

BELL SYSTEM PRACTICES
Private Branch Exchange
Installation and Maintenance

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GENERAL DESCRIPTION OF THE No. 555 P.B.X.

Contents	Page
1. GENERAL	1
2. EQUIPMENT DESCRIPTION	3
(A) Capacity	3
(B) Face Equipment	4
(C) Rear Equipment	5
(D) Cord Circuit Unit	7
(E) Attendant's Telephone Unit	7
(F) Central Office Trunk Unit	8
(G) Tie Trunk Units	8
(H) Conference Unit	9
3. OPERATING FEATURES	10
(A) General	10
(B) Operating Ranges	10
(C) Station Line Circuit	11
(D) Cord Circuit	12
(E) Attendant's Telephone and Dial Circuit....	21
(F) Position Grouping Circuit	24
(G) Central Office Trunk	24
(H) Two Way Ringdown Tie Trunk	26
(I) Automatic Tie Trunk	28
(J) Tie Trunk to Dial Type P.B.X.	30
(K) Manual Conference Circuit	33
(L) Auxiliary Signal and Battery Cut Off Key..	34
(M) Power Supply	34
4. SPECIFICATIONS AND CIRCUIT DRAWINGS	35

I. GENERAL

1.01 This section describes the No. 555 P.B.X. which is a small manual non-multiple switchboard. It provides intercommunication service between two extension stations or

between one extension station and an outside subscriber by means of plug and jack connections established manually by an attendant. Conference connections may also be established manually for a maximum of 5 subscribers. This P.B.X. may be used in either manual or dial central office areas.

1.02 The principal features of the No. 555 P.B.X. are as follows:

- (a) Operation on a wide range of supply voltage; i.e., 16 to 50 volts.
- (b) Low power consumption. Many installations will operate on only 1 or 2 direct battery feeder pairs and the need for individual storage batteries at the P.B.X. will be greatly reduced.
- (c) Increased trunk and station signaling range, which reduces the need for line relays and long line circuit units.
- (d) Improved trunk ringing bridge circuit providing a locked-in signal on initial ring and non locking signal on toll rering, thus eliminating the need for a rering relay in the cord circuit.
- (e) Three types of supervision may be obtained for trunk calls; i.e., non-through supervision on all calls, through supervision on all calls, or automatic discrimination, which provides through supervision on outgoing calls and non-through supervision on incoming calls.
- (f) An optional key permitting the attendant to monitor on any busy line with minimum transmission loss.
- (g) A splitting key for announcement purposes to permit the P.B.X. attendant to hold an incoming call on a trunk while consulting privately with the called extension station.
- (h) Push button type ringing keys separate from the talk and dial key, which eliminates the overthrow difficulties formerly encountered with lever type keys.
- (i) Demountable relay units, jack and lamp units, etc., provide easier factory assembly and field maintenance.
- (j) The switchboard shelf is free of equipment, providing ample writing space for the attendant.
- (k) An auxiliary signal buzzer with adjustable sound output for incoming calls.
- (l) Removable wooden panels, finished in oak or mahogany-walnut, to match subscribers premises and to facilitate repairs.
- (m) Reduced maintenance through the use of twin contacts on most relays and keys.

2. EQUIPMENT DESCRIPTION

(A) Capacity

2.01 This P.B.X. has a capacity of 60 station lines when the jacks are mounted on 1 inch centers and 120 station lines when the jacks are on 1/2 inch centers. It will accommodate 15 cord circuits and 14 central office trunks or tie trunks. One or more conference circuits may be furnished, each permitting a telephone conference for a maximum of 5 subscribers.

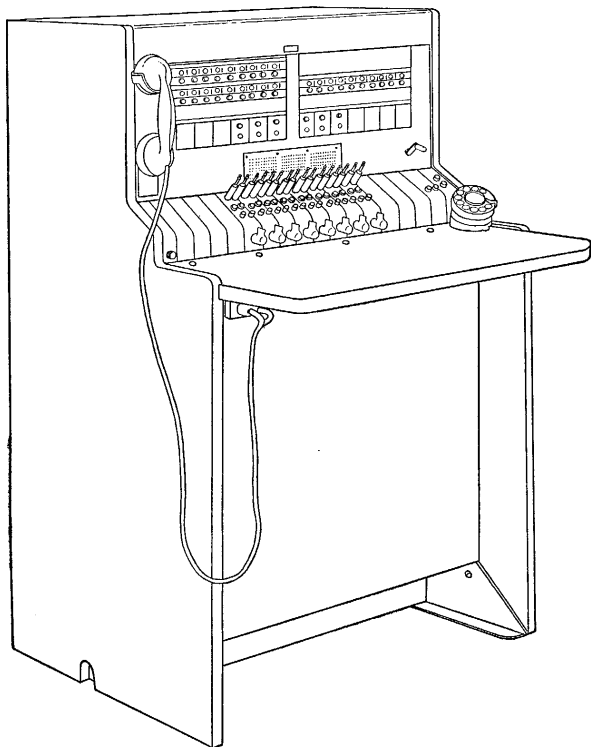


Fig. 1—Front View

(B) Face Equipment

2.02 The No. 555 P.B.X. switchboard section is approximately 4 feet high, 2-1/2 feet wide, and 2-1/2 feet deep. Up to 120 extension line jacks and lamps may be mounted in two panels in the upper front section, as shown in Figure 1. The line jacks and lamps are arranged in three rows in each panel. Below these a level is provided for the removable individual units containing the lamps, jacks, and keys associated with the central office trunks and tie trunks. Spaces in the face of the switchboard not equipped with trunk units are closed by suitable apparatus blanks.

2.03 A card containing condensed instructions for operation of the P.B.X. is located below the jack and lamp panels. The removable cord circuit units, containing cord plugs, lamps and keys, and the attendant's telephone unit containing the "Split" key and optional "Mon" key, are located on the next level below. The cord circuit units are in the center and the attendants telephone unit is at the right of the switchboard.

2.04 The attendant's telephone set, which connects to jacks located under the left side of the switchboard shelf, may be of the hand set type or the head telephone type. The hand set type, when not in use, may be hung on a mounting provided for that purpose on the left side of the board. The dial, when required, is mounted at the rear right corner of the switchboard shelf where it is convenient for use. A hand generator for emergency ringing is mounted to the right of the cord circuits. The end panels of the P.B.X. are removable for easy replacement when necessary, due to subscriber request for change of the finish, refinishing of panels in connection with repairs, etc. The lower front panel of the P.B.X. is similarly removable in connection with replacement of worn cords and other maintenance.

