Easy to build projects for everyone

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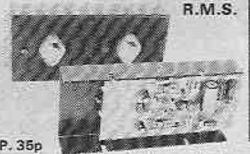
High quality audio accessories from BI-PAK

AL120

50W R.M.S.

AUDIO AMPLIFIER
(With integral heat sink and short-circuit protection).



£11.95
+ 8% V.A.T. P. & P. 35p

OUTPUT POWER	50 Watts R.M.S.
SUPPLY	70 Watts
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	05% Max. (Typically 02%)
FREQUENCY RESPONSE ±1dB	25Hz-20kHz
SENSITIVITY	500mV
MAX HEAT SINK TEMP.	45 deg. C
DIMENSIONS	192 x 89 x 49 mm

Introduced to fulfill the demand for a fully protected power amp., capable of driving high quality speaker systems at up to 50w., with distortion levels below 05%. Ideal for domestic use, Discos, P.A. systems, electronic organs etc. The generously rated components ensure continuous operation at high output levels.

SPM120

STABILISED POWER SUPPLIES

SPM120/45
SMP120/55
SMP120/65

£5·80
+ 12½% V.A.T.
P. & P. 35p

NEW

AC INPUTS	
SPM120/45	40-48v
SPM120/55	50-55v
SPM120/65	60-65v
OUTPUT CURRENT	2.5A
RIPPLE	1A 100mV 2A 150mV

SPM120 is a fixed voltage stabiliser available with an output voltage of either 45v, 55v, or 65v. Designed primarily for use in audio applications, the stabiliser which provides output currents up to 2.5A., operates direct from a mains transformer requiring only the addition of 2 Electrolytic capacitors to complete the s/c protection.

GE100 Mk2.

10 CHANNEL MONOGRAPHIC EQUALISER

£20·00
+12½% V.A.T.
P. & P. 35p

NEW

Control Range	±12dB
Dynamic Range	110dB
Maximum Output	+15dB
Frequency Response	30Hz-20KHz (±1dB)
Power Supply	15–0–15v.
Voltage Handling Input	3v R.M.S.
T.H.D.	005%

Only 155mm x 65mm x 50mm including the 10 x 10K 1in slider potentiometers and knobs which are mounted on a board positioned above the circuitry. In the frequency range of 31Hz to 20KHz you can cut and boost ±12dB with the 10 sliders, each of which has its frequency marked on the circuit board. The GE100 has numerous uses including mixers, P.A. systems and discos. It will also greatly improve the sound reproduction of your existing audio equipment. Power Supply for GE100, o/d SG30 £3.80.

VPS30

REGULATED VARIABLE STABILISED POWER SUPPLY

£7.60 +8% V.A.T.
P. & P. 35p

AC Input Maximum	25v
Voltage Regulation	2-30v
Regulated Current	0-2A
Incorporating short circuit protection	

This NEW versatile Regulated Variable Stabilised Power Supply with short circuit protection and current limiting, is a must for all electronics enthusiasts. It incorporates adjustable voltage from 2v–30v, with a current limiting range of 0–2A. With this module there is no need to build a separate power supply for each of your projects, with the simple addition of a transformer (o/d 2033), 0–1ma (o/d 1310 or 1305), plus a suitable shunt, a voltmeter (o/d 1311 or 1306), a 470ohm pot (o/d 1896), a 4K7 pot (o/d 1899), it can be used again and again as a self-contained bench, power supply, eliminating the use of batteries and thus saving ££'s!

PA200

STEREO PRE-AMPLIFIER

£16.55
+12½% V.A.T.
P. & P. 40p

FREQUENCY RESPONSE		20Hz to 20kHz × 1dB	
TOTAL HARMONIC DISTORTION		Less than 1% (Typically ·70%)	
SENSITIVITY INPUTS	1. TAPE 2. RADIO TUNER 3. MAGNETIC P.U.	100mV/100 K ohms 100mV/100 K ohms 3·5mV/50 K ohms	For an output 500mV
EQUALISATION		Within ± 1dB from 20Hz to 20kHz	
BASS CONTROL RANGE		± 15dBs at 75Hz	
TREBLE CONTROL RANGE		+ 10-20dBs at 15kHz	
SIGNAL/NOISE RATIO		Better than 65dBs (All inputs)	
INPUT OVERLOAD		Better than 2dBs (All inputs)	
SUPPLY		35 to 706v	
DIMENSIONS		300 × 90 × 33mm (less controls)	

The PA200 is basically our popular PA100. Modifications have been made to make it compatible with the higher output AL120 and AL250 amplifiers.

HEADPHONES

A top quality headphone with cushioned earpads and headband. Separate balance/volume controls. Stereo or Mono switch. Impedance: 8 ohms. Frequency: 30-18,000Hz. o/n 884. **£8.70.** + 12½% V.A.T. p&p 70p.

A brilliant compromise between price and performance. Superb stereo reproduction for the newcomer to Hi-Fi. Impedance 8 ohms. Frequency: 30-15,000Hz. o/n 885. **£4.40.** + 12½% V.A.T. p&p 50p.

BIB HI-FI ACCESSORIES

Parallel Tracking GROOV KLEEN
The very latest in automatic record cleaning. Designed to suit all modern single play decks. Simple to fit, it is extremely efficient. Complete with two types of base and three height extensions. o/n 8101. **£3.68.** + 8% V.A.T. p&p 35p.

Cassette Tape Editing Kit
Enables cassette tapes to be edited and joined easily, quickly and accurately. Kit comprises: Tape Splicer ⅛" (3.2mm). 2 Precision Tape Cutters. Tape Piercer. 9 Self-adhesive Labels. Reel of Splicing Tape. 3 Winders and removers and instructions, all in a handy wallet. o/n 811. **£2.40.** + V.A.T. p&p 35p.

GROOV-STAT
The BIB Groov-Stat static reducer neutralises the static charge on records and other plastic surfaces. o/n 8103. **£5.45.** + 8% V.A.T. p&p 35p.

Cassette Head Cleaner
Essential for cleaning of tape heads, capstans and rollers. Pack contains Tape Head Applicator and tape head polisher tools. Plus bottle of special formula cleaning fluid and full instructions. o/n 832. **£0.56.** + 12½% V.A.T. p&p 35p.

ADAPTORS

AC-DC enables a large range of battery powered radios, recorders, calculators to be run off the mains. (220-240v AC) Switchable for 6, 7.5 or 9 volts. Current rating 2,500mA. Polarity reversing switch. Universal plug incorporated. o/n 137. **£3.95.** + 12½% V.A.T. p&p 35p.

DC-DC for use in all cars, boats etc., with pos. or neg. earth for a regulated output of 6, 2.5 or 9 volts DC at 1A max. For radios, recorders etc. o/n 138. **£2.80.** + 12½% V.A.T. p&p 32p.

CROSSOVER NETWORKS

2-WAY channels for high and low frequencies to correct speakers – high to tweeters, low to woofers. Complete with instructions. Frequency: 3,000Hz. o/n 1904. **£1.10.** + 12½% V.A.T. p&p 35p.

2-WAY for 8 ohm speakers up to 30 watts. Frequency: .3KHz. o/n 1905. **£1.65.** + 12½% V.A.T. p&p 35p.

3-WAY for 8 ohms speakers up to 30 watts. Frequency: 800Hz and 4.5KHz. o/n 1906. **£2.95.** + 12½% V.A.T. p&p 35p.

BI-PAK

**DEPT. E.E.1, P.O. BOX 6,
WARE, HERTS.**

E.E.1

METERS

Miniature Balance & Tuning Meter
Miniature moving-coil meter for stereo balance indicator, tuning indicator for FM or similar application. Pointer at centre indicates zero or null position. Robust construction. Sensitivity: 100–0–100MA. Dimensions: 23 x 22 x 26mm. o/n 1318. **£1.95** +8% V.A.T. p&p 35p.

Balance and Tuning Meter
Clear view edgewise meter. Centre zero application. Sensitivity: 100–0–100UA. Dimensions: 45 x 22 x 34mm. o/n 1319. **£2.00.** +8% V.A.T. p&p 35p.

Miniature Level Meter
Moving coil, for accurate level indication for tape recorders, amplifiers etc. Neat design, rugged construction – will withstand five times rated value. Sensitivity: FSD: 200UA. OdB: 130UA. Dimensions: 23 x 22 x 26mm. o/n 1320. **£2.80.** +8% V.A.T. p&p 35p.

Vu Meter
Calibrated –20 to +3 and 0-100%, making it suitable for use as a recording level meter or as a power output indicator. Sensitivity: 130uA. Dimensions: 40 x 29mm. o/n 1321. **£2.00.** +8% V.A.T. p&p 35p.

MICROPHONES

DYNAMIC CASSETTE
For equipment requiring a high quality microphone. Sturdy, solid moulded body in black with neat chrome surround. Pick-up pattern is omnidirectional. On/Off switch, 1 metre of tough lead with floating 2.5 and 3.5mm plugs. Matching moulded strut. Impedance: 200 ohms. Sensitivity: 90dB. Frequency: 90-10,000Hz. Size: 20mm dia x 120mm. o/n 1326. **£1.50.** + 12½% V.A.T. p&p 35p.

DYNAMIC MICROPHONE
Superior quality portable cassette recorder mike with built-in remote control switch and lead fitted with 5-pin 240° DIN plug (remote switch) and 3 pin DIN plug (microphone). Provides a direct replacement for those supplied with recorders. With detachable stand. Omnidirectional. Impedance: 200 ohms. Freq. response: 100 to 10,000Hz. Sensitivity: 79dB at 1,000Hz. o/n 1327. **£2.65.** + 12½% V.A.T. p&p 35p.

RE – 317: DYNAMIC MICROPHONE
Highly sensitive, high-grade desk or hand mike suitable for use with many popular cassette decks. Incorporates On/Off switch and 1 metre lead with moulded standard jack plug. Complete with desk stand. Omnidirectional. Impedance: 5,000 ohms. Freq. response: 100 at 12,000Hz. Sensitivity: (–7dB at 1,000Hz). o/n 1336. **£4.10.** + 12½% V.A.T. p&p 35p.

OMNIDIRECTIONAL CARDIOID
Powered by a 1½v battery located within the aluminium body. Satin silver finish with front disk protection to the diaphragm housing. On/Off switch. Also with 'Busby' type windshield, "U" bracket and stem and extremely supple cable. Consumption: 0.2mA from 1½v battery providing approx., 8-10,000 hours continuous life. Impedance: 600 ohms. Sensitivity: 70dB. Frequency: 30-16,000Hz. Size: 23mm dia + 267mm. o/n 1329. **£12.80.** 12½% V.A.T. p&p 35p.

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Dual imp. 600 and 50,000 ohms. Response 50 to 14,000Hz. Sensitivity 54dB at 50K/ohms. Size: 1½" dia x 6½" long. Weight approx., 190gm. o/n 1328. **£10.95.** + 12½% V.A.T. p&p 35p.

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GOOSENECK CHROME FLEXIBLE HOLDERS
Length 320mm. o/n 1333. **£2.40.** + 12½% V.A.T. p&p 35p.
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117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0.68*
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Please add 8% V.A.T. to all the above.

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TECHNICAL SPECIFICATION

- Shock resistant ABS case.
- Audio Output: 500 mW (from internal output module and loudspeaker).
- Size: 260mm × 200mm × 50mm.
- Batteries: 4 × HP7 (Not supplied).

Accessories provided:

- Crystal Earpiece.
- Aerial & Connecting Wire (ferrite rod aerial built in).
- Clips & Test Rods.

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EMI SPEAKER BARGAIN

Stereo pair 350 kit. System consists of 13" x 8" approx. woofer with rolled surround; 2½" approx. Audax tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS. 20 watts max. 8 ohm impedance.

£14.95 Per stereo pair + £3.40 p&p

★ As above but complete with all woodwork in kit form, finished in simulated teak veneer, with instructions. Size approx 20" x 11" x 9½" **£28.00** Per stereo pair + £5.00 p&p

EASY BUILD RECORD PLAYER KIT

for the D-I-Y man who requires a stereo unit at a budget price, comprising ready assembled stereo amp. module. Garrard auto/manual deck with cueing device, pre-cut and finished cabinet work. Output 4 watts per channel, phones socket and record/replay socket including 2 SPHERICAL HIFI speakers. **£19.95** p&p £4.05

BARGAINS FOR PERSONAL SHOPPERS

PORTABLE STEREO RADIO CASSETTE RECORDER UNREPEATABLE MW, LW, SW and Stereo VHF. 6 watts output Battery/Mains operation. **£69.95**

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POCKET CALCULATOR. With LED display, memory and percentage key. **£2.95**

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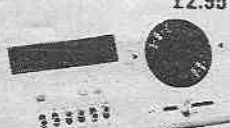

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Mains power supply for above unit. **£3.50**

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Power Output 5 watts per channel Sine at 2% THD into 15 Ohm 7 watts speech and music.
Tape Sensitivity Playback 400mV/30K OHM for max output Record 200mV/50K output available from 25KHz. (150mV/100K) deviation FM signal **Frequency Range (Audio)** 50Hz to 17KHz within ± 1dB
Radio FM sensitivity for 3dB below limiting better than 10 uV AM sensitivity for 20dB S/N MW 350 uV/Metre LW 1mV/Metre
Size approx length 16" x height 2¾" x depth 4¾"
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Brushed aluminium fascia and rotary controls.
Five vertical slide controls, master volume, tape level, mic level, deck level. PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level.
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Projects... Theory...

and Popular Features...

There are, two principal methods of circuit construction in general use. One uses the standard off-the-shelf stripboard which is versatile and suitable for most designs. The majority of projects in EE are built this way. The other method involves a printed circuit board (p.c.b.).

A p.c.b. takes time to produce—or acquire, whereas stripboard, or plain s.r.b.p. for that matter, is usually at hand. Thus if one wishes to commence building a project immediately, the latter methods have the advantage. This is especially so with the smaller projects.

But without doubt, the larger and more complex the circuit the greater the advantage there is in using a printed circuit. A classic example is provided by our *2020 Tuner Amplifier*. If a project of this magnitude were tackled using stripboard the task would be irksome and fraught with danger of errors occurring during the making of numerous connections.

A detailed illustrated account of the making of a printed circuit board appears in this issue. This article should interest all readers, including those who may in the end prefer to purchase ready made p.c.b.s from firms specialising in this business.

The constructors own exhibition *Breadboard* held in London in November was a resounding success. That this hobby attracts people of all ages was well demonstrated by the enthusiastic throng that turned up each day. We were pleased to meet many of our readers and to have the opportunity of letting them see some of our projects in the flesh. Here's to the next time!

Besides introducing entirely new games electronics is playing a lively part in restoring the popularity of party or parlour games known to our grandparents. The *Solid-State Roulette* is our latest offering in this field. Then as a complete contrast to the "gaming scene" we revive memories of more innocent childhood amusements with an electronic version of a game of skill. This version of Snap is called *I'm First!*

Because of matters over which we have little control, this issue of EVERYDAY ELECTRONICS may arrive a little late to permit building the larger project *Roulette* before Christmas. But you should be able to build *"I'm First!"*—even if you are a beginner—in the time available.

Whatever you build, have fun. And seasonal greetings to you all from all of us at EE.

Fred Bennett

Our February issue will be published on Friday, January 19. See page 27 for details.

Readers' Enquiries

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

Telephone enquiries should be limited to those requiring only a brief reply. We cannot undertake to engage in discussions on the telephone, technical or otherwise.

Component Supplies

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

Everyday ELECTRONICS

VOL. 8 NO. 1 JANUARY 1979

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

Back issues of EVERYDAY ELECTRONICS June 1977 onwards (October to December 1977, January to March 1978 NOT available) are available world-wide at a cost of 60p per copy inclusive of postage and packing. Orders and remittance should be sent to: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF.

Binders for Volumes 1 to 7 (state which) are available from the above address for £2·85 inclusive of postage and packing.

I'M FIRST!

IDEAL FOR BEGINNERS

HEADPHONE ENHANCER

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

ROULETTE

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.

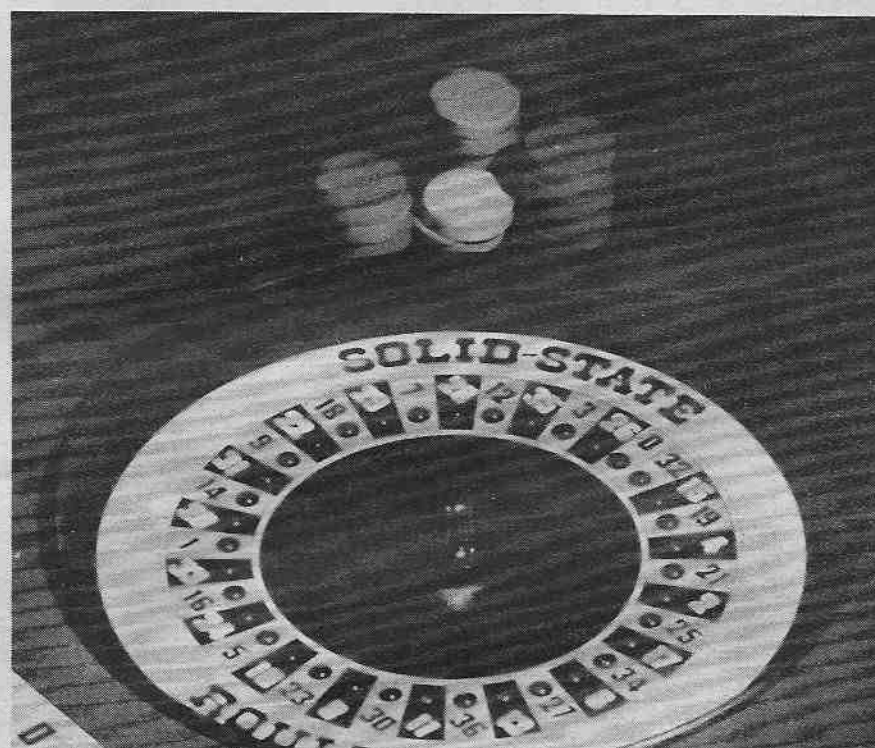
As seen from a truth table for a 7442 i.c., at any one time nine of these outputs are high (logic 1) and the remaining one low, the position of the latter depending on the binary output count from the counters. Decoder IC4 functions as the "unit" position indicator of the input pulses to IC2 and IC5 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".

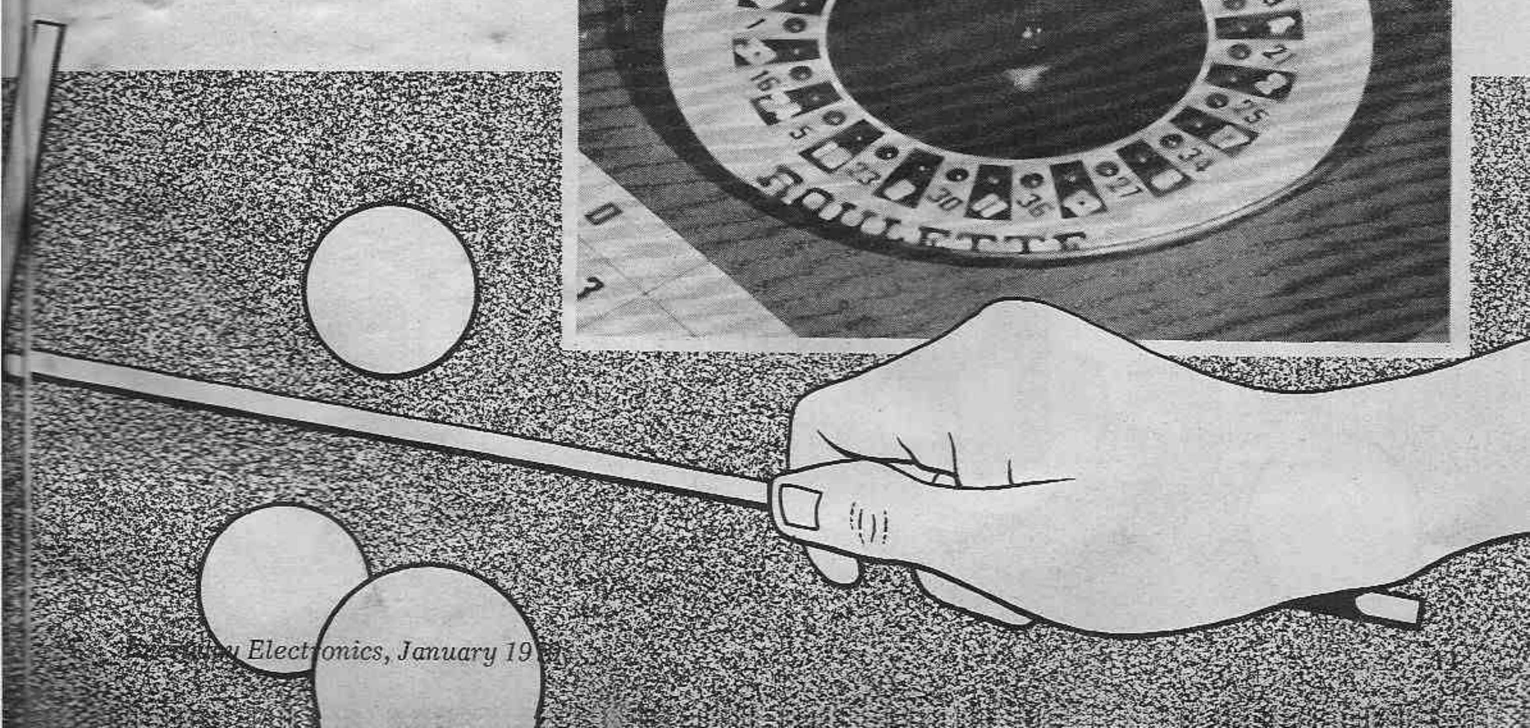
DIODE MATRIX

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.

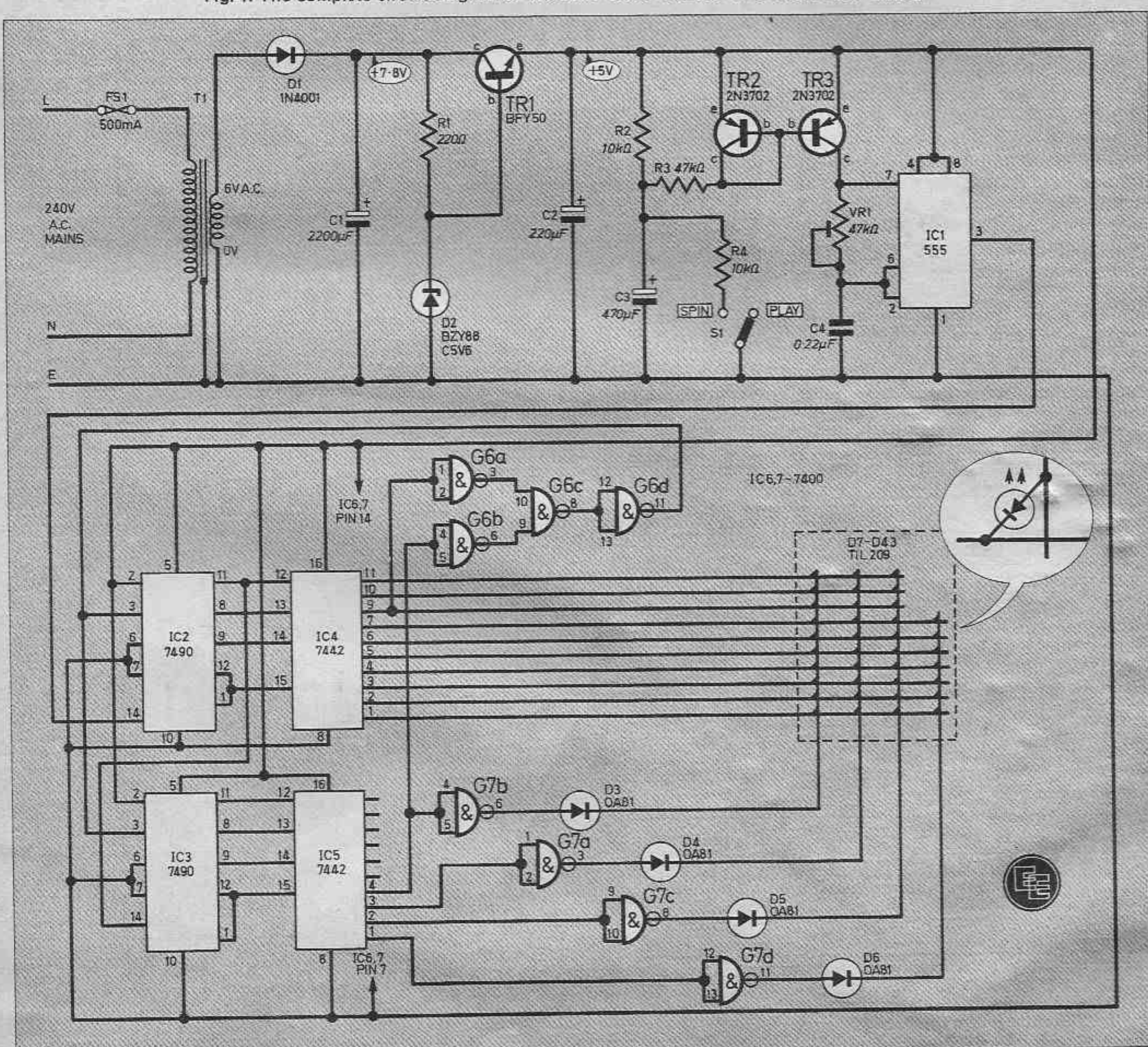
CONSTRUCTION starts here

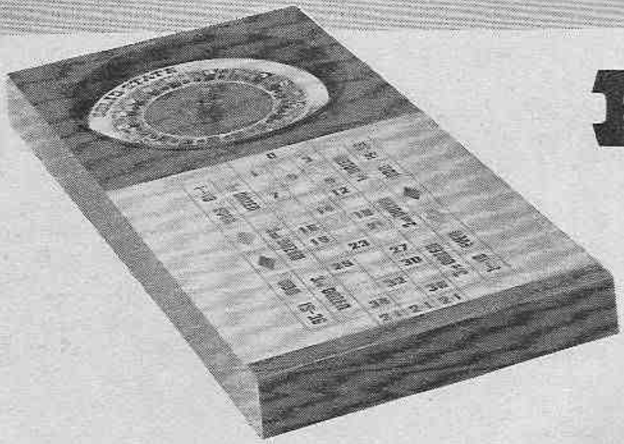
The prototype Solid-State Roulette used two separate circuit boards, one for the power supply section and the other for the main circuitry. However, there is no reason why a single circuit board cannot be used if desired. The layout is not critical but outputs to the l.e.d.s should be routed away from 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

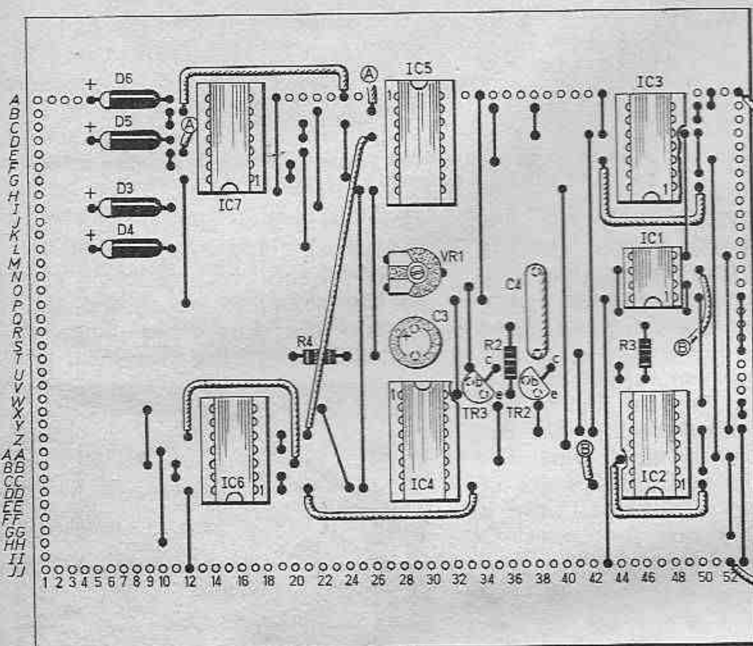
Fig. 1. The complete circuit diagram of the Solid-State Roulette including power supply.





ROULETTE

COMPONENTS approximate cost £15 excluding case



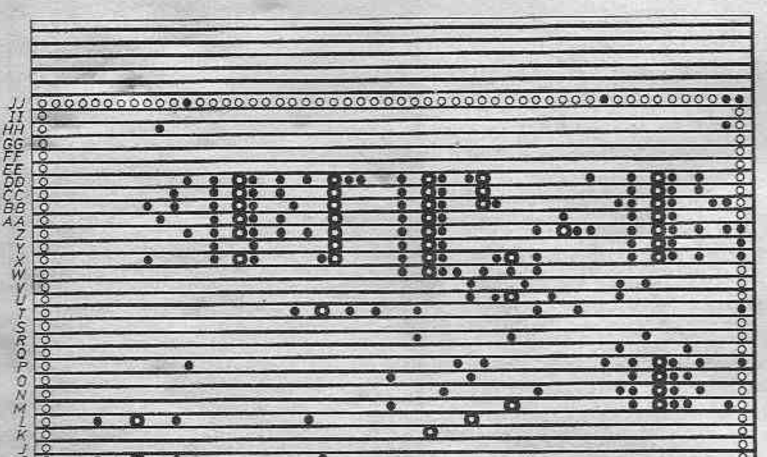
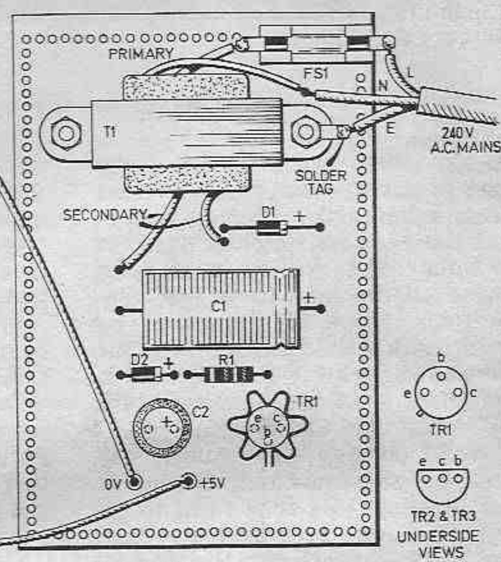


Fig. 2. The layout of the components on the main circuit board, showing inter-track links and breaks to be made on the underside.



