PRACTICAL WIRELESS

APRIL
1970

3/6

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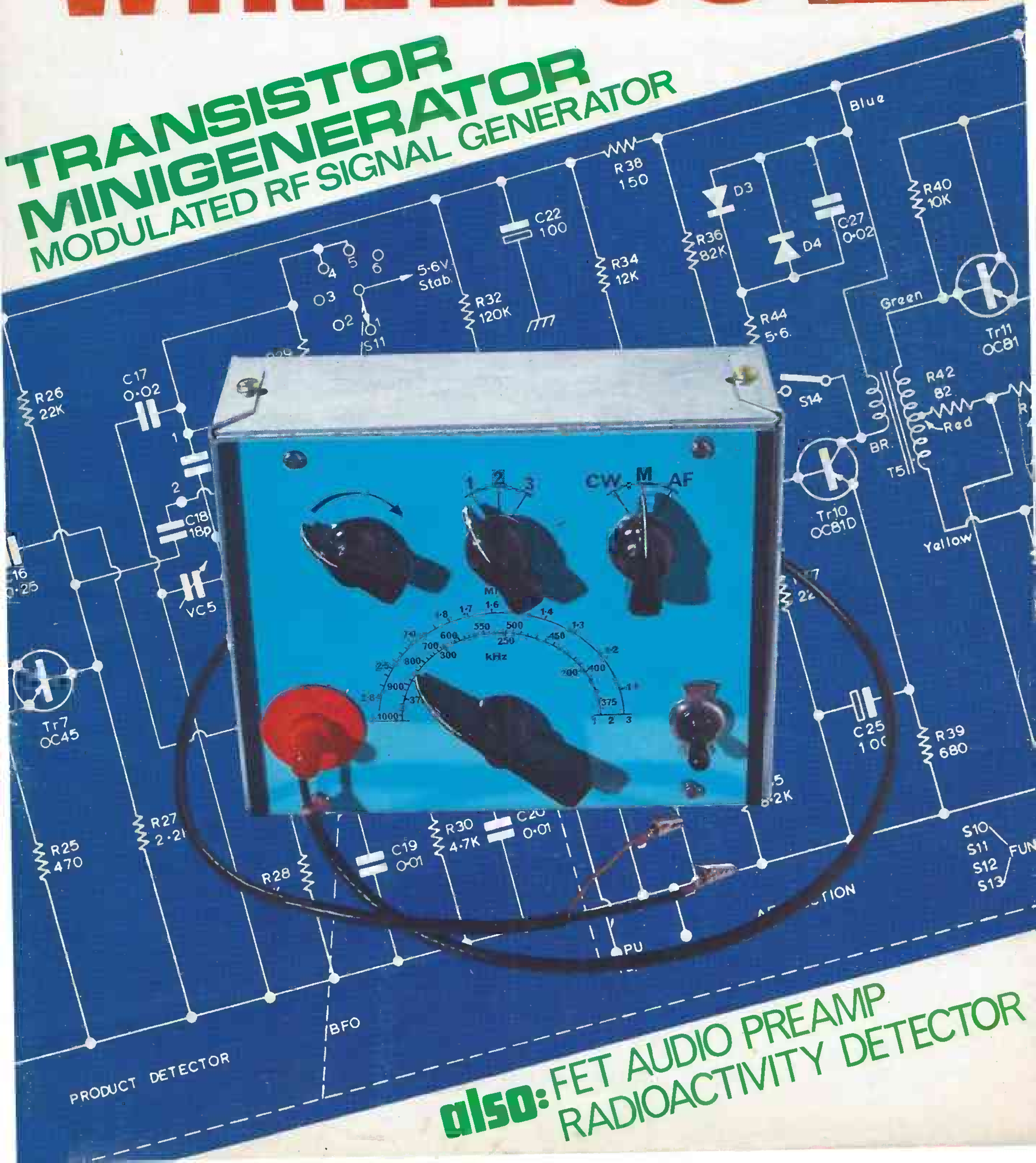
MODULATED RF SIGNAL GENERATOR



also: FET AUDIO PREAMP
RADIOACTIVITY DETECTOR

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12BE6	6/6
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12Q7GT	5/-
12SC7	5/-
12SG7	7/-
12SH7	5/-
12SJ7	5/-
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12SL7GT	8/-
12SN7GT	8/-
12SQ7	8/-
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35B5	13/-
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6939	42/-
7199	15/-
7360	36/-
7586	25/-
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CY31	7/-
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DK96	8/-
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DL92	7/-
DL93	4/-
DL94	8/-
DL95	8/-
DL96	7/9
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EBC41	10/6
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EBC90	5/-
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EC88	12/-
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EC93	9/6
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ECC81	6/6
ECC82	6/-
ECC83	6/-
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ECF80	7/-
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ECH81	5/9
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ECL81	8/6
ECL82	6/6
ECL83	12/6
ECL84	11/-
ECL85	10/6
ECL86	8/6
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EF40	10/-
EF41	12/6
EF42	14/-
EF55	13/-
EF80	5/-
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EF86	6/6
EF89	5/6
EF91	4/6
EF92	7/6
EF93	4/6
EF94	5/-
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EF97	10/-
EF183	6/6
EF184	7/-
EF800	20/-
EF804	20/-
EF811	15/-
EF812	15/6
EF814	13/6
EK90	5/-
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EL36	9/6
EL38	27/6
EL41	11/-

EL42	11/6
EL81	10/-
EL83	8/3
EL84	5/-
EL85	8/6
EL86	8/6
EL90	6/6
EL91	5/-
EL95	7/-
EL360	23/-
EL803	17/-
EL821	11/-
EL822	18/-
ELL80	15/-
EM34	16/-
EM71	12/6
EM80	8/-
EM81	8/6
EM84	7/6
EM87	11/-
EN91	6/6
EY51	8/-
EY80	9/-
EY81	8/-
EY83	11/-
EY84	10/-
EY86	8/-
EY87	8/6
EY88	8/6
EZ35	5/6
EZ40	9/-
EZ41	9/-
EZ80	5/6
EZ81	5/6
EZ90	5/-
GY501	16/-
GZ30	7/6
GZ31	6/-
GZ32	9/6
GZ33	16/-
GZ34	11/-
HABC80	8/6
HBC90	5/-
HBC91	6/-
HF93	6/6
HF94	5/6
HK90	6/6
HL92	7/-
HL94	8/-
KT66	27/6
KT88	33/-

N78	21/-
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PC86	11/6
PC88	13/-
PC97	8/6
PC900	9/6
PCC84	7/-
PCC85	8/-
PCC88	12/-
PCC89	10/6
PCC189	11/-
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PCC806	17/-
PCE800	15/-
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PCF82	6/9
PCF84	9/-
PCF87	16/-
PCF800	15/-
PCF801	10/-
PCF802	10/-
PCF805	15/-
PCF806	13/-
PCF808	15/6
PCH200	14/-
PCL81	10/-
PCL82	7/9
PCL83	13/-
PCL84	8/9
PCL85	9/6
PCL86	9/6
PCL88	17/-
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PEN46	7/6
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PF86	11/-
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PL36	11/-
PL81	9/6

PL82	9/-
PL83	8/-
PL84	7/-
PL302	15/-
PL500	15/-
PL504	16/-
PL508	17/6
PL509	30/-
PL801	16/-
PL802	14/-
PM84	9/-
PY31	5/-
PY32	11/-
PY33	12/6
PY80	6/6
PY81	6/-
PY82	6/-
PY83	7/6
PY88	8/-
PY500	20/-
PY800	10/-
PY801	10/-
PZ30	7/-
QQVO2-6	42/-
QQVO3-10	25/-
QVO3-12	13/-
SU2150A	15/-
TT21	48/-
TT22	50/-
U18/20	13/6
U20	13/6
U25	15/-
U26	15/-
U31	9/-
U37	30/-
U50	6/-
U52	6/-
U76	5/-
U78	5/-
U191	15/-
U201	7/-
U281	8/-
U282	8/-
U301	11/6
U403	10/-
U404	7/6
U801	20/-

UABC80	6/9
UAF41	10/-
UAF42	10/6
UB41	11/-
UBC41	9/6
UBC81	8/-
UBF80	7/3
UBF89	7/-
UBL1	10/-
UBL21	12/-
UC92	6/6
UCC85	8/-
UCF80	10/6
UCH21	11/-
UCH42	13/-
UCH43	12/-
UCH81	6/6
UCL81	11/-
UCL82	7/-
UCL83	12/-
UF9	11/-
UF11	10/-
UF41	10/-
UF42	12/-
UF43	11/-
UF80	7/6
UF85	8/-
UF89	7/-
UL41	12/-
UL84	6/6
UM4	8/-
UM84	4/-
UY1N	10/-
UY11	11/-
UY21	11/-
UY41	8/-
UY82	10/-
UY85	6/6
VR75/30	9/-
VR105/30	7/-
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VU39A	10/-
VU111	10/-
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Z309	10/-
Z329	17/-
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TRANSISTORS

2N404	3/6
2N410	3/6
2N412	3/6
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2N696	4/6
2N697	4/6
2N698	8/6
2N705	15/-
2N706	3/-
2N708	3/6
2N753	4/9
2N929	6/-
2N930	6/8
2N987	6/6
2N1131	8/6
2N1132	9/6
2N1184	25/-
2N1301	7/-
2N1302	7/-
2N1304	4/6
2N1305	4/6
2N1306	5/-
2N1307	6/-
2N1308	7/6
2N1309	9/6
2N1711	6/-
2N1756	15/-
2N2147	14/9
2N2160	23/-
2N2217	6/6
2N2218	7/9
2N2219	8/6
2N2369	4/6
2N2477	12/6
2N2646	12/6
2N2905	10/-
2N2923	3/-
2N2924	3/-
2N2926'b'	3/-
2N2926'r'	3/-
2N2926'o'	3/-
2N2926'y'	3/-
2N2926'g'	5/6
2N3053	6/3
2N3055	15/-
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2N3134	8/6
2N3391	4/-
2N3392	3/2
2N3393	2/6
2N3394	2/6
2N3395	3/6
2N3402	5/-
2N3403	5/-
2N3404	6/6
2N3414	4/-
2N3415	4/3
2N3416	4/6
2N3417	5/2
2N3702	4/6
2N3703	3/10
2N3704	5/6
2N3707	4/-

2N3709	3/5
2N3710	3/-
2N3819	12/-
2N3906	6/-
AC113	3/-
AC125	6/6
AC126	5/-
AC127	5/6
AC128	4/6
AC132	7/6
AC153	5/-
AC154	3/-
AC157	4/-
AC169	2/-
AC176	6/9
ACY17	6/-
ACY18	4/-
ACY19	4/9
ACY20	4/-
ACY21	3/11
ACY22	2/8
AD140	16/-
AD149	12/6
AD161	9/-
AD162	9/-
AF102	15/6
AF114	6/-
AF115	6/-
AF116	5/6
AF117	4/6
AF118	10/-
AF125	6/-
AF126	5/3
AF127	5/3
AF178	12/6
AF186	11/-
AF239	10/-
AFY19	22/6
AFZ11	9/-
ASY26	6/-
ASY27	6/6
ASY28	6/6
ASY29	6/-
ASY54	6/-
ASY73	10/-
ASY74	16/-
ASY77	7/-
ASY82	4/-
ASY86	4/6
ASZ16	14/9
ASZ17	15/-
ASZ18	15/-
ASZ21	8/9
BC107	3/-
BC108	3/-
BC109	4/-
BC118	8/6
BC147	4/6
BC148	3/3
BC149	3/6
BC152	3/2
BC175	5/6

BCY30	7/-
BCY31	5/-
BCY33	5/-
BCY34	5/-
BCY39	5/-
BCY72	3/10
BCZ11	7/6
BD121	18/-
BD123	25/-
BF167	5/-
BF173	6/-
BF184	7/6
BF194	3/6
BF195	3/-
BFX88	5/4
BFY17	8/6
BFY18	5/-
BFY19	5/-
BFY50	5/-
BFY51	4/6
BFY52	4/10
BSY26	5/-
BSY27	5/6
BSY28	5/-
BSY65	4/6
BSY95A	3/9
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OC22	13/-
OC23	12/6
OC24	15/-
OC25	7/6
OC26	6/-
OC28	14/6
OC29	14/9
OC30	15/-
OC35	11/3
OC36	12/6
OC42	6/6
OC44	4/-
OC45	3/6
OC71	3/6
OC72	5/-
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OC75	5/-
OC76	5/-
OC78	5/-
OC78D	3/3
OC81	4/6
OC81D	3/-
OC83	4/6
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OC139	7/6
OC140	9/6
OC170	5/-
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OC203	6/3
OC204	6/-
OC205	13/-
OC206	14/-

SILICON POWER RECTIFIERS

WIRE ENDED

1N2071	600p.i.v.	700mA	4/-
1N5399	1000p.i.v.	1·5A	4/6
1N5408	1000p.i.v.	3A	6/3
1S113	400p.i.v.	400mA	4/6
1S115	600p.i.v.	400mA	7/6
BY127	600p.i.v.	1A	3/6
BY130 equivalent (Y1928)	450p.i.v.	800mA	1/6
D226B	400p.i.v.	300mA	2/9
D226V	300p.i.v.	300mA	2/6

STUD MOUNTED—Supplied with Washers and Nuts

D242	100p.i.v.	10A	6/-
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KD202B	50p.i.v.	1A	3/-
KD202D	200p.i.v.	3A	6/-
KD202E	200p.i.v.	1A	3/6
KD202G	100p.i.v.	1A	3/3
KD202I	300p.i.v.	1A	3/8
KD202V	100p.i.v.	3A	5/-

MULTIMETERS

TYPE MF16

D.C. voltage range:
0-0·5-10-50-250-500V
A.C. voltage range:
0-10-50-250-500V.
D.C. current range:
500μ-10-100mA.
Resistance ranges: 100MΩ-1MΩ. The meter is also calibrated for capacity and output level measurements. Sensitivity 2000Ω V. Accuracy ±2·5% for D.C. and ±4% for A.C. measurements.
Dimensions: 4½ × 3¼ × 1⅜in. Price £4.5.0.

Type 100-IT: 24 range precision portable meter, 5000 o.p.v. D.C. Volts: 2·5-10-50-250-500-2500V. A.C. Volts: 10-50-100-250-500-2500V; D.C. current 0·5-5-50-500mA. Resistance 2000-20,000 ohms; 2-20 megohms. Power output calibration in A.C. for 600 ohms line. Complete with prods and batteries, £6.5.0. P. & P. 5/-.

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INTEGRATED CIRCUIT AMPLIFIERS

CA3005 RF Amplifier with 100mc/s bandwidth. Max. dissipation 26mW. For use as RF amplifier, balanced mixer, product detector or self-oscillating mixer 27/-

CA3012 wide Band Amplifier (up to 20mc/s), suitable as IF Amplifier for VHF/FM receivers 22/-

CA3020 General Purpose Audio Amplifier of 550mW output 30/-

CA3036 Buffer amplifier consisting of two 'super-alpha' pair of transistors suitable for stereo pick-up systems 19/-

The above four I.C's are in TO5 encapsulation.

PA222 Audio Amplifier providing a max. output of 1·2 watts 65/-

PA234 Audio Amplifier providing a max. output of 1 watt 27/6

PA237 2 watts Audio Amplifier 40/-

The above three I.C's are in epoxy moulded double four-in-line package.

MC1709CG General Purpose operational amplifier in TO-99 case 40/-

TAA263 3-stage direct coupled amplifier for use from DC to 600kc/s: 70mW dissipation. Output 10mW into 150Ω load 15/-

TAA293 3-stage amplifier with connection brought out to the individual leads. Bandwidth 600kc/s. 160mW dissipation. Output 10mW into 150Ω load 20/-

TAA320 MOST input stage followed by a bi-polar transistor stage. 200mW dissipation 13/-

TAD100 Integrated AM receiver circuit containing *all* active components, except output stage, required to build a complete receiver 45/-

SL403A 3 watts Audio Amplifier into 7·5Ω Loudspeaker. Operating voltage 18V. Overvoltage protection 49/6

Data sheets are available for all the above I.C's.

Please note that certain external components like resistors, capacitors, etc. are required to build complete amplifiers. Circuit details are supplied free of charge with amplifiers, but are charged at 1/- each if supplied separately.

MOVING COIL METERS

MODERN RECTANGULAR FACE MOVING COIL METERS TYPE 101. 4in. × 4⅜in. face.

101DA 40AMPS FSD. Basic movement 1mA. Supplied complete with external shunt	74/-
101DV, 600V FSD. Basic movement 1mA	77/-
120DA, 40 microamps	82/-
120DA, 250 microamps	65/-
120DA, 10 Amps, with internal shunt	60/-

The Premier Stereo System "ONE" consists of an all transistor stereo amplifier. Garrard 2025 T/C auto manual record player unit fitted stereo mono cartridge and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 10 transistor amplifier has an output of 5 watts per channel with inputs for pick-up, tape and tuner also tape output socket. Controls: Bass, Treble, Volume, Balance, Selector. Power on off, stereo mono switch. Brushed aluminium front panel. Black metal case with teakwood ends: Size 12 × 5½ × 3½in. high (Amplifier available separately if required £14.19.6. Carr. 7/6.)

SPECIAL OFFER CARTRIDGES

SHURE

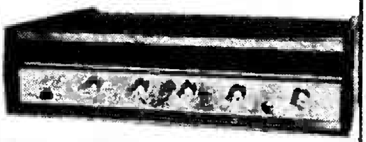
	List Price	Premier Price
M3D	£8.10.6	£6.19.6
M44-5	£14.9.1	£10.10.0
M44C	£12.19.5	£9.9.0
M44E	£17.8.4	£13.19.6
M55E	£20.16.1	£15.15.0
M75-6	£17.8.4	£13.19.6
M75E	£25.18.10	£21.0.0

AUDIO TECHNICA

A.T.33.7 stereo	£10.14.3	£7.19.6
A.T.7S stereo	£22. 0.0	£15. 0.0
A.T.7X elliptical	£25. 0.0	£18. 0.0

Post and Packing 1/6 each

"NOVA" 505 TRANSISTOR STEREO AMPLIFIER



A superb stereo amplifier offering every facility for the hi-fi enthusiast. Output 5 watts per channel. Frequency response 40-20,000 Hz ± 3dB. Inputs for radio, P.U. Ceramic, P.U. Magnetic Tape. Separate bass and treble controls, Volume and Balance controls, Mono Stereo Switch. Also features headphone socket and tape output. Teak case with attractive illuminated front panel. Size 14½ × 9½ × 3½in. A.C. 200/250V.

WONDERFUL VALUE AT ONLY **18 Gns.** Carr. 10/-.

PICK-UP CARTRIDGES
AT MONEY SAVING PRICES!

GOLDRING G800 (Stereo)	£8.19.6
SONOTONE 9TAHCD (Stereo)	£2.15.0
ACOS GP91 1SC (Mono compatible)	£1.13.5
ACOS GP93-1 (Stereo)	£2. 8.7
ACOS GP94 (Stereo)	£2.14.8
B S R X3M (Mono compatible)	£1.16.5
B S R X3H (Mono compatible)	£1.16.5
RONETTE 105 (Stereo)	£1.15.0
RONETTE 106 (Stereo)	£1.15.0

All complete with mounting brackets and instructions. Post and Packing 1/6 each.

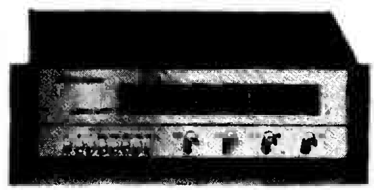
WIDE RANGE OF HI-FI STEREO EQUIPMENT ON DEMONSTRATION

All leading makes available including Rogers, Armstrong, Dulci, Wharfedale, Goodmans, Goldring, Shure, etc., etc.

PREMIER STEREO SYSTEM "TWO"

As system 'ONE' above but with Garrard SP25 Carriage 35/- **45 Gns.**

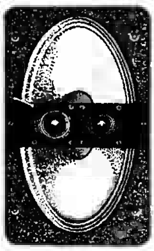
ALBA UA100D ALL TRANSISTOR STEREO TUNER AMPLIFIER



Covers Long, Medium and Short Waves plus VHF/FM with built in stereo decoder and A.F.C. Output 15 watts r.m.s. per channel into 8 ohms (distortion less than 0·3%). Response 20Hz–20kHz. Inputs for Magnetic and ceramic p.u. and Tape. Tape outlet socket. Tuning, Volume, Bass, Treble and Balance controls. Push button selector. Black leatherette top, teak ends and brushed aluminium front panel.

PREMIER PRICE **£67.11.6** Carriage 12/6.

E.M.I. 13 × 8in. HI-FI SPEAKERS



Fitted two 2½in. tweeters and crossover network. Impedance 3 and 15 ohms. Handling capacity 10 watts. Brand new.

99/6 P. & P. 7/6

Also available without tweeters

49/6 P. & P. 7/6

PREMIER STEREO SYSTEM "THREE"

Nova 505 Amplifier (as above), £18.18.0; Garrard SP25, £11.19.6; Sonotone 9TAHCD, £2.15.0; Teak base and cover, £5.10.0; Pair of 3-Unit Hi-Fi Enclosures fitted E.M.I. Speakers, £26.5.0. Total cost if purchased separately, £65.7.6.

PREMIER PRICE **55 Gns.** Carriage 35/-.

VERITAS V-149 MIXER

Battery operated 4-channel audio mixer providing four separate inputs. Size 6 × 3 × 2in. suitable for crystal microphone, low impedance microphone with transformer, radio, tape, etc. Max. input 1·5v. Max. output 2·5v. Gain 6 dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.

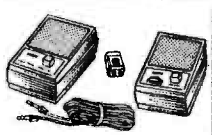
MONO MODEL **59/6** STEREO MODEL **69/6** P. & P. 2/6.

SANYO M48M Cassette Tape Recorder

A truly compact lightweight recorder size 8 × 4½ × 2½in. 5 transistors and 1 diode. AC Bias. 2½in. speaker. Record level indicator. Earphone socket. Complete with carrying strap, remote control microphone with pouch and tape cassette. Output 300mW. Operates on 4 U11 batteries.

PRICE **£21** P. & P. 7/6

TWO STATION TRANSISTOR INTERCOMS.



Complete with battery and 50ft. connecting wire. Compact size, two way call system. Ideal for home, office, factory, etc.

65/- P. & P. 4/-.

VERITAS V-313 TAPE HEAD DEFLUXER

A must for all tape users! Tape heads become permanently magnetized with constant use: this leads to background noise that prevents perfect recordings. Simply applied to recording head the V313 leaves head free of magnetism. Cleans any tape head in seconds.

34/6 P. & P. 1/6.

TAPE CASSETTES

C60 (60 min.) **7/6** THREE FOR 21/-

C90 (90 min.) **12/6** THREE FOR 36/-

C120 (120 min.) **17/6** THREE FOR 51/-

P. & P. 1/-.

CASSETTE HEAD CLEANER

Removes unwanted deposits from delicate tape heads. Fits all cassette recorders.

11/6 P. & P. 1/-.

"VERITONE" RECORDING TAPE

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

LP3	3"	250'	P.V.C.	5/6	LP6	5¾"	1200'	P.V.C.	12/6
TT3	3"	450'	POLYESTER	7/6	DT6	5¾"	1800'	POLYESTER	22/6
DT3	3½"	600'	POLYESTER	11/6	TT6	5¾"	2400'	POLYESTER	37/6
SP5	5"	600'	P.V.C.	8/6	SP7	7"	1200'	P.V.C.	12/6
LP5	5"	900'	P.V.C.	10/–	DT7	7"	2400'	POLYESTER	25/–
DT5	5"	1200'	POLYESTER	15/–	TT7	7"	3600'	POLYESTER	50/–

TAPE SPOOLS 3" 1/-, 5", 5¾", 7" 1/9, TAPE CASES 5", 7" 2/6.
Post and Packing 3" 1/-, 5", 5¾", 1/6, 7" 2/-. (3 reels and over Post Free).

PREMIER RADIO

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

TRANSISTOR RADIOS TO BUILD YOURSELF

Backed by after sales service

NEW! roamer eight mkI

WITH VARIABLE TONE CONTROL

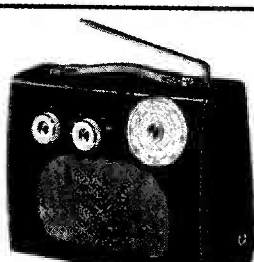
7 Tunable Wavebands: Medium Wave 1, Medium Wave 2, Long Wave, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for Medium and Long Waves. Five section 22in. chrome plated Telescopic aerial for Short Waves can be angled and rotated for maximum performance. Push pull output using 600 mW transistors. Socket for car aerial. Tape record socket. Selectivity switch. Switched earpiece socket complete with earpiece for private listening. Eight transistors plus 3 diodes. Famous make 7in. x 4in. Speaker. Air spaced ganged tuning condenser. On/Off switch volume control. Wave change switch and tuning control. Attractive case in rich chestnut shade with gold blocking. Size 9 x 7 x 4in. approx. Easy to follow instructions and diagrams make the Roamer Eight a pleasure to build.

Total Building Costs **£6.19.6**

P & P 7/6.

Parts Price List and Easy Build Plans 5/- (FREE with parts).

roamer seven mkIV



SEVEN FULLY TUNABLE WAVEBANDS—MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for Medium and Long Waves. Five Section 22in. chrome plated telescopic aerial for Short Waves—can be angled and rotated for peak S.W. listening. Socket for Car Aerial. Powerful push-pull output. Seven transistors and two diodes including Micro-Alloy R.F. Transistors. Famous make 7 × 4in. P.M. speaker. Air spaced ganged tuning condenser. Volume/on/off control, wave change switches and tuning control. Attractive case with carrying handle. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build. Parts price list and easy build plans 3/- (FREE with parts). Personal Earpiece with switched socket for private listening, 5/- extra.

Total building costs **£5.19.6** P. & P. 7/6

NEW! trans eight

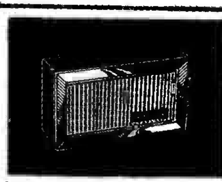
SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case in black with red grille and cream knobs and dial with polished brass inserts. Size 9 x 5½ x 2¾in. approx. Tunable on Medium and Long Waves, three Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. Eight improved type transistors plus 3 diodes. Push pull output. Ample power to drive a larger speaker. Parts price list and easy build plans 5/- (FREE with parts). Earpiece with switched socket for private listening 5/- extra.

Total building costs **89/6**
P & P 5/6

pocket five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER AND EARPIECE

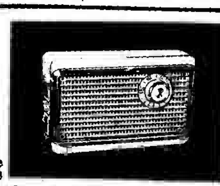


Attractive black and gold case. Size 5½ x 1½ x 3½in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker, also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

Total building costs **44/6** P. & P. 3/6

transona five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER AND EARPIECE

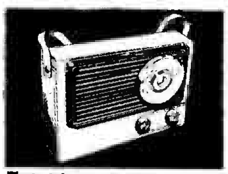


Attractive case with red speaker grille. Size 6½ x 4½ x 1½in. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

Total building costs **47/6** P. & P. 3/9

roamer six

SIX WAVEBAND PORTABLE WITH 3in. SPEAKER



Attractive case with gilt fittings. Size 7½ x 5½ x 1½in. Tunable on Medium and Long waves, two short waves, Trawler Band Plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and telescopic aerial for Short waves. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors etc. (Carrying strap 1/6 extra). Easy build plans and parts price list 2/-. (FREE with parts).

Total building costs **79/6** P. & P. 4/6

* *Callers side entrance Stylo Shoe Shop*

* *Open 10-1, 2.30-4.30 Mon-Fri. 9-12 Sat*

RADIO EXCHANGE CO

61 HIGH STREET, BEDFORD. Tel. 0234 52367

I enclose £.................. please send items marked

ROAMER EIGHT	☐	ROAMER SEVEN	☐
TRANSONA FIVE	☐	TRANS EIGHT	☐
POCKET FIVE	☐	ROAMER SIX	☐

Parts price list and plans for ....

Name ....

Address ....

....

PW.16

Complete stereo system – £29-10

The new Duo general-purpose 2-way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally.
Type 1 SPECIFICATION:–
Impedance 10 ohms. It incorporates Goodmans high flux 6″ × 4″ speaker and $2\frac{1}{4}$″ tweeter. Teak finish 12″ × $6\frac{3}{4}$″ × $5\frac{3}{4}$″. **4 guineas** each. 7/6d. p. & p.
Type 2 as type 1. Size $17\frac{1}{2}$″ × $10\frac{3}{4}$″ × $6\frac{3}{4}$″. Incorporating $10\frac{1}{2}$″ × $6\frac{1}{4}$″ bass unit and $2\frac{1}{4}$″ tweeter 3 ohms impedance **£6-6-0** plus 15/- p. & p.

Garrard Changers from £7.19.6d. p. & p. 7/6d.
Cover and Teak finish Plinth £4.15.0d. 7/6d. p. & p.

The items illustrated can be purchased together for £29-10.

The Duetto is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more.
SPECIFICATION:–
R.M.S. power output: 3 watts per channel into 10 ohms speakers.
INPUT SENSITIVITY: Suitable for medium or high output crystal cartridges and tuners. Cross-talk better than 30dB at 1Kc/s.
CONTROLS. 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control.
TONE CONTROL: Treble lift and cut. Separate on/off switch. A preset balance control.

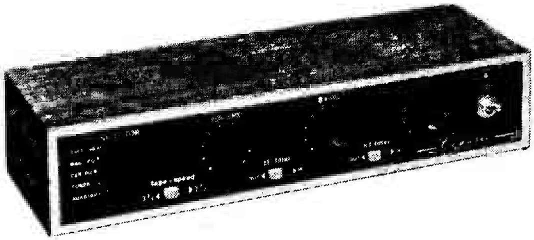
Duetto Integrated Transistor Stereo Amplifier **£9-10** plus 7/6d. p. & p.

The above 5 items can be purchased together for £29.10 + £1.10.0 p. & p.

The Classic **£9** plus 7/6 p. & p.

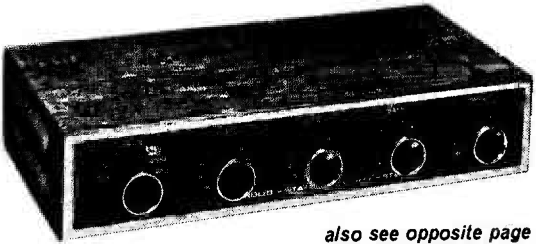
Controls: Selector switch Tape speed equalisation switch ($3\frac{3}{4}$ and $7\frac{1}{2}$ i.p.s.). Volume. Treble. Bass. 2 position scratch filter and 2 position rumble filter.

Specification: Sensitivities for 10 watt output at 1KHz into 3 ohms. *Tape head:* 3mV (at $3\frac{3}{4}$ i.p.s.). *Mag.P.U.:* 2mV. *Cer.P.U.:* 80 mV. *Tuner:* 100mV. *Aux.:* 100mV. *Tape/Rec.output:* Equalisation for each input is correct to within ±2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone control range:* Bass ±13dB at 60Hz. Treble ±14dB at 15KHz. *Total distortion:* (for 10 watt output) <1·5%. *Signal noise:* <—60dB. A.C. mains 200–250v. Built and tested. Size $12\frac{1}{2}$in. long, $4\frac{1}{2}$in. deep, $2\frac{3}{4}$in. high. Teak finished case.



The Viscount **£14.5** plus 7/6 p. & p.

Integrated High Fidelity Transistor Stereo Amplifier. Specification—Output: 10 watts per channel into 3 to 4 ohms speakers (20 watts monaural). Input: 6 position rotary selector switch (3 pos. mono and 3 pos. stereo), P.U., Tuner, Tape and Tape Rec. out. Sensitivities: All inputs 100mV into 1·8M ohm. Frequency Response: 40Hz–20KHz ±2dB. Tone Controls: Separate bass and treble controls; treble, 13dB lift and cut (at 15KHz); Bass, 15dB lift and 25dB cut (at 60Hz). Volume Controls: Separate for each channel. A.C. Mains Input: 200–240V. 50–60Hz. Size, $12\frac{1}{2}$″ x 6″ x $2\frac{3}{4}$″ in teak finished case. Built and tested.
VISCOUNT MARK II for use with magnetic pick-ups specification as above. Fully equalised for magnetic pick-ups. Suitable for cartridges with minimum output of 4mV/cm/sec. at 1kc. Input impedance 47k. **£15.15** plus 7/6 p. & p.



also see opposite page

RADIO & TV COMPONENTS
R-TV
(ACTON) LIMITED

SPECIAL OFFER!

Complete stereo system comprising BALFOUR 4-speed autoplayer with stereo head, 2 Duo speaker systems, size 12in. x $6\frac{3}{4}$in. x $5\frac{3}{4}$in. Plinth (less cover) and the DUETTO stereo amplifier. All above items

£25 plus £2 p. & p.

NEW COMPLETE HI-FI STEREO SYSTEM - £41

comprising SP 25 Garrard Mk II with diamond cartridge, or 2025 TC, Viscount Mk I amplifier, two type 2 speakers, plinth and cover

£41 plus £2-10-0 p. & p.

Circuit 2/6
FREE WITH PARTS.

The ELEGANT SEVEN
Mk. III (350mW Output)

7 transistor fully tunable M.W.–L.W. superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction.
MAINS POWER PACK KIT: 9/6 extra.

Price **£4.9.6** plus 7/6 P. & P.

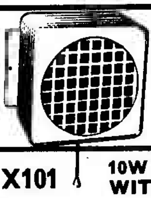
The DORSET
(600mW Output)

7-transistor fully tunable M.W.–L.W. superhet portable—with baby alarm facility. Set of parts. The latest modulised and pre-alignment techniques makes this simple to build. Sizes: 12 × 8 × 3in.

Price **£5.5.0** plus 7/6 P. & P.

MAINS POWER PACK KIT: 9/6 extra

Circuit 2/6
FREE WITH PARTS.



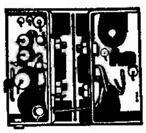
EXTRACTOR FAN

A.C. mains 230/250v. complete with pull switch. Size: 6 × 6 × 4in.

Price **27/6** plus 7/6 P. & P.

X101 10W SOLID-STATE HI-FI AMP WITH INTEGRAL PRE-AMP

Specifications: *Power Output* (into 3 ohms speaker) 10 watts. *Sensitivity* (for rated output): 1mV into 3K ohms (0.33 microamp).
Total Distortion at 1KHz at 5 watts, 0.35%, at rated output 1.5%.
Frequency Response: Minus 3dB points 20Hz and 40KHz.
Speaker: 3-4 ohms (3-15 ohms may be used).
Supply voltage: 24V. DC. at 800mA (6-24V. may be used).



Price **69/6** plus 2/6 P. & P.

Control assembly: including resistors and capacitors. 1. Volume: PRICE 5/-, 2. Treble: PRICE 5/-, 3. Comprehensive bass and treble: PRICE 10/- The above 3 items can be purchased for use with the X101.

Power Supplies for the X101:
P101 M (for mono) 35/- plus 4/6 p. & p.
P101 S (for stereo) 42/6 plus 4/6 p. & p.

CAR TRANSISTOR IGNITION SYSTEM
by famous manufacturer

For 6 volt or 12 volt positive earth systems. Comprising: special high voltage working hermetically sealed silicon transistor mounted in finned heat-sink, high output ignition coil, ballast resistor and hardwear (screws, washers, etc.).

Price **£4.19.6** plus 5/- P. & P.

50 WATT AMPLIFIER
A.C. Mains 200-250V

Price **£28.10** plus 20/- p. & p.

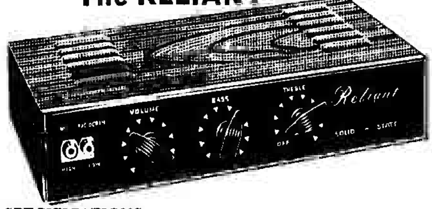
An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money.
TECHNICAL SPECIFICATIONS
3 electronically mixed channels, with 2 inputs per channel, enables the use of 6 separate instruments at the same time. The volume controls for each channel are located directly above the corresponding input sockets. SENSITIVITIES AND INPUT IMPEDANCES. Channels 1 & 2 4mV at 470K. These 2 channels (4 inputs) are suitable for microphone or guitars. Channels 3 & 4 300mV at 1m. Suitable for most high output instruments (gram, tuner, organ, etc.). Input sensitivity relative to 10w output. TONE CONTROLS ARE COMMON TO ALL INPUTS. **Bass Boost** +12dB at 60Hz. **Bass Cut** —13dB at 60 Hz. **Treble Boost** +11dB at 15 KHz. **Treble Cut** —12dB at 15 KHz. With bass and treble controls central —3dB points are 30 Hz and 20 KHz. POWER OUTPUT: For speech and music 50 watts rms. 100 watts peak. For sustained music 45 watts rms. 90 watts peak. For sinc wave 38.5 watts rms. Nearly 80 watts peak. Total distortion at rated output 3.2% at 1KHz. Total distortion at 20 watts 0.15% at 1KHz. Output to match into 8 or 15 ohms speaker system. NEGATIVE FEEDBACK 20dB at 1KHz. SIGNAL TO NOISE RATIO 60dB. MAINS VOLTAGES adjustable from 200–250V. A.C. 50–60 Hz. A protective fuse is located at the rear of unit. Output impedance 3, 8 and 15 ohms.

B.S.R. TD-2 TAPE DECK

Takes 5¾in. spools, fitted with B.S.R. ½ Track Heads. Size 13½in. long by 8¾in. wide.

Price **£8.19.6** plus 7/6 P. & P.

The RELIANT
SOLID STATE GENERAL PURPOSE AMPLIFIER



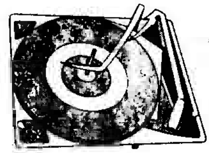
SPECIFICATIONS
Output—10 watts
Output Impedance—3 to 4 ohms
Inputs—1. -xtal mic 10mV
2. -gram/radio 250mV
Tone Controls—Treble control range ±12dB at 10 KHz.
Bass control range ±13dB at 100Hz
Frequency Response—(with tone controls central) Minus 3dB points at 20Hz and 40KHz. Signal to Noise Ratio—better than —60dB. Transistors—4 silicon Planar type and 3 Germanium type. Mains input—220/250V. A.C. Size of chassis—10½" × 4¼" × 2¼". For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Separate bass and treble lift control. Two inputs with control from gram. and mike. Built and tested.

RELIANT Mk. I
As above less teak case
£5.15 plus 7/6 P. & P.

RELIANT Mk. II
In teak finished case.
£6.16 plus 7/6 P. & P.

RECORD PLAYER SNIP
A.C. Mains 240V

The "Princess", 4-speed automatic record changer and player engineered with the utmost precision for beauty, long life, and trouble free service. Will take up to ten records which may be mixed 7" to 10" or 12". Patent stylus brush cleans stylus after each playing and at shut off, the pick-up locks itself into its recess, a most useful feature with portable equipment—other features include pick-up height adjustment and stylus pressure adjustment. This truly is a fine instrument which you can purchase this month at only **£5.19.6** complete with cartridge and ready to play. Post and ins. 7/6 extra.



ONLY **£5.19.6** plus 7/6 P. & P.

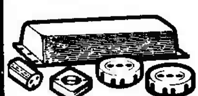
POCKET MULTI-METER

Size 3¾ × 2½ × 1¼in. Meter size 2¼ × 1¼in. Sensitivity 1,000 O.P.V. on both A.C. and D.C volts 0–15, 0–150, 0–1,000 D.C. current 0–150mA Resistance 0–100kΩ. Complete with test prods, battery and full instructions.

42/6 plus 3/6 P. & P.

FREE GIFT for limited period only. 30 watt Electric Soldering Iron value 15/- to every purchaser of the Pocket Multi-Meter

40W FLOURESCENT LIGHT KIT



Incorporating GEC Choke size 8¼ × 1¼ × 1¼in. 2 bi-pin holders. starter and starter-holder. P. & P. 5/6. **11/6**

Similar to above: 80W. Fluorescent Light Kit incorporating GEC choke size 11¾ × 1¾ × 1½in. 2 bi-pin holders, start and sterter holder. P. & P. 6/6 **17/6**

THREE-IN-ONE HI-FI 10 WATT SPEAKER

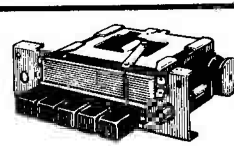
A complete Loud Speaker system on one frame, combining three matched ceramic magnet speakers with a low loss crossover network. Peak handling power 10 watts. Impedance 15 ohms. Flux density 11,000 gauss. Resonance 40–60 c/s. Frequency range 50c/s to 20Kc/s. Size 13½ × 8$\frac{1}{16}$ × 4½in. By famous manufacturer.

List price £7   OUR PRICE **74/6** plus 5/- P. & P.

Similar speaker to the above without tweeters in 3 and 15 ohms 44/6 plus 5/- p. & p.

PYE CAR RADIO
Push Button Tuning Heart

This PRESTOLOCK 5 station Push-Button Tuner Heart with Manual Over-ride is an ideal basis for a quality AM car radio. Size 6¼" × 4" × 2".
As illustrated but without knobs.



25/- plus 3/- P. & P.

