pocket bagatelle

An electronic version of the age-old dexterity game.

Many traditional games, which have been passed on unchanged from generation to generation, can now be simulated electronically (see, e.g. 'Marbles' in Elektor 21, January 77). In particular, 'video' games, which utilise the screen of a TV set to represent the field of play, have achieved enormous popularity in recent years, and with the advent of more and more complex 'games chips', this trend shows little sign of slowing down. However there are still many electronic versions of popular games which can be played without recourse to a TV set. One of the more simple (but not necessarily easy!) games, which is ideally suited as a small Christmas present, is 'bagatelle'.

There are several variations of the game 'bagatelle'; the one described here belongs to the species of manual dexterity games which are designed to test a steady hand, strong nerves and infinite patience. The original and simplest version of the game consists of a round flat container with a transparent top, inside which a small ball rolls around.

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The object of the game is to manoeuvre the ball into a shallow hole set into the bottom of the container. However, since the ball is very small and light, and both it and the surface over which it rolls are extremely smooth and have a very low coefficient of friction, it is extraordinarily difficult to control the direction in which the ball will move, or indeed to hold it steady at any one point. Furthermore, the hole itself is quite shallow, and very little is needed to make the ball jump back out.

This fact is particularly annoying if one has a more complicated version of the game with two or more balls to be manoeuvred into two or more holes. It is quite amazing how many times one can manipulate one ball into its hole and be just on the point of succeeding with the second, when the first ball suddenly pops back out. Grown men have been seen to weep with frustration! With Christmas not too far away, the following circuit for an electronic version of this tantalising game may help to solve that perennial problem of choosing presents — especially as far as younger relatives are concerned.

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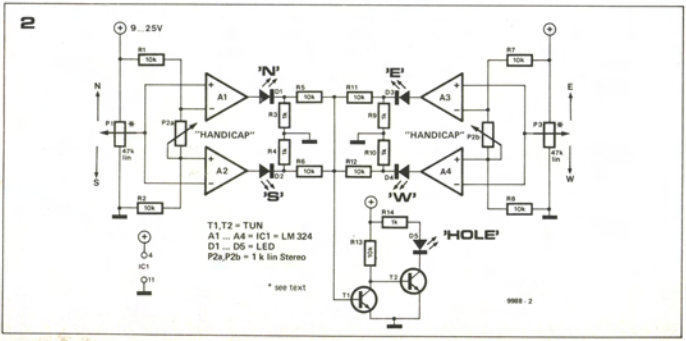


The game is played as follows: a single 'ball', whose position is indicated by four LEDs, has to be manoeuvred into a central 'hole' represented by a LED of a different colour. The arrangement of the LEDs is shown in figure 1. The 'ball', which in fact does not physically exist, can be 'rolled' in two directions: north-south and east-west. The four LEDs, one at each of the compass points, indicate whether the ball is to the north, south, east or west of the 'hole'. The position of the ball is controlled by two potentiometers, one for each direction. When the ball has been successfully manoeuvred into the 'hole', the central LED lights up and the other four LEDs are all extinguished. The degree of difficulty of the game, as it were the 'size of the hole', can be varied by means of a third, 'handicap' potentiometer.

Figure 1. The board of the 'pocket bagatelle' contains five LEDs. The middle (green) LED lights up when the player succeeds in rolling the ball into the hole. The other four (red) LEDs indicate the position of the ball relative to the hole.

Figure 2. The complete circuit diagram of the pocket bagatelle, which is based on two window comparators.

Figure 3. The basic circuit of a window comparator.

Figure 4. This figure shows how the two output voltages of the comparators, u_1 and u_2, vary with the input voltage, u_i.

The circuit

The electronics of the game are revealed in the circuit diagram of figure 2. The circuit basically consists of the two window comparators formed by A1/A2 and A3/A4. To help explain how this type of circuit works, the basic circuit diagram of a window comparator is shown in figure 3. As can be seen, the circuit has a single input signal, u_i, and two output signals, u_1 and u_2. Op-amps A1 and A2 are connected as comparators, i.e. due to the absence of feedback, their outputs are always in one of two states: either high or low. When the voltage at the non-inverting (+) input of a comparator is greater than that at the inverting (–) input, the output voltage of the device swings up to + supply. However if the voltage on the inverting input is greater than that at the non-inverting input, then the output of the comparator swings down to – supply, in this case, to ground.

One of the inputs of each comparator shown in figure 3 is connected to a constant reference voltage. These reference voltages, U_a and U_b, are derived from an attenuator network, consisting of R1, R2 and P. Depending upon the value of the input voltage, u_i, one of three possible situations can occur:

a. U_i is greater than U_a, in which case u_1 will be high and u_2 low.
b. u_i is smaller than U_b, in which case u_2 will be high and u_1 low.
c. u_i lies between U_a and U_b, in which case both u_1 and u_2 will be low.

