STATION SYSTEMS
KEY TELEPHONE SYSTEM NO. 1A
LINE AND SIGNALING CIRCUIT

0. CHANGES

0.1 CHANGED AND ADDED FUNCTIONS

None.

0.2 CHANGES IN APPARATUS

Apparatus	Superseded	Superseded By
KTU Figs.	13B 29, 32	13C 52
Inductor 2A KTU Fig. 11	307J	274AH
KTU Fig. 19	12A	12B

0.3 CHANGES IN CIRCUIT REQUIREMENTS (Not Associated with 0.2 Above)

None.

0.4 DESCRIPTION OF CIRCUIT CHANGES

(a) Fig. 52, using the 13C KTU, supersedes Figs. 29 and 32.

(b) The 12A KTU has been rated Mfr. Disc. and replaced by the 12B KTU.

(c) The 307J inductor has been rated Mfr. Disc. for use in the 2A KTU and replaced by the 274AH inductor.

(d) Provision has been made on Figs. 45, 46, 50, and 51 for joint use with the Key Telephone System No. 1A1 central office and PBX line circuit.

1. PURPOSE OF CIRCUIT

This circuit provides a means for signaling a subscriber's station on a line from a central office or PBX, for holding that line, for automatic cutoff of stations on that line, for a winking visual signal to indicate a held line, and for lighting a busy lamp whenever that line is busy in connection with key and keyless stations of the Key Telephone System No. 1A. It also provides a private line circuit, a private line and intercommunicating battery feed circuit, an intercommunicating line circuit, and an intercommunicating code signaling circuit for the Key Telephone System No. 1A. It also provides for time out of locked-in signals.

2. WORKING LIMITS

The working limits are shown in the Station Systems Range Chart.

3. FUNCTIONS

3.1 ON CENTRAL OFFICE, PBX, OR PRIVATE LINES

This circuit provides for:

(a) Nonlocked-in or locked-in line lamps on incoming calls.

(b) Flashing combined line and busy lamps on incoming calls, and lighting them steadily when the line is busy.

(c) Extinguishing the locked-in line lamps when the call is answered.

(d) Preventing the locked-in line lamps from remaining lighted on an abandoned call by means of a battery cutoff key.

(e) Releasing locked-in line signals automatically after a time interval.

(f) Individual and common audible signals on incoming calls.

(g) Starting the flashing circuit functioning on incoming calls.

(h) Preventing the line lamps and the line and busy lamps from lighting falsely on disconnections.

(i) Lighting the busy lamps when the line is busy.

3.2 ON CENTRAL OFFICE OR PBX LINES ONLY

This circuit provides:

(a) A winking visual signal while the hold condition is on the line.

(b) For holding the line by means of a locked-in relay.

(c) For removing the hold condition on the line when the line is again picked up at any station or when the line is momentarily opened at the central office or PBX.

3.3 ON PRIVATE LINES ONLY

This circuit provides:

(a) For connecting ringing current to the line for signaling the distant private line station.

(b) Talking battery for stations arranged for private line service.

3.4 ON INTERCOMMUNICATING LINES

This circuit provides:

(a) Talking battery for stations arranged for intercommunicating service.

(b) For intercommunicating code or selective signaling.

(c) 2-way automatic line signals between two intercommunicating lines.

(d) For busy signals.

(e) Click reducer when head receivers are used at listening-in stations.

(f) A resistance lamp as a protective device in series with the ringing supply.

3.5 ON CENTRAL OFFICE OR PBX LINES (AUTOMATIC CUTOFF)

This circuit provides for:

(a) Cutting off other stations.

(b) Preventing a station from being cut off after it has been connected to the line.

(c) Cutting off a station after it has been connected to a line.

4. CONNECTING CIRCUITS

When this circuit is listed on a key sheet, the connecting information thereon is to be followed. The following are typical connecting circuits:

(a) Standard central office subscriber line circuits.

(b) Standard PBX station line circuits.

(c) Standard PBX long line circuits.

(d) Power Rectifier Circuit J86205A and H.

(e) Power Plant per J86731.

(f) Standard Key and Telephone Circuits of Key Telephone System No. 1A - SD-69133-01, SD-69188-01, SD-69206-01, SD-69207-01, SD-69208-01, and SD-69219-01.

(g) Attendant's Telephone Circuit - SD-69196-01.

(h) Standard telephone sets and subscriber sets.

(i) Continuous ringing supply.

(j) Automatic Exclusion Circuit - SD-69140-01.

(k) Speakerphone System No. 1A - SD-69255-01.

(l) Station Busy Lamp Circuit - SD-69241-01.

5. DESCRIPTION OF OPERATION

5.01 INCOMING SIGNALS ON CENTRAL OFFICE, PBX, OR PRIVATE LINES

5.01.1 Individual Ringer

When ringing current is applied to the line at the central office, PBX, or distant end of a private line, the individual ringer associated with the line will operate in the usual manner. If the ringer in the key telephone set shown on the key and telephone circuit is associated with the line, the (L) relay, Fig. 8, 38, or 49, may operate on ringing current but will perform no functions.

5.02 ANSWERING OR ORIGINATING A CENTRAL OFFICE OR PBX CALL

When a talking connection is established on a central office or PBX line, the (L) relay, if the holding circuit is provided, will operate. The (L) relay, however, performs no function at this time. The (L1) relay will also operate if the auxiliary hold circuit, Fig. 9, is provided as described in 5.03.

