PBX SYSTEMS
NO. 701A, 701B, 701PK, 702A, 711A, 711B, 711PK OR 740E
ONE-WAY TRUNK CIRCUIT
TO CENTRAL OFFICE
OUTGOING DIAL SELECTED
OR
NO. 701A, 701B, 701PK, OR 740E
TWO-WAY TRUNK CIRCUIT
TO CENTRAL OFFICE
MANUAL AND DIAL SELECTED

CHANGES

A. Changed and Added Functions

A.1 To provide for operation with automatic number identification.

B. Changes in Apparatus

B.1 Added:

G Diode 446F, Fig. 3 WE Option

N Relay AK23, Fig. 13

D. Description of Changes

D.1 In Figures 1, 2, 3, and 8, option WC is designated.

D.2 In Figures 1 and 2, option WD is added providing leads A, B, S1 and S2 to the automatic number identification circuit required for either one-way or two-way trunk operation.

D.3 Option WE, Figure 3, and option WG, Figure 8, are added to provide a continuous metallic path between the trunk sleeve and the automatic number identification circuit via lead P1 under control of relay JK for listed number billing on attendant-assisted or attendant-originated calls to the central office.

D.4 In Figure 3, WF wiring is added transfering the locking path from lead DL to lead SL and changing contact arrangement of the locking path of relay R to provide a continuous metallic path between the trunk and lead P1 under control of relay DD when a 608A switchboard is used.

D.5 In Figures 1, 2, 7 and 12, option WH is designated and option WI is added to Figures 1, 2, 3, 7 and 12.

D.6 Figure 13 is added to prevent shorting of identification pulses and to provide listed number billing when the night jack is operated.

D.7 Requirements for relay N are added to the Circuit Requirements Table.

D.8 Cabling Figures 51, 52, 53, 55, 56, 62, 63, 70, 71, 73 and 84 are changed to reflect added options.

D.9 Sheet 11, cabling Figures 90 and 91 are added.

D.10 Various indexes and Notes 102 and 103 are revised and Note 212 is added.

F. Changes in Description of Operation

F.1 Under DESCRIPTION OF OPERATION, add the following paragraphs after paragraph 16.22.

17. AUTOMATIC NUMBER IDENTIFICATION

17.1 Seizure

The automatic number identification circuit determines the direction of a call through a trunk by detecting the sequence in which ground is applied to control leads A and B by the trunk. The seizure of the trunk by a station making a dial "9" call or by an attendant inserting a cord plug into the trunk jack results in the operation of relay S1. Relay S1 operated grounds lead A. The operation of central office equipment results in the operation of relay CT which grounds lead B.

This order of operation (A before B) turns on a pnpn transistor in the trunk sensing circuit causing a capacitor discharge which sets the trunk location core associated with the seized trunk and starts the identification cycle.

17.2 Identification

17.21 Pulsing

The automatic number identification equipment functions to open the sleeve via leads S1 and S2 and provides a metallic path from the outpulser to the sleeve via the trunk connector. The outpulser sends a 150 to 200 volt positive 30 microsecond pulse (Write, WRP1) over this path and the sleeve of the switchtrain to the station line circuit to set the proper station number cores on station originated calls. The outpulser provides a holding ground on the sleeve during period that the trunk connector is operated.

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17.22 Listed Number Billing

A. Other Than 608A Switchboards with WE Option Figure 3 or WG Wiring Figure 8

Operation of relay JK, on attendant placed calls, completes a metallic path from the trunk sleeve to the operator billing cross connect field via lead P1. The write pulse WRP1 is sent over this path from the outpulser to set the listed number cores.

Diode G, Figure 3, removes this path from ground potential for the identification pulses. With WG wiring, Figure 8, the automatic number identification circuit provides the holding ground via lead P1.

B. 608A Switchboard Figure 3 WF Wiring

With WF wiring, a metallic path is completed from the trunk sleeve to the operator billing cross connect field via leads SL and P1 under control of relay DD. Relay DD will be released on attendant-originated or attendant-assisted calls maintaining a path to the listed number cores for write pulse WRP1.

17.3 Night Operation Figure 13

Inserting a cord plug into a night jack grounds lead S or SL operating relay N. Relay N operated, (1) grounds the selector banks to make the trunk busy to the selector circuit, (2) opens the sleeve to prevent shorting the identification pulses and (3) transfers the sleeve to lead P1 providing listed number billing on all calls during night operation.

F.2 Under Part 4, CONNECT CIRCUITS, add:

4.28 Automatic Number Identification Circuit - SD-1E007-01.

BELL TELEPHONE LABORATORIES, INCORPORATED

(WECo 7760HW-AEK-JGW)
DEPT 5337-LAH

PBX SYSTEMS
NO. 701A, 701B, 701PK, 702A, 711A, 711B, 711PK OR 740E
ONE WAY TRUNK CIRCUIT TO CENTRAL OFFICE OUTGOING DIAL SELECTED
OR
NO. 701A, 701B, 701PK OR 740E
TWO-WAY TRUNK CIRCUIT TO CENTRAL OFFICE MANUAL AND DIAL SELECTED

CHANGES

B. Changes in Apparatus

B.1 Removed:

DL Diode 420G
Opt. XL, Fig. 2

B.2 Added:

NJ Diode 446F
Opt. WA, Figs. 1 and 2

D. Description of Changes

D.1 XV option is designated and rated MD and XW option is added to prevent false operation of the P relay in the station message register pulse circuit.

D.2 WA, XX and XY options are added and XL and G options are rated MD to prevent the false lock up of the DD relay with operated night jacks. When night jacks are not equipped, added option XZ will be used in place of option WA.

D.3 Night jack connections to the 608A switchboard are added to figures 51 and 52 to agree with figure 12. Night jack connections on figures 53, 62 and 70 are designated WB option and rated MD.

