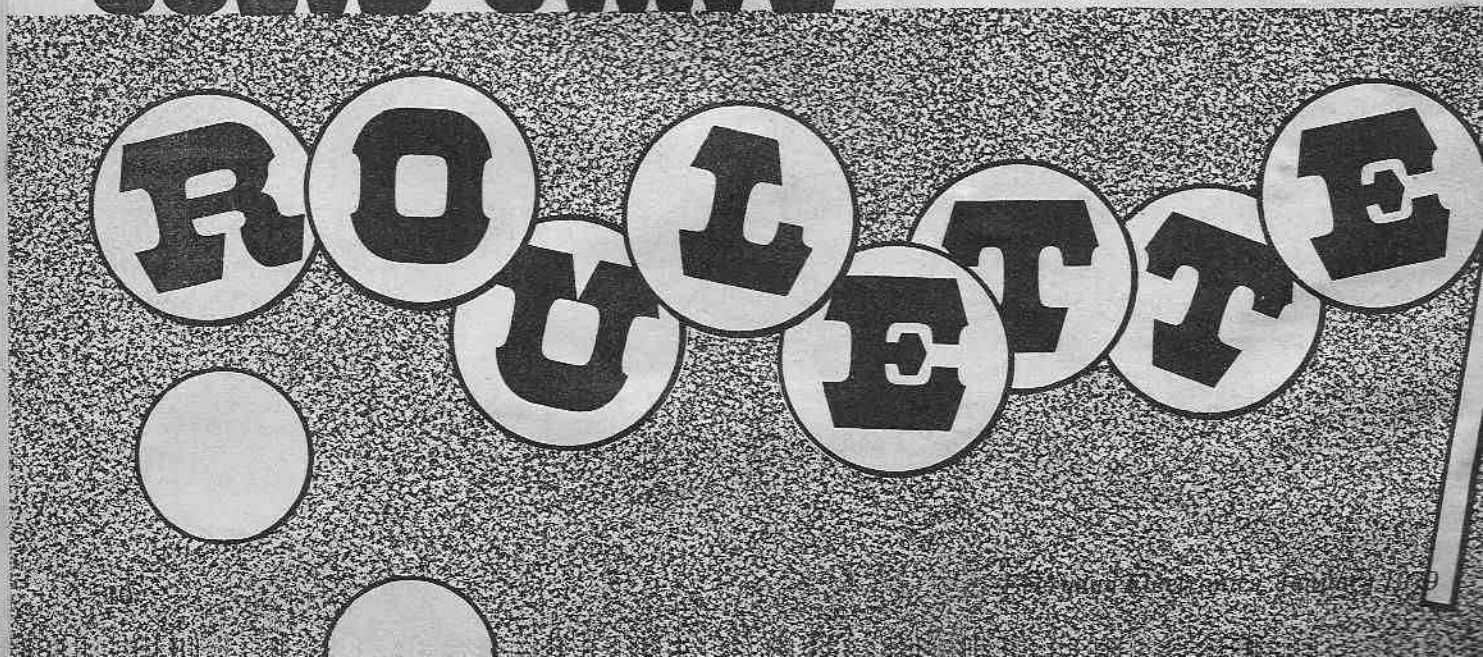
SOLID-STATE ROULETTE

BY E. M. LYNDSELL



THIS unit has been designed to bring the excitement to be experienced at the casino roulette table to your home. It should provide endless hours of entertainment for all the family especially during the imminent festive holidays and other similar occasions.

Roulette is a game of pure chance and this basic requirement has been retained in the solid-state version to be described here.

A roulette wheel contains thirty-seven digits numbered from 0 to 36 some appearing on red squares and some on black. The basic idea is to forecast on which number, group of numbers or colour (red or black) that a ball will land on a spinning wheel, with a shade under straight "odds" being paid out to a correct forecast. For example, the odds offered for an individual number forecast is 35 to 1; mathematical odds for this occurrence is 36 to 1. The difference here is the "0" square which is introduced to favour the bank. When the ball lands on this zero special rules are evoked, see later.

ELECTRONIC VERSION

The Solid-State Roulette operates on identical lines to that described, the only difference being a static wheel instead of the usual rotating one. A fast circularly running light (representing the conventional ball) is, by the action of a switch, caused to decelerate and come to rest alongside a number on the static wheel.

The circuit is tailored for 37 positions on the wheel but can easily be extended to accommodate up to 100 positions. This extended circuit could therefore be employed as a random number generator.

COMPONENTS

Resistors
R1 220Ω
R2 10kΩ
R3 47kΩ
R4 10Ω
All ¼W carbon ±10%

Capacitors
C1 2200μF 10V elect.
C2 330μF 6V elect.
C3 470μF 6V elect. radial leads
C4 0·22μF plastic or ceramic

Semiconductors
D1 IN4001 or similar silicon diode
D2 BZY88C 5·6V 400mW Zener
D3-D6 OA81 or similar germanium diode (4 off)
D7-D43 TIL209 red l.e.d.s (37 off)
TR1 BFY50 silicon *npn*
TR2, 3 2N3702 silicon *pnp* (2 off)
IC1 555 timer i.c.
IC2, 3 74LS90 decade counter (2 off)
IC4, 5 74LS42 b.c.d./decimal decoder (2 off)
IC6, 7 74LS00 quad 2-input NAND gates (2 off)

Miscellaneous
VR1 47kΩ miniature horizontal preset
T1 mains primary/6V 100mA secondary
FS1 100mA 20mm fuse plus chassis fuseholder
S1 s.p.s.t. rotary switch
Stripboard: 0·1 inch matrix 36 strips × 53 holes; 0·1 inch matrix perforated board 38 × 26 holes; connecting wire; mains cable; 4BA fixings and solder tags; self adhesive horizontal board mounts; knob; materials for case and bowl; terminal pins; l.e.d. mounting clips (37 off).

