

**DATA AUXILIARY SETS 801C1 AND 801C2
FOR AUTOMATIC CALLING
THEORY OF OPERATION AND SUPPLEMENTARY
INFORMATION**

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1. GENERAL	1	1. GENERAL
2. EQUIPMENT ARRANGEMENTS	2	1.01 This section provides theory of operation and supplementary information on the Data Auxiliary Sets 801C1 and 801C2. The information is given in sufficient detail to provide background knowledge of design and operation. This section includes such items as input and output information and also covers options and possible modifications to existing units. This information allows qualified personnel to provide different types of service and permits extensive troubleshooting of the data auxiliary set.
3. DESCRIPTION	3	1.02 This section is reissued to correct the option connection table (Table D), to update Fig. 4 through Fig. 15, and to make minor text changes. Since this reissue constitutes a general revision, arrows ordinarily used to indicate changes have been omitted.
SYSTEM DESCRIPTION	3	1.03 The information contained in this section supplements the information contained in other sections and is not required for installation or servicing of the Data Auxiliary Sets 801C1 and 801C2 under normal circumstances.
ACU DESCRIPTION	3	1.04 Each of the Data Auxiliary Sets 801C1 and 801C2 will be referred to in this section as an automatic calling unit (ACU).
CIRCUIT ANALYSIS	7	1.05 Information concerning the business machine is limited to signal characteristics and other general information that is required to determine if the ACU can be used with and is compatible with the equipment in the proposed installation.
POWER SUPPLY	7	1.06 The general configurations and physical dimensions of the ACU are shown in Fig. 1.
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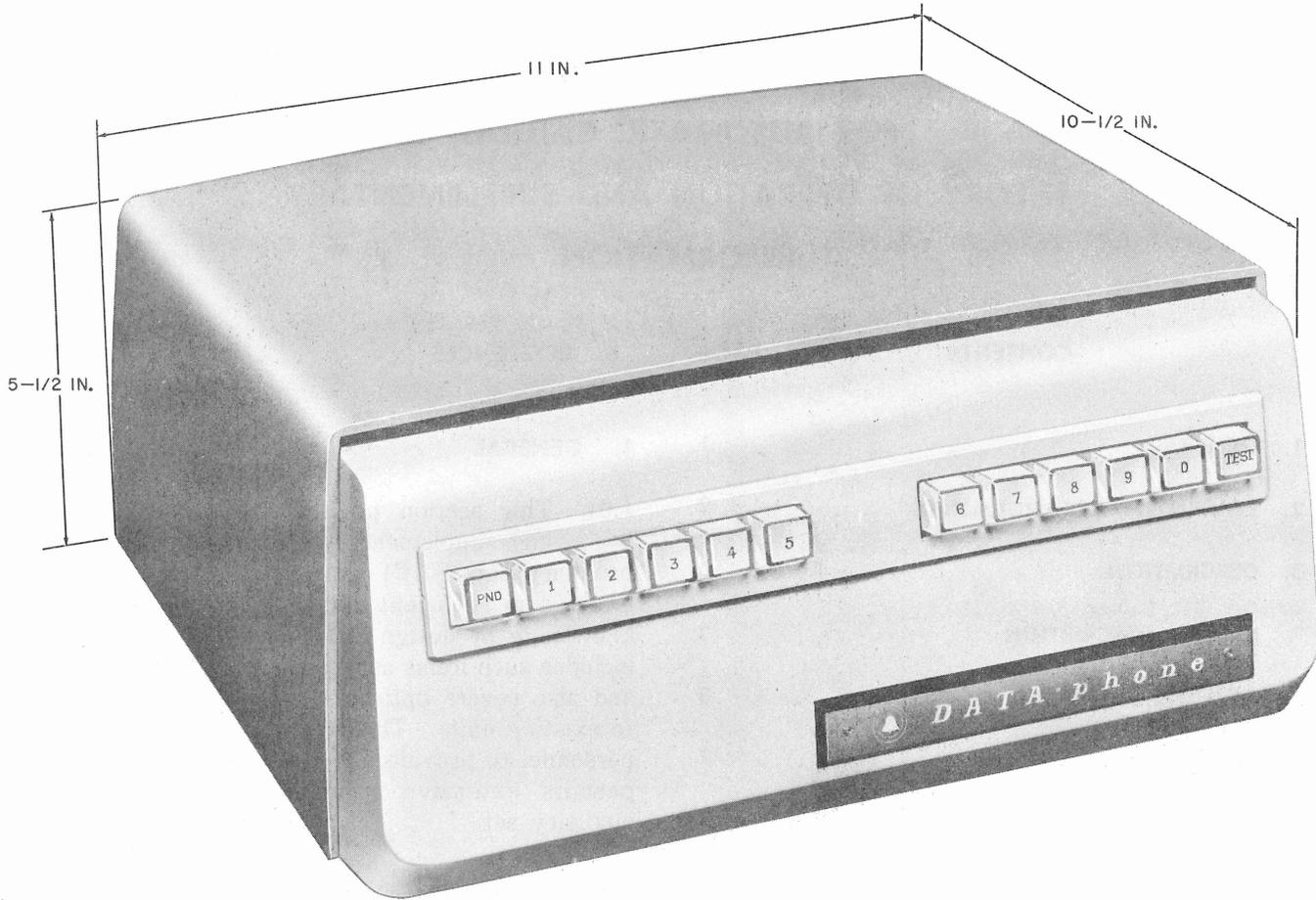


Fig. 1—Data Auxiliary Sets 801C1 and 801C2, Front View

1.07 The ACU is designed to accept information furnished by the business machine and automatically originate DATA-PHONE® calls by transmitting the required TOUCH-TONE® frequencies necessary to initiate the call.

1.08 Power supply requirements and temperature and humidity tolerances are as follows:

Voltage: 117 rms ± 10 percent, 60 ± 0.1 Hz

Temperature range: +40 to 120°F

Humidity range: 20 to 95 percent

The ACU must not be subject to an environment that will cause condensation inside the cover.

2. EQUIPMENT ARRANGEMENTS

2.01 The ACU is connected directly to the business machine and is controlled by the business machine.

2.02 The ACU interface and the assignment of the interface leads conform to EIA standard SP-890. This allows the ACU to be used with any business machine that supplies a compatible voltage level signal.

2.03 The interface lead assignment for the ACU is given in Table A which shows the terminal numbers and lead designations.

2.04 The ACU operation is controlled by the binary signals transmitted by the business machine. The voltage level and polarity of the

TABLE A
ACU INTERFACE LEAD ASSIGNMENT

NAME	TERMINAL
Frame ground (FGD)	1
Digit present (DPR)	2
Abandon call and retry (ACR)	3
Call request (CRQ)	4
Present next digit (PND)	5
Power indication (PWI)	6
Signal ground (SGD)	7
+Power (+P)	9
-Power (-P)	10
Data set status (DSS)	13
Data signal circuit (number bit NB1)	14
Data signal circuit (number bit NB2)	15
Data signal circuit (number bit NB4)	16
Data signal circuit (number bit NB8)	17
Data line occupied (DLO)	22

signals determine the lead status or condition; ie, an "on" condition will be represented by a specific voltage range, and an "off" condition by a different range or polarity. The "1" or "0" condition of a lead is defined in the same way. The signal ranges that are acceptable and correctly operate the ACU circuits are given in Table B.

2.05 The ACU receives the digits of the number to be called over the NB1, NB2, NB4, and NB8 leads. These four leads are used in parallel for the transmission of the binary form of each digit. Table C indicates the corresponding frequencies transmitted by the ACU and the status or binary condition of each lead for any given digit or the end of number (EON).

2.06 By using the various available options, an ACU can be tailored to meet specific requirements. The use of these options allows installation flexibility that would otherwise be impossible. Table D gives a list of the ACU options that are available. The connections required to install options are shown including information on the removal of an option that is not compatible with the new option. Refer to the section entitled Data Auxiliary Sets 801C1 and 801C2—For Automatic Calling—Installation (598-012-200) for complete installation information. Removal of an option is accomplished by disconnecting the straps or breaking

the connections that are specified for the option installation.

3. DESCRIPTION

SYSTEM DESCRIPTION

3.01 The ACU is connected to the business machine by the interface connecting cord. This cord is shown in Fig. 2 with the conductors designated by function.

3.02 The output of the ACU is connected directly to the telephone line, thereby allowing the ACU to call the requested number, specify that the connection has been made, and then transfer the line to the data set.

3.03 The voltage level signals transmitted to the ACU by the business machine are covered in 2.04 and Table B. The output of the ACU consists of the TOUCH-TONE frequencies given in 2.05 and Table C.

ACU DESCRIPTION

3.04 Figure 3 is a functional block diagram of the ACU. This diagram shows the function of each unit and the relationship of these units within the ACU. In order to simplify the diagram,

TABLE B
INTERFACE SIGNALS

LEADS	DC VOLTAGE			
	ON	OFF	ONE	ZERO
CRQ	+3 to +25	-3 to -25	—	—
DPR	+3 to +25	-3 to -25	—	—
NB1	—	—	-3 to -25	+3 to +25
NB2	—	—	-3 to -25	+3 to +25
NB4	—	—	-3 to -25	+3 to +25
NB8	—	—	-3 to -25	+3 to +25
PND	+5 to +25	-5 to -25	—	—
DLO	+5 to +25	-5 to -25	—	—
DSS	+5 to +25	-5 to -25	—	—
ACR	+5 to +25	-5 to -25	—	—
PWI	+5 to +25	511 ohms to ground	—	—

TABLE C

DIGIT	NB8	NB4	NB2	NB1	TRANSMITTED FREQUENCIES
0	0	0	0	0	941, 1336
1	0	0	0	1	697, 1209
2	0	0	1	0	697, 1336
3	0	0	1	1	697, 1477
4	0	1	0	0	770, 1209
5	0	1	0	1	770, 1336
6	0	1	1	0	770, 1477
7	0	1	1	1	852, 1209
8	1	0	0	0	852, 1336
9	1	0	0	1	852, 1477
EON	1	1	0	0	— —

the relays that perform the switching and control functions have been combined into one block labeled control circuits. Connecting lines are used to represent control relationships, control signals, and/or signal flow within the ACU. Individual lead designations, referred to in the following text, are shown in the block diagram.

3.05 Explanation of the ACU call origination (including loop start, ground start, and manual origination), receipt of incoming calls, the

test mode, and call termination is given in the following paragraphs.

3.06 When the ACU uses ground start operation, a call is originated automatically by the business machine presenting a call request. This is accomplished when the business machine turns on the CRQ lead. If the telephone line is idle, the control circuits seize the line from the data set and appear off-hook by grounding the ring side of the line. In response to the central office (CO)

TABLE D
OPTION CONNECTIONS

FEATURE OR OPTION DESCRIPTION		DESIGNATION	DATA AUXILIARY SET CODE		TBI CONNECTIONS	
			801C1	801C2	FROM TERM.	TO TERM.
Terminate call after DSS ON via CRQ.		Z	*	*	11	12
Terminate call after DSS ON via data set.					Remove the Z option.	
Ground start	With	V	*	*	7 18 20 31 33 44	8 19 21 32 34 45
	Without	Y	†		Remove V option connections before making Y option connections. 4 5 17 18 56 57	
Detect answer tone	Beginning of tone	X	†		Remove W option from 801C2 before making X option connections. 1 2	
	End of tone	W	†	*	2	3
Detect answer tone	2225 Hz	T	†		Remove S option from 801C2 before making T option connections. 46 47	
	2025 Hz	S	†	*	47	48
Stop ACR timer after DSS ON.		R	*	*	24	25
Do not stop ACR timer after DSS comes on.					Remove R option connections.	
Data set to data mode by contact to DT.		Q	*	*	9	10
Mounting cord	M14C	N			None required	
	D10P-61	M	*	*	None required	

* Installed by the factory.

† Not available in Data Auxiliary Set 801C1.

ground on the tip side of the line, the control circuits remove the ring ground and turn on the data line occupied (DLO) lead, and the oscillator timer requests a digit from the business machine by turning on the present next digit (PND) lead. The ACU is now ready to dial any number presented by the business machine, and the business machine presents the binary form of the digit to be dialed. See 2.05 and Table C. The most significant bit is presented on the number lead NB8, the next significant bit on NB4, the next on NB2, and the least significant bit on NB1; eg, for the digit 5, NB8 = 0, NB4 = 1, NB2 = 0, and NB1 = 1. When the number leads have been set, the business machine signals the ACU by turning on the digit present (DPR) lead. The TOUCH-TONE transmitter then transmits the corresponding dual-frequency signal to the central office. After the TOUCH-TONE signal has been transmitted, the oscillator timer turns off the PND lead. The business machine, in response to this signal, turns off the DPR lead and then sets the number leads to the next digit. The combined action of the delay and DP timers imposes the required interdigital wait, and the oscillator timer turns on the PND lead. The business machine then sets the number leads and turns on the DPR lead and the sequence is repeated. Any delay by the business machine in turning on the DPR lead after the oscillator timer turns on the PND lead will reduce the dialing rate. If the delay in turning on the DPR lead exceeds the ACR timer interval, an abandon call and retry signal will be given. After the last digit has been dialed and DPR has been turned off, the business machine response to the next PND "on" signal determines the action of the ACU. If the business machine presents the EON code on the number leads and turns the DPR lead on, the control circuits will transfer the telephone line to the associated data set and place the data set in the off-hook condition. If the ACU is equipped with an answer detection option (801C2 only), and the business machine does not respond to the PND "on" signal, the answer detector monitors the line for the answer signal. Upon detection of a valid answer signal, the control circuits transfer the telephone line to the associated data set and place the data set in the off-hook condition. If neither an EON indication nor a valid answer signal is received within the ACR timer interval, the ACR lead is turned on. When the data set goes off-hook and has control of the telephone line, the control circuits inform the business machine by turning on the data set status (DSS) lead. At this time, the ACR timer is disabled if option R is installed.

3.07 If the ACU is equipped for a loop-start operation, the operation sequence is very similar to ground-start operation. In response to a call request signal from the business machine, the control circuits seize the telephone line from the data set and go off-hook by placing the telephone network across the line. When the TOUCH-TONE dual-frequency dial tone is received, the control circuits, by turning on the DLO lead, signal the business machine that the data line is occupied. A digit is requested when the oscillator timer turns on the PND lead. From this point, call origination is identical to the ground-start operation described in 3.06.

