PASS THE BOMB!

by Alan Davies

- * Make your party go with a BANG!
- * Explosive fun for young and old
- * Low cost novel construction

Are you bored with some of the traditional party games - 'musical chairs', 'pin the tail on the donkey', 'blind man's buff etc? Well, here's The Bomb which, while perhaps not quite as exciting as 'postman's knock', gives an electronic 'facelift' to that old party favourite 'pass the parcel'.

For those unfamiliar with this game, one version of it is as follows: those playing sit in a circle just far enough away from one another to be able to pass an object round the ring. This usually takes the form of a 'parcel'. The package is only passed round while some music is playing. When the music stops, the person holding the parcel has to drop out of the game or 'lose a life' (it may be agreed that when a small number of people are playing that each has say three 'lives'). As each person drops out, the circle of people closes in and the process of passing the parcel continues. The winner of the game is of course the person left in at the end of the game when everyone else has had to drop out.

This works well but does have some disadvantages: a piano or record player is required in the room to be able to play at all and of course someone must play the piano or switch the music on and off. This can also create problems if the provider of the music is accused of cheating by stopping the music when the parcel is with a particular person - strictly not in the party spirit!

But all of this is in the past! No more music needed, no more gamesmanship - enter The Bomb!

This is an entirely self-contained unit which consists of a loud alarm and a circuit for varying the time period between soundings. When The Bomb is primed by pressing the priming button the alarm ceases to sound and the game begins. The Bomb is passed around from player to player until it 'goes off (the alarm sounds)

