CIRCUIT DESCRIPTION

CD-5E001-01
ISSUE 3B
APPENDIX 1D
DWG ISSUE 11D
DISTN CODE 3J99

# PBX SYSTEMS
# TRUNK CIRCUIT TO CENTRAL OFFICE
# ONE-WAY OUTGOING -- DIAL SELECTED
# FOR NO. 701A, 701B, 701PK, 702A
# 711A, 711B, 711PK, 740E OR 756A
# OR
# TWO-WAY-MANUAL AND DIAL SELECTED
# FOR NO. 701A, 701B, 701PK OR 740E
# OR
# TWO-WAY-MANUAL SELECTED
# FOR NO. 800A

CHANGES

## D. Description of Changes

D.1 This circuit is rated Mfr Disc.

BELL TELEPHONE LABORATORIES, INCORPORATED

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# 21

PBX SYSTEMS
TRUNK CIRCUIT TO CENTRAL OFFICE
ONE-WAY OUTGOING - DIAL SELECTED
FOR NO. 701A, 701B, 701PK, 702A,
711A, 711B, 711PK, 740E OR 756A
OR
2-WAY - MANUAL AND DIAL SELECTED
FOR NO. 701A, 701B, 701PK, 740E, OR 756A
OR
2-WAY MANUAL SELECTED
FOR NO. 800A

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## SECTION I - GENERAL DESCRIPTION

### 1. PURPOSE OF CIRCUIT

1.01 This circuit provides for one-way service from a dial station to a manual or dial central office. Two-way service between a dial station or PBX attendant and a manual or dial central office is also provided.

### 2. GENERAL DESCRIPTION OF OPERATION

#### A. Incoming Call From Central Office

2.01 The central office is connected to the PBX through the trunk. The trunk may be seized by the central office during the silent or ringing interval. In either case, seizure results in the operation of the H relay. A ringing audible or lighted trunk lamp signals the attendant who answers by inserting the cord plug into the trunk jack. The trunk is then made busy. When the station disconnects, the central office is held until the attendant removes the plug from the trunk jack.

#### B. Outgoing Call to Central Office From Station

2.02 A station line seizes this circuit by dialing the access code assigned to the trunk level in the selector or selector connector banks or a 2-digit number assigned to the universal line circuits in the 756A PBX. Trunk seizure places a ground start signal toward the central office. When the central office equipment is attached the central office returns a ground on the tip of the trunk conductor which cuts the station line through to the central office. Stations which are restricted from the access code must dial the attendant code. The attendant may complete the call via a switchboard trunk jack circuit.

#### C. Outgoing Call to Central Office by Attendant

2.03 The attendant originates a call by inserting the trunk plug of a cord circuit into the trunk jack. This causes the operation of the JK relay which in turn closes the tip and ring circuit. The closed tip and ring starts the central office as described previously. The call is extended to the station in the usual manner for the manual PBX.

#### D. Rering When Connection Is Established

2.04 It is possible for the central office operator to recall the PBX attendant with a call in progress. Ringing current from the central office operates a relay in the cord circuit, lighting a lamp associated with the cord. If the cord circuit is not equipped with a rering relay, relay R operates, which lights the L lamp as a rering signal.

#### E. Toll Diverting

2.05 Stations may dial the central office to reach a toll operator. However, if toll service is not authorized, such calls may be diverted. This feature is called toll diverting and requires the addition of FS11 in the trunk. This circuit is for use only with a central office which reverses the battery after dialing but before the connection is answered. When provided, toll diverting disconnects the station from the central office and transfers it to the attendant or a toll diverting tone circuit.

#### F. Other Features

2.06 A traffic register may be operated through connections to the trunk.

2.07 Optional connectors of a long line circuit between the selector bank and jack appearance may be made.

2.08 Tandem operation allows calls from distant PBXs to be made over a tie trunk through the central office trunk to the central office. The tie trunk connection is made via the selector circuits.

2.09 Night connections are set up through the manual section of the PBX. Both incoming and outgoing calls may be handled.

2.10 Connections to the traffic measurement system (TMS) No. 1A are available to provide (a) waiting time for the attendant, (b) trunk busy, and (c) trunk busy outgoing. Trunk busy outgoing requires connection to the traffic measurement system No. 1A connecting circuit to furnish the COG lead to the TMS.

2.11 Connections are provided to allow this trunk to be associated with the power failure transfer circuit.

## SECTION II - DETAILED DESCRIPTION

### 1. DIAL SELECTED OUTGOING CALL TO A CENTRAL OFFICE FROM A PBX STATION

#### A. Start of a Call via FS1 or FS2 Step-by-Step PBX Operation

1.01 When the trunk is idle and awaiting seizure, three idle conditions exist. First, the trunk will be putting out battery and ground on the tip and ring leads toward the selector bank terminals and, if provided, toward a switchboard jack. If the associated PBX does not contain a register sender, ground will be standing on the tip via the coil of relay S and battery will be standing on the ring via the J resistor. If the associated PBX does contain a register sender, battery will be standing on the tip via the J resistor and the coil of relay S, and ground will be standing on the ring. Second, the coil of relay H will be so connected as to look for seizure from the central office if an incoming call should arrive. Third, one of two treatments will exist on the sleeve lead toward the selector bank terminals. If the associated PBX is a 2-digit machine using selector-connectors, 1200-ohm stopping battery must be applied to the sleeve lead (option G) via resistor D. If the PBX is a three or more digit machine, the sleeve lead will be open having neither battery nor ground on the sleeve in the idle state.

1.02 When a PBX station has initiated a call and dialed the access code for the bank level assigned to this trunk, the selector or selector-connector will start to rotary hunt over the bank terminals assigned to central office trunks. If either type of switch encounters a ground on the first sleeve terminal, it will step to the next terminal. If this terminal is idle (selector sleeve open or selector-connector sleeve 1200 ohm battery), the switch will stop. When the switch stops, relays in the switch will momentarily ground the sleeve lead for the duration of the release cycle of slow-release selector relay B to hold all apparatus until the control office trunk can function. At the same time the switch will cut the station tip and ring circuit through to the trunk where the battery and ground referenced in 1.01 will cause current to flow through the station loop, and the coil of relay S in the trunk operating relay S. Relay S has only one set of contacts, which when actuated, operates relay S1.

1.03 Relay S1 operated (FS1):

(a) Prepares a locking path for relay CT which will lock up when relay SR operates (contact M1).

(b) Grounds lead A to ANI equipment if provided, or grounds lead S1 to the station message register pulse circuit, if provided (contact M2).

(c) Grounds the arrangement of leads variously labeled S, S1, SL, DL, and SS2 which provide common hold control logic basic to further operation of this trunk and all possible connecting circuits. This ground, depending on the options used and the number of connecting circuits provided in the associated PBX, may accomplish one or several of the following:

(1) Ground will be applied to the sleeve leads S to hold the selector switch which has just seized the trunk after the slow-release selector relay B releases. Relay B also marks this bank terminal busy to all other selectors. The sleeve of the night jack is grounded. The ringing range extender circuit, night transfer circuit, or 800A trunk circuit also receives ground.

(2) On leads SL, the ground may operate relay T in FS10 (if provided) to initiate lamping functions. It also travels to the ringing range extending circuit.

(3) On leads S1, the ground goes to the intra-PBX protection of service, ANI equipment, and contacts of relay N for night operation.

(4) On leads DL, the ground prepares a lock path for relay R in the ringing circuit and travels to the auxiliary trunk for use with key telephone sets.

(5) On lead SS2, the ground goes to the station message register pulse circuit.

Note: When some of the connecting circuits are used the ground goes out to them, performs the required operation, and loops back to the trunk on another lead to complete the trunk functions (contact M4).

(d) Grounds lead DD under control of relay SR to operate relay DD in FS3 or FS10 if provided (contact M6).

(e) Opens lead K or BR to the traffic register circuit (contact B7).

(f) Temporarily grounds the ring side of the line toward the central office under control of relay SR as a seizure signal to the central office (contact M8).

(g) Opens one of two possible paths from battery through resistor 13 and relay H coil to the tip side of the central office line (contact B9).

