

33 CALL CONTROL UNITS

DESCRIPTION AND

PRINCIPLES OF OPERATION

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85A1/86A1 selective calling systems, add operating temperature requirements, and provide the latest engineering information. Marginal arrows indicate changes and additions.

1.02 The function of the call control unit is to couple the teletypewriter through a data set to telephone networks. In conjunction with the data set, it provides facilities for initiating, accepting, controlling, and completing calls.

2. DESCRIPTION

2.01 When the call control unit is used with the appropriate data set it is connected with conventional telephone central offices having the required routing and message accounting equipment. These are generally the same offices and equipment serving telephone customers in the area. Direct current signals are used for both originating and terminating traffic, providing the same conditions as conventional local telephone set operation.

2.02 The dial on the call control unit, for initiation of call connections, may be either a dc pulsing or a multifrequency tone device. Also included in the control unit are ringing or tone sounding apparatus for alerting the called party.

2.03 The call control unit, used with 33 sets (ASR and RO) for 85A1/86A1 selective calling systems, is located to the right of the 33 printer. It consists of a sheet metal base 15 inches long and 4.5 inches wide mounted to the right side of the base casting with five screws. The LOCAL-ON LINE mode switch is mounted in the center of the call control unit.

2.04 Behind the mode switch knob (if present) are the AUX RECEIVER switches. The basic components, namely SMD (selector magnet driver), circuit card, wiringfield, auxiliary receiver relay, fuses, receptacle, terminal block, and connectors are located in the rear of unit. The front of the unit accommodates customer supplied attendant set.

1. GENERAL

1.01 This section provides description and principles of operation for model 33 call control units. It is reissued to change the title, add description of call control unit for model 33

2.05 Red and black test jacks for the 911 test set are located along side the mode switch (on ASR sets) or the place where one would mount (on RO sets). The connector mounting bracket provides space for 5-15 pin connectors which supply termination points for ASR or RO sets. An A connector provides a signal line and controls to the customer supplied controller. The K connector and cable is used for interconnecting auxiliary receivers.

2.06 Power input (115 volts ac, 60 hertz) is supplied by a three-wire power cable that attaches to a terminal block (9 terminals) and ground stud at the rear of unit. The 15-pin Molex connector is connected to the reader power pack. The four pin quick disconnect connector is mated with the 48 volt dc power supply connector.

2.07 For specific wiring information, see the pertinent wiring diagram(s) associated with the call control unit or (when provided) the appropriate section.

**CAUTION: THIS EQUIPMENT IS INTENDED TO BE OPERATED IN A ROOM ENVIRONMENT WITHIN THE TEMPERATURE RANGE OF 40° F TO 110° F. SERIOUS DAMAGE TO IT COULD RESULT IF THIS RANGE IS EXCEEDED. IN THIS CONNECTION, PARTICULAR CAUTION SHOULD BE EXERCISED IN USING ACOUSTICAL OR OTHER ENCLOSURES.**

### 3. BASIC UNIT OPERATION

3.01 The call control unit provides for signaling speeds of 100 wpm from dc marking and spacing intelligence pulses originating from the typing unit distributor in the teletypewriter. These pulses are directed to the input of the selector magnet driver in the call control unit, where they are amplified and returned to the typing unit as 0.500-ampere dc pulses to operate the selector magnet.

3.02 If the originate (ORIG) pushbutton (nonlocking) on the call control unit has been depressed and connection with a called station has been satisfactorily completed, the intelligence pulses originated by the typing unit distributor are sent to the data set. The data set converts the dc pulses to tone signals for transmission over telephone lines. Another data set, located at the called station, con-

verts the tone signals back to dc pulses, which are directed to the input of the selector magnet driver to operate the typing unit selector in the teletypewriter of the called station. The teletypewriter at a given station copies both the transmitted and received dc signals, operating on a half-duplex basis.

3.03 Although the data set is not a part of this equipment, a brief discussion of its function is necessary to understand the operation of the system. Start-stop dc signal pulses form essentially a square wave which cannot readily be transmitted over telephone lines. The data set is basically a converter which changes the dc signals from the sending or calling station into frequency-shifted tones for transmission over the telephone network. A marking pulse from a sending station is converted to a 1270-cycle marking signal (F<sub>1</sub> mark) and a spacing pulse becomes a 1070-cycle spacing signal (F<sub>1</sub> space). The data set at the receiving or called station sends a 2225-cycle marking signal (F<sub>2</sub> mark) and a 2025-cycle spacing signal (F<sub>2</sub> space). During transmission of a message the calling station sends mark and space tones (F<sub>1</sub> mark and space) while the called station sends a continuous mark tone (F<sub>2</sub> mark). In this way the telephone facilities are operated on a full-duplex basis. If the signal received at either station (F<sub>1</sub> mark and space at the called station and F<sub>2</sub> mark at the calling station) shifts to a space tone for more than one second, or if the received signal is lost for one second, the data set will cause the station to be disconnected. This provides assurance that the connection is maintained for the entire period of message transmission.

3.04 The call control unit used with the data set operates with conventional telephone central offices that have the necessary routing and accounting facilities. In operation, a call is originated by depressing the ORIG pushbutton. A lamp illuminates the pushbutton and the dial tone will be heard through a loudspeaker. If the line is busy, a busy signal will be heard and the clear (CLR) pushbutton (nonlocking) should be depressed. If the line is not busy, the operator dials the number of the desired station. This causes the called station to go into connect condition. If the teletypewriter is manually operated, the called station operator presses the answer (ANS) pushbutton (nonlocking). Following a short interval, about 1-1/2 seconds, in which telephone facilities are connected, the called station transmits a mark tone (F<sub>2</sub>) and receives a mark tone (F<sub>1</sub>) from the calling

station. Receiving the continuous  $F_2$  mark tone from the called station for 1 second causes the calling station to go into connect condition, and its typing unit motor is turned on. Likewise, the continuous  $F_1$  mark tone from the calling station for 1 second causes the called station to go into connect condition, and its typing unit motor is turned on. Either station can now transmit.

