

PRACTICAL WIRELESS

FEBRUARY
1974

20p

3 STAR PERFORMERS!

1



2



3

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1

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2

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3

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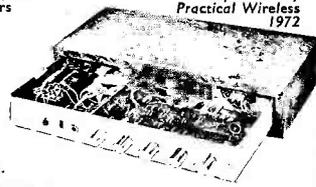


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 As featured by Practical Wireless 1972



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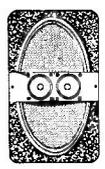
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SN7409AN	0.44	0.44	0.38	SN7481N	1.25	1.10	0.95	SN74161N	1.58	1.58	1.38
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SN7412AN	0.38	0.38	0.33	SN7489N	0.50	0.50	0.44	SN74165N	2.01	2.01	1.76
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SN7438N	0.43	0.43	0.37	SN74119N	1.92	1.92	1.68	SN74191N	2.30	2.30	2.01
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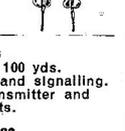
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100 42p	100 13p
500 39p	500 12p
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BY127	OC35
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U4313	20k/Volt AC current. Steel case	10-50
U4341	Plus Built in transistor tester	10-50
Model 500	30k/Volt	9-95

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SE500	Pocket Signal Tracer	1-70 carr. 15p
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TE40	AC Millivoltmeter 1-2mHz	18-95 carr. 35p
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TE22D	20Hz-200kHz Audio Generator	18-95 carr. 40p
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SE400	Volts/ohms/R-C sub./RF field/RF gen.	14-75 carr. 20p

New Revolutionary Super tester 680R

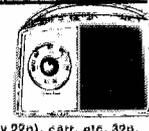
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			each

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D1203	Teleamp. with PU coil	3-80 p & p 20p
LL1	Door Intercomm. and chime	11-95 p & p 25p
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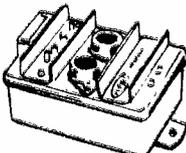
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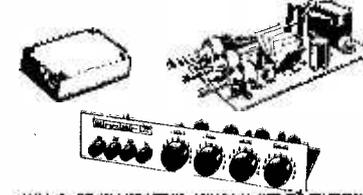
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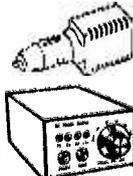


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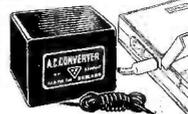
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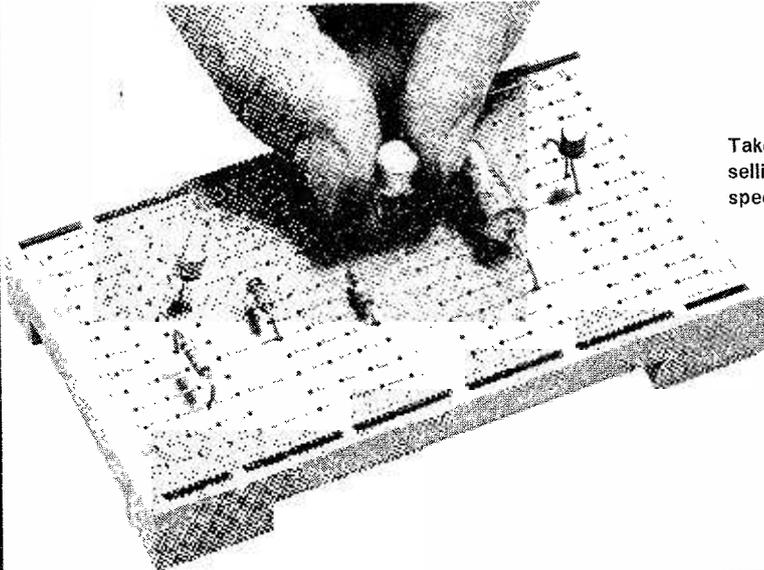
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- Modules link together
- FREE control panel with each DeC
- S-DeC 70 contact points
- T-DeC 208 contact points
- T-DeC accepts standard IC's with adaptor

ZIPPY CABINETS—THE NEW ROBUST ECONOMICAL ENCLOSURES FOR YOUR PROJECTS

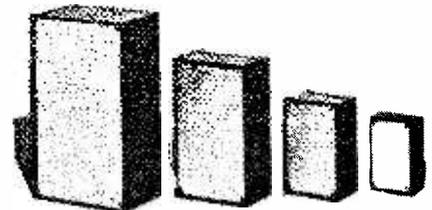
- ROBUST
- EASY TO MACHINE AND DRILL
- ATTRACTIVE FRONT PANEL
- FIXING SCREWS SUPPLIED
- ALL WALLS CONTAIN SLOTS FOR PRINTED CIRCUIT BOARDS

TP1	80mm x 50mm x 30mm
TP2	105mm x 65mm x 40mm
TP3	155mm x 90mm x 50mm
TP4	210mm x 125mm x 70mm

50p
75p
99p
£1.50

all prices plus VAT.

ZIPIES



TP4

TP3

PT2

TP1



*in case of
difficulty
send your
name
address,
requirements
plus payment to*

PB PRODUCTS LTD.
Rosemount House,
14 Lambert Cross,
Saffron Walden,
Essex

Telephone: Saffron Walden 7824

SPECIAL OFFER VOUCHER

Take this Voucher to your stockist. This entitles you to **SAVE 50p** on an S-DeC
Either purchase one S-DeC for **£1.30** instead of £1.80 or
take one S-DeC for **£1.80** plus a FREE TP1 Zippy Cabinet.

SAVE 75p on 1 T-DeC
Either purchase one T-DeC for **£2.55** instead of £3.30
or take one T-DeC for **£3.30** plus a FREE TP2 Zippy Cabinet

All prices subject to additional 10% for VAT.

NEW VAT INCLUSIVE PRICES

OVERSEAS CUSTOMERS DEDUCT ONE ELEVENTH.

74 Series TTL

INTERNATIONALLY KNOWN BRANDS
1st. GRADE DEVICES AT NEW
[ROCK BOTTOM PRICES]

SN7400	17p	SN7473	40p
SN7401	17p	SN7474	40p
SN7402	18p	SN7475	50p
SN7410	17p	SN7476	44p
SN7413	30p	SN7490	60p
SN7420	17p	SN7492	74p
SN7447	99p	SN7493	74p

This range will be increased continuously. Please enquire about any devices not listed.

PRICE BARRIER SLASHED

LED READOUTS

0.3" HIGH (CHARACTERS)  ALSO + 1 REF LED 1A

£1.99 + 20p VAT = £2.19

Veroboard



2 1/2" x 1"	63p	81p	—
2 1/2" x 3 1/2"	22p	18p	11p
2 1/2" x 5"	26p	23p	13 1/2p
3 1/2" x 3 1/2"	26p	23p	—
3 1/2" x 5"	30p	30p	19p
1 7/8" x 2 1/2"	74p	55p	41p
1 7/8" x 3 1/2"	99p	77p	57p
1 7/8" x 5"	—	—	82 1/2p

DIP Breadboard, 4-15in x 6-15in, 110p.
Verostrip, 8-5in x 1-5in, 26p. Spot-Face
Cutter, 40p. Pin Injection tool (state 0-1in
or 0-15in), 52p. Terminal pins, 20p (packs
of 36)—state size.

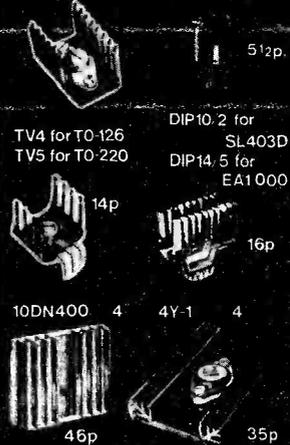
I.C. SOCKETS



8 pin 13 1/2p	16 pin 17 1/2p	36 pin 39 1/2p
14 pin 15 1/2p	24 pin 26 1/2p	40 pin 44p
28 pin 30 1/2p		

HEAT SINKS

TV2 for TO-66	15p	5F for TO-5
TV3 for TO-3	16p	18F for TO-18



DIP 10, 2 for SL403D
TV4 for TO-126
TV5 for TO-220
DIP 14, 5 for EA1000

10DN400 4 4V-1 4
46p 35p

BRIDGE RECTIFIERS



P.I.V.	1 amp	R.M.S.	2 amp
100V	26p	50V	35p
200V	22p	100V	40p
600V	25p	200V	45p
1000V	38p	600V	50p

RECTIFIERS

P.I.V.	1 amp	3 amp
50	1N4001 6 1/2p	1N5400 15 1/2p
100	1N4002 7 1/2p	1N5401 16 1/2p
200	1N4003 9p	1N5402 17 1/2p
400	1N4004 9p	1N5404 22p
600	1N4005 11p	1N5406 26 1/2p
800	1N4006 13 1/2p	1N5407 30p
1000	1N4007 16 1/2p	1N5408 33p

BY100	16 1/2p	BY133	23p
BY103	22p	BY164	55p
BY105	16 1/2p	BY176	£1.65
BY126	16p	BY182	£1.65
BY127	16 1/2p	BY250	25 1/2p

OR

FILAMENT INDICATOR
MINITRON 3015F & G



BREAKTHROUGH

PRICE £1.49

Cheapest Opto yet

GAAsp LED's



RED	LED 2. 0-125"	26p
RED	LED 3. 0-175"	17p
GREEN	LED 4. 0-125"	69p
GREEN	LED 5. 0-175"	75p

Remember Vat Inclusive Prices

DIGITAL CLOCK

on a chip

just imagine, one MOS LSI I.C. eliminating 15 MSI I.C.s and numerous other components. Either

12 or 24 hour, 4 or 6 digit
50 or 60Hz operation
leading zero suppression
single voltage supply
similar to DIGITRONIC in
P.W. March 1973.

Only £7.99

With 4 LED's £16.59

With 6 LED's £20.75

CHROMASONIC electronics

RESISTORS

Rating	Type	Tolerance	Range	Price Each	
1/4 watt	Metal Glaze	±5%	E12 Series	51Ω to 100KΩ	5p
1/2 watt	Carbon Film	±5%	E24 Series	51Ω to 300KΩ	11p
1 watt	Metal Oxide Film	±2%	E24 Series	10Ω to 1MΩ	41p
1 watt	"Cermet" Thick Film	±2%	E24 Series	56Ω to 150KΩ	8p
1 watt	Carbon Film	±5%	E24 Series	10Ω to 10MΩ	11p
1 watt	Carbon Composition	±0.5%	2-20; 2-70; 3-30; 3-90; 4-70	41p	
1 watt	Carbon Composition	±0.5%	5-80; 6-80; 8-20	51p	
1 watt	Carbon Film	±10%	E12 Series	10Ω to 10MΩ	3p
2 watt	Carbon Film	±5%	E12 Series	10Ω to 10MΩ	6p
2 1/2 watt	Wire Wound	±5%	E12 Series	0-22Ω to 0-47Ω	10p
2 1/2 watt	Wire Wound	±10%	E12 Series	10Ω to 270Ω	10p
5 watt	Wire Wound	±5%	E12 Series	0-5Ω to 8-2KΩ	10p
10 watt	Wire Wound	±5%	E12 Series	0-5Ω to 6-8KΩ	11p
10 watt	Wire Wound	±5%	E12 Series	10KΩ; 15KΩ; 20KΩ; 25KΩ	17p
15 watt	Wire Wound	±5%	E12 Series	10KΩ to 6-8KΩ	13p

CAPACITORS

MULLARD C333, 629 and 630 series
—Ceramic Plate, E12 series from 1-8pF to 0-022μF, 53p.

CERAMIC DISC—LOW VOLTAGE—
0-01μF, 0-022μF, 0-047μF, 53p;
0-1μF, 0-22μF, 0-47μF, 63p.

POLYSTYRENE (160V)—From 10pF to 0-01μF in multiples of 10pF: 15pF; 22pF; 33pF; 47pF and 68pF 3 1/2p.

MYLAR PLATE (100V)—1000 pF, 2000pF, 5000pF, 23p; 0-01μF, 0-02μF, 0-04μF, 0-05μF, 33p; 0-068μF, 0-1μF, 5p; 0-2μF, 63p.

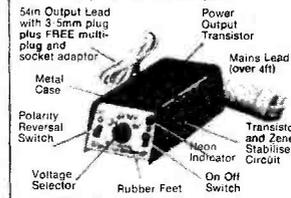
MULLARD C280 (250V POLYESTER)
—0-01μF, 0-015μF, 0-022μF, 0-033μF, 0-047μF, 33p; 0-068μF, 4p; 0-1μF, 0-15μF, 43p; 0-22μF, 53p; 0-33μF, 7p; 0-47μF, 9p; 0-68μF, 12p; 1-0μF, 14p; 1-5μF, 22p; 2-2μF, 26p.

TRANSISTORS and DIODES

AC107	16p	AF179	71p	BC214L	11p	BF177	28p	BSX20	18p	TC44	46p
AC126	15p	AF208	41p	BC266	15p	BF178	29p	BSX21	22p	TC22BD	£1.97
AC127	13p	ASV26	35p	BC327	26 1/2p	BF179	35p	BSV55A	15p	TP141A	51p
AC128	13p	BC107	19p	BC328	24p	BF180	33p	BU105/02	£1.92	TP42A	59p
AC176	15p	BC108	16p	BCV70	17p	BF181	35p	BU105/02	£1.92	TS43	36 1/2p
AC187	22p	BC109	16p	BCV72	17p	BF184	27 1/2p	D13V	53p	TS73	£2.10
AC187K	22p	BC110	15 1/2p	BCV70	17p	BF185	27 1/2p	MA4000	£1.48	TS81	23p
AC188	20p	BC117	25p	BCZ11	28p	BF189	15p	MA4010	£1.48	TS897	16 1/2p
AC188K	20p	BC147	9p	BD115	74p	BF195	17p	MJE320	52p	TS906	13p
AC197	24p	BC148	9p	BD124	82p	BF196	16 1/2p	MJE365	£1.82	TS908	20p
AC198	21p	BC149	9p	BD131	65p	BF197	16 1/2p	MJE365S	92p	TS914	24 1/2p
AC198K	20p	BC157	13p	BD132	83p	BF200	35p	MPE102	27 1/2p	TS930A	23p
AC199	22p	BC158	12p	BD131/2 PR	£1.49	BF220	27 1/2p	MPE103	41p	TS930S	24p
AD140	40p	BC159	14p	BD133	83p	BF243B	27p	MPE104	45p	TS930T	24p
AD148	38p	BC168	11p	BD135	42p	BF252	25p	MPE105	45p	TS930V	24p
AD161	29p	BC169	12p	BD136	50p	BF283	25p	MPE106	49 1/2p	TS930W	24p
AD162	29p	BC171	20p	BD137	57 1/2p	BF272	27 1/2p	OC28	35p	TS930X	24p
AD161/2 PR	35p	BC172	17 1/2p	BD138	74 1/2p	BF360	37p	OC35	38p	TS930Y	24p
AF14	14p	BC174B	36p	BD139	65p	BF328	£1.01	OC36	38p	TS930Z	24p
AF15	14p	BC177	22p	BD140	91p	BF410	87p	OC44	13 1/2p	TS930A	23p
AF16	14p	BC178	22p	BD201	£1.55	BF411	87p	OC45	13 1/2p	TS930T	24p
AF17	14p	BC179	24p	BD202	£1.57	BF467	87p	OC71	13 1/2p	TS930S	24p
AF18	22p	BC182L	9p	BD203	£1.55	BF426	43p	OC72	13 1/2p	TS930V	24p
AF184	24p	BC183L	9p	BD204	£1.57	BF430	37p	OC75	15p	TS930Z	24p
AF195	22p	BC184	9p	BF109	75p	BF468	80p	OC81	15p	TS930S	24p
AF196	22p	BC184L	9p	BF115	25p	BF450	16 1/2p	OC83	25p	TS930T	24p
AF197	22p	BC187	27 1/2p	BF160	25p	BF451	11 1/2p	OC84	22p	TS930S	24p
AF198	35p	BC212L	11p	BF157	27p	BR100	43p	OC70	27 1/2p	TS930V	24p
AF199	25p	BC215L	11p	BF173	27p	BRV39	43p	OC171	35p	TS930S	24p

new stabilised

POWER PACK/CONVERTER
Switched 3, 6, 7 1/2 or 9 volts.
Up to 400mA Output



Our Price £3.99 + P. & P. 16p.
Unstabilised Version of above
Other Eliminators (unstabilised)*

6 volts at up to 50mA	£1.65
9 volts at up to 50mA	£1.65
9 volts (miniature) up to 50mA	£2.09
6 + 6 volts at up to 50mA	£2.75
9 + 9 volts at up to 50mA	£2.75
7 1/2 volts for Cassette Players (small)	£2.20
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Fully Stabilised* Car Battery Converter, giving switched outputs of 6, 7 1/2 or 9 volts

P. & P. on all models 16p.

ZENERS

All 5% tolerance

BZV88, 400mW, 3-3V to 33V	11p
1ZS, 1W, 3-3V to 100V	18p
BZX70, 2-5W, 7-5V to 75V	27p

VAT INVOICES ON REQUEST

UNLESS SHOWN OTHERWISE P&P ON U.K.
ORDERS IS 8p. OVERSEAS ORDERS AT COST



Mullard LP1886
Varactor diode tuned F.M. tuning heart. £4.15, as described in P.E. May 1973. LP1885 matching I.F. strip. £4.85.



THE TEXAN
20 + 20 Watt integrated Stereo Amplifier Kit. Superb state-of-the-art design by engineers of Texas Instruments. £31.35 + P. & P. 49p.



SGS EA1000
3 watt amplifier module. Price including handbook and FREE heatsink. Our price £2.49. Quantity discounts.



A1005S
F.M. tuner chassis fully transistorised. 9 Volt positive earth operation. Our Price £6.35.



A1018
F.M. tuner similar to A1005S but in oiled walnut cabinet, etc. Our Price £9.38.



A1005MS
Multiple Stereo Decoder, fully built and aligned, to match A1005S. Our Price £5.95.

AUDIO I.C.'S

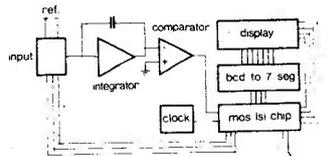
Audio I.C. Leaflet No. 12. FREE (only with I.C.'s—10p separately).

Pre-Amplifiers
Dual. MC1303L £1.89
Low Noise Dual. MC1339P £1.29

Amplifiers
250mW. MFC4000A 49p
1 watt. TAA300 £1.79
2 watt. LM380 £1.59
5 watt. TBA800 £1.59
15 watt. BHA0002 £3.95
35 watt driver. NE540L £1.32



3 1/2 decade DVM



Supplied with complete data All this on a single 16 pin DIL packed MOS LSI Integrated Circuit

A State-of-the-Art Digital Voltmeter I.C. for only £7.79

- Maximum Display + or - 1.999V
- Minimum Display + or - 1mV
- Can be scaled up to read 1.999V
- Automatic Polarity Detection
- Dual Ramp Integration
- Automatic Overrange Indication
- Up to 50 readings per second
- Chopper Output provided.

Coil-less Phase-Locked Loop I.C. Stereo Decoder

MC1312 decodes CBS, SQ. Free leaflet No. 11 gives full circuit and details. Our Price £6.49

Motorola MC1310, supplied complete with our leaflet No. 11 Our Price £3.05

QUADRISONICS

inc. all parts for decoder, inc. Veroboard, V.A.T., P. & P. (Leaflet alone 10p.)

Linear

8pin Dip	TO9	14pin Dtl
709	34p	40p
710	35p	40p
711	—	40p
723	—	90p
741	42p	45p
742	—	45p
748	42p	45p

CA3046	85p	MVRS(L005)	£1.65
CA3075	£1.65	MVRS(L005)	£1.65
CA3082	£1.65	MVRS(L005)	£1.65
LM101H	£1	NE555	99p
LM201H	£1.15	NE560B	£4.92
LM301	£1.05	NE562B	£4.92
LM307N	£1.45	NE565	£3.49
LM308N	£2.59	NE565	£2.75
LM309K	£2.59	NE567	£3.49
LM3900	77p	NE567	£3.08
MC1330	88p	SG3402N	£2.29
MC1350	83p	SL442	£2.29
MC1351	£1.10	TA263	99p
MC1352	£1.10	TA292	99p
MC1357	£1.59	TA310	£1.27
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MC1456G	£1.75	TA350	£2.54
MC1458CP1	£2.42	TA370	£3.15
MC1459	£5.65	TA480	81p
MC1498N	£1.49	TA570	£1.65
MC2401	17p	TA700	£4.49
MC2402A	61p	TAQ100	£1.65
MFC4050	78p	TAD110	£1.65
MFC4055A	45p	TBA560	£1.65
MFC640	£1.10	ULN211A	£1.59

The component people

Dept. I
56, Fortis Green Road, London, N10 3HN.
telephone: 883 3705

INDUCTORS

MULLARD block filter LP1175 as used with TAD100 now only £1.49

R.F. CHOKES, 0.1µH to 19mH. For full details ask for List No. 5. P.&P. 5p.

DENCO COILS

Transistor Range: Series 1T to 5T inclusive Blue, Yellow, Red and White all 44p each.
I.F. Transformers: IFT13, 14, 16 and 17, 55p each; IFT 15, 76p; IFT18, 73p.

Dual Purpose Range: Series 1 to 7 inc. Blue, Yellow, Red and White, 44p each.

1 to 5 Green. List No. 5 gives full details.

Ferrite Aerials: Medium and Long—state 300pF or 500pF tuning, 87p each

Tuning Gangs



Type C804	Type 0	Type 00
50F 61p	365pF	80p
100F 61p	365 - 365pF	90p
150F 61p	—	—
200F 66p	208 - 176pF with screen and trimmers	99p
250F 61p	—	—

P. & P. all types 10p

NEW FERRANTI RANGE

ZN414

The Radio I.C. in a TO18 can. Supplied with our data leaflet No. 10. Giving circuits and component information. (Leaflet alone 10p.)

Our Price	1.32
BFS59	15p
BFS60	20p
BFS61	20p
BFS96	15p
BFS97	23p
BFS98	20p
ZTX107	9p
ZTX108	8p
ZTX109	11p
ZTX212	14p
ZTX213	14p
ZTX214	15p
ZTX300	12p
ZTX301	13p
ZTX302	17p
ZTX303	17p
ZTX304	21p
ZTX311	10p
ZTX312	10p
ZTX313	11p
ZTX314	13p
ZTX320	31p
ZTX330	15p
ZTX331	16p
ZTX332	15p
ZTX382	13p
ZTX383	13p
ZTX384	18p
ZTX450	17p
ZTX451	17p
ZTX500	12p
ZTX501	13p
ZTX502	17p
ZTX503	14p
ZTX504	43p
ZTX510	17p
ZTX530	21p
ZTX531	22p
ZTX550	17p
ZTX551	17p
ZS121	10p
ZS122	13p
ZS123	16p
ZS124	18p
ZS140	25p
ZS141	43p
ZS142	33p
ZS170	10p
ZS171	13p
ZS172	16p
ZS174	17p
ZS176	23p
ZS178	38p
ZS270	11p
ZS271	16p

Our Price
1.32
18p
19p
26p
26p
37p
as
BZY88
11p each.

ELECTROLYTICS

µF	4V	6.3V	10V	16V	25V	40V	63V	100V
1							61p	8p
1.5							61p	8p
2							61p	8p
3							61p	8p
4							61p	8p
5							61p	8p
6							61p	8p
8							61p	8p
10							61p	8p
15							61p	8p
22							61p	8p
33							61p	8p
47	61p						61p	8p
68		61p					61p	8p
100	61p	61p					61p	8p
150		61p					61p	8p
220	61p	61p	61p				61p	8p
330	61p		61p				61p	8p
470		61p	61p				61p	8p
680		61p	61p				61p	8p
1000		61p	61p				61p	8p
1500		61p	61p				61p	8p
2200		61p	61p				61p	8p
3300		61p	61p				61p	8p
4700		61p	61p				61p	8p
6400		61p	61p				61p	8p
10000		61p	61p				61p	8p

Potentiometers

5kΩ	250kΩ
10kΩ	500kΩ
25kΩ	1MΩ
50kΩ	2MΩ
100kΩ	—

Log or lin less switch (and 1kΩ lin)
Log or lin with switch
Dual less switch
Dual with switch 10kΩ, 100kΩ and 1MΩ. log only
10kΩ log + 10kΩ antilog less switch

10kΩ	Single
25kΩ	33p
50kΩ	Dual
100kΩ	55p

New Silver and Black Knob, 161p

Presets

Vertical or Horizontal	0.25 watt	7p
0.1 watt	5p	—
100kΩ	1kΩ	100kΩ
250kΩ	2.5kΩ	250kΩ
500kΩ	5kΩ	500kΩ
—	—	5MΩ

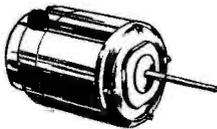
Cermet Type to 1MΩ only. 41p.

VDR's & Thermistors

A156	82p	GL23	£1.10
C21	16p	R53	£1.49
C24	14p	R54	£1.61
C213A	14p	VA1005	161p
C219	14p	VA1028	141p
E296CD A258	13p	VA1033	11p
E296ED A258	11p	VA1034	11p
E296ED A260	11p	VA1039	161p
E296ED A262	11p	VA1040	11p
E296ED A265	11p	VA1053	11p
E296ED P268	11p	VA1055	11p
E296ZZ 05	13p	VA1056	11p
E296ZZ 06	11p	VA1066	11p
E296DD P036	11p	VA1067S	161p
E296DD P338	11p	VA1077	141p
E296DD P342	11p	VA1098	21p
E296DD P348	11p	VA1104	21p
GL16	£1.10	VA1107	29p

Other types obtainable upon application

"SLO-SYN" 3-LEAD SYNCHRONOUS STEPPING MOTOR



MOTOR

Type SS15. These fine motors are easily reversed, starting and stopping in less than 5° without electrical or mechanical braking. Simple relay circuit can be applied to give DC., to winding for a maximum holding torque of 300oz/in with 35v at 0.35 amps through winding. For AC. (synchronous) operation at 120v., 50Hz. Speed 60 rpm at 60Hz., 72 rpm. STEPPING. Holding torque at 50 steps per second—100 oz/in. Can be wired to give 100 or 200 steps per revolution with accuracy of 0.1° per step non-cumulative. Torque characteristics can be modified by simple R.C. circuits. Dimensions: dia. 4", body length 4 1/2", spindle length 2 1/2" x 1/8" dia. Weight 6 1/2 lbs. BRAND NEW in maker's packing. Offered at less than 1/3 maker's price. **OUR PRICE ONLY £15**

MAINS SOLENOID by MAGNETIC DEVICES LTD.

A beautifully constructed solenoid at half normal price. A 2-sided bracket is incorporated for vertical or horizontal mounting. Size: 2" x 1 1/2" x 1 1/2". Pull is approximately 2lbs., plunger travel 1 1/2". Firing eye takes up to 1/4" bolt, plunger non-captive. NEW in original maker's boxes. £1.20. P. & P. 20p. Large number available, special price for quantity.



SMITHS RINGER-TIMER

Reliable 15 minute times, spring wound (concurrent with time setting) 15 x 1min divisions, approximately 1/2" between divisions. Panel mounting with chrome bezel 3 3/4" dia. £1.40. 15p P. & P.

KNOWLE (U.S.A.) MINIATURE MICROPHONE CAPSULES

Impedance approx. 200Ω, output 60 or 80 DB at 1 Kc. As used in deaf aids, bugging devices, etc. Size (60 DB) 7/32" x 5/32" x 1/8"; (80 DB) 3/8" x 5/32" x 1/8". Equipment, all tested. £1.20 each. P. & P. FREE.

