is 1,000 ohms and the other is 2,000 ohms. Current of proper polarity, in either or both windings, will rotate the target. Opposing currents in the windings prevent target rotation. As a signal is connected in the cord circuit of the switchboard, negative battery entering the 2,000-ohm winding at terminal 5 tends to operate the target to *white*. Negative battery entering the 1,000-ohm winding at terminal 4 tends to restore the target to *black*.

e. The contact switch (built into the signal and not visible after assembly is completed) provides swinging contact 3 which makes with contact 8 when the target shows *black*. When the target shows *white*, contact 3 is closed with contacts 1 and 6. The contact numbers correspond to the numbers of the terminals to which they are connected at the back of the signal for wiring purposes.

58. Magneto Line Circuit Description (Completing Calls between Field Telephones on Magneto Signaling Lines or Trunks)

(fig. 22 and 40).

a. Any of line circuits 1 through 30 will operate as magneto lines when corresponding line selector switches S3 through S32 are in the M position. A call on a magneto line is originated by the station user operating the hand generator on his telephone. This causes ringing current to flow over the tip and ring of the line of the switchboard line circuit.

b. The current flowing through the L1 side of the line enters the line circuit, flows through binding post E1, contacts 3 and 4 of line jack J1, and rectifier CR1. At CR1, the current is rectified and only positive half-cycle pulses pass through the rectifier. The rectified current flows through 7–5 winding of line signal I 1, contacts 5 and 4 of line selector switch S3, current-limiting resistor R121, contacts 7 and 8 of jack J1, 4–2 winding of signal I 1, contacts 5 and 6 of line jack J1, binding post E92, and back over the L2 side of the line to the opposite terminal of the hand generator at the station telephone.

c. The current flowing over the line and through the line circuit, as described in subparagraphs *a* and *b* above, causes line signal I 1 to operate from *black* to *white*.

d. After the operator has inserted a plug into jack J1, current flows through terminal E122, current-limiting resistor R1, contacts 9 and 8 of jack J1, 4–2 winding of line signal I 1, contacts 11 and 10 of line selector switch S3, contacts 6 and 1 of signal I 1, and fuse F1 to positive battery at terminal E123. This energizes the coil of signal I 1, and causes it to restore to *black*. When signal I 1 restores, its contacts open and current ceases to flow.

e. The calling cord may be connected to a CBS line, another magneto line, or a CBS trunk without affecting any of the operations described in this section.

f. When the conversation is completed, the magneto station user must ring off with the hand generator to operate the supervisory signal. The first half-cycle of ringing current (in the correct direction) flows through contact 3 (tip) of the line jack and the plug, springs 2 and 1 of stack B on TALK INST.–CONF. switch S202, 5–7 winding of supervisory signal I 201, 8–3 winding of signal I 201, terminal 6 of signal I 201, 2–4 winding of signal I 201, and contacts 3 and 2 of stack E of switch S202 to the ring of the plug through contact 6 on line jack J1 and back to the telephone. This causes answering supervisory signal I 201 to operate from *black* to *white*. To prevent the signal from fluttering, a shunt circuit is connected around the 5–7 winding of answering signal I 201 through the following circuit. Current flowing in the proper direction from the tip side of the line flows through contact 2 of jack J1, rectifier CR31, resistor R91, contacts 7 and 8 of switch S3, 7–5 winding of signal I 1, contacts 5 and 4 of switch S3, resistor R121, contact 2 of switch S3, the sleeve of jack J1, and the sleeve of plug P201 to contact 3 of signal I 201.

g. When the operator removes the plug from the line jack, negative battery from terminal E301 flows through coil L301, –24 binding post on terminal strips J301 and J201, terminal 4 on TB201, contacts 4–2 of plug seat switch S201 (which closes when the plug is normal in the plug shelf), current-limiting resistor R213 to rectifier CR201 (which regulates direction of current flow), terminal 1 of TB201, 4–2 winding of signal I 201, contacts 6 and 1 of signal I 201, rectifier CR205 (which regulates the direction of current flow), to contact 2 of stack A on switch S202, through contacts 1 and 3 of plug seat switch S201, terminal 3 of TB201, +24 binding post on terminal strips J201 and J301, fuse F301, to positive battery of terminal E302. This causes signal I 201 to energize and restore to *black*, opening its own restoring circuit through contacts 1 and 6 of signal I 201.

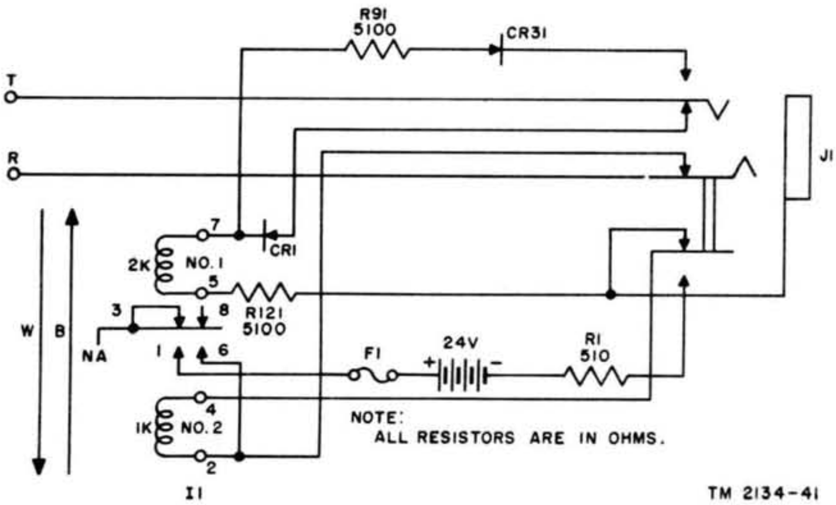

Figure 22. Magneto line circuit, simplified schematic.

h. The talking path completed between a field telephone and Manual Telephone Switchboard SB-86/P is as follows: With switch S202 in the TALK LIST. position, talking current flows over the tip side of the line, through binding post E1, the tip of jack J1, the tip of plug P201, contacts 2 and 3 of stack B on switch S202, AT binding posts of terminal strips P201 and J301, to contact 3 of stack C on switch S301, to capacitor C303, from capacitor C303 through contacts 1 and 2 of stack B on switch S301 to contact 3 of of stack G on switch S301, the receiver of the operator's telephone set, the operator's induction coil T301, to blocking capacitor C302; then through contact 1 of stack H on switch S301, to blocking capacitor C304, then through contacts 1 and 2 of the D stack on switch S301, contacts 1 and 2 of the E stack on switch S202, the ring of plug P201, the ring of jack J1, binding post E92 to the ring side of the field telephone.

i. After receiving information from the calling party, the switchboard operator connects the calling party to the called party and restores switch S202 to the neutral position. The talking path between the two field telephones through Manual Telephone Switchboard SB-86/P is as follows: Talking current flows over the tip side of the line, through binding post E1, the tip of jack J1, the tip of plug P201, contacts 2 and 1 of stack B on switch S202, 1–2 winding of repeating coil T201, to blocking capacitor C201; then through terminal punching 1 on terminal block TB201, contacts 3 and 2 of stack E on switch S202, the ring of plug P201, the ring of jack J1, binding post E92 over the ring side of the line, to the field telephone. The talking current flowing through the 1–2 winding of repeating coil T201 induces a voltage in the 3–4 winding of the repeating coil. This establishes a circuit between the called telephone and the calling telephone. Voltage induced in the 3–4 winding of repeating coil T201 causes current to flow through the winding, out of terminal 3, to terminal 5 on I 203 through contacts 1 and 2 of stack C on switch S202, the tip of plug P203, the tip of the called party's jack over the tip side of the line, the called party's telephone, back over the ring side of the line, the ring of the called party's jack, the ring of plug P203, contacts 2 and 3 of stack H on switch S202, terminal punching 2 of terminal block TB201, to blocking capacitor C203; from blocking capacitor C203 to terminal 4 of repeating coil T201, completing the circuit.

j. Talking paths for magneto trunk circuits operate in the same manner.

k. If it is desired to monitor the telephone conversation between two field telephones through Manual Telephone Switchboard SB-86/P, switch S202 is operated to the TALK LIST. position. Talking current flows from the tip of the calling telephone, over the tip of the line, through binding post E1, the tip of calling jack J1, the tip of plug P201, contacts 2 and 3 of stack B on switch S202, blocking capacitor C303, contacts 3 and 2 of stack C on switch S202, the tip of plug P203, the tip of the called party's line jack, over the tip of the line, the called party's telephone; back over the ring side of the line, through the ring of the called party's line jack, the ring of plug P203, through contacts 2 and 1 of stack H on switch S202, contacts 2 and 1 of stack H on switch S301, to capacitor C304; from capacitor C304 through contacts 1 and 2 of stack D on switch S301, contacts 1 and 2 of stack E on switch S202, the ring of plug P201, the ring of calling jack J1, binding post E92, over the ring side of the line, and through the calling party's telephone.

l. The operator's circuit is bridged across the circuit mentioned above and current flows through contacts 1 and 2 of stack B on switch S301, the receiver of the operator's telephone set, terminals 4 and 3 of operator's induction coil T301, to capacitor C302; from capacitor C302 to contact 1 of stack H on switch S301.

m. To ring forward over the called party's line, switch S202 must be in the TALK LIST. position, and S301 must be in the RING FWD. position. Ringing current enters terminal E308, flows through contacts 3 and 2 of stack H on switch S301, contacts 1 and 2 of stack H on switch S202, the ring of plug P203, the ring of the called party's line jack, over the ring side of the line, through the called party's field telephone, over the tip side of the line, through the tip of the called party's line jack, the tip of plug P203, contacts 2 and 3 of stack C on switch 202, contacts 1 and 2 of stack B on switch S301, contacts 3 and 2 of stack G on switch S301, and out through terminal E307 to the ringing supply (par. 62*b* and c).

n. To ring back over the calling party's line, switch S202 must be in the TALK LIST. position, and switch S301 must be in the RING BACK position. Ringing current enters terminal E308, flows through contacts 3 and 2 of stack D on switch S301, contacts 1 and 2 of stack E on switch S202, the ring of plug P201, the ring of the calling party's line jack over the ring side of the line, through the calling party's telephone, over the tip side of the line, through the tip of the calling party's line jack, the tip of plug P201, contacts 2 and 3 of stack B on switch S202, contacts 3 and 2 of stack C on switch S301 and out through terminal E307 to the ringing supply (par. 62*b* and c).

59. Civilian Trunk Circuit Description (Option)

The civilian trunk option is obtained by operating additional switch S1 (only two circuits available, lines 29 and 30) with corresponding line selector switches S31 and S32 in the M position. This places a 50-ohm holding coil across contacts 2 and 6 on jack J1. When the operator inserts a plug in the jack, holding coil L1 bridges the line to operate the manual central office equipment. There is *no supervision* from the manual central office. In all other respects, operation of the line circuit under the civilian trunk option is the same as described for magneto line circuits in paragraph 58.

60. CBS Line Circuit Description
(fig. 23 and 40)

a. The CBS line circuit functions as follows: With line selector switch S3 in the C position, the station user places dc bridge on the line by lifting the handset of the telephone. When the telephone hookswitch operates, a circuit is completed, negative battery flows from terminal E122, through current-limiting resistor R31, contacts 9 and 8 of line selector switch S3, rectifier CR1 (which regulates the direction of current flow), contacts 4 and 3 of jack J1 over the L1 side of the line, to the telephone hookswitch; back over the L2 side of the line, through contacts 6 and 5 of jack J1, the 2-4 winding of line signal I 1, contacts 8 and 7 of jack J1, contacts 2 and 1 of switch S3, and rectifier CR61 (which regulates the direction of current flow), fuse F1, to positive battery on terminal E123. The line signal operates to *white*. This energizes the 2,000-ohm bias winding of the signal through contacts 1 and 6, but there is no effect as long as there is also current in the 1,000-ohm line winding.

b. The current flowing through the 2,000-ohm bias winding takes the following path: Negative battery from terminal E122 through resistor R31, contacts 9 and 8 of line selector switch S3, 7-5 winding (2,000-ohm winding) of signal I 1, contacts 5 and 6 of line selector switch S3, and signal contacts 6 and 1 to positive battery on terminal E123. If the loop is opened by restoration of the hookswitch before the operator answers, the current flowing through the bias winding restores the signal to *black* due to the 1,000-ohm winding being opened.

c. Intermittent operation of the hookswitch causes the line signal to flash *white* and *black*. The operator inserts answering plug P201 into line jack J1. This removes line signal I 1 from the tip and ring of the line. Negative battery from terminal E122 flows through current-limiting resistor R1,

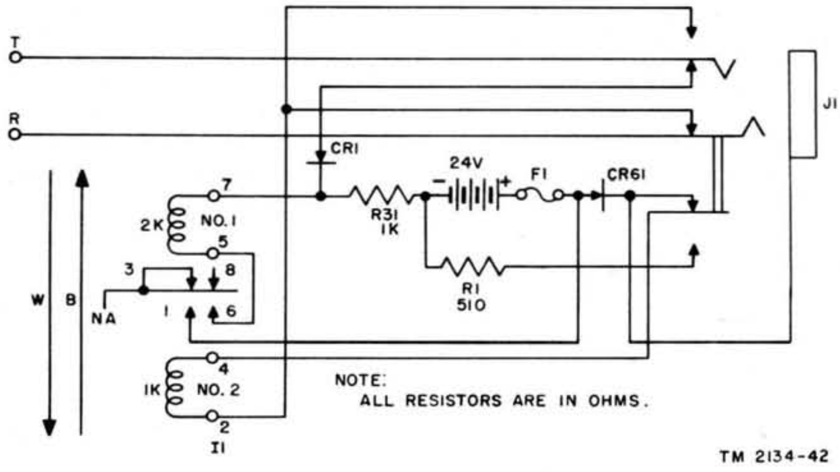

Figure 23. Common battery signaling line circuit, simplified schematic.

contacts 9 and 8 of line jack J1, the 4-2 winding of signal I 1, contacts 11 and 12 of line selector switch S3, and contacts 2 and 3 of jack J1 to the tip side of the line. Negative battery flows through the tip of jack J1, through the tip of plug P201, contacts 2 and 3 of stack B of switch S202 (in the **TALK LIST.** position) through **AT** binding posts on J201 and J301 to contact 3 of stack C on switch S301, current-limiting resistor R303, rectifier CR303 (which regulates the direction of current flow), retardation coil L302, fuse F301, to positive battery on terminal E302. This causes line signal I 1 to operate from *white* to *black.*

d. The operator obtains the number of the called line, inserts the plug of the calling cord into the jack of the line, and rings. If the hand generator is used, the generator crank is turned with ringing switch S301 in the **RING FWD.** position. If machine ringing is available, ringing current is placed on the line by operating the ring switch S301 to the **RING FWD.** position.

e. When the operator restores switch S202, the supervisory signals are placed across the calling and called lines. The operation of the station telephone hookswitches then will control the respective supervisory signals. With the hookswitch of the calling station operated, negative battery flows through terminal E122 of the line circuit, resistor R1, contacts 9 and 8 of jack J1, 4-2 winding of signal I 1, contacts 11 and 12 of line selector switch S3, and contact 2 and 3 of jack J1 to the tip side of the line and cord, and flows in two directions. The current, flowing in one direction, flows through the tip of jack J1 and plug P201, contacts 2 and 1 of stack B on switch S202, 5-7 winding of signal I 201, contacts 8 and 3 of signal I 201, the sleeve of plug P201, the sleeve of jack J1, contacts 2 and 1 of line selector switch S3, rectifier CR61, and fuse F1, to positive battery on terminal E123. The negative battery, flowing in the other direction, passes out over the line, through the telephone, back over the ring conductor of the jack and plug, through contacts 2 and 3 of stack E on switch S202, the 2-4 winding of signal I 201, contacts 6 and 3 of signal I 201, the sleeve of plug P201, the sleeve of jack J1, contacts 2 and 1 of line selector switch S3, rectifier CR61, and fuse F1, to positive battery on terminal E123. These paths cause opposing current in the coils at supervisory signal I 201, and the signal stays in the *black* position. Operation of the calling cord is the same as the answering cord because the circuitry of the calling and answering cords is the same.