(h) Provides a locking ground on lead D22 to hold relay DD in FS3, if provided, and option XN grounds DL2 to the

ringing range extending circuit, if provided (contact M10).

(i) Closes the second of two possible paths from battery through resistance B under control of relay SR (option XP). It also closes the coil of relay H to the tip side of the central office line awaiting the return of ground from the central office thus signifying the CO is fully seized and ready to receive dial pulses (contact M12).

1.04 Relay S1 operated (FS2):

(a) Prepares a locking ground for relay CT which will operate later (contact M1).

(b) Grounds the arrangement of leads variously labeled S, S1, SL, DL, and SS2 which provide control logic basic to further operation of this trunk and all possible connecting circuits. This ground, depending on the options used and the number of connecting circuits provided in the associated PBX, may accomplish one or several of the following:

(1) Ground will be applied to sleeve leads S to hold the selector switch which has just seized this trunk after the slow-release selector relay B releases, and to mark this bank terminal busy to all other selectors. It also grounds the sleeve of the night jack, and goes to the ringing range extender circuit, night transfer circuit, or 800A trunk circuit.

(2) On leads SL, it operates relay T in FS10 (if provided) to initiate lamping functions, and also goes to the ringing range extender circuit.

(3) On leads S1, the ground goes to the intra-PBX protection of service, ANI equipment, and contacts of relay N for night operation.

(4) On leads DL, it prepares a lock path for relay R in the ringing circuit and also goes to the auxiliary trunk circuit for use with key telephone sets.

(5) On lead SS2, the ground goes to the station message register pulse circuit.

Note: When some of the connecting circuits are used the ground goes out to them, performs the required operation, and loops back to the trunk on another lead to complete the trunk functions (contact M2).

(c) Grounds lead S1 to the station message register pulse circuit and lead A to ANI equipment. It also grounds lead DD, under control of relay SR, to operate relay DD in FS3 or FS10 (if provided). Lead DD is grounded to the auxiliary trunk circuit for use with key telephone sets (contact M4).

(d) Removes ground from lead K or BR to the traffic register circuit (contact B5).

(e) Temporarily grounds the ring side of the line toward the central office under control of relay SR via resistor L (unless strapped out) as a seizure signal to the central office (contact M6).

(f) Connects the low resistance winding of relay H in series with battery via resistance B. It also connects the contacts of relays SR and CT to the ring side of the central office line which is awaiting the return of ground from the central office as an indication that the CO is fully seized and ready to receive dial pulses (contact M8).

(g) Opens the path via the high resistance winding of relay H to the ring side of the CO line (contact B9).

(h) Shorts out resistance H (if not already strapped out) in series with the ring side of the line (contact M10).

(i) Grounds lead DL2 (option XF), if provided, to provide a locking ground for relay DD in FS3, and option XN grounds lead DL2 to the ringing range extending circuit, if provided (contact M12).

1.05 If provided, relay DD (outdial relay) operated (FS3):

(a) Locks through its own contact to ground on lead DL2 (contact M2).

(b) Lights the trunk busy lamp on the associated switchboard, if provided, or applies battery to lead IND (contact M4).

(c) Opens the dc locking path for the ringing relay (contact B6).

(d) Opens the operate path for the ringing relay to the ring side of the line thus removing it as a load bridged on the transmission path (contact B8).

(e) If a 556 switchboard is provided, places battery via resistance A on the jack sleeve causing it to test busy to an attendant (contact M10).

1.06 Relay DD (outdial relay) operated, if provided, (FS10):

(a) Opens the operate path for relay JS and grounds lead S to the switchboard jack causing it to test busy to the attendant (contact EBM2).

(b) Locks via its own contact to ground on lead SL (contact M4).

(c) Opens the operate path for the ringing relay thereby removing it as a shunt from across the transmission path (contact B6).

(d) Opens the dc lock path for the ringing relay (contact B8).

B. Outgoing Call to Central Office via FS2 Crossbar Operation

1.07 This circuit may be used in conjunction with the 756A PBX to provide additional trunking facilities through universal line circuits. Use is restricted to one-way outgoing only. The 756A PBX has been arranged to use the dial 8 facilities for the central office. The 756A PBX optional facilities information should be examined to determine the use of this PBX.

1.08 A station may seize this trunk by dialing the assigned access code. The line, link, and marker circuit connects the calling station to the universal line circuit assigned to the trunk. When the connection is completed, the station ring is connected to battery through contact 3B of relay CT and resistor J (ZM option) and the station tip is connected through contact 7B of relay CT, the J1 resistor to ground at contact 6B of relay SR. Relay S operates in series with the station loop operating relay S1. After seizure the trunk operation is similar to seizure and disconnection under FS2.

C. Cut-Through

FS1

1.09 A ground provided by relay S1 (described previously) applied to the ring side of the line toward the central office seizes the central office equipment. When the central office equipment is fully seized and ready to receive dial pulses, the central office will return ground on the tip side of the line toward this trunk as a cut-through completion signal. This ground on the tip operates relay H in the trunk to battery at the B resistor. Relay H has only one set of contacts which, when actuated, operates the CT relay.

1.10 Relay CT operated:

(a) Short circuits its own secondary winding to activate the slow-release characteristic (contact M1).

(b) Operates relay SR. Grounds lead B to PBX ANI, or lead SR to the station message register pulse circuit, if provided (contact M4).

(c) As described previously, in the idle state this trunk provides battery and ground toward the PBX selector bank tip and ring terminals awaiting seizure by a selector. When an associated selector connects to the bank terminals for this trunk the current which then flows, initiates the seizure process. When relay CT is operated this local PBX battery and ground is removed from the switch train via options ZN or ZM (with or without register sender) and replaced by the battery and ground now available from the fully seized central office. The resulting station current continues to hold relay S which in turn holds the rest of the trunk and the associated switch train (transfer contacts 7 and 9).

(d) Prior to SD Issue 9B, prepared a shunt down path for relay H which did not release because the contacts of the operated H relay removed the ground path. On Issue 9B and from now on, this shunt down path has been rated Mfr Disc. by the XO option. The release function has been replaced with option XF which provides a series release function via a contact of the S1 relay (contact M10).

(e) Supplements the ground on the common hold lead S, S1, SL, DL, and SS2 to hold the selector and all other possible connecting circuits (contact M12).

1.11 Relay SR operated:

(a) Provides a supplementary path in parallel with that provided by relay DD in FS3 for certain types of switchboards to keep the busy lamp lighted (contact M3).

(b) Removes battery via resistance B from the coil of relay H causing it to release (contact B4).

(c) Opens another contact in the K or BR lead to the traffic register circuit (contact B6).

(d) Provides a supplementary ground on lead DL2 to the ringing range extender circuit, if provided, and to FS3 if provided, to hold relay DD if a switchboard requiring FS3 has been used in conjunction with the PBX (contact M7).

(e) Removes the operate path to ground toward the associated PBX through which the trunk was originally seized, and opens the operate path for relay DD (contact B8).

(f) Supplements the ground on the common hold leads S, S1, SL, DL, and SS2 to hold the selector and all other pos-

sible connecting circuits (contact M9).

(g) Removes the ground from the ring side of the CO line which was originally utilized to seize the central office. The CO will now be held via the current flow through the PBX station (contact B10).

(h) Grounds lead B or MS to the power ringing circuit (contact M11).

(i) Completes the lock path for relay CJ (contact M12).

FS2

1.12 A ground provided by relay S1 (described previously) applied to the ring side of the line toward the central office seizes the central office equipment. When the central office equipment is fully seized and ready to receive dial pulses, the central office will return ground on the tip side of the line toward this trunk as a cut-through completion signal. This ground on the tip operates relay H in the trunk to battery at the B resistor. Relay H has only one set of contacts which when activated, operates the R1 relay.

1.13 Relay R1 operated:

(a) Provides a supplementary operating path for relay H to hold relay H up until relay SR operates (contact M1,

(b) Operates relay CT (contacts M3, A).

1.14 Relay CT operated:

(a) Shorts out the high resistance secondary winding of relay H (contact M1).

