

An exciting hobby.... for everyone

# everyday electronics

AUG. 74  
20p

EXPERIMENT IN HEADPHONE STEREO



HEADS  
OR TAILS



EASY  
TO BUILD  
PROJECTS

**PLUS!**

- THEORY
- PRACTICE
- POPULAR FEATURES

*Electronics  
made easy!*

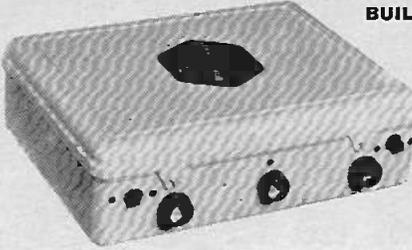


RADIATION MONITOR

# NEW EDU-KIT MAJOR

COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT.

BUILD THESE PROJECTS WITHOUT SOLDERING IRON OR SOLDER.



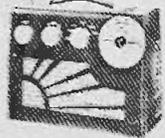
- ★ 4 Transistor Earpiece Radio ★ Signal Tracer ★ Signal Injector ★ Transistor Tester ★ MPX-FMP ★ 4 Transistor Push Pull Amplifier ★ 5 Transistor Push Pull Amplifier ★ 7 Transistor Loudspeaker Radio MW/LW ★ 8 Transistor Short Wave Radio ★ Electronic Metronome ★ Electronic Noise Generator ★ Batteryless Crystal Radio ★ One Transistor Radio ★ 2 Transistor Regenerative Radio ★ 3 Transistor Regenerative Radio ★ Audible Continuity Tester ★ Sensitive Pre-Amplifier.

**Total Building Costs**  
**£7-23** P & Ins. 44p.  
(Overseas P & P £1-85p.)  
(+ 10% VAT 72p)

- ★ 24 Resistors ★ 21 Capacitors ★ 10 Transistor\* ★ 31 loudspeaker ★ Earpiece ★ Mica Baseboard ★ 3 12" wave connectors ★ 2 Volume controls ★ 2 Slider Switches ★ 1 Tuning Condenser ★ 1 Knob ★ 1 Resistor Wound MW/LW/SW Coils ★ Ferrite Rod ★ 6 1/2 yards of wire ★ 1 yard of sleeving, etc. ★ Parts price list and plans 50p (FREE with parts).

## ROAMER TEN

with VHF including aircraft. 10 Transistors. Latest 4" 2 watt Ferrite Magnet Loudspeakers, 9 Tunable Wavebands. MW1, MW2, LW, SW1, SW2, SWS, Trawler Band. VHF and Local Stations also Aircraft Band. Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600 mw Transistors. Car aerial and Tape Recording Sockets. 10 Transistors plus 8 Diodes. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and tone Control. Attractive Case in black with silver blocking. Size 9" x 7" x 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts). Total building costs **£8-50** P & P. £1-85p. Insa. 52p (+ 10% VAT 85p)



## NEW EVERYDAY SERIES

Build this exciting New series of designs

**E.V. 5** 5 Transistors and 2 diodes. MW/LW. Powered by 4 1/2 volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" x 5 1/2" x 2 1/2" approx. Parts price list and Plans 15p. Free with parts.  
**Total Building Costs £2-95** P & P. Insa. 30p (+ 10% VAT 29p)

**E.V. 6** Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, 3" loudspeaker, etc., MW/LW coverage. Push Pull output. Parts price list and Plans 15p. Free with parts.  
**Total Building Costs £3-60** P & P. Insa. 30p (+ 10% VAT 36p)

**E.V. 7** Case and looks as above. 7 Transistors and 3 diodes. Six wavebands. MW/LW. Trawler Band, SW1, SW2, SWS, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" loudspeaker. Parts price list and easy build plans 20p. Free with parts.  
**Total Building Costs £4-08** P & P. Insa. 31p (+ 10% VAT 40p)



## POCKET FIVE

3 Tunable wavebands MW/LW and Trawler Band. 7 stages, 5 transistors and 2 diodes. supersensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 5 1/2" x 1 1/2" x 3 1/2" approx. Plans and parts price list 15p. (Free with parts).  
**Total Building Costs £2-50** P & P. Insa. 20p (+ 10% VAT 25p)



## ROAMER EIGHT Mk 1

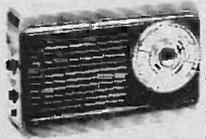
NOW WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mw transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt Ferrite Magnet Loudspeakers. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 x 7 x 4in. approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).  
**Total Building Costs £6-98** P & P. Insa. 47p (+ 10% VAT 69p)



## TRANSONA FIVE

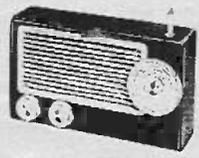
Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and parts price list 15p (Free with parts).  
**Total Building Costs £2-75** P & P. Insa. 36p (+ 10% VAT 27p)



## TRANS EIGHT

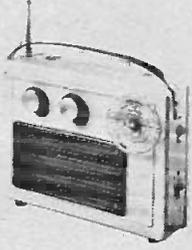
8 TRANSISTORS and 3 DIODES

6 Tunable Wavebands: MW, LW, SW1, SW2, SWS and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 2in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 x 6 1/2 x 2 1/2in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).  
**Total Building Costs £4-48** P & P. Insa. 33p (+ 10% V.A.T. 41p)



## NEW ROAMER NINE

WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors, 9 Tunable wavebands as Roamer Ten, built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mw transistors. 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange control. Attractive all white case with red grille and carrying strap. Size 9 1/2" x 7" x 2 1/2" approx. Parts Price list and Plans 30p (FREE with parts)  
**Total Building Costs £6-95** P & P. Insa. 44p. (+ 10% VAT 69p)

## "EDU-KIT"



Build Radios, Amplifiers, etc. from easy stage diagrams. Five

Components include: Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine 5" Tone Moving Coil Speaker: Terminal Strip: Ferrite Rod Aerial: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three 1/2" Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and plans 25p (FREE with parts).

**Total Building Costs £5-50** P & P. Insa. 33p (+ 10% VAT 56p)

## ROAMER SIX

Case and looks as Trans-Eight

6 Tunable Wavebands: MW, LW, SW1, SW2, SWS, Trawler band plus an Extra Medium waveband for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 2in. Speaker. 6 stages - 6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 x 6 1/2 x 2 1/2in. approx. Plans and parts price list 25p (FREE with parts).  
**Total Building Costs £3-98** P & P. Insa. 31p (+ 10% VAT 39p)

## RADIO EXCHANGE CO

61a HIGH STREET, BEDFORD, MK40 1SA Tel. 0234 52367

Reg. no. 788372

I enclose £..... for.....

Name.....

Address.....

Callers side entrance "Lavells" Shop  
Open 10-1, 2.30-4.30 Mon.-Fri.-9-12 Sat.

(Dept E.E. 8)

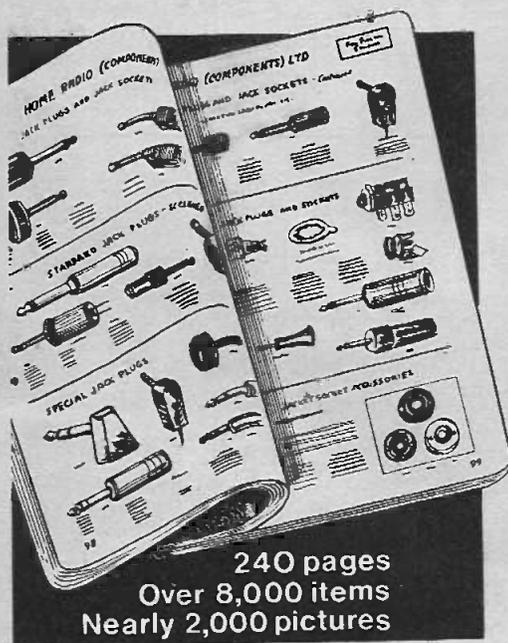
# YES, SIR!



... there are over  
**8,000 electronic  
components  
WITHIN A FEW  
FEET OF YOU!**

**That is, assuming you are on the telephone, and  
that you don't keep it at the top of the garden!**

*If you're not on the phone, the distance is between you and your nearest post box*



**240 pages  
Over 8,000 items  
Nearly 2,000 pictures**

The first thing you need, to enable you to get all your components quickly, easily, economically, is a copy of the 240 page Home Radio Components Catalogue. Apart from listing the vast range of lines we stock, the catalogue contains details of our popular Credit Account Service and many other items of useful information. For example, as there are several ways of ordering, several ways of paying and several ways of delivery, the pros and cons of all the methods are clearly set out in the catalogue. We have the reputation of providing the best-organised service ever offered to buyers of electronic components. Of course, to make good use of this service you need the catalogue. It costs 55 pence, plus 22p post and packing, and when you receive your copy you'll agree it's the best investment you've made for a long time. Moreover with the catalogue we give you 10 Vouchers each worth 5 pence against orders, an up-to-date Price List and a Bookmark with a useful list of technical abbreviations.

**Send off the coupon today. It's  
your first step to solving your  
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**Only 55p. plus 22p POST AND PACKING**

**POST THIS COUPON**  
with cheque or P.O. for 77p.

The price of 77p applies only to customers  
in the U.K. and to BFPO addresses

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**HOME RADIO (Components) LTD. (Regn. No. London 912966)  
Dept. EE, 234-240 London Road, Mitcham CR4 3HD**

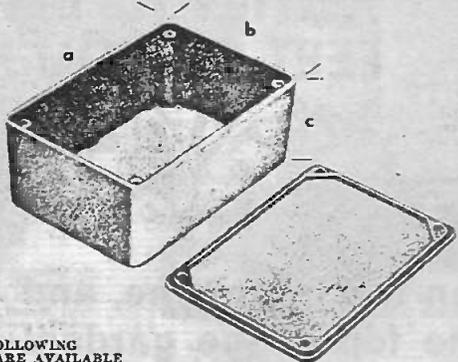


# CRESCENT RADIO LTD.

11-15 & 17 MAYES ROAD, LONDON N22 6TL  
(also) 13 SOUTH MALL, EDMONTON, N.9

MAIL ORDER DEPT.  
11 MAYES ROAD, LONDON N22 6TL  
Phone 888 3206 & (EDM). 803 1685

## PLASTIC BOXES



THE FOLLOWING SIZES ARE AVAILABLE

- 1005 — 10.5 cm x 7.8 cm x 4.7 cm — 51p
  - 1006 — 14.9 cm x 7.3 cm x 4.8 cm — 66p
  - 1007 — 18.2 cm x 12.2 cm x 6.4 cm — 86p
  - 1021 — 10.6 cm x 7.4 cm x 4.5 cm — 50p
- Post and Packing 10p  
— SLOPING FRONT 60DEG (Approx.)

### stabilised

POWER PACK / CONVERTER  
Switched 3, 6, 7½ or 9 volts.  
Up to 400mA Output



£5.25 + VAT. 16p P. & P.

### ELACHI-FI

10" Twin Cone  
Speaker.  
7 Watts  
Free Air  
40 Hz 12000 Hz



£3.75 P. & P. 20p.

### 3 KILOWATTS PSYCHEDELIC LIGHT CONTROL UNIT



Three Channel: Bass—Middle—Trebh. 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 38p P. & P.

### "CRESCENT" 100 WATT R.M.S. ALL PURPOSE AMPLIFIER U. BUILD . IT

We supply the three modules for you to build this Disco-Group-P.A. amplifier into the cabinet of your choice.

#### ★ THE POWER AMP MODULE

170W. r.m.s. sq. wave 300W instantaneous peak into 8 ohm (60W into 16 ohm). £14.28, carr. 45p.

#### ★ THE PRE-AMP MODULE

Four control pre-amp. Vol. Bass, Treble, Middle controls. Designed to drive most amplifiers using F.E.T. first stage. £3.95 carr. 25p.

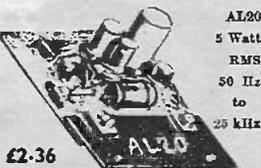
#### ★ THE POWER SUPPLY

Is supplied complete with the mains transformer. £9.66, carr. 50p. Complete fixing instructions are supplied and no technical knowledge is required to connect the three ready wired modules. A fantastic bargain. If you purchase all three modules. £25, carr. 75p. Send S.A.E. for further details on this or our ready built amplifiers.

### MAINS TRANSFORMER

200-240 PR1  
180v. 50MA SEC.  
6-3v. 1 Amp Sec.

£1.00 + 10p P. & P. EACH



£2.36

P. & P. 10p.

### CRESCENT CATALOGUE

If you construct you should own one. Send 20p inc. carriage.

### VAT

Please include 10% VAT on goods plus carriage.

## EXPRESS COMPONENTS

17, Albert Square, London, E15 1HJ



# fuzz box

INTRODUCING the first of our electronic kits for the musician, suitable for use with electric guitars and organs. Kit comes complete with wire, solder, ready drilled case and step-by-step instructions. (Batteries are not supplied).

PRICE FOR KIT OF PARTS £5.75 inc. p. & p.

#### Resistors

10Ω—2.7MΩ 1p each  
E12 ±W 5% low noise

#### Capacitors μF/V

2/25 6p  
10/10 6p  
10/25 7p  
33/25 7p  
100/10 7p  
100/40 7p  
500/25 15p  
1000/25 20p  
1000/40 25p  
2000/12 20p  
2000/50 35p  
2200/25 30p

#### Potentiometers

1k lin.  
10k lin.  
10k log.  
22k log.  
50k lin.  
100k lin.  
470k log.  
1M lin.  
All carbon track

#### Transistors

AD142 35p  
AD161/162 mp 65p  
BC107/8/9 10p  
BC184 11p  
OC71 12p  
OC75 18p  
OC204 25p  
OCP71 55p  
2N2926G 12p  
2N3704 12p

#### Diodes

OA81 8p  
OA91 8p  
IN4148 5p

#### Meters

MR38P 100μA £2.25p

#### I.C.'s

748 8-pin d.i.l. 40p  
7400 14-pin d.i.l. 18p  
NE550L TO-5 95p  
NE555V 8 pin d.i.l. 90p

#### Transformers

Mains/6V ±A 80p  
Beta M218 £1.85p

#### Miscellaneous

Crystal carpiece and socket 70p  
8, 14-pin d.i.l. sockets 18p

#### C.W.O. only add

15p p & p S.A.E enquiries



## become a RADIO-AMATEUR!

learn how to become a radio-amateur in contact with the whole world. We give skilled preparation for the G.P.O. licence

free! Brochure, without obligation to:

BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL, P.O. Box 156, JERSEY

NAME: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

EEB 84.  
BLOCK CAPS please

## RECORD PLAYBACK HEADS

(TRUVOX)

Individual prices of these are:  
2 track record playback heads 50p each.  
4 track record playback heads 72p each.  
Erase heads are also available separately:  
2 track 89p; 4 track 65p.

## NEED A SPECIAL SWITCH

Double Leaf Contact. Very slight pressure closes both contacts. 8p each, 10 for 80p. Plastic pushrod suitable for operating. 8p each, 10 for 54p.



## 1 R.P.M. MOTOR+GEAR-BOX

Made by the famous Chamberlain & Hookham Ltd. These could be made to drive clock or similar. Really robust reliable unit. Price £1-10 each.

## AUTO-ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. £8-85 plus 25p post and insurance.



## MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 8v, 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: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only £1-10, plus 20p postage.

## MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 26p each.



## MULTI-SPEED MOTOR

Six speeds are available 500, 650 and 1,100 r.p.m. and 8,000, 12,000 & 15,600 r.p.m. Shaft is 1/8 in. diameter and approximately 1 in. long. 230/240V. 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 97p plus 25p postage and insurance.



## SLIDE SWITCH

Slide Switch, 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1 1/2 in x 1/2 in rated 250V lamp. 8p each, 10 for 70p. Ditto as above but for printed circuit 8p each, 10 for 63p. Sub Miniature Slide Switch. DPDT 19mm (1/2 in approx.) between fixing centres. 20p each or 10 for £1-90. 8P Change over spring return 250V 1 amp. 11p.



## 15A ELECTRICAL PROGRAMMER

Learn in your sleep: Have radio playing and kettle boiling as you wake—switch on lights to ward off intruders—have warm house to come home to. All these and many 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 £2-15 + 20p p & p or with glass front chrome bezel 83p extra.

## BALANCED ARMATURE UNIT

500 ohm, operates a speaker or microphone, so useful in intercom or similar circuits. 87p each.



## 12 VOLT 1 1/2 AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 mA/4A smoothing. Price £2-20 + p. & p. 20p.

Heavy Duty Mains Power Pack. Output voltage adjustable from 15-40V in steps—maximum load 250W—that is from 6 amp at 40V to 15amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price £6-88 plus 65p post.

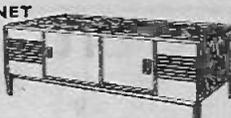


## RESETTABLE FUSE

How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only £1-10 each or £12 per dozen, specify 5, 10 or 15 amp—simply fit in place of switch.

## STEREO RADIOGRAM CABINET

Long, Low and Modern. Teak veneered with sliding front and tapered legs. Speaker shelves each end. Size approx. 4ft. 2in. x 19in. x 15in. Probably cost over £20 to make. Our Price £8-10 each.



## THIS MONTH'S SNIP ULTRA MODERN RECORD CHANGER.

Famous BSR deck with stereo cartridge. £6-95 + £1-00 post.



## 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 £3-85 as illustrated but less case.



## PORTABLE RADIO CASE DE-LUXE

A similar size to the above but a more expensive design. Used with the Good Companion de-luxe model. £2-20 plus 50p post and insurance.



## KETTLE ELEMENTS

Made by the famous A.E.I. Co. Complete with washers and combined fixing ring and plug shroud. Normal 2 round pin and flat pin earth connection and overload reset push button. 3 Models—1 1/2in (approx.) suitable for Swan and other similar models—1 1/2in (approx.) suitable for G.E.C., Hotpoint, etc. All quick boil 2 1/2kW elements at 240V. Price £1-33.

## MULLARD UNILEX STEREO SYSTEM

There is no doubt that it is a good system, we believe that for the money it is without comparison. We demonstrate gladly at our Tamworth Road depot. Prices of the individual items for this—

1 Unilex Amplifier	Ref. EP.9000	£1-60
1 Unilex Amplifier	Ref. EP.9000	£1-60
1 Unilex Pre-Amp	Ref. FP.9001	£1-80
1 Unilex Power Unit	Ref. EP.9009	£2-30

1 Control panel kit with spin aluminium faced knobs £3-30 Or the complete outfit—£11-30 post + VAT paid. Pair of 15 ohm speakers made by E.M.I. are also available if required. £3-30 the pair. No extra postage if ordered with the above, otherwise add 25p



## SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in x 18in £1-89. 13in x 10in £1-2L.



## HORSTMANN "TIME & SET" SWITCH

(A30 Amp Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc. up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Two models 15 amp £1-98, 30 amp £2-88 p & p 25p each.



## SMOKE WILL KILL—GAS WILL KILL—FIRE WILL KILL

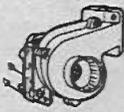
Ruf, if you install SAGA (our smoke and gas alarm) your family will have the latest electronic protection, against these killers. SAGA uses a fantastic electronic sensor which "smells" smoke and gas and sounds the alarm immediately, in a neat case measuring approx. 6in x 3 1/2in x 2 1/2in, it has its own internal alarm, also a connector for additional bells. You just plug it in to the mains and hang it near the ceiling. SAGA uses so little electricity that it will hardly move the meter, leave it on always to give night and day protection. One year's guarantee, also 7-day cash return offer. £6-99 plus 80p post and service.



OUR 1974 CATALOGUE LISTING HUNDREDS OF BARGAINS NOW AVAILABLE PRICE 30p POST PAID

## CENTRIFUGAL BLOWER

Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4 1/2" x 4 1/2" x 4". When mounted by flange, air is blown into the equipment but to suck air out, mount it from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying cabinet or for removing fux smoke when soldering etc. etc. A real bargain at £2-05



## 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 contains two special transistors and all parts including probe tube and crystal earpiece. £2-20, twin stethoscope instead of earpiece. 88p extra—post and ins. 20p.



Sensational "once in a lifetime offer" because Mullard over-produced—definitely not repeatable. Mullard's stocks (now over half sold) are cleared. Hi-Fi 4 transistor amplifier complete in case ready to use, batt., car or mains operated—freq. range 50Hz-15KHz—distortion better than 2%. Comes complete with guarantee and data FREE to purchasers. Great handbook published by Mullard tells all you need to know to build your own stereo. Complete Unilex Stereo System £11-30, pair of speakers for same £3-80.



## ELECTRIC MOTORS

7 powerful battery motors as used in racing cars and power models. Output and types vary to make them suitable for hundreds of different projects—tools, toys, models, etc. All brand new, reversible and all you need to know to build your own stereo. Complete Unilex Stereo System £11-30, pair of speakers for same £3-80.

## FREE

Details of how to make miniature power station.

## FERRITE RODS

For aerials, etc. The following types are in stock: Dia. 3", 4" long 15p. 5" long 18p. Dia. 4", 5" long 20p. 6" long 25p. 8" long 30p. Dia. 3", 4" long 20p. 5" long 25p. 6" long 30p. 8" long 40p. Dia. 3", 4" long 25p; Ferrite Slab 3" long x 3" x 1/2" 20p.

## MINIATURE SEALED RELAY

American made. Our Ref. No. REL A1 Measures only 1 1/2" wide x 3/4" thick and 1 1/2" high and it's a double change over, we don't know any contact rating but estimate this at 3/5 amp. The coil resistance is 600 ohms and 9-12 volt will close it. Ideal for models and miniaturised equipment. It's a plug in relay but we supply complete with base. Price 33p including base.

## TELESCOPIC AERIAL

For portable, car radio or transmitter. Chrome plated—six sections, extends from 7 1/2 to 47in. Hole in bottom for 6B.A. screw. 42p. KNUCKLED MODEL FOR P.M. 55p.

## TREASURE TRACER

Complete Kit (except wooden batteries) to make the metal detector as the circuit in Practical Wireless, August Issue. £2-30 plus 20p post and insurance

## MIDGET TWO GANGS

Tuning condenser as fitted to many Japanese and Hong Kong radios—probably 200pf each section with 1/2" spindle in bottom for 6B.A. screw. Price 38p, with trimmers 60p.

## NUMICATOR TUBES

For digital instruments, counters, timers, clocks, etc. Hi-vac XN.3. Price 99p each, 10 for £9.

## MAINS OPERATED SOLENOIDS

Model TT8—small but powerful 1 1/2" pull—approx. size 1 1/2" x 1 1/2" x 1 1/2". 65p. Model 400/1 1/2" pull. Size 2 1/2" x 2" x 1 1/2". 83p. Model TT10 1 1/2" pull. Size 3" x 2 1/2" x 1 1/2". £1-88 plus 20p post and insurance.

2 1/2" £1-88 plus 20p post and insurance.

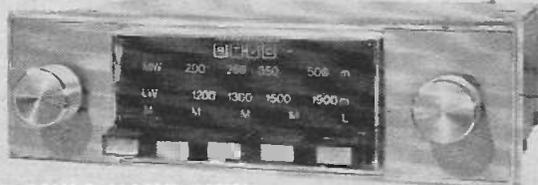
TERMS:—  
Add 10% V.A.T.  
Send postage where quoted—other items, post free if order for these items is £6.00, otherwise add 30p.

## J. BULL (ELECTRICAL) LTD.

(Dept. E.E.), 102/3 TAMWORTH RD., CROYDON CRO IXX.

# R T V C FOR AUDIO ON A BUDGET

## PUSH BUTTON CAR RADIO KIT



### The Tourist II

**NO SOLDERING  
REQUIRED!**

#### NOW BUILD YOUR OWN PUSH BUTTON CAR RADIO

Easy to assemble construction kit comprising fully completed and tested printed circuit board on which no soldering is required. All connections are simple push fit type making for easy assembly. Fine tuning push button mechanism is fully built and tested to mate with printed circuit board.

#### Technical specification:

- (1) **Output** 4 watts R.M.S. output. For 12 volt operation on negative or positive earth.
- (2) **Integrated circuit** output stage, pre-built three stage IF Module.

Controls volume manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands. Size chassis 7" wide, 2" high and 4- $\frac{5}{8}$ " deep approx

**Car Radio Kit £7.70 + 55p post. & pack.**

**Speaker** including baffle and fixing strip  
**£1.65 + 23p postage & packing**

**Car Aerial** Recommended - fully retractable and locking  
**£1.35 post paid**

## STEREO 21



### QUALITY SOUND<sup>(\*)</sup> FOR LESS THAN £19.00

Stereo 21 easy to assemble audio system kit. - no soldering required. Includes:-

**BSR 3 speed deck**, automatic, manual facilities together with ceramic cartridge.

**Two speakers** with cabinets.

**Amplifier module**. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.

For the technically minded:-

#### Specifications:

Input sensitivity 600mV; Aux. input sensitivity 120mV; Power output 2.7 watts per channel; Output impedance 8-15 ohms.

