# LEICH
# PBX L55
# DESCRIPTION

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## 1. GENERAL

1.01 This section describes the Type L55 PBX which is used to manually establish connections between local stations; and between local stations and a central office, distant PABX, or other PBX. This section is re-issued to include recent design changes for the (New Style) Type L55 detailed descriptions, and circuit diagrams of the subject equipment. Due to the extensive number of changes involved, marginal arrows are not used. Remove and destroy Issue 1.

## 2. EQUIPMENT DESCRIPTION

### Physical Characteristics

2.01 The L55 PBX is a manual, non-multiple, cord-type switchboard as shown in Figure 1. It is 29-3/8 inches wide, 29-7/8 inches deep, and 46-1/16 inches high. The surface of the writing shelf is located 30 inches above the floor. Fully equipped, the L55 PBX weighs approximately 400 pounds.

2.02 The L55 PBX may be either of two different configurations, depending on its vintage. Switchboards of earlier manufacture are constructed internally as shown in Figure 2. Those of recent manufacture are equipped with plug-in connectors for connecting to trunks and station lines as shown in Figure 3.

2.03 As shown in Figure 2, the main structure of the L55 PBX consists of a self-supporting steel framework to which plywood panels and other wood trim are attached. In earlier vintage switchboards, all electrical equipment and circuitry are mounted on the steel superstructure of the PBX. In switchboards of recent manufacture, certain apparatus used to provide optional functions are mounted external to the PBX.

2.04 The removable plywood panels and other woodwork are manufactured in standard finishes of mahogany, walnut, and blond ash. In addition an unfinished bay poplar plywood cabinet is available, which can be finished to match special interiors. The cabinet woodwork is plastic-finished nonflammable and stain-resistant. The front and rear doors lift out, and the cabinet panels are easily removed. This permits interchanging woodwork when the surroundings are redecorated, or the PBX is moved to a new location.

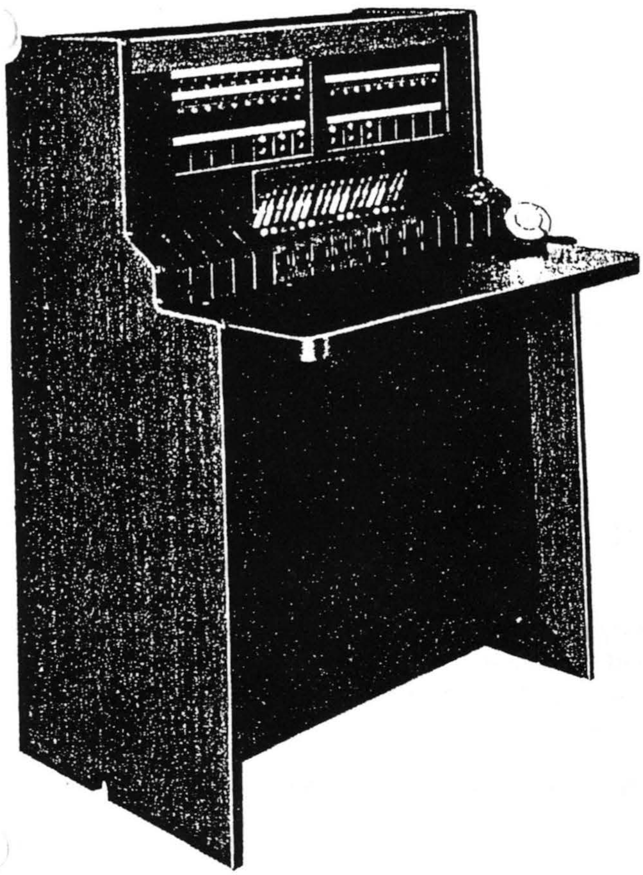


Figure 1. Type L55-A3 PBX.

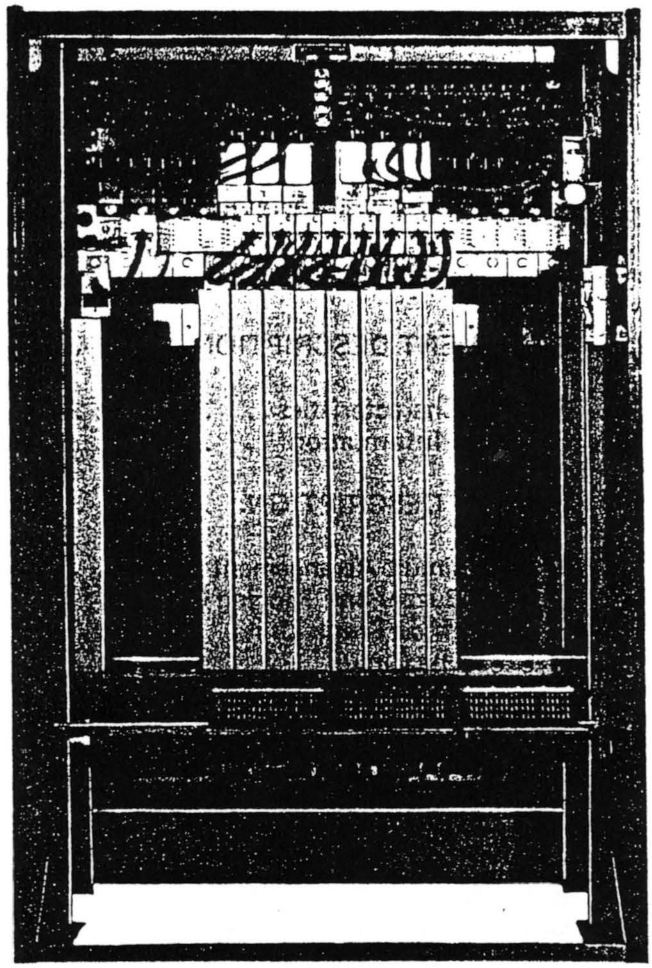


Figure 2. Type L55 PBX (Old Style), Rear View.

2.05 The central office trunk circuits, cord circuits, and attendant's position circuit are individual jack-in assemblies, and are located in the switchboard as shown in Figures 1 and 2. A push-and-turn talk key and side-by-side arrangement of cords are used in the cord circuit assembly. Supervisory lamps and push-type ring keys are located below the plug seats on a sloping surface. This leaves the writing shelf completely clear of cords and keys.

2.06 A reversable metallic instruction plate is mounted in a central location on the front of the PBX between the cord and trunk circuits. One side contains instructions for operation in conjuction with a manual central office. The opposite side has instructions for operation with a dial office. The stock L55 PBX is furnished with the manual office side of the instruction plate exposed.

Ordering Information

2.07 There are three basic stock models of the L55 PBX, each identified by its own code number. They are:

(a) L55-A3X with an ultimate capacity of 60 lines.

(b) L55-B4X with an ultimate capacity of 120 lines.

(c) L55-200X with an ultimate capacity of 200 lines.

NOTE: The suffix "X" in the code number is replaced by a different letter when ordering, to indicate the cabinet finish. These letter designations are given in Table 1.

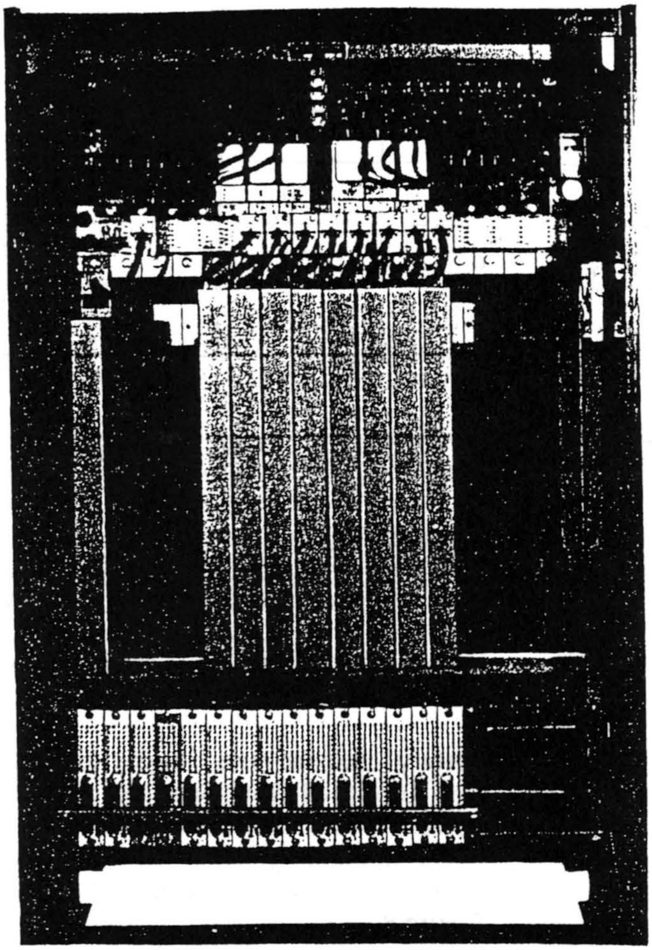


Figure 3. Type L55 PBX (New Style), Rear View.

Table 1. Suffix Letters to Indicate Finish When Ordering.

| SUFFIX | CABINET FINISH |
|---|---|
| A | Brown TV Mahogany |
| B | Webb Walnut |
| C | Blond Ash |
| D | Unfinished Bay Poplar |
| E | Mocha Walnut |
| F | Triangle Walnut |
| G | Pongee Walnut |

2.08 The three stock model switchboards are initially wired and equipped as shown in Table 2. To extend the capacity of the older vintage L55-B4X model beyond 80 lines, a supplementary cable must be installed along with the necessary additional apparatus. The recently manufactured L55-B4X switchboard is wired for its full capacity of 120 lines. All L55-A3X and L55-200X models are factory wired for their respective ultimate capacities, and only require the addition of the necessary jack-in equipment and jack strips to bring them up to their full capacities.

2.09 As shown in Table 2, each of the three stock models of the L55 PBX accommodates 14 central office trunks, or tie trunks, or a combination of both. If additional capacity is required, two L55 switchboards may be installed together to provide a two-position installation with a maximum capacity of 28 trunks and 400 lines.

NOTE: Long cords and special cord weight assemblies are required for position 1 of two-position installation. Every other cord circuit requires two MO-17719-A (Red) assemblies, while alternate cord circuits each require two MO-17719-B (Gray) assemblies in the position 1 switchboard.

2.10 A single attendant's position circuit is provided with each L55 PBX. The attendant's telephone set and mounting, footswitch for controlling the buzzer, dial, and dial mounting are optional and must be ordered seperately.

2.11 Individual jack strips, lamp strips and designation strips are used on the L55-A3 and L55-B4 models of the PBX. To concerve space, combined lamp and designation strips are used on the L55-200 PBX.

## 3. CIRCUIT DESCRIPTION

### Typical Circuit Arrangement

3.01 The L55 PBX is of modular construction with exception of the battery, buzzer and ringing equipment which is a part of the basic system. Modules may be added, removed, and exchanged to adapt the PBX to a particular set of service requirements.

Table 2. Wiring and Equipment Data for the Stock Models of the L55 PBX.

| | L55-A3X | | L55-B4X | | L55-200X | |
|---|---|---|---|---|---|---|
| | WIRED | EQUIPPED | WIRED | EQUIPPED | WIRED | EQUIPPED |
| Station Lines | 60 | 30 | *80 | 40 | 200 | 120 |
| CO Trunks | 14 | 6 | 14 | 8 | 14 | 8 |
| CORDS | 15 | 8 | 15 | 10 | 15 | 10 |
| * Capacity: 120 Lines. | | | | | | |

3.02 The functional block diagram of the L55 PBX is shown in Figure 4, and the schematic diagram of a typical arrangement is shown in Figure 5. All the modular circuits are connected to the battery, buzzer and ringing circuits, at least for battery power. The cord circuits are connected in multiple to both the battery, buzzer and ringing circuits and the attendant's position circuit. Except for battery and signaling power leads, there are no permanent connections from the individual station and trunk circuits to any other circuit in the PBX. These circuits are connected together and to the other PBX circuits by use of the PBX cords. A single line circuit is shown in Figure 5, of which there may be as many as two hundred in a PBX. The circuit shown in for line 1, indicated by the station wire terminal designations of T1 and R1. The station wire terminals for all lines are brought out to a system of terminal blocks in the rear of the old type switchboard. In the new configuration, they terminate in plug-in connectors at the bottom rear of the PBX.

### Battery, Buzzer and Ringing Circuits

3.03 The battery, buzzer and ringing circuits may be any one of four configuration, depending upon the nature of the options included in the particular PBX. The four configurations are:

(a) Basic battery, buzzer and ringing circuits with no optional equipment included as shown schematically in Figure 5.

(b) Battery, buzzer and ringing circuits with optional foot-operated buzzer control switch and auxiliary hand-operated ringing generator, shown schematically in Figure 6.

(c) Battery, buzzer and ringing circuits with optional foot-operated buzzer control switch and ring reversal key shown schematically in Figure 7.

(d) Battery, buzzer and ringing circuits with optional foot-operated buzzer control switch, auxiliary hand-operated ringing generator and ring reversal key, shown schematically in Figure 8.

3.04 All line lamps, trunk lamps and cord supervisory lamps are wired in series with pilot relay NL. When any such lamp lights, relay NL operates and connects ringing potential from terminal 22 on the battery, buzzer and ringing circuits terminal block in series with a resistance lamp to the contacts of the BUZZER key. If this key is in its ON position, the ringing potential sounds the buzzer and returns to the ringing supply common lead at terminal 24.

3.05 If the ringing supply fails, the buzzer will not sound when a lamp lights. However, when the PBX is equipped with the auxiliary hand-operated ringing generator, it can be used to signal stations in such emergencies. Crank contacts on the ringing generator automatically disconnect the cords from the ringing supply and connect them to the output of the ringing generator.

