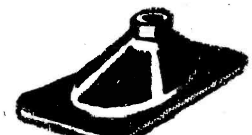

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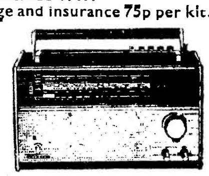

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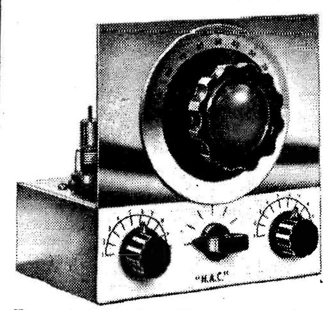

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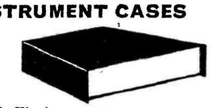

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BV2	11″	× 6″	× 3″	£1·20

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BA2	4″	× 4″	× 1½″	41p
BA3	4″	× 2¼″	× 1½″	41p
BA4	5¼″	× 4″	× 1½″	47p
BA5	4″	× 2½″	× 2″	41p
BA6	3″	× 2″	× 1″	34p
BA7	7″	× 5″	× 2½″	66p
BA8	8″	× 6″	× 3″	84p
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BIB HI-FI ACCESSORIES
De Luxe Groov-Kleen
Model 42 £1·84
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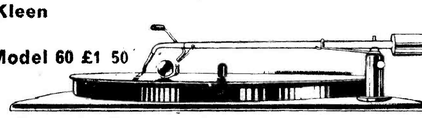

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1020	For model G240 3/32″	38p
1021	For model G240 1/8″	38p
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51	For model X25 1/8″	38p
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C3	50	Precision Resistors 1%, 2% mixed values	0·55
C4	75	⅛th W Resistors mixed preferred values	0·55
C5	5	Pieces assorted Ferrite Rods	0·55
C6	2	Tuning Gangs, MW/LW VHF	0·55
C7	1	Pack Wire 50 metres assorted colours	0·55
C8	10	Reed Switches	0·55
C9	3	Micro Switches	0·55
C10	15	Assorted Pots & Pre-Sets	0·55
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Type	0·55
C12	40	Paper Condensers preferred types mixed values	0·55
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C15	4	Mains Slide Switches	0·55
C16	20	Assorted Tag strips & Panels	0·55
C17	10	Assorted Control Knobs	0·55
C18	4	Rotary Wave Change Switches	0·55
C19	3	Relays 6—24V Operating	0·55
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PS 36 DIN	3 Pin	0·10
PS 37 DIN	5 Pin 180°	0·10
PS 38 DIN	5 Pin 240°	0·10
PS 39	Jack 2·5mm Switched	0·09
PS 40	Jack 3·5mm Switched	0·10
PS 41	Jack ¼″ Switched	0·17
PS 42	Jack Stereo Switched	0·26
PS 43	Phono Single	0·06
PS 44	Phono Double	0·10
PS 45	Car Aerial	0·09
PS 46	Co-Axial Surface	0·09
PS 47	Co-Axial Flush	0·14

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PS 21	D.I.N. 2 Pin (Speaker)	0·13
PS 22	D.I.N. 3 Pin	0·17
PS 23	D.I.N. 5 Pin 180°	0·17
PS 24	D.I.N. 5 Pin 240°	0·17
PS 25	Jack 2·5mm Plastic	0·10
PS 26	Jack 3·5mm Plastic	0·12
PS 27	Jack ¼″ Plastic	0·24
PS 28	Jack ¼″ Screened	0·28
PS 29	Jack Stereo Plastic	0·22
PS 30	Jack Stereo Screened	0·32
PS 31	Phono Screened	0·14
PS 32	Car Aerial	0·15
PS 33	Co-Axial	0·17

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PS 1	D.I.N. 2 Pin (Speaker)	0·11
PS 2	D.I.N. 3 Pin	0·12
PS 3	D.I.N. 4 Pin	0·15
PS 4	D.I.N. 5 Pin 180°	0·14
PS 5	D.I.N. 5 Pin 240°	0·15
PS 6	D.I.N. 6 Pin	0·15
PS 7	S.I.N. 7 Pin	0·15
PS 8	Jack 2·5mm Screened	0·10
PS 9	Jack 3·5mm Plastic	0·09
PS 10	Jack 3·5mm Screened	0·12
PS 11	Jack ¼″ Plastic	0·13
PS 12	Jack ¼″ Screened	0·18
PS 13	Jack Stereo Screened	0·29
PS 14	Phono	0·06
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CP 7	Three Core Mains Cable	0·07
CP 8	Twin Oval Mains Cable	0·06
CP 9	Speaker Cable	0·04
CP 10	Low Loss Co-Axial	0·10

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4·7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M

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ACOS GP96-1. 100mV at 1cm/sec £2·65
TTC J-2005. Crystal/Hi Output 95p
TTC J-20 10C Crystal/Hi Output Compatible £1·10
TTC J-200 CS Stereo/Hi Output £1·60
TTC J-2105 Ceramis/Med. Output £1·64

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R4	50 Mixed 100K ohms–1 Meg. ohms	40p

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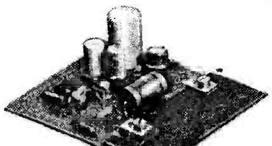
AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0·25%
LOAD IMPEDANCE	—	8 – 16 Ω
INPUT IMPEDANCE	f = 1KHz	100 kΩ
FREQUENCY RESPONSE Œ 3dB	Po = 2 WATTS	50 Hz - 25KHz
SENSITIVITY for RATED O/P	Vs = 25V. Rl = 8Ω f = 1KHz	75mV. RMS
DIMENSIONS		3" × 2½" × 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL = 8Ω f = 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10. 3 watts RMS £2·19
AL 20. 5 watts RMS £2·59
AL 30. 10 watts RMS £3·01

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20) £4·35
PA 100. (Use with AL30 & AL50) £13·15

POWER SUPPLIES

PS 12. (Use with AL10 & AL20) 88p
SPM 80. (Use with also AL30 & AL50) £3·25
FRONT PANELS SP 12 with Knobs £1·10

TRANSFORMERS

T461 (Use with AL10) £1·38 P & P 15p
T538 (Use with AL20) £1·93 P & P 15p
BMT80 (Use with AL30 & AL50) £2·15 P & P 25p

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response 20Hz 50KHz (- 3dB)
Bass control - - ± 12dB at 60Hz
Treble control - - ± 14dB at 14KHz
*Input 1. Impedance 1 Meg. ohm
Sensitivity 300mV
†Input 2. Impedance 30 K ohms
Sensitivity 4mV

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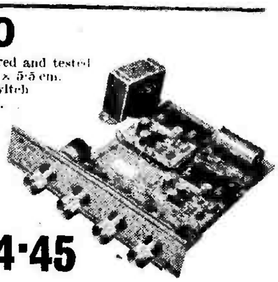
ALL PRICES INCLUDE V.A.T.

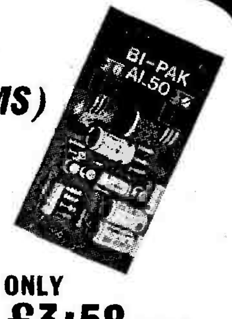
The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls. Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0·25% at 1 watt. Treble con. ± 14dB at 14kHz.



£14·45

50W pk 25w (RMS)



0·1% DISTORTION!
HI-FI AUDIO AMPLIFIER

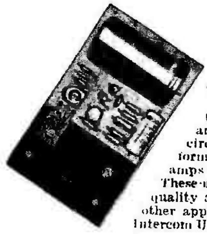
THE AL50

- ★ Frequency Response 15Hz to 100,000—1dB.
- ★ Load—3, 4, 8 or 16 ohms.
- ★ Distortion—better than ·1% at 1 KHz.
- ★ Signal to noise ratio 80dB.
- ★ Supply voltage 10–35 Volts.
- ★ Overall size 63mm 105mm × 13mm.

ONLY **£3·58 each**

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fil the need for all your A.F. amplification needs.
FULLY BUILT TESTED GUARANTEED.

STABILISED POWER MODULE SPM80



AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Address Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

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

SPECIFICATION

Frequency Response	20Hz - 20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs: 1. Tape Head	1·25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1·5 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20 KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than - 65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

ONLY £13·15

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £25·30 FREE p. & p.

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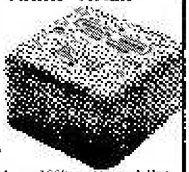
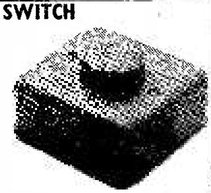
ELECTRONIC MAINS TIMER



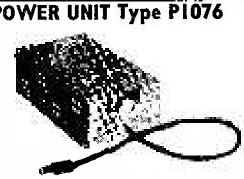
A reliable unit ideal for timing Bathroom/Toilet Ventilators Stairway/ Cloakroom Lighting etc. Gives up to 30 mins delay before switching off. Delay: 1–30 mins adjustable. Max Load: 400VA or 1000 watts resistive. Ivory Case: 3¾" × 3¾" × 2". Fitting instructions included.
Trade Price: £5·80. Post 20p.

DIMMER SWITCH



Type Cl. 300 Watt Light Dimmer for 200/250 Volt A/C operation. Ivory Case: 3⅜" × 3⅜" × 1⅝". Fitting Instructions included.
Price: £2·60. Post 20p. 10 for £2·15 each.
£5·00 per pair. Post 25p. Post 30p.

POWER UNIT Type P1076



Output switched 3, 4·5, 6, 7·5 9 and 12 Volts at 500mA D.C. Operates from 240 V. mains, suitable for Radios, Tape Recorders, Record Players, etc. Size 7·5 × 5·0 × 14·0 cm Price £3·95. Post 25p.

TRANSFORMERS

SAFETY ISOLATING

Prim. 120/240V. Sec. 120/240V. Centre Tap with screen

VA (watts)	Ref. No.	Price £	P & P £
60	149	2·86	0·38
100	150	3·15	0·52
200	151	5·30	0·52
250	152	7·05	0·65
350	153	9·40	0·80
500	154	13·55	1·00
1000	156	24·97	1·20
2000	158	41·25	*
3000	159	64·54	*

50 Volts

Prim:- 200–240V.
Sec:- 19, 25, 33, 40, 50V.

Amps	Type	Price	P & P
0·5	102	1·60	0·30
1	103	2·35	0·38
2	104	3·25	0·42
3	105	4·40	0·52
4	106	5·48	0·52
6	107	8·65	0·67
8	118	11·27	0·97
10	119	14·15	0·97

60 Volts

Prim:- 200–240V.
Sec:- 24, 30, 40, 48, 60V.

Amps	Type	Price	P & P
0·5	124	1·60	0·38
1	126	2·25	0·38
2	127	3·55	0·42
3	125	5·40	0·52
4	123	6·98	0·67
5	40	8·46	0·67
6	120	9·20	0·82
8	121	11·60	1·00
10	122	15·25	1·00
12	189	16·43	1·10

LOW VOLTAGE

Prim:- 200–240V. Sec:- 12 & 24V.

Amps 12V	Amps 24V	Type No.	Price £	P & P £
0·5	0·25	111	1·00	0·22
1	0·5	213	1·23	0·22
2	1	71	1·60	0·22
4	2	18	2·25	0·38
6	3	70	2·70	0·42
8	4	108	3·00	0·52
10	5	72	3·55	0·52
12	6	116	4·50	0·52
16	8	17	5·50	0·52
20	10	115	6·95	0·69
30	15	187	12·90	0·97
40	20	232	18·30	1·00
60	30	226	23·70	1·10

MINIATURE AND EQUIPMENT

Prim 240V with screen

Volts Sec. 1	Volts Sec. 2	Milliamps Sec. 1	Milliamps Sec. 2	Type No.	Price £	P & P £
3–0–3	—	200	—	238	1·12	0·10
0–6	0–6	500	500	234	1·18	0·10
0–6	0–6	1000	1000	212	1·28	0·22
9–0–9	—	100	—	13	0·95	0·10
0–9	0–9	330	330	235	1·28	0·10
0–8–9	0–8–9	500	500	207	1·70	0·22
0–8–9	0–8–9	1000	1000	208	2·30	0·30
15–0–15	—	40	—	240	1·28	0·10
0–15	0–15	200	200	236	1·28	0·10
20–0–20	—	30	—	241	1·09	0·10
0–20	0–20	150	150	237	1·28	0·10
0–15–20	0–15–20	500	500	205	2·16	0·38
0–20	0–20	300	300	214	1·36	0·22
20–12–0–12–20		700(D/C)		221	1·21	0·30
0–15–20	0–15–20	1000	1000	206	3·10	0·38
0–15–27	0–15–27	500	500	203	2·38	0·38
0–15–27	0–15–27	1000	1000	204	2·40	0·38

30 Volts

Prim:- 200–240V. Sec:- 12, 15, 20, 24, 30V.

Amps	Type	Price	P & P
0·5	112	1·20	0·22
1	79	1·64	0·38
2	3	2·45	0·38
3	20	3·00	0·42
4	21	3·55	0·52
5	51	4·40	0·52
6	117	5·25	0·52
8	88	6·80	0·67
10	89	8·36	0·67

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H8/2A	3·3μF	25V	4p
H8/3	3μF	50V	4p
H8/3A	4μF	50V	4p
H8/4	4·7μF	25V	4p
H8/4A	5μF	64V	4p
H8/5	5μF	10V	4p
H8/5A	5μF	150V	4p
H8/6A	10μF	10V	4p
H8/7	10μF	70V	4p
H8/8	16μF	35V	4p
H8/8A	16μF	16V	4p
H8/9	20μF	6V	2p
H8/9A	20μF	70V	4p
H8/10	22μF	50V	4p
H8/10A	22μF	100V	4p
H8/11	25μF	12V	4p
H8/11A	24μF	275V	4p
H8/12	32μF	15V	4p
H8/12A	30μF	10V	4p
H8/13A	32μF	50V	4p
H8/14	40μF	25V	5p
H8/14A	40μF	16V	4p
H8/15	47μF	50V	4p
H8/15A	40μF	35V	4p
H7/1	50μF	6V	3p
H7/1A	50μF	10V	4p
H7/2A	64μF	2·5V	2p
H7/3A	64μF	25V	4p
H7/4	64μF	15V	4p
H7/4A	64μF	35V	5p
H7/5	80μF	16V	4p
H7/6	100μF	25V	5p
H7/7	100μF	25V	4p
H7/8	125μF	16V	5p
H7/8A	100μF	35V	6p
H7/9	100μF	63V	6p
H7/9A	125μF	4V	4p
H7/10	125μF	25V	6p
H7/10A	160μF	2·5V	3p
H7/11	160μF	25V	6p
H7/11A	150μF	16V	5p
H7/13A	200μF	25V	8p
H7/14	220μF	50V	10p
H7/14A	220μF	16V	6p
H7/15	220μF	25V	5p
H7/15A	220μF	35V	10p
H6/1A	250μF	4V	3p
H6/2	250μF	25V	3p
H5/3A	320μF	2·5V	3p
H6/4	320μF	10V	4p
H6/4A	330μF	16V	5p
H6/5	330μF	25V	10p
H6/5A	330μF	35V	15p
H6/8	470μF	25V	10p
H6/8A	470μF	35V	20p
H6/9A	400μF	40V	20p
H6/13A	1000μF	25V	16p

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071 15472	16	4700	3·9 amps	1oz	17p
071 15682	16	6800	5·8 amps	1½oz	22p
072 15752	16	7500 + 7500	10·5 amps	3oz	37p
072 15113	16	11000 + 11000	13·8 amps	4½oz	49p
071 16472	25	4700	5·4 amps	1½oz	22p
072 16502	25	5000 + 5000	9·6 amps	3½oz	37p
072 16752	25	7500 + 7500	12·6 amps	4½oz	49p
071 18681	63	680	2·1 amps	1oz	15p
106 and 107 series					
106 16223	25	22000	17 amps	10oz	£1·12
106 17103	40	10000	12 amps	7½oz	94p
107 10222	100	2200	10 amps	5½oz	74p

Type No.	Voltage	Capacitance	Weight	Price
102 15163	16	16000	8oz	20p
104 90003	20	39000	16oz	30p
102 16802	25	8000	7oz	25p
104 90001	45	20000	16oz	50p

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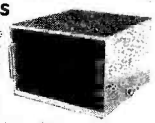

Model 120 all aluminium two part construction. Top and sides. blue hammer finish, front, rear and base: white. Others: mild steel three part construction.
Top, base, sides and detachable rear panel, blue hammer. Detachable aluminium front panel finished in white.

Dimensions in inches.

Model 320

Model	W	H	D	Price
120	8	2½	6	£1·85
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★ S.a.e. please for full technical details.

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SAJ110 7-stage frequency divider in one 14 pin DIL package. Sine or square wave input allows operation from almost any type of master oscillator including the DMO2 (when 97 notes are available). Square wave outputs may be modified to saw-tooth by the addition of a few components. SAJ110: £2·63 each OR special price for pack of 12: £25·00. S.a.e. please for data sheet.

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AD149	47p	OC44	20p	1N4148	4p
AD161/2	69p	OC71	20p	1N4001	6p
BC107	10p	TIS43	28p	1N4002	6½p
BC108	10p	2N1711	24p	1N4003	7p
BC109	10p	2N2219	25p	1N4004	7½p
BC147	10p	2N2646	45p	1N4005	8p
BC148	10p	2N2905	33p	1N4006	8½p
BC149	12p	2N2907	25p	1N4007	9p
BC168	13p	2N2926O	10p	WO05	30p
BC169C	12p	2N2926Y	10p	WO4	33p
BC182L	10p	2N2926G	10p	741C 8-pin	
BC204	14p	2N3053	18p	D.I.L.	36p
BC209C	14p	2N3055	49p	741C 14-pin	
BD131	45p	2N3819	24p	D.I.L.	45p
BD132	54p	AA119	7p	D.I.L. Sockets	
BD131/2	£1·20	BY127	16p	8-pin	20p
BD135	36p	BY164	49p	14-pin	15p

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Axial lead electrolytic

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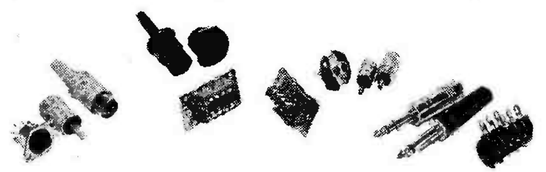
1·5	63	6p	68	16	6p			
2·2	63	6p	68	63	10p			
3·3	63	6p	100	4	6p			
4·7	63	6p	100	10	6p	470	6·3	6p
6·8	40	6p	100	25	6p	470	10	10p
6·8	63	6p	100	40	6p	470	25	12p
10	25	6p	100	63	12p	470	40	18p
10	63	6p	150	6·3	6p	680	6·3	10p
15	16	6p	150	16	6p	680	16	12p
15	40	6p	150	25	6p	680	25	18p
15	63	6p	150	40	10p	680	40	22p
22	10	6p	150	63	12p	1000	4	10p
22	25	6p	220	4	6p	1000	10	12p
22	63	6p	220	10	6p	1000	16	18p
33	6·3	6p	220	16	6p	1000	25	22p
33	16	6p	220	25	10p	1500	6·3	12p
33	40	6p	220	40	12p	1500	10	18p
47	4	6p	220	63	18p	1500	16	22p
47	10	6p	330	4	6p	2200	6·3	13p
47	25	6p	330	10	6p	2200	10	22p
47	40	6p	330	16	10p	3300	6·3	22p
47	63	6p	330	63	22p	4700	4	22p

PLUGS AND SOCKETS



DIN PLUGS
2 pin (1 flat) 8p
3 pin 9p
4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 10p

DIN Sockets
2 pin 6p
3 pin, 4 pin, 5 pin A (180°), 5 pin B (240°), 6 pin 7p

MAINS
P360 3 pin 1·5A chassis plug with line socket. Per pair 24p
SA 2190 3 pin 5A chassis plug 17p
SA 1862 Line socket for above 19p

McMURDO
RP8 8 way chassis plug 36p

RS8 8 way chassis socket 52p

PHONO
Plug plastic 5p
Plug screened 9p
Chassis socket 4p

JACK
Std. ¼" mono plug
Plastic 13p
Screened 17p

Std. ¼" stereo plug
Plastic 16p
Screened 25p
Open mono socket ¼" 10p; Moulded mono socket ¼" with 2 break contacts 13p; Moulded stereo socket ¼" with 3 break contacts 18p; 3·5mm. plug plastic 8p; screened 11p; open socket 8p.

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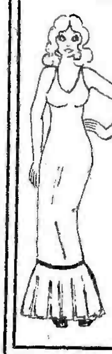

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Sub-min. Mains Transformer
6-0-6V 100mA 95p

12-0-12V 50mA 95p
Size: Both approx. 30 × 27 × 25mm.

Min. Mains Transformer (Size: 46 × 31 × 38mm) 0-12V 250mA, 0-12V 250mA £1·35

Mains transformer MT3AT
Pri. 200-220-240V, Sec. 12-15-20-24-30V 2A £2·48

Mains Transformer MT206AT
Pri. 200-220-240V, Sec. 0-15-20V 1A, 0-15-20V 1A £3·10

Also in stock: Wide range of brass and nylon nuts, bolts and washers + solder tags, shakeproof washers etc.

POTENTIOMETERS

Rotary miniature carbon track ¼" spindle

Single gang Lin or Log
5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M (and 1k Lin) 12p

Dual gang (Stereo) without switch Log or Lin 5k to 2M as above 38p.

Single gang with DP switch 250V 2A Log or Lin 5k to 2M as above 23p

PRESETS
Sub-miniature 0·1W Vert or Horiz
100, 250, 500, 1k, 2·5k, 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M 6p

Wirewound 10% 1W ¼" spindle 10, 50, 100R 34p; 250, 500, 1k, 5k 33p; 10k, 37p; 25k 40p; 50k 44p.

KNOBS

All ¼" shaft. Grub screw fixing

Diameter shown in brackets

K30/1 (13mm) 24p; K30/3 (17mm) 22p; K30/2 (13mm) 26p

BK12 32mm long, black pointer with white stripe 6p

K30/6 (32mm) 41p

F18 (26mm) with numbered skirt 21p

F12 (33mm) 21p

MK50 (34mm) 27p

CK4 (36mm) 14½p

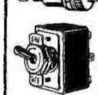
SWITCHES

Rotary with adjustable stop 1 pole 2 to 12 way; 2 pole 2 to 6 way; 3 pole 2 to 4 way; 4 pole 2 or 3 way, each 24p.
Mains rotary DPDT 250V 2A 20p.

Push to make non-locking 12p

Slide Miniature DPDT 9p

Sub-miniature toggle DPDT (12 × 12·5 × 14mm excl. toggle) 250V 3A 61p



Toggle 250V 1·5A with ON/OFF plate 25p.

RESISTORS

Carbon Film	⅛W	5%	1Ω to 1M; 10% 1·2M to 10M	E12	1p
Carbon Film	¼W	5%	1Ω to 10Ω; 10% 1·2M to 10M	E12	1p
Carbon Film	½W	5%	11Ω to 910k	E12 & E24	1p
Carbon Film	1W	5%	10Ω to 10M	E12	3p
Metal Oxide	½W	2%	10Ω to 1M	E12 & E24	4p
Wirewound	2½W	10%	0·22ohms to 0·47ohms	E12	10p
Wirewound	2½W	5%	1ohm to 270ohms	E12	10p

E12 values 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades
E24 values 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and decades

VAT Please add 10% to the final total.

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BSR HI-FI AUTOCHANGER
STEREO AND MONO

Plays 12", 10" or 7" records Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. AC 200/250v. Size 13½ × 11¼in. Above motor board 3¼in. Below motor board 2½in. With STEREO and MONO XTAL **£6·25** Post 25p.

PORTABLE PLAYER CABINET

Modern design. Size 18" x 15" x 7" Black rexine covered. Silver front grille. Padded Lid. Chrome fittings. Motor board cut for BSR deck. **£4·50** Post 25p.

4 TRANSISTOR MONO AMPLIFIER

Powerful 3 watt output. 15 ohm. AC mains operated with transformer. 3-Controls, volume, treble, bass and On/Off switch with knobs. Ready made on printed circuit board. Fused inputs and outputs. Famous make. Size 9in. wide × 4in. deep × 3in. high. Suitable 7" × 4" speaker, £1. **£5·95** Post 25p

BSR JUNIOR SINGLE PLAYER

Heavy duty 4-speed motor with separate pick-up arm fitted LP/78 turnover mono compatible cartridge. **£4·95**

GARRARD DECCA HI-FI DECK

Single play Stereo/Mono Deram transcription head and arm. Four speeds. 10½in. turntable. Anti-rumble filter. Bias compensation. Laboratory motor.

SPECIAL PRICE **£18·50** Post 25p Ideal for Disco-Deck

METAL PLINTH AND PLASTIC COVER

Cut out for most Garrard or B.S.R. Most will play with cover in position. 12½ × 14½ × 7½in. Covered in black leatherette. **£4·95** Post 35p

ALSO AVAILABLE IN SOLID NATURAL MAHOGANY WAX POLISHED FINISH—AT SAME PRICE

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Two full size loudspeakers 13½ × 10 × 3½in. Player unit clips to loudspeakers making it extremely compact. Overall size only 13½ × 10 × 8½in. 3 watts per channel, plays all records 33 rpm 45 rpm. Separate volume & tone controls 240v AC mains

Attractive Teak finish Weight 13lbs. Bargain Price **£25** 85p carriage

SPECIAL OFFER! SMITH'S CLOCKWORK 15 AMP TIME SWITCH 0-60 MINUTES

Single pole two-way Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights etc. Variable knob Turn on or off at full or intermediate settings. Fully insulated. Makers last list price £4·50. Brand new and fully guaranteed. OUR PRICE **£1·65** or £3 pair. Post 25p.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in sides 6 × 4in 45p; 8 × 6in 53p; 10 × 7in 65p; 12 × 8in 85p; 14 × 9in 90p; 16 × 6in 90p; 12 × 3in 50p; 16 × 10in £1.

ALUMINIUM BOXES 3 × 3 × 3 in. 60p. 4 × 4 × 4in. 70p. 6 × 4 × 4 in. 80p. 9 × 4 × 4 in. £1. 12 × 4 × 4 in. £1·30.

ALUMINIUM PANELS 18 s.w.g. 6 × 4in 9p; 8 × 6in 15p; 14 × 3in 16p; 10 × 7in 19p; 12 × 5in 20p; 12 × 8in 28p; 16 × 6in 28p; 14 × 9in 34p; 12 × 12in 40p; 16 × 10in 50p.

PAXOLIN PANEL 10 × 8in 15p.

1¼inch DIAMETER WAVECHANGE SWITCHES, 25p. 2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way, 25p each. 1 p.1 2-way, or 4 p. 2-way, or 4 p. 3-way, 25p.

TOGGLE SWITCHES, sp. 18p; dp. 22p; dp. dt. 22p. Sub-miniature, sp. 30p; dp. 37p; dp. dt. 45p.

R.C.S. STABILISED POWER PACK KITS

All parts and instructions with Zener Diode. Printed Circuit Bridge Rectifiers and Double Wound Mains Transformer. Input 200/240V a.c. Output voltages available 6 or 9 or 12 or 15 or 18 or 20V d.c. at 100mA or less. PLEASE STATE VOLTAGE REQUIRED. Details S.A.E. Size 3½ × 1½ × 1¼in. **£2·20** Post 20p

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE

Ideal for Mike, Tape P.U., Guitar, etc. Can be used with Battery 9-12v. or H.T. line 200-300V. D.C. operation. Size 1¼" × 1¼" × ¾". Response 25 c.p.s. to 25 Kc/s, 26 db gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **99p** Post 10p

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V	14p	250/25V	14p	16+16+16/275v	45p
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8/450V	18p	1000/25V	35p	60+100/350V	85p
16/450V	22p	1000/50V	47p	32+32/250V	20p
32/500V	50p	8+8/450V	22p	32+32/450V	60p
25/25V	10p	8+16/450V	25p	350+50/325V	55p
50/50V	10p	16+16/450V	40p	100+50+50/350V	55p
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2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 95p.
CERAMIC 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p.
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SILVER MICA. Close tolerance 1%. 2·2-500pF 8p; 560-2,200pF 10p; 2,700-5,600pF 20p; 6,800pF-0·01, mfd 30p each.
TWIN GANG. "0-0" 208pF+176pF, 65p;
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SHORT WAVE SINGLE GANG. Precision Silver Plated Gangable Tuning Condensers. Values up to 100pF. **50p** each. Section Couplers supplied FREE with two or more gangs.

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MAINS TRANSFORMERS
ALL POST 25p each

Eagle MT12 12-0-12v 50MA 90p
250-0-250 80 mA. 6·3 v. 3·5 a. 6·3 v. 1 a. or 5 v. 2 a. £2·50
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GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2 amp., 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. £2·80
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Primary 0-110-240v. Secondary 0-240v. 3 amps. 720 watts. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make. (Value £18) OUR PRICE **£10** Carr. 50p
Can be used as 800 watt auto transformers 240-110V.

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Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 15p. D.P. 25p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p

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Wirewound controls 1½in. diam. 3 watts. 10 ohms to 100K British made with long spindles ¼in. dia 45p ea.

HELICAL POT 10k LIN List £8, Bargain 75p.
DUAL CONCENTRIC POT 500k LOG + 500k LIN D.P. switch. Inner spindle 3½in; outer spindle 2½in. 75p.

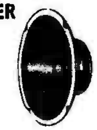
E.M.I. 13½ × 8 in. SPEAKER SALE!

With twin tweeters. And crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. **£4·50** Post 25p

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 cps. Flux 10,000 gauss. State 3 or 8 or 15 ohm. **£2·75** Post 25p

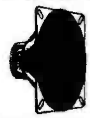
Bookshelf Cabinet
16 × 10 × 9in. Teak Veneer **£5·50** Post 25p

GOODMANS 6½in. HI-FI WOOFER



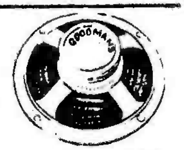
8 ohm, 10 watt. Large ceramic magnet. Special Cambric cone surround. Frequency response 30-12,000 cps. Ideal P.A. Columns, Hi-Fi Enclosure Systems, etc. **£4**
Suitable cabinet 12 × 8 × 6 £4·00.
Suitable Tweeter £2·00.

ELAC CONE TWEETER



The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 3½ × 3½ × 2in. deep. Rating 10 watt, 3 ohm. Crossover £1.25 Post 20p **£1·90**

GOODMANS 8 in. WOOFER



8 ohm 12 watt. Deep cone. Heavy ceramic magnet. Bass resonance 35 cps. Frequency response 30-8,000 cps. Ideal bass unit for Hi-Fi systems **£3·75**

LOUDSPEAKERS P.M. 3 OHMS. 7 × 4in. £1·25; 6½in. £1·50; 8 × 5in. £1·60; 8in. £1·75; 10 × 6in. £1·90; 10in. £2·00.
SPECIAL OFFER! 80 ohm, 2½ in. 2½in. 35 ohm, 2in.; 3in; 25 ohm, 2½in. dia.; 3in. dia.; 5 × 3 in. 15 ohm. 3½in. dia.; 5in. /6 × 4in.; 7 × 4in.; 8 × 5in 8 ohm, 2½in. 2½in., 3½in., 5in. dia. **£1** EACH TYPE (6 × 4in., 8 ohm, £1·50).
RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8in. diameter 4W £2·50, 10in. diameter 5W £2·50; Post 25p. 12in. diameter, 6W, £2·95; 3 or 8 or 15 ohm models.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.
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TWO-WAY 3,000 c.p.s. CROSSOVERS 3, 8 or 15 ohm 95p.

TWO-WAY CROSSOVER NETWORK 3,000 c/s

With variable tweeter attenuator giving accurate high/low frequency balance. Mounted on panel 5½in. × 4in. with control knob, tweeter and woofer leads and input terminals. Suitable for 3 to 8 ohm impedance. **£2·20** Post 20p

VALVE OUTPUT TRANSFORMER 25p
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PUSH-PULL VALVE OUTPUT TRANSFORMERS.
50 watt .... £12·50 100 watt £15

ELECTRO MAGNETIC PENDULUM MECHANISM

1·5v d.c. operation over 250 hrs. continuous on SP2 battery. fully adjustable swing and speed. Ideal displays teaching electro magnetism or for metronome; strobe etc. 95p, Post 20p

R.C.S. VALVE AMPLIFIER

2 Stage Triode Pentode valve. 3 watts 3 ohm output. Volume on/off and tone controls AC mains. Complete and tested. £4·50. Post 25p.

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VALVE HOLDERS 5p; CERAMIC 8p; CANS 5p.

BRITISH FM/VHF TUNING HEART

88 to 108 Mc/s British made. 2 Transistors ready aligned—requires 10.7 Mc/s IF. Complete with tuning gang. Connections supplied but some technical experience essential. Our Price **£3·95** Post 20p.

ALL PRICES INCLUDE VAT MINIMUM POST AND PACKING 20p. CALLERS WELCOME

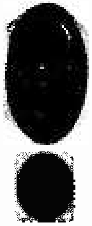
RADIO COMPONENT

Illustrated Colour Brochure, Radio Books & Component Lists 10p. Written guarantee.

ALL OUR PRICES INCLUDE V.A.T.

E.M.I. WOOFER AND TWEETER KIT

£5·75 THE PAIR. Post 25p. (Available separately. Woofer £4·25; Tweeter £1·90).

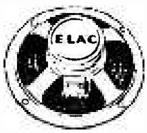


Comprising a fine example of a Woofer $10\frac{3}{4} \times 6\frac{1}{4}$in. with a massive Ceramic Magnet. 44oz. Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter $3\frac{1}{4}$in. square has a special lightweight paper cone and magnet flux 10,000 lines. Crossover condenser and full instructions supplied.

Impedance Standard	8 ohms
Maximum power	12 watts
Useful Response	25 to 18,000 cps
Bass Resonance	45 cps

SUITABLE ENCLOSURE 20 × 13 × 9in. MODERN DESIGN. TEAK WOOD FINISH. **£9·90** Post 25p

8in. or 10in. ELAC HI-FI SPEAKER



Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 cps. Bass resonance 55 cps. 8 ohm impedance. 8in. 10 watts, 10in. 12 watts **£3·75**

TEAK VENEER HI-FI SPEAKER CABINETS
Fluted Wood Fronts

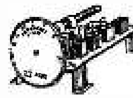
MODEL "A". 20 × 13 × 9in. For 12in. dia. or 10in. speaker. **£9·90** Post 25p

MODEL "B". 16 × 10 × 9in. For 13 × 8in. or 8in. speaker. **£5·50** Post 25p

MODEL "B2" ditto. Triangular corner version.

MODEL "C". 16 × 8 × 6in. For 8 × 5in. speaker. **£4·40** Post 25p

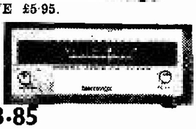
LOUDSPEAKER CABINET WADDING 18in. wide, 15p ft.



BARGAIN AM TUNER. Medium Wave. Transistor Superhet Ferrite aerial. 9 volt. **£4·95**

BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt battery operated. **£3·95**

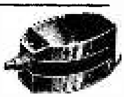
STEREO VERSION OF ABOVE £5·95.



BARGAIN FM TUNER. 88-108 Mc/s Six Transistor. 9 volt. Printed circuit. Calibrated slide dial tuning. Walnut Cabinet. Size 7 × 5 × 4in. **£12·85**

BARGAIN FM TUNER. As above less cabinet. **£8·85**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built with volume, treble and bass controls. 18 volt battery operated. **£4·50**



THE "INSTANT" BULK TAPE ERASER & HEAD DEMAGNETISER. Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/250V. Leaflet S.A.E. **£3·50** Post 20p

WAFER THIN HEATING ELEMENTS

OFFERING 1001 USES for every type of heating and drying applications in the home, garage, greenhouse, factory (available in manufacturing quantities). Approx. size $10\frac{3}{4} \times 8\frac{1}{4} \times \frac{1}{16}$in. Operating voltage 200/250V. a.c. 250 watts approx. Printed circuit element enclosed in asbestos fitted with connecting wires. Completely flexible providing safe Black heat. British-made for use in photo-copiers and print drying equipment.

Ideal for home handymen and experimenters. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal or asbestos, etc., to make efficient clothes dryers, towel rails—ideal for airing cupboards. Ideal for anti-frost device for the garage—preventing frozen radiators or acting as oil sump heater. Use in the greenhouse for seed raising and plant protection. Invaluable aid for bird houses, incubators, etc., etc. Can be used in series for lower heat. Or in parallel for higher heat applications.

ONLY **40p** EACH (FOUR FOR £1·50)

ALL POST PAID—Discounts for quantity.

BAKER MAJOR 12" £9·90

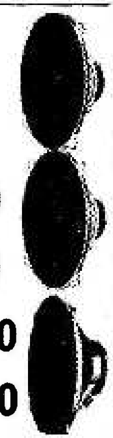
Post Free

30-14,500 c/s. 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s Rated 20 watts. NOTE: 3 or 8 or 15 ohms must be stated.

Module kit. 30-17,000 c/s with tweeter, crossover, baffle and instructions. **£12·50**

Please state 3 or 8 or 15 ohms. Post Free

BAKER "BIG SOUND" SPEAKERS



Robustly constructed to stand up to long periods of electronic power. As used by leading groups. Useful response 30-13,000 cps. Bass Resonance 55 cps.

GROUP "25" 12in. 25 watt 3, 8 or 15 ohms. **£8·80** Post Free

GROUP "35" 12in. 35 watt 3, 8 or 15 ohms **£9·90** Post Free

GROUP "50" 15in. 50 watt 8 or 15 ohms. **£22·00**

NEW 12" VERSION 50 watt 8 or 15 ohms **£17·60**

MAJOR 100 WATT ALL PURPOSE TRANSISTOR AMPLIFIER

All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm. a.c. Mains. Separate treble and bass controls. Guaranteed. Details SAE. **£49** Carr. £1·00

CALLERS ONLY! DE LUXE 100 WATT AMPLIFIER CHASSIS

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HIGH QUALITY — BRITISH MADE

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An inexpensive unit for the beginner in high fidelity and for general purposes. May be used to improve any Radio, Amplifier, Hi-Fi or Television receiver.

Bass Resonance	45cps
Flux Density	12,000gauss
Useful response	45-13,000cps

3 or 8 or 15 ohm models.

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DE-LUXE Mk II
12in 15 watts

Especially designed to provide full range reproduction at an economical cost. Suitable for use with any high fidelity system. Built-in concentric tweeter cone.

Bass Resonance	30cps
Flux Density	14,000gauss
Useful response	25-16,000cps

8 or 15 ohms models.

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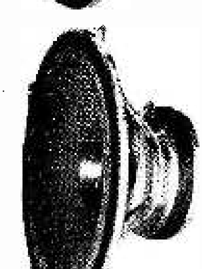
SUPERB
12in. 20 watts



A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.

Bass Resonance	25cps
Flux Density	16,500gauss
Useful response	20-17,000cps

8 or 15 ohms models.

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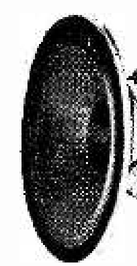
AUDITORIUM
12in. 25 watts



A full range reproducer for high power, Electric Guitars, public address, multi-speaker systems, electric organs. Ideal for Hi-Fi and Discotheques.

Bass Resonance	35cps
Flux Density	15,000gauss
Useful response	25-16,000cps

8 or 15 ohms models.

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AUDITORIUM
15in. 35 watts

A high wattage loudspeaker of exceptional quality with a level response to above 8,000 cps. Ideal for Public Address, Discotheques, Electronic instruments and the home.

Bass Resonance	35cps
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Useful response	20-14,000cps

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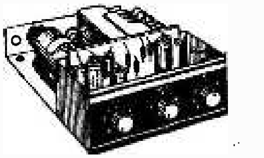
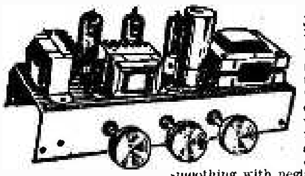


A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohm. Frequency response 12Hz–30KHz ± 3db. Fully integrated pre-amplifier stage with separate Volume. Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high x 6" wide x 7½" deep. AC 200/250V.

PRICE £11·60. P. & P. 50p.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:-2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built & tested to a high standard. **PRICE £9·90.** P.&P. 50p.

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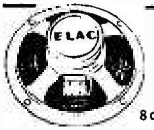

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A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise, level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12–30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12-15,000 Hz. Bass boost approx. to ±12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1.0 amp. Overall Size 12"w. × 8"d. × 2¼"h.
Fully detailed 7 page construction manual and parts list free with kit or send 18p plus large S.A.E.

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Also available ready built and tested £23·10. Post Free.
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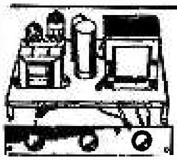
3-VALVE AUDIO AMPLIFIER HA34 MK II.