(b) Prepares its own locking ground to be completed where relay SR operates (contact M2).

(c) As described previously, in the idle state this trunk provides battery and ground toward the PBX selector bank tip and ring terminals awaiting seizure by a selector. When an associated selector connects to the bank terminals for this trunk, the current, which then flows, initiates the seizure process. When relay CT is operated, this local PBX battery and ground is removed from the switch train and replaced by the battery and ground now available from the fully seized central office. The resulting station current continues to hold relay S which, in turn, holds the rest of the trunk and the associated switch train (transfer contacts 3 and 9).

(d) Supplements the ground on the common hold leads S, S1, SL, DL, and SS2 to hold the selector and all other possible connecting circuits (contact M4).

(e) Opens the path from the tip side of the line to battery via resistor J if ZN wiring for register sender was provided, or to ground via resistor J1 if ZM wiring for no register sender was provided (contact B7).

(f) Short-circuits its own secondary winding to activate the slow-release characteristic (contact M10).

(g) Operates relay SR. Grounds lead B to the PBX ANI or lead SR to the station message register pulse circuit, if provided (contact M11).

1.15 Relay SR operated:

(a) Opens the operate path for relay DD (contact B2).

(b) Provides a supplementary ground on lead DL2 to the ringing range extender circuit, if provided, and to FS3, if provided, to hold relay DD if a switchboard requiring FS3 has been used in conjunction with the PBX (contact M3).

(c) Supplements the ground on the common hold leads S, S1, SL, DL, and SS2 to hold the selector and all possible connecting circuits (contact M5).

(d) Removes the operate path to ground toward the associated PBX through which the trunk was originally seized (contact B6).

(e) Grounds lead B or MS to the power ringing circuit (contact M7).

(f) Provides a supplementary path in parallel with that provided by relay DD in FS3 for certain types of switchboards to keep the busy lamp lighted (contact M9).

(g) Removes battery via resistance B from the coil of relay H causing it to release (contact B10).

(h) Completes the lock path for relay CT (contact M11).

(j) Removes the ground from the ring side of the CO line which was originally used to seize the central office. The CO will be held via the current flow through the PBX station (contact B12).

1.16 Relay H released releases relay R1 (contacts 1, 2).

1.17 Relay R1 released has no effect as the CT relay is now locked up via another path.

Note: Once the detailed functions of the contacts of a relay have been described, contacts will not be referenced again in future remarks about the relay. For contact details in such cases refer back to the first time the relay was described.

FS1 or FS2 Connected to Toll Subscribers Line Circuit

1.18 A ringing audible signal is furnished in FS1 and 2 with option ZS for the calling station or the attendant. A ground from the answering operator's jack circuit operates relay H which either operates relay CT directly in FS1, or operates relay R1 that in turn operates relay CT in FS2. Operation of relay CT removes the ringing audible tone and cuts the talking path from the PBX through to the toll operator. The remaining functions are as described in the appropriate paragraphs under B. Cut-Through.

D. Dialing and Talking

1.19 When the station dials, supervisory relay S follows dial pulses opening and closing the circuit to relay S1. Relay S1 is slow-release and holds over the dial pulses so that this circuit remains in the cut-through mode of operation during dialing and subsequent talking. Relay functions in this mode have removed all shunts from tip and ring so transmission is unaffected.

E. Disconnection

1.20 When the calling station disconnects, relay S releases, in turn releasing relay S1 and the central office equipment because the loop has been opened at the station. The slow-release characteristic of relays S1, SR, and CT gives the central office equipment time to start releasing before the coil of relay H is reconnnected to the ring side of the CO line.

FS1

1.21 Relay S1 released:

(a) Opens the lock path for relay CT causing it to slow-release.

(b) Removes the ANI ground.

(c) Removes one of the grounds from the common hold lead.

(d) Opens one of two lock paths for relay DD, if provided.

(e) Prepares a ground for lead K or BR.

(f) Removes the CO seizure ground.

(g) Reconnects relay H to the CO line. Relay H may temporarily reoperate at this time if the central office has not completed releasing. Relay H reoperated will hold relay CT until the CO has completed its release sequence.

(h) Removes one of two locking grounds from lead DL2.

(i) Opens the locking path for relay H.

1.22 Relay C1 released:

(a) Disables its own slow-release function making it fast operate.

(b) Releases slow-release relay SR.

(c) Opens the tip and ring toward the CO and reestablishes battery toward the PBX.

(d) Prior to SD Issue 9B, opened the relay H shuntdown path.

(e) Removes the second of three grounds from the common hold lead.

1.23 Relay SR released:

(a) Opens one of two paths for lighting the switchboard busy lamp if provided.

(b) Prepares an operate path for relay H for use the next time the trunk is seized.

(c) Grounds lead K or BR to message registers.

(d) Releases relay DD in FS3, if provided.

(e) Reestablishes the ground toward the PBX that is awaiting the next seizure.

(f) Removes the final holding ground from the common hold lead thereby releasing all associated connecting circuits and removing the busy ground from this terminal of the selector switch.

(g) Prepares a path for reseizing the central office on the next outgoing call.

(h) Removes the ground from lead B or MS.

(i) Places another open contact in the lock path for relay CT.

FS2

1.24 The release of relay S1 opens the lock path for relay CT permitting it to slow-release. Relay CT in releasing connects the two windings of relay H in series across the tip and ring toward the central office. If the central office has not yet completed releasing, relay H reoperates causing relay R1 to reoperate. Relay R1 causes relay CT to reoperate thus holding the trunk busy until the CO completes its release sequence and removes battery and ground toward the PBX. Then relays H, R1, CT, SR, and DD will release thereby returning the trunk to the

normally released condition described in 1.01. Details of this release function are similar to those outlined in 1.21 and 1.22 for FS1.

1.25 Relay DD released:

(a) Opens its own lock path.

(b) Extinguishes the trunk busy lamp.

(c) Reestablishes the lock path for relay R.

(d) Reestablishes the operate path for relay R.

(e) Removes the busy test from the switchboard jack.

(f) With FS10 reestablishes an operate path for relay JS.

1.26 With all relays released the circuit is available for receiving new calls from the PBX selectors and the central office or manual switchboard, if equipped. When this trunk is connected to a dial central office, provision is made to ensure the release of the PBX selector after a PBX call is terminated in case the station quickly reoriginates another call. This is accomplished by the break contact of relay SR (B8 on FS1 and B6 on FS2) which does not complete a new path to operate relay S until relays S, S1, H, CT, and SR all have released. The switch train will then fall free even though the PBX calling party may have gone off-hook quickly after termination of a call. If this happens, the PBX station will drop back to PBX dial tone. To initiate another central office call, the number will have to be redialed.

## 2. RECALL ON A DIAL SELECTED CALL

### A. General

2.01 Some automated central office toll facilities do not permit the CO operator to hold this trunk. However, if the serving CO will permit it, provision has been made in this trunk to allow a central office operator, such as a toll operator, special service operator, or a manual central office operator, to recall a PBX station after the station has hung up. This capability may not work in a unigage environment at extended ranges because ringing current is insufficient to operate the station ringer. However, in environments where this will work the operation will be as described in the following paragraphs.

2.02 When the PBX station hangs up, a disconnect signal is initiated toward the central office and the trunk starts to release. However, if the call has been answered at a CO switchboard, the CO cord circuit may be able to prevent the CO equipment from releasing. Thus, battery and ground will still be provided from the central office toward the PBX trunk circuit. This battery and ground will prevent the PBX trunk circuit from completing its normal release and will hold the PBX trunk in a partially released state with the CT and several other relays still operated. This will prevent the PBX switch train from falling free.

2.03 When the central office operator rerings toward the PBX, the ringing current will pass back through the contacts of the still operated CT relay and the PBX switch train to the ringer of the PBX station which will ring if sufficient ringing current is present.

### B. FS1

2.04 When the PBX station hangs up, relays S and S1 will release thereby placing relay H back on the PBX battery via the B resistor. The other end of the H relay coil is hard wired to the still grounded tip side of the CO line and relay H will reoperate. This in turn will hold relays CT and SR, thus allowing CO switchboard ringing to reach the station.

