

Construction and theory for everyone

everyday electronics

MAR.77
35p

FREE CHART ...IN THIS ISSUE!
INSTANT INFO.
for **CONSTRUCTORS**



Also inside...

**Electronic
DICE**

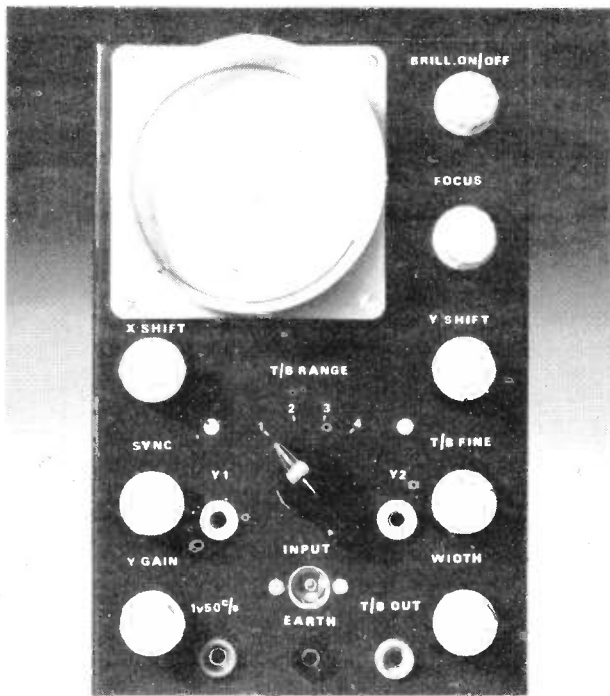


**EXPERIMENTERS
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Bring 'scope' to your interest.

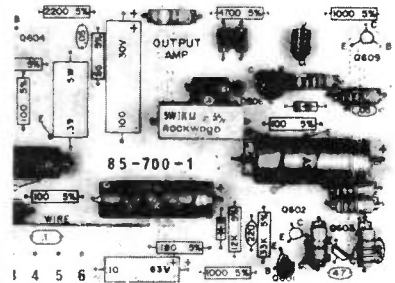
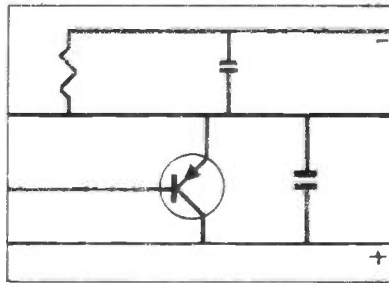
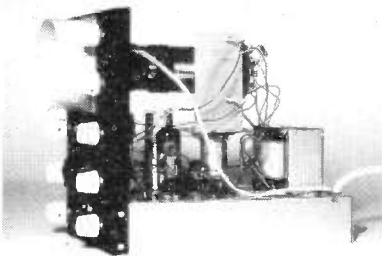


'There's only one way to master electronics... to see what is going on and learn by doing.'

This new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn the practical way in easy steps mastering all the essentials of your hobby or to further your career in electronics or as a self-employed electronics engineer.

All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write, at any time, for advice or help during your work. A Certificate is given at the end of every course.



1 Build an oscilloscope.

As the first stage of your training, you actually build your own Cathode ray oscilloscope! This is no toy, but a test instrument that you will need not only for the course's practical experiments, but also later if you decide to develop your knowledge and enter the profession. It remains your property and represents a very large saving over buying a similar piece of essential equipment.

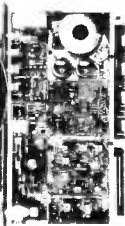
2 Read, draw and understand circuit diagrams.

In a short time you will be able to read and draw circuit diagrams, understand the very fundamentals of television, radio, computers and countless other electronic devices and their servicing procedures.

3 Carry out over 40 experiments on basic circuits.

We show you how to conduct experiments on a wide variety of different circuits and turn the information gained into a working knowledge of testing, servicing and maintaining all types of electronic equipment, radio, t.v. etc.

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A wrist calculator is the ultimate in common-sense portable calculating power. Even a pocket calculator goes where your pocket goes – take your jacket off, and you're lost!

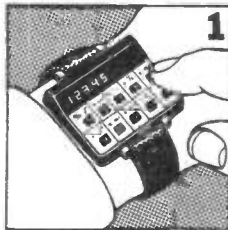
But a wrist-calculator is only worth having if it offers a genuinely comprehensive range of functions, with a full-size 8-digit display.

This one does. What's more, because it *is* a kit, supplied *direct* from the manufacturer, it costs only a very reasonable £9.95 (plus 8% VAT, P&P). And for that, you get not only a high-calibre calculator, but the fascination of building it yourself.

How to make 10 keys do the work of 27

The Sinclair Instrument wrist calculator offers the full range of arithmetic functions. It uses normal algebraic logic ('enter it as you write it'). But in addition, it offers a % key; plus the convenience functions \sqrt{x} , $1/x$, x^2 ; plus a full 5-function memory.

All this, from just 10 keys! The secret? An ingenious, simple three-position switch. It works like this.

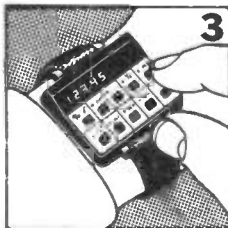


1. The switch in its normal, central position. With the switch centred, numbers – which make up the vast majority of key-strokes – are tapped in the normal way



2. Hold the switch to the left to use the functions to the left above the keys...

3. and hold it to the right to use the functions to the right above the keys.



The display uses 8 full-size red LED digits, and the calculator runs on readily-available hearing-aid batteries to give weeks of normal use.

Dimensions:
1 1/8" (46 mm) wide,
1 1/8" (37 mm) deep.
Weight:
less than 1oz (28 g).

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Sinclair Instrument Ltd,
6 Kings Parade, Cambridge,
Cambs., CB2 1SN.
Tel: Cambridge (0223) 311488.

Assembling the Sinclair Instrument wrist calculator

The wrist calculator kit comes to you complete and ready for assembly. All you need is a reasonable degree of skill with a fine-point soldering iron. It takes about three hours to assemble. If anything goes wrong, Sinclair Instrument will replace any damaged components *free*: we want you to enjoy assembling the kit, and to end up with a valuable and useful calculator.

Contents

Case and display window.
Strap.
Printed circuit board.
Switches.
Special direct-drive chip (no interface chip needed).
Display.
Batteries.

Everything is packaged in a neat plastic box, and is accompanied by full instructions.

The only thing you need is a fine-point soldering iron.

All components are fully guaranteed, and any which are damaged during assembly will be replaced free.

The wrist-calculator kit is available only direct from Sinclair Instrument. Take advantage of this 10-day money-back undertaking.

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To: Sinclair Instrument Ltd,
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EE/3

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Sept. 1977. 192 pages

Beginner's Guide to Radio — 8th Edition — Gordon J. King. Completely up-dated and rewritten it surveys the whole field of radio.
Summer 77. 260 pages

Latest books

BEGINNER'S GUIDE TO AUDIO — I.R. Sinclair

Covers the working principles of devices ranging from the microphone to the loudspeaker and examples of the electronic circuits which are used. Starting with the behaviour of sound waves the text continues with chapters on microphones, pickups, preamplifiers and amplifiers and loudspeakers.

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RADIO, TV & AUDIO TECHNICAL REFERENCE BOOK S.W Amos

In the RADIO, TELEVISION AND AUDIO TECHNICAL REFERENCE BOOK he has had the assistance of 31 contributors, each a specialist in his subject. In consequence, the book is a comprehensive and definitive source of information that will be invaluable to the technical assistant, the technical operator, the service man and the amateur radio or audio enthusiast. Mathematical presentation has been kept to a minimum and the book gives an essentially practical account of modern developments in radio, audio and television.

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2N2102	0-60	2N3790	3-10	AC128	0-37	BC182	0-11	BD240	0-45	BFY51	0-38	CA3028B	1-01	MC1327	1-94	TBA560Q	3-22
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2N3053	0-30	2N5195	0-90	BC113	0-17	BC303	0-60	BF179	0-35	MP8112	0-40	LM317K	3-00	TAA522	1-90	TCA270	2-25
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2N3055	0-70	2N5294	0-40	BC116	0-19	BC308	0-18	BF181	0-40	MPF102	0-30	LM323K	6-40	TAA560	1-60	TCA280A	1-30
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2N3391A	0-25	2N5298	0-40	BC118	0-16	BC318	0-12	BF184	0-38	MPSA120	3-15	LM380-S	0-90	TAA621	2-15	TCA420A	3-13
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2N3441	0-85	2N5459	0-29	BC136	0-19	BC348	0-12	BF198	0-18	MPSU560	6-00	LM702C	0-75	UAA1702	0-00	UAA1702	0-00
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CRESCENT RADIO LTD.

164-166 HIGH ROAD LONDON N22 6EJ
(also) 13 SOUTH MALL, Edmonton, N.9
MAIL ORDER DEPT. 1 St Michaels Terrace Wood Green
London N22 4SJ Phone 888 3206 & MAIL ORDER 888-4474

POWER PACKS

PF1 Switched 3, 4½, 6, 7½, 9 and 12 volt @ 500 m/a, with on/off switch and pilot light.
Size = 130 mm x 55 mm x 75 mm
ONLY = £5.50 + 8%

CASSETTE MICROPHONE

On/Off switch for Remote Control. Split Lead with 2.5mm and 3.5mm plugs. Standard Cassette Mica to suit all types. Complete with Desk Rest. Please state which Impedance required 200ohm/50K.ohm.

PRICE £1.80 + 12½% VAT.

P.C. ETCHING KIT

This kit contains all that the constructor will need to etch the circuits of his own design.

Contents—Plastic etching diab. Sample copper clad board. Laminate Cutter. 1 lb Ferric Chloride. Large Plastic Spoon. Etch Resist Pen. Full Etching Instructions.

Complete and Big Kit Value at £4.25p + 8% VAT.

FERRIC CHLORIDE

Anhydrous ferric chloride in double sealed one pound Poly packs.
OUR PRICE — 65p + PP + 8% per lb.

3 KWATTS PSYCHEDELIC LIGHT CONTROL UNIT

Three Channel Bass, Middle, Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier and connect three 250V up to 1000W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed).



£18.50 plus 75p P. & P. + 8%

U.K. CARR. 50p unless otherwise stated

All prices are excluding VAT. Please add to each item the VAT rate indicated to all orders

ABS PLASTIC BOXES

Handy boxes for construction projects. Moulded extrusion rails for P.C. or chassis panels. Fitted with lmm front panels.
1005=105mm x 73mm x 45mm = 60p
1006=100mm x 74mm x 47mm = 80p
1007=185mm x 124mm x 60mm = £1.80
1021=105mm x 74mm x 45mm = 57p (sloting front) Plus 8% VAT

'C100' 100 WATT AMPLIFIER

All built and tested, mounted on a plain aluminium chassis which measures 18" x 9½" x 4" and which you can mount into a cabinet of your choice. Four Controlled Inputs, Master Volume, Treble, Middle and Bass Controls. S/C protected output. 100 watts Clean into 8ohm L/S. Ideal for Disco, Music Groups. PA and Clubs.

A Bargain at £48 + £1 carr. + 8% VAT.

TI MULTI-METER

Ideal tester for everybody interested in electronics. Weighing less than 100 grammes and only 60mm x 24mm x 90mm.

Ranges: AC volts: 0-10v, 50v, 250v, 1,000v. DC volts: 0-10v, 50v, 250v, 1,000v. DC current: 0-1mA, 0-100mA. Resistance: 0-150K ohm.

PRICE £5.50 + VAT 8%

MINI LOUDSPEAKERS

2½" 8ohm 90p +12½%
2½" 40 ohm 90p +12½%
2½" 8 ohm 90p +12½%

BARGAIN PROJECT BOX

A plastic box with moulded extrusion rails for PC or Chassis panels with metal front plate fitted with four screws (all supplied).
OUR PRICE 50p + 8%

MAGENTA

EEA, 61 Newton Leys,
Burton on Trent, Staffs.
electronics ltd. DE15 0DW

Wire: Single 2A 3p/m, 4A 4p/m. Tinned copper 16swg 13p/m, 18—7p, 20—4p, 22—3.5p, 24—2p. Enamelled copper 18swg 8p/m, 20—4.5p, 22—3.5p, 24 & 28—2.5p, 32 & 36—2p.

Capacitors: Electrolytic. 10V: 22, 47, 100, 220uF 6p, 470 24p, 16V: 680uF 35p, 1000 28p. 25V: 10, 22, 47, 100uF 6p, 220 24p, 470 36p, 2200 59p, 4700 £1.15. 40V: 33, 47uF 6p, 100 8.5p, 2200uF £1.28, 4700 £1.43. C280 250V (uF): 0-01, 0-015, 0-022, 0-033, 0-047 5p, 0-068, 0-16p, 0-156-5p, 0-22 7p, 0-33, 0-4710-5p, 0-68 15p, 1-0 18-5p, 1-5 26p, 2-2 32p. Polystyrene 160V, 10—1000pF (10, 15, 22, 33, 47, 68 etc), 10—470pF 7p, 680—3300 7.5p, 4700—10000 12p. Disc ceramics 500V: 0-001uF 5p, 0-01 7.5p.

Aluminium: 16swg 1-5p, 18 1p/sq. in. Copper 18swg 4p. Brass 24swg 1-5p. Expanded aluminium 1p. Clear Perspex 1p/sq. in. Paxolin 6" x 4" 10p. Screws: pan head 10mm M3 5p/10, M4 7.5p. Nuts M3 & M4 4p/10, Washers M3 & M4 2p/10, Snakeproof M3 & M4 2p/10. Solder tags M3 4p, M4 5p/10.

Copper clad board: paper SS 1.5p/sq. in., glass fibre SS or DS 2.5p. Decon Quick Dri pen 98p. Ferric chloride 63p/250g. Plastic brush 3p. Vere-board: 3-75" x multiples of 1". Coppered 0-1" 16p/in, 0-15" 15p, Plain 0-1" 9p/in. Pins DS 0-1" 3p/10; 0-15" 4p.

Solder: 60/40 22swg 3p/m, Savbit 18swg 9p/m, 22 3-5p. Heat sink cmnd 21p. Core locking 21p. Heat sink T05 crinkle 9-5p. Impact adhesive 24p. Semi mtg kits T03 11-5p, T06 12p, 10—32 stud 12-5p. Speaker fret fabric: 0-5p/sq. in. Brass studing (5") M3 18p, M4 16p. IC sockets: 8 pin 18p, 16 pin 20p.

Resistors: ½W carbon film 5% miniature—E12 4R7—2M2 1-5p. Potentiometers midjet: Log 5K, 100K, 500K, 1MΩ, 2MΩ. LV 5K, 10K, 100K—33p ea. Cases: ABS 111 x 60 x 27mm 58p, aluminium with lids: 76 x 51 x 25 49p, 102 x 70 x 38 57p, 152 x 102 x 51mm 79p. Die cast 121 x 95 x 57 £1.29. TIL209 red 16p, 6mm lod red, green or yellow 37p. BZY88 zeners 12p. 1N4005 6p. 1N4148 5-5p. 0A47 7p. 0A90 9p. AC128 45p. BC183K, BC184K 11p. BC213K, BC214K 12p. TIP31 A 48p. TIP32A 53p. 741 35p. 555 53p. LM324 £1.22. LM380 99p. LM3900 64p. BFY51 18p. MFP102 31p.

Speaker 8 ohm min 1 65p. Crystal earpiece 3-5mm plug 48p. RF choke 10mH 41p. Ferrite rod 8" x ½" 38p. LT700 transformer 48p. Switches: slide mains DPDT 29-5p. toggle mains DPDT 69p, spring return push (on or off) 38p.

Antex X25 soldering iron £3.20. Drills: 0-8mm 1p, 1-6 14p, 3-2 15p, 4mm 19p, 4-4 22p, 5.5mm 31p. Trim tools: suit cores 21p, suit presets 30p. Winder plugs, red or blk 4-5p, sockets 5-5p. Jack plugs 2-5mm 14p, 3-5 11p; sockets 2-5mm 25p, 3-5 23p, 4mm plugs red or blk 9p, sockets 10p. Phono plugs 9p, twin sockets 10p. Battery clips: PP3 11p, PP9 10-5p. Insulated crocodile clips red or blk 8p. Soldering pins 60p/100, 7p/10.

Prices are inclusive but please add 20p to orders under £2. Catalogue of all these and more—send 25p (contains 25p voucher). Includes project ideas. Fast service.

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ADDRESS _____

BLOCK CAPS PLEASE

CONTROL DRILL SPEEDS

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, even a full set of instructions. \$3-45 including post & VAT. Made up model \$1-00 extra.

MAINS TRANSISTOR PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: main transformer rectifier, smoothing and load resistor condensers and instructions. Real snip at only \$1-50 VAT & Postage 50p.

RADIO STETHOSCOPE

Easiest way to fault find, traces signal from aerial to speaker, when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything. Complete kit comprises two special transistors and all parts including probe tube and crystal ear-piece. \$2-95, twin stetho-set instead of ear-piece. \$1-00 VAT and postage incl.



MICRO SWITCH-BARGAINS

Rated at 5 amps 250 volts, ideal to make a switch panel for a calculator and for dozens of other applications. Parcel of 10 for \$1-00, VAT and post paid.

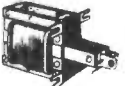


MOTORISED DISCO SWITCHES

With six 10 amp changeover switches. Multi adjustable switches rated at 10 amps each so a total of 2000W's can be controlled and this would provide a magnificent display. For mains operating \$4-25 post & VAT Paid. Ditto 9 switch \$4-95 Post & VAT Paid. DITTO BUT 12 SWITCH \$5-75 POST & VAT PAID.

MAINS OPERATED SOLENOIDS

Model T12—small but powerful 1in. pull—approx. size 1 1/2 x 1 1/2 in. \$1-00.
Model 4001—1in. pull. size 2 1/2 x 2 x 1 1/2 in. \$1-50
Model TT10—1 1/2 in. pull. Size 3 x 2 1/2 in. \$2-50.
Prices include VAT & postage.



STAND TO LIGHT UNIT

Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. \$7-95 plus 95p VAT & Postage



RELAY BARGAIN

Type 600 relay with twin 500 ohm coils which may be joined in series or parallel thus relay will operate off voltages between 5 and 30 volts DC. Price 44p each, 10 for \$4 post and VAT paid.

HONEYWELL PUSH BUTTON PANEL MOUNTING MICRO SWITCH

1-2-3-Bank, each bank consisting of the changeover micro switch rated at 10 amps 250 volts. Through panel fixing by 2 lock nuts complete with black 1" diameter knob. Prices—1 bank 40p—2 bank 55p—3 bank 70p.



MULTISPEED MOTORS

Six speeds are available 500, 850 and 1,100 r.p.m. and 7,000, 9,000 and 11,000 r.p.m. Shaft is 1/2 in. diameter and approximately 1 in. long. \$20-40. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia x 5 in. long. Price \$2-00 including Post & VAT.



SWITCH TRIGGER MATS

So this is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in x 18in \$2-33. Post & VAT 60p.
18in x 10in \$1-85. Post & VAT 60p.



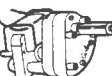
ROTARY PUMP

Self priming, portable, fits drill or electric motor, pumps up to 200 gallons per hour depending upon revs. Virtually uncorrodible, use to suck water, oil, long, 2000V, fertilizer, chemicals, anything liquid. Hose connectors each end. \$2-00 Post Paid.



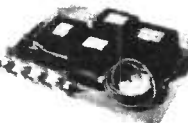
SPIT MOTOR WITH CARTER GEAR BOX

Probably one of the best spit motors made. Originally intended to be used in very high priced cookers however it can be put to plenty of other uses, for instance your garden barbecue or to drive a tumbler for stone polishing; in fact, there are no ends to its uses. Normal mains operation. \$3-25 including POST & VAT.



MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost any one in easy-to-assemble modular form and complete with a pair of Goodmans speakers that should sell at about \$30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only \$14-00 including VAT and postage.



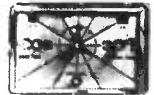
TANGENTIAL HEATER UNIT

This heater unit is most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. Comprises motor, impeller, 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only 2kW control switch. \$5-85 plus VAT & post. 1kW Model as above except 2kW \$4-25 plus VAT & post 75p. Don't miss this. Control Switch 44p. P. & P. 40p.



ISA ELECTRICAL PROGRAMMER

Learn in your sleep; Have radio playing and kettle boiling as you wake—switch on lights to ward off intruders—have a warm house to come home to. All these and other things you can do if you invest in an electrical programmer. Clock by famous maker with 15 amp. on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price \$2-95, VAT & Postage 60p, or with glass front, chrome bezel, \$1-50 extra.



ROOM THERMOSTAT

Famous Satchwell, elegant design. Intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0-30°C. Special snip this month \$2-50, post and VAT paid.



SMITHS CENTRAL HEATING CONTROLLER

Price \$7-50 including VAT and postage.

RANDALL CENTRAL HEATING CONTROLLER

Price \$2-50 including VAT and postage.

THIS MONTH'S SNIP

250 WATT TRANSFORMER

Heavy duty power transformer which can be used for many purposes. Rated at 250 watts it is very well built with frames for upright mounting and is varnish impregnated. Its primary is for 230/240 volts 50 cycles, it has four secondaries each 10V very high current windings. Just a few of the circuits it can power are 10-0-10v at up to 12 amps, 20-0-20v at up to 6 amps; single 10v at 25 amps; single 20v at 12 amps; single 30v at 9 amps; single 40v at 6-5 amps. The transformer can be used for power circuits (charging, etc.) or for amplifiers, there being an earth screen between primary and secondaries. A transformer like this today would cost at least £15 from the makers, however, we are making a special offer at \$5-95 Post & VAT Paid. Grab some while you can, our stock may not last long.

AEROSOL RELEASE LUBRICANT

Dry Film Lubricant. In aerosol can for easy application and for putting lubricant into places where the normal oil can cannot reach. Home and everyday use. We have purchased a large quantity of these from the Liquidator and are able to offer them to you for about half of the original list price. 88p per 8oz can or 12 cans for \$5 Post & VAT Paid. The lubricant is I.C.I. fluon L169.

MAINS RELAYS

With triple 10 amp changeover contacts—operating coil for 230 volts AC, chassis mounting, one screw fixing, ex unused equipment 60p each, 10 for \$5 post and VAT paid.

HORSTMANN 24-HOUR TIME SWITCH

With 6 position programmer. When fitted to hot water systems this could programme as follows:

Programme	Hot Water	Central Heating
0	Off	Off
1	Twice Daily	Off
2	All Day	Off
3	Twice Daily	Twice Daily
4	All Day	All Day
5	Continuously	Continuously

Suitable, of course, to programme other than central heating and hot water, for instance, programme upstairs and downstairs electric heating or heating and cooling or taped music and radio. In fact, there is no limit to the versatility of this Programmer. Mains operated. Size 3in x 3in x 2in deep. Price \$5-50. 80p Post and VAT. as illustrated but less case.



SHORTWAVE CRYSTAL SET

Although this does not battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 31, 29 metre bands. Kit contains chassis front panel and all the parts \$1-90—crystal ear-phone 55p including VAT and postage.