### Central Office Trunk Unit

3.06 The central office trunk unit is shown in Figure 9. It consists of a die-cast metal frame

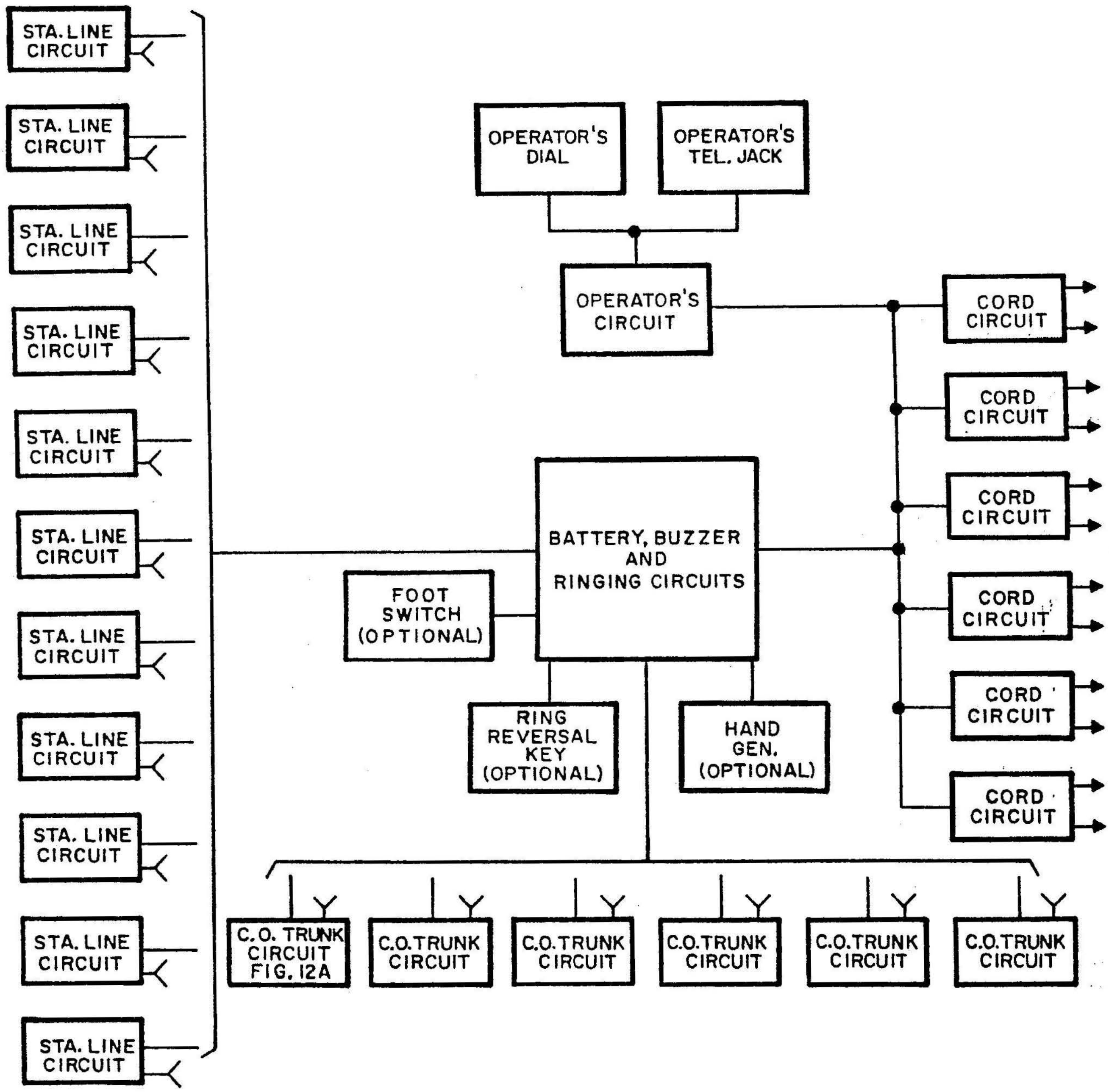



Figure 4. Type L55 PBX Functional Block Diagram.

to which is mounted the faceblock containing the jack and lamp, the ring-up relay, a capacitor, and the other circuit components. The central office trunk may, or may not, be equipped with an idle line termination circuit. The schematic diagram of the central office trunk circuit without idle line termination is shown in Figure 10. Figure 11 contains the schematic diagram of the central office with idle line termination.

3.07 Terminals 1 and 2 of the 6-terminal central office trunk circuit plug connect to the central office line conductors T and R, respectively. When the trunk is seized from the central office for an incoming call, the ringing potential applied to plug terminals 1 and 2, passes through the fullwave rectifier bridge in series with thermistor TR1, and capacitor C1. The resulting pulsating direct current operates ring-up relay R rough its Number 1 winding. Relay R locks, through its Number 2 winding, to ground from plug terminal 3 and a jack contact; and connects battery in series with the pilot relay NL at plug terminal 6 to light the trunk lamp.

NOTE: The series thermistor prevents false signals on stray impulses, since a sustained ring is necessary to reduce the high resistance of the thermistor to a value which permits operation of relay R.

3.08 When the attendant inserts the plug of a left (station and trunk) cord into the trunk jack in response to a lighted trunk lamp, a jack contact opens and releases relay R. At the same time, a second jack contact closes, which applies battery from plug terminal 4 in series with a resistance lamp to the sleeve of the jack. A final jack contact closure completes the conversation path for that cord.

3.09 When the plug of a left cord is inserted into the trunk jack for an outgoing call, a jack contact applies resistance lamp battery to the 'eeve of the jack. The path of the ring conductor not completed until the plug is almost seated. This prevents any possible short-circuiting of the trip and ring springs during insertion of the plug, from being passed on to the central office where it could be acted upon as a false preliminary pulse.

3.10 If the central office rings back on the trunk while a call is in progress, relay R operates in synchronism with the ringing current to light the lamp, but it cannot lock. If the PBX station is on-hook, the station ringer will sound. If the station is off-hook, the cord supervisory lamp may also release.

3.11 If the central office trunk requires termination when the line is idle, the circuit of Figure 11 is used. With this circuit, the series combination of C2 and R1 (and also R2 if the jumper is omitted) is connected across the central office line when there is no plug in the jack. Otherwise, the circuit functions the same as that of Figure 10.

## Station Line Circuit

3.12 The basic station line circuit consists of a jack and lamp connected as shown in Figure 12. Battery in series with the pilot relay in the battery, buzzer and ringing circuits, is fed through the line lamp and a jack contact to the ring conductor. Ground in series with a second jack contact is connected to the tip conductor. When the handset of a station telephone set is lifted, it closes the dc path across the tip and ring conductors of the station line circuit. This causes the station lamp to glow with an intensity which is dependent upon the resistance of the loop. When the plug of a right cord is inserted into the line jack, it opens the jack contacts, disconnecting the lamp and ground from the line conductors. At the same time, a third jack contact applies ground to the sleeve of the jack. When a call is placed to the line, inserting the plug of a left or right cord into the jack performs these same operations.

3.13 The basic station line circuit may be equipped with message waiting signaling. In this case, the basic circuit is as shown in Figure 13. With this circuit, a signal may be sent from a message-waiting turret over the tip conductor of the line to light a lamp at the station, indicating that there is a message for it at the switchboard. Otherwise, the operation of this circuit is the same as for Figure 12 which is contained in Paragraph 3.12.

3.14 When the station loop resistance is too great to permit proper lighting of the station lamp, a station line circuit with a line relay is used. The schematic diagram of such a unit is shown in Figure 14. When this circuit is employed, the jack and lamp are mounted on the front of the PBX in the usual manner, while the line relay is mounted on a panel located elsewhere in the PBX. A standard panel accommodates up to twenty line relays, or enough to equip twenty individual line circuits. In operation,the station line circuit with line relay receives circuit closure between terminals T and R when the station telephone set goes off-hook. This causes line relay LR to operate, the contacts of which close the circuit to the line lamp. The line lamp lights to full brilliance since it is wired directly to the PBX battery supply through the contacts of relay LR, and is therefore independent of the station loop conductors. When the plug of a right cord is inserted into the jack, the jack contacts open. This releases relay LR, which in turn extinguishes the line lamp. Otherwise, the operation of this circuit is the same as that of the basic line circuit described in Paragraph 3.12.

3.15 When it is necessary to include message waiting signaling with a station line circuit with line relay, the circuit of Figure 15 is employed. The only difference in the operation from that described in Paragraph 3.14, is that message waiting signaling is by-passed around the Number 1 winding of the line relay. This renders this winding useless for the purpose of operating the relay. Therefore, the Number 2 winding must perform this operation alone. Otherwise, the line circuit function is performed in the manner described in Paragraph 3.14.

### Cord Circuits - General Description

3.16 The cord unit for the L55 PBX is shown in Figure 16. It consists of a vertical flanged mounting plate with a die-cast gusset at the top. This plate supports the molded plastic block which extends through the front of the switchboard. This plastic block contains lamp sockets, two push-button keys, and a push-turn key which operates the attendant's talk and dial circuit and night and through-dial circuit. The talk key mechanism and contacts, relays, retard coil and capacitors of the cord circuit are mounted on the vertical portion of the unit with the apparatus extending to the rear.

3.17 Each cord circuit uses a capacitor bridge arrangement on calls from one PBX station to another, and provides supervisory signals on both cords. Each cord has a push-type ring key, and a turn key is used to connect the attendant's circuit into the conversation.

3.18 A low-resistance series supervisory relay arrangement is used on calls to and from central office trunks, with the left cord of each pair used for connection to the trunk jack. The cord circuits are factory wired for blocked supervision as shown in Figure 5 and 17. However, field changes may be made to permit through supervision (Figure 18) or to connect an auxiliary automatic discrimination circuit which blocks supervision only on incoing calls (Figure 19). This last option requires an additional relay which must be ordered separately and installed by the customer.

3.19 Regardless of the type of supervision employed, a through connection may be established by restoring the TALK key handle to its vertical position, and then pushing down on it. The same operation is performed for night connections, except that operation of the BATTERY CUTOFF key at night disables the supervisory signals.

### Cord Unit - Incoming Calls

3.20 Referring to the cord circuit schematic diagram of Figure 17, when a call is received over a central office trunk, the plug of a left cord is inserted into the jack of the central office trunk circuit receiving the call. This connects resistance lamp battery from the sleeve of the trunk jack through the break contacts of the NIGHT key to relay T. Relay T operates and connects coil H across the tip and ring terminals, which trips ringing, holds the trunk, disconnects relay S from the sleeve of the right cord, and prepares circuits for relay CS.

3.21 When the plug of the right cord of the same pair is inserted into the jack of a station line circuit to extend the call, ground from the sleeve of the line jack lights right supervisory lamp L1 from battery in series with the pilot relay in the battery, buzzer and ringing circuits, and applied over lead A at socket terminal 11. Depressing the RING RIGHT key also applies ground from the sleeve of the right cord to operate relay AD, which locks through its own Number 3 contacts.

3.22 When the called station answers, relay AS operates on the transmitter current, extinguishing right supervisory lamp L1 and extending ground from the sleeve of the right cord to energize in series the windings of relay CS. Relay CS operates. If the cord circuit is wired for through supervision (Figure 18), relay CS locks through its own Number 3 contacts when the talk key is restored.

3.23 If the cord circuit is wired for through supervision (Figure 18), relay CS completely disconnects the holding bridge of coil H from tip and ring of the left cord and, since relay CS is locked independently of relay AS, keeps it disconnected regardless of hookswitch flashes, dialing, or disconnect. Such operations will, however, flash or light right supervisory lamp L1 each time relay AS releases.

NOTE: The J-strap adjacent to relay H winding performs no electrical function. Its only purpose is to support the end of a 1300 ohm resistor which would otherwise hang free.

3.24 If the cord circuit is wired for blocked supervision (Figure 17) relay CS merely inserts 1300 ohms resistance in the holding bridge of coil H, so that transmission is not impared during the conversation but a dc path sufficient to hold the trunk remains connected when the station handset is restored. Since relay CS has no locking path, it follows any release of relay AS, and short-circuits the 1300 ohm resistance to restore the low-impedance bridge shortly after disconnect.

3.25 If the cord circuit is wired for blocked supervision on incoming calls and through supervision on outgoing calls (Figure 19), no path exists for relay CS to lock, because the Number 2 contacts of relay AD are open. However, the Number 5 contacts of relay AD provides a path equivalent to the blocked supervision wiring of Figure 17. The net effect is the same as for normal blocked supervision for incoming calls.

3.26 When the called station disconnects, relay AS releases and lights right supervisory lamp L1. With through supervision (Figure 18), relay CS remains locked and the central office connection remains held. In this latter case, removing the plug the right cord from the line jack opens the right sleeve. This extinguishes the right supervisory lamp L1 and releases relay AD. Removing the plug of the left cord from the trunk jack opens the circuit to the left sleeve. This releases relay T, which returns the circuit to normal.

Cord Unit - Outgoing Trunk Calls

3.27 An outgoing trunk call is initiated by lifting the handset of the calling station from its cradle. This causes the station line circuit lamp to light. When the plug of a right cord is inserted into the jack of the station line circuit, ground from the sleeve of the line jack passes through the contacts of the NIGHT key, and lights left supervisory lamp L2 and operates relay S. When relay S operates, it splits the left cord from the right cord, connects battery feed coil RB to the right cord, connects one winding of relay CS to the left cord tip conductor, and connects the second winding of relay CS to the ring conductor of the left cord. These windings of relay CS serve as a battery feed source. The cords are now connected for voice transmission through capacitors C1 and C2.

NOTE: To minimize crosstalk between adjacent circuits, the flux coupling between RB and CS is made large by connecting them in opposite polarity. Thus very little stray flux results. Similarly, the tip of the left cord is coupled to the ring of the right cord, and vice versa.

3.28 Relay AS operates on the transmitter current of the calling station, opening the circuit to right supervisory lamp L1 which may have been lighted briefly as the plug was being inserted. The attendant may converse with the calling party by operating the TALK key which connects the attendant's circuit to the cords.

3.29 When the plug of the left cord of the same pair is inserted into the jack of a central office trunk circuit, relay T operates from battery on the sleeve of the jack. When relay T operates, it connects coil H across tip and ring; removes ground from relay CS and connects its windings in series; extinguishes left supervisory lamp L2; and opens the circuit to relay S, releasing it. This action connects the cords together again, metallically, and disconnects coil RB so that battery feed is dependent upon the central office.

3.30 If the loop is long, relay AS may not hold during the time required to seize a finder in an automatic exchange or to attract the operator's attention in a manual exchange, but when the switch has operated or the operator has answered, the current at the station and current in coil H are sufficient to re-operate relay AS. With relay S released and relay AS operated, relay CS operates from ground on the right sleeve. If through supervision is provided either outward or in both directions, relay CS locks through its Number 3 contacts when the TALK key is restored.

3.31 If the PBX is working into a manual exchange, either the calling party or the attendant may pass the number of the desired party, regardless of the type of supervision used in the PBX. When working into an automatic exchange, the calling party may dial after the attendant has restored the TALK key, only if through supervision outward, or in both directions, is provided. When the PBX is wired for blocked supervision, either the attendant must dial, or she must restore both the TALK and NIGHT & THROUGH keys to permit the calling party to dial.

NOTE: Restoring the TALK and NIGHT & THROUGH keys releases relay T, which opens the holding bridge so that pulses from the station can reach the central office.

3.32 If through supervision is used for outward calls, or for calls in both directions, or if the NIGHT & THROUGH key is operated, the central office connection is released immediately when the calling station disconnects. Relay AS releases as the loop is opened, lighting right supervisory lamp L1. With through supervision outward, or in both directions, relay CS remains locked; with blocked supervision and the NIGHT & THROUGH key operated, relay CS releases without effect. If the NIGHT & THROUGH key has not been operated and blocked supervision is used, the central office connection is held after station disconnect, first by the bridge of 1300 ohms inseries with coil H and then after relay CS restores, by the low impedance bridge of coil H.

3.33 If the calling party flashes the hookswitch to call the attendant, relay AS follows the flashes and duplicates them at right supervisory lamp L1. Removing the plug of the right cord from the jack of the station line causes lamp L1 to extinguish. Removing the plug of the left cord from the central office trunk jack releases relay T which returns the circuit to normal.

Cord Unit - Station-to-Station Call

3.34 A call from one PBX station to another is answered with the right cord in exactly the same manner and involving the same operations described in Paragraphs 3.27 and 3.28, with relay S, relay AS, and the TALK key operated, left supervisory lamp L2 lighted, and separate battery feed to each cord as the attendant asks instructions.

3.35 When the plug of the left cord of the same pair is inserted into the jack or another station line, no relay operation takes place, since relay T is short-circuited. Depressing the RING LEFT key disconnects tip and ring of the left cord from the remainder of the circuit and applies ringing potential to signal the called station. When the call is answered, relay CS is energized over the loop and operates. This extinguishes left supervisory lamp L2. With relay T restored, relay CS has no other effect. The TALK key may be restored before the called station is rung, or left operated until the party answers, as desired.

3.36 If either the calling party or called party flashes the hookswitch of their respective telephone sets relay AS or CS, respectively, will release during each flash and light the right or left supervisory lamp for its duration to recall the attendant to the connection.

3.37 When the calling party restores his handset, relay AS releases and lights right supervisory lamp L1. Removing the plug of the right cord from the jack of the calling line releases relay S, extinguishes left supervisory lamp L2 and causes relay CS to restore. If the called party remains on the line, the sidetone in his handset is cut off even though the plug of the left cord remains seated in the jack of his line. Removal of the plug of the left cord from that jack has no further effect in this circuit, but permits the line circuit to reoperate if the station handset remains off-hook.