### C. FS2

2.05 Depending on whether option X or ZO is applied, relay H will either be connected across tip and ring or to PBX battery via the B resistor. In either case, when relays S, S1, and CT release a reoperate path will exist for relay H which will reoperate. This in turn will reoperate relay R1. Relay R1 reoperated will operate relay CT and simultaneously provide a hold path for relay H. Thus relays H, R1, CT, and SR will remain operated holding the trunk partially seized with only the S and S1 relays released. This will hold the PBX switch train. When the CO operator rerings, the current will go back through the still operated contacts of relay CT and the switch train to rering the station.

### D. Station Answers

2.06 When the rerung station answers relays S and S1 will reoperate thereby disconnecting relay H from the circuit and reestablishing the call. This allows the CO operator to converse with the calling party in order to report time and charges. Relay CT remains operated under the control of relays S1 and SR. Relay R which would ordinarily operate after receiving ringing from the central office, cannot operate on this rering because relay DD, which was locked up to a relay SR contact, has under these conditions removed the ring relay from the circuit.

## 3. INCOMING CALL FROM CENTRAL OFFICE

### A. Seizure

3.01 When this trunk circuit is idle, relay H is connected to the CO line to recognize when an incoming call is present at the central office end. With FS1, or with FS2 and ZO option, relay H is connected from the tip side of the line to battery at the B resistor. With X wiring in FS2, relay H is bridged across the tip and ring of the CO line because in step-by-step areas the battery and ground polarity may be in either direction. The direction is determined by whether the trunk was seized by a local or a toll connector which in turn is dependent on where the call originated.

#### Seizure With FS1 or FS2 and ZO Option (Crossbar or Panel CO)

3.02 When the trunk is seized from the central office during the silent interval, the central office equipment will have placed ground on the tip and battery on the ring toward the trunk circuit. The ground on the tip will operate relay H to PBX battery at resistor B. In FS1 relay H will directly operate relay CT. In FS2 relay H will operate relay R1, which will in turn operate relay CT.

3.03 If option YK is provided (station message register surcharge circuit), the operation of relay CT in either FS1 or FS2 will be delayed during surcharge registration of the previous call. After the surcharge is registered, relay CT will then operate.

3.04 If the trunk is seized during the ringing interval, the central office equipment will have applied ringing ground to the tip lead which will also operate relay H as described above. Then relay R1 and/or relay CT will operate under control of relay H. Relay R will operate from CO ringing current on the R lead.

#### Seizure with FS2 and X option (Step-by-Step CO)

3.05 If FS2 with X option is provided, the two windings of relay H are bridged across the tip and ring sides of the central office line. If the trunk is seized during the silent interval, the central office equipment will have placed battery and ground on the leads toward the PBX. The polarity will depend on whether the trunk was seized from a local or a toll connector. This CO battery and ground will operate relay H. Relay H operated will operate relay R1 which will in turn operate relay CT.

3.06 If the trunk is seized during the ringing interval, the central office will have superimposed ringing current on the CO battery and ground on the leads toward the trunk. Relay H will operate on the dc component but may be caused to flutter by the ringing current. Relay H operated will operate relay R1 which will in turn operate relay CT.

3.07 As before, if the station message register surcharge circuit (option YK) is provided, operation of relay CT will be delayed during surcharge registration of the previous call. Then relay CT will operate.

#### Ringing Current Received - FS1 and FS2

3.08 Depending on what type of switchboard is used the trunk will have been provided with ringing relay circuit FS9 or FS13 for incoming calls. In either case, the presence of ringing current on the tip and ring leads will operate the ring relay which, at this time, is bridged across the trunk tip and ring leads.

3.09 To guard against false seizures the ringing relay circuits have thermistor R placed in series with the coil of relay R. When cold, this thermistor has an internal resistance of several thousand ohms, thereby preventing sufficient current to flow to operate relay R. The ringing current however, heats thermistor R thus causing its resistance to drop to less than 100 ohms. This will operate relay R after a delay of several milliseconds. Relay sequences and functions for incoming seizure are as follows.

3.10 Relay H operated:

(a) Operates relay CT in FS1.

(b) Operates relay R1 in FS2.

3.11 Relay R1 operated:

(a) Operates relay CT.

(b) Provides a holding path for relay H.

3.12 Relay CT operated:

(a) Enables its own slow-release characteristic.

(b) Operates relay SR.

(c) Connects the central office line through relay S to the switchboard jack circuit.

(d) Grounds the common hold leads S, S1, SL, DL, and SS2 to initiate functions in the connecting circuits and to mark busy the selector bank terminals that are associated with this trunk. If FS10 is provided, relay T is operated.

(e) Prepares its own locking path to contacts of relays S1 and SR.

(f) Removes PBX battery and ground from the PBX side of the T and R leads.

(g) If FS2 option X is being used, shorts the high resistance winding of relay H.

3.13 Relay SR operated:

(a) Opens the operate path for relay DD.

(b) Grounds lead DL2 to the ringing range extender circuit, if provided.

(c) Supplements the ground on the common hold leads S, S1, SL, DL, and SS2.

(d) Grounds lead B or MS to the power ring circuit.

(e) If FS3 is being used, lights the busy lamp, etc, by applying battery to leads BL, BL1, and IND.

(f) Prepares a lock path for relay CT.

3.14 Relay T operated (if FS13 is provided) operates idle indicating lamp function (contact 6).

3.15 Relay R operated:

(a) Provides its own locking path (contact M8 in FS9 and contact M8 in FS13).

(b) Lights the trunk lamp steadily until the attendant answers the call (contact M6 in FS9 and contact M6 in FS13).

## B. PBX Attendant Answers

### FS3 and Jack Circuit (For 552-, 556-, 605-, and 608-Type Switchboards)

3.16 When the lighted trunk lamp alerts the attendant that a call is incoming, the attendant inserts a switchboard cord plug into the trunk jack that is associated with the lighted lamp to answer the call. Insertion of the plug into the jack actuates contacts on the jack which provide a path for operation of relay JK via the S1 and SL leads. With 552, 556, and 605 switchboards, this path is in series with a relay in the switchboard. With 608-type switchboards this path is to ground at the contacts of the jack circuit. The manner of operation is similar for both families of switchboards and where other differences occur they will be noted in the following paragraphs.

3.17 Relay JK operated:

(a) Cuts the trunk tip and ring leads through to the switchboard jack thereby completing the transmission path (contacts M2 and M4).

(b) With 552- or 608-type switchboards, opens the operate path of relay R. If a 556-type switchboard is used, option F straps out this contact (contact B5).

(c) With 608-type switchboards, XH option places resistance ground on the jack sleeve lead. With 552, 556, or 605 switchboards, this contact is not used (contact M6).

(d) Opens the lock path for relay R causing it to release thereby extinguishing the trunk lamp (contact B7).

(e) Provides a supplementary ground to the common hold lead to ensure marking busy the selector bank terminal associated with this trunk and extends the P1 lead to ANI equipment, if provided (contact M8).

(f) Opens the operate path for relay DD (contact B9).

(g) Provides a supplementary battery path for the busy lamping function via leads BL, BL1, and IND as required (contact M10).

### FS10 and Jack Circuit (For 606- or 607-Type Switchboards)

3.18 When the attendant answers by inserting a switchboard cord plug into the jack associated with the lighted trunk lamp, battery on the ring lead of the switchboard cord circuit will partially operate 2-step relay JK on the first step. This closes preliminary make contacts 6 and 7B on relay JK. This completes an operate path for relay JS via jack lead S to ground in the switchboard cord circuit thereby operating the JS relay. Relay JS operated then causes relay JK to fully operate on the second step.

3.19 Relay JK fully operated:

(a) Opens the operate path for relay DD (contacts 1, 2T).

(b) Opens the locking path for relay R causing it to release and simultaneously extends the P1 lead toward the ANI circuit, if provided (contacts 3, 4, 5T).

(c) Cuts the trunk tip lead through to the switchboard jack thus preparing the transmission path (contacts 6, 7T).

(d) Opens the operate path for relay R (contacts 1, 2B).

