CIRCUIT NO. 33 – SEMIAUTOMATIC KEYER

The semiautomatic Morse-code keyer or "bug" generates a single dot or a series of dots, depending upon how long the paddle-key is depressed; the dash must be made manually. The rate at which dots are generated can be varied.

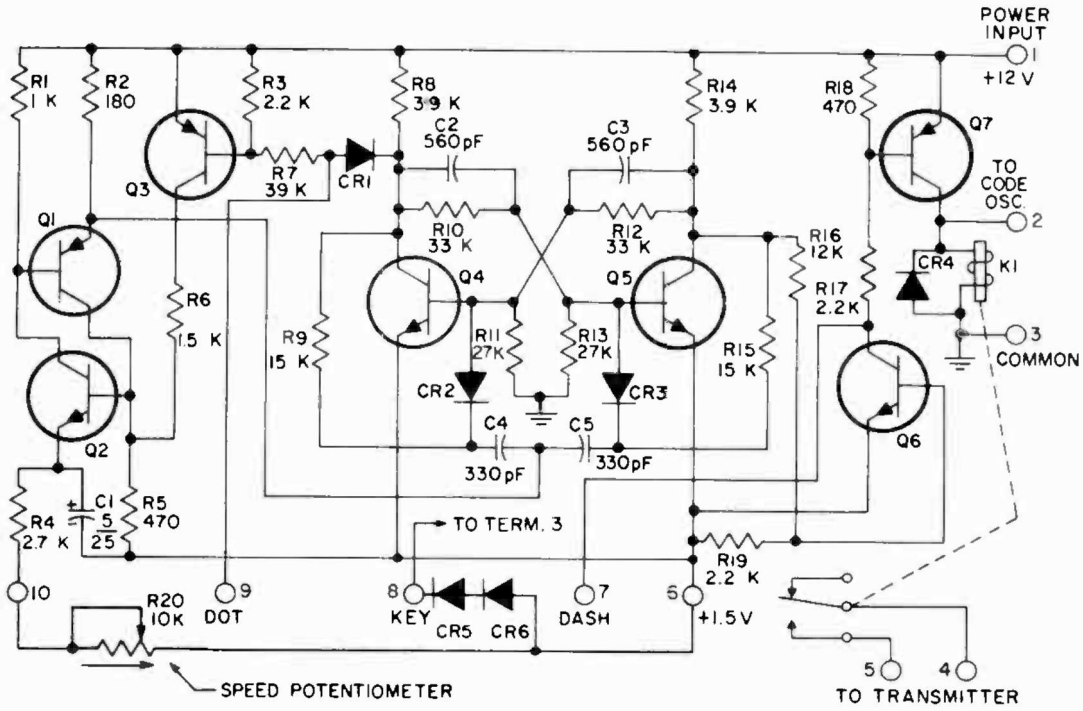
Circuit Operation

The schematic diagram and parts list for the semiautomatic keyer are shown in Fig. 185. The dot repetition rate is determined by R4, C1, and the speed potentiometer R20. These components control the regenerative switch consisting of transistors Q1 and Q2. This switch has a very high impedance before it is triggered and a very low impedance afterward. When the paddle-key is moved to the dot position, the current applied to the base of Q3 turns it on and permits C1 to begin charging through the emitter of Q2. At the same time, Q2 turns on and triggers the regenerative switch into conduction. As capacitor C1 charges, the emitter of Q2 becomes more and more positive until the regenerative switch is cut off. When cutoff occurs, the impedance of the regenerative switch becomes very high and C1 is forced to discharge through R4 and the speed potentiometer R20. As the charge on C1 decreases, the emitter of Q2 becomes less positive and the regenerative switch begins to conduct again. This process repeats itself as long as the paddle-key is held in the dot position. The polarity of the regenerative switch in conduction is such that a negative pulse is applied to the base of transistors Q4 and Q5 in the flip-flop. This negative pulse is sufficient to turn on transistor Q4. Q5 turns off automatically as a result of normal flip-flop action. When Q5 is off, its collector voltage is applied to Q6 through R16, and Q6 turns on. Current through Q6 activates Q7 which, in turn, closes the output relay. Diode CR4 is placed across the relay to protect Q7 from the high-voltage inductive discharges which occur when current to the relay coil is interrupted and its coil field collapses.

When the paddle-key is released from the dot position with Q4 off (i.e., when the paddle-key is released at the end of a dot), Q3 turns off and interrupts the C1 charging path, with the result that the regenerative-switch pulses that cause the dots are stopped. When the paddle-key is released from the dot position with Q4 on (i.e., when the paddle-key is released in the middle of a dot), Q3 continues to conduct because its base current continues to flow through Q4. The regenerative switch pulses once more to complete the dot cycle. Dot-cycle completion is accomplished when the final regenerative-switch pulse returns the flip-flop to its original state and turns Q4, and consequently Q3, off.

If instead of batteries a power supply is used to power this circuit, the 1.5 volts needed (shown as an input at circuit-board terminal No. 6) can be obtained from the drop across the two rectifiers CR5 and CR6 connected in series, as shown in Fig. 185.

When the paddle-key is in the dash position, the relay is not under the control of a transistor, but operates directly.



Parts List

C1 = 5 microfarads, 25 volts, electrolytic
C2 C3 = 560 picofarads, 50 volts or greater
C4 C5 = 330 picofarads, 50 volts or greater
CR1 CR2 CR3 = diode, RCA 1N270
CR4 CR5 CR6 = rectifier, RCA SK3030
K1 = relay, 12 volts, 1350 ohms, Potter and Brumfield No. RS5D or equivalent
Q1 Q3 Q7 = transistor, RCA SK3005
Q2 Q4 Q5 Q6 = transistor, RCA SK3020
R1 = 1000 ohms, 1/2 watt, 10%
R2 = 180 ohms, 1/2 watt, 10%
R3 R17 R19 = 2200 ohms, 1/2 watt, 10%
R4 = 2700 ohms, 1/2 watt, 10%
R5 R18 = 470 ohms, 1/2 watt, 10%
R6 = 1500 ohms, 1/2 watt, 10%
R7 = 39,000 ohms, 1/2 watt, 10%
R8 R14 = 3900 ohms, 1/2 watt, 10%
R9 R15 = 15,000 ohms, 1/2 watt, 10%
R10 R12 = 33,000 ohms, 1/2 watt, 10%
R11 R13 = 27,000 ohms, 1/2 watt, 10%
R16 = 12,000 ohms, 1/2 watt, 10%
R20 = potentiometer, 10,000 ohms, linear taper

Fig. 185 – Schematic diagram and parts list for the semiautomatic keyer.

