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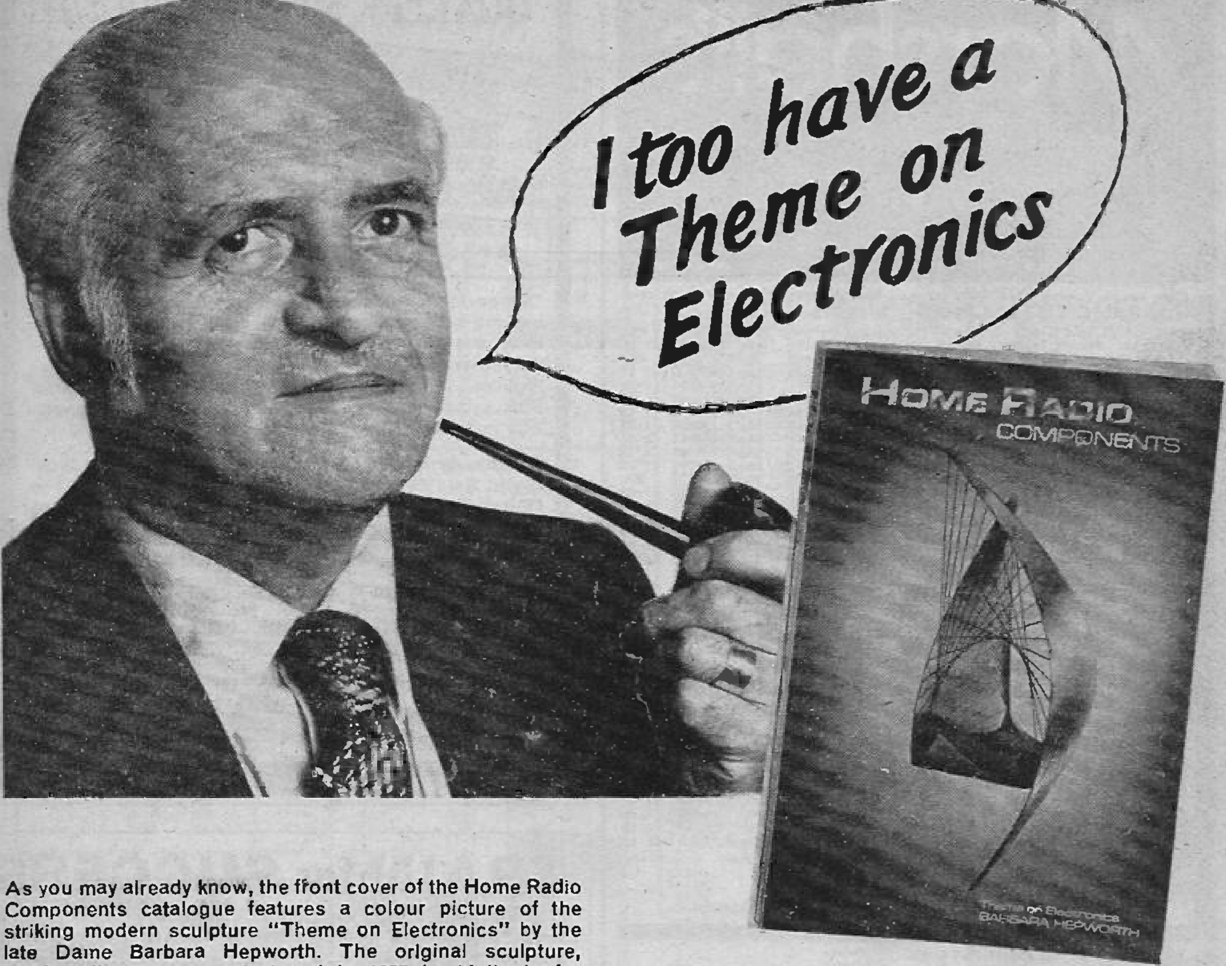

As you may already know, the front cover of the Home Radio Components catalogue features a colour picture of the striking modern sculpture "Theme on Electronics" by the late Dame Barbara Hepworth. The original sculpture, incidentally, was commissioned in 1957 by Mullards for their Electronics Centre showroom.

If you asked me for *my* theme on electronics I'd say that experience has taught me that the simplest and most satisfactory way of getting electronic components is to buy them from Home Radio Components—either over the counter at their shop in Mitcham or by Mail Order. Ninety nine times out of a hundred they can supply just what you want immediately from stock—at very keen prices too. If you're likely to require bits and pieces fairly regularly it will be worth your while to make use of their Credit Account Service. This is a fairly new service provided by Home Radio Components, but they tell me that already about a thousand customers are using it. That doesn't surprise me. I for one have found that it saves me time and money in several ways. No space to give details here, but full information and an application form are given in the catalogue. Whether or not you use the Credit Account Service, you'll certainly need the catalogue, and at £1·30 (85p plus 45p post & packing) it's a real bumper bargain. Its 240 pages list about 6000 components with nearly 2000 illustrations. What's more the catalogue contains Vouchers worth 70 pence when used against orders, so you can soon recover a good slice of your investment.

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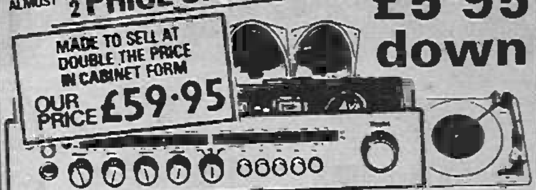

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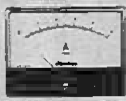

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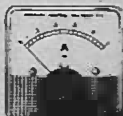

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50-0-50uA	£3.50
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1mA	£3.25
5mA	£3.25
10mA	£3.25
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500mA	£3.25
1A DC	£3.25
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10V DC	£3.25
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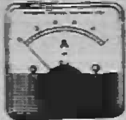

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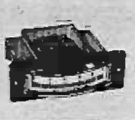

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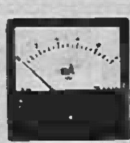
Size: 80 x 80mm



50uA	£4.85
100uA	£4.90
500uA	£4.60
50-0-50uA	£4.80
100-0-100uA	£4.85
1mA	£4.60
1A DC	£4.60
5A DC	£4.60
20V DC	£4.60
50V DC	£4.60
300V DC	£4.60
300V AC	£4.75
VU Meter	£5.95

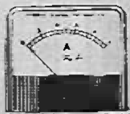
CLEAR PLASTIC MODEL MR 52P
Size: 60 x 60mm

50uA	£4.10
100uA	£3.85
500uA	£3.70
50-0-50uA	£3.85
100-0-100uA	£3.70
1mA	£3.85
5mA	£3.65
10mA	£3.66
50mA	£3.65
100mA	£3.65
500mA	£3.66
1A DC	£3.65
5A DC	£3.66
10V DC	£3.65
20V DC	£3.66
50V DC	£3.65
300V DC	£3.65
15V AC	£3.75
300V AC	£3.75
5 Meter 1mA	£4.20
VU Meter	£4.85
1A AC	£3.65*
5A AC	£3.66*
10A AC	£3.65*
20A AC	£3.65*
30A AC	£3.65*

BAKELITE MODEL MR 65 Size: 80 x 80mm

25uA	£6.80
50uA	£4.40
100uA	£4.35
500uA	£4.05
50-0-50uA	£4.35
100-0-100uA	£4.30
500-0-500uA	£3.95
1mA	£3.95
1-0-1mA	£3.95
5mA	£3.95
10mA	£3.96
50mA	£3.95
100mA	£3.96
500mA	£3.95
1A DC	£3.95
2A DC	£3.95
5A DC	£3.96
10A DC	£3.95
15A DC	£3.95
30A DC	£3.95
50A DC	£4.20
5V DC	£3.95
10V DC	£3.95
15V DC	£3.95
20V DC	£3.95
50V DC	£3.96
150V DC	£3.95
300V DC	£3.95
30V AC	£3.95*
50V AC	£3.95*
150V AC	£3.95*
300V AC	£3.95*
500V AC	£3.95*
VU Meter	£6.20
1A AC	£3.95*
5A AC	£3.96*
10A AC	£3.95*
20A AC	£3.96*
30A AC	£3.95*
50A AC	£3.96*
500mA AC	£3.95
50mV DC	£4.15
100mV DC	£4.15

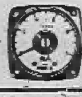
CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm



50uA	£4.35
100uA	£4.25
200uA	£4.20
500uA	£4.15
50-0-50uA	£4.25
100-0-100uA	£4.20
500-0-500uA	£4.10
1mA	£4.10
1-0-1mA	£4.10
5mA	£4.10
10mA	£4.10
50mA	£4.10
100mA	£4.10
500mA	£4.10
1A DC	£4.10
5A DC	£4.10
10A DC	£4.10
15A DC	£4.10
20A DC	£4.20
30A DC	£4.25
50A DC	£4.10
5V DC	£4.10
10V DC	£4.10
15V DC	£4.10
20V DC	£4.10
50V DC	£4.10
150V DC	£4.10
300V DC	£4.10
15V DC	£4.20
50V AC	£4.20
150V AC	£4.20
300V AC	£4.20
500V AC	£4.30
5 Meter 1mA	£4.85
VU Meter	£5.20
1A AC	£4.10*
5A AC	£4.10*
10A AC	£4.10*
20A AC	£4.10*
30A AC	£4.10*
50A AC	£4.10
50mA AC	£4.10*
100mA AC	£4.10*
200mA AC	£4.10*
500mA AC	£4.10*

240° Wide Angle 1mA METERS

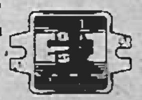
MW1-8,80 x 80mm
£7.45 P & P ins.15p

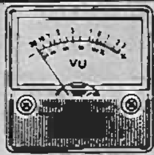


ALL PRICES INCLUDE VAT

BATTERY/LEVEL PANEL INDICATOR

18mm x 18mm Panel mounting.
OUR PRICE 95p P/P & Ins 15p Discounts for quantity.





VU METER TYPE 3

250 uA Size: 33mm x 20mm.
£1.55 P/P & Ins 15p

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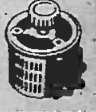
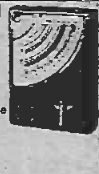
YAMABISHI VARIABLE VOLTAGE TRANSFORMERS

Excellent quality at low cost. Input 230V 50/60Hz. Output 0—260V.
MODEL S260 BENCH MOUNTING



		P/P & Ins:
1A	£7.30	£1.50
2.5A	£10.35	£1.50
5A	£12.95	£1.50
8A	£19.45	£1.50
10A	£23.75	£1.50
12A	£25.90	£1.50
20A	£60.45	£1.50
25A	£64.75	£1.50
40A	£73.40	£1.50

MODEL C7202EN



20,000 o.p.v. DC. 10,000 o.p.v. AC Mirror Scale. 6/25/50/250/500/1000/2500 V. DC. 10/50/100/500/1000 V. AC. DC Resistance x10. x1000 (30Ω centre scale) DC Current 50uA/2·5mA/250mA.—20 to +68 dB.

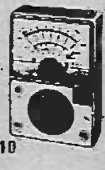
OUR PRICE £7.50 P/P & Ins 30p

U4323 MULTIMETER

20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: x 10, x 100, x 1,000, x 10,000 (50Ω, 500Ω, 5kΩ, 50kΩ centre scale) Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.

OUR PRICE £8.60 P/P & Ins 60p

HIOKI 730X



30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/μA/30mA/300mA. 2K/200K/2 Meg Ohm. −10 to +63 dB.

OUR PRICE £8.10 P/P & Ins 30p

MODEL C7208FM

30,000 opv DC. 15,000 opv AC. 6/3/15/60/300/600/1200 V. DC. 6/30/120/600/1200 V. AC. DC Resistance x 1, x 10, x 100, x 1000 (50Ω centre scale) DC Current 30uA/3/30/600mA. —20 to +63dB.

OUR PRICE £9.65 P/P & Ins 30p

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Cassette Deck with Dolby. VU meters, program counter, and phono input/outputs. slider controls, in sleek black, aluminium, and teak. response: 40-12 kHz on tape and 40-16 kHz on CrO². W/F 0.2%, and with the Dolby Noise Reduction System in, a to noise ratio of 57dB.
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All silicon, transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. INPUTS: 5mV and 100mV. OUTPUT: 50mV per channel.
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Top value 1,000 pocket multi-meter. Ranges: 0/10/50/250/1,000 AC and DC. DC current 0-1mA/100mA. Resistance: 0/150k ohms. Decibels: −10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.
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C120 £3.59 £6.80 £9.84
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MODEL 5 10 15
C60LN £3.59 £6.80 £9.64
C90LN £5.13 £9.72 £13.77
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R1	50	Mixed	100 ohms–820 ohms 1/8th W.	0·60
R2	50	Mixed	1K ohms–8·2K ohms 1/8th W.	0·60
R3	50	Mixed	10K ohms–82K ohms 1/8th W.	0·60
R4	50	Mixed	100K ohms–820K ohms 1/8th W.	0·60
R5	30	Mixed	100 ohms–820 ohms ¼ W.	0·60
R6	30	Mixed	1K ohms–8·2K ohms ¼ W.	0·60
R7	30	Mixed	10K ohms–82K ohms ¼ W.	0·60
R8	30	Mixed	100K ohms–820K ohms ¼ W.	0·60

THESE ARE UNREPEATABLE PRICES

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500	µF	50V Elect	0·09 each
·01	µF	400V	0·03 each

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RF Chokes	CH1	2·5mH	0·27
	CH3	7·5mH	0·29
	CH5	1·5mH	0·28
	CH2	5·0mH	0·28
	CH4	10mH	0·31

COILS DRX1 Crystal set 0·29 DRR2 Dual range 0·42

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Log and Lin
4·7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M.

VC 1	Single Less Switch	0·14
VC 2	Single D.P. Switch	0·26
VC 3	Tandem Less Switch	0·43
VC 4	1K Less Switch	0·14
VC 5	100K Log anti-Log	0·43

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0·1 Watt 0·06 each
100, 220, 470, 1K, 2·2K, 4·7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4·7M.

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CABLES		Per Metre
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CP 3	Stereo Screened	★0·12
CP 4	Four Core Common Screen	★0·21
CP 5	Four Core individually screened	★0·28
CP 6	Microphone Fully Braided Cable	★0·11
CP 7	Three Core Mains Cable	★0·11
CP 8	Twin Oval Mains Cable	★0·08
CP 9	Speaker Cable	★0·06
CP 10	Low Loss Co-Axial	★0·14

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BV2	11"	×	6"	×	3"	★£1·62
BV3	6"	×	4½"	×	1½"	0·92
BV4	9"	×	5¼"	×	2½"	£1·39

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No.	Length		Width		Height	Price
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BA2	4"	×	4"	×	1½"	★0·45
BA3	4"	×	2½"	×	1½"	★0·45
BA4	5¼"	×	4"	×	1½"	★0·54
BA5	4"	×	2½"	×	2"	★0·45
BA6	3"	×	2"	×	1"	★0·39
BA7	7"	×	5"	×	2½"	★0·79
BA8	8"	×	6"	×	3"	★£1·02
BA9	6"	×	4"	×	2"	★0·65

(Each complete with ½" deep lid & screws)

PLEASE ADD 20p POSTAGE AND PACKING FOR EACH BOX.

COMPONENT PAKS

Pak No.	Qty.	Description	Price
C1	200	Resistors mixed values approx. count by weight	0·60
C2	150	Capacitors mixed values approx. count by weight	0·60
C3	50	Precision Resistors mixed values	0·60
C4	75	1/8th width Resistors mixed preferred values	0·60
C5	5	Pieces assorted Ferrite Rods	0·60
C6	2	Tuning Gangs, MW/LW VHF	0·60
C7	1	Pak Wire 50 metres assorted colours	★0·60
C8	10	Reed Switches	0·60
C9	3	Micro Switches	0·60
C10	15	Assorted Pots & Pre-Sets	0·60
C11	5	Jack Sockets 3 × 3·5m, 2 × standard Switch Type	0·60
C12	30	Paper Condensers preferred types mixed values	0·60
C13	20	Electrolytics Trans. types	0·60
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets, etc.	★0·60
C15	5	Mains Slide Switches, 2 Amp	0·60
C16	20	Assorted Tag Strips & Panels	0·60
C17	10	Assorted Control Knobs	0·60
C18	4	Rotary Wave Change Switches	0·60
C19	2	Relays 6-24V Operating	0·60
C20		Sheets Copper Laminate approx. 200 sq. ins.	★0·60

Please add 20p post and packing on all component packs, plus a further 10p on pack nos. C1, C2, C19 & C20.

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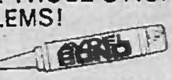

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J	Tape head cleaning kit	★63p
P	Hi-Fi cleaner	★30p
9	Wire stripper/Cutter	★94p
31	Cassette head cleaner	★58p
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32A	Stylus balance	★£1·24
36A	Record stylus cleaning kit	★32p
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43	Record care kit	★£2·68
45	Auto changer groove cleaner	★98p
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51 for model X25 1/8"	★44p
52 for model X25 3/16"	★44p

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PS 13	Jack Stereo Screened	0·33
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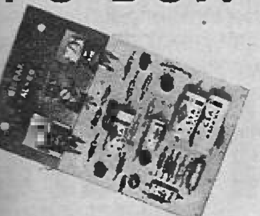
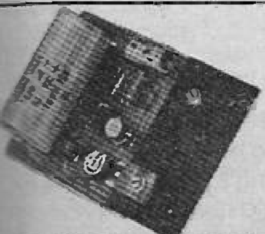


AL 60

50w. PEAK (25w. R.M.S.) **ONLY £3·95**

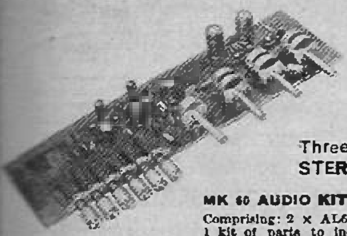
● Max Heat Sink temp 90°C. ● Frequency Response 20Hz to 100K Hz. ● Distortion better than 0·1 at 1KHz. ● Supply voltage 15-50 volts. ● Thermal Feedback. ● Latest Design Improvements. ● Load—3, 4, 5 or 16 ohms. ● Signal to noise ratio 80dB. ● Overall size 63mm x 105mm x 13mm.
Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.



STABILISED POWER MODULE SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm x 105mm x 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address Intercom Units, etc. Handbook available 10p. **PRICE £3·00**

TRANSFORMER BMT80 £2·60



STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100 which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls. **PRICE £13·20**

MK 60 AUDIO KIT
Comprising: 2 × AL60, 1 × SPM80, 1 × BTM80, 1 × PA100, 1 front panel. 1 kit of parts to include on-off switch, neon indicator, stereo headphone sockets plus instruction booklets.
COMPLETE PRICE: £27·55 plus 45p postage

TEAK 60 AUDIO KIT
Comprising: Teak veneered cabinet size 16¾" × 11¼" × 3¾", other parts include aluminium chassis, heatsink and front panel bracket, plus back panel and appropriate sockets, etc.
KIT PRICE: £9·20 plus 45p postage

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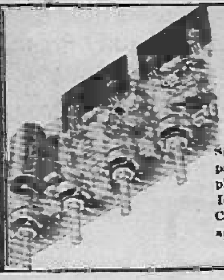

STEREO 30 COMPLETE AUDIO CHASSIS

7 + 7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This with only the addition of a transformer or overwind, will produce a high quality audio unit suitable for use with a wide range of inputs, i.e. high quality ceramic pickup, stereo tuner, stereo tape deck, etc.
Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting bracket, enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available.
Ideal for the beginner or advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty Can be installed in 30 mins.) PRICE: £15·75 plus 45p postage and packing. TRANSFORMER: £2·45 plus 45p postage and packing. TEAK CASE: £3·65 plus 45p postage and packing.

AL 10/AL 20/AL 30

The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home. AL10 £2·30, AL20 £2·65, AL30 £2·95.

M.P.A. 30

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new BiPak M.P.A.30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

Used in the construction are 4 low noise, high gain, silicon transistors. It is provided with a standard DIN input socket for ease of connection.