3.08 A call may be originated manually by using the telephone associated with the data station. When the data set is in the talk mode, an off-hook indication is presented to the ACU. The control circuits of the ACU then present a DLO signal to the business machine and block the call request (CRQ) circuit to prevent the business machine from automatically originating a call. When a loop-start telephone line is used, the ACU plays no further part in originating the call. When the call is terminated, the data set presents an on-hook indication to the ACU. The control circuits then turn off the DLO lead, and 1 second later, the CRQ circuits are enabled. When a ground-start line is used, the control circuits, in response to an off-hook indication from the data set, seize the telephone line and present an off-hook indication to the central office. When the central office has recognized the off-hook indication, the telephone line is returned to the data set, and, as with a loop-start line, a DLO "on" signal is presented to the business machine. When an on-hook indication is received from the data set, the telephone line is monitored for an idle condition. When the central office drops the connection, the control circuits inform the business machine via the DLO lead, and, at the same time, activate the CRQ circuits.

3.09 Incoming calls are handled in the following manner. For loop-start operation, the control circuits present a DLO "on" signal to the business machine when the data set answers an incoming call. If the data set presents a data mode indication to the ACU control circuits, the business machine is informed via the DSS lead. When the call is terminated, the intercall timer (loop-start option) interposes a 1-second time interval to ensure that the central office has recognized the on-hook indication from the data set and has dropped the

connection. When a ground-start line is used, an incoming call results in a DLO "on" signal before the call is answered. The DLO "on" signal is maintained until the central office drops the connection at the end of the call.

3.10 The ACU is equipped with a test mode.

This feature allows the ACU to be tested without external test equipment. The ACU has 12 test keys which are used to originate a test call manually. To use this test circuit, the attendant must depress and hold the TEST button until the TEST lamp lights. This signifies that the ACU is in the test mode and the control of the interface leads has been taken from the business machine.

Note: The ACU may be placed in the test mode only when it is in the idle condition. The operation of any button at any other time will be ignored by the ACU. Operation of the ACU in the test mode is described in the section entitled Data Auxiliary Sets 801C1 and 801C2—For Automatic Calling—Test Procedures (598-012-500).

3.11 When the ACU enters the test mode, it automatically initiates a call request using the same circuits used by the business machine. The ACR timer is set to the maximum timer interval. The PND lead is clamped in the "off" condition and the DLO lead is clamped in the "on" condition. When dial tone is received, the signal tones are made audible by the monitor amplifier and speaker in the ACU. This monitor amplifier circuit is activated only when the ACU is in the test mode. When the lamp in the PND button lights, a digit may be dialed by depressing the corresponding number button and holding this button until the PND lamp goes off. The button is then released and the next digit is dialed when the PND lamp is turned on again. If the ACU uses the EON control, it can be tested by simultaneously operating the number 4 and number 8 buttons. When the number 4 and number 8 buttons are released, the PND lamp should remain off, thereby signifying that the data set is in the data mode. If at any time it is desirable to interrupt the test, the ACU can be released from the test mode by operation of the PND button.

3.12 Termination of an automatically originated call may be accomplished by one of two methods. If the Z option (Table D) is provided, the ACU will seize the line from the data set and

present an on-hook indication to the central office when the business machine turns off the CRQ lead. The ACU control circuits then return the telephone line to the data set when the data mode indication is removed. At this point, the ACU is idle and ready for the next call. If the Z option is not used, the call can be terminated by the ACU at any time prior to the entrance of the data set in the data mode. Once a call has been completed and the line returned to the data set, the call must be terminated by the data set. When the call is terminated, the control circuits turn off the DSS, DLO, and PND leads and revert to the idle state. If the ACU uses a loop-start line instead of a ground-start line, a 1-second time interval is imposed by the intercall timer to ensure that the central office has recognized the on-hook condition and dropped the connection.

3.13 Figure 4 consists of two sequence charts, one showing automatic call origination and the other showing the ACU in the test mode.

CIRCUIT ANALYSIS

3.14 Circuit analysis for the ACU has been divided into several sections with each section covering only one circuit board or functional circuit. Since two of the circuit boards are optional, an ACU may not contain all the circuit boards described in this text. A schematic diagram is used in conjunction with the explanation of these circuits. Interconnections between the circuit boards and the functional circuits described here are shown in Fig. 5.

POWER SUPPLY

3.15 The power supply converts 117-volt, 60-Hz ac power into two regulated 18-volt outputs. These outputs are designed to deliver +18 volts and -18 volts relative to the supply ground.

ACR TIMER

3.16 The ACR timer is a 7- to 40-second adjustable timer. It is adjustable in steps; the interval is determined by the value of the selected resistor (Fig. 6). A +18 volt supply is applied through the nonoperated contacts of the TE relay to switch S1, which is used to select the correct resistor needed to give the desired timer interval. The values of resistors R3 through R7 are selected to give a 7-, 10-, 15-, 25-, or 40-second timer interval.

SECTION 598-012-150

NOTE:
CROSS-CONNECTIONS
WILL VARY WITH TYPE
OF DATA SET PROVIDED.

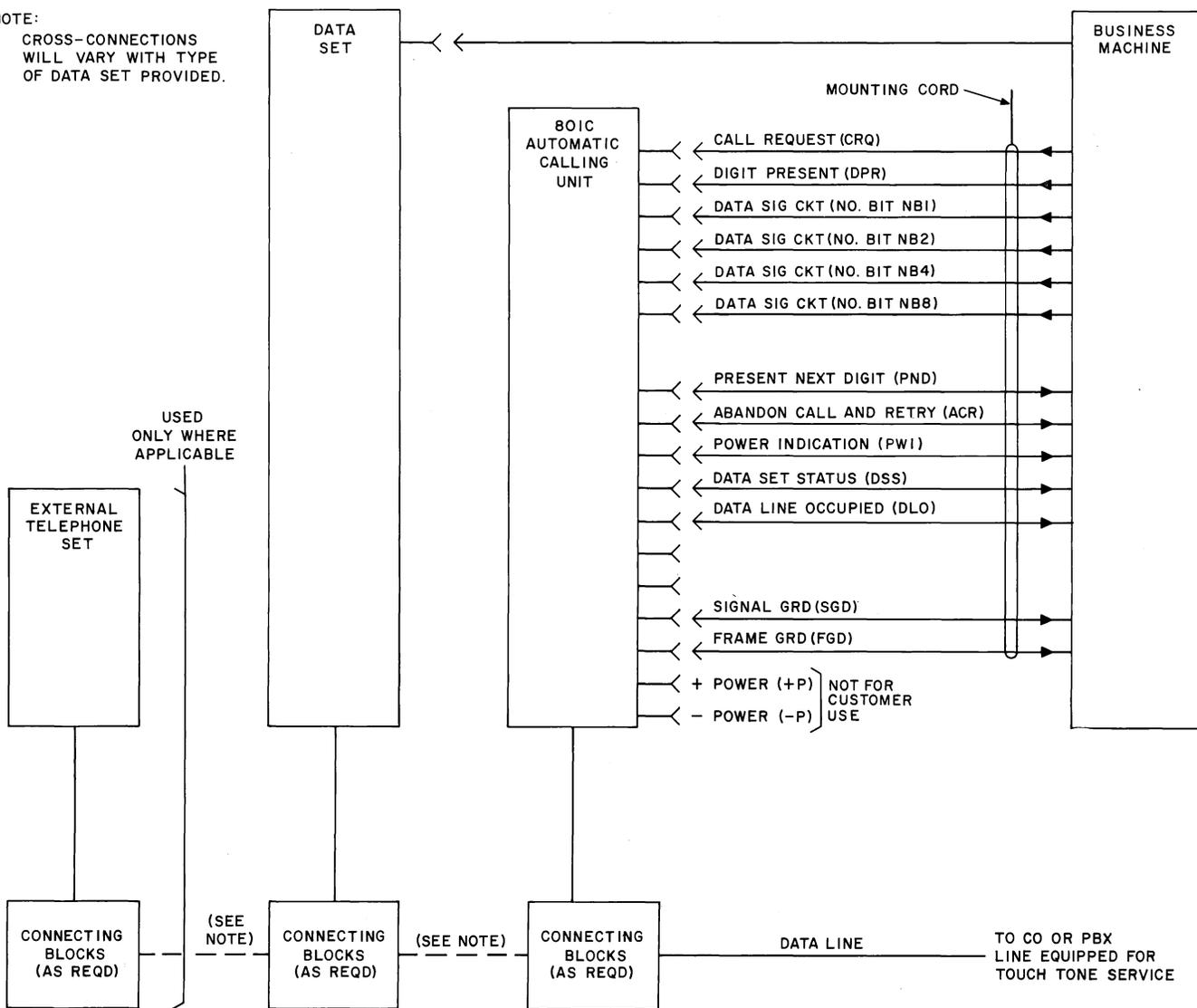


Fig. 2—Data Auxiliary Sets 801C1 and 801C2, Interconnecting Block Diagram

When the ACU is placed in the test mode, the TE relay is operated and +18 volts is applied through the operated contacts of the TE relay to resistor R7, thereby providing for a 40-second timer interval. When -18 volts is connected through pin 4 to resistor R1, capacitors C1, C2, and C3 are initially charged to -18 volts. This voltage is applied through R8 to the base of Q1, holding it in an "off" condition. Transistor Q3 is driven to saturation by the base current through resistor R11. Transistor Q2, along with resistors R10 and R13, form an emitter-follower stage that drives output switch Q4. With Q1 "off" and the emitter output voltage controlled by voltage divider resistors R9 and R12,

the output switch is "off." The timer is started by removing the -18 volts connected to R1. Capacitors C1, C2, and C3 then begin to charge through the selected timing resistor (R3, R4, R5, R6, or R7). As the capacitors become more positive, they finally exceed the emitter voltage of Q1. Diode CR1 then conducts, turning on Q1. Q3 turns off, causing the emitter voltage to decrease, which turns on Q4. This provides a ground for the ACR relay. The subsequent operation of the ACR relay provides a ground for R2, thereby increasing the base current to Q1. The schematic diagram for the ACR timer and the timer controlling relay contacts is shown in Fig. 6. The timer is reset by applying -18 volts

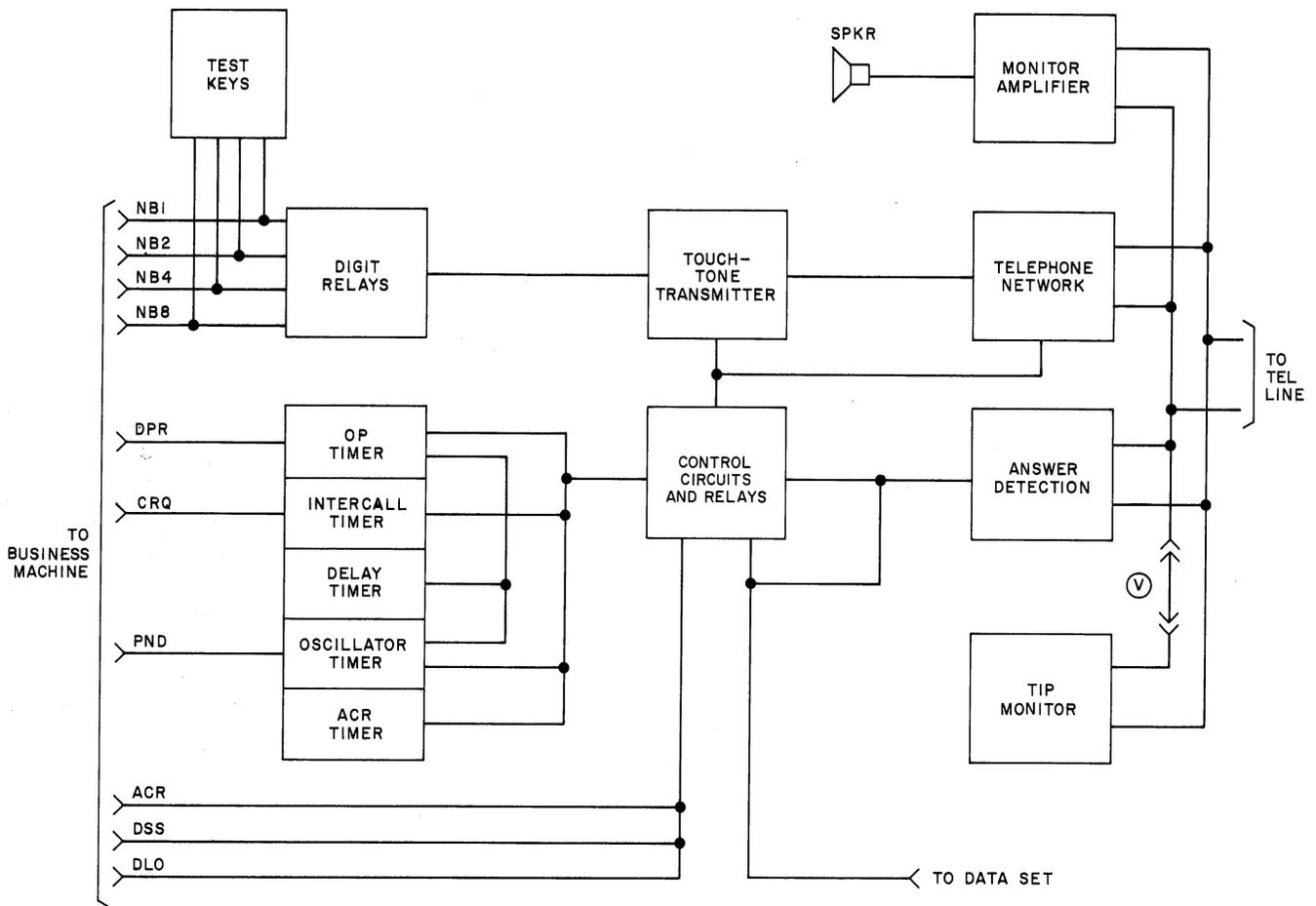


Fig. 3—Data Auxiliary Sets 801C1 and 801C2, Functional Block Diagram

through the relay contacts and R1 to recharge the capacitors.