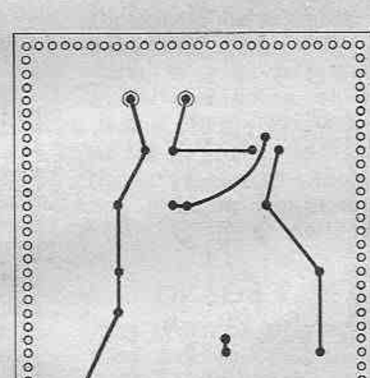
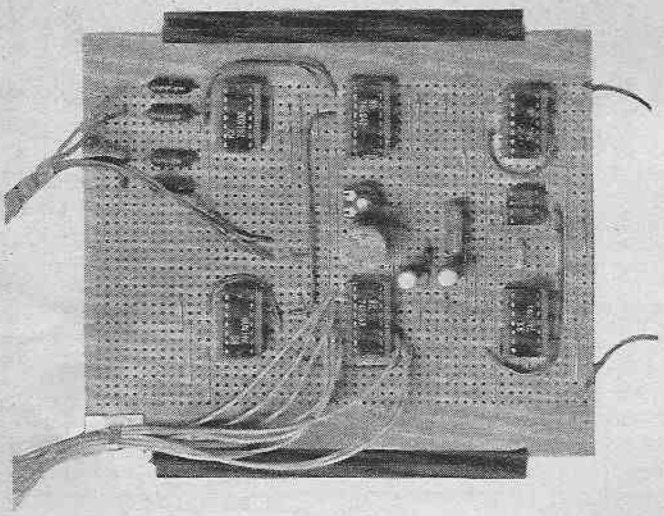
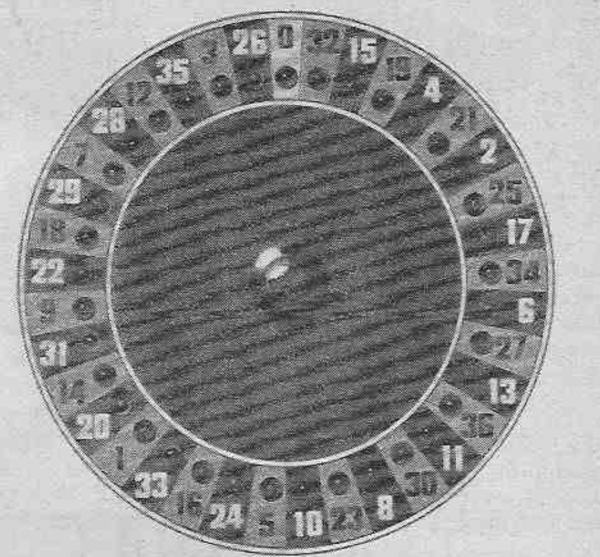


Fig. 3. The layout of the components on the topside of the power supply board and interwiring on the underside.



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.

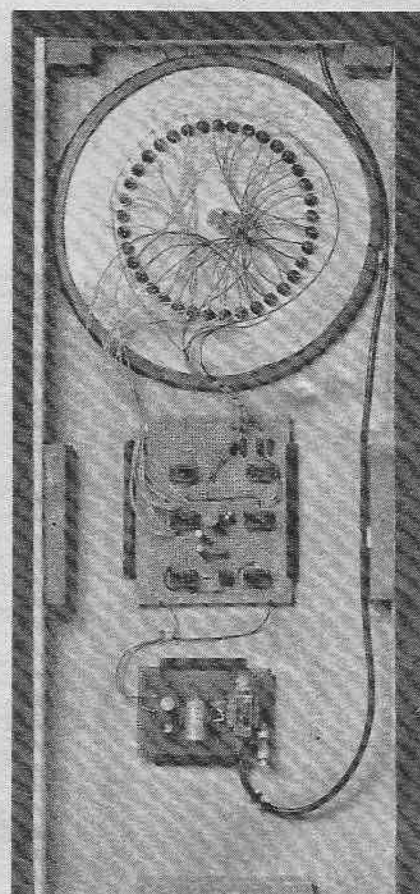
WHEEL

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—

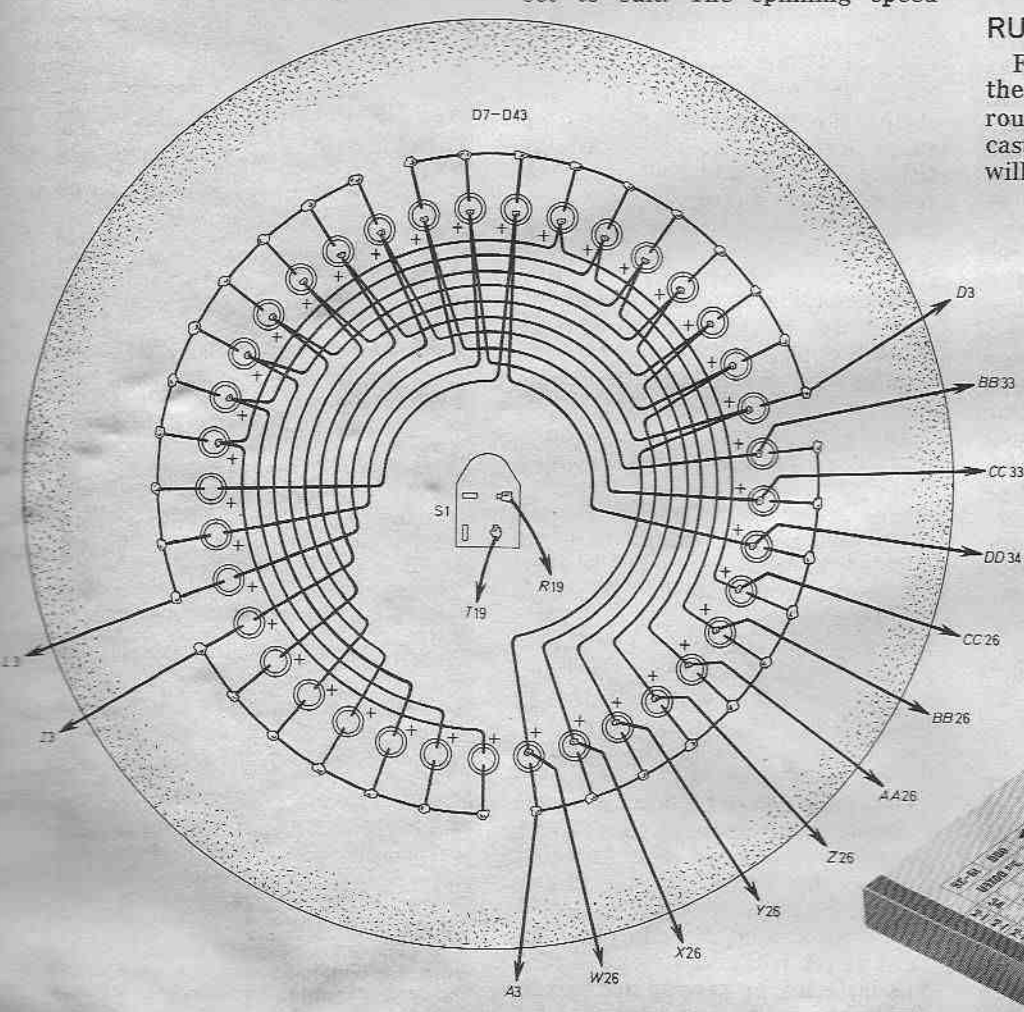
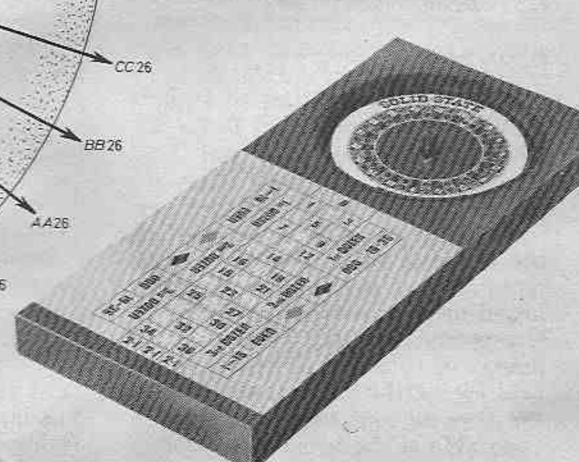


Fig. 4. Shows the underside of the "wheel" showing interconnections. It is essential that insulated wiring be used for interconnecting the l.e.d.s whereas stout tinned copper wire is best for the bus bars connecting the l.e.d. anodes. Note that the cathode is shown marked with a "plus" sign.



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.

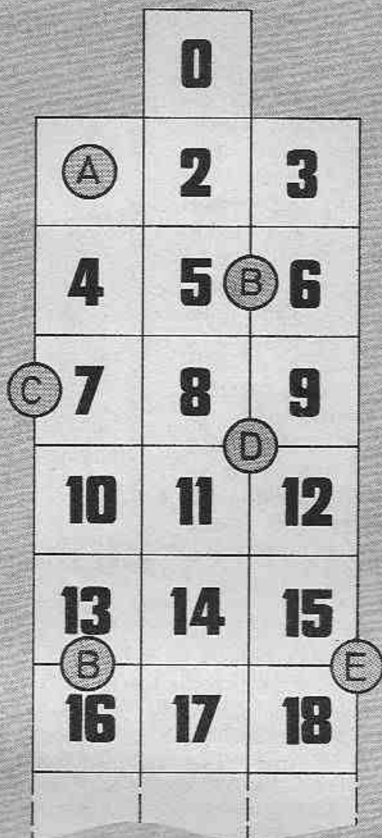
ZERO PLAY

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! ⌑

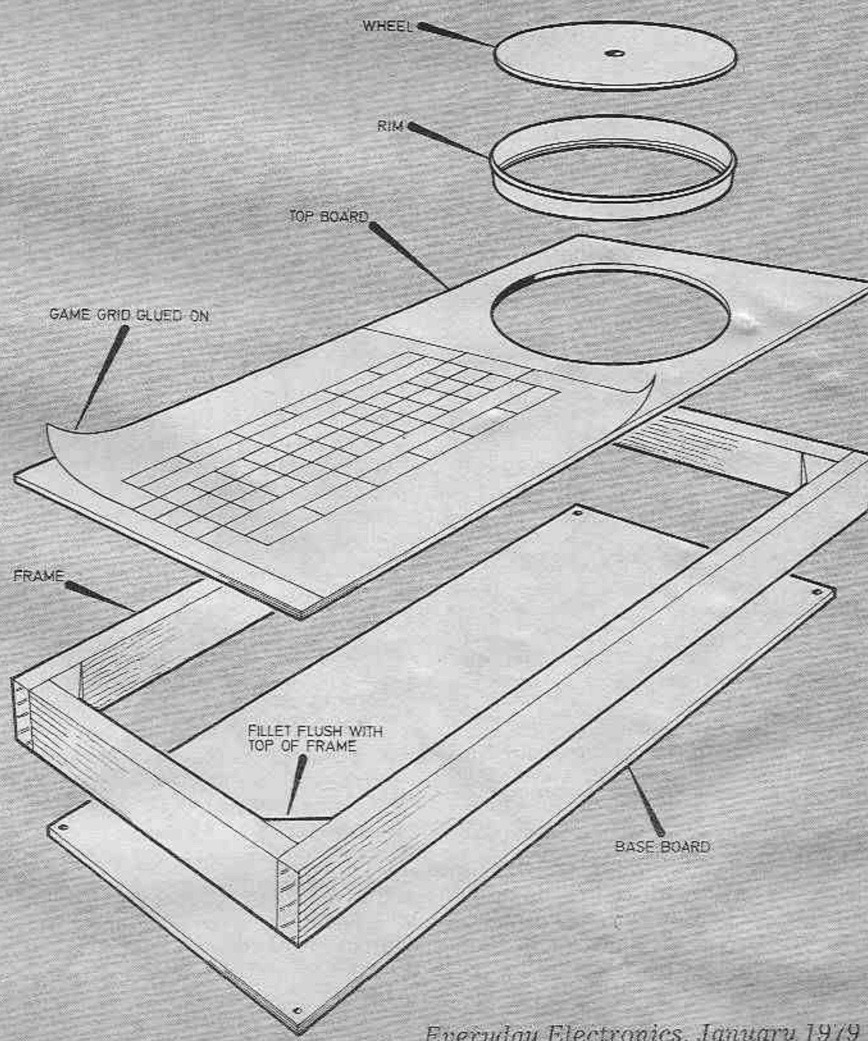


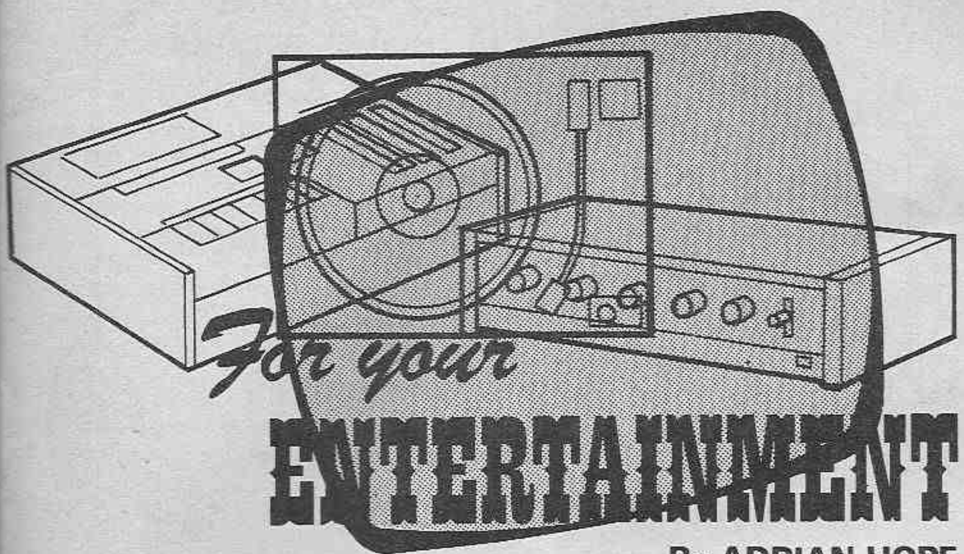
ROULETTE TABLE CUTTING LIST

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. 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.

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.





For your ENTERTAINMENT

By ADRIAN HOPE

End of the Dinosaur

Sooner or later that Dinosaur, 405 line television will finally be allowed to die off. Currently, of course, it soaks up valuable air space by occupying a string of channels on v.h.f. Bands I and III. What a waste. All that lovely available bandwidth devoted to low definition monochrome pictures and a.m. sound. Had there been just a little more forethought after the war and we wouldn't have the current ridiculous situation of all colour TV on u.h.f. Bands IV and V and Bands I and III tied up by an obsolete system.

How it happened is a glorious tale of bureaucratic bumbling. Pre-war television was 405 line, v.h.f. During the war there were no transmissions so the public's sets stood idle in attics and cellars. After the war the government was faced with a choice—either start up transmissions again as before and enable existing owners to continue using their old sets *or* start up on a different, higher definition, line standard and compensate existing set owners.

In fact everyone, including the public, would have won hands down from a compensation scheme because most of the stored sets were "kaput" anyway, their electrolytics leaking gunge all over the chassis. But the government economised and played safe. They kicked off again with 405 lines TV and even now the BBC and ITV are still stuck with transmitting programmes in this derelict format.

Digital Sound

But time is finally running out for low definition TV and when the transmitters finally close down at least Band I will be available for something else.

There are now all kinds of exciting plans for what that something else may be. The BBC is currently running a series of Band I tests which involve the transmission of programmes in digitally encoded sound. The "Beeb" already has encoding equipment for transmitting digital sound over microwave lines, to relay live stereo outside broacasts across the country and back to the studio.

Engineers are now using the same equipment to transmit digital stereo from the Pontop Pike transmitter near Newcastle while engineers drive around the area in cars fitted with whip aerials and receivers capable of picking up the digital programmes, decoding them and reproducing them as in-car entertainment. Another series of tests is designed to check out reception on portable digital receivers with internal ferrite rod aerials just like an ordinary "trannie".

As domestic digital sound equipment, such as the Sony and Matsushita p.c.m. adaptors for use with home video recorders, becomes available there will be growing interest in the possibility of receiving programmes in digitally encoded form. After all, there is no point in having a p.c.m. recorder, capable of flat response from 0Hz to 20kHz and a dynamic range of up to 100dB if the only thing available for recording is an f.m. broadcast of 15kHz bandwidth or a commercially pressed disc knee deep in snap crackle and pop.

Curious Sensation

Here's a puzzle. A leading hi fi systems manufacturer produces a stylish range of amplifiers and tuners that have a brushed aluminium finish and controls. Once in a while this produces a so far inexplicable problem: a few people using the equipment feel a curious electric shock-like sensation when touching the aluminium metal.

It's mild but disturbing to those who feel it. But even when the surface film of oxide that insulates all aluminium in air has been scraped away, or needle electrodes used, it is impossible to read a voltage on the chassis using a voltmeter.

The effect isn't the result of mechanical vibration and it can usually, but, not always, be cured simply by reversing the mains power leads, neutral to live and live to neutral, in the mains plug. This is in fact quite safe because the chassis isn't earthed, there is no earth in the mains lead and all the electronics are insulated to meet British standards.

But what is the cause of the sensation? Is it induction from the transformer? If so, then why does reversing the mains supply sometimes cure the problem? Is it capacitative leakage? At first sight this seems the most likely solution, but again why does reversing the mains lead sometimes but not always cure the problem?

Even more puzzling is the fact that the firm's research lab, in looking for an explanation, have found that an aluminium ash tray placed alongside an electrical appliance such as a table lamp can produce the same effect. Perhaps readers might like to try this one for themselves.

Meanwhile, the firm has a knotty problem on its hands. Apart from not knowing how this curious sensation is generated they dare not make too much fuss about telling the world that it can usually be cured by reversing the mains leads. To do this would quite unnecessarily scare the general public who could quite easily get the wrong end of the stick and assume that there was a risk of electric shock from equipment that is in fact perfectly safe.

If any readers have any theories to offer I'll gladly pass them on to the firm involved who would (for the time being at least) quite understandably prefer to remain anonymous.

Surprise Offer

I am eagerly anticipating the first court case, arbitration dispute or whatever, on computer salaries.

Almost every day in the newspapers classified advertisement section you will see under the "Computer Personnel" job spot some computer orientated firm or other advertising for staff and offering salaries of £4K, £5K, £6K, £8K and so on. I assume the firms are taking K as a handy buzz abbreviation of the word thousand, rather as the Americans call a thousand a "grand".

Well if so, they don't know too much about computers. In computer language the abbreviation "K" stands not for 1,000 but 2^{10} which is actually 1,024. So a firm advertising jobs at £8K instead of £8,000 could well be in for a surprise which costs them an extra £192 per year per employee.

An easy play accessory for beginners

By F. G. Rayer

THIS is probably the simplest "snap" or priority indicator which the beginner can make. It has two transistors, two resistors, two bulbs, and two push switches —plus battery and containers. The small number of components thus makes it an ideal starter project for the beginner.

GAMES PEOPLE PLAY

Snap played with ordinary or snap cards depends on the quickest response to win. With quiz games, the person first ready to answer may win. Another game can have a third person read quite slowly, the two competitors each trying to be first when a word with "B" (or other chosen letter) arises. Another game is coin tossing by a third person, the first to signify "head" correctly, making one point and a first, though incorrect call, losing a point.

With all such games, there is eventually a dispute as to who was in fact first. A snap or priority indicator such to be described here avoids such argument or dispute.

COMPONENTS approximate cost £1.50 excluding containers

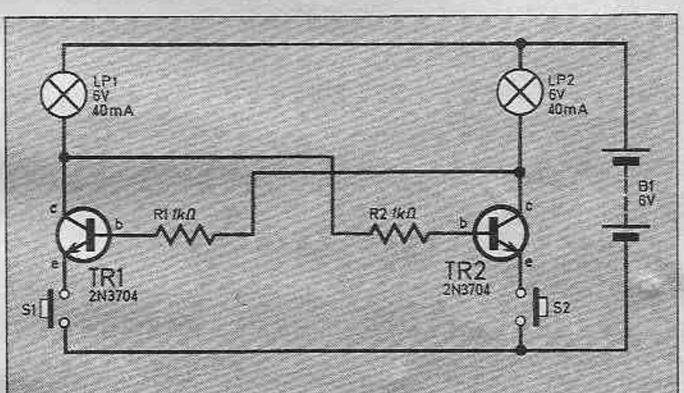


Fig. 1. Circuit diagram of the I'm First game.

CIRCUIT DESCRIPTION

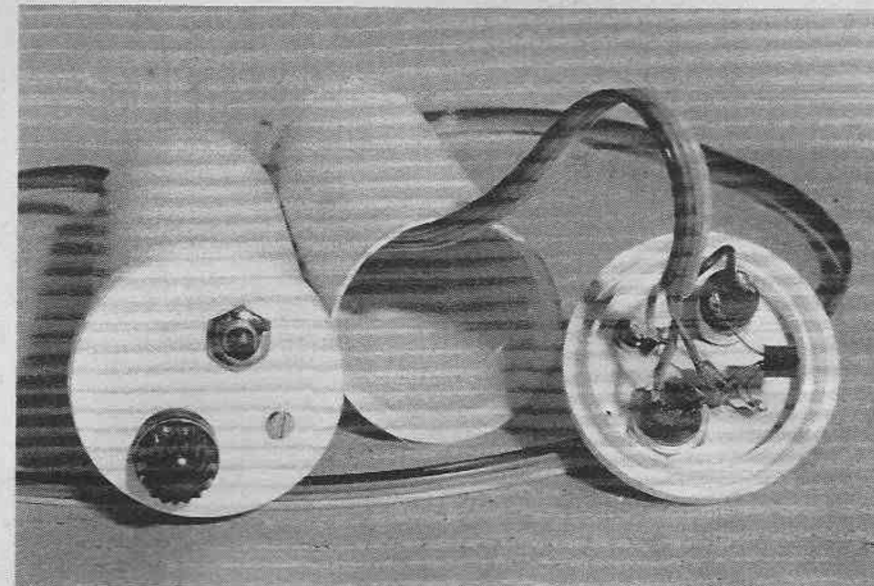
The circuit for the complete unit is shown in Fig. 1. No on/off switch is necessary, because S1 and S2 are normally open. One player has a unit containing S1 and LP1, and the other a unit carrying S2 and LP2.

Base current for TR1 is normally supplied via R1 from TR2 collector, and TR2 base current is supplied via R2 from the collector of TR1. As LP1 and LP2 are not lit, R1 and R2 are for practical purposes connected to the positive line.

Now if S1 is closed first, connecting the emitter of TR1 to ground, TR1 can draw base current through R1. Collector current can then flow through LP1, thus illuminating this lamp. If S2 is now closed, the supply point for R2 has moved negative, since TR1 is conducting, so there is no base current for TR2, collector current cannot therefore flow, hence LP2 remains unlit.

Should S2 be pressed first, the situation is reversed, and LP1 cannot then be lit by pressing S1. So the first player captures the circuit instantaneously.

The winner's indicator lamp remains lit so long as he/she holds the switch closed. When it is released, the circuit reverts back to its original state.



The completed units showing the wiring to the lid of one of the plastic containers. Note the use of four-core "ribbon" cable.

CONSTRUCTION starts here

Construction can commence by cleaning and thoroughly drying the inside of both containers. Those used were "Dip and Blow" bubble liquid, found in many toy shops. At this point it is worth mentioning that a plastic rather than metal container should be used. This will alleviate any problems with insulation. Any container of suitable size can of course be used.

Two solder tags are fitted to the lids as shown in Fig. 2, together with the switches and bulbs. The two transistors and resistors can then be wired up. Note the base lead of each transistor is "floating", and if required can be glued to the lid with an epoxy glue to prevent shorting to other components.

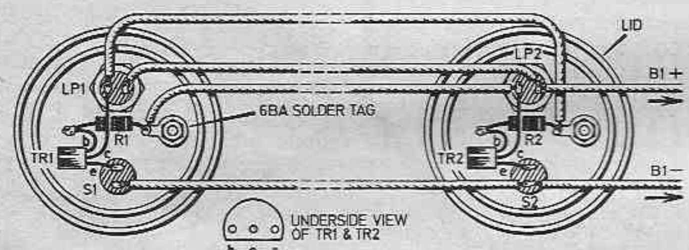


Fig. 2. Wiring details for the two units. All components are mounted on the lids, and wired direct. The length of connecting cable between the units is a matter of choice, but one metre, seems reasonable.

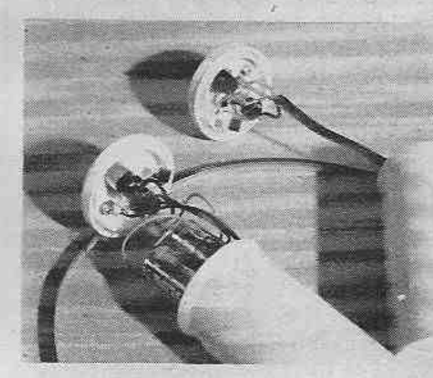
A length of four-core cable is then passed through holes in the bottom of each container, and wired up as shown. We now have one unit complete which can be assembled in its entirety. If the containers are at this stage rather dingy in appearance, they can be painted to suit or covered in Fablon if easier.

The second unit is still unfinished and requires the batteries to be inserted. Four HP7 size batteries are used. Secure them together with adhesive tape and connect each cell in series by joining the positive of one to the negative of another and so on. Solder two leads to the batteries to form the positive and negative connections. These two leads are finally wired into the second unit as shown. Observe polarity — the centre raised cap of the cells are positive. Place the batteries in the container, with some insulating material between them and the lid.

IN USE

As the circuit is very simple, you cannot really test it until it is actually being used. However with all home-built projects it is important to check for errors, in particular solder splashes and short circuits.

If all checks out the units can be put to use—it is just a matter then, of: Who's First! ⌑



Another view of the completed units. Note how the batteries are taped and wired together.

COMPONENTS

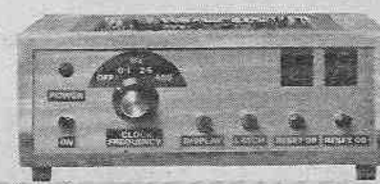
See **Shop Talk** page 34

Resistors
R1 1kΩ
R2 1kΩ
Both ¼W ± 5%

Semiconductors
TR1 2N3704 silicon *npn*
TR2 2N3704 silicon *npn*

Miscellaneous
S1, 2 push to make, release to break, 2 off (RS 337 914).
LP1, 2 6V 40mA bulb and holder, 2 off. (RS 575 790).
B1 6V battery, 4 HP7 size used.
Two round plastic containers, approx 80mm × 40mm (see text); 6BA hardware as required; connecting wire; approx. one metre, four core cable.

DOING IT DIGITALLY



PART 4

By O. N. Bishop

LAST month we saw how the action of a bistable circuit can be latched by suitable gating of the input pulses. By using more complex gating circuits we can obtain even fuller control over the action of the bistable. Such a circuit is rather complicated to build from individual gates, but is available as a completely integrated circuit, the *flip-flop*. Several variations are obtainable in different i.c.s of the 74 series, but we will confine our attention to one particular i.c., the 7473. Pinning details for this device are shown in Fig. 4.1.

J-K FLIP-FLOP

The letter *J* and *K* refer to the two control inputs. The i.c. diagram of Fig. 4.1 does not show the many gates of which the flip-flop is built, but simply shows it as a rectangle with various inputs and outputs. Similarly, we shall not go into the details of its internal circuitry but simply treat it as a "black box". We shall investigate what it does—what outputs are obtained when given combinations of inputs are applied. Later we shall see how we can use it.

The 7473 contains two identical flip-flops, and we shall investigate the behaviour of one of these on the Test-Bed. The circuit for this is shown in Fig. 4.2a and the interwiring of this on the Test-Bed shown in Fig. 4.2b. Note that +5V and 0V connections of this i.c. are via pins 4 and 11—not at pins 14 and 7 as in so many other TTL i.c.s.

Switch the clock to low frequency. The right-hand l.e.d. D10 indicates the state of the clock output, which is being fed to the clock input of the flip-flop. The other two l.e.d.s indicate the flip-flop outputs. Now try various combinations of high and low inputs at *J* and *K*. Try to discover the rules of behaviour of the flip-flop. When you have worked them out, investigate the effect of connecting the *clear* input (pin 2) to 0V instead of to the +5V rail.

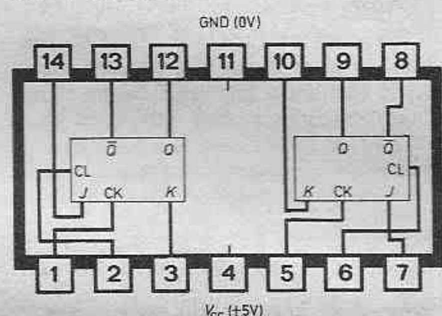


Fig. 4.1. Pinning details for the 7473 dual *J-K* flip-flop integrated circuit. Note that power supply pins are at pin 4 and pin 11.

The action of the flip-flop can be summarised by the points listed below. How many did you discover?

(1) $\overline{Q}$ is the inverse of Q (i.e. $\overline{Q}$ is NOT Q), so that when Q is high, $\overline{Q}$ is low, and the reverse. These are the two outputs of the bistable.

(2) The bistable is triggered to change state by the clock input.

(3) Triggering occurs at the instant the clock input changes from high to low.

(4) The effect of triggering depends on the state of inputs *J* and *K*.

(a) If *J* and *K* are *both low*, there is *no change* of Q or $\overline{Q}$

(b) If *J is low* and *K* is high, *Q goes low* (or remains low, if low already)

(c) If *J is high* and *K* is low, *Q goes high* (or remains high, if high already)

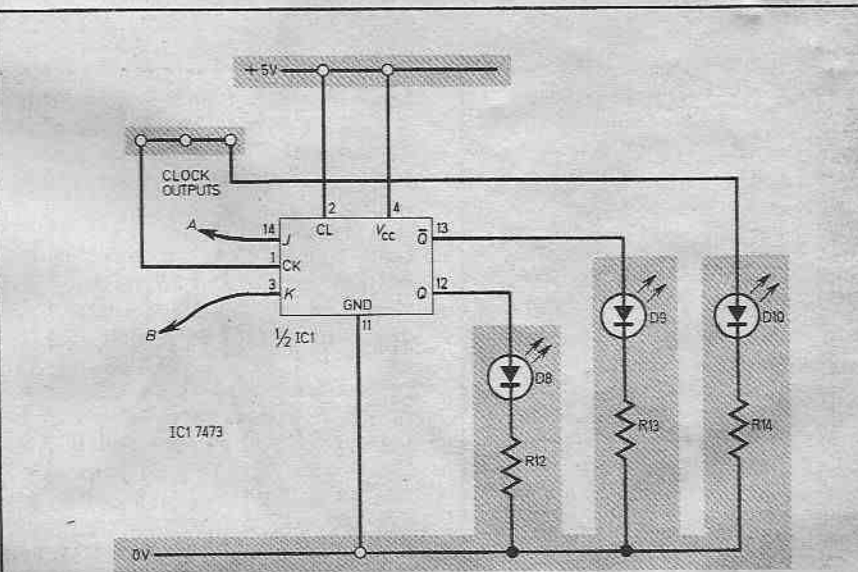


Fig. 4.2a. Circuit for investigating the operation of a *J-K* flip-flop.