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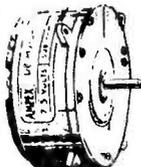
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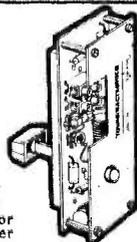
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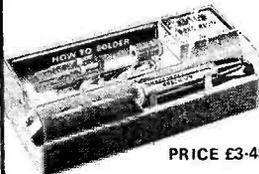
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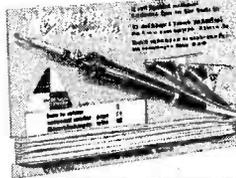


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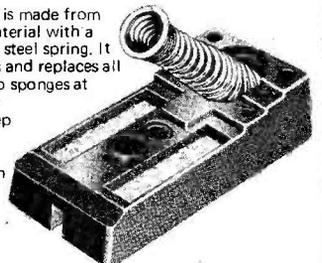


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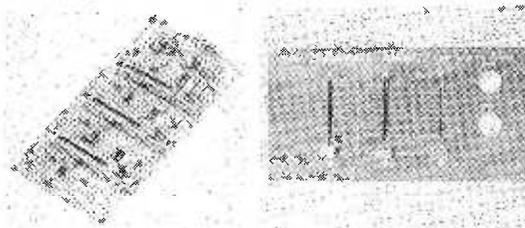
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0-110/120v. 200-230-250v. 50-80 watts	21-25.
150 watts, 22-10	220 watts 23-00; 300 watts 26-40

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Push-Pull 8 watts EL84 to 3 or 15 Ω	85p
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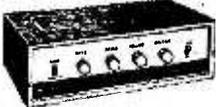
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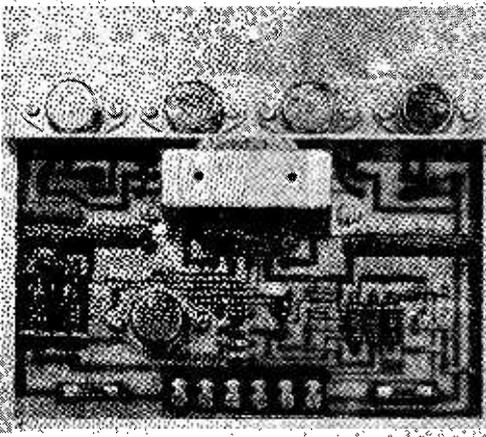
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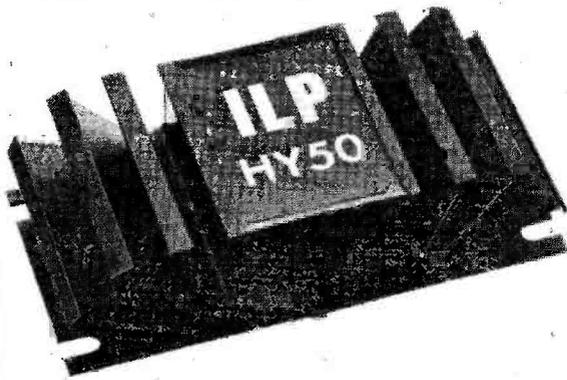
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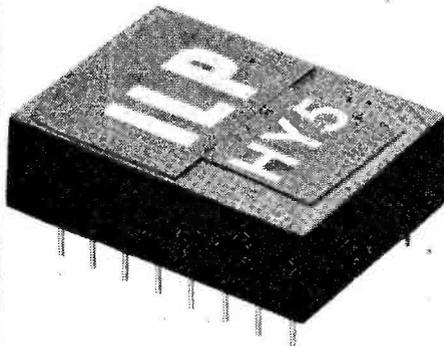
Consistent with modern thinking a triple rated output circuit with a load fuse allows for peak transient response without distortion but ensures the necessary protection.

OUTPUT POWER:	SPEC.
LOAD IMPEDANCE:	25 watts RMS. 50 watts peak music power
INPUT SENSITIVITY:	4-16Ω Into 8Ω
INPUT IMPEDANCE:	Odb (0-775 volts RMS)
TOTAL HARMONIC DISTORTION:	47KΩ
SIGNAL/NOISE RATIO:	Less than 0-1% at 25 watts typically 0-05 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

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Like the HY50, the new HY5 has no external components & has been redesigned to run off a split power-line with improvements in signal/noise, overload, capability & reduced distortion. The output has been increased to match the power module (Odb), and to share the same power supply.

Overall size is reduced by the use of a new thin film circuitry while the device still retains all the functions of the earlier device.

When combined with the HY50 & power supply only potentiometers are required to complete a simple mono amplifier with input & output facilities expected to be found on Hi-Fi amplifiers.

The combination of two HY5's two HY50's sharing a common power supply (PSU50) are linked by a balance control to form a complete stereo system.

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)

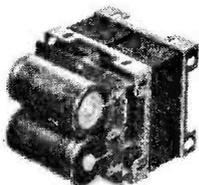
ACTIVE TONE CONTROLS
Treble ± 12db at 10kHz
Bass ± 12db at 100Hz

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

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

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

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 - Philips RH 621 £72.95
 - Metrosound FMS 20 Mk II £37.90
 - Rogers R/brook FET 4 (Cha) £32.95
 - Rogers R/brook FET 4 (Cased) £36.50
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 - Sinclair 4000 tuner £27.95
 - Teleton GT202 (N/P) £29.95

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VIBRATORS 12 1/2" pin Non-synch. 121HD4, 2 1/2" ex pins 33p. Same but 3 1/2" ex pins. USA 16 1/2", 12v/7 pin SYNCH. (12SR7 type) 72p (any type 9p).

ELIMINATORS for use with most cassette recorders and players, sets, etc. Mains input 240v. AC front switch, pilot lamp, leads output 3, 6, 7 1/2 and 9v. 400 mA. stabilised Model 5C with multi output adaptor £5.50 (30p). Model NR, extra 12v. output, and 500mA £6.00 (30p).

We supply all types of British and Continental **PLUGS, SOCKETS and LEADS**, detailed in our LIST, as are many more of all above items, also cartridge and styl comparisons, non-repeatable special offers, aerial rods, CASSETTES, TAPE & GRAM, accessories, cleaners, &c., diads, transistor, volume controls, Neos, indicator lamps, multi-meters and other test equipment, pocket screwdriver testers, Telephone pick-ups, amplifiers, wire, cable, terminals, Test Prods, Vero-board, Valve holders and many more components and accessories at lowest prices. TRADE quantity enquiries invited on several items.

Our list is supplied free if requested on an order or sent against a stamped addressed envelope (also required for replies for all enquiries). **CHARGES** are shown in brackets after all items. **CASH WITH ORDER ONLY.** **PRICES INCLUDE V.A.T.** and charges apply to UK and EIRE only. Overseas purchasers can deduct 10% from all prices shown but postage is required. This includes Eire and the Channel Isles.

RECORD PLAYBACK HEADS (TRUVOX)

Individual prices of these are:
 2 track record playback heads 50p each
 4 track record playback heads 72p each
 Frase heads are also available separately—2 track 30p, 4 track 55p
 MU-metal mounting shields 30p each
 2 track-heads already fixed on heavy mounting plate with shield £1.22.

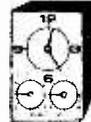


DRILL CONTROLLER NEW IKW MODEL

Electrically 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, have 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 Condensers with built-in LW switch and 3" Ferrite slab and litz wound MW coil, 75p.
 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, falls extendable to 40m 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 7 1/2 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, 5 1/2" casing with 5 1/2" 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 1 1/2 x 1 1/2 x 1 1/2in. 60p.
 Model 4001—1in. pull. Size 2 1/2 x 2 x 1 1/2in. 83p.
 Model 771—1 1/2in. pull. Size 3 x 2 1/2 x 2in. £1.95 plus 20p post and insurance.

MAINS TRANSISTOR P.P.

Designed to operate transistors, diodes and amplifiers. Adjustable output 6v, 9v, 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PPI, PPS, PP4, PP6, PP7, PPS, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real sup 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" x 3 1/2" x 2 1/2". 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 GD 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. 65p brings the catalogue and the next 6 monthly supplements.

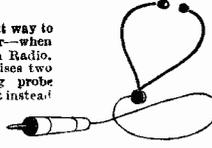
TWENTYLITE



Battery operated shrouded lighting 2 ft unit complete £2.50, 40 inch unit complete £2.50. These work off a 12 volt car battery. 24 volt light inverters also available send for this.

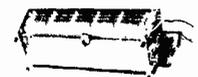
RADIO STETHOSCOPE

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 earstowet instead of earpiece 83p. extra—post and ins. 20p



TANGENTIAL VELOCITY UNIT

This heater unit is the very latest type, most efficient, and quiet running. Is 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. x P. 40p



STANDARD WAFER SWITCHES

Standard size 1 1/2" wafer—silver-plated 5 amp contact, standard 1/2" spindle 2" long—with locking washer and nut.

No. of Poles	2way	3way	4way	5way	6way	8way	9way	10way	12way
1 pole	44p	44p							
2 poles	44p	44p							
3 poles	44p	44p							
4 poles	44p	44p							
5 poles	44p	44p							
6 poles	44p	44p							
7 poles	77p	77p							
8 poles	77p	77p							
9 poles	77p	77p							
10 poles	77p	77p							
11 poles	77p	77p							
12 poles	77p	77p							



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 £2.55 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 x 18in £1.69
 18in x 0in £1.21

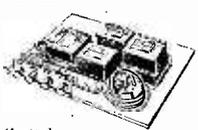


PHOTO ELECTRIC KIT

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 Unilex Amplifier Ref. E.P. 900 £1.60.
 1 Unilex Pre-Amp Ref. EP.300 £1.95.
 1 Unilex Power Unit Ref. EP.900 £2.55. 1 Control panel kit with spun aluminium faced knobs £2.30. Or the complete outfit £11.30 post paid. Pair of 15 ohm speakers made by K.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 1 in. diameter and approximately 1 in. long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia. x 5 in. long. Price 97p plus 23p postage and insurance



SLIDE SWITCHES

Slide Switch, 2-pole changeover panel mounting for two G.A. lamps. Size approx. 1in x 2in rated 250V lamp 5p each, 10 for 73p. Ditto as above but for printed circuit 6p each 10 for 63p
 Sub Miniature Slide Switch, DPDT 19mm (3in approx.) between fixing centres. 20p each 10 for £1.90. SP Change over spring return 250v 1 amp 11p



TREASURE TRACER

Complete Kit (except wooden battery) 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 Glass Company. Complete with sealing washers suitable for 200-240 volt A.C. Depth into tank 1 1/2, 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 2F Moutle 1172. Cabinet size approx. 11" wide x 8" high x 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 batteries 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. 50m 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 ferrous chloride or other etchant on removal the circuit stands in high relief. 99p.

SL105D, 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 SL105D 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 30p 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. Transparencies 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 otherwise items, post free if order for these items is £6.00 otherwise add 20p.

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TRANSISTORS BY SIEMENS AND NEWMARKET, ETC.

2N3055 npn silicon power	60p
AC153K pnp germanium low power	37p
AC176K npn germanium low power	38p
AD161 npn germanium medium power	42p
AD162 pnp germanium medium power	40p
AF139 pnp germanium UHF	57p
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

DIODES

OA90, OA91, OA95, 6p each; OA200, 9p; OA202, 9p. Other semiconductors: AC128, 17p; AF117 34p; BF51, 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.

TRANSFORMERS—MAINS

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
13TOS 13V/4A, CT	£1.38
28TOS 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**.

MINITRON DIGITAL INDICATORS

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**

No. 3015G showing + or - and 1 and dec. pt. **£1.20**

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All goods are sold on the understanding that they conform to manufacturers' specifications and satisfaction is guaranteed as such. All items are brand new—no rejects, 'seconds' or sub-standard merchandise is offered for sale.

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are allowed on all items except those shown at NETT PRICES, as follows:

10% on orders from £5.00 to £14.99.

15% on orders for £15 or more.

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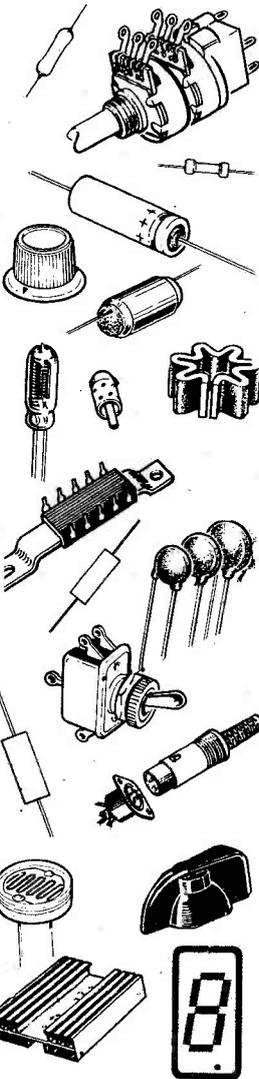
on U.K. orders (except Baxandall speaker). A surcharge of 10p is made on small mail orders under £2.00.

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GIRO A/c No. 38/671/4002

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**SIEMENS
NEWMARKET
RADIO HM
GUEST INTERNATIONAL
SOLDERSTAT**



ELECTROLYTIC CAPACITORS

Axial Lead

Rated volt.:	3V	6.3V	10V	16V	25V	40V	63V	100V	
Capacity μ F	0.47	—	—	—	—	—	—	11p	8p
	1.0	—	—	—	—	—	—	11p	8p
	2.2	—	—	—	—	—	—	8p	8p
	4.7	—	—	—	11p	—	—	8p	8p
	10	—	—	—	—	8p	8p	8p	10p
	22	—	—	—	—	8p	8p	8p	10p
	47	8p	—	8p	8p	8p	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	—	—	—	—	—	—

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ROTARY, CARBON TRACK, DOUBLE WIPE

SINGLE P20 lin. 100 Ω to 2.2M Ω 14p.

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JP20 log. 4.7K Ω to 2.2M Ω , 48p.

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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.

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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.

CARBON SKELETON PRESETS

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% \pm 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 (see note below) 10–99 100 up*

C 9 8 7.5

C 1 1 0.75 nett

C 0 0.9 0.75 nett

C 1 2 1 0.95 nett

MO 2 5 2 1.6 nett

WW 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, Electrofil 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 demotes 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

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V.A.T.

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TERMS OF BUSINESS

All items are offered for sale in accordance with our standard terms of business, a copy of which is available on request. Prices subject to alteration without notice. Enquiries from quantity users invited.

ORDERS BY POST AND ALL ENQUIRIES

must be addressed to Head Office at Englefield Green. Enquiries requiring an answer should be accompanied by S.A.E.

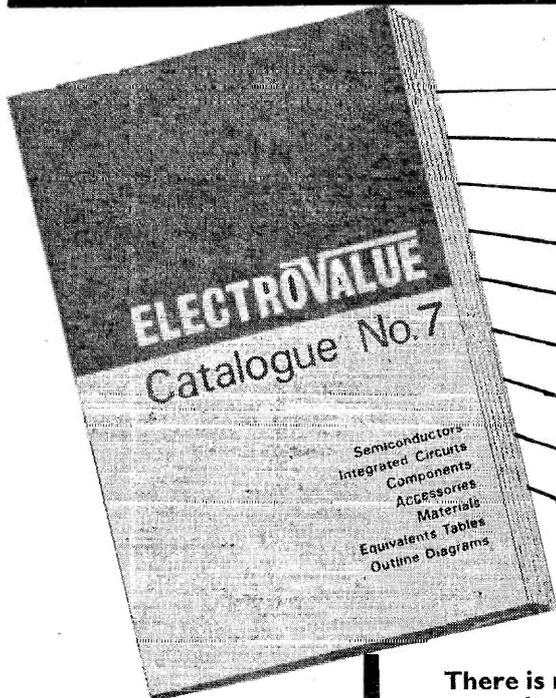
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ADDRESS

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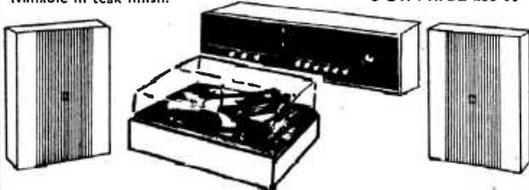
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Fantastic Bargain Offer!**

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A COMPLETE AUDIO SYSTEM

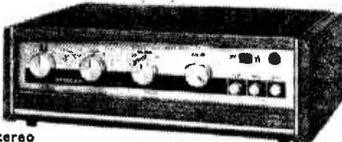
An all "White" Hi-Fi Stereo System to blend with modern furnishings. Solid state, fully transistorised tuner/amplifier with Stereo Multiplex Decoder, 4 wavebands Long/Medium/Short/VHF, 8 watts per channel (music power) output. The latest BSR C129 3 speed Mono/Stereo record changer. Two white matching bookshelf speaker units. Also available in teak finish. **OUR PRICE £55.00**



Credit terms £5.00 deposit plus £2.50 p. & p. followed by 12 payments of £5.00. Total Credit Terms £65.00 SEND £7.50 TODAY.

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High performance Stereo Amplifier designed for home entertainment at economical cost. Represents a considerable advance in solid state, high fidelity stereo amplifiers. Outstanding performance is allied to meticulous construction, comprehensive facilities, installation simplicity and attractive styling. 10 watt RMS per channel; push button selectors; tone controls; balance control; tape record and replay facilities. Stereo headphone socket on front panel with automatic speaker muting; Teak finish. **Our price £75.00 + £2.50 p. & p.** Credit Terms £7.50 deposit + £2.50 p. & p. 18 monthly payments of £4.75 (total £93.00) SEND £10.00 TODAY.

THE AVON AUDIO SYSTEM



The uncabineted system is ideal as an economical replacement for in outdated chassis. Stereo Amplifier for Stereo/Mono record reproduction. Tuner with medium and short wavebands provides Worldwide coverage, even the weakest continental stations can be received with superb clarity. Push button band selection, 10 watts total output. Frequency response 25-18000 Hz. **LATEST BSR STEREO/MONO RECORD CHANGER** plays all types of 7in., 10in., and 12in. Mono or Stereo records. Manual or automatic play. These low impedance, permanent magnet units have been specially selected to provide the fullest range of audio reproduction.



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THE FOLLOWING ITEMS ARE NEW UNUSED CRT type 7BP7A 7" flat face emag deflection & focus, blue/yell phosphor with base conn. £1.83. **BATTERIES** lead acid type 24v 25 A/Hr will split to make 2 x 12v £10.20 also 24v only 4 A/Hr size 9 x 4 x 2 1/2" £4. **SILICON DIODES** 800 PIV 750 Ma 15 for £1.10. **TRIMMERS** 20pf air spaced ceramic base 10 for 60p. **HEADPHONE LEAD** & high to low impedance matching trans with 5ft cord & standard jack plug 65p. **HEAD & MIKE SETS** for 19 set low res moving coil mike & headphones £1.80. **TAC STRIPS** solder type 24 way 10 for 30p. **NEONS** wire ended type 1/25th watt req 470K for 240v 10 for 60p. **GAUGES** vehicle type scale 0/160 elec operated 50p **BLOWER MOTORS** small double ended type will work on 6 to 28v DC, 10,000 RPM on 28v £1.90. **ROTARY CONVERTORS** 1/P 28v DC at 9 amp for full O/P, O/P 115v 400c/s 3 phase 115 watts £7.48. **MIKES** type T.17 carbon £1.10.

THE FOLLOWING ITEMS ARE EX EQUIPMENT.

R.F. SWITCHING RELAYS 12v coil uses Reeds as 2 NC & 1 NO RF circs & 2 NO aux circs size 1 1/2 x 1 x 1" 75 ohm R.F. circ type 55p. **POWER UNIT** 917 1/P 230v 50c/s O/Pe -2.2Kv EHT, +300 & -300v at 180 Ma ea DC smoothed, 6.3v twice & 4v for CRT, will work most ex surplus 3 & 6" Ind £8.38. **METERS** 270 deg 1 Ma FSD scale 0 to 20 also as center reading type meter in same case 100-0-100 Ua center mark only, possible use as combined Rev counter & Battery voltage ind (circ for battery volt ind supplied) ex aircraft £3. **MORSE KEYS** enclosed type with swt (American type) £1.10. **C.R.T.** 3" with base & shield, green screen okay for scope use, conn. data supplied £3.30. **JOY STICK** controller as 4 x 1 pole c/o micro swts + 2 aux swts gives control in 4 directions scale £1.45. **VIDICON CCTV** camera tubes standard 1" type by E.E. & E.M.I. suitable gen purpose use with data sheet, graded according to scan marks £6 & £9 ea. **VALVES** 12A6, 12J5GT, 12SJ7, 5U4, 6X5, 6SN7, 6AK5, 6BH6, 6H6, 6Y6, 2X2, 6SK7M, 6N7M, 12AX7, 12AT7, 12AU7, 6AK6, 6X4, EF50, 6J6, 85A2, 6SJ7M, OB2, ECC88 any 3 for 60p also QQV03-20 £2 inc. base, 5783 55p, OA2 33p. **INVERTOR TRANS** 12v DC to 300v at 150 Ma with circ req 2xOC28 or similar £2. **COAX CABLE** good quality 75 ohm type silver plated braid 20 yds for £1.32. **MOD TRANS** transistor type to match 2xOC35 to QQV03-20 or similar with P.A. spk winding £1.40. **U.H.F. WAVEMETER** assembly range approx 420 to 480Mc/s with knob & dial (not cal in freq) okay for high Q Rx cavity £2. **TUNING CONDS** split stator type 25pf per section 1" x 1/2 shaft 2 for 55p. **DIODES** 200 PIV 8 amps 4 for 66p, also 600 PIV 12 amps 4 for £1.10. **METERS** 1 Ma FSD 2 1/2 Sq scale 0 to 1 & 0 to 180' 88p also 500 Ua scale 0 to 5 1/4" OSD on panel with 2 swts £1.25. **TRANSISTORS** type OC42 with long leads 50 for 60p.

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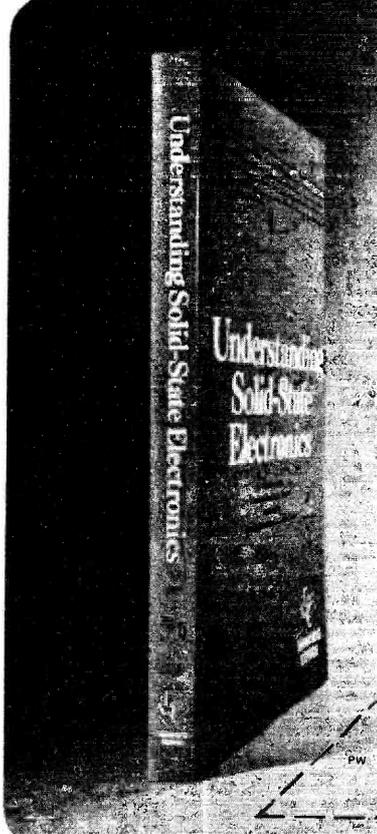
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0B2	.40	6BH6	.70	6N7GT	.60	19AQ5	.42	90C1	.75	EB34	.25	EL25	.50	KT62	.53	PL82	.37	UL41	.65	AC132	.22	BC116	.28	OA90	.14	
0Z4	.47	6DJ6	.50	6Q7G	.50	19G6	1.40	60G2	2.40	EB91	.16	EL37	1.00	KT41	.48	PL84	.39	UL84	.38	AC154	.28	BC118	.25	OA91	.10	
1A2	.50	6KQ7A	.80	6Q7QT	.50	60D4	0.00	10B2	.75	EB041	.25	EL41	.60	KT44	.75	PL84	.48	UL84	.38	AC156	.28	BC119	.25	OA92	.10	
1A5GT	.50	6BR7	.85	6Q7(M)	.55	20F9	.75	807	.60	EB081	.25	EL41	.60	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
1A7GT	.65	6BR8	.85	6R7G	.60	30L1	.85	6702	.80	EBF80	.39	EL83	.55	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
1B3GT	.52	6B8T	1.40	6R7M	.75	20P1	.55	6733	2.00	EBF83	.43	EL84	.25	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
1H5GT	.65	6BW6	.85	6SA7	.44	20P3	.80	7475	1.00	EBF89	.30	EL85	.40	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
1L4	.14	6BW7	.68	6SC7GT	.33	20P4	.88	AC/PEN	.98	EBL21	1.50	EL86	.38	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
1N5GT	.65	6BZ6	.49	6SH7	.44	20P5	1.30	AC2/PEN	.78	EC86	.59	EL91	.38	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
1R5	.38	6CB6A	.40	6SK7GT	.44	26A6G	.38	DD	.98	EC88	.59	EL95	.38	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
1B4	.35	6C4	.28	6SQ7GT	.38	26L6G	.50	AC6/PEN	.38	EC92	.45	EL96	1.20	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
1T4	.45	6C6	1.25	6V8G	.17	28Y6G	.70	AC/TH1	.21	EC033	1.00	EL96	1.20	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
1U5	.90	6CDBG	.80	6V8GT	.60	28Z4G	.38	AL60	1.00	EC035	.85	EM80	.40	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
2D21	.49	6CC8A	.75	6X4	.30	25Z5	.80	ATP4	.40	EC040	.75	EM81	.40	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
2GK5	.55	6CH6	.60	6XS5GT	.28	28Z6G	.70	AZ1	.60	EC031	.29	EM83	.55	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
3A4	.42	6CL6	.55	7B6	.75	28D7	1.00	AZ31	.60	EC032	.28	EM84	.40	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
3D6	.19	6CM7	.75	7B7	.70	30A6	.65	AZ41	.65	EC033	.28	EM85	1.00	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
3Q4	.49	6CUG	.75	7H7	.75	30C15	.75	CL53	1.60	EC034	.30	EM87	.68	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
3Q5GT	.55	6CW4	.70	7E7	1.50	30C17	.90	CV63	.63	EC035	.85	EM88	.22	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
3R4	.33	6DE7	.75	7Y4	.85	30C18	.78	CV10	1.00	EC036	.85	EV51	.40	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
4DB6	.55	6DT8A	.75	7Z4	.80	30C19	.75	CV31	.45	EC038	.44	EV81	.40	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
5C08	.55	6EW6	.75	9D7	.65	30FL1	.75	DAF91	.30	EC039	.53	EV83	.54	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
6T4	.80	6E5	1.00	10C2	.65	30FL2	.75	DAF96	.44	EC040	.60	EV84	.70	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
5U4G	.30	6F1	.70	10D7	.55	30FL12	1.00	DF91	.30	EC041	.60	EV87	.68	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
6V4G	.54	6FG	.80	10F1	.50	30FL13	.55	DF96	.44	EC042	.34	EV88	.40	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
6V9GT	.90	6F10	.80	10F5	.45	30FL14	.45	EG69	.90	EC043	.44	EV89	.40	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
6Z4G	.35	6F14	.75	10F18	.55	30L15	.75	DH76	.45	EC044	.44	EV91	.40	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
8Z4GT	.35	6F18	.60	10LD11	.70	30L17	.70	DK40	.70	EC045	.44	EV92	.40	KT66	2.40	PL84	.48	UL84	.38	AC158	.28	BC121	.25	OA93	.10	
6/80L2	.90	6F99	.85	10P13	.70	30T4MR	.70	DK92	.70	2.10	EV21	.25	PD500	1.44	UCL21	.65	28228	.55	28228	.55	28228	.55	28228	.55	28228	.55
6A8G	1.25	6F24	.85	10P14	2.00			DK96	.55	ECH21	1.50	EV50	1.75	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6A7	.49	6F26	1.00	12A6	1.00	30P19	.80	DL92	.33	ECH35	.65	GZ32	.54	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6A6	.27	6F28	.70	12A6	.65	30P19	.80	DL96	.44	ECH42	.70	GZ34	.57	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6A8H	.60	6F28	.65	12AD6	.65	30P4	.75	DM70	.44	ECH42	.70	GZ34	.57	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AJ5	.75	6G88A	.75	12AE6	.65	30PL1	.65	DM71	2.00	ECH43	.44	GZ37	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AK6	.34	6GK5	.65	12AT6	.35	30PL13	.75	DY87	6.00	ECH44	.44	HAC80	.44	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AK6	.60	6GU7	.75	12AV6	.45	30PL14	.80	DY802	.33	ECH40	.40	HL23DD	.75	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AM8A	.55	6HGT	.18	12AV6	.40	30PL15	.85	EB0CC	1.65	ECL82	.34	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AN6	.49	6J5GT	.32	12BA6	.30	35A3	.85	EB0F	1.20	ECL83	.67	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AQ5	.40	6J6	.25	12BE4	.38	35B3	.75	EB3F	1.20	ECL84	.60	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AR5	.55	6J7G	.30	12BH7	.27	35L6GT	.55	EB8CC	.80	ECL85	.60	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AS7	1.00	6J7(M)	.38	12J7GT	.55	35W4	.43	EB92C	1.00	ECL86	.40	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AT6	.33	6J7A	.75	12K5	.95	35Z4GT	.42	EL180F	1.00	EF22	1.50	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AU6	.30	6K7G	.19	12K7GT	.38	35Z5GT	1.00	EL182CC	1.00	EF40	.60	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AV6	.33	6K8C	.85	19Q7GT	.45	60B5	.85	EL148	.53	EF41	.40	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AW6A	.65	6L1	2.00	12S27	.50	60C3	.45	EAS0	.37	EF42	.55	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6AX4	.55	6L6GT	.68	12S67	.38	60CD6G	1.25	EAF7	1.00	EF73	1.50	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6BSG	.30	6L7	2.00	12SH7	.35	50EH5	.55	BARC80	.30	EF80	.20	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6BA6	.28	6L18	.49	12S7	.44	60L6GT	.65	EAC91	.75	EF83	.60	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	
6BC8	.60	6L19	2.00	12SQT	.65	85A2	.60	EAF42	.50	EF85	.34	HL1ADD	.67	PN45	.80	UCH42	.65	28228	.55	28228	.55	28228	.55	28228	.55	

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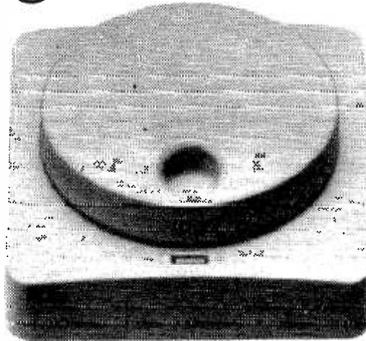
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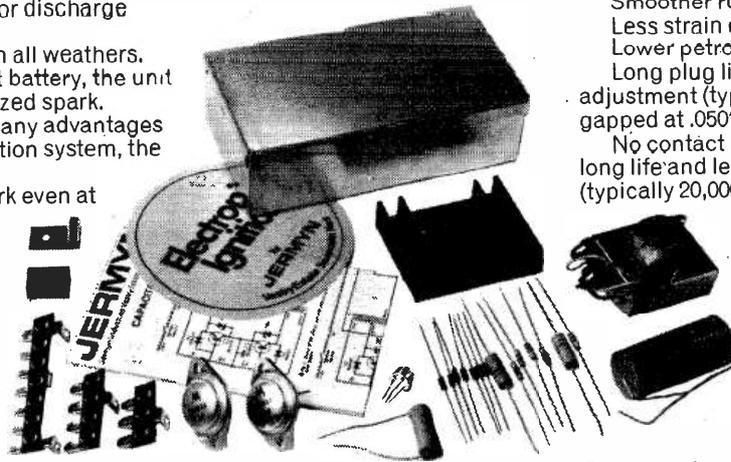
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		22µF	61p		
		47µF	61p		
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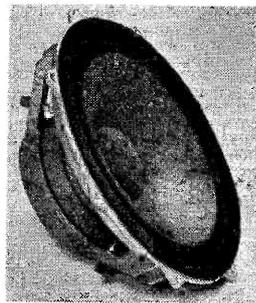
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The unique VISCOUNT III amplifier, plus the Garrard SP25 Mk III deck, plus the magnificent Duo Type III matehead speakers (or Duo Type II for a small room) give you an audio installation that will prove unbeatable for listening pleasure! And the teak 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!

