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CROSSBAR SYSTEMS
 NO. 3
 AUXILIARY LINE CIRCUIT
 FOR CALL-WAITING SERVICE

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4. <u>INCOMING CALLS WITH CALL-WAITING</u>		1. <u>PURPOSE OF CIRCUIT</u>	
<u>STATION IN TALKING MODE</u>	3	1.01 The purpose of this circuit is to	
CALL ANSWERED ON LINE 2	3	provide call-waiting service for an	
CALL ANSWERED ON LINE 1	3	individual customer in the No. 3 crossbar	
INCOMING CALL DURING RINGING OF		office.	
CALL-WAITING STATION	3	2. <u>GENERAL DESCRIPTION OF OPERATION</u>	
5. <u>CALL TRANSFER</u>	3	2.01 This circuit utilizes the 2-line hunt	
TRANSFER TO CALL-WAITING ON LINE		feature of the No. 3 Crossbar System	
2	3	for its operation. Each line which is to	
TRANSFER TO CALL-WAITING ON LINE		be provided call-waiting service is as-	
1	3	signed to a 2-line hunt group and is pro-	
TRANSFER FROM LINE 1 TO LINE 2,		vided with an auxiliary line circuit per	
WITH LINE 2 PREVIOUSLY ANSWERED.	3	this schematic. The auxiliary line circuit	
TRANSFER FROM LINE 2 TO LINE 1,		is interposed between the customers loop	
WITH LINE 1 PREVIOUSLY ANSWERED.	4	and the two line appearances of the hunt	
		group on the line, line switch and connector	
		circuit. The customers directory number is	
		assigned to the line location associated	

with one line group and the directory number of the second appearance is treated as a blank number.

2.02 A call-waiting customer may originate a call on appearance one, or accept an incoming call to either appearance in the usual manner. Once the initial connection is established, subsequent incoming calls directed to the idle line will signal the customer, by the application of high tone, that a call is waiting on the other line. By flashing the switchhook, the call-waiting customer may transfer between the two calls. While talking on one line the other line is held by a resistance bridge.

TRANSFER TO IDLE LINE

2.03 If the call-waiting customer attempts a transfer to an idle appearance, the circuit is arranged to return overflow tone to the call-waiting customer. A subsequent switchhook flash will effect a transfer to the original connection.

SECTION II - DETAILED DESCRIPTION

1. CALL ORIGINATED ON LINE 1

1.01 The customer initiates a dial tone request by removing the handset and is connected to an originating register. The channel sleeve holding ground supplied by the originating register is through an 18.75 resistance which causes the sleeve 1 detector (S1-DET) to operate, preventing call-waiting tone or transfer while the customer is connected to the register. Incoming calls received during this interval will supply audible ring tone to the calling customer, but call-waiting tone will not be transmitted to the call-waiting customer. Once the originating connection is established, solid ground from the trunk on the sleeve, causes S1-DET to release, allowing L- detector to operate. The circuit is now in a state that call-waiting tone will be transmitted and a transfer made if an incoming call is received. Upon completion of the call, replacing the switchhook returns the circuit to normal.

2. TERMINATING CALLS TO AN IDLE CALL-WAITING STATION

CALL TO LINE 1

2.01 The marker establishes a connection to line 1 in the normal manner. Relay S1 operates from sleeve ground. Upon release of the trunk F relay, ringing is applied to line 1. Removal of the switchhook trips ringing, establishes the connection to the calling line, and causes

operation of the L- detector which conditions the circuit for subsequent transfer if required.

CALL TO LINE 2

2.02 If the marker attempts to complete a call to line 1 as in 2.01 and finds it busy, it will hunt to the second appearance, and attempt to set to line 2. If during this interval, line 1 becomes idle, the marker will still establish the connection to line 2. The application of sleeve ground on line 2 causes S2 to operate. The operation of S2 with S1, A1, and L- detector normal will operate TR and TRA causing ringing to be applied to the call-waiting station. Removal of the switchhook causes ring trip, completing the connection of the calling line on appearance two.