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7¾"w. × 4"d. × 4¾"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £5·50. P. & P. 45p.
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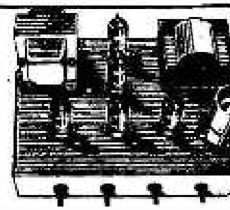
10/14 WATT HI-FI AMPLIFIER KIT



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ACY19	25p	BD123	75p	MM1613	43p	OC77	40p	1N659	7p	2N3232	64p
ACY20	25p	BD124	60p	MM1712	60p	OC81	23p	1N914	8p	2N3702	10p
ACY39	50p	BD131	75p	MPF102	45p	OC82	25p	1N916	8p	2N3703	10p
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AF118	50p	BFX85	30p	MPSU56	70p	TIP30A	58p	2N698	25p	2N3820	55p
AF172	25p	BFX86	25p	NKT135	35p	TIP31A	62p	2N706	12p	2N3866	85p
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BA156	15p	BFY5	22p	OA5	20p	TIP41A	75p	2N1303	16p	2N4061	12p
BC107	10p	BFY5	10p	OA10	20p	TIP42A	90p	2N1304	20p	2N4062	12p
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BC147	12p	BSW6	60p	OA79	12p	TIP31B	70p	2N1307	25p	2N4287	15p
BC148	12p	BSW6	75p	OA81	10p	TIP32B	82p	2N1308	25p	2N4288	15p
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BC157	13p	C111	40p	OA91	10p	TIP34B	£1·60	2N1613	20p	2N4290	15p
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BC182	10p	BY126	20p	OA211	35p	TIP42B	98p	2N2217	18p	2N5191	95p
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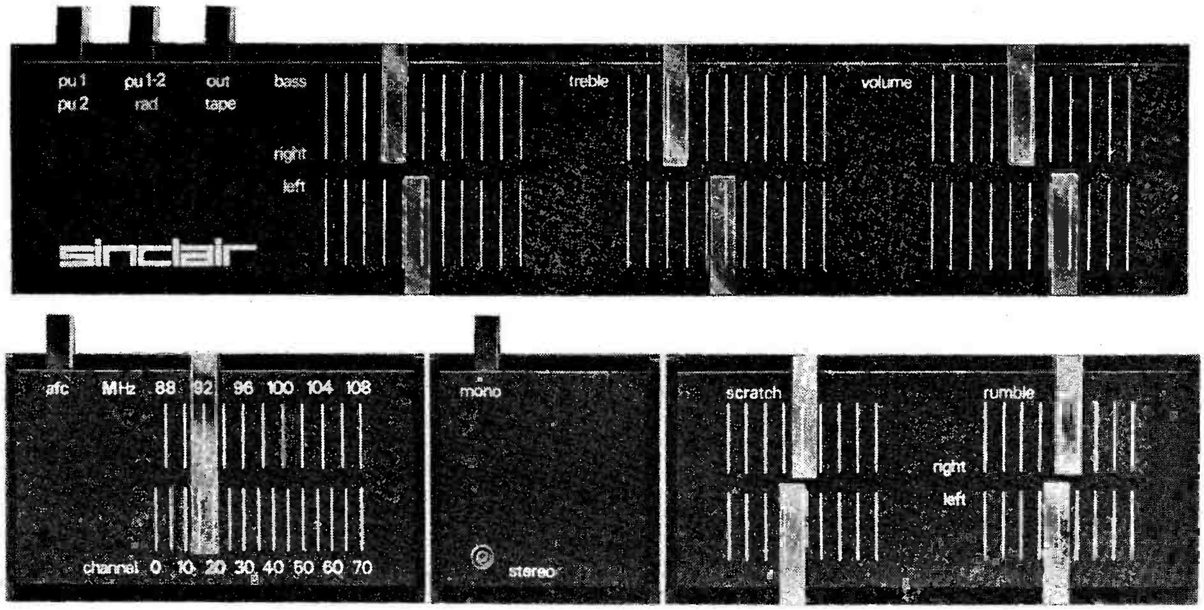

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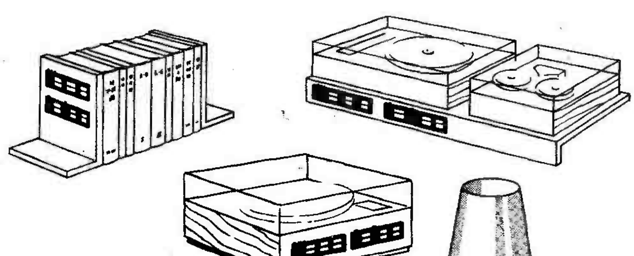

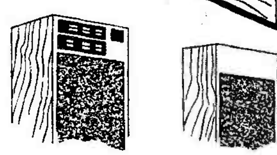

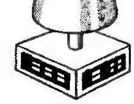

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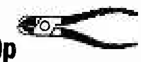

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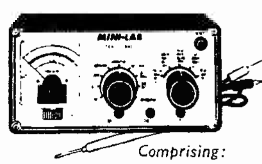

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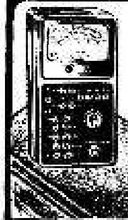

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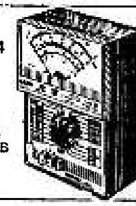

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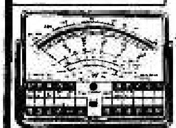

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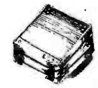

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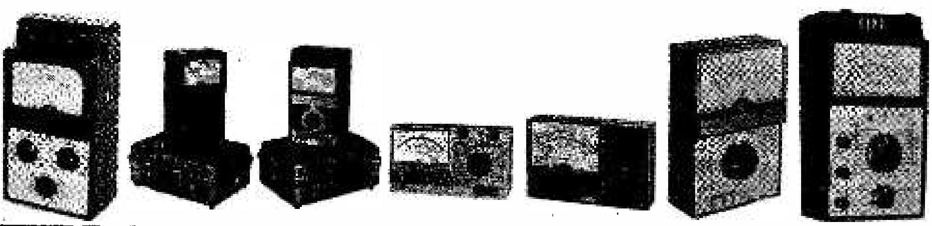

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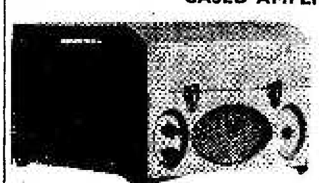

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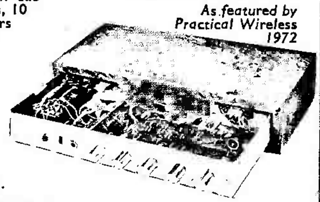

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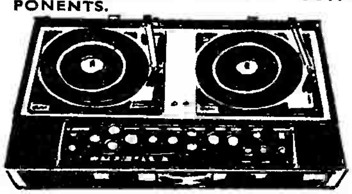

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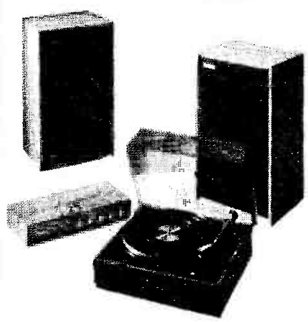

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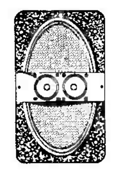

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ISSUE 804
FEBRUARY 1974

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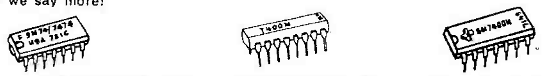

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SN7412AN	0·38	0·38	0·33
SN7413N	0·30	0·27	0·25
SN7414N	0·72	0·72	0·63
SN7416N	0·30	0·27	0·25
SN7417N	0·30	0·27	0·25
SN7420N	0·20	0·18	0·16
SN7422N	0·28	0·28	0·25
SN7422AN	0·38	0·38	0·33
SN7423N	0·37	0·34	0·32
SN7425N	0·37	0·37	0·32
SN7427N	0·37	0·37	0·32
SN7428N	0·43	0·43	0·37
SN7430N	0·20	0·18	0·16
SN7432N	0·37	0·37	0·32
SN7433N	0·43	0·43	0·38
SN7433AN	0·57	0·57	0·50
SN7437N	0·43	0·43	0·37
SN7438N	0·43	0·43	0·37
SN7438AN	0·57	0·57	0·50
SN7440N	0·20	0·18	0·16
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SN7454N	0·20	0·18	0·16
SN7460N	0·20	0·18	0·16
SN7470N	0·33	0·30	0·27
SN7472N	0·38	0·38	0·34
SN7473N	0·44	0·41	0·37
SN7474N	0·48	0·48	0·42
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SN7476N	0·45	0·36	0·32
SN7480N	0·80	0·70	0·50
SN7481N	1·25	1·10	0·95
SN7482N	0·87	0·80	0·72
SN7483N	1·20	1·10	1·00
SN7485N	1·87	1·87	1·63
SN7486N	0·50	0·50	0·44
SN7489N	4·32	4·32	3·78
SN7490N	0·75	0·70	0·63
SN7491AN	1·10	1·00	0·90
SN7492N	0·75	0·70	0·63
SN7493N	0·75	0·70	0·63
SN7494N	0·85	0·80	0·75
SN7495N	0·85	0·80	0·75
SN7496N	1·00	0·90	0·83
SN74100N	2·16	1·89	1·89
SN74104N	0·60	0·53	0·45
SN74105N	0·60	0·53	0·45
SN74107N	0·51	0·51	0·45
SN74110N	0·57	0·57	0·50
SN74111N	0·86	0·86	0·75
SN74116N	2·16	2·16	1·89
SN74118N	1·00	0·90	0·83
SN74119N	1·92	1·92	1·68
SN74120N	1·05	1·05	0·92
SN74121N	0·57	0·57	0·50
SN74122N	0·80	0·80	0·70
SN74123N	1·44	1·44	1·26
SN74125N	0·69	0·69	0·60
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SN74156N	1·09	1·09	1·00
SN74157N	1·09	1·09	0·95
SN74159N	2·44	2·44	2·14
SN74160N	1·58	1·58	1·38
SN74161N	1·58	1·58	1·38
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SN74175N	1·29	1·29	1·13
SN74176N	1·44	1·44	1·26
SN74177N	1·44	1·44	1·26
SN74180N	1·44	1·44	1·26
SN74181N	5·18	5·18	4·53
SN74182N	1·44	1·44	1·26
SN74184N	2·16	2·16	1·89
SN74185AN	2·16	2·16	1·89
SN74188N	6·48	6·48	5·67
SN74190N	2·30	2·30	2·01
SN74191N	2·30	2·30	2·01
SN74192N	2·30	2·30	2·01
SN74193N	2·30	2·30	2·01
SN74194N	1·72	1·72	1·51
SN74195N	1·44	1·44	1·26
SN74196N	1·58	1·58	1·38
SN74197N	1·58	1·58	1·38
SN74198N	3·16	3·16	2·77
SN74199N	2·88	2·88	2·52

LARGER QUANTITY AND O.E.M. PRICES PHONE (01) 723 3646. **PRICING OF SN7400 SERIES IS CALCULATED ON THE TOTAL NUMBER ORDERED REGARDLESS OF MIX.** SN74 . . . HIGH POWER . . . SN74 . . . LOW POWER SERIES IN STOCK . . . SEND FOR LIST 36, FREE ON REQUEST. LOW PROFILE SOCKETS 14 PIN . . . **15p** 16 PIN . . . **17p.** 8 PIN . . . **14p**

TRANSISTORS

A SELECTION FOR **FULL** LIST SEND FOR BOOKLET 36 TODAY

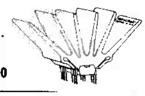
AAZ13	10p	BC182	12p	BYZ13	35p	OC36	65p	ZTX108	10p	2N3714	1·60
AC107	35p	BCY32	85p	CIO6D	55p	OC44	18p	ZTX300	14p	2N3771	1·75
AC128	20p	BCY39	1·00	GET111	55p	OC45	18p	ZTX302	18p	2N3773	2·25
AC187	20p	BCY55	2·50	GET115	75p	OC71	15p	ZTX500	15p	2N3790	2·25
ACY17	35p	BCY70	15p	GET880	55p	OC72	25p	2G301	40p	2N3819	35p
ACY39	65p	BCY71	20p	LM309K	1·87	OC77	55p	2N697	15p	2N3866	75p
AD149	50p	BCY72	13p	MAT121	25p	OC81	28p	2N706	10p	2N3903	15p
AD161	39p	BD124	80p	MJE340	50p	OC83	25p	2N930	20p	2N4002	14p
AD162	39p	BD131	45p	MJE520	65p	OC140	65p	2N987	45p	2N4126	15p
AF117	20p	BF115	22p	MJE3055	75p	OC170	25p	2N1132	25p	2N4871	35p
AF118	50p	BF180	33p	MPF105	46p	OC200	55p	2N1304	22p	2N5457	36p
AF139	33p	BF194	13p	NKT217	45p	OC202	90p	2N1613	20p	2S001	3·00
AF186	40p	BFX13	25p	NKT404	60p	OCP71	1·00	2N1671	1·00	2S026	8·90
AF239	44p	BFX34	55p	OA5	60p	ORP12	55p	2N2147	75p	2S303	70p
ASY27	30p	BFX88	22p	OA81	10p	ORP60	45p	2N2160	69p	40250	45p
BA115	10p	BFY50	20p	OA200	8p	P346A	20p	2N2926	10p	40361	45p
BAX13	5p	BFY51	20p	OA202	10p	TIL209	25p	2N3053	20p	40362	40p
BC107	12p	BFY64	45p	OC16	85p	TIP29A	49p	2N3054	45p	40408	50p
BC108	12p	BFY90	75p	OC20	1·25	TIP30A	58p	2N3055	45p	40486	75p
BC109	12p	BLY36	6·25	OC28	65p	TIP31A	61p	2N3440	50p	40636	1·00
BC109C	14p	BSX20	15p	OC35	55p	TIP41A	74p	2N3442	1·10	40430	85p
BC113	16p	BU105	2·20			TIP42A	90p	2N3525	80p		
BC147	12p	BY100	15p			TIS43	26p	2N3614	59p		
BC169C	14p	BY127	15p			V405A	25p	2N3702	11p		

TBA800 5 WATT I.C.

Suitable alternative to SL403D. 5/30 volt operated. 8/16 ohm 5 watt output. **With circuits and data £1·50**

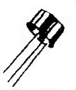
Sinclair IC12

with circuits and data. 6 watt IC with printed circuit board 28 volt operated **£1·80**



ZN414 IC

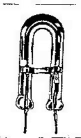
Integrated circuit radio as featured by many magazines (PW Jan. 73 Reprint Ref. No. 19 for **10p**) **£1·20**



STROBE TUBE

ZFT4A/XTF2. Suitable for Dec. '73 Pract. Electronics **£2·50**

ST2 (D32) DIAC **25p**
CRS1/40 SCR **45p**

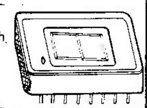


Ultrasonic Transducers

Operate at 40Khz up to 100 yds. Ideal remote switching and signalling. Complete with data transmitter and receiver new I.C. circuits.
Per pair **£5·90**
TA960 IC with socket **£1·80**

3015F 7 SEG.

I.C. size complete with data price **£2** each or 4 for **£7** (digital clock circuits ref. No. 31, **15p**)



TRANSISTORS SPECIAL OFFER

2N3055
25 ......**47p** ea
100 ......**42p**
500 ......**39p**
1000 ......**34p**

AF117
25 ......**15p** ea
100 ......**13p**
500 ......**12p**
1000 ......**10p**

BY127
25 ......**12p** ea
100 ......**10p**
500 ...... **9p**
1000 ...... **8p**

OC35
25 ......**46p** ea
100 ......**42p**
500 ......**38p**
1000 ......**34p**

ZENER DIODES

400 m/w BZY88/BZX83. From 3·3 volt – 33 volts **10p** each

1·3 watts 5% Miniature Tubulars IN4700 series. From 3·3 volt – 33 volt **18p** each.

10 watts. Stnd Mounting. ZS series 6·8 volts – 100 volts 5% **40p** each.

LINEAR I.C.

702C (T05)	75p
709C (T05)	39p
709C (D.I.L.)	39p
723C (T099)	90p
723C (D.I.L.)	90p
728C (D.I.L.)	45p
728C (T099)	45p
741C (T05)	50p
741C (D.I.L.)	50p
747C (T099)	£1·0p
748C (D.I.L.)	61p

SILICON RECTIFIERS

1 amp series IN4001 to IN4007 From **6p** ea
1·5 amp PL4001 to PL4007 From **8p** ea
3 amp PL7001/IN5400 From **14p** ea
Send for full list 36

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Semi-Conductor QUANTITY DISCOUNTS

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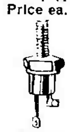
Any one type except where quantity discounts shown.

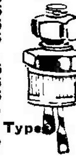
Min. order £1·00 please.

TRIACS – Stnd. mounting with accessories

Type	P.I.V.	1–11 Price ea.
3 AMP RANGE		
SC35A	100v	80p
SC35B	200v	85p
SC35D	400v	90p
SC35E	500v	£1·20
6 AMP RANGE		
SC40A	100v	90p
SC40B	200v	95p
SC40D	400v	£1·20
SC40E	500v	£1·50
10 AMP RANGE		
SC45A	100v	£1·05
SC45B	200v	£1·15
SC45D	400v	£1·45
SC45E	500v	£1·85
15 AMP RANGE		
SC50A	100v	£1·45
SC50B	200v	£1·65
SC50D	400v	£1·95
SC50E	500v	£2·25



3 Amp
T048



TRIACS – Additional Types
40430 TRIAC (T066) **85p**
40669 TRIAC (Plastic) **90p**
40486 TRIAC (T05) **75p**

NEW RANGES
BRIDGE RECTIFIERS
FEATURES SMALL SIZE AND LOW COST Sizes. are approx.

250M/A QUARTER AMP
B025/05 50 PIV **16p**
B025/10 100 PIV **18p**
¼ x ¼ x ¼" dia.

½ AMP 1-11 Pricing

Type	P.I.V.	Price ea.
B05/05	50v	20p
B05/10	100v	22p
B05/20	200v	23p
B05/40	400v	25p
B05/60	600v	27p

½H x ½L x 3/16" dia.

1 AMP P.I.V.

B1/05	50v	25p
B1/10	100v	25p
B1/20	200v	28p
B1/60	600v	30p

½H x ½L x 3/16" dia.

1 AMP P.I.V.

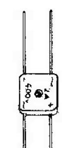
W005	50v	29p
W01	100v	30p
W02	200v	32p
W06	600v	35p

⅜ x ⅜" Tubular

2 AMPS P.I.V.

B2/05	50v	35p
B2/10	100v	40p
B2/20	200v	45p
B2/60	600v	50p
B2/100	1000v	55p

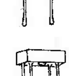
½H x ½L x 3/16" dia.



4 AMPS P.I.V.

B4/100	100v	55p
B4/200	200v	59p
B4/400	400v	65p
B4/600	600v	75p
B4/800	800v	£1·00

½H x ½L x 3/16" dia.



6 AMPS P.I.V.

B6/05	50v	65p
B6/10	100v	70p
B6/20	200v	80p
B6/40	400v	90p
B6/6x0	600v	£1·00

½H x ½L x 3/16" dia.

SILICON CONTROLLED RECTIFIERS

Type		1–11
ONE AMP (T05) P.I.V		
CRS 1/05AF	50v	30p
CRS 1/10AF	100v	30p
CRS 1/20AF	200v	35p
CRS 1/40AF	400v	45p
CRS 1/60AF	600v	55p
THREE AMP (T048)		
CRS 3/05AF	50v	40p
CRS 3/10AF	100v	40p
CRS 3/20AF	200v	45p
CRS 3/40AF	400v	55p
CRS 3/60AF	600v	65p
FIVE AMP		
CRS 5/400	400v	60p
SEVEN AMP (T048)		
CRS 7/100	100v	60p
CRS 7/200	200v	67p
CRS 7/400	400v	85p
CRS 7/600	600v	95p

All types offered subject to availabilty. Prices correct at time of press E. & O. E. 10% VAT to be added to all orders. UK post, etc, 15p. per order.

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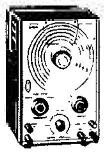
UK's LARGEST RANGE OF KITS & GADGETS

TEST EQUIPMENT



MULTIMETERS
(carr. etc. 30p)

M210	20K/Volt Slimline	6·75
TLH33D	2K/Volt Robust	7·50
U437	10K/Volt Steel case. AC up to 40 KHz	4·95
U4324	20K/Volt with AC current ranges	8·00
AF105	50K/Volt	11·95
U4313	20K/Volt AC current. Steel case	10·50
U4341	Plus Built in transistor tester	10·50
Model 500	30K/Volt	9·95

OTHER EQUIPMENT

SE250B	Pocket Signal Injector	2·10 carr. 15p
SE500	Pocket Signal Tracer	1·70 carr. 15p
TE15	Grid Dip meter 440kHz–280mHz	15·00 carr. 30p
TE40	AC Millivoltmeter 1·2mHz	18·95 carr. 35p
TE65	28 Range valve voltmeter	19·95 carr. 40p
TE20D	120kHz–500mHz RF Generator	17·95 carr. 40p
TE22D	20Hz–200kHz Audio Generator	18·95 carr. 40p
SE350A	Deluxe Signal Tracer	12·50 carr. 20p
SE400	Volts/ohms/R-C sub./RF field/RF gen.	14·75 carr. 20p

New Revolutionary Supertester 680R
680R Multi-tester
£18·50

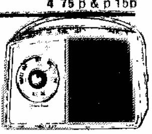
Accessories

Transistor tester	11·00
Electronic voltmeter	18·00
Ampclamp	11·95
Temperature probe	11·95
Guass meter	11·95
Signal Injector	5·95
Phase Sequence	5·95
EHT Probe	5·95
Shunts 25/50/100A	4·50 each

A SELECTION OF INTERESTING ITEMS

C3025	Compact transistor tester	5·50 p & p 15p
E1300	Mono mag. cart. preamp.	1·95 p & p 15p
E1310	Stereo mag. cart. preamp.	4·95 p & p 25p
Easiphone telephone amplifier		6·15 p & p 25p
D1203	Teleamp. with PU coil	3·60 p & p 20p
LL1	Door intercomm. and chime	11·95 p & p 25p
Chattalite (lights as you talk)		13·90 p & p 20p
1 Kw Dimmer/controller		3·00 p & p 10p
9" Twin spring unit	For	2·75 p & p 15p
16" Twin spring unit	Reverbs	6·50 p & p 25p
Car Tachometer Electronic		7·50 p & p 15p
VHF 105 Aircraft Band Corrector		3·95 p & p 15p
B2005 4 Ch. mic. mixer		2 95 p & p 15p
B2004 2 ch. Stereo mixer		4 75 p & p 15p

BUILD THIS RADIO



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

EXCLUSIVE: SPECIAL OFFERS

MW/LW CAR RADIO
+ or – Earth with speaker and fixings. **£6·50** carr./packg. 30p.

8 TRACK CAR STEREO
(– Earth) with speakers in Pods & fixings. **£12·50** carr/packg. 40p.

HANIMAX HC1000
Battery cassette recorder, **£10·50** carr/packg. 25p.

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Stereo cassette recorder, **£59·95** carr/packg. 50p.
Pair Akai ADM microphones. **£6·95** carr/packg. 20p.

5 WAVEBAND PORTABLE TWIN SPEAKER RADIO.
FM/MW/SW/AIRCRAFT—PUBLIC SERVICES. **£10·45** carr/packg. 30p.

PORTABLE CASSETTE TAPE PLAYER—
for car or carry around. **£7·25** carr/packg. 20p.

HANIMAX BC808 POCKET CALCULATOR WITH % KEY. £28·95.

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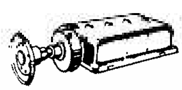
AVOMETER MOVEMENTS
AVO 8 or 9 50mA MOVEMENTS.
Ex Brand New AVO's **£3·50**
Post 20p.

UHF TV TUNERS CHANNELS 21 TO 64
Brand new transistorised geared tuners for 625 Line Receiver IF output. **£2·50.** Post 20p.



EASY TO BUILD KITS BY AMTRON— EVERYTHING SUPPLIED

Model No.		
310	Radio control receiver	2·98
300	4-channel R/C transmitter	5·95
345	Superhet R/C receiver	5·95
455	AM signal generator	12·33
65	Simple transistor tester	1·40
115	8 watt Amplifier	3·90
120	12 watt amplifier	4·70
125	Stereo control unit	5·70
130	Mono control unit	3·60
605	Power supply for 115	4·55
610	Power supply for 120	4·55
615	Power supply for 2 x 120	5·73
230	AM/FM aerial amplifier	2·93
240	Auto packing light	5·90
275	Mic. preamplifier	6·08
570	LF generator 10Hz–1mHz	15·80
575	Sq. wave generator 20Hz–20Khz	14·60
590	SWR meter	12·85
620	NI-CAD Charger 1·2–12v	8·00
630	STAB Power supply 6-12v 0·25-0·1 A	8·15
690	DC motor speed Gov.	2·87
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705	Windscreen wiper timer	6·80
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835	Guitar preamp.	4·25
840	Delay car alarm	6·15
875	CAP. Discharge ignition for car engine (–Ve Earth)	13·15
80	Scope Calibrator	2·25
255	Level Indicator	6·15
525	120–160mHz VHF timer	11·30
715	Photo cell switch	7·70
795	Electronic continuity tester	4·30
860	Photo timer	13·25
871	Slide projector auto feed control	7·15
235	Acoustic Alarm for driver	7·60
465	Quartz XTAL checker	8·75
220	Signal Injector	2·30
390	VOX	15·50
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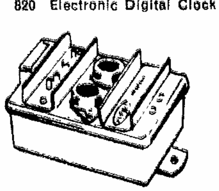

BUILD THIS TUNER
MW/LW Radio Turner to use with any amplifier. Features Mullard RF/IF module Ferrite aerial, built in battery. Excellent results. Size 7" x 2¼" x 3¼". All parts **£4·85**, carr. 15p.

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10–1	10 Projects	3·60
50–1	10 Projects	8·00
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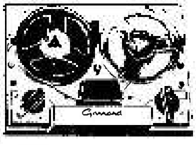
Telephone Communicator		7·20
X20	20 (Elec.) } Projects	4·95
X40	40 (radio) } Projects	9·45

(carr./packing 40p)

All transistor circuits with hand books

All types offered subject to availability. Prices correct at time of press E & OE. 10% VAT TO BE ADDED TO ALL ORDERS. UK post etc. 15p per order unless stated.



GARRARD BATTERY TAPE DECK
GARRARD 2 speed 9 volt tape decks. Fitted record/play and oscillator/Erase heads. Wind and rewind controls. Takes up to 4" spools. Brand new complete with head circuits.
£9·50 carr. 30p

TOP QUALITY SLIDER CONTROLS
60mm stroke high quality controls complete with knobs (post, etc. 15p any quantity).

Singles Log and Lin 5K, 10K, 22K, 50K, 100K, 250K, 500K, 1 Meg. **45p** each.

Ganged Log and Lin 10K, 22K, 50K, 100K, 250K, **65p** each.
(Quantity discounts available)

Complete with knobs.

MARRIOT TAPE HEADS
4 TRACK MONO or 2 TRACK STEREO
'17' High Impedance **£2·00**
'18' Med. Impedance **£2·00**
R730/E73 2 track mono Record/Erase low imp. **75p** pair.
Erase Heads for '17' and '18' **75p**
'63' 2 track mono, Hi imp. **£1·75**
'43' Erase Head for '63' **75p**
(Post, etc. 15p any quantity).

SINCLAIR, MINIATURE AMPLIFIERS & TUNER/DECODER
AMPLIFIERS (carr., etc. 20p)

4-300, 0·3 watt 9 volt	1·75
104, 1 watt 9 volt	2·20
304, 3watt 9 volt	2·50
555, 3 watt 12 volt	2·85
E1208, 5 watt 12 volt	4·50
608, 10 watt 24 volt	4·10
410, 10 watt 28 volt	4·95
Z30, 15 watt 30 volt	3·57
E1206, 30 watt 45 volt	9·75
Z50, 30 watt 50 volt	4·37
E1210, 2½ + 2½ watts 12 volt	5·25
RE500, 5 watt IC mains operated Amplifier with controls	£6·30
SAC14, 7 + 7 watt Stereo with controls	£8·00
SAC13, 15 + 15 watt Stereo with controls	£11·00

SINCLAIR (carr. 20p)
PROJECT 60
Z30 3·57 Z50 4·37
Stereo 60 Preamp. 7·97
PZ5 £3·97, PZ6 £6·37
PZ8 (for Z50) £4·77 (TRANS £2·95)
AFU £4·45

New SINCLAIR PROJECT 80

Stereo Preamp.	11·95
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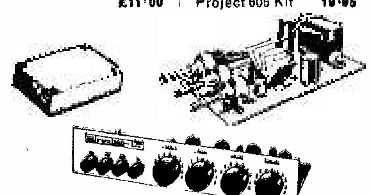
PZ8 Mod. (S Tab) 1 on 2 Z60	7·98
TRANSFORMER FOR PZ8	2·95
Project 605 Kit	19·95



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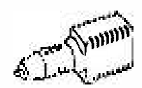

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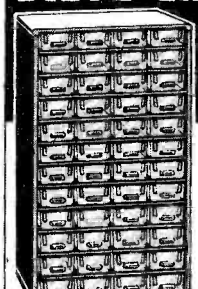

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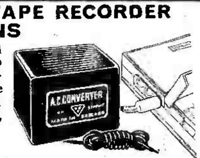

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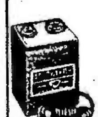

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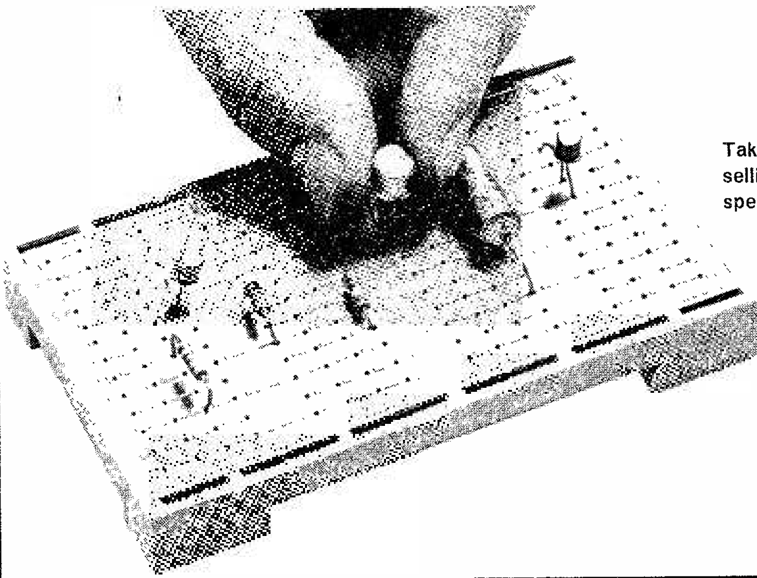

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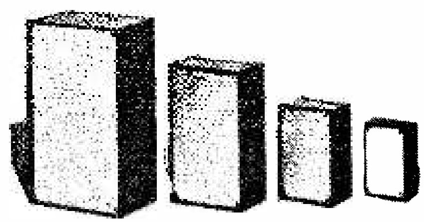

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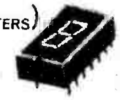

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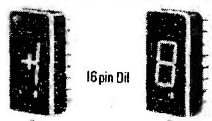

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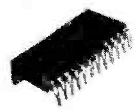

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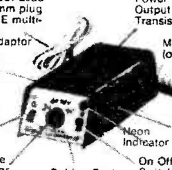

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9 volts (miniature) up to 50mA	£2·09
6 + 6 volts at up to 50mA	£2·75
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P. & P. on all models 16p.

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AC107	16p	AF179	71½p	BC214L	11p	BF177	28p	BSX20	18p	TIC44	46p								
AC126	13p	AF239	41p	BC268	15p	BF178	29p	BSX21	22p	TIC226D	£1·97								
AC127	13p	ASY26	33p	BC327	26½p	BF179	33p	BSY9SA	13p	TIP41A	81p								
AC128	13p	BC107	10p	BC328	24½p	BF180	33p	BU105	£1·75	TIP42A	99p								
AC176	15p	BC108	10p	BCY70	17p	BF181	35½p	BU105/02	£1·92	TIS43	36½p	2N3054	55p	2N4289	16½p	AAZ13	11p	BAX13	9p
AC187	22p	BC109	10p	BCY72	17p	BF184	27½p	D13V	53p	TIS73	£2·10	2N3055	52p	2N4441	87p	BA100	10p	BAX16	10p
AC187K	20p	BC114	15½p	BCZ10	28p	BF185	27½p	MJ4000	£1·48	TIS91	33p	2N3391A	29p	2N4442	£1·06	BA102	27½p	BAY38	41p
AC188	22p	BC117	22p	BCZ11	28p	BF194	15p	MJ4010	£1·49	2N697	16½p	2N3566	18p	2N4443	£1·45	BA110	45p	BB105	42p
AC188K	20p	BC147	9p	BD115	74p	BF195	17p	MJE340	52p	2N706	13p	2N3638	20p	2N4444	£2·09	BA111	55p	BB141	99p
ACY17	24p	BC148	9p	BD124	82p	BF196	16½p	MJE2955	£1·82	2N708	16½p	2N3702	11p	2N4871	60p	BA112	99p	BB142	82p
ACY18	21p	BC149	9p	BD131	68p	BF197	16½p	MJE3055	92p	2N914	24½p	2N3703	10p	2N5129	16½p	BA114	9p	OA5	99p
ACY19	25p	BC157	13p	BD132	53p	BF200	35½p	MPF102	27½p	2N1302	20p	2N3704	11p	2N5172	9p	BA115	19p	OA10	94p
ACY20	22p	BC158	12p	BD131/2 PR	£1·49	BF220	27½p	MPF103	41p	2N1303	24p	2N3705	10p	2N5459	38½p	BA116	9p	OA47	11p
AD140	40p	BC159	14p	BD133	83p	BF244B	27p	MPF104	45p	2N1304	24p	2N3706	10p	2N5777	47p	BA128	11p	OA79	10p
AD149	38p	BC168B	11p	BD135	42p	BF262	25p	MPF105	45p	2N1305	24p	2N3707	12p	2N6076	14p	BA129	23p	OA81	8p
AD161	29p	BC169	12p	BD136	50p	BF263	25p	MPF106	49½p	2N1306	24p	2N3708	9p	3N140	£1·01	BA143U	75p	OA85	10p
AD162	29p	BC171	20p	BD137	57½p	BF272	£1·21	OC28	33p	2N1307	27½p	2N3709	10p	3N141	89p	BA143V	67p	OA90	8p
AD161/2 PR	59p	BC172	17½p	BD138	74½p	BF390	37p	OC35	38p	2N1308	27½p	2N3710	11p	3N152	101p	BA144	20p	OA91	8p
AF114	14p	BC174B	35p	BD139	78p	BFS28	£1·01	OC36	38p	2N1309	27½p	2N3711	11p	3N153	89p	BA145	22p	OA95	9p
AF115	14p	BC177	22p	BD140	91½p	BFW10	67p	OC44	13½p	2N1613	22p	2N3771	£1·82	40360	51p	BA148	22p	OA200	11p
AF116	14p	BC178	22p	BD201	£1·55	BFW11	67p	OC45	13½p	2N1711	26p	2N3772	£2·75	40361	50p	BA154	20p	OA202	12p
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AF118	92p	BC182L	9p	BD203	£1·55	BFX29	43p	OC72	13½p	2N2160	£1·54	2N3819	28p	40408	55p	BA156	16½p	OA211	30p
AF124	24p	BC183L	9p	BD204	£1·37	BFX30	37½p	OC75	15p	2N2219	41p	2N3823	99p	40430	£1·39	BA182	26½p	IN914	8p
AF125	22p	BC184	9p	BF109	75p	BFX88	26p	OC81	13½p	2N2646	55p	2N3903	16½p	40432	£2·17	BA220	7p	IN916	10p
AF126	22p	BC184L	9p	BF115	25p	BFY50	16½p	OC83	25p	2N2905	46p	2N3904	19p	40673	55p	BA221	7p	IN4148	5½p
AF127	22p	BC187	27½p	BF160	25½p	BFY51	16½p	OC140	22p	2N2924	18p	2N3905	23p	AA119	10p	BA222	7½p		
AF139	35p	BC212L	11p	BF167	27½p	BR100	43p	OC170	27½p	2N2926 all	10p	2N3906	25p	AA120	10p	BAV10	11p		
AF172	25p	BC213L	11p	BF173	22p	BRY39	44p	OC171	33p	2N3053	22p	2N4058	13½p	AA129	10p	BAW62	10p		

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All 5% tolerance

BZY88, 400mW, 3·3V to 33V	11p
1ZS, 1W, 3·3V to 100V	18p
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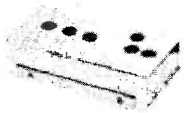

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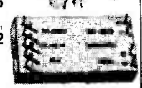
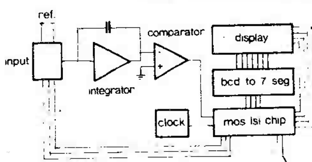


3½ decade DVM



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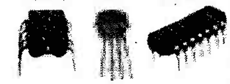

	8pin Dip	TO99	14pin Dil
709	34p	40p	35p
710	35p	40p	39p
711	—	45p	39p
723	—	96p	95p
741	42p	45p	43p
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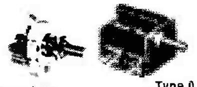

Type C804

5pF	**61p**	50pF	**66p**
10pF	**61p**	60pF	**79p**
15pF	**61p**	75pF	**79p**
20pF	**66p**	100pF	**75p**
25pF	**61p**		

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BFS97	23p	ZTX311	10p	ZTX502	17p	ZS140	25p		
BFS98	20p	ZTX312	10p	ZTX503	14p	ZS141	43p		
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ZTX107	9p	ZTX314	13p	ZTX510	17p	ZS170	10p		
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ZTX109	11p	ZTX330	15p	ZTX531	22p	ZS172	16p		
ZTX212	14p	ZTX331	16p	ZTX550	17p	ZS174	17p		
ZTX213	14p	ZTX341	22p	ZTX551	17p	ZS176	23p		
ZTX214	15p	ZTX382	13p			ZS178	38p		
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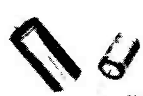
KSO30A Zener Series as BZY88 Series **11p** each.

ELECTROLYTICS



µF	4V	6.3V	10V	16V	25V	40V	63V	100V
1							6½p	8p
1.5							6½p	
2.2							6½p	
3.3							6½p	
4.7							6½p	8p
6.8						6½p	6½p	
10					6½p		6½p	9p
15				6½p		6½p		
22			6½p		6½p		6½p	11p
33		6½p		6½p		6½p		
47	6½p		6½p		6½p	6½p	8p	
68		6½p		6½p			10p	
100	6½p		6½p		6½p	8p	11p	23p
150		6½p		6½p	6½p	10p	13p	
220	6½p		6½p	8p	10p	11p	19p	31p
330	6½p		8p				22p	39p
470		6½p	10p		13p	19p	26p	48p
680		10p		13p	20p	23p		59p
1000	10p		11p	17p	22p	25p	44p	79p
1500		12p	20p	23p				
2200		18p	20p		36p	44p	79p	149p
3300		20p						
4700	29p			44p	68p	79p	149p	252p
6400				75p	93p			
10000							299p	333p

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25kΩ 1MΩ
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E298ED A265	11p	VA1053	11p
E298ED P268	11p	VA1055S	11p
E298ZZ 05	13p	VA1056S	11p
E298ZZ 06	11p	VA1066S	11p
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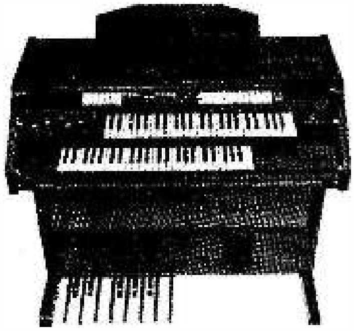
D.I.Y. ELECTRONIC ORGAN KITS



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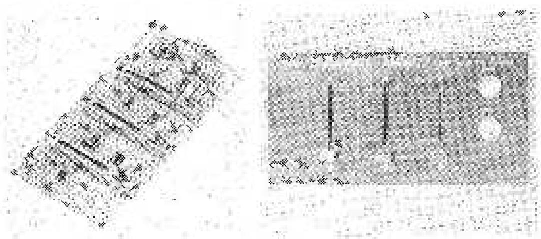
DABAR MN3 MIXER KIT



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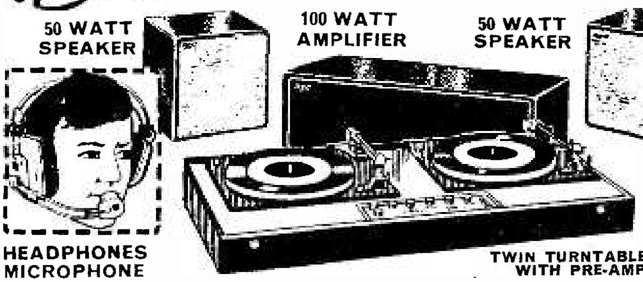

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TYPE C132 30-40 WATTS Fitted two exceptionally efficient, low feedback howl characteristic high flux 13" × 8" 20 watt speakers. Terms: Dep. £2·95 and 9 m'thly payments £2·43 (Total £24·82) Carr. 65p. **£21·95**

TYPE C313 50 WATTS Low feedback characteristic. Fitted three 13" × 8" deep cone high flux speakers with high power voice coils. Size approx. 54" × 14" × 11". Dep. £4·72 & 9 mthly pymts £3·58 (£36·94) Carr. 85p **£32·72**

TYPE C4100 100 WATTS inc. four 12" 50 watt speakers for conservative rating. Extra heavy construction. Size approx. 58 × 16 × 10" Acoustically filled and pressurised. Terms: Dep. £15·50 & 12 mthly. pyts. £5·46 (Total £81·02). Carr. £1·50 **£71·50**

FANE ULTRA HIGH POWER LOUDSPEAKERS

All power ratings are R.M.S. continuous. 2 YEARS' GUARANTEE High flux ceramic magnets. ALL CARRIAGE FREE.

'POP' 100 — 18" 100 Watt 14,000 gauss 8/15Ω **£25·95** Dep: £5·95 and 9 monthly payments £2·56 (Total £28·99)

'POP' 60 — 15" 60 Watt 14,000 gauss 8/15Ω **£14·75** Dep. £3·75 and 9 monthly payments. £1·50 (Total £17·25)

'POP' 50 — 12" 50 Watt 13,000 gauss 15Ω **£11·99** Dep £2·99 and 9 monthly payments £1·28 (Total £14·51) PAIR SUITABLE ALL PURPOSES

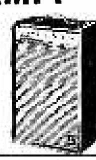
FOR BASS GUITAR, ELECT. ORGAN, ETC.

FANE SPEAKERS 'POP' 25/2 12 in. 25 WATT

Dual Cone 15 Ω (for uses other than Bass Guitar or Electronic Organ). Carr. free **£7·95** or Dep. £1·25 and 9 mthly payments 89p (Total £9·26).

MINSTREL 8W GUITAR AMP.

Incorporating Tremolo and 13" × 8" or 10" Speaker. Output 8 watts R.M.S. Continuous. 3 Jack Inputs for Microphone and Instrument. Mains Neon Controls: Volume, Tone, Tremolo Speed Tremolo Intensity.
Terms: Deposit £2·75 and 9 monthly payments £2·17 (Total £22·28). **£19·95**
Carr. free



FANE CRESCENDO SPEAKERS

Full range available at ALL BRANCHES

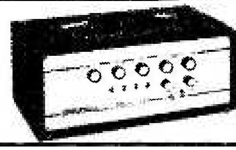
GROUP/DISCO EQUIPMENT PACKAGE OFFERS

F.A.L. PHASE 50 MK.III AMPLIFIER	£39·93	PACKAGE PRICE
PR. FANE POP 25/2 25W L/SPEAKERS	£15·90	**£51·50** carr. £1·10
Terms: Deposit £7·50 and 12 monthly payments of £4·29 (Total £58·98)	£55·83	
F.A.L. PHASE 50 MK.III AMPLIFIER	£39·93	PACKAGE PRICE
PR. FANE POP 50 L/SPEAKERS	£23·98	**£59·50** carr. £1·10
Terms: Deposit £9·50 and 12 monthly payments of £4·88 (Total £68·06)	£63·91	

OTHER PACKAGE OFFERS AVAILABLE

FAL PHASE 50 Mk.III AMPLIFIER 50 WATT.

Solid state. 4 Separately controlled inputs Plus master vol. control. Ind. Bass and Treble Controls. Protective circuit to guard against damage from accidental shorts. Output for Speaker/s 3 to 30 ohms. Size 17" × 7" × 7¼" 200-250v. A.C. mains. Output 50 watts music rating. Or deposit £6·93 & 9 monthly payments £4·22. Total £44·91. **£39·93**



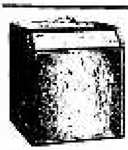
HIGH QUALITY LOUDSPEAKER UNITS

ALL TWO TONE REXINE AND VYNAIR FINISH
L125 50 WATT Fitted pair of 12" 50 watt high flux speakers for conservative rating. Impedance 8-15 ohms. Carr. £1·50 **£37·95**
Or deposit £3·95 and 9 monthly payts. of £4·34. Total £43·01

L12/20 12" 20-25 WATT 13,000 lines 15 ohms Dep £2·15 & 9 mthly pymts £1·50 (Total £15·65) **£13·15** Carr. 55p.

L12/10 10-15 Watt veneer finish cabinet 12" unit 8-15 ohm. Size approx. 14" × 14" × 9". Carr. 50p. Dep. £1·25 & 9 mthly pymts £1·06 (Total £10·79) **£8·25**

RSC PHANTOM '50'



Combined 50W Amplifier and 12in. Loudspeaker.

For Lead Guitar, Mic., Gram, Radio, Tape (Not for use with Bass instruments). Inc. 3 inputs and 2 vol. controls plus Treble, Bass and Presence. Output Jack for additional 15 ohm Speaker. Attractively finished in black with silver-finished fascia and trimmings. Compact size. Fitted carrying handle.
Terms: Deposit £8·95 and 12 monthly payments £4·97 (Total £68·59). Carr. £1·50 UK Mainland
SAE for leaflet
ONLY £59·95

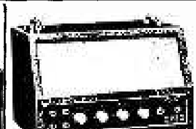
CREDIT TERMS AVAILABLE ON PURCHASES OVER £10 (Kits Excepted) INTEREST CHARGES REFUNDED ON CREDIT SALES Settled in 3 months

RSC BASS-REGENT 50 WATT AMPLIFIER

A powerful high quality all-purpose unit for lead, rhythm, bass guitar, vocalists, gram, radio, tape. Peak Output rating. Loudspeaker unit either horizontal or vertical mounting.
★ Two extra heavy duty 12in. 50w Loudspeakers.
★ Four Jack inputs and two Volume Controls for instant use of up to four pick-ups or "mikes". Bass and Treble controls. Send S.A.E. for leaflet.
Credit Terms: Deposit £15·50 & 12 monthly payments of £5·56. (Total £82·12.) Carr. £2·50 **£72·50**

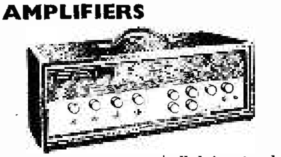
RSC GP30 HI-FI AMPLIFIER

For Guitar, Vocal or Instrumental Group



A 4 input, 2 vol. control Hi-Fi 30 watt unit with Separate Bass and Treble controls. Current valves. Peak output rating. Strong Rexine covered cabinet with handles. Attractive black/silver P.V.C. fascia. Neon indicator. For 200-250v. A.C. mains. For 3 or 15 ohm speakers. Send S.A.E. for leaflet. Terms: Deposit £4·40 and 9 monthly payments of £2·75 (Total £29·15). **£25·85** Carr. 75p

FAL TWIN CHANNEL AMPLIFIERS



Solid State. 4 sep. controlled inputs plus master volume control. Individual Bass and Treble controls. Output for speakers 3–30 ohms. Protective circuitry against damage from short circuits.

FAL 'SUPER 50'
50W ATTS MUSIC RATING Terms: Dep. £8·50 & 12 mthly. payments £4·97 (Total £68·14) **£59·50** Post free

FAL 'SUPER 100'
100 WATTS MUSIC RATING. Terms: Dep. £11·95 & 12 mthly. pymts. £6·63 (Total £91·51). Prices include protective dust cover. **£79·95** Post free

FAL PHASE 100/2 AMPLIFIER

100 WATTS MUSIC RATING. Solid State. Sep. Bass and Treble Controls. 4 separate controlled inputs plus master control. Output for speakers 3–30 ohms. Includes protective circuit against damage from short circuits. Terms: Deposit £7·86 & 12 monthly payments £6·05 (Total £80·45). **£69·85** Carr. free

R.S.C. BATTERY/MAINS CONVERSION UNITS

TYPE BM1. An all-dry battery eliminator. Size 5½ × 4½ × 2½in. approx. Completely replaces batteries supplying 1·5v and 90v, to battery radio where A.C. mains 200/250v. Post 30p 50c/s is available.
ASSEMBLED READY FOR USE **£4·15**

R.S.C. TRANSFORMERS, L.F. CHOKES & RECTIFIERS

FULLY GUARANTEED. Impregnated and Interleaved where necessary. Primaries 200-250v. 50c/s. Screened

MIDGET CLAMPED TYPE 2⅜ × 2⅝ × 2¼in.

250v., 60mA, 6·3v. 2a	£1·10
250-0-250v., 60mA 6·3v 2a	£1·16

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250v. 60mA, 6·3v. 2a., 0-5-6·3v. 2a.	£1·55
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
300-0-300v. 130mA, 6·3v. 4a. c.t., 6·3v. 1a. For Mullard 510 Amplifier	£2·95
350-0-350v. 100mA, 6·3v. 4a., 0 5-6·3v. 3a.	£2·45
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·95
425-0-425v. 200mA, 6·3v. 4a., c.t., 5v. 3a.	£5·45
425-0-425v. 200mA, 6·3v. 4a., Twice 5v. 3a.	£5·60
450-0-450v. 250mA, 6·3v. 4a., c.t., 5v. 3a.	£6·00

TOP SHROUDED DROP-THRO' TYPE

250-0-250v. 70mA, 6·3v. 2a., 0-5-6 3v. 2a.	£1·49
250-0-250v. 100mA, 6·3v. 3·5a.	£1·71
250-0-250v. 100mA, 6·3v. 2a., 6·3v. 1a.	£1·75
350-0-350v. 80mA, 6·3v. 2a., 0-5-6·3v. 2a.	£1·81
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
300-0-300v. 130mA, 6·3v. 4a., c.t. 6·3v. 1a. Suitable for Mullard 510 Amplifier	£2·85
350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·85

FILAMENT or TRANSISTOR POWER PACK Types 6·3v. 1·5a. 55p; 6·3v. 2a. 60p; 6·3v. 3a. 85p; 6·3v. 6a. £1 45; 12v. 1a. 61p; 12v. 3a. or 24v. 1·5a £1·50; 0-9-18v 1¼a £1·25; 0-12-25-42v 2a £1·95.

CHARGER TRANSFORMERS 0-9-15v. 1½a. £1·10, 2½a. £1·25; 3a. £1·40; 5a. £1·60; 6a. £1·85; 8a. £2·20

AUTO (Step UP/step DOWN) TRANSFORMERS 0-110/120v. 200-230-250v. 50-80 watts £1·25, 150 watts, £2·10 250 watts £3·00; 500 watts £6·40

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Push-Pull 8 watts EL84 to 3 Ω or 15 Ω	95p
Push-Pull 10 watts 6V6, ECL86 to 3-5-8-15 Ω	£1·55
Push-Pull EL84 to 3 or 15 Ω 10-12 watts	£1·50
Push-Pull Ultra Linear for Mullard 510, etc.	£2·45
Push-Pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15 Ω	£2·20
Push-Pull 20 watt high quality sectionally wound EL34, 6L6, KT66 etc. to 3 or 15 Ω	£3·65

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All 6/12v. D.C. output. Max. A.C. input 18v.
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SMOOTHING CHOKES
150mA, 7-10H, 250 Ω 77p; 100mA, 10H, 200 Ω 56p; 80mA, 10H, 350 Ω 55p; 60mA, 10H, 400 Ω 28p.