(d) If J and K are *both high*, Q changes state.

(5) The above changes occur only if the clear input is held high. If, *at any time*, clear is made low, Q *immediately* goes low. This change is *not* triggered by the clock input, so can be used to reset the flip-flop at any time without waiting for the falling pulse from the clock.

USING TWO FLIP-FLOPS

The single flip-flop has a number of applications as a memory or data store. Two flip-flops or more connected together can be used to build some useful counting circuits. In Fig. 4.3a the Q output from flip-flop A becomes the clock input of flip-flop B. For both flip-flops, J and K are high, so that each flip-flop changes state when it receives the falling edge of a pulse at its clock input terminal.

Connect up the circuit as shown in Fig. 4.3b and switch the clock to low frequency. When the clock is low, clear both flip-flops by touching the CLEAR wire to ground (0V). When this has been done, all the l.e.d.s will be off. Watch what happens next. Record what happens in the table above, using "1" to indicate a high output (l.e.d. on) and "0" to indicate a low output (l.e.d. off). Continue recording until the stage is reached when all l.e.d.s are off.

Check your table with that appearing on page 23.

What do you notice about the sequence of figures in the table? (see answer (1)).

(Note: The flip-flops will be needed again later, so do not disconnect them yet.)

Table 4.1

	Flip-flop *B* (*B*)	Flip-flop *A* (*A*)	Clock
Flip-flops cleared	0	0	0
Flip-flops changing state	..	..	..
	..	..	..
	..	..	..
	..	..	..
	..	..	..
	..	..	..
	..	..	..
Recording complete	0	0	0

Check your table with that appearing on page 23.

FLIP-FLOPS AS COUNTERS

The state of the l.e.d.s can be read as a *binary number*, which tells us how many times the clock output has gone low since the system was last cleared. In this way we can count the number of clock pulses. We can do this for a regular series of pulses, such as we obtain from the clock, or for an irregular series.

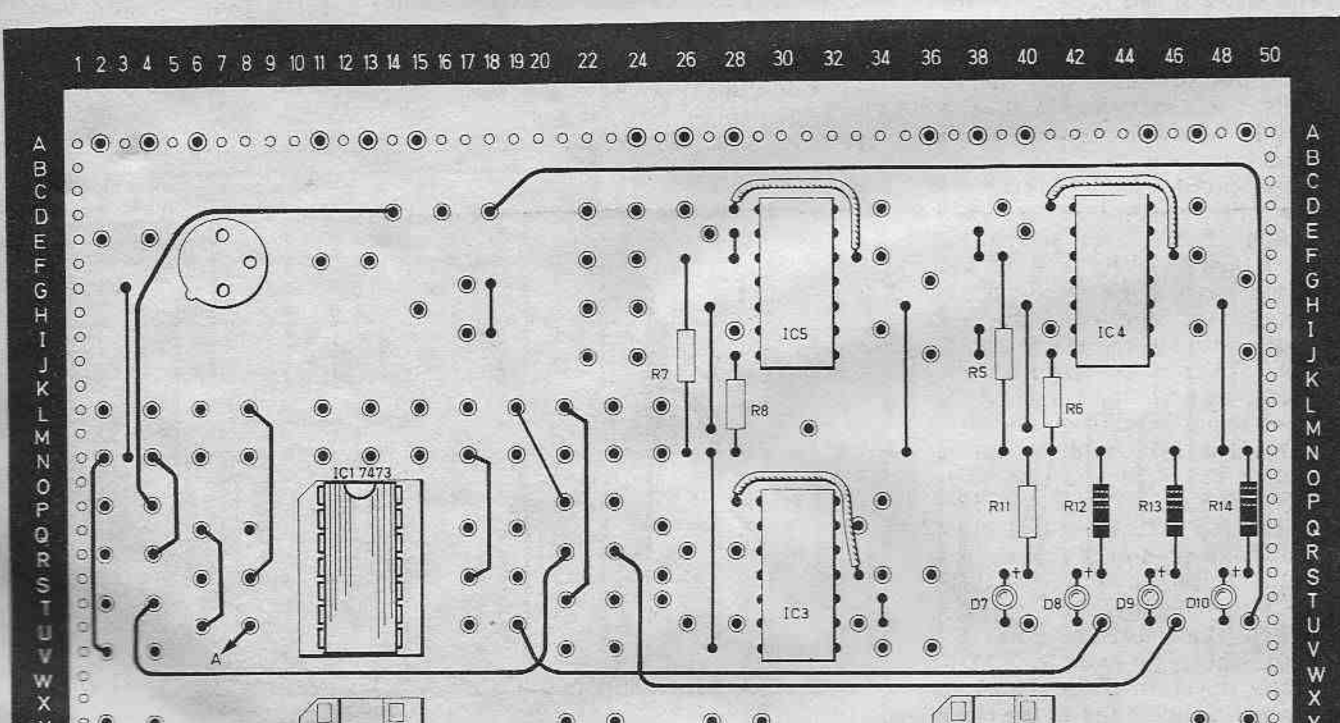
For example, a photocell circuit can be used to generate a pulse whenever a person passes through the doorway. If this is connected to a number of flip-flops in series, the number of persons passing through can be counted. A practical circuit for this will be given later in the series.

COUNTER

The counter we have built is an 8-stage counter, counting from 0 to 7 and then returning to 0. It repeats this sequence for as long as the counter is running and the CLEAR input remains high. To count numbers larger than 7 we simply connect more flip-flops to the chain, the Q output of one to the clock input of the next.

To count up to a hundred or more would mean a lot of connections to the three or more i.c.s required, but fortunately the manufacturers have provided us with a range of i.c.s in which four or more flip-flops are ready connected to

Fig. 4.2b. The interwiring details on the Test-Bed for the experiment of Fig. 4.2a.



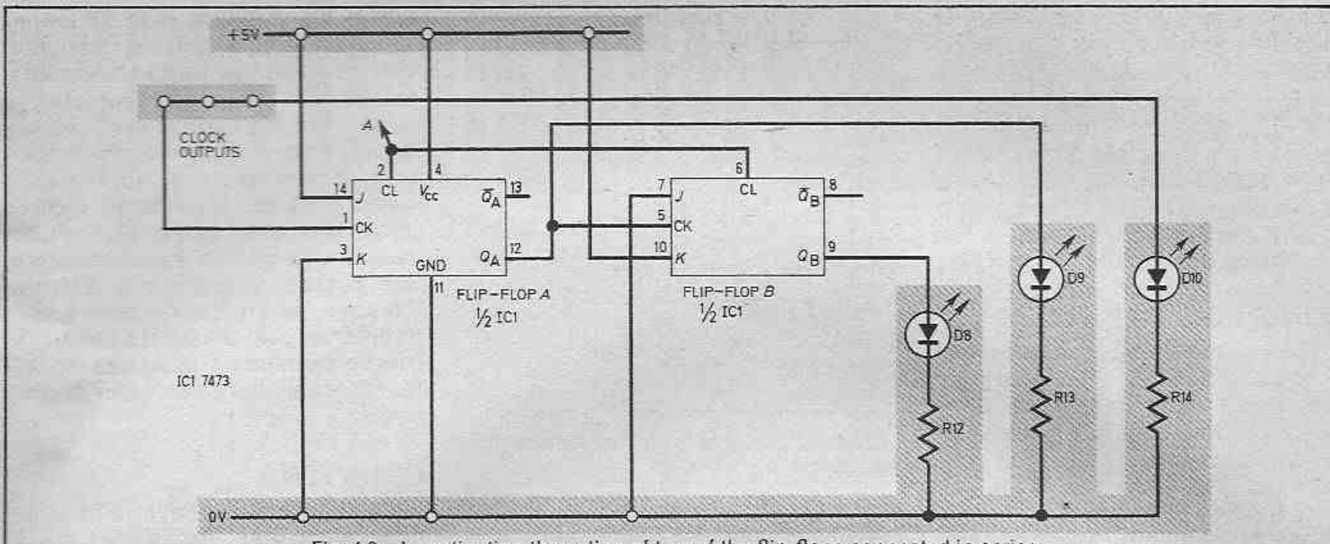


Fig. 4.3a. Investigating the action of two of the flip-flops connected in series.

form a counting chain, their J and K inputs being permanently connected to V_{CC}. These i.c.s we shall meet later.

FLIP-FLOPS AS DIVIDERS

There is another way of looking at the output of a series of flip-flops, see Fig. 4.4. If the total time represented in Fig. 4.4 is one second, the frequencies of the clock, Q_A and Q_B are 16, 8, and 4Hz respectively. The output of each flip-flop in a chain has a frequency that is exactly *half* that of the flip-flop before it. Flip-flops can act as *frequency dividers*. Turn the clock control knob to high frequency and listen to the note you get when you touch the tip of the plug of an earphone to each of the l.e.d. pins in turn, with the stem of the plug connected to the 0V line by means of crocodile clips.

The note from Q_A is one musical octave below that taken direct from the clock. A musical octave represents a halving of frequency and if you have a reasonably musical ear you will recognise that the two notes are an octave apart.

Similarly the musical interval between the note from Q_A and the note from Q_B is also an octave.

We can use our chain to divide frequencies by two or by four—how can we use it to divide by three? How this may be done is shown in Fig. 4.5a. When the outputs (read left to right) reach binary 6 (110) the inputs to the NAND gate are both high. Its output goes low, and this clears the flip-flops to zero. Thus Q_B produces one pulse for every three pulses of the clock. Used as a counter, this circuit counts up to six, then returns

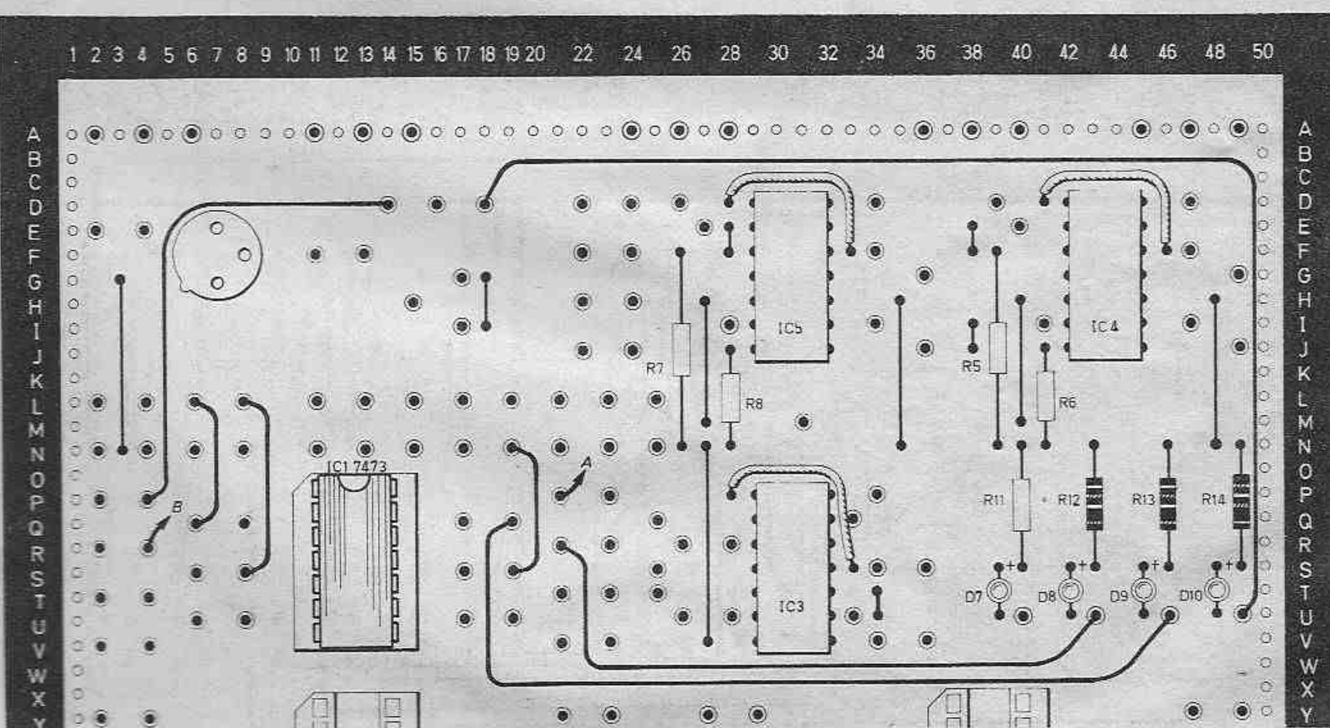


Fig. 4.3b. The circuit of Fig. 4.3a wired on the Test-Bed.

to zero, and so on. The layout on the Test-Bed for this experiment is shown in Fig. 4.5b.

Problem: Design a circuit to count up to five (answer (2)).

Answers

(1) Taking clearing as zero, the sequence is as shown in the table below. There are eight steps (0 to 7). If the figures in the Q_B, Q_A and CLOCK columns are read as binary numbers (000, 001, 010 etc), we find that these are equal to the decimal numbers in the STEP NO. column.

Readers unfamiliar with binary notation can think of the CLOCK column as a record of single pulses or "units", the Q_A column records pairs or "twos", the Q_B column records "fours". Thus at step two, the binary equivalent is 010 (no "fours", one "two", no "units" therefore total $=0+2+0=2$; at step seven, the equivalent is 111 (one "four"; one "two"; one "unit"; total $=4+2+1=7$).

Table 4.2

Q_B	Q_A	CLOCK	STEP NO.
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7
0	0	0	0

(2) A NAND gate can be used to detect binary 101, by using clock and Q_B as its inputs. The counter resets after counting to step 4.

(To be continued)

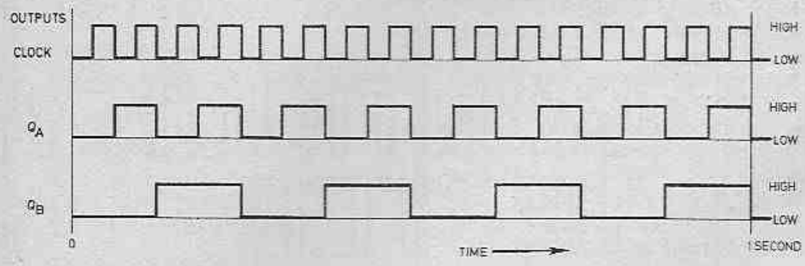


Fig. 4.4. Output sequence of the series flip-flop and the clock of Fig. 4.3a.

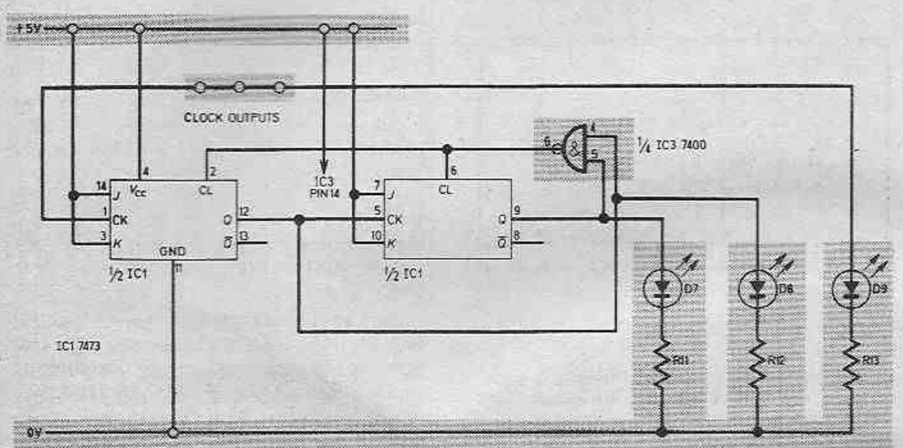


Fig. 4.5a. (above). A six step counter (÷3). Similar to the circuit of Fig.4.3a, but the NAND gate (in-built IC3) is used to clear the flip-flops.

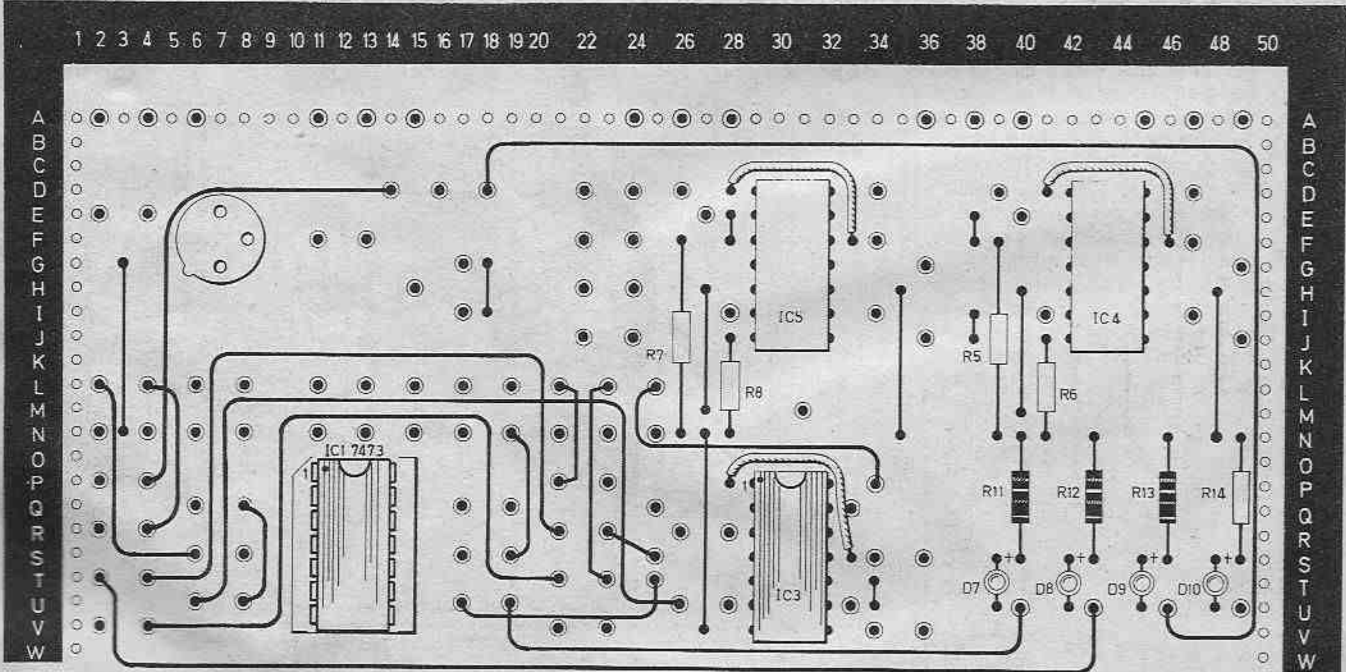


Fig. 4.5b. The circuit of Fig. 4.4a wired up on the Test-Bed.

MINI-MODULES

By George Hylton

Handy "Beginner" projects based on simple circuits and featuring a variety of building methods.

4 CONTINUITY TESTER

THE continuity tester in this article is a sort of electronic buzzer which takes less than 10mA (normally about 5mA if set carefully). The voltage applied to the circuit under test is also low, even when this has a high resistance. The actual voltage depends on how high the circuit resistance, since this determines the current. This tester can be used safely on all but the most delicate circuit components.

PRINCIPLE OF OPERATION

Plain connections in electronic equipment are comparatively short and even when made with thin wire their resistance is unlikely to be more than a few ohms and is usually only a fraction of an ohm. There are circumstances in which an accidental increase in resistance from something very low to say half an ohm can have disastrous effects. (A case in point is stray resistance in the common connection of a power amplifier, which can cause enough accidental positive feedback to destroy the output transistors.)

What is needed, therefore, is a tester which can tell the difference between a genuine "short circuit" (that is a very low resistance) and a small but possibly important resistance such as a few tenths of an ohm.

The strategy adopted in this design is to use the resistance of the circuit under test (R_d) to control the amount of negative feedback applied to an amplifier. See Fig. 1. The greater the resistance the greater the negative feedback. The amplifier also has positive feedback, applied via a different route (R_a, R_b).

By itself, this positive feedback is enough to make the circuit oscillate. The negative feedback tends to suppress the oscillation.

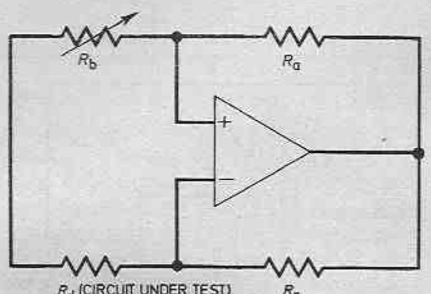


Fig. 1. General principle. Positive feedback set by Ra and Rb is offset by negative feedback via Rc and Rd.

PRACTICAL CIRCUIT

Our mini-module project employs two discrete transistors rather than the op amp implied by Fig. 1. It is, in fact, an unusual form of relaxation oscillator in which the timing circuit is R3 and C2. (C1 and C3 are merely r.f. bypass capacitors to prevent high-frequency interference and oscillation.) Adjustable positive feedback is applied emitter-to-emitter via R2 and VR1 and negative feedback via R4 and the resistance of the circuit under test. This is fed to the base of TR1 via the timing capacitor C2.

To set the tester to its most discriminating condition the test leads are connected together (making a zero-resistance circuit-under-test) and VR1 is adjusted until steady oscillation (a high pitched whistle) is just obtained. The tester is then ready for use.

In the prototype the sound source is a 2½ inch 80-ohm loudspeaker. The precise impedance is not important and any small high impedance speaker (or a telephone earpiece of not more than a few hundred ohms) will probably work.

For non-critical work where the greatest sensitivity to small amounts of resistance is not needed it is sufficient merely to switch on and use VR1 to set the tester to give any convenient pitch of note when the test leads are connected together. The

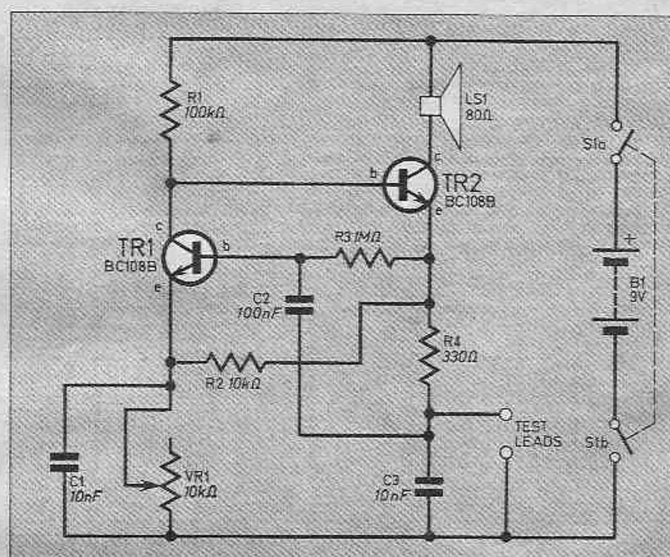


Fig. 2. The circuit of the continuity tester.

COMPONENTS

Resistors

R1 100kΩ R3 1MΩ
R2 10kΩ R4 330Ω
All carbon, 5% tol. ¼W

Potentiometer

VR1 10kΩ log. with d.p.s.t. switch (S1)

Capacitors

C1 10nF polyester
C2 100nF polyester
C3 10nF polyester

Semiconductors

TR1, TR2 BC108 *npn* transistor (2 off)

Miscellaneous

LS1 2½ inch loudspeaker 80Ω approx.
B1 9V PP3 battery
S1 see VR1
Perforated s.r.b.p. 550 × 500mm. Two terminal posts. Hardboard and Formica for box. Knob.

tester is then just a straightforward substitute for a buzzer or lamp (but with much lower power level, of course).

CONSTRUCTION

The Continuity Tester should be given an insulated case and operated from a built-in battery. The speaker should also be built in; do not use a headphone in case of accidental connection to a live high-voltage circuit. A small low-power 9V battery such as a PP3 is adequate since the standby drain is only about 100μA. (A 6V battery is also usable.)

The prototype is housed in a home-made box measuring 140 x 80 x 40mm, with sides of hardboard and back and front of Formica. The hardboard was fixed rough side out and stained with ink to improve its appearance. (For details of simple case construction see *Box It* in the December issue.) The size of box is governed by the speaker diameter and the depth of the potentiometer VR1 which serves as the setting-up resistance and has the on/off switch S1 ganged to it.

A battery compartment was formed by gluing a small strip of hardboard to the bottom and one side of the case to form a "slot" for the PP3. The connector is made from the connector on an old battery, with due regard to the changed polarity when used in this way.

The easiest way to fix the speaker is with glue. Before doing so drill a few small holes in the panel (from the decorative side of the Formica if this is the material) to let the sound out.

The circuit was built on a piece of perforated insulating board, 550 x 500m. The component leads were threaded through the small holes and soldered together behind the board. The finished board was fixed by blobs of glue to the speaker magnet and the potentiometer. (It would probably be sufficient to support it on its own connections, however.)

Two small insulated screw terminals are used for the external connections but if these are not readily obtainable a piece of 2-amp screw terminal strip with two connections will do quite nicely.

Next Month: Audio Modulator

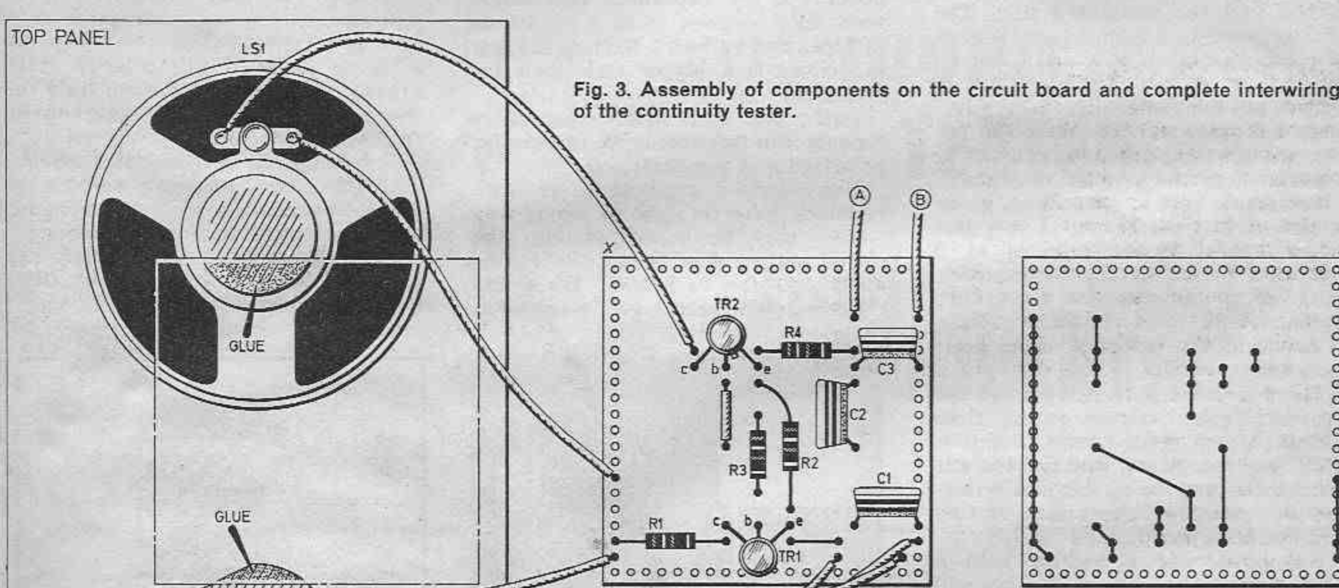
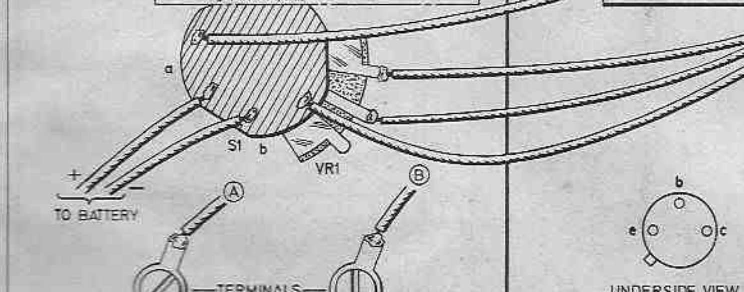



Fig. 3. Assembly of components on the circuit board and complete interwiring of the continuity tester.

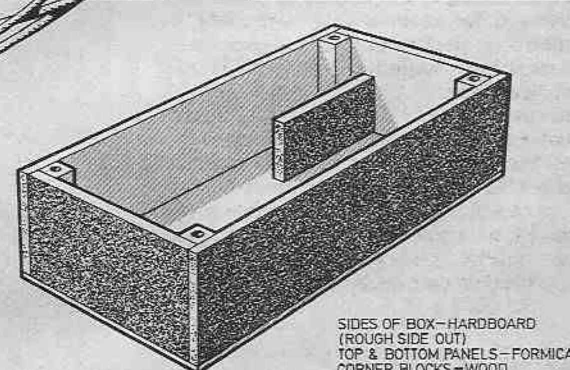


Fig. 4. Hardboard case for the continuity tester.

SQUARE one FOR BEGINNERS

So far in this series the resistor, the capacitor, and the transistor have been introduced. These are the most important components used in electronic circuits and one must get familiarised with them and learn how to handle them.

This month we look further into the resistor and the capacitor.

FIXED RESISTORS

The fixed-value resistor is the most common of all electronic components. The two types widely used are the carbon and the metallised film. The resistor comes in various sizes—that is physical dimensions—according to the power rating. The smallest is tenth-watt, then come eighth-, quarter-watt, half-watt and one-watt. The latter two are less frequently used, in general, than the smaller ratings.