3. INCOMING CALLS ON LINE 2 WITH CALL-WAITING STATION OFF-HOOK

CALL-WAITING STATION CONNECTED TO ORIGINATING REGISTER

3.01 If an incoming call is connected to line 2 while the call-waiting station is originating a call on line 1, relay S2 operates over sleeve ground, and audible ring tone is heard by the calling customer. However, due to the 18-ohm ground supplied by the register on the sleeve of line 1, the S1-detector is held operated, preventing the operation of the L- detector. While in this state, the call-waiting station is unaware of the call on line 2 and ringing tone continues to the calling customer. When the call-waiting station is connected to a trunk, resistance ground on sleeve 1 becomes solid ground, releasing the S1-detector. The L- detector will now operate from the loop, operating A1 and CW as in 8.01. The operation of CW applies call-waiting tone to the call-waiting customer as a signal that a call is incoming on the other line.

CALL-WAITING STATION IN LOCK-OUT MODE

3.02 If an incoming call is connected to line 2 while the call-waiting station is in the lock-out condition, the operation of S2 from the sleeve ground on line 2 will operate the L- detector through the CO relay of the line circuit on the tip of line 1. The L- detector operated prevents TR from operating and the circuit remains with reorder tone to the call-waiting circuit and audible ring to the calling customer. If the call-waiting station goes on-hook, the CO relay of the line circuit releases, allowing the L- detector to release and TR and TRA to operate. The operation of TR and TRA applies ringing

to the call-waiting station and the call proceeds as a terminating call to line 2 as described in 2.02.

CALL-WAITING STATION ABANDONS CALL DURING DIALING

3.03 If an incoming call is connected to line 2 while the call-waiting station is dialing on line 1, S2 is operated from the sleeve of line 2, but the operation of S1-detector will prevent the operation of TR. If line 1 abandons, the release of S1 allows TR and TRA to operate, applying ringing to the call-waiting station and the call proceeds as a terminating call to line 2 as described in 2.02.

4. INCOMING CALLS WITH CALL-WAITING STATION IN TALKING MODE

CALL ANSWERED ON LINE 2

4.01 If a call has been established to line 2 as described in 2.02, relays S2, TR, TRA, A2, and the L-detector have been operated in setting this connection. A call subsequently set to line 1 will operate S1 from sleeve ground on line 1. The operation of S1 with S2, A2, TR, and TRA operated and A1 normal will operate CW as in 8.01 which applies high tone to the call-waiting customer as a signal that a call is waiting on the other line.

CALL ANSWERED ON LINE 1

4.02 If a call has been established to line 1 as described in 2.01, relays S1, and L-detector have been operated to set the connection to line 1. A subsequent call set to line 2 will operate S2 from sleeve ground on line 2 and A1. The operation of S2 with S1 and A1 operated and A2, TR, and TRA normal will operate CW which applies high tone to the call-waiting customer as a signal that a call is waiting on the other line.

INCOMING CALL DURING RINGING OF CALL-WAITING STATION

4.03 If an incoming call as described in 2.02 is connected to line 2 and is ringing the call-waiting station, and at the same time another call is incoming on line 1, the operation of TR will prevent ringing from line 1, but audible ring tone is transmitted to the calling customer, and ringing is maintained from line 2. When the call-waiting station goes on-hook, L-detector operates, ringing from line 2 is tripped and a connection is established to the calling customer. A path is now

closed to operate CW as in 8.01 which applies high tone to the call-waiting customer as a signal that a call is waiting on the other line.

