# Mello-Phone: The Super Musical Telephone Ringer

## *Build-it-yourself project substitutes up to 200 selectable musical tunes of extended length for a standard telephone ringer*

**By Steve Lympany**

It occurred to me one day, while calming my nerves following a startling blast from my phone's bell ringer, that there must be a pleasant yet effective way of signalling an incoming telephone call. Electronic music being one of my hobbies, I decided what I wanted was a telephone ringer that plays music, and thus was born the "Mello-Phone."

While there are commercial products that substitute an electronic music box for the normal telephone ringer, these are generally limited to just a few notes from a fixed set of tunes chosen by the manufacturer. I wanted to select the tunes to suit my personal tastes and be able to listen to more than seven or eight notes for each tune, as with the Mello-Phone. The Mello-Phone can play up to 200 different selections of varying lengths of up to 252 notes and rests. I use selections such as college fight songs, seasonal tunes, and a few Mozart and Beethoven pieces. The choices, of course, are unlimited.

The Mello-Phone installs between your telephone set and your telephone wall outlet using standard RJ11C telephone connectors. It requires external power from a commonly available 9-volt dc adapter. It won't interfere with normal telephone operation, and it can be used with rotary or Touch-Tone™ dialers. When someone calls, the Mello-Phone automatically disables the bell in your telephone and replaces it with a musical tune that plays repeatedly until you answer the phone or the caller terminates the call. In the latter case, the Mello-Phone will play the current tune through to completion and then stop automatically.

## *Circuit Description*

As shown in Fig. 1, the Mello-Phone uses only four ICs. Here, *U1* and *U2* are opto-isolators, *U3* is the music synthesizer and *U4* is an EPROM for storing the music. The music synthesizer is a General Instruments AY-3-1350 microprocessor.

Operation of the Mello-Phone is as follows. Firstly, P1 plugs into the telephone outlet and your telephone plugs into *J1*. Now, when a 20-Hz ring signal of 40 to 150 volts is present at the tip and ring leads (green and red leads of *P1*), current flows through *R17, C6, D6* through *D9, D1* and opto-isolator *U2*. The current through pins 1 and 2 of *U2* causes pin 5 to go low to signal a start-tune request from the synthesizer via *Q2*.