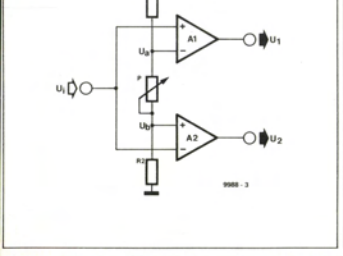
When this occurs, the input voltage, u_i, can be said to lie 'inside the window'. The height of the window can be varied by means of potentiometer P.

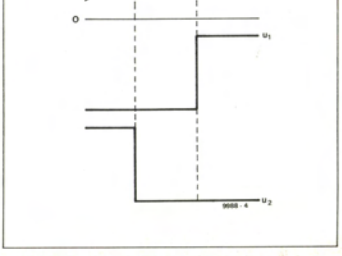
These three situations are illustrated by the diagram of figure 4, which shows how the outputs of the two op-amps react to a rising input voltage.

Two such window comparators are employed in the circuit of the pocket bagatelle. The input of each is derived via a potentiometer, these being P1 and P3 respectively. P1 controls the vertical position of the ball, whilst P3 varies the horizontal position. Each of the outputs of the two window comparators drives an LED; it is clear from figure 4 that each output voltage goes high when the input voltage of the window comparator lies on that 'side' of the window. With two window comparators, whose input voltages represent the horizontal *and* vertical position of the 'ball' (and whose windows intersect) it is obvious that the logic state of the comparator outputs, and hence the on/off state of the corresponding LEDs, tell us whether or not the 'ball' has 'rolled' to a given side of the 'hole'. If all four 'pointer' LEDs are extinguished, the centre LED will come on indicating that the player has succeeded and the ball has been manoeuvred into the hole.

The LEDs are driven directly by the outputs of the comparators; the current through the LEDs is limited by a series resistor. The voltage across this resistor is also used to turn on T1. This transistor will remain conducting as long as one of the LEDs D1 . . . D4 is lit. If all four LEDs are extinguished, however, T1 will turn off, causing T2 to turn on, and the green central LED, D5, to light up.

The dimensions of the window, and hence the difficulty level of the game, can be varied by means of stereo potentiometer P2ab.





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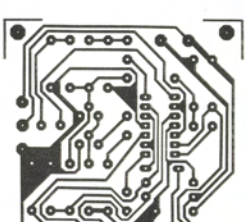

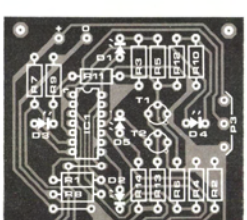

Parts list

Resistors:
R1,R2,R5 . . . R8,
R11, R12,R13 = 10 k
R3,R4,R9,R10,R14 = 1 k
P1,P3 = 47 k (50 k) lin
potentiometer
P2ab = 1 k lin
stereo potentiometer

Semiconductors:
IC1 = LM 324
T1,T2 = TUN
D1 . . . D4 = LED red
D5 = LED green

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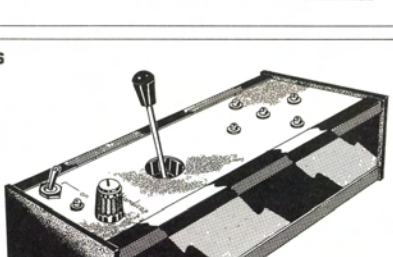

Construction

The circuit of the pocket bagatelle can be constructed on the printed circuit board shown in figure 5. The potentiometers are deliberately mounted 'off-board'. This keeps down the size and cost of the board and allows the constructor a free hand in the choice of controls and type of case. With games such as these, especially if they are intended as gifts, an attractive exterior is just as important as the electronics.

Although the physical construction of the game is, as already mentioned, left to the ingenuity of the individual, figure 6 provides an example of a possible approach. Regarding the controls, there is one point worth mentioning: one can, of course, use conventional rotary- or slider potentiometers for P1 and P3. However, if one is willing to go to the extra expense (or trouble of making it oneself), the enjoyment of the game can be considerably enhanced by using a joystick to replace these two potentiometers. Using a joystick prevents one from adjusting just one of the potentiometers to the correct position (until the corresponding LEDs are extinguished), and then homing in with the second potentiometer. Like it or not, both potentiometers are operated simultaneously in a joystick. What is more, as figure 6 shows, a more interesting case design also becomes possible.

A means of constructing a joystick from two conventional rotary potentiometers is discussed elsewhere in this issue. For those readers who do use potentiometers (whether in a home-made joystick or not), it should be noted that the values of P1 and P3 are anything but critical and if needed, could lie anywhere between 1 k and 1 M. It is also of little importance if P1 and P3 have different, even widely different values. ⋈

Figure 5. The printed circuit board for the pocket bagatelle. The potentiometers are deliberately not mounted on the board.

Figure 6. One of the many possible designs for housing the circuit of the pocket bagatelle in a suitable case. The playing possibilities and the physical construction of the bagatelle are improved by incorporating a joystick in place of the two control potentiometers P1 and P3.