

## GENERAL DESCRIPTION 755A PBX

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### 1. GENERAL

1.01 This section describes the No. 755A PBX, which is a small dial telephone system employing crossbar switches. It provides dial intercommunication service and outside trunk service without an attendant and can be used in either manual or dial central office areas.

1.02 The principal features of the No. 755A PBX are summarized as follows:

- (a) Dial intercommunicating service.
- (b) A crossbar switch is used as the switching device, which eliminates all rotary moving parts.
- (c) All incoming central office calls can be answered and transferred at any key station.
- (d) Key stations may be arranged for any one of three different classes of service in connection with central office calls as follows:
  - (1) Lockout Service—This prevents a station from being connected to a busy trunk except when there is an unanswered incoming call or hold condition on the trunk.
  - (2) Non-Lockout Service—This permits a station to be connected to a busy trunk. This class of service is employed where trunk conference connections or "executive right-of-way" service is desired.
  - (3) Restricted Service—This prevents a station from making outgoing trunk calls but does permit the station to answer incoming trunk calls or connect to a trunk where there is a hold condition on the trunk.
- (e) Provision of a combined dial hand telephone set with the necessary key buttons mounted in the base for establishing local and trunk service.
- (f) A control key arrangement is available for use at key stations to provide means for connecting keyless type stations to central office trunks without limiting the use of the key station at which the control key is located.
- (g) One or more key stations may be connected as extensions of a main key station on any station line.
- (h) Arrangements are provided to permit line hunting on certain lines when required.
- (i) Local conference connections may be established by dialing.
- (j) Trunk lamps may be provided at the stations and are arranged to flash to indicate unanswered calls and to light steadily when their associated trunks are busy.
- (k) Lamp signals similar to those used for trunks may be provided for local lines.

### 2. EQUIPMENT DESCRIPTION

#### Capacity

2.01 The capacity of this PBX is 20 station lines, 4 central office trunks and 3 link circuits. Where 10 or less station lines are equipped only one crossbar switch is provided; however, the other crossbar switch can be added later. The station capacity may be augmented by the use of key station extension stations and the trunk capacity by the use of pick-up keys.

#### Numbering Plan

2.02 The station line circuits are numbered from 20 to 39 with lines 20 to 29 being in the first group and lines 30 to 39 in the second group. The equipment is designed so that preliminary pulses are absorbed by the link circuits. If a number is dialed for which no station is assigned no connection will be completed and no tone will be heard.

### Station Equipment

2.03 Four different types of telephone sets may be used at key stations and are as follows:

- (1) Combined hand telephone set.

Note: On the earlier installations of the No. 755A P B X's the No. 205 type hand telephone set with an E type mounting and a subscriber set containing a ringer, induction coil and condenser may be installed.

- (2) No. 213 (hang up) type hand telephone set.
- (3) No. 206 type hand telephone set.
- (4) No. 653 wall type subscriber set.

2.04 The combined hand telephone set is complete with the ringer, induction coil, condensers and keys mounted in the base of the set and is shown in Fig. 1.

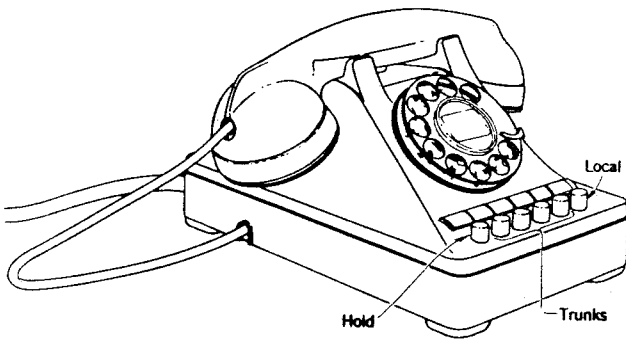


Fig. 1—Combined Hand Telephone Set.

2.05 The No. 213 type hand telephone set is for use at the side of a desk or any location where a hang-up type of instrument is desired. The No. 206 type set is for use where a set without keys in the base is desired. When these types of sets are used a separate subscriber set containing a ringer, induction coil and condensers is required.

2.06 When the No. 213 or No. 206 type hand telephone sets or the No. 653 type subscriber sets (wall type) are used for key stations the keys required for completing local or trunk calls are mounted external to the set and furnished as a unit known as the No. 6021-J3 key. This key is shown in Fig. 2.

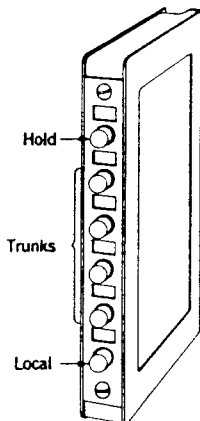


Fig. 2—No. 6021-J3 Key.

2.07 The No. 6021-J3 key for key stations consists of six push button type keys. Four of the key buttons are used for making connections to four central office trunks, one is used for making local calls between the P B X stations and the other one is used for holding connections on central office trunks.

2.08 When any one of the key buttons is depressed all other buttons are released.

2.09 The four key buttons used for making connections to trunks and the one used for making local calls remain locked in the operated position after being depressed. The remaining key button, which is used for holding connections on central office trunks, does not lock when it is depressed.

2.10 The locking button furthest from the hold button is generally used for local calls and the other four locking buttons are used for trunks.

### Lamp Signals

2.11 Lamp signals can be provided at the stations to indicate local calls and incoming trunk calls. When lamps are used for this purpose they are housed in one of the following types of indicators as required.

- (1) Beehive type indicators.

15A for one lamp.  
17A for two lamps.  
18A for three lamps.

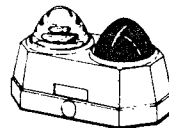
- (2) Surface mounted indicators.

14A for three lamps.  
20A for four lamps.

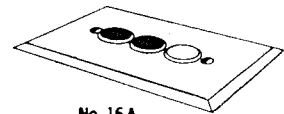
- (3) Flush mounted indicators.

16A for three lamps.

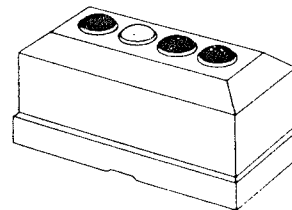
2.12 Fig. 3 shows some of these indicators.



No. 17A



No. 16A



No. 20A

Fig. 3—Indicators.

2.13 B2 type lamps are used in all indicators.

### Framework

2.14 The framework housing the P B X apparatus is constructed of steel members welded together and its design is similar to that of a single bay of floor supported relay rack arranged to mount 2" x 26" mounting plates in the lower portion and 2" x 20-1/2" mounting plates in the upper portion. Adjacent to the shorter mounting plates in the upper portion of the framework are details for holding the connecting cable terminal strips. The frame is approximately 6' high. It is provided with a wooden base to afford a means of insulating it from local ground where the storage battery is charged on a metallic return basis. The lower part of the frame is arranged to house the power plant including the storage batteries and associated charge and discharge apparatus. The fuse panel is located just above the battery compartment. Space just above the fuse panel is available for two additional mounting plates for miscellaneous equipment. Above this are mounted the relay units for the common tone, ringing, alarm and link allotter circuits as well as the trunk and link circuits. Over this are mounted the two crossbar switches with the line relay units and the associated common control and cut-off unit between them. Figs. 5 and 6 show a front and rear view respectively of the frame with the apparatus in place.

### Casings

2.15 The framework is fitted front and rear with lightweight sheet steel casings designed to be lifted off the frame rather than hinged to it. Four separate casings are provided; one for the front and one for the rear of the battery compartment and one for the front and one for the rear of the upper or switching compartment. The upper casings are equipped with locks which are operated by the same keys used for opening the keyshelves of manual P B X's. Fig. 4 shows the framework with the casings in place.

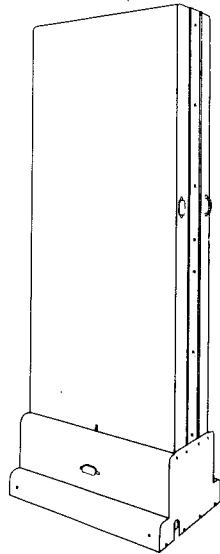


Fig. 4—Framework With Casings in Place.

### Equipment Arrangements

2.16 The equipment is arranged on a unit basis to facilitate equipping varying numbers of line, link and trunk circuits as required for particular installations. For small installations, where the requirements do not exceed ten station lines, only one crossbar switch may be provided. When the requirements exceed ten station lines two crossbar switches are provided which will care for a maximum of twenty station lines.

2.17 The trunk and line units are designed on a two and four circuit basis respectively with arrangements for providing either a full or partially equipped unit. The link units are designed on a single circuit unit basis.

### Crossbar Switch

2.18 The crossbar switch used in this P B X is equipped with 10 vertical units each having 10 sets of contacts with six pairs of make contact springs in each set. Each set of contacts has an actuating spring to control the closing of the contacts. Associated with each vertical unit is a holding magnet and holding bar which is attached to the armature of the magnet. There are five selecting bars which run horizontally across the switch unit and each bar is equipped with 10 selecting fingers, one for each vertical unit. Each selecting finger is a flexible wire about 3 inches long which extends from the horizontal bar to a position near the vertical holding bar between the actuating springs of two sets of contacts, which are located one above the other. Associated with each selecting bar are two selecting magnets; one of these magnets rotates the bar so as to move the selecting fingers upward and the other magnet rotates the bar in the reverse direction to move the selecting fingers downward. The actuating spring is moved horizontally to close the contact springs and this action is caused by the movement of the holding bar when the holding magnet is energized if a selecting finger is entrapped between the actuating spring and the holding bar before the magnet is energized. One of these crossbar switches is shown in Fig. 7.

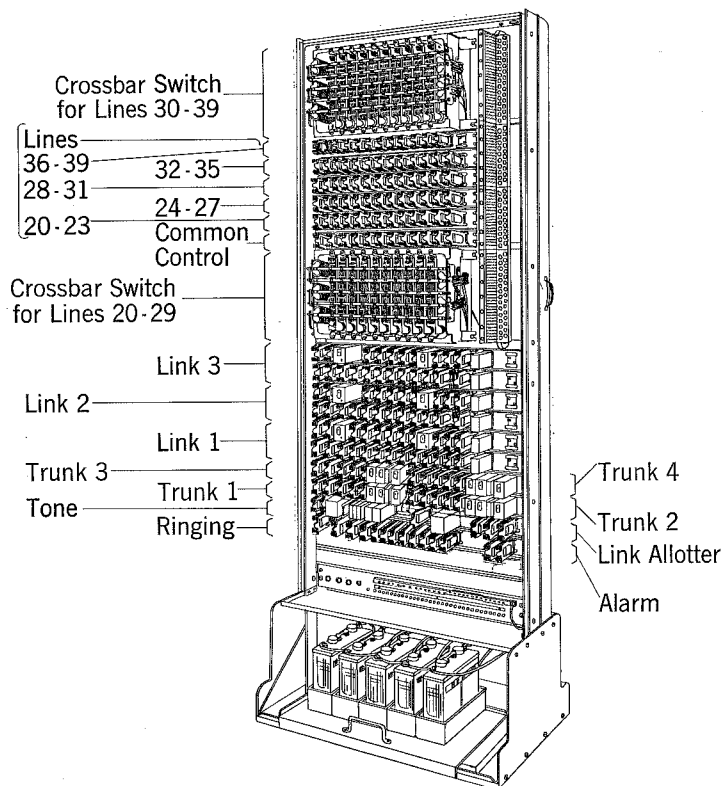


Fig. 5—Front View.

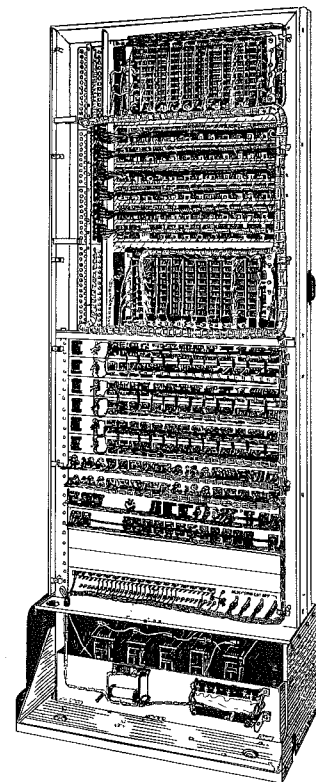


Fig. 6—Rear View.

2.19 The operation of a selecting magnet causes its associated selecting bar to rotate and move all 10 of its selecting fingers into traps between the vertical holding bars and the actuating springs so that any set of contact springs on the horizontal level of the operated selecting magnet can be closed when the associated holding magnet operates. Therefore, any one of the 100 sets of contact springs on a switch can be closed by first operating the proper selecting magnet and then operating the proper holding magnet. The contact springs which are closed by this procedure are those to the left of the holding magnet which has operated and above the horizontal bar which has operated if the selecting fingers on the bar are moved upward, or below the bar if the selecting fingers are moved downward. Fig. 8 shows an illustration of the selecting and operating elements of the crossbar switch.

2.20 After a set of contact springs has been closed as described in 2.19, the selecting magnet is released but the holding magnet continues to be energized to hold the contact springs closed. The pressure exerted by the holding bar through the selecting finger to the actuating spring holds the selecting finger in the selecting position after the selecting magnet is restored to normal. All other selecting fingers on the same bar which are not held by holding magnet armatures restore to normal when the selecting magnet is released. Each selecting finger is equipped with a damping spring which reduces its vibration when the selecting bar is operated or released so as to minimize the possibility of false operations of the switch contacts.

