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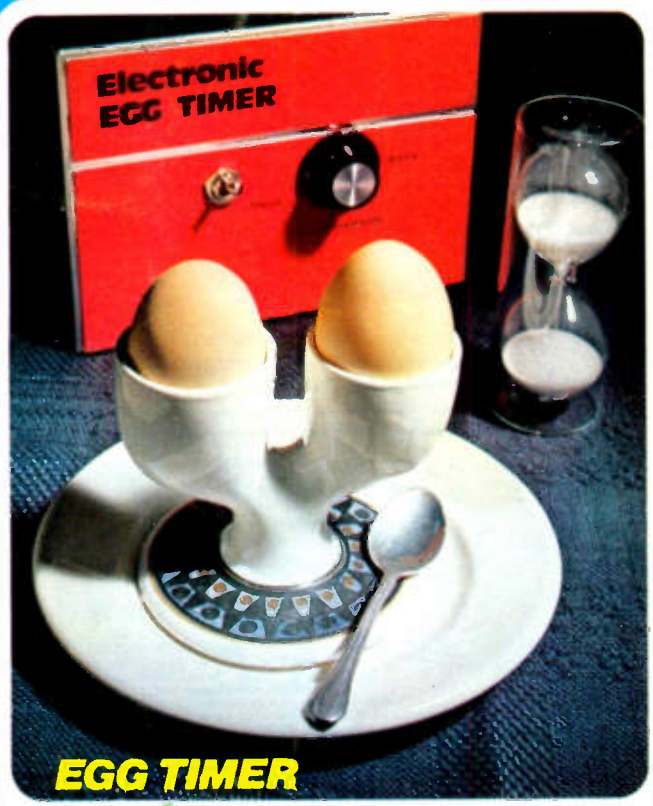

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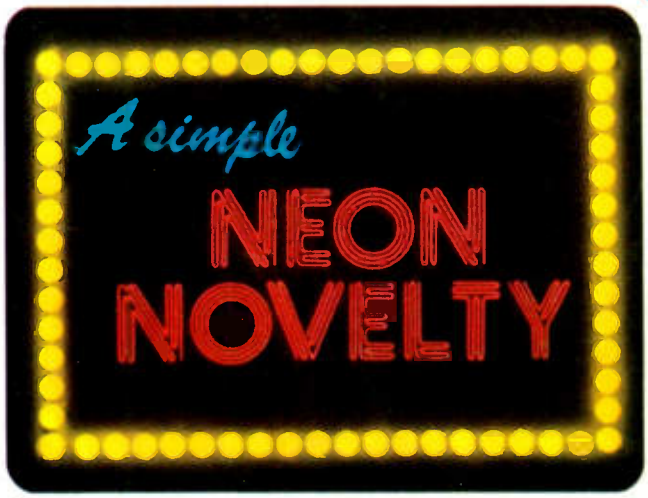

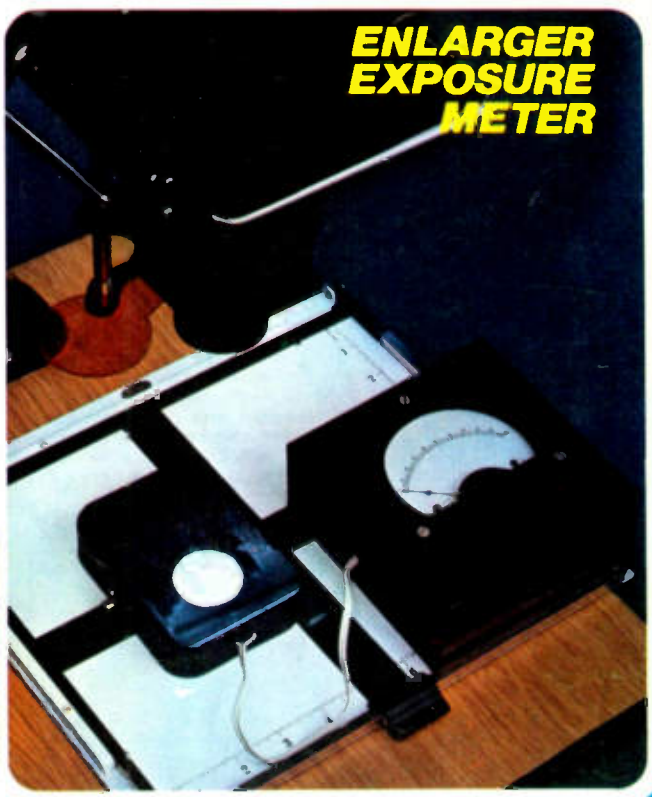

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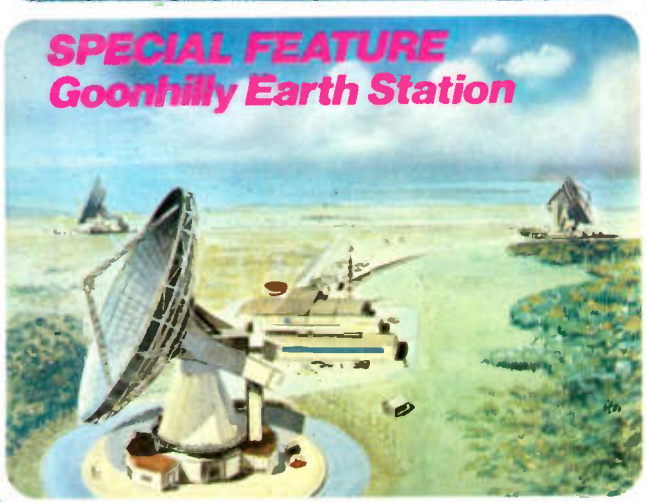

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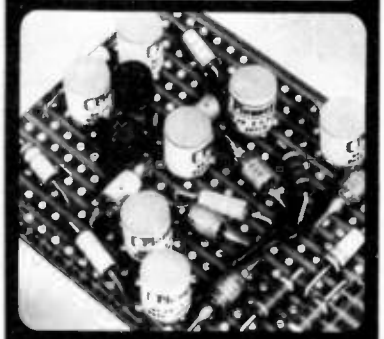

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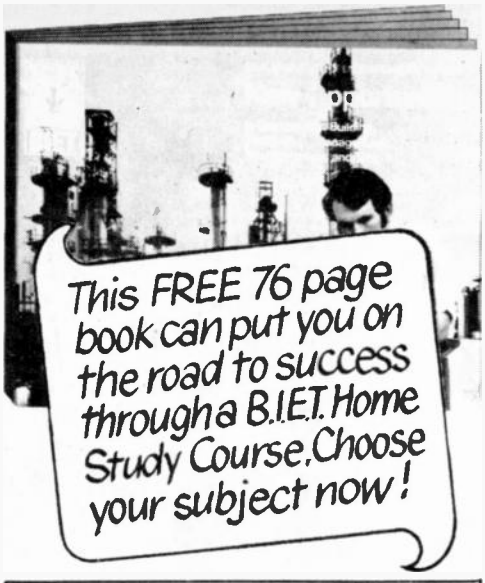

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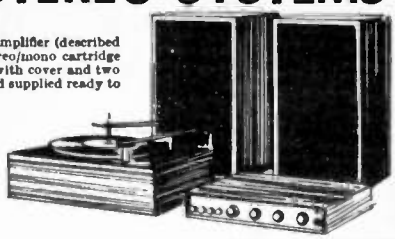

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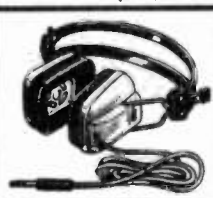

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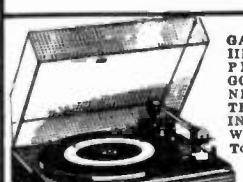
Fitted two 2½in tweeters and crossover network. Impedance 8 or 15 ohm. Handling capacity 10W. Brand new.

£3·47 P. & P. 50p



GARRARD SP25 MK III SINGLE RECORD PLAYER FITTED GOLDRING 800 MAGNETIC STEREO CARTRIDGE. COMPLETE IN TEAK PLINTH WITH COVER. Total list price over £34.

PREMIER PRICE **£17·95** P. & P. £1

E.M.I.

LOW NOISE CASSETTES

In library cases

C60 (List 71p) 45p
C90 (List 98p) 65p
C120 (List £1·48) 85p
P. & P. 10p

QUALITY RECORDING TAPE

SPECIALLY MANUFACTURED IN U.S.A. FROM EXTRA STRONG PRE-STRETCHED MATERIAL. THE QUALITY IS UNEQUALLED. TENSILISED to ensure the most permanent base. Highly resistant to breakage, moisture, heat, cold or humidity. High polished splice free finish. Smooth output throughout the entire audio range. Double wrapped—attractively boxed.

TT3	3"	450'	POLYESTER	87p	DT6	5½"	1800'	POLYESTER £1·12
DT3	3½"	600'	POLYESTER	57p	TT6	5½"	2400'	POLYESTER £1·37
SP5	5"	600'	P.V.C.	42p	SP7	7"	1200'	P.V.C. 62p
LP5	5"	900'	ACETATE	50p	LP7	7"	1800'	ACETATE 75p
DT5	5"	1200'	POLYESTER	75p	DT7	7"	2400'	POLYESTER £1·25
LP6	5½"	1200'	ACETATE	75p	TT7	7"	3600'	POLYESTER £2·50

TAPE SPOOLS 3" 5p, 5", 5½", 7" 9p.
Post and Packing 3" 5p, 5", 5½", 8p, 7" 10p (3 reels and over Post Free).

WELLER "EXPERT" SOLDER GUN.

Simplifies soldering in the home and service dept. Two position trigger gives instant dual heat. 100/140 watt. 240 volt A.C.

£3.95 P. & P. 50p

"Litesold" Soldering Iron. Lightweight ⅛" pencil bit. Ideal for regular beach use and around the home. 25 watts. 240 volt A.C. £1·50 P. & P. 16p.

LOW-NOISE COMPACT CASSETTES

Screw fixing—fully guaranteed. In Library cases.

	EACH	3 for	6 for	10 for
C60	29p	81p	£1·56	£2·50
C90	40p	£1·11	£2·16	£3·50
C120	52p	£1·40	£2·76	£4·50

P. & P. 10p each (3 and over 15p)

PREMIER RADIO

23, TOTTENHAM COURT ROAD, LONDON, W.1 Tel: 01-636 3451

SAXON ENTERTAINMENTS.

STANDARD & CUSTOM-BUILT AUDIO & ELECTRONIC EQUIPMENT
NEW & SECONDHAND MUSICAL INSTRUMENTS. MAIN DISTRIBUTORS FOR A.K.G. HIGH QUALITY MICROPHONES.

SA25-SA35-SA100

LOW-PRICED AUDIO MODULES FOR DOMESTIC & COMMERCIAL USE

THESE THREE MODULES HAVE ENJOYED UNPARALLELED SUCCESS DURING THE FIRST FEW MONTHS OF THEIR BEING MADE AVAILABLE TO THE GENERAL PUBLIC. WE ARE PLEASED TO ANNOUNCE THAT WE CAN NOW OFFER FAST DISPATCH ON MOST OF OUR ADVERTISED ITEMS, INCLUDING THESE THREE MODULES.

SA25 £2·95 carr. free
25 WATTS RMS. 7 transistors 7 diodes

SA35 £4·45 carr. free
35 WATTS RMS. 7 transistors 7 diodes

SA100 £10·90 carr. free
100 WATTS RMS. 11 transistors 6 diodes

ALL THREE MODULES HAVE OPEN & SHORT CIRCUIT PROTECTION, AND THE SA100 IS PROOF AGAINST OVER-DISSIPATION & FAULTY INDUCTIVE LOADS. ONLY ADVANCED DESIGN TECHNIQUES MAKE THESE EXTRA-ORDINARILY LOW PRICES POSSIBLE.

BRIEF SPEC. FOR ALL THREE MODULES

Freq. response	15–40,000 Hz ± 1dB
Distortion	0·2% at 1 kHz
Loads	4 to 16 ohms
Quiescent current	15 mA
Noise	Better than —75 dB
Supply voltage	25–45 volts SA25/35 40–70 volts SA100
Size	4½" x 4" x 1" (SA100) 4" x 3" x 1" (SA25/SA35)

Circuits, connecting instruction and application data are supplied free with all modules.

POWER SUPPLIES FOR THE SA25/35 & SA100 AUDIO MODULES

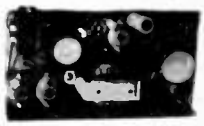
PU45	Unstabilized supply for 2 SA25/35	£4·90
PU70	Unstabilized supply for one or two SA100	£7·75 carr. 40p
MT45	Transformer for above, heavy duty	£2·85 carr. 20p
Stab PS45	Stabilized module for 2 SA25's or two SA35's	£3·50 carr. free
MT30	Transformer for unstabilized supply complete with rectifier diodes mounted	£3·50 carr. 20p
MT70	Transformer for PS70	£4·90 carr. 40p
PS70	Stabilized supply module for one or two SA100's	£4·90 carr. free

ALL MODULES ARE BUILT ON GLASS FIBRE P.C. BOARD AND ARE SUPPLIED FULLY TESTED

OTHER SAXON PRODUCTS . . .

120 WATT HEAVY DUTY MODULE £13·90 + 20p carr. or with supply
£18·95 + 40p carr.

Featuring a rugged class A driver stage, this module will run from all our mixers, etc., and most other makes of mixer. It delivers 120 watts into an eight ohm load and employs 4 T03 can (115 watt) output transistors.



SPECIFICATION

Power output	120 watts into 8 ohms
Freq. response	20-20,000 HZ ± 2dB
Input sensitivity	200 mV into 10K
Construction	Fibreglass board
Size	8" x 4" x 4" (5" with supply)

Low distortion parallel push-pull output stage.

NEW 160 watt version & supply **£27·90**

SINGLE CHANNEL SOUND/LIGHT CONVERTER

This compact and reliable unit operates from amplifiers with outputs from 5–100 watts. Does not impose a heavy load on the amplifier, or, if connected in the wrong polarity, cause any damage, as with some units.

Operation is simplicity itself and the unit is fully fused. The unit is supplied to function from bass notes but may easily be converted to respond only to treble or mid-range notes by the addition of components costing less than 5p.

£8·90 carr. free

THREE CHANNEL SOUND TO LIGHT UNIT

Handling the total of 3000 watt (3kw) this unit is unique for its price in that not only bass, middle and treble but also master controls are provided. Two amplifier sockets eliminate the need for split leads etc. Supplied in tough white steel case with a blue hooded cover. Fully guaranteed.

£19·75 carr. 30p

MONO VERSION £6·50 carr. 20p (As illustrated. S.A.E. details 9 volt operation) Outputs up to 1 volt RMS

£15·80 carr. 30p

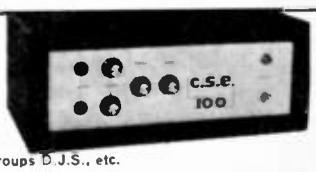
SAXON STEREO CONTROL UNIT

Two decks, and full headphone monitoring. The unit is mains operated and measures 17½" x 3" x 4" deep and is finished with a smart white on black facia. The controls are: Left/Right deck fader, volume, bass, treble, Headphone Selector and volume, Microphone volume, bass, treble, mains on/off.
THIS IS A MUST FOR THE HOME BUILT HIGH QUALITY DISCOTHEQUE AND IS COMPARABLE TO UNITS AT OVER TWICE THE PRICE. (N.B.—Stereo only has mic input.)

COMPLETE AMPLIFIERS

The CSE 100. £34·90 carr. free

This versatile unit is now available in a black vynide case and so represents even better value than ever delivering speech and music powers of up to 100 watts RMS and continuous signal outputs of 70 watts. Two individually controlled inputs with wide range bass and treble controls. Ideal for small groups D.J.S., etc.



The SAXON 100 £48·50 carr. free

With an RMS output of 120 watts speech and music, 100 watts continuous power, four individually controlled FET input stages and wide range bass and treble controls, this amplifier has established itself as a unit offering quality and reliability at low cost.

LOUDSPEAKERS British made bargains!!
12" 25 watt 8/15 ohms £5·95 carr. 30p. 15" 50W 8/15 ohm £14·50 carr. 50p.
12" 40 watt 15,000 gauss magnet system 8/15 ohm £11·50 carr. 40p.

A.K.G. MICROPHONES suitable for disco, group or general P.A. use.
D11DHL rrp £11·00 our price £9·45 post free
D190C High Z rrp £21·50 our price £17·45 post free
D1000C 24 ct gold plate rrp £37·00 our price £32·00 post free

SEND SAE FOR OUR AKG PRICE LIST. DISCOUNTS ON ALL MICS.

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to 5.30 p.m.

TERMS OF BUSINESS:
C.W.O. or C.O.D. (35p extra)
All cash in regd. envelopes please!
Telephone orders to our CROYDON BRANCH.
TRADE & EXPORT enquiries invited.

ZN414 £1.25 POST FREE

The I.C. Radio in a TO18 can. Supplied complete with data sheet No. 10 which contains specification, circuit and details and prices of components such as ferrite rods, compression trimmers etc.

I.C. Sockets

Dual-in-line or Zig-Zag (Dual), 14 and 16 pin
Our Price 1p per pin

Slider Pots

Single	Dual	log
10K	10 + 10K	or
25K	25 + 25K	lin
50K	50 + 50K	
100K	100 + 100K	Knobs
30p	50p	10p.

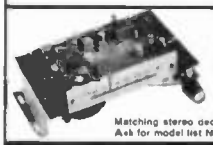
NEW LISTS

LOUDSPEAKERS	No. 4
COILS AND INDUCTORS	No. 5
TRANSFORMERS	No. 6

(postage 5p)

Diodes & Rectifiers

AA119	9p	BA156	15p	BY176	£1·50
AA120	9p	BA243	56p	BY182	£1·50
AA129	9p	OA47	10p	BY250	23p
BA102	25p	OA79	9p	IN4001	6p
BA115	17p	OA90	7p	IN4002	7p
BA130	10p	OA91	7p	IN4003	8p
BA145	20p	OA200	10p	IN4004	8p
BA148	20p	BY100	15p	IN4005	10p
BA154	13p	BY126	15p	IN4006	12p
BA155	14p	BY127	15p	IN4007	15p



FM TUNER chassis fully transistorised 8 volt operation. **OUR PRICE £6·25**
Matching stereo decoder £4·87
Ask for model list No. 11.

VDR's & Thermistors

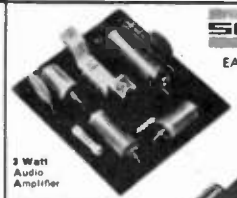
A158	75p	GL23	£1·00	VA1005	15p
CZ1	15p	R53	£1·32	VA1026	13p
CZ4	13p	R54	£1·46	VA1033	13p
CZ13A	13p			VA1040	10p
E298 ED/A258	10p			VA1053	10p
E298 ZZ/06	10p			VA1055S	10p
GL16 £1				VA1034	10p

Resistors

¼ watt 5% Carbon Film – low noise Hi-Stab
All E24 values 1p each plus p. & p. 7p for up to 50 Resistors and a further 2p for each additional 50. Deduct 33⅓% for 100 of one type or 25% for mixed orders over £1 in value.

1 W	10% Carbon Composition	3p each
2 W	10% Carbon Composition	6p each
2 W	5% Wire wound	9p each
5 W	Wire wound	9p each
10 W	Wire wound	10p each

plus p. & p. 7p for up to 25 resistors plus 1p for each additional 25.



SGS EA1000

3 Watt Audio Amplifier
Our Price inc. handbook £2·49

10+ less 18%
25+ less 25%
100+ less 33⅓%

5 Watt Audio Amplifier
Our Price £3·99
Less quantity discount.

Potentiometers

5KΩ	50KΩ	500KΩ
10KΩ	100KΩ	1MΩ
25KΩ	250KΩ	2MΩ

log or lin less switch (& 1KΩ lin) 12p
log or lin with switch 24p
dual less switch 40p
dual with switch 10K, 100K & 1M log only 52p
10K log + 10K antilog less switch 40p

Eliminators

9 volt @ 20mA (PP3)	£1.25
6 volt @ 50mA	£1.50
9 volt @ 50mA	£1.50
6 + 6 volt, 50mA	£2.50
9 + 9 volt, 50mA	£2.50
7½ volt for cassette recorders	£2.00
6, 7½ or 9 volt	£3.00
3, 4½, 6, 7½, 9, 12 @ 500mA (illus.)	£3.99

Car Battery Converter fully stabilised to provide 6, 7½ or 9 volts £4.99
(p. & p. 15p on all types)

Presets

Vertical or Horizontal

0·1 watt 5p	0·25 watt 7p			
100	1K Ω	10K Ω	100K Ω	1M Ω
250	2·5K Ω	25K Ω	250K Ω	2·5M Ω
500	5K Ω	50K Ω	500K Ω	5M Ω

Capacitors

disc ceramic		low voltage	
·01μF 18v	5p	0·1μF 30v	5p
·022μF 18v	5p	0·22μF 6v	5p
·047μF 12v	5p	0·47μF 3v	5p
ceramic plate		30V	
1000pf	10p	4700pf	10p
2200pf	10p	10,000pf	10p

Ceramic – plate	63V (C333)	
1·8pf	8·2pf	33pf 120pf
2·2pf	10pf	39pf 150pf
3·3pf	12pf	47pf 180pf
3·9pf	15pf	56pf 220pf
4·7pf	18pf	68pf 270pf
5·6pf	22pf	82pf 330pf
6·8pf	27pf	100pf

all 5p. each

mylar film	100V		
1000pf 2p	·01μF 3p	·068μF 4p	
2000pf 2p	·02μF 3p	·1μF 4p	
5000pf 2p	·04μF 3p	·2μF 5p	
	·05μF 3p		

polystyrene 160V
10pf to 10,000pf in multiples of 10, 15, 22, 33, 47 & 68. **3p each**

metallised polyester	250V (C280)		
·01μF 3p	·068μF 3½p	·47μF 8p	
·015μF 3p	·1μF 4p	·68μF 11p	
·022μF 3p	·15μF 4p	1μF 13p	
·033μF 3p	·22μF 5p	1·5μF 20p	
·047μF 3p	·33μF 6½p	2·2μF 24p	

metallised polyester	400V (C281)	
·01μF 4½p	·047μF 6p	·22μF 10p
·015μF 4½p	·068μF 6p	·33μF 14p
·022μF 4½p	·1μF 7p	·47μF 15p
·033μF 5½p	·15μF 8p	

silvered mica 1% (>50pf) 500V

2·2pf—820pf	7p	4·7nF—5600pf	18p
1nF—2·2nf	9p	6800pf—·01μF	29p
2·7nF—3·6nF	16p		

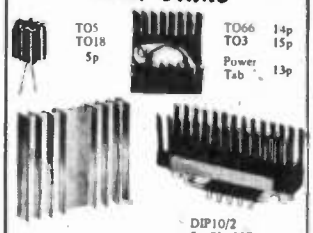
mixed dielectric	600V		
·01μF 7p	·047μF 7p	·22μF 16p	
·022μF 7p	·068μF 8p	·47μF 24p	
·033μF 7p	·1μF 8p	1μF 33p	

mixed dielectric	1000V		
1000pf 6p	6800pf 9p	·1μF 12p	
2200pf 6p	·01μF 9p	·22μF 22p	
3300pf 6p	·022μF 9p	·47μF 30p	
4700pf 6p	·047μF 12p		
Ceramic			
12KV.d.c.	8KV.d.c.	HI-K 750V.	
10pf 9p	200pf 9p	1000pf	5p
15pf 9p	220pf 9p	1500pf	5p
22pf 9p	250pf 9p	2000pf	5p
68pf 9p	270pf 9p	3000pf	5p
82pf 9p	300pf 9p	5000pf	5p
100pf 9p	750V DISC	10,000pf	5p
120pf 9p	470pf 5p	feed-through	
140pf 9p	1000pf 5p		
150pf 9p	5000pf 5p		
180pf 9p	10,000pf 5p	1000pf	5p