QUALITY MAINS TRANSFORMER

Input 250 volts. OUTPUT (All RMS values) 4 windings of 11.5 volts connected in series total 46 volts at 4.5 amps (conservatively rated). The following combinations may be used. 1. 23–0–23 volts. 2. 46 volts.
Both of these above voltages are commonly used in medium to high powered transistor amplifiers, power supplies, etc.

Price **35/-** plus 7/6 P. & P.

RADIO & TV COMPONENTS R+TV (ACTON) LIMITED

TERMS C.W.O.
All enquiries S.A.E.

Goods not despatched outside UK

RADIO & T.V. COMPONENTS (ACTON) LTD
21c High Street, Acton, London W.3.
Also at 323 Edgware Road, London W.2.
ALL ORDERS BY POST TO OUR ACTON ADDRESS

R.S.C. SENSATIONAL HIGH FIDELITY STEREO 'PACKAGE' OFFERS

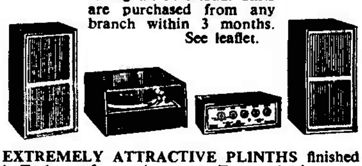
★ Super 30 Amplifier (30 watt) in veneered housing
★ Goldring Transcription Turntable on Plinth
★ Shure or Goldring Magnetic Pick-up Cartridge
★ Pair of Stanway II Loudspeaker Units

Special total price. Four fully wired units ready to "plug-in". Carr. 30/-. **86 Gns.**

TERMS AVAILABLE ALL PACKAGE OFFERS

Matching as recommended for optimum performance. Send for coloured brochure showing other money-saving offers.

Package prices apply providing all individual units are purchased from any branch within 3 months. See leaflet.



EXTREMELY ATTRACTIVE PLINTHS finished in Teak or Afrormosia veneer. Trans. plastic cover.

★ Super 30 amplifier (30 watt) in veneered housing
★ Garrard SP25 Mk II Turntable on Plinth
★ Goldring CS90 Ceramic P.U. Cartridge with diamond stylus
★ Pair Stanway II Speaker Units

Four fully wired units ready to "plug-in". Special total price **76 Gns.** Carr. 30/-.

★ TA12 Amplifier (13 watt) in veneered housing
★ Garrard SP25 Mk II 4 sp. player unit on plinth
★ Goldring CS90 Ceramic P.U. Cartridge
★ Pair of Dorchester Loudspeaker Units. **53 Gns**

Special total price Carr. 25/-. Or Dep. £10.0.3 and 9 mthly. payments £5.15.5 (Total 59 gns.). Transparent plastic cover 3 gns. extra.

As above but with Garrard 3000 Autochanger (fitted Sonotone 9 TA Cartridge) in lieu of SP25 or Dep. £9 and 9 monthly payments. £5.4.9 (Total £56.2.9). Transp. plastic cover 3 *gns.* extra inc. carr. **47½ Gns.** Carr. 25/-

AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS

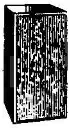
Heavy construction. Latest high efficiency ceramic magnets. Treated Cone surround. "D" indicates Tweeter Cone providing extended frequency range up to 15,000 c.p.s. Impedance 3 or 15 ohms. Please state choice. Exceptional performance at low cost.

Prices include carriage.

				HF100D	10"	15W	£4.19.9
HF510L	5"	10W	49/9	HF120	12"	15W	79/9
HF801D	8"	8W	59/9	HF120D	12"	15W	89/9
HF811D	8"	10W	4 gns.	HF126	12"	15W	£5.5.0
HF102D	10"	10W	65/-	HF126D	12"	15W	£5.15.0

HIGH FIDELITY LOUDSPEAKER UNITS

Cabinets latest style Satin Teak or Afrormosia veneer. Acoustically lined or filled acoustic damping. Ported where appropriate, credit terms available.



DORCHESTER Size 16 x 11 x 9in. Appr. Range 45–15,000 c.p.s. Rating 8–10 watts. Fitted High flux 13x8in. Dual Cone spkr. Imp. 3 or 15 ohms. **£8.19.9** Carr. 7/6

STANWAY II Size 20x10½x9½in. approx. Rating 10 watts. Inc. Fane 13x8in. speaker with highly flexible cone surround, long throw voice coil and 11,000 line magnet. High flux tweeter. Handsome Scandinavian design cabinet. Range 35-20,000 c.p.s. Imp. 15 ohms. Gives smooth realistic sound output. **16 Gns.**

RECORD PLAYING UNITS

Money saving units. Mounted on Plinth. Supplied with transparent plastic cover Ready to plug into Amplifier or Tape recorder.

RP2C Garrard SP25 Mk II (with heavy turntable) fitted Goldring CS90 high compliance ceramic Stereo/Mono cartridge with diamond stylus. Inc. Carr. **23 Gns.**

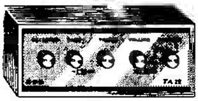
RP5C Garrard 2025 Auto Unit fitted Garrard GCS 23 Stereo Cartridge with diamond tip. Plinth & Cover as RP2C. inc. carr. **15 Gns.**

Other types available with Magnetic cartridges and with alternative design plinths.

Limited Number of CLEARANCE LINES in leading makes of Hi-Fi equip. at Branches only

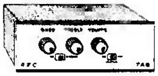
R.S.C. TA12 MKII 13 WATT STEREO AMPLIFIER

FULLY TRANSISTORISED, SOLID STATE CONSTRUCTION HIGH FIDELITY OUTPUT OF 6.5 WATTS PER CHANNEL



Designed for optimum performance with any crystal or ceramic Gram P.U. cartridge, Radio tuner, Tape recorder, 'Mike' etc. ★ 3 separate switched input sockets on each channel ★ Separate Bass and Treble controls ★ Slide Switch for mono use ★ Speaker Output 3–15 ohms ★ For 200–250v. A.C. mains ★ Frequency Response 30–20,000 c.p.s. —2dB ★ Harmonic Distortion 0.3% at 1000 c.p.s. Hum and Noise —70dB ★ Sensitivities (1) 300mV (2) 50mV (3) 100mV (4) 2mV. Output rating I.H.F.M. ★ Handsome brushed silver finish Facia and Knobs. Complete kit of parts with full wiring diagrams & instructions. Factory built with 12 mth gntee 17 Gns or Deposit £5.2.6 and 9 mthly pymts 34/- (Total £20.8.6). Or in Teak or Afrormosia veneer housing 20½ Gns. Dep. £5.10.6 and 9 monthly payments £2.1.7 (Total £24.4.9). **13½ Gns.** Carr. 7/9

R.S.C TA6 6 Watt HIGH FIDELITY SOLID STATE AMPLIFIER



200-250v. AC mains operated. Frequency Response 30–20,000 c.p.s. —2dB. Harmonic Distortion 0.3% at 1,000 c.p.s. Separate Bass and Treble 'lift' and 'cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3–15 ohm spkrs. Max. sensitivity 5mV. Output rating I.H.F.M. Fully enclosed enamelled case. 9½x2½x5½in. Attractive brushed silver finish facia plate 10½ x 3½in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. **7 Gns.** Carr. 7/6

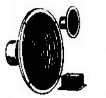
Or factory built with 12 months' guarantee. £8.19.9

R.S.C. PLINTHS

for Record Playing units, cut for Garrard 1025, 2025, 3000, AT60, SP25 etc.

Available **59/9** Inc. Carr. with trans. plastic cover. **6 Gns.**

AUDIOTRINE HI-FI SPEAKER SYSTEMS



Consisting of matched 12in. 11,000 line 15 Watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. **£5.15.0**

Or Senior 15 Watt inc. HF126 15,000 line Speaker £6.15.0. Carr. 6/6 Carr. 5/9

HI-FI SPEAKER ENCLOSURES

Teak or Afrormosia veneer finish. Modern design. Acoustically lined.

All sizes approximate Prices Inc. carr.

JE8 Size 16 x 11 x 9in. Pressurised. Gives pleasing results with any 8in. Hi-Fi 'speaker. **£4.14.6**

SE8 For optimum performance with any 8in. Hi-Fi 'speaker. Size 22 x 15 x 9in. Ported. **£5.15.0**

SE10 For outstanding results with 10in. Hi-Fi 'spkr Size 24x15x10in. P'td. **£5.19.6**

SE12 For exclnt prfmnce with 12in. Hi-Fi speaker and Tweeter. Size 25 x 16 x 10½in. **£6.19.9**

INTEREST CHARGES REFUNDED

On Credit Sales settled in 3 months.

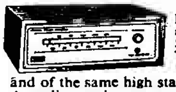
LINEAR L10 HIGH FIDELITY 10W AMPLIFIER with separate Pre-amp. Magnet P.U. matching. To clear **10 Gns.**

THE 'YORK' HIGH FIDELITY 3 SPEAKER SYSTEM

★ Moderate size, only 25 × 14 × 10in. Complete Kit **20 Gns.**
★ Response 30-20,000 c.p.s. Impedance 15 ohms
★ Performance comparable with units costing Carr. 12/6

considerably more. Consists of (1) 12in. 15 watt Bass unit with cast chassis, Roll rubber cone surround for ultra low resonance, and ceramic magnet. (2) 3-way quarter section series cross-over system. (3) 8 x 5in. high flux middle range 'speaker. (4) High efficiency tweeter. (5) Appropriate quantity acoustic damping material. (6) Teak veneered cabinet. (7) Circuit and full instructions. Terms: Dep. £5.10.6 and 9 monthly payments 39/- (Total £23.1.0). DEMONSTRATIONS AT ALL BRANCHES

R.S.C. TFM1 SOLID STATE VHF/FM RADIO TUNER



★ High-sensitivity. ★ 200-250v. A.C. Mains operation. ★ Sharp A.M. Rejection. ★ Drift-free reception. ★ Output ample for any amplifier (approx. 500 m.v.). ★ Output for feeding Stereo Multiplexer. ★ Tuner head using silicon Planar Transistors. ★ Designed for standard 80 ohm co-axial input. Visually matching our Super 15 and 30 amplifiers and of the same high standard of performance and reliability. Printed circuitry. A quality product at considerably less than the cost of comparable units. Factory built 18 *gns.* Or in Teak finished cabinet as illustrated 21 *gns.* Terms: Deposit £6.1.0 and 9 monthly payments. 2*gns.* Total £24.19.0. Stereo version. 23½ *gns.* All prices include carriage.

R.S.C. SUPER 30 MK II HIGH FIDELITY STEREO AMPLIFIER

High Grade Components Specifications comparable with units costing considerably more.

TRANSISTORS 9 high quality types in each channel.

OUTPUT 10 Watts R.M.S. continuous into 15Ω (per channel). 15 Watts R.M.S. continuous into 3Ω.

INPUT SENSITIVITIES Mag. P.U. 4 mV. Ceramic P.U. 35 mV. Tape Amp. 400 mV. Aux. 100 mV. Mic. 5 mV. Tape Head 2.5 mV.

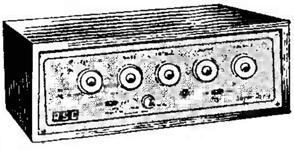
FREQUENCY RESPONSE ±2 dB. 10–20,000 c.p.s.

TREBLE CONTROL +17 dB to —14 dB at 10 Kc/s.

BASS CONTROL +17 dB to —15 dB at 50 c/s.

HUM LEVEL —80 dB.

HARMONIC DISTORTION 0.1% at 10 watts 1,000 c.p.s.



Employing Twin Printed Circuits. 200/250v. A.C. mains operation.

CROSS TALK 52 dB at 1,000 c.p.s.

CONTROLS 5 Position Input Selector, Bass, Treble, Vol., Bal., Stereo/Mono Switch, Tape Monitor Switch, Mains Switch.

INPUT SOCKETS (1) P.U. (2) Tape Amp. (3) Radio. (4) Mic. or Tape Head. (Operation of Input Selector assures appropriate equalisation).

CHASSIS Strong Steel construction. Approx. 12 x 3 x 8in.

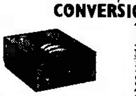
FACIA PLATE Attractive design in rigid Perspex. Spun silver finish matching control knobs as available.

COMPLETE KIT OF PARTS

Carr. 15/- **22 Gns.**

Point to point wiring diagrams and detailed instructions. Eminently suitable for use with any make of Pick-up or Mic. (Ceramic or Magnetic, Moving Coil, Ribbon or Crystal) currently available. Superb sound output quality can be obtained by use with first-rate ancillary equipment. UNIT FACTORY BUILT With 12 mths. guarantee. **29 Gns.** or Deposit £7.5.0 and 9 monthly payments 58/9 (Total £33.13.9) or in Teak or Afrormosia veneer housing 32 Gns. Carr. 15/-. Terms: Deposit £7.3.6 and 9 monthly payments of 66/6 (Total £37.2.0). Send S.A.E. for leaflet.

R.S.C. BATTERY/MAINS CONVERSION UNITS



Type BM1 An all-dry battery eliminator. Size 5½x4½x2in. approx. Completely replaces batteries supplying 1·5v. and 90v. where A.C. mains 200/250v. 50c/s is available. Complete kit with diagram 52/6 or assembled 3 Gns.

R.S.C. SUPER 15 HIGH FIDELITY SOLID STATE AMPLIFIER

Approx. as Super 30 but single channel. Complete kit with full constructional details and point to point wiring diagrams. Carr. 12/6 **12½ Gns.** or factory built 15½ Gns. Carr. 12/6. Terms: Deposit 4 Gns. and 9 monthly payments 31/1 (Total £18.3.9) or in Teak or Afrormosia veneered housing. 19 Gns.

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2N3528	9/6
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2N4290	3/-

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2S036	25/-
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2S104	12/6
2S131	7/6
2S301	6/-
2S302	7/6
2S303	10/-
2S304	12/6
2S305	15/-
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2S321	6/-
2S322	7/6
2S323	10/-
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AC154	3/-
AC169	3/-
AC176	5/-
AC187	5/-
AC188	6/-
ACY17	6/-
ACY18	4/-
ACY19	5/-
ACY20	4/-
ACY21	4/6
ACY22	3/6
ACY28	3/6
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AF117	5/-
AF118	12/6
AF124	6/-
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AF239	8/-
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BC136	7/-
BC137	8/-
BC138	8/-
BCY30	5/6
BCY31	8/6
BCY32	10/-
BCY33	5/-
BCY34	6/-
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BFY20	12/6
BFY50	5/-
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BFY52	5/-
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OAZ209	6/6
OAZ210	6/6
OAZ211	6/6
OAZ212	6/6
OAZ213	9/6
OAZ222	9/6
OAZ223	9/6
OAZ229	9/6
OAZ231	9/6
OAZ238	9/6
OAZ241	4/6
OAZ223	7/6
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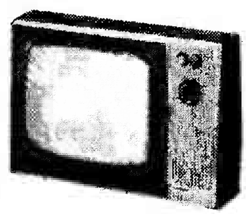
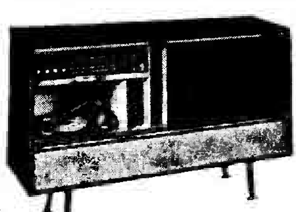


COCKTAIL/STEREOGRAM CABINET 15 gns.



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CUSTOM UNIT BY FAMOUS BRITISH MANUFACTURER

A deluxe custom styled and built record player unit made by world famous British manufacturer. The unit incorporates the renowned Garrard 3000 four speed autochanger with lightweight tubular pick-up arm **FITTED WITH SONOTONE 9TA STEREO CARTRIDGE with diamond stylus.** The beautifully made plinth is finished in richly figured teak veneer with tinted perspex panels in the lid and with attractive charcoal grey "mirror" insert panel on front. All metal trim parts are satin chrome. Blackleather grain underside. The lid allows the player to operate fully automatically when closed and has snap action "stay" when raised. Mains socket and 5 pin DIN audio output socket are at rear. Overall size 15³/₄ x 7³/₄ x 14in.

LASKY'S SPECIAL PRICE £16.15.0 Post 15/-

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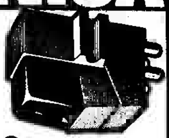

SPECIAL OFFER

AT-35X Stereo magnetic cartridge with elliptical diamond stylus. Frequency response 20–25 kHz ±2 dB. Channel separation 30 dB. Output 5mV. **List Price £24.4.9.**

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Also available AT-35 stereo magnetic cartridges with either 0·5 or 0·7 mil diamond stylus assemblies. List Price £18.10.0. **Lasky's Price £13.10.0.** Post Free.

AT-33 Stereo magnetic cart.—frequency response 20–20 kHz with 0·7 mil diamond stylus. Output 5mV. List £10.14.3.

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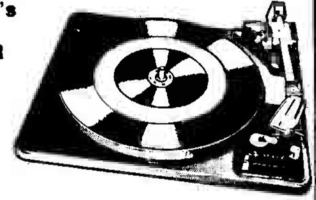
ADC 40 PRECISION PICK-UP ARM

The ADC 40 Mk II is a complete low inertia arm with side thrust compensator and anti-drag lead out arrangement. Single-thrust ball bearings used at four points. Accurately machined walnut non-resonant arm. Adjustable counter-weight. Plug-in head shell accomodates nearly all cartridges. Easy installations. Built-in arm rest. Arm length 10⁶/₈ in. overall. Pivot to stylus tip 9 in. Rear overhang 1³/₄ in.

List Price £19.1.6

OUR PRICE £8.19.6 Post 3/6

Garrard



FROM STOCK

SP.25 Mk II

THE U.K.'s MOST POPULAR HI-FI TURNTABLE

4-speed single record playing deck features include heavy precision-built turntable, pick-up arm bias compensation, calibrated stylus-force adjustment cueing device. After play, the arm automatically rises, returns to rest and switches off motor. Finish: dark green polychromatic and silver.

LASKY'S PRICE £11.19.6

SP. 25 Mk.11 with A.D.76K Stereo Magnetic Cartridge £15.0.0.

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AP 75, £18.19.0 AP75 with AD76K mag. cart., **£21.10.0. 401** Transcription Unit, **£28.0.0**

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Type **WB1** and **WB5** for models AT60 Mk II, 2025TC, 3000, SL65B 1025, SP25 Mk II **Price WB1 £3.16.6. WB5 £5.12.6.** Type **WB4** for models SL72B, SL75B, SL95B **Price £5.12.6. Perspex covers: SPC1** for WB1, **£3.14.1. SPC4** for **WB4** and **WB5** (allows unit to be played with the cover in place)—price **£4.8.0.**

PACKAGE DEALS

AP75 complete with **AD76K** Stereo magnetic cartridge, teak plinth and perspex cover	**£30.0.0**	Post 10/-
SP25 Mk II complete with **AD76K** cartridge, teak plinth and perspex cover	**£19.0.0**	Post 7/6
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Post on Garrard units: 6/- extra—except AP75, SL75B, SL95B and 401 7/6 extra. Post on bases and covers 5/- extra.

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5in.	Long play, 900ft. Acetate	10 0
5in.	Standard play 600ft. ,,	8 6
5¾in.	Double play, 1800ft. Mylar	22 6
5¾in.	Long play 1200ft. Acetate	15 0
5³/₄in.	Standard play 900ft Acetate	12 6
5¾in.	Long play, 1200ft. Mylar	15 0
5¾in.	Triple play, 2400ft	35 0
7in.	Standard play, 1200ft Acetate	12 6
7in.	Standard play, 1200ft. Mylar	12 6
7in.	Long play, 1800ft. Mylar	19 6
7in.	Double play, 2400ft. Mylar	25 0
7in.	Long play 1800ft. Acetate	15 0
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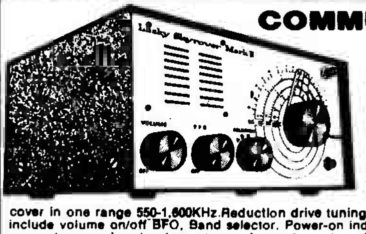
LASKY'S PRICE 10/8 POST 1/- EACH

SKYROVER MkII

COMMUNICATION RECEIVER



A short wave receiver, exclusive to Lasky's, at a real economy price. Four valve line up using one each 6BE6, 6BA6, 6AV6 and 6AR5 valves, gives highly sensitive reception and powerful gain. Switch selected SW frequency range cover: 1·5 to 30 MHz in three separate band-spread ranges and full AM medium waveband cover in one range 550-1,600KHz. Reduction drive tuning with hair line cursor. Controls include volume on/off BFO, Band selector. Power-on indicator lamp. External antenna connections and mains fuse at rear. Internal speaker plus standard 5mm jack socket for phones on front. For 220/240V a.c. mains operation. Strong metal cabinet finished in grey crackle with anodised silver front panel. Size 9½ x 5¾ x 5½in. Complete with mains lead and full instructions.

THE IDEAL BEGINNERS RECEIVER

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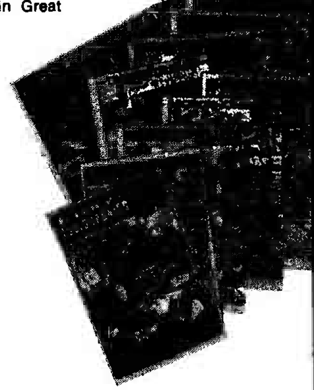
The 1970 edition of Lasky's famous Audio-Tronics catalogue is now available—FREE on request. The 28 tabloid pages—many in full colour—are packed with 1000's of items from the largest stocks in Great Britain of everything for the Radio and Hi-Fi enthusiast, Electronics Hobbyist, Serviceman and Communications Ham. Over half the pages are devoted exclusively to every aspect of Hi-Fi (including Lasky's budget Stereo Systems and Package deals), Tape recording and audio accessories **PLUS Lasky's amazing money saving vouchers worth over £25.** All goods are available by Mail Order—bringing the benefits of shopping at Lasky's to you in the comfort of your home.



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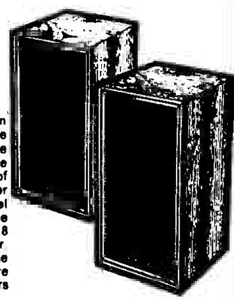
FOSTER "Criterion" MkII

HIGH FIDELITY 2 SPEAKER TWO WAY BOOKSHELF SPEAKER SYSTEM



Another high quality sub-miniature bookshelf system from Foster. The "Criterion" MkII is a sealed infinate baffle type enclosure using 5½in. bass/mid-range woofer with rolled cloth edge and a 2½in. HF cone type tweeter. The compact cabinet is constructed of ½in. laminate with handsome oiled walnut veneer finish and black woven acoustic gauze—front panel with satin chrome edge insert. SPEC: Frequency range 90-20,000Hz. Power Handling 10 watts. Impedance 8 ohms. HF crossover. Screw Tag connections at rear. Size 12½ x 7¾ x 6¾in. The performance of the "Criterion" is superior to many larger and more expensive units and at Lasky's exclusive price offers absolutely unbeatable value.

LASKY'S PRICE **£9.10.0** or 2 for **£17.10.0** Post 1—7/6 2—10/-

SONICS AS-57

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The AS-57 is a real space saver. This fine bookshelf high-fidelity speaker system will provide good quality sound anywhere in your home at remarkably low cost. Designed for use where space is at a premium, the AS-57 system is ideal for the small apartment or isolated listening area. The special high efficiency 5x7in. full range speaker has a frequency range of 70-18,000 Hz with a peak handling capacity of 10 watts. Imp. 8 ohms. Finish: oiled walnut. Size: 5⁷/₈ x 15³/₄ x 8¹/₄in. (May be used upright or longways).

LASKY'S PRICE **£15 per PAIR** Post 10/-

SPECIAL OFFER

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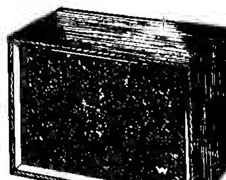
A compact system sold in matched pairs for a perfectly balanced stereo system. Each Denton contains an 8in. bass unit with 3in. H.F. pressure unit, coupled by a Wharfedale cross-over network: Rated input 15 watts maximum. Frequency response 65-17,000Hz. Impedance 4/8 ohms. Cabinet 9¾ x 14 x 8¾ in. These most attractive units are available in oiled teak and are small enough to blend in with most surroundings.

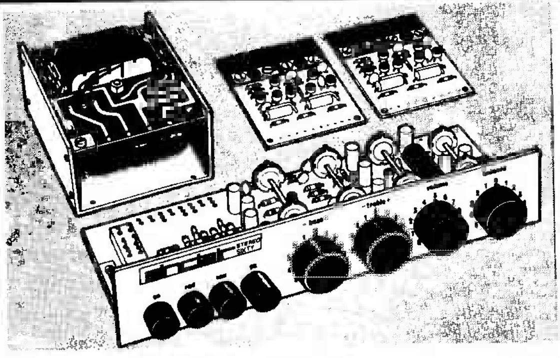


LIST PRICE NORMALLY £36 PAIR

OUR PRICE £33 PAIR

Post 15/-

sinclair Project 60



Project 60 is a range of modules which connect together to form a complete stereo amplifier. The modules are: 1. Z-30 high gain power amp. 2. Stereo-60 pre-amp. control unit. 3. The PZ-5 unstabilised and PZ-6 stabilised power supplies. A complete system comprises two Z-30's, one Stereo-60 and a PZ-5 or PZ-6.

STEREO 60 SPECIFICATION

Input sensitivities: Radio up to 3mV, Magnetic Pick-up 3mV: correct to R.I.A.A. curve ±1dB; 20 to 25,000Hz. Ceramic Pick-up up to 3mV. Auxiliary up to 3mV ● Output: 1 volt ● Signal to noise better than 70dB ● Front panel: brushed aluminium with black knobs and controls ● Size: 8¼ x 1½ x 4in

£9.19.6 post 3/6

Z-30 SPECIFICATION

● Power output 15 w. R.M.S. into 8 ohms using a 35 volt supply ● Frequency response: 30 to 300,000Hz ±1dB ● Distortion: 0.02% ● Signal to noise: better than 70dB ● Input sensitivity: 250mV into 100 K ohms ● Loudspeaker imp 3 to 15 ohms ● Power requirements, from 8 to 35V DC (The Z30 will operate from batteries if required) – Size. 3½ x 2¼ x ½in.

89/6 post 3/6

PZ5 30V unstabilised — sufficient to drive two Z-30's and a Stereo 60 for domestic applications **99/6** Post 2/6

PZ6 35V stabilised — ideal for driving two Z-30's and a Stereo 60 for low efficiency speakers. **£7.19.6** Post 2/6

PACKAGE PRICE For Stereo 60, two Z-30 and one PZ-5 **£21.10.0** Post 10/-

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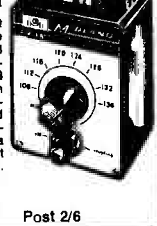

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ECF83	15/6	EM84	8/-	PL82	8/-
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ECF802	12/6	EY51	8/-	PL84	6/6
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OAZ223 to OAZ225	10/-	OC82DM	3/-	1ZT5	13/6	AC126	4/6	BS2	9/3	Z3B range	5/- ea.
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OC26	5/-	OC122	10/-	2N3053	6/6	ACY28	4/-	CRS1/10	5/-		
OC28	8/-	OC139	6/6	2N3054	12/6	AD149	11/-	CRS1/20	9/6		
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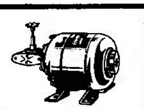

Motor Driven Variable Voltage Transformers by Ohmite (U.S.A.). Input 120/240v., 50/60 c.p.s. Output 0-240v. at 480 v.a. A reversible 115v. a.c. geared motor drives the contact sweep arm in the direction required. There is a micro switch mounted at each end of the track which is cam-operated and intended to be connected as a safety-stop. First class condition. **£8.15.0** P. & P. 10/-.

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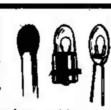

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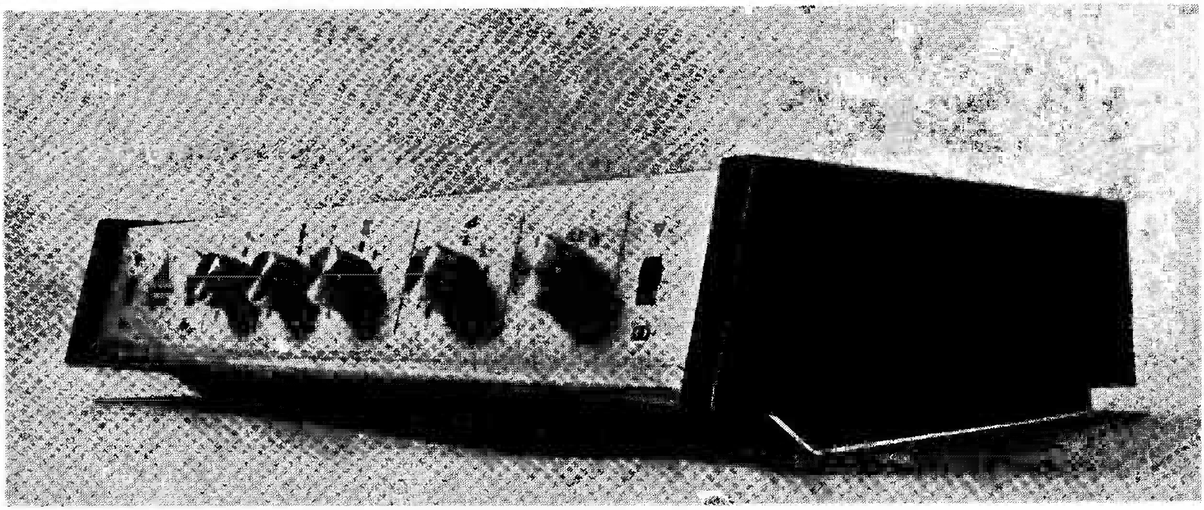
peak sound englefield



developed out of the highly successful PW. 12+12 and now in complete kit form to save you still more

The Peak Sound Englefield is a system offering great flexibility whilst providing cost-performance ratios which have never been bettered in high fidelity. Here top-flight circuitry is housed in a cabinet of elegantly original styling which is both beautiful and completely practical front and back. Now we carry design standards further by offering a 12+12 watt version completely in kit form. The resultant specification surpasses that even of the original PW.12+12 which again was based on Peak Sound design. In this Englefield kit, printed circuit boards are supplied for you to mount the components on. Standards of input sensitivity and overload factor on all channels as well as filter performance are all improved. By giving you the satisfaction of building the Englefield this way, you save considerably and finish with a completely professionally styled instrument. Go to your dealer and start building now, or send direct for delivery by return in case of difficulty.

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Peak Sound guarantee that their equipment meets all specifications as published by them and that these are written in the same terms as used in equipment reviews appearing in this and other leading British hi-fi journals. Audio output powers are quoted at continuous sine wave power in terms of Root Mean Square values (R.M.S.) into stated loads at stated frequencies.

The specification that tells you everything *(See guarantee)*

Using two Peak Sound PA. 12-15's, driven simultaneously at 1 KHz from 240 V. mains supply.
Output per channel: 11 watts into 15 Ω: 14 watts into 8 Ω.
Frequency bandwidth: 10Hz to 45 KHz for 1dB at 1 watt.
Total Harmonic Distortion at 1 KHz at 10 watt into 15 Ω—0.1%.
Input sensitivities: Mag. PU.3.5 mV. R.I.A.A. equalized into 68K Ω: Tape, 100mV linear into 100K Ω: Radio, 100mV linear into 100K Ω.
Overload factor: 29dB on all input channels.
Signal/noise ratio: —65dB on all inputs. Vol. control at max.
Controls: Volume, Treble, Bass, Low-pass Filter. Mono/Stereo: On/off; Balance.

Complete kit of parts including cabinet assembly, knobs, transistors, well-prepared instructions and wire to length, colour coded and stripped at ends as well as built-in mains power supply. *(Post free in U.K.)* **£33.2.0**

Englefield assembly as above, but in easy-to-put-together modules. *(Post free in U.K.)* **£38.9.0**

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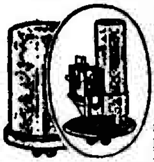
CAR LIGHT FLASHERS



Heavy duty light flasher employs a condenser discharge principle operating on electro mechanical relay. (As inset). Housed in strong plastic case. Flashing rate between 60-120 per minute. 12V DC operation. Maximum load 6 amps. Size 2-11/16in. dia. x 4in. Supplied brand new at a fraction of original cost. 6/6 each P. P. 2/6. (3 for 17/6 P. P. 4/6).

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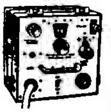

A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6 volts D.C. Ideal for amateur use. Available in good used condition. £5.19.6. Carr. 7/6. Or brand new with accessories. £7.19.6. Carr. 7/6.

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Crystal controlled. 1·2–19 Mc/s. Mains or 12V. D.C. operation. Complete with calibration charts. Excellent condition. £12.10.0. Carr. 30/–.

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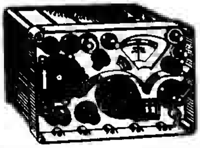
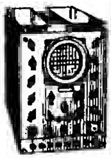


TYPE 13A DOUBLE BEAM OSCILLOSCOPES



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MARCONI T/44/TF956

AF Absorption Wattmeter

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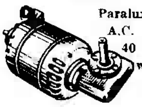
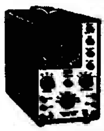
GEARED MAINS MOTORS



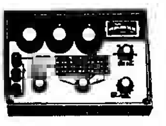
Paralux type SD19 230/250V. A.C. Reversible. .30 r.p.m. 40 lb./ins. Complete with capacitor. Excellent condition. 99/6. Carr. 10/-.

TO-3 PORTABLE OSCILLOSCOPE



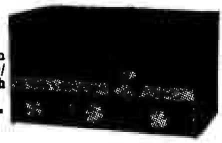
3in. tube. Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1·5 MHz. Input imp. 2 meg Ω 25pF. X amp. sensitivity 0·9v p-p/CM. Bandwidth 1·5 cps–800KHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps–300 KHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½ lb. 220/240V. A.C. Supplied brand new with handbook. £17.19.6 Carr. 10/-.

TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 megΩ 6 Ranges ±1%. L.1 μ H – 111 HENRYS 6 Ranges –2%. C. 10pF ±1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7½ × 5 × 2in. £20. P. & P. 5/-.

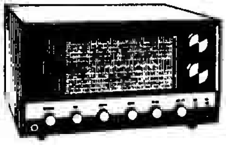
UNR-30 4-BAND COMMUNICATION RECEIVER



Covering 550 Kc/s–30 Mc/s. Incorporates BFO. Built in speaker and phone jack. Metal cabinet. Operation 220/240V. A.C. Supplied brand new, guaranteed with instructions. Carr. 7/6. **13 gns.**

TRIO JR.310 New Amateur Band 10–80 Metre Receiver in stock. £77.10.0.

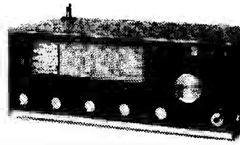
LAFAYETTE SOLID STATE HA600 RECEIVER

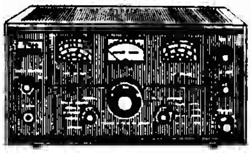


5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 Kc/s–400 Kc/s and 550 Kc/s–30 Mc/s F E T front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230V. A.C./12V. D.C. neg. earth operation ● RF gain control. Size 15in. × 9½in. × 8½in. Weight 18 lbs. EXCEPTIONAL VALUE. £45. Carr. 10/-. S.A.E. for full details.

UR-1A SOLID STATE COMMUNICATION RECEIVER

4 bands covering 550 Kc/s–30 mc/s continuous. Special features are use of FET transistors, S meter, built in speaker and telescopic aerial, variable BFO for SSB reception, noise limiter, bandspread control, sensitivity control. Output for low impedance headphones. Operation 220/240 volt A.C. or 12 volt D.C. Size 12⅛in × 4¾in × 7in. Excellent value. ONLY £24 carr 7/6.



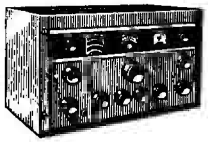


TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

4 band receiver covering 550 Kc/s to 30 Mc/s continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit, 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 455 Kc/s ● Audio output 1·5 W. ● Variable RF and AF gain controls. 115/250V. A.C. Mains. Beautifully designed. Size: 7 × 15 × 10in. With instruction manual and service data. £42, carriage paid. TRIO COMMUNICATION TYPE HEADPHONES. Normally £5.19.6. OUR PRICE £3.15.0 if purchased with above receiver.

TRIO JR. 500SE 10-80 Metre Receiver £69.10.0

TRIO TS 510 AMATEUR TRANSCEIVER with speaker and mains P.S.U. £212. IN STOCK!



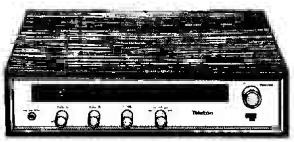
RCA COMMUNICATIONS RECEIVERS AR88D

Latest release by ministry BRAND NEW in original cases. 110-250v. A.C. operation. Frequency in 6 Bands. 535 Kc/s–32 Mc/s continuous. Output impedance 2·5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price £87.10.0. Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

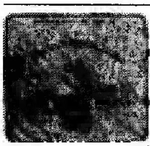
A completely new transistorised receiver covering 152–174 Mc/s. Fully tunable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75Ω aerial input. Headphone jack. Operation 230V. A.C./12V. D.C. Neg. earth. £37.10.0. Carr. 10/-.

TELETON CR-10T AM/FM STEREO TUNER AMPLIFIER



A new model from Teleton. 31 solid state devices. 4+4 watt output. Inputs for ceramic/crystal cartridge. Frequency range AM 540–1600KHz FM 88–108MHz. Automatic FM Stereo reception. Stereo Indicator. Controls: Tuning, function selector, Tone and R & L volume controls. AFC switch. Stereo headphone socket. Size 13½" × 3½" × 9½" approx. PRICE £34.0.0. Carr. 7/6.

CLEAR PLASTIC PANEL METERS



First grade quality Moving Coil panel meters. Type MR 38P. $1^{21}/_{32}$in. square fronts.

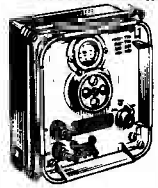
50μA 40/–	500-0-500μA 27/6	50mA 27/6	150V. D.C. .. 27/6
50-0-50μA 37/6	1mA 27/6	100mA 27/6	300V. D.C. .. 27/6
100μA 37/6	1-0-1mA 27/6	150mA 27/6	500V. D.C. .. 27/6
100-0-100μA 35/–	2mA 27/6	200mA 27/6	750V. D.C. .. 27/6
200μA 35/–	5mA 27/6	300mA 27/6	15V. A.C. .. 27/6
500μA 40/–	10mA 27/6	500mA 27/6	50V. A.C. .. 27/6
	750mA 27/6	3V. D.C. 27/6	150V. A.C. .. 27/6
	1 amp 27/6	10V. D.C. 27/6	300V. A.C. .. 27/6
	2 amp 27/6	20V. D.C. 27/6	500V. A.C. .. 27/6
	5 amp 27/6	50V. D.C. 27/6	S meter 1mA 32/–
	20mA 27/6	100V. D.C. .. 27/6	VU meter .. 42/–

FULL RANGE OF OTHER SIZES IN STOCK. SEND S.A.E. FOR LEAFLET

Variable Voltage TRANSFORMERS

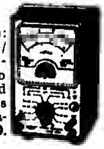
Brand new, guaranteed and carriage paid.
High quality construction. Input 230V. 50–60 cycles.
Output full variable from 0·260 volts. Bulk quantities available.
1 amp.—£5.10.0; 2·5 amp—£6.15.0; 5 amp.—£9.15.0;
8 amp.—£14.10.0; 10 amp.—£18.10.0; 12 amp.—£21.0.0;
20 amp.—£37.0.0.

CRYSTAL CALIBRATORS NO. 10



Small portable crystal controlled wavemeter. Size 7 x 7½ x 4in. Frequency range 500 Kc/s–10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300V. D.C. 15mA and 12V. D.C. 0.3A. Excellent condition. 89/6. Carr. 7/6.

TE-40 HIGH SENSITIVITY A.C. VOLTMETER



10 meg. input 10 ranges: ·01/·003/·1/·3/1/3/10/30/100/300V. R.N.S. 4cps.-1·2 Mc/s. Decibels –40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V. A.C. £17.10.0. Carr. 5/-.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0–20 Kc/s. on 2 ranges. Output 500Ω or 5kΩ. Operation 200/250V. A.C. Supplied in perfect order. £12.10.0. Carr. 10/-.

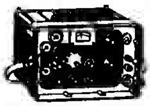
TE-65 VALVE VOLTMETER

High quality instrument with 28 ranges. D.C. volts 1·5—1,500v. A.C. volts 1·5—1,500v. Resistance up to 1,000 megohms. 200/240v. A.C. operation. Complete with probe and instructions. £17.10.0. P. & P. 6/-. Additional probes available: R.F. 35/-. H.V. 42/6.

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

D.C. coupled. Band width 1Kc/s. Perfect order. £25. Carr. 30/-.

AM/FM SIGNAL GENERATORS



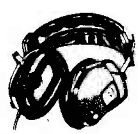
Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20-80 Mc/s. AM CW/FM. Incorporates precision dial, level meter, precision attenuator 1μV–100mV. Operation from 12 volt D.C. or 0/110/200/250 volt A.C. Size 12 × 8½ × 9in. Supplied in brand new condition complete with all connectors fully tested. £45. Carr. 20/-.

EDDYSTONE VHF RECEIVERS Model 770R. 19–165 Mc/s. Excellent condition. £150.