f. When the handset is placed on the hookswitch of the calling telephone, the 2-4 winding of I 201 no longer is energized, but negative battery flows from terminal E122 in the line circuit through resistor R1, contacts 9 and 8 of jack J1, 4-2 winding of line signal I 1, contacts 11 and 12 of line selector switch S3, and contacts 2 and 3 of jack J1 of the tip side of the line. The current then flows through the tip of jack J1 and into the cord circuit, through the tip of plug P201, contacts 2 and 1 of stack B on switch S202, the 5-7 winding of signal I 201, 8-3 winding of signal I 201, sleeve of plug P201, sleeve of jack J1, contacts 2 and 1 of line selector switch S3, rectifier CR61, and fuse F1, to positive battery on terminal E123. This causes answering supervisory signal I 201 to operate from *black* to *white*. Repeated operation of the station telephone hookswitch causes the signal to flash from *black* to *white*. The line signal, however, remains *black*. The operation of the calling supervisory signal is the same as the answering supervisory signal.

g. In the event of single supervision, and if a challenge by the operator is necessary, the operation of switch S202 to the TALK LIST. position causes the supervisory signal to go from *white* to *black*. When this condition arises, and switch S202 is in the TALK LIST. position, negative battery flows from terminal E301, through retardation coil L301, —24 binding post on J301 and J201 punching 4 on terminal board TB201, contacts 2 and 3 of stack D on switch S202, punching 2 of terminal board TB201, resistor R213, rectifier CR201, punching 1 on terminal board TB201, the 4-2 winding of signal I 201, contacts 6-3 of signal I 201, sleeve of plug P201, sleeve of jack J1, contacts 2 and 1 of switch S3, rectifier CR61, and fuse F1, to positive battery on terminal E123.

h. When the call is completed, supervisory signal I 201 turns *white*. When the operator removes the plug from the jack, and plug seat switch S201 restores, negative battery flows through contacts 4 and 2 of plug seat switch S201, resistors R213, rectifier CR201, the 4-2 winding of signal I 201, and contacts 6-1 of signal I 201, rectifier CR205, contacts 1 and 3 of plug seat switch S201, terminal punching 3 on TB201, +24V binding post on J201 and J301, fuse F301 to positive battery on terminal E302. The supervisory signal restores to *black*. The operation of the calling cord is the same as the answering cord. The line and cord circuits are now normal.

i. The talking and ringing paths for this circuit are the same as for magneto line operation.

61. CBS Trunk Circuit Description (Using a CBS Trunk Circuit for Completing Calls Between Two Manual Telephone Switchboards SB-86/P)

(fig. 24 and 40)

Note. The local lines may be either magneto or CBS lines. The procedures for handling the initiation of a call, therefore, will be the same as described for magneto or CBS lines.

a. Line selector switch S3 must be in position T, which closes contacts 2 and 3, and contact 11 goes to a neutral position. A call over the trunk is originated by inserting a plug into the trunk jack. TALK LIST.-CONF. switch S202 must be in the TALK LIST. position and CONF. SUPV.-TRK SIG switch S302 must be in the TRK SIG position. Signaling may be accomplished over the calling cord only. When the plug is inserted into the line jack, all elements in the local line circuit are disconnected from L1 and L2. Negative battery flows from terminal E301 through retardation coil L301, contacts 3 and 2 of stack E on switch S302, contact 2 of stack H on switch S301, contacts 1 and 2 of stack H on switch S202, the ring of plug P203, and the ring of the jack of the line circuit to the second switchboard. The current enters the second switchboard over the L2 side of the line, through contacts 6 and 5 of jack J1, 4-2 winding of signal I 1, contacts 8 and 7 of jack J1, contacts 2 and 3 of switch S3, rectifier CR61, fuse F1, and through the battery at terminal E123. From the battery (terminal E122), negative current flows through resistor R31, contacts 9 and 8 of switch S3, contacts 4 and 3 of jack J1, and over the L1 side of the line to the calling switchboard. Negative battery flows over the L1 side of the line through the tip of jack J1, the tip of plug P203, contacts 2 and 3 of stack C on switch S202, terminals CT on J201 and J301, resistor R302, rectifier CR302, retardation coil L302, fuse F301, to positive battery on terminal E302. *This provides current to operate the line signal at the distant switchboard. The circuit voltage is increased because the path just traced goes through the batteries of both switchboards in series.*

b. When the distant operator plugs into the line jack to answer, the jack springs disconnect all elements from L1 and L2. Supervisory signals at both ends of the trunk remain *black*. The line signal at the called switchboard goes from *white* to *black*.

c. When either operator disconnects, the line jack restoring at that switchboard connects L1 through jack springs 3 and 4, rectifier CRI, contacts 8 and 9 of switch S3, and resistor R31 to negative battery at terminal E122. Also, 12 is connected through jack contacts 6 and 5, 2-4 winding of signal I 1, contacts 8 and 7, contacts 2 and 3 of switch S3, rectifier CR61, fuse F1, to positive battery at terminal E123. The negative battery on L1 flows over the line to the distant switchboard, through the two windings of the cord supervisory signal in series, back on L2 to positive battery as just traced. The distant supervisory signal goes *white*, but the local line remains *black* since the current tends to hold it in that condition. If the calling operator reinserts the plug into a CBS trunk line circuit

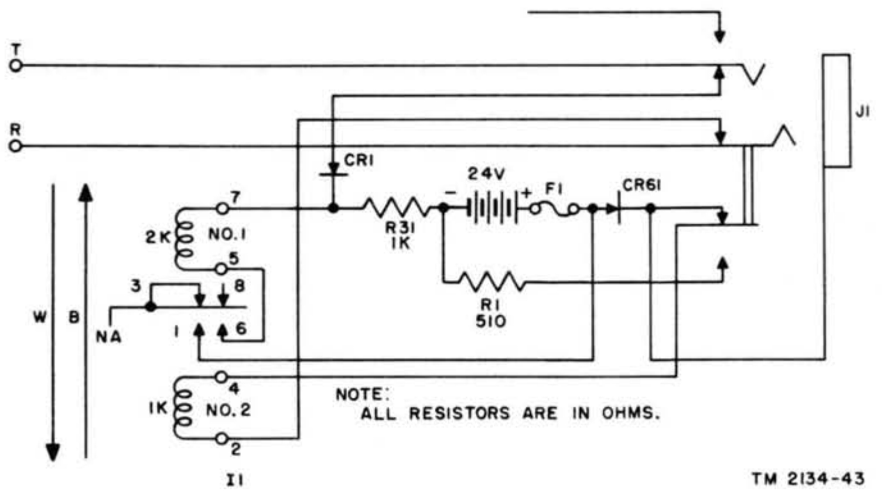

Figure 24. Common battery signaling trunk line circuit, simplified schematic.

before the distant operator has removed the cord from a previous disconnect signal, the supervisory signal at the called end will remain *white* until the called operator disconnects. At that time, the line signal at the called switchboard will operate to *white*, indicating a recall.

62. Operator's Telephone Circuit Description

a. The operator's telephone circuit contains the following components: an induction coil, retardation coils, capacitors, 3-volt battery supply, a hand-operated ringing generator, a common ringing switch with facilities to operate from an external source of 20-cycle ringing power, a switch to allow monitoring on conference connections and ringing on CBS trunk circuits, and toggle switch to disconnect the 3-volt talking battery from the operator's transmitter.

b. To ring through any cord circuit (except for a cord circuit that is used with CBS trunk operation), TALK LIST.-CONF. switch S202 must be operated to the TALK LIST. position. The tip sides of the calling and answering cords are made common by the operated contacts of switch S202. To ring across the tip and ring of the calling cord, no operation other than turning the hand generator and operating the RING BACK-RING FWD. switch to either position is necessary. If a machine ringing supply is available, it is connected to the EXT. GEN. binding posts and it is necessary only to operate ring switch S301 to the RING FWD. position. If a vibrator-type pole changer ringing supply is available, a contact at the ringing key closes the start circuit of the vibrator so that it operates only when the ringing key is off normal.

c. To ring back, ringing switch S301 must be operated to the RING BACK position. If the hand generator is the only source of ringing power, it must be operated while ringing switch S301 is held in the RING BACK position.

d. To ring through a cord circuit that is used with CBS trunks, operate CONF. SUPV.-TRK SIG switch S302 (in the operator's pack) to the TRK SIG position and TALK LIST.-CONF. switch S202 (in the cord pack) to the TALK LIST. position.

e. The operator's induction coil is bridged across the calling cord through the cord circuit switch in the TALK LIST. position and through normally closed contacts of switch S301. When switch S301 is operated to the RING BACK position, the operator's induction coil is disconnected from the calling cord. The induction coil is connected in the RING FWD. position.

63. Optional Circuits

a. Conference Circuit. If a conference circuit is desired, the operation of the TALK LIST.-CONF. switches, of the cord circuits making up the conference circuit, to the CONF. position is necessary. This places C1 and C2 of each cord circuit across the tip and ring of that cord circuit and all circuits are bridged through C1 and C2. The talking path of the conference circuit is similar to the normal talking circuit as described for the magneto line circuits. Operation of the CONF. SUPV.-TRK SIG switch to the CONF. SUPV. position, places the operator's telephone set across C1 and C2 which bridges the tip and ring of the conference circuit permitting the operator's supervision of the circuit.

b. Night Alarm. Visual or audible night alarm features are present in Manual Telephone Switchboard SB-86/P. A three-position N. A. VIS-OFF-AUD switch is available for this selection. When any line signal is in the *white* condition, a circuit is completed to the night alarm circuit, depending on operation of the night alarm switch to either the VIS or AUD position through the 1-3 contacts on signal I 1. Negative 3-volt battery flows through buzzer I 33 and through N. A. switch S34 (in AUD position), contact 3 and 1 of line signal I 1, and back to the 3-volt battery. This causes the buzzer to operate until the signal restores to *black*. If the night alarm switch is in the visual position, then the negative battery goes through the lamps instead of through the buzzer. Operation of switch S33 causes lamps I 31 and I 32 to remain lighted.

64. Ringing Power Supply

(fig. 38, 40, and 42)

a. When ringing power is needed, RING FWD.-RING BACK switch S301 is operated to either position. This grounds the vibrator inverter through the 2 and 3 contacts of stack A or E on switch S301, the ST. VIB. lead at binding post E304, causing it to generate 20-cycle ac voltage. As current is supplied to vibrator G601, a magnetic field is set up in the coil which attracts the vibrator reed and causes the current to flow through resistor R601. With the resistor in the circuit, the magnetic field is reduced, causing the reed to return. A vibrating action thereby results. When the reed is displaced to the left, a circuit is completed causing negative battery to flow through the 2-1 winding of transformer T601, coil L601, and the reed contact to ground (chassis of ringing converter is insulated from the power pack to reduce radio interference). When the reed is displaced to the right, a circuit is completed causing a negative battery current to flow through the 2-3 winding of transformer T601, coil L602 and the reed, to ground. This action causes pulsating dc to flow in the primary of the transformer in alternating directions. Voltage is induced in the secondary, and ringing current flows out of terminals E607 and E608. Lamp I 601 glows while the device is generating voltage.

b. To test battery A, operate switch S601 to position 1. Current flows from the negative side of battery A through switches S603 and S602, voltmeter M601, and switch S602 to ground of battery A.

c. To test battery B, throw switch S601 to position 2. Current flows from the negative side of battery B, through switch S601, voltmeter M601, and switch S602 to positive side of battery B.

d. Switch S603 is used to add or remove one cell of battery A to keep the voltage as close as possible to 24 volts, or between 20 and 26.5 volts.

CHAPTER 6
FIELD MAINTENANCE

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available, and by the skill of the repairman.

Section I. PREREPAIR PROCEDURES

65. Tools, Materials, and Test Equipment

The following tools are required for field maintenance of the switchboard:

Tool Equipment TE-49
Tool Equipment TE-111
Multimeter TS-352/U
Test Set I-142
Test Set TS-140/PCM
Test Set I-181

66. Inspecting, Cleaning, and Testing Removed Parts

a. Inspecting, Cleaning, and Testing Fuses.

(1) *Inspecting.* Inspect fuse ends for signs of burning, corrosion, and looseness.

(2) *Cleaning.* Clean fuse ends with an emery cloth, then wipe with a clean cloth. If a file is used to remove deep pits, use a crocus cloth to smooth the contact surface and wipe with a dry clean cloth.

(3) Check the fuse for continuity.

b. *Inspecting, Cleaning, and Testing Lamps.*

(1) *Inspecting.* Inspect the lamp for breakage.

(2) *Cleaning.* Clean the base with solvent (SD) and wipe with a clean dry cloth.

(3) *Testing.* Test the lamp for continuity.

67. Cleaning and Inspecting Switchboard

a. *Inspecting.* Make a visual inspection to determine the general condition of the equipment when it is received for repairs (fig. 25 through 37). Remove the jack field section chassis, cord packs, and operator's pack from respective cases. Remove the covers from the operator's pack and the cord pack and proceed as outlined below:

(1) Inspect all of the components for burned insulation or resistors. Examine all of the insulation for discoloration which may indicate overheating.

(2) Inspect the wiring for broken leads, brittle or damaged insulation, and corrosion.

(3) Inspect all of the connections in the following components for broken leads, broken lugs, and poorly soldered connections.

(*a*) Jack field section.

(*b*) Operator's pack.

(*c*) Power pack.

(4) Inspect the lamp and fuse holders for bent contacts, damaged covers, and corrosion.

(5) Test the operation of all switches. They should operate easily and have a positive action. Inspect for any corrosion, dirt, or foreign matter that might affect operation.

(6) Inspect for loose, damaged, or missing screws.

(7) If there is no visible indication of damage or fault, connect the equipment for operation and follow the procedures listed in the equipment performance check list (par. 54) to determine if the equipment is operating properly.

b. *Cleaning.*

(1) Clean the outside of the equipment with a clean, lint-free cloth.

(2) Remove dirt from the exterior of the equipment with a cloth moistened only with clear water. Dry the equipment thoroughly before attempting any further cleaning.

(3) Use air pressure, if it is available, to blow out accumulated dust, dirt, sand, lumps of solder, and wire cuttings. Apply the air pressure so that dust is blown away from switch contacts. If air pressure is not available, brush accumulated dust and dirt from the interior of the equipment with a soft bristle brush. Be careful not to damage equipment wiring. Use orangesticks or spudgers to dislodge caked dirt.

(4) Remove oil and grease with a cloth moistened with solvent (SD). Wip dry with a clean, dry cloth.

(5) Remove corrosion, fungus growth, and similar foreign material on the structural framework with #0000 sandpaper or a brush; clean with solvent (SD) when necessary.

Section II. TROUBLE SHOOTING AT FIELD MAINTENANCE LEVEL

68. Trouble-shooting Procedures

The first step in servicing defective equipment is to sectionalize the fault. Sectionalizing means tracing the fault to the major component or circuit. The second step is to localize the fault. Localization means tracing the fault to the defective part. Some parts can be located by smell, sight, or hearing, such burned-out lamps, fuses, relay coils, or shorted repeating coils, etc. The majority of faults must be localized, however, by checking the magnetic signal and switch contacts of these units in the component or circuit in question.

69. Trouble-shooting Data

Before trouble shooting, refer to the schematics and wiring diagrams (fig. 38 through 44) of the component at fault. Become thoroughly familiar with the theory of operation and the physical layout of all the circuits associated with the faulty component. Refer to the applicable illustrations to locate the parts indicated by symbols on the circuit schematics and wiring diagrams. Refer to paragraph 93 for information concerning the adjustment and repair of the magnetic signals.