CHROMASONIC electronics

MAIL ORDERS: Where no p. & p. charge is shown, a minimum of 7p applies. p. & p. on overseas orders is charged at cost.
ADDRESS TO: **M. O. Dept.**
56, Fortis Green Road, London N10 3HN
Telephone 01-883 3705

Heat Sinks



TO5 TO18 5p
TO66 TO3 14p 15p
Power Tab 13p
DIP10/2 for SL403D 10D 50p 15p

Veroboard

	Copperclad		Plain
	0.1"	0.15"	0.15"
2½" x 1"	6p	6p	—
2½" x 3⅜"	20p	16p (9)	10p
2½" x 5"	24p	21p (7)	12p
3⅜" x 3⅜"	24p	21p (8)	—
3⅜" x 5"	27p	27p (10)	17p
17" x 2½"	67p	50p	37p
17" x 3⅜"	90p	70p	52p
17" x 5"	—	—	75p

Spot-face Cutter 36p
Pin Insertion Tool 47p
Terminal Pins 18p per pack of 36

NEW LISTS

BOXES, CHASSIS, etc	No. 7
TRANSISTORS, I.C.'s, etc.	(soon)

(postage 5p)

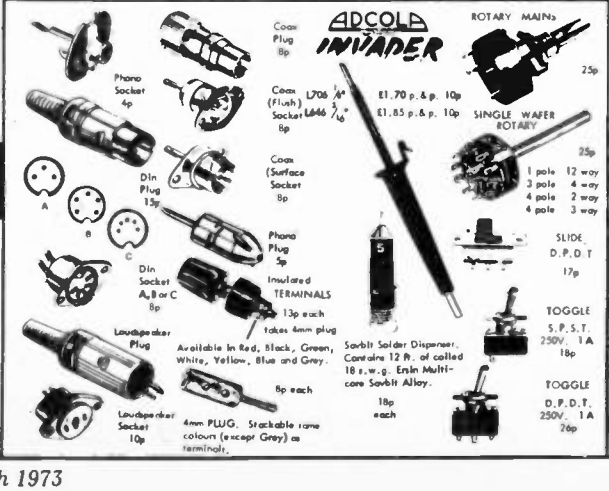
Aluminium Boxes

Including baseplate and screws

No.	L.	W.	D.	Price	p. & p.
(7)	2⅜"	x 5⅛"	x 1½"	35p	8p
(8)	4"	x 4"	x 1½"	35p	8p
(9)	4"	x 2¾"	x 1½"	35p	8p
(10)	4"	x 5⅛"	x 1½"	40p	8p
11	4"	x 2½"	x 2"	35p	8p
12	3"	x 2"	x 1"	32p	9p
13	6"	x 4"	x 2"	50p	10p
14	7"	x 5"	x 2½"	58p	12p
15	8"	x 6"	x 3"	75p	18p
16	10"	x 7"	x 3"	85p	20p

Transistors & Integrated Circuits

AC107	25p	BC147	10p	BF196	15p	OC81	16p	2N1304	22p	2N5172	15p
AC126	17p	BC148	10p	BF197	15p	OC140	28p	2N1711	25p	BZY88 ZENERS SERIES	19p ea.
AC127	15p	BC149	10p	BF272	53p	OC170	23p	2N1893	38p		
AC128	15p	BC157	12p	BFY90	24p	OC171	38p	2N2926 all	10p	LO05T1	£1.50
AC176	15p	BC158	10p	BFY51	21p	ZTX107	15p	2N3053	23p	LO38T1	£1.50
AC187	25p	BC159	12p	BRY39	38p	ZTX108	12p	2N3054	50p	LO37T1	£1.50
AC187K	25p	BC169	15p	BSX21	28p	ZTX109	15p	2N3055	49p	MC1303L	£1.75
AC188	25p	BC268	15p	BSY95A	14p	ZTX300	12p	2N3702	12p	MC1330	88p
AC188K	25p	BD115	67p	BU108/02	£1.75	ZTX301	15p	2N3703	12p	MC1350	75p
ACY20	20p	BD131	70p	MJE340	67p	ZTX302	20p	2N3704	19p	MC1351	£1.00
AO140	40p	BD132	70p	MPF192	48p	ZTX303	20p	2N3705	19p	MC1352	£1.80
AO149	40p	BO131/EM.P.		MPF103	37p	ZTX304	25p	2N3706	18p	MFC4000B	48p
AD161 AD162	60p		148p	MPF104	37p	ZTX341	20p	2N3707	15p	MFC4010A	55p
AF114	18p	BF180	21p	MPF105	48p	ZTX500	15p	2N3708	12p	LM380	£1.48
AF115	18p	BF167	20p	MPF106	45p	ZTX501	15p	2N3709	12p	SL403D	£1.50
AF116	18p	BF173	20p	OC28	40p	ZTX502	20p	2N3710	12p	TAD100	£1.50
AF117	18p	BF180	25p	OC35	48p	ZTX503	17p	2N3711	12p	FILTER CRYSTAL	£1.00
AF139	28p	BF181	30p	OC44	15p	ZTX504	50p	2N3819	35p		
BC107	10p	BF184	25p	OC45	15p	ZTX531	25p	2N3903	15p	μA709C	45p
BC108	10p	BF185	25p	OC71	11p	2N697	18p	2N3904	17p	μA710	45p
BC109	10p	BF194	15p	OC72	17p	2N706	12p	2N3905	21p	μA723C	£1.85
BC109	10p	BF195	15p	OC76	15p	2N708	15p	2N3906	12p	μA741C	38p



Mullard & Siemens Electrolytics

CAP μF	VOLTAGE 4	6.3	10	16	25	40	63
1	—	—	—	—	—	—	6p
1·5	—	—	—	—	—	—	6p
2·2	—	—	—	—	—	—	6p
3·3	—	—	—	—	—	—	6p
4·7	—	—	—	—	—	—	8p
6·8	—	—	—	—	—	8p	6p
10	—	—	—	—	6p	—	6p
15	—	—	—	8p	—	8p	8p
22	—	—	8p	—	8p	—	8p
33	—	8p	—	8p	—	6p	—
47	6p	—	6p	—	8p	6p	8p
58	—	8p	—	8p	—	—	10p
100	8p	—	8p	—	8p	6p	12p
150	—	8p	—	8p	8p	10p	12p
220	8p	—	8p	8p	10p	12p	18p
330	8p	—	8p	10p	—	—	21p
470	—	8p	10p	—	12p	18p	40p
680	—	10p	—	12p	18p	21p	—
1000	10p	—	12p	18p	21p	40p	60p
1500	—	12p	18p	21p	—	—	—
2200	—	18p	21p	40p	45p	56p	83p
3300	—	21p	—	—	—	—	—
4700	21p	—	—	80p	75p	93p	—

CAP μF	VOLTAGE 16	25	40	64
500			33p	40p
1250			80p	—
1600			—	75p
2000		40p	50p	—
2500		—	75p	93p
3200		50p	—	—
4000		—	75p	93p
6400		75p	93p	—

Quantity Prices on application.

Hi-Volt Electrolytics

1; 2; 4; 8μF	450V	14p	32μF	450V	20p
16μF	450V	15p	50μF	350V	20p
8+8μF;	450 V.W	18p	32+32μF;	350 V.W	25p
8+16μF;	450 V.W	20p	32+32μF;	450 V.W	43p
16+16μF;	450 V.W	25p	50+50μF;	350 V.W	35p

MAINS OPERATED CONTACTOR

220/240v. 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10 amps. Extremely well made by a German Electrical Company. Overall size 2½ × 2 × 2in. £1·50 each.

NEED A SPECIAL SWITCH?

Double Leaf Contact. Very slight pressure closes both contacts. 7p each. 10 for 60p. Plastic pushrod suitable for operating. 5p each. 10 for 45p.

CAR PANEL SWITCH

Our Ref. No. S02. Arco made. Has long flat ended toggle, black and chrome finish. Rated 2A at 250V and is double pole on/off. Listed at 45p. Our price 22p each.

CAR PANEL AUTO SWITCH

Ref. No. S03. Again a flat ended toggle. Made by Arrow. A 3 position double pole changeover switch centre off for auto aerials, reversing motors, etc. 30p each.

MAINS TRANSISTOR POWER PACK

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

MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 20p each £1·80 for ten, your assortment.

PORCELAIN FUSE AND CARRIER

20A 250V MEM Ref. No. 15LBB/15LRHW. Make your own fuse board. Price 20p per pair.

FLUORESCENT TUBES

Standard types—B9pin ends, ideal pelmet lighting as well as for standard replacements—18in 15W, 24in 40W, 36in 40W, 39½in 40W. All first grade tubes offered at one price—£3·50 per box of 24—i.e. less than 15p each. If not collecting then please add 50p per box per 200 miles.

MULTI-SPEED MOTOR

Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000; 12,000 & 16,500 r.p.m. shaft is ¼ in. diameter 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price 88p plus 23p postage and insurance.

MAINS MOTOR

Precision made—as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at 65p. Postage 20p for first one then 10p for each one ordered.
1" stackmotor 85p.
1½" stackmotor £1.

PANEL NEON INDICATOR

Our Ref. No. P101. Oblong type self-fixing into oblong hole. Suitable for 200/250V. Price 13p each.

FLUORESCENT CONTROL KIT

Each kit comprises seven items—Choke, 2 tube ends, starter, holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Groilux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15–20 w. £1. Kit B—30–40 w. £1. Kit C—80 w. £1·20. Kit E—65 w. £1·20. Kit F for 8ft, 125 w. tube £1·75. Kit MF1 is for 6in., 9in. and 12in. miniature tubes £1. Kit MF2 for 21in. 13 w. miniature tube £1. Postage on Kits A and B 23p for one or two kits then 23p for each two kits ordered. Kits C, D and E 23p on first kit then 18p for each kit ordered. Kit F 33p then 23p for each kit ordered. Kit MF1 18p on first kit then 15p on each two kits ordered.

HEAT & LIGHT LAMP

Plugs into a lamp holder. Ideal in bathroom, toilet, over bed, etc. 90p plus 20p P. & P.

HOUR MINUTE TIMER

Made by Smiths. Complete with control knob and calibrated dial. Useful in kitchen, office, dark-room, etc. Bargain at 50p.

MIGHTY MIDGET

Probably the tiniest possible radio, as described in Practical Wireless, January 73. All electronic parts £2 post paid.

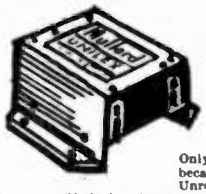
DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work, £2·25 plus 23p P. & I

HORSTMANN "TIME & SET" SWITCH

(A30 Amp Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc. up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price £1·50 Post and ins. 23p.

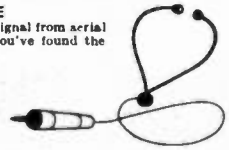
4 WATT AUDIO AMPLIFIER



Works off dry batteries, car battery or mains power pack. Only £1·65. This low price possible only because the make is over produced. Unrepeatable once stocks are cleared. Made by the famous Mullard company and carries their full guarantee. Complete in dustproof case, amplifier may be used for Mono or Stereo, music or speech. Hundreds of applications. Frequency response 50H3-16KH3. Supplied complete with connection diagram and operating notes.

FREE all purchasers receive Mullard booklet "Do It Yourself Stereo" tells all you need to know to build your own stereo system. Write today to avoid missing this terrific offer.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything — complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2—twin stethoset instead of earpiece 75p extra—post and ins. 20p.

24hr. REPEATING TIME SWITCH

Made by Smiths these are A.C. mains operated. NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours. 5 amp change-over contacts will switch circuit on or off during these periods £2·50 post and ins. 23p. Additional time contacts 50p pair.

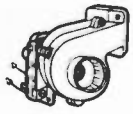
ATLAS TWENTYLITE

Fluorescent lighting units with polyester choke and finished white enamel. 2ft model, ideal kitchen, bedroom, hallway, porch, loft etc. With tube assembled ready to instal. £1·99 + 40p postage.

HONEYWELL THERMOSTAT

Made by Honeywell for normal air temperatures 40°–80°F (5–25°C). This is a precision instrument with a differential which can be adjusted to better than 1·5°F. A mercury switch breaks on temp. rise—the switch is operated by a coiled bi-metal element and adjustable heater is incorporated for heat anticipation. Elegantly styled and encased in an ivory plastic case with clear plastic windows thermometer above and switch setting scale below-size approx. 3·8" x 3·2" x 1·4" deep—can be mounted on conduit box or directly on wall. Price £1·25 each for ten for £11·25.

CENTRIFUGAL BLOWER



Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4½" × 4½" × 4". When mounted by flange, air is blown into the equipment but to suck air out, mount it from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying cabinet or for removing flux smoke when soldering etc. etc. A real bargain at £1·85.

BATTERY CONDITION TESTER

Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese—nicad—silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads "replace" "weak" or "good". The tester is complete in its case, size 3½" x 6½" 2" x with leads and prods. Price £2·50 plus 20p postage.

12 WAY SUB-MINIATURE MULTI-CORE CABLE

7·0076 copper cores each core P.V.C. insulated and of different colour. P.V.C. covered overall and approx. 3/16in. thick. Price 20p per yard.

SNAP ACTION SLIDE SWITCH

Rated 5a. 240v. Made by Arrow. Type fitted in the handles of electric drills, vacuums, etc. 5p each. 10 for 45p.

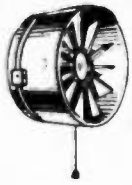
BATTERY CHARGER KIT

Comprising 3 amp 12V mains trs. and rectifier with wiring diagram. £1·25 + 25p P. & P.

BLACK HEAT ELEMENTS

Ideal for making convectors and similar devices Two joined in series approx. 1KW. Price 75p per pr. + 20p postage.

EXTRACTOR FAN



Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact, 5½" casing with 5½" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets. £2·50 + 20p P. & P.

CD CAR IGNITION

This system which has proved to be amazingly efficient. We offer kit of parts as P.W. Circuit £5·95 plus 20p p. & p. Deluxe model with prepared circuit board £6·95. When ordering please state whether for positive or negative systems.

EXIT SIGNS

One of our customers has pointed out how easily our box signs can be converted to exit signs. These are illuminated having a 20W fluorescent lamp with associated control gear. The front is very thick. clear plastic. Directly onto this you can stick down the letters available at most stationers. There is room inside the box for a battery and low volt lamp in the case of power failure. Size of sign is 2ft high × 14in wide × 5in deep. Solidly made from sheet steel and hammer finished in enamel. Price £3·50 plus 50p carriage per 200 miles.

SPIT MOTOR

200-250V induction motor, driving a Carter gearbox with a 1½" output drive shaft running at 5 revs p.m. Intended for roasting chickens, also for driving models—windmills, coloured disc lighting effects, etc. £1·85 plus 20p post and ins.

SOLDER GUN

A must for every busy man, gives almost instant heat also illuminated job. 100 watt £2·25 plus post and ins. 20p. BIG JOB 250 watt model £4·75 plus post and ins.40p.

TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. 38p. KNUCKLED MODEL FOR F.M. 50p

TREASURE TRACER

Complete Kit (except wooden battens) to make the metal detector as the circuit in Practical Wireless, August issue. £2·95 plus 20p post and insurance

MINIATURE ROCKER SWITCH

Our Ref. RS01. 10A 240V. Self-fixing into hole size approx. 1in × ½in by famous French maker Rumsemburgh. Price 10p each.

MAINS OPERATED SOLENOIDS

Model 772 — small but powerful 1" pull —approx. size 1½ × 1½ × 1½" 60p.

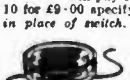
Model 400/1 ½" pull Size 2½" × 2 × 1½" 75p.

Model TT10 1½" pull size 3 × 2½ × 2" £1·80 plus 20p post and insurance.

RESETTABLE FUSE

How long does it take you to renew a fuse? Time yourself when next one blows. Then reckoning your time at £1 per hour see how quickly our resettable fuse (auto circuit breaker) will pay for itself. Price only £1 each or 10 for £9·00 specify 5, 10 or 15 amp—*simply fit in place of switch.*

LIGHT CELL



Almost zero resistant in sunlight increases to 10 K Ohms in dark or dull light, epoxy resin sealed. Size approx. 1in. dia. by ¼in. thick. Rated at 500 MW, wire ended. 60p with circuit. Also ORP 12 light cell 60p.

TAPE HEADS

We are gradually obtaining more information about the Truvox tape heads we have, we are told that these have been wound in a very ingenious way so that winding may be coupled either in parallel or in series depending whether high or low impedance is required. We also have matching erase heads and now offer these in pairs. 1 record and 1 erase head. Price of the 2 track 45p per pair. 4 track 75p per pair. Pair mounted on plate 45p extra.

1 R.P.H. MOTOR

Made by the famous Smiths Company. 240v 50 cycle mains working. Ideal motor to drive clock mechanisms. Price £1 each or 10 for £9.

DRILL CONTROLLER

NEW IKW MODEL

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £1·50 plus 13p post and insurance. Made up model also available. £2·25 plus 13p post & p.

HIGH ACCURACY THERMOSTAT

Uses differential comparator I.C. with thermister as probe. Designer claims temperature control to within 1/7th of a degree. Complete kit with power pack £5·50.

WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. 50p post free.

15A ELECTRICAL PROGRAMMER

Learn in your sleep; Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an electrical programmer Clock by famous maker with 15 amp. on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours. Independent 60 minnta memory jogger. A beautiful unit. Price £1·95 + 20p p & p or with glass front chrome bezel 75p extra.

INSTANT START UNITS

For 2ft tubes. Philip's or Smart & Brown in a tray complete with tube clips and tube ends. Price £1·50 each or 10 for £13·50.

EDUCATIONAL KITS—all with pictorial instructions

THIS BALANCE KIT FREE

Eagle educational kits. Japanese made these are excellent value for money. We do not expect to be able to repeat this offer once stocks are sold. Brief description of each kit is given below and with 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits 40p each post paid. Special price for all 8 kits £3·00 with free balance kit.

KA1 Balance Kit. Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism with an automatic switch results in an operating buzzer.

KA2 Lens Kit. Eleven parts, including candle, one concave lens, one convex lens, stage and slit frame, etc. Watch light rays bend as they pass through different lenses.

KA3 Water Pump Kit. Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working. Three types of pump may be made: Lift pump, Force Pump and Force Pump with reservoir and nozzle.

KA4 Buzzer Kit. Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism with an automatic switch results in an operating buzzer.

KA6—2-Pole Motor Kit. Twenty-four parts including enamel wire, armature and pole piece, etc. Motor operates from 1½ volt battery. Illustrates and teaches how electro-magnetism operates a motor.

KA7 Electro-Magnet Kit. Fifteen parts, includes compass. Makes two electro-magnets, one with one layer of wire and one with several layers of wire. Picks up tacks, nails and any small parts showing how magnetism works.

KA8 Current and Resistance Kit. Twenty-nine parts, including bench and light bulb. Conduct interesting and educational projects to learn the application of "OHMS LAW" and see the difference in current and resistance with different types and lengths of wire.

KA9 Bell Kit. Eight parts, including bell and push button switch. Build a complete electric bell and see how the hammer is triggered to make the bell ring.

KA10 Morse Key buzzer and bell kit. 25 part kit easy to construct, simple to operate.

ELECTRONIC EGG TIMER
ENLARGER EXPOSURE METER
NEON NOVELTY

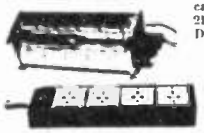
To receive parts for these and other projects featured in this issue send quoted approximate amount any cash adjustment can be made later.

THYRISTOR LIGHT DIMMER

For any lamp up to 600 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interferences. Price £2·95 plus 20p post and insurance.

TANGENTIAL HEATER UNITS

This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. 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 need control switch. £3·50. 2kW. Model as above except 2 kilowatts £2·50. Don't miss this. Control Switch 35p. P. & P. 40p.



DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 x 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. £2·25 plus 23p P. & I

THIS MONTH'S SNIP

5 AMP VARIAC for £3

This heading is not quite accurate because it is not a variable transformer that we are offering but a solid state device which serves the same purpose in almost all applications and, of course, much smaller. Made by Ultra Electronics, can be fitted into ordinary switch box. Engrave a circle on the front plate, mark this off in divisions, fit a pointer knob, calibrate with your voltmeter (you will find the scale almost linear) you now have a power controller equal to a 5 amp variac costing £12 or more.

BARGAIN PARCEL OF SEVEN MOTORS FOR £1

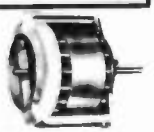
A bargain parcel of 7 motors for £1. Some not as large as a postage stamp and only ¼" thick, largest is 1½" x 1½" dia. Some work off 1½v some as high as 18v. These motors are used in racing cars, power toys etc. The largest is so powerful that it will drive a Mini drill model lathe, or similar. This is a 4 pole motor, optimum working 16·5v but very powerful even as low as 4½v. Don't miss this wonderful snip.

STANDARD WAFER SWITCHES

Standard size 1½" wafer—silver-plated 5-amp contact, standard ¼" spindle 2" long—with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	40p	40p	40p	40p	40p	40p	40p	40p	40p
2 poles	40p	40p	40p	40p	40p	40p	40p	70p	70p
3 poles	40p	40p	40p	40p	70p	70p	70p	95p	95p
4 poles	40p	40p	40p	70p	70p	70p	70p	£1·20	£1·20
5 poles	40p	40p	70p	70p	95p	95p	95p	£1·45	£1·45
6 poles	40p	70p	70p	70p	95p	95p	95p	£1·70	£1·70
7 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£1·95	£1·95
8 poles	70p	70p	70p	95p	£1·20	£1·20	£1·20	£2·20	£2·20
9 poles	70p	70p	95p	95p	£1·45	£1·45	£1·45	£2·45	£2·45
10 poles	70p	70p	95p	£1·20	£1·45	£1·45	£1·45	£2·70	£2·70
11 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£2·95	£2·95
12 poles	70p	95p	95p	£1·20	£1·70	£1·70	£1·70	£3·20	£3·20

PAPST MOTORS



Est. 1/40th h.p. Made for 110–120 volt working, but two of these work ideally together off our standard 240 volt mains. A really beautiful motor, extremely quiet running and reversible. £1·50 each. Postage one 23p, two 33p. 230V model £3.

BAKELITE INSTRUMENT CASE

Size approx. 6¼" x 3¼" x 2" deep with brass inserts in four corners. This is a very strong case suitable to house instruments and special rigs, etc. Price 45p each. Par lid 10p extra.

50 MICRO AMMETER Square, panel mounting type. £2

INTEGRATED CIRCUIT BARGAIN

A parcel of integrated circuits made by the famous Plessey Company. A once-in-a-lifetime offer of Micro-electronic devices well below cost of manufacture. The parcel contains 5 ICs all new and perfect, first-grade device, definitely not sub-standard or seconds. 4 of the ICs are single silicon chip GP amplifiers. The 5th is a monolithic NPN matched pair. Regular price of parcel well over £5. Full circuit details of the ICs are included and in addition you will receive a list of many different ICs available at bargain prices 25p upwards with circuits and technical data of each. Complete parcel only £1 post paid.

DON'T MISS THIS TERRIFIC BARGAIN.

CHIP RADIO

Ferranti's latest device ZN414–gives results better than superhit. Supplied complete with technical notes and circuits. £1·25 each. 10 for £11.

12 VOLT 1½ AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 m/f/d" smoothing. Price £1·95, plus 20p post & packing.

250 WATT POWER PACK

9-50 volts, 20·5 amp using full wave and half wave circuits voltage changes by inter connection of push-on tag. Price £5·50 + 50p p. & p. N.B. Note these make excellent car battery chargers.

