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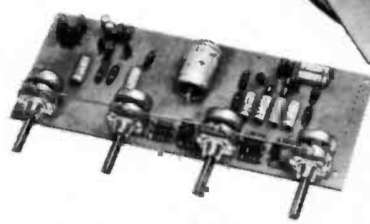
STIRLING SOUND policy is to ensure customer satisfaction by designing and making their products in their own factory in Essex and selling direct. Production control-checked throughout. All QV Modules are compatible within the range and with much other equipment.



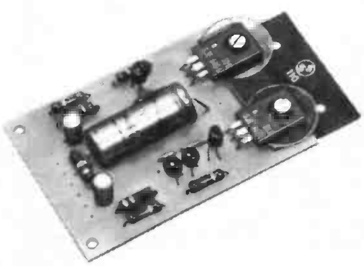
PRE-AMP/TONE CONTROL MODULES

SS.100 Active tone control, stereo. ±15dB on bass and on treble **£1·60**

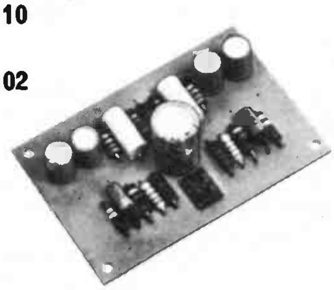
SS.101 Pre-amp for ceramic cartridges, radio, tape. Stereo. Passive tone control circuit shown in data supplied **£1·60**

SS.102 Stereo pre-amp for low output magnetic P.Us. R.I.A.A. corrected. Linear feedback facility. **£2·65**

UNIT ONE PRE-AMP/TONE CONTROL
Combined pre-amp with active tone-control circuits. ±15dB at 10Khz treble and 30 Hz bass. Stereo. Vol./balance/treble/bass. 200mV out for 50mV in. Takes 10-16V. **£7·80**



SS.110



SS.102

POWER AMPLIFIERS

SS.103 3 watt r.m.s. mono I.C. with built-in current, short, and thermal protection **£1·75**

SS.103-3 Stereo version of above **£3·75**

SS.105 5 watts r.m.s. into 4 ohms, using 12V **£2·25**

SS.110 10 watts r.m.s. using 24V and 4 ohm load **£2·75**

SS.120 20 watts r.m.s. into 4 ohms, using 34V **£3·25**

The above all measure 89 x 50 x 19mm (3½ x 2 x ¾ ins) Suitable power supplies will be found in the accompanying range.

FM TUNING MODULES

SS.201 Front end tuner, slow geared drive, two gang. A.F.C. facility. Tunes 88—108 MHz **£5·00**

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SS.203 Stereo Decoder for use with the above or other FM mono tuners. A LED may be fitted **£3·85**

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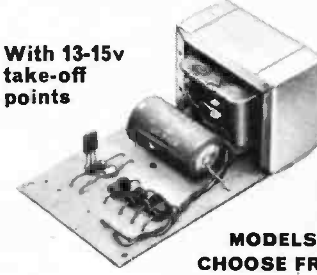
With 13-15v take-off points



7 MODELS TO CHOOSE FROM

Complete with mains transformers and low volt take-off points. (except SS.300) All at 8% V.A.T. rate. Add 50p for p/p any model.

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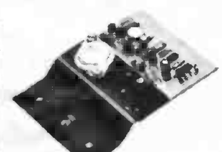
SS.318	18V/1A	£4·15*
SS.324	24V/1A	£4·60*
SS.334	34V/2A	£5·20*
SS.345	45/V2A	£6·25*
SS.350	50V/2A	£6·75*

SS.300 Power stabilising unit 10-50V adjustable for adding to unstabilised supplies. Built-in protection against short circuit (p/p 35p) **£3·25**



SS.300

SS.310/50 Stabilised power supply with variable output from 10 to 50V/2A Built-in protection against short circuit. **£11·95***

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Unique full-function 8-digit wrist calculator... available only as a kit.

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

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

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

How to make 10 keys do the work of 27

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

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

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

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

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

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

Assembling the Sinclair Instrument wrist calculator

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

Contents

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

Everything is packaged in a neat plastic box, and is accompanied by full instructions. The only thing you need is a fine-point soldering iron.

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

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

Send the coupon today.

KIT ONLY £9.95 PLUS VAT, P&P

To: Sinclair Instrument Ltd,
6 Kings Parade, Cambridge, Cambs., CB2 1SN.

* Please send me . . . (qty) Sinclair Instrument wrist-calculator kits at £9.95 plus 80p VAT plus 25p P&P (Total £11).

* I enclose cheque/PO/money order for £....................

* Complete as applicable.

Name ____________________

Address ____________________

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(Please print)

I understand that you will refund my money in full if I return the kit undamaged within 10 days of receipt. EE/1

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

SEMICONDUCTORS—COMPONENTS

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA129	0·08	BY100	0·16	BYZ11	0·31	OA91	0·07
AAY30	0·09	BY107	0·12	BYZ12	0·31	OA95	0·07
AAZ13	0·10	BY105	0·18	BYZ13	0·26	OA182	0·07
AAZ17	0·10	BY114	0·12	BYZ16	0·41	OA200	0·08
BA100	0·10	BY124	*0·12	BYZ17	0·36	OA202	0·08
BA102	0·32	BY126	*0·15	BYZ18	0·36	SD10	0·06
BA148	0·15	BY127	*0·16	BYZ19	0·28	SD19	0·06
BA154	0·12	BY128	0·16	OA10	0·35	IN34	0·07
BA155	0·14	BY130	*0·17	OA47	0·07	IN34A	0·07
BA156	0·14	BY133	*0·21	OA70	0·07	IN914	0·06
BA173	0·15	BY164	0·51	OA79	0·07	IN916	0·06
BB104	0·15	BY176	*0·75	OA81	0·07	IN4148	0·06
BAX13	0·07	BY206	0·00	OA85	0·09	IS44	0·05
BAX16	0·08	BYZ10	0·36	OA90	0·07	IS920	0·06

SILICON RECTIFIERS

Type	Price	Type	Price	Type	Price	Type	Price
IS920	0·06	IN4003	0·07	IS020	0·10	IS031	0·25
IS921	0·07	IN4004	0·08	ISO21	0·11	IN5400	0·13
IS922	0·08	IN4005	0·09	IS023	0·13	IN5401	0·15
IS923	0·09	IN4006	0·10	IS025	0·14	IN5402	0·18
IS924	0·10	IN4007	0·11	IS027	0·16	IN5404	0·17
IN4001	0·05	ISO15	0·09	IS029	0·20	IN5406	0·21
IN4002	0·06					IN5407	0·25

TRIACS

2 Amp. Volts	TO5 No.	Case Price	10 Amp. Volts.	TO48 No.	Case Price
100	TR12A/100	0·31	100	TR110A/100	0·77
200	TR12A/200	0·51	200	TR110A/200	0·92
400	TR12A/400	0·71	400	TR110A/400	1·12

6 Amp. Volts	TO66 No.	Case Price	10 Amp Volts	TO220 No.	Case Price
100	TR16A/100	0·51	400	TR110A/400P	1·12
200	TR16A/200	0·61			
400	TR16A/400	0·77			

DIACS

BR100 0·23 D32 0·23

THYRISTORS

600mA Volts	TO18 No.	Case Price
10	THY600/10	0·13
20	THY600/20	0·13
30	THY600/30	0·19
50	THY600/50	0·22
100	THY600/100	0·25
200	THY600/200	0·38
400	THY600/400	0·45

1 Amp Volts	TO5 No.	Case Price
50	THY1A/50	0·26
100	THY1A/100	0·27
200	THY1A/200	0·28
400	THY1A/400	0·36
600	THY1A/600	0·45
800	THY1A/800	0·58

3 Amp Volts	TO66 No.	Case Price
50	THY3A/50	0·25
100	THY3A/100	0·27
200	THY3A/200	0·33
400	THY3A/400	0·42
600	THY3A/600	0·50
800	THY3A/800	0·65

5 Amp Volts	TO66 No.	Case Price
50	THY5A/50	0·36
100	THY5A/100	0·48
200	THY5A/200	0·50
400	THY5A/400	0·57
600	THY5A/600	0·69
800	THY5A/800	0·81

5 Amp Volts	TO220 No.	Case Price
400	THY5A/400P	0·57
600	THY5A/600P	0·69
800	THY5A/800P	0·81

7 Amp Volts	TO48 No.	Case Price
50	THY7A/50	0·48
100	THY7A/100	0·51
200	THY7A/200	0·57
400	THY7A/400	0·62
600	THY7A/600	0·78
800	THY7A/800	0·92

10 Amp Volts	TO48 No.	Case Price
50	THY10A/50	0·51
100	THY10A/100	0·57
200	THY10A/200	0·62
400	THY10A/400	0·71
600	THY10A/600	0·99
800	THY10A/800	1·22

16 Amp Volts	TO48 No.	Case Price
50	THY16A/50	0·54
100	THY16A/100	0·58
200	THY16A/200	0·62
400	THY16A/400	0·77
600	THY16A/600	0·90
800	THY16A/800	1·39

30 Amp Volts	TO94 No.	Case Price
50	THY30A/50	1·18
100	THY30A/100	1·43
200	THY30A/200	1·63
400	THY30A/400	1·79
600	THY30A/600	3·50

No.	Price
BT101/500R	0·80
BT102/500R	0·80
BT106	1·25
BT107	0·93
BT108	0·98
2N3228	0·70
2N3525	0·77
BTX30/50L	0·33
BTX30/400L	0·46
C106/4	0·60

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PAK No.		Order No.	
U50	100 Germ. Gold bonded OA47 diode	16130	0·50
U51	150 Germ. OA70/81 diode	16131	0·60
U52	100 Silicon Diodes 200mA OA200	16132	0·60
U53	150 diodes 75mA 1N4148	16133	0·60
U54	50 Sil Top Hat 750mA	16134	0·60
U55	20 Sil Rect Stud Type 3 Amp	16135	0·60
U56	50 400mW Zeners D07 Case	16136	0·60
U57	30 NPN Trans BC107/8 Plastic	16137	*0·60
U58	30 PNP Trans BC1uu/178 Plastic	16138	*0·60
U59	25 NPN TO39 2N697/2N1711 sil.	16139	0·60
U60	25 PNP TO59 2N2905 silicon	16140	0·60
U61	30 NPN TO18 2N703 silicon	16141	0·60
U62	25 NPN BFY50/51	16142	0·60
U63	30 NPN Plastic 2N3906 silicon	16143	*0·60
U64	30 PNP Plastic 2N3905 silicon	16144	*0·60
U65	30 Germ. 0071 PNP	16145	0·60
U66	15 Plastic Power 2N3055 NPN	16146	1·20
U67	10 TO3 Metal 2N3055 NPN	16147	1·20
U68	20 Unijunction trans IIS43	16148	0·60
U69	10 1amp SCR TO39	16149	1·20
U70	8 3 amp SCR TO66 case	16150	1·20

Code No's mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

COMPONENT PAKS

Pack No.	Qty.		Order No.	Price
C1	200	Resistor mixed value approx. (Count by weight)	16164	*0·60
C2	150	Capacitors mixed value approx. (Count by weight)	16165	*0·60
C3	50	Precision resistors. Mixed values	16166	0·60
C4	80	⅛th W resistors mixed preferred values	16167	*0·60
C5	5	Pieces assorted ferrite rods	16168	*0·60
C6	2	Tuning gangs. MW/1W VHF	16169	*0·60
C7	1	Pack wire 50 meters assorted colours single strand	16170	0·60
C8	10	Reed switches	16171	*0·60
C9	3	Micro switches	16172	*0·60
C10	15	Assorted pots	16173	0·60
C11	5	Metal jack sockets 3 x 3·5mm 2 x standard switch types	16174	*0·60
C12	30	Paper condensers preferred types mixed values	16175	*0·60
C13	20	Electrolytics trans. types	16176	*0·60
C14	1	Pack assorted hardware—Nuts/bolts, gromets etc.	16177	0·60
C15	5	Mains slide switches ass.	16178	*0·60
C16	20	Assorted tag strips and panels	16179	0·60
C17	15	Assorted control knobs	16180	*0·60
C18	4	Rotary wave change switches	16181	*0·60
C19	2	Relays 6–24V operating	16182	*0·60
C20	1	Pak, copper laminate approx. 200 sq ins	16183	0·60
C21	15	Assorted fuses 100mA—5 amp.	16184	0·60
C22	50	Metres PVC sleeving assorted size and colour	16185	0·60
C23	60	⅓ watt resistors mixed preferred values	16188	*0·60
C24	25	Presets assorted type and value	16186	*0·60
C25	30	Metres stranded wire assorted colours	16187	0·60

SLIDER PAKS

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S2	6	Slider potentiometers, all 470 ohms	16191	*0·60
S3	6	Slider potentiometers, all 10k lin.	16192	*0·60
S4	6	Slider potentiometers, all 22k lin.	16193	*0·60
S5	6	Slider potentiometers, all 47k lin.	16194	*0·60
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MC3	24 miniature ceramic capacitors 3 of each value—470pf, 560pf, 680pf, 820pf, 1000pf, 1500pf, 2200pf & 3300pf	16162	*0·60
MC4	21 miniature ceramic capacitors, 3 of each value—4700pf, 6800pf, ·01uf, ·015uf, ·033uf & ·047uf, ·022uf	16163	*0·60

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74F 50 Flip-Flops assorted 7470-72-73-74-76-104-109 Etc.
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EC3 Values from 100mFD to 680mFD
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C280 CAPACITOR PAK

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R4 60 mixed ⅛w 100Kohms–820Kohms
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R7 40 mixed ½w 10Kohms–82Kohms
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R9 60 mixed ⅛w 1 Meg–10Meg ohms
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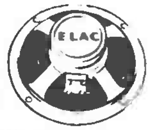

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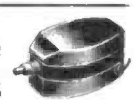

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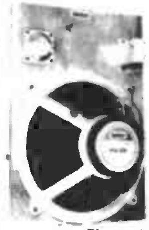

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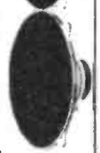

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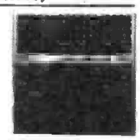

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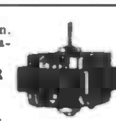

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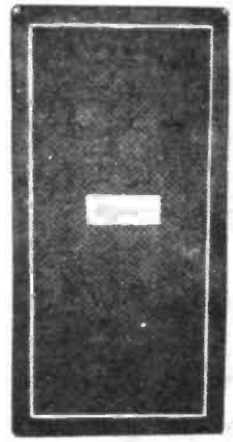

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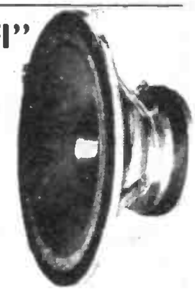

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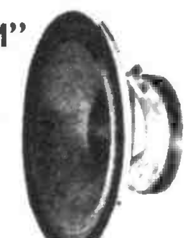

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everyday electronics
PROJECTS. THEORY....

JOINTS AND JOINTS

There is one immediate way to judge the quality of a constructor. Look at his or her joints—the soldered variety. They will speak volumes. But it is not only the external appearance—though this is important. The lustreless, messy and untidy kind of joint is likely to be unsound and unsatisfactory the whole way through—and that's just where it really counts.

No one should be frightened of soldering. Like most things, it requires knack, yet this can be easily acquired by a little patient practice. Soldering techniques have changed of course with the reduction of size of components. And rather more adroitness is demanded than in days of yore.

So those returning to the subject after some years absence as well as those approaching electronics for the first time will find themselves in need of guidance and advice on the art of soldering. A special illustrated feature awaits them within our pages this month.

If an iron has yet to be acquired our Special Offer for a soldering kit will meet this requirement perfectly.

MADE TO MEASURE

If a soldering iron is number one item, a multimeter is a hot contender for second place amongst those essential items to be purchased when taking up constructing. You can't make your own soldering iron, but you can make a multi-tester, as we fully explain in this issue.

Incidentally, this *Multi-Tester* has been designed around components specified for the *Teach-In 76* experiments. So followers of that series will have already in their possession the majority of parts needed. These items can now find a permanent and most worthy home in this useful instrument.

Other readers will have no difficulty in obtaining all required components from retailers advertising in *Everyday Electronics*. By the way, please do mention this magazine when ordering from our advertisers. This helps them, it helps you, and it helps us.

HOME AND DRY

Someone's wife, or mum, is going to be pleased with our *Tumble Dryer Controller*. Just what the doctor ordered for those machines without a built-in humidity sensor/controller. (But not a project for beginners—see article.) Another Special Request and another example of how EE helps you keep up with the times.

And talking of times, right now it is opportune to send greetings to all our readers, from all of us at EE. Happy Christmas and may it be a brighter and more cheerful New Year.

Our February issue will be published on Friday, January 21
See page 35 for details.

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VOL. 6 NO. 1 JANUARY 1977

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

BACK NUMBERS, LETTERS AND BINDERS

We are unable to supply back copies of Everyday Electronics or reprints of articles and cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. An s.a.e. should be enclosed for a personal reply. Letters concerning published articles should be addressed to: The Editor, those concerning advertisements to: The Advertisement Manager, at the address shown opposite.

Binders for volumes 1 to 6 (state which) are available for £2·10, including postage, from Post Sales Department, Lavington House, 25 Lavington St., London SE1 OPF

New Year's Resolution

I will place a regular order for EE with my newsagent.

Tumble Dryer CONTROLLER

By A. J. BASSETT

TUMBLE dryers have in recent years been steadily gaining in popularity as a washday aid in the home, but in many homes there is a tendency to allow the machine to continue working after the clothes are dry enough.

A reader has suggested a "humidity-sniffer" to be placed near to the outlet of the dryer, to sound an audible warning when the relative humidity of the effluent air falls to a predetermined level.

The author has taken this interesting suggestion a stage further with a design which will switch the tumble-dryer off when the effluent air becomes dry enough. By this prompt and direct action the device will save even more electricity than the "audible warning" version, which calls for a human response in order to be effective.

The prototype is furnished with a level control to allow adjustment of the humidity level at which switching off takes place, and by pressing a button the controller can be over-ridden for a short period to enable the tumble dryer to re-start.

The design for the controller described here employs mains and the mains neutral appears on the sensor, which must be placed in the air outlet of the machine. Therefore **not only is it important that the unit is correctly constructed and earthed but it is also very important that the sensor is enclosed in a suitable earthed housing and permanently mounted out of reach.**

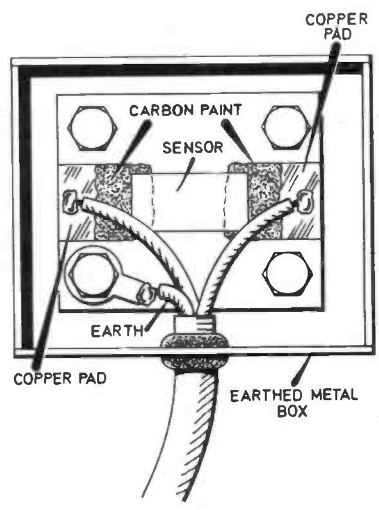
If any constructor is in doubt about any of the above points we would suggest that he leaves this design well alone and chooses instead the Audible Warning Device which is battery powered, more simple, cheaper and which will be published shortly.

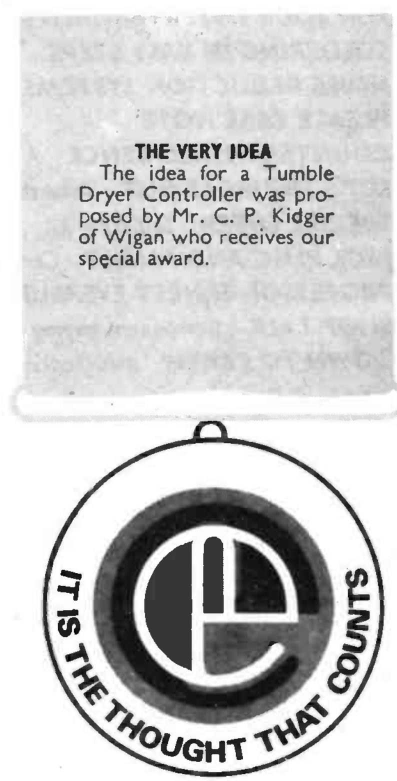
SENSOR

The sensor consists of a piece of thin blotting paper or tissue paper soaked in sea water or a 3 per cent (approx.) solution of sea salt in distilled water or rain-water.

The sensor may be constructed according to Fig. 1. It employs a piece of printed circuit board for mounting the sensor paper, with graphite conducting paint used to make the connections between copper and sensor, to avoid corrosion.

Fig. 1. Sensor construction and mounting.





