PRACTICAL WIRELESS

MARCH 1970

3/0

UNIT BUILT

GENERAL COVERAGE RECEIVER

ALSO:

METAL LOCATOR
FET's AND THEIR USES

ADCOLA
PRODUCTS LIMITED
(Regd Trade Mark)

THE RELIABLE SOLDERING INSTRUMENT!

SEND COUPON FOR LATEST LEAFLET

ADCOLA PRODUCTS LTD
ADCOLA HOUSE
GAUDEN ROAD
LONDON SW4
Telephone 01-622 0291/3

NAME ....
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PW177

SEMICONDUCTORS

BRAND NEW AND FULLY GUARANTEED

1N914	1/6	2N2905A	8/-						
1N916	1/6	2N2906	6/-	ACY22	4/-	BD121	17/6	MJ481	27/6
1S021	4/-	2N2906A	8/-	ACY28	4/-	BD123	21/6	MJ490	22/6
1S025	5/-	2N2923	4/-	AD140	8/-	BD124	12/-	MJ491	29/6
1S113	3/-	2N2924	4/-	AD149	11/6	BF115	5/-	MPF102	8/6
1S120	2/6	2N2925	3/6	AD161	7/6	BF117	10/6	MPF103	7/6
1S121	2/6	2N2926		AD162	7/6	BF167	5/6	MPF104	7/6
1S130	2/6	.. Green	3/-	AF114	5/-	BF173	7/6	MPF105	8/-
1S131	2/6	.. Yellow	2/9	AF116	5/-	BF180	7/-	NKT0013	8/6
1S132	2/6	.. Orange	2/9	AF117	5/-	BF181	6/6	NKT216	7/6
1S44	2/-	2N3011	12/6	AF118	12/6	BF184	7/6	NKT217	8/6
2G301	4/-	2N3053	6/6	AF124	4/6	BF194	5/-	NKT261	4/-
2G302	4/-	2N3054	12/6	AF125	4/6	BFX12	4/6	NKT262	4/-
2G303	4/-	2N3055	15/-	AF126	4/-	BFX13	4/6	NKT264	4/-
2G371	3/-	2N3702	3/6	AF127	3/6	BFX29	12/6	NKT271	4/-
2N696	4/6	2N3703	4/6	AF139	7/6	BFX30	9/-	NKT272	4/-
2N697	5/-	2N3704	4/6	AF181	8/6	BFX35	19/6	NKT274	4/-
2N698	4/6	2N3705	4/-	AF186	11/-	BFX43	8/6	NKT275	4/-
2N706	2/6	2N3706	4/6	AF239	7/6	BFX44	8/6	NKT281	5/6
2N706A	2/6	2N3707	4/-	ASY26	5/6	BFX84	7/6	NKT403	15/-
2N708	4/-	2N3708	3/6	ASY27	8/6	BFX85	9/-	NKT404	12/6
2N929	5/6	2N3709	3/6	ASY28	5/6	BFX86	6/6	NKT405	15/-
2N930	7/-	2N3710	4/-	ASY29	5/6	BFX87	6/6	NKT613	6/6
2N1090	6/6	2N3711	4/-	ASZ20	7/6	BFX88	5/-	NKT674	5/-
2N1091	6/6	2N3819	9/-	ASZ21	7/6	BFY10	4/6	NKT677	5/-
2N1131	6/6	2N3820	23/6	BAX13	1/6	BFY17	4/6	NKT713	5/-
2N1132	6/6	2N3906	7/6	BAX16	2/9	BFY18	4/6	NKT773	5/-
2N1302	3/6	2N4058	5/6	BAY31	1/6	BFY19	4/6	NKT781	6/-
2N1303	3/6	2N4059	5/-	BAY38	3/6	BFY20	12/6	NKT20329	8/6
2N1304	4/6	2N4060	5/-	BC107	3/6	BFY41	10/-	NKT80111	15/6
2N1305	4/6	2N4061	4/6	BC108	3/6	BFY43	12/6	NKT80112	19/6
2N1306	5/-	2N4062	4/6	BC109	3/6	BFY50	4/6	NKT80113	22/6
2N1307	5/-	2N44254	8/6	BC113	6/6	BFY51	4/6	OA5	2/6
2N1308	6/-	2N4255	8/6	BC116	12/6	BFY52	4/6	OA9	2/-
2N1309	6/-	2N4284	3/6	BC118	6/6	BFY76	8/6	OA70	1/6
2N1507	5/6	2N4285	3/6	BC125	11/-	BFY77	11/6	OA73	2/-
2N1613	5/6	2N4286	3/6	BC126	11/-	BFY90	12/6	OA79	1/9
2N1711	6/6	2N4287	3/6	BC147	3/6	BSX19	3/6	OA81	1/6
2N1889	6/6	2N4288	3/6	BC148	3/6	BSX20	3/6	OA85	1/6
2N1893	8/6	2N4289	4/6	BC149	3/6	BSX21	7/6	OA90	1/6
2N2102	15/-	2N4291	3/6	BC167	3/6	BSX26	10/6	OA91	1/6
2N2147	14/6	2N4292	3/6	BC168B	3/6	BSX27	10/6	OA95	1/6
2N2148	12/6	40361	12/6	BC168C	3/9	BSX28	6/-	OA200	2/-
2N2160	12/6	40362	14/6	BC169B	3/6	BSX29	13/6	OA202	2/-
2N2193	5/6	3N128	18/6	BC169C	3/9	BSY26	4/-	OC26	6/6
2N2193A	5/6	3N140	19/6	BC182L	4/6	BSY27	4/-	OC28	8/6
2N2194A	5/6	3N141	21/6	BC212L	5/-	BSY28	4/-	OC29	15/-
2N2217	6/6	3N142	16/6	BCY30	5/6	BSY29	4/-	OC35	6/6
2N2218	6/6	AAZ13	2/-	BCY31	5/6	BSY38	4/6	OC36	6/6
2N2219	6/6	AAZ15	2/6	BCY32	7/6	BSY39	4/6	OC44	4/-
2N2220	5/-	AAZ17	2/6	BCY33	4/-	BSY40	6/6	OC45	2/6
2N2221	5/-	AC107	6/-	BCY34	4/6	BSY51	8/6	OC71	2/6
2N2222	6/6	AC126	4/-	BCY38	4/6	BSY52	9/-	OC72	2/6
2N2368	5/-	AC127	5/-	BCY39	7/6	BSY53	8/6	OC75	4/6
2N2369	5/-	AC128	4/-	BCY40	6/6	BSY54	10/6	OC81	4/-
2N2369A	5/6	AC176	5/-	BCY42	3/-	BSY95A	3/6	OC83	4/6
2N2539	4/6	AC187	12/-	BCY43	3/-	BY100	4/6	OC81D	4/6
2N2540	4/6	AC188	12/-	BCY54	7/6	BYX10	5/6	OC84	5/-
2N2646	11/6	ACY17	5/-	BCY70	4/6	BYZ10	9/-	OC139	6/6
2N2904	8/-	ACY18	5/-	BCY71	8/6	BYZ11	7/6	OC140	6/6
2N2904A	8/-	ACY19	5/-	BCY72	4/-	BYZ12	6/-	OC200	6/6
2N2905	8/-	ACY20	5/-	BDY20	25/6	BYZ13	5/-	OC201	7/6
		ACY21	5/-	BD116	35/-	MJ480	20/6	OC202	10/6

MULLARD INTEGRATED CIRCUITS

FCH211 Hextuple DTL Inverter Gate	28/6
FCH221 Triple 3 Input DTL Line	28/6
FCJ101 3 Input JK Flip Flop	35/-
TAA241 Operational Amplifier	47/6
TAA243 Operational Amplifier	47/6
TAA 263 Linear AF Amplifier	18/6
TAA 300 Linear A.F. Amp	47/6
TAA320 Most LF Preamplifier	15/6
TAA 350 Wide-band Lim Dif Amp	45/-

SPEAKERS (3 ohm)

10in. × 6in. **37/6**, 9in. × 4in. **23/6**, 8in × 5in **19/6**, 7in. × 4in. **15/6**, 5in. × 3in **12/6**, 3in. **9/6**, 5in **14/6**, 8in. **27/6**, 12in. **39/6**.

Post and Packing 2/9

THERMISTORS

R53 (STC)	25/6
K151 (IK)	2/6

All various Mullard Thermistors in stock.

SEND 6d. STAMP FOR CATALOGUE

P.P. for Components **1/6** per order.

THYRISTORS

1 AMP. 50V **5/-**, 100V **5/6**, 200V **7/-**, 400V **9/6**.
3 AMP. 50V **6/-**, 100V **7/6**, 200V **8/-**, 400V **10/6**
ZENERS. 1½ WATT 2·7–33V **4/6**.
400m/w 3·0–33V **4/-**

INTEGRATED CIRCUITS—R.C.A.

CA3005 **30/-**, CA3011 **20/-**, CA3012 **25/-**, CA3013 **30/-**, CA3014 **30/-**, CA3018 **25/-**, CA3019 **25/-**, CA3020 **27/6**, CA3021 **42/6**, CA3022 **35/-**, CA3023 **32/6**, CA3026 **27/6**, CA3028A **25/-**, CA3028B **35/-**, CA3035 **35/-** CA3036 **20/-**.

FAIRCHILD

L900, 914 **11/-**, L923 **14/-**, L701C **17/6**, L702C **45/-**, L709C **27/6**.

DATA SHEETS FOR RCA DEVICES **2/-** per type

Presets std., horiz. or vert. **1/6**
Potentiometers, Log/Lin **3/3 each**

MFD	V	Price	MFD	V	Price	MFD	V	Price
1	15	1/6	25	10	1/6	200	6·4	1/9
1	40	1/9	25	25	1/6	200	16	2/-
2	15	1/6	25	50	1/6	250	25	2/9
2	350	2/-	32	15	1/6	250	50	3/9
2·5	16	1/9	32	450	1/6	320	10	1/6
4	15	1/6	40	6.4	1/6	400	16	2/9
4	40	4/9	40	16	1/6	500	6	2/6
4	350	2/3	50	12	1/6	500	25	3/9
5	15	1/6	50	25	1/6	500	50	4/9
6·4	6·4	1/9	50	50	2/-	640	16	3/6
8	18	1/6	64	25	1/6	1000	16	4/-
8	40	1/6	80	6·4	1/6	1000	25	5/-
8	450	3/-	80	16	1/6	1000	50	7/6
10	15	1/6	100	6·4	1/6	2000	25	8/6
10	25	1/6	100	12	1/6	2000	50	12/6
12·5	25	1/9	100	25	1/6	2500	25	9/6
16	18	1/6	100	50	2/6	5000	25	12/6
25	6·4	1/6	125	4	1/6			

VEROBOARD

	·15 Matrix	·1 Matrix
2½ in. × 3¾ in	3/6	4/-
2½ in × 5in	4/3	4/9
3¾ in × 3¾ in	4/3	4/9
3¾ in. × 5in	5/6	5/6
2½ in. × 17in.		12/6
3¾ in. × 17in.	16/-	21/6

Cutter 9/-

RESISTORS

¼ watt 5% . **4d.**
⅛ and ½ watt 5% . **5d.**
1 watt 10% . **6d.**
2·5 watt 5% . **1/6**
5 watt 5% . **2/-**
10 watt 5% . **2/6**

A. MARSHALL & SON

28 CRICKLEWOOD BROADWAY, LONDON N.W.2
01-452 0161/2/3 CALLERS WELCOME

Post & Packing U.K. only. 1/6. Europe 10/-. Commonwealth (Air) 13/-

The Premier Stereo System consists of an all transistor stereo amplifier. Garrard Model 2025 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	£20.15.1	£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" TRANSISTOR STEREO AMPLIFIER

A superb stereo amplifier offering every facility for the hi-fi enthusiast. Output 10 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 14¼ × 9¼ × 3½in. A.C. 200/250V.

WONDERFUL VALUE AT ONLY **25 Gns.** Carr. 10/-.

"NOVA" 5 WATTS PER CHANNEL STEREO AMPLIFIER. Specification as above. £18 18 0, Carr. 10/-.

PICK-UP CARTRIDGES
AT MONEY SAVING PRICES!

GOLDRING G800 (Stereo)	£8.19.6
SONOTONE 9TAHC/D (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

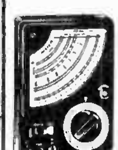
All leading makes available including Rogers, Armstrong, Dulci, Wharfedale, Goodmans, Goldring, Shure, etc. etc.

SAVE NEARLY £5!

Premier Stereo System with "Nova" 10 watt Stereo Amplifier as above. 45 Gns. Carr. 35/-.

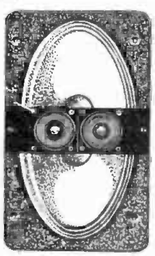
MULTI TESTERS

"TEST 7". A really versatile instrument that makes a handy pocket size tool. Measures AC or DC voltage in three ranges of 0–15–150–1000 volts. Resistance 0–100,000 ohms. Current 0–150 mA D.C. Size only: 3¾" x 2¼" x 1⅛" Complete with battery test leads and instructions. **59/6** P. & P. 2/6.



POCKET SIZE MULTI-TESTER With wide angle, jewelled meter movement, ceramic long-life, low-loss switching, tough impact resisting case. Sensitivity 20,000 ohms/volt D.C. 10,000 ohms/volt A.C.
19 Ranges: 0-5-25-50-250-500-2500 volts DC. 0-10-50-100-500-1000 volts AC. 0-50µA-2·5 mA-250 mA DC. 0-6000 ohms-6 megohms, 10µ µf-0·001 mfd-1 mfd. —20 to +22dB. Complete battery, test lead and instructions. **£4.19.6** P. & P. 3/6.

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

VERITAS V-149 MIXER

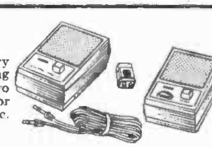
Battery operated 4-channel audio mixer providing four separate inputs. Size 6 × 3 × 2in. suitable for crystal microphone, low impedance microphone with transformer, radio, tape, etc. Max. input 1.5v. Max. output 2.5v. Gain 6 dB. Standard jack plug socket inputs, phonoplugs output. Attractive teak wood grain finish case.

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

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.

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/-.

FOUR STATION INTERCOM. Master unit and 3 slaves. Ideal for office and home. Complete with battery and connecting wire £7.19.6. P & P. 5/6.

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

JULIETTE NA.5018 5 BAND 18 TRANSISTOR MAINS BATTERY RADIO

Covers AM 540–1600Kc/s. Marine 1.6–4.6Mc/s. FM 88–108Mc/s. VHF 108–134Mc/s. PB 148–174Mc/s. Ferrite bar aerial for AM MB. Telescopic aerial for FM/VHF PB. 4" P.M. Speaker and BFO switch. Operates on AC 250v. or D.C. by four 1.5v. batteries. Size: 9¾" x 5¼" x 3¾".

PREMIER PRICE **39** GNS. P. & P. 10/–.

"PREMIER" 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	3¼"	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

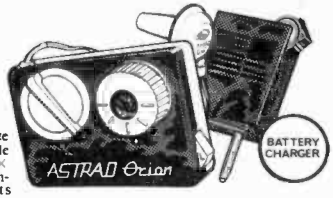
Lasky's

SCOOP! THE WORLD'S SMALLEST 6 TRANSISTOR

TWO WAVEBAND RADIO RECEIVER

Over 10,000 sold

The Astrad ORION



Made to the highest space age standards — this remarkable micro-set measures only 1$\frac{11}{16}$ × 1$\frac{3}{10}$ × $\frac{5}{16}$in. yet it contains 6 transistors and other components combined in a photo etched circuit only $\frac{3}{4}$ × $\frac{1}{4}$in.; tuning capacitor, ferrite rod aerial, battery, wave band selection switch, etc. Output to a high impedance crystal earpiece, giving ample volume (automatically adjusted) and clear tone. Brief tech. spec: Waveband coverage—Medium wave 525 to 160kc/s, Long wave 150kc/s to 408 kc/s. Sensitivity: 35MV max. Selectivity —10dB (at 30kc/s de-tuning). Power source: 1 × 1.4V Mercury battery.

The Orion is supplied fully built and tested complete with battery, left and right fitting earphone supports and attractive black and ivory plastic carrying case—the Orion is an ideal gift for all, providing a constant source of enjoyment without disturbing others.

LASKY'S PRICE ONLY 39/6 Post 2/6 Extra rechargeable battery 3/6

*NOTE: The battery we supply with the Orion is a rechargeable type. Charger units are available enabling you to recharge the battery from AC Mains 220/240V supply.

PRICE 19/6 extra Post Free with radio—otherwise 2/-

RECORD PLAYERS

AUTOCHANGERS

SL 72B	£25 0 0
AT 60 Mk II	£13 5 0
2025 TC complete with stereo cart.	£8 17 6
3000 complete with 9TA HC stereo cart.	£9 19 6
SL 65B	£15 19 6
1025 complete with stereo cart.	£6 19 6
SL 95B	£40 0 0
SL 75B	£32 0 0

SINGLE PLAYERS

AP 75	£18 10 0
AP 75 with AD 76K mag. cart.	£21 10 0
SP 25 Mk II	£11 19 6
401 Transcription Unit	£28 0 0
12P25 Mk. II complete AD76K stereo cart	£15 10 0

BASES AND COVERS FOR GARRARD UNITS Type WB1 and WB5 for models AT60 Mk II, 2025TC, 3000, SL65B, SL55, 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.

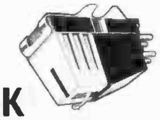
GARRARD PACKAGE DEALS

AP 75 complete with AD 76K Stereo mag. cart., teak plinth and perspex cover (illustrated).	£30.0.0	Post 10/-
SP 25 Mk II complete with AD 76K catridge teak plinth and perspex cover.	£19.0.0	Post 7/6
1025 complete with J2105 stereo crystal cart., teak plinth and perspex cover.	£11.19.6	Post 7/6

Post on Garrard units: 6/- extra—except AP 75, SL 75B, SL 95B and 401 7/6 extra. Post on bases and covers 5/- extra.

AUDIO DEVELOPMENT

LOW COST - HIGH QUALITY MAGNETIC CARTRIDGES



AD-76K

Frequency response: 20-20,000Hz. Output: 5mV. Stylus: Diamond LP, Mono. Compatible. Channel balance: 1dB. Channel separation: 20dB. Compliance: 12 × 10^{-6} cm/dyne. Tracking force: 2 gms.

£4.10.0 Replacement stylus type JS.P1. 38/6

AD-96K

Frequency response: 20-20,000Hz. Output: 5mV. Stylus: Diamond LP 0.7 mil, mono compatible. Channel separation: 20dB. Compliance: 10 × 10^{-6} cm/dyne. Tracking force: 2gms. 0.5gms. ±

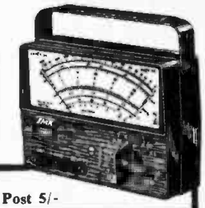
£5.18.6 Replacement stylus type Y.960S. 51/6

Both Post Free.

TMK METERS

These meters incorporate the very latest developments in design and set a new standard in quality and accuracy. The new shape permits a more compact cabinet yet the meter size is actually increased! All have strong impact resistant cabinets with carrying handles and are complete with test leads, batteries and full instructions.

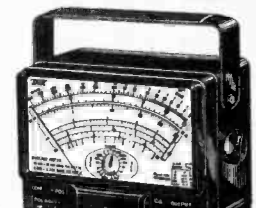
Model PL-436



20,000 O.P.V. Multitester for the amateur or professional. Features mirror scale and wood grain finish front panel. SPEC: DC/V ranges: 0·6, 3, 12, 30, 120/600V at 20K/O.P.V. AC/V ranges: 3, 30, 120, 600V at 8K/O.P.V. DC current: 50μA, 0·6, 60, 600mA. Resistance: 10K, 100K, 1M and 10M ohms end scale (65, 650, 6·5K and 65K ohms centre scale). Decibels: —20 to +57dB in four ranges. Operates on 2 × 1.5V U7 type batteries. Size: 5$\frac{1}{4}$ × 4$\frac{3}{8}$ × 2$\frac{3}{8}$in.

LASKY'S PRICE £6.19.6 Post 5/-

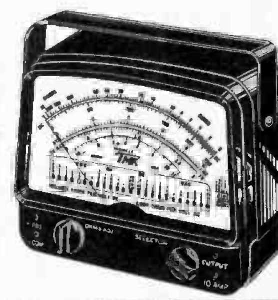
Model 5025



50,000 O.P.V. Multitester suitable for all professional and educational uses. Features a fantastic 57 measurement range cover (±2% accuracy on full scale DC). High speed range selection, polarity reversal switch and overload meter protection circuit. SPEC: DC/V ranges: 0·125 to 1000V in 12 ranges (0·25 to 500V at 50K/O.P.V.). AC/V ranges 1·5V to 1000V it 10 ranges (1.5 to 500V at 5K/O.P.V.). DC current: 25μA to 10A. Ohms: 0 to 10M ohms. Decibles: —20 to +81·5dB in 10 ranges. Operates on 2 × 1·5V U7 type batteries. Size: 6$\frac{3}{4}$ × 5$\frac{1}{4}$ × 2$\frac{3}{4}$in.

£12.10.0 Post 5/- Also available in kit form price £10.10.0.

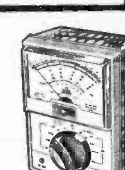
100,000 O.P.V. "LAB" Model



A highly accurate yet rugged Multitester using a 10μA meter hand calibrated to a DC accuracy of ±3% of full scale. Special features—ultra large meter scale 6$\frac{1}{4}$ × 3$\frac{1}{4}$in. incorporating an entirely new type of range selection panel which gives instant range identification without taking your eyes from the meter. An audible buzzer is provided for easy short testing. SPEC: DC/V ranges: 0·5, 2·5, 10, 50, 250, 500, 1000V at 100K/O.P.V. AC/V ranges: 3, 10, 50, 250, 500, 1000V at 5K/O.P.V. DC current: 0–10, 100μA, 0–10, 100mA, 0–2·5, 10A. Resistance: 0–1K, 10K, 100K, 10M, 100M/ohms. Decibles: —10 to 49·4dB. Continuity test: Audible buzzer Operates on 1 × 1·5V U2 and 1 × 15V B. 154 type batteries. Cabinet size 7$\frac{1}{2}$ × 6$\frac{3}{4}$ × 3$\frac{1}{4}$in. Weight 4lb.

LASKY'S PRICE £19.10.0 Post 5/-

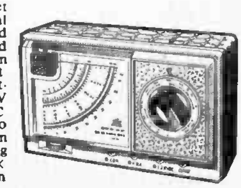
TTC Model C-1000



A really tiny 1,000 O.P.V. pocket multi-tester with "big" meter performance. Precision 2 jewel meter movement. ±3% accuracy on full scale of DC ranges, 4% on AC ranges. 2$\frac{1}{4}$in. square meter. SPECIFICATIONS: AC/V ranges: 0–10, 50, 250, 1,000 V at 1K/O.P.V. AC/V ranges: 0–10, 50, 250, 1,000V at 1K/O.P.V. DC current: 0–1–100mA. Resistance: 0–150K/ohms (3,000 ohms centre scale). Decibles: —10 to +22dB. Operated on one penlight cell. Two colour buff/green case—size only 3$\frac{1}{2}$ × 2$\frac{1}{4}$ × 1in. Click stop range selection switch. Ohms zero adjustment. Complete with test leads, battery and inst.

LASKY'S PRICE ONLY 39/6 Post 2/6

TTC Model C-1051



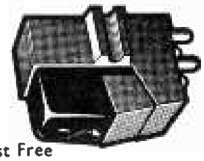
A completely new design 20,000 O.P.V. pocket multimeter with mirror scale and built in thermal protection circuit. Exceptionally large easy to read meter with D'Arsonval movement. Colour coded scales. Single positive click-in, recessed selection switch for all ranges. Ohms zero adjustment Range spec. AC volts: 0–6–30–300–1200V at 10K/ohms/V. DC volts: 0–3–15–150–300–1.2KV at 20K/ohms/V. Resistance: 0–60K, 6m. DC current: 0–60μA–300mA. Decibels: —20dB to +17dB. Extremely high standard of accuracy on ranges. Uses one 1$\frac{1}{2}$V penlight battery. Strong impact resistant plastic cabinet—size only 4$\frac{3}{4}$ × 3$\frac{3}{8}$ × 1$\frac{1}{4}$in. Two colour buff/green, finish. Complete with test leads and battery.

LASKY'S PRICE 75/- Post 2/6

Lasky's

AUDIO TECHNICA

SPECIAL OFFER



A-35X Stereo magnetic cartridge with eliptical diamond stylus. Frequency response 20-25KHz—2dB. Channel separation 30dB. List Price £24 4s 9d

LASKY'S PRICE £17.10.0 Post Free

Also available AT-35 stereo magnetic cartridges with either .5 or .7 mil diamond stylus assemblies. List Price £18 10s 0d

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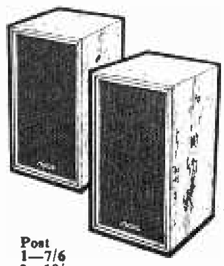
AT 33 Stereo Magnetic Cartridge with .7 mil diamond stylus. List Price £10 14s 3d.

LASKY'S PRICE £7.19.6

EXCLUSIVE

FOSTER "Criterion" MkII

HIGH FIDELITY
2 SPEAKER TWO WAY BOOK-SHELF SPEAKER SYSTEM



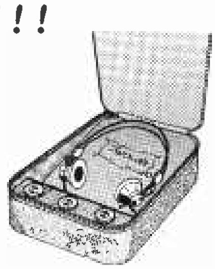
Another high quality bookshelf system from Foster. The "Criterion" MkII is a sealed infinite baffle type enclosure using 5½in. bass/mid-range woofer with rolled cloth edge and a 2½in. HF cone type tweeter. The compact cabinet is constructed of ½in. laminate with handsome oiled walnut veneer finish and 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.

Post
1—7/6
2—10/-

LASKY'S PRICE £9.10.0 or 2 for £17.10.0

SPECIAL BARGAIN ! !

S. G. BROWN "DIPLOMAT" STEREO HEADPHONE AUDITORIUM



Comprising light weight headset and control unit in smart zip-topped case. Control facilities include independant left/right volume controls, channel mixing for perfect stereo balance or mono operation, switched impedance selection for either 15 or 600 ohms input. Complete with all cables and instructions in fitted case — available in either ivory or pigskin. List price £12 10s 6d

LASKY'S PRICE £7.19.6 POST 3/6

AKG MODEL K20

Frequency response 30-20,000Hz. impedance 75 ohms (600 ohms each earpiece). Sprung cushion padded earpads for maximum comfort. Pale grey finish, with adjustable headband. List Price £6 5s 0d

LASKY'S SPECIAL PRICE 79/6 POST 3/6

AUDIO TRONICS '70

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, Servicemen 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 0s 0. All the goods shown are available from any of our branches or by Mail Order to any address in the U.K. or Overseas —bringing the benefits of shopping at Lasky's to you in the comfort of your home.

Send: Your name, address and 2/0d for the post only and inclusion of your name on our regular mailing list

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3in.	Message tape, 300ft. ..	7 6	7in.	Standard play, 1200ft Acetate	12 6
3¼in.	Triple play, 600ft Mylar	10 0			
5in.	Double play, 1200ft ,,	15 0	7in.	Standard play, 1200ft. Mylar	12 6
5in.	Long play, 900ft Acetate	10 0			
5in.	Standard play 600ft ,,	8 6	7in.	Long play, 1800ft Mylar	19 6
5¾in.	Double play, 1800ft M'lar	22 6	7in.	D'ble play, 2400ft Mylar	25 0
5¾in.	Long play 1200ft Acetate	15 0	7in.	Long play 1800ft Acetate	15 0
5¾in.	Standard play 900ft PVC	12 6	7in.	Triple play 3600ft Mylar	50 0

P. & P. 1/ extra per reel, 4 reels and over Post Free. Special quotes for quantities

BUDGET CASSETTES from U.S.A.

C60	7/6 each post 1/-	Fives 35/- post 2/-	Tens 65/- post 3/-
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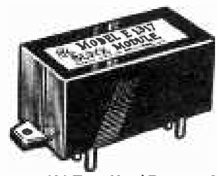
METROSOUND CASSETTE HEAD CLEANER

This ingenious device enables the delicate recording heads and drive system of your Cassette Recorder to be cleared without damage. Just slip in the cassette like any other cassette and run through once. Only takes moments and removes all dirt and oxide deposits in seconds.

LASKY'S PRICE 10/8 POST 1/- EACH

LASKY'S ENCAPSULATED SOLID STATE MODULES



Size of each module only ½ × 1½ × ¾in. Ready for immediate use—just connect to power source usually 9V battery), input and output. Encapsulated modules are shockproof and almost indestructible. Complete with full ins. Post 1/6 each.