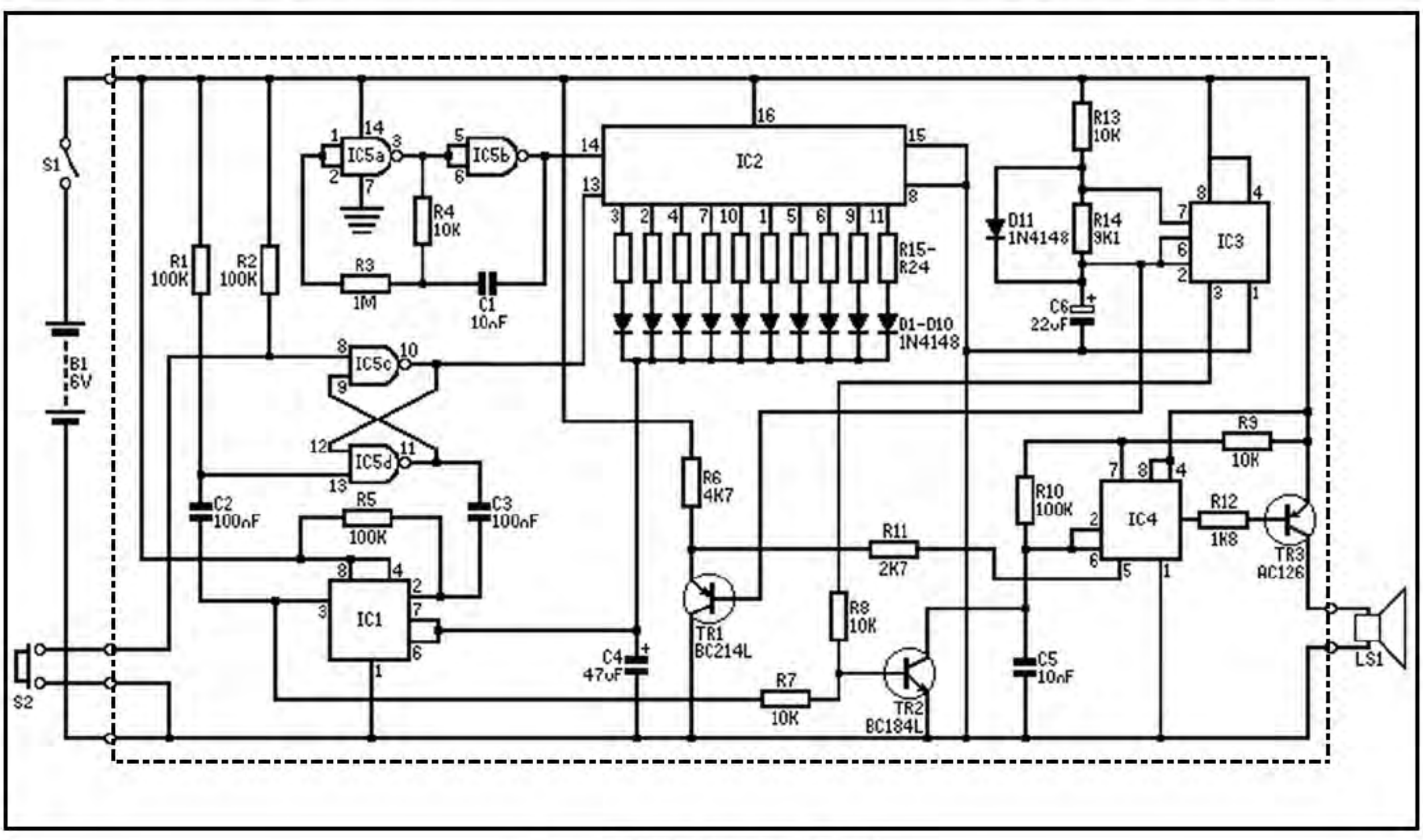


Figure 1. Circuit diagram of The Bomb.

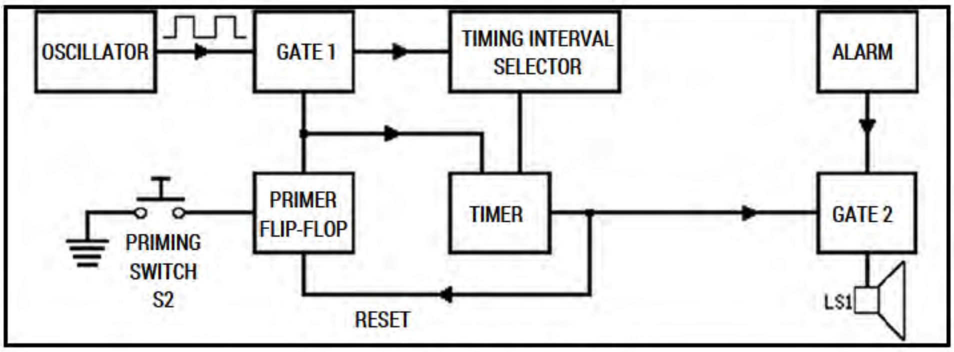


Figure 2. Block diagram of The Bomb.

in someone's hand. This person then has to drop out and the game continues until one player remains - the winner!

Principle of Operation

With reference to the block diagram, Figure 2, it will be seen that The Bomb consists of two main sections: timing and alarm.

During a timing period (when the alarm is off) the output from the timer switches gate two off preventing the alarm signal reaching the loudspeaker. As soon as the timing period is over, gate two is switched on and the alarm sounds. Whilst the alarm is sounding a clock waveform produced by the oscillator is allowed through to the timing interval selector via gate one. The timing interval selector consists of a ten-stage counter one of whose outputs is 'high' at any one time. As the priming button is pressed to initiate a new timing cycle, gate one is switched off and the timer itself is triggered and produces a timing period dependent upon which output of the timing interval counter was 'high' at the moment the priming button was depressed.

The oscillator clock rate is sufficiently fast (kHz) that it is impossible to predict where the counter in the timing interval selector will stop and hence which one often timing periods will have been selected when the priming button is pressed. The timing periods range from 3-25 seconds approximately.