70. General Precautions

Whenever any component of Manual Telephone Switchboard SB-86/P is serviced, observe the following precautions.

a. Only competent repairmen supplied with suitable tools and equipment are authorized to service and repair this equipment. An inexperienced person may seriously damage the equipment and necessitate major repairs. Careless workmanship makes new faults inevitable.

b. When removing and replacing defective parts and circuit elements, be careful not to damage wires or other parts by pulling or pushing them out of the way.

c. Before a part is unsoldered, note the position of the leads; if a part, such as a switch, has a number of connections, tag each lead as it is removed from the part.

d. Do not use more solder than is necessary to make a secure connection. Well soldered joints are important since a poorly soldered joint is very difficult to locate.

e. Do not allow drops of solder to fall into the unit since they may cause short circuits.

f. When replacing a part, place the new part exactly as the original part was placed. Use leads of the same length as the original leads.

71. Operational Test

Operate the switchboard as described in the equipment performance check list (par. 54). The equipment performance test may disclose the location and nature of an equipment fault.

72. Trouble-shooting Chart

The trouble-shooting chart is an aid in locating trouble in the equipment. The chart lists the symptoms that may be observed during operation, the probable trouble or troubles, and the procedures for correcting the defect. Once the trouble has been localized to a circuit, voltage and resistance measurements of the circuit will aid in determining the exact cause.

72. Trouble-shooting Chart (cont)

Symptom	Probable trouble	Correction
Voltmeter M601 does not indicate. (Power Supply PP-990/G)	*a.* Battery A or B worn out.	Check batteries. Replace if necessary.
	b. BATT. -EXT. -INT. switch S602 defective.	Check switch for dirty contacts and replace if necessary.
	c. INT. SWBD. BATT. switch S603 defective.	Check switch for dirty contacts and replace if necessary.
	d. Voltmeter switch S601 defective.	Check switch for dirty contacts and replace if necessary.
	e. Voltmeter M601 damaged.	Replace meter.
Lamp I 601 (Power Supply PP-990/G) does not glow when vibrator start circuit is closed.	*a.* Fuse F602 open.	Check and replace if necessary.
	b. Lamp I 601 is defective.	Check and replace if necessary.
	c. Transformer T601 shorted or open.	Check resistance values of transformer. Refer to paragraph 77. Replace if necessary.
	d. Coils L601 and L602 open.	Check continuity of coils and replace if necessary.
	e. Vibrator G601 defective.	Replace vibrator.
	f. Capacitor C601 shorted.	Check and replace if necessary.
	g. Resistor shorted.	Check and replace if necessary.
	h. Switch S301 defective.	Check switch for positive action or dirty contacts and replace if necessary.
Common battery signaling line signal (I 1 through I 30) does not operate to *white* on incoming signal.	*a.* Fuse F1 open.	Check and replace if necessary.
	b. Line selector switch (S3 through S32) may not be set correctly.	Set selector switch to position C.
	c. Jack (J1 through J30) defective.	Check and replace if necessary.
	d. Rectifier (CR1 through CR30 or CR61 through CR90) defective.	Check and replace if necessary.
	e. Signal (I 1 through I 30) defective.	Check and replace if necessary. *Use* a signal with *red band* around it.
	f. Line selector switch (S3 through S32) defective.	Check and replace if necessary.
	g. Resistor (R151 through R180) shorted.	Check and replace if necessary.

72. Trouble-shooting Chart (cont)

Symptom	Probable trouble	Correction
Common battery signaling trunk signal (I 1 through I 30) does not operate to *white* on incoming signal.	*a.* Line selector switch (S3 through S32) not set correctly.	Set switch in position T.
	b. Fuse F1 open.	Check and replace if necessary.
	c. Jack (J1 through J30) defective.	Check and adjust or replace if necessary.
	d. Line selector switch (S3 through S32) defective.	Check and adjust or replace if necessary.
	e. Rectifier (CR1 through CR30 and CR61 through CR90) defective.	Test and replace if necessary.
	f. Resistor (R31 through R60) defective.	Test and replace if necessary.
	g. Signal (I 1 through I 30) defective.	Test windings. Check mechanical operation and replace if necessary.
	h. Resistor (R151 through R180) defective.	Test and replace if necessary.
Magneto line or trunk signal (I 1 through I 30) does not operate to *white* on incoming signal.	*a.* Line selector switch (S3 through S32) may not be set correctly.	Set selector switch to position M.
	b. Protector (E31 through E60 and E62 through E91) grounded, shorting L1 and L2.	Check and clean or replace protectors if necessary.
	c. Jack (J1 through J30) defective.	Check and adjust or replace if necessary.
	d. Line selector switch (S3 through S32) defective.	Check and adjust or replace if necessary.
	e. Signal (I 1 through I 30) defective.	Test windings. Check mechanical operation and replace if necessary.
	f. Rectifier (CR1 through CR30 and CR61 through CR90) defective.	Test and replace if necessary.
	g. Resistor (R121 through R150) defective.	Test and replace if necessary.
	h. Resistor (R151 through R180) defective.	Test and replace if necessary.

72. Trouble-shooting Chart (cont)

Symptom	Probable trouble	Correction
Common battery signaling line or trunk signal (I 1 through I 30) remains *white* after operator plugs into line jack.	*a.* Signal (I 1 through I 30) defective.	Test windings. Check mechanical operation and replace if necessary.
	b. Line selector switch (S3 through S32) defective	Check and adjust or replace if necessary.
	c. Jack (J1 through J30) defective.	Check and adjust or replace if necessary.
Magneto line signal (I 1 through I 30) remains *white* after operator plugs into line jack.	*a.* Resistor (R1 through R30) defective.	Test and replace if necessary.
	b. Signal (I 1 through I 30) defective.	Check for electrical and mechanical operation and replace if necessary.
	c. Line selector switch (S3 through S32) defective.	Check and adjust or replace if necessary.
Panel lamps (I 31 and I 32) do not light when lamp switch is ON or line signal operates with N. A. switch on VIS.	*a.* Lamp battery (two Batteries BA-30) defective.	Test battery. Replace if necessary.
	b. Lamps I 31 and I 32 burned out.	Test lamps. Replace if necessary.
	c. Switches S33 and S34 defective.	Check switches. Replace if necessary.
Night alarm buzzer fails to operate. N. A. switch in AUD position.	*a.* Buzzer I 33 defective.	Check buzzer. Replace if necessary.
	b. Switch S34 defective.	Check switch. Replace if necessary.
	c. Line signal (I 1 through I 30) contacts defective.	Check signal for electrical and mechanical operation. Replace if necessary.
Supervisory signals in a cord pack do not operate and restore properly.	*a.* Signals (I 201 through I 204) defective.	Check for electrical and mechanical operation and replace if necessary.
	b. Defective cord pack.	Remove cord pack from switchboard. Test wiring and parts preferably with an ohmmeter. Replace defective parts if necessary.

72. Trouble-shooting Chart (cont)

Symptom	Probable trouble	Correction
Operator cannot ring any station.	*a.* Ringing generator defective. *b.* Vibrator defective. *c.* Ringing switch S301 in opertor's pack defective. *d.* Loose connections.	Test hand generator. Replace if necessary. Check and replace if necessary. Check and replace if necessary. Check connections.
Operator cannot ring any station, using a particular cord circuit.	Cord circuit defective.	Remove cord pack from switchboard. Test circuits and components, replacing parts if necesary.
Operator can ring stations on all but one line.	*a.* Jack (J1 through J30) associated with line defective.	Check jack. Adjust or replace if necessary.
Operator cannot transmit.	*a.* Operator's telephone set defective. *b.* Operator's battery worn out. *c.* Operator's pack defective.	Replace the operator's set with a set known to be in operating condition. Test battery in operator's pack and replace if necessary. Check and repair or replace if necessary.
Operator cannot transmit over any line through a particular cord circuit.	Cord pack defective.	Check cord pack and repair or replace if necessary.
Parties cannot transmit through a particular cord circuit.	Cord pack defective.	Check cord pack and repair or replace if necessary.
Civilian central office equipment not seized on lines 29 and 30 when operator plugs in.	*a.* Switches S1 and S2 not operated, or defective. *b.* Retardation coils L1 and L2 defective. *c.* Line jack J29 or J30 defective.	Check and replace if necessary. Test and replace if necessary. Check and adjust or replace if necessary.
Operator cannot supervise conference calls	CONF. SUPV. -TRK SIG switch S302 defective.	Check switch. Adjust or replace if necessary.
Station user at field telephone cannot talk or receive in a conference connection.	Defective TALK LIST. -CONF. switch S202 or S203.	Check switch. Adjust or replace if necessary.

Section III. REPLACEMENT OF PARTS

73. General

The switchboard is so designed that the defective cord packs and operator's pack may be replaced (par. 55*e* and *f*). Individual parts, other than those discussed in paragraphs 74 through 77, should be replaced completely unless the defect is such that repair may be accomplished readily. Tag all wires before they are removed from a part. Consult the wiring diagrams (fig. 39, 41, 43, and 44) for color coding of wires and for terminal connections before replacing any parts.

74. Switchboard Signal Assembly TA-207/P
(fig. 25 through 28)

When it is necessary to repair or replace any of the internal parts of the jack field section, the chassis must be removed from the case. Follow the steps outlined in subparagraphs *a* through *d* below to remove the chassis from the case.

a. Remove the three screws from the top and bottom of the jack field section that hold chassis supports in position.

b. Remove the four retaining screws from each of the chassis supports and remove the supports.

c. Remove the 12 retaining screws from the front of the case.

d. Remove the chassis from the case.

e. Remove the four screws that hold the back panel to the four supporting posts. This permits the panels to be separated so that binding posts, jacks, and magnetic signals can be repaired or replaced.

f. To replace a magnetic signal follow the instruction below.

(1) Unsolder and tag the leads connected to the terminals of the magnetic signal to be replaced. Check the position of terminal 6 which is indicated by the molded web at the terminal end.

(2) Remove the lens cap and the hexagonal nut on the front of the defective signal.

(3) Remove the damaged signal from the panel and replace it with a new signal which has a *red band* around it. Refer to paragraph 93 for the adjustment procedure of the line signals.

g. To replace a line jack and line selector switch assembly follow the instructions given in subparagraphs (1) through (4) below and refer to figure 29. The assembly contains a terminal board that is used to mount all of the resistors and rectifiers used with the line. To replace any of the parts it is necessary to remove the complete assembly from the panel.

(1) Unsolder and tag all of the leads connected to the assembly.

(2) Unscrew the hexagonal nut from the front of the jack assembly and slide it to the rear.

(3) To disassemble the jack assembly further, proceed as explained below.

(*a*) Remove the terminal board from the frame of the line switch.

(*b*) Unsolder the part to be replaced from the strap wire.

(*c*) Replace the damaged part and reassemble the jack assembly.

(4) Replace the jack assembly by reversing the procedure given in subparagraphs (1) through (3) above.

h. Refer to paragraphs 78 and 79 for the adjustment requirements of the jack and line selector switch.

75. Cord Telephone Circuit TA-208/P
(fig. 30)

To replace any of the internal parts of the cord pack follow the steps outlined in subparagraphs *a* through *h* below.

a. Remove the cover by unscrewing the six screws in the right side of the cord pack and lift the cover from the pack. This exposes all of the components of the cord pack.

b. To replace the repeating coils follow the step-by-step procedure below.

(1) Unscrew the four screws in the bottom of the pack and lift the repeating coil bracket from the pack.

(2) The coil mounted with the terminals toward the top of the pack is used with circuit 1. To remove this coil from the pack unsolder the connections, unscrew the retaining nuts, and lift the coil from the pack.

(3) To remove coil two from the pack, loosen coil one and slide it out so that coil number two will clear the bracket, and then

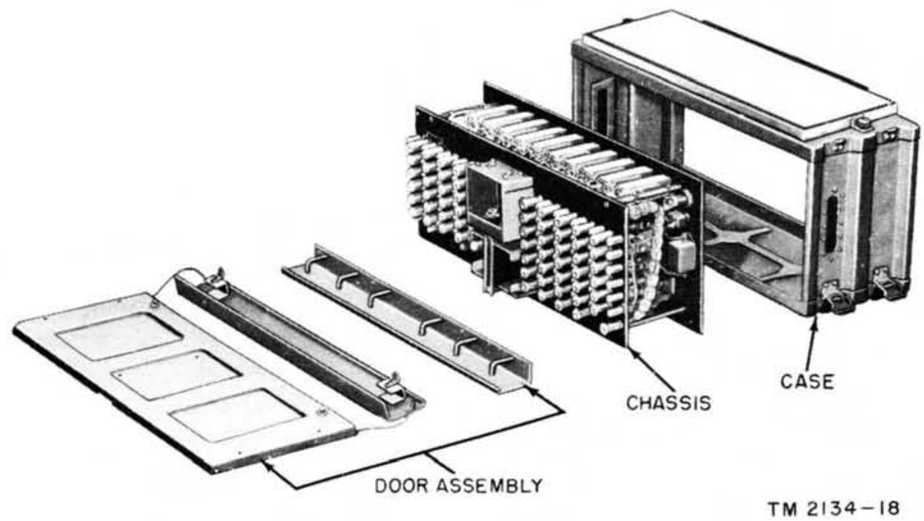

Figure 25. Switchboard Signal Assembly TA-207/P, partially dismantled.

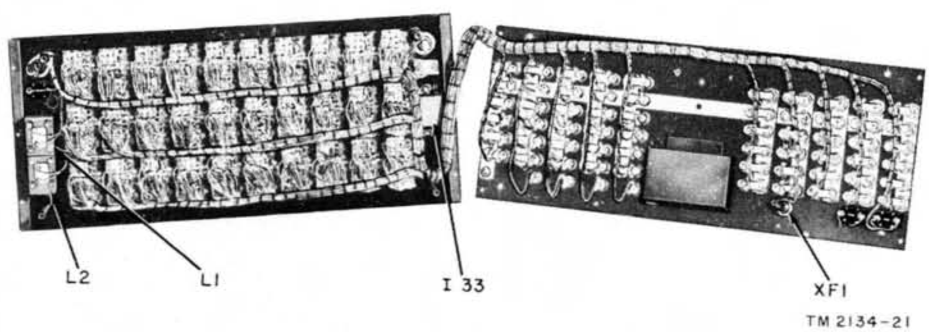

Figure 26. Switchboard Signal Assembly TA-207/P, dismantled for maintenance.

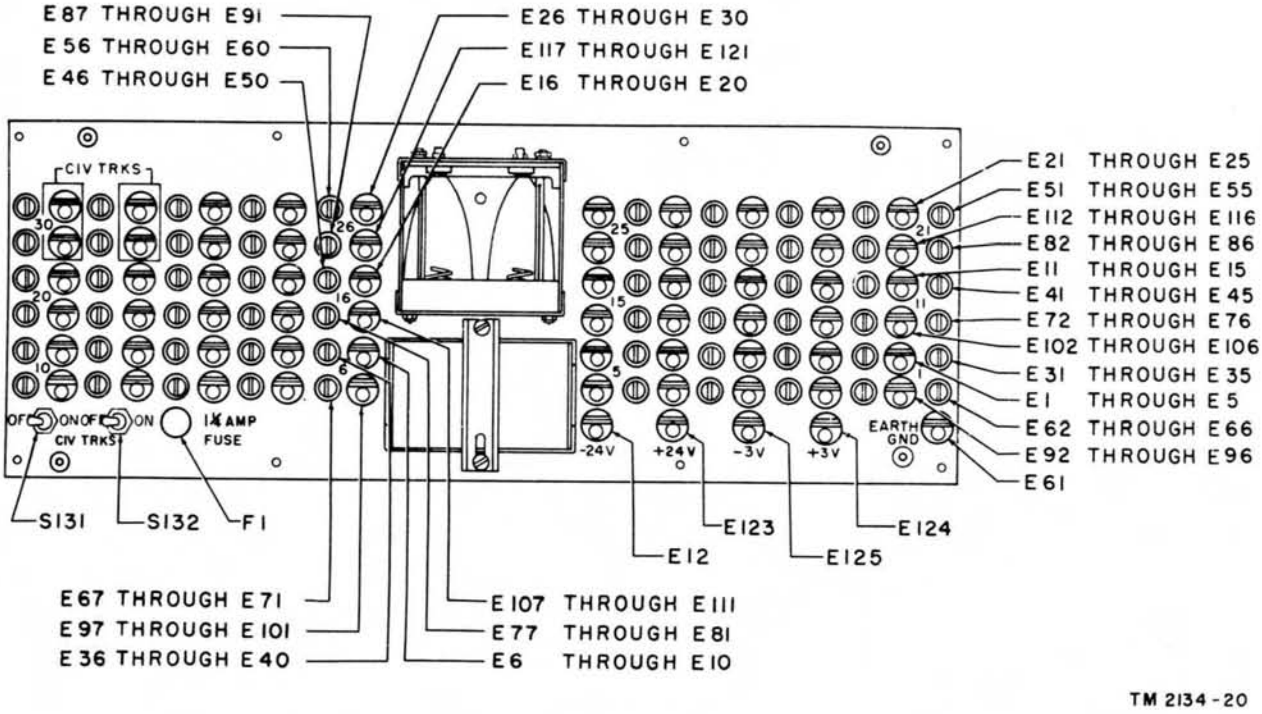

Figure 27. Switchboard Signal Assembly TA-207/P, location of parts, rear panel.