5.03 AUXILIARY HOLD CIRCUIT, FIG. 9

The auxiliary holding circuit is required only when a station not arranged for holding excludes stations arranged for holding, or when a cutoff key is used to cut off stations arranged for holding. When a connection is established from one of these stations, which may be excluded or cut off, to a central office or PBX line, the (L1) relay will operate and close through the "H" and "B" leads to that station. When the station is excluded or cut off, the "H" and "B" leads to that station are open at the (L1) relay contacts.

5.04 AUTOMATIC CUTOFF CONTROL CIRCUIT AND AUTOMATIC CUTOFF CIRCUIT, FIGS. 39 AND 36

5.04.1 Stations Which Cut Off Other Stations, "ZP" and "Z1" Wiring

When a call is answered or originated at such a station, the (L2) relay operates, operating the (CT) relay. The operating circuit for the (L2) relay is through the back contacts of the (CO) relay, Fig. 36. The (CT) relay closes the "T," "R," "B," and "H" leads through to the station and operates the (CO) relay. The (CO) relay opens the "T" and "R" leads to all stations which are arranged to

be cut off, and operates the (SR) relay, Fig. 25, 40, 41, 43, 44, or 49, or the (SW) relay, Fig. 37.

5.04.2 Stations Which Cannot Cut Off Other Stations but Can Be Cut Off Except When on the Line, "ZP" and "ZJ" Wiring

When a call is answered or originated at such a station, the (L2) relay operates, operating the (CT) relay. The (CO) relay, Fig. 36, does not operate. Therefore, other stations can come on the line. The (CT) relay closes the "T," "R," "H," and "B" leads through to the station so that should another station which operates a (CO) relay come on the line, the station which was first connected to the line would not be cut off. The (CT) relay, by means of "ZJ" wiring, operates the (SR) relay, Fig. 25, 40, 41, 43, 44, or 49, or the (SW) relay, Fig. 37.

5.04.3 Stations Which Cannot Cut Off Other Stations but Can Be Cut Off at Any Time, "ZJ" Wiring

When a call is answered or originated at such a station, the (L2) relay operates, operating the (CT) relay. The (CT) relay, by means of "ZJ" wiring, operates the (SR) relay, Fig. 25, 40, 41, 43, 44, or 49, or the (SW) relay, Fig. 37. The (CO) relay, Fig. 36, does not operate. Should a station which operates the (CO) relay come on the line, the station which was first connected to the line would be cut off. The operation of the (CO) relay would open the tip and ring leads to the first station since "ZP" wiring is omitted.

5.04.4 Effect of Automatic Cutoff on Signaling Circuits

When stations are connected through the automatic cutoff control circuit, Fig. 39, the (B) relay in the 6B, C, 18D, or E KTU of the signaling circuit, Fig. 22, 23, 24, 25, 26, 40, 41, 42, 43, or 44, or in the 18D or E KTU, Fig. 49, is bypassed and does not operate on calls answered or originated by these stations. This (B) relay, however, does operate over the holding bridge when the line is held, as described in 5.05.1 or 5.05.2. With signaling circuit 22, 23, 24, 26, or 42, the (SW) relay in Fig. 37 operates as previously described and performs the same function as the (B) relay in the signaling circuit. "ZL" wiring in the signaling circuits is provided for this purpose where indicated. With signaling circuit 25, 40, 41, 43, or 44, or when Fig. 49 is used, the function of this (B) relay is taken by the (CO) or (CT) relay which operates the (SR) relay in the signaling circuit directly, as previously described. The function of the relays in the signaling circuit is described in 5.09.2 through 5.09.12.

5.05 HOLDING ON CENTRAL OFFICE OR PBX CONNECTIONS

5.05.1 For Fig. 8 or 38

The line is held by the operation of the hold key in the key telephone set shown on the key and telephone circuit. The hold key, when operated, opens the operating path for the (L) relay, releasing it, and closes a circuit which operates the (H) relay through its primary winding, in series with the central office or PBX loop and the station set.

5.05.11 For Fig. 8

The (L1) relay, Fig. 9, if used, releases when the hold key at the station is released. When the (H) relay operates, its holding tertiary winding is connected across the line in series with its non-inductive quaternary winding and in parallel with its primary winding. When the hold key is released, the operated pickup key in the key telephone set will release, the operating primary winding circuit of the (H) relay will be opened, the (H) relay will be held operated by its tertiary winding, and the key telephone set will be disconnected from the line. The secondary winding of the (H) relay and the "B" lead is used to balance the line to prevent crosstalk interference.

5.05.12 For Fig. 38

When the (H) relay operates, it will be connected across the line in series with the 80- to 85-ohm 19GB resistor for holding the relay operated when the hold key is released. The "B" lead and the 85 ohms are used to balance the line to prevent crosstalk interference.

5.05.2 When Visual Holding Signal Is Provided, Fig. 49

When the wink signal is provided to indicate a hold condition, the operation is the same as described in 5.05.1, with options "ZX" and "ZY" corresponding, respectively, to Figs. 8 and 38. However, in this case, the winding of the (B) relay of the 18D or E KTU (H) is included in the holding bridge and operates to start the winking circuit when the line is held.