3.38 Rectifier CR2 and its associated resistance provide a shunt into which the counter-emf induced in relay S as the plug is removed from the jack, may be dissipated. This reduces the inductive surge on the sleeve. Rectifier CR1 functions in the same manner for relay T and the other cord.

Cord Unit - Night Connections

3.39 To connect a central office trunk to a station to permit direct handling of calls when the PBX is unattended, the NIGHT & THROUGH key may be operated to disable relays S and T and left supervisory lamp L2. The plug of the left cord is then inserted into the jack of the central office trunk, and the plug of the right cord is inserted into the night answering station's line jack. The right supervisory lamp will light from ground on the sleeve of the right cord, but when the battery key is turned off for the night, the lamp will be extinguished. Relay AS may operate when ringing potential is applied to the trunk on incoming calls, and may follow pulses on dialing for outgoing calls to an automatic central office.

3.40 When the attendant returns to duty, she should first turn the battery key on. Any cord pair used for night connections on which the light is then lit, may safely be taken down, but a dark lamp indicates a call in progress which must not be disturbed.

Attendant's Position Circuit

3.41 The attendant's position circuit (Figure 20) enables the PBX attendant to talk to both parties on a connection, to dial a trunk connection, to split off the trunk party of a trunk-to-station call, while conversing with the party at the PBX station, and to monitor a conversation. The talking and splitting features are normally provided, but the monitor equipment and the dial required for use in automatic central offices must be ordered separately and installed in the field.

3.42 The attendant's position circuit takes on one of four configurations, depending on whether the PBX is equipped with a dial or a Touch Calling unit, and whether or not a monitor key is included. The schematic diagram of the attendant's position circuit with rotary dial and monitoring key, is shown in Figure 21. Figure 22 shows the schematic diagram of an attendant's position circuit for use with a Touch Calling unit but without a monitoring key. When the circuit of Figure 21 is used without the monitoring key, induction coil C connected as shown in Figure 22. nversely, when the circuit of Figure 22 is uipped with a monitoring key, induction coil C is connected as shown in Figure 21.

3.43 The attendant may converse with either, or both parties connected to the cords by operating the TALK key of the respective cord circuit. This connects the leads from the attendant's position circuit into the cord circuit as follows:

(a) Leads LT and LR (connector terminals 1 and 3) are connected to the tip and ring, respectively, of the right cord.

(b) Leads RT and RR (connector terminals 4 and 5) are connected to the tip and ring, respectively, of the right cord.

(c) Leads ZT and ZR (connector terminals 6 and 7) are connected together to bridge the attendant's telephone set receiver across terminals 2 and 4 of induction coil C.

(d) Ground is connected to lead P (connector terminal 8) which energizes the attendant's telephone set transmitter in series with the windings of coil P.

3.44 When the fingerwheel of the dial is drawn back while the TALK key of a cord circuit is operated, the break springs of the off-normal set open. This inserts the winding of relay ON in the transmitter energization path. Relay ON operates, shunts the attendant's telephone set receiver, extends ground from lead P to operate relay SP, and prepares to shunt a winding of induction coil B (terminals 3 and 4) with 51 ohms. Relay SP locks to lead, splits the left cord from the right cord, and connects battery and ground to the windings of coil A to provide battery feed to the station over the right cord. Although the input winding of induction coil B is connected across the left cord, and the output winding of induction coil B in series with capacitor C1, is connected across the right cord, the former remains shunted by 51 ohms as mentioned above. Therefore, the dial pulses fed to the left cord as the dial is allowed to return, are not audible to the station party on the connection.

3.45 When the fingerwheel of the dial returns to normal after the desired number has been dialed, closure of the break springs of its off-normal set shunts relay ON, which releases. This removes the shunt on the attendant's telephone set receiver, and also removes the 51 ohm shunt from across the output winding of induction coil B. Using coil B as a repeat coil, the attendant may converse with the answering party, although relay SP remains locked and the cords remain split. The station party on the right cord may also participate in the conversation since battery feed is provided by coil A.

3.46 When the attendant restores the cord circuit TALK key, removal of ground from lead P causes relay SP to release, and removal of battery from lead BT causes relay BT to restore, returning the circuit to normal in preparation for use with another cord circuit. Leads LT, LR, RT and RR are disconnected from the cords and the call, now established, proceeds independent of the attendant.

Busy Test in The Attendant's Position Circuit

3.47 If the station lines are connected to other apparatus which may hold them in use without the knowledge of the PBX attendant, it may be necessary to make a busy test before inserting the plug of a cord into a vacant jack.

3.48 Half-battery potential from a voltage divider circuit consisting of two 5K resistances, is connected through 620 ohms in series with 1800 ohms (if the strap is omitted) and one winding of coil A to leads RT and RR when the talk key is operated. If connection is made to a central office trunk, battery on the sleeve of the left cord connected by the TALK key lead BT (connector terminal 10) operates relay BT which disconnects this busy test potential from these leads to avoid interference with the central office battery feed.

3.49 If either cord is plugged into a jack, battery from the cord circuit or from the trunk appears on leads LR and RR. If the tip of the plug of the free cord is touched to the sleeve of the jack of a busy line, ground from the sleeve will appear on leads LT and RT, impressing its potential across the induction coil so that a click is audible to the attendant as indication that the line is busy.

Monitoring and Splitting in the Attendant's Position Circuit

3.50 When the attendant's position circuit is equipped with a MONITOR key, operation of this key before the TALK key is operated on an established connection, opens the circuit to terminals 7 and 8 of induction coil C. This silences the transmitter of the attendant's telephone set. Therefore, room noise at the PBX location is not audible to the parties conversing on the connection.

3.51 Operation of the SPLIT key when the TALK key of a cord circuit is operated, extends ground from lead P to operate relay SP. Relay SP locks to lead P, splits the left cord from the right, and provides battery feed to the right cord. Although relay SP connects the input winding of induction coil B across the left cord, a contact of the SPLIT key short-circuits that winding and the cord. Similarly, although relay SP connects the output winding of induction coil B in series with capacitor C1 across the right cord, another contact of the SPLIT key opens this path. Consequently the party on the left cord can hear nothing, while the party on the right cord may converse with the attendant but cannot hear the party on the left. Release of the SPLIT key opens the short-circuit across the input winding of induction coil B and closes the circuit to the output winding of this coil. This permits the two parties to converse with each other and with the attendant, using induction coil B as a repeat coil. When the TALK key is restored, ground is removed from lead P and relay SP restores.

Position Grouping

3.52 When two individual positions, each serving its own group of extension stations and having its own cord circuits, are mounted side-by-side, a position grouping circuit permits one attendant to handle calls on both positions. Figure 23 contains the schematic diagram of two attendant's position circuits without monitoring keys interconnected by position grouping, while Figure 24 contains the schematic diagram of two attendant's position circuits with monitoring keys interconnected by position grouping. In both circuits, position 1 can answer and process calls at position 2 when the attendant's telephone set at position 2 is unplugged. However, the attendant at position 2 cannot, under any circumstances, process calls at position 1. Position grouping is placed in operation automatically when the attendant's telephone set at position 2 is unplugged.

3.53 With position grouping, only one battery cut-off key, buzzer and buzzer cut-off key are provided for the two positions. This arrangement eliminates possible confusion which might be caused with two sets of this equipment. A modification in the interconnection and fusing of the battery feeders supplying the two positions equalizes the potential when using cable feeder battery supplies, and eliminates the possibility of the system being out of service when trouble in one position causes a fuse to blow.

Tie Trunks

3.54 Tie trunks (Figure 25) consist of two units, a jack and lamp unit and a relay unit, interconnected by a plug-ended flexible cable. The jack and lamp unit mounts in the face of the board in one of the positions 10 through 14, in the same manner as a central office trunk unit. The relay unit consists of circuit apparatus mounted on a 23-inch mounting plate located in the lower rear portion of the switchboard. Three types of tie trunks are used with the L55 PBX. They are tie trunks with:

(a) Ringdown signaling to a manual switchboard (Figures 26 and 27).

(b) Capability for providing service to a PABX (Figure 28).

(c) Automatic signaling to a manual switchboard (Figure 29).

3.55 The ringdown tie trunk may be used to provide service to another PBX, two-way ringing toll termination service, service to a magneto central office, service to a local battery party line served by the PBX, and to terminate full period talk circuits. A signaling key is provided as part of the face equipment.

3.56 The dial tie trunk enables the PBX attendant to dial directly into a distant PABX. Circuit features include automatic line lamp signals, line lamp supervision, reverse battery signaling and supervision from the PABX, battery feed to the cord circuit when the trunk cord is used, dialing by separate dial jack, and prevention of false line lamp signal after disconnect.

3.57 The automatic-signaling tie trunk provides service to a distant PABX or to the floor type attendant's cabinet of a PABX. Circuit features include automatic line lamp signals, line lamp supervision, battery application to the trunk to signal the distant end, and battery feed to the cord circuit when the trunk cord is used.

### Manual Conference Unit

3.58 A manual conference unit may be incorporated in the L55 PBX to provide a means for establishing conference connections among a maximum of five stations, four stations and one central office or tie trunk, or three stations and two central office or tie trunks. Equipment for one complete circuit consists of a jack unit, equipment unit, and an interconnecting cable. The jack unit consists of a mounting with five jacks and occupies space of two central office trunk jacks. The equipment unit requires one miscellaneous horizontal mounting plate space on the lower rear of the PBX frame. The schematic diagram of the manual conference circuit is shown in Figure 30. Patch cables are used to interconnect the two units. The jack units are usually installed in trunk mounting spaces 13 and 14, in which case a hand generator may still be installed without mounting interference.

## 4. OPERATING RANGES AND BATTERY FEEDER RESISTANCE

### Station Line Circuits

4.01 When the L55 PBX station line circuit is not equipped with a line relay, the maximum station loop resistance is determined by the ability of the line lamp to light satisfactorily in series with the station loop at the minimum supply potential. Table 3 gives the values of maximum station loop resistance (conductor + instrument) for various values of supply voltage. The combined maximum insulation resistance of all station lines without line relays common to one NL relay is 8K.

4.02 When the L55 PBX station line circuit is equipped with a line relay, the maximum station loop resistance is determined by the ability of the cord circuit supervisory relay CS to operate at minimum supply voltage. Refer to Table 4 for values of maximum station loop resistance for a station line circuit equipped with a line relay. Minimum permissible insulation resistance for a line-relay-equipped station is 30 K.

### Central Office Trunks

4.03 For central office trunk circuits, trunk conductor loop resistance plus the maximum station loop resistance, plus an allowance of 33 ohms for the PBX series relay, must not exceed the subscriber's loop resistance range of the central office to which the PBX is connected. The ability of the cord circuit AS relay to operate in series with the called station loop, while shunted by the cord circuit holding bridge, is a limiting trunk loop factor. The resistance of the bridge is adjusted to a value to provide a combined resistance of the bridge and trunk loop as large as possible consistent with the limits of the central office trunk loop range. See the appropriate section in this series of the GTE Practices for bridge adjustment instructions.

4.04 The minimum insulation resistance for a central office trunk, working into a step-by-step central office is 30K. For all other types of central offices, it is 20K.

### Ring-Down Tie Trunks

4.05 Loop limitations for the ring-down tie trunk, are determined by the value of the ringing

Table 3. Maximum Station Loop Resistance With Series Lamp Signaling, for the L55 PBX.

| Minimum PBX Potential (Volts) | 16 | 18 | 20 | 22 | 24 | 26 |
|---|---|---|---|---|---|---|
| Maximum Station Loop Resistance (Ohms) | 150 | 240 | 330 | 420 | 510 | 600 |

Table 4. Maximum Station Loop Resistance With Line Relay Signaling for the L55 PBX.

| Minimum PBX Potential (Volts) | 16 | 18 | 20 |
|---|---|---|---|
| Maximum Station Loop Resistance (Ohms) | 450 | 600 | 780 |

potential and the ringing scheme used. When bridged ringing is used, the following limits apply:

(a) For a ringing potential of 20 volts ac, the maximum permissible loop resistance is 5K.

(b) For a ringing potential of 90 volts ac, the maximum permissible loop resistance is 11K.

4.06 When ground return ringing with blocking capacitor is used with the ring-down tie trunk, the following conditions apply:

(a) For 70 volts ac ringing potential, the capacitor loop may be:

(1) 2 microfarad and 8k.

(2) 4 microfarad and 10k.

(b) For 90 volts ac ringing potential, the capacitor loop may be:

(1) 2 microfarad and 13k.

(2) 4 microfarad and 15k.

Dial Tie Trunk to a PBX

4.07 The electrical requirements for a dial tie trunk to a PBX are:

(a) Working range - 16 to 50 volts.

(b) Maximum loop resistance - 4k.

(c) Minimum insulation resistance - 20k.

Automatic Signaling Tie Trunk to a Manual Switchboard

4.08 The external circuit loop limits for the automatic signaling tie trunk working into a distant manual switchboard are as shown in Table 5. Minimum insulation resistance for this application is 30k.

Feeder Supply Considerations

4.09 Tables 6 and 7 indicate the limits within which the resistance of the battery feed conductors must fall to permit proper operation of the L55 PBX. The tables are based on regulated 48 volt central office batteries having a minimum potential of 45 volts. These resistances cannot be exceeded without danger of the potential at the PBX falling below the 16 volts minimum under peak load. Feeder resistances less than the minimum will create the hazard of over-loading the 1-1/3 ampere fuse at the central office under conditions of peak load and maximum central office potential.

4.10 To determine maximum feeder resistance when power is supplied from a regulated 24 volt central office battery based on a minimum potential of 21 volts, divide the values of Table 6 by 5.8. Since the resistance of the feeders will seldom approach the maximum, the potential at the PBX will usually fall between 16 and 25 volts. Table 7 provides means of determining the minimum potential at the PBX from the known feeder resistance. Tables 6 and 7 are extended to 20 cords to facilitate the consideration of tie trunk and conference loads. For each tie trunk, add three cords to the total, and for the conference unit

Table 5. Maximum External Circuit Loop Resistance for Automatic Signaling Tie Trunks in the L55 PBX.

| | MINIMUM POTENTIAL THIS PBX | EXTERNAL CIRCUIT LOOP RESISTANCE (OHMS) MAXIMUM POTENTIAL 25 V. | EXTERNAL CIRCUIT LOOP RESISTANCE (OHMS) MAXIMUM PBX POTENTIAL 50 V. |
|---|---|---|---|
| Outgoing Call | 16 V. | 2060 | 1200 |
| | 18 V. | 2340 | 1400 |
| | 20 V. | | 1570 |
| | 32 V. | | 2500 |
| | 44 V. | | 3600 |
| | 45 V. | | 3700* |

| | MINIMUM POTENTIAL DISTANT PBX | EXTERNAL CIRCUIT LOOP RESISTANCE (OHMS) |
|---|---|---|
| Incoming Call | 14 V. | 1785 |
| | 20 V. | 2600 |
| | 32 V. | 4200 |
| | 44 V. | 5500 |

* The value of 3700 Ohms applies only when battery per Note 3 of Figure 29 is supplied from the central office over an individual feeder, and then it includes resistance of this feeder.

add five cords. Thus, nine cords, two tie trunks and a conference circuit would be equivalent to 20 cords. When two positions are used, the feeder requirements for each are the same as for an individual switchboard having the same equipment.

### Local Battery Operation

4.11 When cable feeders are not practical, or desired, the following information will assist in the selection of the required battery or its equivalent. A battery of nine cells should generally be sufficient. Where there are long off-premises lines beyond the signaling range of the line lamp at minimum voltage for nine cells, the battery may be raised to ten or eleven cells, or line relays may be added to serve the affected lines.