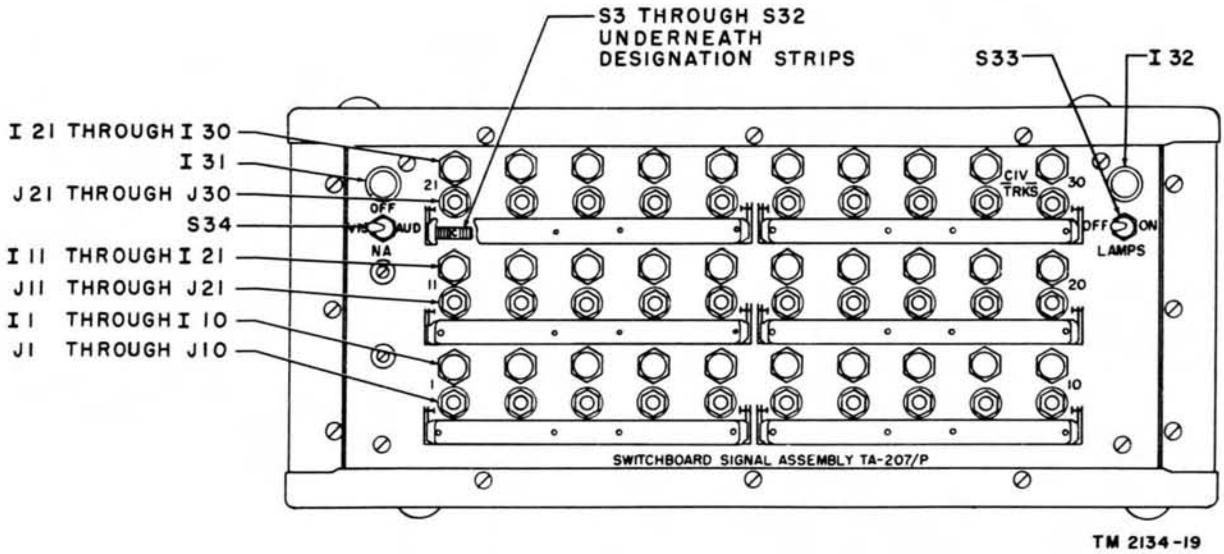

Figure 28. Switchboard Signal Assembly TA-207/P, location of parts, front panel.

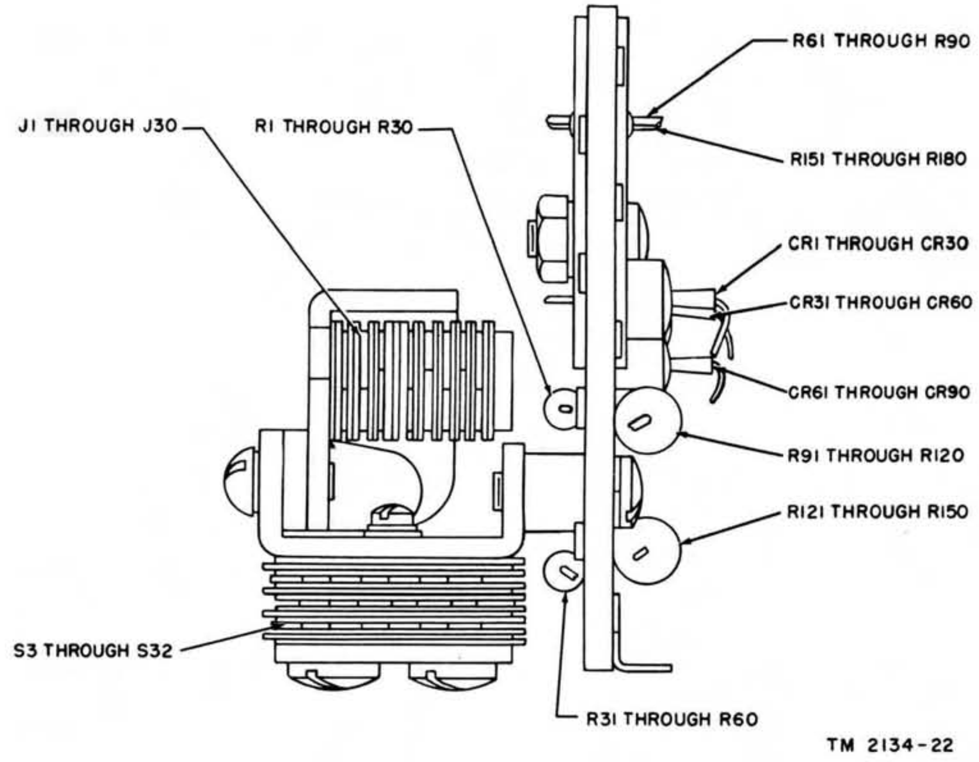

Figure 29. Switchboard Signal Assembly TA-207/P, location of parts on rear of line jack.

proceed as explained in subparagraph (2) above.

c. To replace or repair the cord switches follow the step-by-step procedure below:

(1) Remove the repeating coil bracket as explained in subparagraph *b*(1) above.

(2) Remove the handles from the switches.

(3) Remove the four screws from the top of each switch and slide the switch toward the bottom of the pack until the top of the switch clears the top of the pack.

(4) Lift the switch from the pack and perform the necessary maintenance. The adjustment requirements are explained in paragraph 80.

(5) Be careful when removing the leads from the switch, do not burn adjacent wiring or the terminals with the soldering iron. Be sure to tag all of the leads when they are removed from the switch.

(6) Replace the switch by reversing the procedure given for disassembly.

d. To replace the supervisory signal follow the instructions below:

(1) Remove the repeating coil bracket as explained in subparagraph *b*(1) above.

(2) Remove the lens cap and the retaining nut from the top of the signal to be replaced.

(3) Swing the signal out of the pack so that the terminals are accessible.

(4) Unsolder and tag the wires from the signal to be replaced.

Caution: Be sure the signal is mounted so that the terminals are in the same relative position as the signal which was removed from the pack so the magnetic fields of adjacent signals will not interfere with other signals. Terminal 6 is indicated by the molded web on the rear of the signal.

(5) Replace the signal by reversing the procedure explained in subparagraphs (1) through (4) above.

e. To remove the plug seat switch (cord reel switch), follow the step-by-step procedure outlined below.

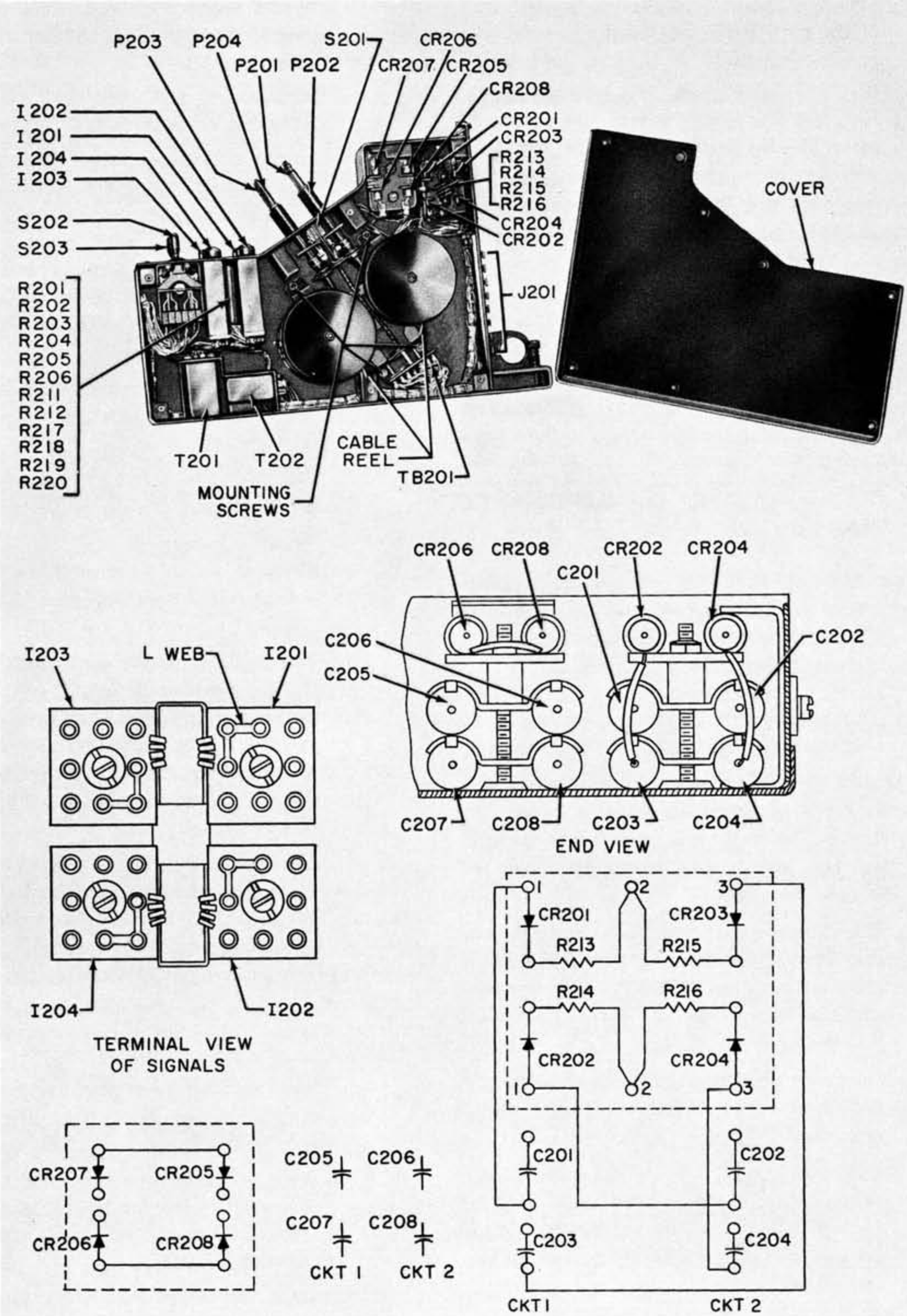

Figure 30. Cord Telephone Circuit TA-208/P, location of parts.

(1) Unscrew the four screws on the left side of the cord pack that hold the cord reel bracket assembly in position and swing the cord out of the cord pack.

(2) Pull the four cords out of the cord reel assembly far enough to clear the plug seat switches and fasten them so that they will not be retracted.

(3) Unsolder the leads connected to the plug seat switch.

(4) Unscrew the two screws and nuts that fasten the switch plate (E) to the cord guide brackets and loosen, but do not remove, the screw that fastens the cord guide bracket to the cord reel bracket.

(5) Slide the switch out of the cord guide bracket.

(6) To reassemble the cord seat switch reverse the procedure explained above.

Caution: Be sure that the new switch is positioned properly because the contact arrangement is different for the calling cord than for the answering cord.

(7) The adjustment procedure for the plug seat switch is explained in paragraph 81.

f. To repair or replace a cord reel, follow the instructions given in subparagraph *e*(1) and (2) above to remove the cord reels from the cord pack. Then follow the instructions below to repair or replace the reel assembly.

(1) Examine the defective reel carefully, noting how it is mounted, the direction of rotation required to tension the springs, and the side of the cable reel on which the leads wires project.

(2) Compare the new cable reel with the defective reel to determine how it is to be mounted.

(3) Clip off the lead wires on the side of the cable reel on which they will not be required. The lead wires should be cut off as close as possible to the hub of the cable reel.

(4) Unsolder the cable reel lead wires of the defective reel that connect to the terminal board and discard the reel. Salvage the cord and plug assembly if they are in good condition.

(5) Solder leads from the cable reel to the proper terminals on the terminal board assembly.

(6) Reassemble the cord reel assembly by reversing the disassembly procedure.

g. To remove capacitors C201 through C204, a terminal board, with rectifiers CR201, CR202, CR203, and CR204 and resistors R213, R214, R215, and R216 mounted on it, must be removed first. The terminal board and capacitors (with clamps) are mounted on two screws. To disassemble, follow the procedure outlined in subparagraphs (1) and (2) below.

(1) Remove the two nuts that secure the entire assembly, and lift the terminal board off the screws.

(2) Unsolder the defective part and replace it with a part known to be in good condition.

(3) Reassemble by reversing the procedure outlined in subparagraphs (1) and (2) above.

(4) To replace capacitors C205 through C208, a terminal board, with rectifiers CR205, CR206, CR207, and CR208 mounted on it, must be removed first. To disassemble, follow the procedure described in subparagraphs (1) through (3) above.

h. A defective switchboard plug may be replaced without removing the cord pack or the cord reel bracket assembly. Follow the procedure outlined in subparagraphs (1) through (4) below when replacing damaged or worn cords.

Note. Tie a knot in the cord and loop it over the other plug in the same cord circuit to prevent retraction of the cord while the plug is being changed.

(1) Remove the plug shell screw and the plug shell so that the plug terminal screws are exposed.

(2) Remove the screws that hold the tip and ring cord terminals to the plug, and the screw that holds the sleeve conductor to the plug adapter.

(3) Hold the adapter securely and unscrew the plug from the adapter. *Never attempt to unscrew a plug from the adapter without removing the plug shell and disconnecting the terminals, or the cord conductors will break as a result of the twisting.*

(4) Replace the defective plug with a new one, fold the sleeve conductor back into the groove on the adapter, and assemble the screw to hold the conductor to the adapter. Fasten the tip and ring terminals to the associated terminals of the plug. Assemble the plug shell and plug shell screw. Remove the knot in the cord and allow it to retract.

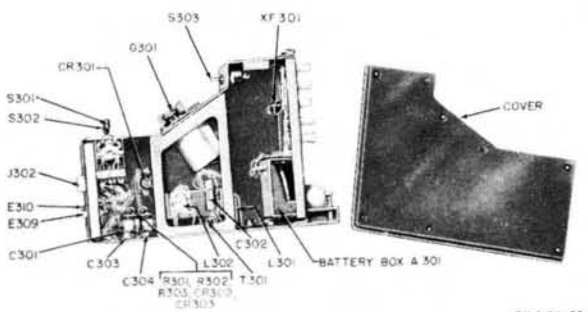

Figure 31. Operator's Telephone Circuit TA-220/P (Order No. 1669-Phila-51 only), showing location of parts.

76. Operator's Telephone Circuit TA-220/P

(fig. 31 through 33)

To make repairs or replacement of any part, it is necessary that the cover of the pack first be removed. The arms of the cable have sufficient length so that an individual part may be dismounted and swung into a more suitable position for unsoldering of connections and making repairs or adjustments. The procedure for replacing defective parts is as follows.