3.05 At the end of the message, either station may originate a disconnect by depressing the CLR pushbutton, at which time each station goes back to its idle condition, ready to receive or originate other calls. For keyboard practice, maintenance purposes, or preparation of copy, the local mode (LCL) pushbutton (locking) is depressed. This turns on the typing unit motor and disables automatic answering facilities, if present. In the event of an incoming call during local operation, the call control unit responds to ringing signals and the ANS pushbutton must be operated manually. Operation of the test (TST) pushbutton (locking) causes received signals to be retransmitted to the test center for maintenance purposes. A lamp, associated with each pushbutton, illuminates the pushbutton whenever that pushbutton has been operated and the operating condition exists. The ANS lamp is pulsed in response to ringing signals of an incoming call, and lights continuously when the call is answered. The CLR lamp is automatically extinguished 1.5 seconds after the pushbutton has been depressed, and disconnect is completed.

3.06 A steady mark signal blinds the associated teletypewriter during all intervals, except when in the connect condition. This prevents spurious characters from being printed except when due to loss of signals, circuit noise, or deliberate break or space-disconnect signals.

3.07 Power Requirements: Power input to the teletypewriter is  $115V \pm 10$  per cent, 60 cps  $\pm 2$  per cent. Average power consumption is 35 watts (not including typing unit motor) with peaks up to 50 watts permitted.

#### PROGRESS OF A CALL

3.08 To originate a call, the ORIG pushbutton is momentarily depressed. This connects the station to the line and lights the ORIG lamp. During the period of time in which connection is being made, the telephone central office makes no time measurements. When the ORIG

pushbutton is closed, the call control unit is connected to the telephone line through the data set and an off-hook condition is set up. The amplifier is connected into the circuit so that the dial tone from the central office is heard. The called station is dialed while the amplifier monitors the progress.

3.09 At the called station audible and visible signaling devices are operated. The called station goes off hook and into the connect condition upon operation of the ANS pushbutton circuit, by manual or automatic means, at the distant point. At this time, there is a nonsignaling interval of 1.225 seconds during which accounting and toll recording facilities at the telephone exchange will be cleared. Following the nonsignaling interval, the called station transmits its  $F_2$  mark tone and sets its monitoring timer to respond to the  $F_1$  mark tone from the calling station. When the continuous  $F_2$  mark tone is received at the calling station for a period of 1 second, indicating that a station has answered, it will go into the connect condition and turn on its typing unit motor. When the continuous  $F_1$  mark tone is received at the called station for an interval of 1 second, it will go into the connect condition. The station may now acknowledge the call either by operator keyboarding, or by automatic answerback message transmission. The monitoring timers at both stations are set to respond to reception of a space tone from the distant station. Traffic can now be exchanged from either station on a half-duplex basis.

#### DISCONNECTING A CALL

3.10 During the time the two stations are connected (traffic interval), either station can initiate a disconnect as follows:

(a) A call is normally terminated by the "end-of-transmission" (EOT) code combination which provides fast disconnect without introducing hit characters. This is accomplished by the data set in response to EOT contact closures in the typing unit function boxes of both the sending and receiving teletypewriters.

(b) A call connection can also be cleared manually by momentarily depressing the CLR pushbutton. Operation of the CLR pushbutton at either station will cause transmission of a spacing signal of 1.5 seconds duration, after which the station originating

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the disconnect will discontinue its tone transmission and go back on hook. The other station, after receiving the spacing signal for 1 second, will automatically transmit its 1.5-second spacing signal and then go on hook. Both stations will then be back in their original idle condition in which calls can be either originated or accepted.

### ANSWERING A CALL—MANUAL AND AUTOMATIC

#### A. Manual Answering

3.11 To answer a call manually, momentarily depress the ANS pushbutton. This connects the station to the line and lights the ANS lamp. The lamp remains lighted until the answer mode is terminated. Manual answering is necessary only when the automatic answer-back circuit is disabled. The automatic answer-back circuit is disabled by low-paper contacts, data set relay contacts (when in local mode), and the OUT OF SERV. key.

#### B. Automatic Answering

3.12 Call control units equipped with automatic answering facilities will respond to received ringing signals, turning the teletypewriter on at the end of the ringing interval and proceeding through to the connect condition. Automatic message answer-back is a part of this feature. The presence of an operator is required in order to complete disconnect and return the teletypewriter to idle condition. For unattended service, an automatic disconnect timing device (optional) actuated when a call is answered, will cause the teletypewriter to go through the connect condition, send the 1.5-second spacing tone, and go back on hook if the F1 mark tone is not received within 8 seconds after the called station answered. This is designed to prevent the unattended station from being made busy by (telephone) calls that fail to cause a full connection to be set up. This feature does not affect normal automatic disconnect upon receiving the 1-second spacing tone or loss of tones due to a dropoff.

#### LOCAL MODE

3.13 The local mode (LCL) provides off-line operation of the teletypewriter. The operator selects the local mode by depressing the LCL pushbutton. This lights the LCL lamp and

operates the motor control relay (MCR) to energize the typing unit motor. The data set connects the sending circuit to the receiving circuit and enables the keyboard and answer-back to transmit. In this condition the teletypewriter can be used for preparing copy, for operator practice, or for maintenance purposes. If an incoming signal is received during this time, ringing signals are received and manual operation of the ANS pushbutton is required in order to receive the message. If the teletypewriter is in a terminal hunting group, the operator must turn the out-of-service (OUT OF SERV.) knob to the RESTORE position momentarily and then to NORMAL.

