

CIRCUIT DESCRIPTION  
SWITCHING SYSTEMS DEVELOPMENT DEPARTMENT

CD-96357-01  
Issue 2-AR  
Appendix 5-D  
Dwg. Issue 9-D

COMMON SYSTEMS  
SIGNAL CIRCUIT  
NO-SUCH-NUMBER TONE SUPPLY  
FOR CROSSBAR, STEP-BY-STEP OR PANEL OFFICE

CHANGES

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Note 104 is extended to include connection to switch trouble alarm circuit for selector shelves in No. 1 and 350A offices and misc. alarm ckt. for selector shelves in No. 355A office.

All other headings, no change.

4. CONNECTING CIRCUITS

Where this circuit is listed on a keysheet, the connecting information thereon shall be followed.

4.01 Vacant Code Trunk Circuits,  
SD-21038-01, SD-25134-01,  
SD-25272-01 and SD-31937-01.

4.02 Signal Circuit Vacant Level Tone  
in Old #1 and 350A Step-by-Step  
Offices, SD-31228-01.

4.03 Tone Jack Circuit in Toll DSA Boards,  
SD-62831-01.

4.04 Tone Jack Circuit in Local DSA  
Board, ES-241904.

4.05 Tone Demonstration Circuit in Cross-  
bar or Panel Office, SD-96299-01.

4.06 Subscriber Sender Circuits  
SD-21193-01 and SD-25012-01 (Arranged  
for timed release).

4.07 Fuse Alarm Circuit for Senders  
SD-21272-01 and SD-25048-01 (Arranged  
for timed release).

4.08 Interrupter Frame Circuit in Crossbar  
Offices SD-25062-01.

4.09 Misc. Ckt. for Misc. Interrupter  
Frame in Panel Offices, SD-21666-01.

4.10 60 and 120 IPM Interrupter Ckt. in  
Step-by-Step Offices, SD-31606-01.

4.11 10 IPM Int. & Impulse Clock Ckt. in  
Step-by-Step Offices, SD-96343-01.

4.12 Audible and Visual Alarm Circuit,  
SD-96188-01.

4.13 Pilot Lamp and Power Alm. Lamp  
Ckt. in 350A Step Office,  
SD-31573-01.

4.14 Misc. Alm. Ckt. for Aisle Pilots in  
355A Step Office, SD-31980-01.

4.15 Misc. Alm. Ckt. for Alarm Control  
in 355A Step Office, SD-31970-01.

4.16 Misc. Alm. and Register Ckt. in Old  
355A Step Office, SD-31798-01.

4.17 Pilot Lamp Ckt. in Old #1 Step-  
by-Step Office, SD-31548-01.

4.18 Floor Alm. Frame Misc. & Aux. Alm.  
Ckt. in Old Crossbar Offices,  
SD-25047-01.

4.19 Floor Alm. Board Misc. & Aux. Alm.  
Ckt. in Panel Offices, SD-21203-01.

4.20 Misc. Alarm Ckt. for Relay Rack in  
355A Step-by-Step Offices,  
SD-31974-01.

4.21 Vacant Code Trunk Ckt.  
SD-25508-01.

4.22 Sw. Tbl. Alm. Ckt. for Sel. Shelves  
in No. 1 or 350A Offices or Misc.  
Alm. Ckt. for Sel. Shelves in No. 355A  
Office, SD-32043-01.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 2353-JPD-EWO-GE

CIRCUIT DESCRIPTION  
SYSTEMS DEVELOPMENT DEPARTMENT

CD-96357-01  
Issue 2-AR  
Appendix 4-B  
Dwg. Issue 8-B

COMMON SYSTEMS  
SIGNAL CIRCUIT  
NO-SUCH-NUMBER TONE SUPPLY  
FOR CROSSBAR, STEP-BY-STEP OR PANEL OFFICE

CHANGES

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

C.1 "Remove associated (TR) lamp" is  
added in the remarks column for  
the (J) U1016 relay.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3330-MHK-AJB-YT