Circuit

The Bomb circuit diagram is shown in Figure 1. The clock oscillator is formed using two of the NAND gates in IC5, a and b. These are wired as inverters and form an RC oscillator with R3, R4 and C1. Since R3 is much larger than R4 the approximate frequency of the oscillator is given by:

$$\frac{0.455}{R4 \times C1} \text{ i.e. } 10\ kHz$$

The square wave output from this oscillator is fed into the clock input (pin 14) of IC2 which is the ubiquitous 4017 - a 5-stage Johnson counter with ten decoded active 'high' outputs.

The remaining two NAND gates of IC5, c and d, are configured into an RS flip-flop (see Figure 5). When the priming button S2 is pressed a 'low' is produced on pin 8 of the IC. This causes pin 10 to go 'high' and pin 11 to go'low'. (Further depressions of S2 will have no further effect - this means that once The Bomb is primed no one can cheat by resetting it to the start of its timing cycle by pressing S2 as it is passed around). The 'high' produced on pin 10 stops the 4017 from counting as it is connected to the clock inhibit input of the IC (pin 13). In this way one of the 4017 outputs is selected to charge up C4 (a low leakage tantalum lead capacitor) via one of the resistors R15-R24. Diodes D1-D10 ensure that all the charging current goes into C4 and that some is not taken to ground via a parallel combination of the remaining nine unselected resistors. (Remember all but the selected output of the 4017 IC are at logic '0' which equals ground potential.)

This resistor-diode-capacitor network is connected to the timing pins of IC1 - another popular chip the 555 timer.

This IC is triggered by a falling edge waveform on pin 2 which is generated by the RS flip flop, R5 and C3. The resistor capacitor network ensures that a 'low-going' pulse is produced which resets 'high' (due to R5) despite the output of the flip flop remaining 'low'. If pin 2 of IC1 were continually 'low' then it would not function as desired.

The sequence of events thus far then is: IC2 counting and alarm sounding - S2 pressed - flip-flop activated - timer triggered - timing period selected (counter stops) - alarm stops.

Whilst IC1 is timing its output, pin 3 is 'high'. This is used to switch off the alarm circuit which comprises IC3 and IC4 (both 555 timers) with their associated components. The timing capacitor of IC4 (C5) is shorted to ground using TR2 as a switch (a 'high' on the base input = switch ON, low resistance; a 'low' on the base input = switch OFF, very high resistance).

When IC1 comes to the end of its period, pin 3 goes 'low' which resets the 'priming' flip-flop via C2 and R1, which generates a low going pulse on pin 13 of IC2.

The 'low' on IC1 pin 3 also switches TR2 off allowing the alarm to sound once more. Thus a complete cycle has been generated and The Bomb awaits re-priming via S2.

The alarm circuit itself comprises timer IC4 configured as an astable oscillator with a basic frequency:

1.46

f = (R9 + 2 R10) C5 700 Hz

This frequency is modulated via TR1 at pin 5 by a ramp waveform generated at pins 2 and 6 of IC3. The sound is further enhanced by switching it on and off using the square wave produced at pin 3 of IC3 to turn TR2 on and off. TR2 thus serves a dual purpose - that of totally switching the alarm off and that of modulating the sound the alarm produces.

Construction

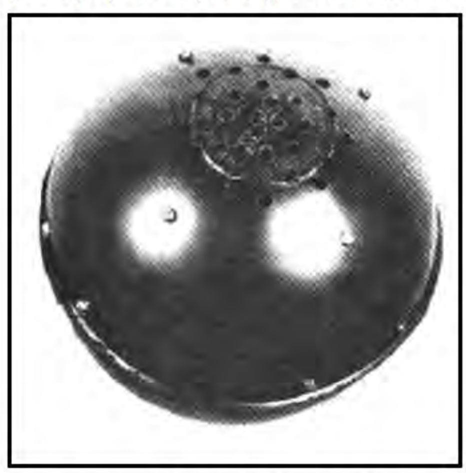
The printed circuit board with component overlay is shown in Figure 3. It is recommended that IC sockets be used at least for the CMOS chips IC2 and IC5 and if desired for the 555 timers.