2.21 The release of a holding magnet permits the selecting finger to restore to its normal position. If a holding magnet should be operated when none of the selecting magnets are operated, none of the selecting fingers would become operated and none of the 10 sets of contact springs in the vertical unit would be closed.

2.22 Each holding magnet is equipped with a set of off-normal springs which operate whenever the holding magnet is operated regardless of the operation of any of the selecting magnets. The selecting magnets are also equipped with off-normal springs.

2.23 The switch contacts which are closed by the holding magnets in combination with the selecting fingers and the selecting magnet off-normal springs are all of the make type. The holding magnet off-normal springs have break contacts as well as make contacts.

2.24 One of the springs of each pair in the sets of contacts operated from the selecting fingers is fixed while the other spring is moved by the holding magnet armature and thus the contact pressure is obtained by flexure of the moving springs. The fixed springs for all 10 sets of contacts in a vertical unit are stamped from a single piece of metal so that these contacts are permanently interconnected electrically. The moving contacts are individual springs. The movable springs are provided with twin electrical contacts and each of the contacts on each spring is of palladium capped nickel.

2.25 One vertical unit of a crossbar switch is provided for each station line. Therefore each station line can be connected to any one of 10 different points through the 10 sets of contacts in the vertical unit. Four of these 10 sets of con-

tacts are arranged for connections to four central office trunk circuits. The other six sets of contacts are provided for the three link circuits, there being one set for the originating end of each link and another set for the terminating end of each link. One crossbar switch is sufficient for 10 station lines. The No. 755A P B X is designed for two crossbar switches therefore having a capacity for 20 station lines.

2.26 Since the selecting magnets and associated selecting fingers are common to all vertical units on a crossbar switch, only one connection through a switch can be completed at a time although after one connection has been completed, others can be completed in turn until a total of 10 holding magnets have been operated in succession on different connections on one switch. The time required to complete a connection by the operations of the selecting magnets and holding magnets is less than one second. If two calls should originate in the same one-second period, one of the calls would be delayed until the other was completed and this is accomplished by the call allotter circuit.

#### Power Equipment

2.27 The power plant consists of 5 small two cell storage batteries (15 ampere hour capacity) with associated charge and discharge equipment. The storage battery provides a voltage range of 18 to 25 volts and may be charged over cable pairs from a 48-volt central office battery or by a copper oxide rectifier connected to a 110-volt 80 cycle commercial power source.

#### Cabling and Wiring

2.28 The wiring between the apparatus on each equipment unit is done on a surface wiring basis. Only three different colors of wire insulation are employed with this type of wiring. Ground supply wires are black, battery supply wires are red and all other wires are green. Wires between terminals on the same unit can be identified by referring to the running sheets which are provided instead of wiring diagrams. On these running sheets each wire is numbered individually and the apparatus terminals to which it is connected are definitely indicated.

2.29 Wiring between the various equipment units is provided in local cables and these wires are connected directly to the apparatus terminals as no terminal strips for this purpose are provided on the units. The surface wiring to each terminal, to which a local cable Skinner is to be attached, is wound around the terminal so that the Skinner can be fastened through the regular hole at the end of the terminal. These local cables are of the conventional type using wires having various combinations of colored insulation.

2.30 The outside cable can be brought into the P B X either through a hole in the top of the framework adjacent to the right hand corner or through a hole in the left hand side of the framework just above the floor. The outside cable may be connected either directly to the terminal strips on which the P B X circuits are terminated or to separate terminal strips, for which space is provided, from which cross-connections are extended to the terminals of the P B X circuits.

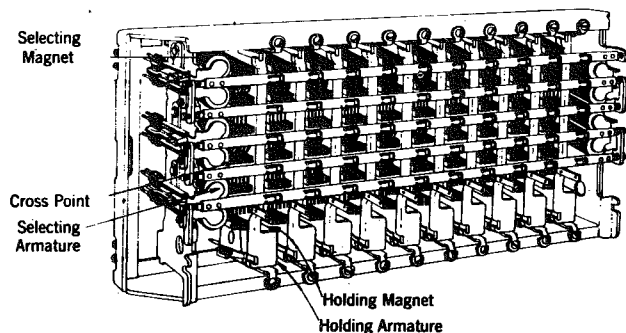


Fig. 7—Crossbar Switch.

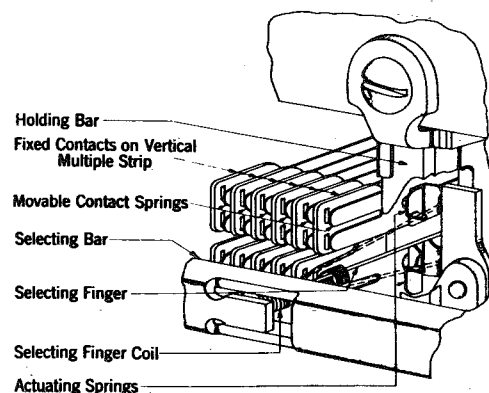


Fig. 8—Selecting and Operating Elements.

### 3. OPERATING FEATURES

#### General

3.01 Local connections between P B X stations are established by the link circuits. A link circuit is automatically connected to a station line when the hand set is removed from its mounting after the local push button key is depressed.

3.02 A link allotter circuit selects the particular link which is connected to the station line. The allotter is arranged to allot successive links on successive calls thereby providing an equal distribution of traffic among the links and also causing different links to be used on successive calls from the same station during periods of light traffic.

3.03 The links contain the apparatus for receiving the dial pulses and for establishing the connections to the station lines that are called and for ringing and tripping.

3.04 If none of the push button keys at a key station are in an operated position when the hand set is removed from its mounting, no connection is established and normally no tone is heard in the receiver. However, tone will be heard under this condition if the P B X busy tone interrupter happens to be started at the same moment by any one of the following conditions: (1) by an attempt to originate a local call from any other station when all links are busy or (2) by an attempt to originate a trunk call from a restricted station or (3) by an attempt to originate a trunk call from any other station when all trunks are busy.

#### Local Connections Between Key Stations

3.05 To originate a local call at a key station the hand set is lifted from the mounting after the local key is depressed. Through the operation of the call allotter, common control and link allotter the calling station line is connected to a link. Then dial tone is heard, except that if all links are busy, busy tone is heard instead of dial tone. After dial tone is heard the number of the desired station line is dialed. After the first digit has been dialed the dial tone is disconnected. After the second digit has been dialed audible ringing tone is heard if the called station line is not busy. However, if the called station line is busy, busy tone is heard. If the number dialed corresponds with a line to which no station apparatus is connected, no tone is heard. The call is answered at the called station by removing the hand set from its mounting after depressing the local key. When the called party answers, the ringing stops, the audible ringing tone is disconnected and the connection is completed from the calling station line through the link circuit to the called station line.

3.06 A diagram illustrating the progress of a typical local call between station 36 and station 22 is shown in Fig. 9.

3.07 If a trunk call should occur simultaneously with a local call, the local call must be answered first. If an attempt is made to answer the trunk call first or if under any condition the hand set is removed with a trunk key depressed

after the terminating end of a link circuit has been connected to the called station line, the talking connection through the link is not completed and audible ringing tone is heard by the called party the same as that heard by the calling party. When the local key is depressed the connection through the link is completed in the normal manner.

3.08 Machine ringing is tripped immediately after answering a local call in the proper manner at a key station regardless of whether the answering occurs during a ringing or silent period.

3.09 The hold key is effective only in connection with trunk calls and its operation while the local key is depressed will not establish a hold condition on the link but will cause a disconnection of the station from the link.

#### Calls Between Keyless Stations

3.10 Local connections between keyless stations are accomplished in the same way as for key stations except that no local key is used and also the tripping of machine ringing may not always occur immediately after answering if the answering occurs during a ringing period. However, ringing will always be tripped immediately during silent periods.

#### Calls from Key Stations to Central Office

3.11 An outgoing trunk call to a central office can be made from any key station, except those arranged for restricted service, by operating the trunk push button key associated with the particular trunk over which the call is to be made and removing the hand set from its mounting. If the station is arranged for lockout service and the trunk selected is busy, busy tone will be heard. Successive trunk buttons should then be depressed until a connection to a trunk is completed. However, if the station is arranged for non-lockout service and trunk lamps are not provided it is necessary to listen for conversation or challenge in order to determine whether the trunk is busy as no busy tone is returned to these stations. If trunk lamps are provided, these lamps can be observed to determine which of the trunks are free for use, a free trunk being indicated by an extinguished lamp. A diagram illustrating the progress of a typical outgoing trunk call from station 25 is shown in Fig. 10.

3.12 If a key station arranged for restricted service attempts to make an outgoing trunk call the occurrence of such an attempt will cause busy tone to be heard unless an unanswered incoming call or hold condition is on the trunk in which case the station is connected to the trunk.

3.13 If any key station is unintentionally connected to a trunk when an unanswered incoming call is waiting on the trunk, the incoming call should be completed in the normal manner from this station because the flashing of the trunk lamps is stopped and the bells are silenced by this connection and a disconnection by this station without completing the call, might prevent the call from being completed and cause the calling party to be charged.

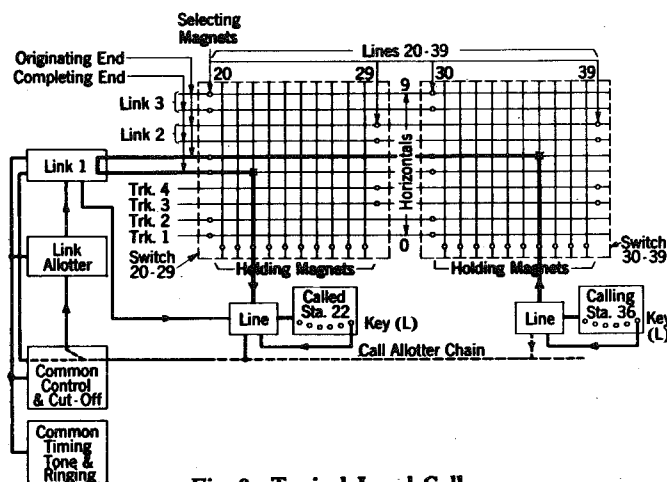


Fig. 9—Typical Local Call.

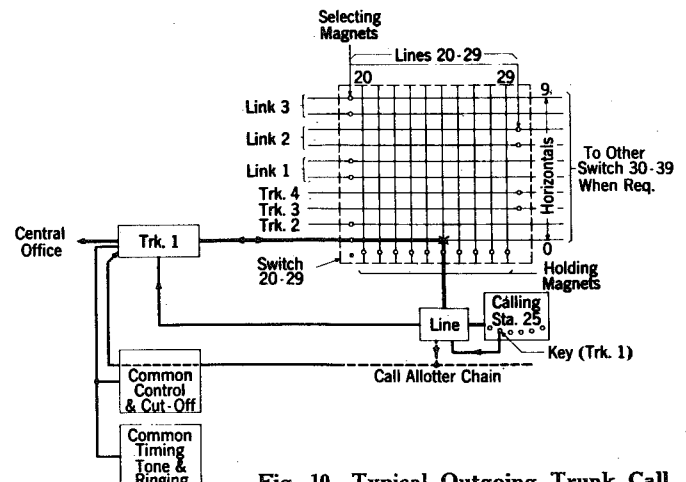


Fig. 10—Typical Outgoing Trunk Call.

3.14 If any key station is unintentionally connected to a trunk on which a call is being held the hold key should be depressed at this station before the station is disconnected from this trunk in order to avoid a cut-off on the call being held.

#### Calls from Central Office to Key Stations

3.15 An incoming call on a trunk from the central office is indicated by either an audible or flashing visual signal or by both, depending on the facilities provided. This type of call can be answered at any key station which has a push button key associated with the particular trunk on which the call appears. The incoming trunk call is answered by removing the hand set from its mounting after depressing the proper trunk key button. This causes the audible signals to be silenced and the visual signals, if provided, to light steadily.

3.16 If the incoming call is for a person located at another key station the call is transferred to this other station by first depressing the hold key to hold the call on the central office trunk. The local key is then depressed and the desired station is dialed as on a regular local call. When this local call is answered, the person answering is advised that a call is waiting on a particular central office trunk. This person then depresses the trunk key button which is associated with that trunk and the incoming call is thereby completed. The person who originally answered the trunk call performs no further functions in connection with the call after the desired party has been advised of the call over the local connection other than to restore his hand set to its mounting. A trunk call can be transferred from the second key station to another key station in the same manner as it was transferred from the first key station.

#### Trunk Connections to Keyless Stations by Control Key

3.17 Facilities for connecting a keyless station to the central office trunks may be provided by means of a control key located at a key station which is known as a control station.