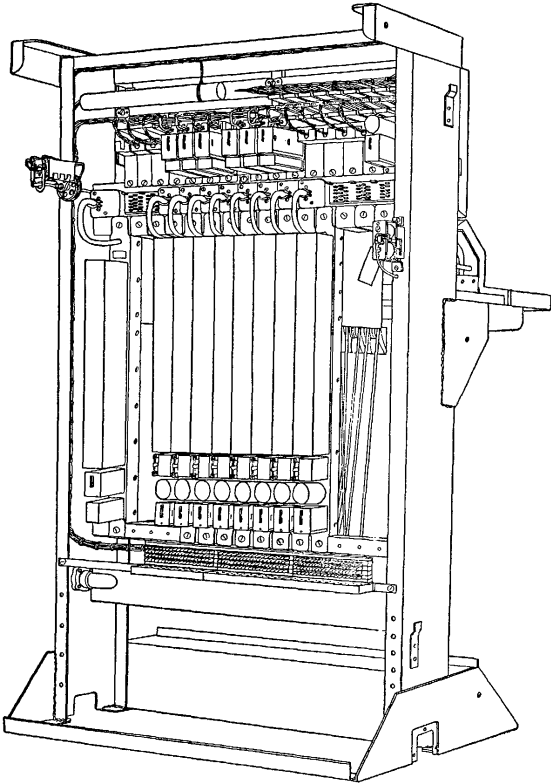


Fig. 2—Rear View—Woodwork Removed

(C) Rear Equipment

2.05 A removable back panel provides access to the rear of the section. See Fig. 2. All the relay apparatus associated with each cord circuit, central office trunk, tie trunk, and conference circuit, is assembled in separate self-contained units which may be removed from the rear of the switch-

board. Each unit terminates in a flexible cord and multi-contact plug, allowing ready connection or disconnection without soldering. The extension lines, central office trunks, tie trunks, battery, ground, and ringing current supply, all terminate on soldering lugs in the lower rear of the switchboard. There is space below these terminals for four 23" mounting plates on which the relay apparatus associated with tie trunks and the conference circuit may be mounted when required.

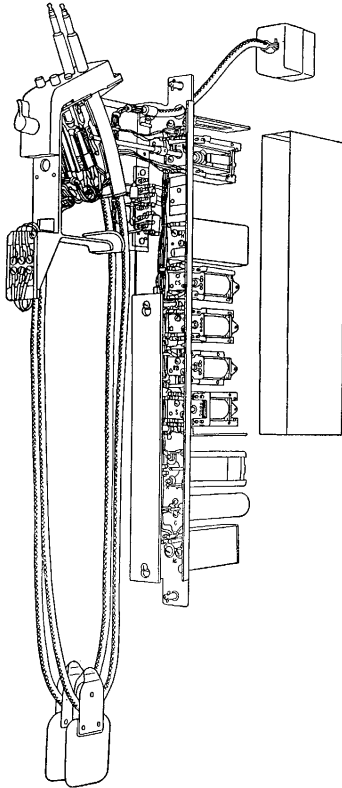


Fig. 3—Cord Circuit Unit

(D) Cord Circuit Unit

2.06 As shown in Fig. 3, the cord circuit unit is complete in the sense that it not only contains all of the relay apparatus required, but the keys, lamps, cords, and cord weights as well. The relays are arranged in a vertical row on the unit, with the contact springs toward the rear of the board where they are accessible for maintenance. The wiring terminates in a flexible cord and plug arranged to connect to a bus bar type of connector in the rear of the board. The plugs, lamps and keys are mounted in a molded plastic block at the top of the unit, and these items are all that are seen from the front of the board with the unit in place. The right and left cords of each cord circuit terminate on a connecting block on the unit, and worn cords of standard length (4 feet) may be changed from the front of the board without removing the unit from the P.B.X., access being gained through the removable lower front panel. The cord units are so designed that where more than one switchboard section is required, long cords may be installed without the need of a platform to elevate the section from the floor. This is accomplished by the use of a triple pulley cord weight in place of the single pulley cord weight. When long cords are furnished, the cord units must be removed in order to replace worn cords.

2.07 In the stock switchboards, the cord pairs are colored alternately red and slate, and the supervisory lamp caps are red and white to correspond.

2.08 The ringing keys are of the push button type and are separate from the talk and dial key, thus eliminating overthrow difficulties formerly encountered with the lever type keys used for both talking and ringing. The attendant's talk and dial key, and the night and through key are operated from the same key handle. The talk and dial key contacts are operated by a rotary motion of the handle, while the night and through dial springs are actuated by pushing the handle toward the rear of the switchboard. An interlocking mechanism guards against operation of both sets of key springs at the same time.

(E) Attendant's Telephone Unit

2.09 This unit contains all the apparatus associated with the attendant's telephone circuit with the exception of the dial and the telephone jacks. It consists of a key and relay equipment. This key, designated "SPLIT", appears at the right side of the switchboard when the unit is mounted in place. It is used by the attendant to split off and hold an incoming trunk call while she consults privately with the called extension station. An optional monitoring key may be added when desired

which permits the attendant to monitor on any busy line, with minimum transmission loss. The relay apparatus requiring adjustment is so mounted as to be accessible from the rear of the board. Like other units, the attendant's telephone unit connects to the P.B.X. by means of a plug and flexible cord. It also has an additional connector for establishing the electrical connections to the dial and the telephone jacks.

(F) Central Office Trunk Unit

2.10 The central office trunk unit consists of a jack and lamp, a ring-up relay, and other miscellaneous apparatus such as condensers, thermistors, etc. When the unit is mounted in place on the P.B.X., the jack and lamp appear in the face equipment, and the relay and miscellaneous equipment extend out into the rear of the board, just above the cord circuit units. Contrary to usual practice, the line lamp in this unit is located above the jack because the lamp is used both as a line signal and as a rering or recall signal. If the lamp were below the jack, the recall signal would be obscured by the cord. This apparatus terminates in a plug on the upper side of the unit, which connects to the switchboard by means of a socket and flexible cable extending from the P.B.X. wiring.

(G) Tie Trunk Units

2.11 Three types of tie trunks are available i.e., ring-down tie trunks, automatic tie trunks, and tie trunks to a dial type P.B.X. Unlike the central office trunk, which is a self contained unit, the tie trunks consist of two units, one containing the jack, lamp, and key apparatus, and the other containing the relay apparatus. Each unit is plug ended, and connection is made between the two units by means of a flexible cable which has a socket at each end.

2.12 The tie trunk relay units consist of the circuit apparatus mounted on 23-inch mounting plates, ordinarily located at the bottom rear of the switchboard. Because of the length of the stock cables used with the connecting sockets, the jack and lamp units are ordinarily mounted in trunk positions 10, 11, 12 or 13 in the face of the board. Other trunk positions may be used if unavoidable, but in these cases an interconnecting cable of suitable length must be made up locally.

2.13 As seen from the front of the switchboard, the face block of the ring down tie trunk unit mounts the jack and above side by side, the line lamp and the push button ringing key used to signal the distant P.B.X. The face block of the automatic tie trunk unit mounts the jack with the line lamp above. The face block of the tie trunk to a dial P.B.X.

(see Fig. 4) mounts the talk jack and above, side by side, the line lamp and dial jack.

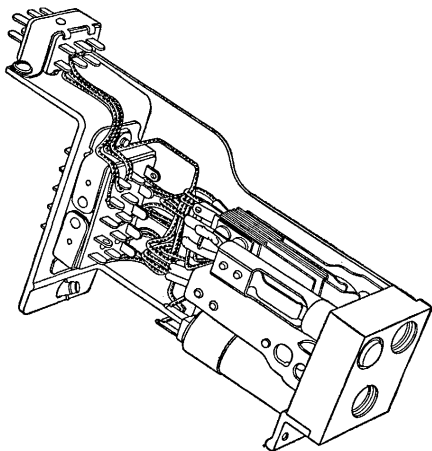


Fig. 4—Jack Unit for Tie Trunk to Dial Type P.B.X.

(H) Conference Unit

2.14 The conference circuit, which makes it possible for the attendant to connect together manually a maximum of five stations for a telephone conference, consists of two units; a jack unit and a relay unit. Each unit is plug ended, and connection is made between the two units by means of a socket ended flexible cable. The flexible cable is universal, that is, it can be used with any of the three types of tie trunks as well as with the conference circuit.