The current drain for this circuit is approximately 5 milliamperes.

Construction

The semiautomatic electronic keyer is built on the same circuit board as the automatic keyer, Circuit No. 34. The drilling template for both circuits is shown at the back of this Manual; a component placement diagram is shown in Fig. 189.

CIRCUIT NO. 34 – AUTOMATIC KEYER

The fully automatic keyer produces either dots or dashes continuously for as long as the paddle-key is held in the dot or dash position. The speed of the dots and dashes can be varied to suit the operator. The keyer circuit is composed of a number of the building blocks described in the section on **General Circuit Considerations**: the pulser or clock, the flip-flop, and the lamp driver. The 12-volt supply is needed to power the keyer; eight flashlight batteries in series or a 12-volt supply such as that described in Circuit No. 2 may be used.

Circuit Operation

The schematic diagram and parts list for the fully automatic keyer are shown in Fig. 186. The dot or dash repetition rate of the keyer is determined by speed-control potentiometer R29; the potentiometer controls the frequency of the pulser or clock oscillator consisting of transistors Q1 and Q2. When the paddle-key is moved to the dot position (i.e., when terminals 8 and 9 on the circuit board are connected), a current is transmitted to the base of Q3, this current turns Q3 on. Q3 in turn activates the regenerative switch consisting of Q1 and Q2 and permits C1 to begin charging through the emitter of Q2. As capacitor C1 charges, the emitter of Q2 becomes more and more positive until Q2 is cut off. When cutoff occurs, the total impedance of Q1 and Q2 becomes very high and C1 is forced to discharge through R4 and the speed-control potentiometer R29. As the charge on C1 decreases, the emitter of Q2 becomes less positive and transistors Q1 and Q2 begin to conduct again. This process repeats itself as long as the paddle-key is held in the dot or dash position. Q1 and Q2, when in conduction, produce a negative pulse that is applied to the bases of transistors Q4 and Q5 in the flip-flop. This negative pulse is sufficient to turn off transistor Q5; Q4 is turned on automatically as a result of normal flip-flop action. When Q5 is off, current is conducted through R12, CR10, and R27; this current turns Q9 on. Current through Q9 activates Q10 which, in turn, energizes the output relay.

The dash flip-flop composed of transistors Q6 and Q7 is held inoperative during the dot cycle by the clamping transistor Q8 which is held in the conductive state by current through R17 and R16. Rectifier CR11 is placed across the relay to protect Q10 from the high-voltage pulse produced when current to the relay is interruped and its coil field collapses.

When the paddle-key is released from the dot position with Q4 off

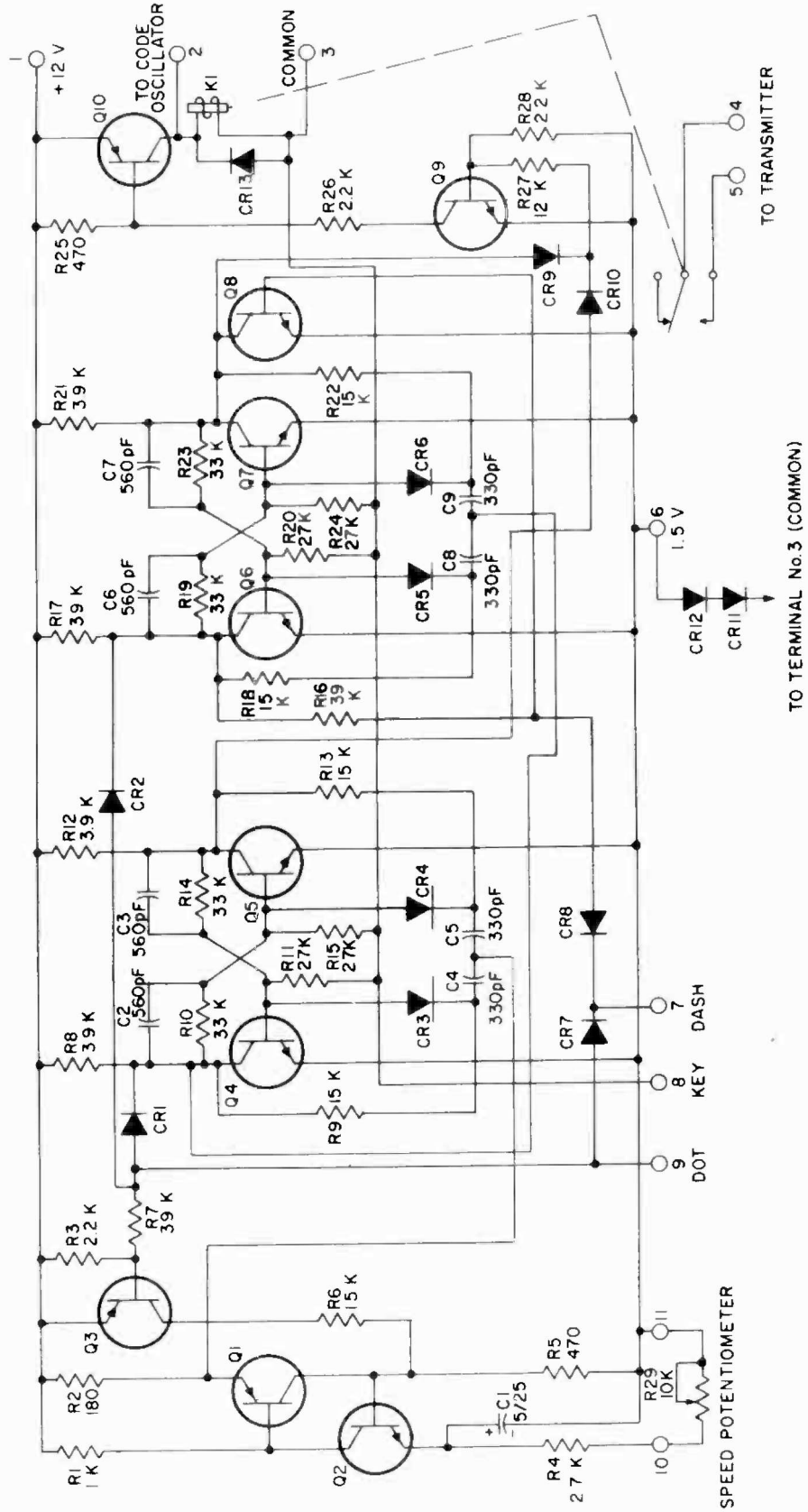


Fig. 186 – Schematic diagram and parts list for the automatic keyer.