3.18 To originate an outgoing central office trunk call from a keyless station the line circuit of which has been equipped with a control key, the key station at which the control key is located is first called in the normal manner from the keyless station and the person who answers is requested to connect the keyless station to a central office trunk; and if the trunk terminates in a dial central office the person at the control station is also advised of the central office number desired in order that the dialing of the number can be performed from the control station. After receiving instructions from the keyless station the person at the control station observes the trunk lamps to see if an idle trunk is available and if all trunks are busy advises the person at the keyless station. If an idle trunk is available the person at the control station connects his telephone to a central office trunk in the normal manner. After the control station is connected to a trunk circuit and the desired number is dialed, if dialing is required, the control key is operated to its position associated with the keyless station desiring the trunk connection. The operation of the control key automatically connects the keyless station to the central office trunk in multiple with the control station. The control key is held operated until the connection is completed which will generally occur within an interval of about one second; then the key is released. The person at the control station can tell when the connection is completed by a characteristic click and change in sidetone. The party at the keyless station remains at the telephone during the above procedure and becomes advised of the completion of the connection when he hears the audible ringing signal or the answer of the called operator or subscriber. The hand set at the control station is restored to its mounting after the connection is completed. This disconnects the control station from the trunk and thereafter this control station is free for use on other calls in the normal manner. The connection of the keyless station to the central office trunk remains until the hand set is restored to its mounting at the keyless station. This automatically releases the connection.

3.19 To complete an incoming central office trunk call to a keyless station, the call is answered at the key station at which the control key is located or if answered at some

other key station, it is transferred to the control station. The hold key is depressed at the control station to hold the call on the trunk and then the keyless station is called over a link circuit in the normal manner. The person answering at the keyless station is advised of the incoming call and requested to remain on the line. The person at the control station then returns to the trunk connection by operating the trunk key button in the normal manner and then operates the control key associated with the keyless station. The operation of the control key connects the trunk to the keyless station and the control key is released when the completion of the connection is indicated by a characteristic click and change in sidetone. The person at the control station advises the others that the connection is completed and after hearing the conversation restores his hand set to the mounting. This disconnects the control station from the trunk and thereafter it is free for use on other calls in the normal manner. The connection of the keyless station to the central office trunk remains until the hand set is restored to its mounting at the keyless station. This automatically releases the connection.

#### Local Conference Connections

3.20 A local conference connection can be originated by any key or keyless station. To originate a conference call, station "A" calls station "B" in the normal manner. Station "B" answers and then after being advised of the conference call replaces his hand set on its mounting. Station "C" is then dialed at station "A" without the hand set being restored at station "A." Dial tone is not heard at station "A." After the first digit of the number for station "C" has been dialed the bell at station "B" will start to ring in accordance with the regular machine ringing cycle. After the second digit of the number for station "C" has been dialed the bell at station "C" will ring in synchronism with that at station "B" and audible ringing tone will be heard at station "A" if station "C" is not busy.

3.21 When the hand set is removed at either station "B" or "C" the ringing ceases at both stations. Normally the person at station "B" would wait until ringing stopped before removing his hand set so that he could be assured that station "C" had answered. The answering of stations "B" and "C" connects these stations in multiple to the link and this completes the conference connection.

3.22 If station "C" is busy the completion of the dialing of the second digit from station "A" will cause busy tone to be heard in the receiver at station "A" and the ringing to cease at station "B." The discontinuance of ringing is the signal for station "B" to come back in on the connection. When station "B" returns to the connection busy tone is removed and stations "A" and "B" are connected together as originally.

3.23 If the person at station "C" does not answer, the person at station "B" returns to the connection before ringing ceases and is thereby connected to station "A" as originally, except that the line circuit of station "C" continues to test busy until the link is released by the disconnection of stations "A" and "B."

3.24 When a conference connection is completed the link is held busy until all three of the stations are disconnected. Station "A" (which is the calling station) can be disconnected from the link before stations "B" and "C" by merely restoring the hand set to its mounting. If stations "B" and "C" (which are the called stations) are of the keyless type, neither of these two stations can be disconnected from the link until the receivers are restored at both stations. If stations "B" and "C" are of the key type neither of these two called stations can be disconnected from the link by the depression of a trunk push button key unless the station receiver is restored at the other of these two called stations.

#### Conference Connections on Trunks

3.25 Several stations can be simultaneously connected to a single trunk and thus be arranged in a conference connection if all of the stations or all but one of the stations are wired for non-lockout service in connection with the trunk.

3.26 A conference connection on a trunk with all but one of the stations wired for non-lockout service can be established by the following procedure: First a station with

non-lockout service establishes the connection to the trunk to be used for the conference. Then the hold key is depressed at this station. Following this the station which is arranged for lockout or restricted service is called over a link in the normal manner and the person at this station is advised to depress the proper trunk button for the conference. After this station is thus connected to the trunk, the stations with non-lockout service are called and they connect to the trunk in the normal manner by the operation of their trunk keys, and then the conference connection is completed, since all stations are connected to the same trunk.

3.27 No circuit arrangements are provided to improve transmission for conference connections.

#### **Automatic Hunting on Station Lines**

3.28 Optional wiring arrangements are provided in the link circuits to permit line hunting on lines Nos. 26 and 27 and on lines Nos. 36 and 37. When the hunting arrangement is provided, a connection will be completed to the higher numbered line of the pair if the lower numbered line is busy when a calling station dials the lower numbered line. Busy tone will not be heard at the calling station after dialing the lower number of the pair unless both lines of the pair are busy. However, dialing the higher number of the pair when it is busy will not cause the connection to be completed to the lower numbered line if it is idle.

#### **Emergency Key for Trunk Service**

3.29 To insure central office service under all trouble conditions an emergency key can be provided at one of the key stations and connected so that the operation of this key connects the key station directly to one of the central office trunks.

#### **Restricted Service**

3.30 Key stations which are arranged for restricted service cannot connect to trunk circuits to originate outgoing calls but can be connected to trunks to answer incoming or transferred calls or to originate outgoing calls after the hold condition has been established on the trunk at a non-restricted station. The restricted service feature can be provided in connection with any or all of the trunk circuits at any key station. All keyless stations have restricted service.

#### **Line Pickup Keys**

##### **General**

3.31 Any station may be arranged to be connected through pickup keys to more than one local line or to one or more central office lines in addition to those terminated in the P.B.X. trunk circuits. Pickup keys for this purpose may consist of one of the following arrangements.

1. Spare trunk push buttons at key stations.
2. Non-locking keys external to the key stations.
3. Wiring plan keys at keyless stations.

These arrangements permit one station to be arranged to answer calls for another station, permit two or more stations to make common usage of their local lines, and permit the connection of a station to additional direct lines to the central office.

3.32 The pickup arrangements for key stations do not include facilities for holding calls. The operation of the hold push button key during a connection through one of these arrangements will not produce a holding condition but will release the connection.

#### **Key Station Buttons Used as Line Pickup Keys**

3.33 If a key station does not have access to a maximum of four trunks the spare trunk push button keys may be used as line pickup keys. Each available key may be used to connect the station to the local line of another station or to a direct line to the central office which is not otherwise connected to the P.B.X.

3.34 A call is originated or answered with this arrangement by removing the receiver after operating the trunk push button key used for pickup service.

#### **Separate Non-Locking Pickup Keys at Key Stations**

3.35 At key stations where all of the regular push button keys are employed for regular service, separate non-locking pickup keys can be installed external to the station. These keys are associated with the regular local push button key at each of the key stations where they may be used.

3.36 A call is originated or answered with this arrangement by operating first the local push button key removing the receiver and then operating the external key.

#### **Wiring Plan Keys**

3.37 Keyless stations may be arranged for pickup service by employing various wiring plans for this service. Each line from a wiring plan may be connected to an individual central office line, a keyless station line circuit or to a trunk circuit of the 755A P.B.X.

3.38 A call is originated or answered with this arrangement by removing the receiver after operating the wiring plan key.

## **4. CIRCUIT FUNCTIONS**

#### **Station Circuit**

4.01 The station circuit drawing shows the station equipment required for key stations the control key for use at control key stations and the keys required for emergency service. No circuit drawing is provided for keyless stations since the apparatus employed is of the common type used for regular two-wire dial P.B.X. extensions except that high impedance ringers are required.

#### **Line, Line Switch and Call Allotter Circuit**

4.02 The line, line switch and call allotter circuit provides means for connecting a key or keyless station to a link circuit and a key station to a central office trunk. It also provides means for allotting calls in succession so that not more than one line may be associated with the crossbar switch selecting magnets at one time thereby preventing double connections.

#### **Link and Link Allotter Circuit**

4.03 The link circuit is used in establishing local connections between P.B.X. stations, for controlling dial and busy tone, for receiving dial pulses from the calling station, recording the pulses, causing the operation of the proper switch magnets, ringing the bells of the called station and tripping the ringing when the called station answers. Each link circuit requires two horizontal paths on the crossbar switch, one for the originating end and one for the terminating end of the link.

4.04 The link allotter rotates the traffic over the links, automatically makes a link busy if its fuse should operate and controls the connection of busy tone to a calling line when all links are busy.

#### **Central Office Trunk Circuit**

4.05 The trunk circuit provides a means for connecting a central office trunk to the crossbar switch and includes the relays which hold central office trunk connections when the hold key is depressed at a key station and the relays for operating the visual and audible signals for indicating incoming calls. The hold condition on a trunk is released either by the connection of a P.B.X. station to the trunk or by a momentary interruption in the supply of battery and ground to the trunk from the central office.

#### **Tone, Ringing, Alarm and Common Timing Circuit**

4.06 This circuit provides dial tone, busy tone, ringing supply, visual and audible fuse alarm, and timing interruptions to produce the machine ringing intervals, busy tone interruptions and other interruptions to control the flashing of the lamps.

4.07 Dial tone and busy tone are produced by a relay which is operated as a buzzer. For busy tone, the tone from the buzzer relay is interrupted by a relay which operates and releases at the rate of about two times a second.



4.08 20 cycle ringing current will generally be supplied over a cable pair from the central office. However, a small ringing machine may be provided at the P B X if the central office source of ringing is not readily available. The ringing from either a central office or local ringing machine is continuous, but it is interrupted by relays in the ringing circuit. On local calls over the link circuits, the ringing is interrupted at the rate of about one second on and three seconds off. Ringing on trunk ringers is interrupted at the regular central office rate.

4.09 The operation of a fuse on the P B X fuse panel lights a lamp on the fuse panel and continuously rings a bell which is located at a suitable point outside the P B X cabinet. A non-locking key is mounted adjacent to the bell and this key is operated to silence the bell. However, the lamp remains lighted until the defective fuse is replaced. The removal of the defective fuse automatically restores the relay which was operated by the key so that a subsequent fuse operation will again ring the bell.

4.10 The primary source of the timing interruptions is a group of three relays which produce the busy tone interruptions and flash the lamps. Interruptions from these relays are counted on other relays which produce the machine ringing intervals of one second on three seconds off. Pulses from these machine ringing relays are counted on other relays which produce the time intervals of from four to fourteen seconds for continuing the flashing of the trunk lamps after ringing from the central office ceases.

### Charge and Discharge Circuit

4.11 The charge and discharge circuit is arranged so that charging current flows continuously to the P B X battery but the magnitude of the current changes in two steps. The larger charging current flows while any call is in progress through the P B X or while a defective fuse closes a circuit to the fuse alarm bar; and after the larger charging current has started, it continues until the battery is fully charged. The fully charged condition produces a voltage which operates a charge control relay when no calls are in progress and all fuses are normal. The operation of this relay reduces the charging current to the smaller value. The larger charging current is adjusted to a value which will prevent a complete discharge of the battery in the event of a continuous current flow produced by a station hand set being inadvertently left off the switchhook.

## 5. WIRING MODIFICATIONS

## General

5.01 In order to obtain some of the service features of this P B X certain wiring modifications are required.

## Keyless Station Lines

5.02 All station lines are normally arranged for key stations. To convert a station line circuit for use with keyless stations certain wiring changes have to be made at the P B X terminal strip and at the (CO) relay.

### Control Key

5.03 The installation of a control key at a key station to permit central office service for a keyless station involves wiring changes at the terminals of the crossbar switch for the key and keyless stations and also at the (CO) relay of the keyless station line circuit. Also new wiring is required between the control key and the keyless station line circuit and the crossbar switch associated with the key station.

### **Lockout, Non-Lockout or Restricted Service**

5.04 All key station line circuits are normally arranged for lockout service. However, the class of service of any line with respect to any one of the trunk circuits can be changed by changing the wiring between the terminal strips mounted on the line units and the class of service terminal strip located adjacent to the common call allotter unit.

## Line Hunting

5.05 To provide this feature it is necessary to make changes in the wiring at the terminals of certain relays in each

of the link circuits. This feature is available only on station lines 26 and 27 and 36 and 37.

### Station Line Lamps

5.06 When a station line circuit is equipped with a line lamp, a relay is added to the line circuit and certain changes are made in the wiring.

### Line Pick-up Keys

5.07 The provision of pick-up arrangements for extra lines at key stations involves the addition of one or two relays in each line circuit and modification in the wiring on the line units.

## Connection of Trunks to Wiring Plans

5.08 To arrange a trunk circuit for connection to a line of a wiring plan, an extra relay is mounted on the trunk unit in the space provided for it and wiring changes are made on the unit. Extra wires are installed between the windings of this relay and a terminal strip in the P B X from which they are extended to the wiring plan keys.

## Vacant Terminals

5.09 Each line circuit for which a crossbar switch vertical unit is provided but to which no station apparatus is connected requires a slight modification consisting of the cutting of a strap between two of the off-normal springs of the switch vertical unit.