PAPST MOTOR

West German make, these fine motors are noted for their performance and reliability. Special features are the rotating heavy outer which acts as a flywheel to eliminate wobble and flutter and switchable reversing. We have four types in stock, all 1350 revs., including starting capacitor.

- (1) Reference No. KLZ 20.50-4, 230 volts 60HZ, price \$5-50
 - (2) Reference No. KLZ 32.50-4, 230 volts 60HZ, price \$6-50
 - (3) Reference same as above, 115 volts 60HZ, price \$3-50
 - (4) Reference same as above, 110 volts 60HZ, price \$3-50
- Post and VAT 80p each extra.

TERMS: Where order is under \$6 please add 50p surcharge to offset packing expense

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.), 103 TAMWORTH ROAD, CROYDON CR9 1SG.

ITS FREE!

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—its an interesting list and its free—just send S.A.E. Below are a few of the Bargains still available from a recent list.

Remember 7,029? Electricians of the old school most certainly will, and with good reason. It has greater current capacity (20 amps against 13 amps) and being stranded it will not break so easily and being larger it is easier to use. A fortunate buy enables us to offer 3 core 7-029 cheaper than we could offer 3 core 2-6mm. If you are contemplating installing a ring main, an immersion heater, storage heaters or fires, then you should definitely buy some of this cable. It is p.v.c. covered, correctly colour coded and up to all British standards; in fact, was made by one of our most famous cable companies. Price \$9-50p + 76p per 100 metre coil. Carriage \$2-50 + 20p.

For lighting we offer 3 core 1.5mm at only \$5-50p + 44p per 100 metres. Post \$1-50 + 12p.

Isolation Transformer. Very high current 110 amps, primary 0-280 volts, 100 60 volts in 10 volt steps so this transformer can be used to step up voltages for instance at the end of a long cable run. Secondary, centre tapped 120v-0-120v so the transformer will isolate and step down or up to isolate at normal mains in and normal mains out or finally it will isolate and step up. A big transformer completely enclosed in sheet steel box weighing about 300 lbs. Price \$100 + \$8. Carriage at cost but we would prefer you to collect this. **5 Bank Switch Panel.** This is a Government Surplus item so it is very well made and contains switches which will break 15 amps DC. The 5 switches are completely separate so may be used to control separate circuits or they may be ganged together to bring in 5 heaters or parallel suitable for mains or battery work. Size of the switch is approximately 5 1/2 x 1 1/2 x 1 1/2 and operation is by nickle plated toggles. Price 75p each + 6p. Post 20p + 2p.

Cooling Thermostat. The normal thermostat switches off as the temperature in the room rises. It is, therefore, suitable for controlling electric room heating. We have a similar stat but with contacts which switch on as the temperature rises. These are for air conditioning or cooling circuits. Contacts again rated at 20 amps and these have changeover contacts for switching 12V fluorescent tubes for cooling or heating or both but can be used for other functions was intended for cooling they are set and calibrated for 12-40°F. Price \$3-50p + 26p. **Flash Ernie** is the name we have given to our latest disc light display because it is a random flasher and is very effective especially with coloured bulbs. Kit consists of motorised stud switch, master control switch, anti spark caps, 9 lamp holders, connecting wire and wiring diagram. Price \$5 + 40p. Post 60p + 6p.

Neon Novelties. One of the most versatile of electronic devices is neon. You can make it do all sorts of things to regulate voltage, imitate "Ernie" by lighting numbers at random. We have miniature neons at 20p each also just come in neon valves 4 pin type, 10 for \$1 + 8p. Post 50p + 4p.

Emergency Lighting. Here are coming up to the darkest and coldest days so most of us will have memories of power cuts during the previous similar periods. If you are thinking of installing temporary emergency lighting at all you may be interested to know that we have just received some Philips inverters for working 12V fluorescent tubes from 12v car batteries. We are able to offer these inverters at half the proper price, namely \$1-50p + 12p. Post 40p + 3p. **Miniature Tubes** also available 12" 75p + 6p., no extra post if ordered with inverters, 8 pin holders for these miniature tubes 10p + 1p each.

Central Heating; Regulating, Mixing, Pumping System. In addition to circulating the water through the system, this can be used to regulate the supply to upstairs and downstairs or to domestic water or central heating as well as to normal water pumping (which is itself adjustable 4 ways) the output of the pump passes first through a valve system, this valve system is motorized (or can be hand operated) and can be made to share the output evenly between two sets of pipes or can be made to give an increased amount to one at the expense of the other. In the Spring for instance, you may not want much heat going through to your radiators but you still want maximum for baths etc. During the daytime you do not want to heat the bedrooms so you can send all the hot water through the downstairs room etc. The pump is for normal mains operation and comes complete with 4 pipe unions. Summary of the special features of this system is as follows:—Inductive pump drive (without shaft). Self cleaning pump construction, continuous water lubricated rotor, pump output adjustable in 4 stages. Switch to gravity circulation possible. Accurate automatic temperature regulation ± 1°C. We understand that the regular price of this pump is around £40. Our price is \$20 + \$1-60p. Post \$3-24p.

Panel Meters mainly G.P.O.
(1) 3" x 2 1/2" flush mounting, 25VIA f.s.d., scale calibrated 0-1000 meg ohms ideal if you are thinking of making a portable insulation tester. Price \$3-24p. Post 40p + 4p.
(2) Edgemounting, size 3" x 1 1/2" scaled meg ohms, specification same as above.
(3) 3" x 2 1/2" centre zero 25-0-25 nA special purpose scale, price \$2-50p + 20p. Post 40p + 4p.
(4) 3" circular scaled dB-0-minus 15 plus with current transformer. 0db 1 mW 600 ohms. Price \$4 each + 32p. Post 40p + 4p.

B. BAMBER ELECTRONICS

Dept. EE, 5 STATION ROAD, LITTLEPORT, CAMBS., CB6 1QE
Telephone: ELY (0353) 860185 (2 lines) Tuesday to Saturday

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

PLEASE ADD 8% VAT UNLESS OTHERWISE STATED

GARRARD 9V DC MINIATURE MOTORS, Type 318M, 3200 RPM (revised size approx. 1 1/2 in. dia. x 1 1/2 in. high, with 2mm spindle. Brand New 60p each or 2 for £1.

SILICON HIGH VOLTAGE RECTIFIER STICKS, BY185 (new) 35kV 2.5mA £1 each, BY140 (ex-equip) 12kV 2.5mA 45p each.

VARIABLE STABILISED POWER SUPPLY, mains input, 0-24V output, stabilised and current limiting at 500mA - 32V at 50mA. Brand new by British manufacturer. Size approx. 7 1/2 x 2 1/2 x 4 in. complete with external 50k 3-turn pot for voltage control. Connection data supplied. £7.

14 DIL REED RELAYS, 5 to 12V DC, 450 ohm coil. Designed to work directly from TTL Logic. Single Pole Change over. Contact ratings 28V 1/4A 3W. £1.75 each.

PLASTIC BOXES 3 1/2" square, 1 1/2" deep (wall-mounting type) with 5-pin din plug on front panel, 50p each.

MAINS ISOLATION TRANSFORMERS. Tapped mains input, 240V at 3A + 12V at 500mA output. New, boxed, made by Gardners, £12.

SOLDER SUCKERS (Plunger Type). Standard Model, £4-50. Skirted Model, £4-95. Spare Nozzles 60p each.

2N3055 type Transistors. O.K., but unmarked, 5 for £1.

110V NEONS, SCREW-IN-TYPE, 4 for 50p.

SLOW MOTION MOTORS (suitable for programmers, displays, etc.) 230-240V a.c. input, rotation, 1 rev. every two to three minutes. Sorry, sold out.

MINIATURE PLIERS. High quality "Crescent", made in USA. £4-35 + VAT (35p).

SIDE CUTTERS. High quality. £3-70 + VAT 30p.

MIXED COMPONENT PACKS, containing resistors, capacitors, pots, etc. All new. Hundreds of items. £2 per pack, while stocks last.

4MHz XTAL PACKS (10 assorted xtals between 4MHz and 5MHz), our selection only, £1 Pack.

PROGRAMMERS (magnetic devices). Contain 9 microswitches (suitable for mains operation) with 9 rotating cams, all individually adjustable. Ideal for switching disco lights, displays, etc., or industrial machine programming. (Need slow motion motor to drive cams, not supplied.) 9 switch version £1-50.

HEAVY DUTY HEATSINK BLOCKS, undrilled, base area 2 1/2 in. x 2 in. with 6 fins, total height 2 1/2 in. 50p each.

SPERRY 7 SEGMENT P.G.D. DISPLAYS, digit height 0.3 in. red, with decimal points, 150V to 200V (nominal 180V) operation. These are high-voltage industrial type and therefore brighter than normal displays. All brand new, AT THE BARGAIN PRICE OF 50p PER DIGIT. TYPE 332 (two digits in one mount) £1 each. (Sorry, no single digit available.) Data supplied.

BSX20 (VHF Dsc/Mult), 3 for 50p.
BC108 (metal can), 4 for 50p.
PBC108 (plastic BC108), 5 for 50p.
8F51 Transistors, 4 for 60p.
BCY2 Transistors, 4 for 50p.
PNP audio type T05 Transistors, 12 for 25p.
BF152 (UHF amplifier), 3 for 50p.
2N3819 Fet., 3 for 60p.
BC148 NPN SILICON, 4 for 50p.
PBC158 PNP SILICON, 4 for 50p.
8A131 Signal Diodes, 10 for 35p.
BA121 Varicap Diodes, 4 for 50p.
1N914 Diodes, 10 for 25p.

SMALL MAINS SUPPRESSORS (small chokes ideal for radio, Hi-Fi inputs, etc.). approx. 1/2 in. x 1 1/2 in., 3 for 50p.

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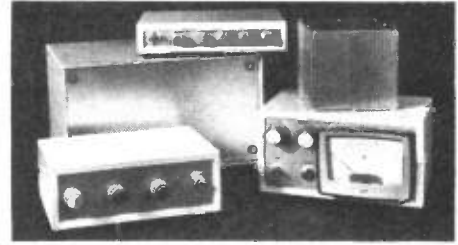
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22/16 6p	147B 10p	41A 67p
25/25 6p	148 9p	41A 67p
33/50 8p	148B 10p	41A 67p
47/6V3 5p	149B 11p	41A 67p
47/10 5p	14C 10p	41A 67p
47/16 5p	BC154 18p	41A 67p
47/25 6p	330/16 15p	41A 67p
50/10 5p	470/6V3 10p	41A 67p
50/15 5p	470/10 10p	41A 67p
100/18 5p	470/16 15p	41A 67p
100/25 5p	470/25 18p	41A 67p
100/35 5p	680/25 25p	41A 67p
100/50 11p	1000/16 25p	41A 67p
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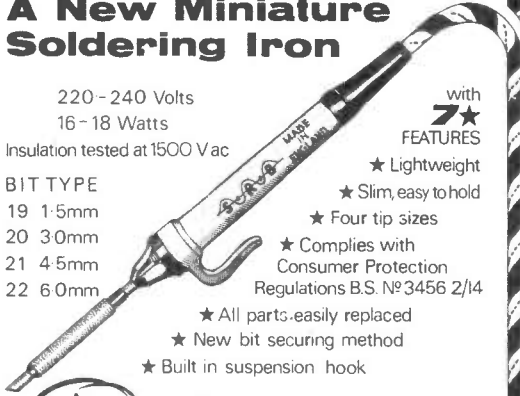


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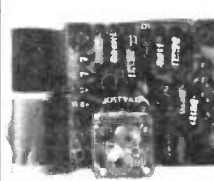
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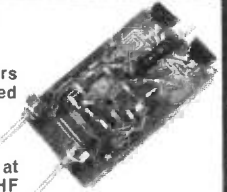
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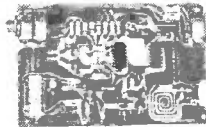
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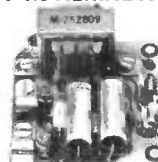
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PROJECTS.
THEORY...

DON'T BE FRIGHT

It really is quite amazing how some quaint ideas still persist. Talking (off-duty) to a fellow the other day the subject of electronics by chance cropped up. "Oh, but your's is a *specialist's* subject of course". The undue emphasis on "specialist's" told a lot. Quite obviously in the speaker's mind electronics was another world—far beyond his reach or perception. What poppycock! It makes one recall what a great American President once said on an admittedly bigger and more profound matter: "We have nothing to fear, save fear itself".

How very true this is. For people are inclined to erect barriers themselves, where no real obstacle exists. Electronics is a classic example: it is held in awe by most outsiders, whereas those who have taken the trouble to give the subject a good hard look often become enthralled and take to the building of electronic circuits with practically no trouble at all.

So never be frightened merely by the "reputation" of electronics. Take to reading EVERYDAY ELECTRONICS regularly, for what *we* specialise in is cutting electronics down to size and serving it up in portions both appetizing and digestible.

What's in a name? Those who indulge in the hobby of electronics may be described quite correctly as "specialists", but equally so those of their friends and neighbours who devote time and apply serious effort in their various spare time pursuits. Come to think of it, every avenue,

road, street and way up and down the country houses a mixed bag of specialists, all "doing their thing".

In this general sense of the word, to become a "specialist" in electronics is not at all difficult. Ask any of our readers.

SOMETHING FOR EVERYBODY

All of that was (as if you didn't guess) by way of an introduction, and a welcoming one, we hope, to the uncommitted. As a further incentive to the newcomer to electronics, this issue contains a special chart with see-at-a-glance information. Indispensable to the beginner, this chart is of permanent worth to all constructors. Carry it with you; you'll be amazed how frequently you'll turn to it for "info".

There's a grand selection of projects in this issue, too. The only real difficulty will be in determining which to start off with. Anyhow, good constructing, all you fellow "specialists". And *do give it a try* you non-specialist on-lookers. Then write and tell us what you think about electronics as a hobby, or raise any particular problems. We'll always help if we can.



Our April issue will be published on Friday, March 18.

See page 135 for details.

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VOL. 6 NO. 3

MARCH 1977

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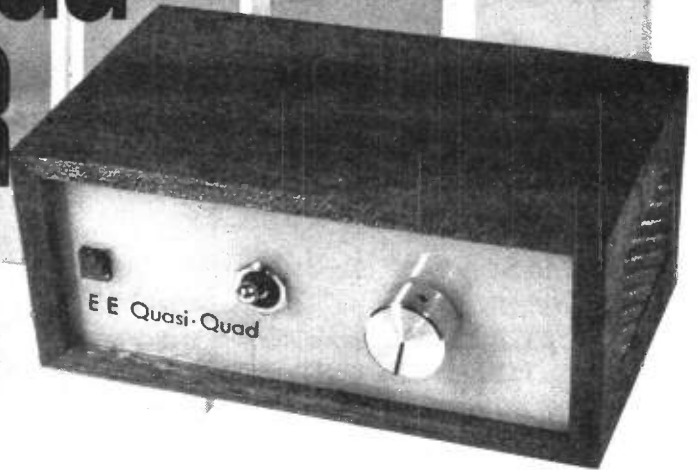
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Quasi-Quad ADAPTOR

By K. Lenton-Smith



TRUE quadrasonic systems work on either matrix or multiplex principles, but are expensive to set up—let alone the cost of the special recordings designed for them. Interesting effects may be obtained from stereo (and quadrasonic) recordings by adapting the Hafler system.

In 1970, David Hafler suggested adding a rear channel to stereo systems by using the *difference* signal between left and right channels (Fig. 1). Using two rear speakers, connected out of phase with respect to each other, this difference signal produces a better "quadrasonic" effect (Fig. 2).

DIFFICULTIES

There are, however, several practical difficulties with the

arrangement of Fig. 2. Direct connection of the extra pair of speakers tends to reduce separation between the main channels. "Way out" recordings can produce freak difference signals, which can endanger the equipment or blow an output fuse. Lastly, the volume of the rear speakers may be adjusted only by adding low value resistors in the main speaker circuits: this is inconvenient and could cause mismatch.

Bearing in mind one important caveat, the solution to these problems is to use a low-power amplifier to drive the pair of rear speakers: this method also allows the constructor to utilise a pair of inexpensive speakers for the rear channels and it is not necessary to match them to the frontal pair. The Quasi-Quad Adaptor

obtains its input from the "live" terminals of each of the main channels as before, but the rest of its circuitry is *completely isolated* from the main stereo amplifier.

CIRCUIT

Connection of the adaptor is shown in Fig. 3, whilst Fig. 4 illustrates the circuit of the adaptor and its power supply.

Note that VR1 (10 kilohm potentiometer) has a high resistance compared with the impedance of the main speakers, so that separation is unaffected when the adaptor is fitted; VR1 also protects the stereo amplifier from damage due to freak difference signals and enables the user to control the rear channels according to the listening position. Although the Quasi-Quad Adap-

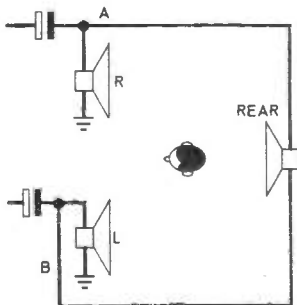


Fig. 1. The Hafler method of adding a third rear channel.

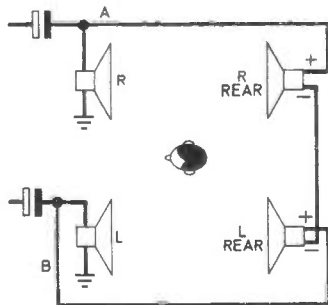


Fig. 2. Extension of Hafler's system to obtain two rear channels.

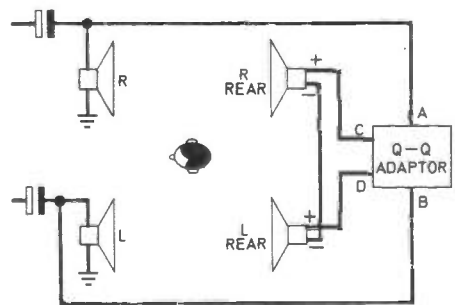


Fig. 3. Using the Quasi-Quad Adaptor to produce 4 channels.

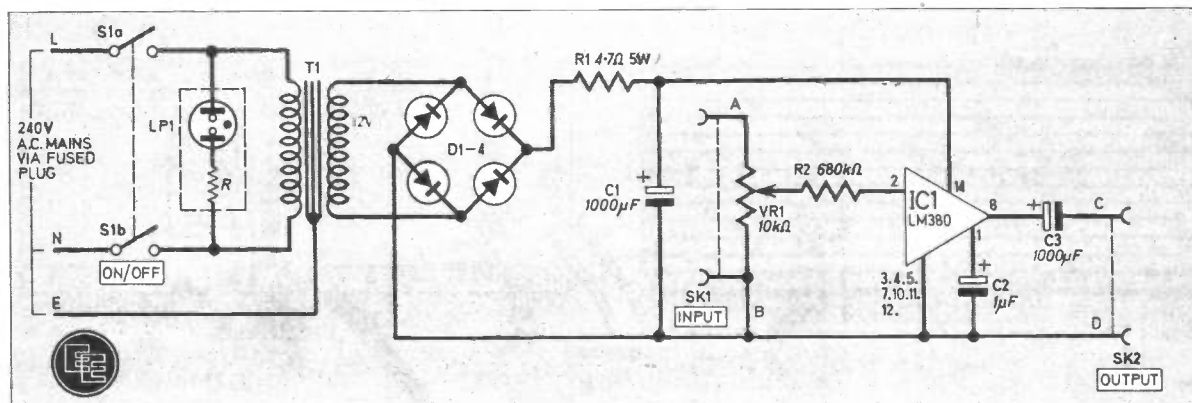


Fig. 4. The complete circuit diagram of the Quasi-Quad Adaptor.

tor can be tested on battery power (by removing the link on the Veroboard), a mains-derived power supply is desirable as the unit may be in use for long periods.

The power supply is not critical and it will be seen that simple R/C smoothing is all that is required. The mains transformer need not be exactly as specified provided that the output of the power supply section is between 10 and 20 volts. By removing the link on the Veroboard, the supply voltage can be checked before connecting it to the remainder of the circuit.

The LM380N is a power audio amplifier with gain internally fixed at 34dB. The output automatically adjusts itself to one half of the supply voltage, it is short-circuit proof and thermal limiting is built in: in short, a most useful device for the constructor. Harmonic distortion is typically 0.2 per cent for an output of 2W, though this power level will probably not be required for domestic listening in this application.

The central six pins of the LM380N should be connected to a heat sink, if required: the copper strips of the Veroboard will normally suffice to dissipate heat generated in the device (so cut the track as shown in Fig. 5). If the reader wishes to use the maximum power from this i.c., he should solder copper foil "wings" on the underside of the Veroboard, on either side of the device.

In this application, the non-inverting input is used, leaving the inverting input floating: thus the input series resistor R2 is connected to pin 2. No connections are made to pins 6, 9 and 13. The by-pass capacitor C2 decouples the early stages of the i.c. and reduces noise or hum injected by the power supply.

SUPPLY

The LM380N must not be supplied with more than 22 volts, 15 volts being a suitable target figure. However, this cannot be obtained from the main stereo system. Input "B" is taken from the "live" side of the left channel, so that a common negative system would short circuit that speaker and damage its output transistors. The caveat mentioned previously is that—

The power supply for the adaptor must be completely independent from the stereo amplifier. The Adaptor's negative line should not be earthed to the a.c. mains.

If using 3-core cable for the mains supply to the adaptor, connect the earth lead to the frame of the transformer *only*. Ensure that this earthing is not transferred to the circuitry, so

it is best not to use a metal housing.

CASE

The cabinet illustrated is on the "matchbox" principle, using Perspex sheet for the chassis "tray" and a veneered wooden "cover" to slide over it. Any plastics box would be suitable but, as the Quasi-Quad Adaptor has been designed to complement a stereo system, presentable case-work seems a prerequisite.

As the mains transformer gets warm in operation, some form of ventilation is necessary: the veneered wooden cover of the prototype has thus been fitted with expanded metal grilles at each end. By making these grilles an accurate push fit, they may be cemented into place firmly with Araldite. Four holes have been drilled through both case and chassis from the underside and, by tapping the chassis with 6 BA threads, screws may be inserted through rubber feet to hold the unit together.

CONSTRUCTION

Apart from the special precaution already mentioned, construction of the unit should pose no problems. However, it is as well to remember that most i.c.s are instantly destroyed if the supply polarity is reversed. The LM380N is no exception, so use the link to verify that the bridge rectifier has been properly connected. The 35 x 13 hole 0.1 inch matrix Veroboard is non-standard and was cut this size with the dimensions of the finished unit in mind: the layout might still be followed using a slightly larger board.