F. Changes in Description of Operation

F.1 The changing of option XL to an MD rating (see D.2) removes the DL2 lead, figures 1, 2 and 7, and the DL diode, figure 2, from the circuit. CD references to the DL2 lead as a locking path for the DD relay, figure 3, are no longer correct and should be replaced by reference to the DL lead as providing the lock up circuit for relay DD. The DL2 lead references are in paragraphs 6.1, (3 references), and 6.4, (1 reference). The description of the DL diode function in paragraph 6.22 should be removed.

BELL TELEPHONE LABORATORIES, INCORPORATED

(WECo 7760-RFS-JGW)
DEPT 5337-LAH

PBX SYSTEMS
NO. 701A, 701B, 701PK, 702A, 711A, 711B, 711PK OR 740E
ONE-WAY TRUNK CIRCUIT
TO CENTRAL OFFICE
OUTGOING DIAL SELECTED
OR
NO. 701A, 701B, 701PK OR 740E
2-WAY TRUNK CIRCUIT
TO CENTRAL OFFICE
MANUAL AND DIAL SELECTED

CHANGES

D. Description of Changes

D.1 This change is made on a class D, no record basis.

D.2 Sheets 017 and 018 which include Figures 86, 87, 88 and 89 are cancelled; and references to them are removed.

D.3 Figures 51, 52, 54 and 55 previously rated MD are rerated standard.

D.4 All SD drawing pages are renumbered.

D.5 Figures 51 and 52 are redrawn without change on pages 0109 and 0110.

D.6 Equipment note 211 is added.

BELL TELEPHONE LABORATORIES, INCORPORATED

(WECo 7760HW-RFS-JGW)
DEPT 5337-LAH

PBX SYSTEMS
NO. 701A,701B,701PK,702A,711A,711B,711PK OR 740E
ONE-WAY TRUNK CIRCUIT
TO CENTRAL OFFICE
OUTGOING DIAL SELECTED
OR
NO. 701A, 701B, 701PK OR 740E
TWO-WAY TRUNK CIRCUIT
TO CENTRAL OFFICE
MANUAL AND DIAL SELECTED

CHANGES

A. CHANGED AND ADDED FUNCTIONS

A.1 Station message register pulse service and station message register surcharge service are provided for outgoing central office trunks.

D. DESCRIPTION OF CHANGES

D.1 "XR" option is designated and "XS" option is added to provide station message register pulse service in Figs. 1 and 2.

D.2 "XT" option is designated and "XU" option is added to provide station message register surcharge service in Figs. 1 and 2.

D.3 Fig. 51 is modified and rated Mfr Disc. and replaced by Fig. 86.

D.4 Fig. 52 is modified and rated Mfr Disc. and replaced by Fig. 87.

D.5 Fig. 54 is rated Mfr Disc. and replaced by Fig. 88.

D.6 Fig. 55 is modified and rated Mfr Disc. and replaced by Fig. 89.

D.7 Figs. 56, 59, 60, 61, 65, 70, 73, 76, 77, 78, 81, 84 and 85 are modified.

D.8 Equipment note 210 is added to cover modification of existing trunk units to provide station message register pulse and surcharge service.

F. CHANGES IN CD SECTIONS

F.1 The following circuits are added to Part 4 - "Connecting Circuits".

4.26 Station Message Register Pulse Circuit - SD-66915-01.

4.27 Station Message Register Surcharge Circuit - SD-66922-01.

BELL TELEPHONE LABORATORIES, INCORPORATED

(WECo-7760-OCS-JGW)
DEPT. 5337-RAV

PBX SYSTEMS
NO. 701A, 701B, 701PK, 702A, 711A, 711B, 711PK
OR 740E ONE WAY TRUNK CIRCUIT
TO CENTRAL OFFICE
OUTGOING DIAL SELECTED
OR
NOS. 701A, 701B, 701PK OR 740E
TWO WAY TRUNK CIRCUIT
TO CENTRAL OFFICE
MANUAL AND DIAL SELECTED

CHANGES

B. CHANGES IN APPARATUS

B.1 Added

Diode DL
420G
Opt. XL - Fig. 2

B.2

Superseded	Superseded by
Res. D 18BJ 1200 ω Opt. XG - Fig. 1	Res. D 1/2 19JN 1200 ω Opt. XH - Fig. 1
Res. B 18AE 600 ω Opt. XG - Fig. 1	Res. B 1/2 19JN 600 ω Opt. XH - Fig. 1
Network C 177F Opt. XI - Fig. 1	Network C 186B Opt. XJ - Fig. 1

D. DESCRIPTION OF CHANGES

D.1 Option M is removed from Circuit Note 102 (Feature and Option Table) and is added to the "Standard" column under "Use In Circuit" in Circuit Note 103. This is to make Option M applicable to all switchboards.

D.2 Option XG is designated and Option XH is added in Figure 1.

D.3 Option XI is designated and Option XJ is added in Figure 1.

D.4 Option XK is designated in Figure 3, and Option XL is added in Figures 1, 2 and 3.

D.5 Legend information is added to Figures 2, 55, and 77, and wiring information is added to Figure 77 to provide a more suitable wiring arrangement between the trunk equipment located on the 701PK modules and the ringing leads circuit.

D.6 A multiple lead is added to the BAT "B" lead in Figures 70 and 76 with the legend "Multiple to 9 Other Trunks Max."

D.7 The capacitor value in Section II, Paragraph 2.2 of the Circuit Description is corrected to read 2.0 μf cap., and formerly read 0.2 μf cap.

D.8 Additions are made in Circuit Note 103 to reflect option changes made on Issue 25D.

D.9 The "Options Used" table is changed to include all the options added on Issue 25D.