Note. Manual Telephone Switchboard SB-86/P procured on Order No. 96-Phila-52 is equipped with Operator's Telephone Circuit TA-220/P which is electrically and physically interchangeable with Operator's Telephone Circuit TA-220/P provided with Manual Telephone Switchboard SB-86/P procured on Order No. 1669-Phila-51. However, the location of some of the parts has been changed slightly as shown in figure 32. The instructions for the repair and replacement of parts apply equally to both operator's packs.

a. Switches (S301 and S302). The contact arrangement of these switches is identical and they mount without special positioning.

(1) Remove the switch handle and the four mounting screws of the defective switch.

(2) Swing the part into position to make the terminal accessible.

(3) Unsolder the wires connected to the switch terminals.

(4) Replace the defective switch with a new switch and reassemble.

(5) The adjustment procedures for the switches are explained in paragraph 80.

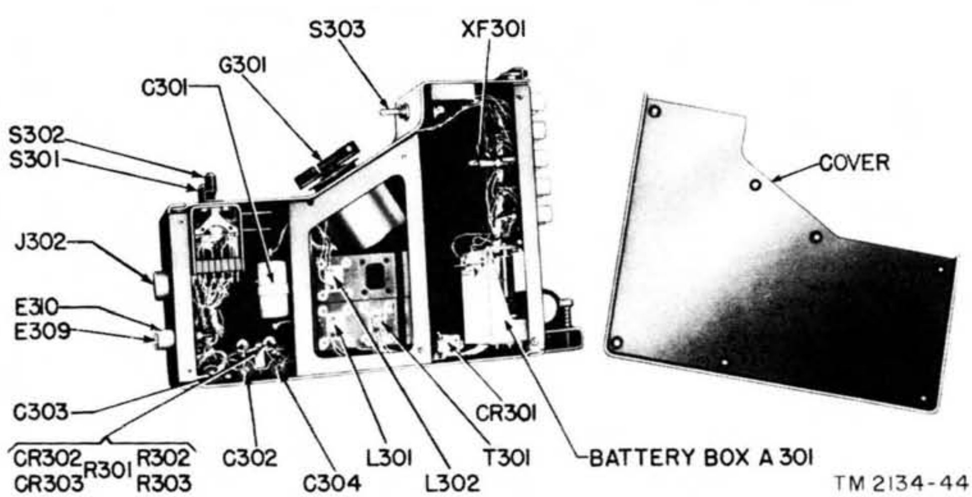

Figure 32. Operator's Telephone Circuit TA-220/P (Order No. 96-Phila-52 only), showing location of parts.

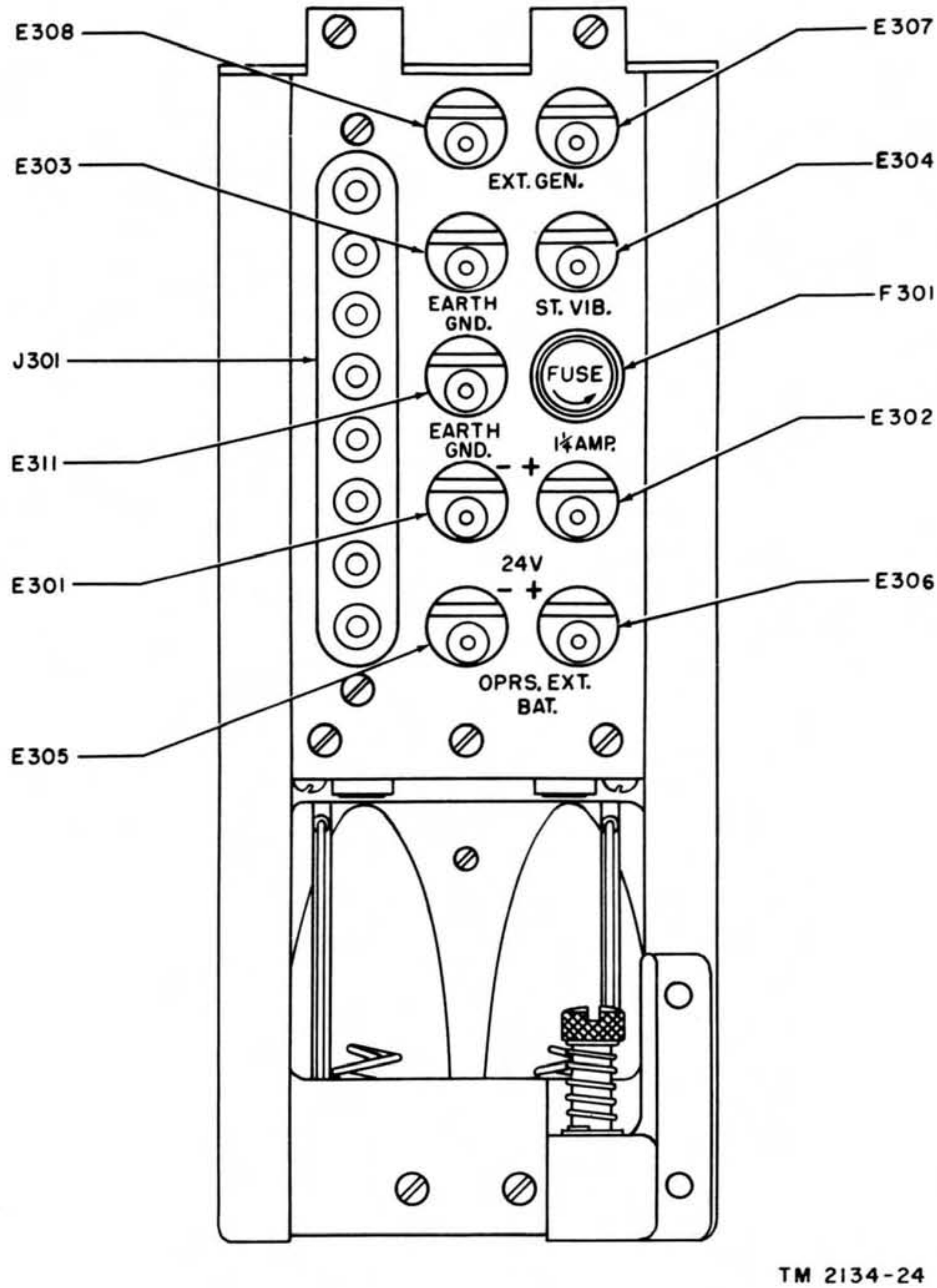

Figure 33. Operator's Telephone Circuit TA-220/P, location of parts.

b. Hand Ringing Generator G-42/PT.

(1) Remove the screw and washer from the center of the crank wheel and lift off the crank wheel.

(2) Unscrew the ring that secures the hand generator to the pack. The generator should be supported with one hand to prevent it from dropping when the ring is removed.

(3) Swing the hand generator out of the pack and unsolder the wires connected to the terminals.

(4) Replace the generator with a new one and reassemble.

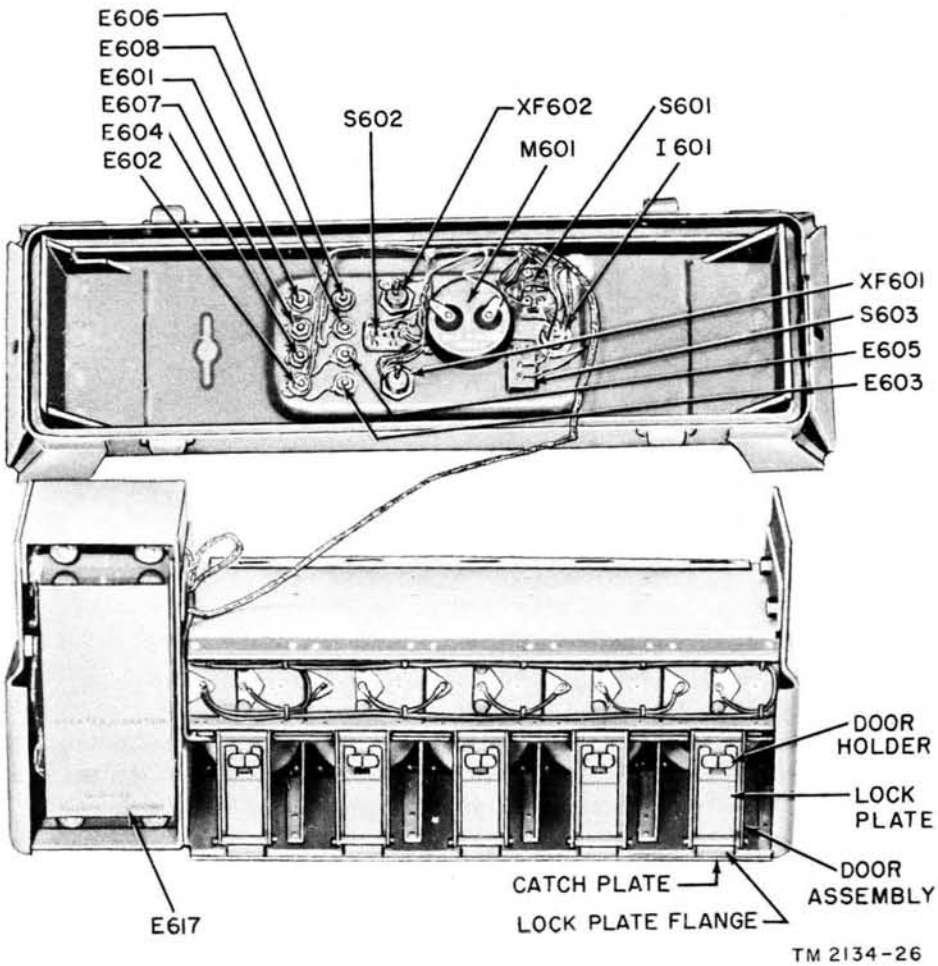

Figure 34. Power Supply PP-990/G, location of parts.

c. Operator's Induction Coil (L301).

(1) Remove the four screws on the bottom of the operator's pack that hold the coil mounting bracket in place.

(2) Swing the bracket out of the pack so that the terminals of the coil are accessible.

(3) Unsolder the wires connected to the terminals.

(4) Remove the mounting nuts that hold the coil to the bracket and replace the defective coil with a new one.

d. Capacitors, Rectifiers, and Resistors. Rectifiers CR302 and CR303, resistors R302 and R303, and varistor R301 are mounted on a terminal board. This terminal board is mounted on top of capacitors C303 and C304 by two screws and two nuts. One of the screws also holds down the clamp for capacitor C301. To disassemble, proceed in the following order: remove the nuts, terminal board, capacitor clamp, and capacitor C301, and the capacitor clamp and capacitors C303 and C304. Replace defective parts and reassemble following the reverse of the procedure above.

77. Power Supply PP-990/G

(fig. 34 and 35)

To replace any of the internal parts of the power pack follow the step-by-step procedure outlined in subparagraphs *a* through *e* below.

a. Unlatch the four trunk-type latches located on the sides of the case and lift the chassis from the case.

b. Remove the batteries (par. 23).

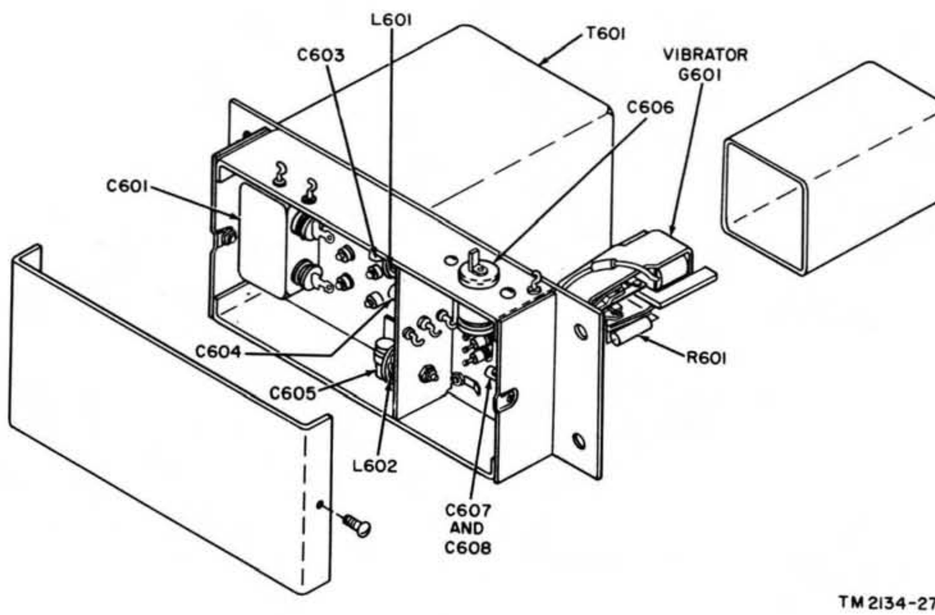

Figure 35. Power Supply PP-990/G, inverter vibrator, location of parts.

c. To remove the top section that contains the panel and cover, unscrew the two screws from each end of the chassis and lift the top section from the chassis. All of the parts are now accessible for replacement.

d. To remove the voltmeter follow the step-by-step instructions below:

(1) Disconnect the two wires from the meter.

(2) Unscrew the three screws that hold the meter into the panel and lift the meter from the panel.

e. To remove the vibrator inverter (E617) from the chassis, remove the screw, washer, insulator bushing, and insulator plate from each corner of the vibrator. Slide it out of the chassis and unsolder the three wires connected to the terminals. To remove vibrator G601 from the inverter follow the instructions in subparagraphs (1) and (2) below and to remove the transformer T601, refer to subparagraph (3) below.

(1) Remove the cover from the bottom of the vibrator inverter.

(2) Unsolder and tag the wire from the bottom of the vibrator and remove the nuts from the four studs. Lift the vibrator from the base plate.

(3) Unsolder and tag the six leads from the terminals on the transformer, remove the nuts from the studs, and lift the transformer from the base plate. To test the transformer windings, refer to paragraph 95.

f. To reassemble the power pack reverse the instructions in subparagraphs *a* through *e* above.

Section IV. ADJUSTMENTS

78. Line Selector Switch Adjustments

The line selector switch must be removed from the jack field section before the adjustments can be made. The minimum spring tension for the selector switch contacts is 30 grams. If the contacts do not meet this requirement they should be retensioned with a spring bender.

79. Line Jack Adjustments
(fig. 36)

The line jack assembly must be removed from the jack field section before the contacts can be adjusted. Subparagraphs *a* through *e* below are the minimum requirements that must be met during the test.

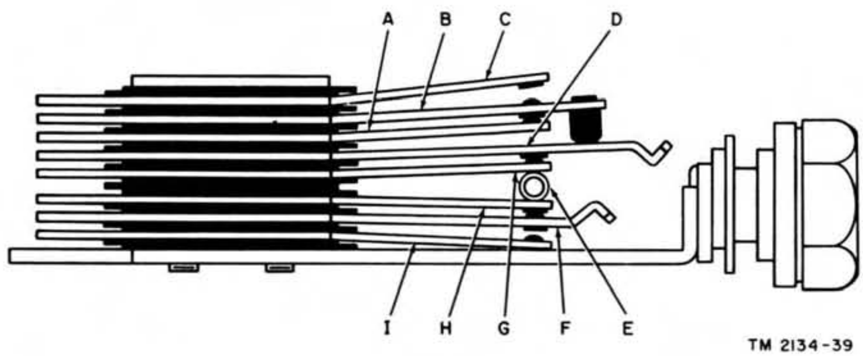

Figure 36. Telephone jack.

a. Springs G-H must be tensioned to press against center post E at all times.

b. Without a plug insert into the jack, contact pressure between the contacts springs A-B should be at a minimum of 80 grams.

c. When a plug is being inserted into the jack, the contacts springs G-D and the contacts springs A-B should open before the contacts springs B-C are closed. The contacts springs F-H are opened before the contacts F-I are closed.

d. The contacts springs B-C and F-I should have perceptible contact follow after they are closed.

e. Springs C-I are adjusted so that when a plug is being inserted, the gap between the contacts springs B-C and the gap between the contacts springs F-I should be minimum and still meet requirements described in subparagraph *b* above. This is to insure good contact follow and maximum contact presures between springs F-I and B-C.