Diodes *D2* through *D5* form a

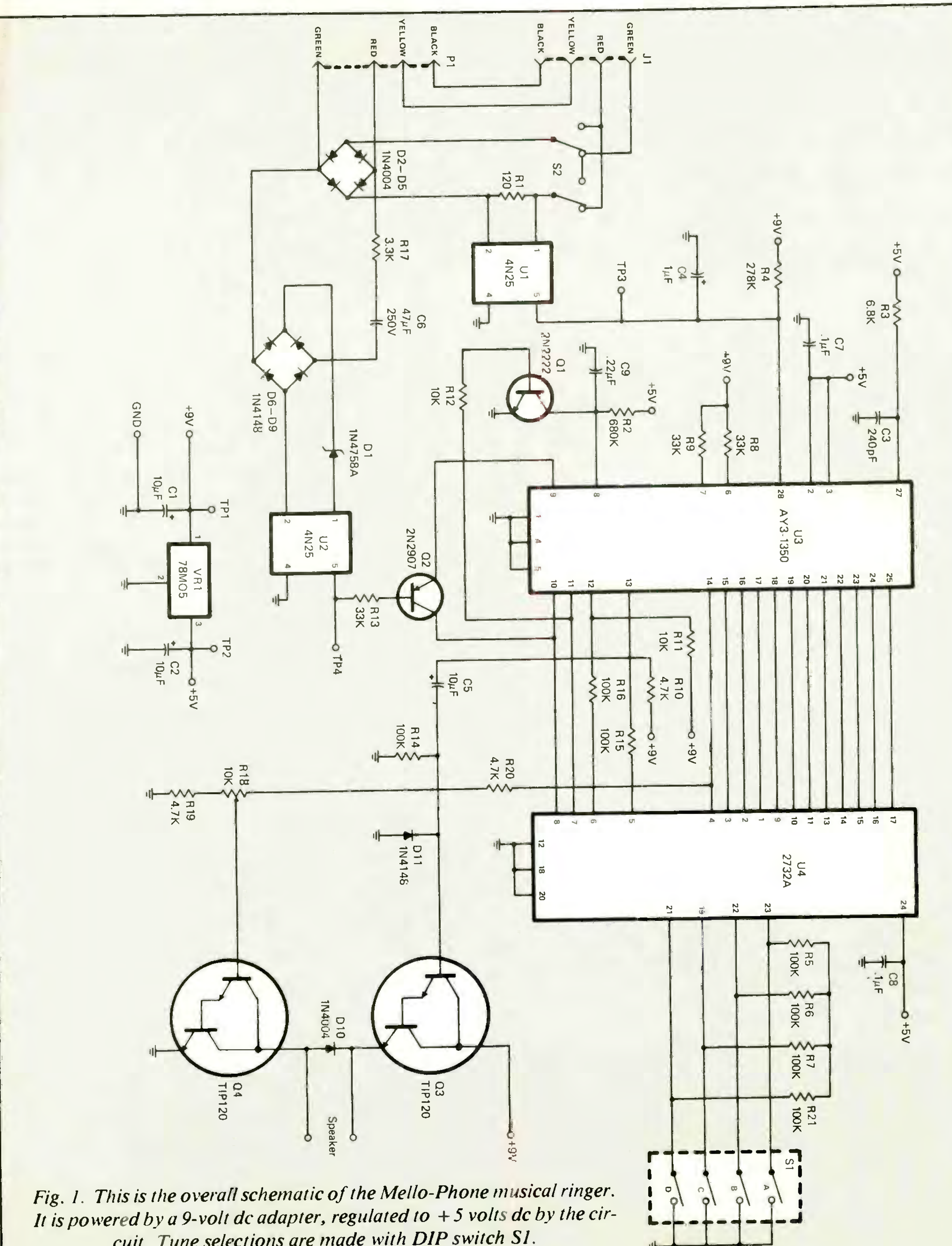


*Fig. 1. This is the overall schematic of the Mello-Phone musical ringer. It is powered by a 9-volt dc adapter, regulated to +5 volts dc by the circuit. Tune selections are made with DIP switch S1.*

*"Plays tune until phone is answered or song over."*

**PARTS LIST**

**Semiconductors**
D1—1N4758A zener diode
D2 thru D5,D10—1N4004 rectifier diode
D6 thru D9,D11—1N4148 diode
Q1—2N2222A npn transistor
Q2—2N2907A pnp transistor
Q3,Q4—TIP120 Darlington transistor
U1,U2—4N25 opto-isolator
U3—AY-3-1350 music synthesizer (General Instruments)
U4—2732A EPROM (programmed; see Notes below)
**Capacitors**
C1,C2,C5—10-μF, 25-volt electrolytic
C3—240-pF disc
C4—1-μF electrolytic
C6—0.47-μF, 250-volt metallized Mylar
C7,C8—0.1-μF disc
C9—0.22-μF disc
**Resistors** (¼-watt, 10%)
R1—120 ohms
R2—680,000 ohms
R3—6800 ohms
R4—270,000 ohms
R5,R6,R7,R14,R15,R16,R21—100,000 ohms
R8,R9,R13—33,000 ohms
R10,R19,R20—4700 ohms
R11,R12—10,000 ohms
R17—3300 ohms
R18—10,000-ohm upright pc-mount trimmer potentiometer

**Miscellaneous**
J1—RJ11 (6-position) telephone jack
P1—Telephone line cord
S1—4-position DIP switch
S2—Dpdt slide switch
SPKR—Miniature (2″) 8-ohm speaker
Printed-circuit board; 9-volt dc, 150- to 200-mA adapter; IC sockets; suitable enclosure; spacers; hookup wire; solder; etc.