E-1311 Phono Pre-amp Module—max. output 3V. RMS, input 50mV, input imp. 100kΩ, gain 28dB, RIAA compensation **29/6**

E-1312 Tape Head Pre-amp Module—max. output 3V, RMS, input 50mV, input imp. 100kΩ, gain 25dB, NARTB compensation **29/6**

E1313-Microphone Pre-amp Module—max. output 4V, RMS, input 50mV input imp. 100kΩ, gain 28dB, response 10.50kc/s. **29/6**

E-1314 Power Amplifier Module—max. output 300mW, input imp. 1kΩ, gain 20dB, response 50-10kc/s, distortion 3% at 20mW. **29/6**

E-1315 Electronic Organ (tone oscillator) **Module**—frequency 200-1,000 c/s, output 80mW. For use with keyboard, variable resistors and 8Ω speaker. **25/-**

E-1316 Morse Code Practice Oscillator Module—frequency 400c/s, output 80mW. For use with morse key and speaker. **25/-**

E-1317 Modulated Wireless Signal Transmitter for use in test bench fault finding—frequency 400c/s-30Mc/s, tone freq. 400c/s. For use with any AM receiver. **25/-**

E-1318 Lamp Flasher Module—flashes two miniature lamps alternately. For use with 6V, 100/200mA bulbs and 6V power supply. **25/-**

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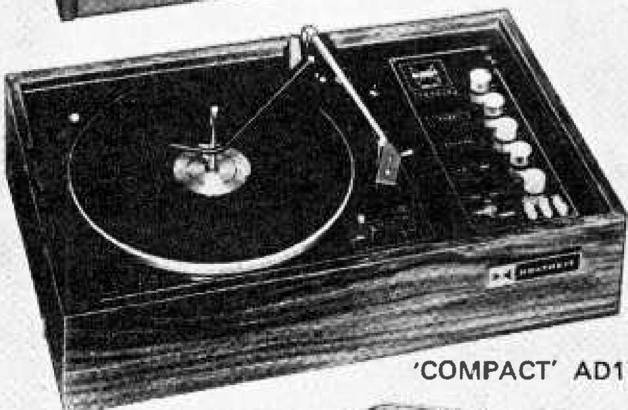
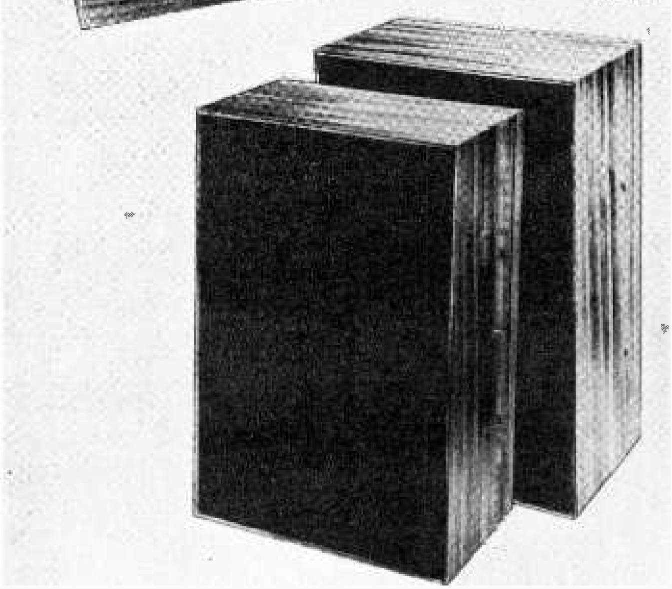
Heathkit for the new "Compact" Sound of the 70's

'COMPACT' AD27



'COMPACT' AD17



AMBASSADOR SPEAKERS

The fabulous stereo "Compacts" Models AD–17 and AD–27 are setting the pace in hi-fi for the 1970's. They offer outstanding value and performance. The AD-17 comprises a BSR MA-65 turntable/Shure M44-MB magnetic cartridge and a 10 watt (RMS) per channel stereo amplifier all mounted on a Teak or Walnut plinth.

Kit Price £54. Carr. 13/-

The AD–27 is similar but uses the MA–70 turntable and includes an FM stereo tuner. In this case the "plinth" is better described as a small cabinet. It has the additional features of a "Roller Shutter" lid and is available in Teak or Walnut.

Kit Price £82. Carr 13/-

Heathkit offer many excellent loudspeaker systems the new "Ambassador" Hi-Fi loudspeaker is winning many friends. Its cabinet is supplied ready assembled and finished in selected Teak or Walnut veneers to harmonise with other current Heathkit hi-fi equipment. It uses three loudspeaker units a 12in. bass, 5in. mid range and a 1in. Dome Pressure Tweeter.

Kit Price £29.16.0 Carr. 15/-

The complete Heathkit hi-fi range of stereo amplifiers, tuner/amplifiers, FM tuners, Stereo "Compacts", loudspeaker systems and ancilliary hi-fi equipment are all described and illustrated, many in full colour. In a wonderful free catalogue.

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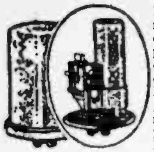
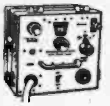
CAR LIGHT FLASHERS



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).

CLASS D WAVEMETERS



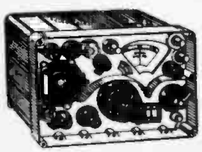
A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6 volts D.C. Ideal for amateur use. Available in good used condition. £5.19.6. Carr. 7/6. Or brand new with accessories. £7.19.6. Carr. 7/6.

CLASS D WAVEMETERS No. 2

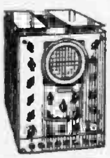
Crystal controlled. 1·2–19 Mc/s. Mains or 12V. D.C. operation. Complete with calibration charts. Excellent condition. £12.10.0. Carr. 30/-.

R209 MK II COMMUNICATION RECEIVER

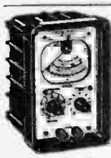
11 valve high grade communication receiver suitable for tropical use. 1·20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, B.F.O., aerial trimmer, internal speaker and 12v. D.C. internal power supply. Supplied in excellent condition, fully tested and checked £15.0.0. Carr. 20/-



TYPE 13A DOUBLE BEAM OSCILLOSCOPES



An excellent general purpose D/B oscilloscope. T.B. 2 cps–750 Kc/s. Bandwidth 5·5 Mc/s. Sensitivity 33mV/CM. Operating voltage 0/110/200/250V. A.C. Supplied in excellent working condition. £22.10.0. Or complete with all accessories, probe, leads, lid, etc. £25. Carriage 30/-.



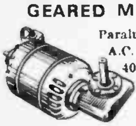
MARCONI T/44/TF956

AF Absorption Wattmeter

1 μ/watt to 6 watts.

£20. Carr. 10/-.

GEARED MAINS MOTORS

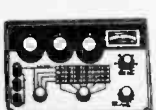


Paralux type SD19 230/250V. A.C. Reversible. 30 r.p.m. 40 lb./ins. Complete with capacitor. Excellent condition. 99/6. Carr. 10/-.

TO-3 PORTABLE OSCILLOSCOPE

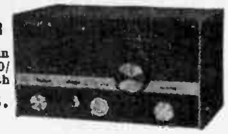
3in. tube. Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1·5 MHz. Input imp. 2 meg Ω 25pF. X amp. sensitivity 0·9v p-p/CM. Bandwidth 1·5 cps–800KHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps-300 KHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½ lb. 220/240V. A.C. Supplied brand new with handbook. £37.10.0 Carr. 10/-.

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



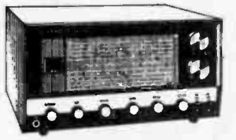
A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω–11·1 meg Ω 6 Ranges ±1%. L.1 μ H - 111 HENRYS 6 Ranges –2%. C. 10pF ±1110mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. £20. P. & P. 5/-.

UNR-30 4-BAND COMMUNICATION RECEIVER



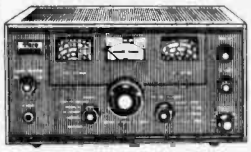
Covering 550 Kc/s–30 Mc/s. Incorporates BFO. Built in speaker and phone jack. Metal cabinet. Operation 220/240V. A.C. Supplied brand new, guaranteed with instructions. Carr. 7/6 **13 gns.**

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.



TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

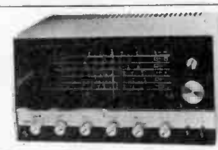
4 band receiver covering 550 Kc/s to 30 Mc/s continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit, 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 455 Kc/s ● Audio output 1·5 W. ● Variable RF and AF gain controls. 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.

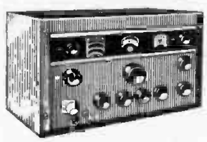
TRIO JR. 500SE 10-80 Metre Receiver £69.10.0

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

LAFAYETTE HA-800 SOLID STATE AMATEUR COMMUNICATION RECEIVER

Six bands 3·5-4, 7-7·3, 14-14·35, 21-21·45, 28-29·7, 50-54Mc/s. Dual conversion on all bands. 2 × 455 Kc/s mechanical filters. FET front end, product detector, variable BFO, 100Kc/s crystal calibrator. 'S' Meter. Huge slide rule dial. Operation 230V AC or 12V DC. Size 15 × 9½ × 8½in. Complete with instruction manual. £57.10.0 Carr. Paid. 100Kc/s crystal 39/6 extra.



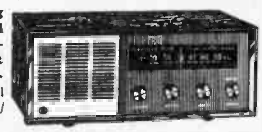


RCA COMMUNICATIONS RECEIVERS AR88D

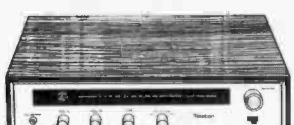
Latest release by ministry BRAND NEW in original cases. 110-250v. A.C. operation. Frequency in 6 Bands. 535 Kc/s–32 Mc/s continuous. Output impedance 2·5-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price £87.10.0. Carr. £2.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

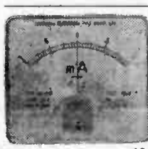
A completely new transistorised receiver covering 152–174 Mc/s. Fully tunable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75 Ω aerial input. Headphone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



TELETON MODEL 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 13¾" × 3½" × 9¾" approx. PRICE £34.0.0. Carr. 7/6.



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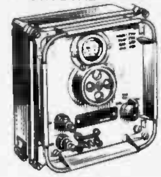

Small portable crystal controlled wavemeter. Size 7 x 7½ x 4in. Frequency range 500 Kc/s–10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300V. D.C. 15mA and 12V. D.C. 0.3A. Excellent condition. 89/6. Carr. 7/6.

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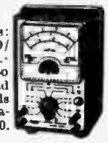
TE-40 HIGH SENSITIVITY A.C. VOLTMETER



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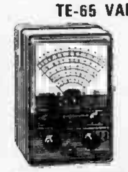

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Duetto Integrated Transistor Stereo Amplifier **£9-10** plus 7/6d. p. & p.

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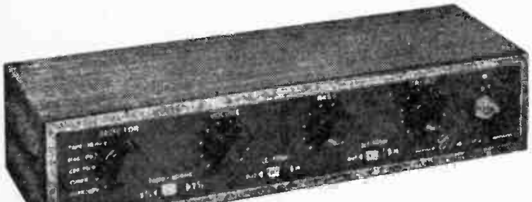
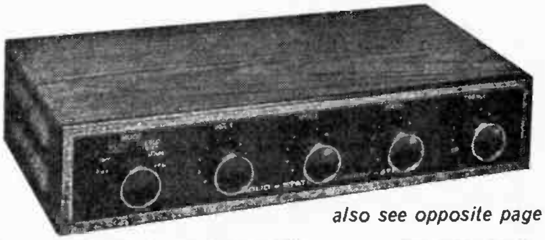


The Viscount **£14.5** plus 7/6 p. & p.

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, 12½" x 6" x 2¾" 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 6¾in. x 5¾in. Plinth (less cover) and the DUETTO stereo amplifier. All above items

£20 plus 20/- p. & p.

NEW COMPLETE HI-FI STEREO SYSTEM - £39

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

£39 plus £2 p. & p.

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.

Circuit 2/6
FREE WITH PARTS.

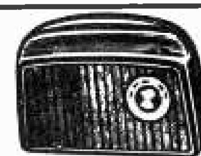
Price £4.9.6 plus 7/6 P. & P.

The DORSET
(600mW Output)

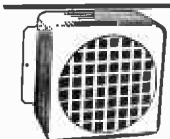
7-transistor fully tunable M.W.–L.W. superhet portable—with baby alarm facility. Set of parts. The latest modulised and pre-alignment techniques makes this simple to build. Sizes: 12 × 8 × 3in.

Price £5.5.0 plus 7/6 P. & P.

MAINS POWER PACK KIT: 9/6 extra



Circuit 2/6
FREE WITH PARTS.



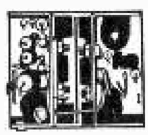
EXTRACTOR FAN

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.

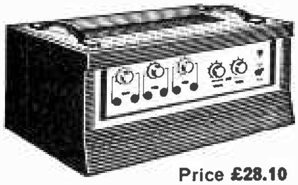
Power Supplies for the X101:
P101 M (for mono) 35/- plus 4/6 p. & p.
P101 S (for stereo) 42/6 plus 4/6 p. & p.

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.

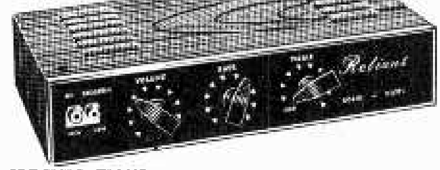
An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money. TECHNICAL SPECIFICATIONS 3 electronically mixed channels, with 2 inputs per channel, enables the use of 6 separate instruments at the same time. The 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. ¼ Track Heads. Size 13¾in. long by 8¾in. wide.

Price £8.19.6 plus 7/6 P. & P.

The RELIANT
SOLID STATE GENERAL PURPOSE AMPLIFIER



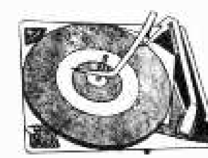
SPECIFICATIONS
Output—10 watts
Output Impedance—3 to 4 ohms
Inputs—1. -xtal mic 10mV
2. -gram/radio 250mV
Tone Controls—Treble control range ±12dB at 10 KHz.
Bass control range ±13dB at 100Hz
Frequency Response—(with tone controls central) Minus 3dB points at 20Hz and 40KHz. Signal to Noise Ratio—better than −60dB. Transistors—4 silicon Planar type and 3 Germanium type. Mains input—220/250V. A.C. Size of chassis—10¼" × 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.

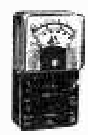
RELIANT Mk. II
In teak finished case.
£6.16 plus 7/6 P. & P.

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 3½ × 2¼ × 1¼in. Meter size 2¼ × 1¾in. 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

STEREO PRE-AMPLIFIER

Inputs—6 position rotary switch (3 position mono, 3 position stereo). Tuner 150mW into 680k. Magnetic pick-up fully equalised and suitable for magnetic cartridges with minimising output of 4mV/cm/sec. Load 47k. Ceramic pickup 150mV into 680k. Sensitivities taken for 200mV output. Controls—separate volume controls for each channel. Twin ganged bass. 12dB lift and 15dB cut at 60c/s. Twin ganged treble. 10dB lift and 15dB cut at 10kc/s. Voltage required 23–30V DC at 5mA. Size 12¼ × 3¼ × 2¼in. In teak finished case, complete with front panel and knobs. Built and tested.

£7.7.0 plus 5/- P. & P.

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 13¼ × 8$\frac{1}{16}$ × 4¼in. 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 6½" × 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
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(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
★ Pai. Stanway II Speaker Units

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

13 WATT OUTPUT

★ Garrard SP25 Mk II 4 sp. player unit on plinth
★ Goldring CS90 Ceramic P.U. Cartridge
★ TA12 Amplifier in veneered housing
★ 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.

AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Treated Cone surround for low fundamental resonance. "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	£5.15.0
HF510L	5"	10W	57/9	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

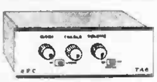
HIGH FIDELITY LOUDSPEAKER UNITS

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. 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.**

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, 9½x2¾x5½in. 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

RECORD PLAYING UNITS

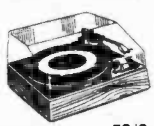
Money saving units. Mounted on Plinth. Supplied with transparent plastic cover Ready to plug into Amplifier or Tape recorder.

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. inc. carr. **15 Gns.** Other types available with Magnetic cartridges and with alternative design plinths.

R.S.C. PLINTHS

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

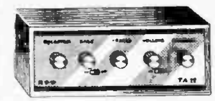


Available **59/9** with trans. plastic cover. Inc. Carr. **6 Gns.**

INTEREST CHARGES REFUNDED On Credit Sales settled in 3 months.

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. **13½ Gns.** Carr. 7/9 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).

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

LINEAR L10 HIGH FIDELITY 10W AMPLIFIER

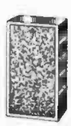
with separate Pre-amp. Magnet P.U. matching. To clear **10 Gns.**

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**

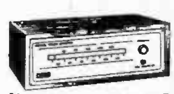
THE 'YORK' HIGH FIDELITY 3 SPEAKER SYSTEM



★ Moderate size, only 25 × 14 × 10in. Complete Kit **20 Gns.**
★ Response 30-20,000 c.p.s. Impedance 15 ohms Carr. 12/6
★ Performance comparable with units costing 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. Only high grade transistors and components used. 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, inc. carr. 23½ gns.

R.S.C. BATTERY/MAINS CONVERSION UNITS

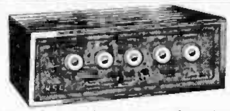
Type BM1

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 30 MkII 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.



Employing Twin Printed Circuits. 200/250v. A.C. mains operation.
HARMONIC DISTORTION 0.1% at 10 watts 1,000 c.p.s.
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. **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. 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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BLACKPOOL (Agent) O. & C. Electronics, 227 Church Street
BIRMINGHAM 30/31 Gt. Western Arcade 021-236-1279 (Half-day Wed.)
DERBY 26 Osmaston Rd., The Spot (Half-day Wed.) Tel. 41361
DARLINGTON 18 Priestgate (Half-day Wed.) Tel. 68043
EDINBURGH 133 Leith St. (Half-day Wed.) Tel. Waverley 5766
GLASGOW 326 Argyle St. (Half-day Tues.) Tel. CIty 4158
HULL 91 Paragon Street (Half-day Thursday) Tel. 20505

R·S·C HI-FI CENTRES LTD.

MAIL ORDERS TO: 102 Henconner Lane, Bramley, Leeds 13. No C.O.D. under £1. Terms C.W.O. or C.O.D. Postage 4/6 extra under £2. 5/9 extra under £5. Trade supplied. S.A.E. with enquiries. **Branches open all day Sats.**

MAIL ORDERS MUST NOT BE SENT TO SHOPS

32 High Street (Half-day Thurs.) Tel. 56420 **LEICESTER**
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13 Exchange Street (Castle Market Bldgs.) (Half-day Thursday) Tel. 20716 **SHEFFIELD**

PRACTICAL WIRELESS

VOL 45 NO 11
Issue 757

MARCH 1970

TOPIC OF THE MONTH

Is the RAE just?

THE object of an examination is to test the ability and proficiency of a candidate in a particular subject. But although the attainment of a pass certificate or diploma endows the holder with appropriate status, there is no doubt that in certain cases this is largely a reflected glory. Due to personal factors such as temperament and academic factors such as choice and phrasing of questions, it is still possible for one candidate to pass and another of greater talent to fail.

When one comes to examinations that are not purely academic, the situation is more complex and can be even more unsatisfactory. Two such examinations that touch our particular field, in which theory and practice intermingle, are the RTEB exam for service engineers and the RAE for aspiring amateur radio operators. Both, in our view, fall short of the ideal mainly because of the complicating factor of practical ability.

One of the commonest and most persistent criticisms of the Radio Amateurs Examination is that the format is heavily weighted in favour of the younger candidate who, because of greater learning ability, is best able to tackle the theoretical nature of the questions. Candidates in older age-groups have often forgotten the magic formulae learned years ago but nevertheless may be perfectly capable of building, operating and maintaining an amateur radio station. (Incidentally, it seems ludicrous that candidates for exams are not allowed to use standard reference sources on the spot—as they are able to do in any later practical application of the type of work involved.)

Of course, it is virtually impossible to arrange oral or practical examinations across the country since the RAE is organised by the City and Guilds of London Institute, not the GPO (to use its old name!). The question paper is set by a Committee including representatives of the RSGB, the GPO and C & G, and to these bodies we strongly recommend that Part 2 of the RAE be divided into sections of (a) theory and (b) practice, Surely some way could be devised to ensure that future licence holders have been tested in some measure as to their *practical* ability to run a station, and are not passed purely as egg-heads with good memories.

The validity of the present RAE surely rests on two basic questions: (1) Is the primary object to screen out the incompetent? and (2) Does the present set-up ensure that those who pass can fulfil the requirements and responsibilities of running an amateur transmitting station?

W. N. STEVENS—*Editor.*

NEWS AND COMMENT

CONSTRUCTIONAL

OTHER FEATURES

APRIL ISSUE WILL BE PUBLISHED ON MARCH 6th

PRICE INCREASE

We regret that owing to mounting production costs it has been necessary to increase the price of Practical Wireless to 3s. 6d. as from the April issue.

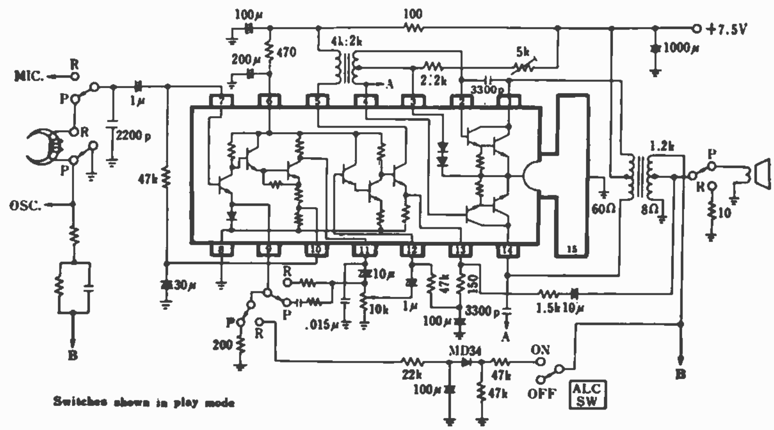
NEWS... NEWS... NEWS...

Integrated audio amplifier

A 1 watt audio amplifier integrated circuit that has been designed for use as a single a.f. amplifier or as a semiconductor bed of a tape recorder, is one device in a new range of linear integrated circuits available from UECL, Microelectronics Division.

This audio amplifier, M5101P, is designed for use on a V_{CC} up to 12 volts and with the addition of a fin will dissipate 1·8 watts. Distortion is typically 0·5% at 45% circuit efficiency.

The device consists of a pre-amplifier, driver and power amplifier and has input resistances of 30,000 ohms to both the pre-amp and driver sections. The circuit consumes only 15mA under zero signal conditions. The whole device is packaged in plastic dual-in-line and will operate over the temperature range −10° to +125°C.



Switches shown in play mode

This integrated circuit, being d.c. coupled, may also be used as a servo amplifier.

The M5101P is available ex-stock at a price of 25s. 5d. on a cash with order baisis. Further details of this device may be obtained from *Ultra Electronic (Components) Limited, 35-37 Park Royal Road, London, N.W.10. Tel: 01-965 5744.*

Hear it at Graham's

One comparative newcomer to the Hi-Fi scene is GRAHAMS HI-FI CENTRE at 86-88 Pentonville Road, N.1 (837 4412). They have set up instantaneous comparison facilities.

Grahams have provided a comprehensive Hi-Fi auditorium which offers customers the opportunity of viewing a wide spectrum of the market. Their policy is first to ascertain the budget level of each customer and to stick to that as closely as possible. "Subject," they say, "to a discreet observation of the customer's reaction to the sound of equipment at his stated price level; if we feel that he is likely to "outgrow' his set-up, to feel dissatisfied with it after a little while, then we explain that we would rather not make a sale at that time. If his ear is so acute, better that he should get the right advice and not buy, than buy the wrong thing. In practice, most people return for equipment that will give them lasting pleasure, perhaps buying it in stages."

Grahams' agencies include Akai, Armstrong, Arena, Bang & Olufsen, Bryan, Dual Dynatron, Ferguson, Grundig, Rotel, Sony, Tandberg and Vandermolen, in addition to dealing in the normal range of high-quality equipment including Uher, Leak, Quad, Rogers, Thorens, Revox and Goldring.

Playback

'Playback' is the title of a 16-page mini-magazine available free of charge from stockists of Scotch magnetic tape.

The issue now available from electrical and hi-fi shops includes features on actor David Hemmings and his use of a tape recorder both on and off the film set; tape recording in schools; and 'how-to-do-it' articles on recorder care and recording the spoken word. There is also some helpful advice on using a tape recorder to make your party go with a swing.

'Playback' is published quarterly by the 3M Company, manufacturer of Scotch magnetic tapes and cassettes.

Anglian rally

The date has been fixed for the above venture, 20th and 21st June, 1970, at the Suffolk Show Ground, Ipswich. Due to the success of the first one, it has been decided to hold a convention on Saturday afternoon, and a social and dance that evening. Sunday the Rally itself will take place. No guest speakers have as yet been appointed.

Another feature is that three awards will be made. (1) Any electronics equipment for groups up to 15 years; (2) Any electronic equipment for groups up to 19 years; (3) Any electronic equipment for any individual any age. For details, send a s.a.e. to *D.W.N.Thomas, G8BVE, 9 Burlington Road, Ipswich, Suffolk.*

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

Eddystone light shines on...

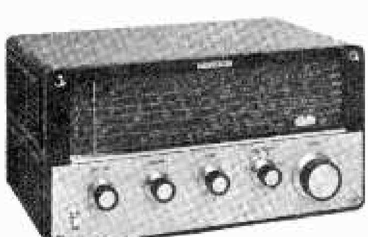
. . . two new receivers. They are the EC10 Mk. 2 and the EB35 Mk. 2. The EC10 Mk. 2 is a re-styled replacement for the earlier model EC10 incorporating a number of additional features, including an integral carrier level meter, fine tuning control and desensitising facilities. Coverage is 550kHz to 30MHz and a low-level output is provided for tape recording. Other features include: Solid state design, 1% calibration accuracy, standby switch, size of 12½ x 6⅜ x 8in. and there is a guaranteed 10 years availability of spares. Price is £69 10s.

The EB35 Mk. 2 is a fully transistorised a.m./f.m. broadcast receiver designed for the person who requires something superior to the normal domestic set. It has a high sensitivity and wide frequency range (88-108MHz, 8·5-22MHz, 3·5-8·5MHz, 1·5-3·5MHz, 550-1500kHz and 150-350kHz). A version is available for stereo multiplex v.h.f. broadcasts.

An internal speaker is fitted and outputs are available for tape recorder and Hi-Fi speaker connection. The audio stages can be used independently for microphone, tape or record reproduction. Price is £82 4s 9d.

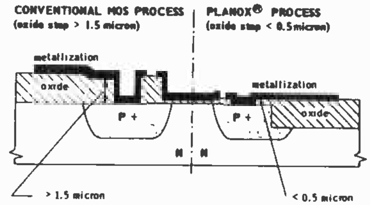
For further information, contact J. H. Roche at *Imhofs Ltd., 112-116 New Oxford Street, London, W.C.1. Tel.: 01-636 7878.*

EC10 Mk2



EB35 Mk2

SGS steps forward



The SGS International Group of semiconductor companies have developed a new process called Planox that enables the oxide layers on the surface of a silicon wafer to be effectively flat so that reliability is greatly enhanced and manufacturing yields improved. Applicable to both bipolar and metal-oxide-silicon devices (M.O.S) the Planox process is of particular importance in the production of M.O.S. integrated circuits where oxide thickness varies greatly and metal interconnection patterns are complex.

In a M.O.S. device the oxide layer grown on the gate regions has to be extremely thin in order to achieve low threshold voltage sensitivity while the oxide layer in the field region has to be thick to avoid spurious M.O.S. effects.

With conventional methods, the thick layer on the field region gives rise to high "steps" of oxide on the chip surface over which the metalization pattern has to be formed. Resultant sharp bends in metallization can lead to weak spots.

The Planox process eliminates this problem by removing sufficient underlying silicon to accomodate the oxide thickness so that the resultant surface is essentially flat. This is made possible by depositing a thin layer of silicon nitride on the silicon wafer. This prevents oxidation and enables selective etching with respect to silicon dioxide. The nitride film is then masked and etched to lay bare the regions where thick oxide is to be grown.

THE WRONG DATE

In the November 1969 issue of P.W. on page 474, under the heading "Free Radio and More for Television" the date for the licence rise should read 1st April 1971.

Rally diary notes

APRIL 19: North Midlands Mobile Rally. **MAY 10:** Ealing and District Amateur Radio Society Mobile Rally. **JUNE 21**: University College of Swansea Amateur Radio Club Annual Rally, Singleton Park, Swansea. **JUNE 28**: Longleat Safari Mobile Rally, Longleat House, Nr. Warminster. Organised by the City and Council of Bristol RSGB Group. **JULY 5**: South Shields Mobile Rally. **JULY 12**: Worcester and District Amateur Radio Club Rally.

They've got it taped!

"Tape Recorders: A-Z" is a book which covers every audio tape recorder in the VTR, professional, domestic and Hi-Fi fields, currently available on the UK market.

All machines listed carry detailed specs. and most entries carry a photograph. The Domestic and Hi-Fi section contains some 250 entries with prices ranging from £20 to £300.

Two sub-sections are included in the Professional, Scientific & Industrial Audio Tape Recorder section, one part dealing with the upper range in the "studio" class and the other with high-quality machines costing £1,000 or less.

Car tape players are dealt with as are mixers, headphones, tape and accessories.

Tape Recorders: A-Z costs £1 (price includes post and packing) and is obtainable from the publishers: *A.P.A. Publishing (Catalogues) Ltd., 4th. Floor, Quality House, Quality Court, Chancery Lane, London, W.C.2.*

Diode power

Philips Research Laboratories, Eindhoven, Holland announce for their silicon diodes in oscillators of the "Avalanche Transit Time" type, a continuous output of 1·75W at a frequency of 5GHz (6cms wavelength). For a wavelength of 3cms it is 0·5W at 10GHz.