Though not strictly necessary

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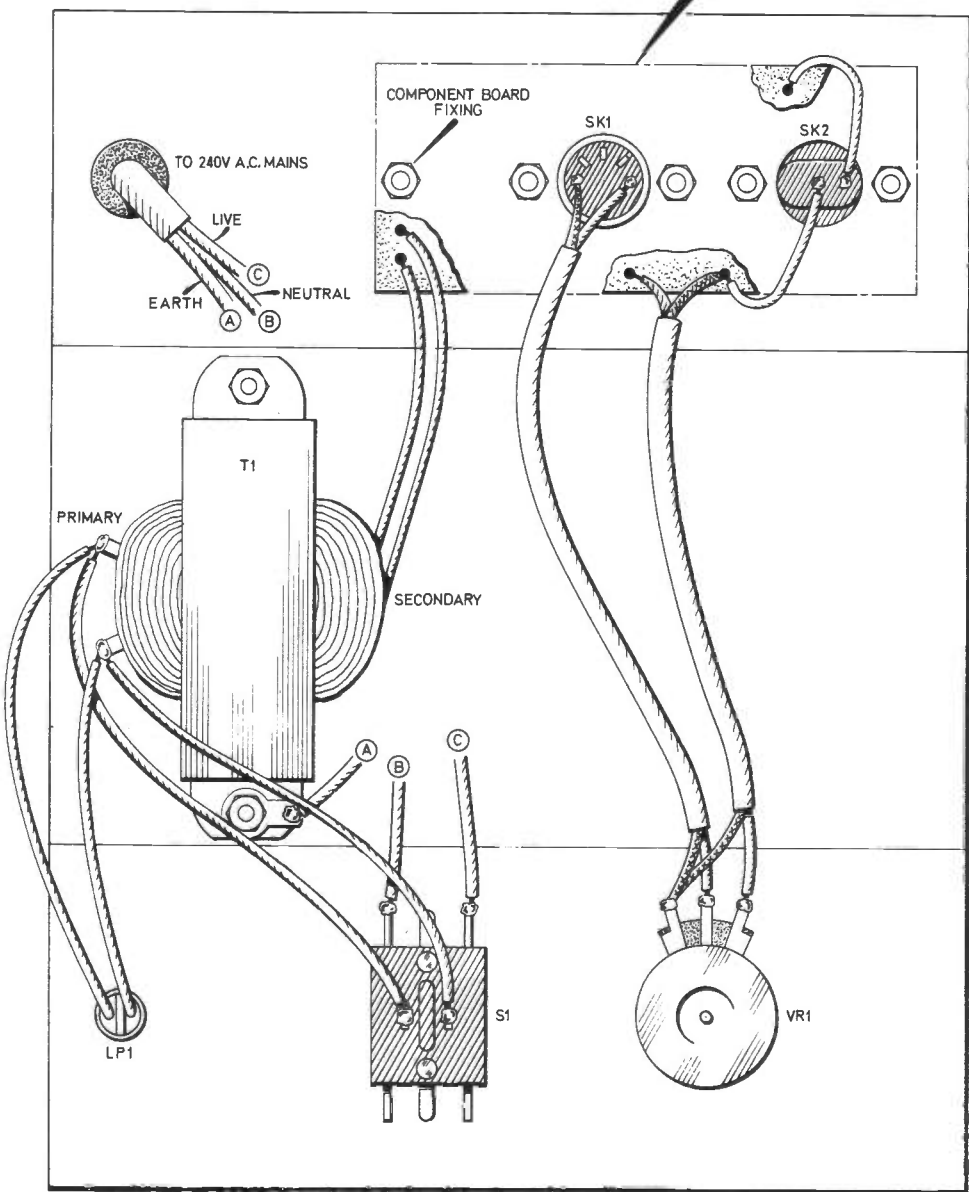
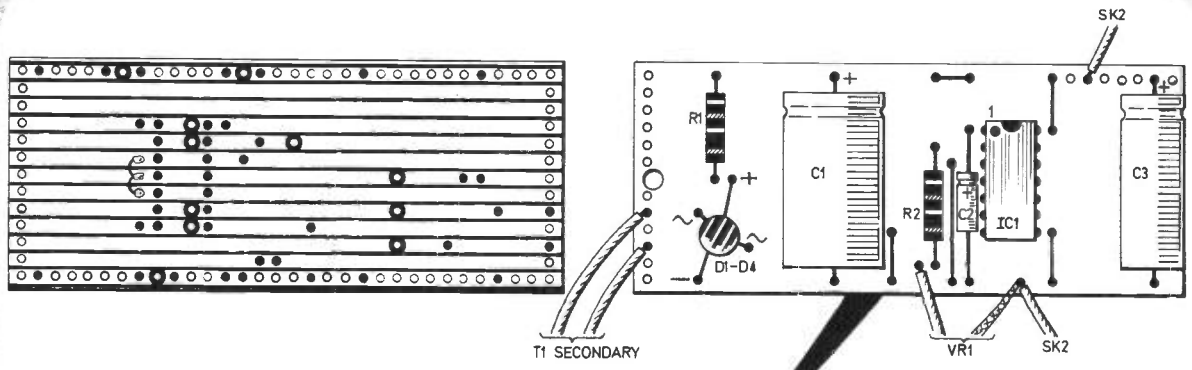


Fig. 5. The layout of the components on the stripboard and complete wiring-up details within the case.

for this application, it is as well to use screened leads to the volume control VR1 to avoid the possibility of mains hum from the transformer. The i.c. is best fitted to the Veroboard last of all.

TESTING

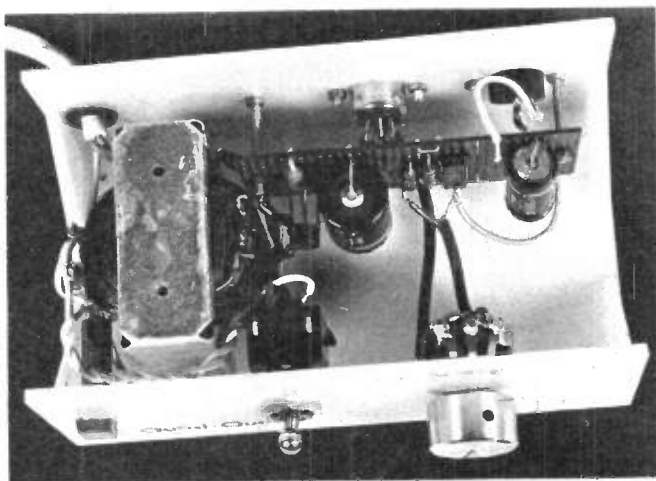
When the wiring has been carefully checked, especially the mains supply to the primary of T1, a single speaker should be connected to the output socket SK2. After switching on, touching the pin 2 end of R2 should produce hum if all is in order. With the chassis exposed, the reader is reminded to take care to avoid those parts live to the mains.

Before dealing with setting up the unit finally, the question of speakers should be mentioned. For domestic use, the power required by the main speakers is surprisingly small: rear channels of the Quasi-Quad system need even less, so that a small amplifier and ordinary speakers are all that is required.

Though the rear channel speakers should be similar to each other, their impedances may be whatever is to hand—up to 15 ohms each. For preference, 8 ohm speakers should be used and have been fitted to the prototype because they happened to be going spare! The reader may have speakers lying idle and so they have not been specified or allowed for in the approximate cost. Similarly, the casework can usually be made from offcuts.

INSTALLATION

Assuming that the single-speaker hum test was satisfactory,



Everyday Electronics, March 1977

Components

Resistors

R1 4.7Ω 5W w/w
R2 680kΩ 1/4W ± 5
VR1 10k Ω log.

Capacitors

C1 1,000μF elect. 25V
C2 1μF elect. 10V
C3 1,000μF elect. 10V

Semiconductors

D1 to D4 Bridge rectifier 1A 100 p.i.v.
LM380N audio power amplifier i.c.

Miscellaneous

T1 mains primary/12V 500mA secondary transformer
S1 d.p. mains switch 2A rating
LP neon indicator (with integral resistor)
SK1 3 or 5-pin DIN socket
SK2 2 pin speaker socket (DIN)
Control knob; stripboard 0.1 inch matrix 35 x 13 holes;
connecting wire; 6BA fixings; materials for case etc.

the Quasi-Quad unit may be finally installed. Figs. 1 to 3 show the output capacitor connected to one side of each of the main channels. There should be no difficulty in finding points A and B (the "live" terminals) of the main channel speakers as these will be driven through the output capacitors: these points are connected to the input socket SK1.

The output socket SK2 should supply the two rear channel speakers in series, but out of phase. If using a similar pair of mass-produced speakers, it should be easy to connect correctly. If in doubt, apply a 6V battery across the speech coil and note which way the cone moves: using the same battery polarity, test the second speaker. When wired in series,

application of the voltage should make one cone move forward, the other backward; when so wired, the speakers may be permanently connected to the Adaptor.

Play a stereo record through the system, listening from the middle of the speaker area. Try reversing the input leads to SK1 and reversing the positions of the rear channel speakers and settle for the best result. Once this has been obtained, the constructor will find that the addition of the Quasi-Quad Adaptor gives a new dimension to his records: stereo radio and tape will also be enhanced by this method. Indeed, plain stereo will sound lacking without it.

AMPLIFIER

It will be seen that the Adaptor is nothing more than a self-contained amplifier, and can be used as such. For bench-testing a piece of audio equipment, the input is still connected to A and B but, if a single speaker is fitted via SK2, it is best to consider 16 ohm as the lowest impedance to be used. It would be possible to utilise the remaining pins of SK1, with a suitably wired DIN plug, to *purposely* connect the negative rail to earth, if so desired. In view of the foregoing warning, however, it is best to earth the transformer frame only.

In its present form, the amplifier will handle signals of any type except from a magnetic head, which gives a very small output. □

See
**Shop
Talk**



THIS unit provides a novel electronic alternative to a conventional dice. The circuit is based on two integrated circuits which greatly simplify what would otherwise be an extremely complex device. The method of operation is also very simple provided, as so often has to be the case these days, one only considers what the i.c.s do rather than how they actually achieve it.

There are several ways of electronically simulating the action of a dice, but the arrangement used here is probably the most simple method. The display consists of a row of six light emitting diodes which are numbered one to six. The electrical analogue of throwing the dice is to momentarily depress a push button switch.

While the switch is being operated all the l.e.d. indicators will light up, but when it is released only one l.e.d. will remain on. The number of the l.e.d. which remains on is the number indicated by the dice. It is purely a matter of chance as to which of the six l.e.d.s is the one which is left on at the end. An accurate simulation of throwing a dice is thus obtained.

OPERATING PRINCIPLE

The operating principle of the unit is illustrated in Fig. 1. The circuit consists basically of an oscillator feeding a decade counter or divide by ten circuit. The particular decade counter i.c. used here has ten outputs apart from the usual divided by ten one, and it is seven of these outputs which are employed here.

The outputs are numbered "0" to "9", and they are normally in

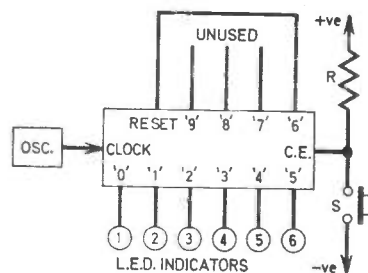


Fig. 1. Operating principle of the Dice.

the low state (logic 0 or at virtually zero volts). However, they go high for one complete input cycle in sequence. A l.e.d. indicator is driven by each output from "0" to "5", and so each l.e.d. will be switched on sequentially.

A feature of the counter is its reset terminal which will return the counter to zero ("0" output high) if it is briefly taken to the same potential as the positive supply rail (the high state or logic 1). This input is connected to the "6" output, and so after outputs "0" to "5" have in turn gone high, output "6" goes high

Electronic DICE

By R. A. Penfold



FOR GUIDANCE ONLY



ESTIMATED COST OF COMPONENTS * excluding V.A.T.

£3.60

excluding case

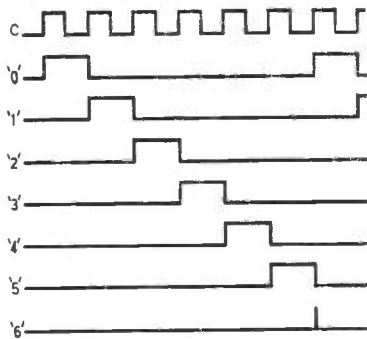


Fig. 2. Waveforms produced at the input and outputs of IC1.

and immediately resets the counter back to zero.

Outputs "0" to "5" then each go high in sequence again and then output "6" goes high and resets the counter back to zero. The decade counter is in fact being used as a divide by six circuit in this particular application.

The oscillator operates at a frequency of about 1kHz and so it is impossible for the human eye to perceive the action of the l.e.d.s as they are flashing on and off at such a fast rate. To an on-looker it will appear as though all six l.e.d.s are continuously alight. The waveforms produced at the clock input and outputs "0" to "6" of the i.c. is shown in Fig. 2.

A clock enable terminal is another feature of the counter i.c., and the clock signal is blocked when this is in the high state and enabled when it is in the low state. It is normally held high by R and so the counter goes to zero and then remains dormant when the supply is initially turned on.

When S is operated the clock

Components



Resistors

- R1 56k Ω
- R2 39k Ω
- R3 56k Ω
- All $\frac{1}{4}$ W $\pm 10\%$ carbon

Capacitor

- C1 15nF plastic

Semiconductors

- D1-D6 TIL209 or similar l.e.d.s.
- IC1 NE555V timer i.c.
- IC2 CD4017 CMOS counter

Miscellaneous

- S1 push to make release to break pushbutton switch
- S2 s.p.s.t. toggle or slide switch
- B1 9V PP3 battery and connector
- Veroboard 0.1 inch matrix, 24 holes by 10 strips; connecting wire; suitable case—see text.

See
**Shop
Talk**
page 144

enable input is taken to the low state the circuit will operate in the manner described above, and it will continue to do so until S is released. At the moment S becomes open circuit the count will stop and the l.e.d. which happened to be on at that particular instant will remain on.

There is, of course, no way of predicting which l.e.d. this will be as they each come on for the same length of time (one clock cycle) and therefore have an equal chance of being the one that happens to be on when S goes open circuit.

CIRCUIT

The complete circuit diagram of the electronic dice appears in Fig. 3. The clock oscillator utilises the well known NE555 i.c. in the astable mode (IC1). This does not provide a proper 1:1 mark space ratio squarewave output,

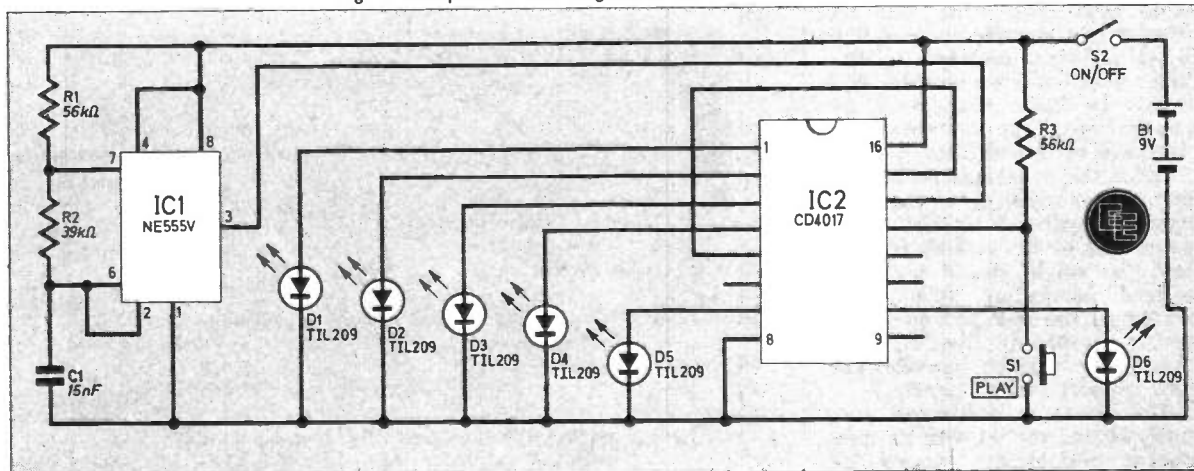
but this does not affect the circuit operation as it is on the positive edge of the clock signal that the counter circuit is triggered.

The time between each positive output excursion is constant and so each l.e.d. is on for the same length of time, regardless of the mark space ratio of the input signal. It is necessary for the clock signal to have a fast rise-time if the counter is to be operated reliably, and this is accomplished comfortably by the NE555.

A CMOS 4017 i.c. is the decade counter (IC2) which is used in this design, and this is capable of supplying a current of a few milliamps to the l.e.d. indicators (D1 to D6) without the need of any driver transistors or current limiting resistors.

Resistor R3 and S1 are the equivalents of R and S of Fig. 1. S2 is an ordinary on/off switch. Power is obtained from a PP3 9

Fig. 3. Complete circuit diagram of the Electronic Dice.



volt battery and the current consumption of about 6mA gives a reasonable battery life.

CONSTRUCTION

A plastic box having outside dimensions of approx. 120×65×40mm was used as the case for the prototype unit, but any plastic box of around this size should be satisfactory. A metal case can be used if adequate precautions against any wiring being short circuited through the case are taken.

The lid of the box is used as the constructional basis of the unit. The six l.e.d.s are mounted in a row along the upper half of the lid and the two switches are mounted below them. This general arrangement can be seen from the photographs of the prototype, and the layout is not at all critical.

The l.e.d.s are mounted in plastic panel clips. The author used a push type switch for S2, but a slider switch or miniature toggle type will fit in just as well if preferred.

A 0.1 inch matrix stripboard having 10×24 holes with the copper strips running lengthwise is used to wire up the components which are not mounted on the front panel. Details of this board are shown in Fig. 4, it also shows most of the other wiring of the unit.

Construction of the panel commences with the cutting out of a board of the appropriate size, and this can be done using a junior hacksaw. The 16 breaks in the copper strips can then be made using either the appropriate tool or a small (about size No. 24) hand held twist drill. The six components and the various link wires are then soldered in. The link wire which crosses IC2 should be made from p.v.c. insulated wire, but the others do not have to be insulated.

After the panel has been completed it is wired up to the components mounted on the front panel and to the battery connector. Use single strand p.v.c. insulated connecting wire when wiring up the unit and keep this wiring reasonably short as it is these wires which provide the only support for the panel.

The panel is positioned centrally behind the lid with its component side facing towards the

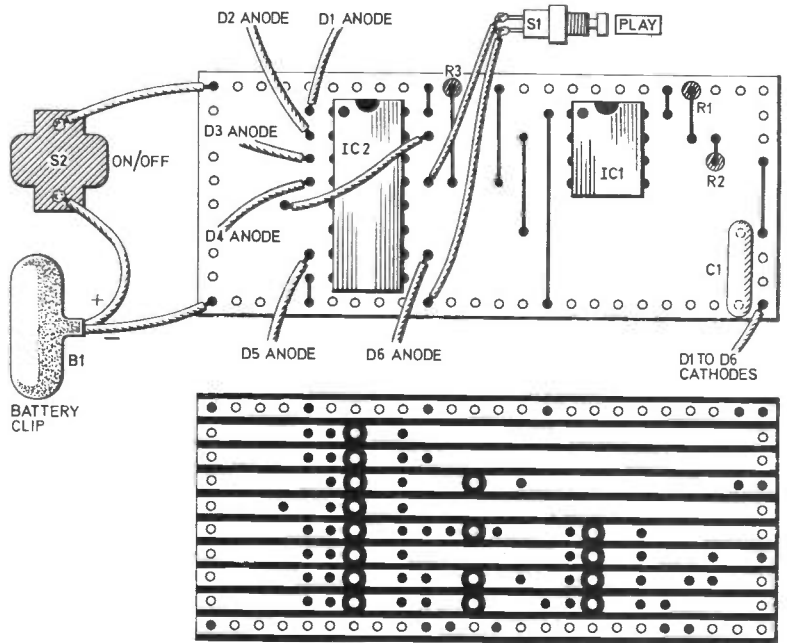


Fig. 4. Layout and wiring of the Dice.

lid. There is plenty of space for the battery at either end of the case. If necessary a piece of foam rubber can be placed inside the case so that the battery is firmly held in place when the lid is screwed down.

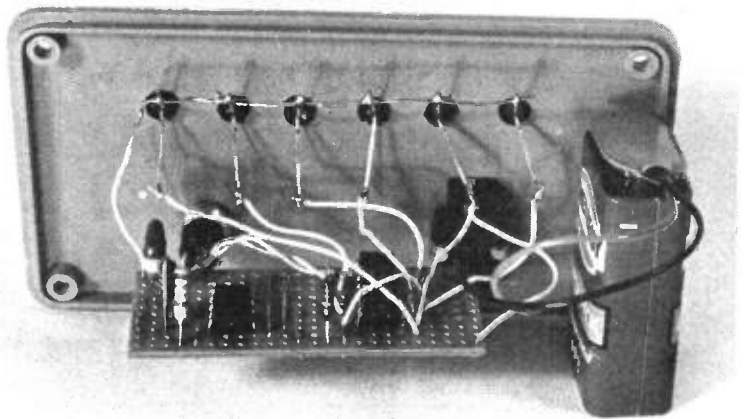
TESTING

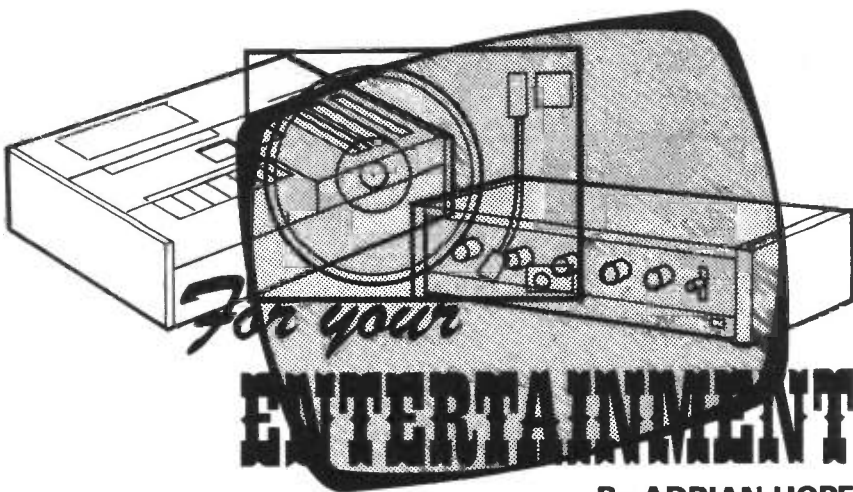
Upon switching the finished unit on, the "1" indicator should come on. When S1 is depressed the l.e.d.s should all come on but rather dimly. Only a single l.e.d.

should remain on when S1 is released.

Transfers such as Letraset are used to provide the l.e.d.s with legends from 1 to 6.

Do not be surprised if after a few operations of S1 some numbers have not come up at all while others have perhaps appeared three or four times in succession. This could quite easily happen with an ordinary dice, and so it does not necessarily mean that the unit is malfunctioning due to some fault. ☞





By ADRIAN HOPE

A COUPLE of odd electronic faults and their even odder causes recently came casually to light. Interesting in their own right, they also serve as a useful reminder that every new advance in electronics brings some new problems.

Firstly, it seems that in the USA some tape recording enthusiasts have been running their machines off a mains supply which is in circuit with a thyristor control. Quite why they should do this is unclear, but with thyristor power controls becoming ever cheaper and more common it becomes ever easier to plug into a circuit without realising, or remembering, that it contains a thyristor control. And it emerges that some odd things happen to tape recorders under such circumstances. Like, for instance, they appear to work perfectly but flatly refuse to record a sound signal!

No one has yet sorted out exactly why a recorder on a thyristor controlled circuit may refuse to record an audio signal but readers of this column will doubtless be able to make an informed guess. As previously explained, a thyristor control works by chopping the wave form so that the amount of mains power supplied to the load varies while the mains frequency stays the same. At each chop a spike of r.f. energy is produced, which can interfere with medium and long wave radio reception.