Remember that in electronics, much of the work is performed at very low power levels. Power supplies of 9 volts or less and currents of the order of 1 or 2 milliamperes (mA) are commonplace. Thus a resistor capable of handling $\frac{1}{10}$W or $\frac{1}{4}$W is often more than adequate.

There is no harm in using a resistor with a higher wattage rating than specified for a given circuit. But it is pointless; the larger wattage resistor costs more and being physically bigger may cause problems in mounting on the circuit board.

But never use a resistor with a lower rating than specified. This will prove false economy. If a resistor is called upon to handle higher-power than it is designed for, the result will be overheating of the component. If this is excessive or prolonged, breakdown of the resistor will occur.

This may not be a terrible disaster so far as one small component is concerned, but the consequences upon neighbouring parts of the circuit may be more serious. For example, a transistor could be destroyed through the failure of a tiny, insignificant, inexpensive resistor.

Fixed resistors are non-polarised; that means they have no particular "right way" round when wiring into a circuit: either way will do. However, it is good practice to mount resistors so the coloured bands run in the same direction. This helps when reading values on a circuit board, since one is not constantly turning one's head this and that a'way. A small point, but well worth noting and observing right from the start. And it helps to make the fininshed article "professional looking".

CAPACITORS

Number two in the popularity stakes amongst passive circuit components is the capacitor. This single term does however cover a multitude of types and varieties. Getting to know capacitors is a bigger task than for resistors.

First, we can divide capacitors broadly into two distinctive categories: polarised and non-polarised.

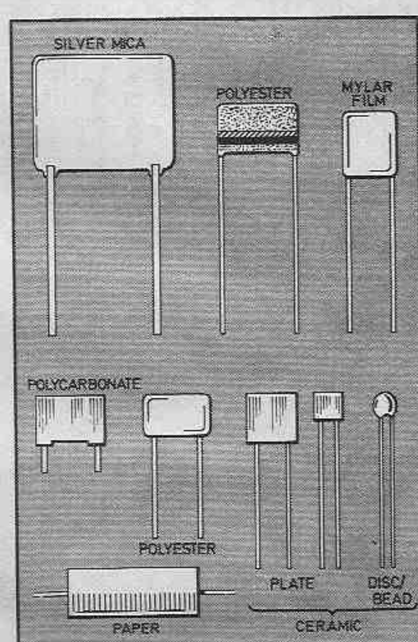
Non-polarised capacitors, as with resistors, have no right or wrong way —they may be connected into the circuit either way round. So far so good. But the variety of types and range of capacitances available makes the selection and/or identification of these components a bit of an art. The wisest course for the inexperienced is to strictly obey the components list and use the identical type as specified.

When you have become familar with capacitors, you will know just what alternatives may be employed with perfect safety in given instances. Examine some components lists in this magazine. Following each capacitor value there appears a term, for example: polyester, tantalum, or paper. This describes the kind of dielectric used in the manufacture of the capacitor. Dielectric is the insulating material between the two "plates" of the capacitor; this is an important feature in a capacitor, contributing towards the component's ability to maintain its nominal value under various conditions, and to withstand certain a.c. voltages, and other characteristics.

Thus when selecting a capacitor it is not sufficient merely to choose the correct value: we have to select the *kind* of capacitor that will perform satisfactorily in the particular circuit.

Apart from the electrical characteristics, capacitors of similar values can differ considerably in physical shape and size and lead configuration. It will be obvious that difficulties may arise in accommodating a capacitor on a circuit board if this component is greatly different from that used in the original model and specified in the component list.

This is not an insurmountable problem, for experienced constructors do adjust the location of components on a circuit board in order to fit in a component that is not entirely as specified; but this can only be done with proper knowledge.



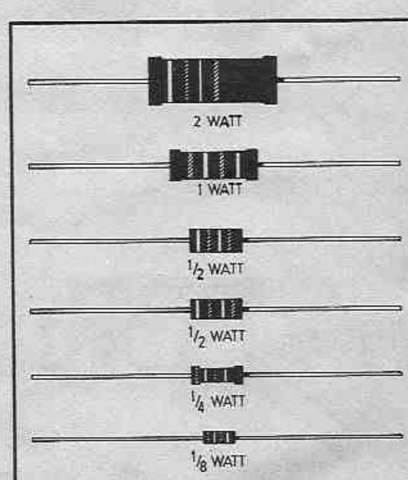
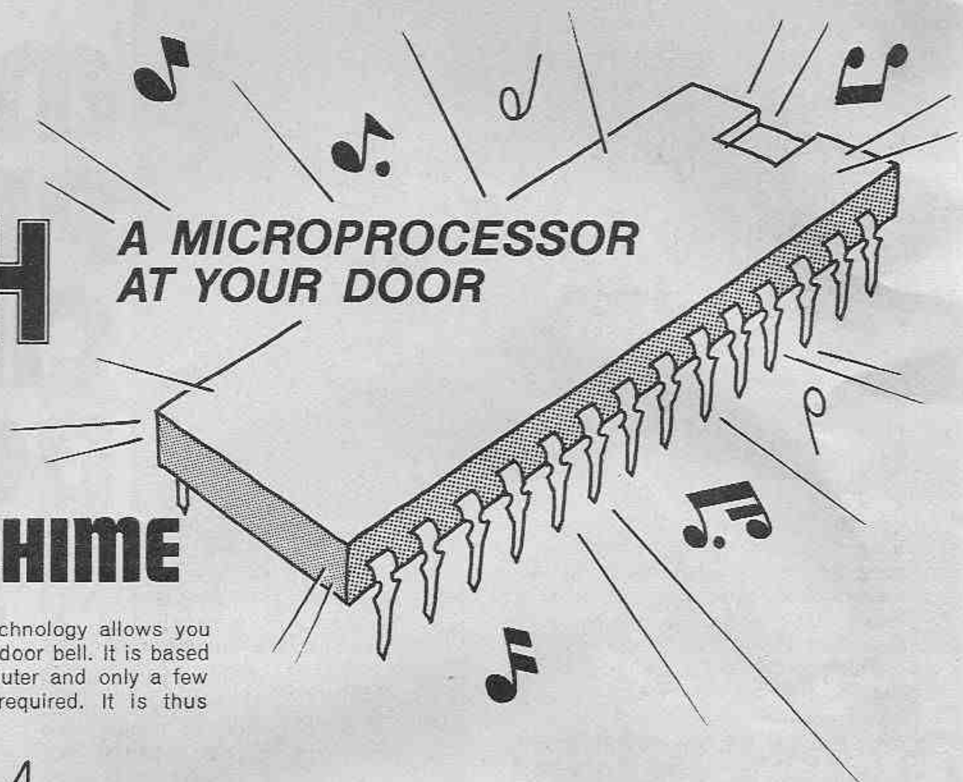


Fig. 1. (left) Outlines of typical capacitors, approximately two thirds actual size.

Fig. 2. (above) Outlines of carbon and metallised film resistors, approximately two-thirds actual size.

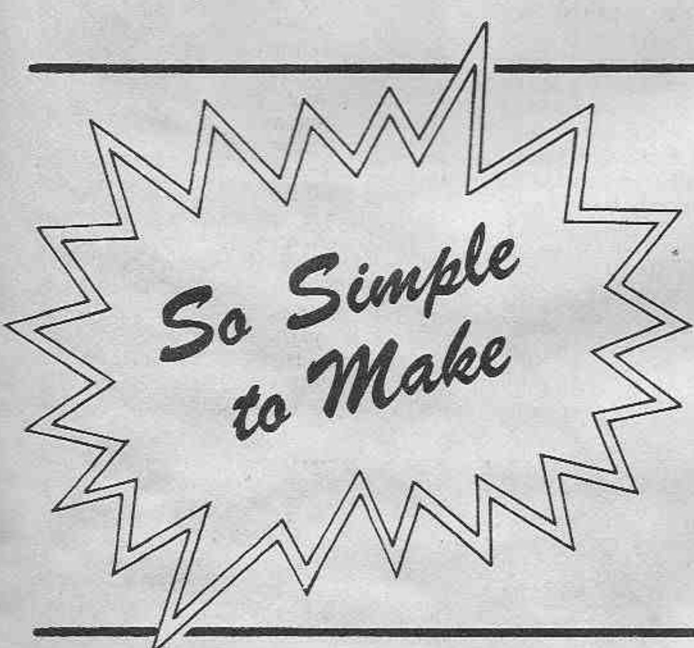
NEXT MONTH

A MICROPROCESSOR AT YOUR DOOR



MICROCHIME

The latest microprocessor technology allows you to build this 24-tune musical door bell. It is based on a single chip micro-computer and only a few additional components are required. It is thus easy to build.



THYRISTOR TESTER

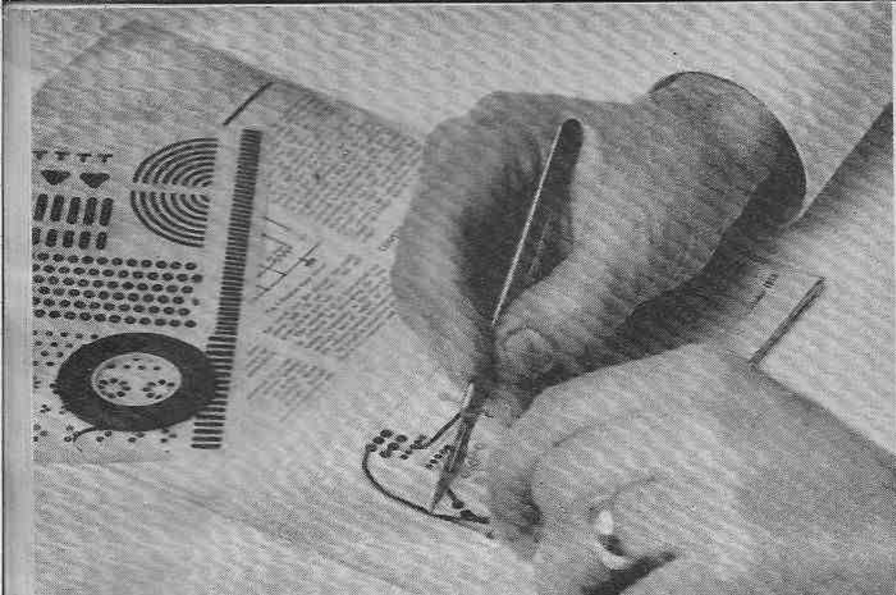
MINI-MODULE: MODULATOR

FOR RADIO 4 — L.W. CONVERTOR

Everyday ELECTRONICS

FEBRUARY

ISSUE ON SALE FRIDAY, JANUARY 19



MAKING PRINTED CIRCUIT BOARDS

By E. M. Lyndsell

The use of printed circuit boards (p.c.b.s) in the design of constructional projects is becoming somewhat of a regular feature in EVERYDAY ELECTRONICS. At least one has appeared every month since the September issue. This month sees the start of the construction of the *EE2020 Tuner Amplifier* which in all uses five p.c.bs.

In view of this it seems only fitting to feature an article about making your own p.c.b.s thereby giving those unfamiliar with p.c.b. manufacture a choice between making their own or buying ready-made boards on offer by advertisers.

Several methods are available to the home constructor and each will be described here in detail.

PRINTED CIRCUIT BOARD

What is a printed circuit board? A p.c.b. is a piece of insulating material —usually synthetic resin bonded paper (s.r.b.p.) or fibreglass—and bonded to this is a particular pattern of copper designed to link all the components on the board in accordance with the circuit diagram.

The copper pattern is peculiar to the project circuit and cannot, except in unusual circumstances, be used for any other project.

The copper pattern can appear on one or both sides of the insulating material, the latter being employed for highly complex circuitry.

The latter is described as "double sided" p.c.b. but we shall not concern ourselves with this variety here as special precision techniques and equipment is demanded for its manufacture, although not outside the scope of the home constructor.

In its raw state the material for making a p.c.b. is a piece of insulating material that has bonded (glued) to one face a thin sheet of copper, see Fig. 1. To produce the required pattern on this board certain areas need to be removed. For simple rectangular patterns, this can be done with a sharp hobby knife cutting around a pencilled pattern line and the unwanted copper literally "wrenched" from the board. Heat from a soldering iron applied to one corner of the copper to be stripped will cause the effect of the adhesive to lessen to enable a pair of pliers to grip the copper foil.

For any pattern other than the simplest, a process known as "etching" must be adopted. This requires the use of a chemical solution, ferric chloride, which is a solvent of copper.

By masking the areas of copper to remain on the board (protecting them from the solvent) and then immersing the board in the chemical solution the unwanted copper will be "etched" away leaving the required copper pattern, see Fig. 2. The masking material is known as the "etch resist" and can take several forms.

ETCH RESIST

All constructional articles using a p.c.b. includes a full-size drawing of the copper-side of the p.c.b., black regions representing the copper, see Fig. 3 so these areas must be masked and it is this process that can be done in several ways.

Self adhesive resist

Self-adhesive materials such as Fablon and Contact used for covering objects make an efficient etch resist. A white or other light colour is recommended.

Place a sufficient area of either of these materials under the page containing the master pattern and place a sheet of carbon paper between the two sheets. Trace through the pattern

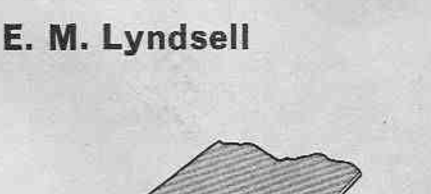


Fig. 1. Printed circuit board consists of a copper foil bonded to an insulating material.

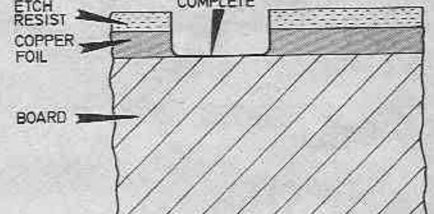


Fig. 2. The exposed copper areas will be etched away.

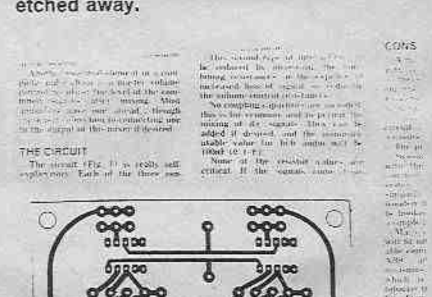
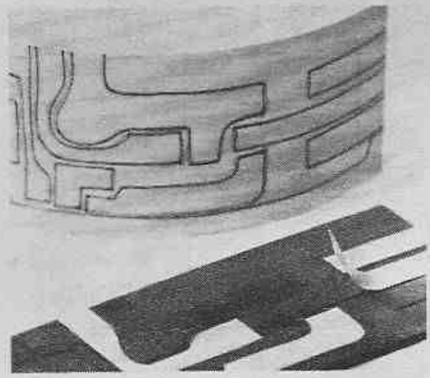
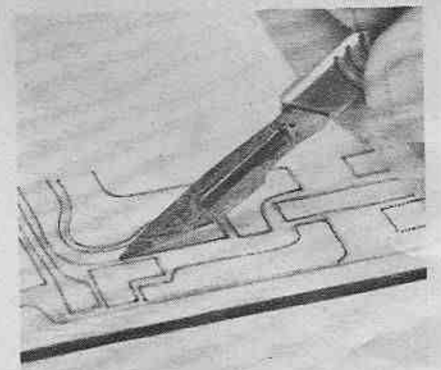


Fig. 3. The master copper pattern printed in the magazine. This appears full-size and is viewed from the copper side. Black regions represent copper to remain.

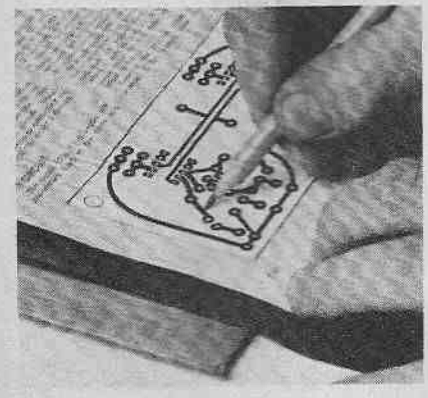
(*a*) Raw and etched p.c.b.s.



(*b*) The self-adhesive resist.

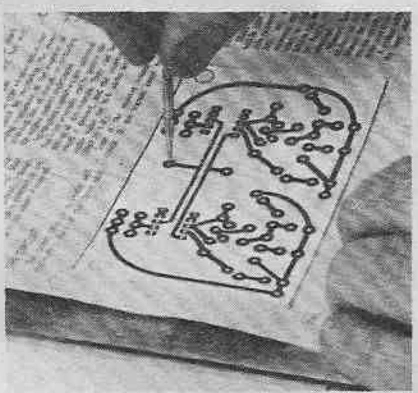


(*c*) Cutting around the self-adhesive pattern glued to the copper side.

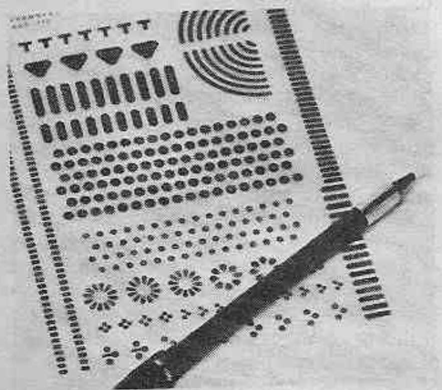


(d) Tracing the copper pattern directly onto the copper side of the board.

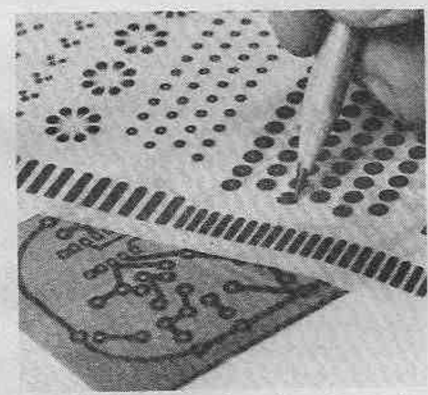
(*e*) Painting on an enamel resist.



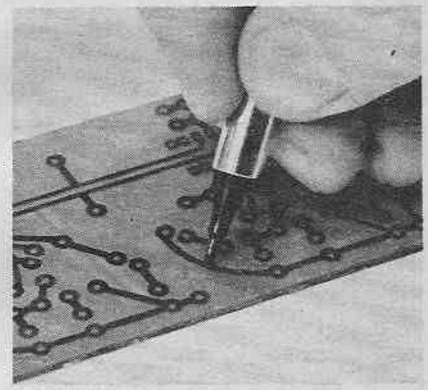
(f) Pricking through the pad centre points onto the copper board.



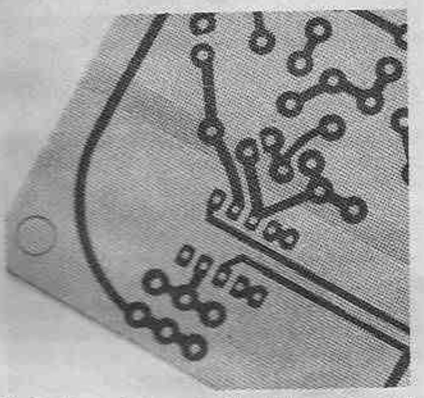
(*g*) Etch resist transfers and ink-resist pen.



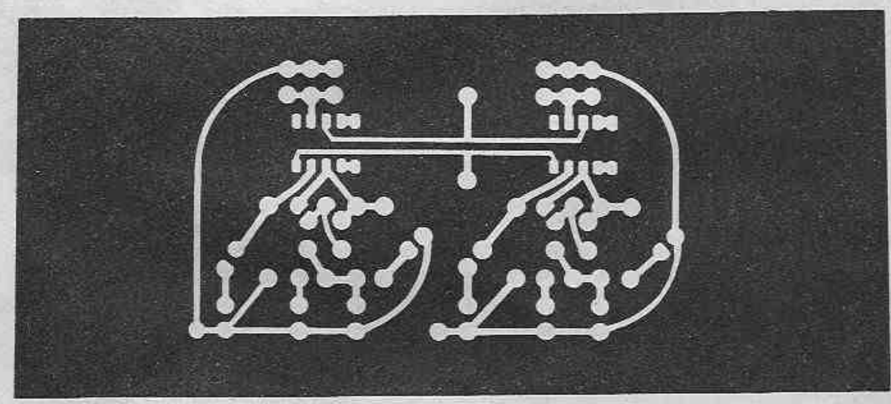
(*h*) Rubbing the transfers directly onto the copper.



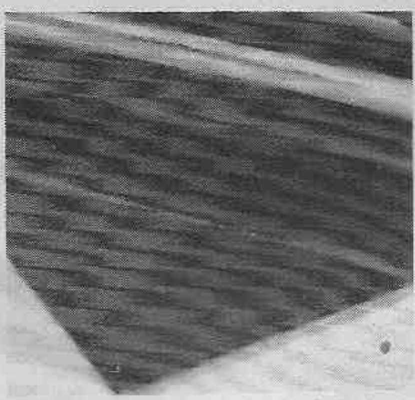
(*i*) Interconnections between the pads being made with resist pen.



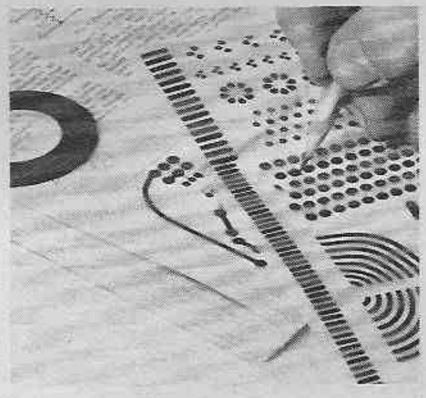
(*j*) Section of a board with all transfers and tape positioned.



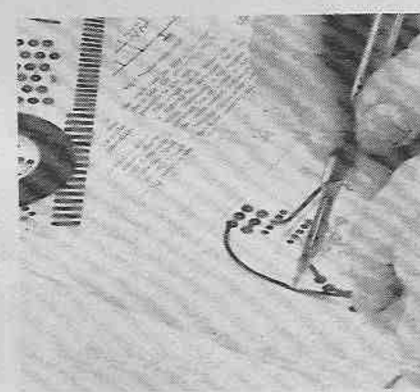
(*k*) A stencil made for the copper pattern appearing in Fig. 3.



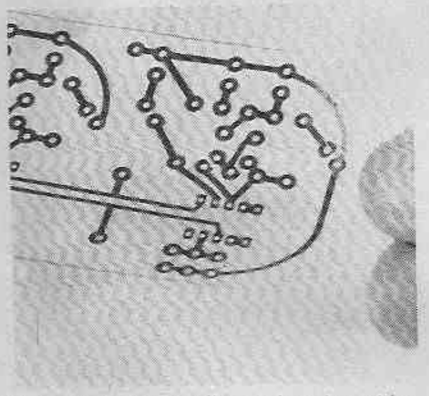
(*l*) Removing the protective film from a photo-sensitive resist treated board.



(*m*) Making a master pattern on tracing paper for use with photo-resist boards.



(*n*) Laying tape for interconnecting the pads on a tracing paper master.



(*o*) A photographically produced positive master on film.

onto the Fablon and when complete stick this to the copper clad board.

Using a hobby knife cut around the pattern and remove the sections to be etched. Rub down well all edges and the board is ready for etching.

Paint

An early etch resist used was enamel paint and nail varnish. The paint or nail varnish is applied to a thoroughly cleaned board that has had the pattern traced onto it by the carbon paper method described above. Using a fine artist's paint brush, the areas of copper to remain after etching are covered with paint and left to dry thoroughly before etching.

This method is "old fashioned" and tedious but could allow a project to proceed if components for the other methods described were not available at the time.

Transfers

A significant step up from the previous method is the use of rub-down transfers. A vast range of different "pad" sizes are available in single or specific configuration to suit transistors, i.c.s, etc.

With this method, the board is placed under the master drawing and the pad hole position pushed through using a pin or bradawl. It is not necessary to make any marks for the interconnecting tracks.

Next with reference to the master, position the appropriate transfers over the pin-pricks (pad centres) and rub the transfer sheet with a pencil lead to "glue" the pad to the board. Position all the pads.

The interconnecting tracks can be made using "tape" or a special pen containing an etch resist ink. Experience proves that the tape gives a more professional finish and eliminates possibility of smudging before the ink is dry, although the pen is quicker.

For the artistically skilful, the pen can be used for both pads and tracks.

Stencil

Making several boards with the same pattern by any of the above methods would consume much time and patience. For limited quantity runs one can make use of a stencil.

Trace through from the master via carbon paper onto a piece of thin cardboard. Use a hobby knife to cut out from this board all the areas of copper to remain after etching. Place the stencil on each board to be made and "fill-in" using paint/varnish or etch resist ink.

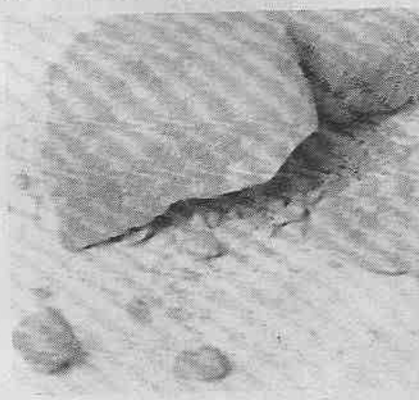
This method may not be suitable for some designs especially maximum copper type patterns as the stencil will be in many pieces.

Photo-sensitive etch-resist

Copper-clad board is available coated with a photo-sensitive film on the copper which also acts as a resist to ferric chloride. When exposed to ultraviolet light, the exposed areas "soften" and can then be removed with a solution of sodium hydroxide (caustic soda).

Aerosol sprays containing such a resist can be purchased and sprayed onto a thoroughly cleaned copper board. Experience shows that a near dust free area is required which may be difficult to obtain in domestic surroundings. Dust on the film produces unsatisfactory results.

For this method to be used, the master mask pattern must be put onto a transparent film. Special polyester



(*p*) Ferric chloride crystals.

film is available but virtually any transparent semi-transparent paper/film will do. Tracing paper for instance has been used by the author with satisfactory results.

Lay the transparent paper over the published master, and copy this onto the sheet using transfers/tape or Indian ink or any combination.

Alternatively, a photograph of the master can be taken and a positive of the correct size produced on film (i.e. black pads/tracks on a clear background).

Either of these masters is laid on the photo-sensitive treated copper, a piece of glass laid on top of this to hold the film/board closely together and then exposed to ultraviolet light (e.g. light from a mercury lamp) for about 10 minutes. The exact time will vary from lamp to lamp and is best determined by trial and error on off-cuts of the board.

After exposure, you will be able to see in the "right light", the pattern on the resist. This should now be placed in a dish containing a weak solution of sodium hydroxide (N/10) and the unwanted resist will be seen to dissolve and the solution become tinted blue. Agitating the contents of the tray will cause the exposed copper to be seen more quickly. When completed remove the board using a pair of tweezers and thoroughly wash in running water. The board is now ready for etching.

The resist in some cases also acts as a protective and flux and so it is not necessary to be cleaned off after etching.

A "negative" photo-sensitive resist is also available—used mainly by industry in which a negative of the master is required. Exposing the marked board to u.v. causes the exposed areas to become insoluble in sodium hydroxide.

ETCHING

Whatever method is used to produce the masked board, the following etching process applies to all.

As previously mentioned ferric chloride solution is used which is a solvent for copper. Now ferric chloride is a corrosive and poisonous substance and therefore requires care when handling. It is not generally available in liquid form, instead it is usually in crystalline form and requires adding to water. A concentration of 500g/litre is suitable for an etching time of about 20 minutes.

Rubber gloves are recommended to avoid any contact with skin; if contact with the skin does occur wash off immediately under running water. A measuring cylinder with glass rod is a suitable mixing receptacle.

Tip the made-up solution into an enamel or plastic photographic tray (or similar), sufficient quantity to immerse the board. (Do not use bare metal trays, especially aluminium.)

Using a pair of tweezers carefully place the board copper side down in the solution and leave to etch. From time to time, agitate the contents of the tray and after about 20 minutes use the tweezers to inspect the board. A little heat (e.g. from a hair dryer) will reduce etching time.

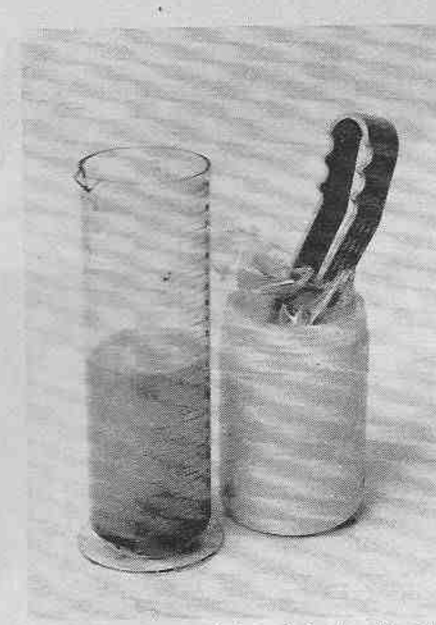
After all the unwanted copper has been removed, place the board in a second tray alongside to remove any excess ferric chloride and then thoroughly wash the board under running water.

Except for certain photo-sensitive resist, remove the resist; for paint, ink or transfer resist, an abrasive domestic powder or steel wool is suitable to yield a bright copper pattern.

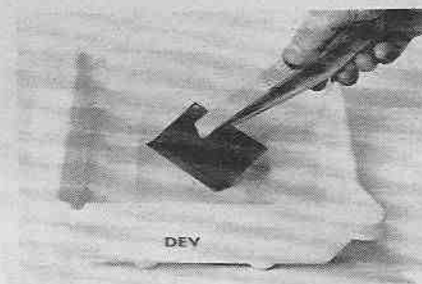
To protect this from oxidation, special aerosol laquers are available which also act as a flux.

DRILLING

The final stage in the preparation of the board is drilling the holes for the component leads. A lightweight high-speed electric drill and bit such as the Bimdrill shown are required, a mini drill-stand for best and easiest results. A 1mm diameter hole will suit most miniature components; for i.c.s and transistors, smaller holes can be drilled, but it is not essential. Drill out any larger holes, e.g. fixing holes, presets, terminal pins etc. to suit, using the 1mm holes as guides. ⌑

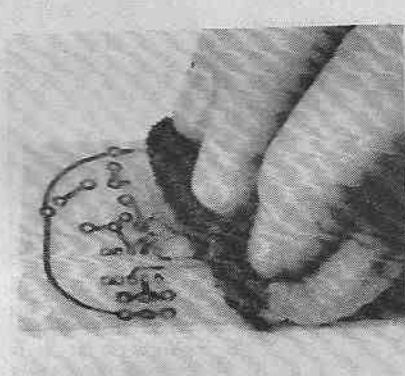


(*q*) Making up a solution of ferric chloride in a measuring cylinder.