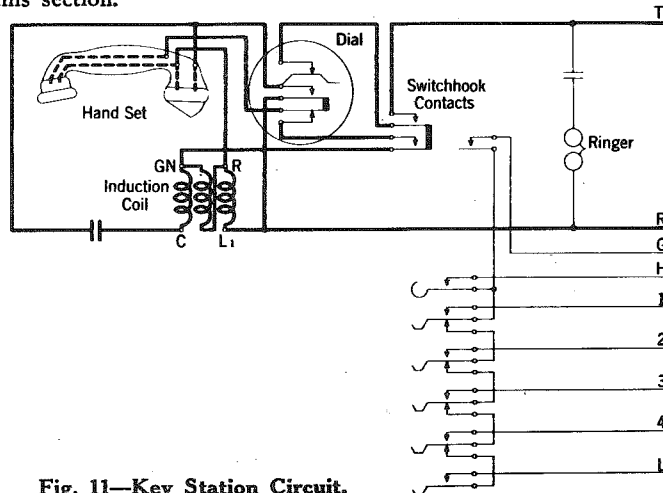
## 6. OPERATING FUNCTIONS

## General

6.01 Some of the operating functions of the P.B.X. are described herein together with schematic diagrams to illustrate various operating principles. These schematics are intended to be used only for educational purposes and references should always be made to the actual circuit drawings in connection with installation or maintenance considerations for a particular P.B.X.

6.02 The key station circuit used with this P B X is arranged so that when the hand set is lifted from its mounting a path is closed from the tip to the ring of the line in the usual manner. Also a control lead "G" is connected through a contact of the switchhook to one side of all push button keys. Therefore, the operation of any push button key connects this control lead "G" to the associated circuit. A schematic diagram of the key station circuit is shown in Fig. 11

6.03 The station equipment employed for keyless stations is of the common type used for regular two-wire dial P.B.X. extension stations except that high impedance ringers are required. Since no control leads are extended to the keyless station circuit, as with key stations, it is necessary to make certain wiring changes in the line circuit to provide for proper operation when using this type of station equipment. The operating functions of the PBX circuits where keyless stations are employed are explained in succeeding portions of this section.



**Fig. 11—Key Station Circuit.**



6.04 In describing the operating functions for a local station-to-station call it is assumed that station line 20 originates a call to station line 28.

#### Originating a Local Call

##### Link Seizure

6.05 A schematic diagram illustrating the seizure of a link by a key station is shown in Fig. 12.

6.06 When the hand set at station line 20 is removed from its mounting and the local (L) push button key is depressed the (L) relay operates and then battery through the winding of the (ST) relay will be on the "L" lead if there is an idle link available. Otherwise, the battery on the "L" lead will come from the winding of relay (BY) and when this

relay operates busy tone through the contacts of the operated (L) relay will be heard in the receiver. Relay (L1) is marginal, so it will not operate in series with (BY) but will operate in series with (ST).

6.07 If an idle link circuit is available the (L1) and (ST) relays will operate in series from the battery at the (ST) relay over the "L" lead through the local (L) key and switchhook contacts in the station circuit and over the "G" lead through the winding of relay (L1) and back contact of the (E1) relay to ground. Operation of the (ST) relay causes the (T) relay to operate which produces dial tone. Operation of the (L1) relay operates relay (E). Operation of relay (E) operates relay (E1) which operates relay (MS). Operation of the (MS) relay operates the selecting magnet associated with the originating end of the link which has been seized.

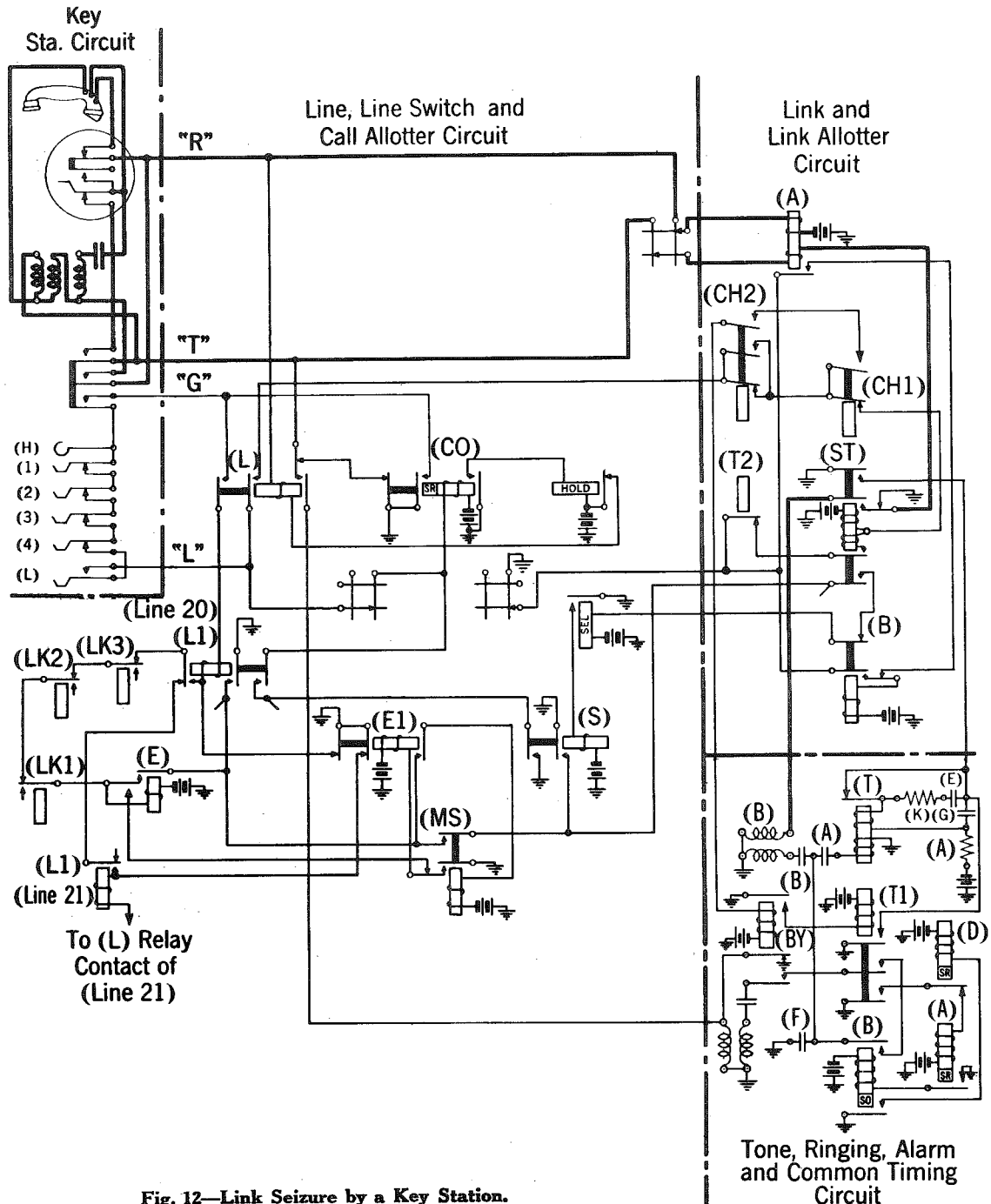


Fig. 12—Link Seizure by a Key Station.

6.08 Operation of the selecting magnet operates the (S) relay which operates the (CO) relay and holds the (E) and (MS) relays operated. Operation of the (CO) relay operates the holding magnet and prepares a locking path for itself through the crosspoints of the crossbar switch, the contacts of the (L) key and the switchhook contacts. Operation of the holding magnet releases the (L) and (L1) relays and closes the crosspoints (contact springs) on the level of the crossbar switch associated with the originating end of the link circuit which has been seized. The closure of the crosspoints completes the circuit for holding the (CO) relay operated, causes the (A) relay to operate and provides a lockup path for the (ST) relay. The closure of the crosspoints when relay (ST) is operated causes the calling party at station line 20 to receive

dial tone. The operation of relay (A) operates relay (B) which locks through the crosspoints (contact springs). The operation of relay (B) releases the selecting magnet. Release of the selecting magnet causes relay (S) to release which in turn releases the (E) and (MS) relays. Release of the (MS) relay releases relay (E1).

6.09 Double connections from station lines to links are prevented as follows. If lines 20 and 21 originated calls at the same time, the (L1) relays in both line circuits would operate. However, only the (L1) relay of line 20 (lower numbered line) would lock after relay (E1) operated because of the chain circuit through these relays. The operation of relay (E1) in the call allotter circuit opens the path of other (L1) relays to prevent their operation.

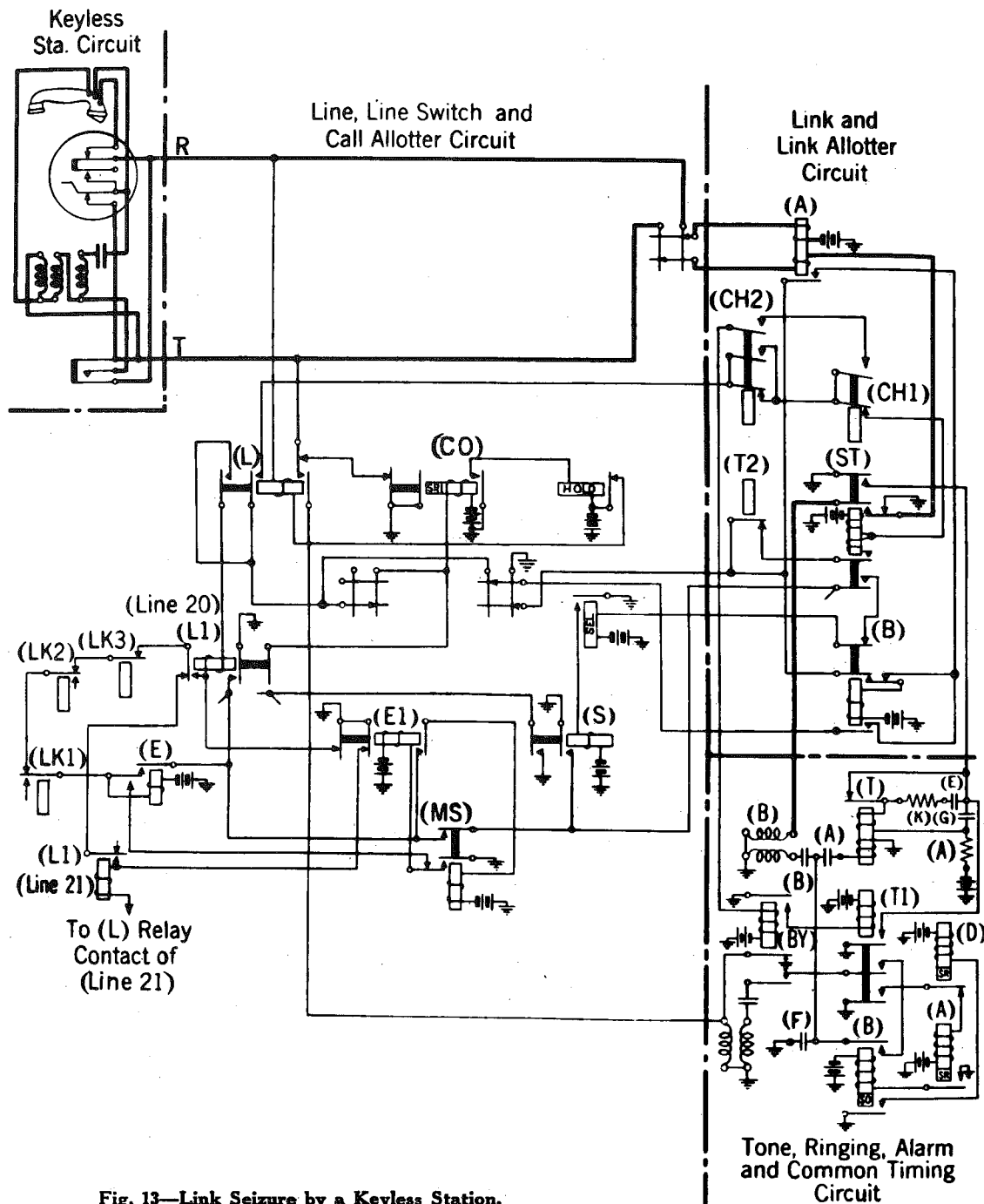


Fig. 13—Link Seizure by a Keyless Station.

6.10 The call allotter relays (S), (E), (MS), and (E1) used in establishing the connection from the calling station to the link are operated on each call. When these relays are normal, another connection may be started.