It seems likely that this spike of r.f. interference gets through the tape recorder circuitry and onto the record head. There it erases the signal as it is recorded. This may well happen even when the control is turned full "up", as it may well still be chopping the waveform slightly in this position.

L.S. Overdrive

Another fascinating problem is that being encountered by audio enthusiasts, particularly discotheque and rock group equippers, who try to cut corners by using a relatively low-powered amplifier to produce high level sounds. We all know what the obvious problems will be. The amplifier will run into clipping when it is driven too hard, and the result will be audible nasties. But something else happens as well—the loudspeaker coils burn out even though their wattage rating says they shouldn't.

At first this seems impossible. How can a loudspeaker coil burn out when under-powered by an amplifier? Well, when an amplifier runs into clipping, it starts chopping off the top of the sine wave audio signal to produce something that looks more like a square wave. And a square wave can be regarded as pulsed d.c., which some loudspeakers most definitely do not like. So, odd as it may sound, increasing the power of the amplifier driving a high powered system may well produce not only better sound but a reduction in overall expenditure.

Deceitful and devious!

In a Rotterdam department store I recently noticed what must surely be the next electronic gimmick to hit England. For around 50p you can have an "electrographic personality analysis" of your handwriting performed in 30 seconds by an immensely impressive looking computer which, probably quite unnecessarily, is the size of a small room.

Certainly its festoons of flashing

lights and weird bleeping noises owe more to Hollywood than science and are totally redundant. The customer pays up and signs his normal signature on a card, which is then loaded into the machine. The lights and bleeps become even more enthusiastic, the computer tape spools spin in truly impressive fashion, and out comes a card which contains several dozen headings, through which a wavy graph line wanders in what the designers (EMASO Computers) consider to be "surprisingly accurate" manner.

I must henceforth, therefore, consider myself complacent, lethargic, unobservant, lackadaisical, aggressive, deceitful and devious. At this rate the machine should make a lot of friends and prove very popular.

(We believe a similar machine was in use at the D.I.Y. Exhibition at Olympia last year. Ed.)

What price a body?

That television science soap opera, *The Six Million Dollar Man* (and *Woman* with, rumour has it, bionic children to follow) postulates a part-artificial human being with all manner of electronic gadgetry built in. As such it is usually written off as rubbish, but don't be too sure.

Recently I came across a patent for a system of helping the deaf to hear by implanting an electromagnetic motor system inside the inner ear and feeding it with amplified audio signals picked up by a microphone implanted in the skin. The motor moves the pivoted bones in the inner ear against the sensitive nerve cells to produce a supposedly quite normal sensation of sound. And of course implanted pulse generator circuitry is now regularly used to pace the beats of a defective heart.

One method of powering such a pacemaker is to provide it with a battery of storage cells which are recharged by applying a strong magnetic field from an electromagnet held on the wearer's chest like a giant bulk tape eraser.

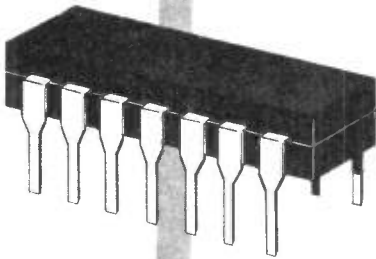
Perhaps oddest of all, an American scientist, Prof. Harold Morowitz of Yale, has recently published an analysis of how much it would cost to synthesise a working replica of the human body, starting with all raw ingredients at current retail value. Although some 65 per cent of our constituency comes out very cheap, being pure water, the remaining 35 per cent is extremely expensive to make, buy or replicate, and pushes up the overall cost alarmingly.

In fact, Prof. Morowitz's final total for just the raw materials in an average human frame comes out at just fifteen dollars and forty-four cents over the six million dollar figure. Coincidence? Surely not. Could it be that the producers of the TV series were aware in advance of the Professor's researches—or could it be that the Professor is actually a secret fan of the series?

Doing it Digitally...

Part 6

By O. N. Bishop



THIS MONTH we will be looking at addition of binary numbers. A circuit for adding two binary numbers will be described which can be built on the special breadboard already dealt with in a previous article.

In order to feed numbers into the adder a simple "paper tape reader" will be described which can be built for a few pence using a piece of stripboard and some paper clips.

With some circuit alterations the adder can be turned into a subtractor.

BINARY ADDITION

Adding two and two to get four is not as simple as it sounds when one tries to use integrated circuits. Look at the circuit shown in Fig. 6.1. This circuit will add one and one to give two and even this needs seven gates!

The input to the circuit consists of two numbers labelled A and B. Each number consists of one digit which can either be 0 (low) or 1 (high). Of course these are binary numbers so the answer will also have to be in binary.

If zero and zero are added the answer is zero. If one and zero are added the answer is one. So far the answer has only consisted of one digit but when one and

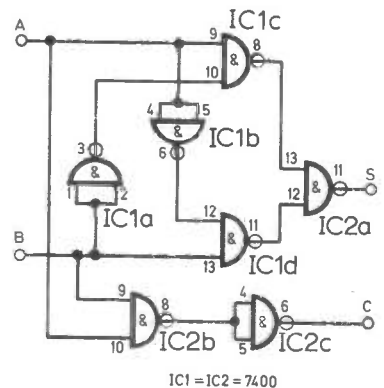


Fig. 6.1. NAND gates used to make a half adder which will add two binary digits.

one are added the answer is two which needs two binary digits to represent it since decimal two equals binary "10".

Thus the circuit must have two outputs: one the sum (S) and the other the carry (C). More about the function of the carry later.

The truth table of the circuit of Fig. 6.1 is shown as Table 6.1.

The circuit can be built on the experimental board as shown in Fig. 6.2. It means quite a bit of wiring but is interesting to analyse.

The circuit which gives the sum

Table 6.1. Truth Table for Fig. 6.1.

Inputs (numbers to be added)		Outputs (answer)	
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

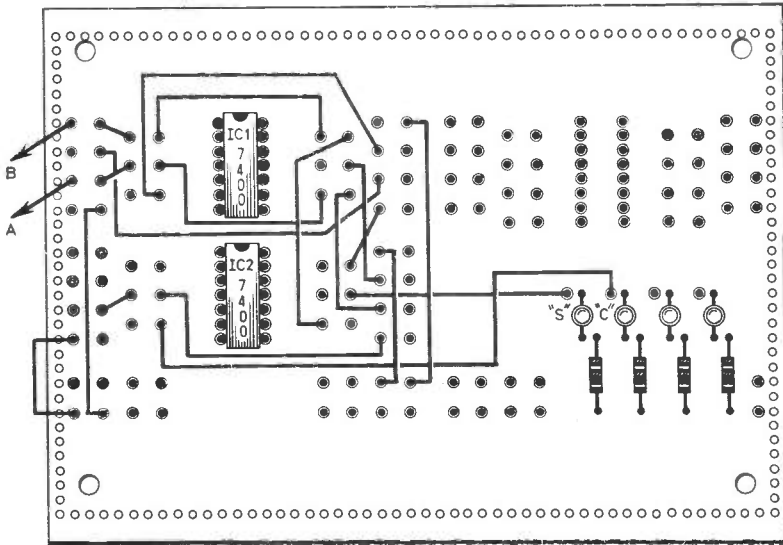


Fig. 6.2. The circuit of Fig. 6.1 built up on the experimental deck.

(S) output, gates IC1a to IC1d and IC2a form what is called an EXCLUSIVE OR gate. Table 6.1 indicates that S is high when A is high OR when B is high but not when both are high. This circuit is very useful when designing other types of logic combinations.

ADDING LARGER NUMBERS

The circuit of Fig. 6.1 can be used for adding numbers with more than one digit, but with some numbers a problem occurs. Consider what happens when we try to add 11010 (decimal 26) and 11111 (decimal 31).

We start by adding the two least significant digits on the circuit. This gives 0 plus 1 which equals 1 with no carry.

Next add the next most significant digits. We get 1 plus 1 which gives no sum but a carry of 1. We now have three digits to add, a 0 from A, a 1 from B and the carry. Since digit A is 0 we can instead feed the carry input here to give 1 plus 1 equals sum 0 carry 1. At the next stage we are really stuck as the digit from A is 1, the digit from B is 1 and the carry is 1. What is needed is a circuit which will add 1 and 1 and 1 to give sum 1, carry 1.

We can see that the simple two input adder (or half adder as it is sometimes known) is not capable of adding multidigit numbers unless it is modified to have a carry input. This can be done but it makes the logic complicated and takes several extra

gates. At this stage we give up trying to make the adder from NAND gates and look to the i.c. manufacturers for assistance. We find it in the form of the 7480.

THE 7480 ADDER

The 7480 is an integrated circuit which will add two single digit numbers but which also has a carry input (see Fig. 6.3). It can do more things besides but these will be discussed later.

It contains 16 gates but costs less than four 7400s and saves all that complicated wiring—good value for money.

Connect the i.c. on the experimental board as shown in Fig. 6.4. Try the addition that defeated us with the simple adder.

Note that this circuit gives an inverted carry output: when the carry lamp is lit there is no carry, when it is out there is a 1 to carry.

It should now be possible to get the full answer by recording the sum output at each stage and the sum and carry for the most significant digit. This gives an answer of 111001 (decimal 57).

Of course one has to remember or write down both the sum and carry at each stage which can be very tedious so here is a way of supplying numbers to the adder and a simple way of remembering the carry figure.

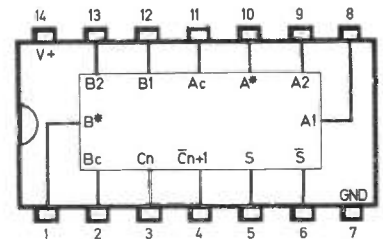


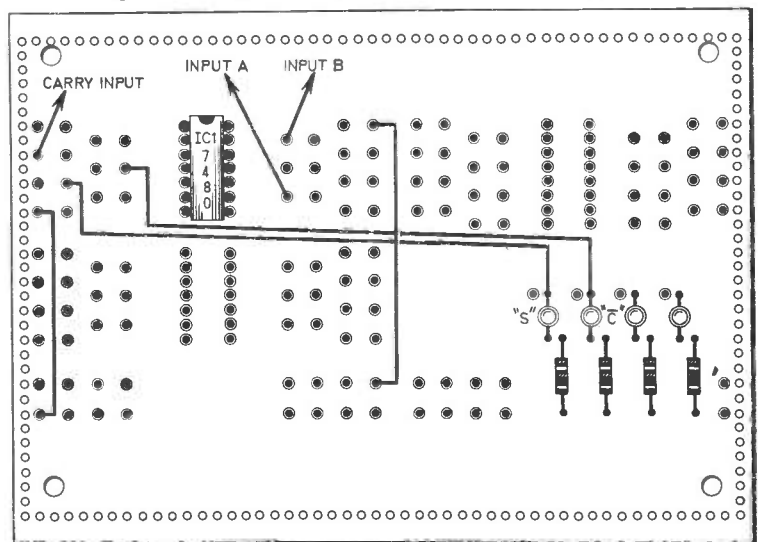
Fig. 6.3. Pin and basic internal details of the 7480. C_n is the carry input and C_{n+1} the inverted carry output.

TAPE READER

The method to be described is often used for feeding data into computers—a tape reader.

The numbers to be added are punched onto paper tape and this is read by the tape reader which

Fig. 6.4. Wiring of the 7480 i.c. on the experimental board.



passes the numbers on to the adder.

The tape reader can be made from 0.1in or 0.15in matrix strip-board. Constructional details are shown in Fig. 6.5.

First solder a piece of paper clip to the board so that it is just wider than the width of the paper tape to be used. Next bend three paper clips as shown and solder them to the board. Press the ends of the clips down onto the cross wire whilst soldering.

These clips act as the hole detectors and also as paper tape guides. Two pins can be soldered about two inches from the clips so that the tape runs through straight.

As well as the tape reader proper, a switch is needed and this is constructed from a paper clip and a drawing pin. First the drawing pin is soldered to the board and its point cut off. The paper clip is then bent as shown and soldered to the board so that it lies just above the drawing pin head. When pressed it should make contact but should spring away when released.

The tape has three rows of holes: the top row represents a "clock" input which feeds an input to a clock circuit as the tape is pulled through the reader. This allows the tape to be pulled through at any speed and lets you stop as long as necessary at each step.

Between the clock holes are the two rows of number holes: the upper number representing A and the lower number B. Where a hole is punched there is a 0 and where there is not one is a 1.

A paper punch is used to punch the holes in the paper. The length of tape will depend on the length of the numbers to be added. Fig. 6.6 shows the tape punched for "23+13".

FULL ADDER WITH CARRY STORE

The circuit to which the tape reader is connected is shown in Fig. 6.7a and the layout on the experimental board in Fig. 6.7b. As the tape is pulled through the reader, the adder will add each pair of digits in turn, any carry which is generated being stored in the 7473 flip-flop for use at the next addition.

The sequence of operations is as follows.

(1) Push the tape into the

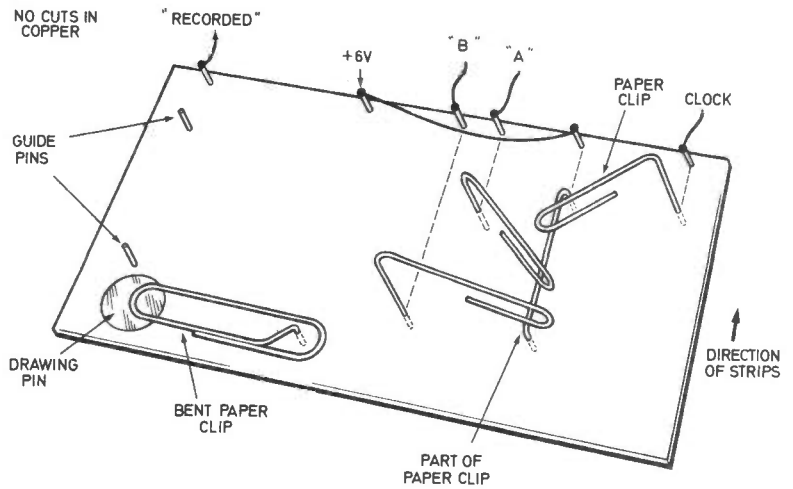


Fig. 6.5. Construction of a simple tape reader using paper clips and a piece of stripboard.

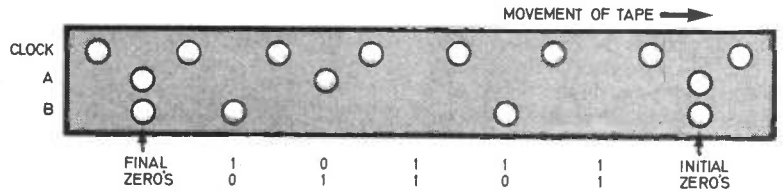


Fig. 6.6. A paper tape punched to carry out the addition of 13 and 23.

reader as far as the first pair of holes and press the "recorded" switch. This will clear the carry store flip-flop. Now move the tape past the first clock hole to the first holes of the number A and B.

(2) Record the state of the lamp (1 for on, 0 for off).

(3) Press the "recorded" switch. If the lamp changes state ignore it.

(4) Move the tape on past the next clock hole to the next number holes (or if there are no holes where the holes could be).

(5) Repeat stages (2) and (3) until the end of the tape is reached.

(6) At the end of the tape is another pair of holes. Stop at these in case there is any digit carried over from the previous stage. Record it.

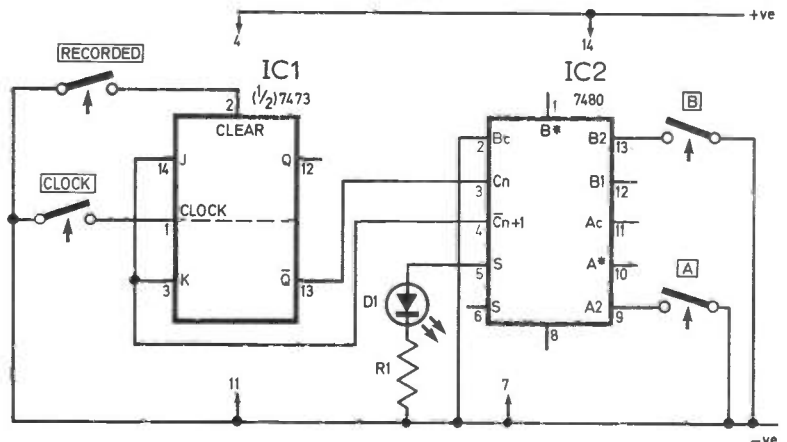
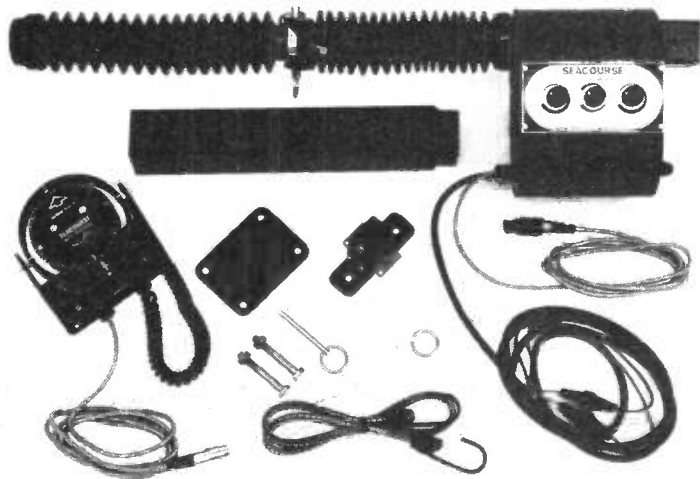


Fig. 6.7a. Circuit diagram of the adder and flip-flop connected to form a full adder with carry store. The switches shown are those on the tape reader.



BOAT SHOW '77

Even for those with no interest in boats or sailing a look at the electronics used on board small boats can be an interesting eye opener to another of the many applications of our fascinating hobby. With this in mind we went along to the annual boat show at Earls Court and found an almost bewildering variety of equipments—some of which are detailed below.



Component parts of the Seacourse Autopilot.

The neat and compact Nautech Autohelm Mk II.

THE opening words of Jack Knight's press release on the boat show are "In sailing the accent is on performance" and this statement seems to be proved simply by the ever increasing range of electronic equipment for boats, large and small. Many of the items are aimed at getting the best performance from any boat and—if the available range is anything to go by—the average owner must be spending a fair amount on such accessories.

Autopilots

One of the largest growth areas is perhaps in the small boat autopilot and the last few years has seen the introduction and refinement of many systems. There are four of particular interest to the small boat sailor and these are all designed for both wind vane or compass steering and supply from 12V battery.

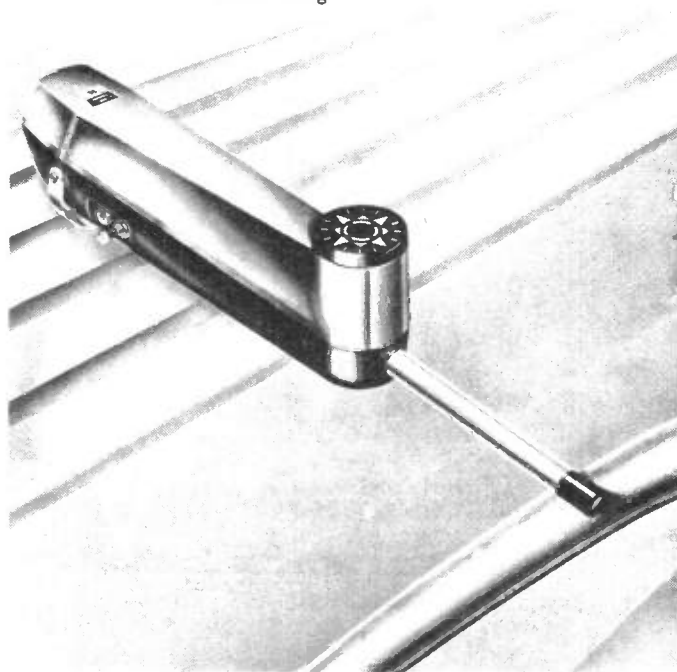
Of these the Nautech Autohelm is outstanding because it is the only unit to employ a feedback system to adjust the amount of helm applied—of the others one relies on a preset yaw control which allows the boat to deviate from the set course by the preset amount before applying correcting helm (the Mariner TS2) and the

other two (the Sharp Mate and the Electronic Laboratories Seacourse) have a yaw control in addition to a rudder or tiller control which presets the amount of helm applied.

Prices for the above systems for both compass and wind vane are approximately: Nautech Autohelm Mk II £160, Electronic Laboratories Seacourse £179, Mariner TS2 £248, Sharp Tiller Mate £335, all exclusive of V.A.T. We must however point out that both the compass sensor and wind vane of the Mariner TS2 are part of their M6 system and can be used both for the autopilot and for meter indication of deviation from set course and wind speed and direction by the addition of meter units.

Let us not mislead you and give the impression that these were the only systems available, however most of the others are intended for larger craft and for compass course only.

Of particular note are the Cetrek 701 series with the option of a fully automatic course following system, the very compact Benmar Course Setter 21 with automatic variable rudder rate and simple two control operation. A fully automatic—push button—variable rudder rate system from Solent Autopilots, which has been recently introduced, and—also recently announced—the Decca Pilot 150 designed to fill the gap at the small boat end of the existing Decca range.





The Programmable Direction Finder shown with the wind speed and direction transducers.

New Ideas

There were of course many other new products—some of which we will mention later—but two which are particularly interesting. The first and perhaps the most interesting and useful item yet seen at any show is the Programmable Direction Finding receiver (P.D.F.) from Mariner. The receiver uses a servo controlled screened ferrite rod, mast mounted, aerial linked to a receiver with five pretuned beacon frequencies and a sixth user-variable frequency channel. The receiver contains a quartz clock which scans the bands, selecting each pre-set beacon at its transmitting time.

The aerial can then be remotely rotated with a single knob until a meter null is obtained and the bearing of the ship's heading recorded. The beacon number being received is digitally displayed and, on good signals, is pulsed with its morse identification code.

The very comprehensive layout of the Solent Autopilots system.



Once programmed the unit can be operated solely from a cockpit mounted dial which shows the digital beacon identification, null meter and aerial rotator/bearing.

This company also produce an interesting range of instruments for yachts—some with inset digital readout of second parameters on each meter scale. The Mariner 5 range will appeal to the cruising man and this range provides information on two, three, four or five parameters on one combination meter—the "ultimate" giving water speed, log, depth, wind speed and 360 degree wind direction on a single 150mm dial. The complete system costs about £300.

The second particularly interesting new item is a Variable Alarm Window depth sounder from Space Age Electronics. This is an I.e.d. rotating type depth sounder with an alarm that can be set to trigger over part or all the depth range.



Variable Alarm Window depth sounder.

The alarm window is shown by a red arc over the alarm section required and is set by two knobs—one for start of arc or window and the other for the finish. Price is about £60 including VAT and depth and alarm repeaters are available.

New Products

Other new products include a rather highly priced I.e.d. depthsounder



Seascribe II depth sounder with I.e.d. and chart readout.

from Brookes and Gatehouse also a digital readout tuner unit for the Homer receiver from the same firm. A Seascribe II depthsounder with I.e.d. and chart recorder and a Muti Seavoice 61 channel v.h.f. radio telephone with dual listening watch facility, both from Electronic Laboratories.