PLESSEY SL.403A 3 watt Integrated Amplifier Circuit 49/6 Post Paid.

TE-16A Transistorised Signal Generator. 5 ranges 400kHz–30mHz. An inexpensive instrument for the handyman. Operates on 9v battery. Wide easy to read scale. 800kHz modulation. 5¼ × 5¼ × 3½in. Complete with instructions and leads. £7.19.6. P. & P. 4/-.

HOSIDEN DH-08S DE-LUXE STEREO HEADPHONES



Features unique mechanical 2 way units and fitted adjustable level controls. 8 ohm impedance. 20-20,000cps. Complete with spring lead & stereo jack plug £7.19.6 P. & P. 2/6

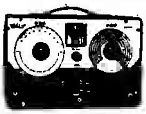
AUTO TRANSFORMERS

0/115/230V. Step up or step down. Fully shrouded.

150 W.	£2. 2.6.	P. & P. 3/6.
300 W.	£2.19.6.	P. & P. 4/6.
500 W.	£4.10.0.	P. & P. 6/6.
1,000 W.	£6.10.0.	P. & P. 7/6.
1,500 W.	£7.19.6.	P. & P. 8/6.
7,500 W.	£15.10.0.	P. & P. 20/–.

G. W. SMITH & CO (RADIO) LTD.
Also see oppos. page

ARF-100 COMBINED AF-RD SIGNAL GENERATOR



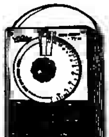
A.F. SINE WAVE 20–200,000 c/s. Square wave 20–30,000 c/s. O/P. **HIGH IMP. 21V.** P/P600Ω 3·8V. P/P. TF 100 Kc/s–300 Mc/s. Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF output and % mod. on R.F. 220/240V. A.C **£32.10.0. Carr. 7/6.**

TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 Kc/s–500 Mc/s on 6 bands. Directly calibrated Variable RF attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. **£15.** Carr. 7/6. Size 140 × 215 × 170 mm.

PEAK-SOUND PRODUCTS. Full range of Amplifiers, Kits, Speakers in stock.

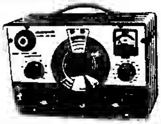
TY75 AUDIO SIGNAL GENERATOR



Sine Wave 20c/s to 200 kc/s. Square Wave 20c/s to 30kc/s. High and low impedance output. Output variable up to 6 volts. 220/240 volts A.C. Size 210 × 150 × 120 mm. Brand new with instructions. **£16.** Carr. 7/6.

MARCONI TF142E DISTORTION FACTOR METERS. Excellent condition. Fully tested. **£20.** Carr. 15/-.

LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYSER



2 pF-2000 mFd 2 ohms 200 megohms. Also checks impedance, turns ratio, insulation, 200/250V. A.C. **Brand New** **£17.10.0** Carr. 7/6.

MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0·7–0·9967. B: 5–200. Ico: 0–50 microamps 0–5mA. Resistance for diode 200Ω–1MΩ. Supplied complete with instructions, battery and lead. **£5.19.6.** P. & P. 2/6

ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons

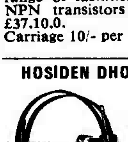
J1B. AUDIO SIGNAL GENERATOR. 15 c/s to 50 Kc/s. Sine wave. Output 600 ohms or 5 ohms. £30.0.0.

VM79. UHF MILLIVOLT METER. 100 Kc/s to 1,000 Mc/s. AC. 10 mV to 3v. DC. 10 mV to 3v. Current 0·01 uA to 0·3 mA. Resistance 1 ohm to 10 megohm. £125.0.0.

TT1S. TRANSISTOR TESTER. Full range of facilities for testing PNP or NPN transistors in or out of circuit. £37.10.0.

Carriage 10/- per item.

HOSIDEN DH04S 2-WAY STEREO HEADSETS



Each headphone contains a 2½in. woofer and a ⅝in. tweeter. Built in individual level controls. 8Ω imp. 25–18,000c/s with cable and stereo plug. **£5.19.6.** P. & P. 2/6.

AVOMETER MOVEMENTS

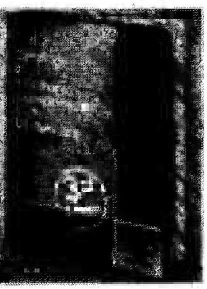
50μA 20KΩ/V

Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multimeter. Brand New & Boxed. **69/6.** P. & P. 3/6.

Latest Catalogue

range of HI FI ... COMPONENTS ... MENT and ... EQUIPMENT ... fully ...

SEND NOW—ONLY 7/



GARRARD

FULL CURRENT RANGE OFFERED BRAND NEW AT FANTASTIC SAVINGS

2025 stereo	£7.19.6	AP75	£16.19.6	SL55 with Sonotone 9TAHCD £12.10.0
2025 T/C stereo	£8.17.6	SL75	£25.19.6	
3000 stereo	£9.19.6	SL75B	£29.0.0	
SP25 Mk II	£11.9.6	SL95B	£35.0.0	
SL55	£11.12.6	A70/11	£11.19.6	
SL65B	£14.19.6	401	£26.10.0	

Carriage 7/6 extra each item.

TEAK PLINTHS & PERSPEX COVERS

1. For SP25, SL65, SL55, 3000, 2025 T/C 2025, 1000. **£4.10.0**
2. For AP75, SL75, SL95 **£7. 9.6.**
3. For SP25 etc. to operate with lid in place **£6.19.6.** Carriage 7/6 extra each type. Full range of Garrard accessories available.

LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER

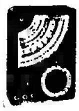
19 transistors, 8 diodes, IHF music power, 30W at 8Ω. Response 30–20,000 ± 2dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3–16Ω. Separate L and R. volume controls. Treble and bass control. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complementary metal case. Size 10¾ × 3 9/16 × 7 13/16in. Operation 115/230V. A.C. **£24.** Carriage 7/6.

MULTIMETERS *for EVERY purpose!*

TE-51. NEW 20,000Ω/VOLT MULTIMETER with overload protection and mirror scale. 0/6/60/120/1,200v. A.C. 0/3/30/60/300/600/3,000v. D.C. 0·60μA/12/300mA. D.C. 0/60K/6 meg. ohm. **92/6.** P. & P. 2/6.

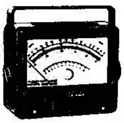
TE-900 20,000Ω/VOLT GIANT MULTIMETER mirror scale and overload protection. 6in. full view meter. 2 colour scale. 0/2·5/10/250/1,000/5,000 v. A.C. 0/25/12·5/10/50/250/1,000/5,000v. D.C.0/50μA/110/100/500 mA/10 amp. D.C. 02K/200K/20 MEG. OHM. **£15.** P. & P. 5/-.

MODEL AS-100D. 100K Ω/VOLT. 5in. mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1,200v DC 0/6/30/120/300/600v AC. 0/10μA/6/60/300 mA/12 amp. 0/2K/200K/2M/200MΩ. −20 to +17dB. **£12.10.0.** P. & P. 3/6.

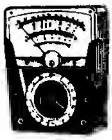


MODEL TE-10A. 20kΩ/Volt 5/25/50/250/500/2,500v. D.C. 10/50/100/500/1,000 v. A.C. 0/50μA/2·5mA/250mA D.C. 0/6K/6 meg. ohm. −20 to +22dB. 10·0, 100mFd. 0·100-0·1mFd. **69/6.** P. & P. 2/6.

MODEL TE-90 50,000 OPV mirror scale overload protection 0/3/12/60/300/600/1200 v. DC. 0/6/30/120/300/1200v. DC. ·03/6/60/600mA. DC. 16K/160K/1·6/16meg Ω. −20 to +63dB. **£7.10.0.** P. & P. 3/-.

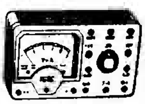


LAFEYETTE 57 Range Super 50kΩ/volt Multimeter. D.C. volts 12 mV–1000V. A.C. volts 1·5V–1000V. D.C. current 25μA–10 amp. Ohms 0–10 meg Ω dB—20 to +81 dB. Overload protection. **£12.10.0.** Carr. 3/6.



MODEL TE-70. 30,000 OPV. 0/3/15/60/300/600/1200v DC. 0/6/30/120/600/1200v AC. 0/30μA/3/30/300mA. 0/16K/160K/1·6M/16 Meg. Ω. **£5.10.0.** P. & P. 3/-.

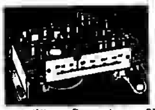
MODEL TE-80. 20,000 O.P.V. 0/10/50/100/500/1,000v A C 0/5/25/50/250/500/1,000v D C. 0–50μA, 5/50/500mA. 0/6K/60K/600 K/6meg. **£4.17.6.** P. & P. 3/-.



MODEL PT-34. 1,000 OPV. 0/10/50/250/500/1,000v AC and DC. 0/1/100/500mA DC. 0/100K Ω. **39/6.** P. & P. 1/6.

MODEL TE-12 20,000 O.P.V. 0/0·6/6/30/120/600/1,200/3,000/6,000v. D.C. 0/6/30/120/600/1,200v. A.C. 0/60μA/6/60/600mA. 0/6K/600K/6Meg./60 Meg.Ω 50pF. 0·2mFd. **£5.19.6.** P. & P. 3/6.

★ TRANSISTORISED FM TUNER ★

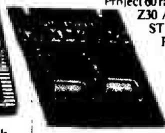


6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6 × 4 × 2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88–108Mc/s Ready built ready for use. Fantastic value for money. **£6.7.6.** P. & P. 2/6. Stereo multiplex adaptors **99/6.**

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM

Operative over amazingly long distances. Separate call and press to talk buttons, 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. **£6.19.6.** P. & P. 3/6.

SINCLAIR EQUIPMENT



Project 60 range of new models now in stock.

Z30 Amplifier	89/6
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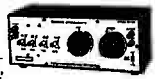

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PRACTICAL WIRELESS

VOL 45 NO 12

Issue 758

APRIL 1970

TOPIC OF THE MONTH

Behind the times

WHAT on earth are the BBC and the Government up to? Having decided to open twenty local radio stations by the Autumn and twenty more within the next few years, and having found accommodation for them in Band II, the Minister of Posts and Telecommunications decides that these stations will also operate partly on m.w.

A government decision in the face of BBC opposition? Certainly not, for Ian Trethowen, managing director of BBC Radio, "warmly welcomes" the Minister's decision. The justification for using m.w. channels is said to be the shortage of suitable car radios and lack of v.h.f. portables. This is largely nonsense, although our set makers *have* been somewhat tardy in producing v.h.f. car radios.

But who can blame them for this, when the BBC still clings pathetically to a.m. For if the BBC is not seen to be convinced that v.h.f.-f.m. radio is the medium of today then how can set makers and the general public be swayed?

The BBC has been bold enough to set a target for the phasing out of 405-line v.h.f. television and this, of course, has given the industry and the public clear guide lines. What we need is a similar declaration on the future of sound broadcasting. As it is, the grandiose BBC plan of "Broadcasting in the Seventies" could be construed as meaning the *Eighteen* Seventies! Not to labour the point, our sound broadcasting is twenty years or so behind the times. Whereas, after the war, Europe and the USA in particular, put their faith in v.h.f.-f.m. we have largely dragged our heels, seemingly reluctant to take the final decisive plunge.

The local stations will use a.m. only during daylight, so that the best those without v.h.f. receivers will have is half a service. This is futile and half baked! So much so, that one can be excused for suspecting ulterior motives. And the only one we can think of at the moment is that the BBC and/or the Government have agreed to establish squatters rights on the two m.w. channels to thwart pirate and/or commercial stations from setting up house.

Whatever the case, the decision to use m.w. part of the time is a negative one and not in the interests of the development of sound broadcasting in this country.

W. N. STEVENS—*Editor.*

MAY ISSUE WILL BE PUBLISHED ON APRIL 3

NEWS AND COMMENT

CONSTRUCTIONAL

OTHER FEATURES

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

Brema figures

Colour television deliveries to the Trade continued to rise during November (when three channel colour broadcasts officially began) according to the Economic and Statistical Division of the British Radio Equipment Manufacturers' Association. 28,000 colour sets were delivered, bringing the total for the period January-November to 129,000 sets.

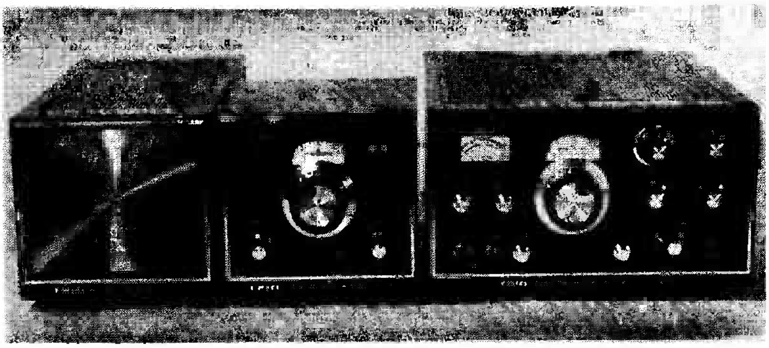
On the other hand, for the sixth month running deliveries of monochrome sets fell below the comparable month for 1968—165,000 monochrome sets were delivered in November, 9% below November 1968 (181,000).

The slight recovery in deliveries of radiograms has continued and for the third month in a row deliveries for the month have improved on the same month for 1968—deliveries in November were 25,000 as against 24,000 in November 1968.

No end to the fall in deliveries of radios (67,000) and car radios (20,000) was experienced in November; for the period January to November the figures continue to be 28% and 15% respectively below 1968.

These estimates are net figures of deliveries by manufacturers to the home market on firm and other accounts including those to specialist rental and relay companies.

A trio from Trio



At the November 1969 R.S.G.B. Exhibition, Trio (B. H. Morris & Co. (Radio) Ltd.) introduced a new transceiver—the TS510 together with a companion v.f.o. and power supply/speaker unit.

The TS-510 Transceiver, on the right of the picture, employs a high-frequency crystal filter and covers all Ham bands from 3·5 to 29·7MHz. Both Rx and Tx sections employ the dual conversion configuration. The receiver is a dual-conversion superhet in which the r.f. and local oscillator are independently tuned. A selectivity switch is provided for s.s.b. and c.w. modes and the a.g.c. circuit features signal strength meter indication independent of r.f. gain adjustment. Type of emission is s.s.b. (A3J), c.w. (A1). Rated input: 160W at 3·5-21 MHz, 120W at 28MHz. The transceiver uses 14 valves, 2 f.e.ts, 13 transistors and 29 diodes. Dimensions: 13 x 7 x 13⅝in.

Stability is assured in the v.f.o. type 5D through the use of two f.e.ts plus two other transistors. This unit is equipped with the same precision double-gear drive as the TS-510 transceiver which tunes a 25kHz range in one rev. Crystal controlled operation permits spot channel communication and built-in RIT circuit permits slight shifting of receive/transmit frequencies when desired. Frequency range on 80m is 3·5-4·1 MHz; 40m 7·0-7·6MHz; 20m 14·0-14·6MHz; 15m 21·0-21·6MHz; 10m (A) 28·0-28·6MHz; 10m (B) 28·5-29·1MHz; 10m (C) 29·1-29·7MHz.

The PS 510 power supply speaker unit measures 7½ x 9 x 12in. approx. Further details may be obtained from *B. H. Morris & Co. (Radio), 84-88 Nelson Street, London, E.1,* or your nearest amateur radio equipment stockist.

The new President, Dr. Saxton

The present and past

Dr. J. A. Saxton, DSc., PhD, CEng, FIEE, FInstP was installed as the 36th President of the Radio Society of Great Britain on January 16th.

Dr. Saxton, before, during and after the last war, was working on propagation studies and research in radio meteorology. He was appointed Deputy Director of the Radio Research Station in 1960 and in 1964 to 1966, he held the post of Deputy Director of the U.K. Scientific Mission and scientific counsellor at the British Embassy, Washington, U.S.A. Upon returning to the U.K., Dr. Saxton was appointed Director of the Radio & Space Research Station.

Immediate Past President, J. W. Swinnerton.

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

Oh to be in Finland

Christmas in Helsinki, Finland, was made a little livelier in 1969 due to the medium of TV. Finnish people were shocked when a pornographic film was shown over the air. Apparently the film was meant to be a closed-circuit test picture but it was put out on the air because a technician did not pull the right switch!

Bromsgrove move

The Bromsgrove & District Amateur Radio Club, G3VGG, (Club Spot February) now meet at the Royal Oak pub, Catshill, Bromsgrove. Meetings are held the second Friday of the month at 8 p.m.

Mobile radio systems

A conference on "Mobile Radiocommunication Systems" is to be held from June 30th to July 2nd. The conference which is being organised by the Society of Electronic and Radio Technicians will be held at Brunel University, Uxbridge.

The conference will deal principally with vehicular and personal mobile systems. The increase of this field of communication, makes the subject of very wide interest not only to those already operating such systems but also to those contemplating such a step. The conference will cover all aspects of mobile radiocommunication including propagation problems, system planning and design, statutory requirements and manufacturer and user experience.

This will primarily be a non-residential conference although hostel accommodation has been reserved for those delegates who are unable to travel to and from Uxbridge each day. The registration fee including lunch and refreshments each will be £7 7s. 0d. for members of the Society and £10 10s. 0d. to non-members.

Further information and registration forms may be obtained from: *The Conference Secretary, Society of Electronic and Radio Technicians, Faraday House, 8-10 Charing Cross Road, London, W.C.2.*

Lasky's Hi-fi centre

Europe's biggest Hi-Fi and audio centre was officially opened in London recently. The Chairman of the company which operates the 5,000 sq. ft. store, Mr. Harry Lasky told over 150 electronics company guests from all over the world, "Our customers will have the choice of more than 10,000 items of equipment—that is the biggest selection outside the USA."

The centre in Tottenham Court Road, W.1. contains a demonstration studio where customers, with the aid of a custom-built comparator, can instantly compare the latest Hi-Fi installations exactly as they will sound in their own homes. Experts staff the new centre and they will plan a 'customised' system to suit the home and pocket of the prospective customer.

Mr. Lasky said, "Our new centre is designed to cater for the absolute beginner as well as the enthusiast with thousands of pounds to spend and it is an important landmark in the continuous process of introducing Hi-Fi to an ever-widening circle of the public."

The address of the new centre is: 42-45 Tottenham Court Road, London, W.1. Another Hi-Fi audio centre is at 118 Edgware Road, London, W.2. and the seven-branch group headquarters is 3-15 Cavell Street, London, E.1.

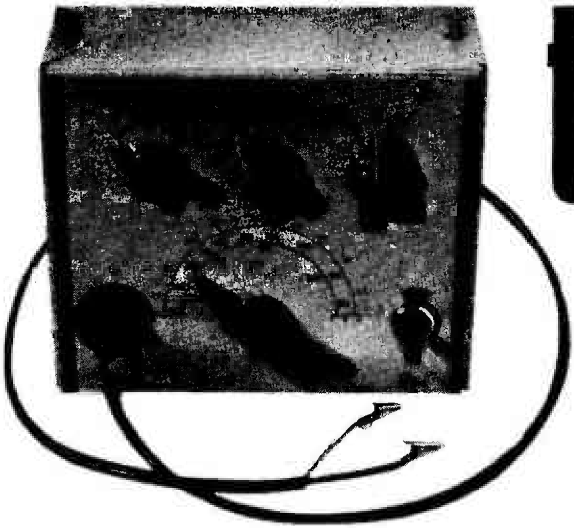
The photograph shows the Lasky demonstration studio which enables customers to make a balanced comparison of equipment.

Motorola semiconductor data book

Motorola have just announced the availability in the U.K. of the fourth edition of 'The Semiconductor Data Book'. The price is £3 (plus 6s. postage) and it is available through the Modern Book Co., 19 Praed Street, London, W.2.

This latest edition has been enlarged (it now includes 2,160 pages) and the format has been redesigned to make it easier to retrieve data. Instead of a number of product catagories, discreet device specifications are presented in alphanumeric sequence in three major sections, namely: '1N' numbered devices, '2N' and '3N' numbered devices, and devices with Motorola house numbers. Also included is a 50-page section of selection guides which enable application needs to be directly related to semiconductor device numbers. Furthermore, the Data Book lists all EIA registered 1N, 2N and 3N devices along with their short-form specifications.

In all, more than 12,700 types are listed together with details of their characteristics.



transistor

A SIGNAL generator is extremely useful for trimming, aligning and testing receivers, and testing amplifiers. The transistor signal generator described here is of small size, and has three tuned ranges:

(1) 190-375kHz (approx. 1600-800 metres).
(2) 375-1000kHz (approx. 800-300 metres).
(3) 1·1-2·8MHz (approx. 275-105 metres).

These frequencies are available as c.w., or modulated with an audio tone. In addition, the audio tone is available, for amplifier and audio circuit checks. The ranges cover 470kHz, 1·6MHz and similar intermediate frequencies, as well as medium and long waves, while harmonics can be used for higher frequencies.

Circuit Details

Figure 1 is the circuit, Tr1 being the audio oscillator, with feedback from primary to secondary of the transformer T1. Tr2/Tr3 are in the r.f. oscillator circuit, tuned by VC1. S3/S4 is a 2-pole switch, selecting coils L1, L2 or L3, for the required band.

S1/S2 is a further 2-pole switch. When S1 is at "C.W." the base of Tr1 is shorted to the positive line, cutting off Tr1. Tr2/Tr3 then provide an unmodulated r.f. signal, via C7, S2, and R9. With S1/S2 in the "Mod" position, Tr1 oscillates at audio frequency, and modulates Tr2/Tr3 due to the a.f. impedance of C2/R10. This gives an audible r.f. signal. With S1/S2 at "A.F." Tr2 base is shortend and moved positive, while a.f. from C4 is taken by S2 to R9. In all cases VR1 is an attenuator, and C8 gives d.c. isolation of external circuits.

Each kind of output signal—c.w., modulated, or a.f.—has its own particular uses, described later.

The coils L1, L2 and L3 are of fixed inductance, and manufactured to a high degree of accuracy. So provided VC1 is the capacitor listed, band coverage and calibration can be expected to agree well with that given. If wished, individual calibration can be made in the way described.

Panel and Case

The completed generator is 5 × 6 × 2in. and the case is made from "universal chassis" members. The box has a 5 × 6in. front, and sides 5 × 2in., top and bottom being 6 × 2in.

Sides, top and bottom are flanged, so they can be fitted later. This allows all construction and wiring to be done with the front and bottom only fitted together as in Fig. 2. Holes should be punched in

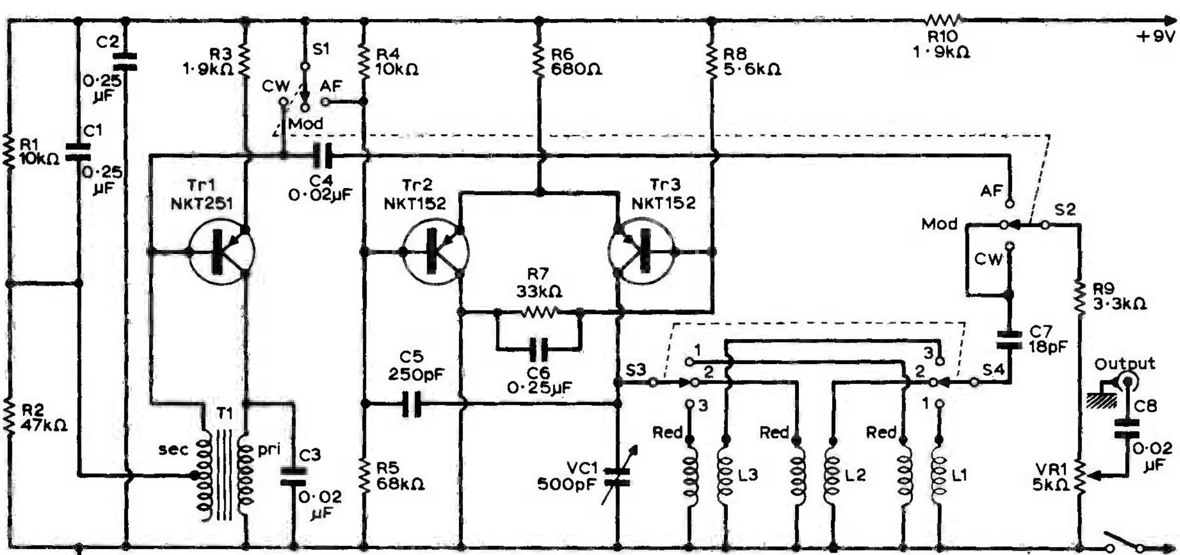
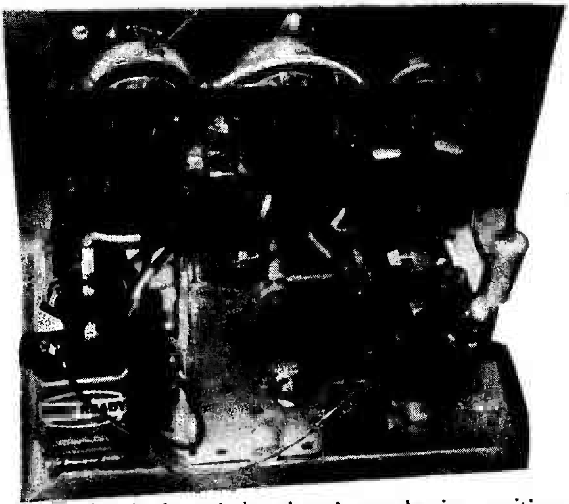


Fig. 1: Complete circuit of minigenerator

mini generator

R.F. GRAHAM



the front for VC1, the switches, output socket, and VR1. VC1 is bolted to the bottom runner, which is then fixed to the panel. A countersunk bolt with extra nuts is passed through the panel and a hole in the top corner of the frame of VC1, the tag MC being locked here.

L1, L2 and L3 are held with countersunk bolts, through the panel and base into the mounting strips. The socket for C8 provides an output insulated from the metal.

The items in Fig. 2 are wired as shown, with sleeving on all leads. Note that the circuit has a negative earth (metal box), not positive as in much transistor equipment.

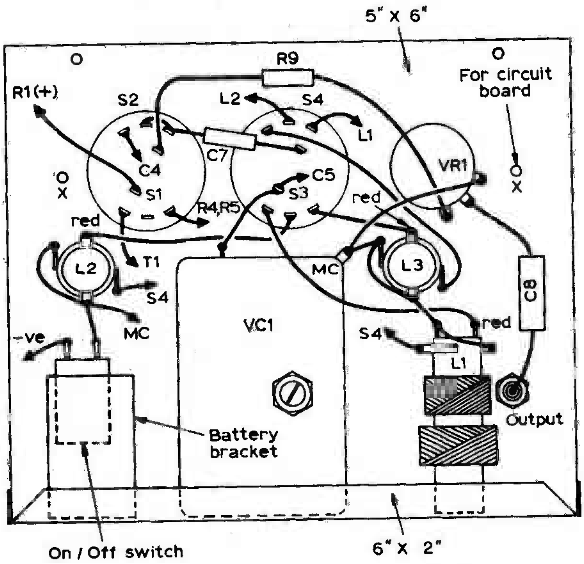


Fig. 2: Major component layout and wiring

The other components are assembled on a paxolin panel 5 × 1½in., as in Fig. 3. The holes X-X of the circuit board match holes X-X in the metal panel, Fig. 2. Countersunk bolts pass through the panel, and are locked here. Extra nuts are put on the bolts, and the finished circuit board can then be put into place, and held with further nuts, resting behind VR1 and the rotary switches.

The transformer is a driver type for OC81D/2xOC81, and if a different transformer is fitted, it may be necessary to reverse connections to one winding, to obtain audio oscillation.

Wiring of the circuit board should be quite straightforward. Take thin red flex from R10, for the battery positive connection. Leave flying leads from the points shown, for S1, S2, etc.

The circuit board is placed nearly in position, and the leads cut and soldered to S1, S2 and S3. The MC or negative connection is to the tag at VC1, and metal cabinet. The board can then be pushed right on the bolts, and held with nuts, leaving a little space between it and the tags of the switches.

Case

The generator can be tested before finishing the case, by setting the switch to "Mod" and swinging VC1 on Range 2, when an audio tone should be heard in a nearby receiver on medium waves.

Elastic holds a PP3 9V battery to a bracket behind the on/off switch. Current drain is about 2-3mA at "Mod" with about 4½V working voltage due to drop in R10. The back is held in position with self-tapping screws.

Calibration

By fitting the specified coils and tuning capacitor VC1, coverage about as listed can be expected. The pointer knob is fully clockwise with VC1 closed, so goes a little beyond the mark at the other end of the scales.

CALIBRATION POINTS

Range 1	°	Range 2	°	Range 3	°
180 kHz	179	375 kHz	169	1·1 MHz	166
200 „	147	400 „	149½	1·2 „	143½
250 „	95	450 „	123	1·3 „	127
300 „	58	500 „	99	1·4 „	112
350 „	27½	550 „	82	1·5 „	98
375 „	14½	600 „	68	1·6 „	87
		700 „	56½	1·7 „	76½
		800 „	42	1·8 „	67½
		900 „	24	2·0 „	51
		1000 „	3	2·5 „	30
				2·8 „	13

The frequency markings are copied on the card, before finally adding the perspex, and knobs. If the scales are to be individually calibrated, first put frequency markings directly against the pointer position, then add the perspex later.

For individual calibration of the scales, one of several methods can be used, according to the equipment available. The brief details following should be helpful.

With Signal Generator. If a calibrated generator can be borrowed, tune it to various frequencies, tune in the signal with a receiver, and adjust the Minigenerator tuning to the same frequency and mark its scale.

With Calibrated Receiver. If an accurately calibrated receiver is to hand, set this at various frequencies, tune the Minigenerator to the same frequencies, and mark its scales. This is the easiest and most accurate method when harmonic pips from a 100kHz crystal marker are available to give exact receiver tuning throughout.

With Uncalibrated (or poorly calibrated) Receiver. Tune in the BBC on 200kHz. Tune Minigenerator to same frequency, and mark 200kHz. Leave Minigenerator tuning untouched, and tune receiver to harmonic heard on 400kHz. Leave receiver tuning untouched, tune Minigenerator to 400kHz, and mark its scale. Repeat the procedure each time for 600kHz, 800kHz, 1,000kHz, etc., up to 1,400kHz for a MW receiver, and up to 2,800kHz (2·8MHz) for an all-wave receiver.

Use of Harmonics. Tune the receiver to a known high frequency, such as MSF, or 2,000kHz derived from the 200kHz BBC transmission as mentioned. Leave the receiver tuning, and tune the Minigenerator progressively towards lower frequencies. Harmonics will then be heard when a multiple falls on 2,000kHz (or other chosen frequency). As example, on 1,000kHz (x2), 500kHz (x4), 400kHz (x5), and so on. This allows calibration over 400-500kHz, for intermediate frequencies.

★ components list

Resistors:

R1	10k Ω	R6	680 Ω
R2	47k Ω	R7	33k Ω
R3	1·9k Ω	R8	5·6k Ω
R4	10k Ω	R9	3·3k Ω
R5	68k Ω	R10	1·9k Ω

All resistors 10% ½ watt
VR1 5k Ω linear pot.

Capacitors:

C1 0·25μF 150V
C2 0·25μF 150V
C3 0·02μF 150V
C4 0·02μF 150V
C5 250pF silver mica
C6 0·25μF 150V
C7 18pF silver mica
C8 0·02μF 350V
VC1 Jackson 500pF variable, Home Radio Cat. No. VC5.

Semiconductors:

Tr1 NKT251
Tr2 NKT152
Tr3 NKT152

Miscellaneous:

L1, L2, L3. C083A, C083G, C083F, Home Radio; 5 x 6 x 2in. Universal chassis CU13, Home Radio; Two 2-pole 3-way rotary switches; On/off toggle switch; T1 Type RS.T/T6, Home Radio; KN9 type knob; PK4 insulated socket; PK3 plug; BTS33 perforated eyelet board, Home Radio; PP3 battery; sleeving; bolts; etc.

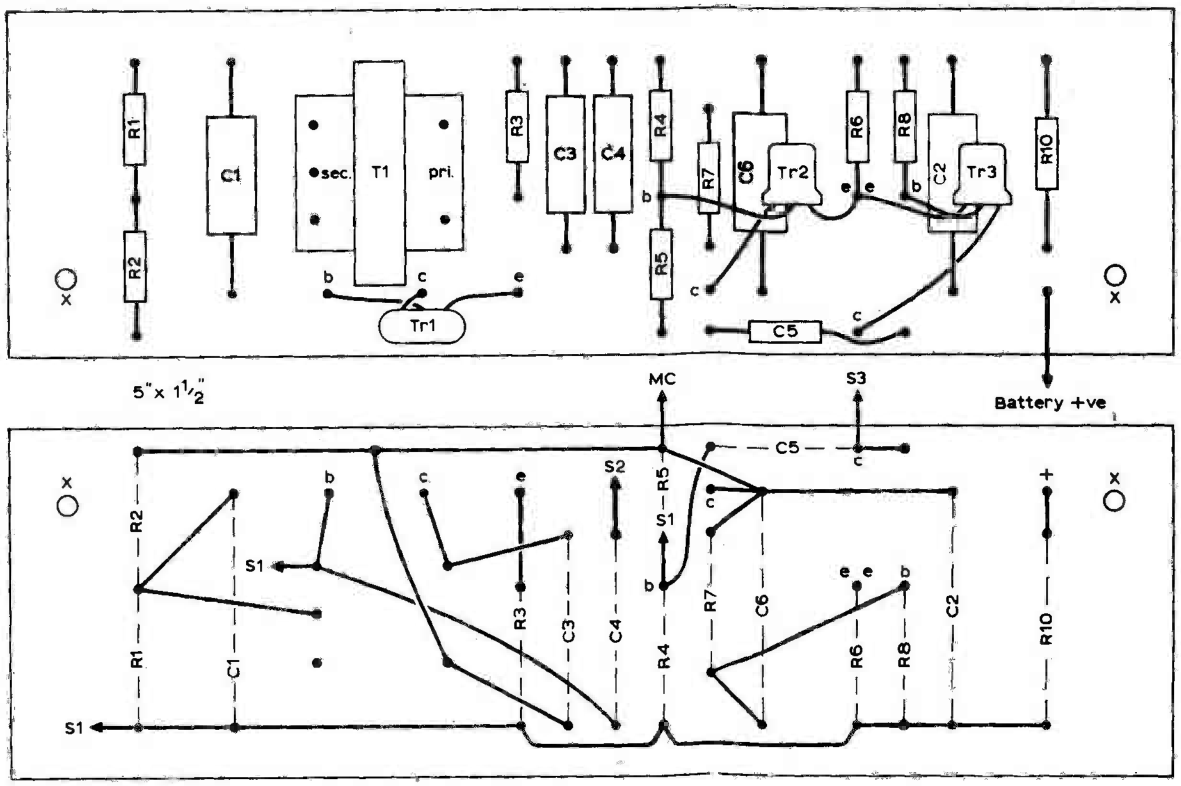


Fig. 3: Circuit board component layout and wiring

Generator Output

The c.w. output resembles that of a transmitter during a silent interval in programmes. It will heterodyne with another c.w. signal (as from a crystal marker) or can be heard with a receiver having a b.f.o. It operates a tuning meter or indicator. It is used for critical alignment.

The modulated output has an audio tone accompanying the r.f., so can be tuned in with any receiver, and heard with the loudspeaker.

The a.f. output is used for audio circuit tests only, by injecting a.f. into various amplifier points, working backwards from the loudspeaker. When signals cease, the last coupling circuit or stage introduced is the one at fault.

To Align I.F.T.'s

Set the generator to the wanted intermediate frequency. Should the i.f.t.'s be badly out of alignment, work backwards from the detector, dealing with them in turn. Then inject at the mixer base or signal grid, and check all i.f.t. cores. With all such work, keep signal strength well down. Output can be checked with a meter in one battery lead, with push-pull transistor receivers, or with an a.f. meter, or by watching the a.v.c. voltage.

Checking Band Coverage

To adjust a receiver band coverage, set oscillator trimmers at the h.f. end of each band, and coil inductance at the l.f. band ends. In this way each band can be adjusted to have the wanted frequency range.

R.F. Alignment

To adjust aerial or r.f. circuits for best results, deal with each band separately, in the manner described for the receiver. This usually requires that trimmers are set for best results near the h.f. end of a band, and coil inductances are adjusted near the l.f. end of each band.

Coupling

Coupling from the signal generator to a receiver should always be very loose. With portables, a short lead can be plugged into the generator output socket, and placed near the receiver or its ferrite aerial. For other receivers, connect a short lead to the aerial socket, and place this near the generator output lead, or lightly twist the insulated wires together.

Use of Harmonics

There are two main uses for the harmonic outputs of the signal generator. Such outputs are on multiples of the frequency to which the generator is tuned. For example, if the generator is tuned to 1MHz, a signal will be heard on 1MHz, 2MHz, 3MHz, 4MHz, and other multiples, the limit depending on receiver sensitivity. If the generator were tuned to 1MHz, a home-built receiver could thus be tuned from 1MHz upwards, and its scales marked to indicate 2MHz, 3MHz, etc. In this particular case, the 0·5MHz points could be found as harmonics of 0·5MHz, or 500kHz, if wanted.

Harmonics also allow exact calibration of small frequency bands. As example, if the generator is tuned to 200kHz, harmonics will appear on multiples of this. Those on 1,800kHz and 2,000kHz would set the limits of the 1·8-2·0MHz amateur band.

With a completely uncalibrated receiver, harmonics may if needed by identified by using the generator on two frequencies. As example, if all 1MHz points are marked, but not known, 5MHz can be identified by tuning the generator to 2·5MHz, as the 2nd harmonic falls on 5MHz. Or 6MHz could be identified from 2MHz on the generator (3rd harmonic), which would also give 4MHz as 2nd harmonic. When one frequency has been identified in a receiver tuning range, the remaining 1MHz points can be counted up and down from this.

Audio Circuits

These are tested by injecting a.f. With some equipment, an earth return is required, from equipment chassis to generator case. The earth terminal allows this.

Tests should not be made on a.c./d.c. equipment, having a live chassis.

Where little or no amplification is available, the full generator output will be wanted. But when tests bring into circuit one or more amplifier stages, output must be reduced with the generator potentiometer VR1, to avoid overloading the output or other stages in the receiver or amplifier. ■

I.C. OF THE MONTH

L.A.J. IRELAND

Number 6 — The Sanken SI-1020A/50A Audio Amplifiers

JAPANESE electronic firms have always been quick to follow on the heels of their American and European counterparts and the same trend is becoming evident in the world of microcircuits. Lately the Sanken Electric Co. of Tokyo has introduced two rather advanced hybrid i.c.'s one of which can give an audio output power in excess of 50 watts. A very attractive feature of the units is that they comprise virtually the complete amplifier, the only external components required being a power supply, loudspeaker of 8Ω impedance and coupling capacitor. They provide therefore an ideal beginners project in electronics since with so few components involved, success is virtually guaranteed and a first-class hi-fi amplifier obtained.

A look at Fig. 1 shows that the amplifier itself is fairly orthodox and straight forward in design. The common emitter input stage Tr1, provides a typical input impedance of 70kΩ and degeneration from the output can be applied across its emitter resistor via pin 3 of the i.c. The signal is then r.c. coupled to Tr2 which acts as a driver for the complementary pair Tr3 and Tr4 and these in turn are direct coupled to the power output stage. Provision is made for the inclusion of a ripple filtering circuit in the 1050A version which is not included in the 1020A.

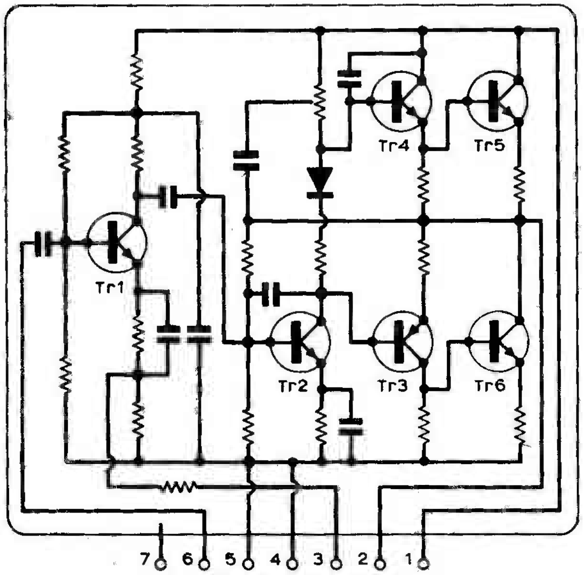


Fig. 1: Circuit of the SI-1020A

Characteristic	Symbol	SI–1020A	SI–1050A
Supply Voltage	V_{cc}	48V	62V
Maximum Continuous Output Power (distortion <0·5%)	P_o max (rms)	25W	50W
Voltage Gain	G_v	30dB typ.	30dB typ.
Frequency Range (output 1W)		20Hz—100kHz	20Hz—100kHz
Input Impedance	Z_{in}	70kΩ typ.	70kΩ typ.
Output Impedance	Z_{out}	0·2Ω typ.	0·2Ω typ.
S/N Ratio		90dB typ.	90dB typ.
Idling Current		30mA typ.	30mA typ.