2.15 The jack unit contains five conference jacks and occupies two trunk positions on the front of the board. The flexible connecting cable between the jack unit and the relay unit permits mounting the jack unit in positions 11 and 12, 12 and 13, or 13 and 14.

2.16 The relay equipment is mounted on a **23-inch mounting plate**, 2 inches wide, arranged to mount in the lower rear of the P.B.X.

3. OPERATING FEATURES

(A) General

3.01 The circuits for the No. 555 P.B.X. are designed to operate over the extremely wide voltage range of 16 to 50 volts. With this range, the majority of installations will require only one or two pairs of battery feeders from the central office. Various means have been employed to keep the current drain to a minimum, including the use of high resistance UA relays where possible, high resistance transmitter battery supply, and others. The rering feature has been made a part of the trunk circuit where, by means of thermistors, the ring up relay is made to do double duty.

(B) Operating Ranges

3.02 Where the line circuits are not equipped with line relays, the maximum permissible station loop resistance over which the No. 555 P.B.X. will operate on a station to station call is 150 ohms with a supply voltage of 16 volts at the P.B.X. This loop limit is fixed by the ability of the line lamp to produce a satisfactory signal in series with the station loop resistance at the minimum voltage. In most installations, the minimum P.B.X. voltage will be greater than 16 volts. The following table indicates the maximum permissible station loop resistance (conductors + subset) for various minimum P.B.X. voltages.

Minimum Voltage at P.B.X.	16	18	20	22	24	26
Maximum Permissible Station Loop Resistance in Ohms (No Line Relay)	150	240	330	420	510	600

3.03 Where the station loop range desired at a given voltage exceeds that given in the table above, line relays may be added locally. In this case, the station loop range ceases to be limited by the line lamp condition, but instead is limited by supervision, that is by the ability of the CS relay in the cord circuit to operate, as shown in the following table:

Minimum Voltage at P.B.X.	16	18	20
Maximum Permissible Station Loop Resistance in Oms (With Line Relay)	450	600	780

3.04 On central office trunk calls, the trunk conductor loop resistance plus the maximum station loop resistance shall not exceed the subscribers loop resistance range of the central office to which the P.B.X. is connected, less an allowance of 35 ohms for the P.B.X. series AS relay. A limiting factor is the ability of the AS relay in the cord circuit to operate in series with the called station loop while shunted by the cord circuit holding bridge on incoming central office trunk calls. Accordingly the circuit employs an AS series supervisory relay of high sensitivity, and a cord circuit holding bridge of adjustable resistance. The resistance of the bridge is adjusted to a value such that the total resistance of the P.B.X. bridge plus the trunk resistance is as large as possible, without exceeding the external circuit working limit of the central office to which the P.B.X. is connected.

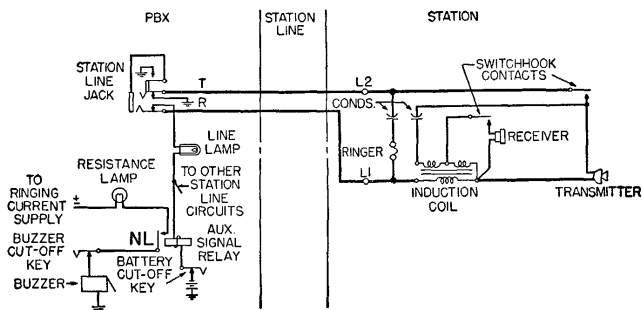


Fig. 5—Station Line Circuit

(C) Station Line Circuit

3.05 The station line circuit shown in Fig. 5, employs a cut-off jack and a line lamp operating on current over the station loop. When the station hand set is removed from the mounting, the line lamp lights, and when the P.B.X. attendant inserts a right cord in the associated jack, the cut-off contacts on the jack retire the line lamp.

3.06 Where the line signaling range requirements cannot be met by the line lamp alone, the line circuit may be modified locally to add a line relay. The range of the line

relay is at least as good as the supervision range of the cord circuit on station-to-station calls, as discussed in 3.03.

3.07 In some installations, modification of the P.B.X. line circuit may be necessary for special services. The circuit drawings show station line circuits for use with Nos. 1 and 4 Order Turrets, commercial office subscriber sets or key equipments, and two party service on a jack per station basis.

(D) Cord Circuit

3.08 The cord circuit is used by the attendant for establishing connections to extension stations, central office trunks and tie trunks. The relay apparatus comprising the cord circuit terminates in left and right plugs, which correspond respectively to the front and rear plugs of older type cord circuits.

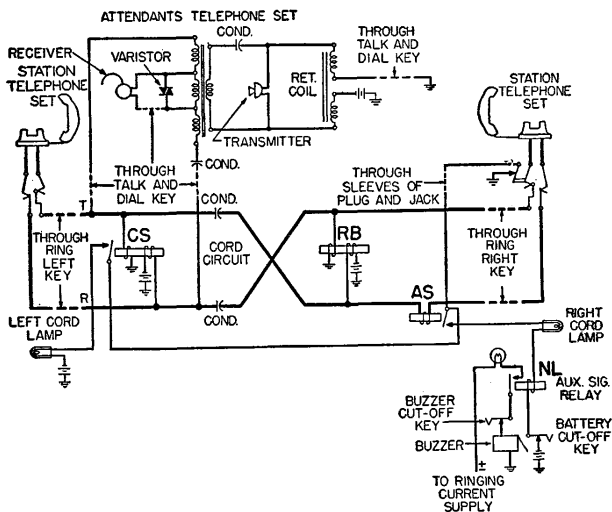
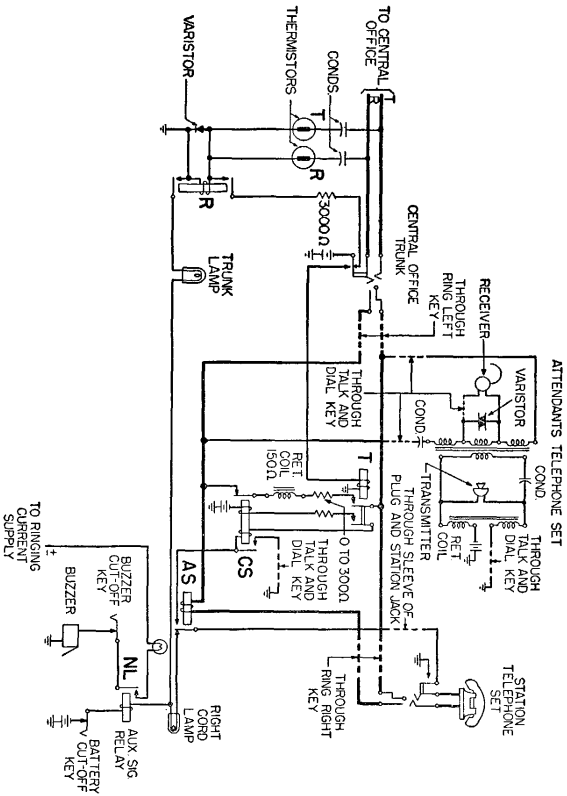


Fig. 6—Station-to-Station Call

3.09 On station-to-station calls, as shown in Fig. 6, the calling station lifts his hand set causing the P.B.X. line lamp to light. The P.B.X. attendant inserts the right plug in the calling jack, operates the talk and dial key to ascertain the station desired, and completes the call by connecting the left plug into the called station jack and pressing the push button ringing key associated with the left cord. The called station supervisory lamp remains lighted till the call is answered. Supervision is obtained independently from both stations on station-to-station calls. When the two stations hang up, both supervisory lamps light, and the attendant takes down the connection. The internal connection of the cord circuit under this condition is the series condenser bridged impedance type. It contains two 1 mf condensers in series with the tip and ring leads and two 520-520 ohm relay structures for supplying battery independently to the two cords of the cord pair. This arrangement permits greater supervision range on station-to-station calls, and provides substantial power supply economies as compared with the single impedance cords formerly used.