TO BE USED AS AN ORIGINAL  
BY THE HAWTHORNE MAIN SHOP

COMMON SYSTEMS  
SIGNAL CIRCUIT  
NO-SUCH-NUMBER TONE SUPPLY  
FOR CROSSBAR, STEP-BY-STEP OR PANEL OFFICE

CHANGES

B. CHANGES IN APPARATUS

B.1 Superseded,

(H) "W" option U362 relay

Superseded By

(H) "V" option U1238 relay

C. CHANGES IN CIRCUIT REQUIREMENTS OTHER  
THAN THOSE APPLYING TO ADDED OR RE-  
MOVED APPARATUS

C.1 The adjustment for

(H1) (D) relay Y139 was

(H) relay U362

	Soak	Opr.	Hold	Rel.
Test	31	18	1.7	0.8
Readj.	31	17	1.6	1.1
Test		13.5	1.6	
Readj.		12.8		

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 The W and V options were added to  
the circuit note 106 and to the  
(H) relay.

D.2 The weak value for relays (D)  
and (H1) was 31 ma.

All other headings, No change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3350-HCM:JLD

COMMON SYSTEMS  
SIGNAL CIRCUIT  
NO-SUCH NUMBER TONE SUPPLY  
FOR CROSSBAR, STEP-BY-STEP OR PANEL OFFICE

CHANGES

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 "X" wiring and apparatus are added to provide protection for the 60 IPM interrupter contact that supplies interrupted ground to this circuit.

D.2 Position designations "1" and "2" are added to the 577A key top to agree with equipment drawing. Likewise the "A" and "B" designations of springs on the TR key are removed.

All other headings, No change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3350-RLQ-JLD

COMMON SYSTEMS  
SIGNAL CIRCUIT  
NO-SUCH NUMBER TONE SUPPLY  
FOR CROSSBAR, STEP BY STEP OR PANEL OFFICE

CHANGES

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

- C.1 The release adjustment for relay D was, readj. 0.9; H1 was, readj. 0.9.
- C.2 Added test note "Adjacent relays shall not be energized. See B.S.P."

C.3 Added blocking and insulating inf. for relay D on ckt. req. tables.

C.4 Removed reference to test note 3 at relay D.

C.5 Removed (H) NO block inf. for relay H1 and added (G) NO instead.

All other headings, No change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3350-RLQ-RSW

RR 200.4

COMMON SYSTEMS  
SIGNAL CIRCUIT  
NO-SUCH-NUMBER TONE SUPPLY  
FOR CROSSBAR, STEP-BY-STEP OR PANEL OFFICE

CHANGES

B. CHANGES IN APPARATUS

B.1 Removed - 18FW Resistance J.

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Resistance J and "W" and "X" wiring are removed from the circuit to eliminate operation of relay (F) under certain conditions, causing false transfers. This automatically eliminates "Grounded A Relay Cover" trouble, previously cared for on Drawing Issue 3-B by replacing "X" with "W" wiring.

D.2 Information previously given in Circuit Note 103 is now included under Circuit Note 102 to emphasize use of Potentiometer PO in obtaining desired tone.

All other headings under "Changes", no change.

1. PURPOSE OF CIRCUIT

1.1 This circuit generates a distinctive tone for indicating to a subscriber or operator that dialing has resulted in a no-such-number indication to the switching mechanism and supplies this tone to vacant code trunks and sender circuits for transmission to the calling party.

2. WORKING LIMITS

2.1 This circuit has capacity for supplying tone to a maximum of 50 vacant code trunks or a maximum of 25 code trunks and 25 sender circuits.

3. FUNCTIONS

3.1 To generate a distinctive siren like tone on a start-stop plate circuit and a continuously closed filament circuit basis.

3.2 To provide means for regulating the volume and pitch of the tone.

3.3 To provide a half second open period in the tone supply approximately once every six seconds to permit the release of voice frequency Toll Line Dialing connections.

3.4 To provide, thru the use of a transfer key, for supplying tone from either of two separate sources.

3.5 To give an alarm upon failure of a generator to supply tone.

3.6 To provide for automatically transferring the tone supply from one generator to a second generator under alarm conditions.

