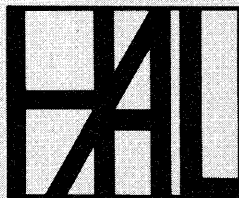


HAL MKB-1 MORSE KEYBOARD



INSTRUCTION MANUAL



HAL COMMUNICATIONS CORP.
BOX 365
URBANA, ILLINOIS 61801

QUALITY COMMUNICATIONS EQUIPMENT

WARRANTY

HAL Communications Corporation warrants that all factory-assembled MKB-1 Morse Keyboards shall be free of defects in materials and workmanship under normal use and service for a period of one year from the date of the original invoice, and further warrants that all parts supplied with MKB-1 kits shall likewise be free of such defects for the same period.

Should such defects occur within the warranty period, notify HAL Communications Corp. promptly in writing. The notification letter must be postmarked prior to one year from the date of the original invoice. Please do not return your unit to the factory for repair until you have sent a letter of notification and have received a written return authorization.

Keyboards or parts returned to the factory under warranty will be repaired or replaced at no charge except for transportation costs.

This warranty is and shall be in lieu of all other warranties, whether expressed or implied, and of all other obligations or liabilities on the part of HAL Communications Corp. resulting from the installation or use of this keyboard.

The foregoing warranty is completely void on all keyboards which have been damaged, abused, modified, or improperly installed or operated.

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1. INTRODUCTION

The HAL MKB-1 is a completely self-contained morse code keyboard. Pressing the keyswitch for any character automatically produces the proper sequence of dots and dashes needed to transmit the character. By means of an internal transistor switch, the MKB-1 can key a transmitter directly. A sidetone monitor and speaker are included.

The MKB-1 combines digital and linear circuitry to provide the following features:

- Code speed is adjustable from 6 to 60 words per minute.
- Adjustable weight ratio is unaffected by changes in speed.
- Connection for auxiliary hand key is provided.
- Transistor switch can be connected for either grid-block or cathode keying.

The logic circuitry and power supply are built on a single 3 × 6 inch printed circuit board, through-plated so that all soldering is done on one side of the board. The keyboard and toroidal keyencoder mount on a 5 × 11 inch board. The complete unit including power supply is housed in an attractive sloping panel cabinet.

2. INSTALLATION

The MKB-1 is simple to install. Connect the line cord to a 115 VAC, 60 Hz outlet. A hand key may be connected to J1 on the rear panel if desired. The keyboard audio is available at J3 and may be used to drive an external audio amplifier or small speaker.

The transistor keying switch in the MKB-1 may be used for either cathode or grid-block keying, depending on which of the two rear-panel jacks is used. The two jacks may not be used simultaneously, however.

For cathode keying, the transistor switch is inserted in series with the cathode circuit of the stage to be keyed. Connect the cathode lead to the tip contact of a phone plug using the center conductor of a length of shielded wire. Ground the shield braid at the transmitter. Plug in the (+) CATHODE jack on the rear panel of the MKB-1. A typical installation is shown in Figure 2.1.

NOTE: The transistor keying switch is rated to handle +250 volts at up to 100 ma. Before connecting the keyboard to the transmitter, make certain that the voltage and current at the keying point in the transmitter do not exceed these values.

For grid-block keying, the transistor switch shorts the grid bias voltage to ground. Using the center conductor of a shielded cable, connect the bias voltage to be keyed to the tip contact of a phone plug. Ground the shield at the transmitter and connect it to the sleeve of the phone plug. Insert the plug in the (-) GRID jack on the rear panel of the MKB-1. Figure 2.2 shows a typical hookup.

NOTE: The transistor switch is rated to handle -150 volts at up to 100 ma. Check the voltage and current at the transmitter keying point to ensure that these values are not exceeded.

CAUTION: Some transmitters (such as the Yaesu FTDX-560 and several of the Swan transceivers) provide a wave-shaping filter in the key line, with a high-value capacitor (on the order of 0.1 ufd) connected directly across the key terminals. The charge stored in this capacitor can produce a current surge large enough to destroy the keyboard's switching transistor when the transmitter is keyed. Check the schematic diagram of your transmitter to determine whether such a capacitor is present. If so, insert a $\frac{1}{2}$ -watt resistor (of any value between 100 and 390 ohms) in series with the keying line. Use the highest value that does not affect the transmitter keying. The resistor can be mounted conveniently inside the phone plug used to connect the transmitter to the MKB-1 keying jack.

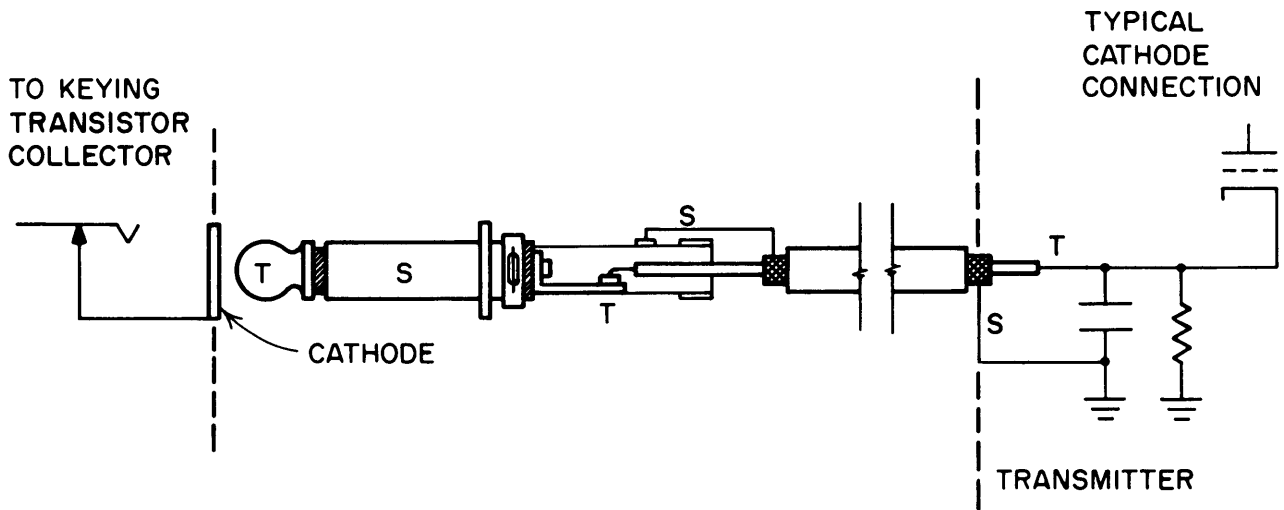


Figure 2.1 Typical Connection for Cathode Keying

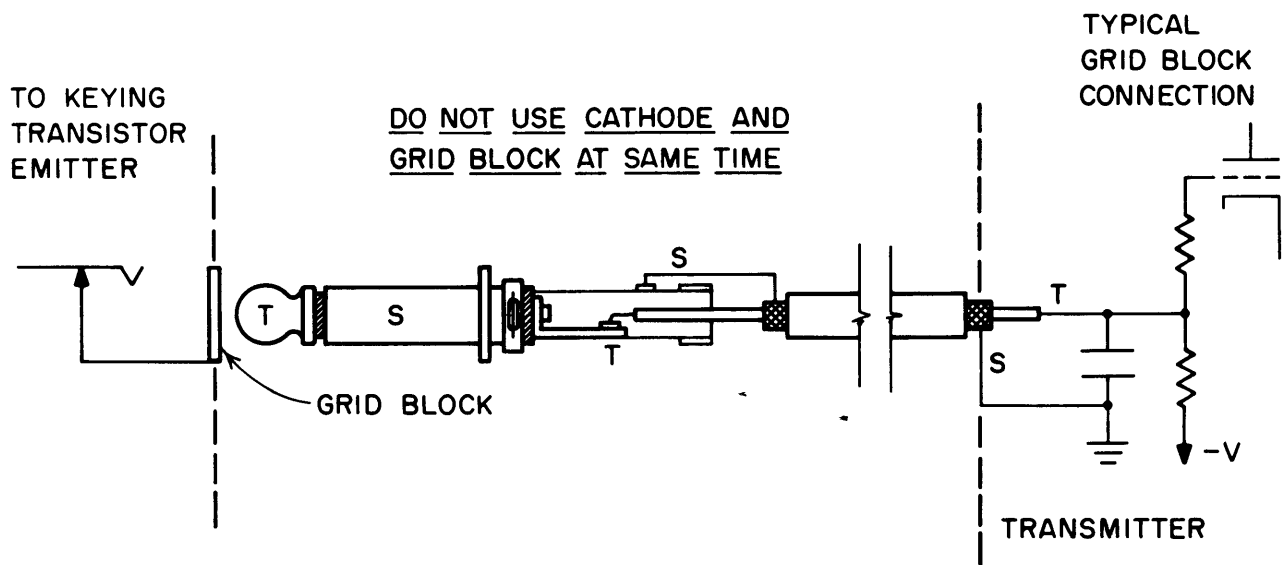


Figure 2.2 Typical Connection for Grid-Block Keying

3. OPERATING YOUR KEYBOARD

The MKB-1 operates very much like a standard typewriter. After a short practice period, sending code will be as easy as typing. It will be helpful to practice with the keyboard alone, listening to the code signal from the sidetone monitor, before using the unit on the air.

To turn the keyboard on, rotate the volume control clockwise. Touch one of the keys and adjust the volume and tone controls for a pleasing sound from the sidetone monitor.

Rotate the speed control fully counterclockwise to the slowest code speed. Practice typing until you get the "feel" of the keyboard; then gradually increase the speed as you type. The weight control may be adjusted to achieve the desired ratio of dot-to-space duration.

The following tips will help you become proficient at codotyping:

- The code character produced by any key will repeat continuously as long as you hold the key down. To send the character only once, release the key before the character has been completed.
- For best performance when sending a string of characters, push the first key and hold it momentarily until the character has started. Then press the next key and hold it until the first character completes and the second character starts. Proceed to the third key, and so on. Using this method will ensure that there are no unduly long gaps between characters and that no character will be omitted.
- The tune key parallels the external hand key input. Depressing it keys the transmitter for tuning. The transmitter will stay on as long as the key is held down.