A range of items from Rutherford Electronics including intruder and gas alarms, radar detector and anchor alarm. What could be termed a "standard range" of yacht instruments from Tekflo Marine—the Aquatronic range.

It is interesting to see some very expensive desk calculators coming into being with various navigational capabilities—one astronavigation calculator for use with sextant and quartz clock was displayed in prototype form by Rigel who hope to market it during '77 for about £400.

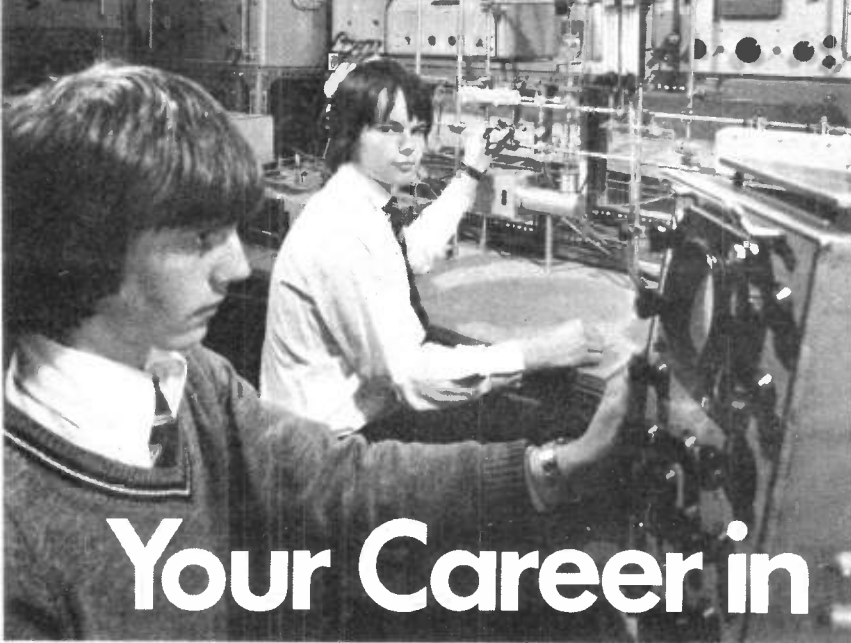
Land Applications

For those who do not aspire to boat owning, or dreaming, one item which could be of interest to caravanners and others is the Selectmarine wind-driven electric generator, "Aero-charge 3", which can supply up to 0.4A into a 12V battery in a 25 m.p.h. or more wind. The unit will start to charge at 10 m.p.h. wind speed and is designed to withstand a force 8 gale.

The blades are only 430mm in diameter and the unit is designed to be taken down easily when not in use. Price is about £50 plus V.A.T. and 12 or 24V versions are available. The company also produce a higher output system for around £250.

Multi Seavoice dual watch radio telephone.





Two of the team of young scientists from King Edward VI Grammar School, Guildford, who were finalists in the BBC Young Scientists of the Year contest. Among the equipment they used for their research study on ozone breakdown by aerosols was an 18-year old EMI photomultiplier tube.

Your Career in Electronics

by Peter Verwig

THE WIDE WORLD OF EMI

MUM's having an evening out at Bingo. Dad's at home watching the telly. The kids are all doing their own things. Jill's gone to the cinema, her younger sister Kate is flexing her muscles at tenpin bowling. Bill's having a night in the local, Jimmy has taken his girl for a night out at Talk of the Town.

Young Jenny's up in her bedroom quietly playing over her new LP. Reg is in the army in Germany, relaxing after a hard day of field exercises. He's one of the crew of a mobile mortar-locating radar. All except Reg, who can't get leave, are looking

forward to next week when Uncle Roger and Auntie Flo arrive from Australia where, by hard work and a little luck, they struck rich since going there just after the war and this is their first holiday back in the old country.

They've booked for a month at the Selfridge Hotel to be in the centre of London life and that's where the family re-union party will be. Years ago Roger and Flo spent their honeymoon in Blackpool. They plan a nostalgic return there to the Tower and the Winter Garden.

Although the thought wouldn't cross their minds they are all customers of EMI. We might invent a few more situations. Uncle

Harry who has a jewellery shop and would have lost a lot of stock last week but for a very good burglar alarm he recently had installed. Poor old Grandpa who was rushed off to hospital for a check-up, and how relieved everyone was when, after a run through on a new X-ray scanner, they found nothing serious.

Jimmy, the ambitious one of the family, is sure he's going to make it and when he does he'll keep his cabin cruiser at the new Brighton Marina. Bill likes his pint at the local, as we have seen, but likes to keep fit so he also fits in a hard game of squash. This is all good business for EMI.

MULTINATIONAL

EMI is a great British multinational company employing 50,000 people in more than 30 countries. By merger, acquisition of other companies and vigorous internal development it has also become a conglomerate, an organisation with not one but many business interests and of great variety. There are, however, two easily identifiable main streams of activity. One is the exploitation of electronics technology, the other is in the provision of leisure products and services.

Let's dispose of the leisure activities first. Mum was at one of the company's 150 bingo clubs. Dad was watching a TV film made by EMI Elstree Studios through

Data modems under evaluation in SE Labs research department. EMI has a £2 million contract for modems.



Checking out EMI-Scanners for export.



Thames TV in which EMI is a major shareholder with Redifusion. Jill was at one of EMI's 200 cinemas. Kate was at an EMI tenpin bowling alley. Talk of the Town, where Jimmy took his girl friend, is one of a whole chain of EMI restaurants operating under different names of which Angus Steak House is an example.

Bill was having his pint in one of EMI's pubs while Jenny was playing her EMI LP record. Uncle Roger and Auntie Flo might have stayed at other EMI top hotels in London (or in Birmingham, Glasgow and Edinburgh). The Blackpool Tower Company belongs to EMI, so does the Squash Club where Bill keeps fit. EMI has interests in the Brighton Marina where ambitious Jimmy hopes to keep his boat.

On the more serious side, Uncle Harry's shop was protected by an AFA-Minerva (EMI) Ltd automatic alarm, Grandpa was relieved of his anxieties by the revolutionary EMI-Scanner, and Reg's mortar-locating radar was designed and built by the Systems and Weapons Division of EMI Electronics.

FINANCES

EMI's financial year ends on June 30 and the 1975/76 returns to this date show none of the sickness experienced by many other great enterprises. Sales world wide were up 33 per cent at £671.44 million, and pre-tax profit up 70 per cent at £65 million. The total business can be divided into four activity groups, Music, Leisure, Television and Electronics.

The sales of each group were Music £344.74 million, Leisure £81.43 million, Television £38.22 million and Electronics £207.05 million. Although electronics, the sector in which we are primarily interested, represents only 31 per cent of the total EMI turnover, the profit contribution was 40 per cent of the profit total.

We can see at once that EMI is soundly based and that chairman Sir John Read, who took over from Sir Joseph Lockwood in November 1974, is continuing to build the company on the solid foundation established by his predecessor. In this he is ably assisted by Dr. John A. Powell, managing director, who first sprang into prominence in the

electronics industry in the UK as managing director of Texas Instruments.

The initials EMI used to mean Electric and Musical Industries but with the passage of years and diversification of interests the old and cumbersome name became meaningless. The same thing happened with the Radio Corporation of America who now is just known as RCA.

HISTORY

EMI came into being through business deals with elements of RCA and the Marconiphone Company in the late 20s and early 30s. In those days the leading gramophone companies were The

name Marconiphone on its products and the signature G. Marconi which was subject to copyright. In fact the pioneer of radio himself, Guglielmo Marconi, was EMI's first president. EMI also now had access to both Marconi and RCA receiver patents and, in the transfer of resources, a number of Marconi engineers now became EMI engineers.

TELEVISION

I have often mentioned in this series that a company is as good and only as good as the people in it. The young EMI company was fortunate that one of the new arrivals was Isaac Shoenberg who



Giant 700ft high oil production platform for Burmah Oil's Thistle 'A' field under construction. It was successfully placed in position with the aid of over £1 million worth of remote control and telemetry equipment of EMI design.

Gramophone Company Ltd. (famous for "His Master's Voice" labels) and the Columbia Gramophone Company.

The Gramophone Company was then a subsidiary of the Radio Corporation of America. David Sarnoff of RCA first acquired the domestic radio receiver business of The Marconi Company and then of Columbia and the new business, now much larger, was re-named Electric and Musical Industries.

The injection of the Marconi domestic receiver interests gave EMI its first move forward into electronics. The newly formed company was able to use the

had been a director of Marconiphone and headed up its patent department. He now became EMI's first research director and was to lead the team which developed the video equipment for the Marconi-EMI high-definition TV system adopted in 1936.

It must here be emphasised that the rest of the Marconi business carried on separately, and so did RCA. There was never a financial link between EMI and Marconi then, although they did co-operate on research from time to time and enjoyed cross-licensing of some patents. The trade names of Marconiphone and Columbia were transferred to



An EMI logic probe of the type supplied to the Royal Navy for checking out ship-borne data processing equipment.

other manufacturers from EMI in the post-war years when EMI decided to discontinue domestic radio receiver production.

T.V. DEVELOPMENT

There was, however, a marriage of convenience through the formation of a joint company, the Marconi-EMI Television Company, in the early 30s. The reason for this was that Marconi had all the experience in radio transmission and, in fact, had already developed a v.h.f. transmitter thought to be suitable for the transmission of television. On the other hand, EMI had business links with RCA in America including some access to the work of Vladimir Zworykin, who had fled the Russian revolution and was now working on electronic scanning systems.

EMI engineers led by Isaac Shoenberg developed the first Emitron TV camera tube and the video circuits which were then latched on to a Marconi transmitter and antenna. The television service was abandoned throughout the war years and so Marconi-EMI Television Company became an idle concern.

After the war both companies had expertise in both fields and after the installation of the BBC's transmitter at Sutton Coldfield, supplied through the alliance, Marconi-EMI Television Company was finally dissolved in 1948. It had served a useful pur-

pose but henceforth the two companies were to be in competition with each other.

During the war EMI was able to exploit its TV expertise in other equipments, especially radar, and one of the notable wartime developments from Shoenberg and his boffins was one of the first attempts at miniaturisation seen first in airborne radar and then the first ever proximity fuze for anti-aircraft shells. Thus, by the end of the war, EMI had become a fully fledged electronics company already noted for technical innovation.

TODAY

And so to the present day, when EMI engineers still tread the same pathways at Hayes as the pioneers such as Shoenberg and Blumlein trod 40 years ago. Blumlein was one of the early workers on radar. He was responsible for developing the modulator for the airborne interception radar AI Mark IV fitted in British night fighters.

He also played a key role in developing the ground-plotting H2S airborne radar system which was a war-winner. The prototype was fitted in a Halifax bomber used as a flying testbed and this machine crashed in South Wales during trials on June 7, 1942, killing Blumlein and four other scientists. A great loss to the nation as well as to EMI.

Today the EMI Central Research Laboratory at Hayes is a



An EMI-Scanner in hospital use.



EMI colour TV camera and monitor as used in many TV studios.

powerful 250-strong unit serving the basic research needs of EMI operating divisions in the UK and overseas. Out at the divisions there are strong specialist teams working on product development as well as hundreds of qualified engineers and technicians working on production, testing, installation and maintenance.

Best known man in EMI research today is Godfrey Hounsfield who invented the EMI-Scanner computerised axial tomography X-ray machine. This development has been recognised world-wide as the biggest medical diagnostic breakthrough since the discovery of X-rays by Rontgen in 1895. Hounsfield has been the recipient of honours from all over the world, and his Scanner has already generated £130 million worth of profitable business for EMI.

PRINCIPAL COMPANY

The principal electronics company in EMI is EMI Electronics Ltd based at Hayes. This company, 1,500 strong, is largely engaged in military and industrial electronics. Among its products are radar systems, radar and infra-red proximity fuzes, ultrasonic and electro-optic equipment, telemetry systems, digital processing systems, underwater technology, and electrically controlled mechanical handling systems.

Also at Hayes is EMI Electronic Tube Division with 500 people and large elements of EMI Sound & Vision Ltd which, in total,

employs some 1,400 people. The fastest growing company is EMI Medical Ltd formed to expand and promote medical electronics spearheaded by the EMI-Scanner. The company has already close on 1,000 people at Radlett and Hayes and is also responsible for the activities of SE Labs (EMI) Ltd with 850 people spread over plants at Feltham, Wells and Frimley; SE Labs being an instrument manufacturer whose products are largely complementary to the medical business.

EMI Medical also controls Pantak (EMI) Ltd at Windsor with some 200 people engaged on X-ray equipment, not only for medical diagnosis but also for non-destructive testing in industry and check-in baggage inspection at airports.

USA

Because of brisk medical business in the USA, EMI has already established an American sister company of some 300 people near Chicago and is rapidly expanding the North American bridgehead including the acquisition last February of SHM Nuclear in Sunnyvale, California. At home, last October saw EMI increasing its stake in Nuclear Enterprises Ltd from 28.8 per cent to 90 per cent.

Even during the recent period of trade recession, EMI has made a good showing in all its electronics activities and spectacular growth in medical electronics. An example of the medical electronics punch packed by EMI is that last September Japan ordered another £8 million worth of Scanners.

Looking at the Broadcast Equipment Division we saw at the recent 1976 International Broadcasting Convention a glimpse of EMI's strength, further fortified by Prowest Electronics Ltd, now in the Group. In broadcasting EMI can now supply almost everything from TV cameras to transmitters and antennas. Among recent orders was a further £0.5 million contract with Dubai Broadcasting Service bringing EMI equipment value there to £1 million. Antenna systems are surprisingly big business. The installation supplied for the CN Tower in Toronto, which is the tallest structure in the world, cost over £1.25 million.

Everyday Electronics, March 1977

MILITARY EQUIPMENT

In military equipment EMI's two major projects are the Cymbeline mortar locating radar, a smaller and lighter version of Green Archer, also developed by EMI and which went into British Army service in 1962, and the Searchwater radar. Cymbeline, the replacement for Green Archer, is in full production for the British and overseas armies. Searchwater is the latest British airborne radar for installation in maritime reconnaissance aircraft such as the Nimrod.

Performance details are classified information but it is known that a computer is used in the signal processing enabling small objects such as tips of periscopes or "snorts" to be detected at longer range and in higher sea states than hitherto.

OTHER ACTIVITIES

Two other activities with a strong electronic flavour not so far mentioned are the Telecommunications Division based on Treorchy, South Wales, and AFA-Minerva (EMI) Ltd with an HQ at Twickenham and 22 branch offices throughout the country. Telecommunications has a strong section on cable-television with major markets in the UK and Europe.

AFA-Minerva is probably the UK's largest specialist company in the field of fire and crime prevention with 2,500 people employed. Thirteen of its branch offices have central monitoring and control stations connected to

thousands of premises throughout the country. Each of the premises is scanned electronically for alarm state every few seconds. The latest project is MAINLINE described as an advanced automatic alarm communications system.

APPRENTICESHIP

EMI, like all large organisations has well-defined apprenticeship and graduate recruitment schemes and follow-up schemes for further career development once you are in one or other of the companies. Entry qualifications are broadly in line with those that have been so often outlined in this series. In engineering branches you will need English, Maths and Physics or Science subjects at any level of entry.

Apprenticeship schemes can vary depending on plant location and type of business. Initial enquiries can be directed to the Personnel Department, EMI Ltd., 135, Blyth Road, Hayes Middlesex.

The Group as a whole has had a continuous sales growth since 1967. Then, sales were barely £100 million. Today they are £670 million. They have doubled in the past three years. So if you are looking for a career in a growth situation EMI looks hard to beat, even though much of the growth is outside the field of electronics. But the electronics business of over £200 million a year is still very substantial by British standards, is well diversified in products and services and capable of much further development. ☐

PLEASE TAKE NOTE

INSTANT INFO. for CONSTRUCTORS

We have noticed an error on the chart given free with this issue, but unfortunately it was too late to amend it. It is with reference to transistors BD131 to BD140 inclusive concerning the base drawing 7. The metal mounting surface should be indicated on the upper face of the transistor body and not as shown. The base reference shown is correct for transistors TIP29 to TIP42 inclusive.



Tumble Dryer ALARM

By A. J. Bassett

THIS device has been designed as a more simple, cheap, battery powered alternative to the controller published recently. It gives an audible warning when the humidity of the air at the outlet of a tumbler-drier falls below a chosen level, indicating that the clothes are becoming dry enough. This can save time on washday, and most important, help to conserve electrical energy and cut electricity costs.

Being battery-operated and

portable, the unit can be used as an humidity-sniffer for other purposes. It involves no mains wiring, making an ideal beginners' project.

PRINCIPLES OF OPERATION

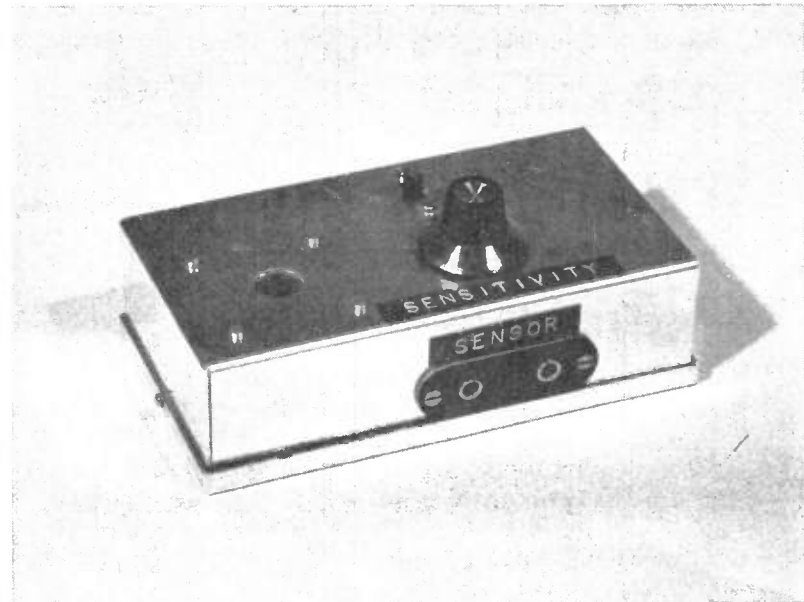
The unit senses the humidity of the air by measuring the electrical resistance of a thin layer of salt solution which is in contact with the air. Because the layer is thin, its concentration

quickly comes to equilibrium, through evaporation or absorption of water-vapour into the solution, and the circuit responds noticeably, within seconds, to changes in humidity.

To measure the resistance of salt solution, which is an electrolyte, an a.c. measuring current must be used and this is generated in this circuit by a transistor oscillator.

CIRCUIT

If a direct current were used to measure the resistance of the electrolyte, problems would arise due to polarisation at the electrodes. The electrolyte is therefore isolated from direct current by means of capacitors C2 and



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£3.20
excluding case

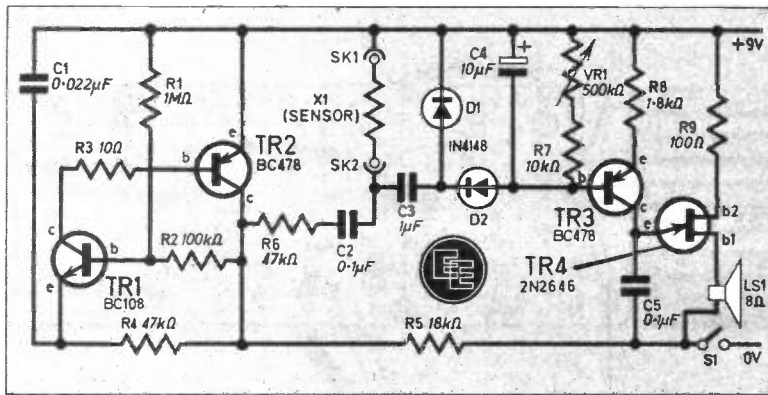


Fig. 1. Circuit diagram of the Tumble Dryer Alarm.

C3 (Fig. 1) so that only the a.c. measuring current flows through it.

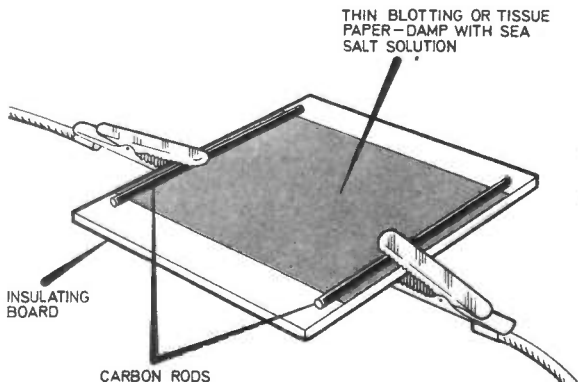
The resulting alternating voltage across the electrolyte is detected (rectified) by diodes D1, D2 and the d.c. output stored by capacitor C4. When the voltage across C4 reaches about $\frac{1}{2}$ a volt, TR3 begins to conduct, and this activates the oscillator circuit of TR4.

A buzz will then be heard from the speaker, and as the electrolyte dries out and its resistance rises, the pitch will rise like a warning siren. When this happens, the tumble dryer may be switched off.

CONSTRUCTING THE SENSOR

It is remarkably easy to construct an *electrolytic variable resistor* which responds in seconds to changes in the humidity of the surrounding air (this can be demonstrated by breathing over it), and use it as an humidity sensor.

Fig. 2. Construction of a simple sensor.



The sensor consists basically of a piece of thin blotting-paper or tissue paper soaked in salt solution. As the salt absorbs moisture from the air, the resistance decreases, and as it dries out the resistance rises.

Lay a piece of suitable paper onto an insulating paxolin or plastic board about 2 or 3 cm square. Clamp it in place by means of two lengths of carbon rod and two crocodile clips with wires attached, as shown in Fig. 2. Do not let the crocodile clips touch the paper, as the salt solution would then cause corrosion.

Current is carried between the salt solution on the paper, and the crocodile clips, by means of the carbon rods, as carbon, although it is not a metal, is able to conduct electricity.

Suitable rods may be obtained from HP7 or U10 batteries, or by using thick soft pencil leads.

The paper should be damped using a few drops of clean seawater, or else a 3 to 5 per cent solution of sea salt in distilled water or rainwater. Ordinary table-salt, rock-salt or cooking salt should not be used, as there are chemical differences and additives, such as magnesium carbonate to prevent absorption of water-vapour. Suitable sea-salt can be, however, easily bought from health-food shops, and aquarium and tropical-fish suppliers.

BOARD CONSTRUCTION

Solder the components into place as shown in Fig. 3, on a piece of 0.1 inch Veroboard 62 x 27 mm, making cuts in the copper tracks at the points shown. The board may be mounted, using 8BA nuts and bolts with insulating spacers (short lengths of plastic tube) in an aluminium box approximately 135 x 75 x 40 mm (Type AB7) as shown, together with loudspeaker, level control VR1, on/off switch, battery and a socket for the sensor.

An ordinary small loudspeaker about 50mm diameter may be used, and any impedance from 8 ohms up to 80 ohms will work, but the author found that an even louder sound was obtained by using an ex-government telephone insert type IT-BA5.