(e) Opens the original operate path by which relay JK was operated on the first step and simultaneously cuts the trunk ring lead through to the switchboard jack thereby completing the transmission path (contacts 3, 4, 5B).

(f) Continues to provide an operate/hold path for relay JS (contacts 6, 7B).

3.20 With either FS3 or FS10, when the transmission path is completed through to the switchboard cord circuit there is a bridging

impedance across the cord circuit tip and ring which trips central office ringing. At the same time, the dc current which flows from central office battery and ground operates relay S in the trunk. Relay S operates relay S1 which removes relay H from the circuit and provides a locking path for relay CT as described in A. Start of a Call via FS1 or FS2 in 1. of this section.

C. Disconnection on Incoming Calls

3.21 When the PBX station to which the attendant extended the incoming call disconnects, a bridge is connected across the tip and ring in the switchboard cord circuit to hold the central office until the switchboard attendant removes the plug from the jack. When the plug is removed, the current path for relay S is opened causing it to release which in turn causes relay S1 to release. A disconnect signal is sent to the central office and the trunk releases from this point as described in D. Disconnection, in 1. of this section.

## 4. OUTGOING CALL FROM MANUAL APPEARANCE

4.01 When a switchboard attendant is required to extend an outgoing PBX call to a central office over this trunk, the busy lamps or idle indicating lamps are first inspected to locate an idle trunk. When an idle trunk is detected, the trunk switchboard plug for the call to be extended to the central office is inserted into the idle trunk jack.

4.02 Depending on what family of switchboards has been provided, one of two jack relay circuits will have been installed with the trunk. The jack relay circuit of FS3 will have been installed if the associated switchboard is of the 552, 556, 605, or 608 family. Jack relay circuit FS10 will have been installed if the associated switchboard is of the 606 or 607 family of switchboards. The appropriate jack circuit for the particular switchboard will have been selected from FS4, FS6, FS7, the universal jack circuit, SD-65778-01, or from the 608 switchboard drawings and installed in the switchboard. Because the functions of FS3 and FS10 are different they will be described separately.

A. FS3 and Jack Circuit for 552, 556, 605A, and 608 Switchboards

4.03 FS3 can be used with two types of switchboards. One type is represented by 552, 556, or 605A switchboards. The other type is represented by 608-type switchboards. The manner by which the jack relay is operated differs on the two types of switchboards. In the case of the 552, 556, or 605 switchboards insertion of the left plug of a cord pair into the jack closes the contact springs in the jack circuit thereby connecting a grounded relay in the switchboard cord circuit over lead S1 or SL in series with relay JK to the PBX battery thus operating both the JK relay and the cord relay. In the case of the 608-type switchboards insertion of the plug into the jack operates a set of jack contacts which places a ground on lead S1 or SL operating relay JK directly. Thereafter the operation in the jack relay circuit is similar.

4.04 Relay JK operated:

(a) Cuts the switchboard T and R leads through to the trunk circuit (contacts M7 and M4).

(b) With 552- or 608-type switchboards, opens the operate path of relay R. With 556-type switchboards option F straps out this contact (contact B5).

(c) With 608-type switchboards XH option places resistance ground on the jack sleeve lead causing the switchboard cord circuit to function thereby placing a bridge on the T and R leads to operate seizure relays in FS1 or FS2. With 552- or 551-type switchboards, this contact is not used (contact M6).

(d) Opens the lock path for relay R (contact B7).

(e) Grounds the common hold leads S, S1, SL, DL, and SS2 thereby marking the selector bank terminals busy for any dial selected call that may be simultaneously processed by the associated PBX (contact M8).

(f) Opens the operate path for relay DD (contact B9).

(g) Places battery on leads BL, BL1, and IND to light the busy lamps (contact M10).

B. FS10 and Jack Circuit for 606- or 607-Type Switchboards

4.05 When an attendant must extend a call to a central office through a 606- or 607-type switchboard the idle indicating lamps must be examined to locate an idle trunk. The front switchboard cord plug is then inserted into the jack. When the plug is fully seated the ring lead will be closed through to the secondary coil of 2-step relay JK. Battery from the switchboard cord circuit on the ring lead then operates relay JK on the first step. Relay JK then operates relay JS which in turn fully operates relay JK.

4.06 Relay JK operated:

(a) Opens the operate path for relay DD (contacts 1, 2T).

(b) Opens the locking path for relay R thus preventing its operation during the outgoing call. It simultaneously extends a ground on lead P1 toward the

ANI circuit, if provided (contacts 3, 4, 5T).

(c) Cuts the switchboard tip lead through to the trunk preparing the transmission path (contacts 6, 7T).

(d) Opens the operate path for relay R (contacts 1, 2B).

(e) Opens the original path by which relay JK was operated on the first step, and simultaneously cuts the trunk ring lead through to the switchboard jack thereby completing the transmission path to the trunk. This path provides a current flow path to operate relay S in the trunk, thus initiating seizure (contacts 3, 4, 5B).

(f) Continues to provide an operate/hold path for relay JS (contacts 6, 7B).

C. Dialing and Talking

4.07 With any of the switchboards the cord circuit closure on the tip and ring leads causes the trunk circuit to be seized and in turn to seize the central office. From this point on, seizure dialing and talking is the same as that outlined in 1. of this section.

4.08 The call is extended to the station in the usual manner in the manual PBX. In other words, the station may have stayed in on the connection when the attendant was dialing. Alternatively, it may have disconnected and waited for the attendant to recall it after dialing was completed. Or, the attendant may have established a through dial connection in which case the station would have dialed the call. The operation of the trunk in all circumstances is the same as discussed previously.

## 5. RERING WHEN CONNECTION IS ESTABLISHED VIA A MANUAL SWITCHBOARD

5.01 As noted in 2.01, when the serving CO equipment permits holding on attendant dialed calls to toll operators, it is sometimes necessary for the central office operator to recall the PBX attendant after the attendant has left the connection. In offices utilizing a unigage cable plant, it may not be possible to accomplish this at maximum unigage ranges because of insufficient ringing current. In such cases, information such as time and charges must be passed back to the PBX attendant by the toll operator thereby disconnecting and calling the PBX attendant back. However, in cases where the PBX is within ringing range the toll operator may ring toward the PBX. The incoming ringing current from the central office will operate a ring relay in the PBX switchboard cord circuit thus lighting the lamp on the PBX switchboard for that particular cord circuit. Relay S in the trunk will follow the pulsations of the 20-Hz ringing current holding relay CT and S1 operated. The trunk remains seized.

5.02 With relay CT hold and the trunk still seized, the ringing current can go back through the operated CT and JK relay contacts and operate the ring relay in the switchboard.

5.03 When the switchboard cord circuit does not contain a rering feature such as the 556 switchboard used with FS3, option F must be applied to the trunk ringing circuit. This prevents the operate path of the ring relay from being opened up by the operation of relay JK. Then when rering current is applied from the central office the thermistor in the trunk ring relay will heat up allowing the ring relay to operate. The lock path is opened for relay R, so it will not remain locked up, and follows central office ringing. This in turn causes the trunk lamp to flash everytime ringing current is applied thereby alerting the attendant to come back on the circuit.

## 6. OPERATION OF RINGING RELAY CIRCUIT

6.01 FS9 and 13 cover the ring relay circuit which employs a thermistor-varistor combination that 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 one half second or longer, the resistance is reduced thereby providing an operating path for relay R. Diode R is provided for two purposes:

(a) To provide a low resistance operating path for the thermistor.

(b) To shunt relay R on one half of the ringing cycle so that relay R will operate steadily during the other half cycle.

6.02 Varistor D is provided for two purposes:

(a) The shunt reduces the effective (heating) current through the thermistor, due to dialing transients, to such an extent that false relay operation is eliminated.

(b) Protects diode R and thermistor R by offering a high resistance on normal ringing and dialing voltages. However, on high transients and surges, its resistance becomes low in order to shunt the high voltage around the varistor and thermistor. Relay R operated locks and connects battery or ground over the L lead to light the L or TRK lamps.