Fig. 7—Central Office Trunk to Station Call



3.10 On central office trunk to station calls, as shown in Fig. 7, the left cord is connected to the trunk and the right cord is connected to the station. This causes the left cord sleeve relay "T" to operate, removing the bridged impedance circuit and cutting the cord through so that the station receives transmitter battery from the central office over the

trunk. Control of the cord supervisory lamp is obtained from a series relay "AS" of the non-reactive type in the cord.. This non-reactive relay differs from the relay formerly used for supervision in that it has no non-inductive shunt across its operating winding. The transmission path is through the inductive winding, but the impedance of this winding is very low because it is wound parallel to another winding on the relay which is short circuited. When conversation is finished on a trunk connection on either an inward or outward call, the right cord lamp lights when the station disconnects. The cord circuit is normally arranged for through supervision on all calls. With through supervision, as shown in Fig. 8, a locking path is furnished for relay "CS" so that the cord circuit holding bridge is not re-connected when the station hangs up. The central office equipment therefore releases immediately. By a simple wiring change, non-through supervision may be obtained on all calls except night calls and calls dialed by the station. Where non-through supervision is provided as shown in Fig. 9, disconnect by the station releases the "CS" relay, re-connecting the cord circuit hold bridge. In this case, the central office equipment is not released until the cord is pulled down. By providing relay "AD" in the cord circuit as shown in Fig. 10, automatic discrimination between inward and outward calls may be obtained, resulting in non-through supervision on inward calls and through supervision on outward calls. On inward calls, relay "AD" operates under control of the right ringing key to open the locking circuit to relay "CS" thereby providing non-through supervision. On outward calls, relay "AD" does not operate, relay "CS" locks up, and through supervision is obtained. Through supervision will of course be obtained on night connections.

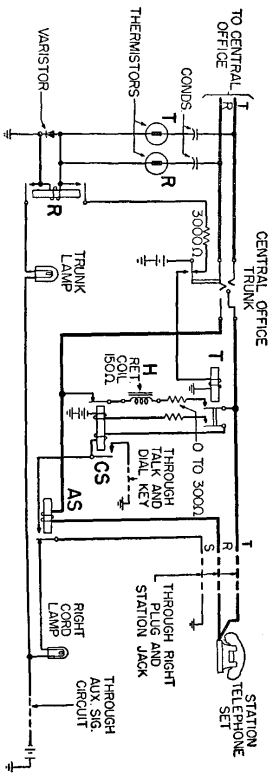


Fig. 8—Through Supervision on All Calls

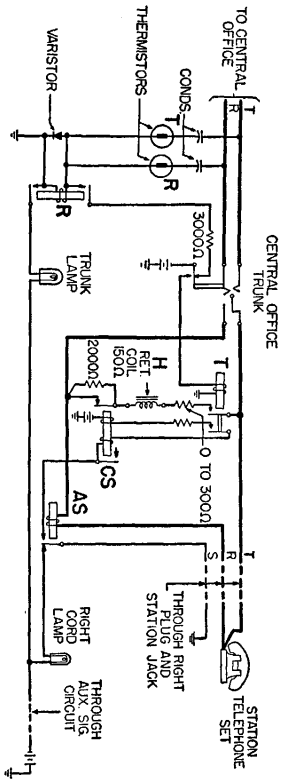


Fig. 9—Non-Through Supervision on All Calls

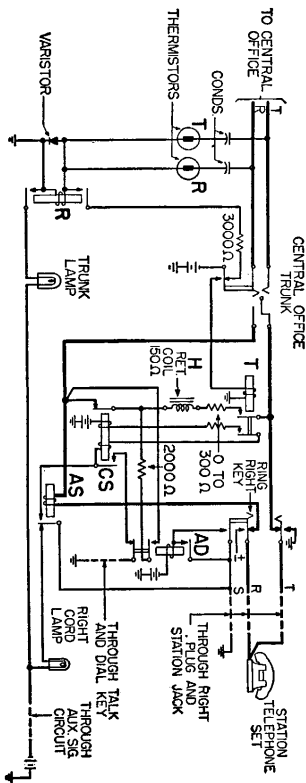


Fig. 10—Through Supervision on Outgoing Calls
—Non-Through Supervision on Incoming Calls

3.11 On tie trunk to station calls, the right cord is used for the station and the left cord for the tie trunk. Supervision is obtained from the station on the right cord lamp. On station to tie trunk calls and in dialing by attendant on repeating tie trunk calls to dial P.B.X., the right cord is used for the station and the left cord for the tie trunk.

3.12 On central office trunk to tie trunk calls, the left cord is used with the central office trunk and the right cord with the tie trunk.

3.13 The station instead of the attendant may dial outgoing central office calls when desired. In this case, the attendant connects the right cord to the extension station, operates the night and through dial key and then connects the left cord to the trunk. This removes the cord circuit holding bridge, leaving the station bridged across the trunk, as shown in Fig. 11. When dial tone is received, the extension station may dial out his call.

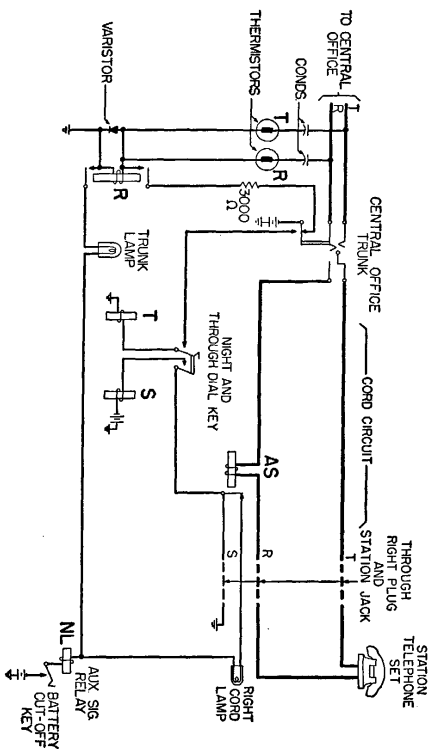


Fig. 11—Night and Through Dial Connections

3.14 Night connections provide a means whereby certain stations may obtain incoming and outgoing telephone service via a central office during periods such as nights, week ends, or holidays when the attendant is not on duty. Night connections, as shown in Fig. 11, may be set up by operating the night and through dial key of a cord circuit, plugging the left cord into a central office trunk jack and the right cord into the station requiring night telephone service. Operation of the BAT key to the OFF position will prevent the lighting of the right cord lamp on these connections. Incoming calls from the central office ring the bell at the station directly, and outgoing calls may be made to a manual or dial central office without the aid of the attendant.