F. DESCRIPTION OF OPERATION

F.1 For description of operation see CD Issue 11AC.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT. 5336-EME-FNR-WJ

PBX SYSTEMS
NO. 701A, 701B, 701PK, 702A, 711A, 711B, 711PK OR 740E
ONE-WAY TRUNK CIRCUIT TO CENTRAL OFFICE OUTGOING DIAL SELECTED
OR
NO. 701A, 701B, 701PK OR 740E
TWO-WAY TRUNK CIRCUIT TO CENTRAL OFFICE MANUAL AND DIAL SELECTED

CHANGES

B. CHANGES IN APPARATUS

B.1 Superseded	Superseded By
Diode S1-420G-OPT.XC-FIG. 2	Diode S-446F-OPT.XN-FIG. 3
Diode S2-420G-OPT.XC-FIG. 2	

D. DESCRIPTION OF CHANGES

D.1 Option XM is designated, and Option XN is added in Fig. 3 to supersede Option XC in Fig. 1, and Options XC, XD and YS in Fig. 2.

D.2 Option XO is designated, and Option XP is added in Figs. 1 and 2.

D.3 Option XQ is designated, and is that portion of Option YX (Mfr Disc.) which is located in Figs. 8 and D.

D.4 Circuit Note 102 is corrected to reflect option changes of Issue 24AC

D.5 Additions are made in Circuit Note 103 to reflect option changes made on Issue 24AC.

D.6 Circuit Note 108 is added to indicate that XQ option is required for the 606B, 607A and 607B PBX's, and that Option YY is retained in Figs. 8 and D for those 608A PBX's which used Figs. 8 and D prior to Issue 23B.

D.7 The Options Used table is changed to include all the new options added on Issue 24AC.

D.8 Option and wiring information is added to Figs. 51, 52, 70, 76 and 84.

1. PURPOSE OF CIRCUIT

1.1 This circuit provides for one-way service from a dial station to a manual or dial central office or two-way service between a dial station or PBX attendant and a manual or dial central office.

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2. WORKING LIMITS**

2.1 Signaling Ranges

	Max. Ext. Ckt. Res. to Grd.	Max. Ext. Ckt. Loop at 45V	Max. Ext. Ckt. Loop at 47.5V	Min. Ins. Res.	Earth Potential
(H) Relay		1800Ω	2590Ω	30,000Ω	
"X" Option		2170Ω	3120Ω	50,000Ω	
		2570Ω	3670Ω	100,000Ω	
"W" or "X" Option	4265Ω			*	0V., +20V.
	2365Ω			*	-5V., +20V.
	990Ω			*	-10V., +20V.
	140Ω			*	-13V., +20V.
				20,000Ω	
				30,000Ω	

*Panel, Manual, or Crossbar Step-By-Step Without long line equipment the combined trunk and station minimum insulation resistance should not be less than these figures.

**Without long line equipment the combined loop of maximum extension station and maximum trunk conductor loop plus the series resistance of the core circuit when Figure 3 is used, shall not exceed the subscriber loop range of connecting central office less:

Option "F"	33 ohms	Option "E" and Figure 6	82 ohms
Option "E"	58 ohms	Option "F" and Figure 5	74 ohms
Option "F" and Figure 6	56 ohms	Option "E" and Figure 5	100 ohms

3.28 To provide a ringing audible signal for the PBX attendant until the toll switchboard operator answers.

3.3 Incoming Calls

3.31 To make the PBX end of the trunk busy to the selector circuits and to light the trunk busy lamps or extinguish the indicating lamps when the central office end is seized.

3.32 To light the trunk lamp when ringing current is applied in the central office.

3.33 To cut the trunk through the PBX cord circuit when the attendant answers.

3.34 To start the ringing machine when associated with a long line circuit when used ringing current furnished by an intermittently operated ringing machine.

3.35 To provide means for passing ringing current to the cord circuit on a re-ring from central office or to provide line lamp rering when core circuit has no rering feature.

3.4 Tandem Operation

3.41 To provide for tandem operation from a tie trunk which is arranged for tandem dial operation.

3.5 Night Service

3.51 To provide for incoming and outgoing night service to a specified station via a manual PBX cord circuit and an optional night jack on both outgoing and two-way trunk circuits.

4. CONNECTING CIRCUITS

When this circuit is listed on a key-sheet the connecting information thereon is to be followed.

4.01 Manual, Panel, Step-by-Step or Crossbar Central Office Subscriber's Line and Long Line Circuits which are arranged for ground signaling on the Ring Conductor - SD-25003-01 (Typical).

4.02 552A, 552D or 605A PBX Cord Circuits - SD-66198-01 (Typical).

4.03 552A, 552D or 605A PBX Auxiliary Buzzer or Night Alarm Circuit - SD-66467-01.

4.04 Selector Circuits - SD-66359-01. SD-30200-01 (Typical).

4.05 Selector Connector Circuits 701A or 711A - 740E - SD-65721-01 (Typical).

4.06 Toll Diverting Attendant's Trunk Circuit - SD-66450-01.

4.07 Toll Diverting Tone Circuit - SD-66446-01.

4.08 Long Trunk Circuit - SD-66474-01 (Typical).

4.09 Long Line Circuit - SD-66060-01 (Typical).

4.10 Toll Diverting Trunk Circuit - SD-32067-01.

4.11 556 Cord, Telephone Dial, Buzzer, Ringing, and Battery Circuit - SD-65658-01.

4.12 Traffic Register Circuit - SD-65771-01 (Typical).

4.13 Power Ringing Circuit - SD-80946-01 (Typical).

4.14 Emergency Transfer Key Circuit - SD-66451-01.

4.15 Idle Trk. Indicating Circuit - SD-66657-01.

4.16 Cord Circuits 607A, SD-66707-01, 607B, SD-65670-01.

4.17 Night Alarm Circuit - SD-66653-01.

4.18 Power Supply for ac Busy and Idle Line Indicating Lamps - SD-80770-01.

4.19 Auxiliary Trunk Circuit - SD-65725-01.

4.20 No. 552A, 552B, 552D, 552E, 605A, 607A, 607B, or 608A Jack Circuit for Attendant Switchboard Positions - SD-65778-01.

