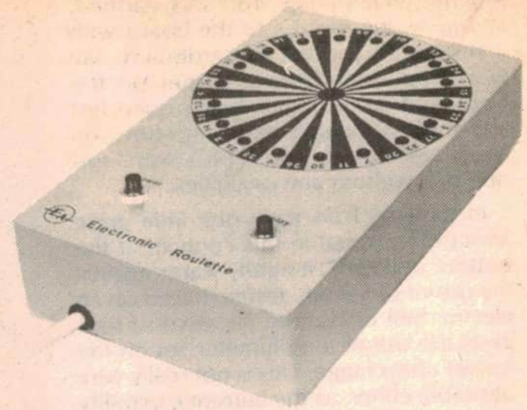
Build this fascinating game of chance

An electronic roulette wheel



Are you interested in games of chance? If so, then our Electronic Roulette Wheel is the thing for you. Fully solid state, and functioning in a suitably random manner, it will keep you amused for hours at a time.

by DAVID EDWARDS

Man has always been fascinated by games of chance, and one of the most popular forms of this mania is the wheel of fortune. Ranging from the simple chocolate wheel as used at fetes, to the complicated machines employed by casinos, these devices always seem to attract large crowds of people willing to "have a go".

Much care is required in the construction of these machines, to ensure that the wheel runs true, so that the final result is completely random, and not biased in any way. Anyone who has seen a roulette wheel in a casino will appreciate the skill and workmanship required.

Our Electronic Roulette Wheel has no moving parts, and thus does not require the same skills in construction. It is based upon an electronic number generator, which cannot be "fiddled" in any way. Admittedly, it does not have the same visual appeal as a large wheel which gradually slows down before stopping at the final number, but at the same time it is considerably less expensive, and does have a visual appeal of its own.

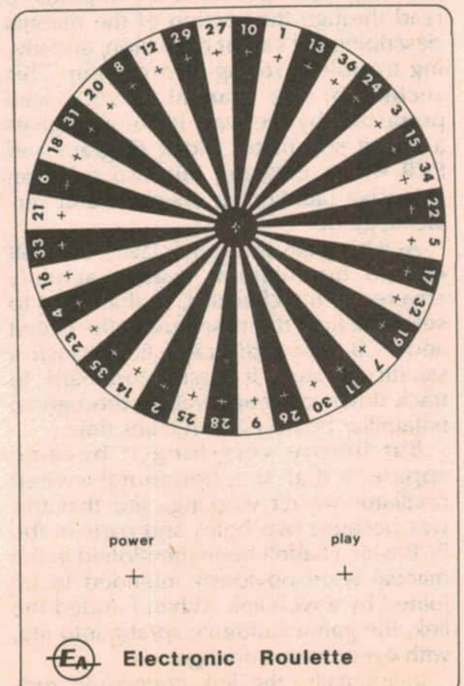
As you can see in the photographs, our unit consists of a fairly large box, fitted with thirty-six small lights, arranged in a circle. The circle is divided into alternate black and white segments, with each segment being numbered at random from one to thirty-six. Only one of these lights is illuminated at any one time.

When the PLAY button is pressed, the lights appear to move rapidly round the circle. Once the button has been released, the lights start to slow down, just like a true roulette wheel, and eventually come to a stop at some randomly selected number.

Fig. 1 is a block diagram explaining the way in which we have implemented the necessary functions. The clock generator is controlled by the PLAY switch. When the switch is depressed, the oscillator runs at a high speed, and feeds pulses to the divide-by-eighteen counter. After the switch is released, a time constant in the clock circuit makes the clock slow down to a stop in about 14 seconds.

The outputs from the counter are fed to a decoder, which has eighteen outputs. These are normally high, and each one goes low in turn as the counter cycles through its states. When the counter has reached eighteen, it is reset, and starts counting again.

This reset signal is also used to trigger a flip-flop, which thus changes state every time the counter re-cycles. The complementary outputs from the flip-flop are used to gate the outputs from the decoder, so that only one of the lamps connected to each decoder output is energised at a time. When the Q output of the flip-flop is high, lamps 1 to 18 are energised sequentially. The counter then resets, the flip-flop changes state, and lamps 19 to 36 are energised sequentially. The cycle then repeats for as long as clock pulses are supplied.



The front panel of our roulette wheel. Full size dyeline copies, positive or negative, are available, price $2.00.

Physically, the lamps are arranged in a circle, so that each one is illuminated in turn. Visually, the energised light appears to be rotating in the same way as a normal roulette wheel does.