3.15 The windings of both cord sleeve relays are shunted with a resistor in series with a germanium varistor to dissipate the energy from the relay winding when the attendant disconnects the associated cord from the jack. The varistor, which conducts current only in one direction, is poled to oppose the battery voltage. Power supply economy is thus obtained. Since the voltage of self induction of the relay winding is opposite to the battery voltage, the varistor provides the conducting path to eliminate it. The resistor is provided to avoid burning out the varistor should the battery feeder become accidentally reversed. A condenser in series with a resistor would provide a satisfactory means for absorbing the undesired voltage with the same power supply economy as the varistor. However, the latter is used because of space considerations.

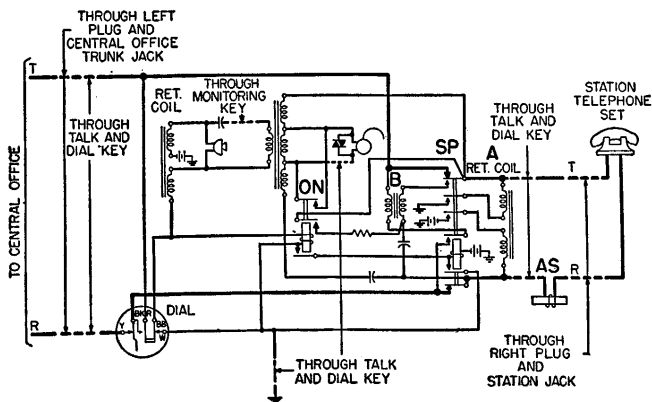


Fig. 12—Attendant's Telephone and Dial Circuit

(E) Attendant's Telephone and Dial Circuit

3.16 The attendant's telephone and dial circuit is used by the attendant for answering originating calls, talking on established connections, and dialing on outgoing central office trunks and repeating tie trunks to dial P.B.X.'s. As shown in Fig. 12, it consists mainly of a local battery anti-sidetone telephone set for talking purposes, and a dial with associated relay apparatus, for establishing connections to a dial type central office or P.B.X. The operation of any talk and dial key connects the attendant's telephone set across the cord circuit associated with the operated key and closes a circuit to energize the transmitter. The attendant now may talk to either station on the cord circuit.

3.17 The attendant's telephone is furnished in two types, i.e., handset or head telephone set, as desired. These sets terminate in a suitable plug arranged to connect to the attendant's telephone set jacks located under the left edge of the switchboard shelf.

3.18 When the attendant dials on an outgoing connection, the movement of the dial off normal causes the operation of relays "ON" and "SP". This action (a) short circuits the attendant's receiver to prevent the attendant from hearing dial clicks, (b) short circuits the tip and ring of the dial circuit to reduce the resistance of the dialing loop to a minimum, (c) connects the primary winding of the "B" retardation coil across the tip and ring of the line to hold the trunk connection between digits and after dialing is completed, (d) connects a low resistance across the secondary of the "B" retardation coil to reduce the impedance of the coil in order to prevent false pulses due to surges when the short is removed from tip and ring as the dial returns to normal at the end of each digit, (e) connects the secondary winding of the "B" retardation coil in series with a condenser across the station side of the connection to provide a by-pass feature or transmission coupling to enable the calling extension and the distant called party to converse should the attendant fail to restore the talk and dial key after dialing and (f) connects battery and ground through retardation coil "A" to the station for talking and signaling purposes until the talk and dial key is restored. Fig. 13 shows schematically, the connections in the attendant's telephone and dial circuit with the dial off normal. When the dial returns to normal at the end of each digit, the short circuit is removed from the "B" retardation coil, and relay "ON" releases. Relay "ON" releasing, removes the resistance from the secondary of coil "B" and also removes the short circuit from the attendant's receiver. Relay "SP" does not release until the talk and dial key is restored.

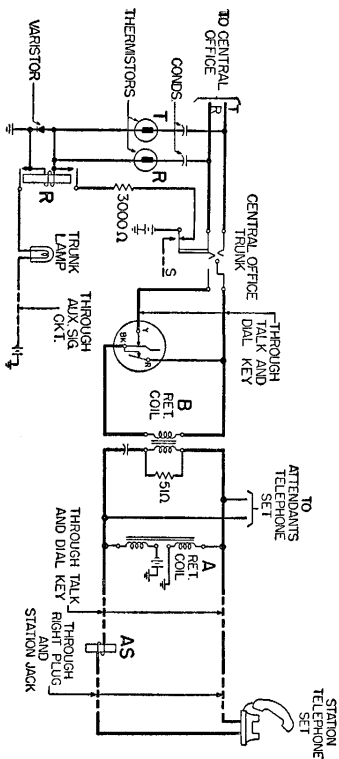


Fig. 13—Attendant's Telephone and Dial Circuit—Dial Moved Off Normal

- 3.19 The station instead of the attendant may dial outgoing calls when desired, as described in section 3.13.
- 3.20 The attendant's dial may be either a normal speed dial (10 P.P.S.) or a high speed dial (20 P.P.S.) as desired.

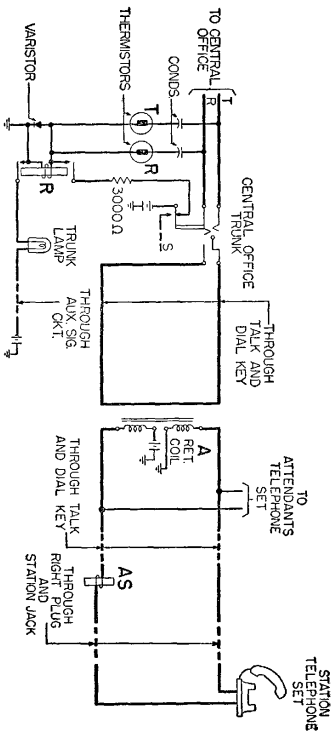


Fig. 14—Attendant's Telephone and Dial Circuit-Split Key Operated

3.21 The splitting key, designated SPLIT is used for announcement service on calls incoming to the P.B.X. over a central office trunk or tie trunk. On such an incoming call, the attendant operates the talk and dial key and learns from the outside party the extension station desired. With the talk and dial key still operated, the attendant operates the SPLIT key. As shown in Fig. 14, this splits the transmission circuit between the two cords of the pair, leaving the outside

party connected to the left cord, and the attendant's telephone connected to the right cord. Using the right cord, the attendant can then connect to the called extension station to announce the name of the calling party without the calling party hearing the conversation.

3.22 The monitoring key, added when required, permits the attendant to monitor on an established connection with minimum transmission loss. When operated, the monitoring key opens the transmitter winding of the induction coil raising the impedance of the primary windings of the coil to a satisfactory value for monitoring, and at the same time preventing interference due to room noise pick-up by the transmitter.

(F) Position Grouping Circuit

3.23 The position grouping circuit is for use where two individual No. 555 P.B.X.'s, each serving its own group of extension stations, each having its own cord circuits, are mounted side by side so that when one attendant is absent the remaining one can handle calls on both positions. The circuit arrangement is such that when the vacating attendant removes her telephone set plugs from the jacks, her cord circuits are automatically transferred to the remaining attendant's telephone circuit by relay action controlled by contacts on the telephone jacks.