Parts List

C1 = 5 microfarads, 25 volts, electrolytic
C2 C3 C6 C7 = 560 picofarads, 25 volts or greater
C4 C5 C8 C9 = 330 picofarads, 25 volts or greater
CR1 through CR10 = diode, RCA 1N270
CR11 CR12 CR13 = rectifier, RCA SK3030
K1 = relay, 12 volts, 1350 ohms, Potter and Brumfield No. RS5D or equivalent
Q1 Q3 Q10 = transistor, RCA SK3005
Q2 Q4 Q5 Q6 Q7 Q8 Q9 = transistor RCA SK3020
R1 = 1000 ohms, 1/2 watt, 10%
R2 = 180 ohms, 1/2 watt, 10%
R3 R26 R28 = 2200 ohms, 1/2 watt, 10%
R4 = 2700 ohms, 1/2 watt, 10%
R5 R25 = 470 ohms, 1/2 watt, 10%
R6 = 1500 ohms, 1/2 watt, 10%
R7 R16 = 39,000 ohms, 1/2 watt, 10%
R8 R12 R17 R21 = 3900 ohms, 1/2 watt, 10%
R9 R13 R18 R22 = 15,000 ohms, 1/2 watt, 10%
R10 R14 R19 R23 = 33,000 ohms, 1/2 watt, 10%
R11 R15 R20 R24 = 27,000 ohms, 1/2 watt, 10%
R27 = 12,000 ohms, 1/2 watt, 10%
R29 = potentiometer, 10,000 ohms, linear taper

(i.e., when the paddle-key is released during a space at the end of a dot or a series of dots), Q3 turns off and the oscillator pulses that cause the dots are no longer generated. When the paddle-key is released from the dot position with Q4 on (i.e., when the paddle-key is released in the middle of a dot), Q3 continues to conduct and permits the oscillator pulse to complete the dot cycle. This last pulse turns Q4, and consequently Q3, off, and the oscillator pulses cease.

A dash or series of dashes is produced when terminals 7 and 8 are connected (i.e., when the paddle-key is moved to the dash position). Under this condition Q3 is turned on by a signal applied to its base through R7 and CR7. At the same time Q8 is turned off by the grounding of its base through CR8. The first pulse from the clock oscillator sets both the dot and dash flip-flops to the output state. Q3 receives a base signal not only from the paddle-key but from the dash flip-flop through CR2 and the dot flip-flop through CR1. Q9 receives a dash signal from either the dash or dot flip-flop through their respective diodes CR9 or CR10. The second pulse from the oscillator sets the dot flip-flop to the no-output state but does not disturb the dash flip-flop, and Q9 remains in the conducting state. The third pulse sets the dot flip-flop to the output state and the dash flip-flop to the no-output state, and Q9 remains conductive. When a fourth pulse is developed, both flip-flops are in the no-output state and Q9 is turned off. If at this time the paddle-key is in the neutral or middle position (circuit-board terminals 7 and 8 disconnected), Q3 is also turned off and the system returns to its quiescent state. If the key is still in the dash position, the cycle repeats. Fig.

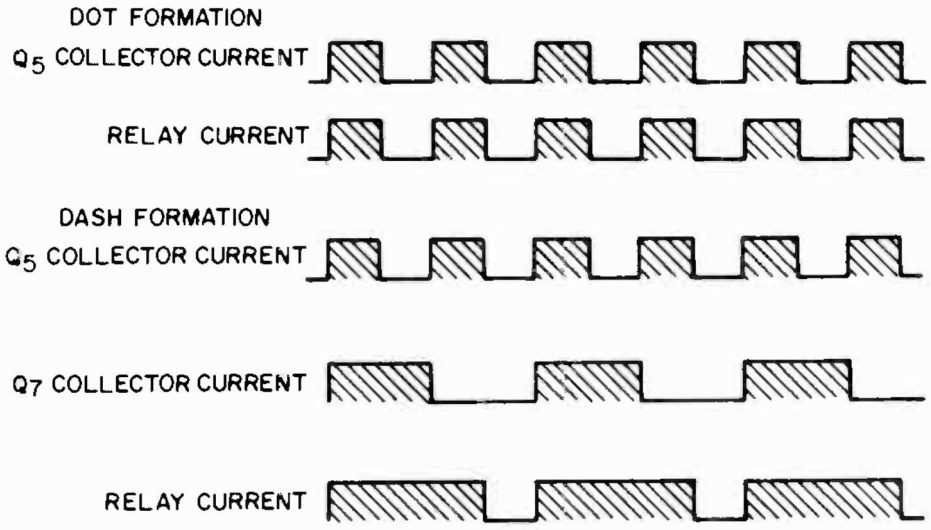


Fig. 187 — Voltage and current waveforms at selected points in the automatic keyer circuit.

187 shows the voltage and current wave forms at selected points in the circuit. Relay current during a single dash cycle flows for a time equal to three dots and is cut off for a period equal to one dot.

The current drain for this circuit is approximately 20 milliamperes.

Special Considerations

If instead of batteries a power supply is used to power this circuit, the 1.5 volts needed (shown as an input at circuit-board terminal No. 6) can be obtained from the drop across the two rectifiers CR12 and CR13 connected in series, as shown in Fig. 186.

Construction

The drilling template for the automatic keyer is shown at the back of this manual. A photograph of the completed circuit board and a component placement diagram are shown in Figs. 188 and 189, respectively.

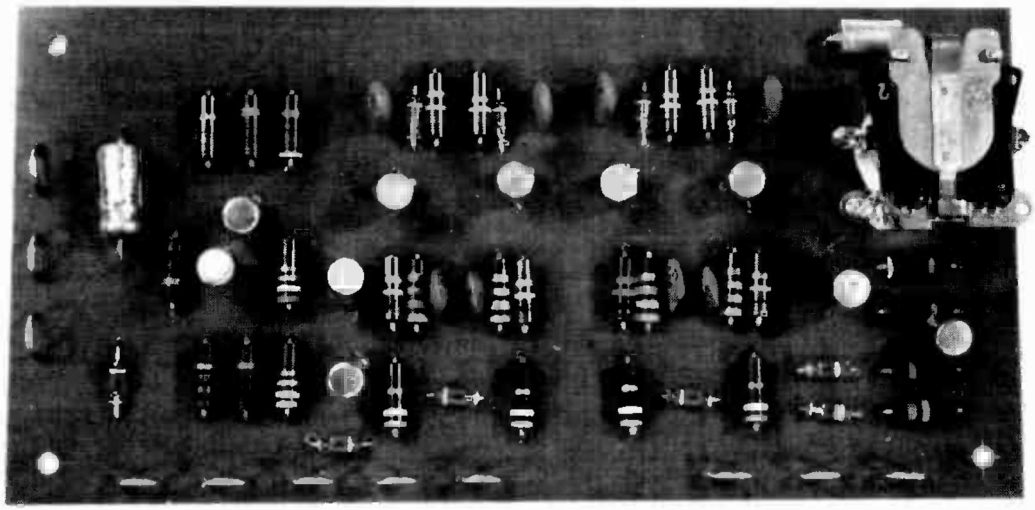


Fig. 188 — Completed circuit for the automatic keyer.