MONITOR AMPLIFIER

3.17 Operation of the TE relay places the monitor amplifier across the telephone line only when the ACU is in the test mode. Voltage is produced by passing dc current through varistors RV1, RV2, RV3, RV4, RV5, and RV6. Diode CR2 is used as a polarity guard, and capacitor C8 is used as a filter for the voltage generated. Resistors R18 and R19 provide the necessary bias for emitter-follower Q5. Bias for directly coupled voltage amplifiers Q7 and Q6 is provided by R22 and R24, respectively. Resistors R21 and R23, along with bypass capacitors C9 and C10, provide bias stabilization for the two stages. Capacitor C7 prevents high-frequency oscillation. Capacitor C6 couples the signal to the circuit. When the amplifier is used on a telephone line, varistors RV7 through RV10 provide the required lightning protection. The output of the

monitor amplifier is applied to HT1, which is a receiver mounted in the ACU that provides for monitoring the call progress tones. Refer to Fig. 7 for the monitor amplifier schematic diagram.

TELEPHONE NETWORK AND LINE HOLDING INDUCTOR

3.18 The telephone network and line holding inductor is connected to the telephone line as shown in Fig. 8. This unit is also connected directly to the TOUCH-TONE transmitter. The telephone network terminals are connected to the circuit pack terminals as follows: terminal R is connected to terminal 1, terminal RR is connected to terminal 2, terminal B is connected to terminal 3, and terminal C is connected to terminal 6. The tip side of the telephone line is switched from the line holding inductor L1 to circuit pack terminal 2 by the operation of the DP relay. Operation of the PD relay breaks the connection between the TOUCH-TONE transmitter and terminal R of the telephone network.

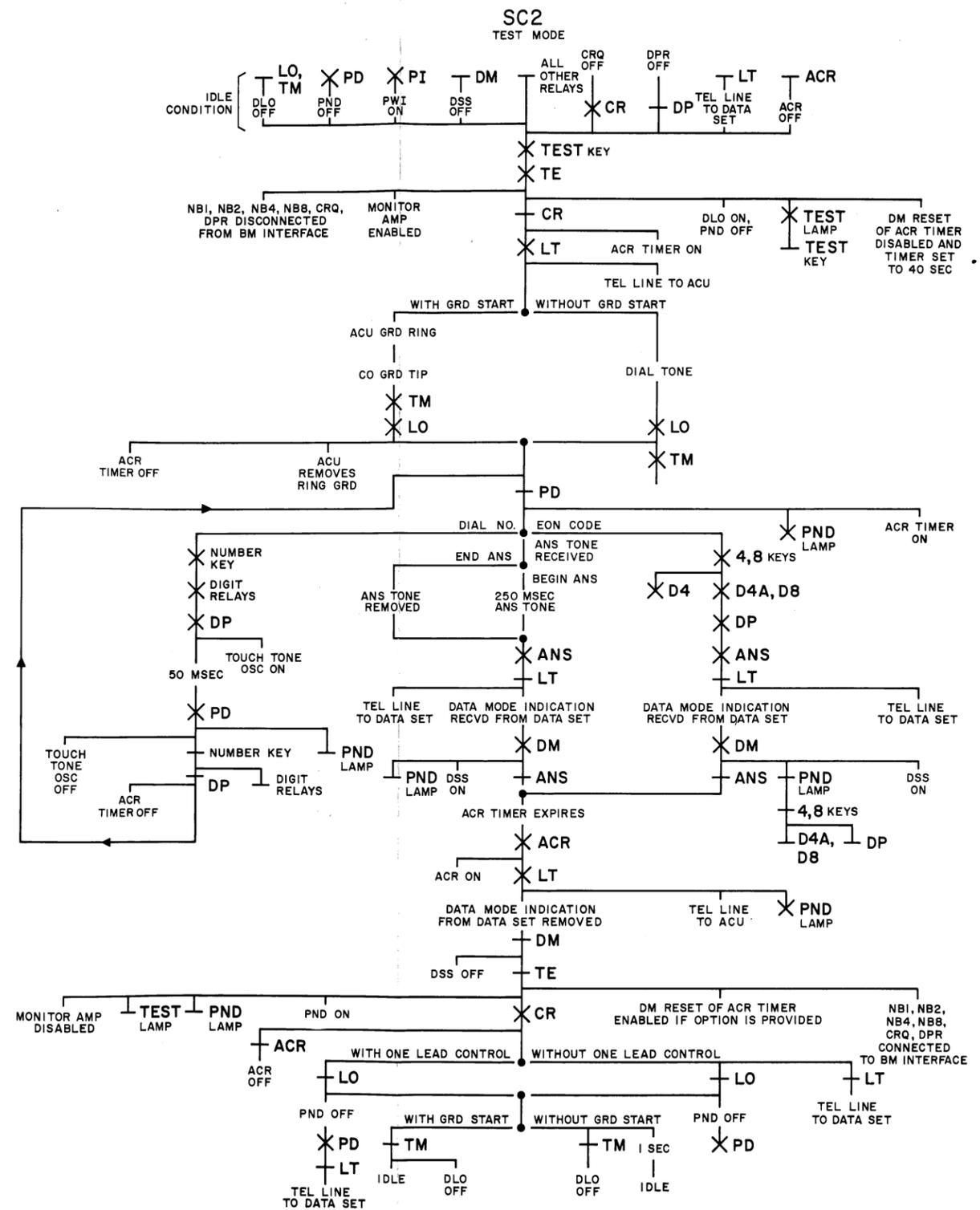
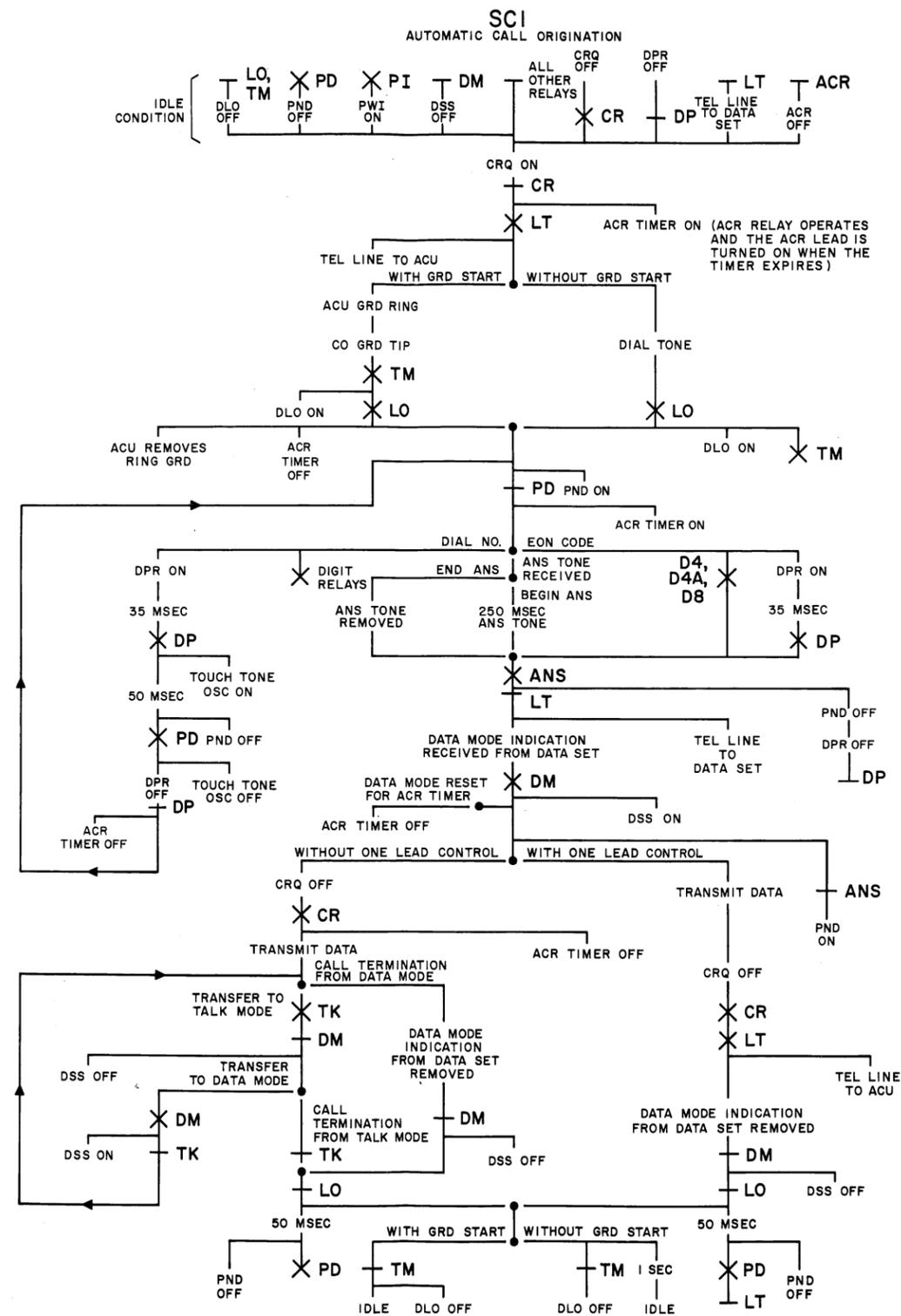


Fig. 4—Data Auxiliary Sets 801C1 and 801C2, Sequence Charts

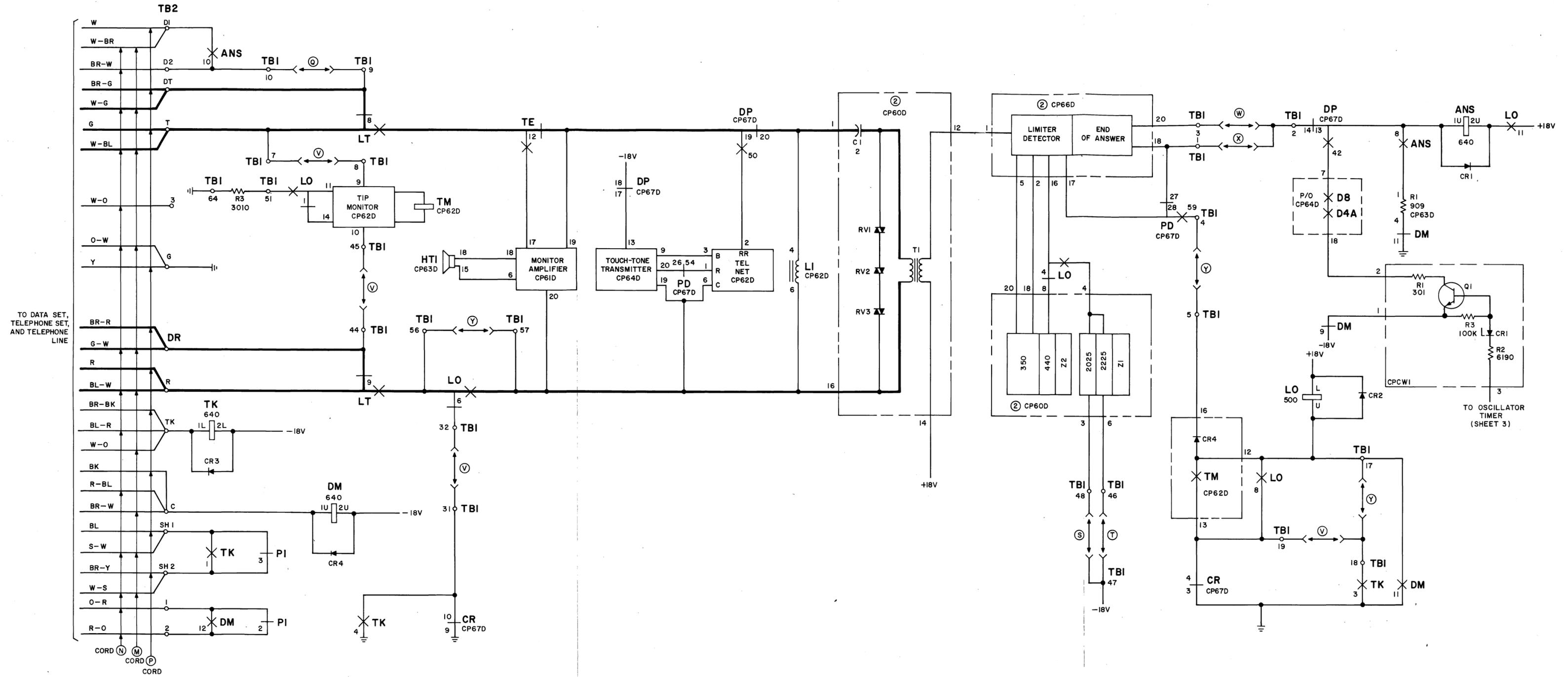


Fig. 5—Data Auxiliary Sets 801C1 and 801C2, Schematic Diagram (Sheet 1 of 3)

