

CROSSBAR SYSTEMS
NO. 3
INCOMING PLUG-ENDED TRUNK
CIRCUIT
USING BYLINK
REVERSE BATTERY OR
E AND M-LEAD SUPERVISION

CHANGES

D. Description of Changes

- D.1 The FSI has been revised to show the addition of J option.
- D.2 Circuit Note 104 has been modified.
- D.3 Circuit Note 105 is added.
- D.4 The CAD 1 has been modified.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 5245-GFC

WE DEPT 25830-JRF-GWC-VK

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CHANGES

B. Changes in Apparatus

<u>B.1</u>	<u>Superseded</u>	<u>Superseded By</u>
	M - 18BH Resistor - Fig. 3, Option S	M - 533A Diode - Fig. 3, Option R
	T1 - 535AS Capacitor - Fig. 1, Option P	T1 - 535BS Capacitor - Fig. 1, Option N
	R1 - 535AS Capacitor - Fig. 1, Option P	R1 - 535BS Capacitor - Fig. 1, Option N

D. Description of Change

- D.1 The FS1 has been revised to show the addition of N and K options. Options P and M were not formerly designated and are rated Mfr Disc.
- D.2 The FS2 has been revised to show the addition of R option. Option S

was not formerly designated and is rated Mfr Disc.

D.3 Circuit Note 104 has been revised.

D.4 The SC4 has been revised.

D.5 The FS2 and CAD 2, reference to "Transmission and Signaling Facilities with Type I Interface" is added.

F. Changes in CD SECTION II

F.1 In 5.01, change (a) and (c) to read:

(a) Releases relay DS which opens the R lead to the trunk switch and connector circuit which opens the loop to the called line releasing the S relay.

(c) Its 1 make-contact opens the sleeve lead which drops the connection to the called line.

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<u>ANSWER AND DISCONNECT.</u>	2	<u>1. PURPOSE OF CIRCUIT</u>	
<u>SECTION II - DETAILED DESCRIPTION.</u>	2	1.01 This incoming trunk circuit completes calls from step-by-step offices on a bylink basis. It is arranged for reverse battery or E and M lead supervision.	
<u>1. SEIZURE AND PULSING - SC1.</u>	2	<u>2. GENERAL DESCRIPTION OF OPERATION</u>	
<u>PREFACE.</u>	2	<u>SEIZURE</u>	
<u>SEIZURE.</u>	2	2.01 Seizure of this trunk is made by the step-by-step office during an interdigital interval, making it necessary that an incoming register be attached and ready for pulses before the end of the interval. The incoming register link is provided with a bylink path to the register being connected so that pulses, repeated by the supervisory relays, may be received before the register is attached to the trunk through the link switch. In the event that pulsing commences prior to closure of the bylink path (this might occur on delay in obtaining a register), a means is provided to return overflow to the customer.	
<u>PULSING.</u>	2	<u>COMPLETING THE CONNECTION</u>	
<u>A. Bylink Failure</u>	2	2.02 The marker seizes the trunk via the incoming register link but places the ringing code information in the trunk through the trunk switch and connector circuit. The marker sets up the connection to the called line, makes checks of the T, R, and S, turns supervision of the connection over to the trunk and releases both itself and the incoming register. Ringing of the called station is now started by the trunk.	
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ANSWER AND DISCONNECT

2.03 When the called customer answers, ringing is tripped, the talking path is cut through and answer supervision is returned to the calling end. If at the end of conversation, the calling party disconnects first the trunk releases the connection to the called party and returns to normal. Should the called party disconnect first the trunk sends on-hook supervision to the calling end and awaits their disconnect. An optional time-out feature, if provided, will within 32 seconds release the local (called) customers line should the calling customer fail to hang up.

SECTION II - DETAILED DESCRIPTION

1. SEIZURE AND PULSING - SC1

PREFACE

1.01 This trunk may be arranged either for reverse battery supervision (App Fig. 2) or E and M lead supervision (App Fig. 3). The supervisory relay for the originating end is the A relay (App Fig. 2) or the E relay (App Fig. 3). In the FS, it can be seen that each A relay contact is paralleled by an E relay contact. One additional E relay contact, 9 break, is used in conjunction with a pulse shaping network for relay E. Therefore for the purposes of this description, relay A or E will be written relay A/E and separate paragraphs will not be used to describe the circuit actions when the trunk is equipped for reverse battery supervision (App Fig. 2) or for E and M lead supervision (App Fig. 3).