Supplied with full, easy to follow instructions. **PRICE £2·65**

STORAGE/CARRYCASES ★

RECORD CASES
7 in E.P. 18 ½th in x 7 in x 8in (50 records) *£2·48
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CASSETTE CASES
Holds 15. 10in x 3½in x 5in. Lock and handle. *£1·50

8-TRACK CARTRIDGE CASES
Holds 14. 13in x 5in x 6in. Lock and handle *£2·20
Holds 24. 13½in x 8in x 5½in Lock and handle *£3·20

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GP93-1	280mV at 1cm/sec	£1·48
GP96-1	100mV at 1cm/sec	£2·31
TTC		
J-2005	Crystal/Hi Output	97p
J-2010C	Crystal/Hi Output Compatible	£1·11
J-2006S	Stereo/Hi Output	£1·52
J-2105	Ceramic/Med. Output	£1·81
J-2203	Magnetic 5mV/5cm/sec. including stylus	£4·78
J-2203S	Replacement stylus for above	£2·88
AT-55	Audio-technica magnetic cartridge 4mV/5cm/sec	£3·06

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TYPE B1223. 200 ohms impedance. Complete with stand, on/off switch and 2·5mm and 3·5mm plugs. Suitable for cassette tape recorders. **PRICE £1·67**

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The Black Watch kit

At £17.95, it's

★**practical** – easily built by anyone in an evening's straightforward assembly.

★**complete** – right down to strap and batteries.

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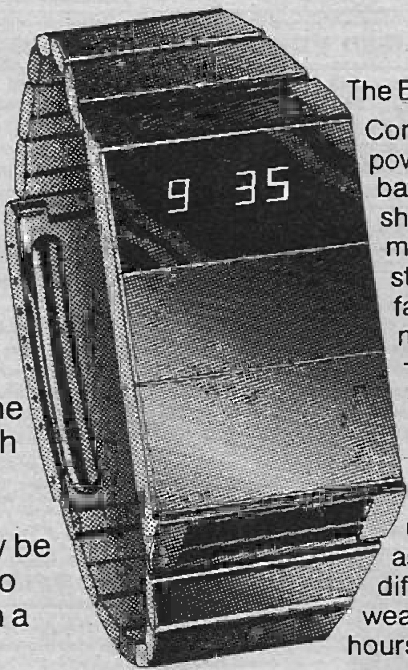


The Black Watch by Sinclair is unique.

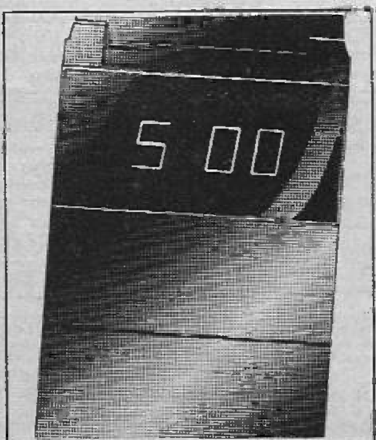
Controlled by a quartz crystal... powered by two hearing aid batteries...using bright red LEDs to show hours and minutes and minutes and seconds...it's also styled in the cool prestige Sinclair fashion: no knobs, no buttons, no flash.

The Black Watch kit is unique, too. It's rational – Sinclair have reduced the separate components to just four.

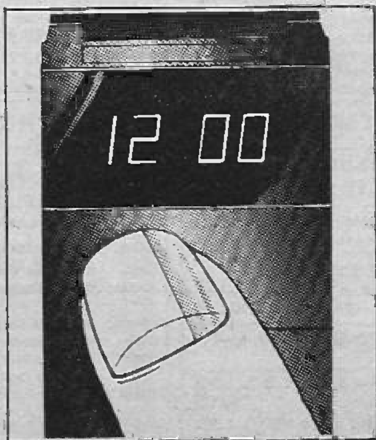
It's simple – anybody who can use a soldering iron can assemble a Black Watch without difficulty. From opening the kit to wearing the watch is a couple of hours' work.

The special features of The Black Watch

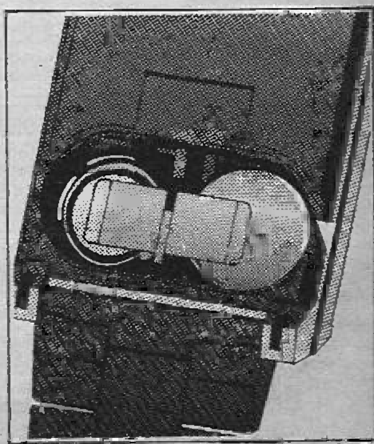
Smooth, chunky, matt-black case, with black strap. (Black stainless-steel bracelet available as extra – see order form.)



Large, bright, red display – easily read at night.
Touch-and-see case – no unprofessional buttons.



Runs on two hearing-aid batteries (supplied). Change your batteries yourself – no expensive jeweller's service.



The Black Watch – using the unique Sinclair-designed state-of-the-art IC.

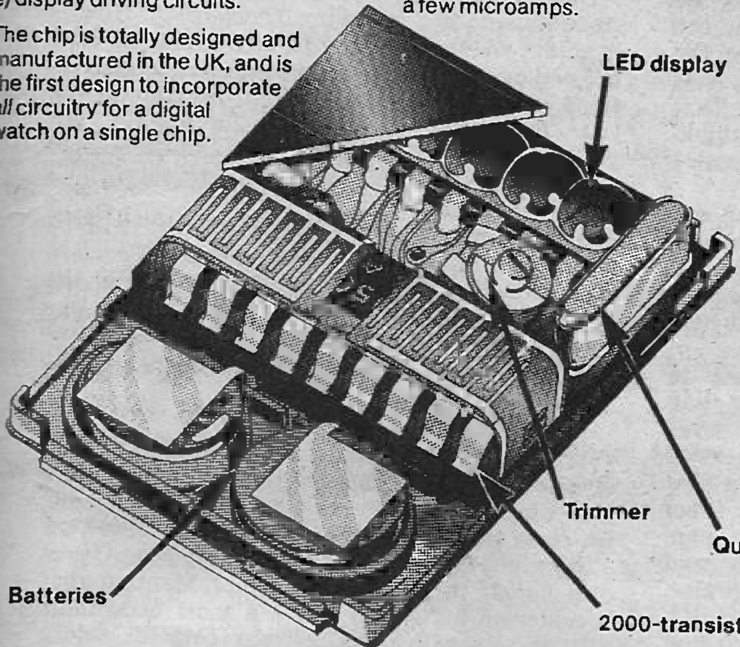
The chip...
The heart of the Black Watch is a unique IC designed by Sinclair and custom-built for them using state-of-the-art technology – integrated injection logic.

This chip of silicon measures only 3 mm x 3 mm and contains over 2000 transistors. The circuit includes

a) reference oscillator
b) divider chain
c) decoder circuits
d) display inhibit circuits
e) display driving circuits.

The chip is totally designed and manufactured in the UK, and is the first design to incorporate *all* circuitry for a digital watch on a single chip.

...and how it works
A crystal-controlled reference is used to drive a chain of 15 binary dividers which reduce the frequency from 32,768 Hz to 1 Hz. This accurate signal is then counted into units of seconds, minutes, and hours, and on request the stored information is processed by the decoders and display drivers to feed the four 7-segment LED displays. When the display is not in operation, special power-saving circuits on the chip reduce current consumption to only a few microamps.



Complete kit £17.95!

The kit contains
1. printed circuit board
2. unique Sinclair-designed IC
3. encapsulated quartz crystal
4. trimmer
5. capacitor
6. LED display
7. 2-part case with window in position
8. batteries
9. battery-clip
10. black strap (black stainless-steel bracelet optional extra – see order form)
11. full instructions for building and use.

All you provide is a fine soldering iron and a pair of cutters. If you've any queries or problems in building, ring or write to the Sinclair service department for help.

Take advantage of this no-risks, money-back offer today!
The Sinclair Black Watch is fully guaranteed. Return your kit within 10 days and we'll refund your money without question. All parts are tested and checked before despatch – and correctly-assembled watches are guaranteed for one year. Simply fill in the FREEPOST order form and post it – today!

Price in kit form: £17.95 (inc. black strap, VAT, p&p).

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.... (qty) black stainless-steel bracelet(s) at £2.00 (inc. VAT, p&p). ....

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PROJECTS
THEORY...

TO AID THE PARTY

Time flies. Indeed, it seems but yesterday we were anticipating the coming of autumn and the delights that come in its train, not least the opening of the new constructing season. Now we are a mere four weeks from Christmas. That means time we got down to some serious thinking about projects for use during the festive season.

So right here and now we present for our readers' edification, amusement and pleasure—a novel flasher for decorative lights and an electronic version of that traditional game heads or tails. Both are quite easy to build and will help create the party atmosphere in the home.

And incidentally, what finer opportunity to show off one's own skill as a constructor than that once-a-year occasion when family relatives and friends are suddenly brought together? It may make them sit up and view you in a new and different light! "Oh, I just knocked them up in a couple of evenings" our hero nonchalantly replies as admiring relatives and friends utter words of astonishment and praise. "Now let me show you that amplifier I built."

But watch it. Be real canny or else you'll find yourself committed to building a baby alarm for cousin Sue, an egg timer for Aunt Judith, or a car intruder alarm for Uncle Jim. Even worse, saddled with the repair of innumerable radios.

NEW ENTRANTS

Now a word or two to our latest class of students who are following *Teach-In 76*. How is it going? Well, we trust. In any event, be sure to keep up the good work despite varied distractions which may appear around this time of the year. But should you succumb for a while, put your copies of EE in a safe place and then catch up with the series as soon as you are able. Don't skip an instalment.

Also, remember your "course tutor" will be pleased to help with any particular *Teach-In* queries if you write to him. It's just part of the EE service—a service we extend to all our readers through the several specialist contributors who make up our advisory team.

SPECIAL OFFER

We started this month writing about the constructor's contribution to the domestic scene this Christmas. Since charity begins at home, we close with the following thought.

Why not drop a gentle hint or two *on your own behalf* in the right quarter? Mention that a soldering kit would prove a most acceptable gift and casually deposit your copy of EE in some conspicuous place at home, open at page 651. Best of luck.

Fred Bennett

Our January issue will be published on Wednesday, December 17

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VOL. 4 NO. 12 DECEMBER 1975

CONSTRUCTIONAL PROJECTS

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I.C. STEREO AMPLIFIER

An easy to build 4 + 4 watt stereo amplifier

By R. A. PENFOLD

This stereo amplifier uses two high performance integrated circuit audio amplifiers (one in each channel), and by considerably reducing the number of components required in the circuit when compared with a discrete component amplifier, the use of i.c.s greatly simplifies construction. This also helps to minimise the cost of the unit.

The TBA800 i.c.s used are capable of a maximum continuous output of 5 watts r.m.s., but in this application has been restricted to 4 watts r.m.s. per channel. This provides more volume than one might imagine, and although not very high by modern standards, it is more than adequate for most domestic purposes.

The prototype amplifier has been mainly used as a record player amplifier, and as such can be fed from either a crystal or ceramic cartridge, but not a magnetic type. However, the input sensitivity and impedance (250mV. r.m.s. into 350 kilohms), are such that the unit can be fed from most stereo tuners, tape decks, etc.

Output quality is very good, and the amplifier is suitable for the reproduction of classical, as well as pop music. The frequency response of the amplifier extends from about 40Hz to 50kHz, and bass and treble, boost and cut tone controls are incorporated in the design.

THE CIRCUIT

The circuit diagram of the amplifier showing one channel only is provided in Fig. 1. The tone controls, volume control, and amplifier are duplicated in the other channel, but the power supply unit and balance control are of course common to both channels.

The tone controls are situated at the input to the circuit, and these use a well-known Baxandall configuration. Separate bass and treble controls are provided, and with reference to 1kHz, these provide about 12dB boost and cut at 100Hz and 10kHz respectively. The input signal is fed to the tone controls via VR1, which is the volume control.

Operation of the tone controls is possible by virtue of the fact that the reactance of a capacitor varies with frequency, and in fact reduces as frequency increases, doubling the frequency causing the reactance to be halved.

The tone control networks use a passive circuit, and therefore have no gain. Thus when the controls are set to give bass or treble boost, the boost is relative to other frequencies, and even at the boosted range of frequencies there are some losses in the networks.

The input sensitivity of the integrated circuit is significantly higher than the required input sensitivity of the amplifier as a whole, and so its extra gain is used to compensate for these losses.

The output of the tone controls is taken from VR2 slider, and connected to the input of IC1 at pin 8.

With this type of circuit, minute voltage drops in the power supply wiring can cause an increase in the distortion level, or can even cause the circuit to oscillate. In order to prevent this a supply decoupling capacitor must be connected physically close to the i.c., and this is the purpose

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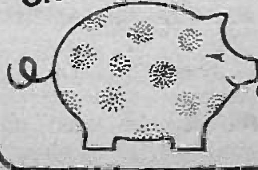

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*Based on prices prevailing at time of going to press

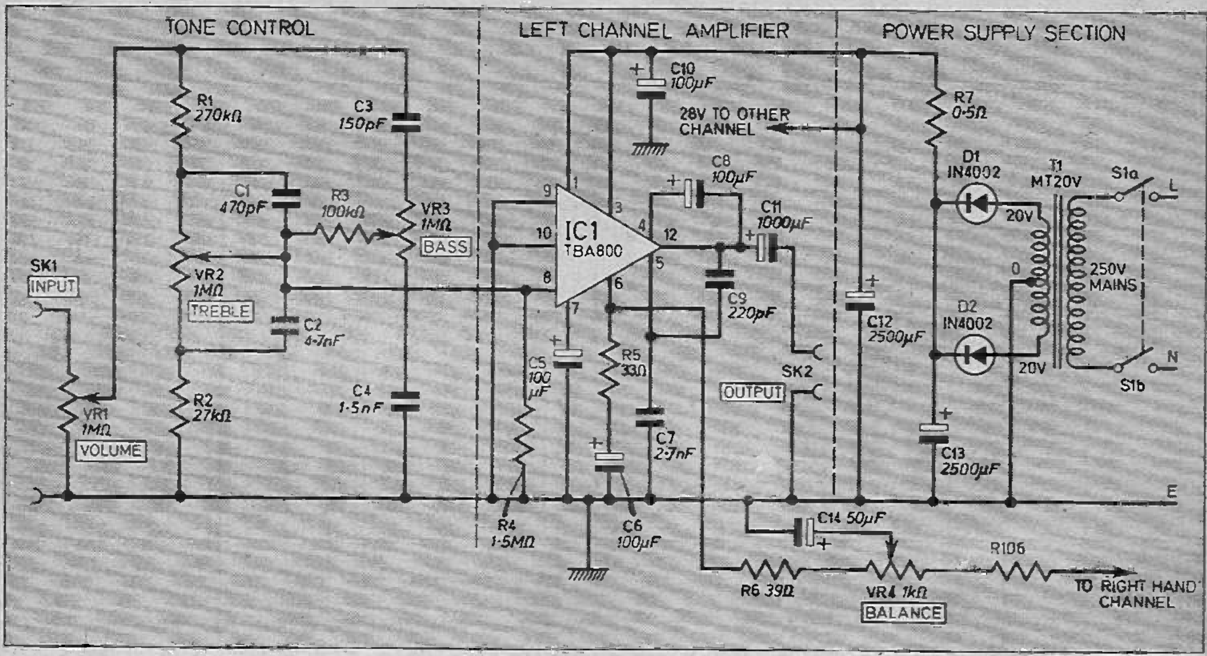

Fig. 1. The circuit diagram of the I.C. Stereo Amplifier.

of C10. Capacitor C5 smoothes the supply to the pre-amplifier section of the i.c., and ensures a low mains hum level at the output, even when a very simple mains power supply unit is used.

As the circuit uses quite a large amount of negative feedback, its frequency response would extend well into the r.f. spectrum with resulting instability, if precautions were not taken to limit the response. It is the purpose of C7 and C9 to provide this roll off in the r.f. response.

Capacitor C8 provides what is known as boot-strapping, which in this case consists of coupling some of the output signal back to the input of the output stage, in order to provide a greater maximum voltage swing on positive half cycles. This enables the i.c. to operate more efficiently from the available supply voltage. The output signal is coupled to the loudspeaker via C11 and provides d.c. blocking.

BALANCE CONTROL

Negative feedback is applied to pin 6 of the i.c. via its internal circuitry. The gain is set to the required level by decoupling the appropriate amount of feedback by connecting a decoupling capacitor in series with a limiting resistor, between pin 6 and the negative supply rail. This is the function of C6 and R5. The gain of the i.c. is determined by the value of the resistor, the lower its value, the more feedback which is decoupled, and the higher the gain.

The balance control, VR4, can be used to boost the gain of either channel by up to about 5dB, in order to compensate for any inequalities in the amplifier gains, speaker efficiencies, etc., between the two channels. Control VR4 shunts a low value resistance, R6, across R5 to increase the decoupling effect on the feedback, and so achieve an increase in the gain of that channel. This is rather unconventional, but works well in practice.

POWER SUPPLY

A simple unregulated power supply is used, which is all that these i.c.s require for satisfactory operation. A centre tapped mains transformer, T1, feeds a fullwave push-pull rectifier using D1 and D2. The rough d.c. output of these is smoothed to a continuous d.c. by C13, R7, and C12. The on/off switch, S1, should be a double pole type. A potential of about 28 to 30 volts is developed across the output under quiescent conditions, but this drops to about 22 volts at full output.

CHASSIS

A ready made 230 x 180 x 50 mm 16 s.w.g. aluminium chassis was used, and drilling and cutting of this is shown in Fig. 2.

Start by drilling the mounting holes for the controls, T1, the loudspeaker sockets, and the mains input cable. Then drill the mounting holes for the input socket, which is a dual phono type. No dimensions are shown for these as they must be varied to suit the particular make of socket used. The large cut-out for the socket can be made using a fretsaw.

The approximate position in which the 5-way

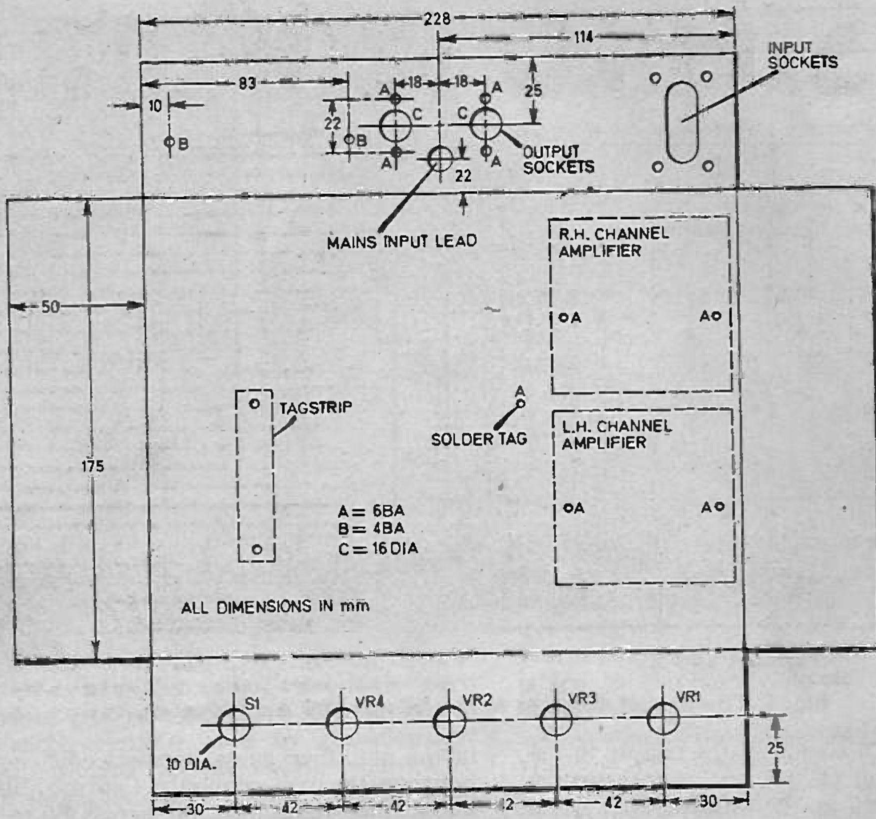

Fig. 2. Details of the chassis.

Components....

Note: Component reference numbers prefixed by 100 refer to right hand channel.