Stereo headphone socket with automatic speaker cutout.

Provision for auxiliary inputs - radio, tape, etc., and outputs for taping discs. Overall Dimensions. Speakers approx.

15 $\frac{1}{2}$ " x 8" x 4". Complete deck and cover in closed position approx. 15 $\frac{1}{2}$ " x 12" x 6". Complete only **£18.95**

Extras if required.

Optional Diamond Style: **£1.37**

+£1.60 p & p.

Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance. **£3.85.**



## DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.

Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).

Inputs \*4 Electrically Mixed Inputs \*3 Individual Mixing controls. \*Separate bass and treble controls common to all 4 inputs

\*Mixer employing F.E.T. (Field Effect Transistors). \*Solid State Circuitry. \*Attractive Styling.

#### INPUT SENSITIVITIES

Input 1.) Crystal mic. guitar or moving coil mic. 2. and 10 mV. (selector switch for desired sensitivity. -Inputs-2). 3). 4. Medium output equipment - ceramic cartridge, tuner, tape recorder, organs etc.

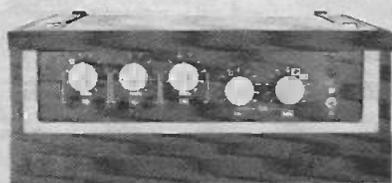
- all 250mV sensitivity.

AC Mains 240V. operation.

Size approx. 12 $\frac{1}{2}$ " ins x 6 ins x 3 $\frac{1}{2}$ " ins

**£15.00 + 60p. post & pack**

## DISCO 50

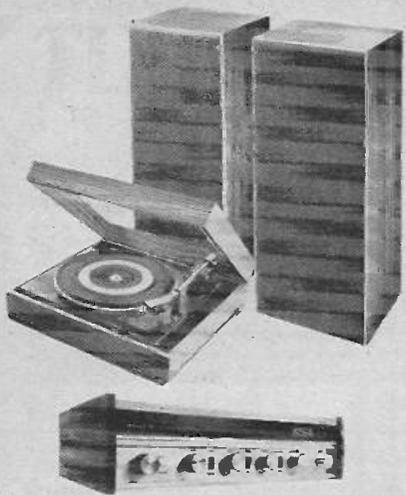


### 45 WATT R.M.S. MONO DISCOTHEQUE AMPLIFIER

Ideal for Disco Work. Output Power: 45 watts R.M.S. Frequency Response 3dB points 30Hz and 18KHz. Total Distortion: less than 2% at rated output. Signal to noise ratio: better than 60dB. Bass Control Range: 13dB at 60Hz. Treble Control Range: 12dB at 10KHz. Inputs: 4 inputs at 5mV into 470K. Each pair of inputs controlled by separate volume control. 2 inputs at 200mV into 470K. Size: 19 $\frac{1}{2}$ " x 10 $\frac{1}{2}$ " x 8ins. approx. Amplifier **£27.50 + £1.50 p. & p.**

**Special Offer:** Disco 50 plus two 15" E.M.I. speakers type 14A/780 (as illustrated on opposite page). **Complete £57.00 + £4.00 p&p.**

# COMPLETE(\*) STEREO SYSTEM



**£51-00**

40 Watt Amplifier.  
Viscount III - R102 now 20 watts per channel.  
System I includes,  
Viscount III amplifier - volume, bass, treble  
and balance controls, plus switches for mono/  
stereo on/off function and bass and treble  
filters. Plus headphone socket.

**Specification**  
20 watts per channel into 8 ohms.  
Total distortion @ 10W @ 1kHz 0-1%. P.U.1 (for  
ceramic cartridges) 150mV into 3 Meg. P.U.2  
(for magnetic cartridges) 4mV @ 1kHz into 47K.  
equalised within -1dB R.I.A.A. Radio 150mV  
into 220K. (Sensitivities given at full power).  
Tape out facilities: headphone socket, power  
out 250mV per channel. *Tone controls and filter  
characteristics.* Bass: +12dB to -17dB @  
60Hz. Bass filter: 6dB per octave cut. Treble  
control: treble +12dB to -12dB @ 15kHz.  
Treble filter: 12dB per octave. *Signal to noise  
ratio:* (all controls at max.) -58dB.  
Crosstalk better than 35dB on all inputs.  
Overload characteristics better than 26dB on all  
inputs. Size approx. 13 1/2" x 8" x 3 1/2"  
Garrard SP25 deck, with magnetic cartridge,  
de luxe plinth and hinged cover.  
Two Duo Type II matched speakers -  
Enclosure size approx. 17 1/2" x 10 1/2" x 6" in  
simulated teak. Drive unit 13" x 8" with parasitic  
tweeter. 10 watts handling

**Complete System £51.00**

**£69-00**

**System II**  
Viscount III amplifier (As System I)  
Garrard SP. 25 (As System I)  
Two Duo Type IIIA matched speakers—  
Enclosure size approx. 31" x 13" x 11 1/2".  
Finished in teak veneer. Drive units approx.  
13 1/2" x 8 1/2" with 3 1/2" HF speaker. Max. power  
20 watts. 8 ohms. Freq. range 20Hz to 20kHz.

**Complete System £69.00**

**PRICES: SYSTEM 1**  
Viscount III R 102 amplifier £24-20 + £1 p & p  
2 Duo Type II speakers £14-00 + £2-20 p & p  
Garrard SP25 with  
MAG. cartridge de luxe plinth  
and hinged cover \* £21.00 + £1.75 p & p.  
total £59.20

Available complete for only **£51.00 + £3-50 p. & p.**

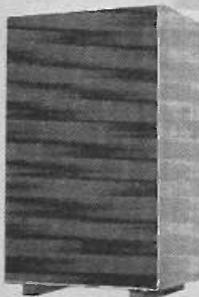
**PRICES: SYSTEM 2**  
Viscount R102 amplifier £24-20 + £1-00 p. & p.  
2 Duo Type IIIA speakers £39-00 + £4-00 p. & p.  
Garrard SP25 with  
MAG cartridge de luxe plinth £21-00 + £1-75 p. & p.  
and hinged cover total £84-20

Available complete for only **£69.00 + £4 p & p.**

## EMI SPEAKERS AT FANTASTIC REDUCTIONS

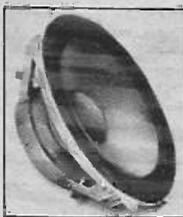
**THE ULTIMATE COMPLETE SPEAKER SYSTEM  
EMI LE 315**

List Price **£86.00**



A professional standard five way speaker  
system with enclosure giving top quality  
performance.  
**Enclosure Dimensions**  
approx. (3ft. x 2ft. x 1ft.).  
**Drive Units**  
Hand built - 15" diameter bass with 3"  
voice coil. - two 5" diameter Mid Range  
units, - two 3 1/2" HF. units, plus matching  
crossover panel with two variable  
potentiometers for mid and high frequency  
adjustment.  
**Power Handling**  
Continuous rating 35 W rms., Peak power  
rating 70 W.  
**Frequency Response**  
20 Hz to 20,000 Hz. Imp. 8 ohms.

Our price **£45-00 + £3-50 p. & p.**



**15" 14A/780 BASS UNIT**

Bass unit on a rigid diecast chassis.  
Superior cone material handles up to 50  
watts RMS, and is treated to give a smooth  
frequency response. Resonance 30 Hz. flux  
density 360,000 Maxwells. Impedance at  
1 kHz is 8 ohms. 3" voice coil.

Recommended retail price **£40-80.**

**OUR PRICE £18-70 + £1-50 p & p + £1-50 p & p Special Offer.**



**950  
KIT**

Five matched speakers and crossover unit  
for handling up to 45 watts, frequency  
response from 20 to 20,000 Hz.  
Huge 19" x 14" (approx.) high efficiency  
Bass-Speaker with 16,500-gauss magnet  
built on a heavy diecast frame.  
The four 10,000 gauss tweeters, each 3 1/2"  
dia. approx., are fed by the crossover which  
critically adjusts signal for maximum  
fidelity. Impedance at 1 kHz is 8 ohms.  
Bass coil 2", others 0-5". Recommended  
list price £44-00. **OUR PRICE £19.50**



**BUILD YOUR OWN  
STEREO AMPLIFIER(\*)**

For the man who wants to design his own stereo - here's your chance to start,  
with Unison - pre-amp, power amplifier and control panel. No soldering -  
just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV  
(for ceramic cartridge). The heart of Unison is high efficiency I.C. monolithic  
power chips which ensure very low distortion over the audio spectrum.  
240V. AC only.

**£7-64 + 55p. p & p**



**8 TRACK CARTRIDGE  
PLAYER(\*)**

Elegant self selector, push button player for use with your stereo system.  
Compatible with Viscount III system, Unison module and the Stereo 21.  
Technical specification Mains input, 240V, Output sensitivity 125mV  
Comparable unit sold elsewhere at £24-00 approx.

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The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter for any car with normal coil ignition system.

**£1-10p** each

## Ex GPU Push Button Intercom Telephones

Exactly as internal telephone systems still in everyday use where automatic internal exchanges have not yet taken over. Available in 5, 10 or 15 ways. Complete with circuits and instructions. Price of each instrument is independent of the number of ways. Please phone for latest details of cable.

**£2.75 p.p. 38 1/2p** Per Instrument

Extension Telephones. 71p each. p.p. 27 1/2p. £1-37 1/2 for 2. P.&P. 55p. These phones are extensions and do not contain bells.

## New X Hatch

Our new vastly improved Mark Two Cross Hatch Generator is now available

Essential for alignment of colour guns on all colour T.V. receivers. Featuring plug in IC's and a more sensitive sync. pick-up circuit. The case is virtually unbreakable—ideal for the engineer's tool box—and only measures 3" x 5 1/2" x 3"

Ready built unit only **£10-92** Complete kit **£8-72** (includes V.A.T. and p. & p. but no batteries)



## LM380 AUDIO IC

We have just received a large consignment of LM380 IC's. These are specially selected to a higher grade and are marked with the number SL60745.

This fantastic little 3 watt audio IC only requires two capacitors and two potentiometers to make an amplifier with volume and tone control. The quality is good and has to be heard to be believed.

Our special price **£1-10** ea complete with data and projects book

## Over 1,000,000 Transistors

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We hold a very large range of fully marked, tested and guaranteed transistors, power transistors, diodes and rectifiers at very competitive prices. Please send for free catalogue.

### Our very popular 4p transistors

TYPE "A" PNP Silicon alloy, TO-5 can  
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TYPE "G" NPN Silicon similar ZTX 300 range  
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**8 RELAYS FOR VARIOUS TYPES P & P 27 1/2p £1-10p**

## UHF TV Tuner Units

Brand new by a famous manufacturer

Data supplied **£2.75**

## Plastic Power Transistors

NOW IN TWO RANGES



These are 40W and 90W Silicon Plastic Power Transistors of the very latest design, available in NPN or PNP at the most shatteringly low prices of all time. We have been selling these successfully in quantity to all parts of the world and we are proud to offer them under our Tested and Guaranteed terms.

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High Speed Magnetic Counters 4 digit (non-reset) 24V or 48V 4 x 1 x 1in 33p p & p 5p.

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### BUILD THIS RADIO

Portable MW/LW radio kit using Mullard RF/IF module. Features MW—bandspread for extra selectivity. Slow motion tuning. Fibre glass PVC cabinet. 600MW output. All parts £7-98 (battery 22p), carr. etc. 32p.



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CHANNELS 21 TO 64  
Brand new transistorised geared tuners for 625 Line Receiver IF output. £2 50, Post 20p.



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New purchase of 4 button transistorised uhf tuner. £3 50 + post 20p.

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- ALL KITS OFFERED SUBJECT TO STOCK AVAILABILITY
- Prices correct at time of preparation. Subject to change without notice.



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MW/LW Radio Turner to use with any amplifier. Features Mullard RF/IF module Ferrite aerial, built in battery. Excellent results. Size 7" x 2 1/2" x 3 1/2". All parts £5 25, carr. 15p.

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Suitable alternative to SL403D.  
5/30 volt operated. 8/16 ohm  
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With circuits and data £1 95.  
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ZFT4A. Suitable for December 73 Pract. Electronics £3 50.  
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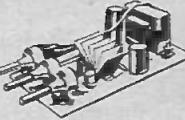
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2-2	—	—	—	—	11p	—	—	8p
4-7	—	—	—	11p	—	—	—	8p
10	—	—	—	—	8p	8p	8p	8p
22	—	—	8p	—	8p	8p	8p	8p
47	8p	—	8p	8p	8p	8p	8p	8p
100	9p	8p	8p	8p	8p	8p	8p	8p
220	8p	8p	8p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
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### Easy to assemble

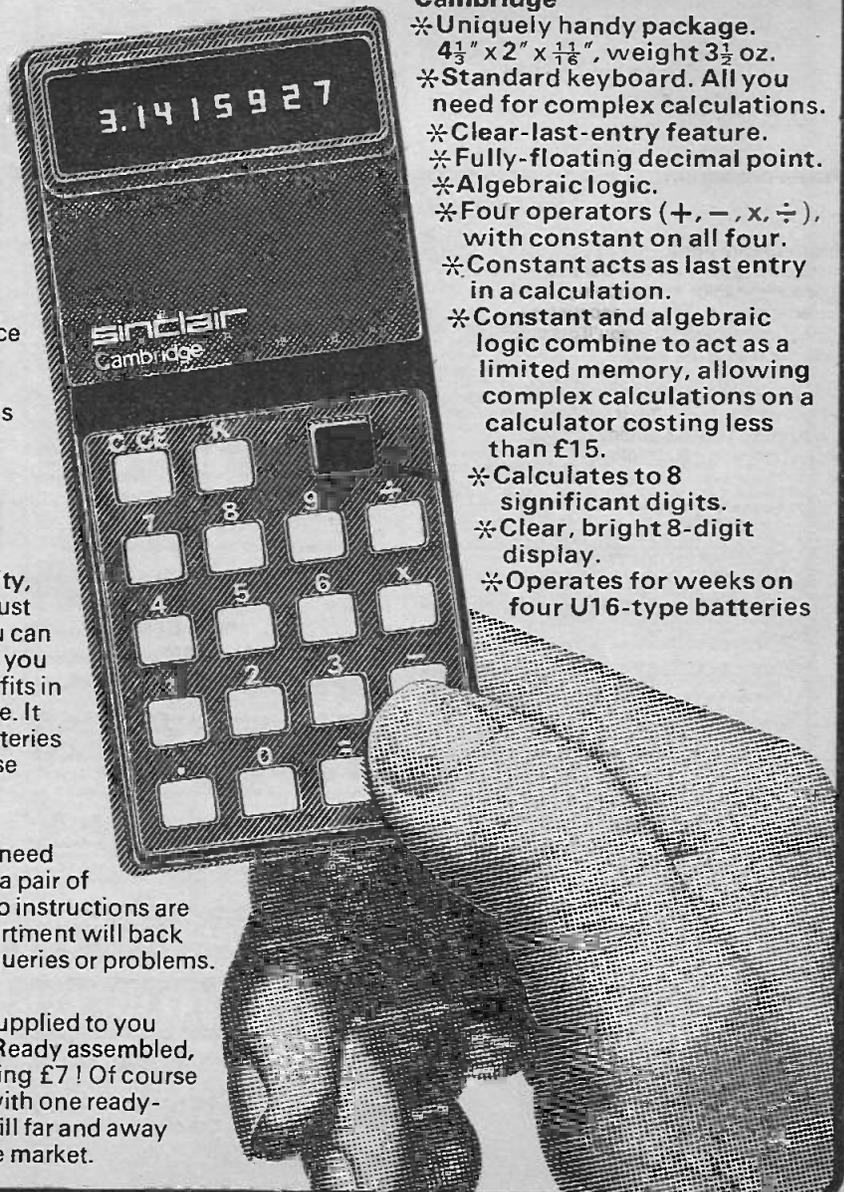
All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our service department will back you throughout if you've any queries or problems.

### Total cost? Just £14.95!

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### Features of the Sinclair Cambridge

- \* Uniquely handy package.  $4\frac{1}{3}'' \times 2'' \times \frac{1}{8}''$ , weight  $3\frac{1}{2}$  oz.
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- \* Fully-floating decimal point.
- \* Algebraic logic.
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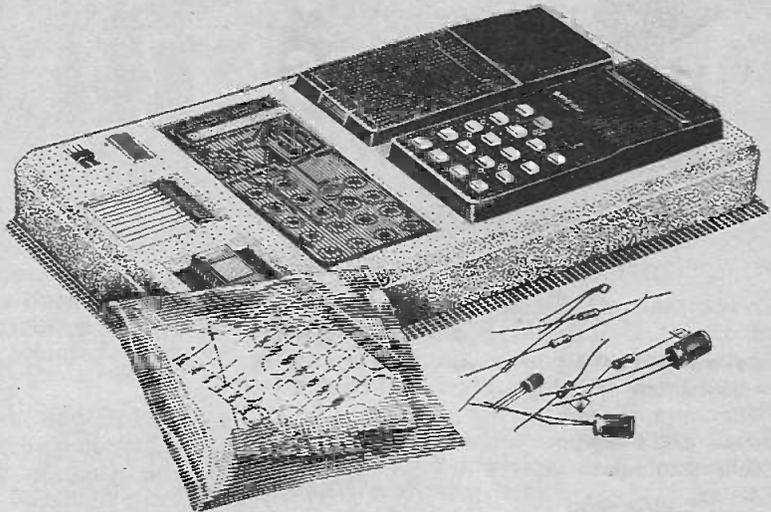


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If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

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# everyday electronics

PROJECTS....  
THEORY.....

## CURRENT PROBLEMS

Conventions are not always soundly based on logic or fact. Despite this it is sometimes preferable and convenient to continue to accept certain traditional beliefs rather than to be entirely rational.

Take, for example, the direction of electric current flow. It is generally known that time-honoured ideas conflict with scientific fact substantiated long after the idea of "positive to negative" had become firmly established. So like it or not, we have the terms conventional current (positive to negative) and electron current flow (negative to positive) in common usage. All very confusing. Or is it really so?

In elementary instruction electricity is often depicted as something similar to water in a system of pipes, and flowing from a high level, or pressure, downwards. Thus "positive" or high pressure always seems perfectly natural at the top of a drawn circuit diagram, with negative at the bottom.

This custom helps to preserve in our minds the idea of current flowing from positive to negative. And this convention is perfectly acceptable when considering a circuit from a purely electrical point of view.

However when looking closely into the operation of the electronic devices such as diodes and transistors (and of course thermionic valves) we cannot evade scientific truth and so have to perform some mental gymnastics, and reason everything out in an *electron flow* sense; that is, from negative to positive.

But let newcomers be quickly reassured—it sounds much more difficult and confusing than it is in practice. This two-way approach to currents becomes second nature in a short while.

## A FALSE REMEDY

Not surprisingly, the apparent absurdity of the situation has brought forth from time to time demands that everyone should think exclusively in terms of electron flow. This apparently simple remedy will not do however. The custom of thinking in terms of positive to negative is too firmly engrained.

Yet far more disturbing to our mind is the rumour that some "enlightened" educationalists have not merely abandoned conventional (positive to negative) current in their teachings but have actually purloined this term and misapplied it to mean electron flow. If this is actually so, it is to be greatly deplored.

The confusion caused by such independent defiance of widely accepted conventions must build up a store of problems for the future. We have indeed already encountered some of these problems through correspondence from a few readers, all of whom have presumably been brought up in the belief that in this electronic era conventional current is as dead as the dodo.

Those who are still perplexed should find this month's *Down to Earth* helpful in unravelling this conundrum of the currents.

*Fred Bennett*

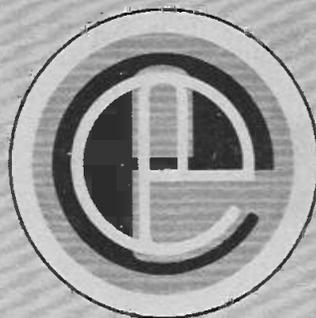
Because of prevailing production problems, no firm publishing date can be announced for the September issue. Readers are advised to check regularly with their local supplier from mid-August onwards.

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# EASY TO CONSTRUCT SIMPLY EXPLAINED



VOL. 3 NO. 8

AUGUST 1974

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## NEWSAGENT



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# LIGHTS - ON ALERT

By E.J. BYATT



Produces an audible tone when the driver inadvertently leaves on the car side lights.

IT IS quite common, especially during the winter months, to see car headlights unintentionally left on while the owner is at work. When he returns he finds the car difficult to start because the battery has run down and become flat.

In the light of experience this unit has been devised so that if the sidelights of the car are on when the ignition switch has been turned off, an audible warning is sounded to bring the driver's attention to this fact.

## CIRCUIT

The circuit diagram of the unit is shown in Fig. 1 and can be visualised in three parts, the oscillator, amplifier and control switch.

The oscillator is the common unijunction relaxation type and comprises TR1, R1, R2 and C1.

When the battery is connected to the circuit, capacitor C1 charges up at a rate controlled by the value of R2.

While the potential at the emitter of TR1 is below a certain value the resistance between emitter and base 1 is, to all intents and purposes, infinite, but when a threshold level is

reached at the emitter this resistance becomes almost zero and the capacitor discharges through this path.

Once discharge has taken place the capacitor begins to charge again and the process is repeated, and continues for as long as the battery supply is connected.

Thus the voltage seen at the emitter is approximately a sawtooth waveform formed by the charge and discharge contours of the capacitor.

This sawtooth wave is coupled to the base of TR2 by C3, which blocks any d.c. content. Transistor TR2 is connected in the common emitter mode and is operated in an overdriven state. That is to say the output at the collector is a clipped sawtooth and becomes an approximate square wave.

The output of TR2 is directly coupled to the base of TR3 which amplifies the signal to feed the loudspeaker, LS1. Resistor R2 determines the output volume by controlling the current through TR3.

The oscillator frequency may be changed by altering the value of R2 slightly. Resistor R6 is selected by using the highest value possible without sacrificing volume and will probably lie in the range 47 ohms to 1 kilohm. In the prototype a value of 470 ohms was found satisfactory. Components R3 and C2 form decoupling between the amplifier stages and the oscillator, values are not too critical but C2 must be at least 100 microfarads.

If the output tone is too harsh a capacitor can be inserted between TR3 collector and base. Too large a value will reduce the output volume, try experimenting with capacitor values about 0.01 microfarads.

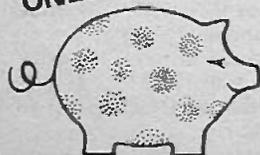
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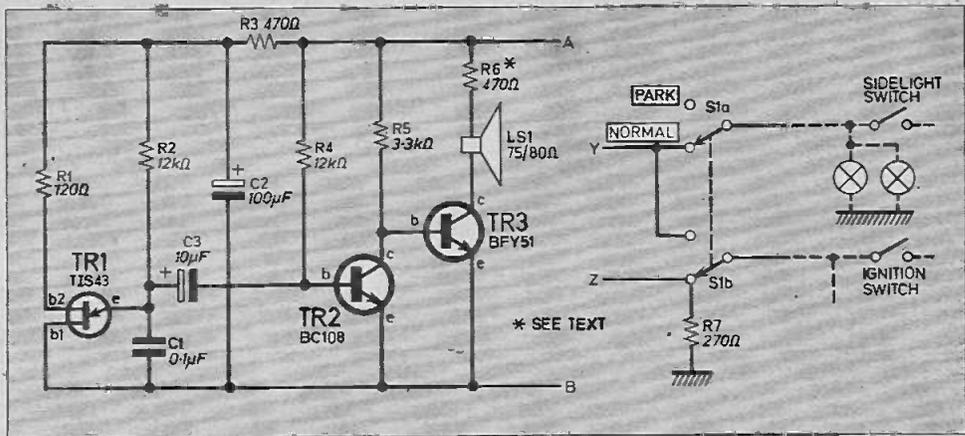


Fig. 1. Circuit diagram for the Lights-On Alert.

### CONTROL SWITCH

The control switch, S1 determines the mode of operation by selecting the potentials to the supply rails of the circuit A and B.

This switch has two positions, "park" and "normal"; Table 1 gives a summary of events for the various positions of the three relevant switches.

