HEADS OR TAILS

THE MULTIVIBRATOR IS ONE OF the most commonly-used circuit blocks in electronics – especially in digital circuitry. And the multivibrator forms the basis of this 'head or tails' project.

The multivibrator is a basic form of square-wave oscillator which in our design runs at about 700Hz whenever the push-button is pressed. When the button is released the oscillator will stop and the circuit will assume one of the two possible stable states. Either Q1 will be conducting and Q2 will be cut off, or Q2 will be conducting and Q1 will be cut off. Whichever transistor is conducting draws enough current down through the resistor and the light-emitting diode (in series with its collector) to cause the LED to light.

Notice that the circuit is symmetrical and that the two transistors are cross-coupled between their collectors and bases (via R3, C1 and R4, C2). If corresponding components on each side are matched there is equal probability of either transistor being on

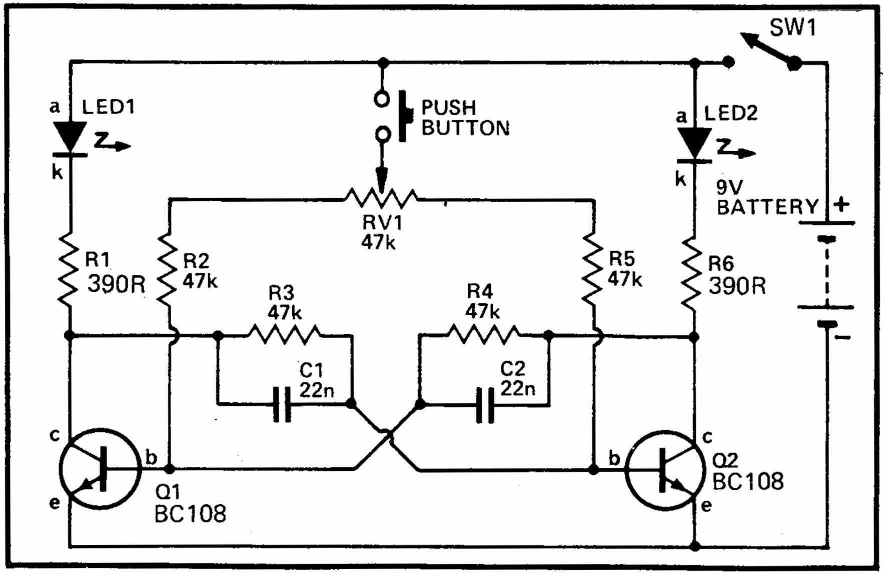
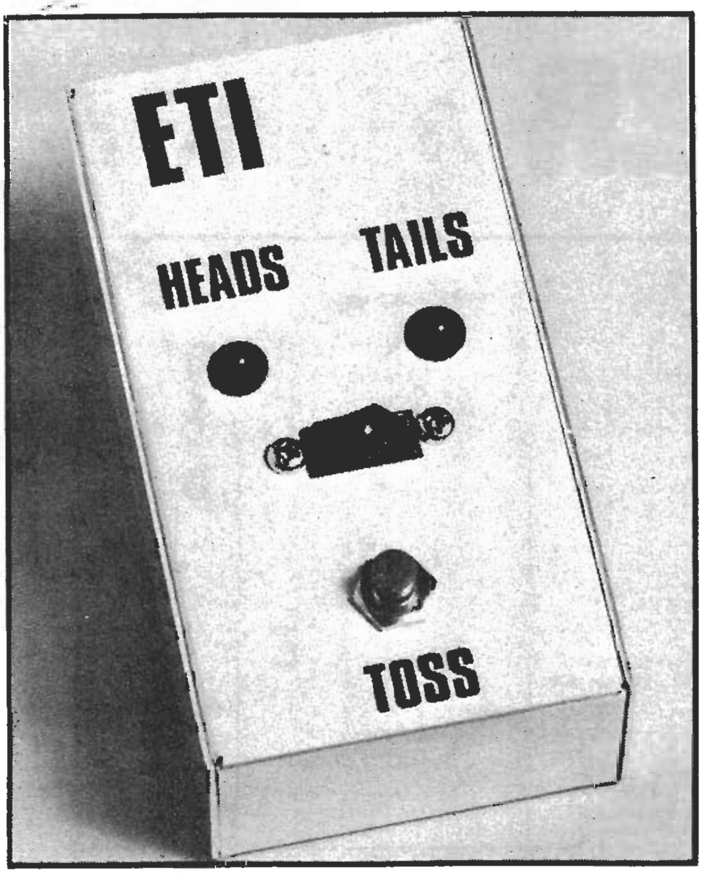
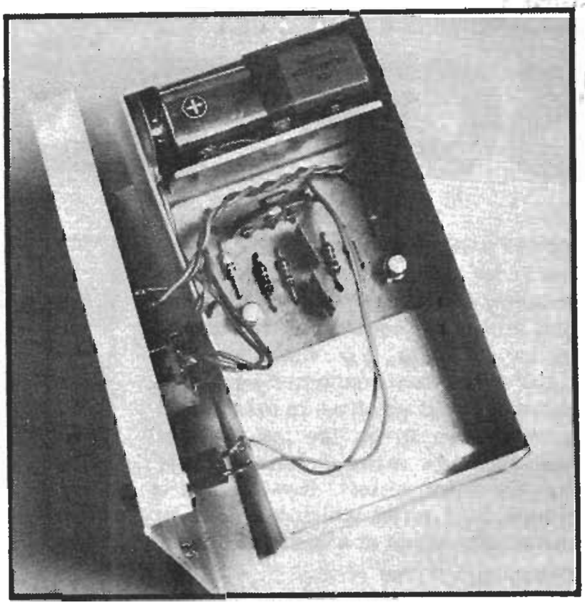