Begin assembly by soldering the two wire links as shown and then insert the resistors followed by the capacitors. The diodes should be fitted next taking care to assemble them the correct way round as per the band on the casing. Now solder the transistors in place also taking care with their correct orientation. Next solder the battery connections ensuring that the polarity is correct. The two off board switches S1 and S2 and the loudspeaker may then be soldered allowing approximately 6 inch lengths of wire.

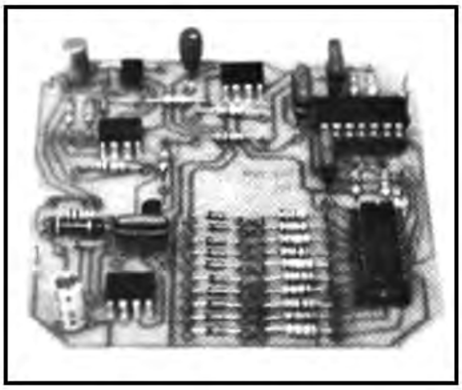
Before inserting the ICs into their holders connect the batteries up to the board and check that the correct power supply voltage is reaching the appropriate pins on each socket. Finally, disconnect the batteries and check for any solder bridges on the track side of the PCB. The ICs may now be inserted and the circuit tested.

Switch on and wait for the alarm to sound. Reset the circuit by depressing S2 and wait for the alarm to sound again. Do this a few times checking against your watch that a varying period of time elapses between S2 being pressed and the alarm sounding. If all is well you may then proceed to fit the unit into a case.

As may be noticed from the photographs the prototype was fitted into



Base view showing loudspeaker holes.



Assembled PCB of The Bomb.

a plastic lavatory cistern float which may be obtained from most ironmongers. A black one is ideal although another colour could be painted but is liable to scratching due to the excessive handling which the final device undergoes. Two basic types are available, the main difference being the position of the threaded section. This is either internal or external as shown in Figure 4, which also gives the internal layout of The Bomb. The construction is the same for both types except where stated.

If a float is used first cut the float in half along the 'equator' as shown in Figure 4 keeping the screw thread entry point as the 'North Pole'. This cutting operation can be difficult. The best method is to drill a few small diameter holes e.g. 1 mm close together along the seam and then enlarge these laterally into a slit into which a pad saw (keyhole saw) fitted with a fine toothed blade may be inserted. Proceed to saw carefully around the float.