1.02 The differences between the two types of supervision should be kept in mind when using this Circuit Description. With reverse battery supervision, signaling, pulsing, and speech are sent on the T and R between offices. Whereas with E and M lead supervision the signaling and pulsing from the originating office is sent on the E lead over the signaling facilities, speech is transmitted on the T and R leads.

SEIZURE

1.03 A step-by-step office seizes this trunk by operating relay A/E, during an interdigital interval. Relay A/E operated:

- (a) Prepares the pulsing paths to the incoming register by grounding leads R and BL.

- (b) Connects battery to the ST start lead to the incoming register link.

- (c) Operates slow-release relay B which remains operated as the A/E relay follows dial pulse and thereby holds the trunk busy during the digit dialing interval.

As soon as the trunk gains preference, the link grounds lead RL which operates relay R on its primary winding to resistance battery from the incoming register on the LK lead. Relay R operated is the signal to the trunk that a register is available to the trunk and that the bylink pulsing path over lead BL is closed through to the register.

PULSING

A. Bylink Failure

1.04 Should there be a delay in seizing a register and the bylink pulsing path is not cut through, the R relay will not be operated when the A/E relay releases at the start of digit pulsing at the end of the interdigital interval. With relay A/E released and R released, ground on 8 make B through 2 break CT, 5 break R and break-contacts of A/E operates the BY relay. Relay BY operated grounds the ST lead to the interrupter circuit and connects 120-IPM overflow tone, through its 12 make-contact and A capacitor to the tip lead to the calling customer. Relay BY locks operated to 8 make B and:

- (a) Its 10 break opens the bylink pulsing path to leads BL and R.
- (b) Its 11 break-contact removes battery from the ST lead to the link removing the bid for a register.
- (c) Opens the operate path of the R relay to the LK lead.

The trunk remains in this state until the calling customer hangs up. Then the A/E relay releases followed by the B which releases the BY cutting off the overflow tone. The trunk is normal and ready for another call.

B. Register Attached

1.05 If the trunk gains preference in the link before pulsing begins relay R is operated by the link. Relay R operated:

- (a) Locks operated from ground on 7 break S through 4 make and secondary coil of R, 4 make B relay to resistance battery.
- (b) Transfers through contact 6 control of the ST lead to the link from the trunk to the LK lead from the link.
- (c) Contact 5 break opens the operate path of the BY relay to prevent it from operating during digit pulsing.
- (d) Through contact 2 make partially closes an operate path of the PU pickup relay.
- (e) Contact 8 make partially closes a path to ground from the S sleeve lead.
- (f) Connects resistance battery through the coil of the CT to the sleeve the T1 jack (App Fig. 2) or the T2 jack (App Fig. 3). The potentials which are switched on and off of these jacks are for use of the test circuit when a test call is directed to the trunk.

The dial pulsed digits are received by the trunk A/E supervisory relay and transmitted to the incoming register first over the BL lead bylink path and then, after the register is attached, over the R lead through the link switch crosspoints.

1.06 When the register has received all of the digits it makes a marker start and grounds the CT lead to the trunk which operates the CT cut through relay. The CT operated:

- (a) Cuts through the tip and ring leads from the trunk facilities to the trunk switch and connector circuit.
- (b) Locks to ground under control of 8 make B and transfers ground onto the sleeve of the T1 jack (App Fig. 2) or T2 jack (App Fig. 3).
- (c) Further removes battery from the ST lead to the incoming register link.
- (d) Through 1 make, closes ground to the path which later connect to the S sleeve lead and hold the connection to the called line.

Relay CT is a slow-release relay to hold over momentary releases of the A/E relay. The register monitors the CT lead for the return of the CT relay locking ground as an indication that the call has not been abandoned. Absence of the ground causes the incoming register to time out and release.

2. MARKER OPERATIONS - SC1

2.01 The marker seizes the trunk through crosspoints on the incoming register link circuit. Resistance battery from the marker over lead F operates the F relay. Relay F operated:

- (a) Opens the operate path of the PU pickup relay.
- (b) Grounds the JC, SW, and TT1 leads to the trunk switch and connector circuit.
- (c) Cuts through to the marker the operate paths of the R2, R3, and TP ringing combination relays.
- (d) Transfers the T, R, and S leads to the marker over the T1, R1, and SL leads. The marker performs a trouble ground test on the sleeve and controls the channel over the SL lead. After the channel has been set up, the marker checks tip and ring continuity using the T1 and R1 leads.
- (e) Operates the DS relay.