6.11 A schematic diagram illustrating the seizure of a link by a keyless station is shown in Fig. 13.

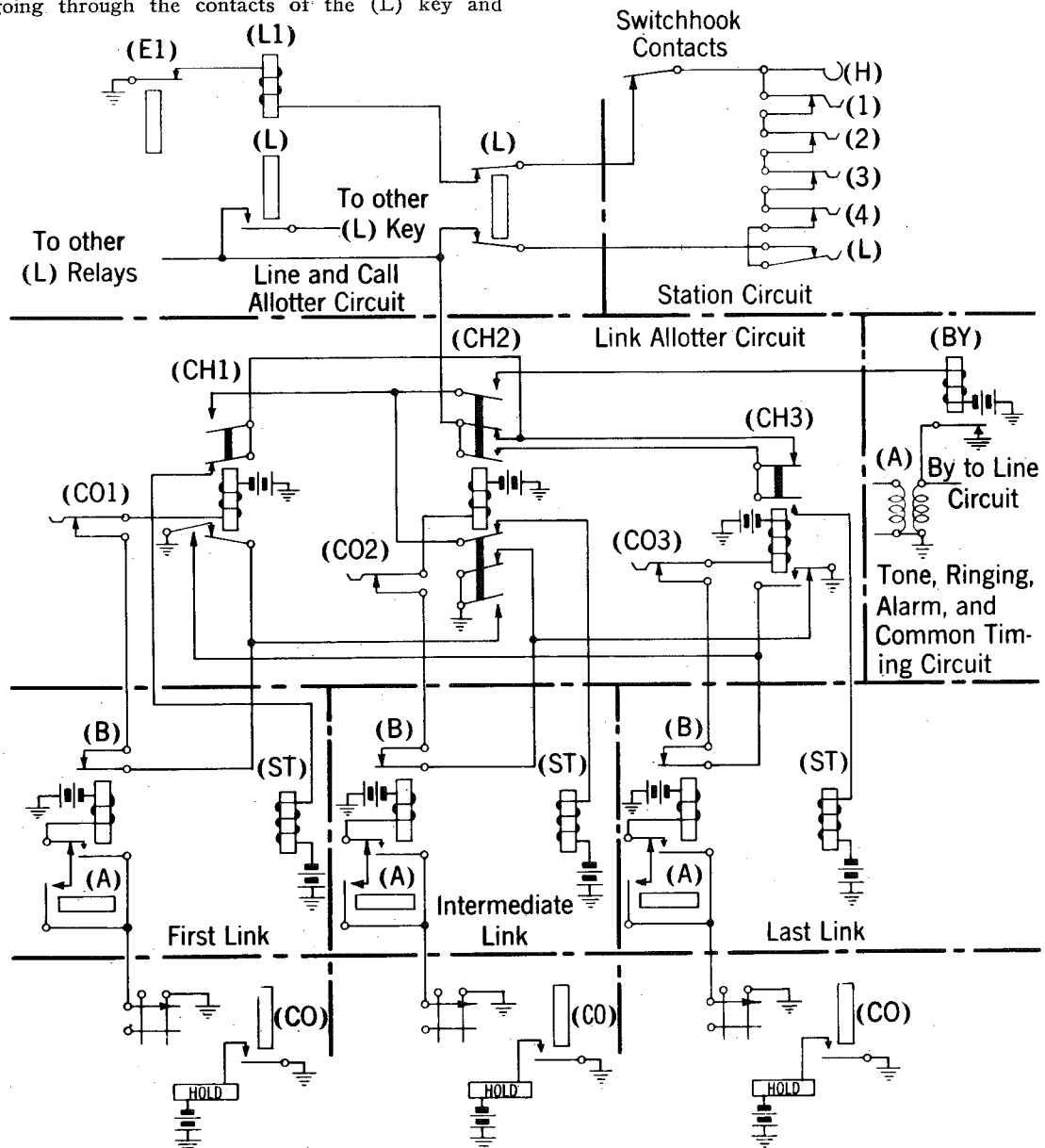
6.12 When the hand set at keyless station line 20 is removed from its mounting the (L) relay operates. If all links are busy the (BY) relay will operate from battery on its winding to ground at the back contact of the (E1) relay. This path is through the contacts of the (CH2), (CH1) and (L) relays and the winding of the (L1) relay. The (L1) relay is marginal so it will not operate in series with the (BY) relay. When the (BY) relay operates busy tone through the contacts of the operated (L) relay will be heard in the receiver.

6.13 If an idle link is available the operation is the same as for key stations described in 6.06, 6.07, 6.08, and 6.09 except that the operating path for the (L1) and (ST) relays instead of going through the contacts of the (L) key and

switchhook is strapped through the (L) relay. Also the (CO) relay instead of locking to a ground through its own contact and over the (L) and (G) leads through the station circuit, it locks to ground through two sets of crosspoints, the contacts of the (B) and (A) relays in the link circuit through another crosspoint to ground. The (CO) relay is, therefore, under control of the (A) relay which is held operated as long as the hand set is removed from its mounting.

#### Link Allotment

6.14 The (L1) relay operates in series with one of the (ST) relays of an idle link. The selection of the link is controlled by the (CH1), (CH2) and (CH3) relays and the path for this selection is from ground through the winding of the (L1) relay, contacts of the (L) relay, station keys, contacts of the (CH) relays to battery through the winding of the (ST) relay of the particular link selected. Two of the (CH) relays are continuously operated except when all links or all but one link are busy or out of service. The particular link selected



Line and Line Switch Circuit

Fig. 14—Link Allotment.

when the (CH1), (CH2) and (CH3) relays are operated or normal is shown in the following table:

Relays Operated	Relays Normal	Link Selected
CH1	CH2 and CH3	First
CH1 and CH2	CH3	First
CH1 and CH3	CH2	Last
CH2	CH1 and CH3	Intermediate
CH2 and CH3	CH1	Intermediate
CH3	CH1 and CH2	Last
—	CH1, CH2 and CH3	None

6.15 If a call is attempted when all links are busy or out of service, the (BY) relay will operate and cause busy tone to be given the calling station. When a connection from the calling station to the link is established, the (A) relay operates which operates relay (B) and it locks through the crosspoints. Operation of relay (B) releases relay (CH). The (CH) relay will not operate again until the link becomes idle and another (CH) relay is normal. The schematic diagram covered by Fig. 14 shows the seizure of the first link since relays (CH1) and (CH2) are operated and relay (CH3) is normal.

6.16 The operation described in 6.14 and 6.15 is the same for either key or keyless stations.

Dialing Tens Digit

6.17 Since the station numbering plan of this P B X is from 20 to 39 the first digit dialed will normally be 2 or 3. Fig. 15 shows a schematic diagram of the register relays for the tens digits.

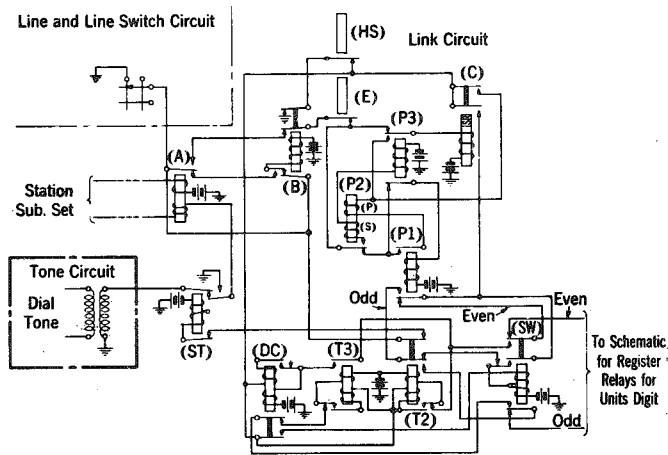


Fig. 15—Dialing Tens Digit.

6.18 Assume that station line 28 is dialed. Then in dialing the digit 2, the (P1) and (C) relays operate on the first release of the (A) relay and cause the (SW) relay to operate. On the first reoperate of the (A) relay the (SW) and (C) relays will remain operated as the (C) relay is slow to release and will hold between pulses of the digit dialed. Also on the first reoperate of the (A) relay the (P2) relay will operate on its primary (P) winding in series with relay (P1). On the second release of relay (A), relay (P3) operates in series with the (S) winding of relay (P2). The operation of relay (P3) releases relay (P1) which causes the operation of relay (T2). The operation of relay (T2) releases relay (ST) which substitutes direct ground for dial tone ground to the winding of the (A) relay. On the second reoperate of relay (A), the (P2) and (P3) relays release. Since relay (A) does not release again before the slow releasing time of relay (C) expires, relay (C) releases and this releases relay (SW). Relay (T2) remains operated to register the fact that the digit 2 was dialed.

6.19 If the first digit dialed is 3, the pulsing operation described in 6.18 is the same for the first two pulses except that the (C) and (SW) relays remain operated after the second reoperate of the relay (A) and until after the third reoperate of relay (A). On the third release of relay (A), the

(P1) relay operates, causing the (T3) relay to operate through the contacts of the operated (SW) and (T2) relays. On the third reoperate of relay (A), the (P2) relay operates on its primary (P) winding in series with relay (P1). When relay (C) releases, relays (P1), (P2) and (SW) also release.

6.20 If the first digit dialed is higher than 3, the pulsing operation described above is the same for the first three pulses. Then on the fourth release of relay (A), relay (P3) operates in series with relay (P2). The operation of relay (P3) releases relay (P1) causing the (DC) relay to operate. After the fourth reoperate of relay (A), relay (C) releases as in the case where the first digit dialed was 2 or 3 while the operation of relay (DC) causes relay (SW) to stay operated. Therefore, with the (SW) relay operated the path to the register relays for recording the units digit is open preventing the registering of any further pulses.

6.21 If the first digit dialed is one such as would be produced by a preliminary pulse, the (A) relay will release and the (C), (P1) and (SW) relays will operate in the normal manner. After the (A) relay reoperates and the (C) relay releases the (P1) and (SW) relays release and prepare the circuit to receive the first digit again. The control leads are not extended to the relays for registering the units digit until the (T2) relay is operated.

Dialing Units Digit

6.22 When the units digit is dialed, the odd and even leads are alternately grounded by the operation and release of the (P1) relay, ground always being connected to the odd lead first. A schematic diagram illustrating the register relays for the units digit is shown in Fig. 16.

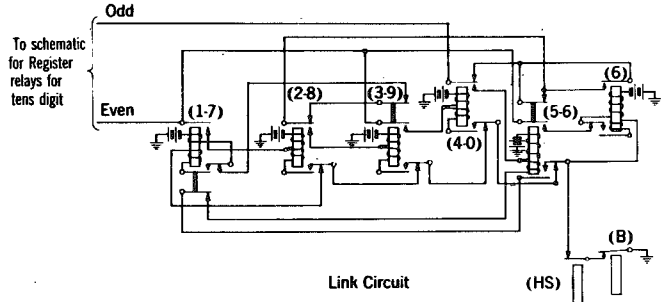


Fig. 16—Dialing Units Digit.

6.23 On completion of the dialing of the units digit certain of the register relays remain operated depending on the digit dialed. The following table indicates the condition of these relays at the completion of dialing.

Digits Dialed	Relays Remaining Operated
1	1-7
2	2-8
3	3-9
4	4-0
5	5-6
6	5-6, 6
7	1-7, 6
8	2-8, 6
9	3-9, 6
0	4-0, 6

6.24 Therefore, if station line 28 was dialed the 2-8 and 6 relays would remain operated upon completion of dialing of the units digit 8. During the progress of this pulsing operation the 1-7, 2-8, 3-9, 4-0 and 5-6 relays would operate and release, the 6 relay would operate and hold, the 1-7 relay would operate and release a second time and the 2-8 would operate a second time and hold.

Test of Busy Line

6.25 A schematic diagram showing how the link makes a test of a busy line is shown in Fig. 17. The operation is the same for either key or keyless stations.

6.26 If the called station line (line 28) is busy the holding magnet of the busy line will have been operated and

therefore, ground will be connected to the "CO" lead to the contact of the units register relay 2-8 shown in Fig. 17. When relay (C) operated at the beginning of the dialing of the units digit, relay (C1) operated and locked up. On completion of dialing of the unit digit 8, the (C) relay releases and this operates relay (DC) through a contact of relay (C1). The (DC) relay locks through the contacts of relay (HS) and (B). Operation of the (DC) relay causes the operation of the (SW) relay, opens the operating path for the (T3) relay to prevent its operation in case another digit is dialed and connects the (BY) relay to the "CO" lead of the busy line causing it to operate to ground through the contacts of the units register relay 2-8 and the holding magnet. Relay (BY) locks to ground through the contacts of relays (HS) and (B) and causes the operation of relay (T1). Operation of relay (T1) closes a circuit to the busy tone interrupter and operates relay (A) in the common timing circuit. Relay (A) operates relay (B) which completes a circuit for busy tone from the interrupter to the calling station. Relay (B) in the tone circuit also operates relay (D) which releases relay (A) which in turn releases relay (B). Release of relay (B) removes busy tone, releases relay (D) which in turn causes relay (A) to reoperate. The above cycle of relays (A), (B), and (D) in the common timing circuit continues to produce busy tone interruptions at the rate of about 60 per minute until the calling station disconnects. The (A), (B), and (D) relays are slow in releasing to provide interrupted busy tone at the proper intervals.

