

P.B.X. SYSTEMS
NO. 750A
LINE AND LINK CIRCUIT

CHANGES

D. DESCRIPTION OF CIRCUIT CHANGES

- D.1 This circuit is reissued for redrawing because of poor condition of tracing.

All other headings under "Changes," no change.

1. PURPOSE OF CIRCUIT

- 1.1 This circuit is used in the 750A dial P.B.X. to provide a connection between any two dial stations in the P.B.X.

2. WORKING LIMITS

- 2.1 Maximum external station conductor resistance 200 ohms.
- 2.2 Minimum insulation resistance 20,000 ohms.

3. FUNCTIONS

- 3.01 When the station receiver is removed, to operate the line relay in the line circuit and cause an idle link to select the line, extending the tip and ring of the station to the pulsing relay in the link.
- 3.02 To ground the sleeve of the line circuit to make the line busy to other links.
- 3.03 To extend the start circuit to the next link.
- 3.04 To furnish dial tone to the calling station from the link when it is ready to receive dial pulses.

- 3.05 To step the link switch under control of the station dial.
- 3.06 To test the called station.
- 3.07 To furnish busy tone to the calling station on a preliminary pulse or if the called station is busy or unequipped.
- 3.08 If the called station is idle to supply interrupted ringing current to ring the station bell.
- 3.09 To furnish ringing induction tone to the calling station while the called station bell is being rung.
- 3.10 To trip ringing when the called station answers.
- 3.11 To place a busy condition on the sleeve of the called station line circuit when the line is seized.
- 3.12 To provide talking battery to both calling and called stations.
- 3.13 To ground the start leads for the ringing interrupter, dial tone and busy tone when these are required.
- 3.14 To restore the switch and link to normal when the calling station replaces the receiver on the switchhook.
- 3.15 To hold the start lead cut through to the succeeding link by means of the chain relay when the link is restored to normal except when the chain relays in all other links are operated. This permits a subscriber to obtain a second link if the first link seized is in trouble.
- 3.16 To open the tip and ring of the link from the line circuit when a station trunk key is operated.
- 3.17 When the last link in which the chain relay is normal, is used, to restore the operated chain relays in all idle links so that the next call will be allotted to the first idle link in the chain.
- 3.18 To prevent more than one line from being connected to the same link.

- 3.19 To pass the call to the next idle link if the pulsing relay in the link seized fails to operate.
- 3.20 When a link fuse operates, to cut the link out of service.
- 3.21 To provide means of manually cutting a link out of service.
- 3.22 To make the dialing of extra digits ineffective.
- 3.23 To give a busy tone to the calling station when all links are busy.
- 3.24 To increase the charging rate of the rectifiers in the power circuit on a local call over that of either a trunk call or normal circuit.

4. CONNECTING CIRCUITS

- 4.1 750A P.B.X. Trunk Circuit.
- 4.2 750A P.B.X. Tone, Ringing Alarm and Common Timing Circuit.
- 4.3 Standard Dial Station.
- 4.4 Power Charge and Discharge Circuits.

DESCRIPTION OF OPERATION

5. SEIZURE OF LINK - FINDING LINE

When a station receiver is removed from the switchhook and the station "L" key is operated, the (L) relay, Figure 1, operates over the loop to ground supplied from the tone, ringing and alarm circuit. Relay (L) grounds the "ST" lead causing relay (ST) in one of the idle links to be operated. The manner of extending this start lead to idle links will be described later. Relay (L) also grounds the "L1," "L2" and "L3" leads to the link (LF) relays associated with the line. The (ST) relay connects battery to all of the (LF) relays in the link but only that one which is grounded at the line relay (L) will operate. Relay (LF) locks in series with the (LO) relay which operates and opens the operating battery of the secondary winding of the (LF) relays, preventing any other (LF) relay from operating from a line circuit. The (LF) also opens the locking ground from all (LF) relays