4.12 The external circuit signaling ranges of the station line lamp at the minimum voltage for nine, ten, or eleven cells are shown in Table 8. Table 9 gives the switchboard amper-hour loads under average traffic conditions. These values may be used in determining the required battery size.

Table 6. Maximum and Minimum Permissible Feeder Resistance.

| NUMBER OF CORDS | FEEDER RESISTANCE (OHMS) | |
|---|---|---|
| | MAXIMUM | MINIMUM |
| 4 | 112 | 0 |
| 5 | 99 | 0 |
| 6 | 94 | 0 |
| 7 | 89 | 0 |
| 8 | 80 | 3 |
| 9 | 77 | 5 |
| 10 | 69 | 9 |
| 11 | 66 | 11 |
| 12 | 63 | 12 |
| 13 | 59 | 14 |
| 14 | 57 | 16 |
| 15 | 52 | 18 |
| 16 | 50 | 19 |
| 17 | 48 | 21 |
| 18 | 47 | 22 |
| 19 | 44 | 23 |
| 20 | 43 | 23 |

Table 7. Maximum Feeder Resistance in Ohms Relative to the Potential at the PBX and the Number of Cords.

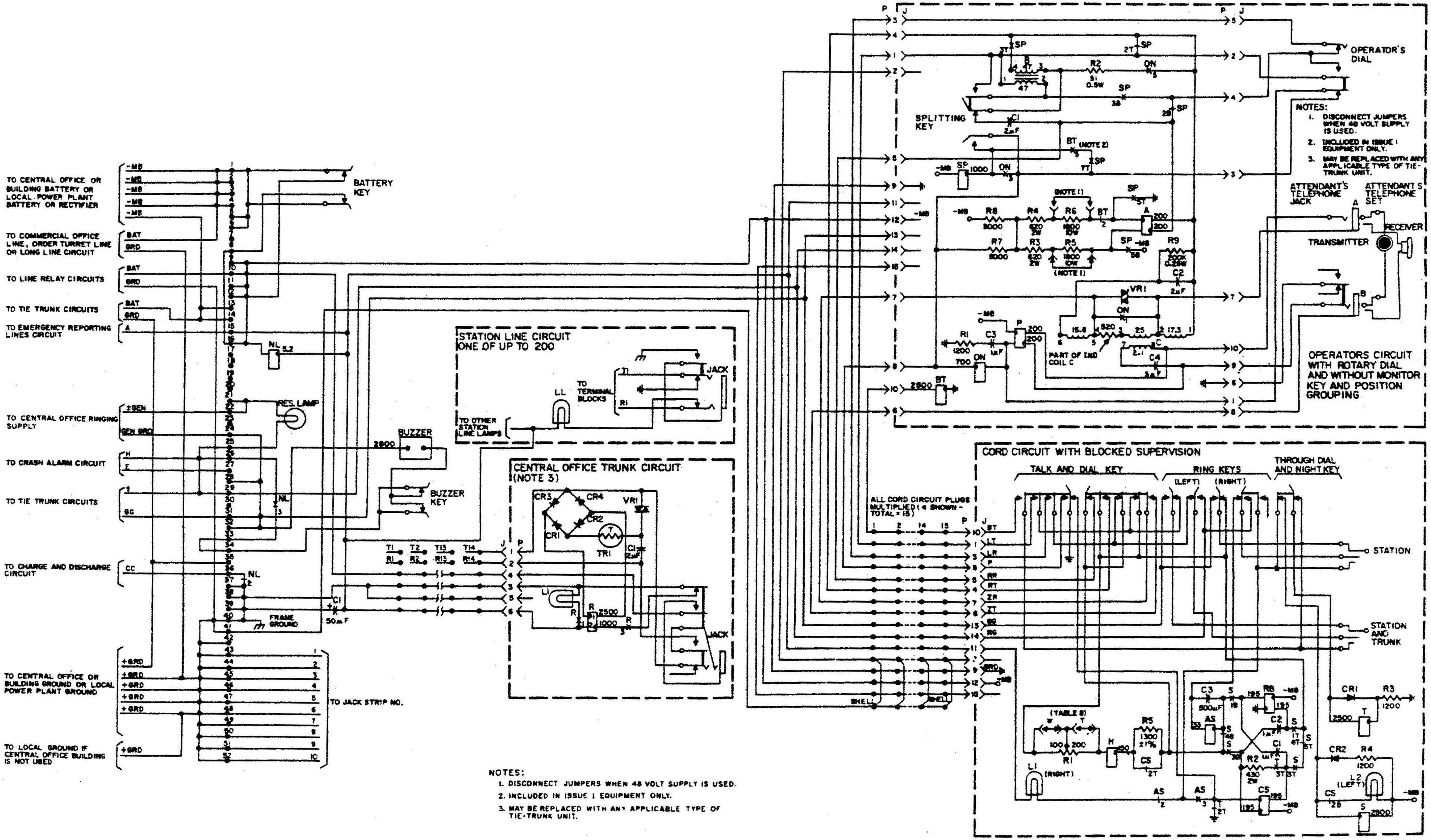
| NUMBER OF CORDS | MAXIMUM FEEDER RESISTANCE VERSUS POTENTIAL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 16 V. | 18 V. | 20 V. | 22 V. | 24 V. | 26 V. | 28 V. | 30 V. | 32 V. | 34 V. |
| 4 | 112 | 93 | 78 | 65 | 54 | 46 | 38 | 31 | 25 | 19 |
| 5 | 99 | 82 | 68 | 57 | 48 | 40 | 33 | 27 | 22 | 18 |
| 6 | 94 | 78 | 65 | 54 | 45 | 38 | 31 | 26 | 21 | 17 |
| 7 | 89 | 74 | 61 | 51 | 43 | 36 | 30 | 25 | 20 | 16 |
| 8 | 80 | 66 | 55 | 46 | 39 | 32 | 27 | 22 | 18 | 14 |
| 9 | 77 | 63 | 53 | 44 | 37 | 31 | 26 | 21 | 17 | 13 |
| 10 | 69 | 57 | 47 | 40 | 33 | 27 | 23 | 19 | 15 | 12 |
| 11 | 66 | 55 | 45 | 38 | 32 | 27 | 22 | 18 | 14 | 11 |
| 12 | 63 | 52 | 43 | 36 | 30 | 25 | 21 | 17 | 13 | |
| 13 | 59 | 49 | 41 | 34 | 29 | 24 | 20 | 16 | | |
| 14 | 57 | 47 | 40 | 33 | 27 | 23 | 19 | | | |
| 15 | 52 | 43 | 37 | 30 | 25 | 21 | | | | |
| 16 | 51 | 42 | 35 | 29 | 24 | 20 | | | | |
| 17 | 48 | 40 | 33 | 28 | 23 | | | | | |
| 18 | 47 | 39 | 32 | 27 | 22 | | | | | |
| 19 | 44 | 37 | 30 | 26 | | | | | | |
| 20 | 43 | 32 | 29 | | | | | | | |

Table 8. External Circuit Signaling Ranges of Station Line Lamp for Different Battery Sizes.

| | | | |
|---|---|---|---|
| Number of Cells | 9 | 10 | 11 |
| Minimum Battery Potential (Volts) | 17 | 19 | 21 |
| Station External Circuit Range Less Relays (Ohms) | 195 | 295 | 375 |

Table 9. Daily Load in Ampere-Hours.

| NUMBER OF CORDS | 19.4 VOLTS (9 CELLS) | 21.5 VOLTS (10 CELLS) | 23.6 VOLTS (11 CELLS) |
|---|---|---|---|
| 4 | 0.10 | 0.11 | 0.12 |
| 5 | 0.15 | 0.16 | 0.17 |
| 6 | 0.21 | 0.23 | 0.25 |
| 7 | 0.26 | 0.29 | 0.32 |
| 8 | 0.32 | 0.36 | 0.39 |
| 9 | 0.39 | 0.43 | 0.47 |
| 10 | 0.46 | 0.51 | 0.55 |
| 11 | 0.53 | 0.59 | 0.65 |
| 12 | 0.60 | 0.66 | 0.73 |
| 13 | 0.68 | 0.76 | 0.82 |
| 14 | 0.76 | 0.84 | 0.92 |
| 15 | 0.83 | 0.92 | 1.00 |




NOTES:

1. DISCONNECT JUMPERS WHEN 48 VOLT SUPPLY IS USED.
2. INCLUDED IN ISSUE 1 EQUIPMENT ONLY.
3. MAY BE REPLACED WITH ANY APPLICABLE TYPE OF TIE-TRUNK UNIT.

Figure 5. Schematic Diagram of a Typical L55 PBX.

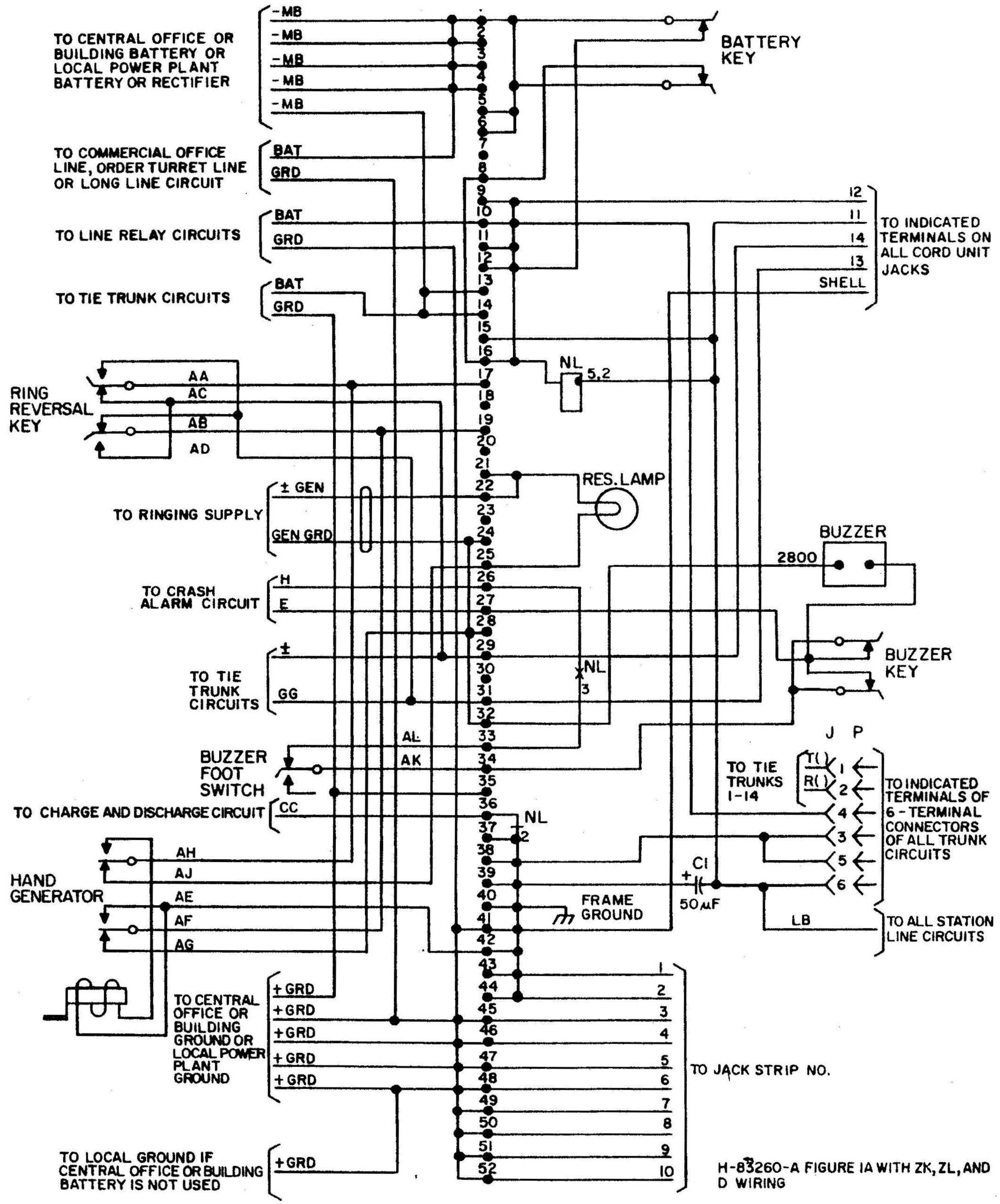



Figure 8. Battery, Buzzer and Ringing Circuits with Ring Reversal Key, Buzzer Footswitch, and Hand-operated Ringing Generator, Schematic Diagram.

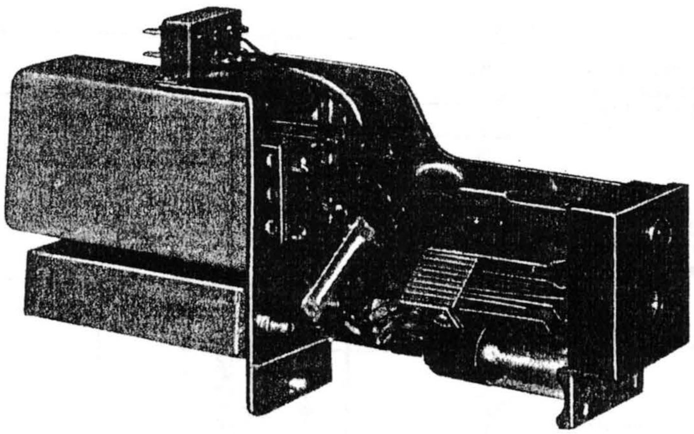


Figure 9. Central Office Trunk Unit.

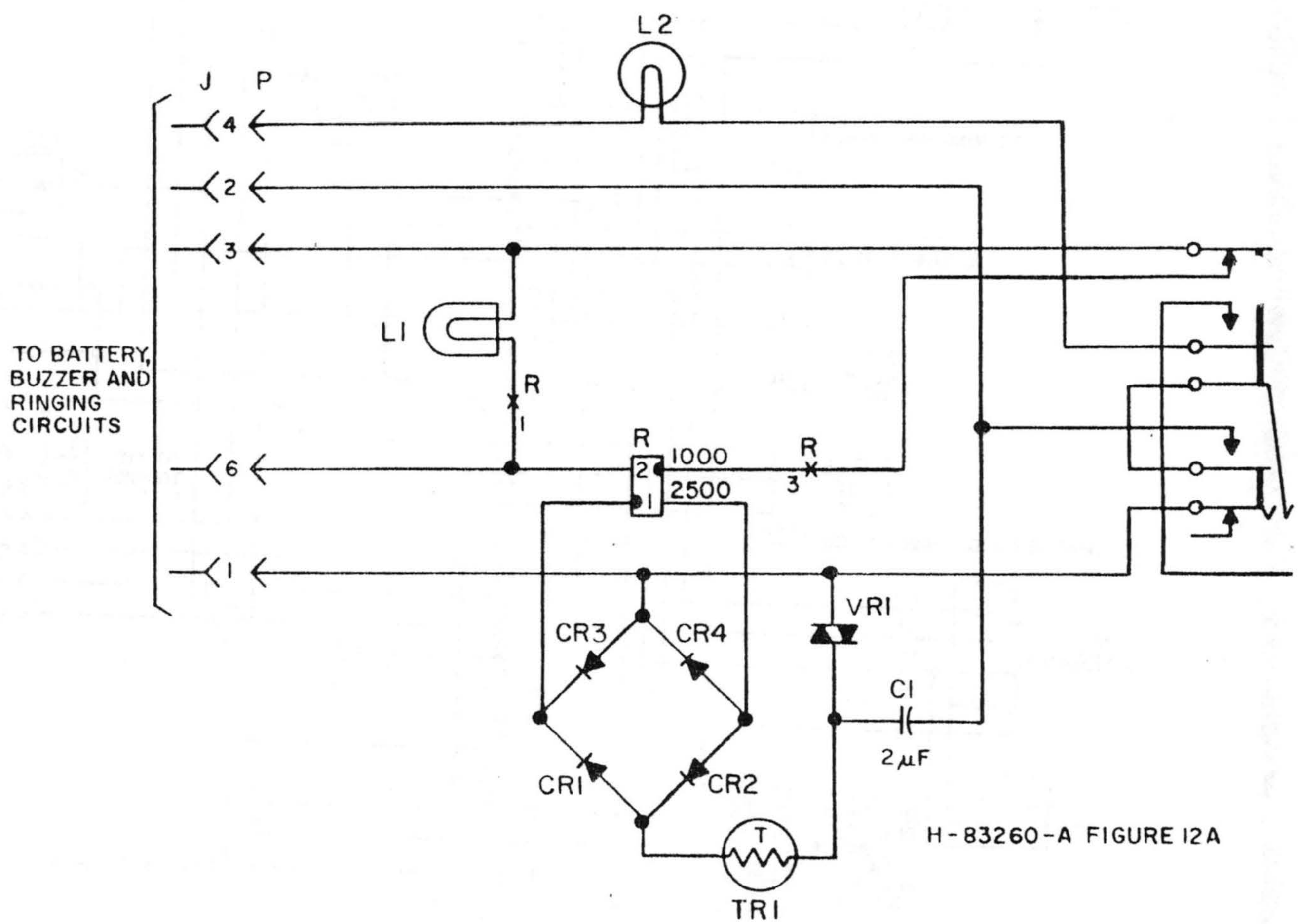



Figure 10. Central Office Trunk Circuit without Idle Line Termination, Schematic Diagram.