Components

Resistors

R1	1M Ω	R6	47k Ω
R2	100k Ω	R7	10k Ω
R3	10 Ω	R8	1.8k Ω
R4	47k Ω	R9	100 Ω
R5	18k Ω		All $\frac{1}{4}$ W \pm 10% carbon

Capacitors

C1	0.022 μ F
C2	0.1 μ F
C3	1 μ F tantalum 12V
C4	10 μ F elect. 12V
C5	0.1 μ F

Semiconductors

D1, D2	IN4148 diodes (2 off)
TR1	BC108 silicon npn
TR2, TR3	BC478 silicon pnp
X1	sensor—see text

Miscellaneous

VR1	500k Ω carbon lin.
SK1, SK2	single pole sockets and plugs to suit (2 off each)
LS1	8 to 80 ohm miniature loudspeaker (see text)
S1	s.p.s.t. slide or toggle switch
	Veroboard 62 x 27mm, 0.1 inch matrix; knob; case; connecting wire

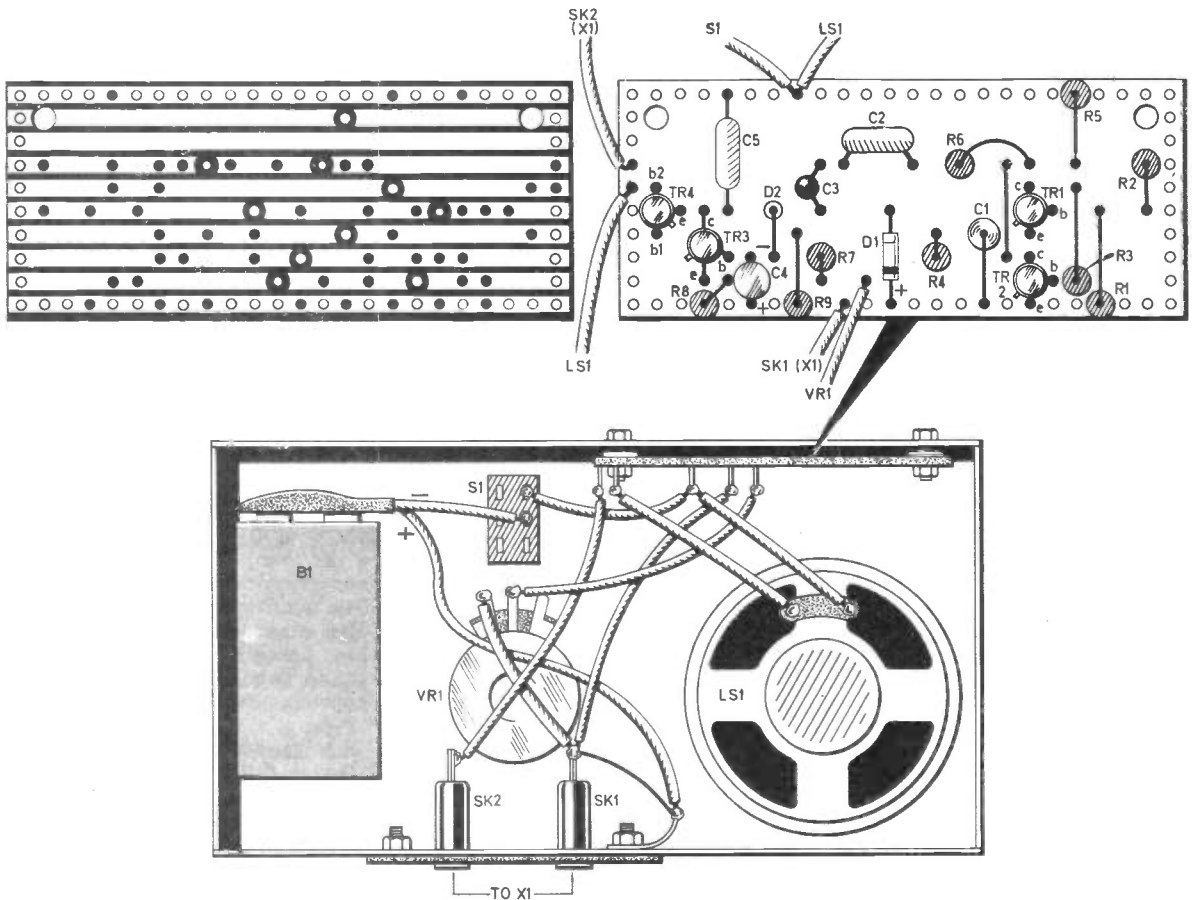


Fig. 3. Layout and wiring of the Tumble Dryer Alarm.

TESTING AND USING

Switch on the unit with no sensor connected. When VR1 is adjusted to high resistance, a rising pitch, like a warning siren, will be produced from the loud-speaker. As the resistance of VR1 is decreased, the pitch falls to a low buzz, and at the lowest setting of VR1 may become silent.

Connect the sensor, and adjust VR1 so that when the sensor is damp the unit is silent, and when the sensor is dry the alarm sounds.

To make the sensitivity of the sensor suitable for your machine, it may be necessary to damp it several times with the salt solution, drying out each time.

EXPERIMENT

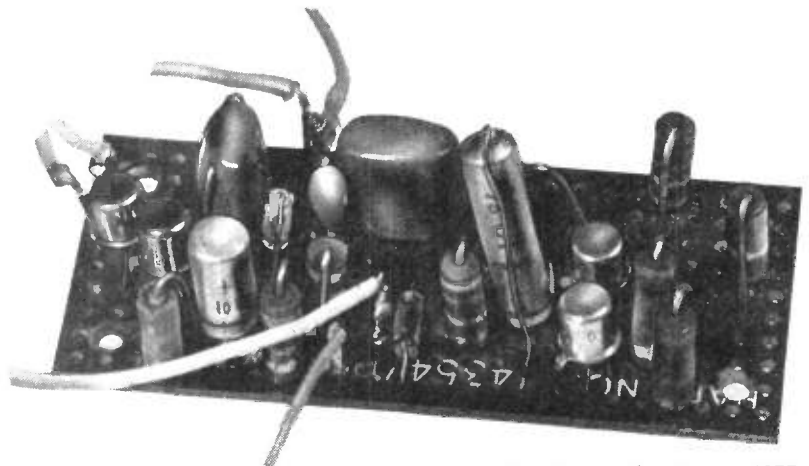
Try making up several different sensors using alternative electrolytes. Experiment by adding a small quantity of glycerine to the salt solution. Even less than 1/2 per cent of glycerine has a noticeable effect!

Try connecting the sensor

terminals to the top layer of soil in a plantpot. When the plant needs water, the alarm will sound.

Of course it is not essential that an electrolyte variable resistor should be used with the circuit. A light dependent resistor type ORP 12 may be used, so that when the lights are switched out the unit produces a wail.

If a thermistor type CZ4 or similar is connected to the sensor terminals, placed near a heater and a few minutes allowed for it to warm up, it will give a warning when the heater cools down. By adjusting VR1, the alarm will commence to 'tick' at a chosen temperature, giving a low temperature alarm. □



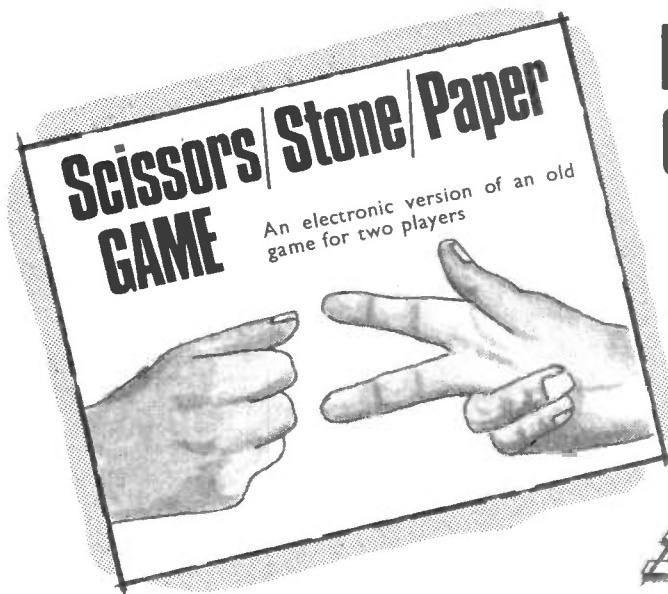
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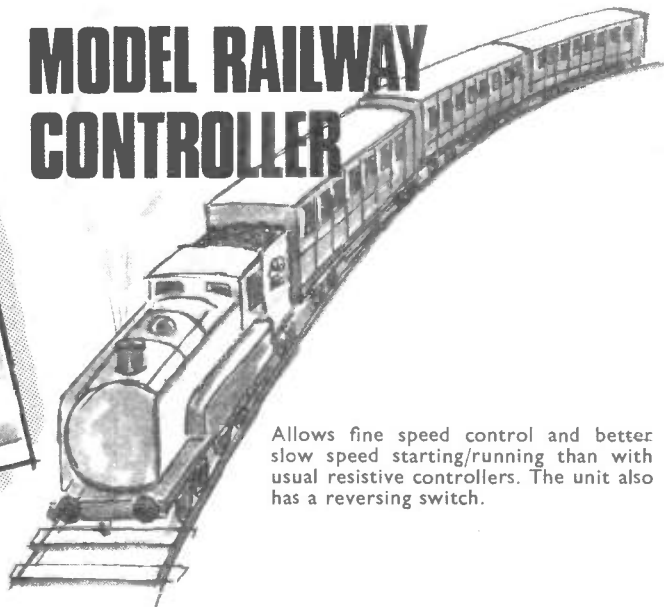
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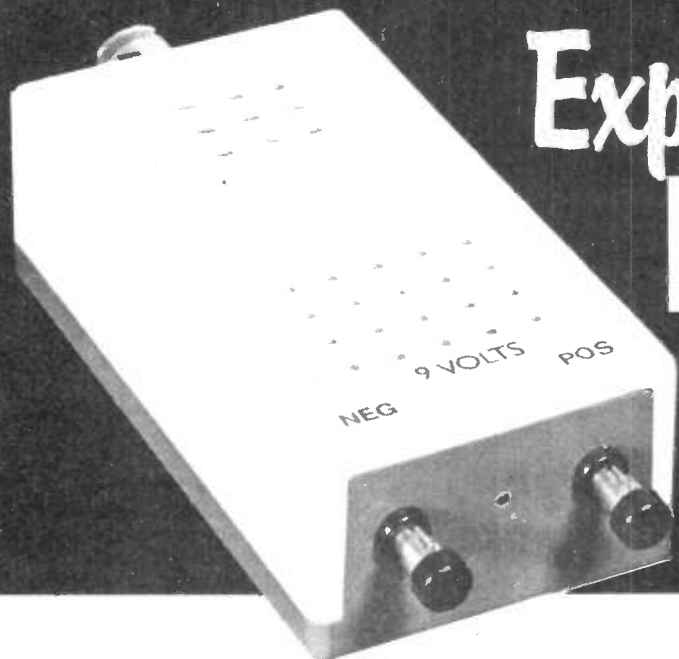
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Experimenters' POWER UNIT

By A. P. Stephenson



THE modern mains operated d.c. power supply can be a very sophisticated animal with built in safeguards against short-circuit output, temperature rises, noise spikes on the mains input and so on.

Nevertheless, there is often a need for a simple version such as the model described here. It delivers a reasonably steady output of 9 volts d.c. in spite of variations of load current between zero and a hundred milliamps (nominal) and the inevitable variations in the so-called 240 volt mains. Currents in excess of 100mA can be drawn but the Zener stabilising action will cease, causing the output voltage to fall with increasing current.

Although no protection circuitry is included, the values of components are such that temporary short circuits across the

output cause no damage or dangerous temperature rises. (In fact the output can be permanently shorted although this is not recommended).

Because this project is primarily for students of *Teach-In 76*, the design has been influenced by the available components in the original kit. For new readers however, the components can be varied: there is no need, for example, to stick rigidly to the Freidland bell transformer because any small mains version with a nominal 8 or 9V output at 500mA or more would be suitable.

DESIGN THEORY

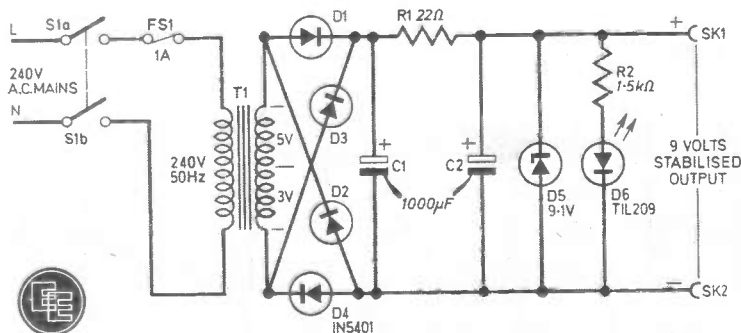
The line and neutral from the mains plug is applied, via the double pole mains switch S1 and

fuse FS1, to the 240 volt primary winding of the transformer (Fig. 1).

The secondary 8 volt output is rectified by the four-diode bridge and appears across the reservoir capacitor C1. Although the secondary is rated 8 volts, the reservoir raises this to peak value, i.e. $8 \times 1.41 = 11.28$ volts. The voltage however will be subject to a 100 Hz ripple (because of the full wave frequency doubling action). To reduce this, a low pass filter (R1,C2) is included. Using $X_c = 1/2\pi fC$ arithmetic wizards will conclude that C2 behaves as a 1.59 ohm shunt across the line which, in conjunction with the series 22 ohm resistor, will reduce the ripple by approximately 14:1.

Because the voltage across C1 is higher than 9.1 volts the Zener

Fig. 1. Circuit diagram of the Experimenters Power Unit.



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£5.00 excluding case

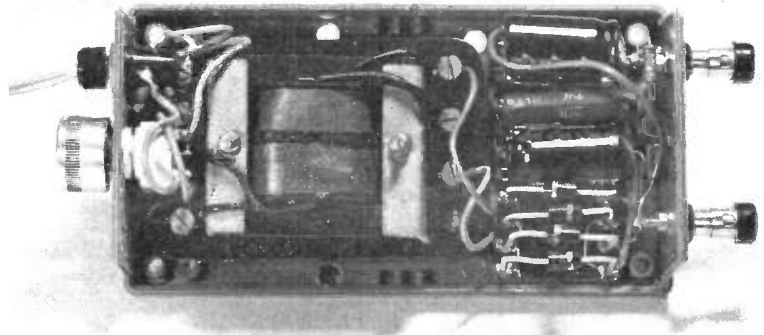
will pass current, maintaining almost a constant 9 volts nominal across the output terminals—providing we don't try to draw too much current from the output.

It is easy to find what is the maximum current by remembering that R1 must not drop the voltage from 11.28 to less than 9.1 volts, i.e. *no more than 2.18 volts!* So $I_{max} = 2.18/22 = 100mA$ approx.

These calculations of course are rough because the mains might not be exactly 240V, so we cannot predict to any great accuracy that C1 will have exactly 11.28 volts across it. This means that, depending on where you live and how many electric cookers are switched on in your street, some constructors will have to be content with perhaps 90mA and others will be luckier with perhaps 110mA or more.

The l.e.d. warning light is not essential but is useful to indicate on/off conditions. The 1.5 kilohm series resistor R2 limits the lamp current to 6mA. Finally, what happens if we short-circuit the output terminals? (This can happen quite often during an orgy of experimenting). All that happens is the volts across C1 are now in parallel with R1 so the nominal current is 11.28 volts/22 ohms = 0.5 amp.

The power dissipated in R1 is $0.5 \text{ amps} \times 11.28 \text{ volts} = 5.64 \text{ watts}$ which is within the power rating of R1 (7 watts rating). We must remember however to drill some strategically positioned air-holes in the case to allow the heat to escape.



CONSTRUCTION

The power unit can be squeezed into a Verobox Type 102 but components can vary in size, depending on the source. The external dimensions of this case are 80mm wide, 150mm deep and 50mm high so it would be advisable to check transformer size before ordering. A home made case is an attractive alternative if money is at a premium!

The components are mounted on a tag board and to increase heat escape, the connecting wires of the diodes, Zener and R1 should be left at their original length. The leads can be neatly bent at right angles. Construction is shown in Fig. 2.

In the interests of safety, the fuse, main switch and power leads are placed at the rear. It may appear unusual for an on/off switch to be at the back but it is wise to keep 50Hz mains wiring well away from the output. The

switch shown is two pole rotary type simply because this type is more slender than the conventional toggle and could just be squeezed into the prototype version. If room is available, any switch will do providing it is two pole and is rated at 240 volts.

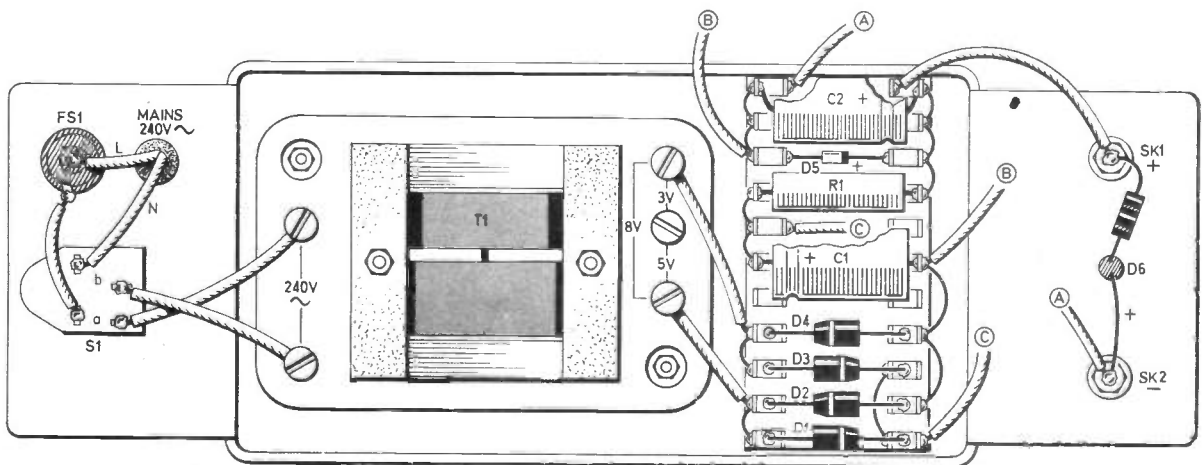
On no account use a single pole switch in the live side only because your electrical domestic wiring can never be guaranteed the right way round. The fuse can be a small panel mounting or a chassis mounting clip type but the latter **must not be mounted externally**.

Drill a series of holes underneath the case and fix four rubber feet or grommets to allow air to enter. Likewise drill a pattern of holes on the top of the case over the tagboard.

TESTING

Check the wiring, particularly

Fig. 2. Layout and wiring of the Experimenters Power Unit. If a metal case is used this must be connected to mains earth.



the polarity of the four diodes and the Zener. Insert the fuse, plug in and switch on. Check the voltage at the output which of course should be a nominal 9.1 volts. Leave the voltmeter connected and leave the unit switched on for at least ten minutes. You will find the output will rise a fraction because the Zener has a small positive temperature coefficient. The voltage should however remain constant at perhaps 9.2 or 9.3 volts.

Now connect a 100 ohm resistor across the output to load it to about 90mA. The output should not drop to less than 9 volts. Finally short circuit the output terminals with a screwdriver for a few seconds. The fuse should not blow and the 9 volts should reappear after the short is removed. ✧

Components

See
**Shop
Talk**

page 144

Resistors

- R1 22Ω 7W wirewound
- R2 1.5kΩ ¼W carbon ±10%

Capacitors

- C1 1000µF elect. 25V
- C2 1000µF elect. 25V

Semi conductors

- D1-D4 IN5401 (Teach In parts), IN4001 or similar diodes (4 off)
- D5 9.1V 1.3W Zener diode
- D6 TIL209 or similar I.e.d.

Miscellaneous

- S1 d.p.s.t. rotary or toggle mains switch
- FS1 1A miniature fuse and panel mounting screw holder
- T1 Mains to 8 or 9V at 500mA transformer.
- SK1, SK2 Single spring loaded terminals (2 off)
Tag strip—double type with 11 positions; knob for S1 if required; connecting wire; mains lead and plug; case—see text.

Toggle switches: s.p.d.t. 19p 49p
Speakers 180 x 100mm 1.20p 2.52p

I have of course altered the prices to decimals, and I have shown along side, the approximate current prices. This shows an average increase of 210 per cent (the variable capacitors increase it quite a lot) over 15 years. I wonder what else has increased by so little? I mention this for the benefit of the very small minority who tend to go berserk if the poor retailer puts the price of his resistors up by a penny and I think it is worth quoting what one well known economist said recently.

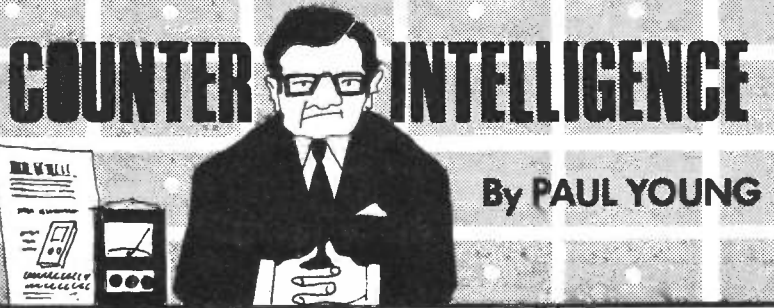
"In general prices for small quantities and great variety are significantly too low!"

I was intrigued by a remark made by my colleague, Simon Ginsberg, in a recent article of his. He was talking about the possibility of putting a magnetic coding on the metal strip on treasury notes. It reminded me that a few years ago I was thinking about the possibility of a type of metal detection device, to spot forgeries, as none of the forgeries I have examined have ever had the strip in them. I then discovered to my dismay that the "metal" strip in notes is not metal.

A letter to *Wireless World* asking if any of their readers could tell me what it was made of, failed to produce any replies. If any readers can enlighten me, I should be pleased to hear from them, as Mr. Ginsberg and myself are having the greatest difficulty in making passable fivers.

P.S. With reference to inflation I have just been looking at some copies of *Popular Wireless* dated 1923 and I see S. G. Brown's light weight headphones cost 30/-. We must relate that to a mans weekly earnings in 1923 and I would hazard a guess that they did not exceed £3! That's food for thought indeed!

Everyday Electronics, March 1977



I HAVE often felt sorry for those long legged willowy models that are to be seen in the glossy magazine adverts. In the winter they are displaying furs and in the summer the latest in bikinis. The trouble is these adverts are prepared at least six months in advance, so these poor creatures are photographed swathed in furs, when the temperature is in the nineties, and worse still with the thermometer registering ten below zero, have to stand by the edge of the Serpentine clad only in the tiniest twopiece, and smile!

In a minor way those who contribute to the electronic journals, have a similar problem. As I write this article it is Christmas afternoon, and I am sitting here with my breathing short circuted by turkey and mince pies and knowing full well that by the time you read it, your thoughts will be turning towards Easter. All the same I would like to thank all of you who have written to me during 1976, and I must quote from one letter: "Tell the editor to give Paul Young more space".

At the end of the letter, the writer tells me he is 14!! Even so, what perspicacity the lad has to spot talent like that. He will either finish up in charge of B.B.C. Television, or more

important still, as editor of EVERYDAY ELECTRONICS. If you do see the title suddenly changed to *Paul Young's Electronics*, you will know what's happened. Thank you for your encouragement Christopher.