6.03 Option YC adds capacitor R1 in parallel with capacitor R of FS9 to provide 23 uF of capacitance to allow relay R to operate on toll rering when used with a

556-type switchboard. (Toll rerings with a minimum voltage of 95 volts through a 13C resistance lamp.)

6.04 The locking path of relay R is extended through the break contacts of relay DD so that the relay will release relay R when the call is answered at an auxiliary trunk circuit.

## 7. TOLL DIVERTING APP FIG. 10

7.01 In some PBX systems the PBX stations are allowed to have direct access to the toll DDD network central office operator or toll operator. In other PBX systems the customer desires to restrict the access of the PBX stations to the toll network and permit access only to the local area dial network. In some cases tie lines from other PBX systems must be similarly restricted when they have dial access to the central office trunk circuit. For PBX customers who require toll restriction the feature known as toll diverting may be provided by adding App Fig. 10 to the basic central office trunk circuit. Addition of relays TS and OP, contained in FS11, permits the trunk circuit to make use of logic state reversals sent from the central office to control toll denial. Properly equipped central offices are able to provide a battery and ground polarity reversal toward the PBX trunk after dialing is completed but before the call is answered. This occurs only if a toll access code has been dialed. Such a polarity reversal is not provided by the central office for access codes dialed within the allowed local dealing area. Polar relay TS in FS11 gives the trunk the ability to recognize the polarity reversal logic.

7.02 Relay TS is a polar relay which has the low resistance primary winding connected in series with the ring side of the line toward the central office. As long as the central office provides ground on the tip, and battery on the ring sides of the line the resulting current flow is in the wrong direction to operate relay TS because of its polarized characteristics. However, when the central office either momentarily or permanently reverses the polarity by placing battery on the tip, and ground on the ring side of the line the resulting current flow is in the proper direction and causes relay TS to operate. The central office equipment only provides this reversal when an access code is dialed which could result in connection to the toll network, such as a DDD number, a central office operator, or a toll operator.

7.03 If relay TS is not operated the call progresses normally. However, if relay TS is operated it in turn operates the OP relay. Relay OP operated disconnects the PBX calling station from the central office line and transfers or diverts the calling PBX station either to an attendant or to a toll diverting tone circuit depending on which arrangement has been provided in the PBX.

7.04 When the OP relay disconnects the PBX station from the central office line the current source for relay S in the trunk is opened up causing it to release. This releases relay S1 which in turn releases relays H, CT, and SR. Release of relay SR removes the locking ground for relay OP. In the meantime, the toll diverting tone circuit or attendant trunk has supplied a ground on lead S to hold the OP relay. Relay OP remains operated until the station is dismissed by the attendant if this arrangement is provided, or until the PBX station hangs up on receipt of the toll divert tone.

7.05 While relay OP is operated, the circuit is marked busy to the selector bank multiple terminals by means of a ground on lead S1 from the toll diverting trunk or tone circuit. The central office is released immediately when relay OP operates in order to avoid tying up the central office equipment. Use of FS11 provides toll diverting for all stations of the PBX. If it is necessary that some PBX stations be toll denied and some other PBX stations be allowed toll access, separate line finder-selector groups and trunks not containing FS11 must be added to the PBX.

7.06 Relay TS operated:

(a) Closes through a path to hold relay TS operated and to operate relay OP with the secondary winding of relay TS in series with the coil of relay OP to battery (contacts 3, 7).

(b) In some panel and crossbar areas a momentary polarity reversal may occur when a tandem office finds all trunks busy. This may falsely divert a non-toll call rather than return busy tone. In such cases thermistor S may be added via option ZJ to delay operation of relay OP until thermistor S heats sufficiently long to operate relay OP. Then the brief polarity reversal will not falsely divert the call.

7.07 Relay OP operated:

(a) Provides its own lock path via lead S (contact M4).

(b) Removes control of the selector sleeve lead from the trunk and transfers it to ground from lead S1 (contact EMB6).

(c) Opens the PBX station tip and ring leads toward the central office and transfers them to the attendant trunk circuit toll diverting or to the toll diverting tone circuit whichever has been provided (contacts EBM8 and EBM10).

7.08 Ground from operated night jack, feeding through the operated toll diversion circuit, is prevented from reaching the group

multiple and falsely locking up diverted dial selected trunks by use of diode S, ZU option.

## 8. TOLL DIVERTING - APP FIG. 14

8.01 As outlined in 7.01, toll diversion is provided when the customer desires to restrict the PBX station users from the toll network. The circuit as designed in FS15 provides a winding of relay TS in both the tip and ring conductors. The poling of the relay windings allows operation of the relay only when battery and ground are reversed at the central office. This allows local calls to proceed normally. In addition, this arrangement prevents a false ground on the ring conductor at the station set from shunting the sensing relay (TS) and defeating the toll diversion feature.

8.02 Relay TS is a polar relay which has its primary winding in parallel with the tertiary winding in the tip side of the line and its secondary winding in parallel with the quarternary winding in the ring side of the line. As long as the central office applies ground on the tip and battery on the ring sides of the line the resulting current flow is in the wrong direction to operate the relay. When the station user dials an access code for a toll destination, the central office equipment will reverse the battery and ground and operate relay TS. Relay TS operated will operate relay OP. Relay OP locks to ground on the sleeve lead and transfers the PBX station user to either an attendant trunk or to a toll diverting tone, as provided.

8.03 When the station user is diverted as outlined in 8.02, the trunk is disconnected from the switch bank multiple. Relays S, S1, H, CT, SR, and TS release. Relay OP remains operated from the locking ground furnished on the S lead by either the attendant trunk or the tone trunk.

8.04 In some panel or crossbar areas a momentary polarity reversal may occur when a tandom office finds all trunks busy. When the PBX is located in such an area, the S thermistor may be added under the WG option to delay the operation of relay OP during the reversal intervals. In offices where the register furnishes the reversal for toll diversion this problem cannot occur.

## 9. TRAFFIC MEASUREMENT SYSTEM

9.01 Connections to the traffic measurement system No. 1A are provided as follows.

(a) The WFA lead, WB option, measures the attendant waiting time. The WFA lead is grounded when the trunk is seized on an incoming call and the ground is removed when the attendant answers.

(b) The TMS lead, WA option, indicates a trunk busy condition. This lead is grounded whenever the trunk is seized either incoming or outgoing and the sleeve lead is grounded by the S1, SR, or CT relays operated.

(c) The DSET and DLOCK leads, WC options, furnish an indication of an outgoing call. These leads connect to the traffic measurement system No. 1A connection circuit which in turn furnishes a ground on the COG lead to the TMS No. 1A. The DSET lead is grounded when the DD lead is grounded in the jack circuit. The DLOCK lead is grounded when the trunk sleeve is grounded by the operation of the S1, SR, or CT relays. The ground on the D set lead is removed when the SR relay operates.

## 10. TRAFFIC REGISTER

10.01 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.

## 11. LONG LINE CIRCUITS

11.01 Provision is made to optionally connect 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 which have a combined resistance exceeding the central office working range.

## 12. TANDEM OPERATION

12.01 Calls from distant PBXs may be established over the trunk through the central office trunk to the central office without the attention of the PBX attendant. 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 operators' trunks are arranged to reverse the battery.

## 13. NIGHT CONNECTIONS

### A. 701A, 702A, 711A, or 740E PBX Used With 552-Type or a 608A Switchboard Selection with Night Jacks

13.01 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 FS8 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.

13.02 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.

Outgoing Calls

13.03 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 1. of this section.

Incoming Calls

13.04 When seized at the central office, the trunk functions as described in 3., except that the station bell rings and no PBX attendant answers. The presence of resistance H, FS2, limits the amount of ringing current and prevents false operation of the central office tripping relay. When the station answers relays S and S1 operate. The operation of relay S1 places a short on resistance H, FS2 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.

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

13.05 Night connections are established through the manual section associated with the 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 FS7. Relay JK operates and performs the functions described in 4.04. However, the busy lamps will not light during periods when the switchboard is unattended since battery designated B, (option YA) is supplied through the battery cutoff key.

Outgoing Calls

13.06 When the receiver at the station is removed from the switchhook, the trunk is started and functions as described in 1. of this section.