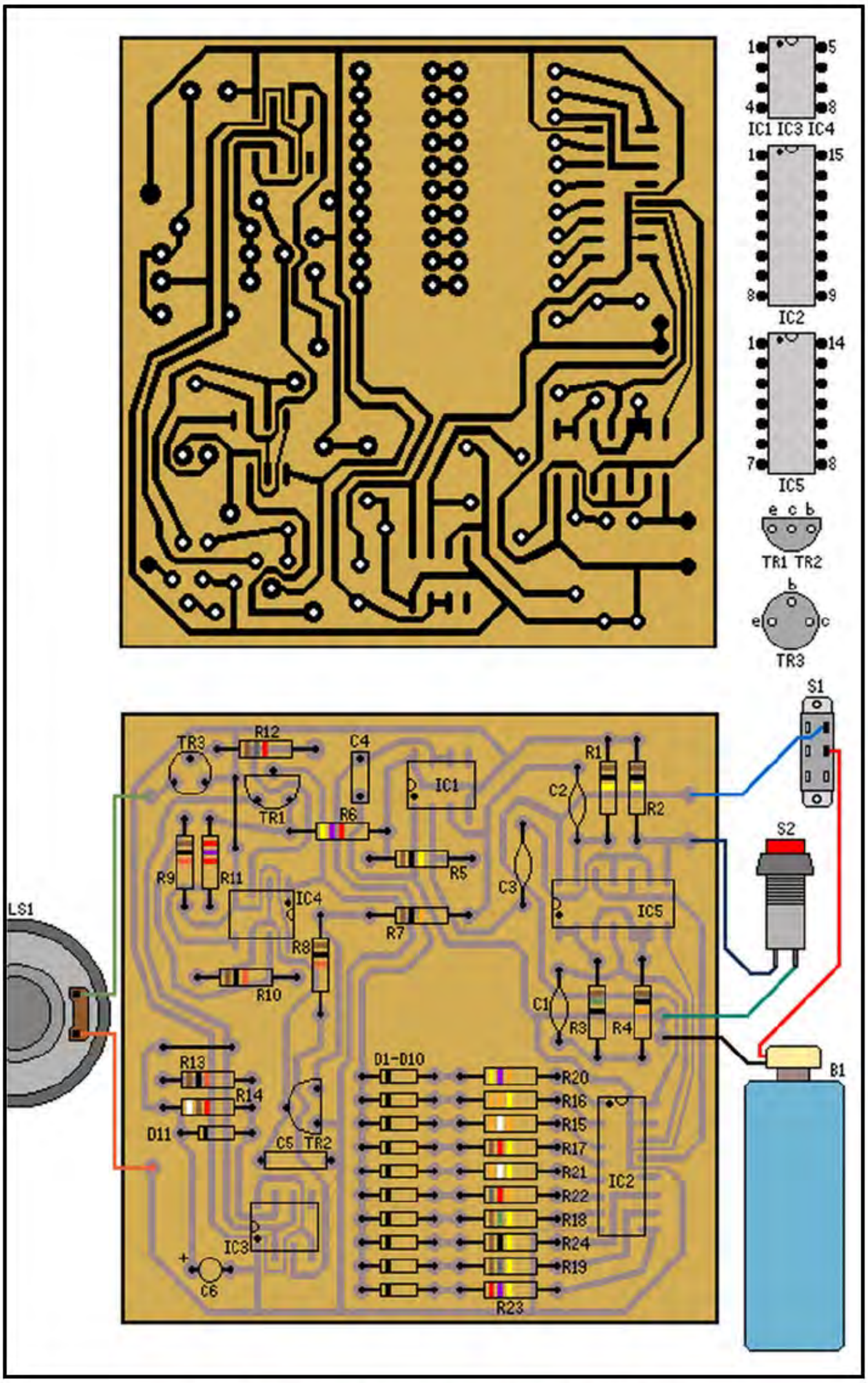


Figure 3. PCB track layout, component overlay and wiring.

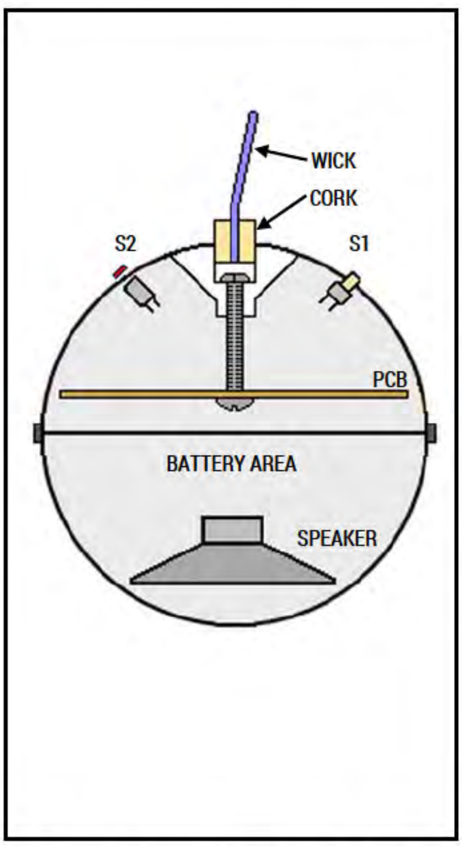


Figure 4. Internal layout of The Bomb.