4. CONNECTING CIRCUITS

4.01 Vacant Code Trunk Circuits, SD-21038-01, SD-25134-01, SD-25272-01 and SD-31937-01.

4.02 Signal Circuit Vacant Level Tone in Old #1 and 350A Step-by-Step Offices, SD-31228-01.

4.03 Tone Jack Circuit in Toll DSA Boards, SD-62831-01.

4.04 Tone Jack Circuit in Local DSA Board, ES-241904.

4.05 Tone Demonstration Circuit in Crossbar or Panel Office, SD-96299-01.

4.06 Subscriber Sender Circuits SD-21193-01 and SD-25012-01 (Arranged for timed release).

4.07 Fuse Alarm Circuit for Senders SD-21272-01 and SD-25048-01 (Arranged for timed release).

4.08 Interrupter Frame Circuit in Crossbar Offices SD-25062-01.

4.09 Misc. Ckt. for Misc. Interrupter Frame in Panel Offices, SD-21666-01.

4.10 60 and 120 IPM Interrupter Ckt. in Step-by-Step Offices, SD-31606-01.

4.11 10 IPM Int. & Impulse Clock Ckt. in Step-by-Step Offices, SD-96343-01.

4.12 Audible and Visual Alarm Circuit, SD-96188-01.

4.13 Pilot Lamp and Power Alm. Lamp Ckt. in 350A Step Office, SD-31573-01.

4.14 Misc. Alm. Ckt. for Aisle Pilots in 355A Step Office, SD-31980-01.

4.15 Misc. Alm. Ckt. for Alarm Control in 355A Step Office, SD-31970-01.

- 4.16 Misc. Alm. and Register Ckt. in Old 355A Step Office, SD-31798-01.
- 4.17 Pilot Lamp Ckt. in Old #1 Step-by-Step Office, SD-31548-01.
- 4.18 Floor Alm. Frame Misc. & Aux. Alm. Ckt. in Old Crossbar Offices, SD-25047-01.
- 4.19 Floor Alm. Board Misc. & Aux. Alm. Ckt. in Panel Offices, SD-21203-01.
- 4.20 Misc. Alarm Ckt. for Relay Rack in 355A Step-by-Step Offices, SD-31974-01.
- 4.21 Vacant Code Trunk Ckt. SD-25508-01.

which is connected to the grid "C" of the amplifying tube (AM) via terminals 1, 2, 3 or 4.

6.2 The amplified oscillating current or tone from plate "P" of tube (AM) passes through the "T" winding on relay (A), contact 3-2 on relay (F) to ground on lead A<sub>1</sub> or A<sub>2</sub>.

Relay (A) also serves as a transformer by inducing the tone in its secondary winding and thence over leads C<sub>1</sub>D<sub>1</sub> or C<sub>2</sub>D<sub>2</sub>, to vacant code trunk, tone jack or tone demonstration circuits. Tone is also induced in its primary winding and is carried thence over lead S<sub>1</sub> or S<sub>2</sub> to a fuse alarm circuit on lead S where it is picked up by sender circuits in crossbar and panel offices for indicating that dialing has resulted in a partial dial or stuck sender condition. The use of this tone for stuck senders is however required only in those central office areas where a centralized "A" switchboard is installed. In either of the above cases a subscriber receives the distinctive tone generated by this circuit and will be instructed to hang up, check the number and dial over again.

6.3 The tone is made to alternately ascend and descend in pitch at one-half second intervals due to the intermittent operation of relay (B) via contact 5-6 relay (C) over 60 IPM Interrupter Lead 3. The operation and release of relay (B) alternates the potential applied to the grid "G<sub>1</sub>" of tube (OS), this potential varying in accordance with the charge and discharge rate of associated condenser (A). This change in potential causes a corresponding variation in the pitch of the tone generated by tube (OS) and amplified by tube (AM).

