OPERATION WITH LOCAL POWER FAILURE

2.13 Same as in 1.11.

3. 400D LINE CIRCUIT (FS3)

SIGNALING

A. Incoming Signal

3.01 In the idle circuit condition, all relays are in the unoperated state, and transistors Q2 and Q3 are off. Transistor Q1 is held on by current supplied to its base through the resistor network formed by RT1, RT2, R4, R8, R16, R11, and the B and C relay coils.

3.02 Ringing voltage is usually applied across the line with the tip side grounded. Ringing current then flows through the series connected primary and secondary of relay L, resistor R2, and capacitor C3, causing relay L to operate on each half Hz of ringing current. Ringing current also flows through C2 and R18 to terminal 2 of zener diode CR8. The - side of CT is normally maintained at about -16 volts. Negative half Hz of ringing cause CR8 to conduct in the forward direction so that terminal 2 of CR6 is at about -24.5 volts. CR6 is thus forward biased and the - end of CT charges through R3 toward -24 volts.

3.03 Positive Hz of ringing cause CR8 to break down so that terminal 2 of CR6 is at about 0 volt. The - end of CT is somewhere between -16 and -18 volts, so CR6 is reverse biased and CT does not charge. However, CT does discharge through the resistor network formed by RT1, RT2, R8, R11, R16, and the B and C relay coils. The charge lost by CT in this interval is much less than that gained during the negative half Hz. After about 0.3 second, a sufficient number of cycles of ringing will have charged CT to about -18 volts, the base potential of Q1, and Q1 thereby turns off. Because of the symmetry of the detector circuit, its operation will be the same when ringing voltage is applied across the line with the ring side grounded. In this case, ringing current flows to terminal 2 of CR8 through C5 and R17.

3.04 When Q1 turns off, its collector voltage rises and Q2 turns on; zener diode CR7 breaks down and Q3 turns on operating relay B. Relay C does not operate at this time since resistor R11 limits the current through its winding to less than its operate value. Relay B operated connects ground to the ST lead, the L lead to the LF lead, and interrupted (option W) or steady (option T) ringing current or ground (option V) to the RC lead for audible signal control. Transistor Q1 remains off and Q2 and Q3 on until the call is answered or timed out.

B. Time-Out of Ringup Circuit - Z Option Not Provided

3.05 At the instant Q1 turns off, the voltage at the - end of CT is about -18 volts. When the B relay operates, the voltage divider formed by resistors R14 and R15 is switched into the circuit, and the voltage at the + end of CT drops from 0 volt to about -6 volts. Consequently, the - end of CT drops from -18 to about -24 volts. On subsequent positive half Hz of ringing, CR6 will be reverse biased as before. Operation of relay B caused terminal 1 of CR5 to be connected back to -24 volts through resistor R8, transistor Q3, and diode CR4. Terminal 2 of CR5 is connected to the base of Q1, which is at about -24 volts so CR5 does not conduct. The discharge path for CT is thus only through resistors RT1 and RT2 to ground. On negative half Hz of ringing, CR6 will conduct slightly to restore the charge lost by CT during the previous positive half Hz. In this way, the charge on CT which determines the duration of the time-out remains constant once the circuit has operated regardless of the duration of the ringing burst.

3.06 When the first burst of ringing has ceased, the - end of CT begins to discharge towards ground through RT1 and RT2. Transistor Q1 remains off until the voltage at the - end of CT reaches -18 volts, at which time Q1 turns on and its collector voltage drops. This causes Q2, CR7, and Q3 to turn off and relay B to release, and the circuit is returned to the idle condition. The time required for the B relay to release after completion of a burst of ringing is approximately 30 seconds.

C. Time-Out of Ringup Circuit - Z Option Provided

3.07 This arrangement functions in a manner similar to that described in 3.05 and 3.06 with the exception that RT2 is short circuited, thereby lowering the resistance through which capacitor CT discharges. This results in a shorter time-out. On incoming calls where one burst of ringing is received, the time-out is approximately 11 seconds. Subsequent bursts of ringing received before the B relay releases reset the time-out circuit to approximately 10 seconds. Any incoming call, for example, which is signaled with machine ringing will time out in approximately 10 seconds after the call is abandoned.