4.21 No. 608A Auxiliary Signal, Fuse Alarm, Battery Cut-off and Miscellaneous Circuit - SD-66722-01.

4.22 Night Transfer Circuit - SD-65837-01.

4.23 Traffic Usage Recorder Circuit 100 and 200 Terminal Capacity - SD-96549-01.

4.24 PBX No. 552A, 552B, 552D, 552E, 605A, 701A, 740E or 711A Ringing Leads Circuit - SD-66330-01.

4.25 No. 552A, 552B, 552D, 552E, 605A, 607A, 607B, 701B or 711B Ringing Leads Circuit - SD-65771-01.

DESCRIPTION OF OPERATION

5. RELAY FUNCTION

Relays

Figure 1 or 2

(CT) Is a relay which provides the "cut through condition in the trunk circuit.

(H) Is a high resistance relay which is connected to the tip side of the line in manual, panel and crossbar offices and connected across the line in step-by-step offices to recognize when the central office disconnects or seizes the line.

(S) Is the supervisory relay. It may be used with its two windings in multiple for short loops or with its inductive winding shunted with a 60 mf condenser for long loops.

(S1) Is an auxiliary supervisory relay under control of relay (S). It connects the outgoing signaling circuit when a call is originated by the station or an attendant. It is slow release to hold over the dial pulses through relay (S).

(SR) Is a slow release relay in combination with relay (CT) to provide a sufficient open interval after the station or the PBX attendant disconnects to permit the central office equipment to release before reconnecting relay (H) across the line. On the operate condition it provides time for relay (CT) to fully operate before relay (SR) disconnects relay (H) on an outgoing call.

Figure 2

(R1) Is auxiliary to relay (H) and holds while relay (H) follows ringing current on the seizure of the trunk by the central office.

Figure 3

(DD) Operates and locks on an outdial call and opens the lockup circuit to the ring up relay (R), and the trunk lamp.

(JK) Is a jack auxiliary relay to provide for making the jack test busy, lighting the busy lamps, opening the lockup circuit to ring up relay (R) and closing the tip ring and sleeve leads when the jack is occupied.

Figure 5

(TD) Is a relay in series with the "R" lead to selector from which toll calls are to be diverted to provide ground for operating relay (OP).

Figures 5 or 6

(OP) Is the transfer relay for diverting the station from the central office trunk to the toll diverting attendant's trunk or tone circuit.

(TS) Is a polarized relay to recognize reverse battery in order to divert stations to the toll diverting circuit in combination with relay (OP).

Figure 8

(DD) Operates and locks on an outdial call and opens the circuit to the ring up relay (R).

(JK) Is a jack auxiliary relay to provide for making the jack test busy, opening the lockup circuit to ring up relay (R) and closing the tip, ring and sleeve leads when the jack is occupied.

(JS) Recognizes closure of the plug sleeve to the jack sleeve.

(T) Extinguishes the indicating lamps and advances battery to light idle lamps of the next idle circuit if "ZX" wiring is furnished or lights the busy lamp if "ZZ" wiring is furnished.

Figures A, B, C or D

(R) Operates on incoming ringing signals and lights the L or trunk lamp.

6. OUTGOING CALLS TO CENTRAL OFFICES FROM STATION

6.1 Start of Call Figures 1 or 2

When the trunk is idle, battery through the 1200-ohm resistance (D) Figure 1 or (B) Figure 2, "G" wiring or the winding of the (T) relay Figure 8 is standing on the sleeve. The resistance is provided only in PBX's having selector-connectors where the 1200-ohm battery is required to operate the selector-connector cut through relay. When a hunting selector stops on the trunk the selector places ground on the sleeve.

Relay (S) operates over the station loop from battery through resistance (J) to ground on a normal contact of relay (CT) or (SR). The operation of relay (S) causes the operation of relay (S1).

Figure 1

Relay (S1) operated, (1) connects a ground on the ring side of the trunk toward the central office, (2) opens a parallel path of battery through resistance (B) and the winding of relay (H) to the tip side of the central office trunk, (3) closes ground to the "S" lead to hold the selector and to the "SL" lead to operate the (T) relay in Figure 8 to extinguish the idle indicating lamps with "ZX" wiring or lights the busy lamp with "ZZ" wiring, (4) with "F" wiring connects the noninductive winding of relay (S) in parallel with the inductive winding to the tip side of the trunk, (5) disconnects ground from lead "K" or "BR" to traffic register circuit, (6) closes a ground to "DD" lead to Figure 3 or 8 to operate relay (DD), and (7) provides a lock-up ground on the DL2 lead for relay (DD) in Figure 3.

Figure 2

Relay (S1) operated, (1) connects a ground on the ring side of the trunk toward the central office. With "ZE" option this ground is connected through the (L) resistor (2) with "W" wiring battery through resistance (B) is disconnected through a back contact of (S1) and reconnected through a back contact of (SR) and a front contact of (S1) through the winding of (H) to the tip side of the central office trunk. With "X" wiring the ring side of the line is connected through the secondary winding of relay (H) through the contact of (S1) and the primary winding of (H) to the tip of the trunk. Operation of (S1) removes this bridge and battery is supplied through resistance (B) and the contact of (SR) through the winding of (H) to the tip side of the trunk, waiting for ground from the central office to indicate that the circuit at the central office is ready to receive dial pulses. (3) closes ground to the "S" lead to hold the selector and to the "SL" lead to operate the (T) relay in Figure 8 to extinguish the idle indicating lamps with "ZX" or "YJ" wiring or lights the busy lamp with "ZZ" or "YJ" wiring, (4) with "E" wiring closes through the ring of the trunk to central office to front contact of (CT) thereby short circuiting resistance (H) or with "F" wiring connects the noninductive winding of relay (S) in parallel with the inductive winding to the tip side of the trunk, (5) disconnects ground from lead "K" or "BR" to traffic register circuit, (6) closes ground to "DD" lead to Figure 3 or 8 to operate relay (DD) and (7) provides a lock-up ground on the DL2 lead to relay (DD) in Fig. 3.