AMPLIFIER IN CASE WITH SPEAKER

Marketed by British Relay under the name Luxistor. This is in a very neat looking cabinet and is ideal around the home or in the workshop for trouble shooting or for testing out a quick lash up Size approx. 9½" x 6½" x 3½" deep. Input is via a matching transformer and volume control and amplifier may be powered by an internal 9v battery or an external 110v source. Speaker is an R-A eliptical 6" x 3½" 10,000 gauss. The amplifier proper is a Newmarket model ref. P.C.4. Price £3·50 each. 10 for £31·50. Post and insurance 20p

TELEPHONES

Complete as illustrated. Save your legs, time and temper, simply by putting in some telephones. Ex. G.P.O. not new—but guaranteed in good condition and serviceable. supplied with diagram and instructions showing how to connect. Price £1·00 each + 50p post or 2 for £2·50 post paid. Also available separately. dials and bandsets 50p each + 20p post.

ROCKER SWITCH

13 amp self-fixing into an oblong hole. size approximately 1" x ½" 8p each. 10 for 72p.

SLIDE SWITCHES

Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in x ¾in. rated 250V lamp. 7p each. 10 for 63p, 500 for £24. Ditto as above but for printed circuit 5p each 10 for 45p, 100 for £4·25.

Snb Miniature Slide Switch. DPDT 19mm (¾in approx.) between fixing centres. 18p each or 10 for £1·08. SP Change over spring return 250v 1 amp. 10p.

KITS FOR PREVIOUS PROJECTS

Unless otherwise stated, kits contain electronic parts only. The case and special items can be obtained locally. Also batteries are not included. Kits may be returned for refund if construction has not been started. We reserve the right to substitute components should deliveries be protracted so as to avoid undue delay.

HOME SENTINEL INTRUDER ALARM	£3·75
SNAP INDICATOR	75p
WINDSCREEN WIPER CONTROL	£2·25
RECORD PLAYER	£5·50
(amplifier components only)	
DEMO DEC	£7·00
FUZZ BOX	£1·85
PHOTOGRAPHIC COLOUR TEMPERATURE METER	£2·65
ASTRON RADIO	£3
REMOTE TEMPERATURE COMPARATOR	£4·25
ELECTRO LAUGH	£2
RAIN WARNING ALARM	£1·80
WA-WA PEDAL	£2·90
SIGNAL INJECTOR	80p
SOIL MOISTURE METER	£3·00
SIMPLE CALCULATOR	£2·20
DC POWER SUPPLY	£5·00
BABY ALARM	£4·00
AUDIO TONE GENERATOR	£2·60
METAL LOCATOR	£4·00
LIGHT TO SOUND CONVERTER	£1·70
THRU LENS LIGHTMETER	£3·50
DRILL SPEED CONTROLLER	£2·00
ELECTRONOME	£1·75
SHAVER INVERTER	£3·75
I.R. BURGLAR ALARM	£3·50
L & M RADIO TUNER	£2·50
TAPE POWER SUPPLY MAINS	£2·00
CAR	£1·10
ELECTRONIC MOUSE-TRAP	£2·75
REACTORMATIC	£3·00
RADIO CONTROL RECEIVER	£3·00
RADIO CONTROL TRANSMITTER	£5·50
BIT SAVER	£1·50
ICE WARNING DEVICE	£1·40
BETA TREBLE BOOST & FUZZ	£6·00
AUDIO COLOUR UNIT	£6·50
DAMP LOCATOR	£1·25
UHF AERIAL less boom	£1·50

Where postage is not stated then orders over £5 are post free. Below £5 add 20p Semiconductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.), 7 Park Street, Croydon CRO 1YD

Callers to: 102/3 Tamworth Road, CROYDON.

everyday electronics

PROJECTS... THEORY.....

THE HEART OF IT ALL

A hobby for all ages, catering for all inclinations: this is present day electronics, thanks to the transistor. Young people naturally enough accept the transistor for what it has become—the heart of electronics, upon which all circuits depend. Yet it was not always so, as older constructors will recall.

The transistor first appeared on the scene twentyfive years ago. Prior to that event, the valve was the vital active component and things were very different. Electronics extended very little beyond the fields of radio communication and sound amplification. The home constructor of the pre-transistor era was likewise limited to those two traditional areas, apart from a rare excursion into a "non-electronic area" as exemplified, perhaps, by the building of a simple timer for photographic purposes.

ENTER THE TRANSISTOR

The transistor changed all that, and how! Let us briefly recall the pattern of development.

Tiny in size relative to the valve, the semiconductor device needed but a modest power supply. Thus as equipment became "transistorised" it became physically smaller and lighter in weight. Electronic equipment composed of quite complex and extensive circuitry was no longer restricted to more-or-less permanent installations. It could now be installed or used in environments and situations never before practical or accessible.

Twentyfive years ago saw the start of the emancipation of electronics. The following years brought forth great and exciting developments in circuit design. These circuits were often based upon ideas that were not always new in themselves, but which had been denied practical realisation in the days of valves, because of the physical encumbrances inseparable from thermionic devices.

SOLID STATE REVOLUTION

The transistor proved to be just the beginning of a solid state revolution. Soon it was followed by a whole family of different, but related semiconductor devices. Some, for example, were designed for detecting heat and light radiation, others for controlling large amounts of electrical power.

Thanks to the versatility of these semiconductor devices the possible uses for electronic circuits grew steadily. And men of ideas soon started to apply electronics to fields far remote from those of the valve days. Today, possible applications of electronic circuits are far from exhausted. The future holds even greater promise.

Our April issue will be published on Friday, March 16

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VOL. 2 NO. 3 MARCH 1973

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

EGG TIMER

by R. Gwinn

A simple design to enable eggs to be boiled to your satisfaction.

CONVENTIONAL egg timers have one major drawback, there is no positive indication that timing has stopped. It is infuriating to turn around and look at the egg timer, only to find all the sand in the bottom and a very hard egg in the saucepan. The electronic Egg Timer provides an audible warning.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Egg Timer is shown in Fig. 1. During the positive half of the mains cycle, C2 is charged through D2 to 9V. In the negative half cycle, C3 is charged through D3 to 9V. As these capacitors are in series, 18V appears across the d.c. power supply rails of the circuit.

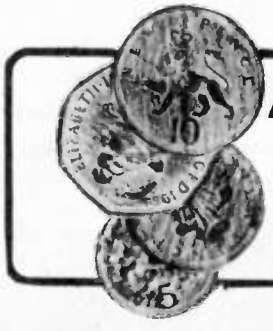
When the circuit is first switched on, C1 is completely discharged as it is shorted out when the timer is off. The gate of the field effect transistor (f.e.t.) TR1 does not take any current, so all the current flowing through the series combination of VR1 and R1 flows into the capacitor C1 and charges it slowly, hence the voltage on the gate of TR1 rises slowly.

When the gate of a f.e.t. is very negative with respect to its other electrodes, very little current flows through them as it is "pinched off" by the depletion region, an area in which virtually no current flows and whose size is controlled by the gate potential; the f.e.t. is in this state when the timer is first switched on.

As the gate becomes more positive with respect to earth (less negative with respect to the drain electrode) this region becomes smaller and more current is allowed to flow through TR1, R2 and VR2. This causes the voltage across VR2 and on TR2 base to rise.

When the voltage on the base exceeds that of the emitter by 600mV, base current, and hence collector current, begins to flow. When there is sufficient current to pull in the relay, its contacts apply 6·3V a.c. to the buzzer WD1.

Switching off removes the mains and shorts C1 ready to begin another timing cycle.



Approximate cost of components £3·75 plus case

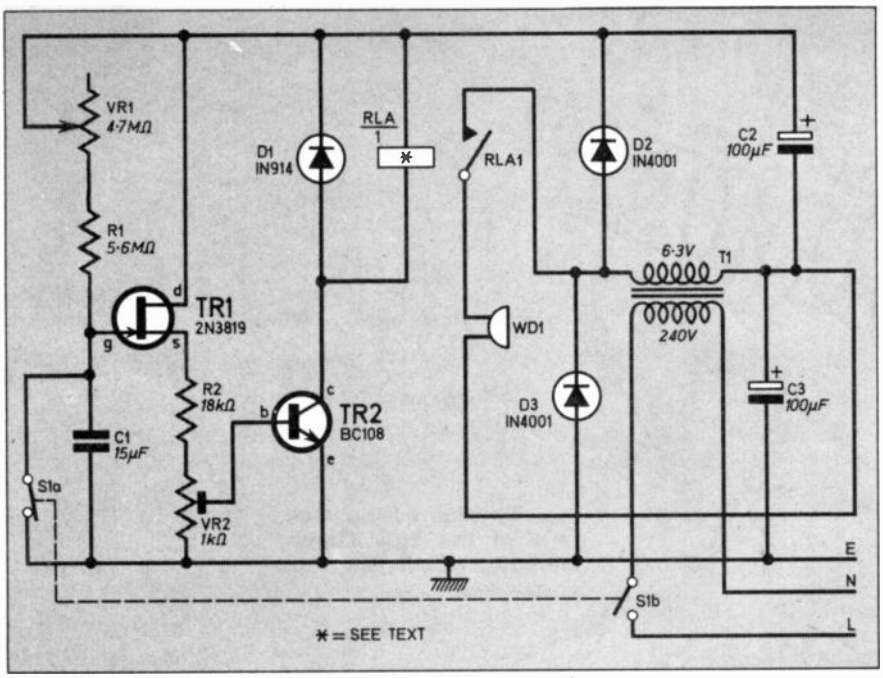
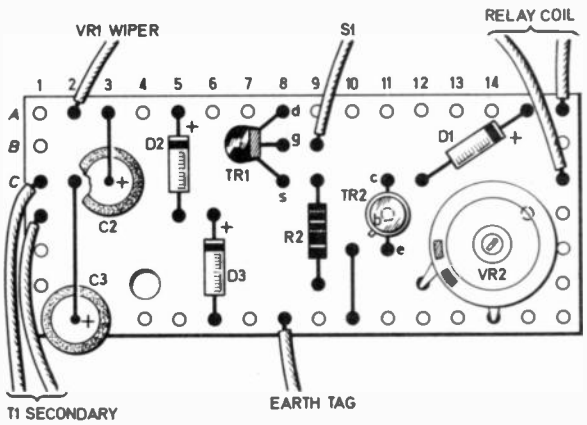
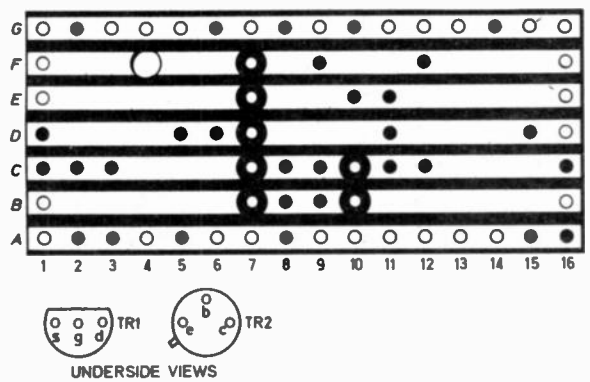


Fig. 1. The complete circuit diagram of the Egg Timer.

Fig. 2 (below). The positions of the Veroboard components and the areas of copper strip to be removed.





CONSTRUCTION DETAILS

The components to be mounted on the 0·15in. matrix Veroboard, size 16 x 7 holes, are shown in Fig. 2.

First, cut the copper strips in the correct places as shown in Fig. 2, drill the mounting hole and solder the components in position, not forgetting the link wire *E*10 to *G*10. The transistors and diodes should be soldered in position last and heat shunts used on their leads, otherwise permanent damage may be done to them.

The prototype was fitted inside a standard aluminium case size 5 in. x 7in. x $2\frac{1}{2}$in. The layout of the components within the case is not important so any size case may be used.

With reference to Fig. 3 mount the other components in position and fix to the case; now wire up as indicated. As can be seen from Fig. 3 the potentiometer VR1 and switch S1 are attached to the lid of the case.

Ensure that an earthing tag is attached to the transformer fixing bolt. When the wiring is complete, bolt the component board securely to the case using a spacer to keep the board at about $\frac{1}{4}$in. from the case. As a safeguard against shorting of the board via the case, insulating tape can be stuck to the case below the board.

The mains lead should be led out through the side of the case via a rubber grommet. A few ties of string around the outer sheath of the mains cable, on the inside of the case, will prevent a tug on the mains lead from doing any damage internally.

RELAY

The relay used in the prototype was one which came out of a surplus telemeter unit, but any relay that operates on 18V and draws less than

EGG TIMER

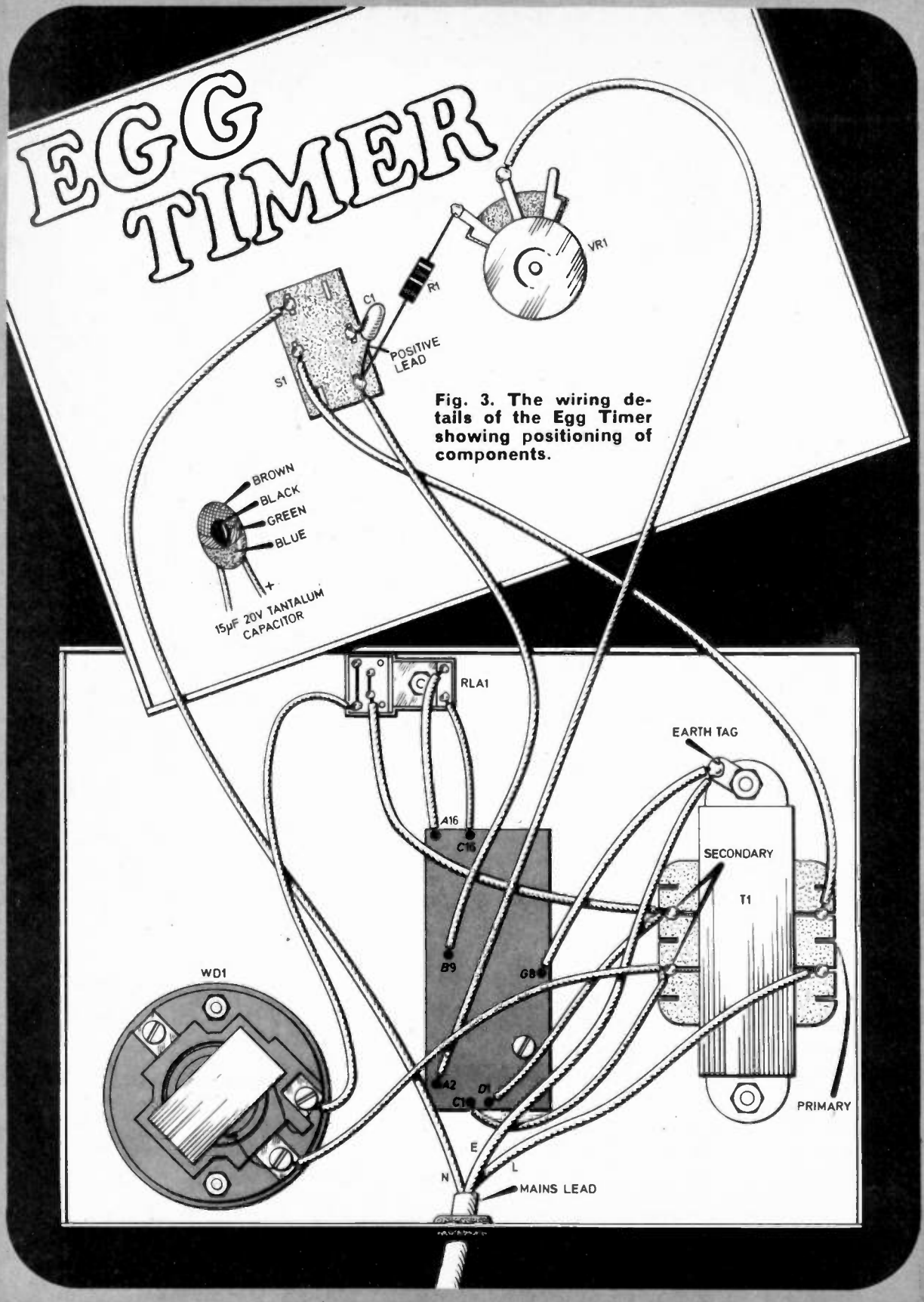
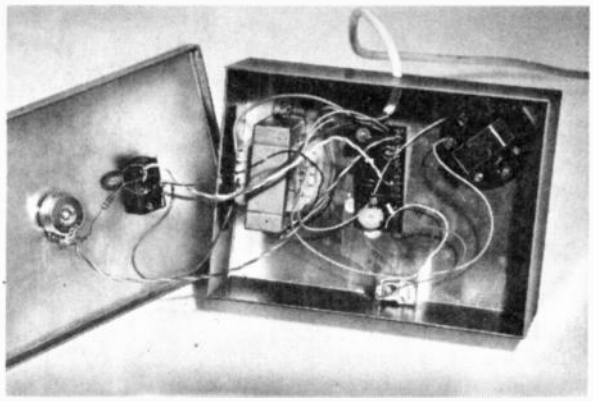


Fig. 3. The wiring details of the Egg Timer showing positioning of components.



Photograph of the inside of the completed Egg Timer.

25mA (coil resistance greater than 700 ohms) will be suitable. The higher the resistance of the relay coil, the more accurate the timing interval is likely to be.

It may not be possible to obtain a relay with only one-pole make contact as is required, but this should present no problem as any contact arrangement can be easily adapted for this particular purpose, as in the prototype.

TESTING AND SETTING UP

Thoroughly check out the wiring and make sure the component board does not touch the metal case. It may be a good idea to glue a piece of foam rubber between the board and case so that the board is additionally supported and protected. This may be found necessary after testing due to the vibration of the unit when the buzzer is activated. Also check that the on/off switch does not touch any components inside the case when the lid is placed in position, insulating tape may be used as an extra safeguard.

Disconnect the buzzer and wire a 6V bulb in its place.

When you are completely satisfied that the wiring is correct, plug into the mains via a fused plug containing a 1A fuse.

When carrying out the setting up details given below, **you should be extremely careful not to touch any wiring because mains voltages are on some wires and will give a nasty electric shock.**

Adjust VR1 so that it is at its maximum, i.e. fully clockwise. With VR2 set to minimum resistance (fully anticlockwise), switch on via S1 and time for 7 minutes.

At this time, carefully (and quickly) adjust VR2 turning clockwise until the bulb glows. Now switch off via S1 (this discharges capacitor C1) for a few seconds and then switch on and record the time it takes for the bulb to switch on. It should be 7 minutes. If this is so, place a blob of glue on VR2 to secure it in this position, and mark the pointer position of VR1 on the lid to this effect. If the recorded time is not 7 minutes adjust VR2 further until this time is achieved and then secure VR2 as above.

Now set VR1 to minimum position (fully anticlockwise) and measure the time from switch-on to the bulb glow and mark this time alongside VR1 point on the lid. This should be about $1\frac{1}{2}$ minutes.

Intermediate times can be marked around VR1 knob by trial and error methods.

Required egg condition, i.e. soft, semi-hard and hard can be marked alongside the correct time if so desired as shown in front cover photograph, but this depends on many things such as size of egg, temperature of water, whether the egg has been stored in a refrigerator or not and is best done by trial and error.

Now replace the bulb with the buzzer and screw on the lid. The unit is now complete.

USING

When using the unit in the kitchen **it is essential that a good earthing connection is available** at the mains socket. The electronic Egg Timer, because it is using a mains supply, should be kept well away from any source of water or steam and not handled with wet hands.

To use the unit, select the "egg cooking time" required and switch on at the commencement of this time. The buzzer will sound when the set interval has elapsed. ▣

Components....

Resistors

R1 5·6MΩ
R2 18KΩ ½ watt carbon ±10%

Potentiometers

VR1 4·7 MΩ carbon linear
VR2 1KΩ preset

Capacitors

C1 15μF 25V tantalum bead type
C2 100μF elect 16V
C3 100μF elect 16V

Semiconductors

TR1 2N3819 *n* channel f.e.t.
TR2 BC108 silicon *npn*
D1 1N914
D2 1N4001
D3 1N4001

SEE SHOP TALK

Miscellaneous

T1 Mains transformer, 240V primary, 6·3V 2A secondary
S1 Double-pole changeover toggle
WD1 Friedland 182 buzzer
RLA see text—suitable type STC 4189GD
Veroboard 0·15in. matrix size 16 x 7 holes; metal case, size 5in. x 7in. x 2½in.; three core mains cable; three pin fused plug; rubber grommet; 6V bulb—for test purposes only (see text).

Britain's Earth Station ...GOONHILLY

By TONY FORD

THE development of communications by space satellite is one of the most dramatic and fast moving chapters in the history of man's technological progress. Today, about 60 per cent of the world's inter-continental telephone traffic is carried by satellites stationed 22,300 miles out in space. Millions of people watch worldwide TV transmissions relayed by satellites positioned over the Atlantic, Indian and Pacific Oceans.

Yet it was as recently as 1962 that communication by satellite began when the first 'phone calls and TV pictures were beamed across the Atlantic via the pioneer satellite, Telstar. The historic signals were picked up at the Post Office satellite earth station at Goonhilly, Cornwall, a few miles from Lands End.

DEVELOPMENT

Since then Britain and Goonhilly have figured prominently in the rapid and exciting development of satellite communications. From the first commercial operations in 1965 with a single giant aerial focused on to a satellite, known as Early Bird, over the Atlantic, Goonhilly has become one of the busiest earth stations in the world. There are now three aerials at Goonhilly —the latest aerial coming into operation last year (1972)—which is the first earth station to have three aerials in simultaneous commercial operation to three satellites (two over the Atlantic and one over the Indian Ocean).

Developed at a total cost (at the end of 1972) of about £14m, Goonhilly has become the pattern for virtually all the world's satellite earth stations—more than 70—which have mushroomed in the past decade. The huge aerials on the lonely Cornish moor have, therefore, helped realise a technological dream.