D. Provision for Reduced Time-Out

3.08 In cases where a shorter time-out than that obtained with the Z option is desired, this can be obtained by shunting the RT1 resistor with an appropriate resistor, R. The time-out desired as a fraction of the original time-out, TO, can be obtained by using the appropriate resistor R selected from the table below. Where the duration of machine ringing is 1 second, the time-out

shall not be reduced below 50 percent of the original time-out.

Time-Out Desired	R, megohm
3/4 TO	1.2
2/3 TO	0.75
1/2 TO	0.39
1/3 TO	0.20

E. Answering an Incoming Call - Busy State

3.09 An incoming call is answered by operating the pickup key associated with the line being rung and going off-hook. The station is then connected across the line through the switchhook and key contacts, and ringing is tripped at the CO. Ground is also connected through the switch hook and key contacts to the A lead, operating relay A, which shunts terminals 1 and 3 of relay L preventing it from operating on line current and connects -24 volts to the winding of relay C causing it to operate. Relay C operated disconnects the - end of CT from the base circuit of Q1 and connects resistor R6 across CT causing it to discharge. Transistor Q1 turns on immediately causing Q2 and Q3 to turn off and release relay B. Relay C also removes the center tap of the ringup bridge from the rest of the circuit, thereby preventing the introduction of noise into the talking path. It also disconnects the secondary of relay L and eliminates the shunting effect on the line of the secondary winding in series with R2 and C3. Relays A and C operated (a) establish the talking path, (b) connect the L lead to ±10 volts, and (c) open the RC lead to discontinue local audible signaling.

OUTGOING CALL - BUSY STATE

3.10 The procedure for making an outgoing call is the same as that for answering an incoming call except that transistors Q2 and Q3 are normally off and relay B is released.

HOLDING

3.11 A busy line can be placed on hold by operating the hold key on the telephone set. When the hold key is depressed, ground is disconnected from the A lead causing relay A to release. The A contact shunting the L relay primary opens and, since the station has not yet been disconnected from the line, the L relay operates on line current. Operation of the L relay causes the base circuit of Q1 to be connected through resistor R3, diode CR6, and the operated C relay contact to -24 volts. The voltage at terminal 2 of the L relay contact drops to nearly -24 volts, causing Q1 to turn off and transistors Q2 and Q3 thereby turn on. Q3 will have turned on about 2 ms after relay A releases, and a hold path is thereby provided for relay C through R11, Q3, and CR4, to -24 volts. Finally, relay B operates through Q3. Relays B and C operated (a) connect the hold resistor R1 in series with the primary of relay L across the CO line, (b) connect the LG lead to the ST lead, and (c) connect the L lead to the LW lead (Y option) or to ±10 volts (X option). When the hold key is released, the station is disconnected from the line. Line current through the L relay and R1 maintains the circuit in the hold state.

A. Release of the Holding Bridge by a Station

3.12 Any station of the key telephone system that seizes the line by operating the associated pickup key and going off-hook will cause the A relay to operate and shunt the primary of the L relay, which thereby releases. Transistor Q1 then turns on and Q2 and Q3 turn off releasing relay B. Relay C is held by operation of the A relay. The circuit is thus restored to the busy state.

B. Release of the Holding Bridge from Central Office or PBX - Open Circuit Line (ZC or ZD Option)

3.13 In the event a held party abandons, the line circuit can be released from the connecting switching equipment by providing an interruption of the line current of at least 20 ms (no option provided), 50 ms (ZD option), 500 ms (ZC option). This causes the L relay to release. Transistor Q1 thereby turns on, Q2 and Q3 turn off, and relays B and C release restoring the circuit to the idle state. The above times are valid with short time-out only.

C. Release of the Holding Bridge from the Central Office or PBX - Battery Reversal ZB Option Not Provided

3.14 If the voltage across the line is reversed when the line is in the hold state, the line circuit hold will be retired. Reversal of the line current causes the L relay to release and then immediately reoperate. When the L relay releases, Q1 turns on, Q2 and Q3 turn off, and relays B and C begin to release. The voltage at the collector of Q3 rises to nearly 0 volt, and CR5 conducts providing current to the base of Q1 through R8. After about 2 ms , the L relay reoperates and current is diverted from the base of Q1 through R4, R3, CR6, and the operated C relay contact to -24 volts. However, there is still sufficient current supplied through R8 to keep Q1 on so that Q2 and Q3 remain off and relays B and C therefore ultimately release restoring the circuit to the idle state.