See Shop Talk page 34

CIRCUIT DESCRIPTION

The complete circuit diagram of the Solid-State Roulette is shown in Fig. 1. Since TTL devices are being used and current consumption is in the order of 60mA a mains derived power supply is more economical than batteries.

Mains voltage enters the unit via FS1 and appears across the primary of T1. This is stepped down by T1 and appears across its secondary where half-wave rectification is afforded by D1 and smoothed by reservoir capacitor C1. The d.c. voltage at this point is about 7·8 volts which appears at the collector of TR1. Zener diode D2 holds the base of TR1 at 5·6 volts producing about 5 volts at TR1 emitter; C2 across the power supply output affords additional smoothing.

The next stage encountered is the oscillator built around IC1, the much used timer i.c. type 555. This

is wired as an astable multivibrator whose frequency is arranged to be voltage controlled; VR1 also affects the frequency.

Transistors TR2 and TR3 form a constant current source which charges up the timing capacitor C4 via VR1. The value of this current is determined by the base current of TR2; TR1 acts as a diode to clamp the base of TR2 at 0·6 volts when the former is forward biased. A transistor of the same type number is used for close matching of base/emitter voltage drop.

When S1 is in the SPIN position, C3 is discharged, thus the junction of C3/R3 is almost at 0 volts. Hence base current for TR3 is at a maximum and the oscillator runs fast. If S1 is now turned to the PLAY position C3 begins to charge up via R2 which reduces the voltage across R3 thereby reducing TR3 base current.

The charge current is proportionally reduced and so the oscillator frequency decreases. After a time determined by the values of R2 and C3, the voltage across the latter reaches and exceeds 4·4 volts (rail voltage less drop across TR2 base/emitter) and IC1 ceases to oscillate due to TR3 being biased off.

OSCILLATOR OUTPUT

The output from the oscillator —a train of rectangular pulses—is passed to the BCD/decade counter IC2. Output from here is in binary form. The most significant digit of the binary count acts as a divide-by-ten (oscillator frequency divided by ten) and this is connected to the input of a second decade counter IC3. Each counter is connected to a decimal decoder, IC4 and IC5. There are as the name suggests ten outputs labelled 0 to 9.

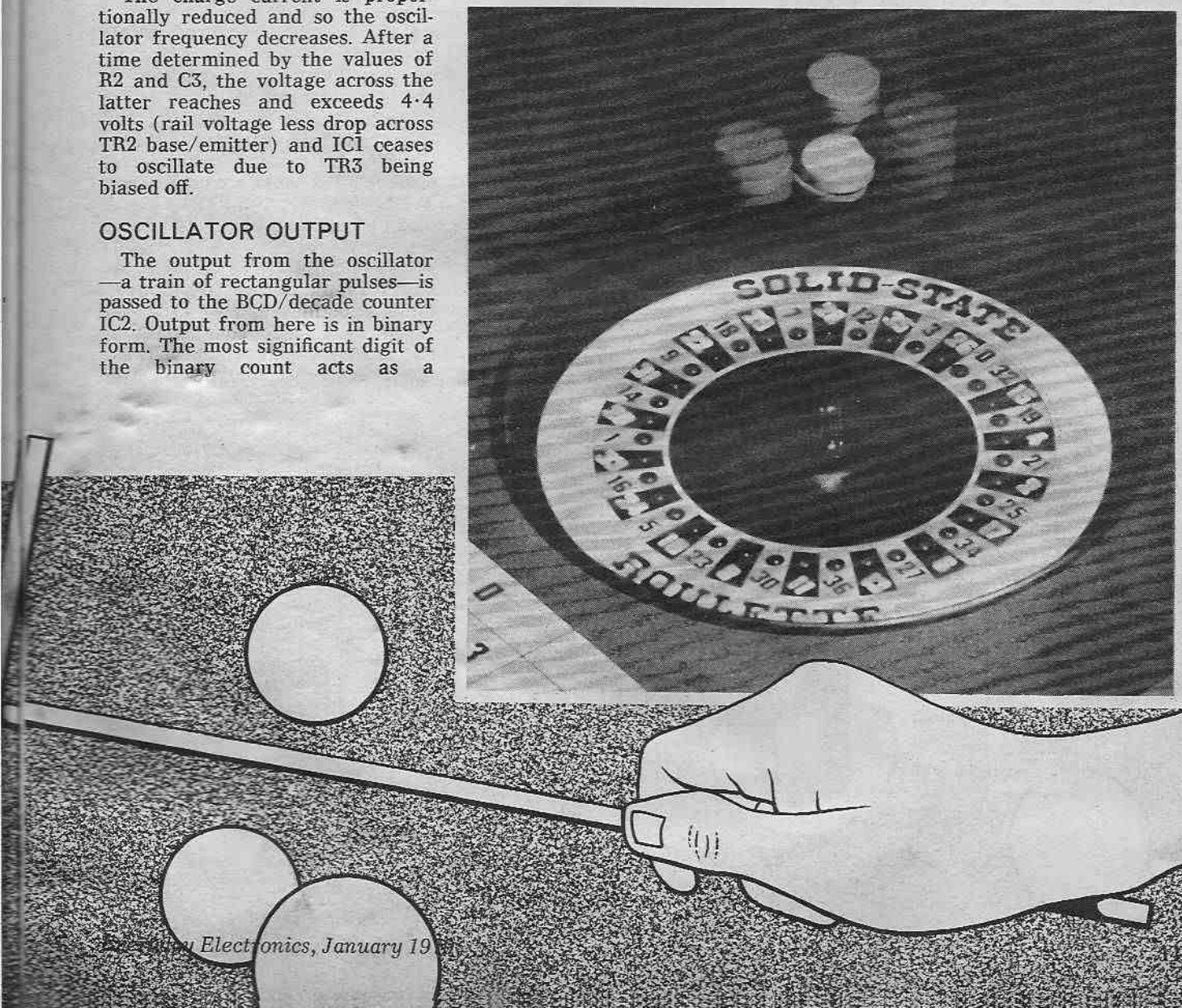
As seen from a truth table for a 7442 i.c., at any one time nine of these outputs are high (logic 1) and the remaining one low, the position of the latter depending on the binary output count from the counters. Decoder IC4 functions as the "unit" position indicator of the input pulses to IC2 and IC5 the "tens" position indicator. Only four outputs from IC5 are required as will become evident soon, and these are inverted by the NAND gates in IC7 (inputs linked to produce inverting action). Therefore the outputs from IC5 (via IC7) will consist of one "high" and the remainder "low".