5.05.3 Lamp Winking Circuit, Fig. 50

When the line is held, as described in 5.05.2, and the (B) relay of the 18-type KTU (H) operates, this (B) relay operates the (SR) relay of the same 18-type KTU to ground the "HA" lead and thereby also the "L" lead of Fig. 50. The "HA" lead operates the (SW) relay of the 17B KTU, which grounds lead "1." Lead "1" carries ground through Fig. 49 to Fig. 45 to hold the (TO) relay of Fig. 45 operated. The (SW) relay also grounds lead "2" to start the flashing circuit of Fig. 46. The ground on lead "L" of Fig. 50 is connected to a contact on the (B) relay of Fig. 46. When the (B) relay of Fig. 46 operates, it connects this ground over the "B" lead to operate the (W) relay of Fig. 50, under control of the (WT) relay. The (W) relay, when operated, extinguishes the signal lamps and operates the (WT) relay. The (WT) relay locks operated under control of the (B) relay of Fig. 46, and releases the (W) relay of Fig. 50, which lights the lamps again. When the (B) relay of Fig. 46 releases, it releases the (WT) relay of Fig. 50, and the cycle repeats for each operation of the (B) relay. The lamp circuit is opened for approximately 30 milliseconds, once per second.

5.06 RELEASE OF HOLDING BRIDGE WHEN CALL IS AGAIN PICKED UP

When the call is again picked up at any station, the (L) relay will operate, thus shorting the holding tertiary winding of the (H) relay if Fig. 8 or option "ZX" of Fig. 49 is used, or shorting the primary winding of the (H) relay if Fig. 38 or option "ZY" of Fig. 49 is used, releasing the (H) relay. This removes the holding bridge from across the line.

5.07 RELEASE OF HOLDING BRIDGE FROM CENTRAL OFFICE OR PBX

In case the hold circuit is not removed by a station picking up the call, the hold condition may be released from the central office by opening the line momentarily, which releases the (H) relay, restoring the circuit to normal.

5.08 ANSWERING OR ORIGINATING A PRIVATE LINE CALL ON PRIVATE LINE CIRCUIT, FIG. 7

The pickup keys shown on the key telephone set drawings are employed to complete the talking circuit. The operation of a pickup key will cause no operation in Fig. 7 but will operate relays in the signaling circuit, if provided, as described in 5.09. However, on outgoing calls, the signaling key in the telephone set is operated, which operates the (PL) relay. This connects ringing current to the private line for signaling the station at the distant end of the private line.

5.09 SIGNALING CIRCUITS FOR CENTRAL OFFICE, PBX, OR PRIVATE LINES

5.09.1 Manual and Dial Areas

Fig. 22 provides equipment indicated for manual or dial areas. Figs. 42 and 44 are designated for manual areas, and Figs. 40, 41, and 43 are designated for dial areas.

The manual area circuits and equipment are required for use with long line circuits in manual offices because a large number of these long line circuits provide for ringing through repeating coils which will not work satisfactorily with the 15-type KTU circuits. Manual area circuits can be used for other lines in manual areas where 14A KTUs are available. However, except for the above cases, the dial area circuits and equipment are intended for use in both dial and manual areas.

5.09.2 Nonlocked-in Lamps, Figs. 5 and 6, or Fig. 22

When ringing current is applied to the line at the central office, PBX, or distant end of a private line, the (R) relay will operate which will operate the common ringer or buzzer and light the individual line lamps, Fig. 2, when Fig. 5 is used, or the line lamp in Fig. 28, or in the key telephone set when Fig. 22 is used. This common ringer or buzzer will operate and the lamps will light only while the ringing current is applied to the line. The ringer in the key telephone set, shown on the key and telephone circuit, or the external ringer may be used as the common ringer. Also, both individual ringers and common ringers may be associated with the same line. When the line is busy, because a station has been connected to the line or because the hold condition has been placed on the line, the (B) relay will be operated, lighting the busy lamps. With "ZU" wiring, in Fig. 22, the operation of the (B) relay will also disconnect ground from the ringup relay to prevent a noise condition after ringing stops. This has been experienced in a few locations due to a temporary imbalance of the 15-type KTU, after ringing stops. "ZL" wiring is required in connection with "ZU" wiring when Fig. 37 is provided for automatic cutoff (see 5.04.4).

5.09.3 Locked-in Line Lamps - Dial Areas, Fig. 23

When ringing current is applied to the line at the central office, PBX, or distant end of a private line, the (R) relay will operate on current passing through the secondary winding to ground direct or through the (R1) relay and (R1) varistor combination. The (R) relay will lock, operated, on its primary winding under control of the (B) relay and the battery cutoff key. The operation of the (R) relay lights the line lamps, and, if the (R1) relay is not used, operates the common ringer or buzzer. If the (R1) relay is provided, the common ringer or buzzer will operate only while this relay is operated. The (R1) relay is used only to provide an intermittent signal.

When the line is busy, because a station has been connected to the line or because the hold condition has been placed on the line, the (B) relay will operate lighting the busy lamps, and also will release the (R) relay if it is operated, extinguishing the line lamps and silencing the common ringer or buzzer.