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with MAG. cartridge	
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MAG cartridge	
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THE TOURIST PUSH-BUTTON CAR RADIO KIT £6.60

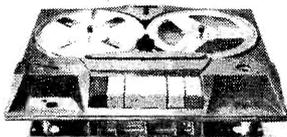
The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. It is permeability tuned and sturdily constructed. Output is a full 2.5 watts into an 8 ohms speaker. But the Tourist PB will operate into any loud-speaker from 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 modulated 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 4½in 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.



PE TAPE LINK CONSTRUCTORS

Suitable 3 speed tape deck, less heads. Caters up to 5½ins. spools. 240V AC mains. Unused but store soiled hence no warranty. **£4.00** £1 p. & p.

RELIANT MK IV MONO AMPLIFIER

- *5 Electrically Mixed inputs.
- *3 Individual Mixing controls.
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- *Solid State Circuitry.
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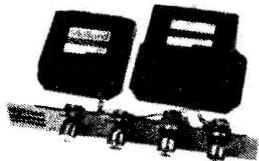
INPUTS 1. Crystal Mic or Guitar 9mV. 2. Moving coil Mic. or Guitar 8mV. Inputs 3, 4 & 5 are suitable for a wide

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. 12½ x 6 x 3½ in. **£13.50** p. & p. 60p

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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.



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 **£10.60** + 90p. p. & p. will accept this unit, simply connect up.

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.

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.

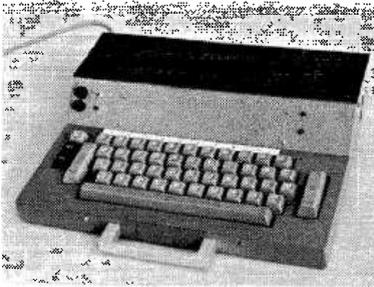
He conceived the idea of a portable electronic device which would enable him to communicate with others easily and set about the task of putting his idea into practice. After reviewing the electronic components available, he knew that his ideas were not just a pipe dream but a practical possibility. 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:—

$$Q = CV \dots \dots \dots (1)$$

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 :—

$$Q = \int I dt \dots \dots \dots (2)$$

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

$$Q = It \dots \dots \dots (3)$$

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

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

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 $1k\Omega$ 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 $500\mu A$ in the $10k\Omega$ 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 $250\mu F$) is measured using a conventional voltmeter (say $20k\Omega/V$) 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.

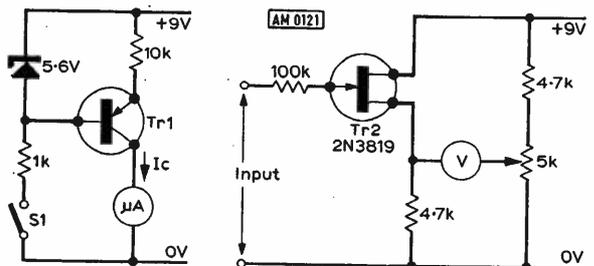


Fig. 1, left: Basic circuit of a constant-current generator. Fig. 2, right: Circuit of high impedance voltmeter.

The circuit is shown in Fig. 2. The FET gives an extremely high input impedance, of the order of $500M\Omega$ so that the time-constant with a $250\mu F$ 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 $250\mu\text{F}$ was chosen. Then, with the current at $250\mu\text{A}$, 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 voltage 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.

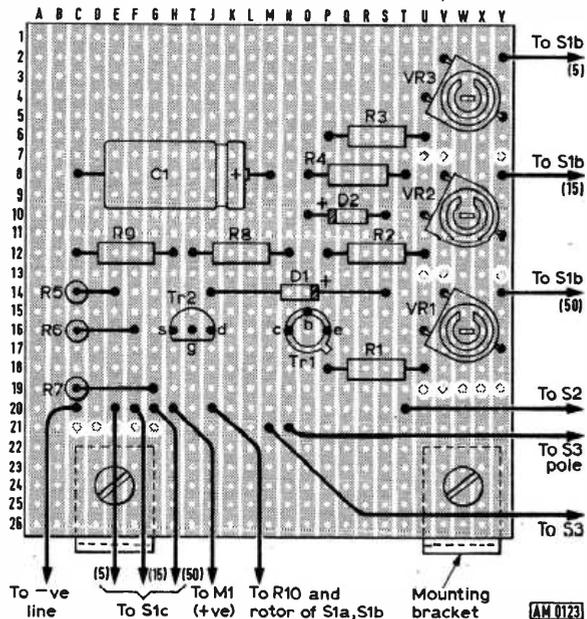


Fig. 3b: Layout of components on 0.1in matrix standard Veroboard. Remainder of components are located on front panel.

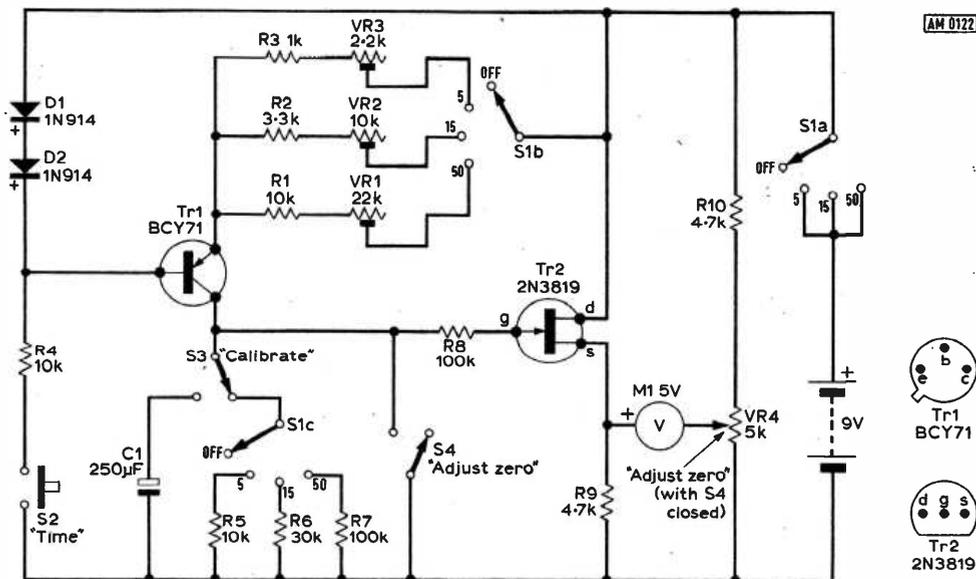


Fig. 3a: Complete circuit of the electronic stop-watch combining the circuits of Figs. 1 and 2.

CONSTRUCTION

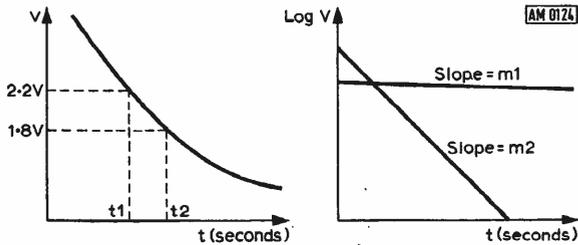
Layout is not critical, and the method of construction may be varied considerably. The prototype used an Elf instrument case which provides a smart and convenient housing.

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 $C = 5(t_2 - t_1) \mu\text{F}$.

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

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 $V/1M\Omega = V \mu\text{A}$.

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 $V_1 + V_2 / 2 \mu\text{A}$.

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:—

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

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

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

★ components list

Resistors:

R1 10k Ω 5%	R5 10k Ω 2%	R9 4.7k Ω 5%
R2 3.3k Ω 5%	R6 30k Ω 2%	R10 4.7k Ω 5%
R3 1k Ω 5%	R7 100k Ω 2%	R11 1M Ω 2%
R4 10k Ω 5%	R8 100k Ω 5%	

All resistors $\frac{1}{4}\text{W}$. 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 22k Ω VR2 10k Ω VR3 2.2k Ω

All skeleton pre-sets

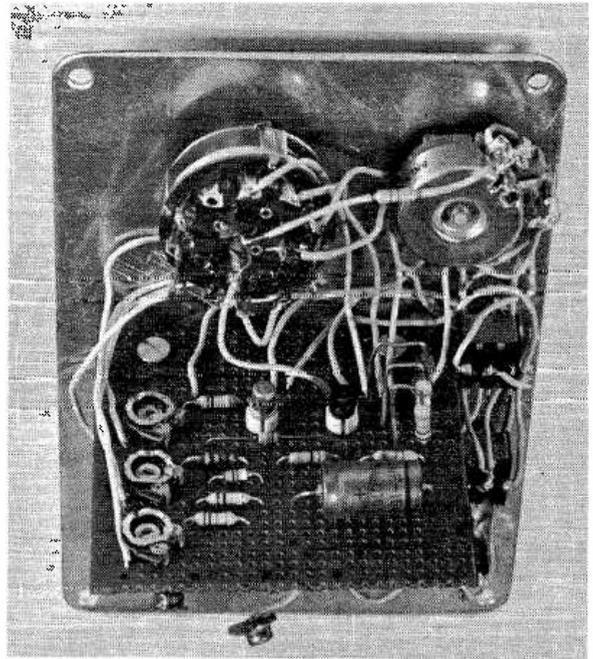
VR4 5k Ω potentiometer, linear

Semiconductors

Tr1 BCY71 Tr2 2N3819 D1/2 1N914

Miscellaneous

Capacitor C1, 250 μF 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 biased toggle. S4, SPST push-to-make. Veroboard. Battery PP3 and terminal clips. Knobs. Instrument case (West Hyde Developments).



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 V_0 and allowed to discharge through its leakage R, the voltage at time t is given by:—

$$V = V_0 e^{-\frac{t}{CR}}$$

Taking logarithms to the base e:—

$$\log_e V = \log_e V_0 - \frac{t}{CR}$$

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 μF , as in the prototype, the current on range 3 (0.5 seconds)

should be set to $390\mu\text{A}$. 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.

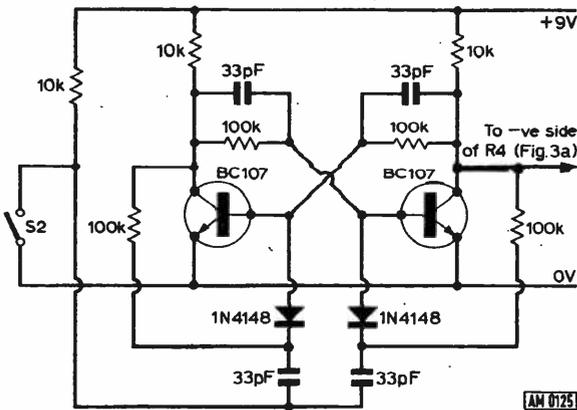


Fig. 6: Additional bistable switch circuit for long intervals, in place of S4.

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 $250\mu\text{F}$ capacitor may have an actual value from $125\mu\text{F}$ to $500\mu\text{F}$.

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.

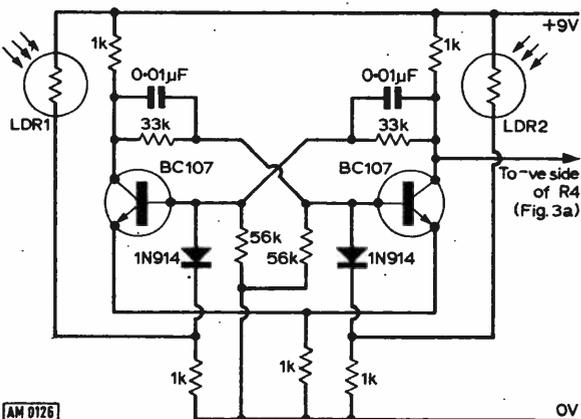


Fig. 7: In this circuit the bistable is operated by LDR's.

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 $100\text{k}\Omega$ if low gain transistors are used.

TELEVISION

IN THE FEBRUARY ISSUE

CONVERTING FOREIGN RECEIVERS

Every so often you are likely to be approached by someone wanting a foreign set converted for use in the UK. Just what can and can't be achieved? Now that we are on 625 lines quite a number of conversions can be satisfactorily carried out without too much trouble. Keith Cummins outlines the approach to be adopted and also takes a look at a type of portable not often encountered in the UK—the type with a compactron valve line up.

SIMPLE FET VOM

Even a $20\text{k}\Omega/\text{V}$ meter can give misleading readings when transistor stages are being checked. A really high-impedance meter is thus a great help. The use of a field effect transistor provides the solution: Bob MacClay describes a simple meter with an input impedance of $10\text{M}\Omega/\text{V}$ ($20\text{M}\Omega/\text{V}$ on the 1V range).

SERVICING TV RECEIVERS

The next chassis to be reported on by Les Lawry-Johns is that used in the Decca MS2000/MS2400 series. This is a hybrid (valves/transistors/i.c.) chassis with several pitfalls for the unwary.

THE SILICON VIDICON

The latest phase in TV camera tube technology is the development of the silicon diode array vidicon. The silicon vidicon has high sensitivity and is not damaged by over-exposure. The basic silicon-diode array will also feature in the all solid-state cameras at present being developed. Ian Sinclair reports.

SERVICE NOTEBOOK

More hints and reports from George Wilding's TV servicing experiences.

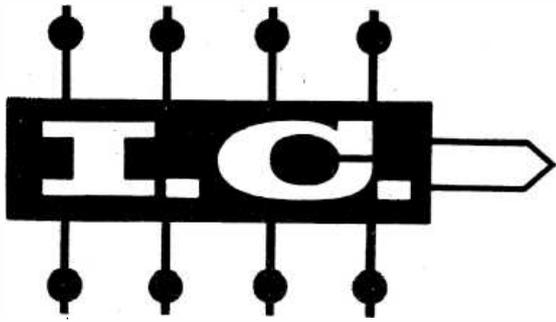
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OF THE MONTH

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

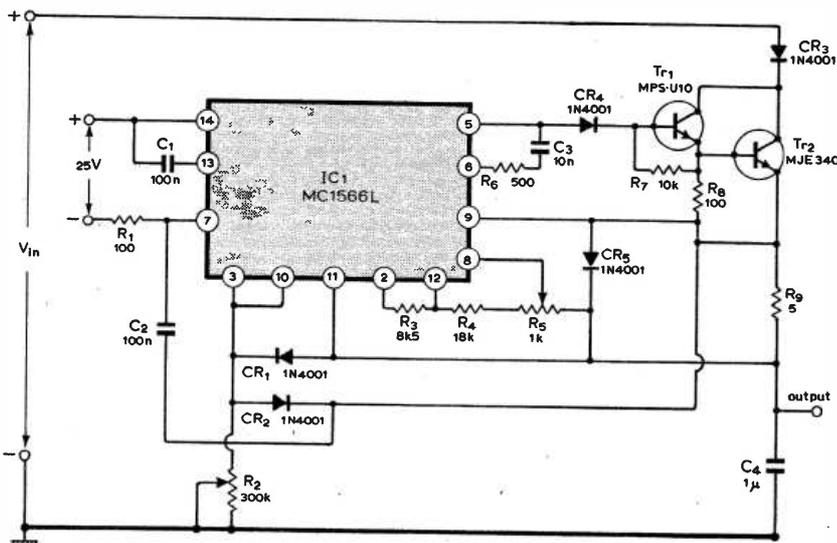


Fig. 1: Practical circuit of the constant-current source fed from a high voltage supply.

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 l, x, y, z (where x, y and z are direction cosines and l 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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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 200 μ A to 10mA; above 10mA take care not to exceed the ratings of the MJE340. At both the 200 μ A and the 1mA settings, output impedance exceeds 200M Ω .

The 1 μ F 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.

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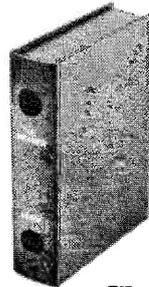
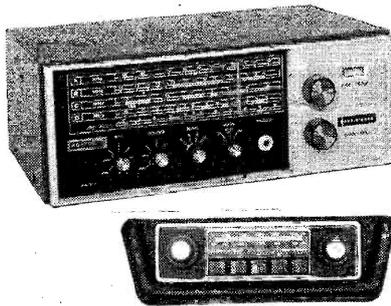
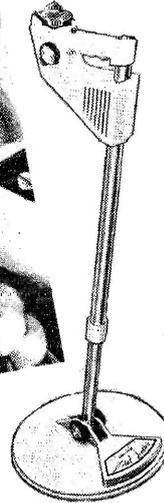
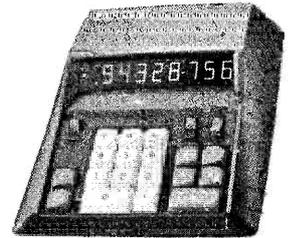
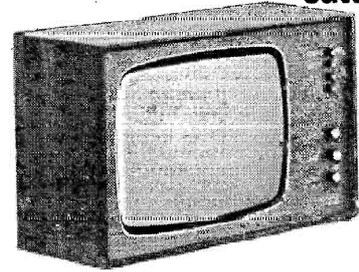
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Two Transistor RECEIVER

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.

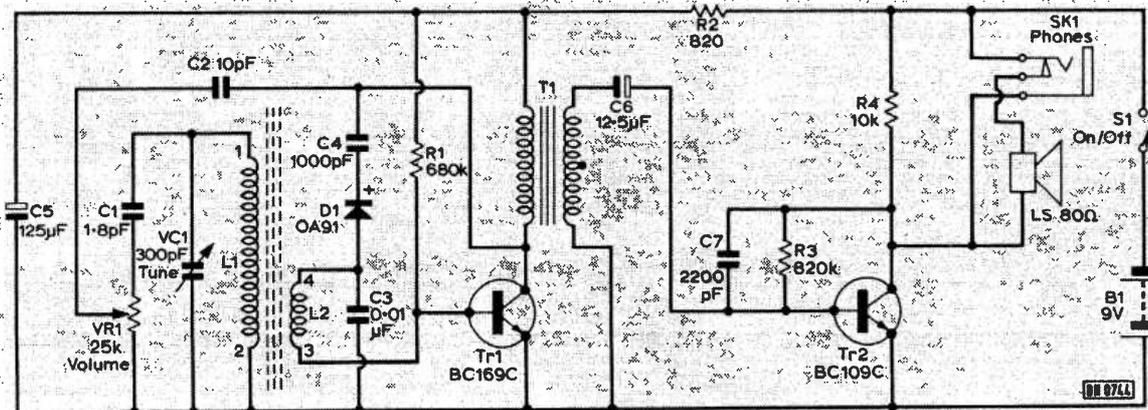


Fig. 1: Circuit of the two transistor receiver.

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.

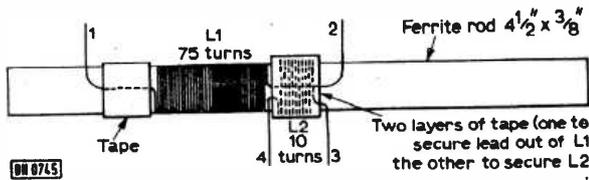


Fig. 2: The ferrite rod aerial.

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 $\frac{1}{8}$ 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

★ components list

Resistors	
R1	680k Ω
R2	820 Ω
R3	820k Ω 5%
R4	10k Ω
All $\frac{1}{4}$ watt, miniature	
VR1	25k Ω lgg or lin with switch

Capacitors	
C1	1.8pF ceramic
C2	10pF ceramic
C3	0.01 μ F polyester
C4	1000pF ceramic
C5	125 μ F 10 V.W.
C6	12.5 μ F 25 V.W.
C7	2200pF ceramic

Semiconductors	
Tr1	BC169C
Tr2	BC109C
D1	0A91

Miscellaneous	
Paxolin, fret, etc. for case; $2\frac{1}{2}$ in, 80 Ω L.S. 3.5mm switched jack socket; crystal earpiece with plug (3.5mm); miniature driver transformer (see text); $4\frac{1}{2}$ in. x $\frac{3}{8}$ in. 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.	

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.

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.

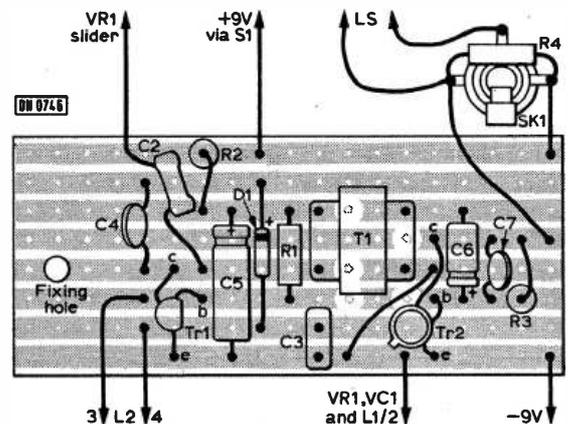


Fig. 3: Veroboard panel component layout.

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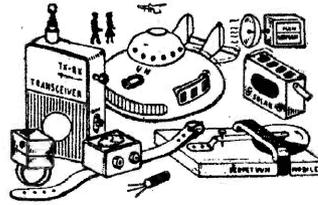
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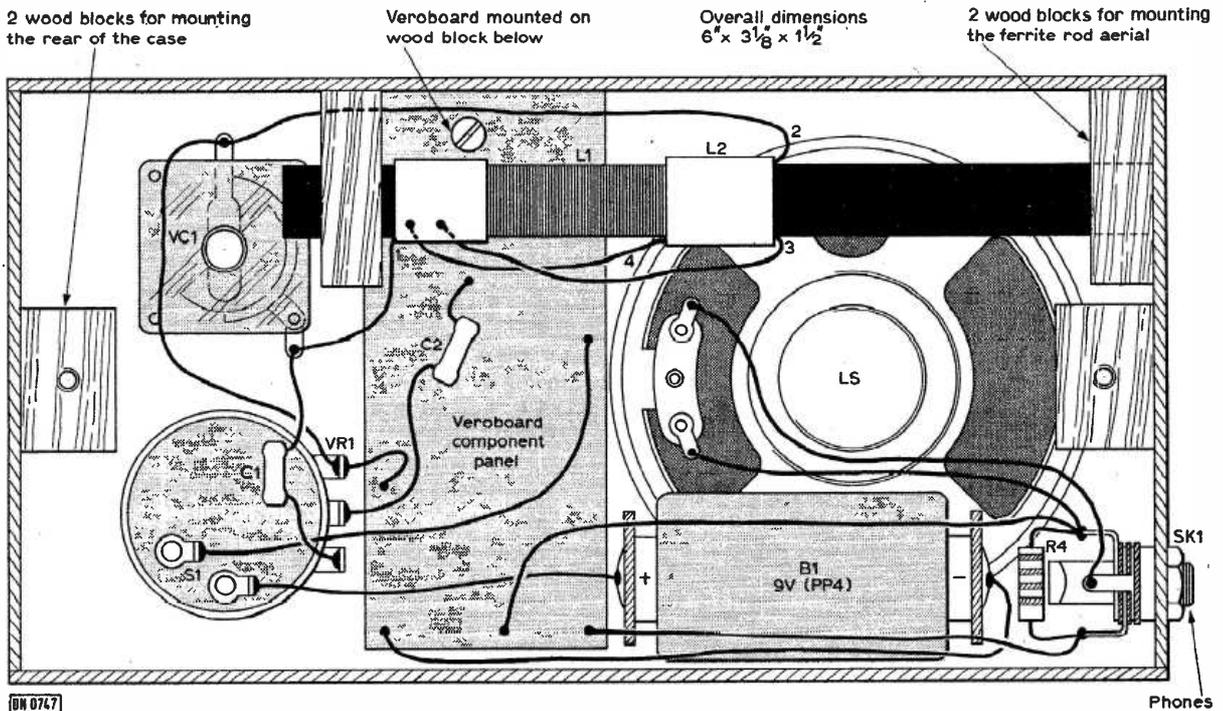


Fig. 4: General construction and layout details.

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. $1 \times 3/4 \times 1/4$ 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.

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. ■



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.

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 damndest. Can you imagine



Eavesdrop on a prompt.

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?

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 *nieu 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 "comparator" 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.

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AD161	33p	BC157	14p	BF250	20p	2N3054	58p	40362	40p
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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 biased 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

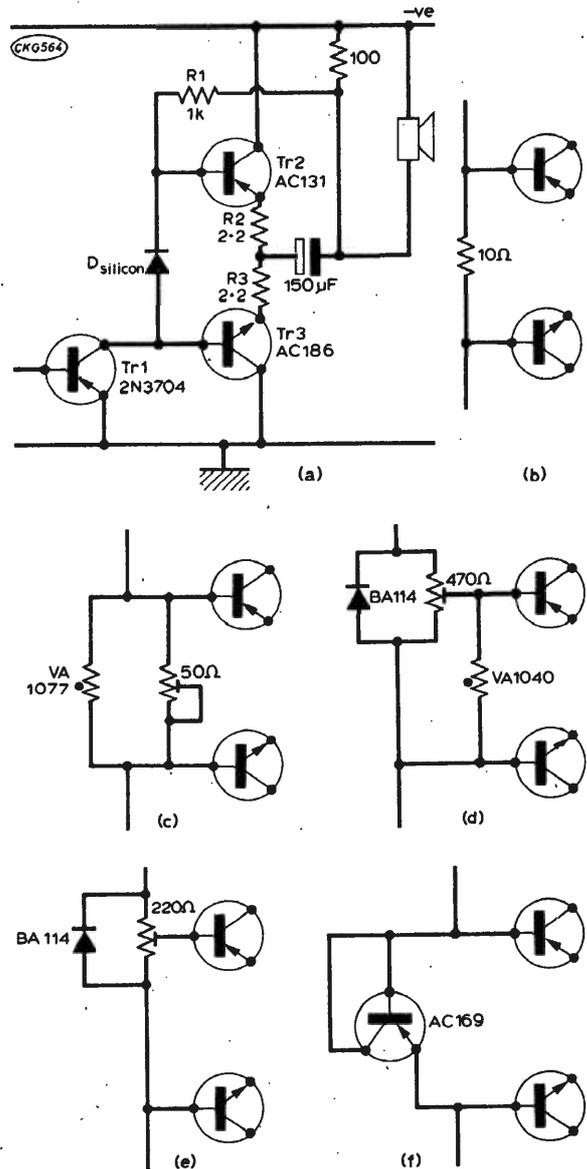


Fig. 1: (a) Basic complementary push-pull output stage, obtaining bias for the matched transistors from the voltage developed across diode. For germanium transistors, one silicon diode will develop the required p.d., but for silicon transistors, two silicon diodes in series will be necessary. Fig. 1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

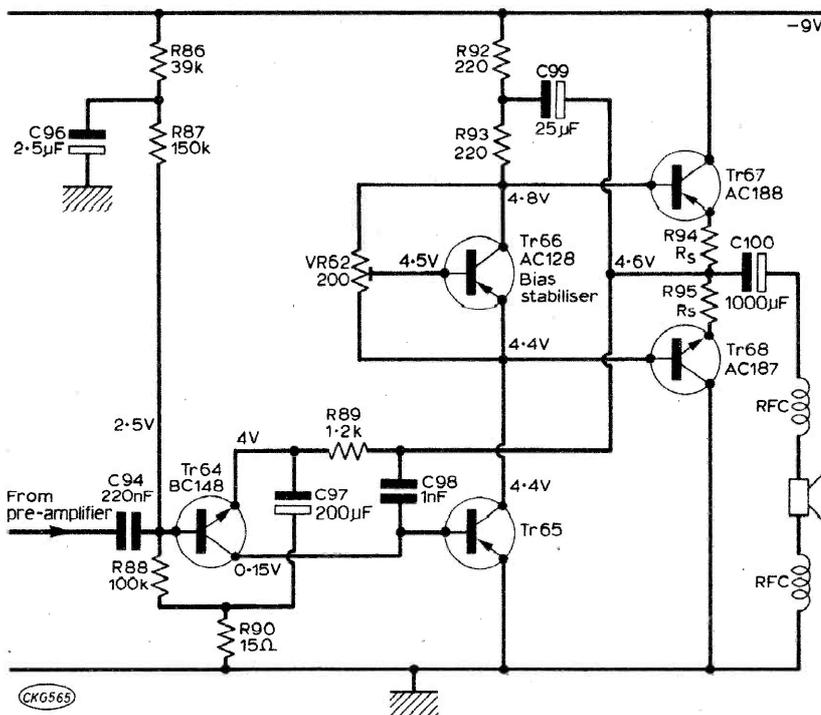


Fig. 2: DC coupled driver and output stages used in GEC 2541/Sobell 1541 six wave-band portables. The complementary push-pull output stage is stabilised in two ways, by Tr64 which equalises their mean operating voltages via Tr65, and by Tr66, which compensates their forward bias against variations in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

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.