5. CALL TRANSFER

TRANSFER TO CALL-WAITING ON LINE 2

5.01 If the call-waiting station is talking on line 1 either as a result of originating a call or accepting an incoming call, and receives a call-waiting tone as a signal of another call incoming on line 2, a transfer to the other line is made by flashing the switchhook. When the switchhook is depressed, the L-detector is released allowing TR to operate. Ringing may be heard from line 2 depending on the ringing cycles since TR in operating closed R2 to the call-waiting station. Relay TR with A1 previously operated, places resistance H1 across the tip and ring of line 1 to maintain the connection. Release of the switchhook reoperates L-detector and removes the shunt from TRA allowing it and A2 to operate. The operation of TRA completes the transfer to line 2, ringing is tripped and the connection is established. While the connection to line 2 is maintained, line 1 is held through the H1 resistance.

TRANSFER TO CALL-WAITING ON LINE 1

5.02 If the call-waiting station is talking on line 2 as a result of an incoming call and receives a call-waiting tone as a signal of another call incoming on line 1, a transfer to line 1 is made by a switchhook flash. When the switchhook is depressed, the L-detector is released, which sunts down TR. Ringing may be heard from line 1 depending on the ringing cycle, since TR in releasing closed R1 to the call-waiting station. Relay TR released with A2 previously operated placed resistance H2 across the tip and ring of line 2 to maintain the connection. Release of the switchhook reoperates L-detector, releasing TRA and operating A1. The release of TRA completes the transfer to line 1, ringing is tripped and the connection is established. While the connection to line 1 is maintained, line 2 is held through the H2 resistance.

TRANSFER FROM LINE 1 TO LINE 2, WITH LINE 2 PREVIOUSLY ANSWERED

5.03 If the call-waiting station is talking on line 1 and wishes to transfer back to a call held on line 2, a transfer is effected by a switchhook flash. Depressing the switchhook releases L-detector and operates TR. Relay TR places

a hold on both lines. Line 1 is held by bridging H1 resistance across T1, R1 through A1 and TR operated, line 2 is held by bridging H2 resistance across T2, R2, through A2 operated and TRA released. Releasing the switchhook operates the L- detector which removes the shunting ground from TRA, allowing it to operate. The operation of TRA completes the transfer to line 2, while line 1 is still held.

TRANSFER FROM LINE 2 TO LINE 1, WITH LINE 1 PREVIOUSLY ANSWERED

5.04 If the call-waiting station is talking on line 2 and wishes to transfer back to a call held on line 1, a transfer is effected by a switchhook flash. Depressing the switchhook releases L- detector which shunts TR down through TRA operated. The release of TR places a hold on both lines. Line 1 is held by bridging H1 resistance across T1, R1 through A1, and TRA operated, line 2 is held by bridging H2 resistance across T2, R2 through A2 operated, and TR released. Releasing the switchhook operates the L- detector and releases TRA. The release of TRA completes the transfer to line 1, while line 2 is still held.

6. TRANSFER TO AN IDLE LINE

6.01 When the call-waiting station attempts a transfer to an idle line either through an error, or due to an abandoned call, reorder tone is transmitted to the call-waiting customer as a signal that the appearance is idle. When the switchhook is depressed on the attempted transfer, the L- detector will release causing TR to change state. When the switchhook is released to complete the transfer, TRA changes state which connects reorder tone to the call-waiting customer. The customer may return to the original connection by another switchhook flash.

7. DISCONNECT

DISCONNECT FROM LINES 1 AND 2 WITH BOTH HELD BY DISTANT END

7.01 The call-waiting station going on-hook will release the L- detector causing TR to change state placing a hold on both lines by bridging the H1 and H2 resistances across the tip and ring of each line. Battery is now placed on the CW thermistor, and TR and TRA being in opposite states, causes CW to operate. The

operation of CW releases A1 and A2 causing TRA to change state and removes the H1 and H2 resistance bridge, starting the timed release of both trunks. When the line 1 trunk releases, S1 is released and S2 follows the release of the line 2 trunk. The release of S1, S2 will release TR and TRA, if operated, and return the circuit to normal.