5.09.4 Locked-in Line Lamps - Manual Areas, Fig. 24

When ringing current is applied to the line at the central office, PBX, or distant end of a private line, the (R) relay will operate through its secondary winding. The (R) relay will lock, operated, through its primary winding, the (AU) relay, and the battery cutoff key. The (R) relay also lights the line lamps. The (AU) relay operates the common ringer or buzzer. When the line is busy, because a station has been connected to the line or because the hold condition has been placed on the line, the (B) relay will operate, lighting the busy lamps, and also will release the (R) and (AU) relays if they are operated, extinguishing the line lamps and silencing the common ringer or buzzer.

5.09.5 Combined Line and Busy Lamps - Dial Areas, Fig. 25

When ringing current is applied to the line at the central office, PBX, or distant end of a private line, the (R) relay will operate, current passing through its secondary winding direct to ground or through the (R1) relay and (R1) varistor combination.

The (R) relay will lock, operated, on its primary winding under control of the (SR) relay and the battery cutoff key. The operation of the (R) relay starts the flashing relays functioning, and, if the (R1) relay is not used, operates the common ringer or buzzer. The flashing relays cause the line and busy lamps to flash. If the (R1) relay is provided, the common ringer or buzzer will operate only while this relay is operated. The (R1) relay is operated only while ringing current is applied to the line and is used to provide an intermittent signal.

When the line is busy, because a station has been connected to the line or because the hold condition has been placed on the line, the (B) relay will operate, operating the (SR) relay. The (SR) relay will light the line and busy lamps steadily, and also will release the (R) relay which stops the flashing relays and silences the common ringer or buzzer. The (SR) relay is a slow releasing relay and is used to prevent the flashing of the line and busy lamps during dialing. When the automatic cutoff circuit is used, the (SR) relay operates directly from that circuit or the automatic cutoff control circuit. The (B) relay does not operate in this case.

5.09.6 Combined Line and Busy Lamps - Manual Areas, Fig. 26

When ringing current is applied to the line at the central office, PBX, or distant end of a private line, the (R) relay will operate through its secondary winding. The (R) relay will lock, operated, through its primary winding and the battery cutoff key directly or through the (AU) relay. The (AU) relay operates the common ringer or buzzer, and is used if the audible signals are to operate on 60-cycle 16- through 21-volt ac or 105-volt ac supply. The operation of the (R) relay starts the flashing relays which flash the line and busy lamps. The (R) relay also operates the common ringer or buzzer if the (AU) relay is not provided. When the line is busy, because a station has been connected to the line or because the hold condition has been placed on the line, the (B) relay will operate, lighting the line and busy lamps steadily, stopping the flashing relays, and silencing the common ringer or buzzer. If the line and busy lamps are operated on alternating current or if the lamps are in key telephone sets operating on either alternating current or direct current, the 17A KTU is provided and will control the lamps.

5.09.7 Battery Cutoff Key, Figs. 23 through 26

When the battery cutoff key is operated, the (R) relays will operate only while ringing current is applied to the line. This provides a means for preventing unnecessary current drain in the case of abandoned calls when the system is unattended. In Fig. 24, when this key is operated the common audible signal will not sound.

5.09.8 Combined Line and Busy Lamp with Automatic Time Out for Dial Areas, Fig. 40

Fig. 40 is designed to make it possible to obtain time out with existing 15A, B, and 18B and C KTUs. It is rated Mfr. Disc. because these key telephone units are rated Mfr. Disc. It performs the same function as Fig. 43, except that it does not protect against a noise condition experienced in a few locations due to a temporary imbalance of the 15-type KTU after ringing stops.

When ringing current is applied to the line at the central office, PBX, or distant end of a private line, the (R) relay will operate on current passing through the secondary winding direct to ground or through the (R1) relay and (R1) varistor combination. The (R) relay will (a) lock up through its primary winding under control of the (SR) and (TO) relays; (b) start the flashing relays (A) and (B) causing the line and busy lamps to flash; (c) operate the common ringer or buzzer, if a common steady audible signal is provided; and (d) close the circuit to the thermal winding of the (TO) relay to start this relay timing, provided no line is busy at the time. If the (R1) relay is provided, the common ringer or buzzer will operate only while this relay is operated. The (R1) relay is therefore used to provide a common intermittent audible signal.

When the line is busy, because a station has been connected to the line or because the hold condition has been placed on the line, the (B) relay will operate, operating the (SR) relay. The (SR) relay will (a) light the line and busy lamps steadily; (b) release the (R) relay, if operated; and (c) operate the (TO) relay to prevent this relay from timing out when any line is busy. The (SR) relay is a slow releasing relay in order to prevent the line and busy lamps from flashing during dialing. The (R) relay, released, stops the flashing relays and silences the common ringer or buzzer in cases where the (R1) relay is not provided. When the automatic cutoff circuit is used, the (SR) relay operates directly from that circuit or from the automatic cutoff control circuit. The (B) relay does not operate in this case.

5.09.9 Locked-in Line Lamp Only with Automatic Time Out for Dial Areas, Figs. 41 and 45

When ringing current is applied to the line at the central office, PBX, or distant end of a private line, the (R) relay will operate on current passing through the secondary winding direct to ground or through the (R1) relay and (R1) varistor combination. The (R) relay will lock up through its primary winding under control of the (SR) and (TO) relays. The operation of the (R) relay will (a) light the line lamps; (b) complete the circuit of the thermal winding of the (TO) relay to start this relay timing, provided no line is busy at the time; and (c) cause the common ringer or buzzer to operate when a common steady audible signal is provided. If the (R1) relay is provided, the common ringer or buzzer will operate only while this relay is operated. The (R1) relay is therefore used to provide a common intermittent audible signal.