4. THEORY OF OPERATION

The basic function of the MKB-1 circuitry is to translate a keystroke into the sequence of dots and dashes needed to transmit a Morse code character. A transistor switch is included to key an external transmitter. The keyboard also activates a sidetone oscillator to permit monitoring of the code characters transmitted.

The circuit consists of five basic sections: a clock oscillator, a shift register, a character generator, the keying stage with sidetone oscillator, and a regulated power supply. A schematic of the MKB-1 is shown in Figure 7.1 (page 32).

A shift register is used to transform each keystroke into a sequential binary code. When one of the character keys is pushed, the binary code for that character is loaded into the shift register through a toroid matrix at the register's parallel input terminals. The clock oscillator then starts, causing the contents of the register to appear sequentially at the register output terminal. This output is combined in the character generator with pulses from the clock oscillator, producing the series of dots and dashes required to transmit the character. The character generator output controls a transmitter keying transistor, and it also activates the audio sidetone oscillator.

Character Shift Register

The shift register consists of seven integrated-circuit flip-flops connected so that the state of each flip-flop will transfer to the next flip-flop in the line whenever a dot or dash is completed. The clock terminals of the flip-flops are connected in parallel so that all receive shift pulses simultaneously.

Initially, all of the flip-flops are in the "1" state; that is, the Q output (pin 5 or 9) is high. Some of the flip-flops are cleared (set to the low or zero state) by the keyswitch closure, depending on the code character to be produced. As shift pulses are received, the register contents appear in sequence at the output of the last flip-flop. This sequential binary code is fed to the character generator. If the register output is low during a given clock pulse, a dot will be produced. If it is high, a dash results.

Because each key represents a different character, each must load a unique binary code into the register. Closure of a given keyswitch must result in some of the flip-flops being left in the high state and others being cleared to the low state. Consequently, each keyswitch must be isolated from all the others. This isolation is provided by the seven toroidal transformers, whose secondary windings are connected between the flip-flop clear terminals and the +5 volt supply.

The toroids have a number of primary "windings", each of which consists of a length of wire connected from the 2N5062 silicon controlled rectifier (SCR) to a keyswitch. When the keyswitch is closed, it grounds the wire,

causing the SCR to fire and a current pulse to flow in the wire. The wire passes through the toroids of those flip-flops which must be cleared. The pulse induces a negative-going secondary voltage large enough to drive the flip-flop clear input to zero and to reset the flip-flop. The binary code corresponding to the character's pattern of dots and dashes is thus loaded into the shift register.

As an example of how the shift register works, consider the transmission of the letter "R" (dot-dash-dot). The wire from the R keyswitch to the SCR passes through the toroids connected to flip-flops FF0, FF2, and FF3. When the keyswitch is closed momentarily, these flip-flops are cleared and their outputs go to the zero state. All of the other flip-flops remain in the high state, as shown in Figure 4.1a.

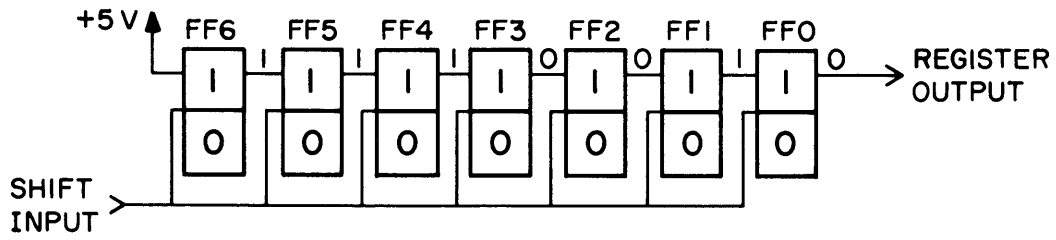
The R keyswitch clears flip-flop FF0 so that its output is low, since it will produce the first dot. It does not affect the second flip-flop, FF1, because the second character will be a dash. However, it clears the third flip-flop, FF2, to produce the final dot. The fourth flip-flop, FF3, is also reset to produce a space at the end of the character, as will be explained later.

After the flip-flops are set to the proper states, the clock oscillator starts and the character generator produces its first output pulse. Since the output of the shift register is low, the pulse is short: a dot. At the end of the dot, the state of each flip-flop shifts one stage to the right. FF0 is now in the high state, FF1 and FF2 are in the low state, and the remainder are in the high state. Since the data input to FF6 is tied to the +5 volt bus, this flip-flop remains in the high state. The register contents are now as shown in Figure 4.1b. When the next clock pulse occurs, the high level at the register output results in the production of a dash, and the register contents again shift one stage to the right.

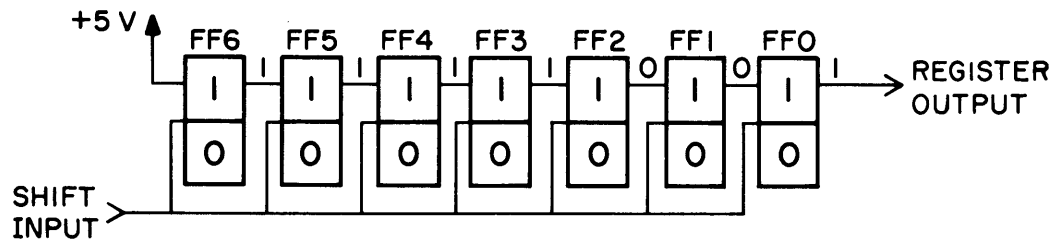
Each time the register contents shift, a "1" is again read into FF6, and the former "1" code is transferred to the next stage. After the second dot has been sent, the register stages are therefore all set high except FF0. This last zero output would normally produce a dot during the next clock pulse. A special gate, however, prevents the dot from being transmitted. The inputs of IC7, which forms a NOR gate, are connected to the inverted outputs of the register stages. With all of its inputs low, the NOR gate output bus will be high. This signal is fed through an inverter to the input of a NAND gate (pin 13 of IC5) in the character generator, driving it low. The NAND gate output therefore must remain high regardless of the character generator output state. Although the character generator produces a dot, the gate prevents its output from reaching the keying transistor and sidetone oscillator. This feature provides an intercharacter space between the completion of one letter and the beginning of the next one.

Clock Oscillator

Timing for the keyboard circuits is provided by the clock oscillator, which consists of an operational amplifier (IC2), a monostable multivibrator (IC3), two transistors, a timing capacitor, and the speed control.



(a) Register Contents after Character "R" is Loaded



(b) Register Contents after Completion of First Dot

Figure 4.1 Shift Register Operation for Letter "R"

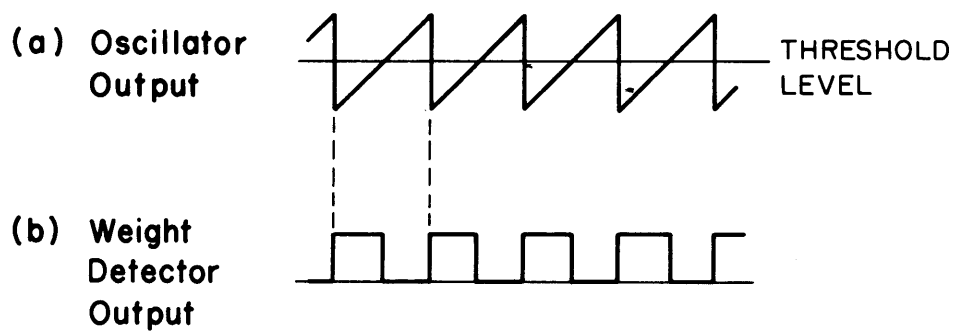


Figure 4.2 Clock Waveforms

When the oscillator is quiescent, the 4.7 μ fd timing capacitor connected to pin 3 of the operational amplifier is partially charged. Pin 3, the non-inverting input, is therefore held at a positive voltage. Because the inverting input, pin 2, is held at +5 volts by the clock keying line, the amplifier output is negative.

To start the oscillator, the clock keying line is driven toward ground. The amplifier output goes high, triggering the monostable to produce a short pulse. This pulse is shifted in level by the MPS3703 transistor and is fed to the base of a MPS3395 transistor connected across the timing capacitor terminals. During the monostable's output pulse, the transistors conduct and the capacitor is discharged. Pin 3 of the amplifier is driven to -6 volts and the amplifier output goes negative.

At the end of the monostable pulse, the MPS3395 ceases to conduct and the capacitor begins to charge through the speed control potentiometer. When the capacitor's positive terminal exceeds the voltage on pin 2 of the op amp, the amplifier output again goes high and the cycle is repeated. The oscillator output, a sawtooth wave, appears across the timing capacitor. The frequency is adjusted by the speed control, which determines the charging time of the capacitor.

The oscillator keying line is driven by the outputs of IC7. When one of the keyswitches is closed, one or more of the shift register flip-flops is cleared, and the output of IC7 goes low. This signal is fed to a NAND gate (pin 5 of IC5) and then through an inverter to the keying line. The output of the NAND gate goes high, the inverter output goes to zero, and the oscillator starts. A connection from flip-flop FFO to a second input of the NAND gate (pin 4 of IC5) ensures that the clock keying line will be held low and that the clock oscillator will be kept running while the intercharacter space is produced. After the space is completed, the register contents are shifted once more. All stages are then high and both inputs to the NAND gate are high. The keying line goes high and the oscillator stops until the next keystroke.

The clock keying line also drives the gate terminal of the SCR. For the SCR to fire, one of the keyswitches must be closed, providing a path for the anode current, and the gate terminal must have a positive potential applied to it. While a character is being produced, the keying line is held low and the SCR cannot fire. The keyboard is therefore "locked out"--closing one of the keyswitches will have no effect on the contents of the shift register until the character is completed and the keying line goes high again. Holding a key down will cause the character to repeat, since the SCR will re-fire as soon as the character is transmitted and the clock line has gone high.

Character Generator

Pulses from the clock oscillator are fed to the character generator, where they are combined with the binary code from the character shift register to produce the series of dots and dashes which make up each character.