electrically beyond so that if two (LF) relays had operated due to two (L) relays being operated at the same time, only one (LF) would lock, thus preventing more than one station from being connected to the same link. The (ST) relay also opens the chain circuit to other links and locks on its secondary winding in series with the (LK) relay which operates. Relay (LK) operates the chain relay (CH) which transfers the start lead "ST" to the next link but this lead is held open at the (ST) relay thus preventing another link from being seized. Relay (LF) operates the (CO) relay in the line circuit and extends the tip and ring of the line circuit to the pulse relay (A) in the link. Relay (CO) releases the line relay (L). Relay (A) operates relay (B) which in turn operates relay (B1). This prepares the pulsing circuit to the stepping magnet and closes the (FH) relay to the switch interrupter contact. Relay (B1) also operates relay (B2) which in turn operates relays (BC) and (B3) and closes a ground to hold the (CO) and (LF) relays. Relay (BC) grounds the "CT" lead. Relay (B3) releases the (LK) and (ST) relays. Relay (ST) closes the chain circuit through to the next link so that other calls may proceed. Relay (DT) operates from the normal terminals of switch bank No. 2 to ground on the (B2) relay, grounds the dial tone start lead "DTS" to the tone, ringing alarm and common timing circuit and closes dial tone on the "DT" lead from that circuit to the (A) relay winding giving an indication to the station that dialing may begin. Relay (DT) also operates relay (T) in order to prepare a circuit for the operation of relay (BT) in case of a short preliminary pulse. The preliminary pulse will step the selector one step after which the (T) relay will release and close a circuit to the (BT) relay through its back contacts. If the (A) relay should fail to operate when the link is seized, a circuit will be closed from the back contact of the (A) relay, back contact of the (B1) relay, and the front contact of the (LK) relay to the (B2) relay to operate it. Relay (B2) will then operate relay (B3) in order to release the (ST) and (LK) relays and restore the link to normal. However, the (CH) relay remains locked mechanically thus closing the chain circuit through to the next link.

6. STATION NUMBERS

The numbering of the stations in this system is 2 to 9 and 02 to 00 inclusive.

6.1 Stations 2 to 9

When relay (A) releases under control of the dial, ground on its back contact through the front contact of relay (B1) operates relay (SR) in series with the stepping magnet of the switch. When relay (A) reoperates, the switch steps but relay (SR) being slow in releasing holds operated during the impulses from relay (A). Relay (SR) in operating opens the ground from the No. 2 brush of the switch and closes a circuit to hold the (T) relay. Relay (DT) releases when the switch steps off normal, opening the dial tone from the line. Relay (PH) also operates and releases under control of the (A) relay and the interrupter contact of the switch and closes ground to the stepping magnet in order to insure stepping of the switch. Each working terminal of bank 2 of the switch is connected to a (CT) relay corresponding to a line in the P.B.X. and when the dial impulses have ceased the (SR) relay releases operating one of these (CT) relays which corresponds to the line which has been dialed.

If the called station is idle the (BT) relay will fail to operate due to the absence of ground on the sleeve and when the slow release (T) relay releases, the sleeve is connected to the grounded winding of the (T1) relay operating the relay to battery on the cut-off relay in the line circuit. Relay (T1) locks on its other winding to ground on the (B2) relay, opens the pulsing circuit to prevent the switch from stepping if another digit is dialed, operates the (RC) relay and grounds the sleeve of the called line to operate the cut-off relay and to make it busy.

6.2 Stations 02 to 00

When 0 is dialed the stepper steps as described above but upon the release of relay (SR) the ground which it places upon the brush of arc #2 which is standing on contact #10 prevents relay (T) from releasing. No circuit is provided for operating relay (T1) and the stepping circuit remains closed so that upon the receipt of the pulses of the second digit the stepper steps again and selects a line as described above.

7. TESTING - BUSY LINE

When the relay (CT) operates, it closes the sleeve from the called line circuit through the front contact of the (T) relay through the winding of relay (BT). Relay (T) is slow in releasing so that if the called line is busy the (BT) relay may operate from ground on the sleeve. Relay (BT) operated locks to ground on the (B2) relay, opens the switch pulsing circuit to prevent the switch from stepping if another digit is dialed, opens the sleeve circuit from the back contact of the (T) relay, connects ground to the busy tone start lead "BTS" to the tone, ringing alarm and common timing circuit, and connects busy tone to the ring of the line as an indication to the calling station that the called station is busy. The circuit will remain in this condition until the calling station hangs up.