SEE SHOP TALK

Resistors

- R1, 101 270kΩ (2 off)
- R2, 102 27kΩ (2 off)
- R3, 103 100kΩ (2 off)
- R4, 104 1·5MΩ (2 off)
- R5, 105 33Ω (2 off)
- R6, 106 39Ω (2 off)
- R7 0·5Ω 1 watt

All ¼W carbon ±10% unless stated otherwise

Potentiometers

- VR1, 101 1MΩ dual gang carbon log. (1 off)
- VR2, 102 1MΩ dual gang carbon lin. (1 off)
- VR3, 103 1MΩ dual gang carbon lin. (1 off)
- VR4 1kΩ carbon lin.

Capacitors

- C1, 101 470pF polystyrene (2 off)
- C2, 102 4·7nF polystyrene (2 off)
- C3, 103 150pF polystyrene (2 off)
- C4, 104 1·5nF polystyrene (2 off)
- C5, 105 100μF 25V elect. (2 off)
- C6, 106 100μF 10V elect. (2 off)
- C7, 107 2·7nF polystyrene (2 off)
- C8, 108 100μF 10V elect. (2 off)
- C9, 109 220pF polystyrene (2 off)
- C10, 110 100μF 40V elect. (2 off)
- C11, 111 1000μF 16V elect. (2 off)
- C12 2500μF 30V elect.
- C13 2500μF 30V elect.
- C14 50μF 25V elect.

Semiconductors

- D1, D2 1N4002 or similar 100V 1A silicon rectifier diodes (2 off)
- IC1, 101 TBA800 5 watt audio power amplifier integrated circuit (2 off)

Miscellaneous

- S1 mains on/off switch d.p.d.t.
- SK1, 101 phono sockets (2 off)
- SK2, 102 DIN 2 pin loudspeaker sockets (2 off)
- T1 MT20V mains/20-0-20V 750mA secondary (Osmabet)

Veroboard: 0·1 inch matrix 24 strips by 23 holes (2 off); aluminium chassis size 230 x 180 x 50mm; 5-way tagstrip; knobs (5 off); aluminium for heat radiators; screened wire; grommet; mains lead and plug; materials for outer casing.

I.C. STEREO AMPLIFIER

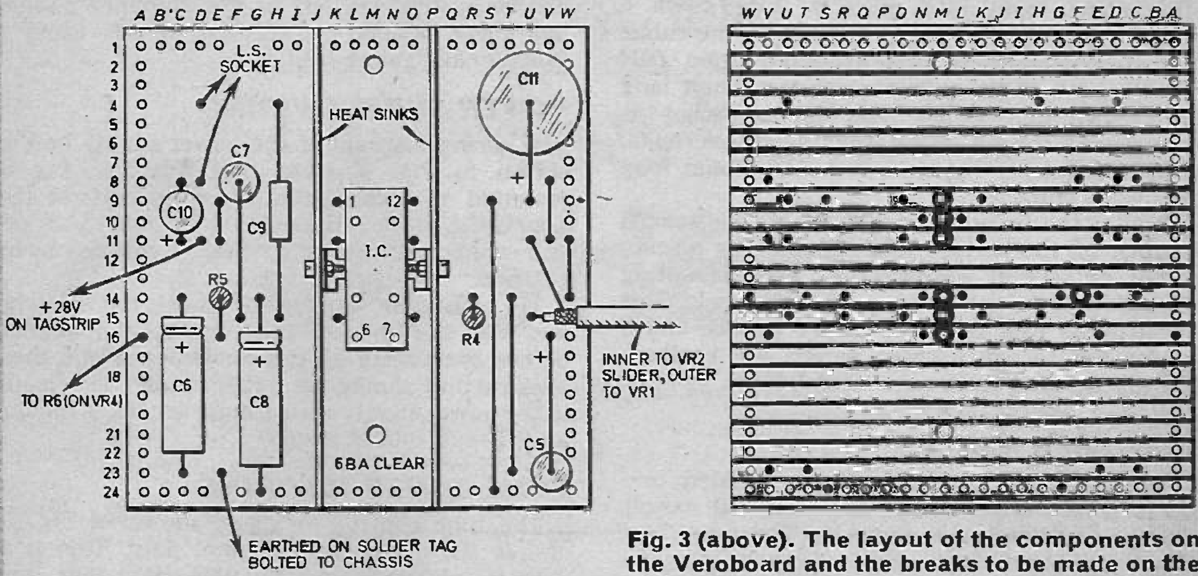

Fig. 3 (above). The layout of the components on the Veroboard and the breaks to be made on the underside. Two of these boards are needed.

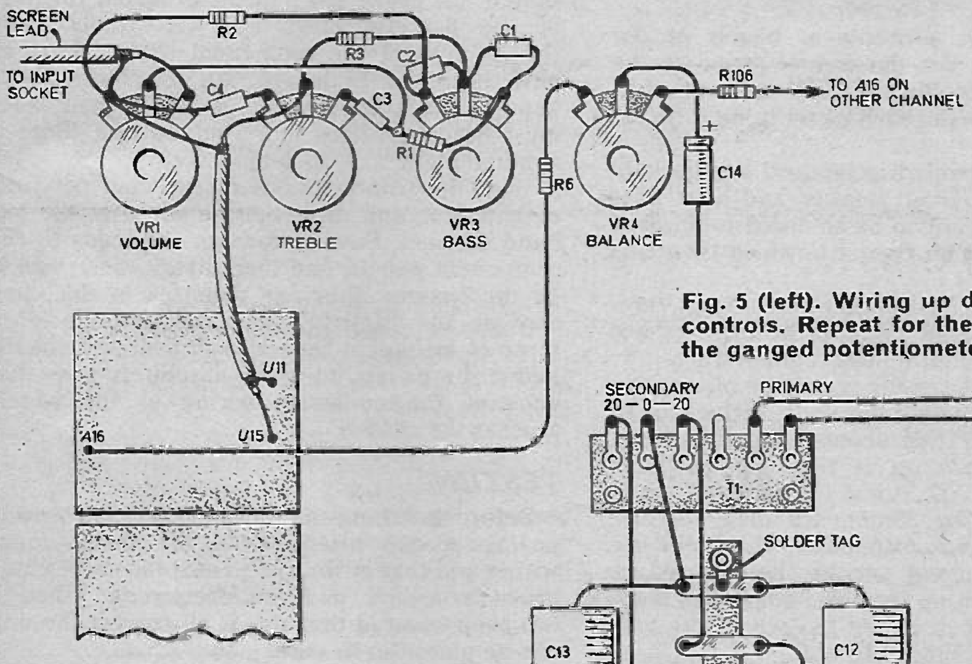

Fig. 5 (left). Wiring up details for the tone controls. Repeat for the other channel on the ganged potentiometers.

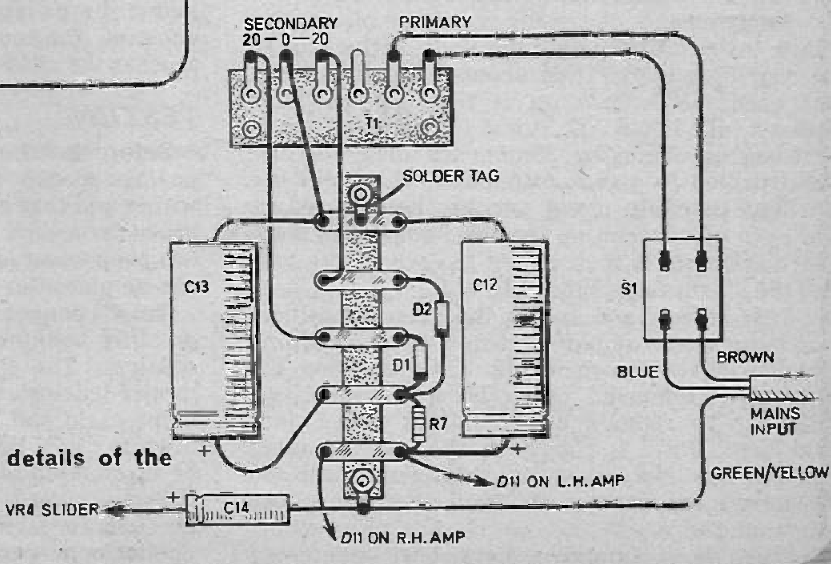

Fig. 4 (right). Wiring up details of the power supply section.

tagstrip on which the power supply circuitry is constructed, is mounted, is shown in Fig. 2, the exact position not being critical.

Having completed the drilling, the various components can then be mounted. The hole for the mains input lead must be fitted with a rubber grommet for the protection of the cable. The loudspeaker sockets are both 2-pin DIN sockets and these each require two 5mm long 6BA mounting bolts. The input socket is similarly mounted using four of these bolts. The transformer requires two 4BA 12mm long mounting bolts.

Mount the 5-way tagstrip so that it is spaced slightly off the bottom of the chassis, by placing a nut or several washers over each mounting bolt, between the tagstrip and the chassis. This tagstrip, as well as the amplifier panels, and a solder tag to which these panels are earthed, are all mounted using countersunk bolts.

AMPLIFIER PANELS

The wiring of the amplifier is divided into three sections, the amplifier panels, the power supply unit, and the controls. The amplifiers are constructed first, and are each built on 0·1inch matrix Veroboard having 24 copper strips by 23 holes.

Start by cutting a couple of panels of the correct size. Then cut the copper strips at the points indicated in Fig. 3. Then drill the two 6BA mounting holes in each panel using a No. 31 twist drill.

The i.c.s are intended to be used on specially prepared printed circuit boards, and have heat tabs which are meant to be soldered to an area of copper laminate on the p.c.b. which then acts as a heat sink.

This obviously is not possible when using Veroboard, and so instead the tabs of the i.c.s are connected to aluminium heat radiators.

Bend the tabs flat using a pair of pliers, and then very carefully drill the ends of the tabs to accept 8BA bolts. Then about 5mm of the end of each tab is bent up at right angles. Four pieces of 18 to 22 s.w.g. aluminium, each measuring 65mm by 35mm, are then cut out, and drilled to accept 8BA bolts. The holes are drilled centrally along one of the long edges of each piece, 4mm up from the edge. One piece of aluminium is then bolted to each of the tabs of the i.c.s, using a short 8BA bolt.

Next mount and solder the i.c.s in position, and the other amplifier components, according to the layout shown in Fig. 3. Ensure that the i.c.s are connected correctly, as it would be difficult to remove one from its panel once soldered. Pin 1 is clearly marked on the cases of the i.c.s. Note that five short link wires are required for each panel, and that these use insulated wire.

When both amplifiers have been completed and checked, they can be used as templates to mark the positions of the two 6BA mounting holes they each require. The positions in which the amplifiers are mounted is shown in Fig. 2. A solder tag is mounted on the bottom of the chassis just to the left of the amplifier panels, and these panels are earthed to this using a fairly heavy gauge lead.

POWER SUPPLY WIRING

A wiring diagram of the power supply unit is shown in Fig. 4. Note that a solder tag is mounted on each of the mounting bolts of the tagstrip. A proper three-pin mains plug (3A fuse) and cable must be used so that the chassis can be earthed.

Tin with solder the tags of T1, S1, the tagstrip, and also the ends of the component leadouts, before connecting up the components, and then construction should be quite simple. The leads in the power supply wiring must use wires having a fairly substantial gauge.

TONE CONTROL WIRING

The tone control wiring is shown in Fig. 5, and is shown for one channel only. This is a very simple point to point wiring system, and should not prove too difficult provided the tags of the potentiometers are well tinned; also tin the ends of the component leads once they have been cut to length. All leads should be kept as short as possible, and screened leads must be used where indicated, so that there is a minimum of stray pick-up.

Wire the front sections of the dual potentiometers first, and these can be wired in the left hand channel. Finally, connect the leads to the component panels, and then mount these boards on the chassis. They are mounted in the same way as the tagstrip, with the addition of a layer of insulation tape spread over the chassis under the panels, to make absolutely sure that none of the underside wiring of the panels touches the chassis.

TESTING

Before switching the unit on, check all wiring, paying special attention to the mains input wiring and that of the i.c., as mistakes here could prove expensive or even dangerous. When it has been ensured that this is all correct the unit can be placed in its case.

Then connect an input from a record deck or other equipment, and also connect a pair of speakers. The speakers should be contained in proper enclosures, have an impedance of 15 ohms each, and be capable of handling at least 5 watts r.m.s. The speaker leads must of course be terminated in 2 way DIN plugs. The unit can then be turned on, and the tone controls, etc. checked to ascertain that the entire system is operating properly. ▣

CHRISTMAS LIGHTS FLASHER

JAMES A. BRETT

The flasher described is simple to make and costs little for the increased pleasure it can give when used with Christmas tree lights or other decorative lighting. The unit has an adjustable flash rate so that it can be set for the most pleasurable effect. A particular flash rate may give pleasure in one arrangement but be a source of annoyance in another.

The circuit is designed to be independent of load current and may be used to operate any lamp circuit up to 1 amp, i.e. 240 watts on the standard 240 volt mains.

THE CIRCUIT

The circuit shown in Fig. 1 uses the relaxation oscillator principle of a capacitor charging to the breakdown voltage of a neon lamp which fires, or more correctly ionises, with a visible glow, the voltage across the neon lamp being stabilised at a lower voltage.

In this circuit let us assume that the neon lamp LP1 is ionised and glowing, the voltage across LP1 is therefore fixed at approximately 80 volts. The capacitor C1 slowly charges up through VR1 and R2, the current also flowing through the neon lamp LP1 until the voltage across LP2 rises to the breakdown value, some 120 volts. When LP2 fires the voltage across it falls immediately to the burning value of approximately 85 volts. Since the voltage across the capacitor C1 cannot change instantaneously the voltage across LP1 is depressed by about 35 volts to approximately 45 volts. This voltage is not sufficient to maintain ionisation and the neon lamp extinguishes and ceases to pass any current.

The capacitor C1 now starts to charge up, with a reversed polarity, via VR1 and R1. When the voltage across LP1 reaches the breakdown voltage the neon lamp LP1 fires, extinguishing LP2 and the cycle repeats.

When LP2 is ionised and passing current this current is fed to the gate of CSR1 causing it to conduct and light the lamp load. When LP2 deionises the triggering supply is removed from the gate of the thyristor and the CSR1 will cease to conduct at the end of the main half cycle.

Adjustment of VR1 alters the charging time of the capacitor C1 and hence provides control to set the flash rate. Resistor R3 is needed to ensure that when the neon lamp LP2 is deionised any internal leakage current in the thyristor between the anode and gate is allowed to flow away to the cathode without triggering CSR1 when it is in the non-conducting part of the flashing sequence.

The use of a full wave diode bridge and a thyristor instead of a triac, apart from being less costly, is necessary for two technical reasons: firstly a triac requires about twenty times more gate current than a thyristor and hence, to keep the same flash rate, the resistor values would have to be reduced by a factor of twenty and the capacitor value increased to some 40μF which is not very practical in a non

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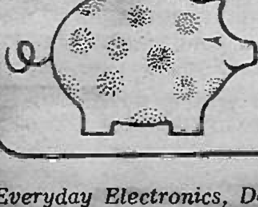

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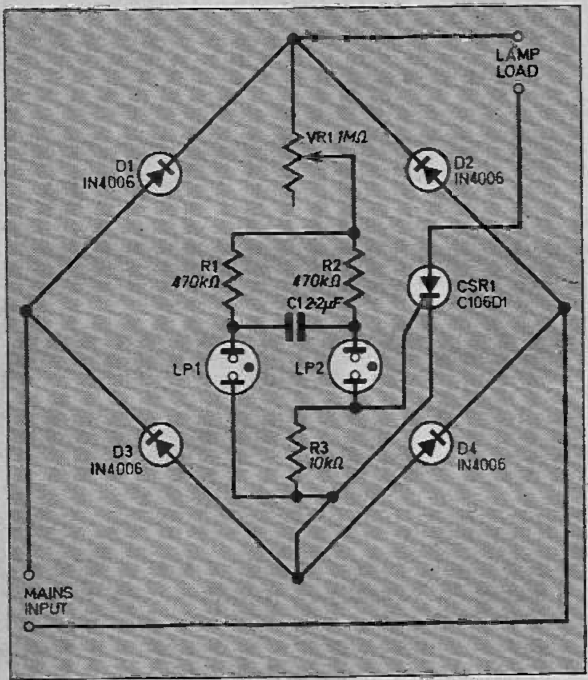


Fig. 1. Circuit diagram of the Christmas Lights Flasher.

CHRISTMAS LIGHTS FLASHER

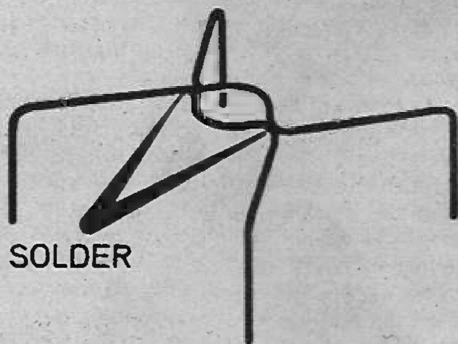


Fig. 3. Wire fixing for VR1 when it is not of the type shown.

Components....

SEE SHOP TALK

Resistors

R1	470kΩ
R2	470kΩ
R3	10kΩ

All ± 10% ½W carbon

Potentiometer

VR1 1MΩ linear ½watt composition (preferably with insulated spindle)

Capacitor

C1 2·2µF 250V d.c. Mullard C280 type or similar non-electrolytic type

Semiconductors

D1	1N4005/6	or other 1A 600 p.i.v. silicon diodes
D2	1N4005/6	
D3	1N4005/6	
D4	1N4005/6	
CSR1	General Electric C106D or Int. Rectifier IRC40	

Miscellaneous

LP1 miniature wire ended neon (90V type)
LP2 miniature wire ended neon (90V type)
Enclosure made from single MK moulded box and insulated blank cover plate, insulated knob.
Veroboard, 0·15 inch matrix, 13 strips by 13 holes; two terminal blocks, each two way; two gromets, screws, nuts and wire.

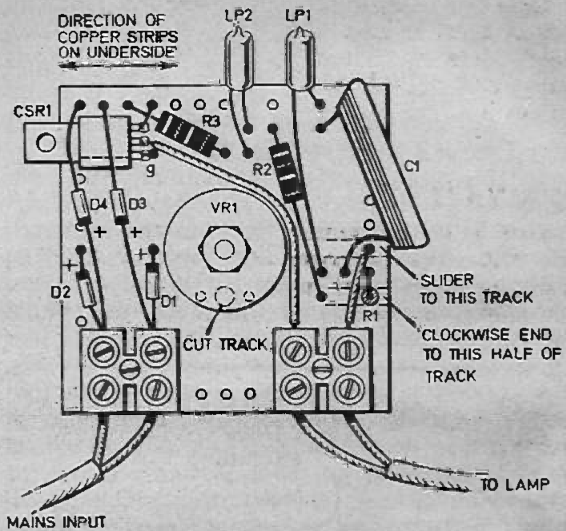


Fig. 2. Construction and wiring details of the flasher unit.

polarised non-electrolytic capacitor. Secondly rectification is needed to provide a d.c. supply for the neon timing circuit. The fact that the supply is not smoothed does not matter and in fact it increases the time for each flashing cycle without having to use an even larger capacitor.

CONSTRUCTION

Cut a piece of 0·15 inch matrix Veroboard to give 13 copper tracks by 13 holes. Check that this piece will fit squarely into the MK moulded box. Referring to Fig. 2 drill the two holes to mount the two terminal blocks.

If a potentiometer with end connections is used drill the Veroboard so that the potentiometer can be mounted with its shaft exactly over the centre of the board. If the potentiometer has side connections make a small supporting bridge using two pieces of 1·5mm or 18 s.w.g. tinned copper wire bent and soldered as shown in Fig. 3. After fitting this bridge over the shaft of the potentiometer and securing with a nut, insert the wire ends through holes in the Veroboard on unused tracks, such as track numbers 4 and 9 in Fig. 2, and solder in place. Wire links are fitted to make the connections between the clockwise end of the potentiometer and track 5 and between the slider and track 7.

The other components can now be mounted as shown in Fig. 2 ensuring that there are no short circuits by sleeving the component leads where necessary. Note that the heat sink tab of the thyristor is electrically internally connected to the anode and that the leads from D3 and D4 must be spaced off the tab even though they are insulated, as heat from the thyristor could soften the sleeve and cause a short circuit.