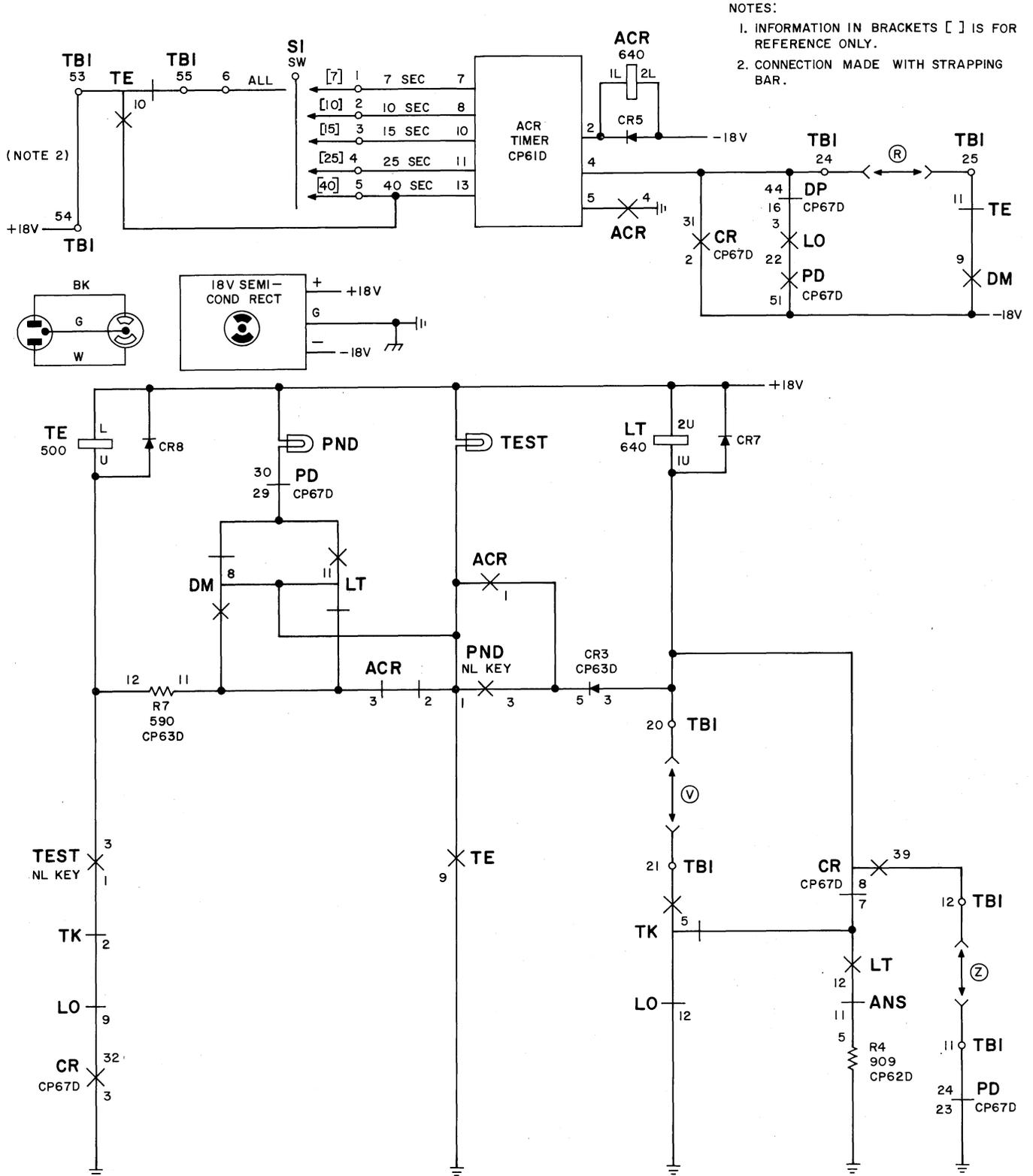


Fig. 5—Data Auxiliary Sets 801C1 and 801C2, Schematic Diagram (Sheet 3 of 3)

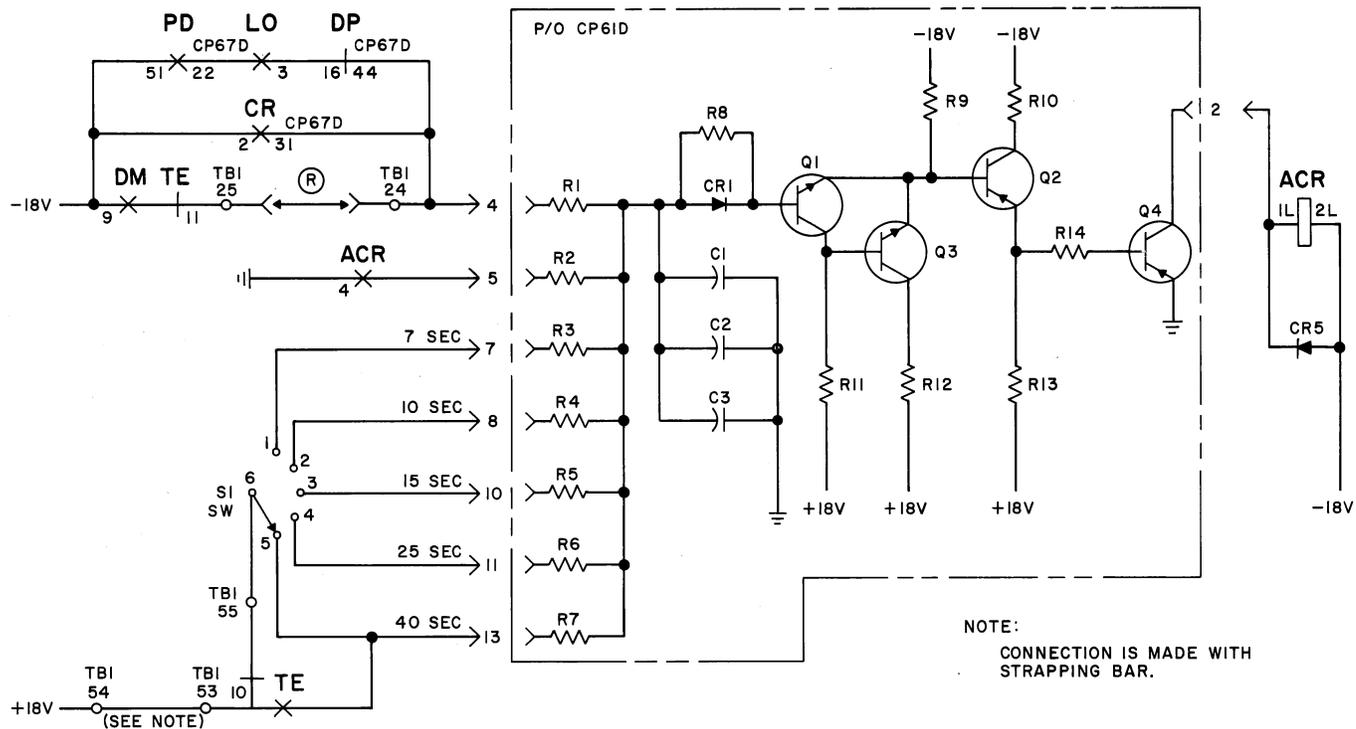


Fig. 6—ACR Timer, Schematic Diagram

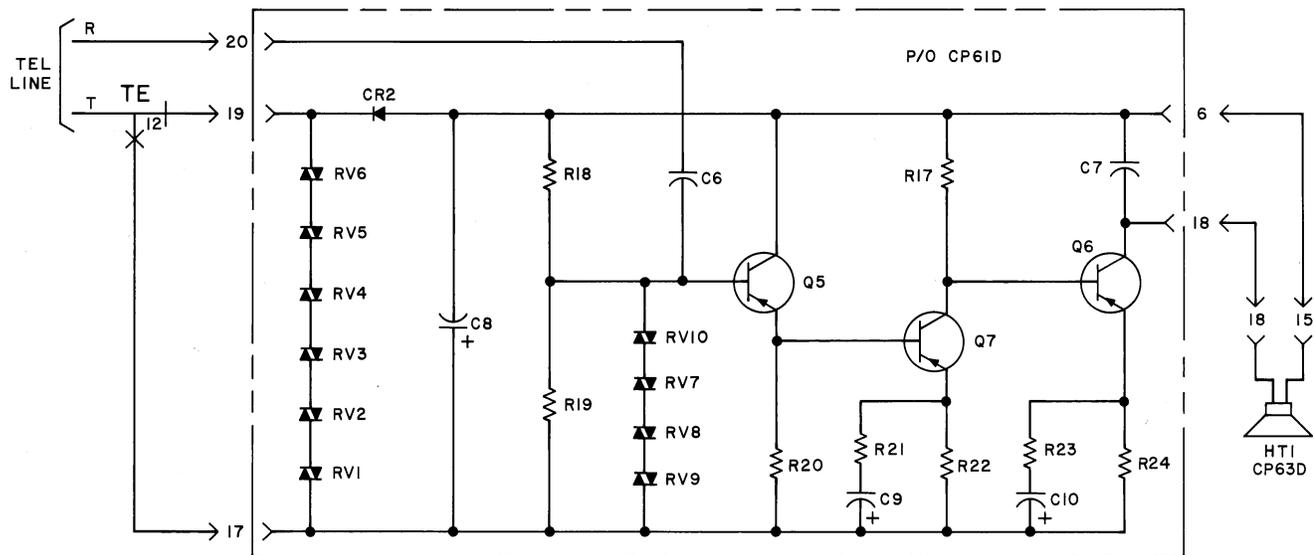


Fig. 7—Monitor Amplifier, Schematic Diagram

TIP MONITOR

3.19 The schematic diagram of the tip monitor circuit is shown in Fig. 9. The ACU must be equipped with option V for the tip monitor circuits to be used. Resistors R1 and R2 and diodes CR1 and CR2 comprise an OR circuit. This circuit is used to drive transistor Q1 when the LO relay is not operated. An external ground applied to either side of this OR circuit will cause Q1 to actuate the TM relay. Resistor R3 is used to

distinguish (select the threshold) between a ground on the tip and leakage to ground. Diode CR5 limits the reverse bias applied to Q1 when the OR circuit is not in use. Diode CR3 limits induced voltages across the TM relay when Q1 is turned off.

TOUCH-TONE TRANSMITTER AND CONTROLS

3.20 The TOUCH-TONE transmitter is controlled by the operation of four relay drivers and

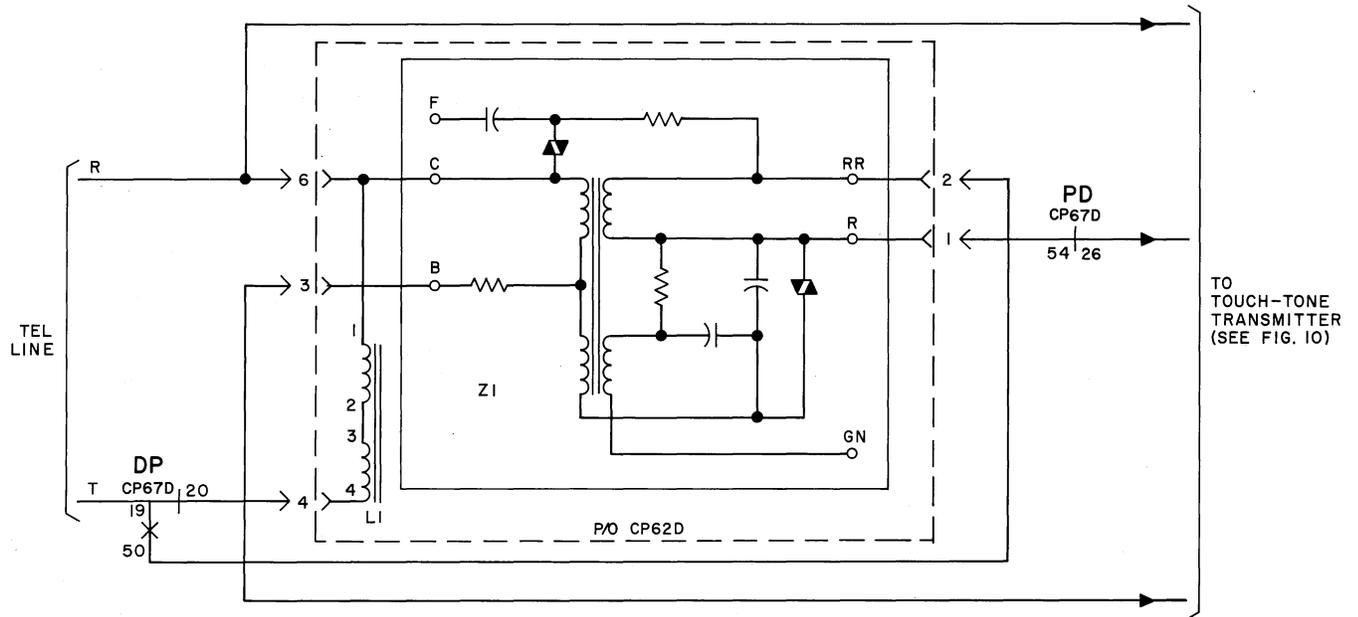


Fig. 8—Telephone Network and Line Holding inductor, Schematic Diagram

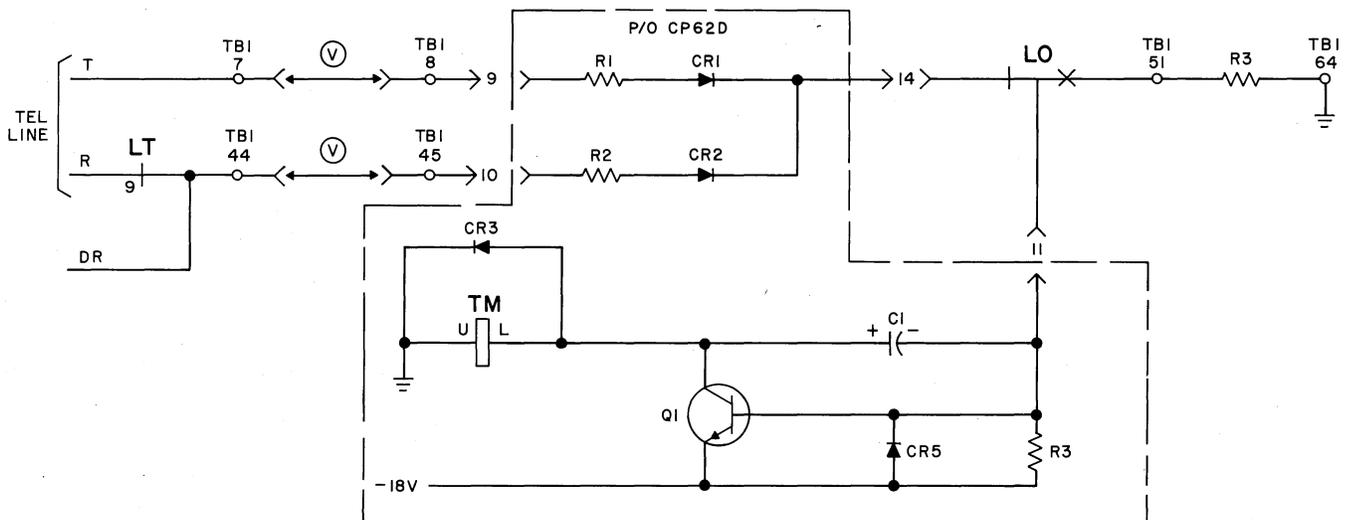


Fig. 9—Tip Monitor, Schematic Diagram

their associated relays. The relay drivers receive a number in binary form from either the test keys or the business machine (Fig. 10). When the ACU is in the test mode, the TE relay is operated and the test keys are connected to the relay driver circuits. When the ACU is not in the test mode, the TE relay provides a set of contacts that connect the business machine leads to the relay drivers. The operation of the relay drivers is identical whether the signals are supplied by the test keys or by the business machine. The digits are presented to the relay drivers in binary form on terminals 5, 8, 10, and 4. Since the operation of all the relay drivers is identical, only Q1 will be described.

