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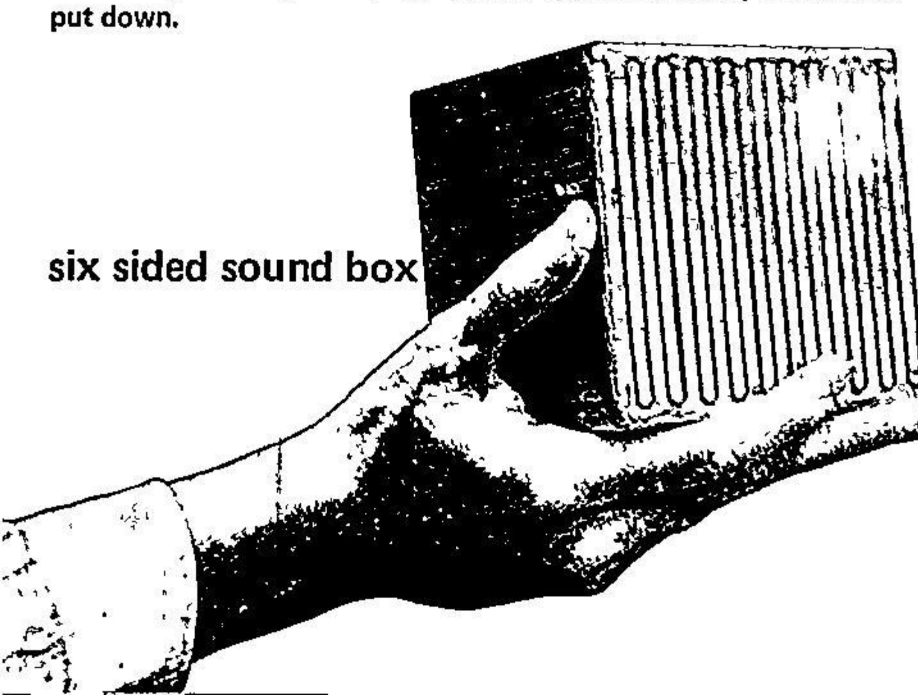
cubular bell

Cubes are attractive to the human mind, a fact well proved by the pyramids and the popularity of Rubiks cube. The cube described here contains an electronic 'bell' with a tone that is dependant on how the cube is picked up. Each face of the cube has a touch switch on its surface and contact with one or more of these will cause the cube to produce a sound. However, the sound will vary depending on how many and which of the faces are touched. The Cubular Bell is quite fascinating to all ages and, once picked up, becomes very difficult to put down.

six sided sound box



To answer the first question, what have the pyramids got to do with cubes? It came to pass that El Pharina, a well known tomb designer of that era, was attempting to revolutionise the current tomb designs of the period for a wealthy and influential customer. On the way to the office one morning he happened to stub his toe on a gold inlayed ebony block that was used to keep his garage door open (hence the origin of base-over-apex doors, better known lately as up-and-over). He thus hit upon the idea of using a cube as the basis for his next tomb. It was duly constructed in the grand manner. However, the foundations were contracted to an outside construction company and this is where the troubles began. The dead weight of the gigantic tomb cube was far greater than the foundations could stand and the tomb toppled over at an angle of 45°. Pharina sued of course, putting the mining company out of business. The disaster became known locally as Pharina's yonder ruination of Achmed Mining in the desert, or 'pyramid' for short. All was not lost however, since all the other tomb designers adopted the resultant shape as the state of the art thus creating numerous legends and tall stories, of which, this is one!

History will probably show that Rubik has done more for todays cube than all the other ancients put together and it is entirely possible that our Cubular Bell will not reach the same degree of fame. However, it is musical and therefore not really in the same class. That is not to say that it is a musical instrument, more a musical game. In effect, the cube will produce a tone whenever a side is touched. Each side has its own individual tone but this will be changed if two or more sides are touched at the same time, when picking it up for instance. Replacing the cube on the table will immediately silence it.