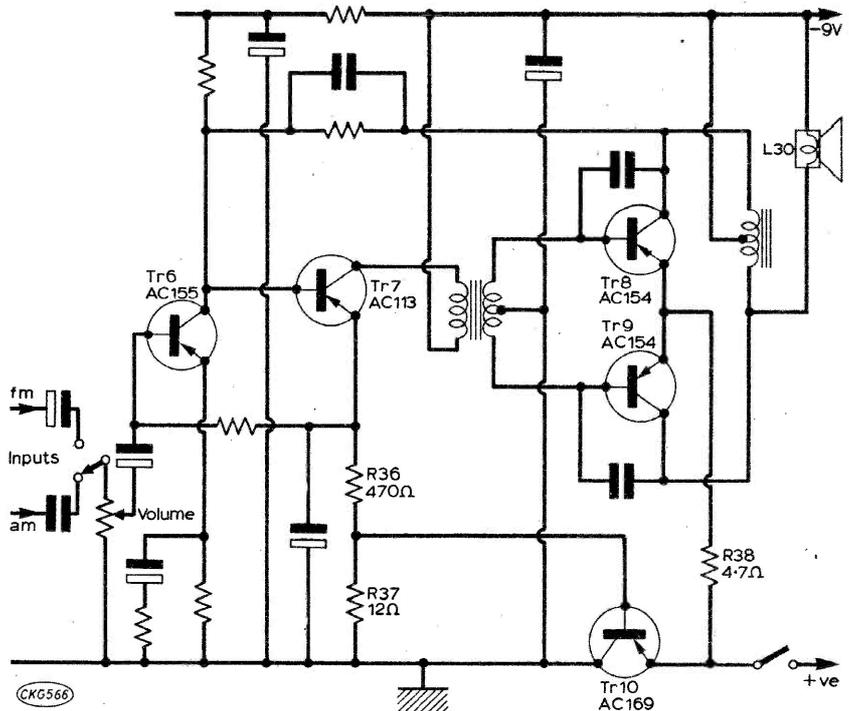
Tr64's collector current will therefore increase and as this is also the base current of driver Tr65, the latter's collector current will increase but decrease its collector voltage applied to the bases of the output transistors.

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

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.



R94/95 is $-4.6V$, ignoring the small voltage drop across resistors, the output transistors are each forward biased 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, i.e. 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

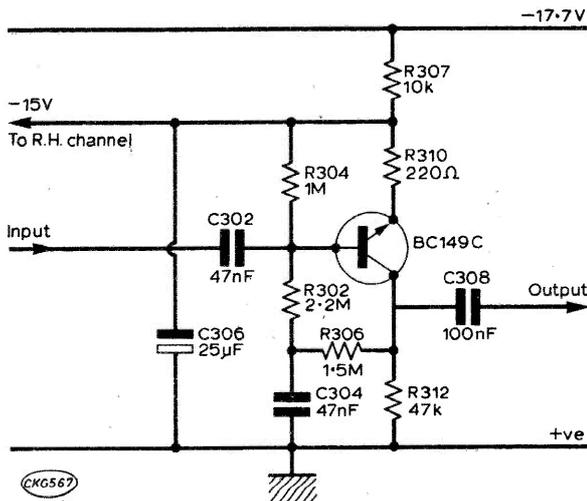


Fig. 4: Low noise audio input stage of GEC six + six stereo unit, forward biased from the collector, but with the AF signal largely filtered out by decoupler C304. R306/302 therefore DC stabilise the transistor while the undercoupled emitter resistor R310 introduces negative feedback.

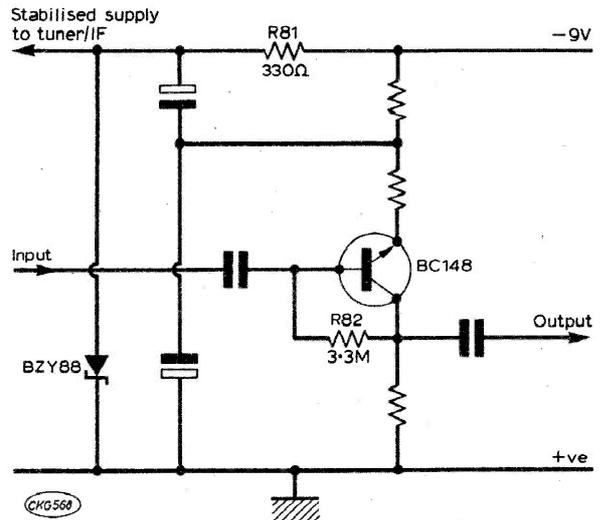


Fig. 5: AF pre-amplifier used in the GEC/Sobell range of portables forward biased by R82 directly from the collector, and applying both negative feedback and DC stabilisation.

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

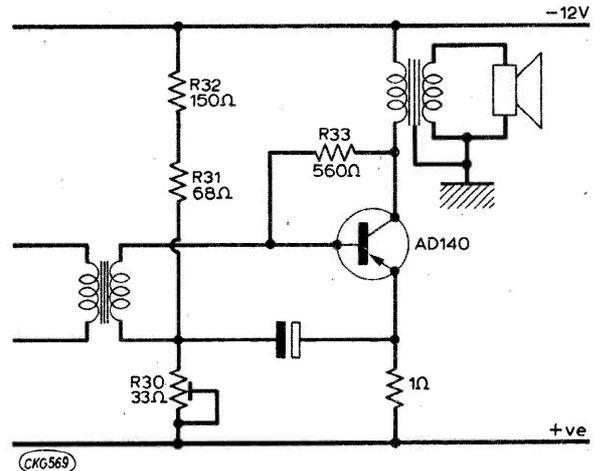


Fig. 6: Single-ended output stage used in many Philips car radio portables. R33 provides signal negative feedback, but not DC stabilisation, due to the primary resistance of the output transformer (only being one ohm). R30 is set to produce a no-signal collector current of 550 mA.

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!

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 suffi-

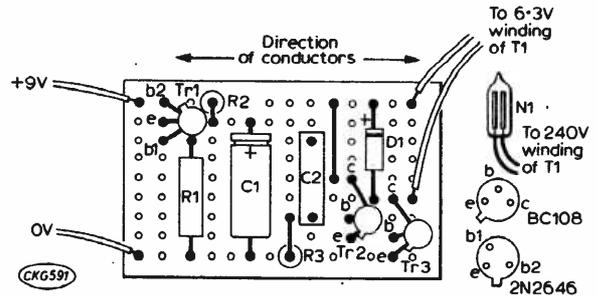


Fig. 2. The circuit can be constructed on veroboard as shown above. The board, transformer and neon lamp could be fitted into a suitable aluminium or plastic box.

cient 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.

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.

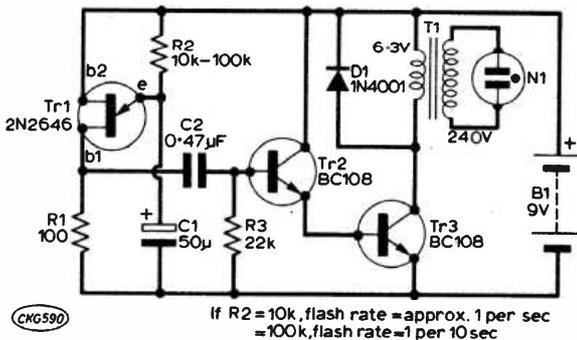
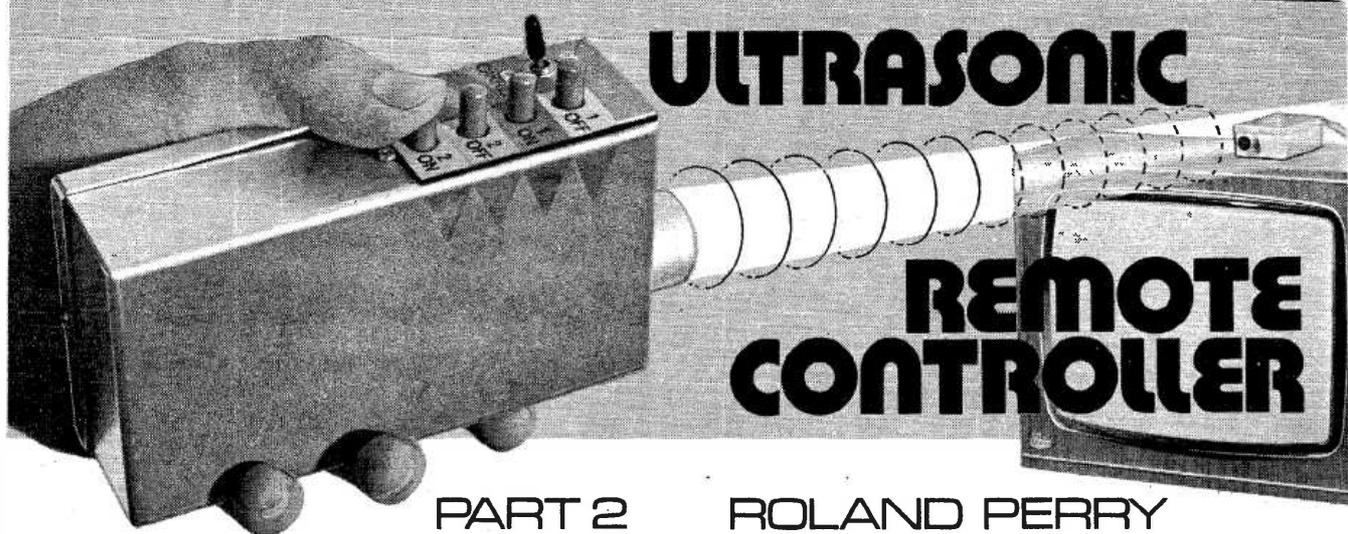


Fig. 1. Circuit of the neon flasher. R2, which, with C1, controls the flash rate could be made variable using a potentiometer. Additionally, C1 could have switched values.

★ 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		



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 harder 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.

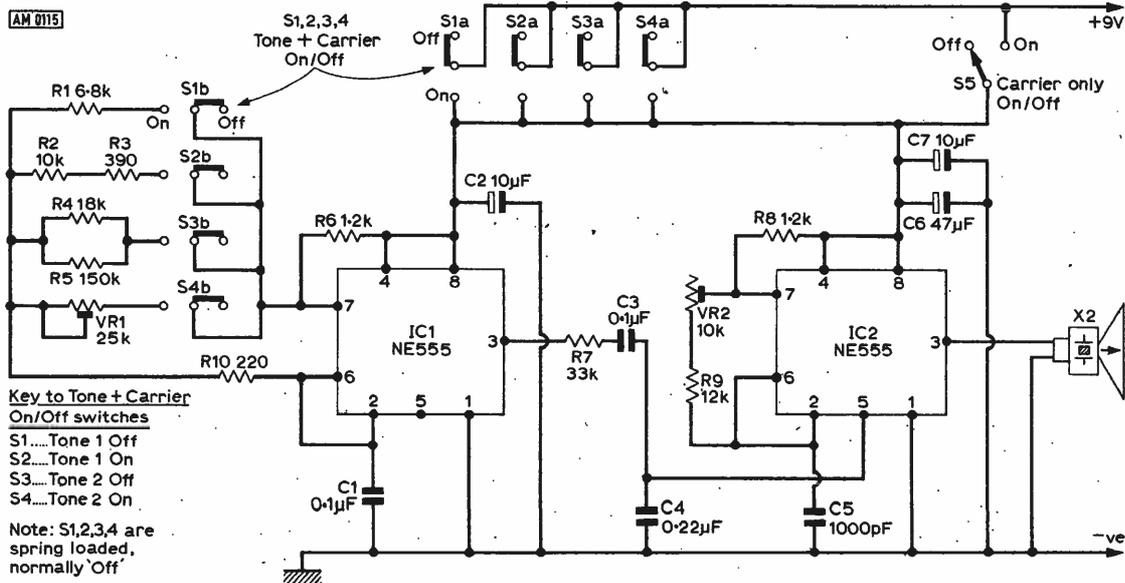
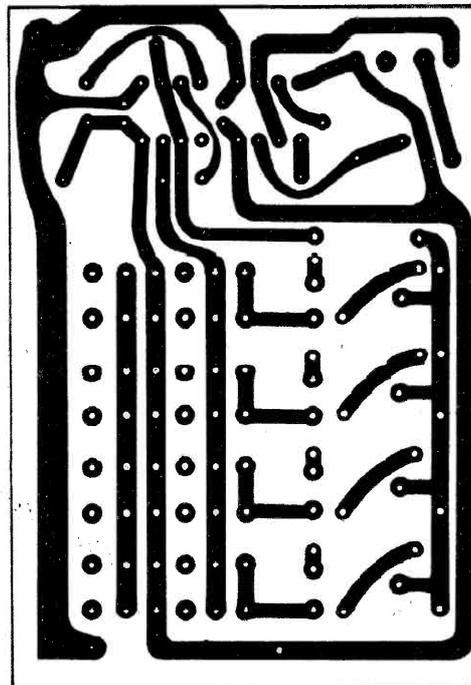
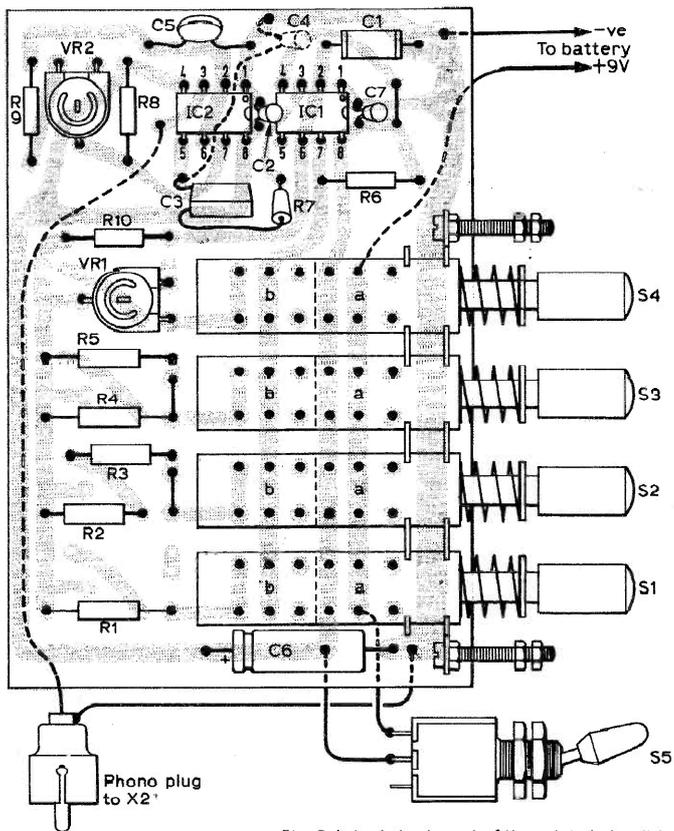
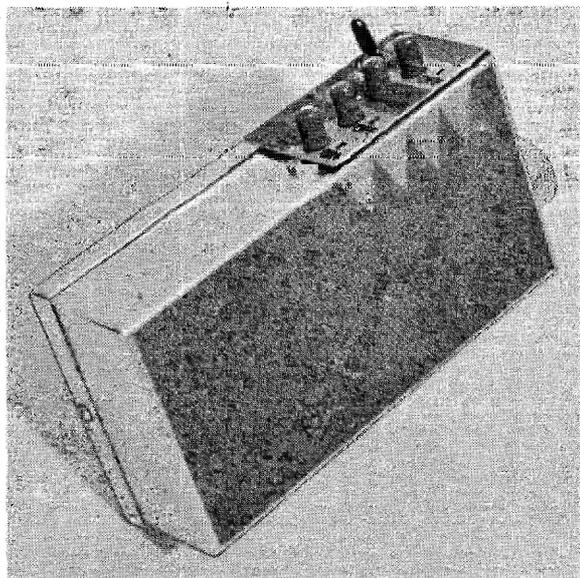


Fig. 6. Circuit of the transmitter or controller, IC1 providing the tones which modulate the carrier produced by IC2 Note:—R10 was inadvertently omitted from components list.

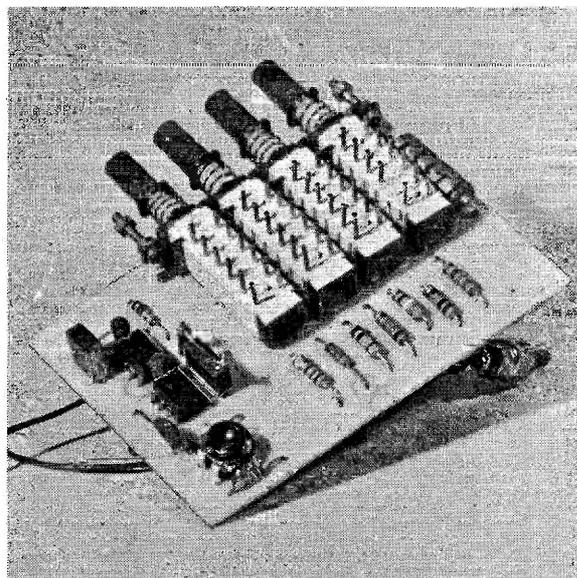


AM 0116

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

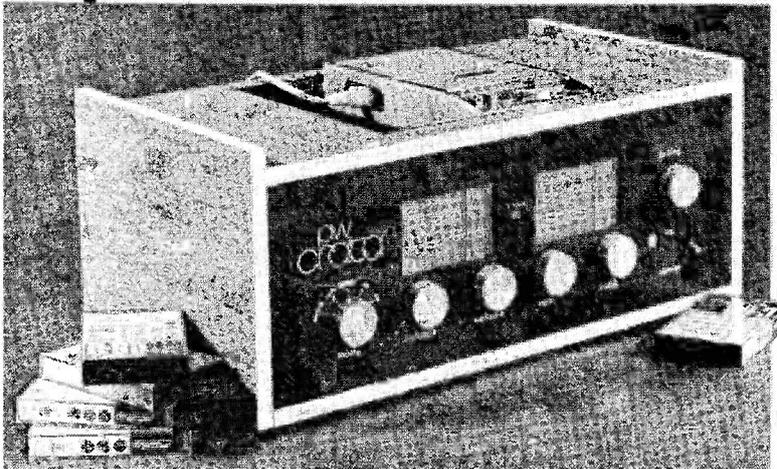
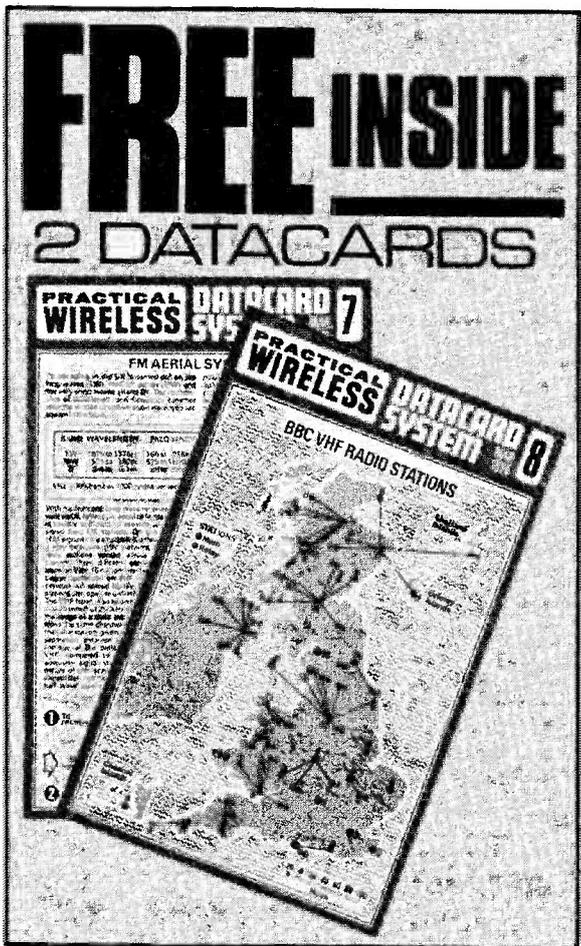
1. Operation of the carrier transmitter, IC2, is checked by supplying 9V to the system. Place the transmitter and receiver close together and monitor the output at pin 9 or 7 of the SN76660N. Now tune the transmitter preset on IC2 until the meter reading deflects, indicating

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, R_x , should be chosen to suit the available LED, a typical value is 820Ω for a TIL209, Fig. 3.

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BENCH

STABILISED POWER SUPPLY

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.

DESIGNED AND DEVELOPED BY THE IPC TECH

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. (CKG584)

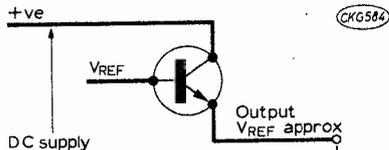


Fig. 2: Improved performance is obtained by use of a difference amplifier. (CKG585)

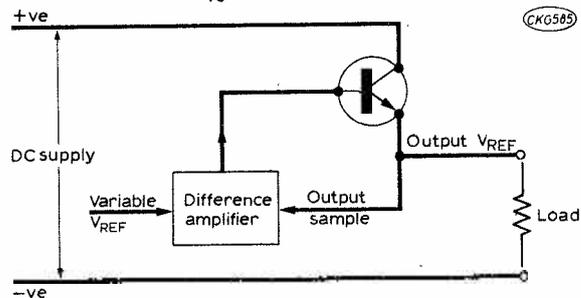


Fig. 3: A 0-30V 1A stabilised supply with overcurrent limiting and voltage and current metering. (CKG586)

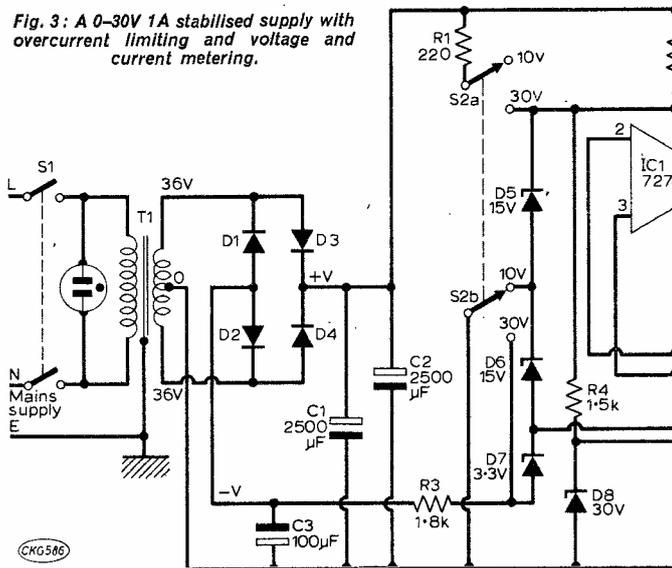


Fig. 2 shows how to modify the basic circuit by adding a difference amplifier to improve stability. A sample of the output voltage passes to the difference amplifier, which compares it with a reference voltage. The difference amplifier has a very high gain, so that if the output voltage increases or 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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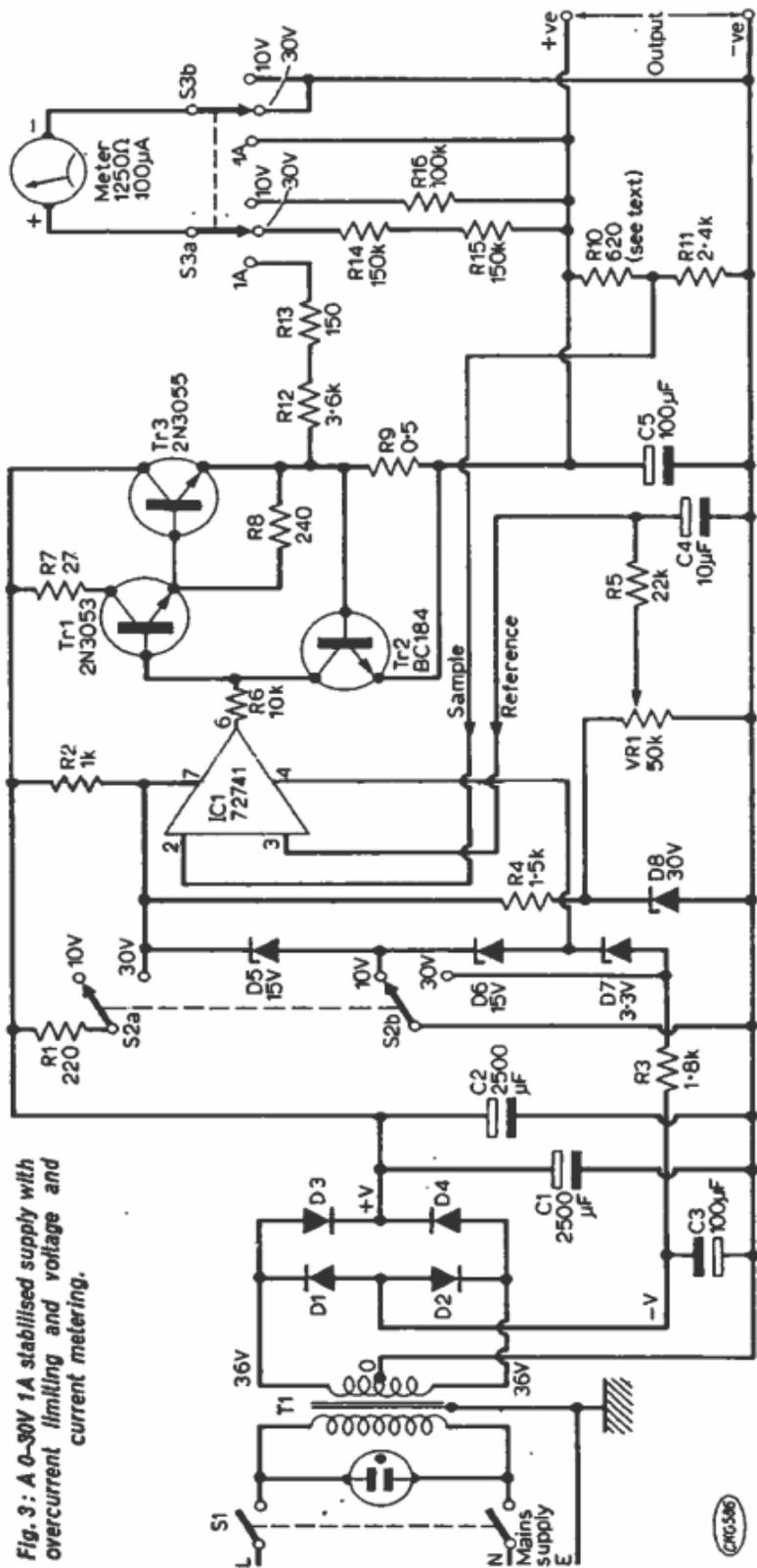
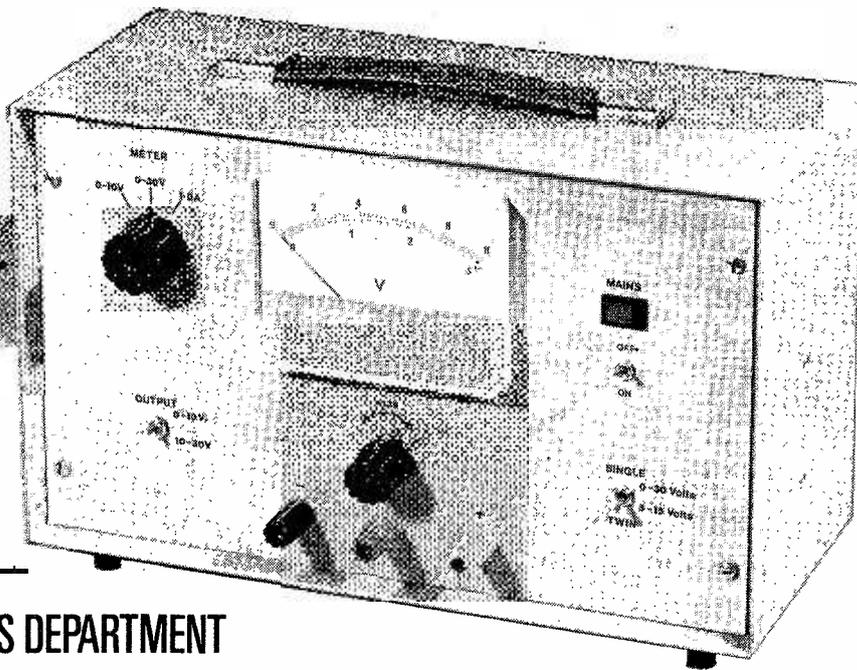
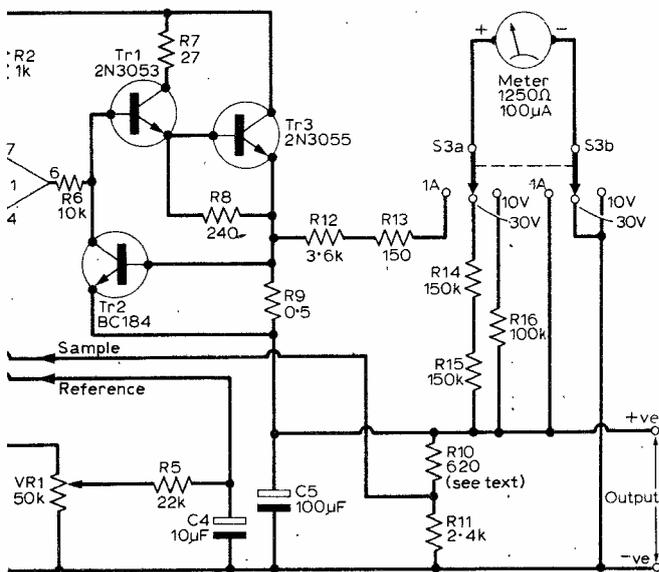


Fig. 3: A 0-30V 1A stabilised supply with overcurrent limiting and voltage and current metering.