Drill two holes in the side of the MK moulded box of a size to suit the cable and gromets being used, slide in the ends of the two cables for input and output. Make off the ends of these cables in to the two terminal blocks.

INSULATION

Drill a 10mm diameter hole in the centre of the MK insulated cover plate and fit over the potentiometer shaft using a second potentiometer nut to hold the assembly to the plate. Offer up the plate to the box and screw together. Fit an insulated knob to the potentiometer shaft. For safety reasons this knob should be fitted with a well recessed screw or be fitted with an internal spring retaining clip. The knob should also be large enough to completely cover the potentiometer nut. These precautions must be taken to ensure a freedom from electric shocks.

Connect up the lamp circuit and the mains supply and if the assembly has been carried out correctly with fault free components the flasher is finished and ready for use. ▣

TEACH-IN 76

By A. P. STEPHENSON

Part Three

3.1 THE MULTIRANGE VOLTMETER

The voltmeter on the Circuit Deck was wired according to the theoretical diagram of Fig. 3.1a.

The common negative probe is connected to the negative terminal of the meter. The positive probe is connected to any of the four terminals according to the full scale voltage range required; *R4* has already been calculated as 250 kilohms. Using the same Ohm's law methods, we can now calculate the other three.

R1 = 1 volt/100 microamps = 1/100 megohm = 10 kilohm
R2 = 5 volt/100 microamps = 1/20 megohm = 50 kilohms (2 × 100 kilohms in parallel)
R3 = 10 volt/100 microamps = 1/10 megohm = 100 kilohms
R4 = 25 volt/100 microamps = 1/4 megohm = 250 kilohms (100 kilohm and 150 kilohm in series)

These calculations have neglected the resistance of the fine wire coil inside the meter which would probably be less than 1 kilohm. Since this "internal resistance" will always be in series with our external ones, we should, strictly, reduce all our values by about 1 kilohm to allow for this. The discrepancy, however, will be trivial, and for our standards absurd, the meter is about 5 per cent tolerance anyway, and we are not trying to compete with the National Physical Laboratory.

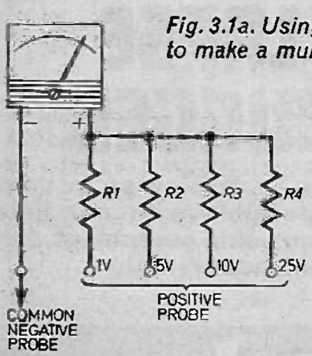


Fig. 3.1a. Using a bank of series resistors to make a multirange multimeter.

You may be puzzled to know why we are not going to use our meter to read current. There are two reasons:

(a) To measure current we cannot slap the probes across two points in circuit. A wire must be "broken" somewhere and the probes complete the circuit via the meter, this is a nuisance.

(b) The meter can easily be damaged if the current is much greater than you thought it should be. (A pointer hurtling across the face at supersonic speed and ending in a twisted wreck is a very depressing scene.)

Using the voltmeter, we are relatively safe because the highest voltage anywhere in the circuit is the battery voltage, so it is simply a case of using a range sufficient to cover this voltage. If the pointer only moves a small amount, it is safe to come down to the next lowest range. It is seldom necessary to directly measure current. Measure voltage drop and use Ohm's law.

3.2 THE VOLTAGE DIVIDER

If a certain component requires a lower voltage than the battery supply, a resistive **voltage divider** can be used, see Fig. 3.2a. Note we are labelling the battery voltage V_{IN}, ("input voltage"). Resistors R1, R2 form the voltage divider producing an "output" across R2.

There is a simple way to find V_{OUT}, based on the ratio R2/(R1 + R2). For example, since R2 is 4 kilohms and R1 is 6 kilohms, the output is 4/10 of the input.

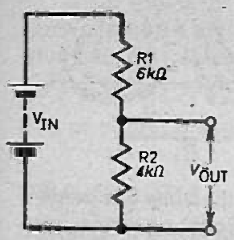


Fig. 3.2a. Using a resistive voltage divider to obtain a lower voltage.

This can be represented in equation form as shown below.

$$V_{OUT} = V_{IN} \left[\frac{R2}{R1 + R2} \right]$$

Since the voltage divider idea is widely used, it is important that you develop an instinct for ratios so some examples are shown in Fig. 3.2b.

Notice that the actual resistor values are unimportant, only their ratios matter in these exercises.

For those that like juggling formulae around, try and prove the above equation using Ohm's law.

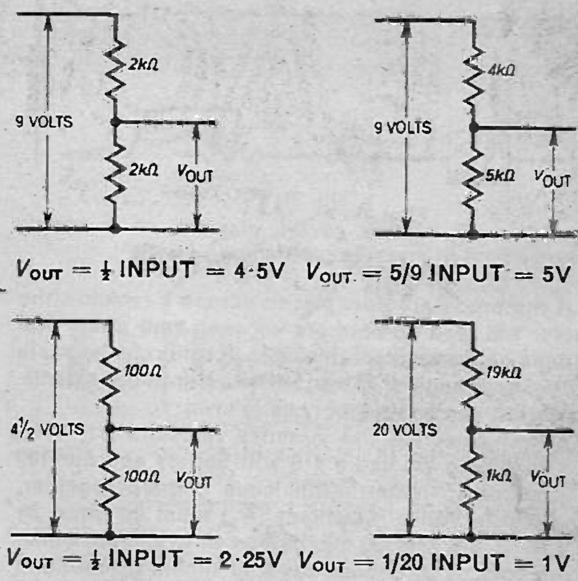


Fig. 3.2b. Examples illustrating the principle of the voltage divider.

3.3 VARIABLE RESISTORS

There are four variable resistors on the Circuit Deck in the form commonly known as "potentiometers" or simply "pots". The circuit symbol and physical construction are shown in Fig. 3.3a.

Rotating the knob moves the wiper arm which varies the resistance between *A* and *B* (and between *B* and *C*). The resistance across the "outer" connections *AC* remains constant. When we speak of say a "10 kilohm pot", we mean the resistance across *AC*.

If the knob is rotated to bring the wiper round to *A* the resistance between *A* and *B* will be zero, but the resistance between *B* and *C* will be maximum. If the wiper is moved round to *C* the conditions are reversed.

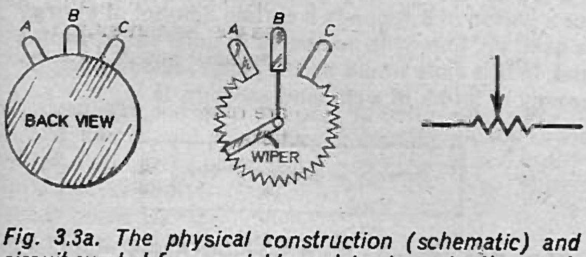


Fig. 3.3a. The physical construction (schematic) and circuit symbol for a variable resistor (or potentiometer).

There are two ways of using potentiometers:

(a) As a simple variable resistor, in which case only two of the terminals are used, the middle and one of the outers (the other outer is left "up in the air").

(b) As a variable voltage divider using all three terminals:
V_{OUT} can be varied smoothly from zero volts (slider at bottom) to maximum volts (slider at top), see Fig. 3.3b.

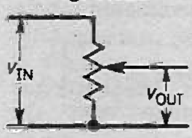


Fig. 3.3b. Using the potentiometer as a variable voltage divider.

On the Circuit Deck, each potentiometer has its three wires brought out to screw terminals for ease of connection which, in experiments, we shall refer to as "top" and "bottom". If top and bottom are reversed in an experiment, the knob will work "backwards". When the knob is rotated fully clockwise (looking at the knob), *B* is shorted to *C*. (Hold this page up to the light and look at wiper arm diagram from the back.)

3.4 MEASURING RESISTANCE

A simple arrangement to measure resistance is shown in (Fig. 3.4a).

The values of *R1* and *VR1* are calculated such that when the test prods are shorted together, the meter reads full scale, which corresponds to zero ohms externally. The variable resistor is to enable this initial state to be adjusted accurately before attempting a measurement. With the test prods left open, there is no current so the meter reads zero, corresponding to infinite external resistance.

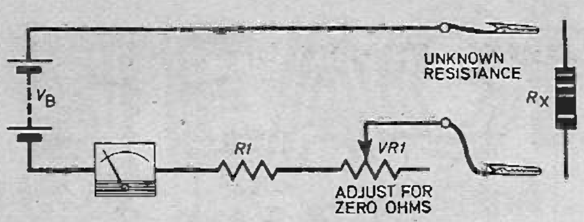


Fig. 3.4a. Theoretical circuit diagram of a simple arrangement to measure resistance.

If the prods are now placed across a resistor, the meter will read somewhere between zero ohms and infinite ohms, all that remains is to calibrate the scale by using a range of known resistors or (more scientifically) to use basic theory as follows:

(a) First calculate the in-series resistors *R1*, *VR1*, assuming we use a 4·5 volt battery and our 100 microamp meter. With leads shorted together, total in series resistance (R_T) must be given by $R_T = 4{\cdot}5$ volt/100 microamps = 45 kilohm, which allows us to choose say a 39 kilohm resistor and a 10 kilohm variable for *R1* and *VR2* respectively.

(b) To calibrate the scale in ohms is a little tricky because it will be "non-linear" (meaning the values will not be evenly spaced over the dial).

Let I_{fs} be full scale deflection (zero external ohms) then $I_{fs} = V_B R_T$. When an external resistor (R_X) is being measured, the current will then be $I = V_B/(R_T + R_X)$, so we have,

$$\frac{I}{I_{fs}} = \frac{V_B/(R_T + R_X)}{V_B/R_T} = \frac{R_T}{R_T + R_X}$$

Let us call I/I_{fs} the "full scale multiplying fraction"—(M) so as to write a more conventional equation

$M = \frac{R_T}{R_T + R_X}$ which in percentage terms becomes

$$M = 100\left(\frac{R_T}{R_T + R_X}\right) \text{ per cent of full scale}$$

In our worked example, we had R_T equal to 45 kilohms, so if we were to measure say an external resistor of value 45 kilohms, M equals 50 per cent (meaning pointer reads half scale) a 250 kilohm resistor gives approximately 15 per cent full scale reading.

3.5 POWER, HEAT AND ENERGY

When current passes through a resistance, the electrons "bump" against atoms, causing them to vibrate and become hot. Since we can't get heat for nothing it follows that **power** is being consumed or "dissipated".

Power is measured in **watts** and is dependent both on the current through *and* the voltage across a resistor the equation being:

Power = voltage × current or $P = VI$

Example

If the voltage across a resistor is 5 volts and it is passing 4 amps, the power is 5 volts × 4 amps = 20 watts. However, since $I = V/R$ and $P = VI$, then $P = V^2/R$. Also, since $V = IR$ and $P = VI$ then $P = I^2R$, so we may use any of these equations to find the power. $P = VI$ or $P = V^2/R$ or $P = I^2R$.

Examples

(a) A 5 ohm resistor passing 2 amps consumes $2^2 \times 5 = 20$ watts.

(b) A 2 ohm resistor with 200 volts across it consumes $(200)^2/2 = 20{,}000$ watts or 20 kilowatts.

Heat is sometimes desirable, such as in electric fires, but in most electronic circuits it is a menace and every effort is made to operate components at low power levels to keep the temperature down.

The resistors specified for the Circuit Deck experiments are rated at $\frac{1}{4}$ watt, which means they will overheat if this rating is exceeded. Larger power ratings require resistors of larger physical size. Fortunately, the majority of resistors in circuits operate at milliwatt level, so heat is not a problem.

Be careful with your arithmetic when dealing with milli- or microamps. If we square milliamps, we get microamps.

Example

5 milliamps through a 4 ohm resistor dissipates a power equal to $(5\text{mA})^2 \times 4$ ohm.

$= 25\,\mu\text{A} \times 4$ ohm = 100 microwatts.

If we operate a component at a power of 20 watts for a period of 5 seconds a certain amount of energy is used up. Energy is measured in units called **joules** and, in this case would be 100 joules. The formula for energy in terms of *watts* and *seconds*, is

Energy = power × time

Note that 20 watts for 2 seconds burns the same energy as 10 watts for 4 seconds. A battery for instance has a certain amount of stored energy and we can please ourselves whether we use it at a high power rate for a short time, or a low power rate for a longer time.

Mains electricity is paid for in **kilowatt hours** known as "one unit". Thus we can burn one kilowatt for one hour, or $\frac{1}{2}$ kilowatt for two hours, and we shall still pay for one unit which from the above, is equivalent to 3·6 million joules.

TEACH-IN '76 EXPERIMENTS

EXPERIMENT 3A

Use of potentiometer as simple variable resistor.

PROCEDURE

1. Connect up as shown (Fig. 3A.1.) using the 50 ohm potentiometer terminals, switch, 4·5 volt battery and lamp.
2. Switch on and verify that brilliance can be varied by rotating the control knob of the potentiometer, switch off again.
3. Remove wire from top terminal of the potentiometer and refix it in the bottom terminal. Switch on and verify that control knob still varies brilliance but works backwards.
4. Turn knob to maximum brilliance of light. Measure voltage across battery terminal (using 5V meter range). Now switch off and measure battery voltage again. The voltmeter should read a little higher with switch off. This is because the battery itself has some internal resistance and its voltage will therefore drop when current is drawn.

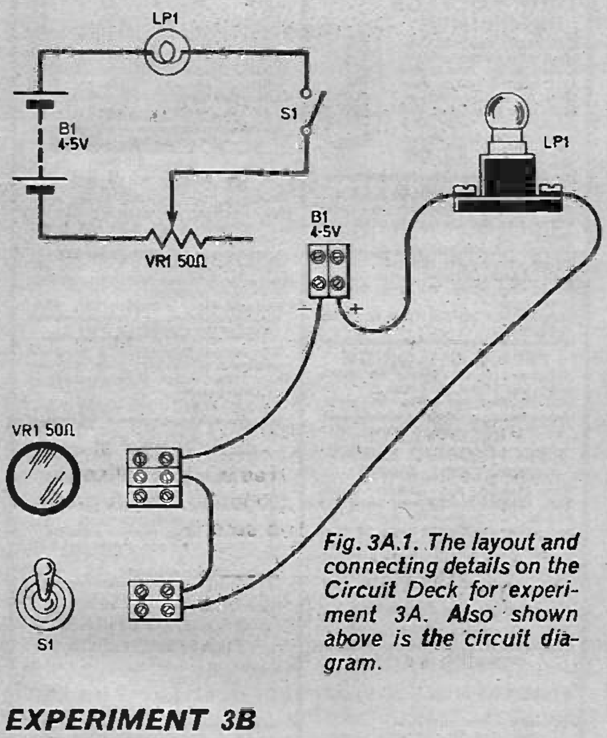


Fig. 3A.1. The layout and connecting details on the Circuit Deck for experiment 3A. Also shown above is the circuit diagram.

EXPERIMENT 3B

(a) To show how a potentiometer can smoothly control a voltage.
(b) To show the effect of the meter resistance on circuit behaviour.

PROCEDURE

1. Assemble the circuit shown in (Fig. 3B.1.) using the 1 kilohm potentiometer, the 9 volt battery and the meter on the 10V range. Set control fully anticlockwise.

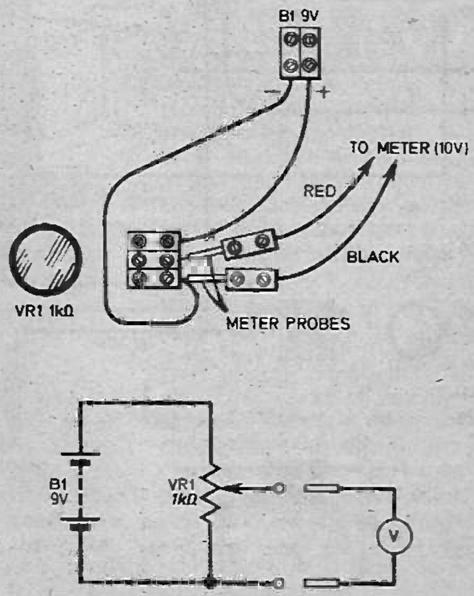


Fig. 3B.1. Shows the connections on the Circuit Deck for experiment 3B together with the theoretical circuit diagram.

2. Rotate the control slowly over its full extent and note the voltmeter reading will change smoothly from zero volts up to 9 volts. If the meter flickers or jumps erratically at certain positions of the control you have a poor potentiometer, the resistance track is probably dirty or worn. Replacement is the only cure.
3. Perform the same action all over again but using the 1 megohm potientiometer. Notice this time that the meter reading seems to lag behind the control (large movements of control near the zero volts end have only a small effect on the voltage). The reason for this is the meter and its resistance acting as a heavy parallel "load" of 100 kilohms which, although negligible with the 1 kilohm potentiometer, is appreciable with the 1 megohm potentiometer.

EXPERIMENT 3C

To construct and calibrate an ohmmeter.

PROCEDURE

1. Connect up as shown in (Fig. 3C.1) using the meter in the 1V range and set the 25 kilohm potentiometer fully anticlockwise.
2. Momentarily touch together the two crocodile clips. If all is well with the meter (needle does not rush at high speed across the face), leave the clips connected and adjust to read exactly full scale

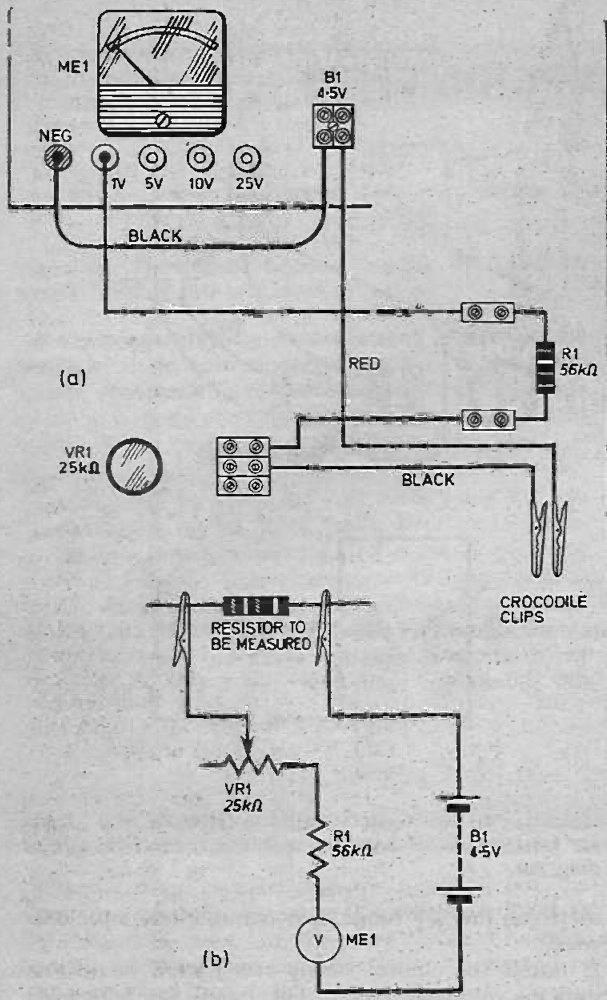


Fig. 3C.1. The layout and wiring details on the Circuit Deck for experiment 3C. Also shown is the theoretical circuit diagram.

(100μA) which is "zero ohms". Now separate the clips as the system is now "set up".

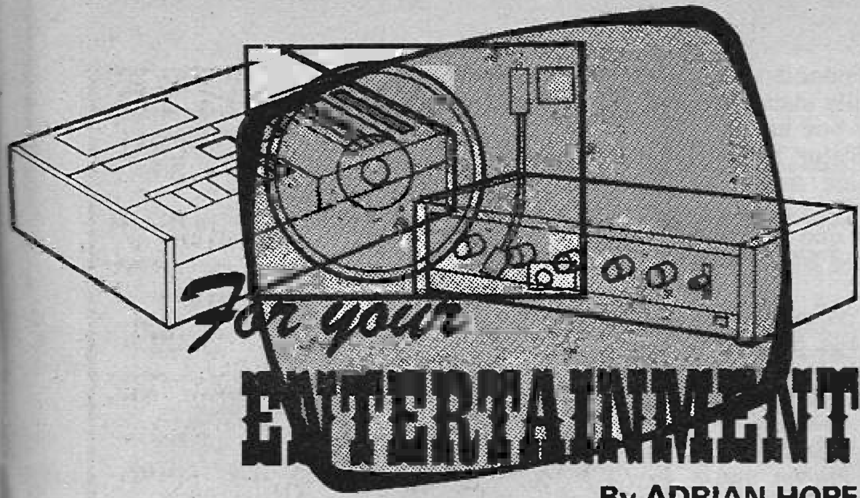
3. Cut a strip of white card 12mm wide and long enough to cover the scale of the meter and lay it on the glass ready for calibration. Extreme right, mark "0", extreme left mark "∞" (infinity).