DIODE MATRIX

By forming a matrix of diodes (light emitting diodes) at the intersections of the inverted outputs from IC5 with those from IC4, at any one time there will always be one high output from IC5 and one low output from IC4. Thus the l.e.d. connected across these outputs will be forward biased and will light.

A running oscillator will therefore cause all the l.e.d.s to light one at a time. Arranging these l.e.d.s in a circular format will give the impression of movement—a ball rolling around a wheel—the desired effect.

The fourth used output of IC5 ("tens") and the seventh output of IC4 ("units") are fed to the input of IC6 logic circuitry, four NAND gates wired as a two-input NOR gate. This gives a high output only when both inputs are low, and this is fed to the reset pins on



IC2 and IC3. Thus the counters are reset to zero after count 37 and the counting sequence starts again to repeat for as long as pulses are produced by the oscillator.

Diodes D3 to D6 are included to eliminate possible damage to the l.e.d.s by reverse biasing.

Low power TTL integrated circuits were used throughout to reduce the overall power consumption to about 60mA. These devices are recognised by the interjection of *LS* in the type number, eg, a low power 7400 is identified as 74LS00. Standard types may be substituted but current supply capabilities will need to be increased accordingly.

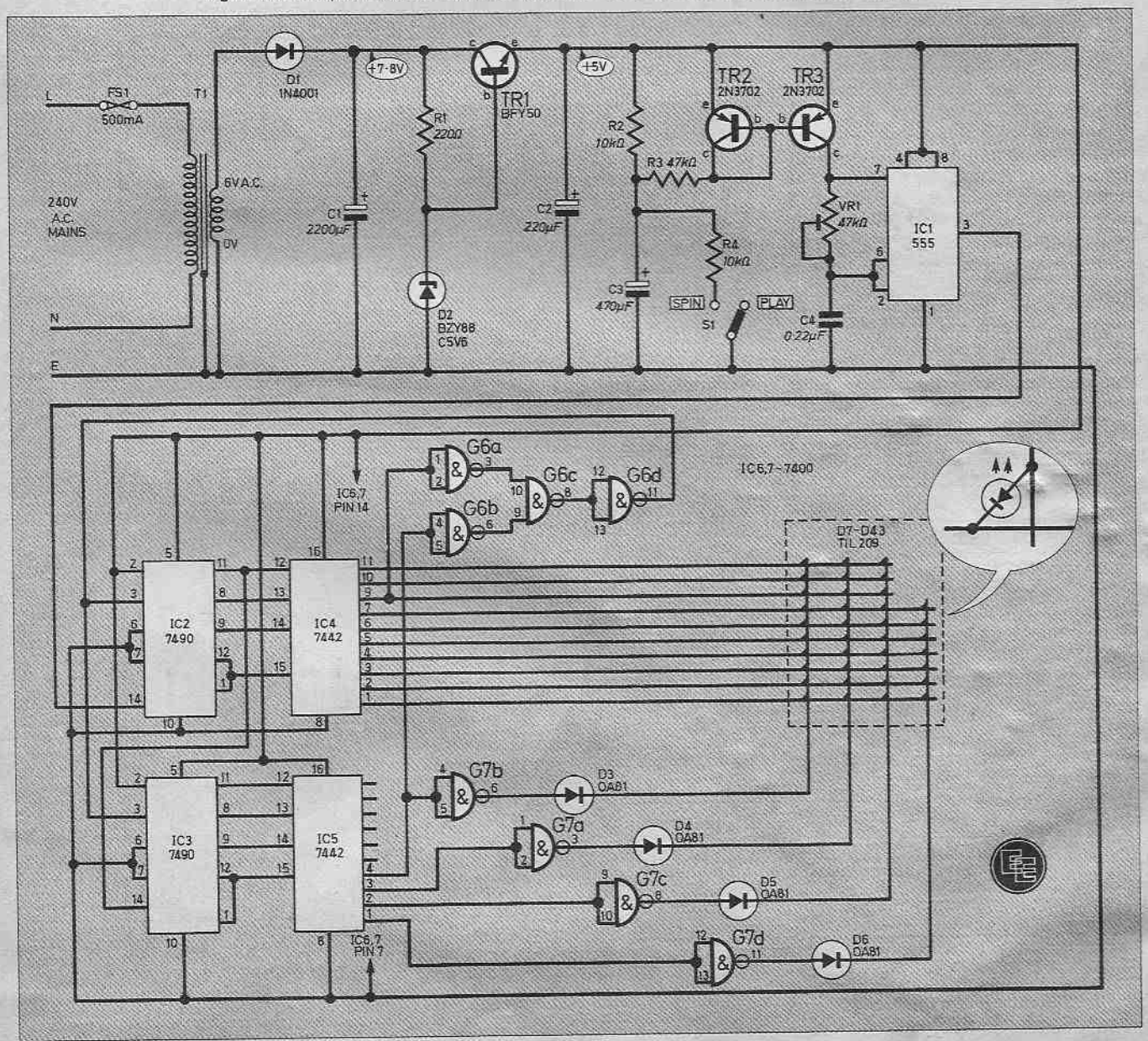
CONSTRUCTION starts here

The prototype Solid-State Roulette used two separate circuit boards, one for the power supply section and the other for the main circuitry. However, there is no reason why a single circuit board cannot be used if desired. The layout is not critical but outputs to the l.e.d.s should be routed away from the counter inputs to avoid spurious triggering causing the "ball" to skip position towards the end of its motion. This was experienced on an early prototype and could be viewed as more realistic, but was not the effect desired by the author.

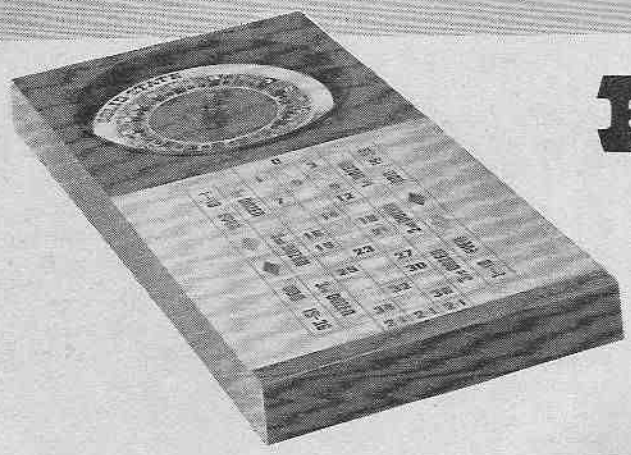
The main circuitry was built on a piece of 0·1 inch matrix stripboard size 36 strips x 53 holes and is shown in Fig. 2 which also shows the breaks to be made on the underside.

Although not essential, i.c. sockets were used to facilitate easy replacement of devices should this prove necessary. Use of

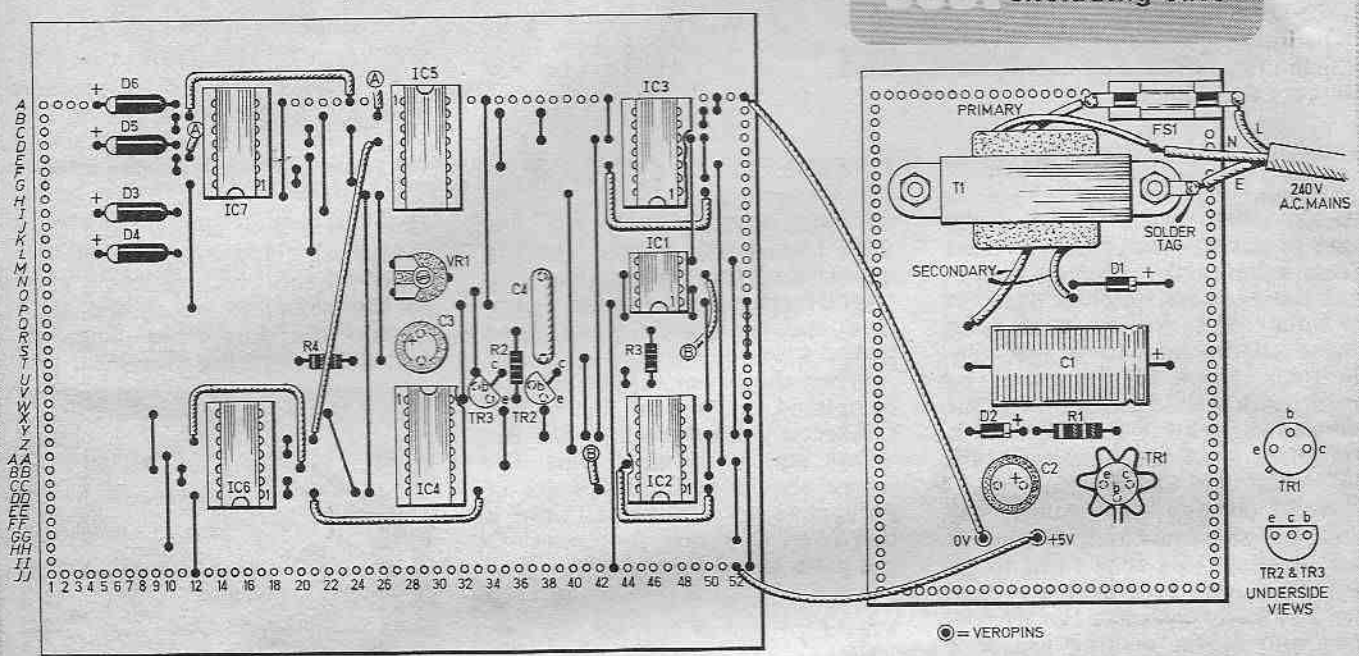
Fig. 1. The complete circuit diagram of the Solid-State Roulette including power supply.