Initially, when the clock is running at a high speed, it is impossible to distinguish between individual lights, all one sees is a blur of light in a circle. However, as the clock shows down, one is able to see a rotating pattern, until eventually, the individual lights can be seen. Finally, only one light will remain illuminated.

This final light is randomly selected because it is impossible to ascertain exactly when the PLAY switch is released. This uncertainty is due to the high initial clock speed. Extensive (and time consuming!) tests with our prototype failed to show any bias whatsoever.

Since our design is only capable of providing an even number of digits we decided not to have any zeros on our wheel. Zeros are normally provided to give a bias in favour of the casino. Having no zeros means that our wheel will not favour the banker over any player.

We decided to use TTL logic to implement our design, on the grounds that it is readily available, economical, and is capable of driving light emitting diodes (LEDs) directly. Although it has a high power consumption, we felt that for a mains powered device, this would not be too great a disadvantage.

The other main decision to be made concerned the type of lights to be used. While incandescent lamps are quite cheap, they are not capable of interfacing directly with TTL logic, due to their high current drain. In this respect LEDs are quite suitable, their only disadvantage until recently being price, particularly where, as in our case, large numbers were required.

Fortunately, in recent times, the price of LEDs has fallen drastically. They are now selling, in quantity, for less than 20c each. In some cases this includes a mounting kit for each LED. This is very good value.

Having decided on the general scheme of things, as described above, we were then faced with realising our design. Implementation of the clock generator did not prove difficult. As you can see from Fig. 2, we have used a type 566 function generator.

This is a voltage controlled oscillator with both triangle and square wave outputs. The basic oscillator frequency is set by the resistor connected to pin 6, and the capacitor connected to pin 7. With the values we have used, this gives a frequency of about 1700Hz.

The frequency is also influenced by the voltage on pin 5. With the PLAY switch pushed, this voltage is a minimum, and the frequency is a maximum. When the switch is released, the 220uF capacitor commences to charge. This increases the voltage, and progressively lowers the frequency, until the oscillator stops completely. This takes about 14 seconds.

The recommended supply voltage for the 566 is 12V, and the current drain about 10mA. This is quite easily provided, but more about that later.

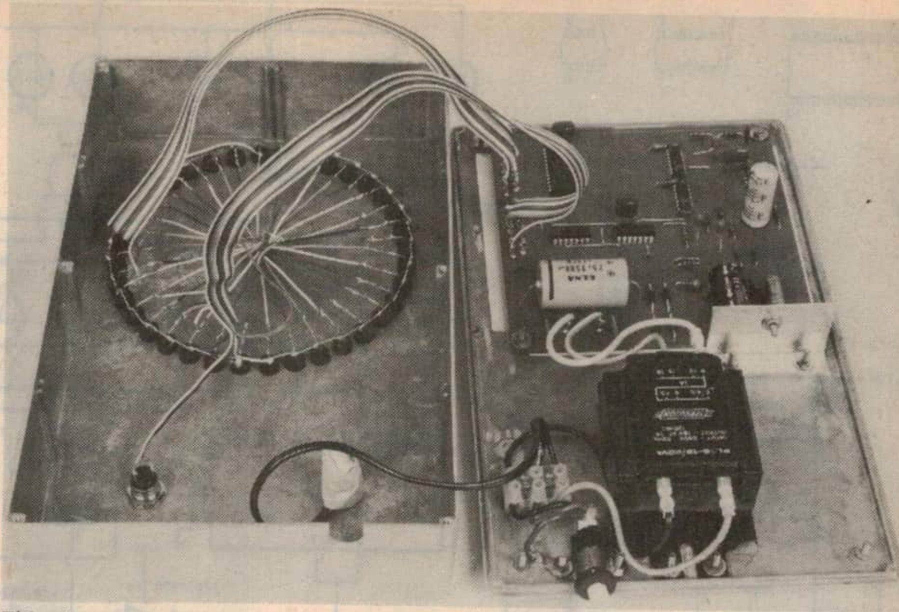
The square-wave output from pin 3 must be conditioned to suit TTL logic levels. This is done by the BC548 NPN transistor. The conditioned clock signal is then applied to the input of a 7493 type 4-bit binary counter.

This is converted into an eighteen stage counter by the addition of a J-K flip-flop and a 3-input NAND gate. The flip-flop is clocked from the output of the 7493. The NAND gate is used to generate a signal when the nineteenth count is reached, and this is used to reset the counter to the zero state. An inverter is necessary between the clear input of the flip-flop and the preset input of the counter, while two series inverters are used to "stretch" the reset pulse to ensure reliable operation.