4. Calibrate the scale between these extremes by either,

(a) Using your own stock of resistors and noting each reading when the clips are connected across each of them in turn.

(b) Using the theory, explained earlier. You will notice that the scale is very cramped at the right-hand side and resistors lower than a few kilohms read almost "zero ohms".

Save the calibrated card because this circuit can always be assembled again. **Never attempt to measure ohms on a resistor already carrying current,** it could destroy your meter!



For your ENTERTAINMENT

By ADRIAN HOPE

INEVITABLY, some readers will sooner or later order something electronic by mail order through an advert in this (or another similar) magazine, and suffer frustrating delays in delivery of the goods. It might help both readers and advertisers alike to have a few points clarified.

Placing An Advertisement

When a firm places an advert in a monthly magazine (EVERYDAY ELECTRONICS included), it could be up to eight weeks before that advert appears in print on the news-stands. In printing parlance, that eight weeks is referred to as "lag". Any firm worth its salt knows all about the pitfalls of "lag" and will try and make sure that he has plenty of the advertised goods in stock by the time the advert appears.

But a lot of unpredictable things can happen in that time. There may be an unprecedented run on the sale line, for instance as a result of other adverts in previous issues or other magazines, or perhaps in weekly or daily papers. And the line may either be unrepeatable at the advertised price or further stocks may be slow coming through from the manufacturer.

Sometimes the advert has been placed on the strength of a manufacturer's promise to provide stocks for sale by the date that the advert is due to appear. But in each case the result is the same; the poor chap who has sent in his money can't have his goods promptly. And this is where the problems really begin.

Having been in the position myself several times, I know only too well how infuriating it is to have parted with your money but seen nothing through the post.

As the weeks roll by, one feels more and more worried about whether the firm in question has gone bust. So one writes off, demanding either the goods or money back. By now the mail order firm perhaps has a firm promise of the goods from the manufacturer, and thus is reluctant to write back when he hopes to be able simply to supply the goods very soon. But then, and it happens quite often, the manufacturer lets the mail order firm down, and promises another date for delivery. And so it goes on, the bad feeling growing.

Acknowledgements

Of course, in a perfect world the mail order firm would acknowledge every order and follow up with an apology letter if delivery is unavoidably delayed. But it is not a perfect world, and even a second-class acknowledgement costs not only secretarial time but also hard cash in postage.

Such costs may seem insignificant to the chap who has paid his money and has had no goods in return, but as a journalist who spends literally pounds every week replying to readers' letters, I can tell you it is not insignificant for the chap who is writing replies and paying for the postage.

Pay By Cheque

Let's try to be constructive. Firstly, readers should try always to pay for mail order goods by cheque. This way, you can obtain from your bank, in the form of a cancelled cheque, proof positive that you have paid. The mail order firm knows this and thus knows also that the customer can, if he wishes, check whether or not his original order has gone astray.

Again, if it were an ideal world, a firm would not cash cheques until it could send out the goods. But often incoming cheques are handled by one employee as a routine, while outgoing orders are handled by another, perhaps in a separate warehouse. Also, people have been known to send cheques that bounce, so there is an incentive to cash a cheque before supplying the goods.

Waiting Time

It is probably reasonable to start getting impatient after two or three weeks of silence have elapsed. The first thing to do is check that your cheque has been cleared through your bank. Then write a polite note, confirming that you have not yet received any goods, and asking for information if nothing is likely to be sent off within the next week. That will take the time from ordering up to around a month.

If a month passes without any goods, any apology or any reply to your enquiry, and if your cheque has long since been cleared through your bank, it is reasonable to write again. This time firmly, but still politely, demanding either goods by return, or an explanation by return, or money back by return.

If that produces no reaction after a week or so, you should contact the magazine that ran the original advert. You owe this not only to yourself, but to the magazine and future readers of future adverts from the same firm. But bear in mind that it is usually a house rule that such queries will only be dealt with if they are in writing. This isn't red tape for the sake of it, but a precaution to safeguard everyone. It is not unknown for someone to claim non-delivery of goods when in fact they have received them, but fancy receiving another batch free. Although some people are prepared to tell lies over the telephone, they are usually unwilling to put them in writing.

One final point. Remember that although it may be frustrating not to receive acknowledgements from a firm prior to despatch of goods, it is only by cutting corners like these that the firm can keep its mail order prices down.

THIS simple little novelty device demonstrates how it is possible to electronically simulate the tossing of a coin. It consists of a box having a push button switch and two indicator lamps on the front panel, one lamp being marked heads, and the other being marked tails.

When the push button is pressed one of the lamps is illuminated, indicating either heads or tails.

The circuit is arranged so that it is purely a matter of chance whether the heads or tails lamp is illuminated when the push button is pressed, the circuit thus providing the same effect as tossing a coin.

A more serious side to the device is that it illustrates the operation of a well-known and extremely useful electronic building block—the bistable multivibrator.

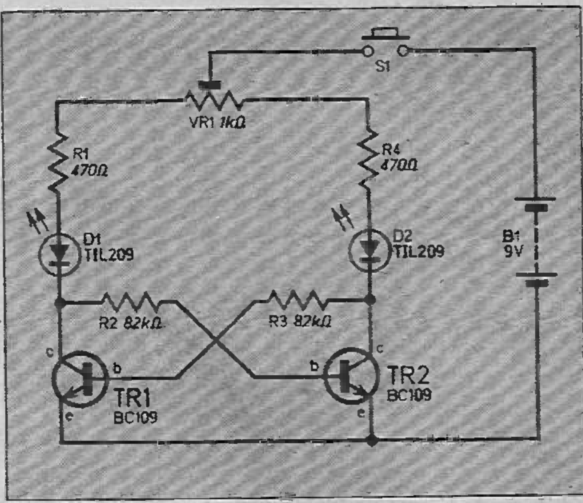


Fig. 1. The circuit diagram of the Heads & Tails Game.

CIRCUIT OPERATION

The theoretical circuit diagram of the Electronic Heads and Tails is shown in Fig. 1. The two indicator lamps are the two light emitting diodes (l.e.d.s), D1 and D2. These are protected against passing excessive currents by the series resistors R1 and R4. Diode D1 is illuminated when TR1 is turned on, and D2 will be illuminated when TR2 is turned on.

If VR1 is ignored for the time being, when the push button switch, S1, is depressed, the positive supply will be connected to the circuit. The transistors will obviously both begin to turn on, TR1 receiving its base bias current via R4, D2, and R3, and TR2 receiving its base current via R1, D1, and R2.

It is, however, not possible for both transistors to turn hard on at the same time, as if TR1 is turned hard on, only a fraction of a volt will

A novel device which illustrates the operation of a basic circuit configuration

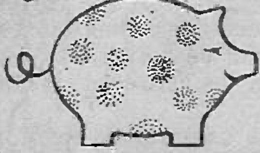
HEADS & TAILS GAME

By ROBERT GOFFIN

Everyday Electronics, December 1975

FOR GUIDANCE ONLY

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



£1.30

excluding case

*Based on prices prevailing at time of going to press

Components....

Resistors

R1 470Ω
R2 82kΩ
R3 82kΩ
R4 470Ω
All ¼W carbon ± 5%

SEE **SHOP TALK**

Potentiometer

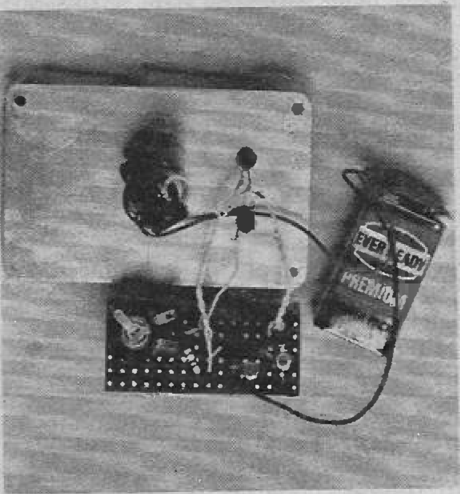
VR1 1kΩ horizontal skeleton preset

Semiconductors

TR1 BC109 silicon *npn*
TR2 BC109 silicon *npn*
D1 TIL209 or similar l.e.d. with holder
D2 TIL209 or similar l.e.d. with holder

Miscellaneous

S1 push-to-make, release-to-break push button switch
B1 9V PP3 with connector
Veroboard: 0·15 inch matrix size 7 strips by 16 holes; case type Minos M2; connecting wire



Photograph illustrating the construction of the prototype unit.

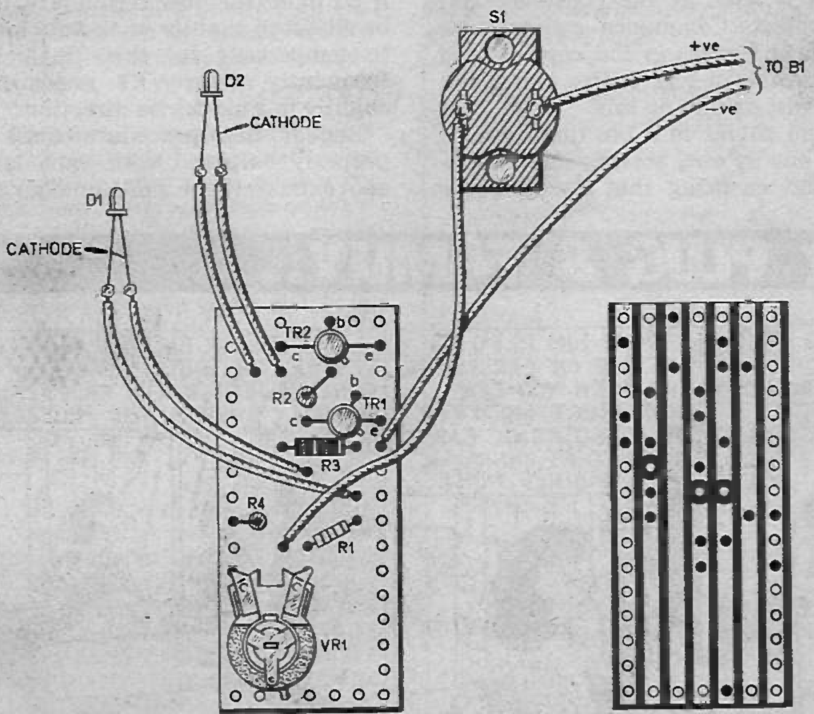


Fig. 2. Layout and wiring of the complete unit.

appear at its collector, and TR2 cannot receive the necessary bias current to turn hard on. If TR2 turns hard on then the same is true for TR1.

What happens when the supply is connected is that both transistors begin to turn on, but due partially to chance, and partially to a slight unbalance in the resistor values, transistor gains, etc. of each half of the circuit, one will begin to turn on faster than the other. In doing so it tends to starve the other transistor of base current as its own collector swings towards earth potential.

On the other hand this enables it to obtain a heavy base current from the collector of the other transistor, as this has its collector still at virtually the full supply potential. This regenerative action results in one transistor being biased to saturation, and the other being cut off. Obviously only one of the lamps will light up.

If the unbalance introduced by the component tolerances could be removed, it would obviously then be a matter of chance which of the lamps became illuminated. This is the purpose of VR1, which compensates for the component tolerances by supplying a higher supply voltage to one or other side of the circuit, and is adjusted by trial and error.

The action of the circuit is of course extremely fast, and it appears to the observer that the moment S1 is closed one of the lamps lights up.

CONSTRUCTION

Veroboard having 16 holes by 7 strips by 0·15 inch matrix is used as the constructional basis for the project. Commence construction by making the three breaks in the copper strip at the places indicated in Fig. 2. Use either the special tool or a twist drill to do this.

Then mount and solder into position each of the components, one by one, leaving the transistors until last and ensuring that an adequate amount of solder is used for each joint. Also connect up the l.e.d.s and S1 using approx. 75mm lengths of thin insulated wire, and also connect the battery clip leads. Make quite sure that the l.e.d.s are connected with the correct polarity, as if they are incorrectly connected they will fail to light, and could be destroyed. With l.e.d.s type TIL209, the longer lead is the cathode.

The front panel of the case should next be drilled to take S1 and the diodes. Switch S1 is mounted in the centre of the panel, and the l.e.d.s are mounted to the right of this, one above the other, see photograph.

The case used in the prototype was a Minos type size 100 x 65 x 50mm with runners to take the component board.

The light emitting diodes should be purchased together with the plastic panel holders in which they are mounted. The required dimensions for these holes will depend upon the type and make of components used.

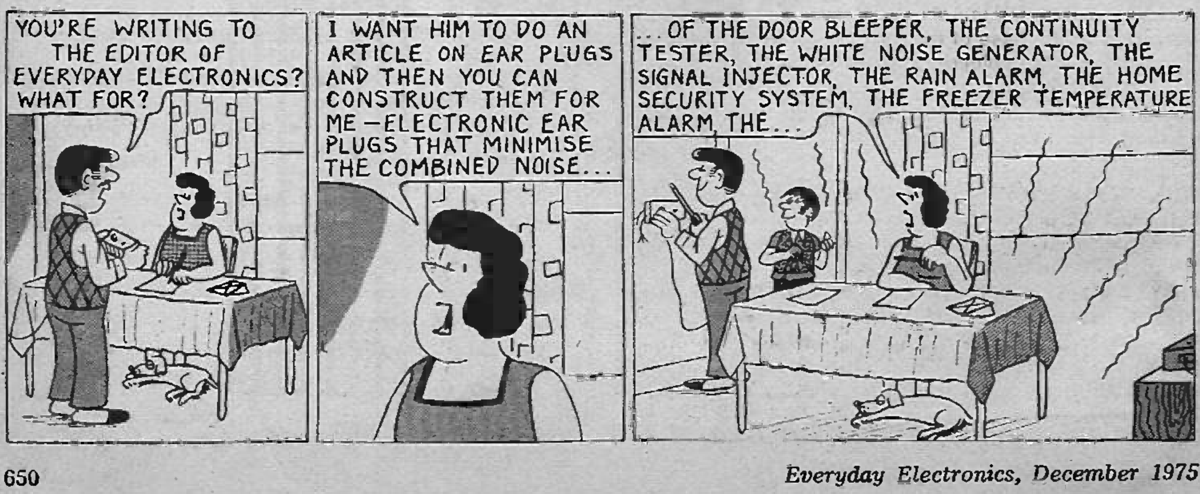
The component panel is mounted vertically at the extreme left-hand side of the case in the slots moulded into the outer casing. There is a space for the battery, a PP3, beneath the two l.e.d.s.

ADJUSTMENT

Start with the slider of VR1 at a central position and then press S1 a number of times (25 or more). It will probably be found that one lamp lights up much more often than the other. If D1 lights up more frequently, then VR1 should be adjusted slightly in an anticlockwise direction to compensate for this. If D2 lights up more frequently, then VR1 needs to be adjusted slightly in a clockwise direction.

Repeat this procedure until the circuit is properly balanced with each lamp lighting up approximately the same number of times. ▣

JACK PLUG & FAMILY...



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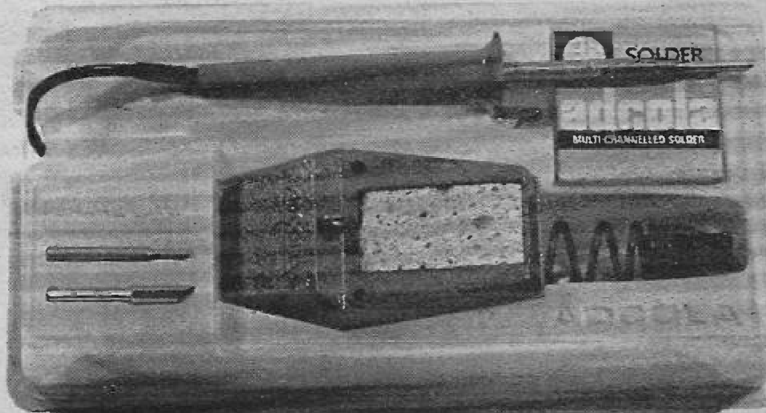

SOLDERING KIT

All the essentials for simple soldering are contained in this soldering kit produced by Adcola Products Ltd. The kit measures approx. 300mm x 160mm x 60mm and contains an Invader precision soldering instrument—approved by the Design Centre, a stand, flux cored solder, two spare soldering bits and an instruction card providing hints on soldering.

The Invader soldering instrument is thermally controlled to provide a constant level of the correct heat for soldering. It features a pencil slim handle for easy control and weighs less than 2ozs. The standard soldering tip provided is 4·75mm ($\frac{3}{16}$in) diameter but two replacement bits of 3·2mm ($\frac{1}{8}$in) and 6mm ($\frac{1}{4}$in) diameter are included to provide complete versatility for the 25W soldering instrument.

The smaller bit is designed to undertake small detailed work and the larger for jobs calling for an increased heated area. These bits are merely inserted in the collet at the end of the Invader to convert it from one task to another.

An Invader stand is also contained in the kit to provide the user with a mobile and safe receptacle for the hot soldering instrument. The stand features an integral sponge for cleaning excess solder from the soldering bits and two holders to contain the spare bits. A spring holder is mounted on the base of the stand at an angle of about 45 degrees, and the soldering tool is simply inserted into the holder when not in use.

To complete the kit a packet dispenser of Adcola solder wire—which contains its own flux.

YOUR ORDER WILL NORMALLY BE DESPATCHED IN TIME FOR YOU TO RECEIVE IT WITHIN 28 DAYS, BUT PLEASE ALLOW AN ADDITIONAL 14 DAYS TO COVER ANY CARRIAGE DELAY.

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No. of kits required ☐

Name ....

Address ....

....

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Tel. No. (Home or Work) ....

No. of kits required ☐

Name..

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....