Incoming Calls

13.07 When seized at the central office, the trunk functions as described in 3. Relay R may operate but will not lock because relay JK is operated. The station bells ring from ringing current at the central office upon the operation of relay CT.

14. AUTOMATIC NUMBER IDENTIFICATION

A. Seizure

14.01 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 by the trunk leads A and B. 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.

14.02 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.

B. Identification

14.03 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 us pulse (write, WRP1) over this path and the sleeve of the switch train 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 periods that the trunk connector is operated.

14.04 Outgoing calls from a manual appearance results in the operation of relay JK which completes a metallic path from the trunk sleeve to the operator billing cross-connect field via lead P1. This completes a path to set listed number cores with write pulse WRP1 on attendant originated or attendant assisted calls to the central office.

C. Night Operation

14.05 Inserting a cord plug into a night jack grounds lead S or SL thereby operating relay N. Relay N operated:

(a) Grounds the selector banks to make the trunk busy to the selector circuit.

(b) Opens the sleeve to prevent shorting the identification pulses.

(c) Transfers the sleeve to lead P1 providing listed number billing on all calls during night operation.

## SECTION III - REFERENCE DATA

### 1. WORKING LIMITS*

1.01 Signaling Ranges

| | Max Ext Ckt Res to Grd | Max Ext Ckt Loop at | Min Ins Res | Earth Potential |
|---|---|---|---|---|
| | | 45V 47.5V | | |
| H Relay X Option | | 1800 2590 | 30,000 | |
| | | 2170 3120 | 50,000 | |
| | | 2570 3670 | 100,000 | |
| H Relay W or X Option | 4265 | | + | 0.0 +20 volts |
| | 2365 | | + | -5 +20 volts |
| | 990 | | + | -10 +20 volts |
| | 140 | | + | -13 +20 volts |

*Without long line equipment, the combined loop of maximum extension station and maximum trunk conductor loop plus the series resistance of the cord circuit when FS3 is used shall not exceed the subscriber loop range of connecting central office less 82 ohms with FS11, or 58 ohms without FS11.

+Panel, manual, or crossbar 20,000; step-by-step 30,000 without long line equipment, the combined trunk and station minimum insulation resistance should not be less than these figures.

### 2. FUNCTIONAL DESIGNATIONS

2.01 Relays

| Designation | Meaning |
|---|---|
| CT | Cut Through |
| DD | Outdial |
| H | High Resistance |
| JK | Jack Auxiliary |
| JS | Jack Sleeve |
| N | Night |
| OP | Toll Diversion Transfer |
| R | Ringup |
| R1 | High Resistance Auxiliary |
| S | Supervisory |
| S1 | Supervisory Auxiliary |
| SR | Slow Release |
| T | Transfer |
| TS | Toll Diversion Supervisory |

### 3. FUNCTIONS

A. Outgoing Calls From Stations

3.01 To light the trunk busy lamps or extinguish the indicating lamps and cause the jack sleeve to test busy.

3.02 To signal the central office.

3.03 To connect the calling station to the central office when the central office answers in the case of a manual central office, or when the dial equipment functions and is ready to receive pulses in the case of a dial central office.

3.04 To hold the trunk circuit in the cut-through condition while the station is dialing to a central office.

3.05 To give a disconnect signal to the central office when the PBX station disconnects.

3.06 To hold the PBX end of the trunk busy when the PBX station disconnects until the central office end of the trunk is released.

3.07 To provide for reringing the station when the central office operator rings on the trunk circuit on night connections or on connections dialed by the station.

3.08 To disconnect the station from the central office trunk and connect it to a toll diverting attendant trunk circuit when the central office trunk is arranged to recognize reverse battery from a CLR trunk, or a special operator trunk circuit when the PBX is equipped with a manual section. If the PBX is not equipped with a manual section, the station, under this traffic condition will be connected to a toll diverting tone circuit to indicate that outgoing toll service has been denied.

3.09 To receive an incoming call or to permit the attendant or nontoll diverting stations to make an outgoing call while a toll diverted station is being held by the attendant.

3.10 To provide a ringing audible signal for the station until the toll switchboard operator answers.

3.11 To provide station message register pulse service and station message register surcharge service for outgoing central office trunks.

3.12 To provide connections for the ANI circuit.

3.13 To provide connections for traffic measurement circuits.

B. Outgoing Calls Originated by PBX Attendant

3.14 To light the trunk busy lamps or extinguish the indicating lamps and to make the circuit busy to the PBX selector circuits when the attendant inserts a plug in the jack.

3.15 To signal the central office.

3.16 To connect the PBX cord circuit through to the central office when the operator answers in the manual central office or when the dial central office is ready to receive dial pulses.

3.17 To hold the trunk circuit in the cut-through condition while the attendant is dialing to a central office.

3.18 To give a disconnect signal to the central office when the station disconnects, provided the cord circuits are arranged for through supervision, or when the PBX attendant removes the plug from the trunk jack when the cord circuits are arranged for nonthrough supervision.

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

3.20 To start the ringing machine when associated with a long line circuit which uses ringing current furnished by an intermittently operated ringing machine.

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

3.22 To provide connections for ANI circuits.

3.23 To provide connections for traffic measurement circuits.

C. Incoming Calls

3.24 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.

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

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

3.27 To start the ringing machine when associated with a long line circuit which uses ringing current furnished by an intermittently operated ringing machine.

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

D. Tandem Operation

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

E. Night Service

3.30 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 2-way trunk circuits.

4. CONNECTING CIRCUITS

4.01 When this circuit is listed on a keysheet, the connecting information thereon is to be followed.

(a) Manual, Panel, Step-by-Step, or Crossbar Central Office Subscribers Line and Long Line Circuit - Arranged for Ground Signaling on the Ring Conductor - SD-25003-01 (typical)

(b) 552A, 552D, or 605A PBX Cord Circuits - SD-66198-01 (typical)

(c) 552A, 552D, or 605A PBX Auxiliary Buzzer or Night Alarm Circuit - SD-66467-01

(d) Selector Circuits - SD-66359-01, SD-30200-01 (typical)

(e) Selector Connector Circuits 701A, 711A, or 740E - SD-65721-01

(f) Toll Diverting Attendant Trunk Circuit - SD-66450-01

(g) Toll Diverting Tone Circuit - SD-66446-01

(h) Long Trunk Circuit - SD-66474-01 (typical)

(i) Long Line Circuit - SD-66060-01 (typical)

(j) Toll Diverting Trunk Circuit - SD-32067-01

(k) 556 Cord, Telephone Dial, Buzzer, Ringing, and Battery Circuit - SD-65658-01

(l) Traffic Register Circuit - SD-65771-01 (typical)

(m) Power Ringing Circuit - SD-80946-01 (typical)

(n) Emergency Transfer Key Circuit - SD-66451-01

(o) Idle Trunk Indicating Circuit - SD-66657-01

(p) Cord Circuits 607A and 607B - SD-66707-01, SD-65670-01

(q) Night Alarm Circuit - SD-66653-01

(r) Power Supply for AC Busy and Idle Line Indicating Lamps - SD-80770-01

(s) Auxiliary Trunk Circuit - SD-65725-01

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

(u) No. 608A Auxiliary Signal, Fuse Alarm, Battery Cutoff, and Miscellaneous Circuit - SD-66722-01

(v) Night Transfer Circuit - SD-65837-01

(w) Traffic Usage Recorder Circuit 100 and 200 Terminal Capacity - SD-96549-01

(x) PBX No. 552A, 552B, 552D, 552E, 605A, or 740E Ringing Leads Circuit - SD-66330-01

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

(z) Station Message Register Pulse Circuit - SD-66915-01

(aa) Station Message Register Surcharge Circuit - SD-66922-01

(ab) Automatic Number Indentification Circuit - SD-1E007-01

(ac) Line or Trunk Access Circuit - SD-1E045-01

(ad) No. 800A One-Way Outgoing Central Office Trunk Circuit - SD-1E013-01

(ae) Intra-PBX Protection of Service - SD-1E031-01

(af) No. 608D Auxiliary Signal, Fuse Alarm, Battery Cutoff, and Miscellaneous Circuit - SD-67039-01

(ag) Rotary Out Trunk Switch Circuit - SD-30868-01

(ah) Rotary Out Trunk Switch Circuit - SD-30891-01

(ai) Ringing Range Extending Circuit - SD-5E058-01

(aj) Auxiliary Signaling Circuit for E&M Lead Applications for Use in F-Type Signaling System - SD-1C227-01-A1

(ak) Signaling and Transmission Systems Compatibility Drawing - SD-99421-01

(al) Traffic Measurement System No. 1A Remote Scanner - SD-3B200-01

(am) Traffic Measurement System No. 1A Connecting Circuit - SD-5E061-01

(an) Power Failure Transfer Circuit - SD-5E040-01

(ao) 756A Line, Link, and Marker Circuit - SD-65741-01

## 5. MANUFACTURING TESTING REQUIREMENTS

5.01 The central office trunk shall be capable of performing all of the functions specified in this circuit description and meeting all of the requirements of the Circuit Requirements table.