When the line is busy, because a station has been connected to the line or because the hold condition has been placed on the line, the (B) relay will operate, operating the (SR) relay. The (SR) relay will (a) release the (R) relay, extinguishing the line lamps and silencing the common ringer or buzzer

when the common steady audible signal is provided; (b) disconnect the ground connection for the ringup relay circuit to prevent a possible noise condition due to an imbalance of the 15C KTU after ringing stops; and (c) operate the (TO) relay to prevent this relay from timing out while any line is busy. When the automatic cutoff circuit is used, the (SR) relay operates directly from that circuit or from the automatic cutoff control circuit. The (B) relay does not operate in this case except on hold.

5.09.10 Locked-in Line Lamps Only with Automatic Time Out for Manual Areas, Figs. 42 and 45 (See 5.09.1)

When ringing current is applied to the line at the central office or PBX, the (R) relay will operate through its secondary winding. The (R) relay will lock, operated, through its primary winding under control of the (B) and (TO) relays, and will operate the (SW) relay of the 17-type KTU (A) which will operate the (SW) relay of KTU (B), when provided, to cause the common steady audible signal to operate. The 17-type KTUs (A) and (B), or (A) alone, will also (a) light the line lamps; and (b) complete the circuit of the thermal winding of the (TO) relay to start this relay timing, provided no line is busy at the time.

When the line is busy, because a station has been connected to the line or the hold condition has been placed on the line, the (B) relay will operate. The (B) relay will release the (R) relay if it is operated, and will also operate the (TO) relay to prevent this relay from timing out while any line is busy. The (R) relay, releasing, will release the two (SW) relays, extinguishing the line lamps and silencing the common ringer or buzzer. When the automatic cutoff circuit is used, the functions of the (B) relay are performed by the (SW) relay of Fig. 37. The (B) relay does not operate in this case, except on hold.

5.09.11 Combined Line and Busy Lamps with Automatic Time Out for Dial Areas, Figs. 43, 45, and 46

When ringing current is applied to the line at the central office, PBX, or distant end of a private line, the (R) relay will operate on current passing through the secondary winding direct to ground or through the (R1) relay and (R1) varistor combination. The (R) relay will (a) lock up through its primary winding under control of the (SR) and (TO) relays; (b) start the flashing relays (A) and (B) causing the line and busy lamps to flash; (c) operate the common ringer or buzzer if a common steady audible signal is provided; and (d) close the circuit to the thermal winding of the (TO) relay to start this relay timing, provided no line is busy at the time. If the (R1) relay is provided, the common ringer or buzzer will operate only while this relay is operated. The (R1) relay is therefore used to provide a common intermittent audible signal.

When the line is busy, because a station has been connected to the line or because the hold condition has been placed on the line, the (B) relay will operate, operating the (SR) relay. The (SR) relay will (a) light the line and busy lamps steadily; (b) release the (R) relay, if operated; (c) disconnect the ground connection from the ringup relay circuit to prevent a possible noise condition due to a temporary imbalance of the 15-type KTU after ringing stops; and (d) operate the (TO) relay to prevent this relay from timing out when any line is busy. The (SR) relay is a slow releasing relay to prevent the line and busy lamps from flashing during dialing. The (R) relay, released, stops the flashing relays and silences the common ringer or buzzer in cases where the (R1) relay is not provided. When the automatic cutoff circuit is used, the (SR) relay operates directly from that circuit or from the automatic cutoff control circuit. The (B) relay does not operate in this case, except on hold.

5.09.12 Combined Line and Busy Lamps with Automatic Time Out for Manual Areas, Figs. 44, 45, and 46 (See 5.09.1)

When ringing current is applied to the line at the central office or PBX, the (R) relay will operate through its secondary winding, operating the (SW) relay of the 17-type KTU (A) which will operate the (SW) relay of the 17-type KTU (B), when provided, to cause the common steady audible signal to operate. The 17-type KTUs (A) and (B), or (A) alone, will also (a) complete the circuit to the thermal winding of the (TO) relay to start this relay timing, provided no line is busy at the time, and (b) start the flashing relays causing the line and busy lamps to flash.

When the line is busy, because a station has been connected to the line or because the hold condition has been placed on the line, the (B) relay will operate, operating the (SR) relay. The (SR) relay will (a) light the line and busy lamps steadily; (b) release the (R) relay if operated; and (c) operate the (TO) relay to prevent this relay from timing out when any line is busy. The (R) relay, released, releases the two (SW) relays which stop the flashing relays, and silences the common ringer or buzzer. When the automatic cutoff circuit is used, the (SR) relay operates directly from that circuit, or from the automatic cutoff control circuit. The (B) relay does not operate in this case except on hold.

5.09.13 Private Line Signaling and Battery Feed Circuit for Combined Line and Busy Lamps or Locked-in Line Lamps Only, Fig. 48

5.09.13.1 Arranged for Combined Line and Busy Lamps with Figs. 45 and 46

When the private line circuit at the distant end applies ringing current over the line, the (R) relay will operate on current passing through its secondary winding direct to ground or through the (R1) relay and (R1) varistor combination. The (R) relay will (a) lock up through its primary winding under control of the (BF) and (TO) relays; (b) start the flashing relays (A) and (B) causing the line and busy lamps to flash; (c) operate the common ringer or buzzer if a common steady audible signal is provided; and (d) close the circuit

to the thermal winding of the (TO) relay to start this relay timing, provided no line is busy at the time. If the (R1) relay is provided, the common ringer or buzzer will operate only while this relay is operated; that is, only while ringing current is connected to the line at the distant end.