8. RINGING

Relay (RC) grounds the ringing start lead "RS" to the tone, ringing and alarm circuit to start the ringing interrupter, closes the tip and ring of the called station to the "M" and "N" leads in series with the (RT) relay. Interrupted ringing is supplied from the tone, ringing and alarm circuit over the "M" and "N" leads to ring the called station bell. Relay (RT) will not operate under this condition as it does not receive sufficient current. Relay (RS) is normal at this time as it is shunted by the back contact of the (RT) relay. While the called station is being rung the calling station receives audible ringing induction tone which is passed back over the ring of the calling station through condenser (C). When the receiver at the called station is removed from the switchhook, the (RT) relay operates due to the increased current, and opens the shunt on the (RS) relay allowing it to operate. Relay (RS) operated releases the (RC) relay, opening the ringing current from the called station, and connects the (C) retard coil to the tip and ring of the called station when the (RC) relay is released.

9. TALKING AND RELEASE

With the (C) retard coil connected, the talking circuit is completed from the called station to the tip and ring condenser. The (C) retard coil supplies talking battery to the called station.

The connection is now under control of the calling station which has talking battery supplied to it through the windings of the (A) relay. When the called station hangs up, the link is held by the calling station. When the calling station hangs up relays (A), (B), (B1), (B2) and (B3) release in the order named. Relay (B2) releasing, releases relays (T1), (RS) and (CT). Relay (B3) releasing closes ground through the No. 1 brush and bank of the switch to the interrupter contact of the stepper switch and the switch then restores to normal. "V" wiring. The purpose of connecting the ground from the back contact of the (B3) relay through the normal terminal of the No. 1 switch bank to the (B) relay contact is to prevent the operation of the (B1) relay and the (B2) and (B3) relays while the switch is restoring to normal in the event that this link should be re seized before the switch is normal. "W" wiring. The release of relay (B3) removes ground from spring 2 of relay (B) so that relays (B1), (B2) and (B3) cannot be reoperated, in the event the link is re seized, until the stepper returns to normal.

10. ALL LINKS BUSY

The chain relays (CH) are mechanically locking relays. When a link is seized the (CH) relay will operate and will be energized throughout the conversation. However, when the link is released the (CH) relay will remain locked mechanically though deenergized and extend the start lead to another link so that the next call will be taken up by the link. When all the (CH) relays are operated, a circuit is closed for operating the (S) relay which operates the (S1) relay. The (S1) relay energizes the restore windings of the (CH) relays restoring them to normal if the links are idle. When the (S1) relay is operated it closes a circuit to the "Tone, Ringing Alarm and Common Timing Circuit" to connect busy tone to the line circuit over the "LG" lead in order to give an indication that all of the links are busy. When any (CH) relay releases, the circuit for the (S) relay is opened. The (S) relay releases the (S1) relay which in turn deenergizes the restore windings of the (CH) relays.

11. LINK CUT-OUT KEY

A (CO) key is associated with each link so that the chain circuit may be extended to the next link in case there is trouble. Operation of the (CO) key operates the (F) relay which transfers the chain and all links busy signal.

12. LINK FUSE OPERATED

Operation of a link fuse operates the (F) relay which transfers the chain circuit to the next link and closes the all links busy chain.

13. PRELIMINARY IMPULSE

If a single pulse is received before the station number is dialed due to fumbling of the receiver in removing it from the hook relay (BT) will operate, thus preventing further pulses being effective to step the stepper and place a busy tone on the calling line. This prevents the calling line from getting a wrong number under this circumstance.

BELL TELEPHONE LABORATORIES, INC.

CIRCUIT DESCRIPTION:
AMERICAN TELEPHONE & TELEGRAPH CO.,
DEPT. OF DEVELOPMENT & RESEARCH.
BELL TELEPHONE LABORATORIES, INC.
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P.B.X. SYSTEMS
NO. 750A
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CHANGES

A. CHANGED AND ADDED FUNCTIONS

A.1 No change.