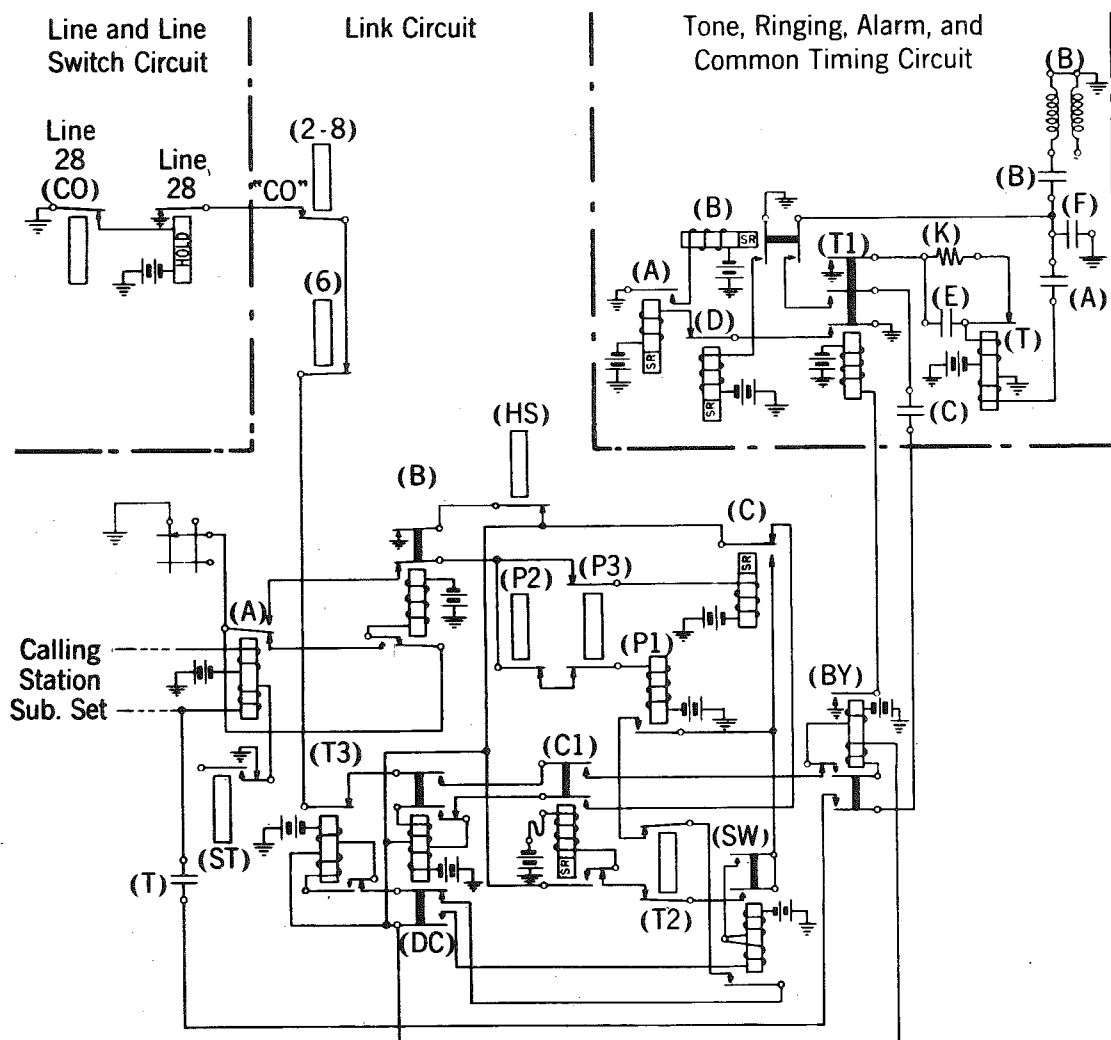


Fig. 17—Test of Busy Line.

**Link Connection to Idle Line**

6.27 A schematic diagram showing the link connection to an idle line is shown in Fig. 18.

6.28 If the called station line (line 28) is idle the holding magnet of the idle line will be normal connecting battery through the winding of the (CO) relay of line 28 to the contacts of units register relay 2-8. On completion of dialing of the unit digit 8, the operating circuit for the (C) relay is opened. When relay (C) releases, the (DC) relay operates and locks through the contacts of relays (HS) and (B). Operation of relay (DC) causes the operation of relay (SW) and opens the operating circuit for relay (T3) to prevent its operation in case another digit is dialed. Operation of relay (SW) causes relay (LK1) to operate (since the call is assumed to be on link 1) to ground through the contacts of relays (BY), (SW), (C1), and (E1). Relay (LK1) in operating causes the operation of relays (B) and (E) in the call allotter circuit. Operation of relay (E) provides a locking circuit for relay (LK1) and causes the operation of relay (E1) which in turn operates relay (MS). Relay (MS) in operating holds relay (E1) operated and causes selecting magnet No. 4 to operate which in turn operates relay (S). Operation of relay (S) causes relay (C1) to release by short circuiting its winding. Relay (C1) in releasing opens the circuit for relay (B) and causes the operation of the (CO) relay of line 28. Relay (CO) in operating causes the holding magnet to operate which closes the crosspoints (contact springs) connecting the (E) relay to the called line and holding relay (CO) operated. Operation of the (CO) relay and the holding magnet also opens the operating circuit of relay (L). The (B) relay of the call allotter circuit is a slow release relay and will hold the selecting magnet operated until the crosspoints (contact springs) of the switch are closed. When relay (B) releases it causes the selecting magnet No. 4 to release which in turn releases relay (S). Release of relay (S) causes relay (LK1) to release which in turn causes relays (E) and (MS) to release. The release of relay (MS) releases relay (E1). A connection from the calling station to the called station is now established.

6.29 The call allotter circuit relays (B), (S), (E), (MS), and (E1) used in the establishment of the connection to the called station are required on each call. When these relays are normal, another connection may be started.

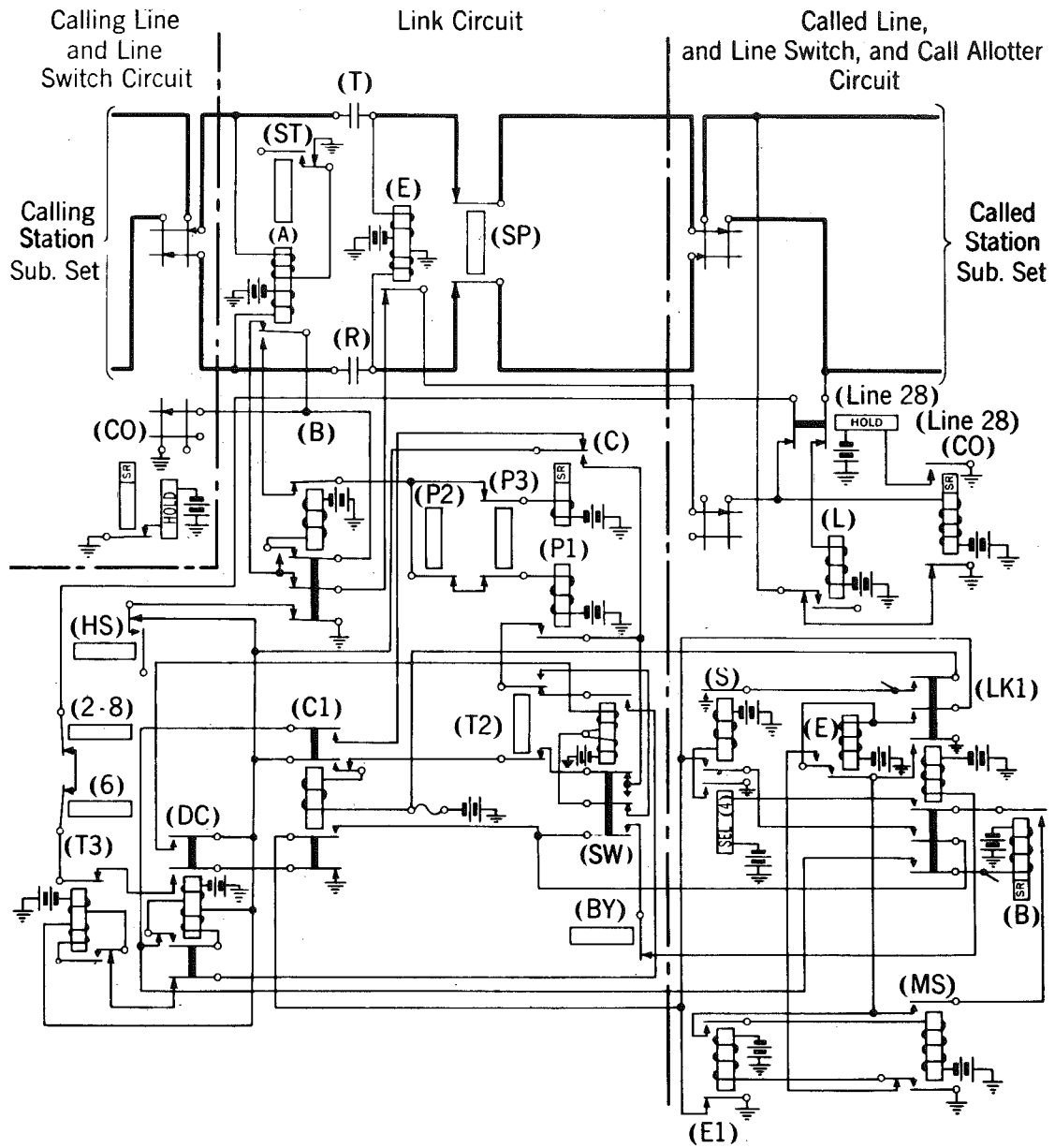


Fig. 18—Link Connection to Idle Line.



**Ringling Called Station and Called Station Answer**

6.30 A schematic diagram showing the manner in which ringing is applied to a called key station on a local call and the relay operations when the called key station answers is shown on Fig. 19.

6.31 After the crosspoints (contact springs) of the switch are closed by the operation of the holding magnet of the called line, relay (SP) operates to ground through the crosspoints of the switch. Operation of relay (SP) causes relays (A) and (R) in the ringing and common timing circuit to operate. Relay (R) in operating connects ringing current for signaling the called station and provides an audible ringing signal to the calling station through the vacuum tube. Operation of relay (A) causes relay (B) to operate which in turn operates relay (D). Relay (D) in operating releases relay (A) which causes relays (B) and (D) to release. With the (D) relay released, relay (A) again operates starting the second cycle of operations for the (A), (B), and (D) relays. These relays are slow acting for the purpose of providing a time period in conjunction with the (W), (Z), (W1) and (Z1) relays that will produce machine ringing intervals of about one second on and three seconds off for signaling the called station. The (W), (Z), (W1) and (Z1) relays that will remain operated after each cycle of operation and release of the (B) relay are shown in the following table.

Cycle	(B) Operated	(B) Released
1	(W) Opr.	(W) and (Z) Opr.
2	(Z) and (W1) Opr.	(Z1) and (W1) Opr.
3	(W), (W1) and (Z1) Opr.	(W), (Z), (W1) and (Z1) Opr.
4	(Z) and (Z1) Opr.	None Opr.

6.32 When the (Z), (Z1) or (W1) relay operates, it opens the circuit of the (R) relay in the ringing circuit causing battery instead of ringing to be connected to the called station. When the (Z), (Z1) and (W1) relays are normal, the (R) relay operates causing ringing current to be connected to the called station.

6.33 When the called station answers, relay (R) in the link circuit will operate regardless of whether or not the (L) key at the station is operated except under some conditions of ringing voltage and relay adjustment, relay (R) will not operate during a ringing period. The (R) relay will hold operated under control of the (SP) relay. When the (L) key at the called station is operated, the (HS) relay operates causing the (T2), (DC), (SW) and (2-8) relays to release. Release of the (T2) relay causes the (SP) relay to release connecting the (E) relay to the called station and releasing the (R) relay. Release of relay (SP) causes all the relays in the ringing and common timing circuit to return to normal. Operation of relay (E) opens the path which was holding the (CO) relay of the called station operated. However the (CO) relay remains operated under control of the operated (HS) relay and the (L) key. The connection is now established with only the (A), (B), (E) and (HS) relays being operated in the link circuit.

6.34 In case the called station should remove the receiver while the (L) key is non-operated, ringing tone will be connected to the called station as an indication that the station is being called.

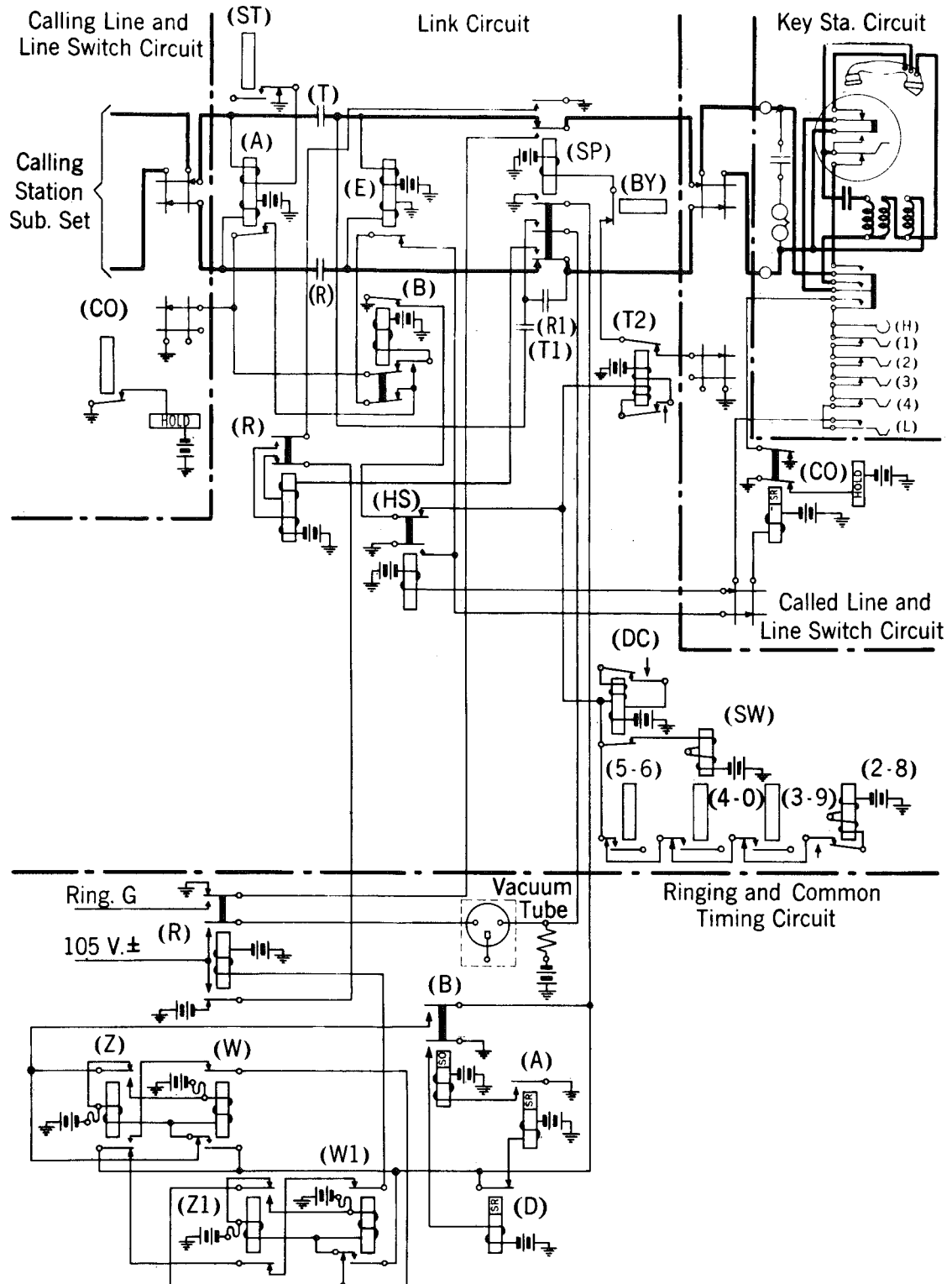


Fig. 19—Ringing and Answering at Called Key Station.