#### "OUT OF SERV." SWITCH

3.14 The OUT OF SERV. switch prevents the automatic answering of incoming calls. In its NORMAL position (arrow on knob upright), it has no effect or function; in the OUT OF SERV. position (knob rotated counterclockwise and detented) it sets the following conditions:

- (a) A contact is closed that causes the OUT OF SERV. lamp to light.
- (b) A contact is closed that shorts the ringer coils. This makes the ringer inoperative. As an option the contact can be located to shunt both the ringer and series capacitor (ie, the telephone line). This makes the station appear to be in an off-hook condition or busy to the central office.
- (c) A contact is opened that breaks the automatic answer circuit to the answer relay. This prevents the relay from operating in response to the ring-up relay and thus the teletypewriter will not answer.

3.15 For stations that are not in terminal hunting groups, the operator may return the teletypewriter to service by turning the OUT OF SERV. knob to the NORMAL position. For terminal hunting stations, however, the operator must turn the knob to the RESTORE position and hold it until a dial tone is heard. In this position:

- (a) A contact is closed that shorts the tip to ring (off-hook condition). This condition is detected by the central office which then releases the teletypewriter from lockout and applies the dial tone.

(b) A contact is closed that completes a path from the speaker amplifier to ground. This permits the amplifier to pass the line signals (dial tone).

The OUT OF SERV. switch is then restored to NORMAL.

#### LOW-PAPER ALARM

3.16 A low-paper alarm is provided in the teletypewriter. When a low-paper condition occurs, make contacts in the low-paper switch provide ground to the low-paper buzzer, permitting it to operate. Depressing the buzzer-release (BUZ-RLS) pushbutton (locking) in the call control unit silences the buzzer and causes the (BUZ-RLS) lamp to light. Attempting to release the pushbutton without replenishing the paper supply will result in the buzzer operating. When the paper has been replenished, the teletypewriter is returned to normal by releasing the BUZ-RLS pushbutton.

3.17 Break contacts on the low-paper switch disable the automatic answer-back circuit. The operator can override this condition by answering manually. If the low-paper alarm occurs during a call the operator has the option of completing the call before changing the paper, or interrupting the call. To interrupt the call, the operator stops transmission by depressing the BREAK key on the keyboard followed by depressing the BRK-RLS pushbutton to notify the distant station of the problem. The connection is cleared by simultaneously operating the control (CTRL) and EOT keys on the keyboard. Turning the OUT OF SERV. knob to the detent position insures that the teletypewriter will not automatically answer a call while paper is being replenished.

3.18 To restore the teletypewriter to service after paper has been inserted, depress the CLR pushbutton and return the OUT OF SERV. knob to its NORMAL position. (For teletypewriters in terminal hunting groups, turn the knob to its RESTORE position and hold it there. When a dial tone is heard, release the knob.) The teletypewriter is now in a normal idle operating position.

#### RESTRAIN LAMP

3.19 This high intensity restrain (REST) lamp lights when a restraining signal is received from an 8-level to a 5-level converter

used in transmission to 5-level TWX stations on the DDD switching plan. The lamp remains lighted until the restraining signal is removed. The purpose of this feature is to limit the sending speed from 8-level teletypewriter transmitting at 100 wpm to 5-level teletypewriters receiving at 60 wpm.

#### TEST MODE

3.20 If the TST pushbutton is operated while the teletypewriter is connected to a test center, the message sent by the test center will be recorded on the teletypewriter and turned around and sent back for analysis. This is accomplished by connecting the teletypewriter to the data set through a set of transfer contacts and a break contact to ground. This type of operation can be terminated by momentarily operating any of the nonlocking pushbuttons, which will then release the TST locking pushbutton.

#### SIGNAL GENERATION

3.21 The teletypewriter can send by operating the keyboard, answer-back mechanism, or BREAK key. The keyboard signal generator contacts and answer-back contacts are in parallel with the signal generator (distributor) which is, in turn, connected to the data set. The BREAK key connects to the data set via separate leads.

#### SELECTOR MAGNET DRIVER

##### A. General

3.22 The data set supplies a 20-ma dc signal to the selector magnet driver associated with the teletypewriter. The selector magnet driver amplifies the signal to 500 ma to operate the typing unit selector on the teletypewriter. The selector magnet driver is a 2-stage transistorized amplifier capable of switching high output currents (0.500 ampere) at very closely controlled input current levels. The output of the selector magnet driver is automatically regulated and is essentially independent of normal variations in power supply voltage and of selector-magnet and current-limiting resistance values.

##### B. Circuit Description

3.23 Figure 1 illustrates a schematic drawing of a selector magnet driver circuit used on Bell System switched network service. For