80. Cord Circuit Switch Adjustment

The cord circuit switch must be removed from the cord pack before making any adjustments because the contacts are positioned so that they can not be adjusted when the switches are in the cord pack. Test the contact pressures and air gaps by applying pressures and making measurements at points adjacent to the contacts as explained below.

a. On contact stacks B, C, E, F, G, and H (designations on wiring diagram, figure 43) adjust the center spring to withstand 30 grams before the normally made contacts break. When the break occurs, there must be an .008 inch minimum air gap between the normally open contacts.

b. On contact stacks B, C, E, F, and H, adjust the springs so that when the switch is operated, the break contacts have an air gap of .008 inch minimum before the normally open contacts make. In the operated position, the contact pressure should be 30 grams minimum.

c. Contact stacks A and D are off-normal contacts operating when the normally open contacts at contact stacks E, B, C, and H are closed. This provides an additional form A and form B contact arrangement required for circuit operation. The contact pressure requirements should be the same as for the comparable arrangements of contact stacks B, C, E, F, G, and H (subpar. *a* above). On any readjustment of the off-normal sets of springs a check must be made to assure that the lever springs do not foul on the roller when the switch is operated.

81. Plug Seat Switch Adjustment
(fig. 37)

The plug seat switch assembly must be removed from the plug guide assembly before making the adjustments. The adjustment values for the switch are given below:

a. For the unoperated switch (plug in the seat), the distance between the rollers of contact assemblies A 1, A 2, and electrical switch plate E should not be greater than .47 inch as indicated. Spring B may be adjusted to control this dimension.

b. For the unoperated switch, the contact gap between spring assemblies C1, C2, and the mating D spring should be .031 inch minimum as indicated. Adjust the D spring to meet this requirement.

c. To open the contacts between contact assemblies A 1, A 2, and B, the pressure applied against the rollers, in a direction at right angles to switch plate E, should be between 45 and 65 grams. Tension A 1 and A 2 as required to meet this value.

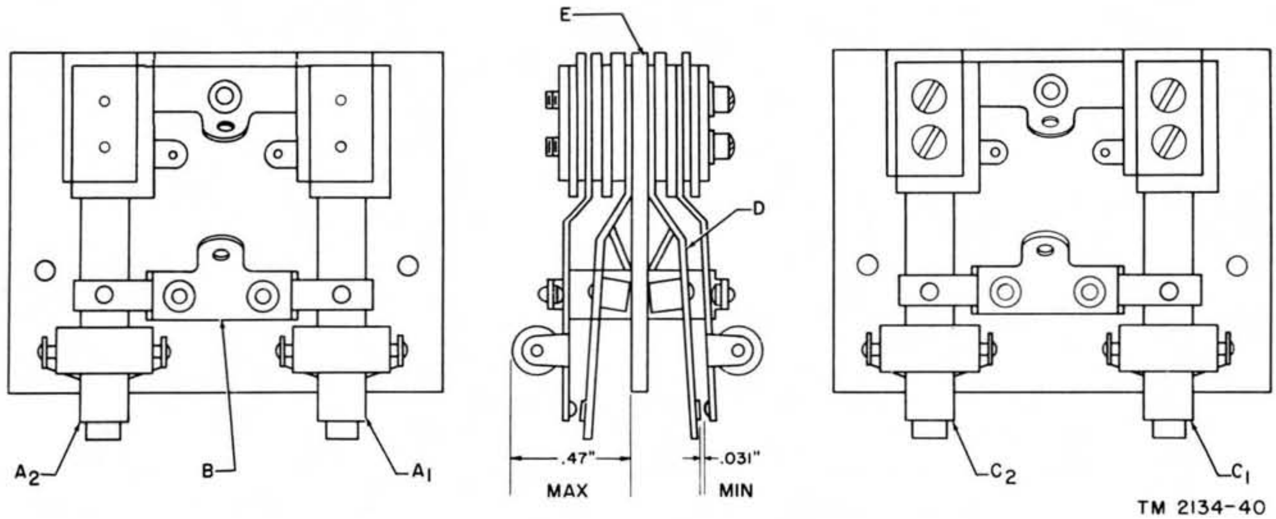

Figure 37. Plug seat switch.

d. There should be perceptible follow after contact assemblies C1, C2, and D make contact.

e. Due to variations in the parts involved, a final check on the operation of the switch, with the associated plug, should be made before a new switch is mounted on the cord reel and bracket assembly. Some added adjustment may be required.

82. Ringing and Trunk Signaling Switch Adjustment

(fig. 44)

Switches S301 and S302 must be removed from the operator's pack before adjustments. Test contact pressures and air gaps of these switches by applying pressures and making measurements at points adjacent to the contacts as explained below.

a. On contact stacks A through H, adjust the center spring to withstand 30 grams before the normally made contacts break. When the break occurs, there must be an .008 inch minimum air gap between the normally open contacts and the center spring.

b. When the switch is operated, the break contacts must have an air gap of .008 inch minimum before the normally open contacts make.

Section V. FINAL TESTING

83. General

This section is to be used as a guide in determining the quality of a repaired component. The minimum test requirements outlined in paragraphs 85 through 95 below may be performed by maintenance personnel with adequate test equipment and necessary skills.

84. Test Equipment Required for Final Testing

The table below tests the equipment required to perform the final tests for Manual Telephone Switchboard SB-86/P and gives a brief description of the equipment.

Test equipment	Description
Multimeter TS-352/U	Used as voltmeter and ammeter for tests on power pack.
Test Set I-142-(*)	Composite measuring instrument for measuring electrical characteristics of switchboard.
Test Set I-181	Current-flow type relay adjusting set used to test signals in switchboard.
Test Set TS-140/PCM	Consists of Signal Generator SG-15/PCM and DB Meter ME-22/PCM transmission measuring set.

85. Power Pack Tests

a. Test all of the toggle switches for ease of operation and positive action.

b. Test the voltmeter by checking the voltage of a battery known to be at full strength.

c. Check all of the binding posts by depressing and releasing them. The movement should be smooth and easy; however, the spring should be strong enough to retain the wire.

d. Test the vibrator by following the step-by-step procedure outlined below.

(1) Install new Batteries BA-200/U in the lower battery bank.

(2) Connect the ST. VIB. binding posts to the +24-volt binding post which will cause the vibrator to operate.

(3) Connect a 400-ohm resistor across the RING SUP. binding posts.

(4) Check the voltage output of the vibrator with Multimeter TS-352/U. The voltage output should be approximately 117 volts with a 30-volt dc input.

e. Check the exterior of the case for broken or missing parts.

f. Check the cover to be sure that the gasket is not damaged and that the knurled screw is not stripped or damaged.

86. Switchboard Tests

a. General.

(1) Connect EE-A (*) to TA-43 field telephones to line binding post L1 (upper binding post) and L2 (lower binding post).

(2) Set the line selector switch on switchboard to one of these positions:

M (magneto operation),

C (common battery signaling), or

T (common battery signaling trunk)

b. Magneto Line Test.

(1) Operate hand generator of station telephone.

(2) Associated line signal operates to white. Night alarm (NA) buzzer will sound if the NA switch is in AUD position or panel lamps will light if NA switch is in VIS position.

(3) Insert the answering plug (rear) into the calling party's jack (line signal should restore to black) and operate the associated TALK LIST.-CONF. switch to the TALK LIST. position. Operator and calling party should be able to talk (operator's TALK BATT. switch in ON position).

(4) Insert calling plug (front) of same cord circuit into jack associated with called party's line. TALK LIST.-CONF. switch to remain in the TALK LIST. position.

(5) Ringing called party accomplished by either of the methods listed below.

(a) If Power Supply PP-990/G is connected to the switchboard, operate ring switch in operator's pack to RING FWD. position.

(*b*) If Power Supply PP-990/G is not available, operate ring switch to RING FWD. position and turn crank of hand ringing generator.

(6) Restore TALK LIST.-CONF. switch to normal position when called party answers.

(7) To make a ring off check of the switchboard, proceed as follows:

(*a*) Operate the generator crank at a magneto station. The associated supervisory signal in cord pack operates to white.

(*b*) When the plugs are returned to the plug seat, the supervisory signals should restore to black.

c. Common Battery Signaling (CBS) Line Test.

(1) Lifting of a handset on a station telephone should cause associated line signal on the switchboard to operate to white. Night alarm operation is the same as described under magneto line test (subpar. *b* (2) above).

(2) Completion of call handled in the same manner as described under magneto line test (subpar. *b* (3) above).

(3) With the cords up, depressing the line switch (hook switch) on the station telephone should cause the associated supervisory signal to operate to white.

(4) When the plugs are pulled down and returned to the the plug seat, the supervisory signals should restore to black.

d. Common Battery Signalling (CBS) Trunk Test.

(1) Connect one SB-86/P to a second SB-86/P. Each switchboard should have its own battery supply.

(2) Insert the calling cord into the trunk jack at the originating switchboard and operate the associated switch of the cord pack to TALK LIST. position.

(3) The trunk signal at the terminating switchboard should operate to white. Since its signal restores to black through its own contacts, a flashing signal may be produced by operation of the TALK LIST. switch at the originating switchboard.

(4) Plug an answering cord into the trunk jack associated with the trunk signal at the terminating switchboard. The trunk signal should restore to black.

(5) Either operator may disconnect. The operator to pull down the cord first will cause the supervisory signal at the distant board to operate to white. Returning the cord to the plug seat on the switchboard that has the operated trunk supervisory signal will cause the signal to restore to black.

e. Civilian Trunk Option (Lines 29 to 30 only).

(1) Test the resistance of the trunk circuit with a plug in the trunk jack and the CIV. TRKS. switch in the OFF position by connecting an ohmmeter across the L1 and L2 binding posts. The circuit should test as an open circuit.

(2) Operate the CIV. TRKS. switch to the ON position and follow the procedure outline in subparagraph (1) above. The ohmmeter should indicate approximately 50 ohms which is the resistance of coil L1.

Note. The signals are in the black position in the following tests.

87. Cord Pack Insertion Loss Test

a. This test is to be made with the cord pack and operator's pack installed in the keyshelf section. Connect the output terminals of Signal Generator SG-15/PCM to the tip and ring of the answering cord of the cord circuit being tested. Use Jack JK-22 which has leads soldered to the tip and ring terminals. If a complete SB-86/P is available, the answering cord may be plugged into a jack in the jack field section and connections to the signal generator made at the line terminals of that jack.

b. Connect the tip and ring of the calling cord of the same cord circuit to the terminals of DB Meter ME-22/PCM. Connections may be made as in subparagraph *a* above.

c. No source of *direct current should be connected* to the equipment under test.

d. TALK LIST.-CONF. switch of the cord circuit being tested must be in the unoperated position and both switches on the operator's pack must be left unoperated.

e. Adjust output control of Signal Generator SG-15/PCM to 0 decibels referred to 1 milliwatt in 600 ohms (dbm) at 1,000 cps.

f. Reading of DB Meter ME-22/PCM now will indicate the loss of the cord circuit, which should not be greater than 1.5 db.

88. Transmitting Test, Operator's Pack

a. Connect the output terminals of Signal Generator SG-15/PCM to the tip and ring of the answering cord circuit previously tested and known to be good.

b. Remove all dc sources from the equipment being tested, including the transmitter battery within the operator's pack.

c. Connect a jumper between the OPRS. EXT. BAT. binding posts, and operate TALK BAT. switch to ON position.

d. Prepare a test cord by connecting a length of the cord, used for the operator's telephone set, to a spare Plug PL-77/U and then connect the plug to the receptacle on the front of the operator's pack. Strip the free ends of the conductors.

e. Operate the TALK LIST.-CONF. switch of the cord circuit being used to the TALK LIST. position.

f. Connect a resistor of approximately 300 ohms across the receiver leads of the test cord.

g. Connect the transmitter leads of the test cord to the terminals of DB Meter ME-22/PCM.

h. Adjust the output control of Signal Generator SG-15/PCM to obtain a level of 0 dbm at 1,000 cps.

i. DB Meter ME-22/PCM now should indicate a loss of not more than 12.5 db.

89. Receiving Test, Operator's Pack

a. Repeat the steps in paragraph 87*a* through *e*.

b. Connect a resistor of approximately 50 ohms across the transmitter leads of the test cord.

c. Connect the receiver leads of the test cord to the terminals of DB Meter ME-22/PCM.

d. Adjust the output control of Signal Generator SG-15/PCM to obtain a level of 0 dbm at 1,000 cps.

e. DB Meter ME-22/PCM now should indicate a loss of not more than 11.0 db.

90. Efficiency Test on Microphone of Operator's Telephone Set (Headset-Microphone H-91/U)

a. This test is to be made with Test Set I-142-(*) and in accordance with TM 11-2062, Test Set I-142 and Test Set I-142A, (par. 26).

b. Connect the transmitter leads of a test cord to the TRANSMITTER and COMMON test set clip terminals of Test Set I-142-(*). The transmitter leads terminate on contacts C and D of the cord plug, and connection to the test set will be aided by the use of a test cord prepared by connecting spare Receptacle U-79/U, to a length of operator's telephone set cord.

c. Operate switch 1 to LBPE.

d. Operate switch 2 to RCT.

e. Set control D1 to position 2.

f. Set control D3 to position 4.

g. Precondition the microphone by rotating it back and forth about its central axis and hold it in front of the sound source screen.

h. Operate switch 8 to TRANS.

i. Depress switch 9 and observe deflection on meter M1. It should be to the right of +2db. If not, the microphone is defective.

91. Efficiency Test of Operator's Telephone Set Receiver (Headset-Microphone H-91/U)

a. This test is to be made with Test Set I-142-(*) and in accordance with TM 11-2062.

b. Connect the receiver leads of the test cord (par. 90*b*) to the RECEIVER and COMMON test set clip terminals.

c. Operate switch 2 to RCT.

d. Set control D2 to position 2.

e. Set control D4 to position 6.

f. Hold the receiver in front of the second source. Position the cap in the center of the screen and flush against it.

g. Operate switch 8 to REC.

h. Depress switch 9 and observe the db scale reading on meter M1. Reading should be to the right of 0 db. If not, the receiver unit is defective.

92. Testing Hand Ringing Generator G-42/PT

Generator G-42/PT is tested by connecting its output to jack L1-L2 of Test Set I-142-(*) by means of the cord supplied. Details of the operation of the test for this test are given in TM 11-2062. The most convenient connection to the generator output depends on the available assemblies.

a. If a complete switchboard is being tested, connect jack L1-L2 of Test Set I-143-(*) to the terminals of a line in the jack field section. Plug the calling cord of a cord circuit into the jack of this line and operate the cord circuit switch to TALK LIST. While holding the ringing switch of the operator's pack to RING FWD. operate crank of the generator at approximately 200 rpm, and observe the reading of meter M1 of the test set.

b. If the operator's pack is assembled to a cord pack only, by means of multiple cable, the output of Generator G-42/PT may be measured at the tip and ring of the plug of a calling cord. The leads should be soldered to the tip and ring of jack JK-22, which in turn are connected to the test cord of Test Set I-142-(*). The switch of the cord circuit being used should be operated to TALK LIST. and the ringing switch of the operator's pack should be held in the RING FWD. position. Proceed as in subparagraph *a* above.

c. When only the operator's pack is available, the leads from L1-L2 of Test Set I-142-(*) are connected directly to the CT and CR terminals at the back of the operator's pack. Complete the test as explained in subparagraph *a* above.

d. For an unassembled generator, the leads from L1-L2 of Test Set I-142-(*) are connected to terminals 1 and 3 of the generator.

e. In all of the above cases, operation of Test Set I-142-(*) is the same as given in detail in TM 11-2062. Operation of the crank of the generator at approximately 200 rpm should produce a deflection on meter M1 of 0 db or higher. A lower reading indicates a defect in the generator or the switchboard circuits being used.