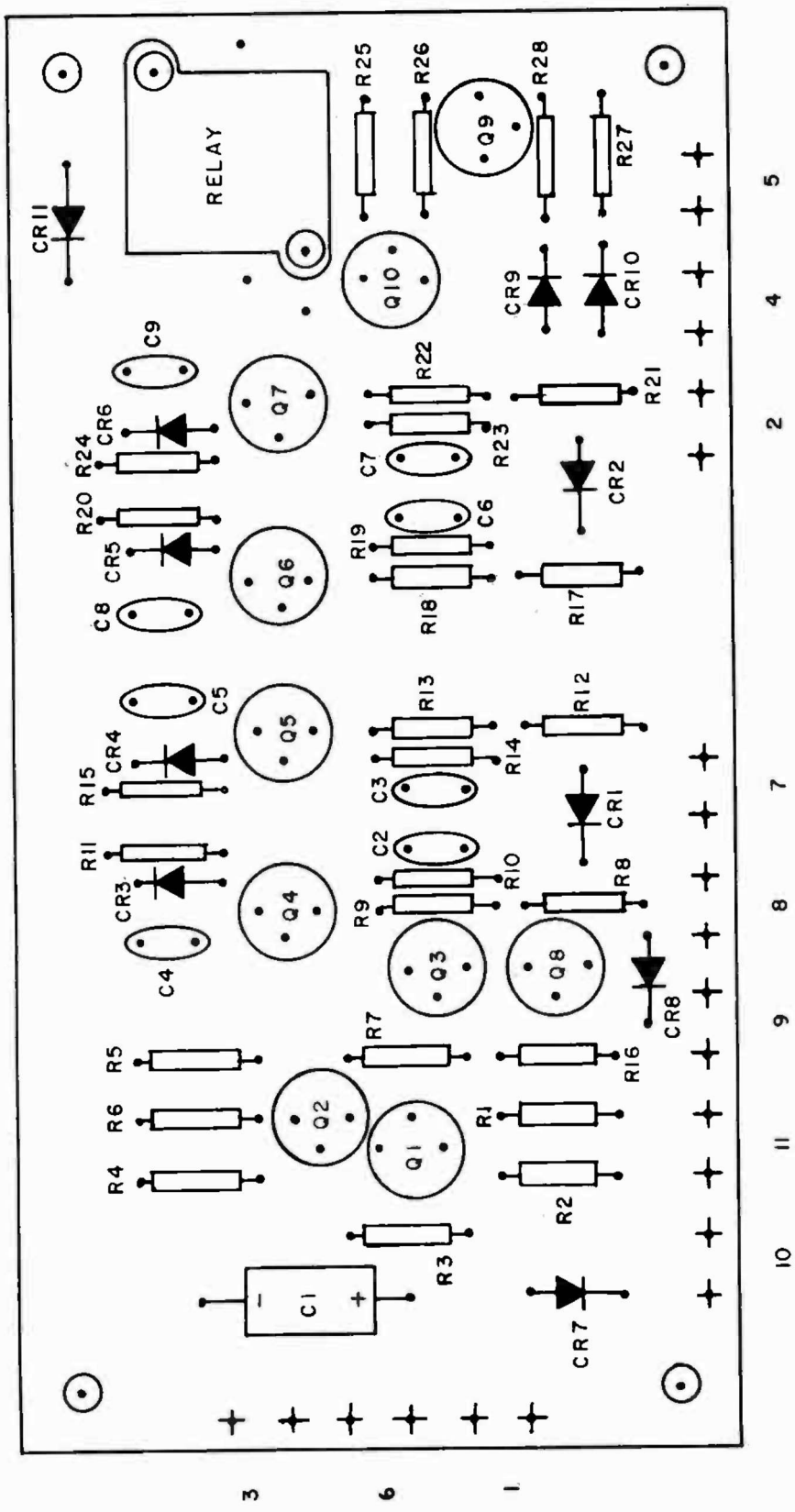


Fig. 189 — Component placement diagram for the automatic keyer.

CIRCUIT NO. 35 – AUDIO TAPE KEYER

The audio tape keyer, shown in a suggested enclosure in Fig. 190, is actually a magnetic-tape keying system that is useful in code recording and transmission. Such equipment can be a desirable addition to the ham shack. Not only can it be used for "skeds" and for automatic-calling in contests, but to provide code instruction as well. Code can be recorded at one speed and played back at another; thus it is possible to double or even halve the original rate.

Actually more than a simple keyer, the magnetic tape-to-code converter can also be used to record voice transmissions. As an additional feature, its side-tone oscillator can be combined with the mixer to form an excellent code-monitoring device.