CONDITION : 25°C ambient, 1kHz, R_L=8Ω

Electrical characteristics of the two amplifiers

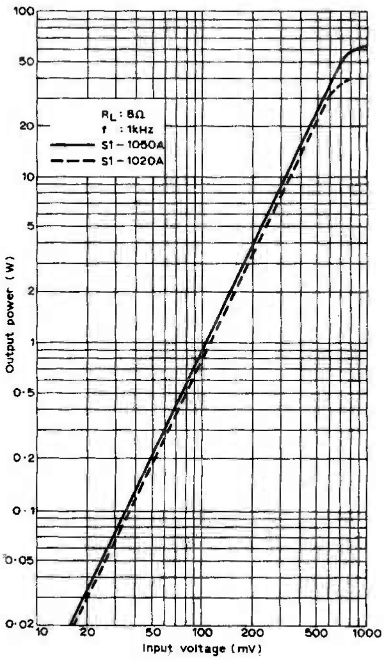
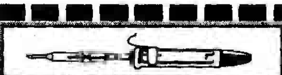


Fig. 2: Graph showing required signal input for a given power output.

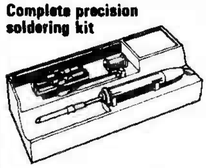
Sign here.! for your miniature soldering iron.

CN 15 Watts. Ideal for miniature and micro miniature soldering. 18 interchangeable spare bits available from .040" (1mm) up to 3/16" For 240, 220, 110, 50 or 24 volts.

from 32/6



Complete precision soldering kit



This kit—in a rigid plastic "tool-box" — contains

- Model CN 15 watts miniature iron, fitted 3/32" bit. Interchangeable spare bits 1/8", 3/16".
- Reel of resin-cored solder
- Felt cleaning pad
- Stand for soldering iron

PLUS 38-page booklet on "How-to-Solder"—a mine of information for amateur and professional.

From Electrical and Radio Shops or send cash to Antex. **49/6**

Model CN 240/2
15 watts - 240 volts
Fitted with nickel plated bit (3/32") and in handy transparent pack. From Electrical and Radio Shops or send cash to Antex. **31/-**

A N T E X

PRECISION MINIATURE SOLDERING IRONS

Antex, Mayflower House, Plymouth, Devon.
Telephone: Plymouth 67377/8.
Telex: 45296. Giro No. 2581000.

☐ Please send me the Antex colour catalogue

☐ Please send me the following irons

Quantity	Model	Bit Size	Volts	Price
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

I enclose cheque/P.O./cash value ....

NAME ....

ADDRESS ....

.... PW4

A diagram of the complete amplifier together with a suitable power supply is given in Fig. 3. The 1A fuse (2A in the case of the 1050A model) in series with the power supply provides adequate protection in the event of a short-circuit of the loudspeaker terminals. The units themselves are capable of withstanding a short-circuit of the output terminals for 5 seconds under all operating conditions and so the fuse will blow before any damage is done. The metal housing in which the amplifier is mounted provides sufficient heat dissipation and in addition it can be directly bolted to the chassis or case without the need for insulating washers as it is electrically insulated from the i.c. itself. The 1020A measures approx. 3·15in. × 1·8in. and the 1050A 3·9in. × 1·6in. approx. overall.

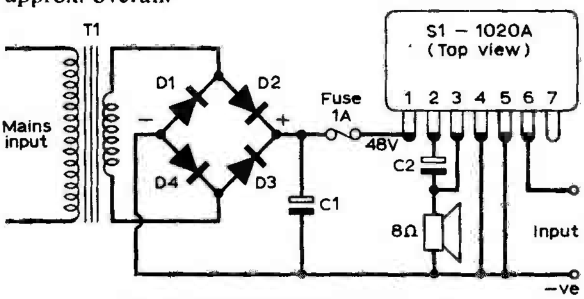


Fig. 3: Circuit of suitable power supply

Two very attractive features of the units are their frequency response, 20Hz. to 30kHz., and harmonic distortion of less than 0·5% at the full output power levels and with a signal to noise ratio of greater than 90dB. they should fill the requirements of the most discerning hi-fi enthusiast. One slight disadvantage however, especially if the units are to be put to mobile use is the rather high operating voltage required but even here idling current has been reduced to a mere 30mA which ensures economical battery operation.

★ components list

Capacitors :

C1 4000μF 60V (70V for 1050A)
C2 2000μF 30V (40V for 1050A)

Miscellaneous :

D1-4 60V 1A (70V 2A for 1050A)
(Henry's Radio Type RS32AF)
T1 Transformer (Henry's Radio Type MT104AT)
IC Type SI-1020A or SI-1050A
(Photain Controls Ltd., Randalls Road, Leatherhead, Surrey)

The signal input levels required for various power outputs can be derived from Fig. 2.

At the present state of the art, these are the most powerful i.c.'s available and provide the obvious answer to anyone requiring a rugged and miniature audio power amplifier.

NEXT MONTH: The RCA 3052 i.c., comprising four separate amplifiers, will be reviewed. It is ideal for use ahead of the SI-1020A or SI-1050A amplifier reviewed above. ■

THE MW COLUMN

CONDITIONS on the band this winter have been the best for several years. Especially noticeable were the number of Far East stations logged in the afternoons—China on 940, 1000, 1230 and 1290kHz, Taiwan on 750 and 1200, Ryukyu islands on 1178 and 1360, South Korea on 1190. Calcutta 1130kHz was a regular for several weeks. Near East stations logged were Bagdad 760, Teheran 895 and 1325, Kabul 1280, Kuwait 1345 and at night the Indians—Rajkot 1070 and Jabalpur 1180. North American DX was almost unbroken all winter. The writer started the year with a fine logging of *KOMO Seattle* on 1000kHz from 0740 to 0800 Hrs GMT on the 2nd January. Earlier the same morning *WVOV Huntsville Alabama* on the same frequency was heard doing an equipment test at 0630. Other DX includes *CBF Montreal* 690kHz, a Newfoundland relay station on 740, *WJR Detroit* 760, *WWL New Orleans* on 870, *CBM Montreal* 940, *WCFL Chicago* 1000, *CFRB* 1010 in Toronto, *KMOX St. Louis* on 1120, *WBT Charlotte North Carolina* 1110, *WOAI* 1200 in *San Antonio Texas*. Some of the best North American DX occurs in the spring and autumn. Stations that have been logged in this country are *KOMO* 1000kHz in *Seattle*, *KING* 1090 also in *Seattle*, *KNX* 1070 *Los Angeles*, *KEX* 1190 *Portland Oregon*, *KFBK* 1530 in *Sacramento, California*.

The Caribbean area is often heard well at this time of year. After midnight, look for *CMGN* 720kHz *Radio Rebelde* in Colon, Cuba, *St. Vincent* in the Windward Islands on 705, *Port Maria, Jamaica*, on 750 with the call *JBC*, *ZFY Radio Demerara, Georgetown, Guyana*, 760, *ZBVI Roadtown, Tortola, British Virgin Islands* on 780, *PJB Trans World Radio Bonaire Netherlands Antilles* on 800 (an easy one), *4VEC 'La Voix Evangelique'* 830kHz *Cap Haitien, Haiti* in French and English, *Radio Belize, British Honduras* on 834, *Radio Caribbean* 840 *Castries, St. Lucia* in English and French, *Radio Antilles* 930 in Montserrat, *Leeward Islands* in French and English, *TIFC 'The Lighthouse of the Caribbean'* 1075kHz in Spanish and English, *WBMJ* 1190kHz in *San Juan Puerto Rico* with pop music and English announcements, *PJD2 'The Gospel Voice of the Eastern Caribbean'* 1295kHz in *St. Maartin, Netherlands Antilles* in Dutch and English. A new station is *Radio Anguilla* on 1505kHz with a power of 500 watts.

The new 1000kW station at *Beida, Libya*, is now on the air on 1124kHz and has been heard in North America. Another powerful North African is *Azilal Morocco* on 209kHz on the Long Waves. This station is the only African on this band and it can be heard in Spanish, French and English as well as in Arabic. The Spanish station audible at sunset on 1140 is ECS11 *Radio Centro Madrid* which has moved from 1394kHz. Another member of the same network is ECS13, *La Voz de Ciudad Real*, currently on 1145kHz.

CHARLES MOLLOY

practically wireless commentary by HENRY

No. 67

Just playing about!

I DO not know Mr. Matthews. And he knows Henry only by the odd effusions he occasionally picks up in this column. Odd. it would seem, is hardly a strong enough term. My informant is Mrs. Matthews, whose bus-top confidences to Mrs. Henry sparked off the idea for this month's contribution.

You see, Mr. Matthews is one of our unsung electronic heroes—a radio enthusiast, an avid constructor, a lonely wielder of the soldering iron who does not believe in flaunting his merits abroad. In the privacy of his own two-up, two-downer, he struggles with the intricacies of transistor testers, knocks up a record player for his younger daughter. modifies the family radio set and will one day provide his doted-on grandson with a personal communications receiver.

Henry would never have heard of him if it were not for his distressing tendency to drop hot solder on the tufted living-room carpet. One can almost hear the whoops of commiseration as the two ladies swopped horror stories.

'It's just the same in our house! Once he gets his nose into that book, and spreads his wires all over the floor, there's no stopping him.'

That book, as you will have guessed, is *Practical Wireless*, which, if the ladies get the emancipation they are militating for and rule our lives in deadly earnest, will soon join the Fahrenheit 451 list of banned, subversive literature. And what will Henry do then, poor thing?

"My informant is Mrs. Matthews"

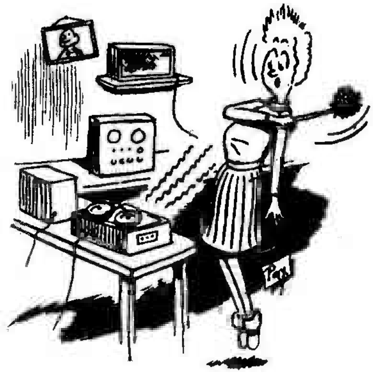
Well, I'll tell you what he may do. He may join Mr. Matthews and others of like bent in the formation of a radio-dabblers underground movement. One of the basic rules is that members shall have suffered at least a single eviction from what they thought was going to be a snug den, to a draughty corner of the potting shed or equivalent.

The ladies, bless them, just do not understand. Poor Mr. Matthews, I am told, has suffered the final indignity of having his precious equipment jocularly dismissed as 'toys'. He is 'permitted' to play at set hours, in carefully circumscribed places, so long as he does not make too much noise. That he still manages to derive a great deal of fun from his hobby is as much a tribute to his sense of humour and tolerance as to the well-known attraction of the electron. A few spots of solder on the Cyril Lord are a small price to pay for such peace of mind that our hobby can give—and, after all, flourishing pliers and tin-snips does not drag us away from the family hearth. That is surely a plus-point, madam?

Reading this, Mr. Matthews will realise I am joking—having mastered the initial shock of my intrusion into his privacy. Indeed, I would not have known about him at all—though he, apparently, has the advantage of me—were it not for his wife's very obvious pride in her lord and master's prowess.

The fact that a chap can string two wires together and make an invisible power give voice smacks something of witchcraft and we all know how superstitious the hausfrau can be.

Mrs. Henry, for example, has little regard for my prowess as a gardener. She prefers to remember the time I uprooted a corner of dormant 'busy-lizzie' in the belief I was ridding the world of convolvulus rather than the bird-activated pea-protector that very nearly was successful. Only the switching time of an OC71 was the best we could do in those days . . .



"Programmed to yell 'don't touch me!

But the communications corner of my den still scares her. In this last refuge, from which I am still winkled when the approach of visitors demands I turn it back into the spare bedroom, I can at least be sure of some isolation. I believe my advantage stems from the time Joe and I were experimenting with an intriguing—and probably quite illegal—voice-operated CQ switch, and Mrs. H. was interrupted in the middle of a private tidying-up session by the clicking of relays and a disembodied Joe asking: 'Hallo there, are we together?'

It would not be much trouble for Mr. Matthews and me to collaborate in the design of a series of proximity switches that could activate a solenoid-switched tape recorder programmed to yell 'Don't touch me!' loud and clear. Now *that* would be a toy worth having. Even better than that electronic shoehorn (bootstrapped circuit, of course) that young Bob has promised to make me.

ON THE SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

Times in GMT • Frequencies in kHz

THE BROADCAST BANDS

Malcolm Connah

This month I have enough DX News and logs to fill several pages so I will start with:—

Peter Giles of Wolverhampton has a Heathkit RG-1 and a 70 foot end-fed aerial which enabled him to send in the following log:—

11855 *S. Arabia* in English from 0430 to 0530
11970 *R. Lebanon* in English from 0230 to 0300
15105 *WIBS* in English (weak signal), 1945 to 2130
17705 *Havana*, Cuba in English from 2010 to 2138
17920 *UAR* in English from 1315 to 1430.

N. G. Pope of Chesterfield also heard the Saudi Arabian station in English on 11855 but at the earlier time of 1716-1730.

Mr. Pope also mentions that the *Voice of Denmark* will continue to broadcast in Danish in accordance with the following schedule:—

On 15165 at 0730-0815, 0945-0950, 1130-1155, 1200-1245, 1330-1345, 1400-1445, 1730-1815, 1830-1915 and 2100-2145 also on 9520 from 0100-0145.

The station will only answer letters and reports which are written in Danish.

Mr. T. R. Gibbs of Swindon sent me his log which included: *Radio Portugal* on 17895 and 21495 at 1350-1415: *Radio Australia* on 9570 at 2100-2130 and *All India Radio* on 7215, 11775 and 15435 at 2200-2230.

Michael R. Preston of London, NW11 used his HMV Domestic and 12 metre wire to send in one of the best logs this month:—

9540 *R. Lubumbashi*, Katanga, Congo in French at 2200
9605 *Athens* at 1832
11925 *Tashkent* at 1400.

Michael also mentions that *Radio Finland* now uses 11755 instead of 11805 in all transmissions including English from 1800-1830 which is also on 9550 and 15185. Another news item from Michael says that *Radio New Zealand* plans to increase its power from 7·5 to 20kW.

Robert Hanstock of Sheffield sent me the English schedule of *Radio Belgrade* which reads:—

1530-1600 on 9620, 11735 and 15240; 1830-1900 on 6100 and 2000-2030 on 7200 and 9620.

Another good log came from **Mr. R. Ellis** of Stroud with his Hammarlund receiver and 49 metre 'V' dipole:—

7250 *Vilnius, Lithuania* from 2230 to 2300
11855 *S. Arabia*, good signal from 1830 to 1900
15150 *Radio Kuwait*, 55455 from 1600-1615
15180 *ETLF* in English sign on at 1600
15255 *HCJB*, Ecuador, 54343 from 1900 to 1915
17750 *Karachi*, Pakistan, 44344 from 1500 to 1511
17850 *Bucharest*, Rumania, 44233 from 1315 to 1330.

Kevin Goulding of Bath informs me that the World Radio-TV Handbook Co. Ltd. (see December 1969 issue) has changed its address to: Søliljevej 44, 2650 Hvidovre, Denmark.

Africa

Sierra Leone: The latest schedule from Radio Sierra Leone indicates that all transmissions are on the frequency of 3316 (10kW) and the hours of broadcasting are: 0600-0930, 1245-1330 and 1545-2300 Monday to Friday; 0600-1000 and 1200-2330 on Saturday and 0600-2230 on Sunday.

South Africa: Radio RSA continues to broadcast in English to the U.K. from 1756 to 1850 on 15250 and 21480 but has dropped the frequency of 17795.

Asia

Nepal: Radio Nepal signs on at 0120 on 7105 and 11970 and also at 1220 on 7165 and 11970, the power used is 5 or 100kW.

Mongolia: According to a new programme schedule from Radio Ulan Bator the station now broadcasts in English from 1220 to 1250 on 15445 and 17785 and also from 2200 to 2230 on 9540 and 11860.

Qatar: Radio Qatar is now using the new frequencies of 5150, 6135, 9550, 9770 and 11710. This should make reception easier as the station used to be on the very crowded channel of 9570 only.

South Vietnam: Radio Vietnam in Hue broadcasts in Vietnamese on 9667 until sign off at 1500, this station is not listed in the World Radio-TV handbook.

Oceania

Australia: Radio Australia has a new broadcast in English for the Pacific area on 15140 from 0900 to 1400. The station is also testing the frequency of 11920 between 2000 and 2055.

Gilbert and Ellice Islands: Radio Tarawa can be heard on 4912·5 and the following schedule is given:—
English and Vernaculars from 1845 to 2000 Monday to Saturday and in English from 0700 (0630 on Sunday) to 0745 daily.

New Zealand: Radio New Zealand has been picked up in England between 0700 and 0845 with fair strength on 11780.

Tahiti: Radio Tahiti, Papeete has been heard around 0600 on 11825 with strong interference from several adjacent stations.

Many thanks to all of you who sent in your logs for the benefit of the other readers, I hope that you will continue to do so and will be joined by many other contributors.

73 and good DX until the next time.

THE AMATEUR BANDS

David Gibson, G3JDG

IT has been one of those months on the amateur bands. Such a mixture of logs and contradictions that it's difficult to decide just what is what.

One s.w.l. claims that the l.f. bands have been very good and appeared to be getting better towards the end of the month. Another tells harrowing tales of evenings spent listening to long slices of noise, and at times even the arrival of a solitary European station was enough to cause a minor celebration.

The same tale has been repeated at the other end of the spectrum. Some have described ten metres as an r.f. cemetery while others have praised its service in the interests of amateur radio. Perhaps some of us have listened at the wrong times.

At the home QTH, the l.f. bands, forty metres and below, have appeared reasonable. Hoards of W stations have been heard s.s.b-ing to each other and a number of EUs have been logged both calling and working Oceania, although it must be confessed that VK stations and the like could not be received and so don't count.

In the v.h.f. region we scooped an all-time record—two logs received. One exponent of these frequencies threatens to listen on seventy centimetres. Any one doing anything with lasers yet?

P. Knisely (Surrey) informs of two more stations now active from Anguilla, VP2EQ and VP2EM. Owls may care to QRX on twenty and fifteen from midnight on most nights.

John Morris, G3ABG, sends details of the Worked All Britain award. Interesting to note that there are certificates for s.w.ls. Interested enthusiasts, and sheepskin hunters, should drop John a line at 24 Walhouse Street, Cannock, Staffs.

P. Flatman (Suffolk), NCX100 plus PR30 pre-selector, admits to plundering 80. The swag includes: CN8HD, EA6BG, OHØNC (Aaland Is.), VE1IE, VO1FG, W2HBW, 4X4GV, all s.s.b.

Pearls of wisdom from **Pat Johnson** regarding the where and when on 80. For W/VE/VO, any time after 2300 up until 0800. Best DX frequencies are 3·790 and 3·80MHz. Pat advises to QRX for LA5KG or ON4UN and listen to their QSOs. He also reckons that the best EU DXers seem to favour a half-wave vertical with ground radials. So if you can plant a 130 odd feet of vertical in your back yard, you're in business. Pat used an Eagle RX60, PR30, a.t.u. and 35ft end fed running N/S, or a 70ft wire running N/E-S/W for s.s.b. sigs from: CN8MN, EA5JK, HK3WO, K1KTH, K2ADY, K3UZE, K4JY, LX1GP, OA8V, OJØMR (Market Reef, between Aaland Is. and Sweden), OY2Z, TA3RF, UW9AF, VE1BU, VE3AYS, VO1CC, VS6DO, W1CF, W3AGM, W4OKL, W9WIB, WB2LWH/VP9, YV4UA, 4S7PB.

J. Jackson (Leeds), TCS13, a.t.u. plus "wire in the loft" detected 80 metre s.s.b. from: CN8MN, CR4BC, HK3WO, KV4FZ, OJØMR, TA3RF, UW9AF, VE1AUC, VE2MY, VE3HJ, VO1CV, VP2VI, WA1AIM/P/VO2, W1FZ, W2PV, W4AQW, W5IOU, YV4UA. He also logged YT3OV, a special Yugoslavian station.

Stephen Champion (Herts) has an R1155 with a 60ft end fed. He claims that 80 is packed with EUs but that the DX is there for the patient. Stephen's best were HK3WO and VK3MV.

Tom Maxwell (Lanarkshire) CR7OA and 18ft end fed had a long, lingering lugfull on fifteen and twenty. Rewards incude: CN8MN, CR6IS, CT2AK, EA3JE, IT1TTH, KV4FZ, LX1BA, OK4PI/MM, PY4AS, PY8OL, TF2WLM, TI2JCC, UB9KAG, UN1KAM, VE3GKH, VO9JJ, VP2AA, VR6GX, YV4WT, ZB2BV, ZP5CF, ZS6AJS, 3V8AL, 6Y5GB, 8R1U, 9K2CM, all on 20 s.s.b.

David Robbins (Warwick), CR7OA, 60ft of mains cable "looped vertically up to 20ft." (The Electricity Board shall hear of this!) The following procession passed through the hoop on 15 s.s.b.: CN8HD, CN8HL, CR4BB, CT2AT, HC1MG, IS1LIO, JX3DH, KP4RK, KV4FZ, OJØMR, PY4AKR, TF2WKI, TF3HS, TU2BB, VP2AA, W6-QI, YDK, YWQ, ZFN, FDR, HGU, ZB2BY, ZL3JC, ZS6BRK, 4X4AX, 4X4FC, 4Z4HG, 9H1BL, 9Q5SN, 9X5SP.

N. Richardson (Bucks) CR70A, PR30, 30ft end fed at 18ft, queries RA3BCF claiming to be in Moscow. His best on ten metres s.s.b. were: CR6LX, KV4AD, UV3DN and ZS6HR.

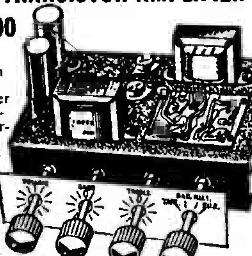
John Moore (Leicester) is eavesdropping on two metres. A home brew (good lad) G3BKQ f.e.t. convertor into a CR100/2 tuning 24·9-26·9MHz is fed with a 6-element Yagi indoors. (What happens when you want to have a bath, OM?) Signals bearing the a.m. label received from: G3GJY, G3JXN, G3PYG/A (near Sheffield), G8CB, G8BPO, G8BRT/P (near Sheffield), G8BYW/P (Derbyshire). Two independent squeaks of s.s.b. heard from G3CCH and G6NB.

"Tell Glyn Richards he isn't the only 2 metre fan in G.B.", says **L. Coombes** who lives in Cwmbran. (I don't know either, it's certainly not near St. Albans.) Listening on an Interceptor 1880 raised: G3YRN, G8AFA, G8DCK, GW3IJE, GW5NF, GW8CCA. The antenna is an inverted L about 75ft long.

Quite an active month for contest enthusiasts. March 7-8th BERU contest; 7-8th ARRL phone contest; 21-22nd ARRL c.w. contest; April 5th 80 metre QRP contest.

A special one on March 28-19th April is the IARC propagation research contest, which is a phone only one. Don't forget that it's nearly mobile rally time. The first in my diary is the North Midlands Rally on 19th April. Listen for a talk-in station at all these rallies on topband. For the c.w. types, National Field Day this year will be on the 6-7th of June. Just time to get a bit of practice in on the key. ■

MONO TRANSISTOR AMPLIFIER HSL.700



A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated pre-amplifier assembled on special printed sub panel. AD161-AD162 operating in symmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for AC mains 200-240v. Controls: Bass, Treble, Volume/on/off. Function selector for PU1, PU2, Tape, Radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9¼ × 5 × 4½in. high.
Sensitivity: PU1-50m/v. 56K input impedance.
PU2-110m/v. 1 meg input impedance.
Tape—110m/v. 1 meg input impedance.
Radio—110m/v. 1 meg input impedance.
Output power measured at 1Kc—6.2 watts RMS into 3 ohms. 5.8 watts RMS into 15 ohm. Overall frequency response 30 c/s-18 Kc/s: Continuously variable tone controls: Bass, +8db to—12db at 100c/s. Treble, +10db to −10db at 10Kc/s. The HSL.700 has been designed for true high fidelity reproduction from Radio Tuner, Gramophone deck and Tape Recorder preamp. Supplied ready built and tested, complete with knobs, attractive anodised aluminium front escutcheon panel, long spindles (can be cut to suit your housing requirements) full circuit diagram and operating instructions.

Our Special Price **£7.19.6** P. & P. 7/6.

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BRAND NEW. 12in. 15w. H/D Speakers, 3 or 15 ohms. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly £5.10.0. P. & P. 7/6 Guitar models: 25w. £6.0.0. 35w. £8.0.0.
E.M.I. 3½in. HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3 or 8 ohms 15/- each: 15 ohms 18/6 each. P. & P. 2/6.
12in. "RA" TWIN CONE LOUDSPEAKER. 10 watts peak handling. 3 or 15 ohm 37/6. P. & P. 6/-.
35 OHM SPEAKERS
3½in. 14/-. P. & P. 2/6: 7 × 4in. 21/-. P. & P. 4/-.
80 OHM MOVING COIL SPEAKERS
High Flux Magnet. 2½in. dia. 12/- each. P. & P. 1/6.

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HIGH IMPEDANCE DYNAMIC STICK MIKES. High sensitivity. 39/6. P. & P. 2/6.

PYE MICROSWITCHES S/P. C/O. Lever roller action Rating 250v. AC at 5 amps. Size approx. 1 × ¾ × ⅜in. 4/- each. P. & P. 1/- (6 or more post free).
HONEYWELL MICROSWITCHES. S/P. C/O. Push button action. Rating 250v. AC at 15 amps. Size approx. 1¾ × ¾ × ⅝in. 5/- each. P. & P. 1/- (6 or more post free).

TELESCOPIC AERIALS WITH SWIVEL JOINT. Can be angled and rotated in any direction. 12 section Heavy Chrome. Extends from 7in. to approx. 56 in. Maximum diameter ½in. 10/- each. P. & P. 1/6. 6 section Lacquered Brass. Extends from 6in. to 22½in. approx. Maximum diameter ¼in. 5/- each. P. & P. 1/-.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0–210–240v. Secondary combinations 0–5–10–15–20–25–30–35–40–60v. half wave at 1 amp. or 10–0–10, 20–0–20, 30–0–30v. at 2 amps full wave. Size 3in. long × 3½in. wide × 3in. deep. Price 32/6. P. & P. 6/-.
MAINS TRANSFORMER. For transistor power supplies.
Pri. 200/240v. Sec. 9–0–9 at 500 mA. 11/-. P. & P. 2/6.
Pri. 200/240v. Sec. 12–0–12 at 1 amp. 14/6. P. & P. 2/6.
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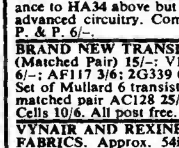

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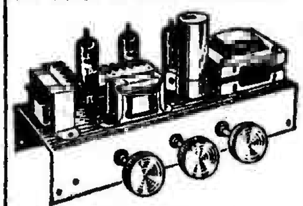

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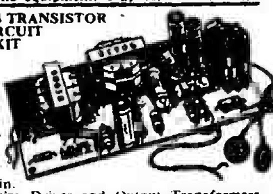

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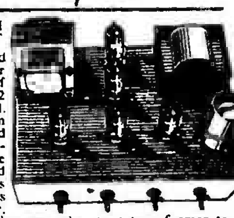

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FET's AND THEIR USES

T. SNOWBALL

PART 2

LAST MONTH THE PARAMETERS OF F.E.T'S WERE DISCUSSED TOGETHER WITH A TESTER SUITABLE FOR DETERMINING THESE. THE SECOND PART DESCRIBES A NUMBER OF CIRCUITS USING F.E.T'S.

F.E.T. CASCADE WITH TRANSISTOR AS A PRE-AMP FOR CRYSTAL OR CERAMIC PICK-UP

A very useful combination that presents a high input impedance and low output impedance suitable for other transistor stages and provides gain is shown in Fig. 7.

The output transistor is set at a collector current of 0·5mA if the output is at plus 8V and R1 + R2 is 16kΩ. As it is a feedback amplifier, putting in a signal of 0·1V means that for the circuit to be satisfied, 0·1V must be fed back to the source from R2. If 0·1V occurs across R2, then the current change must be 0·1/R2, and to the voltage across R1 + R2 must be 0·1/R2 × (R1 + R2); so this voltage, which is the output voltage, will be $\frac{R1 + R2}{R2}$ times the input voltage, or in the other words the gain is $\frac{R1 + R2}{R2}$ ......(11)

$$\text{Gain} = \frac{15 + 0{\cdot}68}{0{\cdot}68} = 20$$

Taking a typical MPF103 with a V_P of 3V at a bias of 2·5V, I_D will be about 100μA. I_{DSS} will be about 3mA.

Thus from (3)

$$g_m = \frac{2 \times 3}{3}\left(1 - \frac{2{\cdot}5}{3}\right) = 0{\cdot}34\text{mA/V}$$

The output impedance will be much lower than in Fig. 6 because the g_m is multiplied by the transistor gain, say times 50.

$$R_{out} = \frac{15000}{1 + (15 \times 0{\cdot}34 \times 50)} = \frac{15000}{250} = 60\Omega$$

And input impedance is of course 2·2MΩ.

At 0·5mA I_C for the output transistor plus the 0·1mA through the f.e.t. only 0·4V is produced across the 680Ω resistor, so the rest of the f.e.t. bias of 2·5V must be made up by a source resistor in the f.e.t. This is 2·1V at 100μA i.e.. approximately 22kΩ which must be by-passed by a capacitor to prevent negative feedback. The 100μA drain current must not be allowed to go into the transistor base, which with a gain of 50 will only need about 10μA. This gives a value of drain resistor equal to 6·8kΩ but this may need adjustment to set the output voltage at approximately 8V.

Hi-Fi- TONE CONTROL

Figure 8 shows a Hi-Fi tone control circuit which gives up to ±15dB of bass and treble control. It is a big improvement over ordinary circuits because most of the capacitors are a tenth of the normal value, these being the most bulky items and so a much smaller unit is possible.

Once again an N-channel f.e.t. is used, source bias is chosen to set the f.e.t. at a low value of I_D to allow a high drain resistor for good gain. At present N-channel f.e.t.'s are the most common and cheapest. For instance, taking a Newmarket type NKT0213 with a typical V_P of 1V and I_{DSS} of 0·4mA, if we bias it at 100μA from equation (2)

$$V_{gs} = 1{\cdot}0\left(1 - \sqrt{\frac{0{\cdot}1}{0{\cdot}4}}\right) = 0{\cdot}5\text{V}$$

$$\therefore\ R_{source} = \frac{V_{GS}}{I_D} = \frac{0{\cdot}5}{0{\cdot}1} \simeq 4{\cdot}7\text{k}\Omega$$

If the supply voltage is 12V and we let the drain voltage be 3V then $R_L = \frac{9}{0{\cdot}1} \simeq 82\text{k}\Omega$

Then from (3)

$$g_m = \frac{2 \times 0{\cdot}4}{1}\left(1 - \frac{0{\cdot}5}{1}\right) = 0{\cdot}4\text{mA/V}$$

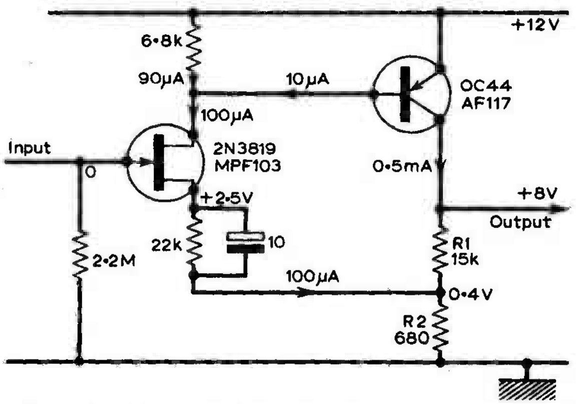


Fig. 7: A high input impedance/low output impedance preamplifier.

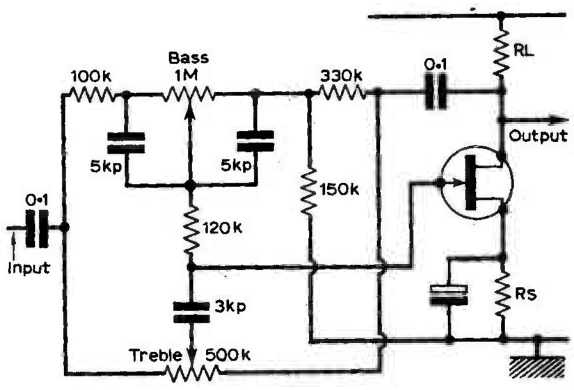


Fig. 8: A hi-fi tone control—see text.

So gain from (7) = 0·4 × 82 = 33

This figure of 33 is the inherent gain of the stage but the feedback tone controls reduce this to a low level at middle frequencies and the gain is used to give the treble and bass boost.

F.E.T. VOLTMETER

If f.e.t.'s are used to drive a meter, then a voltmeter with a very high input impedance will result.

For instance, Fig. 9 shows a voltmeter with 20MΩ input impedance on all ranges, using a 100μA meter. In this circuit the tester should be used to get two f.e.t.'s matched so that, at the drain current used, the gate bias is within 10 per cent.

Using a 9V battery and a potential divider which sets the gate of the right hand f.e.t. at +3V with respect to the negative terminal of the battery, is the starting point of design.

If 1mA is chosen as a useful operating current, then measuring V_{GS} on typical Motorola MPF103's will give a bias of about 1V. Thus the sources should sit at about +4V. With the zero set pot. at its mid-position of 2·5kΩ, then to make 1mA flow the fixed source resistor must be 1·5kΩ.

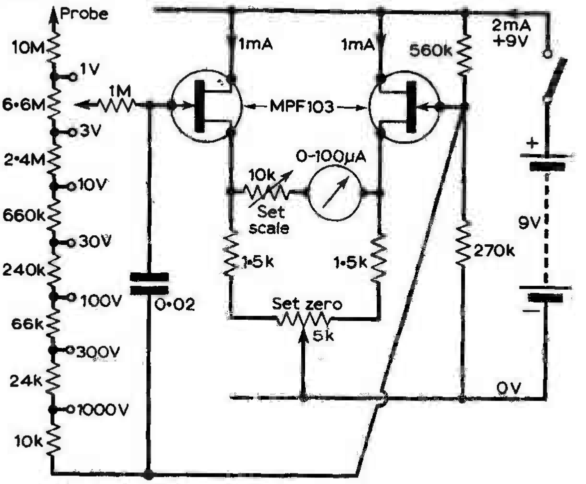


Fig. 9: F.E.T. voltmeter circuit.

These sums shown here are to enable the constructor to redesign the circuit should he not have f.e.t.'s of similar ratings.

Setting-up procedure consists of adjusting the set pot. for zero meter reading with the scale pot. set at zero resistance.

Then apply a known test voltage on the correct range and adjust the scale pot. to correct meter reading; this is a pre-set adjustment and should not require changing again.

This meter drifts very little with temperature, time or battery voltage down to about 6V, due to the long tailed pair circuit configuration.

In passing it should be mentioned that due to the high impedances involved, pick-up can be troublesome and it is suggested that a metal box be used for construction and a screened lead for the probe.

SENSITIVE F.E.T. MILLIVOLTMETER

If the constructor does not wish to use a sensitive 100μA meter or requires greater sensitivity, then the addition of two transistors as amplifiers will allow the use of a 1mA meter with a sensitivity of 30mV f.s.d. Figure 10 shows such a circuit with an input impedance fixed only by the input attenuator, which can be as high as 50MΩ.

The circuit will be recognised as a doubling up of Fig. 7 with some extra complications.

The meter used is made up to 100Ω resistance, which means that 100mV is required to give f.s.d. The 2·7kΩ and 1·5kΩ resistors give a gain of 2·8 times but the shunt of 18kΩ and the gain set pot. means this can be increased and set accurately to times 3·3 so the input signal required for f.s.d. is only 30mV.

This sensitivity can be reduced to read any higher voltage in a similar manner to the earlier circuit. But in order to reduce the effects of amplifier drift, it is recommended that the first set of range switching to say 1V, is carried out by inserting series resistors in the meter circuits. The test meter runs from three 9V batteries and consumes about 6·5mA. The f.e.t.'s can be selected on the meter for matched V_{GS} at an I_D of 1mA. The lower f.e.t. is used as a constant current source for the amplifier. If the voltage on the drain of an f.e.t. is varied, then the current through it will not vary by more than a few per cent, as long as the voltage is greater than V_P. In this case the tester is used to select an f.e.t. with an I_{DSS} equal to 6mA and it is put in the circuit with $V_{GS} = 0$, or simply gate and source strapped together, so now variations of battery voltage will not change the current fed to the amplifier. Should it prove difficult to get an f.e.t. with the correct I_{DSS}, then select one with greater than 6mA and insert a source resistor as calculated from Fig. 5a to give an I_D of 6mA.

The transistors should be silicon types but are not critical as regards frequency response.

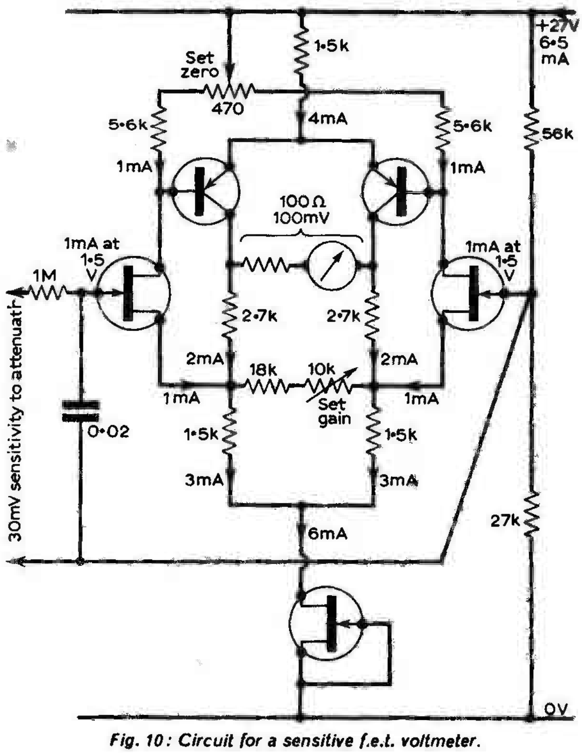


Fig. 10: Circuit for a sensitive f.e.t. voltmeter.

TAPE PRE-AMPLIFIER

In replaying tapes, the aim of the amplifier is to present a high impedance at least ten times the head reactance and if possible, upon switching on, not

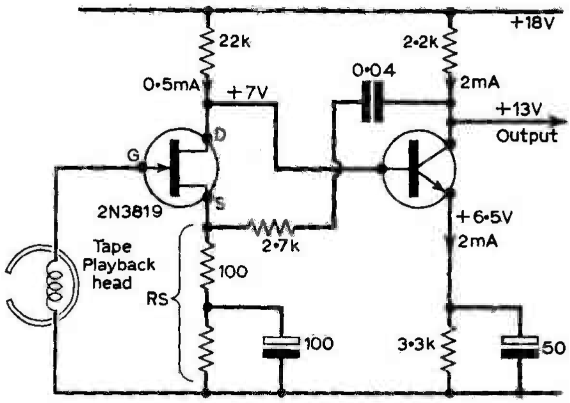


Fig. 11: Tape preamplifier equalised for 3¾ i.p.s. The transistor should be shown as a 2N2926.

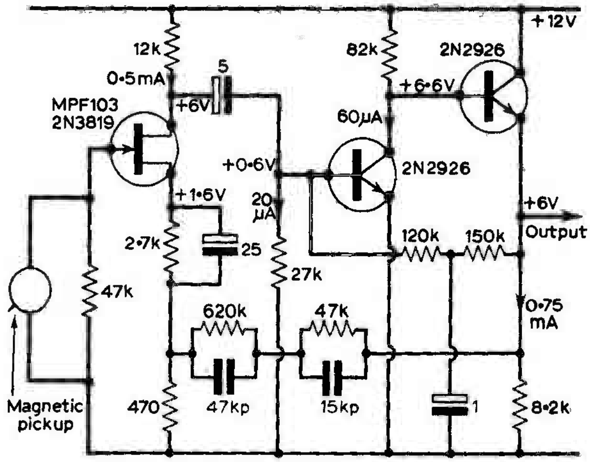


Fig. 13: Preamplifier for a hi-fi magnetic pick-up cartridge.

introduce any capacitor charging currents or d.c. into the head circuit, because these will cause noise to be impressed on the tape.

Most normal transistor circuits inevitably do cause charging currents to flow, however they can be made high impedance enough with some trouble; but an f.e.t. pre-amplifier gets around all these troubles. The tape head can be fed directly into the gate, and so no capacitors are involved; also the high input impedance is unquestioned.

Figure 11 shows a circuit with 120μS equalisation for normal 3¾in. recorded tapes.

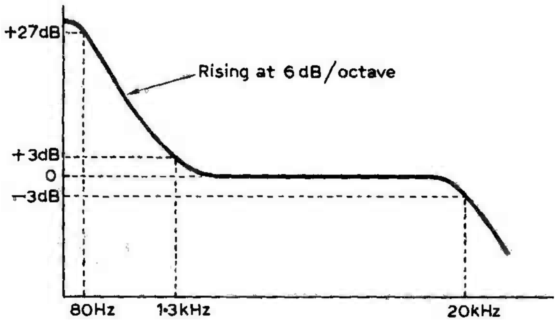


Fig. 12: The equalisation curve used in Fig. 11.