Fig 1: The circuit of our Heads-or-Tails unit.

when the button is pressed. However, electronic components do not have exactly the values they are supposed to have so it is necessary to include potentiometer RV1 to adjust for equal probability. Alternatively it may be useful to maladjust RV1 so that the effect of bias on the results can be assessed.

When either Q1 or Q2 is on, as said before, the associated LED will be on





Internal view of the completed unit.

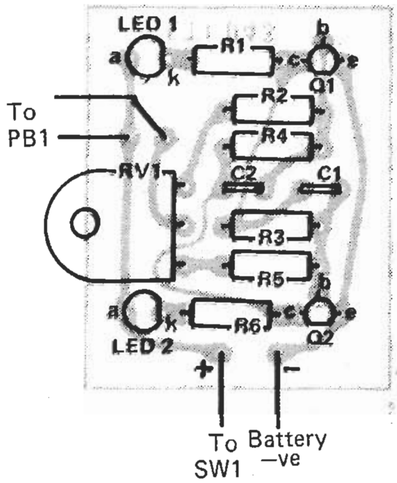


Fig. 3: The component overlay.

Parts List

R1	Resistor	390R ¼w 5%
R2-5	Resistor	47k ¼w 5%
R6	Resistor	390R ¼w 5%
RV1	Potentiometer	47k trim
C1,2	Capacitors	22nF polyester
Q1,2	Transistors	BC108
LED 1,2	Light emitting diodes (large type)	
P.B.1	Press to make	
S.W.1	On/off switch	
Battery	PP3	
Battery clip		

Aluminium box 4 x 2 x 1½in.

Total cost, inclusive of box and VAT: about £2.00

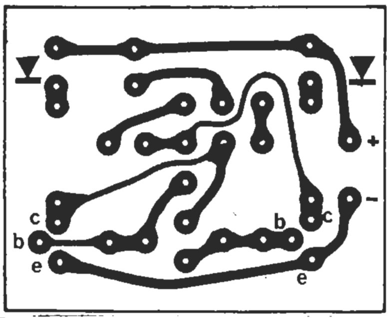


Fig. 2: The PCB layout. Full size 50 x 40mm.

How it works

This circuit may be considered as a multivibrator, when the button is pressed, and as a flip flop when the button is released. If initially we consider the circuit with R2, R5, C1 and C2 deleted we have a standard flip flop. If Q1 is on, it robs current from the base of Q2, thus turning it off. Transistor Q1 will be held on by the current through R6 and R4. However, if Q2 is on, the reverse is the case. Thus only one of the transistors can be on at any time - never both.