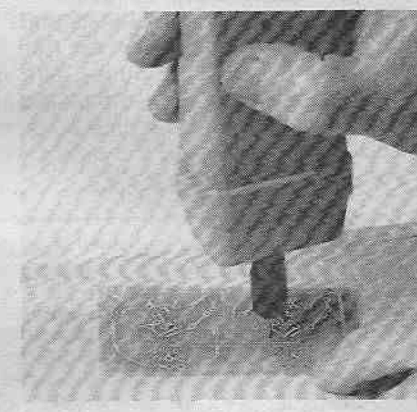


(*r*) Carefully place the board in the solution using tweezers.

(*s*) Etching underway with board face down.



(*t*) Cleaning off the resist with an abrasive cloth.



(*u*) Completing the drilling.

(*v*) The p.c.b. is ready for component assembly.

(*w*) The completed board.

(*x*) A typical d.i.y. printed circuit and panel labels kit from Mega Electronics Ltd., called the Photolab kit comprising an ultra-violet exposure unit, drafting aids and film, positive resist coated epoxy glass laminate sheets, developing and etching trays, label and panel materials, high-speed drill, and all the requisite developers.

Everyday News

DIAL-A-VIDEO MESSAGE

A voice plus video transmission system over ordinary telephone lines is under development by Philips in Holland. The telephone has a video display unit and a writing pad. The idea is that you can draw diagrams and talk simultaneously. Very useful in a technical discussion or, for example, to draw a map while giving directions by phone.

Both the voice and video signals can be recorded on a normal cassette recorder for replay if desired. Both-way voice is continuous but while one end is writing or drawing the other can only receive the graphics. The Scribofoon, as it is to be called commercially, is based on a research programme at Delft University of Technology.

SITUATIONS VACANT

The new British l.s.i. company INMOS has suffered a set-back through the resignation of three senior designers who have decided to set up their own company in the United States. INMOS, backed by the National Enterprise Board, is reported to be having difficulty in recruiting good designers but this is a common problem with all the IC manufacturers at the present time.

In-Flight TV

Long-haul civil air transport has long offered cinema shows to ease the boredom of flight for passengers. Now colour TV is taking to the air. Curtis and Green Engineering Ltd is producing a video-cassette system for airborne use. It replays pre-recorded programmes in PAL, NTSC or SECAM systems and is approved for all phases of flight including take-off and landing.

'Electronica 78', held in Munich last November is now the Number One electronics exhibition in the world. There were 1,800 exhibitors from 30 different countries.

In all, the exhibition needed 20 large halls at the Munich exhibition centre to house all the exhibits.

TEACH-IN

A family of low-cost easy-to-use conversational computers which, it is claimed, office staff can teach themselves to use, has been announced by NCR.

Called the I-8130 and the I-8150, they are intended principally for smaller organisations that are not familiar with computing techniques.

WELCOME TO THE CLUB

Sony UK is the first large Japanese-owned company to gain admittance to membership to the Confederation of British Industries (CBI). Sony manufactures colour TV sets in Bridgend, South Wales. Current workforce is 620 people making 85,000 sets a year of which half are exported, mainly to Western Europe.

Now that Sony has been accepted, will Matsushita, Hitachi and the new joint Rank-Toshiba companies swell the list of Japanese members?

In the first eight months of 1978 colour TV deliveries to the trade topped one million sets according to the British Radio Equipment (BREMA). Eighty per cent of deliveries were British made sets.

The overall demand for radio and TV is stated to be stable but prices and profits continue to be squeezed.

BAR ON RADIO TIMES

Among future developments in broadcasting is the possibility of choosing a number of radio programmes in advance with the radio switching on automatically and tuning to the correct station. The receiver would have a memory into which is fed coded information using a light-pen from bar-codes printed against each programme in the Radio Times.

This is one of many new ideas in broadcasting put forward by the Director of Engineering, BBC, in his inaugural address as President of the Institution of Electrical Engineers.

Automatic MAC

The Post Office has signed up a new £10 million ally in its drive to improve Britain's telephone service.

It is a system of 61 Maintenance and Analysis Centres (MACs) and its aim is to reduce telephone faults dramatically by spotting them automatically and alerting engineers to deal with them more quickly. The "brain" of the MAC is a GEC 2050 mini-computer.

The task of each MAC is to send test phone calls at a rate of about twenty per minute spread over all the exchanges in its locality, throughout Britain's telephone network, and keep a record of what happens to them. If they do not get through because of a fault, the MAC traces the location and immediately alerts engineers to put things right.

—ANALYSIS

ENQUIRE WITHIN

After massive publicity, few people in the UK can still be unaware of public information networks such as Viewdata, now to be known as Prestel. And there is yet more publicity still to come from field trials and the official launch of the system.

The only new aspect of Prestel is that it is for the general public and can be accessed from the home using a TV receiver as a video terminal. Little known to the public at large is that video information technology is long established in business and professional circles and that dozens of databases are already operating.

We are in the middle of a great information explosion which has generated a new academic discipline known as Information Science. Without it and the electronic computers which go with it, the professionals who need specialised information would never keep up with the flow.

Take the case of patents in science-based industry. Some 12,000 are published weekly, 9,000 of which are in languages other than English. Rather than scan through all these, assess them, classify them and set up a filing system, most firms who need patent information subscribe to a central database such as that run by Derwent Publications who employ 400 full time staff (120 of whom are chemists and engineers) and another 400 freelance specialists.

Another British database is INSPEC (International Information Services for the Physics and Engineering Communities). This year alone INSPEC added 160,000 items to its database. To achieve this, INSPEC classified and indexed 130,000 articles from 2,300 journals, 25,000 papers from over 500 conferences, 1,500 technical reports and university theses and some 300 scientific books.

But as well as commercial services there are many private systems. Police forces, for example, who keep on computer file, and constantly updated, registers of missing and wanted persons, vehicle registrations, stolen vehicles, owners of weapons and, using electro-optics, the matching and sorting of fingerprints.

On-line data access has been made possible by modern communications and data processing technology. But that is the easiest part and the least costly. You need a lot of manpower. Systems and software specialists, compilers and cataloguers. For science-based databases you need qualified scientists to make abstracts of scientific papers or patents. Even more mundane commercial and financial databases you need experts in the various fields to sort and classify the mass of incoming information.

The electronics in the system is magnificent for storage and retrieval of information. But it is only a tool. Without brainpower and human beings nothing would work.

Brian G. Peck.

CHECKOUT WITH A COMPUTER

The supermarket chain, Tesco, has ordered seven minicomputers from Computer Automation Inc. (UK) Ltd. The first is being used for system development and the other six will be installed at six of Tesco's distribution warehouses serving 500 stores.

They are to be used for on-line entry of incoming goods to the warehouses and for stock control.

DVM BOOM

The digital multimeter market is booming. The John Fluke Corporation which has a European manufacturing unit in Holland and a sales and service base in the UK reports sales of over 150,000 of their original 8000A DMM and 80,000 of the hand-held 8020A since its launch just over 18 months ago.

After a fierce international competition, Racal Electronics Group emerged winner for re-equipping the Australian defence forces with transportable h.f. communications equipment. The contract is worth £8·8 million and the great bulk of the equipment will be built in Britain.

JUST THE JOG

If your really looking for that something different for Christmas then the Toshiba EMH-1000 fitness trainer is just the item for off-loading some of that festive spirit.

Inspired by the current jogging mania, the trainer consists of two units; an on the spot running mat incorporating a pressure pad and a battery powered control unit.

The control unit allows the user to preset the length of the exercise period up to 30 minutes or to preset the number of paces to be jogged up to 9,990. A pacesetter is also incorporated with a "bleep" signal, adjustable from 100 up to 220 paces a minute.

The fitness trainer can be used indoors or outside, so the less athletic looking who might feel bashfull about running in public can jog happily in the privacy of their own homes.

The recommended retail price of the Toshiba EMH-1000 fitness trainer is £94·50 including VAT. You should certainly get a good run for your money.

Water Divining

A weather radar is being installed on Hameldon Hill, Lancashire, by Plessey. It will measure water precipitation to improve flood warning facilities and control of water resources in the area. The new radar will be operated by the North West Water Authority.

Partners in the scheme are the Meteorological Office, the Ministry of Agriculture, the Water Research Centre and the Central Water Planning Unit.

The Fairchild-GEC joint venture to mass produce l.s.i. circuits in the UK is on schedule. The new plant will produce memories and MPUs with production in late 1979.

By Dave Barrington

Component Catalogues

We have just received the first of many of the 1979 Components catalogues and most are up to the usual high standards set by our advertisers.

The new Home Radio Components catalogue contains 128 pages and a profusion of illustrations and photographs are included. This catalogue has now been streamlined compared with previous issues and a lot of the very old and obsolete components have been omitted.

This catalogue contains a very good range of hardware including cases and soldering irons. The section on capacitors, particularly variable types, is one of the best we have seen in a components catalogue.

Like most component suppliers today, Home Radio issue separate price lists during the year which now include Bargain Lists.

The price of the Home Radio Components Catalogue is £1 plus 25p postage and packing (No redeemable vouchers). Orders should be sent to Home Radio (Components) Ltd., Dept EE, 234-240 London Road, Mitcham, Surrey CR4 3HD.

We were most disappointed with the quality and reproduction of the Ace Mailtronix mail order catalogue and feel it does not do justice to the service this company provides.

However, at 30p this 35-page catalogue is still good value for money and gives a fairly comprehensive list of popular semiconductor devices and ready made modules. Component prices are given separately on their current mail order forms and it would be nice to see the month of issue stamped on the form to help in keeping up to date with prices.

Copies of the Ace Mailtronix Mail Order Catalogue can be obtained from Ace Mailtronix Ltd., Dept. E.E, Tootal Street, Wakefield, West Yorkshire, WF1 5JR. Catalogue outlay is refunded on first order over £5.

Readers who are interested in home computers might like to obtain a copy of the Transam Computer Products catalogue.

This is a new company formed specially to cater for the growing needs of home computer enthusiasts and carries details of hardware and software equipments, including a complete home computer design.

Supplies of the Computer Products catalogue can be obtained from Transam Components Ltd., 12 Chapel Street, London N.W.1.

Special Gift

Are you still looking for those last minute Christmas gifts to keep the young amused during the Christmas holidays? If so, we can strongly recommend the very latest "fun projects" from Watford Electronics.

Known as Sunday Kits there are nine projects available at the moment ranging from a Photo Electric Switch to a Cycle Indicator Flasher. These kits come packed in a plastic "bubble" which also forms the case.

The bicycle indicator flasher was impressive and would easy mount on a child's tricycle and give hours of fun. The mini electronic organ was very unimpressive.

The price of the kits range from £6·20 to £7·95 and for further details readers should contact Watford Electronics, Dept EE, 35 Cardiff Road, Watford, Herts. (Wat. 40588/9).

Constructional Projects

No real problems should be encountered with *Car Lights Reminder*.

Although we have not tried it in the model, it would seem perfectly feasable to use a 33 ohm resistor in place of R1 if the specified value proves difficult to obtain. If the speaker specified is hard to locate then a larger type of the same impedance can be used but, of course, a larger case will be required.

The *I'm First* is a very simple project and there should be no problems.

The containers used were, in fact, "bubble liquid" holders used by children for blowing bubbles. They can be bought from most toyshops. If you're a photographer then plastic film cans may be used, but the components may be a tight fit.

No problems are envisaged for the *Roulette* game. As 37 l.e.d.s with holders are called for in this project readers should be able to obtain a special price from advertisers.

An ideal mounting tray for the l.e.d. array would be the coil detector covers called for in our Treasure Hunter project published recently. These are available from Arrow Electronics Ltd., Dept. EE, Leader House, Coptfold, Brentwood, Essex.

The *Headphone Enhancer*, and the *Continuity Tester* in our *Mini Module* series are very simple projects and should not create any problems.

All component difficulties which are likely to be encountered with the *EE2020 Tuner Amplifier* were covered last month.

JACK PLUG & FAMILY...

BY DOUG BAKER

EE2020 TUNER AMPLIFIER PART 2

HI-FI SERIES

BY E. A. RULE

THIS Second Part of the 2020 Series deals with the printed circuit boards A, C, and E. (The remaining two boards will be dealt with next month.

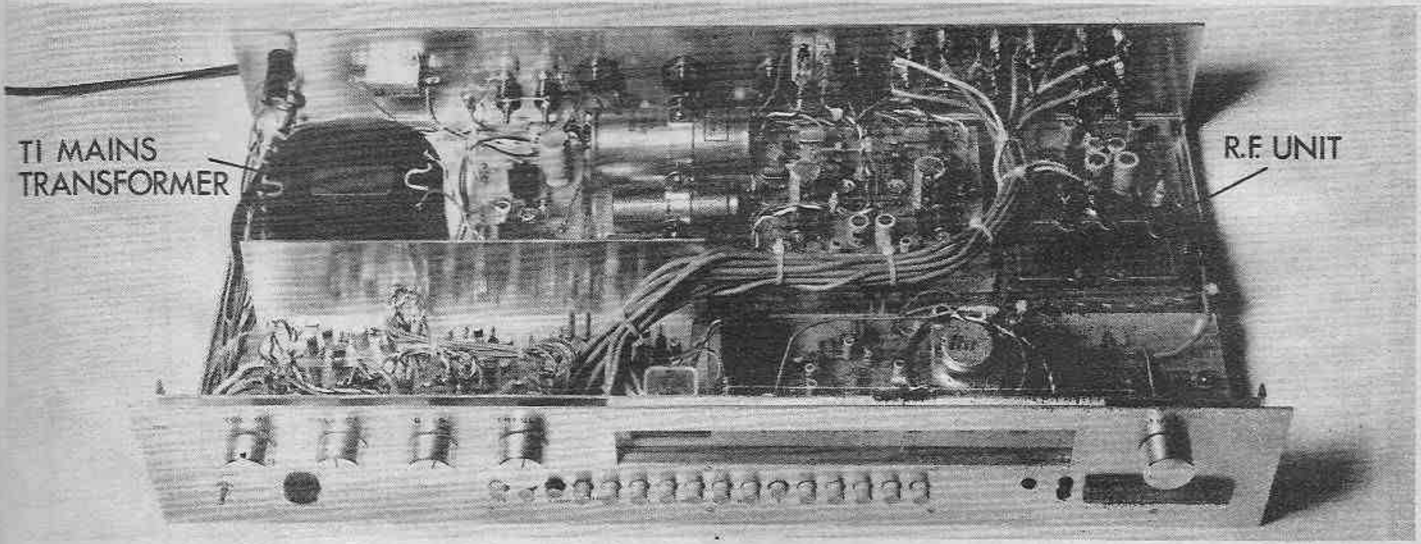
COMPONENTS

A fully detailed components list for each board is given. Components that are duplicated for left and right stereo channels are identified by the suffix "a" and "b" respectively. For example R25a, b. Those components that are mounted off the board, that is on the main chassis, or front or rear panel, are indicated by an asterisk in the components lists. Reference to the block diagram Fig. 1.1 and to the circuit diagram Fig. 1.2a and Fig. 1.2b will make clear the close electronic relationship of such components to particular boards; and also how the physical interconnections are made via terminal pins (TA1 etc.).

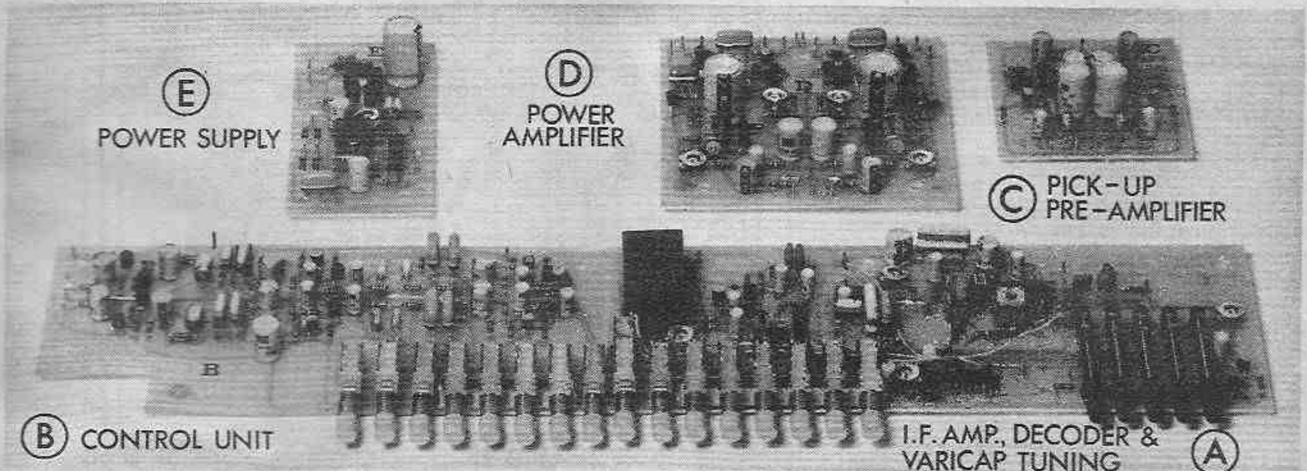
A list of hardware items is also included this month.

Although it does not matter in which order these three boards are tackled, it is recommended that the two smaller ones, C and E, be assembled first. This will allow experience to be gained in handling the boards, mounting the components, and soldering in position.

In the case of the two larger boards, A and B, pushbutton switch units have to be fitted before any other work is commenced. Details of this operation appear later in this article.



General view of the 2020 Tuner Amplifier.



The five circuit boards of the 2020 Tuner Amplifier arranged in their relative chassis positions.

DI.Y. OR READY MADE P.C.B.S

Full-size patterns of the printed circuits are included in the following pages. Constructors who are already experienced in making their own p.c.b.s can proceed straight away with the production of boards A, C, and D. Others who are interested in this procedure should study the special article in this issue *Making Printed Circuit Boards*, and then gain some practical experience by making a trial-run with a small board before setting out to make the 2020 boards.

Grade 1 Fibreglass should be used for all printed circuit boards.

Drilling Details:

(*a*) normal component holes 1mm.
(*b*) coils, pushbutton switches, preset potentiometers, and terminal pins 1·2mm.
(*c*) board fixing and presets VR4-VR8 4mm.

An alternative to d.i.y. is to purchase these p.c.b.s ready made from one of the several firms who specialise in offering this service to our readers.

EXAMINING THE BOARDS

Before assembling the components onto the printed circuit boards, hold each board in turn with the track side towards you and shine a bright light through the board from its rear. By doing this it is possible to clearly see if there are any broken tracks or bridges of copper between tracks and pads.

Examine each board carefully, because failure to find a possible fault at this stage could mean expensive and/or time consuming fault finding later. Although it is unlikely that any faults will be found with commercially made boards, don't start assembly without a thorough examination first.

ASSEMBLING COMPONENTS

Assembly of the components can now proceed. Do not rush this stage of the construction, allow about five hours each for the completion of the larger boards and one or two hours each for the smaller. Each time a component is fitted, check and then double check that it is the correct way round (i.e. polarity of electrolytics), the soldering is good and, last but not least, that solder hasn't shorted across to adjacent track or pads.

Remember all the time that an unnoticed mistake or solder bridge at this stage of the construction could mean many hours of frustrating time spent chasing faults later.

Have the appropriate p.c.b. pattern and the component layout diagram before you, also the circuit diagram Fig. 1.2a,b (December issue). It is a good exercise to cross-check each component on the circuit diagram before mounting in position according to the component layout diagram.

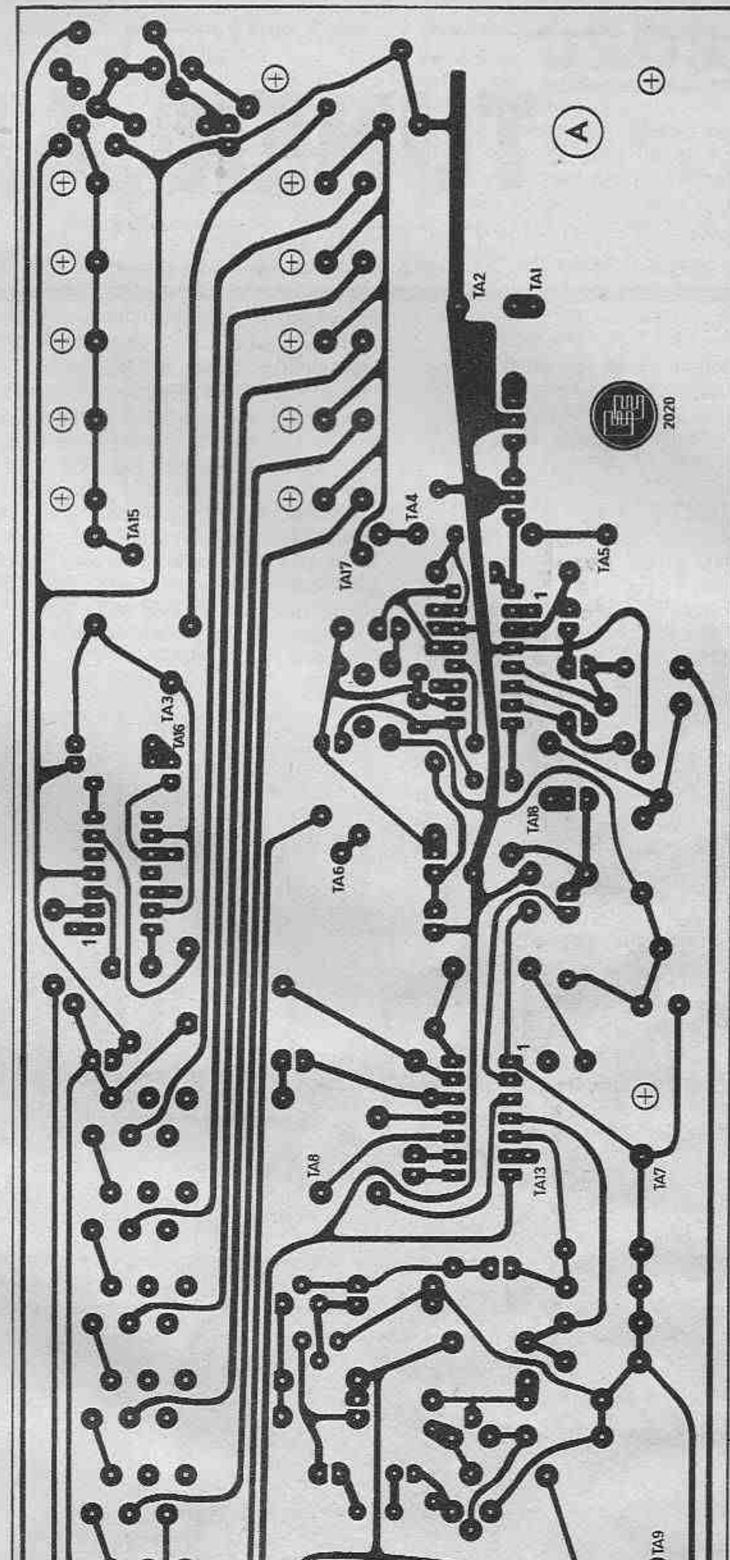


Fig. 2.1. Board A of the 2020 Tuner Amplifier: underside view showing printed circuit (full size).

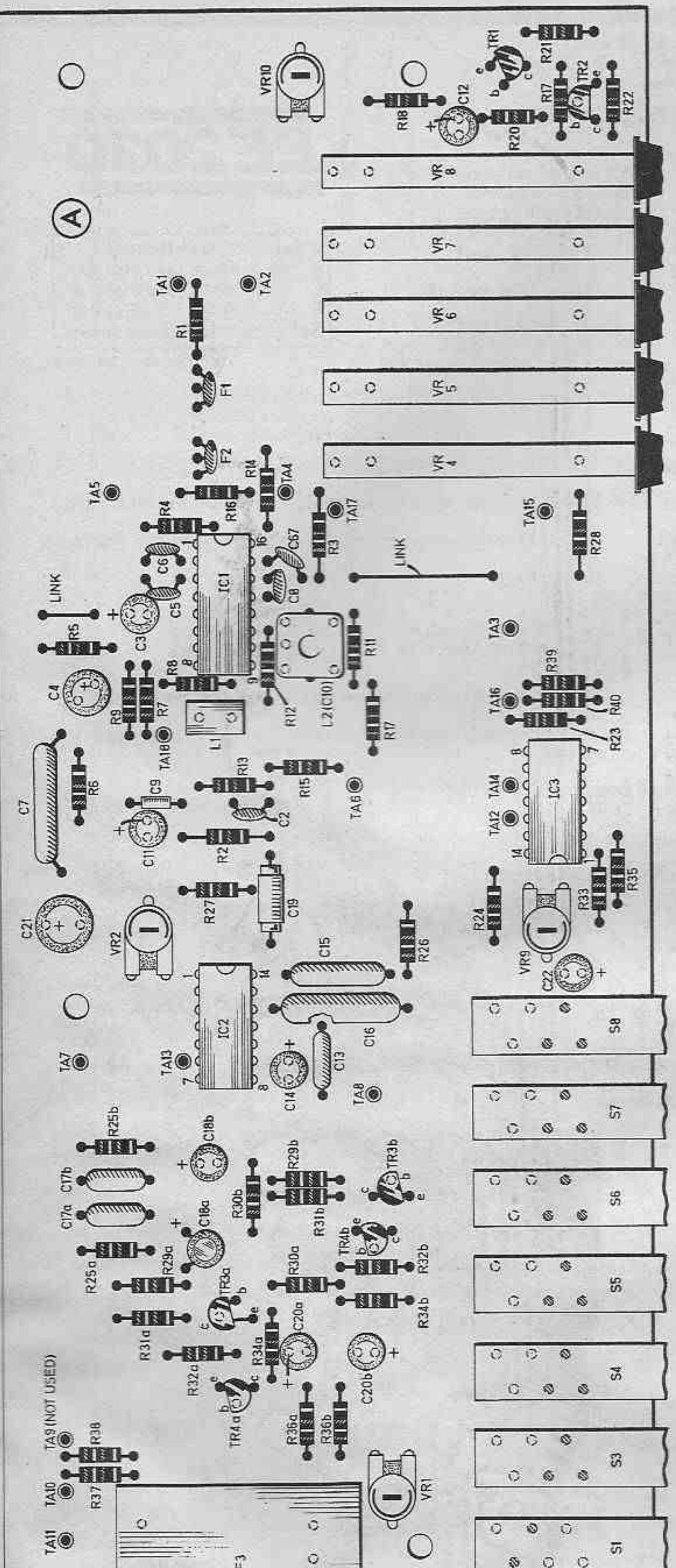


Fig. 2.2. Board A of the 2020 Tuner Amplifier: top view showing components in position.

Start by identifying and fitting the terminal pins. These pins are inserted from the top of the board and are a tight push-fit. Once fitted they are soldered on the underside to ensure good electrical contact to the track.

Next fit the resistors. The resistor wire ends are bent down at right angles to the body and then pushed through the board; after soldering, the surplus wire is cut off. *Warning. Hold the free end of the wire when cutting to prevent the wire "flying" and causing possible personal injury.* If the wires are bent slightly outwards after insertion in the board, this helps to hold the component secure when the board is turned over for soldering.

When all the resistors are in position a final check should be made for accuracy of location and value.

Continue, step by step, as detailed below:

Fit the capacitors, observing the correct polarity in the case of electrolytics. Check values and working voltage where mentioned.

Fit the semiconductors. The transistor leads may require bending or "forming" to suit the appropriate holes on the p.c.b.s. The types as specified (with "TO5" suffix) will fit directly.

Observe the correct polarity with the diodes. Fit the heat sinks to TR24 and TR25 (*Board E*).

Fit the i.c.s, taking care that pin No. 1 is in the correct position and that *all* pins are through the p.c.b. before soldering.

Fit the skeleton preset potentiometers.

Fit the multi-turn tuning potentiometers, the filters F1, F2, F3, and the coils L1, L2 (*Board A*).

Fit any wire links that may be shown.

Set all the skeleton presets to the midway setting. Fit the knobs onto the pushbutton switches (*Board A*). These are a press fit and will snap on with a little pressure.

The completed boards should be carefully stored to keep clean and safe from damage.

PUSHBUTTON SWITCHES

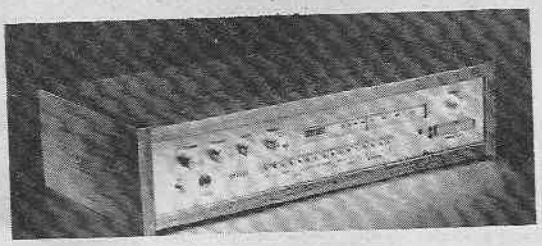
Only the specified pushbutton switches, made by Jean Renaud, are suitable for this project.

After initially inspecting board A, the first job is to fit the pushbutton switches. These are supplied as single units and some of them have to be assembled into switch units of 6 and 4 pushbuttons, for Boards A and B respectively.

At present we are concerned just with board A.

Referring to Fig. 2·7, take six of the single push switches and remove the bronze 'hold-on" clips and links. Carefully pulling the clips upwards with a small pair of pliers will enable

COMPONENTS



BOARD A

Resistors

R1	270Ω
R2	100Ω
R3	10kΩ
R4	330Ω
R5	47kΩ
R6	100kΩ
R7	470Ω
R8	470Ω
R9	1kΩ
R10	1kΩ
R11	3·9kΩ
R12	47Ω
R13	10kΩ
R14	10kΩ
R15	4·7kΩ
R16	100kΩ
R17	4·7kΩ
R18	1·5kΩ
R19	4·7kΩ
R20	100kΩ
R21	33kΩ
R22	2·7kΩ
R23	33kΩ
R24	33kΩ
R25a,b	4·7kΩ (2 off)
R26	1kΩ
R27	15kΩ
R28	2·7kΩ
R29a,b	330kΩ (2 off)
R30a,b	330kΩ (2 off)
R31a,b	1kΩ (2 off)
R32a,b	1kΩ (2 off)
R33	1MΩ
R34a,b	1kΩ (2 off)
R35	1MΩ
R36a,b	3·9kΩ (2 off)
R37	4·7kΩ
R38	4·7kΩ
R39	10kΩ
R40	10kΩ

All $\frac{1}{4}$W ± 5% high-stability carbon film

Capacitors

*C1	2·2μF 6·3V elect.
C2	0·01μF disc ceramic
C3	2·2μF 63V elect.
C4	22μF 63V elect.
C5	0·01μF disc ceramic
C6	0·01μF disc ceramic
C7	0·47μF polyester
C8	0·01μF disc ceramic
C9	68pF polystyrene
C10	(with L2)
C11	2·2μF 63V elect.
C12	2·2μF 63V elect.
C13	0·047μF polyester
C14	2·2μF 63V elect.
C15	0·22μF polyester
C16	0·47μF polyester
C17a,b	0·01μF polyester (2 off)
C18a,b	2·2μF 63V elect. (2 off)
C19	500pF polystyrene
C20a,b	2·2μF 63V elect. (2 off)
C21	100μF 16V elect.
C22	2·2μF 63V elect.
C67	0·01μF disc ceramic

All electrolytics (elect.) are the small single-ended p.c.b. type; all polyester are Mullard type C280.