2.02 Relay DS operated locks through its 9 make-contact to 1 make CT. Contact 8 make partially completes the path from ground to the sleeve lead while contact 10 make partially closes the operate path to the RL thermal time delay relay.

2.03 The marker operates the RC ringing control relay. It checks that RC operates and that its locking path is intact by checking for ground on the RA lead. The path to ground starts at the RA lead and goes through 6 make F, 6 break RT, 12 make RC, and 1 make CT to ground. The marker stores the called party ringing information in the trunk by operating the proper combination of R2, R3, and TP relays. These relays lock to ground through 12 make RC and 1 make CT.

2.04 The marker sets up the channel from the called line to the trunk, performs its tests on the T, R, and S and prepares to release by releasing the trunk F relay. The released F relay transfers the T, R, and S from the line into and under control of the trunk. The marker checks for ground, through 1 make CT, 8 make R, 8 make DS, and 8 break F, to the sleeve lead and then releases. When it releases, the marker dismisses the incoming register which releases.

LINE-BUSY OR OVERFLOW

2.05 If the called line is busy or if there are no paths through the switches, the

marker releases the RC relay. The released RC removes locking ground from the R2, R3, and TP ringing combination relays which release. The RC transfers the called end tip and ring leads from the ringing potential leads and cuts them through to the calling end. The marker connects the trunks vertical appearance on the trunk switch to level 9 of that switch. If it selects appearance A on level 9, 60-IPM line-busy tone will be sent to the calling end and selecting appearance B will send 120-IPM overflow tone. When the marker releases the F relay, line-busy or overflow will be returned to the calling end. Relay S does not operate to send answer supervision.

RINGING COMBINATIONS				
Called Party	Relays Oper	Ringing		Applied To
		Superimp	Coded	
1		Code 1-	Code 1	Ring
2	TP	Code 1-	Code 1	Tip
3	R2	Code 1+	Code 2	Ring
4	R2,TP	Code 1+	Code 2	Tip
5	R3	Code 2-	Code 3	Ring
6	R3,TP	Code 2-	Code 3	Tip
7	R2,R3	Code 2+	Code 4	Ring
8	R2,R3,TP	Code 2+	Code 4	Tip

2.06 The trunk remains in this state until the calling customer hangs up. Relay A/E releases releasing relay B which releases relays CT and R. The CT removes ground from the sleeve releasing the trunk switch. Relay DS releases returning the trunk to its normal idle state.

3. RINGING - SC1

3.01 The marker released the trunk F relay when it prepared to release. The 11 break of the F completes a path from the PU pickup relay coil to either ground or to the PU lead from the PRTD circuit. The combination of transfer contacts, 9 on R2 relay and 4 on R3 relay, and options T and V provide that, if code 1 ringing is to be applied to the tip or ring, the operate path of the PU relay will be grounded through 2 make R and it will operate immediately. If on the other hand, any other code of ringing is to be applied, the operate path will be brought out to the PU lead. The 250-millisecond pulse of ground, which appears on the PU lead near the end of the 6-second ringing cycle, operates the PU at a time which assures that ringing codes 2, 3, or 4 are applied at the beginning of their sequences. In any event the PU relay operates and locks through its 5 make-contact to ground appearing at 12 make of the RC. One of the ringing potentials coming from the PRTD over leads C1, C2, C3, and C4 is applied through the RT ringing trip relay and 3 make PU to either the tip or ring of the called customers line. The following chart specifies the ringing codes sent to the called customer for the various combinations of operated R2, R3, and TP relays.

4. ANSWER - SC2

4.01 Ringing potential is applied to the ring lead of the customers line through 9 make RC or to the tip lead through 8 make RC. Ringing ground through either 3 break or 5 make TP is applied to the side of the line opposite from ringing potential. Some of the ringing potential is feedback as audible tone to the calling customer through the T1 and R1 capacitors. When the called customer answers, the impedance of the line is reduced so that the resultant increased current flow operates the RT ringing trip relay. Contact 6 break of the operated RT opens the lock path of the RC ringing control relay causing it to release. The RC released:

- (a) Releases the ringing combination relays R2, R3, and TP.
- (b) Opens both an operating and the locking path of the PU relay releasing it.
- (c) Completes another path, through its 1 break-contact, from ground to the S sleeve lead.
- (d) The 8 and 9 transfer contacts remove ringing from the called line and cut on the S supervisory relay, which supplies talking battery and ground to the called party; operating the S relay and releasing RT.