**Note:** The following are available from Steve Lympany, Clavier Electronics, Inc., P.O. Box 51281, Raleigh, NC 27609: etched and drilled pc board for $6.95; AY-3-1350 for $5.50; preprogrammed 2732A EPROM for $7.50; RJ11 (6-position) telephone jack for $2.25; 4N25 opto-isolator for $1.50 each; complete kit of parts, including speaker, 9-volt adapter and enclosure, for $43.00. Include $1.00 P&H.

bridge circuit that allows only a dc signal to flow through the telephone during incoming ringing. This effectively disables the normal bell or chirp ringer in your telephone, since they require ac to operate. Zener diode *D1* prevents stray current surges, such as those that result from other pulse-dialing telephones on your line, from triggering a tune.

Mello-Phone will play the selected tune until the telephone is answered or until the song is over. While the song is playing, subsequent ringing bursts will not reset the tune. When the tune ends, the next ring burst will restart it, beginning a new cycle.

When the telephone is answered, dc flows through bridge circuit *D2* through *D5, U1,* and out to the telephone via the red and green leads of *J1*. The current through pins 1 and 2 of *U1* pulls pin 5 low, resetting the synthesizer and stopping the tune. Answering the phone resets the processor so that the next time a ring signal comes in, the tune will start at the beginning. Resistor *R1* prevents the ring signal and other minor surges from triggering the off-hook circuit.

In the audio section of the Mello-Phone, envelope control is accomplished with *U3* pin 13. When no tune is playing, pin 13 remains low, keeping *C5* discharged. This allows *R19* to pull the base of *Q3* low, keeping it off. When a note is being played, the note frequency appears at *U3* pin 14. Pin 13 goes to a high-impedance state and allows *R10* to charge *C5* to 9 volts dc. This turns on *Q3* and places 9 volts dc on the emitter of *Q3*. Pin 14 toggles *Q4* to produce the desired pitch at the speaker. At the end of the note duration, pin 14 continues to toggle at the previous note frequency. However, pin 13 goes low, allowing *C5* to discharge through *R19*. This results in a decaying sound upon turn off of each note. If desired, you can replace *R19* with a 100,000-ohm potentiometer to permit adjusting for various decay envelopes.

Other than the address and data lines between the synthesizer and EPROM *U4*, the rest of the Mello-Phone circuitry involves adjustments and song selection switching.

Speaker volume is adjusted by *R21*, which varies the drive level to *Q4*. Tempo resistor *R2* sets the speed at which the synthesizer steps through the notes. If you prefer to be able to vary the tempo, you can replace *R2* with a 1.2-megohm potentiometer. The indicated fixed 680,000-ohm resistor provides a quarter note duration of approximately 250 milliseconds. Absolute pitch of the notes can be adjusted by varying the oscillator frequency at pin 27 by changing the value of *R3*. If you wish, you can replace *R3* with a 10,000-ohm potentiometer. (The fixed 5699-ohm resistor results in a middle C frequency of about 185 Hz, which is low by about six semitones.)

Switches *S1A* through *S1D* are used to select which of the 16 tunes is to be played. These switches set the status of the upper four address bits of the *U4* EPROM. Thus, the switches can select one of 16 "pages" of memory in *U4*, each page containing 256 bytes. (Up to 25 selections can be programmed per page, but more complicated circuitry involving sharing the synthesizer address bus for tune selection is required. There are also 28 tunes programmed into the synthesizer that can be accessed. Interested readers can contact me, per the address in the Parts List, or refer to the General Instruments data sheets for information on these features).

As designed, the Mello-Phone dedicates one page of memory per tune. This simplifies the tune-selection circuitry and permits longer tunes, containing up to 252 notes and rests, to be played. A 2716 EPROM can be substituted as long as *S1D* is set to OFF at all times. Thus, eight tunes can be selected using switches *S1A, S1B* and *S1C*.

Power for the circuit is derived from the ac line via a 9-volt adapter feeding *VR1, C1* and *C2*. The incoming 9 volts is regulated down to the 5-volt dc level required by the remainder of the circuitry. A standard 9-volt, 150- to 200-mA adapter is sufficient for powering the Mello-Phone. Maximum power consumption of about 1 watt occurs when the phone is ringing and speaker volume is turned up to maximum.