I suppose the worst aspect of 1976 was the rapid inflation, this drove many firms to the wall and made your task of buying, so much harder. On the credit side I am pleased to report several new firms have opened up. Pondering about inflation, I wondered if the cost of electronic components had gone up all that much, in comparison with other commodities. To help my research, I picked up a copy of our catalogue printed in 1960. I was pleasantly surprised at what I found. Here are just a few examples.

	1960	1976
Capacitors:		
silver mica	6p	30p
paper	7½p	24p
ceramics	4p	10p
electrolytic	10p	14p
variable twin gang	70p	3.78p
Resistors:		
¼ watt ±10 per cent	2p	5p
5 watt wire wound	11p	22p
Coils: Denco	20p	69p
Pots: lin less switch	15p	29p

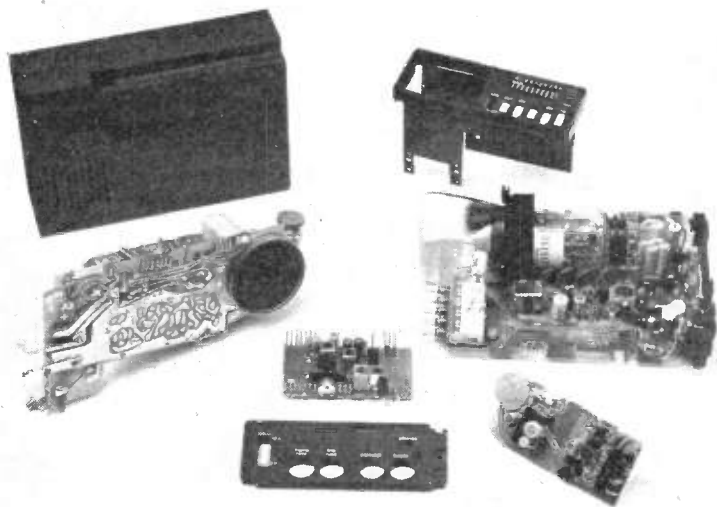
MICROVISION LAUNCHED

MONDAY January 10 saw the launch of the "world's first pocket television" by Sinclair Radionics. The set, which has been the subject of 12 year's research and development and for which Sinclair is now believed to have been granted £750,000 backing by the National Research Development Corporation for further development, has already been aided by a £650,000 stake in the company from the National Enterprise Board.

Called the Microvision the set operates on three transmission standards, u.h.f. and v.h.f. and consumes only 0.75W from its internal rechargeable cells—it can also be operated direct from the mains by means of an adaptor. It has thus been designed with the traveller in mind and will operate in most countries in the world.

The size of the set is approximately 150 × 100 × 40mm; screen size is 50mm diagonal which provides a similar picture size when viewed at 300mm to that of a 600mm (24inch) tube at about 4 metres. Most of the electronics are contained within five i.c.s, three of which have been specially designed by Sinclair for the set. The tube was developed and is made by A.E.G. Telefunken but a British second source is being sought.

Basic components of the Microvision; servicing is by means of module replacement. Some idea of the packing density can be gained by realising that the four circuit boards shown all fit inside the case.

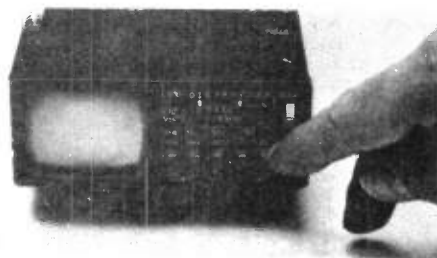


The set, with u.h.f. aerial raised, being operated by Clive Sinclair. A v.h.f. telescopic aerial is also fitted and provision has been made for connection to an external aerial.

The major design problems were said to be with reducing power consumption, this being allied to tube design, and with the u.h.f., v.h.f. tuner which uses variable capacitance diodes for tuning.

Price of the set is at present a rather high £200 but it is thought that the £750,000 grant from the N.R.D.C. is to aid development of a single standard set aimed solely at the British Market. This would undoubtedly be cheaper and therefore more attractive to the British buyer who is not likely to travel abroad very often.

The front panel of the set showing basic controls. Additional controls are mounted on the back panel—these being brightness, contrast, line and frame hold and a headphone output socket for private listening.



WHEN the author was a very young lad a number of crystal sets passed through his hands, with varying degrees of performance; the one that stood out as being better than the rest, was one that employed a variometer. A variometer consists of two coils of wire, one of which can be rotated inside the other. By connecting the two in series you have, basically, a variable inductance.

Generally the larger the diameter of a tuning coil the more efficiently it operates, and that was the secret of the variometer. It was decided to construct one to see how it performs under modern conditions.

CIRCUIT

The circuit in which the variometer is used is very simple indeed, it is shown in Fig. 1. Unlike most modern receivers tuning is by means of the variable inductance and not capacitance. The capacitor shown dotted across the variometer is not a component but simply the capacitance between the aerial and earth.

Detection is provided by D1 which can be a small germanium diode or—as in the original—a galena crystal and a “cat’s whisker.” The output from the detector is fed to a pair of high

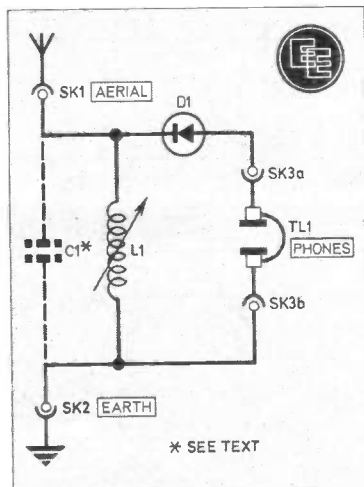


Fig. 1. Circuit diagram of the crystal set.

impedance headphones (about 4,000 ohms).

In such a simple design a good aerial and earth are essential and you should not expect results without an external aerial as high and long (not less than 10m) as possible, and a good earth, employing an insulated wire to an earth spike driven into the ground. The spike can be any metal about 1m long driven into the earth with a good connection to the connecting wire.

CONSTRUCTION

If you wish to indulge in some nostalgia, here is how to make the set. It should be made clear at the outset that the mechanical side is more difficult than the electronic side, a complete kit of parts is available (see *Shop Talk*).

Take the larger piece of Paxolin tubing specified and drill a small pilot hole (about 2mm diameter) as indicated in Fig. 2a. Drill another hole the same size exactly opposite. It is vital that the hole is exactly opposite. To make certain, measure the diameter and find the circumference by multiplying it by π .

The piece recommended has a diameter of 86mm, half the circumference comes to 135mm. Tie

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excluding phones
and case

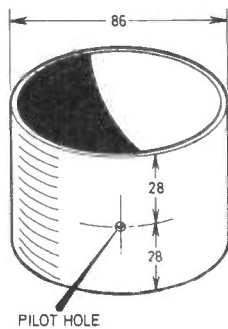


Fig. 2a. Initial drilling of large former.

a knot in a piece of string and thread it through the pilot hole with the knot on the inside. Cut the string so that the piece extending out is exactly half the length of the circumference (135mm). Take the string round the tube and make a mark, then take it round the other way and if you have measured your string accurately, it will reach the same mark. If it overlaps or there is a gap you must adjust the mark accordingly.

When satisfied with the position of the mark drill another pilot hole. Repeat this procedure on the smaller tube. (Half the circumference is 114mm.) Take the bigger tube and drill a hole to enlarge each pilot hole to take the two bushes. Take a very small drill (about 1mm) and drill holes as shown in Fig. 2b.

Take the smaller tube and enlarge the pilot holes to take a 6 BA thread. Four other holes are also required in this tube, using the 1mm drill, as shown in Fig. 3. Now wind the larger coil. It is wound with 26 s.w.g. enamelled copper wire and about a 2oz reel should be sufficient.

First anchor the end of the wire by threading it through the two small holes at the edge of the tube. Make sure it is firmly fixed by threading it through three or

Fig. 3. Drilling of the smaller former.

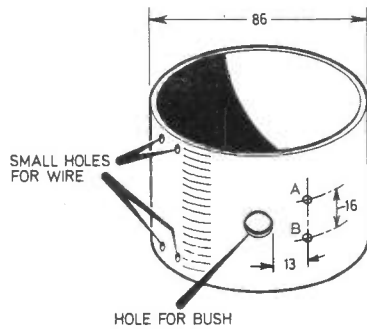
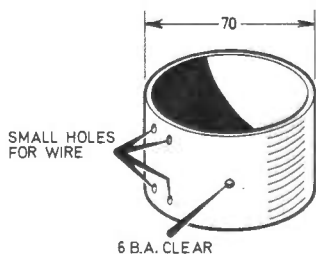


Fig. 2b. Final drilling of larger former.

four times. While you are winding the coil keep a good tension on the wire all the time. About 35 turns will bring you to the first small hole near the centre. Cut the wire leaving about 10 inches over.

Thread the end down through hole A Fig. 2, back up through hole B, back through hole A and finally back through hole B; pull the wire tight. This will keep the first half of the coil tight, while you solder your reel of wire on to the spare end. Clean both ends carefully with emery cloth and slide on about 2 inches of 1mm sleeving on to the end (preferably the end of the reel of wire). Carefully solder the two wires together, cover the join with sleeving. Carry on winding the coil making sure you are still going in the same direction, i.e. if you started off clockwise, carry on from the middle in the same direction.

Another 35 turns approximately will bring you to the two holes at the outer edge. Cut the wire leaving about 150mm over and anchor through the two holes. Now wind the smaller coil. There is no need to cut and rejoin the wire this time but when you get within 5mm from the centre take

the wire diagonally across and carry on winding. Remember you will be fitting a 6mm spindle on each side of this coil and it *must not* trap the wire.

ASSEMBLY

Take the two large nuts off the two bushes and right on the edge of each nut solder a length of connecting wire. Solder about 200mm of wire on one, and 150mm on the other, use different colours to aid identification. You are now ready to start assembling the coils. Take the larger coil and place one bush in each hole with the thread facing away from the centre of the tube. Fix the two bushes in position with the wire attached nuts Fig. 4. Be careful that when you tighten the nuts you do not trap any of the coil windings.

If the coils are rather close it should be possible to gently slide the section of the coil near the bushes towards the outer edge. Place the smaller coil inside the larger one and place the two spindles in position as shown in Fig. 4. Again care must be taken to make sure that the edges of the spindles do not trap the wire of the coil. If there is any doubt place one or two nylon washers over the threads.

Before assembly it is necessary to place one or two washers over the spindle itself to ensure that the inside coil is positioned centrally inside the outside coil. As long as it is correctly spaced by washers at the top end, you need not worry about the bottom, because the tuning knob will prevent the coil from dropping down; Fig. 4 will help to make this clear. Now the moment of truth. Hold the larger coil in your hand, turn the knob and the small coil should rotate freely through 360 degrees. However,

Components

See
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Talk**

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- TL1 4000 Ω headphones
 - DI OA91 or galena crystal and holder with "cat's whisker" arrangement (see text)
 - SK1 Aerial connector, screw type
 - SK2 Earth connector, screw type
 - SK3 a and b Headphone connector screw type (2 off)
 - L1 Variometer; Paxolin tube 86mm dia x 57mm and 70mm dia x 38mm; brass bushes with nuts (2 off); 2 oz reel of 26 s.w.g. enamelled copper wire.
- Knob with calibrations over 180 degrees; connecting wire; materials for case; 4BA fixings; solder tags, etc.

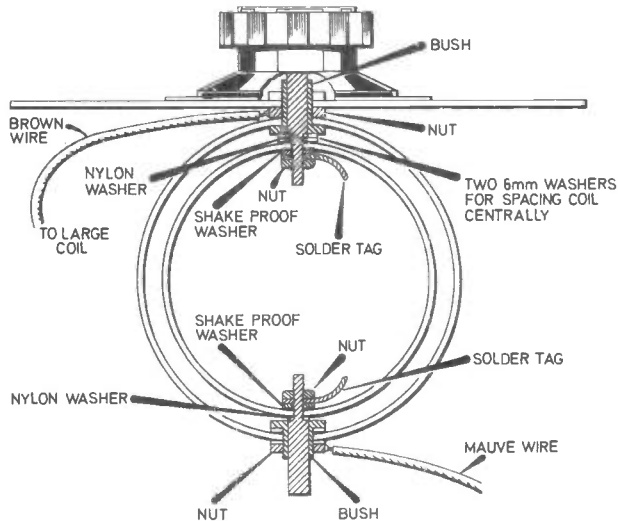


Fig. 4. Assembly of the Variometer.

the clearances are very small, so do not be surprised if it catches slightly. If it catches badly it can be put right by elongating the bottom hole, which will enable you to re-position the bottom of the coil, until it rotates freely all the way. Of course a small amount of rubbing can be cured by carefully filing away the offending edge.

WIRING UP

Connect one end of the inside coil to one solder tag and the

other end to the other one. The top wire (Fig. 4) is connected to one end of the larger coil, the other end is connected to the earth terminal. The remaining connections are shown in Fig. 5. Construction of the crystal detector, can be clearly seen in the photograph. The parts for this are available as part of a complete kit for the receiver.

Make a small indentation with a 3mm drill directly above the knob and fill it with white paint. The woodwork can either be a small desk shaped box (as illus-

trated) or even a square box. Before trying the "cat's whisker" and crystal just hook a diode across the crystal detector (an OA81 or OA91) to check that the set is working.

Naturally the tuning is flat and stations tend to overlap, we even suffered from it in my day when stations were about 1kW output; if it is very bad you can effect some improvement by shortening the aerial or putting a small capacitor in series with the aerial lead; try a few values starting with a 47pF.

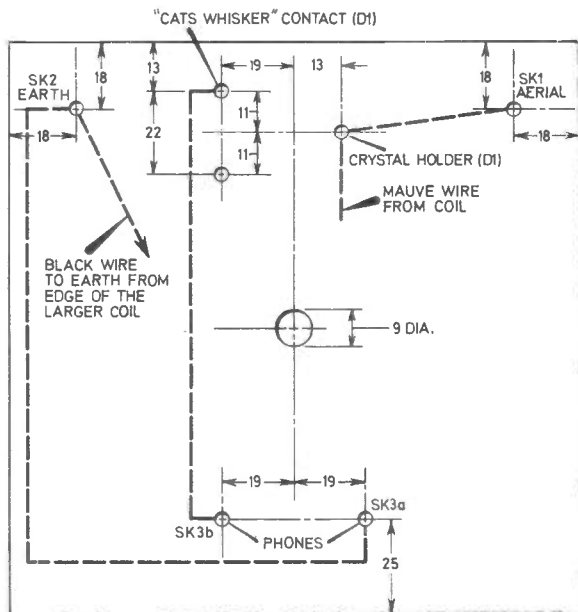
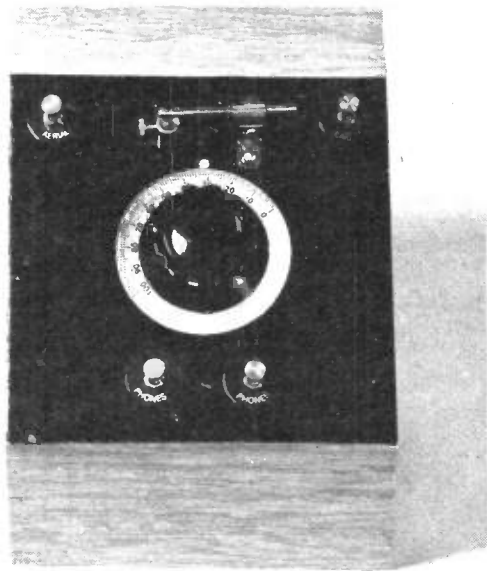
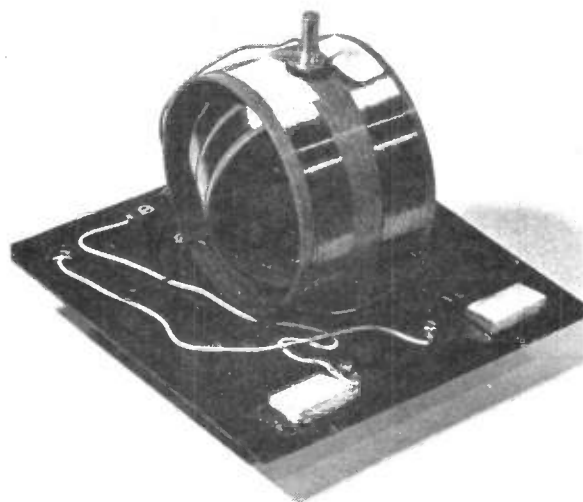


Fig. 5. Drilling of the panel and wiring details.



Physics is FUN!

By DERRICK DAINES

WHAT is a random event? Just exactly what do we mean by a random number? Such questions pose fascinating problems for physicists and often lead to a deeper understanding of the nature of natural phenomena. Take that humble random-number generator, the common die. I roll it and it comes up 6. Why? Is it truly random?

When we start looking into it we see that the die shows six because of the interactions of many factors such as the way I held it, the way I threw it, the angle that it struck the table, the speed of rotation and so on and so on. Theoretically, if I could reproduce exactly all of the conditions pertaining to my throw, then I could roll a 6 every single time even with a perfectly good die!

Two things prevent me from doing so. (A) I do not understand all of the influences acting upon the die, (B) it would be extremely difficult to reproduce them at will, even if I did understand them.

Heads and Tails

As an example of the latter restriction, consider the type of circuit that often appears on the pages of this and sister magazines—the "Heads and Tails Indicator". The circuit is usually very basic and easily understood (Fig. 1). Two transistors or gates of an i.c. are arranged so that both strive to switch "on" but in doing so switch the other "off". This is an inherently unstable configuration and the result is that the oscillation of on-off switching proceeds at a very high rate.

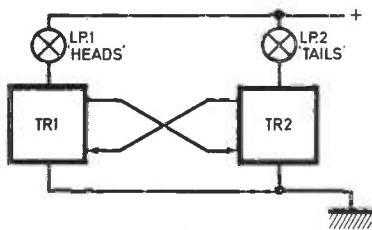


Fig. 1. Equal chance selector.

A lamp is arranged in series with each device so that when a "stop" switch is thrown to stop the oscillation, one or the other of the lamps is lit. Let us assume for the sake of argument that whilst oscillation is proceeding, both lamps light fully in their turn (which they do not), then even though I have all the information that I need, plus a full understanding of what is happening, I cannot react quickly enough to stop the circuit in favour of one lamp against the other.

ERNIE is a good example of the type of circuit that produces random numbers by means of a noise generator. The acronym is short for Electronic Random Number Indicating Equipment. The principle is shown in Fig. 2.



Fig. 2. Random noise.

A noise generator produces a spiky waveform that is truly random in appearance. Some types of random number generators count the number of spikes; ERNIE counts the number of spikes that occur above a preset amplitude. Surely this number is truly "random"? Not quite. The noise spikes themselves are the result of atomic particles moving, colliding, rebounding ad infinitum.

In other words, they are caused by a definite sequence of events and could we have every atomic particle in its right place, proceeding at the right speed and in the right direction, we would be able to reproduce the "random" number chosen.

Truly Random

So—what is a random event? There are scientists—and lately this particularly applies to astronomers—who claim that they have discovered truly random events that are not caused by any natural phenomena. There are also others—and that includes me—who argue that this is only apparent and

that the causes may be found in phenomena that are not yet understood or even known about.

Perhaps I have said enough to show that a random number sequence is a mathematical code for random events, and that if random events occur through forces beyond our understanding and/or control, then the same applies to random numbers. In other words, we cannot predict a random number or affect its outcome in any way. This poses the thought that there might be some sort of mathematical formulae that act in the same way? Indeed there are—millions of them, an infinite variety of them.

After all, if I ask a child of seven the square of 1.414 I could pull any number I liked out of a hat and he would accept it as true because he does not understand. In the same way, any formula that I cannot work out in my head will produce what is for me a random number.

When I want a sequence of random numbers—as distinct from only one—there are restrictions. The human mind is for ever seeking patterns and if I told my child that the square of 1.414 is 10, that the square of 7.895 is 10 and that the square of 78.9999 is 10, he would reasonably assume that the square of all numbers was 10. In the same way, if I roll 8 consecutive sixes, you would reasonably assume that my die was loaded:

In a series of random numbers therefore, all numbers must have an equal chance of appearing. In a very long sequence comprising all digits from 0 to 9, all would appear roughly the same number of times and there would be an absence of any "runs" or recurring patterns of numbers, that would in any way enable you to make a prediction.

Formulae

Even with such restrictions there are an enormous number of formulae that may easily and quickly be tapped out on any hand-held calculator—many waiting to be found. The method is shown in Fig. 3. A chosen number is entered into the constant memory. I have chosen 2.3025851 as this is a "standard" number ($\log_e 10$).

Another number is then entered into the current register as a starting point. The value of π is a good one, but any will do. I take off the whole-number portion and for the first time round do not use the remainder because of course I know what they are.

Thereafter I multiply by the constant and subtract whole numbers as they appear. Of the decimal part remaining I make a predetermined choice of the digits displayed. I may for example use only the first digit, the last, the middle three or all of them or whatever, depending upon what I am using the random numbers for. For the sake of discipline I will of course have written down this decision before carrying out the multiplication operation.

The advantage of this type of random number generation is that it is repeat-

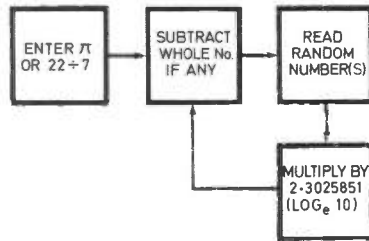
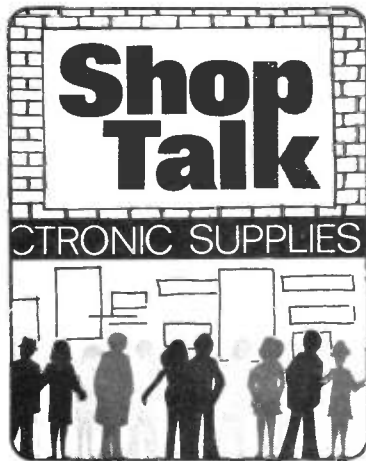


Fig. 3. Generation of random numbers using a calculator.

able. If a design team is working on, for example, an atomic power station then inherent in their design task is the consideration of apparently random events, the movement of atomic particles.

A simpler case might be a queuing problem, since customers arrive in a random fashion. In all such cases the design team might be dissatisfied with the outcome using a particular random series. However, not only may the sequence be replayed in slow motion for study, but by making alterations to their design the same random sequence may be utilised for analysis.

The formula given in Fig. 3 is reasonably good for domestic use in games of chance, etc., but I am sufficiently confident in the ability of readers to believe that better formulae will be found. So for this month's experiment, take your calculator and try different starting numbers and different multipliers. Let us know if you find a particularly good combination.



Shop Talk

By Mike Kenward
New products and component buying for constructional projects.

YOU will find news of new products—such as the Microvision—and of boat equipment elsewhere in this issue so this month we will concentrate on buying components.

Having been involved in procuring and sorting out all the information for next month's buyers guide we find one comment coming from a number of firms. It is that they receive a few orders from our readers that do not carry any name or address. Some of the firms now give a return of post service for stock items and they say they quite often get orders from Mr. Anonymous followed a week or two later by a "hot under the collar" letter asking where the parts are. So please make sure you add your name and address.