3.24 When a grouping circuit is installed, one designated position may be grouped to the other, but not vice versa.

3.25 Only one battery cut-off key is provided. This key controls the battery supply to both positions, eliminating possible confusion that might be caused by two such keys. Similarly, only one buzzer and one buzzer cut-off key are provided for the two positions. The ringing current and hand generator connections are such that, whether vacant or occupied, each position will be regularly supplied with ringing current, or in emergencies, with hand generator ringing current. Another modification involves interconnection and fusing the battery feeders supplying the two P.B.X.'s to equalize the potential between the two positions when using cable feeder battery supply.

(G) Central Office Trunk

3.26 The central office trunk circuit provides the facilities whereby the P.B.X. extension stations may communicate with subscribers reached via a central office. By means of the cord circuits, the central office trunk circuit may be extended to a P.B.X. station or to a tie trunk circuit.

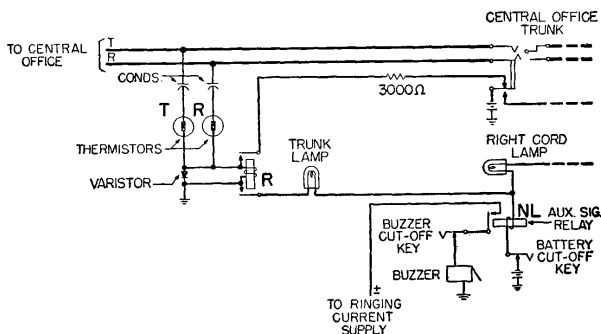


Fig. 15—Central Office Trunk Circuit

3.27 As shown in Fig. 15, the ring up bridge across the trunk consists of two 1 mf condensers and two thermistors in series, the midpoint being connected through the parallel combination of the ring up relay and varistor to ground. It is readily responsive to ringing current but is insensitive to false operation from voltage surges caused by dial impulses, disconnects, etc. On a call incoming to the P.B.X. from a central office, ringing current flows over one side of the line through one condenser, one thermistor, the ring up relay and varistor to ground, operating the R relay and lighting the trunk lamp. The R relay locks in under control of a contact on the trunk jack, keeping the lamp lighted until the attendant plugs in with her left cord to answer the call. At this time the relay is released and the lamp is extinguished. The sensitivity of the ring up circuit is such that it will reoperate to light the trunk lamp on a toll rering against the holding bridge in the cord circuit under extreme trunk loop conditions. In this case, however, the trunk lamp lights only while ringing current is applied to the trunk. The thermistors normally have a resistance of about 60,000 ohms each. The passage of ringing current through them for 1/2 second or more reduces their resistance to less than 3000 ohms, permitting operation of the R relay. This time delay characteristic provides margin against false operation of the relay on surges. The thermistors also provide a sufficiently high impedance across the trunk to permit the satisfactory transmittal of

high speed dial pulses from the attendant's dial. The varistor across the winding of the ring up relay is provided to prevent chattering of the relay armature during ringing. It also provides a low resistance path for operation of the thermistor during half of each cycle of ringing current.

3.28 The P.B.X. attendant originates a call to a central office by inserting the left cord of a cord circuit into a trunk jack. Battery on the sleeve of the trunk jack causes the P.B.X. holding bridge to be connected across the trunk, bringing in either a central office operator who will complete the call manually, or dial tone, whereupon the P.B.X. attendant may dial out her call.

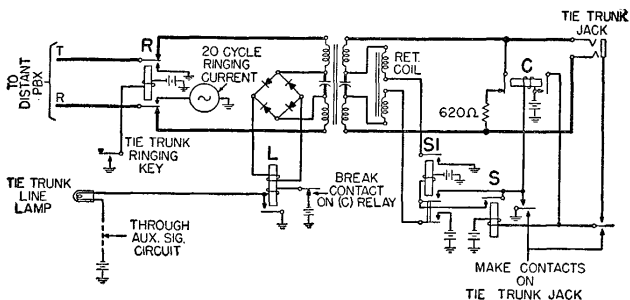


Fig. 16—Two Way Ring Down Tie Trunk

(H) Two Way Ring Down Tie Trunk

3.29 The two way ring down tie trunk circuit provides means whereby the No. 555 P.B.X. and a distant P.B.X., also equipped with some form of ring down circuit may signal each other over the trunk by means of 20 cycle ringing current. In general, as shown in Fig. 16, an incoming ring on the tie trunk causes line relay L and the associated line lamp to operate and lock in until the attendant answers by inserting a left cord in the tie trunk jack. On a rering from the distant P.B.X., the line lamp lights again, but only while ringing current is on the line. The ring up circuit consists of a sensitive B type relay operated from a full wave rectifier, which converts the incoming 20 cycle ringing current into direct current for more efficient operation of the relay.

3.30 On tie trunk to station calls, an extension station of the distant P.B.X. is connected to an extension station of the No. 555 P.B.X. On this type of call, the incoming ring to the No. 555 P.B.X. causes the line lamp to operate. The attendant plugs in with her left cord and completes the call to the extension by means of the right cord. The tie trunk circuit feeds repeating coil battery toward the extension station for talking and supervision. When conversation is finished, the No. 555 P.B.X. attendant receives a disconnect signal on the supervisory lamp of the cord circuit upon hang-up of the extension station. Disconnect signals are not given over the tie trunk by the disconnection of either attendant.

3.31 On station to tie trunk calls, the right cord of the No. 555 P.B.X. is in the station jack, and the left cord is in the tie trunk jack. The attendant signals the distant P.B.X. by depressing the tie trunk ringing key. This operates relay "R" to disconnect the repeating coil and connect ringing current directly to the trunk while the key is depressed.

3.32 On tie trunk to central office calls, a connection is established whereby an extension station of the distant P.B.X. talks to a central office subscriber reached via a No. 555 P.B.X. central office trunk. When the distant P.B.X. rings on the tie trunk, the trunk lamp lights and the attendant inserts her left cord in the tie trunk jack. Upon learning that a central office call is desired, she disconnects the left cord from the tie trunk jack and inserts the right cord into the jack. The left cord is then connected to an idle central office trunk jack. This places the cord circuit holding bridge across the central office trunk, and the attendant completes the call via the manual or dial central office. With the right cord in the tie trunk jack, there is no operating path for the S and S1 relays and the tie trunk remains dry. The No. 555 P.B.X. attendant does not receive disconnect signals from either end of the connection unless the distant attendant rings off, therefore it will be necessary for her to listen in at intervals to determine when the conversation is finished.

3.33 On central office to tie trunk calls, the left cord of the No. 555 P.B.X. is in the central office trunk jack, and the right cord is in the tie trunk jack. The No. 555 P.B.X. attendant depresses the tie trunk ringing key, signaling the distant P.B.X. attendant who completes the call to the desired extension.

3.34 On tie trunk to tie trunk calls, a connection is established at the No. 555 P.B.X. whereby an extension station of one distant P.B.X. may talk to an extension station of another distant P.B.X. Under this condition, the left cord

of the No. 555 P.B.X. connects to either tie trunk and the right cord to the remaining tie trunk. The cord circuit holding bridge is connected in the circuit in this case, but performs no useful function. If the transmission loss caused by the holding bridge is undesirable, it can be eliminated by operating the night and through dial key of the associated cord circuit. The tie trunk repeating coils provide a splitting means so that a ringing signal from either tie trunk will light only the respective tie trunk lamp.