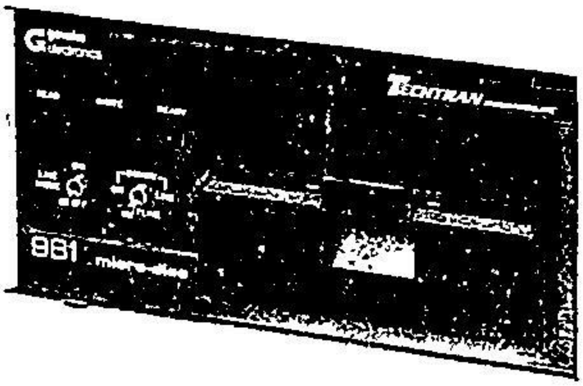
This could all work out to be a very complex circuit but a glance at the circuit diagram will show this not to be the case. It will be obvious that the heart of the circuit must be an oscillator and this is formed by the two inverters N7 and N8. The timing components of the oscillator are capacitor C1 and the resistor chain consisting of R7 to R13. Six electronic switches (ES1 to ES6) placed across the resistors are controlled from a touch plate in each face of the cube. If touch switch S1 is bridged by a finger then ES1 will be activated effectively taking R8 out of circuit. The frequency of the oscillator is determined by the total value of the resistors that are in circuit. Which face operates which electronic switch is left up to the constructor, some combinations may be better than others

The output of the oscillator is fed via a buffer, N9, to our 'audio stage', transistor T1 and the speaker. The type of speaker used is not critical providing it is 8 Ω. The available space will probably be the determining factor!

The one essential point of the cube is that all the faces appear to be identical in order that its orientation remains a mystery. This causes a major problem when a on/off switch is to be fitted. To overcome this we have included an electronic power switch consisting of gates N10 and N11 together with ES7. Briefly, if no touch switch (S1 to S6) is bridged the electronic switch ES7 becomes open circuit thus switching off the oscillator The use of CMOS ICs ensure that power consumption is kept to a very low level therefore the 9 volt battery should last for quite a time.

Construction

Manufacturing a cube is on a par with making four chair legs independantly — only three legs will ever touch the ground at any one time. Murphy's Law definitely states that the final face of a cube will not fit its alloted space when completing the cube and you can bet your reel of solder on that! For this reason another source of cubes would be a major advantage. Toy shops for the young are a cubic paradise and should provide one or two ideas. Another cube to check out are the 'picture cubes' from that well-



- During transmission of a logic one, no data pulse appears at the 'W' output of the data selector (IC4).
- During transmission of a logic zero, one data pulse appears between two clock pulses at the 'W' output of the data selector (IC4).
- Each clock or data pulse has a length of only 500 nanoseconds.

The signal at the 'W' output of the data selector forms the coded FM signal which is transmitted via buffer N21 to the floppy disk drive. The WRITE DATA diagram for the write encoder is shown in figure 10.

To be able to read back the data from the diskette, the clock and data pulses must be separated again. After separation, the clock pulses are utilized to shift the serial data pulses into the ACIA at a rate of 125 kilobaud. The separating of clock and data pulses is performed by a data separator consisting of N13, N14 . . . N17, MF1, MF2 and FF2.

Incoming data from the floppy disk drive are inverted by N13. The NAND port N16 is enabled by NAND N17, so that the first clock pulse can trigger both monostables MF1 and MF2. MF1 triggers on the negative edge of the clock pulse whilst MF2 triggers on the positive edge. The Q-output of MF2 should be at logic zero for about 5.5 microseconds, so that N14 is enabled and N16 is disabled. As soon as a data pulse is present between two clock pulses, flip-flop FF2 is set via N14.

The Q-output of monostable MF1 emits a clock pulse of about 1 microsecond to the CRx input of the ACIA. The leading edge of the clock pulse transfers the data bit currently being transmitted to the serial input register of the ACIA. The data bits come from the Q-output of flip-flop FF2. A data pulse on the preset input sets flip-flop FF2. The Q-output then goes to logic zero. The subsequent clock pulse transfers this zero into the ACIA. When MF1 toggles back to the stable state, it clears flip-flop FF2 via the clock input. Figure 11 shows the timing diagram of the READ DATA separator in detail.

Construction and alignment

Construction and alignment of the floppy disk interface are quite simple. All wire links should first be connected on the printed circuit board (figure 12). Since some tracks are very close to each other, soldering requires great care.