## DESCRIPTION OF OPERATION

### 5. NORMAL CONDITION

With the transfer (TR) key of Fig. 2 in either the normal or operated position, ground will be connected over lead "FIL<sub>1</sub>" or "FIL<sub>2</sub>" for continuously energizing the filaments of the vacuum tubes (OS) and (AM) in the generator circuit per Fig. 1 that is to be the preferred source of tone. This places the tone generator in condition to give out a tone signal the moment ground is connected to start lead "A" of Fig. 2. Ground on lead "FIL<sub>1</sub>" or "FIL<sub>2</sub>" of Fig. 1 is traced through filament of amplifier tube (AM), resistances (H) and (H<sub>1</sub>), filament of oscillator tube (OS), resistances (G), (F) and (E) in combination with potentiometer (PO), and resistance (D) to battery. The potentiometer (PO) controls the pitch of the tone by varying the bias on grid G of the tube (OS), a bias of .5 volt nominally being maintained at contacts 1 and 3 of relay (B). This places the circuit in condition to start generating a tone the moment ground is connected to start lead (A).

### 6. GENERATION OF DISTINCTIVE TONE

6.1 When vacant code trunk, timed release subscriber's sender, tone jack, or tone demonstration circuits require tone they will connect ground to start lead "A" which then conditions the circuit to supply tone over leads S and C, D. Ground over the "A<sub>1</sub>" or "A<sub>2</sub>" lead is traced through the back contact of relay (F) and thence thru the "T" winding relay (A) to the plate of tube (AM). Relay (A) operates and causes relay (C) to operate which then connects ground thru high resistance (B), the 4-3 winding of retard coil (A), and contact 5-6 relay (E) to plate "P<sub>1</sub>" of tube (OS) which in combination with condenser (B) causes tube (OS) to oscillate. This induces current in the 1-2 winding of retardation coil (A)

### 7. OPEN TONE INTERVAL

7.1 An open tone interval provides for extending voice frequency inter-toll dialing connections over local train selectors in step-by-step offices. This is accomplished as a result of the operation of relay (A) which closes a circuit from battery through resistance (N) and normally closed contact 1-3 relay (E) through winding relay (C) to ground. Relay (C) operated, closes a path for the operation of relay (B) on 60 IPM ground connected to lead 3, opens a path for giving an alarm over lead ALM<sub>1</sub> or ALM<sub>2</sub> and opens the circuits through contacts 1-2 to prevent the operation of relay (F) at this time. Relay (C) also closes a path traced from ground through relay (D), thru contact 4-5 relay (E), thru resistance (P) to 10 IPM battery supply over lead 4. When battery is closed to lead 4 relays (D) and (E) operate in

sequence and the (E) relay at top contacts 3-4-5 transfers the circuit of relay (D) to direct battery through resistance (R) thus making the release of relay (D) dependent on release of relay (C). Relay (E) at BOT. contacts 1-2-3 also transfers the circuit of relay (C) to the 10 IPM battery over lead 4. When this battery supply on lead 4 is opened by the interrupter, relay (C) at once releases and at contact 5-6 opens the plate circuit of tube (OS) because the parallel bot. contact 5-6 relay (E) was previously opened by operation of relay (E). The release of relay (C) also opens the circuit through relay (D) to start timing of the period that the plate circuit of tube (OS) remains open. During this interval relay (C) closes the circuits through contact 1-2 to test relay (F) which will be described later.

7.2 After approx. .5 second relay (D) releases causing relay (E) to release thereby again closing the plate circuit of tube (OS) at contact 5-6 relay (E). The release of relay (E) at bot. contact 1-3 again closes the circuit for relay (C) which reoperates and restores the circuit conditions awaiting the next pulse of 10 IPM battery. The effect of this is to stop tone being generated in the "T" winding of relay (A) during the releasing time of the (D) and (E) relays. During this release time a circuit thru resistance (A2) is connected in parallel with condenser (A) to prevent distortion of the tone when it is again connected.

## 8. CONTROL OF PITCH AND VOLUME OF TONE

Tubes AM and OS are the source of the tone supply and therefore both the Pitch and Volume must be adjusted initially and readjusted if either tube is subsequently changed.

8.1 The "pitch" is changed by first blocking relay B non-operated and then turning the knob of the potentiometer P0 until the pitch corresponds approx. to that of central office dial tone.

8.2 The "volume" of tone may be increased or decreased within certain limits by connecting terminal 1 to terminal 2, 3, or 4. This acts as a potentiometer across the 1-2 winding of retard coil (A) to change the potential of the grid of tube (AM).