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From: Everyday Electronics,
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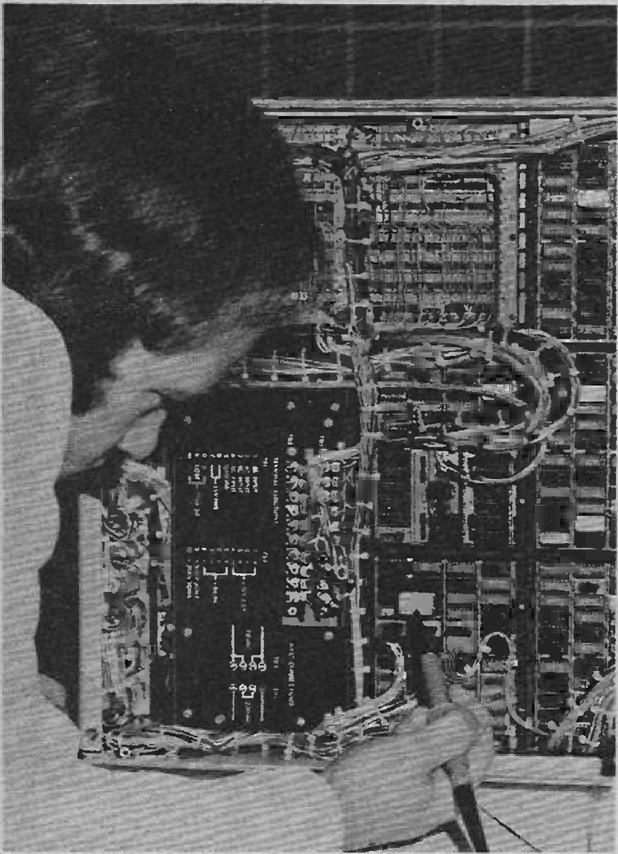
Cut Round Dotted Line



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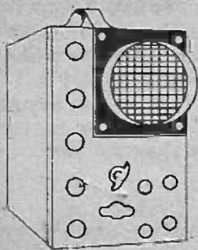

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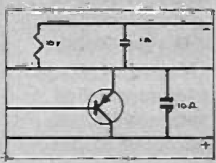

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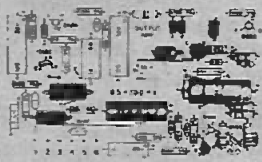

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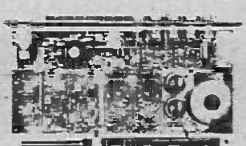

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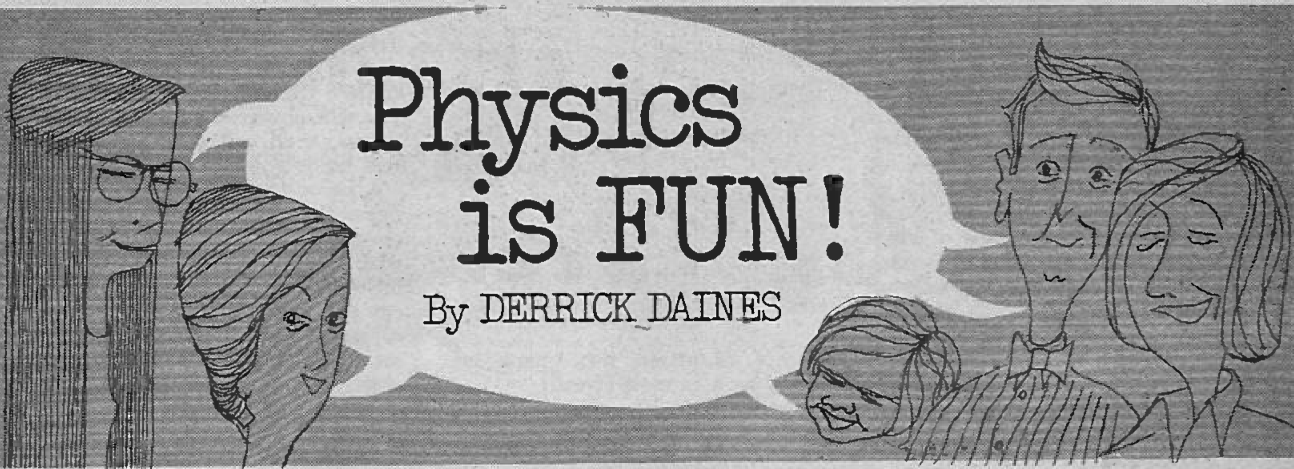


Physics is FUN!

By DERRICK DAINES

MAGNETIC EFFECT OF CURRENT

That an electric current causes a magnetic effect even in a straight wire can be demonstrated in a classic experiment which may easily be duplicated.

Take two stiff pieces of wire of about 1 metre in length and form a short right-angle at one end of each so that they may be suspended from the top of a suitable length of wood, (Fig. 1). The bottom ends of the wire should swing with perfect freedom, clear of the ruler and of the support.

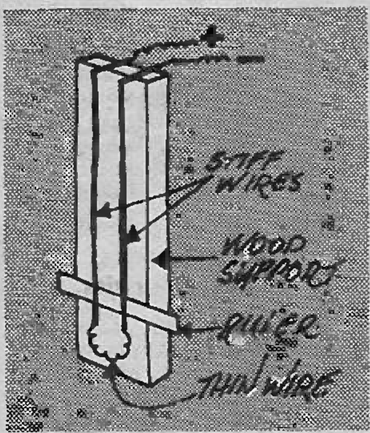


Fig. 1. Arrangement for demonstrating magnetic effect of a current.

In the classic form of the experiment, the ends were just immersed in a dish of mercury that provided a frictionless electrical connection between them, but an effective substitute is provided by a slack loop of extremely thin flexible wire; secure it to the bottom of each wire with a spot of solder. The same very thin wire should be used to connect a battery to the top of the wires.

If a ruler is secured to the upright horizontally, a definite movement will be observed in the two wires. When the current is switched on they move away from each other. Switch off, and they return to their original positions.

The only force that can have caused such a movement is magnetism created when the current passed through the wire. Since the wires repelled each other, each wire must have offered the same polarity to the other.

We can investigate this phenomenon further by winding 20 turns of enamelled copper wire in a large rectangular shape, see Fig. 2. Bare the ends by scraping. Now cut a square of thick card and make a vee cut on opposite sides so that the coil fits into them. Sprinkle iron filings over the card before switching on the battery. Tap the edge of the card very gently and the iron filings will arrange themselves in circles round the wires, as shown in Fig. 2.

The two experiments taken together give us a picture of a sheath-like magnetic field surrounding every wire that carries current and is a very important concept to hold. However, isn't there someting very odd about those circles of iron filings? Regular readers will remember a similar experiment that we did with a permanent magnet; how the filings arranged themselves in arcs between the North and South poles. So what is odd? Simply this—in the sheath of magnetism round a wire, where are the poles?

Suppose we find out. Switch off the battery and remove the filings. Switch on the current again and "map" that magnetic field by means of a miniature compass. That is, place the compass near the wire and make a mark on the card by the North-seeking point.

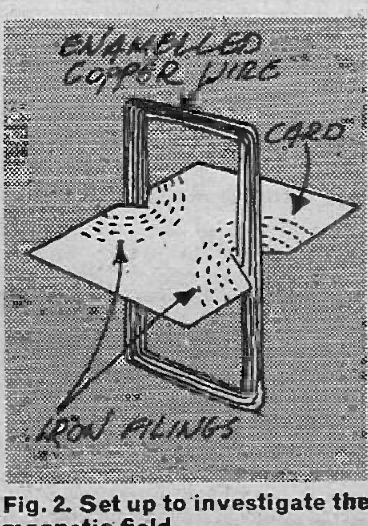


Fig. 2. Set up to investigate the magnetic field.

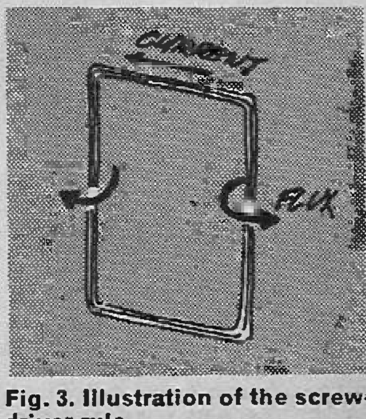


Fig. 3. Illustration of the screwdriver rule.

Move the compass and repeat several times. Soon the marks will be observed to form continuous circles; there are *no* North or South poles!

This single fact makes us stop and think about the nature of magnetism and what we think of as its "direction". Note the flow of the current and the flow of magnetism round the wire; it is easy to remember as the screwdriver rule (Fig. 3).

Imagine that you are holding a screwdriver in the right hand, pointing in the direction of current flow. Then a twist of the screwdriver to the right gives the direction of the magnetic flux. If you change the polarity of the supply you will observe that the compass turns round and the mnemonic still holds good.

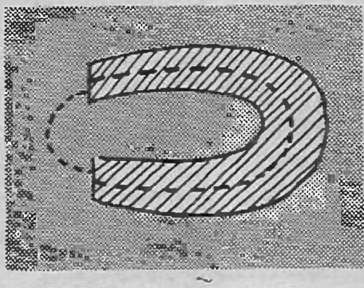


Fig. 4. Magnetic flux can exist only as a closed circuit.

Like electrical currents, magnetic flux can exist only as a closed circuit and we may if we wish think of the circular form we have seen as the "pure" form that can exist only when it is contained in non-ferrous material, but distorted when *near* iron and completely conducted in iron, Fig. 4.

New products and component buying for constructional projects

SHOP TALK

By Mike Kenward

Since there are very few points to discuss concerning supplies of components for projects in this issue it gives us a bit more space to cover other things. A couple of new products of interest have appeared this month, the first is from Home Radio (Components) Ltd, and is a ready made signal injector case. The case consists of a 28mm internal diameter plastic tube 118mm long (may be easily cut down to about 70mm minimum—due to end stoppers) with two plastic push-in end stoppers, one with an 80mm brass probe fixed to it. Cost of the complete thing is 60p including V.A.T. plus 10p post and packing—Home Radio advertise in all our issues.

The second product is from GEC-Henley Ltd., and is a 65W Solon soldering iron with an adjustable bit. Just the job for heavier type work, say in the car where joints may be difficult to get at. The iron gives a choice of straight or angled bit at the turn of a screw.

The recommended price for the iron—available through normal retail suppliers—is £3·77 plus V.A.T. at 8 per cent.

More news on the catalogue scene comes from Maplin Electronic Supplies. In addition to their 132-page catalogue which covers an extensive range of components, modules, cases, etc., and carries plenty of technical information and circuit data for i.c.s, they now send out a news-sheet free with the catalogue. A new news-sheet (try saying that qnickly) is produced every two months. The sheet carries "up to the minute" information on new products, i.c. data, prices, etc.

The two they have sent us carry some great cartoons by a local "Leonardo", a nice piece about Mr. Healey's "add 25 per cent to everything" scheme and plenty of news of kits and new products not covered by their catalogue. In addition to all this the prices quoted in each sheet are guaranteed to stand for the two months' life of the sheet—not bad in this day and age when some suppliers say prices can only be quoted on the day of ordering.

I.C. Stereo Amplifier

One or two of the components specified for the *I.C. Stereo Amplifier* may not be available from all the suppliers but most of the larger ones should be able to cover them all. This is where catalogues come in handy. Readers must appreciate that to be fair to retailers we cannot quote one supplier unless he is the *only* supplier we know of, equally we cannot provide a long list of stockists for each item.

Heads and Tails

Once again no difficult to get components for the *Heads and Tails Game*. In fact the only part which may not be readily available is the Minos M2 case—this is one of the West Hyde Developments range. This, or a similar type and size case, should be available from most retailers.

Probe Tracer

This *Probe Tracer* has not been designed to fit the case mentioned earlier but could be modified in layout by anyone who knows what he is doing. However, the case described is neat, functional and very cheap.

The only part which needs some comment is the headphone, this must be of approximately the correct impedance—so check this when buying. Some surplus type phones would be suitable and probably much cheaper than new ones.

Christmas Lights Flasher

The circuit of the *Christmas Lights Flasher* is simple but unusual. However, none of the parts should be difficult to get, the neons should be the wire-ended type—not mounted in cases. Although these are harder to find they are much cheaper than the mounted type indicator, which would have to be dismantled for this application anyway.

One point to watch when buying is the insulation of the control knob; this must be fully insulated to protect the user and must cover the fixing nut of the control. It would also be an advantage if the pot. had a plastic spindle.

For the Christmas number our Editor kindly allows me to stray slightly from the straight and narrow. It follows that the tenor of this article will differ from the norm. I trust that if it does not instruct at least it will entertain. As they say in all the best serials, "Now read on".

In 1932 we were still in the grip of the depression. There were twenty men after every job, and to be jobless meant near starvation. I was searching for a job, when an advert caught my eye:

"Wanted radio engineer used to P.A. work, must be able to drive car, apply Alexander Black, The Wireless Doctor, 32 Ebury St, London SW1".

There was one little snag, I had never driven a car but I needed a job and anyway, I figured, I had driven a motorcycle and there could not be much difference. My friends still do not believe me when I tell them that my first experience of driving a car was from Victoria up to Marble Arch, down Oxford Street and along Tottenham Court Road to the Y.M.C.A., but the purpose of this story is not to tell you about a trip that still gives me nightmares, but about the job.

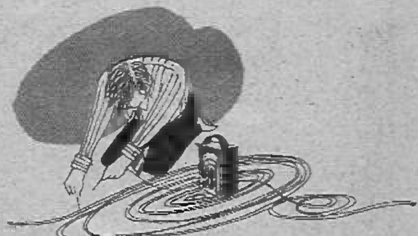
Much of the work consisted of putting in temporary public address systems in various London theatres and controlling them during the show. Needless to say our equipment was primitive by modern standards, big heavy valve amplifiers, feeding huge exponential horn speakers. The microphones, believe it or not were carbon granule, powered by a nine volt grid bias battery. Woe betide any singer, who in a moment of enthusiasm picked one up. The noise, sounded as if the roof was falling in.

After a short while I was asked to do the installation for a new play opening in London entitled "Whistling in the Dark". It would also be my duty to travel round with it. It was an ingenious play and had a great success in America where it was made into a film, but in order that you appreciate the full flavour of my later predicament, I had better briefly explain the plot. Some gangsters capture a writer of "Who dunnits" and his girl friend. They threaten to torture the girl if he does not invent a way to kill the District Attorney without detection.

The writer explains how to put poison in his toothpaste. The gangsters rip the telephone out, remove it and leave the hero and heroine locked in the room while they go off to commit the perfect crime. Our hero has got to get a message to the outside world somehow. Being a resourceful man, and no doubt having been a regular reader of Everyday Electronics, he has noted there is a radio set in the room, and he works out that by connecting the telephone leads to the output stage, he could utilize the speaker as a microphone and call the exchange, and then by changing the leads on the detector stage, he could hear their reply. After several attempts he succeeds and the D.A. is saved and all ends happily.

My job was to provide all the necessary sound effects. We played the Comedy Theatre, the old Fulham Shilling Theatre, and then we went to the Theatre Royal Chatham. I always used to get to a new location about two o'clock which gave me a good four hours to lay out the cables, plug in the mains and test. The last job was usually to connect the two wires to the microphone battery. The mains was a long way from the stage and I ran out my cable and connected up.

I switched on and bang went all the main fuses. Having ascertained the amplifier was alright I looked at the cable and to my horror I found I had been given 1/044, the type of cable you use for permanent house wiring. I had already rolled it up and un-rolled it a few times and having only one copper wire in each lead, it was now beginning to break up. I could not possibly find any new cable in the short time left, so I had to search for the breaks with

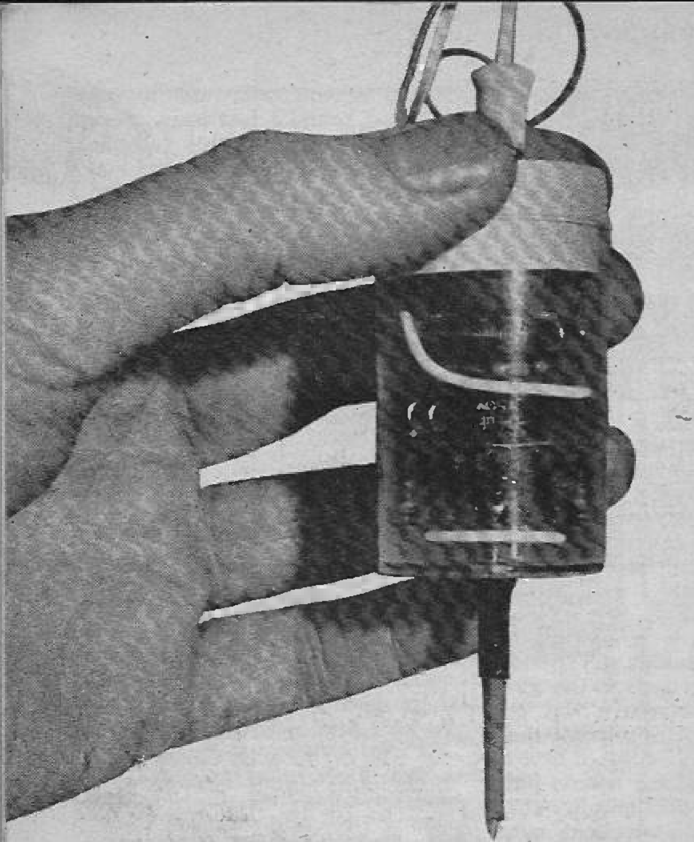


an Avometer and a pin connected to one test lead. As I found each break I had to repair it; there were four of them all told. By now they were ready to start Act I.

The stage manager was very understanding and so were the actors. They said they could stall in Act I (where the radio was just switched on to establish its presence) but if the outfit did not work at the appropriate time in Act II, they would have to return everyones money. I should explain here, that at the right moment, a girl acting as a telephone operator, spoke into the microphone off stage and the result came out of the loud speaker of the radio.

You will never believe this, but it's true, I connected up the microphone battery with just two seconds to spare. I held my breath, and then to my utter relief, I heard a nasal feminine voice coming from the stage radio saying "Number please". You will now understand that I did not acquire all my white hair, through trying to advise you on component buying!

Happy Christmas.



PROBE TRACER

By F.G. RAYER

A signal tracer allows the presence of a signal to be followed through the various sections of a receiver, and can thus be of considerable aid in locating the site of a fault. The tracer shown here is contained within a small probe unit, to hold in the hand, with output to a single earpiece, or pair of headphones. It is suitable for radio frequency, intermediate frequency, and audio circuits.

THREE-STAGE CIRCUIT

The circuit diagram is shown in Fig. 1 and is basically a demodulator D1 followed by two audio amplifiers; C1 is an isolating capacitor, so that touching the probe upon various circuit points does not cause a short circuit, or upset d.c. working conditions in the receiver or other apparatus.

Capacitor C1 is rated at 150V, and the unit is intended for working on transistor equipment, where only low voltages will be present.

Capacitor C2 couples the demodulator to the first audio amplifier TR1, and C4 couples to the second stage TR2. Current for TR1 and TR2 base is obtained through R5 and the headphones. This allows the probe to be switched on or brought into use by plugging in the phones. It is switched off when they are unplugged. Current drain is small, from a single dry cell in the unit and should therefore last a long time.

CASE AND BOARD

The tracer is constructed to fit in a plastic container 70mm long by 35mm in diameter. The container was originally used for holding confectionary decorations and spices. The exact dimensions are not important, provided all the components can be accommodated.

The prototype circuit board was 0·15 inch plain matrix board size 55 x 32mm and was cut so that it would slip inside the container. A little needed to be filed away each side near the lid, so that the latter could fit. If the container is not quite the same size as this, the board is cut to suit. It is not likely to be easy to fit the parts in a case which is very much smaller than that mentioned.

BOARD WIRING

The probe should be fitted first, and is a 6 BA threaded rod, about 65mm long. It is fixed with adhesive, and tied using thread passed through the holes in the board, using a needle, and similarly smeared with adhesive; C1 is best soldered to the probe before fixing it in this way.

As the battery rests along the underside of the board, no leads or joints occupy the centre rows of holes. Components R1, R6, TR1, and TR2 must be kept inwards so that the board can be placed in the container, see Fig. 2.

The battery will seldom need renewing, and leads are soldered to it, the outer case being negative. Though the HP7 cell can be fitted, the smaller HP16 cell would be satisfactory, if necessary.

CASE FITTING

The tracer can be tested before fixing it in the case. The probe passes through a hole drilled in the bottom. A washer and nut are put

FOR GUIDANCE ONLY

ESTIMATED COST* OF COMPONENTS
excluding V.A.T.
£1.80
excluding case and headphones

*Based on prices prevailing at time of going to press

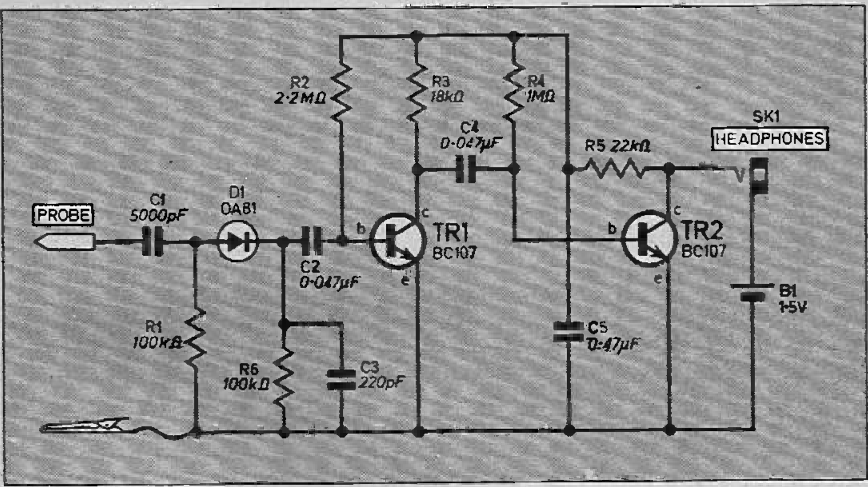
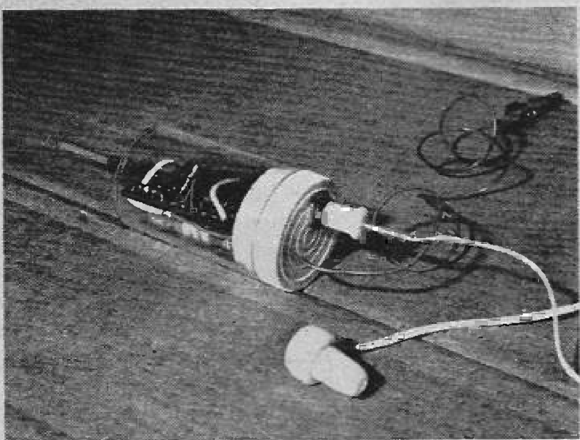


Fig. 1. The complete circuit diagram of the Probe Tracer.

on here, and insulated sleeving to cover the probe nearly to its point.