ROULETTE



COMPONENTS approximate cost £15 excluding case



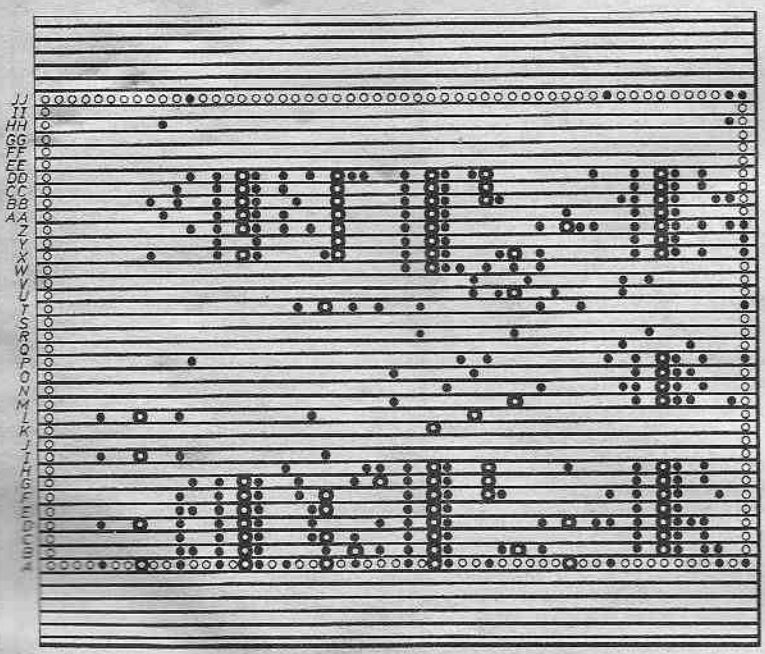


Fig. 2. The layout of the components on the main circuit board, showing inter-track links and breaks to be made on the underside.

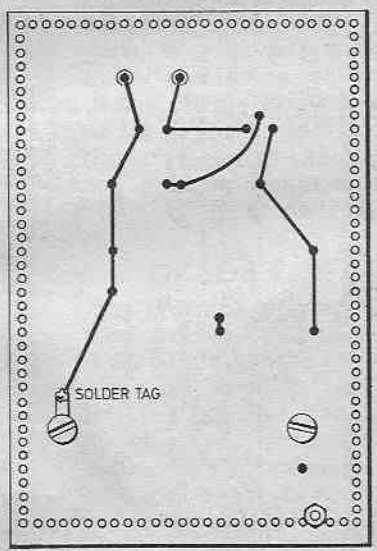
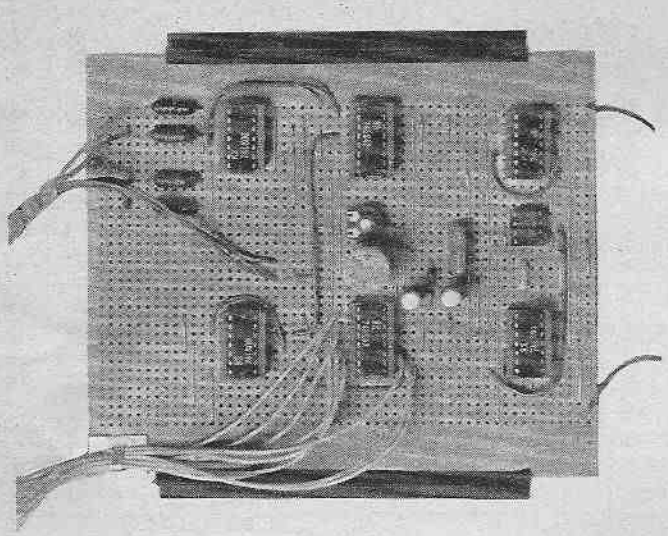
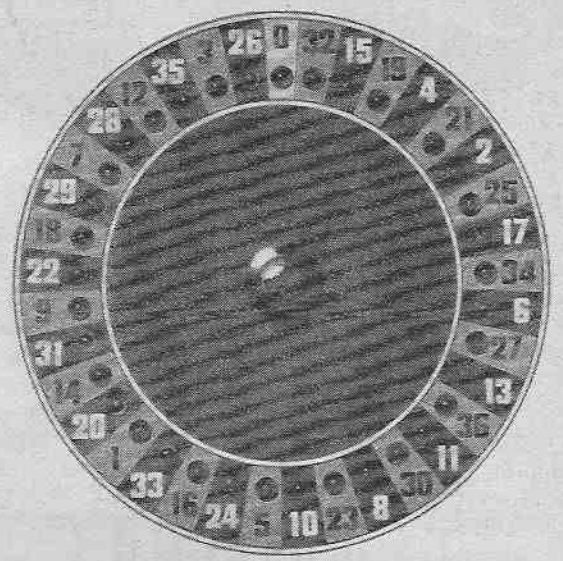


Fig. 3. The layout of the components on the topside of the power supply board and interwiring on the underside.



Photograph of the topside of the completed main circuit board with flying leads attached.



A close-up plan view of the numbered wheel. The angles between the l.e.d.s can be measured to produce a full size wheel.

sockets also enables quick isolation of a particular circuit section from other active elements without the need for desoldering.

Mount the sockets and then make all the inter-track link connections. Some of these can be made with tinned copper wire but others will require insulated wire; for these solid insulated wire will be better than the stranded type.

Next position and solder the resistors and capacitors. The holes for locating VR1 may need to be enlarged to accommodate the leads. Finally assemble the transistors and diodes making use of a heatshunt on their leads if you are a novice at soldering.