INICAL SERVICES DEPARTMENT



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 2,500 μ F smoothing capacitors, but a single 5,000 μ F 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 ± 15 V 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 ± 15 V 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 ± 10 V 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 0.5 Ω resistor R9 in series with the

★ Specification

Voltage ranges

0-10V	range 1
10-30V	range 2
$\pm 5-15$ V twin pack	range 3

Current capability

1A all ranges. Short circuit protection incorporated

Voltage stability

0.3V zero to full load
0.015V per $^{\circ}$ C
1.5% for 10% mains change

Ripple

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3mV full load

Pulse response

Full recovery in 25 μ S

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 100 μ A 1,250 Ω 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)

$$R_{TOTAL} = \frac{10 \times 1000}{0.1} = 100k\Omega$$

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)

$$R_{TOTAL} = \frac{30 \times 1000}{0.1} = 300k\Omega$$

The most satisfactory way of producing this resistance is to use two 150k Ω 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:—

$$R_{TOTAL} = \frac{0.5 \times 1000}{0.1} = 5,000\Omega$$

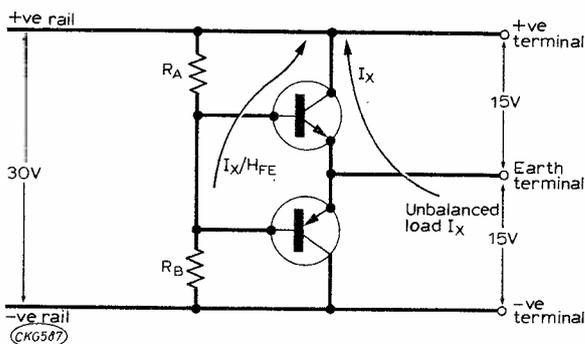
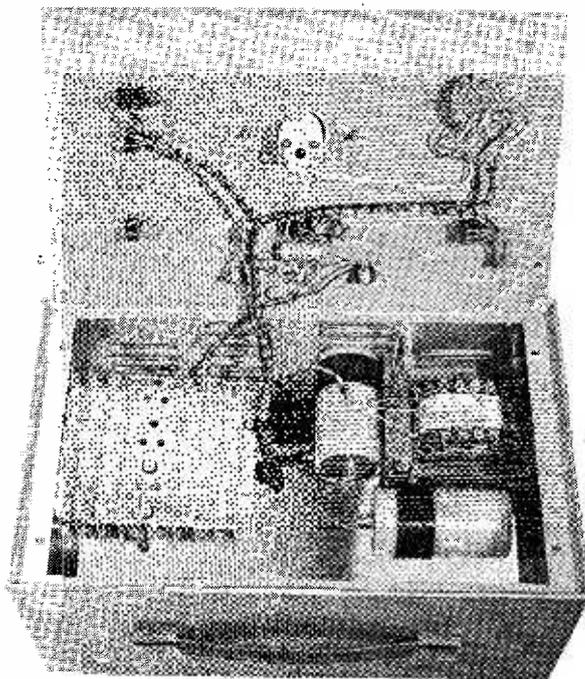


Fig. 4: Basic voltage divider using two emitter-followers.



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 3,750 Ω . One can make this up from a 3.6k Ω in series with a 150 Ω 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 100 Ω , 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.

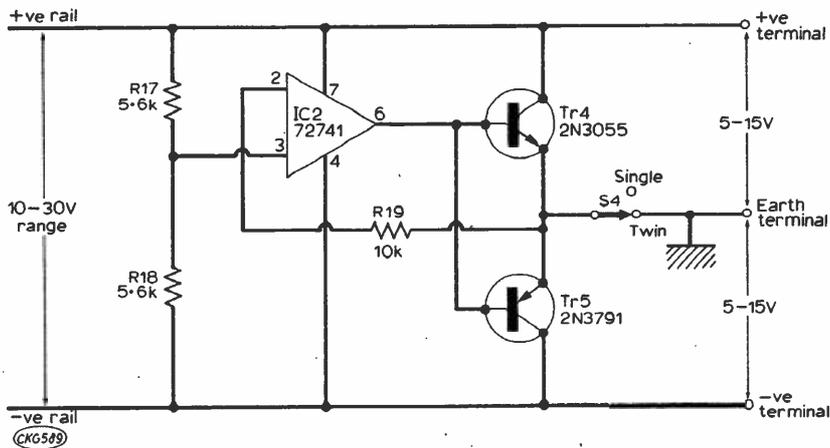


Fig. 5: Adding this circuit across the output of Fig. 3 provides an optional balanced output facility.

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 ($\pm 5-15V$) 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.

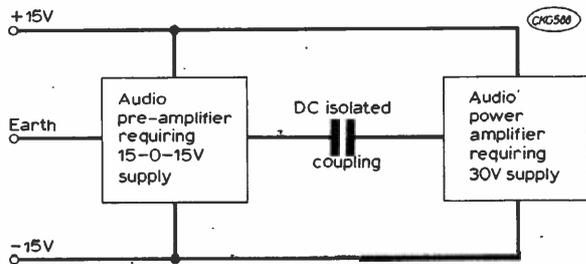
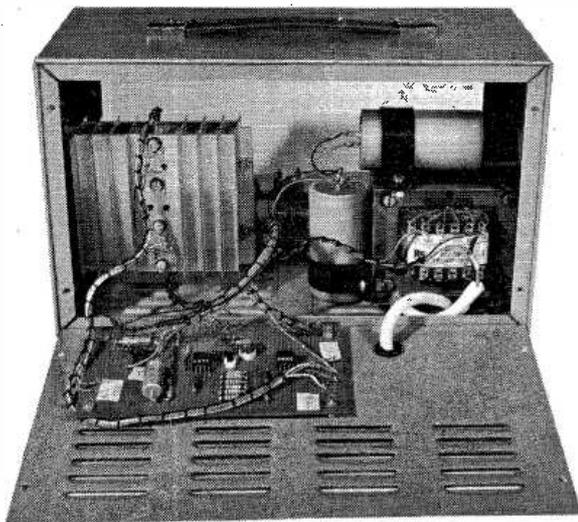


Fig. 6: Powering balanced and unbalanced equipment from a single supply.

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 $\pm 15V$ 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.



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

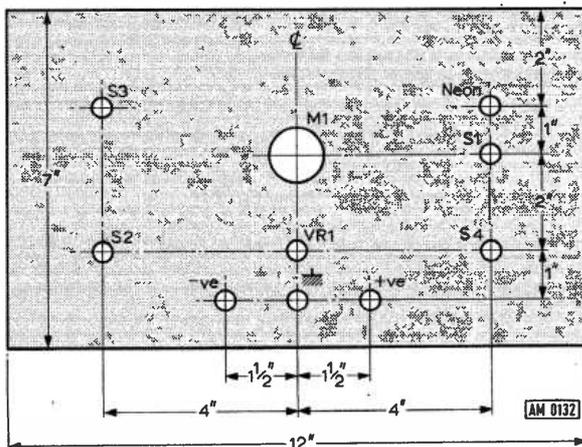
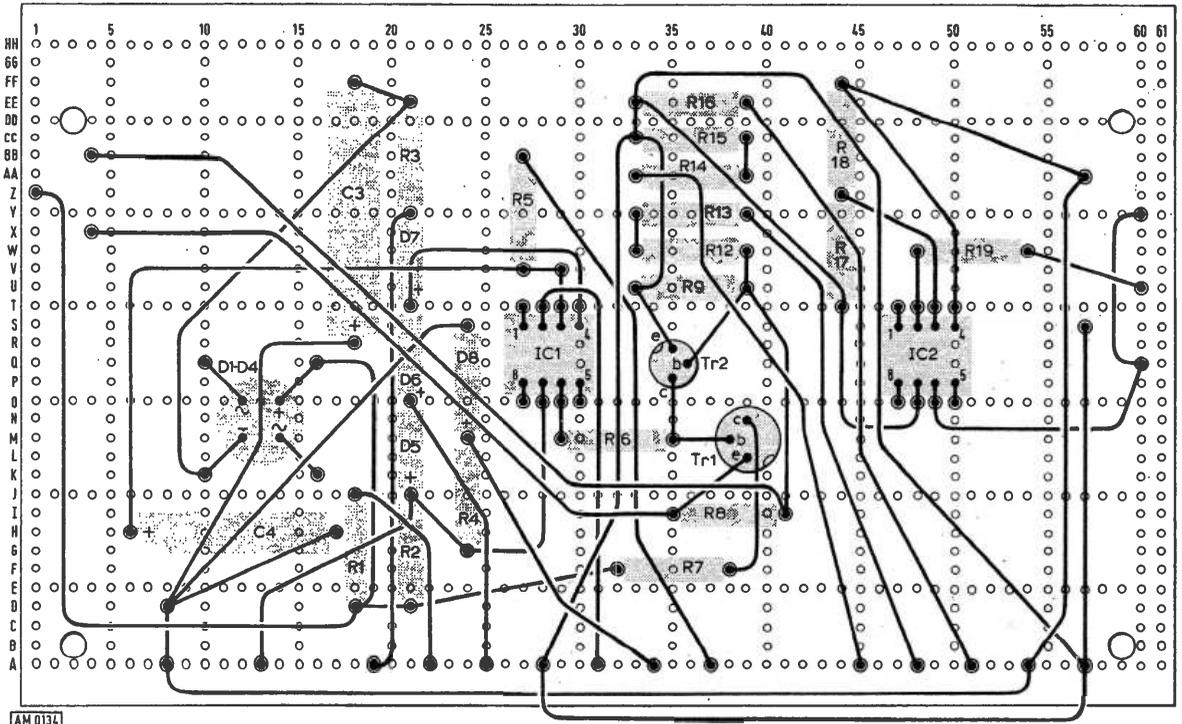
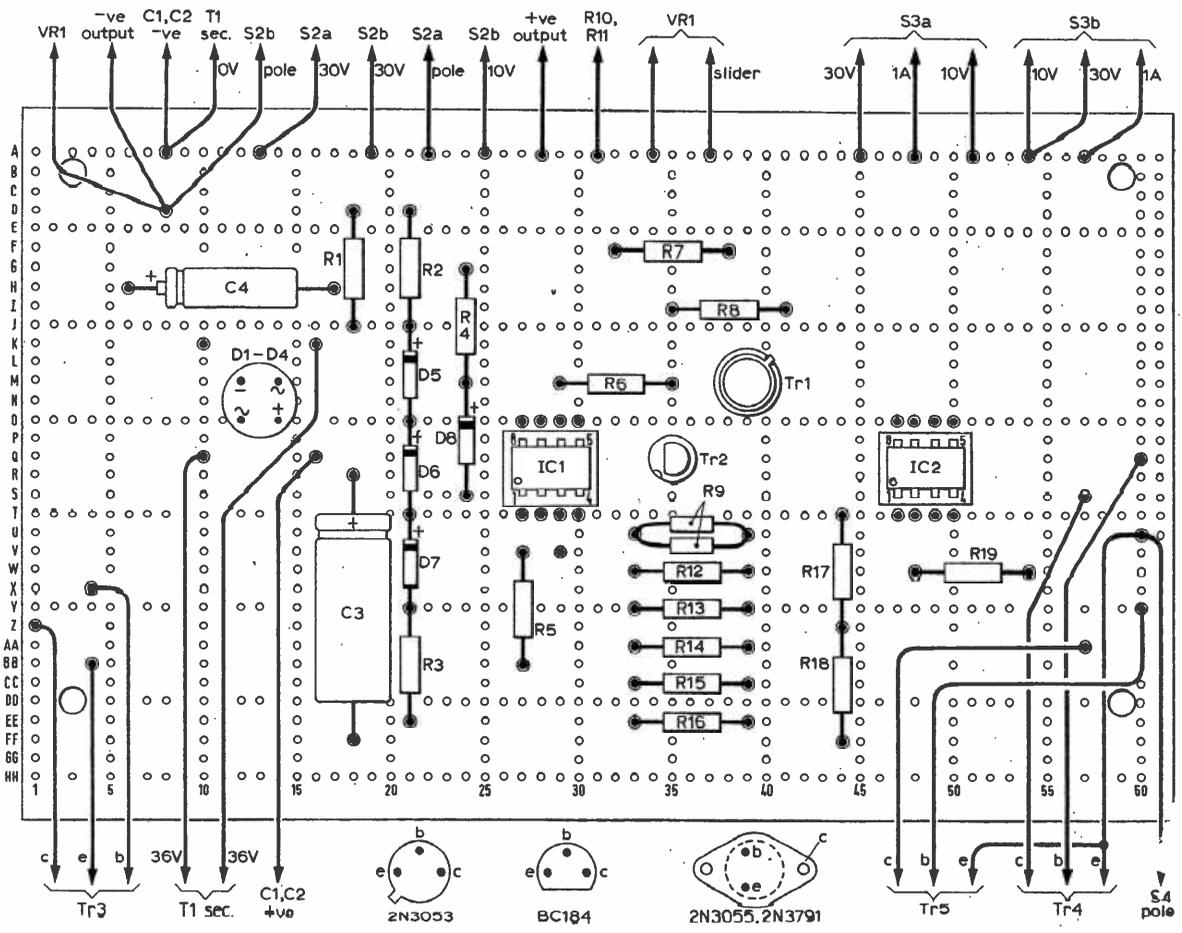


Fig. 7: Drilling dimensions for the front panel. Hole sizes should suit the components used.



AM 0134

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 waf. 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 3½ in. 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 3½ in. 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.

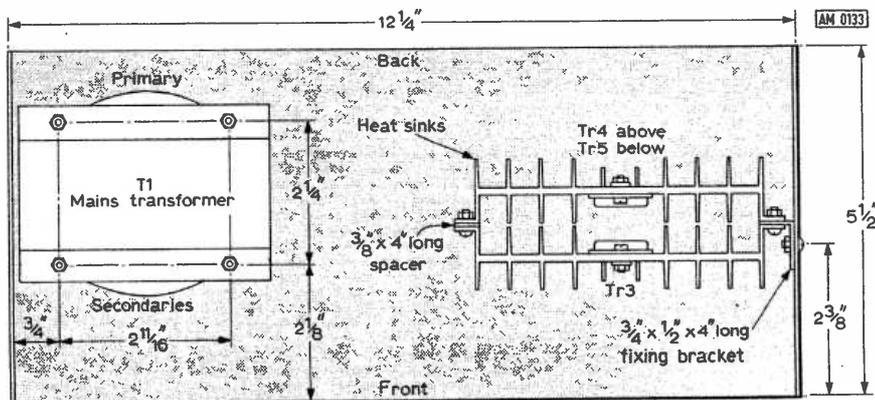


Fig. 9: Plan view showing mounting details of mains transformer and power transistor heatsinks.

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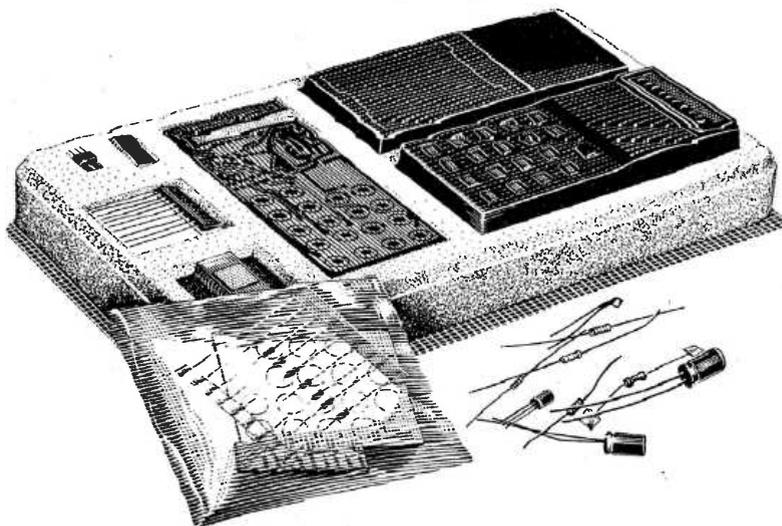
- * Uniquely handy package. $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$, weight $3\frac{1}{2}$ oz. Smart black and tan styling.
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Contents:

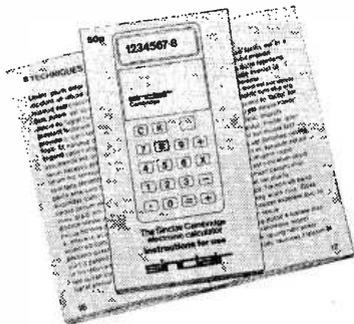
1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips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



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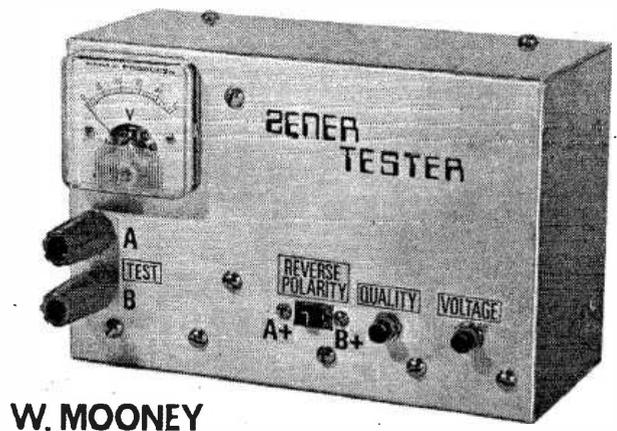
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Please send me	Name _____
<input type="checkbox"/> a Sinclair Cambridge calculator kit at £24.95 + £2.50 VAT (Total: £27.45)	_____
<input type="checkbox"/> a Sinclair Cambridge calculator ready built at £29.95 + £3.00 VAT (Total: £32.95)	Address _____
*I enclose cheque for £ _____, made out to Sinclair Radionics Ltd, and crossed.	_____
*Please debit my *Barclaycard/Access account. Account number _____	_____
*Delete as required.	PLEASE PRINT

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 $\frac{1}{2}$ W 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

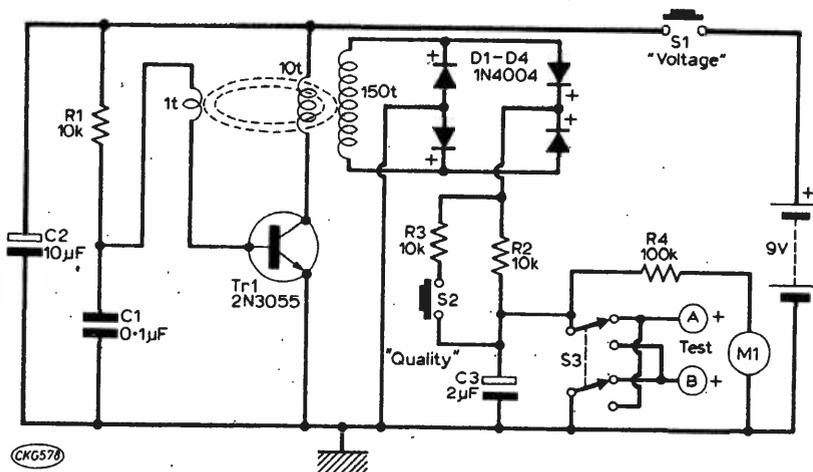


Fig. 1: Circuit of the diode tester. Rectifiers D1/D4 could be a single bridge unit. Layout of components is not critical. Panel layout can follow that used by author, as in the heading photograph.

★ components list

Resistors	
R1 10kΩ ½W	R3 10kΩ ½W
R2 10kΩ ½W	R4 100kΩ 5% ½W
Capacitors	
C1 0.1μF polyester	C2 10μF 12V
	C3 2μF 400V
Semiconductors	
D1-D4 1N4004	Tr1 2N3055
Miscellaneous	
S1, S2 P _u sh-to-make switch. S3 DPDT slide switch. Meter 500μA FSD. Terminals (2). Case, 6 x 4 x 2½ in. 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 R_m 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.

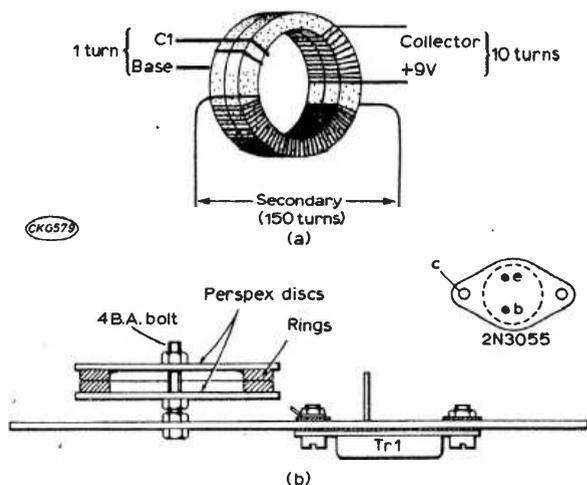


Fig. 2: Details of the construction of the oscillator transformer and its mounting on plate with the transistor. Two ferrite rings are used, taped together.

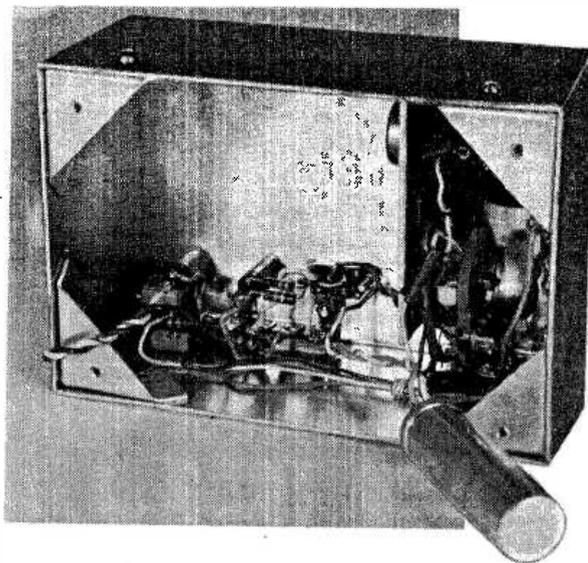
The ferrite rings have plenty of space for easy winding. There are many rings available which are of similar dimensions and although the magnetic properties may not be known, in a simple application like this, most rings will suffice. A little experimentation with the number of turns in the feedback 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 ¼in 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 R_d 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

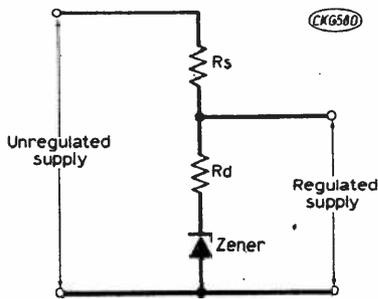
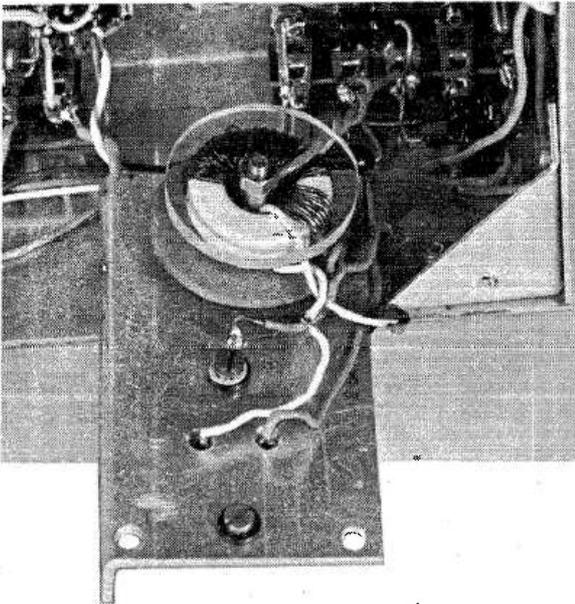


Fig. 3: Circuit of a perfect zener diode with a series resistance approximates the zener diode in practice.

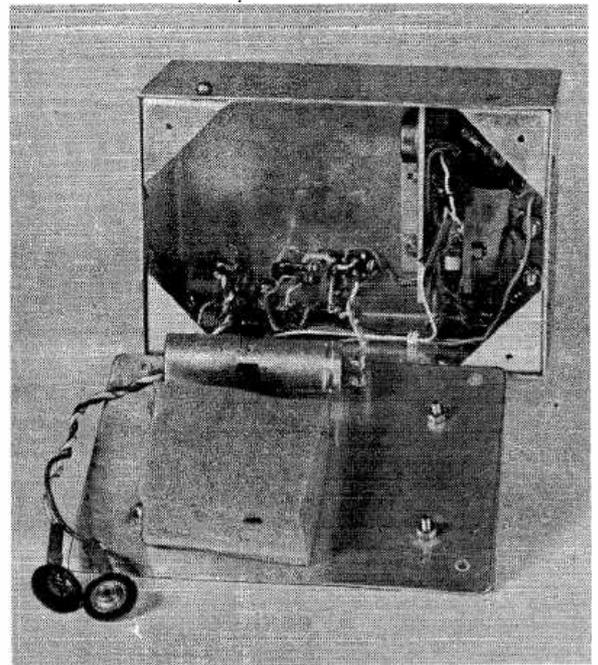
resistive component is very small the plot becomes as in Fig. 4d, a similar increase in current now causes only a small change in reference voltage. In a normal diode the situation is in Fig. 4b.

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.

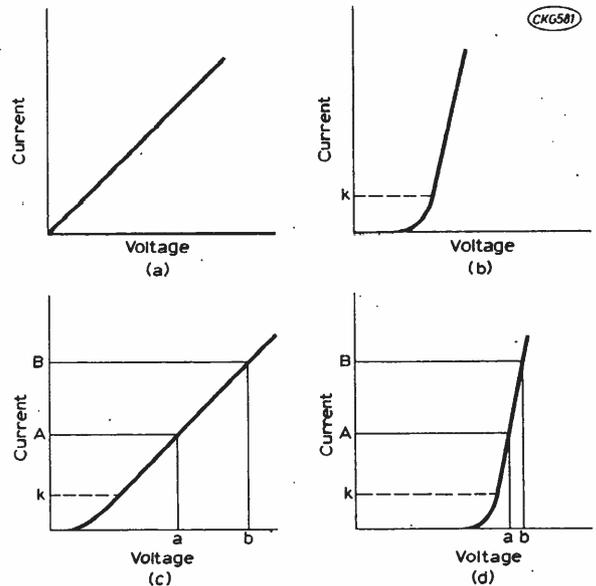
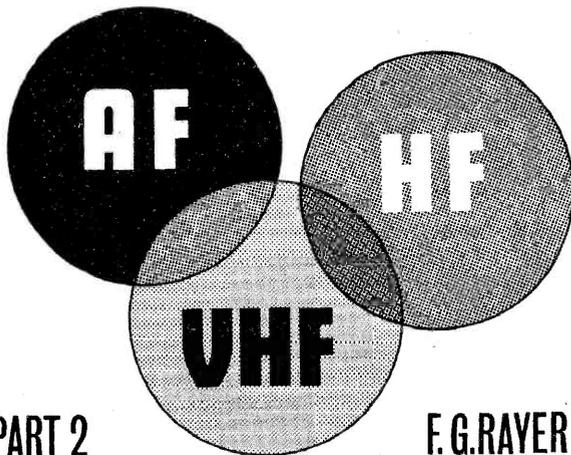


Fig. 4: Four graphs to illustrate the operation of a zener diode as described in the text.

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.

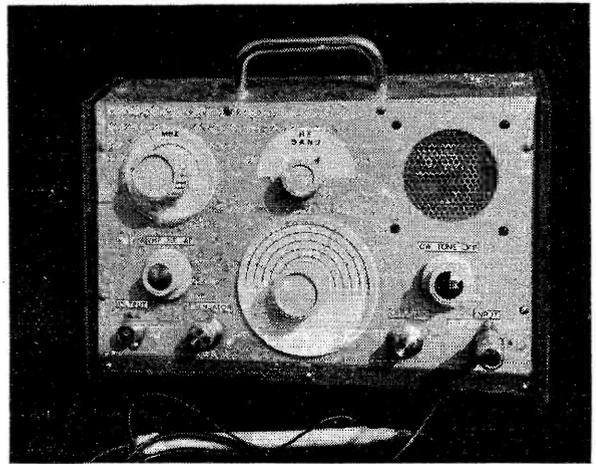
Base emitter junctions of some silicon transistors have low reverse breakdown voltages, in the region of 5V, and act as excellent zeners. To test these the collector lead is left open circuit and the base and emitter leads connected to the instrument as in the case of a normal diode.



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.