On an outgoing call one of the stations at this end of the line operates a signaling key, either in a key telephone set or separately mounted, operating the (PL) relay through Fig. 21. The (PL) relay, operated, connects ringing currents to the private line to signal the station at the distant end of the private line.

When one of the stations at this end of the line removes a handset to answer or originate a call, the (BF) relay will operate. The (BF) relay will (a) light the line and busy lamp steadily; (b) release the (R) relay, if operated; (c) disconnect ground from the ringup relay circuit to prevent a possible noise condition due to a temporary imbalance of the 15-type KTU after ringing stops; and (d) operate the (TO) relay to prevent this relay from timing out when any line is busy. The (R) relay release stops the flashing relays and silences the common ringer or buzzer.

5.09.13.2 Arranged for Locked-in Line Lamps Only with Fig. 45

The circuit operation is the same in this case except that the operation of the (R) relay will cause the line lamps to light steadily, and there will be no flashing relays. The operation of the (BF) relay will not light any lamps, but the release of the (R) relay will extinguish the line lamps.

5.09.14 Time-Out Relay

When a locked-in signal closes the circuit to the thermal winding of the (TO) relay, as described in 5.09.8 through 5.09.13, and this circuit is not broken by the operation of any (SR), (B), (SW), or (BF) relay within 20 seconds, the thermal winding of the (TO) relay will cause bottom contacts 1 and 2 to open, releasing any locked-up (R) relays.

5.09.15 Purpose of (T) and (R) Thermistors and the (R) Varistor, Figs. 22, 23, 25, 40, 41, 43, 48, and 49

The (T) and (R) thermistors in Figs. 22, 23, 25, and 40 are used to prevent a false operation of the (R) relay on reversal of current which may occur on disconnections. Also, they prevent the false operation of the (R) relay on dial pulses.

In Figs. 41, 43, 49, and in Fig. 48 when the 16A KTU is not provided, ground is disconnected from the ringup relay circuit whenever the (SR) relay is operated. However, the (T) and (R) thermistors are both retained to prevent trouble in case the (SR) relay drops down during dial pulses.

The thermistors are thermal devices which ordinarily have a resistance in the order of 50,000 ohms. When the ringing voltage is applied to the line, it causes enough current to flow through one of the thermistors, according to which side of the line ringing current is impressed; and the resistance of the thermistor changes in approximately 1/2 second from 50,000 ohms to about 3,000 ohms. The path for the current through the thermistors is through varistor (R) and relay (R), direct to ground or through the (R1) relay and the (R1) varistor combination. Only one-half of the ringing cycle passes through varistor (R). The other half is blocked and will pass through relay (R). When the thermistor resistance drops to about 3,000 ohms, sufficient current flows on the half-cycle through relay (R) to cause it to operate.

5.09.16 Line Indicator, Fig. 17

When the line indicator is used as a visual signal, it responds to each cycle of ringing current. Under certain line conditions it may flash during dialing and switchhook operation.

5.10 SIGNALING CIRCUIT FOR CENTRAL OFFICE AND PBX, WITH HOLDING

5.10.1 Combined Line and Busy Lamps with Automatic Time Out, Fig. 49

When ringing current is applied to the line at the central office, PBX, or distant end of a private line, the (R) relay will operate on current passing through the secondary winding, direct to ground or through the (R1) relay and (R1) varistor combination. The (R) relay will (a) lock up through its primary winding under control of the (SR) and (TO) relays; (b) start the flashing relays (A) and (B) causing the line and busy lamps to flash; (c) operate the common ringer or buzzer if a common steady audible signal is provided; and (d) close the circuit to the thermal winding of the (TO) relay to start this relay timing, provided no line is busy at the time. If the (R1) relay is provided, the common ringer or buzzer will operate only while this relay is operated. The (R1) relay is therefore used to provide a common intermittent audible signal.

When the line is busy because a station has been connected to the line, the (B) relay of the 18-type KTU (B) operates, operating the (SR) relay of the same unit. The (SR) relay will (a) light the line and busy lamps steadily; (b) release the (R) relay, if operated; (c) disconnect the ground connection from the ringup relay circuit to prevent a possible noise condition due to a temporary imbalance of the 15-type KTU, after ringing stops; and (d) operate the (TO) relay to prevent this relay from timing out when any line is busy. The (SR) relay is a slow releasing relay in order to prevent the line and busy lamps from flashing during dialing. The (R) relay, released, stops the flashing relays and silences the common ringer or buzzer in cases where the (R1) relay is not provided. When the automatic cutoff circuit is used, the (SR) relay operates directly from that circuit or the automatic cutoff control circuit. The (B) relay does not operate in this case except on hold.

When the line is in the hold condition, the (B) relays of the 18-type KTUs (B) and (H) operate, and the (SR) relays of both units operate. The (SR) relay of unit (H) starts the winking circuit.