It is seen that for S1 in the "normal" position the alarm is only sounded when the sidelights are on and the ignition switch is switched off as is the case when leaving the car parked after driving with the lights on, and forgetting to turn them off.

If it is required to park the car with the lights on, S1 should be set to "park" when the ignition is switched off.

### CONSTRUCTION DETAILS

The prototype unit was constructed on a piece of 0.1in matrix Veroboard size 33 holes by 24 strips and was housed in a readily available Eddystone diecast box, size 115 x 90 x 55mm.

The layout of the components on the topside of the Veroboard is shown in Fig. 2; the layout is not critical and can be changed if desired. There are no breaks along the copper strips on the underside of the board.

Table 1: Possible switching arrangements

Ignition switch	Sidelight switch	Alarm	S1 position
On	Off	Off	Normal
On	On	Off	
Off	Off	Off	
Off	On	On	
On	Off	Off	Park
On	On	On	
Off	Off	Off	
Off	On	Off	

Begin construction by drilling the four fixing holes and then assembling the components on the board according to Fig. 2. The transistors should be soldered in place last of all and a heatshunt used to avoid thermal damage from the hot soldering iron.

Now prepare the diecast box to accept the components S1 and LS1, and the four fixing bolts. A hole drilled at one end of the box and plugged with a rubber grommet allows the three external wires to pass through.

Fix the case mounted components in position and wire up to the board as detailed in Fig. 2

## Components....

### Resistors

- R1 120Ω
- R2 12kΩ
- R3 470Ω
- R4 12kΩ
- R5 3.3kΩ
- R6 —see text
- R7 270Ω 1W carbon
- All ½W ±10% carbon

### Capacitors

- C1 0.1μF
- C2 10μF elect. 16V
- C3 100μF elect. 16V

### Transistors

- TR1 TIS43
- TR2 BC108 silicon npn
- TR3 BFY51 silicon npn

### Miscellaneous

- S1 d.p.d.t. toggle or slide
- LS1 miniature loudspeaker with coil impedance of 75–80 ohms
- Veroboard: 0.1in matrix 24 strips x 33 holes ;
- Eddystone diecast box size 115 x 90 x 55mm ;
- 4BA nuts, bolts, washers and spacers (4 off each); rubber grommet

SEE  
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TALK**

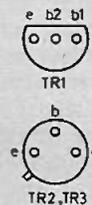
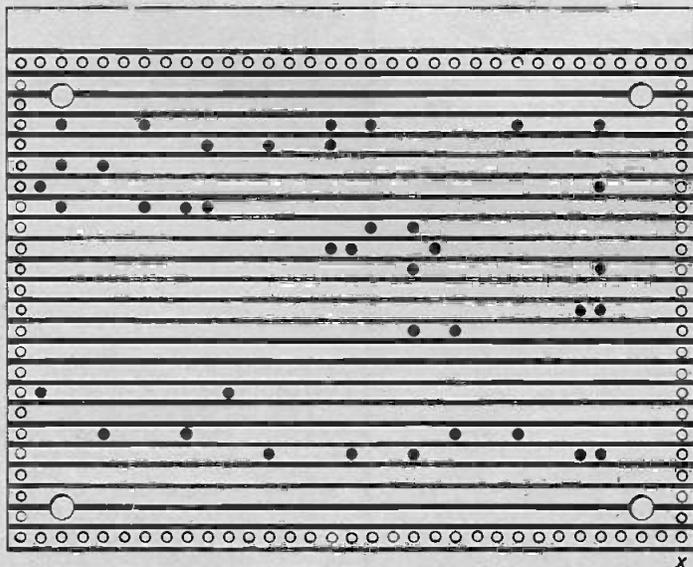
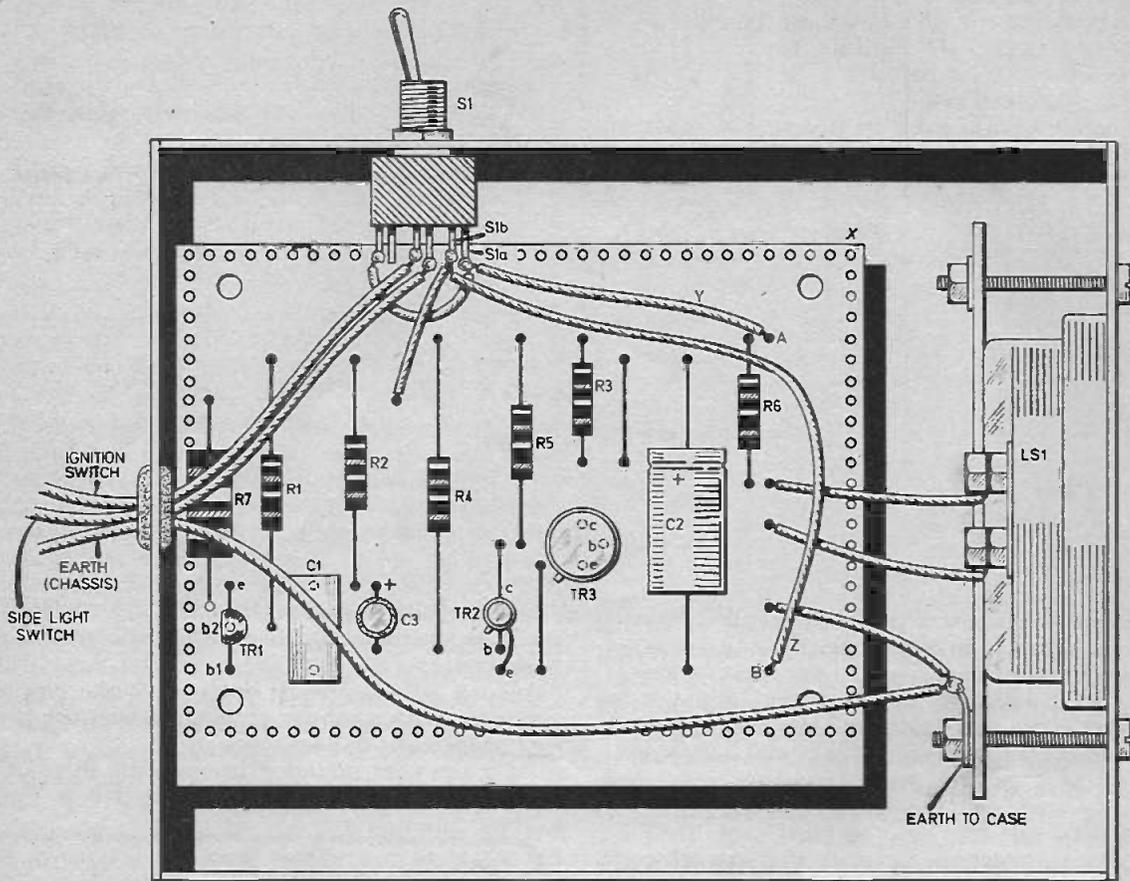


Fig. 2. Layout and wiring of the complete Lights-on Alert. Wiring is shown for negative earth, for positive earth move wire Y to point B and wire Z to point A.

according to the polarity of the car in which the unit is to be fitted.

When complete, the board should be secured in position by means of the four fixings; 10mm stand-off spacers must be used to prevent shorting of the board and case.

Thoroughly check out the wiring and when satisfied feed the three external wires (three different colours are recommended) out through the grommet and screw the lid in place. The switch positions should be labelled "park" and "normal" as shown. The unit is ready for installation in the car.

## INSTALLATION AND USE

The unit should be fitted in a position within easy reach of the driver of the car. It is not necessary that the box makes contact with the car chassis as one of the flying leads provides this connection.

Connect the earth lead from the unit, to a good earth point on the car using a solder tag, nut, bolt and sprung washer.

Connect the lead from S1b pole to a tag on the ignition switch where power is supplied only when the ignition is switched on.

The lead from S1a pole should be connected to the sidelight switch on the same side as the connection to the sidelight lamps. The installation is complete.

## TESTING AND USE

Set S1 in the "normal" position and switch on the sidelights. The audible tone should be heard. Switch on the ignition and the tone should cease. Switch off the ignition and the tone should be heard again and will stop when the sidelights are switched off.

Now set S1 to "park" and turn on the sidelights. No tone should be heard. Switching on the ignition will cause the alarm to sound and this then can only be muted by switching to the "normal" position.

If all the above results are observed the unit is functioning satisfactorily. Now the unit is fitted in the car, and it is not required to have the sidelights on, set S1 at "normal."

In the event of the lights being unintentionally left on once the ignition has been turned off, the alarm will sound and can only be stopped by either switching off the lights, or if parking lights are required, by putting the control switch to "park." When the driver next switches on the ignition the alarm will sound to tell him that the lights are on and the switch must be returned to "normal" before the alarm ceases.

This circuit is foolproof in that it cannot be "turned off" and will always give an indication of the lights being left on unintentionally.



## ...Counter Intelligence

BY PAUL YOUNG

*A retailer discusses component supply matters.*

WHEN there is a shortage of any commodity the person who is usually the last to be aware of it, is the ultimate consumer, in other words *you* the reader!

At least six months ago we were feeling the pinch and several months before that the manufacturers were crying out for raw materials. This was before the coal and oil problem, both of which have undoubtedly accentuated our difficulties, (many of the plastics are oil by-products).

Our old friends R. S. Components Ltd., who always made a point of keeping at least six months stock in reserve, were now running out of items much quicker. Firms whose production lines had ground to a halt, would come to us to buy three or four thousand capacitors at the full price. Only yesterday one firm wanted one hundred Bulgin knobs. We, as you all know, regard ourselves as strictly retail, and I have had to issue firm instructions

to our staff, that they must not run our stocks down, to satisfy one "trade" customer, and by so doing, create one hundred disgruntled customers!

The point is, what can we, the retailer do, and you the customer do, to minimise this frustration? We certainly are trying very hard to help you: I personally have demanded to see every order where we cannot supply 100 per cent of the goods requested. I then advise the staff where I think a substitute will be acceptable.

For example, a customer will order 15 $\mu$ F 10V capacitor; we are out of stock, but we have in stock 15 $\mu$ F at 25V. Unless physical size is of paramount importance this will obviously do. You may order a  $\frac{1}{4}$  watt 5 per cent resistor and we lack the particular value you require; all right, we have one in  $\frac{1}{2}$  watt, so we send that.

I am sure that 99 per cent of our customers would rather receive something that is usable

rather than nothing at all! For your part I would advise the following, be patient and *don't* re-order an out-of-stock item until you have checked with the firm concerned *first* (by telephone if possible). Most mail order firms are probably handling upwards a thousand orders a week. If you have had one order returned, with certain goods out of stock, don't wait a couple of weeks and re-order regardless. Because if you do, when the firm receive it, they may well feel they cannot send the order straight back to you again, and whatever they do with it, it will be easily overlooked, and the goods you want may come in and be sold again, while your order gathers the dust! Remember too, that in the circumstances that prevail to-day *no-one* can give you an accurate forecast of delivery!

It will help us tremendously if on the goods you order, you give the *widest possible* specification. For example resistors  $\frac{1}{8}$  to  $\frac{1}{2}$  watt, tolerance 2-20 per cent. With capacitors choose the lowest voltage you can possibly use. You will see that this gives us far more scope for finding you something.

**New products and component buying for constructional projects**

# SHOP TALK

By Mike Kenward

OUR brief note concerning the supply of transistors for the *Transistor Assisted Ignition* last month underlines the general component supply problems that face retailers at the present time. It is not unusual to find a supplier quoting a delivery date and two or three weeks after it has passed, quoting a new date a month or two in the future.

Unfortunately, it is not always possible to blame the manufacturer as he can easily be let down on supply of raw materials such as plastic, which—as we are constantly being told—there is a world shortage of. Although some delays are unnecessary, we must ask readers to be more patient than usual and for once spare a thought for the retailer who is the “man in the middle” in this situation. We all know he is in business to make a profit but we

should also realise that it is not in his interest to delay the supply of components.

## Radiation Monitor

The halogen quenched gamma counter tube (CV2247)—to give the Geiger tube its correct name—for the *Radiation Monitor* is available from Henry's Radio, for £1.25 plus V.A.T. plus 20p post and packing—we make that about £1.58.

A suitable transformer for this project should be available from most of the larger suppliers—the transformer and case must be compatible. We suggest you obtain the transformer and C4 and C5 before buying the case, since these components must be able to fit into the case side by side.

## Heads or Tails

The components most likely to be difficult to get hold of for the *Heads or Tails* game are, surprisingly enough, the 6V 0.06A bulbs. However, these are supplied by R. S. Components, and can be ordered by any supplier from them.

The integrated circuit is generally available for around 20p and should not cause any problems. It is a good idea to order a holder for the i.c. when purchasing it.

## Lights-On Alert

Almost all the components for the *Lights-On Alert* are readily available, only the 75 ohm loudspeaker may cause problems, and Henry's Radio can supply this for

60p plus V.A.T., plus 15p post and packing—81p!

The diecast box used for housing the prototype is eminently suitable for use in cars as it is very robust and quite easily machined. Most of the larger component suppliers provide these boxes.

## Experiment in Headphone Stereo

In the final design described in the *Experiment In Headphone Stereo* article on 8 $\mu$ F non polarised capacitor is called for—the author utilised a paper type but since these are hard to find we have suggested the use of four 2.2 $\mu$ F Mullard C280 types, wired in parallel—this gives 8.8 $\mu$ F but is near enough to the required value.

The high voltage resistors and the low value potentiometers may prove difficult to get, but these should be available from the larger suppliers—it does seem that we use that term quite often, but we cannot quote a single supplier when we know that a number of suppliers can provide particular components. Although these particular components may not be readily available, when we know of more than two or three suppliers it is not fair to quote the name of only one, and not possible to quote them all with prices etc., so you must do some hunting.

The headphones mentioned in the text have not been recommended by us, they are quite simply those that the author purchased—any 8 ohm to 16 ohm stereo types will do.

## JACK PLUG & FAMILY...

TELL ME SOMETHING — IF YOU'RE TESTING YOUR SOUND-IMPROVEMENT DEVICE, AND NOT JUST WEARING...



...THOSE HEADPHONES SO THAT YOU CAN'T HEAR ME CONTINUOUSLY NAGGING YOU TO MOW THE LAWN...



...HOW COME THERE'S NO RECORD ON THE TURNTABLE?





# HEADS or TAILS

A simple electronic game.

By M.G. ARGENT

**T**his unit is an electronic version of a heads and tails game, which is simple and inexpensive to build. An integrated circuit is used to simplify the construction.

## CIRCUIT

The circuit is shown in Fig. 1, TR1 and TR2 form an astable multivibrator which is the timing circuit of the unit. The output from either of the collectors is a square wave as shown in Fig. 2a. The waveform is a series of square pulses where the pulse, or mark as it is known, is the same width as the space between the pulses.

The diagram in Fig. 2a is correct, as the mark and the space are of equal width. Fig. 2b is incorrect as the mark is much shorter than the space. The reason for having a 1:1 mark/space ratio is that when the output from TR2 collector is a pulse (mark), one of the lamps will light up, and when the output is at 0V (space) the other lamp will light, so the mark/space ratio must be 1:1 otherwise one lamp will be on longer than the other.

The square wave output is taken from TR2 collector via the spin switch (S1) to the integrated circuit IC1. The IC consists of two NAND gates wired as a bistable or memory store. A NAND gate is an electronic switch with two or

more inputs and one output. When all of the inputs to the gate are at +5V, the output is at 0V. In other words the output is the inverse of the input.

To change the state of the gate, only one of the inputs need be taken to 0V, regardless of the condition of the remaining inputs, and the output will then change to +5V. In "computer language" the +5V state is referred to as a logical "1" level, and 0V is referred to as logical "0" level.

## IC OPERATION

The operation of IC1 is as follows. Referring to Fig. 3, if a logical 1 level is applied to pin 9, pin 8 will go to logical 0, taking with it pin 5, this turns on LP2 and changes pin 6 to logical 1

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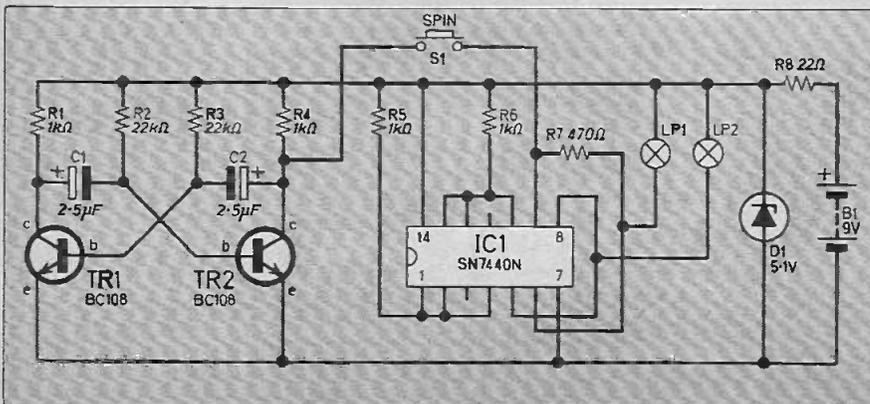
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\*Based on prices prevailing at time of going to press



**Fig. 1. Complete circuit diagram of the Heads or Tails game.**

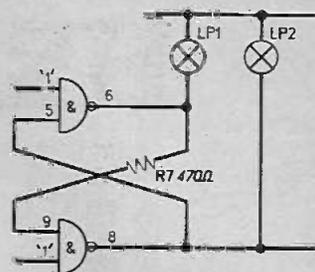
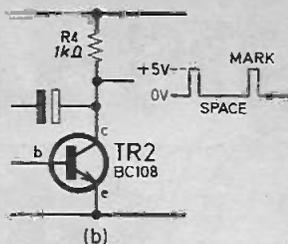
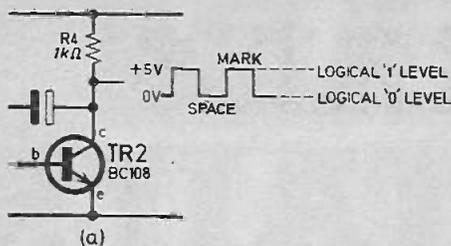


Fig. 2a. Equal mark to space ratio of a correctly balanced output (b) incorrect mark to space ratio.

Fig. 3. Showing the wiring of the two NAND gates in IC1.

turning off LP1. IC1 will stay in this state as long as the input to pin 9 is not taken to 0V.

If pin 9 is now taken to logical 0, pin 8 will turn to logical 1, turning off LP2 and taking with it pin 5 which turns pin 6 to logical 0, turning on LP1. IC1 will now stay in this state until pin 9 is taken to logical 1.

When the spin switch is operated, the square wave output from TR2 collector, which alternates between logical 0 and logical 1 level makes the bulbs light alternately, when the spin switch is opened IC1 will stay in which ever state it was in immediately before the switch was opened.

As stated earlier, IC1 is used in this circuit as a bistable or memory store, which is a switch which will remain in whatever state (logical 1 or logical 0 level) it was left in, until it is triggered over by an input, which in this case is the output of TR2 collector via the spin switch.

The speed of the multivibrator is slow enough to appreciate the operation but too fast for anyone to follow the sequence, which would enable players to cheat. A frequency of 10 hertz was chosen to be best, and as the mark/space ratio is 1:1 there is no bias towards one lamp staying lit longer than the other.

The integrated circuit used is the SN7440N which is capable of driving low power bulbs directly, without the need for additional transistors. This IC requires a supply voltage of 5V and D1 and R8 are provided to limit the supply voltage to approximately this value.

## CONSTRUCTION

All the components except the lamps and switch are mounted on a piece of 0.1 inch matrix Veroboard size 16 holes by 20 strips. The components are mounted as shown in Fig. 4, and the reverse with cutaways is also shown. The cutaways can be made with a small drill or the special spot face tool available. Care must be taken especially when soldering IC1, so as not to overheat it. If the board is clean and free from grease there should be no trouble in making a quick clean joint (an IC holder will eliminate this trouble).

The board, battery and bulbs are assembled into a small tin, in the prototype this was

originally a throat pastille tin, there is no reason why any other container should not be used. The main idea is to keep the project simple and cheap to build.

As the tin used by the author was very small, no on/off switch was used, but this presented no problem as the lid can be lifted and the battery connected when required. If a larger tin is used, a switch can be incorporated in series with the battery lead. The spin switch is on a flying lead on the prototype, but again this can be built into a larger tin. The preference is up to the constructor.

Complete the unit by wiring up all the parts (S1, B1 and LP1 and 2) as shown in Fig. 4, and fitting inside the box. In operation, when S1 is pressed both lights will light rather dimly (they are only on half the time) and when S1 is released one lamp will stay lit while the other extinguishes. □

## Components . . . .

### Resistors

R1 1kΩ	R5 1kΩ
R2 22kΩ	R6 1kΩ
R3 22kΩ	R7 470Ω
R4 1kΩ	R8 22Ω
All ¼ W ± 10% carbon	

### Capacitors

C1 2.5μF elect. 6V
C2 2.5μF elect. 6V

### Semiconductors

TR1 BC 108 silicon npn
TR2 BC 108 silicon npn
IC1 SN 7440N integrated circuit and holder to suit
D1 5.1V 300mW Zener diode

### Miscellaneous

LP1,2 6V 0.06A bulbs (2 off)
S1 Push to make release to break push button
B1 9V PP9 battery and connecting clip
Veroboard 0.1 inch matrix 20 strips by 16 holes, 2 rubber grommets to hold bulbs, case (see text), connecting wire.

SEE  
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TALK**

# HEADS or TAILS

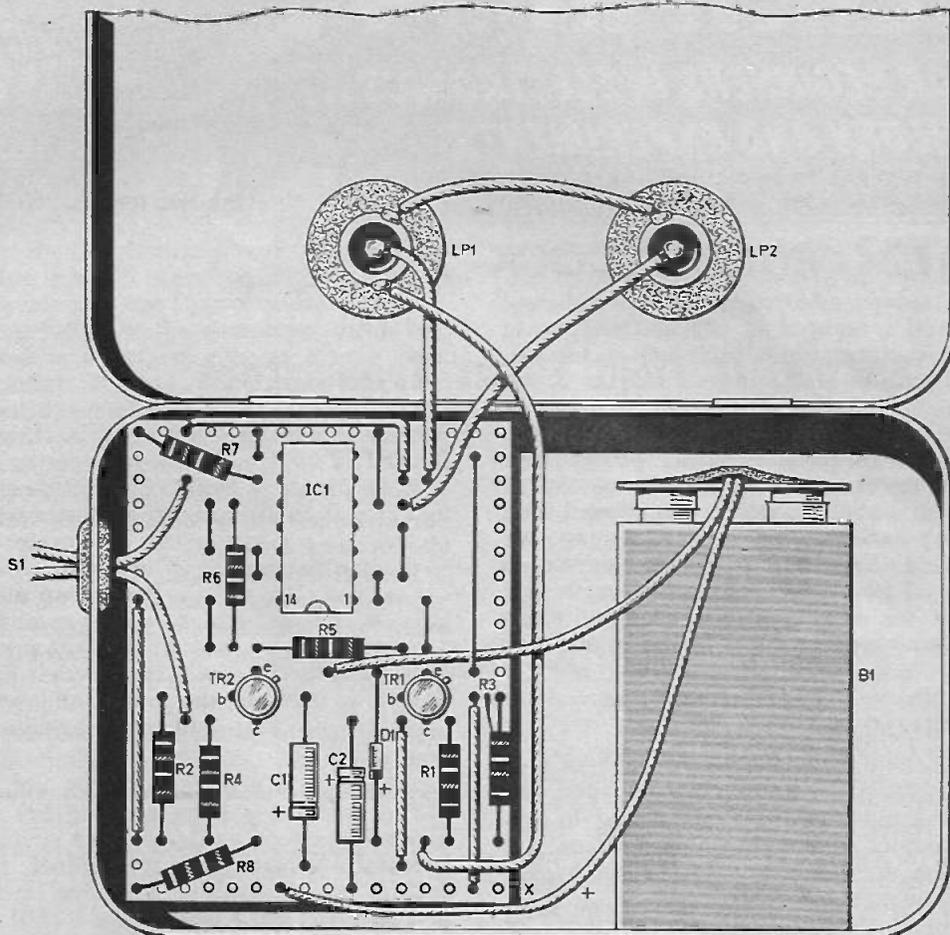
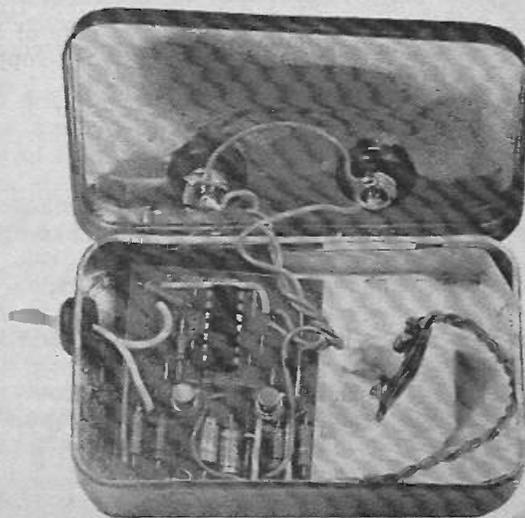
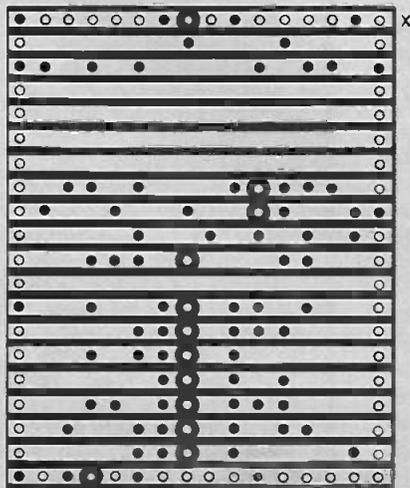


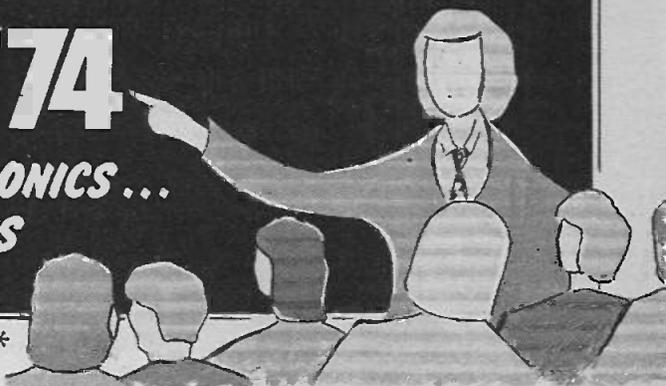
Fig. 4. Construction details of the Heads or Tails unit.