The eighteen line decoder is formed from a 74154 MSI 4-line to 16-line decoder, in conjunction with two 3-input NAND gates and two inverters. A signal applied to the strobe input of the 74154 disables it during the seventeenth and eighteenth counts, preventing spurious outputs.

Two small signal PNP transistors are used to buffer the output of the flip-flop used to select either of the two groups of LEDs. Resistors (120 ohms) in the collector leads serve to limit the LED current to about 20mA.

The configuration adopted is quite economical in terms of package utilization, only 6 ICs are used, and all of these are used fully except for one inverter. Total current drain of the circuit is about 130mA, from a 5V rail.



This picture gives a good idea of the complete layout. Note the "L" shaped bracket, to the right of the power transformer, which supports the BD135 transistor. The wiring board is mounted on spacers, with a sheet of cardboard beneath it as a precaution.

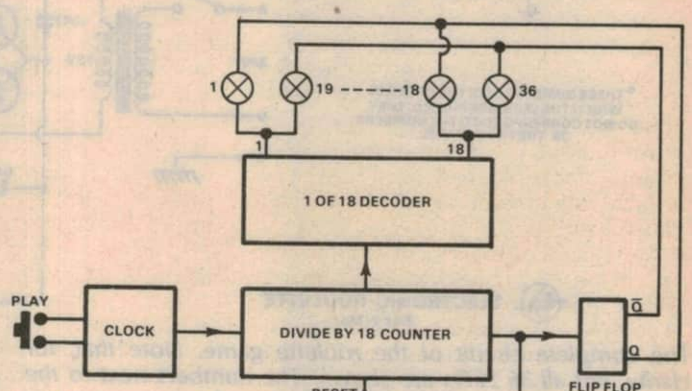


FIG. 1

Block diagram of the roulette wheel. Pulses from the clock are fed to the divide-by-18 counter and thence to the decoder. The flip-flop converts the 18 outputs to 36 outputs for the LED display.

PARTS LIST

SEMICONDUCTORS

- 1 74154 1-of-16 decoder
- 1 7493 4 bit binary counter
- 1 7473 dual J-K flip-flop
- 1 7410 triple three-input NAND gate
- 1 7404 hex inverter
- 1 566 function generator
- 1 BD135 NPN power transistor, or equivalent
- 1 BC548 NPN transistor, or equivalent
- 2 BC558 PNP transistors, or equivalents
- 4 EM401 silicon diodes, or equivalent
- 37 LEDs, with mounting clips. See text
- 1 5.6V 400mW zener diode, BZX79C5V6 or equivalent
- 1 6.8V 400mW zener diode, BZX79C6V8 or equivalent

CAPACITORS

- 1 2500uF 25VW pigtail electrolytic
- 1 1000uF 16VW pigtail electrolytic
- 1 220uF 16VW PCB electrolytic
- 1 100uF 10VW pigtail electrolytic
- 3 0.1uF plastic
- 2 0.047uF ceramic
- 1 0.039uF plastic
- 2 0.001uF plastic