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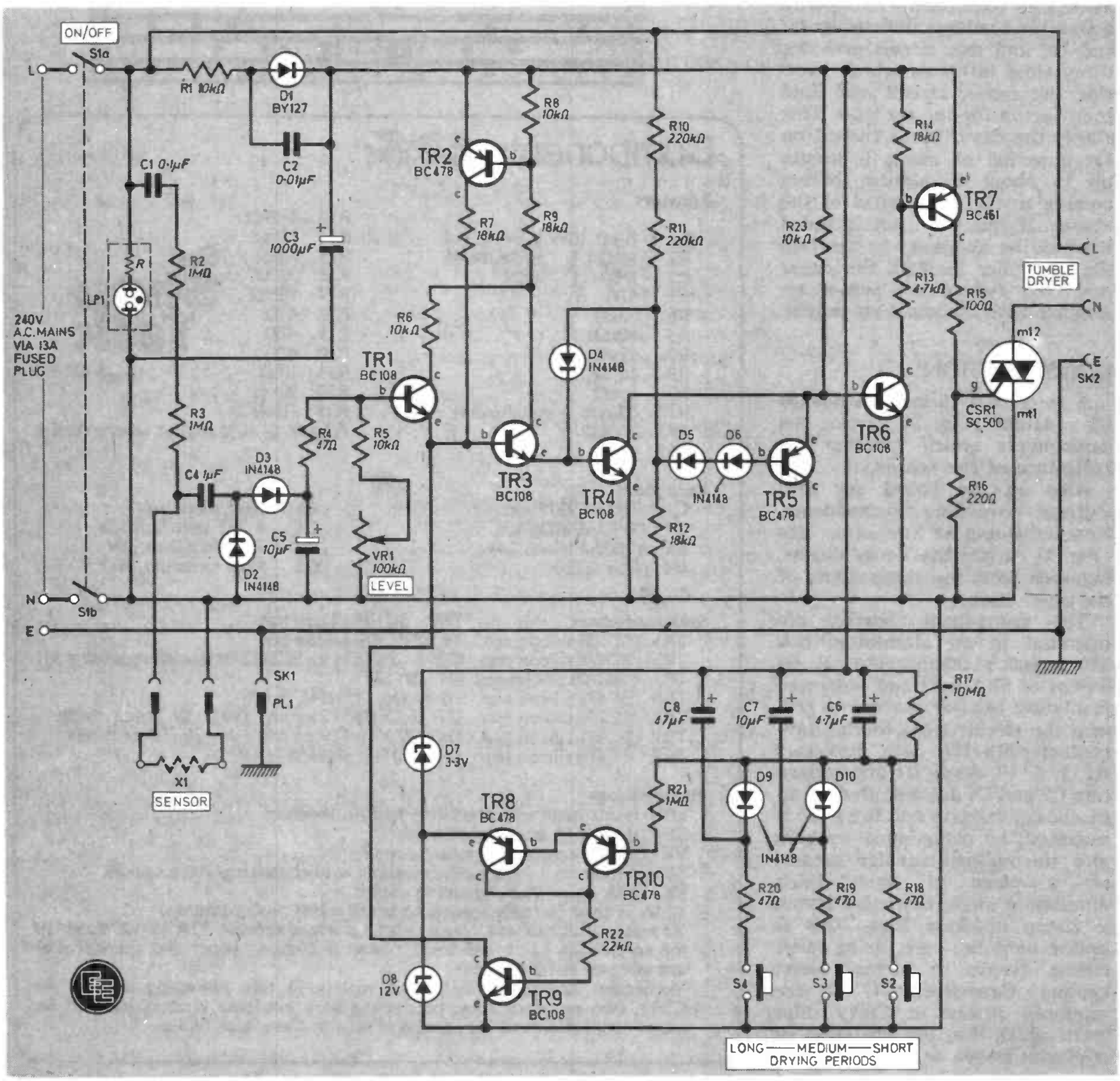
The special paint is made by mixing 1 part varnish, 2 parts thinners with powdered graphite taken, if necessary, from a very soft pencil. This forms a thin paste which when dried is a conductor.

CIRCUIT

When this type of humidity sensor is used we are measuring the electrical resistance of the electrolyte (salt water), and a d.c. measuring circuit would cause problems due to polarisation effects.

To overcome this problem the sensor is placed in a potential divider (R2, R3) which is placed across an a.c. voltage derived from the mains via C1 (Fig. 2). With variation in the resistance of the sensor the voltage across it will vary—rising as the sensor dries out—and this voltage is rectified, smoothed and its level is then sensed by TR1 to TR4 and

Fig. 2. Circuit diagram of the Tumble Dryer Control.



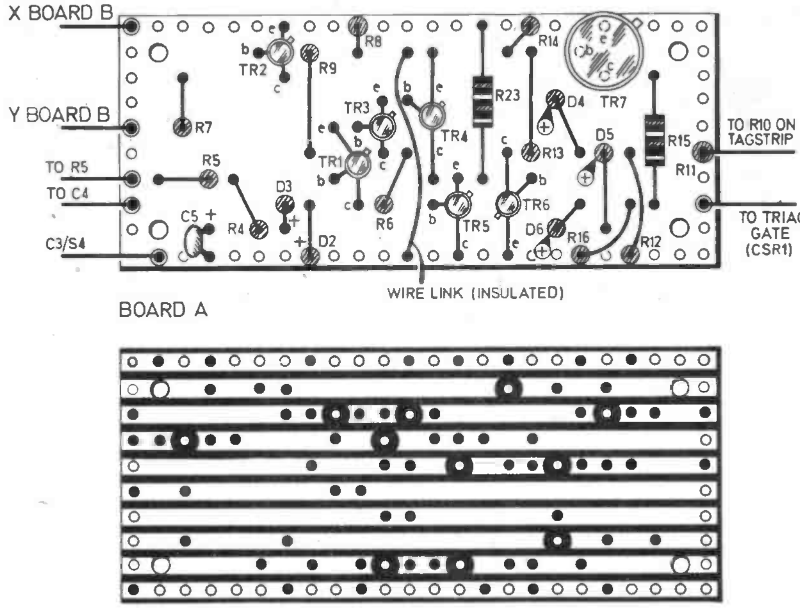


Fig. 3. Layout and wiring of the main circuit board.

used to prevent drive to a triac, when a certain point is reached, via TR6 and TR7. The triac supplies mains voltage to SK2 and hence the dryer. Potentiometer VR1 sets the turn off level.

The circuitry comprising TR5 and associated components is a zero voltage switch, which makes sure triggering of the triac occurs when the mains voltage is at or near zero, thus preventing r.f. radiation and interference problems.

The timing section of the circuit comprising TR8 to TR10 and associated components is fed with a stabilised voltage derived by D7 and D8 and this circuit provides three time intervals which override the sensor circuit and hold the triac on for the set time. This allows the dryer to be turned on for a period of about 1 minute up to about 5 minutes before coming under the control of the sensor. If this were not included it would be necessary to override the controller to start the dryer and thus reduce the sensor resistance with the moist air output.

CONSTRUCTION

A piece of 0·15 inch Veroboard 95 x 41mm (Fig. 3) carries the components which monitor the resistance of the sensor.

Also on the board are zero voltage - switching components. Another board of the same size (Fig. 4) carries the Zener diodes, together with the components of the timer circuit.

The component boards are mounted in an aluminium box 150 x 100 x 50mm (Fig. 5) by means of 6BA nuts and bolts and insulating tubular spacers to prevent the circuit from coming into contact with the case. Resistors R1, 2, 3, 10, diode D1 and capacitors C2 and C4 are mounted on an insulating tagstrip and the triac is mounted, by using mica washers and silicon heat-transfer grease, on a piece of 3mm thick aluminium angle extrusion 50mm x 25mm x 50mm long. This is bolted onto the case, using more silicon grease to further assist cooling. Capacitors C1, C3 are mounted firmly in Terry clips from which they are insulated by a plastic sleeve or p.v.c. tape.

Components

Resistors

R1 10kΩ 10W wirewound
R2 1MΩ } metal oxide
R3 1MΩ } 250V
R4 47Ω
R5 10kΩ
R6 10kΩ
R7 18kΩ
R8 10kΩ
R9 18kΩ
R10 220kΩ } metal oxide
R11 220kΩ } 250V
R12 18kΩ
R13 4·7kΩ
R14 18kΩ
R15 100Ω
R16 220Ω
R17 10MΩ
R18 47Ω
R19 47Ω
R20 47Ω
R21 1MΩ
R22 22kΩ
R23 10kΩ
All ¼W ± 10% except where stated

See **Shop Talk** page 43

Capacitors

C1 0·1μF 300V a.c.
C2 0·01μF 300V a.c.
C3 1000μF elect. 24V
C4 1μF C280
C5 10μF elect. 16V
C6 4·7μF tantalum 35V
C7 10μF tantalum 35V
C8 47μF tantalum 16V

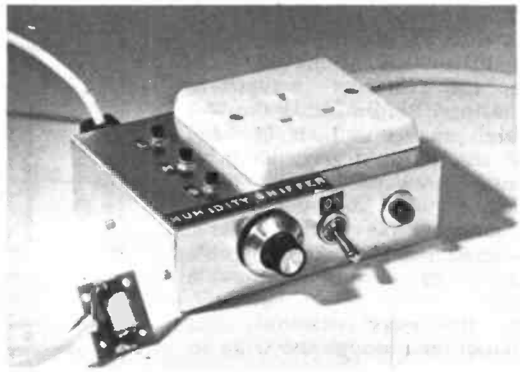
Semiconductors

TR1 BC108 silicon *npn*
TR2 BC478 silicon *pnp*
TR3, 4 BC108 silicon *npn*
TR5 BC478 silicon *pnp*
TR6 BC108 silicon *npn*
TR7 BC461 silicon *pnp*
TR8 BC478 silicon *pnp*
TR9 BC108 silicon *npn*
TR10 BC478 silicon *pnp*
CSR1 2N5574 or SC50D triac with mounting kit
D1 BY127
D2 to D6 1N4148 (5 off)
D7 BZX85-3V3 or any 1W 3·3V Zener diode
D8 BZX61-12V or any 1W 12V Zener diode
D9 to D11 1N4148 (3 off)

Miscellaneous

LP1 mains neon indicator with built-in resistors
S1 d.p.s.t. 15 amp mains switch
VR1 100kΩ carbon lin. potentiometer
SK1 miniature 3 pin mains connector with chassis mounted socket.
SK2 13A mains flush mounting socket
S2 to S4 push to make release to break mains push buttons
X1 materials for sensor, copper clad p.c. board approx. 30 x 25mm, materials for conducting paint (see text), tissue or blotting paper and **sea water** or **sea salt** and distilled water.
Veroboard 92 x 38mm, 0·15 inch matrix (2 off). Mounting bracket for CSR1, two capacitor clips, connecting wire insulated knob mains lead for mains connection and connection of sensor. Case, 6BA fixings.

Tumble Dryer CONTROLLER



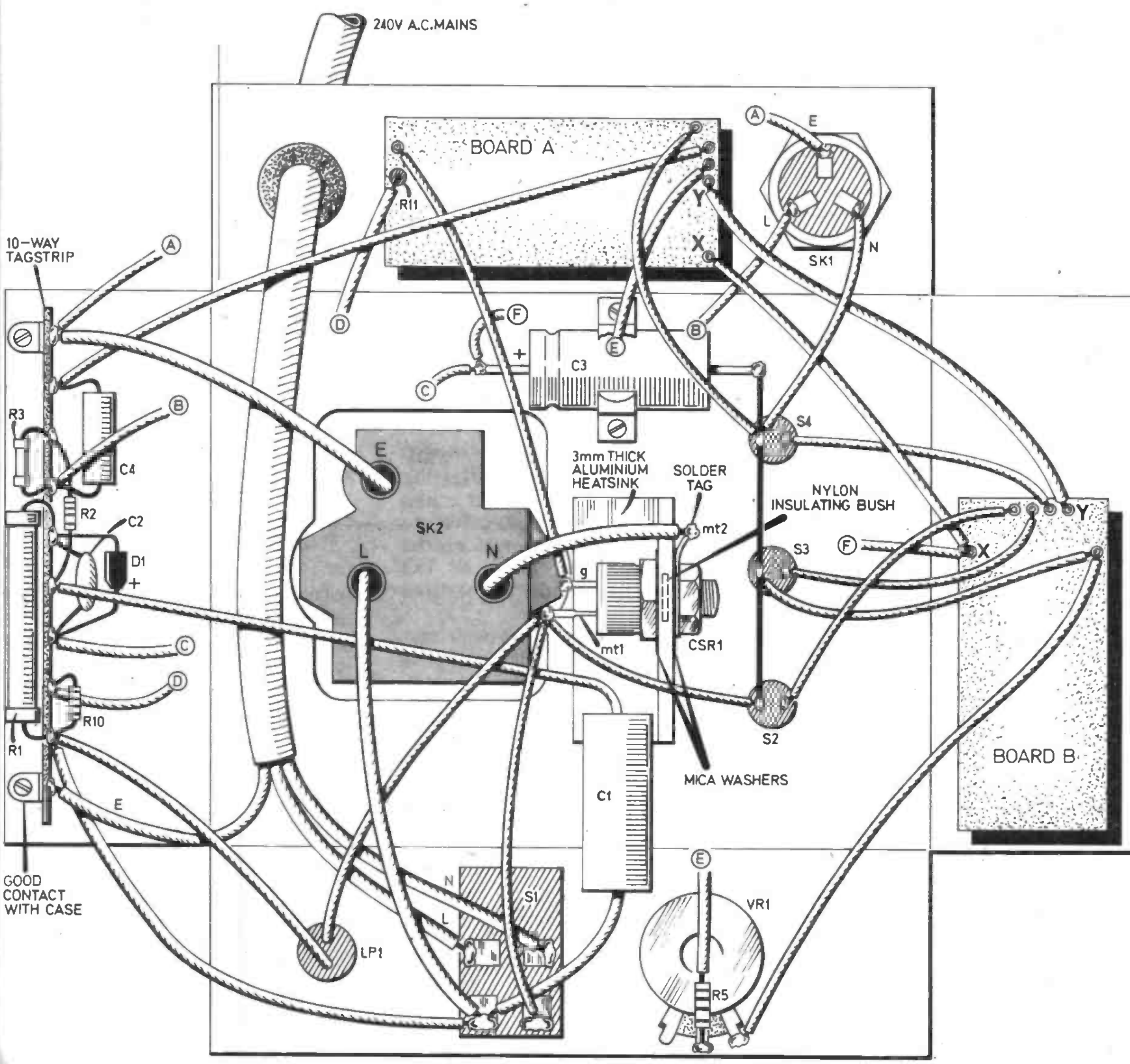


Fig. 5. Layout and wiring of the complete system.

Drill and cut the aluminium box to accommodate the 13A socket SK1, the sensor socket SK2, humidity control VR1, on/off switch S1, the neon indicator, the three push-buttons S2, 3, 4, and the internal component mountings. Before fitting the 13A socket, connect to L, N, E using 13A single cable flex, as it is usually awkward to wire after fitting. Fit the 13A socket, then 3A mains cable using a p.v.c. grommet, and clamping the cable securely by means of a cable clamp.

Fit the other external components, then mount the triac on the aluminium angle, taking care that there are no rough edges to damage the insulating washers, and that the triac stud, case and fixing nut cannot short-circuit to the aluminium. Electrical connection to the triac stud is by a large solder tag fitted on the stud.

Bolt the aluminium angle firmly into place inside the box, and fit the two Veroboard panels, and the tagstrips and other internal components. Wire up according to Fig. 3. The sensor socket is wired up although the sensor is not connected until preliminary tests have been completed.

Check all circuitry and wiring being especially careful to ensure that the earth wire is securely connected to the metal case, and to the 13A socket and sensor socket.

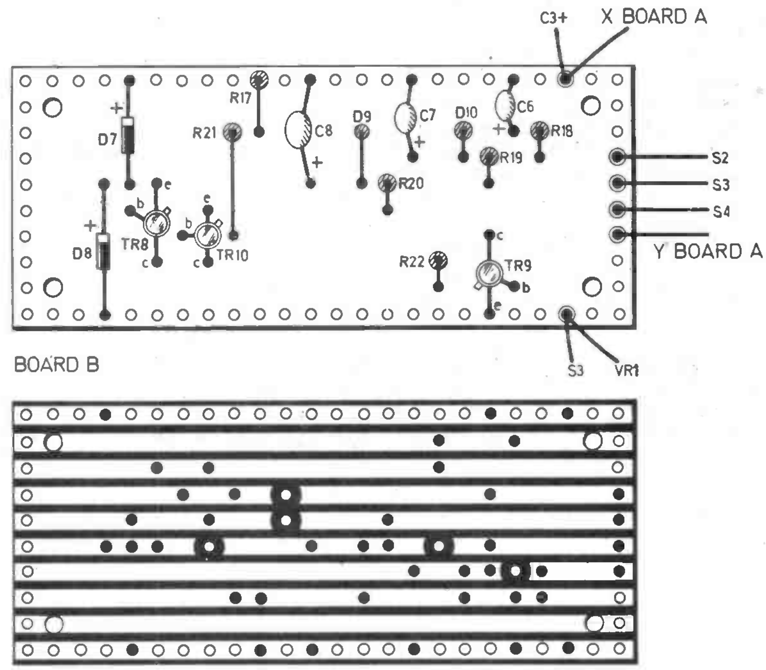


Fig. 4. Layout and wiring of the timer board.

TESTING

When you are sure that it has been wired and built correctly, test the unit, first of all by plugging an electric lamp into the socket using a 3 amp fuse in the plug. Switch on and allow a few seconds for C3 to charge up to working voltage. Set VR1 to maximum resistance and press the short time button S2. The lamp should light and stay on for nearly a minute, then extinguish.

Pressing the other buttons S3, S4 should give a longer period (up to 5 minutes) before the lamp goes out.

Set VR1 to minimum resistance and once again press S2. The lamp should still come on, and go out after about 1 minute. If it does not go out, gradually adjust VR1 until the light goes out, then unplug the unit from the mains. Disconnect one wire from VR1 and measure the combined resistance of VR1 and R5 necessary to cause reliable extinguishing of the lamp. Repace R5 with a resistor of this value or slightly more, and re-connect.

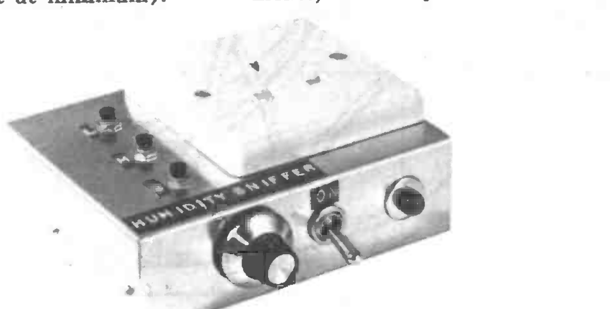
Make up a connecting lead to fit the sensor input socket, using thin mains, 3-core wire, but before fitting sensor to the other end of the lead, fit instead a one megohm variable resistor VR2.

Set VR2 to minimum resistance. Remember when adjusting this potentiometer that **one terminal of it is connected to mains neutral, so it should not be touched, and the body of the potentiometer should be earthed for safety.**

Using an insulated screwdriver, momentarily short the collector (case) of TR9 to the nearby neutral pin on the Veroboard. The lamp should light and remain lit. (If it does not remain lit, VR2 is probably not at minimum).

By adjusting VR2 a point should be found at which the lamp goes out. But by altering VR1 this point will be varied. Confirm that at all the settings of VR1, the lamp can be extinguished by adjusting VR2, and this being so, unplug the unit and replace VR2 with the humidity sensor. The sensor should be mounted in an aluminium container, **which must be earthed for safety.** Small holes drilled over the sensor face will allow it to sense the humidity level.

The unit should now be ready for action, although it may be necessary to use several applications of salt solution to the paper, drying it out between one application and the next before the best response is obtained. **Unplug the sensor when applying salt solution or making any other adjustments,** for safety reasons. ⌑



THIS receiver utilises one of the transparent "snap box" or photo cubical boxes as a case, and the sides and back can be left clear, or filled in with 90×90mm photographs in the way originally intended. Apart from being a novelty in this way, it will provide very good loudspeaker reception, or allow personal listening by plugging a personal earpiece or headphones into the socket fitted.

The receiver is straightforward and employs one integrated circuit and four transistors. As there are no alignment or other adjustments to be made, and headphones can be operated from the i.c. alone, or i.c. and one transistor, it is ideal for a beginner. The circuit can also be tested initially before adding long wave coverage, and this extra waveband can be included at any stage wished.