4.02 The S relay operates over the called customers loop and maintains supervision of the line throughout the call. The S operated:

- (a) The 7 break-contact opens the lock path of the R relay which releases.
- (b) Apparatus Fig. 2 - The 4 and 8 transfer contacts reverse the polarity on the trunk conductors to the originating end as the answer supervision signal.
- (c) Apparatus Fig. 3 - The 4 contact transfers the M lead to the signaling facilities from ground to resistance battery as the answer supervision signal.
- (d) Apparatus Fig. 3 - The 8 break-contact removes the T idle circuit termination bridged across the T and R.

The trunk is now in the state in which conversation can take place between the calling and called customers. It will remain in this state, with the A/E, B, CT, DS, and S relays operated, until disconnect.

5. DISCONNECT

CALLING STATION FIRST - SC4

5.01 The calling station hanging up causes the A/E relay to release from the on-hook supervisory signal sent by the originating end. Relay A/E releasing releases slow-release B relay. When option Y is provided the 13K ohm B resistor causes the B relay to take more time to release. The option available to help this trunk to maintain the connection when certain step-by-step repeaters are used which may when signaling open the tip and ring inordinate lengths of time. When B releases it releases relay CT. Relay CT released:

- (a) Releases relay DS.
- (b) Opens the T and R paths through the trunk.
- (c) Its 1 make-contact opens the sleeve lead which drops the connection to the called line. The release of the channel releases relay S.

The released S relay returns the disconnect supervisory signal to the originating end by either reversing the potential on the trunk conductors to the step-by-step office (App Fig. 2) or by transferring the M signaling lead from resistance battery to ground (App Fig. 3).

CALLED STATION FIRST - SC3

5.02 When the called party hangs up first, the S relay releases. It sends the disconnect supervisory signal to the originating end by either reversing the potential on the trunk conductors to the step-by-step office (App Fig. 2) or by transferring the M signaling lead from resistance battery to ground (App Fig. 3). It also completes a path from ground on its 7 break-contact through 4 break R, 10 make DS, and 11 break RC to the heater of the RL thermal time delay relay. The RL will require up to 32 seconds time before it operates. If the calling customer hangs up before the time out interval of the RL relay the A/E relay will release followed by the B and then CT. The CT relay released releases both the DS relay and the sleeve holding the connection to the called line. Relay DS released removes ground from the RL relay and the trunk is normal.

A. Time-Out and Permanent Signal Alarm

5.03 The S relay released started the RL thermal time delay timing cycle. If time-out occurs before disconnect supervision is received from the step-by-step office, relay RL operates and operates relay RC. Relay RC operated:

- (a) Removes ground from the RL relay heating element allowing it to cool.
- (b) Removes ground from the S sleeve lead dropping the connection to the called customers line.
- (c) Locks to ground on 1 make CT.
- (d) Option Z - Through its 11 make-contact connects ground to the PS lead to the alarm circuit. This starts a permanent signal alarm as a warning of possible trouble in the step-by-step office switch train.

The trunk remains in this state waiting for the disconnect signal from the step-by-step office. When the A/E relay releases, the results are the same as in 5.02 except that the CT relay releases the RC relay instead of the already released channel and the PS lead is opened by the DS releasing.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.01 The customer working limits for this trunk will be found in the No. 3 crossbar keysheet.

1.02 TRUNK PULSING (App Fig. 2)

Option	Loop Puls		Bat-Grd Puls		A Supervisory Relay	
	W	X	W	X	W	X
Max Ext Ckt Loop Res					2410	4465
Max Cond Loop Res	1200	2500*	2000	4200		
Max Miles of Cable	**	**	**	**		
Min Ins Res	30,000		30,000			

*Minimum of 1200 **See Notes 302 and 303.