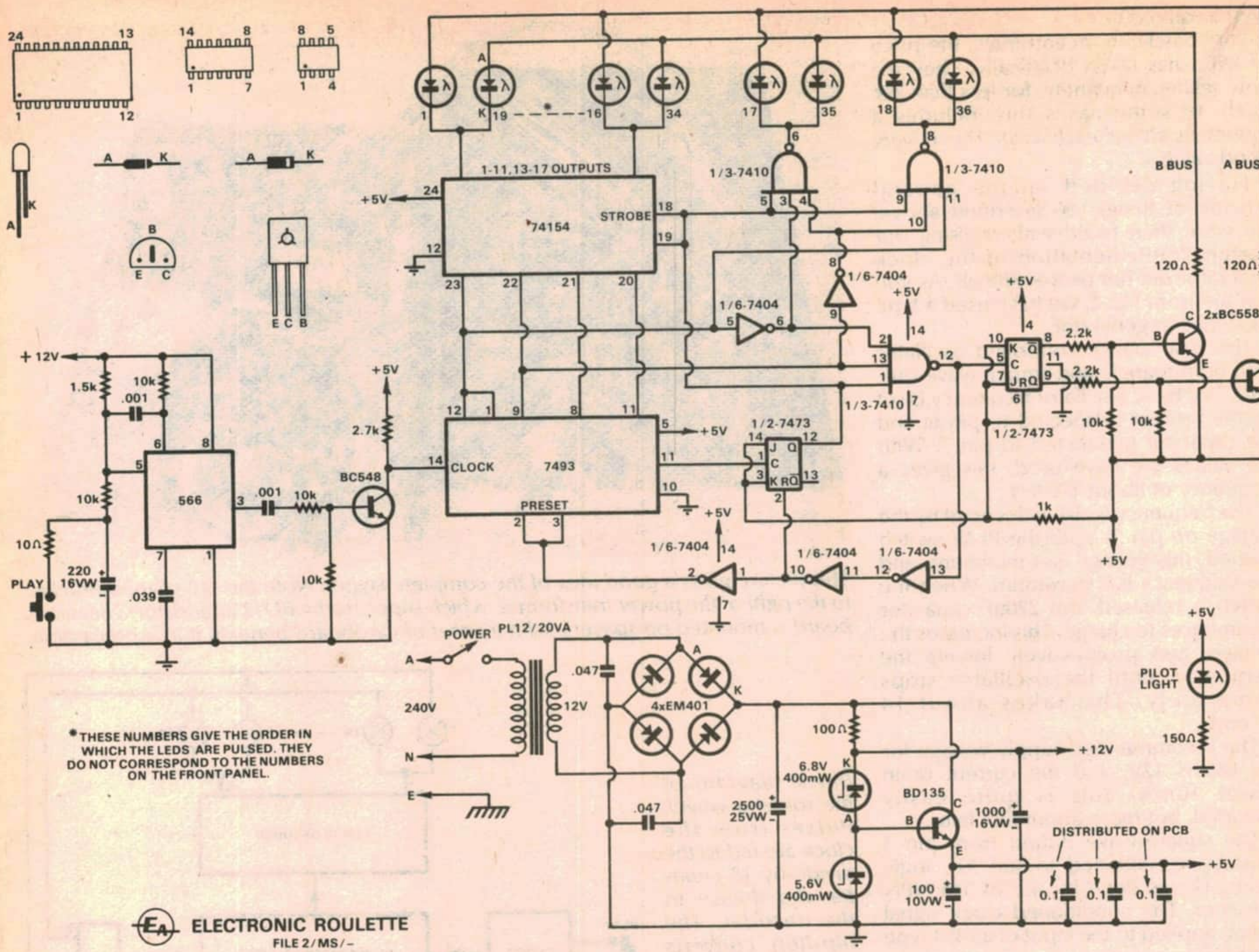
RESISTORS (½ watt rating)

6 10k, 1 2.7k, 2 2.2k, 1 1.5k, 1 1k, 1 150 ohm, 2 120 ohm, 1 100 ohm, 1 10 ohm

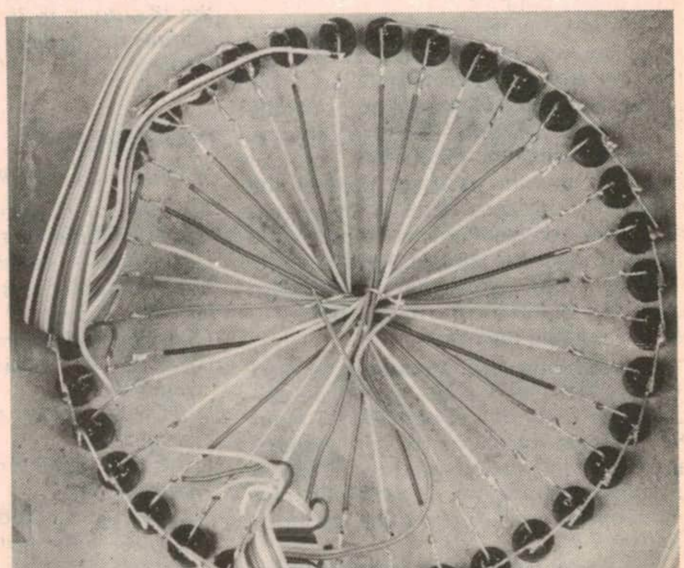
MISCELLANEOUS

- 1 printed circuit board, coded 76rt3, 140 x 140mm
- 1 transformer, 240V to 12V, PL12/20VA or equivalent
- 1 diecast box, 170 x 272 x 55mm
- 1 front panel, see text
- 1 240V rated, push on-push off switch
- 1 N/O momentary contact push switch to match
- 1 mains plug, 3-core flex, grommet, cord clamp and 3-way terminal block
- 4 rubber feet

Scrap aluminium, machine screws, nuts, washers, solder, hookup wire, rainbow cable, mica washer, silicon grease, circuit board pins



The complete circuit of the roulette game. Note that, for clarity, not all 36 LEDs are shown. The numbers next to the various circuit elements are the IC pin numbers.