A similar problem arises with our post, because of the high cost of postage we simply cannot undertake to answer letters unless they are accompanied by a stamped addressed envelope—or in the case of overseas readers by an international reply coupon. Please also note that we cannot undertake a design job for individual readers and are unable to answer queries concerning commercial equipment—these should be directed to the manufacturer or supplier. Our full address and phone number is shown on the editorial page each month.

Whilst talking about the magazine in general it is worth mentioning that we are getting more and more letters from readers asking for issues that they have missed or simply not been able to get from the newsagent. It is an unfortunate fact that we are unable to supply back issues of the magazine and, although a few libraries keep issues, once one is out of print it is virtually unobtainable. The only way to avoid disappointment is to place a regular order with your newsagent who will then deliver or hold the issue for you.

Grandad's Crystal Set

Perhaps the only comment one can make about the parts used for Grandad's Crystal Set is that they were probably all obsolete about 10 years ago. However don't worry about that because, as is our normal policy, we would not have published the design if you could not obtain the parts. In fact a full kit of parts is available from Home Radio Components for £5.00. This does not include the headphones or case but is inclusive of V.A.T., postage and packing. Home Radio advertise regularly in our pages.

The case is also available in kit form or built up from Home Radio at a cost of £3.90 inclusive.

Digital Dice

Not very much in the Digital Dice really—so many circuits for these have been published that we tried to find you a simple one and we feel Mr. Penfold's design fits the bill! The i.c.s. should be available from most of the larger stockists—you can usually find such devices or likely suppliers by seeing who lists a large number of i.c.s. in their ads or by getting a few catalogues.

None of the other dice components should present any problems.

Quad Adaptor

The main point to watch when building the Quasi Quad Adaptor is the need for complete circuit insulation as the circuit cannot be earthed. Provided the construction shown is followed there should not be any problems. As far as component buying goes the points made above concerning i.c. supply should be noted, otherwise all parts should be readily available.

Tumble Drier Alarm

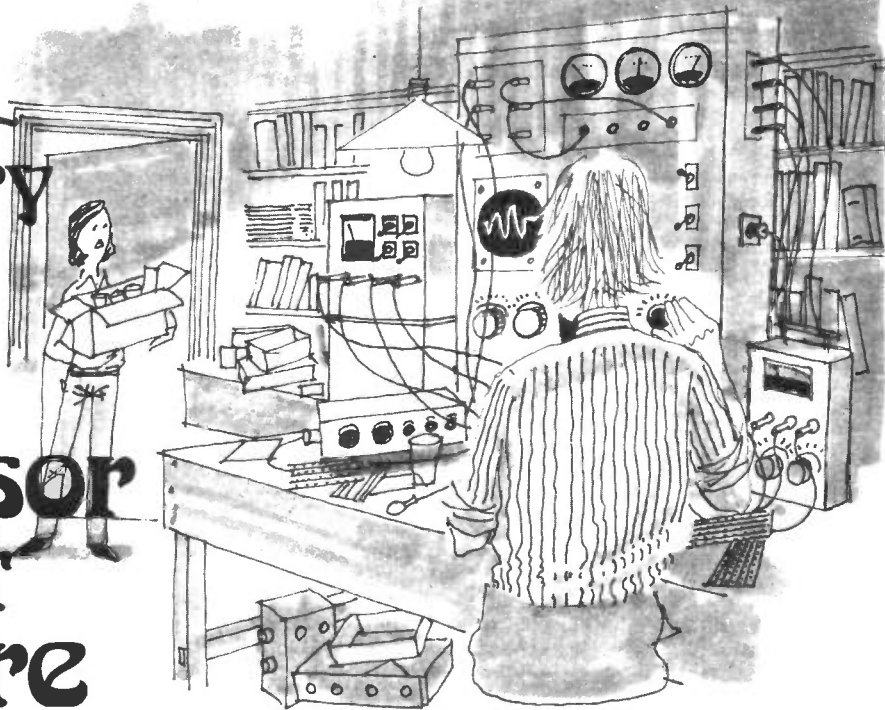
A derivation of our previously published Tumble Drier Controller this simple circuit is suitable for anyone to build since no mains wiring and switching is involved.

Once again all parts should be readily available although the author's comments on the supply of salt should be noted. As is stated in the article this little unit could easily be employed in a number of other applications and should prove interesting for those who just like to experiment.

Everyday Electronics, March 1977

The Extraordinary Experiments of Professor Ernest Eversure

by Anthony John Bassett



Soon the Prof. had completed his sketch, and by adding the components R4, R5, R6, S1, D2, TR4 and TR5 to the original, the circuit shown in Fig. 1 was the result.

"This circuit will give the option of hair-trigger sensitivity by opening switch S1, or variable handicap by closing switch S1 and adjusting VR1 to give the desired handicap."

The Prof's. experimental Robot arrived from the laboratory stores with some components, and whilst Bob and Tom took these over to one of the laboratory work benches to discuss the practical matters of putting the steady hand tester together, and to begin building it, Maurice plied the Prof. with a few questions about the circuit.

"I understand how VR1 can act as a handicap control by varying the time-constant for charging C1," he began, "but what is the function of the other control VR2?"

VOLUME

"That is a volume control for the bell," explained the Prof., "since it is likely that it would be in constant use at the charity event, it seems a good idea to be able to control the volume in order to prevent annoyance."

"That is such a simple idea, I'm surprised that I've never heard of it before!" exclaimed Maurice. "I did not even realise that it would be possible to control the volume of a bell or buzzer by use of a simple wirewound variable resistor! I suppose that it would be possible to connect such a resistor in series with almost any doorbell or buzzer to make it sound more softly?"

"Yes," replied the Prof., "almost anyone can easily fit a wirewound volume-control in series with the doorbell—it can reduce nervous tension and annoyance from the 'noise-pollution' of an excessively loud bell or buzzer, and also, because less electrical energy is used for each ring of the bell, energy is conserved, giving longer battery life, or less strain on a bell-transformer."

SPURIOUS TRIGGERING

"Why do you recommend threading a ferrite bead over the base lead of TR4, Prof?" Maurice asked, "I cannot see what effect this could have on the circuit's operation."

"This is because I know someone who used a similar circuit as part of a sensitive burglar-alarm, and the alarm went off each time a police-car, ambulance, fire en-

gine or radio-taxi went by. Each time that such a vehicle went by, its close-range radio-transmissions would get into the circuit, as the burglar-alarm wiring acted as an aerial, and trigger off the sensitive hair trigger circuit. By threading ferrite beads over some of the wiring, the susceptibility to these transmissions was greatly reduced. Only a few of the beads were needed, together with a capacitor (C4), to cure the problem."

"Our hi-fi sometimes picks up radio-cab and police messages," remarked Maurice, "even with the radio tuner turned off. It is very annoying, and I have been told it's illegal to listen into the police. Can I use ferrite beads to solve this problem?" "It might help," replied the Prof., "it depends very much on how the interfering signals are getting into the equipment. Mains wiring, loudspeaker wires, turntable wire, almost any wiring connected to the hi-fi can act as an aerial, and lead interference into the set."

Fortunately the ferrite beads are inexpensive, and you could thread one or two onto each of the wires at its point of entry into the equipment. Sometimes it is possible to fit one or two beads over each of the signal-carrying wires in din plugs, phono-plugs or speaker-plugs, and where this is not possible, they can usually be

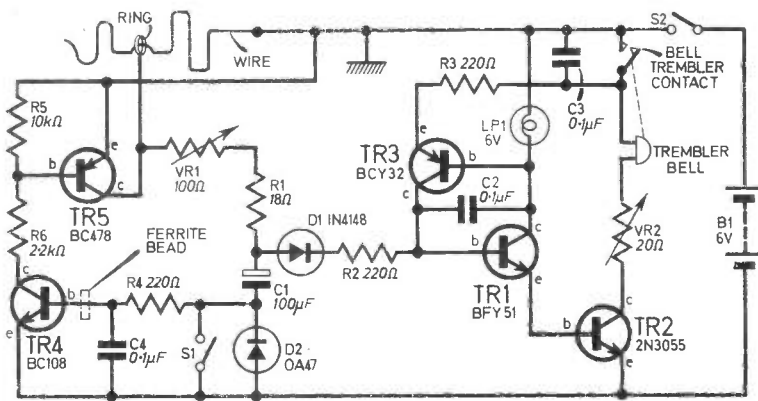


Fig. 1. The circuit diagram of the Profs. Steady Hand Tester (Mk. II).

fitted inside the equipment as close as possible to the point of entry of each wire into the chassis."

TESTING

Although Maurice had a few more questions for the Prof., at this point Bob and Tom began to test the Steady Hand Tester which they had nearly completed. Tom had mounted the bell, switch, volume-control and handicap control on a box, with the indicator light made prominent by a large red plastic dome.

Bob had mounted most of the electronic components onto a piece of stripboard 25×65mm with the power-transistor TR3 mounted on a small aluminium bracket, and C3 inside the bell casing, connected across the bell contacts. He had also brought an extra wire out from C3 to

allow current to flow through the bell contacts to R3. He had wired the tester up according to the circuit (Fig. 1) and connected Tom's bent wire and ring; now a few sharp rings from the bell brought Maurice and the Prof. over to inspect the result.

With great diligence and concentration, Tom was carefully threading the ring along the wire. "I'm sure I can do it this time," he remarked, "although the handicap control VR1 had been set to minimum resistance, and the hair-trigger switch S1 was open." "I would really like to see how effective this volume control is," Maurice told the Prof., and gently nudging Tom's elbow so that the ring once again contacted the wire, he twiddled the volume control VR2. Fortunately the sound of the bell obscured the most expressive of Tom's expletives; however the volume control

really did work, as Maurice adjusted it, the bell gradually became quieter until a point was reached where it became silent, but the lamp remained lit.

LATCHING

As Maurice turned the volume control gradually up again, a point was reached where the bell sounded for a moment, very quietly, and the lamp extinguished.

"This is because TR1 and TR2 form a 'latching circuit' which tends to keep the lamp lit up," the Prof. explained, "when C1 becomes discharged below the level at which it can trigger the latching action, the circuit can be 'unlatched' by the action of the trembler bell. When the bell contacts open, this interrupts the current through R3. When the contacts close again the circuit remains unlatched, the lamp goes out and the bell remains silent until the ring contacts the wire and once again charges C1.

If VR2 is set to too high a resistance, the bell contacts do not open, the bell does not sound and the lamp remains lit. As this could cause the battery to run down quite rapidly, and might cause VR2 to overheat, a wire-wound resistor may be connected in parallel with VR2. The value of this resistor, which will depend upon the individual bell you use, can be found by measuring the resistance of VR2 at which the lamp just extinguishes, and applying the formula for two resistors in parallel."

To be continued

BOOK REVIEWS

PRACTICAL ELECTRONIC PROJECT BUILDING

Author Alan C. Ainslie & M. A. Colwell

Price £1.99

Size 215 × 135mm, 106 pages (plus adverts), paperback

Publisher Newnes-Butterworth

ISBN 0 408 00231 X

ANOTHER in the Newnes Constructors Guide series and another with adverts, this one with them in the text—if they are to appear surely they should

not get among the chapters. However if they keep the price down how can one object?

These two authors have provided a comprehensive guide to circuit building and the various aspects of the actual construction and finishing of the project. There are no circuits to build but a brief chapter is included on fault finding.

Basically these two have got it all together and provided a useful book for those just starting construction.

M.K.

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GEORGE HYLTON brings it down

Audio Delay Circuits

A CHESHIRE reader, J. Phillips of Stockport, makes an interesting suggestion. He points out that if it were possible to delay an audio signal electronically echo effects could be obtained without the use of an echo chamber. All you'd need to do would be to add the delayed signal to an audio system: following on the original signal it would sound like an echo.

Is it feasible? To begin with, we need to know how much delay is needed. Anybody who has listened to

take special care with impedance matching to make sure that they aren't.)

The average cable transmits at something like $2/3$ the speed of light, or 200,000 km/second. For a one-second round trip you'd need 100,000 km of line. So that's out. It is, however, possible to construct an artificial line with inductors and capacitors (Fig. 1a). These are used a lot in radar and television for delays of a few microseconds, but they become bulky and expensive for anything much larger. I once saw one which gave about 10 milliseconds audio delay: it occupied a large equipment rack in a laboratory.

Phase Lag

An alternative to the LC line is the RC line (b). Each RC section can produce a phase lag of up to 90 degrees, and resistors are much cheaper than inductors. At, say 100 Hz, a 90 degree phase lag (one quarter of a cycle) amounts to 2.5 milliseconds. So if

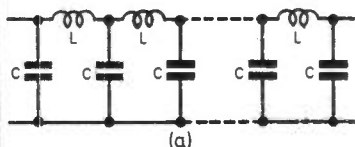


Fig. 1a. Delay line using resistors and inductors.

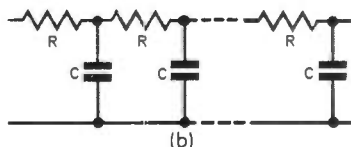


Fig. 1b. Delay line with resistors and capacitors.

real-life echoes know that most of them come within about a second after the original sound. You usually have time to shout "Hello!" and then back comes the echo.

This ties up with the speed of sound in air: about 300 metres per second. An echo from, say, the side of a tall building 150 metres away must take one second to appear, since the round trip from your mouth to the building and back is 300 metres.

Telephone Line

The simplest electrical equivalent is a telephone line. It takes a certain time for speech signals to travel along a line, and they can easily be bounced back. (Telephone systems engineers have to

90 degrees were a practical value, and you wanted 0.5 second delay (500m sec); 200 RC sections would be needed.

Unfortunately each RC section is a "top cut" network so the frequency response is terrible and a second lot of sections, this time CR, is needed to correct it. Also the attenuation is large. Another snag is that the delay varies with frequency.

So artificial electrical transmission lines are out. Are acoustic delay lines possible? After all, sound travels much more slowly than electrical waves. By analogy with the old-fashioned speaking tube, a suitable line might be made from a reel of hose pipe say 300 metres long with a loudspeaker at one end and a microphone at the other. This is rather bulky.

If you try to reduce the bulk by using thin tubing the attenuation increases and the lower frequencies are lost. An alternative is the solid acoustic transmission line. This can be a wire, coiled into a spring for compactness. Unfortunately sound travels much faster in solids than in air, so for the same delay a much longer line is needed.

Spring Line

Practical "spring" lines give delays of up to a few tens of milliseconds.

They make good reverberation units, because the sound travels up and down the wire many times before it dies away. But they are hardly practical for echo.

Some of the most successful echo units use magnetic recording. If you record then play back a second later you have the equivalent of a one-second echo. By using several playback heads spaced apart multiple echoes can be simulated. An endless band of tape (or more usually, a disc whose edge is coated with magnetic oxide) is used, with heads arranged to give a record-play-wipe sequence.

Electronics?

Does this mean that electronic delay of audio signals is utterly impracticable? Not quite. Professor Eversure pointed out to me recently that computer-like techniques are beginning to come to the rescue of the idea.

If a measurement of the audio voltage is made at frequent intervals—say 10,000 times per second—and

10,000 of these samples are stored in some form of memory, then the memory holds one second of sound. This can be extracted and used to reconstitute the original sound as a one-second echo.

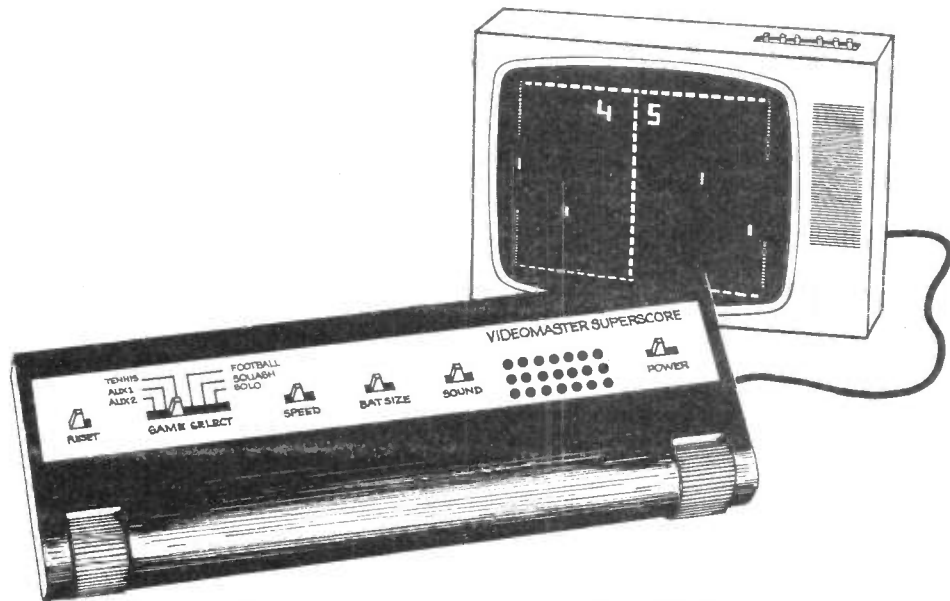
In the past, the audio samples have had to be encoded in some form. However, analogue storage devices are now becoming available which avoid this complication, so the idea is becoming more practicable, though still expensive.



"Why don't you just pay the licence and stop spending hours trying to construct as T.V. detector van detector?"

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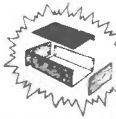
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Type	Quantity	Type	Quantity	Type	Quantity
1	100	1	100	1	100
£ p	£ p	£ p	£ p	£ p	£ p
7400	0 09 0 08	7448	0 70 0 68	74122	0 45 0 42
7401	0 11 0 10	7450	0 12 0 10	74123	0 65 0 62
7402	0 11 0 10	7451	0 12 0 10	74141	0 68 0 65
7403	0 11 0 10	7453	0 12 0 10	74145	0 75 0 72
7404	0 11 0 10	7454	0 12 0 10	74150	1 10 1 05
7405	0 11 0 10	7460	0 12 0 10	74151	0 65 0 60
7406	0 28 0 25	7470	0 24 0 23	74153	0 70 0 68
7407	0 28 0 25	7472	0 20 0 19	74154	1 20 1 10
7408	0 12 0 11	7473	0 26 0 22	74155	0 70 0 68
7409	0 12 0 11	7474	0 24 0 23	74156	0 70 0 68
7410	0 09 0 08	7475	0 44 0 40	74157	0 70 0 68
7411	0 22 0 20	7476	0 26 0 25	74160	0 95 0 85
7412	0 22 0 20	7480	0 45 0 42	74161	0 95 0 85
7413	0 26 0 25	7481	0 90 0 88	74162	0 95 0 85
7416	0 28 0 25	7482	0 75 0 73	74163	0 95 0 85
7417	0 26 0 25	7483	0 88 0 82	74164	1 20 1 10
7420	0 11 0 10	7484	0 85 0 80	74165	1 20 1 10
7422	0 19 0 18	7485	1 10 1 00	74166	1 20 1 10
7423	0 21 0 20	7486	0 28 0 26	74174	1 10 1 00
7425	0 25 0 23	7489	2 70 2 50	74175	0 85 0 82
7426	0 25 0 23	7490	0 38 0 32	74176	1 10 1 00
7427	0 25 0 23	7491	0 65 0 62	74177	1 10 1 00
7428	0 36 0 34	7492	0 43 0 35	74180	1 10 1 00
7430	0 12 0 10	7493	0 38 0 35	74181	1 90 1 80
7432	0 20 0 19	7494	0 70 0 68	74182	0 80 0 78
7433	0 38 0 36	7495	0 60 0 58	74184	1 50 1 40
7437	0 26 0 25	7496	0 70 0 68	74190	1 40 1 30
7438	0 26 0 25	74100	0 95 0 90	74191	1 40 1 30
7440	0 12 0 10	74104	0 40 0 35	74192	1 10 1 00
7441	0 60 0 57	74105	0 30 0 25	74193	1 05 1 00
7442	0 60 0 52	74107	0 30 0 25	74194	1 05 1 00
7443	0 95 0 90	74110	0 48 0 45	74195	0 80 0 75
7444	0 95 0 90	74111	0 75 0 72	74196	0 90 0 85
7445	0 80 0 75	74118	0 85 0 82	74197	0 90 0 85
7446	0 80 0 75	74119	1 30 1 20	74198	1 90 1 80
7447	0 70 0 68	74121	0 28 0 26	74199	1 80 1 70

Devices may be mixed to qualify for quantity price. Data is available for the above series of I.C.'s in booklet form price 35p.

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TBA 800		*75p
72709 14 pin DIL		*20p
7471P 8 pin DIL		*18p
72747 14 pin DIL		*36p
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NE 555 Timer		38p
NE 556 Dual Timer		78p

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BPS8 8 pin	1611 9p
BPS14 14 pin	1612 10p
BPS16 16 pin	1613 11p

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T05 TR12A/400	50p
10A/400P Plastic	
TR110A/400P	80p

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400mW PAK No.	
1 Containing 20 3V-10V	
2 Containing 20 11V-33V	
£1 per PAK*	

DIACS

DR100	15p	D32	15p
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16201 18 Electrolytics	47 µF-10µF
16202 18 Electrolytics	10 µF-100µF
16203 18 Electrolytics	100µF-680µF

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16161 24 Ceramic Caps	100pf-390pf
16162 24 Ceramic Caps	470pf-3300pf
16163 21 Ceramic Caps	4700pf-0.047µF

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16214 1/8th	1K-8.2K
16215 1/8th	10K-8.2K
16216 1/8th	100K-1M

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AC 176K	22p	OC 72	14p
AC 187K	22p	OC 81	14p
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AC 188K	22p	ZTX 108	*6p
BC 107	6p	ZTX 109	*6p
BC 108	6p	ZTX 300	*7p
BC 109	6p	ZTX 301	*7p
BC 118	*10p	ZTX 302	*9p
BC 154	*16p	ZTX 500	*8p
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BC 148	*8p	ZTX 502	*12p
BC 149	*8p	2N 696	10p
BC 157	*10p	2N 697	11p
BC 158	*10p	2N 706	7p
BC 159	*10p	2N 706A	8p
BC 169C	*10p	2N 708	8p
BC 170	*6p	2N 1613	15p
BC 171	*6p	2N 1711	15p
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5A/600 PIV	THY 5A/600	50p
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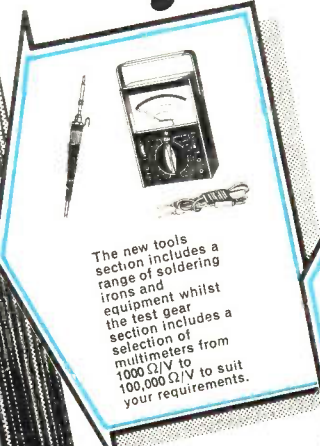
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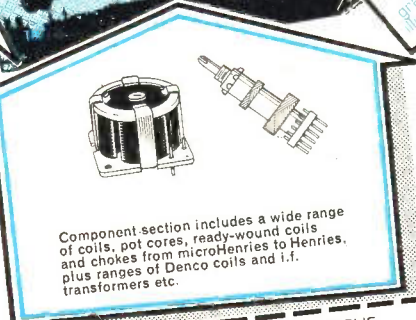
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