The clock pulses drive a weight detector, composed of a 741 operational amplifier operated in the open loop (maximum gain) configuration. A reference or threshold voltage, controlled by the weight potentiometer, is applied to the amplifier's non-inverting terminal (pin 3); the sawtooth output of the clock oscillator drives the inverting input (pin 2). When the clock signal is more positive than the threshold voltage, the amplifier output is negative; when the clock is negative with respect to the threshold level, the output becomes positive. Thus the sawtooth input waveform of Figure 4.2a is converted to a rectangular wave, as shown in Figure 4.2b. The ratio of the time during which the output is positive to that during which it is negative determines the "weight" (dot-to-space ratio) of the transmitted code, and may be adjusted by changing the threshold voltage with the weight control.

The weight detector output drives a Schmitt trigger, composed of two inverters (IC4). This circuit converts the weight detector output to a voltage level suitable to trigger the dash flip-flop. The Schmitt trigger output drives the clock input of the flip-flop. An inverted output is taken from pin 8 of IC4.

The direct clear terminal of the dash flip-flop (pin 13) is controlled by the output of the shift register. When this terminal is held low, the flip-flop is prevented from changing states; the output from pin 8 remains high. When the clear terminal is high, the flip-flop toggles at the beginning of each positive clock pulse.

When a key has been pushed and a character code loaded into the shift register, the clock oscillator starts, as previously described. Assume for the moment that the character to be produced is an "H"--four dots followed by an intercharacter space. The first five flip-flops in the shift register will be set to the zero state.

Immediately after the key is pushed, a positive clock pulse is produced, as shown in Figure 4.3a. The inverted clock pulse from the Schmitt trigger (Figure 4.3b) is supplied to pin 1 of NAND gate IC5, which goes low. The clear terminal of the dash flip-flop (Figure 4.3c) is held low by the shift register output, so the dash flip-flop output, fed to pin 2 of IC5, remains high (Figure 4.3d). Since only one input of the NAND gate is high, the output will also be high, producing the first dot (Figure 4.3e). When the inverted Schmitt trigger output goes high at the end of the clock pulse, the NAND gate output goes low, producing a short space before the next dot. This signal is fed through a second NAND gate and an inverter (pins 1 and 2 of IC6) to the keying stage.

At the end of the first dot, the clock terminals of the shift register stages, driven by inverters from the first NAND gate output, go high, causing the register's contents to shift one stage to the right.¹ Since

¹Two inverters (pins 5, 6, 12, and 13 of IC4) are used to provide sufficient current to drive all seven register clock terminals.

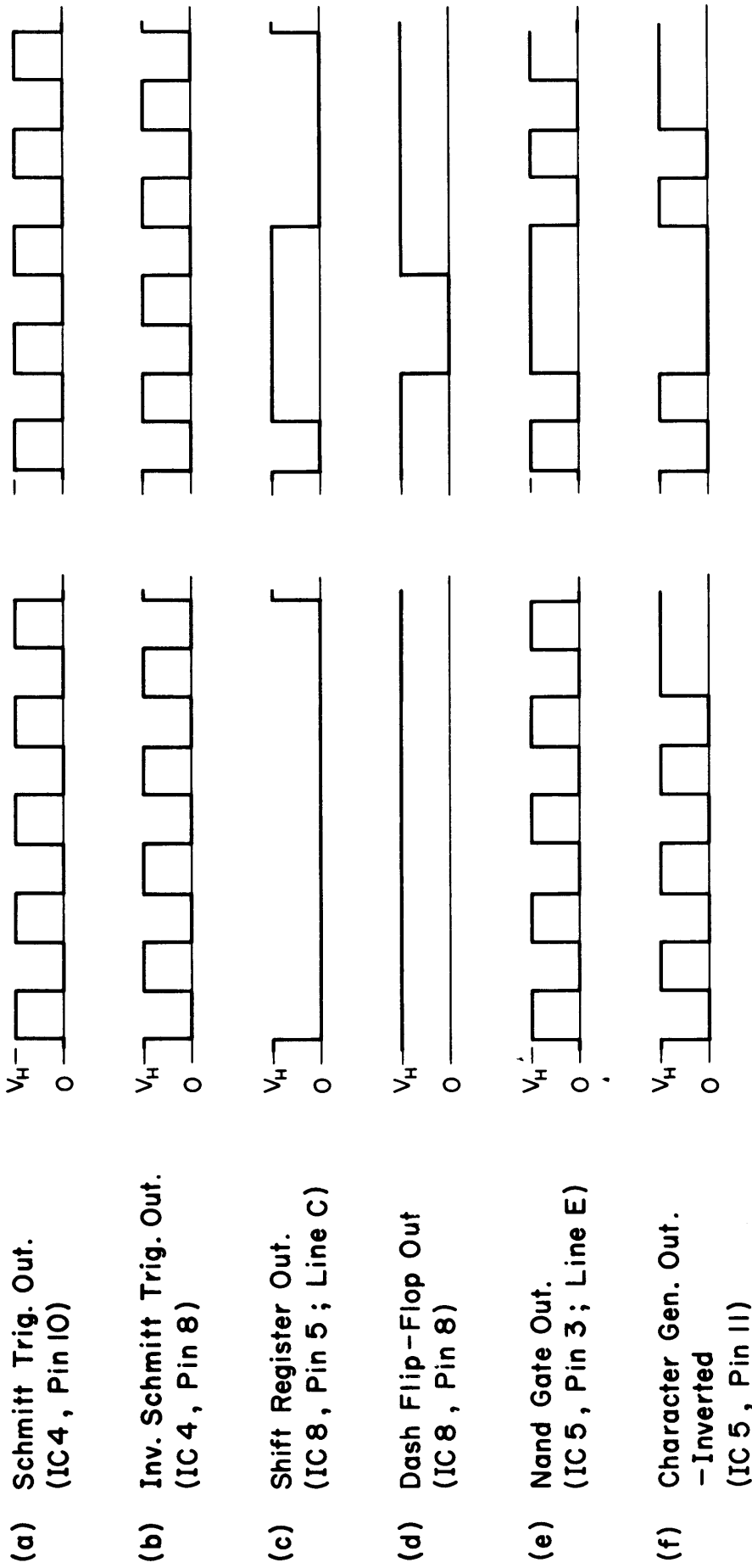


Figure 4.3 Logic Diagrams for Letter "H"

Figure 4.4 Logic Diagrams for Letter "R"

the second code element stored in the register is also a zero, the shift register output remains low. On the next clock pulse, the dash flip-flop is again prevented from toggling and a second dot is generated. This process is repeated until five dots have been produced. The last dot, however, is suppressed. Each time the register shifts, flip-flop FF6 is set to the high state, as discussed previously. When stages one through six are all high, the output of IC7 goes high. This signal passes through an inverter to one input of a NAND gate (pin 13 of IC5). The output of the character generator is applied to the gate's other input. With pin 13 held low, the gate output (pin 11) cannot change state. Thus the final dot is prevented from reaching the keyer stage.

Now consider the sequence of operations in generating the letter "R" (dot-dash-dot). After the R keyswitch is closed, the first register stage contains a zero for the initial dot, the second remains high to produce a dash, and the third and fourth are set to zero to create the final dot and an intercharacter space. The logic sequence is shown in Figure 4.4.

When the oscillator starts, the first dot is produced as before. The dash flip-flop does not toggle at the beginning of the dot because its clear terminal is held low by the shift register output. However, when the register contents shift at the end of the dot, the register output goes high. The flip-flop output remains the same temporarily. At the beginning of the next positive clock pulse, however, the flip-flop toggles and its output goes low. With a low input to pin 2, the output of IC5 goes high for one clock period. After the leading edge of the next clock pulse, the flip-flop toggles again, its output returning to the high state. The NAND gate output is held high now by the low input from the inverted clock pulse applied to pin 1. At the end of the clock pulse, both inputs of the gate become high, the output goes low, and a short space is produced before the beginning of the next clock pulse. The dash generated is three times as long as a dot.

At the end of the dash, the register contents shift once more, and the third code element, a zero, appears at the output. During the next clock pulse, a dot is produced. As with the character "H", an extra dot is also generated but suppressed to produce an intercharacter space.

The inverted output from the character generator appears at pin 11 of IC5. This terminal is tied in parallel with the hand key and the tune keyswitch, and is connected to the input of an inverter (pin 1 of IC6). When either of the contacts is closed or the NAND gate output is low, the inverter output becomes high, triggering the sidetone oscillator and the keying transistor.

Sidetone Oscillator

Portions of IC5 and IC6 are connected in a feedback arrangement to form an audio oscillator for monitoring the transmitted code signal. When the oscillator is quiescent, the input to pin 10 of NAND gate IC5 is low, allowing the gate output to go high. This signal is applied to an inverter (pin 13 of IC6), forcing its output low. The output is connected to one terminal of the timing capacitor, a 2.2 μ fd electrolytic, and to the input

of a second inverter. The latter inverter output is high, applying a positive voltage through the tone control to the other terminal of the capacitor and to the second input of the NAND gate.

When the oscillator is keyed by applying a high level to pin 10 of IC5, the NAND gate output goes low, driving pin 12 of IC6 high and pin 8 low. The capacitor discharges through the tone control until pin 9 of the NAND gate approaches zero. The NAND gate output then goes high again, the capacitor recharges, the output of IC5 is again driven low, and the cycle repeats. The frequency of the oscillator is determined by the time constant of the capacitor and tone control.

Output from the oscillator is taken from pin 12 of IC6 and fed through an inverter to supply the current required to drive the speaker and an external audio load, if any.

Keying Stage

The transmitter to be keyed by the MKB-1 is connected to either the cathode keying or the grid-block keying jack. Current through these jacks is controlled by a 2N5655 switching transistor. The keying signal from the character generator, taken from pin 2 of IC6, drives the base of the keying transistor through a 2N5401 connected as a common base amplifier.

Power Supply

The +5 volts DC required for the majority of the MKB-1 circuitry is provided by a full-wave rectifier and a conventional series-pass regulator circuit. A potentiometer permits adjustment of the output voltage over a limited range.

The operational amplifiers, IC1 and IC2, require a negative supply voltage as well. A simple full-wave rectifier and filter circuit, followed by a 1N4735 zener diode regulator, supply the -6 volts required.