B. CHANGES IN APPARATUS

B.1 Superseded

Superseded By

Added

Fig. 3-Res.(A) 18G-200Ω 19BY-(A)1075Ω/220Ω
Res.(B) 18BH-1000Ω

C. CHANGES IN CIRCUIT REQUIREMENTS OTHER THAN THOSE APPLYING TO ADDED OR REMOVED APPARATUS

C.1 No change.

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Added Note 111.

D.2 Resistances A and B are now combined in one resistance (A) to reduce the cost of the circuit.

DEVELOPMENT

1. PURPOSE OF CIRCUIT

1.1 This circuit is used in the 750A dial P.B.X. to provide a connection between any two dial stations in the P.B.X.

2. WORKING LIMITS

2.1 Maximum external station conductor resistance 200 ohms.

2.2 Minimum insulation resistance 20,000 ohms.

OPERATION

3. FUNCTIONS

3.01 When the station receiver is removed, to operate the

line relay in the line circuit and cause an idle link to select the line, extending the tip and ring of the station to the pulsing relay in the link.

- 3.02 To ground the sleeve of the line circuit to make the line busy to other links.
- 3.03 To extend the start circuit to the next link.
- 3.04 To furnish dial tone to the calling station from the link when it is ready to receive dial pulses.
- 3.05 To step the link switch under control of the station dial.
- 3.06 To test the called station.
- 3.07 To furnish busy tone to the calling station on a preliminary pulse or if the called station is busy or unequipped.
- 3.08 If the called station is idle to supply interrupted ringing current to ring the station bell.
- 3.09 To furnish ringing induction tone to the calling station while the called station bell is being rung.
- 3.10 To trip ringing when the called station answers.
- 3.11 To place a busy condition on the sleeve of the called station line circuit when the line is seized.
- 3.12 To provide talking battery to both calling and called stations.
- 3.13 To ground the start leads for the ringing interrupter, dial tone and busy tone when these are required.
- 3.14 To restore the switch and link to normal when the calling station replaces the receiver on the switch-hook.
- 3.15 To hold the start lead out through to the succeeding link by means of the chain relay when the link is restored to normal except when the chain relays in all other links are operated. This permits a subscriber to obtain a second link if the first link seized is in trouble.
- 3.16 To open the tip and ring of the link from the line circuit when a station trunk key is operated.
- 3.17 When the last link in which the chain relay is normal, is used, to restore the operated chain relays in all idle links so that the next call will be allotted to

the first idle link in the chain.

- 3.18 To prevent more than one line from being connected to the same link.
- 3.19 To pass the call to the next idle link if the pulsing relay in the link seized fails to operate.
- 3.20 When a link fuse operates, to cut the link out of service.
- 3.21 To provide means of manually cutting a link out of service.
- 3.22 To make the dialing of extra digits ineffective.
- 3.23 To give a busy tone to the calling station when all links are busy.
- 3.24 To increase the charging rate of the rectifiers in the power circuit on a local call over that of either a trunk call or normal circuit.

4. CONNECTING CIRCUITS

- 4.1 750A P.B.X. Trunk Circuit.
- 4.2 750A P.B.X. Tone, Ringing Alarm and Common Timing Circuit.
- 4.3 Standard Dial Station.
- 4.4 Power Charge and Discharge Circuits.

DETAILED DESCRIPTION

5. SEIZURE OF LINK - FINDING LINE

When a station receiver is removed from the switchhook and the station "L" key is operated, the (L) relay, Figure 1, operates over the loop to ground supplied from the tone, ringing and alarm circuit. Relay (L) grounds the "ST" lead causing relay (ST) in one of the idle links to be operated. The manner of extending this start lead to idle links will be described later. Relay (L) also grounds the "L1", "L2" and "L3" leads to the link (LF) relays associated with the line. The (ST) relay connects battery to all of the (LF) relays in the link but only that on which is grounded at the line relay (L) will operate. Relay (LF) locks in series with the (LO) relay which operates and opens the operating battery of the secondary windings of the (LF) relays, preventing any other (LF) relay from operating from a line circuit. The (LF) also opens the locking ground from all (LF) relays electrically beyond so that