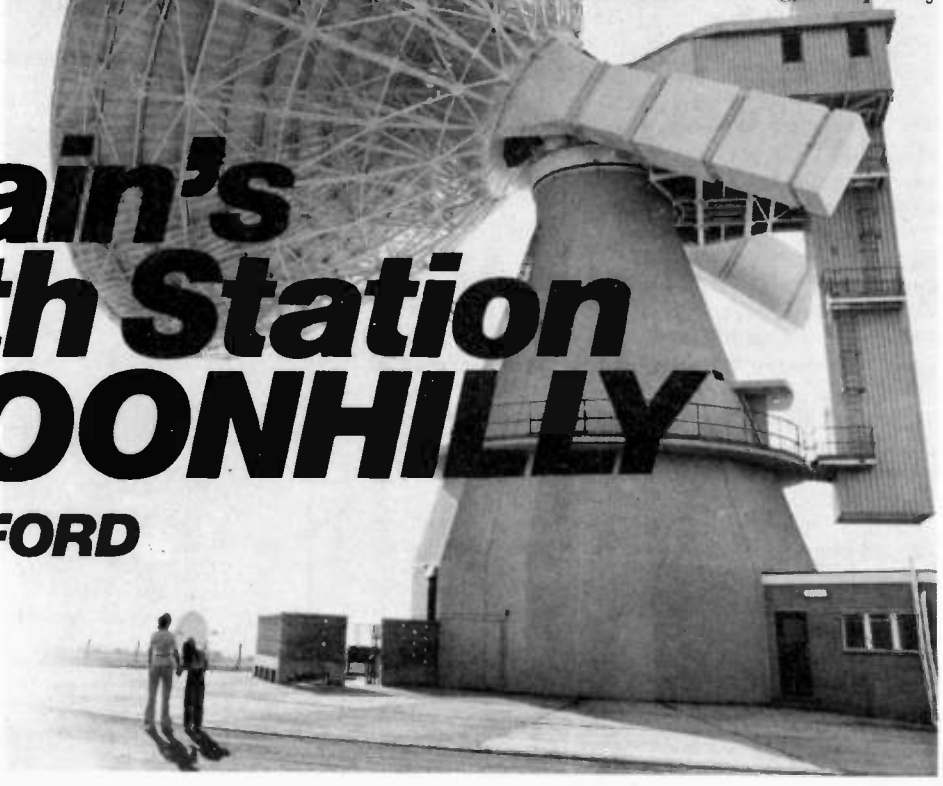
CABLE OR SATELLITE

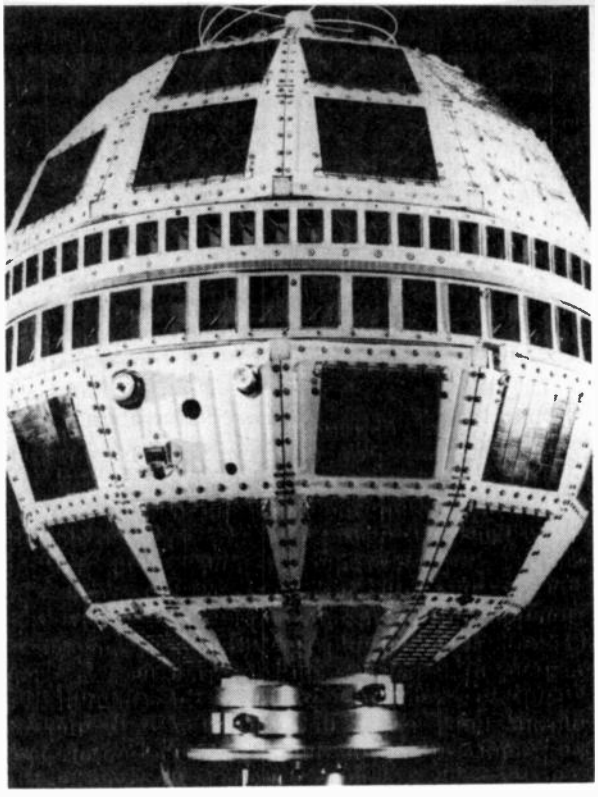
It is necessary to define the role of satellites before looking in detail at the development of satellite communications. Will, for example, satellites eventually replace the other and traditional means of inter-continental telecommunications, undersea cables?

The short answer is no. The demand for international telecommunications service is doubling every four years and both cables and satellites are needed to meet the demand. Cables are ideal for busy or short routes and are still directly competitive over transatlantic routes. New developments in undersea cable technology (reviewed in EVERYDAY ELECTRONICS, September 1972, now no longer available) are dramatically increasing the communications circuit capacity of modern submarine cables.

The satellite has, however, one major advantage over the cable. It makes possible intercommunication between many different and widely scattered countries through a single piece of equipment—the satellite. Importantly too the satellite is the only way of providing inter-continental TV. In addition, the service provided by a satellite is flexible and can easily be adjusted to meet changes in demand.

The only other contender in the field of international communication is high frequency





Shown above is the Mark II version of the original Telstar satellite.

radio which does not possess the capacity, reliability or quality of service needed for modern communication. In a remarkably short time, therefore, satellites have assumed a commanding and vital position in the expansion of global communications.

OPERATIONAL CONCEPT

Yet even during the brief space communications era there has been a fundamental change in the operational concept of satellites. In 1962 when the Telstar satellite was launched and USA, France and Britain took part in the first experiments it was envisaged that communications satellites would orbit in series and earth station aerials would track the satellites as they passed. Consequently during the Telstar experiments Goonhilly was only operational between the time the satellite appeared over one horizon and disappeared below the opposite horizon on its way around the earth—a period of only 20 minutes or so every two-and-a-half hours.

Barely had the feasibility of satellite communications been proved by Telstar when it became possible through the development of more powerful launching rockets, to place a satellite so far out in space that its orbit coincided with the Earth's rotation. At this distance, 22,300 miles above the Earth, the satellite appears to remain stationary—an orbit that is described as geo-stationary.

Earth stations could now focus permanently on the satellite and the complications involved in swiftly picking up and locking on to lower orbiting satellites and tracking them across the sky were removed.

INTELSAT

The global communications scenes then began to move swiftly. A group of 11 major countries, Britain included, signed an agreement in 1964 to form INTELSAT, the consortium responsible for providing the satellites and associated tracking and control facilities. This responsibility, described as the "space segment", does not include Earth stations which are the sole concern of the satellite users. Subsequently the number of INTELSAT members has grown to a total of 83 countries.

With the advent of the geo-stationary satellite whole new frontiers of technology were revealed. The science of space communications had to be created and perfected—the satellites, the aerials, ancillary earth station controls and telecommunications links to and from the earth stations and their national internal networks. One major problem was the maintenance of signal strength. The satellite picks up the signal beamed from the aerial, increases its strength and re-transmits it to a second earth station which means that the signal travels a total of about 45,000 miles.

Transmission and reception are simultaneous but the signals do not clash because different frequencies are used. The time taken for the signal to travel from earth to satellite and back to earth is about a quarter of a second.

When the signal arrives back on earth it is, however, so faint that it could be swamped even by the small amount of "thermal noise" made by the receiving equipment. To overcome this problem the receiving equipment at Goonhilly is cooled to minus 256 degrees Centigrade. This minimises molecular activity in the receiving equipment and enables the incoming signal from the satellite to be received with great clarity. The signal is then amplified in a series of steps until it is strong enough for ordinary transmission over the telephone network.

ACCESS

The amplified signal is, in the case of Goonhilly, carried by a microwave radio link in the 6000MHz band which connects the earth station with the international switchboard through the Post Office Tower in London. This link is routed via Plymouth and Bristol and a reserve system can be used for TV transmission simultaneously with telephony.

Since Goonhilly has multi-access to three satellites it has to break down the channel capacity of the baseband content of the inland microwave link to component super-groups and where necessary, to individual groups of chan-

nels, and then reassemble them in required channel content for transmission to the satellites. The same process must also be carried out in reverse for signals received from the satellite. This function is performed at Goonhilly by multiplex equipment which also provides pilot-frequency monitoring as a check on system performance.

The below baseband (0-12kHz) spectrum of each satellite carrier is used to provide engineering service order wires, both voice and teleprinter, which are separated from the traffic baseband before it reaches the multiplex equipment. Translation of these circuits is separately made in another, specially designed, multiplex equipment installation.

CONTROL

Operational control of the Goonhilly earth station is centralised in a main building separate from the three aerials. A console suite contains the engineering control of the aerial steering systems in addition to associated communications equipment. The console also allows monitoring of the continuity of traffic signals through the system.

For both colour and monochrome television there is a separate control and monitoring suite. Complementing this control there are speech and teleprinter engineering service circuits and two switchboards. From these the controller can maintain contact, through the satellite, with engineers at distant earth stations and their operational control centres. The entire working station is duplicated and there is automatic change-over when any unit fails. Manual change-over can also be made if necessary.

SITE

The planning for Goonhilly earth station began with the initial choice of the site for the station. It had to be in the west of the country for maximum mutual visibility to the, then, low altitude satellites working with a station in the USA. It also had to be in the south because 95 per cent of the world's telephone users are to the south of Britain (and, therefore, satellite systems were also likely to be in the south).

The sub-strata had to be stable enough to support the weight of the aerials (about 1,000 tons each in the case of the first two aerials) and there had to be an all-round clearance elevation above about five degrees. Goonhilly easily meets both criteria. The earth station site has a rock base hundreds of feet thick and is on a plateau with an all-round clearance of half a degree in elevation.

Goonhilly is reasonably close to inland communications links, is also free from radio interference and does not cause interference to other communications systems.

The weather in the area had to be considered, for with three aerials whose dishes range from 85ft to 97ft in diameter on such an exposed site 350ft above sea level, wind damage could be calamitous. In fact, wind speeds at Goonhilly rarely exceed 60 mph, but to be on the safe side the aerials have been designed to survive wind speeds well over 100 mph and even, in the case of the third and latest aerial, up to 130 mph. Finally, heavy snowfalls, which could build up and overload the aerial structures, are rare at Goonhilly while rainfall, although frequent, is not unduly heavy.

The main control console for all three aerials at Goonhilly.

An engineer checks pictures at the television control and monitoring console.

SATELLITES

After choosing the ideal site and spending, to date, about £14m on developing Goonhilly, the Post Office has also spent some further £12m towards the purchase and launching of satellites by INTELSAT. The money, together with that from other INTELSAT member countries, has provided for the development of a series of satellites each more sophisticated than the last.

Since the first days of the INTELSAT consortium in 1964, four series of satellites have been built. From a single Early Bird satellite (Intelsat I) with 240 circuits and point-to-point access only, in 1965, the system progressed to a multiple-access global service in mid-1969 using Intelsat III series satellites and then to Intelsat IV service by mid-1972.

Compared with the single links in 1965 from the USA to the UK or France or Germany there is now a global network of about 200 simultaneous links between pairs of earth stations.

Today's satellites, Intelsat IV's, are able to handle up to 5,000 communications circuits at once plus separate TV transmission facilities. They weigh almost one-and-a-half tons at launch, are taller than a double-decker bus and cost £6m each, plus about £7m for each launch. America's National Aeronautical and Space Administration (NASA) launches all INTELSAT's satellites and the powerful Atlas Centaur rocket is used to launch the Intelsat IV which has a design life of about seven years.

The Intelsat IV satellites have two important new features which make them more efficient to operate compared with earlier satellites. In addition to providing global coverage with its signals the Intelsat IV is able to concentrate part of its power in two spot beams focused on the busy routes such as North America and Canada in the east and Britain, Europe and North Africa in the west.

Part of Intelsat IV's capacity can also be reserved for "demand assignment". This new system will allow a country with several light traffic routes to use, say, two or three access channels to cover them all where previously one pre-assigned circuit was required for each route.

Since January 1971, four Intelsat IV satellites have been launched and between them they carry all the INTELSAT traffic. Another four Intelsat IV satellites will be launched to provide spares-in-orbit over the three operating regions —the Atlantic, Indian and Pacific Oceans.

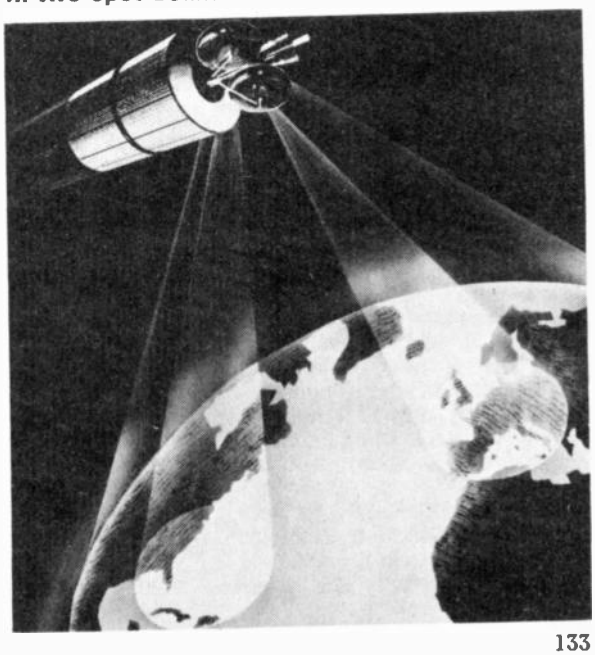
It should be explained that Russia is not a member of INTELSAT as they have their own and separate satellite communications system known as ORBITA which employs satellites in orbits quite different from those used by INTELSAT but which are especially suited to the coverage of the whole of Russia.

DEMAND

Despite the greater capacity for circuits provided by the latest satellites, demand is growing so rapidly that it is likely that by about 1975 still more capacity will be needed and even bigger satellites may be required. The growth in the number of circuits used by satellites has been startling. In mid-1967 the number of satellite circuits in use totalled 100. Today the global total is about 3,500 plus 5 to 10 per cent added for "occasional" use such as TV programmes. In the Atlantic region alone the

This comparison shows the size of Intelsat IV communications satellite.

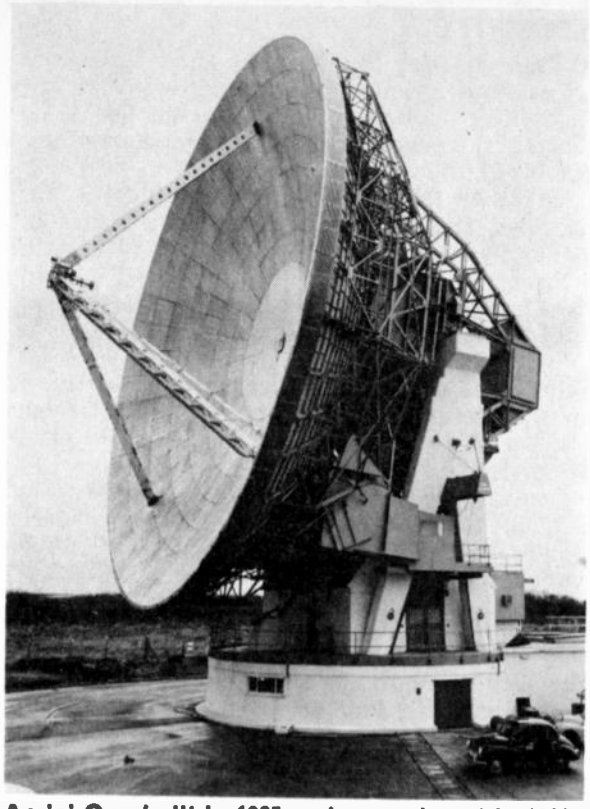
Part of the Intelsat IV's power is concentrated in two spot beams.



number of satellite circuits in use is more than 2,000, of which just under 500 are via Goonhilly. (In addition just over 600 UK-Atlantic circuits go by undersea cable.)

The three aerials at Goonhilly provide direct communication via satellite with 34 countries. Aerial Two (built in 1968) and Aerial Three (built in 1972 at a cost of £2¼m) are linked to 18 countries by satellites over the Atlantic. Aerial One (built in 1965 and re-equipped in 1969) operates to 16 other countries via a satellite over the Indian Ocean. Within the next few years a further 20 or more countries will join the INTELSAT system. At present Goonhilly has almost 700 long distance telephone circuits in operation.

Of all the statistics underlining the impressive growth of international telecommunications perhaps one of the most satisfying relates to the decreasing cost to the user. Today a phone call to North America can be made on international subscriber dialling for as little as 50p a minute. Yet when transatlantic 'phone services were begun 45 years ago the minimum charge for a similar call was £15—in those days the equivalent of several weeks' wages. Such dramatic cost reductions have not stemmed wholly from the advent of satellites, but their use has allowed countries to expand their international communications links more cheaply than if there had been no alternative to the laying of trans-oceanic cables. ▣



Aerial One built in 1965 and re-equipped in 1969. It operates to 16 countries via a satellite over the Indian Ocean.

Ruminations

By Sensor

Self-help

Most of us take our television for granted. In most parts of England good quality colour television programme reception is enjoyed but what about the folk in more isolated places who cannot get a decent black and white picture? For example, north of Inverness and in North West Scotland it is impossible to receive BBC 2 transmissions and ITA reception is poor. The BBC 1 signal is not always received—particularly, if there is a mountain between one's home and the transmitter.

In December 1972 BBC 1 colour programmes became available to viewers in the Inverness area from the transmitter at Rosemarkie, and a low power relay station further south at Rosehearty helps to extend the area of the Aberdeenshire transmitter and the new station at Rosemarkie. The BBC plan to build many more of these low power relay stations, like the one at Rosehearty but it will be well into the 1980's before these are completed. Even then, there will always be many areas which cannot be reached because of the mountainous terrain.

The inhabitants of one village may enjoy relatively good reception whilst their neighbours only a mile away may receive nothing at all. Of course, the capital cost involved in providing even BBC 1 black and white pictures to certain parts of the Highlands would be quite prohibitive. However many communities have subscribed sufficient funds to erect their own communal mast on some suitable hill in order to enjoy their "telly". In one such village viewers pay £25 a year plus £4 maintenance costs into a television "club", in addition to their licence fee and rental payments, for their piped television.

Deprived

Many people living in these remote areas feel that they are deprived in so many other respects such as libraries, further education facilities, cinemas and theatres, and yet, they are expected to pay the full licence fee even though they will not receive the full range of BBC and ITA services. It is natural that they should feel that a graded licence system ought to be introduced for areas of this kind.

Of course, all will be well when we each have our own satellite receiver. The thrifty Highlander will quickly learn to construct his reflector dish from old oil drums, driftwood and rubbish left by the English tourist and, with true Highland hospitality, will invite his "bed and breakfast" guests to watch the Highland Games in full colour whilst they are gathered around the peat fire. But that's nae yet!

BASIC 5 Electricity

Motors, Generators, Alternators

By Maureen Birch

WE HAVE seen that a current flowing through a coil of wire that is suspended in a magnetic field produces movement of the coil. The coil always tends to align its axis with the field because the current flowing through it makes it behave like a magnet with its own north and south poles. These poles attract or repel the poles of the fixed magnet (producing the field) and the combination of these forces rotates the coil until it reaches a stable position —its axis in line with the field. This simple principle is adapted and refined to drive motors which in turn drive machines.

CONTINUOUS ROTATION

Continuous rotation of the coil can be achieved by arranging that just as the axis of the coil lines up with the field, the current flowing is momentarily stopped and the inertia of the coil is allowed to carry it past "top dead centre." The current is then reversed so that the poles that were attracting each other are now repelling each other, and vice versa.

Provided this is done every time the coil is about to line up with the fixed magnetic field continuous motion can be obtained. To turn the attractive forces to ones of repulsion we must either reverse the north/south direction of the fixed magnetic field, or, as is more usual, the direction of current flow through the coil.

COMMUTATOR

This reversal is accomplished by means of a commutator. It consists of a copper tube over an insulated cylinder that is fitted on the shaft that pivots the coil. The tube is fastened to the cylinder and is cut into two parts by two diametrically opposite saw cuts along its length.

The wires from the coil are each connected to one of the halves of the commutator and current is fed to the coil via brushes made of springy material (or in larger motors, carbon) that make contact with the commutator.

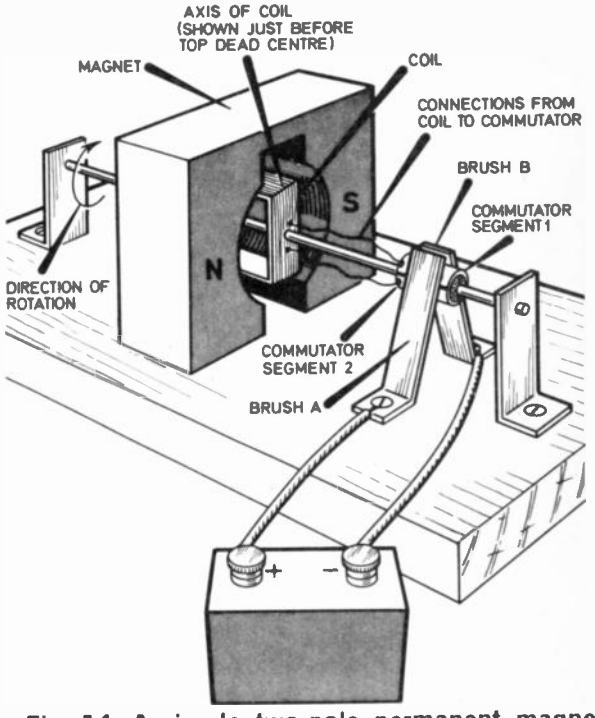


Fig. 5.1. A simple two-pole permanent magnet motor.

If a source of direct current is connected across the brushes the current will always enter by brush A (Fig. 5.1) and leave by brush B. When section 1 of the commutator is in contact with A, the current will flow through the coil in one direction and the coil turns until top dead centre is reached; the current flow is then momentarily broken and section 2 of the commutator makes contact with brush A. The direction of current flow is thus reversed and the coil continues to swing round towards top dead centre in the opposite direction.

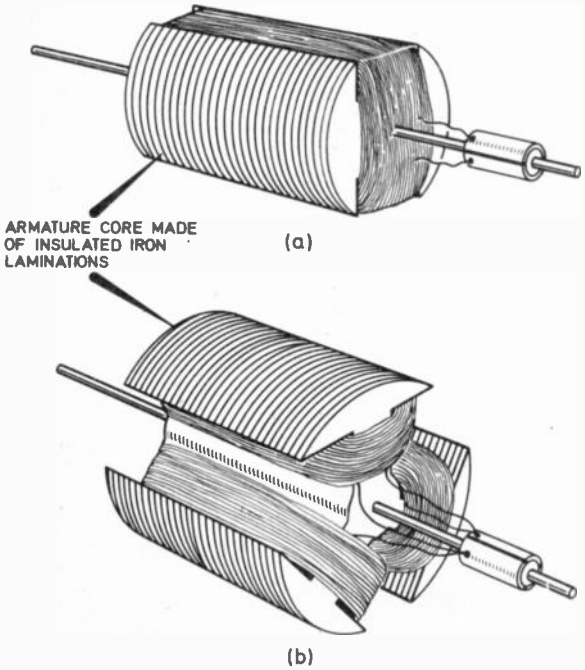
ARMATURE

The forces acting on the coil are considerably increased if the coil is wound on a core of soft iron. This core, called an **armature**, is usually built up of thin sheet stampings that are electrically insulated from each other by thin paper. This reduces what are known as **eddy currents** which are induced in any metal object that moves in a magnetic field and in such a direction that they try to oppose the motion that is taking place.

The torque (twist) produced by the current and field is greatest when the axis of the armature is at right angles to the field and becomes zero at the top dead centre position. Because of remanence effects a simple two-pole motor like the one described will usually stop with the armature in the top dead centre position and therefore when current is re-applied there will be no torque and the motor will not start by itself unless spun by hand. This leads to the device of winding several coils on one armature, most commonly in the case of small model motors, three coils are used on a three-pole armature, see Fig. 5.2. There must be as many commutator segments as there are coils so that current can be made to change direction and be applied to the right set of coils at the right time.

The advantage of a three-pole motor is that there can never be a time when all three poles are at top dead centre and therefore there will always be some torque when current is applied and the motor is thus self starting.

Fig. 5.2. (a) Two pole, (b) three pole armatures and commutators.



FIELD WINDING

In the case of small model motors the magnetic field is usually provided by a strong permanent magnet, but in the case of powerful machine motors, the field is produced by a separate coil called a **field winding**. The field winding can be connected in series with or in parallel with the brushes, see Fig. 5.3.

When series connected, one obtains very high starting torque but the speed of running is load dependent; with the parallel connection not so much torque is produced at switch on, but is better for running at constant speed under varying load conditions. Very powerful motors —as used for traction purposes—often have a switch which is used to convert them from series to parallel (sometimes called shunt) connection thus giving the driver the best of both worlds.

GENERATOR

One of the most momentous discoveries of the past was that of producing an electric current in a circuit without the aid of a battery. The principle of the **generator** is very simple. Whenever a wire, that forms part of a closed circuit is *moved* in a magnetic field, an electromotive force is induced and this causes a current to flow through the circuit of the wire.

If the wire is in the form of a coil, preferably on an iron core, the effect is greatly enhanced.

SIMPLE EXPERIMENT

If you have a radio with auxiliary record player input connections or a small amplifier, you can see what we mean, by connecting our electromagnet (from last month) straight across the record player input and then bring a small permanent magnet up in contact with the poles of the electromagnet, Fig. 5.4. This is the same as moving the coils of the electromagnet in a field.