INTEGRATED CIRCUIT

The integrated circuit is designated IC1, Fig. 1. It has only three leads, and is particularly intended for receivers of this and similar types. It provides radio frequency amplification, detection, and automatic volume control. Input is from the tuned circuit inductors L1/L2, and audio output (lead 1) is sufficient to operate headphones.

The medium wave winding of the ferrite rod aerial is L1, and L2 is the long wave winding. Both these windings have high Q, or provide high efficiency, L1 being Litz wound. Switch section S1 shorts out L2 for m.w. reception. For l.w. reception, L1 and L2 are in series.

For m.w. tuning only, a little simplification can be obtained, if wished, by omitting L2 and connections to S1. The free end of L1 is then taken directly to the frame of VC1; L2 and connections to S1 can be provided at any later date.

An initial test that this part of the circuit is working can be made by connecting medium or high impedance phones to points X-X. Only the tuned circuit, C1, C2, C3 and C4, R1, R2, R3 and R4 need have been wired, with IC1. If all is in order, this will give moderate headphone volume reception of those m.w. stations which are strongly received in the area, plus the BBC transmission on 1500m, if L2 is provided and the receiver is within the coverage of this long wave station.

Resistors R3 and R4 are a potential divider, providing about 1·3V for IC1. It would be possible to take R2 directly to a 1·5V dry cell, instead of using the 9V battery, but this is scarcely worth while in the present receiver.

AUDIO AMPLIFIER

Transistor TR1 is the first audio amplifier, and VR1 the volume control; C6 and R6 are to decouple the collector supply to this stage. Audio signals are normally from C7 to the output pair driver stage TR2.

The operation of TR1 can be checked by connecting the phones from Y to Y. Reception should be as before, but at considerably higher volume — probably too loud for comfort with VR1 at maximum. Should a personal headphone receiver be wanted, leads can be taken from Y-Y to the jack socket, and the remaining stages can be omitted.

DRIVER AND OUTPUT

Transistor TR2 is the driver, and TR3/TR4 the complementary output pair. Direct coupling is used and d.c. feedback from the emitter circuits of TR3/TR4 to the base of TR2 stabilise working conditions.

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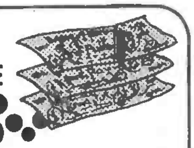


ESTIMATED COST OF COMPONENTS excluding V.A.T.

£10.00

excluding case

This particular circuit requires few components, has a low current consumption, yet can provide ample volume for this kind of receiver, and also operates well with a wide range of output loads. The speaker may be 35 to 80 ohms, the latter being used here, and most headphones or personal earpieces of 30 ohms or

PHOTOCUBE RECEIVER

By F. G. RAYER

A mw/lw receiver that can be built and tested in easy stages making it ideal for the less experienced constructor.

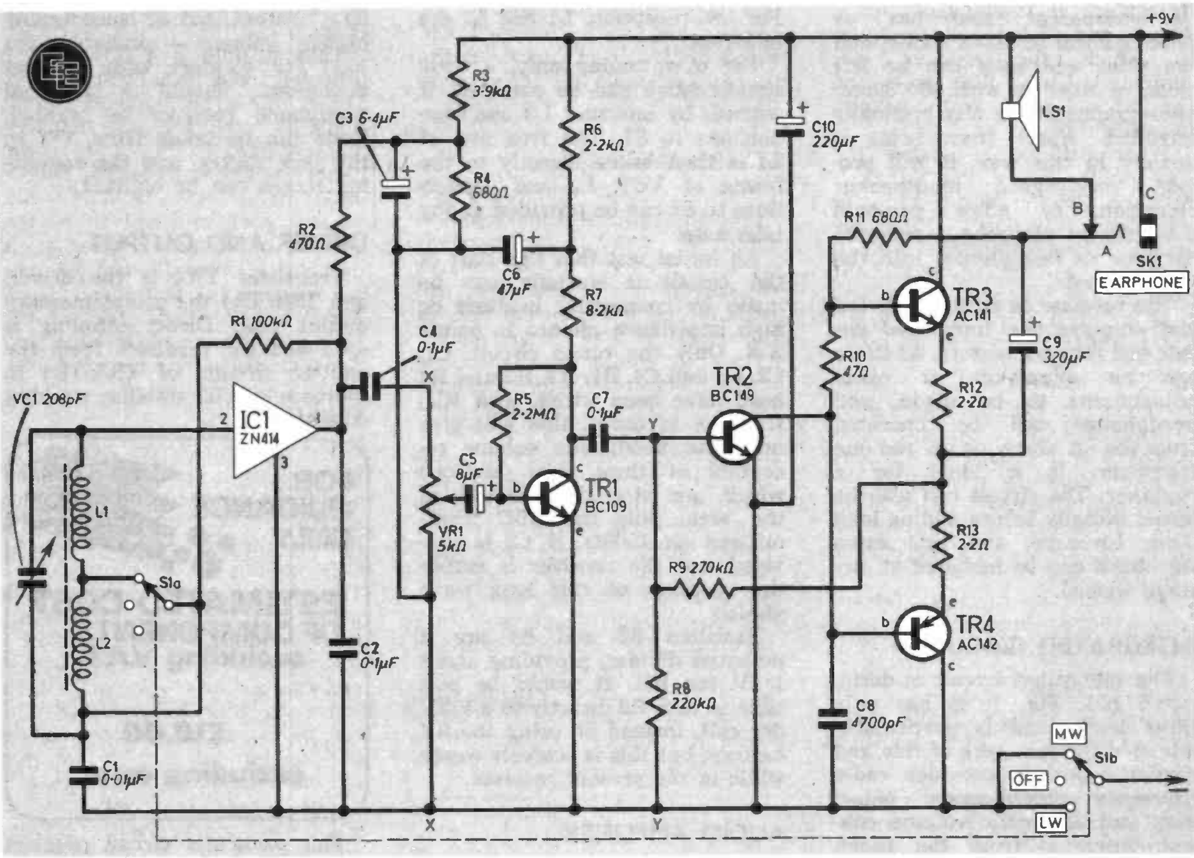


Fig. 1. The circuit diagram of the Photocube Receiver.

more (but **not** crystal earpieces) will be satisfactory.

If the receiver has been tested with phones as described, it is only necessary to add R8 to R13, C8, C9 and C10, with TR2, TR3 and TR4, and the speaker, to complete the receiver.

The output jack is connected so that when a plug is inserted the circuit to the speaker is broken. The shape and construction of jack sockets varies considerably, but it is usually possible to see which tags to use. If not, test with a meter to see that the circuit is from A to B with no plug in, and from A to C (via the phones) with a plug inserted. If phones will never be wanted, wire the speaker directly from C9 positive, to battery positive.

CASE PREPARATION

The box consists of two U-shaped sections, and the receiver is constructed wholly in one. Drills should be sharp, and used with relatively light pressure, at moderate speed, to avoid cracking the plastic material, or melting it so that it clogs the cutting edge.

Tuning capacitor VC1 is centrally placed, about 30mm down from the inside edge of the "panel". With VC1 located as in Fig. 3, mark and drill for the three 4BA bolts which run into the tapped holes of the capacitor. Countersunk headed bolts are most suitable here. They must be short, or cut down or filed, so that they do not project through the front plate and foul the moving plates. Alternatively, washers can be put between the panel and capacitor, provided the spindle projects enough for the tuning knob to fit properly.

Two 10mm holes are needed for VR1 and the switch. If necessary, smaller holes can be carefully enlarged with a reamer or file. Also drill holes for two 6BA bolts, which will secure small angle brackets, Fig. 3.

It is essential to support the panel by resting the *back of the panel* on a piece of wood, or on the work table or bench. Drill matching holes for 6BA bolts in the bottom of the case, also supporting the material as described.

The front (taking the speaker) is then drilled. A grille of 21 holes at 12mm centres, each about 5mm in diametre, was used for the

speaker. The front was backed by a piece of 2mm paxolin, 90×90mm, and with matching holes, to which the speaker was cemented. Three 6BA bolts and the jack outlet secure the paxolin in position.

When drilling is finished the case can be dusted, and the parts fitted. A piece of thin tinted card 90×90mm is cut to fit under the panel. A scale marked 0-10 is drawn on this for tuning, and the volume control is marked, and also the switch, for m.w., off, and l.w. positions.

CIRCUIT BOARD

The circuit board is 90mm high, so that it will fit correctly, and 85mm wide (to clear the paxolin mentioned). It is secured to the small angle brackets at both the top and bottom, and also serves to brace the top and bottom of the box.

A strip of similar material about 16mm wide is cut and fixed at the other side of the case, again with top and bottom brackets. The ferrite rod is secured to this strip, with glued thread passed through small holes.

The circuit board can be wired and then fitted in position, or components can be inserted and wired to the fitted board, as the board "underside" is fully accessible.

BOARD WIRING

Both sides of the board are shown in Fig. 2, and the layout is arranged so that no connections cross each other. In most places the wire ends of components will be long enough to reach, but for the negative line in particular, 22s.w.g. or similar wire is needed.

The electrolytic capacitors have polarity marked, and must be put so that leads come as shown. Bend resistor and capacitor leads over, cut them as required, and solder on the underside of the board. If connections are run approximately as indicated, insulated sleeving is not necessary here.

Leads for IC1 and the other semiconductors can be identified from Fig. 2. The wires are spread so that they cannot touch each other, and are taken down through the holes shown. These joints in particular should not be subjected to prolonged and unnecessary heating when soldering them.

Thin flexible flying leads are provided for external connections. These may be colour coded. Black is used for the negative battery line, to S2. Red is for battery positive, from R3. Yellow leads from C9 positive and battery positive line run to the speaker or output jack socket. A green lead from C1 and R1 passes through the board and is soldered to one of the tags of the *frame* of the tuning capacitor. Connections to VR1 are as shown.

FERRITE ROD

The 125mm ferrite rod has to be reduced to a length of about 85mm (some variation from this length is not important, except that if the rod is too long the case cannot be fitted together). The rod can be shortened by filing a notch or groove in it all round, then holding it securely at this point and tapping the unwanted end sharply with a metal tool.

Thread and adhesive holds the rod to the strip. It is shown out of position in Fig. 3 so that switch connections can be seen.

The tuning capacitor is a 2-gang component, having a front section of 208pF, and rear section of 176pF. This type is used because it is easily available, and L1/L2 are intended to be tuned by 208pF. So the rear section is unused. Fitting a capacitor of different value will not change efficiency, but will of course modify the actual tuning ranges.

Coil L1 has a small coupling winding, not required here, which can be unwound. Coil L2 has a tapping, also not needed, and this can be wound round the tube and secured with a little adhesive.

Place L2 so that its turns are in the same direction as those of L1. Each winding is pushed about 6 to 8mm on from the end of the rod (similar to Fig. 3). As movement of the windings will change the tuning position of stations, they are glued in place.

BATTERY ETC.

A PP6 9 volt battery is most suitable. Take care that the snap connectors are soldered to the receiver leads for correct polarity.

The tuning capacitor has threaded holes, one of which can take a 4BA bolt to secure the two parts of the box together. It

Components

Resistors

R1	100kΩ
R2	470Ω
R3	3·9kΩ
R4	680Ω
R5	2·2MΩ
R6	2·2kΩ
R7	8·2kΩ
R8	220kΩ
R9	270kΩ
R10	47Ω
R11	680Ω
R12	2·2Ω
R13	2·2Ω
VR1	5kΩ log. pot

All ±5% ¼ watt carbon

Capacitors

C1	0·01μF
C2	0·1μF
C3	6·4μF elect. 4V
C4	0·1μF
C5	8μF elect. 4V
C6	47μF elect. 10V
C7	0·1μF
C8	4700pF
C9	320μF elect. 6·4V
C10	220μF elect. 10V
VC1	Jackson 00, 208/176pF (208pF only used) or any variable of approx. 208pF—see text.

Semiconductors

IC1	ZN414 integrated circuit
TR1	BC109 silicon *npn*
TR2	BC149 silicon *npn*
TR3	AC141 silicon *npn*
TR4	AC142 silicon *pnp*

Miscellaneous

L1/L2	Denco MW/LW FR5 ferrite aerial.
S1	2-pole 3-way rotary switch.
	90 mm photocube box
LS1	80Ω 60mm or similar speaker
SK1	3·5mm jack socket (switched)
B1	PP6 battery, with connector
	40mm knob; two small knobs. Veroboard, 0·15 inch matrix plain, 90 x 85mm 4BA and 6BA fixings etc.

SEE SHOP TALK page 43

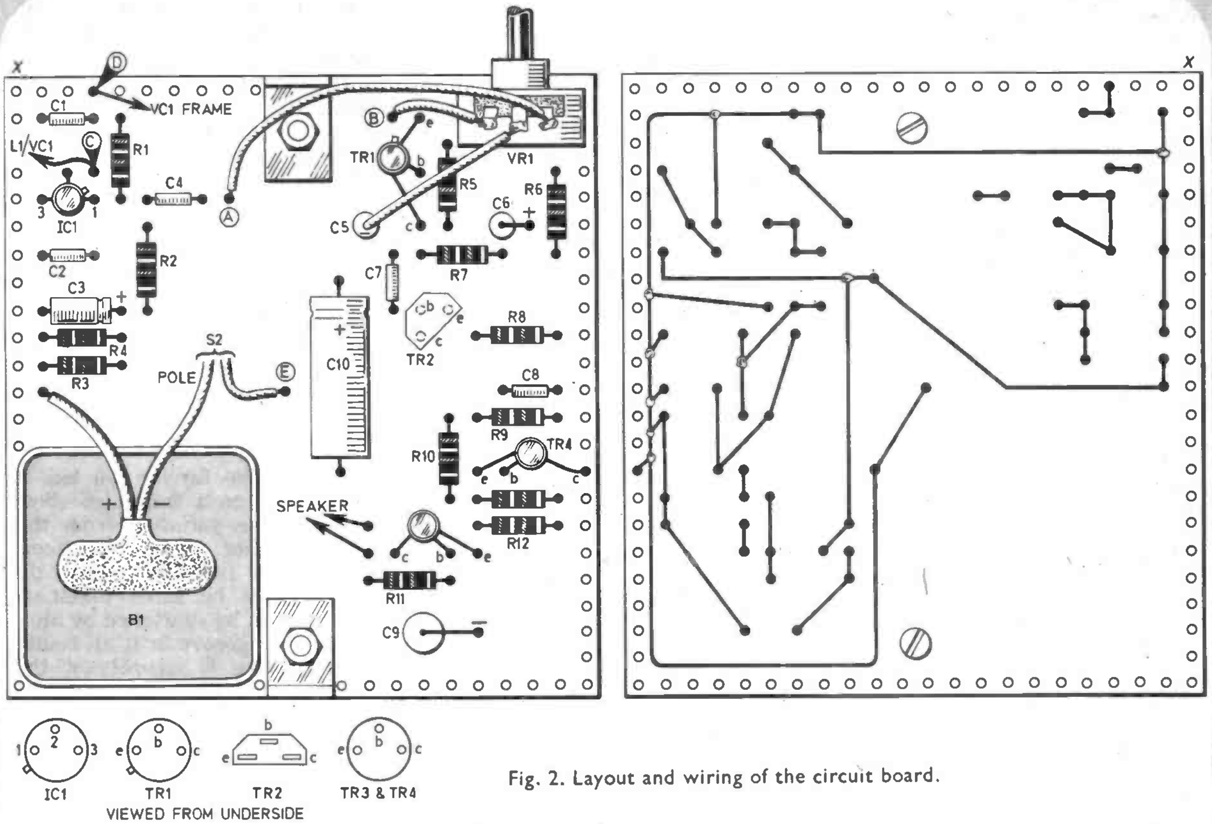


Fig. 2. Layout and wiring of the circuit board.

PHOTOCUBE RECEIVER

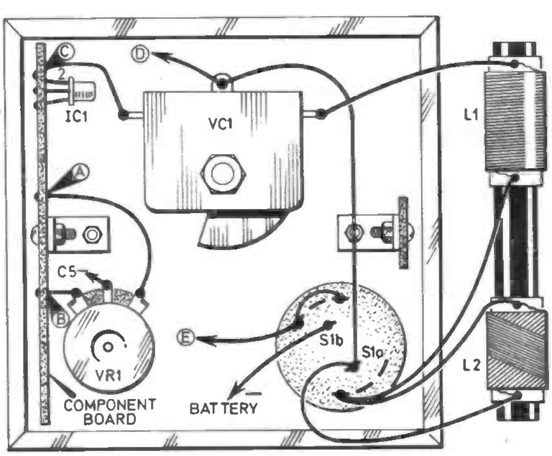
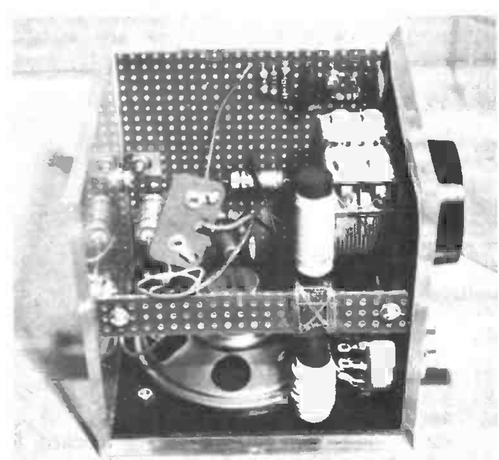


Fig. 3. Connection of the board to the remaining components



should not penetrate beyond the thickness of the capacitor frame.

Occasionally it may be worth while turning the receiver so that the aerial provides best reception or freedom from interference.

NOTE ON COMPONENTS

The 2-pole 3-way switch may be manufactured as a 6-way item with a stop which can be adjusted when the bush nut is removed. Place this for three ways only. If there is any doubt about the tags to use, test with a meter or similar means of showing continuity. Switch S1a is closed in the medium wave position only; S1b is closed except for the central off position.

The switch and VR1 will normally have long spindles. Grip the free end of the spindle in a vice and cut off so that 10mm of spindle remains for the knob.

As usual, electrolytic capacitors can be of higher voltage rating. There is a fair amount of free space, if some components are larger than the original items; C6 could be 50μF; C3 need not be 6·4μF, as 4μF to 10μF is suitable; C5 can be 2μF to 8μF. ⌑

Physics is FUN!

By DERRICK DAINES

Radio Resonance

Resonance is the acoustic or electrical parallel to reverberation. Let me explain. If we set a swing in motion it will swing to and fro until friction brings it to a halt. Similarly, in certain circumstances electricity may —for the sake of simplicity—be thought of as surging backwards and forwards in a circuit rather like bath water sloshing up and down the length of the bath. Similar effects are observable with radio waves.

Take the spark equipment of last month, see Fig. 1. Wind two coils L1 and L2, each of about 35 turns of any thin insulated wire wound flat round the hand giving a flat coil some 80 to 90mm diameter. Hold the coils with Sellotape. Capacitor C1 should be of paper or polystyrene, about 500pF; C2 is also 500pF, but a variable tuning capacitor. Make up the circuit as shown and we are ready to go.

Switch on the battery and obtain a spark across the gap, then shield it with a tin to prevent radio interference as mentioned last month. Lay coil L1 on top of L2 and adjust the variable capacitor until the neon lamp lights. Try moving the coils away from each other. Now unwrap a few turns from one of the coils and it will be found that the neon lamp will go out, necessitating an adjustment of C2 to get it to glow again.

There are a lot of important lessons to be learned from this apparently meaningless experiment. First, both electrodes of the neon lamp glow, clearly indicating that alternating current flows through it. If we disconnect C1, this phenomenon ceases, which proves two things. First, that the a.c. of the last circuit is induced by a.c. of the second; and secondly, that the capacitor C1 is vital to this process.

When a spark is used to close a a circuit, resonance is set up between the coil and capacitor. The period of oscillation (or frequency) depends upon the inductance of the coil and the capacitance C1. If one could observe on an oscilloscope the waveform through the inductance L1 caused by just one spark, one would see not just a simple waveform but a *damped* sinewave, that is, a decaying sinewave as shown in Fig. 2.

Removal of L2 from L1 for some short distance without affecting the glow of the neon lamp indicates the presence of some sort of radio magnetic waves between the two and indeed, as the presence of radio interference shows (mainly on long wave), the section of the circuit containing the spark gap is indeed a radio transmitter. By means of the insertion of a Morse key almost anywhere in this part of the circuit, Morse can be transmitted and read off at the neon.

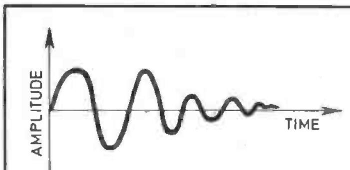


Fig. 2. The damped sinewave.