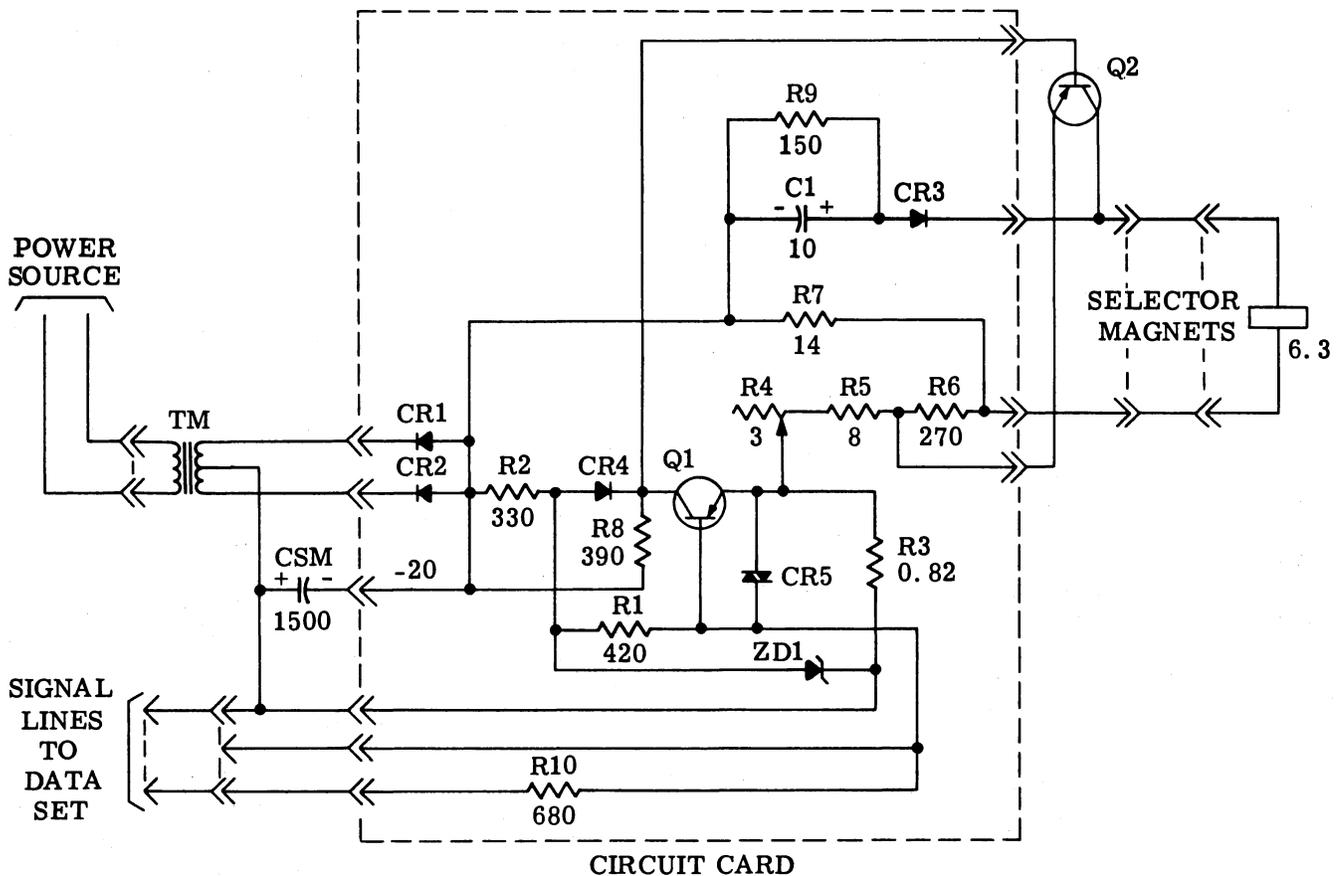


Figure 1 — Selector Magnet Driver Circuit

additional information, see the pertinent wiring diagram(s) or (when provided) the appropriate section.

**3.24 Open Line:** When the line circuit is open (spacing), transistor Q1 will be turned on by the regulated current flowing through R1 into its base. This current, which is controlled by R1, will be set near the desired switching level. With Q1 conducting, Q2 will be cut off, since the potential at the base of Q2 will be more positive than at the emitter. In this condition, only small leakage currents will flow in the collector circuit.

**3.25 Space-to-Mark Transition:** As the space-to-mark transition begins, the negative bias current flowing in the base of Q1 is diverted to the line circuit. As the line current rises toward the marking current value, it extracts

base current from Q1. When the line current approaches the total current supplied to the base of Q1 to within 0.001 ampere, which is about one-half the nominal mark current value, Q1 begins to turn off. Q2 will then begin to receive forward bias current from R8 and begin to turn on. The base current will then be amplified by Q2, and a current which is a multiple of the base current will appear in the emitter circuit. This increase in emitter current results in an increase in the negative potential measured across R3. The increase in the negative potential at the emitter of Q1 causes it to go further into cutoff. The feedback process continues until the current in the selector magnet reaches a value which is determined by the Zener reference voltage, clamp diode CR4, and the emitter resistance of Q2 (the emitter resistance of Q2 is adjusted by R4 to compensate for component variations). As the line current completes the transition to the final marking current value, the base of Q1 becomes positively

biased. The positive bias current will be approximately one-half the total marking line current. The positive potential to the base of Q1 is clamped to approximately 0.6 volt by the input protecting varistor, CR5.

3.26 Mark-to-Space Transition: The line current, in changing from mark to space, will finally reach the point where R1 will begin to supply some forward current to the base of Q1. The line current level at which this occurs will be a little more negative than the point at which the circuit switched from space to mark, due to the common emitter resistor voltage feedback. As Q1 begins to turn on, the current through R8 will be diverted from the base of Q2, causing it to begin to turn off. As Q2 turns off, the voltage across R4 will begin to go positive, causing Q1 to be further turned on. This effect gives regeneration to the mark-to-space transition.

3.27 Mark-to-Space Switching Transient:

When Q2 is turned off during the mark-to-space transition, a negative voltage transient is developed at its collector. This transient is due to dissipation of the energy stored in the magnetic field of the driven magnet when energized by 0.500 ampere. If the high voltage developed at the collector of Q2 were not limited, it would continue to rise until it reaches the point where the collector-to-emitter breakdown voltage is exceeded. It has been found that repeated breakdown of this kind causes deterioration of the transistor and finally a collector-to-emitter short circuit. Therefore, it is necessary to provide a transient suppressing network at the collector of Q2. The transient-suppression network presently in use is a compromise which affords a minimum peak voltage combined with a magnet release time to provide for adequate teletypewriter margins. The network consists of C1 in parallel with R9. CR3 isolates the network from voltages more positive than negative battery potential.

#### SPEAKER AMPLIFIER SYSTEM

3.28 Figure 2 illustrates a schematic drawing of a speaker amplifier circuit used in Bell System switched network service. For additional information, see the pertinent wiring diagram(s) or (when provided) the appropriate section.