At the top of the case, a hole is made in the lid so that the jacket outlet bush passes through it. Run 300mm or so of thin flexible wire (from the emitter of TR1) through a small hole, and fit this with a crocodile clip. The lid can then be put on, followed by the outlet nut.

A surplus pair of 100 ohm headphones was found ideal for use with the probe, but phones of other resistance, or single personal type earpieces (except crystal) can be used instead.



Photograph of completed unit and earpiece. Alternatively headphones can be used.

METHOD OF USE

Tests begin at the earliest point in a receiver where signals can be heard, and proceed step by step through the circuit. When the point where a fault which prevents reception exists is passed, signals cease. Detailed checks are then made between this point and the earlier point, where signals were present.

The typical circuit for which the probe may be used is shown in Fig. 3. This a superhetrodyne circuit and will be helpful in understanding how the tracer can be employed.

The probe earth clip is attached to the receiver earth line. Referring to Fig. 3, the probe could be placed at some later point such as *E*, to check that TR1 and TR2 are operating. But assuming that the method of use is more easily followed if the circuit is taken from the beginning, a first test could be made with the probe at *A*. To obtain sufficient signal strength, a temporary aerial needs to be attached to the receiver. If there is no external aerial socket, it can be taken to *A*. If signals cannot be tuned in, L1, VC1 and T1 and connections to them are

Components....

SEE SHOP TALK

Resistors

- R1 100kΩ
- R2 2·2MΩ
- R3 18kΩ
- R4 1MΩ
- R5 22kΩ
- R6 100kΩ

All ¼W ± 5% carbon

Capacitors

- C1 5000pF 150V working ceramic or plastic
- C2 0·047µF plastic or ceramic
- C3 220pF ceramic or polystyrene
- C4 0·047µF ceramic or plastic
- C5 0·47µF ceramic or plastic

Semiconductors

- D1 OA81 or similar germanium type
- TR1 BC107 silicon *npn*
- TR2 BC107 silicon *npn*

Miscellaneous

- SK1 3·5mm jack socket
- B1 1·5V HP7

Plain matrix board size 0·15 inch x 55 x 32mm; plastic tubular case, connecting wire; 65mm long 6BA bolt.

PROBE TRACER

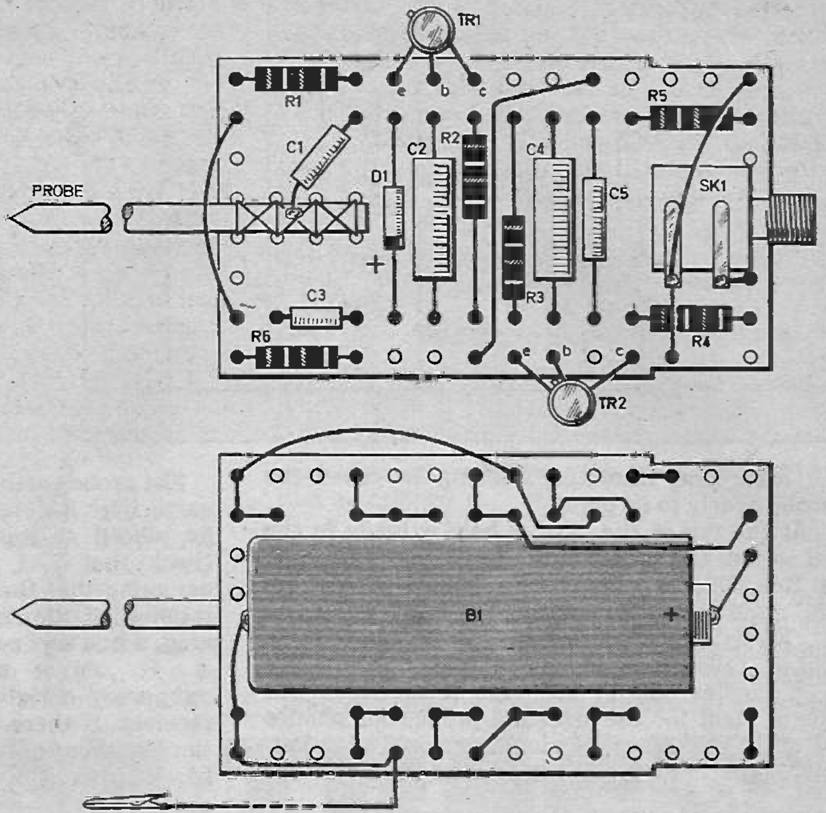


Fig. 2. The layout of components and wiring details on the component board.

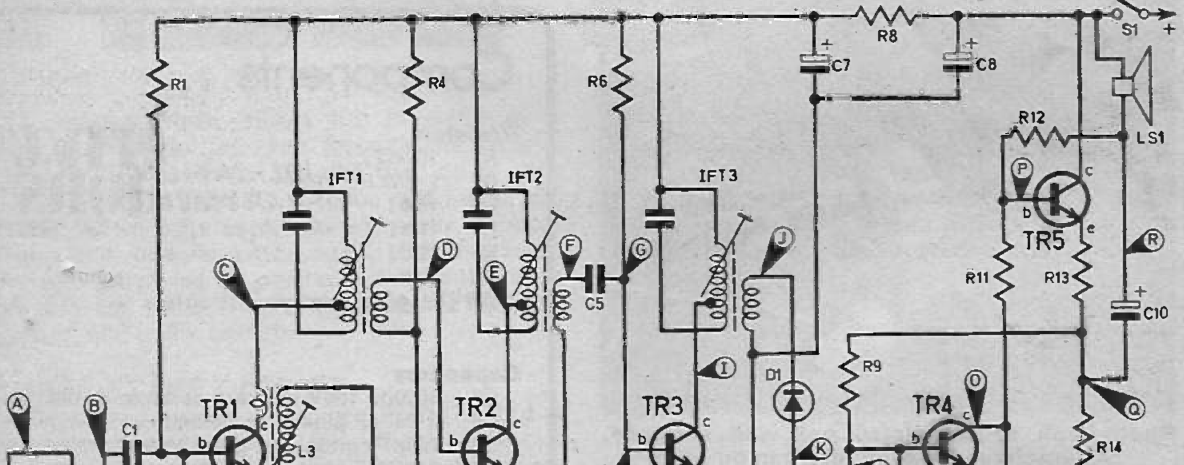


Fig. 3. The circuit of a typical superhetrodyne receiver with test points to illustrate the method of using the Probe Tracer.

suspected. Assuming signals are obtained, moving the probe to *B* checks L2. Volume will normally fall considerably, as L2 has few turns.

Signals should be received with the probe at *C*. If not, TR1 and its associated components R1, R2, R3, L3, C2, VC3 and VC4 are suspect.

Volume at *D* will again fall, due to the loss in IFT1. If signals are present at *C*, but not at *D*, IFT1 or its connections need checking.

Point *E* introduces TR2, and considerable gain should be apparent, compared with *D*. No signals at *E* (when obtained at *D*) suggest that TR2, R4, R5, VR1 and C4 need checking, and also IFT2.

Tests continue at *F*, then *G*. With a circuit board which may have a virtually invisible conductor crack, a test such as at *G* then at *H* will establish if the signal is lost in a typical foil conductor such as that from *G* to *H*.

Point *I* tests TR3 stage, and point *J* completes IF tests.

Audio circuit tests can be at *K*, and at *L*, to check VR1. Location *M* checks R7, and after this *N* checks C9. Point *O* checks TR4 stage. *P*, *Q*, and *R* are subsequent test points.

When moving ahead in this way through the receiver, volume may be expected to become too great. Up to point *K* this can be avoided by de-tuning or finding a weaker signal. After VR1, volume is controllable by this component.

Where sounds from the speaker are troublesome when tracing the source of an intermittent contact or some other fault which does not wholly prevent reception, the speaker can be temporarily disconnected. A resistor of about the same value is temporarily connected in its place.

When a defective stage has been located, some fault such as a poor joint, or short-circuit between conductors, may be obvious. If not, it is then necessary to check components and connections individually. There may only be a few items in the part of the circuit which has been found to be defective.

A voltmeter will show if the expected voltage is found across C8 (clearing the on/off switch, etc.) and across C7 (clearing C7 and R8), and at points such as *C*, *E* and *I*, to check any suspected winding here. Naturally detailed checks are only necessary over any part of the circuit which could cause the loss of signals between consecutive test points, as explained.

A resistor of about 1 megohm may be soldered directly to the probe tip, and can be included in the sleeving, to minimise the loading of any circuit by the probe. This does, however, reduce sensitivity to very weak signals, and normally any loading by the probe, or de-tuning produced by it, will not be of importance in circuit tests which are intended to locate a fault. ▣

Your Career in ELECTRONICS

By Peter Verwig

TECHNICAL PUBLICATIONS

EVERY item of electronic equipment and, indeed, most of the electronic components with which they are built, need backing up with user documentation of one sort or another. For a component such as a transistor or integrated circuit there is at least a specification and generally some application notes as a guide to the user on how to best use the component in practical electronic circuits and what pitfalls to avoid.

An equipment needs a user manual to instruct on the method of operation. This manual will often include a full description of how the equipment works and if so it will also include block schematic diagrams. It may also include a section on fault finding and maintenance. If the equipment includes electro-mechanical equipment such as magnetic tape drive mechanisms which are subject to mechanical wear there may be a separate overhaul manual with detailed step-by-step instructions for dismantling, repair and re-assembly.

In the early days of electronics when equipment was simple in character the task of describing the equipment, how to operate it and what to do if it went wrong, was often left to the design engineer and was regarded as almost a part-time job. From a few jottings by the engineer a junior clerk might be expected to knock the text into shape. A friendly draughtsman could produce the illustrations.

PUBLICATIONS DEPARTMENT

The situation is vastly different today. Even comparatively small companies have a technical publications department with full time authors and illustrators. In large companies such a department may number a hundred or more people on its staff. They produce technical manuals which can, for a big electronics system, run into hundreds of thousands of words bound in several volumes.

Even the typical technical handbook for an average piece of equipment will have some 15,000 words and perhaps 20 illustrations in 50 or so pages. Very small companies often have their technical publications produced by contractors specialising in such work.

The technical author and technical illustrator work behind the scenes but they are important, well respected, and have a good career structure with excellent

Illustrators co-relating drawings with equipment.

salaries. Moreover, because equipment is becoming ever more complex the demand for professional authors and illustrators is always increasing. It is a growth area offering job security as well as interest, the opportunity to be creative within certain limits and, at the end of each project, the satisfaction of seeing an end-product in which your own work is recognizable.

Note that I have stated in the preceding paragraph that there is opportunity to be creative *within certain limits*. There is, of course, no objection to a very creative person being employed in technical publications. But a good technical illustrator does not have to be an artist and a technical author does not have to be literary.

I once knew an illustrator who had water colours hung at the Royal Academy and whose postage stamp designs were adopted by a number of countries. A technical author of my acquaintance had a rising reputation as a novelist. These special skills were not, however, needed in their ordinary work. In the department, they exercised the same firm discipline as their fellow authors and illustrators in presenting facts plainly and simply, unembellished by their imaginations.

RACAL GROUP

As most readers of this series of career articles will have an engineering rather than artistic interest, I shall concentrate on the technical author rather than the illustrator. For an up-to-date assessment of requirements I consulted the Technical Handbooks Manager of Racal Group Services Ltd., which is a central organisation serving all the UK-based manufacturing companies in the Racal Electronics Group which employs 6,000 people world-wide and has a turnover of £75 million a year.

The Group's business is founded on radio communications, instrumentation, data transmission and magnetic recording with a wide product range. The Technical Handbooks Section of the Group Publicity Department employs twenty technical authors and illustrators and may be regarded as typical. The general principles described are equally relevant to other manufacturers who may employ more or fewer people, and who may have their business in other sectors of the electronics manufacturing industry.

Unlike the other careers already outlined in this series, technical authorship is not open to the school-leaver. But if you are a school leaver intent on building a career in electronics read on. You could be a technical author in five years time and if you think you have ability and an aptitude for technical exposition, your "apprenticeship" will be all the more valuable if you have a definite target in mind.

QUALIFICATIONS

What qualifications do you need? Certainly the ability to express yourself clearly and concisely. Remember that your work as well as being clear to English-speaking operators and engineers may also have to be translated into French, German, Spanish, Arabic, Japanese or Chinese, and by translators who may have only a superficial technical knowledge. But far more important is engineering knowledge and experience.

Before you can write on any subject you must understand it. And if you are to be effective in writing on maintenance and overhaul of equipment you will need to have done some trouble-shooting and overhaul yourself although not necessarily on the equipment for which you are writing the manuals.

You will need a good personality because the actual writing of the text is the only solitary part of the total work and may take up only half or even less of your time. The rest is spent on discussion with design engineers, with the illustrators working on your project, with printers and with service engineers. You also need to be discreet and trustworthy. This is because the technical author is brought in at an early design stage of a new product so that the handbooks are printed and ready to accompany the first units leaving the factory.

You will need to preserve commercial security. No company wants to employ people who leak out confidential information. If you are working on military projects you will be bound by the Official Secrets Act and it may be that your section of the office will be isolated physically from that engaged on commercial projects.

The blend of qualities needed for a good technical author are both complex and considerable. There are very few really good handbooks produced in Europe or the United States and this is a reflection on the difficulties of finding good authors and why, when they are found, they are in such demand.

A fruitful field of recruitment is in test departments and in field engineering departments. Five years experience in either of these is a good foundation for a budding technical author. In either of these jobs a thorough knowledge of professional electronic products is obtained together with trouble-shooting experience and ability to use initiative and take responsibility.

You will have acquired a working knowledge of most techniques in electronics including analogue and digital circuits and logic. You will be capable of reading circuit diagrams and recognise the functions of each stage of a circuit. You will probably have acquired an Ordinary National or Higher National Certificate.

Given a good test engineer or field service engineer the rest can be taught. However brilliant you may be at English composition you will never get a job or hold a job as a technical author unless you have the technical knowledge appropriate to your subject. But the person with the right mix of experience and only reasonable competence in exposition can be successful.

INTERPRETER

Remember that the technical author is not writing advertising copy or a great work of literature. He is above all an interpreter. He gets notes, either written or verbal from design engineers and these are often scanty and incomplete. He may have to re-write them, expand them, compress them, edit them to make them comprehensible to the person new to the equipment. In conjunction with designers he may have to originate trouble-shooting charts and overhaul procedures.

It will be seen that this is a job for an engineer with writing ability rather than a writer with a little engineering knowledge. Given a good engineer, a technical publications department can train a newcomer in the craft of technical writing and this they are willing to do. A newcomer would generally work under supervision for his first few months, perhaps on amendments to existing manuals following product modification, or on the simpler sections of a large manual.

As experience is gained so his responsibilities will be enlarged so that he is not only meeting engineers and originating his own material but also instructing illustrators on the diagrams and other art work which will be used in support of his written matter. A senior technical author may "employ" a junior author and a couple of illustrators. Some projects are so large that they need a group leader. Salaries for senior authors are currently in the £4,000 bracket and a junior may expect to start in a technical publications department at £2,500.

Publications dealing with defence equipment are almost invariably produced to a fixed specification in relation to layout and contents. These are currently laid down for the Army, Navy and Air Force, each of which differs in certain respects although there is a move to harmonisation. For commercial equipment most departments have their own internal standards so that most handbooks have a uniform appearance and structure of contents. But within the constraints of standardisation there is room for initiative in the art of engineering exposition.

PROMOTION

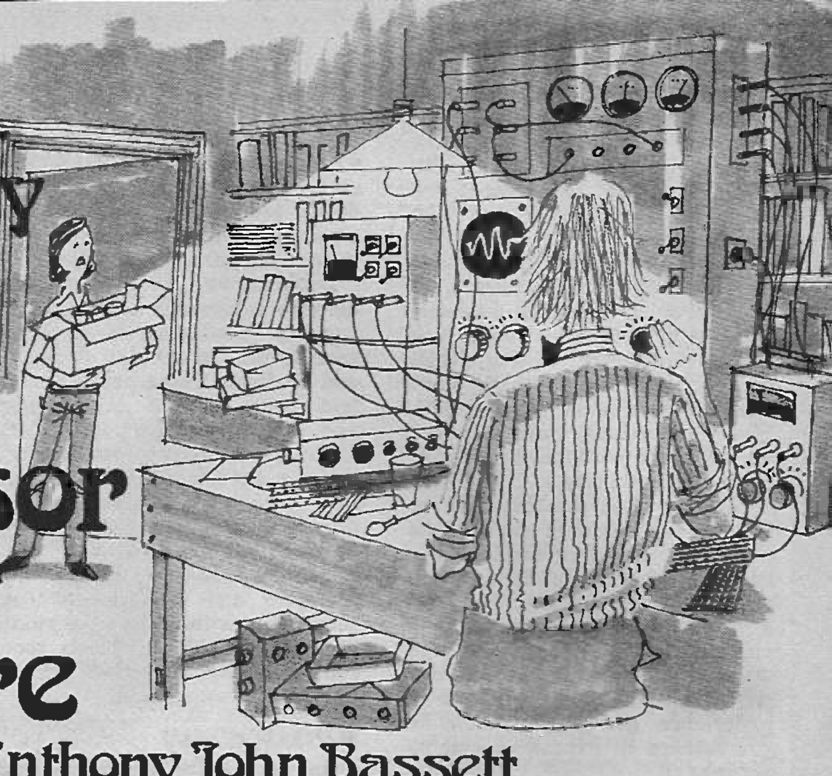
An author promoted to section leader status has additional administrative responsibilities. He will delegate tasks to authors under his control, arrange for equipments to be photographed, arrange printing orders and editorially check individual authors' drafts. At times when pressure of work is such that subcontractors may be called in, he will usually liaise with them and supervise the quality of their work.

To be a technical author is not a dead-end occupation. There is opportunity to rise to management status. Even at the bottom of the careers structure the technical author is generally regarded as being in the professional staff category on a monthly salary and entitled to additional benefits applicable to salaried staff in the company. At the least, these benefits will normally include a shorter working week and longer holidays than for shop-floor staff.

Technical authorship is a challenging occupation. It is not easy at any time and it can be very frustrating when, for example, late design changes or modifications involve re-writing or alterations to circuit diagrams or illustrations. But it can also be very rewarding. A good handbook enhances the product and although your name may not be printed on the cover it is still a book you have written or helped to write and in which you can take pride.

Technical authors may apply for membershsip of the Institute of Technical and Scientific Communicators who issue a diploma to those suitably qualified and experienced. The Institute has its own quarterly journal and monthly news letter, holds meetings in London, and arranges visits to industrial establishments and seats of learning. The address of the Institute is 17, Blue Bridge Avenue, Brookman's Park, Hatfield, Herts.

Engineer and Author discussing PCB circuit details.



The Extraordinary Experiments of Professor Ernest Eversure

by Anthony John Bassett

NON-DESTRUCTIVE BREAKDOWN-VOLTAGE TESTER

Professor Ernest Eversure, or the Prof. as his friends call him, has been experimenting in electronics for more years than anyone can remember and we thought that you might like to hear of, and perhaps repeat, some of his extraordinary experiments. Anthony J. Bassett recounts some of these experiments every month so why not follow the Prof's work and learn along with young Bob, his friend.

From a safe distance Bob had seen how, with the Prof's own breakdown voltage tester, huge sparks flickered as thousands of volts flashed out to test components for his experiments. But the Prof. was now busily designing a miniature tester which would be safe for Bob to use himself. Soon he had produced a circuit-diagram for the tester (Fig. 1).

Bob collected together the necessary parts. For ME1 he used a small recording-level meter with a full scale deflection rating of 1mA. With the Prof's help, he measured the chassis, marked it and made holes to mount the meter, control, switches and terminals. (An aluminium or plastic case of about 200×150×60mm is suitable.)