# TEACH-IN '74

FOR BEGINNERS IN ELECTRONICS...  
THEORY AND EXPERIMENTS

TUTOR: PHIL ALLCOCK\*



## LESSON 11 Field Effect Transistors

So far in the Teach-In '74 series we have considered the operation of *npn* bipolar transistors in some detail and have mentioned that "opposite" polarity types, known as *pnp*, are also available. In addition to these devices a wide range of field effect transistors exists and this month we are going to examine these devices to see how they differ from the *npn/pnp* types.

### TERMINOLOGY

Essentially a field effect transistor, abbreviated f.e.t., is controlled by voltage rather than current. A semiconductor material is used to provide a "channel" through which current can flow and the actual flow is controlled by the effect of an electric field.

This field is itself due to the presence of electric charge in a region close to the channel, known as the gate. The channel can be either *p*-type or *n*-type, depending on the semiconductor employed and in addition we have two distinct types of device known as **enhancement** and **depletion**.

An **enhancement** f.e.t. is one in which the channel is normally off, or non-conducting, and we must therefore apply a suitable bias to the gate to turn the transistor on.

The current flow in the channel is enhanced by the gate bias. In the other type the channel is normally conducting and current can be stopped by applying a suitable bias voltage.

The channel current flow is depleted by the applied bias voltage. As if this was not enough, we also find that new names are used for the connections to the ends of the channel, namely *drain* and *source*, and that there are two distinct f.e.t. families known as junction f.e.t.'s. and MOSFET's.

### MOSFET

So much for the terminology—let us continue our investigation by looking at the MOSFET device in more detail.

The letters MOS refer to a field effect transistor that employs a metal gate insulated by an oxide layer from the semiconductor channel and a typical arrangement is shown in Fig. 11.1.

Starting with a piece of foundation material known as the substrate, which in this case is made of *n*-type semiconductor and therefore has free electrons, two *p*-type regions are diffused side by side into the surface.

The surface is then covered by a layer of insulating silicon oxide and two strips of metalisation are arranged to contact the *p*-type regions via windows in the oxide layer. A third metallisation strip lies on the top of the oxide, immediately over the gap between the two *p*-type regions, and forms the gate electrode.

With no bias voltage (or signal) connected to the gate, current cannot flow between the two *p*-regions, which are known as source and drain, due to the intervening *n* type region. This region effectively forms two *pn* junctions back to back, and is illustrated in Fig. 11.1.

The situation is similar to a *pnp* bipolar transistor with no connection at the base but the size of the intervening *n* region is different in the two cases.

### BASIC OPERATION

If we connect the gate metallisation to a battery so that the gate is made negative (with respect to the source region) the gate will become negatively charged and the region of semiconductor immediately underneath the gate will acquire an opposite positive charge.

\*North Staffordshire Polytechnic (Any communications arising from the Teach-In '74 series must be addressed to Everyday Electronics, Fleetway House, Farringdon Street, London E.C.4).

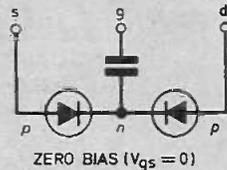
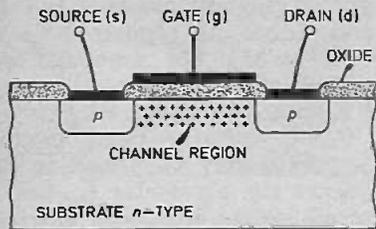


Fig. 11.1. A cross section of p channel MOSFET and an equivalent circuit.

In effect the electric field set up by gate repels the electrons and attracts the holes so that a "bridge" p type region is effectively formed which links the p type source and drain. Current can now flow in this p type channel if an external path is provided by the circuit in use.

The oxide insulates the gate from the p type channel and in effect behaves as a very small value capacitor. The gate current will be negligible if the oxide is free from leakage effects and the transistor therefore exhibits a very high resistance at the gate terminal.

From the description given it should be clear that the transistor considered in Fig 11.1 has the following features:

- (a) Normally off with zero gate voltage.
- (b) MOS construction.
- (c) Channel is formed by a p-type region.

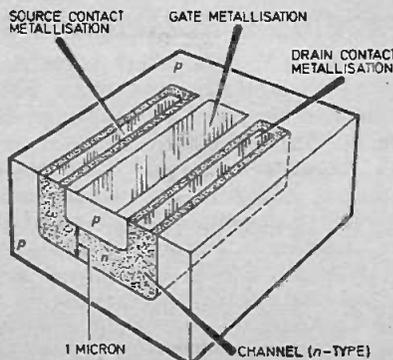
The device would therefore be described as a p-channel enhancement MOSFET and this type of transistor has been widely used in certain types of integrated circuits.

### JUNCTION F.E.T.

An alternative method of construction for the gate region employs a "diode", which is normally kept under reverse bias and is formed by the junction between the gate region material and the channel. Such a device is illustrated in Fig. 11.2 and would be known as a junction f.e.t. or JUGFET.

All junction f.e.t.'s. are normally conducting at zero gate bias and are thus classed as depletion type transistors. The gate voltage must

Fig. 11.2. Typical n channel JUGFET. Note that the n type channel is surrounded by p type "gate" region.



always be chosen to maintain the gate-channel diode in the reverse bias condition if correct f.e.t. operation is required.

The transistor used for the Tutor Board experiments is a junction type employing an n-type channel and the device symbol and typical bias polarities are illustrated in Fig 11.3. The current in the drain/source channel is usually called  $I_{ds}$  and varies with the gate voltage  $V_{gs}$  as shown in Fig. 11.4.

Note that the curves are similar in shape to those given earlier for the npn transistor, in which the base current was used for control. Two of the parameters normally listed by the manufacturer are  $I_{dss}$ , the channel current with  $V_{gs}=0$ , and  $V_{gs(off)}$  which is the bias voltage required to cut-off the channel (or reduce the current to some specified low value).

As might be expected the manufacturer usually quotes a range for each parameter and in the case of the 2N3819 the values are:

$$I_{dss} = 2 \text{ to } 20 \text{ mA}$$

$$V_{gs(off)} = 8 \text{ V (maximum)}$$

The alternative names, pinch-off or threshold voltage are sometimes used instead of  $V_{gs(off)}$  but it is more usual nowadays to reserve the term threshold voltage for the voltage level at which enhancement MOS devices start to turn-on.

Fig. 11.3. (left) Symbol for n channel JUGFET. All polarities and "arrow" on gate lead are reversed for p channel device.

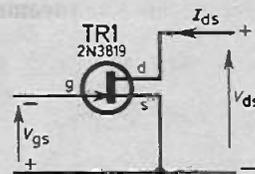
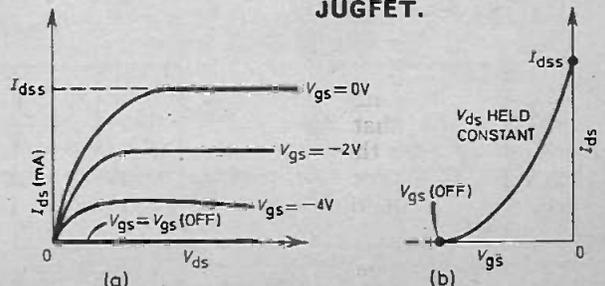


Fig. 11.4. Characteristics for n channel JUGFET.



## DIFFERENCES

The most obvious difference between the BC107 *n*pn bipolar transistor and the 2N3819 *n*-channel JUGFET is the very high input resistance of the latter device which can be of the order of 1,000 megohms. Thus if we require a circuit having a very high input resistance it would be wise to consider a field effect transistor for the intended application.

The Tutor Board experiments this month include one circuit which utilises the high input resistance feature of the 2N3819. Whilst on the subject of high input resistance it is worth mentioning that MOS devices can be damaged if the gate electrode acquires a static charge which causes the gate breakdown voltage rating to be exceeded.

The gate capacitance is usually very small, typically a few pF, and since  $V=Q/C$ , a small charge can easily give rise to excessive voltage.

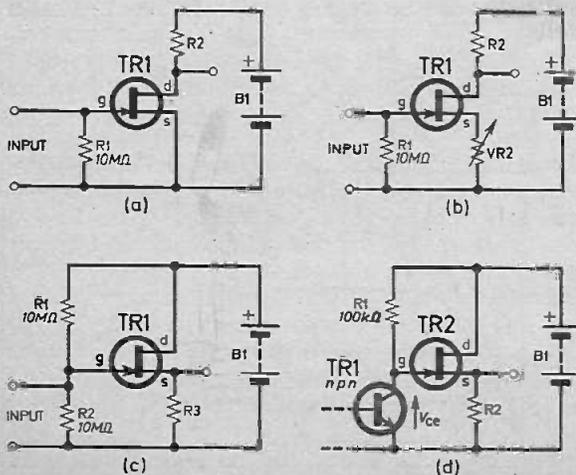
MOS transistors are often fitted with a small wire clip or spring which shorts all connections together. These clips should only be removed after the transistor has been connected to the external circuit. Since a thin oxide layer is not used for making the gate of a JUGFET these problems do not occur but the manufacturers ratings should not be exceeded.

## JUGFET BIAS CIRCUITS

To become more familiar with field effect transistors let us look at some of the circuits that can be employed. Fig. 11.5 shows several ways of arranging the necessary gate and drain supplies for the 2N3819 *n*-channel JUGFET.

Notice that in each case the drain is connected to the positive supply terminal and  $I_{ds}$  will flow

Fig. 11.5. Some "bias circuits" for an *n* channel JUGFET (a) Common source circuit with  $V_{gs} = 0$ . (b) Common source circuit with self bias ( $V_{gs}$  negative). (c) Source follower circuit. (d) Source follower fed from *n*pn transistor stage.



into the drain terminal and out at the source terminal (conventional current assumed). In Fig. 11.5a the gate and source are connected via a relatively high value resistor (10 megohms) but since the gate leakage current is normally very small no voltage drop occurs across R1.

Consequently  $V_{gs}=0$  and the drain circuit current will be approximately  $I_{dss}$  providing R2 is not too large. Since the parameter  $I_{dss}$  has a very wide spread of 2-20mA the drain current is not very well defined by this circuit and will vary from one transistor sample to another.

In Fig. 11.5b a resistance (VR2) is included in series with the source lead and gives rise to a voltage drop of magnitude:

$$\begin{aligned} \text{Voltage across VR2} &= (\text{VR2}) \times I_{ds} \\ &= -V_{gs} \end{aligned}$$

Since  $I_{ds}$  depends on  $V_{gs}$  as shown in Fig. 11.4b the circuit tends to compensate partly for variation of  $I_{ds}$  between transistor samples. For example, if  $I_{ds}$  "tries" to increase by say 1mA and we assume that VR2 was set at one kilohm this would give an increase in the magnitude of  $V_{gs}$  of one volt. Since this  $V_{gs}$  change will tend to reduce the current  $I_{ds}$ , the final change in current is less than it would be with VR2 not fitted.

To calculate the actual working current is slightly complicated by this feedback action and in practice we can make VR2 variable and adjust the resistance to give the required working current which must of course be less than the transistor  $I_{dss}$  value for the sample used. (If the manufacturer's curve of  $I_{ds}$  against  $V_{gs}$  is available it can be used to work out the bias point.)

The circuit shown in Fig. 11.5c gives the field effect transistor equivalent of the usual emitter follower circuit and in this example the voltage at the gate will be one half the power supply.

The circuit requires R3 to be greater than  $\frac{V_{ds}}{2 I_{dss}}$

if correct operation is to be achieved. Fig. 11.5d is similar to (c) except that the gate voltage is determined by the bias arrangements for the *n*pn stage. In this circuit R2 must be greater than  $\frac{V_{ce}}{I_{dss}}$  for correct operation.

## VOLTAGE CONTROLLED RESISTANCE

By operating a field effect transistor at low  $V_{ds}$  voltages, typically less than 500mV, the transistor can be used as a voltage controlled resistance. The effective resistance of the channel depends only on  $V_{gs}$ , providing the drain/source voltage is kept small, and actually corresponds to operation at (or near) the origin of the characteristics shown in Fig. 11.4a.

This principle can be employed as an electronic "volume control" by arranging the transistor as one part of a potential divider system. The principle is illustrated in Fig. 11.6 which is

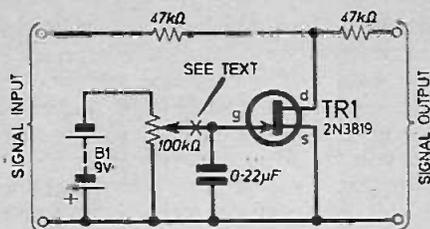


Fig. 11.6. Experimental electronic volume control.

suitable for experimental purposes providing input signals of less than a few 100mV are used.

The transistor is effectively open circuit when  $V_{gs} = -9V$  and the input signal can then pass directly from input to output. The signal will suffer some attenuation depending on the load resistance connected at the output.

For a load of 100 kilohms the maximum output signal will be about 50 per cent of the input. If this circuit is used in place of a conventional carbon track volume control a noise free control is achieved.

The 0.22μF capacitor acts as a filter to remove any noise produced by the adjustable 100 kilohm bias-voltage control. Additional filtering can be provided if necessary, by including an extra 100 kilohm fixed resistor at point X.

Next month we shall examine the action of the thyristor and give some simple tests based on the type BTX 30-25. (The components list April '74 issue gave the BTX 30-25 as a triac—it should have read thyristor).

## TUTOR BOARD EXPERIMENTS

### Test No. 22. Measurement of f.e.t. parameters.

Low cost field-effect transistors are usually wide tolerance devices and in this test we illustrate some simple measurements that can be made to determine the  $I_{dss}$  parameters of a typical sample.

Set up the circuit shown in Fig. 11.5a on the Tutor-Board, but make R1 zero by shorting the gate and source connections with a wire link. (The 2N3819 transistor should be mounted in the same manner as that used for the BC107. The connections are shown in Fig. 11.7.)

Use a fixed 100 ohm resistor for R2 and 9V for the supply. Set up the standard 0-10 voltmeter circuit and measure the voltage across R2. From this reading it is possible to calculate  $I_{dss}$  since:

$$\text{Voltmeter reading (in volts)} = \frac{I_{dss}(\text{mA}) \times 100}{1000}$$

$$= \frac{I_{dss}(\text{mA})}{10}$$

For example, a reading of 1.5 volts would correspond to  $I_{dss} = 15$  mA. If the voltmeter reading is too small to observe accurately, the range of the voltmeter can be reduced to 0-1 volt by using a 10 kilohm  $\pm 5$  per cent resistor in parallel with the normal 100 kilohm  $\pm 2$  per

cent meter resistor. With this modification it is only possible to cater for  $I_{dss}$  values up to 10 mA.

### Test No. 23.

This test demonstrates the very high input resistance at the gate terminal of the 2N3819. The circuit is shown in Fig. 11.8 and should not present any layout problems on the Tutor-Board.

The potentiometer VR2 is set to mid-position (approximately) and the switch is closed after setting VR3 for maximum resistance. Except for the capacitor the circuit is now similar to Fig. 11.5c.

The capacitor will rapidly charge up to the voltage level determined by the setting of VR2 and a reading should be apparent on the meter. The meter can be set to full scale deflection by adjustment of VR3.

Fig. 11.7. Connections for 2N3819.

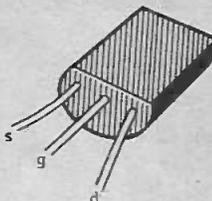
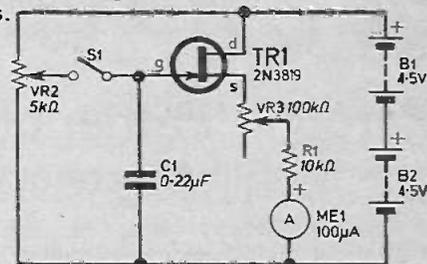


Fig. 11.8. Capacitor discharge observation circuit, VR3 should be set for maximum resistance before connection of batteries.

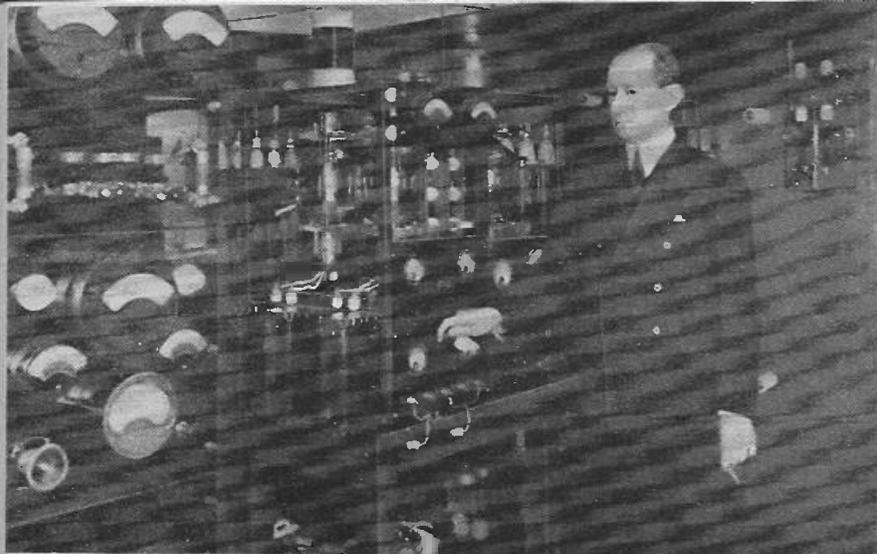


If the switch is now opened the capacitor can only discharge via the high input resistance of the f.e.t. and the capacitor leakage paths. The very slow discharge will be apparent by the slow fall in meter reading.

The circuit is a source-follower with the meter reading the current flowing in the source resistance. As the gate voltage falls due to the capacitor discharge the transistor current also falls.

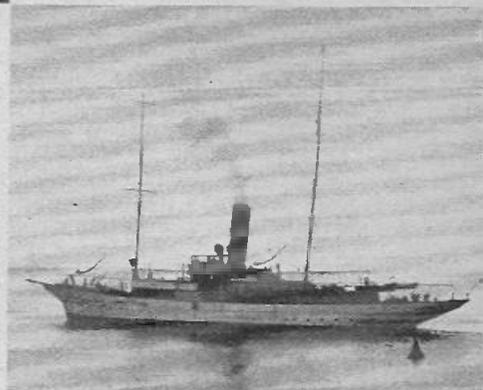


"Stan's still having trouble with the practical side of his electronic devices."



Left. Marconi in the laboratory of his yacht *Eletra*, pictured beside a high power short wave transmitter. (Marconi)

Marconi's steam yacht *Eletra*, fitted with extra topmasts for aerial height. (Marconi)



# Centenary of an Amateur

## Marconi 'Father of Wireless'

By Bill Maconachie

**I**N this centenary year of the birth of Guglielmo Marconi a great deal has already been written about his inventive genius, portraying him—rightly enough—as the founder of a great industry and of great companies. But there was a side to his personality about which little has been said, and this is perhaps best illustrated by a remark he made in 1933 when he visited the World Fair in Chicago.

One of the features of the exhibition was an amateur radio shack. Marconi called in, introduced himself, and was shown over the station with, one can imagine, a mixture of pride and embarrassment on the part of the man who had built it. Marconi congratulated him on his workmanship and he modestly replied that of course he was only an amateur. "Yes," said Marconi. "But then I am only an amateur myself".

That remark was in all probability not prompted by false modesty, for Marconi's character indicates that while in no way a boaster he nevertheless always had a proper sense of his own achievements. To say that he was an amateur was no more than a simple statement of fact. He began as an amateur, and an amateur he always remained until his death in 1937.

His first attempt at communication was in the Villa Grifone at Pontecchio, near Bologna,

shortly after ten in the morning on Saturday, 25th April, 1874. There was nothing special about it, for it was no more than the wail common to all newborn babies and no doubt it didn't carry very far, anyway. Far enough, though, to delight his Irish mother Annie, the daughter of Andrew Jameson of County Wexford and whiskey fame, and to stop the pacing of his father Giuseppe.

### EARLIEST EXPERIMENTS

There was nothing special about his early boyhood either, but very soon he developed a fascination for electricity, and before he was ten he had started reading about it and experimenting with its effects.

Precocious, you might think, but then he had no formal schooling and, except for his brother Alfonso who was nine years older, lacked the company of other boys and their interests. His mother had taught him to read and write, and he found books on electricity of absorbing interest. For his crude experiments he used whatever materials he could lay his hands on, and among his domestic acquisitions was a set of dinner plates which he decided would come in handy as insulators for a high-voltage line across a stream near the house. The result was disaster.

The plates were smashed. To Marconi's father Giuseppe, a man in the old Victorian *pater-familias* mould, mean almost to the point of miserliness, this was senseless destruction of valuable property, and from that day on he systematically demolished any bits of the boy's apparatus he found around the house. Annie, however, stood up for her son and eventually a sort of armistice was reached and young Marconi was given the run of the attic floor of the house where his grandfather Domenico kept trays of silkworms. In their silent company he was allowed to dabble undisturbed.

### STATIC ELECTRICITY

When he was thirteen the family took an apartment in Leghorn for the winter and young Marconi attended the Technical Institute there, for the first time receiving some real education in electrophysics. He rigged up a zinc contraption on the apartment roof and succeeded in using the charge of static electricity it built up during a thunderstorm to ring a bell downstairs. And he met an old telegraphist named Nello Marchetti who taught him the Morse code.

There were distractions, two of them deliberately arranged by his father who opened his purse to buy the boy a small sailboat and to pay for piano lessons. Young Marconi learned to sail and to play the piano rather well, and developed a passion for music, but he kept returning to his electrical experiments though for some time these seemed to have no definite aim more than the satisfying of his curiosity.

Then in January, 1894, Heinrich Rudolf Hertz died and shortly afterwards Marconi read an article by Augusto Righi on the work of Hertz. He was fascinated by the account of the "Hertzian rays" and from that point on his hitherto rather aimless dabbling had a firm goal, the transmission of electrical signals without connecting wires.

### FIRST WIRE-LESS SUCCESS

Back home in the attic of the Villa Grifone he worked ceaselessly, far into the night, and his mother's reward for the earlier encouragement of her son came one night when she was asleep. It was almost midnight when her twenty-year-old son woke her and asked her to come up to the attic. There she watched while he pressed a Morse key and at the far end of the attic a bell rang. There was no wire, no thread, connecting the key and the bell. Twenty-year-old Guglielmo Marconi had sent electrical impulses through the air.