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Or for £3 extra Goldring G800 Cartridge worth over £10 fitted to above unit.
BSR MP60 T/Table & P.U. **£9·95** (Rec. Price £14·95) Carr. 40p

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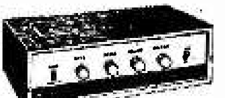
LEAK DELTA 30 Amplifier **£49·95** (Rec. Price £76·89) Carr. 40p
LEAK DELTA 70 Amplifier **£59·95** (Rec. Price £94·49) Carr. 45p
LINEAR 202 10 + 10W ,, **£29·95** Carr. 54p

RSC G66 MkII 6+6 WATT high quality STEREO AMPLIFIER

Individual Ganged Controls: Bass, Treble, Volume and Balance. Printed circuit construction employing 10 Transistors plus Diodes. Output rating I.H.F.M. Frequency range 20-20,000 c.p.s. Bass Control ± 12db. Treble Control ± 13db. Selector switch for P.U. or Tape/Radio. For loudspeaker output impedances of 3 to 15 ohms. For standard 200-250v. A.C. mains operation. Attractive Black and Silver finished metal fascia plate and matching control knobs. COMPLETE KIT OF PARTS INCLUDING FULLY WIRED PRINTED CIRCUIT and COMPREHENSIVE WIRING DIAGRAMS & INSTRUCTIONS **£12·65** Carr. 40p
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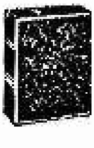
Teak veneer finish. Acoustically lined. Sizes approx. Carr. 35p. per enc.

JE8 Size 16" × 11" × 9". Pressurised. Gives pleasing results with any 8in. Hi-Fi speaker. **£5·50**
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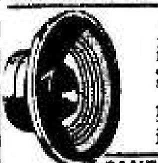
SE8 For optimum performance with any 8in. Hi-Fi speaker. Size 19 × 10½ × 9in. **£6·50**
SE12 For excellent performance with 12in. Hi-Fi speaker and tweeter 25½ × 16 × 9in. **£7·95**

AUDIOTRINE HIGH FIDELITY SPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Plasticised Cone surround. "D" indicates Tweeter Cone providing extended frequency range up to 15,000 c.p.s. Impedance 3 or 8-15 ohms PLEASE STATE CHOICE.
Exceptional performance at low cost.

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HF102D	10"	10W	£3·30	HF126	12"	15W	£6·35
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A full range 8in. 10 watt unit for excellent sound quality, in suitable enclosure. Cast chassis Roll P.V.C. cone surround and long throw voice coil to achieve very low fundamental resonance of 30 c.p.s. Tweeter cone is fitted to extend high note response. Frequency range 25 Hz to 15 KHz. Gauss 10,000. Impedance 3 or 8-15 Ω. **£3·99**
PLEASE STATE IMPEDANCE REQUIRED List £4·99
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Consisting of matched 12in. 11,000 line 15 Watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. **£6·50** Carr. 33p
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200-250v. AC mains operated. Frequency Response 30-20,000 c.p.s. ±2dB. Harmonic Distortion 0·3% at 1,000 c.p.s. Separate Bass and Treble 'lift and cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3-15 ohm spkrs. Max. sensitivity 5mV Output rating I.H.F.M. Fully enclosed enamelled case, 9¾ × 2¾ × 5¾in. Attractive brushed silver finish facia plate 10¾ × 3½in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. **£8·50** Carr. 40p.
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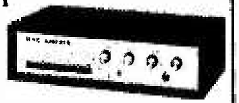
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COMPLETE KIT (less cabinet). Carr. 70p. Cabinet if req. £5 extra. **£22·50**

FACTORY BUILT UNIT INC. CABINET with 12 months' guarantee. Or Dep. £7 and 9 monthly payments £4·54 (Total £47·86). **£42·50**

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★ Moderate size only 25 × 14 × 10in. approx.
★ Response 30-20,000 c.p.s. Impedance 15 ohms
★ Performance comparable with units costing considerably more

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Consists of (1) 12in. 15 watt Bass unit with cast chassis, Roll rubber cone surround for ultra low resonance, and ceramic magnet. (2) 3-way quarter section series cross-over system. (3) 8 × 5in. high flux middle range speaker. (4) High efficiency tweeter. (5) Appropriate quantity acoustic damping material. (6) Handsome Teak veneered cabinet. (7) Circuit and full instructions. Terms: Deposit £5·25 and 9 monthly payments £2·56 (Total £28·29).

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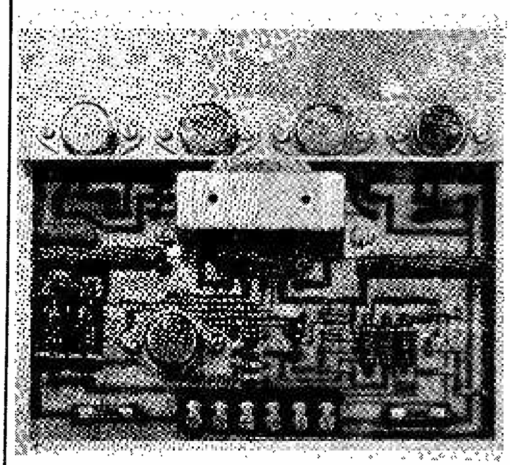

TUAC POWER MODULES

TP125 illustrated **£15·25**
- ★ 125 Watts RMS continuous sine wave output
- ★ 4 RCA 150 Watt 15 Amp output transistors
- ★ Special layer wound driver transformer
- ★ Short, open, and thermal overload protection
- ★ Compact size: 7 x 6½ x 3 in.

TL100 **£11·50**
- ★ 100 Watts RMS sine wave
- ★ 2 RCA 15 Amp output transistors
- ★ Rugged transformer driver
- ★ Full thermal overload protection
- ★ Compact size: 5 x 5 x 3in.

TL60 **£9·75**
- ★ 60 Watts RMS sine wave
- ★ RCA 115 Watt output transistors
- ★ Only six connections to make
- ★ Same size as TL100

Power supplies vacuum impregnated Transformers with supply board incorporating stabilised pre-amp supply:

PS 125 ±50 volts for one TP125	£8·75
PS 100 ±45 volts for one TL100	£8·00
PS 60 ±40 volts for one TL60	£6·75
PSU 2 For supplying Disco Mixer	£3·50

Specification on all three power modules:
All output power ratings ±1dB. Output impedance 8–15 Ohms. THD at full power 1% typically 0·5%. Input sensitivity 60mV into 10kΩ. Frequency response 10Hz–25kHz ±2dB. Hum and noise better than —75dB.

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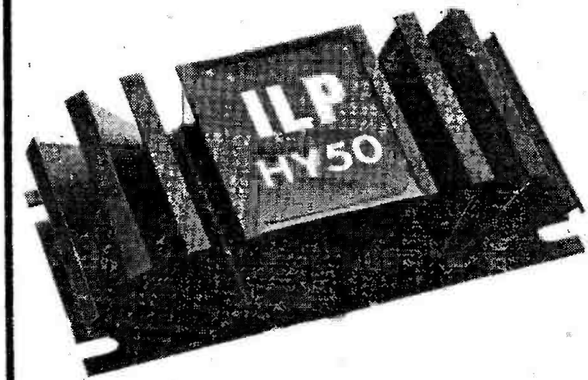

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LOAD IMPEDANCE:	4·16Ω into 8Ω
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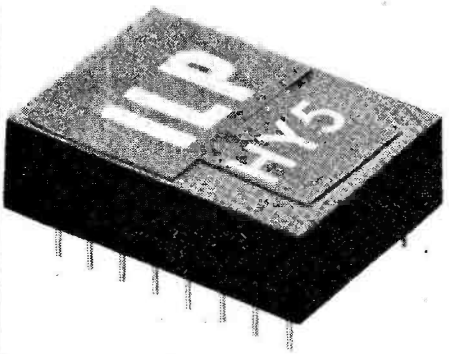
INPUT IMPEDANCE:	47KΩ
TOTAL HARMONIC DISTORTION:	Less than 0·1% at 25 watts typically 0·05
SIGNAL/NOISE RATIO:	better than 75db
FREQUENCY RESPONSE:	10Hz-50KHz ± 1db
SUPPLY VOLTAGE:	± 25 volts
SIZE:	105 x 50 x 25 mm

Price £5·40 mono, £10·80 stereo

Price inclusive of VAT & P & P

NEW HY5 PRE-AMPLIFIER



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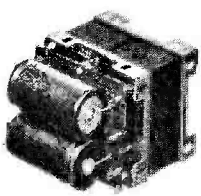
INPUTS **SPEC.**
Magnetic Pick-up 3mV (within 1db RIAA curve)
Ceramic Pick-up up to 3mV
Microphone 10mV
Tuner 250mV
Auxiliary 3–100mV
Input impedance 47kΩ 1kHz

OUTPUTS
Tape 100mV.
Main output, Odb (0·775volts)

ACTIVE TONE CONTROLS
Treble ± 12db at 10kHz
Bass ± 12db at 100Hz
OVERLOAD CAPABILITY (equalization stage) 40db on most sensitive input
OUTPUT NOISE LEVEL (below 10mV magnetic input) 68db
DISTORTION 0·05% at 1kHz
SUPPLY VOLTAGE ± 16-25 volts
SUPPLY CURRENT 15mA
Price £4·51 mono, £9·02 stereo
Price inclusive of VAT & P & P

POWER SUPPLY PSU50



The new PSU50 has a low profile look being only 2½ inches high and can be used for either mono or stereo systems.

SPEC.
OUTPUT VOLTAGE ± 25 volts
INPUT VOLTAGE 210-240 volts
SIZE L. 70, D. 90, H. 60 mm

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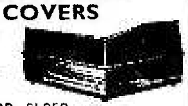

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ELIMINATORS for use with most cassette recorders and players, sets, &c. Mains input 240v. AC, front switch, pilot lamp, leads output 3, 6, 7½ and 9v. 400 mA, stabilised Model SC with multi output adaptor £5·50 (30p). Model NR, extra 12v. output, and 500mA £6·00 (30p).
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Individual prices of these are:
2 track record playback heads **50p** each
4 track record playback heads **72p** each
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MU-metal mounting shields **39p** each
2 track-heads already fixed on heavy mounting plate with shield **£1·22**.

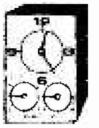
DRILL CONTROLLER
NEW IKW MODEL

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. **£1·95.** Made up model also available. **£2·95.**

MIGHTY MIDGET

Probably the finest possible radio, as described in *Practical Wireless*, January 73. All electronic parts **£2·20** post paid.

TIME SWITCH



Smith's mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars, keep pets warm, halve your heating bill, etc **£1·95**.

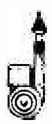
I CHIP RADIO

Ferranti's latest device ZN414 gives results better than superhet. Supplied complete with technical notes and circuits. **£1·38** each. 10 for **£11·11**.

HI-Q TUNER COMPONENTS

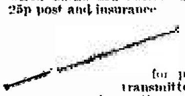
For experimenting with the ZN414.
KIT NO. 1. Plessey Miniature Tuning Condenser with built-in LW switch and 3" Ferrite slab and litz wound MW coil, **72p.**
KIT NO. 2. Air spaced tuning condenser 6" ferrite rod litz wound MW and LW coils, **94p.**
KIT NO. 3. Air spaced TC with slow motion drive 8" ferrite rod, with litz wound LW and MW coils, **£1·10.**
KIT No. 4. Permeability tuner with fast and slow motion drive and LW loading coils, **50p.**

AUTO—ELECTRIC CAR AERIAL



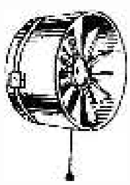
with dashboard control switch fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch **£6·35** plus 25p post and insurance

TELESCOPIC AERIAL



for portable, car radio or transmitter. Chrome plated six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. **42p.** KNUCKLED MODEL FOR F.M. **55p.**

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, 5¼" casing with 5¼" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets. **£2·75** plus 20p post and ins.

MAINS OPERATED SOLENOIDS

Model 772 — small but powerful 1in. pull—approx. size 1½ × 1½ × 1¼in. **66p.** **Model 4001/**—½in. pull. Size 2¼ × 2 × 14in. **83p.** **Model TT1**—1½in. pull. Size 3 × 2½ × 2in **£1·98** plus 20p post and insurance

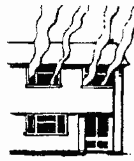
MAINS TRANSISTOR P.P.

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 at only **£1·10**

DESK TELEPHONES

Ex G.P.O. Black standard model with dialling dial but no internal bell. Supplied with connection diagram **£1** each. Ditto with bell but without dialling dial **£1·25** model as illustrated with bell and dial **£1·50** each plus 50p post for single then 65p per pair.

SMOKE WILL KILL—GAS WILL KILL—FIRE WILL KILL

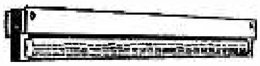


But, if you install SAGA (our smoke and gas alarm) your family will have the latest electronic protection against these killers.
Saga uses a fantastic electronic sensor which "smells" smoke and gas and sounds the alarm immediately In a neat case measuring approx. 5" × 3½" × 2½". it has its own internal alarm, also a connector for additional bells. You just plug it in to the mains and hang it near the ceiling. Saga uses so little electricity that it will hardly move the meter, leave it on always to give night and day protection. **£6·99** plus 30p post or Kit of Parts **£5·99**. Battery Model Kit only **£4·99**.
Censor (G) only **£2·20**

Solid State Stopwatch Bench Power Supply

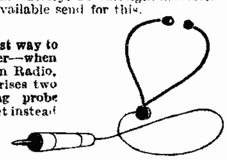
As featured this issue! Our 1974 catalogue lists hundreds of bargains and probably many of the parts needed for this project. **66p** brings the catalogue and the next 6 monthly supplements.

TWENTYLITE



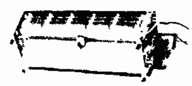
Battery operated fluorescent lighting 2 ft unit complete **£5·50**, 40 inch unit complete **£8·50**. These work off a 12 volt car battery. 24 volt light inverters also available send for this.

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. **£2·20**—twin stethoset instead of earpiece **83p.** extra—post and ins. **20p**

TANGENTIAL HEATER UNIT



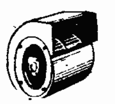
This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters. Comprises motor, impeller, 2kW. element allowing switching 1, 2W, and with thermal safety cut-out. Can be fitted into any metal case or cabinet. Only needs control switch, **£2·75**. Don't miss this. Control Switch **44p.** P. & P. 40p

STANDARD WAFER SWITCHES

Standard size 1¼" wafer - silver-plated 5 amp contact, standard ¼" spindle 2" long—with locking washer and nut.

No. of Poles	2way	3way	4way	5way	6way	8way	9way	10way	12way
1 pole	44p	44p	44p	44p	44p	44p	44p	44p	44p
2 poles	44p	44p	44p	44p	44p	44p	44p	77p	77p
3 poles	44p	44p	44p	44p	77p	77p	77p	£1·04	£1·04
4 poles	44p	44p	44p	77p	77p	77p	77p	£1·32	£1·32
5 poles	44p	44p	77p	77p	£1·04	£1·04	£1·04	£1·60	£1·60
6 poles	44p	77p	77p	77p	£1·04	£1·04	£1·04	£1·87	£1·87
7 poles	77p	77p	77p	£1·04	£1·32	£1·32	£1·32	£2·15	£2·15
8 poles	77p	77p	77p	£1·04	£1·32	£1·32	£1·32	£2·42	£2·42
9 poles	77p	77p	£1·04	£1·04	£1·60	£1·60	£1·60	£2·70	£2·70
10 poles	77p	77p	£1·04	£1·32	£1·60	£1·60	£1·60	£3·00	£3·00
11 poles	77p	£1·04	£1·04	£1·32	£1·87	£1·87	£1·87	£3·25	£3·25
12 poles	77p	£1·04	£1·04	£1·32	£1·87	£1·87	£1·87	£3·52	£3·52

CENTRIFUGAL FAN



Mains operated, turbo blower type. Pressed steel housing contains motor and impeller. Motor is 1/10th h.p. giving considerable air flow but virtually no noise. Approx. dimensions 10½ in. wide × 12 in. dia. outlet into trunking 10½ × 4½ in. **£6·55** plus £1 post and insurance.

CAPACITOR DISCHARGE CAR IGNITION

This system which has proved to be amazingly efficient and reliable was first described in the *Wireless World* about a year ago. We can supply kit of parts for an improved and even more efficient version (*Practical Wireless*, June). Price **£6·55** plus 20p post. When ordering please state whether for positive or negative systems. De-luxe model including printed circuit board, etc. **£7·65.**

SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc.

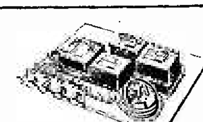
24in × 18in **£1·69**

13in × 9in **£1·21**

PHOTO ELECTRIC KIT

Contains photo cell, relay, transistor and all parts to make light operated switch. **£1·75** plus 20p post and ins.

MULLARD UNILEX STEREO SYSTEM



There is no doubt that it is a good system, we believe that for the money it is without comparison. We demonstrate gladly at our Tamworth Road depot. Prices of the individual items for this: -
1 Uniflex Amplifier Ref. E.P. 900 **£1·60**.
1 Unilex Pre-Amp Ref. EP.9001 **£1·98.**
1 Uniflex Power Unit Ref. EP.9002 **£2·53.** 1 Control panel kit with spun aluminium faced knobs **£3·30**. Or the complete outfit - **£11·30** post paid. Pair of 15 ohm speakers made by E.M.I. are also available if required, Price **£3·30** the pair. No extra postage if ordered with the above, otherwise add 25p.

MULTI-SPEED MOTOR.

Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000, 12,000 and 15,500 r.p.m. Shaft is ⅛ in. diameter and approximately 1 in long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia. × 3 in. long. Price **97p** plus 23p postage and insurance

SLIDE SWITCHES

Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in × ⅜in rated 250V lamp **8p** each. 10 for **73p**, Ditto as above but for printed circuit **6p** each 10 for **63p** **Sub Miniature Slide Switch.** DPDT 19mm (¾in approx.) between fixing centres. **20p** each or 10 for **£1·90**. SP Change over spring return 250v 1 amp **11p**

TREASURE TRACER

Complete Kit (except wooden battens) to make the metal detector as the circuit in Practical Wireless, August issue. **£3·30** plus 20p post and insurance

IMMERSION HEATERS BY REMPLOY

Standard fitting for domestic water tanks, made by the famous Remploy Company. Complete with sealing washers suitable for 200/240 volts A.C. Depth into tank 11". 2kw or 3kw **£1·65** plus 40p each post and insurance

GOOD COMPANION I.C. VERSION

We can now offer these again in I.C. version using Ferranti ZN414 and Mullard AF Module 1172. Cabinet size approx. 11" wide × 8" high × 3" deep. Complete assembly instruction. Excellent tone wood cabinet. **£5·75** plus 25p post and insurance.

SEVEN MOTORS FOR £1·50

30p Post plus V.A.T

As used in racing cars and power models. All battery operated and reversible.

MAINS MOTOR

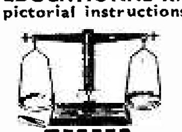
Precision made as used in record decks and tape recorders ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at **72p.** Postage 20p for first one then 10p for each one ordered.

PC BOARD MARKER

Valve action fire tipped marking pen filled with black etch resist it's easy with this to make a perfect PC board, just draw straight on to the copper—allow 15 mins. to dry, then immerse in ferric chloride or other etchant on removal the circuit stands in high relief. **99p.**

SL103D. Plessey IC, three watt amplifier which works with the Ferranti ZN414 to become probably the first two IC radio in existence, the circuit and constructional details appeared in September's *Practical Wireless*, so we can supply the SL103D at **£1·75**, the ZN414 at **£1·35** also most other items, send for PW IC radio parts list

EDUCATIONAL KITS—all with pictorial instructions



With 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits **44p** each post paid. Special price for all 7 kits **£3·00** with free balance kit.

KA2 Lens Kit. Eleven parts, concave lens, one convex lens, stage and slit frame, etc.
KA3 Water Pump Kit. Thirteen parts. Transparent so that operating parts may be observed. You can make Lift Pump, Force Pump and Force Pump with reservoir and nozzle.
KA4 Buzzer Kit. Eleven parts. Operation of buzzer seen.
KA7 Electro-Magnet Kit. Fifteen parts, includes compass, showing how magnetism works.
KA8 Current and Resistance Kit. Twenty-nine parts, including bench and light bulb. Learn "OHMS LAW", etc.
KA9 Bell Kit. Eight parts, including bell and push button switch. Build a complete electric bell.
KA10 Morse Key buzzer and bell kit. 25 part kit easy to construct, simple to operate.

TERMS: 10% discount if ten of an item ordered, send postage where quoted- other items, post free if order for these items is £6·00 otherwise add 20p.

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NPN: BC107 **15p**, BC108 **14p**, BC109 **18p**, BC167 **12p**, BC168 **11p**, BC169 **12p**.
PNP: BC177 **21p**, BC178 **19p**, BC179 **22p**, BC257 **14p**, BC258 **12p**, BC259 **14p**.
Standard groupings available.

BD135 *npn* medium power	37p
BD136 *pnp* medium power	39p

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OA90, OA91, OA95, **6p** each; OA200, **9p**; OA202, **9p**. Other semiconductors: AC128, **17p**; AF117 **34p**; BFY51, **20p**. Full lists and technical data will be found in Catalogue. Ready now.

ZENER DIODES full range E24 values: 400mW: 2·7V to 36V, **14p** each; 1W: 6·8V to 82V, **21p** each: 1·5W: 4·7V to 75V, **48p** each. Clip to increase 1·5W rating to 3 watts (type 266F) **4p**.

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MT3 30V/2A plus 4 taps	£3·35
MT103 50V/1A plus 4 taps	£3·05
MT104 50V/2A plus 4 taps	£4·20
MT127 60V/2A plus 4 taps	£4·50
13TO5 13V/½A, CT	£1·38
28TO5 12 + 12V, 2–0–2V	£1·70

BAXANDALL SPEAKER KIT

As designed by P. J. Baxandall and described originally in "Wireless World." Simple to assemble, fantastically good results and a greater money saver. Carries 10 watts RMS. 15 ohms impedance. Size 18in x 12in x 10in. Complete kit, including pack-flat cabinet, **£14·90**

The size and weight of this product obliges us to charge 70p part cost of carr. in U.K.

Equaliser Assembly, **£2·30**.

Loudspeaker Unit 59RM109, **£2·45**.

Cabinet Kit (to Baxandall design), **£10·45**.
Cross-over choke included in full kit above **£1·30**.

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30151F seven segment, filament, compatible with standard logic modules.
0 to 9, + decimal point. 9mm characters. In 16 lead DIL.

Some alphabetical symbols available	£1·20
Suitable BCD decoder driver 7447	£1·15
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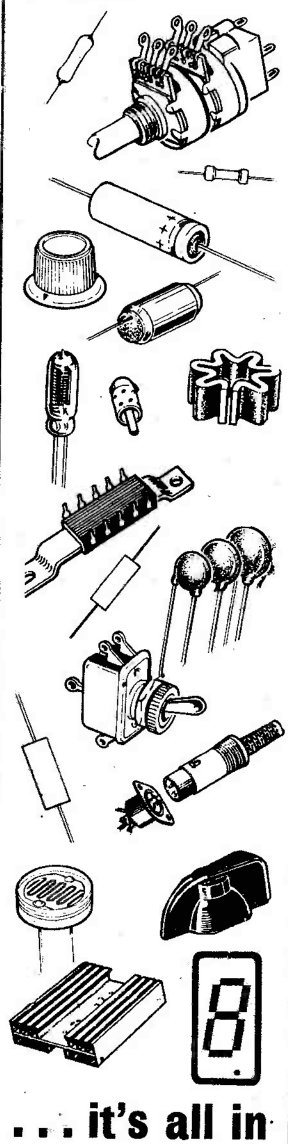

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ELECTROLYTIC CAPACITORS
Axial Lead

Rated volt.: Capacity μF	3V	6·3V	10V	16V	25V	40V	63V	100V
0·47	—	—	—	—	—	—	11p	8p
1·0	—	—	—	—	—	11p	—	8p
2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	8p
10	—	—	—	—	8p	9p	8p	8p
22	—	—	8p	—	9p	8p	8p	10p
47	8p	—	9p	8p	9p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	19p
220	8p	8p	9p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	15p	18p	23p	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
10,000	42p	46p	—	—	—	—	—	—

POTENTIOMETERS

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SINGLE P20 lin. 100 Ω to 2·2M Ω **14p**.
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JP20 log. 4·7K Ω to 2·2M Ω, **48p**.

DUAL GANG lin. 4·7K Ω to 2·2M Ω, **42p**.
Dual log. 4·7K Ω to 2·2M Ω, **48p**.
Log/antilog, 10K, 22K, 47K, 1M Ω only, **48p**.
Dual antilog. 10K only, **48p**.
Any type with 2A D.P. mains switch, **14p** extra.
Only decades of 10, 22 and 47 available in ranges quoted.

DUAL CONCENTRIC DP20 in any combination of P20 values, **69p**; with switch, **83p**.

SLIDER
Lin. or log. 10K to 1 meg. in all popular values, each **30p**.

CONTROL KNOBS blk./white/red yel./gr./blue/dk. grey/lt. grey, **6p** each. Escutcheon plates, black, white **10p**.

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Small high quality, PR lin. 100 Ω, 220 Ω, 470 Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M2, 5M, 10M Ω. Vertical or horizontal mounting, **6p** each.

RESISTORS—10%, 5%, 2%

Code	Power	Tolerance	Range	Values available
C	1/20W	5%	82 Ω–220K Ω	E12
C	1/8W	5%	4·7 Ω–470K Ω	E24
C	1/4W	5%	4·7 Ω–10M Ω	E12
C	1/2W	5%	4·7 Ω–10M Ω	E24
C	1W	5%	4·7 Ω–10M Ω	E12
MO	1/2W	2%	10 Ω–1M Ω	E24
WW	1W	10% ±1/20 Ω	0·22 Ω–3·9 Ω	E12
WW	3W	5%	1 Ω–10K Ω	E12
WW	7W	5%	1 Ω–10K Ω	E12

Code	1–9	10–99 (see note below)	100 up*
C	9	8	7·5
C	1	0·9	0·75 nett
C	1	0·9	0·75 nett
C	1·2	1	0·95 nett
C	2·5	2	1·6 nett
MO	4	3	2 nett
WW	7	7	6
WW	7	7	6
WW	9	9	8

Codes: C—carbon film, high stability, low noise.
MO—metal oxide, Electrosil TR5, ultra low noise.
WW—wire wound, Plessey.

Values:
E12 demotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions of one penny on total value of resistor order.) *Prices apply to units of 100 only.

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Prices quoted here do not include Value Added Tax. Orders from U.K. customers must be accompanied by an additional amount equal to 10% of the total nett value of the order, including cost of carriage or postage where charged.

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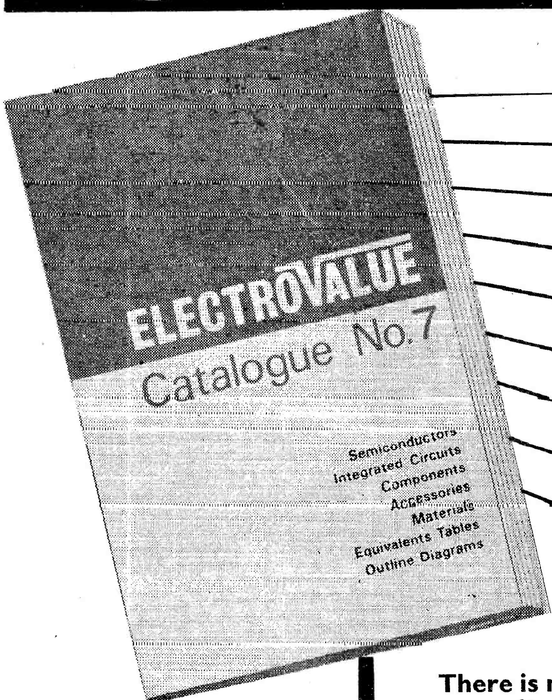

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1B3GT	.52	6BS7	1.40	6R7M	.75	20P1	.55	5763	2.00	EBF83	.43
1H5GT	.65	6BW6	.85	6SA7	.44	20P3	.80	7475	1.00	EBF89	.30
1L4	.14	6BW7	.66	6SC7GT	.33	20P4	.88	AC/PEN	.98	EBL21	1.50
1N5GT	.65	6BZ6	.49	6SH7	.44	20P5	1.30	AC2/PEN/		EC86	.59
1R5	.38	6CB6A	.40	6SK7GT	.44	25A6G	.38	DD	.98	EC88	.59
1S4	.33	6C4	.28	6SQ7GT	.38	25L6G	.50	AC6PEN	.38	EC92	.45
1U4	.65	6C9	1.25	6V6G	.17	25Y5G	.70	AC/TH1	£1	ECC33	1.50
1U5	.90	6CD6G	.80	6V6GT	.38	25Z4G	.33	AL60	1.00	ECC35	.95
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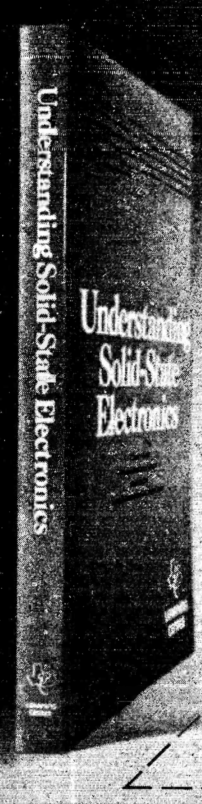
2GK5	.55	6CH6	.60	6X5GT	.28	25Z6G	.70	AZ1	.60	ECC81	.29
3A4	.42	6CL6	.55	7B6	.75	28D7	1.00	AZ31	.60	ECC82	.28
3D6	.19	6CM7	.75	7B7	.50	30A5	.65	AZ41	.65	ECC83	.28
3Q4	.49	6CU5	.75	7H7	.75	30C15	.75	CL33	1.50	ECC84	.30
3Q5GT	.55	6CW4	.70	7R7	1.50	30C17	.90	CV63	.53	ECC85	.36
3S4	.33	6DE7	.75	7Y4	.65	30C18	.73	CY1C	1.00	ECC86	.85
4CB6	.55	6DT6A	.75	7Z4	.80	30F5	.85	CY31	.45	ECC88	.44
5CG8	.55	6EW6	.75	9D7	.65	30FL1	.75	DAF91	.30	ECC189	.53
5T4	.30	6E5	1.00	10C2	.65	30FL2	.75	DAF96	.44	ECC804	.60
5U4G	.30	6F1	.70	10DE7	.55	30FL12	1.00	DF91	.30	ECC807	1.00
5V4G	.54	6F6G	.50	10F1	.50	30FL13	.55	DF96	.44	ECF80	.34
5Y3GT	.99	6F13	.55	10F9	.65	30FL14	.85	DH63	.60	ECF82	.34
5Z4G	.35	6F14	.75	10F18	.55	30L15	.75	DH76	.45	ECF86	.75
5Z4GT	.35	6F18	.55	10LD11	.70	30L17	.70	DK40	.70	ECF804	
6/30L2	.60	6F23	.85	10P13	.70	30P4MR		DK92	.70		2.10
6A8G	1.25	6F24	.85	10P14	2.00		1.00	DK96	.55	ECH21	1.50
6AC7	.49	6F25	1.00	12A6	1.00	30P12	.80	DL92	.33	ECH35	.65
6AG5	.27	6F28	.70	12AC6	.65	30P19/		DL96	.44	ECH42	.70
6AH6	.50	6F32	.65	12AD6	.65	30P4	.75	DM70	.44	ECH81	.30
6AJ5	.75	6GH8A	.75	12AE6	.65	30PL1	.66	DM71	2.00	ECH83	.44
6AK5	.34	6GK5	.65	12AT6	.35	30PL13	.75	DY87/6	.30	ECH84	.44
6AK6	.60	6GU7	.75	12AU6	.45	30PL14	.80	DY802	.33	ECL80	.40
6AM8A	.55	6H6GT	.18	12AV6	.40	30PL15	.95	E80CC	1.65	ECL82	.34
6AN8	.49	6J5GT	.32	12BA6	.30	35A3	.65	E80F	1.20	ECL83	.57
6AQ5	.40	6J6	.25	12BE6	.38	35D5	.75	E83F	1.20	ECL84	.60
6AR5	.55	6J7G	.30	12BH7	.27	35L6GT	.55	E88CC	.80	ECL85	.60
6AS7	1.00	6J7(M)	.38	12J7GT	.55	35W4	.33	E92CC	1.00	ECL86	.40
6AT6	.33	6JU8A	.75	12K5	.95	35Z4GT	.42	E180F	1.00	EF22	1.50
6AU6	.30	6K7G	.19	12K7GT	.38	35Z5GT	1.00	E182CC	1.00	EF40	.60
6AV6	.33	6K8G	.35	12Q7GT	.45	50B5	.85	E1148	.53	EF41	.70
6AW8A	.65	6LI	2.00	12SC7	.50	50C5	.45	EA50	.27	EF42	.55
6AX4	.55	6L6GT	.58	12SG7	.38	50CD6G	1.25	EA76	1.00	EF73	1.50
6B8G	.30	6L7	2.00	12SH7	.35	50EH5	.55	EABC80	.30	EF80	.26
6BA6	.28	6L18	.49	12SJ7	.44	50L6GT	.65	EAC91	.75	EF83	.60
6BC8	.60	6L19	2.00	12SQ7	.65	85A2	.60	EAF42	.50	EF85	.34

EF86	.30	HN309	1.40	PL81A	.55	UF89	.38	AC128	.22	BC115	.17	OA85	.09
EF89	.27	HVR2	.53	PL82	.37	UL41	.65	AC132	.22	BC116	.28	OA90	.14
EF91	.30	HVR2A	.53	PL83	.39	UL84	.38	AC154	.28	BC118	.25	OA91	.10
EF92	.30	KT2	.50	PL84	.33	UM80	.44	AC156	.22	BCY10	.50	OA95	.10
EF98	.80	KT41	.98	PL504/500		UY41	.49	AC157	.28	BCY12	.55	OA200	.10
EF183	.29	KT44	.75		.67	UY85	.38	AC165	.28	BCY33	.22	OA202	.11
EF184	.32	KT66	2.40	PL508	.90	U10	1.00	AC166	.28	BCY34	.25	OC22	.42
EH90	.45	KT81	2.00	PL509	1.15	U12/14	1.00	AC168	.42	BCY38	.25	OC23	.42
EL32	.50	KTW61	£1	PL802	.95	U19	1.73	AC176	.61	BCY39	.28	OC24	.42
EL34	.54	KTW62	£1	PY33/2	.50	U25	.65	AC177	.31	BCZ11	.42	OC25	.42
EL35	1.00	MHLD6	£1	PY81	.31	U26	.60	ACY17	.28	BF158	.32	OC35	.35
EL37	1.00	P61	1.00	PY82	.25	U191	.70	ACY18	.22	BF159	.28	OC36	.47
EL41	.66	PABC80	.38	PY83	.33	U251	.80	ACY19	.21	BF163	.22	OC44	.11
EL81	.60	PC86	.60	PY88	.33	U301	.58	ACY20	.20	BF173	.42	OC45	.12
EL83	.55	PC88	.60	PY500	.80	U403	.75	ACY21	.21	BF180	.33	OC46	.17
EL84	.23	PC95	.75	PY500A	.80	U404	.49	ACY22	.17	BF181	.44	OC70	.14
EL85	.40	PC97	.45	PY800	.31	U801	.76	ACY28	.20	BF185	.44	OC71	.12
EL86	.38	PC900	.45	PY801	.31	U4020	.55	AD140	.40	BF194	.17	OC72	.12
EL91	.38	PCC84	.40	PZ30	.48	VP23	.75	AD149	.55	BFY50	.25	OC74	.25
EL95	.39	PCC85	.44	QQV03/10		VP41	.75	AD161	.50	BFY51	.21	OC75	.12
EL360	1.20	PCC88	.60		1.20	VU133	.35	AD162	.50	BFY52	.22	OC76	.17
ELL80	1.00	PCC89	.50	QS75/20	£1	W107	.65	ADT140	.69	BY100	.20	OC77	.30
EM80	.40	PCC189	.53	QS95/10	£1	W729	.75	AF106	.55	BY105	.20	OC78	.17
EM81	.40	PCF80	.28	QV04/7	£1	X65	.65	AF114	.28	BY114	.20	OC78D	.17
EM83	.55	PCF82	.33	R19	.38	X66	.65	AF115	.17	BY126	.17	OC81	.12
EM84	.40	PCF84	.59	TH233	.98	**Transistors**		AF117	.21	BY127	.20	OC81D	.12
EM85	1.00	PCF86	.55	TP2620	.98	**& Diodes**		AF121	.33	BYZ10	.28	OC82	.12
EM87	.68	PCF200	.67	UABC80	.33	2N404	.20	AF124	.28	BYZ11	.28	OC82D	.12
EMM803	£2	PCF801	.48	UAF42	.55	2N966	.58	AF125	.19	BYZ12	.28	OC83	.22
EY51	.40	PCF802	.50	UBC41	.53	2N1756	.55	AF126	.20	BYZ13	.28	OC84	.26
EY81	.40	PCF806	.70	UBC81	.45	2N2147	.94	AF139	.72	CG12E	.22	OC123	.25
EY83	.54	PCH200	.70	UBF80	.38	2N2297	.25	AF178	.75	GD9	.22	OC139	.25
EY84	.70	PCL82	.32	UBF89	.35	2N2369	.24	AF180	.53	GET113	.22	OC169	.25
EY87/6	.33	PCL83	.54	UBL21	.77	2N2613	.43	AF186	.61	M1	.17	OC172	.39
EY88	.40	PCL84	.38	UC92	.45	2N3053	.36	BA115	.15	OA5	.31	OC200	.24
EZ40	.55	PCL805/85		UCC84	.75	2N3121	2.75	BA116	.28	OA9	.14	OC201	.42
EZ41	.50		.55	UCC85	.38	2N3703	.21	BA129	.14	OA10	.47	OC203	.33
EZ80	.24	PCL86	.47	UCF80	.65	2N3709	.22	BA130	.11	OA47	.11	OC204	.33
EZ81	.25	PD500	1.44	UCH21	.66	2N3988	.55	BA153	.17	OA70	.17	OC205	.47
GY501	.75	PEN45	.80	UCH42	.65	2S323	.55	BC107	.14	OA73	.17		
GZ32	.54	PEN46	.20	UCH81	.38	AA119	.17	BC108	.14	OA79	.10		
GZ33	1.00	PEN453DD		UCL82	.38	AA120	.17	BC113	.28	OA81	.10		
GZ34	.57		2.00	UCL83	.60	AA129	.17						
GZ37	.67	PENDD-		UF41	.70	AAZ13	.20						
HABC80	.44	4020	2.00	UF42	.70	AC107	.17						
HL23DD	.75	PL33	.40	UF80	.35	AC113	.28						
HL41DD	£2	PL36	.55	UF85	.44	AC126	.14						
HL42DD	.70	PL81	.44	UF86	1.00	AC127	.19						

MATCHED TRANSISTOR SETS:—
LP15 (AC113. AC154. AC157. AA120) ·58p per pack. 1—OC81D & 2—OC81, **47p.** 1—OC44 & 2—OC45, ·47p. 1—OC82D. & 2—OC82 ·53p. Set of 3—OC83 ·72p.

VALVES ALSO REQUIRED FOR CASH. LOOSE OR BOXED, BUT MUST BE NEW. OFFERS MADE BY RETURN.

All goods are unused and subject to the standard 90 day guarantee. Cash or cheque with order only. Despatch charges:—Orders below £5, add 10p per order up to three items, each additional item 3p extra. Orders between £5 and £10 add 25p total. Orders over £10 are post free. Same day despatch by first class mail. Any parcel insured against damage in transit for only 3p order extra. Terms of business free on request.
Business hours Mon.-Fri. 9–5.30 p.m. Closed 1–2 p.m. and Sats. We do not handle seconds or rejects, which are often described as "New and Tested" but have a limited and unreliable life. No enquiries answered unless S.A.E. is enclosed for reply. No overseas orders accepted.



Understand Solid State Electronics?

Quite possibly you do – it's also quite possible your knowledge is not as broad as it might be and probably you're keen to fill in the gaps.

Whatever the extent of your knowledge in this fast-moving technology, it's a fair bet that this little book can help you find a few missing answers.

Designed for anyone who wants (or needs) to understand how semiconductors work and how they work together in solid state electronic systems, this book takes the reader through a 12-lesson, self-teaching course written in layman's language.

The course, complete with quizzes and glossaries covers basic theory and use of diodes, transistors, thyristors, optoelectronic devices. It also covers logic and bipolar, MOS and linear integrated circuits.

Texas Instruments, acknowledged leaders in the field of semiconductor technology originally produced "Understanding Solid State Electronics" as a 12-hour videotape presentation. Such was the response to the course for a back-up text book that this 242-page volume was published. Now available in the U.K. for the first time, "Understanding Solid State Electronics" priced at £1.20 (inc. p & p) gives a comprehensive treatment of electronics without assuming any prior knowledge of electronics or mathematics.

Complete the order coupon below, mail it with your remittance to Data Sales, M.S.21, Texas Instruments Limited, Manton Lane, Bedford, and your copy of "Understanding Solid State Electronics" will be despatched by return.

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Please send me . . . . copy(ies) of Understanding Solid State Electronics at £1.20 each (inc. p & p) (Cheques should be made payable to Texas Instruments Limited)

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Can you really get sound quality like this FOR LESS THAN £19? YES, YOU CAN! WITH THE NEW

STEREO 21

Until now, richly satisfying sound has always cost a richly satisfying price. *But not any more!* For an almost unbelievable **£18·45,** you can have Stereo 21—audio for the connoisseur! Whatever your taste in music, you can hear it on STEREO 21 the way its composers heard it in their dreams! Beethoven or Mahler . . . Ellington or Jellyroll Morton . . . Das Nibelung or Jesus Christ Superstar . . . Carols from King's College Chapel or the return of a Beatle . . . everything from a prettily fluting baroque organ to the newest pop group at full throttle—STEREO 21 does them all justice!

And have you ever seen a handsomer audio installation? Compact enough to go in a university student's bedroom-study, elegant enough for the suavest penthouse pad in Town, STEREO 21 offers you all the pride of possession as well as a thrilling musical experience!

Top-quality amplifier, BSR turntable, matching speakers. Deck and speaker cabinets you simply wrap round and glue to build. Screw in the amplifier and connect up (all push fit no soldering whatsoever), so simple literally anyone can do it. Except for glue and panel pins all parts supplied including full instructions—all for £18·45 (plus the cost of post and packing if you buy by mail), and—to round it all off—a money refund if not satisfied if your pleasure in STEREO 21 is not complete!

Just think—in only a few days you could be giving your ears the treat of a lifetime—AND introducing your envious friends to STEREO 21 !

Power Output 2·7 Watts per channel and headphone socket with automatic cut out provision for auxiliary inputs—radio, tape, etc. and output for taping discs. Overall Dimension: Speakers approx. $15\frac{1}{2}'' \times 8'' \times 4''$. Complete deck and cover enclosed position approx. $15\frac{1}{2}'' \times 12'' \times 6''$.

Personal shoppers and mail order price

£18·45 INCLUDING VAT plus £1·60 p + p.

Diamond stylii, if required, £1·37 extra

Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance, if required £3·85.

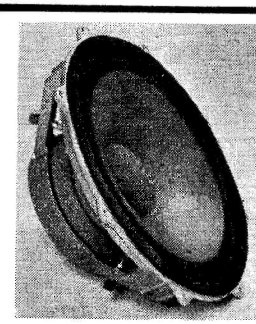
EMI SPEAKERS AT UNBELIEVABLE PRICES

950 Kit. Five matched speakers and crossover unit for handling up to 45 watts, from 20 to 20,000 Hz. Huge – 19" x 14" (approx.) high efficiency 16, 500-gauss bass unit built on a heavy diecast frame. The four 10,000 gauss tweeters, each $3\frac{1}{4}''$ dia. approx., are fed by the crossover with a critically adjusted signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2", others 0·5". Recommended list price £44·00.

OUR PRICE £25·00 £1·50 p & p

15" 14A/780. Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS, and is treated to give a smooth frequency response. Resonance 30 Hz. Fluse 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3" voice coil. Rec. retail price £40·80.

OUR PRICE £18·70
£1·50 p & p



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RTVC VISCOUNT III

a boost in the output,

VISCOUNT III now gives you an imposing 20 watts per channel—and the price quoted is actually INCLUSIVE OF VAT!

The money's important, of course, but not nearly so important as *value for money!* And that's something you get in abundance with VISCOUNT III. We design it . . . we make it . . . we sell it direct to you—passing on all the economies that come from cutting out middle-men! That's the only way you can get so much quality for so little money!

The unique VISCOUNT III amplifier, plus the Garrard SP25 Mk III deck, plus the magnificent Duo Type III matched speakers (or Duo Type II for a small room) give you an audio installation that will prove unbeatable for listening pleasure! And the teak finish will harmonise and enhance virtually any style of interior decor! On the brushed aluminium front panel of the amplifier you'll find all the facilities you need—volume, bass, treble and balance controls, plus switches for mono/stereo, on/off function and bass and treble filters. Plus headphone socket on the back.

The heart-stopping timbre of Tom Jones at his most virile . . . the last lingering harmonics of a solo performance by Heifetz or Menuhin. . . , the pathos and the panache of Liza Minelli . . the majestic sonorities of the brass band and the elfin subtleties of the virtuoso clavichordist—hear every nuance with a fidelity that you have *never* experienced before!

Come and hear VISCOUNT III! If it's inconvenient to travel, buy by post in the confidence that you won't be disappointed (and with a 24-carat Money-Back Guarantee to give you extra reassurance). Don't settle for second-best!

SPEAKERS: **Duo Type II** Size approx. 17in $\times$ $10\frac{1}{4}$in $\times$ $6\frac{1}{4}$in. Drive unit 13in $\times$ 8in with parasitic tweeter. Max. power 10 watts 8 ohms. Simulated Teak cabinet. £14·00 a pair + £2·20 p. & p. **Duo Type III** Size approx. $23\frac{1}{2}$in $\times$ $11\frac{1}{2}$in $\times$ $9\frac{1}{2}$in. Drive unit approx $13\frac{1}{2}$in $\times$ $8\frac{1}{4}$in with HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. £32·00 a pair + £3·30 p. & p.

STILL ONLY £49 COMPLETE

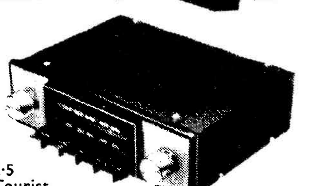
PRICES : SYSTEM 1

Viscount III R102 amplifier	£24·20 + £1 p & p
2 Duo Type II speakers	£14·00 + £2·20 p & p
Garrard SP25 Mk III with MAG. cartridge /plinth & cover	£18·00 + £1·75 p & p
total	£56·20
Available complete for only	**£49·00** + £3·50 p & p

PRICES : SYSTEM 2

Viscount R102 amplifier	£24·20 + £1 p & p
2 Duo Type III speakers	£32·00 + £3·30 p & p
Garrard SP25 Mk III with MAG cartridge plinth & cover	£18·00 + £1·75 p & p
total	£74·20
Available complete for	**£65·00** + £4 p & p

THE TOURIST PUSH-BUTTON CAR RADIO KIT £6·60



The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. It is permeability tuned and sturdily constructed. Output is a full 2·5 watts into an 8 ohms speaker. But the Tourist PB will operate into any loud-speaker from 8 to 15 ohms.

Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulised IF stages which are pre-aligned before despatch. As well as electronic components this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.

The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale. Chassis size is: 7in wide, 2in high and $4\frac{3}{16}$in deep. Circuit diagram and comprehensive instructions 55p free with parts.

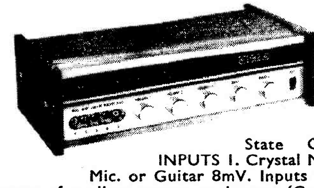
Fully retractable and lockable car aerial £1·37 post paid.

CAR RADIO KIT £6·60 p. and p. 55p. Speaker with baffle and fixing strips £1·65, + 23p p. & p. post free if bought with the kit. Send stamped addressed envelope for leaflet.

If you can solder on printed circuit board, you can build this push-button car radio kit. It's simple—just follow the step-by-step instructions.

RELIANT Mk IV

MONO AMPLIFIER

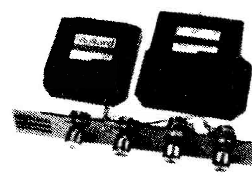


*5 Electrically Mixed inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.

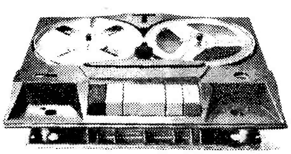
INPUTS 1. Crystal Mic or Guitar 9mV. 2. Moving coil Mic. or Guitar 8mV. Inputs 3, 4 & 5 are suitable for a wide range of medium output equipment (Gram, Tuner, Monitor, Organ, etc.) All 250mV sensitivity. Output 20 watts into 8 Ω (suitable for 15 Ω.) Size approx. $12\frac{1}{2}$ x 6 x $3\frac{1}{2}$ ins. **£13·50** p. & p. 60p

UNISOUND MODULES

ONLY £7·64 + 55p. p & p

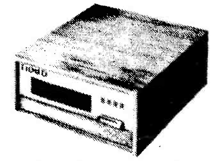


For the man who wants to design his own stereo—here's your chance to start, with Unisound—pre-amp, power amplifier and control panel. No soldering—just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic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



PE TAPE LINK CONSTRUCTORS

Suitable 3 speed tape deck, **less heads.** Caters up to $5\frac{3}{4}$ins. spools. 240V AC mains. Unused but store soiled hence no warranty. **£4.00** £1 p. & p.



IN-CAR ENTERTAINMENT AT HOME

With this elegant stereo 8 track add on unit, audio enthusiasts now have the opportunity to extend their systems to include the playing of 8 track cartridges. Simply select your channel, by push button, four digital lamps indicate channel selected. The Viscount III, the fabulous Stereo 21 and the Unisound Modules will accept this unit, simply connect up. **£10·60** + 90p. p. & p.

SEE OPPOSITE PAGE FOR ADDRESS DETAILS

DIAGNOSIS

OF all the constructional projects that you can possibly think of, which do you think would attract the least interest? Before you answer, take a look at our contents page this month and you will very likely find a clue. It is probably understandable that test equipment does not reach the realms of glamour in most constructors eyes, perhaps because it does not perform an entertaining function. But if you are always looking for entertainment you will be missing out on the "nitty-gritty" of the true do-it-yourselfer.

What does test equipment conjure up in your mind on first impact; a box of knobs, dials and meters, a standard performance by which your other projects are compared, or a dull boring necessity to the spectrum of your fullest activities? All of these are confirmed to us by readers who write to us asking for guidance in fault-finding or setting-up.

If you have test gear, that's fine; if you bought it ready made, you should know what it can do for you. Most of all its performance and/or limitations must be compatible with your requirements.

There are areas, however, that are either too specialised or require only occasional application of test gear, making the cost of outright purchase too high. This is where the constructor comes into his own.

This issue of *Practical Wireless* takes a look at some test equipment and next month starts a series that will help you to obtain the most from oscilloscopes. Some simple add-on circuitry is often useful and we will be publishing some ideas later with constructional details. Also in this issue is the second part of the "Trouble Tracer" which will be valuable for those who like to cure faults on a wide range of radio and audio equipment.

Of special interest is the stabilised 30 volt power supply, designed for transistor and i.c. circuitry; this is invaluable as a workshop "tool" or as a standby supply in the event of failure in other equipment. We also have a neat little unit that can be used for testing Zener diodes, and next month's issue will include a signal generator providing square, pulse and triangular waveforms.

Test equipment presents an art of its own, the brick wall on which much other equipment likes to lean. It is security to the "home-brew" and peace of mind to the constructor. It has even been described as the difference between furrowed brows and inspired genius—possessing a magical potion that cannot be obtained on doctor's prescription. Probably the greatest asset of test gear is its usefulness as an electronic doctor, diagnosing symptoms and dispensing strange "noises". You, the constructor, are the surgeon.

M. A. COLWELL—*Editor*.

The March issue will include P.W. CRATA; a waveform generator providing square, pulse and triangular waveforms; a second channel interference rejector (or pre-selector) for 10 to 30 MHz; P.W. Datacards nos. 7 and 8; a crystal calibrator and the start of our series on using oscilloscopes. We apologise that this latter feature could not be started in this issue due to an overwhelming demand on our space.

Further details on page 967

NEWS...

Tandy's here!

A massive American operation called Tandy is now installed at their new warehouse premises just north of Birmingham. Tandy aims to acquire retail outlets and issue franchises to sell its own branded audio, electronic components and kits.

Their optimism in the face of the existing competition is to be admired, but has already caused some component suppliers to beware of the power of the financial backing of Tandy. For readers of this magazine, they offer a very wide range of components, and goods in the domestic electronics field were packed in wooden crates originating from Taiwan. The shop at the front of the warehouse was large and a browser's paradise. Our reporter, however, arrived with some degree of concern for the British businessmen; even the launching festivities did not deter him from talking to the Area Sales Manager in the shop. Whilst the components side of the business was our main interest, we were surprised to find that "bubble-pack" cards bearing American prices had also been priced in Sterling. A glossy catalogue shows only a part of the range, and readers who acquire one will be surprised to find component prices so much higher than in most British concerns.

Our reporter concluded that Tandy must belatedly study the British market or think again.

Sonex 74—Latest

THE Sonex, high fidelity exhibition, will be at the Post House Hotel, London Airport, from March 29 to 31st.

The Post House is ideally situated to the M4 Motorway and the airport giving easy access to overseas and British visitors. The organisers, British Audio Promotions Limited, confidently expect that they will be able to provide adequate car parking facilities close by.

NEWS... NEWS... NEWS...

IMPORTANT MESSAGE TO ALL READERS

Readers of "Practical Wireless" and most other magazines will be aware of the restrictions imposed by the Government and as a result of Trades Union action in various industries. To ensure that you receive your copy of "Practical Wireless" at the earliest possible date, we have to rely on effective communications and delivery through the post and by railway. We also depend on the operation of electrical equipment and printing machinery. Petrol and diesel oil are vital to the needs of our job in quick and effective processing of editorial and advertising material.

We are sure that you will understand the many problems that confront all of us. We therefore request your patience and understanding during any temporary period when publication may be delayed.

It would help you and us enormously if you make sure of ordering your copy of "Practical Wireless" in advance. We try to help you by telling you a little of what will be published in the next issue and what you can expect in future issues of P.W.

Electronic aid for the disabled

ABOUT five years ago, Toby Churchill—a qualified mechanical engineer working for Lucas—contracted an unidentified virus disease which left him with a number of disabilities. These include a complete loss of the power of speech and a paralysed right arm.

He conceived the idea of a portable electronic device which would enable him to communicate with others easily and set about the task of putting his idea into practice. After reviewing the electronic components available, he knew that his ideas were not just a pipe dream but a practical possibility. The Engineering Department at Cambridge University heard of Toby's ideas and agreed that they would form the basis of a worthwhile project.

Very quickly the ideas became reality. A typewriter-like keyboard was coupled to a Burroughs 'self-scan' display system. Circuits were designed to allow the unit to be powered from rechargeable batteries.

Toby now talks to people using the keyboard: the letters, words and numerals appear in a very easily-read form on the self-scan display panel.

A number of people assisted with the development of the unit—which has been called the Lightwriter—in many different ways. Burroughs, keyboard manufacturers, Cambridge University and Burroughs' UK agents, Walmore Electronics Ltd., all played their parts.

As a result of pressure from friends and acquaintances with similar disabilities, a company—Toby Churchill Ltd.—has been set up to manufacture the Lightwriter. The company has financial backing and production facilities, and it is expected that the first units will become available in the first half of 1974.

The heart of the Lightwriter is the self-scan display panel which is manufactured by Burroughs Corporation in America and available through the UK agents, Walmore Electronics Ltd. It was found that the self-scan display was the only display device available which successfully met all the Lightwriter's requirements.

The display unit consists of a long matrix of special gas-discharge tubes set in cavities. The display used in the Lightwriter has sufficient cavities to form 32 properly spaced alpha-numeric characters, each character being presented in a 5 x 7 dot matrix format.

British quad success

A BRITISH research team has developed a quadrophonic sound recording and reproduction system that could be an answer to the complex requirements of broadcasting quad while being adaptable to existing commercial systems. The work has been carried out at the University of Reading in collaboration with IMF, the broadcast monitor loudspeaker company, under sponsorship of the National Research Development Corporation.

In a communication from John Wright of IMF, the system describes a recording technology compatible with existing disc, tape and f.m. broadcasting and will be publicly demonstrated at the Sonex exhibition at the Post House Hotel, Heathrow Airport, in March. The system, called "ambisonics", is aimed at giving the listener the experience not only of the spacial disposition of the performers, but also of the directional qualities of the reverberant sound, thus extending the stereo medium beyond currently used stereo and quadraphonics.

A full account of information so far available has been written for *Practical Wireless* and appears in this issue.

Mid-Lanark A.R.C.

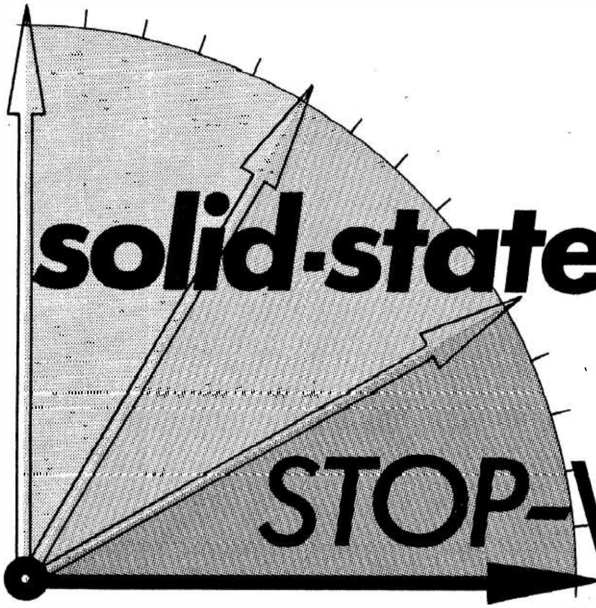
THE Mid-Lanark Amateur Radio Club have sent us details of their future programme. On 4th January they will have a lecture entitled "The Oscilloscope"—how it works and how to use it. A demonstration will be given by GM8DRQ.

On 1st February there will be an Amateur TV demonstration by GM6ADR/T.

Meetings are held at 7.30 p.m. in the Wrangholm Hall Community Centre, Jerviston Road, Motherwell.

Visitors will be made especially welcome and should 'phone D. H. Plumridge (Hon. Sec.) on Hamilton 28759 if further information is required.

solid-state STOP-WATCH



R. JEFFERSON

As its title suggests, this instrument was designed as an electronic alternative to a conventional stop-watch. The main design requirements were:—

(a) Good accuracy and reproducibility
(b) Simplicity
(c) Low cost

The low cost requirement ruled out a digital timer, so an analogue circuit was used. The final circuit gives three ranges, 0-5, 0-15 and 0-50 seconds, and the complete instrument including case and meter can be built for about £7.

THEORY

For a capacitor C charged to a voltage V, the charge Q is given by:—

$$Q = CV \quad \ldots\ldots(1)$$

However, assuming the capacitor was previously discharged, the charge Q is also equal to the integral of the current I with respect to time t:—

$$Q = \int I\,dt \quad \ldots\ldots(2)$$

If the charging current is held constant, this simplifies to:—

$$Q = It \quad \ldots\ldots(3)$$

Combining equations (1) and (3) gives:—

$It = CV$ and, rearranging, $t = \frac{C}{I} \times V$

If C and I are made numerically equal, the time in seconds can be read directly as a voltage. This forms the basis of the instrument.

CONSTANT-CURRENT GENERATOR

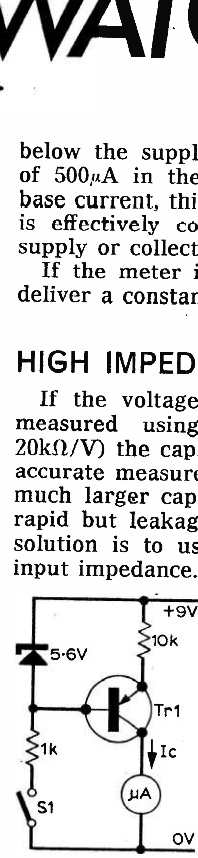
The basic circuit of a constant-current generator is shown in Fig. 1. With S1 open, no base current flows, and the current shown on the meter is the leakage current, which is so low as to be negligible.

When S1 is closed, current flows through the zener diode and the 1kΩ resistor, holding the base 5·6V below the supply voltage. Since Tr1 is now conducting, there is a drop of about 0·6V across the emitter-base junction, so the emitter is held constant at 5V below the supply voltage. This produces a current of 500μA in the 10kΩ resistor and, neglecting the base current, this is also the collector current, which is effectively constant in spite of changes in the supply or collector voltage.

If the meter is replaced by a capacitor, Tr1 will deliver a constant charging current.

HIGH IMPEDANCE VOLTMETER

If the voltage across a capacitor (say 250μF) is measured using a conventional voltmeter (say 20kΩ/V) the capacitor will discharge so rapidly that accurate measurements will be impossible. If a very much larger capacitor is used the discharge is less rapid but leakage currents become a problem. The solution is to use a voltmeter having a very high input impedance.



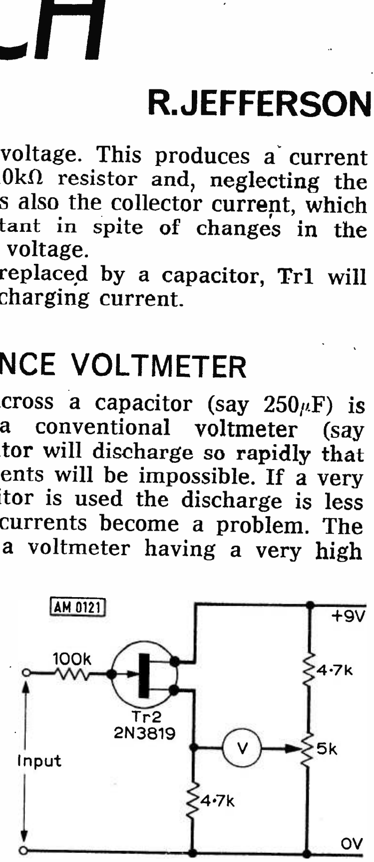


Fig. 1, left: Basic circuit of a constant-current generator. Fig. 2, right: Circuit of high impedance voltmeter.

The circuit is shown in Fig. 2. The FET gives an extremely high input impedance, of the order of 500MΩ so that the time-constant with a 250μF capacitor is about 35 hours! VR1 is used to set the voltmeter to zero when the input is short-circuited.

An interesting feature of this circuit is that the voltmeter does not indicate the absolute value of the input voltage but a proportion of it. However, since all measurements have this constant multiplier (about 0·9 in the prototype) no corrections need be made.

R1 has no effect during normal operation but gives some protection against switching transients.

The capacitor used must be large enough to allow the constant-current transistor to operate at a reasonable collector current but not so large that leakage currents are a problem. In the final circuit a value of 250μF was chosen. Then, with the current at 250μA, the voltage will reach 5V in 5 seconds.

FINAL CIRCUIT

The final circuit is shown in Fig. 3a. S1 is a 3-pole 4-way switch and is used as an on/off switch and a range selector. S1a connects the battery to the circuit while S1b allows three different currents to be preset. S1c, in conjunction with S3, replaces the capacitor C1 with a fixed resistor so that a calibration check may be made.

S2 connects the base circuit of Tr1 and allows a charging current in C1 to flow while it is closed. (Alternative methods of starting and stopping the timer are given later in the text.)

The diodes D1 and D2 act as a low votage zener diode and hold the base of Tr1 at about 1·2V below the supply voltage as part of the constant current generator.

S4 short-circuits the input to the voltmeter circuit and discharges the capacitor C1 if S3 is "Normal". While S4 is operated VR4 is adjusted so that the voltmeter reads zero.

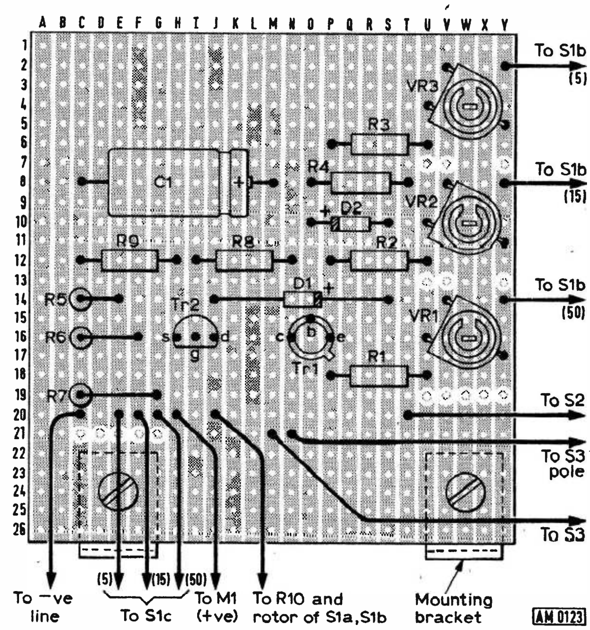


Fig. 3b: Layout of components on 0·1in matrix standard Veroboard. Remainder of components are located on front panel.

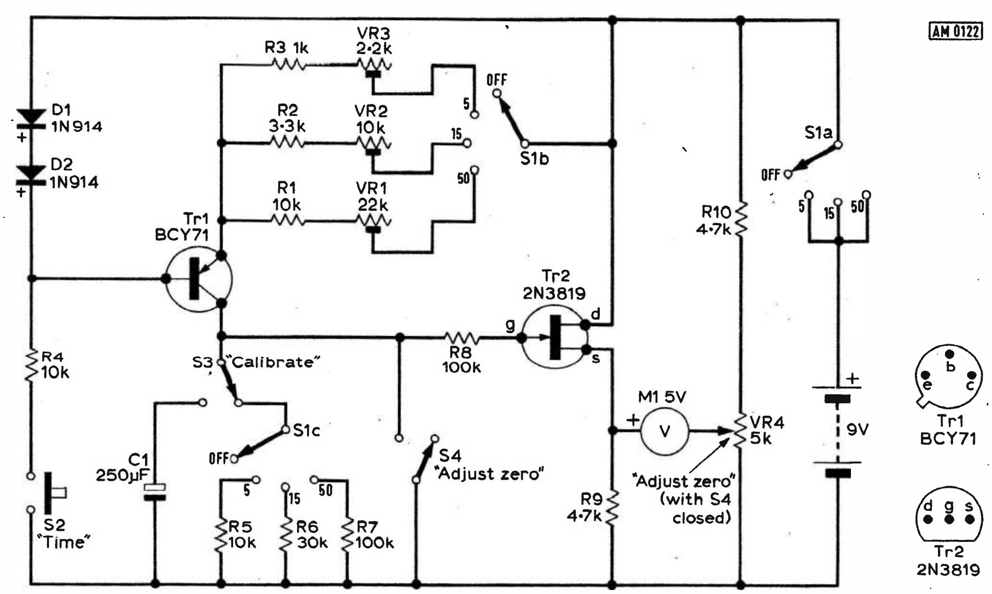


Fig. 3a: Complete circuit of the electronic stop-watch combining the circuits of Figs. 1 and 2.

CONSTRUCTION

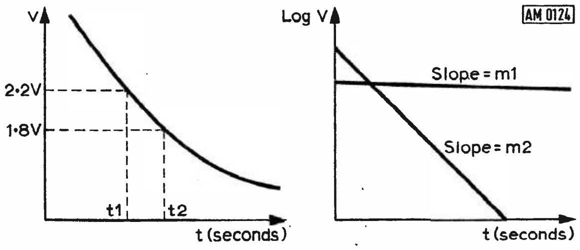
Layout is not critical, and the method of construction may be varied considerably. The prototype used an Elf instrument case which provides a smart and convenient housing.

The meter should be chosen for accuracy and readability. It need not be mounted in the case: a multimeter set to the 5V range and connected by flying leads would work perfectly well, although this arrangement might be rather cumbersome. With a 5V meter, the maximum overload that can occur to the meter is about 50%, which should not cause any damage.

CALIBRATION

C1 must first be checked for an acceptably low leakage current. S1 should be set to range 1 and the capacitor charged to about 4V. S2 should now be released and a note made of the voltage and the time. The voltage should be checked again 15 minutes later: it should be at least 90% of its original value. If the voltage has fallen below 90% the leakage current is too high and C1 must be replaced (although it may still be suitable for other circuits).

There are two methods of measuring the value of C1 given here, as alternatives.



Figs. 4 and 5: Graphs to illustrate the two methods of determining the value of C1.

Simple method

R11 should be temporarily wired across C1, and the capacitor charged to about 4V. When the charging current is stopped the voltage should fall faster than before. Plot a graph of voltage against time, taking readings every 15 seconds for 10 minutes.

Draw a smooth curve, Fig. 4, through the points and note the time in seconds at 2·2V and 1·8V, t_1 and t_2 respectively.

The value of C is given by $C=5(t_2-t_1)\mu F$.

Example. If $t_1=212$ seconds and $t_2=280$ seconds, C is 5 $(280-212)=340\mu F$.

For the mathematically minded, the theory of this method is as follows:—

At any instant t_1 the current through the resistor is given by $V/1M\Omega=V\mu A$.

For small changes in voltage, the exponential discharge may be considered linear with time, so that if the voltage falls from V_1 to V_2 the average current through R11 is $V_1+V_2/2\mu A$.

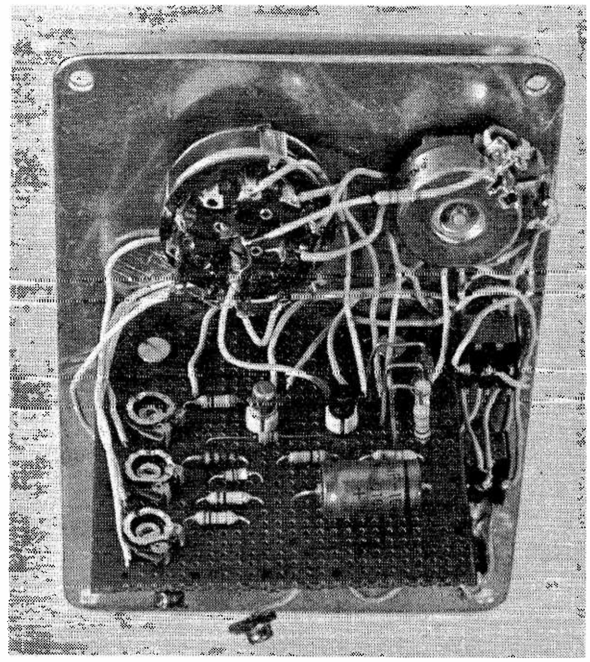
Hence the charge lost by C1 is $V_1+V_2/2\times t$.

But this is also equal to $C(V_1-V_2)$, therefore:—

$$C=\frac{V_1+V_2}{2\,(V_1-V_2)}\times t\,\mu F.$$

Although the purist may note that the average voltage is less than

$$\frac{V_1+V_2}{2}$$



Photograph of prototype showing Veroboard bolted to front panel and interconnecting wiring.

the effective discharge resistance is rather less than $1M\Omega$, due to leakage, and these two errors tend to cancel.

Accurate method

For this method a table of natural logarithms is required. If a capacitor C is charged to a voltage Vo and allowed to discharge through its leakage R, the voltage at time t is given by:—

$$V=Vo\ e^{\frac{-t}{CR}}$$

Taking logarithms to the base e:—

$$\log_e V=\log_e Vo-\frac{t}{CR}$$

Plotting $\log_e V$ against t gives a straight-line graph of slope $m_1=\frac{-1}{CR}$ (see Fig. 5).

R here represents the parallel combination of the capacitor leakage resistance and the input impedance of the FET voltmeter. A second graph is plotted with R11 in parallel with C1.

The effective resistance is now:—

$$\frac{R\times 1M}{R+1M}\text{ and the slope } m_2=\frac{-(1+R)}{CR}$$

where R is in $M\Omega$ and C is in μF.

Simple algebra shows that $C=\frac{1}{m_1-m_2}$

(Note that both m_1 and m_2 are negative, and that m_1 is the correction factor for leakage. The value of the leakage resistance is given by $R=(\frac{m_2}{m_1}-1)M\Omega$.

Whichever method is used, at least three "runs" should be plotted and an average taken to give the value of C. R11 should now be removed.

Next the constant-current ranges must be set. If the capacitor was measured as $390\mu F$, as in the prototype, the current on range 3 (0-5 seconds)

★ components list

Resistors:

R1 10kΩ 5%	R5 10kΩ 2%	R9 4·7kΩ 5%
R2 3·3kΩ 5%	R6 30kΩ 2%	R10 4·7kΩ 5%
R3 1kΩ 5%	R7 100kΩ 2%	R11 1MΩ 2%
R4 10kΩ 5%	R8 100kΩ 5%	

All resistors ¼W. The final calibration depends largely on the accuracy of R5, R6, R7 and R11, so use 2% or better. R11 is used only for calibration so does not appear in circuit diagrams.

VR1 22kΩ VR2 10kΩ VR3 2·2kΩ
All skeleton pre-sets
VR4 5kΩ potentiometer, linear

Semiconductors

Tr1 BCY71 Tr2 2N3819 D1/2 1N914

Miscellaneous

Capacitor C1, 250μF 16V, see text. Meter, 5VDC FSD (G. W. Smith Model SD640). Switch S1, 4 pole 3 way, break before make. S2 SPST, push-to-make. S3, SPCO biassed toggle. S4, SPST push-to-make. Veroboard. Battery PP3 and terminal clips. Knobs. Instrument case (West Hyde Developments).

should be set to 390μA. Switch S3 to CAL and adjust VR3 until the voltmeter indicates 3·90V. Now switch to range 2 and adjust VR2 until the voltmeter again reads 3·90V. Repeat using VR1 on range 1.

Finally operate S4 and check that the meter still reads zero. If the zero has drifted it must be re-adjusted using VR4, when VR1, VR2 and VR3 may all have to be reset.

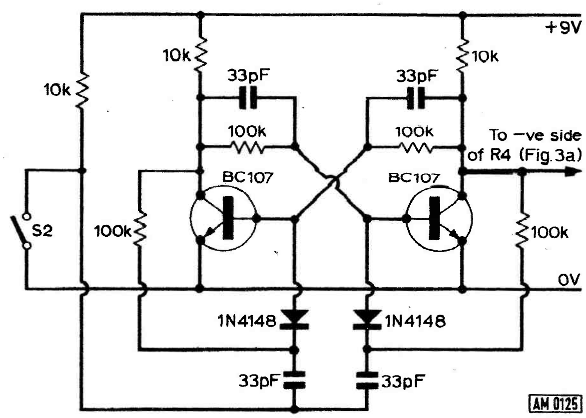


Fig. 6: Additional bistable switch circuit for long intervals, in place of S4.

As it would be rather inconvenient to hold S4 operated during timing, a bistable can be used so that S4 is pressed once to start, and again to stop timing. The circuit is given in Fig. 6.

It is worth remembering that electrolytic capacitors normally have a tolerance range of −50% to +100% so that the nominal 250μF capacitor may have an actual value from 125μF to 500μF

LIGHT OPERATION OF TIMER

Another idea that was used with the prototype was a bistable operated by light-dependent resistors, Fig. 7.

Two LDR's are used, type ORP12. Interrupting the light falling on LDR1 operates the bistable so that Tr2 is conducting, which turns the timer on.

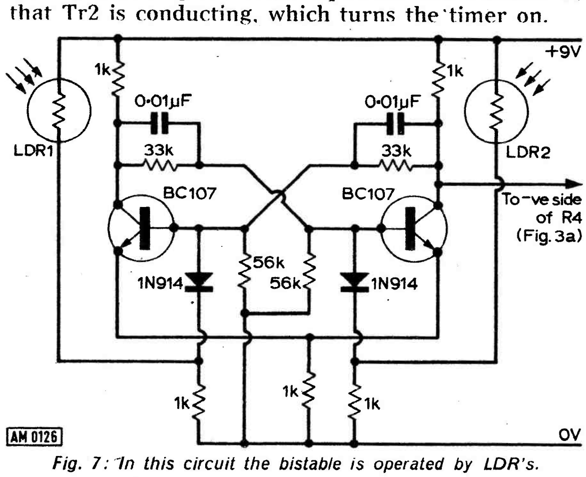


Fig. 7: In this circuit the bistable is operated by LDR's.

Interrupting the light to LDR2 restores the bistable so that Tr2 turns off. R8 may be altered to a lower value which will affect the sensitivity. It may be necessary to increase R6 and R7 to, say 100kΩ if low gain transistors are used. ■

I.C. OF THE MONTH

Number 43 — **Motorola MC1566L Constant-Current Source**

WHEN a constant-current source is required and the various advantages offered by the use of IC's are to be exploited, an input voltage limit of 40 or, possibly, 50V is normally necessary if the IC's are not to be damaged.

Neil Wellenstein, an applications engineer working in Motorola's Arizona laboratories, discovered a means of obtaining a variable constant-current supply with input voltages as high as 750V using a standard regulator IC. In fact, the input voltage is limited only by the breakdown voltage of the series-pass transistors employed.

Development

The IC used by Wellenstein was the MC1566L which has the ability to "float" on its own output voltage. However, when used conventionally, a voltage sensitive error occurs in the constant-current mode which is large enough to prevent the device from being used as a precision constant-current source. Normally the constant-current feature of the MC1566L would only be used to provide short circuit protection when the device is employed as a voltage regulator. The magnitude of the current error is small enough to be of no consequence in this application.

The MC1566 contains a current sensing and a voltage sensing amplifier which "float" on the output voltage and which are supplied from an on-chip regulator. The on-chip regulator receives its input from an auxiliary 25V supply external to the chip.

When used conventionally a constant 1mA flows from pin 3 through a resistor to earth to establish the reference voltage for the voltage sensing amplifier. The error voltage appears between pins 8 and 9. When the device goes into the current limit mode (short circuit conditions) part of the 1mA output from pin 6 can flow through a diode to pin 9 thereby upsetting the error voltage and producing a voltage sensitive output current error.

Practicalities

Wellenstein discovered that by reversing the roles of the voltage and the current sensitive amplifiers, he could eliminate this problem altogether. The accompanying drawing shows the circuit, Fig 1. The net effect is that any portion of the reference current that appears in the load must pass through the current sensing resistor R9 which cannot be bypassed as was previously the case.

The maximum input voltage to the circuit is

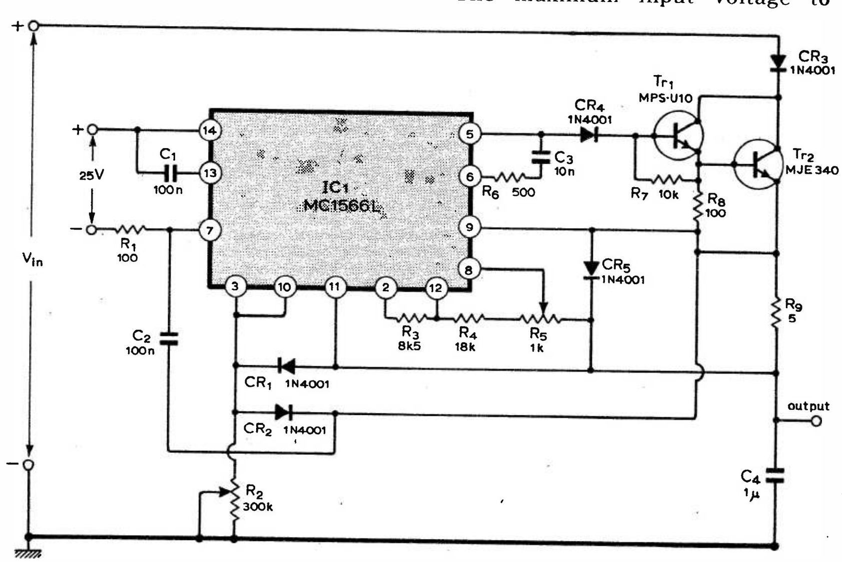


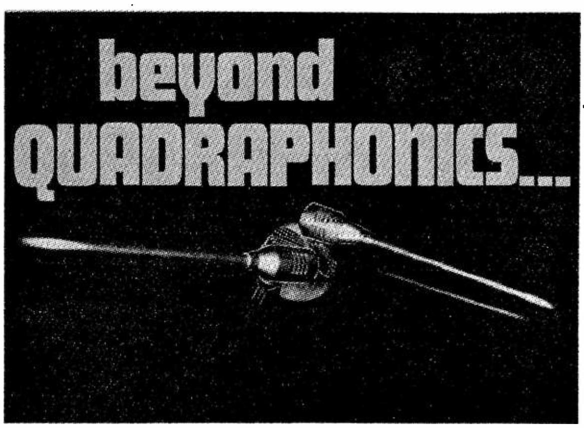
Fig. 1: Practical circuit of the constant-current sourcs fed from a high voltage supply.

—continued on page 950

TO record, without addition or loss, the total directional reverberant information of a live performance inherently needs a microphone technique responsive to the direction of arrival of the sound and capable of delivering this directional information in a format suitable for recording. Such microphones do not at present exist in a commercial form, but have been improvised using tetrahedral arrays of cardioid microphones in promising experiments by Michael Gerzon of the Mathematical Institute, University of Oxford.

An integrated microphone exhibiting these properties is under development with the assistance of Calrec Audio. Such a microphone will sense sounds from all directions, including those from above as well as from all around horizontally.

Sounds having a vertical component cannot be avoided, and the microphone must be designed to respond in a suitable manner so that this vertical information can either be retained or rejected electronically later in the system according to requirements. The signals generated from such a microphone could be amplified and fed directly to four loudspeakers, but *not* with these speakers positioned in the conventional square array.



Similarly the signals, for purposes of information storage, may be fed to a four-channel tape recorder, but again the resultant tape would not be directly suitable for conventional playback.

By the use of suitable decoders such a tape could be replayed through any number of loudspeakers purposefully arranged; these arrangements specifically including the commonly proposed four speaker array or two speaker stereo or even true mono.

This four track tape, or the signals direct from the microphone, may be encoded onto *two* channels of information in such a way that allows the original directional information to be in large measure decoded for multi-speaker playback. The two channel signal, be it on disc, cassette or f.m. radio, is directly suitable without decoding for stereo presentation a la Blumlein and with no more than the usual adverse compatibility to mono when the two channels are directly paralleled.

THREE CHANNEL ENCODING

The original four signals can also be encoded onto the three audio channels potentially available within the bandwidth of f.m. broadcasts, to provide marginal improvement particularly in phase relationship and mono/stereo compatibility. The use of a third channel on disc, possibly of reduced bandwidth, has been advocated by Prof. Duane Cooper of Illinois for similar reasons.

Finally, encoding the four signals onto four tracks of tape or a multiplexed disc such as the JVC-CD4 makes optimal use of the capabilities of four genuine audio channels and enables the full recovery of all information, including that of height, without phase anomalies. Demonstrably there are more versatile ways of employing four independent channels of information than merely feeding them to four loudspeakers.

COMPATIBLE QUAD

Certain of the commercial 'quadraphonic' systems have features consistent with ambisonics, without however exhibiting all its essential properties. Most notably the Nippon-Columbia UMX system of Cooper & Shiga comprises a compatible series of 2-, 3- and 4-channel codings basically consistent with ambisonics although hitherto confined to pan-potting in horizontal angle.

The Japanese 'Regular Matrix' defines a potentially ambisonic 2-channel system, but is vague about the distinction between internal and overhead sounds. Recordings made on any of these systems could be played back through an ambisonic system, with limitations in what could be reproduced but without glaring anomalies, by suitable switching between the basic units of the ambisonic decoders.

It is apparent that true compatibility between different systems, numbers of communication channels, and numbers and configurations of the loudspeakers the listener may use, can come only from the ambisonic approach of considering how to record the directional character of all the sound that may reach the microphone, and then considering how this full directional information can be collapsed down successively to horizontal-only, stereo and mono presentation.

RICHER GAMUT

Experiments with systems aimed at reproducing the true directional quality of original sound shows how restricted are the methods of synthesis and pan-potting in current use. Ambisonics provides a much richer gamut of possibilities.

In so far as it is possible to imitate synthetically the signals due to any sound that the system could record naturally, the possible effects include a previously recorded or synthesised signal being made to appear to recede into the distance or rush up to the listener, changing the character of its reverberance and 'atmosphere', swooping around the listener or even looping the loop.

In addition there is the possibility of creating sounds that never existed in nature, including the so-called 'internal' or 'in-the-head' sounds. At the present stage of development no limits can be placed on the possibilities thus opened up for future developments of the art in synthesised music of 'pop' effects.

In what is called 'serious' music, ambisonics can be the means of reversing the current trend of elaborate recording techniques coming between the listener and the performance. It represents a return to the concept of creating a sound at a good listening position at the live performance, and then recording as accurately as possible the characteristics that give this sound its live quality; surely what 'high fidelity' reproduction is all about.

PARAMETERS

The physical basis of these developments can be expressed in terms of wave-equation of sound. The sound-field at a point is completely determined by knowledge of the pressure p and the three resolved cartesian components of fluid velocity v_x, v_y and v_z. These four parameters can evidently be transmitted along four communication channels each of audio-bandwidth.

A natural way of doing so has been discussed, with much other relevant theory, by Gerzon, in terms of signals representing the four spherical harmonics of order zero and unit, namely 1, x, y, z (where x, y and z are direction cosines and 1 represents an omni-directional component). Note that this or equivalent methods are optimal in the use made of four channels, and are quite distinct from the inferior way the four channels are used in 'quadraphonics'.

If attention is confined to progressive sound-waves, without any standing-wave component, knowledge of the three velocity components v_x, v_y and v_z determines the pressure p uniquely except for an ambiguity of sign caused by the inability to distinguish two waves of opposite phase travelling in opposite directions.

Thus knowledge of p is partially redundant, and this redundancy can be used to compress the information into three channels each of audio bandwidth, if some limitations are accepted. With respect to sounds arriving horizontally, the transformation between four and three channels can be made completely reversible, so that for this application three and four channel systems are strictly equivalent.

TO TWO CHANNELS

The possibility of compression (with some further compromise) into two channels can be expressed in terms of representing the direction of arrival of sound by the two parameters of horizontal angle Θ and vertical angle Φ (i.e. azimuth and altitude angles). Two degrees of freedom are available in a two channel signal, after normalisation to represent the intensity of the sound, namely the relative amplitudes and the relative phases of the signals in the two channels. Thus by using phase information, the three-dimensional sound field can be correctly identified.

Developments in the realisation of the above theoretical possibilities are the subject of current patent applications in the U.K., Canada, Denmark, France, Germany, Italy, Japan, Netherlands, Switzerland and the U.S.A.

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IC OF THE MONTH

—continued from page 948

limited by the series-pass transistor. In the case of the MJE340 shown, the maximum input voltage is 300V. The circuit provides a constant-current output which is adjustable from 200μA to 100mA; above 10mA take care not to exceed the ratings of the MJE340. At both the 200μA and the 1mA settings, output impedance exceeds 200MΩ.

The 1μF capacitor C4 is necessary to ensure circuit stability. However, it limits the rate at which the voltage across the load can change in response to a sudden change in load resistance. This response time can be found by multiplying the capacitor value by the final load resistance. The instantaneous load current is found by dividing the instantaneous output voltage by the final value of load resistance.

The MC1566L is made to a military specification, the 'civilian' equivalent being the MC1466L. The MC1466L costs £3·30, the MPSU10 is 75p and the MJE340 (or BD158) is 41p, all obtainable from Jermyn Home Electronics, 112 Vestry Estate, Sevenoaks, Kent. Add 25p for P/P plus 10% VAT to total cost.

PW TECHNICROSS PUZZLE

Solution to No. 2

presented last month

1 D	2 I	S	3 C	■	4 T	5 W	E	6 E	T	7 E	R	8 S
■	S	■	R	■	■	O	■	L	■	L	■	A
9 R	O	S	Y	■	10 S	O	L	E	N	O	I	D
■	T	■	11 S	E	T	■	■	V	■	P	■	N
12 V	O	L	T	■	R	■	13 D	E	L	E	T	E
■	P	■	14 A	D	A	M	■	N	■	■	■	S
15 B	E	L	L	■	D	■	16 R	■	17 T	A	18 P	S
A	■	■	■	19 L	■	20 T	O	N	E	■	R	■
21 T	A	22 S	S	E	L	■	M	■	23 T	R	I	G
T	■	P	■	N	■	■	24 A	I	R	■	N	■
25 E	L	E	C	T	R	26 O	N	■	27 O	A	T	H
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28 Y	O	D	E	L	L	E	R	■	29 E	D	D	Y

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DL96	55p	EF85	31p	PCC85	40p
DM70	60p	EF86	27	PCC88	55p
DY86	35p	EF89	25p	PCC89	45p
DY87	30p	EF91	37p	PCC189	50p
DY802	30p	EF92	40p	PCF80	25p
E88CC/01	£1·08	EF95	35p	PCF82	35p
E180CC	65p	EF183	26p	PCF84	54p
E182CC	£1·15	EF184	31p	PCF86	55p
EA50	18p	EFL200	60p	PCF200	75p
EABC80	38p	EL34	50p	PCF201	75p
EAF42	55p	EL36	47p	PCF801	50p
EB91	20p	EL41	55p	PCF802	45p
EBC33	60p	EL81	52p	PCF805	90p
EBC41	65p	EL82	52p	PCF806	65p
EBF80	40p	EL84	21p	PCF808	85p
EBF80	40p	EL85	44p	PCH200	70p
EBF83	40p	EL86	36p	PCL81	50p
EBF89	27p	EL90	31p	PCL82	35p
ECC81	35p	EL95	36p	PCL83	65p
ECC82	25p	EL500	70p	PCL84	35p
ECC83	33p	EL504	70p	PCL86	45p
ECC84	27p	EM31	60p	PCL805	50p
ECC85	36p	EM80	45p	PD500	£1·30
ECC86	80p	EM84	35p	PFL200	65p
ECC88	39p	EM87	70p	PL36	55p
ECC189	65p	EY51	40p	PL38	65p
ECF80	31p	EY81	40p	PL81	40p
ECF82	35p	EY86	40p	PL82	40p
ECF83	67p	EY88	40p	PL83	45p
ECF801	56p	EZ40	50p	PL84	30p
ECH42	70p	EZ41	75p	PL500	75p
ECH81	30p	EZ80	28p	PL504	75p
ECH83	40p	EZ81	27p	PL508	90p
ECH84	40p	GY501	70p	PL509	£1·10
ECL80	40p	GZ34	60p	PL802	95p
ECL82	31p	GZ37	63p	PY33	63p
ECL83	70p	KT66	£2·30	PY80	35p
		KT88	£2·90		

TRANSISTORS, ZENER DIODES etc.