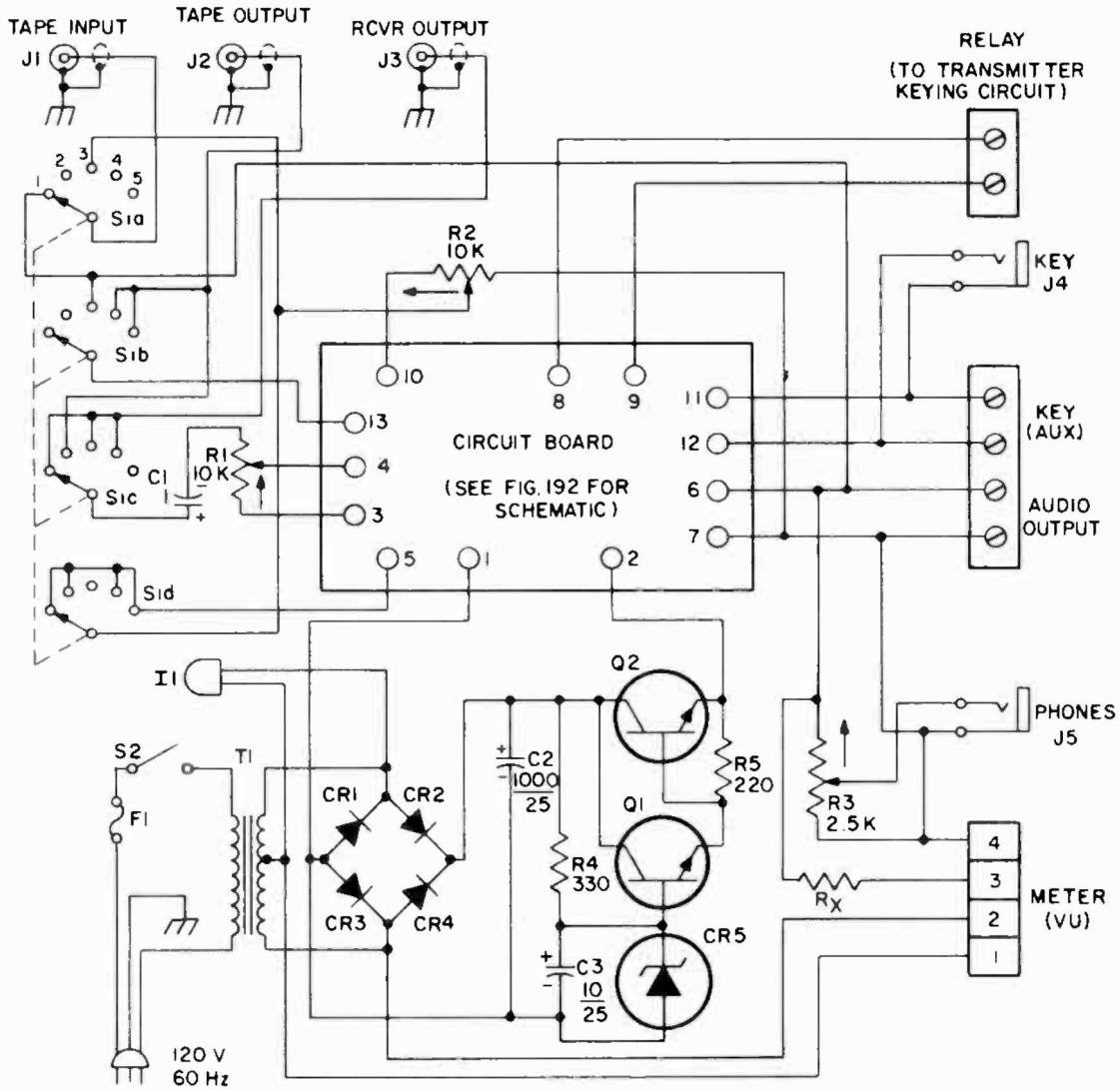
The basic elements of the system consist of a tape recorder, tape-to-relay converter, keying relay, code oscillator, and key. No alterations are required of the tape recorder and use of the converter is extremely simple.

Fig. 190 – Suggested enclosure for the audio tape keyer.

The code oscillator is built in so that pitch will not vary with code speed.

Construction

Fig. 191 shows the schematic diagram and parts list for the entire audio-tape-keyer circuit; Fig. 192 shows the schematic diagram and parts list for the circuit on the board shown in Fig. 191. Fig. 193 shows a component placement diagram for the board, and Fig. 194 a photograph of the completed board. Fig. 195 shows the board installed in the suggested enclosure of Fig. 190;



Parts List

C1 = 1 microfarad, 25 volts, electrolytic, for solid-state receivers; 0.5 microfarad, 400 volts, paper for tube-type receivers

C2 = 1000 microfarads, 25 volts, electrolytic

C3 = 10 microfarads, 25 volts, electrolytic

CR1 CR2 CR3 CR4 = rectifier, RCA SK3016

CR5 = zener diode, 15 volts, 1 watt

Fig. 191 – Schematic diagram and parts list for the entire audio-tape-keyer system.

Parts List (Cont'd)

F1 = fuse, 1 ampere, slow-blow
I1 = lamp No. 47
J1 J2 J3 = RCA type phono jack
J4 J5 = single-circuit phone jack
Q1 = transistor, RCA SK3020
Q2 = transistor, RCA SK3024
R1 R2 = 10,000 ohms, potentiometer, linear taper
R3 = 2500 ohms, potentiometer, linear taper
R4 = 330 ohms, 1/2 watt
R5 = 220 ohms, 1/2 watt
RX = VU meter calibration resistor; will vary with meter
S1 = rotary switch, 4-pole, 5-position
S2 = toggle switch, single-pole, single-throw, 3 amperes
T1 = filament transformer, 12.6 volts at 2 amperes

spacers separate the circuit board from the metal of the enclosure. The drilling template for the keyer is shown in the back of this Manual.

Keyer Connections

The keyer is readied for operation by making the connections described below and illustrated in Fig. 196.

The Rcvr Output jack, J3, on the keyer is first connected to the headphone jack on the communications receiver. The shielded wire from the Tape Input jack, J1, on the keyer is then connected to the Line or Aux input on the tape recorder. If the recorder has a Line or Aux output jack, shielded wire should also be connected from that jack to the Tape Output jack, J2, on the keyer. If the tape recorder does not have a Line or Aux output, some modification of recorder wiring will be required prior to making this third connection; the modification is shown in Fig. 197.

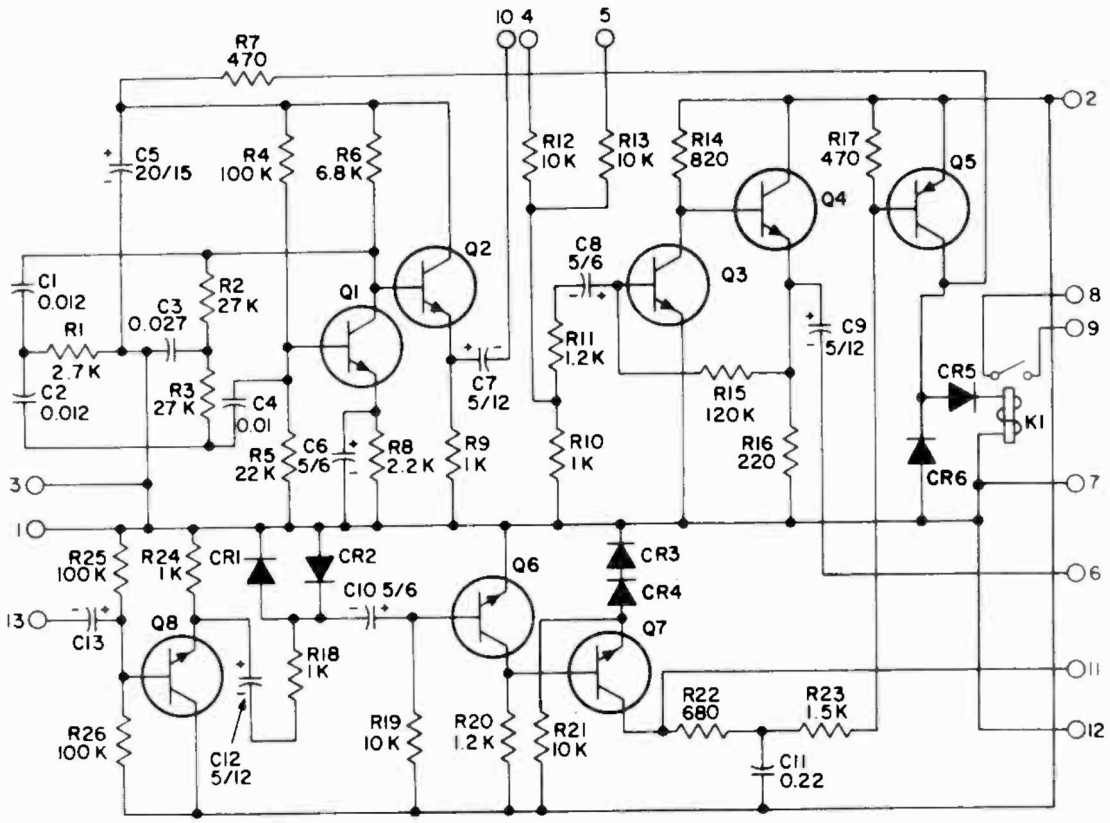
The transmitter keying-relay contacts are next connected to the Relay terminals on the keyer and a hand or auto key plugged in at the Key jack, J4. The magnetic-tape keyer control is now ready for use.