Relay (DD) in operating locks through its front contacts to ground on the DL2 lead with Figure 3 disconnects the circuit for the trunk lamp (L) so that it will not light if the central office should rering before disconnecting and connects battery from resistance (A), Option XB, with Fig. 3 or ground with Fig. 8 to the jack sleeve to make it test busy. With Figure 3, relay (DD) also lights the trunk busy lamps.

6.2 Cut Through

6.21 Figure 1

When the equipment in the central office functions, relay (H) operates from central office ground on the tip side of the trunk and closes the circuit to relay (CT) which operates. Relay (CT) cuts the station through to the tip and ring of the central office trunk, connects ground in multiple with the ground on the (S1) relay to hold the selector over the "S" lead, and closes a circuit to relay (SR) which operates. Relay (S) now holds from battery and ground at the central office.

Relay (SR), (1) removes the battery through resistance (B) from the tip side of the trunk thereby releasing relay (H), (2) closes a locking circuit for relay (CT), (3) disconnects the ground from the ring side of the trunk, (4) provides an additional ground for holding the selector, (5) provides a supplementary lock-up circuit for holding relay (DD) operated, (6) closes a supplementary circuit for lighting the busy lamps with Figure 3, and (7) closes a supplementary circuit for operating relay (T) in Figure 8 to extinguish the idle indicating lamp with "ZX" or "YJ" wiring or lights the busy lamp with "ZZ" or "YJ" wiring. The station now hears dial tone from the central office in the case of a dial office or the challenge of the operator in the manual office and may dial the central office or pass the call to the central office operator in the usual manner.

6.22 Figure 2

When the (H) relay operates from ground on the tip side of the trunk it causes relay (R1) to operate which in turn operates relay (CT). From here on, the operation proceeds as described in Paragraph 6.21, except that relay (CT) also shorts the secondary winding of relay (H) and when relay (H) releases, relay (R1) also releases.

The (DL) diode prevents the (DD) relay supplementary lock-up ground, provided by relay (SR), from falsely locking-up relay (CT).

6.23 Figure 1 or 2 Connected to Toll Subscribers Line Circuit

A ringing audible signal is furnished in Figures 1 and 2 for the calling station or attendant with Option "YU". A ground from the answering toll operator's jack circuit operates the (H) relay which operates the (CT) relay. Operation of the (CT) relay, removes the ringing audible, and cuts through the talking path from the PBX to the toll operator. The remaining operations are as described in 6.21 and 6.22.

6.3 Dialing and Talking

When the station dials, relay (S) follows dial pulses opening and closing the circuit to relay (S1). Relay (S1) is slow to release and holds over the dial pulses so that this circuit remains in the "cut through" position while the station is dialing and during the talking interval.

6.4 Disconnection

When the station disconnects, relay (S) releases in turn releasing relay (S1) and the central office equipment, because the loop is opened at the station. The

slow release characteristic of relay (S1) gives the central office equipment time to start releasing before relay (H) is applied to the trunk.

Figure 1

The release of relay (S1) opens the locking circuit of relay (CT) permitting it to release. The release of relay (CT) removes the ground from resistance (B) which permits relay (H) to operate from battery through resistance (B) to ground on the tip from the central office if the central office has not yet released. Relay (H) causes relay (CT) to operate and stay operated until the central office equipment releases and removes ground from the tip.

Figure 2

The release of relay (S1) opens the locking circuit of relay (CT) permitting it to release. The release of relay (CT) connects the two windings of relay (H) in series across the tip and ring of the trunk. If the central office has not yet released, relay (H) operates causing relay (R1) to operate. Relay (R1) causes relay (CT) to operate and stay operated until the central office equipment releases.

When the central office equipment has released, relay (H) releases causing the release of relays (R1), (CT) and (SR). With these relays normal, ground is removed from the "S" lead to the switches, releasing all operated switches, and relay (T) if Figure 8 is specified. The release of relay (SR) removes the ground from the DL2 lead to release relay (DD). With these relays released, the circuit is available for receiving new calls from the switches, the manual station, if equipped, or the central office.

When this trunk is connected to a dial central office, provision is made to insure the release of the PBX selector after a call in case the station reoriginates quickly.

7. RECALL ON A DIAL SELECTED CALL

Provision is made in this trunk for allowing a central office operator such as a toll operator, special service operator or a manual central office operator to recall the station after the station has hung up.

When the station hangs up, a disconnect signal is transmitted to the central office and the trunk circuit starts to release but holds under control of the central office, which does not release, as described in Paragraph 6.4.

When the central office operator rerings, relay (CT) remains operated during the ringing period.

7.1 Figure 2

Relay (H) operates intermittently on its primary winding from the ringing current and operates relay (R1) which holds relay (CT). The ringing current is connected through the contacts of relay (CT) to the station.

7.2 Figure 1 or "W" Wiring, Figure 2

In manual, panel and crossbar areas relay (H) operates to the ringing ground on the tip side of the trunk in turn holding relay (CT) operated. The ringing current is connected through the contacts of relay (CT) to the station.

7.3 Station Answers

The station bell is run in the usual manner and when the station answers, relay (S) operates, in turn operating relay (S1) which disconnects relay (H) from the trunk circuit but relay (CT) remains operated under control of relay (S1) and (SR). Relay (R), in the case of the 2-way trunk, will operate after ringing has been connected to the trunk for a short period but performs no useful function under this condition.

8. INCOMING CALL FROM CENTRAL OFFICE

8.1 Seizure

When this trunk circuit is normal, relay (H) is connected to the trunk to recognize when a connection is set up at the central office end of the trunk. With Figure 1 or "W" wiring, Figure 2, relay (H) is connected from the tip side to battery. With "X" wiring, Figure 2, relay (H) is bridged across the tip and ring of the trunk, because in the step-by-step areas the battery polarity may be in either direction depending on whether or not the trunk is seized by a local or a toll connector.