AC 07	35p	BC118	20p	NKT222	30p	OC75	25p	ORP61	45p	2N2411	55p
AC113	15p	BC182A	11p	OA5	60p	OC76	25p	ORP90	95p	2N2646	45p
AC126	20p	BC212A	13p	OA10	40p	OC77	45p	ORP93	£1·10	2N2904	20p
AC 27	20p	BCY72	15p	OA70	10p	OC78	25p	RAS310AF	35p	2N2989	£4·00
AC128	20p	BD136	45p	OA71	10p	OC78D	25p	SD94	21p	2N3053	20p
AC132	25p	BF115	25p	OA73	15p	OC81	20p	V405A	25p	2N3054	45p
AC176	20p	BF167	25p	OA74	15p	OC81D	20p	ZR11	50p	2N3055	55p
AC187	25p	BF173	25p	OA79	10p	OC81DM	20p	ZR21	30p	2N3646	30p
AC188	25p	BF173	25p	OA81	08p	OC82	25p	ZR22	25p	2N3730	65p
ACY17	35p	BF177	20p	OA91	·07p	OC82DM	30p	ZT20	£1·00	2N3731	70p
ACY28	35p	BF180	35p	OA200	·07p	OC83	25p	ZT83	60p	2N3819	25p
AD139	40p	BF200	30p	OA202	10p	OC84	25p	ZT84	£1·00	2S303	70p
AD149	50p	BFY51	20p	OAZ200	50p	OC122	£1·00	ZT91	£2·00	2S304	80p
AD161	35p	BFY52	20p	OAZ201	45p	OC139	25p	ZT202	50p	2S307	£1·60
AD162	35p	BFY90	75p	OC16	£1·00	OC140	65p	ZT203	50p	2S703	75p
AF118	25p	BSY29	30p	OC22	£1·00	OC141	60p	ZTX302	20p	40594	65p
AF127	30p	BYZ13	35p	OC25	40p	OC170	25p	1N823A	65p	40595	75p
AF139	30p	BYZ16	60p	OC26	35p	OC171	30p	1N4785	75p	40636	£1·00
AF178	48p	CRS1/10	30p	OC28	65p	OC200	40p	2N918	37p	40669	90p
AF180	48p	CRS1/20	40p	OC29	65p	OC201	75p	2N987	43p	**ZENER DIODES**	
AF181	48p	CRS1/40	48p	OC35	50p	OC202	90	2N1304	22p	10W/1V	45p
AF186	40p	CRS3/40AF	50p	OC36	65p	OC203	55	2N1305	22p	10W/2V	45p
AFZ12	£1·00	CRS25/025	75p	OC44	17p	OC204	65	2N1306	25p	10W/6·2V	45p
ASY26	25p	GET115	75p	OC45	12p	OC205	£1·00	2N1307	25p	10W/7·5V	45p
ASY28	25p	GET116	85p	OC70	12p	OC206	£1·10	2N1308	27p	10W/11V	45p
BC107	10p	GEX66	£1·50	OC71	12p	OCP71	£1·00	2N1309	28p	10W/15V	45p
BC108	10p			OC72	20p	ORP12	55p	2N2147	75p		
BC113	16p			OC73	30p	ORP60	50p				

PY81	30p	UBC41	48p	UY41	45p	3Q4	60p	6AC7	45p	6BA6	25p
PY82	30p	UBF80	35p	UY85	35p	3S4	35p	6AH6	60p	6BE6	32p
PY83	35p	UBF89	40p	VR105/30	40p	3V4	45p	6AK5	35p	6BG6G	70p
PY88	38p	UBL1	70p	Z800U	£2·00	5B/254M	£3·00	6AK8	38p	6BY6	55p
PY500	£1·00	UBL21	70p	Z801U	£2·00	5B/255M	£3·10	6AL5	20p	6BQ7A	55p
PY800	45p	UCC85	45p	Z803U	£1·25	5R4GY	75p	6AL5W	50p	6BR7	£1·00
PY801	45p	UCF80	60p	Z900T	£1·10	5U4G	35p	6AM6	35p	6BW6	90p
QQV03-10	£1·20	UCH42	70p	1L4	20p	5V4G	45p	6AN8	60p	6BW7	90p
R19	35p	UCH81	35p	1R5	45p	5Y3GT	45p	6AQ5	42	6C4	30p
TT21	£4·20	UCL82	35p	1S4	30p	5Y4G	35p	6AQ5W	65p	6C6	40p
U25	85p	UCL83	65p	1S5	30p	5Z3	70p	6AS6	50p	6CH6	55p
U26	85p	UF41	65p	1T4	30p	5Z4	75p	6AT6	38p	6CL6	50p
U191	68p	UF80	30p	1X2A	60p	5Z4GT	45p	6AU6	30p	6D6	35p
U801	80p	UF85	35p	1X2B	60p	6AB7	45p	6AX4GT	75p	6EA8	70p
UABC80	40p	UF89	35p	2K25	£8·00			6AX5GT	80p	6F23	80p
UAF42	55p	UL41	60p	3A4	50p			6B7	55p	6F33	£3·25
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6Y7M	45p	19H4	£6·25	9002	50p
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6K7	40p	25L6GT	60p	9004	25p
6K7G	25p	30C15	90p	9006	25p
6K8GT	40p	30C17	£1·00		
6K25	70p	30C18	90p		
6L6M	£1·35	30F5	£1·00	**C.R. Tubes**	
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6SG7	40p	30L15	95p	MW13-35	£15·00
6SY7	40p	30L17	95p	VCR139A	£7·50
6SY7GT	28p	30P12	95p	VCR517B	£9·00
6SK7	45p	30P19	95p	3BP1	£4·00
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6SN7GT	45p	30PL13	£1·00	88Y	£7·00
6SQ7	45p	30PL14	£1·00	88L	8·10
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6V6GT	45p	35W4	40p	**Special Valves**	
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12AV6	50p	931A	£4·75		
12AX7	30p	954	50p		
12BA6	40p	955	40p		
12BE6	50p	956	30p		
12BH7	50p	957	40p		
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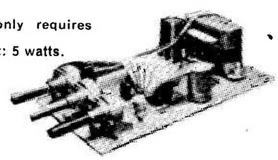

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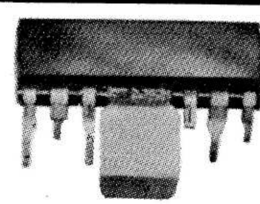

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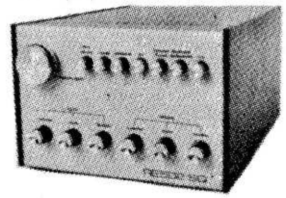

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Nominal I/P 100mV RMS
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Rear separation > 20dB

Amplifier
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Sensitivity for full O/P 100mV
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Two Transistor RECEIVER

R. A. Penfold

ALTHOUGH this receiver uses only two transistors, it is capable of receiving local broadcast stations at reasonable volume from a loudspeaker. In most areas it will also receive several foreign stations after dark. There is also provision for a crystal earpiece.

The set is self contained, having an internal 9 volt battery (PP4), $2\frac{3}{4}$in. dia. loudspeaker and ferrite rod aerial. It tunes the medium wave band only and measures $6 \times 3\frac{1}{8} \times 1\frac{5}{8}$in., excluding control knobs.

As the circuit uses only the minimum of components, it is both inexpensive, and easy to construct and has proved to be stable and reliable. It is a feature of the receiver that once it has been constructed, no special alignment is required before it can be used.

How it works

The circuit consists of a reflexed stage with controlled regeneration, coupled to a single transistor operated as a class A output stage.

The circuit diagram of the receiver is shown in Fig. 1. Tr1 stage provides the majority of the circuit gain. L1 is the tuned winding of the ferrite aerial, and this is tuned by VC1. L2 couples the r.f. signal to the base of Tr1. Tr1 is biased by R1, and C5 plus R2 provide the supply decoupling. R1 is taken to the junction of T1-R2 so that no a.c. negative feedback is introduced, but a certain amount of d.c. feedback is, and this has a stabilising effect on the biasing of Tr1.

The primary winding of T1 forms an a.f./r.f. load for Tr1, and an amplified r.f. signal will appear at Tr1 collector. From here it is coupled via C4 to D1. The r.f. signal is detected by D1. It is important that D1 has the polarity shown.

The audio signal present at the junction of D1-C3 is coupled to the base of Tr1 via L2 winding. Tr1 now operating as an audio amplifier, with T1 primary forming an a.f. load.

In order to increase sensitivity, and also selectivity, regeneration is applied to Tr1 stage. This is the process of feeding some of the r.f. signal at Tr1 collector back to the base of Tr1 (via L1/L2) for further amplification.

Tr1 inverts the r.f. signal, and from Tr1 collector the r.f. signal is coupled via C2 to VR1 slider, and from here via C1 to L1/L2. VR1 controls the regeneration, and maximum sensitivity is obtained with this adjusted just below the point at which the circuit breaks into oscillation. It would appear logical to connect C2 to the top of VR1, and C1 to the slider, but when this was tried the circuit was rather unstable.

Tr1 and Tr2 are coupled by transformer T1, C6 providing the necessary d.c. blocking between the base of Tr2 and the d.c. path to earth through T1 secondary. T1 is a miniature driver transformer for two OC72's. The centre tap on the secondary is ignored. Various transformers were tried and despite differences in impedances and ratios, they all gave virtually identical results.

Tr2 operates as the output transistor. This is biased by R3. The loudspeaker forms the collector load for Tr2 when the loudspeaker is in use, and R4 forms the load when the earpiece is used. The jack socket for the earpiece has a break contact which is used to cut out the loudspeaker from circuit when the earpiece is plugged in. As R4 has a relatively high value it can be left in circuit when the loudspeaker is being used, without having a detrimental effect on performance. C7 introduces a certain amount of negative feedback at the high audio frequencies which helps to improve the audio response.

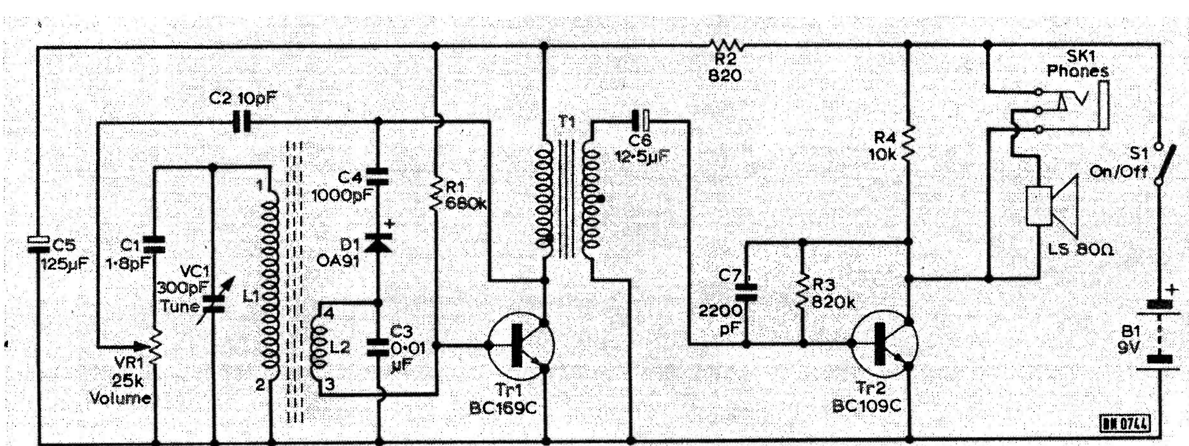

Fig. 1 : Circuit of the two transistor receiver.

Ferrite aerial

This is wound on a $4\frac{1}{2} \times \frac{3}{8}$in. ferrite rod. This size should be readily available. Enamelled or d.c.c. wire is used, the exact gauge not being too important. Something in the region of 30-32 s.w.g. is a good choice as this is fairly easy to use, and gives a reasonably compact winding. Fig. 2 shows the construction of the aerial.

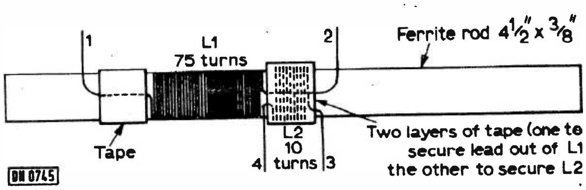

Fig. 2: The ferrite rod aerial.

As can be seen from Fig. 2, L1 winding consists of 75 turns of wire. This wound in a single layer, and should be kept as tidy as possible, avoiding any overlaps. The leads at each end of the coil are taped to the rod, using insulation tape, so as to hold the coil in place. The coil is wound slightly off centre, so that when the aerial is mounted in the case it can be positioned slightly away from the speaker.

L2 winding consists of 10 turns of wire wound over one of the pieces of insulation tape, with a further layer of tape placed on top of this in order to hold it in position. The coil has a single layer, and again it should be free from overlaps.

The case is made from $\frac{1}{16}$in. sheet paxolin, or a similar material. A cut-out for the speaker is made using a coping or fret saw. This and the other holes should be made before the various parts are assembled. The way in which the parts fit together can be ascertained from the diagram. A good quality household adhesive, such as Araldite is recommended.

Two small blocks of wood approx. $\frac{3}{4} \times \frac{5}{8} \times 1$in. are glued to the sides of the case (as shown in Fig. 4). The rear of the case is held in place by two wood screws which pass through two holes already drilled in the back and then screw into the two small blocks of wood.

The method of mounting the ferrite rod can be seen in Fig. 4. The two blocks of wood on which it is mounted measure approx. $1 \times \frac{5}{8} \times \frac{1}{4}$in. and $1\frac{1}{8} \times \frac{5}{8} \times \frac{1}{4}$in. The rod is mounted as far to the rear of the case as possible. A $\frac{3}{8}$in. dia. hole is drilled in each of the blocks of wood, and the rod is pushed into these (it need not be glued). The blocks are then glued to the case.

Some of the initial wiring can now be commenced. This is shown in Fig. 4. This also shows the position of the battery and Veroboard component panel.

★ components list

Resistors
R1 680kΩ R3 820kΩ 5%
R2 820Ω R4 10kΩ
All ¼ watt, miniature
VR1 25kΩ log or lin with switch

Capacitors
C1 1·8pF ceramic
C2 10pF ceramic
C3 0·01μF polyester
C4 1000pF ceramic
C5 125μF 10 V.W.
C6 12·5μF 25 V.W.
C7 2200pF ceramic

Semiconductors
Tr1 BC169C
Tr2 BC109C
D1 0A91

Miscellaneous
Paxolin, fret, etc. for case; 2½in, 80Ω L.S. 3·5mm switched jack socket; crystal earpiece with plug (3·5mm); miniature driver transformer (see text); 4½in. x ⅜in. ferrite rod; wire for coils (see text). 250 or 300pF variable capacitor, miniature solid dielectric or air spaced; PP4 battery with clips to suit; Veroboard for component panel; two control knobs, hardware.

Mounting the loudspeaker

A piece of speaker fret is glued behind the speaker cut-out, and the speaker is then in turn carefully glued to this. A sticky backed plastic material is used to cover the case, and so give a smart finish.

VC1, VR1, and the jack socket can then be mounted. VC1 may have a $\frac{3}{8}$in. dia. single hole fixing, but many types have a two or three hole screw fixing. In these cases it is best to glue the capacitor to the front panel.

Veroboard panel

With the exceptions of C1, and R4, all the small components are mounted on a small piece of 0·15in. matrix Veroboard. This has the copper strips running lengthwise. The component layout of this panel is shown in Fig. 3.

If T1 is of a type, which has a mounting clip and flying leads, the clip should be removed and the leads cut short so that it can be treated as a printed circuit type.

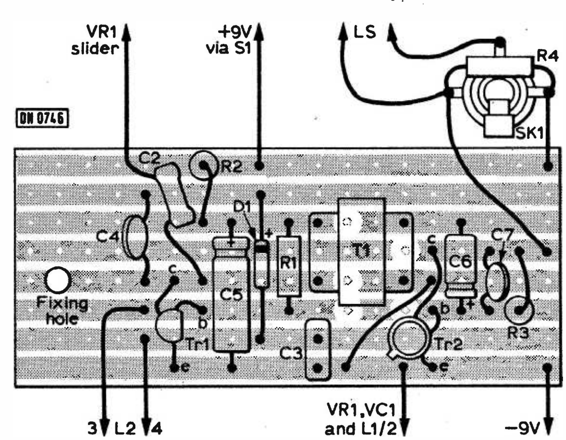

Fig. 3: Veroboard panel component layout.

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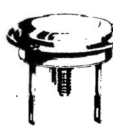

B79	4	IN4007 Sil. Rec. diodes. 1,000 PIV lamp plastic	55p
B81	10	Reed Switches, 1" long, ⅛" dia. High Speed P.O. type	55p
B99	200	Mixed Capacitors. Approx. quantity, coun ed by weight P & P 15p	55p
H4	250	Mixed Resistors. Approx. quantity counted by weight P & P 15p	55p
H35	100	Mixed Diodes, Germ, Gold bonded, etc. Marked and Unmarked.	55p
H38	30	Short lead Transistors, NPN Silicon Planar types	55p
H39	6	Integrated Circuits. 4 Gates BMC 962, 2 Flip Flops BMC 945	55p
H41	2	Sil Power transistors comp pair BD131/132	55p

Unmarked Untested Paks

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B66	150	Germanium Diodes Min. glass type	55p
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	55p
B86	100	Sil. Diodes sub. min. IN914 and IN916 types	55p
H16	15	Experimenters' Pak of Integrated Circuits, Data supplied	55p
H20	20	BY126/7 Type Silicon Rectifiers 1 amp plastic. Mixed volts.	55p
H34	15	Power Transistors, PNP, Germ. NPN Silicon TO-3 Can.	55p

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H65	4	40361 Type NPN Sil. transistors TO-5 can comp to H66	55p

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H66	4	40362 Type PNP Sil. transistors TO-5 can comp to H65	55p
H67	10	3819N Channel FETs plastic case type	55p

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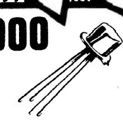

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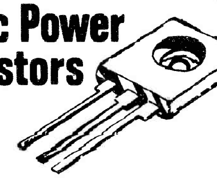

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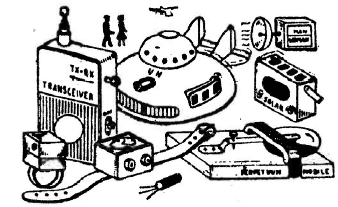

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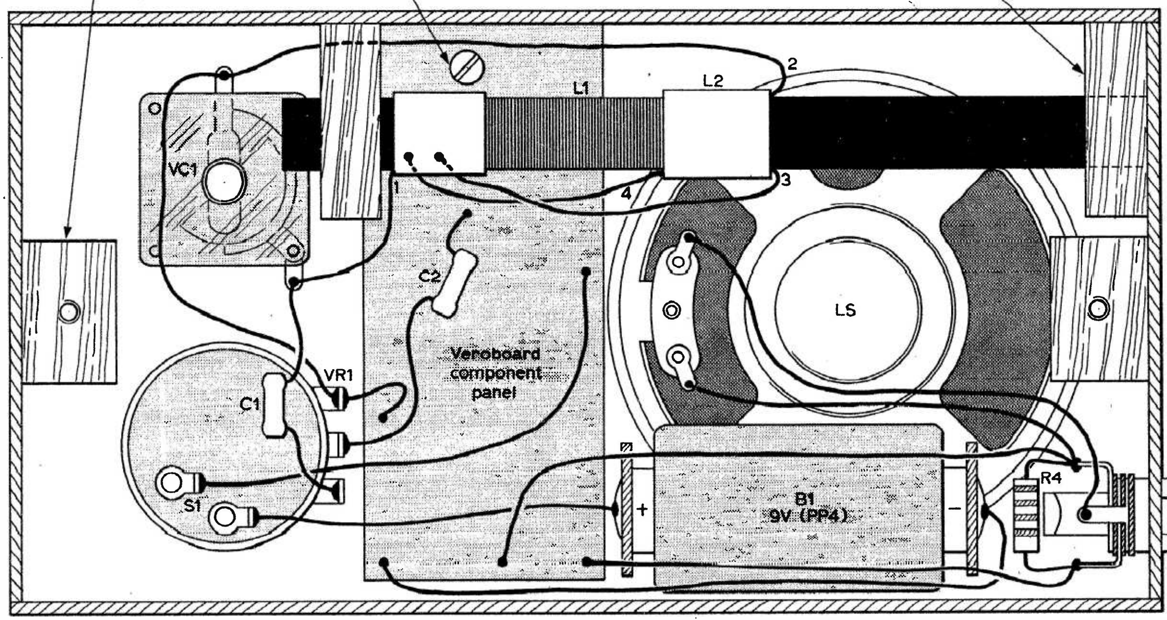


Fig. 4: General construction and layout details.

The 10pF capacitor C2, should have its lead out wires left full length. These can be insulated with sleeving, but this is not essential. The free end of C2 should not be connected to VR1 slider until the Veroboard panel has been mounted

The method of mounting the board is quite simple. A piece of wood approx. $1 \times \frac{3}{4} \times \frac{1}{4}$in. is glued to the inside of the front panel, at the top between the speaker fret and VC1. The Veroboard panel is then positioned as shown in Fig. 4, and a small wood screw is placed through the mounting hole and screwed tight into the block of wood.

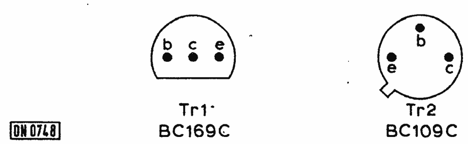


Fig. 5: Transistor base connections.

Using the Set

For initial testing it is suggested that the earpiece is used. If VR1 is adjusted to turn the receiver on, and VC1 is then adjusted, it should be possible to receive two or three stations, although these will probably be rather weak. If VR1 is rotated further clockwise the stations should become louder. If VR1 is turned too far the receiver will begin to oscillate, and whistles will be heard from the earpiece as the set is tuned across the band. If the receiver fails to oscillate, try reversing the connections of L2 winding. The receiver is most sensitive with VR1 set just below the point at which oscillation occurs.

As the ferrite aerial is directional, the set should be rotated for optimum signal.

If the set works properly using the earpiece it can be tried using the speaker. For satisfactory speaker reception it will probably be found necessary to always adjust VR1 for maximum sensitivity and it will need re-adjustment each time the set is re-tuned.

Conclusion

The receiver may suffer from hand capacity effects. This is where putting ones hand near VC1 tends to slightly alter the tuning. This is a common failing of simple circuits of this type where a single tuning capacitor with a non-metallic chassis is used. It can be eliminated by placing a sheet of aluminium between the front panel and VC1-VR1. The aluminium panel should be connected to the negative supply.

Current consumption of the unit is approximately 11mA when using the loudspeaker and 4mA when using the earpiece. ■

OSCILLOSCOPE TECHNIQUES

Part 1 of this series due to commence in this issue has been held over until the March issue because of pressure on editorial space.

practically wireless commentary by HENRY

No. 102

No noise is . . .

TELL it not in Gath. Certain of our exalted boffins are dreaming up new ways of overcoming noise. No, not polishing up Dolby—those lads are quite capable of effecting refinements themselves; you should see the latest Japanese version of the Dolby-B circuit, shorn of all but its essentials!

There are alternatives. Now that f.m. broadcasting has become and will continue to become, an everyday part of our lives, some means of bettering signal-to-noise ratio is needed. What we suffered from mono, because we could make a direct and favourable comparison with a.m., is intolerable when we listen to stereo v.h.f. broadcasts.

This is partly psychological. In this country, some parts at any rate, stereo radio is very new: in some parts, still a vague promise. We tend to want our money's worth. We listen more intently. We wait, with bated breath, for some evidence that the studio engineer has his wires crossed and is allowing us to eavesdrop on a prompt from the wrong side of the wings.

The trouble, however, goes deeper. We now have the artistes aware of anti-noise possibilities; feeling they may have been cheated out of their full whack of exposure unless the engineering department has done its damnedest. Can you imagine someone like Arthur Garratt chatting scientifically to us without the full benefit of every decibel available; or James Burke, let alone Raymond Baxter, doing a 'what's to come' piece without the full armoury of technics at their backing?

Evesdrop on a prompt.

Henry was particularly amused by the Larry Adler comment that *Woman's Own* would not let him retain his title for an article: 'What kind of noise annoys an Oistrakh?' They etiolated it to: 'No Noise is Good Noise.'

Beneath the levity is a serious question. What sort of noise *would* annoy an Oistrakh? Certainly not always the same sort of noise that perturbs ordinary mortals like you and me. Noise is a subjective thing. In an iron foundry, Thor could bash on regardless, but while I am tapping out this piece, the clack of a pair of platform soled shoes beneath my window can be utterly distracting. Well, I mean, they have a new *au pair* just down the road . . .

In the middle of the night, noise is the breathing of a wayward moth. To Patrick Moore, 1420MHz is probably the *bête noir* frequency*, while to sundry girl operatives in a factory, constant vibrations at 37Hz caused genuine excuses for sick headaches.

Probably the noise that would annoy an Oistrakh would be a second fiddle slightly out of tune in the opening of the Bach Double Violin Concerto. You can't do much about that with Dolby.

Trouble with the f.m. broadcast situation is that everybody has to be in on the act, or there is no point in applying signal tailoring. The other trouble, less often mentioned, is that current systems act on signals below a certain arbitrary level and within certain frequency bands. Which is all very well, but what about the *background* noise that accompanies some high level sounds and can still be heard?

Breathing of a wayward moth.

Studio types will tell you that "compandor" systems carry that particular penalty. Get a few of those big bass drum thwacks in the Panufnik "Heroic Overture" overriding a musing woodwind, and the processing inserts a 'noise swish' that has become so much a familiar phenomenon to us that we think the live performance lacks something.

Just like the old lady who complained after a concert that the orchestra did not sound as 'mellow' as on her pre-transistor radiogram.

Even the best BBC boffins will not be able to reinsert her "lost" frequencies in the right proportion. They cannot even do much to restore power lost to you by your distance from the receiver. It is a point not aired often enough by those hi-fi salesmen who insist (metaphorically) on assuring customers that they can get good stereo on a discarded clothes-line! That is, transmitter power will not of itself determine the range of broadcast reception. This is determined by the height of the aerial, the topography of the earth, humidity, temperature and other atmospheric mysteries. What the extra power does is precisely what we are here concerned with: it improves the signal-to-noise ratio.

** 1420MHz is the radiation frequency of the neutral hydrogen that results from the collision of hydrogen atoms: the intergalactic wavelength.*

transistor BIAS & FEEDBACK

G. R. WILDING

TRANSFORMERLESS complementary output stages are widely used in transistor receivers and amplifiers, since they confer the advantage of push-pull operation without the disadvantages of wound components.

The bases of the output pair are directly fed from the collector of the preceding driver stage and it only becomes necessary to include a low value resistive component between driver load and collector to develop the required p.d. for establishing their no-signal forward bias.

When germanium output transistors are used, requiring a base/emitter p.d. of about 0·2V, a silicon diode will develop the voltage to bias them both, but if silicon transistors are employed, two silicon diodes will be necessary.

Alternatively, a low value fixed or variable resistor may be used, and shunted by a miniature thermistor so that as ambient temperature increases, the latter's resistance decreases to reduce forward bias and thus stabilise the mean operating current. In some receivers a diode-connected transistor may be used and, if of similar thermal characteristics to the output pair, will compensate for temperature changes in similar fashion to a thermistor.

Current designs employ diodes, thermistors, fixed and variable resistors in many permutations and some of the more common ones are shown in Fig.1 together with a typical basic transformerless output stage. R1 constitutes the driver collector load with the forward biassed diode developing the required potential for Class B operation, R2 and R3 stabilising output transistor working and minimising their spreads in characteristics.

When the driver collector voltage rises, b/e potential of Tr2 rises to increase its conductance, but the b/e potential of Tr3 is reduced to lower its conductance still further from the Class B position, and into cut-off.

When driver collector voltage reduces, the reverse happens, so that each transistor virtually only amplifies one half-cycle of the applied signal. By carefully selecting the no-signal operating point just above cut-off and therefore the most curved section of the transfer characteristic, highly efficient working with minimum crossover distortion can be achieved.

In the latest GEC 2541/Sobell 1541 portables, the amplifying properties of a transistor are utilised to give particularly good bias compensation against variations in amplifier supply voltage and ambient temperature.

The circuit is shown in Fig.2, with the output from a BC148 pre-amplifier being capacitively fed to audio amplifier Tr64.

This latter stage also DC stabilises the output

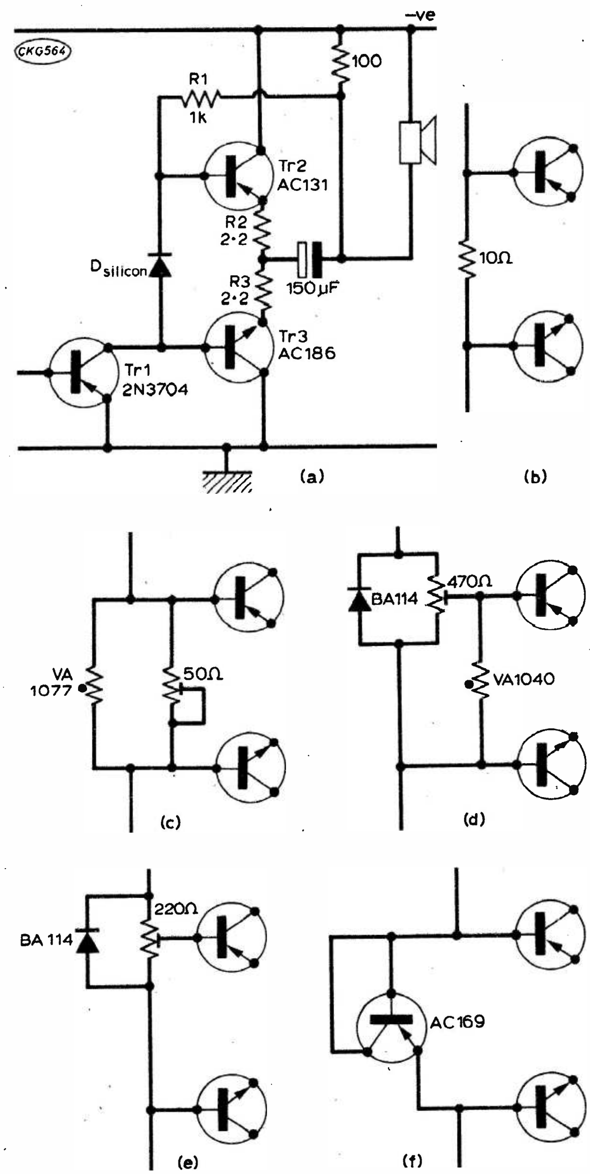


Fig. 1: (a) Basic complementary push-pull output stage, obtaining bias for the matched transistors from the voltage developed across diode. For germanium transistors, one silicon diode will develop the required p.d., but for silicon transistors, two silicon diodes in series will be necessary. Fig. 1 (b) to (f): Alternative methods of providing forward bias, showing typical values, exact values depending on transistors used and supply voltage.

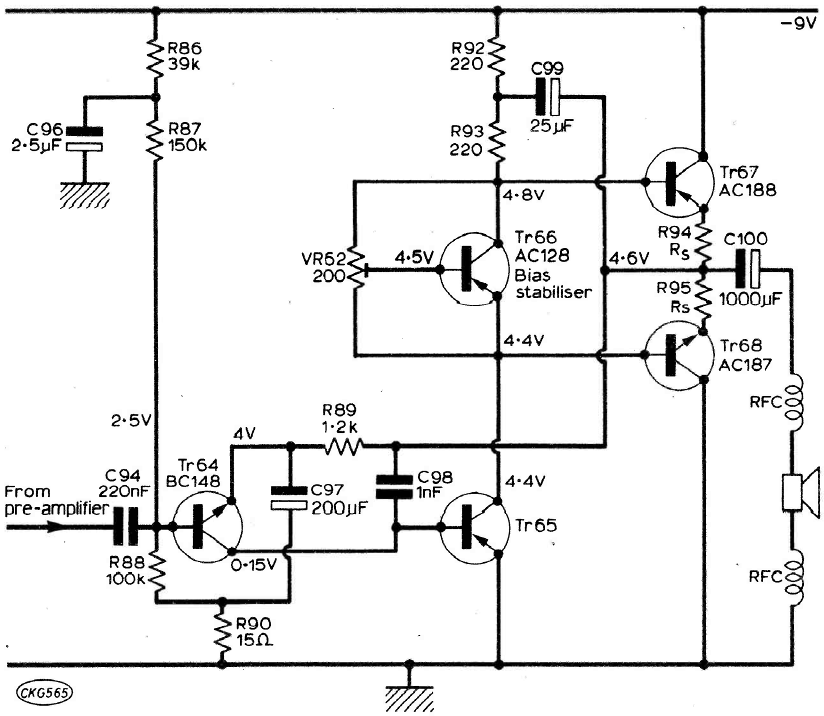
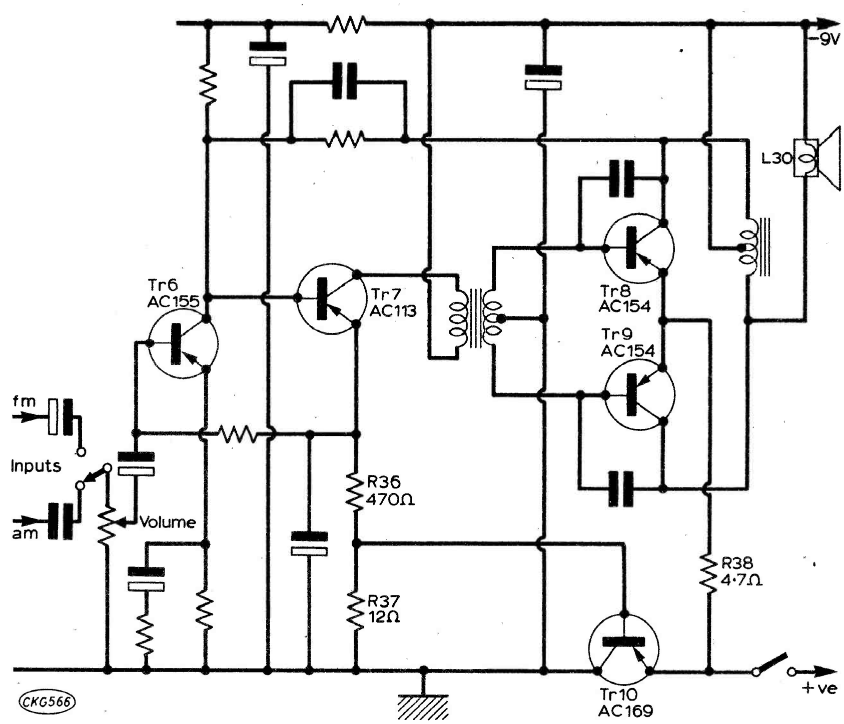


Fig. 2: DC coupled driver and output stages used in GEC 2541/Sobell 1541 six waveband portables. The complementary push-pull output stage is stabilised in two ways, by Tr64 which equalises their mean operating voltages via Tr65, and by Tr66, which compensates their forward bias against variations in supply voltage and ambient temperature.

Fig. 3: AF circuit used in several BRC portables, utilising a saturated transistor Tr10 in series with the supply to provide forward bias to the push-pull output stage. With Tr6 being DC coupled to Tr7, variations in the former's emitter current due to supply or temperature changes produce changes at the junction of R36/37 which effect compensating alterations to Tr10's bias and the voltage developed across it.



transistors, for with its emitter resistor being returned to the junction of their emitter resistors, while its base is held at a fixed potential by the R86/87/88/90 chain, any variation in the voltage at the output transistors emitters produces collector current changes in Tr64, which, due to DC coupling being maintained throughout the circuit, alters the individual biasing of Tr67/68 and equalises their working conditions.

Normally, the voltage at the junction of R94/95 is −4·5V, but if this tends to rise due to inequalities in the conductivity of Tr67/68, the emitter voltage of Tr64 will also be raised to increase its forward bias.

Tr64's collector current will therefore increase and as this is also the base current of driver Tr65, the latter's collector current will increase but decrease its collector voltage applied to the bases of the output transistors.

Net bias to Tr67 will therefore reduce, but increase to Tr68 and result in a lowering of the voltage at the junction of R94/95 to its original value.

Bias compensation is achieved by utilising the voltage developed across Tr66 and VR62 to forward bias the output transistors.

Normally, collector voltage of Tr66 is −4·8V and emitter voltage is −4·4V, and as the junction of R94/95 is −4·6V, ignoring the small voltage drop across resistors, the output transistors are each forward biassed to 0·2V.

Due to the collector current of Tr64 being the base current of Tr65, the latter transistor becomes very sensitive to small changes in supply voltage and temperature. Increases in Tr65's collector current produce proportional increases in the voltage developed between the slider of VR62 and Tr66's emitter to reduce the c/e potential and therefore forward bias to the output stage.

Bias for the transistors in conventional push-pull transformer circuits is usually obtained from a potential-divider across the supply, invariably including a thermistor for compensation against thermal changes.

However, several BRC receivers incorporating this type of circuit employ a transistor specifically for bias compensation whether from changes in temperature or supply voltage.

A typical example of such a circuit is shown in Fig. 3 where the compensating transistor, Tr10, is placed in series with the positive supply line to chassis.

The emitters of the output transistors are returned to positive by the 4·7Ω resistor R38, while the bases are taken directly to chassis via the centre-tapped secondary of the driver transformer.

The chassis is slightly negative to positive supply by the voltage developed across Tr10 which in turn is regulated by the forward bias tapped from the junction of R36/37 in the emitter lead of Tr7.

As Tr6 is DC coupled to Tr7, variations in the former's collector current, due to changes in supply voltage or ambient temperature, become amplified by the latter and produce proportional changes across R37 to vary the bias applied to Tr10 and thus its collector/emitter p.d.

Although worked in a highly saturated condition, Tr10 dissipates only a small wattage since its collector-emitter voltage is only a fraction of 1V.

SINGLE STAGE FEEDBACK

The simplest method of introducing negative feedback to one transistor stage is to omit the emitter resistor's decoupling capacitor, so that as emitter voltage follows base voltage, the effective b/e potential is reduced to reduce stage gain.

When the emitter resistor is fully decoupled, ie, by a capacitor large enough to hold emitter voltage constant at the lowest frequency handled, full gain is obtained.

A less widely used but very effective arrangement

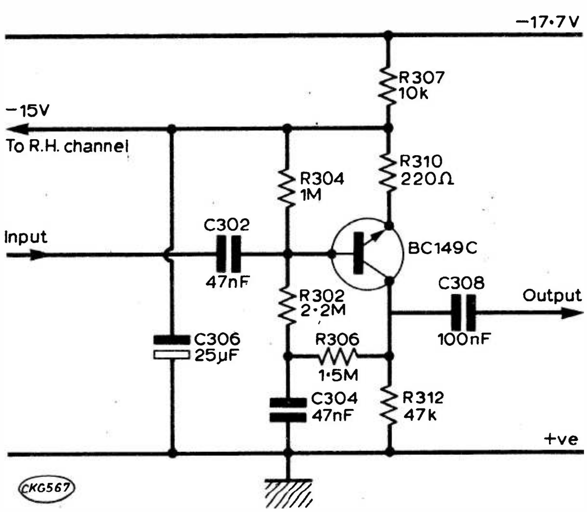


Fig. 4: Low noise audio input stage of GEC six + six stereo unit, forward biased from the collector, but with the AF signal largely filtered out by decoupler C304. R306/302 therefore DC stabilise the transistor while the undercoupled emitter resistor R310 introduces negative feedback.

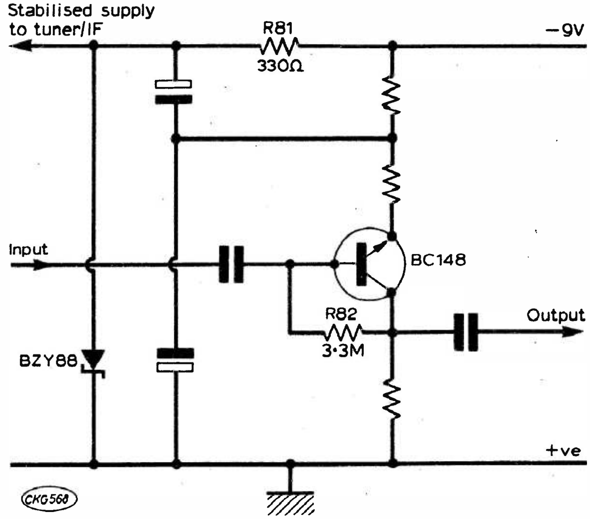


Fig. 5: AF pre-amplifier used in the GEC/Sobell range of portables forward biased by R82 directly from the collector, and applying both negative feedback and DC stabilisation.

is to supply the base bias feed from the transistor's collector instead of from the It rail.

This can be done whether emitters or collectors stem from chassis, and as well as introducing signal negative feedback, also stabilises the transistors DC working conditions, since an increase in I_c for any reason increases the voltage drop across the collector resistor to reduce forward bias and restore the original position.

For DC stabilisation without signal negative feedback, it is only necessary to split the base bias resistor and decouple the junction with a high value electrolytic capacitor.

An example of such an arrangement is given by both of the low noise audio input stages of the GEC 6+6 stereo unit, as shown in Fig.4.

R312 is the collector load stemming from positive chassis, while R306 and R302 provide forward bias directly from the collector.

Both being of very high value, practically all the

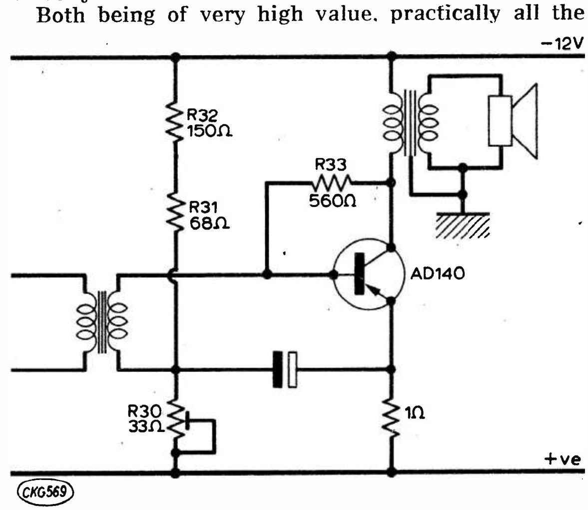


Fig. 6: Single-ended output stage used in many Philips car radio portables. R33 provides signal negative feedback, but not DC stabilisation, due to the primary resistance of the output transformer lonly being one ohm. R30 is set to produce a no-signal collector current of 550 mA.

TAKE 20

DAVID ANDREWS

No. 57
NEON FLASHER

A series of simple transistor projects, using not more than twenty components.

IT must be admitted that the possible applications for this circuit are rather few and far between but it is, nevertheless, offered as a novelty that some readers might like to exploit. The author recalls seeing an advertisement a few years ago for a present for the "man with everything"—it was a heated toilet seat with a built-in flasher to act as a beacon in the dark! This circuit could possibly be used in the latter function without risk of electrocution or perhaps it could be used as a sleep inducer in the child's bedroom!

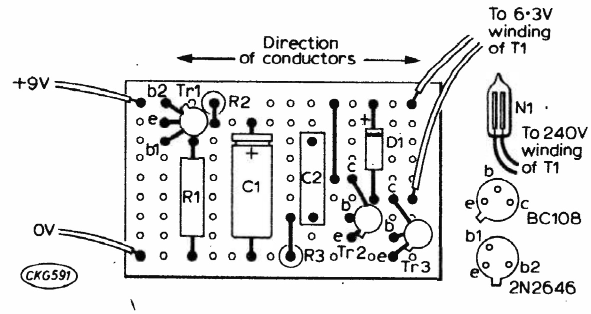


Fig. 2. The circuit can be constructed on veroboard as shown above. The board, transformer and neon lamp could be fitted into a suitable aluminium or plastic box.

Operation

The function is to make a small neon tube flash at a rate of about one flash per second, the driving source being a nine volt battery. Current consumption is very small, approximately 1 to 2 mA (average), thus a small battery could power the unit for considerable periods. The unijunction transistor Tr1 Fig. 1 forms a relaxation oscillator that produces a positive-going pulse at base b1 approximately once a second. Frequency of operation is set by R2 and C1. For the above quoted rate R2 ought to be 10kΩ but slower rates can be obtained by increasing its value to 100kΩ. Should faster rates be required C1 can be reduced in value proportionately.

The positive-going pulses from the oscillator are fed to the emitter follower Tr2 that provides sufficient drive to cause Tr3 to go into saturation. The rapid rise in current through T1's primary induces a high voltage across its secondary windings and this causes the neon to strike. This is repeated every time Tr1 goes through the conductive part of its oscillating cycle.

D1 should not be omitted as it protects the base collector junction of Tr3 from high reverse voltages when Tr3 switches off. The transformer can be any small mains one that has a 6·3V output; note, however, it is connected into the circuit with the 6·3V winding as the collector load and the neon connected across the 240V winding.

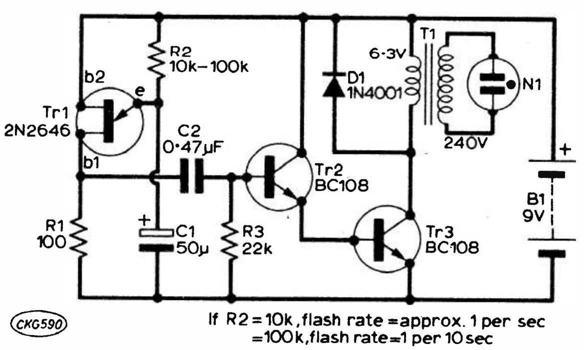


Fig. 1. Circuit of the neon flasher. R2, which, with C1, controls the flash rate could be made variable using a potentiometer. Additionally, C1 could have switched values.

★ components list

R1	100 ohm	Tr1	2N2646
R2	10kΩ (see text)	Tr2	BC108
R3	22kΩ	Tr3	BC108
C1	50µF (6V)	N1	80V neon
C2	0·47µF (polyester)	T1	240V/6·3V
D1	1N4001		

TRANSISTOR BIAS & FEEDBACK

—continued from page 963

AF signal is filtered to chassis through the decoupler C304.

In the latest GEC/Sobell 6 waveband portables, negative feedback and DC stabilisation is applied to the pre-amp stage by a 3·3MΩ resistor from collector to base, further feedback being developed across the unbypassed resistor in its emitter lead, Fig. 5.

In common with the other AF stages, this stage is operated from the negative 9V rail, R81 and zener diode BZY88 providing a stabilised supply for the tuner and i.f. stages.

Most transistor receivers employ a push-pull output stage of one form or another, with a feedback loop extending from the speaker to the driver stage, but in some Philips car radio models, a single AD140 is used, signal feedback being provided by a 560Ω resistor from collector to base.

A typical example is shown in Fig. 6, but no DC stabilisation is provided by the resistor in this case since the DC resistance of the output transformer primary is only 1Ω, but effective signal feedback is achieved since the output transformer's impedance to AF is comparatively high.

Forward bias is therefore provided by R32/R31, and to a lesser extent by R33, since it is much higher in value, while R30 sets the correct no-signal collector current at 550mA. ■

ULTRASONIC REMOTE CONTROLLER

PART 2

ROLAND PERRY

THE TRANSMITTER

The transmitter, Fig. 6, consists of just two NE555 IC's and a few resistors plus capacitors. More resistors may be switched in as required to provide more tones.

The transmitter uses four channel tone encoding, but the receiver only employs two of these. One for 'ON', one for 'OFF'—the other two being spare for future use.

As stated earlier, the simplest of the command functions is accomplished by detecting the presence of the ultrasonic carrier. IC2 is programmed to provide the ultrasonic carrier at the frequency of the transducer. In the authors's case, this was 40kHz. The output of the 555 is a square wave fed directly to the transducer.

The next step is to frequency modulate the ultrasonic carrier. This is very simply achieved by IC1 feeding the appropriate tone into pin 5 of IC2. The tone frequencies can again be selected from Table A and switched by means of a multiway push button unit.

The PCB layout is detailed in Fig. 7, and this board fits neatly inside a Norman Rose AB7 aluminium box, along with battery and clips. The transducer is glued on the outside of the case. No doubt a more pleasing arrangement could be evolved without much effort, since aluminium boxes always betray a certain amateurish technique. A multipurpose plastics case will shortly be made available to accommodate this requirement.

When wielding the soldering iron around the circuit there is not much to be said, apart from "put the 555's in the right way round." Experience (bitter), shows that the 555 is not one of the hardier IC's, and can be made defunct with very little effort. The author finds a desoldering tool of some kind is one of the most invaluable items in the constructor's toolkit.

The switch on the tone channel in the prototype was soldered directly to the board so when designing the board, try and accommodate the switch in a similar fashion, since it can save much time, and should mean that wiring mistakes will not occur. Remember that one pole of the switch on each tone channel is used to switch the supply.