After they had assembled the components onto the chassis, and carefully wired and soldered the assembly to form the circuit of Fig. 1, the Prof. carefully checked it over. In particular he checked that C1 and C2 were firmly clamped into the capacitor clips, and sleeved with insulation to prevent any short-circuit to chassis.

When the Prof. was satisfied that the tester had been safely and properly constructed, he fixed the chassis base in place, and fitted four rubber feet.

TESTS

"This tester can be used for tests on a wide variety of components, Bob," the Prof. began, "and it can also be used to reform electrolytic capacitors, which is necessary when these have been in storage over long periods of time."

"Because the tester is likely to find most use in the testing and selection of transistors and diodes, it has been designed around this function and is therefore provided with a transistor socket and an *npn/pnp* polarity switch (S4).

"It can be used to test almost any type of junction transistor, and because the test-current is limited by R1 to a very low level, the test delivers insufficient energy to damage the properties of the junction.

"Suppose we start with a BC109 transistor. To test this, beginning with S1 switched off, we will set the controls on the tester ready to begin.

"According to the specifications for a BC109, the maximum collector/emitter voltage is only 20 volts, so we can set S3 to the 300 volt range as this is the lowest available on the tester. The BC109 is an *npn* type, so S4 is set for *npn*.

"Now with S2 off, so that you do not touch the test-terminals whilst the test voltage is connected, insert the BC109 into the test socket; S2 can now be switched on. Leave S6 off; and make sure that VR1 is turned towards the S3 end so that when we switch on S1 the test voltage will start at zero.

"In order to measure the test voltage, we will connect a multimeter to the voltage-test terminals SK1 and SK2. It is best to use a high-resistance instrument of 20 kilohms per volt or more. This is because the test-current for the multimeter also flows through ME1, causing a very small error in the reading of ME1. If the multimeter is of sufficiently high

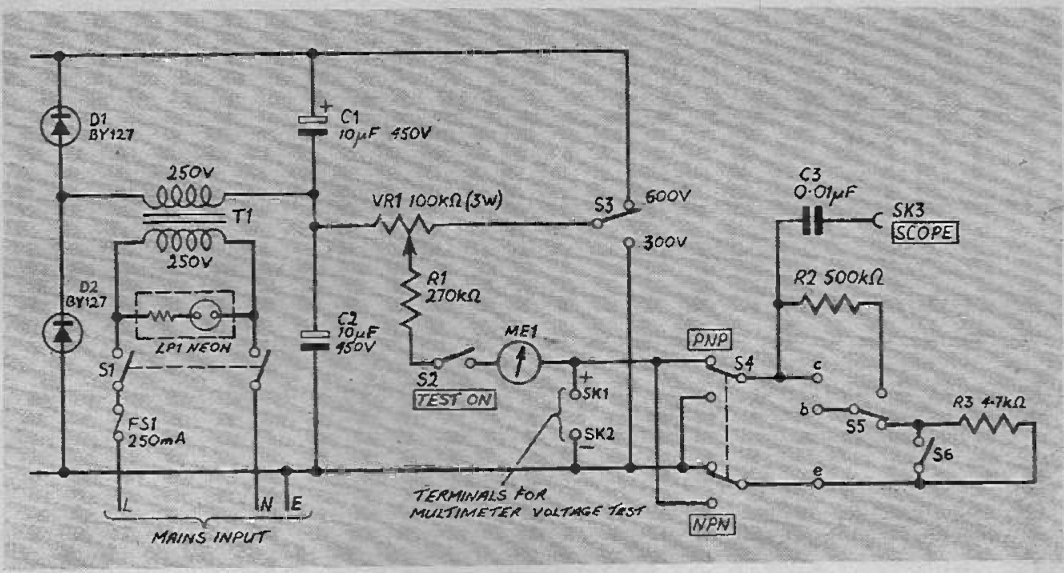


Fig. 1. Circuit diagram of the breakdown voltage tester.

resistance, the error will be so small as to be almost imperceptible, but if a low-resistance multimeter is used, the magnitude of the error would cause difficulty in using the tester."

After Bob had connected the multimeter to the terminals, he set it to the 50 volt range.

"I think the 50 volt range should be right for this test, Prof," he remarked, "as the transistor is rated at only 20 volts V_{cbo} rating."

Seeing that the multimeter was connected correctly, and that everything was ready to begin the test, the Prof. plugged the tester into the mains and switched S1 on.

The neon indicator came on, but nothing else seemed to happen until the Prof. carefully began to turn VR1. As he did so, the needle on the meter ME1 began to move across the scale, indicating that the transistor was conducting and allowing a small current to flow. The voltage indication on the multimeter, however, remained near zero.

"A small bias current is now flowing through R2, and this causes the transistor to conduct," the Prof. informed Bob.

"But if I operate the test switch S5, this disconnects R2, and connects R3 instead, and this provides zero bias. The transistor should then cease to conduct, and a voltage reading will appear on the multimeter."

The Prof. operated S5, and immediately the current reading swung down almost to zero, and a reading of several volts appeared on the multimeter. The Prof. continued to turn VR1 clockwise, and as he did so, the reading on the multimeter rose until a voltage of 20 volts was indicated across the transistor.

SAFETY MARGIN

"This is the manufacturer's maximum rating for the transistor, Bob, but in giving this specification they always allow a margin between the voltage specified, and the voltage which the transistor will actually block or withstand. By using this tester we can find out practically how much higher we can go. This means that we can continue to turn the voltage up, using VR1, until the collector/base junction of the transistor fails to prevent a current flow through the transistor. When this happens, the current flowing will be shown on the meter ME1."

"I think I understand," said Bob; "If the makers have allowed a margin of 5 volts on their specification of 20 volts, then when we reach a reading of 25 volts a current should begin to flow. But if the margin is higher, say 10 volts, appreciable current will not begin to flow through the transistor until we reach 30 volts or higher."

"That is right," agreed the Prof., turning the voltage up first to 25 volts, then to 30 volts. Still no current was indicated.

"We have now reached another of the manufacturer's rated maximum voltage levels, Bob. If you refer to the data once more, I think that you will find that 30 volts is given as the absolute maximum collector/base voltage in free air at 25 degrees centigrade."

The Prof., however, continued to turn the voltage up until the voltage had reached 50.

"I think that the maker's margin for maximum voltage is higher than you anticipated, Bob. We'd better change the meter range."

The Prof. switched off S2 so that the test voltage was removed whilst he changed the range on the meter. Then he switched S2 back on again and continued to turn the voltage up at a slow but steady rate. Only when the voltage reached nearly 60 volts did the needle of ME1 begin to stir to indicate a flow of current.

When this happened, as the Prof. continued to turn VR1, the current continued to rise, but the voltage remained around 60 volts.

"The actual maximum blocking voltage of this transistor has now been reached, Bob, at about 60 volts, which is far higher than the manufacturer's specification."

"Why is it, Prof., that the makers allow such an enormous margin?" enquired Bob, "Why don't they claim that this is, say, a 50 volt transistor and give the user only a 10 volt margin? Wouldn't this be sufficient?"

Answers and more tests next month.

DOWN TO EARTH

By GEORGE HYLTON

STRANGE GOINGS ON AT THE RECEIVING END

FROM time to time readers report peculiar reception of radio signals. Frequently it involves an audio amplifier which produces, unasked, a radio programme or TV sound. In these cases the explanation is nearly always that the reader who owns the audio gear lives near a radio or TV transmitter.

Strong r.f. signals get picked up on the input leads, or the wiring, or the mains connection, and so get into the amplifier, where they are rectified (detected) by a valve or transistor to produce the programme noises. (TV interference is generally accompanied by the buzz of the frame sync. pulses, which sound rather like mains hum.)

Occasionally, the interference is not present all the time. There are just short bursts of speech which disappear after a few seconds. People who experience this generally turn out to be living near roads used by vehicles with mobile radio telephones, such as the police or "radio taxi" services.

A much more unusual type of radio breakthrough is reported by a Portsmouth reader, S. G. Telford. He discovered by accident that his audio amplifier gave out Radio Sweden in English when he connected an electrolytic capacitor across the input. "The reception was perfectly clear", says Mr. Telford, "except for slight fading, but there was another station in the background."

The unusual thing about this case was that it involved long-distance reception. Usually, the signals from distant stations are too weak to break through audibly like this. Our reader thought that perhaps the particular 470μF capacitor he was using was tuning the equipment, so with great presence of mind he tried several others with different values. They all worked. But a short-circuit of the input silenced the programme.

What is the explanation? Well, clearly, this is another case of r.f. breakthrough, but a most unusual one. Fortunately our reader managed, in the short time the effect lasted, to make some simple but useful tests. Shorting the amplifier input silenced the programme, so it seems clear that the transmission was coming in at the amplifier terminals, not through the mains or by direct pickup on the circuit wiring. Secondly, a capacitor—almost any capacitor—aided the breakthrough.

Now, the 470μF capacitance which first gave the effect has, in theory, such a low impedance at any short-wave radio frequency that it is virtually a short-circuit. In practice, however, many types of capacitor—including electrolytics—contain strips of conductor which are *rolled up* to form the usual cylindrical shape. A rolled-up conductor is a coil of sorts. It has inductance. Not much, but enough, perhaps, to tune the amplifier input very broadly to somewhere in the short-wave band.

It's quite possible for capacitors with very different values of capacitance to have similar values of inductance. This could explain why the radio programme was still heard when the capacitor was changed.

SELECTIVITY

Why the selectivity? Only Radio Sweden came in strongly. There's no need to assume that there *was* any special selectivity. This accidental reception could have been the result of freak radio propagation conditions which put a strong signal from *one* station into the amplifier, leaving others too weak to be heard except as background noises. It is just possible, however, that a more selective effect was at work.

For example, the mains wiring in the house could have formed an aerial tuned to Radio Sweden's frequency. The house—including the amplifier—would then have been filled with an enhanced electromagnetic field which assisted breakthrough. Then again, the amplifier itself, though an audio amplifier, could have had stray internal feedback which made it operate as a selective short wave tuner of fixed frequency. But in this case one would have expected reception to happen frequently, not just once.

Another possibility is that the signals weren't coming directly from Sweden at all, but were being re-radiated accidentally by a receiver in the house next door, perhaps on a changed frequency.

FADING

Well, that's about as far as I can go, on the evidence, in explaining that problem. But another reader, M. P. Chamberlain of Thurnby, Leicestershire, says that the station he's listening to on his LW/MW radio starts fading in and out as soon as it gets dark, even with an outside aerial. He doesn't give any further details, but I'm placing a modest bet with myself (that way you don't lose) that it's a medium-wave station, probably near the high-frequency end of the MW band, that gives the trouble, and also that it's a fairly distant station, 100 miles away or more.

The fading happens because signals from such a transmitter can reach the receiver in two ways. During the day, they arrive by only one of these ways—the "ground wave", which is that part of the transmission which is bent round the curved surface of the earth by the process of refraction. By day, the rest of the energy from the transmitter goes off into space.

At night, on these frequencies, the ionosphere becomes a reflector, and the "sky waves" are reflected back to earth. So after dark the receiver picks up both waves—the ground wave and the sky wave. If they happen to be of equal strength, then they can either add together, giving a stronger signal, or cancel one another out. The ionosphere keeps changing all the time, so sometimes the signals add, and later they cancel, then they add again, and so on. The station "fades in and out". The only remedy is to live nearer to the station, where the ground wave is stronger all the time!

everyday electronics

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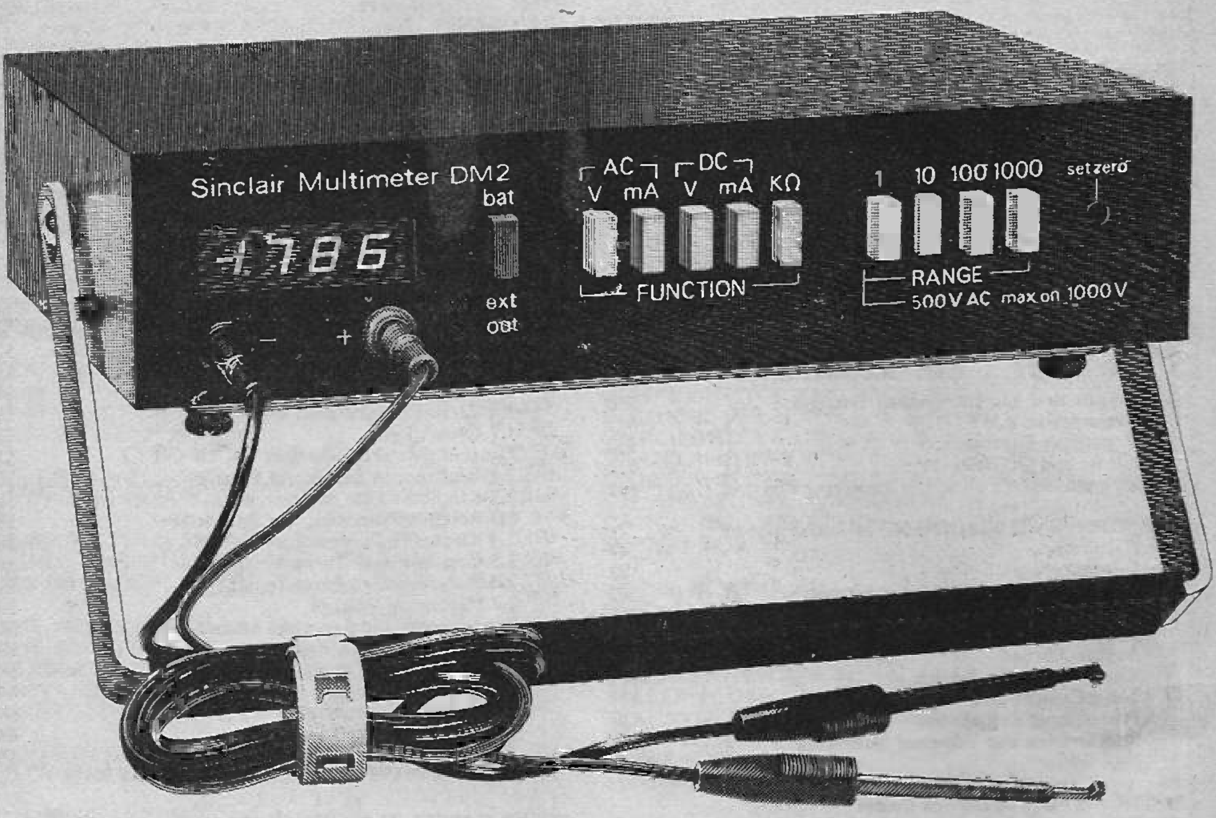

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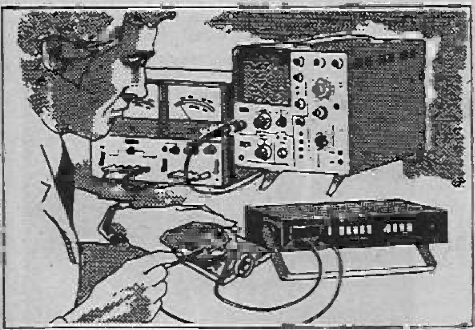

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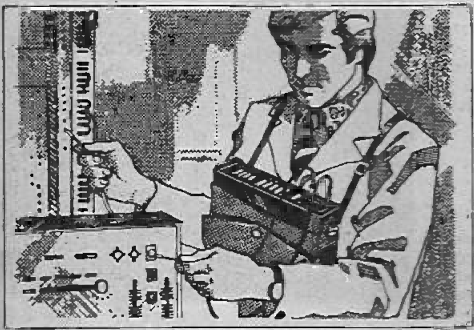

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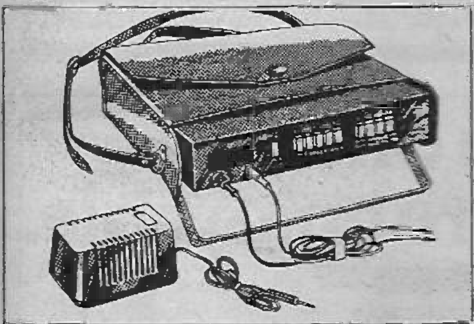

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100 V	0·5% ± 1 ,,	10 MΩ	100 mV
1000 V	0·5% ± 1 ,,	10 MΩ	1 V

Maximum overload – 350 V on 1 V range
1000 V on all other ranges.

AC Volts

Range	Accuracy	Input Impedance	Frequency Range
1 V	1·0% ± 2 Digits	10 MΩ/40 pF	20 Hz–3 KHz
10 V	1·0% ± 2 ,,	10 MΩ/40 pF	20 Hz–3 KHz
100 V	2·0% ± 2 ,,	10 MΩ/40 pF	20 Hz–3 KHz
1000 V	2·0% ± 2 ,,	10 MΩ/40 pF	20 Hz–1 KHz

Maximum overload – 300 V on 1 V range
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DC Current

Range	Accuracy	Input Impedance	Resolution
100 μA	2·0% ± 1 Digit	10 KΩ	100 nA
1 mA	0·8% ± 1 ,,	1 KΩ	1 μA
10 mA	0·8% ± 1 ,,	100 Ω	10 μA
100 mA	0·8% ± 1 ,,	10 Ω	100 μA
1000 mA	2·0% ± 1 ,,	1 Ω	1 mA

Maximum overload – 1A (fused).

AC Current

Range	Accuracy	Frequency Range
1 mA	1·5% ± 2 Digits	20 Hz–1 KHz
10 mA	1·5% ± 2 ,,	20 Hz–1 KHz
100 mA	1·5% ± 2 ,,	20 Hz–1 KHz
1000 mA	2·0% ± 2 ,,	20 Hz–1 KHz

Maximum overload – 1A (fused).

Resistance

Range	Accuracy	Measuring Current
1 KΩ	1·0% ± 1 Digit	1 mA
10 KΩ	1·0% ± 1 ,,	100 μA
100 KΩ	1·0% ± 1 ,,	10 μA
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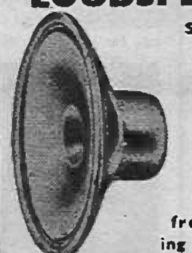

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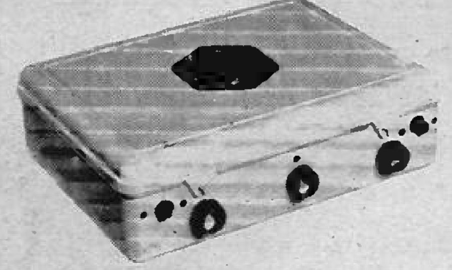

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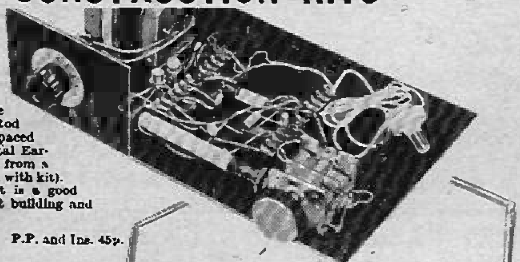

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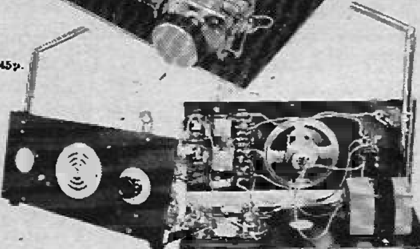

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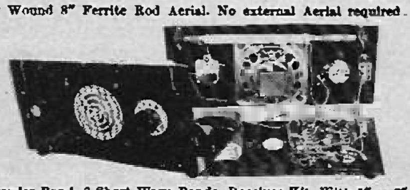

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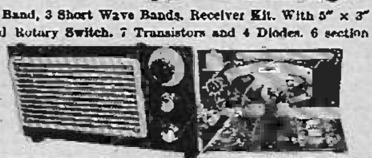

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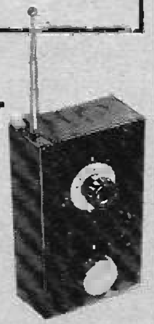

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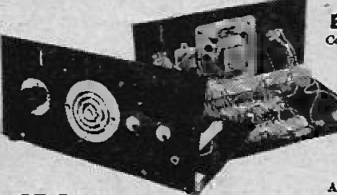
EDU-KIT JUNIOR



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