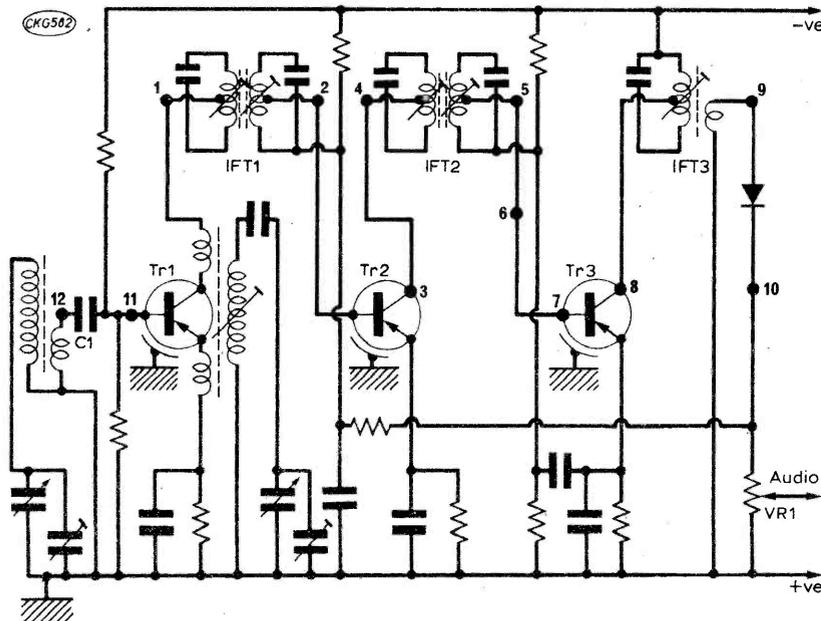


Fig. 1. Essential parts of a circuit comprising a mixer and two IF stages of a receiver to demonstrate fault-finding techniques.

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

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

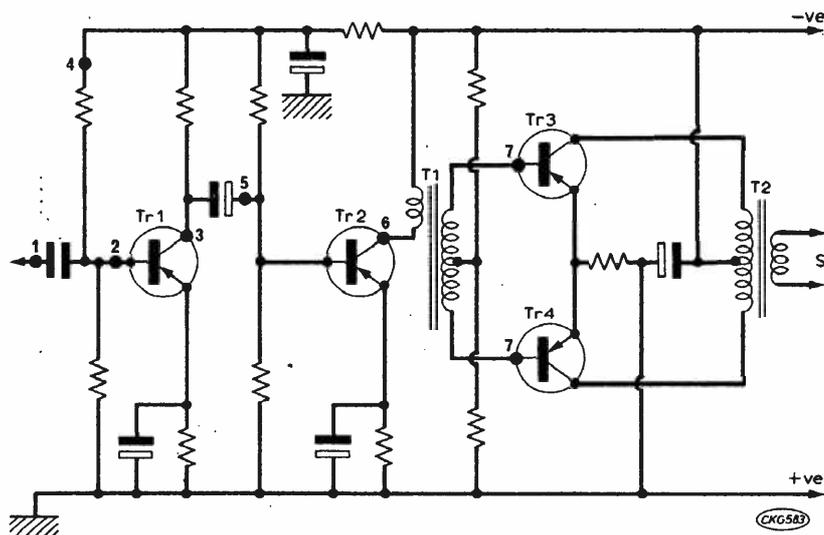


Fig. 2. Basic circuit of a three stage audio amplifier referred to in the text.

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

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.

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. ■



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.l.s 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 call signs 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.



VHF/FM DXING

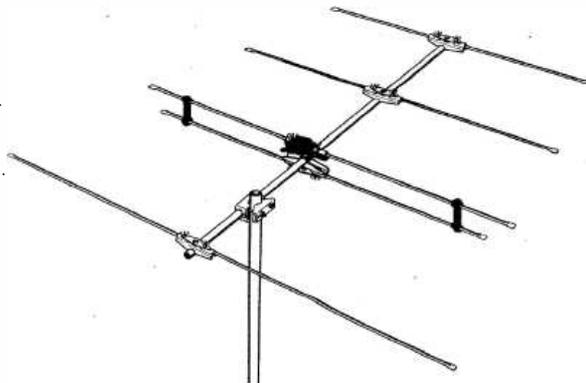
by SIMON DAVID

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 cascade 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



The FM244T

installed, but the mild spell in early December improved matters considerably.

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 ± 0.5 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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DY802	0.45	EF86	0.80	PC84	0.52	PL802	0.99	30C18/	
EABC80	1.00	EF89	0.81	PC88	0.80	PCF505	0.90	30F5/PCF818	
EB91	0.38	EF91	1.30	PC89	0.65	PY33	0.66		1.10
EBF81	0.75	EF92	1.40	PCF80	0.51	PCF818/800	0.50		
EBF89	0.40	EF95	0.60	PCF82	1.30	PCF82	1.30	30FL1/	
EBF83	0.82	EF183	0.60	PCF86	0.85	PCF86	0.85	30FL2	0.75
EBF89	0.53	EF184	0.60	PCF200	0.85	PCF80	0.50	30FL12	1.05
EC86	0.75	EH90	0.56	PCF201	0.87	PCF80	0.50	30FL14	0.85
EC88	0.77	EL34	0.88	PCF801	0.65	U26	1.00	30L1/PC84	
EC881	0.45	EL36	1.05	PCF802	0.71	U191	1.00		0.52
EC882	0.43	EL31	1.35	PCF820	0.85	U193	0.50		
EC883	0.45	EL34	0.47	PCF820	0.85	U193	0.50	30L15/PC805	
EC884	0.85	EL95	0.55	PCF82	0.54	U193	0.50		1.05
EC885	0.85	EL86	0.85	PCF83	0.66	U193	0.50	30L17	0.70
EC888	0.75	EL95	0.70	PCF84	0.59	U193	0.50	30P4MR	1.30
EC891	0.71	EL91	1.31	PCF85	0.83	U193	0.50	30P12/PC801	
BCF90	0.88	ELL80	1.80	PCF86	0.68	U193	0.50		1.05
ECF92	0.78	EL87	1.18	PCF86	0.68	U193	0.50	30P19/PC802	
ECF86	0.71	EL87	1.18	PCF86	0.68	U193	0.50		1.00
ECH91	1.00	EY51	0.83	PD500	1.55	U193	0.50	30PL1/PC801	
ECH83	1.00	EY86/87	0.42	PF200	0.80	U193	0.50		0.95
ECH84	0.78	EY88	0.84	PL36	0.88	U193	0.50		
ECL80	0.53	EZ80	0.61	PL81	0.75	U193	0.50	30PL13/	
ECL82	0.81	EZ81	0.40	PL81A	0.75	U193	0.50	PCL800	1.20
ECL83	0.88	EZ81	0.40	PL81A	0.75	U193	0.50	30P14/	
ECL86	0.83	EZ34	0.78	PL83	0.98	U193	0.50	PCL88	1.25
				PL83	0.98	U193	0.50	30CL15	1.05

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CL33	1.50	EF89	0.28	PC900	0.48	U14	1.00	6K6GT	0.75
CY31	0.50	EF91	0.57	PC84	0.40	U25	0.85	6K7M	0.45
DAF91	0.30	EF92	0.60	PC88	0.55	U26	0.85	6K7G	0.30
DAF96	0.50	EF95	0.40	PC89	0.60	U191	0.75	6K8M	0.70
DC890	1.35	EF98	0.75	PC8189	0.60	U191	0.75	6K8G	0.45
DF91	0.80	EF183	0.30	PCF80	0.30	U191	0.75	6K9G	0.45
DF96	0.50	EF184	0.35	PCF82	0.35	UAF42	0.75	6L25	0.75
DK91	0.45	EL32	0.60	PCF86	0.60	UAF41	0.75	6L6G	0.55
DK92	0.70	EL33	1.75	PCF801	0.50	UAF42	0.75	6L6G	0.55
DK96	0.60	EL34	0.50	PCF802	0.50	UAF41	0.75	6L6G	0.55
DL92	0.40	EL36	0.50	PCF803	0.90	UAF41	0.75	6L6G	0.55
DL94	0.48	EL37	2.50	PCF806	0.75	UAF41	0.75	6L6G	0.55
DL96	0.55	EL41	0.90	PCF808	0.90	UAF41	0.75	6L6G	0.55
DY86/7	0.38	EL42	0.90	PCL82	0.35	UAF41	0.75	6L6G	0.55
DY802	0.37	EL54	0.28	PCL83	0.68	UAF41	0.75	6L6G	0.55
EABC80	0.38	EL95	0.40	PCL84	0.45	UAF41	0.75	6L6G	0.55
EAF42	0.75	ELL80	1.80	PCL85	0.50	UAF41	0.75	6L6G	0.55
EB81	0.22	EM80	0.45	PCL86	0.45	UAF41	0.75	6L6G	0.55
EB83	1.00	EM81	0.60	PCL805/85		UAF41	0.75	6L6G	0.55
EB84	0.75	EM84	0.35			UAF41	0.75	6L6G	0.55
EB85	0.83	EM85	1.00	PD500	1.55	UAF41	0.75	6L6G	0.55
EBF80	0.40	EY61	0.40	PEN45	0.75	UAF41	0.75	6L6G	0.55
EBF83	0.40	EY86	0.40	PL36	0.88	UAF41	0.75	6L6G	0.55
EBF89	0.32	EZ40	0.75	PL81	0.50	UAF41	0.75	6L6G	0.55
EBL31	1.50	EZ41	0.45	PL82	0.45	UAF41	0.75	6L6G	0.55
ECC81	0.40	EZ80	0.28	PL83	0.45	UAF41	0.75	6L6G	0.55
ECC82	0.38	EZ81	0.29	PL84	0.40	UAF41	0.75	6L6G	0.55
ECC83	0.38	EZ82	0.28	PL84	0.40	UAF41	0.75	6L6G	0.55
ECC84	0.30	EZ83	0.40	PL84	0.45	UAF41	0.75	6L6G	0.55
ECC85	0.40	EZ84	0.50	PL84	0.45	UAF41	0.75	6L6G	0.55
ECC88	0.40	EZ34	0.65	PL802	0.95	UAF41	0.75	6L6G	0.55
ECH36	1.25	EZ37	1.25	PL802	0.95	UAF41	0.75	6L6G	0.55
ECH42	1.00	HN309	1.50	PX4	3.50	UAF41	0.75	6L6G	0.55
ECH81	0.30	KT61	1.75	PX25	3.50	UAF41	0.75	6L6G	0.55
ECH83	0.45	KT66	2.50	PY33	0.63	UAF41	0.75	6L6G	0.55
ECL80	0.55	KT81 (70C)		YF81	0.30	UAF41	0.75	6L6G	0.55
ECL82	0.35			YF82	0.35	UAF41	0.75	6L6G	0.55
ECL83	0.70	KT81	1.75	YF83	0.38	UAF41	0.75	6L6G	0.55
ECL86	0.40	KT88	2.90	YF88	0.40	UAF41	0.75	6L6G	0.55
ECLL800	3.20	KTW61	1.00	YF500	1.00	UAF41	0.75	6L6G	0.55
EP37A	1.20	MU14	1.00	YF81/800	0.50	UAF41	0.75	6L6G	0.55
EP39	1.20	N78	2.75	YF801	0.50	UAF41	0.75	6L6G	0.55

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AC107	0.38	BF178	0.28
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AC127	0.25	BF180	0.35
AC128	0.20	BF181	0.35
AC176	0.25	BF194	0.15
AC187	0.20	BF195	0.13
AC188	0.20	BF197	0.15
ACY21	0.22	BF200	0.28
ACY39	0.65	BFS61	0.25
AD140	0.50	BFS98	0.25
AD149	0.50	BFX29	0.28
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AF117	0.20	BFW10	0.61
AF186	0.40	BY100	0.15
AF239	0.40	BY126	0.14
AFY27	0.30	BY127	0.15
ASV28	0.25	BZX61 series	
B208	0.85		
BA115	0.10	BZY88 series	
BC107	0.12		
BC108	0.12	CR81-05	0.30
BC109	0.12	CR81-40	0.45
BC113	0.13	CR83-05	0.40
BC117	0.31	CR86-40	0.55
BC143	0.30	MJE340	0.50
BC147	0.12	MJE370	0.68
BC148	0.10	MJE520	0.65
BC169C	0.14	MJE2855	1.10
BC182	0.12	MJE3055	0.75
BC182L	0.12	MP102	0.40
BC184L	0.13	MPP103	0.38
BCY32	1.20	MPP104	0.35
BCY33	0.38	MPP105	0.46
BCY34	0.45	NKT404	0.60
BCY70	0.15	OA5	0.60
BCY71	0.20	OA10	0.40
BCY72	0.15	OA79	0.19
BCZ11	0.65	OA81	0.10
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BD124	0.80	OA200	0.08
BD131	0.45	OA202	0.10

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OC23	1.25	ZTX503	0.18	2N2904A	0.25
OC25	0.40	ZTX531	0.25	2N2905	0.28
OC28	0.70	ZTX550	0.18	2N2905A	0.28
OC35	0.55	1N914	0.06	2N2906	0.20
OC36	0.68	1N4001	0.8	2N2926	0.10
OC41	0.40	1N4002	0.7	2N3053	0.20
OC44	0.18	1N4003	0.8	2N3055	0.45
OC45	0.18	1N4004	0.8	2N3225	0.80
OC71	0.15	1N4005	0.10	2N3614	0.50
OC72	0.25	1N4006	0.12	2N3815	0.65
OC76	0.40	1N4007	0.12	2N3702	0.11
OC77	0.55	1N4009	0.08	2N3703	0.12
OC81	0.25	1N4148	0.06	2N3704	0.14
OC81D	0.28	1S921	0.07	2N3705	0.12
OC81Z	0.45	1S2033	0.20	2N3706	0.10
OC83	0.25	1S2051A	0.10	2N3707	0.13
OC140	0.65	1S2100A	0.20	2N3708	0.07
OC170	0.25	1S3010	0.25	2N3709	0.10
OC171	0.20	2N666	0.15	2N3710	0.11
OC200	0.15	2N697	0.15	2N3711	0.14
OC201	0.80	2N706	0.10	2N3819	0.35
OC202	0.90	2N706A	0.12	2N3820	0.50
OC203	0.55	2N1131	0.25	2N3823	0.50
OC271	1.00	2N1182	0.25	2N3903	0.15
OC272	0.55	2N1302	0.18	2N3904	0.20
OC273	0.45	2N1303	0.18	2N3905	0.25
OC274	0.20	2N1304	0.22	2N3906	0.16
OC275	0.20	2N1305	0.22	2N4058	0.15
OC276	0.20	2N1306	0.28	2N4059	0.10
OC277	0.20	2N1307	0.28	2N4060	0.13
OC278	0.25	2N1308	0.25	2N4061	0.13
OC279	0.30	2N1309	0.30	2N4062	0.14
OC280	0.10	2N1310	0.20	2N4141	0.81
OC281	0.14	2N1614	0.45	40360	0.40
OC282	0.14	2N2147	0.75	40361	0.45
OC283	0.18	2N2160	0.61	40362	0.50
OC284	0.24	2N2369A	0.16	40430	0.85

SN7400	0.20	SN7425	0.37	SN7473	0.44	SN74107	0.51	SN74157	1.08
SN7401	0.20	SN7426	0.37	SN7474	0.44	SN74110	0.57	SN74170	2.38
SN7402	0.20	SN7428	0.43	SN7475	0.59	SN74111	0.8		

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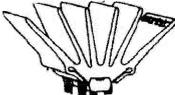
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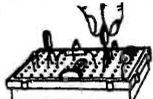
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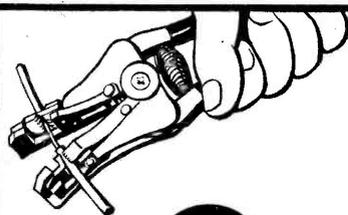
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equipment used. The main receiver is a Marconi Mercury marine communications receiver which covers 15kHz to 4MHz while the standby is a BC946 Medium Wave Command receiver. Two aerials are in use—a standard MW loop antenna and a 90ft longwire at 20ft 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, Venezuela 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'España* 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 Russian-made VEF204 receiver which, when connected to a 10 metre antenna, produced the following:

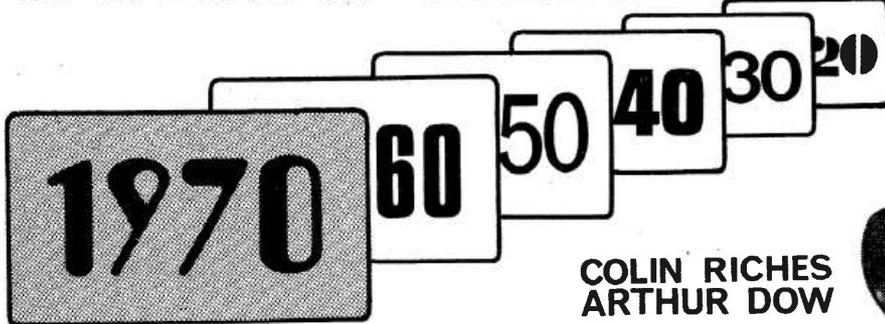
- 6025 R. *Portugal* in English at 2130.
- 7185 *RSA, South Africa* in English at 2000.
- 15185 *Radio Finland* in English at 1200.
- 17750 *Havana, Cuba* in English at 2130.
- 17820 R. *Canada International*, English at 2230.
- 17825 *RSA, South Africa*, English at 1600.

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 short-wave 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 regardless 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 appre-

WHO INVENTED THE NEUTRODYNE ?

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

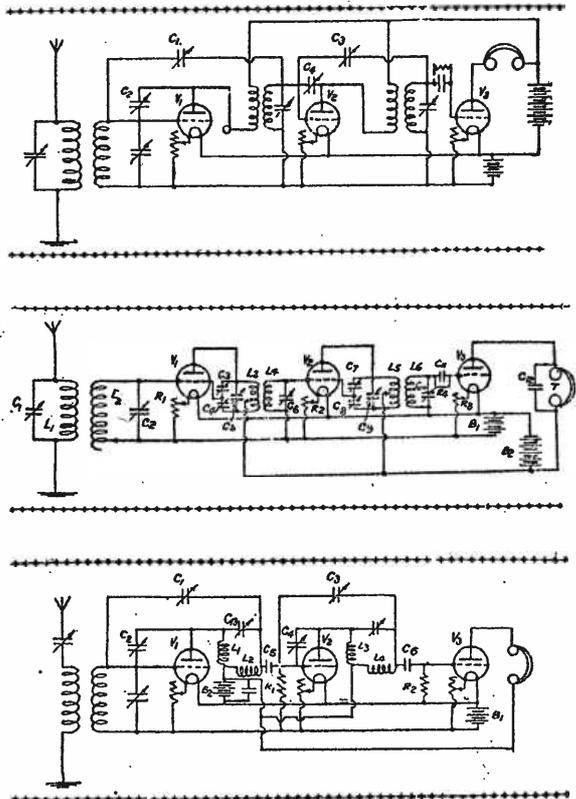
—Professor Hazeltine

NEW FACTS ABOUT A GREAT INVENTION

How it Came to be Sold to America

ciated 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 Neutrodyne '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



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 Neurodyne. Similar work was being done by Mr. Scott-Taggart and I feel that while we in America call it the Hazeltine Neurodyne we should in England call it the Scott-Taggart Neurodyne”.

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 Neurodyne 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.

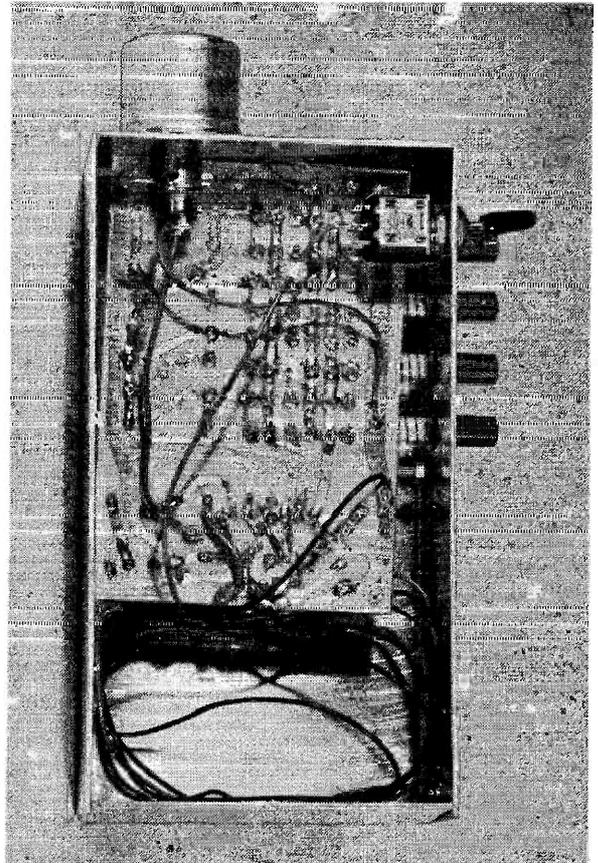
The ironical position developed in which a first class British patent had been sold to America who exported sets to us here which were licensed under the S.T. patent. The Hazeltine Corporation sold licence rights on the patent to no less than fourteen leading manufacturers in the USA. From Wireless again . . . “The value of the invention was appreciated from the first by the Americans and their enterprise is in striking contrast to our own . . . the Neurodyne 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 Neurodyne 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.



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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 monetary 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 emission 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.

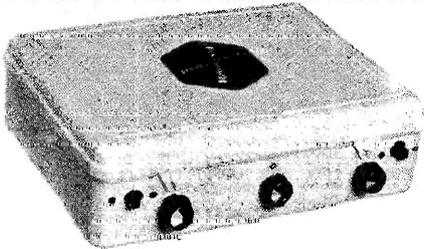
Playback is achieved on a—wait for it—transparent turntable. The 25W light bulb is located beneath the turntable so that it's light shines through both turntable and record. The light is detected by three light sensors or photodiodes. Two of these are responsible for tracking and keeping the lens system 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



NEW EDU-KIT MAJOR

Completely Solderless Electronic Construction Kit
Build these projects without soldering iron or solder

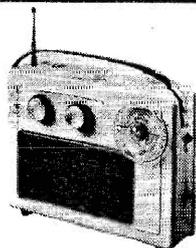
- ★ 4 Transistor Earpiece Radio.
- ★ 5 Transistor Push Pull Amplifier.
- ★ Batteriless Crystal Radio.
- ★ Signal Tracer.
- ★ 7 Transistor Loudspeaker Radio MW/LW.
- ★ One Transistor Radio.
- ★ Signal Injector.
- ★ 5 Transistor Short Wave Radio.
- ★ 2 Transistor Regenerative Radio.
- ★ Transistor Tester NPN-PNP.
- ★ Electronic Metronome.
- ★ 3 Transistor Regenerative Radio.
- ★ 4 Transistor Push Pull Amplifier.
- ★ Electronic Noise Generator.
- ★ Audible Continuity Tester.
- ★ Sensitiv. Pre-Amplifier.

Total Building Costs
£7-23 P P & Ins. 44p
(Overseas P & P £1-85)
(+ 10% VAT 79p)

Components Include: 24 Resistors • 21 Capacitors • 10 Transistors • 3 1/2" Loudspeaker • Earpiece • Mica Baseboard • 3 12-way connectors • 2 Volume controls • 2 Slider Switches • 1 Tuning Condenser • 3 Knobs • Ready Wound MW/LW/SW Coils • Ferrite Rod • 6 1/2 yards of wire • 1 Yard of sleeving etc. • Parts Price List and Plans 50p. (Free with parts).

NEW ROAMER NINE

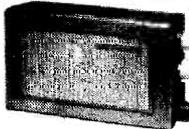
WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors, 9 Tunable wavebands as Roamer Ten. Built in ferrite rod aerial for MW/LW. Retractable chrome-plated telescopic aerial for VHF and SW. Push Pull output using 400mW transistors, 9 Transistors and 4 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 9 1/2" x 7" x 2 1/2" approx. Parts Price List and Plans 30p (Free with parts).

Total Building Costs
£6-95 P P & Ins. 44p
(Overseas P & P £1-85)
(+ 10% VAT 69p)

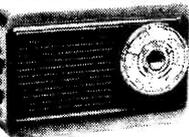
POCKET FIVE



3 Tunable wavebands, M.W. L.W. and Trawler Band, 7 stages, 3 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive black and gold case. Size 5 1/2" x 1 1/2" x 3 1/2" approx. Plans and Parts Price List 15p (Free with parts).

Total Building Costs
£2-28 P P & Ins. 25p
(Overseas P & P £1-25)

TRANSONA FIVE



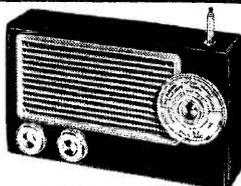
Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and Parts Price List 15p (Free with parts).

Total Building Costs
£2-50 P P & Ins. 25p
(+10% VAT 25p) (Overseas P & P £1-25)

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. 8in. Speaker, 8 Improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 x 5 1/2 x 2 1/2 in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

Total building costs
£4-48 P P & Ins. 33p
(+ 10% VAT 44p) (Overseas P & P £1-25)



ROAMER SIX

CASE AND LOOKS AS TRANS-EIGHT

Trawler band plus an extra Medium waveband for easier tuning of Luxembourg, etc.. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker, 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 x 5 1/2 x 2 1/2 in. approx. Plans and parts price list 25p (FREE with parts).

Total building costs
£3-98 P P & Ins. 31p
(+ 10% VAT 39p) (Overseas P & P £1-85)

NEW Everyday Series

Build this exciting New series of designs

E.V.5. 5 Transistors and 2 diodes, MW/LW. Powered by 4 1/2 volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" x 5 1/2" x 2 1/2" approx. Parts Price List and Plans 15p. Free with parts.

Total Building Costs
£2-73 P P & Ins. 80p
(+ 10% VAT 67p) (Overseas P & P £1-15)

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 30p) (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 £1-65.

Total Building Costs
£4-08 P P & Ins. 31p
(Overseas P & P £1-85) (+ 10% VAT 40p)

ROAMER EIGHT Mk I

NOW WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch, 8 transistors plus 3 diodes. Latest 4" 2 watt ferrite magnet loudspeaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 x 7 x 4 1/2 in. approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

Total building costs
£6-98 P P & Ins. 47p
(+ 10% VAT 69p) (Overseas P & P £1-85)



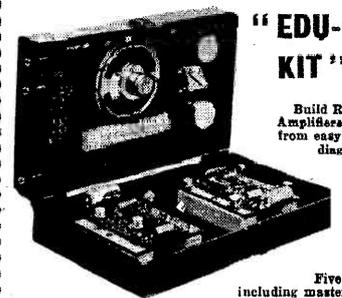
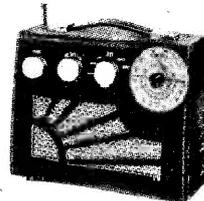
ROAMER TEN

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 Base Board 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" x 7" x 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

Total building costs
£8-50 P P & Ins. 52p
(+ 10% VAT 85p) (Overseas P & P £1-85)



"EDU-KIT"

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

Five units including master unit to construct.

Components include:

Tuning Condenser: 2 Volume Controls: 2 Slider Switches: Fine Tone 3" Moving Coil Speaker: Terminal Strip: Ferrite Rod Aerial: 2 Plugs and Sockets: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three 1/2" Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and plans 25p (FREE with parts).

Total building costs
£5-50 P P & Ins. 33p
(+ 10% VAT 55p) (Overseas P & P £1-85)

RADIO EXCHANGE LTD

★ Callers side entrance "Lavelle" shop.
★ Open 10.1. 2.30 4.30, Mon.-Fri. 9-12 Sat.

To RADIO EXCHANGE CO., 61a HIGH STREET, BEDFORD, MK40 1SA
Tel.: 0234 53867. Reg. No. 788372.

I enclose £..... for

Name

Address

(Dept. PW24.)

TRANSFORMERS

SAFETY MAINS ISOLATING TRANSFORMERS

Pr. 120/240 V Sec. 120/240 V Centre Tapped and Screened

Ref.	VA	Weight	Size cm.	P	P & P
No.	(Watts)	lb oz		£	p
07	20	1 8	7.0 x 6.0 x 6.0	2.32	30
149	60	3 12	9.9 x 7.7 x 8.6	3.45	36
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	82
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

AUTO TRANSFORMERS

Ref.	VA	Weight	Size cm.	Auto Taps	P & P
No.	(Watts)	lb oz		£	p
113	20	1 0	5.8 x 5.1 x 4.5	0-115-210-240	1.22 22
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	0-115-210-220-240	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 82
95	2000	32 0	17.2 x 16.6 x 14.0	"	28.70 -
73	3000	40 0	21.6 x 15.4 x 18.1	"	39.17 *

CASED AUTO TRANSFORMERS

115V 500W enclosed transformer, with mains lead and two 115V outlet sockets, £9.49, P & P 67p. 20 VVatt version £2.02 P & P 27p.