** mounted on r.f. unit*

EE2020

Printed Circuit Boards
A 243 × 96mm (see Fig. 2·1)
C 80 × 76mm (see Fig. 2·3)
E 105 × 57mm (see Fig. 2·5)
See page 36 for drilling details.

Potentiometers

VR1		10kΩ horizontal mounting miniature skeleton preset RS type 184/5
VR2		10kΩ horizontal mounting miniature skeleton preset RS type 184/5
*VR3	*Tune*	220kΩ linear
VR4	*Preset 1*	100kΩ
VR5	*Preset 2*	100kΩ special log. law for diode tuning
VR6	*Preset 3*	100kΩ multi-turn type AB47 (Ambit) (5 off)
VR7	*Preset 4*	100kΩ
VR8	*Preset 5*	100kΩ
VR9		10kΩ horizontal mounting miniature skeleton preset RS type 184/5
VR10		10kΩ horizontal mounting skeleton preset cermet type RS 185-432

** mounted on tuning drive assembly*

Pushbutton Switches

(Manufactured by Jean Renaud)

S1	*Mute*	2-pole changeover	RS type 338-434; ITT type 44012R
S2	*AFC*	4-pole changeover	RS type 338-636; ITT type 44013G
S3	*Tune*		
S4	*Preset 1*		
S5	*Preset 2*		
S6	*Preset 3*	2-pole changeover	RS type 338-434; ITT type 44012R (6 off)
S7	*Preset 4*		
S8	*Preset 5*		

One 6-switch latching assembly (for S3-S8) RS type 338-614; ITT type 44020R

Semiconductors

TR1	BC212L/TO5 *pnp* silicon
TR2	BC384L/TO5 *npn* silicon
TR3a,b	BC384L/TO5 *npn* silicon (2 off)
TR4a,b	BC212L/TO5 *pnp* silicon (2 off)
IC1	CA3189E f.m. i.f. system, 16-pin d.i.l. (RCA)
IC2	SN76115AN stereo decoder, 14-pin d.i.l. (Texas)
IC3	747 dual op-amp, 14-pin d.i.l.
*D1	light-emitting diode TIL 211 (green)
*D2	light-emitting diode TIL 209 (red)
*D3	light-emitting diode TIL 209 (red)

** mounted on front panel*

Miscellaneous

F1, F2	10·7MHz ceramic filter CFSE/SFE 10·7 (Ambit) (2 off)
F3	stereo filter BLR3107N (Ambit)
L1	choke, 220K 22μH (Ambit)
L2	coil KACSK586HM (Ambit) (C10 inside coil)
*ME1	edgewise tuning meter 60-0-60μA movement. (Ambit type 906)
**SK1	coaxial socket RS type 455-539

** mounted on front panel*
*** mounted on rear panel*

BOARD C

Resistors

R70a,b	150kΩ	R71a,b	100kΩ
R72a,b	150kΩ	R73a,b	5·6kΩ
R74a,b	3·9kΩ	R75a,b	5·6kΩ
R76a,b	820Ω	R77a,b	220kΩ
R78a,b	15kΩ	R79a,b	8·2kΩ
R80a,b	3·3kΩ	R81a,b	1kΩ

All $\frac{1}{4}$W ± 5% high-stability carbon film (2 off throughout)

Semiconductors

TR11a,b	BC384/TO5 *npn* silicon (2 off)
TR12a,b	BC384/TO5 *npn* silicon (2 off)
TR13a,b	BC212/TO5 *pnp* silicon (2 off)

Capacitors

C40a,b	10μF 63V elect.
C41a,b	100μF 16V elect.
C42a,b	0·015μF polyester 5%
C43a,b	5,600pF polystyrene 2%
C44a,b	2·2μF 63V elect.
C45a,b	100μF 16V elect.

All electrolytics (elect.) are the small single-ended p.c.b. type. (2 off throughout)

Sockets

SK4a, b *Disc*	phono socket single-hole chassis mounting RS type 477-848 (2 off)

BOARD E

Resistors

R102	10kΩ
R103	2·2kΩ
*R104	100Ω 25W wirewound ± 10%
R105	1kΩ
R106	2·2kΩ
R107	2·2kΩ
R108	2·7kΩ
R109	4·7kΩ
R110	4·7kΩ
R111	2·2Ω 10% $\frac{1}{2}$W

All $\frac{1}{4}$W ± 5% high-stability carbon film, except where otherwise stated.

** mounted on rear panel*

Potentiometers

VR17	10kΩ horizontal miniature skeleton preset RS type 184/5

Capacitors

C57	0·22μF polyester
*C58	4,700μF 63V elect. single-ended
C59	220μF 63V elect.
C60	4,700pF polystyrene
C61	22μF 63V elect.
C62	10μF 63V elect.
C63	100pF polystyrene
*C64	0·047μF polyester
*C65	0·47μF polyester

Unless otherwise stated, all electrolytics (elect.) are the small single-ended p.c.b. type.
All polyester are Mullard type C280.

** mounted on main chassis.*

Semiconductors

TR23	BC384L/TO5 *npn* silicon
TR24	BFY51 *npn* silicon
TR25	BFY51 *npn* silicon
D4-7	IN4001 silicon 1A (4 off)
D8	BZY88C 12V 400mW Zener
IC4	μA723 voltage regulator, 14-pin d.i.l.

Fuses

*FS1	500mA slow blow
*FS2	1A quick blow
*FS3	1A quick blow

** mounted on rear panel.*

Miscellaneous

*LP1	Meter lamp 12V 13mA, wire ends, supplied with ME1
*S17	miniature toggle, d.p.d.t. RS type 316-715
**T1	Mains transformer, toroidal 50VA type: primary 120/240V; secondaries: 0-20V, 0-20V. RS type 207-431. (Available from T & T Electronics, Green Hayes, Surlingham Lane, Rockland St. Mary, Norfolk)

** mounted on front panel*
*** mounted on main chassis*

HARDWARE

Terminal pins, double-sided RS type 433-630	(80 off)
Terminals 4mm, black RS type 423-201	(3 off)
red RS type 423-239	(2 off)
Knobs RS type 499-949	(5 off)
Buttons, grey (for S1—S16) RS type 338-658; ITT type 44037B	(16 off)
Heat sinks T05 RS type 401-548	(2 off)
P.C.B. spacers $\frac{1}{4}$ inch RS type 543-737	(20 off)
Screws self-tap 9·4mm No.6	(20 off)
Screws 8BA C/SK $\frac{1}{2}$ inch	(14 off)
Nuts 8BA full	(14 off)
Lock washers 8BA	(14 off)
Washers 8BA	(14 off)

WIRE

Tinned stranded copper	16/0·2mm: power supply and power transistors. 7/0·2mm: general wiring
Screened leads	7/0·1mm p.v.c. insulated lap screened and sheathed. *or* 7/0·2mm overall dia. 3·1mm.
Mains cable	standard 3-core, 3A.

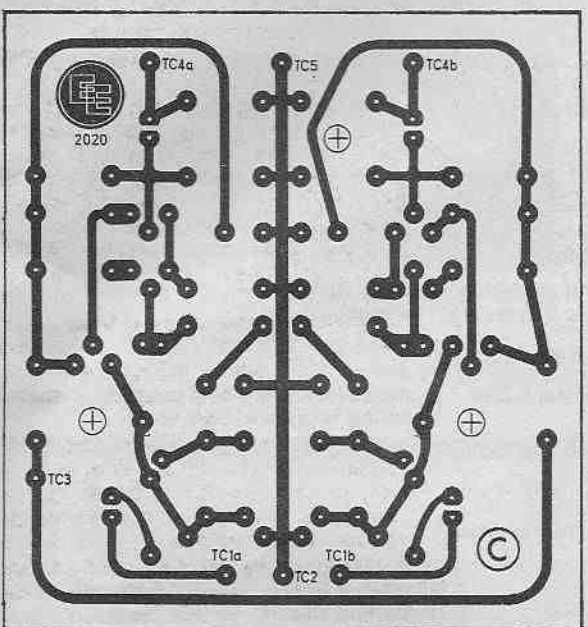


Fig. 2·3. Board C of the 2020 Tuner Amplifier: underside view showing printed circuit (full size).

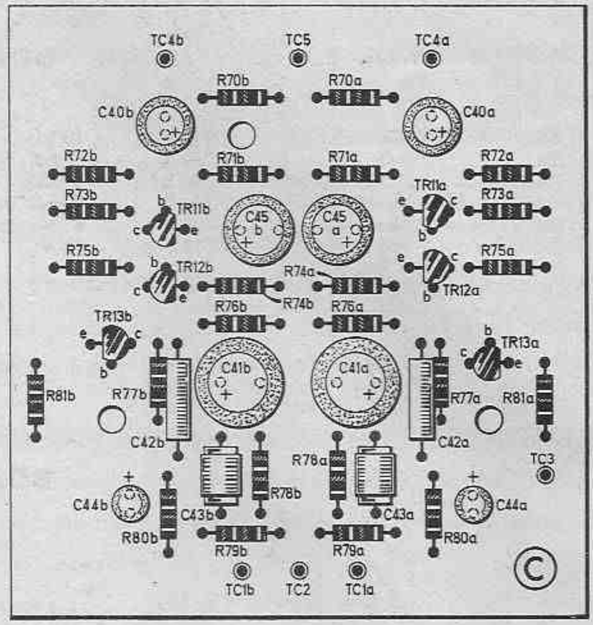


Fig. 2·4. Board C of the 2020 Tuner Amplifier: top view showing components in position.

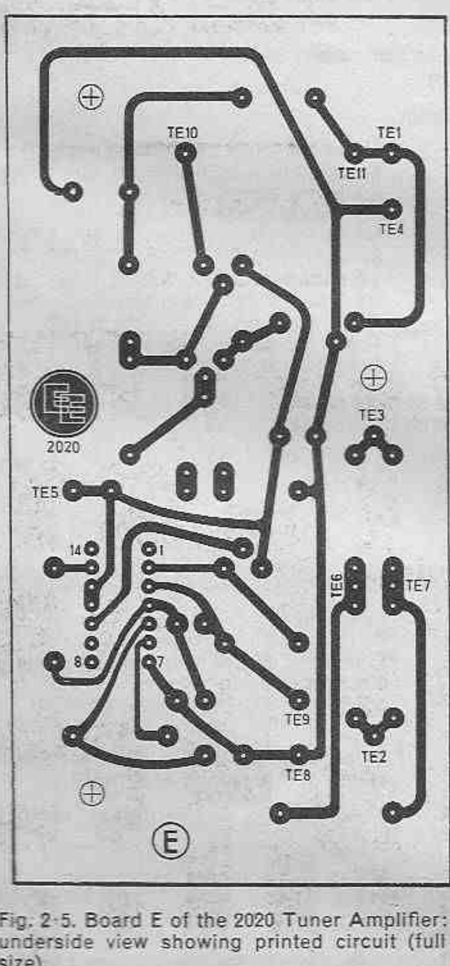


Fig. 2·5. Board E of the 2020 Tuner Amplifier: underside view showing printed circuit (full size).

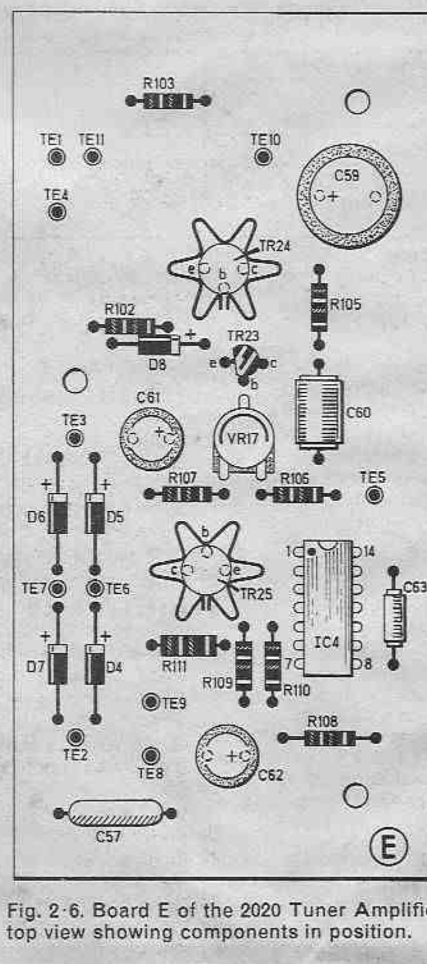


Fig. 2·6. Board E of the 2020 Tuner Amplifier: top view showing components in position.

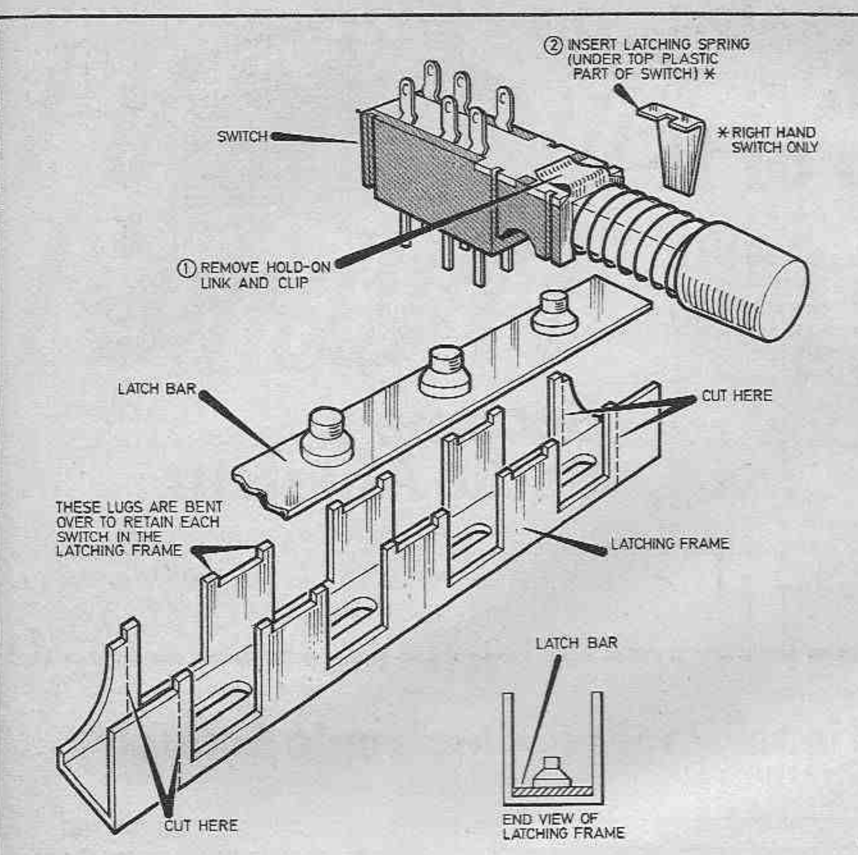


Fig. 2.7. Assembling the pushbutton switches into switch units, as required for Boards A and B.

the clips and links to be removed without damage to the switches. The clips and links can then be discarded.

Place the latch bar into the switch frame as shown in the diagram. (Fig. 2·7).

Supplied with the latch bar kit is a small latching spring, this is inserted into the right hand side of a push-button switch, under the top part of the clear (or white) plastic switch moulding. The switch is then assembled into the right hand position of the latch bar frame as shown in the diagram.

Only the switch in the extreme right hand position is fitted with a latching spring. The other switches are then assembled into the remaining positions in the latch bar frame.

Bend over the top lugs of the frame as shown to hold the switches in position, check that the unit works correctly, i.e., pressing in any one switch releases all the others.

Finally, very carefully cut off the ends of the frame as shown either with a sharp junior hacksaw or a pair of tin snips. Be careful not to distort the frame. Recheck the switch action.

Fit the switch assembly onto board A, ensuring that all pins come through the holes in the board.

Mount the single 2-pole switch (S1) and the 4-pole switch (S2) on board A.

To be continued

EE CROSSWORD No 11 BY D.P.NEWTON

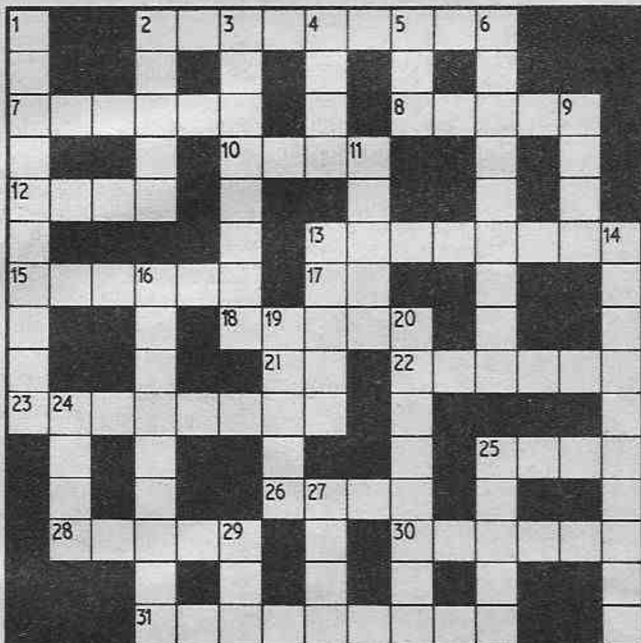
ACROSS

2 Some bridges have such a balancing point (4,5).
7 Cloth tape for a microphone.
8 Wire easily develops these deviant behaviours.
10 For the DIY enthusiast these have everything for the job.
12 Refrain from component balancing.
13 The third line (4,4).
15 Three times at a high pitch.
17 Tail-end of seven across to release the flow.
18 Solar blemishes often interfering with reception.
21 Slow spinner.
22 Part of the switch characterized by its projecting nature.
23 Electronic entitlement on a regular basis.
25 Thin layer.
26 To stumble on a switch.
28 Terminated.
30 A garment-fitting characteristic of many calculators.
31 Very small storage unit.

DOWN

1 Initial circuit as an integral unit (5,5).
2 Of distinguished character.
3 Small, electrical connections between units.
4 Liquid measure.
5 Liquid used in three down.
6 Messing about with something which just might work better.
9 Half-a-mind to conduct.
11 Mean session of duty.
13 Lots of feedback from such a crazy circuit.
14 Spirited device for measuring output (5,5).
16 Planked out to deter intruders (7,2).
19 Not a general member of the animal kingdom.
20 She doesn't stop at laying bare the wire!
24 Elemental fin.
25 A final layer of material was added.
27 House covering.
29 The medical section of a document.

Solution on page 52



Headphone Enhancer

By R. A. Penfold

ALTHOUGH stereo hi fi headphones offer a very high level of performance at relatively low cost, they have a minor drawback in that they do not provide a proper stereo effect from ordinary stereo programme sources.

The basic technique used when making a stereo recording or transmission is to have a microphone each side of the sound stage, and one in the middle. The right hand microphone feeds the right hand stereo channel, the left hand one feeds the left hand stereo channel, and the signal from the centre microphone is mixed equally into both channels. This is something of an over simplification of course, but it illustrates the general principle employed.

COMPONENTS approximate cost £1.50

On playback through suitably placed loudspeakers the original sound stage will be simulated by an audio delusion, and will stretch from one speaker to the other.

When such a signal is played through headphones, the sound stage will still extend from one transducer to the other, giving a sound stage from one ear to the other.

This results in some sounds seeming to emanate from actually inside the listeners head, which can be distracting and even unpleasant.

BINAURAL RECORDING

This phenomena can be overcome by the use of the binaural recording technique where two microphones are used and they are fitted into the ears of a dummy head. The dummy head is placed in the middle of the audience (or where the audience would normally be) so that the microphones pick up the sounds that would be heard by someone sitting at that position in the audience. Anyone listening to this signal through headphones will hear these sounds and will gain a very realistic impression of being actually in the audience at the performance, from a purely audio stand point anyway.

The effect is more like a quadraphonic one than an ordinary stereo one and can be extremely realistic indeed. Unfortunately though, very little programme material is currently in binaural sound as most people prefer to use loudspeakers, and binaural recordings do not produce a good conventional stereo effect when played through loudspeakers.

This has resulted in many attempts to produce signal processors for giving a less localised stereo image when using headphones to listen to a conventional stereo signal. Most simple devices of this type use some form of blend circuit where the two channels are mixed together in some way, but a number of experiments along these lines carried out by the author did not prove very successful. In fact they tended to give a more localised signal.

HAFLER CIRCUIT

Sometimes when listening to a conventional stereo signal through headphones a spacious effect is produced, but this is more by accident than design.

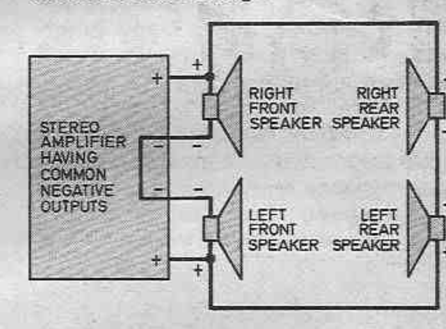


Fig. 1. Four speaker Hafler arrangement.

This widening and general extending of the sound stage away from the listeners head is due to ambience signals. These are produced by sounds which are reflected off the walls, floor, and ceiling before being picked up by a microphone. It is these ambience signals that are used in most quasi-quadraphonic systems to give a spacious surround sound effect, and a similar technique can be used to give increased ambience and thus a less localised stereo image when listening to an ordinary stereo signal through headphones.

This is achieved by using a form of circuit which has become known as the "Hafler arrangement", after its originator. The four speaker Hafler arrangement is illustrated in the circuit of Fig. 1.

The front speakers are wired up in the same way as the speakers in a conventional two channel system, and the rear speakers are almost connected in the same manner, but the common connection of the rear speakers is not connected to the negative amplifier output.

REAR LOUDSPEAKERS

The rear speakers therefore respond to the difference in the output amplitudes of the two channels. Signals at the centre of the sound stage will not be reproduced by the rear speakers, since they will be comprised of identical signals in each channel. Thus, as the voltage at the left hand positive output rises and falls, the voltage at the right hand positive output will vary in precisely the same way. No voltage will be developed across the rear speakers and they will produce no output.

Signals slightly either side of centre will be reproduced at reduced level, because although both outputs will rise and fall in amplitude simultaneously, one output will be at a greater amplitude than the other, and a small difference signal will be developed across the rear speakers.

Signals forming the left and right limits of the sound stage will only appear at one or other of the outputs, and no cancelling of these will occur. They are therefore reproduced at normal volume.

AMBIENCE

Any ambience signals will be randomly phased, and may well be cancelled out in precisely the same way as the centre of sound stage signals were. However, by chance it is likely that some ambience signals will be out of phase. In other words, some of these signals will be positive in polarity at the right hand output when they are negative at the left hand output, and vice versa.

Such a signal might produce an output potential of (say) +1 volt at one output, and −1 volt at the other output. This would give a potential of 2 volts across the rear speakers, and so such a signal would be reproduced twice as loudly from the rear speakers as from the front ones.

In this way the Hafler circuit gives an output from the rear speakers which has boosted ambience and an attenuated main signal. From suitable programme material this produces an extremely effective quadraphonic type effect.

HEADPHONE APPLICATION

This same basic technique can be applied to a headphone enhancer unit using the extremely simple circuit shown in Fig. 2. Here the common connection of the headphones is connected to the common output of the amplifier via a 5 kilohm log. potentiometer, rather than directly as would normally be the case.

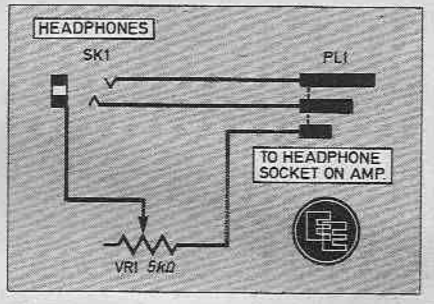


Fig. 2. The circuit of the Headphone Enhancer.

With VR1 adjusted to insert minimum resistance into circuit the headphones will obviously be fed with an ordinary stereo signal and the unit will have no effect. With VR1 adjusted for maximum resistance the headphones are connected in what is virtually the rear speaker Hafler arrangement.

Because VR1 will still provide a signal path, albeit a rather poor one, the ordinary left and right signals will still be reproduced, but at a low level which will be insignificant in comparison to the Hafler difference signal.

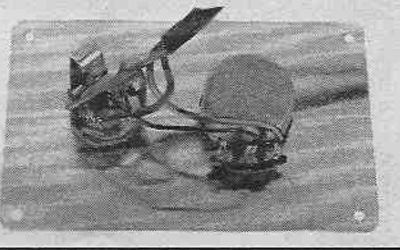
In practice VR1 is adjusted for a compromise between these two extremes. This gives a signal having the centre of the sound stage somewhat attenuated and the amount of ambience increased. One effect this has is to polarise most signals to one side or other of the sound stage, thus helping to eliminate the stereo image from appearing actually inside the listeners head.

The absolute centre of the sound stage will still be present, but the reduced signal level and increased ambience give the signal a rather distant sound, again helping to remove the sound stage from actually within the listeners head.

This does not give the same effect as listening to the signal using loudspeakers, neither does it give a true binaural effect, but does give a more realistic effect than a straightforward stereo signal, and most people seem to find the effect more pleasant than that produced by an ordinary stereo signal.

CONSTRUCTION starts here

The unit can be housed in any small case with VR1 and a stereo jack output socket mounted on the front panel. An entrance hole for the input cable is made in the rear of the case. This lead can consist of about 2 to 3 metres of thin 3-core mains cable terminated in a stereo jack plug (which plugs into the headphone socket of the amplifier). The common input lead connects to the left hand terminal of VR1 (when viewed from the rear) and the centre tag of VR1 is connected to the common tag of the output socket. It is then only necessary to connect the two remaining input leads, one each to the so far not connected tags of the output socket, and the unit is complete.



COMPONENTS

VR1 5kΩ log. potentiometer
SK1 stereo jack socket
PL1 stereo jack plug
Plastic case; screened stereo cable.

See Shop Talk page 34

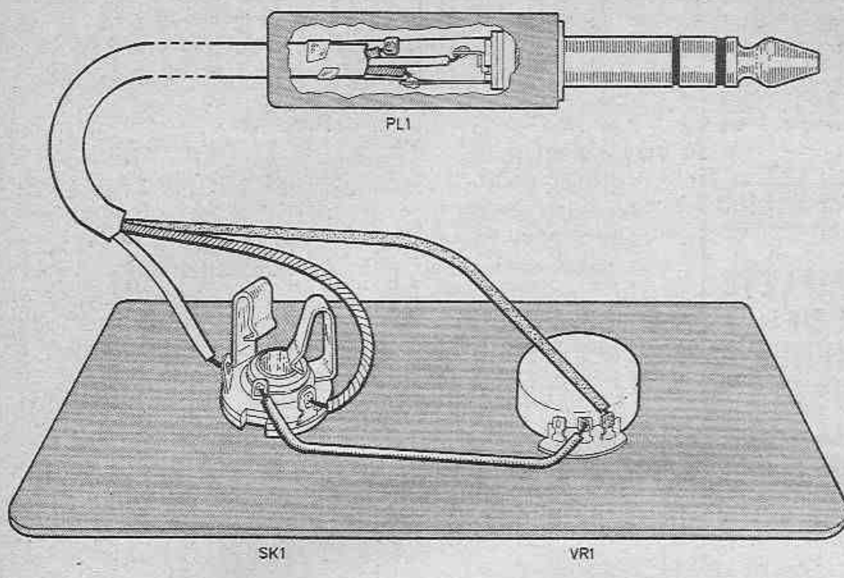


Fig. 3. Layout of the components on the back of the front panel of the case and interwiring.

SETTING UP

With the equipment set up for use and VR1 adjusted fully anticlockwise, ordinary operation should be obtained. Adjusting VR1 in a clockwise direction should produce progressively enhanced results until a point is reached where the stereo effect begins to die away and virtually a mono signal (the Hafler signal) is obtained.

Results will probably be at optimum with VR1 just slightly backed off from this point.

How effective the unit is depends to a large extent on the amount of ambience present on the signal, but it should provide improved results with any stereo signal. The effect of the unit is most apparent on a programme source having plenty of ambience and a soloist at the centre of the sound stage. ⌑

I like to think of you curled up in the armchair in front of the fire on Christmas afternoon, comfortably full of turkey and Christmas pudding, and occasionally nodding off. In one hand you have your copy of EVERYDAY ELECTRONICS and in an effort to keep awake you start to read "Counter Intelligence". This has the effect of sending you to sleep until teatime.

Under the circumstances on this occasion I do not feel called upon to be too serious and the Editor always allows me to reminis a little. It must have been an Irishman who said that "Nostalgia ain't what it used to be" but even so it is great fun especially because we tend to remember the good times and the funny things rather than the bad times and the tragedy.

Brief Encounter

I suppose but for an odd chance meeting, I should have finished up during the War as a wireless operator or in radar. It happened this way. I was walking one day past the Dominion Cinema, Tottenham Court Road, when standing outside having his boots polished was an old friend of mine, Fred Brandt. We were both Service Engineers at Radio Rentals at one time, but I had lost touch with him, so naturally I asked him what he was doing. "I am flying" he replied. I was quite incredulous (you must remember in those far off days we used to look skywards, whenever we saw an aeroplane, they were so rare).

Before I could recover, he said "Come over to Heston on Sunday and I will take you for a trip". Fred was as good as his word and on the Sunday took my wife and myself up in a Leopard Moth. After that I was hooked and within a month I had joined the RAF reserve and the following April started my flying training.

The chances were, that I might never have come back into radio but for two things. After seven years of war time flying and surviving one crash, I was weary of it all, and when my brother, who was a Captain in the signals, suggested we start up our own radio business, I agreed. If it had not been for those two things there would have been no Paul Young.

Outside, the reader who said "What a pity!" Starting a business just after the war had its problems. The biggest stumbling block was, that there were no new sets being made and consequently no stock!