That was his big breakthrough, though only domestically at first. Father Giuseppe at last, if somewhat grudgingly, admitted that there might just be some practical use for his son's dabbling, and even handed over a little cash to buy more materials. Marconi improved his apparatus and

was able to send signals to the other side of a little hill close to the house. Details of the invention were then sent to the Italian Ministry of Posts and Telegraphs, but Signor Sineo, the Minister, turned down the offer without even asking for a demonstration.

### OFF TO LONDON

It must have been a big disappointment, not only to young Marconi but doubtless also to his father who had viewed his cash contribution as an investment and was looking for a return on it. However, Annie Marconi was not to be beaten. Believing that Britain, in those days the world's foremost maritime nation, might see the value of the invention for communicating with ships at sea, she obtained a letter of introduction to W. H. Preece, engineer in chief of the British Post Office, and armed with this set off with her son for London in February, 1896.

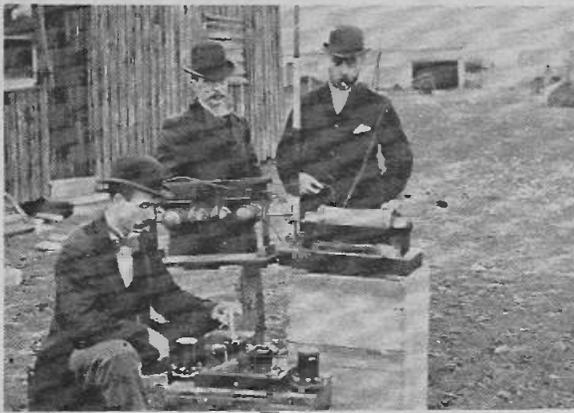
Preece was himself an experimenter in new methods of telegraphy transmission but had had little success with his attempts at using inductive techniques, and he gave the young Italian his support, introducing him as a "surprise guest" at the end of a lecture he gave at Toynbee Hall in December, 1896.

You can perhaps picture this shy, reserved young man walking on to the platform to face his first scientific audience, carrying his homemade apparatus that the Press was soon to call "the mysterious black box", and giving a demonstration of its capabilities while almost certainly praying inwardly that nothing would go wrong. But it worked, even though Marconi carried his black box about the hall to show that there was no deception, and next day the papers carried headline stories about the Italian inventor.

Of course there were sceptics in plenty. Even Lord Kelvin said that so far as sending a message by wireless was concerned he would sooner trust a boy on a pony. And there were others who, while admitting the truth of what

Marconi in London in 1896 with the original apparatus he brought from Italy including the "mysterious black box." (Marconi)





**A group of Post Office officials keenly interested in Marconi's hook-up for the first successful transmission across water from Lavernock to Brean Down in 1897. (Marconi)**

they had seen in Toynbee Hall, would not believe that signals could ever be sent over any substantial distances. As for sending them across water—well, everybody knew that water absorbed electricity from the air, so that was a non-starter.

### **TRANSMISSION ACROSS WATER**

But Marconi proved that he could send signals for considerable distances out of doors, and in May, 1897, confounded those who thought that water would be a barrier by transmitting across nearly nine miles of the Bristol Channel between Brean Down and Lavernock.

That was proof enough for everybody, including even Lord Kelvin who became an enthusiastic convert. Willing financial backers took up the young inventor and the ardent amateur found himself swept into commercialism with the formation of the world's first wireless firm, the Wireless Telegraph and Signal Co., Ltd.

Orders came in from Lloyd's to equip their signal stations for the reporting of passing ships soon after the company was formed on 20th July, 1897—a day, incidentally, when, however important it must have been in Marconi's life, he had actually returned to Italy to demonstrate his apparatus to the Italian Navy which proved much more receptive than that country's postal authorities had been three years earlier and immediately decided to adopt wireless for its ships.

In fact, Marconi's absence from London on the day the company was formed is a pointer to his character. He was always happier at a laboratory bench than behind a desk—always the devoted dabbler with bits of wire rather than the complete business man, an amateur in the truest sense of the word. But he was, too, always a shrewd user of publicity.

### **ROYAL PATRONAGE**

An opportunity for this came his way in 1898

when the then Prince of Wales—later to become King Edward VII—was convalescing on board the Royal yacht *Osborne* off Cowes after an injury, while Queen Victoria was in residence at Osborne House. Since intervening hills made visual signalling between the yacht and Osborne House impracticable, the Queen decided to give the new wireless a trial and have sets installed on board the *Osborne* and at Osborne House. During the next fortnight or so 150 messages were exchanged, with full reporting of the Prince's progress in the newspapers.

Incidentally, there is a story—possibly apocryphal—told about this, in which Marconi, summoned by the Queen, arrived at the front door of Osborne House and sent in his name, but was told to report at the tradesmen's entrance. He refused, and the Queen is said to have commanded "Send for another electrician." No other electrician of his calibre, however, was available, and no doubt the incident ended amicably.

### **BUSINESS DEVELOPMENTS**

In the meantime the new company's affairs were progressing, but slowly, most of its business being with the British government, Army, and Navy, all of which showed great interest but did not come forward with much in the way of firm orders. Marconi himself seemed to care deplorably little for the interests of the shareholders—as long as the company could provide money for further experiments he was happy.

The other directors, however, did not share this attitude and a decision was taken—Marconi's being the only dissenting vote—to reconstitute the company as Marconi's Wireless Telegraph Co., Ltd., in order to capitalise on his name. That was in February, 1900, and two months later Marconi took out his patent No. 7777 for the first method of tuning transmitters and receivers. This was a great step forward since until then transmissions had been untuned over a very broad frequency band and selection of stations to be received had been impossible.

Although Marconi's original idea had been to use wireless to end the isolation of ships at sea, no commercial orders for installing it on ships had been received in the first three years of the company's existence. The breakthrough came with the fitting—not of a British ship—but of the Norddeutscher Lloyd lines *Kaiser Wilhelm* in February 1900.

That April a second company, the Marconi International Marine Communication Co., Ltd., was formed to hire equipment to ships since, under the terms of the Telegraph Acts of 1868 and 1869, the Post Office had a virtual monopoly of all telegraph traffic and if shipping companies had bought their installations each would have had to set up its own coast station.

In May of the following year, 1901, the *Lake Champlain* became the first British ship to be



The liner *Lake Champlain*, in 1901, was the first British merchant ship to be commercially fitted with wireless. (Marconi)

commercially fitted, and soon after Cunard, with their *Campania* and *Luciana* followed suit. Marconi had built a powerful transmitting station at Poldhu, in Cornwall, to handle Transatlantic traffic to ships, and once this was in operation other passenger-carrying ships began to install apparatus. Then Marconi was off again, this time to St. John's in Newfoundland to put up a station there and prove that communication right across the width of the Atlantic was possible. He did it, and in 1902 a permanent station was established at Glace Bay.

## OTHER GREAT INVENTIONS

During the period up to the first World War Marconi and the team of like-minded men he had gathered around him—inquisitive engineers as distinct from the office staff—were busy indeed. Marconi himself devised and patented the magnetic detector to replace the inefficient coherer; Dr. J. A. Fleming, scientific adviser to the company, developed the diode (later improved by Lee de Forrest by the addition of the grid) and the directional aerial, another Marconi idea, was brought into use at Clifden in Ireland where a new station had been erected to replace Poldhu.

This period also saw the first use of wireless in the air, first in communication with a captive balloon and then, in 1910, with an aeroplane. In 1910, too, its use in the capture of the murderer Crippen captured the public imagination, and its value in bringing help to a ship in distress was demonstrated to the world in 1912 when the *Titanic* sank, even though on that occasion assistance arrived too late to save all on board.

Marconi's fertile mind, too, was demonstrated in the course of his evidence at the enquiry into the loss of the *Titanic* when he said that he was considering the feasibility of an instrument that would ring a bell on ships within range of a vessel in distress—the germ of an idea that he was later to develop into the auto-alarm receiver which is compulsory equipment on most single-operator ships today.

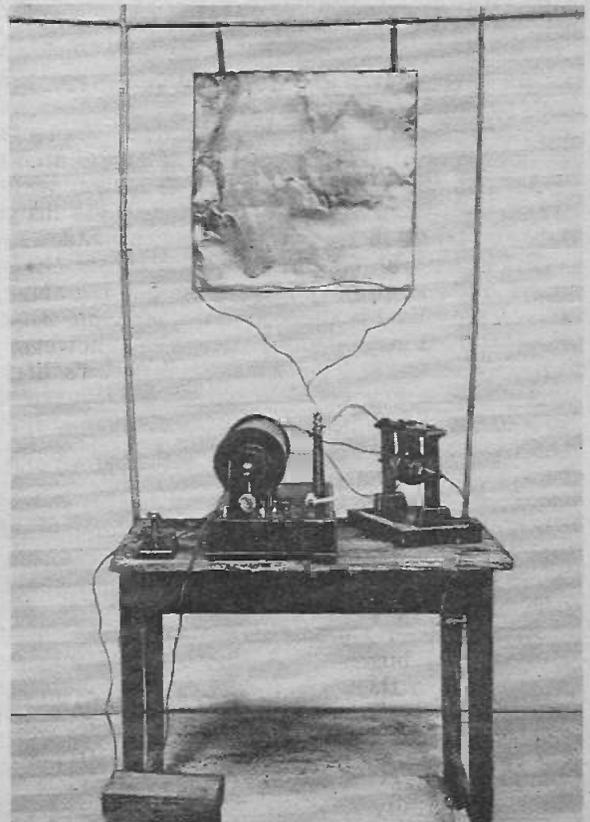
## AIR TO GROUND RADIOTELEPHONY

He had also been intrigued by what he called "the directional effect of wireless emissions" and acting on his observations another of his team, Captain H. J. Round, did a great deal of work in developing the direction-finding receiver which in the 1914-18 war enabled Britain to monitor the movements of German warships and led to the Battle of Jutland. Round and two other colleagues, Prince and Furnival, also overcame the problems of air-to-ground radiotelephony and plane-to-plane telephony, the latter being achieved in 1917.

Radiotelephony became broadcasting in 1920 with two events.

One was when the delegates to the Imperial Press Conference, travelling to Canada on the liner *Victorian*, heard a concert of gramophone records broadcast from Chelmsford, 1,000 miles away—Marconi's flair for publicity again. The other was the first advertised broadcast, a song recital by Nellie Melba in an improvised studio at Marconi's Chelmsford works.

A simulation of Marconi's early experimental transmitter using a copper sheet aerial, induction coil and spark gap. The coil seen in this replica assembly is, however, of much later date and is in fact a production model of a type used for a number of years after 1900. (Marconi)





The handiwork of an amateur. Marconi used a cigar box as a case in which to build his first magnetic detector while experimenting on board the Italian warship *Carlo Alberto* in 1902. (Marconi)

A little over a year later the Marconi company was licensed for regular broadcasting and opened the 2MT station in an ex-army hut at Writtle, and a licence was also granted for the original 2LO London station at Marconi House in the Strand. Later still, in 1922, the Marconi company was one of six which formed the British Broadcasting Company, superseded in 1926 by the British Broadcasting Corporation.

### SHORT-WAVE EXPERIMENTS

Marconi himself, though, took little interest in the development of broadcasting. It presented no real technical challenge to him, and as he once said when tackled on the subject, "Can you compare entertainment with the saving of men's lives?" In 1920 he had bought a steam yacht which he named *Elettra* and fitted out as a floating laboratory, principally to work on investigations into short-wave transmissions in pursuit of one of his greatest personal ambitions, the linking of all the countries of the British Empire by directional short-wave.

In the course of his experiments with short-wave techniques he noticed, as he said in a speech he gave in New York in 1922, "that short-wave transmissions were subject to reflection by metallic objects many miles away." He went on to say "It seems to me that it should be possible to design apparatus by means of which a ship could project a beam which would be reflected back and reveal the presence and bearing of another ship in fog."

Evidently the principle of radar at least existed in Marconi's mind at that time, but being preoccupied with his grand project of the Imperial Wireless Chain he did not pursue the idea and it was left to Sir Robert Watson Watt to give Britain the invaluable lead in radar for World War II, though Marconi did return to thoughts of it shortly before his death.

The Imperial Wireless Chain project almost came to fruition and in fact Marconi had a contract for the setting up of the necessary stations practically within his grasp in 1924. But cable companies throughout the British Empire, seeing their business threatened, brought influence to bear with their respective governments with the effect that their interests were merged with the Marconi scheme and control was vested in a new organisation, Cable and Wireless, Ltd.

### WITHDRAWAL FROM BUSINESS LIFE

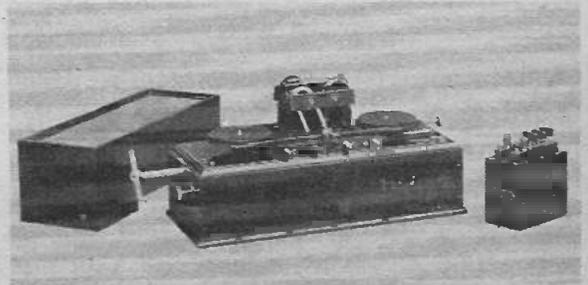
Sorely disappointed and plagued by increasing ill-health, Marconi withdrew more and more to his home in Italy and to life at sea on board the *Elettra*. Business life, that had never really meant much to him, was put aside pretty well completely, and most of his time was spent as it had been in his youth, experimenting and trying out new techniques.

He did a great deal of work on microwave transmission, leading up to the creation of the first microwave radiotelephone link in 1932. Then in 1935 he took up his radar idea again and was able to construct a working model and demonstrate it in principle. His health, however, was failing rapidly and in the early months of 1937 he suffered three minor heart attacks. He had a fourth and major attack on 19th July that year and died early the following morning at the age of 63.

### THE FINAL TRIBUTE

All his life Guglielmo Marconi had had honours and distinctions bestowed upon him, but none could have been matched by the world's tribute on the day of his funeral in Rome when radio and broadcasting stations all over the world closed down for two minutes from 6 p.m. and the "ether" was for a brief period again as silent as it had been before that midnight in the attic of the Villa Grifone at Pontecchio. □

When the magnetic detector went into production it was a much more elaborate affair with a clockwork motor to drive pulleys causing a band of soft iron to rotate through the magnetic field. In a handsome mahogany case, it had a glass-topped lid to keep out dust. (Marconi)



We would like to thank The Marconi Company Ltd., for the photographs used in this article.

# NEXT MONTH!!

*for you to construct*

## ...A METAL LOCATOR

A straightforward design that is inexpensive and easily constructed, this metal locator will provide hours of entertainment and could provide some valuable finds.

### A 2WAY IN-HOUSE COMMUNICATOR



A communication system for your home--no more shouting at father in the garage, simply call him up and request the pleasure of his company.



### AND...A SIMPLE CRYSTAL SET

A very simple m.w. crystal set, with improved selectivity, that can also be used as a simple tuner. This neat unit has been designed for ease of construction.

### PLUS ALL THE REGULAR FEATURES

Because of prevailing production problems, no firm publishing date can be announced for the September issue. Readers are advised to check regularly with their local supplier from mid-August onwards.

# everyday electronics



# KNOW YOUR COMPONENTS...

## Hints & Tips for the Novice Constructor

By Ron Adams

### The Capacitor

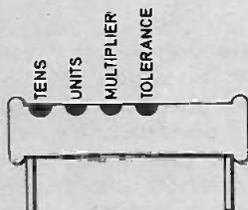
This device normally has its value printed on its body, but many lower value capacitors are colour coded like resistors, see below. Remember, if in doubt—check it out. Remember also that electrolytic and solid tantalum capacitors are polarised—make sure that they are inserted in circuit the right way round.

If the electrolytic body is not marked with polarity, a good tip to bear in mind is that the negative lead is usually con-

nected to the case.

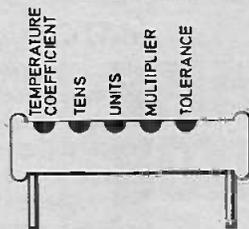
Tantalum bead capacitors can be tricky. They are those capacitors that look like frogs eyes on wires. The way to identify the positive lead on this component is to hold the capacitor with the dot facing you with its wires facing down; the positive lead is on your right hand.

Remember that voltage ratings are important, but obviously a 50V capacitor can be put in place of a 25V capacitor. Again the rule is "up, not down".

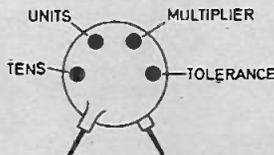


#### CERAMIC TYPES

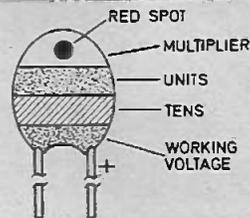
4 DOT COLOUR CODE HAS THE SAME SIGNIFICANCE AS FOR C280 TYPE



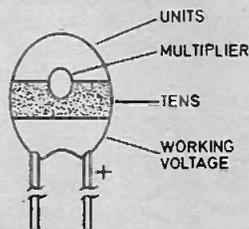
#### 5 DOT COLOUR CODE



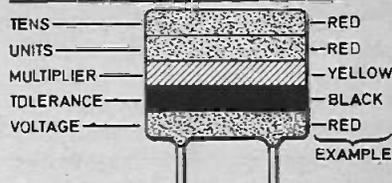
#### SOLID TANTALUM TYPES



WHEN VIEWED WITH SPOT SHOWING POSITIVE LEAD IS AS MARKED



#### MULLARD C280 POLYESTER TYPE



EXAMPLE:—

CAPACITANCE =  $22 \times 10,000\text{pF}$   
 =  $220,000\text{pF}$  OR  $0.22\mu\text{F}$   
 TOLERANCE =  $\pm 20\%$   
 VOLTAGE = 250V

Below right. Photograph of a selection of most of the common types of capacitors including some electrolytics

#### CAPACITOR COLOUR CODE

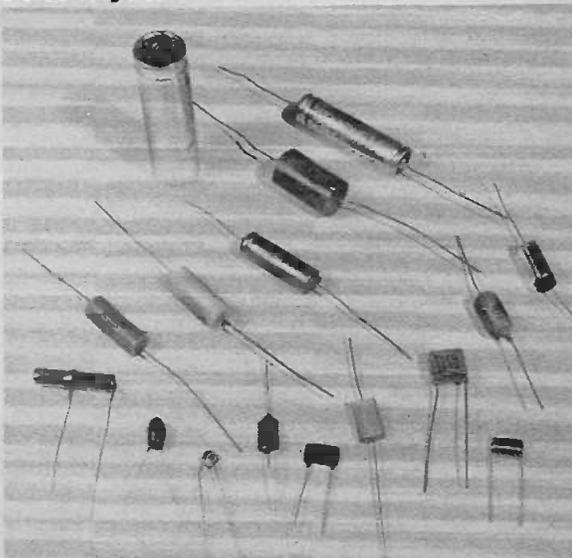
As Used For Mullard C280 Series and Ceramics

Colour	Tens & Units	Multiplier	Tolerance	Voltage
Black	0	x 1pF	$\pm 20\%$	—
Brown	1	x 10pF	$\pm 1\%$	—
Red	2	x 100pF	$\pm 2\%$	250V
Orange	3	x 1,000pF	$\pm 2.5\%$	—
Yellow	4	x 10,000pF	—	400V
Green	5	x 100,000pF	$\pm 5\%$	—
Blue	6	—	—	—
Violet	7	—	—	—
Grey	8	—	—	—
White	9	—	$\pm 10\%$	—

#### CAPACITOR COLOUR CODE

As Used For Tantalum Capacitors

Colour	Voltage	Tens & Units	Multiplier
Brown	—	1	x 10 $\mu\text{F}$
Red	—	2	x 100 $\mu\text{F}$
Orange	35V	3	—
Yellow	6.3V	4	—
Green	16V	5	—
Blue	20V	6	—
Violet	—	7	—
Grey	25V	8	x 0.01 $\mu\text{F}$
White	3V	9	x 0.1 $\mu\text{F}$
Black	10V	0	x 1 $\mu\text{F}$
Pink	35V	—	—



# EXPERIMENT IN HEADPHONE STEREO

An experimental circuit designed to improve the stereo effect when using headphones.

By H.T. KITCHEN

FOR many people, stereo listening via headphones is the norm, either because of circumstances or because of personal preference. Others, like myself, may have a single large lounge which houses both the stereo and the family television set, and here the conflicting demands of both services requires careful and skilful manoeuvring by the head of the house if chaos is not to reign unchecked. However, as the saying sayeth, there is many a slip!

Both wife and seven-year-old daughter failed to recognise the advantages of listening to TV via "phones"; stalemate! Realising that "A Family at War" and "Top of the Pops" had won the day, and that there was a danger of dad's classics suffering from instant silence, I withdrew from the fray and started investigating headphones, dad for the use of.

Not knowing if I would like headphone stereo, I decided to invest in a modestly priced pair, and a short "demo" on mono f.m. radio ended in my purchasing a pair of Eagle SE40's, together with the appropriate shorting socket and a 5 metre extension. (I like conducting Beethoven whilst walking about.) The problem of attaching the 'phones to the Quad II's was on.

Early experiments were encouraging, the sound level and quality from the SE40's being higher than expected.

## MATCHING

A straight changeover from 'speakers to 'phones wasn't liked, the apparent volume levels being too dissimilar, plus the difference in the "central" positions. I decided to try and equalise things. Fig. 1 shows the first attempt at equalising the apparent sound levels, and at providing a balance control that was operative on 'phones only, permitting the Quad pre-amp balance control to be used as a master balance control.

A switch, S1a and S1b was added, this being mounted on the front panel to select 'speakers or 'phones. A rotary 6 pole 2 way switch was used, three pairs of poles being connected in parallel to reduce contact resistance. At low

**FOR GUIDANCE ONLY**

**ESTIMATED COST\* OF COMPONENTS including V.A.T.**

**£3.50**  
excluding case

\*Based on prices prevailing at time of going to press

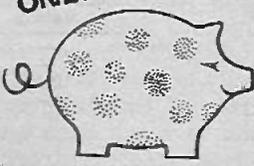
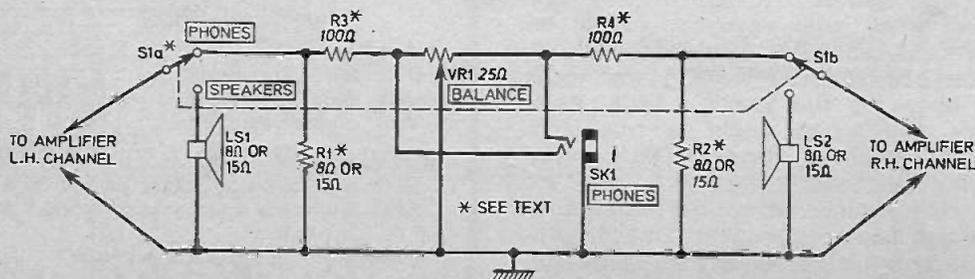


Fig. 1. Basic equalisation and balance circuit.



levels, the oxide layer that inevitably builds up, can act as a rectifier, setting up distortion. Three pairs of switch contacts should assist in reducing contact resistance.

Resistors R1 and R2 are 15 ohm 10 watt components, and substitute for the 'speakers when 'phones only are required. The Quad power amplifiers are tolerant of varying loads, but this should not be taken as an excuse for haphazard "matching". Also, other amplifiers may not be so tolerant, and may suffer consequential damage.

Resistors R3 and R4 are series resistors, subjectively selected to provide approximately equal sound levels when the 'phones are substituted for the 'speakers. The variable resistor VR1 is the balance control. Various resistance values were tried; the 25 ohm resistor gave the best subjective results. Its operation will be obvious.

We now have a circuit which allows one to change from 'speakers to 'phones without a drastic change in the apparent volume levels, and which allows one to set the central image independently.

So far, so good. The family at war is now, domestically speaking, a family at peace. Dad can enjoy his stereo again, albeit his head feels as if it had been firmly clamped in a vice after an hour or so! The sound quality is astonishingly good for such an inexpensive pair of 'phones, even after the initial enthusiasm has worn off.

But wait, and listen, all is not well! The sound quality hasn't altered, but something is amiss. Ahah! I have it! Half the orchestra are on my left, and the other half are on my right. There is very little in front.

## SOUND STAGE

The "fault" does not lie in the equipment. Rather it is the way in which we hear that is the cause. Normally, a sound source directly in front can be identified as being in front, even if the eyes are closed, if both ears have similar characteristics. A sound to the right or to the left can similarly be identified, simply because the brain translates direction in terms of the difference in time taken by the sound to reach each ear.

If a sound takes a millisecond or so less to reach the right ear, than it does the left, then that sound is identified as being to the right of centre; the reverse also applies.