A close-up of the LED wiring. All the cathode leads point towards the centre of the circle and are bridged to the cathode of the LED directly opposite. The anode leads are connected to form two semicircles, each of 18 LEDs.

We have used a LED as a pilot light, and placed it in the centre of the circle of LEDs. While this is not strictly necessary, as one of the other LEDs will always be illuminated, we felt that it improved the look of the circle, by providing a point of interest at the centre. If desired, it can be deleted.

We have used a fairly simple power supply. A full-wave bridge rectifier feeding into a 2500uF electrolytic capacitor supplies a nominal 20V from a 12V rms transformer. Two 400mW zener diodes in series provide nominal outputs of 5.6V and 12.4V. The latter is used to power the 566 clock generator direct. Extra filtering for this is supplied by the 1000uF electrolytic capacitor.

The 5.6V zener drives a series pass transistor, giving a nominal output of 5V. This is stabilised by the 100uF electrolytic capacitor at the output. We have used one of the plastic type transistors, as this is easily mounted on a suitable heatsink. The collector-emitter power dissipation is approximately 2 watts.

We mounted our prototype in a standard die-cast box, measuring 170 x 272 x 55mm. As can be seen in the photographs, we mounted the LEDs on the bottom of the box, towards one end. We used two push switches, identical in appearance, for the POWER and PLAY functions.

We made a front panel for our device using "Scotchcal" photosensitive aluminium. We anticipate that kitset suppliers will be able to make available ready-made front panels. Alternatively, we can supply through our Information Services copies of our artwork. These are full size transparent dye-lines, suitable for use in making bromide prints by the contact method. We suggest that fairly "contrasty" paper is used. (Priced $2.00.)

Construction should be relatively simple, as all major parts are mounted on the printed circuit board. This is coded 76rt3, and measures 140 x 140mm. There

HOW TO PLAY ROULETTE

Roulette is played with a roulette wheel, chips and a betting table. Bets are made by placing chips on the specially marked table. The wheel is then used to select a winning number at random. A normal wheel, as used at a casino, has 36 numbers, and one or two zeros. The zeros are to provide a bias in favour of the casino. Our Electronic Roulette Wheel does not have any zeros, and is thus completely unbiased.

At least two players are required, one of whom becomes the banker. Players bet against the banker, but cannot bet amongst themselves. Each player should be supplied with an equal number of chips. If possible, each player should have different coloured chips, to avoid confusion when many bets are laid on the table.

The banker should be supplied with larger numbers of chips of all colours, to lessen the chance of "breaking the bank". Chips can be improvised from buttons, coloured counters or similar objects.

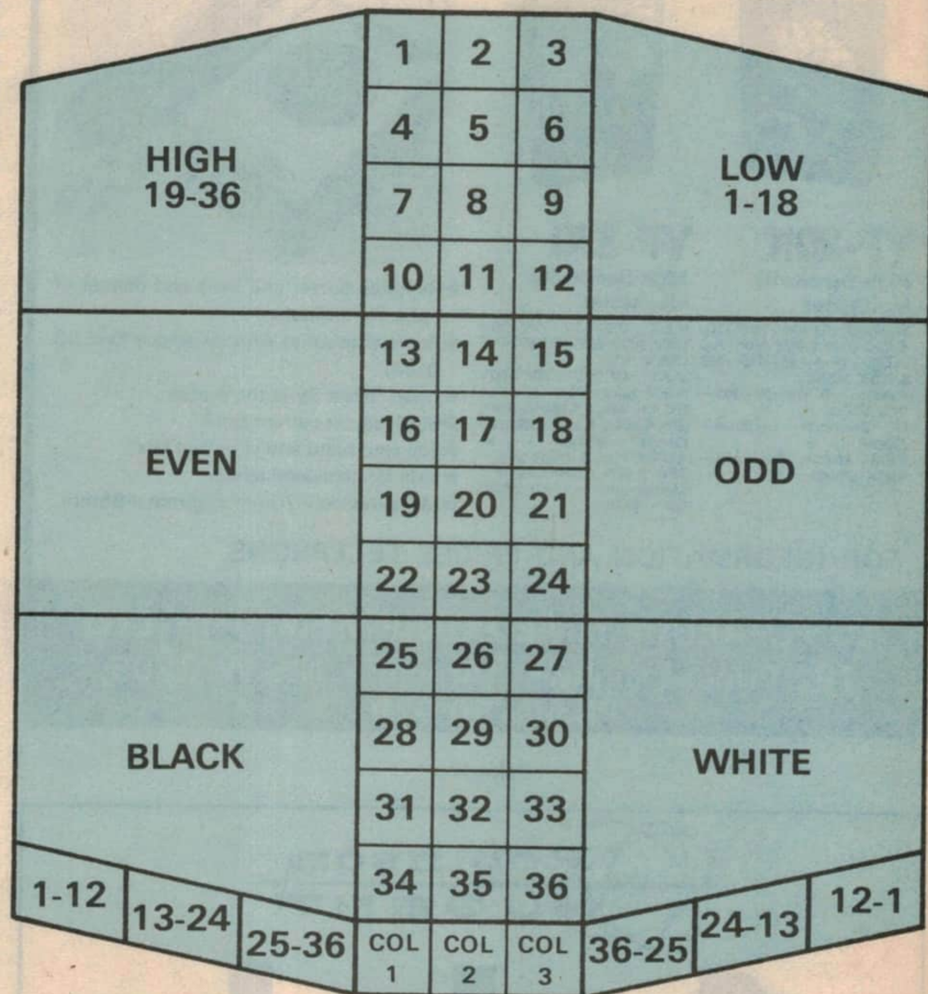
A large copy of the table layout should be made, marked with the numbers as shown. This can be as large as desired. A foolscap size table is suitable for up to six players. The various types of bets, how they are made, and the odds they pay are explained below.