8.11 Seizure During Silent Interval Figure 1 or Figure 2, "W" Wiring

When the trunk is seized at the central office during the silent interval, ground on the tip operates relay (H) which in turn operates relay (CT). In the case of Figure 2, "W" wiring, relay (H) operates relay (R1), which in turn operates relay (CT). Relay (CT) operates, (1) connects the trunk through relay (S) to the jack circuit, (2) connects ground on lead "S" toward the selector multiple, (3) prepares its own locking circuit to relay (SR), (4) closes the circuit to relay (SR) which operates and lights the trunk busy lamps or extinguishes the idle indicating lamp.

When ringing current is applied at the central office it causes the operation of relay (R) of Figures A, B, C or D as described later. Relay (H) remains operated

under this condition to ground on the tip of the trunk at the central office. Relay (R) operated, locks up through a contact on relays (JK) and (DD), keeping the (L) or (TRK) lamp lighted steadily until the PBX attendant answers.

8.12 Seizure During Silent Interval Figure 2, "X" Wiring

When the trunk is seized at the central office during the silent interval, battery may be either on the ring or tip of the trunk and ground on the tip or ring lead. Relay (H) operates under either condition.

The (H) relay operates relay (R1) which in turn operates relay (CT) which shorts the secondary winding of relay (H) and also performs the functions described in Paragraph 8.11. After a short interval relay (R) operates as described in Paragraph 8.11 and lights the (L) or (TRK) lamp.

8.13 Seizure During Ringing Interval With Figure 1 or "W" Wiring Figure 2

Relay (H) operates under this condition as ground is on the tip side of the trunk at the central office under all conditions where this circuit is seized in manual, panel or crossbar central offices. The circuit functions as described in Paragraph 8.11.

8.14 Seizure During Ringing Interval With "X" Wiring Figure 2

Relay (H) operates on the central office ringing current and causes relay (R1) to operate.

Relay (R1) operated, operates relay (CT) which functions as described in Paragraph 8.12 to make the circuit busy at the manual section and also to the selector multiple. When the thermistor in series with relay (R) functions, relay (R) of Figure A or B operates and locks up, lighting the (L) or (TRK) lamp as described in Paragraph 8.11.

8.2 PBX Attendant Answers

8.21 Figures 3 and 4

The PBX attendant inserts the cord plug in jack (T) to answer the call. The operation of the front contacts of jack (T) operates relay (JK) in series with a relay in the cord circuit. The operation of relay (JK), (1) extinguishes the line lamp, (2) opens the locking circuit for relay (R) in Figure A or B, (3) provides a supplementary circuit for the busy lamps, (4) provides a supplementary ground to the sleeve of the selector multiple to indicate that the circuit is busy, (5) cuts through the "T" and "R" leads to jack (T).

The cord circuits have a bridge normally across the cord when the operator inserts the plug into a trunk jack. The bridge trips the central office ringing and in this circuit causes relay (S) to operate in turn operating relay (S1) which removes relay (H) from the trunk.

8.22 Figures 8 and 9 or 10

When the attendant answers, closure of the ring of the plug causes a partial operation of relay (JK) when "YI" option is specified or full operation when "YJ" option is specified. Relay (JS) then operates ("YI" option) over the sleeve and causes relay (JK) to fully operate. Relay (JK) disconnects its primary winding from the ring, closes through the tip and ring, provides a supplementary ground for the sleeves of the selector bank, releases (R) in Figure C or D which retires the trunk lamps. Relay (S) operates from battery and ground in the central office through the cord bridge causing the operation of relay (S1) which removes relay (H) from the trunk, and closes a locking circuit for relay (CT).

8.23 Figure 3 Used With a 608A PBX

The PBX attendant inserts a trunk cord plug into the jack to answer the call. Ground from the operated jack contacts operates relay (JK) which (1) cuts the tip and ring leads from the central office through to the PBX attendants circuit, operating relay (S) in series with the tip side of the line, (2) furnishes a ground through the (SL) resistor to the jack sleeve for the PBX cord circuit, (3) provides battery on the "IND" lead to operate the busy lamps, and (4) opens the locking path for the (R) relay, removing battery from the "L" and "NA" leads to extinguish the trunk lamp and auxiliary signals. The remaining operations are as described in 8.21 and 8.22.

8.3 Disconnection On Incoming Calls

When the station disconnects a bridge is connected across the cord circuit to hold the central office until the PBX attendant removes the plug from the trunk jack. With the plug removed from the trunk jack, relay (S) releases, sending a disconnect signal to the central office and causing the trunk circuit to release as described in Paragraph 6.4.

9. OUTGOING CALL FROM MANUAL APPEARANCE

When the PBX attendant makes an outgoing call she observes that the busy lamps are dark or that the idle indicating lamp is lighted and inserts the trunk plug of a cord circuit in the trunk jack, Figure 4, 9 or 10.

9.1 Figures 3 and 4

Operation of the auxiliary contacts on the tip spring of the jack closes the

circuit to the (JK) relay in Figure 3. Relay (JK) operates in series with a relay in the cord circuit. Relay (JK) is made slow operated to delay the tip and ring closure until the cord circuit relays have functioned in order to reduce the acoustic shock to a station connected to the station end of the cord circuit. Relay (JK) operated, (1) closes through the tip and ring leads to Figure 1 or 2, (2) opens the line lamp circuit when "B" option is not specified, (3) opens the circuit for relay (DD), (4) places ground on the sleeve of the selector multiple to make the circuit test busy, (5) connects battery direct or through the (E) and (F) resistances to the busy lamps, (6) opens the locking circuit for relay (R) in Figure A or B.

9.2 Figure 3 Used With 608A PBX

The PBX attendant inserts a cord plug into the trunk jack to originate a call. The operated jack contacts provide a ground on the "S1" lead to operate relay (JK). The operated (JK) relay (1) provides a ground through resistor (SL) on the "S" lead, Option XL, causing the cord circuit to function to provide a bridge for the operation of relays in Figures 1 or 2, (2) provides battery on the "IND" lead to operate the busy lamps, and (3) opens the trunk lamp and auxiliary signals circuit. The remainder of the operations are as described in 9.1.