The addition of R2, R5 and C1, C2, will not alter the above, providing the push button is not pressed. However if the button is pressed the current through R2 and R5 will try to turn on both transistors.

Take the case where initially Q1 is on and Q2 is off. The voltage on the collector of Q1 will be about 0.5 volts and the voltage on Q2 collector, about seven volts. We therefore have about 6.4 volts across C2 (as the base of Q1 is at about 0.6 volts). When the button is pressed Q2 will turn on and its collector will drop to 0.5 volts.

However a capacitor cannot instantly change its voltage and the base of Q1 will therefore be forced to −5.9 volts which turns off the transistor. Capacitor C2 then discharges via R2 and R4 until the base voltage is again at +0.6 volts when Q1 will turn on again. This however forces the base of Q2 to −5.9 volts (due to C1) thus turning Q2 off. This process continues back and forth until the push button is released. The circuit then stops in the state it was at the instant of releasing the button.

To add bias to the circuit RV1 can be adjusted to change the discharge time of C1 or C2 by up to 50%. In this case the two transistors will not be on for equal times and the results will be biased towards one side.

LEDs are included in the collector circuits of each transistor to indicate which transistor is on. If, for display purposes, a slower-running unit is required the values of C1 and C2 may be increased. If both are 10 microfarad electrolytic capacitors the rate will be about 1.5 seconds. Make sure if electroytics are used that the positive terminal is connected to the collector of the transistor.

and this gives us our 'heads' or 'tails' indication. When the button is pressed, however, the LEDs are switched on and off alternately at a rate of 700Hz. The switching cannot, of course, be seen due to the limited flicker-frequency response of the eye. Both LEDs will therefore appear to be illuminated.

CONSTRUCTION

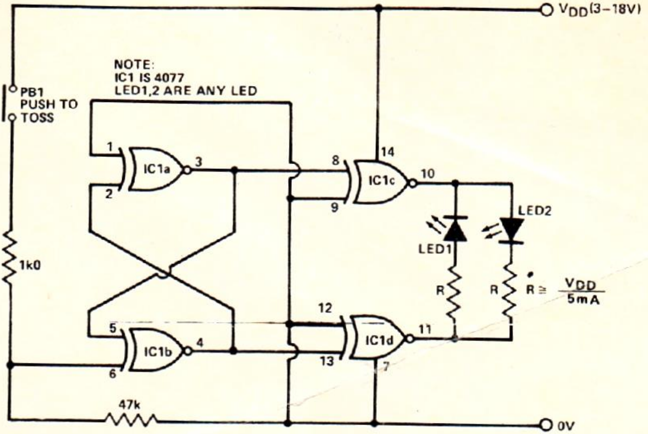
The unit can be assembled onto a small printed-circuit board such as that illustrated.

The main points to watch are that the transistors are correctly orientated and that the LEDs are the correct way around.

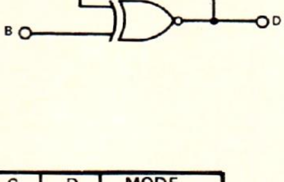
The unit should be thoroughly checked — a transistor or LED can be destroyed if it is wrongly connected. Double-check the battery connection — a reversed battery can also destroy semiconductors. ●