Experienced gamblers may have noticed that we have used a black and white table instead of the more usual black and red one. This was because we found it easier to fabricate a black and white front panel for our Electronic Roulette Wheel. However, there is no reason why a constructor with suitable facilities could not make a red and black panel, as is usually used in casinos. Alternatively, it would be possible to paint or otherwise colour the white sections red. In any case, the table layout should match the front panel of the wheel.

There are six ways of wagering on an even chance. One can bet that the next number will be black or white, even or odd, or high or low. This is done by placing a chip (or chips) on the relevant areas of the table. You may bet on more than one occurrence (e.g., black and odd), and more than one player can bet on the same occurrence.

All these wagers pay even money, i.e., if you wager one chip on the black, and a black number comes up, you receive your original stake back, as well as an extra chip (your winnings). If a white number comes up, you lose your stake.

Odds of 2 to 1 are paid on bets in the nine boxes at the bottom of the table. The centre three boxes represent all the numbers in the columns directly above them. The boxes on either side represent the numbers marked in them. Bets are made by placing chips in the appropriate box. A winning bet is tripled, the winner receiving his original wager plus twice as much.



This diagram should be enlarged and copied onto cardboard. The final size will depend on the number of chips to be used, as well as the number of players.

To receive odds of 35 to 1, you may bet on any single number, by placing your chips in the appropriate box. Odds of 17 to 1 are obtained by betting on two numbers. These numbers must be next to one another on the table, and the bet is made by placing your chips on the dividing line between the two numbers. You win if either number comes up.

To bet on three numbers at once, and receive odds of 11 to 1, place your chips on either side wall of any row. Thus to bet on 13, 14 and 15, place your chips either on the right hand wall of box 15, or the left hand wall of box 13. You will win if either 13, 14 or 15 comes up.

Odds of 8 to 1 are obtained by betting on four numbers at once. This is done by placing your chips on the common corner of four numbers. It is not possible to bet on four numbers which are not adjacent.

By placing your chips on the side walls so that they cover two rows, you receive odds of 5 to 1, and win if any of the numbers in either of the rows comes up.

These are the only bets which can be made. A player may make as many bets at one time as he desires, and as many players as wish can bet on any one number or combination of numbers. When all bets have been laid, the banker calls "no more bets", and spins the wheel.

When the wheel stops spinning, the banker calls the winning number, e.g., "ten on the black", and then removes all losing wagers from the table. He then pays out all the winning bets to those fortunate few. No more bets should be laid on the table until all winning bets have been paid. This will avoid confusion, and prevent unscrupulous players from making bets after the result has been decided.

The game can then continue, until either all the players or the banker goes broke.

are eight wire links on the board, which need not be insulated. The three electrolytic capacitors in the power supply must be pigtail types, rather than PCB types, as the headroom is limited.

The series pass transistor for the power supply mounts in one corner of the board. A small "L" shaped heat-sink must be fashioned from aluminium. The transistor is mounted on this with a mica washer and heat-sink compound. The heat-sink is then screwed to the case, with a little heat-sink compound ensuring a reliable thermal bond.

All other components can be soldered directly on the board. We suggest that the ICs are left until last, to minimise the risk of overheating. Remember to check the polarity of critical components, such as diodes and electrolytic capacitors. Use circuit board pins for all external connections to the board.