Let the permanent magnet touch the pole of our home-made magnet; if you have the amplifier (radio) turned up sufficiently you will hear a "clunk" in the loudspeaker. This clunk is caused by the sudden increase in field strength of the permanent magnet inducing a voltage in the windings of our electromagnet. The radio serves only to amplify the voltage so that we can hear the effect in the loudspeaker. **Under no circumstances try this experiment unless your radio or amplifier has properly installed record player inputs.**

RATE OF CHANGE

This remarkable ability of magnetism to cause a flow of electrons is something we just have to accept. A wire, or coil, moving so that it cuts lines of magnetic force has this voltage induced across it and when moved in the opposite direction the e.m.f. polarity is reversed. The interest-

ing thing is that there is no induced e.m.f. unless the coil is moving, and the faster the coil moves the higher the e.m.f. Alternatively the coil could be kept still and the strength of the influencing magnetic field varied to get the same effect. The induced e.m.f. is proportional to the rate of change of magnetic flux crossing the wire or coil. The e.m.f. is also directly proportional to the length of wire (provided all the wire is subjected to the same change in flux) or, in the case of a coil, the number of turns of wire on the coil.

REGULAR A.C. OUTPUT

Our experiment produced an e.m.f. but it was very hit and miss and could not under any circumstances be called a steady voltage. To get a regularly produced e.m.f. it is usual to suspend a coil on a pivot in a fixed magnetic field and rotate the coil.

The current produced in this way is not steady, it is greatest when the coil's axis is perpendicular to the direction of the field since this is the position where the coil cuts straight

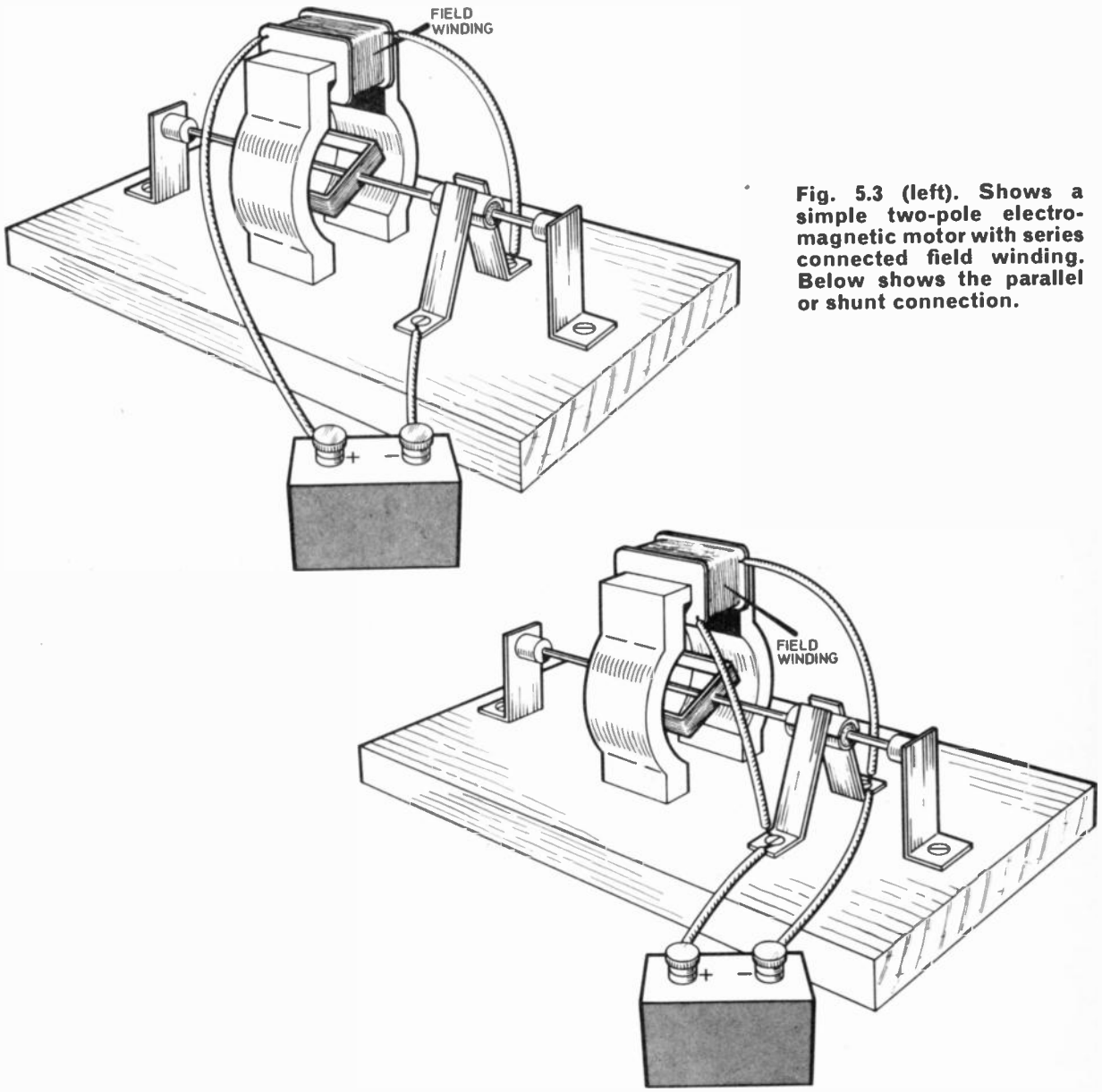


Fig. 5.3 (left). Shows a simple two-pole electromagnetic motor with series connected field winding. Below shows the parallel or shunt connection.

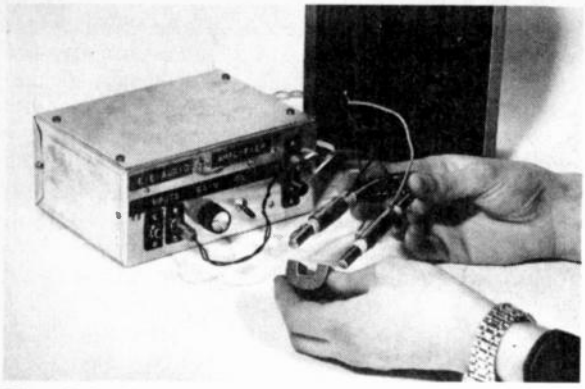
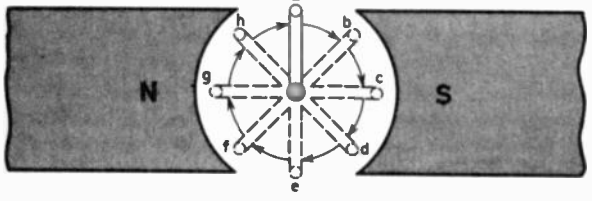


Fig. 5.4. Experiment to demonstrate electro-magnetic induction.

across the lines of force. No current is produced in the top dead centre position because in this position the coil is tending to move along the lines of force and is not actually cutting across any.

If we follow one side of the coil as it rotates, Fig. 5.5, we see that for almost half of each revolution it is moving *up* through the lines of force but for most of the other half is moving *down*. As a result the current changes direction once in complete revolution; we say the current is alternating (a.c.).



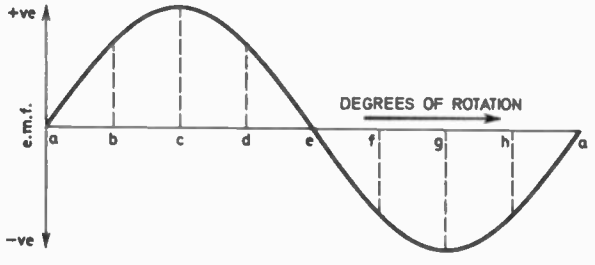


Fig. 5.5. Graphic display of generated e.m.f. as a function of rotation angle.

To get the induced current from the armature windings we use a form of commutator (Fig. 5.6) called a slip ring. Notice there are two slip rings and there is no split in either. The alternating current is picked up by brushes running in contact with the slip rings. This type of device is called an **alternator** and the 50Hz a.c. mains fed to our homes is generated in a similar way.

A direct current generator uses the same principle of induction as an alternator but is

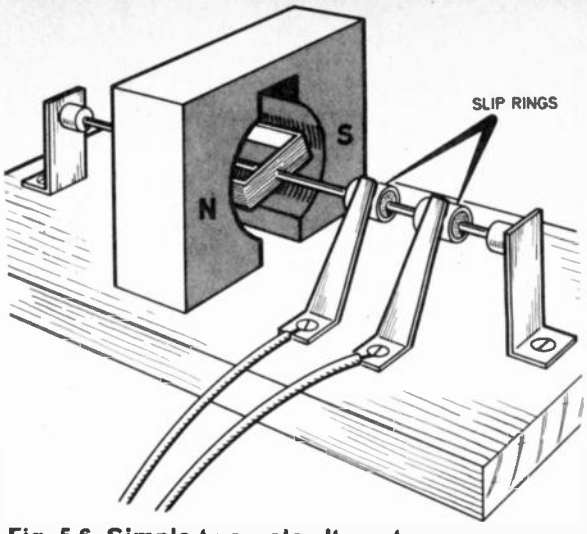
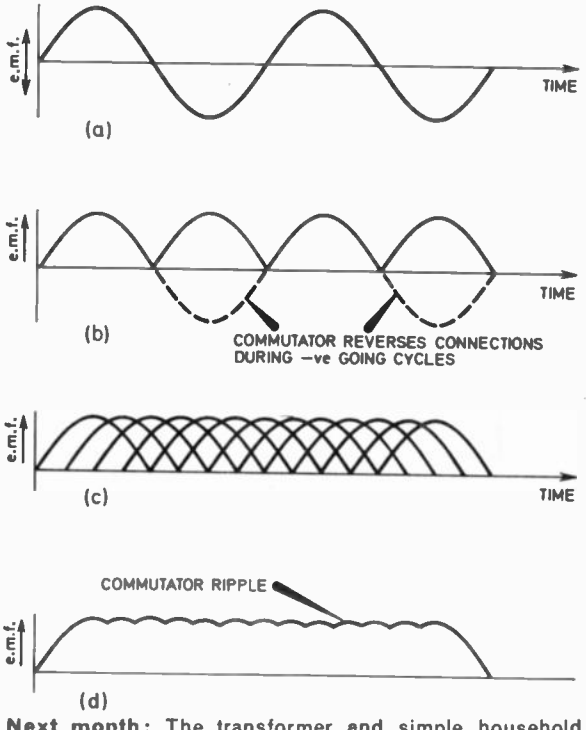


Fig. 5.6. Simple two-pole alternator.

built more along the lines of the d.c. motor. The output must be in one direction only and as steady as possible. By using a commutator instead of slip rings the negative half of each cycle is reversed and the result is a one directional pulsating output, see Fig. 5.7.

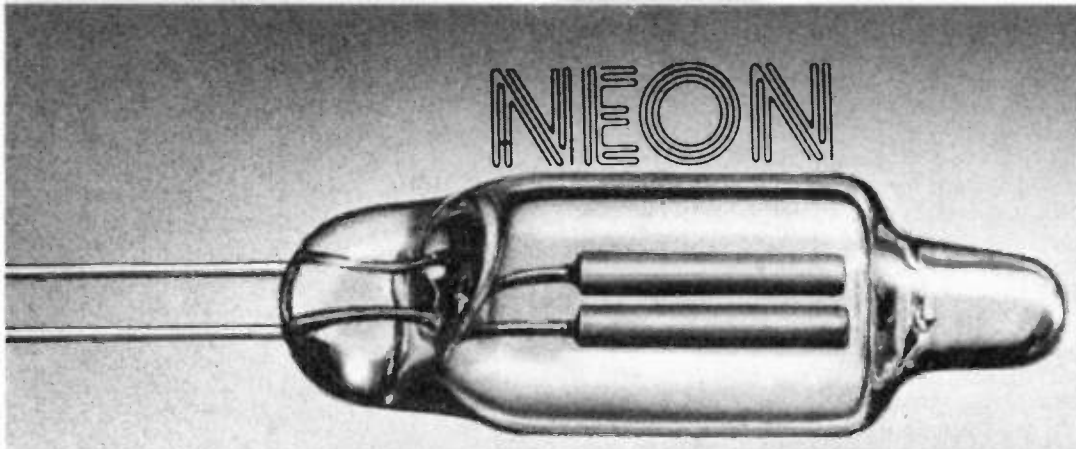
To reduce the level of the pulsations (or ripple) and so produce a more steady output more coils are introduced and the final output shows only small and rapid fluctuations.

Fig. 5.7. Outputs from (a) alternator (b) generator (c) multipole generator (d) effective output from (c).



Next month: The transformer and simple household electricity.

NEON NOVELTY



An inexpensive, intriguing novelty for a youngster or for an unusual modern ornament.

By B. C. Macdonald

A SIMPLE novelty item can be made up using a number of flashing neons arranged in a small plastic case or by using two neons placed in the eyes of a child's toy animal. The first type of novelty—the "flashing block"—could make an interesting paper weight or modern ornament.

Both types of novelty are particularly interesting when viewed in the dark. The neons will continue to flash for a number of years because the drain on the battery, even with 8 neons, is only about 60 microamps. The neon bulbs flash independently of each other, the effect of the orange/red flashes is quite striking.

CIRCUIT DESCRIPTION

It will be seen from Fig. 1 that each neon is wired into a similar circuit, all of which are connected across a 90 volt battery. Each of these circuits operates independently. The basic circuit consists of a 10 megohm resistor (R1) in series with a 0·22μF capacitor (C1). A neon bulb (LP1) is connected in parallel with the capacitor.

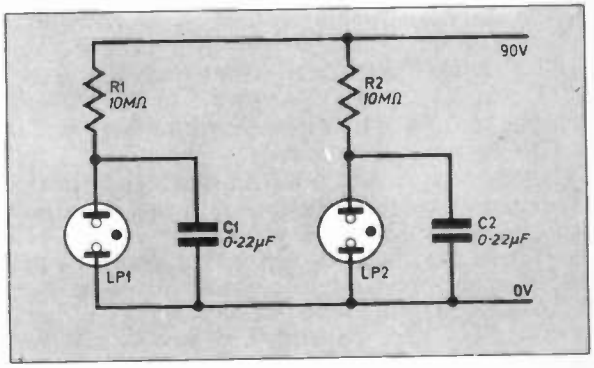


Fig. 1. Basic circuit diagram of Neon Novelty.

A characteristic of neon bulbs is that they do not light or draw any current except at a certain minimum voltage (about 80V for the type of neon used) and as soon as a holding voltage (about 60V) is no longer maintained the neons extinguish and become open circuit.

Consider one circuit only, since each works in the same way. The battery B1 charges capacitor C1 through R1. As the capacitor charges the voltage across it rises and will finally reach the battery voltage if not discharged. The rise in voltage is slowed down by the high value resistor R1, which restricts the current flow. As soon as the "firing" voltage of the neon is reached the neon lights but immediately goes out because in lighting it has discharged the capacitor and thereby reduced the voltage across it to less than the holding voltage. This charge and discharge then continuously repeats.

The rate of flashing (charge and discharge of the capacitors) varies as the product of the capacitance and resistance, but to alter the flashing rate it is only necessary to alter the value of the resistor to vary the rate (reduce to increase the rate).

Although the value of the components is the same for each circuit each neon flashes at a slightly different rate, due to tolerances in the components. For this reason 20 per cent tolerance resistors will, in this case, provide a more varied display than closer tolerance types. As many neons as are required can be used in the circuit.

When six or eight neons are used together as in the unit shown, the effect is that of random flashing, since each bulb is flashing at a slightly different rate and no sequence is obvious. In the case of eight neons it may be found advantageous to vary the value of some of the resistors to alter the rates by a greater extent.

MODIFIED CIRCUIT

When using more than two neons it is possible to slightly modify the circuit to give a softer type of flashing which is, in fact, completely random. This is done by connecting one end of each capacitor together—see Fig. 2—by this means each flash is related to the state of charge in the capacitors, which is in turn related to the flashes of other neons.

The action of such a circuit is too complicated to try and explain fully and is, in fact, very difficult to see since each circuit is inter-related. Suffice to say that it works by the charging and discharging of the capacitors, is completely random and provides a longer "flash" of each neon; this circuit does in fact, provide the best type of display when all the values are similar.

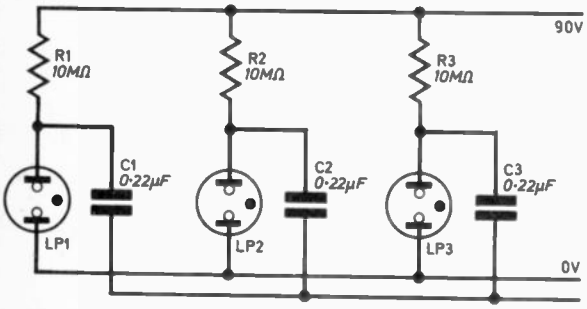


Fig. 2. Modified circuit for random flashing.

THE COMPONENTS

A 90 volt battery is required, such as the Ever Ready B126. Any type of 0·22μF capacitors may be used provided they have a working voltage in excess of about 100 volts. Any type of resistor may be used, but the $^1/_4$ or $^1/_2$ watt carbon kind are of a convenient size (the colour coding of a 10 megohm resistor is brown, black, blue). The value of the resistors is by no means critical and anything from 2 megohm to about 15 megohm will be satisfactory.

The correct type of neon is essential, this must be suited for operation from 70 to 90 volts, such as the Hivac 34L or the American type NE2 (these are direct equivalents). The bulb is in the form of an elongated glass capsule with thin flying leads.

A two pin or three pin plug will be required for making the connection to the battery. The polarity of the battery is not critical and therefore, the third locating pin on the connector is not required.

CONSTRUCTION

It was decided to use connector strip for the two neon circuit (animals eyes) since this requires no soldering and simplifies construction.

Obviously the leopard shown is a very suitable subject, but other animals could be used. In looking for a suitable animal model stuffed types were rejected because of the difficulty in inserting the eyes and connecting wires. A "nodding leopard" was finally used. These are sometimes seen in cars, the head nodding continually due to the motion of the car. The head is suspended in the body and can be easily removed. Both head and body are made of rubber and are hollow and so are quite easily adapted to the purpose required.

Do not cut the wires on the neons, but extend them by soldering short lengths of single plastic covered bell flex or similar wire to their ends. Now push short lengths of sleeving, just large enough to pass over the flex, right up to the neons so as to insulate the bare wires from each other. Secure the sleeving at the point farthest from the neon with a little plastic insulating tape.

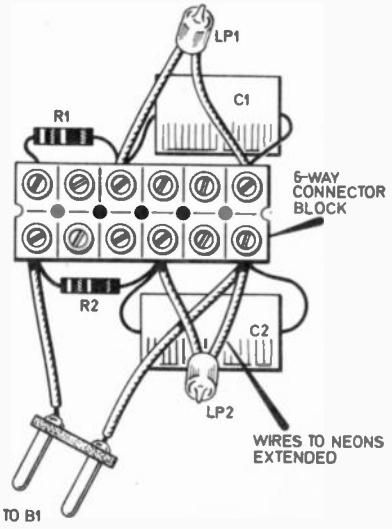
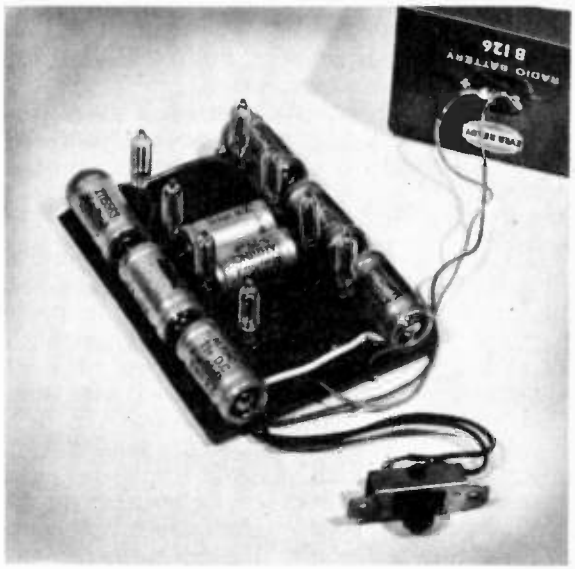
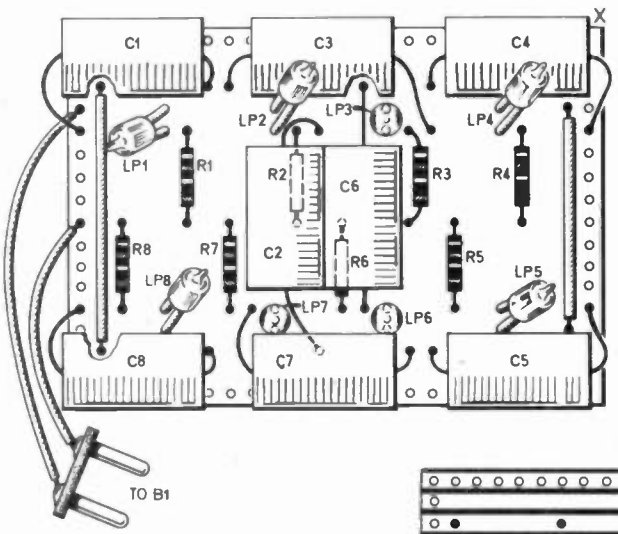


Fig. 3. Wiring for the two neon circuit.

NEON NOVELTY



Photograph showing the completed circuit board and battery for an 8 neon "flashing block" unit.



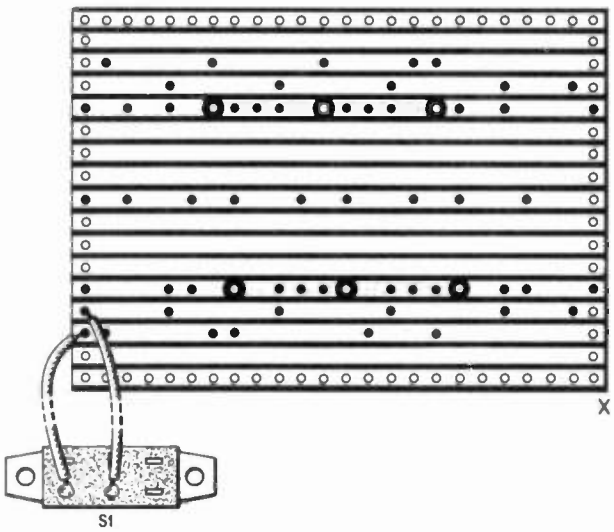


Fig. 4. Layout and wiring of the Veroboard for the 8 neon unit. The underside is shown below with cut aways and S1 wiring. To orientate the lower drawing find corner X on both views.

Fit the resistors, capacitors, the neon wires and the battery wires to the connector strip exactly as shown in the illustration (Fig. 3). Check carefully that all the connections are correct then push the plug into the battery. The neons should commence to flash.

Incidentally it is possible to get a shock from the battery although this is not normally dangerous.

HOUSING

Disconnect the neon wires from the connector strip. Pull out the eyes from the animal's head and insert the wires connected to the neons. Pull the wires through and finally push the neons right into the head so that only the end is showing. They must be secured with some kind of adhesive. Araldite adhesive was used and proved to be very satisfactory but no doubt other types, such as Evostik could be used. Immediately the eyes are in position in the head re-connect them to the connector strip and check if they still flash. This is a necessary precaution. The author found although the neons flashed before fitting they failed to flash after fitting. It was assumed that the very small current required by the eyes was short circuited and some of the plastic insulating tape was removed and the eyes flashed when re-fitted. This is why the sleeving should be taped only at the farthest point from the neons.

Make or otherwise obtain a box of suitable size to easily house the battery and connector strip. A wood or plastic box is best.

The completed leopard lying on the box housing the battery.

Fit the leopard's head to the body, cementing it in place, and passing the wires into the body having previously made a hole in the base so that they can emerge. Any convenient point will do, a hole in the leopard's paw was used in the prototype, the wires passing through this and also through a corresponding hole in the top of the box.

All the wires must be long enough to allow the connections to be made to the connector strip when it is outside the box. The next thing to do is to cement the leopard to the top of the box, using elastic bands to hold it in position while the cement sets.