93. Testing Line Signals

Note. Only the line signals can be adjusted. The supervisory signals in the cord pack cannot be adjusted and must be replaced if inoperative.

a. Adjustment Values.

Note. Current values listed below are used when the signals are mounted in a *position* similar to the actual position of the signals in the jack field section.

(1) The normal position of the signal is with the black portion of the target visible.

(2) The operate and nonoperate values and the restore and nonrestore values for the magnetic line signal are listed in the table below.

Condition of signal	Nonoperate (ma)	Operate (ma)
Black	5.0	5.6
	Nonrestore (ma)	Restore (ma)
White	4.8	5.6

(3) The connections to the line signal windings for proper operation and testing are shown in the table below.

Target operation	Positive battery connections	
	Winding 2-4	Winding 5-7
Black to white	Terminal 4	Terminal 7
White to black	Terminal 2	Terminal 5

b. Test Procedure with Test Set I-181.

Note. Use the nongrounded battery method. Refer to TM 11-2036 (Test Sets I-181, I-181-A, and I-181-B).

(1) *Connections* (Use 22-1/2-volt dry-cell battery.)

(*a*) Connect terminal BAT. to the negative (—) side and terminal GRD to the positive (+) side of the dry-cell battery.

(*b*) Connect single-conductor test cords between terminals T and R of the test set and coil terminals of the signal as follows. For the 2-4 winding of the signal, connect T to terminal 2 and R to terminal 4. For the 5-7 winding of the signal, connect T to terminal 5 and R to terminal 7.

(2) *Test procedure.*

(*a*) Set circuit 1 coarse adjustment (R8) at maximum resistance.

(*b*) Set circuit 1 fine adjustment (P2) at maximum resistance.

(*c*) Set twist switch (K5) 0-3,000-6,000 ohms at 0 position.

(*d*) Check for the nonoperate adjustment value (5.0 ma). Signal target to be in black position as described in subparagraph (*e*) through (*i*) below.

(*e*) Switch **REV** (K7) to be in depressed position.

(*f*) Operate circuit control switch 1 and check the current value. Observe the caution listed in TM 11-2036, paragraph 12, to prevent damage to the meter.

(*g*) Adjust the I-181(*) to 5 milliamperes (ma) as described in TM 11-2036.

(*h*) The signal target should remain black when tested at this value.

(*i*) Increase the current from the I-181(*) and check for operate value. Signal should operate.

(*j*) Check for nonrestore adjustment value (4.8 ma). Signal target to be in white position as described in subparagraphs (*k*) through (*o*) below.

(*k*) No change in connections required.

(*l*) Pull out **REV** switch (K7).

(*m*) Set current to 4.8 ma; signal should remain white.

(*n*) Set current to 5.6 ma; signal should restore.

Note. The nonrestore value could be checked by reversing the T and R leads to obtain connection of positive (+) battery as shown on the chart. However, the reversing switch performs the same function and eliminates necessity of changing connections.

94. Testing Rectifiers

The rectifiers used in the SB-86/P are 1N92 type and are all tested by the same procedure. The voltage and current values shown below are approximate.

a. The forward current when 1/2 volt dc is applied to the rectifier is 310 ma. Connect a resistor, battery, and an ammeter in series with the rectifier to make this test.

b. The reverse current when 200 volts are applied to the rectifier is 1.9 ma. Use the same procedure to check the rectifier in this direction as used in subparagraph *a* above.

95. Coil Data

The table below lists the coils used in the SB-86/P, the dc resistance for each winding, and the location of each coil.

Coil	Location	Terminals	Dc resistance (ohms)
L1, L32	Jack field section	1-2	50
I 1 through I 30	Magnetic signals	5-7 2-4	2K 1K
I 201 through I 204	Cord pack	5-7 2-4	2K 1K
T201, T202	Cord pack	1-2 3-4	11.5 13.5
L301, L302	Operator's pack	1-2	50
T301	Operator's pack	1-2 3-4 4-5	12 33 260
T601	Power pack	1-2 2-3 4-5	8.2 8.2 107

CHAPTER 7
SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

96. Disassembly

The following instructions are supplied as a guide for preparing Manual Telephone Switchboard SB-86/P for transportation and storage.

a. Disconnect all incoming lines from the binding posts of Switchboard Signal Assembly TA-207/P.

b. Disconnect all wires between the switchboard, Power Supply PP-990/G and ground. Coil the two cables connected between the power pack and the switchboard and place them behind the door of the jack field section.

c. Check that all plugs are removed from jacks and are in place.

d. Store the Headset-Microphone H-91/U in the canvas bag on the back of the door of the Manual Telephone Switchboard Section SB-248/P and close the two doors in the rear of the switchboard. Make certain that the camlocs are locked correctly.

e. Remove the switchboard from its mounted position on top of the cover and place it on the ground.

f. Lift the power pack by its handles and place it inside the cover on the side that has a bracket at each end (on the bottom of the cover). Each bracket has a lock nut to be used in securing the power pack within the cover. Insert two locking rods (one on each end of the power pack) through the unit and screw into the lock nuts.

g. With the marking "FRONT" on the cover facing toward the front of the switchboard, place the outer cover over the switchboard. Be certain that the cover is centered properly on the rubber gasket of the keyshelf case. Close the latches that hold the cover to the lower portion of the switchboard. Fold the collapsible legs on top of the cover and secure them in place.

97. Packing for Shipment or Limited Storage

a. The precise procedure for repacking for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored. Refer to paragraph 19 and reverse the instructions given in that paragraph. If possible, use any of the original packaging materials saved at the time of unpacking the equipment.

b. Whenever practicable, place a dehydrating agent such as silica gel inside the cover. Protect the case with a waterproof paper barrier. Seal the seams of the paper with waterproof sealing compound or tape.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

98. General

The demolition procedures outlined in paragraph 99 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

Note. Before attempting to demolish the equipment, remove the cord and operator's packs from the keyshelf case, remove the chassis from the jack field section case, and remove the chassis from the power pack case.

99. Methods of Destruction

a. Smash. Smash the controls, lamps, coils, switches, binding posts, capacitors, resistors, and handsets; using sledges, axes, handaxes, pickaxes, crowbars, or heavy tools.

b. Cut. Cut cords, wiring, and cabling; using axes, handaxes, and machetes.

c. Burn. Burn cords, resistors, capacitors, coils, wiring, and technical manuals; using gasoline, kerosene, oil, flame throwers or incendiary grenades.

d. Bend. Bend panel, chassis and all framework; using crowbars and other heavy tools.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, fox holes, or throw them into streams.

g. Destroy. Destroy everything.

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D

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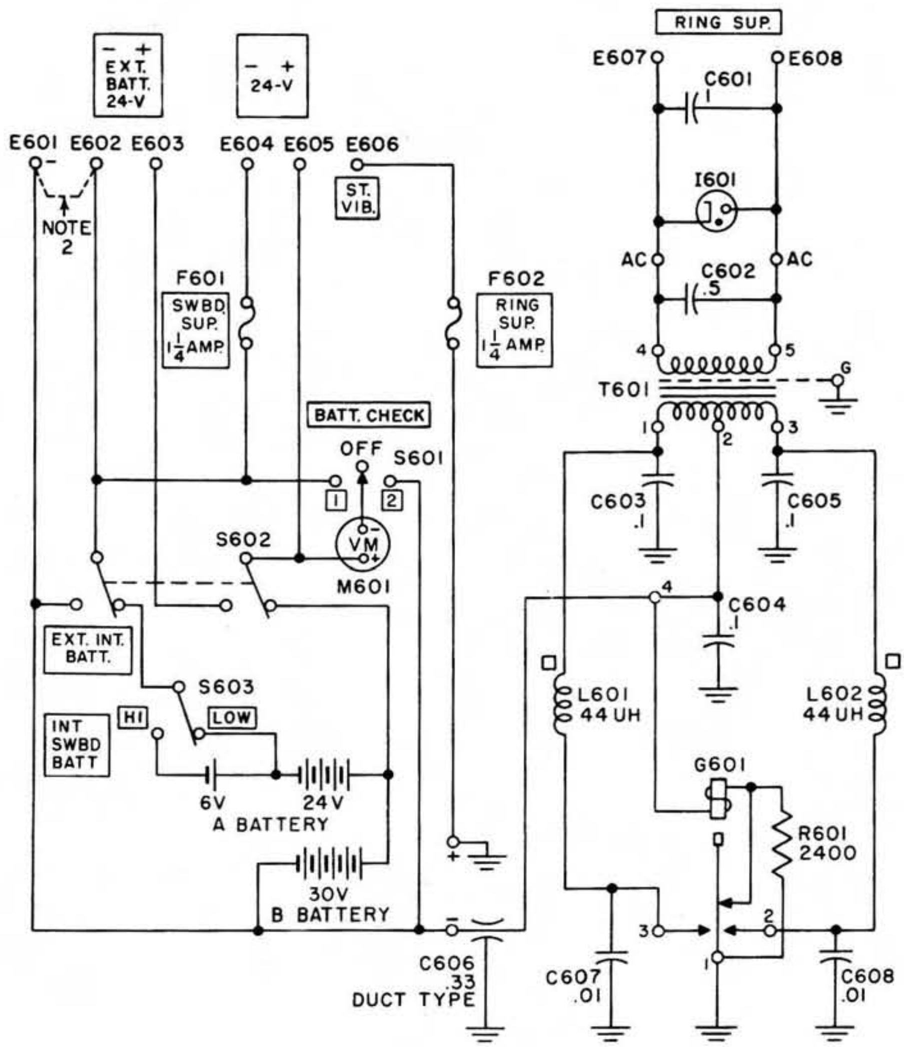


NOTES:

1. UNLESS OTHERWISE SHOWN: RESISTORS ARE IN OHMS, CAPACITORS ARE IN UF.
2. PLACE JUMPER ACROSS BINDING POSTS TO MULTIPLE INTERNAL BATTERIES.
3. GROUNDS SHOWN ARE VIBRATOR INVERTER CHASSIS GROUNDS.
4. VIBRATOR INVERTER CHASSIS IS INSULATED FROM POWER SUPPLY CHASSIS.
5. A BATTERY (UPPER BATTERY GROUP) NORMALLY SUPPLIES THE SWITCHBOARD.
6. B BATTERY (LOWER BATTERY GROUP) NORMALLY SUPPLIES THE RINGING CONVERTER.
7.

VOLTAGE CHECK PROCEDURE			SWITCH	POS.
REMOVE SHUNT WIRE	INT. BATT.	UPPER	INT.	1
		LOWER	INT.	2
	EXT. BATT.		EXT.	1 OR 2

TM2134-32

Figure 38. Power Supply PP-990/G, schematic diagram.

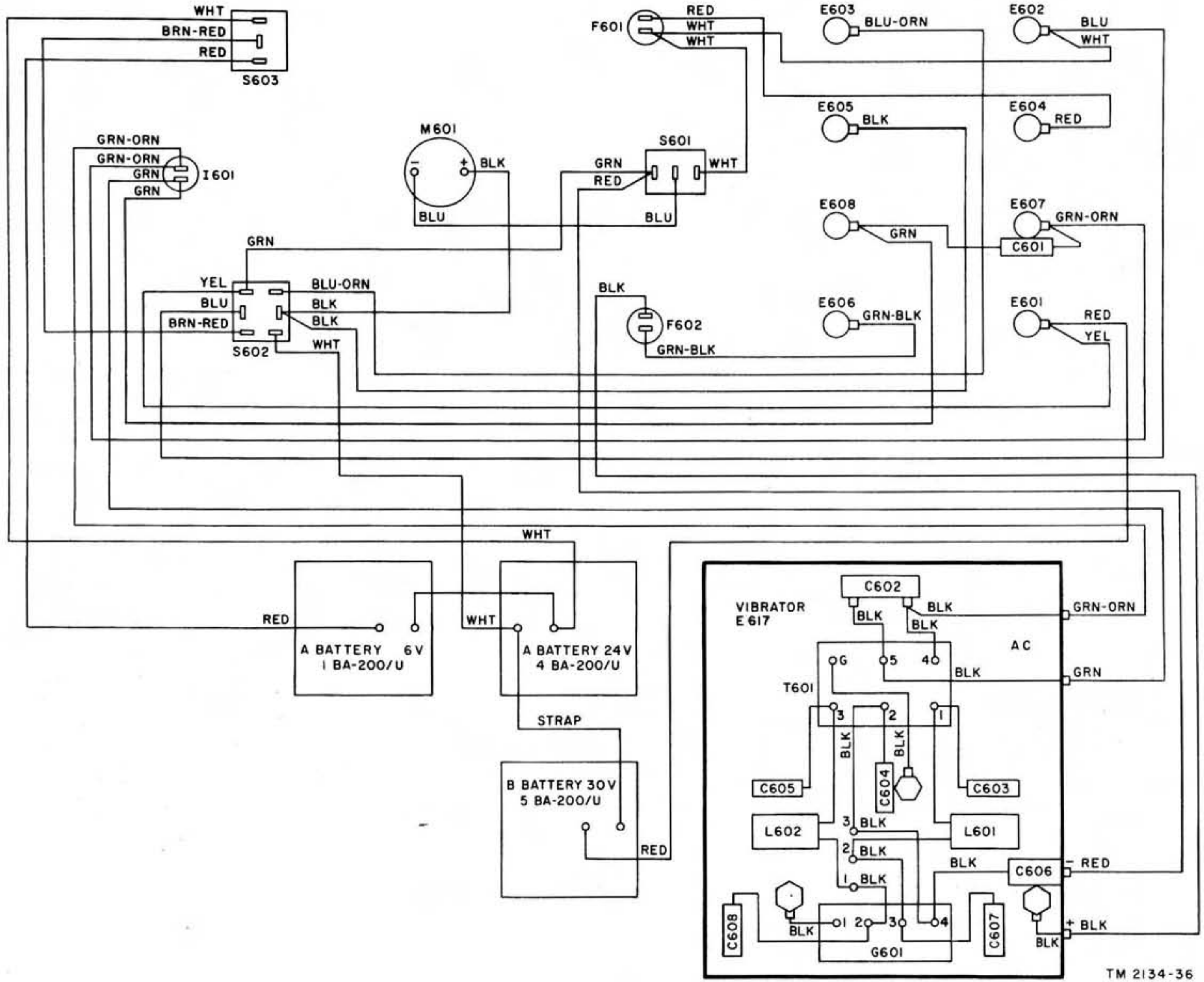
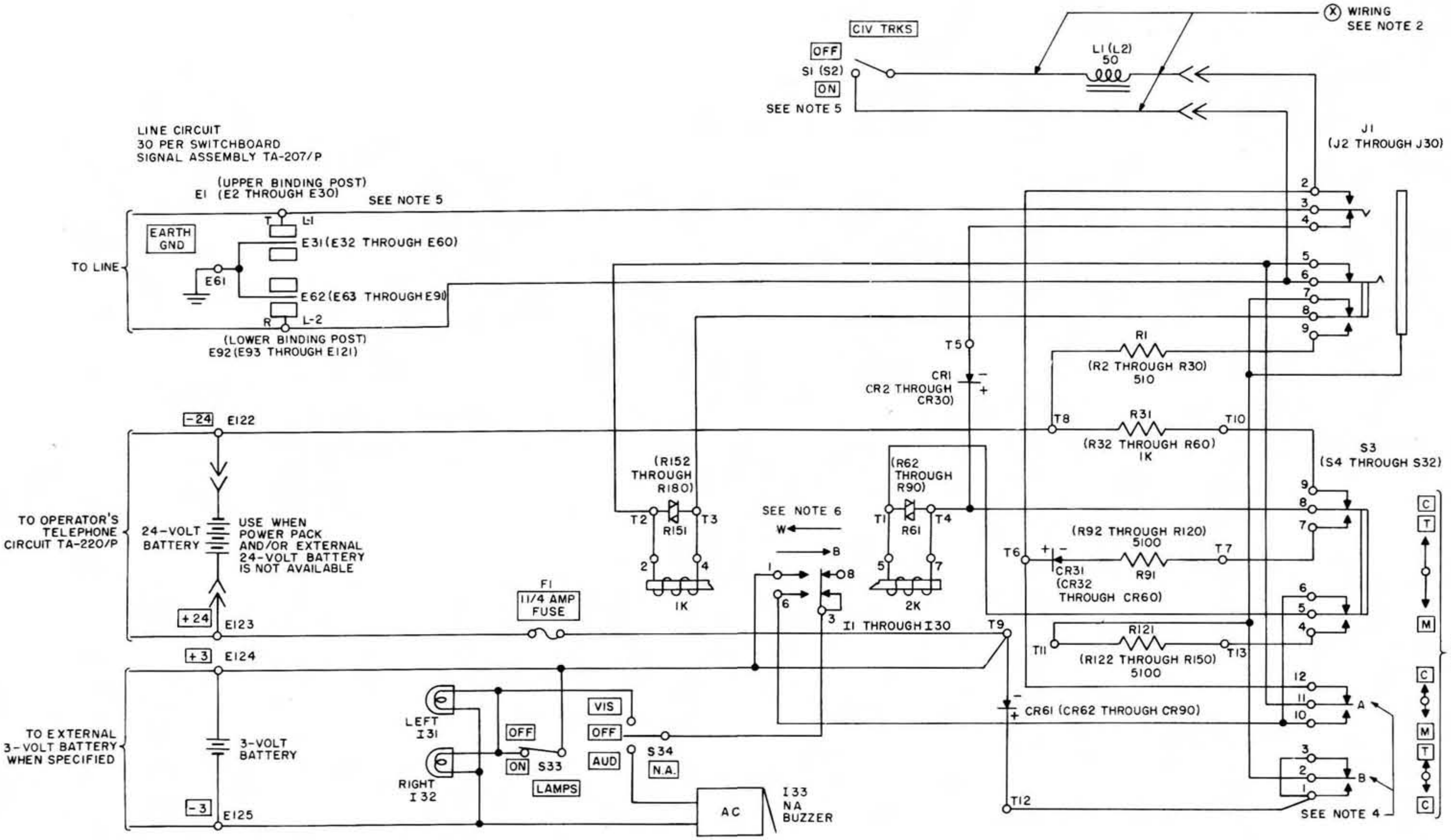