if two (LF) relays had operated due to two (L) relays being operated at the same time, only one (LF) would lock, thus preventing more than one station from being connected to the same link. The (ST) relay also opens the chain circuit to other links and locks on its secondary winding in series with the (LK) relay which operates. Relay (LK) operates the chain relay (CH) which transfers the start lead "ST" to the next link but this lead is held open at the (ST) relay thus preventing another link from being seized. Relay (LF) operates the (CO) relay in the line circuit and extends the tip and ring of the line circuit to the pulse relay (A) in the link. Relay (CO) releases the line relay (L). Relay (A) operates relay (B) which in turn operates relay (B1). This prepares the pulsing circuit to the stepping magnet and closes the (PH) relay to the switch interrupter contact. Relay (B1) also operates relay (B2) which in turn operates relays (BC) and (B3) and closes a ground to hold the (CO) and (LF) relays. Relay (BC) grounds the "CT" lead. Relay (B3) releases the (LK) and (ST) relays. Relay (ST) closes the chain circuit through to the next link so that other calls may proceed. Relay (DT) operates from the normal terminals of switch bank No. 2 to ground on the (B2) relay, grounds the dial tone start lead "DIS" to the tone, ringing alarm and common timing circuit and closes dial tone on the "DT" lead from that circuit to the (A) relay winding giving an indication to the station that dialing may begin. Relay (DT) also operates relay (T) in order to prepare a circuit for the operation of relay (BT) in case of a short preliminary pulse. The preliminary pulse will step the selector one step after which the (T) relay will release and close a circuit to the (BT) relay through its back contacts. If the (A) relay should fail to operate when the link is seized, a circuit will be closed from the back contact of the (A) relay, back contact of the (B1) relay, and the front contact of the (LK) relay to the (B2) relay to operate it. Relay (B2) will then operate relay (B3) in order to release the (ST) and (LK) relays and restore the link to normal. However, the (CH) relay remains locked mechanically thus closing the chain circuit through to the next link.

6. STATION NUMBERS

The numbering of the stations in this system is 2 to 9 and 02 to 08 inclusive.

6.1 Stations 2 to 9

When relay (A) releases under control of the dial, ground on its back contact through the front contact of relay (B1) operates relay (SR) in series with the stepping magnet of the switch. When relay (A) reoperates,

the switch steps but relay (SR) being slow in releasing holds operated during the impulses from relay (A). Relay (SR) in operating opens the ground from the No. 2 brush of the switch and closes a circuit to hold the (T) relay. Relay (DT) releases when the switch steps off normal, opening the dial tone from the line. Relay (PH) also operates and releases under control of the (A) relay and the interrupter contact of the switch and closes ground to the stepping magnet in order to insure stepping of the switch. Each working terminal of bank 2 of the switch is connected to a (CT) relay corresponding to a line in the P.B.X. and when the dial impulses have ceased the (SR) relay releases operating one of these (CT) relays which corresponds to the line which has been dialed.

If the called station is idle the (BT) relay will fail to operate due to the absence of ground on the sleeve and when the slow release (T) relay releases, the sleeve is connected to the grounded winding of the (T1) relay operating the relay to battery on the cut-off relay in the line circuit. Relay (T1) locks on its other winding to ground on the (B2) relay, opens the pulsing circuit to prevent the switch from stepping if another digit is dialed, operates the (RC) relay and grounds the sleeve of the called line to operate the cut-off relay and to make it busy.

6.2 Stations 02 to 08

When 0 is dialed the stepper steps as described above but upon the release of relay (SR) the ground which it places upon the brush of arc #2 which is standing on contact #10 prevents relay (T) from releasing. No circuit is provided for operating relay (T1) and the stepping circuit remains closed so that upon the receipt of the pulses of the second digit the stepper steps again and selects a line as described above.