Note that both hand and auto keys can be connected simultaneously, if desired, by using the Key plug on the front of the keyer for one key and the Key terminals on the side of the keyer for the second key. Volume-controlled audio output is available through the Phones plug, J5, on the keyer, or through the receiver speaker (if the keyer Audio Output terminals are reconnected to the receiver). The loudness of the signal in the phones is controlled by means of the Phone Gain control, R3, on the keyer. The loudness of the signal in the receiver speaker is controlled by the volume control on the receiver. The Receiver control, R1, on the keyer is the input volume control and varies the signal level in both phones and speakers simultaneously.

Keyer Operation

Fig. 196 shows the interconnections of the entire magnetic-tape keying system.

To operate the keyer, the Selector switch is set to position No. 1 and a strong, readable, cw signal tuned in. The Receiver control should be approximately in mid-



Parts List

C1 C2 = 0.012 microfarad, 200 volts, paper

C3 = 0.027 microfarad, 200 volts, paper

C4 = 0.01 microfarad, 200 volts, paper

C5 = 20 microfarads, 15 volts, electrolytic

C6 C8 C10 = 5 microfarads, 6 volts, electrolytic

C7 C9 C12 = 5 microfarads, 12 volts, electrolytic

C11 = 0.22 microfarad, 200 volts, paper

C13 = 5 microfarads, 25 volts, electrolytic for solid-state receiv-

Fig. 192 – Schematic diagram and parts list for the circuit board identified in Fig. 191.

Parts List (Cont'd)

ers; 0.5 microfarad, 400 volts, paper for tube-type receivers
CR1 CR2 CR3 CR4 CR5 CR6 = rectifier, RCA SK3030
K1 = relay, Potter and Brumfield, type RS5D (12-volt coil) or equivalent
Q1 Q2 Q3 Q4 Q6 Q7 Q8 = transistor, RCA SK3020
Q5 = transistor, RCA SK3005
R1 = 2700 ohms, 1/2 watt, 10%
R2 R3 = 27,000 ohms, 1/2 watt, 10%
R4 R25 R26 = 100,000 ohms, 1/2 watt, 10%
R5 = 22,000 ohms, 1/2 watt, 10%
R6 = 6800 ohms, 1/2 watt, 10%
R7 R17 = 470 ohms, 1/2 watt, 10%
R8 = 2200 ohms, 1/2 watt, 10%
R9 R10 R18 R24 = 1000 ohms, 1/2 watt, 10%
R11 R20 = 1200 ohms, 1/2 watt, 10%
R12 R13 R19 R21 = 10,000 ohms, 1/2 watt, 10%
R14 = 820 ohms, 1/2 watt, 10%
R15 = 120,000 ohms, 1/2 watt, 10%
R16 = 220 ohms, 1/2 watt, 10%
R22 = 680 ohms, 1/2 watt, 10%
R23 = 1500 ohms, 1/2 watt, 10%

position after this adjustment. In switch-position No. 1, the keyer amplifier is connected directly to the receiver through mixer input No. 1, and to the side-tone oscillator through mixer input No. 2. The gain control on the tape recorder is then adjusted to the proper recording level. A VU meter is a valuable tool in determining this level and in producing good tapes. If the tape recorder being used does not have a built-in VU meter, an external meter can be inserted into the circuit by use of the Meter plug on the side of the keyer.

The hand key should now be depressed and the Side Tone control, R2, adjusted so that the signal from the side-tone oscillator is at the same level as the incoming cw signal. The keyer is now set to act as a monitor of incoming and outgoing signals and to permit manual keying of the transmitter and recording of both incoming and outgoing signals.

Some text should now be recorded on the tape with the Selector switch in position No. 1. The tape should then be rewound, the Selector switch set in position No. 2, the tape playback position, and proper operation of the keyer and recorder confirmed by listening to the playback. When the Selector switch is in position No. 2, the tape recorder output is connected to mixer input No. 1 instead of to the receiver. Switch position No. 2 is used whenever taped material is to be checked.

In position No. 3, the selector switch connects the receiver to mixer input No. 1 and the amplifier output to the input of the audio keyer section of the keyer. The output of the side-tone oscillator is then impressed upon the tape recorder so that the tone recorded on the tape is that of the side-tone oscillator and not that of the actual incoming signal. The transmitter may be