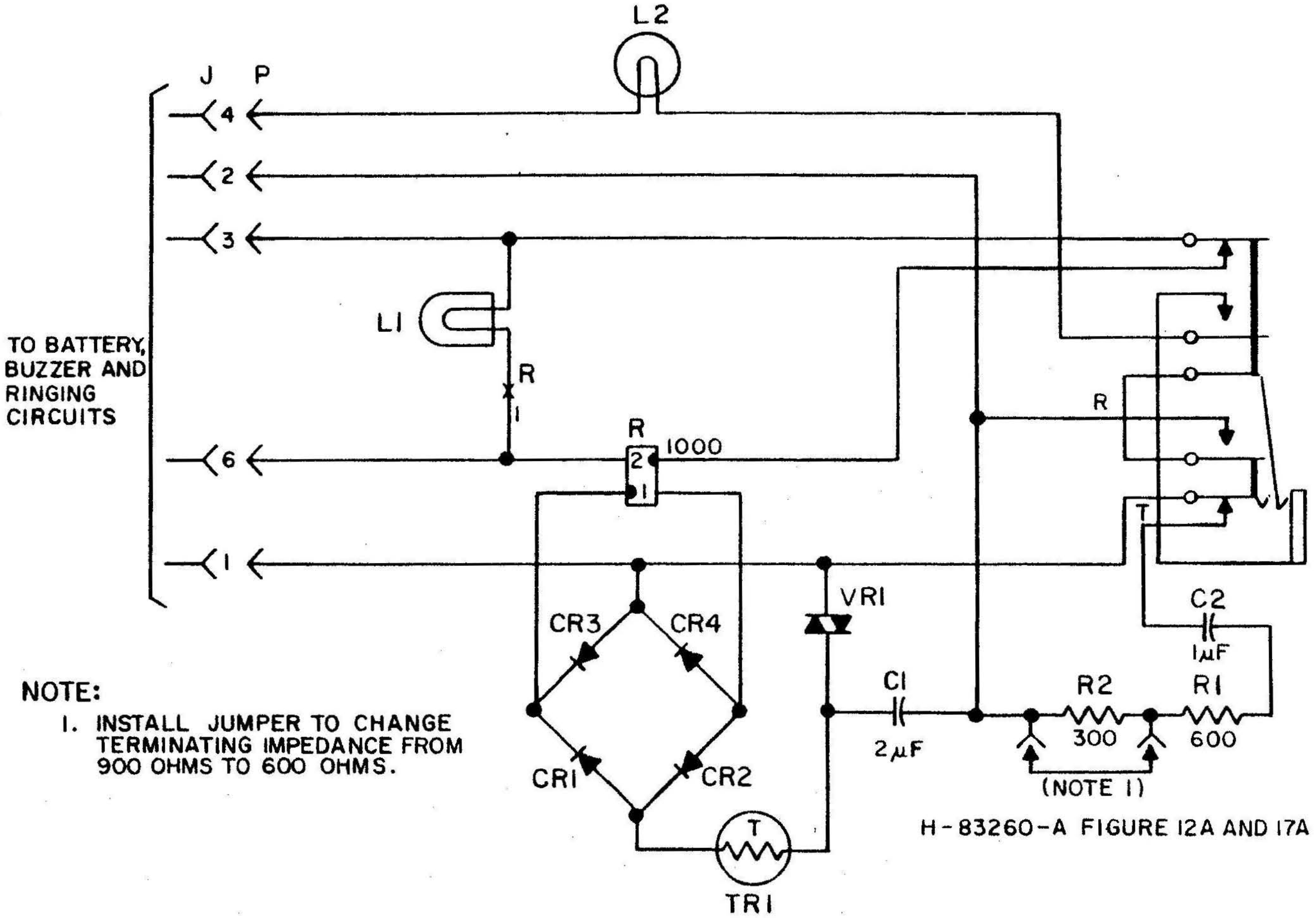



Figure 11. Central Office Trunk Circuit with Idle Line Termination, Schematic Diagram.

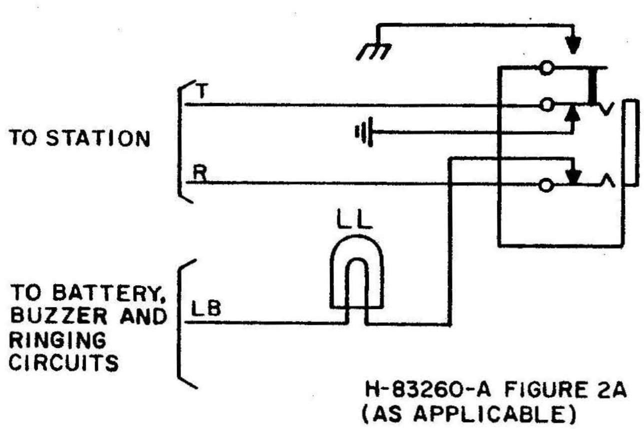



Figure 12. Basic Station Line Circuit Schematic Diagram.

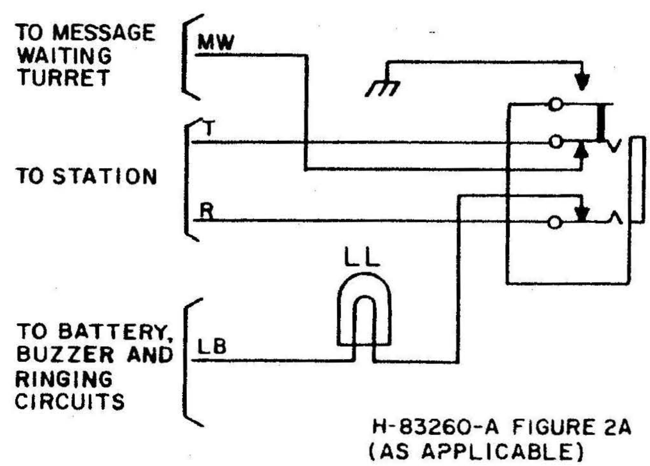



Figure 13. Station Line Circuit with Message-Waiting Signaling, Schematic Diagram.

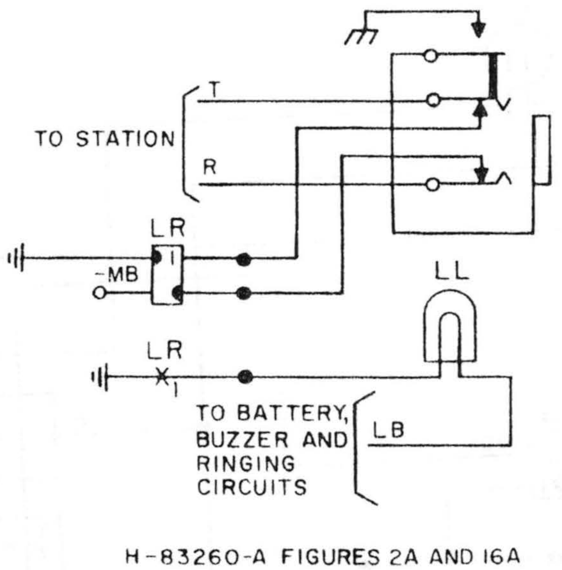



Figure 14. Station Line Circuit with Line Relay, Schematic Diagram.

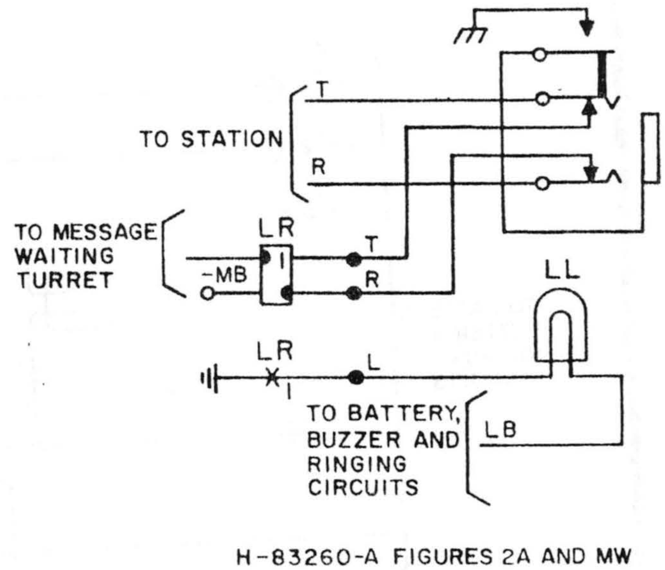



Figure 15. Station Line Circuit with Line Relay and Message-Waiting Signaling, Schematic Diagram.

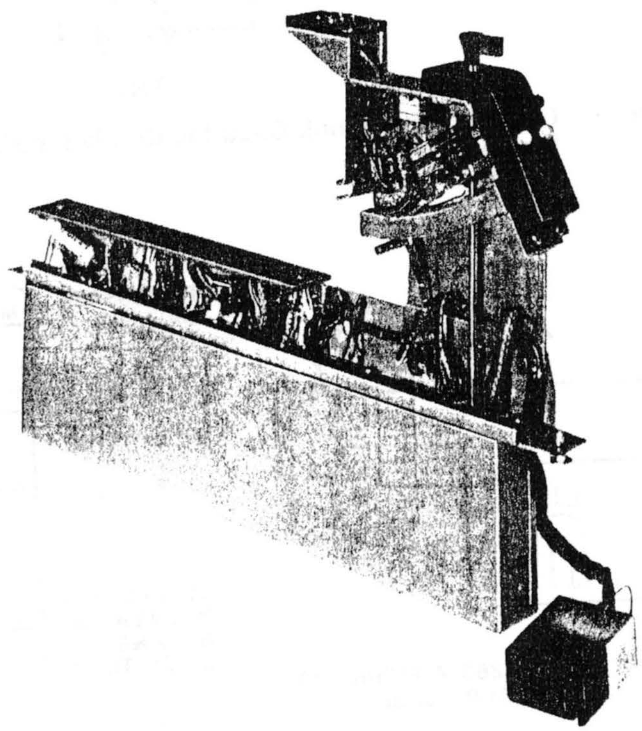


Figure 16. Cord Unit.

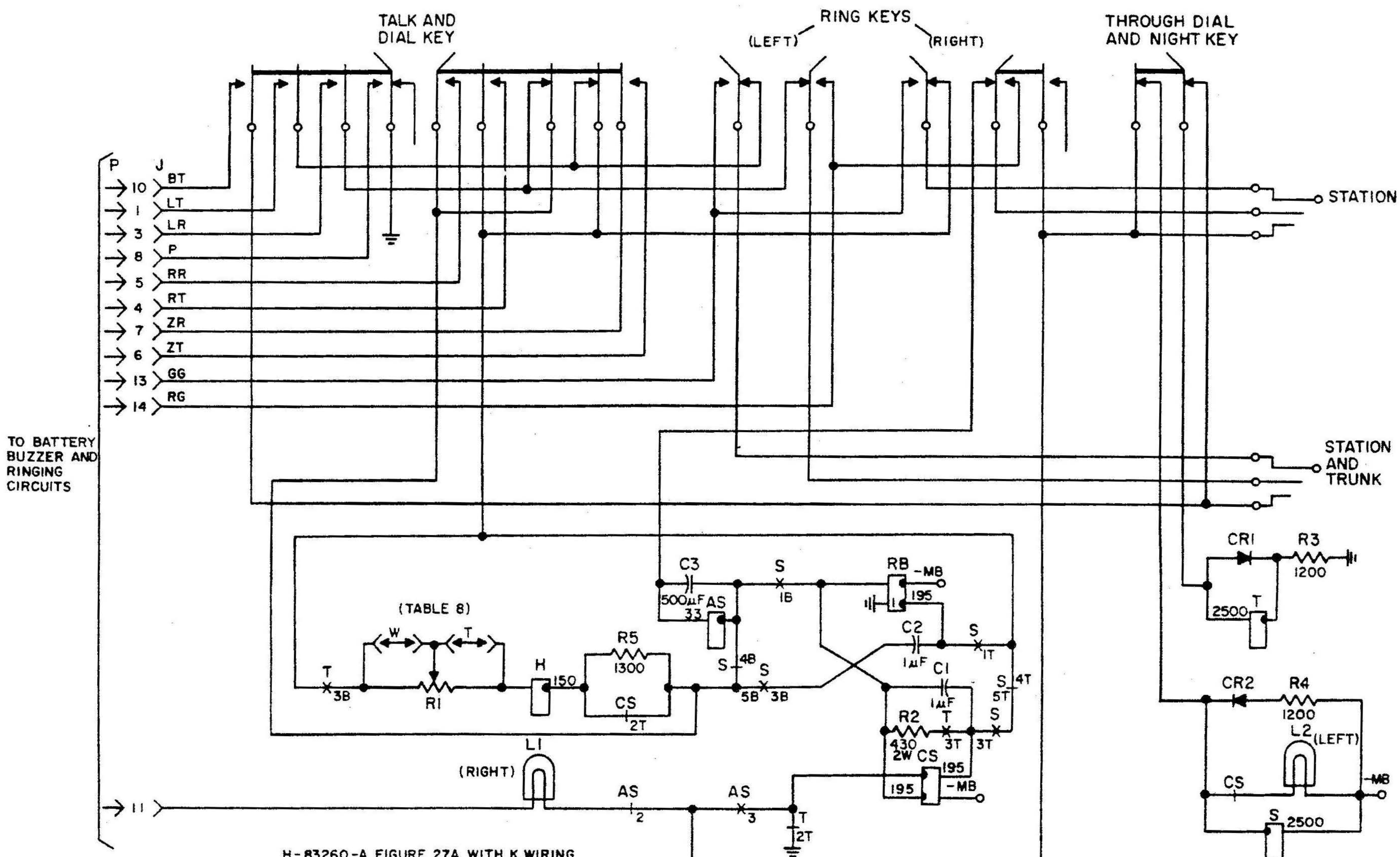



Figure 17. Cord Circuit with Blocked Supervision, Schematic Diagram.