The oscillators are used for supplying the microwave power in links operating in the centimetre wave range.

FET's AND THEIR USES

T. SNOWBALL

PART 1

FIELD EFFECT TRANSISTORS, or f.e.t.'s for short, are becoming cheaply obtainable in very great variety but unfortunately their characteristics have even wider spreads than usual. In the cheaper varieties of f.e.t. the drain current for zero bias voltage can have a spread of up to 15:1, and the bias voltage for cut-off can have a similar spread. Usually the more costly f.e.t.'s of up to £4 each are no better performers than their cheaper brothers, the cost usually just providing a smaller spread of parameters, and metal instead of plastic encapsulation. A simple checker will quickly give you your particular f.e.t. characteristics and enable you to get the maximum performance from the cheap f.e.t.'s now available. It is possible, of course, to allow for spreads of characteristics when designing but of necessity you will only get the performance of the worst unit.

Only two measurements are required on the normal f.e.t. to give the characteristic shown in Fig. 1. Here the drain current (I_D) is plotted against the gate, source or bias voltage (V_{GS}). The two points of interest on this curve are I_{DSS} (The drain current for zero bias) and V_P (The gate source bias voltage for zero drain current).

Having defined I_{DSS} and V_P any other point on the curve is obtained from the equation:

$$I_D = I_{DSS}\left(1-\frac{V_{GS}}{V_P}\right)^2 \qquad \ldots\ldots\ldots\ldots(1)$$

This is an equation for a parabola with its vertex at V_P. The above form is the one to use to work out the drain current for a given value of bias.

Below is the formula to use when working out the bias for a given drain current:

$$V_{GS} = V_P\left(1-\sqrt{\frac{I_D}{I_{DSS}}}\right) \qquad \ldots\ldots\ldots\ldots(2)$$

The two points of interest, I_{DSS} and V_P, are easy to measure in a simple test circuit as in Fig. 2. The checker which forms the subject of this article has the same basic circuit but includes switching for N channel (+ve drain volts) and P channel (−ve drain volts) types. It will also check the newer types such as *insulated gate field effect transistors* (i.g.f.e.t.) or *metal oxide silicon transistors* (m.o.s.t.) as they are sometimes called, *dual gate* f.e.t. and f.e.t.'s with substrate connections. The i.g.f.e.t.'s sometimes need bias voltages with the same sign as the drain supply, and these types are called *enhancement* types as opposed to the more normal ones which are usually junction f.e.t.'s (j.f.e.t.) called *depletion* types.

Sometimes I_{DSS} and V_P are not given in the manufacturer's data, but only I_{DSS} and g_{mo}, where g_m is the transconductance in μmhos, or mutual conductance in mA/V (i.e., the change in I_D for a given change in V_{GS}, the slope of the characteristic at the point of use). Remembering back to school days this is obtained by differentiating equation (1) with respect to V_{GS}:

$$\frac{\Delta I_D}{\Delta V_{GS}} = g_m = \frac{2}{V_P} \times I_{DSS}\left(1-\frac{V_{GS}}{V_P}\right) \qquad \ldots(3)$$

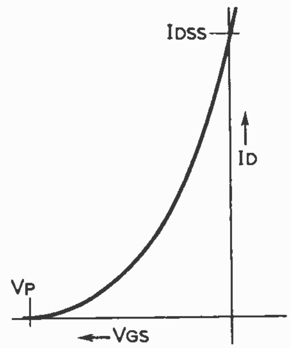


Fig. 1: Drain current versus Gate Source volts.

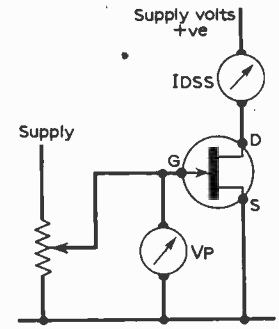


Fig. 2: Test circuit for V_P and I_{DSS}

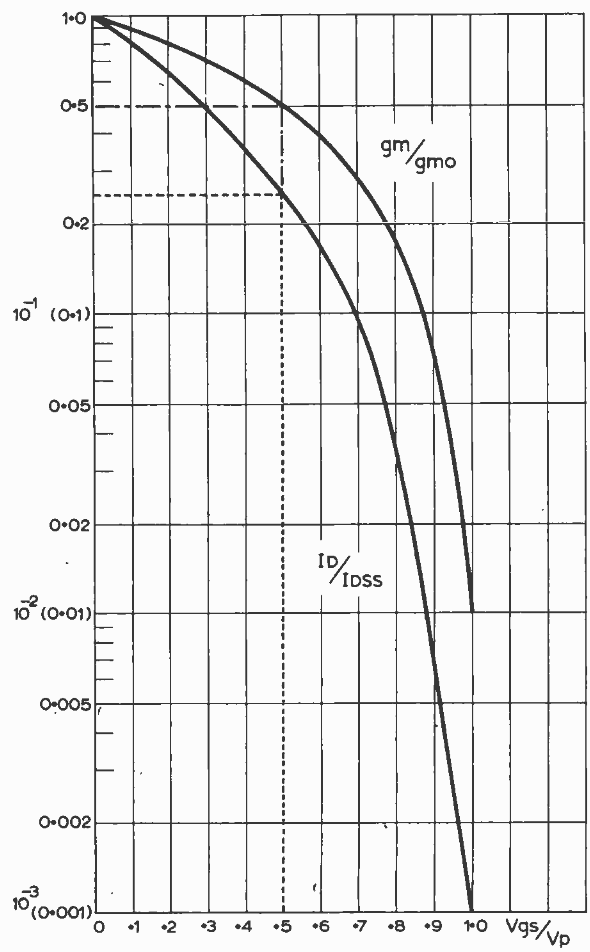


Fig. 3: Normalised curves for I_D and g_M versus V_{GS}.

however, if V_{GS} is made zero, then the g_m at zero bias:

$$g_{mo} = \frac{2I_{DSS}}{V_P} \qquad \ldots\ldots\ldots\ldots\ldots(4)$$

So a simple relationship exists between g_{mo} and V_P

which means that conversion from one type of specification to the other is simple. If we wish to, we can work in g_m easily by using equation (4) to get g_{mo} from the checker measurements of I_{DSS} and V_P.

The mutual conductance at any other value of I_D is given by:

$$g_m = g_{mo}\sqrt{\frac{I_D}{I_{DSS}}} \quad \ldots\ldots\ldots\ldots(5)$$

or at any other value of V_{GS} from (3),

$$g_m = g_{mo}\left(1 - \frac{V_{GS}}{V_P}\right) \ldots\ldots\ldots\ldots(6)$$

A simple graph which will do all the sums in equations (1), (2), (5) and (6) is shown in Fig. 3. This graph is normalised to value one, so as an example, if our measured f.e.t. had an I_{DSS} of 5mA and V_P of 5V we must multiply our answers by 5 when read from Fig. 3. Shown dotted is the point where I_D is $I_{DSS}/4 = 1{\cdot}25$mA, shown as 0·25 on the graph, so going across horizontally to the I_D/I_{DSS} curve and then reading the intercept vertically below on the V_P scale we get the working point to be $0{\cdot}5V_P$ or 2·5V bias. Coming back up the vertical line to intercept the g_m/g_{mo} curve and reading this off horizontally we get $g_m = 0{\cdot}5g_{mo}$, g_{mo} is 2·0 from equation (4), so g_m = 1mA/V at I_D of 1·25mA and V_{GS} of 2·5V.

Tester Description

The two gate potentiometers apply voltages of ±15V through gate series resistors of 100kΩ in order to limit the gate current to a safe value when the f.e.t's are forward biased. These pots are calibrated in 1V steps with the zero voltage point accurately marked.

In the drain circuit of the f.e.t. is a 1mA meter, which is used unshunted for V_P measurements and shunted to 20mA f.s.d. for I_{DSS} measurement. The diode D5 across the meter is a high conductance germanium type, which although it does not interfere with the scale calibration, will start to conduct if the current through the meter exceeds 1mA.

The other diodes D1—D4 are any silicon or germanium junction diodes, their function being to direct the current through the meter in the correct direction irrespective of whether an N or P channel f.e.t. is being tested.

The 0·001μF capacitors on the four terminals of the f.e.t. are to inhibit oscillation, due to the length of connections, while testing high frequency types.

Operation

In using the tester, I_{DSS} is found by setting the V_{GS} pot. to zero, and a direct reading of I_{DSS} is obtained on the 20mA scale of the meter.

In obtaining V_P, which has been specified as the gate source bias for zero I_D, the procedure is to switch to the 1mA scale and increase the bias until I_D has dropped to nearly zero.

The curve gets very flat near V_P and it is difficult to estimate exactly zero I_D so two ways are open. One is to measure V_P at 1 per cent of I_{DSS}, or the one chosen in this tester, is to measure V_P at a fixed low value of I_D, 0·1 mA is used here and is marked as V_P on the meter scale.

Having obtained I_{DSS} and V_P the formulae (1), (2), (5) and (6) or graph Fig. 3 will give all the information required to enable the use of the f.e.t. in any circuit.

Applications

Having tested and measured various f.e.t.'s here are a few ideas on how to use them.

The usual configurations are grounded source, which corresponds to the grounded emitter transistor case and the source follower which is similar to the emitter follower.

The equations for stage gain in the grounded source case are given for two conditions, with and without source feedback Figs. 5a and 5b.

In Fig. 5a the gain $A = g_m R_L \ldots\ldots\ldots\ldots\ldots\ldots(7)$

In Fig. 5b the gain $A = \dfrac{g_m R_L}{1 + g_m R_S} \ldots\ldots\ldots\ldots(8)$

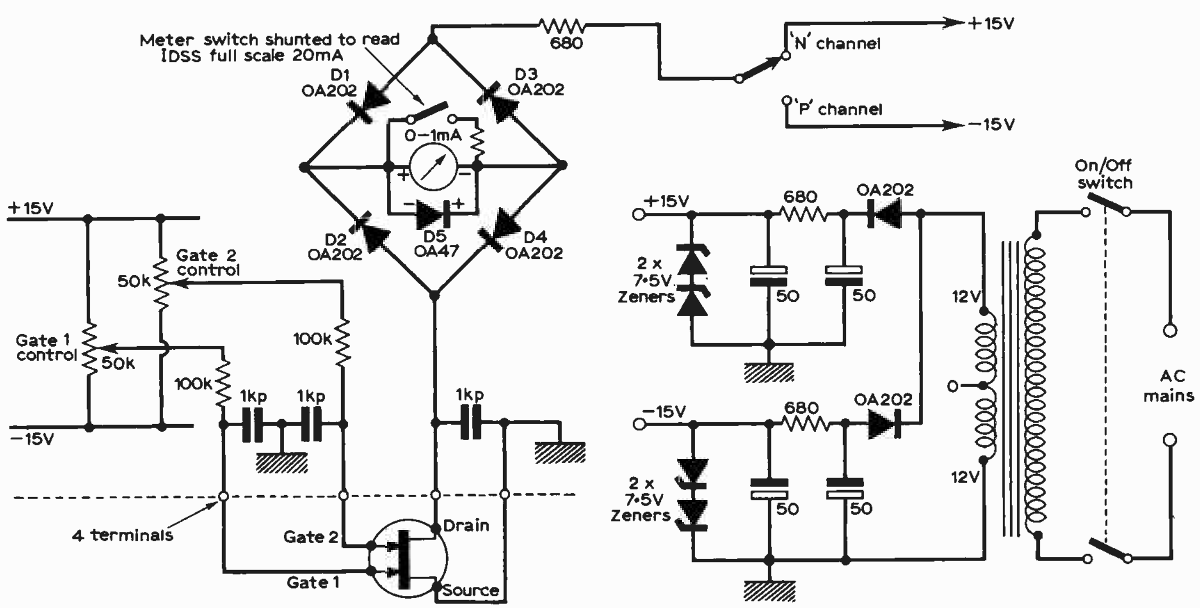
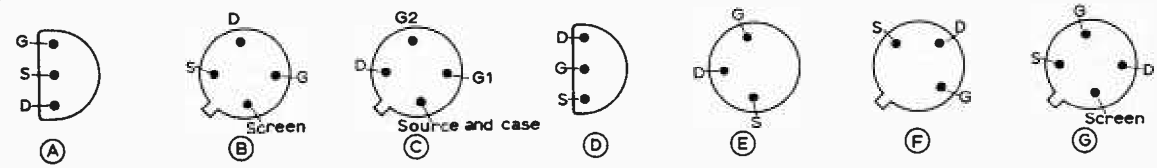


Fig. 4: Circuit of the f.e.t. tester.

F.E.T. DATA TABLE

Type No.	Manufacturer	N Channel or P Channel	Vp at Id Min.	Vp at Id Typical	Vp at Id Max.	Idss (mA) Min.	Idss (mA) Typ.	Idss (mA) Max.	Gmo mA/V Min.	Gmo mA/V Typ.	Gmo mA/V Max.	Vds (max.)	Cin (pF) Min.	Cin (pF) Typ.	Cin (pF) Max.	C Feedback (pF) Min.	C Feedback (pF) Typ.	C Feedback (pF) Max.	Base
MPF103	MOTOROLA	N	100µA	2.5mA	—	1	3	5	1	3	5	25V	—	4.5	7	—	1.5	3	A
MPF104	(plastic)	N	200µA	3.5mA	—	2	6	9	1.5	4	5.5	25V	—	4.5	7	—	1.5	3	A
MPF105		N	400µA	4.5mA	—	4	9	16	2	4.5	6	25V	—	4.5	7	—	1.5	3	A
UC734	UNION CARBIDE (plastic)	N	400µA	1mA	7.5mA	4	—	20	3.5	—	6.5	30V	—	—	4	—	—	0.8	B
3N140	R.C.A.	N	200µA	—	24mA	5	—	30	6	8	18	20V	2	4.5	6	0.01	0.02	0.03	C
3N141	(TO18, metal)	N	200µA	—	24mA	5	—	30	6	8	18	20V	2	4.5	6	0.01	0.02	0.03	C
2N3819	TEXAS	N	200µA	0.5mA	7.5mA	2	—	20	2	—	6.5		—	—	8	—	—	4	
2N3820	(plastic)	P	30µA	0.3mA	7.9mA	0.3	—	15	0.8	—	5	20V	—	—	32	—	—	16	D
TIS34	TEXAS (plastic) (similar to 2N3823)	N	400µA	1mA	7.5mA	4	—	20	3.5	—	65	30V	—	—	6	—	—	2	D
2N4302	AMELCO	N	10µA	—	4mA	0.5	—	5.0	1	—	—	30V	—	—	6				E
2N4303	(plastic)	N	10µA	—	6mA	4.0	—	10	2	—	—	30V	—	—	6	—	—	3	E
2N4304		N	10µA	—	10mA	0.5	—	15	1	—	—	30V	—	—	6				E
MPF151	MOTOROLA	P	—	—	—	1	—	5	1	—	4	40V	—	—	2	—	—	—	E
MPF152	(plastic)	P	—	—	—	2	—	9	1.5	—	5	40V	—	—	2	—	—	2	E
MPF153		P	—	—	—	4	—	16	2	—	6	40V	—	—	2	—	—	—	E
NKT0211		N	1µA	0.5mA	—	0.05	—	0.15	0.2	—	0.7	10V	—	23	—	—	—	—	F
NKT0212	NEWMARKET	N	1µA	0.7mA	—	0.1	—	0.3	0.4	—	1.1	10V	—	23	—	—	—	—	F
NKT0213	(Audio frequency)	N	1µA	1mA	—	0.2	—	0.6	0.6	—	1.5	10V	—	23	—	—	—	—	F
NKT0214	(TO18, metal)	N	1µA	1.5mA	—	0.5	—	1.5	0.9	—	2.2	10V	—	23	—	—	—	—	F
NKT0215		N	1µA	2.5mA	—	1.0	—	3.0	1.3	—	3.0	10V	—	23	—	—	—	—	F
NKT0216		N	1µA	3.5mA	—	2.0	—	6.0	1.8	—	4.2	10V	—	23	—	—	—	—	F
NKT0111	NEWMARKET	N	0.1µA	0.5mA	6mA	0.3	—	6.5	0.7	—	3.5	20V	—	—	3.5	—	—	—	G
NKT0112	(Radio frequency) (TO17, metal)	N	0.1µA	0.65mA	4.5mA	0.45	—	5.0	0.8	—	3.2	20V	—	—	3.5	—	—	—	G



Base connections reference—see data table.

To take a practical case, if we had measured an f.e.t. with $I_{DSS} = 2\text{mA}$ and $V_P = 3\text{V}$ and wanted to run it from a 9V supply line at 0.5mA, from equation (2) the bias needed is:

$$3\left(1 - \sqrt{\frac{0{\cdot}5}{2}}\right) = 1{\cdot}5\text{V}$$

So the source resistor is $IR = 3\text{k}\Omega$

If the drain resistor drops 4V its value is $8\text{k}\Omega$. The gain from (7) will be $A = g_m \times 8$.

The value of g_m can be got from (5) or (6) if we know g_{mo} which we get from (4).

$$g_{mo} = \frac{2 \times 2}{3} = 1{\cdot}3\text{mA/V}$$

$\therefore$ at $I_D = 0{\cdot}5\text{mA}$ from (5)

$$g_m = 1{\cdot}3\sqrt{\frac{0{\cdot}5}{2}} = 0{\cdot}65\text{mA/V}$$

So gain is $8 \times 0{\cdot}65 = 5{\cdot}2$ Fig. 5a. But for Fig. 5b:

$$A = \frac{0{\cdot}65 \times 8}{1 + (0{\cdot}65 \times 3)} = \frac{5{\cdot}2}{2{\cdot}95} = 1{\cdot}75$$

The other characteristics of this configuration are that the input impedance can be very high (equal to the input resistor in fact, which for all normal circuits can be made about $2\text{M}\Omega$) and the output impedance is equal to the drain load.

If the source follower is used as in Fig. 6, the gain is

$$\frac{g_m R_S}{1 + g_m R_S} \quad \ldots\ldots\ldots\ldots\ldots\ldots(9)$$

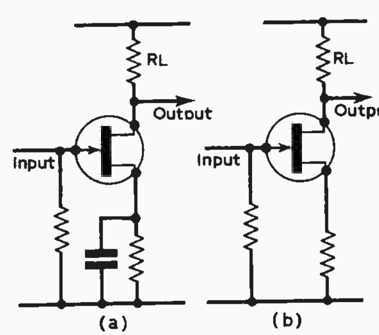


Fig. 5 (a) Grounded source amplifier, (b) with source feedback.

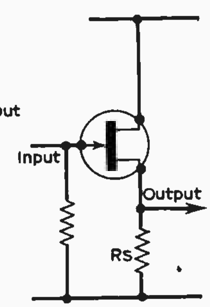


Fig. 6: Source follower.

$$\text{Output impedance} = \frac{R_S}{1 + g_m R_S} \quad \ldots\ldots\ldots\ldots\ldots(10)$$

which for the f.e.t. considered above at 0·5mA. I_D becomes, from (9).

$$\text{Gain} = \frac{0{\cdot}65 \times 3}{1 + (0{\cdot}65 \times 3)} = \frac{1{\cdot}95}{2{\cdot}95} = 0{\cdot}66$$

This is thus similar to an emitter follower except perhaps lower gain (higher g_m f.e.t.'s improve this), the chief characteristic of this configuration is of course lower input capacitance and lower output impedance to help matching to other circuits.

From (10) the output impedance: =

$$\frac{3\text{k}\,\Omega}{1 + (0{\cdot}65 \times 3)} = 1\text{k}\Omega$$

TO BE CONTINUED

A PANORAMIC RECEIVER for 160 to 80 METRES

BY D. BOLLEN PART 3

In this final part the alignment of the receiver is described and examples of displays are shown.

ALIGNMENT

For best results circuit alignment should be carried out with a signal generator. Start by ensuring that the medium wave receiver or i.f. strip is working, and is tuned to a frequency of 1·6MHz. Connect a pair of high impedance headphones, or an audio amplifier and loudspeaker to the detector diode output via S1d (see Fig. 9a). The i.f. transformer cores on the i.f. strip or in the medium wave receiver need not be accurately aligned until later. Temporarily disconnect the three wire links between the diode tuner panel and VC1-VC3, and put S1 in the "listen" position. Connect the converter output lead to the i.f. strip or receiver.

Couple a signal generator to the converter aerial terminal in series with a 470Ω carbon resistor, and inject a modulated signal at 1·67MHz. Fully mesh the vanes of the tuning capacitor VC1-VC3, then adjust the core of T3 to receive the signal. If more than one response is obtained while trimming T3 core, reduce the signal generator output and select the loudest response core position. Next, set the signal generator to 5MHz, and fully open the tuning capacitor vanes. Adjust trimmer TC3 to receive the signal. Now connect a 2·5V d.c. meter in place of the headphones or audio amplifier and repeat the above procedures using an unmodulated signal, this time peaking the meter reading by adjustment of T3 and TC3.

Set the signal generator to 1·83MHz unmodulated and tune in the signal with the tuning capacitor; vanes set approximately 20° from fully meshed. Adjust T1 and T2 cores for maximum output as indicated by the voltmeter. If necessary, reduce signal generator output if the a.g.c. voltage shown by the meter is near maximum. Set the signal generator to 4·5MHz and tune in the signal with the tuning capacitor; vanes set approximately 15° from fully unmeshed. Adjust trimmers TC1 and TC2 for maximum output. If desired, an aerial can now be connected to the converter to check for reception of signals at headphone strength.

THE DIODE TUNER PANEL

The diode tuner panel is deliberately excluded from the early alignment procedures to avoid confusion and to simplify fault tracing. When the converter is working satisfactorily as an ordinary receiver, in conjunction with its i.f. strip, connect up the diode tuner panel to VC1-VC3, and proceed as follows. After making sure that the tuner diode d.c. bias is operational, set the signal generator to 4·5MHz unmodulated, fully unmesh the tuning capacitor, and peak the output meter reading by adjustment of TC3. Now set the signal generator to 4MHz, tune in the signal with the tuning capacitor, and trim TC1 and TC2 for maximum output. The front end of the panoramic receiver will now be correctly aligned, and all that remains is to obtain a satisfactory response from the following i.f. stages.

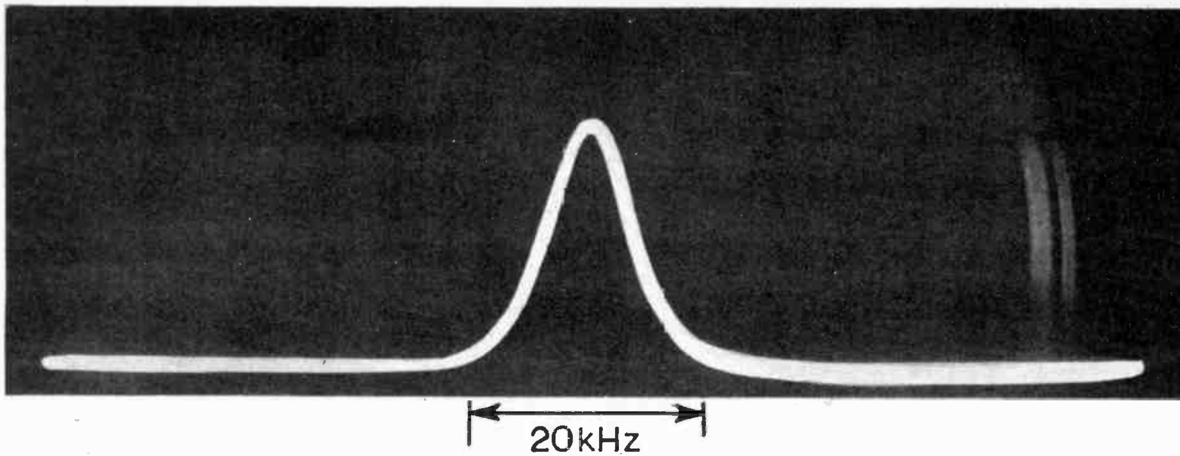
Couple the panoramic receiver to an oscilloscope, according to Fig. 9a. Set the signal generator to 3·5MHz unmodulated, put S1 in the "sweep" position, VR3 at minimum magnification, and VR4 at maximum resistance, and adjust the tuning capacitor until a narrow response curve is seen at the centre of the display. Adjust VR3 until the curve is similar in width to that shown in Fig. 10a. Normally, the sharpest possible response will be required for DX listening, so trim all i.f. transformer cores, including IFT1 on the converter panel, for a steep-sided, symmetrical response curve. Avoid the flat-topped response normally used for broadcast reception.

To complete the setting up of the panoramic receiver, rotate the signal generator dial so that the curve displayed on the oscilloscope screen is moved across the display. With VR3 set for minimum magnification (full sweep bandwidth), look for any falling off in amplitude at the edges of the screen, particularly on the low frequency, left-hand side. Adjust VR4 to give a sweep of approximately ±250kHz at the centre frequency of 3·5MHz, as indicated by the rotation of the signal generator dial. In practice, a perfectly linear response over the full sweep bandwidth is not essential, and some falling off at the edges of the display can be tolerated. If necessary, retrim TC1 and TC2 to correct any tendency for the display to be wedge-shaped in amplitude response, but this correction should not be overdone.

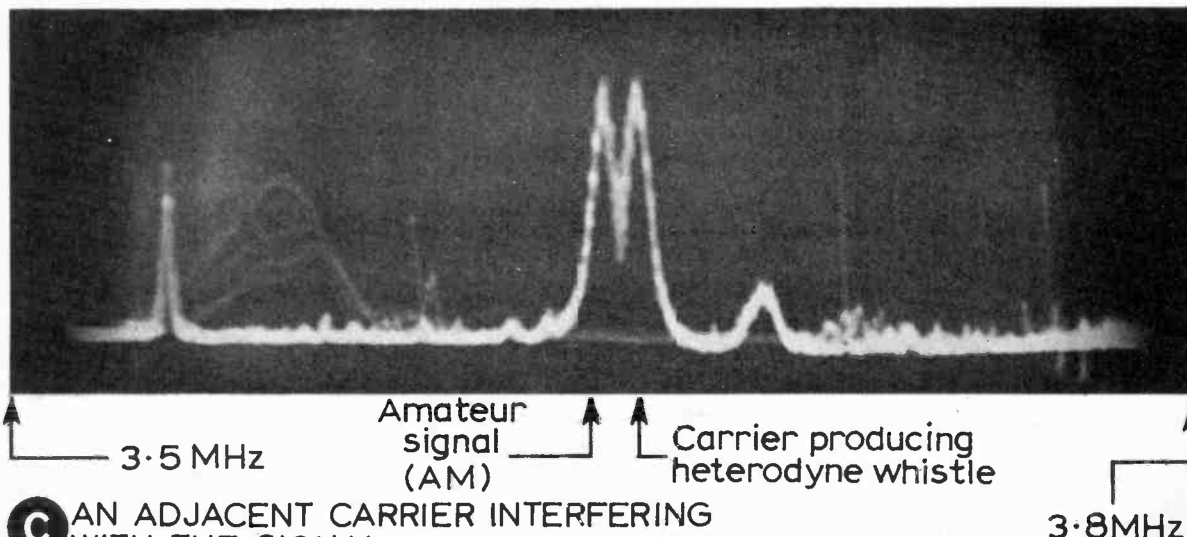
Figure 10 (see overleaf) serves to give some idea of the results obtained with the prototype, but static photographs cannot do real justice to this type of panoramic display, particularly when the timebase speed is slow. Figure 10a shows a plain carrier input signal from a signal generator. A c.w. signal will look like a plain carrier being switched on and off rapidly. In the case of a.m., a modulation ripple is superimposed on the response curve, and when the ripple peaks touch the trace baseline, this corresponds to 100% modulation. Speech clipping and excessive modulation are readily apparent, as is unintentional frequency modulation, which causes the response curve to shift sideways. As might be expected, an s.s.b. signal lacks a response curve during breaks in modulation, and manifests itself merely as a rising and falling modulation ripple.

Figure 10b depicts the 80 metre band on a quiet morning in the middle of the week. An amateur a.m. signal occupies the centre of the display, with another station on the left, and a frequency marker curve from a signal generator on the right. In Fig.