5. CONSTRUCTION

The MKB-1 consists of two main subassemblies, the 3 × 6 inch logic board and the 5 × 11 inch keyswitch board, both of which mount in the keyboard cabinet. The controls, connectors, and the power transformer mount directly in the cabinet. Constructing the keyboard involves four steps:

1. Installing components on the logic board.
2. Installing the toroids and keyswitches on the keyswitch board and wiring the toroid matrix.
3. Mounting components in the cabinet.
4. Connecting wiring harnesses between the subassemblies and the cabinet-mounted components.

Logic Board Construction

Referring to the parts list on page 37, sort out all the components marked on the list with an "L". These are the parts that mount on the logic board.

Figure 5.1 shows the position of all parts on the board. Following the numbered steps below, insert the parts into the board and solder the leads.

All soldering should be done on the bottom (non-component) side of the board. Use just enough heat and solder to obtain good connections. Overheating may damage the board or the components. Check that excess solder does not form a bridge between adjacent conductors.

When installing vertically mounted components, position the component body exactly as shown in the drawing to prevent interference with other parts. Be sure to observe polarity when mounting components such as semiconductors and electrolytic capacitors.

1. Mount all integrated circuits. Note the U-shaped marking or dot at one end of each IC, and install it so that this mark corresponds to the position shown in the drawing. Solder all leads carefully.
2. Insert all resistors and diodes. At each diode location one of the pads is square. The cathode end of the diode should be connected to the square pad. Solder all leads and trim off excess length.
3. Insert all disc and mylar capacitors. Solder the leads and trim off excess.
4. Mount and solder all transistors except the MJE521.

5. Insert the 500 ohm PC-mounting potentiometer in its location near the right end of the board. Solder the three leads.
6. Locate the MJE521 transistor and the black, U-shaped heatsink. If heatsink compound or non-conductive silicone grease is available, apply a small amount to the gold plate on the side of the transistor package. Lay the transistor on the heatsink with the gold plate in contact with the heatsink. Insert the transistor leads into the holes on the circuit board. Bend the transistor and heatsink down toward the board so that the hole in the transistor lines up with the mounting hole in the circuit board. Insert a 4-40 × 3/8 screw through the transistor and heatsink, and fasten the pair to the board with a lockwasher and hex nut. Solder the three leads.
7. Insert and solder the six electrolytic capacitors, carefully observing polarity. Trim off excess lead length.

The circuit board is now complete. Check all connections carefully, looking for leads which may not have been soldered. Then set the board aside temporarily.

Keyswitch Board Construction

Referring again to the parts list, sort out those components designated by a "K". These are the parts needed to construct the keyswitch circuit board. Figure 5.2 shows the location of the parts on the board. To install them, follow these steps:

8. Insert the seven 1.2k, $\frac{1}{4}$ watt resistors in their positions next to the mounting holes for toroids T₀ through T₆. Note that these resistors are mounted vertically. The space between the resistor body and its lead will be used later to hold toroid wiring in place.
9. The toroids are mounted at the seven holes near the edge of the circuit board. Insert a piece of insulated stranded hookup wire or strong twine (such as lacing or dial cord) through hole AA at the left end of the row of toroid mounting holes. Tie a knot in the end of the wire which protrudes above the circuit board. From the bottom of the board, pull the wire tight so that the knot rests on the top surface of the board.

Holding the board with the top surface facing you, thread the wire up through the mounting hole for toroid T₆. Pass the wire through the center hole of one of the toroids, then thread it down through the hole again. Position the toroid so that it stands vertically on the board as shown in Figure 5.3 and pull the wire snug. Mount the remaining six toroids in the same manner.

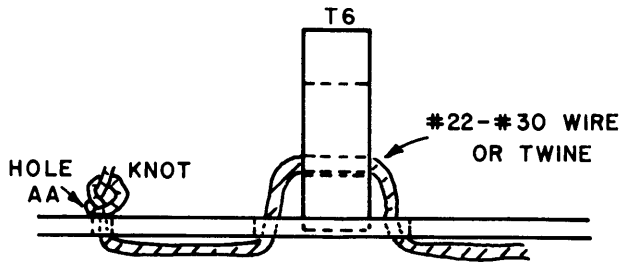


Figure 5.3 Toroid Mounting

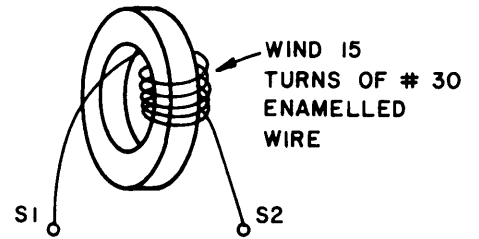


Figure 5.4 Winding the Toroid Secondaries

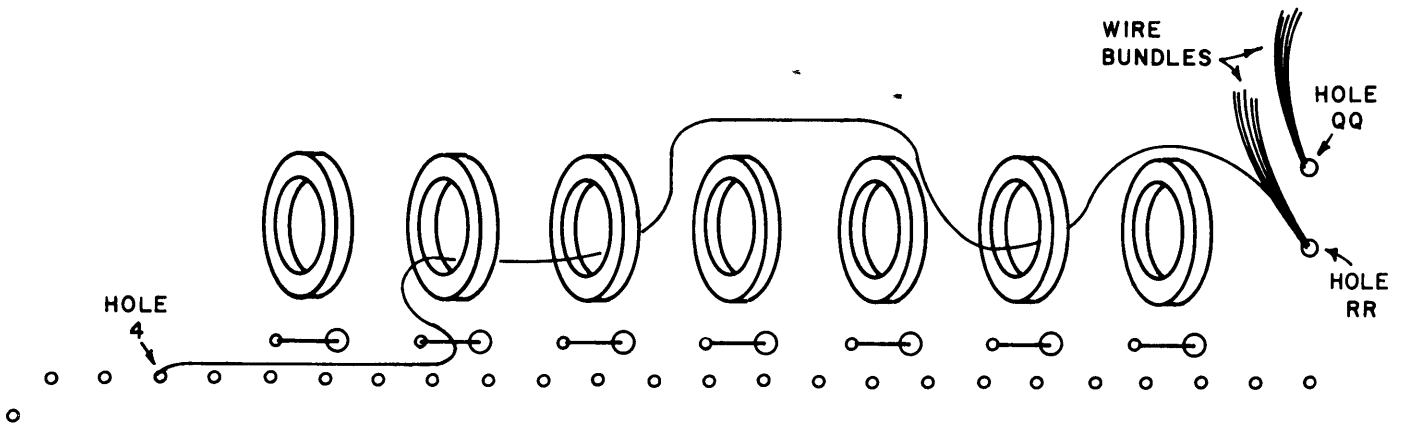


Figure 5.5 Toroid Winding

When you have mounted all toroids, check that the wire is tight at all points. Then pass the free end up through hole BB at the right end of the toroid row and tie a second knot on the top side of the board.

10. Next to each toroid are two holes, designated S1 and S2 in Figure 5.2. A secondary coil is wound on each toroid and connected to these holes.

Lay the board on the bench, printed side down, with the toroids away from you. Scrape the insulation from one end of a 10" length of #30 magnet wire. Insert the wire through hole S2 near toroid T_0 and solder it to the pad on the bottom of the board. Return the board to its former position and pass the wire through the center hole of toroid T_0 . Bringing the end of the wire toward you, wrap it around the toroid body and pass it through the hole in the toroid again. Continue winding turns in this manner, working up the side of the toroid nearest you, as shown in Figure 5.4. Make sure that the turns are closely spaced.

When you have completed the fifteenth turn, pass the free end of the wire down through hole S1. Cut the wire off, leaving about $\frac{1}{4}$ " protruding from the bottom side of the board. Remove the wire from the hole and scrape the enamel from the end. Re-insert the wire through hole S1 and pull it snug. Check that the turns on the toroid are positioned properly and are tight. Then solder the wire to the pad on the bottom of the board.

Wind secondaries on toroids T_1 through T_6 by repeating the process. Be sure to follow the same procedure so that the windings will have the proper polarity.

11. Next mount the keyswitches. Note that some of the modules contain five switches while others contain four. Figure 5.2 shows how the modules should be arranged on the board.

Select one of the five-switch modules. Insert it at position A, pushing it in only far enough that the mounting screws enter the holes in the board. Look under the switch module to see if all pins line up with the holes in the board. If they don't, use a small needle-nose pliers or a screwdriver to gently bend the pins into alignment with the holes.

Carefully push the switch module down until the body rests against the board. Turn the board over and check that all 10 switch pins protrude through the board. Then fasten the module to the board with two 2-56 screws and hex nuts.

Mount the remaining switch modules, one at a time, referring to Figure 5.2 for proper positioning. When all modules are mounted, solder all pins to the circuit board.

Position the board so that none of the keyswitches is depressed. Measure across each pair of switch pins with an ohmmeter. All should show open circuits. If you find a low resistance, check for shorts on the printed circuit board.

Install the keytops on the switches in the positions shown in Figure 5.2. Some keytops require stick-on labels. Apply the labels to the proper keys as shown in the figure.

12. Cut 45 pieces of #30 enamelled wire, each 15 inches long. Scrape the insulation from one end of each of the wires. Group the wires into two bundles of approximately the same size, with all the scraped ends together. Pass the stripped ends of the first bundle down through hole QQ and solder them. Insert the stripped ends of the second bundle into hole RR and solder. Be sure that all wires in each bundle are securely soldered. The enamel may be more easily stripped from the wires if they are first heated with a match, or the entire wire bundle can be dipped in a solder pot if one is available.
13. Each of the 45 wires will now be threaded through the appropriate toroids and connected to a keyswitch. A given wire will pass through the center of some toroids but will be routed around the outside of others. Table 5.1 shows how to route each wire.

For example, the table shows that the first wire should pass around the outside of toroid T_0 , through toroid T_1 , around toroids T_2 and T_3 , and through toroids T_4 and T_5 . After the wire passes through toroid T_5 , it is routed between the body and lead of the resistor nearest T_5 , as shown in Figure 5.5. The wire is then inserted in hole 4 and soldered.

Check each wire after you install it to ensure that it passes through the proper toroids. As a double check, the characters corresponding to the numbered holes are printed on the bottom side of the circuit board. Compare them to the "Character Key" column in Table 5.1 as you connect each wire to make certain that you have connected the wire to the correct hole.

14. Jumper the common bus of T_5 and T_6 to the common bus of $T_0 - T_4$.

The keyswitch board is now complete. After checking it over carefully, set it aside temporarily.