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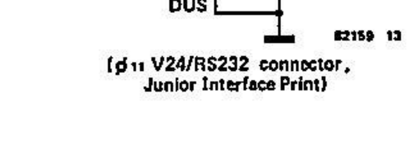

Figure 13. When connecting an EPSON printer with a serial interface, a V24/RS232-to-TTL level converter is required. This little circuit can be wired on the Junior interface PCB in self supporting fashion. PB5 of the 6532 on the basic PCB of the Junior Computer is used as the BUSY line for the printer.

The resistors, capacitors, diode D1 and the two connectors are then fitted to the board. Trimmer potentiometers P1 and P2 are rotated to their midpoints and soldered into the board. If new ICs are inserted, they can be soldered in directly without sockets. Good sockets should always be employed for the 6850 (IC11) and the 6821 (IC5).

The floppy disk interface should normally work immediately if the two trimmers are set to their midpoints. If, however, fine alignment is still required, the procedure is as follows:

1. Remove the plug from connector K2.
2. Jumper the WDA output to the RDA input on the soldering side of the board using a wire link.
3. Align output Q of monostable MF2 to 5.5 microseconds using an oscilloscope.
4. Monostable MF1 is non-critical and can be aligned to a time of about one microsecond. However, the ACIA and the PIA must then be initialized with a short program. We will go into this in more detail when we discuss the software for the floppy disk interface in the December issue.

EPSON interface

In the Elektor laboratory the Junior Computer operates with an EPSON printer and has therefore been equipped with an interface for the EPSON dot-matrix printer. The following is a description of the necessary interface, for those readers who employ one of these printers.

For connection to the Junior Computer, the EPSON requires a serial interface adapter and not the usual Centronics interface. The commercial price for the serial interface adapter for the EPSON is approximately 23 pounds. The baud rate must be set to 1200 baud by means of the digiswitch provided on the printed circuit board. The ELEKTERMINAL should also run at this rate. The EPSON is connected in parallel to the V24/RS232 output of the ELEKTERMINAL.

The EPSON uses the BUSY line to inform the computer whether data can be transmitted to the printer or not. Since cassette control is no longer necessary on the DOS computer, we have used PB5 of the 6532 on the basic PCB of the Junior Computer as the BUSY input. Relay Re2 on the Junior interface PCB can thus be discarded. The green LED (D5) can continue to be used as a transmit data indicator.

Since there is also a V24/RS232 signal level on the BUSY line, conversion to TTL level is required. Figure 13 shows a circuit which can be wired in self-supporting fashion on the component side of the Junior interface PCB.

If no EPSON printer is connected to the Junior, PB5 of the 6532 must be grounded otherwise the computer cannot transmit data. ◼

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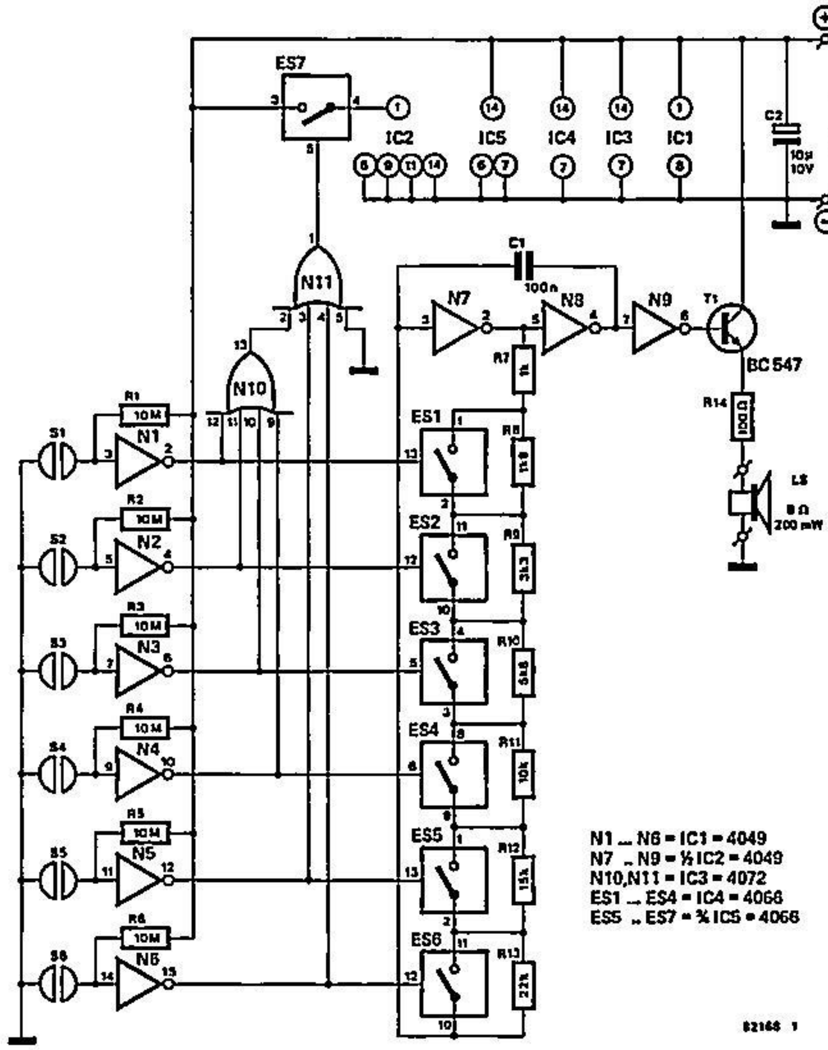