3.21 The relay windings are connected to a -18 volt source through terminal 3 (Fig. 10). Reverse bias supplied to Q1 by R3 is limited by CR5 and the transistor is normally "off." Resistor R2 limits the base current of Q1 when a negative voltage is applied to operate the D1 relay. Diode CR1 limits the induced voltage across the relay winding when the relay releases. Contacts on the digit relays, which are controlled by the relay drivers, control the frequencies of TOUCH-TONE oscillator Z1. This is accomplished by the digit relays D1, D2, D4, and D8 connecting the two capacitors to the appropriate taps on the tuning inductor. Resistor R1 limits the dc current through the tuning inductor. Interruption of the dc current shock excites the oscillator to full oscillation. The output of the oscillator is connected to the telephone line by a telephone network where the power required for the oscillator is derived. Operation of the CR relay removes the -18 volts from the digit relay windings. Operation of the DP relay removes the -18 volts from the TOUCH-TONE transmitter.

INTERCALL TIMER

3.22 A schematic diagram of the intercall timer is shown in Fig. 11. It is composed of transistor switch Q2 which can be delayed for 1 second by the timer circuit composed of Q3 and Q4. The transistor switch controls the operation of the CR relay. When the CR relay is operated, operation of the TM or LO relay provides a holding path. Diode CR2 protects the transistor by limiting the collector voltage when an inductive load is used. Transistor Q2 is biased in the "on" condition by R3 and can be turned off by applying a positive voltage through R4 to the base of the transistor.

When the ACU is in the test mode, +18 volts is applied through resistor R12 to the base of Q2. When the ACU is not in the test mode, the CRQ lead from the business machine is connected to the base of Q2. Diode CR2 is used to limit the reverse bias to a safe value, and Q4 is biased to saturation by R6. Varistor RV1 ensures that the threshold voltage for turning on Q3 is well above the saturated collector voltage for Q4. The negative terminal for Q2 is at -18 volts initially. Diode CR3 prevents the supply ripple from turning off Q4. The timer is started when the LO relay releases (V option is not installed), connecting terminals 1 and 11 together. This, in effect, applies +18 volts to the base of Q4. Transistor Q3 saturates, thus providing an alternate path to ground for the load current. At this time, turning off Q2 has a negligible effect on the load current. Capacitor C2 charges through R6 toward -18 volts. When the voltage at the base of Q4 becomes negative (approximately -0.3 volt), the transistor turns on again, which turns off Q3. The timer is reset by opening the connection between terminals 1 and 11, thus allowing capacitor C2 to recharge through R7.

DP TIMER

3.23 Operation of the DP timer is similar to the operation of the intercall timer described above. Transistor Q7 operates as a switch in a manner similar to transistor Q2. When Q7 is "on," current through R24 causes Q8 to saturate, thus holding Q9 in the "off" condition. Current through R27, R25, and CR9 establishes a voltage differential of approximately 18 volts across timing element C7. The timer is started by turning off Q7. This is accomplished by a positive voltage supplied by the business machine via the DPR lead when the TE relay is not operated, or by +18 volts supplied through R6 by the test keys when the TE relay is operated (Fig. 12). The voltage across capacitor C7 applies a reverse bias to CR9 and the capacitor discharges through R27, R24, and Q8, thus holding the transistor "on." After 27 milliseconds, the voltage across R27 decreases to 18 volts and CR9 begins to conduct, changing the RC timer constant for the circuit. This reduction of the base current causes Q8 to turn off. Current through R1 then causes Q9 to saturate. The operation time for the DP relay is reduced by applying 36 volts across the winding via C6 when Q9 turns on. The holding current for the relay is limited by R18. Diode CR7 limits the collector voltage of Q9 by shorting

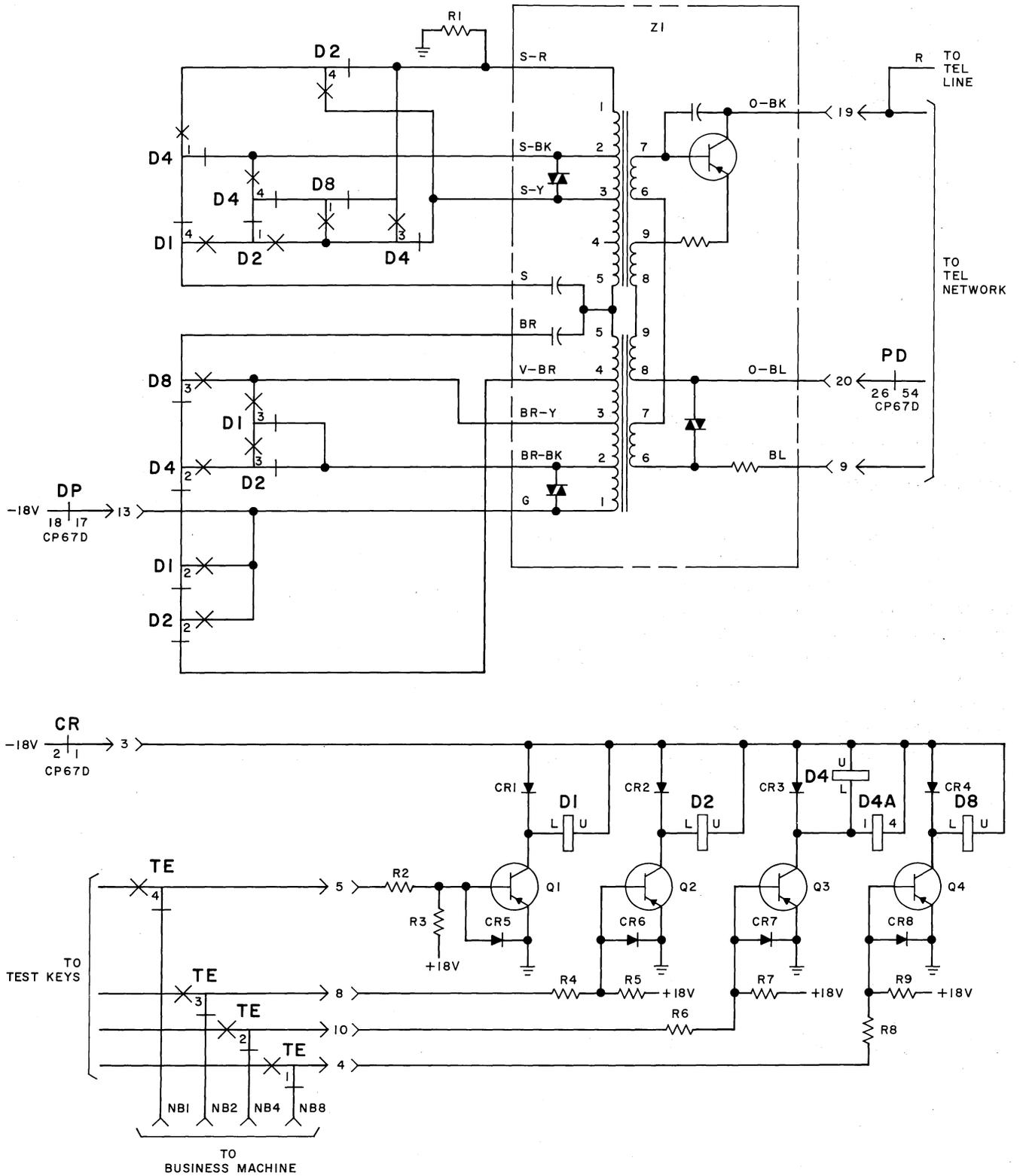


Fig. 10—TOUCH-TONE Transmitter and Control, Schematic Diagram

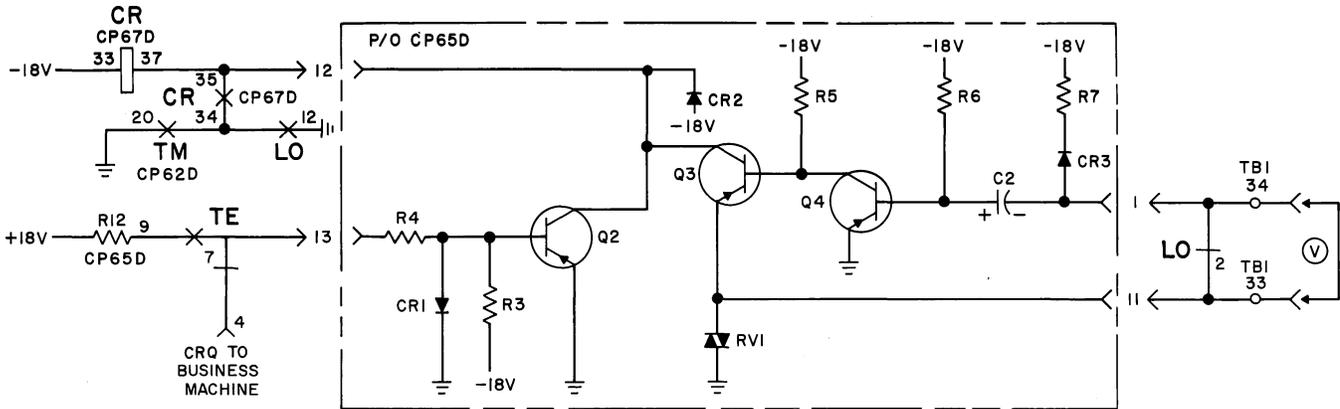


Fig. 11—Intercall Timer, Schematic Diagram

the relay winding when Q9 is turned off. The timer is reset by turning on Q7.

OSCILLATOR TIMER

3.24 The oscillator timer operates in much the same manner as the DP timer with a few exceptions. The timer is started by removing the ground connected to terminal 4 and is reset by replacing this ground. See Fig. 13 for the relay contacts used to connect and remove the ground. A delay circuit is connected to the oscillator timer through these relay contacts (3.25). Feedback through resistor R28 and capacitor C9 is used to decrease the switching time. When Q6 is "off,"

the voltage on the PND lead is controlled by R16 and the external load. When Q6 turns on, the voltage is controlled by the voltage divider composed of R16 (+18 volts), and R15 through CR5 and Q6 (-18 volts). Operation of the PD relay occurs when Q6 is turned on. A transistor circuit contained on CW1 and composed of CR1, Q1, R1, R2, and R3 provides for operation of the ANS relay via the DP, D8, and D4A contacts when the PND lead is turned on.