Heads Or Tails

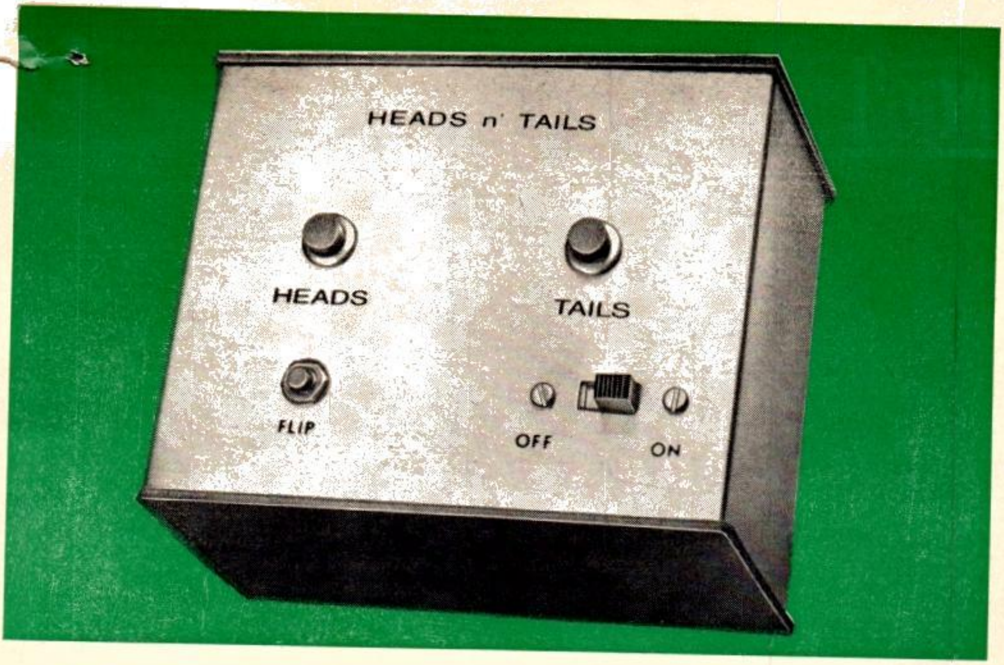
D. Indyk



An ultra-simple heads or tails indicator can be built using a single 4077 EXNOR IC. The circuit is normally in a latched bistable mode; when the switch is closed the circuit will oscillate, ie toss the coin. The astable frequency is approximately 5-10 MHz. If desired a small push-to-make switch can be connected in series with the battery as an on/off switch, such that the battery will be disconnected from the circuit unless the device is being held. The LEDs can be any colour.



A	B	C	D	MODE
0	0	$\overline{D}$	$\overline{C}$	BISTABLE
0	1	$\overline{D}$	$\overline{C}$	ASTABLE
1	0	$\overline{D}$	$\overline{C}$	ASTABLE
1	1	D	C	BISTABLE



HEADS 'n' TAILS

ELECTRONIC COIN FLIPPER GIVES YOU A FAIR SHAKE

BY JIM CRAWFORD

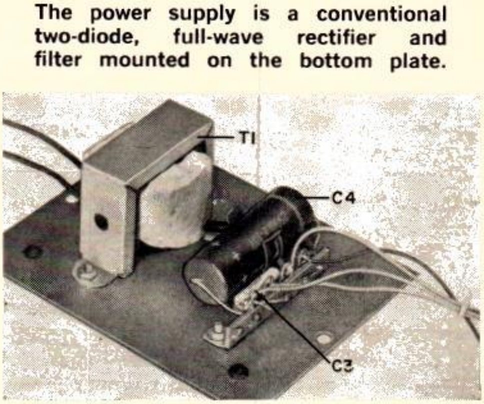
MOST ELECTRONIC games that, in effect, flip a coin are designed to give "the house" an advantage—not so the "Heads 'N' Tails." It's strictly on the up-and-up with an exact 50-50 percentage, unless the circuit is tampered with. The project is ideal for school laboratories as a probability demonstrator or study aid. It is also good for a science fair project—or simply as a means of determining who buys on the next coffee break.