6.35 A schematic diagram showing the manner in which ringing is applied to a called keyless station on a local call and the relay operations when the called keyless station answers is shown in Fig. 20.

6.36 With a keyless station the ringing is applied the same as for key stations described in 6.30 and 6.31. When the call is answered at the keyless station the (R) relay in the link circuit will operate and hold under control of the (SP) relay the same as for key stations. Operation of the (R) relay closes a circuit from ground at the (B) relay through the contacts of the (R) relay and crosspoints to operate the (HS) relay. Operation of the (HS) relay causes the (T2), (DC), (SW) and (2-8) relays to release. Release of the (T2) relay causes the (SP) relay to release, connecting the (E) relay to the called station and releasing the (R) relay. Release of the (SP) relay causes all the relays in the common timing circuit to return to normal. Operation of the (E) relay opens the path which was holding the (CO) relay of the called station operated. However the (CO) relay remains operated under control of the operated (HS) relay. The operation of the (E) relay also furnishes ground for holding the (HS) relay after the (R) relay releases. The connection is now established with only the (A), (B), (E), and (HS) relays being operated in the link circuit which is the same as with key stations.

6.37 In case the calling party disconnects first the called party will be held to the link circuit until the hand set is replaced on its mounting. This prevents the called party from being disconnected from the terminating end of the link and then being connected to the originating end of another link and receiving dial tone.

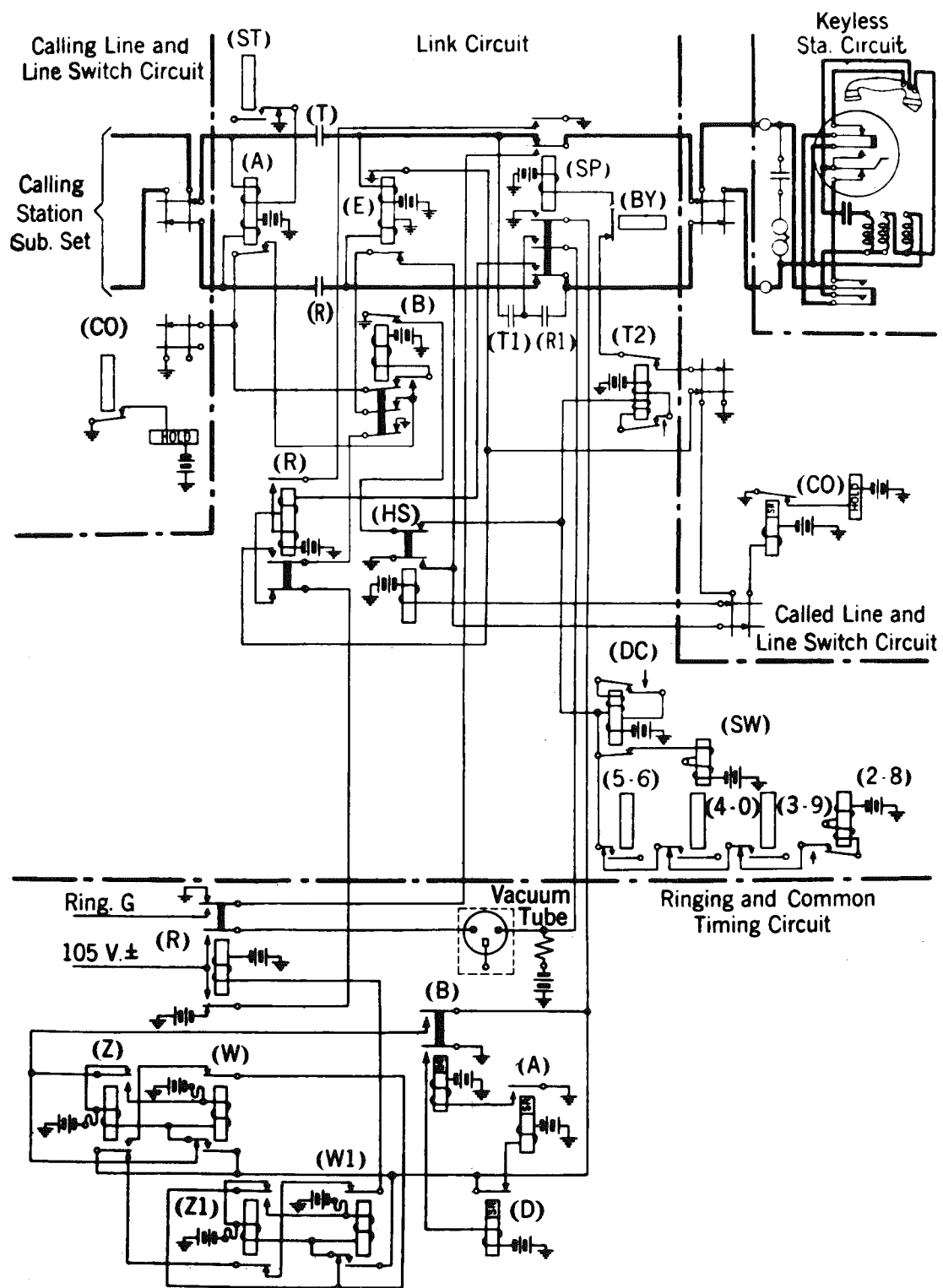


Fig. 20—Ringing and Answering at Called Keyless Station.

**Outward Call to the Central Office****Non-Lockout and Lockout Service**

6.38 A schematic diagram illustrating the operation of the equipment on an outward call from a key station to the central office is shown in Fig. 21.

6.39 The line, line switch and call allotter circuit function in the same manner for a trunk call as for a local station-to-station call except that one of trunk key buttons at the station set is depressed instead of the local (L) key.

6.40 When the hand set is removed from its mounting and one of the trunk key buttons is depressed the (L1) and (T) relays will operate in series from battery at the (T) relay over the "CS-NL" or "CS-LO" lead through trunk key and switchhook contacts in the station circuit over the "G" lead and through the winding of the (L1) relay to ground at the (E1) relay. Operation of the (T) relay prepares a path for operating the selecting magnet associated with the trunk which has been selected for making the call. The selecting magnet operates after the (MS) relay operates, the same as for a local call. The operation of the selecting magnet operates the (S) relay which in turn operates the (CO) relay. The operation of the (CO) relay operates the holding magnet. Operation of the holding magnet releases the (L) and (L1) relays, the same as with a local call, and closes the crosspoints (contact springs) on the level of the crossbar switch associated with the particular trunk which has been selected. Release of the (L) relay releases the (T) relay which in turn releases the selecting magnet. The closure of the crosspoints completes the circuit for holding the (CO) relay operated, connects the tip and ring of the calling station through to the trunk and furnishes ground for operating the (B) relay. The operation of the (B) relay opens the "CS-LO" lead to the (T) relay to prevent stations arranged for lockout service from being connected to the trunk while it is busy, furnishes battery for lighting the trunk busy lamps when provided and opens the ringing bridge circuit of the (R) relay and (R) condenser from across the line. The connection from the calling station to the central office is now complete.

6.41 A key station arranged for non-lockout service may connect to a busy trunk and the operation is the same as described in 6.40. The "CS-NL" lead is connected directly to the (T) relay which makes this possible.

6.42 When a key station which is arranged for lockout service tries to connect to a busy trunk, ground over the "CS-LO" lead through the contacts of the operated (B) relay operates the (BY) relay. The operation of the (BY) relay operates the (T1) relay. Operation of the (T1) relay closes a circuit to the (T) relay which furnishes tone and operates the (A) relay in the common timing circuit. Relay (A) operates relay (B) which completes a circuit for busy tone from the interrupter relay (T) to the calling station through the (A) repeating coil. Relay (B) in the tone circuit also operates relay (D) which releases relay (A) which in turn releases relay (B). Release of relay (B) removes busy tone, releases relay (D) which in turn causes relay (A) to reoperate. The above cycle of relays (A), (B) and (D) in the common timing circuit continues to produce busy tone interruptions at the rate of about 60 per minute until the calling station disconnects.

**Restricted Service**

6.43 When a key station which is arranged for restricted service tries to connect to a trunk, ground will be connected to the "CS-RS" lead when the hand set is removed from its mounting and a trunk key button is depressed. This ground over the "CS-RS" lead through the contacts of the (R1) and (H2) relays operates the (BY) relay which causes busy tone to be returned to the calling station the same as described in 6.42. The schematic diagram shown in Fig. 21 illustrates this condition.

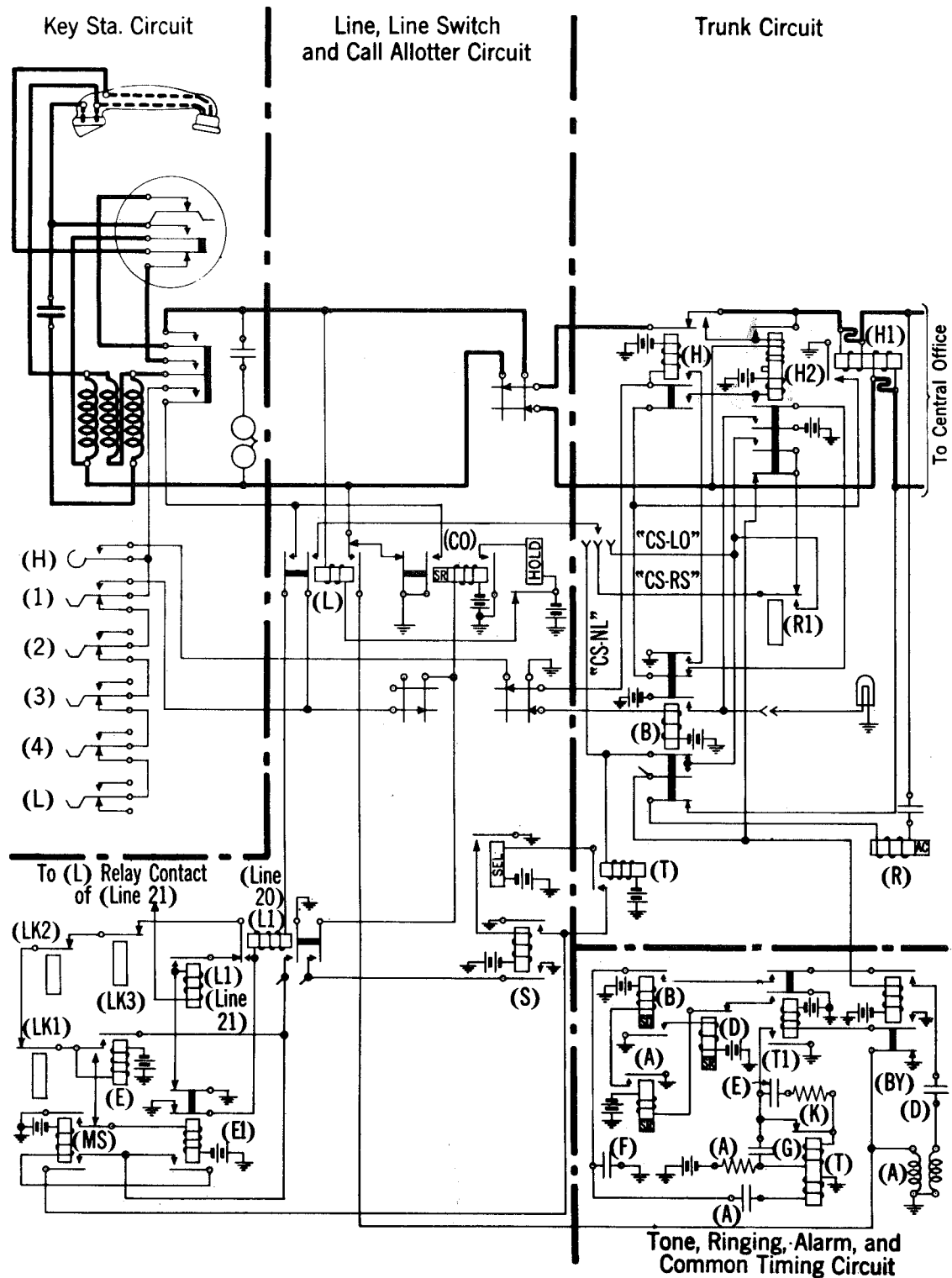


Fig. 21—Outward Call to Central Office.