DELAY CIRCUIT

3.25 The delay circuit is a 15-millisecond timer (Fig. 14). This timer is actuated when the

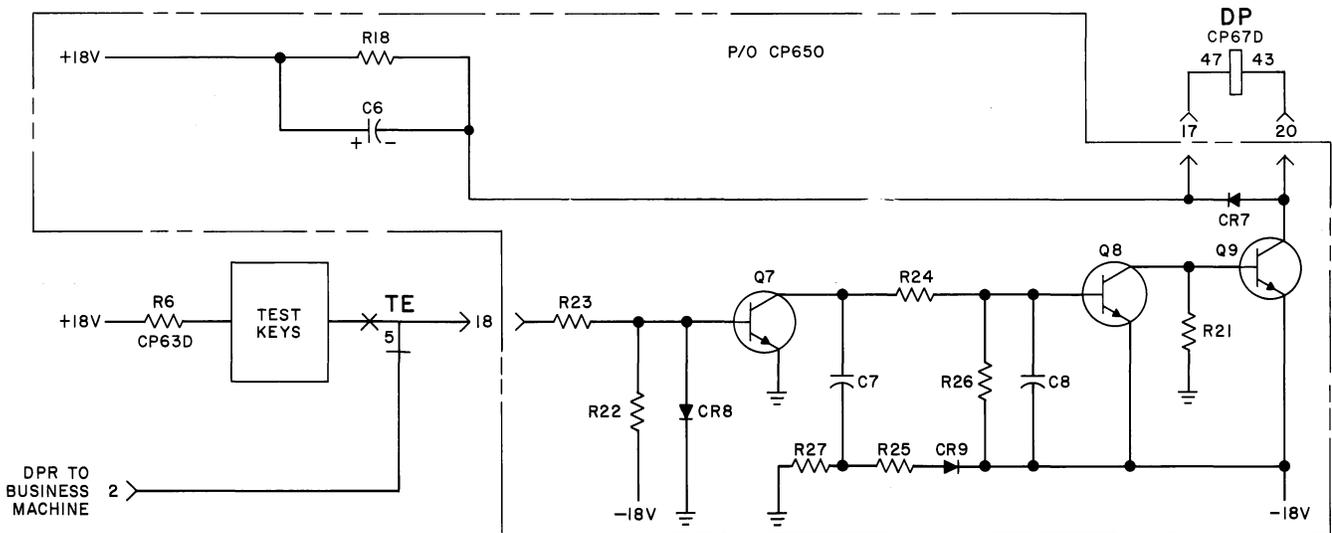


Fig. 12—DP Timer, Schematic Diagram

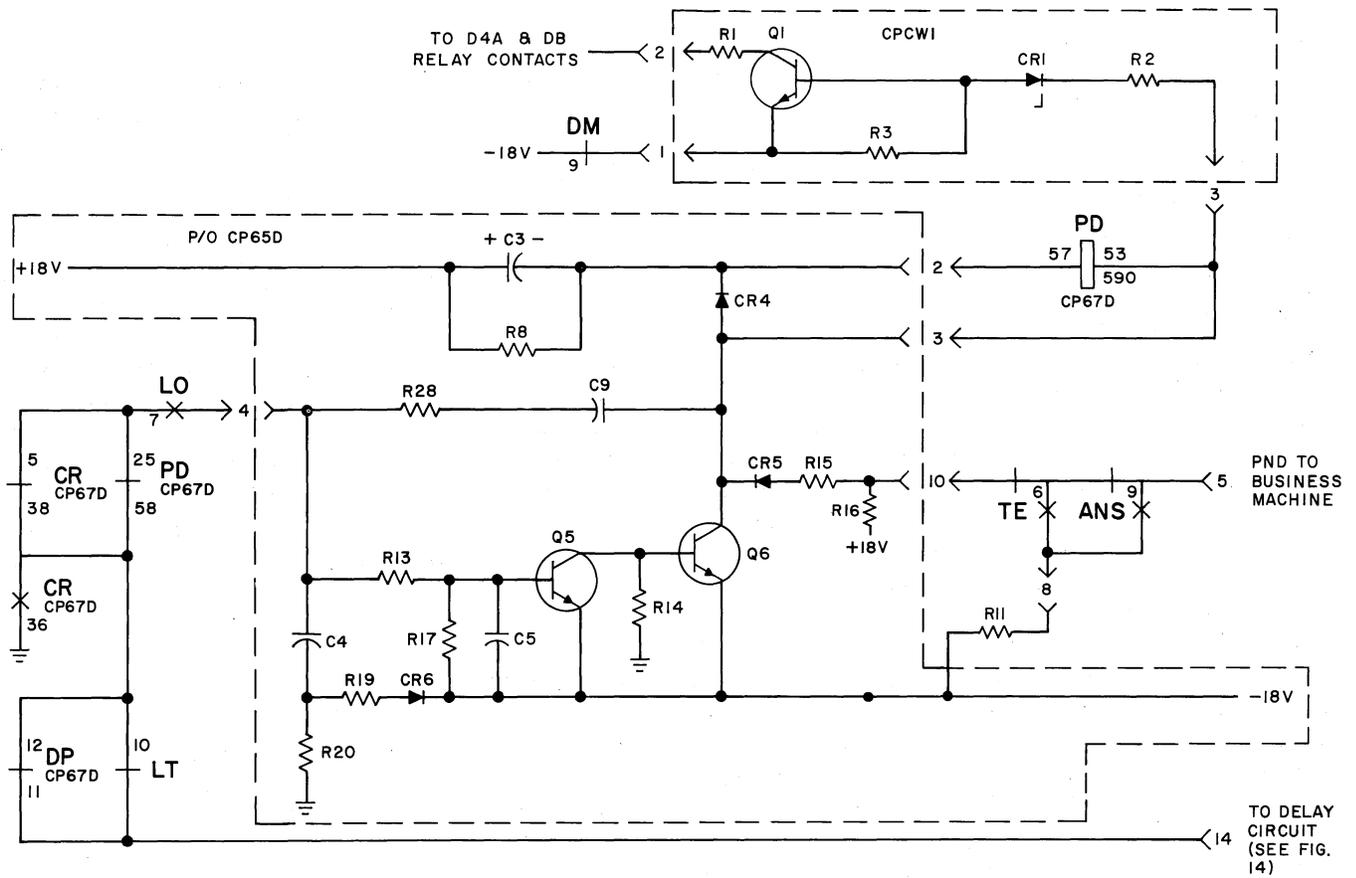


Fig. 13—Oscillator Timer, Schematic Diagram

PD relay grounds terminal 15. Initially, Q1 is driven to saturation by the current through R1. The voltage across C1 is 18 volts when terminal 15 is grounded. Capacitor C1 applies an 18-volt reverse bias to Q1, thereby turning off the transistor. Resistor R1 then lets capacitor C1 charge toward -18 volts. After 15 milliseconds, the voltage at the base of Q1 reaches a low negative value (-0.3 volt approximately) and the transistor turns on again. This supplies a ground for the oscillator timer.

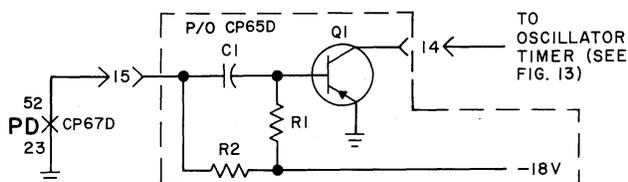


Fig. 14—Delay Circuit, Schematic Diagram

LIMITER AND DETECTOR

3.26 The schematic diagram for the 50-dB limiter and the detector circuit is shown in Fig. 15. The circuit was designed to detect the dual-frequency TOUCH-TONE dial tone (350 to 400 Hz) and either the 2025-Hz or 2225-Hz signal used by data sets as an answer tone. The limiter consists of transistors Q1, Q2, and Q3 and their associated components. When the LO relay is in the nonoperated position and the proper option is installed, dial tone detection is provided by connecting the 350-Hz network to Q1, and the 440-Hz network to Q3. With the LO relay operated and the 2025-Hz or 2225-Hz network selected by installation of the proper option, answer-tone detection is provided. In both cases, operation of the LO relay and selection of the S or T option determine which tuned circuit will be connected to Q3, thereby determining the feature or operating mode provided. A signal from the telephone network is coupled to the base of Q1

through the dc isolation capacitor C1. Bias for this stage is provided by R1 and R2. The high impedance of the tuned circuit connected to the emitter of Q1 reduces the gain of the stage for the signals near 350 Hz, and those signals are rejected. Signals having other frequencies are amplified and coupled to the second stage by capacitors C2 and C3. Varistor RV1 limits the output of the first stage when the input is large. The second stage operates similarly to the first stage except all signals are amplified equally because of the constant impedance provided by R7 in the emitter circuit. Capacitor C10 filters the biased voltage for Q2. The base voltage of Q3 is established at approximately ground potential by R8 and R9. The current through R10 divides equally between the emitter of Q3 and R11 when the signal is not present. When a signal is applied, Q3 is "off" during the positive portion of the cycle and "on" during the negative portion. When Q3 turns off, the emitter current goes to zero and that portion of the current through R10 is shunted by CR1 into capacitor C6, thus maintaining approximately constant emitter voltage. When Q3 turns on, CR1 is reverse biased and the current through R10 enters the emitter lead; therefore, a square wave of current going between zero and twice the quiescent collector current is pulsed into a tuned circuit connected to the collector. The resulting sinusoidal voltage having a frequency equal to the frequency of the impressed signal is applied to the base of Q4. Transistor Q4 is a threshold detector with emitter voltage controlled by the voltage divider R16 and R17 along with the feedback resistor R18. This holds the voltage at approximately -16 volts. The dc base voltage is about equal to the negative supply voltage. When an ac signal is present, Q4 turns on during the positive portion of the cycle during which the voltage is less than -16 volts. The emitter voltage of Q5 is regulated at -6 volts by the breakdown diode CR2 and resistor R15. Current through R12 causes the transistor to saturate when the ac signal is not present. When Q4 turns on, C7 charges rapidly, thus turning off Q5. During the portion of the cycle when Q4 is turned off, C7 discharges slowly through R12, and Q5 remains "off." When Q5 was turned off, C8 started charging through R13 and R14. After approximately 200 milliseconds, the voltage at the base of Q6 reaches a small positive value (approximately 1.5 volts), and Q7 turns on. Feedback through R18 reduces the threshold voltage for Q4, ensuring that Q7 will remain "on." When the signal is removed, C7 discharges through R12; after 15

milliseconds, Q5 turns on, thereby turning off Q7 and discharging C8 through R14. End-of-answer detector Q8 and its associated components are used by connecting the base of Q8 to the collector of Q7 through the released contact of the PD relay. Initially, Q8 is in the "off" condition. The reverse bias is supplied by R22 and limited by CR3. Capacitor C9 has approximately 18 volts across it, and the current through R21 and R20 is zero. When Q7 turns on, C9 discharges through R21 and the collector of Q7. When Q7 turns off, C9 charges through R20, R21, and the base emitter junction of Q8, thus turning on the transistor switch. Transistor Q8 will remain "on" for a minimum of 50 milliseconds after Q7 turns off. The relay contact closures and the option strapping required for operation of the ANS and LO relays are shown by Fig. 15.

4. PERFORMANCE DATA

4.01 The inputs to the ACU are furnished by a compatible business machine and consist of voltage level signals. Table B and 2.04 give the range of these signals.

4.02 In addition to the signals furnished by the business machine, the ACU requires a source of 117-volt, 60-Hz ac power.

4.03 The output of the ACU consists of the TOUCH-TONE signals required to dial a number. The TOUCH-TONE frequencies are given in 2.05 and Table C.

4.04 Circuit characteristics or parameters are given in Tables E through J. These tables cover CP 60, CP 61, CP 62, CP 64, CP 65, and CP 66. Because of their simplicity, CP 63 and CP 67 are not covered by a table.

4.05 Component replacement on the circuit pack assemblies is shown in Fig. 16 through Fig. 23.

5. MAINTENANCE INFORMATION

5.01 No routine maintenance of the ACU is required. It is assumed that the test center has checked with the customer and verified that attempts by the customer to complete calls manually with the test buttons have failed.

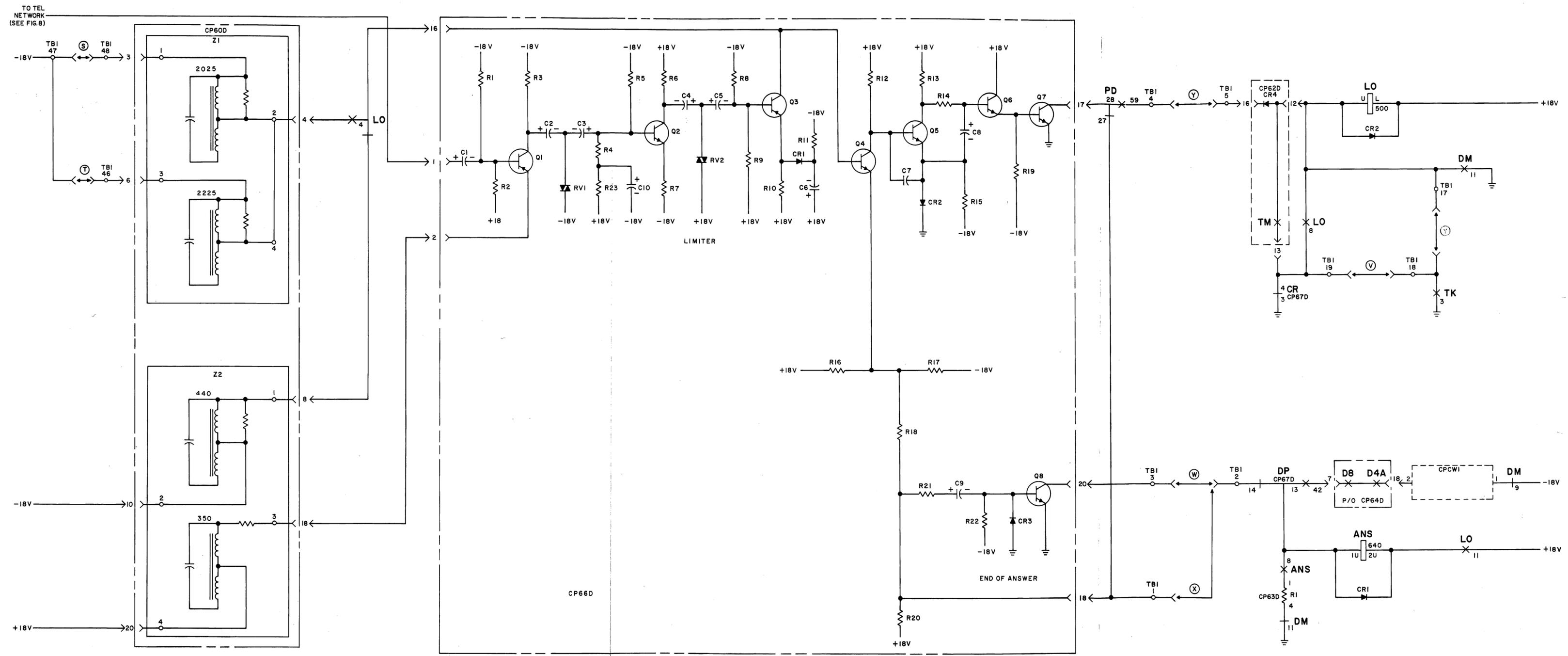


Fig. 15—Limiter and Detector, Schematic Diagram

TABLE E

CP 60

CIRCUIT	FUNCTION OR TYPE
Tuned circuit Z1	Two sections Terminals 3 and 4 connect to 2025-Hz tuned circuit. Terminals 4 and 6 connect to 2225-Hz tuned circuit.
Tuned circuit Z2	Two sections Terminals 8 and 10 connect to 440-Hz tuned circuit. Terminals 18 and 20 connect to 350-Hz tuned circuit.
Transformer T1	2504AC

TABLE F

CP 61

CIRCUIT	FUNCTION OR TYPE
7- to 40-second timer	Timer is started by removing -18 volts from terminal 4. This provides a ground through terminal 2 and saturates Q4 at expiration of time interval.
Monitor amplifier	Call-progress tones from telephone line are amplified for U1 telephone receiver and made audible when ACU is in test mode.

TABLE G

CP 62

CIRCUIT	FUNCTION OR TYPE
Telephone network Z1	4010B
Tip monitor	Actuates TM relay when a ground is applied to OR gate, composed of CR1 and CR2.

TABLE H

CP 64

CIRCUIT	FUNCTION OR TYPE
TOUCH-TONE transmitter	Input consists of contact closures furnished by digit relays.
Digit relays	Relays are actuated by a negative voltage applied by either business machine or test keys.

TABLE I

CP 65

CIRCUIT	FUNCTION OR TYPE
Delay circuit	Timer started by ground applied to terminal 15. Time delay is 15 milliseconds.
Intercall timer	This transistor switch controls the CR relay and can be delayed for 1 second by the intercall timer. The CR relay releases, after time out, when CRQ lead from business machine goes positive.
Oscillator timer	Timer is started by removing ground from terminal 4. Timer actuates PD relay and places a positive voltage on PND lead to business machine at the expiration of the 42-millisecond time interval.
DP timer	Timer is started by a positive input from business machine and actuates DP relay.