DISCONNECTION

3.15 When all stations go on-hook, the A lead is disconnected from ground causing relay A to release. Release of relay A opens the holding path for relay C which, in turn,

releases. In this way, the circuit is restored to the idle state.

OPERATION WITH LOCAL POWER FAILURE

3.16 During periods when the local dc supply is inoperative, it is still possible to originate outgoing calls. When the station goes off-hook, connection to the line is metallic. The primary and secondary of the L relay are connected in series with R2 and C3 across the line but this has a negligible effect on the talk circuit. Incoming calls are signaled by line ringers in the usual way although visual and common audible signals are inoperative.

4. 400D LINE CIRCUIT (FS4)

SIGNALING

A. Incoming Signal

4.01 In the idle circuit condition, all relays are in the unoperated state and transistors Q2 and Q3 are off. Transistor Q1 is held on by current supplied to its base through the resistor network formed by RT1, RT2, R4, R10, R9, and the B and C relay coils.

4.02 Ringing voltage applied across the line causes a current flow through the series connected primary and secondary of relay L, resistor R2, and capacitor C3, causing relay L to operate on each half Hz of ringing current. Relay L in operating on each half Hz of ringing current charges the negative end of capacitor CT through resistor R3 and diode CR4 toward -24 volts.

4.03 During the intervals when the L relay is released capacitor CT discharges through the resistor network formed by RT1, RT2, R10, R9, and the B and C relay coils. However, the charge lost by CT during these intervals is much less than that gained when the L relay is operated. After about 0.3 second, a sufficient number of cycles will have charged CT to the base potential of Q1, and Q1 turns off.

4.04 When Q1 turns off, its collecter voltage rises and Q2 turns on; zener diode CR7 breaks down and Q3 turns on operating relay B. Relay C does not operate at this time since resister R9 limits the current through its winding to less than its operate value. Relay B operated connects ground to the ST lead, the L lead to the LF lead, and interrupted (option W) or steady (option T) ringing current or ground (option V) to the RC lead for audible signal control. Transistor Q1 remains off and Q2 and Q3 on until the call is answered or timed out.

B. Time-Out of Ringup Circuit - Z Option Not Provided

4.05 At the instant Q1 turns off, the voltage at the negative end of CT is at the base potential of Q1. When the B relay operates, the voltage divider formed by resistors R14 and R11 is switched into the circuit, and the voltage at the positive end of CT drops from 0 volt to -6 volts. Consequently, the negative end of CT drops 6 volts to about -24 volts. Terminal 1 of CR5 is connected to -24 volts through transistor Q3 and diode CR4. Terminal 2 of CR5 is connected to the base of transistor Q1 through resistors R10 and R4 and since the base of Q1 is at about -24 volts CR5 does not conduct. Thus, the discharge path for CT is only through resistors RT1 and RT2 to ground. Continuous operation of the L relay restores the charge lost by CT when relay L is released. In this way, the charge on CT which determines the duration of the time-out remains constant once the circuit has operated regardless of the duration of the ringing burst.

4.06 When the first burst of ringing has ceased, the negative end of CT begins to discharge towards ground through RT1 and RT2. Transistor Q1 remains off until the voltage at the negative end of CT reaches the base potential of transistor Q1, at which time Q1 turns on and its collector voltage drops. This causes Q2, CR7, and Q3 to turn off and relay B to release, and the circuit is returned to the idle condition. The time required for the B relay to release after completion of a burst of ringing is approximately 30 seconds.

C. Time-Out of Ringup Circuit - Z Option Provided

4.07 This arrangement functions in a a manner similar to that described in 4.05 and 4.06 with the exception that RT2 is short-circuited, thereby lowering the resistance through which capacitor CT discharges. This results in a shorter time-out. On incoming calls where one burst of ringing is received, the time-out is approximately 11 seconds. Subsequent bursts of ringing received before the B relay releases reset the time-out circuit to approximately 10 seconds. Any incoming call, for example, which is signaled with machine ringing will time out in approximately 10 seconds after the call is abandoned.