Diode (S), Option XN, prevents relays other than relay (JK) from falsely providing a high resistance ground sleeve condition for the 608A PBX cord circuit.

9.3 Figures 8 or 14 and 9 or 10

When the PBX attendant makes an outgoing call she observes that the idle indicating lamp is lighted and inserts the front plug of a cord circuit in the trunk jack, Figure 9 or 10. When the ring closes, (JK) operates partially if "YI" option is specified or fully if "YJ" option is specified. (JS) operates ("YI" option) and fully operates (JK) on its secondary winding. (JK) closes through the tip and ring, opens the circuit through the winding of relay (DD), places a ground on the sleeve of the selector multiple to make the circuit test busy, operates relay (T) which extinguishes the (INDICATING) lamp with "ZX" or "YJ" wiring or lights the busy lamp with "ZZ" or "YJ" wiring.

9.4 Dialing and Talking

The cord circuit closure on the tip and ring leads causes the trunk to start the central office in the same manner described in Paragraph 6. The call is extended to the station in the usual manner in the manual PBX, that is, the station may have stayed in on the connection when the attendant was dialing or may have disconnected and the attendant recalled the station after dialing was completed or the attendant may have established a through dial connection, in which case the station dialed in the usual manner. The operation of the trunk circuit is the same in all cases.

10. RERING WHEN CONNECTION IS ESTABLISHED AT MANUAL POSITION

10.1 On attendant dialed calls to DSA and toll operators, it is necessary sometimes for the central office operator to recall the PBX attendant when the attendant is not on the connection. The incoming ringing current from the central office operates a relay in the cord circuit lighting the lamp in the particular cord circuit. Relay (S) in series with the cord bridge or long line circuit operates and follows the 20-cycle ringing current holding relays (S1) and (CT) operated. Relay (R) in Figure 3, "ZC" option operates after the thermistor resistance is reduced by the ringing current but performs no useful function.

Relay (CT) holds from relay (S1) so that ringing current will pass from the central office leads through to the PBX cord circuit or long line circuit.

10.2 Figure 3, "B" Wiring

When the cord circuit has no rering feature, the circuit performs as in Paragraph 10.1 with the exception that the operation of relay (R) in Figure A or B lights lamp (L) as a rering signal. Since the locking circuit for relay (R) is open at the (JK) relay, relay (R) will follow the ringing current from the central office.

11. RINGING RELAY CIRCUIT

Figure A or C covers the ringing battery circuit which employs the (T) and (R) thermistors for a delay feature in order to prevent a false operation of the ringing relay on reversals of current which may occur upon disconnection. Also, they prevent the false operation of relay (R) on dial pulses either when a station is dialing or when the PBX attendant dials. The thermistors are thermal devices which ordinarily have a resistance in the order of 100,000 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 (generally this is the ring side) and the resistance of the thermistor changes in approximately 1/2 second from 100,000 ohms to about 1,000 ohms. The impedance of relay (R) is so high at ringing frequencies that generally enough current will not flow through the thermistor to cause its operation, therefore varistor (R) is provided in shunt with relay (R). One half of each ringing cycle passes through varistor (R) and the other

half is blocked. When the thermistor resistance drops to about 1,000 ohms sufficient current flows through relay (R) on the half cycle which is blocked causing relay (R) to operate. Relay (R) operated, locks and connects battery or ground over the "L" lead to light the (L) or (TRK) lamps. In Figure 3, "ZC" wiring opens the locking path of relay (R) by opening the ground lead and "ZD" wiring opens the locking path by opening the battery feed lead. Under the rering condition relay (R) may operate in a similar manner except that the current is much reduced by the bridge in the cord circuit.

Figures B and D cover the ring relay circuit which employs a thermistor-varistor combination which prevents false line signals from operating relay (R). The 8A thermistor normally has a high resistance (over 50,000 ohms) but when ringing current is applied for approximately half a second or longer the resistance is reduced, giving an operating path for relay (R). Diode (R) is provided for two purposes, (1) to provide a low resistance operating path for the thermistor, (2) to shunt relay (R) on one half of the ringing cycle so that relay (R) will operate steadily during the other half cycle. Varistor (D) is provided for two purposes, (1) the shunt reduces the effective (heating) current through the thermistor due to dialing transients to such an extent that false relay operation is eliminated, (2) protects diode (R) and thermistor (T) by offering a very high resistance on normal ringing and dialing voltages, but on very high transients and surges its resistance becomes very low so as to shunt the high voltage around the varistor and thermistor. Relay (R) operated, locks and connects battery on ground over the (L) lead to light the (L) or (TRK) lamps.

Option "YP" is added in parallel with capacitor R of Figure B to provide 2 mf of capacitance to allow relay R to operate on toll rering. (Toll rering with minimum voltage of 95 volts through a 13C resistance lamp).

Option "YH" is added to extend the locking path of relay R through the bottom break (1-2) contacts of relay DD so that relay DD will release relay R when the call is answered at an auxiliary trunk circuit.

Option "ZS" Mfr. Disc.

The "ZS" option in Figures A and C functions to increase varistor and thermistor life and to reduce inductive noise. The (M) varistor, (M) resistance and (N) varistor protect the thermistors against transient currents by increasing the impedance in the operating path and in the locking path to ground. The increased impedance reduces the current in the thermistors, and consequently reduces their heating which affords less chance of line unbalance and of interference from induced voltages from excess and uneven thermistor heating.

Option "ZY"

The "ZY" option in Figures A and C functions as a voltage limiting device which protects the 8A thermistors and 400 type varistors by shunting any high voltage surges.