## 6. TAKING EQUIPMENT OUT OF SERVICE

6.01 The central office trunk can be taken out of service by grounding the sleeve terminal. This busies the trunk at the selector bank. To prevent incoming calls, the central office trunk should be made busy at the central office.

## SECTION IV - REASONS FOR REISSUE

### A. Changed and Added Functions

A.1 Connections have been added to the traffic measurement system No. 1A and TMS No. 1A connecting circuits.

A.2 Connections have been added to allow this trunk to be used by the 756A PBX as a one-way outgoing trunk only.

A.3 The use of this trunk with the 800A PBX has been rated Mfr Disc.

A.4 Information has been added to allow this circuit to be connected to the power failure transfer circuit.

A.5 Information has been added to allow lead TO in FS11 to be connected to the auxiliary trunk circuit.

A.6 The NA lead in FS9 has been changed to separate the NA lead from the L lead to allow ground to allow ground to be provided on the NA lead at all times. When the L lead provided battery to the connecting switchboard no provision was made to furnish ground on lead NA.

A.7 The toll diverting circuit FS11, App Fig. 10, has been rated Mfr Disc., replaced by the toll diverting circuit FS15, App Fig. 14.

### B. Changes in Apparatus

| B.1 Superseded | Superseded By |
|---|---|
| OP relay, AF110, Fig. 10 | OP relay, AG38, Fig. 14 |
| TS relay, 280CY, Fig. 10 | TS relay, 280H, Fig. 14 |
| S diode, 446F, Fig. 10, ZU option | S diode, 446F, Fig. 14, XR option |

B.2 Added

SR network, 185A, Fig. 1, WE option

SR network, 185A, Fig. 2, WE option

B.3 Removed

H resistor, 19DT, Fig. 2, XY option

L resistor, KS-8512,L3A, Fig. 2, XY option

Cable ED-1E073-01,G1, Fig. 13

### D. Description of Changes

D.1 The following changes are made to allow the removal of the S diode in the 701B PBX line finder circuit. The removal of this diode will eliminate an incompatibility between the line finder circuit and the automatic call-through test circuit. This change can only be made at those installations where the register sender circuits are arranged for dial tone monitoring.

(a) ZN option has been rated A&M Only and ZM option has been rated Standard.

(b) When ZM option is applied, the CS1 diode may be removed in the associated line finders. The removal of the S diode from the line finders will allow the B relay to be locked operated when a trouble condition is encountered during testing.

(c) If the associated register senders are not equipped for dial tone monitoring, ZN option must be used and the automatic call-through test set will be incompatable with the line finders.

(d) Note 108 is added to emphasize the use of the ZN option with the register sender.

(e) Note 102 is changed to show the new application of options ZN and ZM.

D.2 The toll diverting circuit, FS11, App Fig. 10 has been rated Mfr Disc. FS15 and App Fig. 14 are added and rated Standard. App Fig. 14 and FS15 rearranges the toll diversion feature so that the sensing relay TS is in both the tip and ring leads to the central office. This arrangement prevents a false ground on the ring lead at the station set from shunting the sensing relay and defeating the toll diversion feature. As a result of this change:

(a) ZU option has been rated Mfr Disc., replaced by XR option which is rated Standard.

(b) ZT option is rated Mfr Disc., replaced by XS option which is rated Standard.

(c) ZE option is rated Mfr Disc., replaced by XT option which is rated Standard.

(d) ZF option is rated Mfr Disc., replaced by XT option which is rated Standard.

(e) ZI option is rated Mfr Disc., replaced by WF option which is rated Standard.

(f) ZJ option is rated Mfr Disc., replaced by WG option which is rated Standard.

(g) H option is rated Mfr Disc., replaced by XW option which is rated Standard.

(h) XV option is added and rated Standard.

D.3 The NA lead in the ringing circuit FS9, ZQ option, has been rated Mfr Disc. and replaced by the NA lead, WD option. This new arrangement allows proper operation on both the L and NA leads when the connecting switchboard requires battery on the L lead and ground on the NA lead.

D.4 The SR network, WE option, is added to both App Fig. 1 and 2 for use when the circuits are connected to the ANT circuit. This network will lower the amplitude of spurious voltages on the B lead to the ANI circuit.

D.5 In App Fig. 2, FS2, the H and L resistors and contact 10 of relay S1 are designated XY option and rated Mfr Disc., replaced by XZ option which is rated Standard. The use of these resistors is redundant.

D.6 Circuit Note 102 has the following changes:

(a) Reference is added to show connection to the No. 1 and No. 2 ESS central offices.

(b) The 756B PBX is added as a connecting circuit.

(c) Reference to the 800A PBX is deleted.

(d) Reference to the register sender circuit is changed to reflect a dial tone monitoring requirement instead of whether the register sender is required.

(e) Note 102 has been revised to regroup and clarify the information.

D.7 Circuit Note 107 has been rated Mfr Disc.

D.8 Note 109 is added to retain a record of the use of the 800A PBX with this circuit.

D.9 Connection to the power failure transfer circuit is added to both FS1 and FS2.

D.10 Connecting information to the auxiliary trunk circuit on lead TD is added in FS11.

D.11 Connecting information to the traffic measurement system No. 1A and the No. 1A TMS connecting circuit is added.

D.12 The circuit title is changed to omit the 800A PBX and add the 756A PBX.

D.13 In FS1 and FS2 option YV is rated Mfr Disc., and option WJ is added and rated Standard to provide an S1 lead to the intra-PBX protection of service circuit. Option WJ was formerly a part of YV option. The T and R leads to the central office have also designated the T1 and R1 leads to provide the proper designated leads to the intra-PBX protection of service circuit. The connecting circuit information for these leads have been changed to show connection to the intra-PBX protection of service circuit. This change is made to allow connection to the toll diverting circuit when the trunk is connected to the intra-PBX protection of service circuit.

D.14 Note 105 is expanded to limit the use of the long line circuit as shown. When this circuit is connected to PBX ANI equipment and a long line circuit is required, a ground start long line circuit should be used between the trunk and the central office.

D.15 WI option is added and rated Standard replacing XP option which is now rated Mfr Disc. XP option has been found to perform no useful function in this circuit.

D.16 WK option is added and rated Mfr Disc., replaced by WL option which is added and rated Standard.

D.17 WM option is designated and rated Mfr Disc. This option provides a 60-uF capacitor for existing installations in FS11, which is rated Mfr Disc. This capacitor may be provided locally and installed to eliminate transmission noise caused by longitudinal unbalance when this circuit is connected to marginal cable facilities.

D.18 Circuit Note 110 is added to show the use of this circuit with the 756A PBX.

D.19 Circuit Note 111 is added to show provision of XB option when options XD or WL are used.

D.20 Circuit Note 112 is added to show the use of option WM.

D.21 WN option has been added to provide an S lead to the line or trunk access circuit.

E. Changes in Transmission Test Requirements

E.1 The TS relay, 280H, App Fig. 14, with an individual apparatus loss of 0.2 dB replaces the TS relay, 280CY, App Fig. 10 which has an individual apparatus loss of 0.4 dB. This change should lower the overall circuit loss by 0.2 dB.

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