The sound stage, with 'speakers, cannot be wider than the spacing between the 'speakers, though reflections from suitably (!) placed walls sometimes opens up the image a little. As a consequence, the sound angle is restricted, 90 degrees being about average. The experts' recommendations cannot always be adhered to, because of circumstance, or are not adhered to, because of personal preferences. One demonstration I recently attended (I shall spare the agent's blushes) had the 'speakers at an angle

approaching 160 degrees for the front row. Talk about a hole in the middle!

With 'phones, the ears are completely isolated from one another, and since they are set on opposite sides of the head, a stereo signal will apparently originate on opposite sides of the head, whilst a correctly phased, centralised, signal will apparently originate in the centre of the head. Subjectively, the results can be amusing, bewildering, or irritating. The end result is almost always listening fatigue, and it is worth trying to find even a partial cure, if not a complete cure.

Narrowing of the sound stage can be effected by feeding part of one signal into the other, i.e. part of the right hand 'phone signal to the left hand 'phone, and vice versa. Quite elaborate circuits exist for this purpose, but it was decided to try and see if something simpler would not provide reasonable results. Fig.2 shows the second attempt at improving headphone stereo, ignoring VR3 and C1 for the moment, VR2 is connected across VR1 and functions as the sound width control. At maximum resistance, its effect upon the apparent sound width is negligible.

As the resistance in circuit decreases so the sound stage narrows, until its resistance is zero, when the sound, being fed to two 'phones in parallel, produces a mono image. All other factors being equal, this will provide a central image within, apparently, the listener's head. Although somewhat crude, this method works reasonably well, and is worth experimenting with.

## FREQUENCY SELECTIVE SYSTEM

The drawback to the simple circuit of Fig. 2 is that it compresses the sound stage willy nilly. An extension of this scheme is to introduce frequency selective sound stage narrowing, and this is effected by VR3 and C1.

## Components . . . .

### Resistors

- |    |         |  |
|----|---------|--|
| R1 | 15Ω 10W | } (or to suit amplifier output resistance e.g. 8Ω 10W) |
| R2 | 15Ω 10W |  |
| R3 | 100Ω 1W | } (selected on test—see text)                          |
| R4 | 100Ω 1W |  |

### Capacitor

- C1 8μF metalised polyester (4 × 2.2μF)

### Potentiometers

- VR1 25Ω wirewound  
VR2 50Ω wirewound  
VR3 50Ω wirewound

### Miscellaneous

- S1 6-pole 2-way rotary switch (see text)  
SK1 Standard stereo jack socket to suit phones  
Case, connecting wire, 4 knobs

SEE  
**SHOP  
TALK**

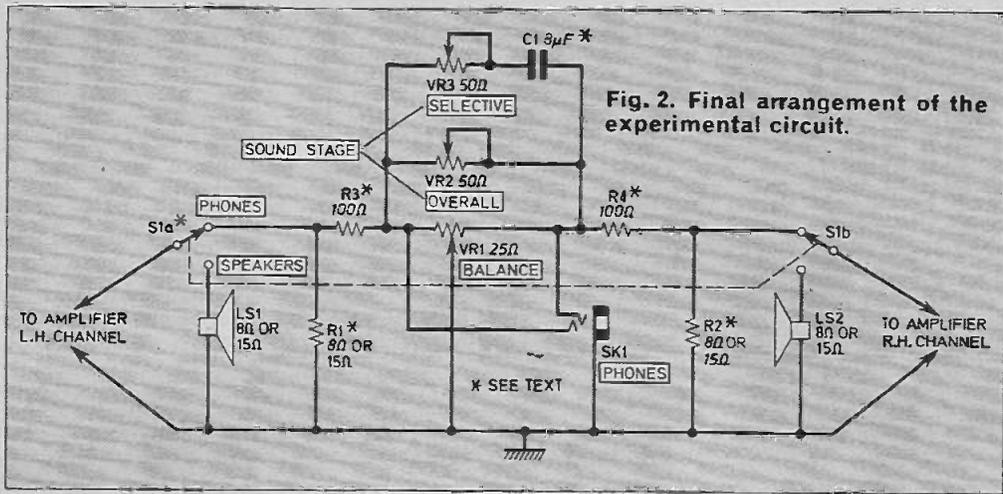


Fig. 2. Final arrangement of the experimental circuit.

The reactance of a capacitor is, as is well known,  $1/2\pi fC$ ,  $C$  being in Farads, and  $f$  in Hz. The reactance of a capacitor is inversely proportional to frequency, i.e. it is halved for every doubling of frequency. As far as this particular application is concerned, all this means is that  $C1$  will offer a reduced resistance to the higher frequencies, so reducing the apparent sound stage for the increasing frequencies.

Assuming  $VR2$  is out of circuit, the low frequency instruments of an orchestra will occupy the extremities of the sound stage, with the higher frequency instruments progressively occupying the central portions of the sound stage.

A theoretical objection to this scheme is the shrinking/expanding piano. Theoretically, this will "move" as the pianist's fingers move across the scales. So too will other wide range instru-

ments or vocalists. This theoretically undesirable effect does not, in practice, appear to obtrude excessively. This is probably due to the fact that the full range is only rarely used at any one time.

The circuits given should, perhaps, be best regarded as being of an experimental nature, to be varied and expanded upon by the individual. The cost, in terms of coin of the realm, is low. Time is the major ingredient, and should, at the very least, lead to a greater understanding and appreciation of stereo via headphones.

Capacitor  $C1$  can be made up of four  $2.2\mu F$  polyester types in parallel—variation of the overall value for experiment is then possible.

A constructional diagram for the circuit of Fig. 2 is shown in Fig. 3. Mount  $S1$  and  $VR1$  to  $VR3$  in a suitable case and wire up as shown. □

TO LOUDSPEAKERS

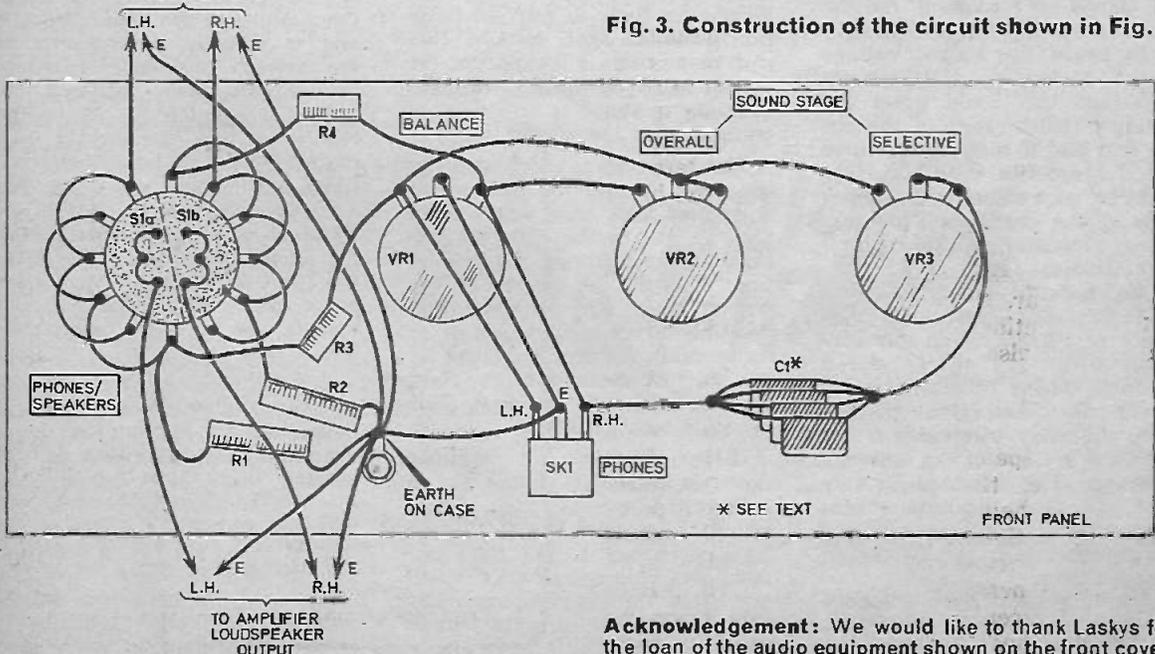


Fig. 3. Construction of the circuit shown in Fig. 2.

**Acknowledgement:** We would like to thank Laskys for the loan of the audio equipment shown on the front cover.



## Decoupling

Can you tell me why one often sees a high value capacitor connected across the power lines of a circuit—even though the circuit is run from batteries and there is no smoothing problem?

These capacitors come into the general category of *decoupling capacitors* and they are usually included for one of two reasons. Some circuits draw modest current from a battery under normal circumstances but may occasionally require a brief surge. If this surge is too great the internal resistance of the battery might cause the output voltage of the battery to fall momentarily and this could upset the biasing of other parts of the circuit and lead to distortion—worse still the drop in supply voltage might act as a signal to an earlier stage of the circuit and low frequency oscillation (instability) might ensue.

The capacitor—straight across the supply rails—acts as an extra source of current when this condition arises; the charge stored within it, during normal running, is withdrawn during the current surge and this compensates for the limiting effect of the battery's resistance. This technique is only valid for short duration surges because time has to elapse for the capacitor to regain its charge between them.

Many amplifiers have a capacitor connected between the supply rail and ground near the pre-

amplifier stage—usually on the pre-amp side of a resistor in the power rail. This has a similar function. When the output stage of the amplifier is drawing peak current there is always a slight drop in supply voltage (it may only be a few millivolts) and this could act as a signal into the input stage—by reducing the collector current of an early transistor. The capacitor and series resistor in effect filter out the slight supply variation.

## A.C. and D.C. Coupling

I am a bit confused by the terms a.c. coupling and d.c. coupling. Can you help?

If one applies a constant current (from a d.c. voltage source) into the base of a transistor the collector voltage will take up a fixed level and will stay there as long as the base current is maintained. If the collector voltage of this stage is directly coupled to the base of a following stage (either through a resistor or by direct connection) then the output of the second stage will follow suit and will stay in the new condition for as long as the original input current is maintained. This is d.c. coupling.

If, however, the voltage at the collector of the first stage is incompatible with the biasing of the second we have to provide isolation from the fixed voltage. This is done by putting a capacitor (or transformer) between the stages and then we have to provide suitable bias for the second stage.

The base current (provided by the input signal) for the second stage will vary only when there are changes in the collector voltage of the first; at the end of the "change" the output of the second stage will always revert (possibly after a bit of time) to its normal quiescent level (set by the bias) irrespective of the fixed base current into the first. This is called a.c. coupling.

If one considers an amplifier there is obviously going to be a lower frequency limit below which the second stage will not respond. Hence to get good low frequency response in a.c. coupled amplifiers the coupling capacitor usually has to be of quite a large value.

## Potentiometers

There seems to be an unlimited range of potentiometer types to choose from—carbon wirewound, log, linear, precision, ganged etc. Would it be possible for you to summarize the differences and give any hints as to what applications the different types have?

Carbon and wirewound simply describe the material used as the resistive element inside the device. On the whole wirewound devices are of better quality and are less likely to fail in use. After a lot of use the carbon tracks of composition potentiometers tend to wear away and the device becomes "noisy"; this is less likely to happen with wirewound devices.

Because there is more bulk in wirewound pots they usually have a greater power dissipation. Because they would require many turns of extremely fine wire high value wirewounds are rare (values greater than a few hundred kilohms are not common). Because they—in effect—form a coil of wire wirewound potentiometers have a significant self inductance and this precludes their use in very high frequency circuits otherwise you can always use a wirewound device to replace a carbon potentiometer.

Linear law (lin.) potentiometers are so called because the resistance between the wiper and one end is directly proportional to the amount of spindle rotation; i.e. with the spindle turned one half of a complete revolution the resistance will be exactly half the total value; a logarithmic law (log.) device does not have this proportionality—the degree of rotation is proportional to the log of the resistance. The latter are used as volume controls because the ear's sensitivity to volume also follows a logarithmic law.

Certain types of log pots are used in analogue computers (as indeed are anti-log pots) but these are usually very expensive devices because there must be an accurate relationship between the rotation and resistive value obtained; these are called precision potentiometers. They are not often used by amateurs—unless you are making a good quality signal generator or such like.

They can come as linear, log, or anti-log devices.

As the name implies, ganged potentiometers are simply two or more potentiometers coupled together on the same spindle so that they all change in value by the rotation of a single knob—most frequently come across in stereo amplifiers and Wein bridge oscillators. These can be of any law depending on the application.

## Capacitor Measurement

Is there any way one can use a multimeter to measure the value of capacitors?

Unfortunately this is not possible with any degree of accuracy. The technique is to apply a known frequency signal to the capacitor and then measure its reactance with a special circuit known as a bridge. We published a capacitance bridge in our September 1972 issue (back numbers or reprints are not available).

## Rectification

I would like to know what value rectifier to use to produce 9V d.c. from the mains?

To produce the voltage you require you must first reduce the value of the mains voltage with a transformer. This also gives you

protection from the live mains. You then use a rectifier which must have a reverse breakdown voltage in excess of the d.c. voltage you require and it must have a current rating higher than the maximum current you expect to draw.

In some instances you might need good smoothing and a capacitor might be necessary. We recommend that you watch these pages for suitable designs; we have published several in the past and there are sure to be more in the future.

## Aerial and Earth

Why was it that old valve radio sets required an aerial and an earth while modern transistor radios need no earth connection?

One could write a book on the theory of radio propagation and reception so our answer will be an oversimplification of the reason. First, there is no distinction on the grounds of valves versus transistors. When a radio signal is transmitted it is made up of two components; an electrostatic signal and an electromagnetic signal. These two signals each carry the information we want to receive and we can arrange to pick up either at the front end of our radio set.

When picking up the electrostatic signal we need a long aerial which acts rather like a single

plate of a capacitor—the other plate of this mythical capacitor is ground. The electrostatic signal induces charges in the aerial which flow through the tuning circuit of the radio down to the earth connection giving rise to the input signal. In many instances it is not necessary to connect the other end of the tuning circuit to a real ground because there is usually quite a high capacitive coupling anyway—nevertheless a good earth connection can make all the difference to the signal pick-up.

Before the days of ferrite aerial rods a number of portable radios used frame aerials which picked up the electromagnetic radiation from the transmitter—in just the same way that a current can be induced in a coil when a magnet is moved nearby. As technology developed we began to get magnetic materials which were efficient at the high frequencies involved and these enhanced the efficiency of the frame aerials giving rise to the ferrite aerial which is no more than a coil affected by the radiated electromagnetic energy.

No earth connection is required because the signal is totally induced within the coil, however, the orientation of the ferrite rod is important as it has to lie along the direction of the radiated lines of force for maximum signal. This occurs when the rod is horizontal and its axis is at right angles to the direction of the transmitting station.

I have recently discovered a quick and easy way of cutting Veroboard, s.r.b.p. board and almost any other type of circuit mounting board.

First rest the board you wish to cut on a hard flat surface and with a straight edge as a guide, score a deep "V" groove with a sharp glass cutter. Now rest the board on the edge of, say, a table, and give it a sharp downward blow; the board should break along the line leaving a neat sharp edge.

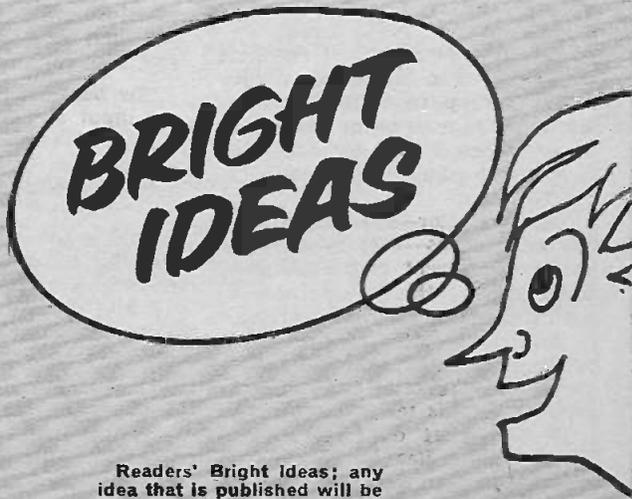
This method works for any type of Veroboard, tagboard or printed circuit board always giving a professional finish and doing away with the need for a hacksaw which can sometimes give a far from straight edge.

T. Holden  
Northampton.

In building my Tutor Board for the Teach-in '74 series I fixed the terminal blocks to the baseboard with medium size pop-rivets. These are easily removed when necessary and are, I think, an improvement on the nail method.

If the rivet shank is loose, it can easily be hammered oval.

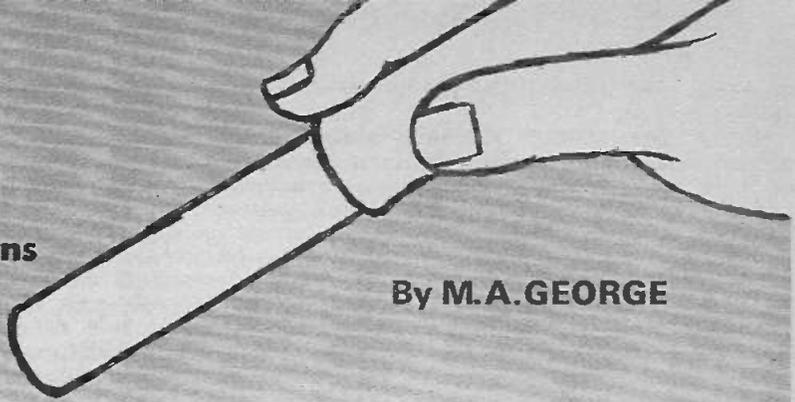
D. Blades,  
Salford, Lancs.



Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

For simple investigations into radioactivity.

By M.A. GEORGE



THIS article describes the construction and use of a portable Radiation Monitor for investigations into radioactivity in the laboratory and out of doors.

It can be used as a simple means of demonstrating the principles of radioactivity in schools (e.g. measuring penetration of  $\beta$ -radiation), radiation pollution monitoring and source checking.

There are also other applications for the basic circuit outside radioactivity such as testing neon lamps, and as a power supply for a battery operated oscilloscope.

The output can be fed via a Schmitt trigger to a ratemeter or decade scaler unit to form a true Geiger counter.

Despite the simplicity of the circuit, the unit is just as sensitive as any commercial one, since sensitivity depends only on the tube used, and having the correct operating voltage.

### CIRCUIT

The complete circuit diagram of the unit is shown in Fig. 1 and is seen to be a Hartley Oscillator (see *Demo Circuits Dec. '73*) followed by a voltage-doubler rectification stage.

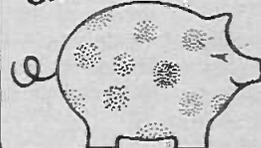
**FOR GUIDANCE ONLY**

**ESTIMATED COST\* OF COMPONENTS including V.A.T.**

**£5.50**

**excluding case**

\*Based on prices prevailing at time of going to press

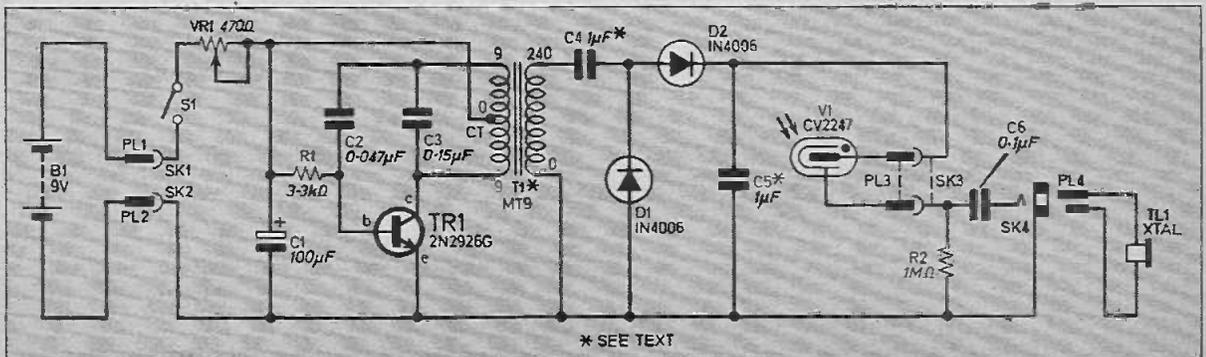


The oscillator load is the secondary of a low voltage, low current miniature mains transformer, the secondary should not be rated at more than 100mA. The frequency of the oscillator is controlled by the choice of C3.

The bias for the oscillator is set by VR1 and positive feedback is obtained via C2 and is sufficient to overdrive TR1 to produce a clean, fast rising edge waveform for the "inverter" section of the circuit.

Due to transformer action, a voltage is induced across the primary of T1 of about 250 volts. Components D1, D2, C4 and C5 are connected to act as a voltage doubler, rectifier and smoothing stage to produce a steady d.c. level

Fig. 1. The complete circuit diagram of the Radiation Monitor.



of about 500 volts required for satisfactory operation of the Geiger tube.

The current through the tube is limited by R2 and the signal across the latter is taken via blocking capacitor C6 to the monitoring device, which in the prototype was a high impedance crystal earpiece, TL1.

Capacitors C4 and C5 must be high quality mixed dielectric types with a minimum voltage rating of 600V d.c. and diodes D1 and D2 should be rated at least 800 p.i.v.

## CONSTRUCTION

The prototype unit was constructed in an aluminium box size 100 x 65 x 55mm and most of the components were mounted on the removable lid; the three bulky components, T1, C4 and C5 were secured to the base of the box. The size, shape and material (metal) of the case are not important and can be modified to suit individual requirements.

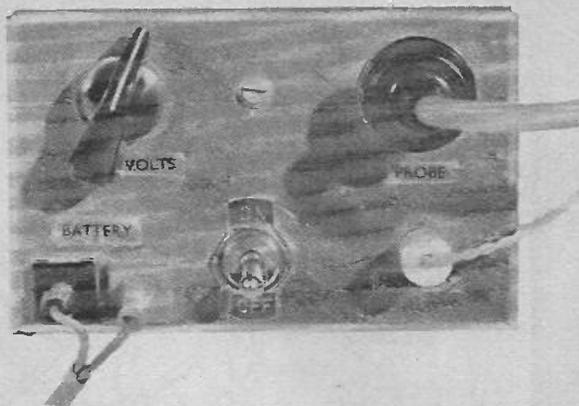
Begin construction by soldering the components to the Veroboard as detailed in Fig. 2. There are no breaks along the copper strips on the underside.

The lid should now be prepared to accept all the lid mounted components as indicated in Fig. 2. Secure these components in position and wire up to the component board as shown.

When screwing the board to the lid, a piece of foam rubber between board and lid will prevent any contact between board and case.

Two capacitor clips (or Terry clips as used in the prototype) should next be screwed to the inside base of the box to hold C4 and C5. The transformer should now be bolted or glued to the base and solder tags fitted to one of the case sides. Place C4 and C5 in position and wire up as detailed in Fig. 2.

A piece of foam rubber should be placed over the base mounted components and held in place with insulation tape before securing the



Details of the component positioning and labelling on the top panel of the prototype.

lid in position. This will avoid any contact between lid and base mounted components. The controls and sockets should now be labelled as shown in the photograph.

## Components . . .

### Resistors

- R1 3.3k  $\Omega$
- R2 1M  $\Omega$
- $\frac{1}{4}$ W  $\pm 10\%$  carbon

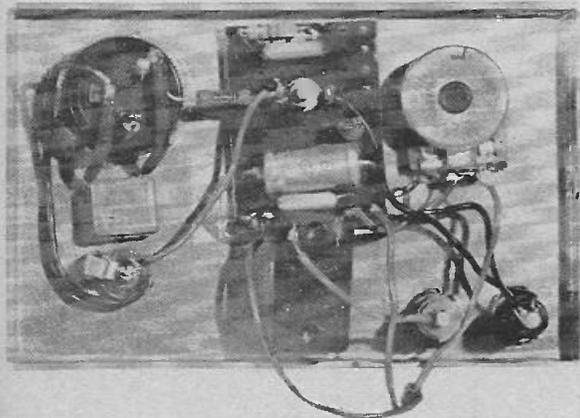
### Capacitors

- C1 100 $\mu$ F elect. 16V
- C2 0.047 $\mu$ F
- C3 0.15 $\mu$ F
- C4 1 $\mu$ F mixed dielectric 600V d.c.
- C5 1 $\mu$ F mixed dielectric 600V d.c.