Finally, consider the role of the variable capacitor C2. The function of this capacitor is to adjust the tuning of the resonant circuit of the final stage to match the resonance of L1/C1. In short, of the three stages of the circuit of Fig. 1, the first stage is the power-pack, the middle stage is the transmitter and the last section is the receiver.

Altogether, the circuit is a most valuable piece of equipment for the understanding and study of radio, and for those readers who would like to make up this gadget for regular use but who are worried about interference on local radio receivers, let me add that the addition of a small capacitor across the spark gap will obviate this problem entirely.

It is impossible to give an exact value, but I suggest experiments starting with 0·047μF and working downwards.

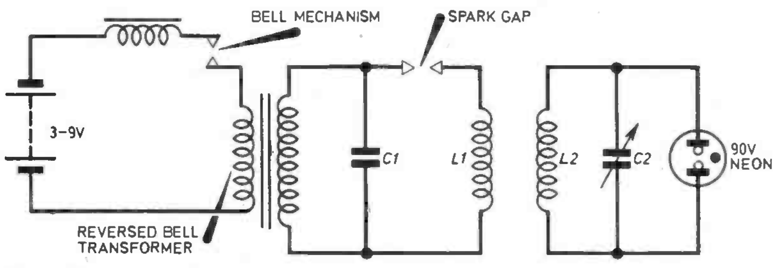
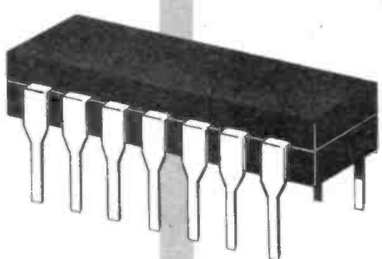


Fig. 1. The circuit of the spark equipment.

Doing it Digitally...

PART 4



By O.N. Bishop

HAVING LOOKED at integrated circuits containing simple two-input gates in previous parts of this series, we now go on to more complex integrated circuits, looking in particular at the dual J-K flip-flop i.c., type 7473.

THE FLIP-FLOP

A flip-flop is a bistable with several control inputs. The changes of state of the J-K bistable are controlled by three types of control signal:

1) **CLOCK** The bistable can only change state when its clock input changes from a high to low.

2) **J, K** By setting each of these inputs to either high or low, four outcomes are possible when the clock pulse occurs. The bistable can be made to:
   a) Stay in the same state
   b) Go low
   c) Go high
   d) Reverse state

3) **CLEAR** Irrespective of the clock, this input sets the Q output low.

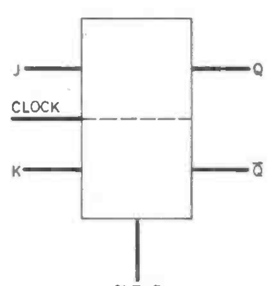


Fig. 4.1. Symbol for the J-K flip flop.

The 7473 integrated circuit contains two J-K flip-flops. The symbol for the J-K flip-flop is shown in Fig. 4.1 and the pin connections of the i.c. in Fig. 4.2. Note that outputs are provided from both halves of the bistable, these being designated Q and Q̄, the bar over the second output indicating that it is the inverse of the former.

The symbol for the flip-flop does not indicate the complexity of the actual circuitry: a total of 22 transistors and 20 resistors are used to make each, and there are two of these for the price of about five cheap transistors.

EXPERIMENTS WITH FLIP-FLOPS

The 7473 i.c. has its power

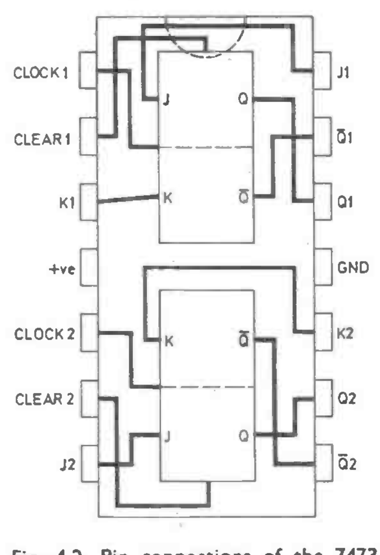


Fig. 4.2. Pin connections of the 7473 integrated circuit.

supply connections made to pins 4 and 11 so make sure that this is remembered when using the i.c.

As a start, the i.c. should be put in the top left position on the experimental board and wired up as shown in Fig. 4.3.

In part 3 we saw how the 7400 i.c. can be made into a "clock" or pulse generator and this circuit is just what is needed to drive the clock input of the 7473. Connect up the 7400 i.c. as a clock using the circuit of Fig. 3.11 with 470μF capacitors to give a slow frequency. Connect up the output from the clock (pin 3, 7400) to pin 1 of the 7473.

It is not essential to use the electronic clock input, connecting the clock input wire alternately to ground and 6V will do just as well (see section on "contact bounce").

At this point the J and K input wires should be left free. Now try all possible variations of J and K inputs clocking the bistable after each change. Make up a Truth Table showing the state of the Q output before and after the clock pulse with all the different J-K inputs. Table 4.1 is how it should appear.

One important point to note is that if the J or K, or both inputs are allowed to go high while the clock is high, this will count as a high input when the clock next goes low, even if the input is put back to low before then.

Which setting of the J and K inputs always makes the flip-flop change state? Which makes it always stay the same?

If during the experiments it is necessary to make the Q output low, touch the clear wire (from pin 2) to ground.

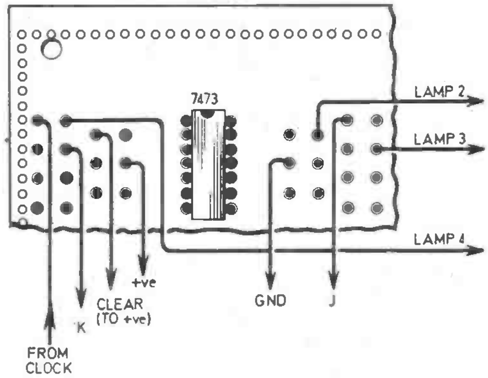


Fig. 4.3. Wiring of one flip-flop on the circuit board.

FLIP-FLOPS IN COMBINATION

So far the second flip-flop in the 7473 i.c. has not been used but this state of affairs will now be rectified.

The circuit of Fig. 4.4 shows how to wire the i.c. Again the electronic clock circuit is a useful addition.

In this circuit both J inputs, both K inputs and both clears are too high so the flip-flops will change state whenever the clock input goes low.

Flip-flop 1 is fed from the clock and its Q output is fed to the clock input of flip-flop 2. The three lamps indicate the state of the clock, the state of flip-flop 1 and the state of flip-flop 2 respectively. Switch on and see what happens.

Wait till all the lamps are out then begin to record the sequence. Table 4.2 shows what will be recorded.

Rewrite the table using a 0 in place of an L and a 1 in place of an H. It will be seen that the outputs indicate the binary numbers from 0 (000) to 7 (111) in ascending order. In other words the circuit is counting from 0 to 7!

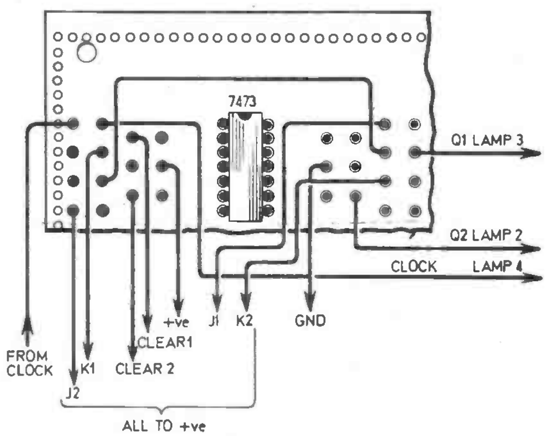


Fig. 4.4. Wiring of both flip-flops in the 7473.

Table 4.1: Truth Table of J-K flip-flop operation

Before clock goes low Inputs		Output	After clock goes low Output
J	K	Q	Q
L	L	L	L
L	L	H	H
L	H	L	L
L	H	H	L
H	L	L	H
H	L	H	H
H	H	L	H
H	H	H	L

In the experimental circuit the clock pulses were obtained from another i.c. connected as a pulse generator but, in fact, the pulses could be derived in other ways. For instance if a light sensitive switch were connected across a doorway in such a way as to produce a clock pulse each time a light beam was broken, then the counting circuit would keep a record of the number of times the beam was broken.

Table 4.2: Lamp sequence in Fig. 4.5

Lamp 2	Lamp 3	Lamp 4
L	L	L
L	L	H
L	H	L
L	H	H
H	L	L
H	L	H
H	H	L
H	H	H

HIGHER FREQUENCIES

Reconnect the circuit of Fig. 4.4 but instead of using large capacitors in the clock generator, use 0·1μF capacitors to give a clock frequency of several hundred pulses per second (hertz). Can the flip-flops count these fast pulses? It is a bit hard to tell by looking at the lamps as they flash too quickly, but here again we can use an earphone (or the loudspeaker unit of Part 3) to see what is going on.

Connect the earphone or loudspeaker unit to the clock, flip-flop 1 and flip-flop 2 outputs in turn.

The output from flip-flop 1 is a note an octave lower than (i.e. half the frequency of) the note from the clock and the output from flip-flop 2 an octave lower again. Thus the flip-flops are dealing well with the high frequency pulses.

This sort of circuit finds use in electronic pianos or organs where a master clock (or oscillator as we call it) produces a note of the required frequency (say the highest G on a piano) and the G's for all the octaves below it are produced by a series of flip-flops, the frequency being divided by two at each stage.

Thus a series of flip-flops can act as either a counter or a frequency divider.

The second flip-flop changes state after every fourth clock pulse so two flip-flops can divide by four. To count larger numbers or divide by larger numbers more flip-flops can be connected. There are some i.c.s available which have four flip-flops in cascade thus enabling counts up to 16 or division by 16 to be achieved. Other integrated circuits are available with as many as 14 flip-flops in a single package enabling counts of 16,384 to be carried out.

CONTACT BOUNCE

There is a problem which might have occurred if the clock input to the flip-flop was made by touching the wire alternately to ground and 6V, which can be identified by erratic jumps in the sequence.

The electronic clock produces "clean" pulses with sharp transitions between states but touching the wire to a voltage rail or even using a mechanical switch produces what is called "contact bounce" where, instead of a high-low transition, a high-low-high-low-high-low transition may be produced. When fed to the clock input of the flip-flop, these transitions are interpreted as a series of pulses which, because they are very rapid, cause the flip-flops to jump several counts in the sequence.

To operate counting chains of flip-flops, the clock pulses must have a clean change from high to low, so if a mechanical switch must be used a "cleaning up" circuit must be placed between it and the flip-flops. This will be described in a later section.

To be continued

Soldering

I am a regular reader of EVERYDAY ELECTRONICS and am re-soldering a project in which I think there may be one or two dry joints. Two problems have arisen.

Firstly, I find that when I try to remove the iron from a joint solder sticks to the bit and leaves solder sticking up in points. Please could you tell why this is and how it can be avoided.

Secondly, is it possible that flux from solder could cause a bridge on Veroboard or is flux a good insulator.

N. Staunton
Taunton.

Providing your iron is reaching the correct temperature, the first problem is caused by the lack of flux, you should always use new solder even when resoldering as a dry joint is caused if all the flux is burnt off before the iron is removed (see page 24). Flux is a good insulator but is best cleaned off as it may hide a solder bridge.

Symbols

I am a beginner when it comes to i.c.s and was pleased to see a Series started on them in E.E.

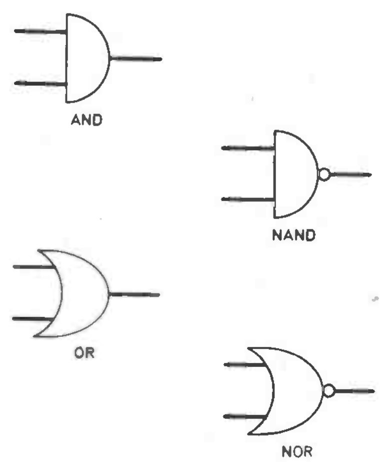
Having just received November's issue I feel as though I've taken a step backward, because of the way the OR gate is drawn on page 601.

My company have issued a booklet showing signs and symbols for components, and gates are as follows.

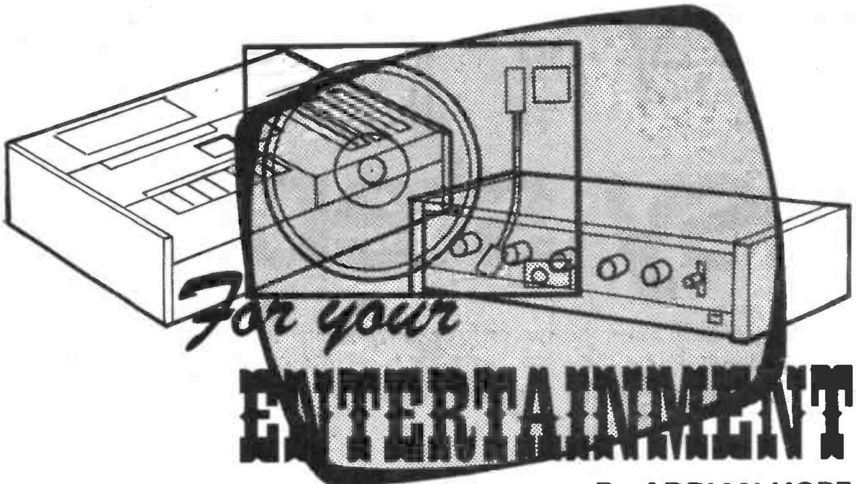
Could you please state who is right, if anyone or does it matter?

Thanks for a very helpful magazine.

L. Miller,
Oldham.



The symbols you show are to the MIL STD 806B specification which is an American spec. used by some i.c. manufacturers. Our symbols for the gates you show are in accordance with BS 3939 section 21 which is the relevant British standard specification. Maybe you work for an American company?



For your ENTERTAINMENT

By ADRIAN HOPE

Sometimes in technology the tail wags the dog. In other words, we are left looking for applications for new developments. This can produce some quite daft examples of over-sophistication. Recently one project feature in a mazagine detailed the design and circuitry for a car burglar alarm. All manner of transistor switching devices are hooked up to the simple microswitch which is normally used automatically to switch on the car interior light whenever the car door is opened so that an alarm sounds whenever the car door is opened.

A self-hold relay, triggered by the switching transistors, stays "on" even when the microswitch is opened again, so that closure of the car door can't stop the alarm. But wait a minute, wouldn't it be easier just to use the self-hold relay in direct connection with the door microswitch, without all those intermediate transistors?

Thermistor

Its also easy, with all the solid-state sophistication now available, to forget about the existence of a handy little gadget called a thermistor or brimistor. These were developed many years ago to protect sensitive circuitry, for instance in TV sets, from the high current surges which usually result when any system is switched on from cold.

A thermistor is a small rod device, looking like an ordinary resistor, which has a high resistance when cold and a much lower resistance when hot. And it is intended to get hot in use. Thus, if it is placed in series with a component that needs protection from a current surge, it very conveniently lets only a small amount of current through to begin with and then an increasing amount of current as it heats up.

The bright idea dawned a while back of using thermistors in series with projector lamps, which can have their working life dramatically extended if protected from switch-on current surges. Remember that projector lamps are expensive beasts which, when cold, have a resistance of only about 1/20th their resistance when hot, and can be subjected to instantaneous current flows of well over ten times their normal operating current. This is why most lamps usually blow at the moment of switch-on.

For a while many people used thermistors in series with expensive lamps, but now all that seems to have been forgotten and the thyristor has taken over—with all its attendant problems of radio and audio interference.

Availability

For the benefit of anyone wanting to take the simple way out, I checked up on the current availability of thermistors. ITT Components still make a full range (all referenced CZ), and ITT confirm that these cheap and useful little gadgets can (if your normal component supplier can't help) be obtained through their distributor, Nobel Electronics, Nobel House, Bowater Road, London SE18 5TN.

All you do is select a thermistor of the correct rating (e.g. a CZ-12 for 500 watt lamp with 200-250 volt supply; a CZ-11 for a 300-watt lamp and similar supply voltage, and so on), and wire it in series. Take care to leave plenty of air space round the thermistor because it has an operating body temperature of up to 250 degrees C. A good idea is to put a by-pass switch across the thermistor to short it out of the circuit once the lamp has warmed up, the surge is over and the thermistor's job is done. One word of warning, however. As learned years ago the hard way, thermistors are: essentially current conscious devices and need to be in series with a fairly high resistance to achieve working equilibrium without burning out. If your projector lamp runs at mains voltage without a transformer, there is no problem, because the current flow is relatively small. But they should not be used in direct series connection with a low-voltage, high-wattage lamp on the secondary side of a transformer, as the current flow will be too great. Thus if the projector incorporates a mains transformer which drops the voltage, for instance to 12 or 24 volts, you should use the thermistor in series with a transformer primary.

This point has been widely overlooked, for instance by at least one photographic manual, obviously written by someone who had never actually used a thermistor.

Calculator Batteries

London readers may have noticed large spreads in their newspapers advertising the new Ever-Ready calculator batteries. The reason these adverts are initially appearing only in London is that the batteries are so far only being test-marketed, and whether they are sold more widely will depend entirely on London's reaction.

The IEC has drawn up provisional suggestions for the ideal battery to use in a calculator, and have based this on an assumption that most calculators are used for around 30 minutes a day and require more current than a radio but less than a shaver. This means that none of the ordinary cheap Leclanche batteries currently on sale fit the bill.

So Ever-Ready is test-marketing a modified Leclanche to fill the gap. The new batteries cost around a third as much again compared with conventional "blue" radio equivalents, but should be up to 100 per cent cheaper (in terms of pennies per useful hour) than the expensive alkali-manganese types that many people now buy for their calculators.

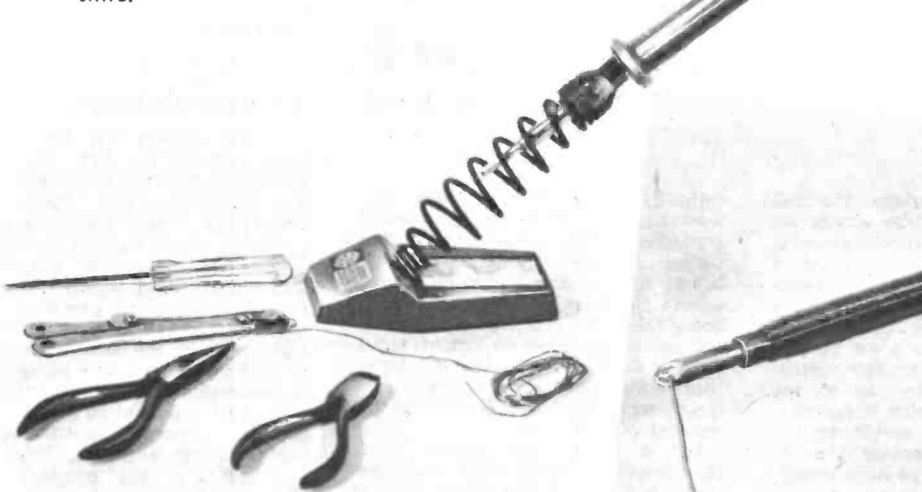
Warning!

But one word of warning; Ever-Ready readily acknowledge that, being Leclanche's, these new calculator batteries will very probably leak if left unused in a calculator for a matter of months (or for that matter destructively drained by a calculator being left on overnight). As Ever-Ready sum up the situation—"With batteries, it is horses for courses, and when you buy you must always choose between use and storage".

Personally, as someone who has several times ruined equipment by leaving leak-prone Leclanche batteries inside for too long or inadvertantly draining them too fast, I would no more use Leclanche's in expensive electronic gear than bathe it in sea water.

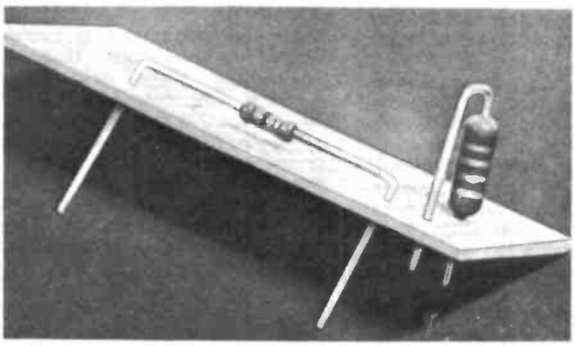
SOLDERING in easy steps

It is a fact—if you cannot solder you will never be successful in this hobby. Follow our sequence carefully then practice making joints until you can achieve a good result every time.