TRANSFORMERS

PRIMARY 240-250 VOLTS 12 AND OR 24 VOLT RANGE

Ref.	Ampls.	Weight	Size cm.	Secondary Windings	P & P
No.	12V 24V	lb oz		£	p
111	0.5 0.25	1 4	4.8 x 2.9 x 3.5	0-12V at 0.25A x2	1.22 22
213	1.0 0.5	1 4	6.1 x 5.8 x 4.8	0-12V at 0.5A x2	1.44 22
71	2 1	1 12	7.0 x 6.4 x 6.1	0-12V at 1A x2	1.90 22
18	4 2	2 12	8.3 x 7.7 x 7.0	0-12V at 2A x2	2.68 30
100	8 4	3 8	8.9 x 8.0 x 7.7	0-12V at 3A x2	3.29 42
70	10 5	4 4	9.9 x 8.9 x 8.6	0-12V at 4A x2	3.60 52
72	10 5	4 4	9.9 x 9.6 x 8.6	0-12V at 5A x2	4.25 52
116	12 6	6 12	9.9 x 10.2 x 8.6	0-12V at 5A x2	5.10 52
17	15 0	8 12	12.1 x 9.9 x 10.2	0-12V at 8A x2	6.56 52
115	20 10	11 8	14.0 x 9.6 x 11.8	0-12V at 10A x2	8.36 67
187	30 15	15 8	14.0 x 12.1 x 11.8	0-12V at 15A x2	15.40 82
226	60 30	32 0	17.2 x 15.3 x 14.0	0-12V at 30A x2	28.44 *

30 VOLT RANGE

Ref.	Ampls.	Weight	Size cm.	Secondary Taps	P & P
No.		lb oz		£	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	11.8 x 9.6 x 8.6	"	4.25 42
5	5.0	6 12	12.1 x 9.6 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.	Ampls.	Weight	Size cm.	Secondary Taps	P & P
No.		lb oz		£	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	"	10.33 67
118	8.0	15 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.	Ampls.	Weight	Size cm.	Secondary Taps	P & P
No.		lb oz		£	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	"	5.46 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 **

MINIATURE TRANSFORMERS WITH SCREENS P & P

Ref.	MA.	Weight	Size cm.	VOLTS	P & P
No.		lb oz		£	p
238	200	2	2.8x2.6x2.0	3-0-3	1.31 10
212	1A IA	1 4	6.1x5.8x4.8	0-6-0-6	1.52 22
13	100	1	4.3x2.6x2.9	0-0-0-9	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, IA	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 1	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, IA	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 36
204	1A, IA	3 4	8.9x7.7x7.7	0-15-27, 0-15-27	2.86 38

PLEASE ADD 10% FOR V.A.T.
INCLUDING P. & P.



'BIG' Discounts

ALL PRICES INCLUDE V.A.T.

SPEAKER BARGAINS

Ref.	Description	£	£	
EMI 3"	8" x 8", 8 or 15 ohm	2.10	ELAC 8" 8ohm Dualcone	2.10
Plain	.. 2.05	FANE 7" x 4" 3 or 8 ohm	1.00	
With Co-Axial Tweeter	.. 2.20	8" Dualcone 8 ohm	2.40	
Twin Tweeter	.. 3.55	CELESTION 8" 15 ohm	1.55	
Type 350	8 ohm, 20 watt	8.00	ADASTRA 10" 8 or 15 ohm,	2.75
6 1/2"	8 ohm, 10 watt	2.70	10 watt	..
8"	8 ohm, 10 watt	3.75	BAKER GROUP 25 12" 8 or	6.45
10"	8 ohm, 20 watt	5.50	15 ohm, 25 watt	..
8" x 5" C/Mag.	5 watt	1.20	P. & P. ..	-.25
8" x 5" Dualcone	8 ohm, 10 watt	2.45	5" 8 ohm, 5 watt C/Mag.	-.85
8 ohm, 10 watt	2.45	2 1/2" 8 ohm or 84 ohm	-.50	
GOODMANS 6 1/2" 8 ohm	1.60	Dualcone	..	-.10

TWEETER & CROSSOVER

Ref.	Description	£	£	
EMI 3 1/2"	3 or 8 ohm C/Mag	1.00	Dome Tweeter 8 ohm, 30 watt	4.00
Cone Tweeter	8 or 15 ohm,	1.90	Crossovers CN25 (3 ohm),	..
10 watt	..	1.90	CN28 (8 ohm), CN216 (16	..
Cone Tweeter	8 ohm, 3 watt	1.00	ohm) ..	1.00
Horn Tweeter	8 ohm, 20 watt	3.50	P. & P. ..	-.10

KIT FORM CABINETS TEAK VENEER

Ref.	Description	£	£	
12 x 12 x 6	with 8" x 8" or 8" x 8" cutout	..	18 x 11 x 9 with 13" x 8" cutout	..
6 1/2"	and 3 1/2" cut out ..	2.45	for EMI 350 ..	4.25
17 x 10 x 9	with 8" or 13" x 8" cutout	..	P. & P. ea.	-.35
cutout	..	3.50	..	..

MICROPHONES

Ref.	Description	£	£	
CM20	Crystal Hand	.. 50	TW206	.. 5.75
CM70	Planet stick metal, switch crystal	1.55	CONDENSER MIKE 600 ohm, uni-dir	7.90
DM160	Dynamic uni-dir, ball metal	3.95	Cassette Stick Mike with R. Control on/off switch (2.5 & 3.5mm J/Plu)	9.35
UD130	50K/600 ohm, uni-dir ball metal	.. 4.50	P. & P. ..	-.15

SOLDERING IRONS

Ref.	Description	£	£	
ANTEX CN240	15 watt	1.60	X25 25 watt (low leakage)	1.60
SK 1 Kit (15 watt iron 2 spare Bie etc.)	..	2.65	P. & P. ..	-.10

CARTRIDGES

Ref.	Description	£	£	
ACOS GP91/25C or GP91/35C	Stereo comp.	.. 1.00	19-TI Stereo crystal	.. .80
GP93/1	Stereo crys.	.. 1.35	BSR SC5M Stereo ceramic	2.25
GP94/1	Stereo crys.	.. 1.75	SX5H Stereo crystal	1.60
GP95/1	..	.. 1.35	SX5M Mono/stereo	1.25
GP96/1	..	.. 1.75	X5M Mono/stereo	1.25
GP101	..	.. .75	GOLDRING G800 G850 £3.85 £2.95	1.95
SONOTONE	..	.. .75	STYLI for above cartridges	..
9THAC	Stereo cer. diam.	1.80	Sapahire -85 D Diamond	1.25
			GOLDRING G800 G850	1.95
			P. & P. ..	-.05

BATTERY ELIMINATORS

Ref.	Description	£	£	
240v input	6, 7.5 or 9 300mA	2.20	lighter socket) 6, 7.5 or 9 d.c. output at 300mA	2.20
12v d.c. input	(fits in car	..	P. & P. ..	-.10

TAPES

Ref.	Stnd.	LP	DP	Stnd.	LP	DP
5"	45p	55p	70p	7"	65p	95p
5 1/2"	55p	65p	95p	P. & P. 1-3, 9p ea.	4 or more, lot 30p	..

LOW NOISE CASSETTES

Ref.	Description	£	£		
C60	35p	33p	30p	Cassette Head Cleaner	35p
C90	45p	43p	40p	P. & P. 1-5, 3p ea.	6-10, 15p lot
C120	55p	52p	50p	11-20, Post Free.	..

PLASTIC LIBRARY CASES

Ref.	Description	£	£	
For 5"	Reels ..	.. 18p	CASSETTE CASES	.. 10p
5 1/2"	Reels ..	.. 22p	P. & P. 1-3, 5p ea.	4 or more, 20p
7"	Reels ..	.. 25p	..	..

BIB ACCESSORIES

Ref.	Description	£	£	
Tape Editing Kit	Ref. 23	1.30	SPECIAL OFFER	..
Recording Tape	..	..	BUSH Stereo System with indep. Vol., Bass & Treble controls on each Speaker for optimum repro. Using Garrard 2025TC Auto Change Deck in deluxe teak plinth and cover. Today's Value £49.50. OUR PRICE £27.50 + £1.50 P. & P. 12 months Guarantee by Maker.	..
Splitter	Ref. 20	1.15	THIS IS A BARGAIN NOT TO BE MISSED!	..
Cassette Tape	..	..	..	..
editing	Ref. 24	1.40	..	..
Cassette Salvage Kit	Ref. 29	40p	..	..
12's Cassette Case	Ref. 34	£1.00	..	..
Stylus Balance	Ref. 32A	1.15	..	..
Spirit Lever	Ref. 46	50p
Hi-Fi Stereo Test Cassette	..	1.90
Groove-Kleen Record Cleaner	..	1.90
P. & P.

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EXPERIMENTAL WORKSHOP

M. J. HUGHES M.A.

LEARNING BY PRACTICAL PROJECT STEPS

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

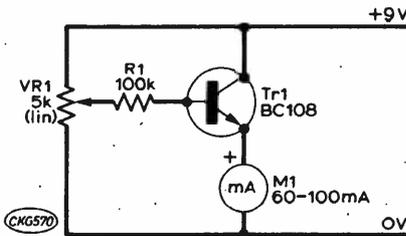


Fig. 29. The emitter current measured is proportional to the base current through R1. The latter is set by VR1.

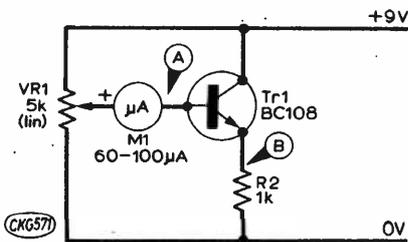
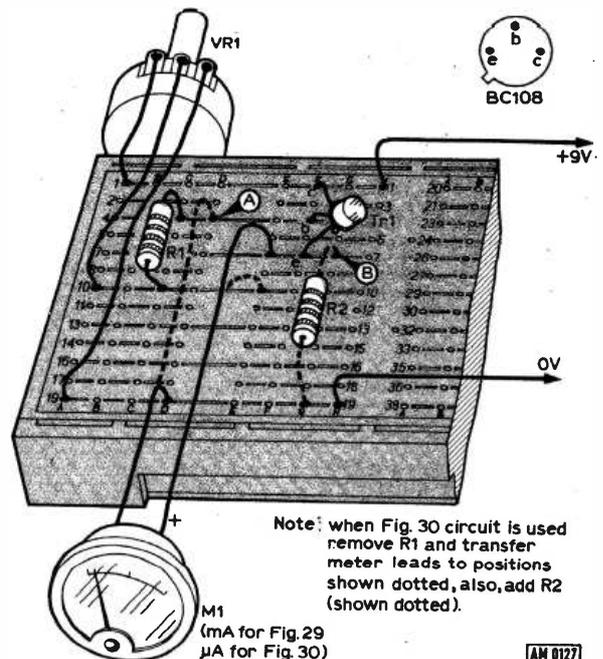


Fig. 30. The transistor draws only the amount of base current necessary to make the potential at B rise to that of A (less the V_{be} of the transistor).



Note: when Fig. 30 circuit is used remove R1 and transfer meter leads to positions shown dotted, also, add R2 (shown dotted).

M1 (mA for Fig. 29)
µA for Fig. 30)

AM 0127

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

$$\text{therefore } \frac{9 - V_{be}}{100k\Omega} = \frac{8.4}{100} \text{ mA} = 0.084\text{mA}.$$

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}):

$$\text{collector current} = h_{FE} \times \text{base current}$$

$$\text{emitter current} = \text{collector current} + \text{base current}$$

$$\therefore I_e = (h_{FE} \times I_b) + I_b$$

$$\text{In other words } I_e = I_b \times (h_{FE} + 1)$$

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 directly 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 $60\mu\text{A}$ 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 $60\mu\text{A}$ (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 1,000 Ω 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

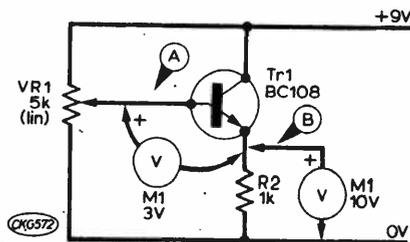


Fig. 32. At all settings of the slider the potential difference between A and B is about 600mV showing that B "follows" A.

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 10k Ω resistor. You will see that the base current drawn by the transistor reduces by a factor of ten. Reduce R2 to 100 Ω 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.

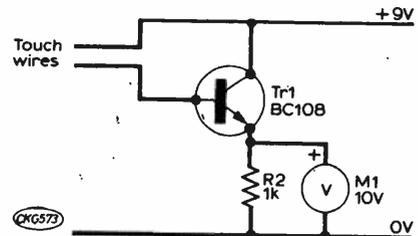


Fig. 33. The small current flowing through the fingers generates emitter current and this is shown as a potential difference across R2.

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 10k Ω .

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,

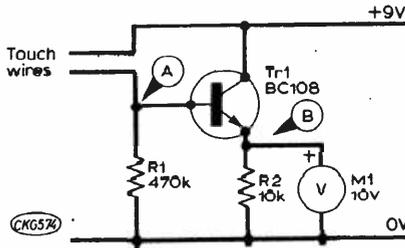


Fig. 34. The potential at A is set by the potential divide of $R1$ with skin resistance and this is reflected by the potential measured at B in the lower resistance emitter circuit.

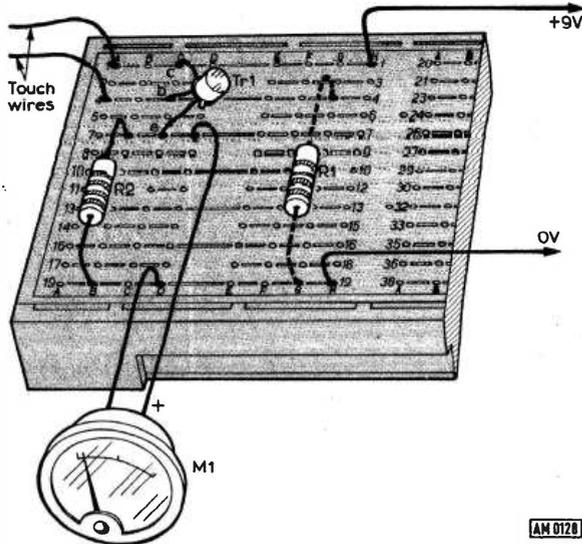


Fig. 35. Layout for Fig. 33. To carry out experiment in Fig. 34 change $R2$ to $10k\Omega$ and insert $R1$.

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*.

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 $0.005\mu A$. In reality more than this has to flow through the skin because we have the $470k\Omega$ 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.

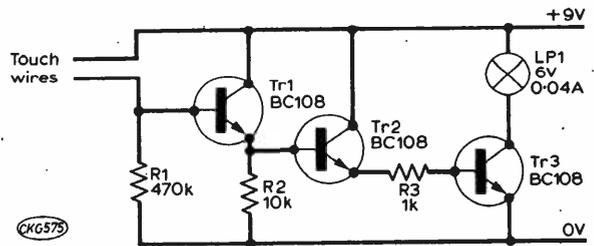


Fig. 36. A touch sensitive light switch. In practice $R2$ can be omitted as can $R1$ but removal of the latter might make the circuit over sensitive. $R3$ should not be omitted.

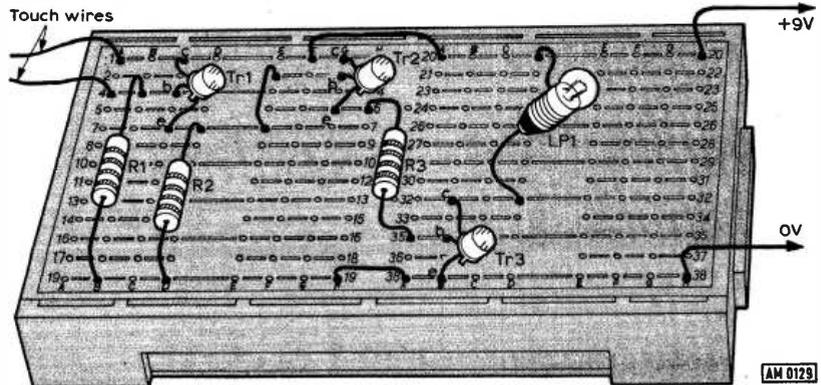


Fig. 37. Layout for Fig. 36.

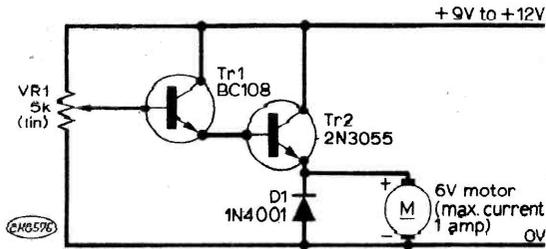


Fig. 38. Simple voltage adjustment to control the speed of low voltage d.c. motors. D1 is included to prevent high reverse voltages from the brushes damaging the transistor. The output is not short circuit protected.

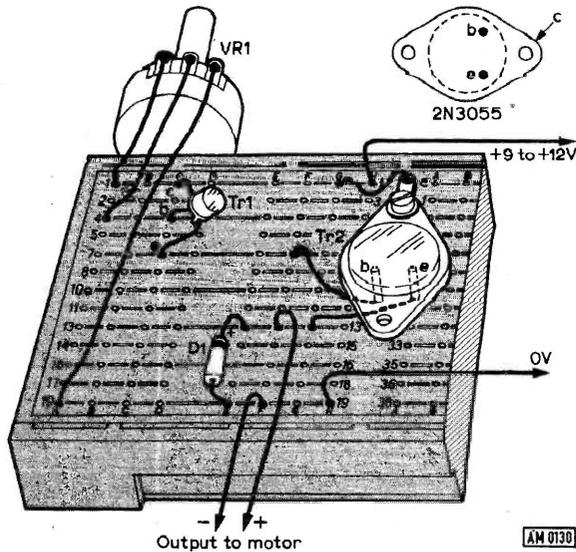


Fig. 39. Layout for Fig. 38. The short leads on Tr2 should be extended to connect to the T-Dec and the collector connection made via a solder tag bolted to Tr2.

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 $I_b h_{FE}$ 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 trans-

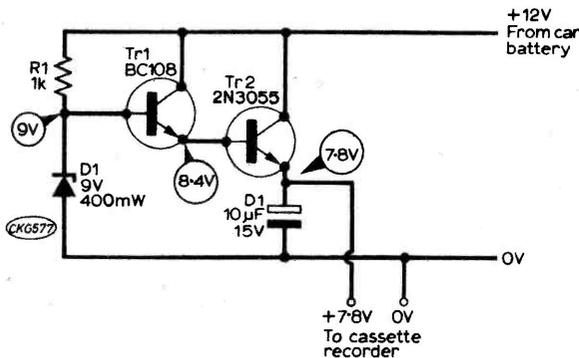


Fig. 40. A simple voltage dropper and regulator for running a cassette recorder from a car battery. Not short circuit protected.

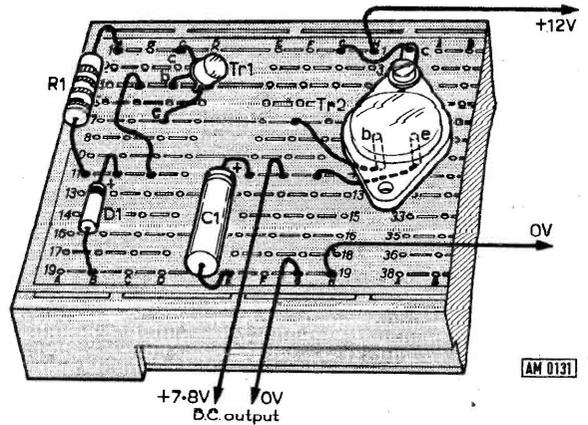


Fig. 41. Layout for Fig. 40.

istor 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.

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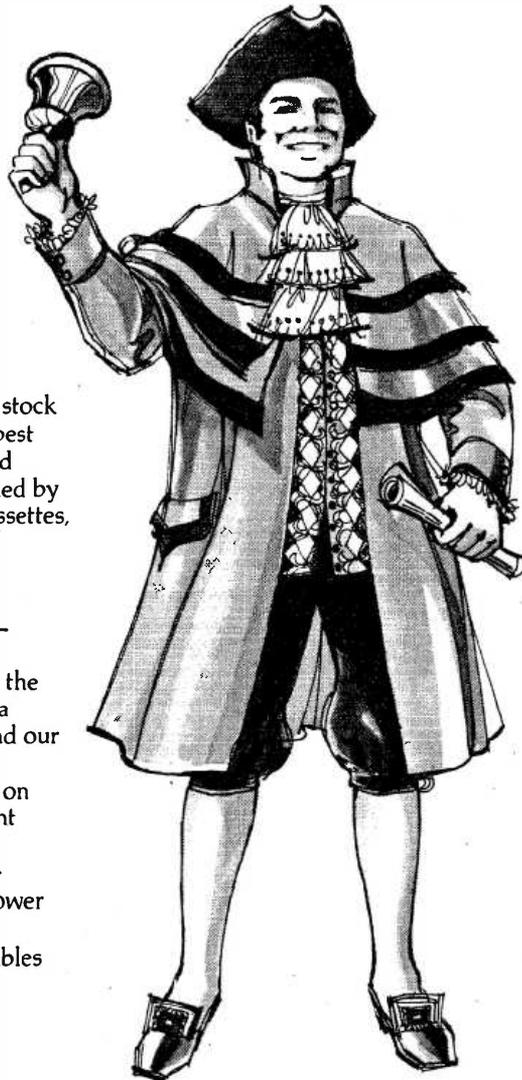
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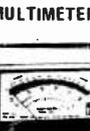
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100,000opv. 6 1/2" scale BUTTER short circuit check. Sensitivity 100,000 opv DC. 0.5/5/25/100V AC. 0.5/2.5/10/50/250/1000V DC. current 10/100uA/10/100/500mA/2.5/10A. Resistance: 1k/10k/100k/10 Meg/100 Meg ohms. -10 to +48dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.



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MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. Ranges: 0/30/750uA/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/1.5/3/7.5/15/30/75V/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.



OUR PRICE £49.00 P&P 60p

AT201 Decade ATTENUATOR

Frequency range 0-200kHz. Attenuator 0-111dB. 0.1dB steps. Impedance 600 ohms. Input power maximum 50dBm. Size: 180 x 90 x 65mm.



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 scale to read scale. 800kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads.



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TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz. On 4 hands. Square wave. Output cps to 30 kHz. Output 150mV to 220V. 5000 Ohms. 200/250V AC operation. Supplied brand new with instruction manual and leads.



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All transistorised compact fully portable. AF sine wave 18Hz to 220 kHz. AF square wave 18Hz to 100kHz. Output Square/200/240V AC operation. Complete with instructions and leads.



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SKYFON 100mW
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 Tests IGO and D, PNP/NPN. Operates from 9V battery. Complete with all instructions etc.
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 Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.
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 Sine 18 x 200,000Hz Square 18 x 20,000 Hz. Maximum output = 10dB (100 ohms) Operates from internal batteries. Attractive two tone case. Size: 186 x 127 x 50mm.
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 High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing. 1/2" diameter shafts. Bulk quantities available.
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 Excellent quality at low cost. All models—input 230V 50/60Hz. Variable output—250V
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 8A **£25.50** 50p
 10A **£28.10** 75p
 12A **£29.50** 100p
 20A **£72.50** 125p
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 0/115/250V. Step up or step down. Fully shrouded.
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 300W **£4.50** P&P 23p
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 1000W **£9.50** P&P 38p
 1500W **£12.50** P&P 43p
 2250W **£20.95** P&P 50p
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SWR METER Model SWR3
 Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%. Impedance 52 Ohm indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.
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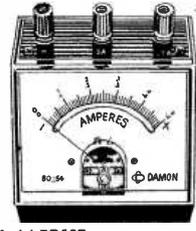
Enlarged Window Model S80



Bakelite Model 65



Clear Plastic Model 45P



Model ED107

RANGE	MR 38P	MR 45P	MR 52P	MR 65P	MR 85P	MR 65	S 80	SW 100	SD 460	SD 640	SD 830	PE 70	ED 107
25uA	—	—	—	—	—	£4.60	—	—	—	—	—	—	—
50uA	£2.55	£2.70	£3.50	£3.70	£4.40	£3.55	£3.50	£4.15	£2.80	£3.05	£3.40	£3.75	£6.90
100uA	£2.45	£2.60	£3.00	£3.15	£4.25	£3.00	£3.40	£3.95	£2.75	£3.00	£3.35	£3.60	£6.40
200uA	£2.40	£2.50	—	£3.05	£3.05	—	—	—	£2.70	£3.00	£3.30	£3.40	—
500uA	£2.25	£2.45	£2.65	£2.75	£3.90	£2.70	£3.05	£3.70	£2.55	£2.95	£3.15	£3.20	—
50-0-50uA	£2.80	£2.85	£2.05	£3.15	£4.25	£3.05	£3.40	£3.95	£2.80	£3.05	£3.40	£3.60	£6.40
100-0-100uA	£2.40	£2.60	£2.95	£3.10	£4.05	£3.00	£3.30	£3.90	£2.75	£3.00	£3.35	£3.50	—
500-0-500uA	£2.25	£2.40	—	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
1mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	£3.20	—
1-0-1mA	£2.25	—	—	—	£3.90	£2.60	—	—	—	—	—	—	—
2mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
5mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
10mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
20mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
50mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
100mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
150mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
200mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
300mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
500mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	—
750mA	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
1A DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	—	£5.95
2A DC	£2.25	—	—	—	—	£2.60	—	—	—	—	—	—	—
5A DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	—	£5.95
10A DC	£2.25	—	—	£2.60	—	—	—	—	£2.60	£2.90	£3.10	—	—
15A DC	£2.25	—	—	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
20A DC	£2.25	—	—	£2.60	—	—	—	—	—	—	—	—	—
30A DC	—	—	—	£2.80	£3.95	£2.60	—	—	—	—	—	—	—
50A DC	—	—	—	£2.90	—	£2.60	—	—	—	—	—	—	—
3V DC	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
5V DC	—	—	—	£2.60	—	£2.60	—	—	£2.60	£2.90	£3.10	—	£5.95
10V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	£2.60	£2.90	£3.10	—	£5.95
15V DC	£2.25	—	—	—	—	—	—	—	—	—	—	—	£5.95
20V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	—	£2.90	£3.10	—	£5.95
50V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	—	£5.95
100V DC	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
150V DC	£2.25	—	—	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
300V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	—	£5.95
500V DC	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
750V DC	£2.25	—	—	—	—	—	—	—	—	—	—	—	—
15V AC	£2.30	£2.45	£2.60	£2.80	£2.95	—	—	—	£2.70	£3.00	£3.30	—	—
30V AC	—	—	—	—	—	£2.65	—	—	—	—	—	—	—
50V AC	£2.30	—	—	£2.80	—	£2.65	—	—	—	—	—	—	—
150V AC	£2.30	—	—	£2.80	—	£2.65	—	—	—	—	—	—	—
300V AC	£2.30	£2.45	£2.60	£2.80	£3.95	£2.65	£3.00	£3.70	£2.70	£3.00	£3.30	£3.25	—
600V AC	£2.30	—	—	£2.80	—	£2.65	—	—	—	—	—	—	—
S Meter 1mA	£2.30	£2.50	£2.60	£2.85	£3.90	—	—	—	—	—	—	—	—
V Meter	£2.65	£2.70	£3.60	£3.70	£4.55	£3.85	£3.70	£4.30	£2.90	£3.15	£3.50	£3.85	—
1A AC	—	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
5A AC	—	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
10A AC	—	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
20A AC	—	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
30A AC	—	£2.40	£2.50	£2.60	£3.90	£2.60	—	—	—	—	—	—	—
50A AC	—	—	—	—	—	£2.60	—	—	—	—	—	—	—
50mA AC	—	—	—	—	—	£2.60	—	—	—	—	—	—	—
100mA AC	—	—	—	—	—	£2.60	—	—	—	—	—	—	—
200mA AC	—	—	—	—	—	£2.60	—	—	—	—	—	—	—
500mA AC	—	—	—	£2.60	—	£2.60	—	—	—	—	—	—	—
50mV DC	—	—	—	—	—	£2.90	—	—	—	—	—	—	—
100mV DC	—	—	—	—	—	£2.90	—	—	—	—	—	—	—
500mA/5A DC	—	—	—	—	—	—	—	—	—	—	—	—	£7.00
1/15A DC	—	—	—	—	—	—	—	—	—	—	—	—	£7.00
5/15V DC	—	—	—	—	—	—	—	—	—	—	—	—	£7.00
5/50V DC	—	—	—	—	—	—	—	—	—	—	—	—	£7.00

SEW PANEL METERS—SIZES AND FIXING INFORMATION

	Front	Panel Hole	Fixing		Front	Panel Hole	Fixing
Model 38P	42 x 42mm	32mm dia.	4 studs	Model SW100	100 x 80mm	65mm dia.	4 studs
Model 45P	50 x 50mm	38mm dia.	4 studs	Model SD460	59 x 46mm	38mm dia.	4 studs
Model 52P	60 x 60mm	48mm dia.	4 studs	Model SD640	85 x 64mm	45mm dia.	4 studs
Model 65P	86 x 78mm	57mm dia.	4 studs	Model SD830	110 x 83mm	58mm dia.	4 studs
Model 85P	120 x 110mm	98mm dia.	4 studs	Model PE70	90 x 34mm	70 x 31mm	2 holes
Model 65	80 x 80mm	64mm dia.	4 studs	Model ED107	Size: 100 x 90 x 150mm high		
Model 580	80 x 80mm	65mm dia.	4 studs				including terminals.