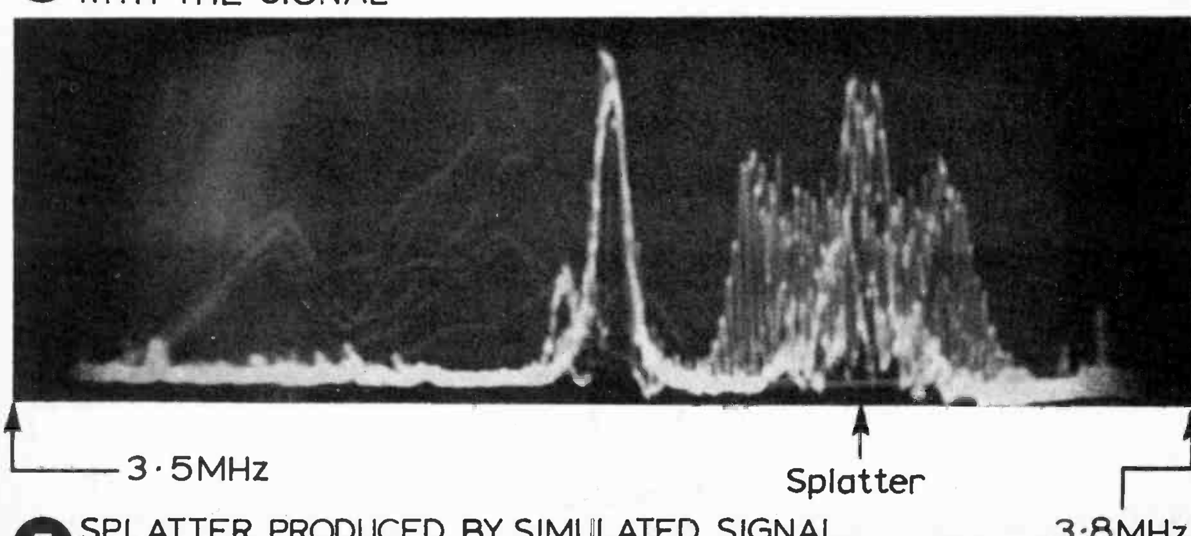
—continued on page 872



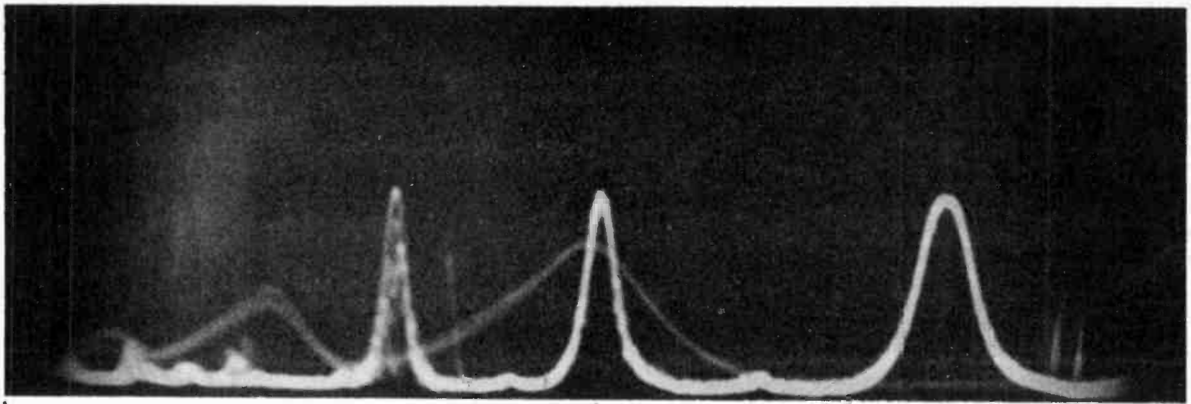
A SIGNAL GENERATOR INPUT PRODUCING RECEIVER RESPONSE CURVE



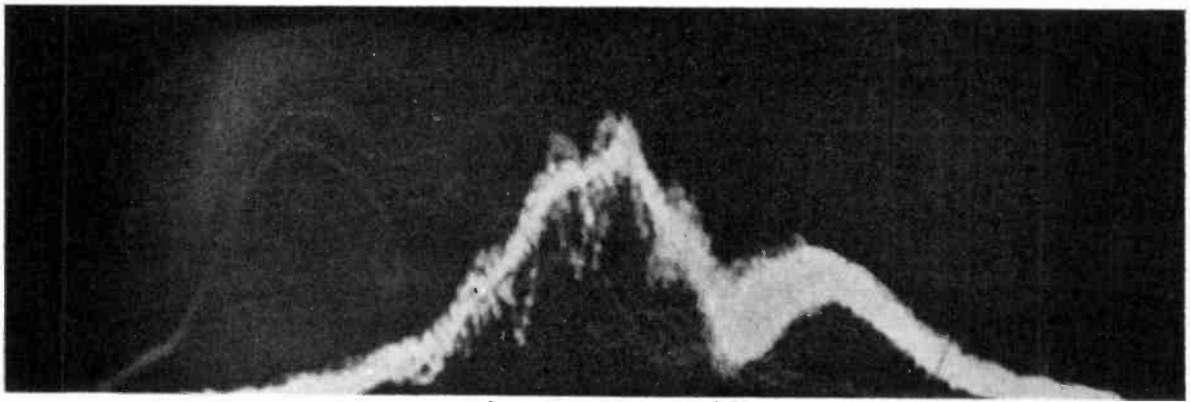
C AN ADJACENT CARRIER INTERFERING WITH THE SIGNAL



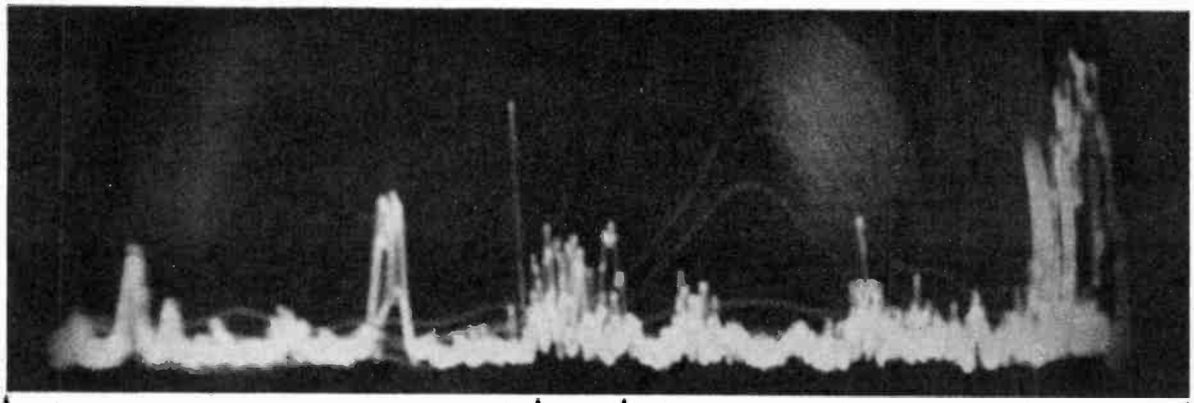
E SPLATTER PRODUCED BY SIMULATED SIGNAL FROM AN OVERMODULATED SIGNAL GENERATOR



B QUIET CONDITIONS ON A PORTION OF THE 80M BAND



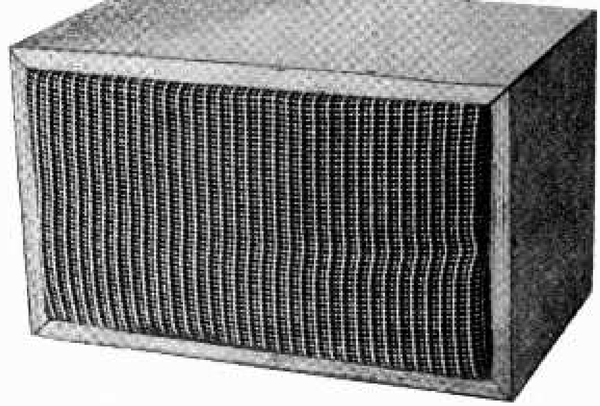
D THE 'C' DISPLAY MAGNIFIED



F NOISIER CONDITIONS LATER IN THE DAY

BOOKSHELF speaker

C. R. BRADLEY



THE 'bookshelf' size loudspeaker enclosure is the choice of many high fidelity listeners despite its unsuitability for sound reproduction. The function of a speaker enclosure is to contain the sound disturbance emitted from the back of the speaker cone and prevent it interfering destructively with the useful forward sound. The oft-quoted 'ideal' speaker mounting is in a hole in a wall between two large rooms. Here the sound pressures can escape from both sides of the speaker without mutual interference, but this arrangement is rarely practical and factors such as wall thickness have degrading effects.

The wavelength of the lowest audio frequencies required in a good quality system may be as long as 30ft. (frequencies down to around 30Hz). Practical speaker enclosures are considerably smaller than this and therefore sound congestion arises behind the speaker unit at low frequencies. The inescapable result is that the useful sound output at low frequencies is reduced. One trick is to provide a small port in the enclosure through which rear emitted sound can escape. It will of course interfere with the forward sound emission but if the round trip it has taken from the rear of the speaker is at least a quarter of the sound wavelength, serious cancellation will not occur. Thus congestion in the enclosure is reduced and bass interference is not serious down to a frequency determined by the enclosure dimensions; this is the bass reflex cabinet. Such a cabinet needs to be fairly large but gives excellent results. There are many standard designs for these which are generally available from the speaker manufacturers.

The infinite baffle enclosure is a perfectly sealed box. The speaker works against the volume of air sealed behind it, alternately compressing and rarifying it. The efficiency of the speaker is reduced but there is no interference between forward and rearward emission. The cabinet must be strong enough to contain high internal sound pressures without resonating. A large infinite baffle has been described by the author in "Practical Wireless" Oct. 1967 (Economical Speaker Enclosure).

The speaker manufacturers put much research into getting good sound from small enclosures. The usual result is to use an infinite baffle enclosure and concentrate on designing the most efficient bass speaker possible. The springiness of the trapped air raises the resonant frequency of the speaker so this must be low to start with. The bass speakers used in commercial bookshelf enclosures have very low resonant frequencies for their small size. They also have large, powerful magnets and permit large cone excursions for better efficiency. These speakers are not often available as separate units.

The loudspeaker enclosure to be described is a two way unit i.e.: it contains a 'woofer' speaker for low and midrange frequencies and a tweeter for high frequencies. The speaker units specified are fairly new and have been found to give together excellent coverage of the audio range. The enclosure is truly 'bookshelf' size as the frontal area is the same as a foolscap sheet (13in. x 8in.) and depth is 8¼in. overall. A series L-C crossover network is used and is shown in Fig. 1. Frequencies above 3kHz appear across L and are fed to the tweeter. Frequencies

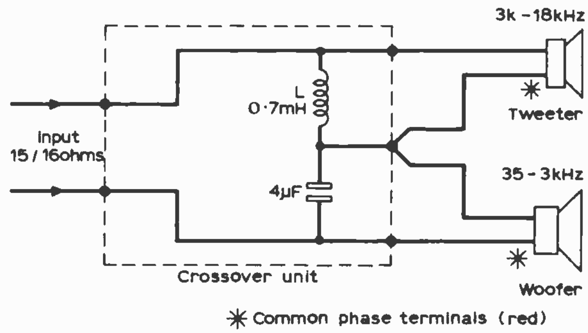


Fig. 1: The circuit of the cross-over network. The capacitor is a non-polarized electrolytic type.

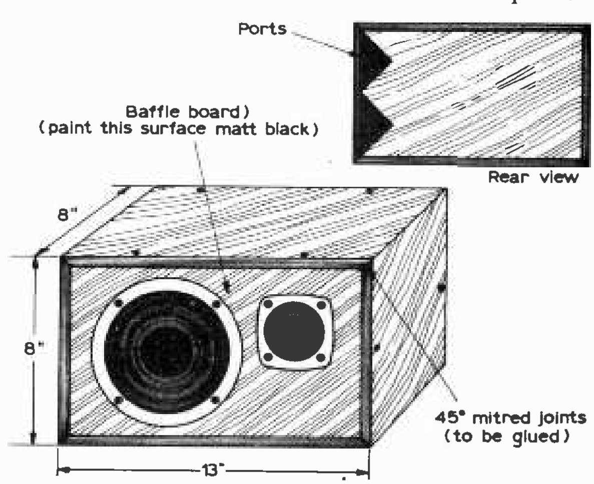


Fig. 2: The assembled enclosure.

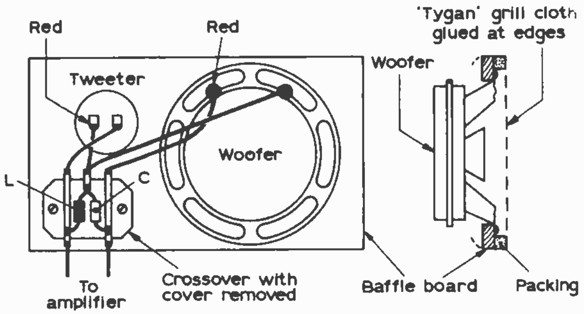


Fig. 3: Mounting and wiring of the speakers on the baffle board.

below 3kHz appear across C and are fed to the woofer. The crossover network can be made up; a non-polarized electrolytic capacitor must be used for C. Messrs. Wharfedale can supply the two components through a dealer. It is easiest to use the ready made crossover unit specified in the parts list. This, like the speaker units, is part of the Eagle product range and can be supplied by any electrical dealer.

The woofer is a 6$\frac{1}{2}$in. 11,000 gauss flux density unit that is capable of full range reproduction alone. However its response curve is very jagged above 3kHz where cone resonances and harsh reproduction occur. We therefore use only the smooth response from 35Hz to 3kHz, the excellent lower limit can be achieved with the help of some bass boost at the amplifier.

The tweeter is a 3in. horn cone type and provides a satisfactory response up to 16kHz and is only 5dB down at 20kHz. The quoted ratings of both woofer and tweeter units is 10W and response curves are supplied with both units. When the units are mounted in a well lagged enclosure this rating seems quite realistic and this input will give much more volume than will normally be required, thus there is good power capacity to handle strong transients such as percussive sounds. Any good valve or transistor amplifier that will provide at least 5W into 15Ω will suffice.

The unusual feature of the loudspeaker enclosure is the rear porting. The cabinet interior is heavily damped and the amount of wadding can be adjusted to vary the effect of the ports. If the ports are blocked by a layer or two of wadding material, the enclosure approximates to an infinite baffle. Alternatively, it is often possible to take advantage of the surroundings by using them to absorb the rear radiation from the ports. By using less wadding and allowing sound to escape from the rear, the effective volume of the enclosure is increased and bass response is improved.

Construction

The cabinet is built from six pieces of $\frac{5}{8}$in. plywood and can be stained, painted, varnished or covered as desired. The joints between the top, bottom and sides are mitred at 45° for good appearance and rigidity. The mitred edges must be cut carefully for a neat fit. Two circular cutouts are required in the baffle board. The two speaker units are screwed to the front of the baffle board for best sound dispersion and avoidance of tunnel effects. Ensure that there is an airtight seal between the two speaker frames and the baffle board. Do not screw down the woofer unit too tightly, or to a warped baffle board, as the pressed steel frame will

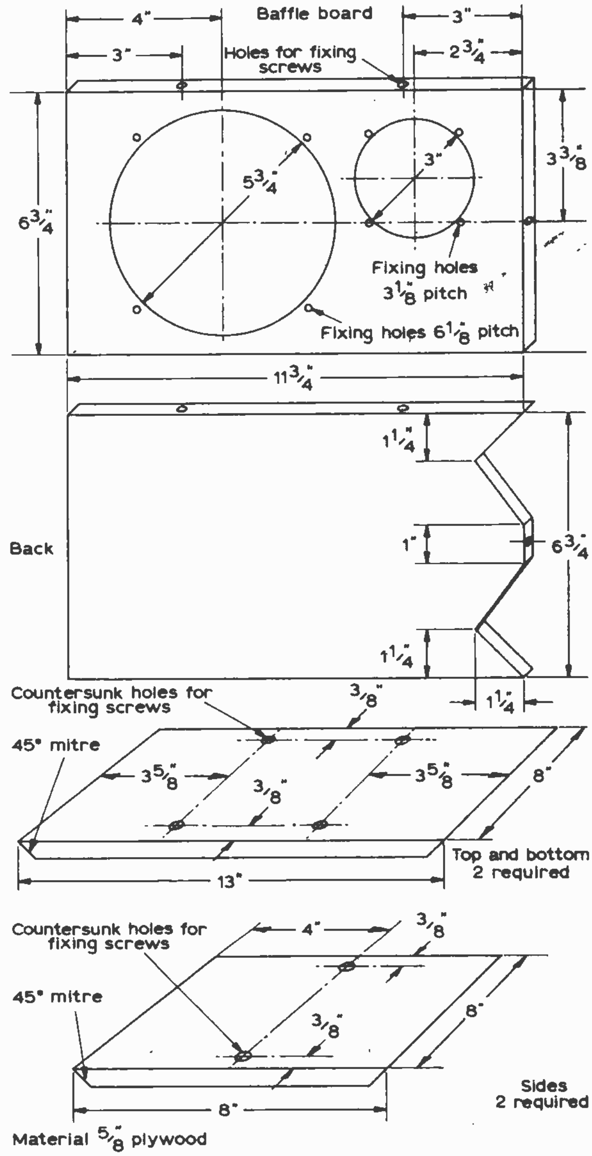
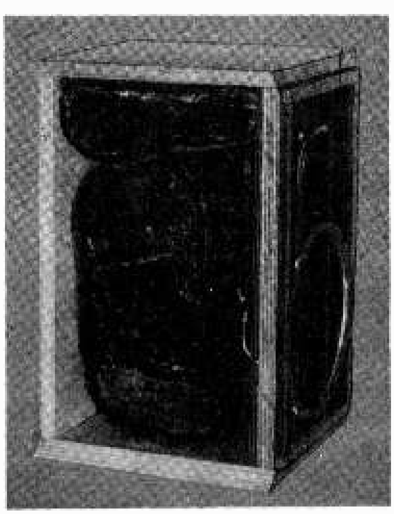


Fig. 4: The cutting details and dimensions.



The wadding is adjusted before the top is fixed in place.

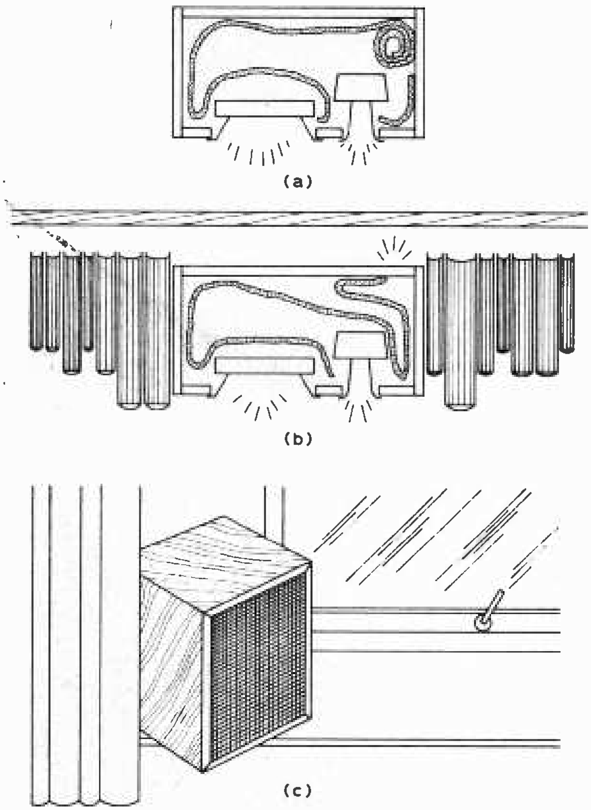
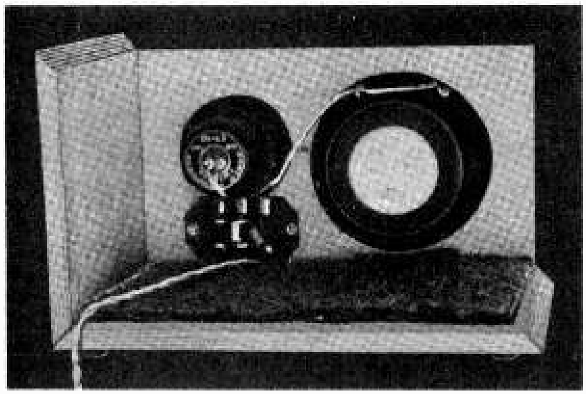


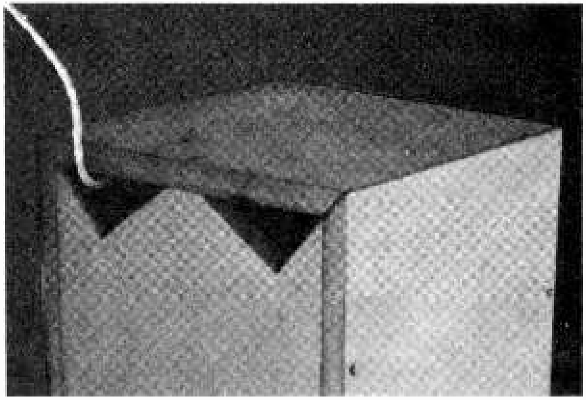
Fig. 5: Alternative wadding arrangements and possible ways of taking advantage of surroundings. a) Infinite baffle. Wadding blocks rear ports and prevents rear radiation. b) Literal bookshelf mounting using space behind books to absorb rear radiation. c) Use of heavy curtains to absorb rear radiation.



The partially assembled enclosure.

be distorted and the precise cone centering ruined. The front edges of the baffle board must be built up by about ¼in. so that the grill cloth will stretch flat across the speakers. Any convenient material such as scrap wood, polystyrene, foam rubber or card-board can be glued in strips around the edges of the baffle board to provide this packing.

The crossover unit just fits on the back of the baffle board if the solder tags are bent upward. The unit's metal case serves no purpose and wastes valuable cubic inches; it should be removed by extracting the two fixing rivets. The fibre base carrying the



The rear radiation ports.

★ components list

Mechanical
⅜in. plywood as shown.
12 1in. fixing screws.
10 ⅜in. speaker and cross-over mounting screws.
Carpet felt, ½in. thick—1 square yard. See text.
Rubber feet
Glue.
'Tygan' grille cloth, 15in. x 10in.
Electrical
Eagle FR65 6½in. loudspeaker.
Eagle CT10 tweeter.
Eagle CN216 16Ω cross-over.
Connecting wire.
Terminals, if required.

components is then screwed to the baffle board. The speakers are wired to the crossover as shown in Figs. 1 and 3.

The author used ½in. wool waste carpet felt material obtained from a carpet dealer for wadding. This material is preferable to fibreglass as there is less chance of particles finding their way into the speakers. Plastic foam is useless for this purpose. A layer of wadding is glued to the inside of the top and bottom pieces. The cabinet is now screwed and glued together and inspected for airtightness. Twin core cable can be brought out through one of the ports for connection to the amplifier or any desired form of sockets or terminals used for connections. Leave the top of the cabinet unglued so that the internal wadding can be adjusted. The arrangement of this is mainly experimental. Start with the rear ports completely blocked by two layers of wadding (infinite baffle). Then see if bass response can be improved by readjusting and taking advantage of the surroundings as suggested. Do not stuff too much wadding into the cabinet especially immediately behind the woofer or midrange response will suffer.

Fit rubber feet to the cabinet which can be stood horizontally or vertically. Two of these enclosures fed from a 10+10W stereo amplifier provide the author with excellent stereo listening. The enclosures are used horizontally and are placed 7ft. apart. There is a slight buzz from the woofer on some sounds but it is only audible a few inches away from the cone and does not detract from the reproduction. It apparently originates in the small 'whizzer' high frequency cone. As the woofer is not used for high frequencies, this additional cone could probably be cut away but the author has not cared to risk it. ■

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EBC90	4/-
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EBF80	6/9
EBF83	8/-
EBF89	6/3
EBL21	11/-
EC53	12/6
EC54	6/-
EC70	4/9
EC86	12/6
EC88	12/-
EC92	6/6
ECC31	15/6
ECC32	4/6
ECC33	31/6
ECC34	29/6
ECC40	9/6
ECC81	3/9
ECC82	4/6
ECC83	4/6
ECC84	5/6
ECC85	5/6
ECC86	8/-
ECC88	7/-
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ECH83	8/-
ECH84	7/6
ECL80	6/6
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EL84	4/9
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EM85	11/-
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EY81	7/-
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EY84	7/6
EY86	6/6
EY87	6/6
EY88	7/6
EY91	3/-
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PC97	8/6
PC900	8/3
PCC84	6/3

PCC85	6/6
PCC88	9/9
PCC89	9/6
PCC189	10/6
PCC805	13/9
PCC806	15/6
PCF80	6/6
PCF82	6/3
PCF84	8/-
PCF86	9/-
PCF87	16/-
PCF800	13/-
PCF801	7/-
PCF802	9/-
PCF805	11/6
PCF806	11/6
PCF808	12/6
PCL82	7/-
PCL83	9/-
PCL84	7/6
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PL83	6/6
PL84	6/6
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PY80	6/-
PY81	5/3
PY82	5/-
PY83	5/9
PY88	6/9
PY301	12/6
PY800	7/6
PY801	6/9
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UCH81	6/6
UCL82	7/-
UCL83	10/-
UF41	10/-
UF42	9/-
UF80	6/9
UF85	6/9
UF86	9/-
UF89	6/9
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UL46	12/6
UL84	6/6
UM80	6/6
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UU5	7/-
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UY1N	9/-
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UY41	7/-
UY85	5/9
U10	9/-
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U25	13/-
U26	11/9
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U33	29/6
U35	16/6
U37	34/11
U43	7/6
U45	15/6
U47	13/-
U49	11/9
U50	5/6
U52	5/6
U76	4/9
U78	4/3
U107	18/3
U151	7/6
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U301	11/-
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BCZ11	3/6
BC107	4/-
BC108	3/6
BC113	5/-
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BC116	5/-
BC118	4/6
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BYZ12	5/-
BYZ13	5/-
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CG12E	4/-
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FSY11A	4/6
FSY28A	4/6
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GD5	5/6
GD6	5/6
GD8	4/-
GD9	4/-
GD10	4/-
GD11	4/-
GD12	4/-
GD14	10/-
GD15	8/-
GD16	4/-
GET103	4/-
GET105	18/-
GET113	4/-
GET115	17/-
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GET873	3/-
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GEX36	10/-
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M1	2/10
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OA9	2/6

OA10	8/6
OA47	2/-
OA70	3/-
OA73	3/-
OA79	1/9
OA81	1/9
OA85	1/6
OA86	4/-
OA90	2/6
OA91	1/9
OA200	1/-
OA202	2/-
OA210	9/6
OA211	13/6
OAZ200	12/-
OAZ201	10/6
OAZ202	9/-
OAZ203	9/6
OAZ204	9/-
OAZ205	9/-
OAZ206	9/-
OAZ207	10/6
OAZ210	7/-
OAZ213	7/-
OAZ224	16/6
OC19	25/-
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OC25	5/-
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OC28	5/-
OC29	23/6
OC35	5/-
OC36	7/6
OC38	8/6
OC41	10/-
OC42	12/6
OC43	23/6
OC44	2/-
OC44PM	8/3
OC45	1/9
OC45M	8/-
OC46	3/-
OC65	22/6
OC70	2/3
OC71	2/-
OC72	2/-
OC73	16/-
OC74	2/6
OC75	2/-
OC76	2/6
OC78	3/-
OC78D	3/-
OC79	8/-
OC81	2/-
OC81D	2/-
OC81M	5/-
OC82	2/3
OC82D	2/3
OC83	2/-
OC84	3/-
OC123	4/6
OC139	12/-
OC140	19/-
OC169	3/6
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practically wireless commentary by HENRY

No. 66

Tidying Up

IT is not even Spring and already I am being threatened. Vague references to 'How much nicer that room would be for Jane.' Now that she is at college, she wants more space for her books. Colour schemes are being compared, furnishing books pored over, the 'homey' magazines explored. Like a squatting hippy facing the Establishment, Henry is in danger of eviction.

Main weapon in the female armoury is the accusation that my den is untidy.

Women can never understand that a workshop, *per se*, is untidy. That clutter of cables—all made for special hook-ups, and hung where they are instantly to hand. You never know when the F layer may shift and someone like Bouvet Island come through weakly, crying out to be recorded, when the only machine switched on is the Humbox Rattler I am repairing for a neighbour. And this uses an odd plug—so I must have a jumper lead ready. Eavesdropping is half the fun of DX.

Henry has the added crime of storing piles of papers. Magazines going back to Caxton, torn columns from newspapers (well, she is always borrowing my scissors, apparently to trim the dog. No harm in that? You haven't seen our dog!) My reference books are downstairs—in the several bookcases that catch visitors' first glances. I am going to start a campaign for Newnes, Butterworth, Odhams, etc., to bring out special engineers' editions in tattered covers.

You haven't seen our dog.

My heart went out to Frank Young, guesting a CB article for me in the November 1969 issue of *Practical Wireless*.

'. . . then she wanted our sanctum door left open. Then she began hanging out in there. Then she said the place was untidy. Then, Lord help us, she cleaned it up.'

Note those doom-laden words, she cleaned it up. Henry cannot count the hours he has spent searching for the crimp-ended angle cutters, or an unrepeatable service manual that Her Ladyship has 'put safe.' I found my latest Heathkit catalogue among a pile of colour supplements. Filed there it seems, because it, too, has a pretty cover.

It has some pretty things inside it, also. Have you seen the latest line in test gear? Henry is aching to build himself an oscilloscope. His baby Cossor and old OS-3 are no longer adequate for the tests he has to make, Mr. Michaelis' projects seem much too complicated for the time available, off-the-peg models are beyond my means.

It will do most jobs, except perhaps some of the colour-TV or VTR tests that crop up. In conjunction with the S-3U dual-trace switch and the new IG-18 Sine-Square wave generator, which can supply both waveforms *simultaneously*, it would form the basis of a newly-planned workshop. Henry might be tempted to listen to the subversive hints about uprooting.

But have you seen the latest range? Gone the functional look. We are in the space-age now. If I completed those projects, they would end up in the kitchen with

"That's how I left it!"

the Mark VII All-Automatic Stove that FPY described. I wonder if Mr. Perriam would let me order a Heathkit instrument minus its case?

That little subterfuge of an unboxed chassis is the only means whereby Henry has retained the use of his Armstrong tuner-amplifier, which performs far better than any of the several radios around the house. All those glowing valves, that surrealistic dial cord, those trailing wires—a deterrent to the tidier-upper.