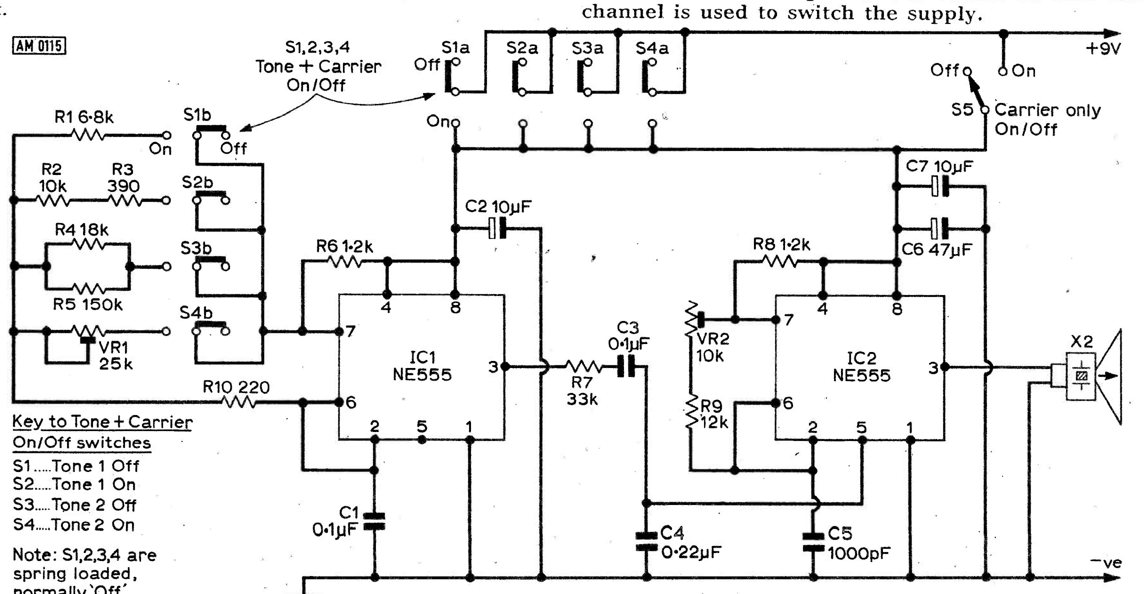
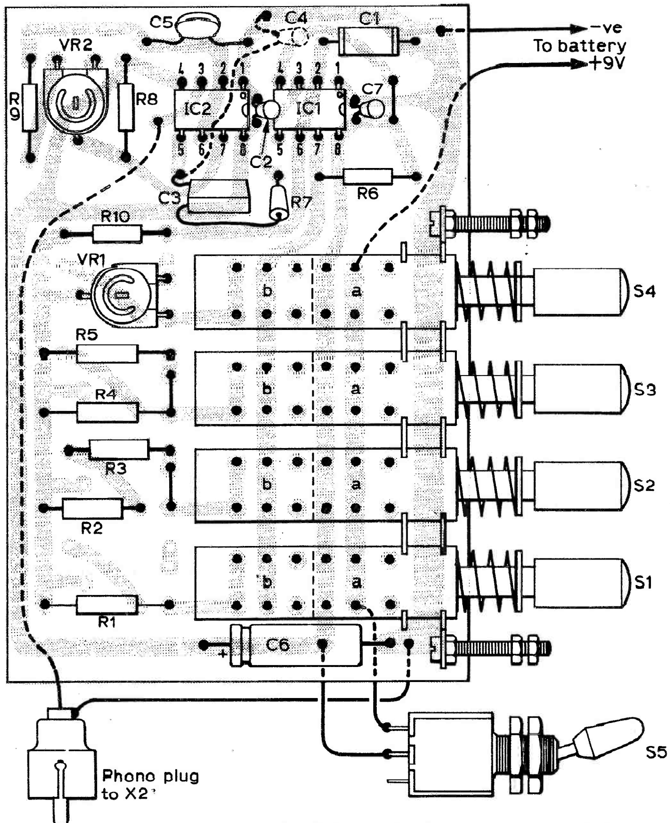


Fig. 6. Circuit of the transmitter or controller, IC1 providing the tones which modulate the carrier produced by IC2 Note:—R10 was inadvertently omitted from components list.



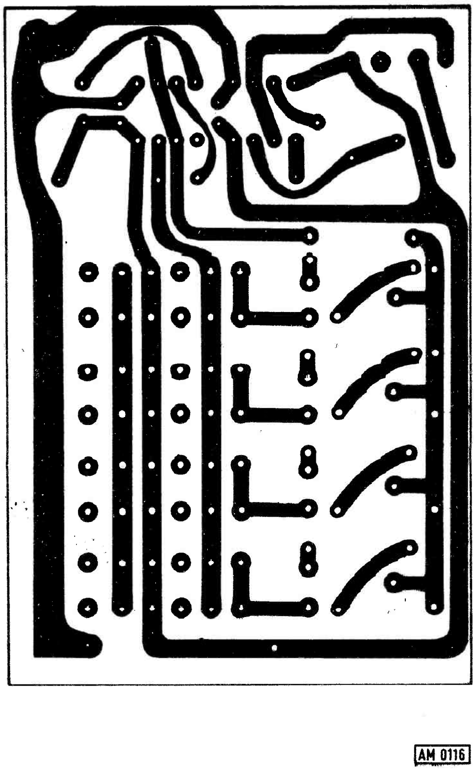
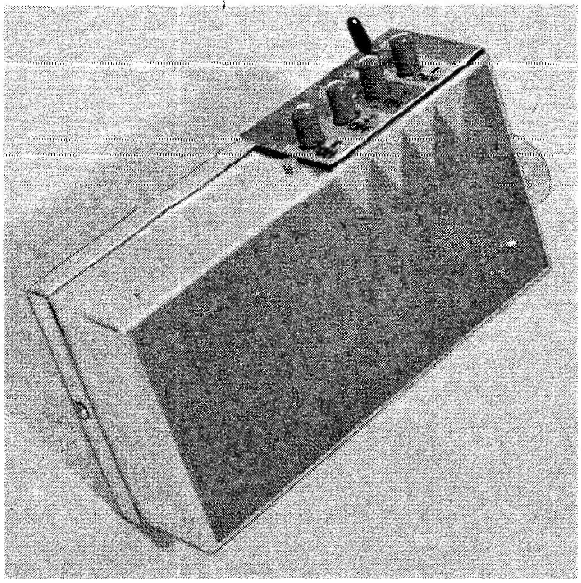
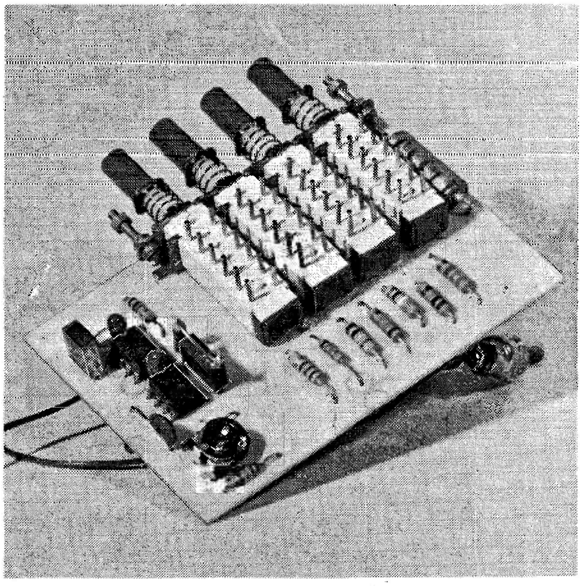


Fig. 7 Actual size layout of the printed circuit board and location of components.



The finished controller, the switch providing "carrier only" control when required.



Completed board ready for mounting into case.

ALIGNING THE TRANSMITTER

1. Operation of the carrier transmitter, IC2, is checked by supplying 9V to the system. Place the transmitter and receiver close together and monitor the output at pin 9 or 7 of the SN76660N. Now tune the transmitter preset on IC2 until the meter reading deflects, indicating the presence of the correct ultrasonic carrier, usually around 40 kHz.
2. Align the ultrasonic tone decoder module as set out in the section on that unit. It may be useful to monitor the output by means of an LED, to indicate output status. The limiting resistor, Rx, should be chosen to suit the available LED, a typical value is 820Ω for a TIL209, Fig. 3.

—continued on page 987

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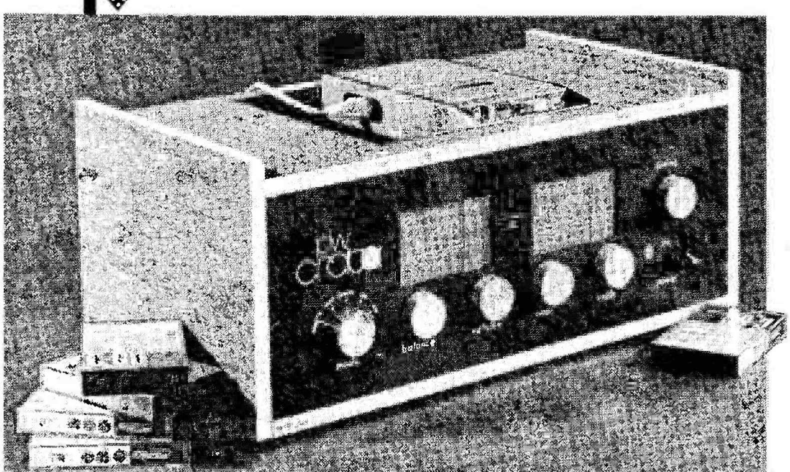

Following the unprecedented success of Project Q4 quadraphonic sound system, Practical Wireless brings you another top design for the home. This is the first British published do-it-yourself domestic high quality tuner amplifier design that includes a built-in cassette recorder, all at a fraction of the cost of commercial equivalents. It is incredibly easy to build if you have basic experience with printed circuit board assembly.

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BENCH STABILISED POWER SUPPLY

DESIGNED AND DEVELOPED BY THE IPC TECH

ALL electronic equipment uses power supplies of one kind or another and so the experimenter needs a variety of DC levels. Power supply stability is unimportant for some circuit designs, but many amplifiers perform better if driven by a stabilised supply and, if it has a really low impedance output, decoupling may be unnecessary. In particular, DC amplifiers require stabilised supplies.

This stabilised supply aims at a professional performance, but uses low cost components readily available to the constructor. The output is fully floating or may be used in twin pack applications (centre-point earthed) described at the end of this article.

BASIC PRINCIPLES

The majority of stabilised power supplies use the emitter follower principle where the emitter takes up a potential slightly less than that applied to the base of a transistor, Fig. 1. A reference voltage from a battery or a zener diode applied to the base of this transistor will yield an output voltage quite well stabilised against load and supply variations. An NPN transistor is shown in Fig. 1, but a PNP will perform equally well in the negative supply line.

Unfortunately, such a simple circuit is seldom adequate, especially if one requires a variable output.

Fig. 1: Basic voltage stabiliser. ▶

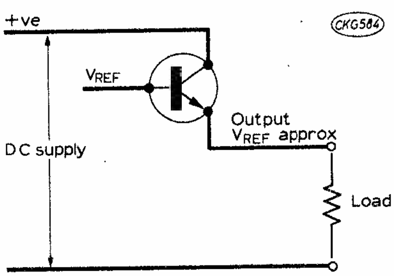

Fig. 2: Improved performance is obtained by use of a difference amplifier. ▼

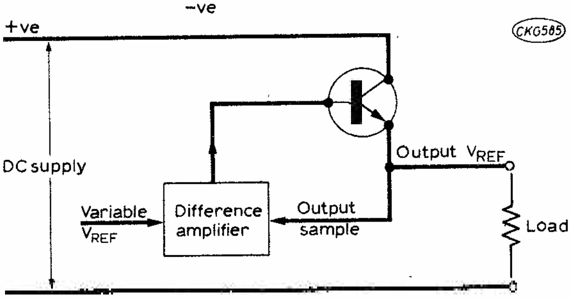

Fig. 3: A 0–30V 1A stabilised supply with overcurrent limiting and voltage and current metering.

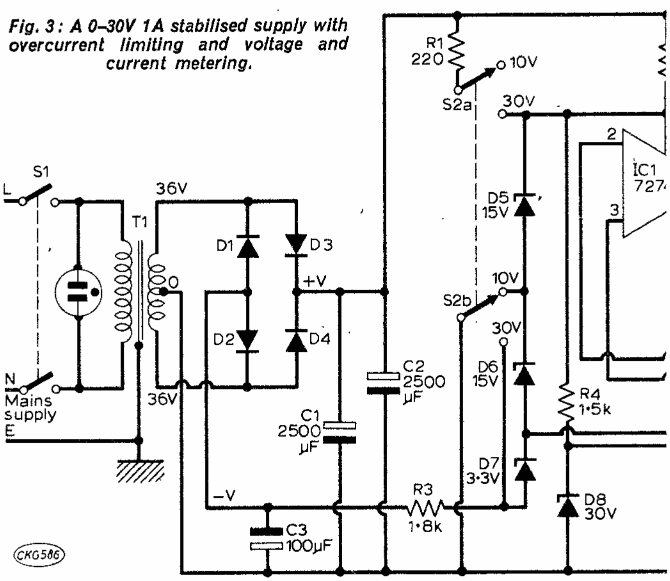

Fig. 2 shows how to modify the basic circuit by adding a difference amplifier to improve stability. A sample of the output voltage passes to the difference amplifier, which compares it with a reference voltage. The difference amplifier has a very high gain, so that if the output voltage increases or decreases compared with the reference, the transistor base voltage immediately moves in a direction which compensates for this change. In addition, because this action is effective up to ripple frequencies, the circuit also provides extra smoothing of the output.

PRACTICAL CIRCUIT

This power supply is based on the circuit of Fig. 2, but incorporates features to overcome practical limitations of the components used. Fig. 3 shows the full

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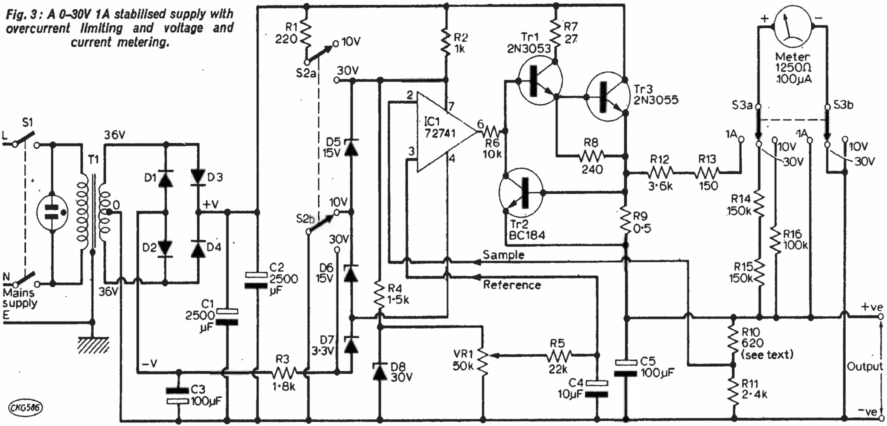
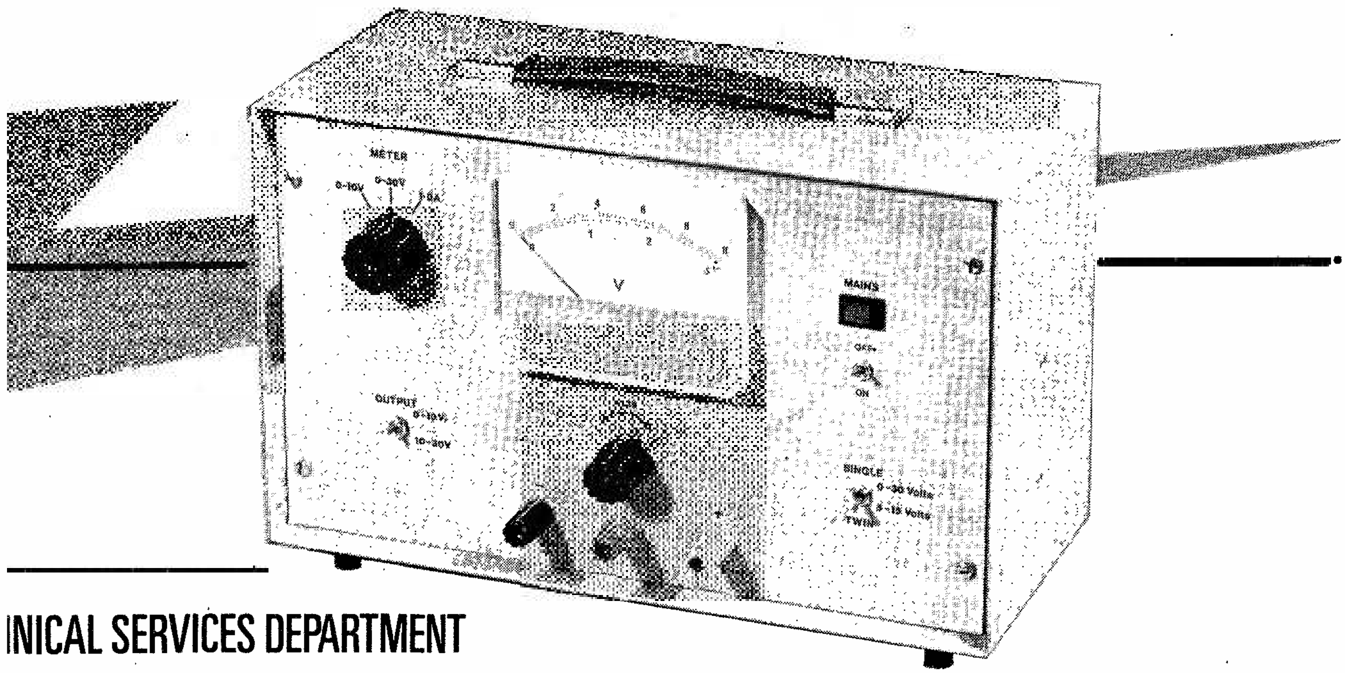
Fig. 3: A 0–30V 1A stabilised supply with overcurrent limiting and voltage and current metering.





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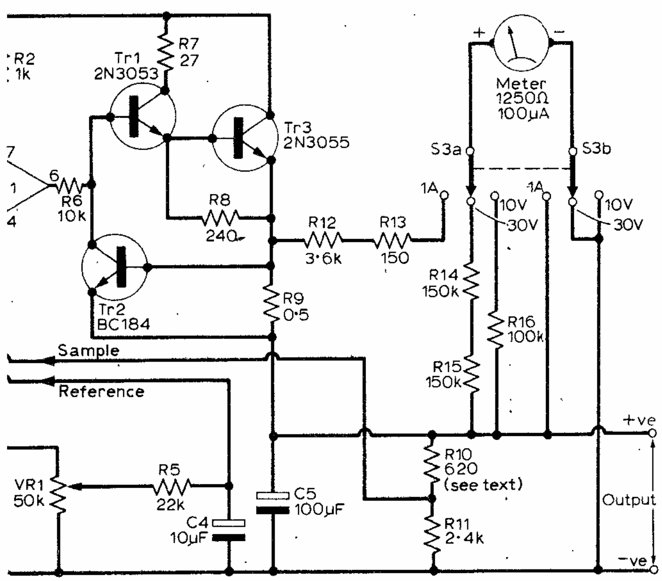


circuit in which a transformer giving 36-0-36V RMS supplies the basic voltage. The transformer voltage is not very critical, windings giving between 32 and 38V would be adequate. For convenience, a bridge rectifier operating as two full-wave rectifiers provides the positive and negative voltage rails, but four separate diodes may be used if preferred. The main positive supply uses two 2,500μF smoothing capacitors, but a single 5,000μF capacitor can be used if available. Negative bias for the reference chain is provided by D1 and D2 and smoothed by C3.

The series regulator (emitter follower) uses a 2N3055 transistor Tr3, connected as a Darlington pair with Tr1 a 2N3053 to reduce the current needed from the difference amplifier IC1. The resistors R10/R11 which sample the output voltage are connected across the output terminals together with C5. R10 may need selecting to ensure that the supply will give its maximum 30-31V output. It is important that R10, R11 and C5 are mounted directly at the output terminals. The output voltage sample from R10/R11 passes to the inverting input of a 741 operational amplifier, which is used because of its low cost and ready availability.

On range 1, which gives 0-10V, the 741 takes its power from ± 15V supplies derived from the main voltage rails by R2, D5 and R3, D6. D7 has no function on this range. The reference voltage is set by potentiometer VR1 which is connected between the ± 15V rails. When switched to range 2, the whole IC1 supply rises positively by 18·3V (D6+D7) and provides a new reference voltage for operating over the 10-30V range. This arrangement is necessary because the 741 integrated circuit will swing between ± 10V satisfactorily, but not reliably outside these limits. However, tests show that the stabilised ranges are in fact rather wider than specified.

Transistor Tr2, whose emitter-base junction is connected across a 0·5Ω resistor R9 in series with the

★ Specification

Voltage ranges
0–10V range 1
10–30V range 2
±5–15V twin pack range 3

Current capability
1A all ranges. Short circuit protection incorporated

Voltage stability
0·3V zero to full load
0·015V per °C
1·5% for 10% mains change

Ripple
1mV off load
3mV full load

Pulse response
Full recovery in 25μS

output, provides current limiting. As the output current rises above 1A, the voltage developed across R9 switches on transistor Tr2. This shunts the control voltage applied to the base of Tr1, reducing the output voltage to a low level. Transistor Tr2 is not critical and a spare lying in the junk box will probably serve for this. One can test the current limiting by supplying 5-10V at 1A and then increasing the voltage until the current stops increasing; if this occurs in the region of 1 to 1·4A the unit will be satisfactory. The current of the design model limits at 1·2A. It is, of course, necessary to use an external ammeter for this test.

METERING

To make a really professional job of this supply, a metering circuit has been incorporated. However, as meters are expensive one can omit this circuit and instead fit a calibrated dial to the potentiometer VR1. This will be suitable for applications not requiring accurate voltage settings. To use a meter which differs from the one specified calculate the appropriate series multiplier resistors.

The following examples, using a 100μA 1,250Ω meter, shows how to calculate the values of the resistors using the formula:—

$$R_{TOTAL} = R\ meter + R\ series = \frac{\text{Voltage range required} \times 1000}{\text{Meter F.S.D. in milliamps}}$$

10 volt range (R16)

$$R_{TOTAL} = \frac{10 \times 1000}{0{\cdot}1} = 100k\Omega$$

Strictly one should subtract the meter resistance from this figure, but in practice the effect is insignificant and may be neglected.

30 volt range (R14+15)

$$R_{TOTAL} = \frac{30 \times 1000}{0{\cdot}1} = 300k\Omega$$

The most satisfactory way of producing this resistance is to use two 150kΩ resistors in series; again one may neglect the meter resistance.

Current range. Since R9 is directly in series with the output current (apart from a small load which R10 and R11 take), it will drop 0·5V at 1A. The meter has to read this voltage to measure the current, using a series resistance obtained from the calculation:—

$$R_{TOTAL} = \frac{0{\cdot}5 \times 1000}{0{\cdot}1} = 5{,}000\Omega$$

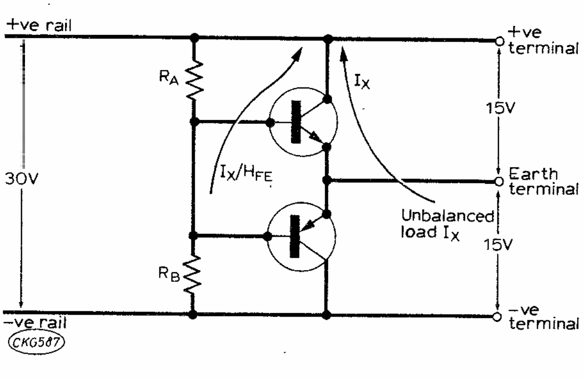
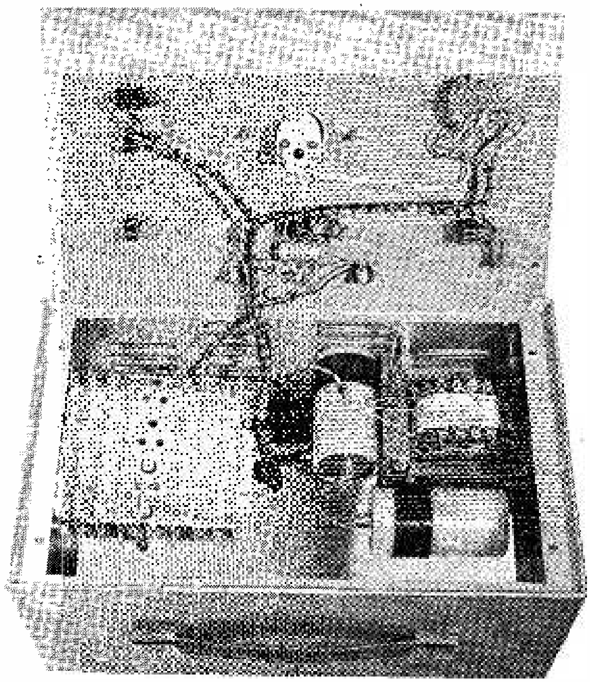


Fig. 4: Basic voltage divider using two emitter-followers.



View with front panel open to show wiring to controls with C5 and R10/11 mounted at the output terminals.

In this case the meter resistance is a significant part of the total and must be subtracted to give the value for R12 & 13 as 3,750Ω. One can make this up from a 3·6kΩ in series with a 150Ω resistor. Close tolerance resistors (2% or better) are essential for the meter circuits.

The current range determines which meter can be used. For example, if one used a 5mA meter the above calculation gives a total resistance of 100Ω, so the internal resistance of the meter would have to be not more than this.

TWIN PACK SUPPLIES

Frequently one needs a positive and a negative supply rail to drive DC amplifiers, operational amplifiers and similar circuits. For these applications one may use two power supplies of the type described, because a floating supply may be connected with either its positive or negative rail earthed. Commercial twin packs usually duplicate the stabiliser circuits and have additional windings on the mains transformer. If a suitable transformer is available, there is no reason why you should not use the same system. However if one is content with lower voltages, then the floating supply can be converted into a twin pack for an additional cost of about £3.

If one connects two equal resistors across the floating output and earths their centre point, the negative rail will be below earth potential and the positive rail will be above earth by an equal amount.

In practice, two resistors are unsatisfactory because the two supply rails will not remain balanced with varying loads, but one can use instead two emitter followers, Fig. 4. In this arrangement the bases of the transistors are connected to a voltage half way across the 30V supply and the emitter follows this voltage. By connecting the emitters to earth one obtains a twin pack supply.

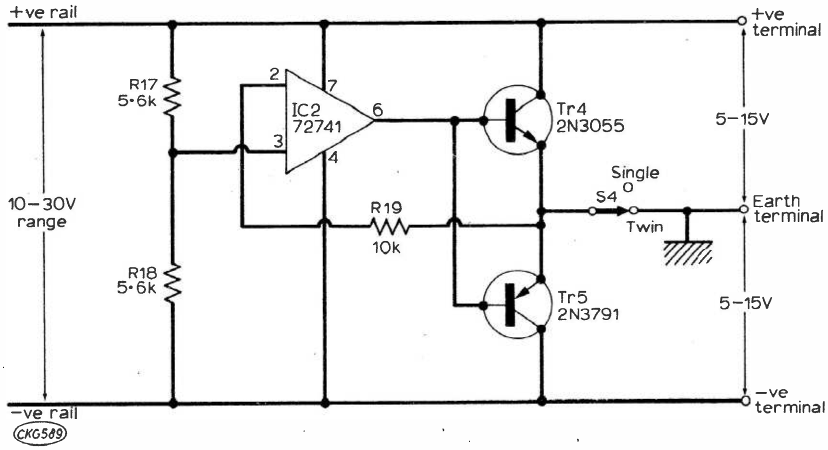
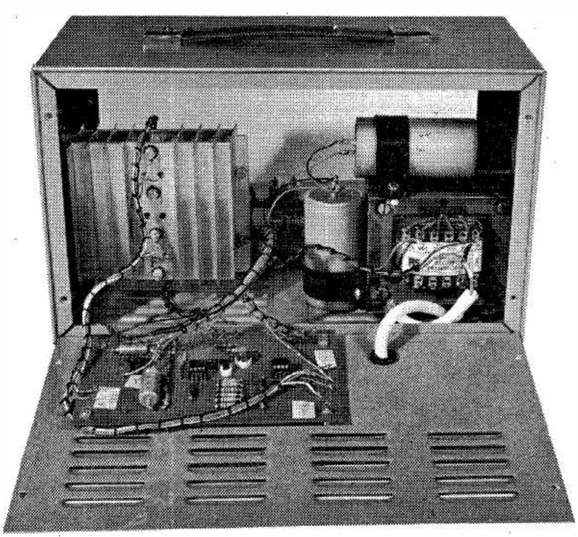


Fig. 5: Adding this circuit across the output of Fig. 3 provides an optional balanced output facility.

The simple circuit shown in Fig. 4 is also unsatisfactory for three reasons. First, short circuits on either of the outputs will 'blow' the opposite transistor. Second, the wattage ratings of the transistors limits the out-of-balance current, so that if one employs low wattage transistors, one must balance the loads carefully. Third, because changes in the out-of-balance current cause an excessive voltage drop in resistor RB, the rails will not be very stable.

Fortunately, one can cure all these faults quite simply by using high power transistors (mounted on a heat sink) driven by a feedback amplifier as shown in Fig. 5. In this arrangement IC2 constantly compares the output of the emitter followers with the reference input, and maintains the balance under all conditions. Because IC2 will not operate at very low levels the voltage range available from this twin pack is limited. However, the range provided (±5-15V) is satisfactory for most applications.

Some difficulty may be experienced in obtaining the 2N3791, used in the prototype. The Motorola MJ2955 (also in a TO3 package) is specified as a PNP complement of the 2N3055 and should be a satisfactory alternative.



View of rear of unit showing circuit board mounted on back panel.

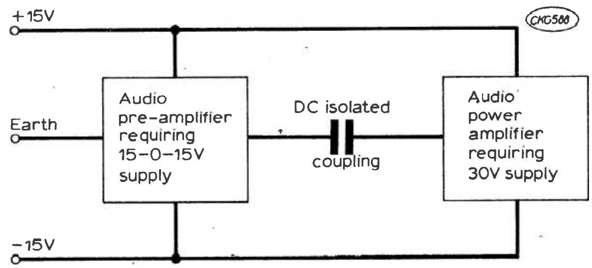


Fig. 6: Powering balanced and unbalanced equipment from a single supply.

In practice, because the very low output impedance makes each rail 'earthy' as far as AC signals are concerned, one can use the full 30V when the supply is wired in this fashion. For example, it is quite in order to connect a 30V amplifier, which is **isolated from earth,** across the terminals and to use a capacitor from a pre-amplifier connected to the ±15V supplies to drive it, Fig. 6.

CONSTRUCTION

A standard instrument case measuring $12\frac{1}{4} \times 7\frac{1}{2} \times 5\frac{1}{2}$in. provides a suitable unit in which to house the power supply. Fig. 7 shows the front panel marked out ready for drilling.

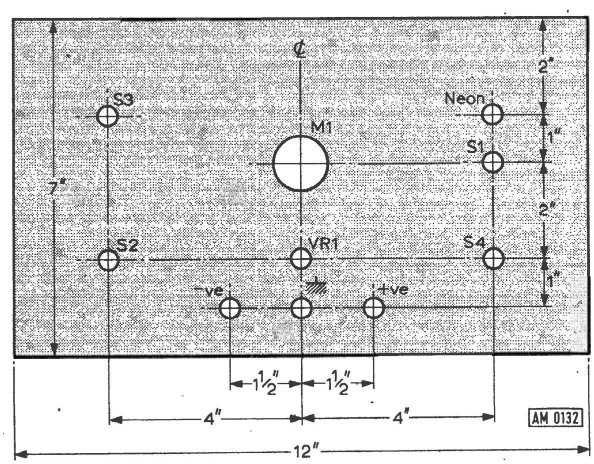


Fig. 7: Drilling dimensions for the front panel. Hole sizes should suit the components used.

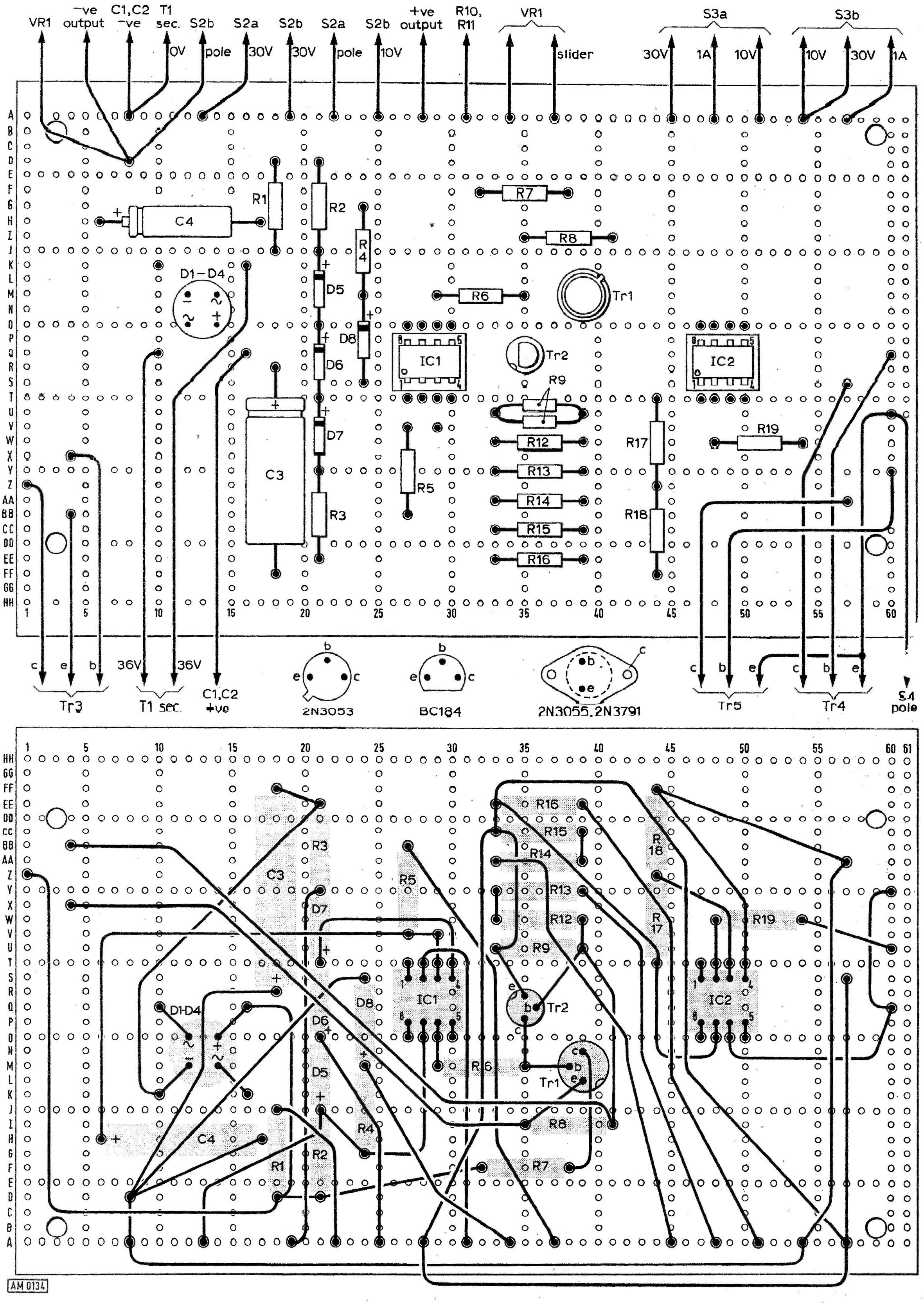


Fig. 8: Layout of component and wiring sides of circuit board. All components are mounted on terminal pins.

★ components list

Resistors

R1	220Ω ½W 5%	R9	0·5Ω 1W 5%
R2	1kΩ 1W 5%	R10	620Ω ½W 5%*
R3	1·8kΩ 1W 5%	R11	2·4kΩ ½W 5%
R4	1·5kΩ ½W 5%	R12	3·6kΩ ½W 2%
R5	22kΩ ½W 5%	R13	150Ω ½W 2%
R6	10kΩ ½W 5%	R14	150kΩ ½W 2%
R7	27Ω ½W 5%	R15	150kΩ ½W 2%
R8	240Ω ½W 5%	R16	100kΩ ½W 2%
VR1	50kΩ ½W Linear	* See text	

Capacitors

C1	2500μF 63V	C4	10μF 63V
C2	2500μF 63V	C5	100μF 63V
C3	100μF 63V		

Semiconductors

Tr1	2N3053	D1–D4	1A 100PIV bridge*
Tr2	BC184*	D5	BZY88/C15
Tr3	2N3055	D6	BZY88/C15
IC1	SN72741	D7	BZY88/C3V3
* See text		D8	BZY88/C30

Miscellaneous

S1 DPST Toggle. S2 DPDT Toggle. S3 2 pole 3 way wafer. Meter 100μA 1250Ω (RS Components MR31S). Transformer 36-0-36V 1·1A (RS Components "Univ. Rec. Tr"). Neon panel lamp (250 VAC). Plain Veroboard 0·1 in. matrix, 6 x 3¾in. TO3 heatsink (Chromasonic Electronics). TO3 mica washer and insulating bushes. Transistor and IC sockets. Terminals. Instrument Case Olson 27A (Home Radio). Knobs.

Additional components for Twin Pack output.

Resistors

R17 5·6kΩ R18 5·6kΩ R19 10kΩ
All ½W 5%

Semiconductors

Tr4	2N3055	IC2	SN 72741
Tr5	2N3791 or MJ2955		

Note:—The 2N3055 and MJ2955 are available at 63p and 73p respectively, plus VAT, from Jermyn Home Electronics, 112 Vestry Estate, Sevenoaks, Kent. Post and packing 25p per order.

Miscellaneous

S4 SPST Toggle. TO3 heatsink (Chromasonic Electronics). TO3 Mica washers and insulating bushes (2 sets). IC socket.

With the exception of the two 2500μF capacitors, which are attached with insulating "P" clips to the transformer, all other components are assembled on a 6 x 3¾in. 0·1 matrix plain veroboard. This is mounted on the back panel using 6BA spacers to give the required clearance.

The layout of the board Fig. 8 does not pose any problems. One can work logically through the circuit diagram starting with the bridge rectifier at one end of the board, and progressing through to the output of transistor Tr1 at the other end. Links between components on the circuit board and points elsewhere in the unit should be made via terminal pins on the edge of the board. Flexible wiring connects these pins and the external components.

ASSEMBLY

First the transformer and heat sinks are mounted inside the case, Fig. 9. Depending upon its size the transformer may foul the output switch mounted on the front panel, in which case it must be moved back. The two heat sinks carrying the transistors Tr3, Tr4 and Tr5 are bolted together and attached to the side of the case using a simple bracket. Mounting these transistors so that their base and emitter connections are accessible when the front and back panels are removed makes wiring and testing easier.

Finally, the interconnecting leads have to be attached to the panel, transformer and power transistors. The transformer wiring is kept separate and wired directly to the mains switch, indicator neon and bridge rectifier connections. The three wires from the output terminals, namely positive, negative and sample, are critical and are loomed together to run directly to their respective circuit board connections.

The remaining interconnecting wiring is also loomed together for neatness, and in consequence wire identification is necessary. The number of wires involved makes colour coding impracticable, so a simple method of wire identification or masking tape marked with letters can be used instead. As a precautionary measure wire lengths should be kept to a minimum, but they should be long enough to allow the back and front panels to be laid flat. ■

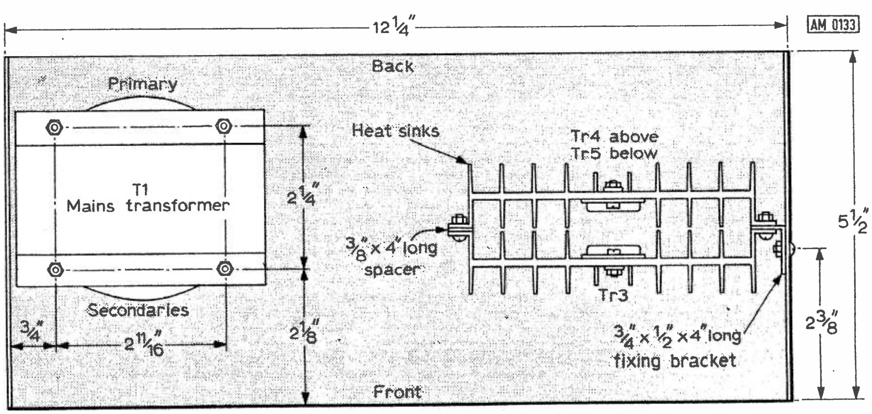


Fig. 9: Plan view showing mounting details of mains transformer and power transistor heatsinks.

A complete kit!

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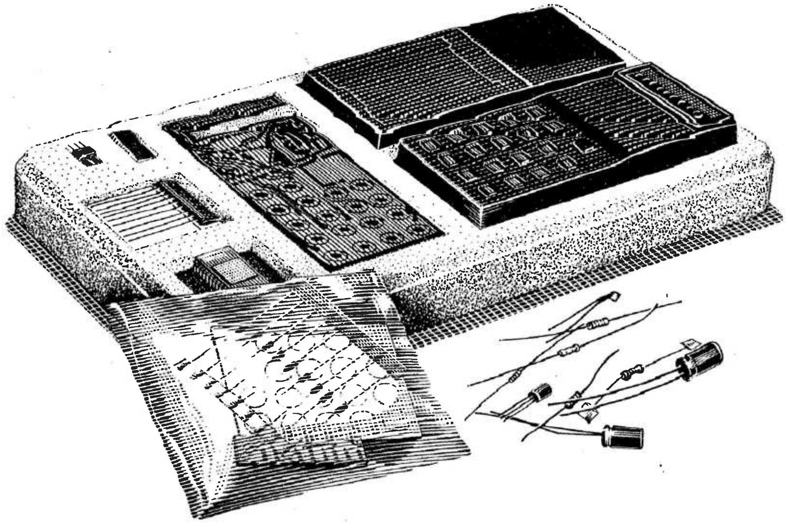
Assembly time is about 3 hours.

Contents:

1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



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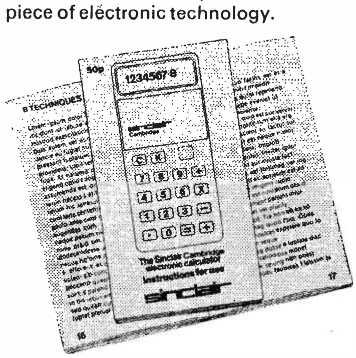

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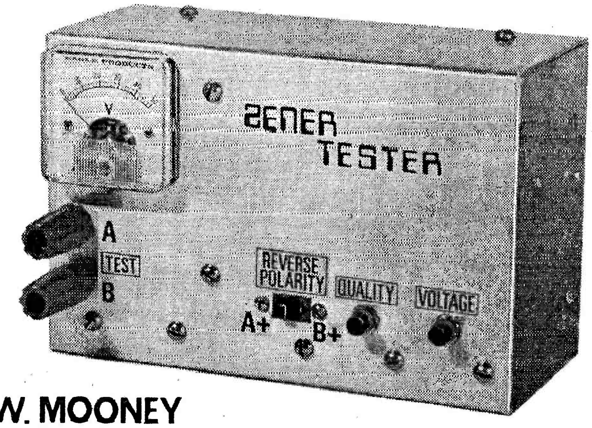
ZENER DIODE TESTER



W. MOONEY

THIS zener diode tester is an inexpensive push-button device which quickly gives the stabilising voltage of a zener diode and an indication of its quality in a matter of seconds. The tester may also be used to determine the polarity of the diode, which is sometimes difficult to establish from visual checks. The instrument may also be used as a "go"-"no-go" tester for normal diodes.

Because of its speed and ease of use, this piece of apparatus is therefore a must for the "Unmarked and untested" device enthusiast and a very useful tool for any electronics workshop.

Although mainly for bench use, battery operation is still desirable so the tester is therefore powered by an internal PP9 battery.

THE CIRCUIT

Most zener diodes in use lie in the range 2V to 30V. Many such diodes will be outside the range of a single 9V battery so some means of high voltage generation must be available. It is possible to obtain the voltage required by the use of two or three 9V batteries in series but this is expensive in the long run and the replacement of batteries can become tiresome. A single transistor/inverter is therefore used to provide the required voltage from a 9V supply.

The inverter consists of a power transistor in an oscillator circuit using a ferrite ring on which is wound a high voltage secondary giving about 200VAC off load. Although the dissipation in the transistor is only about ½W a 2N3055 power transistor is used as these are readily available and will take a lot of abuse during setting up, without failure.

A ferrite ring is used in the transformer resulting in low external radiation and high efficiency. The AC voltage developed across the secondary winding is rectified using a silicon bridge. In the setup described the DC generated can reach around 250V if there is no diode connected to the test terminals.

As can be seen from Fig. 1 the oscillator is very simple in design. On pressing S1, the "Voltage" switch a current flows in the collector winding caused by the bias resulting from R1. The increasing flux in the core causes a feedback current in the base circuit in the correct phase to sustain oscillation. The frequency is a function of the value of R1 and C1 and the collector winding inductance, and greatly depends also on the load applied to the secondary winding. The frequency resulting is in the region of 50kHz and the current in the collector approximates to a squarewave.

The rectified output is applied to C3 via R2, with the zener to be tested connected to terminals A and B. The voltage on C3 builds up until the zener begins to conduct, at its reference voltage. The switch S3 is used to reverse the voltage applied to the zener should it be connected in the forward biased direction. A voltmeter connected across C3 will thus read the zener voltage. Depression of S2, the "Quality" switch, increases the current in the diode to about twice its original value. An increase in the voltmeter reading will result due to the dynamic resistance of

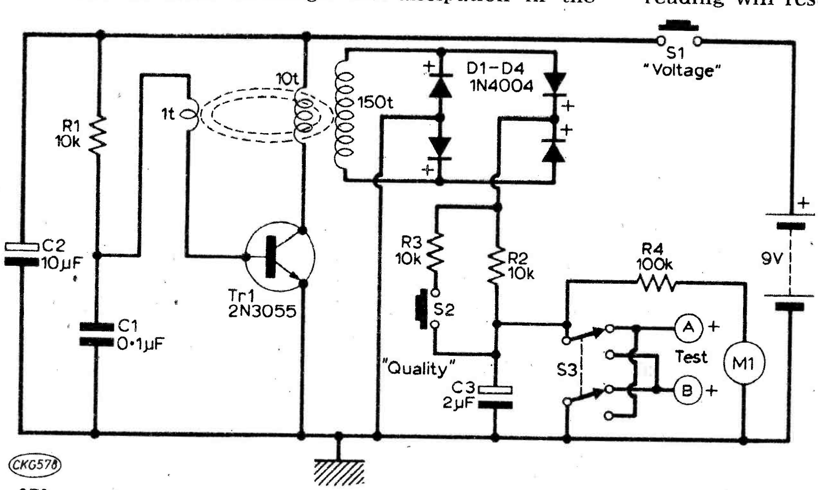


Fig. 1: Circuit of the diode tester. Rectifiers D1/D4 could be a single bridge unit. Layout of components is not critical. Panel layout can follow that used by author, as in the heading photograph.