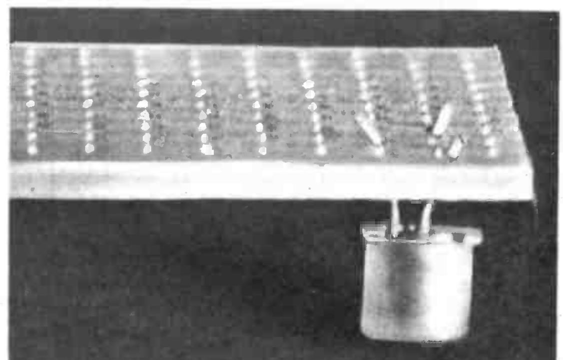


1 You will need a lightweight soldering iron with a 3 to 5mm bit, some flux cored solder and a few general tools.

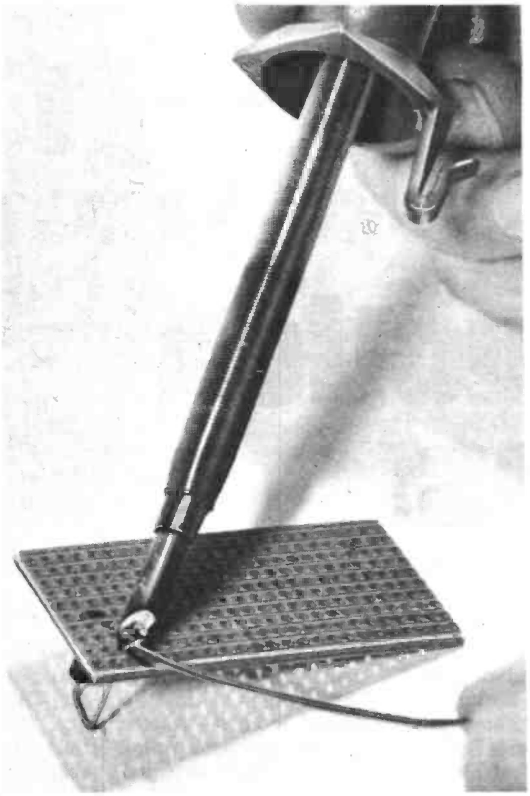
2 The iron should be at the correct temperature, it should melt the solder easily without causing the flux to spit violently, and should always carry a small amount of solder.



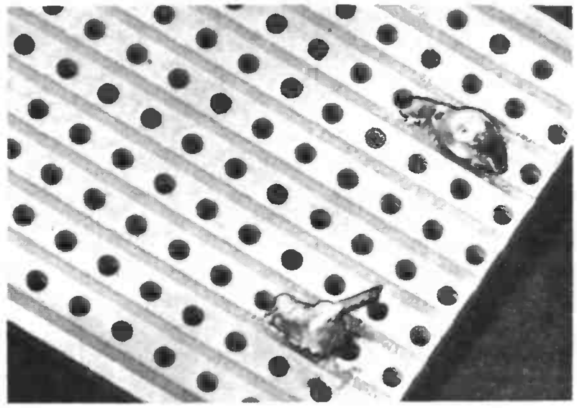
3 Two methods of component mounting on Veroboard. Bend the leads down in line with the strips and cut off leaving about 2 to 3mm.



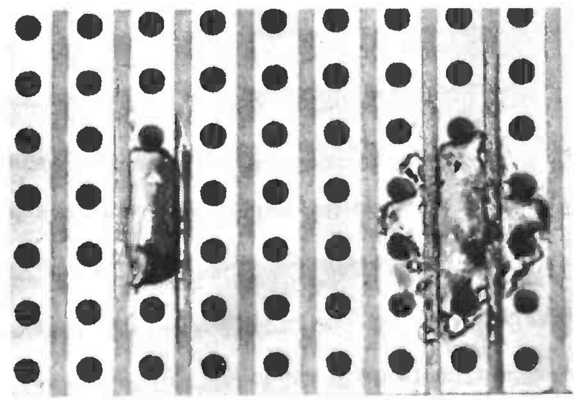
4 Transistors are easier to remove later if their leads are only slightly bent over. Be careful not to overheat them when soldering.



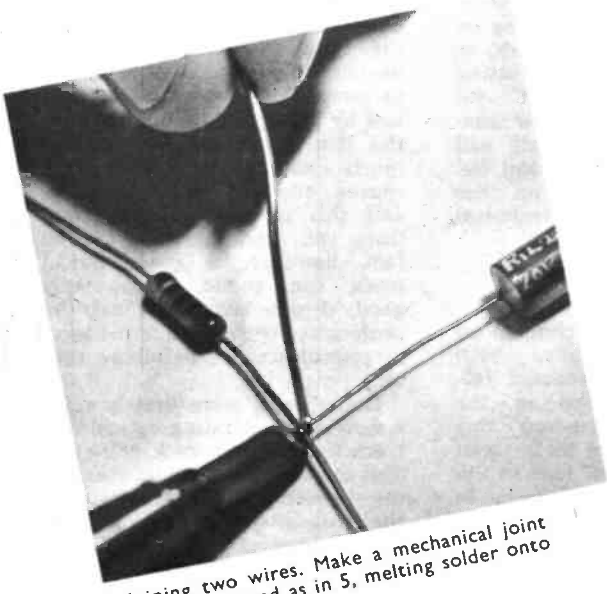
5 Making the joint. Melt a small amount of solder onto the joint, *not onto the iron*, wait just long enough for it to run evenly over the whole area then remove the iron.



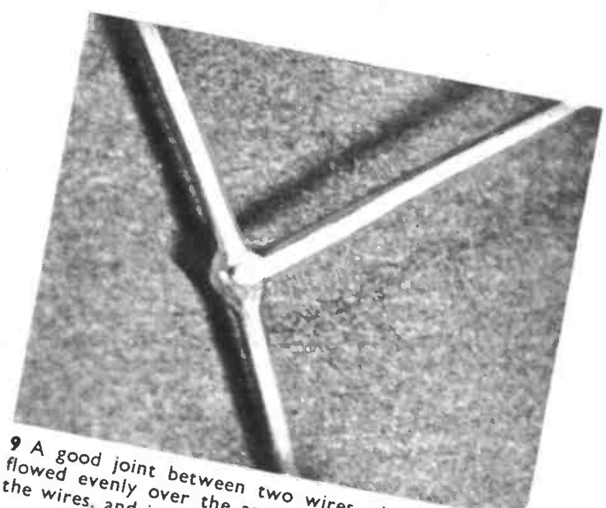
6 Two poor joints. In the upper one the solder has formed a blob on top of the copper and not run evenly over it. In the other the wire was not bent down, or cut short enough.



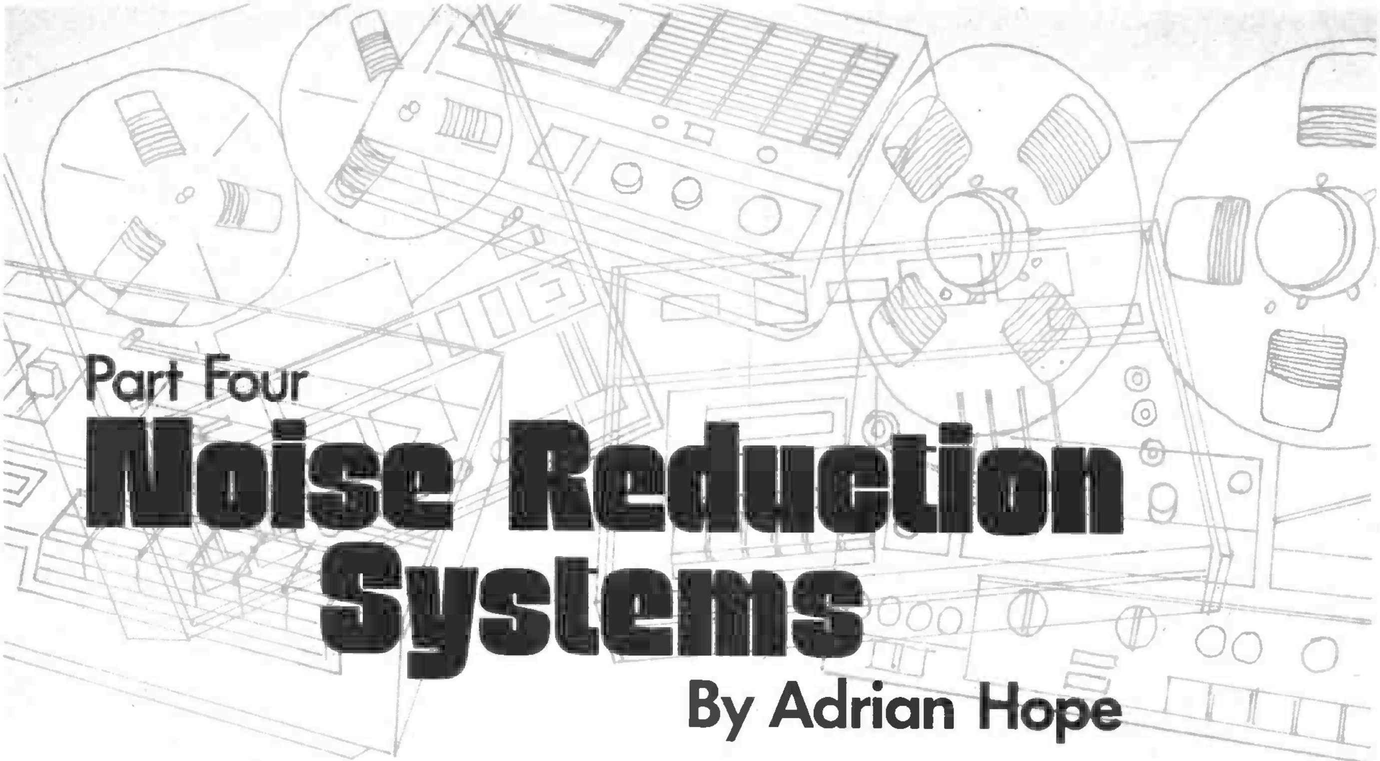
7 On the left how a good joint should look. On the right a mess made by using too much solder and keeping the iron on too long, burning off all the flux.



8 Joining two wires. Make a mechanical joint first then proceed as in 5, melting solder onto the wires *not the iron*.



9 A good joint between two wires, the solder has flowed evenly over the area, but not too far along the wires, and is clean and bright.



Part Four

Noise Reduction Systems

By Adrian Hope

WE conclude this short series by looking briefly at the availability of the final two systems and at some other areas.

BURWEN

At the time of writing, there is no sign of any Burwen equipment on the domestic market, and *dbx* is still largely an unknown quantity.

As a guide, however, on the professional level there is no doubt that *dbx* is regarded by European studios as an addition to Dolby rather than an alternative; it would be commercial suicide for any recording studio to offer *dbx* but no Dolby. But, on the other hand, some record producers would prefer to use *dbx* rather than Dolby if the possibility exists.

Mike Oldfield, for instance, recorded the LP *Ommadawn* using the *dbx* system, and the only time that Dolby master tapes of this recording were produced was when the need arose to send them abroad to studios equipped only with Dolby. Also *dbx* is often found in studios handling master tapes recorded, or partly recorded, in the USA.

On the domestic level, it is likely that some tape machines from Japan will soon be incorporating *dbx* 120 circuitry as an integrated feature, in the manner that many machines now incorporate Dolby B. It is to be hoped, however, that such machines will incorporate both *dbx* and Dolby, rather than *dbx* instead of Dolby, because a Dolbyised tape replayed on a *dbx* machine or *vice versa* will produce decidedly odd results.

Whether *dbx* add-on units (either the 120 series, for encoding on "record" and decoding on "playback" or decoding discs; or the 110 series, for compressing and expanding on "record" and "playback" or expanding or compressing existing material) will succeed commercially in the UK must depend largely on the economic climate and technical reviews in the audio press.

CINEMA SOUND

What of future technological developments? Already, both Dolby and *dbx* professional formats are being used in the cinema. Dolby pioneered this work and it remains to be seen whether their current lead in the field is maintained. (There is in fact already a *dbx* version of the film *Tommy* showing abroad.)

The train of thought linking Dolby to the cinema is logical once it has been explained. In the early days of the professional cinema, it was soon recognised that optical soundtracks were noisy, due to the presence of optical grain on the track and to the ravages of dust and dirt. This noise is hiss which since the thirties has been rolled off according to the so-called Academy Curve.

The curve quite simply takes an axe to all the upper frequencies and in an effort to compensate for the dullness which results, engineers started using equalisation techniques to boost the high frequency content heavily. The idea, as always, was to compensate for what would be lost by putting too much there in the first place. But putting too much sound on an optical track causes clipping and distortion, and this is why a bad optical track can sound terrible. (To be fair, however, a good optical track can sound astoundingly good, if one bears in mind the problems involved in equalising to counteract the Academy roll-off.)

Dolby Labs. were first to offer a system for encoding optical film track to cut down track noise and thus enable engineers to abandon the Academy roll-off and with it the excessive equalisation techniques. Several films with Dolbyised optical tracks have now been produced and released (some in stereo) and the results are impressive.

The frequency range is much wider than has been conventional for cinemas but there is as little, or less, background hiss than with the Academy curve and the wider frequency range makes for crisper, cleaner dialogue, music and effects. At the time of writing there has been no opportunity in this country of hearing a rival system, whereby several tracks are recorded optically, using a hue-modulated system.

BROADCAST

In the area of broadcast, *dbx* have their broadcast encoder, but there are no signs of any move towards *dbx*-encoded broadcasting in Europe, and there are certainly no receivers with the necessary decoder built in. It is more likely that, if noise reduction broadcasting is ever adopted in Europe, it will centre round another clever idea put forward by Dolby Laboratories and adopted by more than a hundred USA radio stations to date.

The proposal is that FM broadcasts should be Dolby B-encoded at transmission, but with modified pre-emphasis of the broadcast signal. If this signal is received on a set which is equipped both with Dolby B decoding facility *and* circuitry adapted to de-emphasise the signal in mirror image fashion to the modified pre-emphasis, then the listener will hear the full benefit of noise reduction.

If, however, the signal is received on a conventional set which has neither Dolby B *nor* modified de-emphasis facilities, then the "wrongness' of the undecoded signal will compensate for the "wrongness" of the incorrect de-emphasis offered by the set. The result of this compensation is claimed to be an overall return to normality, with improved reception over a wider area as a by-product of the higher modulation levels made possible by the modifications of the transmission with respect to conventional transmissions.

In other words, the system is claimed to be compatible, providing improved results for those with facilities to obtain them and no change for the worse for those with no inclination to go out and buy new equipment. Whether the system works as claimed is still open to argument, because neither the IBA nor the BBC will yet countenance even experimental broadcasts in this country to test the system.

However, experience in the USA and some tests carried out in Europe, unbeknown to the listening public, suggest that if problems do exist they are not noticeable to the majority of listeners.

COMPATIBILITY

This point on compatibility neatly sums up the main reason why Dolby has so far succeeded where others have failed. Although the Dolby B system has been criticised for the relatively limited amount of noise reduction that it offers, it has the overriding advantages of being inaudible in action and generally compatible.

If a Dolby-encoded tape is replayed without decoding, it will not sound unduly objectionable. Indeed because Dolby-encoding involves artificial boosting of low level high frequencies, when replay is on a cheap non-Dolby machine (which almost by definition has poor high frequency response), the unnatural brightness of the encoded recording will be an advantage rather than a disadvantage. Moreover, any listener who finds the resultant sound slightly too bright can always turn back the treble tone control of his machine, thereby trimming the top frequencies to restore a more natural sound and in so doing reduce hiss noise.

Although the future is an open book, the past is a closed book. It is already written that the advent of Dolby B as a compatible noise reduction system provided massive impetus to the cassette as a domestic recording medium. On the professional level it is already written that the advent of Dolby A made it possible for recording studios to cram 16, 24, and even 32 separate tracks of recorded sound on a single piece of 2-inch tape, and thereby opened up all the possibilities of modern multitrack recording.

On a final note, and with an eye to the more distant future, it is worth noting that the original work that produced the Dolby A system was clearly directed more at the field of video than audio. In the event, Dolby A, and then B, emerged as salvation for various audio fields. And work by Dolby Labs in other areas continues. It is likely for instance that in the not too distant future the system will be adopted in the field of facsimile transmission. ⌘

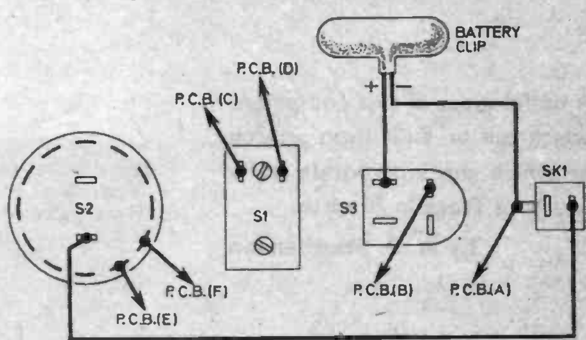
PLEASE TAKE NOTE

In Fig. 2 (page 657) of the *Light Flasher*, November '76. The underside view of the transistor shows e and c transposed.

Some breaks on the Veroboard were omitted in the *Scratch and Rumble Filter* article, page 591 November '76 issue. In Fig. 6 breaks should also be made at M9 to 15 and M26 to 31 to separate channels. Also, in Fig. 8, the two right hand wires to S1 should be transposed. Earthing of SK1 and SK2 is achieved through the metal chassis, if a non-metalic case is used, earth wires should be connected back to the solder tag. The 0V connection on T1 should also be connected to earth.

The diagram shown below was omitted from the *Min Organ* article last month. It should have been included as Fig. 3.

We apologise to readers for these errors.



Some readers have had problems with spurious and even continuous triggering of the *Clunk-Click Jogger* in the September '76 issue. This should be overcome by reducing the value of C1 to 0·01μF.

THE Multi-Tester has been designed primarily for readers who have been following the *Teach-In 76* series and will already have most of the components (it will obviously appeal to all constructors to no less a degree). The additional expenditure is modest—a couple of rotary switches, a few resistors and capacitors. The case can be home made to save money but a Verobox Type 103 will certainly professionalise the appearance and make it at least *look* nice.

The facilities available are as follows:

(a) *Measurement of d.c. Voltage and Current* in the ranges 50V 10V, 5V, 1V, 0·5V, 0·1V and 50mA, 10mA, 1mA, 0·5mA, 0·1mA. In the writer's opinion, these ranges are the best compromise where, for reasons of switch economy, ease of scale marking and simplicity, the choice must be limited to six. However, for those that disagree, it will be a simple matter to vary a few resistor values.

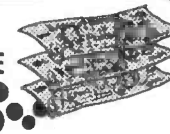
(b) *Measurement of Resistance* is available, unfortunately on only one range with a mid-scale reading of 90 kilohms. Because the ohms scale on any multimeter must range from "zero" to "infinity" the scale markings are always cramped at one end. The choice of a single 9 volt battery and a meter f.s.d. of 100μA results inevitably in the figure of 90 kilohms at centre. The extra switching necessary to bring another battery into circuit was considered an unnecessary complication.

(c) *Continuity Testing* is an "extra" seldom found in a testmeter. The normal resistance scale can detect continuity between two points because it will read "zero" ohms. However, there are distinct advantages in using a system which gives an audible tone when two points are electrically continuous—the most obvious being the avoidance of neck ache. There is nothing more irritating than trying to balance a meter at some perilous angle in order to see the scale without dislocating the cervical vertebrae. When the two terminals marked continuity are short circuited a low level, but easily audible whistle of around 800Hz escapes from the case. (If a morse key is connected across these terminals a convenient practice unit is formed.)

(d) *Audio Signal Injector* To utilise the oscillator (required for continuity) two terminals are provided which will deliver waveforms at 800Hz. One terminal provides a "triangular" wave—or more strictly an exponential sawtooth. The other provides a negative-going pulse waveform. Both of these signals have an amplitude of about 3 volts. It would have been easy to provide two additional pots to control both frequency and amplitude but unless a firm hand is taken in the design the panel could end up like a scene from Star Trek.

(e) *Visual warning of ohms and mA* Many multimeters throughout the laboratories, workshops and backrooms of the world end up in dustbins, their pointers twisted in agony due to a few seconds lapse of attention. The most common cause of this catastrophe is to attempt a voltage reading when the meter is selected on ohms or current. On our in-

FOR GUIDANCE ONLY



ESTIMATED COST OF COMPONENTS *
excluding V.A.T.
for all parts
except case
£9.50

Multi-Tester...