Figure 39. Power Supply PP-990/G, wiring diagram.



NOTES:

1 UNLESS OTHERWISE SHOWN
RESISTORS ARE IN OHMS,
CAPACITORS ARE IN UF,
RELAY WINDINGS ARE IN OHMS.

2 (X) WIRING RUN IN ONLY FOR LINES 29 AND 30.

3 LINE SELECTOR SWITCH DESIGNATIONS:

[C] COMMON BATTERY SIGNALING LINE.

[T] COMMON BATTERY SIGNALING TRUNK.

[M] MAGNETO LINE.

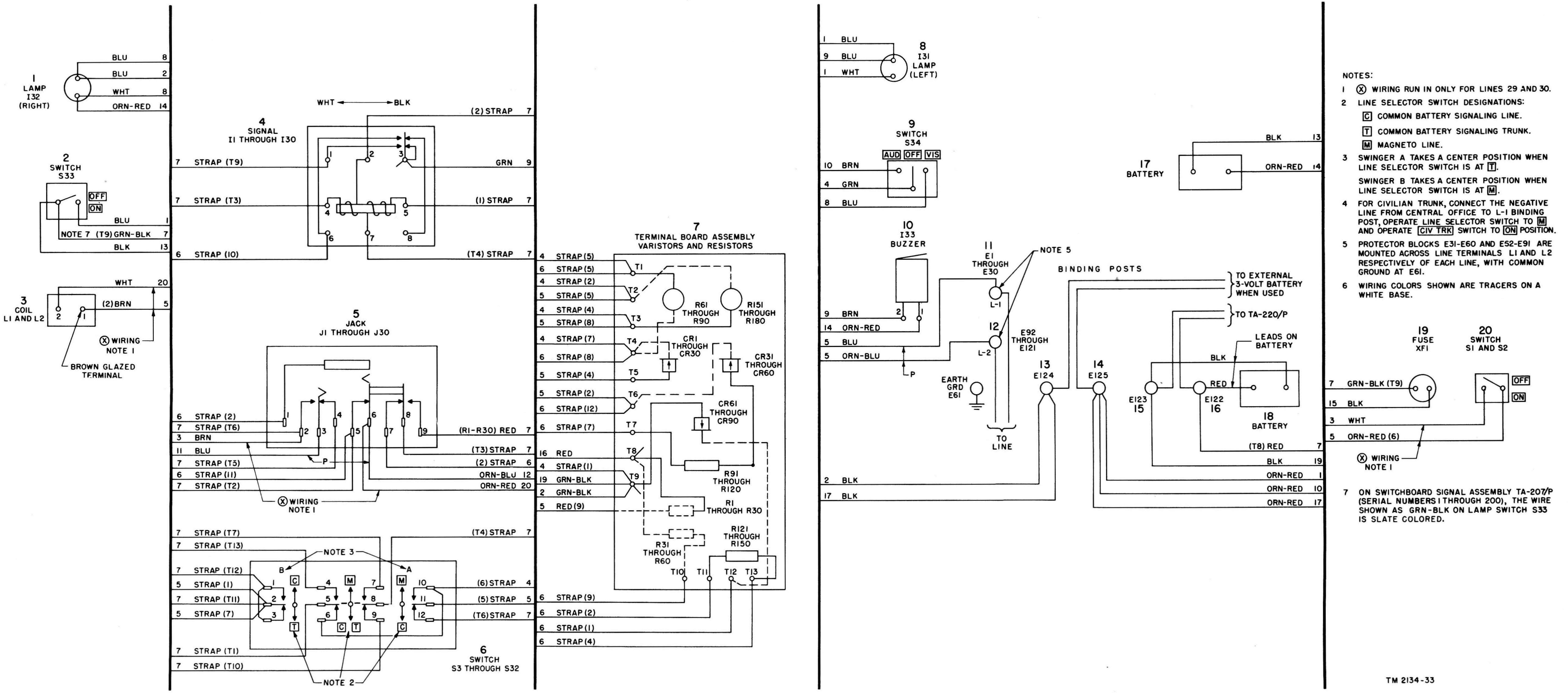
4 SWINGER A TAKES A CENTER POSITION WHEN LINE SELECTOR SWITCH IS AT [T]
SWINGER B TAKES A CENTER POSITION WHEN LINE SELECTOR SWITCH IS AT [M].

5 FOR CIVILIAN TRUNK, CONNECT—48V DC (CENTRAL OFFICE BATTERY) TO T (TIP), OPERATE LINE SELECTOR SWITCH TO [M] AND OPERATE [CIV TRKS] SWITCH TO [ON] POSITION.

6 SIGNAL IS IN BLACK POSITION WHEN CONTACTS 3 AND 8 ARE CLOSED.
SIGNAL IS IN WHITE POSITION WHEN CONTACTS 1 AND 6 ARE CLOSED.

TM 2134-29

Figure 40. Switchboard Signal Assembly TA-207/P, schematic diagram.



NOTES:

1 (X) WIRING RUN IN ONLY FOR LINES 29 AND 30.

2 LINE SELECTOR SWITCH DESIGNATIONS:

[C] COMMON BATTERY SIGNALING LINE.

[T] COMMON BATTERY SIGNALING TRUNK.

[M] MAGNETO LINE.

3 SWINGER A TAKES A CENTER POSITION WHEN LINE SELECTOR SWITCH IS AT [T].

SWINGER B TAKES A CENTER POSITION WHEN LINE SELECTOR SWITCH IS AT [M].

4 FOR CIVILIAN TRUNK, CONNECT THE NEGATIVE LINE FROM CENTRAL OFFICE TO L-1 BINDING POST, OPERATE LINE SELECTOR SWITCH TO [M] AND OPERATE [CIV TRK] SWITCH TO [ON] POSITION.

5 PROTECTOR BLOCKS E31-E60 AND E52-E91 ARE MOUNTED ACROSS LINE TERMINALS L1 AND L2 RESPECTIVELY OF EACH LINE, WITH COMMON GROUND AT E61.

6 WIRING COLORS SHOWN ARE TRACERS ON A WHITE BASE.

7 ON SWITCHBOARD SIGNAL ASSEMBLY TA-207/P (SERIAL NUMBERS 1 THROUGH 200), THE WIRE SHOWN AS GRN-BLK ON LAMP SWITCH S33 IS SLATE COLORED.

TM 2134-33

Figure 41. Switchboard Signal Assembly TA-207/P, wiring diagram.

NOTES:

1. UNLESS OTHERWISE SHOWN: RESISTORS ARE IN OHMS, CAPACITORS ARE IN UF, RELAY WINDINGS ARE IN OHMS.
2. RESISTOR SYMBOLS R207 THROUGH R210 HAVE BEEN DELETED DUE TO CHANGES IN THE EQUIPMENT.
3. THE CIRCUIT DESIGNATIONS IN PARENTHESES ARE FOR CIRCUIT NO.2.
4. SIGNAL IS IN BLACK POSITION WHEN CONTACTS 3 AND 8 ARE CLOSED. SIGNAL IS IN WHITE POSITION WHEN CONTACTS 1 AND 6 ARE CLOSED.

TM 2134-31

Figure 42. Cord Telephone Circuit TA-208/P and Operator's Telephone Circuit TA-220/P, schematic diagram.

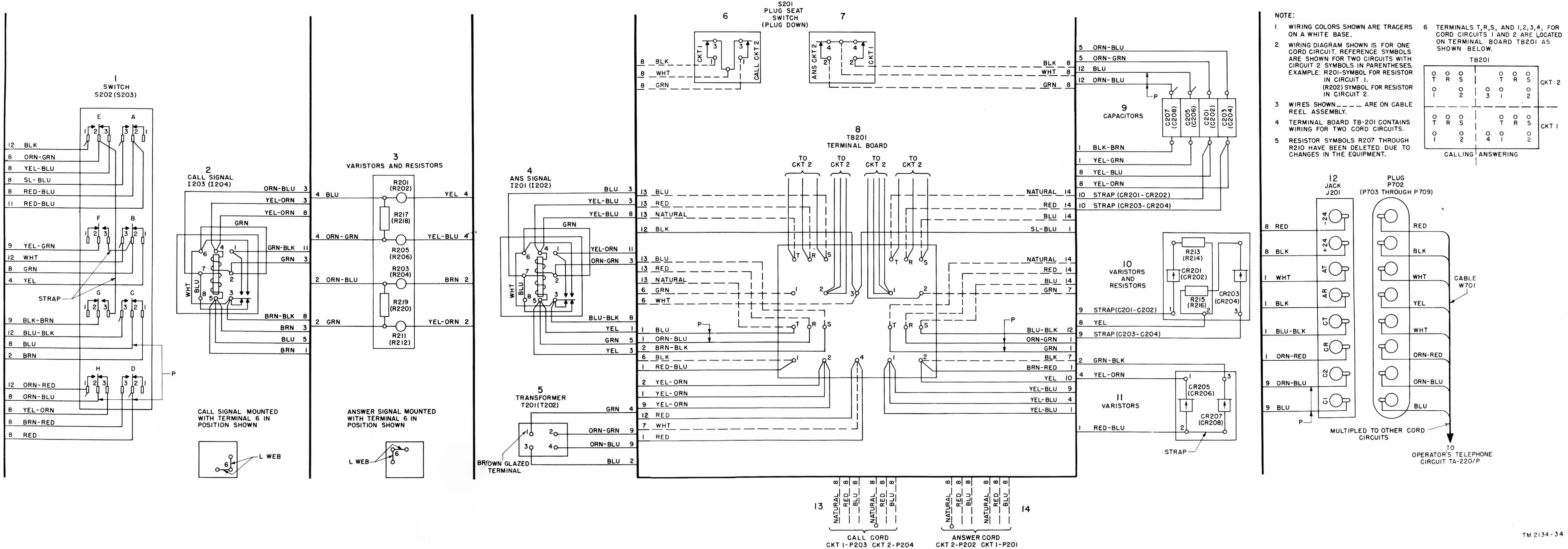


Figure 43. Cord Telephone Circuit TA-208/P, wiring diagram.

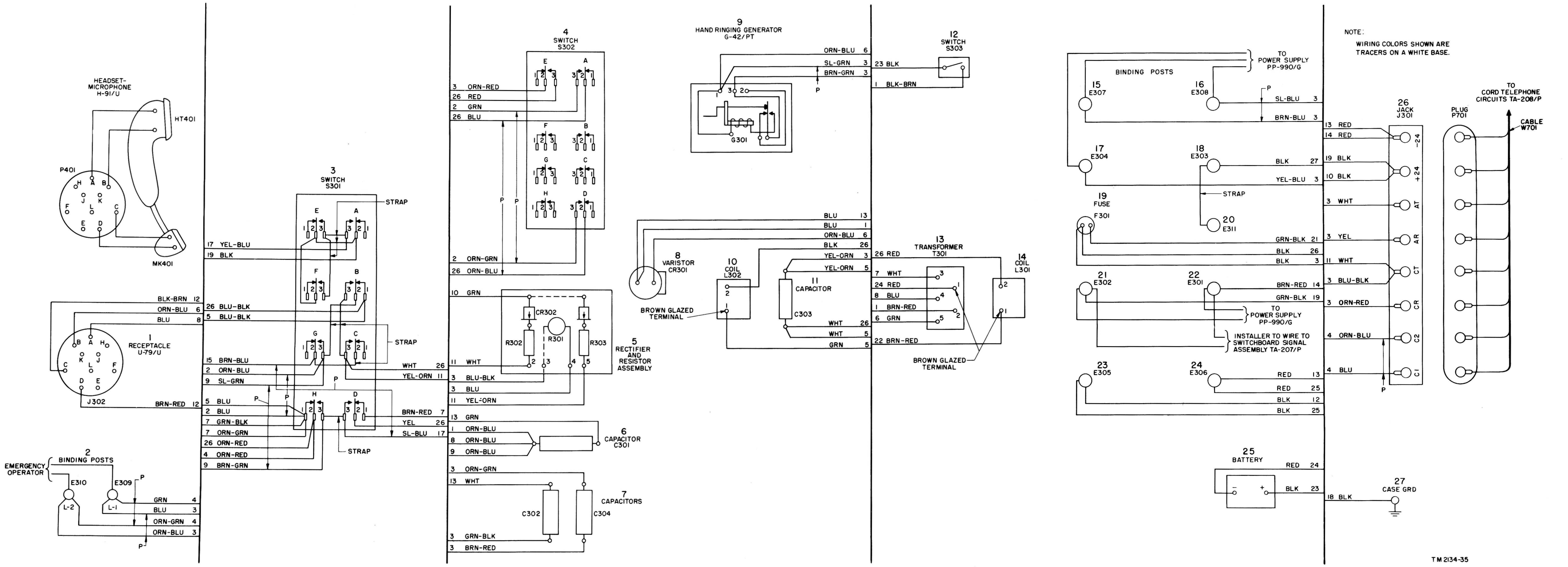


Figure 44. Operator's Telephone Circuit TA-220/P, wiring diagram.


SWITCHBOARD SB-86/P
SER. 1025
ORD.
MFG.
U.S.

DTID:	W81KK310450065A		
NSN:	5805005032660		
QTY:	1	EA	$ 4668.00
NOUN:	SWITCHBOARD,TELEPHO		
ACCUM:	SYBA2VAN	FED CC:	F7
LOC:	SSSSSSSSSSSS	DEMIL:	A