3.29 The speaker amplifier is powered only after the ORIG key is operated and is quieted when the station connects. It has two

inputs, one from the telephone line via the buffer amplifier in the data set limiter and the other from the multifrequency (MF) tone dialer. Three outputs are provided: (1) into the loudspeaker or optional hand-held receiver, (2) into the telephone line through the sending amplifier in the data set, and (3) an auxiliary output into the data set. The line-to-loudspeaker connection permits monitoring of supervisory signals when originating a call. The TOUCH-TONE dial-to-line and TOUCH-TONE dial-to-loudspeaker connection provides for amplification of the outgoing MF dialing signals and for monitoring them during outpulsing. The line-to-second-output connection is provided for the dial tone detector (when furnished). The various connections mentioned are established by switching in the data set and by the common switch in the TOUCH-TONE dialer.

3.30 The speaker amplifier is a conventional direct-coupled, 2-transistor audio amplifier. The input signals from the telephone line are fed through the receiving buffer amplifier in the data set into the primary winding of the input transformer (T1). The primary winding continually carries approximately 4 ma quiescent current from the receiving buffer amplifier. The other input, from the TOUCH-TONE dialer, is fed directly into Q1 through C5. Both inputs are dc isolated from the amplifier stages.

3.31 Two outputs are taken from transistor Q2, one from collector circuit and the other from the emitter.

(a) The collector output is fed through a stepdown output transformer (T2) into the loudspeaker (or receiver). A potentiometer is used to set proper volume for varying loop loss and ambient noise level. The TOUCH-TONE dialer signals are independent of loop loss.

(b) The emitter output splits into two signal lines: one for injecting the MF dial tones into the data set sending amplifier, and the other for feeding the dial-tone detection circuit (when provided). The signal level from the emitter output is essentially independent from the setting of potentiometer.

3.32 Bypassed R6 is a supply voltage dropping resistor. Diode CR1 is provided to block a sneak path (in the answer mode) from ground through the ANS and ORIG lamps. Without the CR1, the ORIG lamp would be dimly lit

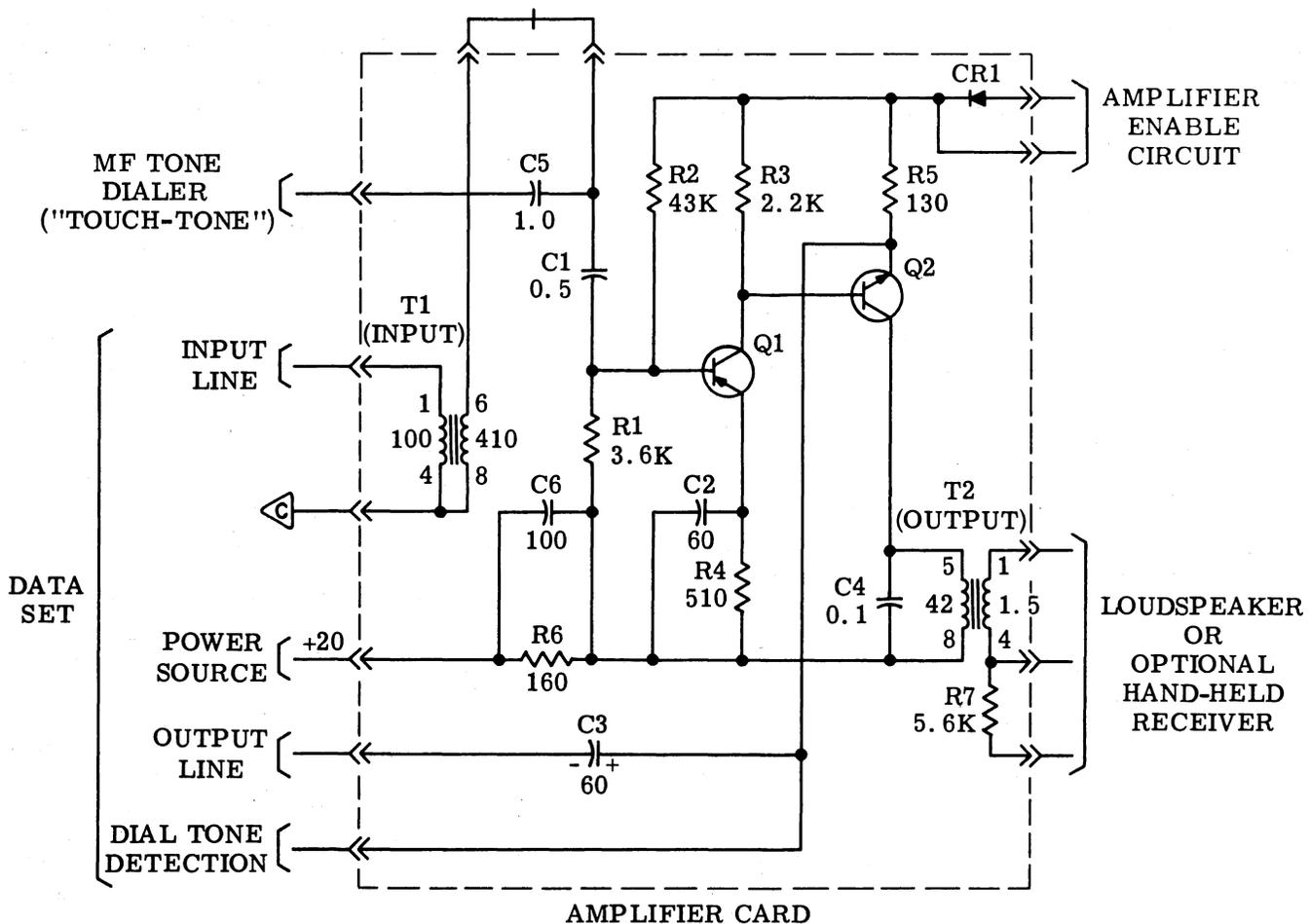


Figure 2 — Speaker Amplifier Circuit

and the amplifier would not be silent when the station is in the answer mode. The amplifier operates only in the originate mode until the station connects. In any mode other than originate, the ground is disconnected. When the station connects, the amplifier input is short-circuited in the data set.