**Incoming Call from the Central Office**

6.44 A schematic diagram illustrating the operation of the equipment on an incoming trunk call from the central office is shown in Fig. 22.

6.45 On an incoming trunk call the (R) relay will operate and the ringer in the (B) subscriber set, if provided, will sound when ringing current is applied to the trunk at the central office. Either the (A) subscriber set or buzzer or the (B) subscriber set is used when individual trunk ringers are provided. The (B) ringer operates from central office ringing current and the (A) ringer or buzzer from local ringing current interrupted at the central office rate. The operation of the (R) relay causes the (R1) and (LK) relays to operate. The (R1) relay locks up to ground at the (Z3) relay over a path through its own contacts and the contacts of the (B) and (Z3) relays. The operation of the (R1) relay prepares a circuit for the operation of the (A) subscriber set, if provided, connects the "CS-RS" lead to the winding of the (T) relay to permit stations having restricted service to answer incoming calls and connects ground to the winding of the (A) relay causing it to operate. It also prepares a circuit for the operation of the common trunk ringer ((C) subscriber set) and the trunk lamps, if provided. The (LK) relay in operating closes local ringing current to the individual (A) trunk ringer or buzzer and common (C) trunk ringer or buzzer, if provided. The operation and release of the (LK) relay is controlled by the (R) relay and, therefore, the interruptions of local ringing current for the trunk ringers or buzzers are at the central office rate. Operation of relay (A) causes relay (B) to operate which in turn operates relay (D). Relay (D) in operating releases relay (A) causing relays (B) and (D) to release. With the (D) relay released, relay (A) again operates starting the second cycle of operations for the (A), (B) and (D) relays. These relays control the flashing of the trunk lamps, if provided, flashing them at the rate of about 2 times per second. These relays also provide a timing period in conjunction with the (W), (Z), (W1) and (Z1) relays for releasing the (R1) relay on an abandoned call.

6.46 The call is answered at a key station by depressing the trunk button associated with the particular trunk and removing the hand set from its mounting. The line, line switch and call allotter circuit associated with the key station function in the same manner as in originating a trunk call to the central office except that the "CS-RS" lead being connected to the winding of the (T) relay through the operation of the (R1) relay permits a key station arranged for restricted service to answer the incoming call. The (T) relay in the trunk circuit operates from ground furnished by the line circuit and this causes the selecting magnet to operate and close the crosspoints on the crossbar switch. Ground through the crosspoints operates the (B) relay in the trunk circuit. Operation of the (B) relay causes the trunk lamps, if provided, to light steadily, releases the (R1) relay which silences the ringers and opens the circuit to the (A) relay causing the (A), (B) and (D) relays to release and also releases any of the timing relays (W), (Z), (W1) and (Z1) that may have been operated. This completes the connection between the central office trunk and a key station.

6.47 If an incoming call is abandoned, ringing on the trunk from the central office ceases causing the (R) relay to remain normal which in turn causes the (LK) relay to release and remain non-operated. The (R1) relay, however, is locked up to ground at the (Z3) relay and this condition causes the (A), (B) and (D) relays in the ringing and common timing circuit to continue operating as described in 6.45. The operation and release of the (B) relay control the functioning of the common timing relays (W), (Z), (W1) and (Z1). When the (LK) relay releases and the (Z1) relay operates, ground from the (R1) relay through the contacts of the (Z1) and (LK) relays operates the (W2) relay. When the (Z1) relay releases the (Z2) relay operates from this same ground through the contacts of the (LK) and (W2) relays. When the (Z1) relay reoperates the (W2) relay releases and the (W3) relay operates. When the (Z1) relay releases the (Z3) relay

operates and the (W3) relay releases removing the ground which held the (R1) relay operated. The release of the (R1) relay opens the circuit to the (A) relay causing the (A), (B) and (D) relays to release and extinguish the flashing of the trunk lamps. Release of the (R1) relay also causes all other relays in the timing circuit to release. This timing arrangement provides for continuing the flashing of the trunk lamps of from four to fourteen seconds after ringing on the trunk ceases in the case of an abandoned call. Should central office ringing current be reapplied to the trunk before the (Z3) relay operates the (LK) relay would reoperate, releasing the (W2), (Z2) or (W3) relays. The (R1) relay would remain operated, being still locked up to ground at the (Z3) relay and, therefore, the audible and visual signals would continue to operate in the normal manner.

**Holding**

6.48 If a person wishes to transfer a trunk call to another key station the hold (H) button at the station set is depressed. The operation of the hold button causes the (H) relay in the trunk circuit to operate. The operating path is from battery at the (H) relay through the crosspoints of the switch through the hold key and switchhook contacts in the station circuit and over the "G" lead to ground at the (CO) relay. The (H) relay locks up to ground under control of the (B) relay. The operation of the (H) relay opens up the trunk toward the station which has answered the call and connects the non-inductive winding of the (H2) relay across the line to prevent opening the trunk to the central office. This bridge also holds the (H1) relay operated. The operation of the (H) relay also causes the (H2) relay to operate. The operation of the (H2) relay provides another holding path for the (H1) relay. This is necessary as the path through the contacts of the (H) relay will be opened by the release of the (H) relay before the circuit operation is completed. The operation of the (H2) relay also closes a circuit for keeping the trunk lamps, if provided, lighted when the (B) relay releases, connects the "CS-RS" lead to the winding of the (T) relay after the (B) relay releases, in order that a key station having restricted service may pick up the trunk if the call is to be transferred to a station having this class of service. It also prepares a holding path for itself through the contacts of the (B) relay to ground at the (H1) relay when the (B) and (H) relays release.

6.49 Operation of the hold button in the station set causes the operated trunk button to release, this in turn releasing the (CO) relay, hold magnet and crosspoints of the crossbar switch. This releases the (B) relay in the trunk circuit which in turn releases the (H) relay and connects the winding of the (T) relay to the "CS-LO" and "CS-RS" leads. The trunk is now held by the bridge provided by the non-inductive winding of the (H2) relay and the line circuit of the key station which wishes to transfer the call is removed from the connection.

**Reseizure**

6.50 The person at the original key station after operating the hold key to place the hold condition on the trunk transfers the call to another key station by operating the local key in the station set and calling the desired station in the regular manner for a local call and advises that a call is waiting for that party on a particular trunk. When the party at the second key station operates the trunk key associated with the particular trunk on which the call is being held, the line, line switch and call allotter circuit function in the regular manner for trunk calls and ground is connected to the "CS-NL," "CS-LO" or "CS-RS" lead operating the (T) relay in the trunk circuit. The operation of the (T) relay causes the selecting magnet to operate and close the crosspoints on the crossbar switch. Ground through the crosspoints operates the (B) relay in the trunk circuit which releases the (H2) relay removing the holding bridge from across the trunk. The release of the (H2) relay also removes the "CS-RS" lead from the winding of the (T) relay. This completes the transfer of the trunk call to the second key station.



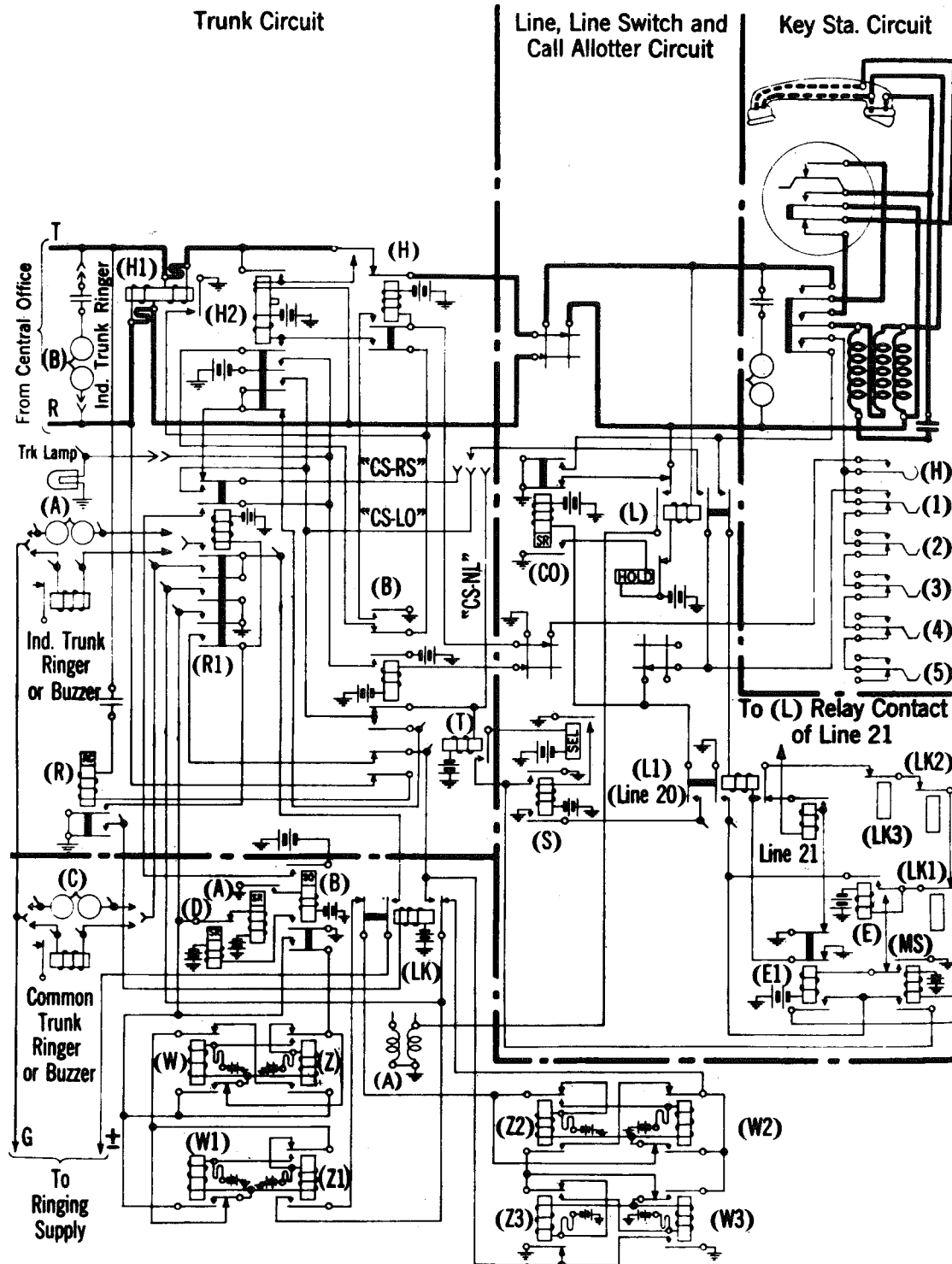


Fig. 22—Incoming Call from the Central Office.

**7. MAINTENANCE FEATURES****General**

7.01 The maintenance methods and procedures employed for the 755A P B X are similar to those employed for other P B X's where the apparatus consists mainly of relays.

**Trouble Alarm**

7.02 All circuit fuses are provided with a common alarm bar. When a fuse operates, a relay in the alarm circuit is operated which causes the (F) lamp on the fuse panel to light to give a visual alarm and operates an alarm bell located near one of the P B X stations to give an audible alarm. The operation of a non-locking lever type key associated with the alarm bell silences the bell. The alarm lamp (F), however, remains lighted until the defective fuse is removed. Arrangements are available for transmitting the fuse alarm signal to the central office and where this is done the alarm signal leads remain closed until the fuse is replaced.

**Link Cutoff Keys**

7.03 A link cut-off key (CO) is provided on the fuse panel for each link circuit. The operation of any one of these keys causes a relay in the link circuit to release which makes the link test busy.

**Charge Control Relay**

7.04 A No. 253A relay is provided in the charging circuit to control the charging current to the battery. This relay automatically maintains the charge in the battery under various traffic load conditions or trouble conditions which might cause a discharge, without excessive overcharging and thus reduces evaporation of water and increases the life of the battery.

**8. CIRCUIT DESCRIPTIONS**

8.01 Table 1 is a list of the circuit drawings pertaining to the No. 755A P B X. Detailed circuit description will be found in the associated CD sheets.

**Table 1**

<b>Title</b>	<b>Drawing</b>
Central Office Trunk Circuit	SD-66503-01
Line, Line Switch and Call Allotter Circuit	SD-66504-01
Link and Link Allotter Circuit	SD-66505-01
Tone, Ringing, Alarm and Common Timing Circuit	SD-66506-01
Station and Control Key Circuit	SD-66507-01
Charge and Discharge Circuit	SD-80588-01
Ringing Circuit	SD-80608-01

8.02 A complete set of schematic drawings, circuit description sheets and wiring drawings will be furnished with each P B X. These data will be included in an envelope which will be secured under clips to the lower part of the upper front casing. A card will be attached to the outside of the envelope on which will be recorded the drawing numbers. Also a duplicate card will be mounted on the framework of the P B X to facilitate replacing drawings if any should be lost.