I well remember I had the good fortune to re-establish contact with an old friend of my pre-war days named Jimmy Reygate. Jimmy used to buy up old wireless sets and repair them. He was a butcher by trade and although he had a heart of pure gold and made marvellous sausages his radio knowledge was minimal, and if the set did not go after changing the valves followed by a swift kick, he would call me in.

A Good Time

Jimmy would let me know, if he heard that anyone was disposing of an old set and we would be round there in a flash. One of these episodes comes back vividly to me. Jimmy had heard that someone had a large HMV radiogram to sell. It was rather a nice model with an automatic record changer and a good quality output consisting of two PX4's in push-pull.

Being worried that if we were too eager, they would push the price up too high he suggested we should pretend we wanted to buy the pianola instead. So there was Jimmy pumping out tunes on the old pianola while we tried to find out the price of the radiogram without appearing all that interested. It took some doing, but we managed it and thus acquired one more piece of stock.

Needless to say there was not the slightest difficulty in selling anything you could obtain. It was an unusual situation, but you have to remember that the public had been unable to buy any consumer goods for over five years! Fortunately supplies of new goods gradually improved so we had something to sell before we starved to death.

A Happy Christmas to you all!

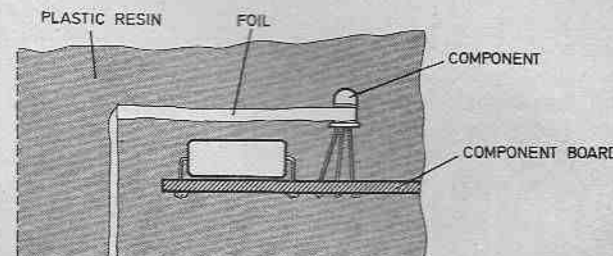
BRIGHT IDEAS

HEATSINK

With reference to my letter in the August '78 issue concerning heat dissipation in encapsulated circuits. I have found that kitchen foil can be used as a very effective heat sink on individual components. The diagram shows how this is done. The foil is tightly wrapped round the component, and carefully arranged so that when the circuit is encapsulated a small piece is lying on the outside.

By natural conduction the heat will be dissipated away from the component to the cool outside.

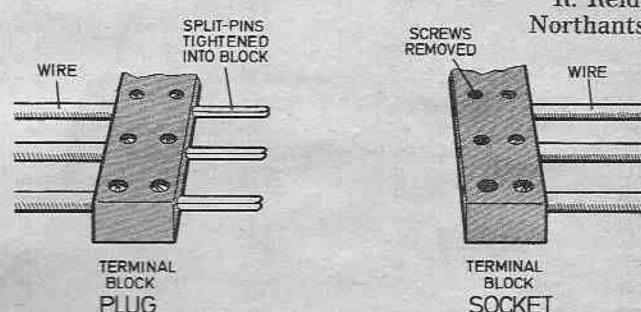
D. Clarke,
Rugby



PLUG AND SOCKET

A very cheap multiway plug and socket can be made using standard plastic connecting blocks and split pins. The diagram shows how this is done. The split pins should have a diameter just smaller than that of the holes in the socket. The split pins should protrude about 10mm from the edge of the socket. I used this method very successfully when building the *Sound to Light* unit.

R. Reid,
Northants



PLEASE TAKE NOTE

TREASURE HUNTER

(October 1978)

We have been informed by the Home Office that the cost we published for a licence is incorrect. A licence for five years costs £1·80.

ELECTROVALUE Buying Guide

Section 1

If you have bought before from Electrovalue, you know just how unusually large and varied our stocks are. If you have yet to know, we are sure you will benefit from studying our current series of monthly ads. to give up-to-date information and prices on the most important items we carry. These ads. appear in stepped rotation in five journals—so that the complete series is available each month. BY DETACHING AND SAVING THESE PAGES, YOU CAN BUILD UP A VALUABLE AND COMPREHENSIVE MONEY SAVING REFERENCE CATALOGUE, AND YOU WILL FIND OUR SERVICE PERSONAL, EFFICIENT AND DEPENDABLE WHEN YOU BECOME AN ELECTROVALUE CUSTOMER.

Section 2—Capacitors
Section 3—I.Cs/Opto/Displays
Section 4—Resistors/Pots/Knobs
Section 5—Ferrites/Solder Tools/Switches/Vero etc.

Transistors/Zeners

1N914	5p	2N4443	£1·14	ASY27	£1·39	BC214 *	12p
1N9142	7p	2N4444	£1·50	ASY28	£1·39	BC238B *	8p
1N916	6p	2N4906	£1·00	ASY29	£1·39	BC238C *	8p
1N4007	8p	2N4915	£1·00	AU111	£2·25	BC239C *	12p
1N4148	5p	2N4991 *	80p	AUY21	£7·31	BC257A *	8p
1N5402	16p	2N5062 *—SCR	45p	AUY22	£10·95	BC257B *	8p
1N5407	20p	2N5163 *	24p	BO126—SCR	30p	BC258A *	8p
IS920	10p	2N5192	85p	BO140 ..	35p	BC258B *	8p
IS940	5p	2N5195	99p	BO226 ..	35p	BC259B *	8p
2N697	36p	2N5457 *	39p	B0240 ..	40p	BC267	16p
2N706	22p	2N5458 *	39p	B0246 ..	96p	BC268C	17p
2N930	21p	2N5459 *	39p	B0680	10p	BC269C	18p
2N1132	24p	6F40	£1·46	B1906	38p	BC300	26p
2N1302	48p	16F40	£1·65	B1912	38p	BC301	24p
2N1303	48p	40HF10	£1·64	BA102	28p	BC303	30p
2N1304	52p	40HF40	£2·28	BA127D	4p	BC327 *	16p
2N1305	52p	40250	95p	BA133F	9p	BC328 *	12p
2N1306	56p	40361	38p	BA138	20p	BC337 *	14p
2N1307	56p	40362	35p	BA145	19p	BC338 *	12p
2N1308	60p	40406	40p	BA156	14p	BC447	29p
2N1309	60p	40408	40p	BA379	25p	BCY31A	96p
2N1599—SCR	88p	40412	56p	BAX13	4p	BCY58	15p
2N1613	23p	40594	£1·18	BB103B	37p	BCY59	16p
2N1711	22p	40595	£1·50	BB103G	37p	BCY70	18p
2N1893	35p	40602	75p	BB104G *	53p	BCY71	18p
2N2218	24p	40636	£1·80	BB105B	28p	BCY72	18p
2N2218A	24p	40673	86p	BB109G *	39p	BCY78	25p
2N2219	24p	A9903	44p	BC107A	14p	BD130	45p
2N2219A	24p	AA113	9p	BC107B	14p	BD131	62p
2N2270	75p	AA116	9p	BC108A	14p	BD132	77p
2N2369A	22p	AA117	9p	BC108B	14p	BD135 *	38p
2N2484	26p	AA118	10p	BC108C	14p	BD136 *	42p
2N2646	69p	AA119	9p	BC109B	14p	BD139 *	41p
2N2904	24p	AC126	30p	BC109C	14p	BD140 *	46p
2N2904A	24p	AC127	48p	BC121W	20p	BDX18N	£1·10
2N2905	24p	AC128	28p	BC122Y	61p	BDY12	90p
2N2905A	24p	AC151R	56p	BC125 *	20p	BDY20	50p
2N2924 *	25p	AC153	40p	BC126 *	20p	BF115	38p
2N2925 *	25p	AC153K	40p	BC140	43p	BF167	30p
2N2926 *	25p	AC176	58p	BC147A *	21p	BF173	34p
2N3053	26p	AC176K	40p	BC147B *	21p	BF177	24p
2N3054	73p	AC187K	70p	BC148A *	21p	BF178	24p
2N3055	70p	AC188K	70p	BC148B *	21p	BF194 *	18p
2N3391A *	41p	ACY17	92p	BC148C *	21p	BF195 *	17p
2N3405 *	64p	ACY18	91p	BC149C *	21p	BF244B	30p
2N3663 *	52p	ACY19	99p	BC154 *	16p	BF254 *	14p
2N3702 *	11p	ACY20	70p	BC157A *	21p	BF255 *	14p
2N3703 *	10p	ACY21	85p	BC157B *	21p	BF457 *	36p
2N3704 *	11p	ACY22	50p	BC158B *	21p	BF458 *	37p
2N3705 *	10p	ACY39	£1·70	BC159B *	21p	BF459 *	40p
2N3706 *	9p	ACY40	45p	BC160	49p	BFR39 *	24p
2N3707 *	12p	ACY41	54p	BC167A *	8p	BFR40 *	24p
2N3708 *	8p	AD136	£2·09	BC167B *	12p	BFR41 *	24p
2N3709 *	12p	AD142	90p	BC168A *	8p	BFR79 *	24p
2N3710 *	12p	AD149	80p	BC168B *	12p	BFR80 *	24p
2N3711 *	12p	AD161	96p	BC168C *	8p	BFR81 *	24p
2N3794 *	21p	AD162	96p	BC169B *	8p	BFT66	£1·83
2N3819 *	22p	AF114	27p	BC169C *	12p	BFX29	24p
2N3820 *	56p	AF115	30p	BC177A	18p	BFX84	24p
2N3823E *	24p	AF116	30p	BC177B	20p	BFX85	24p
2N3904 *	24p	AF117	34p	BC178A	16p	BFX87	24p
2N3906 *	28p	AF124	25p	BC178B	17p	BFX88	24p
2N4036	68p	AF125	32p	BC179B	20p	BFY50	24p
2N4058 *	12p	AF126	25p	BC182L *	12p	BFY51	24p
2N4059 *	12p	AF127	36p	BC182 *	12p	BFY52	24p
2N4060 *	12p	AF139	32p	BC183L *	12p	BFY90	£1·05
2N4061 *	12p	AF200U	10p	BC183 *	12p	BR81WA	80p
2N4062 *	12p	AF239	89p	BC184L *	12p	BR92WA	£1·36
2N4124 *	22p	AF279	30p	BC184 *	12p	BRY39	60p
2N4126 *	27p	AFY12	£2·04	BC202Y	75p	BSX20	22p
2N4286 *	18p	AFY16	£2·69	BC121L *	12p	BSX46	45p
2N4289 *	23p	AFY18D	£5·74	BC212 *	12p	BSX63	£3·89
2N4291 *	24p	AFY18E	£6·15	BC213L *	12p	BT106	£1·47
2N4292 *	21p	AFY42	£3·07	BC213 *	12p	BT107	£1·60
2N4303 *	30p	AL102	£1·60	BC214L *	12p	BU105	£2·50
2N4410 *	39p	ASY26	£1·39				

BU208	£3·90	TIP32A	45p
BUX28	£4·20	TIP41A	60p
BY164	90p	TIP41C	64p
BY238	7p	TIP42A	60p
BYX38-300	65p	TIP42C	64p
BYX38-300R	65p	TIS43 *	35p
C106D1	45p	W02	25p
C0326—SCR	£4·40N	ZTX107 *	12p
C0340 ..	£5·14N	ZTX108 *	11p
C407 *	17p	ZTX109 *	12p
C1406	90p	ZTX300 *	12p
C1412	90p	ZTX301 *	16p
CS2925	20p	ZTX302 *	14p
E99A40—Triac	£7·87N	ZTX303 *	18p
E2506	£1·48	ZTX304 *	21p
E2512	£1·74	ZTX330 *	8p
MJ481	£1·48	ZTX331 *	19p
MJ491	£1·63	ZTX500 *	12p
MJ2955	78p	ZTX500 *	15p
MJE340	78p	ZTX502 *	17p
MJE2955	72p	ZTX503 *	19p
MJE3055	68p	ZTX504 *	22p
MKY7C38E	70p	ZTX530 *	8p
MPF102 *	44p	ZTX530 *	20p
MPS6531 *	24p		
MPS6534 *	24p		
NAS206.S.5—SCR	81p		
NAS0164W3—Triac	58p		
NAS654X5 ..	80p		
NAS065W5 ..	£1·04		
NAS1001X5 ..	60p		
NAS1004W5 ..	£1·60		
NAS1004X5 ..	£1·04		
NKT211	20p		
NKT212	20p		
NKT213	20p		
NKT274	20p		
NKT275	20p		
OA47	12p		
OA90	6p		
OA91	6p		
OA95	8p		
OA202	10p		
OC28	£1·02		
OC29	£1·07		
OC35	£1·07		
OC36	£1·02		
OC45	£1·15		
OC71	70p		
OC72	70p		
OC81	80p		
OC83	70p		
OC84	70p		
PM7A2	£2·68		
PN70 *	5p		
PN72 *	5p		
PN109 *	5p		
PN1613 *	5p		
PN2904 *	5p		
SIOMI	10p		
T2700D	£1·55		
T2800D—Triac	£1·04		
TAG3-400—SCR	£1·00		
TAG302-400—Triac	85p		
TAG302-600—Triac	£1·05		
TIP31A	45p		

HEAT SINKS

Type	Drilled	
2P1	—	53p
2YTO3	1×TO3	54p
2YTO66	1×TO66	57p
2·75R	—	£2·80
5·5R	—	£3·95
5F	TO5 clip	10p
5F2	TO5 clip	10p
6W1	—	£2·05
6W4	2×TO3	£2·25
10DNA		88p
10DNC	2×TO3	£1·14
17C2	2×AD161	20p
18F	TO18 clip	10p
18F2	TO18 clip	10p
224F	TO1 clip	10p
244F	DO1 clip	10p
266F	DO3 clip	10p
A1032	TO1 clip	6p
A1053	2×TO1 clip	8p
A1058	1×TO3	22p
TO921	TO92 clip	7p
TO922	2×TO92 clip	9p
TV2	TO66	24p
TV3	TO3	25p
TV4	BD131	21p
TV5	TO220	21p

ZENER DIODES

400mW 2·7–33V 9p
1·3W 3·3–200V 15p
1·5W 3·3–75V 55p
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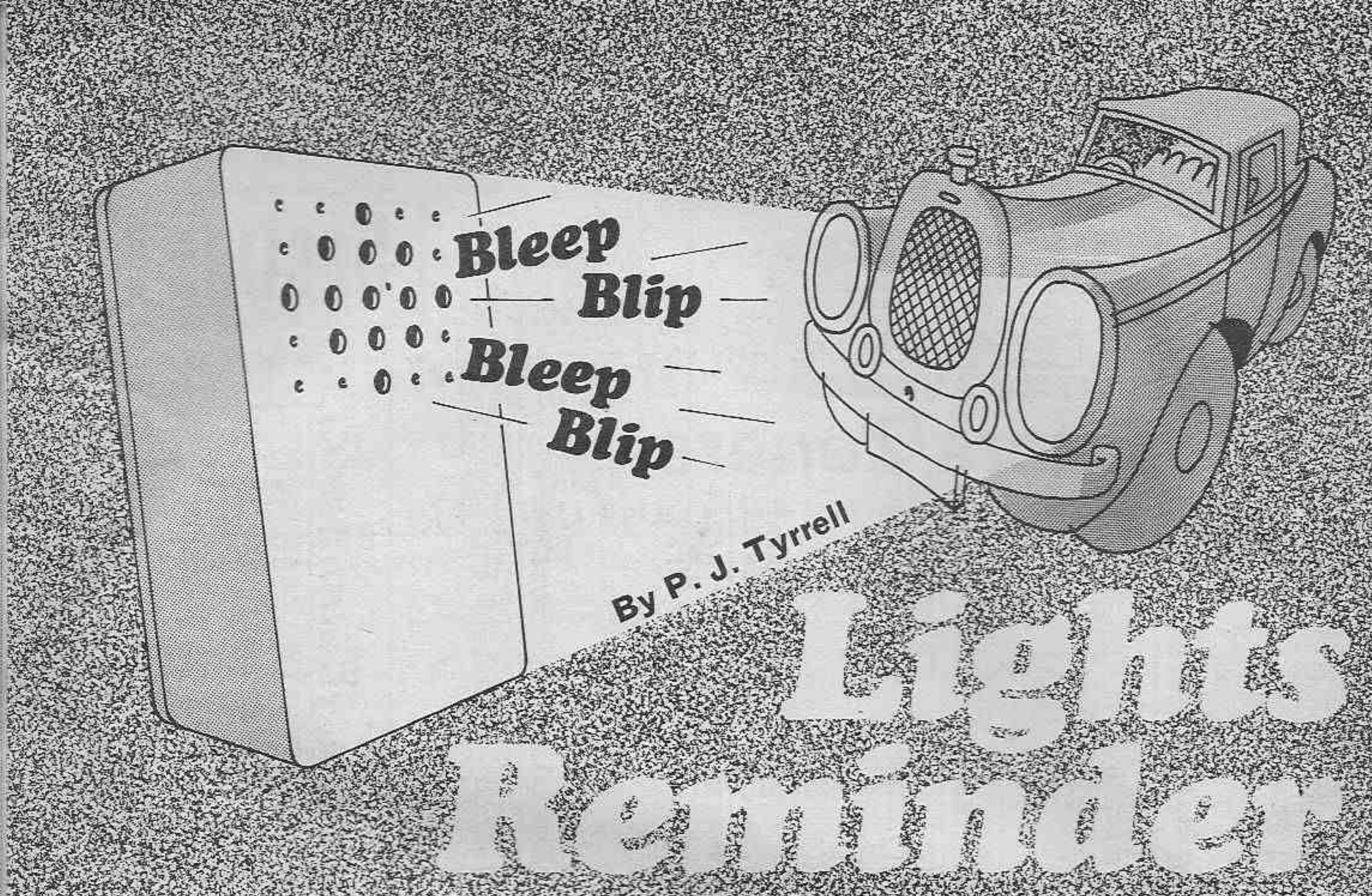


Lights Reminder

By P. J. Tyrrell

WHEN driving during daylight hours the occasion sometimes arises to use lights, as a result of sudden rainfall or a temporary darkening of the sky. It is on these occasions that one is most prone to leave the car parked with the lights left on, particularly if the sky has brightened up again. This simple device provides a two tone audible warning of this condition.

It was decided to have the warning activated when all of the following conditions arise:

1. Car lights on.
2. Ignition switched off.
3. Car driver's door open.

Thus, the warning sounds as the car door is opened, if the lights are switched on. When the door is closed the alarm stops, a useful feature if one wishes to leave one's lights on when parked. Also, the alarm is inhibited if the ignition is switched on. Again useful for dropping off passengers without triggering the device.

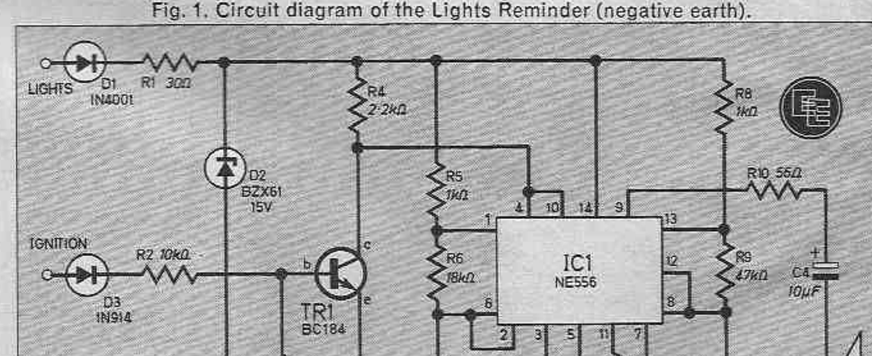
COMPONENTS approximate cost £3.25 excluding case

CIRCUIT DESCRIPTION

The circuit for the Lights Reminder is shown in Fig. 1 and consists basically of two oscillators. One oscillator operates at an audible frequency, whilst the other operates at a much lower frequency. The output from the low oscillator is used to "shift" the frequency of the higher which thus produces the two-tone sound.

The high frequency oscillator comprises one half of a dual timer i.c., an NE556, and timing components R8, R9 and C3. In this circuit the frequency is about 700Hz. The low frequency oscillator uses the remaining half of IC1, and the timing components R5, R6 and C1 to produce a frequency of about 4Hz. The two oscillators are directly coupled via R7.

Fig. 1. Circuit diagram of the Lights Reminder (negative earth).



The waveforms of Fig. 2 show how, when the low frequency oscillator switches on and off, the frequency of the second oscillator is "shifted" up and down in frequency. The resultant two-tone composite output is taken from pin 5 of IC1, via R10 and C4 to the loudspeaker.

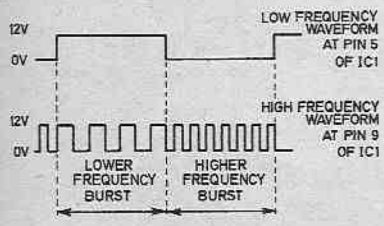


Fig. 2. Typical waveforms appearing at the outputs of the two oscillators.

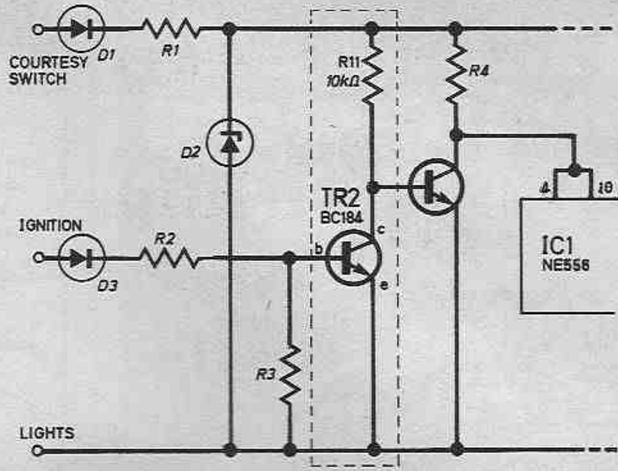


Fig. 3. The original circuit is modified slightly to enable it to operate on positive earth car systems.

OPERATION

For the circuit to operate, 12 volts must be applied. This is obtained as follows: when the lights are switched on, 12V from the light switch appears at the LIGHTS input. In this state the circuit does not operate since there is no 0V connection. Now when the car door is opened, COURTESY SWITCH closed, the 0V or ground condition required now appears at the COURTESY SWITCH input. The unit thus operates and sounds a warning.

The above is only true if the ignition is switched off. This constitutes the main function of the device which is to alert the driver when the car is parked, that the lights are still on.

A useful feature is provided in the unit whereby if the ignition is left switched on, and the door is opened the alarm will not sound. This is useful if it is required to drop off passengers without the annoyance of the alarm.

This part of the circuit is TR1, and operates as follows. With the ignition switched on, +12V appears at the IGNITION input. The transistor is thus turned hard on, its collector potential falls to almost zero. In this condition a "low" potential is presented at pins 4 and 10 of IC1. These pins are in fact the reset terminals of the i.c. and when taken low inhibit the timers from operating.

Zener diode, D2 and R1 stabilises the supply voltage at 15 volts, which is the maximum the i.c. can take without being destroyed. Diode D1 prevents reverse current flowing through the circuit, as would otherwise happen when the lights are off and the courtesy switch open.

POSITIVE EARTH

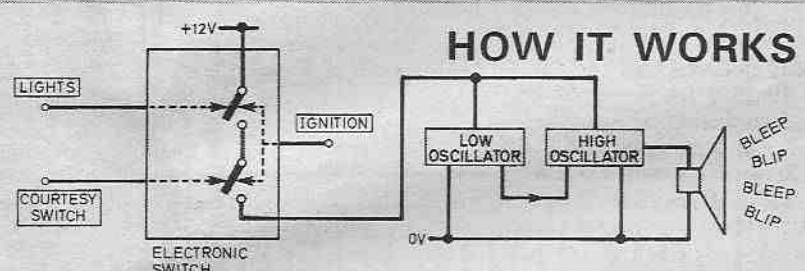
To enable the circuit to operate with positive earth cars, a modification is included to cater for the reverse in supply polarity. This is shown in Fig. 3 and consist of just one extra transistor, TR2, and a resistor, R11.

We can think of a positive earth car as having +12 volts connected to earth, and 0 volts as the supply, rather than the more obvious 0 volts connected to earth and −12 volts as the supply. If this is remembered then the circuit description will be easier to understand.

When the ignition switch is in the off position, the potential at the IGNITION input is +12 volts, transistor TR2 is therefore turned on and the collector becomes 0 volts. This causes TR1 to turn off, its collector potential being at +12 volts. The two oscillators are thus free to operate.

Now when the ignition is turned on, a potential of effectively zero volts is applied to the input of TR2, this transistor is thus biased off. Its collector voltage will now assume a potential equivalent to

HOW IT WORKS



The unit consists of two oscillators, one operating at a very low frequency, the other at a much higher audible frequency. The low frequency oscillator is used to vary the output of the high frequency oscillator thus shifting the frequency up and down producing a two-tone alarm. An electronic switch controlled effectively by three different inputs is used to operate the alarm as required.

If the car lights are switched on and the car door is opened the alarm will sound, thus informing the driver that the lights are switched on when for instance the car is parked for the night.

A facility is incorporated whereby if the ignition is on, and the lights are on the alarm will not sound, useful when actually driving! This facility is also used when the car door is opened to let passengers out, the alarm not sounding in this condition.

Lights Reminder

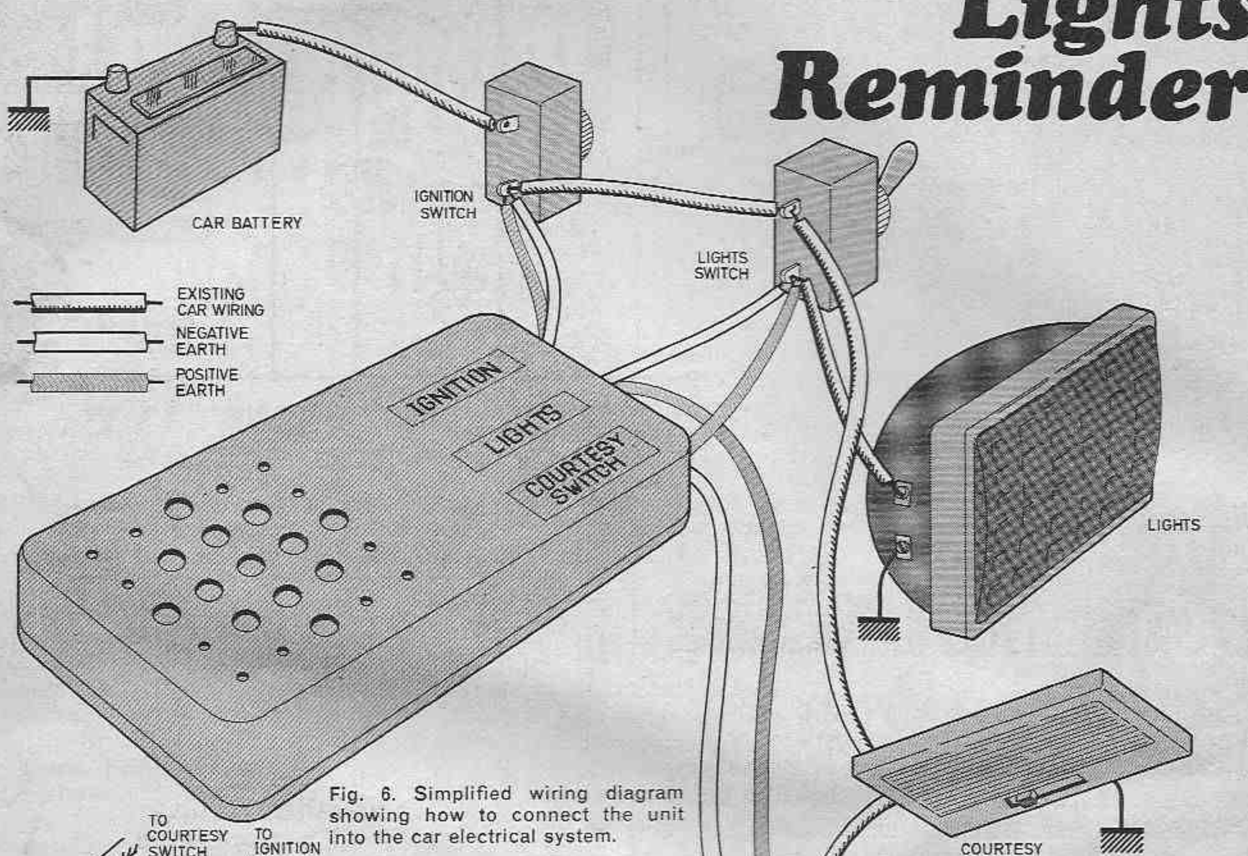
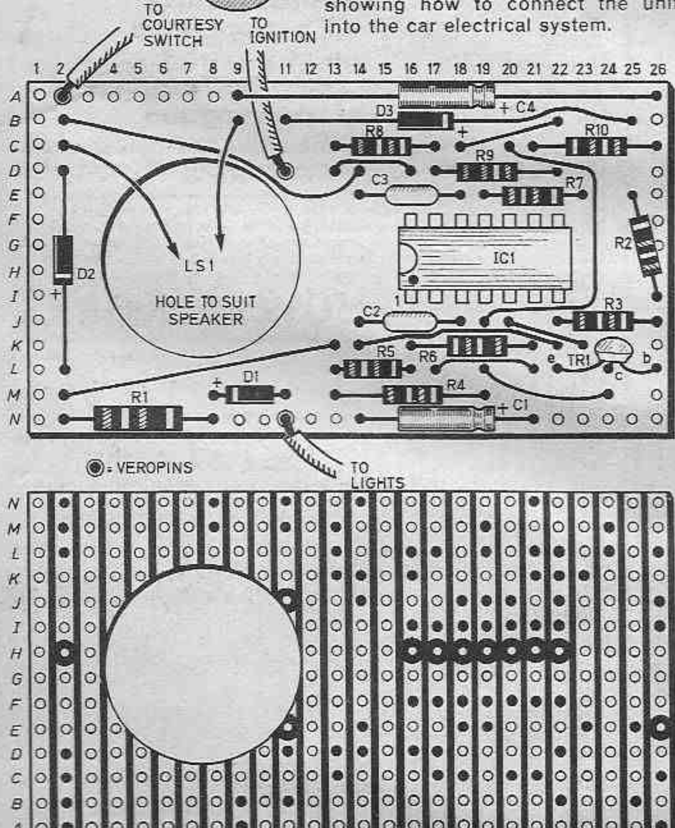
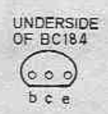


Fig. 6. Simplified wiring diagram showing how to connect the unit into the car electrical system.