TABLE J

CP 66

CIRCUIT	FUNCTION OR TYPE
50-dB limiter	Provides gain and limiting of input signal.
Answer detection	Detects 2025-Hz or 2225-Hz frequencies and controls relay operation.

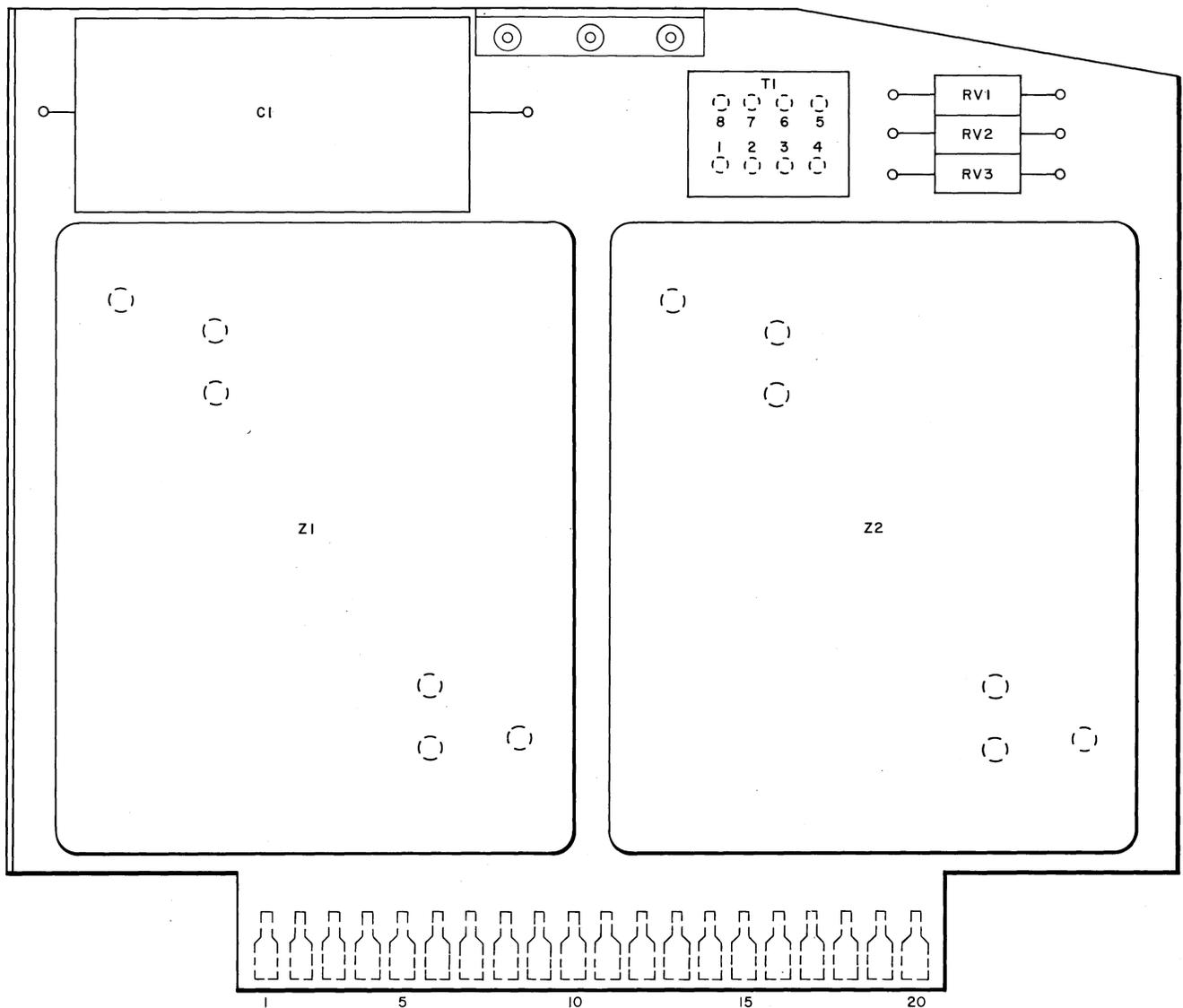


Fig. 16—CP-60 Component Replacement

5.02 The ACU contains no fuses in the power supply circuit. Therefore, if power is available at the customer-furnished receptacle, a check of the connecting cord and the ACU power supply should be made prior to making any other tests.

5.03 Table K gives circuit pack assembly number, features, and designation. This table, in conjunction with the information on inputs and outputs of the circuit packs found in 4.04, should

aid in isolating the trouble to a specific section or circuit pack.

5.04 For detailed maintenance of the circuit packs, refer to Bell System Repair Specification (BSRS) 480.017.

5.05 For additional information on the ACU, refer to Part 6 which contains a list of the applicable specifications and other technical memoranda.