The f.e.t. is run at an I_D of 0·5mA and R_S is calculated from the tester measured characteristics as in Fig. 5a. The 2·7kΩ and 100Ω resistors give a medium to high frequency gain of 27 times, while the capacitor in series with the 2·7kΩ gives the low frequency rising characteristic as needed for tape replay, as shown in Fig. 12.

The time constant should be 120μS for normal 3¾in. tapes, so with the 2·7kΩ resistor

$$CR = 120 \times 10^{-6}$$

$$\therefore C = \frac{120}{2{\cdot}7 \times 10^3}\ \mu F \simeq 0{\cdot}04\ \mu F$$

The rest of the voltages and currents as calculated are all shown on the circuit diagram.

MAGNETIC PICK-UP PRE-AMPLIFIER

Shown in Fig. 13 is a pre-amp for a high fidelity magnetic pick-up cartridge.

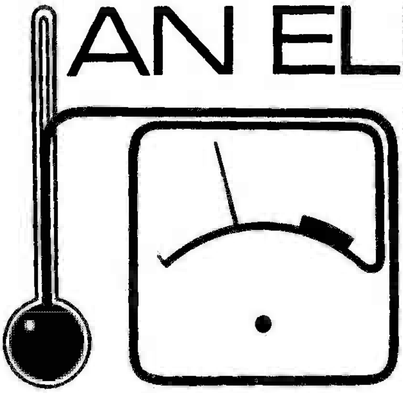
Here the f.e.t. is used to present a very high input impedance and then a resistor is put across the input to match the pick-up in use. Otherwise with a normal transistor circuit one would have to design a high input impedance, say 100kΩ circuit and then put a resistor in parallel to bring it down to the correct value; this would be all right if the input impedance could be relied upon to stay constant over the audio band and also be constant from unit to unit despite transistor variations; however the f.e.t. overcomes all these problems.

The f.e.t. is biased at 0·5mA as previously discussed, followed by a grounded emitter stage to give some more gain, and an emitter follower to provide low output impedance and to drive the equalisation components which feed back into the source to give the correct play characteristics. The transistor pair are coupled together in a d.c. feedback configuration with the a.c. signal removed by the 1μF capacitor.

The circuit gives a gain of 100 at 1kHz with an output swing of about 2V r.m.s., enough to fully drive any normal power amplifier, response is within $\pm$1dB of the RIAA characteristic from 20Hz to 20kHz. Output impedance is less than 1kΩ.

Design voltages and currents are shown on the circuit diagram.

The previous notes should now have given a good idea of how to use f.e.t.'s to their best advantage, but we finish now with the warning that they are, especially m.o.s.f.e.t.'s, rather fragile as regards stray voltages in handling, and it is recommended that plug-in sockets be used whenever possible and leave the f.e.t.'s out of circuit whenever soldering. ■



AN ELECTRIC THERMOMETER

C.R.BRADLEY

THE temperature of a piece of intrinsic semiconductor material determines the number of electrons and 'holes' (spaces left in the structure by departed electrons) available for electric conduction. Therefore the resistance of the material depends on temperature. A thermistor is a component consisting simply of two leads joined by a piece of suitable semiconductor material. The instrument to be described measures the temperature-dependent resistance of a thermistor designed specifically for thermometer use and displays the corresponding temperature on a meter. The electric thermometer possesses several features which make it more versatile than the ordinary mercury- or alcohol-in-glass types, viz:

(i) The temperature-sensitive thermistor is connected to the measuring instrument by ordinary twin flex and may be almost any distance from it. This makes the thermometer suitable for many remote temperature sensing applications.

(ii) A meter scale is generally easier to read than the engravings on a glass thermometer.

(iii) The piece of semiconductor material in the specified thermistor is roughly the size of a pinhead. This means that the thermistor has a small heat capacity and can follow a rapidly changing temperature, and that temperature readings can be taken without delay.

(iv) The thermistor is small enough for insertion in many otherwise inaccessible places, although it is rather fragile.

THERMISTOR

The thermistor specified is a Mullard Varite VA3705 which has a miniature glass bead construction. For general use it can be mounted in a holder made from a hexagonal shape ballpoint pen ('BIC') case (Fig. 1.). The pen cap is used to protect the fragile 'business end' of the thermistor when not in use. Twin flex is connected to the thermistor leads as shown using plastic sleeving to insulate them. This must be done carefully as the leads are fragile. Individual thermistors vary somewhat, but average values of resistance for the VA3705 are: 6·8kΩ at 25°C. (77°F.), 700Ω at 90°C. (194°F.) i.e: resistance decreases with increasing temperature.

CIRCUIT

The circuit of the thermometer is shown in Fig.2. B1 and B2 are two small dry cells connected in series to give about 3 volts. Current passes through current limiting resistor R1 and through zener diode D. The zener diode operates in its reverse breakdown condition so that the voltage drop across it is virtually constant (2·4 volts). This ensures the voltage supply to the thermistor is constant in spite of battery wear. The current passing through the thermistor is

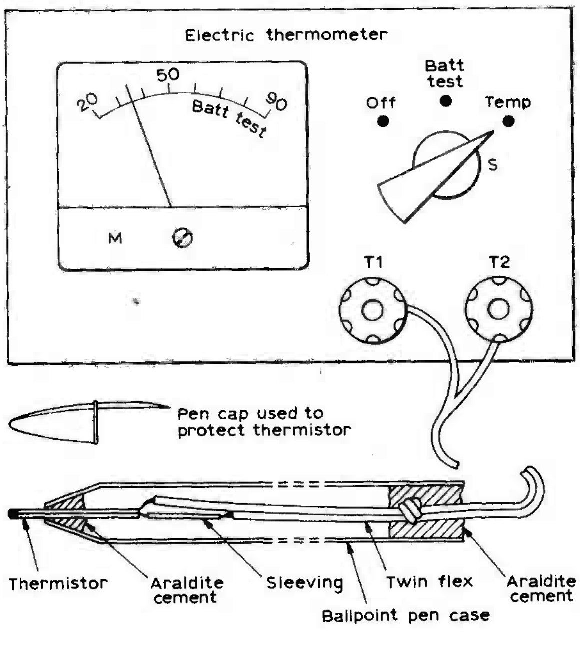


Fig. 1: (top) panel layout (bottom) probe construction

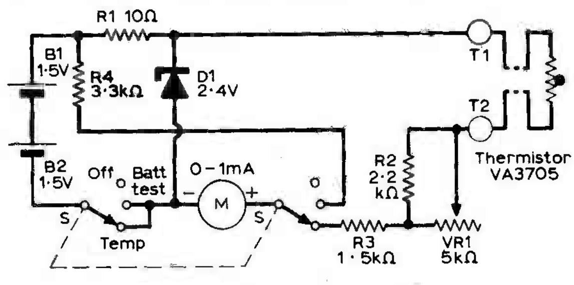


Fig. 2: Circuit of thermometer

measured by meter M which can be directly calibrated in temperature. VR1 is part of the current limiting resistance in series with the thermistor and is preset to give full scale meter deflection (1mA) at 90°C. (194°F.). When S is in the BATT TEST position, the battery voltages under load can be checked on the meter. The dissipation constant of the VA3705 is about 1mW/°C which means that the heating effect of the current passed through it will not introduce an inaccuracy greater than ±1°C.

CONSTRUCTION

The instrument can be constructed in any convenient cabinet and the few components wired direct. The front panel carries rotary switch S, insulated terminals T1 and T2 and 1mA moving coil meter M, which can be any cheap surplus meter, as large as possible for easy reading. VR1 is mounted inside the cabinet as it only has to be set once; it can be any type of potentiometer, a salvaged volume control from a defunct transistor radio will suffice. The author made a simple holder for the two U12 cells (B1 and B2) from a matchbox, a scrap of metal and two drawing pins (Figs. 3a, 3b).

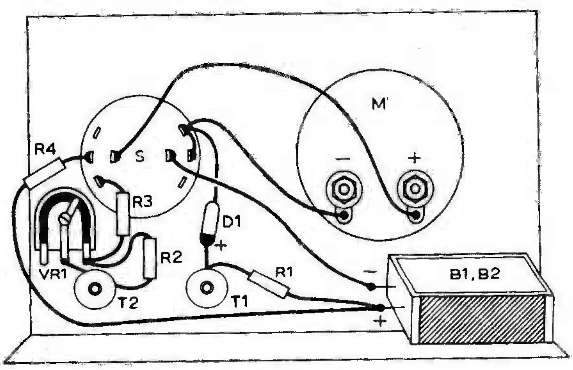


Fig. 3a: Panel wiring

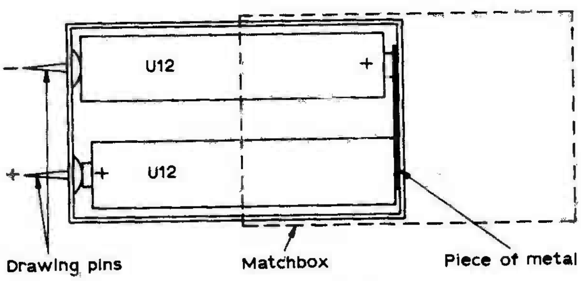


Fig. 3b: Battery holder

CALIBRATION

The instrument is easily calibrated using an ordinary mercury thermometer. With VR1 set to maximum resistance, connect the probe to T1 and T2 and place it in water heated to exactly 90°C. (194°F.) as measured with the mercury thermometer. Adjust VR1 for 1mA deflection and use a dab of glue or wax to fix it in this position. Now place the probe in water, cooled to exactly 20°C. (68°F.) and note the meter reading. Now plot these two readings on a graph (Fig. 4). As the temperature coefficient of the thermistor is linear between these two limits, the two plots have only to be joined by a straight line to provide a complete calibration graph. If a clinical thermometer is available it can be used to provide a third calibration point at 36·7°C. (98°F.).

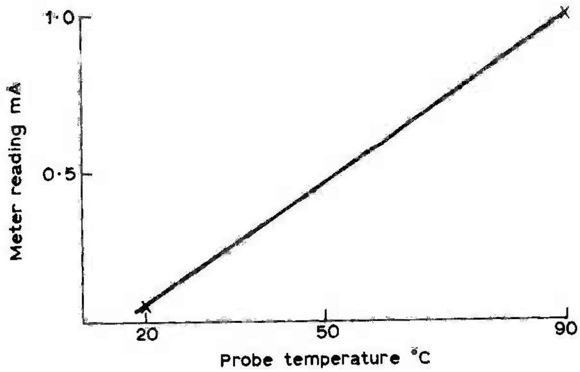


Fig. 4: Construction of graph

★ components list

Resistors:

R1 10Ω ½W 10%
R2 2·2kΩ ¼W 10%
R3 1·5kΩ ¼W 10%
R4 3·3kΩ ¼W 10%

D 2·4V 1W zener diode
M 1mA f.s.d. moving coil meter
VR1 5kΩ pre-set pot.
S Two-pole three-way rotary switch
B1, B2 Ever Ready U12 cells
Thermistor Mullard VA3705

The graph can be used to calibrate the meter scale directly, if desired. Open the meter unit carefully and away from dust to avoid damage to the movement. A piece of paper suitably calibrated in degrees centigrade and/or fahrenheit is then slipped under the needle and glued in place. Mark the scale with a green area above 0·80mA. When the needle fails to reach this area on BATT TEST, the batteries should be replaced. If the thermistor is damaged and has to be replaced, the temperature calibration must be repeated.

USE

The instrument is now complete and will continue to give accurate measurements provided the thermistor temperature does not pass outside the range 20°C. (68°F.) to 90°C. (194°F.). The author's original use for the instrument was measuring transistor heat sink temperatures. Merely touching the probe tip to the heat sink was found to give fairly accurate readings. Overall accuracy of the instrument is better than ±1·5°C. if a good thermometer is used for calibration. The procedures for converting degrees fahrenheit to centigrade and the reverse are as follows: To convert degrees F. to degrees C., subtract 32 from the F. value, multiply by 5 and divide by 9; to convert degrees C. to degrees F., multiply by 9, divide by 5, and then add 32 to the result. Degrees Kelvin or Absolute are degrees centigrade plus 273 degrees. ■

REPAIRING TRANSISTOR RADIOS

V. CAPEL

PART 2

IN the last part we saw that speed is essential in repairing the cheaper transistor radios if an economic job is to be done. Whatever short cuts may suggest themselves in diagnosis and repair should be used even though these may not always be considered to be good practice with more conventional jobs.

Distortion and no-signal faults were dealt with, but now we will consider the symptom of low sensitivity. Almost any stage could give rise to this, but rarely the output stage as faults here generally produce distortion as well. Before getting too involved though, as with other faults, always check the battery first. Although more usually producing distortion, many modern circuits allow the battery voltage to fall to quite low levels before distortion sets in, but sensitivity is bound to suffer.

A quick check can be made by detuning the set and turning up the volume full. A fairly strong background hiss would suggest that the audio circuits were in order and that the trouble probably lay in an early stage, the mixer or the first i.f. A too silent background would indicate that the fault was in the latter stages.

The most usual causes of low sensitivity are mechanical damage, faulty transistors or mis-alignment. Of the first, a broken ferrite rod is perhaps the most frequent example. A visual examination will soon reveal this. When replacing, make sure that the diameter is the same as well as the length.

In cases where the ferrite rod has broken free from its mounting not only can the fine connecting wires be broken away from the print as described in the previous issue, but the coils themselves can sustain damage. The long-wave coil, being layer wound often suffers with other sharp components digging in and penetrating several layers. This may cause a complete open-circuit or a short-circuit of several turns. This short can be reflected into the medium wave windings and cause low sensitivity on both bands.

Faulty transistors can be diagnosed by voltage readings and shunting a replacement across the suspect as described before. Some idea as to the operation of the i.f. stages can be obtained by detuning each i.f. transformer in turn. There should be a sharp tuning peak in each case with the possible exception of the last one which may be damped by the detector. If it is possible to rotate the core with very little drop in volume, then the associated stage would appear to be faulty. Sometimes a stage may be completely inoperative yet low-volume results can still be obtained due to stray coupling from a preceding stage. Thus the signal 'jumps' the offending stage. Where a good peak is obtained, there is unlikely to be a fault in that part of the circuit. Restore each coil to its correct tuning point before dealing with the next.

Coming back to the ferrite rod aerial again, the aerial coils may simply be loose on the rod and therefore out of their optimum position. Aligning and sealing will bring back the sensitivity to normal.

Mis-alignment can come about in many ways. Portable radios are obviously subject to more shock and stress than others, hence there is plenty of opportunity for coils to become loose and slip as well as coil cores to turn. If the few quick checks we have outlined here fail to come up with the answer, try re-aligning. Not only may an alignment cure the trouble, but if a circuit fault exists, aligning will often reveal it, as something does not tune up which should do.

Conventional alignment procedure calls for the use of signal generator and output meter, but the simple circuits we are dealing with here do not require these. As we have seen, speed is all important and it is quite possible to do an alignment in just a few minutes without wasting time setting up an array of equipment, by using broadcast signals and the ear. Results are little inferior to those obtained when doing it 'properly', if at all.

ALIGNMENT

As with more conventional methods, the first step is to align the i.f.'s. A broadcast transmission should be chosen that is weak in order to avoid a.g.c. action, but it should be steady. One of the more distant BBC Home services will usually serve the purpose. Volume should be turned down to a fairly low level as the ear is more sensitive to volume changes at lower levels.

It can be assumed that the i.f. coils are already near the correct i.f. frequency, or perhaps all except one that has been affected by a fault condition which is now cleared. If it is suspected that all or most of the coils are some way out, as would be the case if the receiver had been tampered with, then a signal generator would have to be used to align to the correct i.f. frequency.

Normally though, the broadcast signal can be used. So starting with the last i.f., the cores are tuned for maximum volume. With a weak station there will be a background hiss due to the local oscillator, and as this is steady, it is often easier to listen to this for making the adjustments rather than the programme content which of course will be varying.

In most cases all i.f. coils will be peaked, but there are some that are stagger tuned. These are usually in the better type of receiver, and stagger tuning is rarely if ever found in the types we are discussing. If stagger tuned coils are peaked, then instability will most likely result. The adjustments should be repeated, especially if it was found that one coil was some way out of tune.

Now we come to the oscillator. Circuits differ widely at this point, but with the simpler portable, differences are not so great as to affect alignment much. Most circuits employ a single oscillator coil

QUICK ALIGNMENT SEQUENCE FOR RADIOS WITHOUT L.W. OSCILLATOR TRIMMER

Tune to:	Adjust:
Weak m.w. station	3rd i.f. transformer for max. volume 2nd i.f. transformer for max. volume 1st i.f. transformer for max. volume then repeat procedure.
Radio 2, 1,500m. Radio 3, 464m. BBC West, 206m. or Radio 1, 247.	Oscillator coil for compromise dial setting Oscillator gang trimmer for correct dial setting then repeat procedure
Weak l.w. station	L.W. aerial coil for max. volume
Radio 3, 464m. or nearby weak station BBC West 206m. or nearby weak station	M.W. aerial coil for max. volume Aerial gang trimmer for max. volume then repeat procedure

QUICK ALIGNMENT SEQUENCE FOR RADIOS WITH L.W. OSCILLATOR TRIMMER

Tune to:	Adjust:
Weak m.w. station	3rd i.f. transformer for max.volume 2nd i.f. transformer for max. volume 1st i.f. transformer for max. volume then repeat procedure
Radio 3, 464m. BBC West, 206m. or Radio 1, 247m.	Oscillator coil for correct dial setting Oscillator gang trimmer for correct dial setting then repeat both procedures
BBC 2, 1,500m.	L.W. Oscillator trimmer for correct dial setting
Weak l.w. station	L.W. aerial coil for max. volume
BBC 3, 464m. or nearby weak station BBC West, 206m. or nearby weak station	M.W. aerial coil for max. volume Aerial gang trimmer for max. volume then repeat procedure

for both wavebands. As it stands, it works the medium waveband, and for the long waveband an additional capacitor is switched in. In some cases a trimmer is switched in as well, and the alignment procedure depends on whether this trimmer is present or not.

The first thing to do then, is to look for a trimmer apart from the two appearing on the gang tuning capacitor. Sets having a bandspread medium waveband in addition to the normal medium wave, will have extra trimmers in which case they will have to be identified. This can be done by giving each a slight turn back and forth and seeing which band is affected. Oscillator trimmers tune sharply whereas aerial trimmers are flat.

Going back to the straightforward two-waveband job, if the separate long wave trimmer is present, we start with the medium wave. Tune in a station at the low frequency end of the scale (gang at maximum capacitance), the Third programme on 464 metres is suitable. Adjust the oscillator coil core to bring the station to the correct point on the scale. Now tune to the other end of the band and tune in a suitable station, the West Home Service on 206 metres or Radio One on 247 metres. Adjust the oscillator trimmer on the gang for correct scale calibration. Repeat both adjustments if necessary.

Switching now to the long wave, tune in the Light programme on 1500 metres and adjust the long wave trimmer.

If there is no long wave trimmer, we start on the long wave. Tune in the Light programme and adjust the oscillator coil core to give correct scale reading. Then we switch to the medium wave and check that the Third programme or other station at the l.f. end comes in the right place. If it does not, the coil is adjusted to give a compromise between the two. With this type of set, scale markings are not very precise purposely. Next the h.f. end of the medium wave is aligned using the West programme or Radio One with the oscillator gang trimmer as in the previous case. A check will then have to be made on both l.f. end of medium wave and long wave and a re-adjustment made if needed. In practice, it will be found that the gang trimmer has very little effect on the long waveband.

Finally, the aerial circuits are lined up. Weak stations are best for this, if the ones used for oscillator alignment are weak they can be used, but if not, others nearby should be found. On the long wave, all that is required is to slide the long wave aerial coil (the largest, most likely layer wound) along the ferrite rod for maximum volume. The medium wave is aligned with the medium wave aerial coil at the l.f. end, then the aerial trimmer on the gang capacitor is used to line up the h.f. end. It is useful to remember that with both oscillator and aerial circuits, induction is used to tune the l.f. and capacitance to tune the h.f. end of a waveband.

All that is needed now is to seal the coils on the rod by melting wax over them and so complete an economical repair. ■

CQ!CQ!CQ!CQ!

ISSUES WANTED

...any issues of P.W. containing circuits, constructional articles on electronic musical instruments, particularly the P.W. Electronic Organ published in the 1950's.—D. E. Bray, 104 Fulmerston Road, Thetford, Norfolk.

...October 1966, November 1966 and all the issues of P.W. that had information on the RAE (1964 '65).—C. J. Bourne, 111 Woodhouse Lane, Bishop Auckland, Co. Durham.

...October 1962 issue of P.W. containing part 2 of the Tudor valve receiver.—M. J. Dorby, 266 Canley Road, Coventry, Warwickshire, CV5 6AP.

...the following issues of P.W.: Jan./Dec. inclusive 1964. Jan./Aug. inclusive 1965 Nov./Dec. inclusive 1965. ~~Jan.~~/June inclusive 1966. August 1966. Also the following issues of P.E.: Jan./Oct. inclusive 1966. Dec. 1966. Jan., Feb., April, May and July/Dec. inclusive 1967. All preferably including blueprints.—D. L. Edwards, 18 Parkdale Crescent, Worcester Park, Surrey.

...January 1967 issue of P.W. containing Explorer Rx.—S. Marklew, 4A George Street, Wombwell, Nr. Barnsley, Yorks.

...the periodical with the article about the conversion of WS 38 to top band.—Alan Carter, Rosemary, Shakespear Avenue, Langdon Hills, Basildon, Essex.

...June 1965 issue of P.W.—N. Taylor, 21 Tower Mill Road, Millfield Estate, Bungay, Suffolk.

...April 1966 issue of P.W. dealing with mods to the 19 set.—Thomas Smith, 50b Aldershot Road, Guildford, Surrey.

...July 1963 issue of Practical Wireless and the September 1967 issue of Wireless World.—S. Saethern, Box 336, N-3101 Tonsberg, Norway.

...the issue of P.W. containing the article on the Colour Organ.—4269206 S.A.C. Swift D.G., 'B' (S.C.S.) R.A.F. Stanbridge, Leighton Buzzard, Beds.

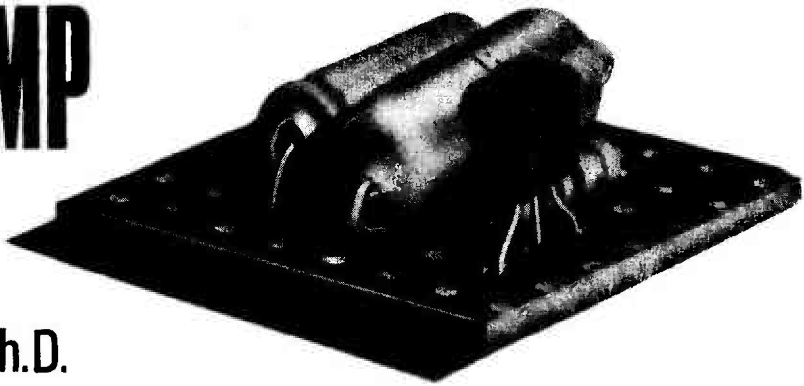
...the issue of P.W. containing E. J. Wotton's t.r.f. receiver. I think it was February 1961.—V. Reed, 25 Aclington, Ashford, Kent.

...the issues that covered the article on the 19 set conversion for 1.8 to 2MHz.—B. W. F. Mainprise, Vine Cottage, Exminster, Exeter.

...the September 1957 issue of Practical Wireless and the circuit diagram of the 266 indicator unit.—Paul Dornington, 383 Spen Lane, Leeds, 16, Yorks.

...October and November 1964 issues of P.W.—John McGregor, 20 Lorton Close, Mirehouse, Whitehaven, Cumberland.

F.E.T. PREAMP



W.T. MORRIS B.Sc., Ph.D.

THE matching of ceramic and crystal pickups to transistorised amplifiers often presents a problem to the constructor. The outputs of these transducers, in common with those of crystal microphones, most valve pre-amplifiers and valve f.m. tuners, must be fed into amplifiers with input impedances of 1MΩ or higher in order to achieve good bass response and a low background noise level. This requirement is easily met with valved amplifiers, but not with most transistorised designs, which have input impedances of a few kilohms only. Remedies such as inserting a high resistance in series with the amplifier input are generally unsatisfactory, since most of the signal is lost, especially the treble frequencies, and the signal to noise ratio is usually very poor.

The achievement of high input resistances with "ordinary" bipolar transistors, even silicon types, demands a fairly complex circuit (see Fig. 1), and even then noise levels can be high, particularly if "cheap" transistors of doubtful origin are used.

Field Effect Transistors (f.e.t.'s) offer an ideal solution to this problem. They have an extremely high input impedance and a very low noise level when driven from a high impedance source such as a ceramic or crystal cartridge. Also, their cost is now low enough to make them a most attractive proposition for the Hi-Fi enthusiast and experimenter. Figure 2 shows a simple circuit using an N-channel f.e.t. Note that this requires a *positive* voltage supply, like an n-p-n transistor. The input impedance is over 2MΩ, as recommended by the manufacturers of such cartridges as the "Deram" 9TAHC, CS90 etc. The performance of the circuit is excellent.

The high frequency response extends into the radio-frequency range. (A roll-off at ultrasonic frequencies above 20KHz can be arranged if required simply by adding a resistor R1 of 330kΩ to 1MΩ as close as possible to the pre-amp. input). Distortion is very low, rising to one per cent only at signal levels of 1·5V to 2V r.m.s. Noise is so low as to be virtually unmeasurable: this feature alone makes the slight extra cost of f.e.t.'s seem worthwhile!

The output voltage of the pre-amp. is typically nine-tenths of the input, i.e. there is a ten per cent loss of voltage. However, it is *current* gain that we require here, and this is of the order of 1,000 times. In conjunction with the f.e.t. pre-amp., the 300mV maximum output of a typical valve f.m. tuner would appear as about 250mV into the load of 2kΩ provided by the input of a transistor power amplifier. In other words, the *current* output of the tuner, $0{\cdot}3/2\times10^6$ amps., i.e. 0·15μA, is amplified by the f.e.t. pre-amp. to a current of $0{\cdot}25/2\times10^3$ amps., i.e. 0·125mA, a current gain of 800 times! Without the aid of the f.e.t. pre-amp., the f.m. tuner could supply only a few millivolts to the power amplifier; bass frequencies would be lost, and there would probably be a high level of background noise.

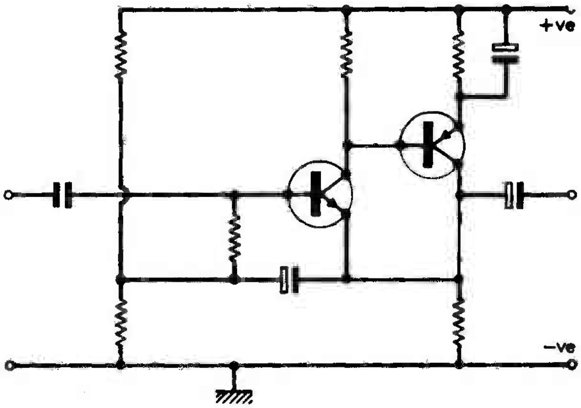


Fig. 1: The circuit configuration necessary for achieving a high impedance using bipolar transistors.

CONSTRUCTION

The pre-amp. is readily accommodated on a piece of 0·15in. matrix "Veroboard", 8 holes (about 1¼ins.) square. Figure 3 gives a convenient layout. Connect the resistors first, then the capacitors, and lastly, the f.e.t. Do not shorten the leads of the transistor, and observe the usual precaution of gripping them with pointed-nosed pliers or crocodile clip while soldering, to avoid overheating the transistor. All connec-

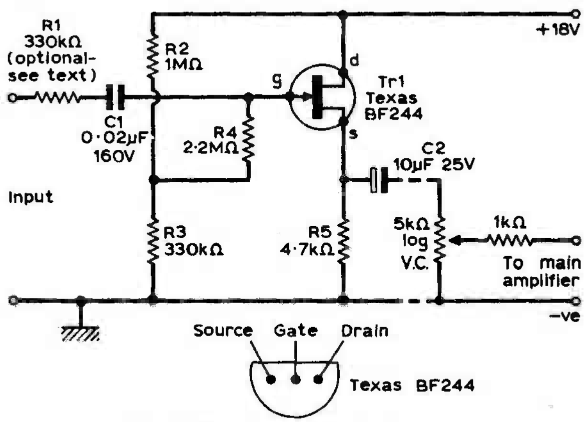


Fig. 2: The circuit of the f.e.t. preamp.

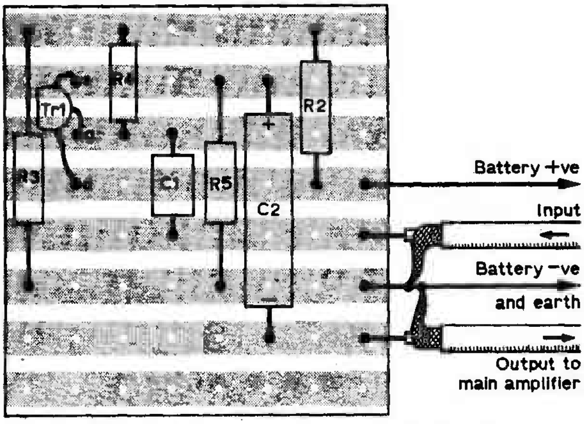
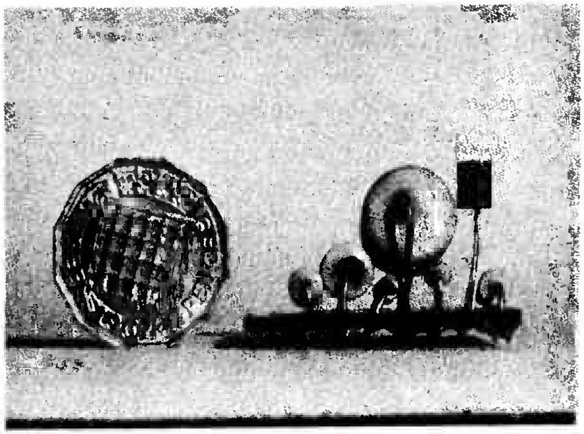


Fig. 3: The component layout on Veroboard.



When built on a small piece of Veroboard the complete unit is very small.

tions to the pre-amp. can be made using the spare row of holes at the edge of the board remote from the f.e.t., again, of course, completing the job quickly to avoid overheating the components. Note that if an f.e.t. different from the one suggested is tried in the circuit, the base connections may not be in the same order as given in Fig. 2, the correct connections for the particular type must of course be known with certainty if an expensive mistake is to be avoided!

The values of the capacitors are not critical. Any value between 0·01μF and 0·1μF will do for C1: miniature polyester types with voltage ratings of 100V to 400V are especially suitable. C2 should not be less than 8μF to avoid any loss of bass: on the other hand there is nothing to be gained by using values above 25μF for audio signals. A voltage rating of 25V is adequate for C2.

POWER SUPPLY

A negative-earth power supply of 18V to 24V at 1 to 2mA is required. The exact value of the current drain will depend on the particular f.e.t., but the circuit is designed to compensate to a large extent for transistor variations. Two 9V batteries connected in series can be used, and large types such as the PP9 will have a very long life even when supplying current to a pair of pre-amps. in a stereo set-up. If a mains power pack is used, it must be very well smoothed, and decoupling capacitors of 1,000μF are recommended if the main amplifier's power supply is used. (Before attempting to use the main amplifier's power pack, check that it is of the correct polarity, i.e. it *must* be positive, with the negative line earthed.)

CONNECTION AND MOUNTING

Input and output connections should be made with screened microphone lead, the input lead being kept short to avoid hum pick-up. The pre-amp. fits neatly into a matchbox, and an ideal mounting position is near the tag-strip under a record-player deck. The output lead can be up to 20ft. long, and likewise there is no restriction on the length of the battery leads. If hum is troublesome, it can usually be cured by wrapping the matchbox in aluminium cooking foil, and earthing the foil.

The circuit given in Fig. 2 will handle signals of at least 1·5V r.m.s., and will therefore accept the outputs of low and medium-output cartridges. Some crystal cartridges, however, give more than 250mV per cm per sec recorded velocity (i.e. maximum outputs of more than 2·5V r.m.s. are possible). In such cases. an attenuator should be fitted as shown in Fig. 4. This will be necessary only if the output of the cartridge is quoted as being 200mV/cm/sec or more. The use of a volume control, a 1 or 2MΩ log. potentiometer, across the input is also possible: if this is done the pre-amp. must be positioned as close to the volume control as possible to minimise loss of treble frequencies. It is normally preferable to place the volume control across the output of the pre-amp., i.e. across the input of the power amplifier, a 5 or 10kΩ log. potentiometer being suitable.

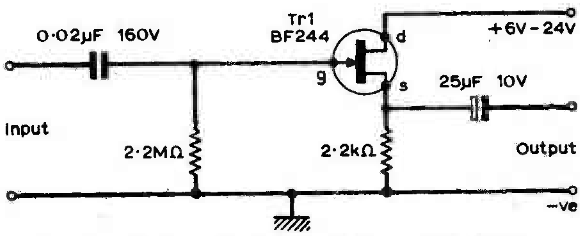


Fig. 5: An even simpler circuit for an f.e.t. preamp.

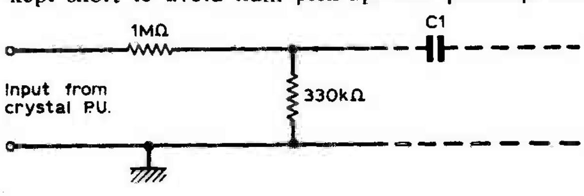


Fig. 4: The circuit of the attenuator necessary when high output cartridges are used. The actual value of the unmarked resistor will depend upon the attenuation required.

A SIMPLER CIRCUIT

The even simpler circuit of Fig. 5 can be used with lower supply voltages, down to 6V if required. However, the current drain varies widely according to the particular f.e.t. sample, and if the current is found to be less than 0·7mA, the attenuator of Fig. 4 will be necessary even with low-output cartridges (50-80mV/cm/sec), though not with f.m. tuners and crystal microphones. The circuit of Fig. 5 is therefore ideal for use with these latter sources, and has the advantage of being insensitive to quite large amounts of ripple on the power supply. ■

SUMS plus CIRCUITS equals UNDERSTANDING

PART 1

LESLIE MOORE

BUILDING electronic circuitry can be an extremely interesting and worthwhile past time. The functions of many of these circuits can be explained in simple terms, provided a basic knowledge of component operation has been attained. More complex circuits, however, cannot be described so precisely and an alternative exact method must be found.

Mathematics can provide a means of describing a circuit function, can be used to determine exactly how a circuit will operate under all conditions and must be used in design techniques, again, assuming an understanding of component operation with, of course, the availability of relevant component data.

The aim of this series is to introduce the reader to several basic mathematical theorems and explain the applications of these theorems to electronic circuitry.

Algebraic Manipulation

One of our aims should be to be able to predict the operation of a circuit given any necessary manufacturer's design data for the components used. A simple example of the use of algebraic manipulation is in the determination of the gain of a thermionic triode amplifier stage, of which a circuit diagram and an equivalent circuit are shown in Fig. 1.1. The equivalent circuit considers the operation of the amplifier under signal conditions. Internal resistances of the h.t. power supply are assumed negligible compared with other resistances in the circuit, hence the effective signal output voltage is developed across R_L. The value r_a, or "anode resistance" is the effective resistance of the valve under given bias conditions, and μ, or "amplification factor," is the ratio by which the valve will amplify a signal applied to the grid.

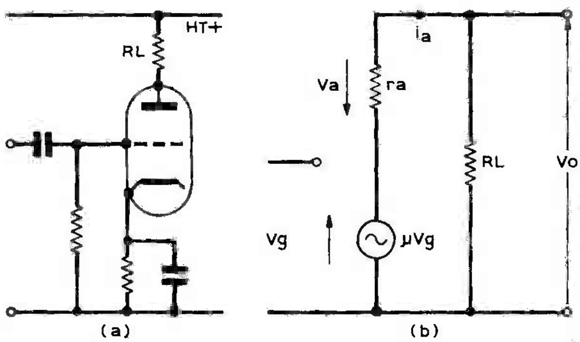


Fig. 1.1 (a) Typical amplifier circuit. (b) Equivalent circuit.

Quantities r_a and μ are supplied in manufacturer's data, but they can be measured. Voltage gain of the amplifier, A, is defined as output voltage, V_o, divided by input voltage, V_g, or:—

$$A = \frac{V_o}{V_g}$$

The valve is represented by a voltage generator in the equivalent circuit, producing a voltage of μV_g. Therefore the amplifier output voltage will only be a fraction of μV_g. Considering Kirchoff's law (explained in detail later) which states that the sum of potentials in a circuit is zero, then :

$$-V_a - V_o + \mu V_g = 0$$
$$\text{or} \quad \mu V_g = V_a + V_o \quad \ldots\ldots\ldots\ldots (1)$$

This equation is obtained from the equivalent circuit because of the potential directions (indicated by arrows). A simple rule is :

Follow current direction in the circuit. For all those potential arrows opposing current flow, subtract; for all those in the same direction as the current, add.

From Ohm's Law

$$V_a = i_a r_a \quad \ldots\ldots\ldots\ldots (2)$$
$$\text{and } V_o = i_a R_L \quad \ldots\ldots\ldots\ldots (3)$$

substitute equations (2) and (3) in equation (1) gives

$$\mu V_g = i_a r_a + i_a R_L$$

Because both r_a and R_L are multiplied by i_a, this equation may be re-written as

$$\mu V_g = i_a (r_a + R_L) \quad \ldots\ldots\ldots\ldots (4)$$

Now, we wish to determine a relationship between V_o and V_g.

Equation (3) states that $V_o = i_a R_L$ and equation (4) states that $\mu V_g = i_a (r_a + R_L)$.

To obtain a relationship for V_g alone, we divide both sides of equation (4) by μ to give

$$V_g = \frac{i_a (r_a + R_L).}{\mu} \quad \ldots\ldots\ldots\ldots (5)$$

By dividing equation (3) by (5) the required result:

$$\frac{V_o}{V_g} = \frac{i_a R_L \mu}{i_a (r_a + R_L)}$$

or, because the effect of i_a cancels:—

$$\frac{V_o}{V_g} = \frac{\mu R_L}{r_a + R_L} = A \quad \text{(Voltage gain of the amplifier)}$$

From the above example it can be seen that algebraic manipulation can be broken down into three parts which are:

(1) Developing an equivalent circuit to represent a circuit under its working conditions.
(2) Deriving equations from the equivalent circuit.
(3) Manipulating the derived quantities into the required form.

Firstly, a familiarity with electronic components and their principles of operation is an important factor. Numerous text books give many standard equivalent circuits, but a good understanding of how these are obtained will prove to be an asset.

Secondly, the derivation of equations from an equivalent circuit requires a knowledge of the more common network theorems, a précis of which is given here:

(1) OHM'S LAW:

The voltage V, developed across a resistance R, is directly proportional to the current I, flowing through that resistance. (see Fig. 1.2).

(2) KIRCHOFF'S LAWS, of which there are two:

(A) The sum of the currents flowing into a junction must equal the currents flowing away from it. (see Fig. 1.3 (a)).

(B) As before, the total sum of potentials in a circuit is zero. (see Fig. 1.3 (b)).

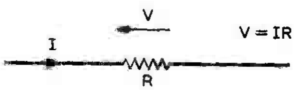


Fig. 1.2: Ohm's Law.

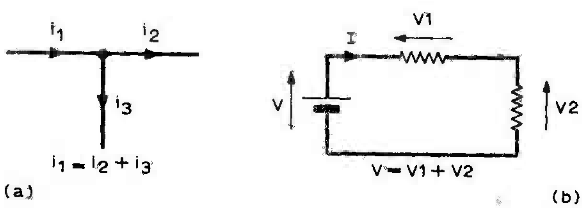


Fig. 1.3: (a) Kirchoff's Law A.
(b) Kirchoff's Law B.

(3) METHOD OF MESH CURRENTS:

Derived from Kirchoff's Laws but, in fact, can provide a simpler solution to complex problems.

(4) THEVENIN'S THEOREM:

This is used for determining the current flowing in a branch of a network and is applied in the following manner:

(a) Make a break in the branch in question.
(b) Determine the voltage which would appear across the break.
(c) Reduce all sources of e.m.f's. (or voltages) to zero and replace them by their internal resistances.
(d) Determine the impedance looking into the break.
(e) Divide the result of (b) by the result of (d) to give branch current.

An example of the use of Thévenin's Theorem is given in Fig. 1.4.

Example:

Determine the current i_2 shown in Fig. 1.4(a)

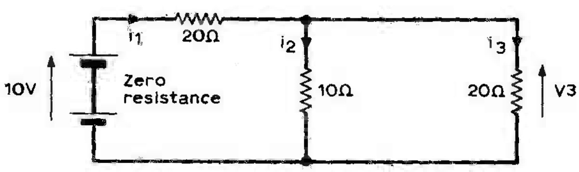


Fig. 1.4: (a) Current i_2 unknown.