Table 5.1: Toroid Wiring

T ₀	T ₁	Toroid Number						Connect to Hole No.	Character Key
		T ₂	T ₃	T ₄	T ₅	T ₆			
Past	Thru	Past	Past	Thru	Thru	----	47	KN	
Past	Past	Thru	Thru	Thru	----	----	6	Z	
Thru	Past	Thru	----	----	----	----	7	A	
Past	Past	Thru	Past	Thru	----	----	8	Q	
Thru	Past	Past	Past	Past	Thru	----	9	1	
Past	Thru	Thru	Past	Thru	----	----	10	X	
Thru	Thru	Thru	Thru	----	----	----	11	S	
Thru	Past	Past	Thru	----	----	----	12	W	
Thru	Thru	Past	Past	Past	Thru	----	13	2	
Past	Thru	Past	Thru	Thru	----	----	14	C	
Past	Thru	Thru	Thru	----	----	----	15	D	
Thru	Thru	----	----	----	----	----	16	E	
Thru	Thru	Thru	Past	Past	Thru	----	17	3	
Thru	Thru	Thru	Past	Thru	----	----	18	V	
Thru	Thru	Past	Thru	Thru	----	----	19	F	
Thru	Past	Thru	Thru	----	----	----	20	R	
Thru	Thru	Thru	Thru	Past	Thru	----	21	4	
Past	Thru	Thru	Thru	Thru	----	----	22	B	
Past	Past	Thru	Thru	----	----	----	23	G	
Past	Thru	----	----	----	----	----	24	T	
Thru	Thru	Thru	Thru	Thru	Thru	----	25	5	
Past	Thru	Thru	----	----	----	----	26	N	
Thru	Thru	Thru	Thru	Thru	----	----	27	H	
Past	Thru	Past	Past	Thru	----	----	28	Y	
Past	Thru	Thru	Thru	Thru	Thru	----	29	6	
Thru	Past	Past	Past	Thru	----	----	31	J	
Thru	Thru	Past	Thru	----	----	----	32	U	
Past	Past	Thru	Thru	Thru	Thru	----	33	7	
Past	Past	Past	Thru	Thru	Thru	----	34	8	
Thru	Thru	Thru	----	----	----	----	35	I	
Past	Thru	Past	Thru	----	----	----	36	K	
Past	Past	Thru	----	----	----	----	37	M	
Past	Past	Past	Past	Thru	Thru	----	38	9	
Past	Past	Past	Thru	----	----	----	39	0	
Thru	Past	Thru	Thru	Thru	----	----	40	L	
Past	Past	Thru	Thru	Past	Past	Thru	41	comma	

Continued on next page . . .

Table 5.1 (continued)

Toroid Number							Connect to Hole No.	Character Key
T ₀	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆		
Past	Past	Past	Past	Past	Thru	----	42	∅
Thru	Past	Past	Thru	Thru	----	----	43	P
Past	Thru	Thru	Thru	Past	Thru	----	44	BT
Thru	Past	Thru	Past	Thru	Past	Thru	45	period
Thru	Thru	Thru	Past	Thru	Past	Thru	4	SK
Thru	Past	Thru	Past	Thru	Thru	----	46	AR
Past	Thru	Thru	Past	Thru	Thru	----	49	/
Thru	Thru	Past	Past	Thru	Thru	Thru	53	?
Thru	Past	Thru	Thru	Thru	Thru	----	48	AS

NOTE: Holes 1, 2, 3, 5, 30, 50, 51, and 52 are not used.
Be sure to leave them empty when wiring the toroids.

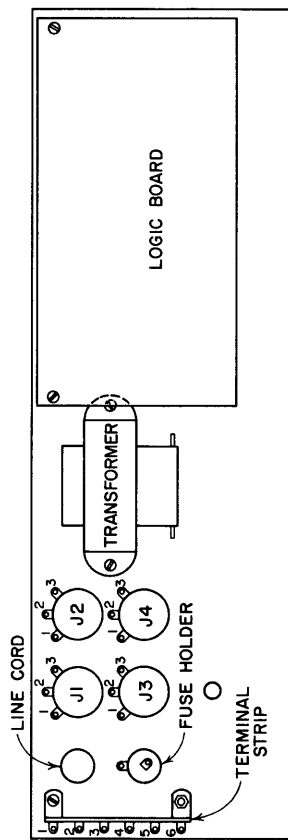
The following optional characters may be coded if desired.

T ₀	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	Connect to Hole No.	Character Key
Past	Thru	Past	Thru	Past	Thru	----	Use	<u>KA</u>
Thru	Thru	Thru	Past	Thru	Thru	----	any	"(Quotation)
Past	Past	Past	Thru	Thru	Thru	Thru	Keyswitch	: (Colon)
Past	Thru	Past	Thru	Past	Thru	Thru	desired	; (Semi-colon)
Past	Thru	Thru	Thru	Thru	Past	Thru		- Hyphen
Past	Thru	Past	Past	Thru	Past	Thru		() Parentheses
Thru	Past	Past	Past	Past	Thru	Thru		' Apostrophe

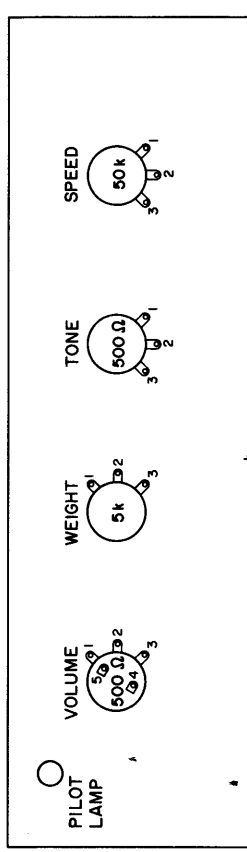
Installing Cabinet-Mounted Parts

The parts which mount directly in the cabinet are designated by the letter "C" in the parts list. The location of the parts is shown in Figure 5.6. Install them in the cabinet in the following order:

14. Mount phone jacks at positions J1, J2, J3, and J4.
15. Mount the fuseholder and pilot lamp at the positions shown.
16. Install the strain relief bushing on the power cord, positioning it about 5" from the end. Insert the bushing in the hole on the rear panel.
17. Install the six-lug terminal strip, using one 6-32 × ½" screw and one 6-32 × ¼" screw. Insert the longer screw in the hole near the bottom lip of the chassis, with the screw head inside the cabinet. Insert the shorter screw at the other hole, with the head outside the cabinet. Fasten both screws with 6-32 hex nuts and lockwashers.



(a) Rear Panel Layout (Interior View)



(b) Top Panel Layout (Interior View)

Figure 5.6 Rear and Top Panel Parts Placement

18. Install the 500-ohm volume control with switch, the 5000-ohm weight control, the 500-ohm tone control, and the 50K-ohm speed control.
19. Mount the power transformer, using 6-32 screws, lockwashers, and hex nuts. Position the transformer so that the terminals are toward the top panel of the cabinet.
20. Using three 6-32 \times 3/8" screws, hex nuts, and flat washers, mount the speaker on the inside of the cabinet bottom cover. The washers should overlap the outside of the speaker flange to hold it to the cabinet.

Wiring

Two 12-conductor cables are used to connect the logic board to the key-switch board and to the cabinet-mounted components.

21. Cut a 16-inch length of 12 conductor cable. Strip the jacket back 8" on one end and 3 $\frac{1}{2}$ " inches on the other, being careful not to nick the insulation on the wires inside. This cable will be used to interconnect the logic and keyswitch boards.
22. The wires at the 3 $\frac{1}{2}$ " end connect to the logic circuit board. Cut the wires to the lengths shown below. Strip $\frac{1}{4}$ " of insulation from the end of each wire. Insert the wires in the numbered holes in the logic board and solder. The hole numbers are printed on the board and are also shown in Figure 1.1. The pink wire is not used. Snip it off close to the jacket.

<u>Color</u>	<u>Length</u>	<u>Hole #</u>
Black	3/4"	26
Brown	3/4"	25
Red	1"	22
Orange	1 $\frac{1}{4}$ "	21
Yellow	1-3/4"	20
Green	2"	19
Blue	2 $\frac{1}{2}$ "	18
Violet	2-3/4"	17
Grey	3 $\frac{1}{4}$ "	16
White	3 $\frac{1}{2}$ "	15
Tan	2"	2

23. The wires at the eight-inch end connect to the keyswitch board. Cut the wires to the lengths shown below. Strip $\frac{1}{4}$ " of insulation from each one. Insert the wires in the holes listed in the table. These holes are not labeled on the board itself, but are shown on the keyswitch board drawing, Figure 5.2. Solder all wires.

<u>Color</u>	<u>Length</u>	<u>Insert in Hole #</u>
Black	1"	EE
Red	1"	FF
Orange	1 $\frac{1}{2}$ "	GG
Yellow	2-3/4"	HH
Green	3 $\frac{1}{4}$ "	JJ
Blue	4 $\frac{1}{2}$ "	KK
Violet	5"	LL
Grey	5-3/4"	MM
White	6-3/4"	NN
Tan	8"	5
Brown	3"	PP

24. Cut an 18" length of 12-conductor cable. Strip the outer jacket back 3 $\frac{1}{2}$ " on one end and 9 $\frac{1}{2}$ " on the other. This cable will connect the logic board to the cabinet-mounted components.
25. The wires at the 3 $\frac{1}{2}$ -inch end connect to the logic circuit board. Cut the leads to the lengths shown in the following table and strip $\frac{1}{4}$ " of insulation from the ends. Insert them in the holes indicated and solder.

<u>Color</u>	<u>Length</u>	<u>Insert in Hole #</u>
Red	1"	3
Orange	1"	1
Yellow	1-3/4"	4
Green	2"	5
Blue	2 $\frac{1}{4}$ "	6
Violet	2-3/8"	7
Grey	2 $\frac{1}{2}$ "	8
White	2-5/8"	9
Pink	3 $\frac{1}{4}$ "	10
Tan	3 $\frac{1}{2}$ "	11
Black	2-3/4"	23
Brown	2-3/4"	24

26. Cut two 11-inch lengths of hookup wire, one green and one yellow. Strip $\frac{1}{4}$ " of insulation from one end of each and twist the wires together. Insert the green wire into hole 12 of the logic circuit board and solder. Insert the yellow wire into hole 13 and solder.