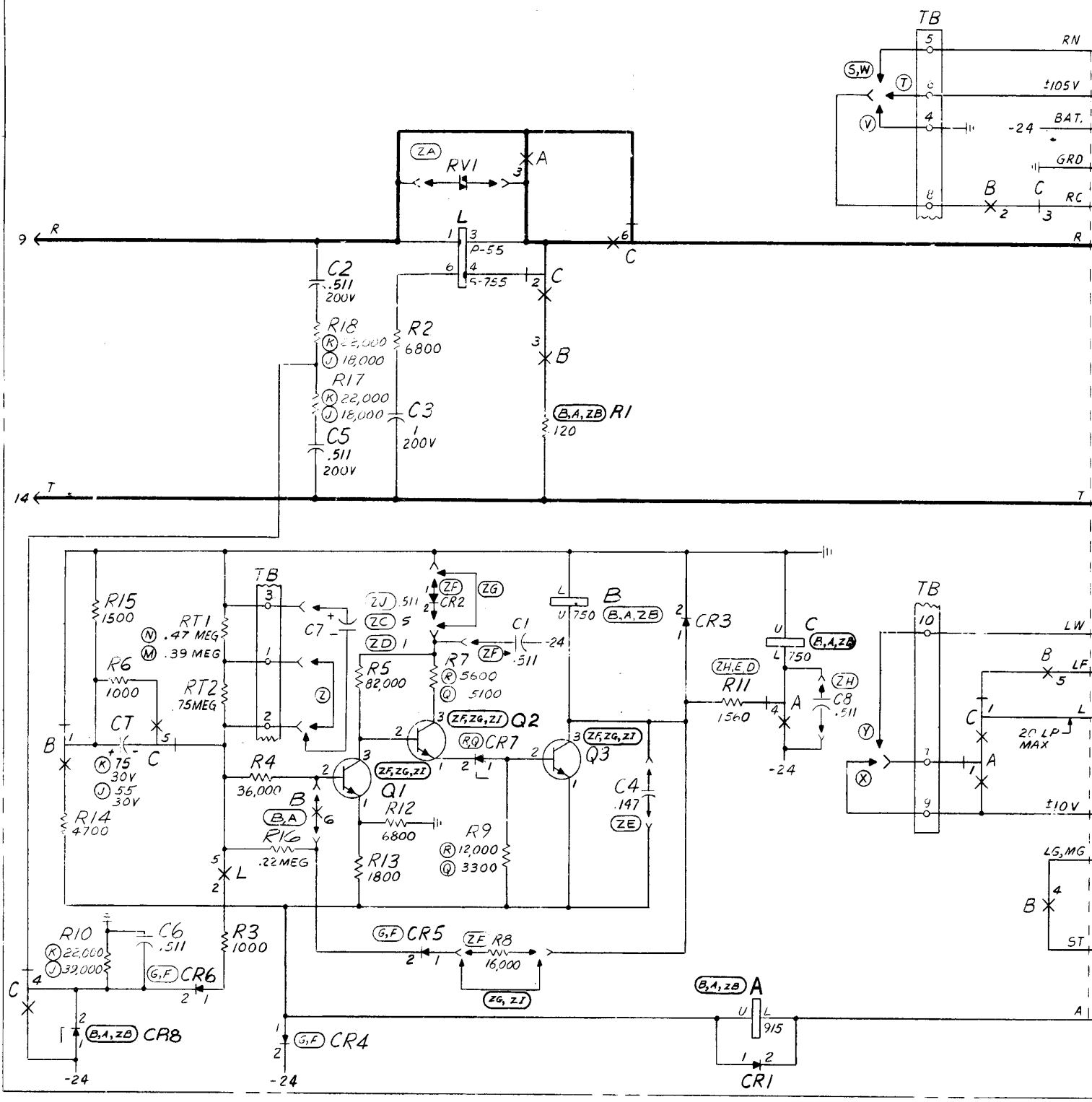
D. Provision for Reduced Time-Out

4.08 If a shorter time-out than that obtained with the Z option is desired, resistor RT1 is shunted with an appropriate resistor, R. The time-out desired as a fraction of the original time-out, TO, can be obtained by using the appropriate resistor R selected from the table below. Where the duration of machine ringing is 1 second, the time-out shall not be reduced below 50 percent of the original time-out.