I am reminded of Colin Reid, whose column in the Oct. 6 *Daily Mail* sparked off a pulse of sympathy. He began with a lovely tale of an actress whose flat was burgled and who led the investigating copper around. He opened the bedroom door and said: 'Whew! They've made a right mess in here, Miss.'

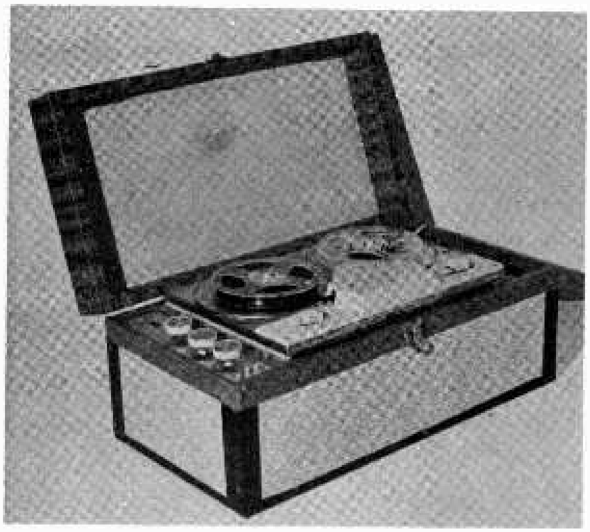
She was wounded. She looked at the drawers pulled open, clothes scattered across the bed, the dressing table a shambles, tights flung across the room, scripts strewn over the floor, and explained:

'No, that's how I left it!'

Colin sympathised, with a quick mental vision of his own den 'where the desk is littered, drawers tilt permanently open and papers, letters and bills are filed on the floor and window ledges for easy reference!'

AN EXTRA HEAD for the BSR TD2

A. OLIVER



The TD2 Tape deck used in a home constructed tape recorder.

A LARGE number of less expensive tape recorders use the TD2 tape deck, extra interest and use can be made by fitting a third head.

To do this, first remove the two push-on operating knobs, then the top-deck cover. (This is fixed by three screws.) The next operation must be done in the order given if the head alignment is to be maintained. Remove the outer fixing screw from the record-replay head base, in its place screw a one-inch length of 6BA brass stud, run a 6BA brass nut down to refix the base. Remove the inner fixing screw on the same head and countersink the hole to take a 6BA screw. The drilling requires only light pressure, the base being made of alloy. Refix the base with a brass countersunk-head screw.

Before altering the erase head, try the tape recorder with a pre-recorded tape to make sure the head alignment is still in order. An easy way to check this is to see that the tape is passing in the same wear groove on the head. A slight adjustment on the screw at one side and the nut at the other side will easily correct any error that is apparent. When satisfied that the playback is correct alter the fixing screws in the erase head base, the 6BA stud on the outside and the countersunk screw on the inside. Test the recorder again to ensure the erase head is in order.

The head to be fitted is the BSR type MN1 55-2R5 which is a half track head, standard fitting to the TD2 deck. When obtained the head is mounted into a base, it is removed from this and fitted with the same screws to a brass strip measuring $2\frac{3}{8}$in. $\times$ $\frac{1}{2}$in. $\times$ $\frac{1}{16}$in. as shown in Fig. 1. This is now fitted as shown. In the authors case it was found that two washers about 0·008in. thick were needed to pack the head to give the correct alignment.

All that remains now is the wiring. This must be done quickly with a hot iron, not dwelling too long on the head terminals. Connect a piece of wire between the terminals shown, remove the wires from the original head and solder to the same terminals on the new head. Now connect a piece of twin screened cable on the original head and bring this out to a suitable socket on the tape-deck panel.

A pressure pad was made by glueing a piece of soft felt to a strip of springy-brass, this in turn being glued or soldered to the existing pressure pad strip on the tape-deck as shown in Fig. 1.

The extra head can be used for monitoring whilst recording, repetitive echo can be given to recordings by feeding the outputs from the new head into the mike input of the tape recorder whilst recording an echo effect can be given to pre-recorded tapes by feeding the output of the new head into a suitable amplifier, these effects can be varied by moving the new head nearer to, or further away from the original head. ■

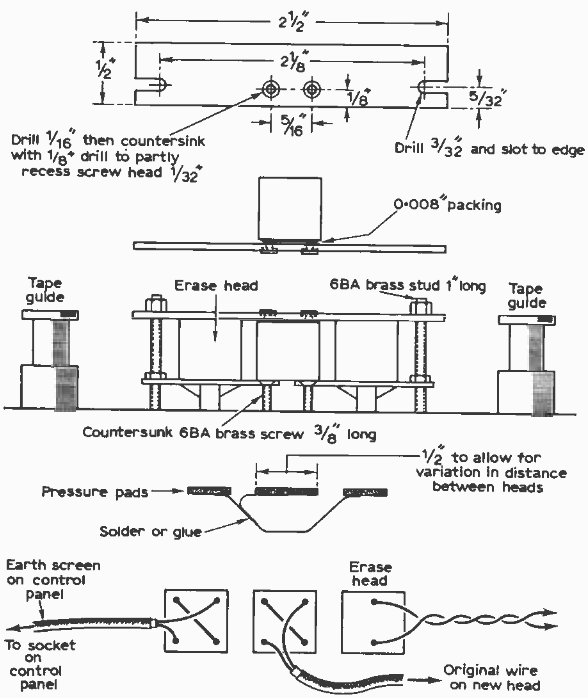


Fig. 1: The constructional details for fitting an extra tape head.

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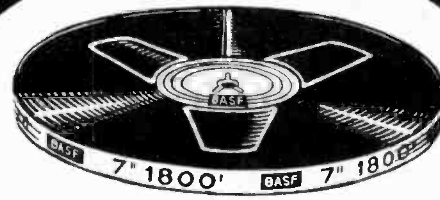

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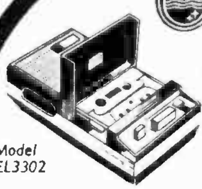

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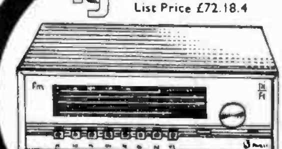

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ON THE SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

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THE BROADCAST BANDS

Christopher Danpure

EDWARD (EDDIE) STARTZ of Radio Nederland's Happy Station programme has been a shortwave personality for nearly twice as long as I have been alive, which makes my task of writing an article on the occasion of his retirement a very difficult one.

I will always remember the first time I heard a shortwave broadcast; that fateful Sunday morning when, more by accident than design, I tuned our old domestic receiver to 6020 and heard Eddie's voice. I say fateful because that Sunday morning made me a shortwave listener for life!

I am sure that every reader of this column has heard Eddie at some time in the past and on your behalf I send him the very best wishes for his retirement with thanks for the years of enjoyment and entertainment that he has given us. Let me conclude by saying that I hope his successor, Tom Meyer, will find as big a place in the hearts of shortwave listeners as Eddie did.

The address of the World DX Club which I gave in the December 1969 issue was incorrect and I apologise to Alan Thompson, former-President of WDXC, for any inconvenience this may have caused. The correct address is: 11 Wesley Grove, Portsmouth, PO3 5ER.

Reader's logs and news

John W. Smith, of Anstruther, Fife owns an Eddystone 840C and a Joystick antenna and a.t.u. which enabled him to hear the Broadcasting Service of the *Kingdom of Saudi Arabia* at 1900 on 11855 (SINPO 33443) and enjoy their English music programme.

John also contributed a news item which says that *Radio Havana*, Cuba, is using 17705 for its English language transmissions to Northern Europe from 2110 to 2140.

Bob Loukes, of Richmond, also mentions the Saudi Arabian station adding the information that English is broadcast from 1700 to 2000 and French at 0900-1100 and 2000-2200. He heard the broadcast using an Eddystone EC10 with a Joystick and a.t.u.

Richard Royall, of London, E.14, has the following equipment: 20 year old, four-valve, domestic superhet. (Pye 19a); a 30 watt p.a. amplifier and a 30 metre sloping wire, despite these difficulties he managed to get: *Radio Baghdad* on 6095 at 1930 (good signal); *Radio Damascus* on 9660 at 2030; *Radio Ghana* on 9545 at 2200 (fair signal); HCJB, Ecuador, on 6050 at 0830 (poor signal); WINB at 1700-1900 on 17820 and 1900-2100 on 11795 and, finally, RSA, South Africa on 17745 from 1800 to 1850.

Frank Plumb, of Londonderry, contributed several news items: *Deutsche Welle* transmits in English to North America on 9605, 11795 and 15245 at 1900-1910; *Radio Canada* transmits to Europe on 17820, 15325 and 11720 at 2115-2152 daily and *Radio Nederland* (weekdays only) transmits to Europe on 6085 and 6020 from 2000 to 2120.

Many thanks to this month's contributors, I hope to receive many more reports by the 17th. of the month to 58 Kensington Gardens, Ilford, Essex.

Africa

Malawi: The 100kW transmitter of *Radio Malawi* should start operation in early 1970, until it does the schedule of the station is: 0300 (0400 on Sunday) to 2110 (2310 on Saturday) on frequencies of 3380 (20kW) and 5995 (10kW).

Europe

Andorra: *Radio Rupert* is a new station which is due to start transmissions in English from Andorra in the early part of 1970. I understand that the programming will be similar to that used by Radio Luxembourg but do not know whether the station will use mediumwave, shortwave or both.

Oceania

Australia: *Radio Australia* has moved its morning transmission to North America to one hour later, i.e., 1215 on 9580 and 11710. The evening transmission is still at 0100 on 15170, 17775 and 21740.

South America

Mexico: *Radio Mexico* (first reported last month) can now be heard on the new frequency of 9535 which you probably recognise as the frequency of SBC, Berne, Switzerland. The Mexican can be heard from 0430 to 0545 whilst Berne is off the air.

Panama: HP5B, *Radio Miramar*, Apt. 4402, Panama 7, is a new shortwave station. It operates from 1030 to 0330 on a frequency of 6030.

Venezuela: *Radio Merida* is a new station operating as YVTR on the frequency of 9720 with a power of 1kW. The address for reports is Radio Merida, Avenida Principal, Merida, Venezuela.

Well we are now right in the middle of the winter and the sunspot number has been falling steadily for some months which has led to good reception on the tropical bands. There must be many l.f. specialists who have excellent logs so how about sending them along for us all to have a look at.

73 and good DX until the next time.

THE AMATEUR BANDS

David Gibson, G3JDG

THINK of all that lovely DX you missed last year just because you couldn't read c.w. How about making this a New Years resolution? Just imagine, lovely narrow selectivity cutting out all that QRM, and the feverish logging of exotic call-signs to boot.

Another resolution worth thinking about is to listen on eighty and forty before going on to the "easy" DX bands. If you are licenced, how about a serious assault on t.v.i. this year so that you can enjoy your hobby all the time, instead of sneaking out a whiff of r.f. when the telly isn't on?

To all those with nice, shiny, commercial gear, how about a constructional project this year. Aerial enthusiasts might make an antenna impedance bridge, then they can be sure just what impedance the poor old pi-tank is struggling desperately to match. For the more daring, a grid dip oscillator or one of the many transistor variants is an extremely useful item.

If you haven't got a ticket yet, what about a crystal marker. You can find plenty of circuitry for both valve and transistor frequency markers and you can give a far better report if you are able to specify a reasonably accurate frequency.

For the poor but practical, send 9d. to the RSGB and receive your very own countries list. The prefixes change so much these days that it's always worth getting a list at the beginning of each year just to see what all those funny callsigns are which keep popping up on twenty metres.

Many people write in asking what is the best aerial, a question which is impossible to answer. Probably most s.w.l's use a piece of wire, usually as long a piece as they can get out. For those who are in this category an aerial tuner unit (a.t.u.) is highly recommended.

Spies have written in to say that Marion Island is on twenty and another island to listen for is St Brandon Is., also on twenty. If any sleuths hear of anything worth while, please drop me a line but mention the times and, if possible, the frequencies when the DX stations are about.

Don't forget that the long cold nights favour DX on the lower frequency bands and eighty is well worth a listen. Remember that some countries can work from 3·5MHz right up to 4MHz, so don't stop spinning the dial at 3·8.

Fifteen metres should continue to provide some good DX. Best times to listen, according to the Gibby crystal ball, are 0800 to 1800. Similar remarks for listening times apply to ten metres.

Trevor Southern (Sussex), reports many G stations on top band. Incidentally, 160 is always worth a listen since there are nearly always a number of local stations on, and many interesting (and sometimes hilarious) discussions take place. Unbelievers of DX on 80 should prepare to weep. Those who only hear G stations and Europeans should re-connect the antenna.

J. Jackson (Leeds), has a TCS 13 receiver and "A length of wire thrown round the loft." Goodies heard roaming the s.s.b. trail on 80 include; CO2DC, CR4BC, EA3OF, EA4JL, HK3NO, HP1JC, HP9FC/MM/EA9 (fancy sending that on c.w.), K3UZE, OE1JPA, OY9LV, VE1ART, VE2LD, VE3CBG, VE8RX, VO1FX, W1FRR, W4OUK, WA4WQB, WB2YYI, 3Z3ATI, 3Z5CK, 3Z7AWA, 3Z9BLF.

James advises that the best times for a listen on eighty are 2400 to early morning. He also heard that the 3Z prefix for Poland went in January so it looks like we are back to the good old SP's. James says that SM7CRJ is a YL named Britt. further afield Bill logged; VE, VO and 4X4.

W. Waldron (Monmouthshire) sends a log of EU's logged in the 50kHz from 3750 to 3800. From further afield Bill logged; VE, VO, and 4X4 plus a

Allan Horne (Middlesex), CR70A, PR30X and 40ft. indoor wire sends in a list of c.w. stations heard on 40. These include DM, DJ, UA1, UA3, and OK. Come on you superhet types, you can't let a t.r.f. get away with that, or can you?

If you are allergic to RA1 receivers, and PR30 preselectors bring you out in spots then be spotty and get some DX. **A. Crooks** (Leicester), has both (but not the spots!), and coupled into a 45ft. end fed logged; CR4BC (Cape Verdi Is.), CT2AS, FG7XT (Guadeloupe), PY7AUT and ZS5KS on ten metres. On fifteen, Andy hooked; EA8GK, HP1RC, HR1KAS, PY1BIM, VE3OSC, VK2AVT, VK4TT, VK7GK, W0JW, ZL4PD, ZS6VE. Twenty raised; CR6FP, KH6BB, OH2AJ/AM on flight from Santa Cruz to Helsinki, PY7BDY, SV1CD, VO1FX, ZS5FC, 9Q5EP.

M. Needham (Kent), has a B40 receiver and the antenna is claimed to be a "Piece of wet string" some 70ft. long. (What gauge OM?) According to the receiver, sigs on fifteen arrived from; F5HN/P/W4, JAIWZV, JA6MVO, KP4DCR, KR6KV, VE3ELP, VE4ZX, VP9MI, 9G1BY.

A quick, but damp, dangle on twenty revealed; VE1AJG, VK2BKM, VK4SD, VK5MS, VK5QX, W8ODV, ZC4AK, ZL1AV, ZL2APT, ZL3SE, ZM2QK. Ten metres proved fruitful with squirts of r.f. from: SV0WA, K8AQS, UA6XA, VE3EWY, W8LBI, ZC4JW, ZE1CX, ZE2JA, ZS6OS.

D. Yeaman (Renfrewshire), Electroniques front end feeding an HRO and a half size G5RV antenna, reports these sigs on twenty: CN8AD, CT1BT, JA4OI, K1MVT/MM/VR2, K2IXT/M/CT1, KG4AN, MP4TCE, OX2TX, SV0WX, TU2CS, VK2FU, VK3FZ, VK7CW, W4CHH/P4, W4ZDW/MM/VR2, WA4DOU/MM, ZS2PX, ZS6XL, ZL1AV, ZL2AUW. ZL2US, 3V8AL, 5N2AAJ, 5R8DB, 6W8DY.

M. Williams (Lincs.), tells of a European/Canadian net on Friday nights. Time to QRX is 2230BST and frequency around 3·8MHz. Maurice has a 9R59DE and reports good sigs on ten metres, mostly from American stations plus a 5 and 9 from HP9FC/MM/ operating off the West coast of Africa.

I think that two metres is just a myth. All you can hear is the spotty-faced G8 in the next block at 5 and 5! Once you've worked both local stations you're dead. Don't agree? Well, how about proving me wrong with some juicy logs. Get those eight-over-eight mechanical monsters swivelling and see what you can sniff out.

Happenings of the month scribbled down in my diary include: February 7-8th., 144MHz contest; 7-8th., ARRL phone contest; 14-15th., 1·8MHz c.w. contest; 21-22nd., ARRL c.w. contest; 23rd., 432MHz contest; 28-March 1st., French phone contest; 7-8th., March, ARRL phone contest (second part).

Address for logs is 5, Edward Close, St. Albans, Herts. and must arrive by the 18th. of the month.

VERSATILE POWER SUPPLY STABILISER

P. R. BROADBENT

THE circuit, see Fig 1, takes in a "rough" d.c. input Vi of variable d.c. level and high a.c. ripple and converts it to a stable d.c. output. Vo, having low ripple. The rough d.c. input would normally be provided by a conventional power supply unit with choke or capacitor input filter. Basically using only seven components, the circuit described gives an improvement in a.c. ripple and d.c. stability of the order of 500 times, so that with typical values, a final output of ± 10 to 100 millivolts d.c. stability and 1 to 5 millivolts peak to peak a.c. ripple should be attained. The output current can be from milliamps up to several amps and a wide open choice of component types is possible.

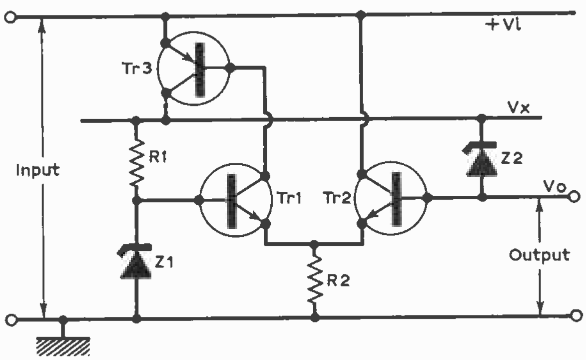


Fig. 1: The skeleton circuit of the power supply.

THEORY OF OPERATION

Referring to Fig. 1, current through Tr3 establishes an "intermediate" voltage, Vx. This value is maintained by the amplifier containing all three transistors and its level is defined by zener diodes Z1 and Z2. In the steady state, the base input voltages of the long-tailed pair Tr1 and Tr2 are equal. The voltage at Tr1 base is zener voltage Z1 (VZ1) and the voltage at Tr2 base is Vx minus zener voltage Z2 (VZ2) so that Vx equals VZ1+VZ2. In this case, provided R2 is appropriately chosen, the collector currents of Tr1 and Tr2 are reasonably balanced and the current in Tr3 base is just sufficient to produce a current from Vi to maintain Vx at its correct value. Now suppose that for some reason Vx rises, the voltage VZ2 remains substantially constant so that Tr2 base voltage rises, Tr2 emitter and hence Tr1 emitter voltage rises. Tr1 collector current falls since Tr1 base voltage is already constant at VZ1. Tr3 base current is thus reduced, its collector current falls, and Vx is allowed to fall back to its original value. The voltage Vx is therefore substantially stabilised with regard to Vi.

Now consider the base of Tr2, which is regarded as the circuit output. Provided no transistors are saturated or turned off, Vo must equal (VZ1 $\pm$ difference in Vbe drops of Tr1 and Tr2). But VZ1 is fairly constant since its current drive is taken via R1 from Vx, already seen to be stable, and changes in (Vbe1—Vbe2) will be small provided the design allows for a fairly low and roughly equal current in these collectors. Thus, the output Vo is highly stable and is almost exactly equal to VZ1. Note that *both* zeners are driven from stabilised current sources giving very low voltage variation.

DESIGN NOTES

The circuit of Fig. 1 deliberately gives no component values, these can be chosen to suit many different requirements as outlined below:

Transistors. As drawn the circuit is negative earth and requires NPN transistors for Tr1, Tr2, with Tr3 PNP. If an NPN type is desired as the power transistor Tr3, then Tr1 and Tr2 will of course be PNP, the zener polarities should be reversed, and earth will be positive.

Transistors may be silicon or germanium, but Tr1 and Tr2 should be of the same type. These last may be a matched pair for highest stability (although not critical), and are low power, but preferably fairly high gain. Their collector voltage rating *must* exceed Vi.

The power rating of Tr3 should exceed (Vi−Vx)× (output current+R1 current), although this may be greatly reduced by connecting a suitable resistor in the collector lead.

As suggested below, Tr1 collector current may be of the order of 1mA. This must produce at least the full output current through Tr3. If the current gain of this transistor is insufficient, it may be increased by connecting a driver transistor Tr4, collector to Vx, base to Tr1 collector, emitter to Tr3 base (having disconnected the latter!). Almost any transistor types can be used provided the above requirements are met, a few suggestions follow:

Tr1 and Tr2	PNP	2N3702 or 2N3703
	NPN	2N3705 or BC183L or 2N2926
Tr3	NPN	2N3055 (up to 110 watts on good heat sink) or as for Tr1 and Tr2 (up to ¼ watt)

Zener diodes. Both are low power, Z1 is chosen equal to desired output voltage Vo. Z2 is any value, provided not below Vi−Vo−1V and not above half Vo (preferably).

Resistor R1. Should give a normal current around 5mA or as appropriate for chosen Zener Z1.

Resistor R2. The normal output current divided by gain of Tr3 (and that of Tr4 if used) gives half the current to be allowed for—this should be of the order of 1 milliamp. The resistor value can then be calculated since the voltage is close to Vo.

Low output currents. If output current can be low or zero, a load resistor is needed across the output sufficient to maintain, say, 5 milliamps through Z2+extra (say 20 milliamps) to avoid cutting off the stabiliser loop.

GENERAL CONSIDERATIONS

1. The circuit is intrinsically safe against indefinite short-circuit output conditions since in this case Tr1 and Tr2 and thus Tr3 are turned off. Partial overload may be protected against by suitable Tr3 collector resistor.

2. It is intereseting to note that if all the transistors are initially turned off, then there is no reason for them to turn on. In normal use, these may require a resistor between Vi and Vx to give at least half a volt to turn on Tr1. Alternatively, the whole circuit can be regarded as a bi-stable whose "on" level is the stable output Vo and "off" level zero. For such an application, trigger pulses might be applied to any or all transistor bases. Alternatively, a momentary short circuit of Vo could be allowed to leave the output permanently zero until reset.

3. It will be clear that Vx (Fig. 1) provides a second stabilised output although not quite so good. If this is used as such, it will have a current capability comparable with Vo, but any ripple imposed on it will be reflected in Vo. ■

CORRIGENDA

Semiconductor Technology — Two errors occurred in Part 1 of this series, published in the May 1969 issue. First the negative charge on an electron is $4{\cdot}8 \times 10^{-10}$ e.s.u. and not $1{\cdot}6 \times 1^{-12}$ e.s.u. (which is in fact the numerical value of 1eV expressed in ergs). Secondly regarding the isotopes of hydrogen, deuterium has one and tritium two neutrons: hydrogen itself has none.

Beginners Portable Receiver—January 1970 issue, page 693. Tr6 is incorrectly drawn in both Figs. 1 and 2. For correct operation the emitter and collector connections must be transposed.

I.C. of the Month—February 1970. It has been suggested that the Weyrad RA2W ferrite rod aerial may be used in this design. The long wave winding should be ignored or alternatively removed from the ferrite rod.

THE MW COLUMN

THE new high power station in Calcutta is coming in very well in the afternoons and should provide newcomers to MW DXing with the opportunity to hear their first Asiatic. The new station is on 1130kHz and has a programme in English daily, between 1530 and 1600hrs GMT. The writer has logged Calcutta several times recently using a loop aerial. Look for the burble on 1133kHz and Calcutta will be found on the l.f. side of it. Wait for a minute or two if you do not hear it at first, although the signal is strong it does suffer from fading. Peking on 1000kHz is another prominent signal when the path is open but in this case the programming is in Chinese.

Last October a DXer resident in Hawaii logged a number of European m.w. stations on two successive nights. The great circle path to Hawaii lies right across the north magnetic pole and it was previously thought that m.w. signals would be absorbed in this region making DX between Hawaii and the UK impossible. A new Alaskan station, KYAK, has now come on the air on 650kHz, its programming is 'country and western' style and it broadcasts for 20 hours a day with a power of 25kW. KYAK is the most powerful m.w. station in Alaska and it ought to be audible in the UK. After midnight, on a night when North American DX is really good, would be the time to try for this station. Others that might be heard on 650kHz are YVLH Venezuala (in Spanish), Godhavn Greenland (sometimes in English) and WSM Nashville Tennessee. WSM is logged occasionally and since its programming too is country and western in the evenings, it is essential that a clear identification be had of the Alaskan to be sure of it. The writer would be glad to hear from any DXer who manages a 'first' from this difficult country.

The band has been quite lively this winter and the following have been logged recently by the writer during the period 2300hrs to 0100hrs GMT. On 590kHz VOCM, St John's, Newfoundland, Tenerife on 620, Canary Islands, YVLH (650) in Spanish, *Radio Giradot*, Maracay, Venezuala, WNBC (660) in New York City, CBF (690) Montreal (CBC French Network), CJOX (710) Grand Bank Nfld., WJR (760) Detroit, Michigan, Dakar (764) Senegal (in French), *Radio Caribbean* (840) on the island of St Lucia (in French), WHDH (850) Boston, CJON (930) St John's Nfld., CBM Montreal (940) (English Network), CKBW Bridgewater, Nova Scotia on 1000, WINS (1010) NYC. WBZ, *Radio 103*, Boston on 1030, CBA (1070) Moncton, N.B., LR1 (1070) *Radio el Mundo*, Buenos Aires, Argentina, WBAL (1090) Baltimore, WBT, Charlotte, North Carolina on 1110, WOWO (1190) Fort Wayne, Indiana, ZBMI (1235) Bermuda (American style programming), PJD2 (1295) St Maartin, Netherlands Antilles, with programmes in English and Dutch, Conakry (1403) Guinea (in French). These are only a selection of what can be heard when conditions are favourable.

Charles Molloy

P.W. GUIDE TO COMPONENTS

PART 15

M. K. TITMAN, B.Sc. (Eng)

Silicon Controlled Rectifier (s.c.r.) or Thyristor

The thyristor or s.c.r. is a four-layer, three-junction structure compounded of alternate p- and n-type semiconductor material and is invariably made from silicon wafers. The circuit symbols commonly used are shown in Fig. 20 and the B.S. preferred symbol is indicated.

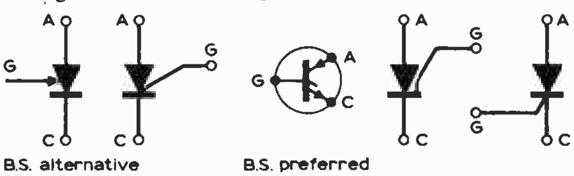


Fig. 20: Thyristor symbols.

The basic structure is illustrated in Fig. 21(a) with the structure split to show the two transistor equivalent structures in Fig. 21(b). The stable operating conditions of the thyristor are best understood by referring to the equivalent circuit of Fig. 21(c). With the polarities indicated the thyristor has two stable modes of operation. If the potential is applied whilst the gate electrode is shorted to the cathode then no conduction takes place as transistor Tr1 is off. The maximum voltage that can be withstood by the thyristor in this mode is known as the peak forward voltage (p.f.v.) and if this is exceeded voltage breakdown occurs.

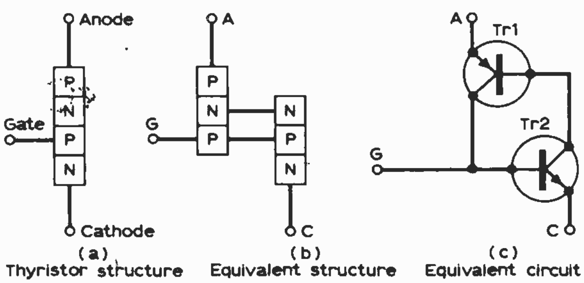


Fig. 21: Basic thyristor structure and the equivalent circuit.

The second stable state with the polarities shown occurs when a positive voltage is applied to the gate. In this mode the thyristor conducts heavily to a saturation potential since Tr1 is made to conduct and its collector current provides the base current for Tr2 which in turn conducts and supplies base current for Tr1. It can be seen therefore that if the gate is shorted to cathode after conduction has taken place this will not affect the conduction of the device. It should be noted that the saturation potential is $V_{be2}+V_{ce}(sat)$[1] and has a value of 0·8V to 1·5V.

When a reverse voltage is applied to the thyristor it behaves as a reverse biased diode and blocks current flow providing the maximum peak reverse voltage (p.r.v. or p.i.v.) is not exceeded. The three conditions of operation are therefore forward on or off and reverse off, and it should be noted that either a positive-going pulse or d.c. voltage can be used to trigger the device into the conducting state.