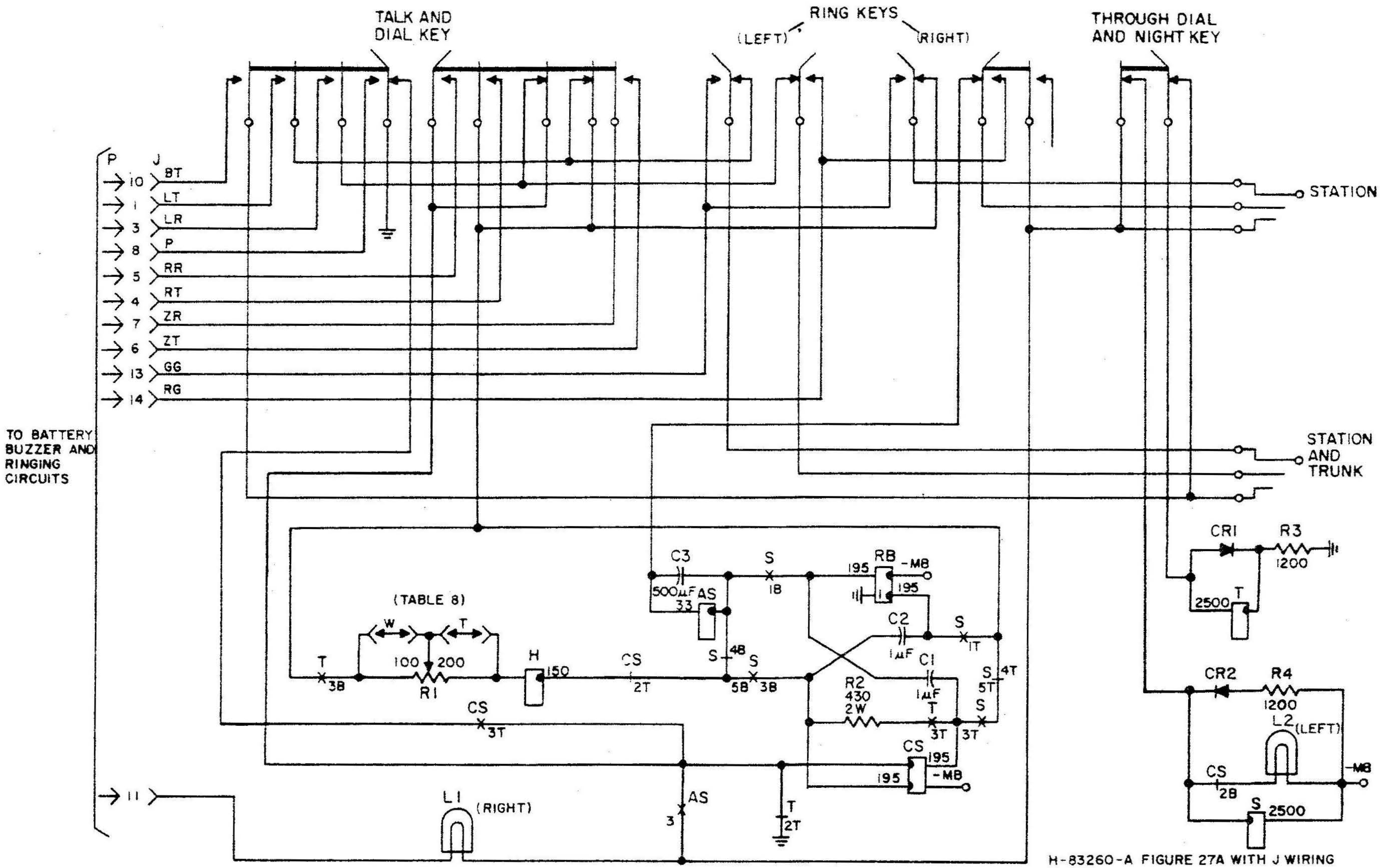



Figure 18. Cord Circuit with Through Supervision, Schematic Diagram.

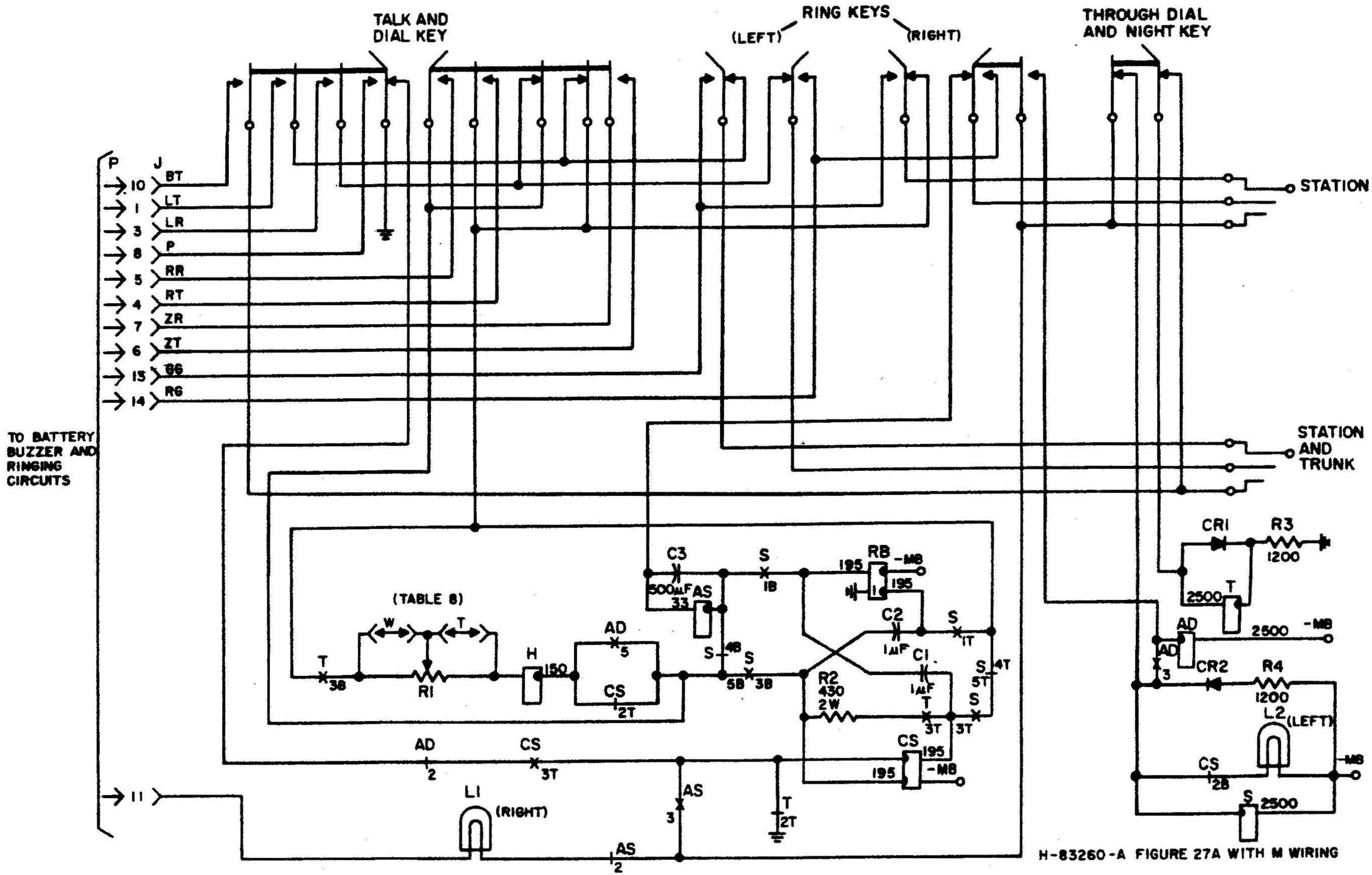



Figure 19. Cord Circuit with Through Supervision Outward and Blocked Supervision Inward, Schematic Diagram.

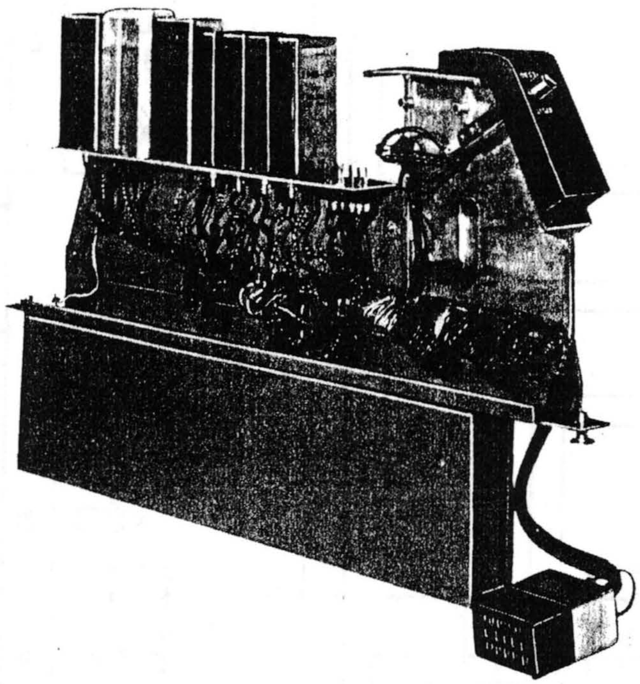


Figure 20. Attendant's Position Unit without Monitoring Key.

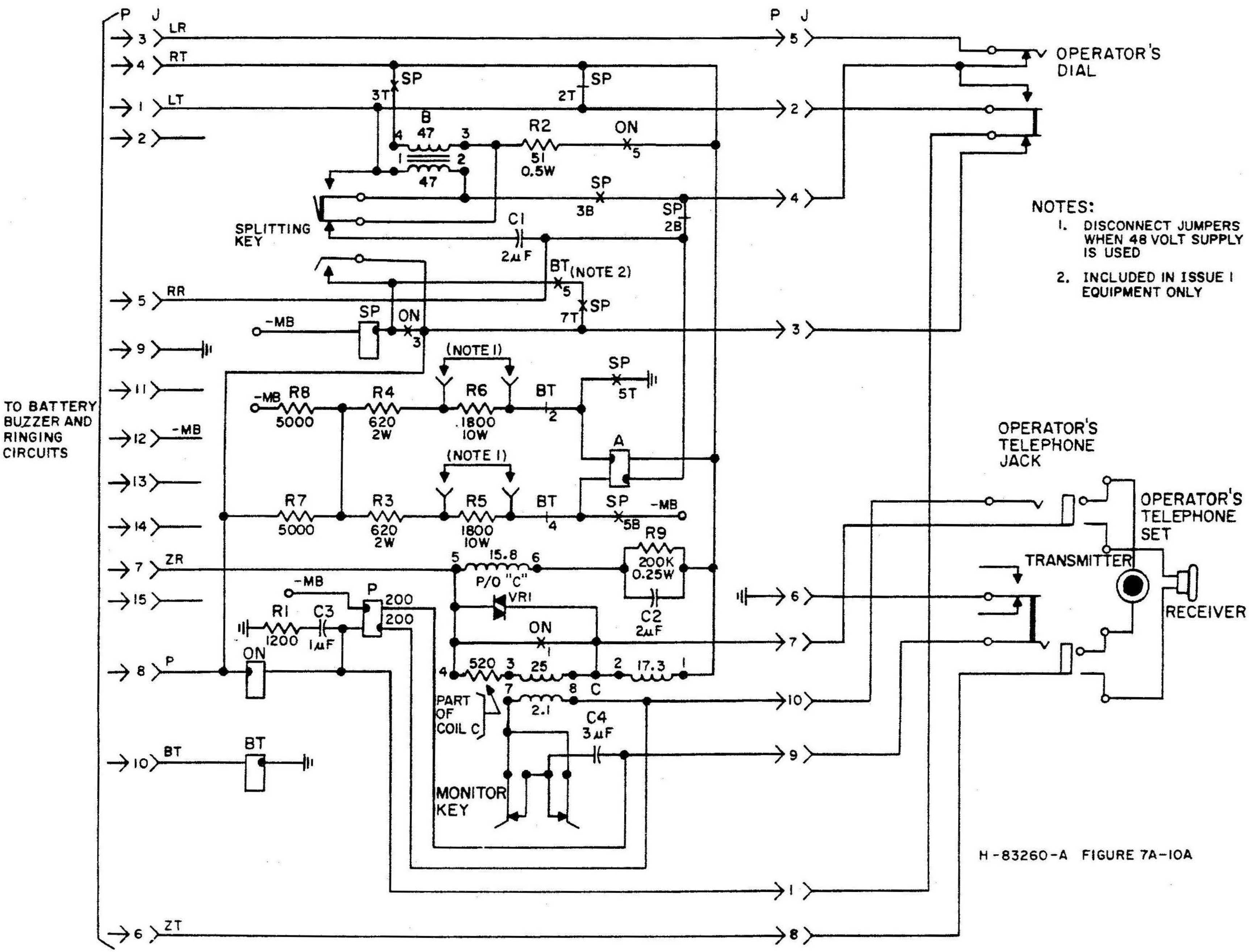



Figure 21. Attendant's Position Circuit Equipped with Rotary Dial and Monitoring Key, Schematic Diagram.