FS 3(MFR DISC)

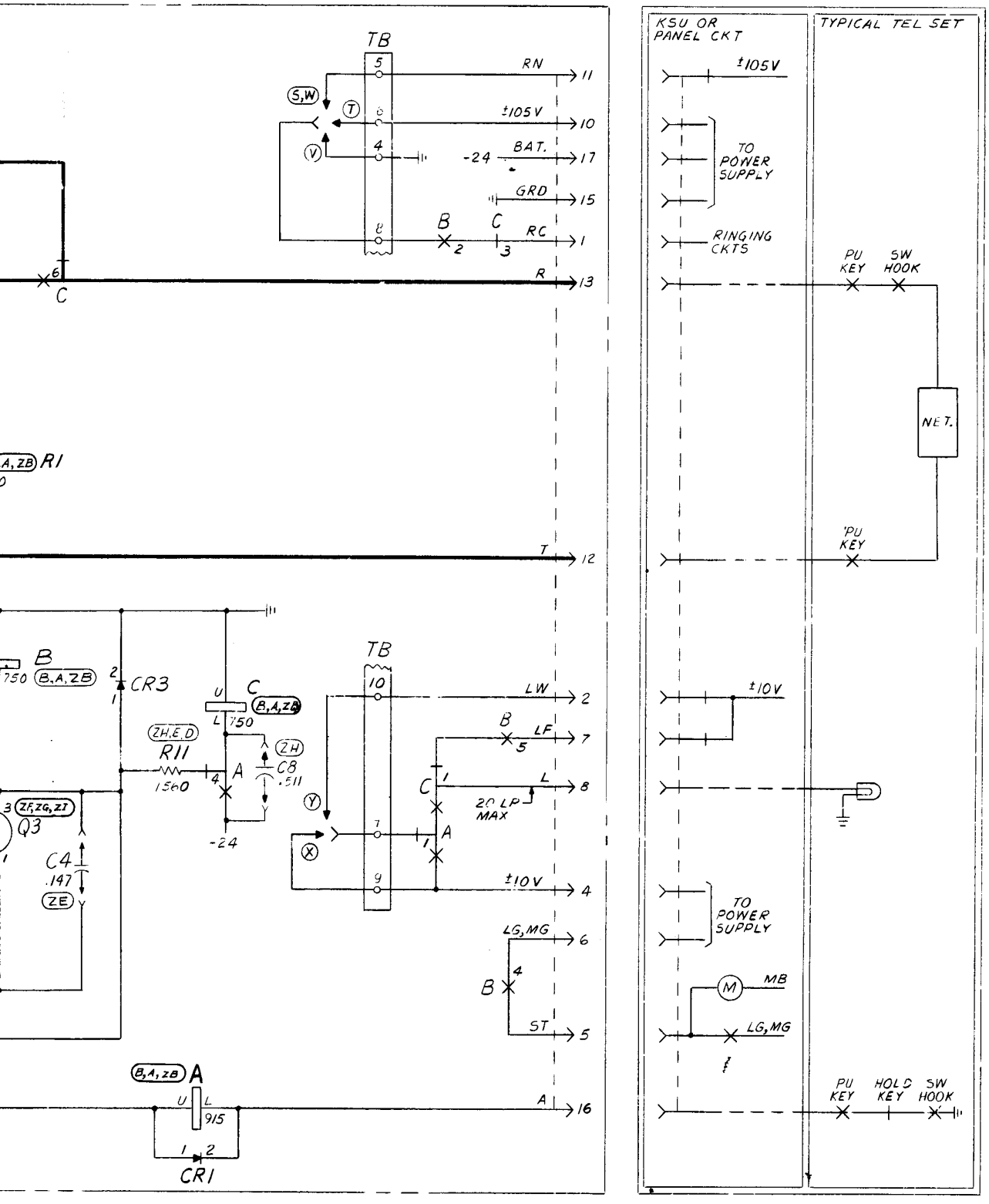
CO OR PBX LINE CKT

400D KEY TELEPHONE UNIT



3(MFR DISC)

O OR PBX LINE CKT



DRAWING ISSUE	
3D	HBU DHC ARM
4A	EFS DHC ARM
6B	HBU KA DLY
7D	- DHC DLY
8B	
9B	
10B	
11B	
12B	
14A	
15B	

CO OR PBX LINE CIRCUIT

SD-69513-01-B3

BELL TELEPHONE LABORATORIES INCORPORATED

DWG SIZE 6S

PRINTED IN U.S.A.