FINISH

The battery and connector strip mush be fitted in the box so that they will not move about and it is suggested that plastic bags should be crumpled up and used as packing and to separate the connector strip from the battery. Since access is not required over a number of years, the box may be closed, using cement but a small hole **must** be provided, otherwise there may be condensation inside the box, resulting in failure of the eyes to flash or pressure may build up as the battery is exhausted and the box may "explode." The box can be finally painted in suitable colours.

Two important points; solder the extension leads to the neon wires close to the ends of these wires and not near the glass. Do not try to light the neons by connecting directly to the battery; they will be destroyed if this is done. A 68,000 ohm series resistor must be used if the bulbs are connected **directly** to the battery. The resistor is replaced by R1 in the circuits.

BLOCK CONSTRUCTION

In order to make construction of the "flashing block" more easy a Veroboard layout is given (Fig. 4). This layout can be used for either circuit (Fig. 1 or Fig. 2) by operating switch S1.

Commence construction by inserting all the resistors, capacitors and wire links, including those to S1, in the Veroboard, cut the leads off and solder each connection. Next make the six breaks in the copper strips as shown and finally connect up the battery leads and solder in the neons so that the bottom of the two electrodes (inside) is about $\frac{1}{8}$ inch above the top of the highest components.

Connect the leads to the battery and check that all the neons operate, now operate switch S1 and compare the two types of display.

If only one type of display is required—a link could be put in place of the switch or both switch and link may be omitted. The unit can be housed in a wooden or plastic box with the neons showing through the top. Some Araldite around the base of each neon will hold them firmly and a Perspex cover could be made to fit over the top to protect the neons.

Continued on page 148

ONCE again we have run into supply difficulties on one particular component — the transformer used in the *Radio Control Receiver*—apparently Ardente are no longer in business and, as far as we know, all supplies of the transformer have now been exhausted. As we stated in the article, a larger type of transformer is available from Henry's Radio and this could be used if the board is extended by 0·6 inches at the TR5 end to hold the transformer, and the connections made using flying leads. If the receiver appears to suffer from lack of range try adjusting the value of C8.

Unfortunately we have been unable to find a transformer with exactly the same specification as the Ardente one and we are unable to give an alternative that will fit into the space on the board —the transformer available from Henry's is not that much larger than the original.

Egg Timer

The first "kitchen aid" that we have published; a design for the *Egg Timer*. A tantalum type capacitor must be used for C1 in this circuit since this type has a much lower leakage current than an electrolytic, which would not be able to charge due to the small current available through VR1 and R1.

Some difficulty may be experienced in obtaining the 4·7 megohm potentiometer specified —Electrovalue of 28 St. Judes Road, Englefield Green, Egham, Surrey, can supply this pot. The cost of this item is 12p plus a small order surcharge of 10p (for orders under £2); this includes postage. Incidentally we do not take postage or any surcharge into account when we calculate the approximate cost of any of our projects.

The buzzer for the timer should be available through most electrical shops and the case of the prototype is a standard aluminium chassis available from many of the firms who advertise in our pages.

The relay used can be any fairly small type provided it has a coil resistance of at least 700Ω —the higher the value the better —and can work on 18V; the prototype unit used a 3000Ω 18V type. The relay should have at least one set of normally open contacts rated at 1·5 amp, alternatively two or more sets having a lower rating could be used, wired, in parallel.

Neon Novelty

There should be no buying problems with components for either *Neon Novelty* described. One point to watch is that the neons are the correct type—the voltage is the important point—and that the glass is not cracked or chipped.

Specific types of capacitor have been given in the components list simply because these types are relatively small in size and should fit easily on the board or the connection block. Any type of capacitor could be used provided its working voltage is greater than 100V.

This is one project where 20 per cent tolerance resistors are as good as—if not better than—the close tolerance types, so almost any high value (over about 6·8 megohm) carbon types will do.

Enlarger Exposure Meter

A project that should be popular with amateur photographers who do their own enlarging, the *Enlarger Exposure Meter* is a neat unit that should present few construction or buying problems.

The meter is the most expensive item and can be replaced by a multimeter if available. Alternatively buy a large type meter preferably 0-100μA with a scale marked 0-100 in single unit divisions. The larger the scale length the better the accuracy but it is hardly worth getting a meter larger than $3\frac{1}{2}$ or 4 inches across.

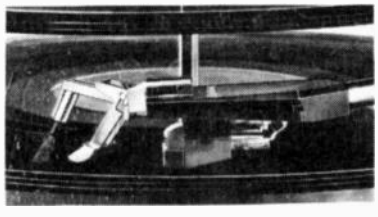
Other parts used in the exposure meter should be readily available.

New Products

What is claimed to be the "world's first cordless soldering iron" is now available in this country through Pact International Electronics Ltd., PO Box 19, Royston, Herts, SG8 5HH. The iron, which is made in the USA is automatically recharged from its stand when not in use. Once the iron is charged it can be used anywhere and heats up in 3 to 5 seconds at the touch of a button. The iron has a working light near the bit, which is said to be of the "indestructible iron plated type."

The iron costs £9·25 complete with stand and two bits.

Bib have introduced a Groov-Kleen for record changers, as opposed to single play decks. The "Changer Groov-Kleen Model 45" fits on the cartridge shell of the tracking arm and rests on the record near the stylus—see photo. The cleaner costs 98p plus purchase tax and will fit most pick-up arms by means of an adhesive black carrier plate, adaptors are provided for fixing to some cartridge carriers. Adjustment of the pick-up arm pressure can compensate for the additional weight on the stylus.



enlarger exposure meter

A light meter to determine the exposure required for satisfactory enlargements

By J. M. Bartlett

THIS article is of special interest to the photographer who does his own enlarging. It describes a light meter to determine the exposure required for satisfactory enlargements without the time consuming, and paper devouring, ritual of test strips. In practice the meter has been adequate for most normal work and variations required to optimise an enlargement have rarely fallen outside a 10 per cent change of the indicated exposure.

Owners of multimeters can use their meters on a low current range with the exposure meter circuit and hence save the cost of the most expensive component—the meter movement. Easy to make and operate, this is a project requiring very little technical knowledge, so is ideal for the home constructor.

BASIC BRIDGE

Consider a voltage V_s applied to two arms of a bridge, (Fig. 1), the left arm of R_a and R3, the right arm of VR1 and R5. In the left arm V_a will vary according to the values of R_a and R3, whilst in the right arm V_b will vary according to the values of VR1 and R5.

Each arm can be regarded as independent of the other for most practical purposes, and if V_a is equal to V_b no current will flow in the meter and the bridge is said to be balanced. If, however, the resistance of R_a rises, the potential V_a falls and current flows from V_b to V_a.

If the current through the meter is very much smaller than the current in VR1 and R5, V_b will remain virtually constant. Resistor R4 is connected in series with the meter so that the full scale deflection (f.s.d.) current is not exceeded to such an extent that the meter is damaged.

The bridge equation is usually stated by saying that the bridge is balanced when $R_a \times R5 = R3 \times VR1$ but the action of the circuit is not so easy to see from this approach.

FULL CIRCUIT

Let us now consider the full circuit (Fig. 2). The right arm is VR1 and R5 as before, with V_b set by the wiper of a subminiature potentiometer, and kept constant. Resistor R3 is in the same position as before but R_a is now a field effect transistor (f.e.t.) with V_a appearing on its source.

As in the basic circuit when V_a is equal to V_b the bridge is balanced and no current flows, but if V_a falls the current is passed through the meter from V_b to V_a.

LIGHT CELL

The light cell is a sensitive photoconductive cell (2CC1). In the dark its resistance rises to nearly 10 megohms falling to only a few hundred ohms in bright light. Under the enlarger it operates between about 1 megohm for a dense negative down to 100 kilohms for maximum meter deflection with a "thin" negative.

These values were determined with a wide variety of negatives, enlargements and stop values and although values outside this range

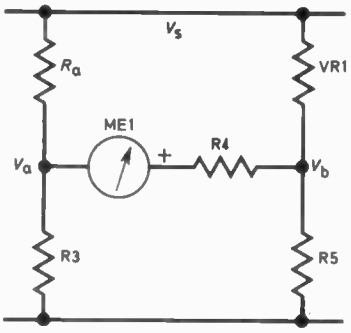
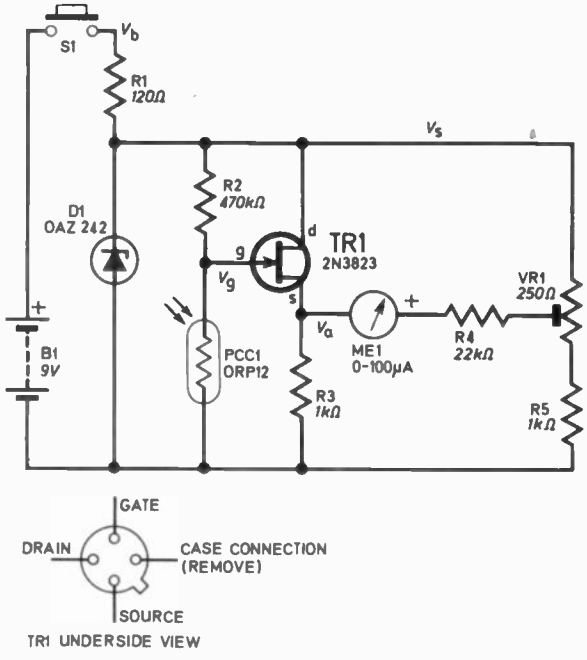


Fig. 1. Basic bridge circuit configuration.

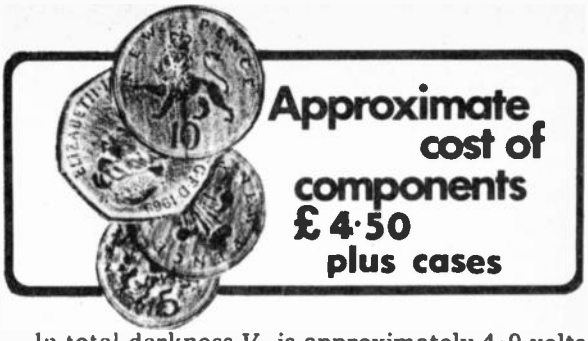
Fig. 2. Circuit diagram of the Enlarger exposure meter.



could be obtained they could be brought back into this working range by varying the stop position on the enlarger.

Incidentally these correspond to light values on the enlarger baseboard of 0·06 lux for a dense negative up to 0·8 lux for a thinner one. This is of purely academic interest but may be worth noting considering the difficulties involved in making such measurements.

In view of the high resistance involved the current passed through R2 and PCC1 is in the order of a few microamps, hence a field effect transistor (*n* channel) must be used as a voltage follower. As V_g falls so does V_s but the gate of the f.e.t. (at V_g) presents an input impedance of many megohms and can therefore be ignored; V_g therefore varies with the incident light and V_s follows this change.



In total darkness V_s is approximately 4·9 volts at which point VR1 is adjusted to give zero deflection on the meter. Under the enlarger the resistance of PCC1 falls, V_g falls, and V_s falls, following the change in voltage. V_s falls about 2·2 volts at the chosen light intensity so at this level of illumination we get $\frac{2{\cdot}2V}{22k\Omega} = 100\mu A$. i.e. full scale deflection.

STABILIZER

To nullify the effects of battery ageing, a Zener diode together with R1 is used to derive a semistable voltage V_s, nominally 5·6V. For a variation in battery voltage of 6·5V to 9V the meter varies only one division at full scale. This does not affect the calibrated exposure to any significant degree.

A push button should be used to switch the circuit on so that the battery is only loaded when a reading is actually being taken.

MECHANICAL CONSTRUCTION

The diagrams and photographs are virtually self explanatory. Commence construction by cutting the board to size and cleaning up the edges with a file. There are no breaks in the copper strips of the board so the next step is to insert and solder up all the components as shown in Fig. 3. Connect the f.e.t. and l.d.r. after the other components and use a heat shunt to protect these components whilst soldering the leads.

The complete circuit except for the meter is mounted in a tin which formerly held Strepsil throat sweets. A one ounce tobacco tin is about the same size, or a die cast box could be bought, but it is not necessary to spend money on a fancy box.

Adhesive foam similar to draught excluding foam used on doors and windows holds the board firmly and a folded tissue on the bottom of the tin prevents the soldered joints from shorting on the tin. The meter leads are fed out through a small grommet.

A one inch diameter hole is cut in the case lid and a piece of diffusing material glued to the underside. It is worth mentioning that a small plywood box has some advantages:—

(a) The soldered joints cannot be shorted.

(b) Most handy-men can bore a one inch hole

enlarger exposure meter

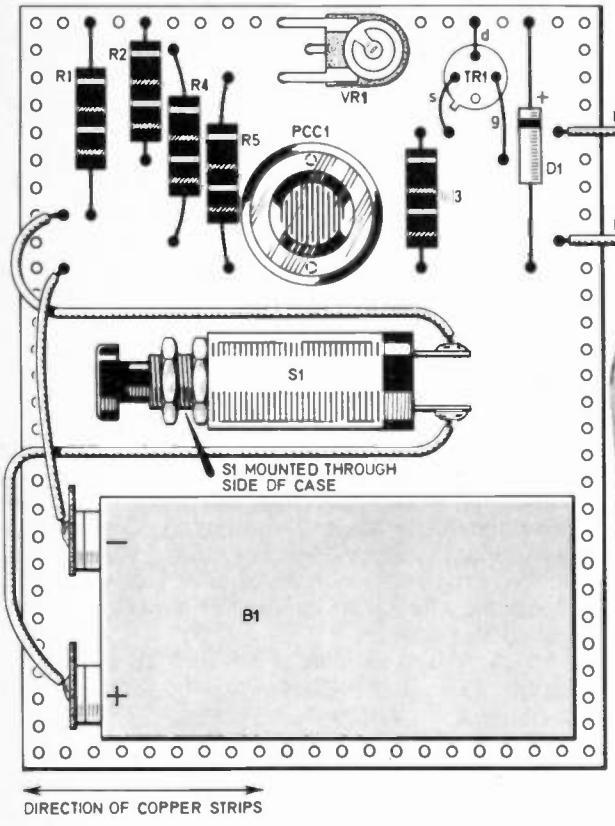
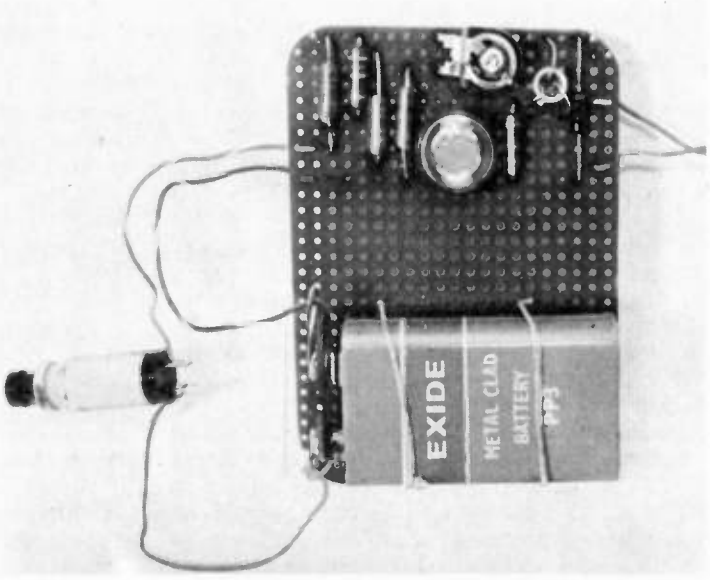


Fig. 3. Layout and wiring of the components mounted on the Veroboard. There are no breaks in the copper strips on the underside.

The completed sensor box with lid removed (above).

The Veroboard complete with all components. Note the mounting of TR1—upside down for easy lead connection. Also note the rounded corners of the board to enable it to fit inside the tin used for the case.



in wood whereas a "Q-max" cutter may not be available to cut the metal case.

(c) The case could be made the exact size to accommodate the Veroboard.

There is a choice of diffusing materials. Tracing paper is adequate but prone to damage. A stronger plastic tracing film could be used but Perspex is more durable and is the best choice. Clear Perspex can be diffused by lightly rubbing it with fine emery cloth.

An alternative is to use a clear window and

diffuse the projected image nearer to the enlarger lens. In this case a general reading is obtained of the whole negative.

The meter can be mounted in any suitable metal, plastic or wood case and connected to the circuitry by a piece of twin core wiring flex —be sure to observe the correct polarity.

To finish the units they can both be painted matt black.

CALIBRATING THE METER

A calibration curve must be produced and this requires a few test strips to be made. The sensor is placed on the base board over the area of particular interest. The push button is operated and the deflection noted. A conventional test strip is made and the best exposure corresponding to that deflection is noted.

The enlarger stop is altered to give a new meter deflection and the best test strip exposure for this deflection is similarly recorded. This is repeated until 6 or 8 meter readings between, say, 10 and 100 with the corresponding exposures have been obtained. The deflection/time graph can be drawn and this is kept as the calibration curve. An example is shown in Fig. 4. Obviously there will be occasions when a difference in exposure is desirable to bring out special effects of shadows etc., but from past experience this has been found to be not more than ±10 per cent of the indicated value.

VARIATIONS

Since we are dealing with a 100μA meter in this article, R4 was chosen as 22 kilohms. Table 1 shows how R4 varies with the meter used.

It is preferable to use the highest sensitivity meter but more important, it should be as large as possible. The meter must be read with the safe light off, using only the fringe lighting

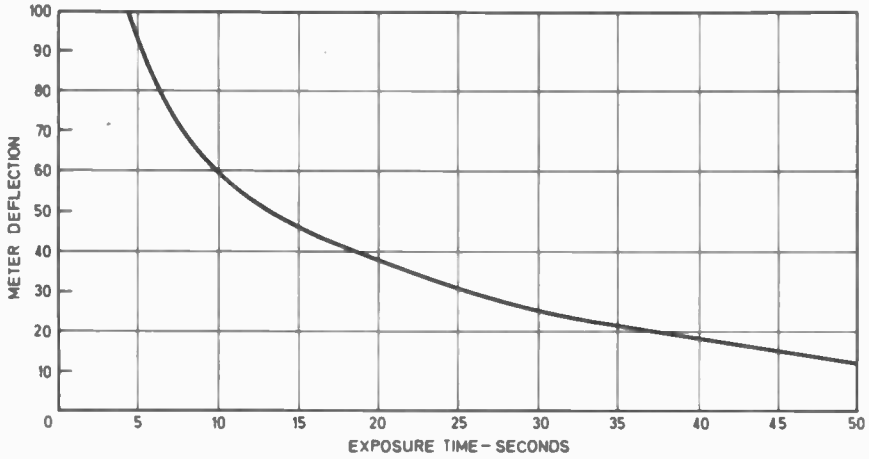


Fig. 4. Calibration curve for the prototype unit. A curve like this must be made for the meter.

Table 1: Resistance value for various meters

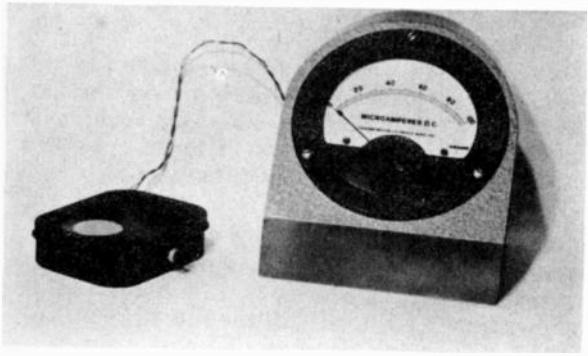
Meter f.s.d. (μA)	R4 (calculated) (KΩ)	Nearest preferred value (KΩ)
50	44	47
100	22	22
150	14·6	15
200	11	12
250	9	10
500	4·5	4·7

from the enlarger, and since a calibration chart is used, meter sensitivity and linearity is less important.

If the meter reads very high all the time, it could be that a particularly bright lamp is fitted to the enlarger or consistently thin negatives are used. This is of no consequence since the sensor can be made less sensitive by increasing R4 from the original value. In this way the illumination has to be brighter to give a full scale reading.

Other variations include having the sensor (PCC1) on flying leads and fitting the bridge, battery and meter into one box. As a home project the exposure meter has several possibilities for the constructor to modify to his own requirements or to make as shown. ▣

The prototype unit.



Components . . . .

Resistors

R1	120Ω	SEE SHOP TALK
R2	470kΩ	
R3	1kΩ	
R4	22kΩ	
R5	1kΩ	

All ¼W ± 10% carbon

Potentiometer

VR1 250Ω subminiature skeleton preset

Semiconductors

PCC1 ORP12 light dependent resistor
D1 5·6V 400mW Zener diode
TR1 2N3823 *n* channel f.e.t.

Miscellaneous

S1 Single pole push to make pushbutton
B1 PP3 9V battery
ME1 0–100μA moving coil meter (or alternative—see text)

Veroboard 2·2 x 2·9 x 0·1 inch matrix, battery connectors, grommetts, connecting wire, tracing paper or perspex for diffusing material, two cases (see text)

Continued from page 142

Since the unit can be expected to work for more than two or three years (possibly much longer) the box can be sealed up, but a small hole **must** be left as mentioned above; also the battery **must not** be a tight fit as it is likely to expand with old age.

ALTERNATIVE DISPLAY

An interesting alternative to the two projects described could be made for use with larger type toy animals. For this a six or eight neon configuration is used with the leads to the neons extended so that four neons form each eye providing a flickering effect in the eyes. ▣

Components . . . .

Resistor

R1 10 MΩ
¼W ± 20% carbon (see text)

SEE SHOP TALK

Capacitor

C1 0·22μF 100V or more working (polyester or polystyrene)

Neon

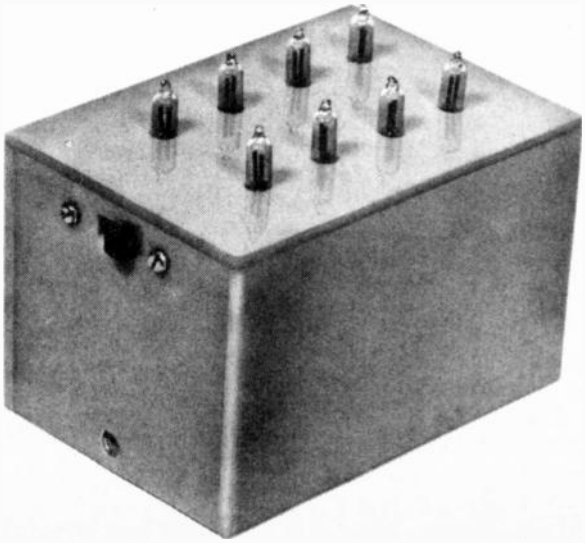
LP1 70 to 90V wire ended neon

Repeat all the above components for each flashing neon required.

Miscellaneous

B1 90V battery (type B126 or similar)
Veroboard (for 8 neon unit 2½ x 3½ x 0·15 inch matrix).
Six way connector (for two neon unit), connecting wire, two way or three way plug to suit battery.
Materials for case and model animal—if used—see text.

Photograph of the completed "flashing block", incorporating two types of switched display.



The team behind the great technological breakthrough *left to right* John Bardeen, William Shockley and Walter Brattain.

The First Transistor

THE whole of electronics depends upon the amplification of electric current. The principal device employed for this function was originally the valve. During the last 15 years or so the transistor has taken over this role. The transistor, a solid state amplifying device, was invented *twenty-five years ago.*

There are interesting similarities in the histories of the valve and the transistor. The thermionic valve first appeared on the scene as as a rectifier. It had two electrodes: a filament (cathode) and an anode, and it was known as a diode.

The usefulness of the valve was greatly increased when a third electrode called the grid was added around 1906. The result was a device capable of amplifying voltages and currents. It was called a triode.