A useful piece of test equipment which can be built from scratch or which can incorporate parts from the *Teach-In 76* series

by A. P. Stephenson

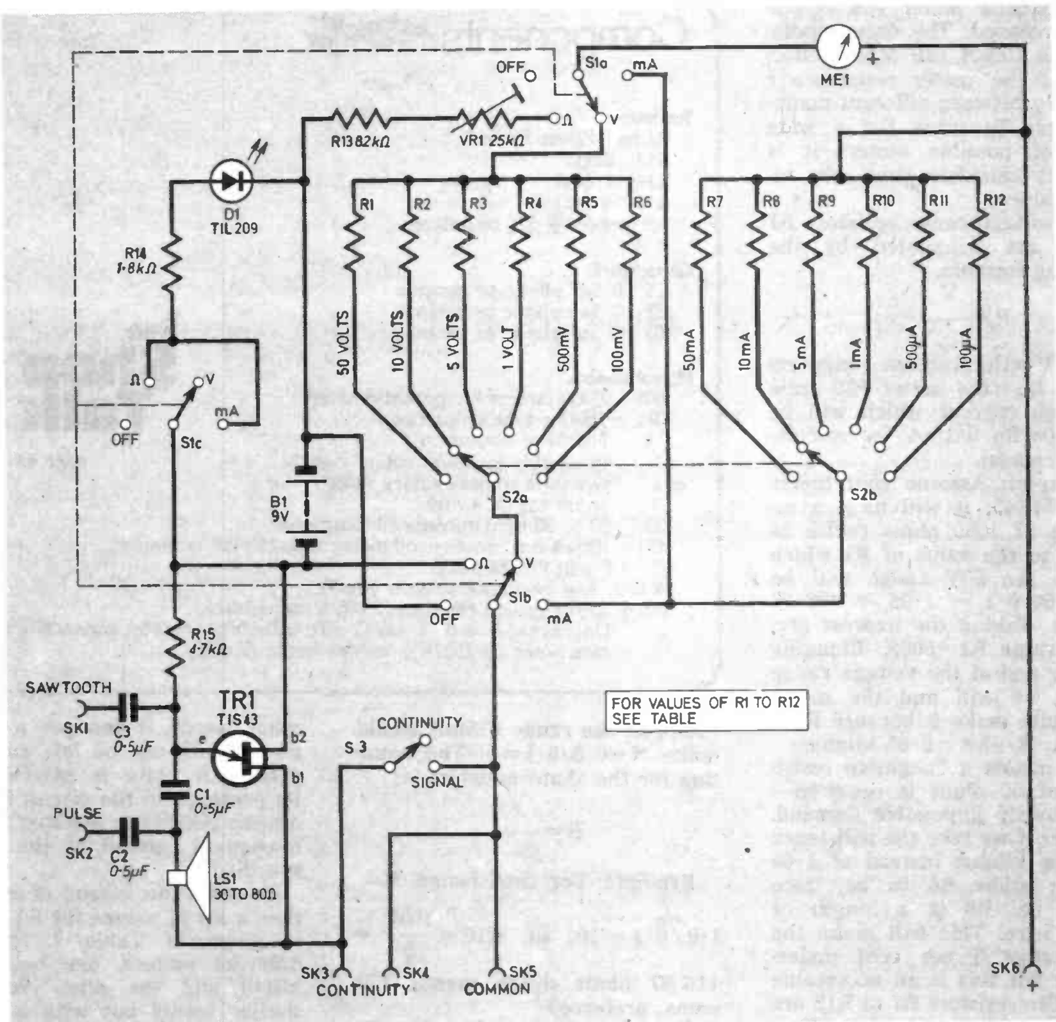


Fig. 1. The circuit diagram of the Multi-Tester.

strument, a red light glows whenever these two ranges are selected—warning the user to take care.

CIRCUIT

Multiway switches are always difficult for the beginner to follow. Switch S1 is used to select which particular function is operative and is defined as three pole—four way. This means that *three separate* switch arms can be moved together by the control knob to any of *four positions*. The separate arms are labelled a, b, and c and the dotted lines indicate mechanical synchronism. Arm S1b is used to switch the common terminal, arm S1a is to switch the negative meter terminal and S1c decides when the l.e.d. warning light comes on. The switch S2 is a two-pole six way used to select which series resistor is used or which parallel resistor; S2a is the arm which selects the appropriate series resistor when volts is selected and S2b selects the parallel resistor when mA is selected.

The oscillator uses a unijunction transistor (u.j.t.) which generates a sawtooth wave-form at the emitter. Capacitor C1 charges via R15 until the emitter reaches a certain critical voltage which initiates a "short-circuit" action to base 1. This quickly discharges C1 causing a current pulse through the speaker. The action repeats ad infinitum—hence the whistle.

Note from Fig. 1 that oscillations can only start when:

(a) S1 is selected to off (arm b puts battery negative to the common terminal and the right hand continuity terminal) *and*

(b) either the continuity terminals are shorted or S3 is closed.

The switch S3 is not strictly necessary but does allow the output signals to be on without the need to short the continuity terminals; it can be omitted if desired. Capacitors C2 and C3 are simply blocking capacitors which isolate the d.c. from the pulse and triangular output terminals, rendering them safe to inject into other equipments. The warning light turns on when appropriate and passes about 4mA via R14 and S1c.

RESISTOR VALUES

Notice from Fig. 1 that no values have been given for R1 to R12 because they will depend on the particular meter you originally purchased. The only stipulation was 100μA full scale deflection but the meter resistance r may vary between different manufacturers. To cater for a wide range of possible meters it is better to calculate your own resistor values.

The voltage range resistors R1 to R6 are calculated by the following formula,

$$R = \frac{V}{I_{fsd}} - r$$

where V = the voltage range required; I_{fsd} = the meter full scale deflection current which will be 100μA (write 0·1mA for calculation purposes).

Examples: Assume your meter is the MR45; it will have a resistance of 1050 ohms (write as 1·05K) so the value of R1 which handles the 50V range will be R1 = 50/0·1 − 1·05 = 498·95 kilohms. Taking the nearest preferred value R1 = 500K. Plunging to other end of the voltage range (0·1V) we will find the meter can't quite make it because R6 = 0·1/0·1 − 1·05 = −0·05 kilohm.

This means a "negative resistance" of 50 ohms is required—an obviously impossible demand. However if we take the resistance r as one kilohm instead of 1·05 we can allow R6 to be "zero ohms", i.e. R6 is a length of copper wire. This will make the 0·1V range 5 per cent under-reading but this is an acceptable error. The resistors R7 to R12 are used as current "shunts". They can easily be calculated providing a ratio N is first defined.

Let N be the ratio of *required* f.s.d. to the meter f.s.d. For example, the range 0·5mA would make N = 0·5/0·1 = 5. The equation for the shunt resistors is:

$$R = \frac{r}{N-1}$$

Example: For 1mA range, N = 1·0/0·1 = 10 so $R10 = \frac{1050}{9}$ = 116·67 ohms which means 120 ohms, preferred.

The lowest range *0·1mA* will not require a shunt at all because $N = 1$, so $R12 = \frac{1050}{0}$ = infinity. In other words, if you use a 100μA meter, R12 can be left out altogether. A place is reserved for its presence in the circuit in case anyone decides to use say, a 50μA movement instead of the 100μA specified.

To save the labour of calculation, a set of values for R1 to R12 is given in Table 1 for two different meters, one being the MR45 and the other being a similar model but with a resistance of 720 ohms. (The 720 ohm model appears to be superseding the MR45).

Components

Resistors
R1 to R12 see Table 1
R13 82kΩ
R14 1·8kΩ
R15 4·7kΩ
All carbon ± 5% or better

Capacitors
C1 0·5μF plastic or ceramic
C2 0·5μF plastic or ceramic
C3 0·5μF plastic or ceramic

Miscellaneous
VR1 25kΩ carbon lin. potentiometer
TR1 TIS43 *n*-type unijunction
D1 TIL209 or similar l.e.d.
S1 three-pole four-way rotary switch
S2 two-pole six-way rotary switch
S3 on/off toggle switch
LS1 30 to 80 ohm miniature loudspeaker
ME1 100μA d.c. moving coil meter type MR45P or similar
B1 9 volt PP3 battery
SK1, 2, 3, 4 miniature sockets (4 off)
SK5,6 spring-loaded terminal (2 off, 1 red, 1 black)
Double tag-board 14-way (2-off); battery connector; connecting wire; case (Vero 65-2522K); pointer knobs (3 off).

See **Shop Talk** page 43

Table 1: Meter Resistance using 100μA Movement

Range and Resistor No.		1050 ohms (MR 45) calculated	preferred	720 ohms calculated	preferred
50V	R1	498·9kΩ	500kΩ	499·2kΩ	500kΩ
10V	R2	98·95kΩ	100kΩ	99·28kΩ	100kΩ
5V	R3	48·95kΩ	47kΩ	44·28kΩ	47kΩ
1V	R4	8·95kΩ	9·1kΩ	9·28kΩ	9·1kΩ
0·5V	R5	3·95kΩ	3·9kΩ	4·28kΩ	3·9kΩ
0·1V	R6	—50Ω	zero	280Ω	270Ω
50mA	R7	2·1Ω	2·2Ω	1·44Ω	1·5Ω
10mA	R8	10·61Ω	10Ω	7·27Ω	6·8Ω
5mA	R9	21·43Ω	22Ω	14·69Ω	15Ω
1mA	R10	116·7Ω	120Ω	80Ω	82Ω
500μA	R11	262·5Ω	270Ω	180Ω	180Ω
100μA	"R12"	infinity	leave out	infinity	leave out

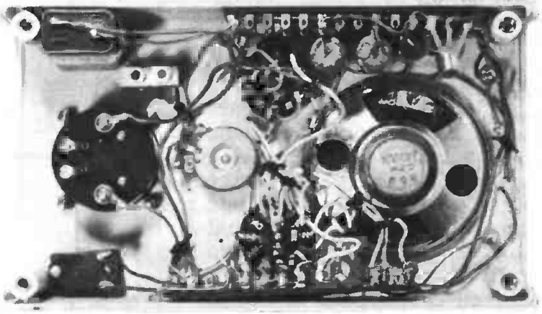
The available preferred resistors often lead to a few per cent error. For higher accuracy use a preferred value carbon resistor lower than calculated and gently file away the body until the correct reading is obtained.

CONSTRUCTION

Commence by drilling the case as indicated in Fig. 2. It is better to provisionally lay out the switches, knobs etc before finally drilling in order to ensure clearance.

Fit all the front panel components. The miniature sockets for continuity and signal outputs can be held in place by a few spots of glue. The small speaker can be fixed by a thin coating of Tensol—not too much and restrict to the outer rim of the speaker. Fit the two tag boards to the side—again use glue to avoid unsightly screws. The tag boards were specified instead of the more usual Veroboard because they are easier for beginners to solder and

Multi-Tester...



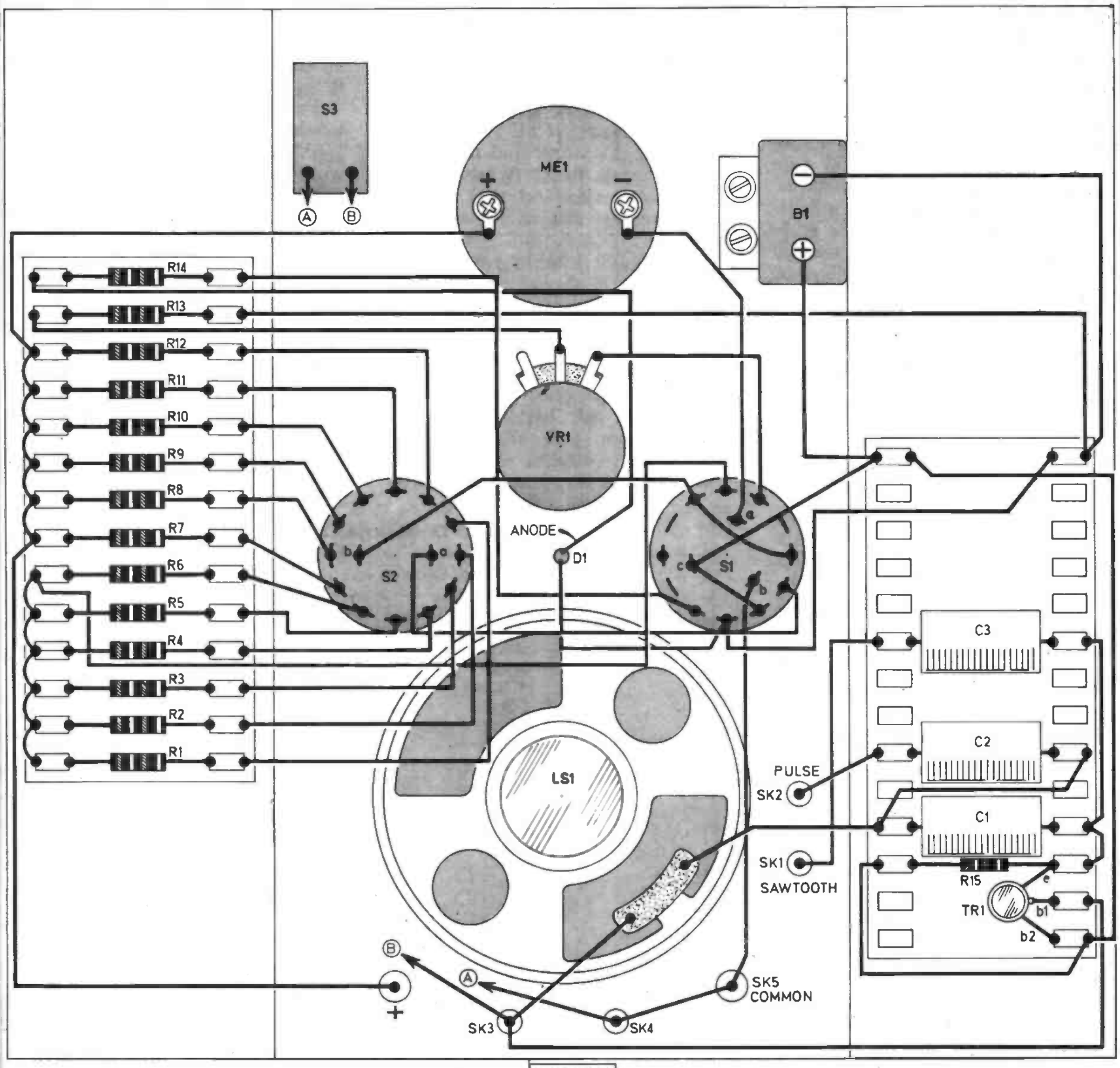


Fig. 2. Construction and wiring of the Multi-Tester.

because they take more kindly to unsoldering if you decide to file some of the resistors; this operation is really a trial and error exercise.

Stick labels on to the tagboard with R1, R2—C1 etc., on them. This is a valuable aid when wiring up and fault finding. Solder the resistors, capacitors and TR1 into position, taking great care that emitter, base 1 and base 2 are correctly positioned.

Wire all connections as shown in Fig. 2 except the wires to the two rotary switches because it is in this area where you are the most likely to make errors. Do not connect the battery yet. Be careful about the l.e.d.—the *long* wire is the anode and must go to R14.

The two rotary switches must now be attacked. First remove them from the panel, fix a knob to them and check that S2 can only be moved in six positions and S1 can only be moved in four positions. If this is not so, the end-stop locking ring is in the wrong hole. Experiment with different positions until correct. In fact it is wise to test the switch arms with the aid of a battery and lamp to ensure the arms are correctly switching. This will also help you to understand multiple switching, particularly if you draw a diagram to match up with Fig. 1.

Replace S1 and S2 and make sure the underside exactly lines up with Fig. 2 (if you get this wrong, every wire on your switch will be wrong with perhaps disastrous results to your meter). Complete the wiring to the switch. Stick some provisional labels on the front panel prior to testing out. The permanent lettering with Letraset (or equivalent) is best left until after the final test.

TESTING

Install the battery either by using a proper clip or solder direct to terminals. Check that l.e.d. lights when on ohms and mA. Switch S3 to signal and selector switch to off. The speaker should whistle. Switch S3 to continuity and the whistle should stop. Short continuity terminals with a piece of wire. Whistle should sound again.

Do not proceed with further tests until the previous tests are proved. Check wiring if faults exist.

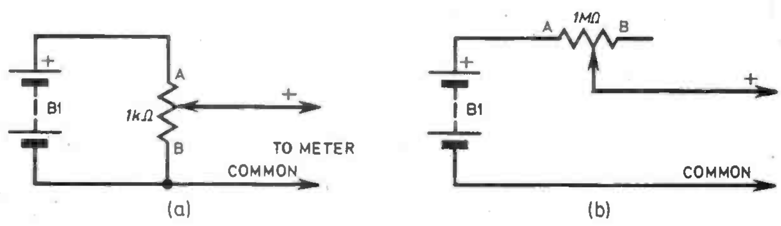


Fig. 3. Connections for testing the Multi-Tester.

Switch to ohms and momentarily touch the meter leads together. The needle should go calmly to about full scale. Keep leads together and adjust zero ohms for exactly full scale.

The word calmly means just that. If the needle rushed like mad across the scale, stop testing and re-check wiring. In fact it is important in all these tests to expect the worst and the habit of the "quick flick" (whilst keeping a fixed stare on that expensive meter) should become a ritual.

Test a 100 kilohm resistor on ohms scale. It should read a little less than half-scale.

The volts range should now be systematically checked by the following method, see Fig. 3(a):

Connect a one kilohm pot across a 9 volt battery and use the "bottom and slider" as a source of voltage, controllable from zero to 9V. Set the control to the zero-volts end, set the meter to 50 volt range and connect the voltage. Very slowly advance the control until the meter begins to read. At full 9 volts, the meter should read just under 1/5th full scale. Repeat again on 10 volts range, and then through to 1 volt range.

To test the 0·1 volt range it would be better to change to a 1·5V battery because the control would be too fierce at the bottom end. While performing these checks a reasonable estimation of meter accuracy can be obtained by comparing the degrees of rotation of the pot with the scale reading (the pot must be linear—log pots are useless for this purpose).

To check the current ranges is a somewhat hazardous task because, unlike voltage ranges, a badly soldered *parallel* resistor (R7 to R12) will result in *all* the test current passing through the

Table 2: Ohms Scale Calibration

R_x	Meter Reading (N)
(approaching full scale deflection)	
10kΩ	0·9
20kΩ	0·82
30kΩ	0·75
40kΩ	0·69
50kΩ	0·64
60kΩ	0·6
70kΩ	0·56
80kΩ	0·53
90kΩ	0·5
100kΩ	0·47
200kΩ	0·31
300kΩ	0·23
400kΩ	0·18
500kΩ	0·15
600kΩ	0·13
700kΩ	0·12
800kΩ	0·1
900kΩ	0·09
1MΩ	0·08

The relevent formula, in a convenient form, is

$$N = \frac{1}{1+0{\cdot}0111\,R_x}$$

Where N = the fraction of f.s.d. produced and R_x is the resistor being measured in kilohms.

poor meter. (Most of it is supposed to be diverted through the parallel resistor).

A source of test current can be obtained by using a 9V battery and one megohm pot, but using only one outer and the slider—in fact using the pot as a series resistance as in Fig. 3(b). Make sure the resistance is initially set to **maximum** and connect the meter set to 10mA range. Only 9μA can pass so the meter cannot be harmed even if there is a fault. The meter actually should barely read at all.

Very slowly advance the control and somewhere near the bottom end the meter should start to rise sharply. Stop this test and start again with the meter set to 5mA then 1mA then 0·5mA and finally 0·1mA.

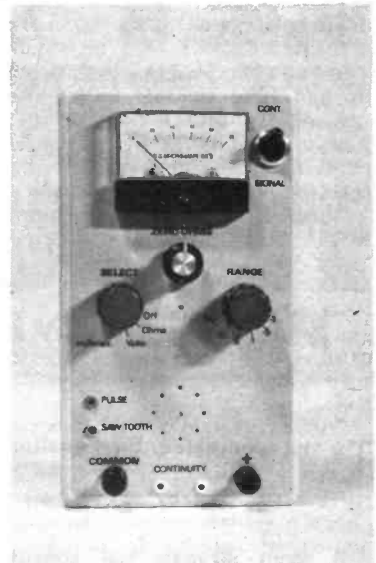
Then recheck the higher current ranges again using a one kilohm pot which can now deliver a minimum of 9mA.

The initial tests are now complete.

FINAL COSMETIC TREATMENT

Remove the knobs (and the switches if they are in the way) and label the panel carefully with Letraset or similar type lettering. The marking of the meter scale itself is tricky. Carefully remove the meter cover and mark out the ohms scale by using known resistors and putting pencil points at, say, 5k, 20k, 50k, 100k, 1M, 10M. Don't attempt too many because you will find difficulty in fixing the numbers. This can be done with the scale removed, using a very fine pen and indian ink or very small transfers. (Table 2 can be used if desired.) If you think this task is too difficult paste Table 2 to the back of the instrument and convert the readings.