## 9. USE OF "Y" AND "Z" OPTIONS

9.1 With "Z" option a trouble condition in the preferred generator causes relay G to operate and close the filament ckt. of the 2nd generator. If the trouble condition remains long enough to permit relay J to operate and transfer the tone supply to the 2nd generator and then disappears, tone supply to all ckts. will be cut off. An alarm will sound as long as the trouble condition is present but terminates when the trouble disappears.

9.2 With "Y" option relay J supplements the filament ground whenever the tone supply is transferred to the 2nd generator, thus preventing trouble in the preferred ckt. from interfering with tone of the 2nd generator.

## 10. MANUAL OPERATION OF TRANSFER KEY

10.1 The circuit of Fig. 2 is arranged so that tone is normally supplied from the first Fig. 1 tone generator circuit and automatically transfers to the second generator of Fig. 1 under alarm conditions. This preference of generator circuits may be reversed by transfer key (TR). Certain procedures must however precede the operation or release of this key made necessary by the time element required for heating the vacuum tubes of the idle generator.

10.2 To change the preference from the first generator to the second generator it is first necessary to operate the (TST) key. This opens the ground connections used in giving an alarm over leads 1 and 2. It opens the ground connection used to operate transfer relay (J) and closes a ground circuit for operating alarm relays (G) and (H<sub>1</sub>). Relay (G) operated at its bottom contacts, connects ground to leads A<sub>1</sub>, A<sub>2</sub> and Fil<sub>2</sub> in order to condition the second generator for use. While the (AM) and (OS) tubes of the second generator are heating up, lamp (2) remains lighted due to the ground connected to lead A<sub>2</sub> traced through normal contacts on relays (C) and (D) over lead AIM<sub>2</sub>. The latter relays cannot operate because relay (A) remains normal awaiting the heating of tube (AM). Lamp (2) going out therefore indicates that the second generator is generating tone and that the transfer key may therefore be operated. After the (TR) key has been operated the (TST) key must be restored in order to make the automatic transfer feature effective.

10.3 To change the preference from the second generator to the first generator the (TST) key must first be operated as just described. Relay (G) operated at its bottom contacts, connects ground to leads  $A_2$ ,  $A_1$  and Fil 1 in order to condition the first generator for use. While the (AM) and (OS) tubes of the first generator are heating up, lamp (1) remains lighted. When lamp (1) goes out the transfer key may then be released and following this the (TST) key must be released.

10.4 If lamps (1) or (2) in the above procedure do not go out it indicates the generator is not functioning properly and the position of the transfer key should not be changed until the trouble in the second or first generator respectively is cleared.

## 11. OPERATION OF ALARMS

### 11.1 Vacuum Tube (AM)

Any trouble condition affecting the filament or plate of the tube (AM) or the operation of relays (A), (C) & (D) will connect ground to lead  $AIM_1$  or  $AIM_2$  to give an alarm, prepare the second generator for use and automatically transfer the tone supply to it. When ground is first connected to lead  $A_1$  or  $A_2$  a normally closed path to lead  $AIM_1$  or  $AIM_2$  exists, which if not opened at contact 3-4 on relay (C) will permit this ground to give an alarm.

Relay (C) may not operate due to a poor contact on relays (E) or (A), an open resistance (N), or failure of (A) relay to operate. The latter relay may fail due to, adjustment, insufficient plate current from a poor tube (AM), an open filament circuit thru tube (AM), a poor contact 2-3 on relay (F), or a shorted condenser (E).

### 11.2 Interrupter Leads 3 and 4

Failure to receive a ground pulse on interrupter lead 3 will cause a steady low pitch tone to be generated without giving an alarm. The failure to receive a battery pulse on interrupter lead 4 will prevent the introduction of an open interval in the tone without giving an alarm and will prevent testing of tube (OS). Both leads 3 and 4 however are partially protected by their own alarms.