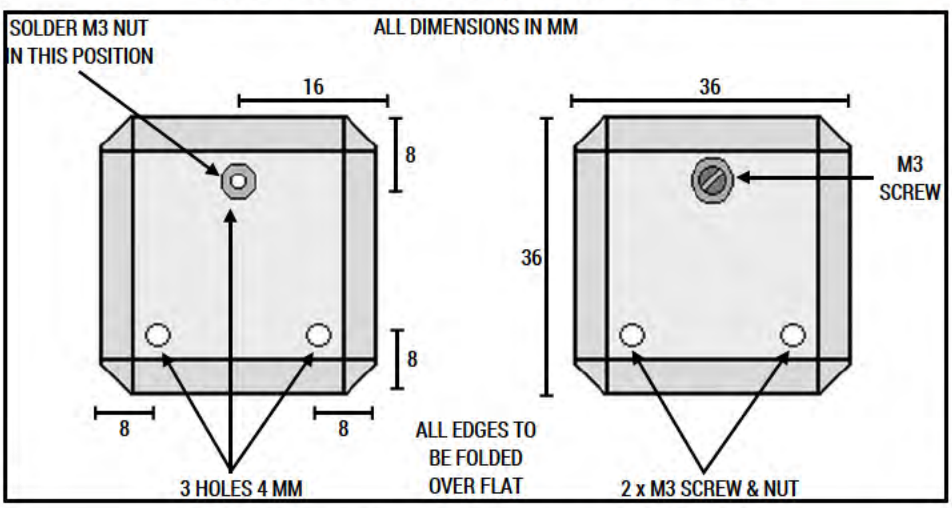
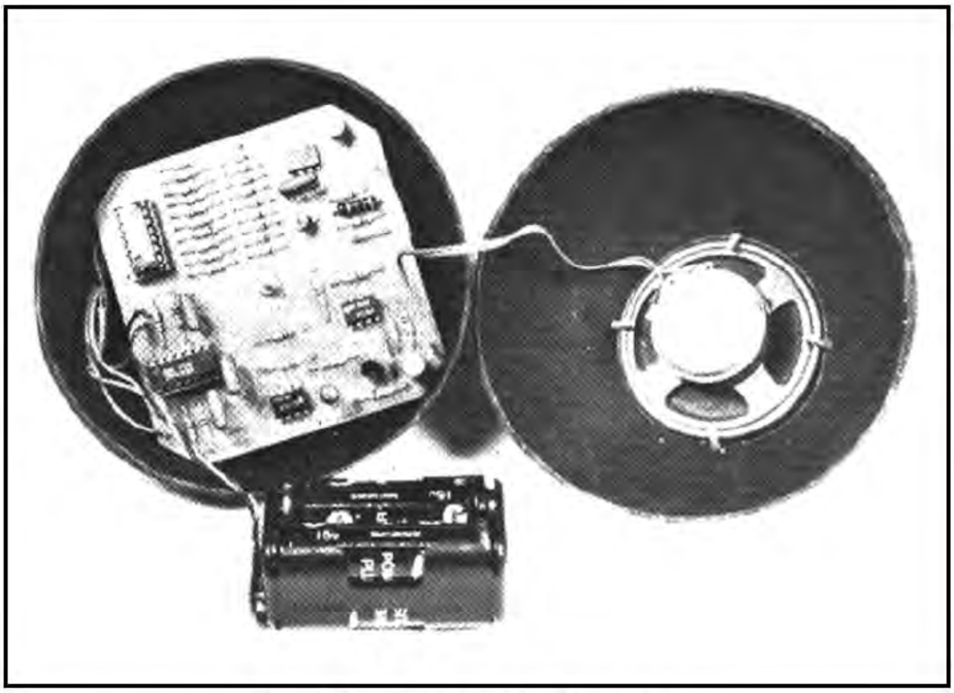


Figure 5. Mounting bracket template.