## *Programming the Synthesizer*

During this discussion, memory locations and data will be referenced in octal, with hexadecimal notation in parentheses. The music to be played by the AY-3-1350 is stored in 2732A EPROM memory in the form of 8-bit data bytes. Each memory byte describes the pitch and the duration of the note being played.

The lower three bits specify note duration, the upper five bits the pitch. This permits 32 different pitches and eight different duration values to be specified. One pitch code is allocated as "silent" to allow musical rests of differing lengths to be implemented. Table 1 gives duration data, while Table 2 gives the pitch data for use in programming.

When programming the EPROM, a few rules must be observed. In each page of memory, EPROM address 000 (00) must contain data 377 (FF). EPROM address 377 (FF) in each page must contain data 125 (55), which is a key to open the external EPROM. Following the tune data, the last two bytes should be 377 (FF) and 376 (FE), indicating the tune end marker and end of listing marker. Fig. 2 is a diagram of EPROM memory allocation per page.

The first part of the "Star Spangled Banner" is shown in Fig. 3 as an example of encoding. Below the notes are shown the octal and hex codes to use.

If you don't have access to an EPROM programmer, you can obtain a preprogrammed EPROM containing 16 tunes ("Camptown Races," Beethoven's Ninth Symphony," "My Darlin' Clementine," "O Come All Ye Faithful," Brahm's Hungarian Dance No. 5, to name just a few) from the source given in the Parts List. Other tunes can easily be programmed from the sheet music; contact the author for details.

**Table 1. Note Duration Table**

| NAME | MUSICAL NOTATION | OCTAL | BINARY |
|---|---|---|---|
| Semiquaver | 𝅘𝅥𝅯 | 0 | 000 |
| Quaver | 𝅘𝅥𝅮 | 1 | 001 |
| Dotted Quaver | 𝅘𝅥𝅮. | 2 | 010 |
| Crochet | ♩ | 3 | 011 |
| Dotted Crochet | ♩. | 4 | 100 |
| Minim | 𝅗𝅥 | 5 | 101 |
| Dotted Minim | 𝅗𝅥. | 6 | 110 |
| Semibreve | 𝅝 | 7 | 111 |

**Table 2. Note Pitch Table**

| NAME | FREQUENCY (Hz) | OCTAL | BINARY |
|---|---|---|---|
| F | 175 | 00 | 00000 |
| F# | 185 | 01 | 00001 |
| G | 196 | 02 | 00010 |
| G# | 208 | 03 | 00011 |
| A | 220 | 04 | 00100 |
| A# | 233 | 05 | 00101 |
| B | 247 | 06 | 00110 |
| C (middle C) | 262 | 07 | 00111 |
| C# | 277 | 10 | 01000 |
| D | 294 | 11 | 01001 |
| D# | 311 | 12 | 01010 |
| E | 330 | 13 | 01011 |
| F | 349 | 14 | 01100 |
| F# | 370 | 15 | 01101 |
| G | 392 | 16 | 01110 |
| G# | 415 | 17 | 01111 |
| A (international A) | 440 | 20 | 10000 |
| A# | 466 | 21 | 10001 |
| B | 494 | 22 | 10010 |
| C | 523 | 23 | 10011 |
| C# | 554 | 24 | 10100 |
| D | 587 | 25 | 10101 |
| D# | 622 | 26 | 10110 |
| E | 659 | 27 | 10111 |
| F | 698 | 30 | 11000 |
| F# | 740 | 31 | 11001 |
| G | 784 | 32 | 11010 |
| G# | 831 | 33 | 11011 |
| A | 880 | 34 | 11100 |
| A# | 932 | 35 | 11101 |
| B | 988 | 36 | 11110 |
| Rest | Silent | 37 | 11111 |

## *Construction*

This is a relatively simple project to build. You can use just about any wiring technique to assemble the circuit. Of course, the printed-circuit-board technique is the simplest, since it offers a neat, logical component arrangement with a minimum of actual hand wiring and minimizes the possibility of making wiring errors.