Once the PCB is completed, it can be mounted on the lid. The transformer is mounted centrally at the other end, as shown in the photographs. The mains cord enters through a grommeted hole, and is then clamped to the lid. File a "U" shaped slot in the edge of the case, so that the lid and bottom may be separated without disturbing the cord clamp.

The earth lead is terminated at a solder lug, screwed to the lid. The active and neutral leads go to the terminal block, and hence to the transformer primary via the power switch. Wrap the terminals of this switch with insulating tape, to eliminate a possible shock hazard.

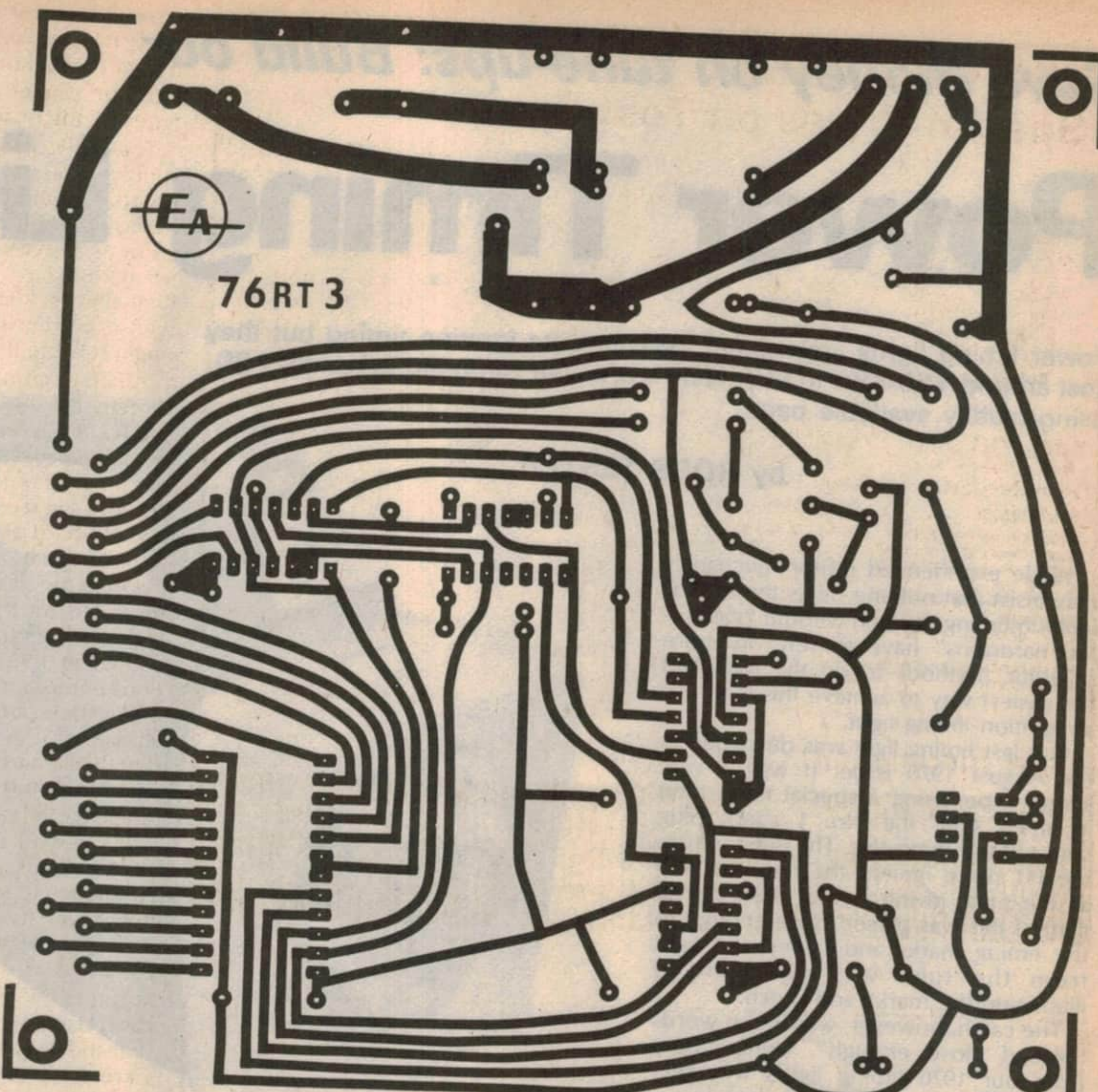
The LEDs can now be mounted in the case. Use the front panel as a template to drill the required 6.35mm (¼ in.) holes. Care is required, to ensure that the template does not move during drilling.