The basic parameters defined by manufacturers are shown in Table 3, together with typical values. From a knowledge of the basic operation discussed above the parameters are self-explanatory. One parameter often neglected is the minimum holding current and this is the current required to maintain saturated conduction. This value is utilised in the operation of thyristors as relaxation oscillators when the device goes out of conduction

Table 3: Typical thyristor parameters and range of values

Parameter	*Symbol*	*Typical values*
Max. peak reverse voltage	p.i.v. p.r.v.	50-1,000V
Max. peak forward voltage	p.f.v.	50-1,000V
Max. average forward current	If(av)	1-100A
Min. holding current	Ih	1-100mA
Turn on time	t on	approx. 3μsec
Turn off time	t off	approx. 12μsec

Table 4: Variation in price and encapsulation with thyristor ratings

Maximum average forward current If (av)	*Maximum reverse voltage* p.i.v.	*Encapsulation*	*Price from*
1	50	Wire ended plastic	5s.
1	800	or metal	15s.
6	50	Stud mounting	15s.
6	800	(4BA)	50s.
30	50	Stud mounting	£2
30	800	(OBA ¼ UNF)	£15
60	50	Stud mounting	£8
60	800	(OBA ¼ UNF) flexible terminations	£22

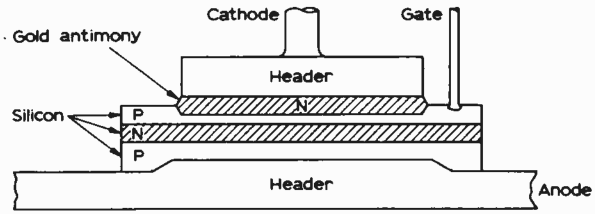


Fig. 22: Thyristor construction.

after discharging a capacitor and the current falls below the minimum holding current.

Thyristors are used in power switching applications such as phase control of heating and motor circuits as well as general a.c. applications. In pure d.c. circuits thyristors require commutation circuits to provide energy in order to switch off and either capacitors or inductors can be used. Thyristors are also widely used in fuse blowing crowbar circuits where the enormous power gain is fully utilised.

The basic construction is very similar to the power rectifier where the junctions are formed by successive diffusions as described in an earlier part of this series. The construction has the advantage of high forward current values but as with rectifiers the disadvantage of slow turn on and turn off times. Thyristor operation at frequencies above 20kHz results in switching power losses. A typical thyristor construction is illustrated in Fig. 22 and this is obtained by successive diffusions. Planar construction techniques are now employed to enable thyristor operation at high frequencies but as yet these devices are considerably more expensive than the conventional diffused construction. As with power rectifiers transient breakdown is limited by edge chamfering and such devices are known as avalanche thyristors.

Since thyristors are essentially power devices they are encapsulated in high heat dissipation metal cases. Low current (~1A) devices are available in TO-5 cans but above 1A stud mounting encapsulations are used. Plastic encapsulations are also used and a selection of encapsulations is shown in Fig. 23.

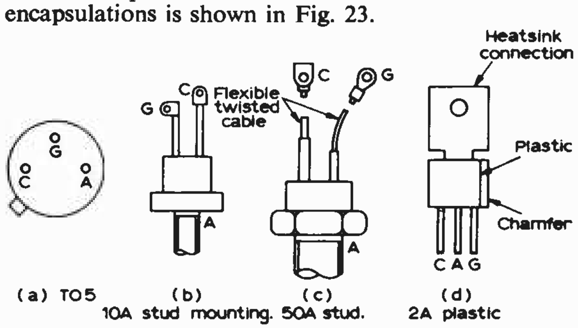


Fig. 23: Thyristor encapsulations.

Thyristor prices vary enormously and generally follow that of power rectifiers in that prices rise with increase in forward current ratings and with maximum blocking voltages. Typical costs are illustrated in Table 4 and in common with other semiconductor devices plastic encapsulations have resulted in price reductions.

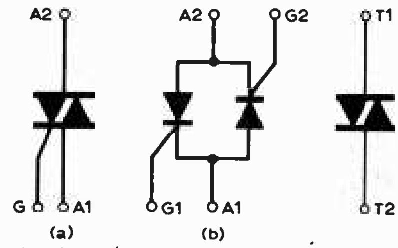
Triac

Triacs are four-layer semiconductor devices which are a development of the thyristor. Essentially they operate as two thyristors in anti-parallel as shown in the equivalent circuit of Fig. 24(b) and the symbol is shown in Fig. 24(a).

Triacs are used for a.c. switching purposes and were developed to replace the thyristor-diode bridge arrangements used previously to allow conduction in both directions. The triac is switched into the conducting state by either positive or negative voltages between gate and anode 1 and can conduct in a saturated mode in either direction. Switch off takes place when the current is zero. When the gate-anode 1 electrodes are shorted no conduction can take place, provided the maximum blocking voltage is not exceeded. Unlike the thyristor however the triac will not sustain damage if the voltage is exceeded since it merely reverts to the saturated mode, but naturally a breakdown at the wrong time could have serious consequences on the following circuitry.

Fig. 24: (a) Triac circuit symbol and (b) thyristor equivalent circuit.

Fig. 25 (right): Diac circuit symbol.



Triacs are available in standard thyristor encapsulations and are available at current ratings in excess of 40A. High voltage ratings are not at present available and the maximum peak voltages available of 500V allow operation up to 250V r.m.s. but not three-phase (440V r.m.s.) switching. Prices are remarkably low and triacs are available from 7s. 6d. for 240V r.m.s. 2A or £2 for 240V, 15A (3·6kW) types.

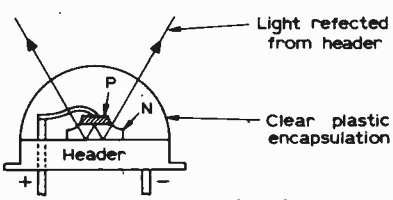
Diac

Diacs are bidirectional breakdown diodes which conduct only when a specified breakdown voltage is exceeded. They are used primarily as trigger sources for triacs and otherwise have limited applications. They are available in normal diode encapsulations and cost approximately 5s. to £1. The symbol for the diac is shown in Fig. 25 and since it is a bidirectional device it is non-polarised.

Light Emission Diodes

Visible light or infra-red radiation is emitted from semiconductor junctions by the recombination of electrons and holes in the junction. Many semiconductor materials produce useful radiation at suitably constructed diode junctions but at present gallium arsenide (infra-red) and gallium phosphide (visible light) are the most commonly available. Because the light output is directly related to the current they are used as light modulating devices for film marking and in transmission systems where electrical-light-electrical-conversion efficiencies of 70% are possible together with operating frequencies up to 1GHz. Another application for these devices is as indicator lamps with extremely long life times and high efficiency and reliability though at present cost precludes this use.

Fig. 26: Gallium arsenide light emission diode using mesa construction.



The basic construction is illustrated in Fig. 26 and consists of a diode junction bonded to a metal header for heat dissipation purposes. The light is emitted from the junction through a transparent cover which is either glass or plastic and often preformed as a lens to give the required optical characteristics.

At present these devices are expensive and are available from £2 to £25 which has prevented their use as alternatives to normal indicator lamps. However much research is continuing and with the demand for increased reliability and low power dissipation it is quite likely that they will supersede standard low voltage indicator lamps. Another application is in solid state viewing tubes to replace c.r.t.s and an experimental version based on diode arrays is in current use. Widespread use still depends on improved technology and perhaps with planar techniques the necessary improvement will result.

Light Operated Devices

Since photon or light bombardment of p-n junctions causes current to flow most devices are available in light activated varieties. These devices, including photodiodes phototransistors, light activated s.c.r.s and triacs, were discussed in a previous part of this series, together with other light operated devices.

The Future

It is extremely difficult to foretell future trends with semiconductor devices. The more important devices discussed in this article will become widely used and understood and a further miscellany of devices introduced. F.E.T.s are particularly likely to become popular due to the simplicity of design, whilst photoemissive diodes can be expected to have a major impact as the technology of manufacture improves.

Thyristors and triacs will increase in popularity and it is very likely that multiple encapsulations performing the functions of power controllers, switches and contactors will become generally available. It is to be hoped in all these improvements that standardisation of symbols, terminations and designations be carried out at the earliest point of mass production.

TO BE CONTINUED

NEXT MONTH IN

PRACTICAL WIRELESS

TRANSISTOR MINIGENERATOR

Describes the construction of an almost pocket size r.f. signal generator covering 180kHz–2·8MHz on fundamentals and to 30MHz on harmonics. An audio oscillator is included for modulation of the r.f. signal or for external use for audio circuit checking. The complete Minigenerator measures 5 x 6 x 2in.

FET AUDIO PREAMPLIFIER

The matching of ceramic and crystal pickups to transistorised amplifiers often presents problems. The outputs of these transducers must be fed into a high impedance load in order to achieve a satisfactory frequency response and signal to noise ratio. This design using a field effect transistor offers an ideal solution to the problem.

PORTABLE RADIOACTIVITY DETECTOR

The high voltage required to operate geiger tubes in portable equipment is usually obtained from high tension batteries. This article describes a method for operating one of these tubes from a 7½ volt battery thus eliminating the need for large and cumbersome power supplies. The pulses produced by radioactive particles are heard as clicks from a loudspeaker or headphone.

PLUS ALL THE REGULAR FEATURES—INCLUDING "I.C. OF THE MONTH", "TAKE 20", AND OTHER CONSTRUCTIONAL ARTICLES

All in the April issue of Practical Wireless—on sale 6th March—price 3s 6d.

UNIT BUILT

GENERAL CO RECEIVE

SSB • CW • 550kHz to 30M

THIS receiver employs twelve transistors and four semiconductor diodes in all, but can be built in simpler form to begin, extra stages being added later. Proceeding in this way has several advantages. A useful, working receiver is obtained as soon as possible, then additional features can be provided in due course. It can also be helpful to check that portion of the receiver already wired, before fitting further stages. Excellent reception is in fact possible over all frequencies with the basic circuit having only six transistors and two diodes.

Coverage is for medium waves and three short wave bands, or about 550kHz to 30MHz in all. The receiver is self-contained with battery. It is capable of long distance reception with the telescopic aerial, though range is naturally greater with a conventional external aerial.

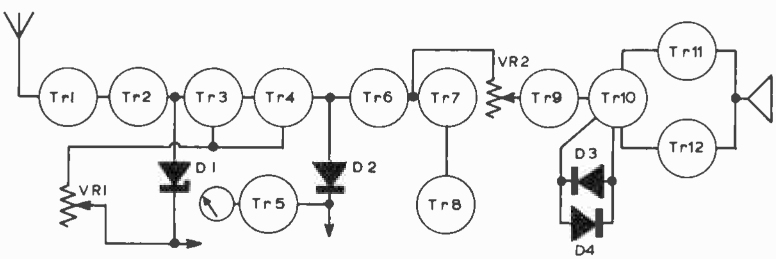
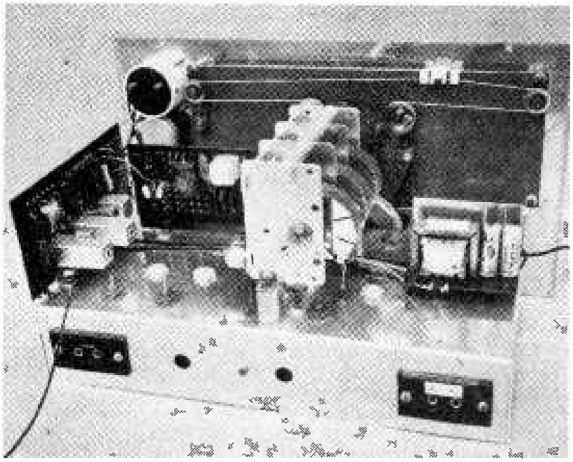


Fig. 1: Block diagram of the complete receiver.



Rear view of the receiver

Block Diagram

The simplified block diagram in Fig. 1 will make stages clear, and also clarify which may be omitted during early or intermediate construction.

Tr1 is the r.f. amplifier, a panel trimmer allowing peaking of this circuit with any aerial. Tr2 is the mixer, Zener stabilised by diode D1. Tr3 and Tr4 are intermediate frequency amplifiers, with double-tuned transformers. VR1 allows manual control of r.f. and i.f. gain, which is often useful. Diode D2 furnishes automatic volume control bias, and also detection for a.m. only, if required.

Tr5 is the S-meter amplifier, working a small meter of the ready calibrated type. Tr6 and Tr7 function in the common-emitter product detector circuit, with Tr8 as beat frequency oscillator. This permits reception of a.m., s.s.b. and c.w., a "function switch" controlling this part of the receiver, and also a.v.c.

VR2 is the audio gain control, followed by audio amplifier Tr9, drivei Tr10, and push-pull pair Tr11 and Tr12, which will give plenty of loudspeaker volume. Phones may be used when wanted. Diodes D3 and D4 function as audio limiters, considerably reducing interference of static and similar type and avoiding sudden bursts of uncomfortable volume with phones.

In the completed receiver, Tr1 and Tr2 are under the metal chassis, with bandswitch, coils, etc. Tr3, Tr4 and Tr5 occupy a paxolin panel, forming the i.f. and meter amplifier section.

Tr6, Tr7 and the b.f.o. Tr8 are wired on a separate panel, and a.m. reception over all bands may be had even if this part of the receiver is wholly omitted, so it can be constructed later.

The audio section, Tr9, Tr10 and Tr11/12 occupy another insulated panel. These various panels are attached to the chassis and grounded to it.

To take advantage of the step-by-step method of wiring, sections are tested as completed. This enormously simplifies the process of locating any fault.

/ERAGE

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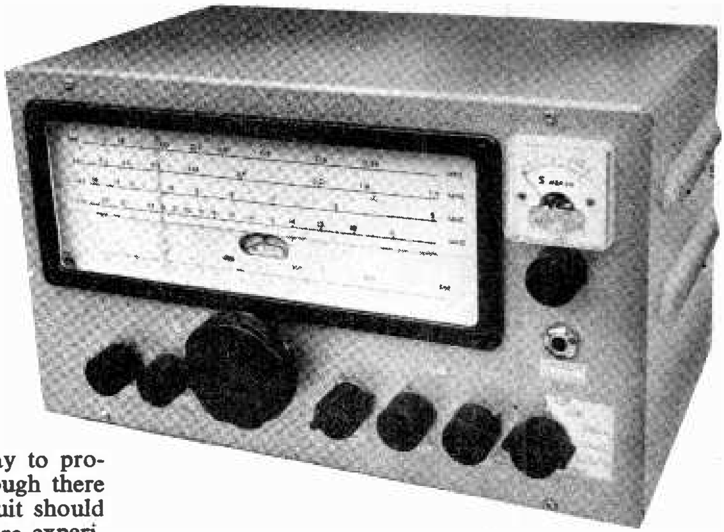
F. G. RAYER G3OGR



The following is probably as good a way to proceed as any, especially for a beginner, though there is naturally no reason why the whole circuit should not be used from the beginning by the more experienced constructor.

(1) Wire mixer Tr2, i.f. amplifiers Tr3 and Tr4, and diode D2, with coils for one band. Feed phones from D2. This will give many transmissions at good phone volume, and allow initial alignment of the i.f. amplifier.

(2) Build the a.f. amplifier, Tr9, Tr10, Tr11/12. Those signals previously heard with phones should now give excellent speaker strength. If a little simplification is wanted, Tr9 can be temporarily omitted.

(3) Add the r.f amplifier Tr1, with aerial coil for the single band chosen, and check working.

(4) Wire Tr5 and the S-meter. The i.f. panel is so placed and arranged that Tr5 can be wired without removing the panel.

(5) Wire the sets of coils for the other three ranges to the wavechange switch, testing and roughly aligning each range as it is added. This will avoid errors in switch wiring, which could be troublesome to locate.

(6) Wire the product detector and b.f.o. panel, insert and wire it. This is also the time to add the a.m./a.v.c./c.w./s.s.b. switch, and minor extras such as p.u. input, tape output, phone jack, diode limiter, etc.

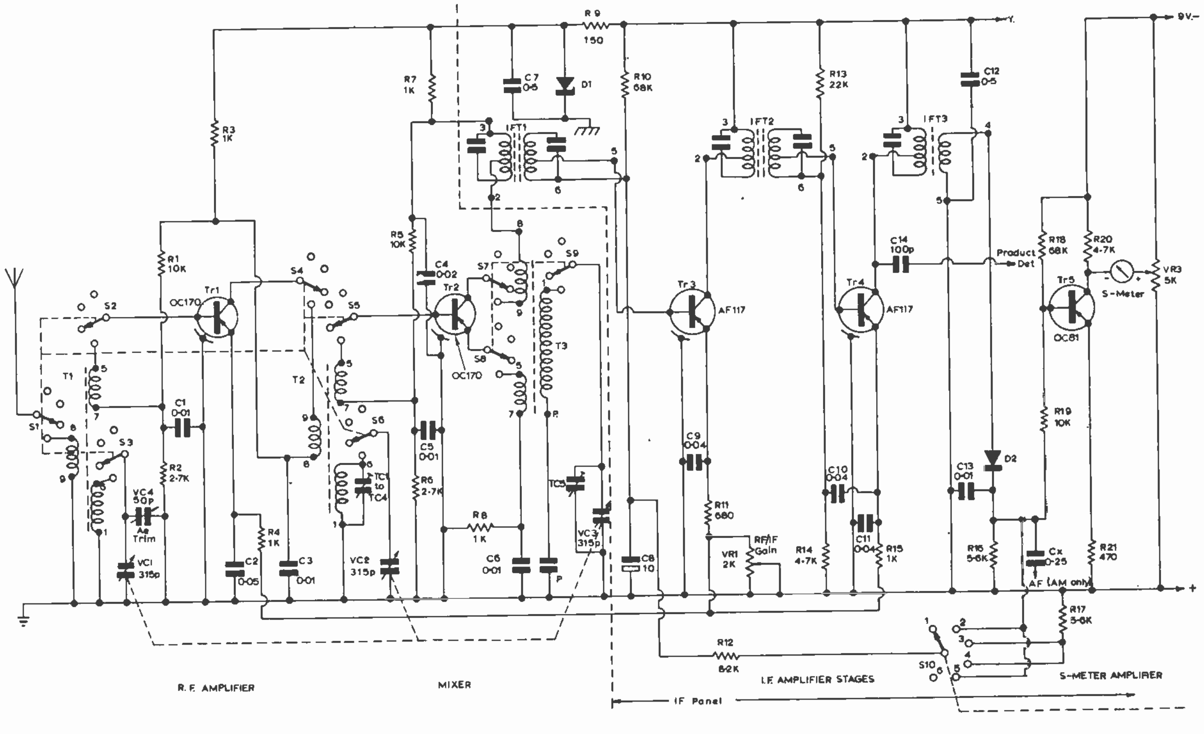


Fig. 2: R.F., mixer, i.f. and meter amplifier stages. See text p.870 for values of padder condenser P. Note: S6 should be shown as ganged to S8.

Coils and Coverage

The bands are approximately as follows:
S.W.1. 30-11MHz. 10-27 metres.
S.W.2. 14-5MHz. 21-60 metres.
S.W.3. 5-1·6MHz. 60-190 metres.
M.W. 1400-550kHz. 210-550 metres.

If a pre-set trimmer were used with each coil, there would be twelve in all. The number of trimmers is reduced to five by having a single trimmer common to all oscillator coils, and an individual trimmer for each mixer input coil. Then the aerial circuit is adjusted with a panel-mounted capacitor, so giving maximum efficiency with any aerial.

There is clearly no reason why a separate trimmer should not be used for each oscillator coil, if preferred. There will then be eight trimmers, plus the panel capacitor.

Circuit Details

Notes on the various stages should prove useful at various periods during construction. Almost no changes to existing circuitry are needed when adding other stages, but there are a few points which must not be overlooked.

Figure 2 shows the r.f., mixer, two i.f., and meter amplifier stages. Band changing is accomplished by using a switch having three wafers, each three-pole four-way. Figure 2 shows coils for one band only. In the aerial section, S1 switches the aerial, S2 Tr1 base, and S3 the tuning capacitor VC1.

The central wafer on the spindle has S4 for Tr1 collector, S5 for Tr2 base, and S6 for VC2. The rear wafer uses S7 and S8 for collector and emitter switching of Tr2, and S9 for the tuned windings of the oscillator coils.

Tag P of the oscillator coils is different for each range, as is the value for the related capacitor P. For S.W.1 (highest frequency band) connect pin 6 to chassis, as no padder is required. With range S.W.2, the padder P is 3,000pF, from pin 4 to chassis. For S.W.3, the capacitor is 1,200pF, from tag 3 to chassis. With the m.w. range, the padder is 350pF, and connected from tag 2 to chassis.

To avoid difficulty in wiring here, it is wise to check that the receiver works correctly on one band, before adding the coils for other bands.

The receiver can be tested without Tr1 and associated circuitry by taking S4 to the aerial, and temporarily connecting 8 to chassis, instead of C3. Results should be good.

Tr1 and Tr2 operate on a stabilised 5·6V line, from D1. D1, i.f.t.1, and the other items shown are on the i.f. panel.

Tr3 and Tr4 are the i.f. amplifiers, operating on the supply Y obtained from the audio amplifier. VR1 controls emitter bias of Tr1, Tr3 and Tr4, and its main use is to reduce the strength of powerful signals, which may overload some stages. It must also be used when the a.v.c. is out of action.

S10 is one pole of the "function" switch. Two positions give a.v.c. from D2, while two substitute R17, eliminating a.v.c. This is primarily of use with some s.s.b. and c.w. signals. The receiver may initially be operated without S10, by connecting R12 to D2. The six positions of the switch are (1) Receiver off, (2) A.M. reception with a.v.c., (3) A.M. reception

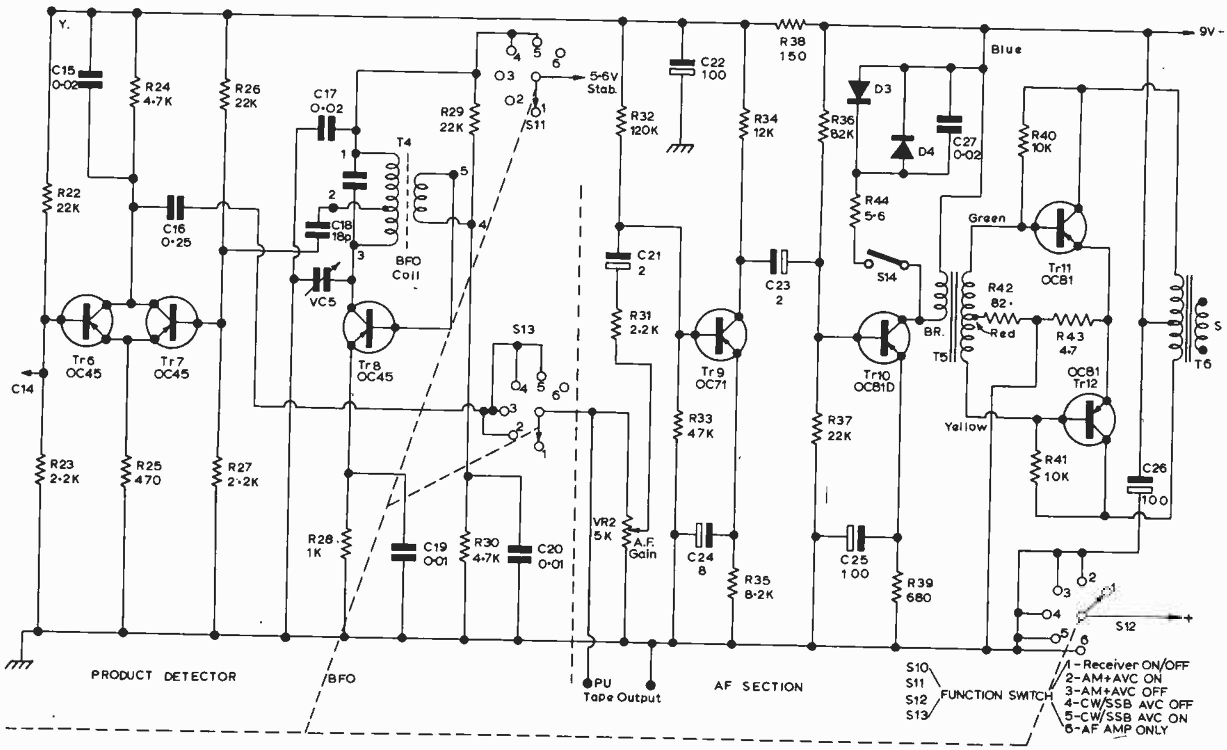


Fig. 3: Product detector, b.f.o., a.f. and output stages. The 5·6 volt stabilised line is taken to the junction of D1/R9 (Fig. 2).

★ sectional components list

Coils:

Aerial (T1): "Blue". Mixer (T2): "Yellow". Oscillator (T3): "Red". Denco miniature transistor type.
S.W.1: Range 5. S.W.2: Range 4. S.W. 3: Range 3.
M.W: Range 2.

VC1/VC2/VC3	Jackson E3 three-gang or similar.
VC4	Jackson C804, 50pF.

Eddystone C898 drive.

R.F. Stage:

Tr1	OC170	R4	1kΩ
R1	10kΩ	C1	0·01μF 150V
R2	2·7kΩ	C2	0·05μF 150V
R3	1kΩ	C3	0·01μF 150V

Mixer Stage:

Tr2	OC170	R8	1kΩ
R5	10kΩ	C4	0·02μF 150V
R6	2·7kΩ	C5	0·01μF 150V
R7	1kΩ	C6	0·01μF 150V

Padders: 350pF, 1,200pF, 3,000pF
TC1 to TC4, each 60pF miniature compression trimmer.
TC5 30pF beehive trimmer.

I.F. Amplifier:

D1	5·6V 1 watt Zener, Z1104
D2	OA81
Tr3	AF117
Tr4	AF117
I.F.T.1	Denco I.F.T. 18/465
I.F.T.2	Denco I.F.T. 18/465.
I.F.T.3	Denco I.F.T.14.
VR1	miniature 1 watt wire-wound, 2kΩ (Home Radio VR25)

R9	150Ω	R14	4·7kΩ
R10	68kΩ	R15	1kΩ
R11	680Ω	R16	5·6kΩ
R12	8·2kΩ	R17	5·6kΩ
R13	22kΩ		
C7	0·5μF 150V	C11	0·04μF 150V
C8	10μF 6V	C12	0·5μF 150V
C9	0·04μF 150V	C13	0·01μF 150V
C10	0·04μF 150V	C14	100pF silver mica

Cx 0·25μF 150V required for "A.M. only" circuit.

Meter Amplifier:

Tr5	OC81		
R18	68kΩ	R20	4·7kΩ
R19	10kΩ	R21	470Ω

VR3 Pre-set or panel linear 5kΩ wire-wound 1W.
1⅝in. sq. 1mA S-meter.

Product Detector and B.F.O.:

Tr6	OC45	Tr8	OC45
Tr7	OC45		
R22	22kΩ	R27	2·2kΩ
R23	2·2kΩ	R28	1kΩ
R24	4·7kΩ	R29	22kΩ
R25	470Ω	R30	4·7kΩ
R26	22kΩ		
C15	0·02μF 150V		
C16	0·25μF 150V		
C17	0·02μF 150V		
C18	18pF silver mica		
C19	0·01μF 150V		
C20	0·01μF 150V		
VC5	15pF variable		

B.F.O. coil, Denco IFT14 (T4)

A.F. Section:

VR2	small 5kΩ log. pot.		
R31	2·2kΩ	R38	150Ω
R32	120kΩ	R39	680Ω
R33	47kΩ	R40	10kΩ 5%
R34	12kΩ	R41	10kΩ 5%
R35	8·2kΩ	R42	82Ω 5%
R36	82kΩ	R43	4·7Ω
R37	22kΩ		
C21	2μF 6V	C24	8μF 6V
C22	100μF 12V	C25	100μF 6V
C23	2μF 6V	C26	100μF 12V
Tr9	OC71		
Tr10	OC81D		
Tr11/12	Matched pair OC81/NKT251/AC128 or similar OC81 types.		
T5	Osmor QXD1		
T6	Osmor QX02		

Limiter:

Two GD9 diodes.
R44 5·6Ω
On-off switch S14
C27 0·02μF 150V.

Miscellaneous:

12 x 7 x 7in. Type W cabinet, H. L. Smith & Co, 289 Edgware Road, W.2. 10½ x 6½ x 2in. Type I chassis (three-sided plus flanges), H. L. Smith & Co, 289 Edgware Road, W.2. WS27A (Home Radio) switch assembly with three WS29 three-pole four-way wafers, studding and spacers (see text). WS27 switch assembly, with two WS29 two-pole six-way wafers, studding and spacers. 1½ x 2¼in. 16 s.w.g. heatsink, knobs, sockets, tags, 6BA bolts, etc. (Home Radio).

without a.v.c., (4) C.W./S.S.B. reception without a.v.c., (5) C.W./S.S.B. reception with a.v.c., (6) A.F. amplifier only in use.

When the product detector and b.f.o. panel is not ready, Cx from D2 is taken to the audio gain control, giving a.m. reception only. For general broadcast s.w. listening, the product detector may be permanently omitted. When it is employed, it is of a type which furnishes a.m. detection with no b.f.o. injection to the emitter pair.

As mentioned, Tr5 and the S-meter may be omitted until some later date. When in use, increased bias from D2 moves Tr5 base positive, reducing current through R20. The collector voltage of Tr5 thus moves negative, due to reduced voltage drop in R20. This operates the meter. With the aerial removed, VR3 is adjusted until the meter reads zero. Readings then rise with signal strength.

This is a lively S-meter circuit, operating with a.v.c. on or off, and not upset by b.f.o. injection. With a steady signal, from a signal generator or BBC transmitter (with extremely short aerial) the S-meter can be used to aid alignment. All trimmers and cores, including those of the i.f.t.s, are peaked for the best S-meter reading.

In normal use, the meter shows any improvement in signal strength, as from changes to aerial or earth, adjustments of an aerial tuner, peaking VC4, or the relative strengths or improvement to amateur signals, etc.