You can fabricate your own pc board, using the actual-size etching-and-drilling guide shown, or purchase a ready-to-use pc board from the source given in the Parts List. In either case, use the components-placement diagram in Fig. 4 to guide you in component installation. When mounting components on the board, make sure you properly orient the diodes and electrolytic capacitors be-

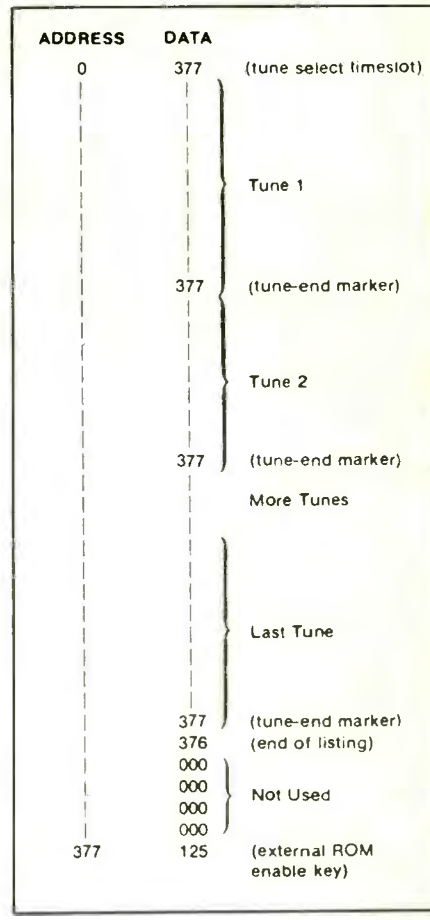


*Fig. 2. EPROM allocation map per memory page, data column in octal.*

*(Continued on page 88)*


*Fig. 3. Opening bar music for the "Star Spangled Banner".*

fore soldering them into place, and don't forget the wire jumpers at locations W1 and W2. Use sockets for all ICs, but don't install the ICs in their sockets until you've performed the initial checkout procedure.

Should you choose to mount the TIP120 transistors on heat sinks, be sure to electrically isolate them from the sinks. That is, place a mica insulator, liberally coated on both sides with silicone heat-transfer paste, between transistor and heat sink.

## *Checkout*

Connect the negative test lead of a dc voltmeter set to the 10-volt range to ground test point TP5 in the Mello-Phone circuit (use this test point as the ground, or common, reference for all voltage checks). With the ICs still not installed in their sockets, apply power to the circuit via the 9-volt adapter. Touching the positive test probe of the meter to TP1 should yield a reading of +9 volts, and touching it to TP2 should yield a reading of +5 volts.

If you don't obtain a proper reading, check to make sure that the 9-volt adapter is indeed delivering 9 volts dc when not connected to the Mello-Phone. If it is, check the wiring of *VR1* to make sure you haven't reversed the lead order during installation. Correct any wiring error and/or replace any defective components before proceeding.

Once you obtain the proper readings at TP1 and TP2, disconnect power from the Mello-Phone and install the ICs in their respective sockets, making absolutely certain to properly index them. Also, since synthesizer *U3* and EPROM *U4* are sensitive to damage from static electricity, use safe handling procedures during installation.