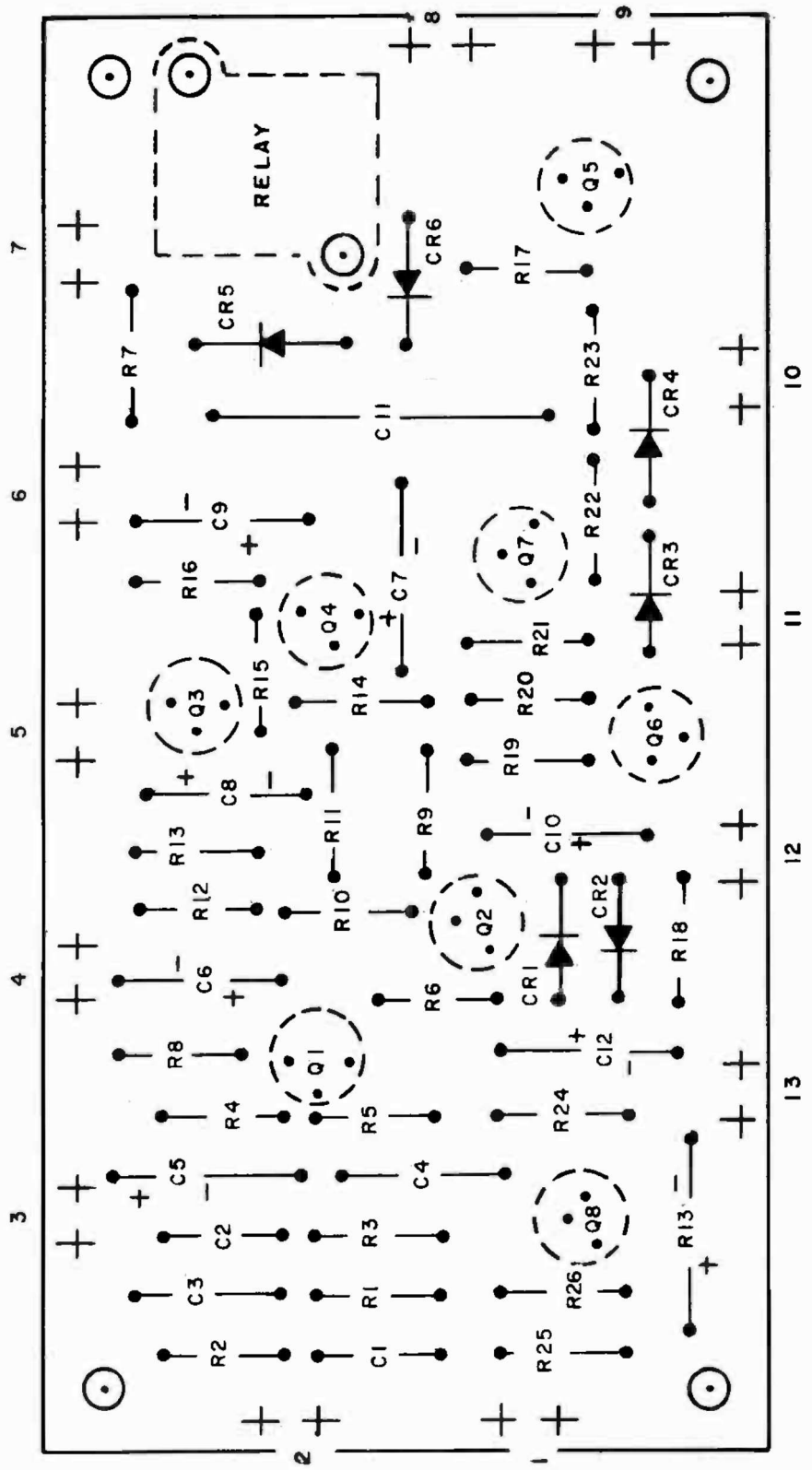


Fig. 193 — Component placement diagram for audio-tape-keyer circuit board.

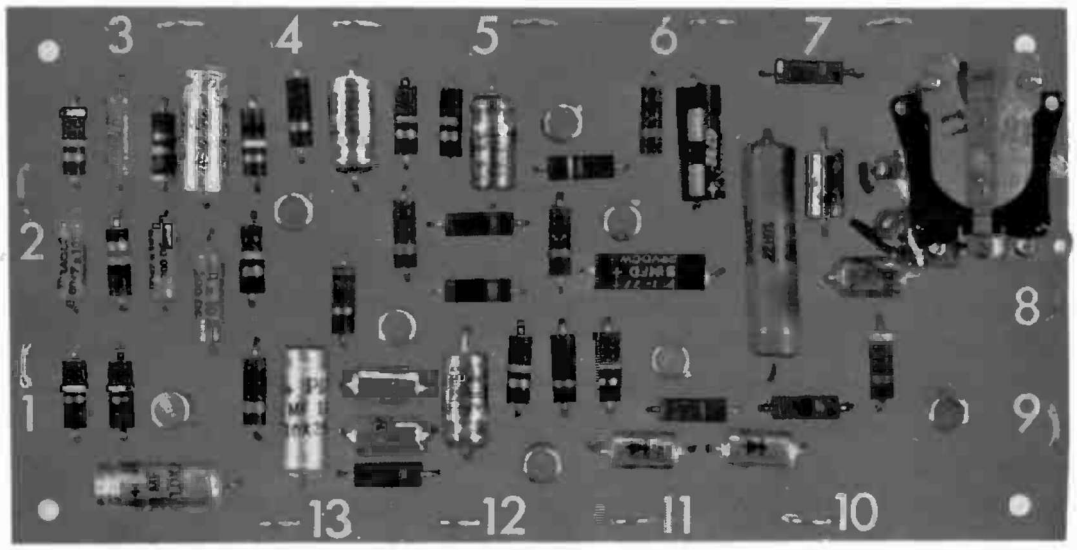


Fig. 194 — Completed circuit board for the audio tape keyer.

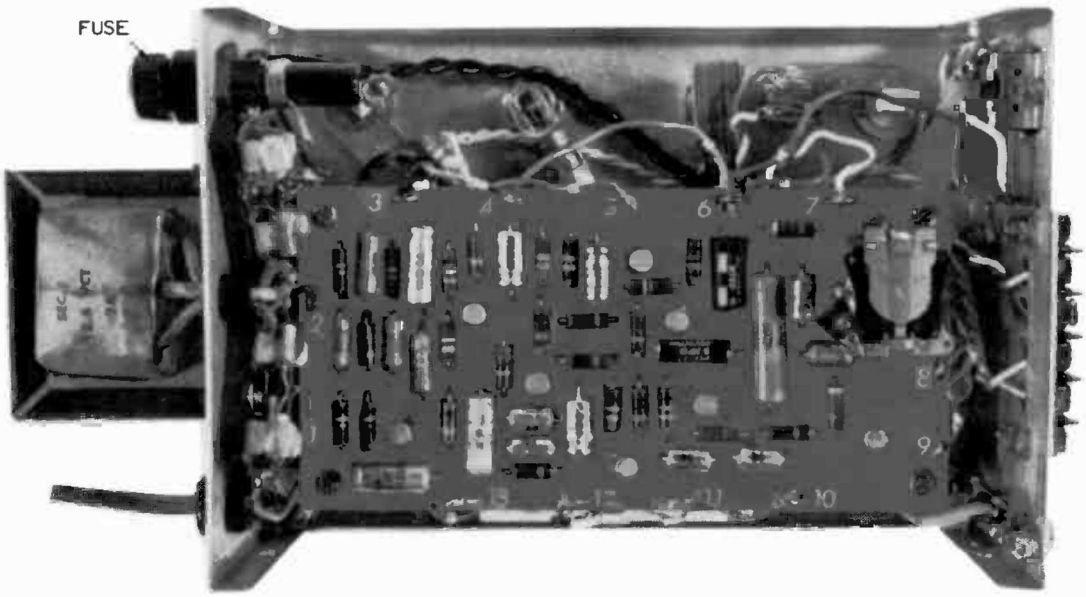


Fig. 195 — Circuit board mounted within the suggested enclosure.