#### DIALER MECHANISM

##### A. Pulsing Rotary Dialer

3.33 For rotary dialer applications a pulsing contact of the rotary dialer is inserted into the telephone line. The manual rotary dialer is equipped with a normally closed pulsing contact and a normally opened off-normal contact. The pulsing contact is inserted into the telephone line when the station originates a call.

When answering, a short circuit is applied across the pulsing contact. The off-normal contact is placed across the output of the amplifier and silences the loudspeaker whenever the dialing disc is moved.

##### B. Pulsing Card Dialer (40A)

3.34 The 40A dialer is operated by direct current furnished from the central office.

3.35 To use the card dialer, the ORIG push-button is depressed. After a dial tone has been received, a card with the telephone number punched in it is inserted in the slot and entirely pushed in. This operation winds a spring motor, which later pushes the card out of the slot as the dialing proceeds.

3.36 The card dialer is started by momentarily depressing the START bar. This operates the card dialer start contact and establishes a path from the ring side of the telephone line through point no. 5 on the card dialer, the released pulsing relay K(P) contacts, released home and dial start contacts, operated dial start contacts, and point no. 2 on the card dialer to the tip side of the telephone line. The current from the central office battery operates the K(P) contacts, which transfers the ring-to-tip path to the matrix. This path is closed or opened according to the code punched in the card. The dial pulse is transmitted as the sensing springs sense the holes in the card.

3.37 Sending of the dial pulse means interruption of the current in the telephone line. This releases the K(P) contacts. Movement of the K(P) relay armature rotates the scanning drum by 1/16 revolution so that the next digit pulse can be sensed and transmitted as the K(P) relay reoperates. After two pulses have been transmitted, the home contacts operate and remain operated until the end of the scanning drum revolution. This establishes a direct operating path for the K(P) relay so that, when the station is returned on hook in the middle of the digit, the digit pulsing can be completed and the drum will be returned to its normal (home) position.

3.38 In this manner, the drum completes the revolution in 16 steps. Ten of the steps are required to send the digits, and six to provide the interdigital time. At the completion of the revolutions, an escapement is tripped which permits the next row of holes on the card to be placed in position for sensing.

3.39 This sequence is repeated at each row as the card advances out of the card dialer. If no "stop" code is punched in the card, the card dialer will keep advancing the card (even if no number code is punched) until the card is released. If the "stop" code is sensed, the card dialer stop contacts operate. With the home contacts released, a transmission path is established from the telephone line to the data set input as follows: Ring side of the telephone line through point no. 5, dial stop contacts operated, home contacts released, point no. 1, hybrid transformer in the data set, to the tip side of the telephone line. The data set can then complete the connection.

3.40 When the station is connected, the card can be released by operating the RELEASE bar. No attempt should be made to release the card by reoperating the START bar, as this will trigger the card dialer mechanism and the following short circuit will be placed across the output of the data set: Point no. 1, home and dial start contacts released, dial start contacts operated, point no. 2. And, after the two first pulses on each revolution: Point no. 1, home contacts operated, point no. 6. This shunt will prevent the station from receiving or sending until the card is disengaged. If this condition persists, the data set will disconnect.

#### C. Pulsing Card Dialer (41A)

3.41 Figure 3 illustrates a schematic drawing of a pulsing card dialer (41A dialer) used in Bell System Switched Network Service.

3.42 In locations with 60-cycle ac power the 41A dialer is used. In this dialer the power to operate the commutator disc is derived from a synchronous motor powered by the 14V ac source in the teletypewriter. The power to advance the card in the dialer is derived from a spring wound by inserting the card in the slot. The switching functions and the motor control are independent of the signal path. These features result in a superior performance as compared with the 40A dialer.

3.43 To operate the dialer, the card is inserted and the START bar is momentarily operated. This closes the start contacts and power is applied to the motor which starts driving the commutator disc. In rotating, the disc closes and opens the path between points no. 5 and 6, causing the dial pulses to be sent to the line.

3.44 When the pulses sent reach the number punched in the card, control relay K1 operates. Operation of K1 applies a short circuit between points no. 5 and 6 and disengages the clutch, allowing the disc to return home. Mechanical linkage then permits the spring, wound by inserting the card, to advance the card for the next digit to be read and dialed.

3.45 As the "stop" code is read, the dialing stops. The card can then (as also at any other time) be released by operating the RELEASE bar.