Internal view of upper and lower hemispheres.

PARTS LIST FOR THE BOMB

Resistors - all ¼ watt 5% carbon unless specified

R1, R2, R5, R24	100K	Brown Black Yellow (4 off)
R3	1M 10%	Brown Black Green
R4, R7, R8, R9		
R10, R13	10K	Brown Black Orange (6 off)
R6	4K7	Yellow Violet Red
R11	2K7	Red Violet Red
R12	1K8	Brown Grey Red
R14	9K1 ½ watt	White Brown Red
R15	39K	Orange White Orange
R16	330K	Orange Orange Yellow
R17	120K	Brown Red Yellow
R18	150K	Brown Green Yellow
R19	180K	Brown Grey Yellow
R20	47K	Yellow Violet Orange
R21	390K	Orange White Yellow
R22	82K	Grey Red Orange
R23	270K	Red Violet Yellow

Capacitors

C1, C5	10nF Polyester (2 Off)
C2, C3	100nF Polyester (2 off)
C4	47µF 10V Tantalum Bead
C6	22µF 16V PC Electrolytic

Semiconductors

D1 - D11	1N4148 (11 off)
TR1	BC214L
TR2	BC184L
TR3	AC126
IC1, IC3, IC4	NE555 (3 off)
IC2	4017BE
IC5	4011BE

Miscellaneous

LS1	8 ohm 0.2 watt miniature loudspeaker
S1	Single pole sub-miniature slide switch
S2	Push switch
	14-pin DIL Socket
	16-pin DIL Socket
	Bolts 6BA ½ inch (9 off)
	Nuts 6BA (9 off)
	Bolts 8BA ½ inch (6 off)
	Nuts 6BA (2 off)
	Case
	6 volt Battery

Having obtained the two halves, take the one with the screw thread and drill a 1/8 inch diameter hole through the screw thread entry point as shown. The 2 inch M3 bolt is inserted into the hemisphere which is used to secure the PCB. In order to get the PCB to fit into the hemisphere it will be necessary to pare off the corners along the lines shown on the component overlay Figure 3.

Now take the other hemisphere and drill the 8BA mounting holes for the loudspeaker and also a pattern of holes which allow the sound out.

In order to join the two hemispheres together whilst still retaining access to change the batteries, occasionally it will be necessary to cut out three pieces of thin tin-plate according to the template in Figure 5 from, for example, a can of beans - washed first unless you want a stink Bomb! This is a delicate operation if injury is to be avoided and if some young constructors are contemplating building The Bomb it is advisable here to ask an adult to do this stage for you. Having cut these out each one should be drilled with three 4 mm diameter holes and a M3 nut should be soldered on to the reverse side of hole A in each case (also shown in Figure 5). If the nuts are plated it will be necessary to remove plating prior to soldering.

These three pieces of tinplate are placed along the rim of the low hemisphere at 120° intervals and are secured in place with two 6BA nuts and bolts passing through holes 'B' and 'C in each case.

Holes are now drilled in the upper hemisphere in order to correspond with hole 'A' in each of the three tinplate pieces. The upper and lower hemispheres may now be joined together by passing three 6BA bolts through the plastic of the top hemisphere and screwing them into the nuts on the reverse side of hole 'A' in each piece of tinplate.

Switches S1 and S2 are secured in place in the top hemisphere in the positions shown in Figure 4. Holes will, of course, have to be cut to accommodate these.

The final touch is added to the design by incorporating a mock 'fuse' which is a short length of white shoelace. If a float with an external threaded section is used this can simply be glued in place. However, for a float with an internal threaded section the hole should be drilled out so that a cork, with the shoelace located through the centre, can be inserted.

All the parts of the unit may now be assembled into the two hemispheres. The batteries sit on top of the loudspeaker as shown in the photographs. Ensure that the circuit board mounting bolt is inserted into the top hemisphere before the mock 'fuse' is glued into place.