5.11 INTERCOMMUNICATING SIGNALING CIRCUIT, FIG. 10

The buzzers of Key Telephone System No. 1A can be arranged for both code and selective signaling. If both code and selective signaling are required for any buzzer at an installation, the (S) relay, Fig. 10, is provided. When the (S) relay is provided, those signaling keys in the key telephone sets, or separately mounted, which are arranged for code signaling will operate the (S) relay, which in turn will operate all the buzzers that are to be operated by code. For selective signaling, the signaling key when operated will operate the buzzer directly. Any buzzer may be connected for both code and selective signaling. If the (S) relay is not provided, the buzzer will operate either on a code or selective basis directly from the signaling keys.

5.12 INTERCOMMUNICATING LINE CIRCUIT

5.12.1 Without Battery Feed Relay, Fig. 13

There are no circuit operations that take place in this circuit. However, on outgoing calls the signaling key in the key telephone set or the key per Fig. 14 is operated, which will operate the buzzers directly or by means of the (S) relay, Fig. 10.

5.12.2 With Busy Lamps and Control of Time-Out Relay, Fig. 47

When the intercommunicating line is picked up at any station, the (BF) relay operates, lighting the busy lamps, if provided, and operating the time-out relay (TO) in Fig. 45 to prevent it from timing out and releasing any incoming signal on another line, as long as the intercommunicating line is in operation.

5.13 INTERCOMMUNICATING LINE CIRCUIT WITH ONE-WAY AUTOMATIC SIGNALING, FIG. 12

When the intercommunicating line is picked at the calling station, the (AL) relay will operate which will operate the buzzer at the called station. When the called station answers, the (BL) relay will operate which will release the (AL) relay. This in turn silences the buzzer. The (BL) relay remains operated until both the calling and called stations disconnect.

5.14 TWO-WAY AUTOMATIC SIGNALING INTERCOMMUNICATING LINE CIRCUIT

5.14.1 With Separate Line and Busy Lamps, Fig. 20 or 29

When Fig. 20 or 29 is used to provide means for intercommunication between two stations, the battery supply is furnished in series with the (A1) relay to the A station and through the (B1) relay to the B station. In case the A station removes the handset from its mounting, the (A1) relay operates, closing a path through the make contact of the (A1) relay and the break contact of the (B1) relay to operate the buzzer and light the line lamp at the B station. With Fig. 29 when either the (A1) or (B1) relay is operated, a circuit is closed for operating the busy lamps at either or both stations. When the B station responds by removing the handset from its mounting, the (B1) relay operates, silencing the buzzer and extinguishing the line lamp. With both the (A1) and (B1) relays operated, the tips of the two lines are connected together, and the rings of the two lines are connected together so that when either station disconnects, both relays are held operated by the last station to disconnect. This prevents a recall by additional buzzer and line lamp operations. The operation of the (A1) and (B1) relays is identical so that station A may call station B, or vice versa.

This circuit will not provide control of the time-out relay circuit provided by Fig. 45 (see 5.12.2).

5.14.2 With Combined Line and Busy Lamps, Fig. 32

Fig. 32 provides the same service as Fig. 29, except that Fig. 32 is used with combined line and busy lamps, whereas Fig. 29 is used with separate line and busy lamps. As in the case of Fig. 29, the removal of the handset at station A will cause the (A1) relay to operate. The (A1) relay operates the (SW) relay in the (A) KTU and operates the buzzer at station B. The (SW) relay lights steadily the line and busy lamp at station A, causing the flashing relays, Fig. 25, 26, 40, or 46 to flash the line and busy lamp at station B. When station B answers, the (B1) relay will operate, silencing the buzzer at station B and operating the (SW) relay in the (B) KTU. This (SW) relay stops the functioning of the flashing relays of Fig. 25, 26, 40, or 46 and lights steadily the line and busy lamp at station B as a busy signal.

With both the (A1) and (B1) relays operated, the tips of the two stations and the rings of the two stations are connected together so that when either station disconnects first, all relays will remain operated. When the last station disconnects, all relays release. This prevents a recall by additional buzzer and line lamp operation. The operation of the (A1) and (B1) relays are identical so that station A may call station B, or vice versa.

This circuit will not provide control of the time-out relay circuit provided by Fig. 45 (see 5.12.2).

5.14.3 With Combined Line and Busy Lamps, Fig. 52

When Fig. 52 is used to provide means for intercommunication between two stations, the battery supply is furnished in series with the (A1) relay to the A station and through the (B1) relay to the B station. In case the A station removes the

handset from its mounting, the (A1) relay operates, closing a path through the make contact of the (A1) relay and the break contact of the (B1) relay to operate the buzzer at B station. The operation of (A1) also lights the combined line and busy lamp steadily at station A and causes the flashing relays of Fig. 25, 26, 40, or 46 to function, thus flashing the line and busy lamps at station B.

When station B answers, the (B1) relay will operate, silencing the buzzer at station B; stop the flashing relays of Fig. 25, 26, 40, or 46; and light steadily the line and busy lamps at station B as a busy signal.

With both the (A1) and (B1) relays operated, the tips of the two stations and the rings of the two stations are connected together so that when either station disconnects first, all relays will remain operated. When the last station disconnects, all relays release. This prevents a recall by additional buzzer and line lamp operation. The operation of the (A1) and (B1) relays are identical so that station A may call station B, or vice versa.

This circuit will not provide control of the time-out relay circuit provided by Fig. 45 (see 5.12.2).

5.15 SWITCHING RELAY CIRCUIT, FIG. 27

This (SW) relay is used wherever it is required to switch two leads.