Step (a)

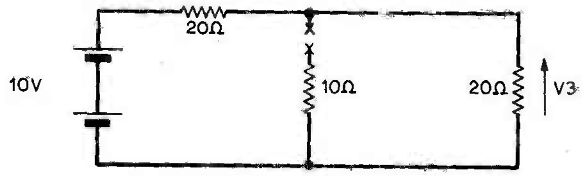


Fig. 1.4: (b) Make a break in the branch.

Step (b) There is now no current in the 10Ω resistor so the voltage looking into the break is equal to V_3

$$V_3 = \frac{20}{20+20} \times 10 \text{ Volts} = 5 \text{ volts.}$$

Step (c)

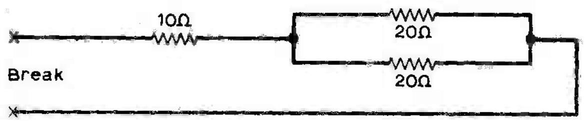


Fig. 1.4: (c) Determine the resistance looking into the break, voltages reduced to zero.

Step (d)

$$\text{Resistance} = 10\Omega + \frac{20 \times 20}{20+20} = 20\Omega$$

Step (e)

$$i_2 = \frac{5}{20} = \tfrac{1}{4} \text{ Ampere (250mA)}$$

(5) NORTON'S THEOREM

This is similar to Thévenin's Theorem but uses equivalent constant current generators.

Such a list could be used to include many more complex theorems, however, if those mentioned were understood completely they would provide a good background to enable the formation of mathematical equations from circuitry.

Thirdly, the manipulation of equations obtained. This may be broken down into three logical steps:—

What is the problem, or what is to be found?
Which pieces of information are required to solve the problem?
How should the equations be manipulated to give this information?

To demonstrate them consider the further example of a transistor amplifier stage using the standard hybrid parameter equivalent circuit as shown in Fig. (1.5).

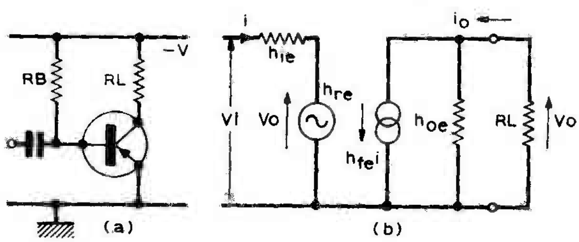


Fig. 1.5 (a) Typical amplifier circuit.
(b) Equivalent circuit neglecting biasing resistor.

From the equivalent circuit which employs voltage and current generators to represent the inherent characteristics of the transistor, the following equations may be derived.

$$V_i = ih_{ie} + h_{re} V_o \quad \ldots\ldots\ldots\ldots\ldots (1)$$
$$V_o = -i_o R_L \text{ (due to current direction)} \quad \ldots\ldots (2)$$
$$i_o = ih_{fe} + V_o h_{oe} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Note that the units of h_{oe} are those for conductance or the inverse of resistance.

Suppose we wish to know the input resistance of the circuit (i.e. at a frequency where capacitive components have negligible reactance to the signal). From Ohm's Law, the input resistance to the circuit is given by the relation:

$$r_i = \frac{V_i}{i}$$

Equation (1) gives an equation containing both V_i and i, but V_o is also present. Therefore we must substitute other quantities to give a relation between input resistance and other circuit constants: From equation (2) we have

$$V_o = -i_o R_L$$

and from equation (3)

$$i_o = h_{fe} i + V_o h_{oe}$$

Substituting for i_o in (2) gives

$$V_o = -R_L (h_{fe} i + V_o h_{oe})$$
$$\therefore V_o (1 - R_L h_{oe}) = -R_L h_{fe}\, i$$
$$\therefore V_o = \frac{-R_L\, h_{fe}\, i}{(1 + R_L h_{oe})} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Substituting equation (4) in equation (1) gives

$$V_i = ih_{ie} - \frac{R_L\, h_{fe}\, h_{re}\, i}{1 + R_L\, h_{oe}}$$
$$\therefore V_i = i\,(1)\, h_{ie} - \frac{R_L\, h_{fe}\, h_{re}}{1 + R_L\, h_{oe}} \; (1)$$
$$\text{or } \frac{V_i}{i} = r_i = h_{ie} - \frac{R_L\, h_{fe}\, h_{re}}{1 + R_L\, h_{oe}}$$

Thus giving the relationship required.

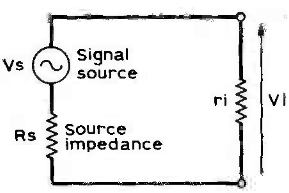


Fig. 1.6: Determination of true input voltage,

Fig. 1.6 shows the importance of being able to determine an amplifier input resistance. All signal sources will have an output impedance which can be represented as a series impedance with the source. The actual amplifier input voltage V_i, will then be only a fraction of the signal source voltage V.

Then the amplifier input voltage will be given by:

$$V_i = \frac{r_i}{R_s + r_i} V$$

The usefulness of algebraic manipulation applied to circuits does not end here. It is hoped, however, that these examples have served as a good introduction and that further articles will help give a complete picture of how mathematics can become another tool of the enthusiast.

TO BE CONTINUED

AUDIO LIMITER

R. F. GRAHAM

FOR short wave reception and personal listening, headphones are frequently used. The output stage of communications type and other receivers will provide enormously more volume than required, so that almost continuous manipulation of the audio gain control is required. Even then, while tuning or listening, bursts of interference, or powerful transmissions, can be very uncomfortable when searching for weaker signals.

This discomfort, and the need for much adjustment of the receiver volume control, can be eliminated by the audio limiter circuit in Fig. 1. Audio is taken from the usual phone outlet of the receiver.

The series resistor R1 limits power reaching the diodes with very strong signals. The diodes conduct to clip positive and negative audio peaks, the residual amplitude depending largely on the diode resistors R2 and R3. The potentiometer VR1 allows a suitable signal level to be taken off for the phones.

The components may be wired on a small panel, or in a box, with twin leads and a jack plug to provide the audio input from the receiver. The phone jack plug is inserted in a socket on the limiter.

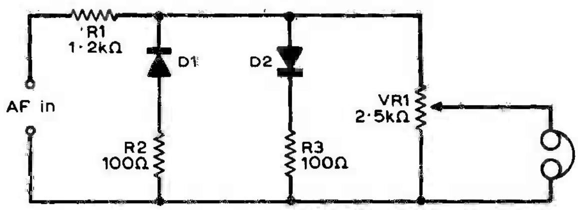


Fig. 1: Limiter for high impedance headphones.

Tune in a signal, adjust the receiver volume control until distortion commences, and turn it back somewhat from this point. VR1 is then adjusted for the required headphone volume. It will then be found that headphone volume does not increase if the receiver gain conrol is advanced, though there is a deterioration in audio quality due to the clipping action. For most signals the receiver volume control can be left in a suitable middle position, giving enough volume with weak transmissions, without serious loss of quality on strong transmissions. The circuit also limits some types of static and similar interference.

Values in Fig. 1 were for high impedance phones. Values could easily be modified if necessary. D1 and D2 were GD9 or OA91 diodes. Others are suitable.

Where output is taken from an extension circuit attached to the secondary of a speaker transformer, and the speaker is out of use, a 10Ω or similar 1-watt resistor may be connected across the a.f. input points, this provides some loading to reduce a.f. peak voltages in the transformer primary. ■

LETTERS...

The Editor does not necessarily endorse the views expressed by correspondents.

Space signals

I cannot agree with Mr. R. Hall, Cornwall that we shall not receive signals from other planets. We can, and do receive signals from the planet Jupiter.

Unintelligible signals, but signals nevertheless, which can be picked up on any domestic receiver, which covers the 21 to 14 metres band.

Electrical or magnetic storms in the atmosphere of Jupiter are thought to be the cause of the signals received.

Other rich sources are the Crab Nebula, and the galaxy Andromeda.

The simplest form of radio telescope could be a television set with directional aerial, steerable and used when the local stations are off the air.

For those who would like to take up this absorbing branch of radio, there are excellent text books in your local libraries, giving constructional details of receivers which are quite easy to construct and operate, together with details of galaxies to search, frequencies, etc.

Who knows, some day or night, we may receive the kind of signals, from many light years away, to reawaken us to revise our whole concept of life as we know it.—**E. Furlong** (*Cheshire*).

Points of view

After reading the letter in your December issue from Mr. E. W. Baigent on the "old days," I became rather dissatisfied with putting "supplied components into holes in a printed circuit board." It seems that construction today is a rather automatic process—I wonder how many of your readers would ever dream of modifying any of your circuits other than by changing slightly the odd capacitance or resistance value. It seems that individuality is a thing of the past—I am no exception to this.

I find it rather harder to agree with his other points, however. One of the greatest and most constantly overlooked needs in electronics is that of standardisation, ("Practically Wireless" No. 63, December issue). In the case of "c.p.s.," what would that mean to a Frenchman or a German? Once established, the use of a name tends to become international and readily understandable to many more people.

As for the new colour coding, this is another example of international standardisation. The colours now coming into use are of necessity a compromise. Though the use of red for live would have been very desirable from our point of view, quite a large number of Continental firms had until recently been using red for earth! In any case, brown is not very far removed from red, and if we remember that on mains wires, the only two-tone wire is the earth, it takes very little adjustment to adapt ourselves to the new system.

The case for the Hertz is very debatable, I agree, but the new wiring takes into account people's lives, no mean commodity, in this country and abroad; we should be glad to have at last an acceptable compromise, and think before we shout.—**A. L. McLeish** (*Durham*).

What, no chips?

Much has been written on the subject of Integrated Circuits (Chips) and I would like to add my own comments.

Having purchased one with the intention of making a record player amplifier, I was amazed at the difficulty of setting it up. One is obliged to experiment with component values and to add this and that to prevent instability. Really, it is reminiscent of tinkering with a regenerative receiver to make it operate correctly!

The small physical size of these chips seems to me to be of no advantage as they need quite a few added external components including large electrolytic capacitors.

Cost-wise too, there is no advantage. For the cost of constructing a 5W mono amplifier using a "chip," I am able to build the P.W. Double 12 in mono which gives 12W (both powers in r.m.s.). I refer to constructing the respective chassis without cabinet trimmings etc. If the integrated circuit amplifier goes wrong, I have to purchase a new chip but if my P.W. Double 12 packs in, I pay, at the most, a few shillings for a new component.

I do not think "chips" pose any threat to our fascinating hobby and to those constructors like myself, who like to build equipment from scratch.—**Frank Casson** (*Teeside*).

No Denial!

Re Mr. R. Hall's letter in the January issue. I well remember that towards the end of the active career of Marconi, the newspapers reported that when he was cruising on his yacht 'Electra' in the Mediterranean, some mysterious long wave signals were being received by him. The reports were really quite reserved. Their general tone was: 'where do the peculiar wireless signals received by Marconi, come from?' A few went further and mentioned the possibility of Mars!

Though Marconi did not actually claim they *did* come from Mars, he in no way said they did not! "He would investigate further."—**A. Trowbridge** (*Middlesex*).

PRACTICAL WIRELESS QUERY SERVICE

Before using the query service it is important to read the following notes:

The PW Query Service is designed primarily to answer queries on articles published in the magazine and to deal with problems which cannot easily be solved by reference to standard text books. In order to prevent unnecessary disappointment, prospective users of the service should note that:

(*a*) We cannot undertake to design equipment or to supply wiring diagrams or circuits, to individual requirements.

(*b*) We cannot undertake to supply detailed information for converting war surplus equipment, or to supply circuitry.

(*c*) It is usually impossible to supply information on imported domestic equipment owing to the lack of details available.

(*d*) We regret we are unable to answer technical queries over the telephone.

(*e*) It helps us if queries are clear and concise.

(*f*) **We cannot guarantee to answer any query not accompanied by the current query coupon and a stamped addressed envelope.**

MEDIUM WAVE DXING

CHARLES MOLLOY

INTEREST has been growing recently in the medium waves. DXers who look for something different, something more exacting or who are simply curious to sample local broadcasting from other parts of the world are turning to the 'broadcast band'. The medium waves do offer a real challenge. In Europe the main problem is interference: several hundred stations broadcast on unauthorised frequencies or use excessive power. Many are on the air 24 hours a day, so the band is never quiet after dark. Directional aerials help to counteract the problem. Loop antennas, based on the frame aerial that was popular in the early days of radio are now standard equipment for the majority of MW DXers. The second problem is knowing the right time to listen. Most parts of the world, with the exception of Australasia, can be logged at some time of the year. The hobby is not seasonal and is not restricted to the winter months. All that is required for success is a path of darkness between transmitter and receiver and of course, favourable propagation conditions. Broadly speaking the best DX to be had in the UK will be trans-equatorial in summer and from the northern hemisphere in winter. The Far East is only heard in winter while stations in East and South Africa are usually only logged in summer. There is no lack of stations, in fact there are many more of them on the medium waves than on all of the Short Wave broadcast bands put together—over 5000 in the United States alone. Canada, United States, Caribbean, Central and South America, Africa, Near East, India, China and Japan, have all been logged on numerous occasions by DXers in this country.

PROPAGATION

The medium waves are used almost exclusively for local broadcasting, propagation being by ground wave. During the daytime the sky wave is absent since high angle radiation is absorbed by the lowest part of the ionosphere—the 'D' layer. This layer disappears at sunset enabling refraction from higher regions to take place; even vertical radiation is returned. The sky wave interferes with the ground wave to produce severe fading in areas where the two are comparable in strength. As distance increases from a MW transmitter, an area is reached where selective fading and distortion occur after dark limiting the useful night-time range of the transmitter. The ground wave diminishes in strength as the distance from the transmitter increases and finally it disappears. Beyond this point after dark, only the sky wave can be received, we are now out of the normal service range of the transmitter and the signal is becoming DX.

Anti-fading aerials are used by large numbers of medium wave transmitters. This type of aerial, which is a vertical, puts out maximum signal at low angles to the horizon and minimum signal at high angles. The reduction in high angle radiation reduces the amount of sky wave into the service area, consequently fading decreases and the night-time range is extended. Low angle radiation is of great interest to the DXer. It enters the ionosphere at a shallow angle and can travel up to 1500 miles in a single hop after reflection by the 'E' layer. Often it continues for thousands of miles in successive hops when propagation is favourable. Conditions on the medium waves are more variable than on the short waves, a factor which frequently causes disappointment to the newcomer. Persistance and patience are the qualities required of the MW DXer. If you do not hear North America at the first attempt then try again a few days later. If conditions are poor they are unlikely to remain so for long.

AERIALS

No serious MW DXer would be without a loop (Fig. 1). This type of aerial is directional, maximum pick-up is along the plane of the windings, minimum pick-up is along a line at right angles to the windings. The depth of the null (degree of signal suppression) depends on the electrical balance of the windings so it is important that they should be symmetrical. The loop is very simple to use. Tune in a station on the receiver, peak it with the loop tuning control and rotate the loop for optimum reception. Frequently it is possible to null-out different stations on the same frequency e.g. on 1070kHz CBA in Canada can sometimes be heard free of interference if the null is pointing towards LR1 in Buenos Aires and similarly LR1 can be heard with CBA nulled-out. There are additional benefits to be had from a loop. Static is reduced, in early summer when much of it comes from thunderstorms to the south, it can be eliminated when listening to the west. Overloading and cross-modulation are reduced leading to the unlikely, but quite correct, claim that audio quality is sometimes better when using a loop. Direction finding can be a help to station identification. Turn the loop until the unidentified station disappears, when its direction will be along a line at right angles to the windings. The 40in. loop is a compromise between pick-up and convenience. A larger loop will have greater pick-up. Alternative sizes can be constructed using approx. 100ft. of plastic covered wire of about 22 s.w.g. for the main winding which should be wound to a whole number of turns. If the loop will not tune to the h.f. end of the band there are too many turns. If it will not tune to the l.f. end then add turns or increase the value of the tuning capacitor.

If anyone has space to erect a long wire aerial several wavelengths long he will find it is directional along the length of the wire and the pick-up will be far greater than that of a loop. DXers in New Zealand achieve remarkable results using long wires. Few of us in this country will have the space for this type of aerial and it is doubtful if one would be of value in the presence of strong QRM. No-one should be deterred from DXing on the medium waves through lack of an outside aerial. The

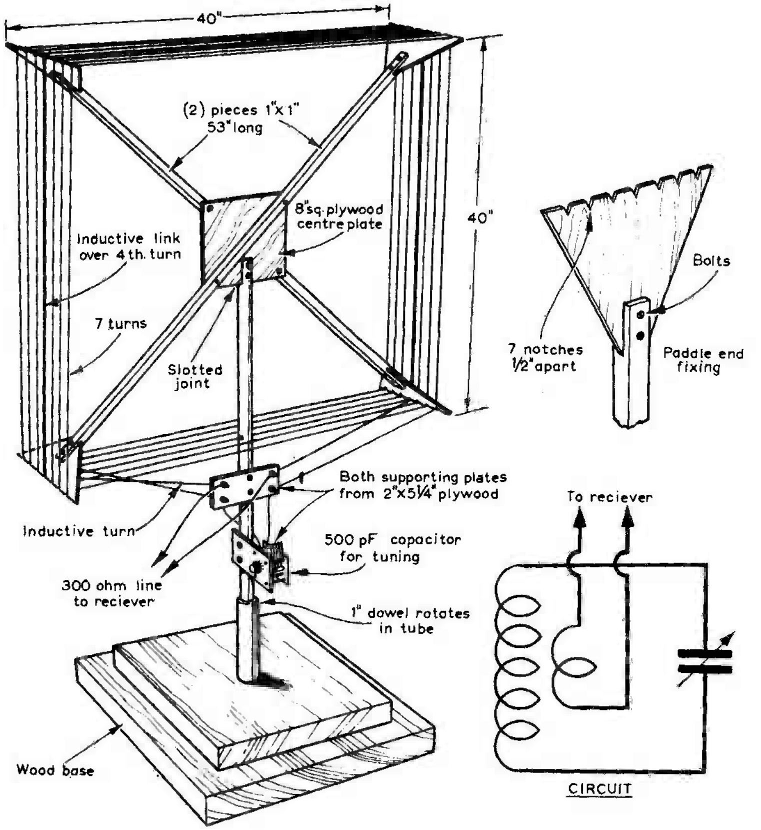


Fig. 1: The loop aerial.

ordinary TV aerial gives excellent results when used in conjunction with a good earth at the receiver. Connect the inner wire of the co-ax downlead to the aerial socket and earth the outer braiding. In some locations better results will be obtained by using the co-ax outer as the aerial.

DXING

Winter is the time of year for Asiatic stations and there are three periods of the day when reception is possible. The first is in the afternoon from approx. 1500hrs to 1700hrs GMT. Stations heard recently include Taiwan on 750kHz; Bagdad (760); Teheran (895); Iran (985); Anwhei, China (940); Peking (1000); Calcutta (1130) in English 1530 to 1600hrs; Philippines (1140); VOA, Okinawa (1178); Korea (1190); Kabul, Afghanistan (1280); China (1290); Teheran (1325); Kuwait (1345). The second period is in the evening from 2000hrs onwards:—Saudi Arabia (588); Jerusalem (677); Allepo, Syria (746); Amman, Jordan (800); Beirut (836); Bagdad (908); Damascus (957); Diyabakir, Turkey (1061); Haifa (1205). The last period is after midnight when stations in India are sometimes logged. The easiest is Rajkot 1070kHz but others have been heard on 910, 1020, 1060, and 1330.

North Americans can be heard throughout the year. In summer those along the east coast of Canada and the United States are audible for an hour before sunrise and are usually free of interference since the greater part of Europe is in daylight at this time. During the winter stations from this area appear regularly after 2300hrs GMT, the time when most Europeans sign-off for the night. If conditions are favourable the following should be heard between 2300hrs and midnight:—WOR (710) and WINS (1010) in New York City; WHDH (850) Boston; CBH (860) Halifax, Nova Scotia; CJON (930) St John's, Newfoundland; CBA (1070) Moncton, New Brunswick; WBAL Baltimore on 1090. More stations appear as the night progresses but at 0300hrs when Eastern Europeans sign-on QRM starts to become troublesome. The following may be heard during this period—WNBC (660), WABC (770), WCBS (880), WHN (1050), and WNEW (1130) all in New York City; CHER (950) Sydney, N.S.; CHNS (960) Halifax; KDKA (1020) Pittsburg; WOWO (1190) Fort Wayne, Indiana; WKBW (1520) Buffalo N.Y.; WCKY (1530) Cincinnati Ohio.

South American stations are at their best in summer. From June to September (when it is winter in the southern hemisphere) during the two hours before sunrise, look for stations from the deep south and the east of the continent such as CX16 (850) *Radio Carve*, Montevideo Uruguay; PRF4 (940), PRE8 (980) and PRE3 (1180) *Radio Globo*, Rio de Janeiro; PRB9 (1000) *Radio Record* in Sao Paulo; CB106 (1060) *Radio Mineria* in Santiago de Chile; OAX41 (1320) *Radio Cronica* Peru. These are but a few of the stations that can be heard and sometimes they come roaring in, especially the Brazilians.

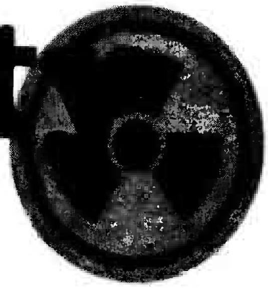
In winter, the Caribbean area and parts of South America are heard regularly after midnight including YVKS (750) *Radio Caracas* Venezuala; Jamaica also on 750 in English; Georgetown, Guyana (760); PJB (800) Bonaire; WKVM (810) in Spanish, and WBMJ (1190) in English of San Juan, Puerto Rico; *Radio Caribbean* (840) St. Lucia in French; *Radio Belize* (835) British Honduras; LR3 (950) *Radio Belgrano* and LR1 (1070) *Radio el Mundo*, both in Buenos Aires; HJHN (960) Barranquilla, Colombia; PJD2 (1295) St Maartin (in Dutch and English).

During the late evening in winter look for the following West Africans:— Tenerife, Canary Islands on 620 and 894; Monrovia, Liberia (629); *Radio Sahara* (656) in Spanish Sahara; Dakar (764) in Senegal; Luanda, Angola (1088); Conakry, Guinea (1403); Funchal, Madeira (1529). Conakry broadcasts in French and is often quite strong at 2300hrs. In summer, the following have been logged from East and South Africa between 0200 and 0400hrs:— Dar es Salaam, Tanzania (638); Lourenco Marques, Mozambique (917); Kitwe, Zambia (1070); Pretoria (1268); Johannesburg (1286).

Medium wave stations in Europe are spaced 9kHz apart while in other parts of the world, including North America, they are usually on 'channels' 10kHz apart. Co-incidence occures every 90kHz, namely on 620, 710, 800, 890, 980, 1070, 1160, 1250, 1340, 1430, 1520 and exceptionally, 1570kHz. This set-up is significant; if a European DXer wants to listen to North America he will find it easier if he listens on those sections of the band

—continued on page 965

radioactivity DETECTOR



L. McNamara

THE high voltage required to operate geiger tubes in portable equipment is usually obtained from h.t. batteries. This article describes a method for operating one of these tubes from a 7·5V battery and eliminates the need for rather large and cumbersome power supplies. The pulses produced by the radioactive particles are heard as "clicks" in the loudspeaker or, if the constructor so wishes, they can be fed into a scaler and counted in this way.

Referring to the circuit diagram, Fig. 1, it can be seen that basically the design consists of a static inverter followed by a voltage doubler circuit to give the high tension required to operate the tube. The inverter is an astable multivibrator with regeneration provided by R3 and R4. The primary of the transformer forms the load for Tr1 and Tr2 while resistors R1 and R2 ensure that the transistor leakage current is kept to a minimum.

For correct operation of the tube 400V is required. If the voltage is too low the tube will fail to trigger when a radioactive particle enters it. If on the other hand it is too high a continuous discharge will take place. To control this voltage a 100Ω pre-set resistor was inserted between one terminal of the battery and the inverter and this can be adjusted to give the correct operating voltage on the tube.

Whenever a radioactive particle enters the tube it ionises some of the gas particles. The negative ions produced in this way will move towards the anode while the positive ions move to the cathode. Some of these charged particles accelerated by the high voltage will collide with other gas molecules causing further ionisation and so a rapid discharge of the tube follows. This pulse is taken from across R5 and fed via C3 to the transistor amplifier. R6 acts as a buffer resistor to limit the current drawn from the geiger tube. If too much current were drawn then the voltage across C2 would drop below 400V with the result that if a number of particles were to follow in quick succession some would fail to register.

The super alpha pair Tr3 and Tr4 further increase the input impedance of the amplifier and biasing resistors were found to be unnecessary as the input pulse was of a sufficiently high amplitude to bias the transistors on. In the absence of a pulse no current flows through Tr3 and Tr4. Consequently the voltage across R7 will be virtually zero and this ensures that Tr5 is biased off and so no current flows through the loudspeaker. When the tube is triggered the negative going pulse biases Tr3 and Tr4 on, and the current flowing through them causes a voltage drop across R7 which in turn biases Tr5 on and this gives rise to a 'click' in the loudspeaker.

Some constructors may find the pulse amplifier

★ components list

Resistors:

R1	470 Ω	R5	2·2M Ω
R2	470 Ω	R6	330k Ω
R3	2·2k Ω	R7	4·7k Ω
R4	2·2k Ω	VR1	100 Ω preset

Capacitors:

C1	0·1μF 250V	C3	0·05μF 250V
C2	8μF 450V		

Semiconductors:

Tr1	2N2926	Tr4	OC81
Tr2	2N2926	Tr5	2N2926
Tr3	OC81	D1, D2	BY100

Miscellaneous:
Geiger tube type CV2247 (G5H)†; Loudspeaker 30 Ω to 80 Ω type; Transformer type MT98, primary 0-250V, secondary 9-0-9V†; copper laminate printed circuit board etc.
† Available from Henry's Radio Ltd.

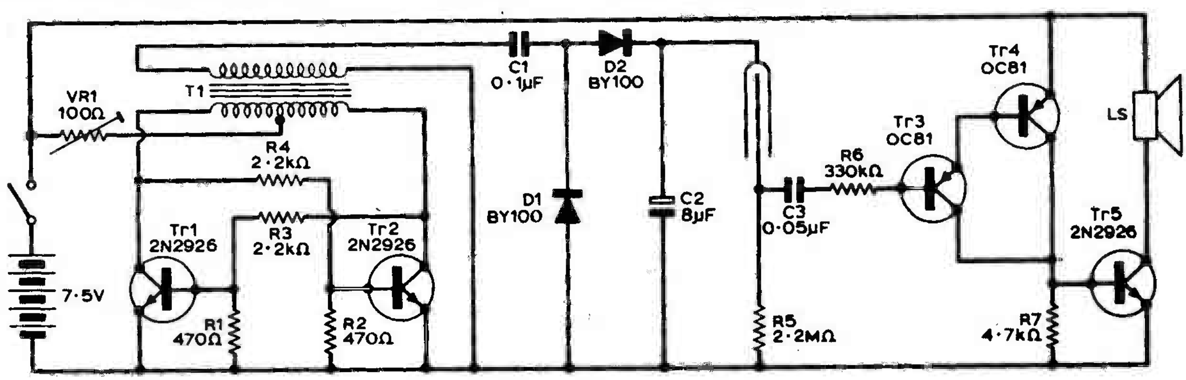


Fig. 1: Circuit of the radioactivity detector.

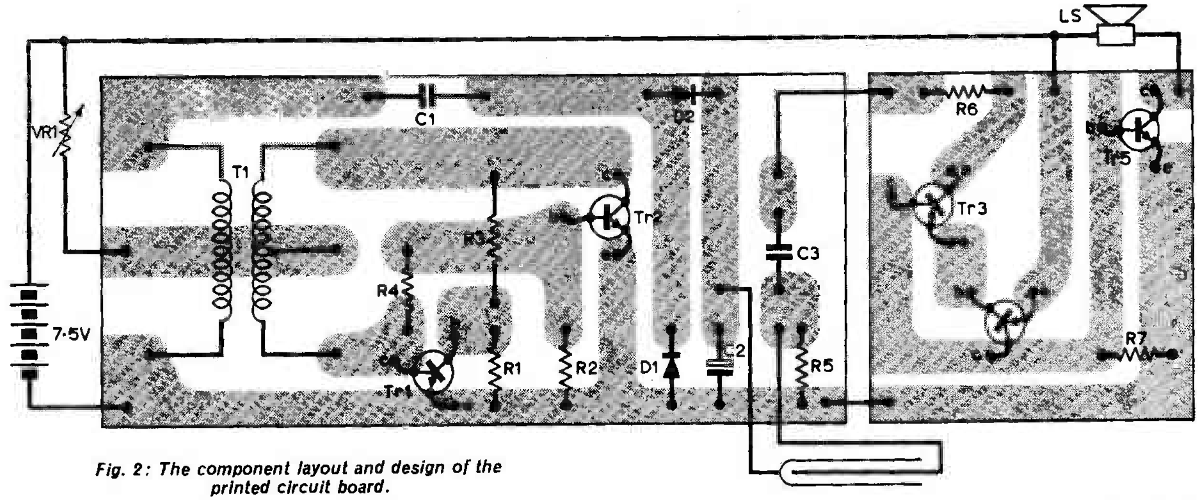


Fig. 2: The component layout and design of the printed circuit board.

unnecessary, especially if they may wish to operate the unit to drive a scaler or an earphone. Consequently the prototype was built on two separate printed circuit boards and Fig. 2 shows the layout pattern which should be painted on a copper laminate board and etched in a solution of ferric chloride.

When the unit is switched on for the first time a meter should be inserted in the battery leads to monitor the current drawn. It should be in the region of 25mA. VR1 can then be adjusted to give the correct operating voltage. The background radiation with the type of tube specified should give a count of approximately 40 per minute but this will vary considerably depending upon the location. ■

MEDIUM WAVE DXING

— *continued from page 963*

where the North American channels are clear of Europeans. For Example, CBA (1070) cannot usually be heard until Paris II signs-off at 2300hrs. On the other hand CJON, St John's Newfoundland on 930kHz can often be heard earlier in the evening since the nearest European frequencies (and QRM) are 926 and 935. Schedules of European stations are important. Many Europeans close down late on Saturday nights but have shorter broadcasting hours on a Sunday. Most, including the BBC, sign-on late on Sunday mornings and many sign-off early on Sunday evenings as well.

DX signals on the medium waves nearly always suffer from slow cyclic fading. The fast fluttery type of fading that can be counted in 'fades per minute' is seldom encountered by the MW DXer. If two stations are heard simultaneously on a channel, it will be found that their relative strengths are changing continually. If the DXer is patient (and lucky) he may hear each station in the clear for a short while during a fade of the other one.

RECEIVERS

It is not necessary to own an expensive communications receiver to DX on the medium waves, especially if a loop is used. Both the R1155 and the PCR receiver are satisfactory. Good sensitivity and selectivity are desirable but freedom from overloading and cross-modulation are of paramount importance and in this respect oldish ex-service equipment excels. The AR88D and the CR100 are popular with MW DXers in this country. The writer uses a CR100 and a BC314, the latter being an l.f. version of the well known BC312. It covers 150kHz to 1500kHz in 4 bands and the i.f. is only 90kHz which gives good selectivity without a crystal filter. The MN26C is similar and more readily available but unfortunately does not have a tuning scale as it was designed for remote control.

Modern communications receivers perform well on the medium waves but beware of double or triple conversion as some are prone to spurios on this band. It is not unknown for modern receivers to have their performance degraded on the MWs, probably to make them suitable for entertainment purposes. If in doubt examine the circuitry and look for damping resistors in the r.f. and mixer stages.

When tuning across the band, switch off the a.g.c. otherwise weak stations close to strong ones may be overlooked. In order to protect the ears use an audio limiter of the type connected between the receiver and headphones.

REFERENCES

There are a number of specialist publications that provide news and information about the MWs. Broadcasting Stations of the World Part 2 published by the US Government Printing Office, Washington D.C. 20402, lists by frequency all broadcasting stations in the range 150kHz to 28MHz except for those in the USA. World Radio and TV Handbook, published annually in Denmark but available in bookshops in the UK, lists MW stations throughout the world as well as containing a mine of information of use to the general DXer. Medium Wave News, the club Magazine of the Medium Wave Circle appears eight times a year and contains recent loggings, station news and information on loops and receivers. Further information can be had from the editor, Ken Brownless, 7 The Avenue, Clifton, York YO3 6AS. For readers in the United States there are the International Radio Club of America, 5421 Clinton Court, Englewood, Colorado 80110 USA and the National Radio Club of America, PO Box 99, Cambridge Mass. 02138 USA. Both clubs specialise in the MWs.

Peak MW DX occurs in years when solar activity is low and since we are currently on a declining part of a sunspot cycle, further outlook is good. Several years of good and improving conditions lie ahead and will no doubt attract many newcomers to the oldest DX band, the medium waves. ■

WHAT DO YOU KNOW ABOUT METER SHUNTS?

PART 1

H.A. COLE, C.ENG., M.I.E.R.E.

IT is presumed that many readers could set about calculating separate shunt resistor values for a multi-range milliammeter but one wonders how many could do the same thing for a universal shunt? Where does one start? What value should be chosen for the shunt? And having selected a value, how does one then go about calculating the various sections of the shunt?

This article hopes to clear up these points and enable the reader to calculate both types of shunt.

The basic ammeter

The great majority of indicating meters used in test-meters are of the moving coil type where a coil of very fine wire is wound over a drum-shaped former and suspended between the poles of a permanent magnet (the pole peices are specially shaped to fit the contour of the drum). When current is passed through the coil a magnetic field is set up around it which interacts with that from the permanent magnet. The interaction is such that the drum carrying the coil is forced to rotate, hence the name 'moving coil' for this type of meter.

Two small coil springs, one at each end of the drum, provide a partial restraining force against the rotation and hold the drum stationary when the deflecting force produced by the interaction of magnetic fields exactly balances that of the two springs. The springs also serve to conduct the current into and out of the coil. A very thin lightweight pointer is attached to one end of the drum so that it rotates with it, and a graduated scale positioned behind the pointer enables the deflection to be measured.

The amount of coil current required for the pointer to reach full scale deflection (f.s.d.) depends, other factors being equal, upon the number of turns in the coil. A coil with many turns may, for example, require only 25μA for f.s.d., whereas a coil consisting of much fewer turns may require 10mA or more to produce the same deflection. Meters requiring very little current for f.s.d. are said to have a high sensitivity, whereas those requiring larger currents (about 1mA or more) are considered to be low sensitivity types. High sensitivity meters e.g., 50μA f.s.d., have coil resistances of the order of 1,000-2,000Ω, whereas low sensitivity types e.g., 10mA, are of the order 50-100Ω. The difference is in the number of turns and the gauge of wire used in the construction of the moving coil: the thinner the wire and the greater the number of turns, the higher the resistance.

For multi-range testmeter applications of the moving coil meter, it is desirable to be able to use the same basic meter to measure a wide range of currents. To do this one must first select a meter which has an f.s.d. suitable to the smallest range of currents to be covered by the testmeter. For example, if the lowest range on the test-meter is to be 0-100μA, then one must use a meter whose f.s.d. is not greater than 100μA. The next step is to provide means for bypassing that portion of the current to be measured which is in excess of the meter f.s.d. For example, for a 100μA meter to indicate 1mA (1,000μA) full scale, it is necessary to by-pass 900μA. By-passing current in this way is called shunting, and is achieved by connecting a resistor of appropriate value in parallel with the meter; such resistors are called *shunts*.

Shunting in practice can be achieved by either of two methods. In the first a separate shunt resistor is used for each current range to be covered by the meter, and the appropriate shunt selected by a switch. In the second method a single shunt resistor is permanently connected across the meter and tapped at intervals along its length so as to provide the required amount of shunting for the ranges to be covered; this form of shunt is known as a *universal shunt*.

The separate shunt method

Assume a 50μA moving coil meter (a very popular choice) which has a coil resistance of 1,000Ω, and that this meter is to be used in a testmeter having d.c. ranges of 0-200μA; 0-1mA; 0-25mA; 0-100mA and 0-500mA. For the first range it is necessary to provide a 150μA shunt so that only 50μA is allowed to flow in the meter (remember, ALWAYS ensure that not more than 50μA is allowed to flow in the meter, no matter what range is to be covered.) The required arrangement is shown in Fig. 1. (R_s is the shunt resistor and R_m is the meter coil resistance). The total current (I_t) applied through the input terminals of the testmeter divides so that 50μA flows in the meter, I_m, and 150μA flows in the shunt, I_s. Now to derive a simple but very useful formula which can be used to calculate the value of R_s for any values of I_t, I_m and R_m.

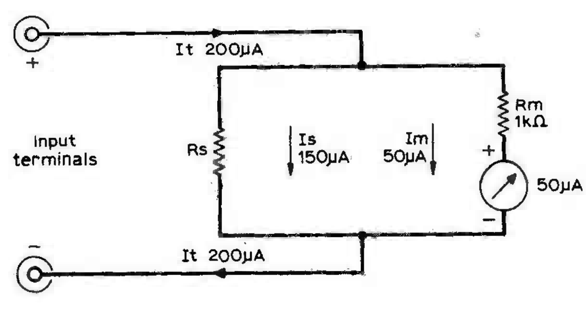


Fig. 1 Simple meter shunt

Referring to Fig. 1, since I_m flows through R_m then a voltage (V_m) will be developed across R_m equal to $I_m \times R_m$ i.e.,

$$V_m = I_m . R_m \text{ (by Ohm's law)} \ldots\ldots\ldots \text{(i)}$$

Now, since R_s is connected in parallel with R_m, then V_m must also appear across R_s and therefore the current in $R_s = I_s = \frac{V_m}{R_s}$ or, by substituting for V_m from equation (i), $I_s = \frac{I_m . R_m}{R_s}$ Transposing for R_s:

$$R_s = \frac{I_m . R_m}{I_s} \ldots\ldots\ldots \text{(ii)}$$

Now, since $I_s = I_t - I_m$, one may substitute $I_t - I_m$ for I_s so that the equation becomes; $R_s = \frac{I_m . R_m}{I_t - I_m}$

Now divide top and bottom of this equation by I_m:

$$Rs = \frac{\frac{I_m}{I_m} \times R_m}{\frac{I_t}{I_m} - \frac{I_m}{I_m}} = \frac{R_m}{\frac{I_t}{I_m} - 1}$$

Finally, since the ratio $\frac{I_t}{I_m}$ is really the multiplying factor of the f.s.d. of our basic meter, call this factor 'N' and write the equation as:

$$R_s = \frac{R^m}{N-1} \ldots\ldots\ldots \text{(iii)}$$

Now to use this equation to calculate the value of R_s for the $105\mu A$ shunt in Fig. 1 (some may prefer to use equation (ii), which is equally valid, by substituting $I_m = 50\mu A$ and $I_s = 150\mu A$).

$$\text{Since } N = \frac{200\mu A}{50\mu A} = 4, \text{ then } R_s = \frac{1{,}000}{4-1} = 333\Omega$$

Summarising, in order to use the $50\mu A$ meter to indicate $200\mu A$ at f.s.d. (range 1), one must provide a shunt resistor (R_s1) of 333Ω.

Now consider the requirements of the second range ($1_m A$), making use of equation (iii):

$$N = \frac{1mA}{50\mu A} = \frac{1{,}000\mu A}{50\mu A} = 20$$

$$R_s2 = \frac{R_m}{N-1} = \frac{1{,}000}{20-1} = 52{\cdot}6$$

$$R_s2 = 52{\cdot}6\Omega$$

For range 3 (25mA),

$$N = \frac{25mA}{50\mu A} = \frac{25{,}000\mu A}{50\mu A} = 500$$

$$R_s3 = \frac{1{,}000}{500-1} = \frac{1{,}000}{500} = 2$$ (ignoring 1 in the denominator because it is so small compared to 500).

$$R_s3 = 2\Omega$$

For range 4 (100mA),

$$N = \frac{100{,}000}{50} = 2{,}000 \text{ and } R_s4 = \frac{1{,}000}{2{,}000} = 0{\cdot}5$$

$$R_s4 = 0{\cdot}5\Omega$$

An important point should be noted at this stage, and that is the fact that since 100mA is 100 times 1mA, then 100 times as much shunt current is required for the 100mA range as was required for the 1mA range. Therefore, since current is inversely proportional to resistance ($I = V/R$), then a 100mA shunt will be 100 times smaller in value than a 1mA shunt. Having already calculated R_s2 for 1mA and found it to be $52{\cdot}6\Omega$ the value of R_s4 for 100mA will be $\frac{52{\cdot}6}{100} = 0{\cdot}526\Omega$ or, approximately $0{\cdot}5\Omega$. This agrees well with the value obtained for R_s4 using equation (iii).

Next calculate R_s5 for range 5 (500mA) using equation (iii), or determine its value by observing that 500mA is 5 times greater than 100mA, and therefore R_s5 (for 500mA) will be 1/5th of the value of R_s4 (for 100mA), i.e., R_s5 for 500mA $= \frac{0{\cdot}5}{5} = 0{\cdot}1\Omega$. Checking this answer by using equation (iii); $N = \frac{500{,}000}{50} = 10{,}000$, therefore $R_s = \frac{1{,}000}{10{,}000} = 0{\cdot}1\Omega$.

$$R_s5 = 0{\cdot}1\Omega.$$

Fig. 2 shows a suitable arrangement for incorporating the shunts just calculated to provide the desired ranges on the testmeter.