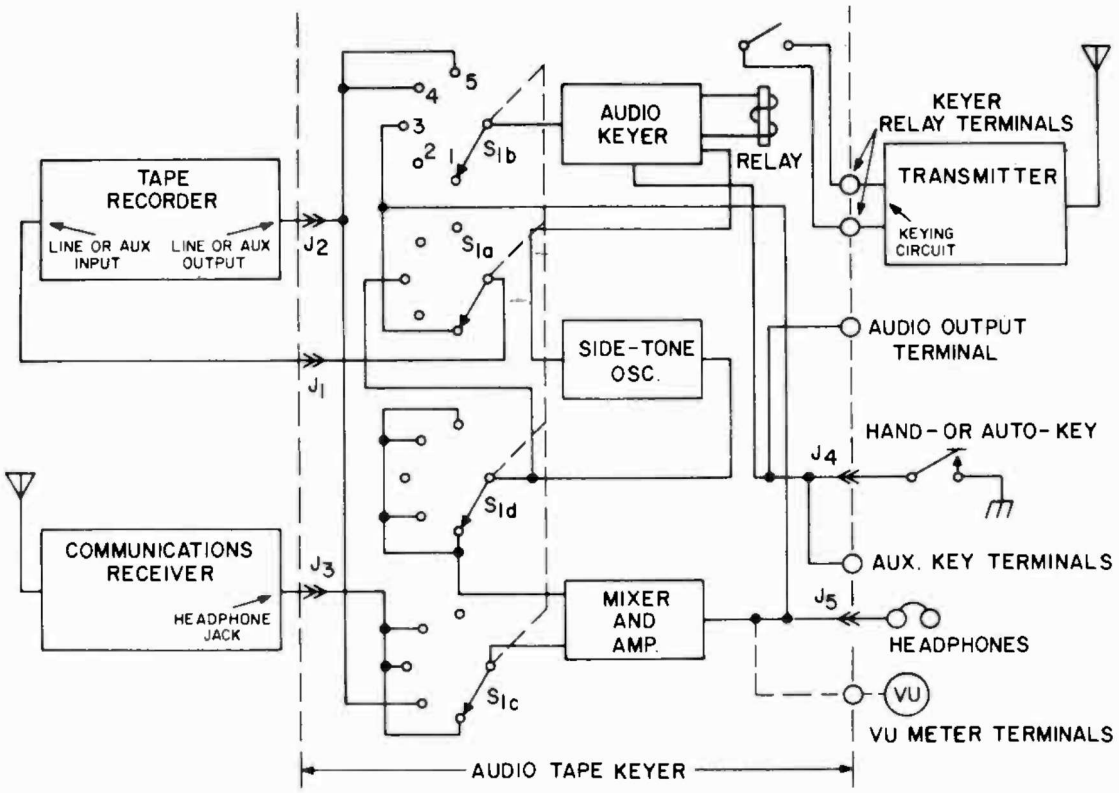


Fig. 196 – Interconnection of audio tape keyer with the equipment it serves.

manually keyed and monitored when the Selector switch is in this position.

The tape should now be rewound again and the Selector switch set to position No. 4. In this setting, the receiver is connected to mixer input No. 1, and the side-tone oscillator to the amplifier through mixer input No. 2. In addition, the Line or Aux output of the recorder is now connected to the input of the audio-keyer section of the keyer. Position No. 4 of the Selector switch is the setting to be used to key a transmitter from a previously recorded tape. In this position, both incoming

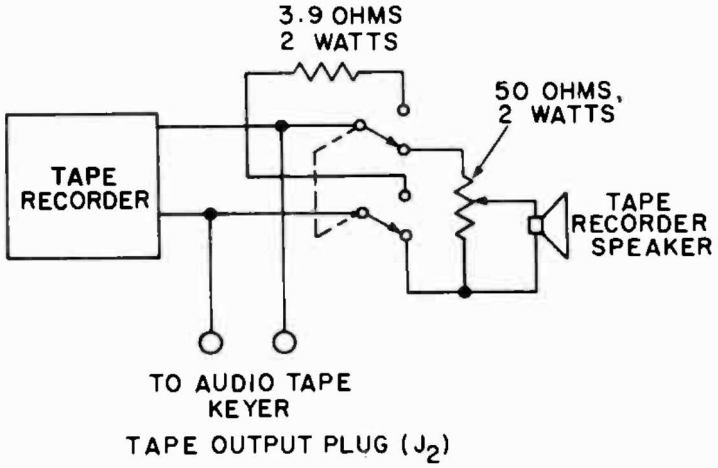


Fig. 197 – Modification required of tape recorder that has no "Line or Aux." output to make the recorder compatible with the audio tape keyer.

and outgoing signals may be heard and the transmitter may also be keyed manually.

To key the transmitter by tape, the tape must be rewound and the output level of the tape recorder adjusted until the relay starts to operate and the side tone is heard in the headphones. Keying should be loud and clear. A signal of 1 to 3 volts is required at terminal No. 13 of the circuit board for satisfactory transmitter keying.

Selector switch position No. 5 is the same as position No. 4 except that incoming signals cannot be heard.

When the system is used for code instruction, the keyer's Selector switch should be in position No. 4. A recording made at a tape speed of 7-1/2 inches per second and a code speed of 20 words per minute can be used to teach code at 10 words per minute by halving the playback tape speed to 3-3/4 inches per second. For inexpensive recorders – in which tape speed is changed by manually changing the capstan – new capstans can be made that will permit transmission of code at almost any speed. The output of the amplifier in the keyer is sufficient to drive up to 10 pairs of high-impedance headphones or to feed the Line or Aux input of any tape recorder.

Table XXIX summarizes the functions of the keyer in the various Selector switch positions.

Table XXIX.
Keyer Functions

Selector Switch Position	Receive	Tape Key	Record	Playback	Monitor
1	Yes	No	Yes	No	Incoming receiver signal and manually keyed side tone.
2	No	No	No	Yes	Tape output and manually keyed side tone.
3	Yes	No	Yes	No	Incoming receiver signal.
4	Yes	Yes	No	No	Incoming receiver signal and manually- and tape-keyed side tone.
5	No	Yes	No	No	Same as Position 4.