### Miscellaneous

- VR1 470 $\Omega$  carbon lin.
  - TR1 2N2926 green silicon npn
  - D1, 2 1N4006 or similar rated 800 p.i.v. minimum (2 off)
  - T1 MT9 (Osmor) or similar mains/9-0-9 80mA secondary transformer—see text
  - S1 s.p.s.t. toggle
  - V1 Geiger tube type CV2247—see text
  - PL1 4mm wander plug, red
  - PL2 4mm wander plug, black
  - PL3 three-pin or two-pin non-reversible plug
  - PL4 2.5mm jack plug
  - SK1, 2 4mm insulated sockets, one red, one black (2 off)
  - SK3 socket to suit PL1
  - SK4 2.5mm jack socket
  - TL1 crystal earpiece
- Veroboard 0.15in. matrix 7 strips x 10 holes; 4BA solder tags (4 off); capacitor clips (2 off); metal case

SEE  
**SHOP  
TALK**



The layout of the components and wiring on the underside of the top panel in the prototype.

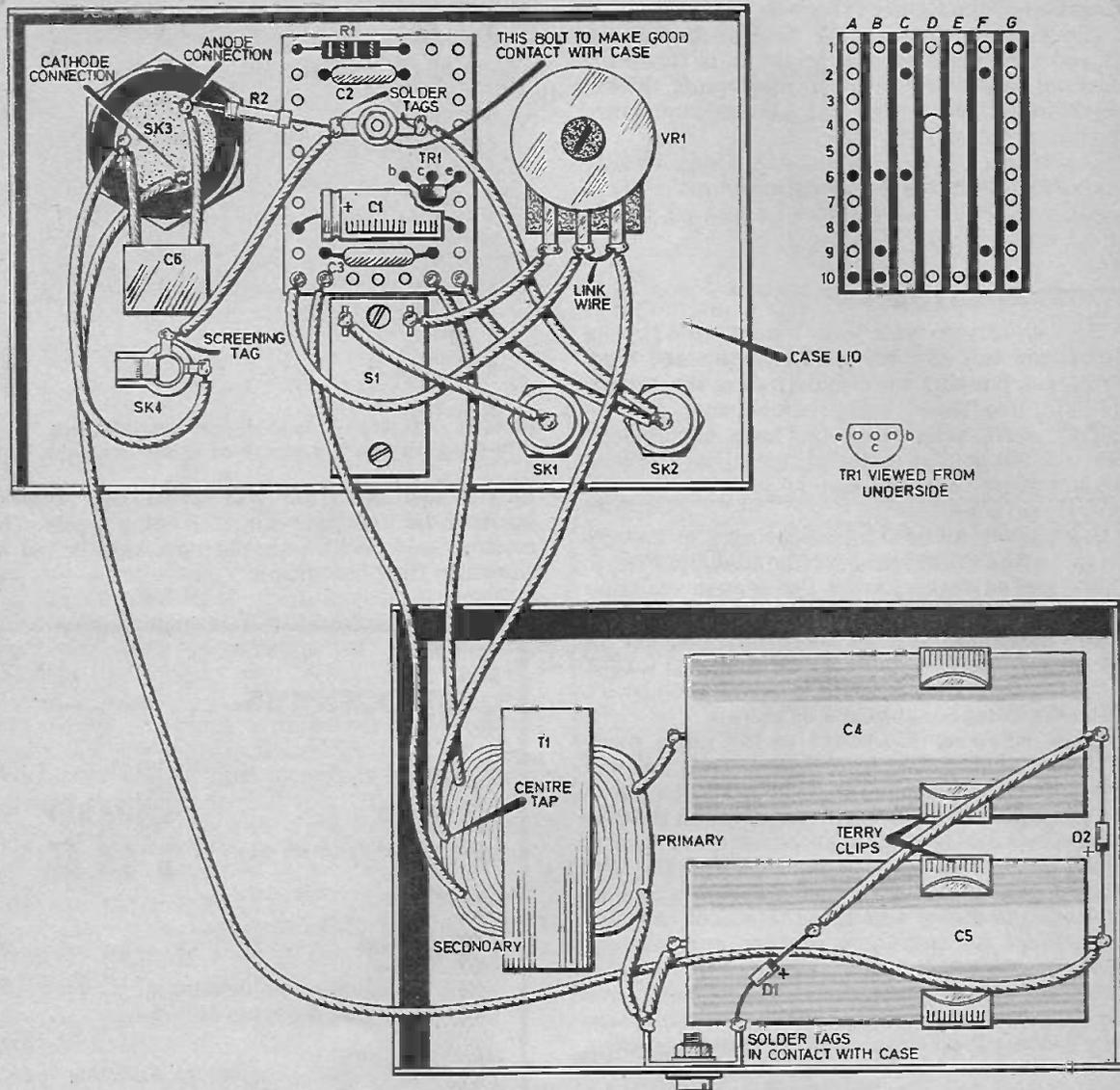


Fig. 2 (above). Assembly and wiring details within the aluminium case.

## RADIATION MONITOR

Photograph (right) of the completed prototype with lid removed.



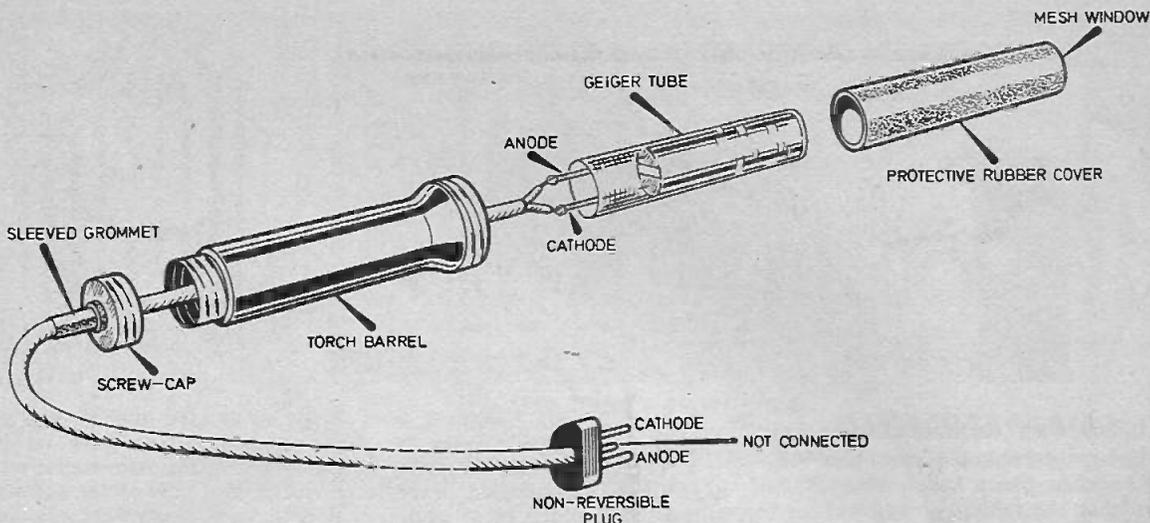


Fig. 3. Construction details for the probe.

## PROBE

The probe in the prototype used a government surplus Geiger tube type CV2247 and was housed in the barrel of a torch. The tube comes complete with a sturdy rubber cover with a wire mesh window at one end for protection.

A length of twin-core mains cable should be soldered to the two terminals of the tube (brown to the anode, blue to the cathode) and fed through the torch barrel and secured there by an adhesive such as Araldite. The cable should be passed through a sleeved grommet in a hole drilled in the screw on the bottom cap, see Fig. 2.

Ensure that the wires from the tube terminals are not in contact with the inside of the torch barrel. It is a good idea to paint the torch barrel for insulation purposes.

The cable should be terminated in a two-pin non-reversible plug. In the prototype a three-pin plug and socket was used since this was at hand and the spare connector pin proved useful.

## TESTING

When completely satisfied with construction the unit may be tested. With S1 in the off position and VR1 set fully anticlockwise, connect the battery leads from a PP9 battery into the appropriate sockets, SK1, 2 on the lid. Insert the crystal earpiece at SK4 and plug in the probe at SK3. Switch on at S1.

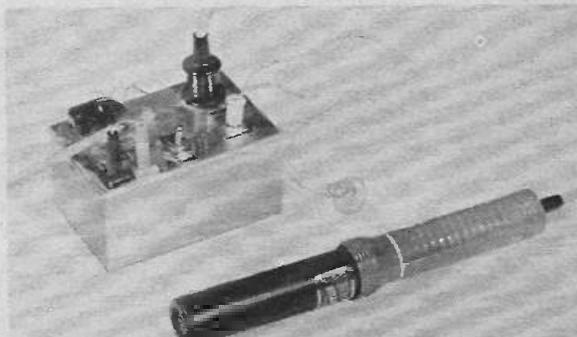
A tone should be heard in the earpiece, building up after a while to a steady high pitched note. Now rotate VR1 control slowly in a clockwise direction, the pitch of the tone should gradually increase. A point will be reached where "clicks" will be heard. The number of clicks will be about 40 per minute this being due to background radiation, however these are very random—there may be

periods of silence followed by bursts of clicks. This will indicate that the unit is functioning correctly.

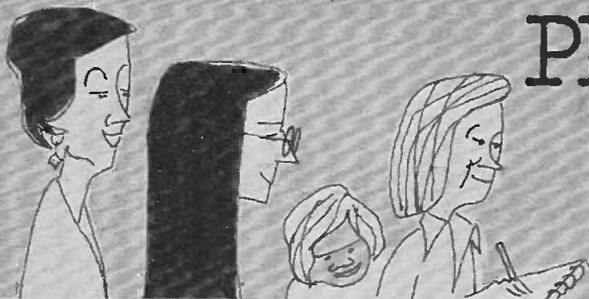
## IN USE

An increase in the number of clicks or "counts" will result if the probe is placed near a source of  $\alpha$  or  $\beta$  radiation (such as the face of a luminous watch or near a TV tube) and can thus be used to compare intensity of radiation, the intensity being directly proportional to the count rate.

The monitoring system can take several forms, audibly via the earpiece as in the prototype, display on an oscilloscope, or via a Schmitt trigger to an analogue or digital ratemeter or decade scaler. The latter two instruments should be well known to those with a knowledge of atomic/nuclear physics. □



The completed unit in case with probe.



# Physics is FUN!

By Derrick DAINES



## THE MAGNETIC FIELD

Obtain a discarded razor-blade or hacksaw blade and holding it firmly on the table with one hand, stroke it down its full length with one pole of your magnet, see Fig. 1. At the end of the stroke, lift the magnet clear and make a wide arc to the beginning again.

Continue until either your patience or the magnet wears out. The razor-blade will now be found to be magnetised. Mark one end and suspend it by a thread. As before, the razor-blade will make an effective compass, having a north-seeking pole.

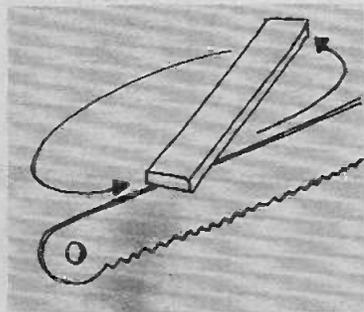


Fig. 1. Making a compass from a razor blade or hacksaw blade using a magnet.

Bring the North pole of your permanent magnet up to the North pole of the blade; the blade will spin away. Bring the North pole of the magnet up to the South pole of the blade; they will be attracted to each other.

Like poles repel—opposite poles attract.

We can compare the magnet/blade relationship with the compass/earth relationship of last month's question. When we hold

the magnet in our hands, it is difficult for an outside force to turn it. Therefore, when we bring it near to the magnetised blade, it is the blade which spins away, but both have experienced the same force. Similarly with the earth; when we suspend the magnet by a thread, it reacts to the Earth's magnetic field shown in Fig. 2. Both the Earth and the magnet have experienced the same force, but it is the tiny mass of the magnet that spins, not the great mass of the Earth.

The earth is a gigantic magnet, whose magnetic field stretches many thousands of miles out into space, (Fig. 2).

The correct answer to last month's question therefore is that both the earth and the compass are active; they react to each

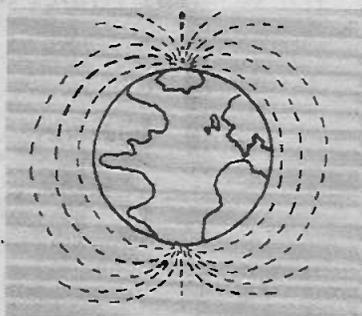


Fig. 2. The magnetic field of the earth. The lines of force are similar all the way around the equator.

other's magnetic field. A similar experiment to that with the iron-filings will model this more clearly.

Obtain a child's compass—the smaller the better. Place your magnet on the table and a sheet

of paper or card over it. Now put your compass anywhere on the paper and make two marks on it opposite the ends of the compass needle. Remove the compass and join the two marks. Repeat all over the paper until the lines begin to join up into longer and longer lines, Fig. 3.

There are two things to notice: (1) The compass needle always points North/South with respect to the magnet; (2) The lines form precisely the same patterns as did the iron filings in last month's experiment. The pattern is of course two-dimensional, but if you turn your magnet over through 90 degrees of arc and repeat the experiment you will easily see that the magnetic field itself extends in all directions through space, i.e. it is three dimensional.

Magnetic fields are three-dimensional

One more experiment for this month; put your small compass in a tin—the deeper the better—and bring the magnet near to it. The compass does not respond. Why? And why did we say that the deeper the tin, the better?

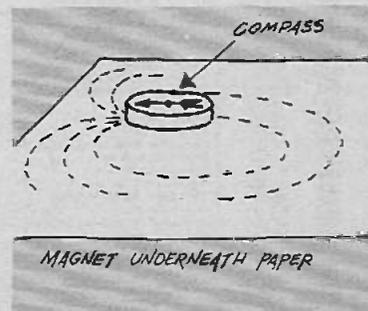
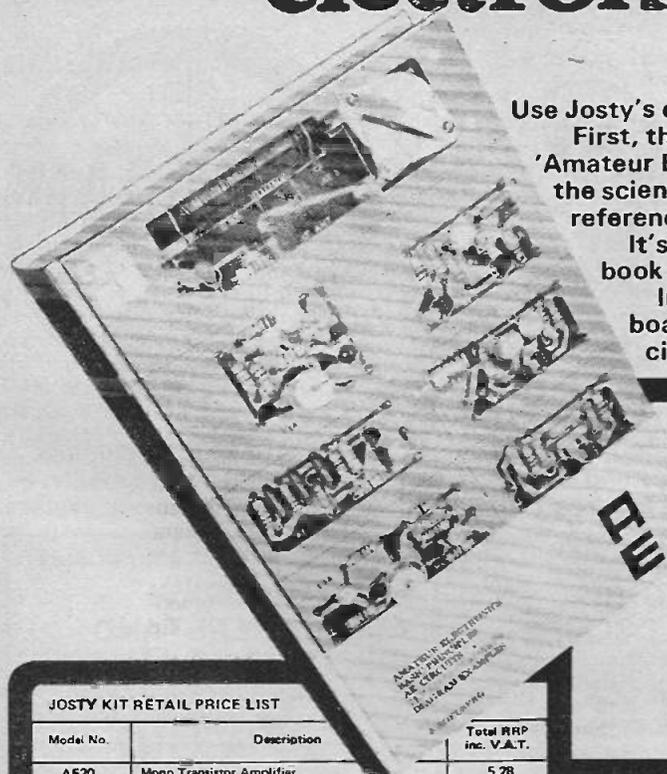


Fig. 3. Plotting the magnetic field of a magnet. This method plots the field on one plane only.



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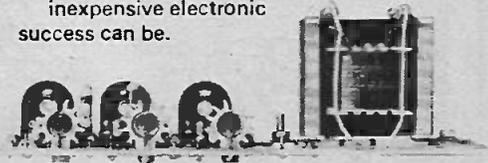
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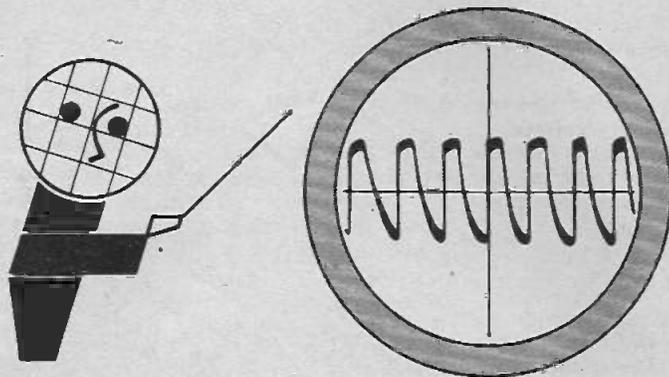
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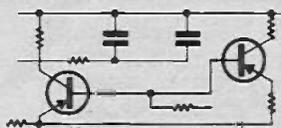
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# SEMICONDUCTOR PRIMER

By A. P. STEPHENSON

## 18 ■ EXPERIMENTAL TRANSISTOR CIRCUIT

An experimental circuit to demonstrate the behaviour of a typical low-power pnp transistor is shown in Fig. 18.1. Component values and suitable meter ranges are given below.

### Battery voltage

12 volts is suitable since nearly all transistors can withstand 12 volts between collector and emitter.

### Meters

0-20mA for measurement of  $I_c$  and  $I_b$   
 0-1mA for measurement of  $I_e$

0-12V for measurement of  $V_C$   
 0-1V for measurement of  $V_B$

} meter sensitivity should be at least 20,000 ohms per volt

### Resistors

- VR1 1 megohm
- VR2 As low as possible, e.g. 100 ohms 2 watt. This will draw 120mA from the battery.
- R1 5 kilohm, this will limit the base current to a safe level if VR1 is set to zero.

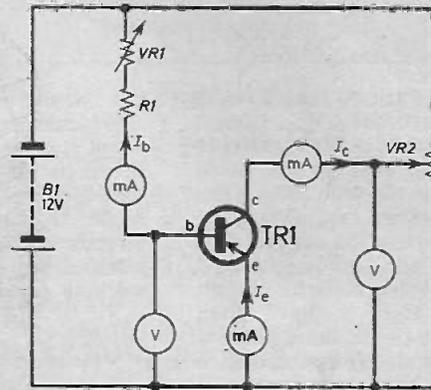


Fig. 18.2. Experimental circuit diagram used for determining some basic characteristics of a low-power pnp transistor.

## 19 ■ SIGNAL GROUND

In Fig. 19.1 point A is obviously 5 volts positive as far as d.c. is concerned, but as an alternating signal is concerned this point is virtually at ground because the capacitor is behaving as a short circuit to the a.c. signal.

The point A is said to be at SIGNAL GROUND.

As far as the value of the capacitor is concerned, its reactance  $X_c$  should be much smaller (say ten times smaller) than the resistor it bypasses.

This calculation must be carried out on the assumption that the LOWEST possible frequency is present.

If it is a reasonable "short", to say 50Hz, it will be even better at 500Hz.

### Examples

- (a) The d.c. supply rail in any transistor circuitry is always at signal ground (because of the large electrolytic capacitors used to smooth the supply).
- (b) The emitter of Fig. 19.2 is 5 volts positive to ground as far as d.c. is concerned but is at signal ground due to the capacitor.
- (c) The common-base amplifier shown in Fig. 19.3 must have the normal d.c. bias on the base but it must be held at signal ground. The capacitor takes care of this.

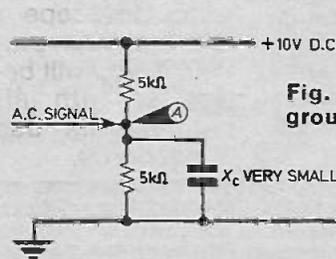


Fig. 19.1. Point A is at ground for a.c.

Fig. 19.2. For a.c. signals the emitter is held at ground by the capacitor.

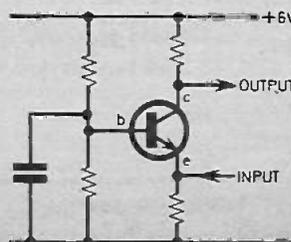
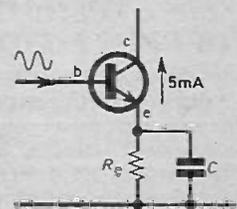


Fig. 19.3. Single-stage common-base amplifier.



# DOWN TO EARTH

By GEORGE HYLTON

"Why does everybody persist in saying that current flows from positive to negative when the electrons, which make up the current, flow from negative to positive?"

The short answer, I suppose, is that not everybody does adopt the convention of positive-to-negative current flow. Some teachers use electron flow. The result is needless confusion.

In one respect the argument is absurd. This can be demonstrated by the simplest electric circuit, see Fig. 1. Here a "box" gives out a voltage (or as some pedants would say, an electromotive force). The box may contain a battery or a dynamo or a solar cell or any other kind of d.c. generator. It doesn't matter which. Let's suppose it's a battery.

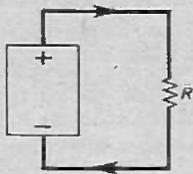


Fig. 1. Direction of arrows shows conventional current flow through R.

## TWO-WAY FLOW

Conventional current flows in the direction shown, from positive to negative. Or does it? Take a closer look. The current goes round and round, through the resistance R, back through the battery, through the resistance . . . and so on. Concentrate on the battery.

Conventional current in the battery does not go from positive to negative, does it? It goes from negative to positive!

So in one part of the circuit we have current going from positive to negative while in another part it goes from negative to positive. If the current consists of a stream of electrons, then it goes the "right" way inside the battery and

the "wrong" way outside it.

Whichever convention you adopt it gives the wrong direction in one part of the circuit. The idea that the direction of electron flow ought to be the same as the direction of current flow must be violated in some part of any working circuit.

## CURRENT CARRIERS

If the battery happens to be a lead-acid accumulator, two kinds of current carrier are at work inside it at the same time. Positive hydrogen ions move to the positive plate, while negative sulphate ions carry their charges to the negative plate. There are no free electrons involved. So the simple idea that current ought to flow the way the charges flow is, in an electrolyte, meaningless.

It's true, of course, that in electronics we are usually concerned only with the external circuit, and not with what's going on inside the power supply. It's also true that the commonest ingredient of electronic circuits, namely bits of wire or their printed or integrated circuit equivalents conduct current through the movement of electrons and only electrons. True also is that these have negative charges and so move towards the positive side of the supply line. True that this movement of electrons is in the opposite direction to conventional current.

## CONTRADICTION

The reason for this contradiction lies in history. Long before the discovery of the electron, physicists were faced with the need to adopt some sort of convention for the direction of flow of the weightless, invisible substance which they called "the

electric fluid". They needed a convention so as to be able to talk to one another about it. Too bad that they guessed wrong, in terms of electron movement.

By the time J. J. Thompson discovered the electron at the end of the 19th century, generations of electrical engineers had grown up and a vast amount of technology and hardware had been produced all in the convention of positive to negative flow. The price of changing the convention would have been enormous, and anyway, the motors still went round the right way, error or no error, so what difference did it make? So they did nothing.

## RADIO VALVE

Things got a little tougher when the radio valve came along. Here was a device in which an electric current passed through a vacuum and there was no doubt at all—after J. J. Thompson's discovery—that the charge carriers in the valve were electrons.

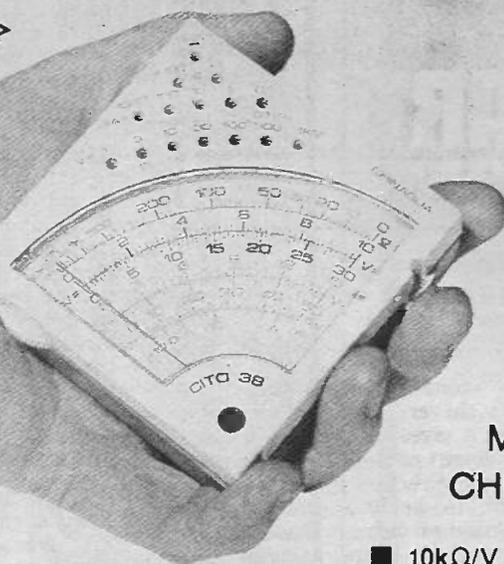
Electrons certainly moved from the negative cathode to the positive anode, the opposite direction to conventional current as indicated on a meter.

Difficult. Yet despite this glaring contradiction generations of radio engineers have managed to ply their trade without coming to grief. With the introduction of the transistor life became easier.

## HOLES

In the transistor, as in the valve or the piece of wire, electrons carry the current. But for reasons of mathematical convenience transistor physicists invented a new, imaginary carrier, the positive "hole". Now, a positive hole is the space left where a negative electron has moved out. It has no real existence; it just happens to be easier, in certain circumstances, to think of positive holes moving one way than negative electrons moving the opposite way.