ANCESTORS OF THE TRANSISTOR

The transistor has as its ancestors certain devices called solid state rectifiers. These have appeared in two different forms: (1) the crystal (point-contact) rectifier, first used as a detector of radio frequencies before the invention of the valve, (2) the plate or contact metal rectifier, used for producing direct current from alternating current supplies, which first appeared in practical forms around 1920.

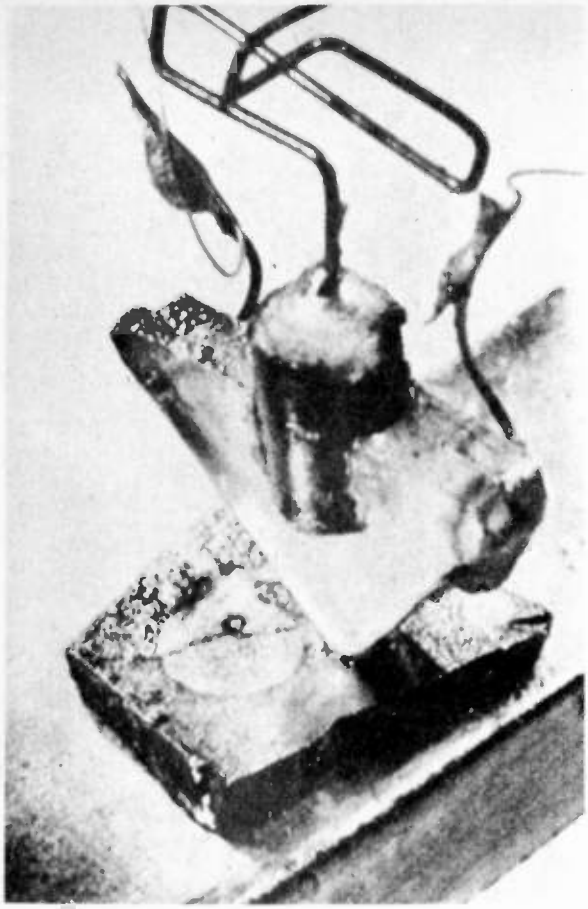
Ever since the American Lee de Forest fitted the grid into Fleming's original diode, scientists have wished to emulate this in the field of solid state, that is with semiconductor materials.

Many attempts to make a solid state version of the amplifying valve must have been made during the last 50 years or so, but without success. This was mainly because the manner in which crystal and metal rectifiers functioned had not been clearly established. The world had to wait until 1947 for this wonder that was destined to revolutionise electronics and very soon the way of life for all.

THE BREAKTHROUGH

On December 24, 1947, two members of a research team at Bell Telephone Laboratories Inc., New Jersey, U.S., achieved the breakthrough. In the course of experiments with semiconductor crystals, John Bardeen and Walter Brattain placed two contacts onto a piece of germanium crystal, the contacts were close but separated from each other. With a third common contact made to the crystal, two separate external circuits were thus formed.

A microphone was coupled to one circuit and it was found that an amplified version of speech current was produced in the second circuit. The crystal device had obviously introduced current



Photograph of the first original semiconductor amplifying device—the transistor.

gain, see Fig. 1. The name transistor was coined from the "transfer resistance" characteristic demonstrated by this device.

The full theory to account for the operation of this "point-contact transistor" was not worked out for some little time afterwards. It was during this theoretical investigation that the principle

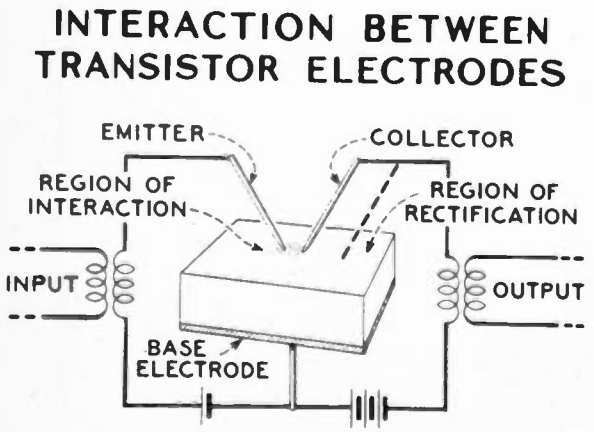


Fig. 1. The basis of the first transistor.

of the *junction* transistor was discovered by William Shockley, who was the leader of the team responsible for the initial transistor discovery.

As is well known, the junction type transistor soon proved to be superior to the point-contact transistor, and within a few years had entirely superceded the latter as a practical device suitable for large scale production. Undoubtedly though, the point-contact transistor provided the dramatic initial breakthrough and inspired subsequent research in this field. Thus it seems right and fair that honours should be shared equally between Bardeen, Brattain and Shockley. Indeed this is what the scientific world thought, because this trio were jointly awarded the Nobel prize in physics for 1956.

The junction transistor consists of a three-layer sandwich of *n* type and *p* type semiconductor material. There are thus two junctions. Alternative arrangements are possible, as indicated in Fig. 2.

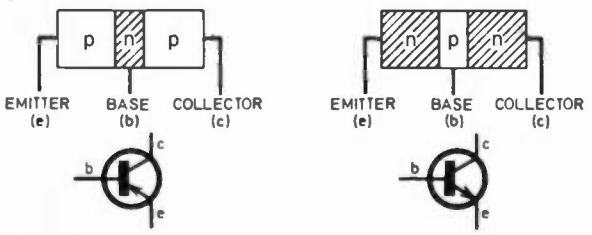


Fig. 2. Alternative arrangements of the junction transistor.

MANY VARIETIES

The ascendancy of the junction transistor was followed by a whole train of exciting and important technical developments. Silicon was introduced around 1960. By the 1960's, this semiconductor material had taken over almost entirely from germanium, the material originally used.

The bipolar junction transistor relies upon the injection of minority current carries (holes and electrons) across the base from one junction to the other. This theory has been applied extensively and a large number of different types of transistor have been developed since the first transistor made its appearance.

A wide range of bipolar *pnp* and *npn* devices specially designed for a.f., r.f. and high power operation have become available. Also switching devices such as the four layer *pnpn* silicon controlled rectifier or thyristor, capable of handling powers from a few milliamperes to hundreds of amperes, and at voltages ranging upwards to 1,000 or more. These four layer devices were invented by Shockley in the early 1950's.

A different principle is involved in the field effect transistor (f.e.t.)—also invented by Shockley in the early 1950's. This is a unipolar device —so called because majority carries alone are

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Hex. Inverter	BMC936	12p	11p	10p
Hex. Inverter	BMC937	12p	11p	10p
Hex. Inverter	BMC940	12p	11p	10p
Hex. Inverter	BMC941	12p	11p	10p
Type D Flip Flop	BMC942	20p	18p	16p
Ex. 2/4-input Power	BMC944	12p	11p	10p
Clocked Flip Flop	BMC945	20p	18p	16p
4/2 Input NAND Gate	BMC946	11p	10p	9p
Clocked Flip Flop	BMC948	20p	18p	16p
4/2 Input NAND Gate	BMC949	12p	11p	10p
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Dual J/K Flip Flop	BMC955	20p	18p	16p
Dual J/K Flip Flop	BMC956	20p	18p	16p
Quad. 2-input Power	BMC958	12p	11p	10p
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involved in the mechanism by which these particular devices function.

The junction unipolar transistor (j.f.e.t.) was followed by the insulated gate field effect transistor also known as the metal-oxide semiconductor transistor (m.o.s.t.) on account of its form of construction.

The m.o.s.t. technique has been adopted for integrated circuit manufacture.

One type of bipolar transistor is, in fact, more correctly described as a double-base diode. This is the unijunction transistor (u.j.t.) it is essentially a switching device.

A wide variety of diodes based on the *pn* junction have been developed. They have use as signal and power rectifiers, as voltage regulators, as variable resistors (varistors) or capacitors (varactors); and as microwave oscillators.

OPTOELECTRONIC DEVICES

Both the single and the multiple *pn* junction have been widely applied in the field of optical radiation.

Devices which detect light are the photodiode and the photo transistor. Diode devices with large contact areas exploit the photovoltaic effect to produce electrical energy are commonly available as photocells or solar cells (or "batteries"—when used in groups).

Other *pn* junction devices convert electrical energy into light. Electroluminescent diodes consisting of a junction of *p* and *n* type gallium arsenide and gallium phosphide are becoming increasingly popular as red and green light emitters. This area of the technology is expanding dramatically with the demand for small direct readout systems.

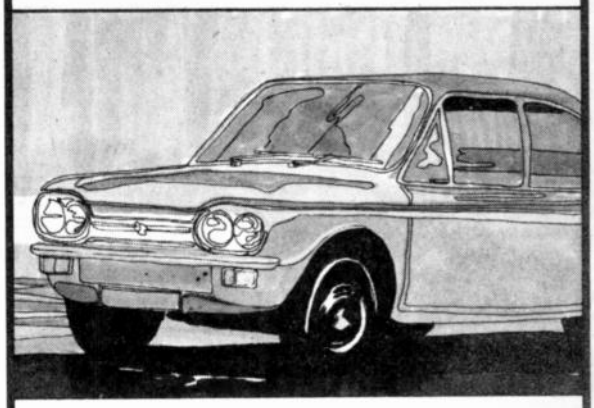
INFRA-RED DEVICES

Much of the future development of semiconductor technology seems to lie in the field of infra-red. Exciting and sophisticated devices are likely to make their appearance in due course. Thus another part of the spectrum will become available for general exploitation through applied electronics. ▣

PLEASE TAKE NOTE

Radio Control Receiver (Jan. 73) **Fig. 2. A break should be made in the copper-strip at position J1. Transformer suppliers—see** *Shop Talk (page 143).*

NEXT MONTH



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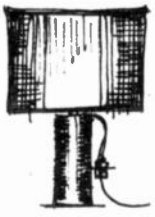

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These constructional projects and all the regular features in the April issue, on sale Friday, March 16.

DEMO CIRCUITS

By MIKE HUGHES

The Grounded Base Amplifier

THE experiment to be described demonstrates two points; first how to get maximum **voltage amplification** out of a transistor and secondly that a loudspeaker can act as a microphone—given the right set of circumstances.

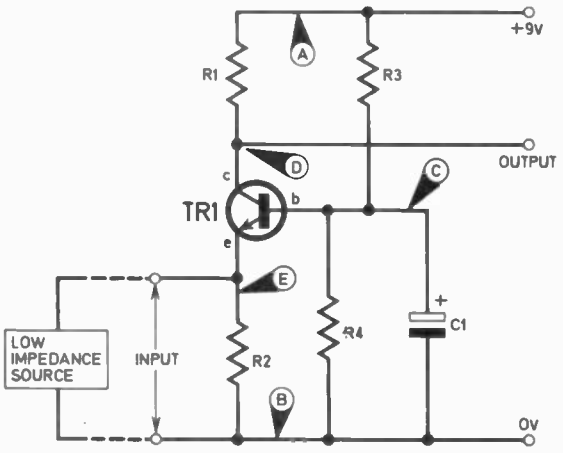

Fig. 4.1. Basic circuit of a grounded base stage.

BASIS OF OPERATION

At first sight the basic circuit for a **grounded base stage** (shown in Fig. 4.1) looks rather like a **grounded emitter;** but look closer. There is a large capacitor connected between the base of TR1 and the ground rail—this, in conjunction with the two resistors R3 and R4, keeps the base at a fixed potential with respect to the earth rail. This means that there is a fixed current flowing between base and emitter, controlled by the potential divide effect of R3 with R4 and the value of R2. Thus the collector current can flow through R1, the transistor and R2; by suitable selection of values for the components we can set the **quiescent output voltage** (output voltage with no input signal) at the collector of the transistor.

Provided C1 shows very low reactance to any alternating currents that may be superimposed on the d.c. levels in the circuit, the potentials at A, B and C are precisely defined and stable. To work as an amplifier a signal that will cause current variations and generate variations in voltage at the collector must be injected. This is done by modulating the emitter current—applying the signal across R2.

The input is therefore between emitter and ground, and the output is between collector and ground; as the potential at the base is precisely defined as a d.c. level, the stage is termed a grounded base configuration. Some books and theoretical articles show the circuit a different way round using separate power supplies (these are necessary to ensure that the base is always positive with respect to the emitter). In practice only one power supply is normally available and this is why we have chosen to describe the circuit in the form shown in Fig. 4.1—this is the way you are most likely to come across it in constructional articles.

CIRCUIT DESIGN

Emitter current is approximately the same as collector current (actually it is equal to collector current plus base current but as the latter is comparatively small it can be ignored at this stage). In order to modulate the emitter current with a low voltage signal, the signal must come from a source of reasonably low resistance (impedance) because emitter current can be quite high (in this case consider it to be about 0·2mA).

To get maximum voltage amplification at the collector the emitter current must be used to generate a collector current that will give the largest voltage variations across a collector load resistor. To get maximum voltage swings across the load resistor for a given current variation the load resistance must be high.

Thus the grounded base stage must be driven from a low impedance source and the output impedance of the stage is usually quite high. To a first order approximation the voltage amplification is set by the ratio of collector load resistance to source impedance. If a 35 ohm loudspeaker is used as a microphone, the output is only in the order of one or two millivolts, for speech very close to the cone. Thus to be able

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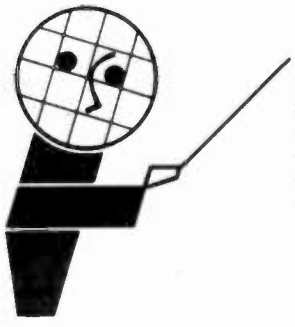

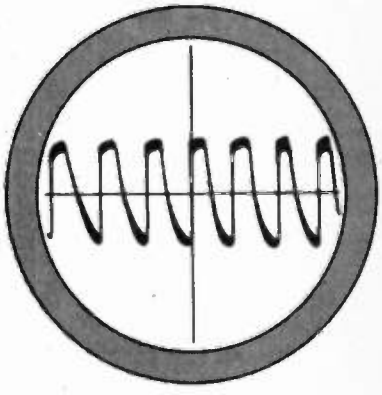

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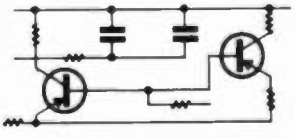

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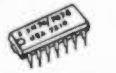

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SN7405	0·20	0·18	0·16
SN7406	0·30	0·27	0·25
SN7407	0·30	0·27	0·25
SN7408	0·20	0·19	0·18
SN7409	0·45	0·42	0·35
SN7410	0·20	0·18	0·16
SN7411	0·23	0·22	0·20
SN7412	0·42	0·40	0·35
SN7413	0·30	0·27	0·25
SN7416	0·30	0·27	0·25
SN7417	0·30	0·27	0·25
SN7420	0·20	0·18	0·16
SN7422	0·48	0·44	0·40
SN7423	0·48	0·44	0·40
SN7425	0·48	0·40	0·35
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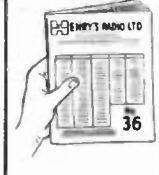

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B1/60	600	35p
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W01	100	35p
W02	200	40p
W06	600	45p
TWO AMPS ½ H × ½ L × ¼		
B2/05	50	35p
B2/100	100	40p
B2/200	200	45p
B2/600	600	50p
B2/1000	1000	60p
FOUR AMPS ½H × ½L × ¼		
B4/100	100	60p
B4/200	200	65p
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B4/600	600	75p
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CR8 3/10	100	30p
CR8 3/20	200	35p
CR8 3/40	400	45p
CR8 3/60	600	55p
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CR8 7/200	200	65p
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to measure the output a high degree of voltage amplification must be introduced. By making R1 22 kilohm the simple rule for amplification gives a factor:

$$\text{Voltage amplification} = (\text{approx}) \frac{Z_{out}}{Z_{in}}$$
$$= \frac{22{,}000}{35}$$
$$= 630$$

Therefore if the circuit works the output voltage should swing by a volt or so resulting from the millivolt or two produced by the "microphone".

COMPONENT SELECTION

If R1 is to be 22 kilohm, the quiescent collector current (to give a mid-rail output of 4·5V) will be

$$\frac{4{\cdot}5}{22} \text{ mA},$$

approximately 0·2mA. The quiescent potential at the emitter (point E) must be sufficiently positive so that the alternating voltage from the microphone does not drive it to zero. If we make the potential at point E, 0·2V, assuming the emitter current is approximately the same as collector current, R2 will be

$$\frac{0{\cdot}2}{0{\cdot}2} \text{ kilohm}$$

(1 kilohm).

Because a silicon transistor is being used, the potential at the base (point C) must be 0·6V more positive than the emitter. Assuming h_{FE} for the transistor to be 200, the base current required to set the quiescent levels chosen must be

$$\frac{I_c}{h_{FE}} = \frac{0{\cdot}2}{200} \text{ mA} = 0{\cdot}001\text{mA}.$$

If (say) 81 times I_b flows through R3, and 80 times I_b flows through R4 (this is much more standing current through the resistor chain than is normally required for common emitter configuration but a high input impedance is not required. A high standing current through R3 and R4 also leads to improved stability and helps maintain the potential at C with very little variation when signal is applied); resistor R3 is therefore

$$\frac{9\text{–}0{\cdot}8}{81 \times 0{\cdot}001} \text{ kilohm} = \frac{8{\cdot}2}{0{\cdot}081} = \text{approx 100 kilohm};$$

$$\text{R4 is } \frac{0{\cdot}8}{80 \times 0{\cdot}001} \text{ kilohm} = \frac{0{\cdot}8}{0{\cdot}08} = 10 \text{ kilohm}.$$

It is now obvious why the factors 81 and 80 were chosen. Capacitor C1 must present a low impedance to the lowest frequencies therefore 50μF will be suitable.

If the loudspeaker (microphone) is connected directly across emitter to ground, its low resistance will modify all the calculations, as it is only the a.c. signal from the coil that is used it can be capacitively coupled to the emitter by C2 (this will not affect our d.c. calculations). Again this capacitor must be of low impedance to the lowest frequencies so again 50μF can be used.

MONITORING CIRCUIT

Because of the high output impedance of the grounded base stage it is difficult to make a simple monitoring circuit that does not in one way or another affect the voltage amplification; however the simple expedient of TR2 in Fig. 4.2 works reasonably well.

Potentiometer VR2 (5 kilohm) should be adjusted so that TR2 is only just conducting (i.e. the meter is just starting to move above zero). Make this adjustment very slowly because the coupling capacitor C3 slows the reaction. Any positive going a.c. signals at the collector of TR1 will be coupled to the base of TR2 and drive it further into conduction showing a useful output on the meter.

Negative going excursions will switch the transistor off and then be shunted to ground

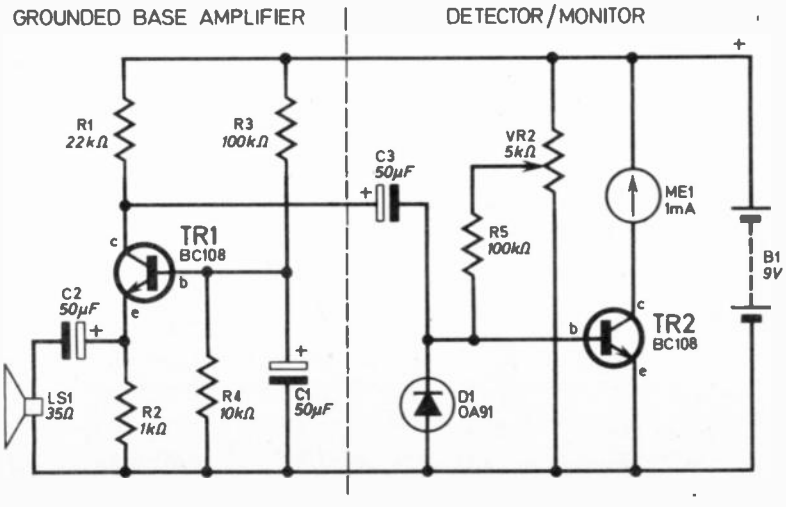


Fig. 4.2. "Working" circuit for the grounded base stage together with a simple monitoring stage.

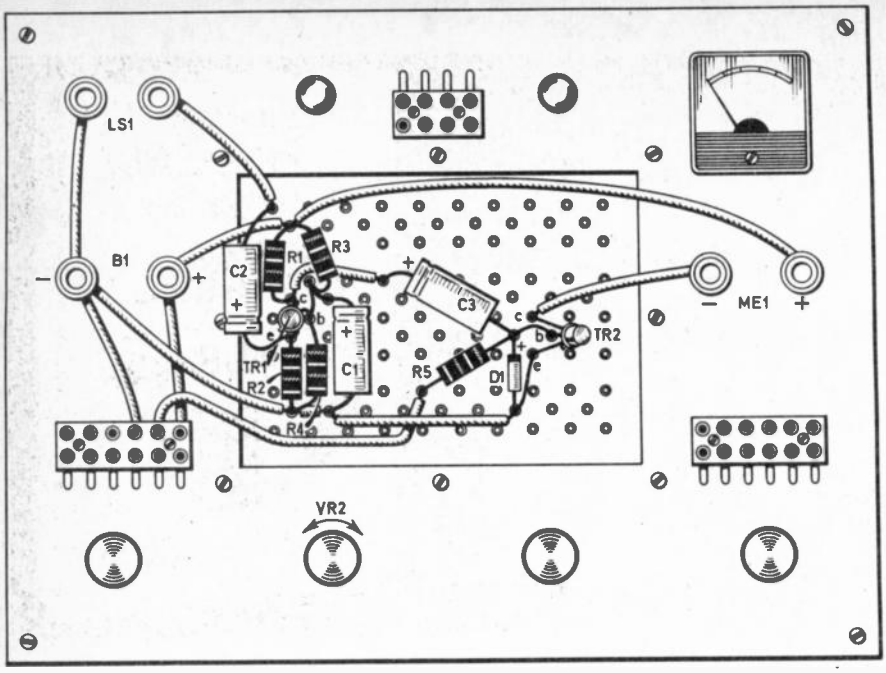
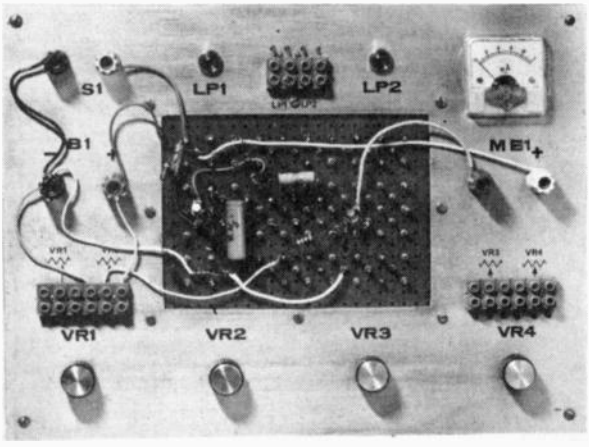


Fig. 4.3. The circuit of Fig. 4.2. Wired up on the Demo Deck. VR2 should be adjusted as mentioned in the text.

by D1. Transistor TR2 is "**starvation**" **biased** and acting as an **audio detector** with a useful amount of power gain that helps match the low impedance of the meter to the high output impedance of the grounded base stage.

Build the circuit of Fig. 4.2 on the Demo Deck as shown in Fig. 4.3 and speak close to the loudspeaker, full scale deflection should be obtained on the meter for loud passages. Strictly speaking the meter is not indicating the amplitude of voltage swings at the collector of TR1 but it can be seen that the amplitude—in parts—is certainly greater than 600mV by disconnecting the 100 kilohm resistor going to the wiper of VR2 (thus removing all bias). Again speak loudly into the loudspeaker, some indication will still be seen on ME1.

Photograph of the construction shown in Fig. 4.3.



To get *any* indication on ME1 means that the voltage fed to the base of TR2 must be exceeding the 600mV base emitter forward voltage drop. When measured on proper test equipment the a.c. signal at the collector of TR1 is in the order of 1·5V—thus bearing out that we are getting very high voltage amplification (between 600 and 700 as calculated).