Band Notes

In order to reduce damping on m.w., a 1kΩ resistor is placed between S2 and tag 5 of the coil for this range only. To avoid squegging, a 100 ohm resistor is wired between S7 and tag 9 of the oscillator coil for this band.

For a similar reason, a 470 ohm resistor is placed between S7 and tag 9 on the S.W.1 and S.W.2 (higher frequency) ranges.

The need for these resistors depends somewhat on the actual transistor Tr2, and also on the run of wiring. If excessive oscillation, shown by hissing and whistles, does not arise on a band, no resistor is required. When resistors are fitted, they are best of the lowest value which will prevent this trouble, and values such as those mentioned give no apparent reduction in sensitivity.

Product Detector and BFO

This is built in a panel holding all components except the pitch control VC5, Fig. 3. This item is connected to the metal chassis, and to 3 on the b.f.o. coil.

When this panel is made, Cx in Fig. 2 is not required. D2 now provides a.v.c. only, and signals go from C14 Fig. 2, to Tr6 Fig. 3. Tr6/7 act in such a way as to provide a.m. reception when no input is available from the b.f.o., Tr8. With the b.f.o. in use, mixing gives reception of s.s.b. or c.w. signals. The function switch wafer S11 brings the 5·6V stabilised supply to Tr8, in s.s.b./c.w. positions. In each case audio passes from C16 to the audio amplifier.

This circuit was found particularly easy to adjust for s.s.b., and though VC5 must be correctly adjusted, it is of small value, so not critical to operate. VC5 and Tr8 are completely out of use for a.m. reception, in the usual manner. About 7V is available at Y, which also supplies the i.f. amplifier.

It is often convenient to have an audio amplifier. The last section of the function switch breaks the circuit from C16 to VR2, in the 6th position. A rear socket strip gives input across VR2, so the a.f. section can be used as an audio amplifier. The same socket provides tape output, VR2 being turned to zero, or adjusted to monitor signals.

Function Switching

The operations described are carried out by a four-pole six-way rotary switch. This gives one control, for all modes of use. But there is no reason why separate switches should not be fitted, if preferred.

If VR2 has a switch, this can be wired for "on-off" in the usual manner. A small rotary or slide single-pole two-way switch can substitute for S10, Fig. 2, for a.v.c. on, a.v.c. off. A further on-off switch may replace S11, so that the b.f.o. can be off for a.m., and on for s.s.b./c.w.

AF Section

This is also shown in Fig. 3. A lead runs from C16 to VR2, via S13, mounted on the panel. VR2 is earthed to the chassis, and its slider tag wired to the audio panel input point.

Tr9 is the first audio amplifier, Tr10 the driver, and Tr11/12 the output pair, with individual feedback. This is a very straightforward type of circuit, with the direct current operating conditions of each stage separate from other stages.

If necessary, the first stage Tr9 can be tested by placing phones across R37, while Tr10 can be checked with phones across the primary of the driver transformer T5.

The exact value of R42 considerably influences results. If Tr11/12 draw almost no current with no signal, and reproduction is distorted, R42 may be slightly increased in value. But if Tr11/12 draw much more than 4mA to 5mA or so, with no signal, R42 should be reduced in value. This depends somewhat on the actual transistors and R40 and R41. The values given should usually be suitable.

Output from the secondary of T6 is taken to a 5in. or other reasonably large 2-3 ohm permanent magnet moving coil speaker, which should occupy a cabinet.

For headphone listening, we may use a jack with contacts which open when the plug is inserted, these contacts being in series with one speaker connection. The loudspeaker is then silenced when the phones are plugged in. Alternatively, T6 secondary may go to a jack outlet, so that speaker or phones can be plugged in, as wanted.

Audio Limiter

This is optional, and formed by D3 and D4, Fig. 3, with C27 and R44. With S14 open, results are normal. With S14 closed, the diodes place R44 across T5, to limit output. VR2 should not be so far advanced that all signals are constantly limited, but only those of excess level, such as static crashes, or the sudden bursts of volume sometimes uncomfortable when tuning with phones. Actual results can be modified by changing the value of R44.

TO BE CONTINUED

A PANORAMIC RECEIVER

—continued from page 849

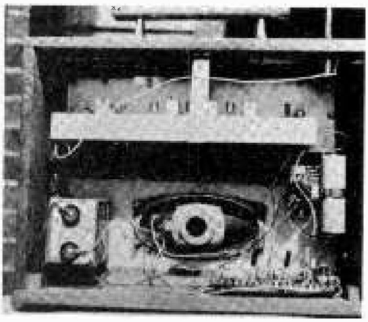
10c an unidentified carrier is beating with a amateur a.m. signal in the centre of the display, and when this is magnified by adjustment of VR3 (see Fig. 10d) the thickening of the trace between the two peaks is visible to the eye as a heterodyne waveform. Figure 10e demonstrates the effect of splatter resulting from a grossly overmodulated signal. Finally, Fig. 10f was recorded late in the afternoon and shows a marked increase in the number of stations and amount of noise. At the centre of the display are two s.s.b. signals side by side.

An interesting feature of the panoramic receiver display is that it distinguishes between noise derived from the mains and other sources. If the oscilloscope timebase is not locked to a sub-multiple of the mains frequency, mains noise is seen as "clumps" of spiky waveforms drifting across the display. Other noise just causes a thickening of the trace baseline, as seen in Fig. 10f. ■

LETTERS...

The Editor does not necessarily endorse the views expressed by correspondents

A reader's special



The two photographs are of a v.h.f. portable comprising the PRACTICAL WIRELESS V.H.F. Tuner (Feb.-March 1968) and basic amplifier (November 1967).

I have used this as a portable for several months now and it even works well in the car. Good reception can be obtained within 40 miles of the transmitter.

The units could have been installed in a smaller enclosure, but it was felt that to do justice to the output a large as possible speaker should be employed.

I have spent many enjoyable hours assembling these units and many more enjoying the results. —**C. W. Britnell** (*Norwich, NOR 76*).

Electric fires

G3TWZ's letter ("P.W.", December 1969) re TO3 "electric fires" reminds me of a true story that I heard about a year ago.

A certain American TV manufacturer was happily producing TV receivers with a power transistor in the line output position. The supply started to dry up so an equivalent (???) from another maker was tried and hence LOPT electric fires. No matter who made these transistors they all did the same. The only solution was a different circuit design for each transistor manufacturer!

If G3TWZ gets the full spec on these transistors and reads it carefully he will see what I mean —they were the same types and the difference only shows up when the circuit uses the characteristics to the full. It seems that the moral is to use the same type and make that the original circuit designer specified.—**A. M. Levett** (*Sussex*).

The early days

Reading a letter in the November copy of PRACTICAL WIRELESS, from F. Towndraw (Newquay, Cornwall), made me think of my early days in Radio. I still have my first licence issued in October 1923. This was the first licence one could obtain, otherwise than a transmission one for a home-built broadcast receiver, cost was 15s. to cover anytime, before that date one had used one without licence, after that, cost was to be 10s. My first set was also a crystal one built in June 1923. At that time one could obtain very few ready-made components, a pair of phones and crystal was about all. Coils had to be hand wound on cardboard formers, studs and switches could be bought. The hours I spent building this set and all taped out at every 10 turns to studs for tuning. Then the great moment trying to get 2LO 30 miles away in London. "NO luck, dead silence." Laying awake at 2.30 a.m., realised mistake I had made in wiring, got up and put right and waited until 2LO started up again and wonder of wonders, after making nearly everything stats, I got 2LO on phones.

In High Wycombe at that time there were 3 of us in town, the dealers and 2 home-built receivers. How much I owed to Mr. Millner the dealer of West Wycombe Road for his help at that time. From this I went on to make a unit-built valve set again hand wound coils, 400 turns of double silk-covered 20-gauge wire in one coil on a former 6×3in. of cardboard. No light needed in room with this set's four bright valves on top of set.

Then on to kit sets obtainable to make up yourself. The old "Cossor Melody Maker set," I made one up for myself and quite a few for other people, with the excitement of hearing people speaking overseas. Now at 73 years old I have a modern 7-valve receiver, a domestic 4-band f.m. short-, medium- and long-wave can listen all over the world on an internal aerial, and with a long wire outside and earth, well you know what can be done.

This has always been a hobby for me not my job, as I was in the furniture trade and still enjoy picking up an old set perhaps at a jumble sale and getting it to work again. An old lady has just given me a very old Marconi set, just medium band, only portable mains line cord with a pancake frame aerial inside back. This is now working very well again great fun working out.

I do not know how long I have taken your PRACTICAL WIRELESS, a great number of years, so I wish you continued success with same.—**F. W. Wells** (*Eastbourne*).

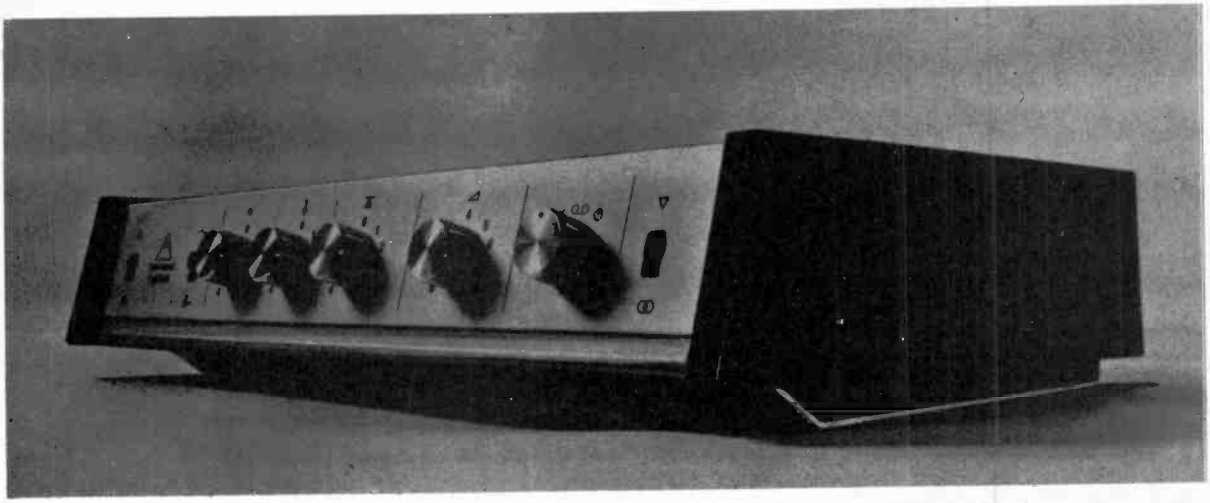
Please leave us be Ladies

I agree most wholeheartedly with F. G. Sadler, G3UZ in his article on page 775 of the February 1970 issue of PRACTICAL WIRELESS. It is one of the World's hardest problems trying to convince a wife or mother that the box or pile of valuable priceless equipment lying in a corner of the bedroom or lounge is not a load of blooming old junk, as many of them will term our equipment.

If us chaps were to go around tidying up heaps of knitting, recipes and piles of *Woman's Owns*, we would soon get a rocket.

So come on wives and mums, let's call a truce. You leave all our equipment, components and service manuals where we put them, or we will gang up on you and start shifting all the piles of ladies' magazines and carefully laid out dress patterns when we feel like having a little tidying up session!—**R. Smith** (*Southgate*).

peak sound englefield



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

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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.

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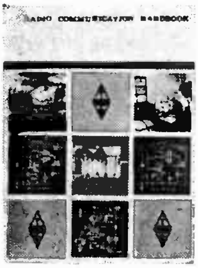

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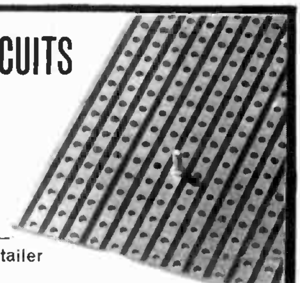

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I.C. OF THE MONTH

L.A.J. IRELAND

Number 5 — The PA246 used as an Audio Amplifier

THE General Electric (U.S.A.) type PA246 integrated power amplifier has finally become freely available on this side of the Atlantic, and is certainly deserving of our attention this month. With a five watt rated output, it is the culmination of a development process which began with the PA222 described in "Practical Wireless" as long ago as August 1968. That device introduced the idea of mounting the monolithic "chip" of silicon carrying the integrated components on a metal tab; when soldered to an area of a printed circuit board this provides a path of low thermal resistance to a heat sink, with the result that a one watt device dissipation figure could be achieved. The disadvantage of the number of external discrete components required was next overcome with the PA234, again a one watt unit, while a variation in the driver stage on the chip enabled the PA237 to dissipate two watts. Finally, with an improved heat sinking method, the PA237 chip was uprated to a higher operating voltage and dissipation, with the PA246 designation. The table gives the characteristics of this family of devices, and the development sequence outlined above can be followed.

Characteristics of the G.E. series of audio power i.c.'s.

	PA 222	PA 234	PA 237	PA 246
Supply Voltage ..	18—24	9—25	9—27	12—34
Audio Output .. (r.m.s.)	1 Watt	1 Watt	2 Watts	5 Watts
Frequency Response	55Hz–15kHz	30Hz–100kHz	30Hz–100kHz	30Hz–100kHz
Input signal ..	52mV	600mV	8mV	12mV
Input impedance	55kΩ	100kΩ	40kΩ	40kΩ
Load impedance	22Ω	22Ω	16Ω	16Ω
Output impedance	1Ω	2Ω	0·85Ω	0·6Ω
Heat Sink Area ..	1 sq. in.	1 sq. in.	2 sq. in.	6 sq. in.
Device Noise ..	—65dB	—80dB	—75dB	—70dB

The PA246 package is a specially designed variant of the familiar 14-lead dual-in-line epoxy i.c. format, with the addition of two wide heat transfer tabs, and staggered leads for greater convenience in the design of printed circuit boards. As with the PA237, only eight of the leads are actually in place, though the manufacturer's literature refers to them by the numbering convention for a full 14-lead package. Further, only six of these leads are actually functional connections to the chip. Figure 2 shows

continued on page 894

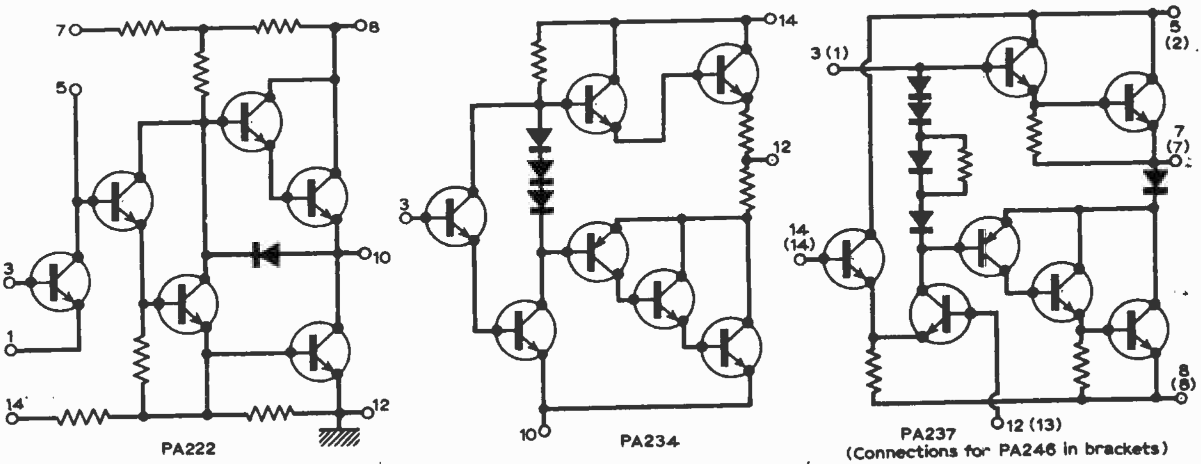

Fig. 1: Equivalent circuits of General Electric (U.S.A.) audio power integrated circuits.

BASIC SEMICONDUCTOR TECHNOLOGY

PART TEN

by M.F. DOCKER, M.Sc.

LAST month the type of logic integrated circuits which are available were described. The average amateur will not find many applications for these devices in his workshop although they serve very well for use in counting circuits, voltage level detector circuits, automatic morse senders and so on. However the integrated circuit industry can still serve this customer with its products—with linear circuits.

Operational Amplifiers

Perhaps the most widely used type of linear integrated circuit is the operational amplifier. Available at well under one pound this circuit has uncountable applications in the home laboratory. With a few external resistors and capacitors they can be used to produce high stability d.c. amplifiers using resistive feedback elements. Bandwidths approaching 10MHz can readily be reached. Using capacitive feedback the circuit can be used to produce an integrator, or with resistive feedback and capacitive input a differentiator is obtained. These three arrangements are shown in Fig. 1. In order to achieve stable operation over a wide bandwidth it is necessary to utilise suitable frequency compensation. Details of this simple procedure, requiring only resistors and capacitors, are obtainable from the device manufacturer—usually free of charge.

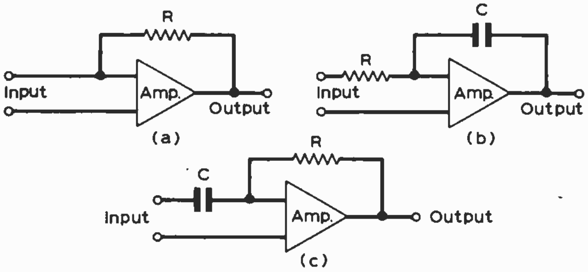

Fig. 1: Operational amplifier applications

Other uses of the operational amplifier are as active filters, using suitable resistor and capacitor arrangements in the feedback networks. Either bandstop or bandpass filters with very high Q values can be obtained without the necessity for the large inductors required with the usual low-frequency filter. Using a diode as the feedback element it is possible to produce a logarithmic amplifier in which the output bears a logarithmic relation to the input voltage. Summing and differencing amplifiers can also be made, using only resistors and operational amplifiers. These have numerous applications in many enthusiasts' experiments.

Also available in integrated circuit form are audio amplifiers. A one-watt amplifier is currently available at under two pounds and a preamplifier utilising a MOST is available at less than ten shillings. The integrated circuits in this field enable remarkable miniaturisation. A one-watt amplifier in a space of less than one-tenth of a cubic inch is quite an achievement, especially as the reliability is also high.

Other Circuits

Numerous other circuits are now becoming available including i.f. amplifiers with built in a.v.c. circuits; combinations of transistors with external connections to suit the user; video amplifiers for use in television equipment; d.c. voltage comparators; and one firm is even making an integrated car radio with all the active elements, including a three-watt output stage, on one chip. The list of circuits which are available grows week by week and not only is the list of available circuits rising but also their prices are falling, some being only one-third of what they were two years ago. Several manufacturers of integrated circuits are now offering customer design services to the users of integrated circuits: in this way the number of integrated circuits which are available can be expected to grow and both the amateur and the professional engineer can hope to benefit from this development!

Thin Film Circuits

Another field of integration which has been in existence for some years is that of the thin film circuit. These circuits consist of microminiature arrangements of resistive, conductive and dielectric films on inert substrates. Using these films it is possible to make resistors, capacitors and inductors. Unfortunately there are no reliable active devices available yet which can be made in thin film form. This means that discrete semiconductor devices have to be attached to the thin film circuit after it has been completely processed. The steps in making a thin film circuit are similar to those used in making a silicon integrated circuit, but instead of diffusion of impurity atoms into the substrate an evaporation of metal or dielectric material on to a glass or mica substrate is carried out.

Resistors are produced by depositing a long, thin filament of metal on to the glass. Metals commonly used are nichrome, well known as the metal used in electrical heating elements, and tantalum. They are deposited on to the substrate by heating them strongly so that metal from their surface evaporates and after passing through a suitable mask lands on the substrate. With thin film resistors a much larger range of values can be obtained than can be obtained with monolithic resistors, and also the parasitic capacitances are smaller.

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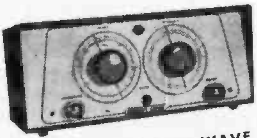

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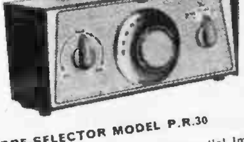

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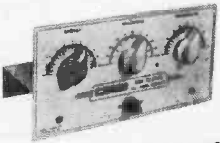

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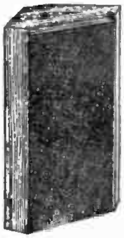

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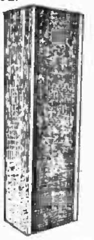

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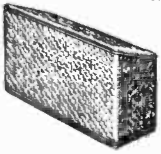

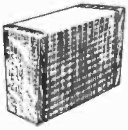

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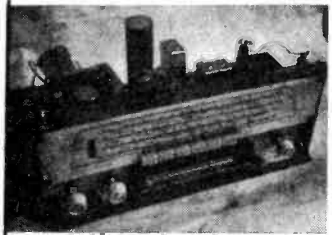

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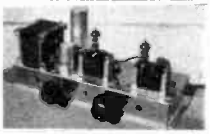

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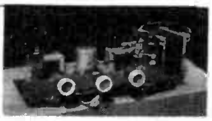

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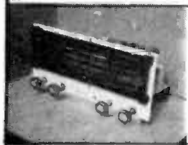

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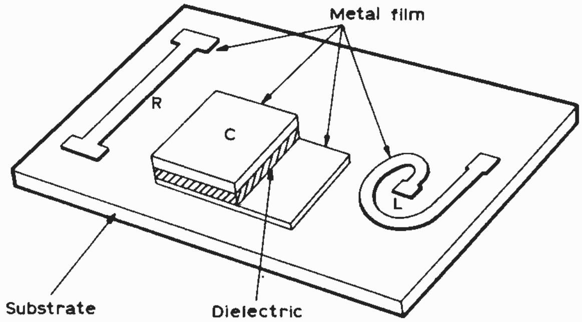

Fig. 2: Examples of a resistor, capacitor and inductor in thin film form.

Thin film capacitors can be produced by first depositing a layer of metal as one electrode, then a layer of alumina or tantalum oxide to act as a dielectric insulating layer, and finally a top electrode of metal. Inductors can also be produced by thin film techniques although values of inductance greater than one microhenry are difficult to produce. They are made by depositing spirals of metal on to the substrate, connections being made to each end of the spiral. Figure 2 shows an arrangement of thin film resistors, capacitors and inductors on a suitable substrate.

Mounting Discrete Components

The active devices required in most circuits are obtained in thin film technology by using discrete semiconductor diodes and transistors as mentioned previously. However there are various methods of mounting them on to the substrate. Either they are attached as complete devices, although this is very rare, or they are supplied to the film manufacturer in an unencapsulated form. Three such forms are shown in Fig. 3: these are the flip chip, tag chip and leadless inverted device (LID). They are soldered into place after all the passive components have been deposited on to the substrate. Finally the circuit is encapsulated.

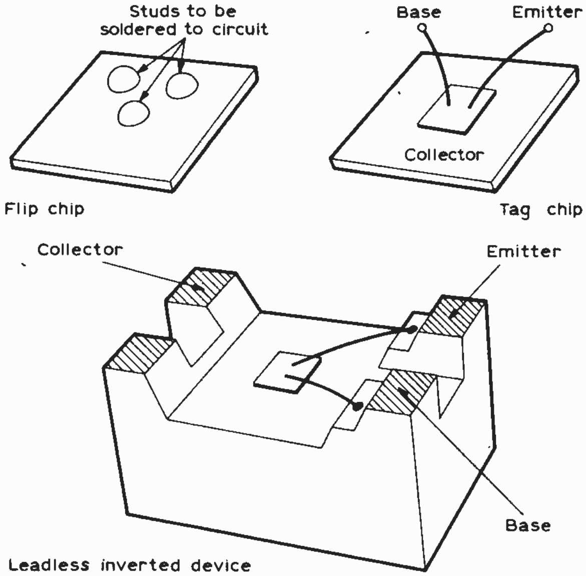

Fig. 3: Three types of device construction for use with thin film circuits.

Thick Film Circuits

A variation on the thin film circuit is the thick film circuit. The essential difference between the two types is not so much in the thickness but in the method of manufacture of the circuit. Thin films are deposited by evaporation of metal whilst thick films are screen printed on to the substrate using special inks which form conductive layers after they have been baked. The advantage of this system is one of cost as using this technique it is possible to mass produce the film circuits. However they have disadvantages in that the accuracy of the components is several times worse with thick film circuits than it is with the thin film equivalents. This is because of the diffusion of ink which takes place during printing and baking and because of the variation in the quality of ink between different circuits. Nevertheless the thick film circuit has sufficient economic advantage to ensure that it will be here for some time to come.

Advantages and Disadvantages

What are the relative advantages and disadvantages of film and silicon integrated circuits? Firstly silicon integrated circuits are considerably cheaper to make in large quantities than film circuits. They are capable of more variety since virtually all components can either be produced on the semiconductor chip or else they can be simulated by the use of other components as in the active filter described previously. Secondly film circuits have far better isolation properties, alleviating the need for special techniques to be applied. Their cost is comparable with the cost of discrete components and it is possible to provide more variety of resistors and capacitors.

Hybrid ICs

A third form of integrated circuit is the "hybrid integrated circuit" or "chip circuit." These are formed by producing all the components in discrete semiconductor form and connecting them with fine wires. This provides the isolation of the film circuit with the ease of production of the semiconductor device. Another advantage of the chip system is that small quantity orders can be met at much lower cost. Several manufacturers are now producing complete film circuits with functions similar to those of silicon integrated circuits but with better properties as regards temperature stability, isolation and specification tolerances.

Conclusion

In this series of articles I have tried to show the enormous range of semiconductor devices which are now available to the circuit designer and to the amateur. Although space has been somewhat limited I have tried to point out the essential mechanisms in the manufacture and operation of the devices and a little of their relative advantages. Only occasionally have I been able to give any specific applications but I trust readers will find this information elsewhere and hope that having read this and other more fully explained texts on these devices they will be able to design their own circuits knowing the limitations imposed on them by the devices themselves. ■

VOX CONTROL UNIT

S. G. WOOD
G5UJ

IT is perhaps not too well known that a simple but effective Vox control unit can be incorporated into almost any transmitter using only a handful of components. Apart from the zener diode, most constructors will probably have the components in their junk boxes.

Basically the Vox unit consists of only four items: a 470kΩ log. potentiometer, a fairly sensitive relay, a capacitor of about 50μF (its actual value will depend on the desired drop-out period) and a zener diode. The actual zener used in the prototype is a type MZ27 and the circuit is based around this one. Operation is as follows: VR1 is advanced until the relay just closes and is then backed off very slightly until it opens. A short space of time must be allowed for the delay in drop-out caused by the holding action of C1, this delay being necessary to prevent the relay from following the peaks of speech which occur when the transmitter is modulated.

Conduction of the zener is brought about by these modulation peaks adding to the d.c. level exceeding the zener voltage and so actuating the relay. When the basic circuit was applied to the authors transmitter it was found that the audio voltage required to operate the Vox unit detracted overmuch from the voltage required to drive the following audio stage. Since it was not possible to 'tap-off' the requisite feed from a further stage the circuit shown in Fig. 1 was evolved. It will be seen in this particular case a double triode was used, one half being used as a voltage amplifier for the microphone whilst the second half is used solely for the operation of the Vox circuit; in this case the circuit solved this problem and it worked perfectly.

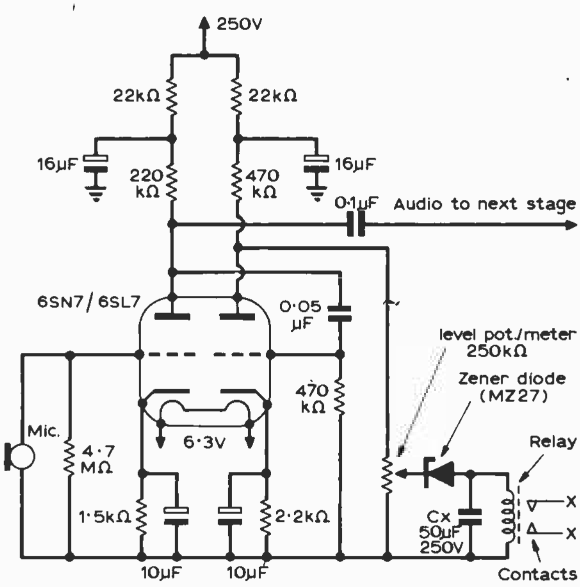

Fig. 1: The circuit of the Vox Control Unit.

The relay can be a G.P.O. '3000' type with an operating current of between 5-10mA although one of the popular plug-in types manufactured by Omron, Siemens or Keyswitch would be suitable. ■

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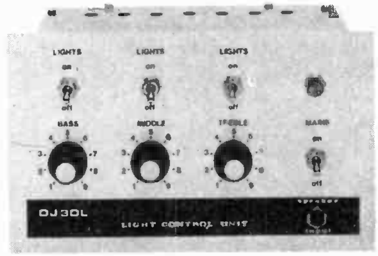

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METAL LOCATOR

HAL MOORSHEAD

This article describes the theory of metal detection and gives realistic assessment of the performance expected. A practical circuit and constructional details are also given.

BEFORE even explaining the function of this project it is important to place home constructed metal detectors in perspective. They are great fun and within their limitations very useful but they are not practical for any but the most rudimentary form of treasure hunting. Using the techniques described here, and another technique described later, a maximum of about 18in. is the greatest detection range under ideal conditions and this is reduced to about 1in. under difficult ones.