The next stage is to attach all the flying leads. For this, use stranded insulated wire of sufficient length to reach the wheel assembly and power supply board. There are eighteen leads in all so it is a good idea to use as many different colours as possible for easy identification later.

POWER SUPPLY BOARD

The power supply board is constructed on a piece of 0·1 inch matrix perforated board sixe 38 x 26 holes. The layout of the components on the topside and the interwiring on the underside of the board is shown in Fig. 3. The transformer is secured to the board by means of 4BA, bolts and shakeproof washers. One of these fixings is fitted with two solder tags for earthing purposes, one on the topside and the other on the underside of the board.

Power supply lines, 0V and +5V from power supply board to main board are via terminal pins on the former to allow easy separation and connection when fitted in the case.

When the power supply board is completed, it should be tested. Connect a voltmeter set to 10V d.c. across the two terminal pins. The meter should indicate 5 volts or very close to this value. Only if this is so is it safe to connect to the main board later.

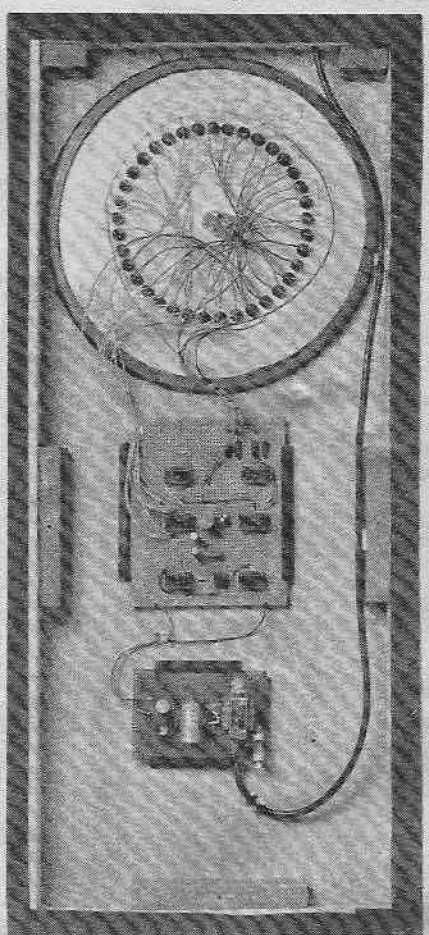
WHEEL

The wheel in the roulette game is made up of thirty-seven l.e.d.s D7-D43 equispaced around the circumference of a circle 200mm in diameter.

In the prototype, the l.e.d.s were fitted to a circular panel of 2mm thick cardboard but can be plywood or hardboard. The overall diameter of this panel will be decided by the internal diameter of the roulette bowl; a 254mm diameter (10 inch) plastic flower pot tray was used with the lower section removed. This was later sprayed matt black. Alternatively, a sandwich cake tin, or the plastic coil cover employed in the *Treasure Hunter* in the October 1978 issue could be used.

Prepare the circular panel to fit the bowl chosen and drill the holes to suit the l.e.d.s. In the model shown, Letraset and coloured paper were used directly onto the card panel. It is recommended that this lettering be carried out before fitting the l.e.d.s and protected by clear varnish or similar, and then the panel glued to the bowl.

Fit all the l.e.d. mounting clips to the complete panel and then secure the l.e.d.s so that all cathodes are facing innermost and



The completed prototype roulette viewed from the underside with the base panel removed, showing positioning of the boards.

then wire up the 37 l.e.d.s according to Fig. 4. Use tinned copper wire for anode bus bars.

The SPIN/PLAY switch is mounted at the centre of the wheel and should be fitted next. It only remains to connect the 14 flying leads from the main board to the l.e.d. complex, board to S1 and the tested power supply board to complete the electronic construction.

FINISH

The appearance of the finished product will be the personal choice of the constructor, but for those wishing to build a unit similar to the prototype details are contained in Fig. 5.

A single piece of self-adhesive green baize with a rectangular cut-out covered the whole of the unit, the cut-out allowing the "table" to show through. The latter was produced using Letraset and coloured paper and then protected by a transparent plastic film.

TESTING

With S1 set to the SPIN position and VR1 set almost fully clockwise, plug the unit into the mains and switch on. The l.e.d.s will all appear to be on and flashing on and off so as to produce a sensation of fast clockwise motion. Turning S1 to PLAY will cause this motion to reduce speed with fewer and fewer l.e.d.s appearing to be on until there is only one moving very slowly which eventually and definitely comes to a rest.

Board mounted control VR1 controls the spinning speed and "speed decay" time and should be set to suit. The spinning speed should however be high enough so as not to enable the precise launch into the decay interval to be observed. If the launch position is noticeable, the rest position can be accurately determined.

Table 1: Forecasts and their odds.