27. Cut the wires at the free end of the 18" cable to the lengths shown below. Save the scraps for use in wiring the chassis components.

<u>Color</u>	<u>Length</u>
Red	9½"
Orange	9½"
Grey	8½"
White	8½"
Black	2¼"
Brown	6"
Yellow	5"
Green	5"
Violet	5"
Pink	2-3/4"
Blue	3"
Tan	2"

Before connecting the free end of the 18" cable, complete the preliminary cabinet wiring steps below. The cabinet layout drawing, Figure 5.6, shows the position of the chassis-mounted components and the lug numbers for each part.

28. Strip the outer jacket from the 5" length of power cord extending through the bushing. Solder the black wire to lug 2 of the fuseholder. Connect the green lead to lug 1 of the terminal strip and the white lead to lug 2. Do not solder these leads yet.
29. Solder one lead of a .01 μ fd disc capacitor to lug 1 of J1. Connect the other lead to lugs 2 and 3 of J1. Solder lug 2 but not lug 3.
30. Solder one lead of a .01 μ fd disc capacitor to lug 1 of J3. Connect the other lead to lugs 2 and 3 of J3. Solder lug 2 but not lug 3.
31. Connect one lead of a .001 μ fd (1000V) disc capacitor to lugs 1 and 2 of J2 and solder. Connect the other lead to lug 3 of J2. Do not solder.
32. Connect one lead of a .001 μ fd (1000V) disc capacitor to lugs 1 and 2 of J4 and solder. Connect the other lead to lug 3 of J4. Do not solder.
33. Connect a .001 μ fd 1KV disc capacitor between lugs 1 and 2 of the terminal strip. Connect a second .001 μ fd 1KV disc capacitor between lugs 5 and 6 of the strip. Solder only lug 6.
34. Connect a short length of hookup wire between lug 1 of the fuseholder and lug 4 of the volume control. Solder both terminals.

35. Slip a length of insulating tubing over one of the pilot lamp leads. Connect the lead to lug 5 of the terminal strip. Do not solder.
 36. Slip a length of insulating tubing over the other pilot lamp lead and connect it to lug 4 of the terminal strip. Do not solder.
 37. Solder a 6" length of hookup wire to lug 5 of the volume control. Connect the other end to lug 5 of the terminal strip. Do not solder.
 38. Connect a short length of hookup wire between lugs 3 and 5 of the terminal strip. Solder all leads at lug 5 but not lug 3.
 39. Connect an 82k ohm, $\frac{1}{2}$ watt resistor between lugs 2 and 4 of the terminal strip. Solder lug 4 only.
 40. Twist together 17" of green and yellow hookup wire. Connect one end of the yellow wire to lug 1 of the volume control. Connect the green wire to lug 2 of the control. Do not solder. Leave the other end of the pair free for the moment.
- NOTE: (Steps 41, 42, and 43) These three wires may be more neatly installed if twisted together.
41. Connect an 8" length of tan hookup wire to lug 2 of the terminal strip. Solder all leads at this lug. Solder the other end of the wire to lugs 3 and 4 of the power transformer.
 42. Connect an 8" length of pink hookup wire to lug 3 of the terminal strip. Solder all leads at this lug. Solder the other end of the wire to terminals 1 and 2 of the power transformer.
 43. Connect an 8" length of black hookup wire to lugs 6 and 7 of the transformer (do not solder). Solder the other end of the wire to lug 1 of the terminal strip.
 44. Connect a 7" length of hookup wire from terminal 6 of the transformer (solder) to lugs 2 and 3 of the weight control (solder).
 45. Solder a 13" length of red hookup wire to lug 3 of J1.
 - 45a. Connect a 150 ohm resistor ($\frac{1}{4}$ " leads) to terminal 3 of the tone control.
 46. The free end of the 18" cable from the logic board may now be connected to the cabinet components. Position the board near its mounting position on the rear panel, but do not fasten the board into place yet. Dress the cable between the transformer and the bottom lip of the cabinet. Connect the wires to the terminals shown in the following table. Solder each connection.

<u>Color</u>	<u>Connect To</u>	<u>Terminal #</u>
Red	Speed control	3
Orange	Speed control	1 & 2
White	Tone control	Free end of 150 ohm resistor
Grey	Tone control	1 & 2
Brown	Weight control	1
Yellow	Volume control	1
Green	Volume control	2
Violet	Volume control	3
Pink	J4	3
Blue	J3	3
Tan	J2	3
Black	Transformer	7

47. Route the green and yellow twisted pair coming from holes 12 and 13 of the logic board to the transformer. Solder the green wire to transformer lug 8. Solder the yellow wire to transformer lug 5.
48. Connect the red wire from J1 to hole 5 of the keyswitch board. Since this hole already holds a tan wire, solder the red wire to the pad on the printed side of the board, being careful not to allow solder to bridge between the printed conductors.
49. Position the bottom cover near the main chassis. Locate the green and yellow twisted pair from the volume control. Solder these wires to the two speaker terminals, being careful not to overheat the terminals. Polarity is not important.

The wiring is now complete. Recheck all steps and look for unsoldered connections before proceeding.

Final Assembly

50. Mount the logic board to the rear panel in the position shown in Figure 5.6, with the printed side toward the panel. Use two $\frac{1}{2}$ " spacers and 4-40 screws.
51. Mount the keyswitch board on the four threaded studs on the top panel. Thread an 8-32 hex nut onto each stud and turn it down until $\frac{1}{4}$ " of the stud projects from the nut. Place the board into position over the studs and fasten it with another 8-32 nut on each stud. Check to see that the keytops do not bind against the edge of the panel before tightening the nuts.
52. Insert the 0.1 SB amp fuse in the fuseholder.
53. Install knobs on the four controls.

54. Apply the four adhesive feet at the corners of the bottom cover.

55. Insert the $\frac{1}{4}$ " hole plug in the unused hole on the rear panel.

The keyboard construction is now completed. Before attaching the bottom cover, perform the tests described in the following section.

6. TESTING AND TROUBLESHOOTING

Preliminary Tests

The following tests should be performed before putting the keyboard into service.

1. With the bottom cover removed, connect the AC power cord to a 115 VAC, 60 Hz outlet.

CAUTION: 115 VAC is exposed at several points inside the keyboard. Avoid contacting these points when conducting the following tests. Use insulated test probes and apply them only to the test points indicated.

2. Rotate the volume control clockwise to switch the power on. The pilot lamp should light.
3. Measure the power supply output voltage by connecting a voltmeter between the center terminal of the speed pot and ground. The meter should read +5 volts DC. If necessary, adjust the voltage control potentiometer on the logic circuit board to obtain the correct reading.
4. Set all controls to the middle of their ranges. Depress any of the character keys and listen for the audio code signal from the speaker. Check that each key produces the proper code character.

If you encounter difficulty, refer to the troubleshooting section below. If the tests are successful, unplug the AC line cord and install the bottom cover using six 3/8" No. 8 sheet metal screws. The keyboard is now ready for use.

Troubleshooting

Should you encounter problems with your keyboard, the following tips will help to isolate the source of the trouble.

Symptom: Power supply voltage low or zero.

Check the AC voltage input at terminals 2 and 3 of the terminal strip. If 115 VAC is present there, check the transformer output at pins 12 and 13 of the logic board. Both pins should read about 6 VAC with respect to the chassis ground. Check the DC voltage at the collector of the MJE521 transistor. It should be between 6 and 8 volts.

The power supply is short-circuit protected. If an excessive load or short is placed on the output, the voltage will automatically drop. If the supply voltage cannot be increased with the voltage control pot, check for a short circuit from the +5 volt circuit to ground. Also check that all integrated circuits are oriented properly on the board and that diode D1 is properly installed.

Symptom: No output when keys are pressed.

Check the output of IC-6 at test point D. After a key has been pressed it should be low (about 0.2 volts). If it is, check the oscillator output (pin 6 of IC-1) to determine whether the oscillator is running.

If test point D is not low, check the input to IC-5 at pin 5. Press any key and observe whether the input goes low. If it doesn't, the code from the keyboard toroids is not being loaded into the shift register. Check the SCR circuit.