5.16 AC POWER SUPPLY FOR LAMPS AND BUZZERS, FIGS. 30 AND 31

Fig. 30 provides the ac power supply for buzzers. Prior to issue 15D, it was also used for supplying (A3) or (B2) lamps in lamp indicators.

Fig. 31 provides the ac supply for the lamps in key telephone sets where a voltage of 7 to 11 volts is required at the lamps, and for (G2) or (51A) lamps in indicators.

5.17 LAMP RESISTANCE CIRCUIT, FIG. 33

Fig. 33 is required where a dc power supply is used for the lamps in the key telephone sets, or for (K2) lamps in indicators operating on 48-volt dc supply. (The dc supply is used only where an ac supply cannot be provided.) A resistance is used in series with each lamp so that the voltage across the lamps will not be excessive.

Where three or more stations are located near each other, the "L" and "LG" leads for these stations, from Fig. 33, may be connected to common "L" and "LG" leads at the apparatus box to serve these stations, provided the total resistance of the common "L" and "LG" leads does not exceed 10 ohms (which is the maximum total resistance for single "L" and "LG" leads) divided by the number of stations in the group. This circuit is required when a dc power supply is used or for (K2) lamps in indicators on 48-volt dc supply for use with a station busy lamp circuit.

5.18 NOISE SUPPRESSION CIRCUIT, FIG. 34

The 500-uf capacitor in Fig. 34 is used to suppress noise interference in the battery supply leads.

5.19 BATTERY SUPPLY INFORMATION

Formula No. 1 with Tables No. 1 and 2 covers the method of computing feeder resistance between a central office or building battery and a Key Telephone System No. 1A. Formula No. 1 shows the method for computing the feeder resistance to maintain a minimum of 14 volts at the station equipment when the load is maximum and the voltage of the central office or building battery is minimum. Table No. 1 shows the minimum and maximum voltages of the central office and building batteries, the feeder voltage dropping to maintain 14 volts at the station system. Table No. 2 shows the current through the relays, buzzers, and lamps, at maximum load when the voltage is 14 volts.

Figs. 101 to 107, inclusive, formula No. 2, and associated notes, provide information for determining the proper fusing to use in a Key Telephone System No. 1A when direct feeders are used. The maximum current which may be supplied to the system when the voltage at the central office or building battery is maximum is computed by formula No. 2. The current in a 2-ampere fuse, under maximum load and voltage condition, is limited to 1.6 amperes to provide adequate life for the fuse since fuses deteriorate rapidly if they carry current close to their rated capacity. If the combined feeder resistance is more than 14 ohms, fuses should not be used at the station end. The reason for this is that should the resistance be more and the wiring at the station end become grounded, the fuses would not operate even if the battery voltage were maximum.

Formula No. 3, Table No. 3, and the other data on the same sheet cover the method for computing the charging rate, the battery feeder resistance, and the fusing when local batteries are used at a Key Telephone System No. 1A. When a local battery is used, the fuses are to be located at the battery. The battery charging current is computed by formula No. 3 and is based on 6 busy hours per day, which should be satisfactory for most installations, especially those located in business establishments operating 8 hours per day. If definite busy-hours-per-day information is available, then the available value should be substituted for Fig. 6 in the formula. The busy-hours-per-day value is obtained by dividing the total daily calls by the total calls in the busiest hour. The 1.25 value in the second part of the formula provides for a 25 per cent allowance to take care of battery losses.

5.20 LAMP AND BUZZER SUPPLY INFORMATION

When (A3) lamps, mounted in lamp indicators only, are used in an installation and power is

supplied from a battery, one set of feeders between the battery and the apparatus cabinet or box may supply both the lamps and relays. When lamps in the key telephone sets are used and power is supplied from a battery, one set of feeders is required for lamps only, and one set of feeders for the relays. Formulae Nos. 4 and 5 provide information for computing feeder resistance for the ac and dc power supplies for the lamps in the key telephone sets.

Formula No. 4 shows the method for computing the feeder resistance from a local battery, a building battery, or a 48-volt central office battery to maintain a minimum voltage of 7 volts at the lamps when the load is maximum and the voltage of the battery is minimum.

Formula No. 5 shows the method for computing the maximum resistance of the wires between the transformer and the apparatus cabinet, to maintain a minimum voltage of 7 volts at the lamps when the load is maximum.

Formula No. 6 shows the method for computing the maximum current requirement for 10-volt ac supply.

Formula No. 7 shows the method for computing the maximum current requirement for the 15- to 25-volt ac supply.

Formula No. 8 shows the method for computing the minimum resistance load on the dc supply. This formula is used for determining whether or not the minimum resistance of the load is less than the allowable minimum of a particular power supply.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 5113-JIG-LHA

STATION SYSTEMS
KEY TELEPHONE SYSTEM NO. 1A
LINE AND SIGNALING CIRCUIT

CHANGES

B. Changes in Apparatus

B.1 Capacitor C, type KS-19524,L9, 60uF, 25V, has been added in Fig. 108.

D. Description of Changes

D.1 Capacitor C has been added across the key telephone units 1A, 5A, 6B, 6C, 18D, and 18E in order to eliminate the poor longitudinal-to-metallic balance caused by lack of the bypass capacitor when a supervisory relay is inserted in one side of the line (see Circuit Note 141, and Fig. 108).

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