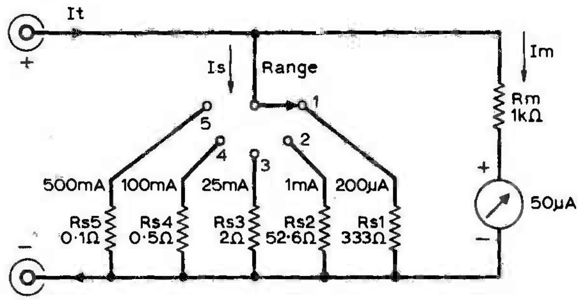


Fig. 2: Final circuit using separate shunts

The big disadvantage with this type of circuit is the contact resistance introduced by the switch. This may not be very important with a new good quality switch but after a period of use the contacts of most switches become dirty causing an increase in the resistance between the contacts, thus introducing measurement errors. The problem is not very important on the lower current ranges because the shunt resistors associated with these ranges are usually so large compared with the contact resistance that its effect may be ignored. On the high-current ranges, however, this is not the case and the contact resistance is comparable in value with that of the shunt (we have just shown that a shunt of only $0{\cdot}1\Omega$ is required for the measurement of 500mA).

The problem of contact resistance may be alleviated considerably by artificially increasing the resistance of the meter (R_m). From equation (iii), the shunt resistance is directly proportional to R_m ($R_s = \frac{R_m}{N-1}$), so if we increase the value of R_m then the value of R_s can be increased in the same proportion. Achieving this will not only reduce the importance of contact resistance but it will also avoid the need for fractional ohmic values of shunt resistance (it is never a simple matter to produce, or obtain, resistor values of less than 1Ω). To illustrate how this can be done, take the same $50\mu A$, $1{,}000\Omega$ meter, and deliberately increase its resistance tenfold i.e., make $R_m = 10k\Omega$; by connecting a $9k\Omega$ resistor in series with it. Now repeat the testmeter design procedure, using equation (iii), for the same current ranges of $200\mu A$; 1mA; 25mA; 100mA and 500mA.

For range 1 (200μA).

$$N = 4, \text{ therefore } R_s1 = \frac{10{,}000}{4-1} = 3{,}333\Omega.$$

$$R_s1 = 3{,}330\Omega$$

For range 2 (1mA).

$$N = 20, \text{ therefore } R_s2 = \frac{10{,}000}{20-1} = 526\Omega$$

$$R_s2 = 526\Omega \text{ and so on.}$$

It will be noticed that the values of R_s1 and R_s2 are now ten times greater than what they were when R_m was 1,000Ω. In other words, multiplying R_m tenfold has enabled us to multiply the shunt resistor values tenfold also. This means that R_s5 for 500mA is now 1Ω instead of 0.1Ω, and this is a standard value which can be obtained without great difficulty. The same applies to the 100mA range; R_s4 is now 5Ω instead of 0·5Ω, which again is readily obtainable. The values of $R_s1 - R_s5$ are now large enough, except perhaps for the 500mA range, to make contact resistance of the switch negligible.

All this sounds very convenient, so what are the snags? The big snag is that the effective resistance of the testmeter i.e., the resistance which would be measured between the two input terminals, is now much larger than it previously was, and this resistance may introduce errors into measurements, particularly when measuring large currents derived from low voltages. To demonstrate this, consider the simple circuit shown in Fig. 3.

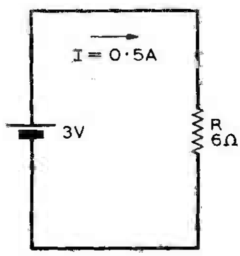


Fig. 3: Simple circuit.

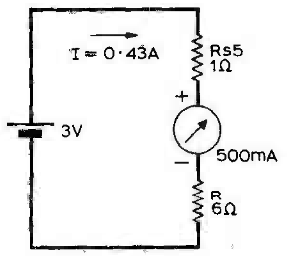


Fig. 4: Effect of adding meter

A 3V battery is connected across a 6Ω resistor (this could be a torch bulb, for instance) causing a current of 500mA to flow (I = 3V/6Ω). Now connect the testmeter, switched to the 500mA range, in series with this circuit so as to measure the current flowing and we shall be adding a resistance of about 1Ω to the circuit (this is the calculated value of R_s5 for 500mA; we can neglect the value of R_m which is 10kΩ because it is so large compared with R_s5). The circuit now appears as shown in Fig. 4 and the current (I) now equals

$$\frac{3V}{R_s5 + R} = 3/7 = 0.43A \text{ (430mA).}$$

This is the current which will be indicated on the meter, although it is known that the *true* circuit current without the meter in circuit is really 500mA. The presence of the meter has therefore introduced an error of

$$\frac{500-430}{500} \times 100\% = 14\%;$$

and this is quite substantial!

Now consider what would happen using the testmeter fitted with the original value of R_s5 for 500mA i.e., 0·1Ω. The circuit current would now be

$$I = \frac{3V}{6\Omega + 0{\cdot}1\Omega} \times 10^3\text{mA} = 491\text{mA}.$$

The measurement error is now

$$\frac{500-491}{500} \times 100\% = 1{\cdot}8\%;$$

this is still significant but much more acceptable.

The price to pay for high meter resistance is reduced measurement accuracy—especially on the high-current ranges. It is interesting to note here that the AVO model 7, which has a 1mA (effective) indicating meter, is much more suitable for measuring low-voltage high-currents than is the AVO model 8, which has a 50μA (effective) indicating meter. This is because the effective resistance of the model 7 is lower than that of the model 8, due to the lower resistor values used for the current shunts (the 1 amp shunt on the model 7 is about 0·14Ω, whereas the equivalent shunt on the model 8 is about 0·5Ω.)

TO BE CONTINUED

TAKE 20

JULIAN ANDERSON

No. 12
LIE DETECTOR

A series of simple transistor projects, each using less than twenty components and costing less than twenty shillings to build.

ASSUMING that the reader has a multimeter, this month's project should cost no more than five shillings since it consists simply of a single transistor with no associated components "pepping up" the performance of the resistance range on a multimeter.

Lie detectors are not very accurate pieces of equipment but they do work in a vague sort of way using a very simple principle and they provide endless hours of fun. The principle of simple lie detectors is that the skin resistance of a person varies with changes of emotion. These changes can easily be measured and are surprisingly rapid especially when the emotion is fear.

Many readers will know that a reading of skin resistance can be obtained using the high resistance range on a multimeter simply by holding the probes, one in each hand. The actual resistance varies enormously—between about 20kΩ and 300kΩ but under most conditions the resistance is between 100kΩ and 250kΩ. Cheaper multimeters will certainly show a reading for this sort of resistance but it will almost certainly be at the extreme end of the scale and to observe changes of about 5 per cent is very hard.

It is however very easy to increase the sensitivity of the meter just by connecting a transistor's collector and emitter to the meter and taking the probes from the base and collector. The battery inside the meter (1·5V in most cases with additional 9V or 15V ones in the better types) provides the supply voltage and it will quickly be seen from Fig. 1 that a very high resistance in the base-collector circuit of the transistor brings about a greater current flow through the meter and thus effectively registers a lower resistance. Note that the positive connection to a meter is actually the negative connection to the battery and so the connections to the transistor are made in what appears to be the wrong way around.

A silicon n-p-n transistor should be used (so here the meter positive lead goes to the emitter) and a 2N2926, BC109 or BC169 or any similar type is ideal. These transistors have very low leakage and very high gain and will bring the meter reading to the centre portion of the scale.

The same circuit is also applicable for measuring very high resistances or checking insulation. Using the circuit shown most meters will give a decent reading for 20MΩ—something quite outside the scope of most meters. Your scale will of course bear no relationship to the resistance being measured but it is a relatively easy matter to plot points on a graph using known resistances for calibration.

The transistor itself should be mounted on solder tags fixed to a small panel of perspex or polythene. The resistance of wood or similar sorts of material will upset the readings. The hand held probes can be made from brass or copper rod and when used these should be firmly held.

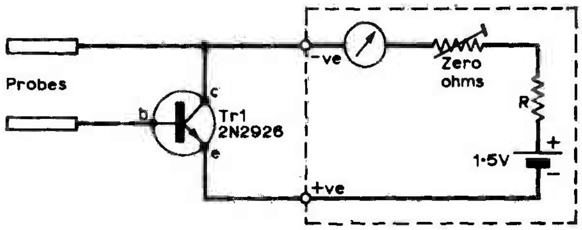


Fig. 1: The circuit of the lie detector. The components inside the dotted line are those within the multimeter itself.

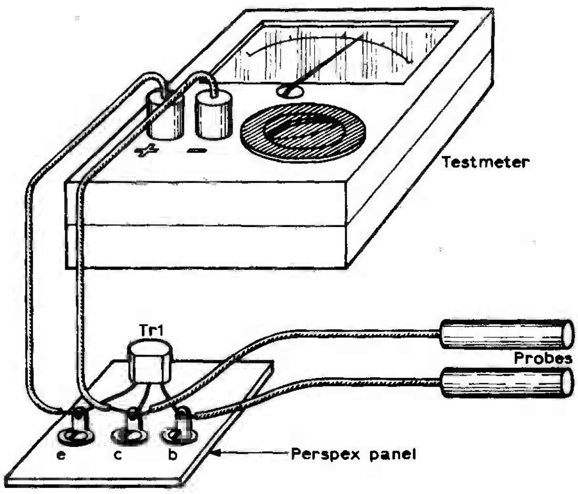


Fig. 2: The connections to the transistor.

The use of the lie detector can be very amusing and provide hours of fun at parties. There is an admirable solution to the inevitable sceptic who mocks the test—pour your drink over his hands! The surprise itself should be enough to produce the reaction but what he will probably not know is that the liquid will improve the probe contact and increase the reading. (Use water with a little salt in for this emergency measure—it looks quite like gin or vodka and after all you don't want to waste your drink do you!) ■

Next month's *Take 20* project is a two transistor radio. The circuit is designed specifically for miniaturisation by the constructor.

GENERAL COVERAGE RECEIVER

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F. G. RAYER G3OGR

Continued from last month

FIXING holes for the drive are located with the paper template included with it. The S-meter is fitted to the right, Fig. 4. Holes are punched to take the controls under the chassis, as in Fig. 5.

An aperture is cut in the chassis to take the flywheel and drive. Holes are positioned for aerial and earth sockets, etc., and under each section of the ganged capacitor. Each coil needs a ¼in. dia. hole and they will be placed as in Fig. 5.

The chassis flanges are fixed to the panel with chromed bolts, the bottom of the chassis being 1/16in. higher than the bottom of the panel, to allow for the cabinet flange.

Leads are soldered to the bottom tags of the variable capacitor, and passed down through the holes mentioned. Capacitor and drive spindles are carefully lined up and joined with a flexible coupling. Spaces or extra nuts are needed under the capacitor, to raise it.

Space is left for a PP9 battery, Fig. 4. When the audio panel is completed, it is fitted a little clear of the chassis as in Fig. 4. This is done with two bolts with extra nuts. One bolt also provides the earth return connection from amplifier positive to chassis.

The i.f. and S-meter amplifier panel is secured with two small brackets, Fig. 4. This allows all cores and underneath wiring to be reached, with short connections where necessary. Positive is returned to the chassis at a bracket.

The small b.f.o. and produce detector panel is also fixed with two brackets, Fig. 4. The b.f.o. coil core is reached from the underside, so it is necessary to have a short adjusting tool, or make one from a strip of paxolin or insulated rod.

Bandswitch

This has a mechanism with moving stop, which is placed to give four positions. The three wafers are placed with their identification marks all the same way, and are threaded on the shaft. The screwed rods are then put in, with spacers allowing the wafers to come approximately as in Fig. 5.

Each wafer is three-pole four-way, and the switch cannot work if any is reversed, or has its rotating section wrongly placed on the shaft. If there is any doubt about its operation, this will be clarified by examining a wafer, and checking with a meter, with the switch in each of its four positions in turn. Also test the receiver with the three coils for one band only actually connected, with the switch in the appropriate position.

The front wafer is S1, S2 and S3. S3 is nearest the chassis, and wired to VC1 (and VC4). Tr1 base goes to S2 as in Fig. 5. The remaining section is S1, used for aerial.

The central wafer is S4, S5 and S6. Tr1 collector goes to S4, Tr2 emitter to S5, Fig. 5, and again the tag nearest the chassis has a short lead through to VC2.

The rear wafer is S7, S8 and S9, Tr2 emitter and collector going to S8 and S7, positioned as in Fig. 5, with a short lead from VC3 to the remaining section S9, near the chassis. This allows short leads where required.

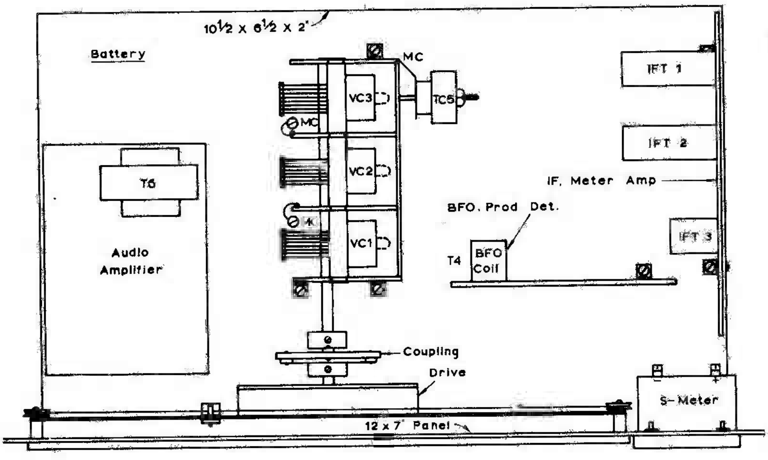

Fig. 4: Layout of main components on the top of the receiver chassis.

Coils, etc.

These are positioned as in Fig. 5, for short leads on the h.f. ranges, while keeping similar coils well separated. The wiring is largely duplicated from one band to the next, as follows:

Blue (Aerial) Coils. 1 and 9 joined on all, and to chassis. 7 joined on all, and to C1. C1 goes directly from S.W.1, pin 7, to chassis, Fig. 5. S1 tags, S2 tags and S3 tags are then wired in sequence to 8, 5 and 6, of S.W.1, S.W.2, S.W.3 and M.W. coils.

Yellow (Mixer) Coils. All tags 1 to chassis. Tags 8 joined and to C3. Tags 7 joined and to C5 at S.W.1, Fig. 5. S4, S5 and S6 then go to 9, 5 and 6. for each range, as before.

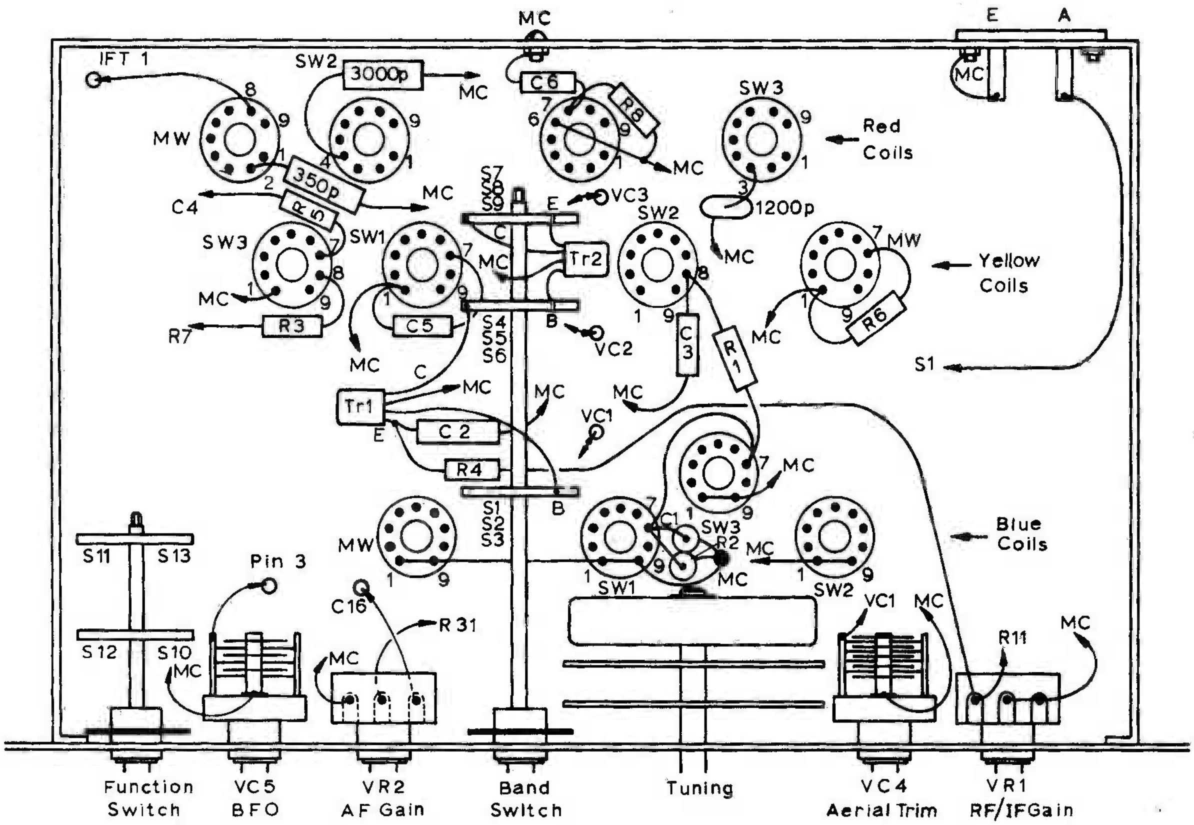

Fig. 5: Layout and part wiring of components on the chassis underside.

Red (Oscillator) Coils. Tags 8 joined, and to 2 on i.f.t.1. Tags 7 to C6 at S.W.1 (Fig. 5). S7, S8 and S9 to tags 9, 5 and 1. Padders as described, and in Fig. 5.

Chassis returns for S.W.1 and S.W.2, including those via capacitors C1, C5 and C6, *must* be very short and direct. For these ranges, 20 s.w.g. connections are suggested, with 26 s.w.g. for the lower frequency coils. Different colours of 1mm sleeving will help identify the leads.

Coils were placed to allow a screen between blue and yellow types, but this was found unnecessary. Shorting type wafers to earth all unused windings are not available in the three-pole type. Small absorption effects were found to arise at about 12, 17 and 24MHz. Since 12MHz is available on both S.W.1 and S.W.2, this may be neglected. The others would be cured by using shorting wafers. This would require more wafers, as they are only available in two-poles per wafer type. Alternatively, the offending coils could be placed in the cans supplied by the maker, for screening.

Tr1 and Tr2 are close to their connecting points, and with each the shield lead goes to the chassis. Actual wires are emitter, base, shield, collector, in line and with extra spacing for the collector lead.

Individual mixer coil trimmers are not shown in Fig. 5 for clarity. These are soldered directly from pin 1 to pin 6 on each yellow coil, the plate adjacent to the adjusting screw-head going to 1 (chassis).

Constructional Points

Amplifiers and product detector with b.f.o. are assembled on insulated eyelet board having holes at 0·2in. centres. Plain board could be drilled to suit.

Some 26 s.w.g. tinned copper or similar wire may be used throughout, with 1mm sleeving. It is helpful to identify external and other connections by colour, and to use red for chassis (positive) and black for

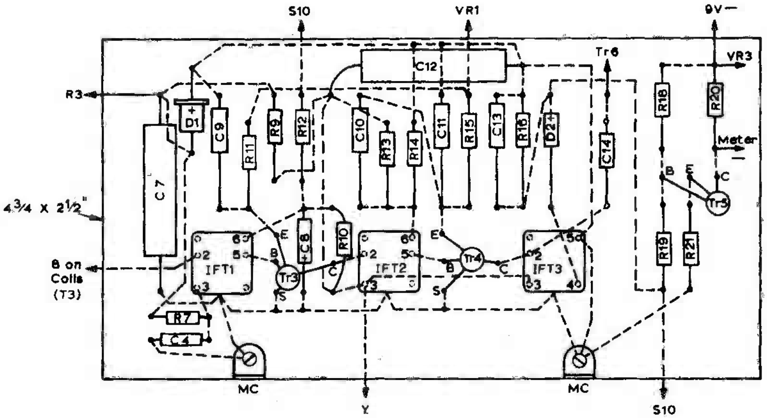

Fig. 6: I.F. amplifier and meter amplifier board.

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RCS DE-LUXE 3 WATT AMPLIFIER. Ready made and tested. A 2-stage unit using triode pentode valve, giving 3 watts output. Tone and volume controls. Isolated mains transformer. With knobs, loudspeaker and valves ECL82, EZ80. Frequency response 50-12,000 cps. Sensitivity 200mV. Post 5/6. **89/6**

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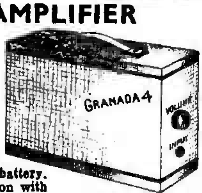

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9-12v. and 200-300v. D.C. operation. Size 1½"×1½"×½". Response 15 c.p.s. to 25 Kc/s, 26 db gain. For use with valve or transistor equipment. Full instructions. Brand new. Guaranteed. **17/6 each**

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RESISTORS. Preferred values, 10 ohms to 10 meg. ¼ w., ½ w., 1 w., 20% 3d.; 1½ w. 8d.; 2 w. 1/-; ½ w. 10% 6d.

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With flared tweeter cone and ceramic magnet. 10 watts. Bass res. 45-60 cps. Flux 10,000 gauss. Speech coil, 3 or 15 ohm. **45/-**

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Also with twin tweeters 3 or 8 or 15 ohms. 10 watt. **79/6**

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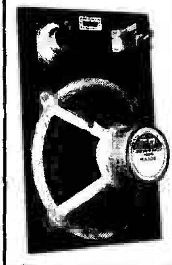
BAKER 12in MAJOR £8



30-14,500 c.p.s., 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 45 c.p.s. Rated 20 watts. Voice coils 3 or 8 or 15 ohms.

Module kit, 30-17,000 c.p.s. with tweeter, crossover, baffle and instructions. **£10.19.6**

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3 inch MOVING COIL METERS BRITISH MADE Various calibrations/movements. 500 Microamp; 1 Milliamp; 50-0-50 Microamp. etc. S.A.E. for list. **37/6**

MAINS ELECTRIC MOTORS

(120v. or 240v. AC). Size 2½ × 2½ × 1¾in. Clockwise 1,200 r.p.m. off load. Heavy duty 4 pole 50mA. Spindle ½ × 3/20. BARGAIN PRICE **17/6** EACH Post 2/6. 3 for 50/-; 6 for 90/-.

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Please mention
PRACTICAL WIRELESS
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negative circuits.

Short pieces of sleeving will also identify transistor leads when these are fitted. Black is suggested for base, yellow for emitter, and red for collector.

I.F./Meter Amplifier. This is the largest unit, shown in Fig. 6. It mounts vertically by two brackets used as chassis return. Figure 6 shows the "top" of the board, with i.f.t.s, resistors, etc. Wiring under the board is shown with broken lines.

It is convenient to fit the i.f.t.s first, with central holes to reach the cores later. All the cans are earthed. If each component and lead is marked with coloured pencil as fitted and soldered it will be easily clear what has been done, and nothing is likely to be omitted.

Later, leads are passed through the chassis to the function switch, 8 on oscillator coils, and other items as shown. A check should be made against Fig. 2 as required. R18 to R21, Tr5 and the meter may be omitted until later.

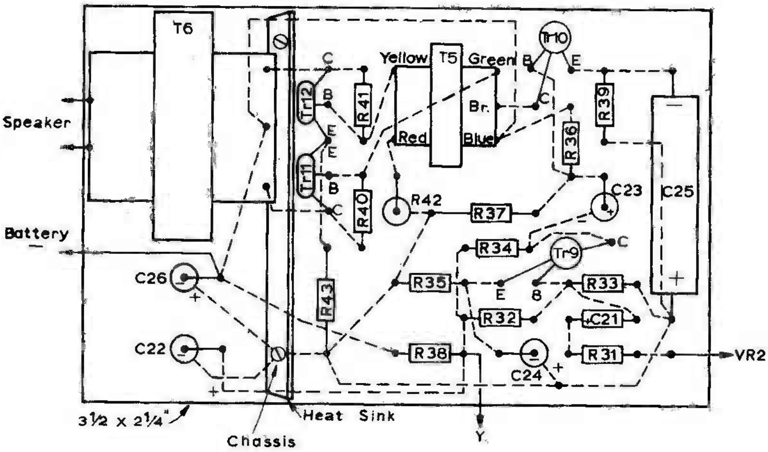


Fig. 7: The audio amplifier board.

Audio Amplifier. Figure 7 shows components and wiring. The heatsink is fixed with two ½in. or similar bolts, and a tag under one nut serves as chassis return. Extra nuts are put on, and the finished board can then be clamped to the chassis, with a little clearance.

Tr11 and Tr12 occupy clips bolted to the heatsink. The connections given for T5 are for the particular transformer listed, and if an alternative is fitted, the maker's data should be followed.

A black flexible lead with negative battery clip runs from C26. The lead Y supplies the i.f. amplifier. VR2 slider runs to R31.

The whole amplifier can be tested by taking an audio input to R31, with battery positive as earth return.

If the receiver is to be temporarily or permanently used for ordinary a.m. reception (speech, music) only, VR2 can be fed from diode D2 via a capacitor, as described.

Product Detector and B.F.O. Connections are shown in Fig. 8. The completed panel again mounts vertically on brackets, and is placed to allow quite short leads from C14 and VC5. A hole is necessary under the b.f.o. coil to reach its core.

The circuit provides a.m. detection when the b.f.o. is off, and the function switch breaks this circuit. Tr6 and Tr7 run from the reduced voltage available from Y at the i.f. amplifier. The b.f.o. receives the regulated supply from the 5·6V Zener diode. When the completed panel is fixed in place, remove the temporary coupling capacitor used to give a.m. reception from D2, if previously fitted.

IF Alignment

The intermediate frequency is 465kHz. If a signal generator is available, loosely couple it to the base of Tr2, and rotate all the cores for best results with a 465kHz input. A c.w. signal will operate the meter, so i.f.t. cores can be adjusted for best meter reading. Input should be kept well down.

With a modulated signal from the generator, adjustments can be for maximum audio output, with gain controls at maximum; or for maximum battery current, shown by a meter in one lead. Input must again be kept well down.

If no generator is available, a stable signal should be tuned in (such as a BBC transmission, with a very short aerial). The five cores are then carefully adjusted for best results.

A properly shaped core adjusting tool is best employed for the i.f.t.s. Final alignment should be with a weak signal. These cores are then left and need no further adjustment.

BFO

With VC5 half closed, and the b.f.o. switched on, a strong heterodyne should be heard when the b.f.o. coil core is rotated with a tool. Ignore any weak whistles produced at other core settings, and place the core so that it is at the central or zero beat position. A whistle, which rises in pitch, will then be heard if VC5 is opened or closed. During these adjustments, a steady carrier should be present, from a signal generator or transmission.

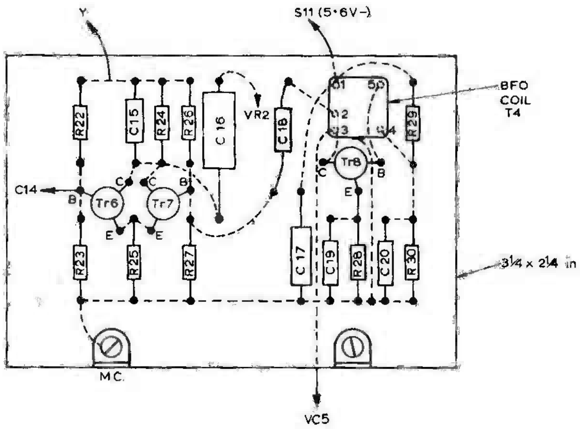


Fig. 8: Product detector and b.f.o. board.

RF, Mixer and Osc

It is necessary to describe adjustments to only one range, as each range is dealt with separately.

TC5 is about two-thirds or so closed. Its setting primarily determines band limits at the high frequency end of the band. The red coil core is adjusted to obtain a suitable band limit at the low frequency end of the band.

The coils are normally packed with the brass screws set right in, so it is as well to unscrew them all so that roughly ½in. of 6BA rod projects, to begin.

Set VC4 (aerial trimmer) about half closed, and rotate the cores of blue and yellow coils for best results, near the l.f. end of the band (ganged capacitor nearly fully closed). Tune to the h.f. end of the band, this time adjusting the yellow coil trimmer for best results.

Repeat these adjustments, as necessary, for suitable band coverage, and best performance. VC4 will not need continuous adjustment, when the blue cores are suitably placed, but this trimmer is helpful when changing aerials, or bringing up weak signals.

Notes on Operating

The dial reads 0-500, to log particular s.w. transmissions, etc. s.w. reception, especially on the h.f. bands, varies greatly from hour to hour, daily, and has seasonal and other variations.

For normal reception, put the function switch to a.m. with a.v.c. When very strong transmissions overload early stages, VR1 must be turned back. VC4 is simply peaked for best results, and should never be fully open or fully closed.

In some cases manual control of r.f. gain only is required, and 3rd and 4th positions of the switch provide this, the latter with the b.f.o. on. In the 4th position, s.s.b. and c.w. do not control gain via the a.v.c. circuit. In the 5th position, these signals provide a.v.c. bias.

With the switch in the 5th position, c.w. and s.s.b. can be resolved over a considerable level of signal strengths. Rotating VC5 one way or the other, from the central or zero position, will resolve an s.s.b. signal, the direction of rotation depending on whether upper or lower sideband is being transmitted. With exceptionally strong or local signals, gain must be reduced with VR1.

With c.w., the b.f.o. acts as a pitch control, and may also be above or below the carrier frequency, as giving best results.

In all cases VR2 controls volume, and it is as well to keep current peaks down to 30-40mA or so, which should give ample output.

S14 can be closed during noisy static conditions, or when wearing headphones. The limiting is fairly heavy, to avoid blasting on phones.

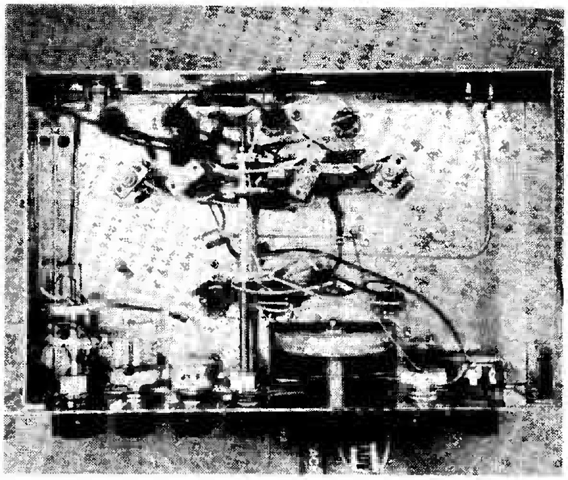
VR3 should originally be set at about its middle position, with VR1 at maximum gain. With no aerial, and no signal tuned in, adjust VR3 for zero on the S-meter. If wished, VR3 can be made up from one or more resistors in series with a potentiometer of lower value, though using 5kΩ as shown is not too critical when adjusting zero.

For very long distance reception, one of the numerous external short wave aerials of improved type may be used—a dipole, doublet, tuned end-fed wire, etc.

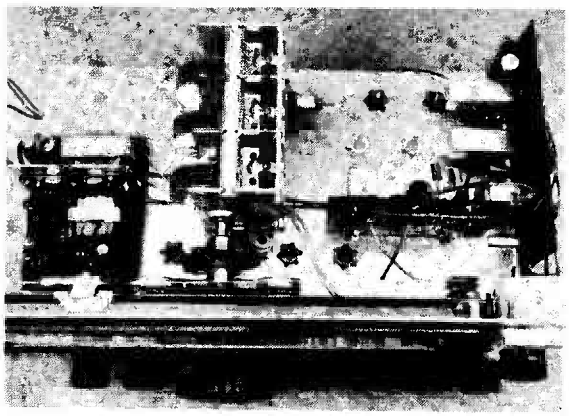
For general results, any end connected wire may be taken to the aerial socket. It will probably be found that a long wire is best avoided for medium and low frequencies.

A telescopic 30in. or similar aerial, fixed to the case but insulated from it, will give very good results over medium and high frequencies, though naturally not with extremely remote stations. A flying lead from the aerial can be taken to the aerial socket, or directly to the fixed section of VC1.

With some frequencies and transmissions, adding an earth will bring about no significant improvement. With other signals (such as weak Top Band amateurs) adding an earth will increase volume very considerably.



Photographs show underside and above views of the complete receiver.



Other Points

R38 and R9 are chosen to drop just over 3V with a current slightly in excess of 10mA. Since D1 maintains 5·6V, 3·4V must be dropped with a 9V supply. The fairly high resistor values are to help reduce current lost through D1.

Though the values shown should prove satisfactory with 10% resistors and some variation in the actual controlled voltage of D1, a stabilised supply may no longer be obtained, when the battery voltage falls even slightly. If so, R9 should be slightly reduced. Battery drain, with no signal, should be about 20-25mA, with VR1 at maximum. ■

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RESISTORS:

Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99	100 up
					SEE NOTE BELOW		
C	1/20W	5%	82Ω–220KΩ	E12	18	16	15
C	1/8W	5%	4.7Ω–830KΩ	E24	2.5	2	1.75
C	1/4W	10%	4.7Ω–10MΩ	E12	2.5	2	1.75
C	1/2W	5%	4.7Ω–10MΩ	E24	3	2.5	2.25
MO	1/2W	2%	10Ω–1MΩ	E24	9	8	7
C	1W	10%	4.2Ω–10MΩ	E12	6	5	4.5
WW	1W	10% + 1/20Ω	0.22Ω–3.3Ω	E12	15d all quantities		
WW	3W	5%	12Ω–10KΩ	E12	15d all quantities		
WW	7W	5%	12Ω–10KΩ	E12	18d all quantities		

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

Values: E12 denotes series: 1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2 and their decades.
E24 denotes series: as E12 plus 1.1, 1.3, 1.6, 2, 2.4, 3, 3.6, 4.3, 5.1, 6.2, 7.5, 9.1 and their decades.

Prices are in pence each for quantities of resistors of same ohmic value and power rating NOT mixed values. (Ignore fractions of one penny on total resistor order.)

COLVERN 3 WATT WIRE-WOUND POTENTIOMETERS:
10Ω, 15Ω, 25Ω, 50Ω, 100Ω, 150Ω, 250Ω, 500Ω, 1KΩ, 1.5KΩ, 2.5KΩ, 5KΩ, 10KΩ, 15KΩ, 25KΩ, 50KΩ. Price only 5/6 each.

CARBON TRACK POTENTIOMETERS: Double wiper ensures minimum noise level. Long plastic spindles.

	each
Single gang linear: 220Ω, 470Ω, 1K etc. to 2.2MΩ	2/6
Single gang log: 4K7, 10K, 22K, etc. to 2.2MΩ	2/6
Dual gang linear: 4K7, 10K, 22K etc. to 1MΩ	8/6
Dual gang log: 4K7, 10K, 22K etc. to 2M2Ω	8/6
Log/Anti-log: 10K, 47K, 1MΩ only	8/6
Dual anti-log: 10K only	8/6
Any type with ½ amp. double pole mains switch	extra 2/3

FETS n-channel low cost general purpose 2N5163, 25 volt, only 5/- each. Audio/r.f. Texas 2N3819 8/6, Motorola 2N5459 (MPF105) 9/9 each. Motorola 2N5457 (MPF103) 9/9 each.

NEW PLESSEY INTEGRATED CIRCUIT POWER AMPLIFIER TYPE SL403A. Only 48/6 nett. Operates with 18V power supply. Sensitivity 20mV into 20MΩ. 3 watts into 7.5Ω. Applications data with two or more. PE Nov. 69 Stereo Amplifier kit less metal work £11/18/- NET complete.

30 WATT BAILEY AMPLIFIER COMPONENTS:
Transistors for one channel £7/5/6 list, with 10% discount only £6/11/0.
Transistors for two channels £14/11/0 list, with 15% discount only £12/7/5.
Capacitors and resistors for one channel list £2.
Printed circuit board free with each transistor set.
Complete unregulated power supply kit £4/17/6 mono or stereo, subject to discount.
Complete regulated power supply kit £9/5/- subject to discount. Further details on application.

SINCLAIR IC.10 Integrated Circuit Amplifier and Pre-amplifier. This remarkable monolithic Integrated circuit amplifier and pre-amp now available from stock. The equivalent of 13 transistor/18 resistor circuit plus 3 diodes and the first of its kind ever. It is d.c. coupled and applicable to an unusually wide range of uses as detailed in the manual provided with it. As advertised, post free 59/6 NET.

CARBON SKELETON PRE-SETS. Small high quality, type PR: Linear only, 100Ω, 220Ω, 470Ω, 1KΩ 2K2, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1MΩ, 2M2, 5M, 10MΩ vertical or horizontal mounting, 1/- each.

S-DeCs put an end to "birdsnesting". Components just plug in. Saves valuable time. Use components again and again. S-DeC only 30/6 post free. Compact T-DeC, increased capacity, may be temperature-cycled T DeC only 51/- post free. Full range available.

CAPACITORS: All new stock
High ripple current types:
2000µF 25V 7/4; 2000µF 50V 11/4; 5000µF 25V 12/6; 5000µF 50V 21/11; 1000µF 100V 16/3; 2000µF 100V 28/9; 5000µF 70V 36/-; 5000µF 100V 58/3; 1000µF 50V 8/2; 2500µF 64V 15/5; 2500µF 70V 19/6.

Medium electrolytics
Axial leads: Values (µF/V): 50/50 2/-; 100/25 2/-; 100/50 2/6; 250/25 2/6; 250/50 3/9; 500/25 3/9; 1000/10 3/3; 500/50 4/6; 1000/25 4/-; 1000/50 6/-; 2000/25 6/-; 3030/25 2/6.

Small electrolytics
Axial leads: 5/10, 10/10, 25/10, 50/10 1/- each, 25/25, 47/25, 100/10, 220/10 1/3 each.

PEAK SOUND ENGLEFIELD KITS

Brilliant new styling and available in two forms:
Stereo 15 watts per channel In kit form with complete amplifier and pre-amplifier modules and power supply. Build it 12 + 12 or 25 + 25 Output per channel into 15Ω 12 watts R.M.S. Price £38/9/- net

25 WATTS PER CHANNEL. As above but Output per channel into 15Ω 25 watts R.M.S. Price £58/15/- Net
Brief specification: Total harmonic distortion 0.1%.
Inputs: Magnetic, Ceramic, Tape, Radio. Signal to noise ratios: Better than 60dB all inputs. O/load factor 28dB all channels.

ENGLEFIELD CABINET to house either above assemblies (as illustrated) £6 Net. OTHER PEAK SOUND PRODUCTS AS ADVERTISED.

MULLARD Sub-min electrolytic C426 range: Price 1/3 each. Axial leads. Values (µF/V): 0.64/64; 1/40; 1.6/25; 2.5/16; 2.5/64; 4/10; 4/40; 5/64; 6.4/6.4; 6.4/25; 8/4:8/40; 10/2.5; 10/16; 10/64; 12.5/25; 16/40; 20/16; 20/64; 25/6.4; 25/25; 32/4; 32/10; 32/40; 32/64; 40/16; 40/2.5; 50/6.4; 50/25; 50/40; 64/4; 64/10; 80/2.5; 80/16; 80/25; 100/6.4; 125/4; 125/10; 125/16; 160/2.5; 200/6.4; 200/10; 250/4; 320/2.5; 320/6.4; 400/4; 500/2.5µF/V.

Wavechange switches: 1P 12W; 2P 6W; 3P 4W; 4P 3W long spindles, 4/9 each.

Slider switches, double pole double throw 3/- each.

BARGAINS IN NEW TRANSISTORS

All power types supplied with free insulating sets

2N696	5/6	2N5192	25/-
2N697	5/6	2N5195	28/3
2N706	2/9	4036	12/6
2N1132	9/9	40362	16/-
2N1302	4/-	AC126	6/6
2N1303	4/-	AC127	6/-
2N1304	4/6	AC128	6/-
2N1305	4/6	AC176	11/-
2N1306	6/9	ACY22	3/9
2N1307	6/9	ACY40	4/-
2N1308	8/9	AD140	19/-
2N1309	8/9	AD149	17/6
2N1613	6/-	AD161 }	16/-
2N1711	7/-	AD162 }	comp. pr.
2N2218	9/3	AF118	16/6
2N2147	18/9	AF124	7/6
2N2369A	5/3	AF127	7/-
2N2646	10/9	BA102	9/-
2N2924	4/-	BC107	2/9
2N2925	4/6	BC108	2/6
2N2926R	2/3	BC109	2/9
2N2926O	2/3	BC147	3/6
2N2926Y	2/3	BC148	3/3
2N2926G	2/3	BC149	3/6
2N3053	5/6	BC153	10/-
2N3054	14/3	BC154	11/-
2N3055	16/-	BC157	3/9
2N3391A	6/3	BC158	3/6
2N3702	3/6	BC159	3/9
2N3703	3/3	BC167	2/6
2N3704	3/9	BC168	2/3
2N3705	3/5	BC169	2/6
2N3706	3/3	BC177	6/3
2N3707	4/-	BC178	5/8
2N3708	3/-	BC179	6/-
2N3709	3/-	BD121	18/-
2N3710	3/6	BD123	24/3
2N3711	3/11	BF178	10/6
2N3904	7/6	BFX29	10/9
2N3906	7/6	BFX85	8/3
2N3731	24/-	BFX88	6/9
2N4058	5/3	BSX20	3/9
2N3325	10/9	BFY50	4/6
2N3794	3/3	BFY51	4/3
2N4284	3/3	MJ480	21/-
2N4286	3/3	MJ481	27/-
2N4289	3/3	MJ491	30/-
2N4291	3/3	P346A	4/6
2N4292	3/3	V405A	7/9
2N4410	4/9	NKP403	15/6
		NKP405	15/-

MAIN LINE AMPLIFIER KITS as advertised. Prices Net. Authorised dealer.