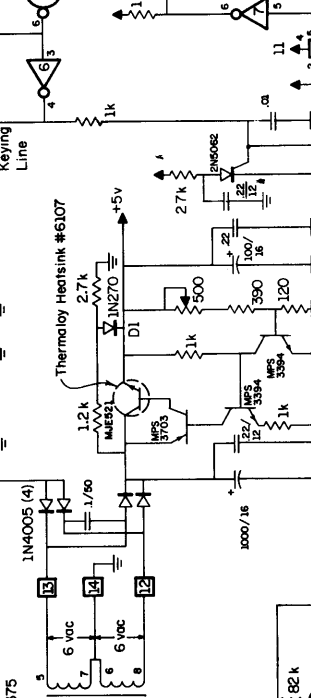
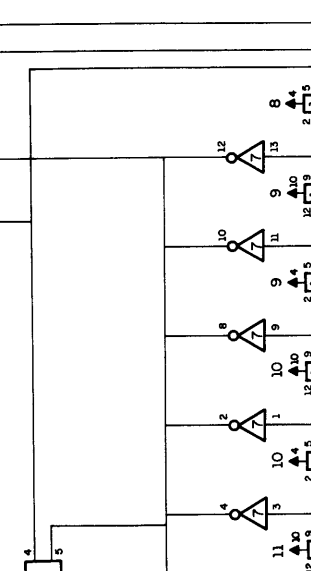
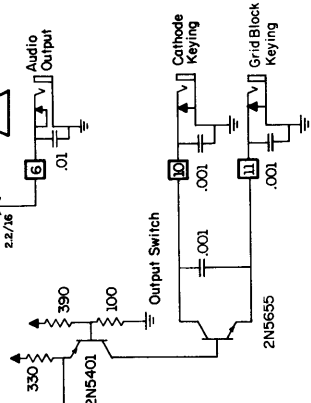
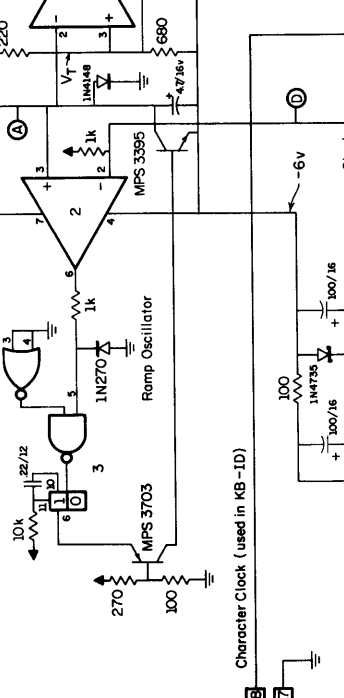
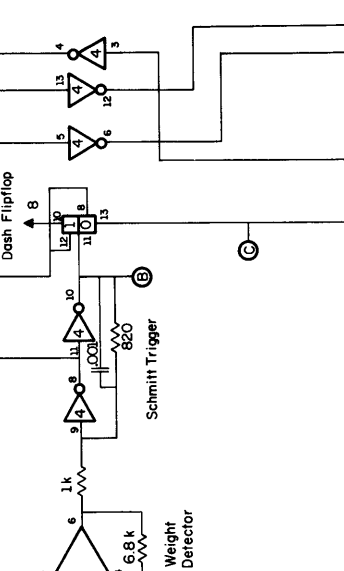
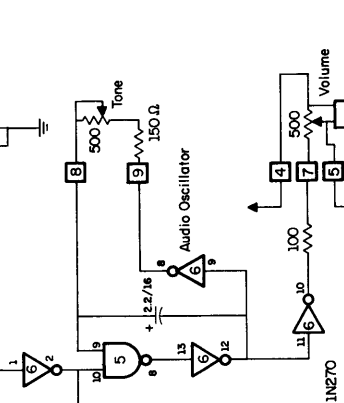
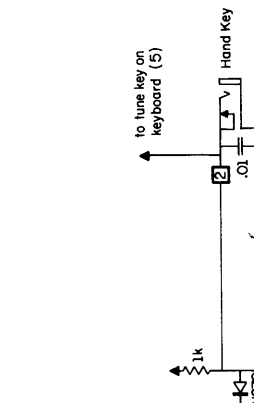
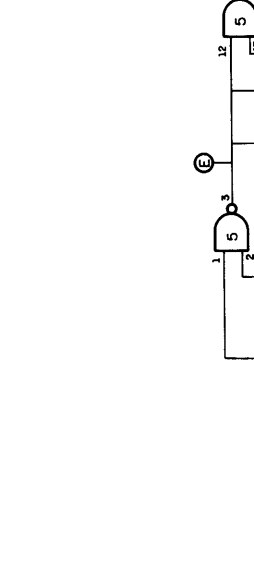
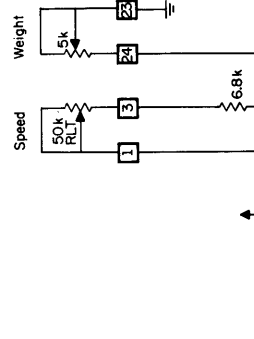
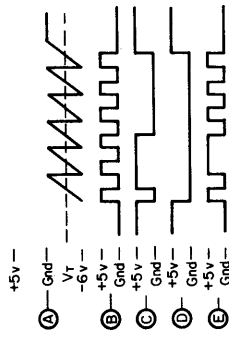
If the shift register loads properly and the oscillator runs when a key is pressed, check the signals at test points B, C, D, and E (shown in the schematic diagram), comparing them to the correct waveforms shown in the drawing.

It will generally not damage a TTL circuit if the output is shorted to the supply bus or to ground, or if the power supply is connected with the wrong polarity for a short period of time. Negative voltages greater than -1 volt applied to an input or an output can cause damage, however. Therefore, be careful when testing not to short the -6 volt supply bus to any of the signal lines.

7. DIAGRAMS AND PHOTOGRAPHS

The schematic diagrams and photographs of the MKB-1 assemblies are shown on the following pages.

Waveforms for Letters "L"



Notes:
 1. All resistors in ohms, 1/4 W, k=1000.
 2. All capacitors in μ f.
 3. All unmarked arrows are +5v.
 4. Note toroid phase marks when coding encoder.
 5. Power connections for 117 VAC operation is shown. For 220 VAC operation, wire transformer primaries in series. Wire indicator lamp across one primary winding only (110 VAC).
 6. T₁₋₆ have 15 turn primaries.
 7. Designators in parenthesis () refer to connection points on keyswitch board.

Character Shift Register
 Toroids
 A B C D E
 1,2,3,5 2,4,5 1,2,3,4,5,6

Key Encoding Example "A" & "L"
 A B C D E
 1,2,3,5 2,4,5 1,2,3,4,5,6

Circuit Number	Type	Circuit Number	Type
1	741C	7	7405
2	741C	8	7474
3	74121	9	7474
4	7404	10	7474
5	7400	11	7474
6	7400		

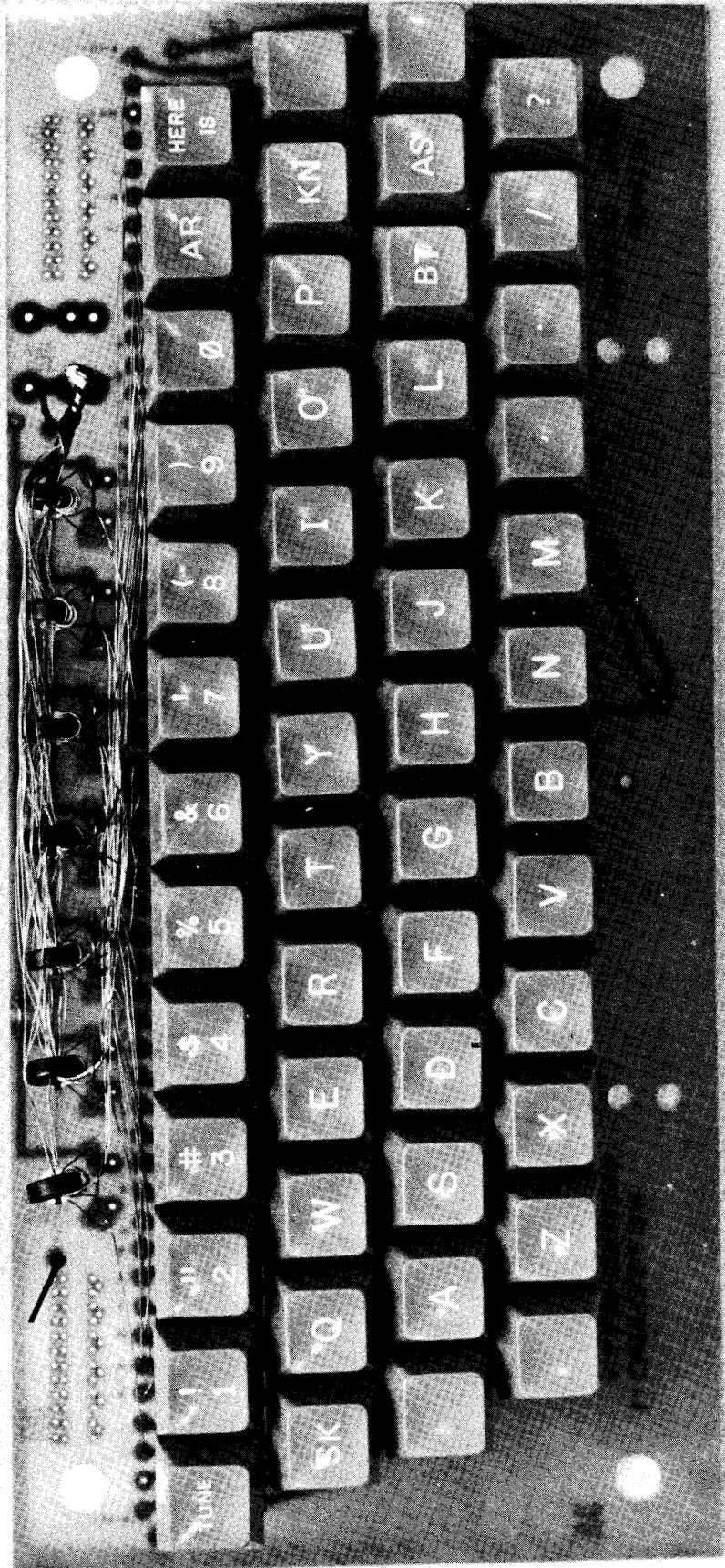
COMMUNICATIONS CORP.
 BOX 365, URBANA, ILLINOIS, 61801