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Input 88-125V AC or 170-250V AC. Output 120V AC or 240V AC. 200V A rating.
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3" tube. V amp sensitivity 0.1Vp-p/CM. Bandwidth: 1.5Hz-1.5MHz. Input Impedance: 2M Ohms, 25pF. X amp sensitivity: 0.5Vp-p/CM. Bandwidth: 1.5Hz-800kHz. Input Impedance: 2 Meg Ohms, 20pF. Time base, five ranges 10Hz to 300kHz. Synchronisation internal or external. Illuminated scale 140 x 215 x 330mm. Weight 15/16 lbs. 220/240V AC. Supplied brand new with handbook.
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Fully transistorised portable VHF receiver. 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 Built-in. Size: 134 x 58 x 180mm.
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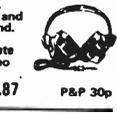
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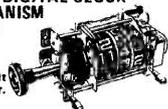


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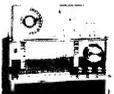


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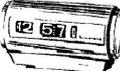
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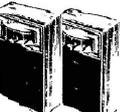
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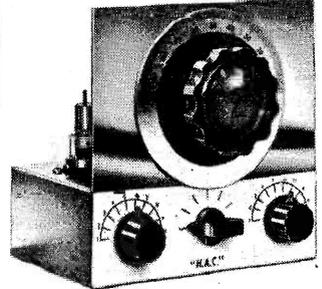
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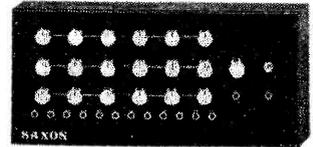
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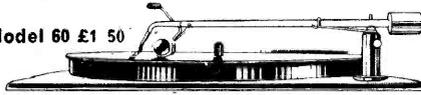
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1020 For model G240 3/32" 38p

1021 For model G240 1/8" 38p

1022 For model G240 3/16" 38p

50 For model X25 3/32" 38p

51 For model X25 1/8" 38p

52 For model X25 3/16" 38p

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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 1" Switched	0.17
PS 42	Jack Stereo Switched	0.28
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
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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 1" Plastic	0.24
PS 28	Jack 1" Screened	0.28
PS 29	Jack Stereo Plastic	0.22
PS 30	Jack Stereo Screened	0.28
PS 31	Phono Screened	0.14
PS 32	Car Aerial	0.15
PS 33	Co-Axial	0.17

PLUGS

Plug	Description	Price
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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
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PS 9	Jack 3.5mm Plastic	0.09
PS 10	Jack 3.5mm Screened	0.12
PS 11	Jack 1" Plastic	0.13
PS 12	Jack 1" Screened	0.18
PS 13	Jack Stereo Screened	0.29
PS 14	Phono	0.08
PS 15	Car Aerial	0.15
PS 16	Co-Axial	0.10

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Cable	Description	Price
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CP 3	Stereo Screened	0.08
CP 4	Four Core Common Screen	0.23
CP 5	Four Core Individually Screened	0.30
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CP 8	Twin Oval Mains Cable	0.06
CP 9	Speaker Cable	0.04
CP 10	Low Loss Co-Axial	0.10

CARBON POTENTIOMETERS

Potentiometer	Description	Price
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VC 1	Single Less Switch	0.14
VC 2	Single D.P. Switch	0.28
VC 3	Tandem Less Switch	0.44
VC 4	1K Lin Less Switch	0.14
VC 5	100K Log anti-Log	0.44

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The E12 Range of Carbon Film Resistors. 1/8th watt available in PAKS of 50 pieces, assorted into the following groups:—
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THESE ARE UNBREATABLE PRICES—LESS THAN 1p EACH INCL. V.A.T.

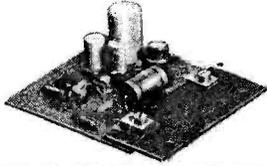
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AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



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	P _o = 3 WATTS f = 1KHz	0-25%
LOAD IMPEDANCE		8 - 16 Ω
INPUT IMPEDANCE	f = 1KHz	100 k Ω
FREQUENCY RESPONSE CE 3dB	P _o = 2 WATTS	50 Hz - 25KHz
SENSITIVITY for RATED O/P	V _s = 25V, R _L = 8 Ω f = 1KHz	75mV, RMS
DIMENSIONS		3" x 2 1/4" x 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 CE, T.H.D. (R _L = 8 Ω 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

POWER SUPPLIES

PS 12. (Use with AL10 & AL20) 85p
SPM 80. (Use with also AL30 & AL50) £3-25
FRONT PANELS SP 12 with Knobs £1-10

PRE-AMPLIFIERS

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

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 102mm x 84mm x 35mm.

Frequency response 20Hz - 20KHz ± 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

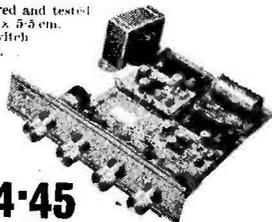
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The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 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

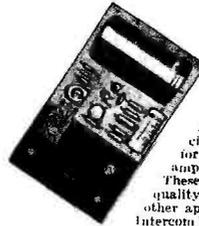
- ★ Frequency Response 15Hz to 100,000-1dB.
- ★ Load—3, 4, 8 or 16 ohms.
- ★ Distortion—better than 1% at 1 KHz.
- ★ Signal to noise ratio 80dB.

ONLY
£3-58 each

★ Supply voltage 10-35 Volts.

★ Overall size 63mm 105mm x 13mm.

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



STABILISED POWER MODULE SPM80

SPM80 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 component and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 10 amps at 25 volts. Size: 63mm x 105mm x 30mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Address Intercom Units, etc. Handbook available 11p. 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.T. 1-5 mV into 50K Ω
All input voltages are for an output of 250mV. Tape and P.T. 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 x 82mm x 35mm

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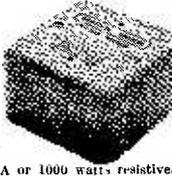
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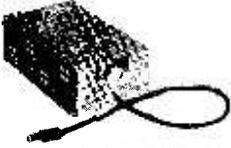
DIMMER SWITCH

Type C1. 300 Watt Light Dimmer for 200/250 Volt A/C operation. Ivory Case: 3 1/2" x 3 1/2" x 1 1/2" Fitting instructions included. Price: £2.60. Post 20p. 10 for £2.15 each. £5.00 per pair. Post 25p.



POWER UNIT Type PI076

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 x 5.0 x 14.0 cm Price: £3.95. Post 20p.



TRANSFORMERS

SAFETY ISOLATING

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

VA	Ref. No.	Price £	P & P £
50	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	0.60
500	154	13.55	1.00
1000	156	24.97	1.20
2000	158	41.25	*
3000	159	64.54	*

LOW VOLTAGE

Prim. 200-240V. Sec. 12 & 24V.

Amps	24V	Type	Price £	P & P £
0.5	0.25	111	1.00	0.29
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	116	6.95	0.65
30	15	187	12.90	0.97
40	20	232	18.30	1.00
60	30	226	23.70	1.10

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
6	51	4.40	0.52
8	117	5.25	0.52
10	88	6.80	0.67
16	89	8.38	0.67

50 Volts

Prim. 200-240V. Sec. 18, 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	8.85	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	6.95	0.67
5	40	8.48	0.67
6	120	9.20	0.82
8	121	11.60	1.00
10	122	15.25	1.00
12	189	18.43	1.10

MINIATURE AND EQUIPMENT

Prim 240V with screen

Volts	Milliamps	Type	Price £	P & P £
Sec. 1	200	No. 238	1.12	0.10
0-6	500	234	1.13	0.10
0-6	1000	212	1.28	0.22
9-0-9	100	13	0.95	0.10
0-9	330	235	1.28	0.10
0-8-9	500	207	1.70	0.22
0-8-9	1000	208	2.30	0.30
15-0-15	—	240	1.28	0.10
0-15	200	236	1.28	0.10
20-0-20	30	—	2.41	0.10
0-20	150	237	1.28	0.10
0-15-20	500	205	2.16	0.38
0-20	300	214	1.38	0.22
20-12-0-12-20	700(D/C)	221	1.21	0.30
0-15-20	1000	206	3.10	0.38
0-15-27	500	203	2.38	0.38
0-15-27	1000	204	2.40	0.38

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H8/2A	3-3µF	25V	4p	H7/7	100µF	25V	5p
H8/3	3µF	50V	4p	H7/8	125µF	16V	5p
H8/3A	4µF	50V	4p	H7/8A	100µF	35V	6p
H8/4	4-7µF	25V	4p	H7/9	100µF	63V	6p
H8/4A	5µF	64V	4p	H7/9A	125µF	4V	4p
H8/5	5µF	10V	4p	H7/10	125µF	25V	6p
H8/5A	5µF	150V	4p	H7/10A	160µF	2.5V	3p
H8/6	10µF	10V	4p	H7/11	160µF	25V	3p
H8/7	10µF	70V	4p	H7/11A	150µF	16V	5p
H8/8	16µF	35V	4p	H7/13A	200µF	25V	8p
H8/8A	16µF	16V	4p	H7/14	220µF	50V	10p
H8/9	20µF	6V	2p	H7/14A	220µF	16V	6p
H8/9A	20µF	70V	4p	H7/15	220µF	25V	5p
H8/10	22µF	50V	4p	H7/15A	220µF	35V	10p
H8/10A	22µF	100V	4p	H6/1A	250µF	4V	3p
H8/11	25µF	12V	4p	H6/2	250µF	25V	3p
H8/11A	24µF	275V	4p	H5/3A	320µF	2.5V	4p
H8/12	32µF	15V	4p	H6/4	320µF	10V	4p
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H8/13A	32µF	50V	4p	H6/5	330µF	25V	10p
H8/14	40µF	25V	5p	H6/5A	330µF	35V	15p
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H8/15	47µF	50V	4p	H6/8A	470µF	35V	20p
H8/15A	40µF	35V	4p	H6/9A	400µF	40V	20p
H7/1	50µF	10V	3p	H6/13A	1000µF	25V	16p
H7/1A	50µF	10V	4p				
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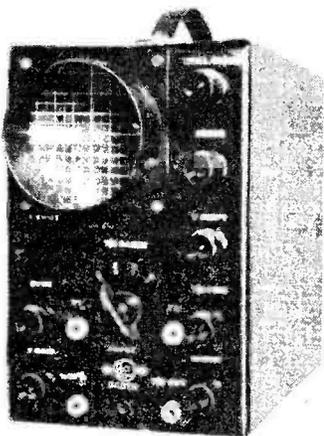
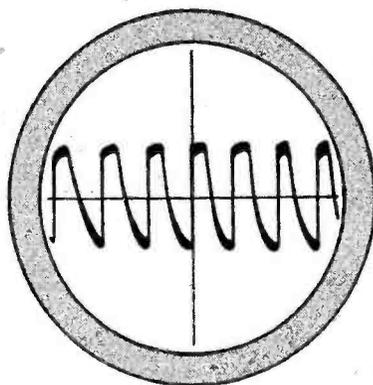
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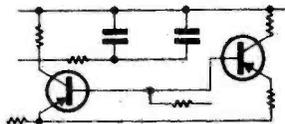
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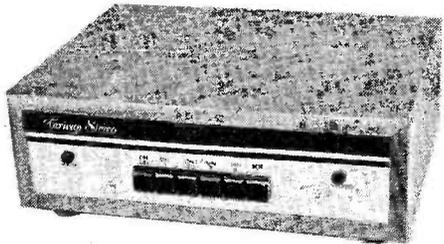
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BC147	10p	2N2646	45p	IN4005	8p
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Sub-miniature Axial lead electrolytic

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2	63	6p	68	63	10p
3	63	6p	100	4	6p
4	63	6p	100	10	6p
6	40	6p	100	25	6p
8	63	6p	100	40	6p
10	25	6p	100	63	12p
10	63	6p	150	4.3	6p
15	16	6p	150	16	6p
15	40	6p	150	25	16p
15	63	6p	150	40	10p
22	10	6p	150	63	12p
22	25	6p	220	4	6p
22	63	6p	220	10	6p
33	6.3	6p	220	16	6p
33	16	6p	220	25	10p
33	40	6p	220	40	12p
47	4	6p	220	63	12p
47	10	6p	330	4	6p
47	25	6p	330	10	6p
47	40	6p	330	16	10p
47	63	6p	330	63	22p

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DIN PLUGS	MAINS	RSS 8 way chassis socket	Std. 1" stereo plug
2 pin (1 flat) 8p	P850 3 pin 1.5A 8p	52p	Plastic 16p
3 pin 9p	9p chassis plug with 4 pin, 5 pin A line socket. Per (180°), 5 pin B pair (240°), 6 pin 10p	SA 2190 3 pin 5A chassis plug 17p	Screened 25p
DIN Sockets	McMURDO	SA 1862 Line socket for above	Open mono socket 1" 10p; Moulded mono socket 1" with 2 break contacts 13p; Moulded stereo socket 1" with 3 break contacts 18p; 3.5mm plug plastic 8p; screened 11p; open socket 6p.
2 pin 6p	RFS 8 way chassis plug 38p	JACK	
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12-0-12V 50mA	95p
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Pri. 200-220-240V, Sec. 12-15-20-24-30V 2A	£2.48
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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 88p.	Single gang with DP switch 250V 2A Log or Lin 5k to 2M as above 88p.
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Wirewound 10% 1W 1/2" spindles 10, 50, 100R 34p; 250, 500, 1k, 5k 33p; 10k, 37p; 25k 40p; 50k 44p.	

KNOBS

All 1" shaft. Grub screw fixing

Diameter shown in brackets

K30/1 (13mm) 24p	K30/3 (17mm) 22p	K30/2 (18mm) 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) 14p	

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Carbon Film 1/4W 5% 1Ω to 1M; 10% 1-2M to 10M E12	1p
Carbon Film 1/4W 5% 1Ω to 10G; 10% 1-2M to 10M E12	1p
Carbon Film 1/4W 5% 11Ω to 910k F12 & E24	1p
Carbon Film 1W 5% 10Ω to 10M E12 & E24	4p
Metal Oxide 1/4W 2% 10Ω to 1M E12 & E24	4p
Wirewound 1/4W 10% 0-22ohms to 0-47ohms E12 10p	
Wirewound 1/4W 5% 1ohm to 270ohms E12 10p	
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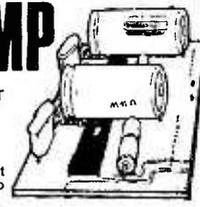
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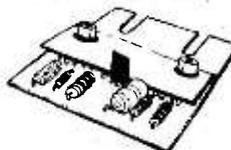
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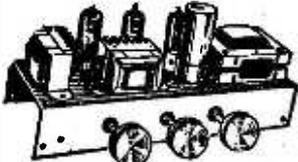
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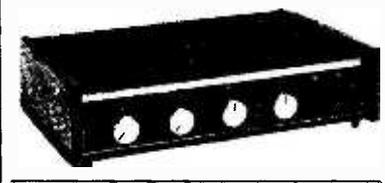
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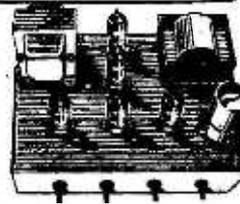
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AF126	15p	BFY45	25p	NKT135	35p	TIP31A	62p	2N708	12p	2N3366	85p
ASV28	30p	BFX88	30p	MKT222	25p	TIP32A	74p	2N708A	15p	2N3367	22p
ASZ21	35p	BFY10	35p	MKT401	25p	TIP33A	£1.05	2N708	15p	2N3905	25p
BA102	30p	BFY44	50p	MKT404	80p	TIP34A	£1.55	2N930	20p	2N4058	12p
BA112	60p	BFY50	25p	NKT773	25p	TIP35A	£2.05	2N1132	25p	2N4059	12p
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BA156	15p	BFY45	20p	OAS	20p	TIP41A	£1.75	2N1303	16p	2N4061	12p
BC107	10p	BFY5	10p	OA10	20p	TIP42	10p	2N1304	20p	2N4062	12p
BC108	10p	BFY9	60p	OA47	10p	TIP29B	58p	2N1305	20p	2N4226	17p
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BC148	12p	BSW6	75p	OA81	10p	TIP32B	82p	2N1308	25p	2N4288	15p
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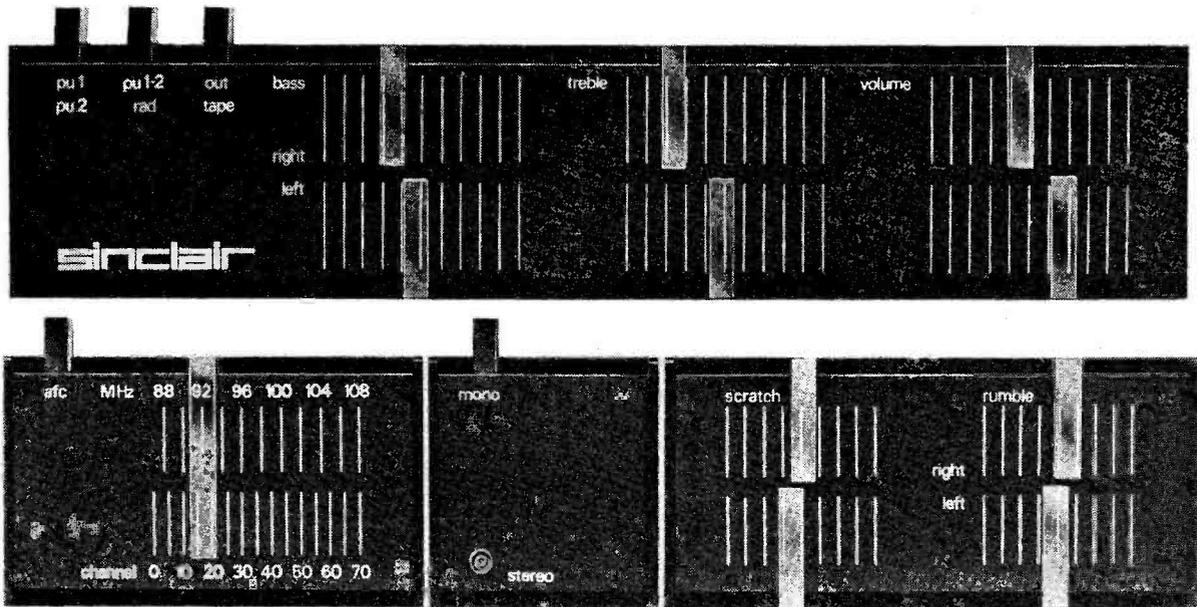
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	4 250 Polyester, Polycarbonate, Paper, etc., Condensers.
Solidev 15W Class B	5 25 Potentiometers, assorted
Audio Amp thick film	6 280 High-stab, 1%, 2%, 5% resistors.
Circuit £3.65.	

Sinclair Project 80

exciting



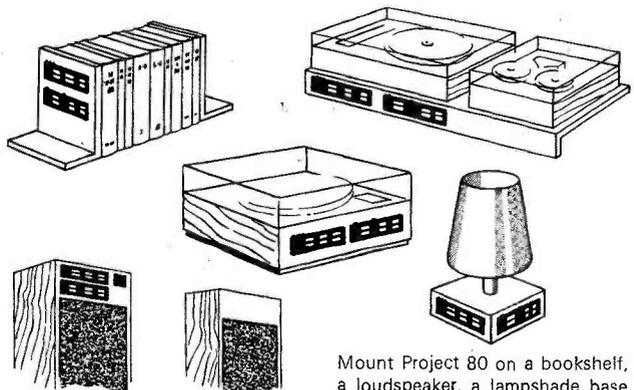
only $\frac{3}{4}$ " deep x 2" high

Living with hi-fi takes on new meaning with Sinclair Project 80. The electronics of these revolutionary new modules are all contained within elegantly designed matching cases no more than three-quarters of an inch deep. They are designed for mounting on any appropriate flat surface by means of 6BA bolts extending from the rear of each module and which pass through suitably drilled holes. Connections are taken away out of sight in a similar manner. The possibilities opened up by Project 80 are endless – superb hi-fi systems can be installed in ways hitherto only dreamed about and never before made practical. No more cutting out and shaping to put modules in position. A few holes drilled with the aid of templates supplied and the job is done. Now you need never again be faced with problems of keeping the hi-fi from clashing with carefully thought-out furnishing schemes. (That will surely please wives!) Slider controls have been introduced in place of knobs and all modules in the range incorporate new up-dated circuitry with emphasis on performance standards and built-in protection against overload and shorting. The aim was to re-think modular construction completely – to make it infinitely more versatile, even simpler and more reliable – the result – Project 80 – another triumph for Sinclair, and the most exciting construction modules ever.

the slimmest, most elegant hi-fi modules ever made

Typical Project 80 applications

System	The Units to use	Units cost
Simple battery record player	Z.40	£5.45 +54p V.A.T.
Mains powered record player	Z.40, PZ.5	£10.43 +£1.04 V.A.T.
30W. RMS continuous sine wave stereo amp.	2 x Z.40s, Stereo 80; PZ.6	£30.83 +£3.08 V.A.T.
50W (8 Ω) RMS continuous sine wave de luxe stereo amp.	2 x Z.60s, Stereo 80; PZ.8	£33.83 +£3.38 V.A.T.
Indoor P.A.	Z.60, PZ.8	£14.93 +£1.49 V.A.T.

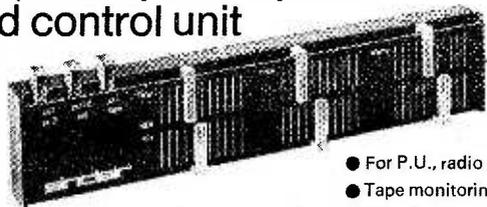


Mount Project 80 on a bookshelf, a loudspeaker, a lampshade base a false wall with two Q.16 loudspeakers ... almost anywhere.

Project 80 FM tuner, decoder, and A.F.U. may be added as required

new thinking in modular hi-fi

Stereo 80 pre-amplifier and control unit



- For P.U., radio and tape
- Tape monitoring switch
- Simplest ever fixing

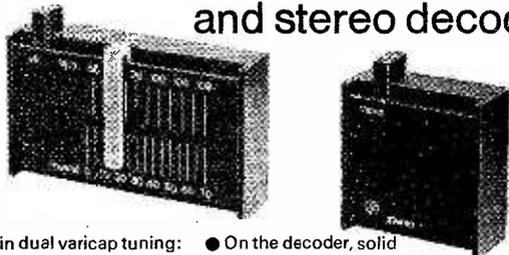
Each channel has its own separate tone and volume controls operated by sliders, enabling ideal environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry that ensures the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

TECHNICAL SPECIFICATIONS

Size - 260 x 50 x 20mm (10 1/4 x 2 x 3/4 ins)
 Finish - Black with white indicators and transparent sliders
 Inputs - Magnetic pick-up 3mV RIAA corrected; Ceramic pick-up 300mV
 Radio 300mV; Tape 30mV
 Signal/noise ratio - 60dB
 Frequency range - 20Hz to 15KHz \pm 1dB; 10Hz to 25KHz \pm 3dB
 Power requirements - 20 to 35 volts
 Outputs - 100mV \pm AB monitoring for tape
 Controls - Press button for tape radio and P.U. Sliders for volume, bass (+ 12dB to - 14dB at 100Hz) treble (+ 11dB to - 12dB at 10KHz)

R.R.P. **£11.95** +£1.19 V.A.T.

Project 80 FM tuner and stereo decoder



- Twin dual varicap tuning: 4 pole ceramic filter; switchable A.F.C.
- On the decoder, solid state stereo indicating beacon.

Making the Project 80 F.M. tuner and decoder available separately gives a wider choice of systems and saves money where stereo reception may not be required. The tuner is a triumph of electronic design and assures excellent performance. The decoder gives a 40dB channel separation with 150mV output per channel. Both units may be used with other than Project 80 systems.

TECHNICAL SPECIFICATIONS OF TUNER

Size - 85 x 50 x 20mm (3 1/4 x 2 x 3/4 ins)
 Tuning range - 87.5 to 108 MHz
 Detector - I.C. balanced coincidence for good A.M. rejection
 One I.C. equal to 26 transistors
 Distortion - 0.2% at 1 KHz for 30% modulation
 4 pole ceramic filter in I.F. section
 Aerial impedance - 75 Ω or 240-300 Ω
 Sensitivity - 4 microvolts for 30dB quieting
 Output - 300 mV for 30% modulation
 Power requirements - 23 to 33 volts

DECODER

Size - 47 x 50 x 20mm (1 7/8 x 2 x 3/4 ins)
 One 19 transistor I.C.

R.R.P. **£11.95** +£1.19 V.A.T.

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Sinclair Radjionics Ltd. London Road, St. Ives, Huntingdon PE17 4HJ

Z.40 & Z.60 power amplifiers totally short-circuit proof



Z.40



Z.60

Intended for use in Project 80 installations, these modules readily adapt to an even wider range of applications. Both incorporate built-in protection against short circuiting and risk of damage from mis-use is greatly reduced.

Z.40 TECHNICAL SPECIFICATIONS

Size - 55 x 80 x 20mm (2 1/4 x 3 1/4 x 3/4 ins) 9 transistors
 Input sensitivity - 100mV
 Output - 15 watts RMS continuous into 8 Ω (35V)
 Frequency response - 10Hz - 100KHz \pm 1dB
 Signal/noise ratio - 64dB
 Distortion - at 10 watts into 8 Ω less than 0.1%
 Power requirements - 72 to 35 volts

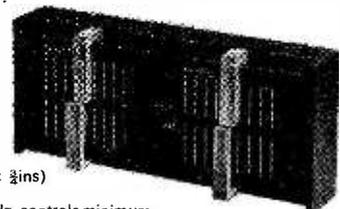
Z.60 TECHNICAL SPECIFICATIONS

Size - 55 x 98 x 15mm (2 1/4 x 3 7/8 x 3/4 ins) 12 transistors
 Input sensitivity - 100-250mV
 Output - 25 watts RMS continuous into 8 Ω (45V).
 Distortion - typically 0.03%
 Frequency response - 10Hz to more than 200KHz \pm 1dB
 Signal/noise ratio - better than 70dB
 Built-in protection against transient overload and short circuiting
 Load impedance - 4 Ω min; max. safe on open circuit

Z.40 R.R.P. **£5.45** + 0.54 V.A.T.; Z.60 R.R.P. **£6.95** + 0.69 V.A.T.

Project 80 active filter unit

Makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape. As with Stereo 80, separate controls applied to each channel make it easier to obtain ideal stereo balance.



TECHNICAL SPECIFICATIONS

Size - 108 x 50 x 20mm (4 1/4 x 2 x 3/4 ins)
 Voltage gain - minus 0.2dB
 Frequency response - 36Hz to 22KHz controls minimum
 Distortion - at 1 KHz - 0.03% using 30V supply
 HF cut off (scratch) - 22KHz to 5-5KHz, 12dB/oct. slope
 L.F. cut off (rumble) - 28dB at 20Hz, 9dB/oct. slope

- For scratch and rumble control
- Transistorised active circuitry

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PZ.8

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 Without mains transformer

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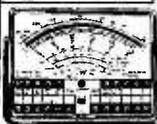
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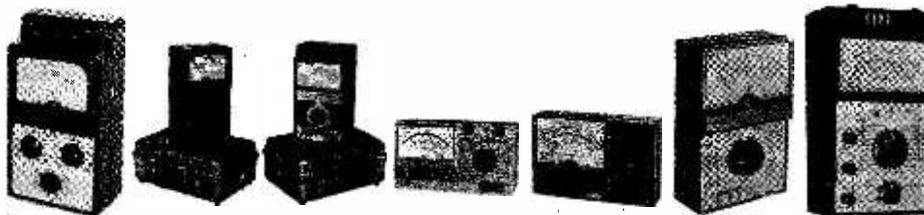
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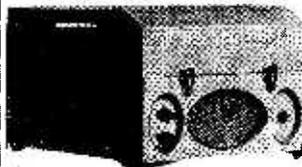
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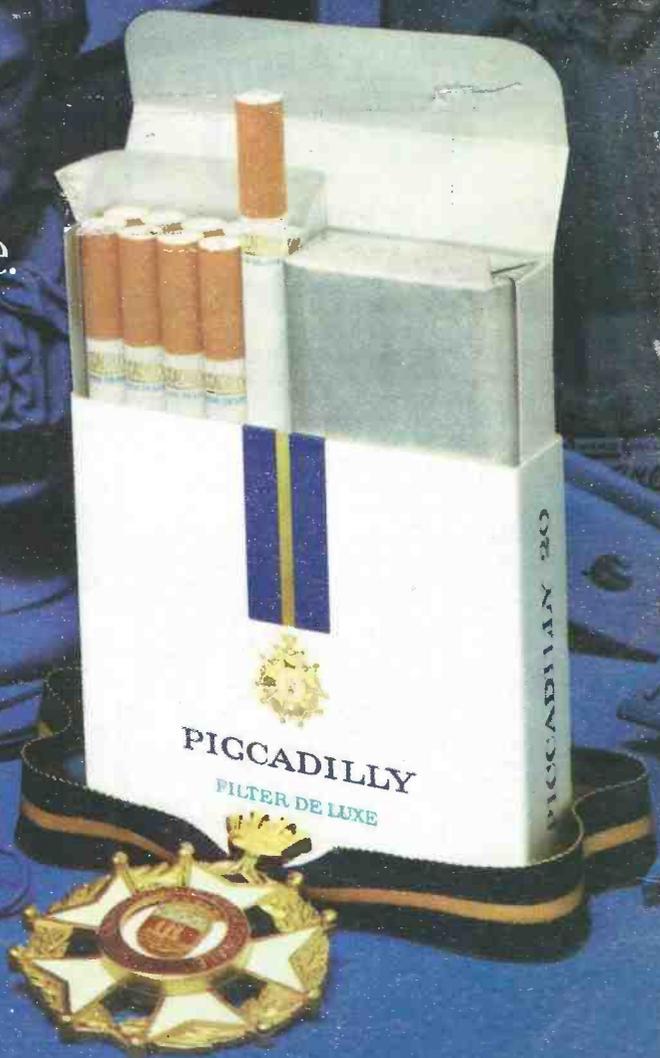
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