Figure 1. The circuit diagram of the Cubular Bell. The battery will last for quite a while since power consumption is very low. The touch switches can be etched on copper clad board.

known High Street store that don't, in fact, sell footwear. It is well worth shopping around for ideas before aquiring your cube because a good cube is an anonymous cube and very few fit into this category. Bear in mind that each face of the cube must contain a touch switch in one form or another. Figure 2 illustrates how this can be achieved by means of a printed circuit type of switch. If these can be made and fitted onto each face of your selected cube your problems are almost over.

The final problem is that of getting the circuit, the speaker and the battery inside the cube — we have to leave that one with you! Don't forget to make some holes in each face to let the sound out or you will have a mute cube on your hands.

Two points that may make for a more appealing cube. The sensitivity of the touch switches can be increased by raising the values of resistors R1 to R6 to about 22 MΩ. Finally, the tone range can be varied by changing the value of C1 to taste

Now, if you can get your cube to stand unsupported on one corner, just let us know how .... ⧓

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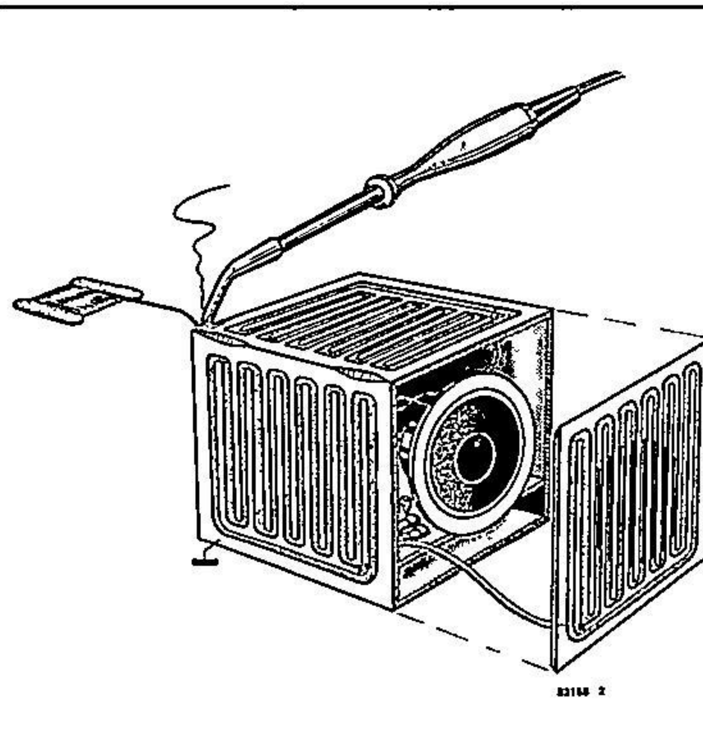

Figure 2. This illustrates one method of making your own cube if a ready made cube is not available. Care is needed if good results are to be achieved.