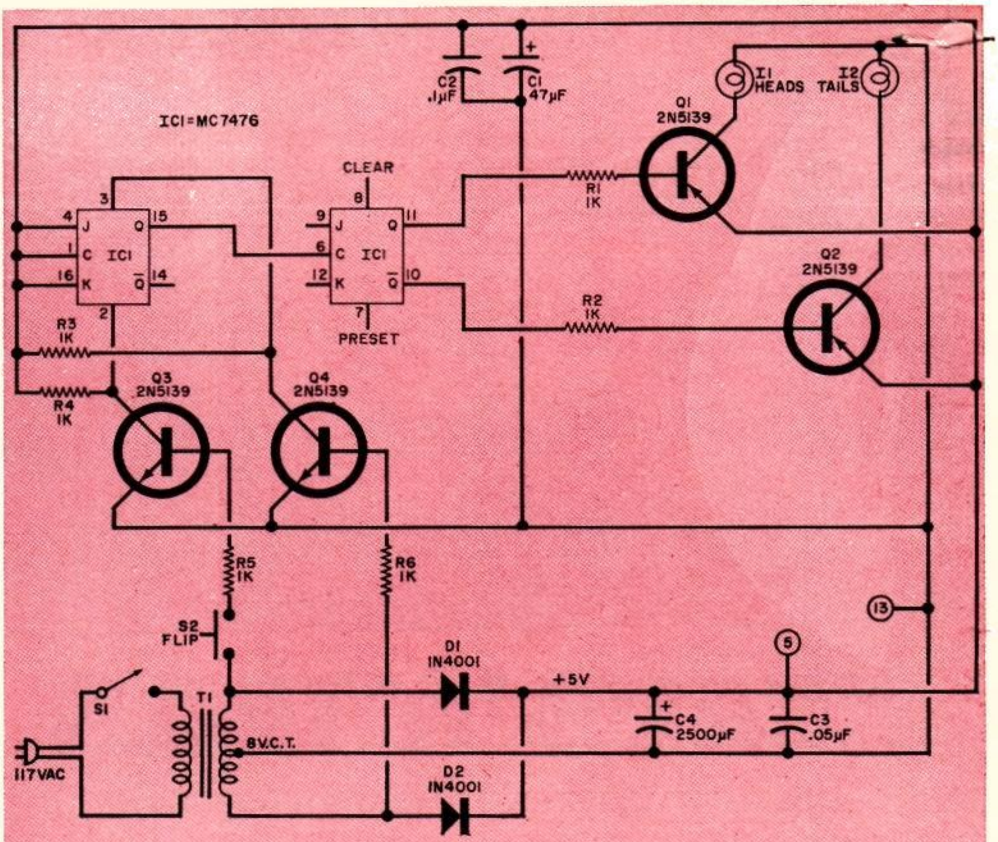
The simple circuit, shown in Fig. 1, uses a transistor-transistor-logic IC and four low-cost transistors. The visual readout of the second flip-flop indicates heads or tails.

Rather than using an astable, or some other potentially unsymmetrical "odds determinator," the Heads 'N' Tails counts the power line frequency so that both the length of time the pushbutton is held down and the phase of the power at the instant the pushbutton is depressed combine to provide a truly random 50-50 long-term result.

In the first JK flip-flop only the direct inputs (clear and preset) are used so that the circuit squares up and follows the power line frequency as long as *S2* is closed. Transistors *Q3* and *Q4* alternately set and reset the flip-flop immediately after each sequential power line zero crossing. The

The power supply is a conventional two-diode, full-wave rectifier and filter mounted on the bottom plate.





PARTS LIST

C1—47-µF, 15-volt electrolytic capacitor
C2—0.1-µF, 10-volt disc ceramic capacitor
C3—0.5-µF, 10-volt disc ceramic capacitor
C4—2500-µ-F, 10-volt electrolytic capacitor
D1,D2—1N4001 (or similar) rectifier diode
IC1—Dual JK flip-flop (Motorola MC7476 or Texas Instruments SN7476)
I1,I2—5-volt, 50-mA lamp (one green, one red)
Q1,Q2—2N5139 transistor
Q3,Q4—2N5129 transistor
R1-R6—1000-ohm, ¼-watt resistor
S1—Spst slide or toggle switch
S2—Normally open spst pushbutton switch
T1—Transformer; secondary: 8 VCT at 500 mA
Misc.—Suitable chassis, line cord, strain relief, mounting hardware, etc.
Note—The following are available from Southwest Technical Products, Box 16297, San Antonio, TX 78216: etched and drilled PC board #187 at $1.85; complete kit of all parts including punched and finished case and power supply #187C at $8.65, plus postage and insurance (optional) for 2 lb.