7. TESTING - BUSY LINE

When the relay (CT) operates, it closes the sleeve from the called line circuit through the front contact of the (T) relay through the winding of relay (BT). Relay (T) is slow in releasing so that if the called line is busy the (BT) relay may operate from ground on the sleeve. Relay (BT) operated locks to ground on the (B2) relay, opens the switch pulsing circuit to prevent the switch from stepping if another digit is dialed, opens the sleeve circuit from the back contact of the (T) relay, connects ground to the busy tone start lead "BTS" to the tone, ringing alarm and common timing circuit, and connects busy tone to the ring of the line as an indication to the calling station that the called station is busy. The circuit will remain in this condition until the calling station hangs

RINGING

Relay (RC) grounds the ringing start lead "RS" to the tone, ringing and alarm circuit to start the ringing interrupter, closes the tip and ring of the called station to the "M" and "N" leads in series with the (RT) relay. Interrupted ringing is supplied from the tone, ringing and alarm circuit over the "M" and "N" leads to ring the called station bell. Relay (RT) will not operate under this condition as it does not receive sufficient current. Relay (RS) is normal at this time as it is shunted by the back contact of the (RT) relay. While the called station is being rung the calling station receives audible ringing induction tone which is passed back over the ring of the calling station through condenser (C). When the receiver at the called station is removed from the switchhook, the (RT) relay operates due to the increased current, and opens the shunt on the (RS) relay allowing it to operate. Relay (RS) operated releases the (RC) relay, opening the ringing current from the called station, and connects the (C) retard coil to the tip and ring of the called station when the (RC) relay is released.

TALKING AND RELEASE

With the (C) retard coil connected, the talking circuit is completed from the called station to the tip and ring condenser. The (C) retard coil supplies talking battery to the called station. The connection is now under control of the calling station which has talking battery supplied to it through the windings of the (A) relay. When the called station hangs up, the link is held by the calling station. When the calling station hangs up relays (A), (B), (B1), (B2) and (B3) release in the order named. Relay (B2) releasing, releases relays (T1), (RS) and (CT). Relay (B3) releasing closes ground through the No. 1 brush and bank of the switch to the interrupter contact of the stepper switch and the switch then restores to normal. "V" wiring. The purpose of connecting the ground from the back contact of the (B3) relay through the normal terminal of the No. 1 switch bank to the (B) relay contact is to prevent the operation of the (B1) relay and the (B2) and (B3) relays while the switch is restoring to normal in the event that this link should be reseized before the switch is normal. "W" wiring. The release of relay (B3) removes ground from spring 2 of relay (B) so that relays (B1), (B2) and (B3) cannot be reoperated, in the event the link is reseized, until the stepper returns to normal.

10. ALL LINKS BUSY

The chain relays (CH) are mechanically locking relays. When a link is seized the (CH) relay will operate and will be energized throughout the conversation. However, when the link is released the (CH) relay will remain locked mechanically through deenergized and extend the start lead to another link so that the next call will be taken up by the link. When all the (CH) relays are operated, a circuit is closed for operating the (S) relay which operates the (Sl) relay. The (Sl) relay energizes the restore windings of the (CH) relays restoring them to normal if the links are idle. When the (Sl) relay is operated it closes a circuit to the "Tone, Ringing Alarm and Common Timing Circuit" to connect busy tone to the line circuit over the "LG" lead in order to give an indication that all of the links are busy. When any (CH) relay releases, the circuit for the (S) relay is opened. The (S) relay releases the (Sl) relay which in turn deenergizes the restore windings of the (CH) relays.

11. LINK CUT-OUT KEY

A (CO) key is associated with each link so that the chain circuit may be extended to the next link in case there is trouble. Operation of the (CO) key operates the (F) relay which transfers the chain and all links busy signal.

12. LINK FUSE OPERATED

Operation of a link fuse operates the (F) relay which transfers the chain circuit to the next link and closes the all links busy chain.

13. PRELIMINARY IMPULSE

If a single pulse is received before the station number is dialed due to fumbling of the receiver in removing it from the hook relay (BT) will operate, thus preventing further pulses being effective to step the stepper and place a busy tone on the calling line. This prevents the calling line from getting a wrong number under this circumstance.

AMERICAN TELEPHONE & TELEGRAPH CO.,
DEPT. OF DEVELOPMENT & RESEARCH.
BELL TELEPHONE LABORATORIES, INC.

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