### 11.3 Vacuum Tube (OS)

A test is made of tube (OS) during every open interval in the tone, while relays (D) and (E) are operated and relay (C) is released. Upon the release of relay (C) at contacts 1-2, the winding of test relay (F) in series with

resistances (C) and (T) is connected across the gap in tube (OS) between the plate and filament terminals and ground through resistance (S) is connected to the plate of the tube. The circuit of the winding of relay (F) thus in effect makes a voltmeter test of the tube (OS). One characteristic of this tube is that the constant voltage between plate and filament increases as the age of the tube increases. For good tubes the voltage should lie between 18 and 26 volts. As the tube ages this voltage gradually increases and test relay (F) with its close adjustment therefore detects poor tubes giving voltages somewhere between 26 and 31 volts. Either a poor tube or open tube filament therefore operates relay (F) which, at its back contact, opens the circuit of the "T" winding of relay (A) and at its front contact locks operated by connecting the ground on lead "Al" direct to resistance (S). Opening the circuit of relay (A) causes it to release and give an alarm as previously described.

11.4 The preceding paragraph refers only to the Fig. 1 that is the preferred circuit because a similar test of tube OS in the second Fig. 1 is prevented by a contact on the (TR) key in the lead  $B_1$  or  $B_2$  being open. This prevents false operation of the (F) relay in the second circuit due to the tubes not yet being heated up.

## 12. AUTOMATIC TRANSFER TO IDLE GENERATOR

12.1 Any alarm condition resulting in ground being connected to the  $AIM_1$  or  $AIM_2$  lead of the preferred generator in service causes lamp 1 or 2 to light and relay (G) to operate. The (G) relay; at bot. contact 1-2 supplements ground on start lead "A" in order to prevent wiping out the alarm in case ground is removed from start lead "A"; at top contacts 5-6 and 7-8 connects ground to office alarms; at bot. contacts 3-4 and 5-6 connects ground to spare generator lead  $FIL_2$  or  $FIL_1$  and  $A_2$  or  $A_1$  to condition the spare generator for supplying tone; at top contact 3-4 connects winding relay (H) to lead  $AIM_2$  or  $AIM_1$  in order to operate this relay on ground over the alarm lead from the spare generator while the tubes of the generator are heating up. Relay (H) in turn operates relay ( $H_1$ ). When the spare generator is operating properly relay (A) will operate and cause relays (H) and ( $H_1$ ) to release and close the circuit thru the relay (J). Relay (J) when operated, locks to release key (REL), lights lamp (TR) and transfers the "A", "S", "C" and "D" leads to the second generator.

12.2 Lamps (1) or (2) lighted and lamp (TR) lighted indicates trouble in one of the generators, with tone supply transferred to the other generator.

12.21 In this case throw test key (TST) to cut-off office alarms and insure operating ground to both generators while testing the generator in trouble or while continuing to hold this generator out of service.

12.22 When trouble is cleared, as indicated by lamp (1) or (2) going out, restore (TST) key and momentarily operate (REL) key to put out (TR) lamp and restore tone supply to the preference circuit due to release of relay (J).

12.3 Both lamps (1) and (2) lighted and lamp (TR) out indicates trouble in both generators and no transfer of tone supply.

12.31 In this case throw test key (TST) to cut-off office alarms, insure operating ground to both generators, and prevent operation of transfer relay (J).

12.32 Proceed with test on opposite one of the generators to which the "TR" key gives preference.

12.33 When trouble is cleared, as indicated by lamp (1) or (2) giving out, restore "TST" key to permit the supply circuit to be transferred to the spare generator as indicated by lighting of lamp (TR).

12.34 Again throw (TST) key and proceed as under paragraph 12.2 above.

### 13. RELEASE

When the circuits connected to the tone supply no longer require tone, ground will be removed from lead "A", thus opening the ground circuit thru winding "T" of relay (A) to plate of tube (AM) and the ground circuit thru resistance (B), thru winding of Retardation Coil (A) to plate P<sub>1</sub> of tube (OS). The release of relay (A) releases relay (C) and therefore prevents further operation of relays (D) and (E). Ground thru the filaments of tubes (AM) and (OS) however remains connected on the preferred circuit in order to avoid a delay in sending out tone the next time lead "A" is grounded.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3350-RLQ-RSW