Finally fix a crock clip to the common flex lead and make some sort of probe to fix to positive lead—brass rod or knitting needle inside a ball point pen makes a good probe. Make up two longer leads to plug into the continuity terminals. ⌑



I WANT to talk about E.S.P., or Extra Sensory Perception. This covers such things as telepathy, precognition, and psychokinetics.

Professor J. B. Rhine established with a fair amount of certainty, that we are able to see a short distance into the future, a matter of seconds, perhaps minutes, and many years ago I proved it, at least to my own satisfaction.

At the beginning of World War II the King decided to give me his commission, but first he decided to send me to Oxford for a medical examination to see if I was fit enough. Now at this time thousands of would-be pilots were striving to enter the Royal Air Force. Many were highly unsuitable; for example, it is a great advantage, if you want to be a pilot, if you can co-ordinate your arms, legs, and eyes. So the boffins were trying to invent a gadget that would speed up the selection.

When I arrived at Oxford they had just received the first prototype. They had tried it out on themselves, and also on some of their new entrants, but they had never yet had a real live pilot to try it out on. Now they had one in the shape of Pilot Officer Young. Needless to say, they pounced on me, and said you must try out our new machine.

The machine consisted of a small cockpit which you sat in and between your legs was a joystick which would move backwards and forwards, and on the floor in front of you was a rudder bar on which you placed your feet. When seated you found yourself facing a cathode ray tube about a foot in diameter. On the screen was a small dot of light. The joystick made it traverse up and down, and the rudder pedals made it traverse from side to side. By combining the two you could make it move anywhere on the screen. However that was not the idea.

In the centre of the screen was marked a small square about 100×100mm, and in the centre of the square was a small black cross. When you were ready they switched the machine on and the dot of light began to move in all directions, first this way and then that, quite at random. Your job was to keep it right in the middle by the use of your two controls. If you allowed it to move outside the square a mark was recorded against you.

As a further distraction, there was a small lever on your left hand side, and if a red light came on you pushed it forward, and if a green light came on you pulled it back. The machine ran for about four minutes and then switched itself off.

I climbed in and all the doctors crowded round to see how I would make out. Then they switched on. At the end of the alloted time I had chalked up four errors. The doctors were amazed: nobody up to then had scored under twenty. Being big headed even at that early age, I said let me have another go. This time my errors were *nil*.

To me the interesting thing was this, that the second time I kept the dot in the centre of the cross the whole time, and to do this I must have foreseen which way it was going to move and made the corrections just as it was about to happen. In other words I was looking into the future, admittedly only by a fraction of a second, and although I have thought about it many times since I can see no other explanation.

So if you have an old cathode ray tube and a couple of pots, you might like to knock up one of these contraptions yourself one Sunday afternoon. Then you can test out whether you have pilot potential, or, more interesting still, if you have E.S.P.

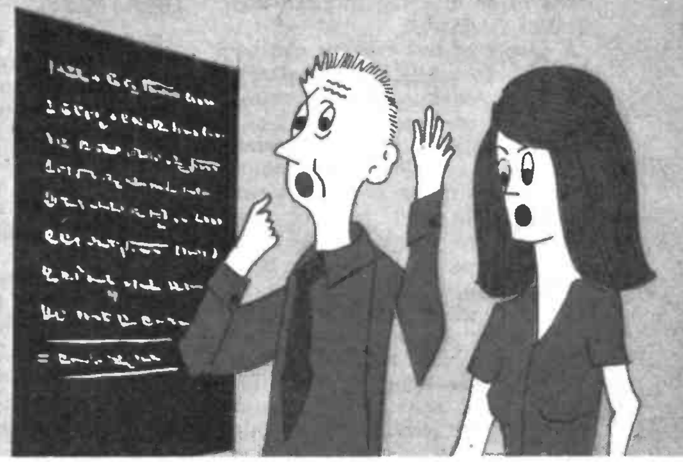
Here's to looking into the future and hoping it's bright.

DO MATHS BOTHER YOU?...

LET'S FIGURE IT OUT

Part 2

By PHIL ALCOCK



TO THE uninitiated, the equation

$$V_{AB} = I(R1 + R2)$$

will seem strange and convey nothing, yet the equation is a very useful concept and is really just a form of shorthand notation. The letters or symbols *V*, *I*, *R1*, *R2* are used to represent the values of certain electrical quantities according to some specific code. Thus "V_{AB}" could stand for voltage, "*R1*" could stand for the resistance of a component (shown as R1) in some diagram, and "I" could stand for the value of a particular current in the circuit, also possibly shown on the diagram. We use letters simply as a shorthand notation, especially if the actual value of the component is not yet known. Thus the above equation *in words* might read as follows:

The voltage between points A *and* B (V_{AB}) *is equal* (=) *to the sum of the two resistance values* (*R1*+*R2*) *multiplied by the value of the current* (I).

Obviously the equation is a big space saver. In addition, equations can be manipulated to achieve some particular purpose. If the values of V_{AB}, *R1* and *I* are known, then the equation can be rearranged to allow us to find the value of *R2* that satisfies the equation, i.e. makes the equation correct by producing the same value on both sides of the equal sign (=).

The equation is rather like a "balance" type of weighing machine in which the contents of one pan are compared against the contents of the other *with the system at balance.*

We can change one side of the equation in any way we wish providing we make similar changes to the other side to keep the balance. Notice that in the above equation the sum of the two resistors is shown enclosed inside a bracket (*R1* + *R2*). This means that we treat the contents of the bracket as one entity.

Since *I* multiplies the "bracket" it must multiply *all* the contents of the bracket, not just the first term *R1*. Notice that the normal multiplication sign (×) is not shown but is implied, i.e.

$$I \times (R1 + R2) \text{ is written } I(R1 + R2)$$

Rather than listing the various algebraic operations in a formal manner the following examples illustrate some of the important features of basic equations and the guidance notes for each should be studied carefully.

Since circuit diagrams may employ several resistors it is usual to show these in EVERYDAY ELECTRONICS as *R1*, *R2*, *R3*, etc. Do not confuse this with say *2.R*, *3.R* which means 2 × *R* and 3 × *R* respectively. In some cases, subscripts are used to avoid possible confusion, e.g. R_1, V_{AB}, h_{fe}, etc. Where ambiguity may exist the use of brackets can help. Thus 10(R), *I*(*R1*), etc.

Continued next month

Table 2.1 Some Mathematical Terms Explained

Shorthand Notation	Guidance Notes
$A - B$	Subtract quantity *B* from quantity *A*
$A + B$	Add *A* and *B* together
$V \times I$ or $V.I$	Multiply *V* and *I* together
$V = 6$	*V* equals 6 (units are normally shown)
$\frac{R}{6}$ or $R \div 6$	Quantity *R* is divided by six
$I(R + 6)$	Add *R* and 6 together, then multiply result by value of *I*
$I.Y - 10$	Multiply *I* and *Y* together, then subtract 10 from result
$R > 10$	Value of *R* is greater than 10
$R1 < 5$	Value of *R1* is less than 5
$V_z \geqslant 4{\cdot}7$	Voltage V_z is equal to or greater than 4·7 (subscript "z" may stand for some word, such as Zener)
$R \simeq 22$ kΩ or $R \cong 22$ kΩ	*R* is approximately equal to 22 kΩ
δI or ΔI	Usually means "A small change in the quantity *I*"
%	Percentage (one hundredth part of)
[ ], ( ), { }	Different shapes of brackets
10^3	10 multiplied by itself 3 times, i.e. 10 × 10 × 10 = 1000

Next Month...

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Cut Round Dotted Line

BRAKE LIGHT WARNING DEVICE

By T.I.R. de Vaux-Balbirnie B.Sc.

IT IS an offence to drive a motor vehicle with defective brake lights. Along with checking tyres and so on, the careful driver would see that his brake lights were working correctly each time he drove the car. It is a safe assumption that few people do this and even if the will is there it is not an easy job without assistance.

Of course, a bulb may blow at any time in the course of driving and this is unlikely to reach the driver's attention for some time. Meanwhile, it will be causing annoyance and possible danger to other road users because intermittent use of the brakes could easily be mistaken for a turning signal—remember that red is a legal colour for rear traffic indicators. A false right turn signal could be especially dangerous for a following car.

There certainly seems to be a case for a device which will signal the driver in the event of failure in the brake light system. This could be due to a bulb blowing or a faulty earth connection at a lighting unit at the rear of the car. The suggested circuit would give a visible dashboard warning when the brakes were applied. If the circuit as a whole is at fault e.g. due to a blown fuse the circuit will not work. Usually this sort of fault is quickly apparent because other electrical equipment fails at the same time.

CIRCUIT DESCRIPTION

The circuit diagram of the Brake Light Warning is shown in Fig. 1. It has been designed for

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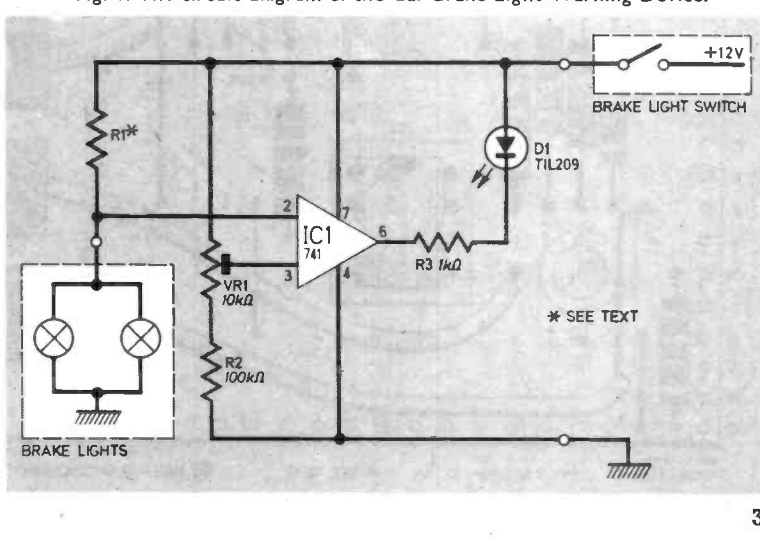
a 12 volt negative earth system as this is used in most modern cars. The unit uses an operational amplifier type 741. This device has two inputs one inverting (−) pin 2 and one non-inverting (+) pin 3. The 741 has very high gain and the output is proportional to this gain and the difference in voltage present at the two inputs with respect to ground; thus the output can be moved towards either supply line.

Imagine two positive voltages one applied to pin 2 and the other to pin 3. These voltages are measured with respect to the negative "earth" line. If the pin 2 voltage is greater than the pin 3 voltage the output will go to "earth" potential. Under these conditions, the l.e.d. indicator D1 turns on. If the conditions were reversed i.e., if the voltage at the inverting input were less than that at the non-inverting input the l.e.d. would remain off. A filament light indicator would be unsatisfactory as its power consumption would be too great.

The input voltages to the

Fig. 1. The circuit diagram of the Car Brake Light Warning Device.



operational amplifier are derived from potential dividers across the supply lines. An adjustable reference voltage is produced by means of the divider action of R2 and VR1 in series. The input to pin 3 being taken from the wiper of VR1. The latter is used for limited fine adjustment. With VR1 set to midway position there is about 11·5 volts on pin 3.

The voltage at pin 2 is derived from the divider action of R1 in series with the two brake lamps (in parallel).

By choosing a suitable value for R1 it is possible to obtain a similar 11·5 volts or so at pin 2 with both lamps working. Due to the potential divider action, however, this voltage will be *higher* if one bulb fails and will be the full 12 volts with both out of action. By adjusting VR1, a setting can be found when the pin 2 voltage will be slightly less than the pin 3 voltage with both lights on, but slightly greater when only one light (or both) is off. This critical setting for VR1 will be found when setting up.

It should be noted that the half-volt drop mentioned above means that half a volt less will be available to operate the stop lights. This is perfectly in order and no difference in brightness should be noticed. In any case, this small voltage drop is well within the differences which may be expected from other causes.

VALUE FOR R1

A calculation is needed to give the value of R1.

A standard brake light bulb is rated at 21 watts so the total wattage is 42 watts.

The current in the brake light circuit with both lamps working is given by $(W/V) = (42/12) = 3{\cdot}5$ amps.

As the voltage required across R1 is 0·5 volt, then by Ohm's law $R1 = (V/I) = (0{\cdot}5/3{\cdot}5) \simeq 0{\cdot}14$ ohms. The power rating for R1 is given by $W = I \times V = (3{\cdot}5 \times 0{\cdot}5) = 1{\cdot}75$ watts.

Theoretically R1 should be a 0·14 ohms resistor rated at 2 watts or so. This causes a problem because this sort of value is far away from those used in most electronic circuits. The constructor has two possible courses of action. He can either make his own resistor from scratch, or use a combination of easily obtainable types.

A home-made resistor was made using resistance wire for the prototype and this worked very well.

Alternatively, four 0·47 ohm ½ watt resistors can be wired in parallel to give a value of 0·12 ohms which is near enough to the required value. This method is shown in Fig. 2.

Resistor(s) R1 becomes quite warm in prolonged operation and should be stood away from the circuit board to allow the heat to dissipate unimpeded.

The purpose of resistor R3 is to limit the current through the l.e.d. to a safe level. Its value may be reduced to about 470 ohms if slightly more brightness is required.

COMPONENT BOARD

The circuit was built on a piece of 0·1 inch matrix stripboard size 16 strips by 19 holes. The layout of the components on the board is shown in Fig. 2; it is not critical and may be changed to suit individual requirements.

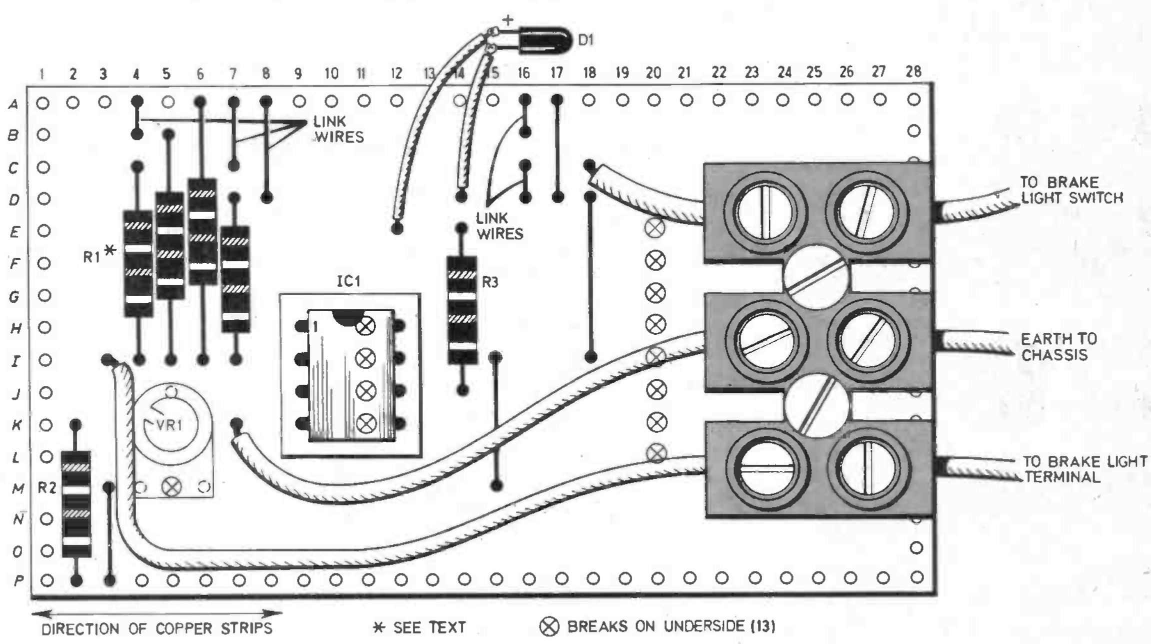
It is recommended that an i.c. socket be used to mount IC1 thereby eliminating possible damage from soldering iron heat; removal is an easy matter should it be necessary.

Begin by making the breaks on the underside of the board, fix the terminal block and then solder the link wires in position followed by the resistors, preset, i.c. holder. Finally solder the flying leads to the l.e.d. and wire up to the fitted terminal block. Use heavy gauge wire for the positive supply lead as this will be carrying about 3·5 amps.

FITTING IN THE CAR

When the circuit has been built and carefully checked it will be necessary to connect it temporarily in the car to make the

Fig. 2. Complete wiring up details and layout of the components on the circuit board.



Components

Resistors
- R1 See text
- R2 100kΩ ¼W
- R3 1kΩ ¼W
- All carbon ±10%

Semiconductors
- IC1 741 operational amplifier 8 pin d.i.l.
- D1 TIL209 or similar l.e.d.

Miscellaneous
- VR1 10kΩ horizontal preset
- Stripboard 0·1 inch matrix 16 strips x 19 holes; 8 pin d.i.l. socket; 5A terminal block; auto-type wire; case; spade connectors.

See **Shop Talk**

operational checks and to set VR1, unless the constructor has available outside the car a car battery and two 21 watt bulbs. The circuit will not work properly if the correct wattage bulbs are not used, so a high power battery is necessary for setting up.

When connecting the circuit to the car's electrical system it is wise to disconnect the car battery. This will eliminate the possibility of inadvertent shorts. The necessary precautions should be taken i.e. proper wire should be used, bought from a car accessory shop, rather than the wire used for general electronics work. Single strand wire must not be used as it soon breaks under vibration. When wires have to be led through holes in the car bodywork grommets should be used.

Using the car wiring diagram locate the wire which leads from the brake pedal switch to the brake lights. This should either be cut at a convenient point or disconnected from the switch itself and then an extension fitted to the switch. From the two new ends, extension wires of the right type should be made up, and led to a convenient place close to the dashboard for connection to the board. A third connection from the circuit board terminal block should be made to a nearby earth point, i.e., joined to the metal body of the car.

If such a point is not to be found, then a small hole will need to be drilled and a self-tapping screw fitted. The wire may be soldered into the form of a loop to go under this screw or a proper "eye" attached to it.

Before reconnecting the car battery to make the tests, care should be taken to ensure that the circuit is entirely isolated from the metalwork of the car (apart from the actual earth connection). When finally fitting it this must also be observed.

To check operation of the circuit, the ignition switch must be operated and the brake pedal gently pressed. VR1 should then be adjusted until the l.e.d. comes on. It should then be backed off until the light just goes out. With one of the brake light bulbs removed to simulate a fault, the l.e.d. should light. The operation may be checked with the other bulb removed and then both bulbs removed. Adjustment of VR1 should be made to give reliable operation.

If all is well, the unit may be fitted in the car permanently. It is suggested that the unit be enclosed in a small plastic container, such as those used for holding soap, and the leads brought out through holes drilled in the side.

The l.e.d. needs to be mounted in an easily visible place on the car dashboard. Red is the obvious colour choice for the l.e.d., but green or yellow could be used especially when other red indicators are in use. The appearance of the project could perhaps be enhanced by using an l.e.d. with a chrome bezel.

Replacement of one or both the brake light lamps should not demand resetting of VR1.

Having built and installed this warning device the only trouble is you will probably drive for thousands of miles without so much as a wink from the l.e.d. One day, however, the faithful little light will glow and keep you out of trouble. ⌑

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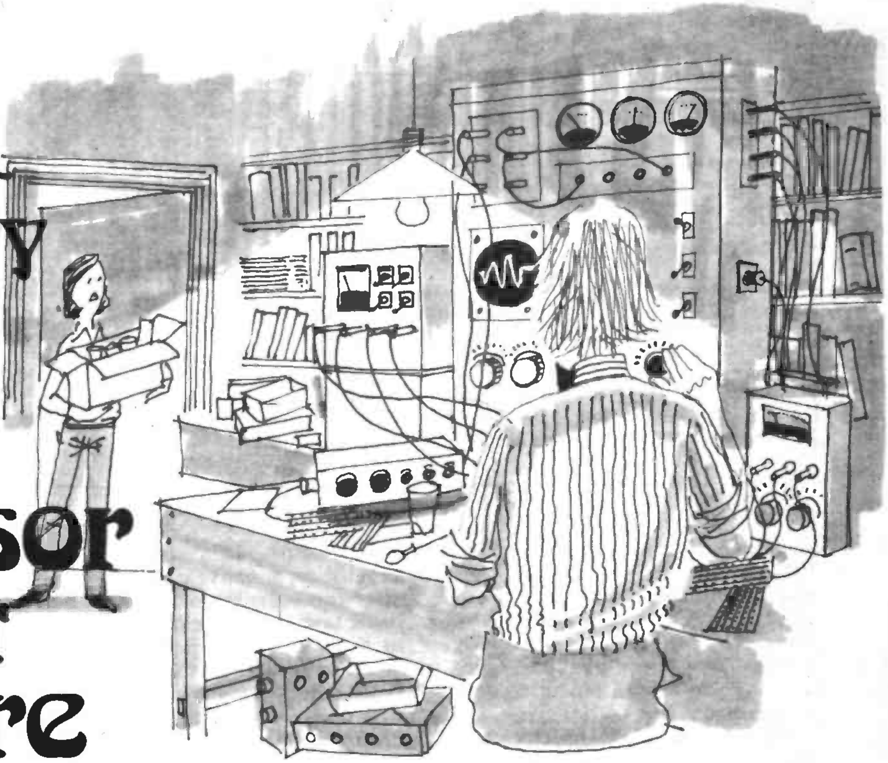

by Anthony John Bassett

THE Prof. showed the boys how to set the bias on each of the Darlington power transistors of the impedance-converter.