COMPONENT DISCOUNTS:
10% on orders for components for £5 or more.
15% on orders for components for £15 or more.
(No discount on net items.)

POSTAGE AND PACKING:
Free on orders over £2.
Please add 1/6 if order is under £2.
Overseas orders welcome; carriage charged at cost.

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P.W. GUIDE TO COMPONENTS

PART 16

M. K. TITMAN, B.Sc. (Eng)

INTEGRATED CIRCUITS

An integrated circuit may be defined as a multi-element circuit module constructed and encapsulated in such a way that the individual elements cannot be isolated by normal bench techniques. They can be divided into various groupings categorised by the constructional methods employed in manufacture. Figure 1 illustrates diagrammatically the basic groupings.

The two basic categories of integrated circuits are thin film circuits—which contain no active semiconductor devices—and semiconductor circuits which contain active semiconductor components. Two methods of construction are used to produce semiconductor integrated circuits and these are known as monolithic and hybrid integrated circuits. Hybrid circuits consist of many discrete circuit elements, such as diode and transistor chips bonded to a header and interwired, whilst monolithic circuits consist of a single silicon die with both active and passive components diffused into the surface.

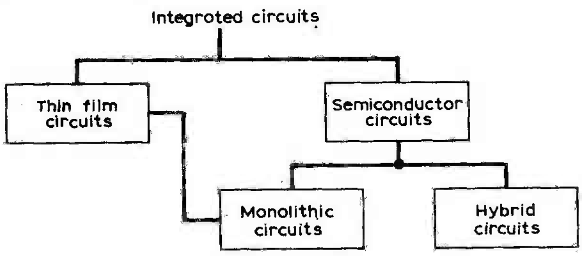


Fig. 1: Basic groupings of integrated circuits.

At present the great majority of integrated circuits available commercially are of monolithic construction, as this form is best suited to mass production techniques. Thin film and hybrid circuits are usually manufactured to suit a particular requirement and are more suitable for small production runs. For example, a manufacturer of, say, missiles would use hybrid or thin film circuits for special applications such as i.f. amplifiers, whilst for switching or logic functions standard monolithic logic circuits would be used. The i.f. amplifiers would be built to the manufacturer's requirements of performance, and in all probability could not be used by other manufacturers.

It follows therefore that the majority of integrated circuits available are of monolithic construction. However thin film techniques are used in monolithic construction for the formation of end connections, resistors and capacitors.

Thin Film Circuits

Thin film circuits are manufactured by depositing layers of metals or metallic compounds on to the surface of a high resistivity substrate to form resistor combinations, capacitors or inductors. A typical thin film circuit is shown diagramatically in Fig. 2. Three types of substrate are in common use: glass, ceramic and glazed ceramic. When compatible thin film circuits are deposited on monolithic silicon structures then the substrate is a layer of oxidised silicon.

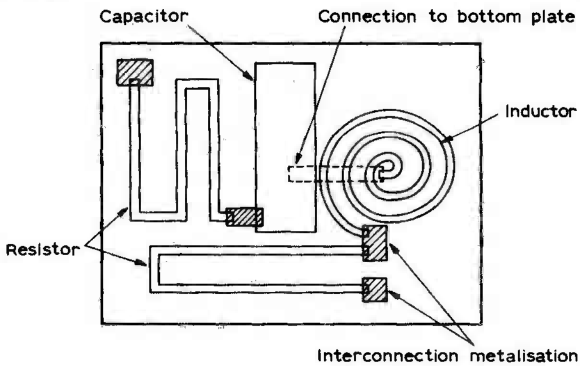


Fig. 2: Typical thin film circuit.

The required materials are deposited on to the substrate by a variety of methods of which the most common are vacuum evaporation, sputtering, gas plating and silk screening. Silk screen layers are deposited in the required pattern by the actual process whereas in all the other processes further work is required, patterning being achieved by a photographic (photoresist) and etching system.

Perhaps the most common deposition system is vacuum evaporation and this is used for gold, silver, aluminium and nichrome (NiCr). The pure metals are used for capacitor plates, inductor windings, and connections and interwiring—whilst nichrome forms the basis of most thin film resistors. Vacuum evaporation is achieved by the evacuation of a glass bell-shaped chamber and rapidly heating the material to be deposited by an electric current through a separate filament. The substrate is positioned near the material, which vaporises, and collects part of the condensate as a thin film over its surface. Subsequent etching then produces the required pattern to give the desired characteristics.

Cathode sputtering is used to deposit tantalum to form resistors or oxidised to form capacitors. In this case deposition is due to bombardment of a tantalum cathode by high energy inert gas particles (often Argon). The substrate is placed at the anode of a highly evacuated jar and the released tantalum atoms are attracted by a high d.c. (or occasionally a.c.) potential difference between anode and cathode. The tantalum atoms impinge on the substrate and adhere, thus building a thin film on to the surface.

Gas plating is used for the production of films of silicone dioxide (SiO_2), aluminium silicate ($Al_2O_3SiO_2$) and aluminium oxide (Al_2O_3), which are used as dielectric layers for capacitors. The chemical reactions are complex and depends upon either hydrogen reduction or thermal decomposition of compounds. The compound in vapour form is passed over the heated substance and decomposition or a chemical reaction takes place to leave the required dielectric layer.

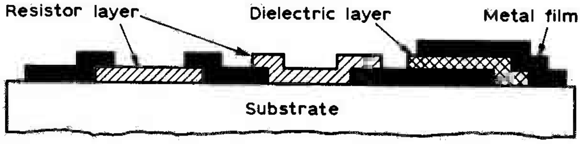


Fig. 3: Cross section of thin film circuit.

We have seen how resistors, capacitors and inductors may be formed and Fig. 3 shows a cross section through a typical thin film surface. Only passive components, however, can be produced by these techniques and although passive filters, attenuators etc. are often required system flexibility is limited. In order to combat these limitations transistor chips, which are manufactured separately, can be bonded to the surface of the film. Wire interconnections are used and hence extremely flexible circuits can be produced. A typical thin film r.f. amplifier is shown in Fig. 4.

Now ideally all-integrated circuits should display the same characteristics as equivalent discrete component circuits, but in practice, because of the close proximity of components, parasitic capacitive and inductive effects are present. These parasitic effects require careful consideration in the initial design.

Another problem resulting from the close proximity of components is leakage paths along the surface of the substrate. Substrates are specifically chosen to reduce surface leakage and these effects are further reduced by careful layout. One considerable advantage of thin film circuits lies in the close component tolerances and wide range of values which can be achieved.

Hybrid Circuits

Hybrid semiconductor circuits are formed by bonding discrete components to a header and interwiring with wire. A typical hybrid circuit is shown in Fig. 5. The header forms part of a TO-5 size transistor case with 10 leads. The discrete transistor chips are usually normal production line transistors whilst the capacitors, resistors and inductors are specially produced to fulfill the circuit requirements.

Interwiring with gold wire is carried out by hand using special micromanipulators and microscopes. This form of fabrication results in an expensive component. However, the yield is high because each component is tested prior to assembly. Hybrid

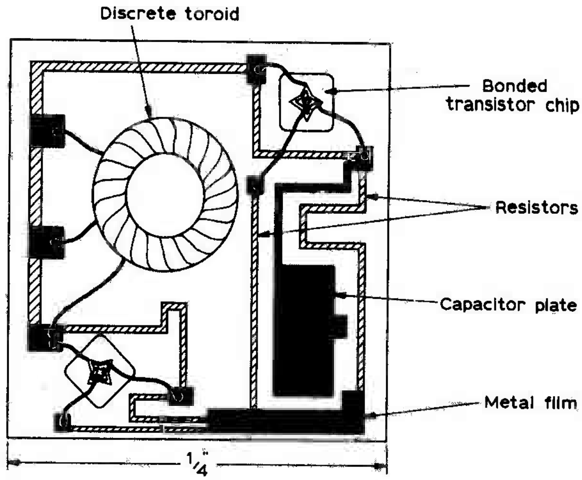


Fig. 4: Some of the components of a thin film r.f. amplifier.

circuits are therefore similar to conventional circuits except that fabrication is carried out in a microminiature assembly. Development is thus considerably simplified as breadboard models can be constructed and the layout tested without investing in costly processes. Because each component is manufactured separately the flexibility of the system is considerable, since every transistor can be chosen for individual characteristics and no component relies on the characteristics of other components. Thus hybrid construction is the costliest production system as a result of the non-automatic assembly techniques but requires considerably less development time to produce.

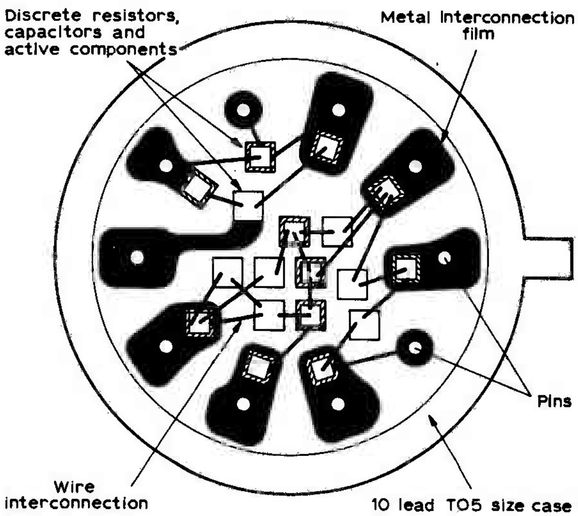


Fig. 5: Hybrid integrated circuit.

Hybrid circuits therefore are particularly suitable for small quantity requirements and production runs. Because of the flexibility, elaborate and close

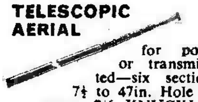
DOOR INTERCOM

Know who is calling and speak to them without leaving bed, or chair. Outfit comprises microphone with call push button, connectors and master inter-com. Simply plugs together. Originally sold at £10. Special snip price 49/6, plus 3/6 postage.

5A, 3 PIN SWITCH SOCKETS

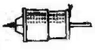
An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered 5A switch sockets for only 10/- plus 3/6 post and insurance. (20 boxes post free).

TELESCOPIC AERIAL



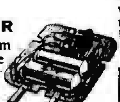
for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. 7/6 KNUCKLED MODEL FOR F.M. 9/6.

PHILIPS TRIMMER



0-30 pf an old design but one which has never been bettered. 1/- each. 10/- doz. £4.0.0 per 100.

PP3 BATTERY ELIMINATOR



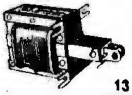
Run your small transistor radio from the mains—full wave circuit—made up ready to wire into your set and adjustable high or low current. 8/6 each.

TOGGLE SWITCH

3 amp 250v. with fixing ring. 1/6 each 15/- doz.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. 19/6 plus 2/6 post and insurance. Made up model 37/6 plus 2/6 p. & p.



230 VOLT SOLENOID

⅞in. stroke. Size 2¼in. × 2in. × 1¾in. 14/6, postage 2/9.

13 AMP FUSED SWITCH

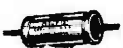
Made by G.E.C. For connecting water heater etc., into 13 amp ring main. Flush type 3/6 each 30/- doz. Metal boxes for surface mounting 1/6 each 15/- doz.

MICRO SWITCH

5 amp. changeover contacts. 1/9 each 18/- doz. 15 amp Model 2 each or 21/- doz.

ISOLATION SWITCH

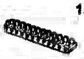
20 Amp D.P. 250 volts. Ideal to control Water Heater or any other appliance. Neon indicator shows when current is on. 4/6. 48/- per dozen.



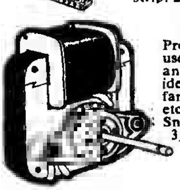
SUPPRESSOR CONDENSER TCC

.1 mfd. 250v. A.C. working, metal cased with fixing lug. 1/9 each 18/- doz.

15/20 AMP CONNECTORS



Polythene insulated 12-way strip. 2/6 each 24/- doz.



MAINS MOTOR

Precision made — as used in record decks and tape recorders — ideal also for extractor fan, blower, heaters etc. New and perfect. Snip at 9/6. Postage 3/- for first one then 1/- for each one ordered. 12 and over post free.

0.005mFd TUNING CONDENSER

Proved design, ideal for straight or reflex circuits 2/6 each. 24/- doz.

250V AC working condensers for power factor correction, motor starting etc. 3.5 mfd. 6/6 each. 6.5 mfd. 8/6 each, 8 mfd. 9/6 each.

3 amp battery charger kit comprises copper backed circuit board, 3 amp mains transformer, regulator resistors and smoothing condenser 29/6 inc. wiring diagram, post & ins. 4/6.

VARIAC CONTROLLERS

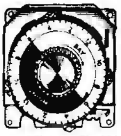
With these you can vary the voltage applied to your circuit from zero to full mains without generating undue heat. One obvious application therefore is to dim lighting. We offer a range of these, ex-equipment but little used and in every way as good as new. Any not so, will be exchanged or cash refunded.

2 amp £4.19.6. 5 amp £7.19.6. 8 amp £12.19.6. 10 amp £15.19.6.

Note : Some of these are panel mounting types

HOUR COUNTERS

If you wish to know how long your equipment has been switched on then this is what you need. Counts running time up to 9999 hours. 50 c/s mains operation. 49/6 plus 3/6 post & insurance. Resettable type 69/6 plus 3/6 post & insurance.



24 HOUR TIME SWITCH

Mains operated. Adjustable Contacts give 2 on/offs per 24 hours. Contracts rated 15 amps. repeating mechanism so ideal for shop window control, or to switch hall lights (anti-burglar precaution) while you are on holiday. Made by the famous Smiths Company. This month only 39/6 with Perspex cover, plus 3/6 postage and insurance, a real snip which should not be missed.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets and on/off switch with neon warning light in metal box. Takes standard 13 amp fused plugs Supplied complete with 7 feet of heavy cable.
39/6 wired up, ready to work plus 4/6 post & insurance.

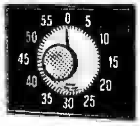
1 WATT AMPLIFIER & PREAMP

5 transistors—highly efficient, made for use with tapehead G4 but equally suitable for microphone or pick up—limited quantity 29/6 Full circuit diag. also shows tape controls 5/-

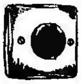
THIS MONTHS SNIP

1 HOUR MINUTE TIMER

Made by famous Smiths company, these have a large clear dial, size 4¾ × 3¾, which can be set in minutes up to 1 hour. After preset period the bell rings. Ideal for processing, a memory jogger or, by adding simple lever, would operate micro-switch 22/6

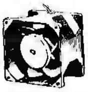


VARYLITE



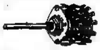
Will dim incandescent lighting up to 600 watts from full brilliance to out. Fitted on M.K. flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob £3.19.6.

MINIATURE EXTRACTOR FAN



Beautifully made by famous German Company. PAPST System. 230/240 A.C. Mains operated, size 3½in. × 3½in. × 2in. Made for instrument cooling but ideal to incorporate in a cooker hood, etc. 65/-.

STANDARD WAFER SWITCHES



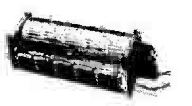
Standard Size 1¾ wafer—silver plated 5 amp contact standard ¼" spindle 2in. long—with locking washer and nut.

Poles	2 way	3 way	4 way	5 way	6 way	8 way	10 way	12 way
1 pole	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
2 poles	6/6	6/6	6/6	6/6	6/6	6/6	10/6	10/6
3 poles	6/6	6/6	6/6	6/6	10/6	10/6	14/6	14/6
4 poles	6/6	6/6	6/6	10/6	10/6	10/6	18/6	18/6
5 poles	6/6	6/6	10/6	10/6	14/6	14/6	22/6	22/6
6 poles	5/6	10/6	10/6	10/6	14/6	14/6	26/6	26/6
7 poles	6/6	10/6	10/6	14/6	18/6	18/6	30/6	30/6
8 poles	10/6	10/6	10/6	14/6	18/6	18/6	34/6	34/6
9 poles	10/6	10/6	14/6	14/6	22/6	22/6	38/6	38/6
10 poles	10/6	10/6	14/6	18/6	22/6	22/6	42/6	42/6
11 poles	10/6	14/6	14/6	18/6	26/6	26/6	46/6	46/6
12 poles	10/6	14/6	14/6	18/6	26/6	26/6	50/6	50/6

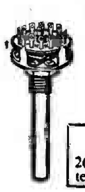
15, 30 & 100 WATT H-FI SPEAKERS

FULL FI 12 INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered. produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address. Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S. Cone Moulded fibre—Freq. response 30-10,000 c.p.s.—Specify 3 or 15 ohms—Mains resonance 60 c.p.s.—Chassis Diam. 12in.—12⅜in. over mounting lugs—Baffle hole 11in. Diam.—Mounting holes 4. holes—⅜in. diam. on pitch circle 11⅜in. diam.—Overall height 5⅜in. A £6 speaker offered for only £3.19.6 plus 7/6 p. & p. Don't miss this offer. 15in. 25 watt £7.19.6 18in. 100 watt £19.10.0.

3kW TANGENTIAL HEATER UNIT



This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW. element and 1kW. element allowing switching 1, 2 and 3kW, and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only need control switch. 79/6. Postage and insurance 6/6. Don't miss this.



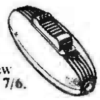
MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 3/6 each. 36/- dozen, your assortment

WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. 10/- post free.

BLANKET SWITCH



Double pole with neon let into side so luminous in dark, ideal for dark room light or for use with waterproof element, new plastic case 5/6 each, 3 heat model 7/6.

COPPER CLAD ELEMENT

1250 watts—4ft. long but bent to U shape, ideal for overhead heater—just mount reflector above. 12/6 each, plus 4/6 post. £6 doz. post paid.

HEAT & LIGHT LAMP

275W, internally mirrored bulb, with b.c. end for plugging into lamp holder. 19/6 each plus 4/6 post and insurance.

TUBULAR HEAT & LIGHT LAMP

Philips 500W. 29/6 plus 4/6 post and insurance.

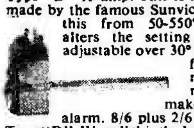
ELECTRIC CLOCK WITH 25 AMP SWITCH

Made by Smith's, these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only 39/6, less than the value of the clock alone—post and insurance 2/9.

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouses, airing cupboard. Has spindle for pointer knobs. Quickly adjustable from 30-80°F, 9/6 plus 1/- post. Suitable box for wall mounting. 5/-. P. & P. 1/-.

Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal screw alters the setting so this could be adjustable over 30° to 1000°F. Suitable for controlling furnace, oven, kiln, immersion heater or to make flame-stat or fire alarm. 8/6 plus 2/6 post and insurance.



Type "D". We call this the Ice-stat as it cuts in and out at around freezing point. 2/3 amps. Has many uses one of which would be to keep the loft pipes from freezing. If a length of our blanket wire (16 yd 10/- is wound round the pipes. 7/6. P. & P. 1/-

Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature. 7/6, plus 1/- post.

Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50° to 150°F. Price 18/- plus 2/- post and insurance.

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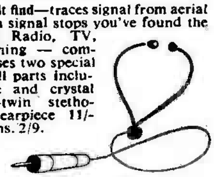
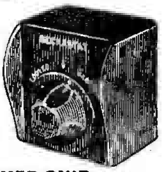
Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything — complete kits comprises two special transistors and all parts including probe tube and crystal earpiece. 29/6—twin stethoset instead of earpiece 11/- extra—post and ins. 2/9.



BECKASTAT



This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal temperatures. 13A loading Will save its cost in a season. 19/6. Post and insurance 2/9.

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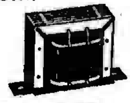

Making a power pack for amplifier or other equipment? These transformers have normal mains primaries (230/240v.) and isolated secondaries two types (1) 12v. 500mA. at 8/6; (2) 15v. 500mA at 8/6.

Where postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

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tolerance circuits can be achieved. Hybrid construction is consequently rarely used for general purpose mass produced devices.

Monolithic

The vast majority of integrated circuits available to the amateur are of monolithic construction as this construction is best employed for mass production. Initial design is difficult and costly whilst the actual manufacture is reasonably economic and hence economically priced units are possible only for large demand circuits.

The fabrication of most monolithic structures combines the planar epitaxial transistor process and thin film technology. Only thin film materials and processes which do not damage the basic structure or impurity concentrations, can be employed, and such films are known as compatible thin films. Let us now examine the steps involved in the fabrication of a circuit using both p-n-p and n-p n. transistors. Most other components are manufactured during one or more of these stages.

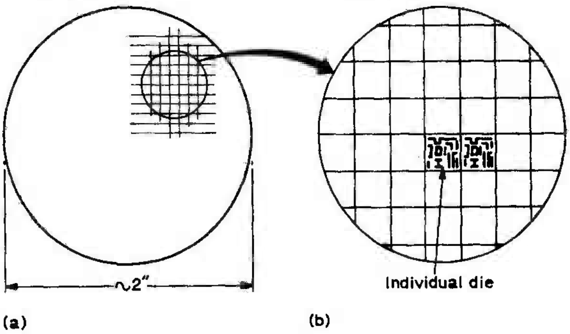

Fig. 6: Monolithic integrated circuit wafer. (a) wafer, (b) enlargement showing dice.

The starting point consists of a p- or n-type silicon wafer such as that illustrated in Fig. 6(a). Fig. 6(b) shows how ultimately the wafer will be subdivided to give individual dies. We will consider only one of the dies and it should be appreciated that in each process perhaps 10-20 wafers each with 100-200 individual integrated circuits are treated simultaneously. In consequence true mass production is carried out in processes which require laboratory standards of accuracy, measurement and cleanliness.

Initially a p-type impurity is diffused into the surface of the basic n-type slice to give the cross section shown in Fig. 8(a). At the end of the diffusion steam is passed over the wafer and forms a layer of silicon dioxide on the surface. The surface is coated with photoresist and the areas to be diffused next masked with an extremely accurate photographic mask. The photoresist is set by exposing the wafer to ultra-violet light and the silicon dioxide is then etched off where the diffusion is required, since diffusion does not penetrate the silicon dioxide layer. The resulting structure is shown in Fig. 8(b).

The second diffusion is known as the isolation diffusion since the areas which are to become components—in this case a p-n-p and an n-p-n transistor—are masked by silicon dioxide. The diffusion is of n-type impurity and is of such a depth as to penetrate through to the n-type substrate, thus forming islands of p-type in the basic n-type substrate as illustrated by Fig. 8(c). At the end of this diffusion a layer of silicon dioxide is again formed to give the structure of Fig. 8(d). The collector of the p-n-p transistor has now been formed by the original p-type diffusion and is isolated from other components by the n-type substrate. This isolation is only effective providing the resultant p-n junction is reversed biased. In consequence an n-type substrate is always electrically connected to the most positive supply voltage and a p-type one to the most negative supply voltage.

In order to reduce the number of diffusions to a minimum it would now seem logical to diffuse the n-type base of the p-n-p transistor and the collector of the n-p-n transistor simultaneously. Unfortunately this is not possible as the impurity concentrations required differ considerably. The n-p-n collector is masked and etched to remove the silicon dioxide. Great care is taken in the alignment of the mask since the final characteristics depend on physical dimensions as well as impurity concentrations. Alignment is aided by instruments but final adjustments are carried out by eye. The n-type diffusion is carried out and a further silicon dioxide layer formed to give the structure shown in Fig. 8(e).

Further masking and diffusions produce the p-n-p transistor base shown in Fig. 8(f) and then by simultaneous p diffusions the p-n-p emitter and n-p-n base shown in Fig. 8(g). The final n diffusion completes the two-transistor structure shown in Fig. 8(h). The interconnecting to other components is carried out by a further mask and etch of the silicon dioxide and the formation of a thin film (often aluminium) interconnection pattern.

Figure 7 shows the schematic of the structure which has been fabricated. Clearly isolation can only be maintained if the isolation diodes Di are reverse biased. Also it will be noted in Fig. 8(h) that the substrate and b-n-p transistor form a p-n-p-n structure (or thyristor) which would fire to the saturated condition unless reverse biased. In addition parasitic effects of leakage current, capacitance and inductance are present and these will be discussed later.

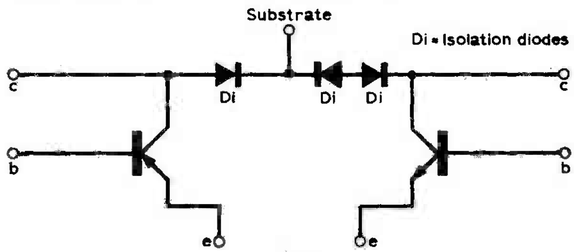

Fig. 7: Schematic of fabricated structure.

Resistors

As far as possible resistors are formed of semiconductor material usually during the resistive base diffusion which results in medium resistivity semiconductor. Occasionally the low resistivity emitter diffusion is used for low value resistors. Fig. 9 illustrates the structure of such a resistor. Isolation is again achieved by reverse biased pn-junctions. Resistor values of from 100Ω to 30kΩ with tolerances of ±10% can be achieved by this method.

Compatible thin film resistors are manufactured from nichrome, tin oxide, tantalum, aluminium,

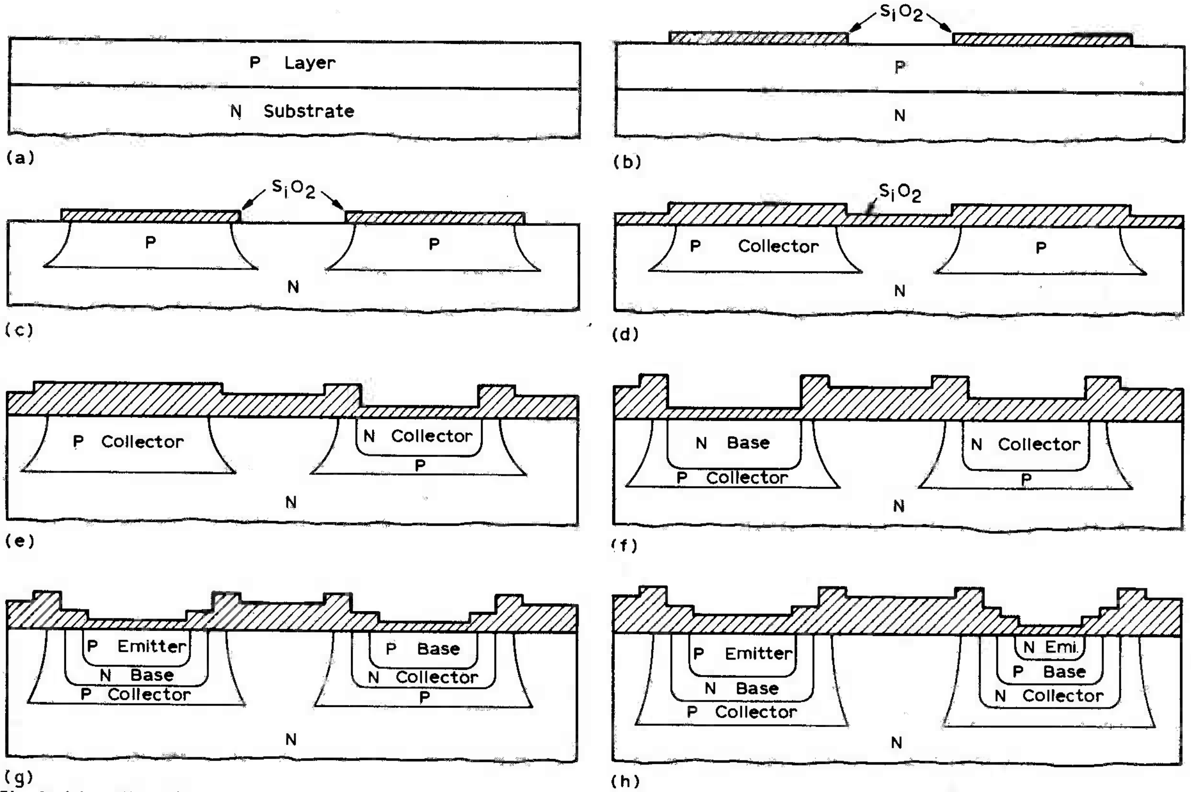

Fig. 8: (a) portion of starting wafer, (b) silicon dioxide masked for transistors, (c) isolation diffusion n type, (d) silicon dioxide grown after diffusion, (e) collector of n-p-n transistor formed, (f) base diffusion of p-n-p transistor, (g) simultaneous p type base and emitter diffusion (h) final n type emitter diffusion.

chromium and nickel. Values from 20Ω to 3MΩ can be achieved with tolerances of ±5%. In all cases the power and voltage ratings are severely limited and are 3mW per square mil maximum power and 20V maximum voltage drop.

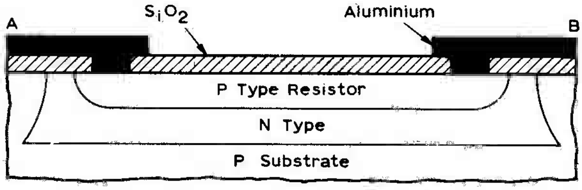

Fig. 9: Diffused resistor structure.

Capacitors

Wherever possible capacitors are fabricated from reverse biased diodes and such a structure is illustrated in Fig. 10. However as the isolation of such diodes is achieved by reverse biased junctions considerable parasitic capacitance is present. Where necessary silicon dioxide dielectric capacitors are fabricated to overcome this disadvantage. Silicon dioxide capacitors have the added advantages that they are non-polar and their capacitance is constant with bias voltage.

Thin film capacitors of tantalum oxide and aluminium are also used and give capacitance values of 2·5pF/mil and 0·3 to 0·5pF/mil respectively. Tolerances generally are ±20% and maximum voltage ratings of 20-50V. Q factors vary from 10-100 and practical maximum capacitance values are 1000pF or 5000pF for tantalum oxide.

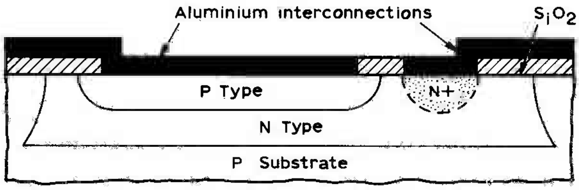

Fig. 10: Diffused capacitor structure.

Inductors

Inductors with practical values of inductance and Q are the most difficult components to produce. Despite the considerable research devoted to inductors it is true to say that their value as an integrated circuit component is severely limited. The maximum practical inductance is limited to 4μH with Q factors of 1-5 in monolithic structures or 30-50 in thin film fabrications.

TO BE CONTINUED

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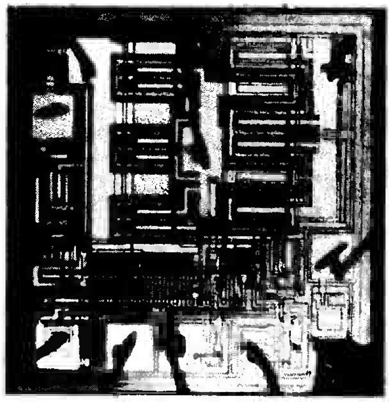
MONOLITHIC INTEGRATED CIRCUIT HIGH FIDELITY AMPLIFIER AND PRE-AMP



the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by a hundredth of an inch thick, has an output of 5 watts R.M.S. (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 Zener diode and 18 resistors, formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is not only more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC-10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of such components as tone and volume controls and a battery or mains power supply. However, it is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout) etc. The photographic masks required as part of the process of producing monolithic I.Cs are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. This enables us to cover every IC-10 with the Sinclair guarantee of reliability.

■ SPECIFICATIONS

Output	10 Watts peak, 5 Watts R.M.S. continuous.
Frequency response	5 Hz to 100 KHz±1dB.
Total harmonic distortion	Less than 1% at full output.
Load impedance	3 to 15 ohms.
Power gain	110dB (100,000,000,000 times) total.
Supply voltage	8 to 18 volts.
Size	1 × 0.4 × 0.2 inches.
Sensitivity	5mV.
Input impedance	Adjustable externally up to 2.5 M ohms.

■ CIRCUIT DESCRIPTION

The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. Generous negative feed-back is used round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently satisfactory.

■ APPLICATIONS

Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

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IC.10 *with IC.10 manual* **59/6**
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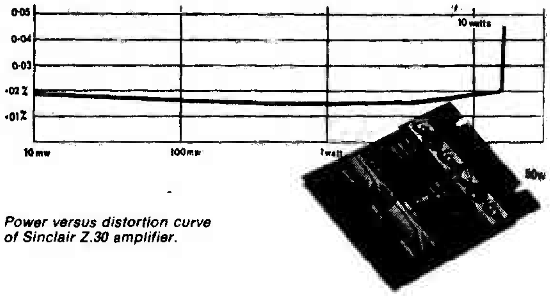
Z.30 TWENTY WATT R.M.S. (40 WATT PEAK) HIGH FIDELITY POWER AMPLIFIER

The Z.30 is a complete power amplifier of very advanced design employing 9 silicon epitaxial planar transistors. Total harmonic distortion is incredibly low being only 0.02% at full output and all lower outputs. As far as we know, no other high fidelity amplifier made can match this specification, no matter what the price. Thus you can be utterly certain that your Project 60 system will do full justice to your other equipment however good it may be. The Z.30 is unique in that it will operate perfectly, without adjustment, from any power supply from 8 to 35 volts. It also has sufficient gain to operate directly from a crystal pickup. So in addition to its use in a high fidelity system you can use a Z.30 to advantage in your car or a battery operated gramophone for your children, for example. These, and many other applications of the Z.30 are covered in the manual of circuits and instructions supplied with every Z.30 high fidelity power amplifier.

APPLICATIONS
Hi-fi amplifier; car radio amplifier; record player amplifier fed directly from pick-up; intercom; electronic music and instuments; P.A.; laboratory work etc. Full details for these and many other applications are given in the manual supplied with the Z.30.



Power versus distortion curve of Sinclair Z.30 amplifier.

SPECIFICATIONS

Power output—15 watts R.M.S. into 8 ohms using a 35 volt supply: 20 watts R.M.S. into 3 ohms using a 30 volt supply.
Output—Class AB.

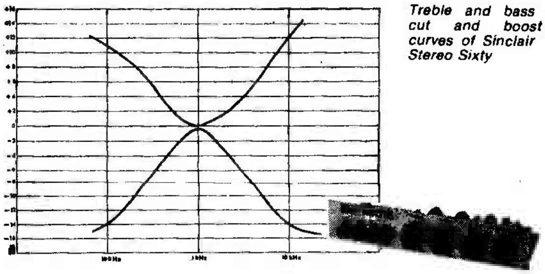
Frequency response:	30 to 300,000 Hz ± 1dB.
Distortion:	0.02% total harmonic distortion at full output into 8 ohms and at all lower output levels.
Signal-to-noise ratio:	better than 70dB unweighted.
Input sensitivity:	250mV into 100Kohms.
Damping factor:	>500.
Loudspeaker impedances:	3 to 15 ohms.
Power requirements:	From 8 to 35 V.d.c.(The Z.30 will operate ideally from batteries if required.)
Size:	3½ × 2¼ × ½ inches.

Z.30
Built, tested and guaranteed, with circuits and instructions manual

89/6

STEREO SIXTY PREAMPLIFIER AND CONTROL UNIT

The Stereo 60 is a stereo preamplifier and control unit designed for the Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout and great attention has been paid to achieving a really high signal-to-noise ratio and excellent tracking between the two channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs. The tone controls are also very carefully designed and tested.



Treble and bass cut and boost curves of Sinclair Stereo Sixty

SPECIFICATIONS

- Input sensitivities—Radio—up to 3mV Magnetic Pickup—3mV: correct to R.I.A.A. curve ± 1dB; 20 to 25,000 Hz. Ceramic Pickup—up to 3mV: Auxiliary—up to 3mV.
- Output—250mV
- Signal-to-noise ratio—better than U0dB.
- Channel matching—within 1dB.
- Tone controls—TREBLE + 15 to − 15dB. at 10 KHz: BASS + 15 to − 15dB at 100Hz.
- Power consumption 5mA.
- Front panel—brushed aluminium with black knobs and controls.
- Size 8¼ × 4 ins.

Ready for immediate installation **£9. 19s. 6d.**

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PZ-5 *30 volts unstabilised—sufficient to drive two Z.30's and a Stereo 60 for the majority of domestic applications.*

Price: **£4. 19s. 6d.**

PZ-6 *35 volts stabilised—ideal for driving two Z.30's and a Stereo 60 when very low efficiency speakers are employed.*

Price: **£7. 19s. 6d.**

GUARANTEE

If at any time within 3 months of purchasing Project 60 modules from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for services thereafter. No charge for postage by surface mail. Air-mail charged at cost.

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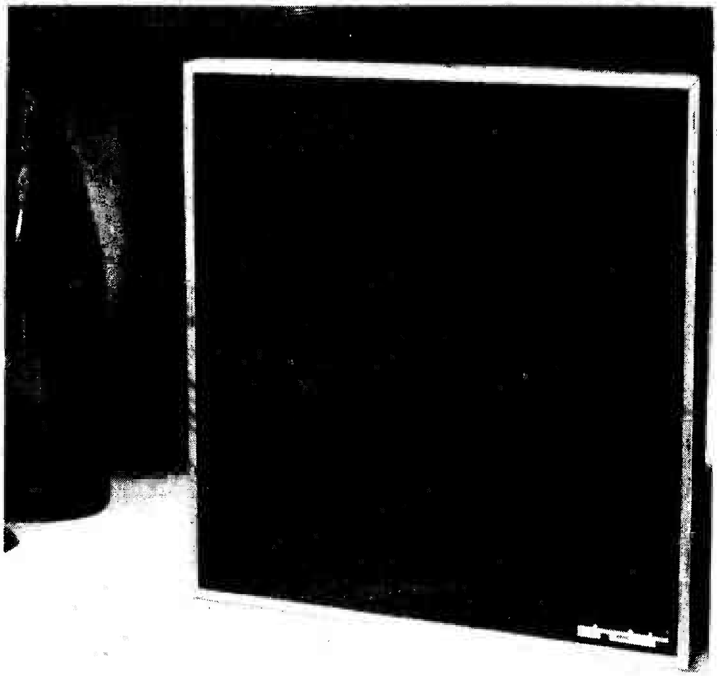

All the superb features which went to make the Sinclair Q.14 have been incorporated in the new Q.16 which gives an exciting new opportunity for you to match your Sinclair equipment with modern decor. Employing the same well proven acoustic system in which materials, processing and styling are used in such a radical and successful departure from conventional design, the new Q.16 presents an entirely new appearance with its attractive teak surround and all-over special cellular foam front chosen as much for its appearance as for its ability to pass all audio frequencies without loss. The Q.16 is compact and slim. Its new styling makes it eminently suitable for shelf mounting, but it is no less versatile than its famous predecessor. Listen to a pair of Q.16s in stereo and marvel at the standards of quality and clarity they give.

The Q.16 will handle loading up to 14 watts R.M.S. and presents an 8 ohm impedance to the amplifier output. Frequency response extends from 60 to 16,000Hz with exceptional smoothness. A specially designed driver system is used in a sealed and contoured pressure chamber to ensure good transient response at all frequencies. Size: 9¾" square × 4¾" deep from front to back.

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Complete kit incl. earpiece, case, solder and instructions in fitted pack. **49/6**

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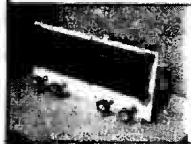

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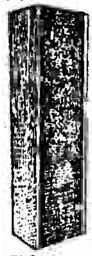

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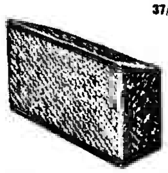

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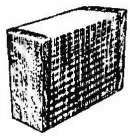

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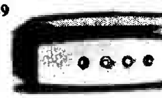

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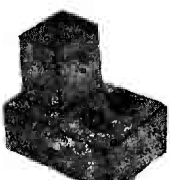

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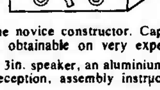

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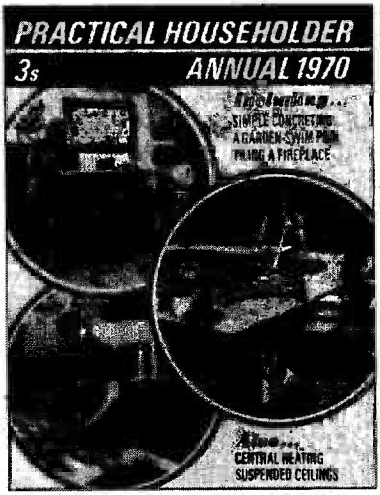

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