The author has seen great claims made for the type of circuit used here but this has never been borne out in practice. Certainly there are metal detectors made which are very much better than the one shown but they cost hundreds of pounds and require great skill and experience to operate. The cost of the project here is unlikely to exceed 50s. including the headphones.

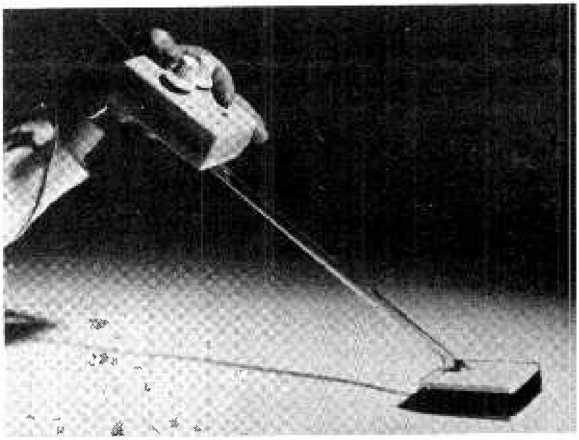
However even with the limitations mentioned, the finished project has considerable uses. Tracing house wiring is the most practical but it can also provide endless hours of fun and is easily adapted to a variety of games for fête side-shows etc.

METAL DETECTION THEORY

There are two common ways in which metal detectors work. The less common and more difficult type (from the point of view of construction) is to have an audio oscillator which relies on the feedback to maintain oscillation being connected through two coils at right-angles to each other. The gain of the oscillator is set so that oscillation is not quite achieved. When the coils are moved into the proximity of an object—especially a metal one—the coupling between the coils is increased causing oscillation to start.

The second more common type makes use of two oscillators, one of which is at a fixed frequency. The second oscillator is tuned near the frequency of first but its inductance takes the form of a search coil. When this comes into the proximity of some material which increases its inductance the frequency alters and beats with the reference oscillator, producing a beat note in the form of an audible tone whose frequency (but not intensity) varies with the inductance of the search coil.

The limitations of this type of detector are governed by the fact that *any* material can vary the inductance although metals have a very much



The prototype of the metal locator.

greater effect than others. A large stone, however, will produce a similar effect to a small nail and it will be quickly appreciated that searching for materials in anything but a few inches of earth is frustrated by many other effects.

The frequencies of the oscillators are not too critical but must lie between about 100kHz and 1MHz. Below 100kHz it is hard to detect the change in note since a 0·5% increase in inductance for instance will alter the frequency by only a few Hertz. Above 1MHz almost anything will change the inductance enough to send the beat note way out of audio range since a 0·5% change will have a considerable effect.

The reference frequency chosen was approximately 450kHz, or in other words the commonest i.f. frequency; this has several advantages. First, an i.f. transformer can be used to produce the reference frequency, secondly the secondary of the transformer can be used as the take-off point for the audio amplifier thus providing a good impedance match and thirdly this frequency enables a standard radio set to be used instead of two of the stages shown. The metal detector circuit shown is self-contained but a simpler version will be described later.

THE CIRCUIT

L1 is the search coil and is connected into a Hartley oscillator with a 250pF trimmer as the tuning capacitor, C1 as the feedback capacitor and R1 acting as the base bias resistor. The tuning capacitor is necessary since the frequency has to be tuned very closely to that of the reference oscillator and it can take account of strays that increase the inductance; In this way the background can be compensated for. The frequency must of course be set at the beginning of each search.

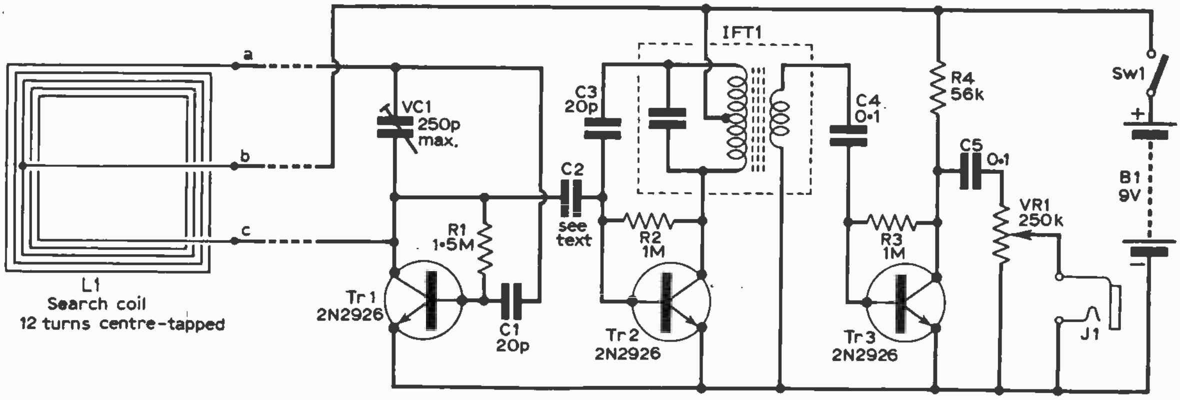


Fig. 1: The complete circuit of the metal locator. Note that C2 is not a physical component as it is stray capacitance; it is drawn here to simplify the explanation.

The i.f. transformer, Tr2, C3 and R2 are also connected to form a Hartley oscillator, the secondary of the i.f. transformer (in which the beat note is developed) couples to the simple amplifier comprising Tr3 with associated bias resistors etc. The output is fed to the volume control. Headphones—preferably good ones with an impedance of 2000Ω—are plugged into the jack to monitor the beat note.

The coupling capacitor which connects the output of Tr1 to the base of Tr2 needs some explanation. This coupling has to be very, very small otherwise one oscillator would trigger the other, clamping the two together. C2 was found unnecessary in practice and the loose coupling relied purely on strays.

CONSTRUCTION

All the components, apart from the search coil, are fitted into a plastic soap box and are fixed to its lid. The majority of the components are fixed to a small piece of Veroboard, 0·15in. matrix type, 6×12 holes; the actual layout is however uncritical.

The 250pF capacitor is of the postage stamp compressor type. To make use of this it is necessary to remove the screw used for compressing the vanes and replace this with a screw of the same thread but one inch long; this will enable the knob to be fitted.

The search coil consists of twelve turns of enamelled copper wire, centre tapped, wound around a 3in. square plastic box. The gauge of the wire is not very important—about 28 s.w.g. is right. The size of the box is not very important as a considerable amount of latitude is allowed for in tuning to bring it to the correct frequency. If a larger sized box is available fewer turns are needed, with a smaller one more turns. A plastic box is not essential and if difficult to obtain a 3in. square of wood about 1in. thick will do as an alternative. The windings around the former—whether it be plastic or wood—should be neat and tight and when finished should be covered with adhesive plastic tape or insulating tape.

The wires then run up a length of non-metallic tube which is connected at an angle of about 45° to the soap box which is clamped to the other end. If a plastic tube is not available then wooden doweling of ½in. diameter will be a good substitute.

If the wires are run up through the tube a small amount of glue should be run down it to stop the wires flapping about; if doweling is used then the wires should be firmly taped to the side.

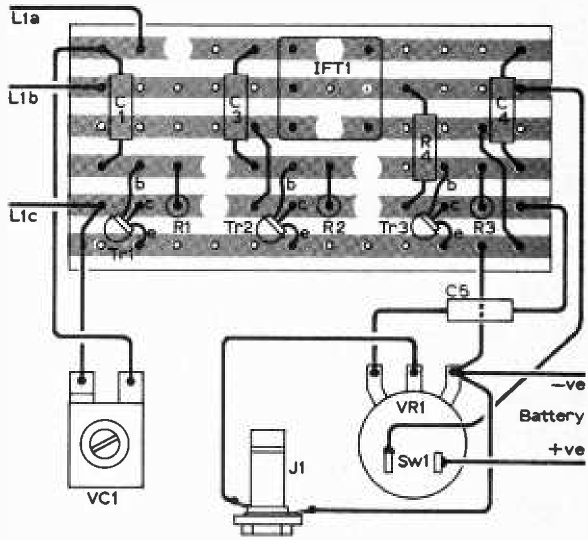
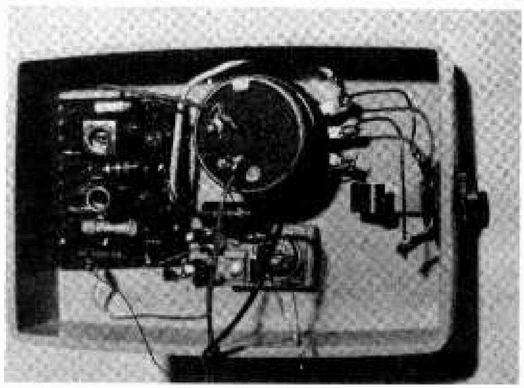


Fig. 2: The component layout inside the soap box.



An interior view of the prototype.

It is very important that the wires associated with the search coil are really firmly held for the detector makes use of the change in inductance and these are in the order of fractions of a per cent and loose wires or turns can easily cause this much when flapping about.

Continued on page 894

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EALING & DISTRICT AMATEUR RADIO SOCIETY G3UUP

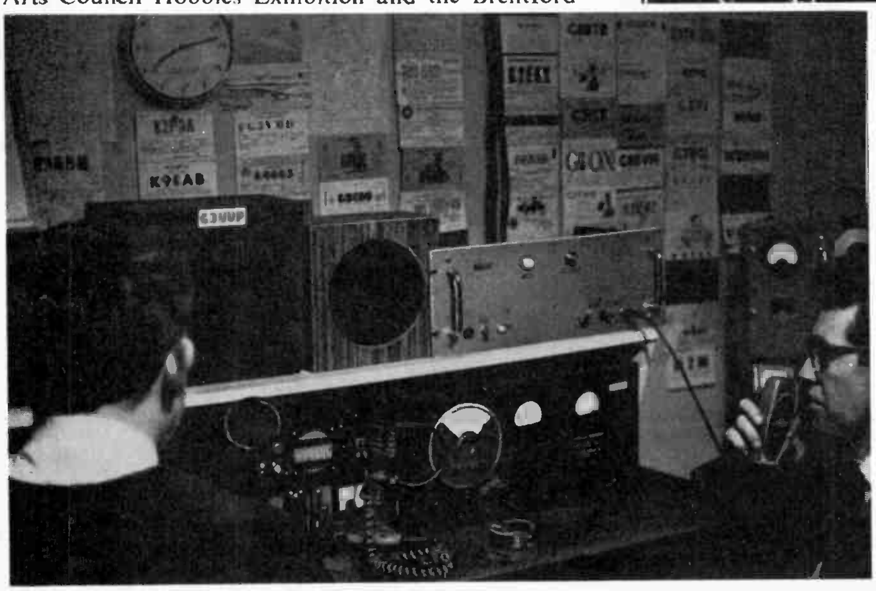
A LOT of water has flowed under the proverbial bridge since the Ealing and District Amateur Radio Society was formed over four years ago in September 1965. After pestering the life out of the local Council to help provide club rooms for eight very enthusiastic Hams, we obtained our present QTH. This is quite unique and a "Palace" when one thinks of some of the very poor conditions in which some Clubs have to operate!

One room, about the size of an average living room is the actual shack in which are housed the stores, benches, tools and equipment. A larger room about twice the size of the shack adjoins and is used for lectures, filmshows, etc. These rooms are the only ones upstairs in the building, which looks something like a sports pavilion with a flat roof which is a radio Amateur's delight for putting up an antenna farm for which there are no restrictions.

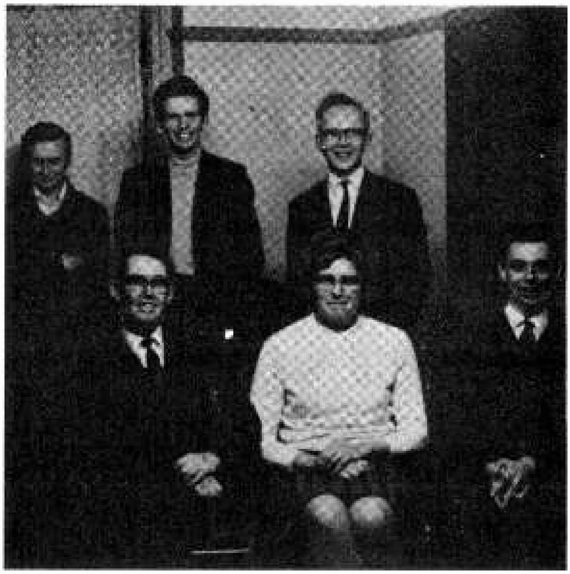
The Society started off with the usual Top Band rig with 132ft. end-fed wire which produced very fair results. Now most of the members are mobile on 4m. with a couple on 2 and 160m.

Whilst some of the SWL's have obtained their licences with the help of the Society, we have had two weddings amongst our celebrations, G3SGS and G3UDV. G3UDV married the daughter of G3TXB.

One side-line of the Society is putting on exhibition stations, three regulars being the Chiswick Town Exhibition for Adult Education, the Ealing Arts Council Hobbies Exhibition and the Brentford



The top picture shows the main tent at the RSGB Amateur Radio Mobile Rally 1969 held at Woburn Abbey.
The photograph above shows the Ealing and District Amateur Radio Society stand which was situated in the main tent. Here members sell donated components and gear to aid the Society funds.
The picture to the left shows the Society station with Bern., G3KLK, (left) and Bill, G3SGT, on the mic.



No, it's not the Ealing and District Amateur Radio Football Club with three reserves, it's a few of the members that we persuaded to say "cheese" when we went along to the Society QTH.

Evening Institute for the RAE and budding Hams.

The latest activity is attending mobile rallies around the London area and selling small components to raise funds for the Society which are still very healthy after buying a much-needed 230V 1kW petrol generator for our many field days.

We are a small Society but members are really keen. Over the four years membership has grown and more equipment has been acquired—much of this has been donated by members. With it, grew the Society's funds which started at £8—each founder-member donating £1 to get the Group under way. It would be grossly unfair to mention any names of dedicated members, because there have been so many that have made this Society the success that it is.

After the Ealing and District Amateur Radio Society was in full swing, with lectures and film-shows on anything from radio to old-time car racing, we began to think about weekend activities.

The Society went out on mad weekends (not dirty ones) everyone taking with them all types of equipment from the home QTH to operate /P. The Devil's Punch Bowl in Surrey was the first target which operated on 160, 80, 40 and 2m. with the YL's and XYL's cooking bangers and bacon and brewing the tea.

Many v.h.f. contests were and still are entered for, with excellent results. We have one prize award for the first-ever recorded 13cm. contact at v.h.f. NFD by G3THQ.

There are about thirty members at Ealing who are active from the Society on 2, 4 and 160m. under the call sign G3UUP.

This year, the Society will be holding a Mobile Rally at the Hanwell Community Association on May 10th.

It is thought that this will be the first time a rally has been held in London. The Automobile Association will do the signposting and will have their own exhibition caravan at the site. The Rally address will be: Hanwell Community Association, Westcott Crescent, Hanwell, London, W.7.

Meetings of the Ealing and District Amateur Radio Society are held every Tuesday evening at the Community Centre, 71a Northcroft Road, London, W.13.

Further details about the Society and the Mobile Rally may be obtained by sending a s.a.e. to the Secretary, Bill Teale, G3SGT, 16 Whitestile Road, Brentford, Middlesex.

NOTE TO RADIO CLUB SECRETARIES
If you would like to see your Club featured in PRACTICAL WIRELESS, drop a line to Colin R. Riches, IPC Magazines Ltd., Fleetway House, Farringdon Street, London, E.C.4.

TAKE 20

JULIAN ANDERSON

No. 11
NOVELTY LIGHT FLASHER

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

THE multivibrator is one of the most widely used forms of oscillator and can be used for a variety of purposes. It is also one of the simplest forms and in this particular circuit we are making it operate small 0·75W bulbs, flashing these at a frequency of about 1Hz, the lights flashing alternately.

THE MULTIVIBRATOR

The multivibrator works as follows: one of the transistors, when a voltage is applied to the circuit, will pass slightly more current than the other; for the sake of explanation we will assume that this is Tr1 but of course it doesn't matter which. Since it is passing more current its collector voltage will drop. This change will be fed to the base of Tr2 causing it to pass less current and so its collector voltage will rise. This action will cause Tr1 to be further switched on and this will go on until Tr1 is completely switched on and Tr2 completely off. C1 then charges up through R2 until the base of Tr2 becomes positive enough to conduct, switching it on and in turn switching off Tr1—and so on.

As will be seen from the above, values of the resistors and capacitors affect the switching rate and by altering these it is an easy matter to choose your own flashing interval. To increase the rate decrease the values of R1, R2, C1 or C2 and to reduce the rate increase any of the values.

If we choose values so that the switching rate falls within the audio range and substitute resistors of 330Ω for the bulbs we could tap off the note from either collector via a capacitor. However in the form shown we are using the changing currents through the transistors to switch the bulbs on and off.

If only one flashing bulb is required a 330Ω resistor can substitute for the other bulb. The current consumption is fairly low using the specified bulbs—between 30 and 40mA and most layer batteries will provide this.

As for uses it is up to you, but flashing lights make the ideal warning device. If used as such one of the bulbs may be replaced by an 80Ω loudspeaker or a lower impedance type with matching transformer to provide audible plops as well as having one flashing light.

CONSTRUCTION

A suitable Veroboard layout is shown in Fig. 2 but of course the construction is uncritical; in the one shown none of the copper strips need be broken.

Make sure you use the specified bulbs as most types are unsuitable; these are a Radiospares product available from most component stockists and although they are rated at 14V they give a very bright emission from only 9V. ■

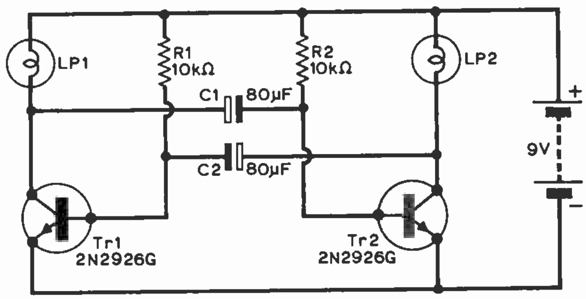


Fig. 1: The circuit of the light flasher.

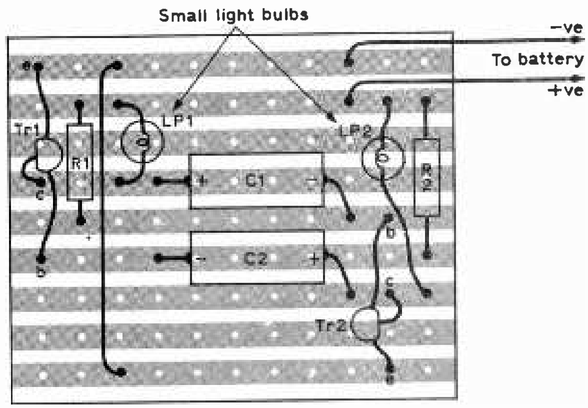


Fig. 2: The component layout on a small piece of Veroboard.

★ components list

R1, R2	10k Ω ¼ watt, 10%	6d.
C1, C2	80µF 12V	3s. 0d.
Tr1, Tr2	2N2926G	5s. 0d.
LP1, LP2	Radiospares 'Lilliput' bulbs, 14V, 0·75W	5s. 0d.
Veroboard, Battery, Battery clips, etc.		5s. 0d.
		18s. 6d.

Next month's *Take 20* describes a simple lie detector which makes use of a multimeter. The circuit also is suitable for the measurement of very high resistance.

Metal Locator — *Continued from page 886*

The length of the connecting tube or dowel is uncritical and will depend on usage, but in the prototype 12in. was found to be a convenient length.

USE WITH A TRANSISTOR RADIO

The circuit can be simplified by using a transistor superhet having an i.f. of between 450 and 470kHz, if this is used the second and third stages are unnecessary (that is the reference oscillator and the audio amplifier). Since the circuit works on approximately the i.f. frequency it is only necessary to make the search oscillator work and beat with the i.f. in the receiver by placing it close to it. It is necessary to tune into a station and listen to the heterodyne produced.

INITIAL SETTING UP

A transistor radio is all that is necessary for setting up. Place the radio near the soap box with it tuned to a station and adjust the core on the i.f. transformer until a beat note is heard. Then move the radio near the search coil and adjust VC1 until a beat note is also heard. When the phones are plugged in and VC1 is slightly adjusted the note will be heard in the phones.

The metal detector will now work as soon as the search coil is moved towards a metal object. It takes a little bit of getting used to before the necessary skills are acquired, but with practice operation is simple.

Just one small practical point in conclusion. Your ears are much more sensitive to a frequency change around 200Hz than below or above and it is best to set the beat note in that region before starting the search. If the two oscillators are exactly together no change will be heard until the audible range is reached and this is probably about 80Hz in the case of normal headphones. ■

★ components list

Resistors

R1	1·5MΩ	R3	1MΩ
R2	1MΩ	R4	56kΩ

All resistors ¼ watt 10% types.
VR1 250kΩ log with switch.

Capacitors

C1	20pF	C4	0·1μF
C2	See text	C5	0·1μF
C3	20pF	VC1	250pF trimmer (Radiospares)

Semiconductors
Tr1, Tr2 and Tr3 2N2926G

Miscellaneous
L1, search coil, see text: IFT1, 465kHz i.f. transformer; J1, headphone jack socket; Veroboard 0·15in. matrix; Soap box; plastic tube, etc.

I.C. of the Month — *Continued from page 877*

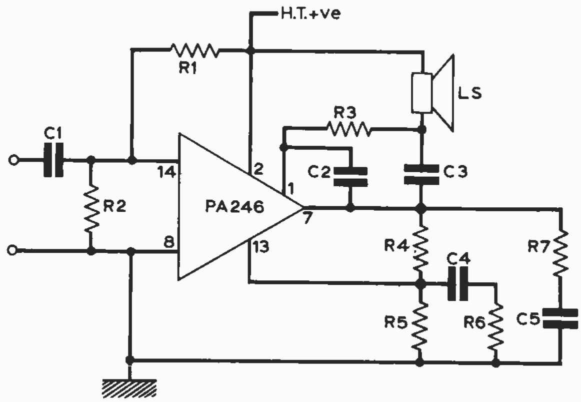


Fig. 2: Practical circuit for the PA246 with 5 watts audio output. Alternatively, the PA237 may be used but the audio output will be 2 watts. Capacitor C3 is an electrolytic—the plus side should be taken to the junction of R3 and the loudspeaker.

★ components list

Resistors:

R1	680kΩ	R5	82kΩ
R2	75kΩ	R6	6·8kΩ for max. freq. response. 0 for max gain.
R3	18kΩ		
R4	330kΩ	R7	22Ω

Capacitors:

C1	0·33μF	C4	4μF 25V
C2	0·001μF	C5	0·05μF
C3	500μF 25V		

Miscellaneous:
Loudspeaker, any 15Ω impedance type.
I.C. PA246 (PA237); General Electric Co. (U.S.A.)

a suitable amplifier circuit for use with the PA246; it should be preceeded by a conventional tone control and volume control circuit. The experienced constructor will find no difficulty in laying out a suitable printed circuit, or assembling a prototype on Veroboard with separate copper heat sinks. ■

BLUEPRINT SERVICE

We would like to draw readers' attention to the fact that the BLUEPRINT SERVICE has been discontinued and therefore no further BLUEPRINTS are available.

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PRACTICAL WIRELESS, MARCH 1970

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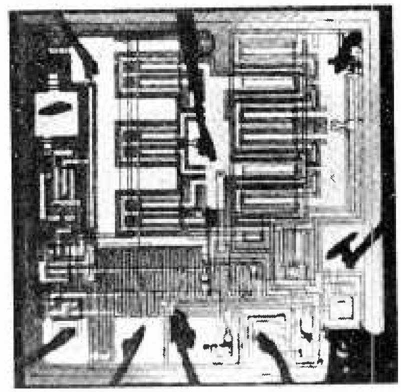
MONOLITHIC INTEGRATED CIRCUIT HIGH FIDELITY AMPLIFIER AND PRE-AMP



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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 feedback 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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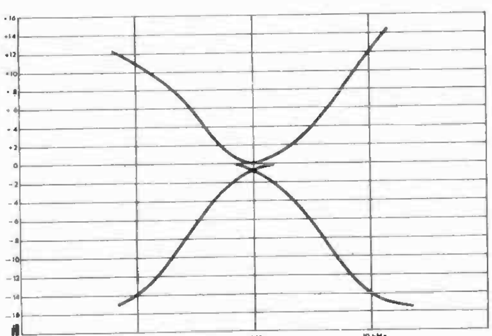

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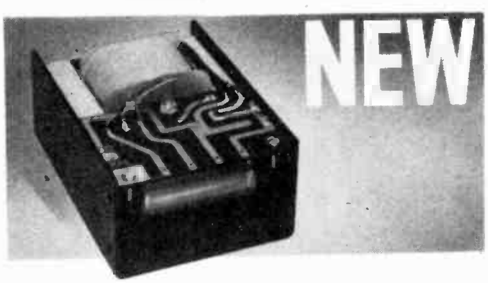

This attractive and completely new unit is intended for use with two new Z.30 amplifiers to provide the finest possible standards of stereo reproduction. Four press buttons and four rotary controls are used to provide on-off, three input selectors and Volume, Bass cut/boost, Treble cut/boost and Stereo balance. The on-off button also switches the power amplifiers. The front panel in brushed aluminium is flush mounted to the cabinet front, it being necessary only to drill holes to accommodate the controls. Rear adjustable brackets hold the chassis tight to the cabinet. The very latest ganged rotary controls are used to afford compactness and extra long working life free from noise.

The Stereo-60 may also be used with 2 IC-10's or any other high performance amplifiers.

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
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- Tone Controls—TREBLE +15 to —15dB at 10kHz. BASS +15 to —15dB at 100Hz.
- Power consumption 5mA.
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Q.16 Loudspeaker and Micromatic on next page.

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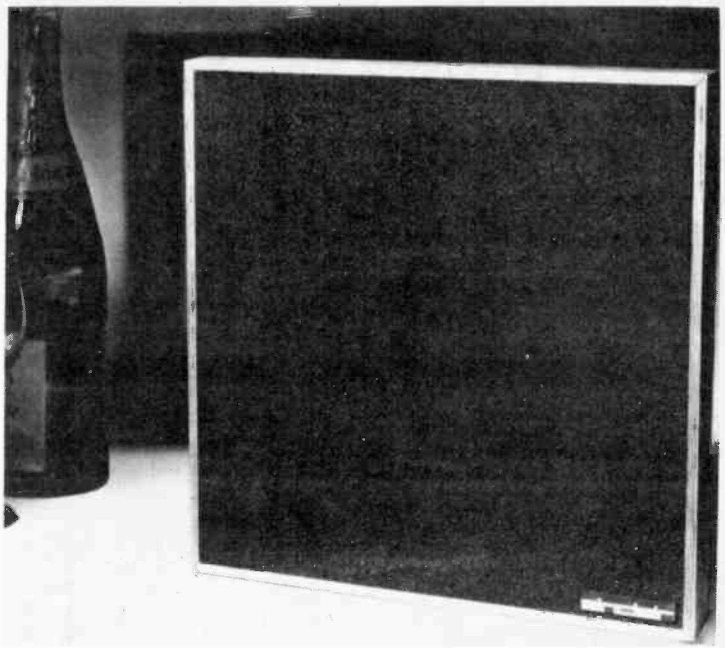

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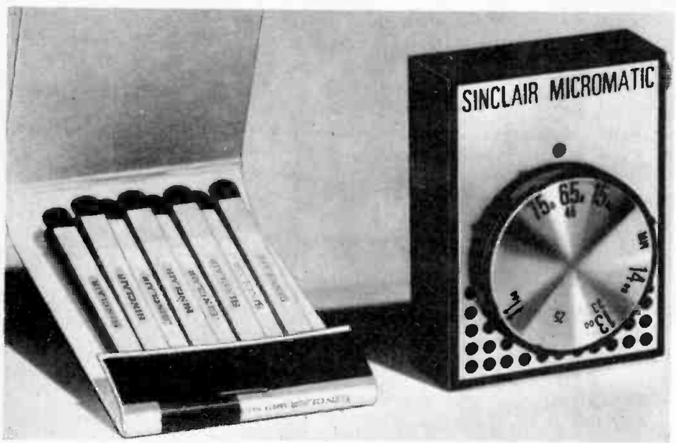

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C	1/8W	5%	4.7Ω–830KΩ	E24	2.5	2	1.75
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C	1/2W	5%	4.7Ω–10MΩ	E24	3	2.5	2.25
MO	1/2W	2%	10Ω–1MΩ	E24	9	8	7
C	1W	10%	4.2Ω–10MΩ	E12	6	5	4.5
WW	1W	10% + 1/20Ω	0.22Ω–3.3Ω	E12	15d all quantities		
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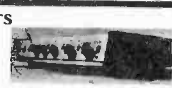
PEAK SOUND ENGLEFIELD KITS



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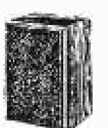

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8⅛″	6⅞″	1 1 0	1 6 6	1 11 3
10⅛″	7⅞″	1 8 6	1 15 6	1 18 9
12⅛″	3⅞″	1 1 0	1 6 6	1 11 0
12⅛″	5⅞″	1 8 0	1 14 0	1 17 6
12⅛″	8⅞″	1 16 0	2 3 0	2 7 3
14⅛″	3⅞″	1 5 0	1 11 6	1 14 0
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500	3/–	6/–	8/6	30/–
600	3/3	6/9	9/–	37/–
800	3/6	7/6	11/–	40/–
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