Fig. 1. The flip-flops count the power line frequency when S2 is held down. The state of the flip-flops is then indicated by the pilot lights.

Q output of the first JK is a noise-free square wave when *S2* is closed, and either a logic 1 or 0 when the switch is open.

The output of the first flip-flop is used to cycle the second JK which is connected as a binary divider. One of its outputs drives the "Heads" indicator lamp, and the other drives the "Tails" lamp. Transistors *Q1* and *Q2* provide sufficient power for the flip-flop outputs to drive the lamps. When *S2* is closed, both lamps cycle on and off 30 times a second—a speed much faster than the eye can follow, to discourage cheating.

Construction. Although any construction technique can be used, a printed circut board such as that used in the prototype is recommended. A foil pattern and compo-

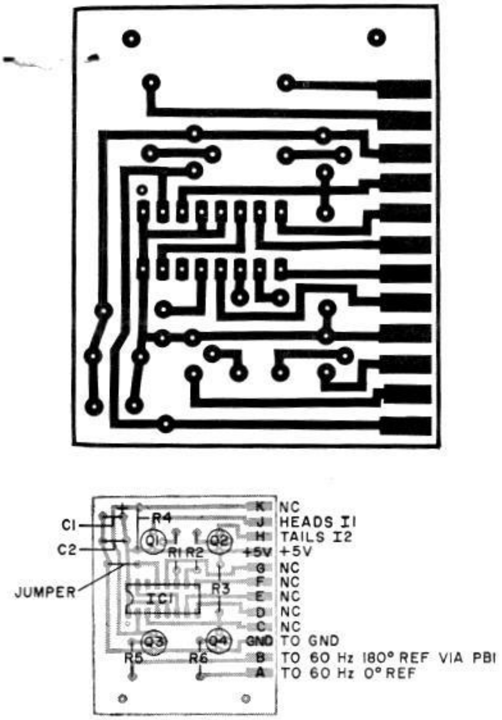
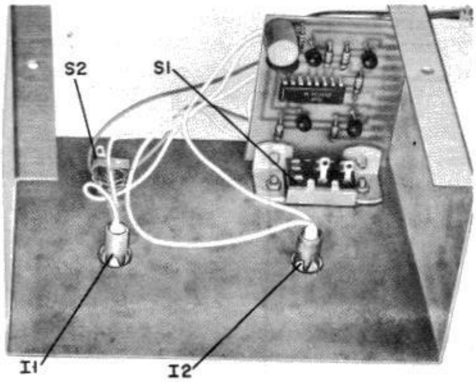


Fig. 2. Actual size foil pattern and component installation. The edge connector is used to facilitate removal.



The board mounts on a pair of angle brackets and doesn't take much room.

nent layout are shown in Fig. 2. Note that one jumper is used on the component side of the board. When mounting the IC, observe the notch and dot code marks. Use a low-power soldering iron and fine solder.

The power supply, which can be used in other projects, is mounted on a separate board.

The project is very simple to use. With power applied, turn on *S1* and depress *S2* for as long as desired. Both lamps will glow. When *S2* is released, only one lamp will remain lit. ◈

TAKING A LAST LOOK AT SOLAR ENERGY PANEL

During final tests at Hughes Aircraft Company, engineers and inspectors are taking their last look at the extended solar panels of the FRUSA (Flexible Rolled-Up Solar Array) system, which is now converting solar energy into electrical power for orbiting satellites. Developed by Hughes for the U. S. Air Force Aero Propulsion Laboratory, Wright-Patterson AF Base, Ohio, the panels, which contain more than 34,000 solar cells to convert the sun's energy into 1500 watts of power, were unfurled in space after being launched Oct. 17, aboard a Thor-Agena satellite. The FRUSA has a 400-mile-high polar orbit. Snugly rolled like windowshade on the 10-inch diameter cylinder during launch, the panels were extended in space by metal booms, which are wound and stored in metal cassettes at each end of the cylinder. Both panels, each measuring 16 by 5½ feet, are shown fully extended on blocks floating in a water-filled table to simulate zero gravity during final process of being wound under tension onto the cylinder.