Forecast	Odds
Any number 0–36	35–1
Any two adjacent table numbers	17–1
Any row of three	11–1
Any four adjacent table numbers	8–1
Any six adjacent table numbers	5–1
Group 1–12 (1st Dozen)	2–1
Group 13–24 (2nd Dozen)	2–1
Group 25–36 (3rd Dozen)	2–1
Any vertical column	2–1
All even numbers (Evens)	1–1
All odd numbers (Odds)	1–1
All numbers on red background (Red)	1–1
All numbers on black background (Black)	1–1
Numbers 1–18	1–1
Numbers 19–36	1–1

RULES AND PLAY

For those not conversant with the rules and mode of play for roulette, the basic idea is to forecast the position where the ball will come to rest—in our case—

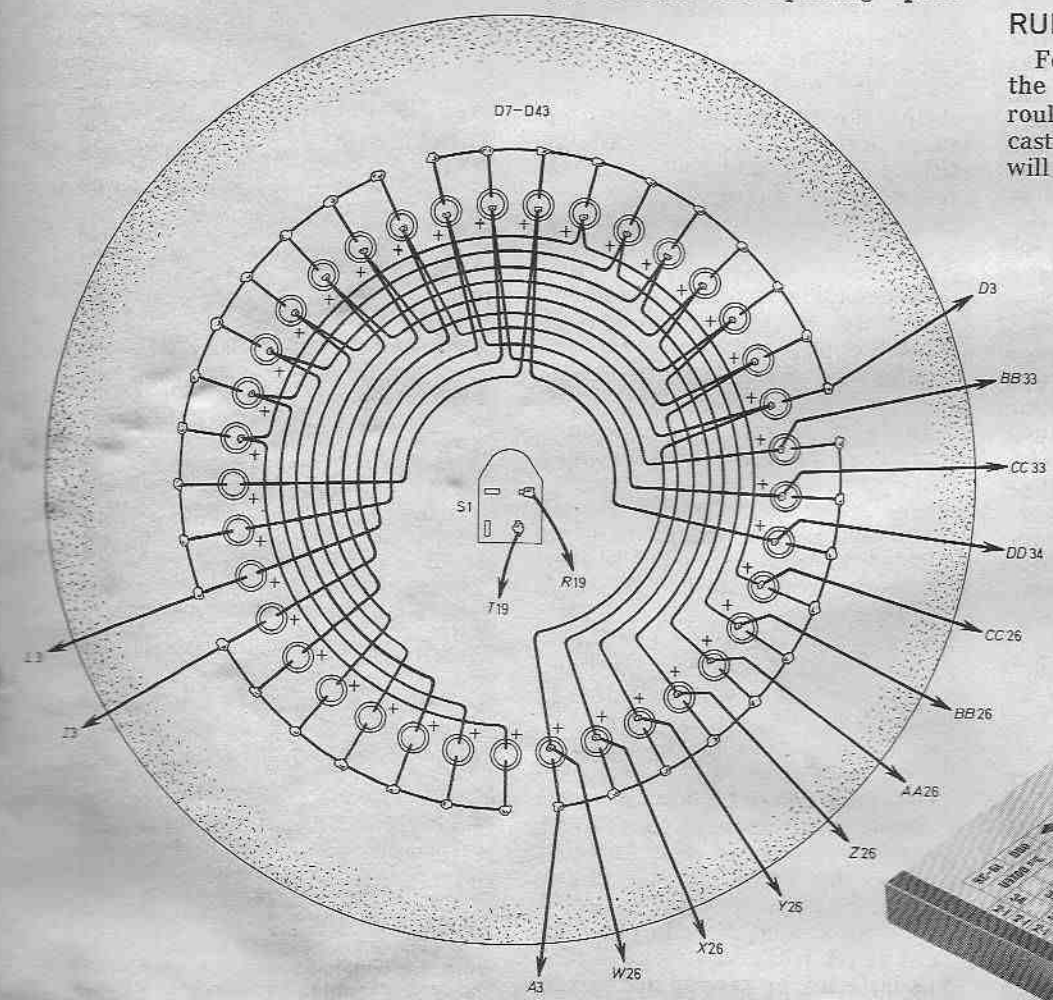
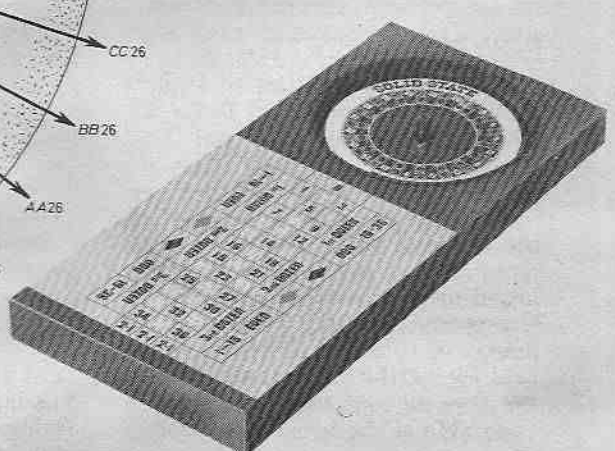


Fig. 4. Shows the underside of the "wheel" showing interconnections. It is essential that insulated wiring be used for interconnecting the l.e.d.s whereas stout tinned copper wire is best for the bus bars connecting the l.e.d. anodes. Note that the cathode is shown marked with a "plus" sign.



the l.e.d. position lit when the oscillations cease.

Depending on the form of your forecast, various odds ranging from evens (1 to 1) to 35 to 1 can be obtained. Forecasts to choose from and their odds are shown in Table 1.

Any number of people may play. One player elects to be *banker* and plays against the rest.

Forecasts are "made" by placing a counter on the "table" in the squares provided. Some of the forecasts require special placing of the counters, see Fig. 6 for details.

SPIN AND PLAY

While players are making their forecasts by placing counters on the table, at the bankers invitation, the wheel is set to SPIN (by S2). The banker may then call *ne va plus rien* (nothing more) indicating that no more forecasts can be accepted, and then sets S1 to PLAY.

The electronic wheel selects a number/colour; the banker then collects all the incorrect forecasts and gives the requisite number of counters to the players with a correct forecast according to Table 1. The banker then repeats his invitation to play and the game continues as above.