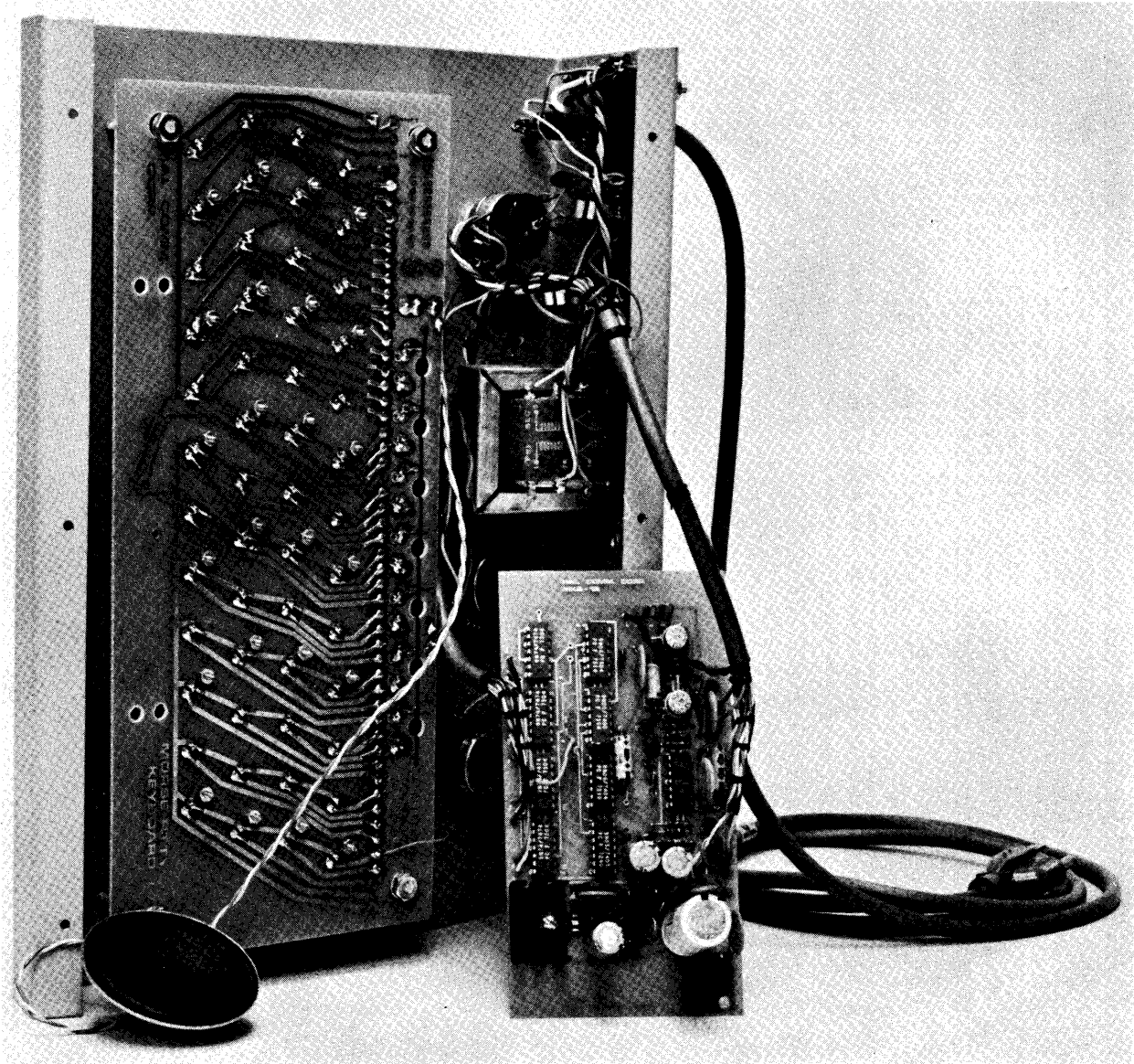
Morse Key Encoder

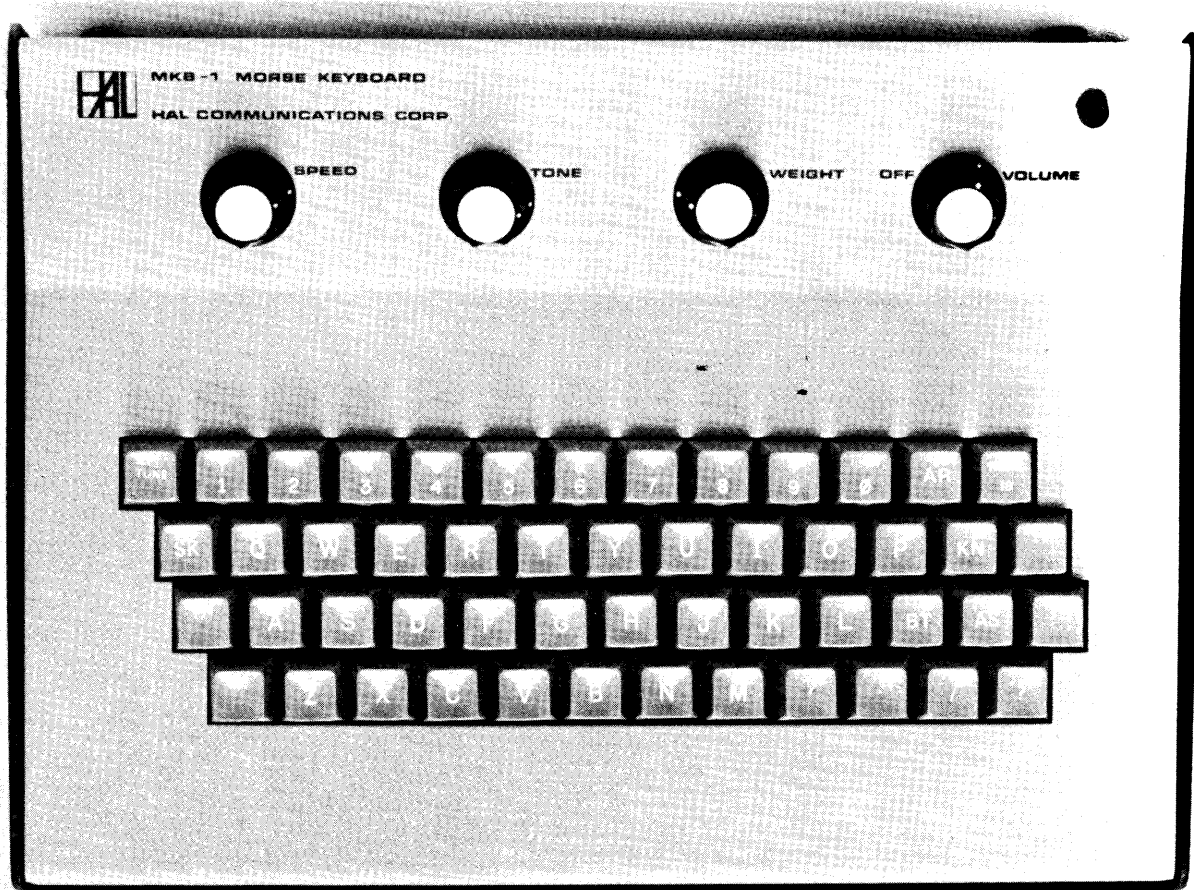
DATE: June 24, 1972
 APPROVED: P. Tucker
 SCALE: No. MKB-1B

Rev.: Nov. 10, 1972
 Rev.: Nov. 9, 1973

To code a Morse character, wire through toroids corresponding to dots and bypass those corresponding to dashes. Follow each character with an additional dot Letter Toroids







8. PARTS LIST

Resistors

4	100 ohm, $\frac{1}{2}$ watt	(L)
1	120 ohm, $\frac{1}{2}$ watt	(L)
1	150 ohm, $\frac{1}{2}$ watt	(L)
1	220 ohm, $\frac{1}{2}$ watt	(L)
1	270 ohm, $\frac{1}{2}$ watt	(L)
1	330 ohm, $\frac{1}{2}$ watt	(L)
2	390 ohm, $\frac{1}{2}$ watt	(L)
1	680 ohm, $\frac{1}{2}$ watt	(L)
1	820 ohm, $\frac{1}{2}$ watt	(L)
8	1000 ohm, $\frac{1}{2}$ watt	(L)
8	1200 ohm, $\frac{1}{2}$ watt	(7K, 1L)
1	2700 ohm, $\frac{1}{2}$ watt	(L)
2	6800 ohm, $\frac{1}{2}$ watt	(L)
1	10K ohm, $\frac{1}{2}$ watt	(L)
1	27K ohm, $\frac{1}{2}$ watt	(L)
1	82K ohm, $\frac{1}{2}$ watt	(C)

Controls

1	500 ohm PC-mount trimpot	(L)
1	500 ohm with switch	(C)
1	500 ohm	(C)
1	5000 ohm	(C)
1	50K ohm reverse log taper	(C)

Capacitors

6	.001 μ fd 1 KV disc ceramic	(2L, 4C)
3	.01 μ fd 50 V disc ceramic	(1L, 2C)
1	.1 μ fd 16 V disc ceramic	(L)
4	.22 μ fd 12 V disc ceramic	(L)
2	2.2 μ fd 16 V electrolytic	(L)
1	4.7 μ fd 16 V electrolytic	(L)
3	100 μ fd 25 V electrolytic	(L)
1	1000 μ fd 16 V electrolytic	(L)

Transistors, Diodes, and SCR

4	1N270	(L)
4	1N4005	(L)
1	1N4148	(L)
1	1N735	(L)
1	MJE521	(L)
2	MPS3394	(L)
1	MPS3395	(L)
2	MPS3703	(L)
1	2N5062	(L)
1	2N5401	(L)
1	2N5655	(L)

Wire and Cable

3	ft. 12-conductor cable	(C)
75	ft. enamelled wire	(K)
4	in. insulating tubing	(C)

Integrated Circuits

2	741	(L)
1	7400	(L)
2	7404	(L)
1	7405	(L)
4	7474	(L)
1	74121	(L)

Fastening Hardware

24	2-56 hex nuts	(K)
4	4-40 \times $\frac{1}{2}$ screws	(2L, 2C)
1	4-40 \times $\frac{3}{8}$ screw	(L)
1	4-40 hex nut	(L)
5	4-40 lockwashers	(L)
2	4-40 \times $\frac{1}{2}$ standoffs	(L)
3	6-32 \times $\frac{1}{2}$ screws	(C)
3	6-32 \times $\frac{3}{8}$ screw	(SPKR)
1	6-32 \times $\frac{1}{2}$ screw	(C)
8	6-32 hex nuts	(C)
4	6-32 lockwashers	(C)
4	6-32 flat washers	(C)
3	6-32 large flat washers	(SPKR)
6	No. 6 sheet-metal screws	(C)
8	8-32 hex nuts	(C)
8	$\frac{3}{8}$ " lockwashers	(C)
8	No. 8 flat washers	(C)

Miscellaneous

1	Logic circuit board	(L)
1	Keypress circuit board	(K)
3	5-unit keyswitch modules	(K)
9	4-unit keyswitch modules	(K)
1	Set of keytops	(K)
7	CF102-06 toroid cores	(K)
1	Thermalloy 6107 heatsink	(L)
1	Cabinet top section	(C)
1	Cabinet bottom cover	(C)
1	Line cord	(C)
1	Strain relief bushing	(C)
1	6-lug terminal strip	(C)
1	P6375 transformer	(C)
1	Fuseholder	(C)
1	0.1 amp time-delay fuse	(C)
1	Pilot lamp assembly	(C)
4	Rubber feet	(C)
1	Speaker	(C)
4	Knobs	(C)
1	Hole plug, $\frac{1}{2}$ "	(C)
4	Phone jacks	(C)
2	Sets of keytop labels	(C)