CALL-WAITING STATION DISCONNECT FIRST WITH CALL ON ONE LINE

7.02 The disconnect sequence is essentially the same with one trunk connection as with two connections as described in 7.01, except that only one of A1 or A2 and S1 or S2 are operated.

CALLING PARTY DISCONNECT FIRST CALL ON BOTH LINES

7.03 If there are two calls established to the call-waiting circuit and the distant party disconnects while the call-waiting customer remains off-hook, reorder tone will be transmitted to the call-waiting customer, and may transfer to the other appearance by a switchhook flash. The release of the trunk removes sleeve ground releasing the sleeve relay associated with the line. The L- detector will be held operated by local battery and reorder tone is transmitted to the call-waiting customer. If a call is established to line one only a distant party disconnect will place the call-waiting customer in the lock out mode if remaining off-hook. The release of the trunk removes sleeve holding ground which releases the line relay in the line link circuit. The cut off relay will hold to the loop resulting in line lock out. If a call is established to line 2 only, a distant party disconnect will result in dial tone on line one if the call-waiting customer remains off-hook. Release of the trunk releases S2 which in turn releases TR, TRA, A2 and L- detector restoring the circuit to normal. If the call-waiting customer remains off-hook, a dial tone connection on line one will be initiated, as described in 1.01.

8. CALL-WAITING TONE

8.01 The operation of relay S2 will place ground on the CWS lead to the interrupter circuit, which causes relay CWI to be pulsed at a 10-IPM rate. The 10-IPM battery is returned on lead CWB to operate

relay CW when a call-waiting signal is required. Relay CW applies high tone to the ring of the call-waiting station as a signal that a call is waiting. The high tone is applied for approximately 250 milliseconds at 6-second intervals until the transfer is effected, or the calling party abandons.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.01 See range chart in keysheet.

2. FUNCTIONAL DESIGNATIONS

2.01 Relays

<u>Designation</u>	<u>Functional Meaning</u>
A1	Answer Line 1
A2	Answer Line 2
CW	Call-Waiting
L-DET	Line Detector
S1	Sleeve Line 1
S1-DET	Sleeve Detector Line 1
S2	Sleeve Line 2
TR	Transfer
TRA	Transfer Auxiliary

3. FUNCTIONS

- 3.01 The call-waiting circuit is designed to perform the following functions.
- 3.02 To permit the call-waiting station to originate a call on line 1.
- 3.03 To connect an incoming call to either line appearance with call-waiting circuit idle.
- 3.04 To recognize a connection to an originating register and to deny call-waiting tone and transfer capability during this interval.

3.05 To prevent call-waiting tone when an incoming call is set to line 2 if the call-waiting station is in the lock-out mode.

3.06 To recognize an incoming call to an idle appearance when the circuit is in use, and to signal the station that a call is waiting.

3.07 To permit a transfer from one line to another and to maintain a hold on the line not in the talking mode.

3.08 To permit a disconnect from either or both lines when held by the far end.

3.09 To return reorder tone upon a transfer to an idle appearance.

3.10 To start the interrupter circuit and apply 10-IPM high tone to the call-waiting station when required as a signal that a call is waiting.

4. CONNECTING CIRCUITS

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

(a) Interrupter Circuit - SD-26407-01.

(b) Line, Line Switch, and Connector Circuit - SD-26382-01.

5. MANUFACTURING TESTING REQUIREMENTS

5.01 The auxiliary line circuit for call-waiting service shall be capable of performing all functions listed in this Circuit Description and meeting all the requirements of the Circuit Requirement Tables.

6. TAKING EQUIPMENT OUT OF SERVICE

6.01 To take this circuit out of service, the cross connection for the directory number in the line number translator should be changed to trouble intercept to prevent incoming seizures and the associated line relays should be blocked nonoperated to prevent originating attempts.

BELL TELEPHONE LABORATORIES, INCORPORATED

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