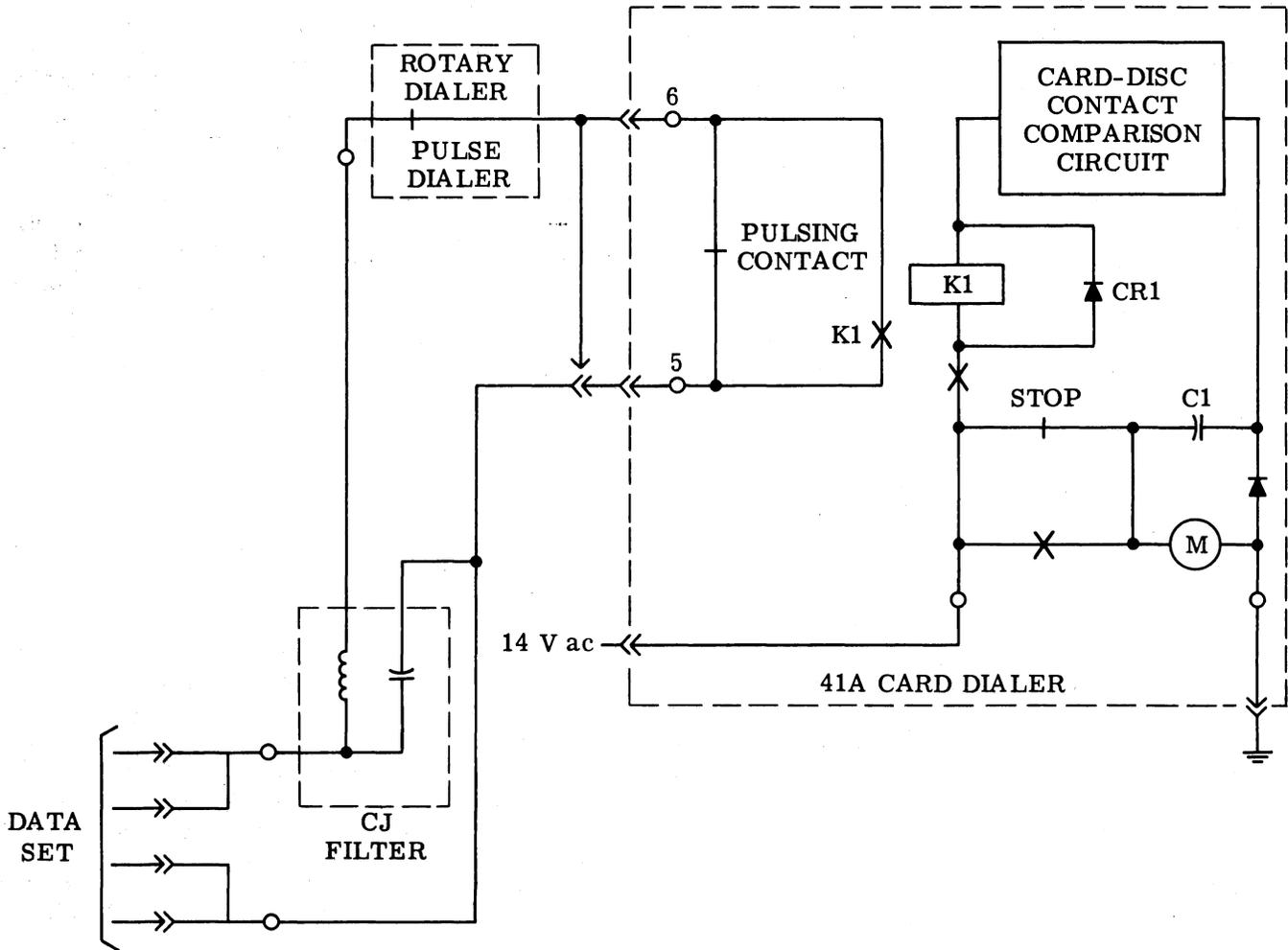


Figure 3 — Pulsing Card Dialer (41A Dialer) Circuit

D. TOUCH-TONE Dialer

3.46 Figure 4 illustrates a schematic drawing of a TOUCH-TONE card dialer circuit used in Bell System Switched Network Service.

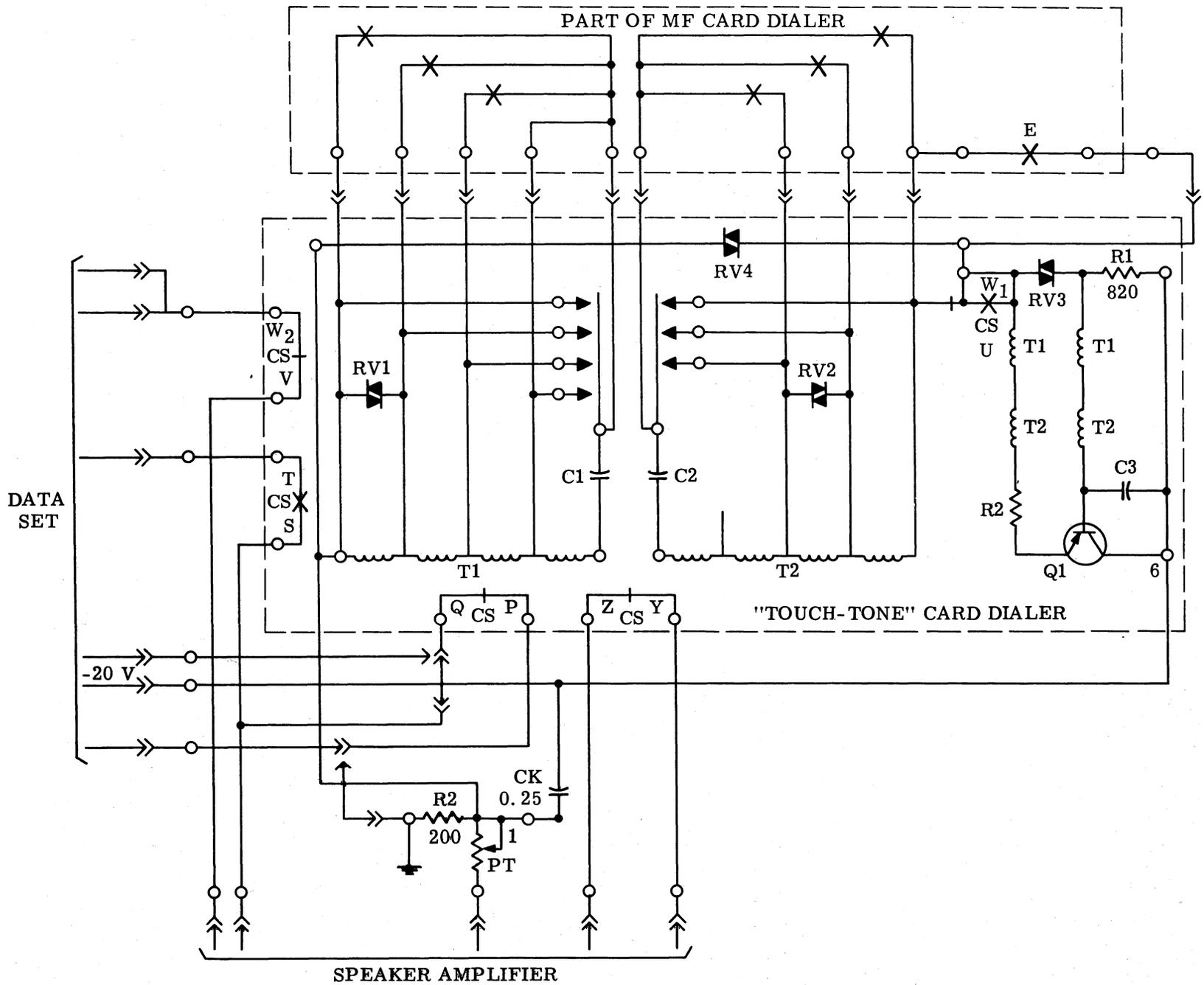
3.47 For multifrequency (MF) dialing applications, the dialing frequencies generated by the TOUCH-TONE dialer are fed through the speaker amplifier and into the telephone line via the sending amplifier in the data set. As the station connects, the output of the TOUCH-TONE dialer is disconnected from the data set so that there is no hazard connected with improper operation of the TOUCH-TONE dialer at that time.