12. TOLL DIVERTING FIGURE 5 OR 6

Ordinarily the station or tie trunk can dial the central office to reach a toll operator. Provision has been made for diverting the connection when unauthorized stations or tie trunks dial codes which provide for toll service. This feature is called toll diverting and is for use with a central office which reverses the battery after dialing is completed but before the connection is answered by the toll of DSA operator. Figure 5 or 6 is provided in the central office trunk to recognize this reversal. Relay (TS) is in series with the ring side of the line and when battery is on the ring side of the line it does not operate. With battery on the tip side of the line relay (TS) operates and closes the circuit through its secondary winding to the (OP) relay. Relay (OP) transfers the station from the central office trunk to the toll diverting trunk or the toll diverting tone circuit according to which arrangement is provided at the particular PBX. When relay (OP) breaks the connection from the station to the central office, the operating circuit for relay (S) is removed, causing it to release and release relay (S1). Opening the "T" and "R" leads to the central office causes it to release and causes the release of relays (H), (CT) and (SR). The release of relays (SR) removes the operating ground for relay (OP) but in the meantime, the toll diverting tone circuit or the attendant's trunk has supplied ground on lead "S" to hold relay (OP). Relay (OP) remains operated until the station is dismissed by the attendant. While relay (OP) is operated the circuit is made busy to the selector multiple by means of ground on lead "S1" from the toll diverting trunk or tone circuit. The central office connection is released immediately when relay (OP) operates in order to avoid tying up the central office equipment.

When toll diverting is required on calls from all stations of the PBX, Figure 6 is provided. When some stations in the PBX are permitted to make toll calls without being diverted, Figure 5 is provided. When a toll call is made by a station which is not to be diverted there is no ground on

the secondary winding of relay (TS) to cause the operation of relay (OP). When a toll call is made from a station which is to be diverted, relay (TD) of Figure 5 provides ground for the operation of relay (OP). When relay (OP) disconnects the station from the central office and connects it to the attendant's trunk, relay (TD) releases momentarily. In order to prevent a buzzing action between relays (OP), (TS) and (TD) at this time, a make first contact is provided on relay (OP) to shunt the contact of relay (TD).

If the central office trunk is seized at the central office before the toll diverting connection has been broken down, relay (R) will function in the usual manner and light the trunk lamp and an attendant can canswer the central office connection without affecting the connection to the toll diverting tone or attendant's trunk circuit. While a toll diverted station is connected to the attendant, the trunk may be used for an outgoing call from a manual position during this time. Also, the trunk may be used for an outgoing call from the nontoll diverting selector banks.

Ground from operated night jack, feeding through operated toll diversion circuit, is prevented from reaching group multiple and falsely locking up diverted dial selected trunks by diode (S).

13. TRAFFIC REGISTER

A circuit for operating a traffic register is provided. This circuit is normally grounded but the ground is removed when all the trunks in the group are busy.

14. LONG LINE CIRCUITS

Provision is shown for optional connection of a long line circuit between the selector bank and jack appearances, and the signaling relays of this circuit. The use of a long line circuit at this point will furnish talking battery at the PBX where so desired because of long central office trunks, and will also permit the use of station and trunk loops whose combined resistance exceeds the central office working range.

15. TANDEM OPERATION

Calls from distant PBX's may be established over a tie trunk through the central office trunk to the central office without the attention of the PBX attendant at this PBX. The tie trunk connection is established to the central office trunk via the selector circuits. The central office trunk circuit functions in the same manner as on a call established from a station via the selectors. However, when the long lines circuit is not provided some tie trunks may cancel pulsing after a battery reversal is received from the central office if a toll code is dialed into a central office where the operator's trunks are arranged to reverse the battery.

16. NIGHT CONNECTIONS

16.1 701A, 702A or 711A PBX, or the 740E PBX Used With 552 Type of a 608A Switchboard Selection With Night Jacks

Night connections are established through the manual section associated with this PBX. With the cord circuit keys operated for night operation there is no dc bridge across the cord and the trunk end of the cord is connected to the night jack in Figure 7 or 12. The tip and ring of the cord will then connect the station through to battery and ground at the contacts of relay (CT) or to the long line circuits. The trunk is made busy to the selector circuits by the auxiliary contact on the ring spring of the jack which grounds the sleeve.

A ground feedback from a night connected outgoing trunk is prevented from falsely locking up a diverted dial selected trunk through the multiple wiring by diode (S).

16.11 Outgoing Calls

If the station desires to make an outgoing call the receiver is removed from the switchhook in the usual manner. The calls proceed in the manner described in Paragraph 6 for outgoing calls from a station.

16.12 Incoming Calls

When seized at the central office the trunk functions as described in Paragraph 8, except that the station bell rings, and no PBX attendant answers. The presence of resistance (H), Figure 2, limits the amount of ringing current and presents false operation of the central office tripping relay. When the station answers, relay (S) and (S1) operate. The operation of relay (S1) places a short on resistance (H), Figure 2 so as not to introduce a transmission loss. Relay (R) which operates on the ringing current, stays operated until relay (SR) releases at the end of the call.

16.2 740E PBX Used With a 556A Switchboard Section or With a 552 Type Switchboard Section Without Night Jacks

Night connections are established through the manual section associated with this PBX. With the cord circuit keys operated for night operation, there is no dc bridge across the cord and the trunk end of the cord is connected to jack (T) in

Figure 4. Relay (JK) operates and performs the functions described in Paragraph 9.1. However, the busy lamps will not light during periods when the switchboard is unattended, since battery designated "B", "XF" wiring, is supplied through the battery cut-off key.

16.21 Outgoing Calls

When the receiver at the station is removed from the switchhook, the trunk is started and functions as described in Paragraph 6.

16.22 Incoming Calls

When seized at the central office, the trunk functions as described in Paragraph 8. Relay (R) may operate but will not lock since relay (JK) is operated. The station bells ring from ringing current at the central office upon the operation of relay (CT).

BELL TELEPHONE LABORATORIES, INCORPORATED

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