USES

The grounded base stage is not the easiest amplifier to design or to use in equipment but nevertheless it has several useful features. It is very easy to design a circuit having a known voltage gain (by using the ratio of input and output impedances); adding a resistor in series with the signal source reduces the gain proportionately. Very frequently low voltage sources (that need voltage amplification) have very low impedance and therefore match the input of a grounded base stage e.g. moving coil microphones and the first stage of u.h.f. radio tuners.

The output signal is in phase with the input—unlike the common emitter stage where there is 180 degrees phase shift. When the input signal goes positive (Fig. 4.1) it opposes the emitter current, this opposes the collector current and the transistor conducts less; therefore the potential at the collector goes positive (in phase with the input). This is a very useful feature in some applications—particularly when dealing with non-symmetric waveforms as are encountered in television systems.

Next month: The Phase Shift Oscillator

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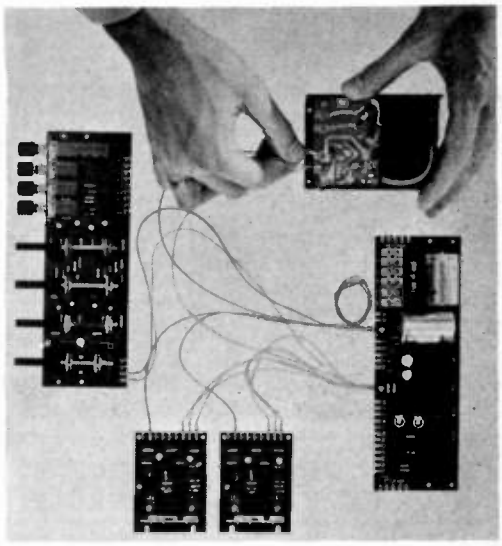

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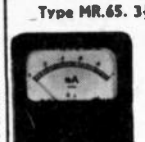

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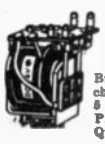

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Ideal for home, office, stores, factories, etc. Supplied complete with batteries, cable and free instructions.

2 Station, £3·97, 3 Station £5·25. P. & P. 15p.
4 Station £6·63, P. & P. 17p.

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G. W. SMITH & CO. (RADIO) LTD.
Also see next three pages

MULTIMETERS *for EVERY purpose!*

TS60 POCKET MULTIMETER
High-precision at low-cost. Ranges: D.C. 15V, 150V, 1,000V (10,000 opv). A.C. 15V, 150V, 1000V (1,000 opv). D.C. Current 150mA. Resistance 100k ohms. £1-85. Post 15p.

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5,000 O.P.V.
0/3/15/150/300/1200 V. D.C. 0/6/30/300/600 V. A.C. 0/300μA/300 MA 0/10K/1 meg Ω
Decibels −10 to +16db
£2·75 each +15p P. & P.

HIOKI MODEL 720X
20,000 O.P.V.
Overload protection
5/25/100/500/1000 VDC. 10/50/250/1000 VAC. 50μA/250mA. 20K/2 meg ohm. −5 to +62db.
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30,000 O.P.V. Overload protection. 6/30/60/300/600/1200 VDC. 12/60/120/600/1200 VAC. 60μA/30 mA/300 mA. 2K/200K/2 megohm. −10 to +63db.
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MODEL TE-12
20,000 O.P.V. 0/0·6/6/30/120/600/1,200/3,000/6,000v. D.C. 0/6/30/120/600/1,200v. A.C. 0/60μA/6/60/600mA. 0/6K/600K/6Meg./60 Meg. Ω 50pF: 0·2mFd. £5·97. P. & P. 17p.

MODEL TE-200
20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1,000V. D.C. 0/10/50/250/1,000V. A.C. 0/50 μA/250 mA. 0/60K/6 meg Ω. −20 to +62db.
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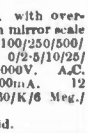

HIOKI MODEL 750X
50,000 o.p.v. 43 ranges 0–0·3 to 1,200v D.C. 0–3 to 1,200v A.C. 0–30μA/300mA. 0–3K/30 meg ohms. – 10 to + 17dB.
£8·97. Post 20p.

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Features A.C. current ranges. 100,000 o.p.v. Mirror Scale. Overload protection.
0/5/2·5/10/50/250/500/1000 V D.C.
0/2·5/10/50/250/1000 V. A.C.
0/10/250μA/2·5/25/250 MA/10 Amp. D.C.
10 Amp A.C. 0/20K/200K/2 2 MEG/20 MEG. – 20 +62db.
£12·50. P. & P. 25p.

370 WTR MULTI-METER
Features A.C. current ranges. 20,000 o.p.v. 0/5/2·5/10/50/250/500 1000 V. D.C.
0/2·5/10/50/250/500/1000V AC
0/50uA/1/10/100mA/1/10 Amp D.C.
0/100mA/1/10 Amp AC
0/5K/50K/500K/5 MEG/ 50 MEG.
−20 +62db.
£15. P. & P. 25p.

RUSSIAN 22 RANGE MULTIMETER
Model U437 10,000 o.p.v. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: : 2·5/10/50/250/500/1000v D.C. 2·5/10/50/250/500/1000v A.C. DC Current 100w A/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3m Ω. Complete with batteries, test leads, instructions and sturdy steel carrying case.
OUR PRICE £5·97. P. & P. 25p

ROUND SCALE TYPE PENCIL TESTER MODEL T.S.68
Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V AC and DC at 2,000 o.p.v. Resistance 0·20K ohms. ONLY £1·97 P. & P. 13p.

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New style 20,000 o.p.v. pocket multimeter. 5/25/50/250/500 / 2500 V. D.C. 10 / 50 / 100 / 500 / 1000V. A.C. 50μA / 250mA. 6K / 6 meg ohms. −20 to + 22 dB.
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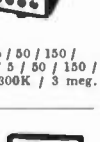
MODEL TH-12
20,000 o.p.v. Overload protection. Slide switch selector 0 / ·25 / 2·5 / 10 / 50 / 250 / 1000V. D.C. 0 / 10 / 50 / 250 / 1000V. A.C. 0 / 50μA / 25 / 250mA. D.C. 0 / 3K / 30K / 300K / 3 meg – 20 to + 50dB
£4·97. Post 15p.

MODEL TE-300
30,000 O.P.V. Mirror scale, overload protection 0/·6/3/15/60/300/1,200V. D.C. 0/6/30/120/600/1,200V. A.C. 0/30μA/6mA/60mA/300mA/600mA. 0/8K/80K/800K/8 meg. ohm −20 to +63 db. £5·97. P. & P. 15p.

MODEL PL436
20k Ω/Volt D.C. 6k Ω/Volt AC. Mirror scale. ·6/3/12/30/120/600 V D.C. 3/30/120/600 V A.C. 50/600μA/60/600 mA. 10/100K/1 Meg/10 Meg Ω −20 to +46db.
£6·97. P. & P. 12p.

TMK MODEL TW-50K
46 ranges, mirror scale, 50K/Vol. D.C. 5K/Volt A.C. D.C.: Volts ·125, ·25, 1·25, 2·5, 5, 10, 25, 50, 125, 250, 500, 1000V, A.C. Volts: 1·5, 3, 5, 10, 25, 50, 125, 250, 500, 1000V. D.C. Current: 25, 50μA, 2·5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEG Ω. Decibels: −20 to +81·5db
£8·50. P. & P. 17p.

MODEL K228A
Taut band suspension. Overload protection. Polarity reversing switch. 30,000 o.p.v. 0 / ·5 / 2·5 / 15 / 50 / 250/ 500 / 1000 / 2500V. D.C. 0 / 15 / 50 / 150 / 500 / 1000V. A.C. 0 / 50μA / 5 / 50 / 150 / 500mA / 5A D.C. 0 / 3K / 300K / 3 meg.
£8·95. Post 20p.



HIOKO MODEL 700X
100,000 O.P.V. Overload protection. Mirror scale. ·3/·6/1·2/1·5/3/6/12/30/60/120/300/600/1200V DC 1·5/3/6/12/30/60/150/300/600/1200 V. A.C.
15/30μA/3/6/30/60/150/300mA 6/12 AMP. DC. 2K/200K/2 Meg/20 Meg ohm −20 to +63dB. £13·50. P. & P. 20p.

MODEL C-7080 EN
Giant 6" mirror scale. 20,000 o.p.v. 0 / ·25 / 1 / 2·5 / 10 / 50 / 250 / 1000 / 5000V. D.C. 0 / 2·5 / 10 / 50 / 250 / 1000 / 5000V. A.C. 0 / 50μA / 1 / 10 / 100 / 500mA / 10 amp. D.C. 0 / 2K / 200K / 20 meg – 20 to + 50 dB.
£13·95. Post 35p.

U4312 MULTIMETER
Extremely sturdy instrument for general electrical use. 667 o.p.v.
0/·3/1·5/7·5/30/60/150/300/600/900 VDC and 75mV.
0/·3/1·5/7·5/30/60/150/300 600/900 VAC.
0/300μA/1·5/6/15/60/150 600MA/1·5/6 AMP. D.C.
0/1·5/6/15/60/150/600MA/1·5/6 AMP. AC.
0/200 Ω/3K/30K Ω.
Accuracy DC 1%. AC 1·5%.
Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. £9·50 plus P. & P. 25p.

Selected TEST EQUIPMENT

FTC-401 TRANSISTOR TESTER
Full capabilities for measuring A, B and ICO. NPN or PNP. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads.
£7·50. Post 20p.

Model S-100TR MULTIMETER TRANSISTOR TESTER
100,000 o.p.v. mirror scale/overload protection. 0/·12/·6/3/12/30/120/600 V DC. 0/6/30/120/600. V AC. 0/12/600μA/ 12/300mA/12 AMP DC. 0/10 K/1 MEG/100MEG. −20 to +50db. 0·01–2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. £13·50. P/P 25p.

MODEL 449A IN CIRCUIT TRANSISTOR TESTER
Checks true A.C. beta in / out. Checks Icbo. Checks diodes in / out. Checks SCR, etc. Beta HI 10 – 500, LO 2 – 50. Icbo 0–5000μA. 220/240 V A.C. operation.
£17·50. Post 25p.

TE-20D RF SIGNAL GENERATOR
Accurate wide range signal generator covering 120 Kc/s 500 Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions £15. Carr. 37½p. Size 140 x 215 x 170 mm.

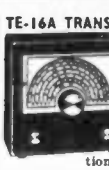
MODEL L-55 FET V.O.M.
Input impedance 10 meg ohms. 0 / ·3 / 1·2 / 6 / 30 / 120 / 600V. D.C. 0 / 3 / 12 / 60 / 120 / 600V. A.C. 0 / 120μA / 120mA D.C. 0 / 1K / 100K / 10 meg /100 meg ohms
£15·97. Post 15p.

CI-5 PULSE OSCILLOSCOPE
For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth 10MHz. Sensitivity at 100KHz VRMS/mm. ·1-25; HOR. AMP. Bandwidth 500KHz. Sensitivity at 100KHz, V RMS/mm. ·3-25; Preset triggered sweep 1·3,000usec.; free running 20-200,000Hz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115-230V. AC operation.
£39·00. Carr. paid.

TO-3 PORTABLE OSCILLOSCOPE
3in. tube, Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1·5cps–800kHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps 300 kHz. Synchronization. Internal/external. Illuminated scale 140 x 215 x 330 mm. Weight 16½lb. 220/240V. A.C. Supplied brand new with handbook. £40·00. Carr. 50p.

RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE
5 mc/s Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in. x 4in. C.R.T. Calibrated triggered sweep from ·2 u/sec. to 100 milli-sec. per cm. Free running time base 50 c/s-1 mc/s. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual
£87. Carr. Paid.

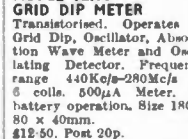
TE-16A TRANSISTORISED SIGNAL GENERATOR
5 ranges 400kHz–30mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide easy to read scale. 800kHz modulation.
5½ x 5½ x 3½in.
Complete with instructions and leads. £7·97. Post 25p



TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE
A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω 11·1 meg Ω 6 Ranges ±1% L.1 μ H – 111 HENRY 8 Ranges 2 – % C.10pF ±1110mFd 6 Ranges ± 2%. TURNS RATIO 1 : 1/1000–1 : 1/100. 6 Ranges ± 1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7½ x 5 x 2in. £20. P. & P. 25p.

MODEL TE.15 GRID DIP METER
Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440Kc/s–280Mc/s in 6 coils. 500μA Meter. 9V battery operation. Size 180 x 80 x 40mm.
£12·50. Post 20p.

BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR
Sine 18 x 200,000 Hz: Square 18 x 50,000 Hz Output max. + 10 dB. (10 K ohms) Operation internal batteries Attractive 2-tone case 7½" x 5" x 2". Price £17·50. Carr. 17½p.



MODEL MG-100 SINE SQUARE WAVE AUDIO GENERATOR
Range 19–220,000Hz Sine Wave 19–100,000 Hz Square Wave. Output Sine or Square wave 10v. P. to P. Size 180 x 90 x 90mm. Operation 220/240v. A.C.
£17·50. Post 37p.

MODEL AT201 DECADE ATTENUATOR
Frequency range 0–200KHz. Attenuator 0–111db, 0·1db step. Impedance 600 ohms. Max. input power 30dbm. Size 180 x 90 x 55mm.
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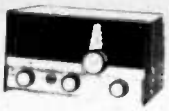
TE-65 VALVE VOLTMETER
28 ranges. D.C. volts 1·5–1,500v. A.C. volts 1·5–1,500v. Resistance up to 1,000 megohms. 200/240v. A.C. operation
Complete with probe and instructions.
£17·50. P. & P. 30p.
Additional probes available: R.F. £2·12½; H.V. £2·50.

MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER
Sensitivity 330 ohms/Volt AC and DC. Accuracy 5% D.C. 1% AC. Scale length 165mm. 0/300/750μA/1·5 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 / 750mA / 1·5 / 3 / 7·5AMP DC 0 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 / 750mA / 1·5 / 3 / 7·5 AMP AC 0 / 75 / 150 / 300 / 750mV / 1·5 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 / 750V DC 0/750mV / 1·5 / 3 / 7·5 / 15 / 30 / 75 / 150 / 300 /750V AC. Automatic cut out. Supplied complete with test leads, manual and test certificates. £49·00. Post 50p.

UNR-30 RECEIVER



4 Bands covering 550Kc/s–30Mc/s. B.F.O. Built-in Speaker 220/240v A.C. Brand new with instructions. £18·75. Carr. 37p.

UR-1A SOLID STATE COMMUNICATION RECEIVER

4 Bands covering 550Kc/s–30Mc/s. FET 8 Meter. Variable BFO for SSB, Built-in Speaker, Bandspread, Sensitivity Control. 220/240v. A.C. or 12v. D.C. 12½" × 4½" × 7" Brand new with instructions. £25. Carr. 37p.

SKYWOOD CX203 COMMUNICATION RECEIVER

Solid state. Coverage on 5 bands 200-420 KHz and ·55 to 30 MHz. Illuminated slide rule dial. Bandspread. Aerial tuning BFO. AVC, ANL, 'S' meter. AM/CW/SSB. Integrated speaker and phone socket. Operation 220/240v AC or 12v DC. Size 325 × 266 × 150 mm. Complete with instructions and circuit. £28·50. Carr. 50p.

LAFAYETTE HA-600 SOLID STATE RECEIVER

General coverage 150–400Kc/s. 550 Kc/s–30Mc/s. FET front end. 2 mech. filters, product detector, variable B.F.O., noise limiter. S. Meter, Bandspread, RF Gain. 15" × 9½" × 8½". 18 lbs. 220/240v. A.C. or 12v. D.C Brand new with instructions. £50, Carr. 50 p.

TRIO 9R59DS COMMUNICATION RECEIVER

4 band covering 550Kc/s. to 30 Mc/s. continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW. ANL. Variable BFO. S meter. Sep. bandspread dial. IF frequency 455 Kc/s. audio output 1·5w. Variable RF and AF gain controls 115/250v. A.C. Size: 7" × 13" × 10" with instruction manual. £49·50. Carr. Paid.

EMI LOUDSPEAKERS

Model 350. 13" × 8" with single tweeter/crossover. 20–20,000 Hz. 15 watt RMS. Available 8 or 15 ohms. £7·25 each P. & P. 37p.
Model 450. 13" × 8" with twin tweeter/crossover. 55–13,000 Hz. 6 watt RMS. Available 8 or 15 ohms. £3·62 each. P. & P. 25p.

HONEYWELL DIGITAL VOLTMETER VT.100

Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt. current and ohms with optional plug in cards. Specification: Accuracy: ± 0·2, ±1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power. 110–230v. A.C. 50/60 cycles. Overall size: 5½in. × 2 13/16in. × 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED. £35·50. Carr. 50p.

SINCLAIR IC-12

List Price £2·98

OUR PRICE **£1·80**

P. & P. 10p

SINCLAIR EQUIPMENT

Project 60 Package offers.
2 × Z30 amplifier, stereo 60 pre-amp, PZ5 power supply. £15·95 Carr. 37p. Or with PZ6 power supply £18·00 Carr. 37p. 2 × Z50 amplifier, stereo 60 pre-amp, PZ8 power supply. £20·25 Carr. 37p.
Transformer for PZ8. £2·97 extra.
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SPECIAL OFFER! GOODMANS AXIOM 301

HI FI 12" 20 watt twin cone full range speaker. 30–16,000 Hz. 16,500 gauss. 8 ohm impedance. Brand new and boxed.
(List price £21.72) OUR PRICE £12·50 each. Carr. 50p.

EA.41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar, etc., and output into your amplifier. Volume control, depth of reverberation control. Beautiful walnut cabinet. 7½ × 3 × 4½in. £5·97. P. & P. 15p.

SPECIAL OFFER! STEREO SPEAKERS

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size 14½" × 9" × 7½". 8 ohms. 8 watt RMS. 16 watt peak. Complete with DIN lead. £12·95 pr. Carr. 50p.

HA-10 STEREO HEADPHONE AMPLIFIER

All silicon transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9v battery. Inputs 5MU/100MU. Output 50MW. £5·97. P. & P. 15p.

SPECIAL PURCHASE! NEAT G30J STATIC BALANCE PICK-UP ARMS

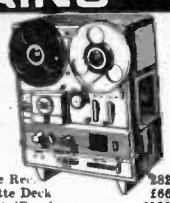
Identical specification to NEAT G30 arm but with two-tone chrome and black finish. Complete with head shell, pick up rest and plug in phono leads.
BRAND NEW—
FULLY GUARANTEED
ONLY £8·95. P. & P. 25p.

ARF-300 AF/RF Signal Generator

All transistorised, compact, fully portable. AF sine wave 18 Hz to 220 KHz. AF square wave 18 Hz to 100 KHz. Output sine / square 10v. P-P. RF 100KHz to 200 MHz. Output 1v. maximum. Operation 220/240v. AC. Complete with instructions and leads. £29·95. Post 50p.

AKAI BARGAINS

SUPER MONEY SAVING OFFERS—
BUY NOW WHILE STOCKS LAST!
BRAND NEW AND FULLY GUARANTEED



1721 Tape Rec.	£73·95		
X5000 Tape Rec.	£99·95		
GX370 Tape Deck	£259·95		
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4000DB Dust Cover	£4·75	GXC40 Cassette Rec.	£82·25
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X201D Tape Deck	£132·95	GXC40T Cassette/Receiver	£123·95
X221D Tape Deck	£169·95	GXC45D Cassette Deck	£89·95
GX220D Tape Deck	£148·50	GXC46D Cassette Deck	£103·50
GX280D Tape Deck	£249·40	GXC46 Cassette Recorder	£115·95
X1810D Tape/8 track Deck	£169·95	GXC60D Cassette Deck	£111·25
GX1900D Tape/Cass Deck	£177·95	GXC65D Cassette Deck	£110·25
X2000SD Tape/Cas/8 Track Rec.	£223·30	C835D Cassette Deck	£59·50
CR81 8 track Rec.	£80·95	AA6300 Receiver	£82·50
CR81D 8 track Rec.	£85·95	AA8030 Receiver	£111·50
CR81T 8 track/Receiver	£118·90	AA8080 Receiver	£144·95
CR80DSS 8-track	£122·50	AA8500 Receiver	£175·00
CR8088 8 track system	£145·00	ADM11 Microphones (Pair)	£7·50

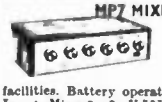
Carriage 50p extra. (Recorders & Decks 75p)

DOLBY SYSTEM NOISE REDUCTION UNIT

Improves the performance of cassette and semi-professional recorders. Reduces tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Controls for input levels and noise reduction on record and replay. 2 meters for Dolby level. Off tape monitoring. Frequency response: 20Hz to 15kHz ± 1dB 19kHz −35dB. Size 15½" × 9" × 3½". AC 200/250V.
OUR PRICE **£32·50** Carr. 50p.

1021 STEREO LISTENING STATION

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6" × 4" × 2½". £2·25. P. & P. 15p.



MP7 MIXER PREAMPLIFIER

5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9½" × 5" × 3" Inputs Mics 3 × 3mV 50K: 2 × 3mV 600 ohm. Phono mag. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K.
£8·97. P. & P. 20p.

TE-1035 STEREO HEADPHONES

Low cost high performance stereo headphones. Foam rubber ear cups Adjustable head-band. 8 ohm impedance 25–18,000 Hz. With lead and stereo jack plug. ONLY £1·97. P. & P. 12p.

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Popular range of Garrard decks with Shure cartridge fitted in deluxe plinth with hinged lid.

SP25 III Module/M75-6	£23·50
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Carr. 50p extra any item.

HOSIDEN DH-08S DE-LUXE STEREO HEADPHONES

Features unique mechanical 2 way units and fitted adjustable level, controls. 8 ohm impedance 20–20,000cps. Complete with spring lead & stereo jack plug £7·97. P. & P. 12p.

GENUINE BARGAIN!

KOSS SP.3XC STEREO HEADPHONES

Response 10–15,000Hz. Impedance 4–6 ohms. Brand new, Boxed & fully guaranteed (List £9.50).
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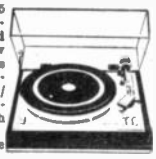

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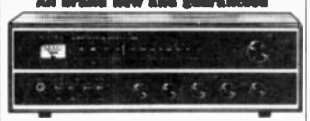

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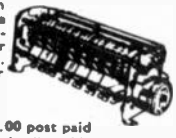

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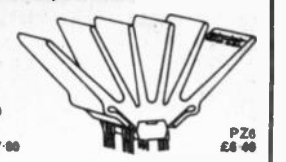

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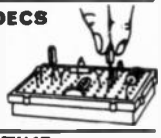

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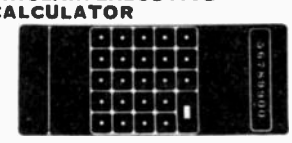

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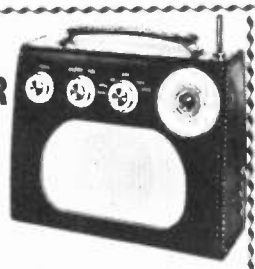

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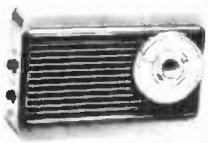

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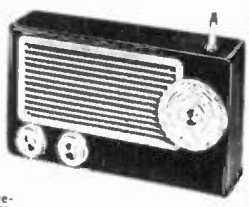

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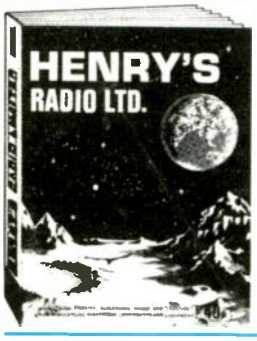

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