ZERO PLAY

When "0" is the winning number, any player on zero receives 35 to 1 and all others lose with the exception of those on Red, Black, Odd, Even, Numbers 1 to 18 and Numbers 19 to 36, in fact all forecasts whose odds are evens. The counters on these forecasts are placed in suspense until a further spin of the wheel. If they lose on this second spin, the counters are collected by the banker; if they are correct the counters are left on the table for a third and last spin and results paid according to Table 1.

No further forecasts can be made during these extra spins.

Some "local" rules concerning the banker probably need to be devised such as a time limit for the length of time a person can remain banker and/or the number of counters he holds (a minimum count). It is assumed that these finer points will be suitably determined by the players themselves.

Bon chance! ⌑

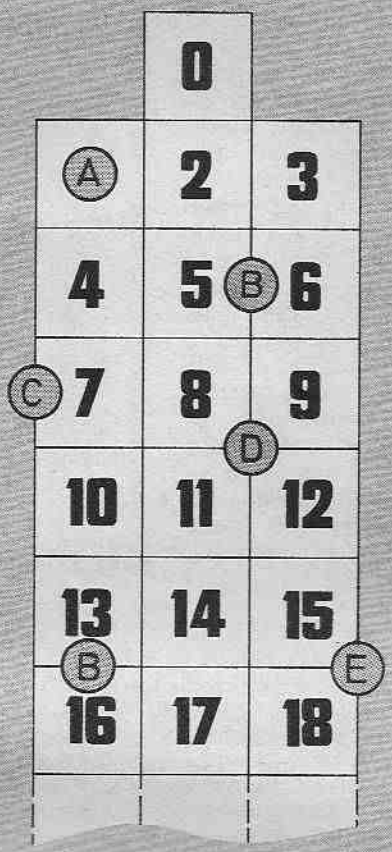


Fig. 6. Specially placed counters: *A* covers 1; *B* (upper) covers 5 and 6; *B* (lower) covers 13 and 16; *C* covers 7, 8, and 9; *D* covers 8, 9, 11, and 12; *E* covers 13 to 18 inclusive.

ROULETTE TABLE CUTTING LIST

Frame	685 × 50 × 21 (2 off) 263 × 50 × 21 (2 off) *Softwood*
Top Board	685 × 305 × 4 (1 off) *Plywood*
Base Board	643 × 263 × 4 (1 off) *Plywood*
Wheel	254 dia. × 3 (1 off) *Card, Hardboard or Plywood*

(*Dimensions in mm*)

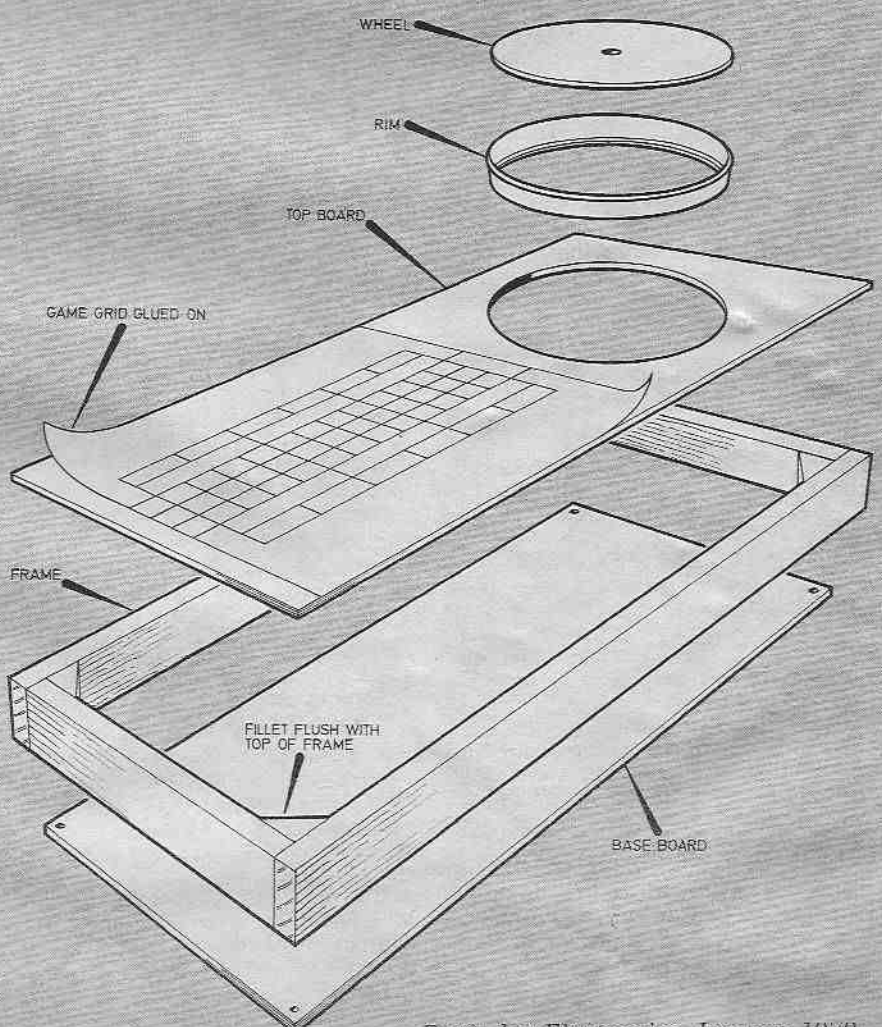


Fig. 5. An exploded view of the case showing the method of construction. The depth of the frame may need to be increased if a deeper transformer is used.