2. FUNCTIONAL DESIGNATIONS

2.01 Relays

<u>Designation</u>	<u>Meaning</u>
A (App Fig. 2)	Traditional (Calling End Supervisory)
B	Busy
BY	Bylink Failure
CT	Cut Through
DS	Delay Seizure
E (App Fig. 3)	Traditional (Calling End Supervisory)
F	Traditional
PU	Pickup
R	Register Attached
R2	Ringing Combination
R3	Ringing Combination
RC	Ringing Control
RL	Release
RT	Ringing Trip
S	Supervisory (Called End)
TP	Tip Party

3. FUNCTIONS

- 3.01 Apparatus Fig. 3 - To bridge the idle circuit termination on the T and R to the transmission and signaling facilities.
- 3.02 To connect battery to the ST lead to the incoming register link as a bid for an incoming register.
- 3.03 To return 120-IPM overflow tone to the calling end in the event that pulsing starts before the trunk has gained preference in the link circuit.
- 3.04 To operate a slow-release relay to hold the trunk busy over the dial pulsing interval.
- 3.05 To repeat the dial pulses to the incoming register over the BL and R leads.
- 3.06 To remove battery from the ST lead and transfer control of the lead to the LK lead.
- 3.07 To apply resistance battery to the sleeve of the T1 jack (App Fig. 2) or to the sleeve of the T2 jack (App Fig. 3).
- 3.08 Upon completion of pulsing to cut through the T and R leads from the transmission and signaling facilities to the trunk switch and connector circuit.
- 3.09 To provide a locking ground for relay CT under control of relay B and extend this ground to the register as a check that the call has not been abandoned.
- 3.10 To ground the sleeve of the T1 jack (App Fig. 2) or the T2 jack (App Fig. 3) for test circuit use, when pulsing is completed.
- 3.11 To operate the trunk F relay when the marker applies resistance battery to F lead of the incoming register link.
- 3.12 To ground leads JC, SW, and TT1 to the trunk switch and connector circuit.
- 3.13 To cut through to the marker the operate paths of the R2, R3, RC, and TP relays.
- 3.14 To return the RC relay locking ground to the marker over lead RA.
- 3.15 To transfer the T, R, and S leads to the T1, R1, and SL leads to the marker for tests and control of the channel.
- 3.16 Prepare a circuit to ground, for the S sleeve lead.
- 3.17 When the marker releases the F relay, to connect ringing current of the

proper code and polarity on the side of the line to which the called customers ringer is attached.

- 3.18 To operate the PU pickup relay immediately on calls requiring code 1 ringing.
- 3.19 To delay the start of ringing to the beginning of the ringing cycle for other than code 1 ringing.
- 3.20 To transmit audible ringing to the calling customer.
- 3.21 When the called customer answers, to trip ringing, release the ringing combination relays, establish the connection between the called and calling customer, supply transmitter battery and ground to the called customer and send to the step-by-step an answer, supervision signal.
- 3.22 When the calling customer disconnects first, to release the called customers line and return to normal.
- 3.23 When the called customer disconnects first, to send an on-hook supervisory signal to the step-by-step office and await disconnect from that end.
- 3.24 While waiting for the calling end to disconnect, to time for an interval of 13 to 32 seconds and upon time-out to release the called customers line.
- 3.25 Option Z - To cause a permanent signal on time out when waiting for disconnect from the step-by-step office.
- 3.26 To provide access for testing the trunk; to cut off the T and R and signaling leads; to bridge the T and R with an idle circuit termination when they are cut off.

4. CONNECTING CIRCUITS

4.01 When this circuit is listed on a key-sheet, the connecting information thereon should be followed:

- (a) Trunk Switch and Connector Circuit - SD-26383-01.
- (b) Incoming Register Link Circuit - SD-26394-01.
- (c) Power, Ringing, and Distribution Circuit - SD-26414-01.
- (d) Alarm Circuit - SD-26393-01.
- (e) CX Set and Repeat Coil Circuit - SD-95004-01 (Typical).
- (f) N1 Carrier Applique Schematic - SD-95121-01 (Typical).
- (g) Standard Outgoing Register Circuits in Step-by-Step Office - SD-31779-01 (Typical).
- (h) Step-by-Step System No. 1 Selector Bank Multiple Circuit - SD-32123-01.
- (i) Standard Outgoing Repeater Circuits in Step-by-Step Office - SD-32087-01 (Typical).

5. MANUFACTURING TESTING REQUIREMENTS

5.01 This circuit shall be capable of performing all of the functions listed in this Circuit Description and of meeting the requirements listed in the Circuit Requirements Tables.

6. TAKING EQUIPMENT OUT OF SERVICE

- 6.01 When it is necessary to take this circuit out of service the outgoing circuit at the step-by-step office shall be made busy.
- 6.02 Apparatus Fig. 2 - Test jack T1 provides access to the trunk. When a plug is inserted the trunk pair is opened.
- 6.03 Apparatus Fig. 3 - Test jacks T1 and T2 provide access to this circuit. Insertion of plugs in the jacks disconnects the trunk circuit from the transmission and signaling facilities.

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