★ components list

Resistors
R1 10kΩ ¼W — R3 10kΩ ¼W
R2 10kΩ ¼W — R4 100kΩ 5% ¼W

Capacitors
C1 0·1μF polyester — C2 10μF 12V
C3 2μF 400V

Semiconductors
D1–D4 1N4004 — Tr1 2N3055

Miscellaneous
S1,S2Pu sh-to-make switch. S3 DPDT slide switch. Meter 500μA FSD. Terminals (2). Case, 6 x 4 x 2½in. approx. Battery PP9 (9V) and terminal clips. Tag strips. Ferrite rings (2) FX1593 (Hawnt Electronics Ltd, 112 Pritchett St., Birmingham B6 4EN, 25p a pair inc.). Insulating kit for 2N3055.

the diode but in a good zener diode the increase should hardly be visible on the meter. The voltmeter consists of M1 and Rm giving a FSD of 50V.

COMPONENTS

The oscillator transistor is a 2N3055 and a specimen with a DC current gain of at least 30 should be chosen. Most devices will meet this requirement but the author has come across devices with gains as low as 2.

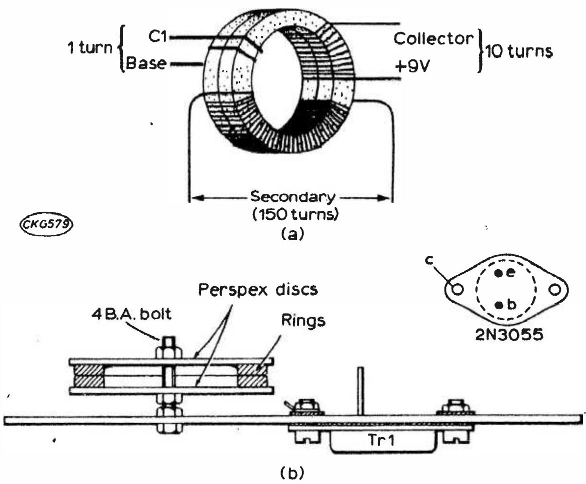


Fig. 2: Details of the construction of the oscillator transformer and its mounting on plate with the transistor. Two ferrite rings are used, taped together.

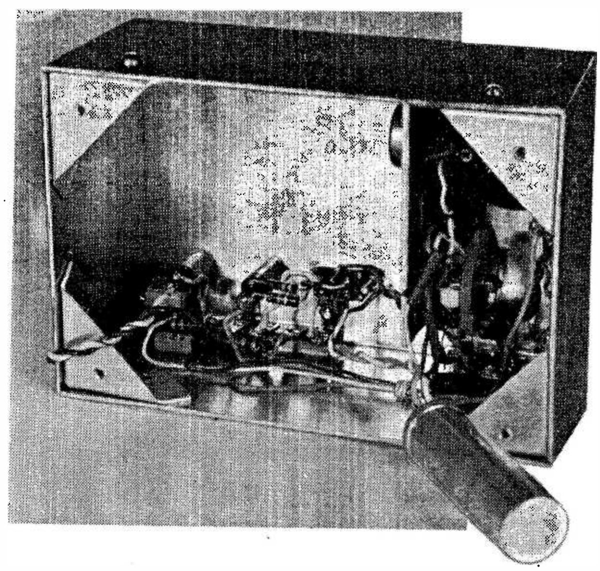
The ferrite rings have plenty of space for easy winding. There are many rings available which are of similar dimensions and although the magnetic properties may not be known, in a simple application like this, most rings will suffice. A little experimentation with the number of turns in the feedback winding should result in success as the setup is far from critical, Fig. 2. The windings on the ring are all pilewound. The feedback and collector windings are made from thin insulated connecting wire. The secondary consists of 150 turns of 30 SWG enamelled copper wire.

CONSTRUCTION

As the layout is in no way critical most constructors will have their own ideas on positioning components. The only important criterion; for right-handed people the "voltage" and "quality" buttons should be on the right hand side of the cabinet and the terminals on the left, the meter being unobscured somewhere in between. In this type of instrument the front panel is best in the horizontal position as in the case of testmeters.

The transistor does not require a heatsink but may be mounted on an aluminium bracket for convenience using the usual insulating mica washer. The transformer may also be mounted on this bracket. A screened cabinet is desirable as severe radio interference can result in the low frequency end of the RF spectrum from harmonics, when the oscillator is running. The original unit was constructed using a ready-made chassis size 6in x 4in x 2½in deep. The front panel layout is shown in photographs. The components were mounted on tagstrips which were bolted to the chassis at convenient points.

A base plate was cut from 1/16in aluminium and four rubber feet attached, the plate held to the cabinet with four self-tapping screws. The battery was held in place with a wad of foam rubber. The PP9 is quite heavy, however, and would best be held in place with an aluminium bracket made for the purpose.



Rectifier diodes D1/D4 are mounted on a tag strip below the oscillator transformer. Remainder of small components are on a tag strip in lefthand compartment.

OPERATION

A zener diode may be considered as a perfect zener in series with a resistor as in Fig. 3. The lower the value of Rd the better the stabilisation will be. A graph of current against voltage for the resistive part, the zener part and a combination of the two is shown in Fig. 4a, b and c. It can be seen that an increase in current from A to B results in an increase in reference voltage from a to b in Fig. 4c. If the

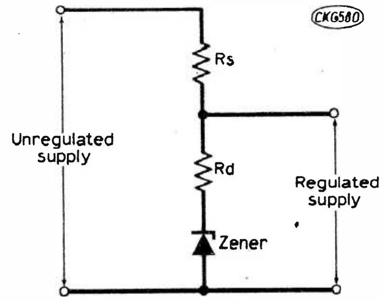
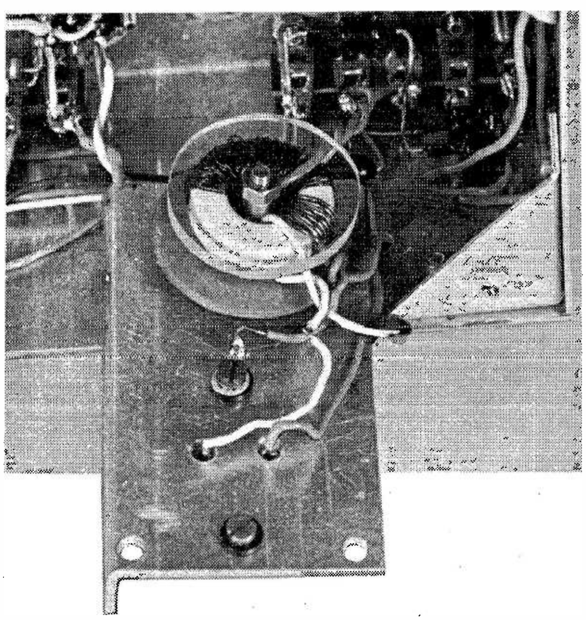


Fig. 3: Circuit of a perfect zener diode with a series resistance approximates the zener diode in practice.

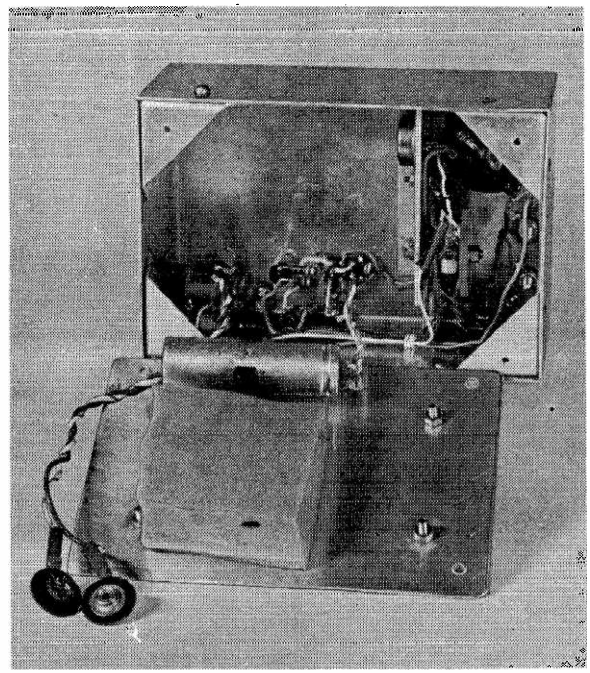
resistive component is very small the plot becomes as in Fig. 4d, a similar increase in current now causes only a small change in reference voltage. In a normal diode the situation is in Fig. 4d.

The portion of the graph marked k in Fig. 4b is called the knee and is usually less than 1mA. The instrument described supplies a current of over 1mA in all cases, therefore this effect should not normally be encountered.



Close-up of the oscillator transformer and its associated transistor removed from case. The one turn base winding is clearly seen.

Assuming that the diode polarity is not known, it is connected across the terminals A and B and the "voltage" button pressed. If the voltmeter reading is very low, say about 0·2V then this is probably the forward biased direction, in which case the polarity should be reversed by operation of S3, and the voltage button pressed again. The meter will (a) rise to the zener voltage, in which case the "quality" button should be pressed, or (b) remain low, in which case the diode is useless, or (c) the voltage will continue to rise and probably go off scale in which case it is an ordinary diode (or a zener with a higher voltage than 50V which is unlikely).



Capacitor C3 is held by a clip to the bottom of the box. A smaller sized capacitor could be fitted inside the box.

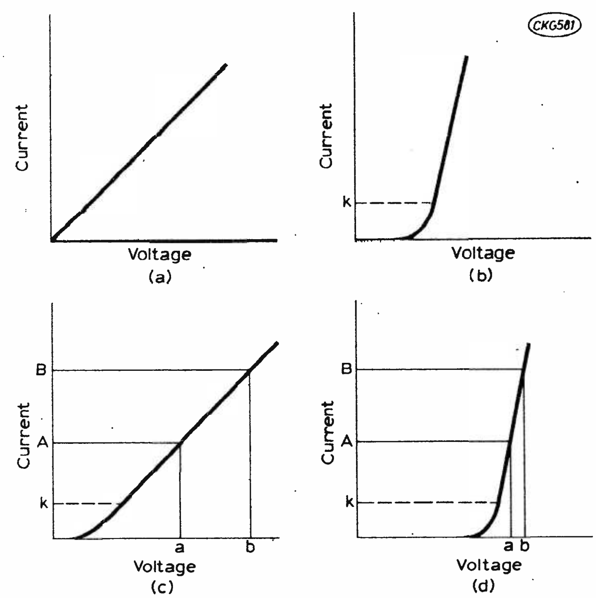
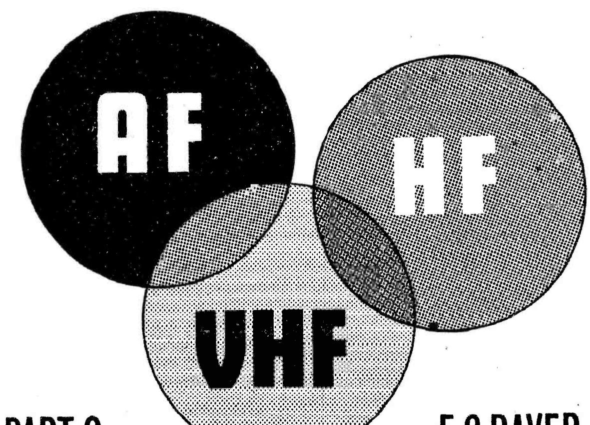
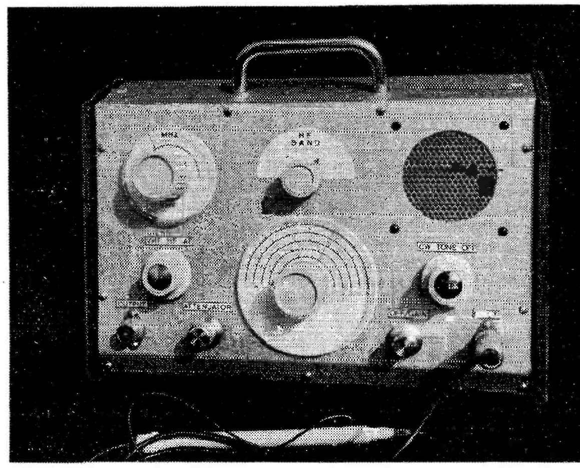


Fig. 4: Four graphs to illustrate the operation of a zener diode as described in the text.

Some diodes which are damaged read a high voltage in both directions, acting as a resistor, pressing the quality button causing a substantial increase in the meter reading.

Base emitter junctions of some silicon transistors have low reverse breakdown voltages, in the region of 5V, and act as excellent zeners. To test these the collector lead is left open circuit and the base and emitter leads connected to the instrument as in the case of a normal diode. ■





PART 2

F. G. RAYER

TROUBLE-TRACER

BRIEF details of the way in which the Trouble-Tracer can be used should prove of help. In some cases a faulty stage may be located with equal speed by using either the generator or the tracer facility. But in other cases one method will be better than the other, so the manner in which faults can be located by either means is outlined. The same general method of working will apply with circuits other than those which are given as examples.

The VHF and HF oscillators produce an unmodulated radio signal which produces no audio output when tuned in with a radio receiver. This unmodulated or CW signal will, however, operate a receiver tuning meter and is used for adjusting some circuits where modulation is not required (e.g., a crystal filter).

For almost all general tests and similar purposes, the tone generator must be switched on. The radio frequency signal, when tuned in with a receiver, then produces an audible tone, which is heard in the receiver speaker. The RF output is also modulated in this way when it is applied to IF stages and an audible indication is required from the radio receiver or equipment being checked.

RF/IF TRACING

Fig. 1 shows typical mixer and IF stages of a receiver. Assuming no results are obtained, a meter has shown that the correct voltage is present from the negative to the positive supply lines, but no audio signal is found at VR1. Therefore the fault must lie in the mixer or IF stages. With the RF probe applied at point 1, one or two local stations ought to be heard on tuning round. If not, the fault is sought in the mixer stage Tr1. Check by testing aerial and oscillator coil windings for continuity and by testing resistors and capacitors as well as Tr1. (More detailed investigation of this stage is possible with the generator.)

If signals are heard at point 2 IFT1 is probably in order. If signals disappear at point 3, Tr2 is not working. So resistors etc. in this stage would be tested. If necessary, a detailed check can be made along any circuit. When transferring the prod from the primary to secondary, such as from 4 to 5 of IFT2, a reduction in volume would be usual, but loss of signals altogether would indicate that IFT2 is probably faulty. Possible localised breaks in a circuit should not be overlooked.

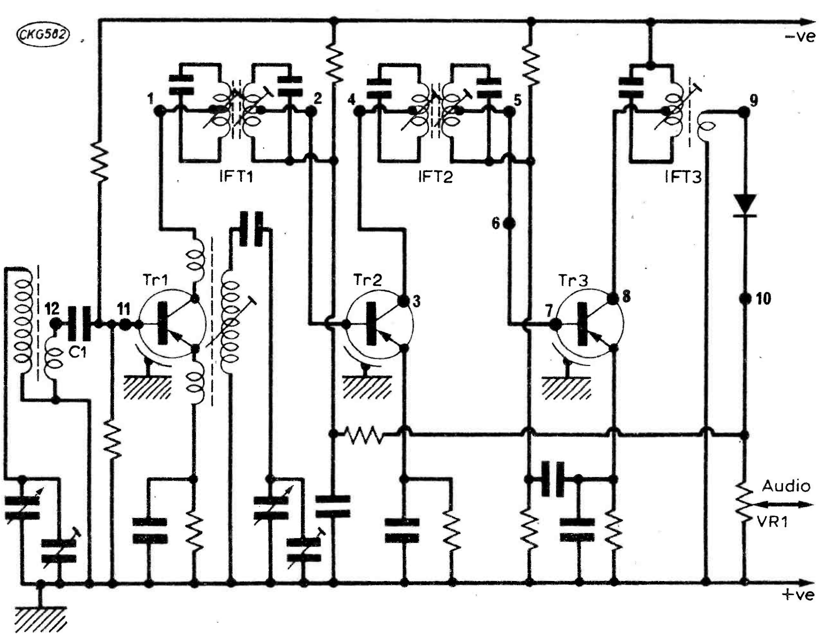


Fig. 1. Essential parts of a circuit comprising a mixer and two IF stages of a receiver to demonstrate fault-finding techniques.

For example, if signals are found at the actual pin of IFT2, point 5, but not at the lead or foil conductor 6, then the soldered joint here needs investigating. Also, if the signal is present at 6, but not at the emitter of Tr3, there is a crack in the foil, or other circuit interruption.

When bringing in a new stage, such as moving from 2 to 3, or from 7 to 8, a considerable increase in volume is to be expected. A test at 9 shows if IFT3 is working. An audio signal should then be found at 10. If not, test D1 and associated circuits.

It will be seen that the method of working is logical and very simple. When the part of the circuit which is defective is brought into use, signals cease.

USING THE GENERATOR

Assuming that the receiver audio section is working, the faulty stage in Fig. 1 may be localised by injecting RF from the generator. In this case, point by point working is carried out **backwards** through the circuit. If the receiver has a 455-470kHz IF, inject at point 8 with a prod from the RF output socket and tune the generator, on the correct range, until the modulated signal is heard. Then transfer the prod to points 7, 5, 4 and 3 systematically. In this way, a stage or IFT can be checked, as well as foil or other conductors. For example, if the generator signal is heard with the prod on IFT2 pin 4, but ceases when the prod is on point 3, the conductor from 4 to 3 needs examining.

Stage by stage checks at intermediate frequency will proceed to point 11, mixer base. With the IF applied here, all the IFT cores (five in Fig. 1) should peak correctly. If not, and results are poor, suspect the IFT which will not tune properly.

For RF tests, tune to the appropriate frequency. Band coverage can be checked with the generator, using very loose coupling from the output lead. Either take it to a loop of a few turns near the ferrite aerial, or place the lead near the aerial. When checking tuned circuits, a prod should not be applied directly to them when they are being trimmed. As an example, a prod can be taken to 4, to check IFT2, but if IFT2 is being adjusted, the prod should be taken to 2, IFT1, or an earlier point. If this is not done, stray capacitance from the prod and lead will upset alignment.

TRACING IN AF CIRCUITS

Fig. 2 is a typical audio amplifier, or audio section of a receiver. With an ordinary prod or preferably a prod on a screened lead with earthing clip taken to point 1, signals should be heard on the tracer speaker. If not, the tuner, pick-up, or other source of audio signals needs investigating.

The signal should similarly be present at 2, and should be much amplified at 3. If not, check Tr1 and associated resistors etc. The source of a trouble, such as distortion, may sometimes be quickly found by this means. For example, if quality is normal at 2, but poor at 3, Tr1 is probably not operating correctly. Its base, emitter and collector resistors should be checked first, including the possibility of a break in the circuit such as at point 4.

Moving to point 5 tests C2 and its conductors and joints. Even more volume should be found with the prod at point 6. If not, check T1 primary, and other items in this stage. Either point 7 should give equal volume. If not, test T1. If the signal is found here, but the set's speaker is not working, check the output stage Tr3/Tr4, T2 and associated items.

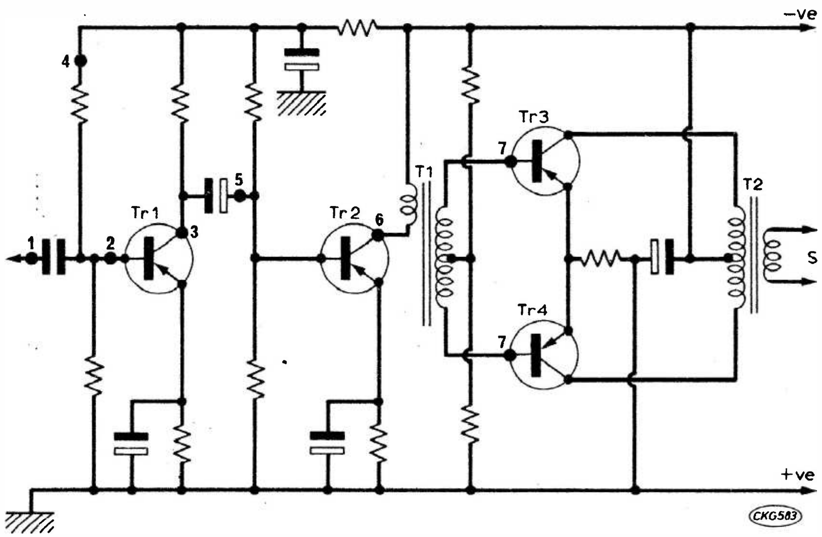


Fig. 2. Basic circuit of a three stage audio amplifier referred to in the text.

GENERATOR TESTS AT AF

Such circuits can be checked also with the audio tone generator. Point by point tests are then made backwards through the equipment, as described for IF circuits. For example, if injecting a signal at 6 Fig. 2 produces an output in the equipment speaker, but not when the prod is moved to 5, then the stage containing Tr2 is faulty.

When a faulty stage has been located, a more detailed check is made to find the resistor, capacitor, or other defective item or to locate the exact fault. It is possible to use both the generator and tracer simultaneously, to check any stage, and this can be useful when there is more than one fault. As an example, injecting AF at 5 and testing for AF at 6 shows if Tr2 is working. ■

ON THE AIR

AMATEUR BANDS

SHORT WAVES
by DAVID GIBSON, G3JDG

HAPPY New Year, and I trust that there's a goodly crop of Santa-delivered receivers all eagerly swishing their antennae about with a view to sending in a luscious log. AR88 owners will, no doubt, have received a crane for ease of servicing!

Each year, most of the Amateur fraternity make huge numbers of New Year resolutions—how many did you keep from last year? More seriously, 1974 should be a "good" year for Amateur Radio and it really is well worth while making a few resolutions. How many receiving stations, for example, have an oscilloscope? They're not difficult to make, and for an s.w.l. it doesn't have to be a complex instrument. Commercial 'scopes are easily available and they offer an invaluable aid. One useful application is to couple a 'scope into the i.f. of the receiver. In this way, you can actually see the signal you are receiving. If you transmit, say, c.w., then by using the receiver/oscilloscope arrangement as a monitor you can observe the keying waveform.

Perhaps the best resolution for the s.w.l. is simply "Better reports for 1974". An s.w.l. QSL card can look very pretty, but remember that it's the information on it that is of interest to the transmitting Amateur. If your card simply has a rubber stamp approach—RST/date/time/mode/please QSL OM, then your chances of getting a QSL in return are minimal. Put as much information as you can into the report. Don't be afraid to write additional notes or even a letter if the report warrants it. Don't forget the conditions on the band at the time of the report. If you hear a station in, say, Brazil, then it will be of interest if you noted that other stations were fading or that Brazil was (or seemed to be) the only S. American area coming in but that many VE stations had been heard at an average strength of RST 559 or whatever.

Projects; we all build these—at least I hope we do. How about planning your projects this year. Plan it and then do it before you move on to the next thing. A grid dip oscillator (GDO) or a solid state version is invaluable and extremely simple to build—and inexpensive. How about making one and playing antennas this summer? You can plan various types of aerials to experiment with. For a wire antenna, ordinary cheap bell wire will do for summer experiments. You can check the resonance of lengths of coax and numerous other things all with a simple g.d.o.

For the transmitting Amateur the resolution must be "Better use of the Bands". Four metres is a must. Don't forget RAEN (Radio Amateur Emergency Network). This organisation has various Nets and carries out exercises on 70MHz. This might make interesting listening for s.w.ls too. Information on this from the RSGB, 35 Doughty Street, London, WC1N 2AE. While you're at it, why not join the Society?

In answer to impassioned pleas in the post from flat dwellers and unfortunate s.w.l. brothers in "No aerials allowed" environments some words of comfort. A length of flex round the picture rail can work wonders and you don't even need a back garden! In a room only 8ft. square, you can put up a twenty metre dipole (16ft. each half and fed in the middle with coax). Don't forget the loft. Quite ingenious antenna systems have been constructed up there by many Amateurs. A four metre beam can be used in some lofts. Even in the smallest, it's possible to wind some flex round the beams and feed the end with an aerial tuner unit (a.t.u.) on all bands from 160 metres to ten metres. So how about an evening's thought to some serious Amateur Radio New Year resolutions?

Readers' Logs

Stanley Sharred (Birmingham), tells exciting tales of happenings of which the following is passed on; listen 2330hrs for KV4FZ on top band. Stanley's best on 160 metres; DK2QL, DK3BJ, DL0PG, HB9ANW, OE3SGA, PA0HIP all on s.s.b. while on c.w. (same band); OK2PEW, VO1KE, W3ZQW, K1NOL, PY6APM, SV1DO, UQ2GCT, K2ANR, KV4FZ, OH3NB/OHS, OK1AYY, OK1FCW, OK1MCW.

P. Barber (Co. Durham) gives a list of stations who are transmitting slow scan television on 14MHz. Frequency quoted is 14230kHz and callsigns heard include: F3RT, F6AZO, F6BIG, F6BKB, F9IB, G2BAR, G3LIV, I1PRQ, I3HDC, I8PSX, I8TMY, JA7FS, OD5HC, OZ4EDR, VE3FCN, W4LAS, W8BT. Connections to the receiver from the slow scan television monitor are made via the phone jack. How about a resolution to look into s.s.t.v. this year?

Glyn Fisher (Rutland), HRO tuning 4—6MHz m.o.s.f.e.t. converter, sends in a list of goodies heard high up on 144MHz. The antenna is a Vee dipole in the bedroom: DC1EU, DK1IE, DL3TR, F1BCD, F1CBH, F1CCP, F1CEC, GD2HDZ, GW8FTA/P, ON4PB, ON5GF, PA0QC, PA0VV. Glyn wants to know of any modern receiver which covers 4-6MHz continuous. At present he can only think of an HRO or Canadian 52 set—anyone any ideas?

BROADCAST BANDS

Short Wave Reports by 15th of the month to Malcolm Connah, 59 Windrush, Highworth, Swindon, Wiltshire, SN6 7DT.

Medium Waves Logs to Charles Molloy, 132 Segars Lane, Southport, PR8 3JG.

VHF/FM Reports to Simon David, c/o Practical Wireless, Fleetway House, Farringdon Street, London, EC4A 4AD.

AMATEUR BANDS

Short Wave/VHF

Logs in alphabetical order please by 15th of the month to David Gibson, G3JDG, 12 Cross Way, Harpenden, Hertfordshire.

ON THE AIR

BROADCAST BANDS

VHF/FM DXING

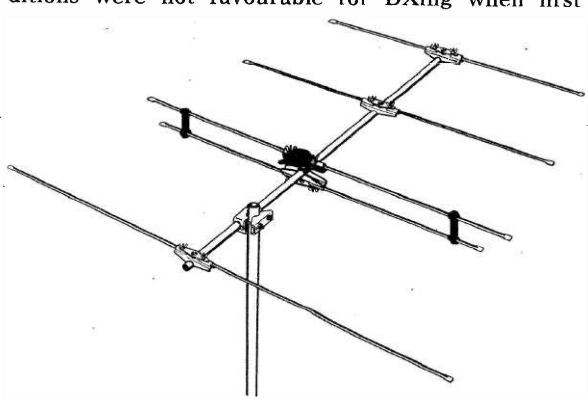
by SIMON DAVID

ENCOURAGING news from the BBC is that more than 99 per cent of the U.K. population can receive v.h.f. broadcasts. Of these, two-thirds are within the service areas of transmitters carrying Radio 2, Radio 3 and Radio 4 stereo programmes. This should provide considerable encouragement for those not yet converted to f.m.

Tuner sensitivities these days are such that you could get by temporarily with the proverbial "wet-string" aerial if you are within good striking distance of the transmitter. One of the *P.W.* authors, Roland Perry, has done this in his second floor apartment room at Cambridge. Roland writes: "The aerial is three feet of wire draped along my desk and at one time or another I have heard BBC Radios Solent, Oxford, London, Nottingham, Humberside, Sheffield, as well as Capital Radio and LBC". Radio 4 transmissions from as far away as Rowridge have also been heard. His cascode f.e.t. preamp is obviously largely responsible.

In Lisburn, Co. Antrim, Mr. R. Montgomery proudly received Radio 3 in stereo for the first time on 91·3MHz. Interesting point here is that he uses a vertically polarised J-Beam 'H' aerial. He also receives stereo from Southern Ireland, Radio Telefis Eirean and Radio Na Gaeltachta.

Talking of "wet-string" aerials I have tried something of this sort with a clip attached to my wall shelving rack. Results some 40 miles North-West of Wrotham were quite good and even produced some surprises from commercial radio. I have been trying out the new FM264T 6-element array from Antiference. This is a combination of the well known "Mushkiller" array with a "Trumatch" dipole. Conditions were not favourable for DXing when first installed, but the mild spell in early December improved matters considerably.



The FM244T

It is easily installed and when lined up in the direction of South-East I have first-class reception of all the Wrotham and Croydon transmissions plus Radio Medway. Also pulled in were Lille 88·8MHz and 98·1MHz, Rheims 98·7MHz, although the latter was not a very strong stable signal.

Reducing this array to 4-elements had a marked effect on signal strength and the weaker stations tended to be almost impossible to get. On a more sensitive receiver, no doubt a 4-element array would be worthwhile. A photo of the 4-element FM244T array is shown here. The important point about the FM264T and FM244T is the uniform broad-band impedance characteristic, with a claimed variance of $\pm 0{\cdot}5$dB over 88 to 100MHz.

Incidentally the FM264T was fitted in the loft about four feet above the joists. Of course, I have a large loft which is essential, but better results are obtainable when mounted outside on the chimney stack. Incidentally, I found it very useful to run two or three cables up to the loft; I can monitor the receiver output while positioning the aerial. The third (4-core) cable is for a rotator. I tend to prefer loft installations for convenience and certainly to avoid the unsightly clutter of outside installations on top of the roof.

The Editor has told me that *P.W.* is giving a pair of Datacards in the March issue, specially devoted to f.m. reception. I shall certainly make sure I don't miss them.

MEDIUM WAVE BROADCASTS

by CHARLES MOLLOY

BRIAN MURRAY (Edinburgh) has been trying the medium waves with his Astrad VEF204 10 transistor receiver using its internal ferrite rod aerial. He reports hearing programmes in English from the American Forces Network, Frankfurt on 872kHz; Radio Tirana, Albania 1394kHz at 2200hrs; Radio Portugal 755kHz at 2310hrs; Trans World Radio, Montecarlo 1466kHz at 2325hrs. Brian has also logged the BBC local radio station at London on 1457kHz at 1740hrs.

Stephen Mason (Loughton, Essex) has an Ultra 8 transistor receiver which he uses with a 7 metre horizontal wire aerial located 10 metres above ground level. His log includes programmes in English from Radio Sweden on 1178kHz; Radio Portugal 755kHz; Milan, Italy 899kHz; Voice of America, Munich 1196kHz; Radio Berlin International 1511kHz; Radio Tirana, Albania 1394kHz; and in Spanish from Radio Espana de Madrid EAJ2 which is a commercial station on 917kHz. Stephen has received verifications (QSLs) from Sweden, Portugal, Warsaw, Milan, Prague and the Voice of America, for reception on the medium waves.

Ian Gordon (Birmingham) has been busy again with his Codar CR70A, aerial tuning unit and 25m longwire antenna. He reports hearing the Radio Peking relay in Albania on 1457kHz sign-on at 1730hrs with interference from BBC Radio Birmingham on the same frequency and Sud Radio, Andorra in French on 818kHz. Ian reports that the IBA (London) has been heard in Birmingham on 719kHz.

Several readers have asked if the writer would include a log of his own MW DX giving details of the

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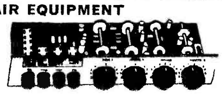

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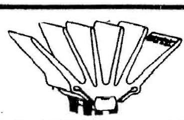

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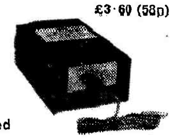

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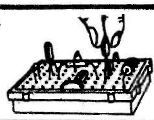

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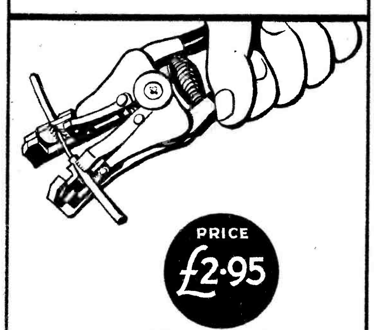

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equipment used. The main receiver is a Marconi Mercury marine communications receiver which covers 15kHz to 4MHz while the standby is a BC946 Medium Wave Command receiver. Two aerials are in use—a standard MW loop antenna and a 90ft longwire at 20ft above the ground. The QTH is Southport in Lancashire. Stations heard regularly in the evening are Radio Na Gaeltachta Conamara, Eire on 539kHz; Baghdad Iraq on 760kHz; Quazvin, Iran 841kHz; Kermanshah, Iran 985kHz; Kuwait 1345kHz. The BBC Eastern Mediterranean relay in Cyprus is now on 1322kHz and is heard relaying the BBC World Service in English at 2305hrs. North American reception has been good this winter with CJON St. John's, Newfoundland, on 930kHz and WNEW New York City 1130kHz conspicuous at 2330hrs. Others heard before midnight are CBN St. John's on 640kHz; CHER Sydney, Nova Scotia 950kHz; WINS New York City on 1010kHz; CBA Moncton New Brunswick on 1070kHz; Radio St. Pierre, St. Pierre et Miquelon (near Newfoundland) in French on 1375kHz. Two South Americans—ZYD66 Rio de Janeiro 940kHz in Portuguese and YVRS Radio Margarita, Venezuala on 1020kHz have been logged frequently along with PJA6 Radio Victoria which is located on the Dutch island of Aruba, near Venezuela and broadcasts religious programmes in English on 925kHz at 2315hrs. On the Longwaves Ankara, Turkey is now heard on 182kHz during the evening along with Azilal, Morocco in Arabic on 209kHz and Tipaza, Algeria on 251kHz in French.

Brian Richardson (Nottingham) asks about Whites Radio Log which gives details of all North American MW stations. This log used to appear in three parts in consecutive issues of an American magazine but it is no longer being published. Currently in the UK there is the Guide to Broadcasting Stations by Butterworth which is available in many bookshops. It lists all MW stations in Europe and a number of the more powerful ones in other parts of the world.

SHORT WAVE DX
by MALCOLM CONNAH

Now that the festivities are over we can all get down to some serious listening, and possibly constructing as well.

This time of year is ideal for trying to catch some of the stations which have eluded you in the past. The only way to catch them is to concentrate all available efforts to the task. One suggestion would be to make a list of all those stations which should be audible on your equipment and then systematically listen for them.

Radio New Zealand, for instance, should soon be audible again. Last year the frequencies were 9540 and 11780 and the time was 0800 GMT.

I wish you all the best with your listening and hope to receive your logs in the near future.

Readers' Logs

A very large number of logs have been received this month and we start with a couple from our overseas readers.

Bruce A. Laird of Greensborough in Victoria, Australia has heard the following stations:

9625 *R. Canada International* in English at 0900.
9675 *Radio Japan* in English at 1100.
9715 *R. Nederland* in English at 0800.
9745 *HCJB, Quito, Ecuador,* English at 0800.
11775 *Swiss B.C.,* in English from 0700 to 0930.
11875 *Radio Japan,* English from 0930 to 1030.
11890 *FEBC, Philippines* in English at 0930.
11940 *R. Japan* in Chinese and Vietnamese at 1000.
15235 *R. Japan* in English at 0930.

Steven Phillips of Durban in South Africa used his Hamerstein Hi-Fi Stereo 30 receiver and 30 odd feet of aerial wire to hear:

6160 *R. Australia* in English at 1500.
11730 *R. Nederland* via Madagascar at 1400.
11770 *BBC, Ascension Is.* relay at 1700.
11815 *NHK, Japan* in English at 1300.
15420 *BBC, East Med.* relay at 0400.
15840 *R. Nederland* in English at 1230.
21600 *Deutsche Welle* noted at 1200.

We return to the U.K. for a log from **Harold Emblem** of Mirfield in Yorkshire who has a Lafayette HA63 receiver and 18 metre long-wire antenna. This combination was used to hear:

9545 *R. Accra, Ghana* from 2104.
11905 *Austrian Radio* at 1900.
15185 *WINB,* Red Lion, U.S.A. at 2115.
15410 *United Nations Radio* noted at 2200.
15440 *WNYN, New York* at 2100.
17855 *United Nations Radio, Tangiers,* 1830.
25790 *RSA, South Africa* noted at 1420.

Simon Auger of Cheshunt in Hertfordshire writes —"After mourning for the injury to my transistor superhet, I blew the dust off my homebrew 2 valve regen.; attached it to my 50 foot end-fed aerial and an A.T.U. and accomplished the following in fourteen afternoons":

4965 *RSA, South Africa* in English at 1330.
6070 *Radio Sofia, Bulgaria* at 1930.
9005 *Voice of Iran, Tehran,* English at 2000.
9630 *Radio Sweden* noted at 1230.
9760 *R. Nacional d'Espana* at 1900.
9912 *AIR, Delhi* in English at 2000.
11775 *Radio Bucharest, Rumania* at 1500.
15340 *Radio Cairo* noted at 1800.

K. Goldsworthy of Hounslow in Middlesex has a Russion-made VEF204 receiver which, when connected to a 10 metre antenna, produced the following:

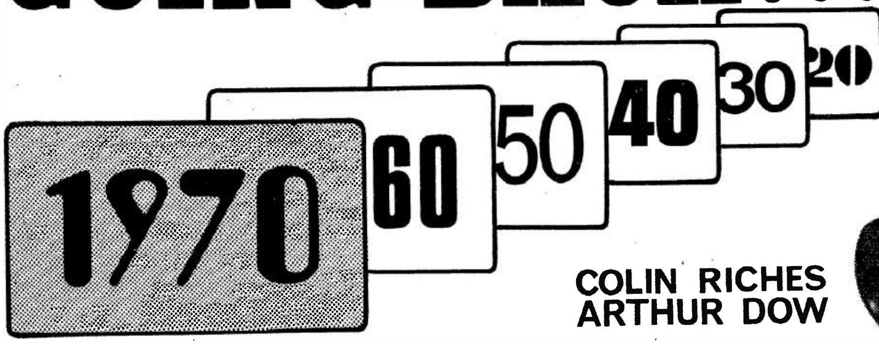
6025 *R. Portugal* in English at 2130.
7185 *RSA, South Africa* in English at 2000.
15185 *Radio Finland* in English at 1200.
17750 *Havana, Cuba* in English at 2130.
17820 *R. Canada International,* English at 2230.
17825 *RSA, South Africa,* English at 1600.

Another point which is worthy of mention at this time of year is the fact that the new edition of the 'World Radio TV Handbook' is due for publication. This book contains details of all Broadcast stations throughout the world. The entry for each station shows a list of all frequencies used; a current programme schedule; details of the Interval Signal; the station announcement; the address of the station and its QSL policy.

The introduction includes general hints on shortwave listening and the last section of the book is a list, by frequency, of all the stations. This list is very useful in identifying particular stations, especially when the frequency to which the receiver is tuned is accurately known.

All in all the handbook is an invaluable asset to all serious DXer's and I would recommend it to anyone regarless of their level of experience.

GOING BACK...



COLIN RICHES
ARTHUR DOW

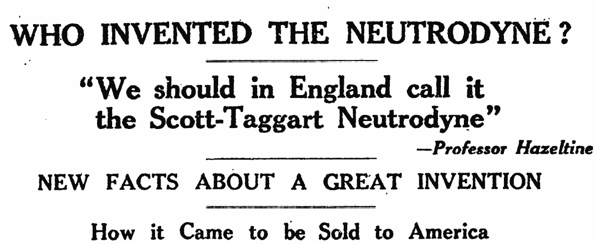
S-T's Neutrodyne

IN our August 1972 Going Back we gave an all-too-brief account of some of the contributions made to the art of wireless in the early days by John Scott-Taggart. We mentioned, among other matters, that he had sold many patents to the big wireless manufacturing companies including one to the Hazeltine Corporation (USA). Our attention has been drawn to an article published in the July 31st, 1926 issue of "Wireless" wherein much is made of the fact that the Neutrodyne (neutralising) circuit was patented by S.T. on January 2nd 1923 while the date for a practically identical patent by Professor Hazeltine in the USA was April 5th, 1923, some three months later.

"Wireless" sported headlines such as "Who invented the Neutrodyne?", "We should in England call it the Scott-Taggart Neutrodyne" and "New facts about a great invention". We only wish that we could be allowed to reproduce the three pages that "Wireless" published on this most interesting story if only to ensure that present day readers of *PW* are made aware that the British habit of throwing away potential moneymaking inventions is no recent acquisition! Remember the Hovertrain, among others?

To further quote Wireless "The utmost interest is being shown in the whole question of the Neutrodyne circuit. Although such circuits have from time to time been incorporated in various receivers, the extraordinary success of the "Elstree Six" has persuaded the wireless public that for selectivity, range, signal strength and non-radiation the Neutrodyne stands supreme . . . Although in America the manufacturers and public immediately appreciated the merits of the Neutrodyne, yet neither have hitherto fully done so in Great Britain. The wide publicity and dozens of demonstrations of the "Elstree Six" have, after three and a half years, made the Neutradyne 'catch on' ".

Professor Hazeltine himself stated that he did not contemplate a wireless receiver, his idea being to use neutralising in land-line telephony. Only later did he develop the principle in wireless sets. At a luncheon at the Savoy Hotel, in front of over one hundred guests, Professor Hazeltine paid generous tribute to the work of Scott-Taggart and discussing the invention said "I had done some work along those



WHO INVENTED THE NEUTRODYNE?

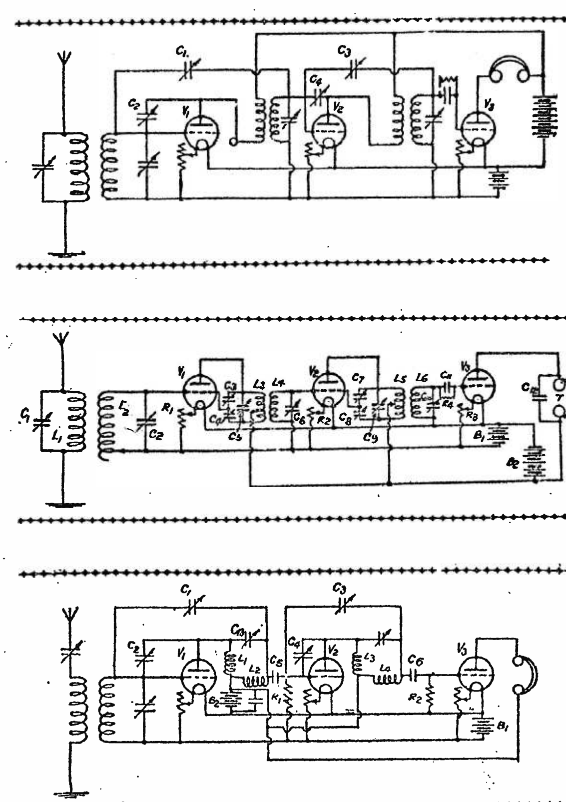
"We should in England call it the Scott-Taggart Neutrodyne"

—*Professor Hazeltine*

NEW FACTS ABOUT A GREAT INVENTION

How it Came to be Sold to America

Headlines from "Wireless" of July 31st, 1926 exposing the story behind the invention of the Neutrodyne.



Three of the actual circuits included in Patent 217971 of January 2nd, 1923, in the name of Scott-Taggart.

lines generally and the result was the receiver known as the Neutrodyne. Similar work was being done by Mr. Scott-Taggart and I feel that while we in America call it the Hazeltine Neutrodyne we should in England call it the Scott-Taggart Neutrodyne".

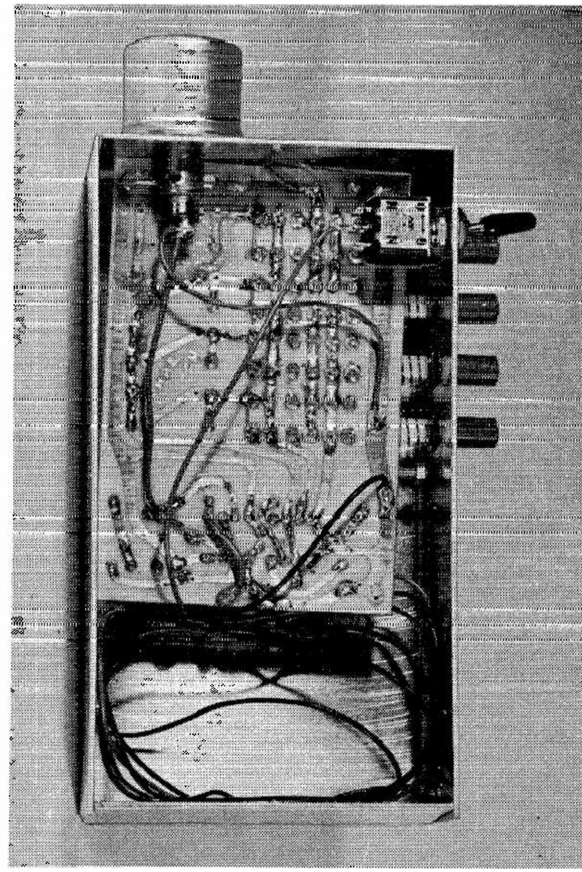
S.T.'s patent had been published in detail in Wireless Weekly in June 1923, and although British industry was fully aware of the inventor's claims not a single firm approached S.T. As Wireless noted "this was not to be wondered at; as recently as a year ago probably the largest manufacturer of broadcast receivers declared publicly that the Neutrodyne was dying out in America and that it could never become popular in this country". After this turn down by the trade here the S.T. patent was bought by the Hazeltine Corporation although S.T. himself was unaware, at the time, of the identity of the purchasers since the arrangements were made through agents.

The ironical position developed in which a first class British patent had been sold to America who exported sets to us here which were licensed under the S.T. patent. The Hazeltine Corporation sold licence rights on the patent to no less than fourteen leading manufacturers in the USA. From Wireless again . . . "The value of the invention was appreciated from the first by the Americans and their enterprise is in striking contrast to our own . . . the Neutrodyne receiver in America has been a colossal success. No other invention has had such an extraordinary vogue. Up to date (1926) £7,000,000 worth of licensed Neutrodyne receivers have been sold. Professor Hazeltine and his associates draw patent licence fees to the extent of £120,000 per annum!"

ULTRASONIC REMOTE CONTROLLER—
continued from page 966

OPERATION AND APPLICATIONS

The prototype system operates at a range of 60 to 80 feet. Bearing in mind the medium of transmission, the best results are obtained under 'line of sight' operation. Ultrasonics behave in a similar fashion to light as far as propagation is concerned, so this means that ultrasonics will be reflected when they strike a hard surface. The prototype system was surprisingly omnidirectional under most conditions, and the user will soon acquaint himself with the possibilities and limitations of ultrasonic command.