Mount the LEDs in position, using the clips supplied. Orient them so that the anode leads all point radially outwards. This will enable them to be bent as shown in the photograph, so that the "A" and "B" busses can be formed without any additional wiring. There must be eighteen LEDs in each buss.

The cathode leads are bent radially inwards, and short lengths of hook-up wire used to connect diagonally opposite LEDs. Commence wiring from the end of one buss, and work around the circle. Once this has been done, only the wiring to the PCB remains to be completed.

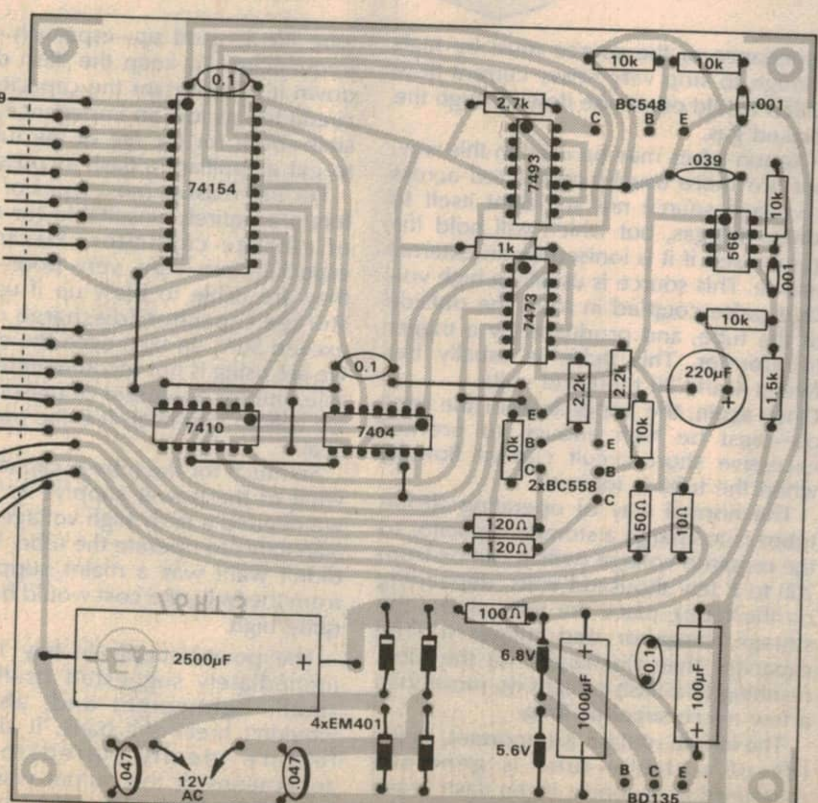
There are 24 connections from the PCB to the LEDs, and these have been grouped in two lots of twelve. We recommend that 12-way rainbow cable is used for these connections, in the interests of neatness and ease of wiring. Two 250mm lengths are required.

The eighteen wires from the PCB labelled "LEDs" must be connected to the eighteen cathode leads. Start at the clockwise end of one buss, and join the cathode of this LED to the first pin of the PCB (i.e. the pin connected to pin 1 of the 74154). Then, working anticlockwise around the LEDs, connect the cathodes sequentially to the circuit board pins. The



Right: The printed board pattern shown full size. As usual, copies of this pattern have been distributed to the board manufacturers and ready made boards should be available from your dealer.

Below: The component layout on the board, shown from the component side. Pay particular attention to the polarity of diodes, electrolytic capacitors, etc., and also to the correct orientation of the ICs.



cathode at the end of the buss should connect to pin 8 of the 7410.

The next two wires from the PCB connect to the two busses. Either wire can be connected to either buss. The next two wires connect to the centre LED. Make sure that the lead marked "anode" is connected to the LED anode. The remaining two wires connect to the PLAY switch.

Construction is now complete, and the machine can be tested. On intitial turn-on, the LEDs should all be flashing sequentially. They may take a little longer than normal to stop, as the 220uF electrolytic capacitor is re-formed.

When the PLAY swith is operated, the LEDs should all appear to be on. As the oscillator slows down, a clockwise rotation will become evident, and eventually only a single LED should be on. If required, the maximum oscillator frequency can be varied by changing the 0.039uF capacitor. The time taken for the oscillator to stop depends on the value of the 220uF capacitor.

You can now commence to play roulette, using your unbiased wheel. For those readers who are unsure of the rules and manner of play, we have prepared a short article and a table layout.