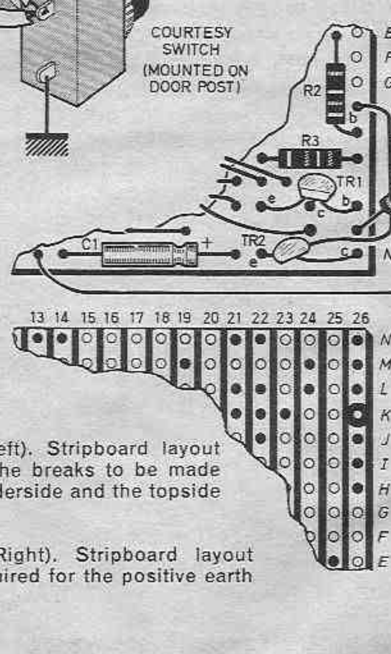
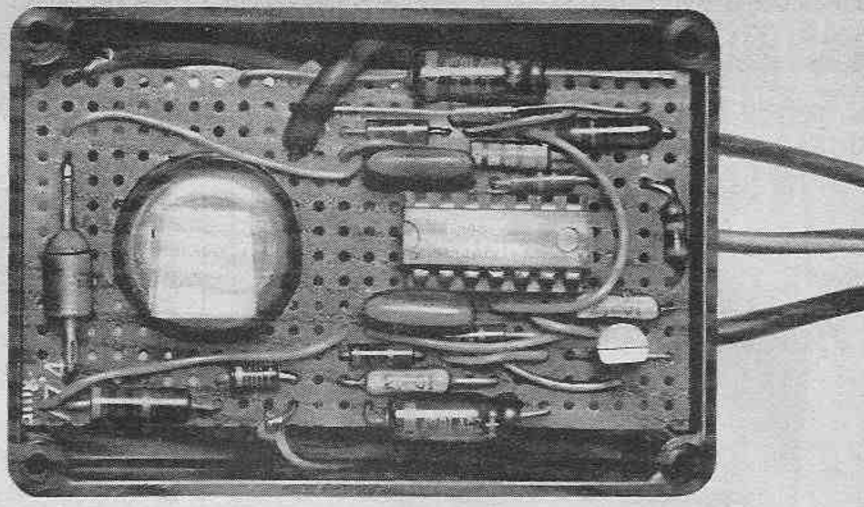


Fig. 4. (Left). Stripboard layout showing the breaks to be made on the underside and the topside wiring.

Fig. 5. (Right). Stripboard layout (part) required for the positive earth version.

a "high" condition. This turns TR1 on, resulting in the collector voltage going low, thus inhibiting the oscillators thereby preventing the alarm from sounding.



The completed circuit board for the Lights Reminder mounted in a suitable case.

CONSTRUCTION starts here

The prototype unit was constructed in a small plastic case 70 x 50 x 20mm. The size is determined entirely by the loudspeaker used, and if the one specified cannot be obtained then a different case must be used.

All components are mounted on a piece of 0·1 inch stripboard having 26 strips by 14 holes, the wiring of which is shown in Fig. 4.

Begin by cutting a hole for the speaker, this needs to be 20mm in diameter and can be cut using either a tank cutter, or by drilling a series of small pilot holes and filing the hole round. At this stage the breaks in the copper strips can also be made. Next the wires links and the i.c. socket can be soldered in position. The remaining components can then be soldered in place, taking note of the transistor leadouts.

To ease construction, Veropins are used to connect the flying leads to the board.

The stripboard can be fixed to the speaker using either glue or double sided sticky tape. If the components are similar in size to those used in the prototype then the stripboard and speaker need no additional fixings, being held in place by the lid of the box.

POSITIVE EARTH

The diagram in Fig. 5 shows the modified layout which is to be used when constructing the positive earth version. Note there is one extra break to be made. The base lead of TR2 should be extended as required. Resistor R11 is a vertically mounted component, and needs to be of small size otherwise the lid will not be a flush fit when finally screwed down.

Remember to complete all the other wiring as shown in Fig. 4 as well as the modification. The unit will not function on the modification alone!

Finally the external wires should be labelled as appropriate for whatever polarity you are using.

IN USE

Once construction is finished the unit can be tested. Insert the i.c. into the circuit, observing the correct polarity, and connect the circuit to, say, a car battery. The circuit should now be heard to oscillate, connecting the IGNITION input to +12 volts should stop the oscillation. If all performs well the unit can be mounted in any convenient position in the car.

The diagram of Fig. 6 shows very simply how the unit is wired into the car's electrical system. Refer to your workshop manual. ⌑

COMPONENTS

Resistors

R1	30Ω	R5	1kΩ	R9	47kΩ
R2	10kΩ	R6	18kΩ	R10	56Ω
R3	2·2kΩ	R7	10kΩ	R11	10kΩ (see text)
R4	2·2kΩ	R8	1kΩ		

All ¼W carbon ± 5%

Capacitors

C1	10μF 25V elect.	C3	22nF polyester
C2	22nF polyester	C4	10μF 25V elect.

See Shop Talk page 34

Semiconductors

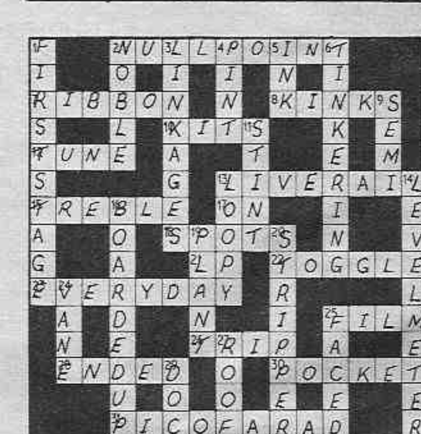
IC1	NE556V dual timer i.c.	D1	IN4001 rectifier
TR1	BC184 silicon *npn*	D2	BZX61C 15V 1·3W Zener
TR2	BC184 silicon *npn* (see text)	D3	IN914 silicon diode

Miscellaneous

LS1 8 ohm 38mm diameter speaker

Stripboard 0·1 inch matrix, 26 strips × 14 holes; small plastic box, 70 × 50 × 25mm; socket to suit IC1; heavy gauge connecting wire; Veropins as required.

Crossword No. 11—Solution



RADIO WORLD

By Pat Hawker, G3VA

Older by the year

It is said that when one of the first trunk telephone circuits was set up in the United States, somebody said to Emerson: "Isn't it wonderful that Maine can now speak to Florida?". "Yes" came the reply "but has Maine anything to say to Florida?".

The question of what as well as how to communicate has always been in the forefront of the questions that radio amateurs are asked by those observing the hobby from the outside. It is not, however, a question that is often asked by amateurs themselves; they remain more interested in the means than the messages, as brought out in the famous skit by the late Tony Hancock.

Many amateur "contacts" follow fairly stereotype, rubber-stamp form: location, signal report, name, equipment, weather etc are duly exchanged whatever the modes of operation. Recently, however, I seem to detect a growing tendency of American amateurs to exchange "age". While this statistic undoubtedly adds an interesting personal glimpse of the distant amateur behind the microphone or morse key, I wonder if I alone have hesitations in replying in kind to young Americans who insist on telling me that they are 15 or 16 years old, and often, if older, their occupation.

I feel sometimes like replying "Yes I had a licence at that age but it was more years ago than I care to commit to the air-waves". Yet one international amateur contest attracts support despite the "serial number" being made up of the age of the participants. At least "young lady" operators are permitted to send "0". Perhaps all males over 18 and under 70 should be allowed to use "00".

No waves in ESP?

As someone with a sceptical attitude towards some, but by no means all forms of extra-sensory perception, I have often wondered whether any form of electromagnetic radiation is involved in such phenomena as dowsing and telepathy, as well as in such matters as direct detection of radio signals in the brain or those curious long-delayed radio echoes which I am convinced have occurred, I strongly doubt whether, as sometimes suggested, they have any connection with unidentified flying objects.

However a long, detailed letter in "Nature" from Professor John Taylor and E. Balonovski of King's College, London seems calculated to send us all back to the drawing board. Professor Taylor, who at one time was a strong advocate of scientific investigation of metal bending as practised by Uri Geller and others, has apparently now lost all belief that such phenomena might be explained by forms of radio signals.

A very detailed investigation using a series of sensors capable of detecting signals from d.c. to infra-red and so including the entire radio spectrum has failed to come up with any signs of natural radiation from the participants. Indeed, the experiments has also failed to find any convincing examples of E.S.P. (an ability to make floating needles swing was found to have been due to static electricity caused by rubbing the surrounding Perspex cylinders).

Even dowsing, which it is accepted happens, is dismissed as due to "muscular twitches brought about by subconscious mental activity" which rather begs the whole question; faith healing he now ascribes to "psychological effects of the healer on the patient". Yet a year or two ago the professor was among the strongest supporters of the metal benders.

Personally, in these days of anti-matter, I wonder whether the r.f. sensors were capable of detecting signals at negative frequencies? There is a hypothesis that a whole unused radio spectrum exists on the other side of 0Hz, just as every electrical engineer uses the square root of minus one!

Paying for TV

The problem of financing ever more radio and television broadcasting has long occupied many minds: advertising, licence fees, pay-TV, Government grant-in-aids, public voluntary contributions, all are in use. The United States has successfully added a Public Broadcasting Service to its fantastically large advertising-financed output still without introducing licence fees.

Less well-known is that four European countries have no licence system: Spain, Luxembourg, Monaco and Vatican City; Portugal has a TV licence costing only about £5; in Austria it works out at about £1 per week. In Greece, payment is made in the form of a surcharge on the domestic electricity bill so that the more electricity you use for any purpose, the more you contribute towards the cost of broadcasting.

In Yugoslavia you have to pay a radio licence, but not if you use a crystal set; in Holland you pay more for a TV set on a wired system. The search for the ideal system continues.

Next steps?

In his presidential address to the Institution of Electrical Engineers, James Redmond, shortly before his retirement from the post of BBC Director of Engineering, listed six possibilities for new radio services and seven for television. For radio, these comprised: quadraphonic (surround) sound on v.h.f.; stereo on f.m.; new modulation systems such as multiplexed p.c.m or wideband f.m. for economic interference-free coverage; a dedicated motoring information service; data transmissions; and channel identification.

The seven possibilities to liven up the TV scene that he put forward were: programmed transmissions for domestic recorders; additional sound channels including stereo; optional subtitling for the hearing impaired; multiple still-picture and sound services; remote writing for teaching programmes; data and software services; and the use of the home TV receiver as a domestic data terminal.

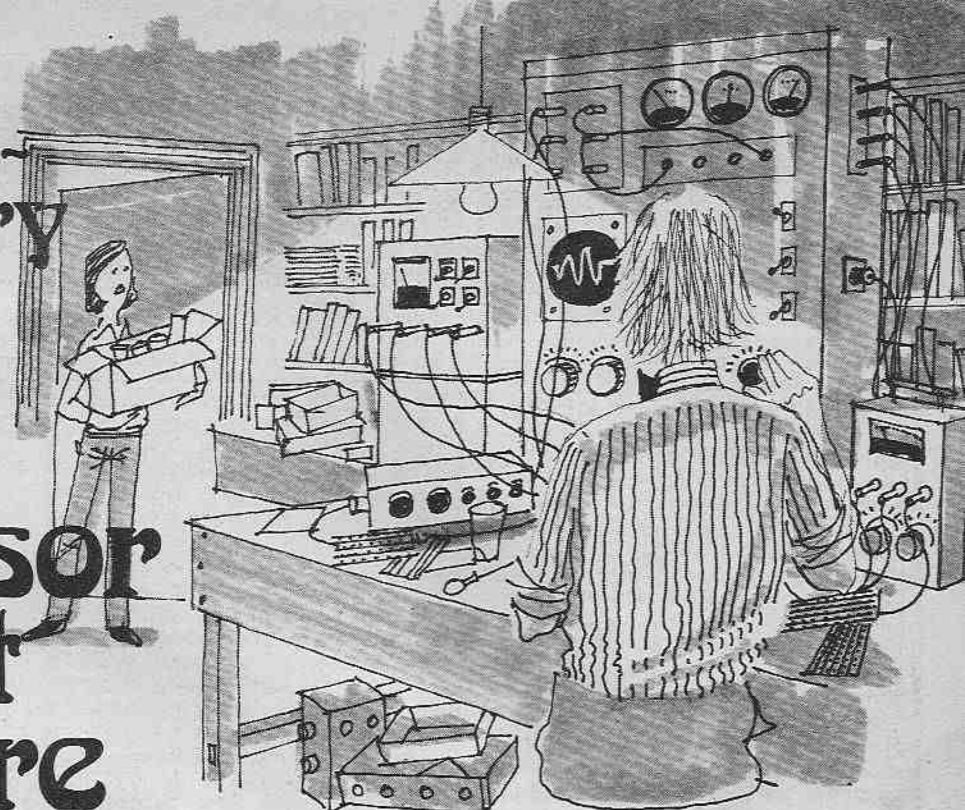
As he pointed out, these are all innovations that would be technically feasible today with current technology (indeed they have all been demonstrated in various parts of the world) although some would require significant investment of risk capital by the set makers. For the industry, of course, the critical question is not whether such systems would work, but whether the public would want them sufficiently to pay the extra costs, in economic numbers.

The relatively slow build up of Teletext users during the past four years has not encouraged the industry to bank on a ready public response to all innovations.

Australian novices

My recent remarks on the desirability of introducing a new form of "novice" amateur licence in the U.K. are supported by reports from Australia where the 1000-plus novice licences are proving a popular and useful introduction to the hobby, with none of the problems that have marked the new Citizen's Band facilities in that country.

The Extraordinary Experiments of Professor Ernest Eversure



by Anthony John Bassett

BOB and the Prof. have discussed various likely causes of breakdown of the output transformer in a valve audio amplifier, and some remedies and preventive measures. Here they continue with two methods of protecting against breakdown caused by "high voltage spikes" which may occur for reasons discussed earlier.

SPARK GAPS

"One very simple method of protecting against high voltage spikes is by the use of spark gaps, Bob." The Prof. drew a sketch, Fig. 1.

"Here is a diagram of how this would work with a class A, one-valve output stage. If high voltage spikes were induced across the primary of the output transformer, they should dissipate by causing electrical breakthrough of the air insulation between the metal conductors of the spark gap. Sparks would then be seen, and as long as the breakdown voltage of the spark gap is lower than the breakdown of the insulation of the output transformer, the transformer will be protected.

"By adjusting the distance between the metal conductors of the spark gap the breakdown voltage may be raised and lowered, and for most amplifiers a distance of about one or two millimetres is usually appropriate.

"Prof. I've not come across this method of protecting the output transformer using a spark gap. It seems so simple and inexpensive, why isn't it used more widely?"

"Several reasons Bob, mainly to do with variation of the breakdown voltage of a spark gap. The breakdown voltage is affected by a large number of factors all of which can change the effectiveness of the protection given by a spark gap.

"Another problem is that whenever sparking occurs, a harsh crackling sound may be heard from the loudspeaker.

"In spite of these problems, spark gap protection is used on a small number of amplifiers with considerable success, in some, an open air spark gap used, whilst in others a sealed gap may be used, with an inert gas instead of air.

"The gas may be used to a pressure greater or less than atmospheric according to application. A spark gap using a gas under high pressure will have a high breakdown voltage, whilst a gas such as neon under low pressure may have a breakdown voltage so low that neon bulbs may even be used for the protection of transistors against voltage spikes."

"That's interesting, Prof! It seems there are quite a lot of things to be learned about spark gaps, and many experiments which could be done with them. But you have yet another circuit for protection of an output transformer from voltage spikes. Does this overcome the snags which may be experienced with spark-gap protection?"

RE-ROUTING DIODES

"Yes Bob, it does, but at greater expense. However, this extra expense can easily be justified where reliability is important to the individual user. Basically it is a circuit for protection by using diodes to re-route the inductive surge in such a way that no harm is done. Here is how this would work with a simple class A, single valve circuit."

The Prof. produced another sketch, Fig. 2.

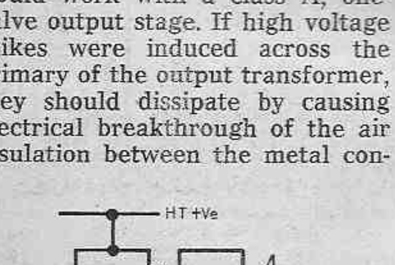


Fig. 1. Using spark gap protection on a simple output stage.

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2N698	0·49	2N2218	0·35
2N699	0·58	2N2218A	0·38
2N706	0·30	2N2219	0·38
2N706A	0·30	2N2219A	0·39
2N708	0·30	2N2220	0·39
2N718	0·30	2N2221	0·25
2N718A	0·54	2N2221A	0·25
2N720A	0·85	2N2222	0·25
2N722	0·45	2N2222A	0·25
2N727	0·50	2N2369	0·27
2N914	0·38	2N2369A	0·27
2N916	0·33	2N2646	0·80
2N917	0·38	2N2647	1·55
2N918	0·45	2N2903	1·60
2N929	0·37	2N2904	0·31
2N929A	0·37	2N2904A	0·31
2N930	0·37	2N2905	0·31
2N930A	0·95	2N2905A	0·31
2N1711	0·30	2N2906	0·25
2N1889	0·30	2N2906A	0·25
2N1890	0·30	2N2907	0·25
2N1893	0·30	2N2907A	0·25
2N2102	0·50	2N2923	0·17
2N2192	0·58	2N2924	0·17
2N2193	0·50	2N2925	0·19
2N2193A	0·52	2N2926	0·17
2N2194	0·42	2N3053	0·25
2N2194A	0·45	2N3054	0·72
2N2195	0·40	2N3055	0·75

2N3390	0·50	2N3905	0·18	2N5086	0·30	2N6107	0·45
2N3391	0·40	2N3906	0·18	2N5087	0·30	2N6108	0·55
2N3391A	0·45	2N4031	0·55	2N5088	0·30	2N6109	0·55
2N3392	0·17	2N4032	0·65	2N5089	0·30	2N6111	0·49
2N3393	0·17	2N4036	0·72	2N5190	0·65	2N6121	0·41
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2N3440	0·75	2N4062	0·20	2N5245	0·37	40362	0·55
2N3441	0·92	2N4064	1·35	2N5246	0·38	40363	1·45
2N3442	1·45	2N4074	2·65	2N5247	0·44	40408	0·82
2N3638	0·17	2N4121	0·27	2N5248	0·44	40409	0·82
2N3638A	0·17	2N4122	0·27	2N5294	0·44	40410	0·82
2N3702	0·14	2N4123	0·19	2N5295	0·44	40411	3·10
2N3703	0·14	2N4124	0·19	2N5296	0·44	40594	0·87
2N3704	0·14	2N4125	0·19	2N5298	0·44	40595	0·98
2N3705	0·14	2N4126	0·19	2N5447	0·16	40673	0·80
2N3706	0·14	2N4284	0·38	2N5448	0·16	40669	1·30
2N3707	0·14	2N4286	0·22	2N5449	0·20	AC126	0·48
2N3708	0·12	2N4287	0·22	2N5457	0·38	AC127	0·48
2N3709	0·12	2N4288	0·22	2N5458	0·35	AC128	0·48
2N3771	2·16	2N4289	0·22	2N5459	0·32	AC151	0·43
2N3772	2·20	2N4347	2·20	2N5460	0·65	AC152	0·54
2N3773	3·15	2N4348	2·65	2N5484	0·37	AC153	0·59
2N3819	0·36	2N4918	0·65	2N5485	0·40	AC153K	0·59
2N3820	0·39	2N4919	0·70	2N5486	0·40	AC176K	0·70
2N3821	0·96	2N4920	0·83	2N5490	0·64	AC176	0·54
2N3900	0·28	2N4921	0·54	2N5492	0·64	AC187	0·59
2N3901	0·30	2N4922	0·60	2N5494	0·65	AC187K	0·65
2N3903	0·20	2N4923	0·75	2N5496	0·67	AC188	0·54
2N3904	0·18	2N4924	1·15	2N6027	0·64	AC188K	0·65

AD161	1·00	BC168B	0·13	BC184LC	0·15	BC303	0·54	BD139	0·43	BD530	0·55
AD162	1·00	BC168C	0·13	BC212	0·15	BC307	0·16	BD140	0·43	BD535	0·70
AF106	0·60	BC169B	0·13	BC212A	0·15	BC307A	0·16	BD181	1·90	BD536	0·70
AF109	0·52	BC169C	0·13	BC212B	0·15	BC307B	0·16	BD182	2·20	BD537	0·74
BC107	0·16	BC177	0·22	BC212L	0·18	BC308	0·16	BD183	2·35	BD538	0·77
BC107A	0·16	BC177A	0·22	BC212LA	0·18	BC308B	0·16	BD187	0·95	BD539	0·60
BC107B	0·16	BC177B	0·25	BC212LB	0·18	BC309A	0·16	BD235	0·46	BD540	0·60
BC108	0·16	BC178	0·22	BC213	0·15	BC309B	0·16	BD236	0·44	BDX14	1·32
BC108A	0·16	BC178A	0·25	BC213A	0·15	BC309C	0·16	BD237	0·44	BDX18	1·90
BC108B	0·16	BC178B	0·35	BC213B	0·15	BC327	0·22	BD238	0·44	BDY20	1·10
BC108C	0·17	BC179	0·25	BC213C	0·15	BC328	0·20	BD239A	0·44	BDY55	1·90
BC109	0·16	BC179A	0·25	BC213L	0·17	BC337	0·20	BD239C	0·59	BDY56	2·10
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CA3060	0·85	LM709B	0·50
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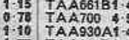

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"The electrolytic capacitor charges up by way of the diode and the 470 ohm resistor so that in use, the voltage on the capacitor is about the same as the peak voltage of the positive half of the audio waveform. This means that if the capacitor is uncharged and the amplifier is then switched on and

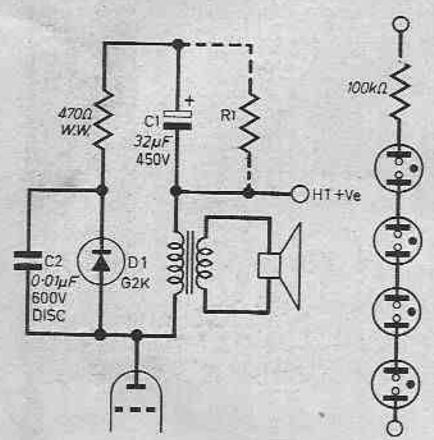

Fig. 2. In this circuit a diode is used to re-route the inductive surges. Using series neons the protection circuit can to some extent be regulated.

brought into use, there will be distortion noticeable for a short time, which may be only a few seconds, until the capacitor becomes charged to a suitably high level.

"Don't some electrolytic capacitors have different leakage characteristics, Prof?" Bob asked. "This would affect the performance of the protection circuit. Is there some way in which the action might be regulated?"

NEONS

"Yes, Bob, quite a good method is the use of a number of neon bulbs and a limiting resistor in series. The neon bulbs should be selected so that the sum of their break-down voltages is equal to the voltage at which the protection circuit is to operate.

"That's a good idea, Prof! In most high power amplifiers the voltage needed would be higher than 300 volts, so that more than four neons would be required. I think that owners of such amplifiers would like to see all of the overload neons on display on their equipment!"

"I agree Bob, and on a high power amplifier the many neons could light up to form quite a spectacular display on overload. With the increased h.t. voltage used in a push-pull power amplifier suitable for stage and band use, public address or similar purposes, it may be necessary to connect extra diodes and capacitors in series with each other to give higher effective working voltages. Here is a circuit suitable for use with push-pull power amplifiers such as the VOX AC30". The Prof. sketched out a circuit diagram, Fig. 3.

CAPACITIVE DIVIDER

"Although the circuit uses high speed avalanche diodes such as type G2K, or even better, fast recovery silicon diodes such as type BYX71, it is advisable to use a high voltage disc ceramic capacitor in parallel with each diode for added protection against fast transient spikes, which might otherwise easily cause breakdown of the diodes. Because in this application the capacitors act as a 'capacitive potential divider' they should be of equal values."

"A capacitive potential divider remarked Bob, that sounds interesting. After we've done this amplifier, can you tell me some more about this?"

"Yes Bob, and we could quite easily rig up one or two circuits to demonstrate the actions of a capacitive potential divider and to show what happens when the values of the capacitors are not equal. The circuits I have in mind are quite simple, and have a good visual impact, they also generate some interesting sound effects, and could make a good school science project! Look, there is another capacitive potential divider in this circuit, so they can be quite useful. It is formed by the two electrolytic capacitors C1 and C2. Because in this circuit the voltage produced may exceed 450V, two electrolytic capacitors are connected in series and they then divide the high voltage between them. This way neither capacitor is subjected to over-rating voltage."

"Prof. I notice that there are two sets of neons in this circuit. Why is this?"

PROTECTION CIRCUIT

"Because, in the capacitive potential divider formed by C1 and C2 the voltage may not be divided equally between the two capacitors due to differences in their values within the wide tolerance limits, a separate series string of neon lamps, together with a discharge limiting resistor, is provided for each capacitor. Each capacitor will then be partially discharged by its own string of neon lamps when the voltage across it reaches the firing voltage of the string of neon bulbs."

Bob constructed the circuit of Fig. 3 on a tag board and mounted it inside the amplifier so that the neons could be perceived through the ventilation slots. When he played some loud music through the amplifier, the neons flashed on some of the loudest musical peaks, and this showed that the protection circuit was coming into action.

The Prof. turned down the music volume and disconnected the loudspeakers. Now when he turned the music up again, the neons lit much more often and more brightly even at a lower setting of the volume control.

"This shows," he told Bob, "that this circuit comes into action to protect the output of the amplifier immediately if the loudspeakers become disconnected, or if the speech coils become open-circuits."

He switched off the amplifier and re-connected the loudspeakers.

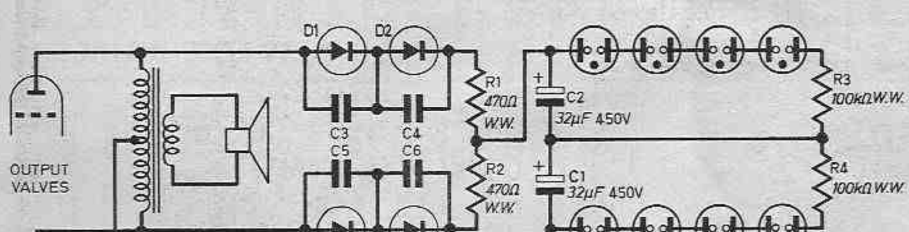

Fig. 3. Applying the protection methods just discussed to the VOX AC30 amplifier.

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	Mains Meter	E017	54*	41	40	—	1·35
	Power Amp-Teach-In	E018	—	1·55	—	—	1·55
	Power Pack	E019	70*	1·32	1·45	2·24	5·71
Jun. 78	Tele-Bell	E020	1·00*	2·84	6·85	—	10·69
	Insitu Transistor Tester	E021	65*	1·22	2·44	79	5·10
	S.W. Receiver—Teach-In	E022	—	2·61	—	—	2·61
	Power Slave	E023	1·75	—	—	—	1·75
	Visual Continuity Tester	E024	—	56	1·88	1·65	4·09
Jul. 78	Auto Night Light	E025	85*	3·17	3·32	2·05	9·39
	Short Wave Radio	E026	—	5·05	2·81	—	7·86
	Quagmire	E027	1·40*	4·78	1·21	—	7·39
	Logic Probe	E028	50*	92	45	79	2·66
Aug. 78	Slave Flash	E029	55*	2·17	—	—	2·72
	M.W. Mini Radio	E030	50*	2·08	1·75	45	4·78
	Audio Frequency Signal Generator	E031	85*	7·75	1·41	2·40	12·41
Sept. 78	RF Signal Generator	E033	—	13·24	2·58	—	15·82
	Sound to Light	E034	—	1·82	2·53	79	5·14
	Guitar Tone Booster	E035	75	1·12	84	1·35	4·06
	Car Battery State Indicator	E036	65*	97	—	—	1·62
Oct. 78	CMOS Radio	E037	1·45*	3·28	3·05	2·54	10·32
	Fuse Checker	E038	—	49	32	79	1·60
	Treasure Hunter	E039	1·25	4·86	5·37	2·54	14·02
Nov. 78	Audio Effects Oscillator	E042	—	1·31	30	79	1·40
	Water Level Alert	E043	70*	1·25	45	1·58	3·98
	Combination Lock	E045	2·55*	4·35	8·50	2·08	17·48
	Hot Line Game	E046	75*	1·00	2·82	—	4·57
Dec. 78	Car flasher warning	048	Prices available on request.				
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	Ignition Immobiliser	050					
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153	350	16·43	1·84
154	500	20·47	2·15
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40	5·0	15·84	1·64
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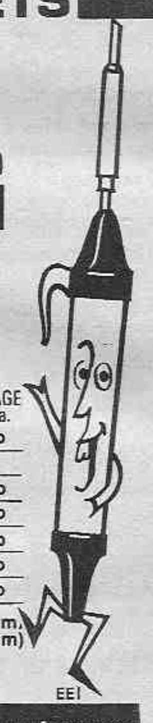

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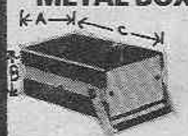

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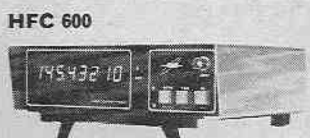

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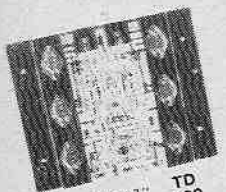

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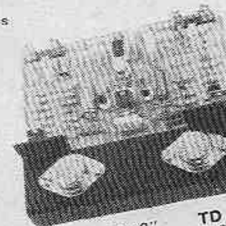

5" x 5" x 2" TD 150

All output ratings are R.M.S. continuous sine wave output.

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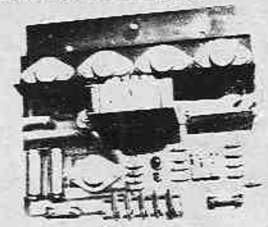

SPEC. INPUT SENSITIVITY 60 mV for full output
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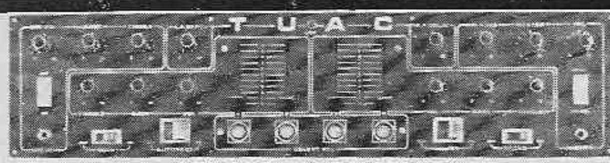

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- Full wave control

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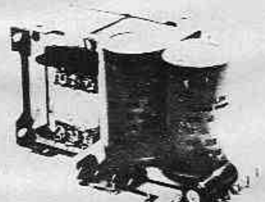

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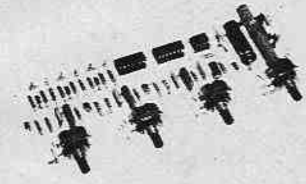

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