The board is fitted into case with the two bolts on the switch unit. The 9V battery fits into the space at the bottom of the case.

Applications are numerous and one that immediately springs to mind is switching lights on and off. This may sound a little mundane to many readers, but how often have you fallen over the garden fork when fumbling about for the garage light switch? With the same transmitter in your pocket, you can turn on entrance lights when you drive in at night, and turn on the radio for the news.

One application of the carrier-only system, that has not been investigated at length in this article, is that of burglar alarms. One American firm now produces a level sensing IC and tone alarm, that will be set off if any one of four inputs indicates a change of state of 25% or so. The change of state can be brought about by interference with the ultrasonic carrier, breaking of light beams etc. ■

HOTLINES ON RECENT DEVELOPMENTS

DODGY FOOD TESTER

EVERY once in a while one reads or hears of a major scare over tinned foods. It's all the fault of those grotty little bacteria and the technical name is Botulism. The "normal" way in which tinned food is tested is to grow a culture and then to turn this over to highly skilled personnel for microscopic analysis. Trouble is that all this culture growing and analysing takes a lot of time and skill.

This is where the "Bactometer" comes into its own. At present it is undergoing various tests, but the great advantages claimed are that the equipment will make the necessary results available in less than an hour, and it doesn't need skilled people to operate it—it's automatic.

How does the Bactometer work? Basically, it is a very sophisticated bridge which measures impedance. The test material is prepared in a liquid culture and a "reference" is made using a medium which is sterile. By putting these two separate cultures into a favourable growing environment the impedance of each is plotted. If there is no growth in the test sample, then the impedance will not differ greatly. However, if growth does take place, indicating contamination, then the impedance drops giving a positive sign. It would appear that bacteria have no resistance to the advance of science! Incidentally, once the samples have been put into the Bactometer, the entire process from that point on is automatic and thus no skill is required to operate the equipment. A chart recorder plots the impedances giving a written printout proof. Perhaps a monitary Bactometer could be devised for bank managers to detect overdrafts?

JAP REPORT

A piece of information which surprised me was that the Japanese home colour television market is approaching saturation point. Apparently some 80% of Japanese households now have colour television and manufacturers are talking about a push to get people thinking about a second set! The scene is an interesting one. Originally, the Japanese manufacturers considered that the smaller colour set was the trend for Japan. Now, Aiwa, a Japanese Company, are to import large screen (24-26in). American models. This has caused quite a stir.

On the Japanese market itself, the accent is now on power saving and this has been underlined with the recent energy availability problems which have become almost international. Meanwhile, Philips, the European-based Dutch giant, have a 26in. colour tube which heats to emmission in only five seconds and yet uses 20% less power than earlier designs. The Japanese finding was that people like to switch on the set and see results almost immediately. The public has been weaned to this by the use of solid state.

VIDEO SYSTEMS

Video recording systems have been in the news, and still are. One favourite method is to record the video signal using a laser beam. On playback, another small laser is used to detect the signal. This approach has been proposed for other markets too, such as mass memories, audio-visual and industrial control. Now, just as everyone is getting used to the idea, a Company has come up with a video playback system which uses the humble 25W light bulb. The bulb needs only about £30 of standard parts to form the basis of the playback system or video record player.

A laser is used to make the video disc by "printing" a series of dots whose individual diameters and densities vary according to the amplitude of the signal being recorded. Some 60 minutes of playing time is provided, the analogue signal being compacted by some 6:1. The train of dots form a spiral which roughly follows the path that a groove would take in an ordinary audio record.

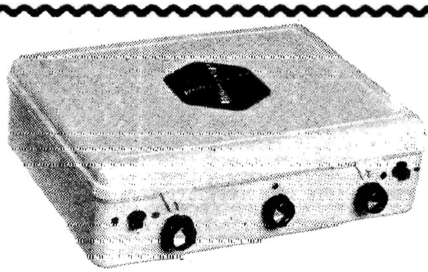
Playback is achieved on a—wait for it—transparent turntable. The 25W light bulb is located beneath the turntable so that it's light shines through both turntable and record. The light is detected by three light sensors or photodiodes. Two of these are responsible for tracking and keeping the lens system in line with the train of dots spiral. The third sensor detects the variations in diameter/density of the dots and this is converted into an amplitude modulated signal. This is mixed with a very small r.f. signal and the resultant a.m. carrier is then fed directly to the aerial terminal of a standard television receiver. Initial experiments have shown that the system should be suitable for digital, audio and analogue recordings.

Please note, the system is experimental and will not be on the market for some time. This column describes state of the art things, and this is one of them.

BOOM TIME

The last year has been a tremendous boom time for the electronics industry. So much so that materials are running out and suppliers just cannot keep pace with the demands of industry. This means that components are becoming scarcer. It is not unusual to find a supplier quoting a 72-week delivery. Couple this with the oil problem and it looks more serious. Plastics are tied in with oil. Although plastic packaged semiconductors are cheaper than ceramic ones, could it be the other way round soon? One thing is easily possible—the price of semiconductors and particularly i.cs may rise soon. It could be the old story of supply and demand, perhaps even a black market. Psst, wanna a buy an OC71 guv?

Ginsberg



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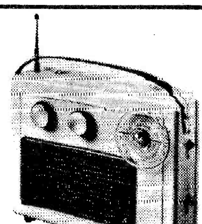
NEW ROAMER NINE

WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors. 9 Tuneable wavebands as Roamer Ten. Built in ferrite rod aerial for MW/LW. Retractable chrome-plated telescopic aerial for VHF and SW. Push Pull output using 600 mW transistors. 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange controls. Attractive all white case with red grille and carrying strap. Size 9½" × 7" × 2½" approx. Parts Price List and Plans 30p (Free with parts).

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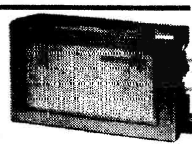
POCKET FIVE



3 Tunable wavebands. M.W. L.W. and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive black and gold case. Size 5½" × 1½" × 3½" approx. Plans and Parts Price List 15p (Free with parts).

Total Building Costs £2·28 P P & Ins. 26p
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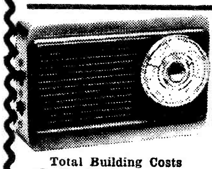
TRANSONA FIVE



Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and Parts Price List 15p (Free with parts).

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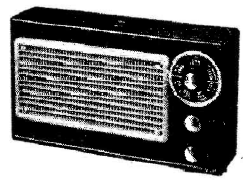

E.V.5. 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" × 5½" × 2½" approx. Parts Price List and Plans 15p. Free with parts.

Total Building costs £2·73 P P & Ins. 30p (+ 10% VAT 27p) (Overseas P & P £1·25)

E.V.6. Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, 3" loudspeaker, etc., MW/LW coverage. Push Pull output. Parts Price List and Plans 15p. Free with parts.

Total Building Costs £3·60 P P & Ins. 30p (+ 10% VAT 36p) (Overseas P & P £1·25)

E.V.7. Case and looks as above. 7 Transistors and 3 diodes. Six wavebands. MW/LW. Trawler Band. SW1. SW2. SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" Loudspeaker. Parts Price List and Easy Build Plans 20p. Free with parts. Overseas P & P £1·05.

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Total building costs £6·98 P P & Ins. 47p (+ 10% VAT 69p)
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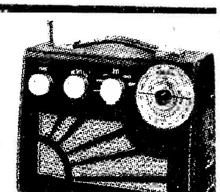
ROAMER TEN

WITH VHF INCLUDING AIRCRAFT



10 Transistors. Latest 4" 2 watt Ferrite Magnet Loudspeakers. 9 Tunable Wavebands. MW1, MW2, LW, SW1, SW2, SW3. Trawler Band, VHF and Local Stations also Aircraft Band. Latest 4" 2 watt ferrite magnet loudspeaker.

Built in Ferrite Rod Aerial for MW/LW. Retractable chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600mW Transistors. Car Aerial and Tape Record Sockets. 10 Transistors plus 3 Diodes, Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off. Wave Change and tone Controls. Attractive Case in black with silver blocking. Size 9" × 7" × 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

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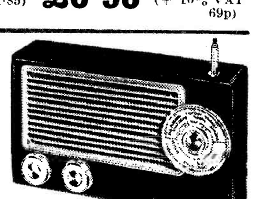
TRANS EIGHT 8 TRANSISTORS and 3 DIODES



6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

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150	100	5 8	9·9 x 8·9 x 8·6	3·79	52
151	200	8 0	12·1 x 9·3 x 10·2	6·45	52
152	250	13 12	12·1 x 11·8 x 10·2	8·41	67
153	350	15 0	14·0 x 10·8 x 11·8	11·22	82
154	500	19 8	14·0 x 13·4 x 11·8	16·25	–
155	750	29 0	17·2 x 14·0 x 14·0	22·10	
156	1000	38 0	17·2 x 16·6 x 14·0	29·87	–
158	2000	60 0	21·6 x 15·3 x 18·1	49·25	–

PLEASE NOTE NEW ADDRESS AS BELOW

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64	75	2 4	7·4 x 6·7 x 6·1	0-115-210-240	2·40	30
4	150	3 4	8·9 x 7·7 x 7·7	0-115-200-220-240	2·89	36
66	300	6 4	9·9 x 9·6 x 8·6	,,	5·63	52
67	500	12 8	12·1 x 11·2 x 10·2	,, ,,	8·36	67
84	1000	19 8	14·0 x 13·4 x 14·3	,, ,,	15·19	82
93	1500	30 4	14·0 x 15·9 x 14·3	,, ,,	21·99	–
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213	1·0	0·5	1 4	6·1 x 5·8 x 4·8	0·12V at 0·5A x 2	1·44	22
71	2	1	1 12	7·0 x 6·4 x 6·1	0·12V at 1A x 2	1·90	22
18	4	2	2 12	8·3 x 7·7 x 7·0	0·12V at 2A x 2	2·68	30
70	6	3	3 8	8·9 x 8·0 x 7·7	0·12V at 3A x 2	3·20	42
108	8	4	5 8	9·9 x 8·9 x 8·6	0·12V at 4A x 2	3·60	52
72	10	5	6 4	9·9 x 9·6 x 8·6	0·12V at 5A x 2	4·25	52
116	12	6	6 12	9·9 x 10·2 x 8·6	0·12V at 5A x 2	5·10	52
17	16	0	8 12	12·1 x 9·9 x 10·2	0·12V at 8A x 2	6·56	52
115	20	10	11 8	14·0 x 9·6 x 11·8	0·12V at 10A x 2	8·36	67
187	30	15	15 8	14·0 x 12·1 x 11·8	0·12V at 15A x 2	15·40	82
226	60	30	32 0	17·2 x 15·3 x 14·0	0·12V at 30A x 2	28·44	*

30 VOLT RANGE

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P £	p
112	0·5	1 4	6·1 x 5·8 x 4·8	0-12-15-20-24-30V	1·42	22
79	1·0	2 4	7·0 x 6·7 x 6·1	,, ,,	1·92	36
3	2·0	3 4	8·9 x 7·7 x 7·7	,, ,,	2·90	36
20	3·0	4 8	9·9 x 8·3 x 8·6	,, ,,	3·58	42
21	4·0	6 4	9·9 x 9·6 x 8·6	,, ,,	4·25	52
51	5·0	6 12	12·1 x 8·6 x 10·2	,, ,,	5·30	52
117	6·0	8 0	12·1 x 9·3 x 10·2	,, ,,	6·31	52
88	8·0	12 0	12·1 x 11·8 x 10·2	,, ,,	8·18	67
89	19·0	13 12	14·0 x 10·2 x 11·8	,, ,,	10·33	67

50 VOLT RANGE

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P £	p
102	0·5	1 12	7·0 x 6·4 x 6·1	0-19-25-33-40-50V	1·90	30
103	1·0	2 12	8·3 x 7·4 x 7·0	,, ,,	2·80	36
104	2·0	5 8	9·9 x 8·9 x 8·6	,, ,,	3·87	42
105	3·0	6 12	9·9 x 10·2 x 8·6	,, ,,	5·26	52
106	4·0	10 0	12·1 x 10·5 x 10·2	,, ,,	6·99	52
107	6·0	12 0	14·0 x 10·2 x 11·8	,, ,,	10·35	67
118	8·0	18 0	14·0 x 12·7 x 11·8	,, ,,	13·51	97
119	10·0	25 0	17·2 x 12·7 x 14·0	,, ,,	16·93	*

60 VOLT RANGE

Ref. No.	Amps.	Weight lb oz	Size cm.	Secondary Taps	P & P £	p
124	0·5	2 4	7·0 x 6·7 x 6·1	0-24-30-40-428-69C	1·93	36
126	1·0	3 4	8·9 x 7·7 x 7·7	,, ,,	2·70	36
127	2·0	6 4	9·9 x 9·6 x 8·6	,, ,,	4·25	42
125	3·0	8 12	12·1 x 9·9 x 10·2	,, ,,	6·46	52
123	4·0	13 12	12·1 x 11·8 x 10·2	,, ,,	8·36	67
40	5·0	12 00	14·0 x 10·2 x 11·8	,, ,,	9 85	87
120	6·0	15 8	14·0 x 12·1 x 11·8	,, ,,	12·14	82
121	8·0	25 00	14·0 x 14·7 x 11·8	,, ,,	13·65	*
122	10·0	25 0	17·2 x 12·7 x 14·0	,, ,,	20·09	*
189	12·0	29 00	17·2 x 14·0 x 14·0	,, ,,	22·49	*

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212	1A 1A	1 4	6·1x5·8x4·8	0-6 0-6	1·52	22
13	100	4	3·9x2·6x2·9	9-0-9	1·12	10
235	330,330	4	4·8x2·9x3·5	0-9, 0-9	1·52	10
207	500, 500	1 00	6·1x5·4x4·8	0-8-9, 0-8-9	2·03	22
208	1A, 1A	1 12	7·0x6·4x6·1	0-8-9,0-8-9	2·73	30
236	200, 200	4	4·8x2·9x3·5	0-15, 0-15	1·52	10
214	300, 300	1 4	6·1x5·8x4·8	0-20, 0-20	1·60	22
221	700 (D.C.)	1 8	7·0x6·1x6·1	20-12-0-12-20	1·41	30
206	1A, 1A	2 12	8·3x7·7x7·0	0-15-20, 0-15-20	3·08	36
203	500, 500	2 4	8·3x7·0x7·0	0-15-27, 0-15-27	2·82	38
204	1A, 1A	3 4	8·9x7·7x7·7	0-15-27, 0-15-27	2·86	38

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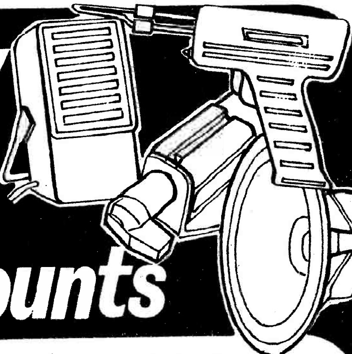

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PART 5—EMITTER FOLLOWER

IT is natural to think that the role of an amplifier is simply to take small voltages and turn them (somehow) into high voltages but this is by no means the end of the story.

Apart from voltage amplifiers we often come across circuits that fulfil some role of amplification that is not always so obvious or, for that matter, easily measurable. To name a few; we have current amplifiers, power amplifiers, impedance converters (sometimes called buffer stages), inverters and operational amplifiers. The transistor can give us all these options in different forms of circuit and we shall explore some of these obvious and not-so-obvious applications.

The transistor is basically a current sensitive device so it would not be unreasonable to look, firstly, at its role as a *current amplifier*. The circuit we shall consider is the *emitter follower* (briefly mentioned in a previous part). The name current amplifier implies that we require a circuit that needs only a very small input current generated by a given voltage to give a larger current in an output circuit with more or less the same sort of voltage swings. If we say that the input and output voltage swings are about the same but impose the condition that the input current is small, it immediately means that the resistances involved in the input circuitry are greater than those we are likely to see in the output (which has larger current variations for the same voltage changes). Fig. 29 is a test circuit that will demonstrate what we mean.

VR1 is used simply to provide a source of variable

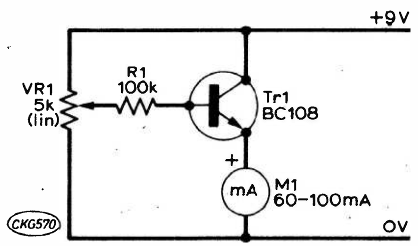

Fig. 29. The emitter current measured is proportional to the base current through R1. The latter is set by VR1.

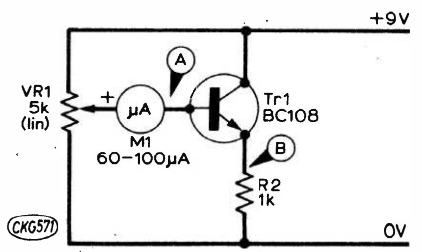

Fig. 30. The transistor draws only the amount of base current necessary to make the potential at B rise to that of A (less the Vbe of the transistor).

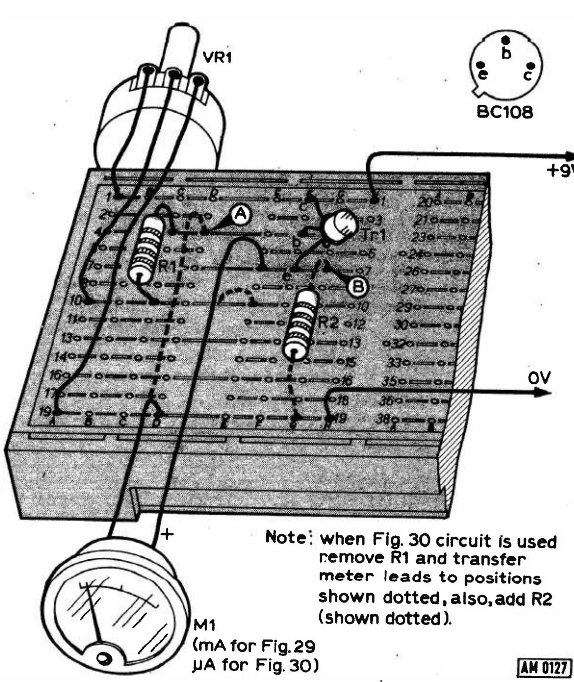

Fig. 31. Layout for Figs. 29 and 30.

voltage that is used to drive base current into Tr1. If you assume the internal resistance of the testmeter (set to current) is zero it is a simple calculation to work out the base current supplied.

The maximum will be when VR1 is set to the top of its track (+9V as a source). The base current is

therefore $\frac{9 - Vbe}{100k\Omega} = \frac{8 \cdot 4}{100}$ mA $= 0 \cdot 084$mA.

The current you will measure in the emitter circuit will be as high as 30mA for this setting of VR1. The increase in current flow is up by a factor of about 300. One could, in fact, have calculated the emitter current from the current gain of the transistor (h_{FE}):

collector current $= h_{FE} \times$ base current

emitter current = collector current + base current

$\therefore\ Ie = (h_{FE} \times Ib) + Ib$

In other words $Ie = Ib \times (h_{FE} + 1)$

Because the h_{FE} for a BC108 is approximately 200 to 300 one can see that the emitter current we measure is about two to three hundred times the base current. An immediate problem that springs out from this calculation is that you can only calculate the result if you know a precise value for h_{FE} but this varies a lot from one transistor to another—even though they may have the same type number. Thus the precise currents you measure in the emitter circuit will be dependent on the particular transistor you are using. Later you will see that steps have to be taken in many circuits to compensate for h_{FE} variations from one transistor to another. It is clear, then, that we can get an amplification of current by using a transistor and if you vary VR1 you should see that to all intents and purposes the emitter current is direcly proportional to the base current supplied.

We can now carry out a variation on the same theme by using the circuit of Fig. 30. At first glance you might think that the base current will be very much greater than 60μA because all that seems to be limiting the base current is R2 in the emitter circuit. Firstly try it out and you should find that by adjusting VR1 the measured base current goes from zero up to a maximum of about 30 to 60μA (depending on your own particular transistor). When VR1 is set to maximum it is tempting to think that the base current is approximately 9V divided by the 1,000Ω of the emitter resistor (about 9mA). If you make this guess you are overlooking the fact that as soon as you start to apply base current into Tr1 we will cause emitter current to flow in R2 and this causes a voltage drop across it. The voltage at B will rise. The

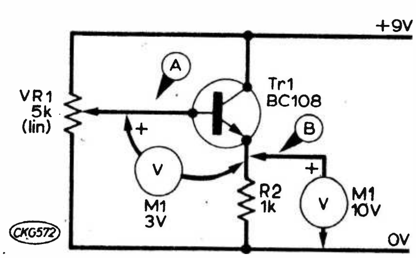

Fig. 32. At all settings of the slider the potential difference between A and B is about 600mV showing that B "follows" A.

base current is thus controlled by the new potential difference between points A and B (NOT between point A and ground!).

You can see the voltage at point B rising by switching the meter to volts (meanwhile connecting point A directly to the base of the transistor, Fig. 32). Notice that there is very little difference between the voltages set at A and those that are given at B. The difference is basically 600mV which is the forward base emitter voltage drop. Return to Fig. 30 and change R2 for a 10kΩ resistor. You will see that the base current drawn by the transistor reduces by a factor of ten. Reduce R2 to 100Ω and the base current increases by about a factor of ten from its original value. The transistor thus gives an output voltage that follows the input voltage and the "following" effect forces the transistor to draw only sufficient base current to make the voltage at B approach that at A.

The input current is self limiting and makes the transistor look as if it has a very high base resistance. We say it presents a high input resistance to the voltage source and the output is more or less the same voltage as the source but the emitter current is very much greater than the input current.

Touch sensitive switch

Another way of looking at this circuit is to consider a limited current coming from a voltage source —Fig. 33—as one might find with a touch sensitive switch where the very small current flowing through the fingers is needed to cause a higher current in another circuit. Bridging the two contacts with the fingers causes base current to flow and the emitter voltage rises towards the voltage of the source (+9V). Depending on how good the skin contact is and how good a conductor you are you may pass sufficient base current to make point B rise to +9V.

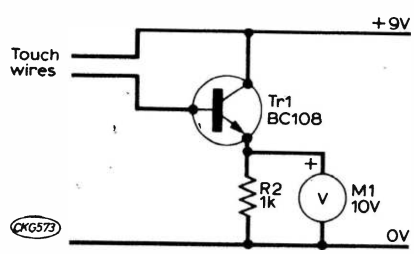

Fig. 33. The small current flowing through the fingers generates emitter current and this is shown as a potential difference across R2.

We have selected a value for R2 so that you may not be able to produce a low enough skin resistance to pass sufficient base current and hence the voltage at B may not follow the base exactly and the voltage you measure will vary depending on how hard you press the contacts with your fingers. To make the voltage at B go to +9V with ease you must reduce the base current requirement and this is done by reducing the amount of emitter current needed to make point B follow the input. This is done by increasing the value of R2 to 10kΩ.

A more precise way of obtaining an output voltage at the emitter of Tr1 proportional to the body's resistance is to make sure that the emitter current, to be controlled, is not limited by the h_{FE} of the transistor. You can then use a circuit that relies on the potential divide effect of the body resistance and R1 (Fig. 34) to give a potential at the base of Tr1 that is reflected in the potential at its emitter (less only the base emitter drop). The current available in the collector/emitter circuit of the transistor is still many times greater than the current flowing through the body and can be used as a signal into other circuits. Fig. 36 is such a circuit. When the contacts are bridged with the fingers a small current flows into the base of Tr1; this produces a higher current in the collector/emitter circuit of Tr1 some, of which, passes into the base circuit of Tr2 where it is further amplified to provide base drive to the inverter Tr3 which needs quite a high base current to turn on the lamp. Bridging the contacts turns on the lamp. If you think about it R2 serves no useful purpose—on the contrary it wastes useful emitter current of Tr1 which could be used as base current for Tr2; thus it can be removed and the circuit still works. The combination of one emitter follower feeding into another emitter follower is often seen when a circuit requires a very high input resistance and the combination is called a *super alpha pair*.

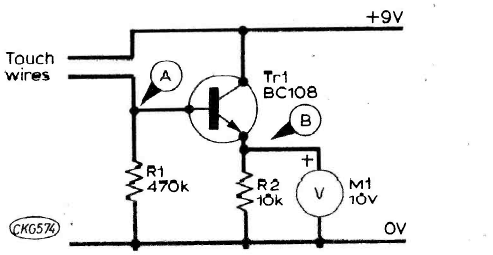

Fig. 34. The potential at A is set by the potential divide of R1 with skin resistance and this is reflected by the potential measured at B in the lower resistance emitter circuit.

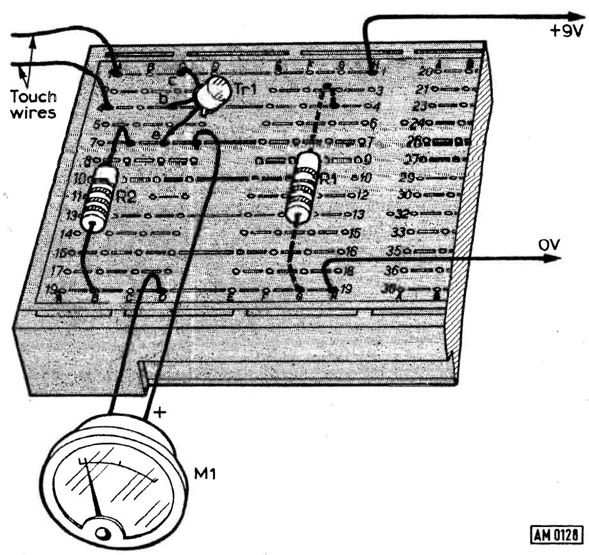

Fig. 35. Layout for Fig. 33. To carry out experiment in Fig. 34 change R2 to 10kΩ and insert R1.

Super alpha pair

The maximum current you can control in the emitter circuit is given by the base current multiplied by the h_{FE} for the transistor. Thus the current gain of a typical single stage using a BC108 is about 200 to 300. For a super alpha pair the gain would be $200 \times 200 = 40{,}000$. In our circuit of Fig. 36 the base current required by Tr3 to turn on the lamp is about 0·2mA. We thus need only one fortythousandth of this as base current into the first stage i.e. about 0·005μA. In reality more than this has to flow through the skin because we have the 470kΩ of R1 shunting the base of Tr1 to ground. It is possible to remove R1 and the circuit will become even more sensitive —the only problem is that it may become too sensitive and trigger by capacitively coupled pick up by Tr1's base. In theory R3 could be omitted but this is unwise; it is there to protect the base emitter junction of Tr3 from too high a current.

The emitter follower principle is often used as the active element in voltage regulators where a variable voltage output is needed from a power supply at quite high currents.

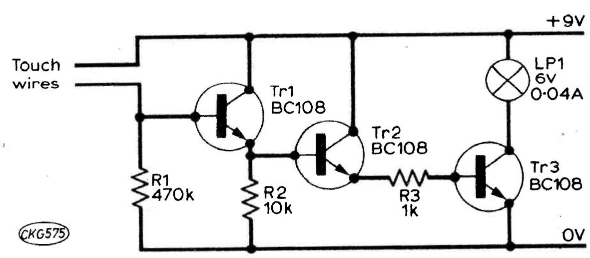

Fig. 36. A touch sensitive light switch. In practice R2 can be omitted as can R1 but removal of the latter might make the circuit over sensitive. R3 should not be omitted.

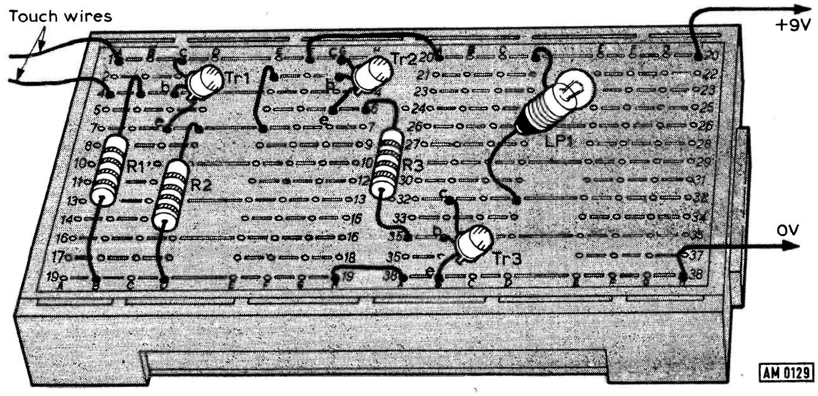

Fig. 37. Layout for Fig. 36.

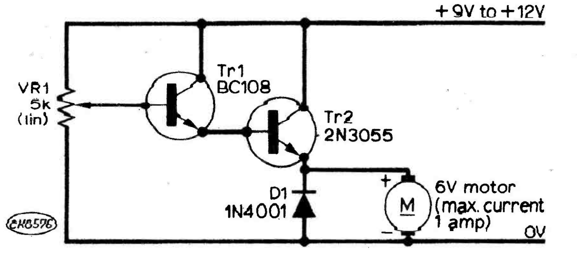

Fig. 38. Simple voltage adjustment to control the speed of low voltage d.c. motors. D1 is included to prevent high reverse voltages from the brushes damaging the transistor. The output is not short circuit protected.

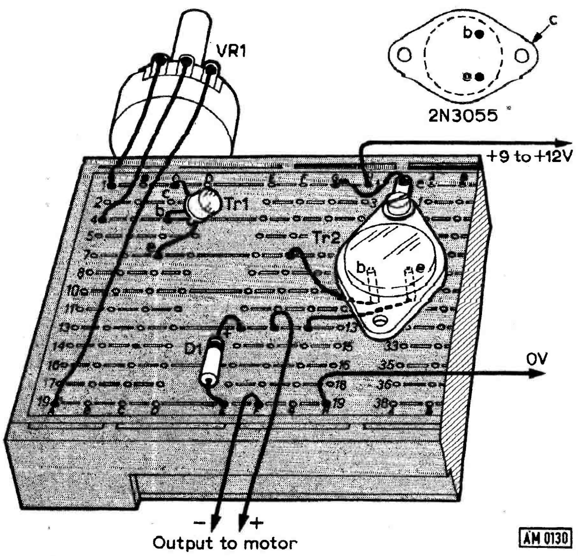

Fig. 39. Layout for Fig. 38. The short leads on Tr2 should be extended to connect to the T-Dec and the collector connection made via a solder tag bolted to Tr2.

It is expensive to use a high power potentiometer but a small potentiometer and a power transistor will do the job very nicely. Provided the output current does not exceed the rating of the transistor and is less than the Ib h_{FE} product the output voltage of Fig. 38 will be approximately equal to the potential set at the wiper of the potentiometer (less the transistors forward voltage drops). With the power transistor shown the circuit would act as a crude speed controller for small model motors. The wiper of the potentiometer provides the reference voltage. This could be generated by means of a zener diode and thus a stabilised power supply could be made to run, say, a cassette tape recorder from a 12V car battery (Fig. 40). C1 is included to suppress ignition noise.

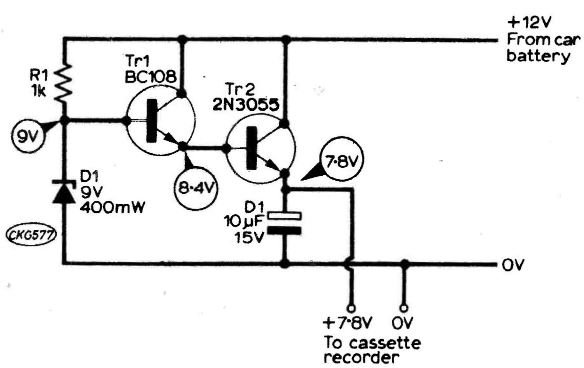

Fig. 40. A simple voltage dropper and regulator for running a cassette recorder from a car battery. Not short circuit protected.

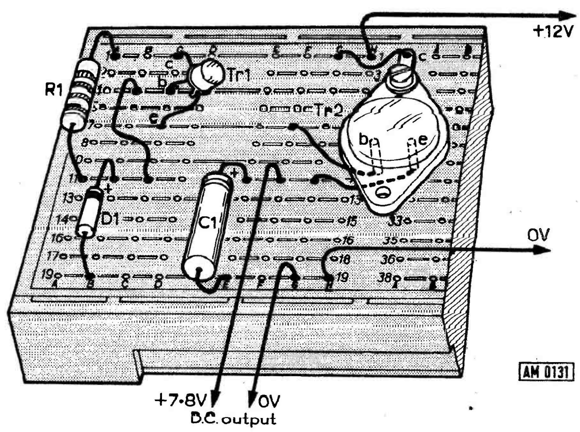

Fig. 41. Layout for Fig. 40.

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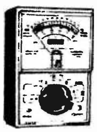
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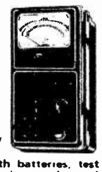
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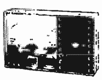
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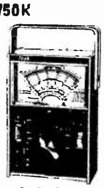
46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistence: 10k/100k/1 Meg/10 Meg ohms. –20 to +81 5dB
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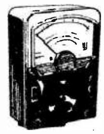
30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA, 12A DC. 0/60k/6 meg/60 megohms.
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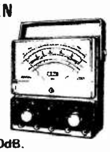
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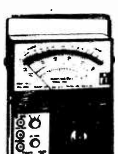
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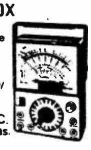
100,000opv. Overload protection. Mirror scale 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. –20 to +63dB.
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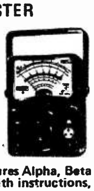
100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA612A DC. 0/10k/1 Meg/100 Meg. –20 to +50dB. 0.01–0.2 MFD. Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.
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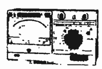
High sensitivity instrument for field and laboratory work Knife edge pointer, 86mm. mirror scale. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: –5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.
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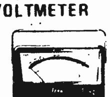
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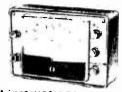
Additional probes available: RF £2.12, HV £2.50

TE40 HIGH SENSITIVITY AC VOLTMETER

10 Meg input. 10 ranges: 0.001/0.03/0.1/0.3/1/3/11/30/100/300V RMS. 5cps–1.2MHz. –40 to +50dB supplied brand new complete with leads and instructions.
OUR PRICE £17.50 P&P 25p

KAMODEN HMG500 insulation resistance tester

Range 0–1,000 Megohms, 500V. Battery operated. Wide range clear meter 4"x 4¼". Complete with deluxe carrying case, batteries and instructions.
OUR PRICE £19.95 P&P 30p

TMK LAB TESTER

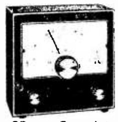
100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/10/100/500mA/2.5/10A. Resistence: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: –10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.
OUR PRICE £19.95 P&P 25p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A 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 device. Supplied complete with test leads, manual and test certificates.
OUR PRICE £49.00 P&P 50p

AT201 Decade ATTENUATOR

Frequency range 0–200kHz. Attenuator 0–111dB, 0.1dB steps. Impedence 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 55mm.
OUR PRICE £12.50 P&P 37p

TE16A TRANSISTORISED SIGNAL GENERATOR

5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads.
OUR PRICE £8.97 P&P 25p

TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedence 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.
OUR PRICE £17.50 P&P 37p

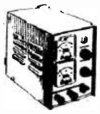
ARF 300 AF/RF SIGNAL GENERATOR

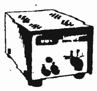
All transistorised compact fully portable. AF sinewave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.
OUR PRICE £29.95 P&P 50p

LASKYS

ALL PRICES EXCLUDE VAT

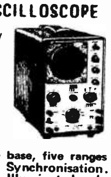
INCORPORATING LASKYS RADIO LTD. & G.W. SMITH & CO. (RADIO) LTD.

PS200 Regulated POWER SUPPLY UNIT

Solid state. Variable output 5–20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.
OUR PRICE £19.95 P&P 25p

PS100B Regulated POWER SUPPLY UNIT

Solid state. Output 6, 9 or 12V DC up to 3 Amp. Meter to monitor current. Input 220/240V AC. Size: 100 x 82 x 159mm.
OUR PRICE £11.97 P&P 25p

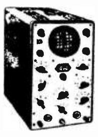
MCA220 Automatic Voltage Stabiliser

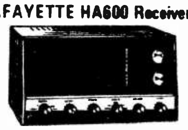
Input 88–125V AC or 176–250 V AC. Output 120V AC or 240V AC. 200V A rating.
OUR PRICE £11.97 P&P 50p

TO3 Portable OSCILLOSCOPE

3" tube. Y amp sensitivity 0.1Vp-p/CM. Bandwidth: 1.5Hz–1.5MHz. Input Impedence: 2 MOhms, 25pF. X amp. sensitivity: 0.9Vp-p/CM. Bandwidth 1.5Hz–800kHz. Input impedence 2 Meg Ohms, 20pF. Time base, five ranges 10Hz. to 300kHz. Synchronisation. Internal or external. Illuminated scale 140 x 215 x 330mm. Weight 15½lbs. 220/240V AC. Supplied brand new with handbook.
OUR PRICE £52.50 P&P 50p

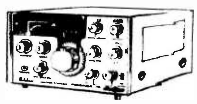
RUSSIAN CI16 Double Beam OSCILLOSCOPE

5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec. to 100 milli-sec/cm. Free running time base, 50Hz–1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.
OUR PRICE £87.00 Carr. paid

CI5 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1–25. HOR. AMP. Bandwidth: 500kHz. Sensitivity ay 100kHz VRMS/mm: 0.3–25 Preset triggered sweep 1–3000usec. Free running 20–200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115–230V AC.
OUR PRICE £39.00 Carr. paid

LAFAYETTE HA600 Receiver

General coverage 150–400kHz, 550 kHz–30MHz. FET front end 2 mechanical filters, product detector. Noise limiter, variable BFO, S Meter, Bandspread and RF gain. 220/240V AC or 12V DC. Brand new with instructions.
OUR PRICE £50.00 P&P 50p

SUPER VALUE TOP QUALITY TRIO communications equipment

TRIO JR599 RECEIVER

Nine wave-bands covering 1.8–29.7 MHz, 144–146MHz and 10MHz WWV SSB, CW, AM and FM. AF output is more than 1 watt. S Meter. Squelch control. BFO. Variable AF and RF controls. 4–16 ohm output and jack for phones. Power requirement 100/240V AC, 12/14V DC. Size: 270 x 140 x 310mm.
OUR PRICE £132.50 Carr. paid

TRIO 9R59DS RECEIVER

Four bands covering 550kHz to 30 MHz continuous and electrical bandspread on 10, 15, 20, 40, and 80 mtrs. 8 valve plus 7 diode circuit. 4 to 8 ohm output and phone jack. SSB–CW, ANL, variable BFO. S Meter and separate band spread dial. IF frequency 445kHz, audio output 1½ watt. Variable RF and AF gain controls. 115/250V AC, with instructions.
OUR PRICE £42.50 Carr. paid

TRIO JR310 SSB RECEIVER

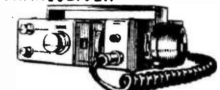
Covers 3.5, 7, 14, 21, 28, 28.5 and 29.1MHz bands and WWV 15MHz. SSB, AM and CW. AF output more than 1W. Crystal controlled BFO for SSB. S Meter, ANL etc. AC 110/120–220/240V. Size: 330 x 179 x 310mm.
OUR PRICE £75.00 Carr. paid

TRIO TR2200 RECEIVER

Fully transistorised portable VHF transceiver Will transmit and receive on six channels between 144–146MHz. 1 watt transmitter. 12V DC internal or external supply. Built-in charger for Ni-Cad cells. Power/volume switch, squelch control, channel selector, mic. socket, earphone/external speaker socket. Complete with microphone and 144.48, 144.72 & 145.32 crystals. Size: 134 x 58 x 180mm.
OUR PRICE £79.50 Carr.paid

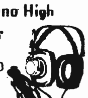
UNR30 RECEIVER

Four bands covering 550 KHz/30MHz BFO. Built-in speaker. Operates from 220/240V AC. Brand new with instructions.
OUR PRICE £15.75 P&P 37p

BELTEK W5400 CAR TRANSCEIVER

Solid state mobile transceiver for 12 volt DC neg. Transmits and receives on any 12 of 28 channels between 144 and 146MHz. Power output 10W and 1W switchable. Controls: On/off/volume, squelch and channel selector. Internal 3" speaker. Complete with dynamic mic. PTT switch, three sets of crystals for 144.48, 144.6 and 145MHz, mounting bracket and instructions. Size: 160 x 76 x 220mm.
OUR PRICE £75.00 P&P 50p

RUH6 Reflex Horn Speaker

Built-in driver unit. Impedence 16 ohms. Power rating 10W. Response 380–7000Hz. Size app. 6" x 6". Weather and shock protected.
OUR PRICE £4.97 P&P 30p

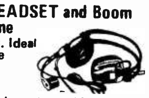
TE1018 Deluxe Mono High Impedence Headset

Sensitive magnetic headset with soft ear pads. Impedence 2,600 ohms (600 ohms DC). Frequency response: 200–4,000Hz.
OUR PRICE £2.25 P&P 30p

DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms. 20–12,000Hz. Complete with lead and plug.
OUR PRICE £2.25 P&P 30p

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.
OUR PRICE £1.97 P&P 30p

BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms.
OUR PRICE £5.95 P&P 30p

SH628 STEREO HEADPHONES

Outstanding value. With soft ear pads and adjustable headband. 8–16 ohms. 20–20,000Hz. Complete with lead and stereo plug.
OUR PRICE £1.87 P&P 30p

SPECIAL PURCHASE!!
BSR 8 Track Player Chassis

Famous BSR 8track chassis as used in model TD8S complete with silver and black escutcheon; ready to fit into cabinet. Output 125mV. 240V AC. Overall size app. 185 x 215 x 80mm.
OUR PRICE £8.95 P&P50p

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WE ARE APPOINTED STOCKISTS AT ALL BRANCHES

All kits are complete with comprehensive easy to follow instructions and covered by full guarantee.

Post and Packing 15p per kit.

AF20 Mono amplifier	£4.80
AF30 Mono pre-amplifier	£2.61
AF310 Mono amplifier	£5.91
AT5 Auto light control	£2.58
AT30 Photo cell switch unit	£5.70
AT50 400W Light dimmer/speed control	£4.80
AT55 1,300W Light control/speed control	£5.70
AT56 2,200W Light dimmer/speed control	£6.90
AT60 1 channel light control	£7.80
AT65 3 channel light control	£14.55
HF61 MW transistor radio	£3.33
HF75 FM transistor radio	£2.88
HF310 FM tuner unit	£15.81
HF325 Deluxe FM tuner unit	£24.12
HF330 FM stereo decoder	£9.96
HF395 Aerial amplifier for AM/FM bands I, II, & III	£1.77
GP310 Stereo pre-amplifier	£21.27
GU330 Tremolo unit	£7.50
NT10 PSU 100mA/9–12V	£6.15
NT300 Professional stabilised PSU. 2 x 30V, 2.2A	£12.51
NT305 Transistor converter 12/15V AC/DC to 6V, 7.5V or 9V DC	£4.50
NT310 PSU 240V AC to 2 x 18V DC at 2A	£4.80
NT315 PSU 240V AC to 4.5–15V DC at 500mA	£9.67
AE1 100mW output stage	£1.65
AE2 Pre-amplifier	£1.26
AE3 Diode receiver	£2.06
AE4 Flasher	£1.09
AE5 Astable multivibrator	£1.05
AE6 Monostable multivibrator	£1.02
AE7 RC generator	£1.06
AE8 Bass filter	99
AE9 Treble filter	99
AE10 CCIR filter	99

NEW FROM JOSTY-KIT 'Amateur Electronics'
The professional book for the amateur—covers the subject from basic principles to advanced electronic techniques. Complete with circuit board for making ten of the kits listed above.
OUR PRICE £3.30 (No VAT)
P & P 25p plus VAT

FRUSTRATED EXPORT ORDER !!
Philco Ford 5245 Mains Tape Recorder.

2 track BSR deck with push button controls for easy operation. Tape counter and volume control. Complete with hand microphone, direct recording lead, 1,200' reel of tape and spare reel. 200/250V AC. Fully guaranteed.
OUR PRICE £17.50 P&P 75p

Philco Ford 5248 Mains Tape Recorder.

Four track, two speeds. Piano key type controls, tape counter, recording level meter, volume and tone controls etc. Complete with hand, microphone lead for direct recording 1,800' of tape and spare reel. 200/250V AC. Fully guaranteed.
OUR PRICE £27.50 P&P 75p

BVD5 Vernier TUNING DIAL

App. 7:1 ratio planetary drive vernier dial. Log scale 0–180 degrees. Blank scales 1–5. Dial size 128 x 76mm. Overall size 190 x 117 x 41mm. deep including knob and coupling. ¼" diam. shaft
OUR PRICE £1.62 P&P 15p

SINCLAIR CAMBRIDGE CALCULATOR

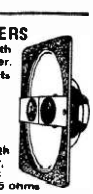
To build yourself. Complete kit of parts with step by step instructions to build a full specification pocket sized calculator.
OUR PRICE £24.95 P&P free
ALSO AVAILABLE READY BUILT
Recommended Price £29.95
OUR PRICE £27.20 P&P 25p

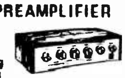
MINUTEMAN MM3 POCKET CALCULATOR

Size only 103 x 77 x 25mm. 8 digit display with overflow and error indicators. Floating decimal. Adds, subtracts, multiplies and divides. Chain and mixed calculations. Constant factor for series multiplication or division. Complete with batteries, instructions and case.
OUR PRICE £23.95 P&P 25p

Also available— SINCLAIR EXECUTIVE
Recommended Price £39.00
OUR PRICE £35.45

SINCLAIR EXECUTIVE with MEMORY
Recommended Price £49.00
OUR PRICE £40.75

EMI LOUDSPEAKERS

Model 350 13 x 8" with single tweeter/crossover. 20–20,000Hz. 15 watts RMS. Available 8 or 15 ohms.
OUR PRICE £7.25 each P&P 37p
Model 450 13 x 8" with twin tweeter/crossover. 55–13,000Hz. 8 watts RMS. Available 8 or 15 ohms
OUR PRICE £3.62 each P&P 25p

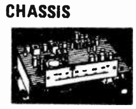
MP7 MIXER-PREAMPLIFIER

5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.
OUR PRICE £8.97 P&P 20p

KE630 3 Station INTERCOM

Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries
OUR PRICE £5.25 P&P 50p

1021 Stereo Listening Station

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on–off slide switch, stereo headphone socket.
OUR PRICE £2.25 P&P 15p

FM TUNER CHASSIS

6 transistor high quality tuner. Size only 153 x 101 x 63mm. 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88–108MHz. Ready built, ready for use. Fantastic value for money.
OUR PRICE £5.95 P&P 20p

A1018 FM TUNER

Specification as above FM chassis but complete in cabinet with on/off switch. Size: 184 x 86 x 127mm.
OUR PRICE £9.65 P&P 30p
Stereo multiplex adapter £4.97