Never mind. If you apply the "hole" concept to an ordinary circuit like Fig. 1 then the holes move in the same direction as the conventional current—in the external circuit, of course—so there's no need to alter the convention after all. Particle motion—imaginary though the particles may be—and current direction are at one, God's in his heaven and all's right with the world.



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AC128	15p	BC212	13p	2N3055	49p	IN5402	19p	50V	46p		
AC141K	26p	BC213	13p	2N3702	14p	IN5404	24p	100V	57p		
AC142K	26p	BC214	13p	2N3703	13p	IN5406	28p	200V	66p		
AC176	18p	BD131	68p	2N3704	14p			400V	77p		
AC187	24p	BD132	90p	2N3705	13p						
AC188	24p	BF194	16p	2N3706	12p	BRIDGE		5 Amp			
AC187K	28p	BF195	17p	2N3707	13p	RECTI-		100V	33p		
AC188K	28p	BF244	27p	2N3708	11p	FIERS		200V	55p		
AD149	49p	BFY50	18p	2N3709	12p	1 Amp		400V	77p		
AD161	38p	BFY51	18p	2N3710	12p	100V	22p	6 Amp			
AD162	40p	BFY52	17p	2N3711	12p	200V	24p	100V	66p		
AF114	20p	MP8111	36p	2N3819	35p	600V	27p	200V	88p		
AF115	20p	OC28	50p	40361	55p	THYRIS-		400V	99p		
AF116	20p	OC36	50p	40362	55p	TORS		10 Amp			
AF117	20p	OC44	16p	40363	69p	1 Amp		100V	99p		
BC107	13p	OC45	10p	IN914	8p	100V	29p	200V	1-32		
BC108	12p	OC71	11p	IN916	8p	100V	32p	400V	1-43		
BC109	13p	OC81	12p	IN4001	7p	200V	34p	400mW			
BC147	13p	2N706	14p	IN4002	8p	400V	44p	ZENER			
BC148	13p	2N1131	24p	IN4003	10p	3 Amp		DIODES			
BC149	13p	2N1132	28p	IN4004	10p	50V	39p	3-3 to 33			
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### C296 SERIES

400V: 0-001µF, 0-0015, 0-0022, 0-0033, 0-0047 3p, 0-0068, 0-01, 0-015, 0-022, 0-033 3½p, 0-047, 0-068, 0-1 4½p, 0-15 6½p, 0-22 8½p, 0-33 12p, 0-47 14½p.

160V: 0-01µF, 0-015, 0-022, 0-033, 0-047, 0-068 3½p, 0-1 4p, 0-15 4p, 0-1 4½p, 0-15, 0-22 5½p, 0-33 7p, 0-47 9½p, 0-68 12p, 1µF 14½p, 1-5µF 22p, 2-2µF 24p.

## Electrolytic Capacitors

6-3 VOLT	16 VOLT	40 VOLT
68µF 6½p	220µF 9p	47µF 6½p
150µF 6½p	680µF 17p	100µF 9p
470µF 11p	1000µF 17p	68µF 10p
680µF 13p	1500µF 25p	220µF 11p
1500µF 18p	2000µF 43p	470µF 19p
3300µF 26p		680µF 25p

10 VOLT	25 VOLT	63 VOLT
47µF 6½p	100µF 6½p	1µF 6½p
100µF 6½p	220µF 6½p	2-2µF 6½p
220µF 8p	47µF 8p	4-7µF 6½p
330µF 10p	100µF 8p	68µF 6½p
470µF 10p	150µF 8p	10µF 6½p
1000µF 11p	220µF 10p	22µF 6½p
1500µF 20p	470µF 13p	68µF 10p
2200µF 24p	680µF 20p	100µF 11p
	1000µF 22p	220µF 13p
	2200µF 39p	68µF 10p
	5000µF 68p	100µF 11p

16 VOLT	40 VOLT	220µF 18p
15µF 6½p	6-8µF 6½p	Pin insertion tool 57p
33µF 6½p	15µF 6½p	Spot face cutter 46p
150µF 6½p	33µF 6½p	Pk. 36 Pins 20p
150µF 8p	1000µF 44p	

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Carbon track 500Ω to 2-2M Ω.  
Log or Linear.  
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± watt 5% carbon 1p  
± watt 10% carbon 2p  
range 10 ohms to 4-7 megohms  
± watt m/o 2% 4p  
range 10 ohms to 1 megohms

## VEROBORD

	0-1	0-15
2½ × 3½	24p	19p
2½ × 5	27p	23p
3½ × 3½	27p	23p
3½ × 5	31p	31p
17 × 2½	82p	63p
17 × 3½	£1-10	83p
17 × 5 (Plain)		90p
Pin insertion tool		57p
Spot face cutter		46p
Pk. 36 Pins		20p



## Ignoramuses?

I write because I take strong exception to the comments of your columnist, Mr. Paul Young in *Counter Intelligence* in your April issue.

He (or the supplier of his material) seems to have the attitude that those who live beyond the English Channel or the Irish Sea are a bunch of ignoramuses who know nothing about the realities of life outside the jungle clearing.

Mr. Young's article is intended

to give the idea that overseas customers wish to be subsidized. No wonder that this firm only gets £1,000 in overseas business a year. Has this firm ever conceived it likely that if they said to customers "You owe us £1.10" or "Please send a remittance of £2.50 to cover costs" that the customer would refuse.

Thankfully, the attitude of this firm in the home country is not shared by some others. I have dealt with a number of them that advertise in your excellent magazine and in those published by IPC Magazines and I can commend to your overseas readers Electrovalue Ltd., Arrow Electronics and Antex Ltd. to name three who are prompt in their despatch of items, are courteous and charge fair prices.

The position is not as one-sided as Mr. Young would have your readers think. There are a number of export mail-order firms that charge outrageous amounts for packaging, and no matter what quantity is added for postage etc., it is kept and no credit given.

Recently two meters that arrived in a light cardboard box surrounded by shredded newspaper cost £1 to package. Couple this with the attitude of Mr. Young's firm and can you wonder why overseas customers have now switched to other countries for their supplies?

I am afraid that besides the unguaranteed and uncertain delivery date of British products another serious casualty of world competition has been the tradi-

tional British reputation for courtesy and impeccable trade practices. But I guess that these do not balance books.

W. C. Trotman  
Barbados,  
West Indies.

*The difficulty in answering Mr. Trotman's letter, is that he accuses me of saying or implying things I neither said nor implied. "Please re-read my article Mr. Trotman". I did not state nor imply that overseas customers were ignoramuses (or is it ignorami?), in fact I commiserated with them on their plight!!*

Mr. Trotman also misses the point, which is that a small mail-order firm like ourselves cannot cope with export orders. The three firms he mentions, one is a manufacturer and two are wholesalers. They would be geared up to export anyway, so that an extra small order would not throw them and they know there is always the chance it will be followed by a big order.

Several years ago we tried very hard to build up our export side, but our turnover never exceeded £2,000 a year and it became obvious that we should never receive any orders other than the small "one off" orders.

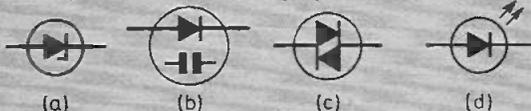
I do not think I would be exaggerating, if I said that even with U.K. orders we probably lose money on any order under one pound, but we regard that as part of our service because that customer returns again and again; the overseas customer rarely does!

Paul Young.

## What do you know?

### DIODES

1. A circuit you are constructing calls for a bridge rectifier of 50 p.i.v. at 1 amp. State what these ratings mean and indicate which of the following bridge rectifiers would be suitable (a) 50V, 1.5A (b) 75V 1A (c) 100V  $\frac{1}{2}$ A.
2. Say what the following symbols represent.



3. Indicate the anode and cathode on diagram

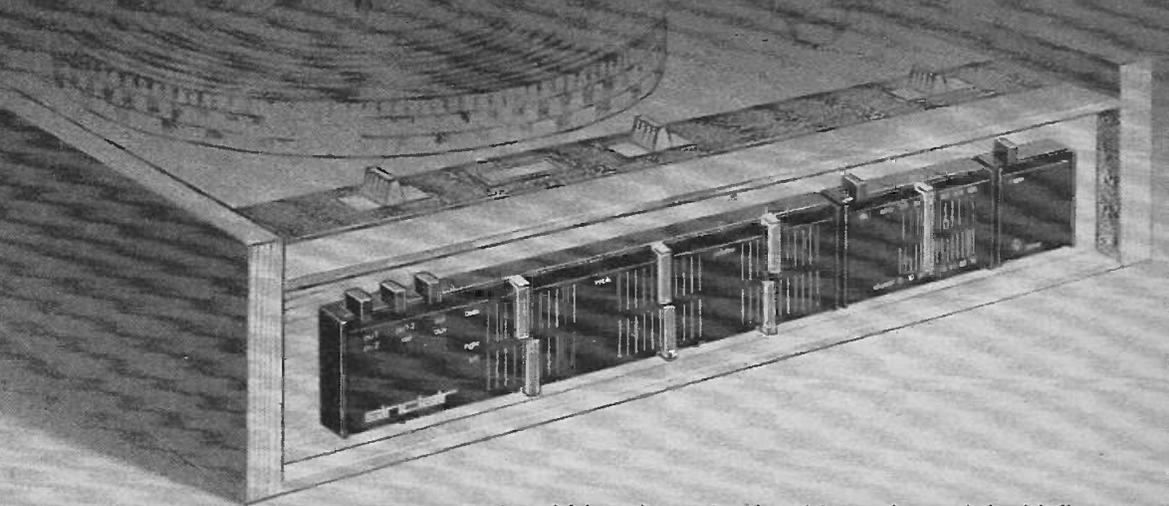
2a and state which end would be marked with a red band or dot or a + sign.

### ANSWERS

1. The 50 p.i.v. means that the diode can stand a peak inverse voltage of 50V, i.e. the voltage is applied so that the diode is reverse biased. Both (a) and (b) would be suitable—the current rating is a maximum thus (c) would not be suitable.
- 2 (a) Zener diode (b) diode used as a capacitive device, e.g. varactor (c) bi-directional diode, e.g. diac (d) light emitting diode (l.e.d.).
3. The cathode is the end to which the arrow points and is normally marked with a red band or dot or a + sign.

# Project 80

a brilliant new concept in modular hi-fi



Project 80 is going to be the ultimate in modular hi-fi construction for a very long time to come. It combines the qualities most demanded of any modern domestic system – good circuitry, reliability and fine performance – with other features to be found nowhere else in the world. For example,

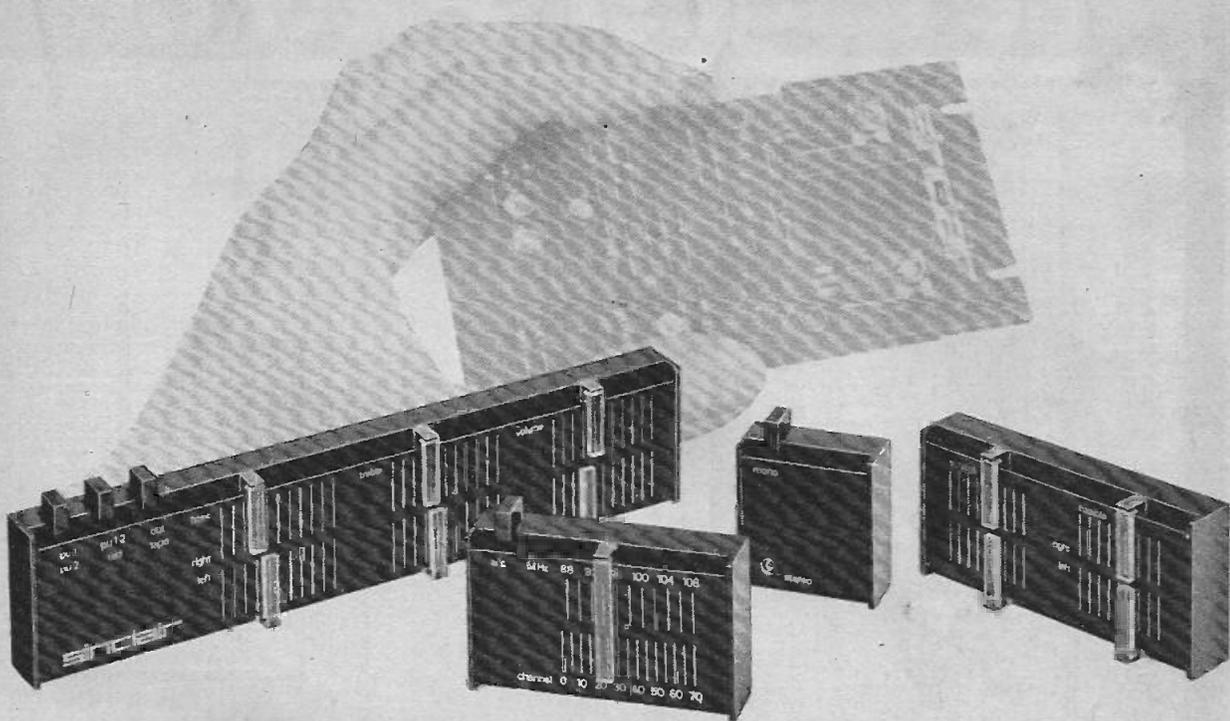
*compactness* – Project 80 control units are  $\frac{3}{4}$ " deep x 2" high, and each one is completely self-contained.

*Elegance* – all of Sinclair's design leadership has been concentrated on producing designs of outstanding functional elegance unsurpassed for styling and simplicity. *Flexibility* – the size and styling of Project 80 modules makes them the most versatile units ever. Combine them how you will, where you will, the Project 80 System of your choice gives you the best.

**sinclair**

Everyday Electronics, August 1974

# Sinclair Project 80



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If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair appointed stockists also offer this guarantee. Should any defect arise in normal use, we will service it without charge.

# sinclair

Sinclair Radionics Ltd  
London Rd., St. Ives  
Huntingdon PE17 4HJ  
Telephone  
St. Ives (0480) 64646

Everyday Electronics, August 1974

**Stereo 80 Control Unit** size 260 x 50 x 20mm (10 1/2 x 2 x 3/8 ins)  
Finish—Black with white indicators and transparent sliders Inputs—Magnetic pick up 3mV RIAA corrected; Ceramic pick-up 350mV Radio 100mV; Tape 30mV Signal/noise ratio—60db Frequency range—20Hz to 15KHz ±1dB; 10Hz to 25KHz ±3dB Power requirements—70 to 35 volts Outputs—100mV—AB monitoring for tape Controls—Press button tape radio and P.U. Sliders on each channel for volume bass treble R.R.P. £11.95 (add £1.19 V.A.T.)

**Project 80 FM Tuner** size—85 x 50 x 20mm (3 3/8 x 2 x 3/8 ins)  
Tuning range Dual varicap—87.5 to 108MHz Detector—I.C. balanced coincidence One I.C. equal to 26 transistors Distortion—0.2% at 1KHz for 30% modulation 4 pole ceramic filter in I.F. section Aerial impedance—75 Ω or 240 300 Ω Sensitivity—5 microvolts for 30dB S/N ratio Output—300mV for 30% modulation Power requirements—25 to 35 volts R.R.P. £11.95 (add £1.19 V.A.T.)

**Project 80 Stereo Decoder** size—47 x 50 x 20mm (1 7/8 x 2 x 3/8 ins)  
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**Active Filter Unit** Separate controls on each channel. Size—108 x 50 x 20mm (4 1/4 x 2 x 3/8 ins) Voltage gain—minus 0.7dB Frequency response—40Hz to 22KHz controls minimum Distortion—at 1KHz—0.03% using 30V supply H.F. cut off (scratch)—22 KHz to 5.5KHz 12dB/oct slope L.F. cut off (rumble)—28dB at 20Hz, 9dB/oct. slope R.R.P. £6.95 (add 69p V.A.T.)

**Z.40 Power Amplifier** size—55 x 80 x 20mm (2 1/8 x 3 1/8 x 3/8 ins) 9 transistors Input sensitivity—100mV Output 18 watts RMS continuous into 4 Ω (35V) Frequency response—30Hz-100KHz—3dB S/N ratio—64dB Distortion—at 10 watts into 8 Ω less than 0.1% Power requirements—12 to 35 volts, built-in protection against overload R.R.P. £5.40 (add 54p V.A.T.)

**Z.60 Power Amplifier** size—55 x 98 x 15mm (2 1/8 x 3 7/8 x 3/8 ins) 12 transistors Input sensitivity—100-250mV Output—25 watts RMS continuous into 8 Ω (50V) Distortion—typically 0.03% Frequency response—15Hz to more than 200KHz ±3dB S/N ratio—better than 70dB Built-in protection against transient overload and short circuiting Load impedance—4 Ω min. safe on open circuit R.R.P. £6.95 (add 69p V.A.T.)

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AC115	20	AD174	55	BC152	19	BD133	72	BF184	28	ML3065	62	2G392	39	2N2194	39
AC117K	32	AF114	27	BC153	31	BD134	44	BF185	33	MT3440	35	2G394	18	2N2217	24
AC123	13	AF115	27	BC154	33	BD136	44	BF187	40	MPF102	46	2G344	20	2N2218	22
AC125	19	AF116	27	BC157	20	BD137	50	BF188	40	MPF104	41	2G346	18	2N2219	22
AC126	19	AF117	27	BC158	13	BD138	55	BF194	13	MPF105	41	2G347	18	2N2220	24
AC127	20	AF118	39	BC159	13	BD139	61	BF195	13	OC219	39	2G371B	13	2N2221	22
AC128	20	AF124	33	BC160	50	BD140	66	BF196	16	OC220	70	2G373	19	2N2222	22
AC132	16	AF125	33	BC161	55	BD141	66	BF197	16	OC221	52	2G374	19	2N2223	22
AC134	16	AF126	33	BC162	19	BD142	66	BF200	10	OC222	54	2G377	33	2N2224	22
AC137	18	AF127	31	BC164	13	BD176	66	BF222	15.05	OC224	62	2G378	18	2N2269A	16
AC141	20	AF130	33	BC169	13	BD177	72	BF257	50.05	OC225	42	2G381	18	2N2211	27
AC141K	32	AF178	55	BC170	13	BD178	72	BF258	96	OC226	32	2G382	18	2N2412	27
AC142	20	AF179	55	BC171	18	BD179	77	BF259	94	OC228	55	2G401	33	2N2946	52
AC142K	32	AF180	55	BC172	16	BD180	77	BF262	61	OC229	55	2G414	33	2N2947	23
AC151	17	AF281	65	BC174	16	BD183	72	BF263	61	OC235	46	2G417	28	2N2972	23
AC154	22	AF186	55	BC174	16	BD189	72	BF270	39	OC236	55	2N2858	33	2N2971	23
AC155	22	AF239	41	BC175	24	BD187	77	BF271	33	OC241	22	2N288A	61	2N2904	10
AC156	22	AL102	72	BC177	21	BD188	77	BF272	38	OC242	27	2N288A	22	2N2904A	13
AC157	27	AL103	72	BC178	21	BD189	83	BF273	39	OC244	17	2N2804	31	2N2905	23
AC165	22	ASV26	28	BC179	21	BD190	88	BF274	39	OC245	14	2N2905A	23	2N2906	17
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AC168	22	ASV28	28	BC181	27	BD196	94	BF280	30	OC278	11	2N2908	46	2N2907A	22
AC168	22	ASV29	28	BC182	11	BD197	99	BF284	24	OC279	16	2N2909	50	2N2908	09
AC169	16	ASV30	28	BC182L	11	BD198	99	BF285	33	OC274	16	2N2909A	24	2N2908A	10
AC176	22	ASV31	28	BC183	11	BD199	105	BF286	24	OC275	17	2N2910	15	2N2909A	16
AC177	27	ASV32	28	BC184	11	BD200	105	BF287	27	OC276	17	2N2911	39	2N2910A	27
AC178	31	ASV34	28	BC184	13	BD206	68	BF288	24	OC277	23	2N2912	39	2N2911A	10
AC179	31	ASV35	28	BC184L	13	BD206	68	BF289	22	OC277	23	2N2913	39	2N2912A	10
AC180	22	ASV56	28	BC186	31	BD207	105	BF290	22	OC281	17	2N2914	38	2N2913A	10
AC180K	32	ASV57	28	BC187	31	BD208	105	BF291	22	OC282	17	2N2915	38	2N2914A	10
AC181	22	ASV58	28	BC207	12	BDY20	110	BFY53	19	OC283	17	2N2916	38	2N2915A	10
AC181K	32	ASV73	28	BC208	12	BDY15	27	BFY55	94	OC289	22	2N2917	39	2N2916A	11
AC187	24	AR221	44	BC209	13	BDY16	27	BFY56	94	OC290	22	2N2918	39	2N2917A	11
AC187K	24	BC107	12	BC212L	12	BF118	77	DSX20	17	OC140	22	2N2919	39	2N2918A	11
AC188	24	RC108	12	BC213L	12	BF119	77	DSY25	17	OC169	22	2N2920	55	2N2919A	11
AC188K	25	BC109	13	BC214L	18	BF121	50	DSY26	17	OC170	22	2N2921	31	2N2920A	11
AC187	25	BC113	11	BC225	28	BF123	55	DSY27	17	OC171	28	2N2922	31	2N2921A	11
AC178	22	BC114	17	BC226	39	BF125	50	DSY28	17	OC172	28	2N2923	31	2N2922A	11
AC179	22	BC115	17	BC231	30	BF127	55	DSY29	17	OC173	28	2N2924	31	2N2923A	11
AC187K	22	BC116	17	BC232	27	BF128	62	DSY30	17	OC174	28	2N2925	31	2N2924A	11
AC187	22	BC117	20	BC233	35	BF153	50	DSY31	20	OC203	28	2N2926	31	2N2925A	11
AC187	22	BC118	11	BC304	40	BF154	50	DSY40	31	OC204	28	2N2927	31	2N2926A	11
AC187	22	BC119	33	BC340	34	BF155	57	DSY41	31	OC205	28	2N2928	31	2N2927A	11
AC187	22	BC120	98	BC340	40	BF156	53	DSY42	31	OC206	28	2N2929	31	2N2928A	11
AC187	22	BC125	13	BCY30	27	BF157	61	DSY43	31	OC207	28	2N2930	31	2N2929A	11
AC187	22	BC126	20	BCY31	29	BF158	61	DSY44	31	OC208	28	2N2931	31	2N2930A	11
AC187	22	BC132	13	BCY32	33	BF159	66	DSY45	31	OC209	31	2N2932	31	2N2931A	11
AC187	22	BC134	20	BCY33	34	BF160	44	DSY46	31	OC210	31	2N2933	31	2N2932A	11
AC187	22	BC135	13	BCY34	28	BF162	44	DSY47	31	OC211	31	2N2934	31	2N2933A	11
AC187	22	BC136	17	BCY70	16	BF163	44	DSY48	31	OC212	31	2N2935	31	2N2934A	11
AC187	22	BC137	17	BCY71	22	BF164	44	DSY49	31	OC213	31	2N2936	31	2N2935A	11
AC187	22	BC138	44	BCY72	18	BF165	44	DSY50	31	OC214	31	2N2937	31	2N2936A	11
AC187	22	BC140	33	BCZ10	22	BF167	24	DSY51	31	OC215	31	2N2938	31	2N2937A	11
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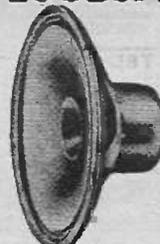
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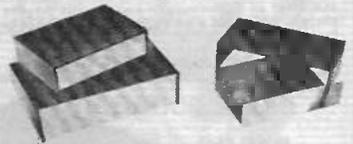


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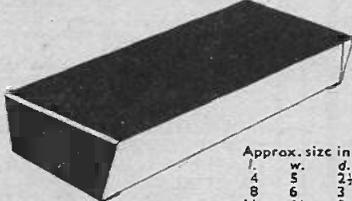
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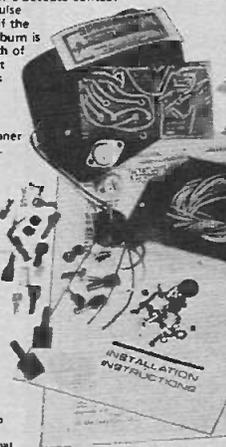
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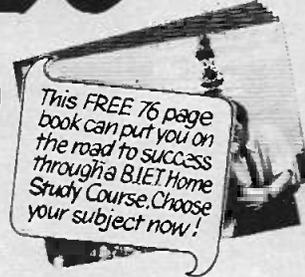
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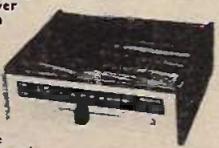
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