First he connected the input terminal to the zero voltage tag on the tag board, and connected the output terminal to an 8-ohm wirewound resistor wired to the zero voltage terminal of the power-supply, then re-connected the mains to the power-supply and once again switched on.

BIAS ADJUSTMENT

He switched a multimeter to measure millivolts, and connected it from the emitter of the MJ3001 Darlington power-transistor to the output terminal. At first there was zero reading on the meter, but the Prof. carefully adjusted VR1 until the meter needle moved slightly to give a reading of a few millivolts.

"Because we are measuring the d.c. voltage across a 0·47 ohm resistor," the Prof. informed Bob, "every 0·47mV we measure will be an indication of 1mA flowing in the resistor. To obtain a current of 20mA we would need to adjust the preset until the voltage across the resistor is 9·4mV. But to begin with we will set it a little lower."

The Prof. adjusted VR1 until the meter reading was 5mV, then transferred the meter leads to measure the voltage across the other 0·47ohm resistor. This he adjusted by means of VR2 until a reading of 5mV was obtained here also.

Now by alternate small adjustments to VR1 and VR2 he brought the voltage across each resistor up to about 10mV, then by final small adjustments, with the meter connected across the 8ohm resistor he brought the voltage across this resistor to zero, then switched the mains supply off.

Allowing a few minutes for the power-supply capacitors to discharge, he explained to Bob and Maurice: "When the input of the impedance-converter is at 0V, its output should also be at 0V, as it is a d.c. coupled circuit, and I have used VR1 and VR2 not only to adjust the quiescent current to a suitable value, but also to "balance out component-tolerances and bring the output voltage to zero, so that when the circuit is in use there is no flow of current in the speaker until a sound is produced".

IMPEDANCE

Now Maurice, who had been contemplating the circuit diagrams thoughtfully, asked, "What is the input impedance of the converter, Prof?"

"A few kilohms, Maurice," the Prof. replied.

"Then how does it match the output impedance of the amplifier, which is only 8 ohms?" Maurice wanted to know, "Because according to one of these circuit diagrams we are connecting it to convert an impedance of 8 ohms to one of 4 ohms (Fig 1), yet if we connect the 8 ohm output of an amplifier to a load of several kilohms surely this might cause damage to the amplifier."

"I wondered who would be the first to spot that," commented the Prof., "and although most modern transistorised amplifiers would not be damaged by too high an impedance, some amplifiers are vulnerable to this condition. So the impedance-converter which we have built is designed to operate in a slightly different manner (Fig 2). Here the high impedance of the input of the converter is placed in parallel with one of the speakers, and does not make much difference to the load seen by the amplifier. Then the output of the converter drives a further 8 ohm speaker."

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12v	1 amp	1·25
6·5v-0-6·5v	1 amp	1·85
18v	1 amp	1·85
24v	2 amp	2·82
24v	3 amp	4·75
12·0-12v	50mA	1·56
6·0-6v	50mA	1·56
8·0-8v	½amp	1·85
25v	1½ amps	2·44
50v 2 amp & 6·3v	1 amp	5·63
60v 5 amp & 5v	1 amp	9·35
27v	8 amp	5·63
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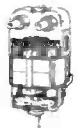

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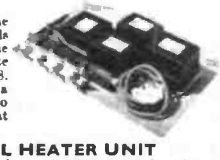

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost any one in easy-to-assemble modular form and complete with a pair of Celestion speakers normally £8. This should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £17 including VAT and postage.

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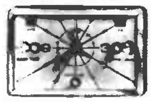
This heater unit is most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. Comprises motor, impeller. 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only needs control switch. £5·83 plus VAT & post £1. 2kW Model as above except 2kW £4·25 plus VAT & post 75p. Don't miss this. Control Switch 44p. P. & P. 40p.

ISA ELECTRICAL PROGRAMMER



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

ROOM THERMOSTAT

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

8 POWERFUL BATTERY MOTORS

For models, Meccano's, drills, remote control, planes, boats, etc., etc. £2·00.

ROTARY PUMP

Self priming, portable fits drill or electric motor, pumps up to 200 gallons per hour depending upon revs. Virtually uncorrodable, use to suck water, oil, petrol, fertilizer, chemicals, anything liquid. Hose connectors each end. £2·00 Post Paid.

MAINS RELAYS

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

TUMBLE DRYER CONTROLLER—MULTI TESTER— PHOTOCUBE RECEIVER AND BRAKE WARNING DEVICE

To receive parts for the projects featured this month, and the estimated price + 40p post. Any cash adjustment can be made later.

HORSTMANN 24-HOUR TIME SWITCH

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

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

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

SHORTWAVE CRYSTAL SET

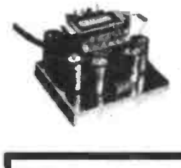
Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 31, 29 metre bands. Kit contains chassis front panel and all the parts £1·90—crystal earphone 55p including VAT and postage.

PAPST MOTOR

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

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

TWIN OUTPUT POWER PACKS



These have two separately R.C. smoothed outputs so can operate two battery radios or a stereo amp without cross modulation (they will of course operate one radio/tape cassette/calculator, in fact any battery appliance, and will save their cost in a few months). Specs: Full wave rectification, double insulated mains transformer—total enclosed in a hard P.V.C. case—three core mains lead—terminal output—when ordering please state output voltage 4½v, 6v, 7½v, 9v, 12v or 24v.
Price £3·95. Post and VAT included.

TERMS: Where order is under £5 please add 40p surcharge to offset packing expenses

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(Dept. E.E.), 103 TAMWORTH ROAD, CROYDON CR9 ISG.

ITS FREE!

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

	Price	Postage
Mullard Unilex with £8 8" round speakers	17·00	1·50
Full-Fi stereo amplifier in teak-look case	9·95	1·00
7 watt stereo amplifier with pre-amp and control	7·00	·40
Stereo amplifier for headphones	3·50	·25
Luxistor amplifier in case with speaker	6·50	·50
AM/FM Tuner with scale and drive shaft	11·50	·40
FM Tuner with scale and drive shaft	9·00	·40
Decoder for stereo to work with above tuner	9·50	·40
Celestion 8" speaker 12½ watts 10 ohms	4·00	·75
10 Watt Speaker System in polished wood cabinet	9·00	3·00
5 Watt Speaker in wood cabinet	4·50	1·50
30 Watt Speaker 14" × 9" heavy duty	12·50	2·00
Light Dimmer, 1250 watts, disco model	4·25	·20
2000 watt motor driven disco light flasher	4·00	·20
9 Switch motor driven disco light controller	4·95	·20
Black light (UV) lamp for disco	7·00	·50
Sound to Light unit	8·50	·25
Remitone 7 transistor pocket radio	2·00	·20
Crystal set kit	2·00	·25
BSR Glenborne Auto Changer, ceramic cartridge & cueing arm	10·95	1·50
Atlas car battery charger with panel meter, 6v and 12v	3·50	1·00
Battery charger kit–transformer –full wave rectifier & flush meter	2·25	·50
Motorised car aerial 12v with controls	7·40	·80
Autoset Timer heart 24 hours on/off	3·95	·40
Smiths Central heating controller	7·50	·30
Randall central heating controller	7·00	·30
Horstmann central heating controller	6·00	·30
Clock with 25 amp switch	3·00	·30
Clock with 25 amp switch, but with glass front & chrome bezel	4·50	·30
12v Mains unit for driving models, cassette, etc.	2·95	
Drill speed controller kit	2·95	·40
Drill speed controller, but made up	3·95	·40
Battery operated fluorescent light unit 12"	3·05	1·00
ICE Multi tester, 40 range	15·66	·65
ICE Multi tester, 80 range	24·30	·85
Multi-range test meter C1000	4·95	·30
Pack of 8 battery motors for model making	2·00	
5 Computer boards (at least 250 transistors, Ic's, etc)	1·00	·50
Batteries (10·7v) pack of 25	1·00	·40
Antex soldering iron kit	4·50	·45
Twin output power packs 6v, 7½v, 9v, 12v, 24v (state volts)	3·50	·40
PC board marker pen	·99	·10
Fluorescent kitchen light 20 watt with tube	2·95	1·50
Jug heater 900 watt immersion heater	3·50	·30
Multi-speed motor	1·50	·45
Automatic night light switch 240v	4·00	·25
Automatic night light switch 12v	1·50	·25
Immersion heater 2kw, standard fitting	2·00	·60
Soil heating kit	3·50	·75
Claymore Intercom/Baby Alarm	5·75	·20
Technical books published by Iliffes—		
50 Photo electric circuits and systems	1·30	
110 Transistor Projects	1·40	·10 or two or more post free
20 Solid State Projects for the home	1·00	
20 Solid State Projects for the car and garage	1·20	
110 Integrated circuit projects for home constructors	1·20	
110 Semi-conductor projects for home constructors	1·20	
International data books—		
Diode equivalent tables (128 pages)	1·95	or two or more post free
Transistor data tables (227 pages)	1·25	
Transistor equivalent tables (176 pages)	1·10	
Thryristor data tables (159 pages)	1·10	

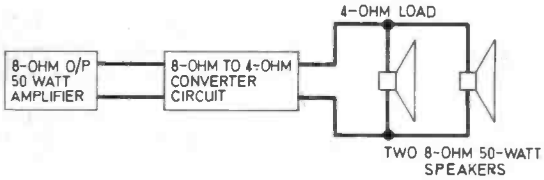
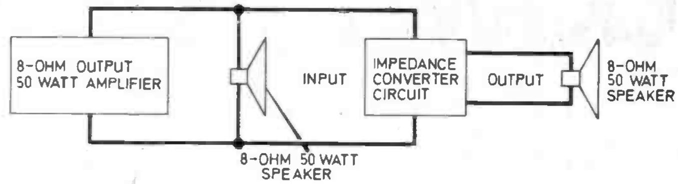


Fig. 1. (left) The circuit to which Maurice referred.

Fig. 2. (below) The diagram showing actual connection of the converter.



At this moment Tom appeared perspiring from another part of the laboratory, where he had been making a case for the impedance-converters. He had obviously been working very hard, sawing, filing, drilling and bending the metal to make the case which he now brought, and showed proudly to the Prof. and his friends Maurice and Bob.

CASE

"Can we fit the impedance-converters into this case now?" he asked, "Then we could check out the system and maybe give it a trial run."

"Not yet, Tom, hang on, we've only made one of them!" replied Maurice, "We need another for the other channel of the stereo amplifier!"

"Oh, Maurice," said the Prof. with a suppressed grin and a twinkle in his eye, "Would you mind opening that package for me?"

Maurice brought over the package which the robot had earlier delivered, and as he looked inside it, gave a sudden yelp of amazement.

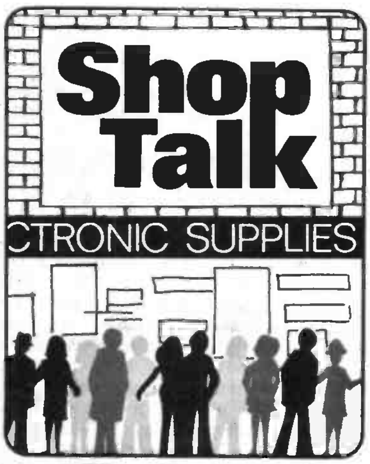
"There are three more impedance-converters in here!" he exclaimed, "Where did they come from?"

"The robot made them, Maurice."

"But it only took him a few minutes from the time you gave him his instructions, to the time he brought this package, and it took all of us ages just to make one converter!"

"That's right," replied the Prof., "But I thought that if we made one converter ourselves, and let the robot handle the routine labour of producing another three, then we could use the time we have saved, to carry out a few other interesting projects!"

Continued next month



By Mike Kenward

A RECENT visit to the D.I.Y. Exhibition at Olympia did not reveal any great displays of electronics and we feel it is a pity that this popular hobby, which anyone can undertake, has been completely neglected. One item of interest did however present itself.

The item we spotted was a tool rack from Hoga Products. The rack is made in England using 22 gauge mild steel with a stove-enamelled finish. It is 91cms long and holds a double row of tools tidily and on display for easy access. The retail price is £3·99 including VAT and they are available through Interore Ltd., 29 Thurloe Street, London SW7 2LQ.

Brake Warning Indicator

None of the parts for the *Brake Warning Indicator* should provide any buying problems. It is important that heavy gauge auto wire is used for the connections to and from the unit and that all joints involved in the lamp circuit wiring are of good quality, this is because the supply current for the brake lights flows through this chain. This is also the reason four strips on the board are linked together.

Photocube Receiver

Photocubes are now generally available from photographic shops; they are designed to hold photographs and one is used for the case of the *Photocube Receiver*. As far as the electronic components go there should be no buying problems, if any parts are not available locally one of the large mail order firms should be able to help.

The Denco aerial can be obtained direct from Denco they supply either MW/LW or MW only type 5FR the price is 94p and 70p respectively plus 12·5 per cent VAT plus 16p postage.

Multi-Tester

For those who have completed the *Teach-In 76* course the *Multi-Tester* project is a good way of putting some of the parts to use—another in the form of a power supply will be published shortly. Buying the parts should not present any problems.

Tumbler Dryer Control

One problem that may arise when constructing the *Tumbler Dryer Control* is a source of supply for sea salt if sea water is not available. I am informed that many grocers, chemists and aquarium shops (particularly those selling salt water fish) can supply this. It is not possible to use ordinary table salt because of the additives in it.

The angle bracket for the triac mounting is made from a piece of angle aluminium of fairly solid proportions to provide a heat sink. You should be able to obtain suitable material from a good d.i.y. or metal shop—they may even have an off cut!

The triac specified comes in a TO48 case which is easily mounted using a single hole for the stud but it must be insulated from the metal with the correct mounting washers.

Literature

Finally brief news of a change of ownership of Arrow Electronics, its new shop and catalogue. The new owner is Peter Clarke who says "My staff are second to none and our large technical library enables us to trace or substitute most of the items used in electronics today, and in most cases supply from our now vastly increased stocks of over 6000 lines".

A new catalogue is now available price 40p.

GEORGE HYLTON brings it down to earth

Inductance Calculations—How to Avoid Them

THERE comes a time in the life of every electronics enthusiast when he must answer the terrible question: How many turns should I put on? Strong men have been known to run away screaming at the thought of having to work it out for themselves. It isn't surprising.

Opening a well-known textbook at the pages on inductance calculations I find a magnificent collection of formulae, all purporting to tell you the inductance of a coil and all different. Here's a selection:

$$L = \frac{a^2 N^2}{9a + 10l} \quad (1)$$

$$L = \frac{a^2 N^2}{(9 - (a/5l))\,a + 10l} \quad (2)$$

$$L = \frac{0 \cdot 252.\, d^2 N^2}{1 + 0 \cdot 46\,(d/l)} \quad (3)$$

It becomes clear, on reading the words that accompany this mathematical feast, that these formulae have one thing in common. They are all wrong! Not *very* wrong, perhaps, but wrong. In order to make life easier for himself the mathematician makes the assumption that the coil is wound with flat tape, infinitely thin. Since real coils are wound with round wire their inductances are different.

You'll notice too that the formulae all give the inductance L. The number of turns N cannot be obtained directly. Before you can do that the formulae have to be rearranged. A mathematician will have no problem here. He'll probably tell you that all that's needed is a trivial piece of manipulation. That's his way of saying: "I'm all right, Jack. I can do it".

What can the rest of us do? We can resort to a few simple "wrinkles" plus trial and error. One thing you will find in all these formulae is the term N^2, which is the square of the number of turns. What this means is that, other things being equal, twice the number of turns gives four times the inductance, trebling the turns gives nine times, quadrupling gives 16 times, and so on. By the same token, halving the turns reduces the inductance to a quarter of what it was, using one-tenth the number gives one hundredth the inductance, etc.

Thick Ones!

In practice, however, it doesn't work out quite like that. If you have a coil like the one in Fig. 1, with 16 turns, and you remove 8 of them, you have done something else, too. You have changed the *shape*. What started off as a coil about twice as long as it was thick, ends up as one whose length is about the same as its thickness (i.e. diameter).

This upsets the situation. The assumption that we now have a quarter of the original inductance isn't quite true. To make it true we'd have to spread out the turns so that they occupied the same length of the former as the original complete coil.

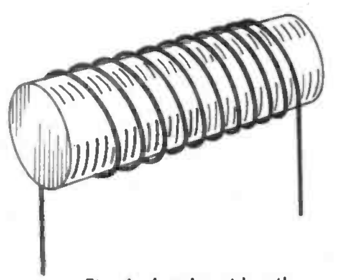


Fig. 1. A solenoid coil.

All the same, you can get a fair idea of the number of turns to add or take off by applying the "squaring" rule. It's even easier to adjust the turns if the coil is part of an LC tuned circuit which has to be set to the right frequency by altering L. In this case, the relation between turns and frequency is quite straightforward.

To double the tuned *frequency* you just halve the turns and so on. To take a practical example, suppose a coil is designed to tune to 2MHz with 400pF. To make it tune to 4MHz with 400pF you halve the turns. To make it tune to 1MHz you double the turns. Remember that this is only approximate, and leave enough loose wire to make a final adjustment!

So far we've been considering different numbers of turns on the *same* coil-former. If the former is different, too, (smaller or larger diameter) then the inductance is different even when the number of turns is the same.

Looking back, we've discovered *three* things which influence the inductance:

Number of turns.
Shape.
Size.

This is why those formulae are so complicated. They take all three factors into consideration. (For any courageous reader with a calculator, the first formula is approximately right for coils of ordinary shape, like Fig 1. Formula (2) is for *short* coils. Formula (3) is for ordinary coils but is more accurate than (1). All dimensions are in *inches* and the inductance is in micro-henries. All coils are "single layer", that is, with just one layer of wire, not several on top of each other.)

Core

The inductance of a coil also depends on the material near it, and in particular on the material *inside* it. If, for example, a coil is wound on a ferrite rod, the material inside it is a magnetic material. This *increases* the inductance. In general, magnetic materials increase the inductance, non magnetic insulators like plastics or paper leave it unchanged, and non-magnetic metals reduce it.

These effects are commonly used to enable inductances to be adjusted. A "core" of material is provided which can be screwed into the bore of the coil former. Depending on how far it is screwed in, the inductance is changed by a little or by quite a lot. Cores are usually made of ferrite or iron "dust" cemented together, but for u.h.f. working are often of brass.

What if the core is of a magnetic *metal*? Laminated transformer cores are, and their effect is to increase the inductance enormously, at *low* frequencies. But as the frequency increases the "metal" effect gains on the "magnetic" effect, and the core becomes ineffective. Iron cores (which must be of "soft" non-magnetisable iron, not steel or any permanent-magnet alloy) are seldom used above the audio frequency range nowadays.

Ferrite cores are used from the higher audio frequencies up into the radio frequency range. Dust-iron is used mainly at radio frequencies. The extent to which the inductance of a coil is increased by a magnetic screw core varies from a few per cent to a factor of several times, depending on the size, shape and material.

The effect of enclosing a coil in a metal "screening can" is to *reduce* the inductance.

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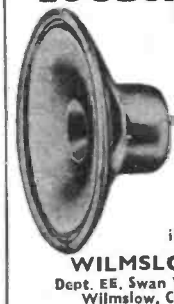

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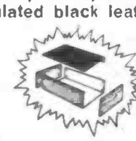

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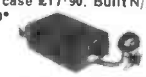

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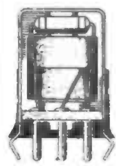

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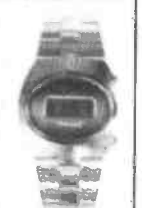

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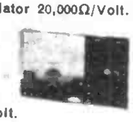

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