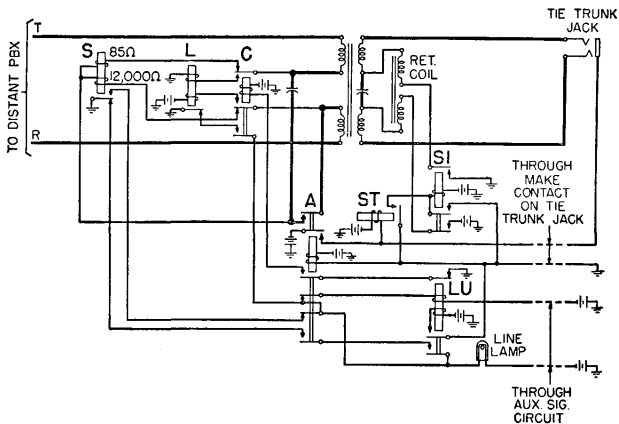


Fig. 17—Automatic Tie Trunk

(I) Automatic Tie Trunk

3.35 The automatic tie trunk circuit shown in Fig. 17, enables a No. 555 P.B.X. and a distant P.B.X. to signal each other automatically by means of direct current sent out over the tie trunk. It is suitable for use where the distant P.B.X. is of the dial type and it is desired that the dial stations of this P.B.X. should be able to reach the No. 555 P.B.X. without the assistance of the dial P.B.X. attendant, and also for the case where the distant P.B.X. is of the manual type but automatic signaling is desired. The circuit is arranged for

automatic line lamp signaling, line lamp supervision, outgoing signaling battery supplied toward the distant P.B.X., incoming high-low supervision, and repeating coil transmission battery toward the station with the left cord in the tie trunk jack. By means of the cord circuits of the No. 555 P.B.X., the tie trunk connection may be extended to an extension station, central office trunk or another tie trunk circuit. Each automatic tie trunk circuit terminates in a jack and lamp. The lamp serves as a line signal for incoming calls, a recall signal for resignaling the No. 555 P.B.X. attendant, and a disconnect signal at the end of conversation.

3.36 On tie trunk to station calls, battery and ground are connected at the distant end of the trunk to signal the No. 555 P.B.X. attendant. This causes the operation of a sensitive high resistance relay S in the tie trunk, lighting the tie trunk lamp. When the attendant answers by inserting the left plug of a cord circuit into the tie trunk jack, the lamp is extinguished and the high resistance relay bridge across the tie trunk becomes low resistance to give supervision to the distant P.B.X. The No. 555 P.B.X. attendant completes the call to the desired station by inserting the right plug of the cord circuit into the called station jack and operating the cord circuit ringing key. If necessary during the call, the distant P.B.X. may recall the No. 555 P.B.X. attendant by re-plugging. This causes the tie trunk lamp to light each time the plug is removed and go out when the plug is reinserted. If, at the end of conversation, the distant P.B.X. should disconnect first, the tie trunk lamp at the No. 555 P.B.X. will light as a disconnect signal. On the other hand, if the No. 555 P.B.X. attendant disconnects first, the tie trunk lamp at the distant P.B.X. will light as a disconnect signal, and the trunk lamp at the No. 555 P.B.X. will remain lighted until the distant P.B.X. disconnects. In addition to the trunk lamp disconnect signal, the attendant receives a disconnect signal on the cord supervisory lamp upon hang up of the extension station.

3.37 On tie trunk to central office trunk calls, the No. 555 P.B.X. attendant, upon learning that a central office call is desired, removes the left cord from the tie trunk jack and replaces it with the right cord. The left cord is then inserted in the central office trunk jack, and the call is completed via the central office. If, after conversation is finished, the distant P.B.X. disconnects first, battery and ground are removed from the tie trunk causing the tie trunk lamp to light at the No. 555 P.B.X. as a disconnect signal. If the No. 555 P.B.X. attendant disconnects first, the tie trunk lamps at both P.B.X.'s will light until the connection is taken down at the distant end.

3.38 On station to tie trunk calls, the extension station lifts his receiver, and the No. 555 P.B.X. attendant answers by connecting the right plug of a cord circuit to the station jack. The station requests the tie line connection, and the attendant connects the left cord to the tie trunk jack. This results in battery and ground being connected to the tie trunk, operating the line lamp at the distant P.B.X. At the same time, the line lamp at the No. 555 P.B.X. lights as a supervisory signal, and remains lighted until the distant P.B.X. answers, when it is extinguished. The distant P.B.X. attendant then completes the connection to the desired station. If, when the call is finished, the distant P.B.X. attendant disconnects first, the lamp at the No. 555 P.B.X. will light as a disconnect signal. The No. 555 P.B.X. then disconnects, returning the tie trunk to normal. If the No. 555 P.B.X. attendant disconnects first, battery and ground are removed from the line, giving a disconnect signal to the distant P.B.X.

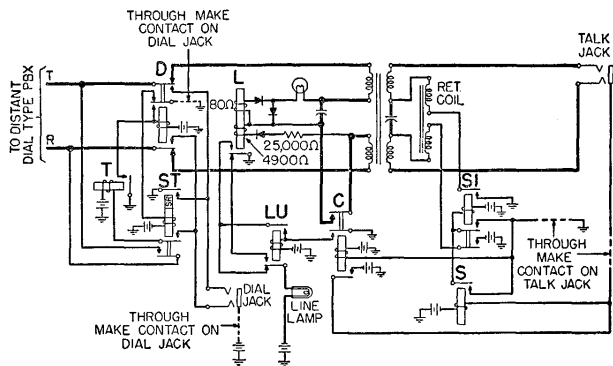


Fig. 18—Tie Trunk to Dial Type P.B.X.

(J) Tie Trunk to Dial Type P.B.X.

3.39 The tie trunk circuit to a dial type P.B.X., shown in Fig. 18 enables the No. 555 P.B.X. attendant by means of her dial to establish connections directly with the extension stations of the distant dial P.B.X. without requiring the assistance of the dial P.B.X. attendant. The circuit is arranged

for automatic line lamp signaling, line lamp supervision, incoming reverse battery signaling and supervision, outgoing high-low signaling and supervision, dial jack dialing, and repeating coil transmission battery toward the station with the left cord in the trunk jack. By means of the cord circuits of the No. 555 P.B.X., the tie trunk connection may be extended to an extension station, central office trunk or another tie trunk. Each tie trunk circuit terminates in a lamp, talk jack, and dial jack. The lamp serves as a line signal to indicate incoming calls, a recall signal for re-signaling the No. 555 P.B.X. attendant during a call, and a disconnect signal at the end of conversation.

3.40 On station to tie trunk calls, the attendant plugs into the talk jack with the left cord of a cord circuit, lighting the tie trunk lamp. She then plugs into the dial jack with the left cord of another cord circuit, transferring the trunk from the talk jack to the dial jack, and placing the cord circuit holding bridge across the tie trunk. The No. 555 P.B.X. attendant operates the talk and dial key associated with the cord connected to the dial jack, and when dial tone is received from the distant P.B.X., she dials the desired extension, thus establishing connection with the distant extension without the assistance of the distant attendant. The attendant then removes the cord from the dial jack, and the tie trunk is transferred back to the talk jack. When the called station at the distant P.B.X. answers, the current sent out by the distant P.B.X. is reversed, extinguishing the tie trunk lamp by the operation of a relay-varistor combination which is responsive to current in one direction only. If at the end of conversation the called station disconnects first, the current flow over the trunk is restored to the original direction, releasing the relay-varistor combination and lighting the tie trunk lamp as a disconnect signal. If the attendant disconnects first by removing the plug from the talk jack, the tie trunk lamp remains extinguished and the resistance of the relay-varistor combination is increased, to give a disconnect signal to the distant P.B.X. When the distant P.B.X. disconnects, the tie trunk circuit restores to normal.