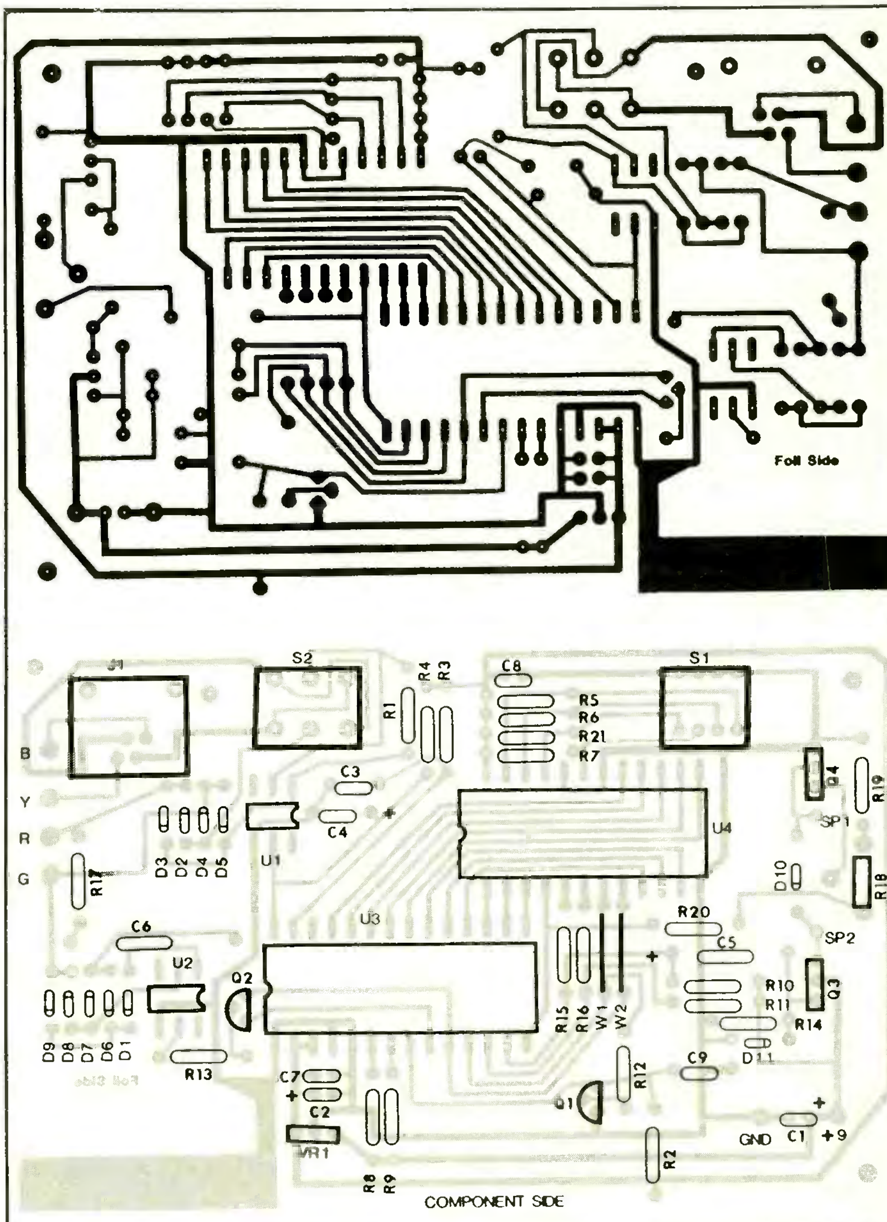


*Fig. 4. Shown at the top is the actual-size etching-and-drilling guide to use if you fabricate your own printed-circuit board. Underneath is the components-placement/orientation diagram to use when wiring the circuit board.*

Power up the Mello-Phone once again and momentarily short TP4 to ground to cause a tune to start playing through the speaker. After a few notes have sounded, momentarily short TP3 to ground to stop the tune.

If you obtain these results, the Mello-Phone is ready to be installed. Just plug your telephone into the jack on the pc board and plug the cord from the Mello-Phone into your telephone wall receptacle. (Note: FCC Rules prohibit the use of this type of ringer with party lines and coin-operated telephones.)

One last test is required if you have

Touch-Tone service. The tone dialer in a Touch-Tone set is powered by dc, which must flow in the proper direction for correct dialer operation. To test this operation, install the Mello-Phone, lift your telephone handset and dial out. If you find that you can't dial out, the bridge circuit in the Mello-Phone has reversed the voltage polarity required by your telephone. To correct this, set *S2* to its alternate position.

## *In Conclusion*

Some final notes concerning operation of the Mello-Phone. Firstly, a test feature is built in. With the Mello-Phone powered up and plugged into the telephone line, lifting and replacing the handset results in a "beep" from the phone ringer, indicating that it is functional and ready for an incoming call. Secondly, when you change tune selection with *S1*, be sure to perform this test routine to reset the memory pointer. If you don't, the first ring burst will result in some random sounds or a partial tune. This condition is only temporary, however, and will correct itself if you forget to run the test routine. Lastly, you might want to house the circuit in a metal or plastic enclosure that can be mounted on a wall or be placed near your telephone. **ME**