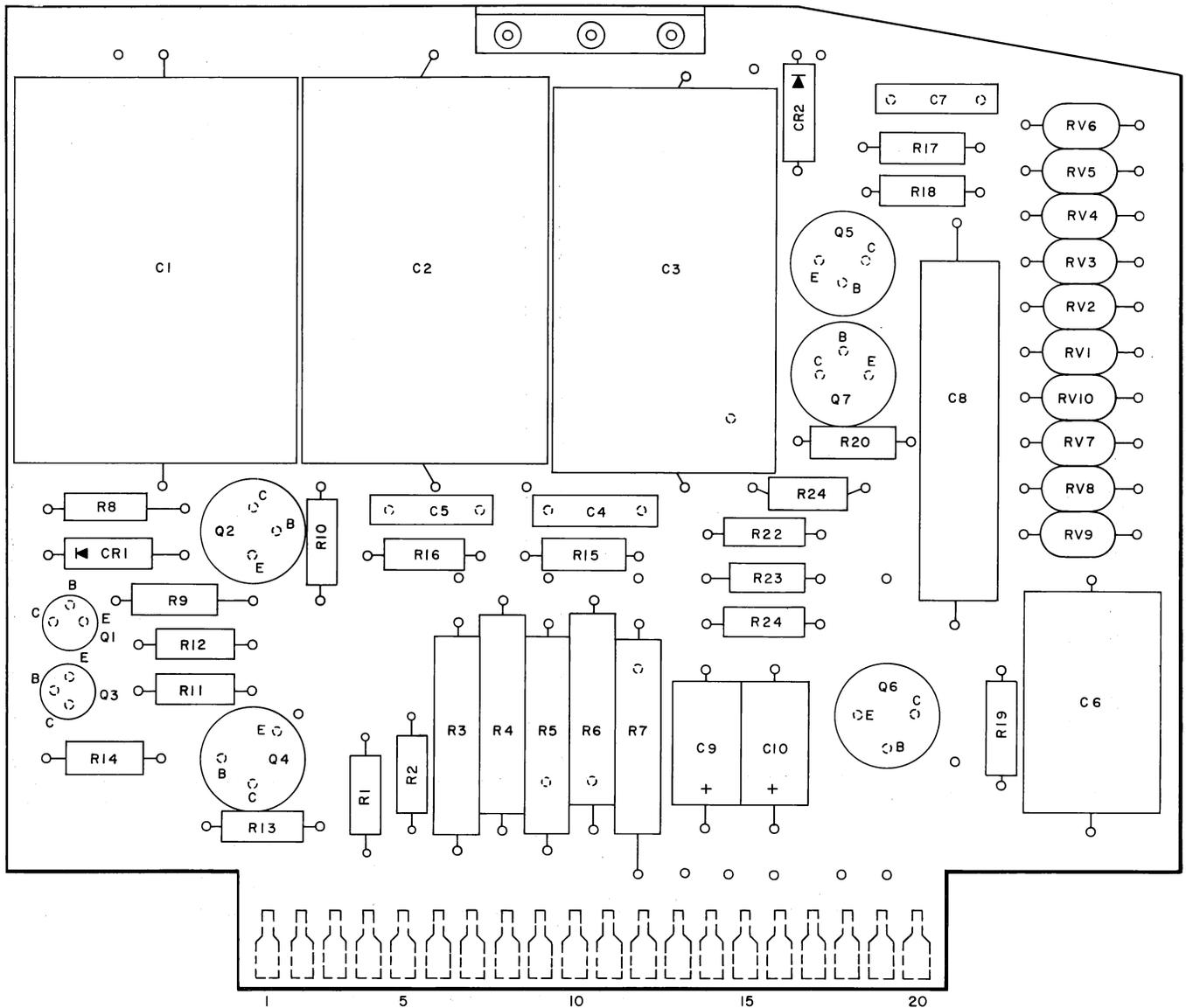


Fig. 17—CP-61 Component Replacement

6. REFERENCES

6.01 Sources of additional information on the ACU are listed below:

(b) SD-1D035-01

(c) BSRS 480.017

(a) CD-1D035-01

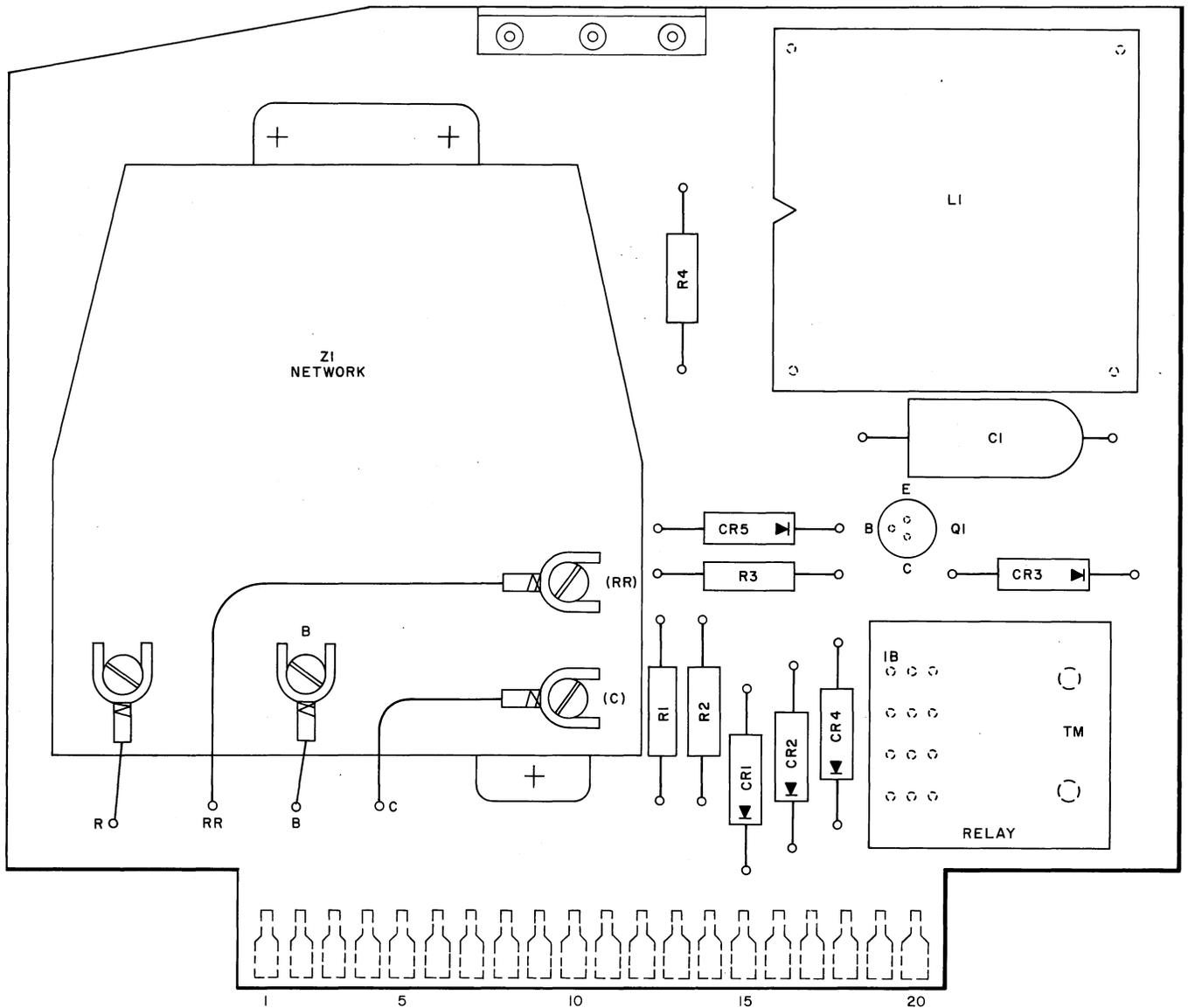


Fig. 18—CP-62 Component Replacement

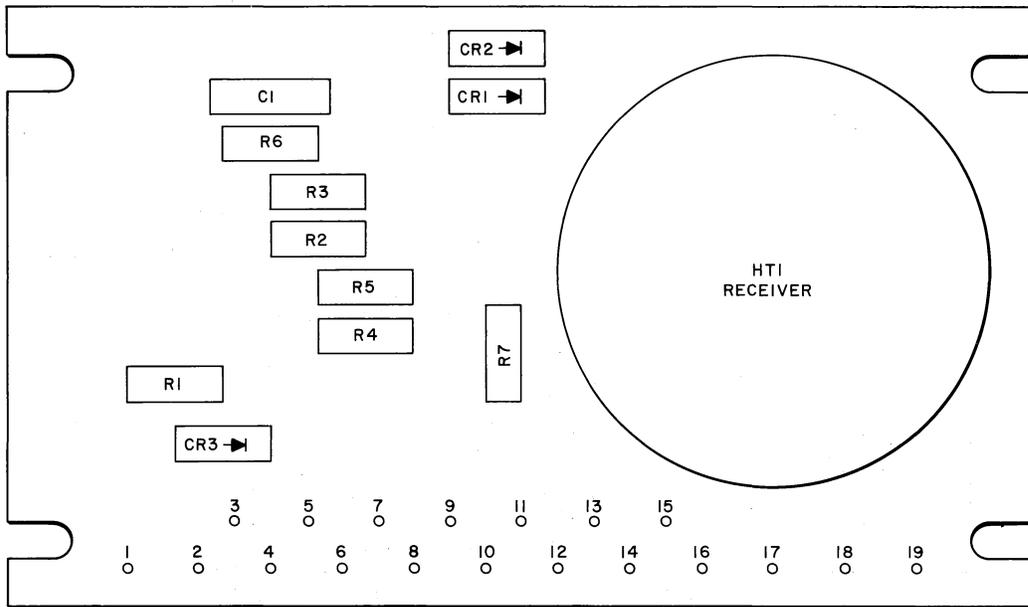


Fig. 19—CP-63 Component Replacement

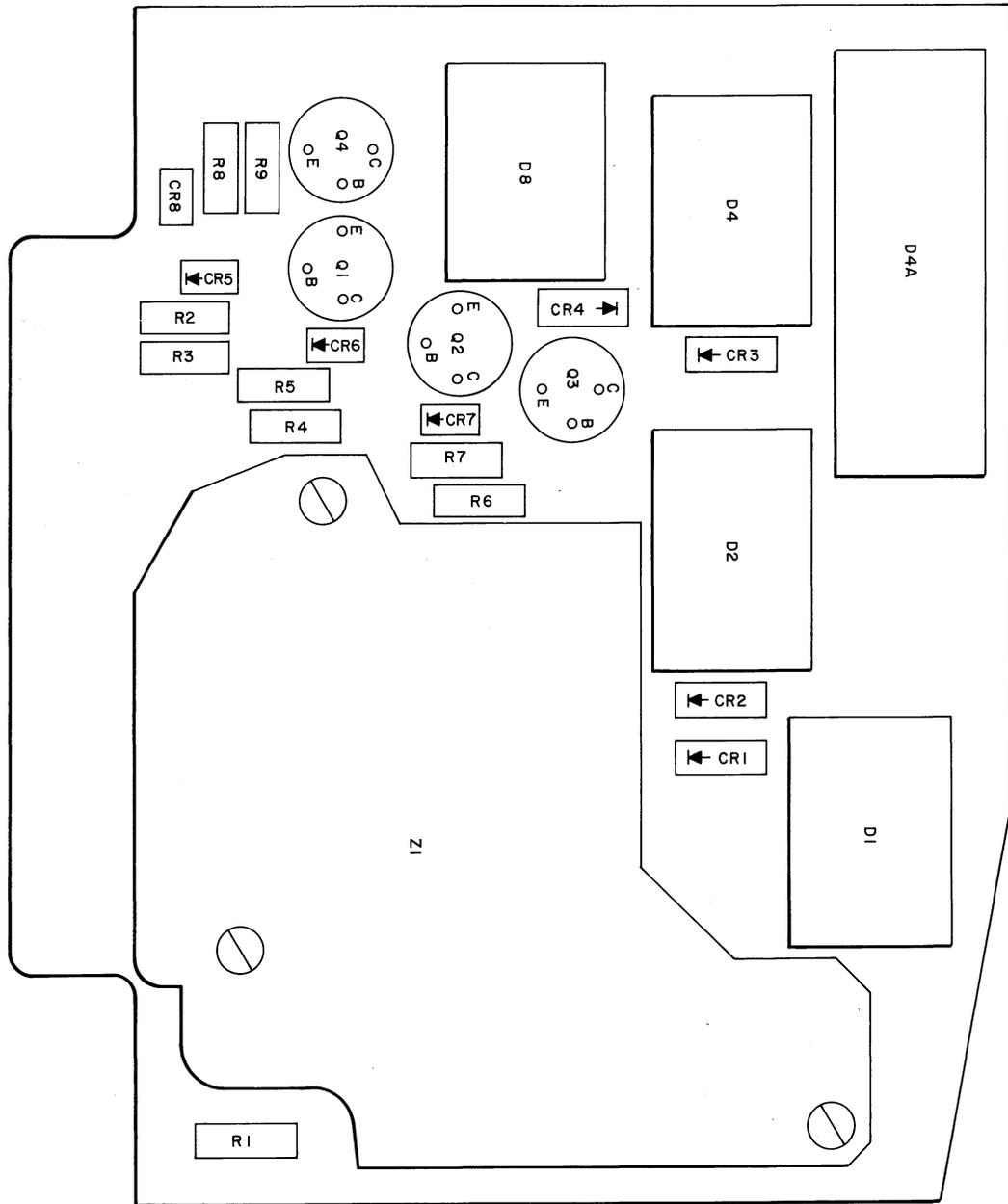


Fig. 20—CP-64 Component Replacement

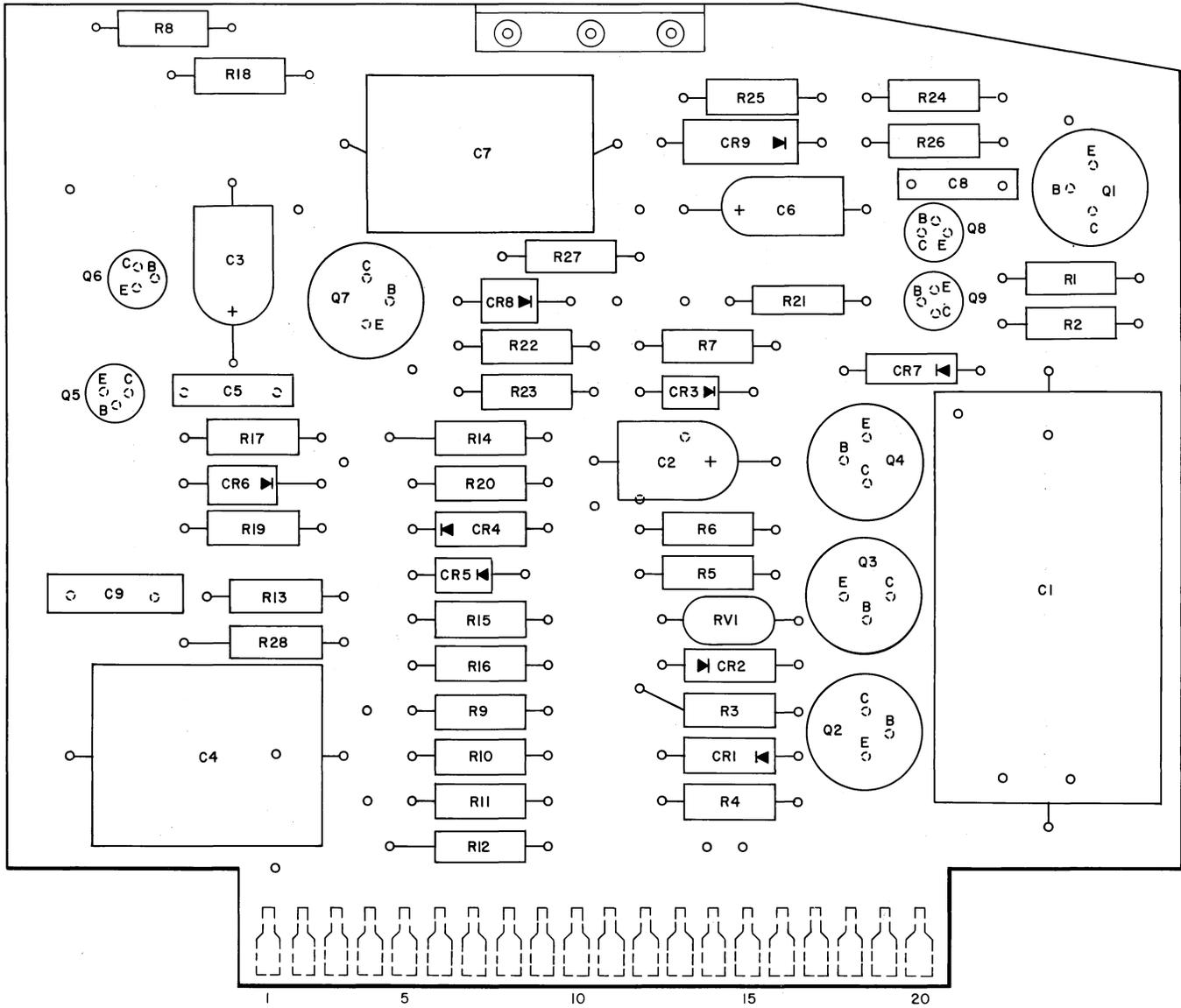


Fig. 21—CP-65 Component Replacement—Timers, CP-65P, Component Layout

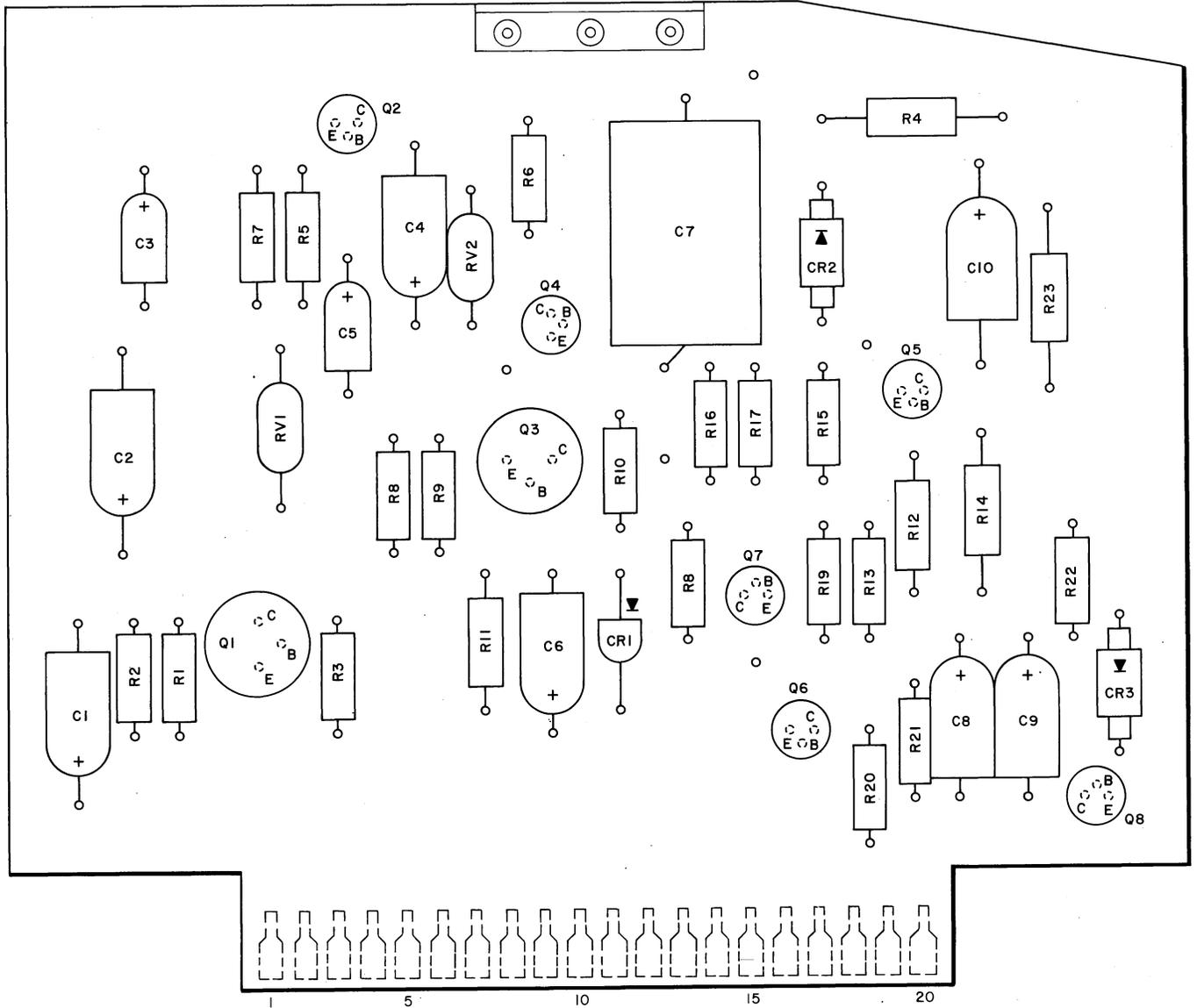


Fig. 22—CP-66 Component Replacement—Limiter and Detector, CP-66D, Component Layout

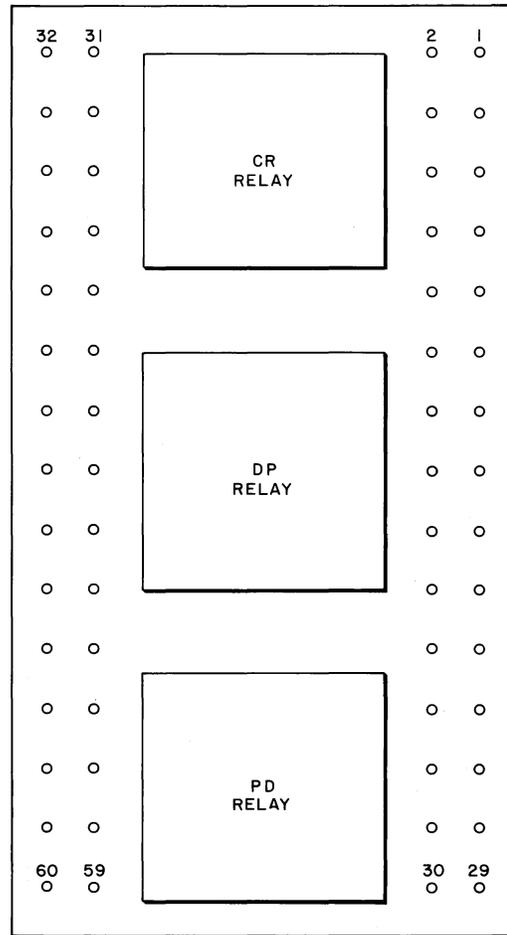


Fig. 23—CP-67 Component Replacement

TABLE K

CIRCUIT PACK IDENTIFICATION

CIRCUIT PACK DESIGNATION	CIRCUIT PACK FEATURES	CIRCUIT PACK ASSEMBLY NO.
CP 60	Tuned circuits and input transformer	A835288
CP 61	7- and 40-second timer and monitor amplifier	A835284
CP 62	Telephone network and tip monitor	A835282
CP 63	Receiver and miscellaneous components	A835287
CP 64	TOUCH-TONE transmitter and control	A835283
CP 65	Timers	A835285
CP 66	Limiter and detector	A835286
CP 67	Relays	A835289
CP CW1	EON Gate	A835803