3.41 On tie trunk to station calls, the current sent out over the trunk from the distant P.B.X. is in the proper direction to operate the relay-varistor combination at the No. 555 P.B.X., causing the trunk lamp to light. When the attendant answers by inserting the left cord in the talk jack, the trunk lamp is extinguished, and the resistance of the relay-varistor combination is reduced to give supervision toward the distant P.B.X. If, at the end of conversation the distant P.B.X. disconnects first, the current flow over the trunk is restored to

the original direction, releasing the relay-varistor combination and lighting the tie trunk lamp as a disconnect signal. If the No. 555 P.B.X. attendant disconnects first by removing the plug from the talk jack, the tie trunk lamp remains extinguished, and the resistance of the relay-varistor combination is increased to give a disconnect signal to the distant P.B.X. When the distant P.B.X. disconnects, the tie trunk circuit restores to normal.

3.42 On tie trunk to central office trunk calls, the No. 555 P.B.X. attendant, upon learning that a central office call is desired, removes the left cord from the tie trunk and replaces it with the right cord. The left cord is then inserted into the central office trunk jack, and the call is completed via the central office.

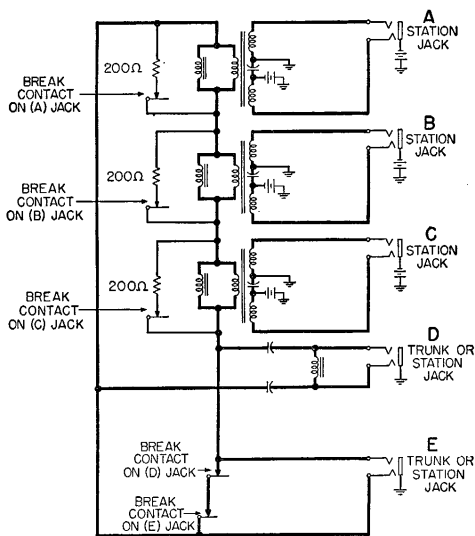


Fig. 19—Manual Conference Circuit

(K) Manual Conference Circuit

3.43 The manual conference circuit, shown in Fig. 19, enables the attendant to set up conference connections between a maximum of 5 extension stations, four stations and one central office trunk or tie trunk circuit, or three stations and two tie trunk circuits. Five conference jacks are furnished in two rows in a single unit in the face the P.B.X. The upper row contains 3 jacks for station connections, while the lower row contains two jacks for trunk or station connections. A separate cord circuit is used for each station or trunk connected for conference.

3.44 If, on an established station-to-station call, the addition of a third extension station is desired, one of the stations flashes the attendant and requests the conference connection. The attendant removes the left cord from the established connection and plugs it into one of the conference circuit station jacks shown as A, B or C in Fig. 19. The connections to the other stations are made similarly, using separate cord circuits, with the left cords in the conference circuit station jacks and the right cords in the extension station jacks. The added extension is signaled in the usual manner by ringing. Battery through the sleeve of the conference circuit station jack causes the operation of the cord circuit sleeve relay, thus making the cord circuit dry. As connection is made to each conference circuit jack A, B or C, a 200 ohm shunt is removed from the secondary of each repeating coil, to prepare the transmission circuit. When the added station answers, the conference connection is completed, and the three way conversation may proceed. Under this condition, each of the three stations is fed with transmitter battery through its own individual repeating coil. The secondaries of the three repeating coils are in series so that speech from any one extension will be heard by the other two. In a similar manner, a fourth and a fifth extension station may be added to the conference, except that either end of the cord circuit may be used to connect the added stations to conference jacks D and E. A retardation coil associated with jack D retires the cord lamp, and the secondaries of the three repeating coils in series similarly retire the cord lamp associated with jack E. Talking and signaling battery for the stations connected to jacks D or E is supplied from the cord circuit. When a station disconnects on a conference connection, the associated cord circuit supervisory lamp lights as a disconnect signal.

3.45 If, on an established central office trunk to station connection, it is desired to add a second extension station, except on an out call with through supervision, the

first station flashes the attendant and requests the conference connection. The attendant then removes the right cord of the existing connection and plugs into the D or E jack of the conference unit. The two extension stations are connected to jacks A and B as described in 3.44 and the added station is signaled in the usual manner by ringing. When the added station answers, the conference proceeds. When the conference is finished and the subscribers hang up, the attendant receives disconnect signals from the extension stations but not from the central office trunk.

(L) Auxiliary Signal and Battery Cut Off Key

3.46 The battery cut off key, designated BAT, is a locking turn button key with an ON position and an OFF position. When this key is in the ON position, battery is supplied to the cord circuits, telephone circuit, and the various lamps associated with the P.B.X. When the key is in the OFF position, battery supply is disconnected from the regular switchboard circuits, thereby avoiding the possibility of battery drain at night.

3.47 The auxiliary signal circuit is arranged for sounding a common buzzer which operates when any line lamp of a station line, central office trunk, or tie trunk is lighted, or when any right cord lamp is lighted. The buzzer operates on ringing current, and its sound output may be adjusted by the attendant to a high or low volume, as desired. A locking turn button key designated BUZ, with ON and OFF positions, is provided for silencing the buzzer when it is not required as an audible signal. A foot switch may also be used for silencing the buzzer.

(M) Power Supply

3.48 The current drain of the No. 555 P.B.X. has been kept as low as possible by the use of high resistance UA relays and other current saving devices. As a result, it is anticipated that most No. 555 P.B.X. installations will operate on one or two direct feeder pairs from a 48 volt central office battery. Local storage batteries at the P.B.X. will seldom be required, except where the P.B.X. is a long distance from the central office, or where battery feed pairs are not available.

3.49 Ringing current is furnished to the P.B.X. over one pair of cable conductors from the ringing machine at the central office. This pair may supply ringing current to as many as ten non-multiple P.B.X. positions in the same building in accordance with ringing supply arrangements now standard. A hand generator is furnished for emergency ring-

ing supply in the event of failure of the regular supply. When the handle of the hand generator is turned, the switchboard circuits are automatically transferred from the regular ringing supply to the hand generator by off normal contacts on the hand generator.

4. SPECIFICATIONS AND CIRCUIT DRAWINGS

4.01 The following table lists the circuit drawings and the J specification pertaining to the No. 555 P.B.X. Detailed circuit description will be found in the associated CD sheets.

<u>Title</u>	<u>Number</u>
No. 555 P.B.X. Switchboard (J59013)	AA 352.024
Keysheet	SD-66525-01
Cord, Telephone, Dial, CO Trunk, Station Line, Buzzer, Ringing, and Battery Circuit	SD-66520-01
Two Position Grouping Circuit	SD-66521-01
Ring Down Tie Trunk	SD-66522-01
Tie Trunk to Dial Type P.B.X.	SD-66523-01
Automatic Tie Trunk	SD-66524-01
Manual Conference Circuit	SD-66531-01
Miscellaneous Circuits	SD-66537-01

4.02 Wiring information for the maintenance man will be provided by a circuit label which will be attached to the rear door at the local shops or the installation site at the time the removable wood panels are attached to the switchboard.

Bell Telephone Laboratories, Inc.