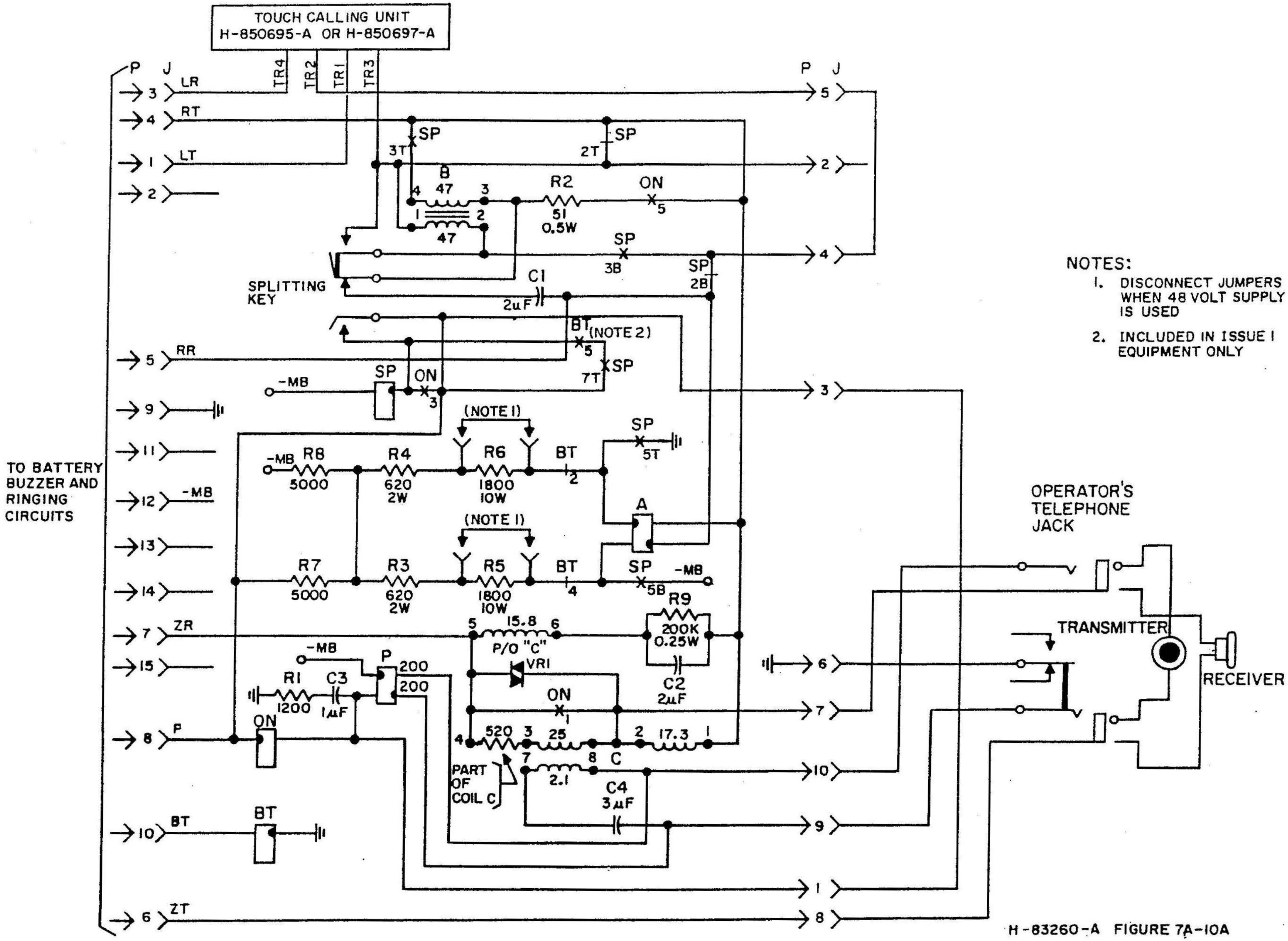
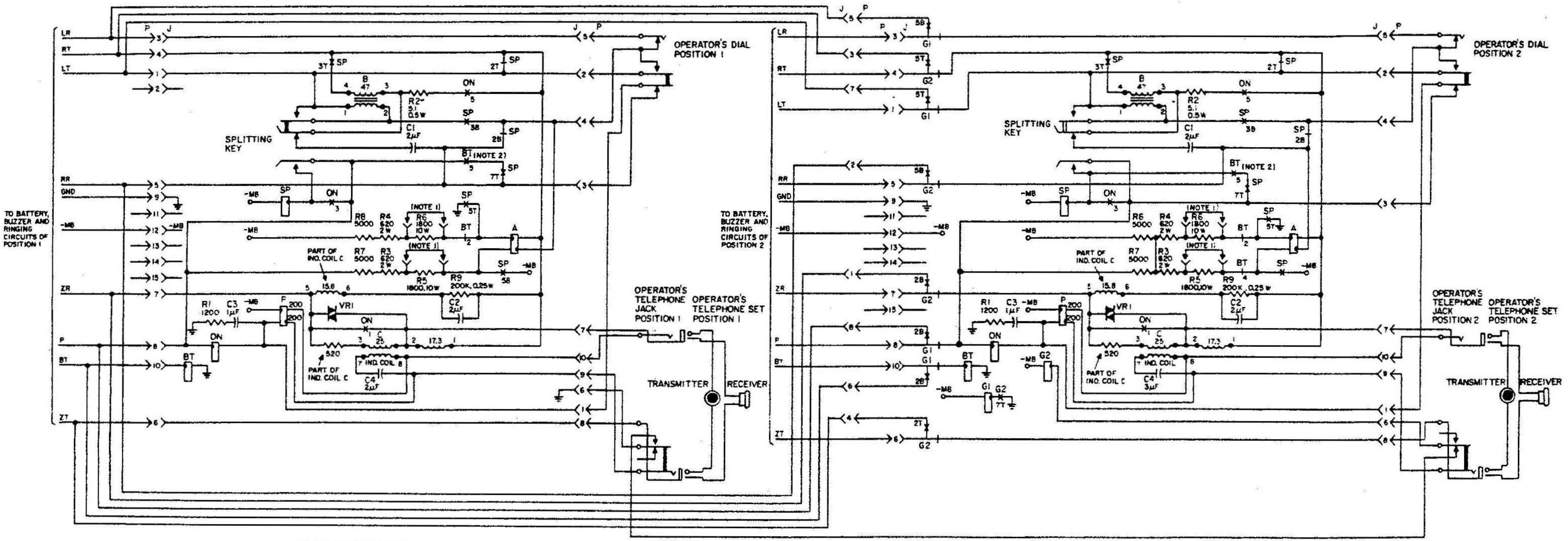



Figure 22. Attendant's Position Circuit Equipped with Touch Calling Unit, But without Monitoring Key, Schematic Diagram.

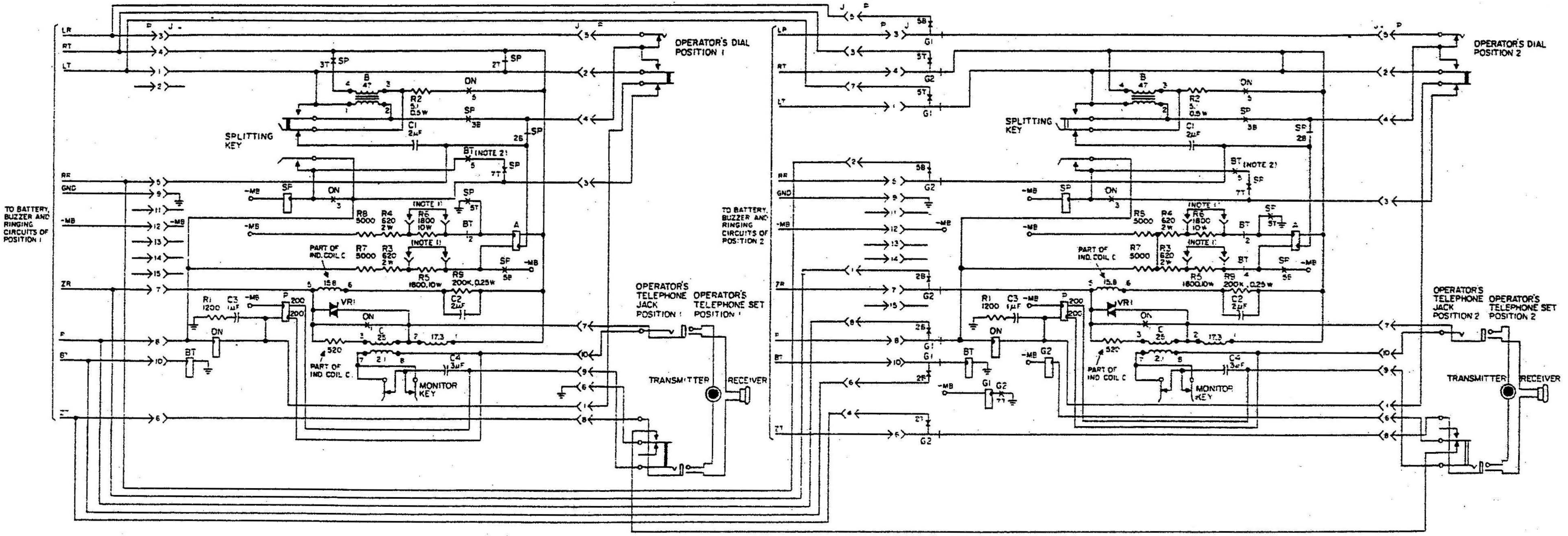



H-83260-A (FIGURE 7A-10A)

H-83260-A (FIGURE 7A-10A)

NOTES:
1. DISCONNECT JUMPERS WHEN 48 VOLT SUPPLY IS USED.
2. INCLUDED IN ISSUE 1 EQUIPMENT ONLY.

Figure 23. Position Grouping without Monitoring Keys, Schematic Diagram.




NOTES

1. DISCONNECT JUMPERS WHEN 48 VOLT SUPPLY IS USED
2. INCLUDED IN ISSUE 1 EQUIPMENT ONLY.

…ure 24. Position Grouping with Monitoring Keys, Schematic Diagram.

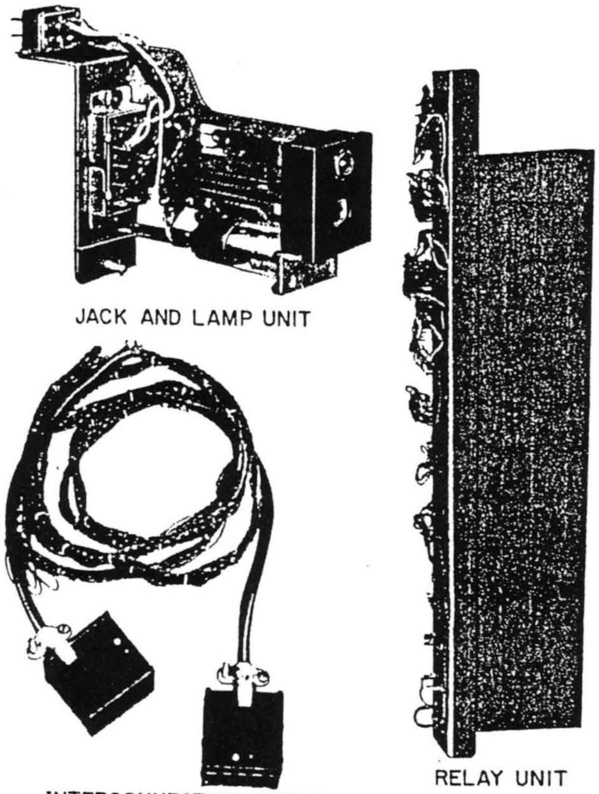
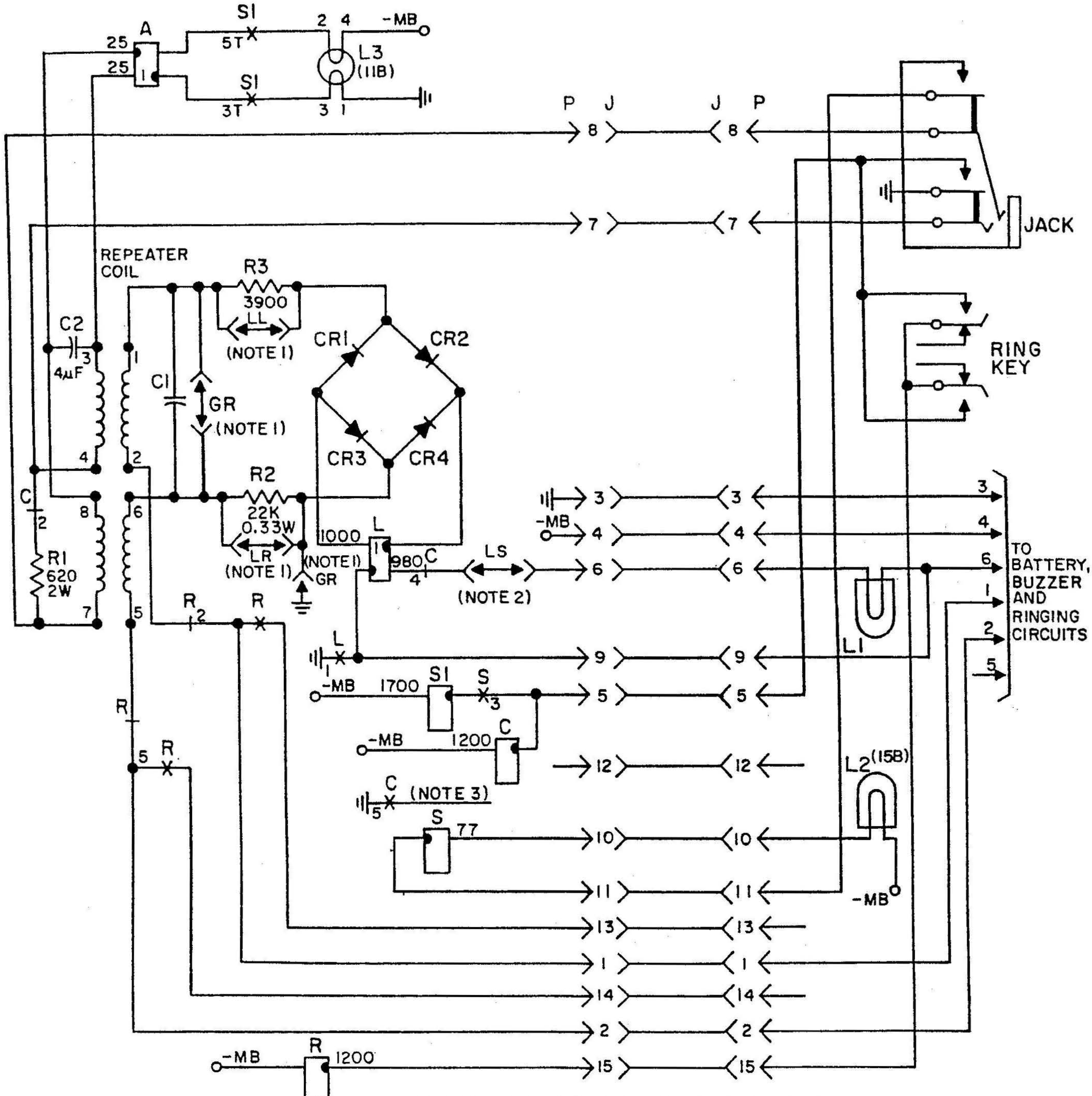



Figure 25. Automatic Tie Trunk to Dial Type PABX (Typical of Tie Trunk Equipment).




NOTES:

1. REFER TO TABLE "A" FOR PROPER JUMPER CONNECTIONS.
2. JUMPER LS IS CONNECTED ONLY FOR LOCKED-IN LINE SIGNALS.
3. THIS WIRING IS INCLUDED ONLY WHEN PBX IS USED WITH TRAIN DISPATCHING SIGNAL EQUIPMENT.

TABLE A. RING-DOWN TIE TRUNK SIGNALING

| RINGING SCHEME | LOOP – OHMS | RINGING-VOLTS | WIRING |
|---|---|---|---|
| GROUND RETURN RINGING | 6000 OR LESS | 70 OR MORE | GR |
| | ABOVE 6000 | 70 OR MORE | GR, LL |
| LOOP RINGING | 2000 OR LESS | 70 TO 90 | LR |
| | 2000 TO 4000 | 70 TO 90 | LR, LL |
| | 4000 OR LESS | 90 OR MORE | LR |
| | ABOVE 4000 | 90 OR MORE | LR, LL |

H-83260-A FIGURES 23A, 24A, AND 25A

Figure 26. Ring-Down Tie-Trunk without Pad, Schematic Diagram.