3.48 The TOUCH-TONE MF signal generated is a 1-transistor oscillator generating two frequencies any time a single pushbutton is operated. Seven frequencies are provided, with each dial digit corresponding to two frequencies according to the following table.

"TOUCH-TONE" FREQUENCIES

cps →	1209	1336	1477	
697	1	2	3	Dial Digits
770	4	5	6	
851	7	8	9	
941		10		

Figure 4 - TOUCH-TONE Card Dialer Circuit



3.49 When the station is idle, a current of about 25 ma flows from ground through PT resistance of point no. 1 of the TOUCH-TONE dialer; then through varistors RV3 and RV4, resistor R1, and out of point no. 6 to -20V in the data set. The transistor Q1 is energized, so that there will be no click when the circuit starts to generate the MF signal. The oscillations are suppressed by dc current through the tank coils T1 and T2 maintained by the potential difference across RV4. By interrupting this initial coil current the oscillation build-up time is minimized.

3.50 To dial a digit, a pushbutton on the dialing plate is operated. This closes two frequency-determining contacts, one for the T1-C1 tank circuit, and the other for the T2-C2 tank circuit. The common switch (CS) operates in the following sequence:

- (1) Y-Z contacts open, making the speaker amplifier input available to MF signal only.
- (2) S-T contacts close and establish a path from the speaker amplifier, through the sending amplifier in the data set, and into the telephone line. The feedback through the receiving buffer amplifier in the data set back into the speaker amplifier is disabled by previously operated Y-Z contacts.
- (3) W<sub>2</sub>-V contacts open, disabling the receiving buffer amplifier in the data set. This eliminates a possibility of false connect due to MF signals.
- (4) Q-P contacts open, together with W<sub>2</sub>-V contacts, resetting the dial-tone detecting circuits, when furnished.
- (5) W<sub>1</sub>-U contacts open, interrupting the dc current through the tank coils. Since the tank T1-C1 and T2-C2 are coupled to the coils in the Q1 circuit, the unit starts oscillating with a very short build-up time.

3.51 The same functions could be assured with W<sub>2</sub>-V contacts operating first and Y-Z contacts eliminated. However, the interruption of current in the primary coil of the input transformer in the speaker amplifier would cause a loud click to be heard every time a digit is dialed.

3.52 The frequencies above 1000 cps are generated at a somewhat higher level to compensate for greater line loss at those

frequencies. There is also a variation of amplitude for various digits. The PT resistor is set at the time of assembly of the call control unit with the data set for an output of 0 dbm on the telephone line for the digit with the highest output level.

#### E. TOUCH-TONE and Card Dialer

3.53 Figure 4 illustrates a schematic drawing of a TOUCH-TONE card dialer circuit used in Bell System switched network service.

3.54 To use the automatic card dialer, the ORIG pushbutton is depressed. After the dial tone has been received, a punched card is inserted into the slot and pushed down. The START bar is then momentarily operated. The card dialer proceeds with dialing under power of a spring motor wound by insertion of the card. When a "stop" code is read, the dialing stops. The card should then be released by reoperating the START bar.

3.55 The sensing contacts in the card dialer are in parallel with the frequency-determining contacts in the associated TOUCH-TONE dialer. As the card advances out of the slot, the sensing contacts sense the holes punched in the card and thus determine the proper frequencies to be transmitted. This occurs for every row on the card.

3.56 The normally opened E contacts in the card dialer are placed across the excitation W<sub>1</sub>-U contacts in the TOUCH-TONE dialer. When dialing manually, the E contacts are opened and there is no interference from the card dialer. With the card down in the slot, the operation of the START bar closes the E contacts and operates the common switch, through mechanical linkage, for the duration of dialing. The common switch connects the input and output circuits of the speaker amplifier, as described previously. Opening of the W<sub>1</sub>-U contacts transfers the excitation function to the E contacts in the card dialer. As the card advances out of the slot, the E contacts open for each row, exciting the TOUCH-TONE dialer into generating the MF signals.

3.57 During dialing, there are short intervals of time when all the sensing contacts are opened and the E contacts are open. Therefore, the TOUCH-TONE dialer will break

into spurious oscillations somewhere between 7 and 14 kc. Although this frequency band is suppressed by the telephone line, these frequencies would be noticeable on the speaker. The actions of capacitors CK and C4A in the speaker amplifier combine to suppress this spurious signal from reaching the speaker.

3.58 Since the card advances out of the slot very rapidly, there is no need for a separate RELEASE bar. When the station connects, relay contacts in the data set disconnect the MF signal input and remove any hazard connected with false operation of the TOUCH-TONE dialer.