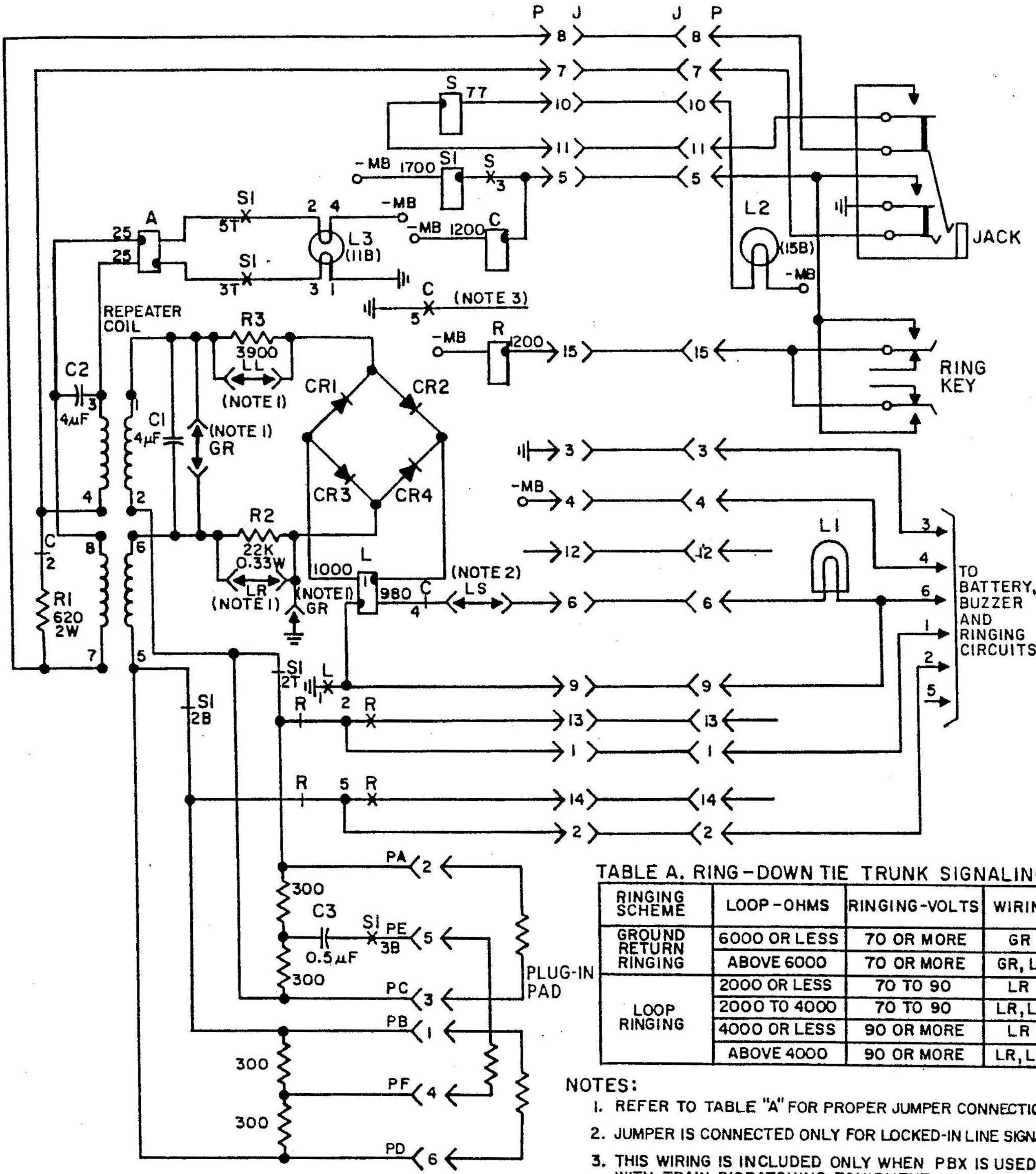


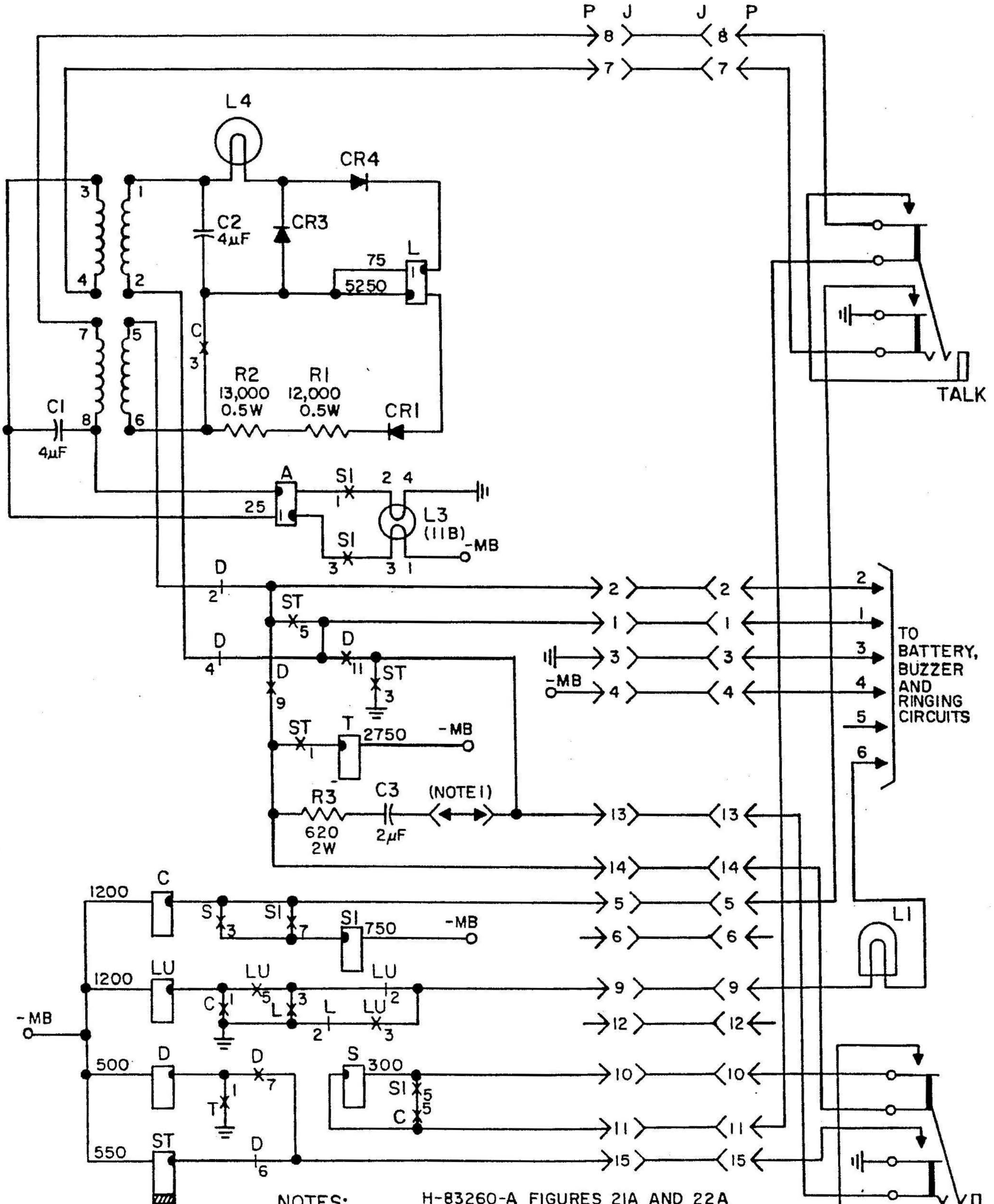

TABLE A. RING-DOWN TIE TRUNK SIGNALING

| RINGING SCHEME | LOOP-OHMS | RINGING-VOLTS | WIRING |
|---|---|---|---|
| GROUND RETURN RINGING | 6000 OR LESS | 70 OR MORE | GR |
| | ABOVE 6000 | 70 OR MORE | GR, LL |
| LOOP RINGING | 2000 OR LESS | 70 TO 90 | LR |
| | 2000 TO 4000 | 70 TO 90 | LR, LL |
| | 4000 OR LESS | 90 OR MORE | LR |
| | ABOVE 4000 | 90 OR MORE | LR, LL |

NOTES:

1. REFER TO TABLE "A" FOR PROPER JUMPER CONNECTIONS.
2. JUMPER IS CONNECTED ONLY FOR LOCKED-IN LINE SIGNALS.
3. THIS WIRING IS INCLUDED ONLY WHEN PBX IS USED WITH TRAIN DISPATCHING EQUIPMENT.

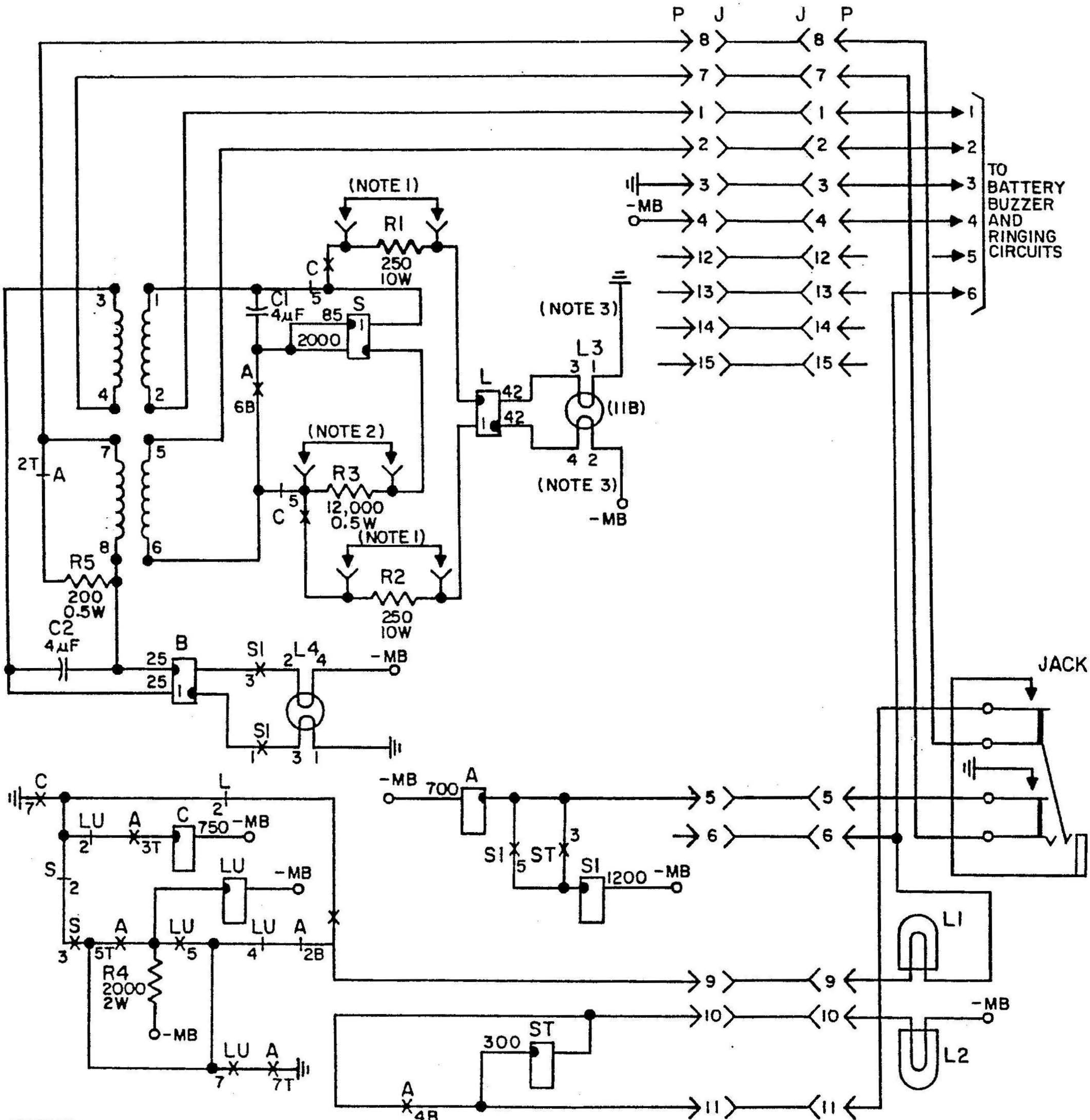
Figure 27. Ring-down Tie-Trunk with Pad, Schematic Diagram.




NOTES: H-83260-A FIGURES 21A AND 22A

1. THIS JUMPER IS NOT CONNECTED UNLESS THIS CIRCUIT TERMINATES ON DISTANT END S X S SWITCHBOARD WITHOUT INCOMING SELECTOR.

Figure 28. Tie-Trunk to Dial-Type PABX, Schematic Diagram.




NOTES:

1. JUMPER IS USED ONLY IF EXTERNAL LOOP EXCEEDS 500 OHMS.
2. JUMPER IS USED ONLY WHEN THE DISTANT END REQUIRES 12,000 OHM HIGH BRIDGE.
3. SHOWN WIRED FOR SIGNAL BATTERY FEED FROM PBX BATTERY. WHEN SEPARATE SIGNALING BATTERY IS USED, GROUND AND -MB LEADS ARE CONNECTED TO PLUG TERMINALS 13 AND 14 RESPECTIVELY AND CONNECTIONS AT TERMINALS 3 AND 4 OF PLUG MAY BE ABSENT.

Figure 29. Two-Way Manually-Selected Automatic Tie-Trunk Schematic Diagram.

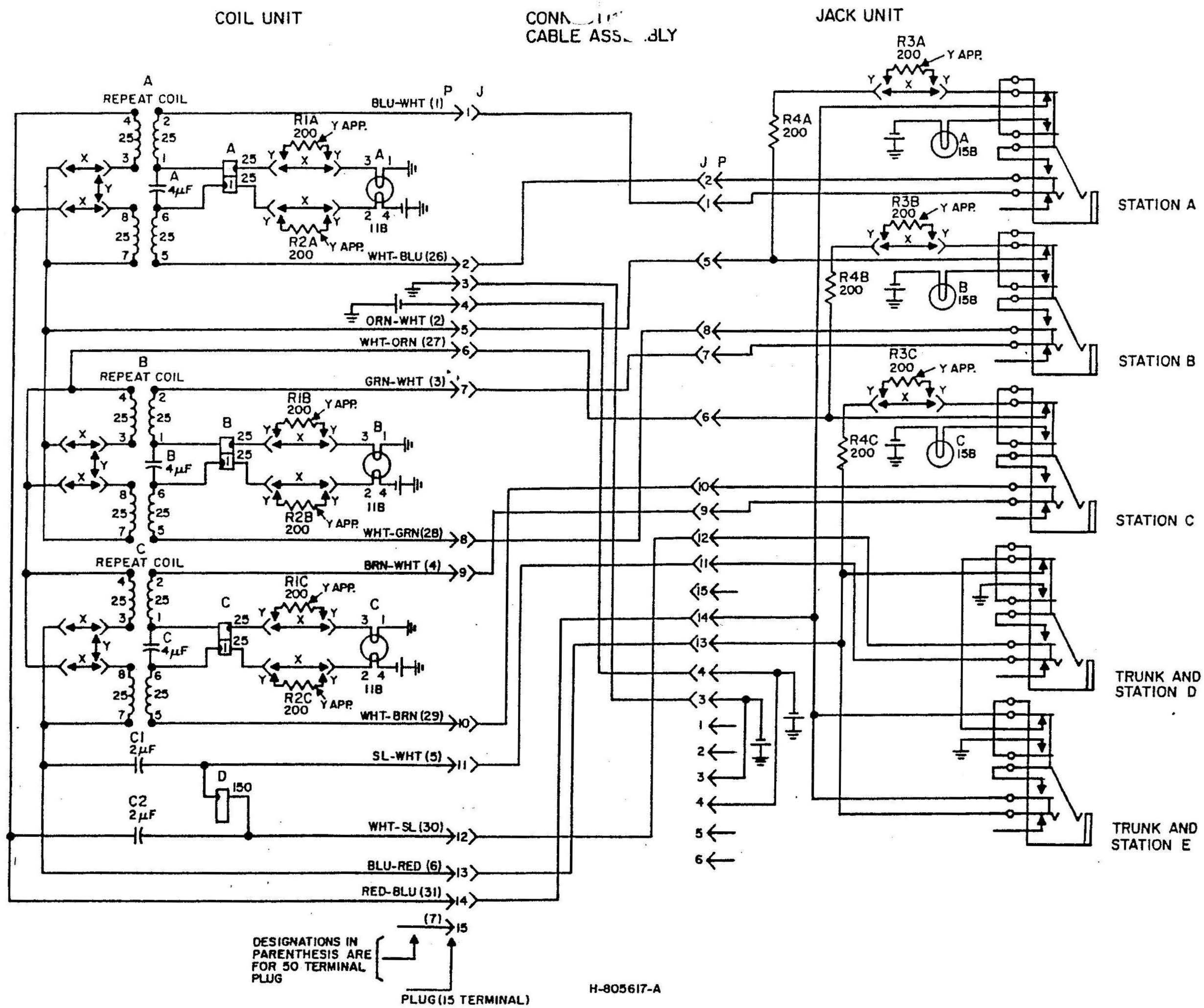



Figure 30. Manual Conference Unit Schematic Diagram.